

# Identity and Access Management for Electric Utilities

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Includes Executive Summary (A); Approach, Architecture, and Security Characteristics (B); and How-To Guides (C)

**Jim McCarthy**  
**Don Faatz**  
**Harry Perper**  
**Chris Peloquin**  
**John Wiltberger**  
**Leah Kauffman**

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NIST SPECIAL PUBLICATION 1800-2

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*The MITRE Corporation  
McLean, VA*

Leah Kauffman, Editor-in-Chief  
*National Cybersecurity Center of Excellence  
Information Technology Laboratory*

July 2018



U.S. Department of Commerce  
*Wilbur Ross, Secretary*

National Institute of Standards and Technology  
*Walter G. Copan, Undersecretary of Commerce for Standards and Technology and Director*

# Identity and Access Management

## for Electric Utilities

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**Volume A:**  
**Executive Summary**

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# Executive Summary

- The National Cybersecurity Center of Excellence (NCCoE) developed an example solution that electric utilities can use to more securely and efficiently manage access to the networked devices and facilities on which power generation, transmission, and distribution depend.
- The security characteristics in this access management platform are informed by guidance and best practices from standards organizations, including the North American Electric Reliability Corporation's (NERC's) Critical Infrastructure Protection (CIP) Version 5 standards.
- This National Institute of Standards and Technology (NIST) Cybersecurity Practice Guide uses commercially available products that can be included alongside your current products in your existing infrastructure. The integration of these products provides a converged view of all users within the electric utility's operational technology (OT) systems and information technology (IT) systems, as well as access to buildings and other facilities.
- The example solution is packaged as a "How-To" guide that demonstrates the implementation of standards-based cybersecurity technologies in the real world. The guide can help organizations to gain efficiencies in access management, while saving them research and proof-of-concept costs.

## CHALLENGE

As the electric power industry upgrades infrastructure to adopt emerging technologies, utilities are also increasing OT and IT convergence. This allows more technologies, devices, and systems to connect to the grid to improve efficiency, provide access to data often held in silos, and enhance productivity.

This convergence challenges OT and IT departments to efficiently and effectively manage identities and access. Many utilities run identity and access management (IdAM) systems that are fragmented and controlled by numerous departments. Several negative outcomes can result: a lack of overall traceability and accountability regarding who has access to both critical and noncritical assets, an increased risk of attack and service disruption, and an inability to identify potential sources of a problem or attack.

To better protect power generation, transmission, and distribution, electric utilities need to be able to control and secure access to their resources, including OT systems, buildings, equipment, and IT systems. IdAM systems for these assets often exist in silos, and employees who manage these systems lack methods to effectively coordinate access to devices and facilities across these silos. This inefficient process can result in security risks for electric utilities, according to our electric sector stakeholders.

In collaboration with experts from the energy sector (mainly electric power companies) and those who provide equipment and services to them, we developed a scenario to describe a security challenge based on normal day-to-day business operations. The scenario centers on a utility technician with access to several substations and to remote terminal units that are connected to the utility's network in those substations. If the technician moves out of the region and resigns, a consolidated IdAM system can quickly and consistently remove the technician's access to all facilities and systems. This provides the timely management of access and reduces the potential for errors. Electric utilities need this ability to provide the right person with the right degree of access to the right resources at the right time.



## SOLUTION

To help the energy sector address this challenge, we developed an example solution that electric utilities can use to more securely and efficiently manage access to the networked devices and facilities on which power generation, transmission, and distribution depend. Our solution uses commercially available products to demonstrate a converged IdAM platform, providing a comprehensive view of users across all of the entity's business and utility operations silos, and the access rights granted to those users. This platform is described in this NIST cybersecurity *Identity and Access Management* practice guide.

Electric utilities can use some or all of the guide to implement a converged IdAM system by referencing related NIST guidance and industry standards, including NERC CIP Version 5. Commercial, standards-based products, like the ones that we used, are easily available and interoperable with commonly used IT infrastructure and investments. In our lab at the NCCoE, which is part of NIST, we built an environment that simulates an electric utility's architecture. This architecture includes the typical technology silos found in a utility (such as operational technology, IT, and physical access control systems).

The practice guide includes three versions of an end-to-end identity management solution that provides access control capabilities to reduce opportunities for cyber attack or human error. It accounts for the risks that converged control can present. In this guide, we show how an electric utility can implement a converged IdAM platform, using multiple commercially available products, to provide a comprehensive view of all users within the electric utility, across all silos, and of the access rights that they have been granted.

The guide:

- maps security characteristics to guidance and best practices from NIST and other standards organizations, including NERC CIP Version 5 standards
- provides a detailed example solution with capabilities that address security controls, and demonstrates a modular approach that uses different products to achieve the same results
- includes instructions for implementers and security engineers, including examples of all of the necessary components and installation, configuration, and integration
- uses products that are readily available and interoperable with your existing IT infrastructure and investments
- can meet the needs of electric utilities of all sizes, including corporate and regional business offices, power generation plants, and substations

While the NCCoE used a suite of commercial products to address this challenge, this guide does not endorse these particular products, nor does it guarantee compliance with any regulatory initiatives. Your organization's information security experts should identify the products that will best integrate with your existing tools and IT system infrastructure. Your organization can adopt this solution or one that adheres to these guidelines in whole, or you can use this guide as a starting point for tailoring and implementing parts of a solution.

## BENEFITS

The NCCoE's practice guide to *Identity and Access Management for Electric Utilities* can help your organization:

- adopt products and capabilities on a component-by-component basis, or as a whole, thereby minimizing impact to the enterprise and existing infrastructure
- reduce the risk of malicious or untrained people gaining unauthorized access to critical infrastructure components and interfering with their operation, thereby lowering the overall business risk
- allow for rapid provisioning and de-provisioning of access from a converged platform, so that personnel can spend more time on other critical tasks
- improve situational awareness: proper access and authorization can be confirmed through the use of a single, converged solution
- improve the security posture by tracking and auditing access requests and other IdAM activity across all networks
- enhance the productivity of employees and speed delivery of services, and support oversight of resources

## SHARE YOUR FEEDBACK

You can view or download the guide at <https://www.nccoe.nist.gov/projects/use-cases/idam>. Help the NCCoE make this guide better by sharing your thoughts with us as you read the guide. If you adopt this solution for your own organization, please share your experience and advice with us. We recognize that technical solutions alone will not fully enable the benefits of our solution, so we encourage organizations to share lessons learned and best practices for transforming the processes associated with implementing this guide.

To provide comments or to learn more by arranging a demonstration of this example implementation, contact the NCCoE at [energy\\_nccoe@nist.gov](mailto:energy_nccoe@nist.gov).

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## TECHNOLOGY PARTNERS/COLLABORATORS

Organizations participating in this project submitted their capabilities in response to an open call in the Federal Register for all sources of relevant security capabilities from academia and industry (vendors and integrators). The following respondents with relevant capabilities or product components (identified as "Technology Partners/Collaborators" herein) signed a Cooperative Research and Development Agreement to collaborate with NIST in a consortium to build this example solution.



Certain commercial entities, equipment, products, or materials may be identified by name or company logo or other insignia in order to acknowledge their participation in this collaboration or to describe an experimental procedure or concept adequately. Such identification is not intended to imply special

status or relationship with NIST or recommendation or endorsement by NIST or NCCoE; neither is it intended to imply that the entities, equipment, products, or materials are necessarily the best available for the purpose.

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The National Cybersecurity Center of Excellence (NCCoE), a part of the National Institute of Standards and Technology (NIST), is a collaborative hub where industry organizations, government agencies, and academic institutions work together to address businesses' most pressing cybersecurity challenges. Through this collaboration, the NCCoE develops modular, easily adaptable example cybersecurity solutions demonstrating how to apply standards and best practices

**LEARN MORE**

Visit <https://www.nccoe.nist.gov>  
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# Identity and Access Management

## for Electric Utilities

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**Volume B:**  
**Approach, Architecture, and Security Characteristics**

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## DISCLAIMER

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National Institute of Standards and Technology Special Publication 1800-2B, Natl. Inst. Stand. Technol. Spec. Publ. 1800-2B, 99 pages, (July 2018), CODEN: NSPUE2

## FEEDBACK

As a private-public partnership, we are always seeking feedback on our Practice Guides. We are particularly interested in seeing how businesses apply NCCoE reference designs in the real world. If you have implemented the reference design, or have questions about applying it in your environment, please email us at [energy\\_nccoe@nist.gov](mailto:energy_nccoe@nist.gov).

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## NATIONAL CYBERSECURITY CENTER OF EXCELLENCE

The National Cybersecurity Center of Excellence (NCCoE), a part of the National Institute of Standards and Technology (NIST), is a collaborative hub where industry organizations, government agencies, and academic institutions work together to address businesses' most pressing cybersecurity issues. This public-private partnership enables the creation of practical cybersecurity solutions for specific industries, as well as for broad, cross-sector technology challenges. Through consortia under Cooperative Research and Development Agreements (CRADAs), including technology partners—from Fortune 50 market leaders to smaller companies specializing in IT security—the NCCoE applies standards and best practices to develop modular, easily adaptable example cybersecurity solutions using commercially available technology. The NCCoE documents these example solutions in the NIST Special Publication 1800 series, which maps capabilities to the NIST Cyber Security Framework [1] and details the steps needed for another entity to recreate the example solution. The NCCoE was established in 2012 by NIST in partnership with the State of Maryland and Montgomery County, Md.

To learn more about the NCCoE, visit <https://nccoe.nist.gov>. To learn more about NIST, visit <https://www.nist.gov>.

## NIST CYBERSECURITY PRACTICE GUIDES

NIST Cybersecurity Practice Guides (Special Publication Series 1800) target specific cybersecurity challenges in the public and private sectors. They are practical, user-friendly guides that facilitate the adoption of standards-based approaches to cybersecurity. They show members of the information security community how to implement example solutions that help them align more easily with relevant standards and best practices and provide users with the materials lists, configuration files, and other information they need to implement a similar approach.

The documents in this series describe example implementations of cybersecurity practices that businesses and other organizations may voluntarily adopt. These documents do not describe regulations or mandatory practices, nor do they carry statutory authority.

## ABSTRACT

To protect power generation, transmission, and distribution, energy companies need to control physical and logical access to their resources, including buildings, equipment, information technology (IT), and operational technology (OT). They must authenticate authorized individuals to the devices and facilities to which the companies are giving access rights with a high degree of certainty. In addition, they need to enforce access-control policies (e.g., allow, deny, inquire further) consistently, uniformly, and quickly across all of their resources. This project resulted from direct dialog among NCCoE staff and members of the electricity subsector, mainly from electric power companies and those who provide equipment and/or services to them. The goal of this project is to demonstrate a converged, standards-based technical approach that unifies identity and access management (IdAM) functions across OT networks, physical access control systems (PACS), and IT systems. These networks often operate independently, which can result in identity and access information disparity, increased costs, inefficiencies, and a loss of capacity and service delivery capability. Also, these networks support different infrastructures, each with unique security risks. The converged IdAM solution must be constructed to effectively address the highest-risk infrastructure. This guide describes our collaborative efforts with technology providers and

electric-company stakeholders to address the security challenges that energy providers face in the core function of IdAM. This guide offers a technical approach to meeting the challenge and also incorporates a business-value mindset by identifying the strategic considerations involved in implementing new technologies. This NIST Cybersecurity Practice Guide provides a modular, open, end-to-end example solution that can be tailored and implemented by energy providers of varying sizes and levels of IT sophistication. It shows energy providers how we met the challenge by using open-source and commercially available tools and technologies that are consistent with cybersecurity standards. The use-case scenario is based on a normal day-to-day business operational scenario that provides the underlying impetus for the functionality presented in this guide. While the reference solution was demonstrated with a certain suite of products, this guide does not endorse these specific products. Instead, this guide presents the characteristics and capabilities that an organization's security experts can use to identify similar standards-based products that can be integrated quickly and cost-effectively with an energy provider's existing tools and infrastructure.

## KEYWORDS

*cyber, physical, and operational security; cybersecurity; electricity subsector; energy sector; identity and access management; information technology*

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Danny Vitale	XTec

The Technology Partners/Collaborators who participated in this build submitted their capabilities in response to a notice in the Federal Register. Respondents with relevant capabilities or product components were invited to sign a Cooperative Research and Development Agreement (CRADA) with NIST, allowing them to participate in a consortium to build this example solution. We worked with:

Technology Partner/Collaborator	Build Involvement
<a href="#">AlertEnterprise</a>	User access authorization provisioning
<a href="#">CA Technologies</a>	IdAM workflow, provisions identities and authorizations to Active Directory instances
<a href="#">Cisco Systems</a>	Network Access control
<a href="#">GlobalSign</a>	Provides North American Energy Standards Board (NAESB)-compliant X.509 certificates
<a href="#">Mount Airey Group (MAG)</a>	Manages attributes that control access to high-value transactions
<a href="#">Radiflow</a>	Controls communication among industrial control system (ICS) devices



Technology Partner/Collaborator	Build Involvement
<a href="#">RSA</a>	IdAM workflow, provisions identities and authorizations to Active Directory instances
<a href="#">RS2 Technologies</a>	Controls physical access
<a href="#">Schneider Electric</a>	Controls access to devices in the ICS / Supervisory Control and Data Acquisition (SCADA) network
<a href="#">TDi Technologies</a>	Controls and logs access to ICS devices by people (ICS engineers and technicians)
<a href="#">XTec</a>	Provides Personal Identity Verification Interoperable (PIV-I) smart-card credentials and a physical-access-control capability using the smart card

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# 1 Summary

When the National Cybersecurity Center of Excellence (NCCoE) met with electricity subsector stakeholders, they told us they need a more secure and efficient way to protect access to networked devices and facilities. The NCCoE developed an example solution to this problem by using commercially available products.

The NCCoE's approach provides a converged access management system that reduces the risk of disruption of service by reducing opportunities for cyber attack or human error.

This example solution is packaged as a "How-To" guide that demonstrates how to implement standards-based cybersecurity technologies in the real world, based on risk analysis and regulatory requirements. This guide helps organizations to gain efficiencies in identity and access management (IdAM), while saving them research and proof of concept costs.

## 1.1 Challenge

As the electric power industry upgrades older infrastructure to take advantage of emerging technologies, utilities are also moving toward greater operational technology (OT) and information technology (IT) convergence. This allows greater numbers of technologies, devices, and systems to connect to the grid to improve efficiency, provide access to data often held in silos, and enhance productivity.

This convergence increases the challenge to OT and IT departments in efficiently and effectively managing identities and access. Many utilities run IdAM systems that are fragmented and controlled by numerous departments. Several negative outcomes can result from this: a lack of overall traceability and accountability regarding who has access to both critical and noncritical assets, an increased risk of attack and service disruption, and an inability to identify potential sources of a problem or attack.

To better protect power generation, transmission, and distribution, electric utilities need to be able to control and secure access to their resources, including OT systems, buildings, equipment, and IT systems. IdAM systems for these assets often exist in silos, and employees who manage these systems lack methods to effectively coordinate access to devices and facilities across these silos. This is inefficient and can result in security risks for electric utilities, according to our electric subsector stakeholders.

In collaboration with experts from the energy sector (mainly electric power companies) and those who provide equipment and services to them, we developed a use-case scenario to describe a security challenge based on normal day-to-day business operations. The scenario centers on a utility technician with access to several substations and to remote terminal units connected to the utility's network in those substations. The technician moves out of the region and resigns. A converged IdAM system can quickly and consistently remove the technician's access to all facilities and systems. This provides the

timely management of access and reduces the potential for errors. Electric utilities need this ability to provide the right person with the right degree of access to the right resources at the right time.

## 1.2 Solution

To help the energy sector address this cybersecurity challenge, we developed an example solution that electric utilities can use to more securely and efficiently manage access to the networked devices and facilities on which power generation, transmission, and distribution depend. Our solution uses commercially available products to demonstrate a converged IdAM platform. This platform provides a comprehensive view of users across all of the entity's business and utility operations silos, and the access rights granted those users. This converged IdAM platform is described in this National Institute of Standards and Technology (NIST) cybersecurity Identity and Access Management practice guide.

Electric utilities can use some or all of this guide to implement a converged IdAM system by referencing related NIST guidance and industry standards, including the North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection ([CIP](#)) Version 5 standards. Commercial, standards-based products, like the ones that we used, are readily available and interoperable with commonly used IT infrastructure and investments.

In our lab at the NCCoE, which is part of NIST, we built an environment that simulates an electric utility's architecture. This architecture includes the typical technology silos found in a utility (such as OT, IT, and physical access control systems [PACS]).

This practice guide includes three versions of an end-to-end identity management solution that provides access-control capabilities to reduce opportunities for cyber attack or human error. It also takes into account the risks that converged control can present. In this guide, we show how an electric utility can implement a converged IdAM platform, using multiple commercially available products, to provide a comprehensive view of all users within the electric utility, across all silos, and of the access rights that they have been granted.

This guide:

- maps security characteristics to guidance and best practices from NIST and other standards organizations, including NERC CIP Version 5 standards
- provides a detailed example solution with capabilities that address security controls
- includes a demonstrated approach that is modular and can be implemented using different products to achieve the same results
- includes instructions for implementers and security engineers, including examples of all of the necessary components and installation, configuration, and integration

- uses products that are readily available and interoperable with your existing IT infrastructure and investments
- can meet the needs of electric utilities of all sizes, including corporate and regional business offices, power generation plants, and substations

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### 1.3 Benefits

The NCCoE's practice guide to Identity and Access Management for Electric Utilities can help your organization:

- adopt products and capabilities on a component-by-component basis, or as a whole, thereby minimizing impact to the enterprise and existing infrastructure
- reduce the risk of malicious or untrained people gaining unauthorized access to critical infrastructure components and interfering with their operation, thereby lowering the overall business risk
- allow for rapid provisioning and de-provisioning of access from a converged platform, so that personnel can spend more time on other critical tasks
- improve situational awareness: proper access and authorization can be confirmed through the use of a single, converged solution
- improve the security posture by tracking and auditing access requests and other IdAM activity across all networks
- enhance the productivity of employees and speed delivery of services, and support oversight of resources

## 2 How to Use This Guide

This NIST Cybersecurity Practice Guide demonstrates a standards-based example solution and provides users with the information that they need to replicate this approach to IdAM for electric utilities. This reference design is modular and can be deployed in whole or in parts.



This guide contains three volumes:

- NIST Special Publication (SP) 1800-2A: *Executive Summary*
- NIST SP 1800-2B: *Approach, Architecture, and Security Characteristics* – what we built and why **(you are here)**
- NIST SP 1800-2C: *How-To Guides* – instructions for building the example solution

Depending on your role in your organization, you might use this guide in different ways:

**Energy utility leaders, including chief security and technology officers** will be interested in the *Executive Summary* (NIST SP 1800-2A), which describes the:

- challenges enterprises face in implementing and using IdAM systems
- example solution built at the NCCoE
- benefits of adopting the example solution

**Technology or security program managers** who are concerned with how to identify, understand, assess, and mitigate risk, will be interested in this part of the guide, *NIST SP 1800-2B*, which describes what we did and why. The following sections will be of particular interest:

- [Section 4.4.3](#), Risk, provides a description of the risk analysis we performed
- [Section 4.4.4](#), Security Control Map, maps the security characteristics of this example solution to cybersecurity standards and best practices

You might share the *Executive Summary*, *NIST SP 1800-2A*, with your leadership team members to help them understand the importance of adopting standards-based IdAM for electric utilities.

**IT professionals** who want to implement an approach like this will find the whole practice guide useful. You can use the How-To portion of the guide, *NIST SP 1800-2C*, to replicate all or parts of the build created in our lab. The How-To guide provides specific product installation, configuration, and integration instructions for implementing the example solution. We do not recreate the product manufacturers' documentation, which is generally widely available. Rather, we show how we incorporated the products together in our environment to create an example solution.

This guide assumes that IT professionals have experience implementing security products within the enterprise. While we have used a suite of commercial products to address this challenge, this guide does not endorse these particular products. Your organization can adopt this solution or one that adheres to these guidelines in whole, or you can use this guide as a starting point for tailoring and implementing parts of a solution for OT systems, PACSs, and IT systems. Your organization's security experts should identify the products that will best integrate with your existing tools and IT system infrastructure. We hope you will seek products that are congruent with applicable standards and best practices. [Section 4.5](#), Technologies, lists the products we used and maps them to the cybersecurity controls provided by this reference solution.

## 2.1 Typographic Conventions

The following table presents typographic conventions used in this volume.

Typeface/ Symbol	Meaning	Example
<i>Italics</i>	filenames and pathnames references to documents that are not hyperlinks, new terms, and placeholders	For detailed definitions of terms, see the <i>NCCoE Glossary</i> .
<b>Bold</b>	names of menus, options, command buttons and fields	Choose <b>File &gt; Edit</b> .
Monospace	command-line input, on-screen computer output, sample code examples, status codes	<code>mkdir</code>
<b>Monospace Bold</b>	command-line user input contrasted with computer output	<b><code>service sshd start</code></b>
<a href="#">blue text</a>	link to other parts of the document, a web URL, or an email address	All publications from NIST's National Cybersecurity Center of Excellence are available at <a href="https://www.nccoe.nist.gov">https://www.nccoe.nist.gov</a>

## 3 Introduction

The NCCoE initiated this project because technology practitioners in the electricity subsector, including those focused on OT, IT, and telecommunications, told us that IdAM was a concern to them. As we developed the original problem statement, or use case, on which this project is based, we consulted with electric-company chief information officers, chief information security officers, security management personnel, and others with financial decision-making responsibility (particularly for security).

The individuals that we consulted told us that they need to control physical and logical access to their resources, including buildings, environmental applications, energy management system (EMS) control and data centers, equipment, IT, and OT systems. They need to authenticate only designated individuals and devices to which they are giving access rights. In addition, they need to enforce access-control

policies (e.g., allow, deny, inquire further) consistently, uniformly, and quickly across all of their resources. Current IdAM implementations can often be fragmented and controlled by numerous departments within an electric utility or by individual equipment owners. Several negative outcomes can result from this situation: an increased risk of attack and service disruption, an inability to identify potential sources of a problem or attack, and a lack of overall traceability and accountability regarding who has access to both critical and noncritical assets. While the example solution presented here is motivated by a problem identified by electric utilities, it can be adapted to utilities that have multiple OT silos, such as utilities that handle electric and water, or electric and gas. Another key consideration is the need for companies to demonstrate compliance with industry standards and/or government regulations.

We, at NCCoE, constructed two versions of an end-to-end identity management solution that provides access-control capabilities across the OT, PACS, and IT networks. We used the same approach for each build, in that we only interchanged two core products that contained the same functionality and capability. [Section 5.3.1](#) and [Section 5.3.2](#) detail these two example solutions. Our build collaborator, AlertEnterprise, independently constructed a third version of the solution; [Section 5.5](#) details this solution. The end result is that a user's access to facilities and devices can be provisioned from a single console. Access privileges can be modified by adding new users and assigning access for the first time, modifying existing user access privileges, or disabling user access privileges. Our goal was to provide the electricity subsector with a solution that addresses the key tenet of cybersecurity—access management/rights—based on the principle of least privilege, which is defined as providing the least amount of access (to systems) necessary for the user to complete his or her job [2].

## 4 Approach

### 4.1 Audience

This guide is intended for technology practitioners (including those focused on OT, IT, and telecommunications) who are responsible for implementing security solutions in electricity subsector organizations.

### 4.2 Scope

This project began with a detailed discussion between NCCoE and members of the electricity subsector community, about their main security challenges. The risk of unauthorized access to facilities and devices, and the inability to verify if user access had been properly established, modified, or revoked, quickly became the focus of the discussion.

In response, the NCCoE drafted a use case that identified numerous desired solution characteristics. After an open call in the Federal Register, we chose technology collaborators based on their ability to provide these characteristics. In the scope, we initially thought that it would be feasible to include

federated identity management services [3], or “arrangement[s] that can be made among multiple enterprises that lets subscribers use the same identification data to obtain access to the networks of all enterprises in the group.” As we progressed through the initial stages of solution development, we realized that access, authentication, and authorization through federated identity means would vastly increase the amount of time needed to complete a build. We narrowed the scope to providing identity management of energy company employees, including a converged provisioning capability to the OT, PACS, and IT networks. The scope became successful execution of the following provisioning functions:

1. enabling access for a new employee
2. modifying access for an existing employee
3. disabling access for a former employee

The objective is to perform all three actions from a single interface that can serve as the authoritative source for all access managed within an energy provider’s facilities, networks, and systems.

## 4.3 Assumptions

This project is guided by the assumptions identified in the following subsections.

### 4.3.1 Security

All network and system changes have the potential to increase the attack surface within an enterprise. In [Section 4.4](#), Risk Assessment, we provide detailed recommendations on how to secure this reference solution.

### 4.3.2 Modularity

This example solution is made of many commercially available parts. You might swap one of the products that we used for a product that is better suited for your environment. We also assume that you already have some IdAM solutions in place. A combination of some of the components described here, or a single component, can improve your identity and access/authorization functions, without requiring you to remove or replace your existing infrastructure. This guide provides both a complete end-to-end solution and options that you can implement based on your needs.

### 4.3.3 Human Resources Database/Identity Vetting

This build is based on a simulated environment. Rather than recreate a human resources (HR) database and the entire identity vetting process in our lab, we assumed that your organization has the processes, databases, and other components necessary to establish a valid identity.

### 4.3.4 Identity Federation

We initially intended to work with energy providers to demonstrate a means for sharing selected identity information across organizational boundaries. While we assumed that the NCCoE could

implement some type of identity federation mechanism to authenticate and authorize individuals who are both internal and external to the organization, this capability exceeded the scope of the build.

#### 4.3.5 Technical Implementation

This guide is written from a “how-to” perspective. Its foremost purpose is to provide details on how to install, configure, and integrate components. We assume that an energy provider has the technical resources to implement all or parts of the build or has access to companies that can perform the implementation on its behalf.

#### 4.3.6 Limited Scalability Testing

We did not attempt to replicate the user-base size that would be found at medium and large energy providers. We do not identify scalability thresholds in our IdAM builds, as those depend on the type and size of the implementation and are particular to the individual enterprise.

#### 4.3.7 Replication of Enterprise Network

We were able to replicate the three silos: (1) PACS, (2) IT or corporate networks, and (3) the OT network, in a limited manner. The goal was to demonstrate, both logically and physically, that provisioning functions could be performed from a converged IdAM system, regardless of its location in the enterprise. In a real-world environment, the interconnections between the OT, PACS, and IT silos depend on the business needs and compliance requirements of the enterprise. We did not attempt to replicate these interconnections. Rather, we acknowledge that implementing our build or its components creates new interfaces across silos. We focused on providing general information on how to remain within the bounds of compliance, should you adopt this example solution. In addition, we provide guidance on how to mitigate any new risks introduced to the environment.

### 4.4 Risk Assessment

We performed two types of risk assessment: the initial analysis of the risk posed to the electricity subsector as a whole, which led to the creation of the use case and the desired security characteristics, and an analysis to show users how to manage the cybersecurity risk to the components introduced by the adoption of the solution.

#### 4.4.1 Assessing Risk Posture

NIST SP 800-30, Risk Management Guide for Information Technology Systems [4][4] states, “Risk is the net negative impact of the exercise of a vulnerability, considering both the probability and the impact of occurrence. Risk management is the process of identifying risk, assessing risk, and taking steps to reduce risk to an acceptable level.” The NCCoE recommends that any discussion of risk management, particularly at the enterprise level, begin with a comprehensive review of the NIST SP 800-37, Guide for Applying the Risk Management Framework to Federal Information Systems [5] material available to the public. The risk management framework (RMF) guidance as a whole proved invaluable in giving us a

baseline to assess risks, from which we developed the project, the security characteristics of the build, and this guide.

Using the guidance in NIST's series of publications concerning the RMF, we performed two key activities to identify the most-compelling risks encountered by energy providers. The first was a face-to-face meeting with members of the energy community to define the main security risks to business operations. This meeting identified a primary risk concern—the lack of converged IdAM services, particularly on OT networks. We then identified the core risk area, IdAM, and established the core operational risks encountered daily in this area. We deemed the tactical risks to be as follows:

- lack of authentication, authorization, and access-control requirements for all OT in the electricity subsector
- inability to manage and log authentication, authorization, and access-control information for all OT using converged or federated controls
- inability to centrally monitor authorized and unauthorized use of all OT and user accounts
- inability to provision, modify, or revoke access throughout the enterprise (including OT) in a timely manner

Our second key activity was conducting phone interviews with members of the electricity subsector. These interviews gave us a better understanding of the actual business risks, as they relate to the potential cost and business value. NIST SP 800-39, Managing Information Security Risk [6], focuses particularly on the business aspect of risk, namely at the enterprise level. This foundation is essential for any further risk analysis, risk response/mitigation, and risk monitoring activities. A summary of the strategic risks is provided below:

- impact on service delivery: Ensuring that people have access to the systems needed to perform their job functions, and do not have access to the systems not needed to perform their job functions, reduces the risk of inappropriate or unauthorized use of access to affect availability.
- cost of implementation: Implementing IdAM once, and using it across all systems, may reduce both system development costs and operational costs.
- budget expenditure, as it relates to investment in security technologies
- projected cost savings and operational efficiencies to be gained as a result of new investment in security
- compliance with existing industry standards: NERC CIP Version 5 requires deliberate and timely control of both logical and physical access to assets.
- high-quality reputation or public image
- risk of alternative or no action
- successful precedents

Undertaking these activities in accordance with the NIST RMF guidance yielded the necessary operational and strategic risk information, which we subsequently translated to security characteristics. We mapped these characteristics to the NIST SP 800-53 Revision4 [7] controls, where applicable, along with other applicable industry and mainstream security standards.

#### 4.4.2 Managing Security Risk from Converged IdAM

As mentioned previously, a foundation of cybersecurity is the principle of least privilege, defined as providing the least amount of access (to systems) necessary for the user to complete his or her job [2]. To enforce this principle, the access-control system needs to know the appropriate privileges for each user and system. An analysis of the IdAM solution reveals two components that need to be protected from both external and internal threat actors: the central identity and authorization store and the authorization workflow management system. The authorization workflow management system is trusted to make changes to the central identity and authorization store. Therefore, any inappropriate or unauthorized use of these systems could change authorization levels for anyone in the enterprise. If that occurred, the enterprise would experience a lack of integrity of the identity and authentication stores. The central identity and authorization store is the authoritative source for the enterprise and holds the hash for each user password, as well as the authorizations associated with each user. Access to this information would enable an unauthorized user to impersonate anyone in the organization. In this situation, the enterprise would lose control over access to resources. Security controls to mitigate this risk are discussed in [Section 5.9.5.1.1](#).

To protect the build components, we implemented the following requirements in our lab environment: access control, data security, and protective technology. [Section 5.9](#) provides a security evaluation of the example solution and a list of the security characteristics. Please note that we addressed only the core requirements appropriate for the IdAM build.

#### 4.4.3 Risk

While risk is addressed in current industry standards, such as NERC CIP Version 5, our sector stakeholders told us about additional risk considerations at both the operational and strategic levels.

Operationally, a lack of a converged IdAM platform can increase the risk of people gaining unauthorized access to critical infrastructure components. Once unauthorized access is gained, the risk surface increases and the opportunity for the introduction of additional threats to the environment, such as malware and denial of service (especially oriented toward OT), is realized.

At the strategic level, you might consider the cost of mitigating these risks and the potential return on your investment in implementing a product (or multiple products). You may also want to assess if a converged IdAM system can help enhance the productivity of employees and speed delivery of services and explore if it can help support oversight of resources, including IT, personnel, and data. This example solution also addresses imminent operational security risks and incorporates strategic risk considerations.

Adopting any new technology can introduce new risks to your enterprise. We understand that this example solution to mitigate the risks of fragmented IdAM may, in turn, introduce new risks. By converging IdAM functions, we decrease the risk that inconsistencies, errors, and omissions across multiple, independent IdAM systems can be used to gain unauthorized access to networked devices. We recognize, however, that converging IdAM functions provides a point of single infiltration of multiple critical systems (OT, PACS, and IT). We address this key risk in detail in [Section 5.9.5.1](#), and provide a comprehensive list of mitigations in [Section 5.9.6](#).

#### 4.4.4 Security Control Map

As explained in [Section 4.3.1](#), we derived the security characteristics through a risk analysis process conducted in collaboration with our electricity subsector stakeholders. This is a critical first step in acquiring or developing the capability necessary to mitigate the risks as identified by our stakeholders. Table 4-1 maps the desired security characteristics and example capabilities of the use case to the Framework for Improving Critical Infrastructure Cybersecurity, also known as the NIST Cybersecurity Framework (CSF); relevant NIST standards; industry standards; and controls and best practices.



**Table 4-1 Use-Case Security Characteristics Mapped to Relevant Standards and Controls**

Example Characteristic		Sector Specific Compliance Guidance					
Security Characteristics	Example Capability	CSF Function	CSF Category	CSF Subcategory	NIST 800-53 Revision 4	IEC/ISO 27001	NERC CIP Version 5
Authentication for OT	Authentication mechanisms	Protect	Access Control	AC-2, IA Family		ISO/IEC 27001:2013 A.9.2.1, A.9.2.2, A.9.2.4, A.9.3.1, A.9.4.2, A.9.4.3	CIP-003-5 R1, CIP-004-5 R4, CIP-004-5 R5, CIP-005-5 R1, CIP-005-5 R2, CIP-007-5 R2, CIP-007-5 R5
Access Control for OT	Access control mechanisms	Protect	Access Control and Protective Technology	PR.AC-2: Physical access to assets is managed and protected PR.AC-3: Remote access is managed PR.PT-3: Access to systems and assets is controlled, incorporating the principle of least functionality	AC-3, AC-17, AC-19, AC-20, CM-7, PE-2, PE-3, PE-4, PE5, PE-6, PE-9	ISO/IEC 27001:2013 A.6.2.2, A.9.1.2A, 11.1.1, A.11.1.2, A.11.1.4, A.11.1.6, A.11.2.3, A.13.1.1, A.13.2.1	CIP-003-5 R1, CIP-004-5 R2, CIP-004-5 R4, CIP-004-5 R5, CIP-005-5 R1, CIP-005-5 R2, CIP-006-5 R1, CIP-006-5 R2, CIP-007-5 R1

Example Characteristic		Sector Specific Compliance Guidance					
Security Characteristics	Example Capability	CSF Function	CSF Category	CSF Subcategory	NIST 800-53 Revision 4	IEC/ISO 27001	NERC CIP Version 5
Authorization (provisioning) OT	Access policy management mechanisms	Protect	Access Control	PR.AC-4 Access Permissions are managed, incorporating principles of least privilege and separation of duties.	AC-2, AC-3, AC-5, AC-6, AC-16	ISO/IEC 27001:2013 A.6.1.2, A.9.1.2, A.9.2.3, A.9.4.1, A.9.4.4	CIP-003-5 R1, CIP-004-5 R4, CIP-004-5 R5, CIP-005-5 R1, CIP-005-5 R2, CIP-006-5 R1, CIP-007-5 R5
Centrally monitor use of accounts	Log account activity	Detect, Protect	Continuous Monitoring & Protective Technology	DE.CM-3: Personnel activity is monitored to detect potential cybersecurity events PR.PT-1: Audit/log records are determined, documented, implemented...	AC-2, AU-12, AU-13, CA-7, CM-10, CM-11, AU family	ISO/IEC 27001:2013 A.12.4.1, A.12.4.2, A.12.4.3, A.12.4.4, A.12.7.1	CIP-003-5 R1, CIP-004-5 R4, CIP-004-5 R5, CIP-005-5 R1, CIP-005-5 R2, CIP-006-5 R1, CIP-006-5 R2, CIP-007-5 R4, CIP-007-5 R5, CIP-008-5 R2, CIP-010-5 R1, CIP-011-5 R2

Example Characteristic		Sector Specific Compliance Guidance					
Security Characteristics	Example Capability	CSF Function	CSF Category	CSF Subcategory	NIST 800-53 Revision 4	IEC/ISO 27001	NERC CIP Version 5
Protect exchange of identity and access information	Encryption	Protect	Data Security	PR.DS-1: Data-at-rest is protected PR.DS-2: Data-in-transit is protected	SC-8, SC-28	ISO/IEC 27001:2013 A.8.2, A.13.1.1, A.13.2.1, A.13.2.3, A.14.1.2, A.14.1.3	CIP-011-5 R1
Provision, modify or revoke access throughout all federated entities	Mechanisms for centrally managed provisioning of access	Protect	Access Control	PR.AC-1: Identities and credentials are managed for authorized devices and users PR.AC-4: Access permissions are managed, incorporating the principles of least privilege and separation of duties	AC-2, AC-3, AC-5, AC-6, AC-16, IA Family	ISO/IEC 27001:2013 A.6.1.2, A.9.1.2, A.9.2.1, A.9.2.2, A.9.2.3, A.9.2.4, A.9.3.1, A.9.4.1, A.9.4.2, A.9.4.3, A.9.4.4	CIP-003-5 R1, CIP-004-5 R4, CIP-004-5 R5, CIP-005-5 R1, CIP-005-5 R2, CIP-006-5 R1, CIP-007-5 R4, CIP-007-5 R5

The relationship of NERC CIP requirements to the security characteristics is derived from a mapping between the NIST 800-53 Revision 4 [7] security controls and NERC CIP requirements. These mappings are for reference only. Please consult your NERC CIP compliance authority for any questions on NERC CIP compliance.

## 4.5 Technologies

Table 4-2 provides information about the products and technologies that we implemented to satisfy the security control requirements. This table describes only the product capabilities that were used in our builds. Many of the products have significant additional security capabilities that were not used in our builds. The “Product” column of the table contains links to vendor product information that describes the full capabilities.

**Table 4-2 Products and Technologies Used to Satisfy Security Control Requirements**

Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
Authentication for OT	Authentication mechanisms	PR.AC-1: Identities and credentials are managed for authorized devices and users	Identity Management Platform	CA	Identity Manager	R12.0 SP14 Build 9140	Implements workflows for creating digital identities and authorizing them access to physical and logical resources, including authoritative source

Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
				RSA	Identity Management and Governance (IMG) Governance Lifecycle	6.9.74968	Implements workflows for creating digital identities and authorizing them access to physical and logical resources
Provision, modify or revoke access throughout all federated entities	Mechanisms for centrally managed provisioning of access		Virtual Directory		Adaptive Directory	7.1.5 R29692	Authoritative source for digital identities and authorized access to resources
			Credential Management	GlobalSign	Enterprise PKI	N/A	Provides North American Energy Standards Board (NAESB)-compliant X.509 certificates to OT personnel

Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
			Credential Management / Physical Access Control	XTec	Credential Issuance Solutions	N/A	Provides Personal Identity Verification Interoperable (PIV-I) smart-card credentials and physical-access-control capability using the smart card
Access Control for OT	Access control mechanisms	PR.AC-2: Physical access to assets is managed and protected	Credential Management / Physical Access Control	XTec	Physical Access Control Logical Access Control Authentication and Validation	N/A	Provides PIV-I smart-card credentials and physical-access-control capability using the smart card
			Physical Access Control Enforcement	RS2 Technologies	Access It!	4.1.15	Controls physical access to power facilities, buildings, etc.
Authorization (provisioning) OT	Access policy management mechanisms	PR.AC-4: Access permissions	Provisioning	AlertEnterprise	Guardian	4.0 SP04 HF3	Provisions access authorizations from the IdAM

Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
Provision, modify or revoke access throughout all federated entities	Mechanisms for centrally managed provisioning of access	are managed, incorporating the principles of least privilege and separation of duties					workflow to Access It Universal
Authorization (provisioning) OT	Access policy management mechanisms		Identity Management Platform	CA	Identity Manager	R12.0 SP14 Build 9140	Provisions identities and authorizations to Active Directory (AD)
Provision, modify or revoke access throughout all federated entities	Mechanisms for centrally managed provisioning of access			RSA	IMG	6.9.74968	
			Secure Attribute Management	Mount Airey Group	Ozone Console and Ozone Authority Secure Attribute Management Public Key Enablement Ozone Mobile	Ozone Authority 4.0.1, Ozone Server 2.1.301, Ozone Envoy 4.1.0, Ozone Console 2.0.2	Manages attributes that control access to high-value transactions

Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
Centrally monitor use of accounts	Log account activity	PR.PT-1: Audit/log records are determined, documented, implemented, and reviewed in accordance with policy	Industrial Control System (ICS) User Access Management	TDi Technologies	ConsoleWorks	4.9-0u0	Controls access to industrial control system (ICS) devices by people (ICS engineers and technicians)
Access Control for OT	Access control mechanisms	PR.PT-3: Access to systems and assets is controlled, incorporating the principle of least functionality	Industrial Control System (ICS) User Access Management	TDi Technologies	ConsoleWorks	4.9-0u0	Creates an audit trail of access to ICS devices by people
			ICS Device-to-Device Access Management	Radiflow	Industrial Control System Firewall and iSIM Software OT Security Substation Security	iSIM 3.6.07	Controls communication among ICS devices



Security Characteristics	Example Capability	CSF Subcategory	Application	Company	Product	Version	Use
			Access Gateway	Cisco	Identity Service Engine (ISE)	1.4.0.253	Controls access to resources in OT by users in IT based on both user identity and device identity
			Access Gateway	Schneider Electric	ConneXium Tofino Ethernet Firewall	2.10	Controls access to devices in the ICS/SCADA network

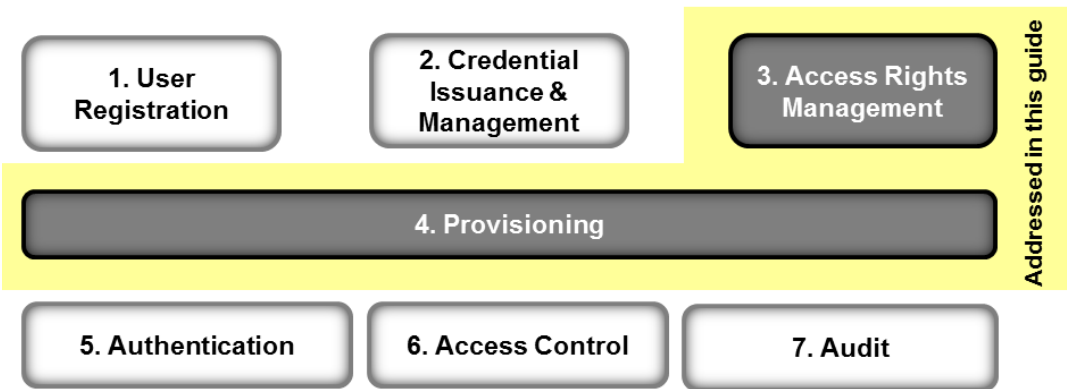
RSA IMG is now known as RSA VIA Governance and RSA VIA Lifecycle.

# 5 Architecture

## 5.1 Architecture Description

IdAM is the discipline of managing the relationship between a person and the resources that the person needs to access to perform a job. It encompasses the processes and technologies by which individuals are identified, vetted, credentialed, and authorized access to resources, and held accountable for their use of these resources. These processes and technologies create digital identity representations of people, bind those identities to credentials, and use those credentials to control access to resources. IdAM is composed of the capabilities illustrated in Figure 5-1, which are detailed, by number, in the text that follows.

Figure 5-1 IdAM Capabilities



1. User registration determines that a reason exists to give a person access to resources, verifies the person’s identity, and creates one or more digital identities for the person.
2. Credential issuance and management provides life-cycle management of credentials, such as employee badges or digital certificates. Additional information on credential issuance and management, as well as authentication, can be found in NIST SP 800-63-2, Electronic Authentication Guideline [8].
3. Access rights management determines the resources that a digital identity is allowed to use.
4. Provisioning populates digital identity, credential, and access rights information for use in authentication, access control, and audit.
5. Authentication establishes confidence in a person’s digital identity.
6. Access control allows or denies a digital identity access to a resource. NIST Interagency/Internal Report (NISTIR) 7316, Assessment of Access Control Systems [9], explains commonly used access-control policies, models, and mechanisms.
7. Audit maintains a record of resource access attempts by a digital identity.

The top three capabilities are administrative capabilities, in that they involve human actions or are infrequently used. For example, verifying identity typically involves physically reviewing documents, such as a driver's license or passport. Credential issuance and management is invoked when an employee is hired, changes jobs, leaves the company, loses a credential, or when a credential expires.

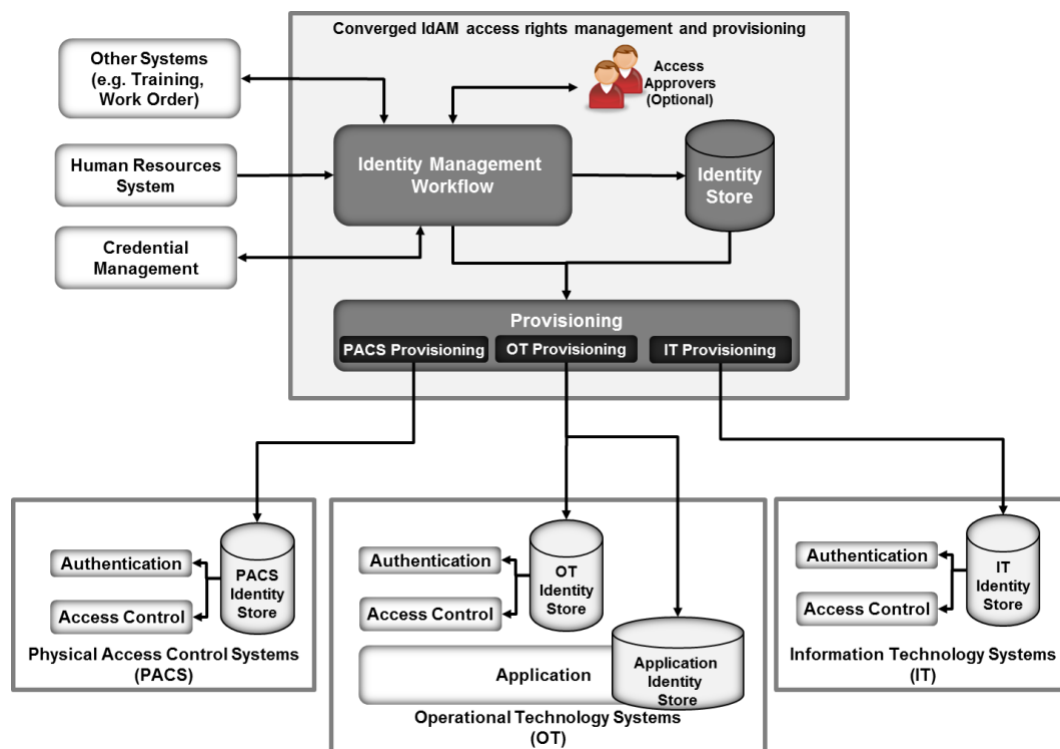
The bottom three capabilities are "run-time" capabilities, in that they happen whenever a person accesses a resource. Authentication, access control, and audit are typically automated activities that occur every time that a person enters a facility by using a badge, or logs into a computer system. A directory, such as Microsoft AD, is often used in the implementation of run-time functions.

Provisioning connects the administrative activities to the run-time activities by providing the run-time capabilities with the information needed from the administrative activities.

In the electricity subsector today, some or all of these IdAM capabilities are frequently replicated at least three times—once for a person's access to OT, again for physical access, and then to access IT. Additionally, these capabilities may be independently replicated for each system within OT or IT. Replication makes it difficult to ensure that employees have access to the resources that they need to perform their jobs, and only those resources. Newly hired employees may not have access to all of the resources they need. Employees who change jobs may retain access to resources they no longer need. Terminated employees may retain access long after they have left. Further, multiple independent IdAM processes make it difficult to periodically review who has access to what resources.

The example solution described here addresses these problems by creating a converged implementation of the IdAM access rights management and provisioning capabilities that is used across OT, PACS, and IT. This converged implementation does not change the run-time capabilities of authentication, access control, and audit, leaving them replicated and distributed. The converged implementation depends on a utility's existing processes, such as employee on-boarding and badge issuance, to provide both user registration and credential issuance and management capabilities. Figure 5-2 illustrates the example solution.

**Figure 5-2 IdAM Example Solution**



The converged IdAM capability implements the following items:

- an IdAM workflow to manage the overall process
- an identity store, which is the authoritative source for digital identities and their associated access rights to resources
- a provisioning capability to populate information from the workflow and identity store into the run-time capabilities. The provisioning capability is further decomposed into OT provisioning, IT provisioning, and PACS provisioning

Each of the three silos, OT, IT, and PACS, may have its own identity stores that contain digital identities and access rights for use in controlling access to systems within the silo. Further, some applications in a silo may have their own application identity stores that are used by the application to control access to the information and to the services that it provides. The converged IdAM capability, through provisioning, manages the information in these other identity stores.

The combined capabilities can reduce the time to update access in the OT, PACS, and IT systems from days to minutes. They also improve the audit trail capture by integrating the three audit logs into one. Provisioning may also verify that authorizations stored locally in the run-time capabilities are consistent with those in the identity store. If locally stored authorizations are inconsistent with authoritative values

in the identity store, provisioning may raise an alarm or change locally stored authorizations to be consistent with the identity store.

The example solution implements three basic transactions:

- creating all required credentials, authorizing access, and provisioning access for a new employee
- updating credentials and access for an existing employee who is changing jobs or requires a temporary access change
- destroying credentials and removing accesses for a terminated employee

The IdAM workflow receives information about employees and their jobs from the HR system. For a new employee, HR is responsible for performing initial identity verification. Based on a new employee's assigned job, the IdAM workflow creates one or more digital identities and determines the credentials and resource accesses required. The workflow triggers credential management capabilities to create physical identification badges, physical access cards, and any logical access credentials, such as X.509 public key certificates, that may be needed. The workflow records information about these credentials in the identity store.

The example solution does not assume that each person will have a single digital identity. A current employee is likely to have several distinct digital identities because of independent management of digital identities in physical security, business systems, and operational systems. Requiring a single digital identity would create a significant challenge to the adoption of the example solution.

Instead, the identity store associates all of an employee's digital identifiers so that all of the person's accesses can be managed together. Once the example solution is in place, an organization can continue issuing multiple digital identifiers to new employees or can assign a single digital identifier that is common to physical security, business systems, and operational systems.

The workflow automatically authorizes some physical and logical accesses that are needed either by all employees or for an employee's job. The workflow stores information about credentials and authorized accesses in the identity store. The workflow then invokes provisioning to populate silo-specific and application identity stores with credential information and access authorizations. This allows the employee to access facilities and systems.

Access to some resources, both logical and physical, will require explicit approval before being authorized. For these, the workflow notifies one or more access approvers for each such resource, and then waits for responses. When the workflow receives approvals, it stores the authorized accesses in the identity store and provisions them to the silos. All information about approved, pending, and provisioned physical and logical access authorizations is maintained in the identity store. Pending access authorizations may be either authorizations that have been approved, but not yet provisioned, or time-bounded authorizations to be provisioned/de-provisioned at a future time. Explicit approval is used to ensure that OT managers and supervisors retain control over access to critical operational systems.

While the system to manage access authorizations is converged, the authority to make access authorizations remains distributed across IT, OT, and physical security management.

When the HR system notifies the workflow that an employee is changing jobs, the workflow performs similar actions. First, it identifies resource accesses and credentials associated only with the employee's former job. It revokes those resource accesses in the identity store and de-provisions them from the silos. It directs that associated credentials be invalidated and destroyed. It removes information about those credentials from the identity store and de-provisions credential information from the silos. Workflow actions are programmable and can be customized to meet organization-specific needs. It then identifies the resource accesses needed for the employee's new job, authorizes them in the identity store, and provisions them to the silos. The workflow identifies any new credentials that will be needed in the new job, triggers the creation and issuance of those credentials, waits for them to be created, updates the identity store, and provisions new credential information to the silos.

When the HR system notifies the workflow that an employee has been terminated, the workflow removes all of the employee's resource accesses from the identity store and de-provisions them from the run-time functions. It triggers the invalidation and destruction of the employee's credentials, removes credential information from the identity store, and de-provisions credential information from the silos.

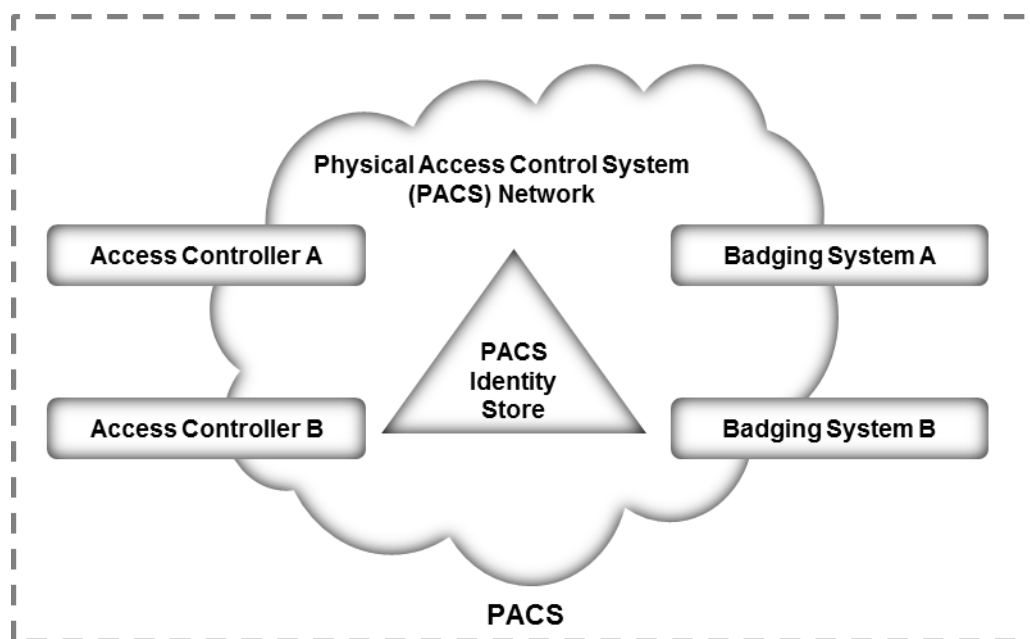
In addition to input from the HR system to process personnel actions, the workflow can provide a portal for employees to request access to resources, which can be reviewed and approved. Also, systems other than HR can be integrated with the workflow to initiate resource access requests. These capabilities reduce overhead and administrative downtime.

### 5.1.1 Physical Access Control System Silo

The PACS silo hosts both access controllers and badging systems. The badging systems implement a credential issuance capability that creates the badges that employees use to gain access to facilities and other physical resources. The access controllers read information from badges and check authorization information to determine if a person should be allowed access. If access is allowed, the access controller unlocks a door, allowing the person to enter the facility.

Figure 5-3 shows the architecture of the PACS silo.

**Figure 5-3 Notional PACS Architecture**



The PACS identity store contains identities and access-control information for the people who operate the badging systems and the people who manage the access-control systems. This access-control information is provisioned into the PACS identity store instance from the converged IdAM system.

Access controllers may also use the PACS identity store to check authorization information to determine physical access. If the access controllers use the PACS identity store, then the IdAM system will provision authorization information to the PACS identity store. If the access controllers use their own internal identity store, then authorization information will be provisioned directly to the access controller. Build #1 provisions directly to the access controller, and Build #2 provisions to the PACS identity store.

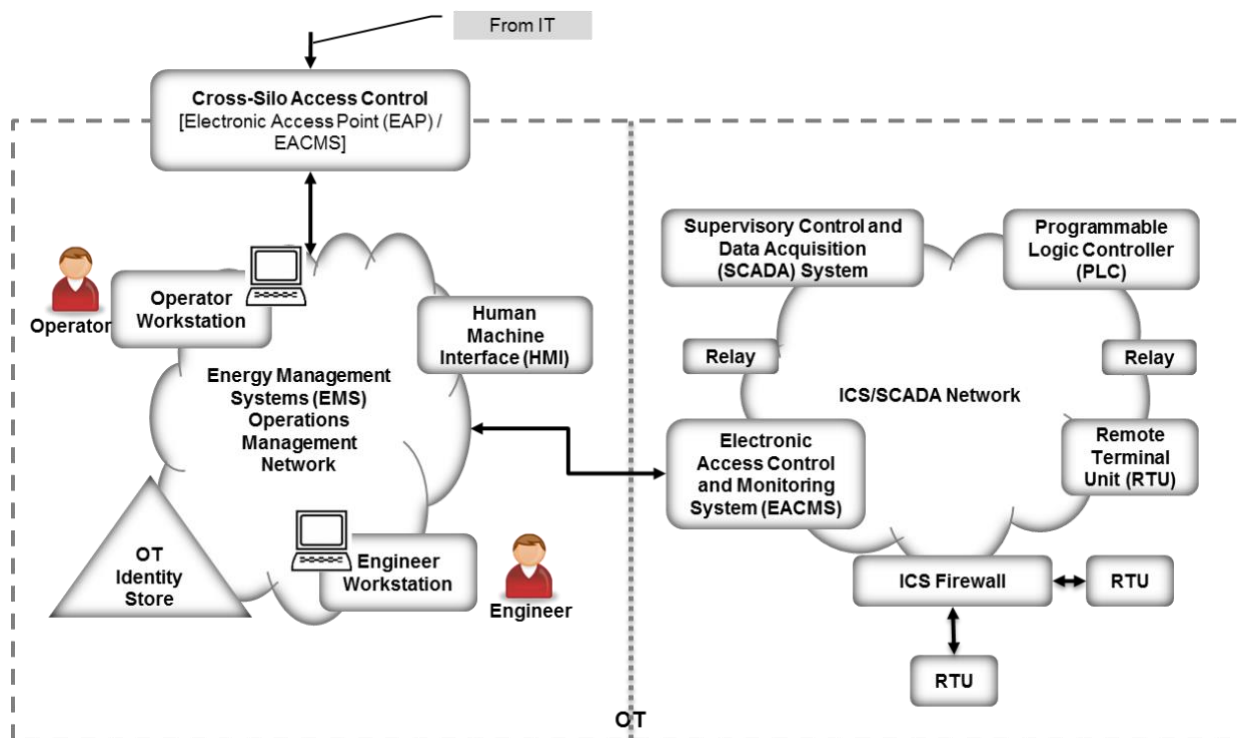
### 5.1.2 Operational Technology Silo

The OT silo is composed of two types of systems:

- operational management systems that operators and engineers use to monitor and manage the generation and delivery of electric energy to customers
- industrial control systems (ICSs) and supervisory control and data acquisition (SCADA) systems that provide real-time and near-real-time control of the equipment that produces and delivers electric energy

Figure 5-4 shows the notional architecture of the OT silo.

Figure 5-4 Notional OT Silo Architecture



The operations and management network within the OT silo has an identity store that contains identities and access authorizations for operational management systems. These identities and authorizations are provisioned from the converged IdAM system. A cross-silo access-control capability allows some access to operational management systems from the IT silo. The converged IdAM system provisions authorizations to access OT resources from the IT silo into the OT identity store.

An electronic access control and monitoring system (EACMS) controls access to ICS/SCADA devices on the ICS/SCADA network, from the operations management network. The EACMS allows operators and engineers to have terminal access to the programmable logic controllers, relays, and remote terminal units (RTUs) that provide real-time control of energy production and delivery. Authorizations allowing access via the EACMS may be provisioned into the OT identity store or directly into the EACMS by the converged IdAM system. The converged IdAM system can provide time-bounded authorizations that will allow access during a limited time period. When the period expires, a workflow is triggered that revokes the authorization in the identity store and de-provisions the authorization from the OT identity store.



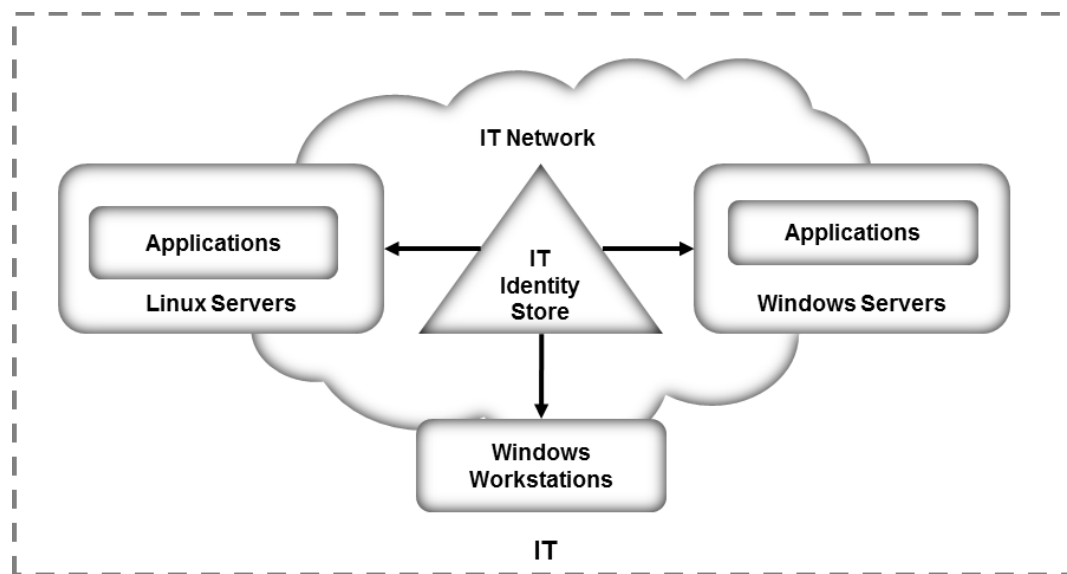
An ICS/SCADA firewall controls communication among ICS/SCADA devices. The converged IdAM system does not currently manage or provision authorizations that control device-to-device communications. Authorizations for device-to-device communications are either learned by the firewall in training mode or configured using a vendor-supplied application. This capability could be added in a future version of the converged IdAM system.

### 5.1.3 Information Technology Silo

The IT silo hosts business systems. These systems consist of user workstations and business applications running on Microsoft Windows or Linux servers. An IT identity store contains identities and access authorizations for both business system users and system administrators who manage the applications and servers. These authorizations are provisioned from the converged IdAM system. Applications that are not able to use an external identity store can be provisioned directly by the converged IdAM system.

Figure 5-5 shows the notional architecture of the IT silo.

Figure 5-5 Notional IT Silo Architecture



## 5.2 Example Solution Relationship to Use Case

When we first defined this challenge in collaboration with industry members, we wrote the following scenario [10]:

*“An energy company technician attempts to enter a substation. She is challenged to prove her identity in a way that provides a high degree of confidence and is not onerous (i.e., does not require a significant behavior change). Her attempt at entry initiates an authentication request that, if possible, connects to the company’s authentication and authorization services to validate*

*her identity, ensure that she is authorized to access the substation, and confirm that a work order is on file for that substation and that worker at that time.*

*Once she gains access to the substation, she focuses on the reason for her visit: She needs to diagnose a remote terminal unit (RTU) that has lost its network connectivity. She identifies the cause of the failure as a frayed Ethernet cable and replaces the cable with a spare. She then uses her company-issued mobile device, along with the same electronic credential she used for physical access, to log into the RTU's web interface to test connectivity. The RTU queries the central authentication service to ensure the authenticity and authority of both the technician and her device, then logs the login attempt, the successful authentication, and the commands the technician sends during her session."*

The first portion of the scenario deals with physical access to a substation. Unlike the description in this scenario, the example solution provides the management of identities and authorizations in a single system but assumes that the decision to allow a particular technician to have access to a particular facility at a particular time may be distributed. Distributing the access decision-making capability helps ensure that access control continues to function in the event of communication failures. Utilities have indicated that communication failures with substations are common. Therefore, authorization to allow the technician to have access to the substation will be created centrally by the IdAM workflow, placed in the identity store, and then provisioned to the PACS responsible for the substation. Accomplishing this requires integrating the work order management system with the IdAM workflow. Assigning a work order, to a technician, that requires access to a substation triggers actions within the IdAM workflow to authorize access to the substation and to provision that authorization to the substation PACS. When the technician presents his/her physical access credential at the substation, the PACS uses the provisioned authorization to determine if he/she should be allowed to have access. Likewise, while not explicitly stated in the example, completion of the work order triggers the IdAM workflow to remove the technician's substation access authorization and de-provision it from the substation PACS.

The second portion of the scenario deals with logical access to ICS/SCADA devices within the substation. Again, unlike the description in the scenario, the example solution centralizes the management of identities and authorizations, but assumes that run-time functions, such as authenticating a user and granting the user to have access to specific ICS/SCADA devices, are distributed functions. In this case, the example solution assumes that the substation contains an EACMS to which the technician connects his/her mobile device. The EACMS authenticates the technician and controls his/her access to ICS/SCADA devices within the substation. Assigning the technician to this work order triggers an IdAM workflow that authorizes him/her to have access to ICS/SCADA devices in the substation, stores these authorizations in the identity store, and provisions both the authorizations and any needed authentication credentials to the substation's EACMS. Completion of the work order triggers the removal of the access authorization, and de-provisioning of authorizations and credentials, from the substation EACMS.

### 5.3 Core Components of the Reference Architecture

To verify the modularity of the example solution and to demonstrate alternative provisioning methods, we created two builds of the converged IdAM capability. Both builds used the following products:

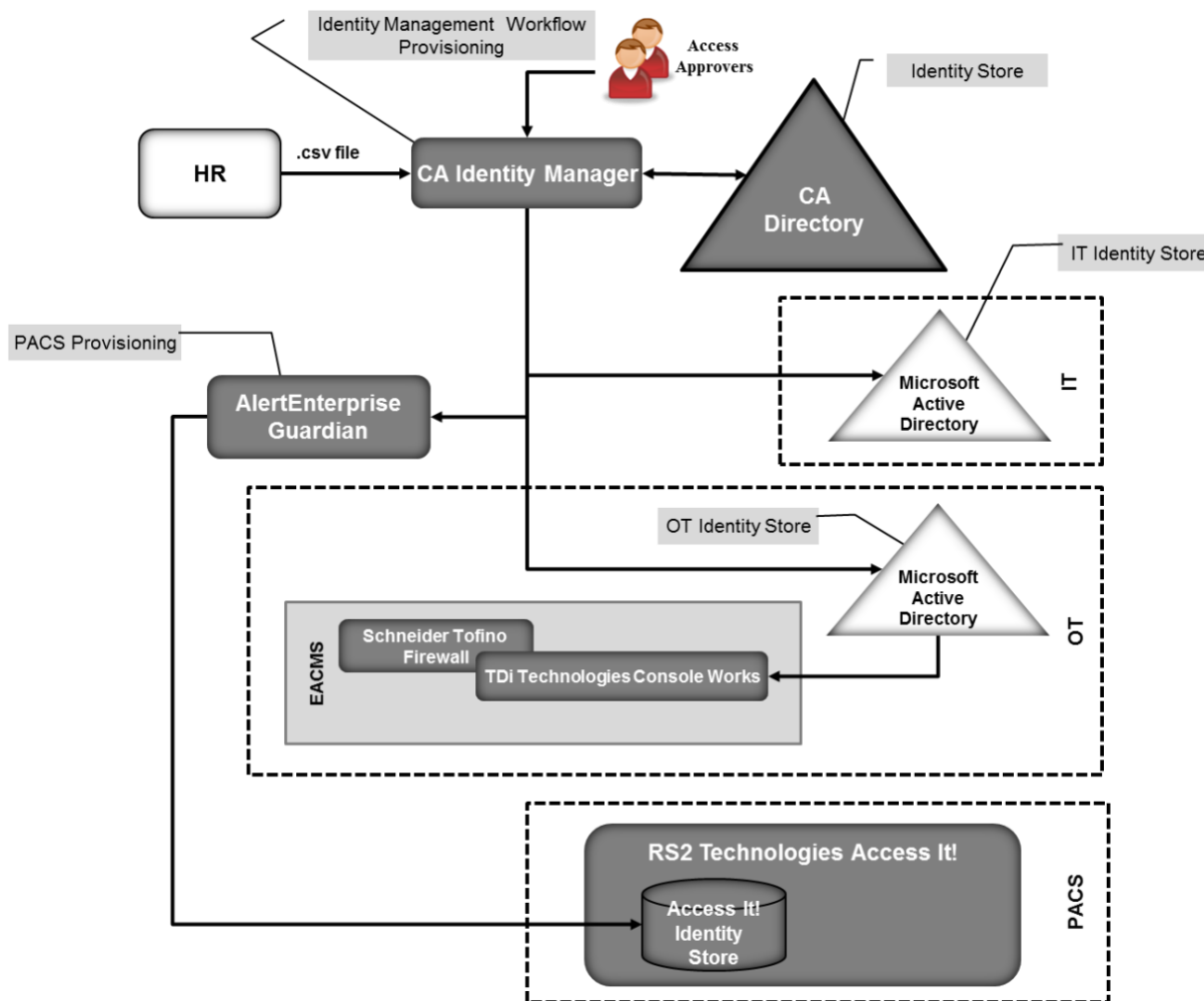
- AlertEnterprise Guardian implements provisioning to an RS2 Technologies (RS2) Access It! PACS.
- TDi Technologies ConsoleWorks and a Schneider Electric Tofino firewall serve as an EACMS.
- A Radiflow ICS/SCADA firewall controls interactions between two Modbus-speaking RTUs—a Schweitzer Engineering Laboratories (SEL) RTU and an RTU emulated by a Raspberry Pi single-board computer.

Build #1 used CA Technologies (CA) Identity Manager to implement the IdAM workflow and aspects of provisioning, and CA Directory to implement the identity store. Build #2 used the RSA IMG (now known as RSA VIA Governance and RSA VIA Lifecycle) to implement the IdAM workflow and the RSA Adaptive Directory to implement the identity store and aspects of provisioning.

### 5.3.1 Build #1

Figure 5-6 illustrates Build #1. See legend in [Appendix B](#).

Figure 5-6 Build #1



CA Identity Manager implements the IdAM workflow. It receives input from an HR system, in the form of comma-separated value (CSV) files. We simulated the HR system by using manually produced CSV files because the NCCoE lab does not have an HR system. A mutually authenticated, integrity-protected connection between an HR system and CA Identity Manager is the preferred solution. CA Identity Manager also provisions information to Microsoft AD instances in business systems (IT) and in the operational system (OT). No relationship among these AD instances is assumed.

IT applications are assumed to be integrated with the IT identity store implemented by Microsoft AD and use credential information and authorization information in this AD instance. If there are IT applications that are not integrated with AD, the provisioning capabilities of CA Identity Manager would be used to directly provision the applications.

AlertEnterprise Guardian provisions physical access authorizations into the RS2 PACS. It is also capable of implementing workflow and provisioning ICS devices; however, those capabilities were not used in this build. CA Identity Minder supports call-outs within a workflow that can be used to invoke external programs. A call-out is used to connect with AlertEnterprise Guardian and to provide information to be provisioned to the RS2 PACS.

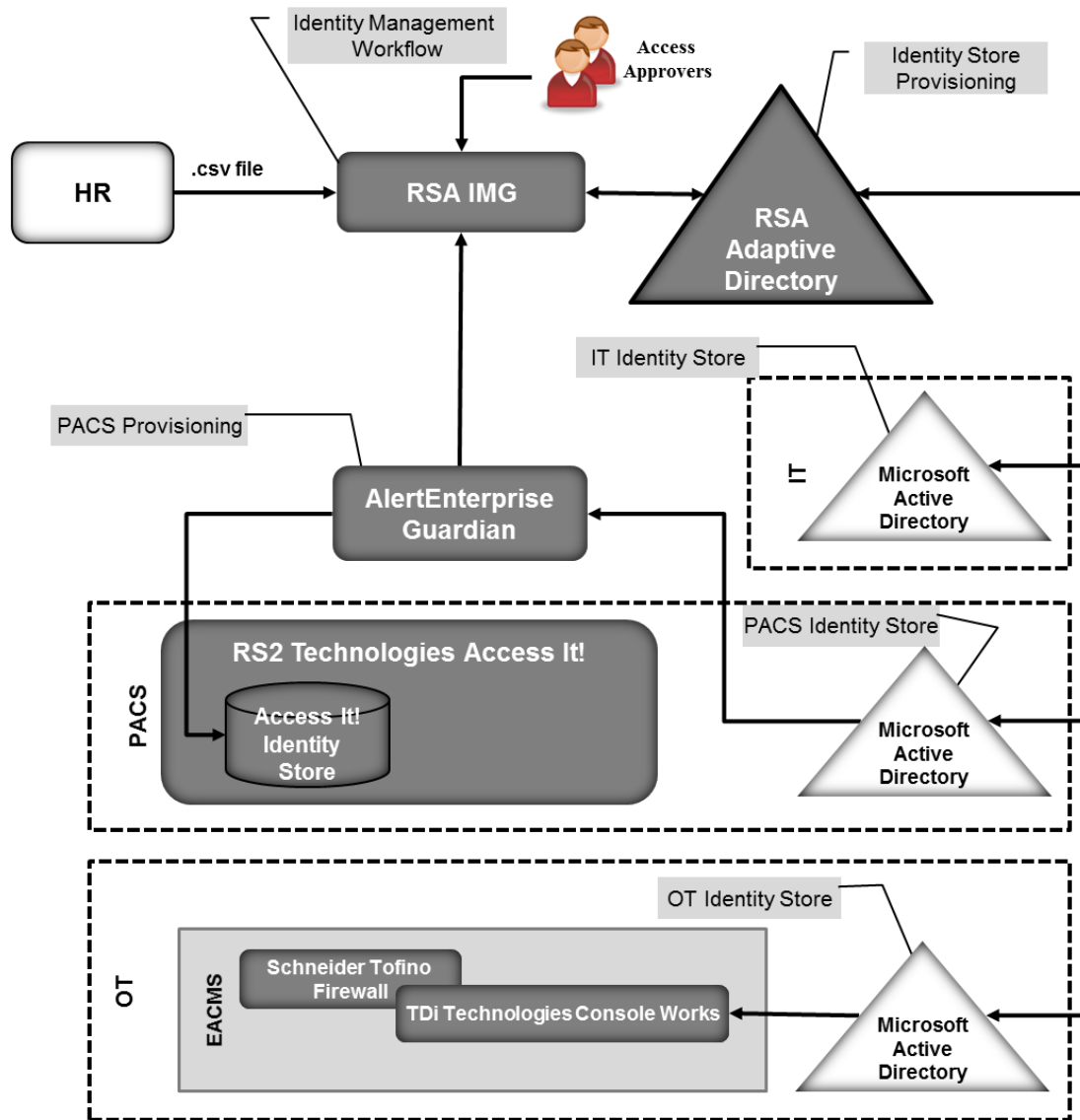
An instance of TDi Technologies ConsoleWorks is installed in the OT silo and integrated with the OT identity store that is implemented by a Microsoft AD instance. Identity Manager provisions ICS/SCADA access authorizations into this AD instance. ConsoleWorks uses the access authorizations in AD to control user access to ICS/SCADA devices. ConsoleWorks also captures an audit trail of all user access to the ICS/SCADA network.

A Schneider Electric Tofino firewall is installed between ConsoleWorks and the ICS/SCADA network. The firewall determines which Internet Protocol (IP) addresses within the ICS/SCADA network are accessible through ConsoleWorks and which network protocols can be used when accessing those addresses, but these are not managed by the converged IdAM solution. The combination of ConsoleWorks and the Tofino firewall implement an EACMS between the EMS / Operations Management Network and the ICS/SCADA network.

### 5.3.2 Build #2

Figure 5-7 illustrates Build #2. See legend in [Appendix B](#).

Figure 5-7 Build #2



RSA IMG implements the IdAM workflow. It receives input from an HR system, in the form of CSV files. In Build #2, RSA IMG stores information in RSA Adaptive Directory, which subsequently provisions the information to the silo identity stores implemented with Microsoft AD instances.

RSA Adaptive Directory implements the identity store and provisioning portions of the example solution. RSA Adaptive Directory is a virtual directory that acts as a proxy in front of multiple back-end directories. The build assumes that each silo—OT, PACS, and IT—hosts a Microsoft AD instance. No relationship among these AD instances is assumed. When an IMG workflow stores information in Adaptive Directory, that information is actually stored in one or more of the underlying AD instances. In this way, storing information in Adaptive Directory provisions that information into one or more AD instances.

AlertEnterprise Guardian provisions physical access authorizations into the RS2 PACS. RSA IMG writes these authorizations into Adaptive Directory, which stores them in the PACS AD instance.

AlertEnterprise Guardian monitors the PACS AD instance for updates, such as changed physical access authorizations for an existing user, the addition of a new user with physical access authorizations, or the removal of an existing user and associated access authorizations. When changes are detected, Guardian provisions them into the RS2 PACS.

As in Build #1, TDi Technologies ConsoleWorks and a Schneider Electric Tofino firewall are used in the OT silo to provide an EACMS between the EMS / Operations Management Network and the ICS/SCADA network. ConsoleWorks utilizes the AD instance in OT for the authorization of users in this build as well.

### 5.3.3 Implementation of the Use-Case Illustrative Scenario

This section explains how each of the two builds implements the scenario in [Section 5.2](#).

A work order management system assigns a technician to resolve an issue with an RTU at a substation. The system initiates a workflow in either CA Identity Manager or RSA IMG that authorizes the technician to have physical access to the substation. In Build #1, this authorization is sent to AlertEnterprise Guardian via a call-out in the workflow in CA Identity Manager. Guardian provisions the authorization into the RS2 PACS. The authorization is also stored in the CA directory. In Build #2, this authorization is written to Adaptive Directory and stored in the PACS AD instance. AlertEnterprise Guardian detects the authorization change for the technician and provisions it to RS2. When the technician arrives at the substation and scans his/her credentials at the door, RS2 allows him/her to enter the facility.

The workflow also authorizes access to ICS/SCADA devices in the substation. In Build #1, CA Identity Manager stores this authorization in the CA directory and provisions it to the OT AD instance. In Build #2, IMG writes this authorization to Adaptive Directory, which stores it in the OT AD instance. When the technician connects his/her mobile device to ConsoleWorks in the substation, he/she is authenticated, and ConsoleWorks checks the OT AD instance, sees that he/she is authorized, and allows him/her to access the ICS/SCADA devices in the substation.

When the work order is closed, the work order management system triggers another workflow that removes the technician's access authorizations. In Build #1, the authorizations are removed from the CA directory. Substation physical access is de-provisioned from RS2 via a call-out from the workflow to AlertEnterprise Guardian. Identity Manager de-provisions ICS/SCADA access from the OT AD.

ConsoleWorks detects the change in the OT AD instance and de-provisions the technician's access to the RTU.

In Build #2, IMG removes the authorizations from Adaptive Directory. This removes the authorizations from the PACS and OT AD instances. AlertEnterprise Guardian detects the change in the PACS AD instance and de-provisions the technician's substation physical access. ConsoleWorks detects the change in the OT AD instance and de-provisions the technician's access to the RTU.

Without an active assigned work order, the technician has no physical or logical access to the substation.

The reference architecture requires substations to have power and communications to receive provisioned authorizations. The reference architecture does not address crisis or emergency situations where this requirement is not met. The reference architecture assumes that existing energy-company procedures for crisis or emergency response will be used/updated to address this challenge.

## 5.4 Supporting Components of the Reference Architecture

In addition to the products used to build an instance of the core example solution (the build), several products provide supporting components to the build, as shown in [Figure 5-8](#). These products implement IdAM capabilities that, while necessary to completely implement IdAM within an organization, are not an integral part of the converged IdAM capability.

XTec AuthentX and GlobalSign demonstrate the outsourcing of some credential issuance and management capabilities. XTec AuthentX also demonstrates the outsourcing of some physical access-control capabilities.

The XTec AuthentX Identity and Credential Management System (IDMS/CMS) provides a PIV-I smart-card credential, based on NIST standards, that can be used for logical and physical access, as well as the description of the XTec product and its role in supporting the implementation of the example solution. AuthentX demonstrates the outsourcing of some aspects of user registration, credential issuance and management, authentication, and access-control capabilities. These capabilities are provided using a cloud-hosted solution with identity vetting workflows, credential issuance stations, and full life-cycle maintenance tools. AuthentX produces Homeland Security Presidential Directive 12-compliant smart cards that are interoperable with, and trusted by, federal counterparts.

The components of the XTec solution in our lab included XNode, card readers, and compliant PIV-I cards. The XTec product places the XNode, an IP-addressable RS232/RS485 controller within close range of the reader and door strike, as opposed to a typical, central control-panel deployment. The XNode can also control SCADA devices and send them encrypted instructions.

AuthentX IDMS/CMS can also provide a web-based implementation of the IdAM workflow in the example solution, as well as credential management and provisioning. AuthentX IDMS/CMS can control, log, and account for identity vetting, credential issuance, and credential usage with AuthentX PACS and



logical access controls, as well as immediately control credential revocation to all interoperable resources.

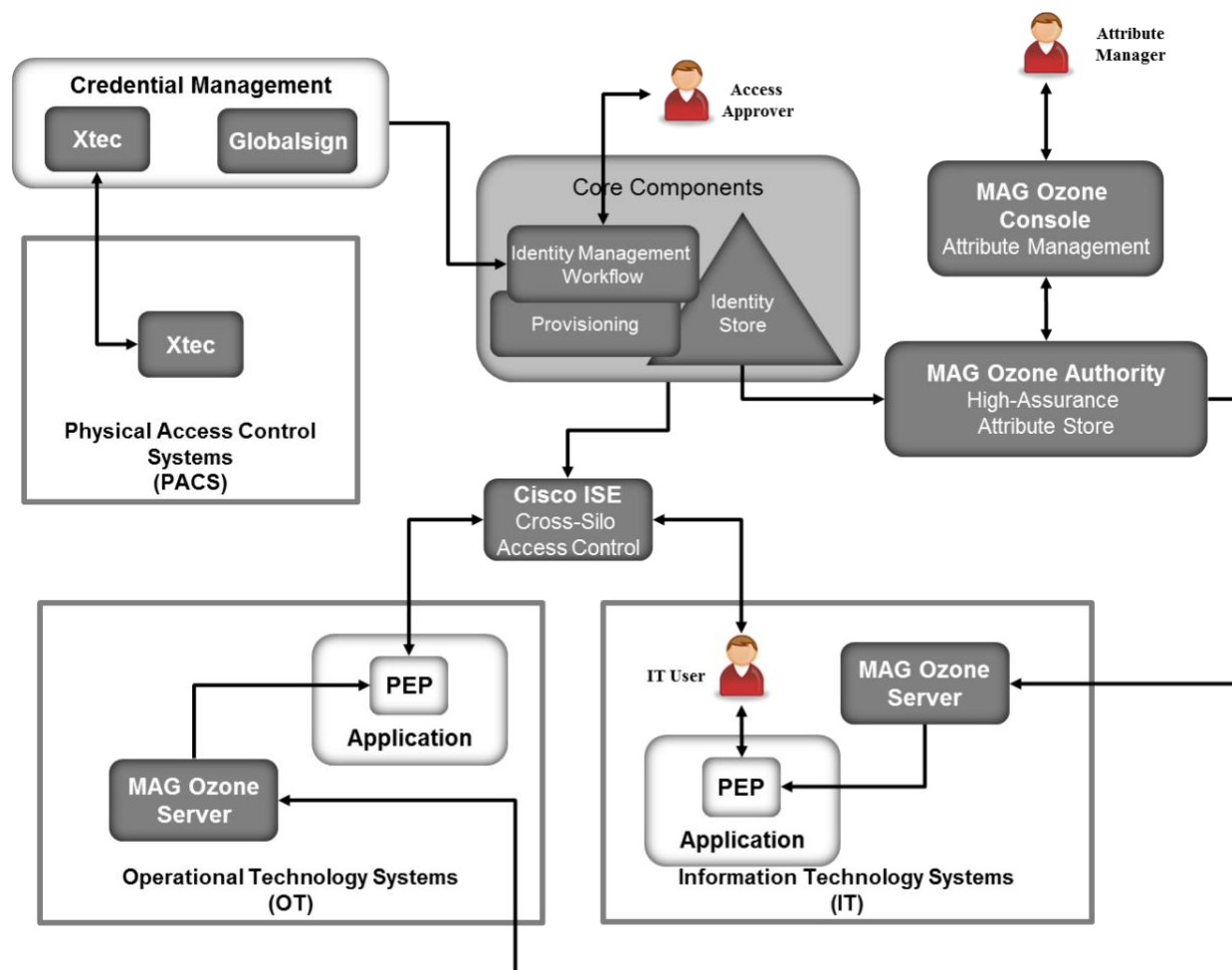
GlobalSign operates an NAESB-accredited software-as-a-service Certificate Authority. It illustrates an outsourced credential issuance and management capability that provides NAESB-compliant X.509 digital certificates. NAESB-compliant digital certificates are required credentials for authenticating Open Access Same-Time Information Systems (OASIS) transactions and access to the Electronic Industry Registry—the central repository for information related to energy scheduling and management activities in North America [11].

Mount Airey Group's (MAG's) Ozone and Cisco's Identity Services Engine (ISE) demonstrate access-control decision and enforcement capabilities that the converged IdAM capability can provision. MAG Ozone can also provide authorization management capabilities.

The MAG Ozone product provides a high-assurance attribute-based access control (ABAC) implementation [12]. ABAC controls access to resources by evaluating access rules using attributes associated with the resource being accessed, the person accessing the resource, and the environment. Ozone Authority provides a high-assurance attribute store. Attributes stored in Ozone Authority are managed using Ozone Console. Ozone manages attributes that control access to high-value transactions, such as high-dollar-value financial transactions.

Ozone Authority pulls attributes either from Adaptive Directory in Build #2 or from an AD instance in Build #1. Once Ozone Authority pulls the attributes, the attribute values are managed through Ozone Console.

Figure 5-8 Supporting Components



Ozone Server uses these attributes, in either the OT or IT silo, to decide if a user is allowed to perform a transaction. Ozone Server provides its decision to the policy enforcement point associated with the application.

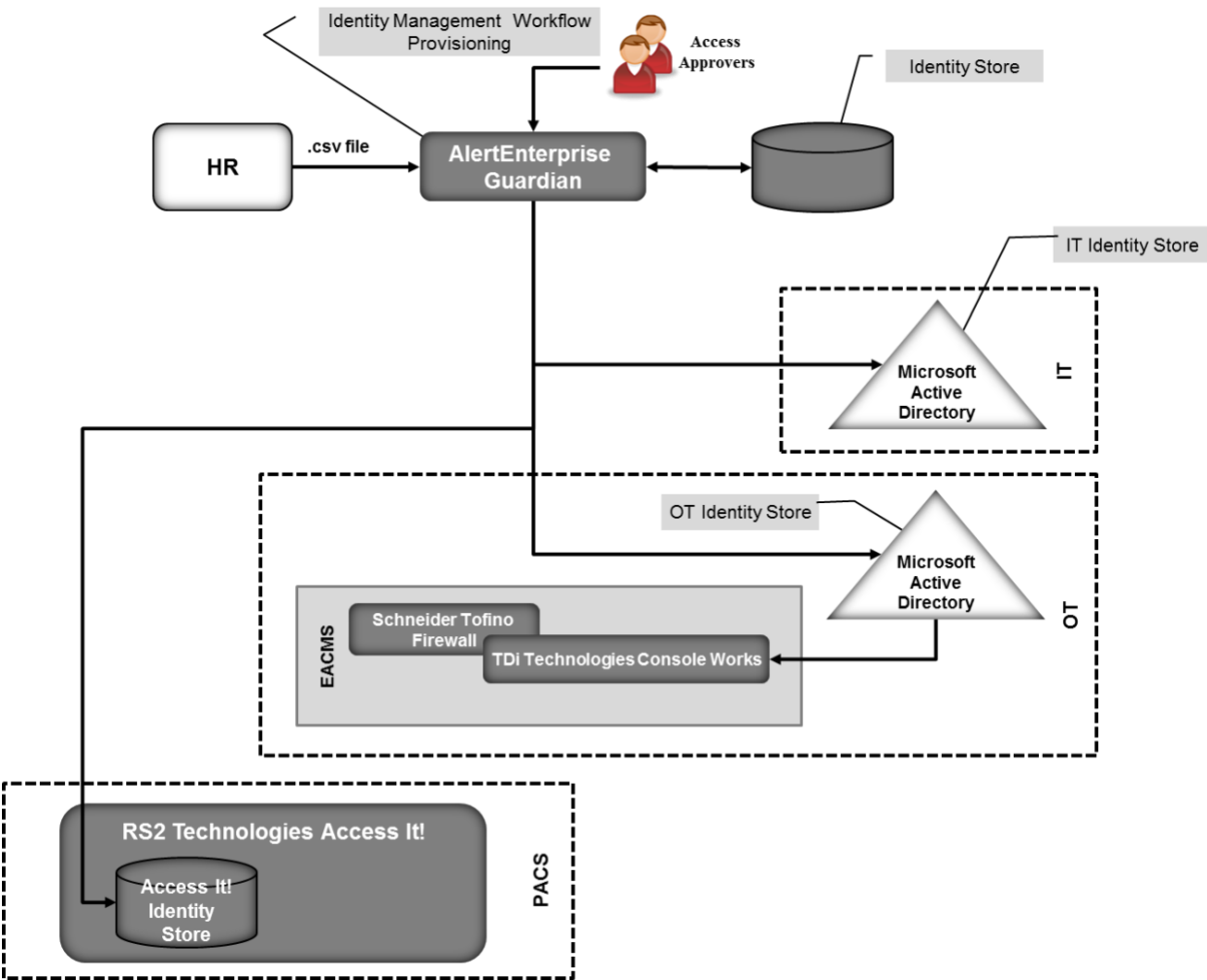
MAG provided an application for the IT silo to demonstrate some of Ozone's capabilities. Other than the MAG demonstration application, a full ABAC capability was not included in the architecture. A separate NCCoE project is creating an ABAC building block that could be used in IT or OT. The application is described in [Appendix A](#) [13].

Cisco ISE controls the ability of devices to connect over the network. ISE expands on basic network address-based control to include the identity of the person using a device. ISE is used in the builds to provide a gateway function between OT and IT, limiting which users and devices are allowed to connect from IT to resources in OT.

## 5.5 Build #3 – An Alternative Core Component Build of the Example Solution

RSA, CA, and AlertEnterprise all provide products that can implement the IdAM workflow, identity store, and provisioning. Our initial builds of the example solution used RSA and CA products to implement the IdAM workflow, the identity store, and AD provisioning. AlertEnterprise Guardian was used to provision the RS2 PACS; however, Guardian can also implement the IdAM workflow, identity store, and both OT and IT provisioning. To illustrate Guardian’s full capabilities, AlertEnterprise created this independent build of the example solution in their labs, using the Guardian product (Figure 5-9). See legend in [Appendix B](#).

Figure 5-9 Build #3



AlertEnterprise Guardian implements the IdAM workflow. It receives input from an HR system in the form of CSV files. We simulated the HR system by using manually produced CSV files because the NCCoE lab does not have an HR system. The preferred solution is a mutually authenticated, integrity-protected connection between an HR system and AlertEnterprise Guardian. Guardian provisions information to Microsoft AD instances in OT and IT. No relationship among these AD instances is assumed.

IT applications are assumed to be integrated with AD, and use credential information and authorization information in the IT AD instance. If there are IT applications that are not integrated with AD, the provisioning capabilities of Guardian would be used to directly provision the applications.

Guardian provisions physical access authorizations into the RS2 PACS. Physical Access and Cardholder life-cycle functions are supported through Guardian workflow to ensure that the right level of access is granted to the right people, based on training, compliance, and security requirements.

An instance of TDi Technologies ConsoleWorks and a Schneider Electric Tofino firewall are installed in the OT silo to implement an EACMS between the EMS / Operations Management network and the ICS/SCADA network. ConsoleWorks is integrated with the OT AD instance. Guardian provisions ICS/SCADA access authorizations in the OT AD instance. ConsoleWorks uses the access authorizations in OT AD to control user access to ICS/SCADA devices.

Additional information about Build #3 is available from the AlertEnterprise website [14].

## 5.6 Build Implementation Description

The infrastructure was built on Dell model PowerEdge R620 server hardware. The server operating system (OS) was the VMware vSphere virtualization operating environment. In addition, we used a 6-terabyte Dell EqualLogic network attached storage (NAS) product, Dell model PowerConnect 7024, and Cisco 3650 physical switches to interconnect the server hardware, external network components, and the NAS.

The NCCoE built two instantiations of the example solution to illustrate the modularity of the technologies. Build #1 uses the CA Identity Manager product. Build #2 uses the RSA Identity Management and Governance (IMG) (now known as RSA VIA Governance and RSA VIA Lifecycle) and RSA Adaptive Directory products.

The lab network is connected to the public internet via a virtual private network (VPN) appliance and firewall to enable secure internet and remote access. The lab network is not connected to the NIST enterprise network. Table 5-1 lists the software and hardware components that we used in the build, as well as the specific function that each component contributes.

**Table 5-1 Build Architecture Component List**

Product Vendor	Component Name	Function
Dell	PowerEdge R620	Physical server hardware
Dell	PowerConnect 7024	Physical network switch
Dell	EqualLogic	NAS
VMware	vSphere vCenter Server Version 5.5	Virtual server and workstation environment
Microsoft	Windows Server 2012 r2 AD Server	Authentication and authority
Microsoft	Windows 7	Information management
Windows	Windows Server 2012 r2 Domain Name System (DNS) Server	DNS
Windows	Structured Query Language (SQL) Server	Database
AlertEnterprise	Enterprise Guardian	Interface and translation between the IdAM central store and the PACS management server
CA	Identity Manager Release 12.6.05 Build 06109.28	Identity and access automation management application, IdAM provisioning
Cisco	ISE Network Server 3415	Network access controller
Cisco	Catalyst 3650	TrustSec-enabled physical network switch
GlobalSign	Digital Certificates	Cloud certificate authority
MAG	Ozone Authority	Central attribute management system
MAG	Ozone Console	Ozone administrative management console
MAG	Ozone Envoy	Enterprise identity store interface
MAG	Ozone Server	Ozone centralized attribute-based authorization server

Product Vendor	Component Name	Function
Radiflow	iSIM – Industrial Service Management Tool	SCADA router management application
Radiflow	SCADA Router RF-3180S	Router/firewall for SCADA network
RSA	Adaptive Directory Version 7.1.5	Central identity store, IdAM provisioning
RSA	IMG Version 6.9 Build 74968	Central IdAM system (workflow management)
TDi Technologies	ConsoleWorks	Privileged user access controller, monitor, and logging system
RS2	Access It! Universal Release 4.1.15 Physical-access-control components	Configures and monitors the PACS devices (e.g., card readers, keypads)
Schweitzer Engineering Laboratories	SEL-2411	Programmable automation controller
Schneider Electric	Tofino Firewall model number TCSEFEA23F3F20	Industrial Ethernet firewall
XTec	XNode	Remote access control and management

### 5.6.1 Build Architecture Components Overview

The build architecture consists of multiple networks that mirror the infrastructure of a typical energy industry corporation. The networks are a management network and a production network ([Figure 5-10](#)). The management network was implemented to facilitate the implementation, configuration, and management of the underlying infrastructure, including the physical servers, vSphere infrastructure, and monitoring. The production network ([Figure 5-11](#)) consists of the following components:

- the demilitarized zone (DMZ)
- IdAM
- IT network – business management systems
- OT network – ICS/SCADA industrial control system and EMS
- PACS network

These networks were implemented separately to match a typical electricity subsector enterprise infrastructure. The network diagrams and descriptions presented here illustrate and explain the laboratory environment that was used at NCCoE to build proof-of-concept implementations of the example solution. This lab architecture is not intended as security guidance. Firewalls block all traffic, except required internetwork communications. The primary internetwork communications are the user-access and authorization updates from the central IdAM systems between the directories and the OT, PACS, and IT networks.

**Figure 5-10 Management and Production Networks**

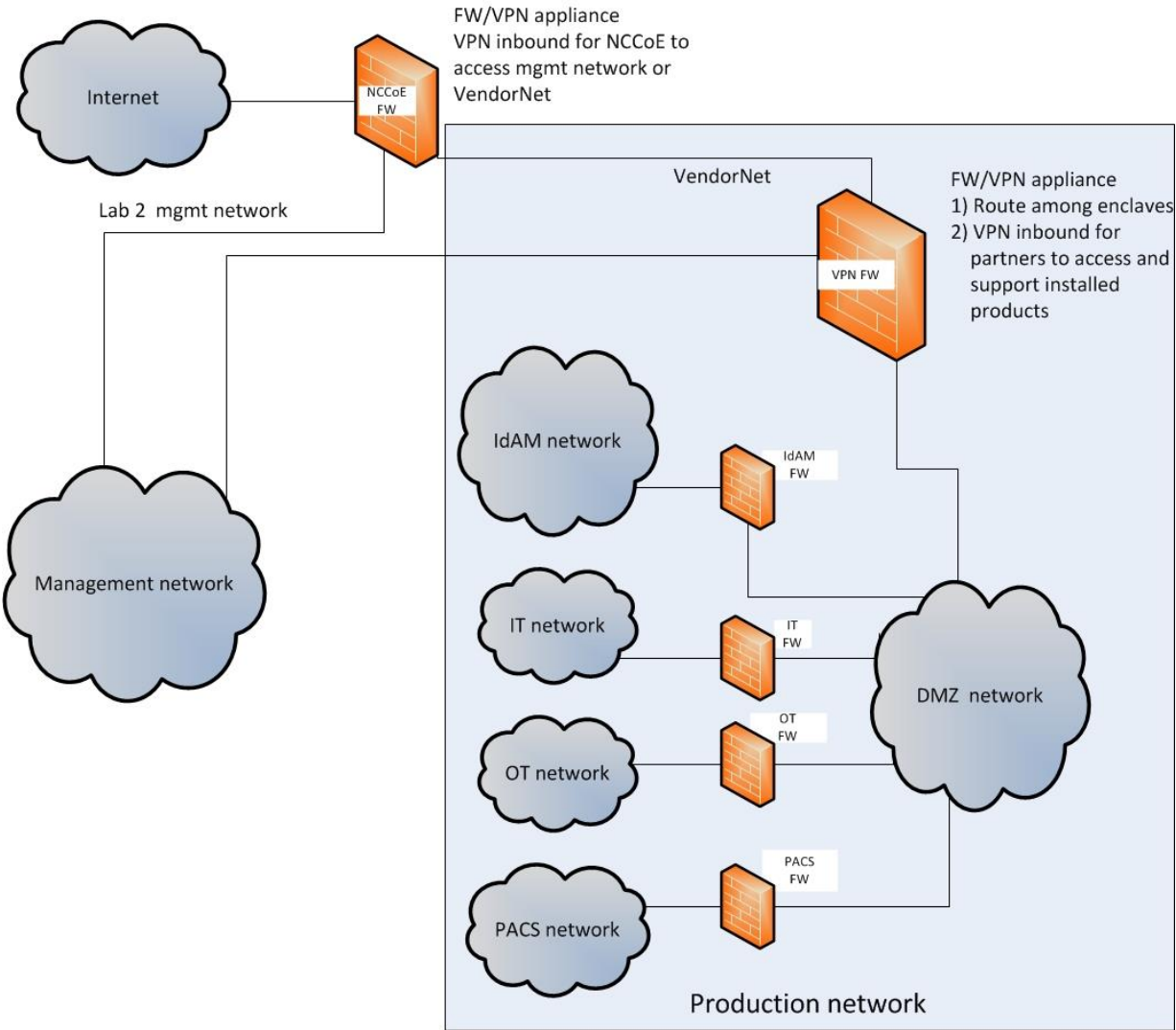
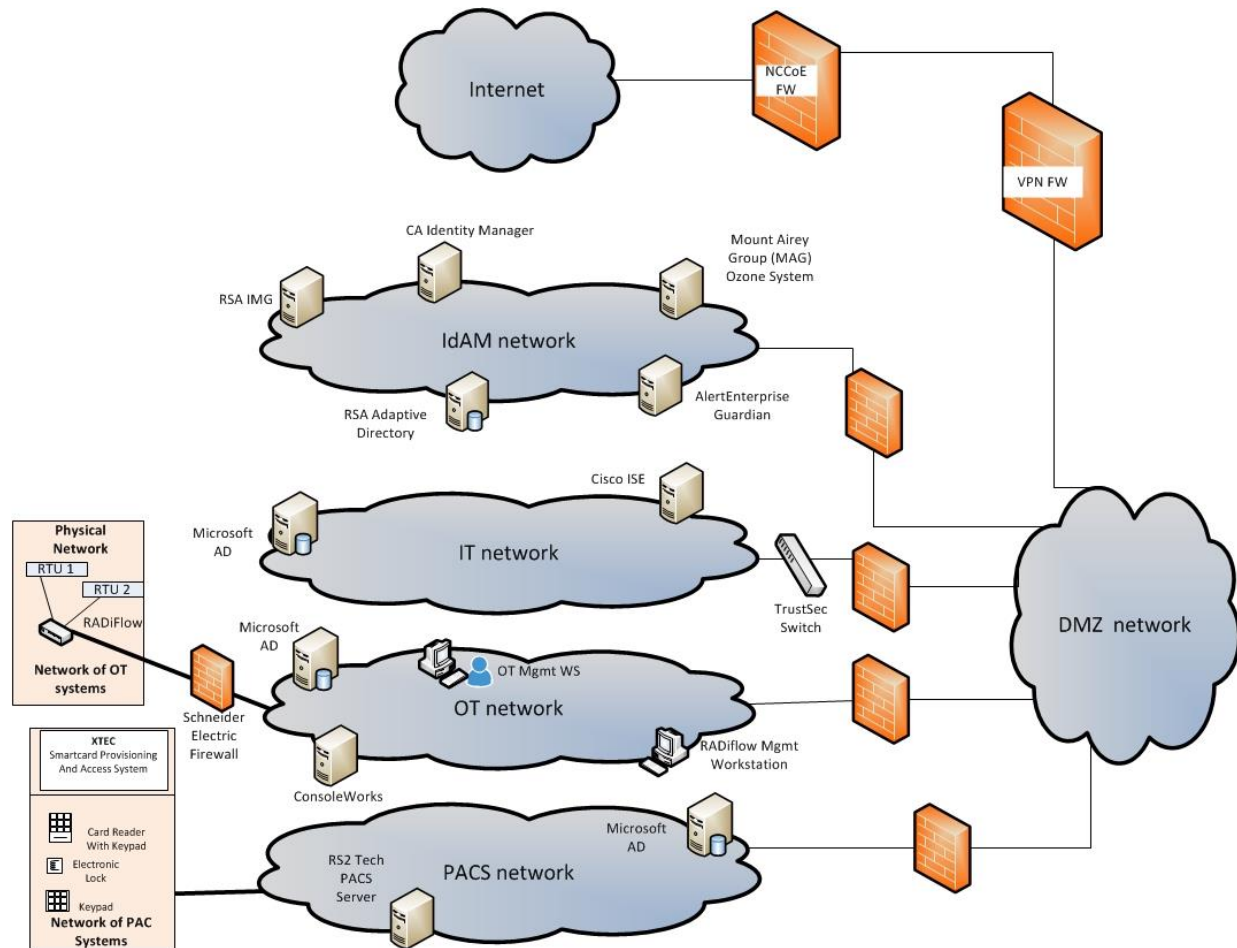


Figure 5-11 IdAM Build Architecture Production Network



The IdAM network represents the proposed converged IdAM network/system. This network was separated into OT, PACS, and IT to highlight the unique IdAM components that were proposed to address the use-case requirements.

The IT network represents the business management network that typically supports corporate email, file sharing, printing, and internet access for general business-purpose computing and communications.

The OT network represents the network that is used to support the EMSs and ICS/SCADA systems. Traffic is allowed into and out of the OT network via the OT firewall, for specific ports and protocols between specific systems identified by IP address.

The PACS network represents the network that supports the PACS across the enterprise. Typically, this network uses the enterprise IT network, and is segmented from the user networks by virtual local area networks (VLANs), which provide traffic and management segregation in the NCCoE Energy Sector lab.



VLANs, alone, should not be considered a security separation mechanism. In our architecture, a firewall allows limited access to and from the PACS network to facilitate the communication of access and authorization information. Technically, this communication consists of user role and responsibility directory updates originating in the IdAM system.

## 5.6.2 Build Network Components

### 5.6.2.1 Internet

The public internet is accessible by the lab environment to facilitate both cloud services and access for vendors and NCCoE administrators.

### 5.6.2.2 VPN Firewall

The VPN firewall is the access-control point for vendors, to support the installation and configuration of their components of the architecture. We used this access to facilitate product training and implementation support. This firewall also blocks unauthorized traffic from the public internet to the production networks. We used additional firewalls to secure the multiple domain networks (OT, PACS, IT, and IdAM).

### 5.6.2.3 Switching and Routing

Switching in the architecture is executed using a series of physical and hypervisor soft switches. VLANs are implemented to segment the networks shown in [Figure 5-10](#) and [Figure 5-11](#). VLAN switching functions are handled by physical Dell switches and the virtual environment. Routing was accomplished using the firewall.

### 5.6.2.4 DMZ

The DMZ provides a protected neutral network space that the other networks of the production network can use to route traffic to/from the internet or each other. The DMZ presented here is designed to support the NCCoE laboratory environment. Organizations should construct DMZs by using the appropriate guidance for their environment, such as NERC Guidance for Secure Interactive Remote Access.

## 5.6.3 Operational Technology Network

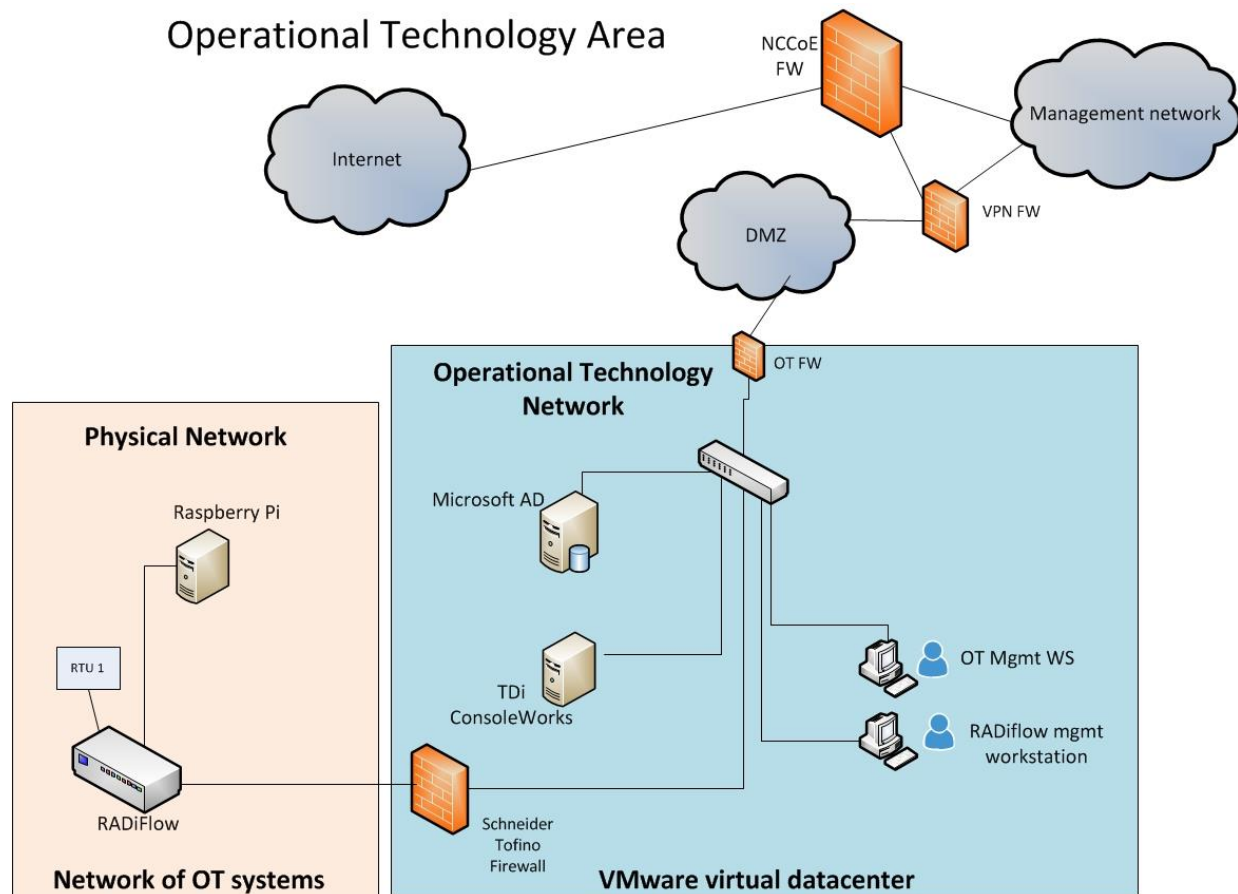
The builds include the following OT network components:

- directory instance
- OT management workstation
- RTU with IP interface
- RTU with serial interface

- ICS/SCADA router
- router management workstation
- ICS/SCADA gateway / access-control system

This network emulates an energy enterprise OT network and systems. The specific vendor products used in this network are identified in Table 5-1 (refer to [Section 5.6](#)) and Figure 5-12.

**Figure 5-12 OT Network**



In the OT network, the Radiflow router performs the ICS/SCADA network firewall function. The ConsoleWorks product provides the access-control/gateway function. The build used the gateway function to manage access to the OT router and RTU management/console interface. The interface can be used to configure the RTU and to issue real-time function commands (e.g., open/close relays). The access-control/gateway function uses the OT directory to obtain access authority for each user requesting access to an RTU.

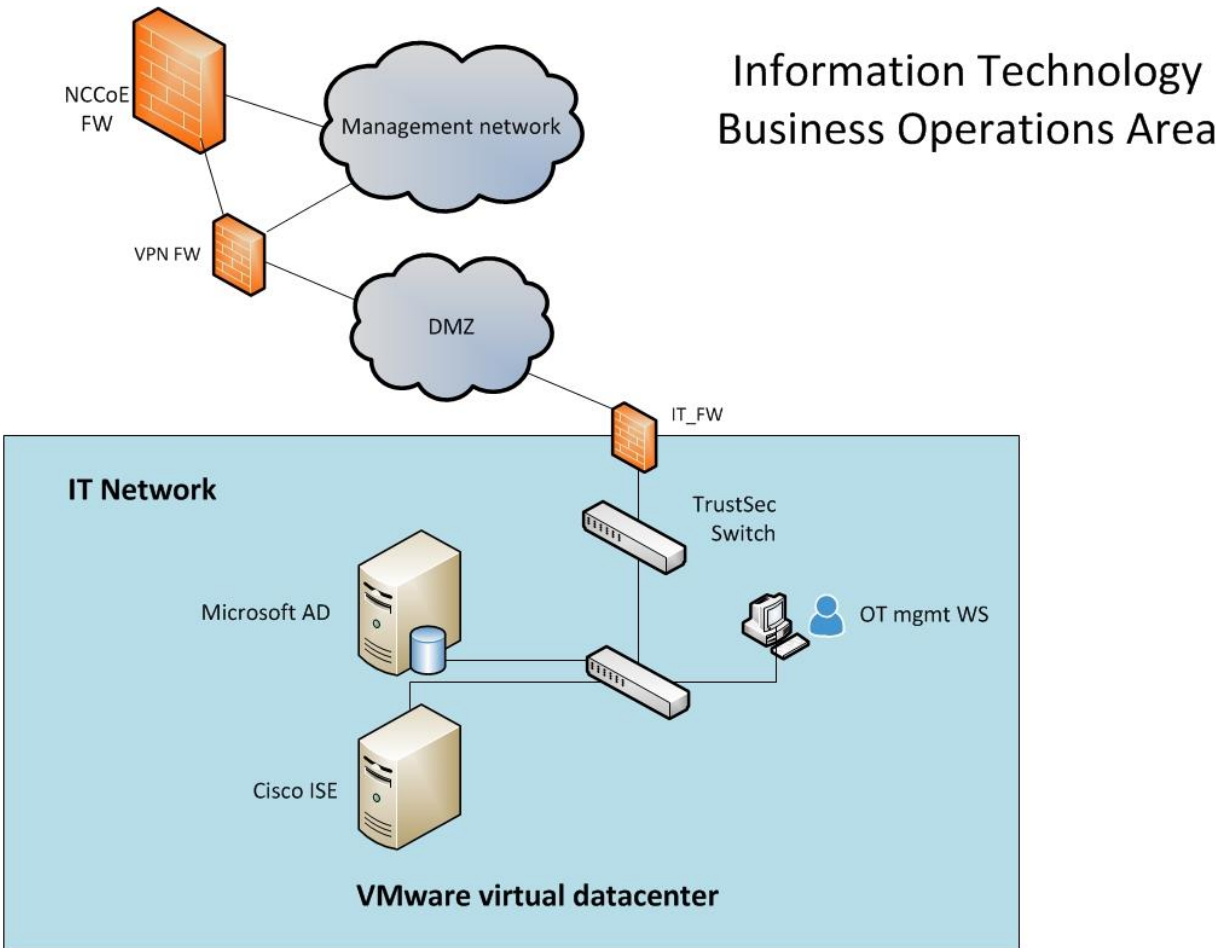
### 5.6.4 Information Technology Network

The builds include the following IT network components:

- AD
- Cisco ISE
- TrustSec switch
- workstation

A typical enterprise includes information-sharing systems, email, and application servers. We did not include these systems in the architecture because they are not needed to demonstrate the effectiveness of the IdAM example solution. The specific vendor products used in this network are identified in Table 5-1 (refer to [Section 5.6](#)) and Figure 5-13.

Figure 5-13 IT Network



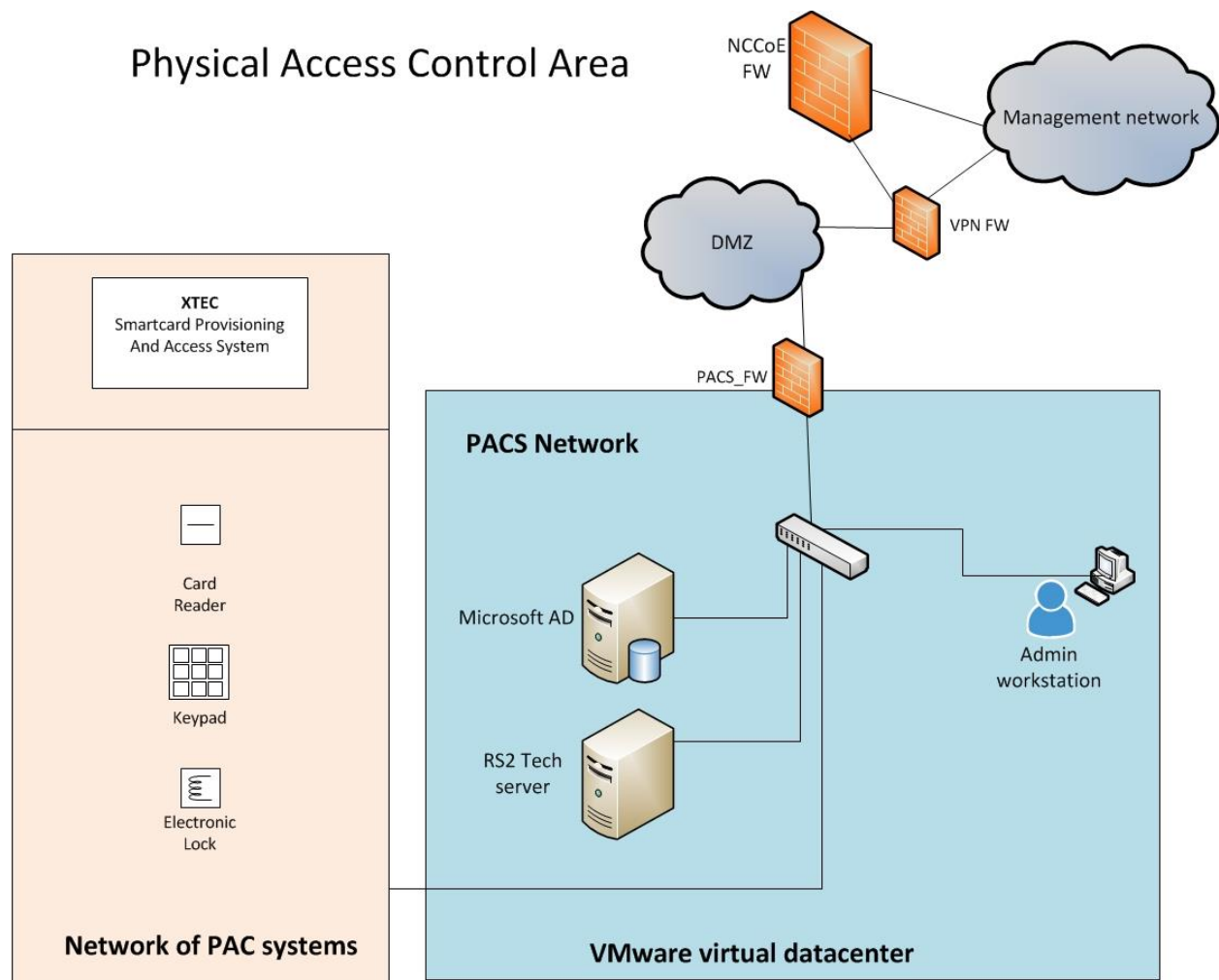
### 5.6.5 Physical Access and Control System Network

The builds include the following PACS network components:

- AD
- PACS control server – Access It!
- integrated access-control unit (including a card reader, keypad, and door strike) – RS2
- workstation

This network emulates a typical enterprise PACS. The specific vendor products used in this network are identified in Table 5-1 (refer to [Section 5.6](#)) and Figure 5-14.

**Figure 5-14 PACS Network**



Two technologies are demonstrated in the PACS network: XTec XNode and RS2 Access It!. XTec XNode is a PACS using smart-card readers, pin pads, and an internet cloud-based authorization service. The cloud service can federate (interoperate) with corporate identity and access stores or can be operated as a fully outsourced PACS IdAM solution. XNode was used as a standalone access-control capability. It was not integrated or federated with the converged IdAM system, and its ability to contribute to compliance with NERC CIP Version 5 security requirements was not addressed. The RS2 system includes card readers, pin pads, and the Access It! local management server. The local management server is integrated with the central identity and access store via the AlertEnterprise Guardian product. In Build #1, Guardian receives IdAM data directly from Identity Manager. Once the information is received, Guardian provisions the information to the PACS management server. In Build #2, Guardian monitors the PACS directory for IdAM changes. Once changes are identified, Guardian collects the information and provisions the IdAM information to the PACS management server.

## 5.6.6 Identity and Access Management Network

### 5.6.6.1 Build #1

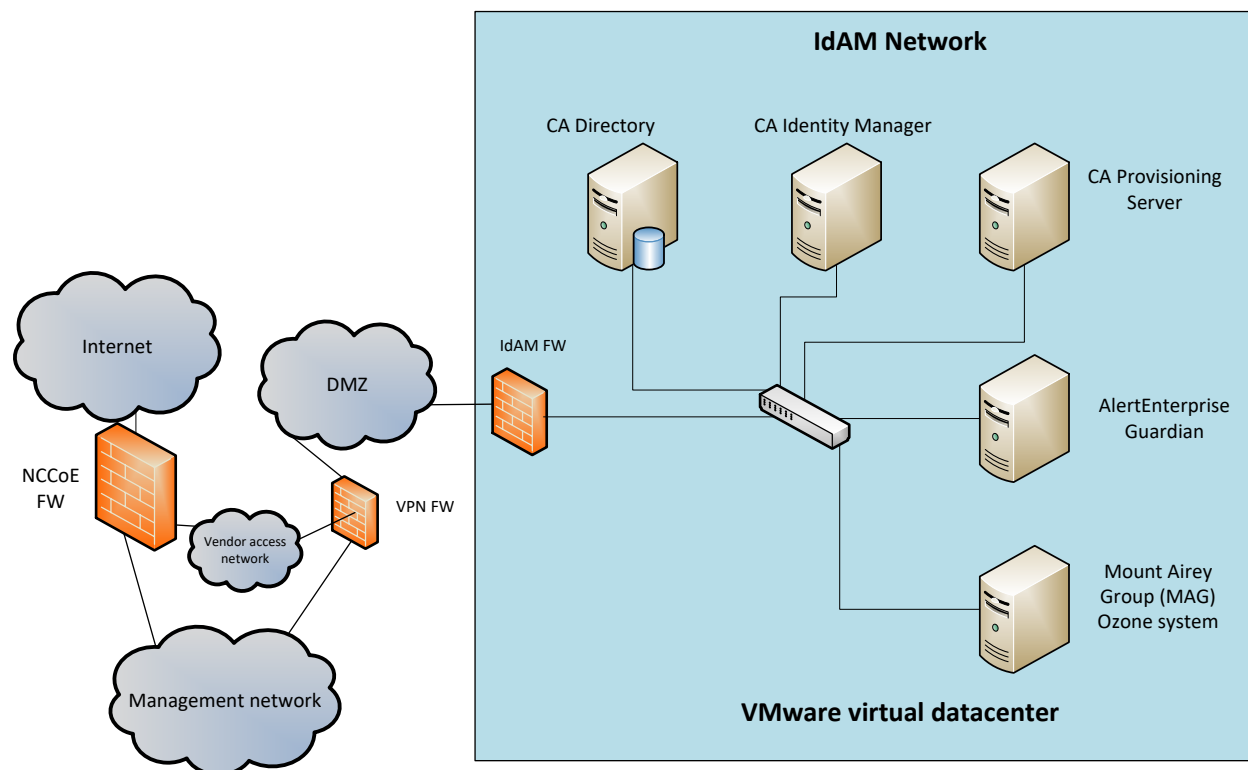
Build #1 includes the following IdAM network components:

- central IdAM system
- PACS IdAM interface system
- SQL server
- MAG Ozone components

The IdAM was separated to highlight the unique IdAM components that were proposed to address the use-case requirements. The implementation is not a recommendation to separate IdAM functions on their own network. The products used in this build are identified in Table 5-1 (refer to [Section 5.6](#)) and Figure 5-15.

Figure 5-15 Central IdAM Network, Build #1

## Identity and Access Management Area



The central IdAM system is the authoritative central store for identity and access authorization data. CA Identity Manager provides a central identity and access store, as well as a workflow management capability, in Build #1 (Figure 5-15). The central IdAM system takes over the control of the directory instances in each silo. The control is implemented by providing an administrative account credential for each managed directory to the IdAM system. This is an important aspect of the implementation. When the administrative credential is issued, the organization must limit access to the managed directories of the IdAM system to a reduced number of administrative users. The security of the solution partially depends on limited access to the managed directories, as discussed in [Section 5.9.6](#).

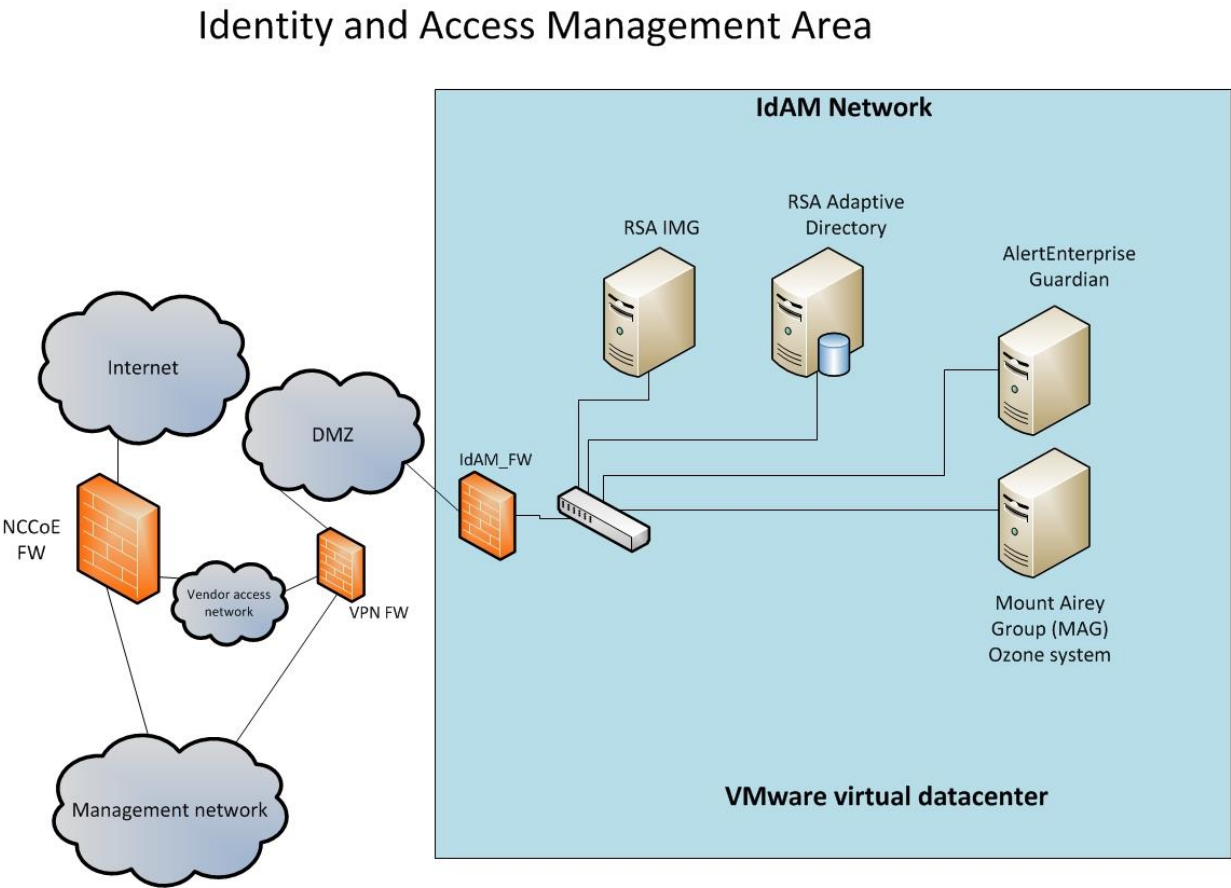
In this build, the OT, PACS, and IT directories synchronize (sync) with the central IdAM system by using Lightweight Directory Access Protocol Secure (LDAPS). This synchronization is set up to immediately sync changes from the IdAM system to each directory. In addition, an automated sync function can be implemented to check for unauthorized changes in each directory to increase the security of the implementation. Automated sync was not implemented in this build.

AlertEnterprise Guardian integrates the IdAM central store with the PACS access management system (Access It!). Guardian includes integration and translation capabilities to transfer the IdAM data to the Access It! management server database. In this build, Guardian is integrated with Identity Manager for IdAM synchronization.

5.6.6.2 Build #2

The IdAM network components include a central IdAM system, PACS IdAM interface system, and the MAG Ozone components. The IdAM network represents the proposed converged IdAM network/system. This network was separated to highlight the unique IdAM components that were proposed to address the use-case requirements. The implementation is not a recommendation to separate IdAM functions own their own network. The products used in this build are identified in Table 5-1 (refer to [Section 5.6](#)) and Figure 5-16.

Figure 5-16 Central IdAM Network, Build #2



The central IdAM systems are the authoritative central store for identity and access authorization data. RSA IdAM products and AlertEnterprise provide central identity and access stores, as well as a workflow management capability. The central IdAM system takes over the control of the directory instances in each silo. The control is implemented by providing an administrative account credential for each managed directory to the IdAM system. This is an important aspect of the implementation. When the administrative credential is issued, the organization must limit the access to the managed directories of the IdAM system to a reduced number of administrative users. The security of the solution partially depends on limited access to the managed directories, as discussed in [Section 5.9.6](#).

In this build, the OT, PACS, and IT directories sync with the central IdAM system by using LDAPS. This synchronization is set up to immediately sync changes from the IdAM system to each directory. The IdAM system automatically syncs with each directory to check for unauthorized changes to increase the security of the implementation.

In this build, Guardian was used to integrate the IdAM system with the PACS access management system (Access It!). Guardian includes integration and translation capabilities to transfer the IdAM data to Access It!. Guardian monitors the PACS directory for IdAM updates.

The MAG Ozone product provides secure attribute distribution within the enterprise. [Section 5.4](#) describes its use.

### 5.6.7 Access Authorization Information Flow and Control Points

The access and authorization for each user is based on the business and security rules implemented in workflows within the central IdAM system products (RSA IMG, CA Identity Manager). The workflows include management approval chains as well as approval/denial data logging. Once the central IdAM system has processed the access and authority request, the updated user access and authorization data is pushed to the central identity store. The central identity store contains the distribution mechanism for updating the various downstream (synchronized) directories with user access and authorization data. This process applies to new users, terminated users (disabled or deleted users), and any changes to a user profile. Changes include promotions, job responsibility changes, and anything else that would affect the systems that a user needs to access.

#### 5.6.7.1 OT Access and Authorization Information Flow

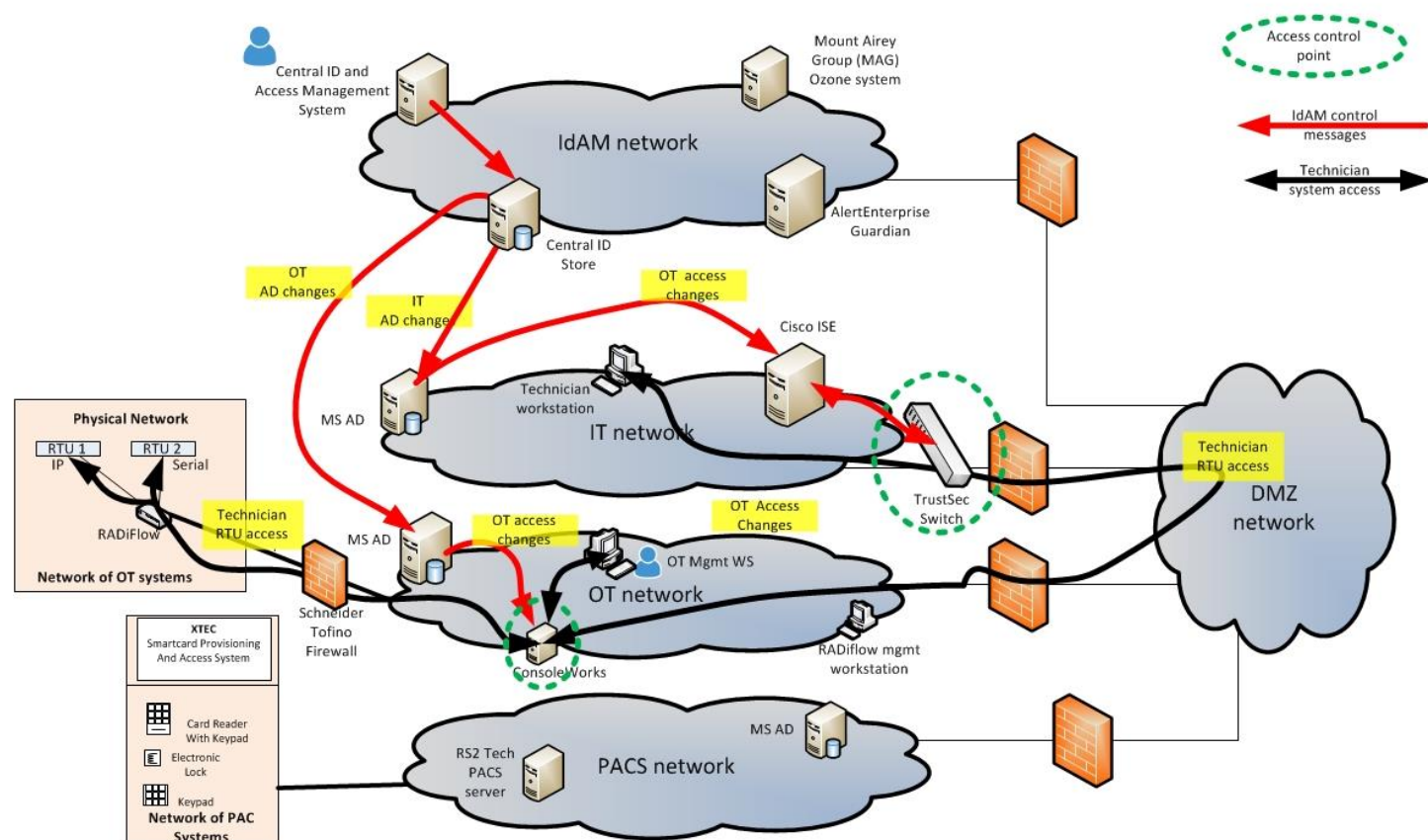
This section describes the OT ICS/SCADA access and authorization information flow for both builds. Figure 5-17 depicts the access and authorization information flow for OT ICS/SCADA devices.



Figure 5-17 Access and Authorization Information Flow for OT ICS/SCADA Devices

## OT Network Identity Access and Management

All messages traverse the DMZ between networks



The red lines in Figure 5-17 indicate the access and authorization data exchanges. The black lines depict the data paths of two OT ICS/SCADA technicians accessing RTUs in the SCADA network (one from the IT network, and one from the OT network). Note that all data routed between networks flows through the DMZ and network firewalls.

In the OT network, ConsoleWorks controls access to the OT ICS/SCADA devices. ConsoleWorks uses the OT directory to determine which users are authorized to access OT ICS/SCADA devices; it is the control point for users accessing OT network devices. ConsoleWorks stores profiles for groups and specific users. The profiles define the OT devices that each user is authorized to access. In addition, ConsoleWorks monitors and logs each user session. This feature allows an organization to monitor user activity, block undesired activities, and generate alerts for suspicious or undesired activities.

In the IT network, a Cisco TrustSec switch controls which users have access to the OT network. ISE controls the TrustSec switch. This provides an Electronic Access Point to the ICS/SCADA network, as described in NERC CIP-005. ISE uses the IT directory identity store to determine user access authority and to limit access to the ICS/SCADA network to authorized users. This capability enhances the enterprise's ability to follow NERC CIP-005. ConsoleWorks also authorizes users to access OT devices.

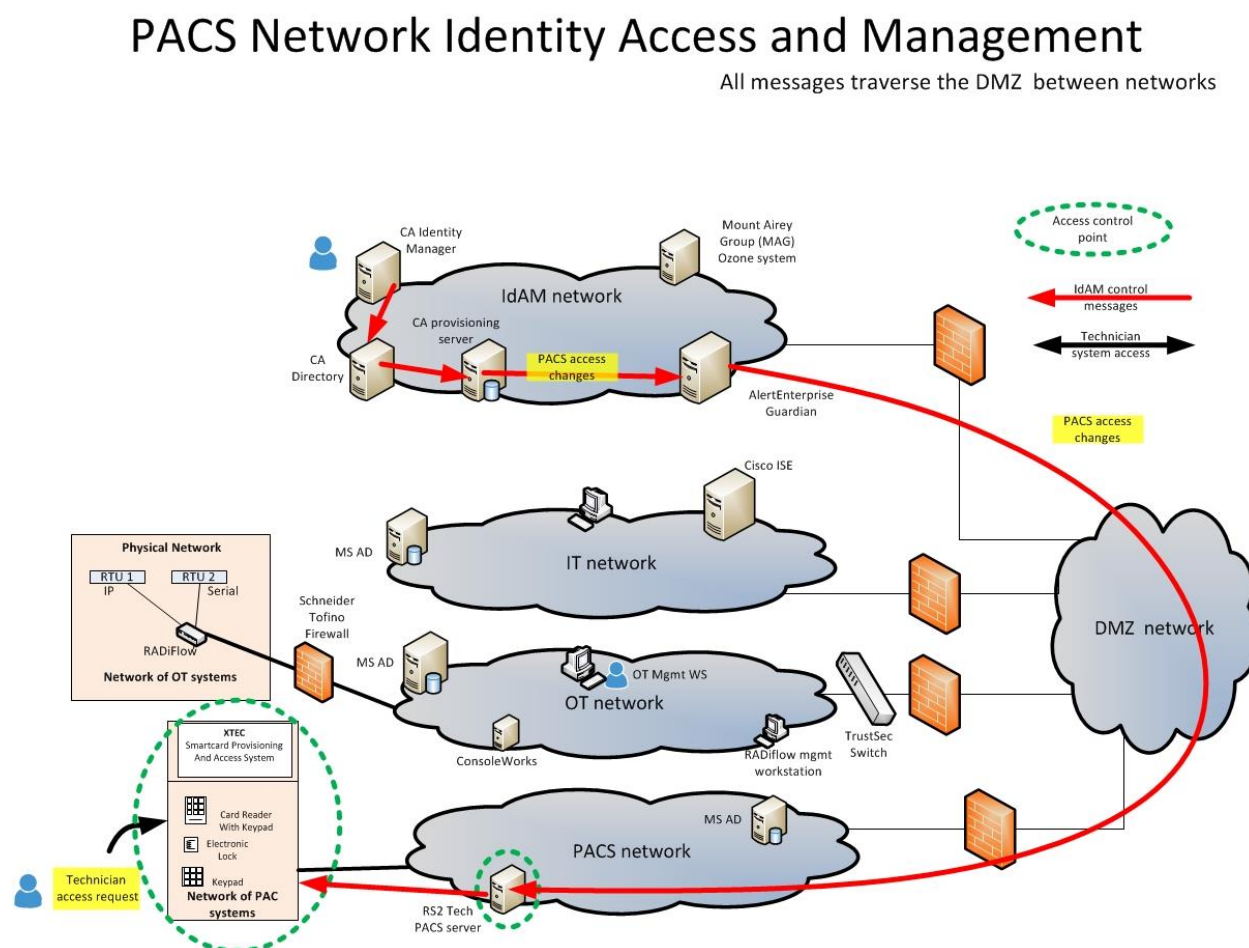
### 5.6.7.2 PACS Access and Authorization Information Flow

The PACS access and authorization information flows in each build are described in this section.

#### 5.6.7.2.1 Build #1

Figure 5-18 depicts the access and authorization information flow for the PACS Network, Build #1.

Figure 5-18 Access and Authorization Information Flow for the PACS Network, Build #1



The PACS network includes devices, such as door locks and keypads. In Figure 5-18, the red lines indicate the access and authorization data exchanges. Note that all data routed between networks flows through the DMZ and network firewalls.

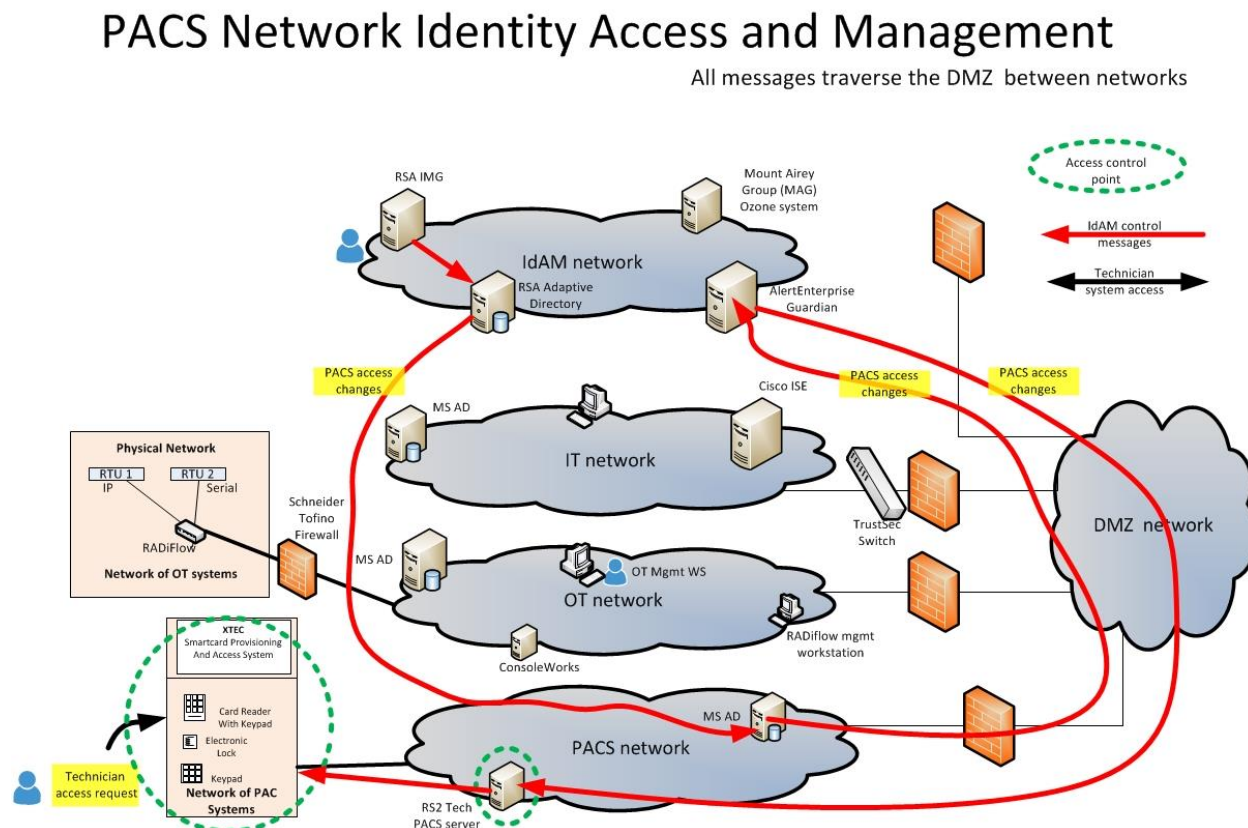
In the PACS network, the Access It! management server controls physical access to facilities, rooms, etc. Access It! updates the PACS devices as needed. The devices also report/log user access to this server for logging/auditing purposes. In most environments, the PACS network is segregated from other networks,

typically using VLANs. Guardian collects the access and authorization data from the Identity Manager provisioning server and provides it to Access It!.

#### 5.6.7.2.2 Build #2

Figure 5-19 depicts the access and authorization information flow for the PACS Network, Build #2.

Figure 5-19 Access and Authorization Information Flow for the PACS Network, Build #2

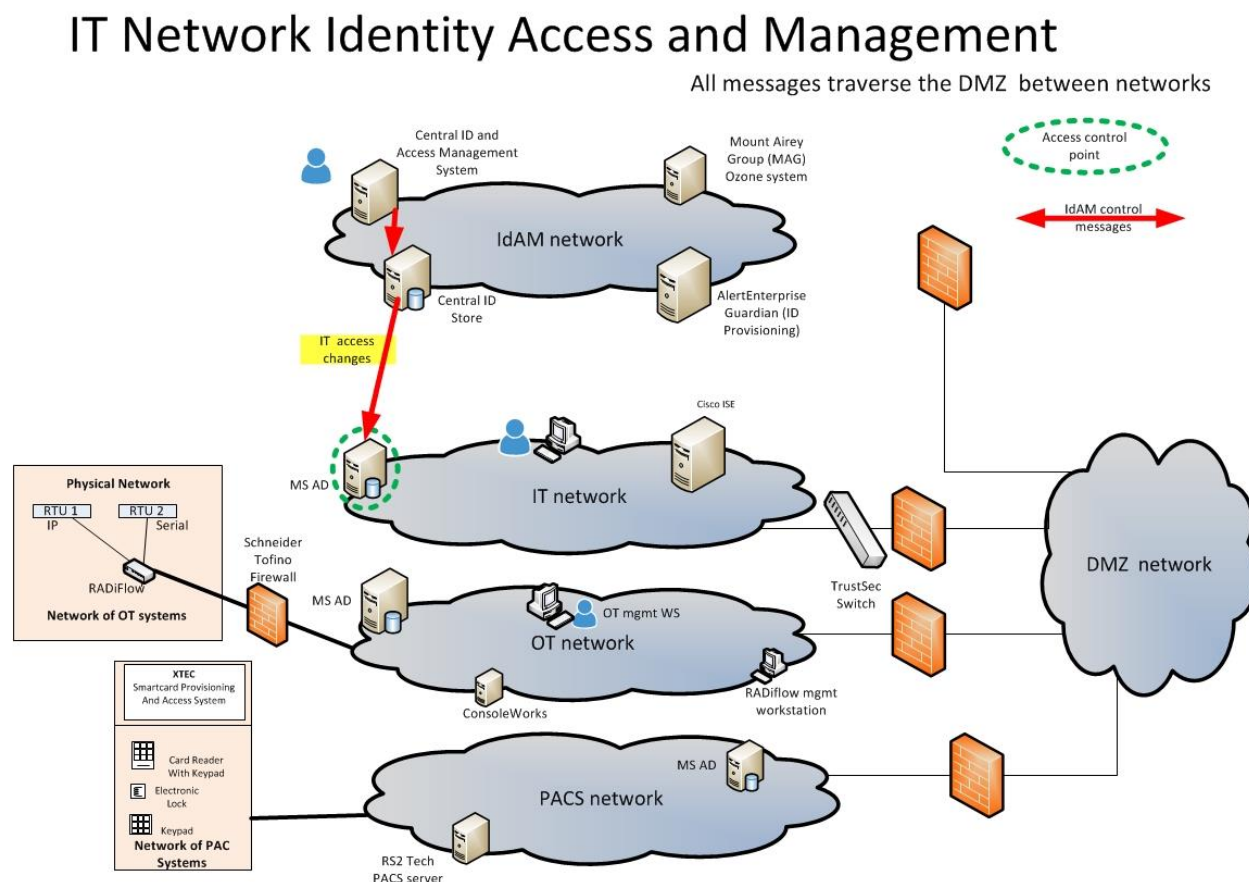


The red lines in Figure 5-19 indicate the access and authorization data exchanges or PACS access in Build #2. The red lines represent logical, not physical, information flows. PACS access changes from RSA Adaptive Directory in the IdAM network to Microsoft AD in the PACS network physically flow through the DMZ network. In this build, IMG provisions all PACS IdAM data to the PACS directory. AlertEnterprise collects the access and authorization data from the PACS directory and provides it to Access It!.

### 5.6.7.3 IT Access and Authorization Information Flow

Figure 5-20 depicts the access and authorization information flow for the IT Network.

Figure 5-20 Access and Authorization Information Flow for the IT Network



The red lines in Figure 5-20 indicate the access and authorization data exchanges in both builds. Note that all data is routed among the OT, PACS, IT, and IdAM networks through the DMZ. In the IT network, the hosts and other systems access the IT directory to determine which users are authorized to access devices on the IT network. AD provides the typical identity store function of storing the access permissions.

## 5.7 Data

The builds required a user data set to populate the central IdAM system. In both builds, the IdAM system was initially populated with user data from a synthetic data set. The data set was designed to mirror a typical HR-system data-set export file. Because the NCCoE lab does not have an HR system, it



used a CSV file, which is a typical HR-system export-file type, to simulate an HR system. The preferred solution is a mutually authenticated, integrity-protected connection between an HR system and the IdAM system. The data included user names, titles, access assignments, unique identifiers, and other details required to complete valid directory entries. Once the set of user data was loaded into the IdAM system, each silo directory was provisioned with the appropriate user data. Each silo directory was pre-configured with the group and attribute fields that are needed to support the builds. For example, the OT network directory had user groups corresponding to the ConsoleWorks user groups. The details are included in the How-To guide (*NIST SP 1800-2C*).

## 5.8 Security Characteristics Related to NERC CIP Version 5

The example solution impacts, and is impacted by, the requirement to conform to NERC CIP Version 5 standards. The NERC CIP cybersecurity standards provide specific requirements that apply to the bulk power system and were used as a reference by the development team. The proposed solution is designed to be CIP-informed. This document attempts to capture some of the key areas where CIP standards are relevant to elements of the solution and its implementation, for reference purposes. Please consult your NERC CIP compliance authority for any questions on NERC CIP compliance.

Because the example solution may control authorizations to access critical cyber assets, it may be subject to security requirements defined in NERC CIP Version 5.

The example solution is informed by NERC CIP Version 5 requirements and may contribute to CIP-aligned implementations by providing mechanisms for efficiently and cost-effectively centralizing the logging and auditing of all IdAM activity. With this solution in place, information regarding which users have access to what components is easily available via the central identity store. Without the solution, this information would have to be gathered separately from each identity store in IT, OT, and PACS.

Table 5-2 describes how the converged IdAM solution relates to some NERC CIP Version 5 requirements.

**Table 5-2 NERC CIP Version 5 Requirements**

NERC CIP Requirement	IdAM Role
CIP 004-5.1 requires completions of training prior to granting electronic access and unescorted physical access to applicable cyber assets.	The IdAM workflow can be configured to check a training system before granting access to critical cyber assets.
CIP 004-5.1 has several requirements related to background investigations, criminal-history checks, and personnel risk assessments being completed before granting logical or physical access to cyber assets.	The IdAM workflow can be configured to verify that individuals have met these requirements before granting access to critical cyber assets.

NERC CIP Requirement	IdAM Role
CIP 004-5.1 requires periodic review and verification of all logical and physical access.	The identity store maintains authoritative information on all logical and physical access to resources. The IdAM workflow can be configured to support periodic access reviews.
CIP 004-5.1 requires timely revocation of logical and physical access when an employee is terminated or changes jobs.	The IdAM workflow receives information on terminations and job changes, from the HR system. It can immediately de-provision access for these employees.
CIP 004-5.1 requires a process based on need to grant logical and/or physical access to assets.	The IdAM workflow is the process for authorizing access. The workflow design and implementation document the process.
CIP-007-5 requires responsible entities to identify and inventory all known enabled default or other generic account types.	The IdAM identity store can maintain this information. The IdAM provisioning capability can ensure that identity stores in OT, IT, and PACS are consistent with the information in the IdAM identity store.

## 5.9 Evaluation of Security Characteristics

The NCCoE gratefully acknowledges the contribution of Sallie Edwards and Susan Symington, from The MITRE Corporation, for writing this section.

The security characteristic evaluation seeks to understand the extent to which the IdAM example solution provides a more secure, uniform, and efficient solution for managing authentication and authorization services and access control across three independent electricity subsector networks. In addition, the evaluation seeks to understand the security benefits and drawbacks of the example solution.

### 5.9.1 Scope

The evaluation included the analysis of the example solution, to identify weaknesses, discuss mitigations, and understand benefits and trade-offs.

We considered the following elements of the IdAM example solution:

- security functionality of the components depicted within the OT, PACS, IT, and IdAM networks in [Figure 5-2](#), and their interactions with each other, with the exception of the XTec standalone access-control system
- analysis of the capabilities and overall workflow process for centralizing the management of authentication and authorization services on, and access control to, the IT, OT, and PACS

networks, including assumptions, threats, vulnerabilities, mitigations, benefits, drawbacks, trade-offs, and risks related to the following characteristics:

- centralization
- automation
- audit (accountability and tracking)
- authentication
- authorization
- access control
- provisioning
- new “cross-silo” attacks that would not have been possible without the converged IdAM capability
- how the example solution addresses the security characteristics listed in the use-case description (<https://www.nccoe.nist.gov/projects/use-cases/idam>)
- security recommendations that should be addressed when deploying the IdAM design in a real-world, operational environment
- hands-on evaluation of the laboratory build, as appropriate, to support the analysis and to demonstrate value
- security-related aspects of the OT, PACS, and IT networks, as they potentially impact the solution posed by the example solution

The following elements of the example solution were not considered:

- evaluation of any specific vendor product or its implementation
- considerations regarding how to secure direct access to each of the three energy networks (OT, PACS, and IT)
- aspects of the build that are specific to the laboratory setting in which the build is implemented

## 5.9.2 Security Characteristics Evaluation Assumptions and Limitations

This security characteristic evaluation has the following limitations:

- The evaluation examines the security claims made by the example solution; however, it is not a comprehensive test of all security components.
- The evaluation cannot identify all weaknesses. Its purpose is to verify that the example solution meets its security claims, and to understand the trade-offs involved in doing so.



- This is not a red team exercise. The intent was to verify the security claims, not to break hardware or software involved in the example solution.
- The lab routers and firewalls were not included in the evaluation. It is assumed that they are hardened. Testing these devices would reveal only weaknesses in implementation that would not be of value to those adopting this example solution.

### 5.9.3 Example Solution Analysis

Table 5-3 lists the example-solution components, their functions, and the security characteristics that they provide. This analysis focuses on these security capabilities, rather than on the vendor-specific components. In theory, any number of commercially available components can provide these security capabilities. Some of these components are in Build #1 of the IdAM example solution, and other components are in Build #2. We discuss these components as generic components that provide a specific security functionality, rather than as vendor products. One vendor product could be substituted for another vendor product that provides the same security functionality, without affecting the results of the evaluation.

**Table 5-3 IdAM Components and Security Capability Mapping**

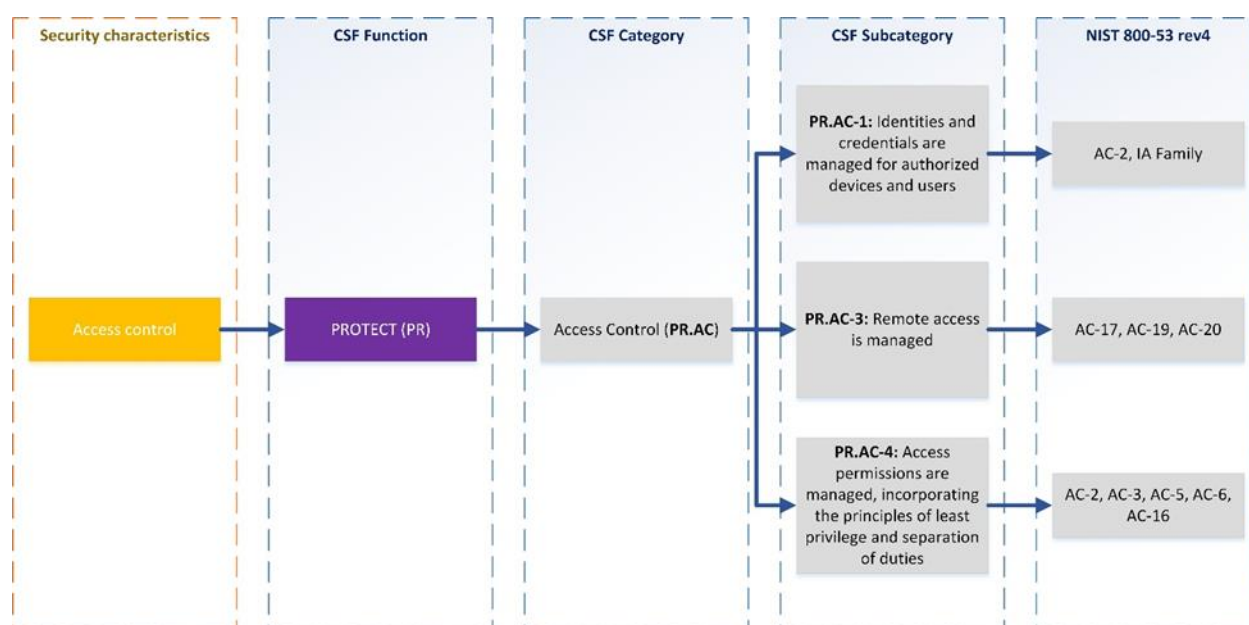
Component	Specific Product	Function	Security Characteristic
Identity, authorization, and workflow manager	RSA IMG or CA Identity Manager	IdAM workflow engine; manages identities, credentials, and authorization for all other network components in the use case; enforces workflows to ensure that access-control policies are enforced	Authentication and authorization
Identity store	RSA Adaptive Directory (identity store), which is used with RSA IMG, or Windows SQL 2012, which is used with CA Identity Manager	Database of user identities	Authentication and authorization

Component	Specific Product	Function	Security Characteristic
High-assurance attribute service	MAG Ozone system	Access control solution with ABAC architecture; provides increased assurance by signing attributes with private key infrastructure (PKI) and requiring users to authenticate with PKI	
Translator between the AD and the PACS and OT access management systems	AlertEnterprise Guardian	Translates from RSA/CA IdAM stores on the IdAM network to OT and PACS access management systems, enabling access management devices in the OT and PACS networks to be provisioned from the IdAM network	Authorization and access control
Directory service	Microsoft AD (for IT devices) or RS2 PACS server (for PACS devices)	Database of PACS or IT resource and user identifiers, and their associated security policies	Authentication and authorization
SCADA router and the remote manager of the SCADA router	Radiflow	IP-addressable industrial control system gateway that enables remote control of physical devices: management workstation enables remote management of physical SCADA router; SCADA router serves as firewall, terminal server, and IP-to-serial connectivity	Access control
Network access-control and policy-enforcement system	Cisco ISE	Allows access policies for network endpoints to be controlled centrally	Network security
Standalone smart-card provisioning and access system	XTec	Smart-card-based physical access control	Authentication, authorization, and access control

## 5.9.4 Security Characteristics Addressed

One aspect of our security evaluation involved assessing how well the IdAM example solution addresses the security characteristics that it was intended to support. These security characteristics are listed in a security control map published in the appendix of the IdAM use-case description [10]. Six security characteristics are listed in the security control map, each of which is further classified by the Cybersecurity Framework (CSF) categories and subcategories to which they map. The CSF subcategories further map to specific sections of each standard or best practice that are cited in the CSF in reference to that subcategory. Figure 5-21 depicts an example of the process for determining the security standards-based attributes for the example solution.

**Figure 5-21 Example Process for Determining the Security Standards-Based Attributes for the Example Solution**



We used the CSF subcategories to provide structure to the security assessment by consulting the specific sections of each standard or best practice that are cited in reference to that subcategory. The cited sections provide example-solution validation points by listing specific traits that a solution that supports the desired security characteristics should exhibit. Using the CSF subcategories as a basis for organizing our analysis, and consulting the specific sections of the security standards that are cited with respect to each subcategory, allowed us to systematically consider how well the example solution supports the security characteristics identified in the use-case description.

The remainder of this subsection discusses how the example solution addresses the six desired security characteristics that are listed in the use-case description appendix [10]:

- authentication for OT
- access control for OT
- authorization (provisioning) for OT
- centrally monitor the use of accounts
- protect the exchange of identity and access information
- provision, modify, or revoke access throughout all federated entities

The remainder of this subsection also discusses how the authentication, access control, and authorization (provisioning) security characteristics are addressed for PACS, not just for OT.

#### *5.9.4.1 Authentication, Access Control, and Authorization for OT*

The implementation includes the capabilities that support these security characteristics. [Section 5.6.7.1](#) describes the information flows for supporting authentication, access control, and authorization (provisioning) on the OT network.

#### *5.9.4.2 Centrally Monitor Use of Accounts*

The example solution supports converged accountability and tracking of user accounts, with the IdAM identity, authorization, and workflow manager acting as the locus of this capability.

On the OT network, the console access manager, which acts as the gatekeeper to all ICS/SCADA devices, monitors and logs all ICS/SCADA access requests and responses, as well as all user interactions with the ICS/SCADA OT devices. These logs should be centrally monitored along with other ICS/SCADA OT monitoring within the enterprise.

The network access-control component also logs all access requests and responses received at, and generated by, the IT network switch that controls access to the OT network from the IT network. These logs should be centrally monitored along with other ICS/SCADA OT monitoring within the enterprise.

On the PACS network, the PACS devices also report/log user access requests and responses to the PACS server. These logs should be centrally monitored along with other ICS/SCADA OT monitoring within the enterprise. In addition, the IdAM identity, authorization, and workflow manager and the translator component log the PACS access change (add, delete, or change) requests.

While these technical security controls provide capabilities to capture the information needed for accountability, they are only effective when combined with necessary procedural and managerial security controls. Implementation of these controls is outside the scope of this guide.

### 5.9.4.3 Protect Exchange of Identity and Access Information

All IdAM-related information exchanges between IdAM components (as shown by the red lines in [Figure 5-17](#) through [Figure 5-20](#)) should be performed in protected mode. In other words, at the least, integrity checking mechanisms are performed on this communication so that tampering can be detected. Preferably, these communications are encrypted. In particular, the following information exchanges should be performed in protected mode:

- all information exchanges to/from the directory services in the IT, OT, and PACS networks
- all information exchanges between the console access manager (e.g., the ConsoleWorks component shown in [Figure 5-17](#)) and the OT directory service
- all information exchanges between the PACS server and the PACS translator component (e.g., the AlertEnterprise component shown in [Figure 5-18](#) and [Figure 5-19](#))

Because of time constraints, the laboratory builds of the example solution did not include encryption or integrity assurance for every IdAM information exchange. Nevertheless, such protection is strongly recommended when deploying the example solution.

### 5.9.4.4 Provision, Modify, or Revoke Access

User authorizations for the use of all IT, OT, and PACS network account assets, for ICS/SCADA devices and for physical access to rooms, facilities, etc., are provisioned, modified, and revoked by modifying user authorization information in the central IdAM identity, authorization, and workflow manager (CA Identity Manager or RSA IMG). These components, in turn, propagate the changes to all entities that are used to make local authorization and access determinations. Such information propagation ensures that all attempts to access IT, OT, and PACS network assets, SCADA devices, and rooms and facilities are uniformly handled because they are subject to the same updated access and authorization information when the silo directory, console manager, PACS server, or other IdAM device is consulted in response to the access attempt.

## 5.9.5 Assessment of Reference Architecture

The IdAM example solution is not intended to encompass all aspects of electricity subsector organization operations. It was designed to centralize the management of authorization and access in three disparate IdAM silos. Thus, our assessment considers the solution itself, not the broader problem of providing general security to all aspects of electricity subsector organization operations.

The example solution includes three network silos (OT, PACS, and IT), plus an IdAM network with numerous components that provide centralization, uniformity, and efficiency through the use of IdAM workflows. All threats and vulnerabilities that are present on the IT, OT, and PACS networks are also present in the example solution, so they will need to be addressed during solution deployment. This evaluation assumes that the OT, PACS, and IT networks are already protected by using physical-access-

control and network-security components, such as firewalls and intrusion detection devices that are configured according to best practices.

#### *5.9.5.1 Threats, Vulnerabilities, and Assumptions*

This evaluation concerns the IdAM network itself, its components, and their interaction with IdAM components on the IT, OT, and PACS networks, which provide the benefits afforded by the example solution and introduce new attack surfaces and potential threats. For example, each of the IT, OT, and PACS networks has directory service components that must be secured. If the information in these directories is not safeguarded against tampering, the organization is at risk. These directories must be safeguarded in both the existing three-silo architecture and the example solution. The example solution, however, includes additional, related directory components that must also be protected, as described in [Section 5.6](#).

The identity, authorization, and workflow manager and the identity store on the IdAM network must be protected from unauthorized access, and their information must be safeguarded. All of the data in the directory service components in the OT, PACS, and IT networks is accessible by the identity, authorization, and workflow manager and the identity store. The ability to propagate data from the IdAM network to the OT, PACS, and IT networks is the main strength, and the greatest vulnerability, of the example solution. If the IdAM identity store, or the identity, authorization, and workflow manager that has access to it, were compromised, this would equate to a compromise of each of the directory services in the IT, OT, and PACS networks. As a result, controlling access to the IdAM network and to each IdAM component, and securing communications among IdAM components, is essential to securing the example solution. Therefore, the analysis of the security of the IdAM network, its components, and the communications among IdAM components is central to the evaluation of the IdAM example solution.

##### *5.9.5.1.1 Controlling Access to the Identity, Authorization, and Workflow Manager*

The identity, authorization, and workflow manager on the IdAM network contains information regarding actual users and accounts for the OT, PACS, and IT networks. It manages the identities and credentials for the rest of the use case, but it does not manage them for itself. In other words, the identity, authorization, and workflow manager component itself does not control user access to the identity, authorization, and workflow manager. It has a separate set of user accounts and passwords that are specific to this component and that IdAM administrators use to log into it. This access must be strictly controlled so that only authorized IdAM administrators can log into the identity, authorization, and workflow manager. Users or authorized systems (such as an HR system or a work order management system) must log into the identity, authorization, and workflow manager to provision all electricity subsector systems (i.e., add identity information and authorization rules for new users, delete information for former users, and modify information as user authorizations change). The risks associated with access to the IdAM workflow are described in [Section 4.3.2](#).

There is no AD running on the IdAM network. In the builds, access to the identity, authorization, and workflow manager and to all other components of the IdAM network is granted by the use of a username and credential, presented via either a web interface or each machine's OS console. An organization deploying the example solution operationally would, of course, be free to implement alternative access-control mechanisms. While both privileged and unprivileged users may access the identity, authorization, and workflow manager and other IdAM components, only highly privileged users should be permitted to create, delete, or modify accounts. Monitoring, logging, and auditing all activity that is performed directly on IdAM components, such as the identity, authorization, and workflow manager or the identity store, is essential to ensure that authorized users are not performing unauthorized activities.

#### 5.9.5.1.2 Logging Activity on IdAM Components

Logging all activity that is performed on IdAM components is crucial for securing the example solution. Ideally, access to all components on the IdAM network should be logged for the purpose of auditing and accountability. The example solution is designed to allow the logging of all user activity on IdAM systems (e.g., identity, access, and authorization changes). The example solution should also log all activity that is performed by administrators so that no activity is exempt from monitoring, logging, and auditing. This section provides a closer look at the following three different types of IdAM system users (in terms of the amount of privilege that they have) and whether or not their activity should be logged:

- unprivileged users
- administrators
- super-administrators

Unprivileged users, by definition, are not authorized to interact with any IdAM system. They cannot create an account on the identity, authorization, and workflow manager, or modify the privileges of a user who already has an account. A user who works for HR, for example, who needs to add a user identity or modify a user's authorizations, would have an account on the identity, authorization, and workflow manager (that was set up by a privileged user) that allows him/her to add to or modify the information in the identity, authorization, and workflow manager component via a web interface. Such a user would never be able to access the identity, authorization, and workflow manager via its machine's OS console. Console access would enable the user to manage the OS on which the component is running. All that the unprivileged user needs is the ability to use his/her own, unprivileged, user-level account on the identity, authorization, and workflow manager's machine. Because the example solution is designed to monitor and log all activity that occurs over a web interface, it will log all unprivileged user activity.

Administrators, by definition, can access OS consoles and create user accounts on IdAM machines, such as the identity, authorization, and workflow manager. However, they are not authorized to change the access-control policies within the console access manager. As a result, when administrators access the



consoles of an IdAM system OS, they must do so via the console access manager. The console access manager will log and monitor all administrator activity at any OS console.

Super-administrators, by definition, can not only access machine consoles and create user accounts on IdAM machine OSs, but they can change the access-control policies within the console access manager. Therefore, the example solution cannot force them to use the console access manager when accessing the consoles of IdAM system machine OSs. If super-administrators do access the consoles of IdAM system machine OSs, and do so not via the console manager, then their activity will not be logged or monitored. So, while super-administrators should be strongly encouraged by policy to use the console access manager, IdAM does not provide a technical mechanism to ensure that they will use the console access manager.

Access to the identity store on the IdAM network also must be strictly controlled, and the identity store should be configured so that it will only perform addition, modification, and deletion requests that are received from the identity, authorization, and workflow manager. If the identity store were to accept updates or edits from another entity, the result could be catastrophic. Any updates made by an administrator would have to be made via the machine console, so, at least, these updates would be logged. Updates made by a super-administrator could escape detection if the super-administrator were to defy organization policy and access the identity store console without going through the console access manager. We acknowledge insider threats, but feel that mitigating the risk of insider threats presently relies more on organizational policy decisions than on technology. Therefore, addressing insider threat is outside the scope of this project.

#### 5.9.5.1.3 Unauthorized Modification of Access and Authorization Information

User identity and credential information is added into the identity, authorization, and workflow manager, and then propagated to other IdAM components. If this information were deleted, modified, or falsified while in transit between components or while stored in a component, the result could be catastrophic. It is essential to protect access to each IdAM component so that adversaries cannot modify IdAM information stored in the components, and so that IdAM information has, at least, its integrity and, ideally, its confidentiality protected when in transit between IdAM components.

#### 5.9.5.2 Mitigations: Essentials for Securing the IdAM Example Solution

Based on the information flows for supporting OT authentication, OT access control, and OT authorization described in [Section 5.6.7](#), securing the part of the IdAM example solution that supports OT access control requires the following actions:

- securing access to the following components:
  - identity, authorization, and workflow manager; identity store; and network access-control components on the IdAM network (i.e., ensuring that only authorized users can access and add, modify, or delete information on these components)



- directory service and console access manager components on the OT network (i.e., ensuring that only authorized users can access and add, modify, or delete information on these components)
- IT network access-control switch that serves as a gateway to the OT network from the IT network
- protecting the integrity of the information exchanges between the following components:
  - identity manager and the identity stores
  - identity store and the directory service on the OT network
  - directory service and the console access manager components on the OT network, as well as the network access-control and policy-enforcement system within the IT network
  - network access-control and component identity stores
  - network access-control component on the IT network and the IT network access-control switch that serves as a gateway to the OT network

Based on the information flows for supporting PACS authentication, PACS access control, and PACS authorization described in [Section 5.6.7](#), securing the part of the IdAM example solution that supports PACS access control requires the following actions:

- securing access to the following components:
  - identity, authorization, and workflow manager; identity store; and IdAM translator components on the IdAM network (i.e., ensuring that only authorized users can access and add, modify, or delete information on these components)
  - IdAM identity store and PACS directory service components on the PACS network (i.e., ensuring that only authorized users can access and add, modify, or delete information on these components)
- protecting the integrity of the information exchanges between the components:
  - identity manager and identity stores
  - identity store on the IdAM network and the PACS directory service on the PACS network
  - IdAM translator component on the IdAM network and the IdAM directory service on the PACS network
  - IdAM translator component on the IdAM network and the PACS management server on the PACS network

### 5.9.5.3 Trade-offs

As mentioned earlier, the very characteristics that are the main objectives of the example solution, namely centralization and uniformity of the management of authorization and access, are also its main vulnerabilities. A successful attack on the IdAM network or its components could result in a compromise of one or all of the OT, PACS, and IT networks. Organizations that implement the example solution may incur additional costs to secure the IdAM network and its components.

#### 5.9.5.3.1 Benefits

The benefits of the IdAM example solution include consolidated management of identity and access audit data; documented and repeatable business and security access decision processes (workflows); approval/denial data logging; rapid provisioning and de-provisioning using consistent, efficient, and automated processes; and better situational awareness through the ability to track and audit all access requests and other IdAM activity across all four networks (IT, OT, PACS, and IdAM). Other important benefits include greatly reduced time to implement access-control changes, and highly automated identity synchronization across silos. For example, an OT, PACS, and/or IT access change request can be implemented within minutes. These benefits directly reduce the cost of the regulatory audit requirements imposed on the energy industry. They also enable IdAM processes to be handled efficiently, and with more granular, prompt, and cost-effective control.

### 5.9.6 Security Recommendations

While the example solution provides a converged IdAM security solution, the solution itself provides a single attack vector that, if compromised, could have devastating consequences. Therefore, an organization that implements the example solution must take great care to secure the IdAM example solution itself. When deploying their own implementations, organizations should adhere to the following security recommendations:

- Conduct their own evaluations of their example-solution implementation.
- Deploy all components on securely configured OSs that use multifactor authentication and are configured according to best practices, based on Defense Information Systems Agency (DISA) Security Technical Implementation Guides (STIGs) [15] and example secure configuration guidelines found in the Center for Internet Security (CIS) Security Benchmarks [16].
- Ensure that all OSs on which example-solution implementation components are running are hardened, maintained, and kept up-to-date in terms of patching, version control, and virus and malware detection.
- Put into place a security infrastructure that will protect the example solution itself, and will secure the communications among the components on the IdAM network and between these components and the IdAM components on the other three networks, as described in [Section 5.9.5.2](#). Many of the remaining recommendations relate to providing such a security infrastructure.

- Design the authorization and workflow policies that are enforced by the identity, authorization, and workflow manager component, to enforce the principles of least privilege and separation of duties.
- Design the authorization and access-control policies that govern user access to the IdAM components themselves, to enforce the principles of least privilege and separation of duties.
- Segregate IdAM components onto their own network, either physically or by using private VLANs and port-based authentication, or similar mechanisms (e.g., in IEEE 802.1X, a standard for port-based network access control [17] that provides an authentication mechanism to devices that are to be attached to a local area network).
- Deploy a security infrastructure to secure the IdAM network and the IdAM platforms themselves. This infrastructure must consist of a holistic set of components that work together to prevent the IdAM network, components, and workflow from being used as an attack vector.
- Protect the IdAM network by using security components, such as firewalls and intrusion detection devices that are configured according to best practices (e.g., in NIST SP 800-41 Revision 1, Guidelines on Firewalls and Firewall Policy [18]).
- Protect each of the OT, PACS, and IT networks by using security components, such as firewalls and intrusion detection devices that are configured according to best practices.
- Strictly control physical access to the OT, PACS, IT, and IdAM networks.
- Configure firewalls to limit connections between the IdAM network and the production (IT, OT, and PACS) networks, except for the connections needed to support required internetwork communications to specific IP address and port combinations in certain directions.
- Perform, in protected mode, all IdAM-related information exchanges between IdAM components (as shown by the red lines in [Figure 5-17](#) through [Figure 5-20](#))—meaning that, at the least, integrity-checking mechanisms are performed on this communication so that tampering can be detected. Preferably, these communications should be encrypted. In particular, the following information exchanges should be performed in protected mode:
  - all information exchanges to/from the directory services in each of the OT, PACS, and IT networks
  - all information exchanges between the console access manager (i.e., the ConsoleWorks component in [Figure 5-17](#)) and the OT directory service
  - all information exchanges between the network access-control manager (i.e., the Cisco ISE component in [Figure 5-17](#)) and the switch in the IT network that controls access to the OT network
  - all information exchanges between the PACS server and the PACS translator component (e.g., the AlertEnterprise component in [Figure 5-18](#) and [Figure 5-19](#))

In the case of IdAM exchanges with the silo directories, protected mode is defined as the use of Start Transport Layer Security (TLS) [19], rather than LDAPS, which uses Secure Socket Layer and has been deprecated in favor of Start TLS.

- Install, configure, and use each component of the example solution (e.g., the identity, authorization, and workflow manager or the PAC server) according to the security guidance provided by the component vendor.
- Configure all IdAM components on the IdAM network so that it is impossible to remotely access them.
- Log all IdAM activity (e.g., direct access to IdAM components on the IdAM network, all messages exchanged between IdAM components). Limit the number of users who are able to control whether or not a performed activity is logged.
- Require super-administrators (i.e., users who are authorized to change the access-control policies within the console access manager) to use a console access manager when accessing the console of all devices on the IdAM network, and never to directly access any console. Use of a console access manager ensures that all activity that is performed via the console is logged.
- Configure the console access manager to have an always-on connection to all devices on the IdAM network so that it can monitor each device's console port. This configuration ensures that all activity that is performed over the console port will be logged. Configure the console access manager to generate an alert if the always-on connection to any device is disconnected. This configuration ensures that security auditors can be aware of any times during which the console port of a device may have been accessed without the activity being logged or monitored.
- Configure all devices on the IdAM network so that they have only one console port (the port to which the console access manager has an always-on connection). Alternatively, where applicable, configure the devices on the IdAM network to allow only one console connection or login at a time. This will ensure that the console access manager will log all activity that is performed via the console of any of these devices.

### 5.9.7 Security Characteristics Evaluation Summary

Overall, the example solution and the workflow processes that it enforces succeed in centralizing IdAM functions across the OT, PACS, and IT networks, to provide an efficient, uniform, and secure solution for authenticating and authorizing access across all systems and facilities. The solution enables access-control policies across all three networks to be enforced consistently, quickly, and with a high degree of granularity, so that users are granted only enough privilege necessary to complete their work, and for only the necessary amount of time. It also enables a converged, simplified audit capability for accountability and tracking. This requires all access to the IdAM network, its components, and the information exchanged between these components and the OT, PACS, and IT networks, to be secured and monitored.

Organizations adopting this example solution must also have policies, procedures, and processes in place that effectively use the solutions capabilities to maximize benefits. Further, the organizations must consider and address the security risks associated with their deployment. [Section 5.9.6](#) describes basic security considerations for the example solution.

## 6 Functional Evaluation

We conducted a functional evaluation of the IdAM example solution to verify that several common key provisioning functions of the example solution, as implemented in our laboratory build, worked as expected. The IdAM workflow capability demonstrated the ability to perform the following actions centrally:

- assign and provision access privileges to users, based on a set of programmed business rules in the OT, PACS, and IT networks and systems
- create, activate, and deactivate users in the OT, PACS, and IT networks and systems
- change an existing user's access to the various networks and systems

Section 6.1 explains the functional test plan in more detail, and lists the procedures used for each of the functional tests.

### 6.1 IdAM Functional Test Plan

This test plan includes the test cases necessary to conduct the functional evaluation of the IdAM use case. The IdAM implementation is currently deployed in a lab at the NCCoE. [Section 5](#) describes the test environment.

Each test case consists of multiple fields that collectively identify the goal of the test, the specifics required to implement the test, and how to assess the results of the test. Table 6-1 provides a template of a test case, including a description of each field in the test case.

**Table 6-1 Test-Case Fields**

Test-Case Field	Description
Parent requirement	Identifies the top-level requirement, or the series of top-level requirements, leading to the testable requirement
Testable requirement	Drives the definition of the remainder of the test-case fields, and specifies the capability to be evaluated.
Associated security controls	The NIST SP 800-53 Revision 4 controls addressed by the test case
Description	Describes the objective of the test case

Test-Case Field	Description
Associated test cases	In some instances, a test case may be based on the outcome of another/other test case(s). For example, analysis-based test cases produce a result that is verifiable through various means, such as log entries, reports, and alerts.
Preconditions	Indicates the starting state of the test case. Preconditions indicate various starting state items, such as a specific capability configuration required or specific protocol and content
Procedures	The step-by-step actions required to implement the test case. A procedure may consist of a single sequence of steps or multiple sequences of steps (with delineation) to indicate variations in the test procedure
Expected results	The specific expected results for each variation in the test procedure
Actual results	The actual observed results, in comparison with the documented expected results
Overall result	The overall result of the test as pass/fail. In some test case instances, the determination of the overall result may be more involved, such as determining pass/fail based on a percentage of errors identified.

## 6.2 IdAM Use-Case Requirements

This section identifies the example-solution IdAM functional-evaluation requirements that are addressed using this test plan. Table 6-2 lists those requirements and the associated test cases.

**Table 6-2 IdAM Functional Requirements**

Capability Requirement (CR) Identification Number	Parent Requirement	Sub-requirement 1	Sub-requirement 2	Test Case
CR 1	The IdAM system shall include an IdAM workflow capability that assigns and provisions access privileges to users, based on a set of programmed business rules in the following networks:			
CR 1.a		IT		
CR 1.a.1			Allow access	IdAM-1
CR 1.a.2			Deny access	IdAM-1

Capability Requirement (CR) Identification Number	Parent Requirement	Sub-requirement 1	Sub-requirement 2	Test Case
CR 1.b		OT		
CR 1.b.1			Allow access	IdAM-1
CR 1.b.2			Deny access	IdAM-1
CR 1.c		PACS		
CR 1.c.1			Allow access	IdAM-1
CR 1.c.2			Deny access	IdAM-1
CR 2	The IdAM system shall include an IdAM workflow capability that can create and activate new users in the following networks and systems:			
CR 2.a		IT		IdAM-2
CR 2.b		OT		IdAM-2
CR 2.c		PACS		IdAM-2
CR 3	The IdAM system shall include an IdAM workflow capability that can de-activate users in the following networks and systems:			
CR 3.a		IT		IdAM-2
CR 3.b		OT		IdAM-2
CR 3.c		PACS		IdAM-2
CR 4	The IdAM system shall include a workflow capability that can change an existing user access to the various networks and systems.			
CR 4.a		IT		
CR 4.a.1			Allow to deny	IdAM-3
CR 4.a.2			Deny to allow	IdAM-3
CR 4.b		OT		

Capability Requirement (CR) Identification Number	Parent Requirement	Sub-requirement 1	Sub-requirement 2	Test Case
CR 4.b.1			Allow to deny	IdAM-3
CR 4.b.2			Deny to allow	IdAM-3
CR 4.c		PACS		
CR 4.c.1			Allow to deny	IdAM-3
CR 4.c.2			Deny to allow	IdAM-3

### 6.3 Test Case IdAM-1

Table 6-3 lists the functional requirements for the IdAM-1 test case.

**Table 6-3 Test Case IdAM-1**

<b>Parent requirement</b>	(CR 1) The IdAM system shall include an IdAM workflow capability that assigns and provisions access privileges to users, based on a set of programmed business rules in the following networks and systems: (CR 1.a) IT, (CR 1.b) OT, (CR 1.c) PACS
<b>Testable requirement</b>	(CR 1.a.1-2) IT, (CR 1.b.1-2) OT, (CR 1.c.1-2) PACS
<b>Description</b>	Show that the IdAM solution can assign and provision access in the OT and IT networks and in the PACS network and system, including allowing and denying access.
<b>Associated test cases</b>	Not applicable
<b>Associated security controls</b>	AC-2, AC-3, IA-2, PE-2, PE-3
<b>Preconditions</b>	<ul style="list-style-type: none"> <li>HR representative CSV file is available.</li> <li>IdAM example solution is implemented and operational in the lab environment.</li> <li>Standard and privileged user sets are known to the testers.</li> <li>A PACS with a card reader and a simulated door access demonstration system is operational in the lab.</li> <li>A simulated OT network with an SEL RTU and an RTU emulator (Raspberry Pi) is implemented in the lab.</li> </ul>



<b>Procedures</b>	<ol style="list-style-type: none"> <li>1. Activate the IdAM workflow engine, and run a command to ingest the HR CSV file.</li> <li>2. At a workstation on the IT network, attempt to log in as a user known to have access in the IT network.</li> <li>3. At a workstation on the IT network, attempt to log in as a user known to be denied in the IT network.</li> <li>4. At a workstation on the OT network, attempt to log in as a user known to have access in the OT network.</li> <li>5. At a workstation on the IT network, attempt to access the SEL RTU administrative interface as a user known to have access to the SEL RTU.</li> <li>6. At a workstation on the OT network, attempt to access the RTU emulator administrative interface as a user known to have access to the RTU emulator.</li> <li>7. At a workstation on the IT network, attempt to access the SEL RTU administrative interface as a user known to be denied access to the SEL RTU.</li> <li>8. At a workstation on the OT network, attempt to access the RTU emulator administrative interface as a user known to be denied access to the RTU emulator.</li> <li>9. At a workstation on the OT network, attempt to log in as a user known to be denied access in the OT network.</li> <li>10. At the demonstration PACS card reader, attempt an “access” with a card for a user known to have access allowed.</li> <li>11. At the demonstration PACS card reader, attempt an “access” with a card for a user known to have access denied.</li> </ol>
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<b>Expected results (pass)</b>	<p>Network access allowed:</p> <ul style="list-style-type: none"> <li>▪ Users with allowed access are able to log into a workstation on the IT network.</li> <li>▪ Users with allowed access are able to log into a workstation on the OT network and on the SEL RTU and RTU emulator.</li> <li>▪ Users with allowed access are able to log into a workstation on the PACS network.</li> <li>▪ Users with allowed access are authorized and allowed access by the PACS card reader and door access demonstration system.</li> </ul> <p>Network access denied:</p> <ul style="list-style-type: none"> <li>▪ Users who are denied access to the IT network are unable to log into a workstation on the IT network.</li> <li>▪ Users who are denied access to the OT network are unable to log into a workstation on the OT network or on the SEL RTU and RTU emulator.</li> <li>▪ Users who are denied access to the PACS network are unable to log into a workstation on the PACS network.</li> <li>▪ Users who are denied access are not authorized and are not allowed access by the PACS card reader and door access demonstration system.</li> </ul>
<b>Actual results</b>	<p>This test functioned appropriately and provided the expected results. Users that were denied access were unable to log into the OT and IT networks, and were denied access to the PACS network. Users who were granted access to each system were able to access the OT and IT networks and were granted access via PACS.</p>
<b>Overall result</b>	Pass

## 6.4 Test Case IdAM-2

Table 6-6-4 lists the functional requirements for the IdAM-2 test case.

**Table 6-6-4 Test Case IdAM-2**

<b>Parent requirement</b>	(CR 2) The IdAM system shall include an IdAM workflow capability that can create and activate new users in the following networks and systems: (CR 2.a) IT, (CR 2.b) OT, (CR 2.c) PACS (CR 3) The IdAM system shall include an IdAM workflow capability that can de-activate users in the following networks and systems: (CR 3.a) IT, (CR 3.b) OT, (CR 3.c) PACS
<b>Testable requirement</b>	(CR 2.a) IT, (CR 2.b) OT, (CR 2.c) PACS (CR 3.a) IT, (CR 3.b) OT, (CR 3.c) PACS
<b>Description</b>	Show that the IdAM solution can create new users, assign access based on business rules, and provision those users to the appropriate network and system access-control systems. New users are users without entries in the authoritative identity store.
<b>Associated test cases</b>	CR 1
<b>Associated security controls</b>	AC-2, AC-3, AC-5, AC-16, AU-12, IA-2, IA-4, IA-5, IA-6, PE-2, PE-3, PE-6
<b>Preconditions</b>	New HR CSV file created with new users included

## Procedures

1. Demonstrate that the new users in the HR CSV file do not have access in the OT, PACS, or IT networks or systems using Test Case IdAM-1.
2. Perform Step 1 of CR 1, with the new HR CSV file.
3. At a workstation on the IT network, attempt to log in as a new user known to have access in the IT network.
4. At a workstation on the OT network, attempt to log in as a new user known to have access in the OT network.
5. At a workstation on the IT network, attempt to access the SEL RTU administrative interface as a new user known to have access to the SEL RTU.
6. At a workstation on the IT network, attempt to access the Radiflow router administrative interface as a new user known to have access to the Radiflow router administrative interface.
7. At a workstation on the PACS network and system, attempt to log in as a new user known to have access in the PACS network and demonstration system.
8. At a PACS card reader, attempt an “access” with a card for a new user known to have access allowed.
9. Using the IdAM system, deactivate access for one or more users with access to the OT, PACS, and IT networks and systems. If one user has access to all three networks, deactivating that user is sufficient.
10. At a workstation on the IT network, attempt to log in as a recently deactivated user known to *previously* have access in the IT network.
11. At a workstation on the OT network, attempt to log in as a recently deactivated user known to *previously* have access in the OT network.
12. At a workstation on the IT network, attempt to access the SEL RTU administrative interface as a user known to *previously* have access to the SEL RTU.
13. At a workstation on the OT network, attempt to access the RTU emulator administrative interface as a user known to *previously* have access to the RTU emulator.

<b>Expected results (pass)</b>	<p>(CR 2) Create and activate a new user. New users are created, and access to the three networks and systems is confirmed. (CR 2.a) IT (CR 2.b) OT network, SEL RTU and RTU emulator (CR 2.c) PACS network and demonstration card reader access system</p> <p>(CR 3) Deactivate a user. User is deactivated, and access is denied to the network(s) and systems to which the user previously had allowed access. (CR 3.a) IT (CR 3.b) OT network, SEL TRU, and RTU emulator (CR 3.c) PACS network and demonstration card reader access system</p>
<b>Actual results</b>	This test was conducted with the expected results received. A CSV file with users was successfully uploaded. Upon approval of the user access stated in the file, the user accounts successfully logged into OT, PACS, and IT. User access was deactivated, and the deactivation was approved. The users were no longer able to access the OT, PACS, or IT.
<b>Overall result</b>	Pass

## 6.5 Test Case IdAM-3

Table 6-5 lists the functional requirements for the IdAM-3 test case.

**Table 6-5 Test Case IdAM-3**

<b>Parent requirement</b>	<p>(CR 4) The IdAM system shall include a workflow capability that can change an existing user's access to the following networks and systems. (CR 4.a) IT, (CR 4.b) OT, (CR 4.c) PACS</p>
<b>Testable requirement</b>	<p>(CR 4.a.1, CR 4.b.1, CR 4.c.1) Allow to deny (CR 4.a.2, CR 4.b.2, CR 4.c.2) Deny to allow</p>
<b>Description</b>	Show that the IdAM solution can change user access for any network or system.
<b>Associated test cases</b>	CR 2
<b>Associated security controls</b>	AC-2, AC-3, AC-5, AC-6, AC-16, AU-12, CM-7, IA-2, IA-4, IA-5, IA-6, PE-2, PE-3, PE-6
<b>Preconditions</b>	Reuse the IdAM system in its

<p><b>Procedure</b></p>	<ol style="list-style-type: none"> <li>1. Choose a set of users with known access, and a set of users without access, for each of the OT, PACS, and IT networks and systems.</li> <li>2. Use the IdAM workflow to deny access for the set of users with known access who were chosen in Step 1 above.</li> <li>3. Use the IdAM workflow to allow access for the set of users without access who were chosen in Step 1 above.</li> <li>4. At a workstation on the IT network, attempt to log in as a user whose access had been changed from allowed to denied.</li> <li>5. At a workstation on the IT network, attempt to log in as a user whose access had been changed from denied to allowed.</li> <li>6. At a workstation on the OT network, attempt to log in as a user whose access had been changed from allowed to denied.</li> <li>7. At a workstation on the OT network, attempt to log in as a user whose access had been changed from denied to allowed.</li> <li>8. At a workstation on the PACS network, attempt to log in as a user whose access had been changed from allowed to denied.</li> <li>9. At a workstation on the PACS network, attempt to log in as a user whose access had been changed from denied to allowed.</li> <li>10. At a PACS card reader, attempt an “access” with a card for a user whose access had been changed from allowed to denied (card access denied in the demonstration system).</li> <li>11. At a PACS card reader, attempt an “access” with a card for a user whose access had been changed from denied to allowed (card access allowed in the demonstration system).</li> <li>12. At a workstation on the IT network, attempt to access the Radiflow router administrative interface as a user whose access had been changed from allowed to denied.</li> <li>13. At a workstation on the IT network, attempt to access the Radiflow router administrative interface as a user whose access had been changed from denied to allowed.</li> <li>14. At a workstation on the OT network, attempt to access the SEL RTU administrative interface as a user whose access had been changed from allowed to denied.</li> <li>15. At a workstation on the OT network, attempt to access the SEL RTU administrative interface as a user whose access had been changed from denied to allowed.</li> <li>16. At a workstation on the OT network, attempt to access the RTU emulator administrative interface as a user whose access had been changed from allowed to denied.</li> </ol>
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	17. At a workstation on the OT network, attempt to access the RTU emulator administrative interface as a user whose access had been changed from denied to allowed.
<b>Expected results (pass)</b>	<p>(CR 4.) Change user access.</p> <p>(CR 4.a) IT</p> <p>(CR 4.a.1) Allow-to-deny changes are successfully provisioned.</p> <p>(CR 4.a.2) Deny-to-allow changes are successfully provisioned.</p> <p>(CR 4.b) OT</p> <p>(CR 4.b.1) Allow-to-deny changes are successfully provisioned.</p> <p>(CR 4.b.2) Deny-to-allow changes are successfully provisioned.</p> <p>(CR 4.c) PACS</p> <p>(CR 4.c.1) Allow-to-deny changes are successfully provisioned.</p> <p>(CR 4.c.2) Deny-to-allow changes are successfully provisioned.</p>
<b>Actual results</b>	The test provided the expected results, with the impact of changes to user access (allow to deny, deny to allow) and privilege levels (privileged to non-privileged, non-privileged to privileged) verified.
<b>Overall result</b>	Pass

## Appendix A Mount Airey Group, Inc. Personal Profile Applications Demonstration Application

The Personal Profile Application (PPA) was developed by Mount Airey Group (MAG) to demonstrate the functionality of the MAG Ozone® suite of products.

Ozone implements atomic authorization for the protection of critical resources by cryptographically binding credentials to specific authorizations, access rights, and/or explicit privileges. Ozone provides a privacy protecting mechanism that allows these authorizations to be distributed across the enterprise—as close to the protected resource as necessary—without concern for tampering, data mining, or compromise. Ozone is meant to protect an organization’s most-sensitive or highest-risk resources. If an application relies on private key infrastructure (PKI)–based smart cards and/or biometrics for authentication, then that system should implement the congruent security (as is provided by Ozone) for the authorization of users for access to that resource.

In support of the National Cybersecurity Center of Excellence (NCCoE) Electricity Subsector Identity and Access Management (IdAM) Use Case, the PPA was configured to incorporate digital certificates that were generated by GlobalSign, Inc., to be compliant with the North American Energy Standards Board (NAESB) certificate profile. Each certificate was provisioned within Ozone to have specific authorizations related to the PPA demonstration.

This application has three main information groups for which actions can be authorized: Personal Information, Credit Reports, and Criminal History. Based on the authorizations associated with a credential, results pages are dynamically populated.

To bring up the demonstration application, the user must present a digital certificate to the application. Upon inspection of the authorizations provisioned within Ozone for the selected certificate, the application dynamically populates the table at the bottom of the first screen with the results of the authorization queries. If the certificate has been authorized for a specific action, then the results table will display “true” for that specific action. The information identifying the certificate that was selected is also displayed above the table.

At that point, the user may either enter a name in the search box on the right, or simply hit the search button to display the Search Results page of the application. The search will return a list of names, as well as links to additional information about the people listed. The links listed will vary depending upon the authorizations for which the user was authorized at logon to the PPA. The available authorizations are as follows:

- View Personal Information – view the personal information of the selected person
- Edit Personal Information – add or edit the personal information of people in the application
- View Criminal History – view the criminal history of the selected person



- Edit Criminal History – add or edit the criminal history of people in the application
- View Credit Report – view the credit report of the selected person
- Request a New Credit Report – request an updated credit report for the selected person

A sample of the table shown on the first page is provided below:

Authorizations for: C=US, O=Blue Corp, OU=People, CN=Criminal History Editor

**Table 6-6 Sample Attributes**

PPA Proof	Authorized
Edit Criminal History	true
Edit Personal Information	false
Request Credit Report	false
View Credit Report	false
View Criminal History	true
View Personal Information	false

A sample of the table on the Search Results page is provided below:

Search Results

**Table 6-7 Search Results**

Name	View CH	Add CH	View CR	Request CR
Hicks, Chick	View	Add	View	Request
McQueen, Lightning	View	Add	View	Request
Sullivan, James P	View	Add	View	Request
Waternoose, Henry J	View	Add	View	Request
Add a new entry...editPI.jsp				

For the NCCoE Electricity Subsector IdAM Use Case, the following authorizations have been configured for the NAESB certificates:

- Jim McCarthy  
Email Address = james.mccarthy@nist.gov, CN = James McCarthy, OU = GSUS, OU = NCCoE NIST Energy IdAM test account, O = GMO GlobalSign Inc., L = Portsmouth, ST = NH, C = US

- View Personal Information
  - Edit Personal Information
  - View Criminal History
  - Edit Criminal History
  - View Credit Report
  - Request Credit Report
- Donald Faatz

Email Address = donald.faatz@nist.gov, CN = Donald Faatz, OU = GSUS, OU = NCCoE NIST Energy IdAM test account, O = GMO GlobalSign Inc., L = Portsmouth, ST = NH, C = US

    - View Criminal History
    - Edit Criminal History
  - Harry Perper

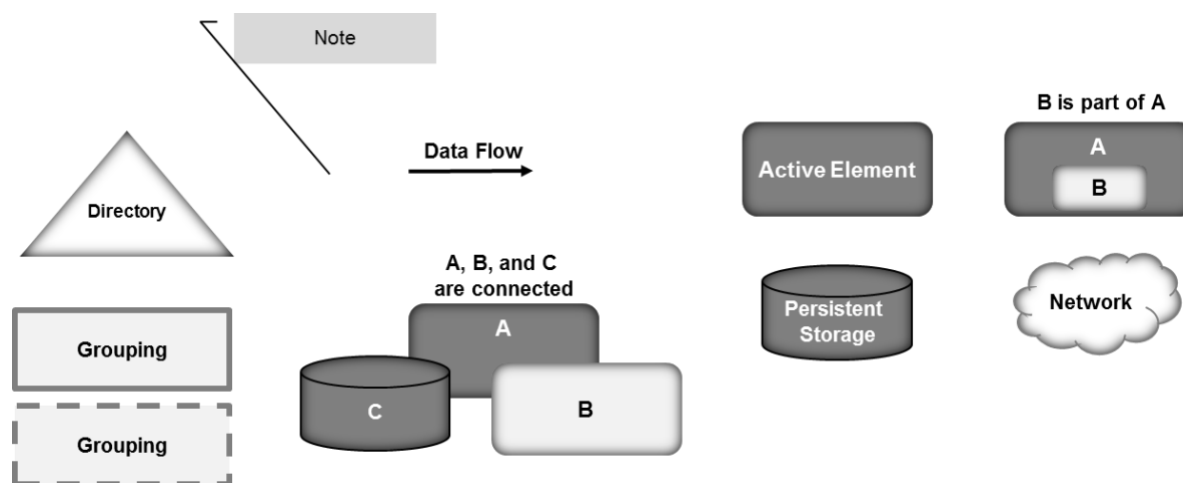
Email Address = harry.perper@nist.gov, CN = Harry Perper, OU = GSUS, OU = NCCoE NIST Energy IdAM test account, O = GMO GlobalSign Inc., L = Portsmouth, ST = NH, C = US

    - View Personal Information
    - Edit Personal Information
    - View Criminal History
    - View Credit Report
  - John Wiltberger

Email Address = jwiltberger@mitre.org, CN=Johnathan Wiltberger, OU = GSUS, OU = NCCoE NIST Energy IdAM test account, O = GMO GlobalSign Inc., L = Portsmouth, ST = NH, C = US

    - View Personal Information
    - View Criminal History
    - View Credit Report
    - Request Credit Report

## Appendix B Legend for Diagrams



## Appendix C List of Acronyms

<b>ABAC</b>	Attribute-Based Access Control
<b>AD</b>	Active Directory
<b>CA</b>	CA Technologies
<b>CIP</b>	Critical Infrastructure Protection
<b>CIS</b>	Center for Internet Security
<b>CR</b>	Capability Requirement
<b>CRADA</b>	Cooperative Research and Development Agreement
<b>CSF</b>	Cybersecurity Framework
<b>CSV</b>	Comma-Separated Value
<b>DISA</b>	Defense Information Systems Agency
<b>DMZ</b>	Demilitarized Zone
<b>DNS</b>	Domain Name System
<b>EACMS</b>	Electronic Access Control and Monitoring System
<b>EMS</b>	Energy Management System
<b>HR</b>	Human Resources
<b>ICS</b>	Industrial Control System
<b>IdAM</b>	Identity and Access Management
<b>IDMS/CMS</b>	Identity and Credential Management System
<b>IMG</b>	Identity Management and Governance
<b>IP</b>	Internet Protocol
<b>ISE</b>	Identity Services Engine
<b>IT</b>	Information Technology
<b>LDAPS</b>	Lightweight Directory Access Protocol Secure
<b>MAG</b>	Mount Airey Group
<b>NAESB</b>	North American Energy Standards Board

<b>NAS</b>	Network Attached Storage
<b>NCCoE</b>	National Cybersecurity Center of Excellence
<b>NERC</b>	North American Electric Reliability Corporation
<b>NIST</b>	National Institute of Standards and Technology
<b>NISTIR</b>	National Institute of Standards and Technology Interagency/Internal Report
<b>OASIS</b>	Open Access Same-Time Information Systems
<b>OS</b>	Operating System
<b>OT</b>	Operational Technology
<b>PACS</b>	Physical Access Control System
<b>PIV-I</b>	Personal Identity Verification Interoperable
<b>PKI</b>	Private Key Infrastructure
<b>PPA</b>	Personal Profile Application
<b>RMF</b>	Risk Management Framework
<b>RS2</b>	RS2 Technologies
<b>RTU</b>	Remote Terminal Unit
<b>SCADA</b>	Supervisory Control and Data Acquisition
<b>SEL</b>	Schweitzer Engineering Laboratories
<b>SP</b>	Special Publication
<b>SQL</b>	Structured Query Language
<b>STIG</b>	Security Technical Implementation Guideline
<b>TLS</b>	Transport Layer Security
<b>UTC</b>	Utilities Telecom Council
<b>VLAN</b>	Virtual Local Area Network
<b>VPN</b>	Virtual Private Network

## Appendix D References

- [1] *Cybersecurity Framework*, National Institute of Standards and Technology [Web Site], <http://www.nist.gov/cyberframework/> [accessed 6/19/17].
- [2] J. H. Saltzer, "Protection and the Control of Information Sharing in Multics," *Communication of the ACM*, vol. 17, no. 7, pp. 388-402, July 1974.
- [3] *Federated Identity Management (FIM)*, TechTarget [Web site], <http://searchsecurity.techtarget.com/definition/federated-identity-management> [accessed 6/19/17].
- [4] Joint Task Force Transformation Initiative, *Guide for Conducting Risk Assessments*, NIST Special Publication (SP) 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, [http://csrc.nist.gov/publications/nistpubs/800-30-rev1/sp800\\_30\\_r1.pdf](http://csrc.nist.gov/publications/nistpubs/800-30-rev1/sp800_30_r1.pdf) [accessed 2/25/14].
- [5] *Risk Management Framework: Quick Start Guides*, National Institute of Standards and Technology [Web site], <http://csrc.nist.gov/groups/SMA/fisma/Risk-Management-Framework/> [accessed 6/19/17].
- [6] Joint Task Force Transformation Initiative, *Managing Information Security Risk*, NIST Special Publication (SP) 800-39, National Institute of Standards and Technology, Gaithersburg, Maryland, March 2011, <http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-39.pdf> [accessed 2/25/14].
- [7] Joint Task Force Transformation Initiative, *Security and Privacy Controls for Federal Information Systems and Organizations*, NIST Special Publication (SP) 800-53 Revision 4, National Institute of Standards and Technology, Gaithersburg, Maryland, April 2013, <http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r4.pdf> [accessed 2/25/14].
- [8] W. E. Burr, D. F. Dodson, E. M. Newton, et al., *Electronic Authentication Guideline*, NIST Special Publication (SP) 800-63-2, National Institute of Standards and Technology, Gaithersburg, Maryland, August 2013, <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-63-2.pdf> [accessed 2/25/14].
- [9] V. C. Hu, D. Ferraiolo, and R. Kuhn, *Assessment of Access Control Systems*, NISTIR 7316, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2006. <http://csrc.nist.gov/publications/nistir/7316/NISTIR-7316.pdf>.

- [10] *Identity and Access Management*, Use Case Version 2, National Institute of Standards and Technology, November 2013, <https://www.nccoe.nist.gov/sites/default/files/library/project-descriptions/es-idam-project-description-final.pdf> [accessed 6/22/17].
- [11] *NAESB Compliant Digital Certificates*, GlobalSign [Web site], <https://www.GlobalSign.com/en/digital-certificates-for-naesb/> [accessed 6/22/17].
- [12] V. C. Hu, D. Ferraiolo, R. Kuhn, et al., *Guide to Attribute Based Access Control (ABAC) Definition and Considerations*, NIST Special Publication (SP) 800-162, National Institute of Standards and Technology, Gaithersburg, Maryland, January 2014, <http://nvlpubs.nist.gov/nistpubs/specialpublications/NIST.SP.800-162.pdf> [accessed 6/19/17].
- [13] *Attribute Based Access Control*, National Cybersecurity Center of Excellence [Web site], <https://nccoe.nist.gov/projects/building-blocks/attribute-based-access-control> [accessed 6/19/17].
- [14] *Standards: NIST NCCoE*, AlertEnterprise [Web site], <http://www.alertenterprise.com/resources-standards-nistcoe.php> [accessed 6/22/17].
- [15] *Operating Systems*, Information Assurance Support Environment (IASE) [Web site], <https://iase.disa.mil/stigs/os/Pages/index.aspx> [accessed 6/19/17].
- [16] *CIS Benchmarks*, Center for Internet Security (CIS) [Web site], <https://benchmarks.cisecurity.org/downloads/benchmarks/> [accessed 6/19/17].
- [17] M. Seaman, Editor, *Port Based Network Access Control*, IEEE 802.1X, Draft 2.0, Institute of Electrical and Electronics Engineers, February 2008.
- [18] K. Scarfone and P. Hoffman, *Guidelines on Firewalls and Firewall Policy*, NIST Special Publication (SP) 800-41 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2009, <https://www.nist.gov/publications/guidelines-firewalls-and-firewall-policy> [accessed 6/19/17].
- [19] J Hodges, R. Morgan, and M. Wahl, *Lightweight Directory Access Protocol (v3): Extension for Transport Layer Security*, Internet Engineering Task Force (IETF) Network Working Group Request for Comments (RFC) 2830, May 2000 <https://tools.ietf.org/rfc/rfc2830.txt> [accessed 6/19/17].

# Identity and Access Management

## for Electric Utilities

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**Volume C:**  
**How-to Guides**

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As a private-public partnership, we are always seeking feedback on our Practice Guides. We are particularly interested in seeing how businesses apply NCCoE reference designs in the real world. If you have implemented the reference design, or have questions about applying it in your environment, please email us at [energy\\_nccoe@nist.gov](mailto:energy_nccoe@nist.gov).

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NIST Cybersecurity Practice Guides (Special Publication Series 1800) target specific cybersecurity challenges in the public and private sectors. They are practical, user-friendly guides that facilitate the adoption of standards-based approaches to cybersecurity. They show members of the information security community how to implement example solutions that help them align more easily with relevant standards and best practices and provide users with the materials lists, configuration files, and other information they need to implement a similar approach.

The documents in this series describe example implementations of cybersecurity practices that businesses and other organizations may voluntarily adopt. These documents do not describe regulations or mandatory practices, nor do they carry statutory authority.

## ABSTRACT

To protect power generation, transmission, and distribution, energy companies need to control physical and logical access to their resources, including buildings, equipment, information technology (IT), and operational technology (OT). They must authenticate, with a high degree of certainty, authorized individuals to the devices and facilities to which the companies are giving access rights. In addition, they need to enforce access-control policies (e.g., allow, deny, inquire further) consistently, uniformly, and quickly across all of their resources. This project resulted from direct dialog among NCCoE staff and members of the electricity subsector, mainly from electric power companies and those who provide equipment and/or services to them. The goal of this project is to demonstrate a converged, standards-based technical approach that unifies identity and access management (IdAM) functions across OT networks, physical access control systems (PACS), and IT systems. These networks often operate independently, which can result in identity and access information disparity, increased costs, inefficiencies, and a loss of capacity and service delivery capability. Also, these networks support different infrastructures, each with unique security risks. The converged IdAM solution must be constructed to effectively address the highest-risk infrastructure. This guide describes our collaborative

efforts with technology providers and electric-company stakeholders to address the security challenges that energy providers face in the core function of IdAM. This guide offers a technical approach to meeting the challenge and also incorporates a business-value mindset by identifying the strategic considerations involved in implementing new technologies. This NIST Cybersecurity Practice Guide provides a modular, open, end-to-end example solution that can be tailored and implemented by energy providers of varying sizes and levels of IT sophistication. It shows energy providers how we met the challenge by using open-source and commercially available tools and technologies that are consistent with cybersecurity standards. The use-case scenario is based on a normal day-to-day business operational scenario that provides the underlying impetus for the functionality presented in this guide. While the reference solution was demonstrated with a certain suite of products, this guide does not endorse these specific products. Instead, this guide presents the characteristics and capabilities that an organization's security experts can use to identify similar standards-based products that can be integrated quickly and cost-effectively with an energy provider's existing tools and infrastructure.

## KEYWORDS

*cyber, physical, and operational security; cybersecurity; electricity subsector; energy sector; identity and access management; information technology*

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Technology Partner/Collaborator	Build Involvement
<a href="#">AlertEnterprise</a>	User access authorization provisioning
<a href="#">CA Technologies</a>	IdAM workflow, provisions identities and authorizations to Active Directory instances
<a href="#">Cisco Systems</a>	Network Access control
<a href="#">GlobalSign</a>	Provides North American Energy Standards Board (NAESB)-compliant X.509 certificates
<a href="#">Mount Airey Group (MAG)</a>	Manages attributes that control access to high-value transactions.
<a href="#">RADiFlow</a>	Controls communication among industrial control system (ICS) devices

Technology Partner/Collaborator	Build Involvement
<a href="#">RSA</a>	IdAM workflow, provisions identities and authorizations to Active Directory instances
<a href="#">RS2 Technologies</a>	Controls physical access
<a href="#">Schneider Electric</a>	Controls access to devices in the ICS / Supervisory Control and Data Acquisition (SCADA) network
<a href="#">TDi Technologies</a>	Controls and logs access to ICS devices by people (ICS engineers and technicians)
<a href="#">XTec</a>	Provides Personal Identity Verification Interoperable (PIV-I) smart-card credentials and a physical-access-control capability using the smart card

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# 1 Introduction

The following guides show information technology (IT) professionals and security engineers how we implemented this example solution. We cover all of the products employed in this reference design. We do not recreate the product manufacturers' documentation, which is presumed to be widely available. Rather, these guides show how we incorporated the products together in our environment.

*Note: These are not comprehensive tutorials. There are many possible service and security configurations for these products that are out of scope for this reference design.*

## 1.1 Practice Guide Structure

This National Institute of Standards and Technology (NIST) Cybersecurity Practice Guide demonstrates a standards-based example solution and provides users with the information they need to replicate this approach to identity and access management (IdAM). This reference design is modular and can be deployed in whole or in parts.

This guide contains three volumes:

- NIST Special Publication (SP) 1800-2A: *Executive Summary*
- NIST SP 1800-2B: *Approach, Architecture, and Security Characteristics* – what we built and why
- NIST SP 1800-2C: *How To Guides* – instructions for building the example solution (**you are here**)

Depending on your role in your organization, you might use this guide in different ways:

**Energy utility leaders, including chief security and technology officers** will be interested in the *Executive Summary (NIST SP 1800-2A)*, which describes the:

- challenges enterprises face in implementing and using IdAM systems
- example solution built at the NCCoE
- benefits of adopting the example solution

**Technology or security program managers** who are concerned with how to identify, understand, assess, and mitigate risk will be interested in this part of the guide, *NIST SP 1800-2B*, which describes what we did and why. The following sections will be of particular interest:

- Section 4.4.3, Risk, provides a description of the risk analysis we performed
- Section 4.4.4, Security Control Map, maps the security characteristics of this example solution to cybersecurity standards and best practices

You might share the *Executive Summary, NIST SP 1800-2A*, with your leadership team members to help them understand the importance of adopting standards-based identity and access management for electric utilities.

**IT professionals** who want to implement an approach like this will find the whole practice guide useful. You can use the How-To portion of the guide, *NIST SP 1800-2C*, to replicate all or parts of the build created in our lab. The How-To guide provides specific product installation, configuration, and integration instructions for implementing the example solution. We do not recreate the product manufacturers' documentation, which is generally widely available. Rather, we show how we incorporated the products together in our environment to create an example solution.

This guide assumes that IT professionals have experience implementing security products within the enterprise. While we have used a suite of commercial products to address this challenge, this guide does not endorse these particular products. Your organization can adopt this solution or one that adheres to these guidelines in whole, or you can use this guide as a starting point for tailoring and implementing parts of IdAM for electric utilities. Your organization's security experts should identify the products that will best integrate with your existing tools and IT system infrastructure. We hope you will seek products that are congruent with applicable standards and best practices. Section 4.5, Technologies, of *NIST SP 1800-2B*, lists the products we used and maps them to the cybersecurity controls provided by this reference solution.

The security characteristics in our access management platform are informed by guidance and best practices from standards organizations, including the North American Electric Reliability Corporation's (NERC) Critical Infrastructure Protection (CIP) standards. In addition, this document was reviewed by the NERC Electricity Sector Information Sharing and Analysis Center (ES-ISAC) to ensure that the approach was informed by standards and NERC regulations.

## 1.2 Typographic Conventions

The following table presents typographic conventions used in this volume.

Typeface/ Symbol	Meaning	Example
<i>Italics</i>	filenames and pathnames references to documents that are not hyperlinks, new terms, and placeholders	For detailed definitions of terms, see the <i>NCCoE Glossary</i> .
<b>Bold</b>	names of menus, options, command buttons and fields	Choose <b>File &gt; Edit</b> .

Typeface/ Symbol	Meaning	Example
Monospace	command-line input, on-screen computer output, sample code examples, status codes	<code>mkdir</code>
<b>Monospace Bold</b>	command-line user input contrasted with computer output	<b>service sshd start</b>
<a href="#">blue text</a>	link to other parts of the document, a web URL, or an email address	All publications from NIST's National Cybersecurity Center of Excellence are available at <a href="https://www.nccoe.nist.gov/">https://www.nccoe.nist.gov/</a>

## 2 Build Overview

The National Cybersecurity Center of Excellence (NCCoE) constructed the IdAM build infrastructure by using commercial off-the-shelf hardware and software. The infrastructure was built on Dell model PowerEdge R620 server hardware. The server operating system (OS) was the VMware vSphere virtualization operating environment. The use of virtualization is an artifact of the NCCoE laboratory environment. It allows the NCCoE build to represent a typical utility environment in the laboratory. The solution can be built on dedicated hardware. In addition, a 6-terabyte Dell EqualLogic network attached storage (NAS) product was used for storage. Dell model PowerConnect 7024 and Cisco Catalyst 3650 and 3550 physical switches were used to interconnect the server hardware, external network components, and the NAS.

The lab network was accessible from the public internet via a virtual private network (VPN) appliance and firewall to enable secure internet and remote access. The lab network was not connected to the NIST enterprise network. Table 2-1 lists which software and hardware components were used in the builds, the specific function that each component contributes, and whether the product was installed within the virtual environment or as physical device.

**Table 2-1 Build Implementation Component List (Including Security Controls)**

Product Vendor	Component	Function	Implementation (physical device or virtual environment)
Dell	PowerEdge R620	Physical server hardware	Physical device

Product Vendor	Component	Function	Implementation (physical device or virtual environment)
Dell	PowerConnect 7024	Physical network switch	Physical device
Dell	EqualLogic	NAS	Physical device
VMware	vSphere vCenter Server Version 5.5	Virtual server and workstation environment	Virtual environment
Microsoft	Windows Server 2012 r2 Active Directory (AD) Server	Authentication and authority	Virtual environment
Microsoft	Windows 7	Information management	Virtual environment
Microsoft	Windows Server 2012 r2 Domain Name System (DNS) Server	DNS	Virtual environment
Microsoft	Structured Query Language (SQL) Server	Database	Virtual environment
AlertEnterprise	Enterprise Guardian	Interface and translation between the IdAM central store and the physical access control system (PACS) management server	Virtual environment
CA Technologies (CA)	Identity Manager Release 12.6.05 Build 06109.28	Identity and access automation management application, IdAM provisioning	Virtual environment
Cisco	Identity Services Engine (ISE) Network Server 3415	Network access controller	Virtual environment
Cisco	Catalyst 3550	Network switch	Physical device
Cisco	Catalyst 3650	TrustSec-enabled physical network switch	Physical device
GlobalSign	Secure Socket Layer (SSL) Certificate	Cloud certificate and registration authority	Virtual environment
Mount Airey Group (MAG)	Ozone Authority	Central attribute management system	Virtual environment
MAG	Ozone Console	Ozone administrative management console	Virtual environment
MAG	Ozone Envoy	Enterprise identity store interface	Virtual environment

Product Vendor	Component	Function	Implementation (physical device or virtual environment)
MAG	Ozone Server	Ozone centralized attribute-based authorization server	Virtual environment
RADiFlow	iSIM – Industrial Service Management Tool	Supervisory control and data acquisition (SCADA) router management application	Physical device
RADiFlow	SCADA Router RF-3180S	Router/firewall for SCADA network	Physical device
RSA	Adaptive Directory Version 7.1.5	Central identity store, IdAM provisioning	Virtual environment
RSA	Identity Management and Governance (IMG) Version 6.9 Build 74968	Central IdAM system (workflow management)	Virtual environment
TDi Technologies	ConsoleWorks	Privileged user access controller, monitor, and logging system	Virtual environment
RS2 Technologies (RS2)	Access It! Universal Release 4.1.15 Physical-access-control components	Configures and monitors the PACS devices (e.g., card readers, keypads)	Virtual-environment server, and physical-device card reader
Schweitzer Electronics Laboratory (SEL)	SEL-2411	Remote Terminal Unit (RTU)	Physical device
Schneider Electric	Tofino Firewall model number TCSEFEA23F3F20	Ethernet / Internet Protocol (IP) firewall	Physical device
XTec	XNode	Remote access control and management	Physical device

## 2.1 Build Implementation Overview

The build implementation consists of multiple networks implemented to mirror the infrastructure of a typical energy industry corporation. The networks include a management network and a production network (Figure 2-1). The management network was implemented to facilitate the implementation, configuration, and management of the underlying infrastructure, including the physical servers, vSphere infrastructure, and monitoring. The production network (Figure 2-2) consists of the following components:

- the demilitarized zone (DMZ): The DMZ presented in this practice guide is designed to support the NCCoE laboratory environment. Organizations should construct DMZs by using appropriate guidance for their environment, such as North American Electric Reliability Corporation (NERC) Guidance for Secure Interactive Remote Access.
- IdAM network
- IT network – business management system
- operational technology (OT) network – ICS/SCADA and energy management system (EMS)
- PACS network

These networks were implemented separately to represent a typical electric utility enterprise infrastructure. Firewalls are configured to route traffic and limit access among the production networks to block all traffic, except required internetwork communications. The primary internetwork communications are the user access and authorization updates from the central IdAM systems to and from the directories and the PACS, IT, and OT networks. The DMZ provides a protected neutral network space that the other networks of the production network can use to route traffic to and from the internet or each other.

**Figure 2-1 Management and Production Networks**

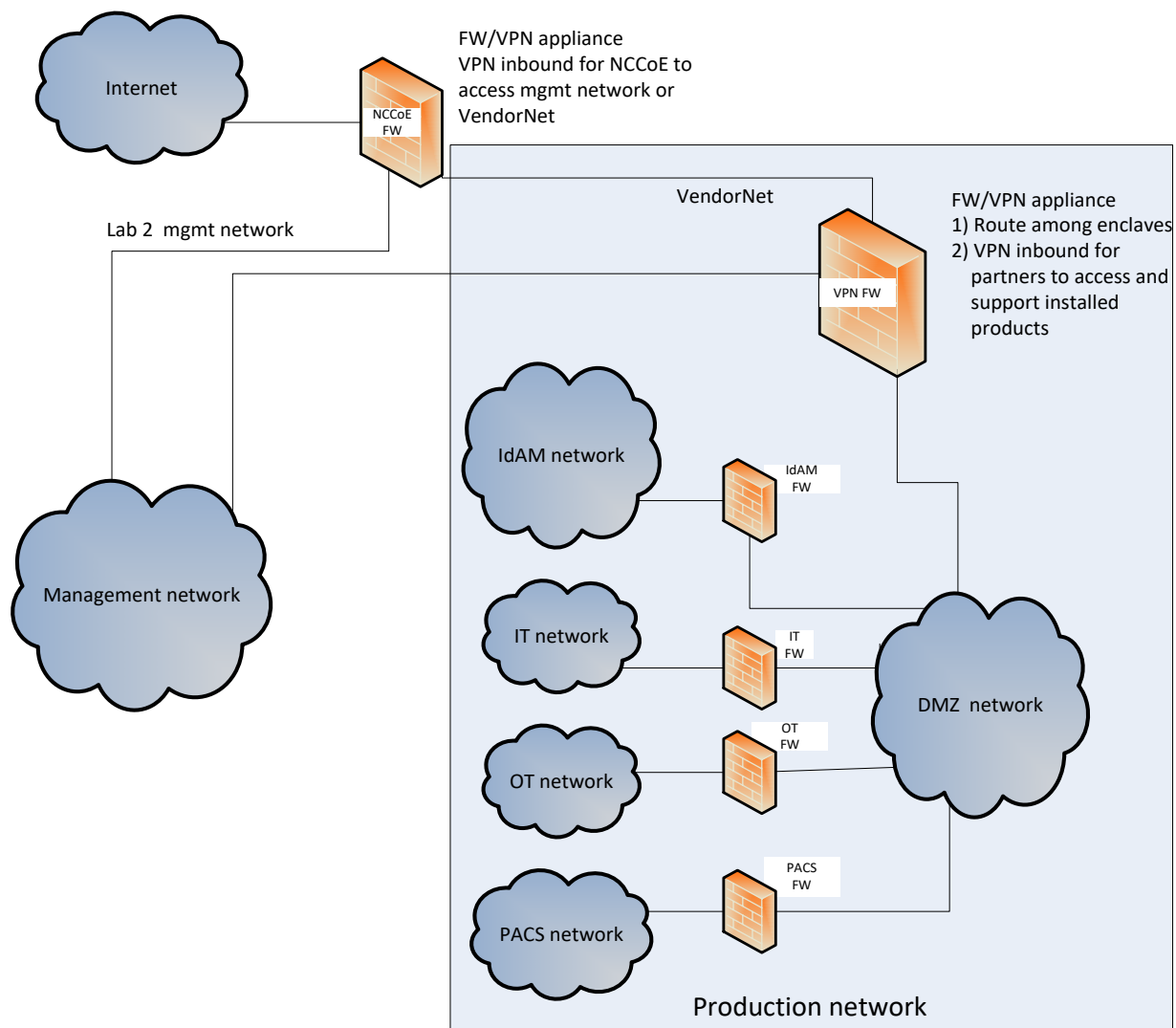
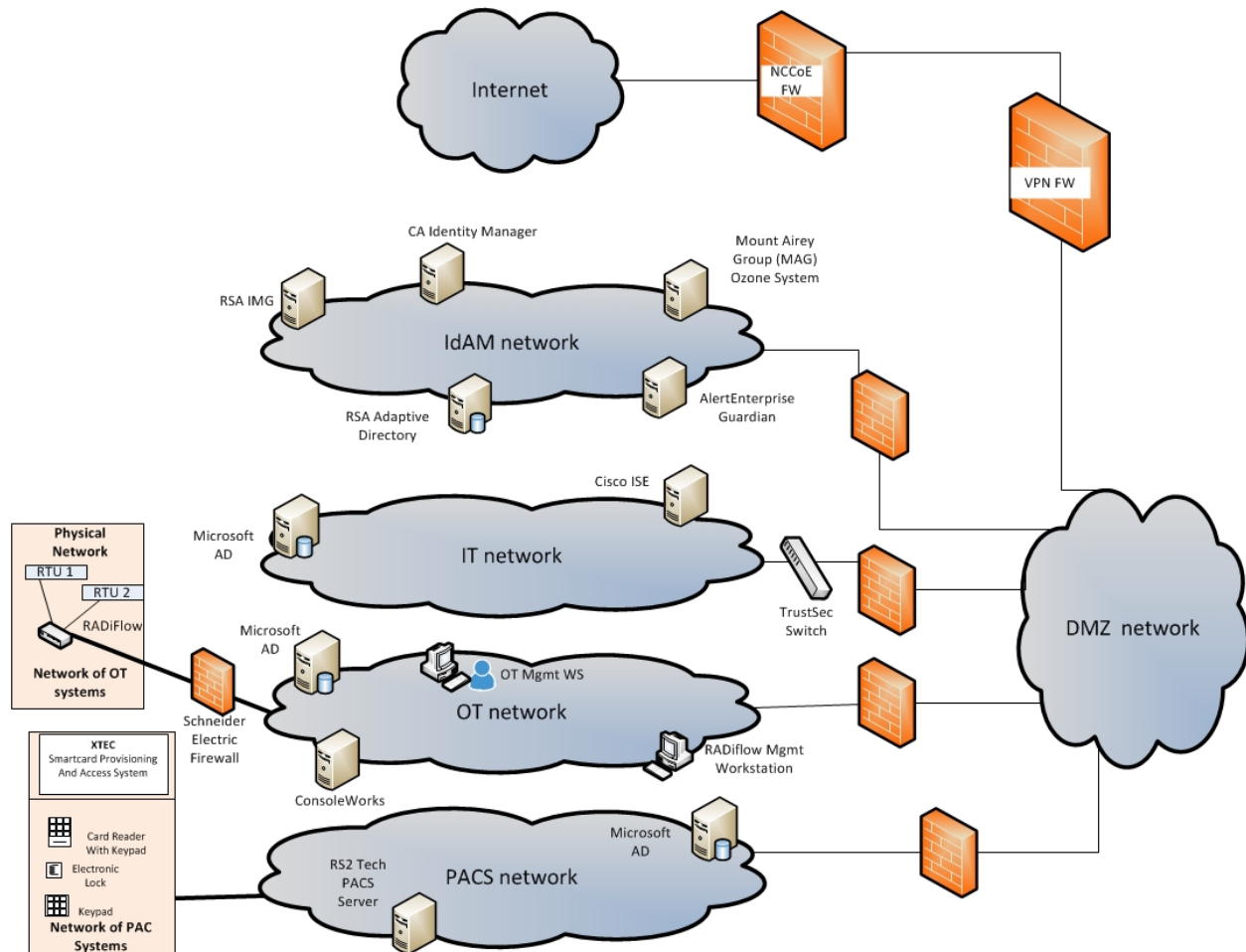


Figure 2-2 IdAM Build Implementation Production Network



The IdAM network shown in Figure 2-2 represents the proposed converged IdAM network/system. This network was separated to highlight the unique IdAM components proposed to address the use-case requirements.

The IT network represents the business management network that typically supports corporate email, file sharing, printing, and internet access for general business-purpose computing and communications.

The OT network represents the network that is used to support the EMSs and ICS/SCADA systems. Typically, this network either is not connected to the enterprise IT network or is connected with a data diode (a one-way communication device from the OT network to the IT network). Two-way traffic is allowed, per NERC Critical Infrastructure Protection (CIP), and is enabled via the OT firewall, only for specific ports and protocols between specific systems identified by IP address.



The PACS network represents the network that is used to support the PACS across the enterprise. In our architecture, a firewall is configured to allow limited access to and from the PACS network to facilitate the communication of access and authorization information. Technically, this communication consists of user role and responsibility directory updates originating in the IdAM system.

The public internet is accessible by the lab environment to facilitate both cloud services and access for vendors and NCCoE administrators.

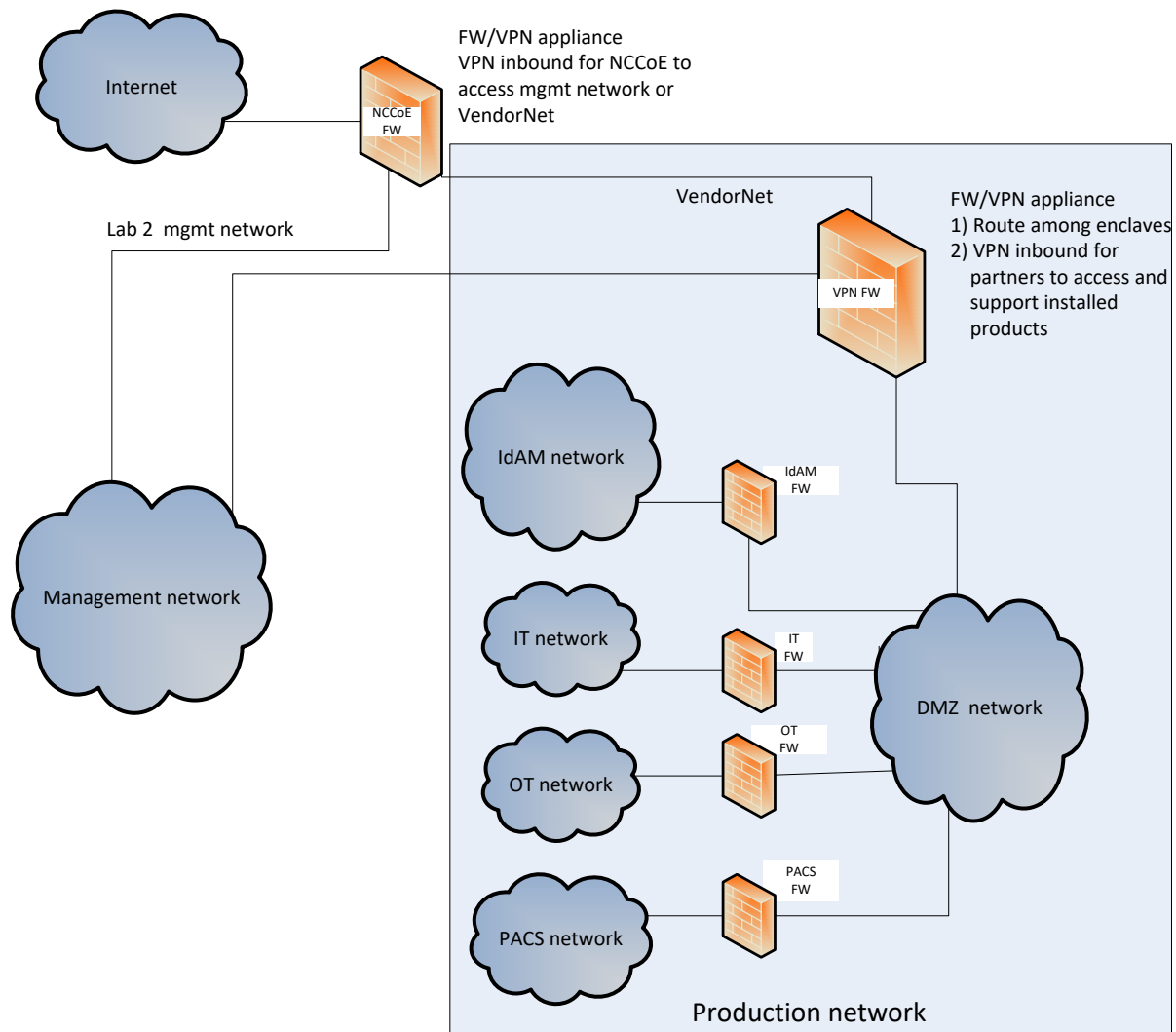
The VPN firewall was the access-control point for vendors, to support the installation and configuration of their components of the architecture. The NCCoE also used this access to facilitate product training. This firewall also blocked unauthorized traffic from the public internet to the production networks. Additional firewalls are used to secure the multiple domain networks (IT, OT, IdAM, and PACS).

Switching in the implementation is executed using a series of physical and hypervisor soft switches. The use of virtualization is an artifact of the NCCoE laboratory environment. It allows the NCCoE build to represent a typical utility environment in the laboratory. Virtual local area network (VLAN) switching functions are handled by physical Dell switches and the virtual environment. Routing was accomplished using the firewalls.

## 2.2 Build Implementation Descriptions

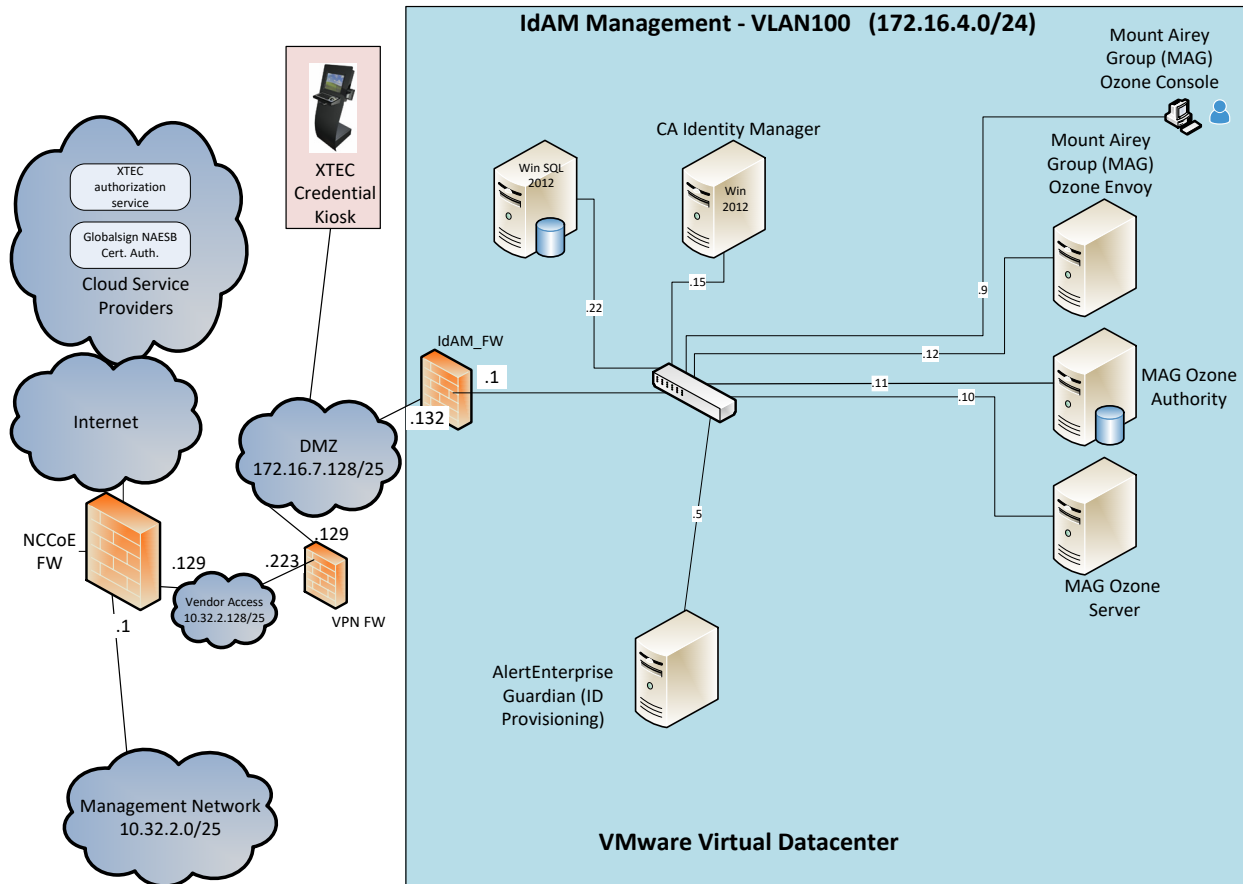
Figure 2-3 depicts the build network comprising the management, VendorNet, IdAM, DMZ, IT, OT, and PACS subnetworks. VendorNet provides remote access for vendors to access, configure, demonstrate, and provide training for each of the implemented products. The IdAM network contains the central IdAM components of the build. The IT, OT, and PACS networks contain the representative components of a typical electric utility enterprise.

**Figure 2-3 Build Network**



The IdAM network (Figure 2-4 and Figure 2-5) contains the central IdAM components for Build #1 and Build #2. The IdAM components are placed into a separate network to highlight the importance of protecting these assets and to simplify the demonstration of their capabilities.

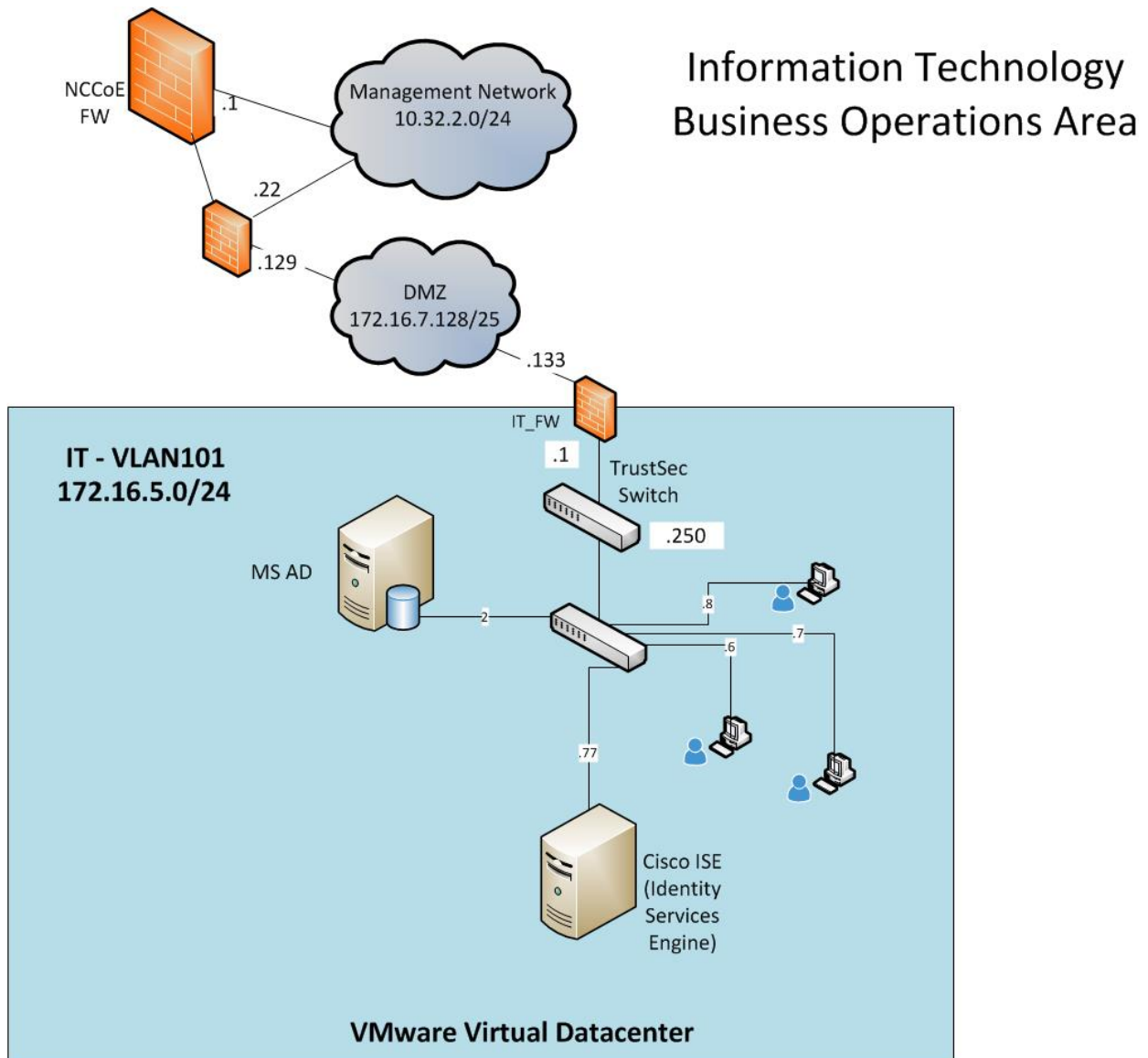
Figure 2-4 Build #1 IdAM Network



Build #1 uses the CA Identity Manager product for the IdAM system and identity store.

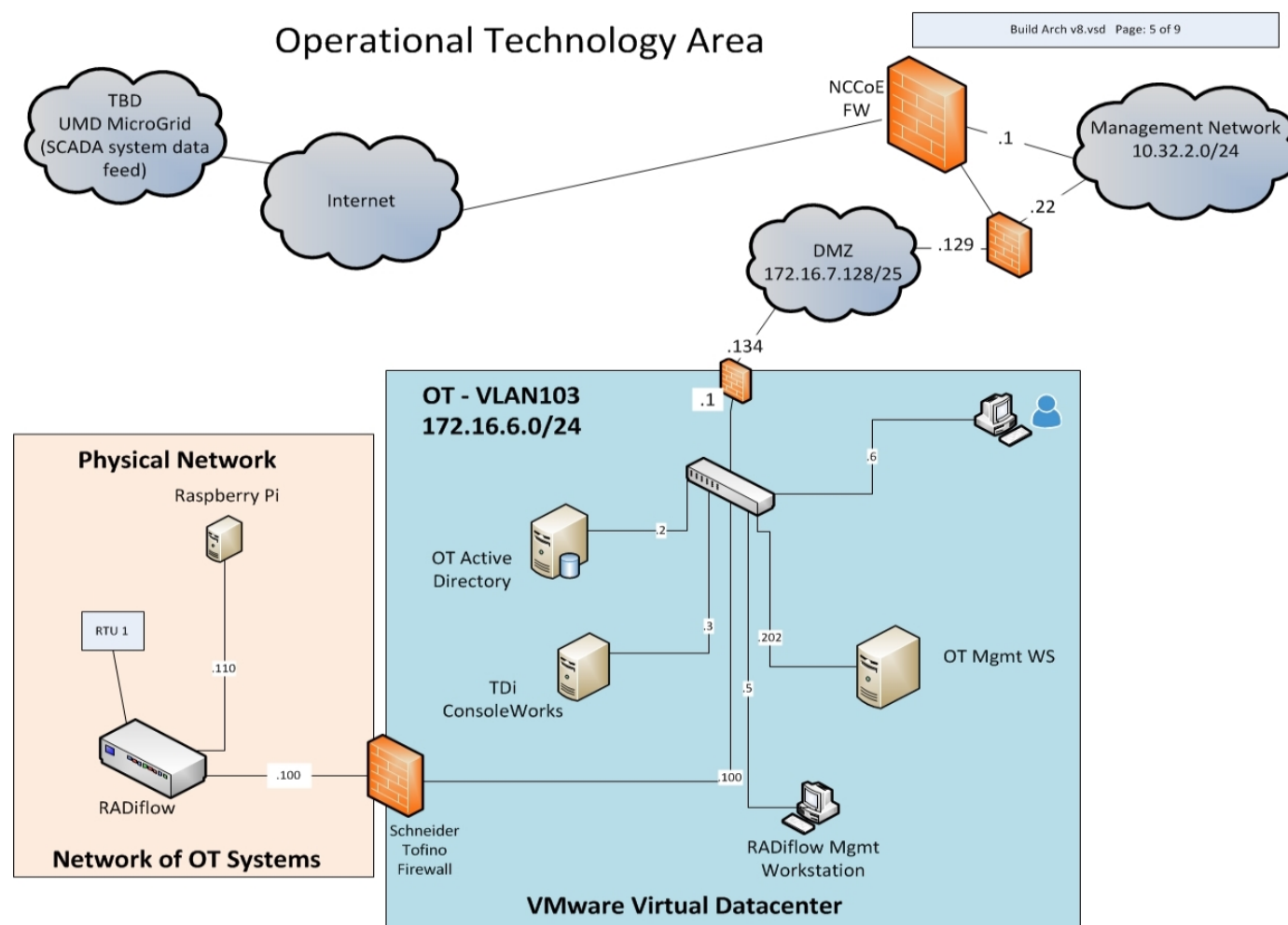


Figure 2-6 IT Network



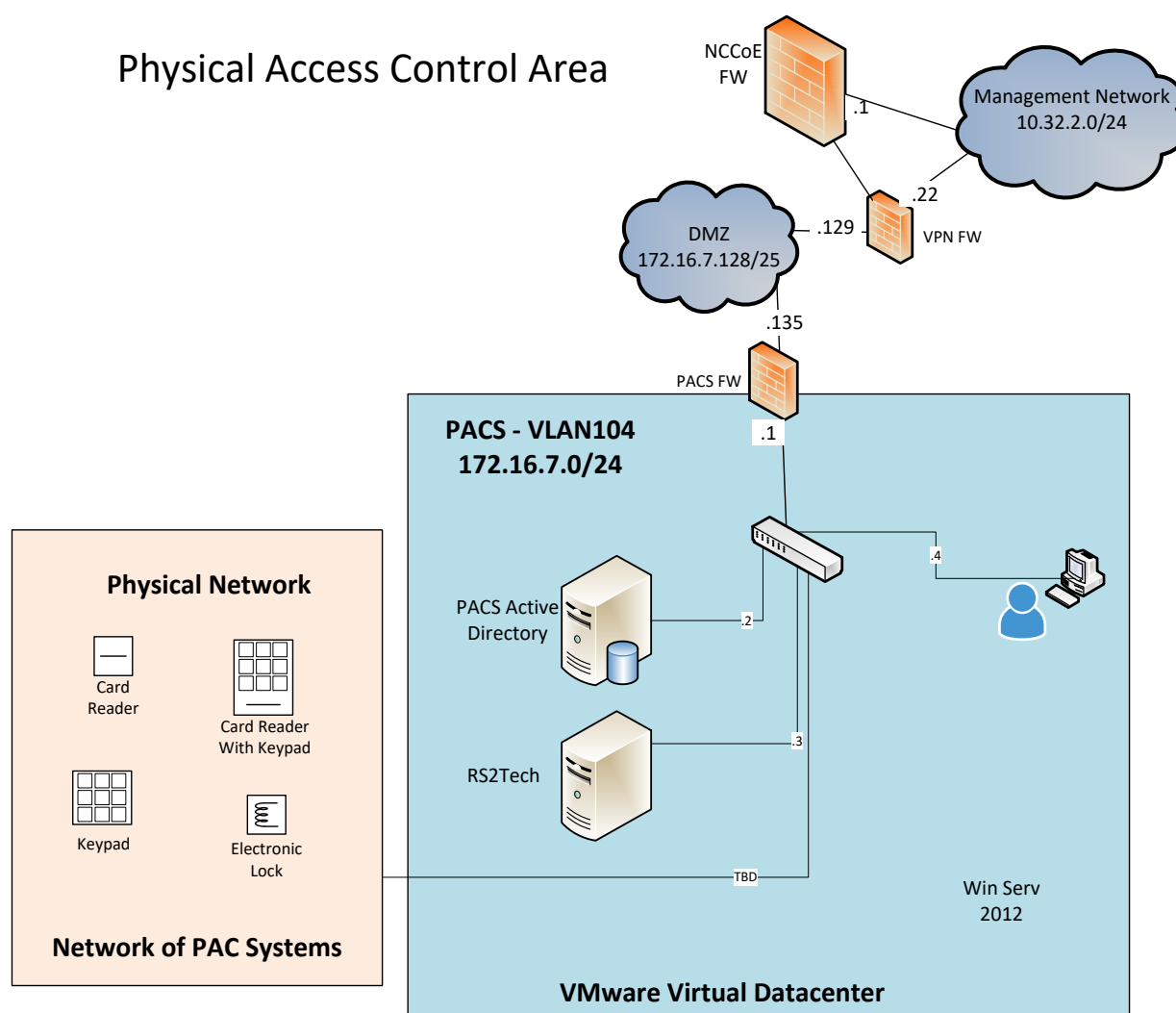
The OT network (Figure 2-7) contains the OT components, which include representative components found in electric utility OT networks/systems. These components were chosen to demonstrate the integration capabilities of the central IdAM capability. The lab did not attempt to replicate a fully operational OT network or set of systems. Because we had a limited number of RTUs available, we used Raspberry Pi on the network to emulate an RTU.

Figure 2-7 OT Network



The PACS network (Figure 2-8) contains the PACS components, which include representative components found in electric utility PACS. These components were chosen to demonstrate the integration capabilities of the central IdAM capability.

**Figure 2-8 PACS Network**



## 2.3 IP Network Address Assignments

Table 2-2 includes the IP address assignments used for the builds.

**Table 2-2 Build IP Address Assignments**

DMZ Network IP	System	Vendor Access Network	System	IdAM Management Network IP	System
10.32.2.0/25	Subnet	10.32.2.128/25	Subnet	172.16.4.0/24	Subnet
10.32.2.1	NCCoE Firewall (FW) /Gateway	10.32.2.129	NCCoE FW/Gateway	172.16.4.1	IdAM FW local area network (LAN)
10.32.2.10	Vcenter	10.32.2.130	Vendor AD	172.16.4.2	RSA IMG
10.32.2.11	ESXi #1	10.32.2.131	Vendor Reliable Datagram Sockets (RDS)	172.16.4.3	RSA Adaptive Directory
10.32.2.12	ESXi #2	10.32.2.132	RSA/SCE	172.16.4.5	AlertEnterprise
10.32.2.22	Border FW Wide Area Network (WAN)	10.32.2.133	AlertEnterprise	172.16.4.9	Ozone Console
10.32.2.50	RS1 file transfer protocol (FTP) Synology	10.32.2.134	CA	172.16.4.10	Ozone Server
10.32.2.X	Veam Backup Server	10.32.2.135	RADiFlow	172.16.4.11	Ozone Authority
		10.32.2.136	MAG	172.16.4.12	Ozone Envoy
		10.32.2.137	TDi	172.16.4.13	Ozone Personal Profile Application (PPA)
		10.32.2.232	Border FW OPT1	172.16.4.15	CA Identity Manager
				172.16.4.22	Microsoft SQL



DMZ Network IP	System	Vendor Access Network	System	IdAM Management Network IP	System
				172.16.4.253	CentOS DNS
IT Network IP	System	PAC Network IP	System	OT Network IP	System
172.16.5.0/24	Subnet	172.16.7.0/25	Subnet	172.16.6.0/25	Subnet
172.16.5.1	IT FW LAN	172.16.7.1	PACS FW LAN	172.16.6.1	OT FW LAN
172.16.5.2	IT AD, DNS, CA	172.16.7.2	PACS AD, DNS, CA	172.16.6.2	OT AD, DNS, CA
172.16.5.6	Workstation	172.16.7.5	N/A	172.16.6.4	RADiFlow FW/ Switch (SW)
172.16.5.7	Workstation	172.16.7.6	XTec XNode	172.16.6.5	Schneider Firewall
		172.16.7.11	PACS Console	172.16.6.6	Workstation
		172.16.7.15	PACS Workstation	172.16.6.8	TDi ConsoleWorks
		172.16.7.101	Laboratory Door Controller	172.16.6.100	RADiFlow Terminal Server for SEL
				172.16.6.202	RADiFlow Vendor Host

## 3 Build Infrastructure

### 3.1 Operating Systems

All machines that were used in the build had one of the following OSs installed:

- Windows 7 enterprise
- Windows server 2008 R2
- Windows server 2012 R2
- MicroFocus SUSE Linux Enterprise Server 11
- CentOS 7

### 3.1.1 Windows Installation and Hardening Details

The NCCoE Windows OS images are derived from the Department of Defense (DoD) Security Technical Implementation Guide (STIG) images. The Windows systems were installed using installation files provided by the Defense Information Systems Agency (DISA). These images were chosen because they are standardized, hardened, and fully documented. The STIG guidelines are available online at <http://iase.disa.mil/stigs/os/Pages/index.aspx>. The NCCoE chose this baseline configuration. Adopters of the NCCoE solution can use other accepted security baseline configurations, such as the Center for Internet Security (CIS) Security Benchmarks (<https://www.cisecurity.org/cis-benchmarks/>).

Modifications to the STIG-compliant OS configurations were required for each product to enable its operation. The compliance results in [Section 17](#) identify the specific OS configuration modifications (noncompliant configuration items) needed in each case.

### 3.1.2 SUSE Linux Enterprise Server 11 Installation and Hardening Details

The SUSE OS was included as part of the virtual appliance image provided by RSA for the IMG product. The center did not make any OS configuration changes. The OS was not configured to meet the DoD CentOS 6 STIG. The OS configurations for the SUSE Linux implementation are listed in [Section 17](#). The compliance results report for SUSE Linux is included for illustration purposes ([Section 17.2](#)).

### 3.1.3 Base Linux Installation and Hardening Details

CentOS 7 was the NCCoE base Linux OS that was used in the build. This OS is available as an open-source image. The OS was configured to meet the DoD CentOS 6 STIG, as no CentOS 7 STIG was available at the time when the build was implemented. The OS configurations for each Linux implementation are listed in [Section 17](#). The compliance results reports identify the configuration items that do not conform to the STIG configuration guide.

## 3.2 Firewall Configurations

The firewalls were deployed to minimize the allowed traffic among the silo networks, as well as to minimize the traffic received from the DMZ and the public internet. The goal was to limit the cross-network traffic/connections to only those required to support the use case.

The following firewall configurations include the rules that were implemented in each of the firewalls for the build implementation (Table 3-1 through Table 3-5). These configurations are provided to enable the reader to reproduce the traffic filtering/blocking that was achieved in the build implementation.

**Table 3-1 Border Firewall Rules**

Aliases						
Name	Values	Description				
VirtualInfra	10.32.2.10-12	Virtualization Systems for Build				
VPNserver	172.16.7.253	VPN Server				
WAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	10.32.2.0/25	Any	Any	Any	Allow all management network traffic
Allow	IPv4 – All	10.255.2.0/25	Any	Any	Any	Center VPN to all systems
Allow	IPv4 – Transmission Control Protocol (TCP)	Any	Any	WAN address	80	Allow access to WebGUI pfSense
Allow	IPv4 – TCP	10.255.2.0/25	Any	172.16.4.8	5176	Center VPN to ConsoleWorks
Allow	IPv4 – TCP	10.255.2.0/25	Any	172.16.4.8	443	Center VPN to ConsoleWorks Hypertext Transfer Protocol Secure (HTTPS)
Deny	IPv4 – TCP	Any	Any	WAN address	Any	Block all access to pfSense
Allow	IPv4 – TCP	Any	Any	172.16.7.110	3389	Remote Desktopo Protocol (RDP) to Lab-PC on PACS (backups)

LAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	172.16.7.135	Any	VirtualInfra	Any	Lab laptop to virtualization
Deny	IPv4 – All	Any	Any	VirtualInfra	Any	Block all to virtualization
Deny	IPv4 – TCP	172.16.8.0/24	Any	10.32.2.0/25	Any	Block vendor VPN from management
Deny	IPv4 – TCP	10.32.2.128/25	Any	10.32.2.0/25	Any	Block vendor VPN from management
Allow	IPv4 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv6 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv4 – TCP	172.16.7.128/25	Any	10.32.2.117	3389	RDP to 117
Allow	IPv4 – User Datagram Protocol (UDP)	172.16.7.128/25	Any	10.32.2.117	3389	RDP to 117
Deny	IPv4 – All	Any	Any	Any	Any	Block IPv4
Deny	IPv6 – All	Any	Any	Any	Any	Block IPv6

**Table 3-2 IdAM Firewall Rules**

Aliases						
Name	Values	Description				
AD_DCs_All	172.16.{5,6,7},2	All Domain Controllers (DCs) in infrastructure				
LinuxSystems	172.16.4.{2,3,8,10,11,12,253}	Used for Secure Socket Shell (SSH)				
MAG_Linux	172.16.4.{10,11,12}	Systems for MAG				
WAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	10.32.2.0/25	Any	Any	Any	Allow all management network traffic
Allow	IPv4 – All	10.255.2.0/25	Any	Any	Any	Center VPN to all systems
Allow	IPv4 – TCP	172.16.7.133	Any	Any	Any	IT to IdAM
Allow	IPv4 – TCP	Any	Any	LinuxSystems	IMG	Allow SSH to Linux
Allow	IPv4 – All	Any	Any	172.16.4.8	161, 162, 514, 5176	Allow Simple Network Management Protocol (SNMP), Syslog, default to TDi
Allow	IPv4 – All	AD_DCs_All	Any	172.16.4.15	Any	AD DCs to IdAM-CA
Allow	IPv4 – All	172.16.8.50	Any	172.16.4.15,22	Any	CA to CA_srv12, CA_SQL_srv12

Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – TCP	Any	Any	172.16.4.2	5900 to 5910	Virtual Network Computing (VNC) to IMG
Allow	IPv4 – TCP	172.16.7.2	Any	172.16.4.2	Any	PACS AD to IMG
Allow	IPv4 – TCP	172.16.7.2	Any	172.16.4.3	Any	PACS AD to Adaptive Directory
Allow	IPv4 – TCP	10.32.2.0/25	Any	172.16.4.8	517, 6443	Management to TDi ConsoleWorks
<b>LAN Interface</b>						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv6 – All	LAN Net	Any	Any	Any	Default allow any LAN

**Table 3-3 IT Firewall Rules**

Aliases		
Name	Values	Description
Alert_Enterprise	172.16.4.5	AlertEnterprise
CA	172.16.4.15	CA
CA_RSA_Alert	172.16.4.{2,3,5,15}, 172.16.7.132	CA, RSA, Alert
ConsoleWorks	172.15.4.8	ConsoleWorks
IT_Network	172.16.7.132	IT network
LinuxSystems	172.16.5.4	All Linux on IT
Ozone	172.16.4.10-12	Ozone products

RSA		172.16.4.2-3	IMG, Adaptive Directory			
WAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	10.32.2.0/25	Any	Any	Any	Allow all management network traffic
Allow	IPv4 – TCP	172.16.7.132	Any	Any	Any	IdAM to IT
Allow	IPv4 – TCP	Any	Any	LinuxSystems	22	Allow SSH to Linux
Allow	IPv4 – All	Any	Any	172.16.5.2	53	Allow DNS
Allow	IPv4 – TCP	IT_Network	Any	172.16.5.4	25443	Alert to ITEMAIL
Allow	IPv4 – TCP	ConsoleWorks	Any	LAN Net	22,161 to 162	TDi to IT-Net
Allow	IPv4 – TCP	CA_RSA_Alert	Any	172.16.5.2	389, 636	Lightweight Directory Access Protocol (LDAP) / Lightweight Directory Access Protocol over SSL (LDAPS) to AD
LAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv6 – All	LAN Net	Any	Any	Any	Default allow any LAN

**Table 3-4 OT Firewall Rules**

Aliases						
Name	Values	Description				
LinuxSystems	172.16.6.7	All Linux on OT				
RADiFlow	172.16.6.{4,6,202}	All RADiFlow IPs				
WAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	10.32.2.0/25	Any	Any	Any	Allow all management network traffic
Allow	IPv4 – TCP	Any	Any	172.16.6.10	22	SSH to Raspberry Pi RTU
Allow	IPv4 – TCP	Any	Any	LinuxSystems	22	Allow SSH to Linux
Allow	IPv4 – All	Any	Any	172.16.6.2	53	Allow DNS
Allow	IPv4 – All	172.16.4.8	Any	LAN Net	22, 161 to 162	TDi to OT-Net
Allow	IPv4 – TCP	Any	Any	172.16.6.2	389, 636	Any LDAP to AD
Allow	IPv4 – TCP	172.16.4.{2,3,15}	Any	172.16.6.2	Any	Adaptive Directory, IMG, CA Identity Manager to AD
Allow	IPv4 – TCP	Any	Any	172.16.6.100	2001 to 2101	Telnet access through RADiFlow



LAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv6 – All	LAN Net	Any	Any	Any	Default allow any LAN

**Table 3-5 PACS Firewall Rules**

Aliases						
Name	Values	Description				
VirtualInfra	10.32.2.10-12	Virtualization Systems for Build				
WAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	10.32.2.0/25	Any	Any	Any	Allow all management network traffic
Allow	IPv4 – All	172.16.7.132	Any	172.16.7.{2,11}	Any	IdAM to PACS-Console, PACS DC
Allow	IPv4 – TCP	Any	Any	172.16.7.2	389, 636	Any LDAP to AD
Allow	IPv4 – All	Any	Any	172.16.7.2	53	Allow DNS
Allow	IPv4 – All	172.16.4.8	Any	LAN Net	22,161 to 162	TDi to PACS-Net
Allow	IPv4 – TCP	172.16.4.{2,3,15}	Any	172.16.7.2	Any	Adaptive Directory, IMG, CA Identity Manager to AD

Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – TCP	Any	Any	172.16.7.110	3389	Microsoft Remote Desktop Protocol (MRDP) Network Address Translation to Laboratory Machine PACS

LAN Interface						
Allow/Deny	Protocol	Source	Port	Destination	Port	Description
Allow	IPv4 – All	LAN Net	Any	Any	Any	Default allow any LAN
Allow	IPv6 – All	LAN Net	Any	Any	Any	Default allow any LAN

### 3.3 Network Services

Microsoft AD was used to provide directory services in each silo network (OT, PACS, and IT). Linux CentOS 7 was used to provide DNS services in the IdAM network. Microsoft Windows Server was used to provide certificate authority services in each network.

#### 3.3.1 IT Network – Network Services (AD and Certificate Authority) Installation and Configuration Settings

##### 3.3.1.1 AD

Use these basic domain controller configuration settings:

- **Hostname:** ITDC
- **Domain:** ES-IDAM-B1.TEST
- **IP:** 172.16.5.2

Step-by-step instructions:

1. Launch **Server Manager**.
2. From the dashboard, select Option 2, **Add Roles and Features**.
3. Select **Role-based or Feature-based installation**.
4. From the server pool, select the local server named **ITDC**.
5. Select **Active Directory Domain Service and DNS Server**.
6. When prompted to add features, select **Add Features** for each role.
7. Wait for Server Manager to finish installing.
8. Select **Post-Deployment Configuration for Active Directory** from the **Task** menu.
9. Perform the following actions after Active Directory Domain Services Configuration wizard automatically launches:
  - a. Select **Add a New Forest** deployment operation.
  - b. Specify **ES-IDAM-B1.TEST** root domain, and then select **Next**.
  - c. Select **Windows Server 2012 R2** for both the Forest Functional Level and the Domain Functional Level.

- d. Perform the following actions under Domain Controller Capabilities:
  - i. Check both **DNS server** and **Global Catalog**.
  - ii. Uncheck read-only domain controller.
  - iii. Specify a password for Directory Services Restore Mode (DSRM), and then select **Next**.
- e. Continue through the wizard without modifying any options.
- f. Select **Install** on the next window. After installation, the server automatically reboots.

### 3.3.1.2 Certificate Authority Role

Use these basic certificate authority configuration settings:

- Certificate authority setup type: `Enterprise CA`
- Certificate authority type: `Root CA`
- Cryptographic options: `RSA 2048` and `SHA1`
- CN: `IT-ES-IDAM-B1-IDAM-ITDC`
- DN suffix: `DC=IT-ES-IDAM-B1, DC=TEST`

Step-by-step instructions:

1. From the Server Manager dashboard, select Option 2, **Add Roles and Features**.
2. Select **Role-based or Feature-based installation** (this is a single option to choose).
3. From the server pool, select the local server named **OTDC**.
4. Select **Active Directory Certificate Services**.
5. When prompted to add features, select **Add Features**.
6. When prompted to select roles services, check **Certificate Authority**.
7. After the Server Manager finishes installing, select **Post-deployment Configuration for Certificate Services** from the **Task** menu.
8. When prompted to specify the certificate authority setup type, select **Enterprise CA**.
9. When prompted to specify the certificate authority type, select **Root CA**.
10. When prompted to specify a private key, select **Create a new private key**.

11. When prompted to specify cryptographic options, select **RSA** with a key length of **2048**, and select **SHA1** for the hash algorithm.
12. Leave the **CN** and **DN** suffix, which should be based on the computer's hostname and domain.
13. Select **5 years** for the certificate validity period.
14. Leave the default options for the certificate database and log location.
15. After the configuration is complete, restart the server.

### 3.3.2 OT Network – Network Services (AD, DNS Server, and Certificate Authority) Installation and Configuration Settings

#### 3.3.2.1 AD Domain Services and DNS Server

Use these basic certificate authority configuration settings:

- **Hostname:** OTDC
- **Domain:** OT-ES-IDAM-B1.TEST
- **IP:** 172.16.6.2

Step-by-step instructions:

1. Launch **Server Manager**.
2. From the dashboard, select Option 2, **Add Roles and Features**.
3. Select **Role-based or Feature-based installation**.
4. From the server pool, select the local server named **OTDC**.
5. Select **Active Directory Domain Service and DNS Server**.
6. When prompted to add features, select **Add Features** for each role.
7. After the Server Manager finishes installing, select **Post-deployment Configuration for Active Directory** from the **Task** menu.
8. The Active Directory Domain Services Configuration wizard launches:
  - a. For the deployment operation, select **Add a New Forest**.
  - b. For the root domain, specify OT-ES-IDAM-B1.TEST, and then select **Next**.
  - c. For both the Forest Functional Level and the Domain Functional Level, select **Windows Server 2012 R2**.

- d. Under Domain Controller Capabilities:
  - i. Check both **DNS server** and **Global Catalog**.
  - ii. Uncheck **read-only domain controller**.
  - iii. Specify a password for **DSRM**, and then select **Next**.
- e. Continue through the wizard without modifying any options.
- f. On the last page, select **Install**. After installation, the server automatically reboots.

### 3.3.2.2 Certificate Authority Role

Use these basic certificate authority configuration settings:

- Certificate authority setup type: `Enterprise CA`
- Certificate authority type: `Root CA`
- Cryptographic options: `RSA 2048 and SHA1`
- CN: `OT-ES-IDAM-B1-IDAM-OTDC`
- DN suffix: `DC=OT-ES-IDAM-B1, DC=TEST`

Step-by-step instructions:

1. Ensure that the domain controller installation has been completed before proceeding.
2. From the Server Manager dashboard, select Option 2, **Add Roles and Features**.
3. Select **Role-based or Feature-based installation** (this is a single option to choose).
4. From the server pool, select the local server named **OTDC**.
5. Select **Active Directory Certificate Services**.
6. When prompted to add features, select **Add Features**.
7. When prompted to select roles services, check **Certificate Authority**.
8. After the Server Manager finishes installing, select **Post-deployment Configuration for Certificate Services** from the **Task** menu.
9. When prompted to specify the certificate authority setup type, select **Enterprise CA**.
10. When prompted to specify the certificate authority type, select **Root CA**.
11. When prompted to specify a private key, select **Create a new private key**.

12. When prompted to specify cryptographic options, select **RSA** with a key length of **2048**, and select **SHA1** for the hash algorithm.
13. Leave the **CN** and **DN** suffix, which should be based on the computer's hostname and domain.
14. Select **5 years** for the certificate validity period.
15. Leave the default options for the certificate database and log location.
16. After the configuration is complete, restart the server.

### 3.3.3 PACS Network – Network Services (AD, DNS Server, and Certificate Authority) Installation and Configuration Settings

#### 3.3.3.1 AD Domain Services and DNS Server

Use these basic domain controller configuration settings:

- **Hostname:** PACSDC
- **Domain:** PACS-ES-IDAM-B1.TEST
- **IP:** 172.16.7.2

Step-by-step instructions:

1. Launch **Server Manager**.
2. From the dashboard, select Option 2, **Add Roles and Features**.
3. Select **Role-based or Feature-based installation** (this is a single option to choose).
4. From the server pools, select the local server named **PACSDC**.
5. Select **Active Directory Domain Service** and **DNS Server**.
6. When prompted to add features, select **Add Features** for each role.
7. After the Server Manager finishes installing, select **Post-deployment Configuration for Active Directory** from the **Task** menu.
8. The Active Directory Domain Services Configuration wizard launches:
  - a. Select **Add a new forest for the deployment operation**. Specify **PACS-ES-IDAM-B1.TEST** for the root domain, and then select **Next**.
  - b. Select **Windows Server 2012 R2** for both the forest functional level and the domain functional level.

- c. Perform the following actions under domain controller capabilities:
  - i. Check both **DNS server** and **Global Catalog**.
  - ii. Uncheck **read-only domain controller**.
  - iii. Specify a password for **DSRM**, and then select **Next**.
- d. Continue through the wizard without modifying any options.
- e. On the last page, select **Install**. After installation, the server automatically reboots.

### 3.3.3.2 Installation of Certificate Authority Role on the PACS Network

Use these basic domain controller configuration settings:

- Certificate authority setup type: `Enterprise CA`
- Certificate authority type: `Root CA`
- Cryptographic options: `RSA 2048` and `SHA1`
- CN: `PACS-ES-IDAM-B1-IDAM-PACSDC`
- DN suffix: `DC=PACS-ES-IDAM-B1, DC=TEST`

Step-by-step instructions:

1. From the Server Manager dashboard, select the Option 2, **Add Roles and Features**.
2. Select **Role-based or Feature-based installation**.
3. From the server pools, select the local server named **OTDC**.
4. Select **Active Directory Certificate Services**.
5. When prompted to add features, select **Add Features**.
6. When prompted to select roles services, check **Certificate Authority**.
7. After the Server Manager finishes installing, select **Post-deployment Configuration for Certificate Services** from the **Task** menu.
8. When prompted to specify the certificate authority setup type, select **Enterprise CA**.
9. When prompted to specify the certificate authority type, select **Root CA**.
10. When prompted to specify a private key, select **Create a new private key**.
11. When prompted to specify cryptographic options, select **RSA** with a key length of **2048**, and select **SHA1** for the hash algorithm.



12. Leave the **CN** and **DN** suffix, which should be based on the computer's hostname and domain.
13. Select **5 years** for the certificate validity period.
14. Leave the default options for the certificate database and log location.
15. After the configuration is complete, restart the server.

### 3.3.3.3 Modify the AD LDAP Schema with Custom PACS Attributes.

Custom attribute details:

- Common name: `pacsAllDoors`
- X.500 object identification (OID): `1.3.6.1.4.1.4203.666.1`
- Syntax: `Boolean`
- Common name: `pacsHomeAccess`
- X.500 OID: `1.3.6.1.4.1.4203.666.2`
- Syntax: `Boolean`
- Common name: `pacsWorkAccess`
- X.500 OID: `1.3.6.1.4.1.4203.666.3`
- Syntax: `Boolean`

Step-by-step instructions:

1. Launch **Command Prompt** as an administrator.
2. Run the command: `regsvr32 schmgmt.dll`
3. Launch the **Microsoft Management Console**.
4. Select **File > Add/Remove Snap-in**.
5. From the **Snap-in** menu, select **Active Directory Schema**, and then select **OK**.
6. Expand the **Active Directory Schema**, and then select **Attributes**.
7. To create an attribute for the all doors access level, right-click on **Attributes**, and then select **Create Attribute**.
8. Select **OK** when prompted with the Schema Object Creation Warning.
9. Enter the following fields:
  - a. Common name: `pacsAllDoors`

- b. LDAP display name: `pacAllDoors`
- c. Unique X500 OID: `1.3.6.1.4.1.4203.666.1`
- d. Syntax: `Boolean`

10. Select **OK** when finished.

11. Create an attribute for the home access level by entering the following fields:

- a. Common name: `pacHomeAccess`
- b. LDAP display name: `pacHomeAccess`
- c. Unique X500 OID: `1.3.6.1.4.1.4203.666.2`
- d. Syntax: `Boolean`

12. Create an attribute for the work access level by entering the following fields:

- a. Common name: `pacWorkAccess`
- b. LDAP display name: `pacWorkAccess`
- c. Unique X500 OID: `1.3.6.1.4.1.4203.666.3`
- d. Syntax: `Boolean`

13. After creating custom attributes, add the attributes to the user class so that every user contains the attribute:

- a. Select the **Classes** drop-down under **Active Directory Schema**.
- b. Right-click on **User**, and then select **Properties**.
- c. Select the **Attributes** tab, and then select **Add**.
- d. Select the attribute that you want to add to the user class, and then select **OK**. Do this for the `pacAllDoors`, `pacHomeAccess`, and `pacWorkAccess` attributes.
- e. Select **Apply**, and then select **OK**.
- f. Restart the server.

### 3.3.4 IdAM Network – Network Services (DNS Server) Installation and Configuration Settings

A Linux CentOS 7 DNS server was established on the IdAM network to provide DNS services to the IdAM components. No other network service was installed in the IdAM network.

System environment settings:

- CentOS 7
- virtual machine (VM) with four central processing units (CPUs): Quad Core 2.199 gigahertz (GHz)
- VM with 16,384 megabytes (MB) of memory
- virtual hard disk containing 98 gigabytes (GB) of storage

#### Linux CentOS DNS Configuration

Basic DNS configuration settings are specified using three different system files that are located in the */etc* and */var* subdirectories of the root directory as follows.

##### 3.3.4.1 System File 1: *named.conf* in the */etc* Subdirectory

```
//  
// named.conf  
//  
// Provided by Red Hat bind package to configure the ISC BIND named(8) DNS  
// server as a caching only nameserver (as a localhost DNS resolver only).  
//  
// See /usr/share/doc/bind*/sample/ for example named configuration files.  
//  
  
options {  
    listen-on port 53 { 127.0.0.1; 172.16.4.253; };  
    #listen-on-v6 port 53 { ::1; };  
    #listen-on-v6 { none; };  
    directory      "/var/named";  
    forwarders      { 8.8.8.8; 8.8.4.4; };  
    dump-file       "/var/named/data/cache_dump.db";  
    statistics-file "/var/named/data/named_stats.txt";
```

```
memstatistics-file "/var/named/data/named_mem_stats.txt";

allow-query { localhost; 172.16.4.0/22; };

allow-transfer { localhost; 172.16.4.0/22; };


/*
- If you are building an AUTHORITATIVE DNS server, do NOT enable recursion.
- If you are building a RECURSIVE (caching) DNS server, you need to enable
  recursion.
- If your recursive DNS server has a public IP address, you MUST enable access
  control to limit queries to your legitimate users. Failing to do so will
  cause your server to become part of large scale DNS amplification
  attacks. Implementing BCP38 within your network would greatly
  reduce such attack surface
*/
recursion yes;

dnssec-enable yes;
dnssec-validation yes;
dnssec-lookaside auto;


/* Path to ISC DLV key */
bindkeys-file "/etc/named.iscdlv.key";

managed-keys-directory "/var/named/dynamic";

pid-file "/run/named/named.pid";
session-keyfile "/run/named/session.key";
};

logging {
channel default_debug {
```

```
file "data/named.run";
severity dynamic;
};

};

zone "." IN {
    type hint;
    file "named.ca";
};

zone "idam-es-idam-bl.test" IN {
    type master;
    file "idam-es-idam-bl.test";
    allow-update { none; } ;
};

zone "4.16.172.in-addr.arpa" IN {
    type master;
    file "4.16.172.db";
    allow-update { none; };
};

zone "ot-es-idam-bl.test" IN {
    type slave;
    masters {
        172.16.6.2;
    };
    forwarders {};
};
```

```

zone "pacs-es-idam-b1.test" IN {
    type slave;
    masters {
        172.16.7.2;
    };
    forwarders {};
};

```

```

zone "es-idam-b1.test" IN {
    type slave;
    masters {
        172.16.5.2;
    };
    forwarders {};
};

```

```
include "/etc/named.rfc1912.zones";
```

```
include "/etc/named.root.key";
```

### 3.3.4.2 System File 2: 4.16.172.db in the /var Subdirectory

```
$TTL 86400
```

```

@ IN SOA idam-dns.idam-es-idam-b1.test. root.idam-es-idam-b1.test. (
    2011071001 ;Serial
    3600 ;Refresh
    1800 ;Retry
    604800 ;Expire
    86400 ;Minimum TTL
)
@ IN NS idam-dns.idam-es-idam-b1.test.
@ IN PTR idam-es-idam-b1.test.

```

idam-dns        IN A    172.16.4.253

101        IN PTR idam-dns.idam-es-idam-bl.test.

System file - idam-es-idam-bl.test in the /etc subdirectory

\$TTL 86400

```
@        IN     SOA     idam-dns.idam-es-idam-bl.test.    root.idam-es-idam-bl.test. (
                               2011071001        ;Serial
                               3600        ;Refresh
                               1800        ;Retry
                               604800 ;Expire
                               86400    ;Minimum TTL
)
```

@        IN     NS       idam-dns.idam-es-idam-bl.test.

@        IN     A        172.16.4.253

idam-dns        IN     A        172.16.4.253

idam-ca                IN     A        172.16.4.15

idam-sql        IN     A        172.16.4.22

adaptivedir    IN     A        172.16.4.3

img            IN     A        172.16.4.2

consoleworks   IN     A        172.16.4.8

ozoneserver    IN     A        172.16.4.10

ozoneenvoy     IN     A        172.16.4.12

ozoneauthority        IN     A        172.16.4.11

alerttent        IN     A        172.16.4.5

WIN-IPERGL2ELUD    IN     A        172.16.4.5

## 4 Remote Terminal Units

RTUs provide the cyberspace-to-physical interface. RTUs are used to collect data, such as voltage, current, and phase, from substation equipment. RTUs are also used to deliver commands via contact closures or output voltage to change device operations, such as switches, circuit breakers, or capacitors.

### 4.1 Transmission-Control-Protocol/Internet-Protocol RTU

The TCP/IP RTU in this build is emulated with a Raspberry Pi 2 system. The system was developed to simulate a Modbus protocol programmable logic controller.

### 4.2 Serial RTU

The serial RTU in this build is an SEL-2411 programmable automation controller that was configured to support the Modbus protocol. It is connected to the RADiFlow ICS Firewall via a serial interface.

## 5 Identity Services Engine and TrustSec-Enabled Switch: Cisco

Cisco ISE controls the ability of devices to connect over the network. ISE expands on basic network address-based control to include the identity of the person using a device. ISE is used in the builds to provide a gateway function between IT and OT networks, limiting which users and devices are allowed to connect from IT to resources in OT.

The Cisco ISE component should be installed in a VM on the IT network. This ISE component will be used in conjunction with the TrustSec switch that is located on the IT network, to control access from the IT network to the OT network.

### 5.1 Security Characteristics

- [Cybersecurity Framework Category](#): PR.PT-3: Access to systems and assets is controlled, incorporating the principle of least functionality.
- [NIST SP 800-53 Revision 4 Security Controls](#): AC-3, CM-7

### 5.2 Pre-Installation Task

1. Obtain the Open Virtualization Archive (OVA) file from Cisco for Cisco ISE 1.4.
2. Place the OVA file in the data store for vSphere installation.
3. Ensure that the user domain has a security group (the build used *OTAccess*) for determining access to the OT network.



## 5.3 Install and Configure

1. Follow the guide located at [http://www.cisco.com/c/en/us/td/docs/security/ise/1-4/installation\\_guide/b\\_ise\\_InstallationGuide14/b\\_ise\\_InstallationGuide14\\_chapter\\_0100.html](http://www.cisco.com/c/en/us/td/docs/security/ise/1-4/installation_guide/b_ise_InstallationGuide14/b_ise_InstallationGuide14_chapter_0100.html).
  - a. This is the Cisco *Identity Services Engine Hardware Installation Guide*, Release 1.4, section on Installing ISE on a VMware VM.
  - b. To deploy the OVA file, follow the instructions at the heading “Installing Cisco ISE on Virtual Machines.”
  - c. After the OVA file is deployed, follow the instructions at the heading “Installing Cisco ISE Software on a VMware System.”
2. After the system is installed, type `setup` at the prompt.
3. The following are prompts and build responses:
  - a. Enter hostname: `ise`
  - b. Enter IP address[]: `172.16.4.77`
  - c. Enter IP netmask[]: `255.255.255.0`
  - d. Enter IP default gateway[]: `172.16.4.1`
  - e. Enter default DNS domain[]: `idam-es-idam-b1.test`
  - f. Enter primary nameserver[]: `172.16.4.253`
  - g. Add secondary nameserver? Y/N[N]: `<blank>`
  - h. Enter Network Time Protocol (NTP) server[time.nist.gov]: `172.16.4.1`
  - i. Add another NTP server? Y/N[N]: `<blank>`
  - j. Enter system time zone[Coordinated Universal Time (UTC)]: `EST`
  - k. Enable SSH service? Y/N [N]: `Y`
  - l. Enter username [admin]: `admin`
  - m. Enter password: `<password>`
  - n. Enter password again: `<password>`
4. After ISE finishes the installation, connect to ISE through the web browser by using the IP address specified during the setup phase.

5. Begin the Setup Assistant.
6. Select **Wired** for setup access services, and then select the **Enforce** radio button. For subnets to protect, type the target network (in the build, the OT network 172.16.6.0/24). Press **Next**.
7. Uncheck **Cisco Unified IP Phone** box. Select AD group `es-idam-b1.test/Builtin/Users`. Leave the default checked boxes as-is.
8. Select **Yes** for authenticate users using Cisco ISE. Select **Join the Active Directory domain**, and then add domain credentials (in the build, we used `es-idam-b1.test` for domain and the domain admin credentials to connect). Fill in the Employee Switched VLAN Interface box with 172.16.5.0/24. Press **Next**.
9. Select switch (the build used Cisco Catalyst 3560 series switches), and then fill in the pertinent information for the switch. For Employee VLAN ID, the build used 104. Select a RADIUS Shared Secret (the build used password). Press **Next**.
10. Confirm that all settings are correct, and then select **Confirm Configuration Settings**.

TrustSec switch configuration information: Taken from the Network Device Configuration tab in the Setup Assistant Review section, the recommended configurations to be set globally on the TrustSec-enabled switch are as follows:

```
aaa new-model
!
aaa authentication dot1x default group radius
aaa authorization network default group radius
aaa authorization auth-proxy default group radius
aaa accounting delay-start all
aaa accounting auth-proxy default start-stop group radius
aaa accounting dot1x default start-stop group radius
aaa accounting network default start-stop group radius
aaa server radius dynamic-author
  client 172.16.4.77 server-key 7 15020A1F173D24362C
!
aaa session-id common
switch 1 provision ws-c3650-48ps
authentication mac-move permit
ip routing
!
ip device tracking
ip dhcp snooping vlan 102
no ip dhcp snooping information option
```

```

ip dhcp snooping
dot1x system-auth-control
!
diagnostic bootup level minimal
spanning-tree mode pvst
spanning-tree extend system-id
!
redundancy
mode sso
!
!
ip ssh version 2
!
class-map match-any non-client-nrt-class
match non-client-nrt
!
policy-map port_child_policy
class non-client-nrt-class
bandwidth remaining ratio 10
snmp trap mac-notification change added
spanning-tree portfast
!
ip access-list extended ACL-DEFAULT
remark Allow DHCP
permit udp any eq bootpc any eq bootps
remark Allow DNS
permit udp any any eq domain
permit icmp any any
permit tcp any host 172.16.4.77 eq 8443
permit tcp any host 172.16.4.77 eq 443
permit tcp any host 172.16.4.77 eq www
permit tcp any host 172.16.4.77 eq 8905
permit tcp any host 172.16.4.77 eq 8909
permit udp any host 172.16.4.77 eq 8905
permit udp any host 172.16.4.77 eq 8909
deny ip any any
ip access-list extended ACL-WEBAUTH-REDIRECT
permit tcp any any eq www
permit tcp any any eq 443
deny ip any any
!

```

```

logging origin-id ip
logging source-interface GigabitEthernet1/0/48
!
radius-server attribute 6 on-for-login-auth
radius-server attribute 6 support-multiple
radius-server attribute 8 include-in-access-req
radius-server dead-criteria time 5 tries 3
radius-server host 172.16.4.77 auth-port 1812 acct-port 1813 key 7
140713181F13253920
!
radius server host
!
wsma agent exec
  profile httplistener
  profile httpslistener
wsma agent config
  profile httplistener
  profile httpslistener
wsma agent filesys
  profile httplistener
  profile httpslistener
wsma agent notify
  profile httplistener
  profile httpslistener
!
wsma profile listener httplistener
  transport http
!
wsma profile listener httpslistener
  transport https
ap group default-group
end

```

For each interface that is to be controlled, the recommended configurations are as follows:

```

interface GigabitEthernet1/0/10
  switchport access vlan 101
  switchport mode access
  switchport block unicast
  switchport voice vlan 105
  ip arp inspection limit rate 2000
  ip access-group ACL-DEFAULT in

```

```
authentication event fail action next-method
authentication event server dead action authorize vlan 101
authentication event server alive action reinitialize
authentication host-mode multi-auth
authentication open
authentication order dot1x mab
authentication priority dot1x mab
authentication port-control auto
authentication periodic
authentication timer reauthenticate server
authentication timer inactivity 180
authentication violation restrict
mab
dot1x pae authenticator
dot1x timeout tx-period 10
spanning-tree portfast
spanning-tree bpduguard enable
ip dhcp snooping limit rate 2048
```

11. Go to the top tabs, and click **Administration > System > Deployment**. (If you get a warning that says, “This node is standby mode. To register other...Role to Primary,” click **OK**.) Under the **Deployment Nodes – Hostnames**, click on the **ise** link. Click **Profiling Configuration**, and ensure that **Netflow**, **Radius**, **DNS**, **SNMPQUERY**, and **SNMPTRAP** are selected. If they are not selected, then select them. Click **Save**.
12. Select **Administration > Identity Management > External Identity Sources**. In the frame on the left, choose **Active Directory**, and then choose `ise.idam-es-idam-b1.test`. Click on the **Connections** tab, and then select the checkbox next to the domain `es-idam-b1.test`. Check to see if there is a green check in the **Status** column. If yes, click **Save**. If not, click **Join**, and then type in the AD Credentials and click **Save**. A green check should appear in the Status column.
13. Select the **Administration > Identity Management > External Identity Sources > Groups** tab. Click **Add > Select Group From Directory**. Click **Retrieve Groups**. Check the **es-idam-b1.test/Users/Domain Users** box, the **es-idam-b1.test/Builtin/Users** box, and the **es-idam-b1.test/Users/OTAccess** box. These items are specified for protected access (the build used OTAccess). Click **OK**, and then click **Save**. Log in again as directed.
14. Select **Administration > System > Settings**. Click on **Policy Sets** in the frame at the left of the screen, and then click **Enabled** (if it is not already clicked). Click **Save** if needed.
15. Select **Policy > Policy Elements > Results**. In the frame at the left of the screen, in the left column, click **Authorization**, and then click **Downloadable ACL List**. Create the following (All IP

addresses are pertinent to the current build; these addresses will need to be replaced with IP addressing that is appropriate to the target environment.):

- a. `All_But_OT-Access-DACL`
  - i. **Name:** `All_But_OT-Access-DACL`
  - ii. **Discretionary Access Control List (DACL) content:**  
`deny ip any 172.16.6.0 0.0.0.255`  
`permit ip any any`

16. Click **Save**.

17. In the left column, select **Authorization Profiles**, and then click **Add** to create the following:

- a. `All_and_OT`
  - i. **Name:** `All_and_OT`
  - ii. **Access type:** `ACCESS_ACCEPT`
  - iii. **Check DACL name:** `PERMIT_ALL_TRAFFIC`

18. Click **Submit**.

- a. `All_But_OT_Access`
  - i. **Name:** `All_But_OT_Access`
  - ii. **Access type:** `ACCESS_ACCEPT`
  - iii. **Check DACL name:** `All_But_OT-Access-DACL`

19. Click **Submit**.

- a. `DenyAccess`
  - i. **Name:** `DenyAccess`
  - ii. **Access type:** `ACCESS_REJECT`

20. Click **Submit**.

21. Select **Policy > Policy Elements > Conditions**. In the left column, select **Authorization**, and then select **Simple Conditions**. Click **Add** to create the following:

- a. `NotOTAccess`
  - i. **Name:** `NotOTAccess`

- ii. Attribute: Select the domain (build uses `es-idam-b1.test`) > **ExternalGroups**
- iii. Operator: **Not Equals**
- iv. Value: Select the Security Group (build uses `es-idam-b1.test/Users/OTAccess`)

22. Click **Submit**.

- a. `IT_DomainUsers`
  - i. Name: `IT_DomainUsers`
  - ii. Attribute: Select the domain (build uses `es-idam-b1.test`) > **ExternalGroups**
  - iii. Operator: **Equals**
  - iv. Value: Select domain users group (build uses `es-idam-b1.test/Users/Domain Users`)

23. Click **Submit**.

24. Select **Policy > Policy Sets**. Select Default, and configure the policies. Choose the arrow next to **Authorization** to expand the section. Choose the top rule, and click the option arrow to the right of the **Edit** link within the policy. Click **New**.

- a. Rule 1: Click the plus sign in the **Conditions** box. Select **Create New Condition** (Advanced Option). Select **Attribute > es.idam-b1.test > External Groups**. Leave **equals** Select **Attributes > es-idam-b1.test/Users/OTAccess**. Click the plus sign in the **Permissions** box. Select the item drop-down, and choose **Standard > All\_and\_OT**. Click the **Done** button on right.
- b. Click the arrow to the right of the **Edit** link within the top policy (new policy created above). Click **Insert Below**.
- c. Rule 2: Click the plus sign in the **Conditions** box. Select **Existing Condition** from Library. Select the arrow to choose **simple conditions > NotOTAccess**. Select the arrow next to the gear icon (on right). Select **Add Condition** from Library. Select the arrow to choose **Simple conditions > IT\_DomainUsers**. Click on the **Permissions** input box. Click the plus sign in the **Permissions** box. Click the arrow, and choose **standard > All\_But\_OT\_Access**. Click **Done**, and then click **Save**.

## 6 Identity Manager: CA Technologies Installation – Build #1

CA Identity Manager implements the central IdAM workflow in Build #1. It receives input from an HR system, in the form of Comma-Separated Value (CSV) files. The access and authorization for each user is based on the business and security rules implemented in workflows within Identity Manager. The workflows include management approval chains as well as approval/denial data logging. Once Identity Manager has processed the access and authority request, the updated user access and authorization data is pushed to the central identity store. The central identity store contains the distribution mechanism for updating the various downstream (synchronized) directories with user access and authorization data. This process applies to new users, terminated users (disabled or deleted users), and any changes to a user profile. Changes include promotions, job responsibility changes, and any other change that would affect the systems that a user needs to access.

### 6.1 Security Characteristics

#### Cybersecurity Framework Categories:

- PR.AC-1: Identities and credentials are managed for authorized devices and users.
- PR.AC-4: Access permissions are managed, incorporating the principles of least privilege and separation of duties.

NIST SP 800-53 Revision 4 Security Controls: AC-2, AC-3, AC-5, AC-6, AC-16, IA Family

CA Identity Manager is installed on the IdAM network on a VM running the Windows Server 2012 R2 OS.

**Important:** The following instructions are for a single-server demonstration environment, and are not intended to be used for a production deployment.

This guide walks you through a basic installation of CA Identity Manager on JBoss, on a single Windows server. For comprehensive instructions for installing CA Identity Manager, refer to the CA Identity Manager Installation Guide for JBoss at <https://support.ca.com>.

### 6.2 Installation Prerequisites

The following steps are required prior to the CA Identity Manager installation. (For supported versions of all software, review the CA Identity Manager Support Matrix at <https://support.ca.com>.)

1. Use a server with a supported OS (e.g., Windows 2012 R2).
2. Install a supported version of the Java Development Kit (JDK) (e.g., 1.7.0\_71).
3. Install a supported version of JBoss (e.g., jboss-eap-6.3).



4. To install JBoss as a Windows service, follow the instructions at the following link:  
[https://access.redhat.com/documentation/en-US/JBoss\\_Enterprise\\_Application\\_Platform/6.3/html/Installation\\_Guide/Install\\_JBoss\\_Enterprise\\_Application\\_Platform\\_6\\_Microsoft\\_Windows\\_Service.html](https://access.redhat.com/documentation/en-US/JBoss_Enterprise_Application_Platform/6.3/html/Installation_Guide/Install_JBoss_Enterprise_Application_Platform_6_Microsoft_Windows_Service.html)
5. Create a database and associated user with database administrator (DBA) permissions on a supported database (e.g., MSSQL 2012).
6. Download and unzip CA Identity Manager software.

### 6.3 Install CA Directory

1. From the unzipped location, go to *CADirectory\_x64\dxserver\windows* and execute *dxsetup.exe*.
2. Select Typical installation.
3. Uncheck DXmanager will manage...
4. Accept all other defaults.

### 6.4 Install CA Identity Manager

1. From the unzipped location, execute *ca-im-12.6.XX-win32.exe*.
2. Select Components: deselect "Connect to Existing SiteMinder Policy Server" and "Extensions for Siteminder...". Leave the rest of the checkboxes checked.
3. Deployment Size: **compact**
4. Provisioning Server Hostnames: Just click **Next**.
5. Provisioning Directory Information: Enter a shared secret and confirmation.
6. Destination Location: Accept default
7. FIPS Information: Accept default
8. Application Server Information: **JBoss**
9. JBoss Application Server Information: Choose and locate the folder where JBoss is installed. Enter the fully qualified Uniform Resource Locator (URL) and Port for JBoss. Leave the Cluster fields blank.
10. Select Java Virtual Machine: Click **Search for Others**. Select *jdk1.7.0\_71\bin\java.exe*.
11. Key Encryption Information: Accept default

12. Select Database Type: Select SQL 2005, 2008, or 2012.
13. Database Connection Information: Enter the hostname, database, and credentials as created in the prerequisites above.
14. Login Information: Enter a username and password to be used for the Management Console. Leave the Enable Secure Login for Management Console checked.
15. Hypertext Transfer Protocol (HTTP) Proxy Settings: Leave blank
16. Review Settings: Click **Install**
17. After the installation completes, start JBoss by executing `jboss-eap-6.3\bin\standalone.bat`
18. Review the log file to verify that JBoss started without error: `jboss-eap-6.3\standalone\log\server.log`
19. If you receive a timeout error, such as “Timeout after [300] seconds waiting for service container stability...,” increase the timeout by modifying *standalone.bat*, adding the following attribute to the startup script: `-Djboss.as.management.blocking.timeout=900`

## 6.5 Create the Sample NeteAuto Directory

1. Open a command prompt as the administrator user.
2. Change directory to `C:\Program Files (x86)\CA\Identity Manager\IAM Suite\Identity Manager\tools\samples\NeteAuto\Organization`.  
You will see several sample files. For this example, we will use *neteauto.ldif*.
3. Execute the following commands:
  - a. `dxnewdsa -s500 neteauto 3895 "dc=security,dc=com"`
  - b. `dxserver install neteauto`
  - c. `dxserver stop neteauto`
  - d. `dxloadadb -v -s neteauto neteauto.ldif`
  - e. `dxserver start neteauto`
4. To log into the IM Management Console, navigate to `http://<ServerName>:8080/iam/immanage`, and log in using the credentials you supplied in Login Information above.
5. From Directories, select **Create or Update from XML**.

6. Browse to *C:\Program Files (x86)\CA\Identity Manager\IAM Suite\Identity Manager\tools\samples\NeteAuto\Organization*.
7. Select **directory.xml**. Click **Next**.
8. Supply values for the fields in this window as follows:
  - a. **Name:** `NeteAuto`
  - b. **Description:** (optional)
  - c. **Connection Object Name:** `neteauto`
  - d. **Host:** (the machine name where you ran the `dxserver` commands above)
  - e. **Port:** `3895`
  - f. **Username/User DN:** `uid=NeteAuto Administrator,ou=People,ou=Employee,ou=NeteAuto,dc=security,dc=com`
  - g. **Password/Confirm Password:** `test`
  - h. **Secure Connection:** **unchecked**
9. Click **Next**, and then click **Finish**.

## 6.6 Create the Provisioning Directory

1. From Directories, select **Create or Update from XML**.
2. Browse to *C:\Program Files (x86)\CA\Identity Manager\IAM Suite\Identity Manager\tools\directoryTemplates\ProvisioningServer*.
3. Select **directory.xml**. Click **Next**.
4. Supply values for the fields in this window as follows:
  - a. **Name:** `Provisioning`
  - b. **Description:** (optional)
  - c. **Connection Object Name:** `provisioning`
  - d. **Host:** (the machine name where IM is installed)
  - e. **Provisioning Domain:** `im`
  - f. **Username:** (the username you supplied in **Login Information** above)

g. **Password/Confirm Password:** (the password you supplied in Login Information above)

5. Click **Next**, and then click **Finish**.

## 6.7 Create the NeteAuto Environment

1. From Environments, select **New**.

2. Supply the following information:

a. **Environment name:** `NeteAuto`

b. **Description:** (optional)

c. **URL alias:** `neteauto`

d. **Base URL:** accept the default (Make sure that it is a fully qualified hostname in the URL.)

3. Click **Next**.

4. Select the **NeteAuto** directory. Click **Next**.

5. Select the **Provisioning** directory. Click **Next**.

a. URL alias that is used to reference public tasks: `neteauto_pub`

b. User for anonymous authentication: `SelfRegUser`

6. Click **Validate**. Click **Next**.

7. Select Create Default Roles. Click **Next**.

8. Select the checkbox for **Active Directory**.

9. Scroll down, and click the **Browse** button.

10. Select the [NIST\\_PXPolicies.xml](#) file provided with this guide. (Download the file from <https://nccoe.nist.gov/sites/default/files/library/sp1800/es-idam-nist-sp1800-2-draft.zip>, and unzip it.)

11. Click **Next**.

a. System Manager: `SuperAdmin`

12. Click **Add**. Click **Next**.

a. Inbound Administrator: `SuperAdmin`

13. Click **Next**.
  - a. **Password/Confirm Password:** (the password that you supplied in Login Information above)
14. Click **Next**.
15. Review the settings, and then click **Finish**.
16. Allow a few minutes for the Environment to deploy.
17. When finished with “0 error(s),” click **Continue**.
18. Click **NeteAuto**.
19. Click **Advanced Settings**, and then click **Workflow**. Enable both checkboxes, and then click **Save**.
20. Click the **Restart Environment** button.
21. Verify that you can log into the environment by going to the environment URL and logging in:
  - a. `http://<FullyQualifiedServerName>:8080/iam/im/<ProtectedAlias>`
  - b. **Username:** SuperAdmin
  - c. **Password:** test

## 6.8 Configure Connection to AlertEnterprises Database

Generate the encrypted password for the Alert Database as follows:

1. From a command prompt, change directory to `C:\Program Files (x86)\CA\Identity Manager\IAM Suite\Identity Manager\tools>PasswordTool`.
  - a. Execute the following command: `pwdtools -JSAFE -p <AlertDBPassword>`
  - b. The result displays the Encrypted value with a prefix of {PBES}.
  - c. Copy this encrypted password to be used below for **EncryptedALERTDBPassword**.
2. From the JBoss installation directory, create the following folder structure: `jboss-eap-6.3\modules\com\mysql\main`.
  - a. Download Connector/J from <http://dev.mysql.com/downloads/connector/>.
  - b. Select **Platform Independent, Compressed Zip Archive**. Download.
  - c. Unzip and copy the `mysql-connector-java-5.1.35-bin.jar` to the `mysql/main` folder that you created above.

- d. Under the same folder, create a text file named *module.xml*. Paste the following text into the file:

```
<?xml version="1.0" encoding="UTF-8"?>
<module xmlns="urn:jboss:module:1.1" name="com.mysql">
  <resources>
    <resource-root path="mysql-connector-java-5.1.35-bin.jar"/>
  </resources>
  <dependencies>
    <module name="javax.api"/>
  </dependencies>
</module>
```

3. From *jboss-eap-6.3\standalone\configuration*, edit *standalone-full.xml*.

4. In the "<drivers>" section, add

```
<driver name="mysql" module="com.mysql">
  <driver-class>com.mysql.jdbc.Driver</driver-class>
</driver>
```

5. Just above the "<drivers>" section, add a new data source:

```
<datasource jndi-name="java:/iam/im/jdbc/jdbc/AlertDB" pool-name="MySQLPool"
use-java-context="true">
  <connection-url>
jdbc:mysql://ALERTDBServerName:3306/ALERTDBName
  </connection-url>
  <driver>
    mysql
  </driver>
  <pool>
    <max-pool-size>30</max-pool-size>
  </pool>
  <security>
    <security-domain>mysqlldb</security-domain>
  </security>
</datasource>
```

6. In the "<security-domains>" section, add the following security domain:

```
<security-domain name="mysqlldb">
  <authentication>
    <login-module
code="com.netegrity.jboss.datasource.PicketBoxPasswordEncryptedLogin"
flag="required" module="com.ca.iam.idmutils">
      <module-option name="userName" value="ALERTDBUserName"/>
      <module-option name="password" value=" EncryptedALERTDBPassword "/>
      <module-option name="managedConnectionFactoryName"
value="jboss.jca:name=iam/im/jdbc/jdbc/WPDS,service=LocalTxCM"/>
    </login-module>
  </authentication>
</security-domain>
```

7. Restart the JBoss service.

8. Review the log file to verify that JBoss started without error: *jboss-eap-6.3\standalone\log\server.log*.

## 6.9 Policy Xpress Policy Review

1. Log into the NeteAuto Environment that you created above by navigating to *http://<FullyQualifiedServerName>:8080/iam/im/<ProtectedAlias>*.
2. For NeteAuto, the username/password is `superadmin/test`.
3. Navigate to Policies > Policy Xpress > Modify Policy Xpress Policy, and click Search.
4. Select the desired Policy to review and modify as desired.
  - a. **Check for Duplicates on Create:** Stops the task with a message to the user if duplicates are detected for the CardNumber or the UserID on the Alert Database
  - b. **Check for Duplicates on Modify:** Stops the task with a message to the user if the CardNumber is already used by another user on the Alert Database.
  - c. **Check for Numeric on Create and Modify:** Stops the task with a message to the user if the Personal Identification Number (PIN), FacilityCode, or CardNumber is not an integer
  - d. **Check PACs fields on Create and Modify:** Stops the task with a message to the user if none of the PACs checkboxes are selected (at least one must be selected)
  - e. **Create AE User:** Creates a user on the Alert Database if all above checks pass; provisions the user to AD
  - f. **Disable AE User:** Disables the user on the Alert Database by setting the UserStatus to "Inactive"
  - g. **Enable AE User:** Enables the user on the Alert Database by setting the UserStatus to "Active"
  - h. **Modify AE User:** Modifies the user on the Alert Database if all above checks pass

## 6.10 Update Create User and Modify User Screens

1. From **Roles and Tasks > Admin Tasks > Modify Admin Task**, search and select **Create User**.
2. Go to the **Tabs** tab, and click the edit pencil next to **Profile**.
3. Click **Browse** next to the Create User Profile.
4. Select the **Default User Profile**, and click the **Edit** button.

5. Click the edit pencil next to each of the following fields:
  - a. **Office:** Change Name to `PIN`.
  - b. **Postal Code:** Change Name to `Facility Code`. Change Permission to Read/Write Required.
  - c. **Cell Phone:** Change Name to `Home Phone`.
  - d. **Business Phone:** Change Name to `Work Phone`.
  - e. **State:** Change Name to `Pacs All Door`. Change **Style** to **Checkbox**. Set **Check Value** to **1**. Set **Unchecked Value** to **0**.
  - f. **City:** Change Name to `Pacs Work Access`. Change **Style** to **Checkbox**. Set **Check Value** to **1**. Set **Unchecked Value** to **0**.
  - g. **Address:** Change Name to `Pacs Home Access`. Change **Style** to **Checkbox**. Set **Check Value** to **1**. Set **Unchecked Value** to **0**.
  - h. **Employee Number:** Change **Name** to `Card Number`. Change **Permission** to **Read/Write Required**.
  - i. For any non-required fields that you don't want to display: Change **Style** to **Hidden**.
6. Click **OK**.
7. Select the **Create User Profile**, and click the **Edit** button.
8. Repeat Step 5 for this profile. When finished, click **OK**.
9. Navigate to **Users >Manage Users >Create User**, and click **Yes** for the warning message about losing changes.
10. Select **Create New User**, and click **OK**.
11. Verify that the fields that you updated are changed as desired.
12. Navigate to **Users >Manage Users >Modify User**, and click **Yes** for the warning message about losing changes.
13. Select **Create Modify User**, and click **OK**.
14. Verify that the fields that you updated are changed as desired.



## 6.11 Install Active Directory Certificate

1. Obtain the AD certificate(s) from the domain controller(s) to which you want to connect, and copy them to the Identity Manager server.
2. Double-click on the certificate, and click **Install Certificate**.
3. Select **Local Machine**, and then place all certificates in the following store. Click **Browse**.
4. Select **Trusted Root Certification Authorities**. Click **OK** twice.

## 6.12 Acquire Active Directory Endpoint

1. From **Endpoints >Manage Endpoints >Create Endpoint**, select **Create a new endpoint of Endpoint type ActiveDirectory**. Click **OK**.
  - a. Endpoint: Give your endpoint a name.
  - b. Hostname: Fully qualified host name for the Active Directory Domain Controller.
  - c. User ID: Fully qualified User ID, for example: domain\userid.
  - d. Password/Confirm Password: Password for the AD User.
2. Click the **Security** tab. Check the **Use LDAP – SSL Encryption** checkbox.
3. Click **Submit**.

## 6.13 Explore and Correlate Active Directory

1. From **Endpoints >Explore and Correlate Definitions >Create Explore and Correlate Definition**, select **Create a New Object of Type Explore and Correlate**, and click **OK**.
2. Explore and Correlate Name: Give it a name, such as “Explore AD <domain controller name>.”
3. Select the **Explore endpoint...** checkbox. Uncheck the rest of the checkboxes.
4. Click the **Select Container/Endpoint/Explore Method** button.
5. Select **Active Directory**, and click **Search**.
6. Select the endpoint that you created above. Click **Select**.
7. Click **Search**.
8. Select the containers that you want to have connected to Identity Manager.
9. Click **Select**, and then click **Submit**.

10. From **Endpoints** > **Execute Explore and Correlate**, select **Execute Now**, and click **Next**.
11. Browse for the Explore and Correlate Definition that you just created, and then click **Finish**.
12. Repeat the steps above to create and execute a Correlate Definition, with only one difference: On the step Explore endpoint step; uncheck **Explore endpoint**; and check **Update User Fields**, **Correlate Accounts to Users**, and **Create Users** as needed.
13. From **System** > **View Submitted tasks**, click **Search**.
14. Verify that both the Explore and Correlate definitions completed successfully.

## 6.14 Create the Active Directory Account Template and Provisioning Role

1. From **Endpoints** > **Account Templates** > **Create Account Template**, select **Create a new Account Template of Endpoint Type "Active Directory"**. Click **OK**.
2. Give the Account Template a name, such as "<domain controller name> Account Template."
3. From the **Endpoints** tab, add the Active Directory Endpoint that you created above.
4. From the **Groups** tab, add the Active Directory groups that you want to provision to the user.
5. When finished, click **Submit**.
6. From **Roles** > **Provisioning Roles** > **Create Provisioning Role**, select **Create a new provisioning role**, and then click **OK**.
7. Give the Provisioning Role a name, such as "<domain controller name> Provisioning Role."
8. From the **Account Templates** tab, add the Account Template that you just created above.
9. From the **Administrators** tab, select a user, or a group of users, that you want to be the administrators of this role. For example, to make the members of a certain admin role be the administrators of this provisioning role, follow the steps listed below:
  - a. Click **Add**.
  - b. From the **Users** drop-down select a group of users, such as users who are members of <role-rule>, and then admin role.
  - c. Browse, search, and select the Admin Role that you want to add.
  - d. From the **Owners** tab, select a user, or group of users, that you want to be the owners of this role, using the same process as used for the Administrators tab.
  - e. Click **Submit**.

## 6.15 Modify Create AE User Policy to Include the New Provisioning Role

1. From **Policies >Policy Xpress >Modify Policy Xpress Policy**, search and select the Create AE User policy.
2. From the **Action Rules** tab, click the edit pencil next to **Create User**.
3. Click the edit pencil next to Add otcd. Click the **Browse “...”** button next to the Provisioning Role Name. Select the Provisioning Role that you just created.
4. Click **Select > OK > OK > Submit**.

## 6.16 Add Workflow Control Over Create User and Any Other Task as Desired

1. From **Roles and Tasks >Admin Tasks >Modify Admin Task**, search and select **Create User**.
2. From the **Events** tab, click the edit pencil next to the **CreateUserEvent** workflow process.
3. Select the Non-Policy Based workflow process **SingleStepApproval**
4. For the approval, select **Approve Create User**
5. For the Participant resolver, select the type of members that you want to assign. For example, **Admin Role Members**.
6. Click **Add Admin Roles**. Search and select the Admin Roles that you want to have approve this workflow.
7. Repeat Steps 4, 5, and 6 above for the Primary Approver.
8. When finished with both approvers, click **OK > Submit**.

The above steps can be used for the Modify User and Enable/Disable User tasks (or any other task).

## 6.17 Test Creation of a User Manually

1. From **Users >Manage Users > Create User**, select **Create a New User**, and then click **OK**.
2. Fill out the fields as desired for the new user, keeping in mind that the policy rules explained above. For example, PIN, Facility Code, and Card Number must be integers, and at least one PACS access checkbox must be checked.
3. Click **Submit**, and click then **OK**.
4. From **Home > View My Worklist**, select and approve the workflow for the Create User task.

5. From **System >View Submitted tasks**, click **Search**. Verify that the Create User task completed successfully.
6. Connect to the AE Database. Verify that the user was created successfully.
7. Connect to the Active Directory Domain Controller. Verify that the user was created successfully.

Repeat all of the steps above for Modify User, Enable User, and Disable User.

## 6.18 Test Creation of a User with a CSV file

1. Download the file *HRBulkUsers4.csv* from <https://www.nccoe.nist.gov/sites/default/files/library/sp1800/es-idam-nist-sp1800-2-draft.zip>, and unzip to use.
2. Modify the CSV file to enter the desired values for the new users to be created. Keep in mind the policy rules that must be followed as described above.
3. From **System > Bulk Loader**, Browse for the CSV file.
4. What field represents the action to perform on the object: **action**.
5. What field will be used to uniquely identify the object: **uid**.
6. Click **Next**.
7. What is the Primary Object: **USER**.
8. Select a task to execute for action “create”: **Create User**
9. Click **Finish**.

Repeat Steps 4 through 7 above, and the steps from [Section 6.17](#), to approve the users and to verify that they were successfully created.

## 7 Identity Management and Governance: RSA (Build #2)

RSA IMG implements the central IdAM workflow in Build #2. It receives input from an HR system, in the form of CSV files. The access and authorization for each user is based on the business and security rules implemented in workflows within RSA IMG. The workflows include management approval chains as well as approval/denial data logging. Once IMG has processed the access and authority request, the updated user access and authorization data is pushed to the central identity store. The central identity store contains the distribution mechanism for updating the various downstream (synchronized) directories with user access and authorization data. This process applies to new users, terminated users (disabled or

deleted users), and any changes to a user profile. Changes may include promotions, job responsibility changes, and any other change that would affect the systems that a user needs to access.

## 7.1 Security Characteristics

### Cybersecurity Framework Categories:

- PR.AC-1: Identities and credentials are managed for authorized devices and users
- PR.AC-4: Access permissions are managed, incorporating the principles of least privilege and separation of duties

NIST SP 800-53 Revision 4 Security Controls: AC-2, AC-3, AC-5, AC-6, AC-16, IA Family

## 7.2 IMG Installation

Install IMG by using the included installation guide on a server running SUSE Linux OS or from an IMG virtual appliance image. The RSA Installation guide is available for licensed customers at <https://community.rsa.com/docs/DOC-36634>.

## 7.3 IMG Configuration and Integration with Directories

After install, open a web browser and point it to the IP Address or DNS name of the RSA IMG server. The following instructions are provided along with screenshots depicting each step. Unless stated otherwise the settings are included in each screenshot.

1. Log in with the default credentials:
  - a. **Username:** AveksaAdmin (case-sensitive)
  - b. **Password:** aveksa123
2. Change the password when prompted to change.
3. Configure system settings:
  - a. **Admin > System > Edit**, and set up the system as shown in Figure 7-1 and Figure 7-2.

Figure 7-1 IMG System Window

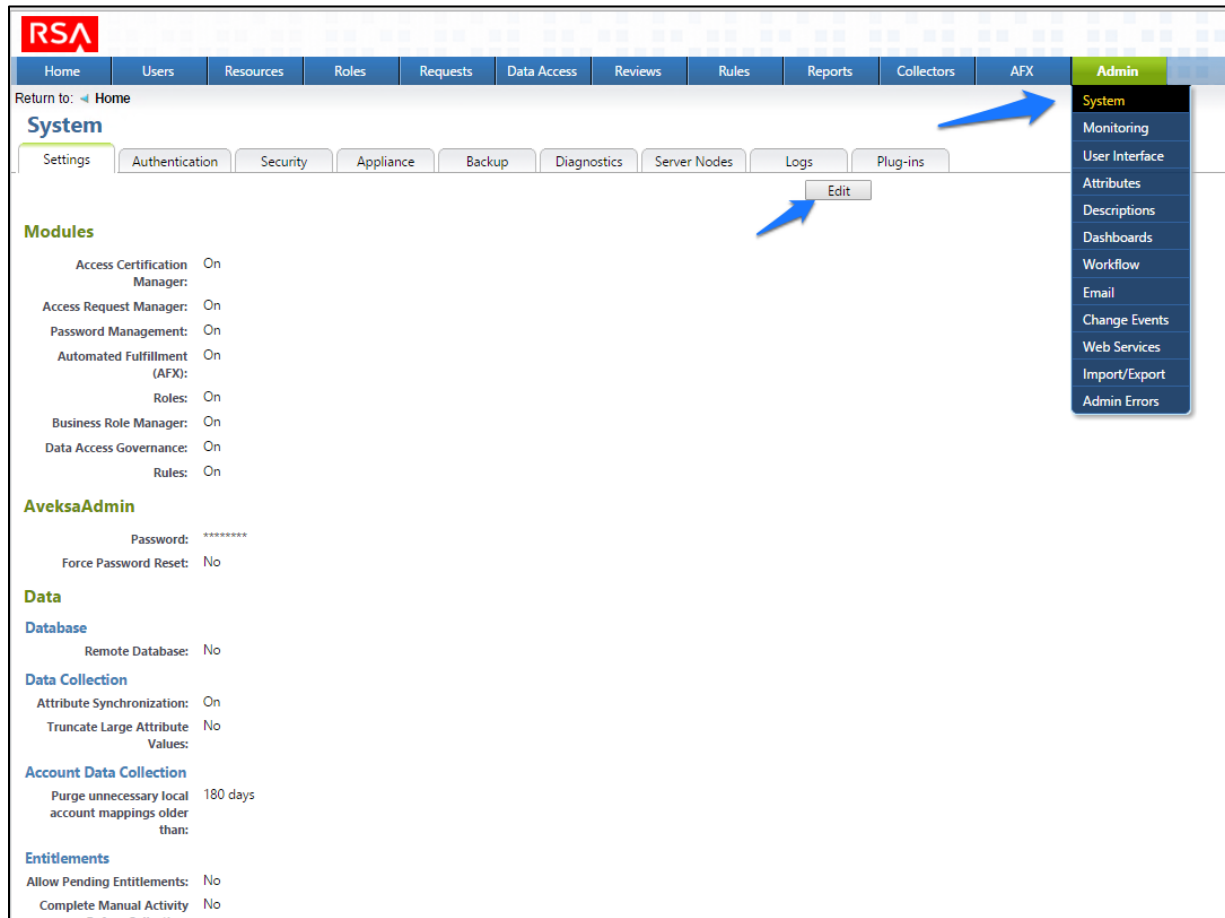


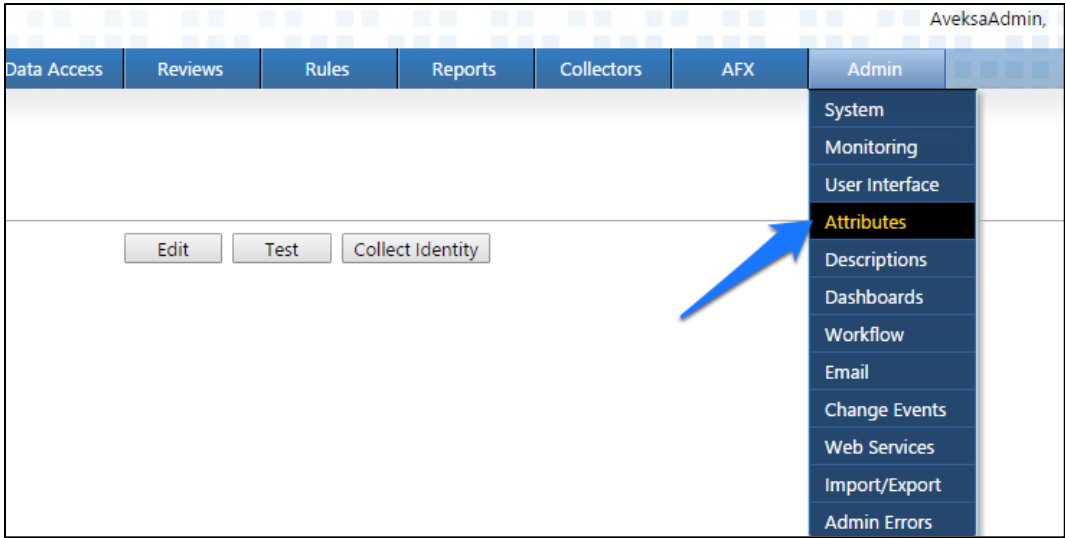
Figure 7-2 IMG System Edit Window

Complete Manual Activity Before Collection:	No
Allow alternate owners for Entitlements:	No
Calculate business descriptions on import:	No
Max items per change request:	0
<b>Files</b>	
Max upload file size:	50 MB
<b>Change Request Password Data</b>	
Expire unviewed password data older than:	48 hours
Days to retain password change history (0 = forever):	0 days
<b>UI</b>	
<b>User Session</b>	
Session Timeout:	300 minutes
Warning Before Timeout:	30 seconds
<b>Menus</b>	
Menus for unprivileged users:	On
My Tasks:	Off
<b>Table Defaults</b>	
Rows/Page:	50
Wrap Header:	Yes
Wrap Data Cells:	Yes
<b>Info Popup Dialog Contents</b>	
Allow links:	Yes
<b>Other Features</b>	
Supervisor Link:	On
User Privileges Tab:	On
<b>Audit Logging</b>	
Audit Logging:	On
Automatic Audit records cleanup:	On

### 7.3.1 Set Up Custom Attributes

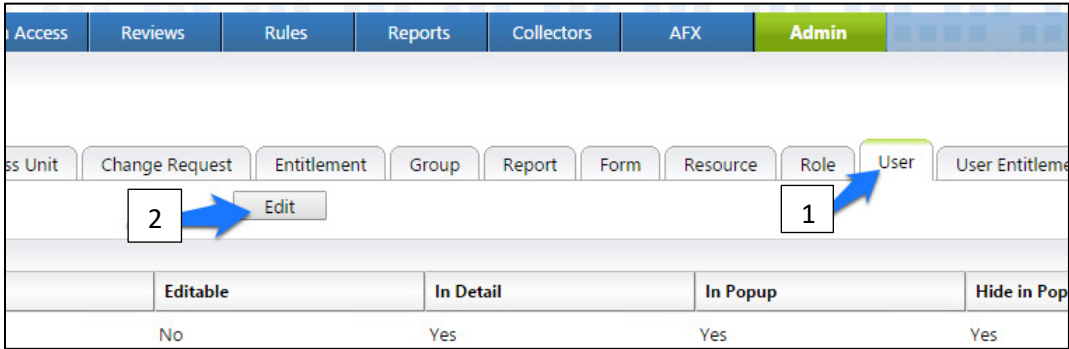
1. Navigate to **Admin**, and select **Attributes**, as shown in Figure 7-3.

Figure 7-3 IMG Attributes Window



2. Click **User > Edit**, as shown in Figure 7-4.

Figure 7-4 IMG Edit User



3. Modify your user attributes to match Figure 7-5 through Figure 7-7.



Figure 7-5 IMG User Attributes Examples (1 of 3)

Attribute Configuration - User									
Once an attribute is configured, it can not be deleted. The option selected for <i>Data Source</i> is a one-time change and cannot be edited later. The <i>Editable</i> option for Collected attributes will be available only for attributes that were mapped in an identity collector.									
Attribute Name	Data Type	Length	Data Source	Editable	Custom Value	Directory	In Detail	In Popup	Hide in Popup if Empty
Backup Supervisor	User		Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Creation Date	Date		Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Deletion Date	Date		Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Department	String	256	Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Email Address	String	256	Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Exception Count	Integer		Managed	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Expiration Date	Date		Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Expiration Value	String	256	Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
First Name	String	256	Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Full Name	String	256	Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is App Owner	String	256	Managed	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is Deleted	Integer		Collected				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is Manager	String	256	Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is Monitor	String	256	Managed	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is Senior Manager	String	256	Managed	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is Terminated	Integer		Collected	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Figure 7-6 IMG User Attributes Examples (2 of 3)

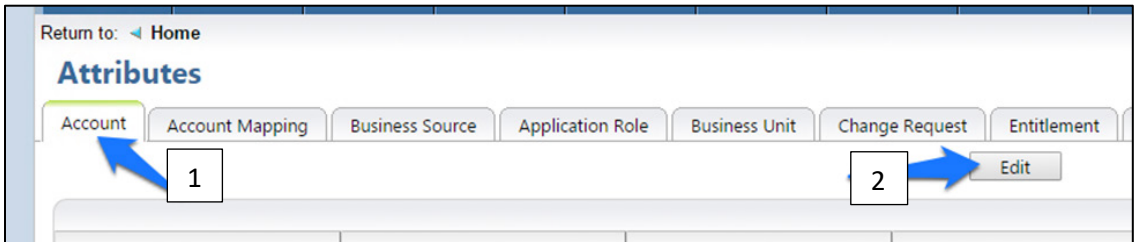
Job Code	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Job Family	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Job Level	Integer		Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Job Status	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Last Name	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Location	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Other	User		Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS All Doors	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS Home AAccess	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS Work Access	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Previous Supervisor	User		Managed	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Self Reviewer	User		Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Supervisor	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Termination Date	Date		Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Title	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Transfer Date	Date		Managed	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Unique Id	String	2000	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
User Id	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
User Risk Level	String	256	Managed	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Figure 7-7 IMG User Attributes Examples (3 of 3)

Violation Count	Integer		Managed	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Login ID	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DN	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
OU	String	256	Collected	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<div>Add Attribute Add Separator</div>							

4. Click **OK**.
5. Click **Account > Edit**, as shown in Figure 7-8.

Figure 7-8 IMG Edit Attributes



6. Modify your account attributes to match those shown in Figure 7-9.

Figure 7-9 IMG Account Attributes Example

### Attribute Configuration - Account

Once an attribute is configured, it can not be deleted. The option selected for *Data Source* is a one-time change and cannot be edited later. The *Editable* option for Collected attributes will be available only for attributes that were mapped in an identity collector.

Attribute Name	Data Type	Database ID	Data Source	Editable	Custom Value	In Detail	In Popup	Hide in Popup if Empty
Account Email	String	CAS10	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Expiration Date	Date	CAD1	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Full Name	String	CAS2	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Risk Level	String	CAS3	Managed	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Risk Score	Integer	CAI1	Managed	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Status	String	CAS8	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Account Technical Name	String	CAS4	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DN	String	CAS7	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Last Reviewed Date	Date	LAST_REVIEWED_D	Managed	<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS All Doors	String	CAS1	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS Home Access	String	CAS5	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PACS Work Access	String	CAS6	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Login ID	String	CAS9	Collected			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Add Attribute
Add Separator

7. Click **OK**.

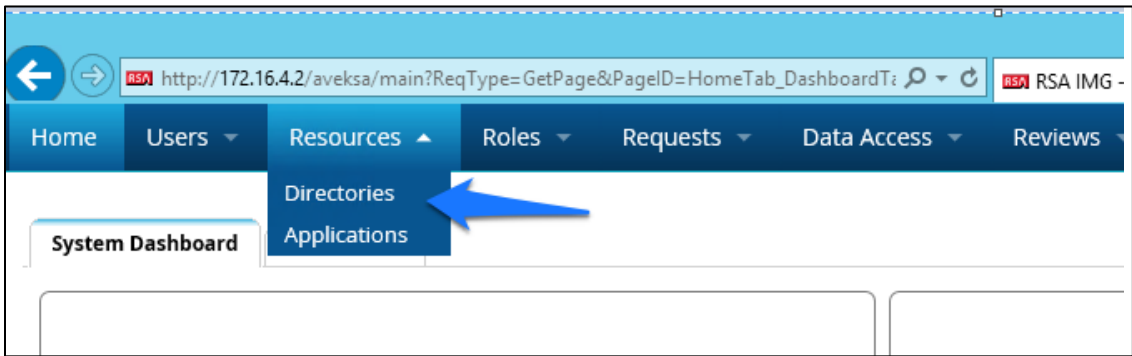
### 7.3.2 Set Up Organization Users

The next step is to set up the organization's existing users. In the example solution, we used a CSV file that contains all of the users in the organization. This CSV file needs to be copied to a convenient location on the IMG server. You can get a sample CSV file, *HR\_Data\_Move.csv*, at <https://nccoe.nist.gov/sites/default/files/library/sp1800/es-idam-nist-sp1800-2-draft.zip>.

Once the CSV file is copied to the server, perform the following actions:

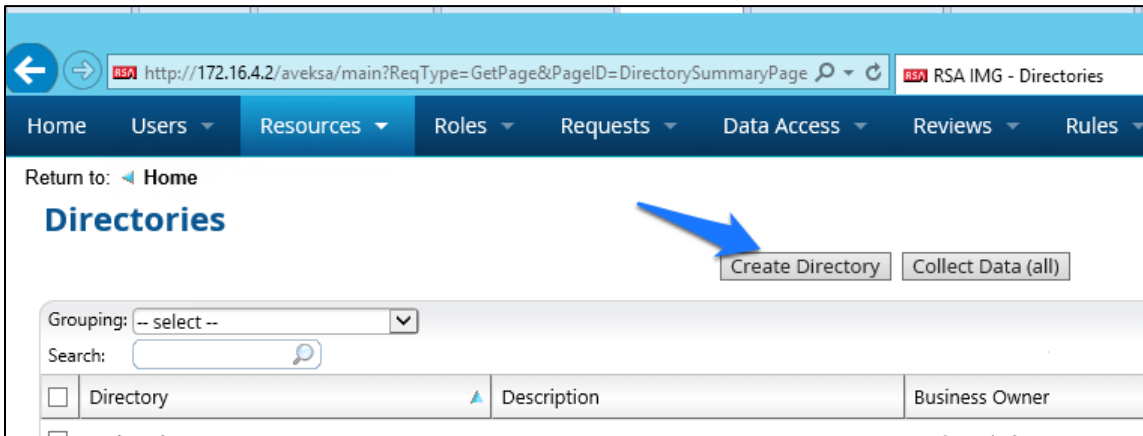
1. Navigate to **Resources**, and select **Directories**, as shown in Figure 7-10.

Figure 7-10 IMG Resources Directories



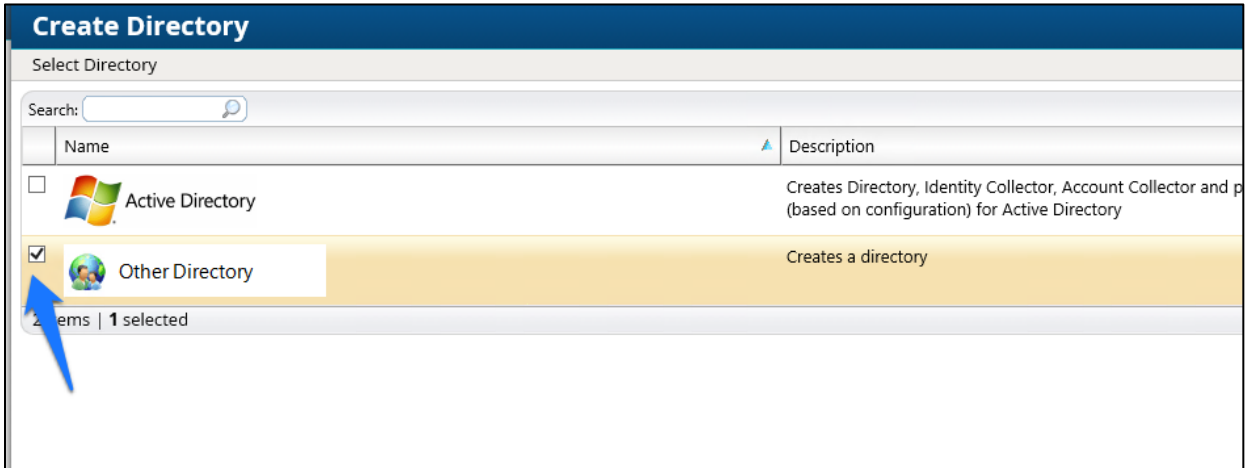
2. Click **Create Directory**, as shown in Figure 7-11.

Figure 7-11 IMG Create Directory



3. Select **Other Directory**, and then click **Next**, as shown in Figure 7-12.

Figure 7-12 IMG Create Directory



4. Enter `HR` in the **Directory Raw Name** field. Click **Finish**, as shown in Figure 7-13.

Figure 7-13 IMG Directory Information

**Create Directory**

Directory Raw Name\*: HR

Directory: HR

Description:

Long Description:

Short Description (Tooltip):

Help Link:

Allow Account Disabling: ☐ Yes ☒ No

Allow Account Locking: ☐ Yes ☒ No

**Directory Attributes**

Business Use:

Category:

Classification:

Functional Ownership:

You have now created your first directory, which will serve as a repository for all of the HR data for the organization.

Repeat the above steps to create a second directory. This second directory will be named “RSA Adaptive Directory.” This container will be used to pull AD accounts from the Adaptive Directory server. In this case, be sure to select the two options highlighted in Figure 7-14.

Figure 7-14 IMG Create Directory

Create Directory

Directory Raw Name\*:
RSA Adaptive Directory Accounts

Directory:
RSA Adaptive Directory Accounts

Description:

Long Description:

Short Description (Tooltip):

Help Link:

Allow Account Disabling:
☒ Yes
☐ No

Allow Account Locking:
☒ Yes
☐ No

Directory Attributes

Business Use:

Category:

Classification:

Functional Ownership:

Locality:

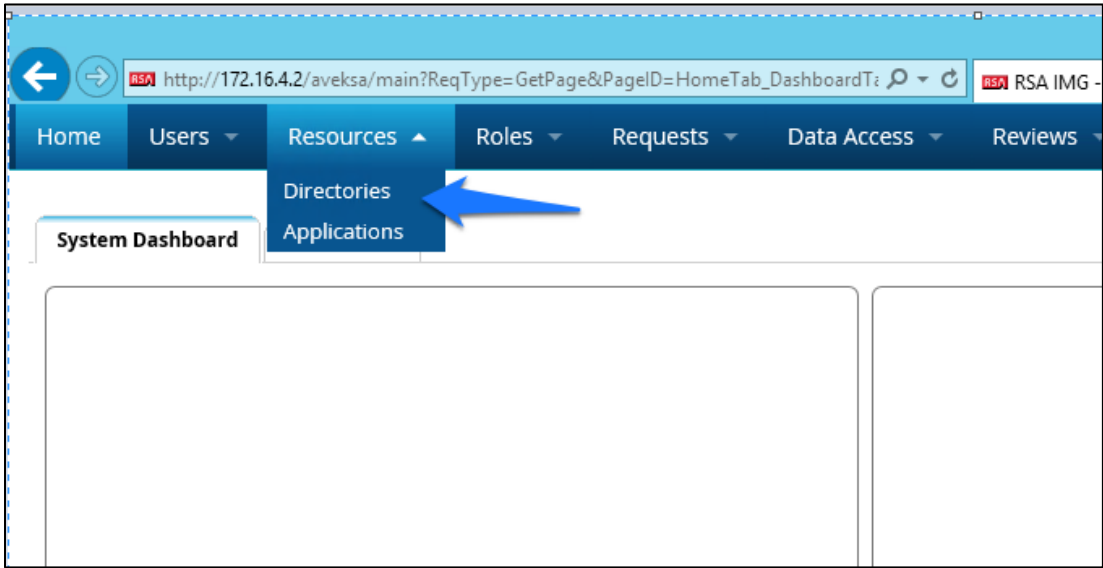
Sensitivity:

### 7.3.3 Populate the HR Directory

The next step is to populate the HR directory with users.

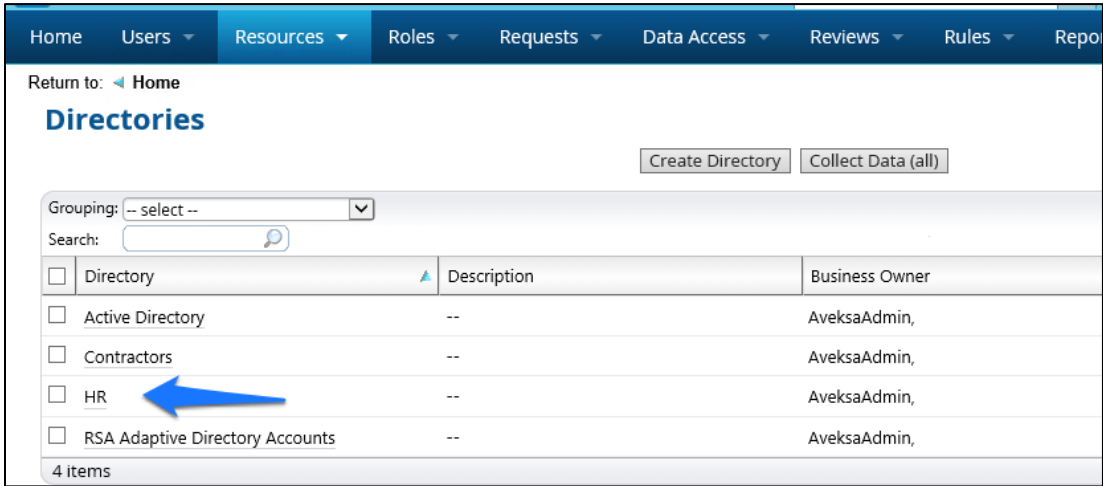
1. Click **Resources > Directories**, as shown in Figure 7-15.

Figure 7-15 IMG Directories



2. Click on the new **HR** directory that you just created, as shown in Figure 7-16.

Figure 7-16 IMG Directories



3. Click on **Collectors > Create Identity Collector**, as shown in Figure 7-17.



Figure 7-17 IMG Create Identity Collector

4. Enter details as shown in Figure 7-18.

Figure 7-18 IMG HR Identities

5. Click **Next**, and then enter details as shown in Figure 7-19.

Figure 7-19 IMG HR Identities (cont.)

The screenshot shows a web form titled "Edit Collector: HR Identities". Below the title is a section header "Database Connection". The form contains the following fields:

- DB Type :** A dropdown menu with "CSV" selected.
- Driver Class\* :** A text input field containing "com.hxtt.sql.text.TextDriver".
- URL\* :** A text input field containing "jdbc:csv:////home/oracle/database/SampleData".
- User Name :** A text input field containing "AveksaAdmin".
- Password :** A text input field with masked characters (dots).

6. Use the same username and password that you use to log into the IMG management web page.

The URL will point to the folder in which the CSV file is located. In this example, the full field is *jdbc:csv:////home/oracle/database/SampleData/Demo/HR/?\_CSV\_Header=true;tmpdir=/home/oracle*.

The CSV file is located in *home/oracle/database/SampleData/Demo/HR*.

7. Click **Next**.
8. Leave **Users** selected, as shown in Figure 7-20, and then click **Next**.

Figure 7-20 IMG HR Identities – Users

The screenshot shows a web form titled "Edit Collector: HR Identities". Below the title is a section header "Select types of identity data to collect". The form contains a single checkbox labeled "Users", which is checked.

9. Enter details as shown in Figure 7-21 and Figure 7-22. The full text of the **User Data Query** is as follows:

```
select fname, lname, user_num, ou, login, email as sAMAccountName, email,
location, bu, department, title, supervisor, job_level, job_status, login as
SR, is_terminated, previous_manager, jobcode, previous_manager as
backjp_supervisor, job_family,concat(lname,' ',fname)as fullname, is_manager,
email as UniqueID from HR_Data_Move
```

Figure 7-21 IMG HR Identities

Edit Collector: HR Identities

Mapping for user attributes

User Data

Users Data Query\* :

select fname, lname, user\_num, ou, login, email as sAMAccountName, email, location, bu, department, title, supervisor, job\_level, job\_status, login as SR, is\_terminated, previous\_manager, jobcode, previous\_manager as backjp\_supervisor, job\_family,concat(lname,' ',fname)as fullname, is\_manager, email as UniqueID from HR\_Data\_Move

User attribute

DB column with value

User ID\* :

sAMAccountName

Business Unit Id :

bu

value is Business Unit

Name

Backup Supervisor :

value is User

User ID

DN :

Department :

department

Email Address :

email

Expiration Date :

Expiration Value :

First Name :

fname

Full Name :

fullname

Is Manager :

is\_manager

Is Terminated :

is\_terminated

Job Code :

jobcode

Job Family :

job\_family

Figure 7-22 IMG HR Identities (Continued)

Job Family :	<input type="text" value="job_family"/>
Job Level :	<input type="text" value="job_level"/>
Job Status :	<input type="text" value="job_status"/>
Last Name :	<input type="text" value="lname"/>
Location :	<input type="text" value="location"/>
Login ID :	<input type="text" value="login"/>
OU :	<input type="text" value="OU"/>
Other :	<input type="text" value="previous_manager"/> value is User <input type="text" value="User ID"/> ▼
PACS All Doors :	<input type="text"/>
PACS Home AAccess :	<input type="text"/>
PACS Work Access :	<input type="text"/>
Self Reviewer :	<input type="text" value="SR"/> value is User <input type="text" value="User ID"/> ▼
Supervisor :	<input type="text" value="supervisor"/>
Termination Date :	<input type="text"/>
Title :	<input type="text" value="title"/>
Unique Id :	<input type="text" value="UniqueID"/>

10. Click **Finish**.

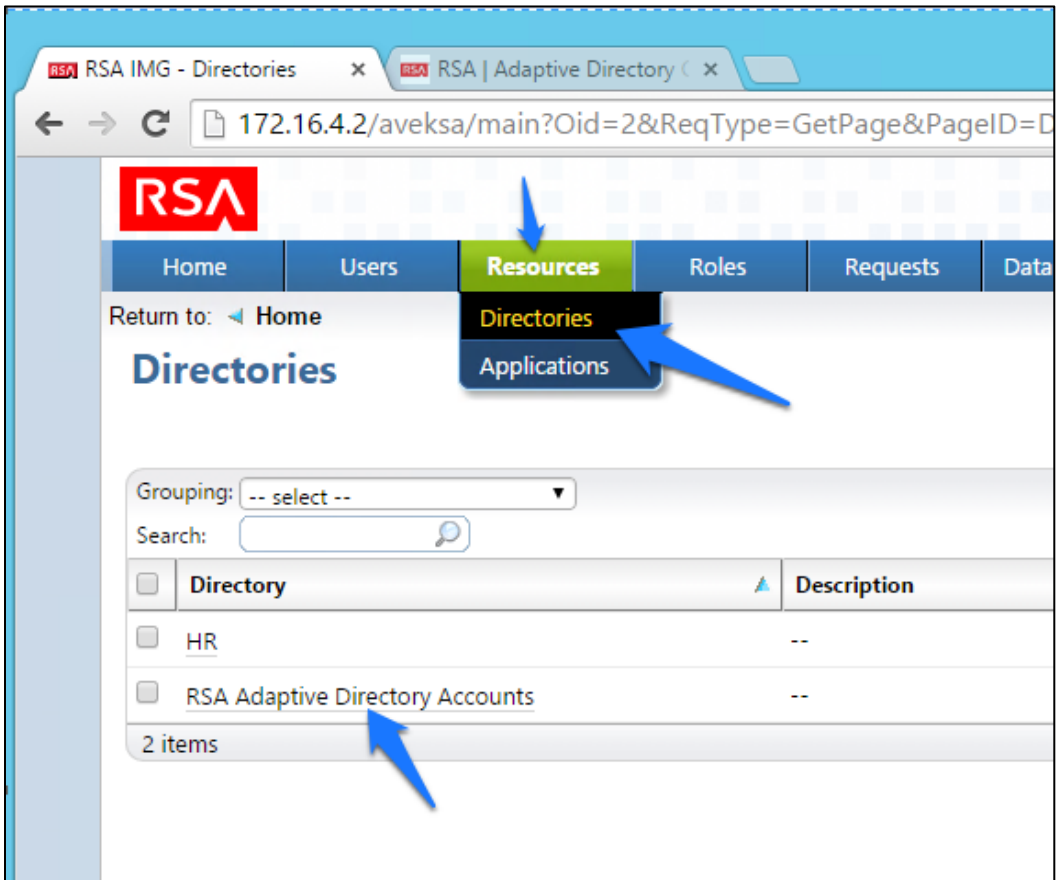
Now we can configure the Adaptive Directory Container with Identity and Account collectors.

### 7.3.4 Configure Adaptive Directory Container

The next step is to configure the Adaptive Directory Container with Identity and Account collectors.

1. Navigate to the Adaptive Directory Container, as shown in Figure 7-23 (**Resources > Directories > RSA Adaptive Directory Accounts**).

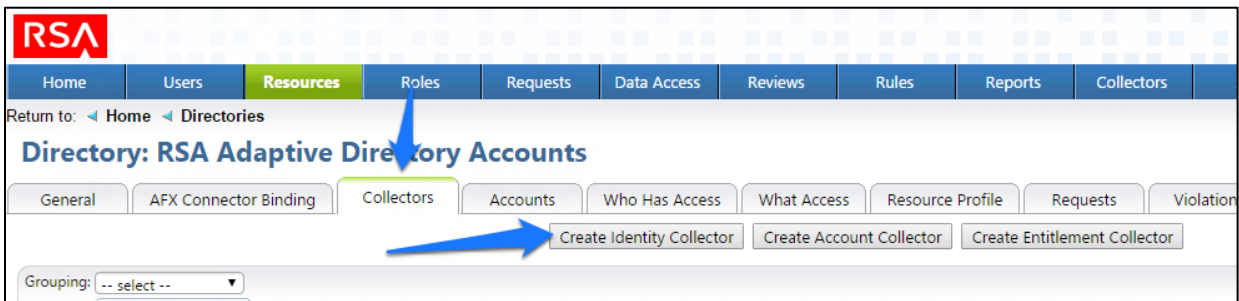
Figure 7-23 IMG Adaptive Directory Container



This identity collector will tie together user identities in Adaptive Directory to user identities in the HR CSV file.

2. Click on **Collectors > Create Identity Collector**, as shown in Figure 7-24.

Figure 7-24 IMG Identity Collector



3. Create the ID collector as follows, clicking **Next** between each screenshot shown in Figure 7-25 through Figure 7-29.

Figure 7-25 IMG AD Identity Collector (1 of 5)

**Edit Collector: RSA Adaptive Directory Identity Collector**

Collector Description

Collector Name\* : RSA Adaptive Directory Identity Collector

Description :

Data Source Type : Ldap

Agent : AveksaAgent

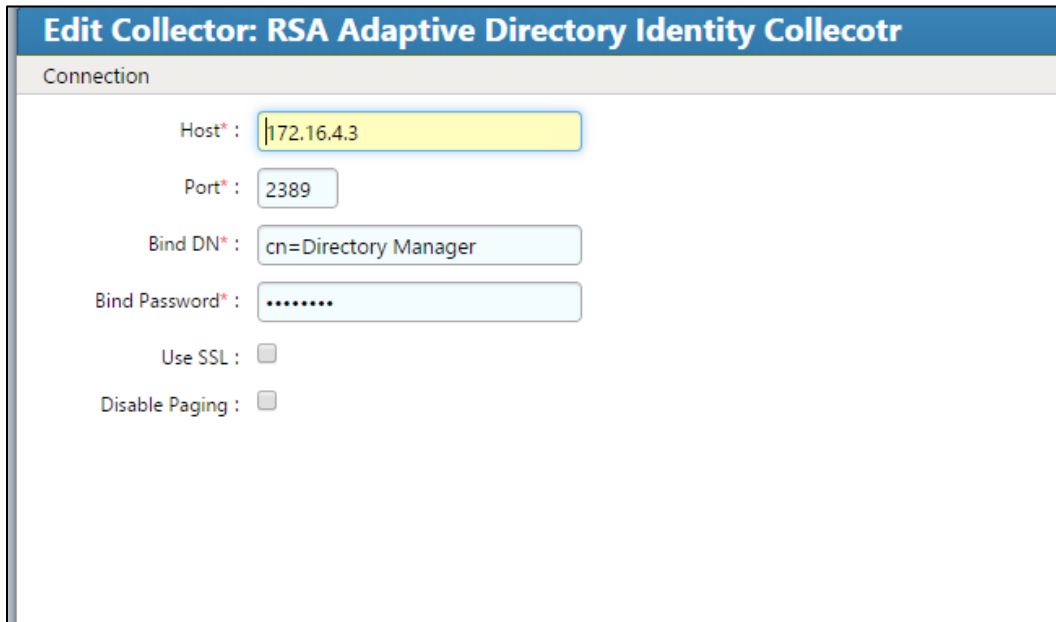
Directory : RSA Adaptive Directory Acco

Status : Active

Schedule

Scheduled : ☐ Yes ☒ No

Figure 7-26 IMG AD Identity Collector (2 of 5)



**Edit Collector: RSA Adaptive Directory Identity Collector**

Connection

Host\* : 172.16.4.3

Port\* : 2389

Bind DN\* : cn=Directory Manager

Bind Password\* : .....

Use SSL : ☐

Disable Paging : ☐

Figure 7-27 IMG AD Identity Collector (3 of 5)



**Edit Collector: RSA Adaptive Directory Identity Collector**

Select types of identity data to collect

☒ Users

Figure 7-28 IMG AD Identity Collector (4 of 5)

Edit Collector: RSA Adaptive Directory Identity Collector

Mapping for user attributes

User Data

User attribute	Mapping
User Base DN*	<input type="text" value="dc=master,dc=test"/>
User Search Scope*	<input type="text" value="Subtree"/>
User Search Filter*	<input type="text" value="(&amp;(objectCategory=person)(objectClass=user)(sAMAccountName=*))"/>
User ID*	<input type="text" value="userPrincipalName"/>
Business Unit Id :	<input type="text"/> value is Business Unit <input type="text" value="Name"/>
Backup Supervisor :	<input type="text"/> value is User <input type="text" value="User ID"/>
DN :	<input type="text" value="dn"/>
Department :	<input type="text"/>
Email Address :	<input type="text"/>
Expiration Date :	<input type="text"/>
Expiration Value :	<input type="text"/>
First Name :	<input type="text"/>
Full Name :	<input type="text"/>
Is Manager :	<input type="text"/>



Figure 7-29 IMG AD Identity Collector (5 of 5)

Is Terminated :	<input type="text"/>
Job Code :	<input type="text" value="employeeNumber"/>
Job Family :	<input type="text"/>
Job Level :	<input type="text"/>
Job Status :	<input type="text" value="userAccountControl"/>
Last Name :	<input type="text"/>
Location :	<input type="text"/>
Login ID :	<input type="text"/>
OU :	<input type="text"/>
Other :	<input type="text"/> value is User <input type="text" value="User ID"/>
PACS All Doors :	<input type="text" value="pacsAllDoors"/>
PACS Home AAccess :	<input type="text" value="pacsHomeAccess"/>
PACS Work Access :	<input type="text" value="pacsWorkAccess"/>
Self Reviewer :	<input type="text"/> value is User <input type="text" value="User ID"/>
Supervisor :	<input type="text"/>
Termination Date :	<input type="text"/>
Test :	<input type="text"/>
Title :	<input type="text"/>
Unique Id :	<input type="text"/>
User Number :	<input type="text" value="employeeID"/>

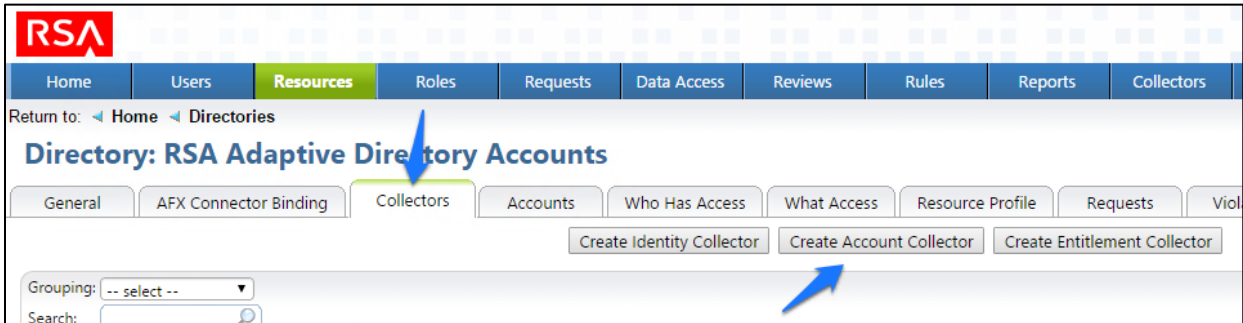
4. Click **Finish**.

### 7.3.5 Create an Account Collector

The next step is to create an account collector, which pulls all relevant attributes from Adaptive Directory.

1. Click on **Collectors > Create Account Collector**, as shown in Figure 7-30.

Figure 7-30 IMG AD Create Account Collector

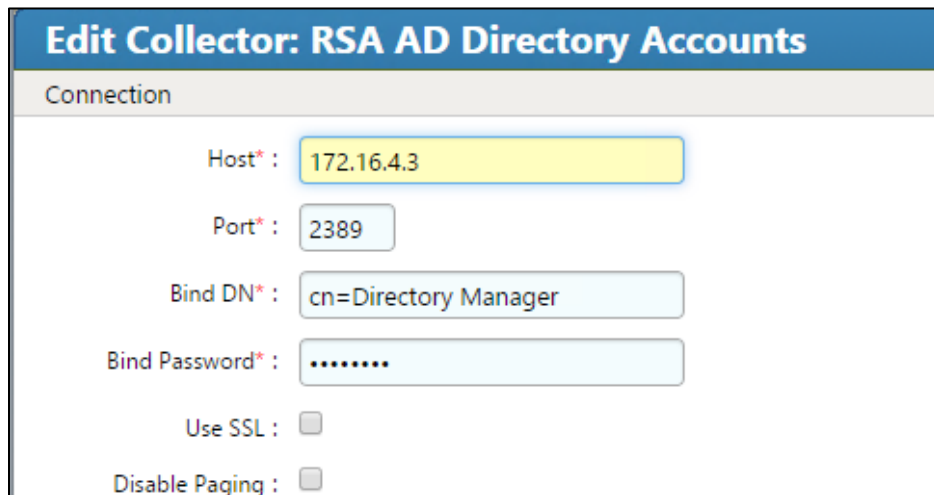


2. Create the account collector as follows, clicking **Next** between each screenshot shown in Figure 7-31 through Figure 7-40.

Figure 7-31 IMG Edit Collector (1 of 10)

The screenshot shows the 'Edit Collector: RSA AD Directory Accounts' form. The form has a blue header bar with the title 'Edit Collector: RSA AD Directory Accounts'. Below the header is a section titled 'Collector Description'. This section contains several fields: 'Collector Name\*' with the value 'RSA AD Directory Accounts', 'Description' (a large text area), 'Data Source Type' with a dropdown menu showing 'Ldap', 'Agent' with a dropdown menu showing 'AveksaAgent', and 'Status' with a dropdown menu showing 'Active'. Below the 'Collector Description' section is a section titled 'Schedule'. This section contains a 'Scheduled' field with two radio buttons: 'Yes' and 'No'. The 'No' radio button is selected.

Figure 7-32 IMG Edit Collector (2 of 10)



**Edit Collector: RSA AD Directory Accounts**

Connection

Host\* : 172.16.4.3

Port\* : 2389

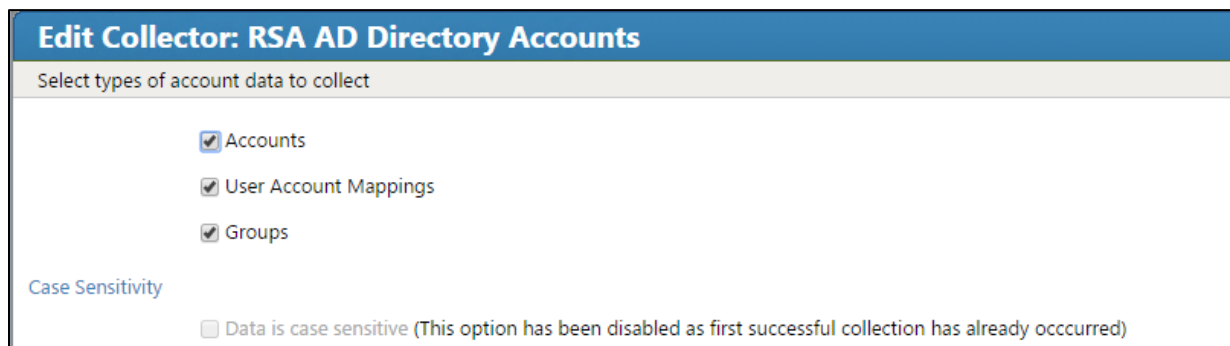
Bind DN\* : cn=Directory Manager

Bind Password\* : .....

Use SSL : ☐

Disable Paging : ☐

Figure 7-33 IMG Edit Collector (3 of 10)



**Edit Collector: RSA AD Directory Accounts**

Select types of account data to collect

☒ Accounts

☒ User Account Mappings

☒ Groups

Case Sensitivity

☐ Data is case sensitive (This option has been disabled as first successful collection has already occurred)

Figure 7-34 IMG Edit Collector (4 of 10)

Edit Collector: RSA AD Directory Accounts

Mapping for account and user account attributes

Search Configuration for Accounts

Accounts will be created by the User Account Mapping, unless the Accounts option is selected in this collector.

Account Base DN\* : dc=master,dc=test

Account Search : Subtree

Scope\* :

Account Search Filter\* : (&(objectCategory=person)(objectClass=user)(sAMAccountName=\*))

Account ID\* : distinguishedName

Account Attribute	Attribute in Ldap schema
Last Login Date :	lastLogon
Account Disabled :	UserAccountControl
Account Locked :	UserAccountControl
Account email :	userPrincipalName
Account expiration : date	accountExpires
Account full name :	displayName
Account status :	userAccountControl
Account technical : name	sAMAccountName

Figure 7-35 IMG Edit Collector (5 of 10)

DN :	<input type="text" value="dn"/>
Login ID :	<input type="text"/>
PACS All Doors :	<input type="text" value="pacsAllDoors"/>
PACS Home AAccess :	<input type="text" value="pacsHomeAccess"/>
PACS Work Access :	<input type="text" value="pacsWorkAccess"/>
<b>User Account Mapping Attribute</b>	<b>Attribute in Ldap schema</b>
User ID* :	<input type="text" value="userPrincipalName"/>

Figure 7-36 IMG Edit Collector (6 of 10)

Edit Collector: RSA AD Directory Accounts

Mapping for group attributes

Group Data

Group attribute	Mapping
Group Base DN*	DC=master,DC=test
Group Search Scope*	Subtree
Group Search Filter*	(objectclass=group)
Group ID/Name*	distinguishedName
Member of Group*	member
DN	cn
Description	description
Domain	
Owner	value is User User ID
Owner	managedBy
Resource type	

Figure 7-37 IMG Edit Collector (7 of 10)

Edit Collector: RSA AD Directory Accounts

Edit User Resolution Rules

Target Collector	User Attribute
Users	User Id

Add More...

Figure 7-38 IMG Edit Collector (8 of 10)

**Edit Collector: RSA AD Directory Accounts**

Edit **Member Account** Resolution Rules

Target Collector: RSA AD Directory Accounts ▼ Account Attribute: DN ▼ [X]

Add More...

Figure 7-39 IMG Edit Collector (9 of 10)

**Edit Collector: RSA AD Directory Accounts**

Edit **Sub-group** Resolution Rules

Target Collector: RSA AD Directory Accounts ▼ Group Attribute: Name ▼ [X]

Add More...

Figure 7-40 IMG Edit Collector (10 of 10)

**Edit Collector: RSA AD Directory Accounts**

Edit **Group Owner** Resolution Rules

Target Collector: Users ▼ User Attribute: User Id ▼ [X]

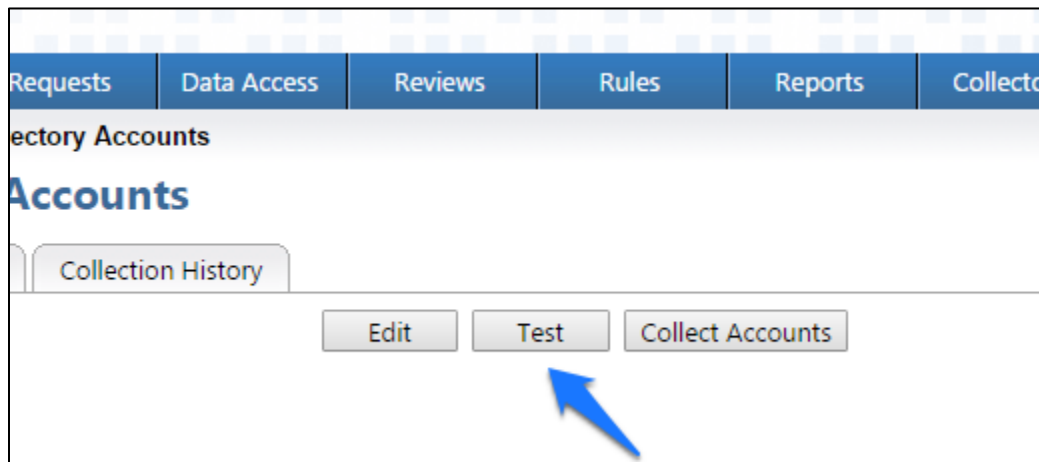
Add More...

3. Click **Finish**.

A **Test** button is provided with each account collector and identity collector.

4. Test each account collector that you created using the **Test** button. This action verifies that IMG can retrieve the account information for each directory added, as shown in Figure 7-41.

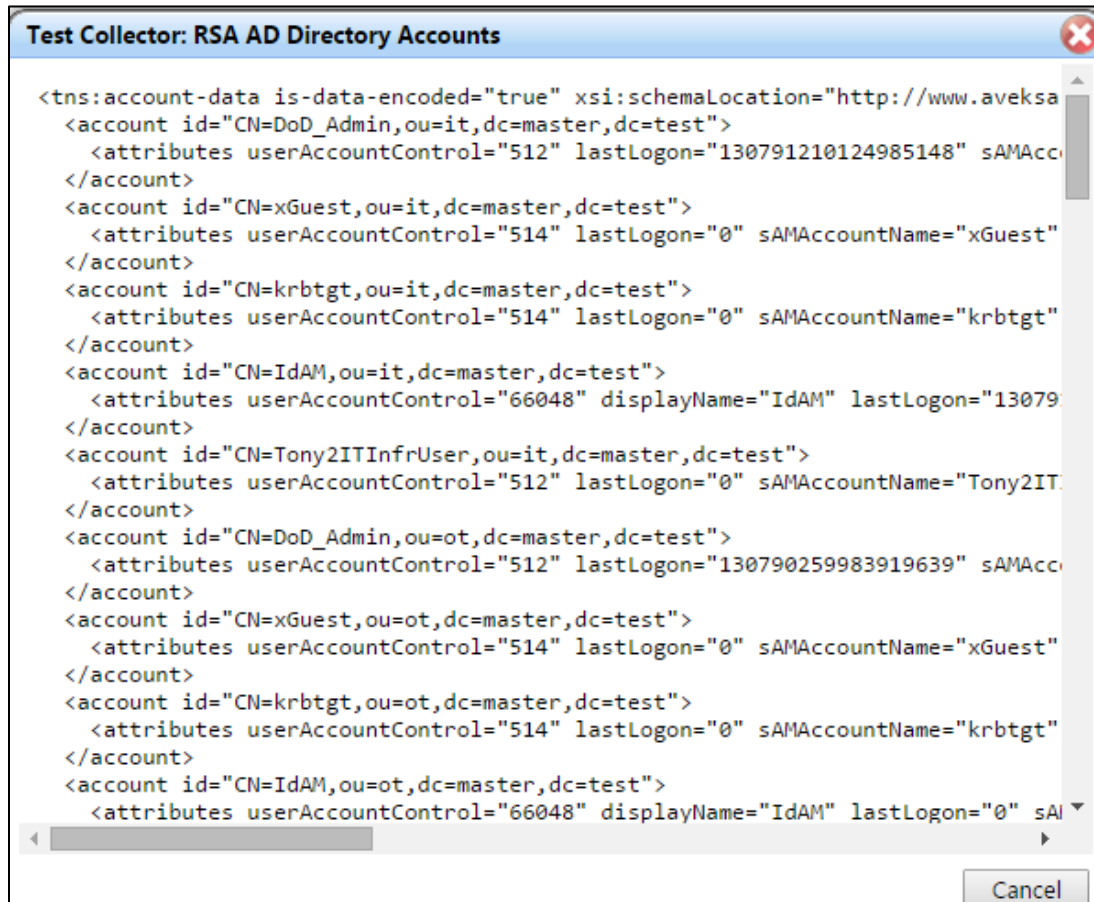
Figure 7-41 IMG Account Test



A successful test will look something like Figure 7-42.



Figure 7-42 IMG Successful Test Example



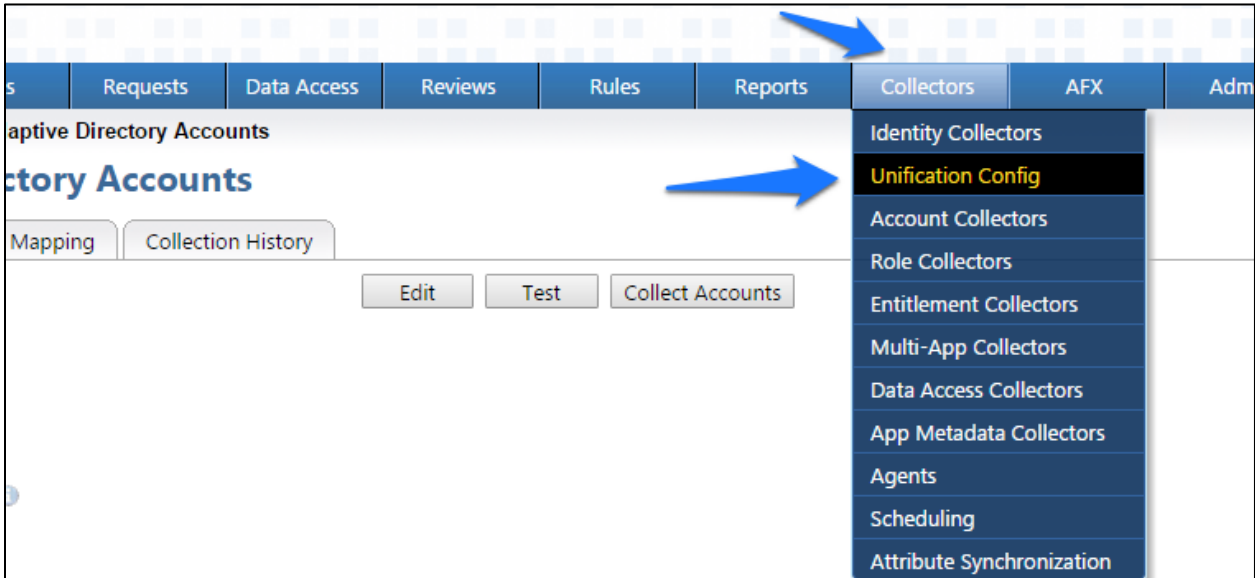
In Figure 7-42 above, you can see valid data in an EXtensible Markup Language (XML) format. A failed test will generate an error message that can help you isolate the problem.

### 7.3.6 Edit the Unification Configuration Participating Collectors

The next step is to configure Unification; this is the process of joining Identities from the HR CSV and the Adaptive Directory collectors.

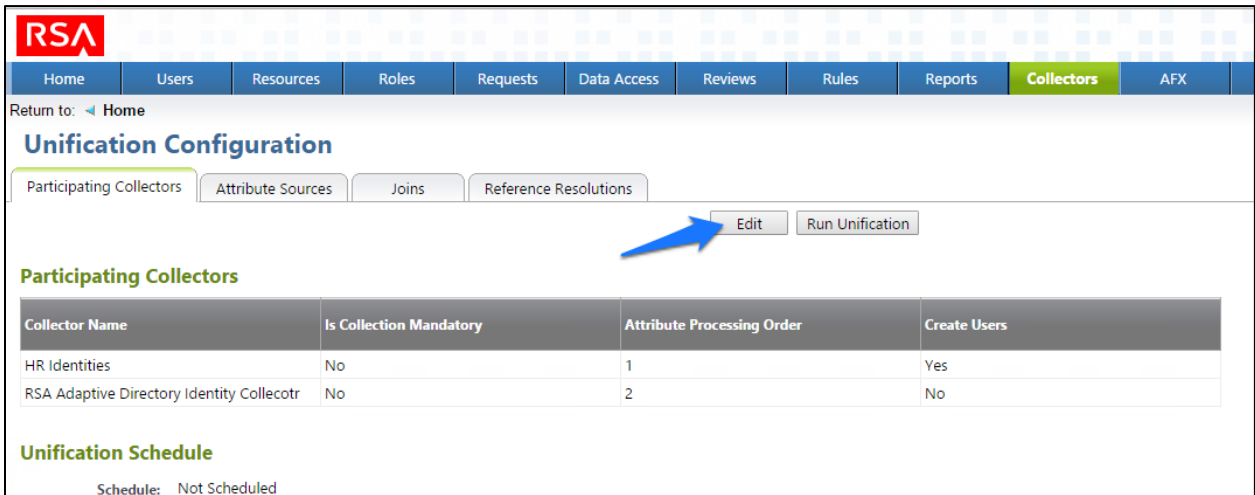
1. Click on **Collectors > Unification Config**, as shown in Figure 7-43.

Figure 7-43 IMG Unification Configuration



2. Choose the **Participating Collectors** tab, and then click **Edit**, as shown in Figure 7-44.

Figure 7-44 IMG Participating Collectors



3. Configure as shown in Figure 7-45 and Figure 7-46, and then click **Next** on each screen.

Figure 7-45 IMG Edit Participating Collectors

Edit Participating Collectors

Edit Collector Participation and Unification Schedule

Collector Name	Collection Mandatory	Create Users
HR Identities	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
RSA Adaptive Directory Identity Collecotr	<input type="checkbox"/>	<input type="checkbox"/>

Scheduled : ☐ Yes ☒ No

Figure 7-46 IMG Edit Participating Collectors (Continued)

Edit Participating Collectors

Select Processing Order for Participating Collectors

Attribute Processing Order

HR Identities

RSA Adaptive Directory Identity Collecotr

In the above example, we have **HR Identities** at the top. This indicates that HR Identities is an authoritative source. If there are any discrepancies between the data between two sources, then the one at the top will win by default; however, this can be overridden, as later discussed.

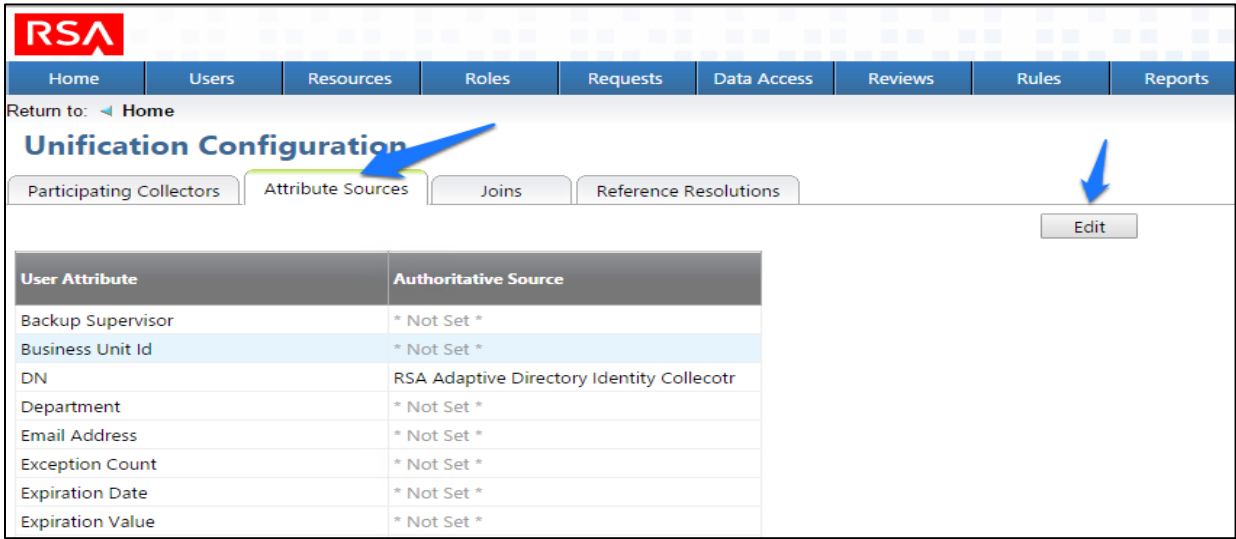
4. Click **Finish**.

7.3.7 Edit User Attribute Source

The next step is to change the default behavior of the authoritative source for the necessary attributes.

1. Choose the **Attribute Sources** tab, and then click **Edit**, as shown in Figure 7-47.

Figure 7-47 IMG Unification Configuration Attribute Sources



2. Edit the Attributes as shown in Figure 7-48 and Figure 7-49. Leave alone any attribute shown as **\*Not Set\***; these attributes will use the default behavior.

Figure 7-48 IMG Edit User Attribute Mapping

Edit User Attribute Mapping

User Attribute	Authoritative Source
Backup Supervisor :	(not collected)
Business Unit Id :	<div>* Not Set *</div>
DN :	<div>RSA Adaptive Directory Identity Collec</div>
Department :	<div>* Not Set *</div>
Email Address :	<div>* Not Set *</div>
Exception Count :	(not collected)
Expiration Date :	(not collected)
Expiration Value :	(not collected)
First Name :	<div>* Not Set *</div>
Full Name :	<div>* Not Set *</div>
Is App Owner :	(not collected)
Is Manager :	<div>* Not Set *</div>
Is Monitor :	(not collected)
Is Senior Manager :	(not collected)
Is Terminated :	<div>* Not Set *</div>
Job Code :	<div>HR Identities</div>
Job Family :	<div>* Not Set *</div>
Job Level :	<div>* Not Set *</div>
Job Status :	<div>* Not Set *</div>

Figure 7-49 IMG Edit User Attribute Mapping (Continued)

Last Name :	<input type="text" value="* Not Set *"/>
Location :	<input type="text" value="* Not Set *"/>
Login ID :	<input type="text" value="* Not Set *"/>
OU :	<input type="text" value="* Not Set *"/>
Other :	<input type="text" value="* Not Set *"/>
PACS All Doors :	<input type="text" value="RSA Adaptive Directory Identity Collec"/>
PACS Home AAccess :	<input type="text" value="RSA Adaptive Directory Identity Collec"/>
PACS Work Access :	<input type="text" value="RSA Adaptive Directory Identity Collec"/>
Previous Supervisor :	(not collected)
Self Reviewer :	<input type="text" value="* Not Set *"/>
Termination Date :	(not collected)
Title :	<input type="text" value="* Not Set *"/>
Transfer Date :	(not collected)
Unique Id :	<input type="text" value="* Not Set *"/>
User Risk Level :	(not collected)
Violation Count :	(not collected)

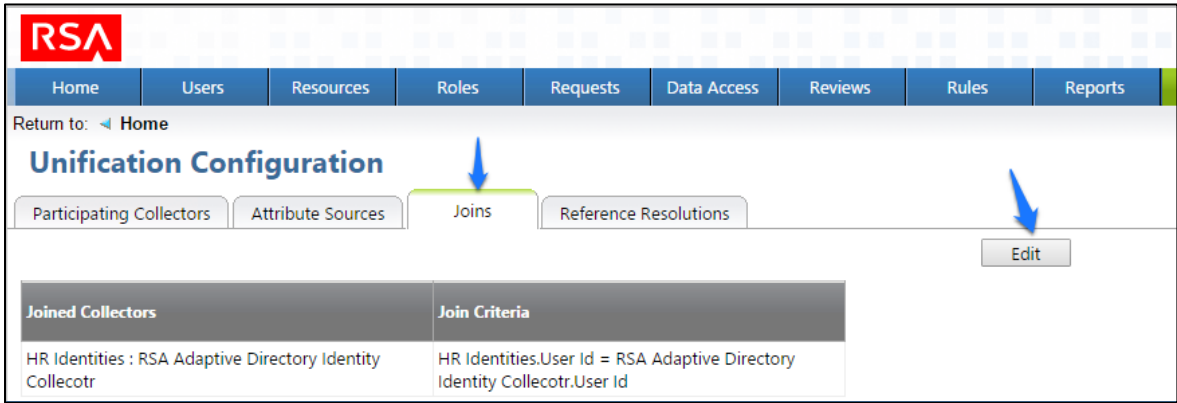
- 3. Click **OK**.

### 7.3.8 Edit Unification Configuration Attribute Source

The next step is to configure which attribute to use from each directory so that IMG knows how to tie users together.

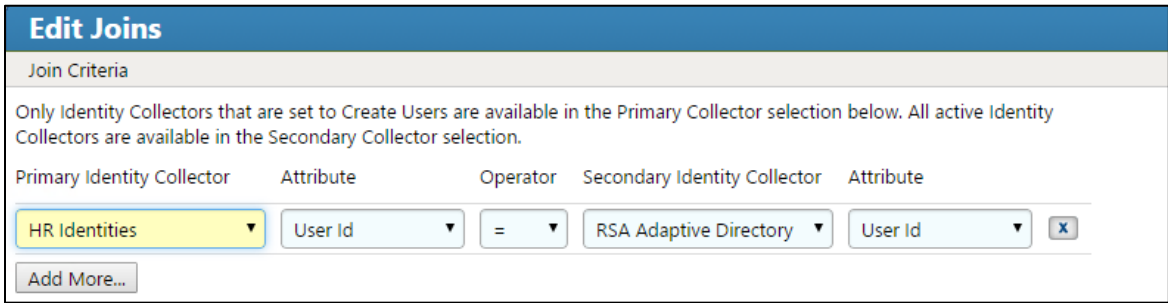
- 1. Click **Joins > Edit**, as shown in Figure 7-50.

Figure 7-50 IMG Unification Configuration Joins



2. Choose **HR Identities** from the **Primary Identity Collector** drop-down box, as shown in Figure 7-51.

Figure 7-51 IMG Edit Joins



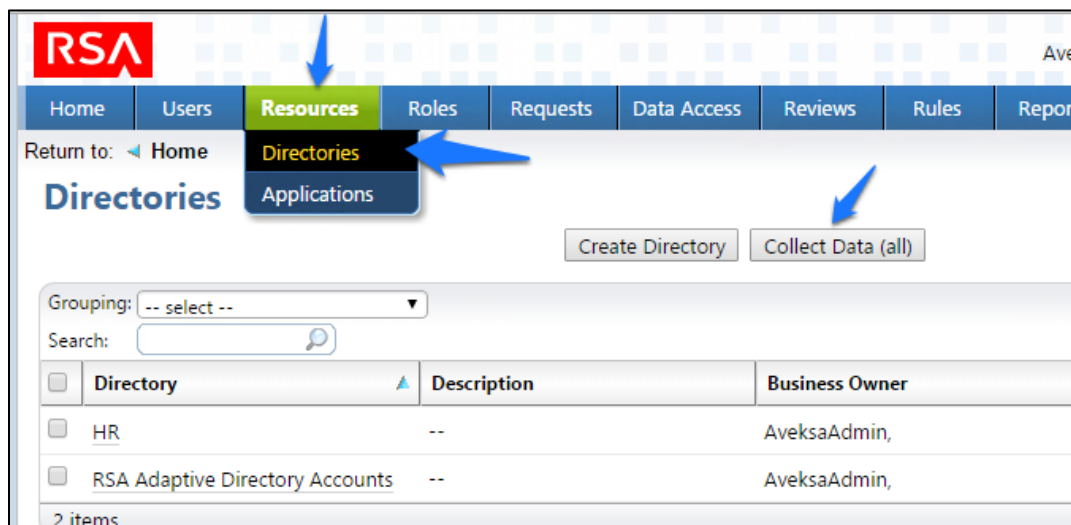
3. Click **Finish**.

### 7.3.9 Start Data Collection

The next step is to start collecting identity data.

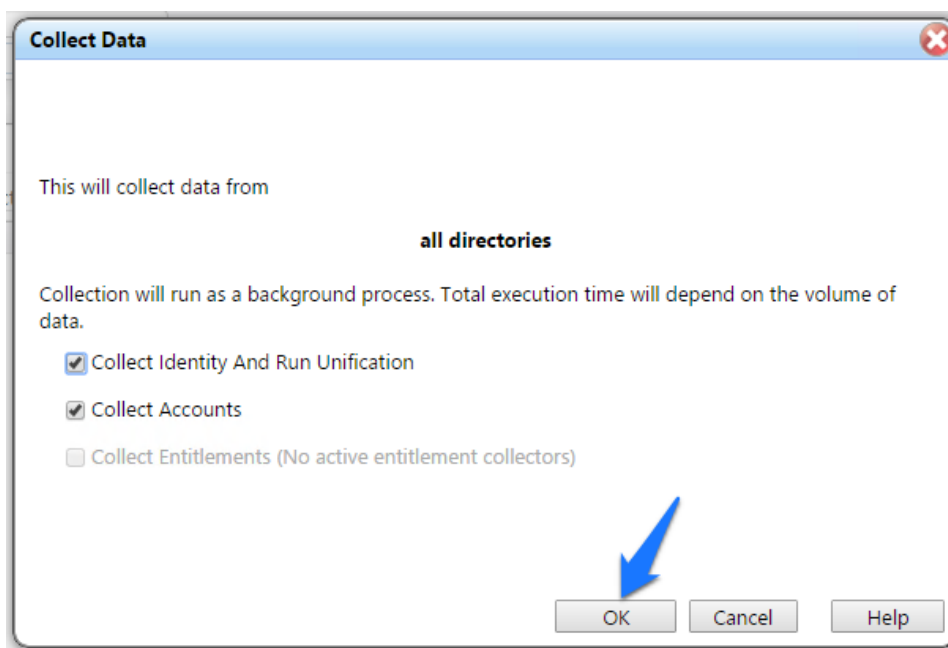
1. From the home page, choose **Resources > Directories**. Click the **Collect Data (all)** button, as shown in Figure 7-52.

Figure 7-52 IMG Start Data Collection



2. Click **OK** on the next window, as shown in Figure 7-53.

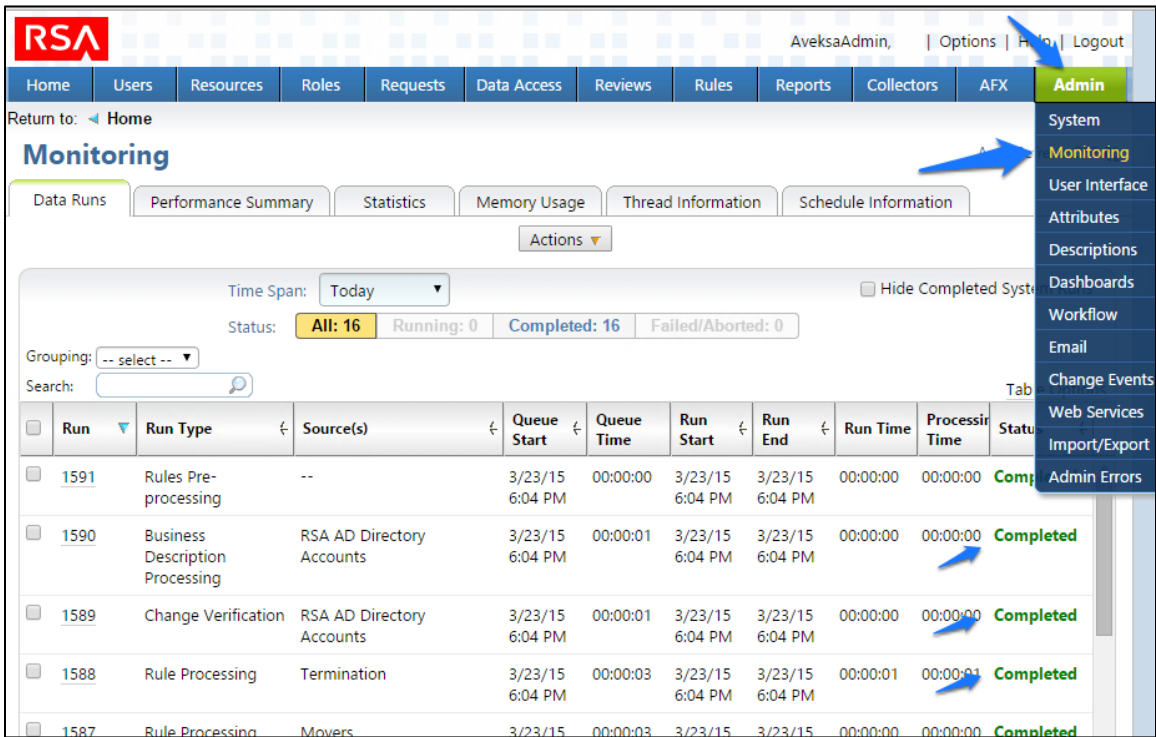
Figure 7-53 IMG Collect Data



3. The process will take 30 seconds or so to complete. You can check the progress by going to **Admin > Monitoring**, as shown in Figure 7-54.



Figure 7-54 IMG Data Collection Monitoring



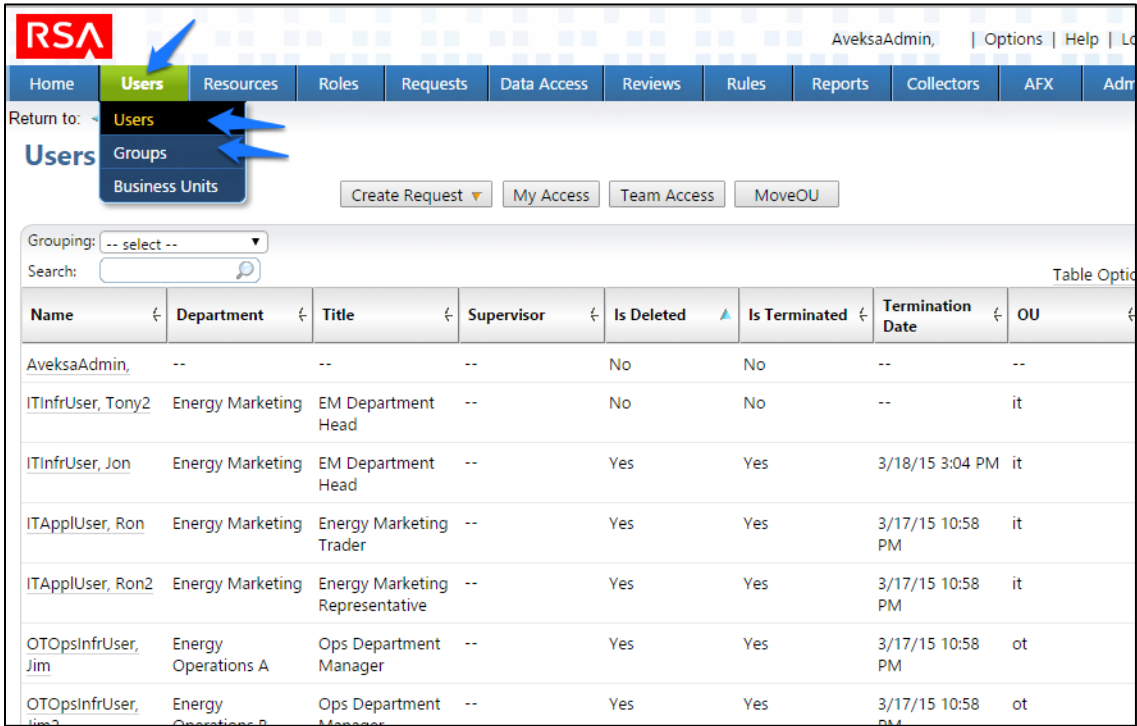
You will see the status of all of the processes change to **Completed** when done.

### 7.3.10 Review Data Collected

Now you can look at this data by going to **Users > Users > Groups**.

1. From the home page, choose **Users > Users > Groups**, as shown in Figure 7-55, to review the data collected.

Figure 7-55 IMG Data Collection Review

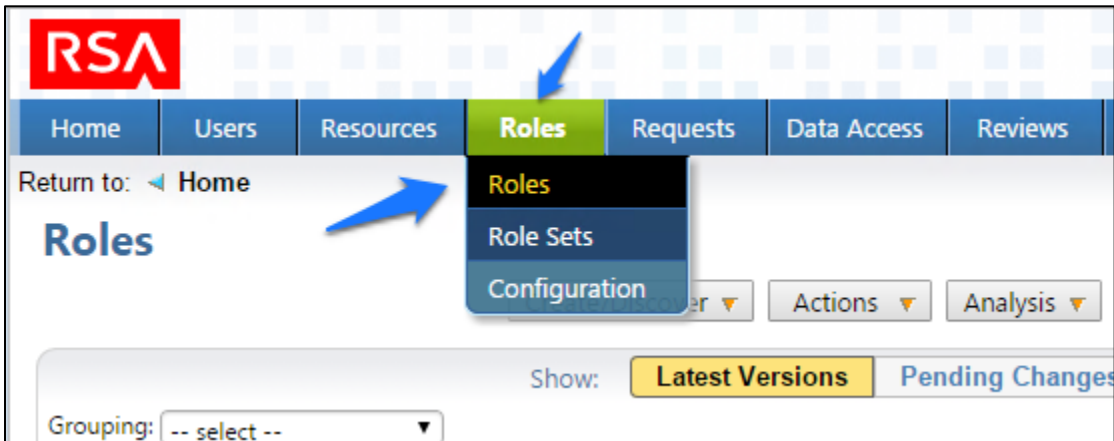


### 7.3.11 Configure Business Rules

The next step is to configure Business Roles.

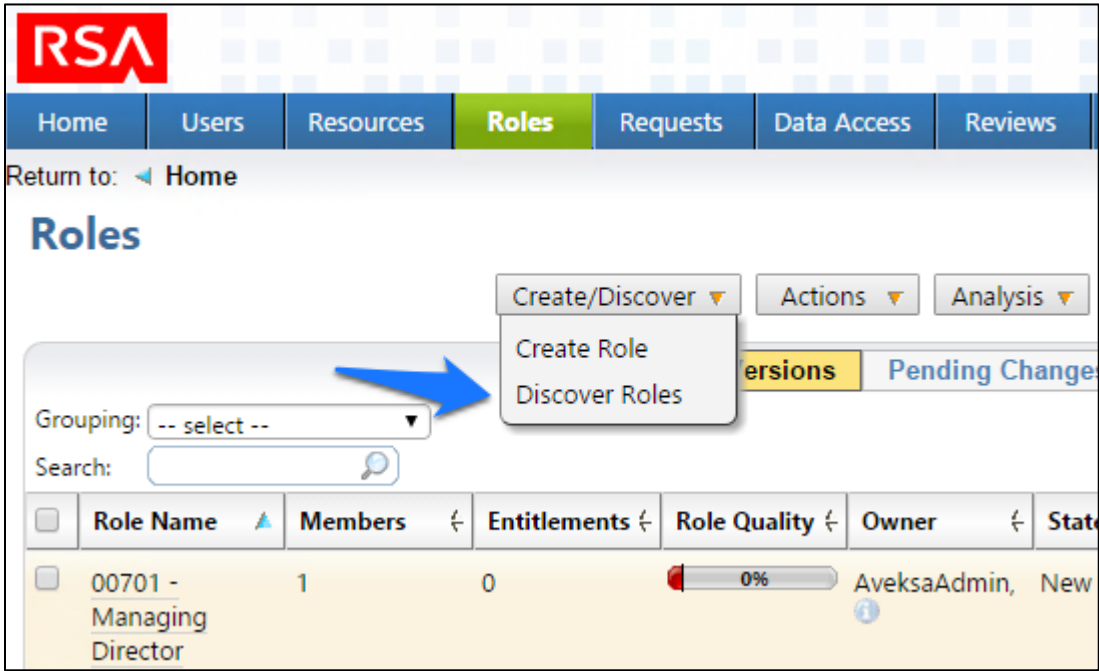
1. Click on **Roles > Roles**, as shown in Figure 7-56.

Figure 7-56 IMG Roles



2. Click **Create/Discover > Discover Roles**, as shown in Figure 7-57.

Figure 7-57 IMG Discover Roles



3. Configure as shown in Figure 7-58 through Figure 7-60.

Figure 7-58 IMG Discover Roles (1 of 3)

**Discover Roles**

Role Creation

How do you want to create the roles?

☒ from users

☐ from user-entitlement clusters

☐ from entitlements

Where do you want to put these new roles?

☒ Existing role set

☐ New role set named  with roles of type

Figure 7-59 IMG Discover Roles (2 of 3)

Discover Roles

Role Creation

Roles will be created for each unique combination of user attributes.

Users matching

All (matches 669 out of 669).

Create Roles Split on these Attributes

User.OU

x

5 unique values

Add More...

5 Roles would be created

Suggest Entitlements

☒ Add suggested entitlements to roles

Suggest Entitlements Matching

All (matches 411 out of 411)

Figure 7-60 IMG Discover Roles (3 of 3)

### Discover Roles

#### Role Information Expressions

What expressions should be used to generate role information?

Name	<input type="text" value="\${User.OU}"/>	▼
Description	<input type="text"/>	▼
Violation Manager Name	<input type="text"/>	▼
Technical Owner Name	<input type="text"/>	▼
Business Owner Name	<input type="text"/>	▼
Business Owner Id	<input type="text"/>	▼
Business Use	<input type="text"/>	▼
Classification	<input type="text"/>	▼
Last Reviewed Date	<input type="text"/>	▼
Locality	<input type="text"/>	▼
Ownership	<input type="text"/>	▼
Risk	<input type="text"/>	▼
Sensitivity	<input type="text"/>	▼
Technical Owner Id	<input type="text"/>	▼
Violation Manager Id	<input type="text"/>	▼

4. Notice how there are some duplicates; the job codes are the same, but the descriptions are slightly different. You can combine these rolls into one, as shown in Figure 7-61.

Figure 7-61 IMG Discover Roles – Combining

Discover Roles

Role Creation

For each row in the table below a new role will be created. The selection checkboxes are used to identify roles for use with the button bar below the table o

<input type="checkbox"/>	Role Name	Members
<input type="checkbox"/>	00701 - Managing Director	1
<input type="checkbox"/>	00702 - Executive Assistant	1
<input type="checkbox"/>	00703 - Business Startegist	1
<input type="checkbox"/>	10100 - Chief Executive Office	1
<input checked="" type="checkbox"/>	10101 - AM Department Mar	1
<input checked="" type="checkbox"/>	10101 - IT Department Mana	1
<input type="checkbox"/>	10102 - Lead Infr Admin	1
<input type="checkbox"/>	10102 - Sr Infr Admin	3

Items 1 - 50 of 66 | 2 selected

Remove

Combine

Remove Users

Remove Entitlements

☐ Hide Entitlements That Are Already Used In Committed Roles

☐ Hide Entitlements That Are Already Used In New Uncommitted Roles

Suggest entitlements that  12 % of members have 

Refresh

Show More

5. When you are done combining duplicates, click **Finish**.

### 7.3.12 Create Automated Rules

The next steps create rules for automatically detecting and invoking workflows for new users and terminations.

1. Click on **Rules** and **Definitions**, as shown in Figure 7-62.

Figure 7-62 IMG Roles Definitions



2. Click on **Create Rule**, and configure as shown in Figure 7-63 and Figure 7-64 for new users.

Figure 7-63 IMG New User

Edit Rule: New User

Rule Name\* : New User

Description :

Owner\* : AveksaAdmin, ⓘ

Control URL :

Control Description :

Type\* : Provisioning - Joiner/Mover ▾

Status\* : Active ▾

Rule Set\* : ☒ Existing rule set Default Rule Set ▾  
☐ New rule set named

Condition

☒ Trigger when new users are detected (joiners)  
☐ Trigger when users change categories (movers)

Actions

☒ Assign provisioning request form Default Provisioning Form ⓘ

Provisioned entitlements\*:


Entitlement Suggestion Modeling ⓘ

For these users: All  
Categorize them based on: Job Code  
Consider the following entitlements when making suggestions: All  
Suggested entitlements that 0% of members have



Figure 7-64 IMG New User

Optional entitlements that 0% of members have

- ☒ Allow arbitrary entitlements  
Allow selection from All 
- ☒ Allow user comparisons

Assignee\*:

- ☒ Supervisor
- ☐ Specified by target user attribute
- ☐ Selected user

☐ For movers also generate a review using review definition:

**Processing Schedule/Trigger**

☒ Use global configuration   ☐ Define for this rule

Scheduled : ☐ Yes   ☒ No

Triggered : ☒ Run after identity unification

3. Click on **Create Rule**, and configure as shown in Figure 7-65 and Figure 7-66 for user terminations.

Figure 7-65 IMG User Termination

Edit Rule: Termination

Rule Name\* : Termination

Description :

Owner\* : AveksaAdmin ⓘ

Control URL :

Control Description :

Type\* : Provisioning - Termination

Status\* : Active

Rule Set\* : ☒ Existing rule set Default Rule Set

☐ New rule set named

Condition

Condition\* : For terminated users matching the following condition  
IT Users ⓘ

Actions

Each action will submit a separate change request

☐ Disable accounts (excludes shared and service accounts)

☒ Delete accounts (excludes shared and service accounts)

For particular accounts All ⓘ

Perform this action

☒ Immediately ☐ After days

Figure 7-66 IMG User Termination (Continued)

☐ Revoke user entitlements (excludes shared and service accounts)

☐ Shared Accounts

☐ Service Accounts

Processing Schedule/Trigger

☒ Use global configuration

☐ Define for this rule

Scheduled : ☐ Yes ☒ No

Triggered : ☒ Run after identity unification

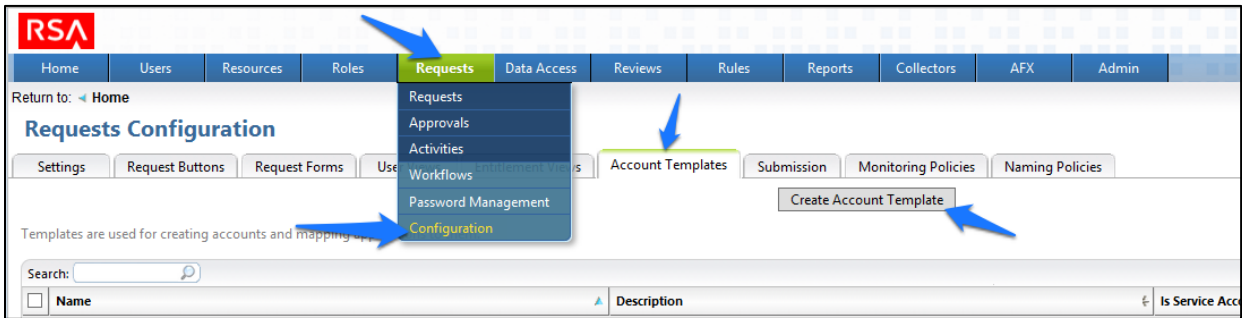
4. Click **OK**.

7.3.13 Create Provisioning Template

The next step is to create a template that IMG uses when provisioning accounts in Adaptive Directory.

1. Click on **Requests > Configuration > Account Template > Create Account Template**, as shown in Figure 7-67.

Figure 7-67 IMG Request Configuration



2. Enter a name, and click **OK**, as shown in Figure 7-68.

Figure 7-68 IMG Account Template

**Account Template**

Name\* : Account Template

Description :

Is Service Account : ☐ Yes ☒ No

Account Creation : None ▾

Form

OK Cancel Help

3. Click on the name of the account template that you just created, and add parameters as shown in Figure 7-69.

Figure 7-69 IMG IT Account Template

Account Template: IT Account Template

Edit

Name: IT Account Template

Is Service Account: No

Template Parameters

Add Parameter

<input type="checkbox"/>	Action	Name	Default Value	Submission Field	Table Options
<input type="checkbox"/>	Edit	CN	\${User.Login_ID}		^
<input type="checkbox"/>	Edit	sn	\${User.Last_Name}		
<input type="checkbox"/>	Edit	sAMAccountName	\${User.Login_ID}		
<input type="checkbox"/>	Edit	mail	\${User.Email_Address}		
<input type="checkbox"/>	Edit	Account	\${User.Login_ID}		
<input type="checkbox"/>	Edit	userPrincipalName	\${User.Email_Address}		
<input type="checkbox"/>	Edit	Password	\${GeneratedPassword}		
<input type="checkbox"/>	Edit	givenName	\${User.First_Name}		v

8 items

Delete

Pending Account Parameters

Add Pending Account Parameter

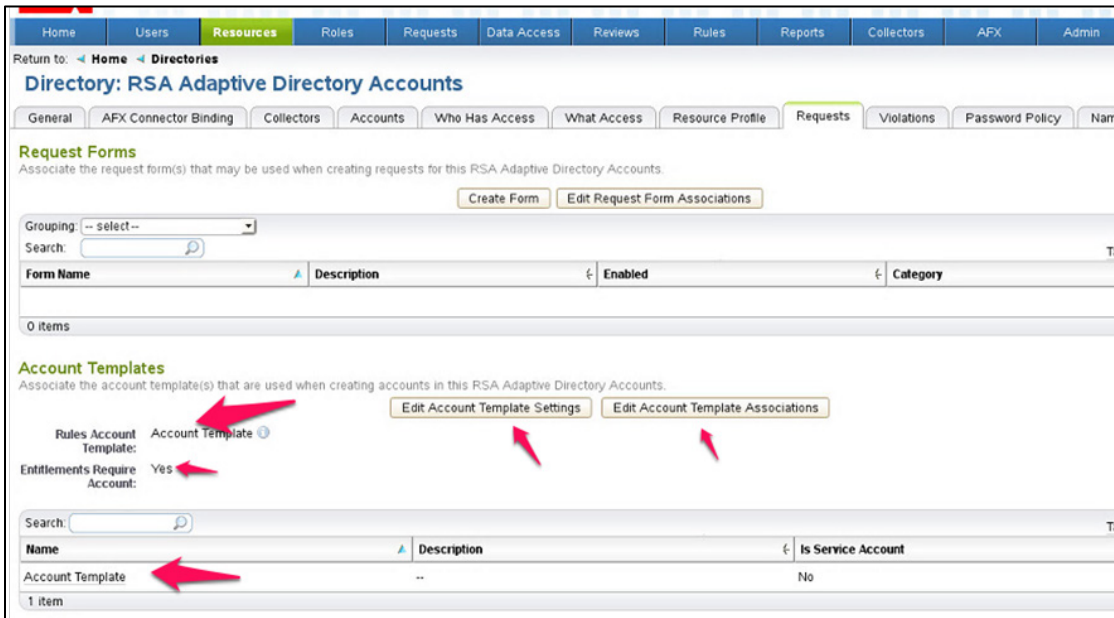
<input type="checkbox"/>	Action	Name	Default Value	Submission Field	Table Options
<input type="checkbox"/>	Edit	Name	CN=\${User.Login_ID},ou=\${User.OU},dc=master,dc=test		^

1 item

Delete

4. Click **Resources > Directories > RSA Adaptive Directory Accounts**, and then make the following changes to the **Requests** tab, as shown in Figure 7-70.

Figure 7-70 IMG AFX Connectors

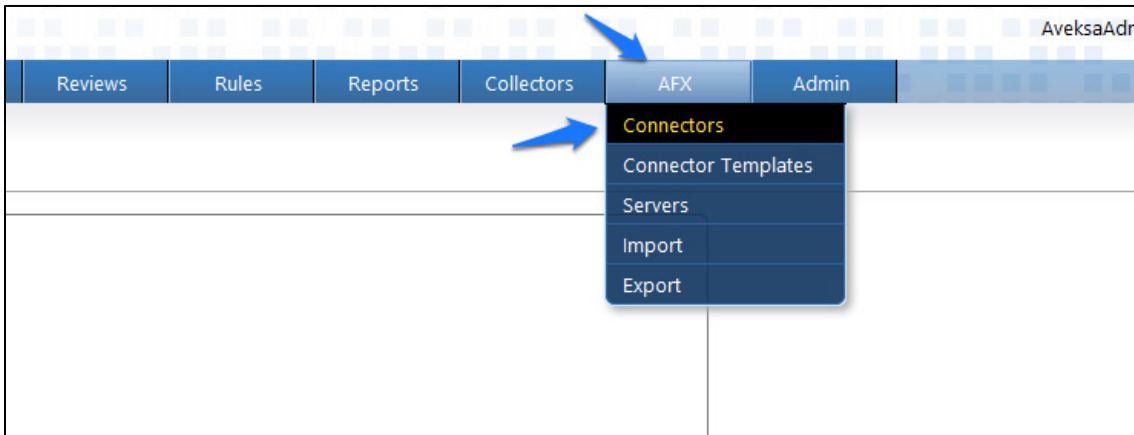


### 7.3.14 Configure AFX Module

The next step is to configure the IMG AFX module, which will allow IMG to provision to Adaptive Directory.

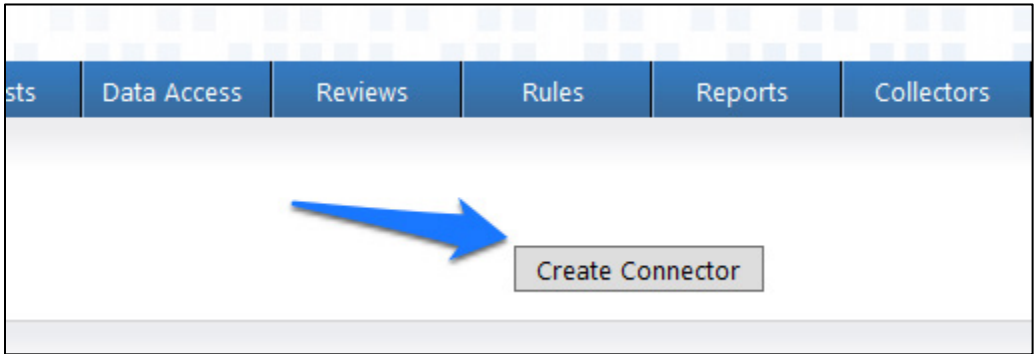
1. Click on **AFX > Connectors**, as shown in Figure 7-71.

Figure 7-71 IMG AFX Connectors



2. Click on **Create Connector**, as shown in Figure 7-72.

Figure 7-72 IMG Create Connector



3. Configure the **General** tab as shown in Figure 7-73.

Figure 7-73 IMG AD Connector AFX Server: General

A screenshot of a web form titled 'Edit Connector: RSA Adaptive Directory Connector'. The form has three tabs: 'General', 'Settings', and 'Capabilities'. The 'General' tab is selected. A blue arrow points to the 'General' tab. The form contains the following fields:

- Name\***: RSA Adaptive Directory Connector
- Description**: (empty text area)
- Server\***: AFX Server (dropdown menu)
- State**: Active (dropdown menu)
- Export As Template**: (empty text field)

4. Configure the **Settings** tab as shown in Figure 7-74 through Figure 7-76.

Figure 7-74 IMG AD Connector AFX Server: Settings (1 of 3)

Edit Connector: RSA Adaptive Directory Connector IT

General

Settings

Capabilities

Connection Details

Host\* : 172.16.4.3

Port\* : 1636

Use Secure : ☒ Connection

Login Distinguished : cn=Directory Manager

Password\* :

Timeout (seconds)\* : 10

Distinguished Name

Account DN Prefix : CN

Account DN Suffix : dc=master,dc=test

Group DN Prefix : CN

Group DN Suffix : dc=master,dc=test

DN Suffix Mappings :

NIST SP 1800-2C: Identity and Access Management for Electric Utilities

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Figure 7-75 IMG AD Connector AFX Server: Settings (2 of 3)

Edit Connector: RSA Adaptive Directory Connector IT

General

Settings

Capabilities

Connection Details

Host\* : 172.16.4.3

Port\* : 1636

Use Secure : ☒ Connection

Login Distinguished : cn=Directory Manager

Name\* :

Password\* :

Timeout (seconds)\* : 10

Distinguished Name

Account DN Prefix : CN

Account DN Suffix : dc=master,dc=test

Group DN Prefix : CN

Group DN Suffix : dc=master,dc=test

DN Suffix Mappings :

NIST SP 1800-2C: Identity and Access Management for Electric Utilities

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Figure 7-76 IMG AD Connector AFX Server: Settings (3 of 3)

**Object Creation**

LDAP object classes to :  
create account\*

LDAP object classes to :  
create group\*

**Group**

User membership :  
attribute for Group\*

**AccountLockUnlock**

Account Lockout :  
Threshold attribute  
value\*

**Miscellaneous**

Dependent Exchange :  
Connector

5. Configure the **Capabilities** tab as shown in Figure 7-77.

Figure 7-77 IMG AD Connector AFX Server: Capabilities



6. Check all capabilities that are needed for the connector. Once all are selected, click on the capability name, one by one, and configure as shown in Figure 7-78 through Figure 7-90.

Figure 7-78 IMG AD Connector IT Capability Configuration (1 of 13)

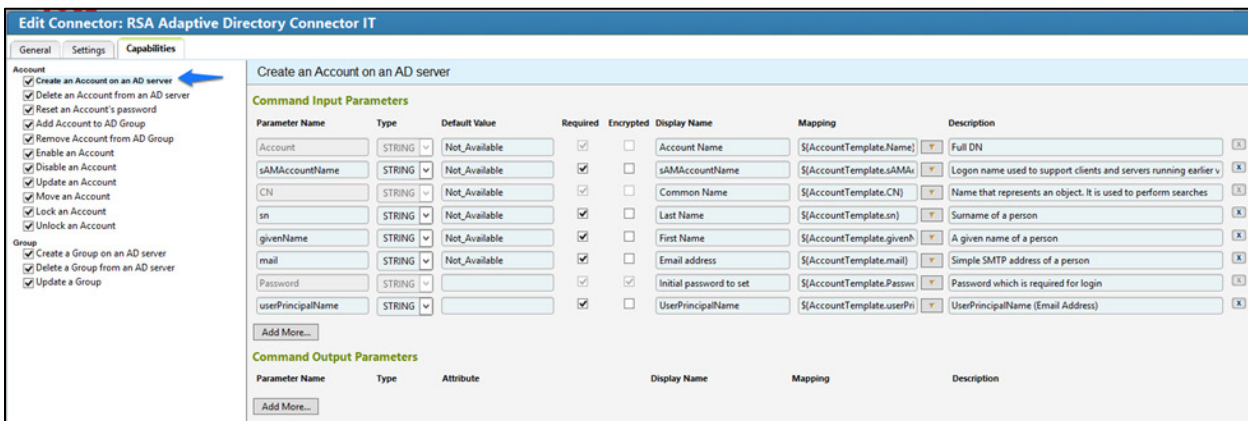


Figure 7-79 IMG AD Connector IT Capability Configuration (2 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Reset an Account's password

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN
Password	STRING		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Initial password to reset to	password	A new password to reset

Add More...

Figure 7-80 IMG AD Connector IT Capability Configuration (3 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Add Account to AD Group

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account DN or Account Name	\$(Account.Name)	Full DN
Group	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Group DN or Group Name	\$(Group.Name)	Full DN of group or group name

Add More...

Figure 7-81 IMG AD Connector IT Capability Configuration (4 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server

Remove Account from AD Group

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account DN or Account Name	\$(Account.Name)	Full DN
Group	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Group DN or Group Name	\$(Group.DN)	Full DN of group or group name

Add More...

Figure 7-82 IMG AD Connector IT Capability Configuration (5 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server

Enable an Account

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN

Add More...

Figure 7-83 IMG AD Connector IT Capability Configuration (6 of 13)

**Edit Connector: RSA Adaptive Directory Connector IT**

General Settings **Capabilities**

**Account**

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

**Disable an Account**

**Command Input Parameters**

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN
<a href="#">Add More...</a>							

Figure 7-84 IMG AD Connector IT Capability Configuration (7 of 13)

**Edit Connector: RSA Adaptive Directory Connector IT**

General Settings **Capabilities**

**Account**

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

**Update an Account**

**Command Input Parameters**

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN
<a href="#">Add More...</a>							

Figure 7-85 IMG AD Connector IT Capability Configuration (8 of 13)

**Edit Connector: RSA Adaptive Directory Connector IT**

General Settings **Capabilities**

**Account**

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

**Move an Account**

**Command Input Parameters**

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN of account or login name
NewParentDN	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	New Parent's DN	\$(Account.DN)	DN of new account base or organizational unit
<a href="#">Add More...</a>							

Figure 7-86 IMG AD Connector IT Capability Configuration (9 of 13)

**Edit Connector: RSA Adaptive Directory Connector IT**

General Settings **Capabilities**

**Account**

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

**Lock an Account**

**Command Input Parameters**

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN of account or login name
<a href="#">Add More...</a>							

Figure 7-87 IMG AD Connector IT Capability Configuration (10 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Unlock an Account

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Account	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Account Name	\$(Account.Name)	Full DN of account or login name

Add More...

Figure 7-88 IMG AD Connector IT Capability Configuration (11 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Create a Group on an AD server

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Group	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Group Name	\$(Group.Name)	Full DN of group or group name
CN	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Common Name	\$(Group.Name)	Name that represents an object. It is used to perform searches
groupType	STRING	-2147483646	<input checked="" type="checkbox"/>	<input type="checkbox"/>	GroupType	\$(Group.Resource_Type)	Set of flags that define the type and scope of a group object

Add More...

Figure 7-89 IMG AD Connector IT Capability Configuration (12 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Delete a Group from an AD server

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Group	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Group Name	\$(Group.Name)	Full DN of group or group name

Add More...

Figure 7-90 IMG AD Connector IT Capability Configuration (13 of 13)

GeneralSettingsCapabilities

Account

- ☒ Create an Account on an AD server
- ☒ Delete an Account from an AD server
- ☒ Reset an Account's password
- ☒ Add Account to AD Group
- ☒ Remove Account from AD Group
- ☒ Enable an Account
- ☒ Disable an Account
- ☒ Update an Account
- ☒ Move an Account
- ☒ Lock an Account
- ☒ Unlock an Account

Group

- ☒ Create a Group on an AD server
- ☒ Delete a Group from an AD server
- ☒ Update a Group

Update a Group

Command Input Parameters

Parameter Name	Type	Default Value	Required	Encrypted	Display Name	Mapping	Description
Group	STRING		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Group Name	\$(Group.Name)	Full DN of group or group name

Add More...

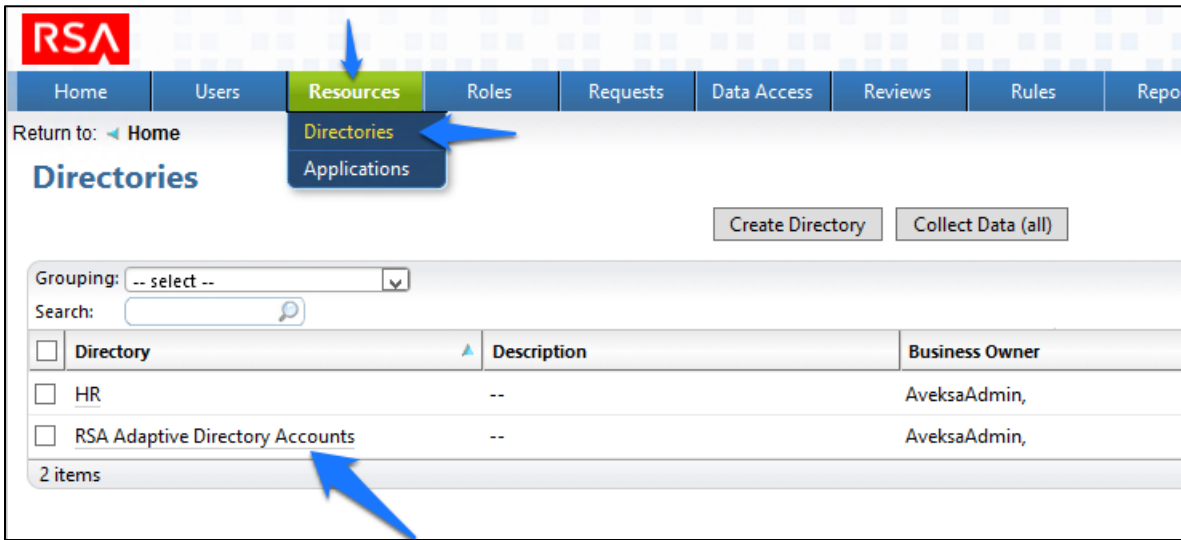
7. Click **OK**.

### 7.3.15 Configure Adaptive Directory to Use AFX Connector

The next step is to configure the RSA Adaptive Directory “Directory” to use the new AFX Connector.

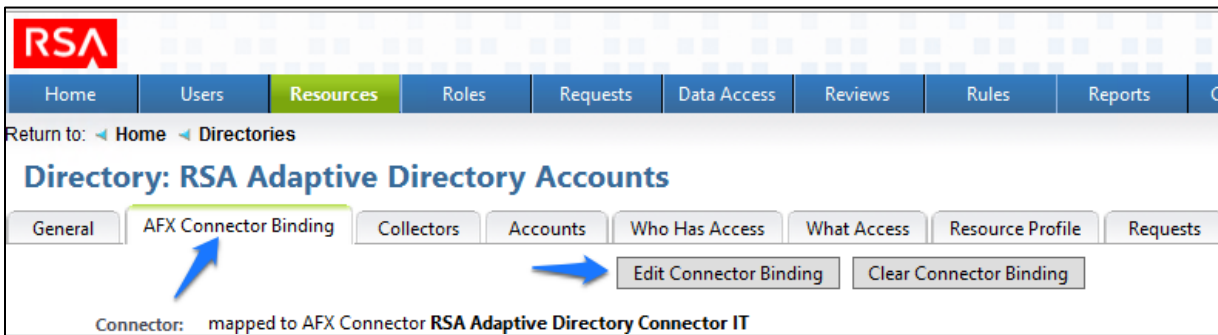
1. Click **Resources > Directories**, select **RSA Adaptive Directory Accounts**, and then click **OK**, as shown in Figure 7-91.

Figure 7-91 IMG Resources Directories



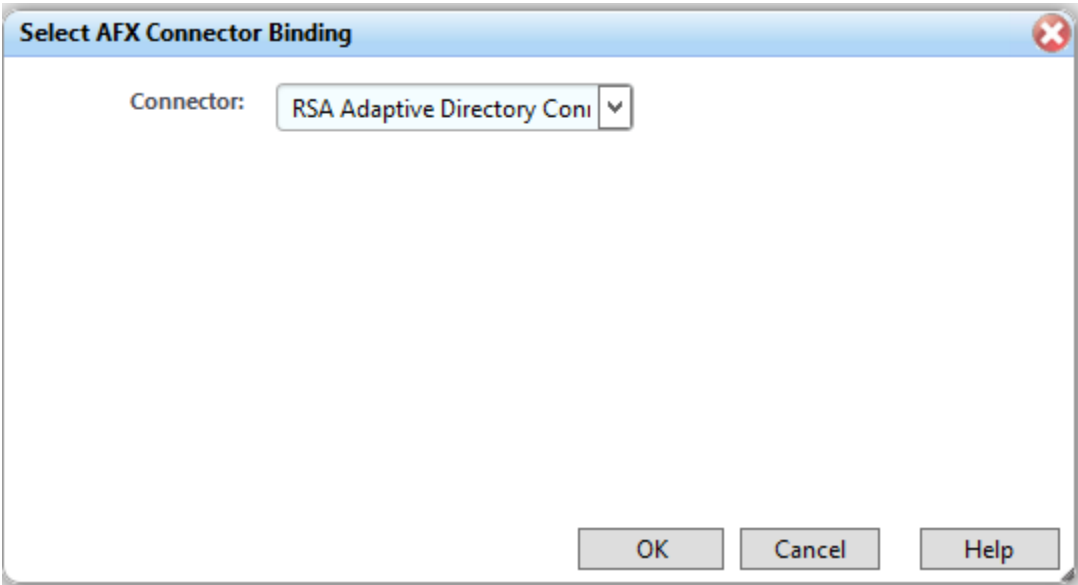
2. In the next window, click **AFX Connector Binding > Edit Connector Binding**, as shown in Figure 7-92.

Figure 7-92 IMG AD Accounts



3. Click **OK**, as shown in Figure 7-93.

Figure 7-93 IMG AD AFX Connector Binding



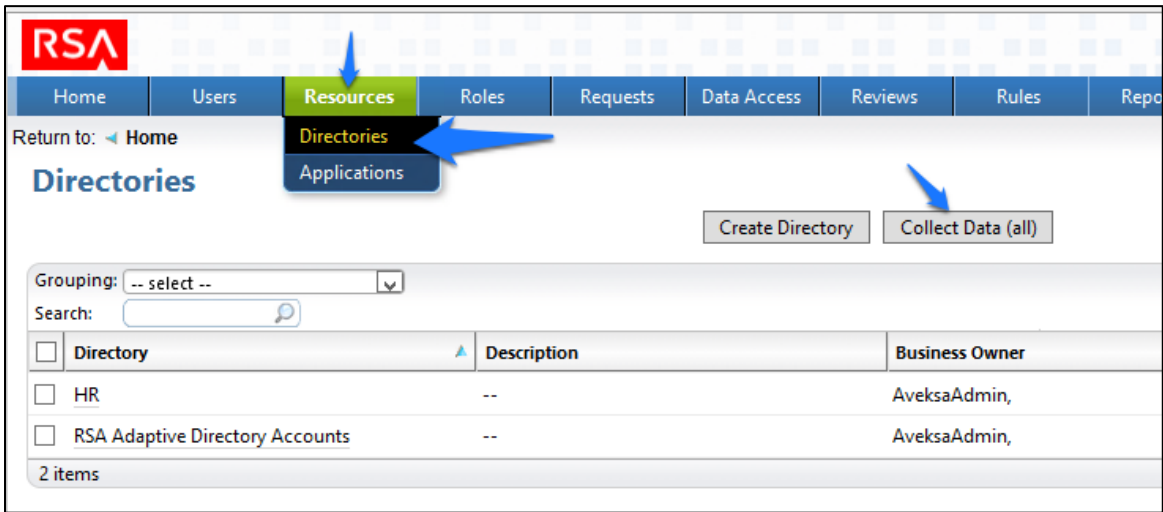
The system is now ready.

### 7.3.16 Adding a New User

To add a new user, you will need to open the *HR CSV* file.

1. Go to **Resources > Directories > Collect Data (all)**, as shown in Figure 7-94.

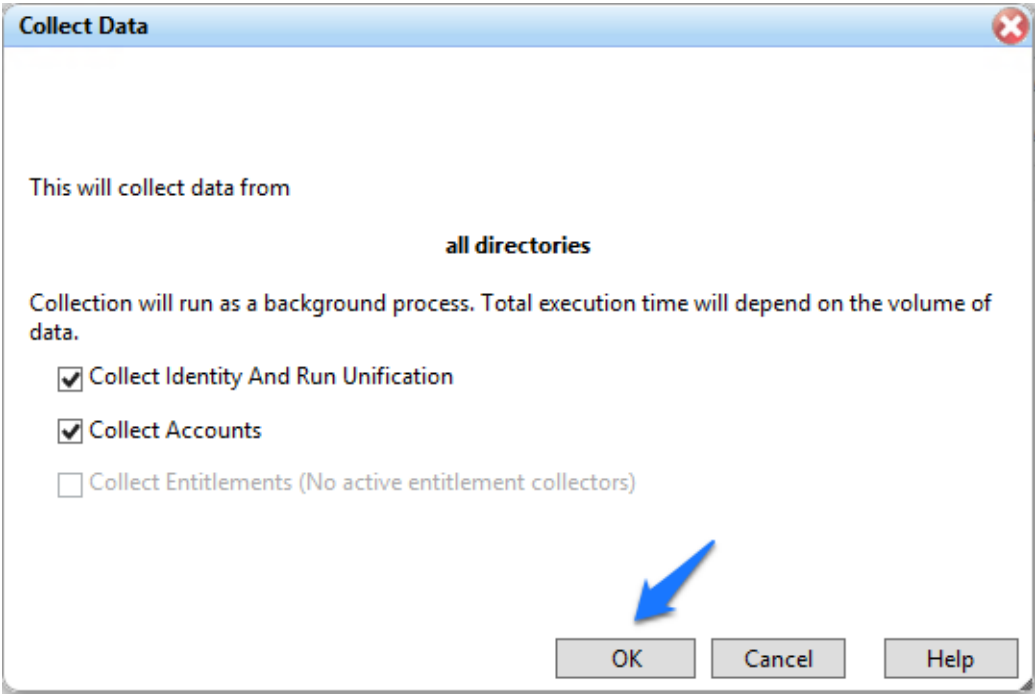
Figure 7-94 IMG Resources Directories





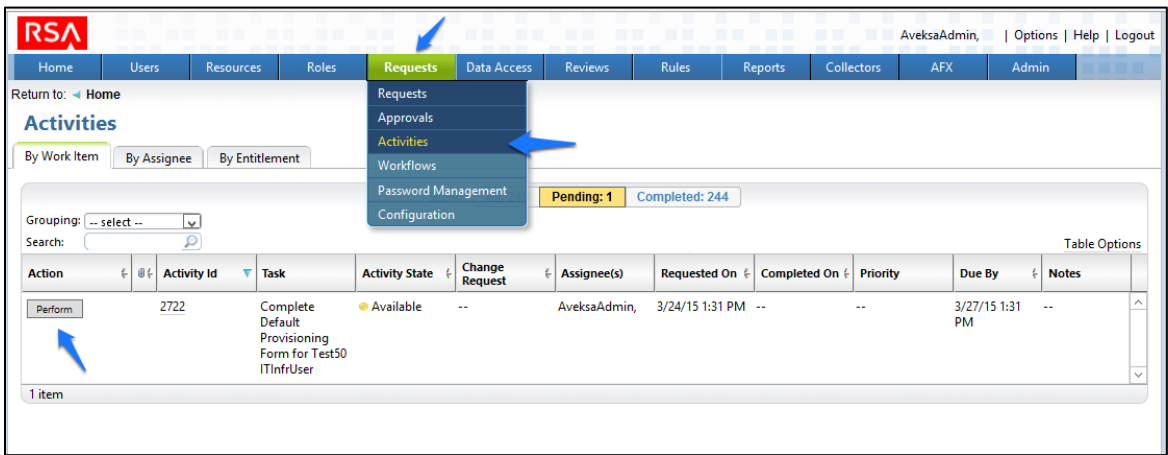
2. Click **OK**, as shown in Figure 7-95.

Figure 7-95 IMG Collect Data



3. After about 30 seconds, go to **Requests > Activities**, and click **Perform** next to the request to add a new user, as shown in Figure 7-96.

Figure 7-96 IMG Requests Activities



4. Select a group to which you would like to add the user, and then click **Next > Accepted**, as shown in Figure 7-97.

Figure 7-97 IMG Accepted Access Request

Access Request: ITInfrUser, Test50

Default Provisioning Form Page 1 of 2

Please select the entitlements Test50 ITInfrUser should have. The suggested entitlements represent the access the system thinks this user should have based on the provisioning rule 'New User'. The optional entitlements represent additional access the system also thinks the user might need.

**Suggested Entitlements (At least 0% of the users have these entitlements)**

Grouping: Business Source Name

Search:

Entitlement Name	Entitlement Type	% of User Have This Entitlement	DN	Description	Domain
<input checked="" type="checkbox"/> RSA Adaptive Directory Accounts (2)					
<input type="checkbox"/> CN=Denied RODC Password Replication Group, ou=it, dc=master, dc=test	group	50	Denied RODC Password Replication Group	Members in this group cannot have their passwords replicated to any read-only domain controllers in the domain	--
<input checked="" type="checkbox"/> CN=Domain Admins, ou=it, dc=master, dc=test	group	50	Domain Admins	Designated administrators of the domain	--

1 Group (2 total items) | 1 selected

**Arbitrary Entitlements**

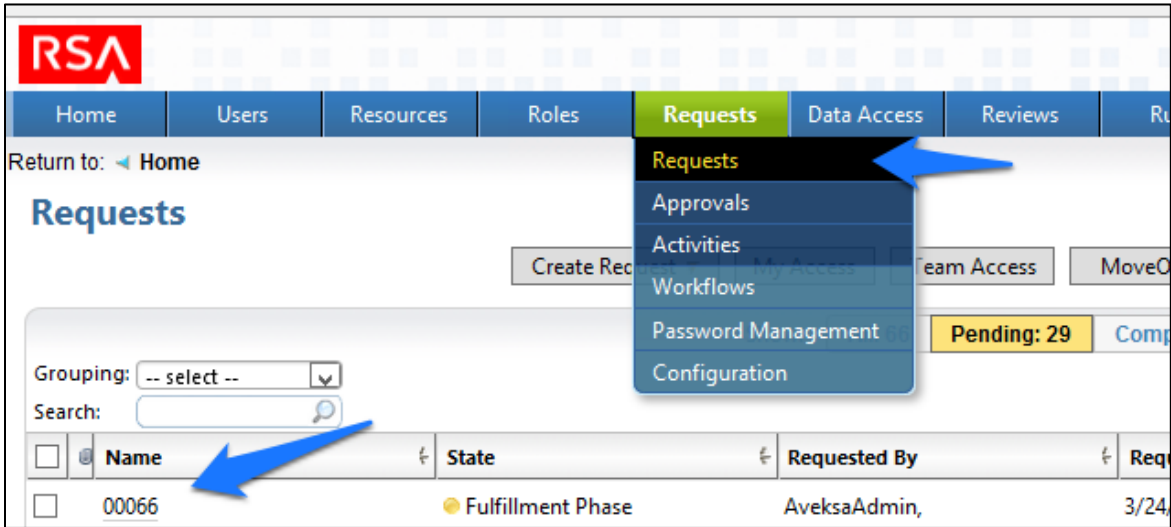
Compare with a typical user

< Back Next Finish Cancel Help

Accepted  
Rejected  
Reassign

5. Enter a description, if you wish, and then click **Finish**.
6. Go to **Requests > Requests**, and then select the name of the request, as shown in Figure 7-98.

Figure 7-98 IMG Requests



7. After about 30 seconds, your new user will be provisioned to AD and will be added to the group that you selected, as shown in Figure 7-99.

Figure 7-99 IMG New User Provisioned

EditCancel

Overall Status: 

50%

 1/2 (Fulfillment Phase)

Name: 00068

Requested By: AveksaAdmin, on 3/24/15 1:53 PM

Notes: --

Workflow Jobs: [Processing Workflow](#)

Email Log: [Email Log](#)

AFX Log: [AFX Log](#)

Additional Information

Default Provisioning Form (For ITInfrUser, Test51)

AccountTemplate.Account: Test51ITInfrUser

AccountTemplate.sAMAccountName: Test51ITInfrUser

AccountTemplate.CN: Test51ITInfrUser

AccountTemplate.sn: ITInfrUser

AccountTemplate.givenName: Test51

AccountTemplate.userPrincipalName: Test51ITInfrUser@ES-IdAM-B1.TEST

AccountTemplate.mail: Test51ITInfrUser@ES-IdAM-B1.TEST

Attachments

Browse...

No file selected.

Upload Attachment

Status

Details: Fulfillment: 

50%

 1/2 Changes Fulfilled (0/0 Activities)

Approval Phase

Fulfillment Phase

IT AFX Fulfillment

Changes processed by AFX handler

Verified

Account Changes

Search:

Table Options

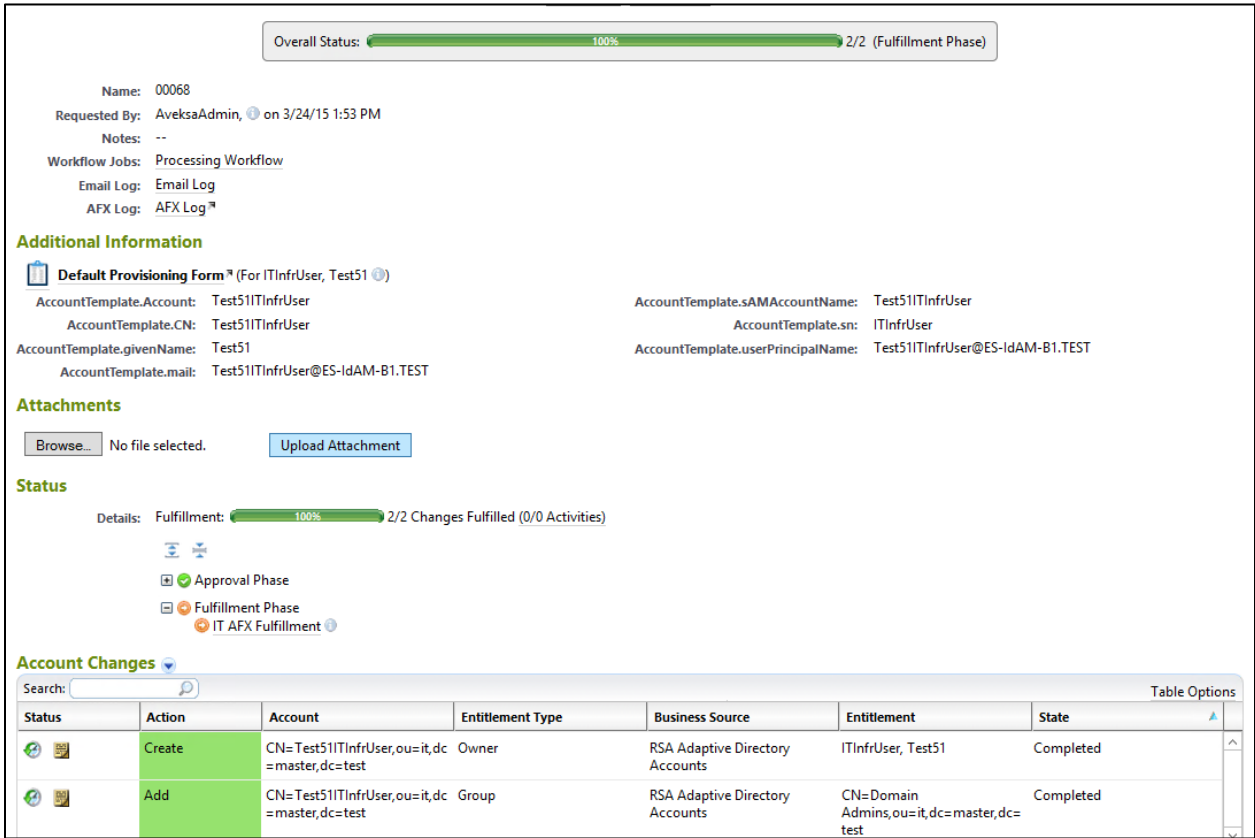
Status	Action	Account	Entitlement Type	Business Source	Entitlement	State
	Create	CN= Test51ITInfrUser,ou=it,dc =master,dc=test	Owner	RSA Adaptive Directory Accounts	ITInfrUser, Test51	Completed

Note: The state of the group add will remain as pending, and the overall status will remain at 50%, until you recollect data from the **Directories** page so that IMG can detect that the user has been added to the group successfully, as shown in Figure 7-100.

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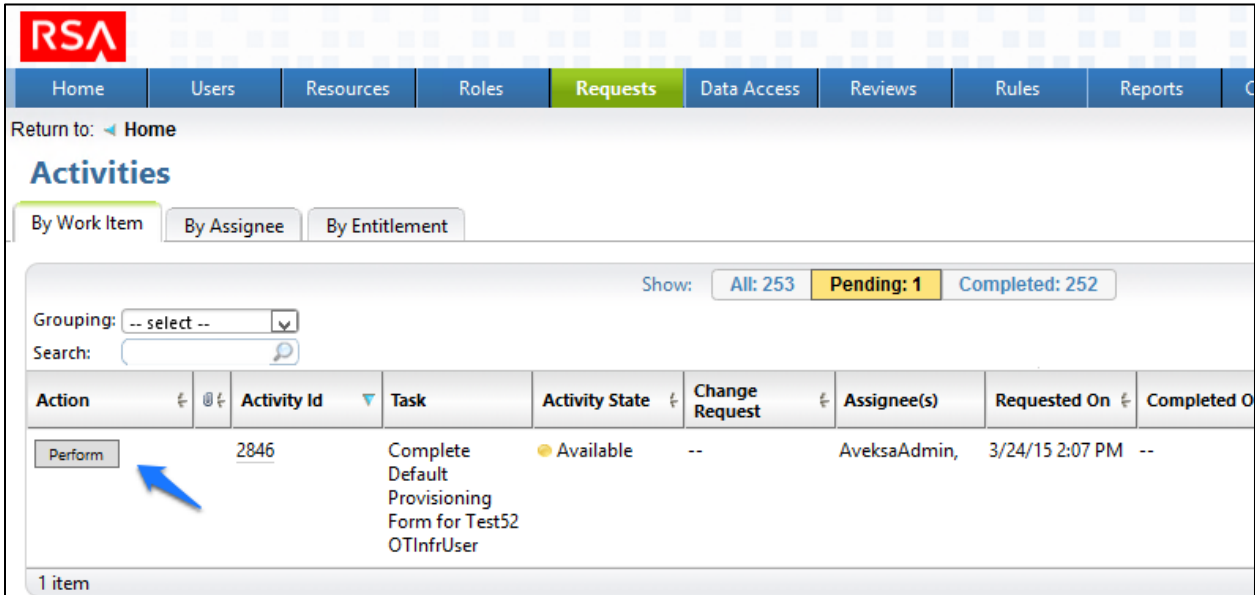
Figure 7-100 IMG Successful User Add



### 7.3.17 Moving a User

1. Open your CSV file, and change the attribute that defines the organizational unit (OU) of the user to a different OU.
2. Collect data again.
3. The OU change is detected, and IMG deletes the user from the original OU and adds the user to the new OU.
4. Go to **Requests > Activities**, and click **Perform**, as shown in Figure 7-101.

Figure 7-101 IMG Requests Activities



5. Select the group to which you would like the moved user to have access, click **Next > Accepted**, and then click **Finish** on the final screen, as you did before when adding a new user.
6. Collect data again so that IMG can confirm that the user is added to the appropriate group in the new OU.

### 7.3.18 Terminating a User

1. Delete the user from the *HR CSV* file.
2. Collect data again.
3. The user is automatically removed.
4. Collect data again so that IMG can confirm that the user is no longer in Adaptive Directory.
5. Go to **Requests > Requests**, and check the **Status**, as shown in Figure 7-102.

Figure 7-102 IMG Request Status

HomeUsersResourcesRolesRequestsData AccessReviewsRulesReportsCollectorsAFXAdmin

Return to: HomeRequests

Request: 00077

EditCancel

Overall Status: 100% 1/1 (Fulfillment Phase)

Name: 00077

Requested By: AveksaAdmin, (through the rule Termination) on 3/24/15 2:12 PM

Fulfillment Date: 03/23/15

Notes: Request submitted by the system for the rule Termination on behalf of the rule owner AveksaAdmin.

Workflow Jobs: Processing Workflow

Email Log: Email Log

AFX Log: AFX Log

Attachments

Browse...No file selected.Upload Attachment

Status

Details: Fulfillment: 100% 1/1 Changes Fulfilled (0/0 Activities)

Approval Phase

Fulfillment Phase

IT AFX Fulfillment

Changes processed by AFX handler

Verified

Account Changes

Search:

Table Options

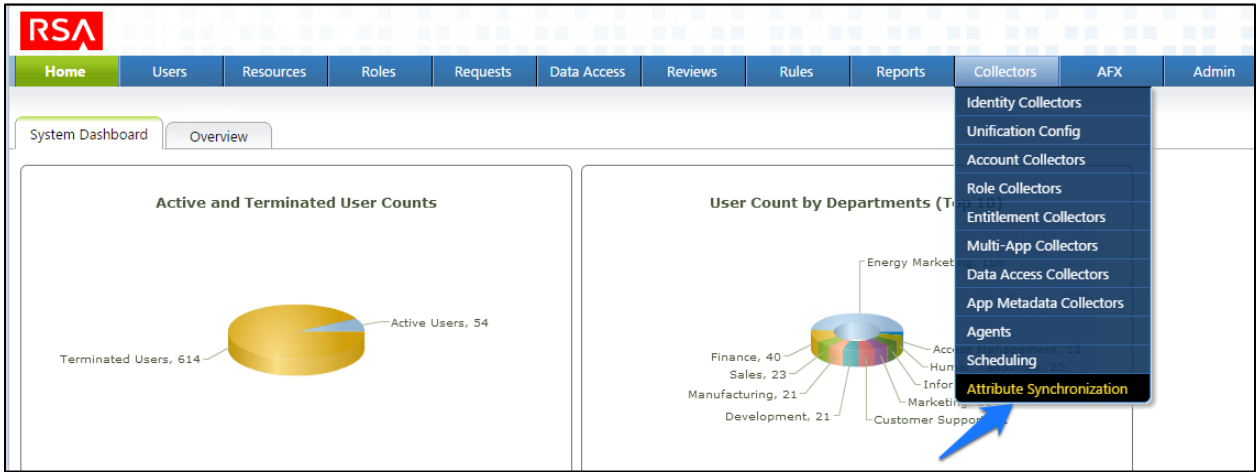
Status	Action	Account	Entitlement Type	Business Source	Entitlement	State
	Delete	CN=Test52OTInfrUser,ou=ot,dc=master,dc=test	Account		OTInfrUser, Test52	Completed

1 item

7.3.19 User Attribute Synchronization

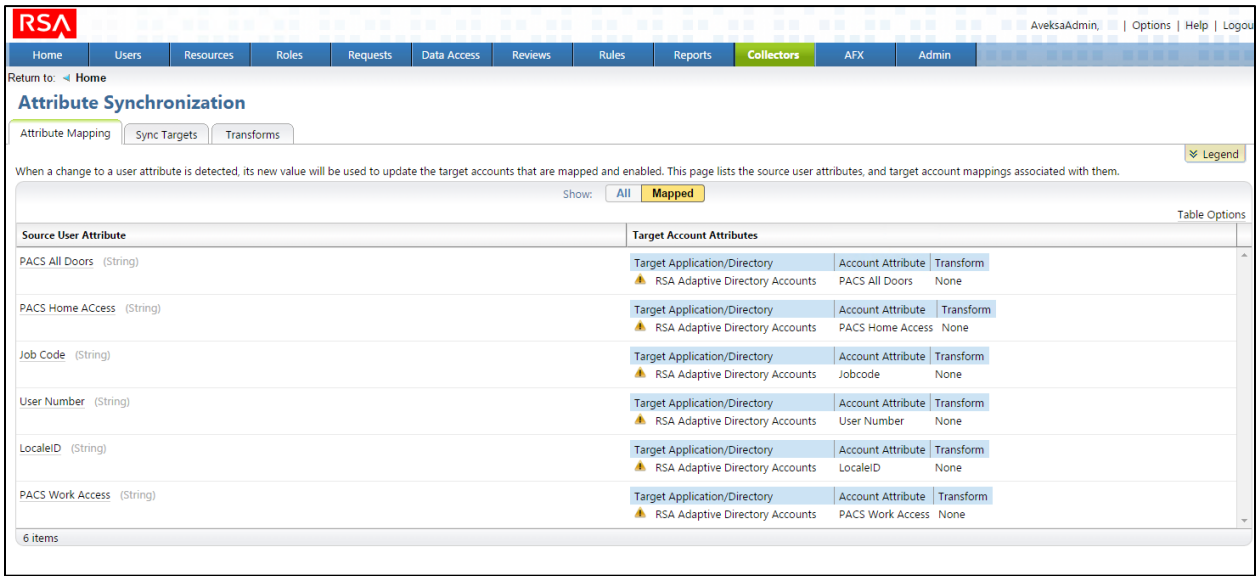
1. Choose **Collectors > Attribute Synchroniation**, as shown in Figure 7-103.

Figure 7-103 IMG User Synchronization Menu Item



2. Configure as shown in Figure 7-104.

Figure 7-104 IMG User Synchronization Status



The IMG installation is now complete.



## 8 Adaptive Directory: RSA (Build #2)

The RSA Adaptive Directory implements the central IdAM identity store in Build #2. It receives input from the central IdAM system (RSA IMG). The central identity store contains the distribution mechanism for updating the various downstream (synchronized) directories with user access and authorization data. This process applies to new users, terminated users (disabled or deleted users), and any changes to a user profile. Changes include promotions, job responsibility changes, and any other change that would affect the systems that a user needs to access.

### 8.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-1: Identities and credentials are managed for authorized devices and users.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-2, IA Family

### 8.2 RSA Adaptive Directory Is Installed on the IdAM Network, on a VM That Is Running CentOS 7

The following lines detail the command-line installation procedure for the RSA Adaptive Directory, including displayed responses:

```
[root@localhost ~]# ls
anaconda-ks.cfg  reports  xml

[root@localhost ~]# cd ..

[root@localhost /]# ls
bin    dev    home  lib64  mnt    proc   run    srv    tmp    var
boot  etc    lib   media  opt    root   sbin   sys    usr

[root@localhost /]# cd media

[root@localhost media]# ls
cdrom

[root@localhost media]# cd cdrom

[root@localhost cdrom]# ls
Documentation  rsa_7.1.5_linux_64.bin  rsa_7.1.5_windows_64.exe

[root@localhost cdrom]# su root ./rsa_7.1.5_linux_64.bin

Preparing to install...

WARNING: /tmp does not have enough disk space!
```

```

    Attempting to use /root for install base and tmp dir.
Extracting the JRE from the installer archive...
Unpacking the JRE...
Extracting the installation resources from the installer archive...
Configuring the installer for this system's environment...
Launching installer...
Graphical installers are not supported by the VM. The console mode will be used
instead...

=====
RSA Adaptive Directory 7.1.5                      (created with InstallAnywhere)
-----

Preparing CONSOLE Mode Installation...

=====

License Agreement
-----

Please read the following License Agreement carefully.

    LICENSE AGREEMENT

*** IMPORTANT INFORMATION - PLEASE READ CAREFULLY ***

(...Lic agreement text omitted...)

DO YOU ACCEPT THE TERMS OF THIS LICENSE AGREEMENT? (Y/N): Y

=====

Choose Install Folder
-----

Please choose a destination folder for this installation

Where would you like to install?

    Default Install Folder: /root/rsa/adaptivedirectory

ENTER AN ABSOLUTE PATH, OR PRESS <ENTER> TO ACCEPT THE DEFAULT

    :

=====

Choose Install Set

```

```

-----
Please choose the Install Set to be installed by this installer.

->1- RSA Adaptive Directory New Cluster / Standalone
    2- RSA Adaptive Directory Cluster Node
    3- Customize...

ENTER THE NUMBER FOR THE INSTALL SET, OR PRESS <ENTER> TO ACCEPT THE DEFAULT
:

=====

New Cluster settings
-----

Enter information below about the new cluster to create:

- The cluster name
- The ZooKeeper ports that will be used

Cluster name: (DEFAULT: cluster1):
ZooKeeper Ensemble Port: (DEFAULT: 2888):
ZooKeeper Leader Election Port: (DEFAULT: 3888):
ZooKeeper Client Port: (DEFAULT: 2181):

=====

Administrator name
-----

Please provide the administrator name:

Admin User Name (DEFAULT: cn=Directory Manager):

=====

Server administrator password
-----

Please provide a password for the administrator user :

Password (DEFAULT: ): secretsecret
Confirm Password (DEFAULT: ): secretsecret

```

```
=====
Adaptive Directory port numbers
-----

Please enter port numbers for Adaptive Directory:
Adaptive Directory Port (DEFAULT: 2389):
Scheduler Port (DEFAULT: 1099):
Adaptive Directory SSL Port: (DEFAULT: 1636):

=====

TLS Configuration
-----

Enable TLS (Y/N)? (DEFAULT: N):

=====

Adaptive Directory HTTP port numbers
-----

Please enter port numbers for Adaptive Directory HTTP services:
Adaptive Directory HTTP Port (DEFAULT: 8089):
Adaptive Directory HTTPS Port (DEFAULT: 8090):

=====

Certificate configuration
-----

Use an existing certificate (Y/N)? (DEFAULT: N):

=====

Application Server Configuration
-----

Enter information below to configure the Application Server
```

- Administrator user name for initial server instance.
- Administrator password for initial server instance (must be at least 8 characters in length).
- Administration server port number for initial server instance.
- HTTP/HTTPS port number for initial server instance.
- JMX port number for initial server instance.

Admin User (DEFAULT: admin):

Password (DEFAULT: ): **secretsecret**

Confirm Password (DEFAULT: ): **secretsecret**

Admin Port (DEFAULT: 4848):

HTTP Port (DEFAULT: 9090):

HTTPS Port (DEFAULT: 9191):

JMX Port (DEFAULT: 8686):

=====

Control Panel Configuration

-----

These are the settings for the web server hosting the control panel.

Enter the HTTP/HTTPS ports to configure the web server on the main instance:

HTTP Port (DEFAULT: 7070): These are the settings for the web server hosting the control panel.

Enter the HTTP/HTTPS ports to configure the web server on the main instance:

HTTPS Port (DEFAULT: 7171):

=====

Port validation failed

-----

Control Panel HTTP port These are the settings for the Web Server hosting the Control Panel. is invalid.

Please select a new one.

PRESS <ENTER> TO ACCEPT THE FOLLOWING (OK):

=====

## Control Panel Configuration

-----

These are the settings for the web server hosting the control panel.

Enter the HTTP/HTTPS ports to configure the web server on the main instance:

HTTP Port (DEFAULT: 7070):

HTTPS Port (DEFAULT: 7171):

=====

## Pre-Installation Summary

-----

Please Review the Following Before Continuing:

Product Name:

RSA Adaptive Directory 7.1.5

Install Folder:

/root/rsa/adaptivedirectory

Install Set:

RSA Adaptive Directory New Cluster / Standalone

Product Features:

Application,

Sample Data

Java VM Installation Folder:

/root/rsa/adaptivedirectory/jdk

Administrator User:

cn=Directory Manager

Adaptive Directory Ports:

2389 8089 8090

Scheduler Port:

1099

SSL Configuration:

1636

Start TLS Configuration:

TLS is disabled.

Certificate Configuration:

Self signed certificate.

App Server Configuration:

4848 9090 9191 8686

Web Server Configuration:

7070 7171

Disk Space Information (for Installation Target):

Required: 1,164.03 MegaBytes

Available: 49,030.86 MegaBytes

PRESS <ENTER> TO CONTINUE:

=====

Installing...

-----

[===== | ===== | ===== | =====]

[----- | ----- | ----- | -----]

=====

Installation Complete

-----

Congratulations. RSA Adaptive Directory 7.1.5 has been successfully installed to:

/root/rsa/adaptivedirectory

In order to start working with RSA Adaptive Directory 7.1.5, please follow these steps:

- LOG OFF AND LOG IN AGAIN
- Copy and paste your license key when prompted after running RSA Adaptive Directory 7.1.5
- Run /root/rsa/adaptivedirectory/bin/openControlPanel.sh

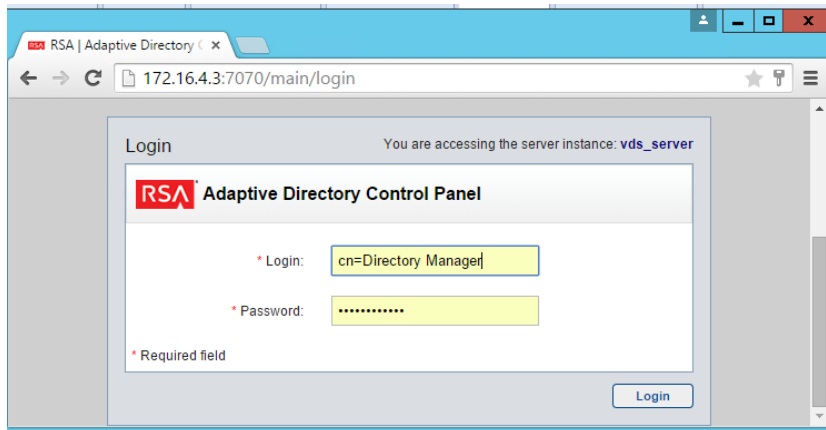
PRESS <ENTER> TO EXIT THE INSTALLER:

### 8.3 Additional Steps Required After Installation Is Complete

After installation is complete, the next step is to install netstat: `yum install net-tools`.

1. Copy the *license.lic* file to `/root/rsa/adaptivedirectory/vds_server`.
2. Open all relevant firewall ports on the CentOS server.
3. Run `/root/rsa/adaptivedirectory/bin/openControlPanel.sh`.
4. Run `/root/rsa/adaptivedirectory/bin/runContextBuilder.sh`.
5. From a web browser, go to `http:IPADDRESS:7070`.
6. Start the server by clicking the **Start** button.
7. Click on the **Tools** menu item, and start the application server.
8. Configuration Procedure:
  - a. From a web browser, connect to the Adaptive Directory server, and log in (note the URL with port number) using the default credentials (see Figure 8-1):
    - i. **Login:** `cn=Directory Manager`
    - ii. **Password:** `secretsecret`

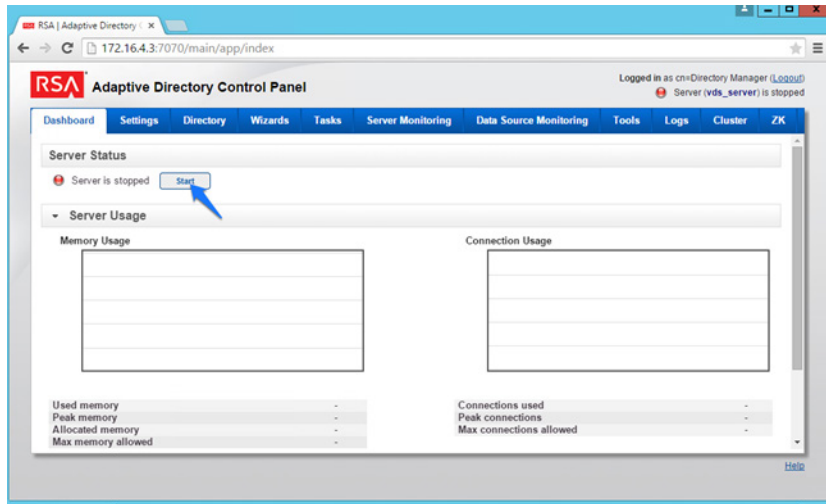
Figure 8-1 Adaptive Directory Login Page



9. On the main page, click **Start** to start the Adaptive Directory server (Figure 8-2).

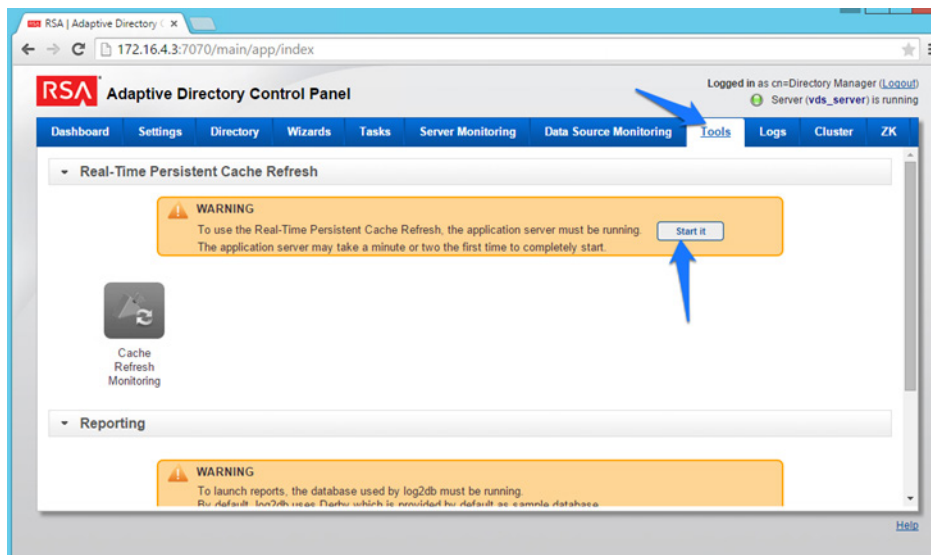


Figure 8-2 Adaptive Directory Main Page



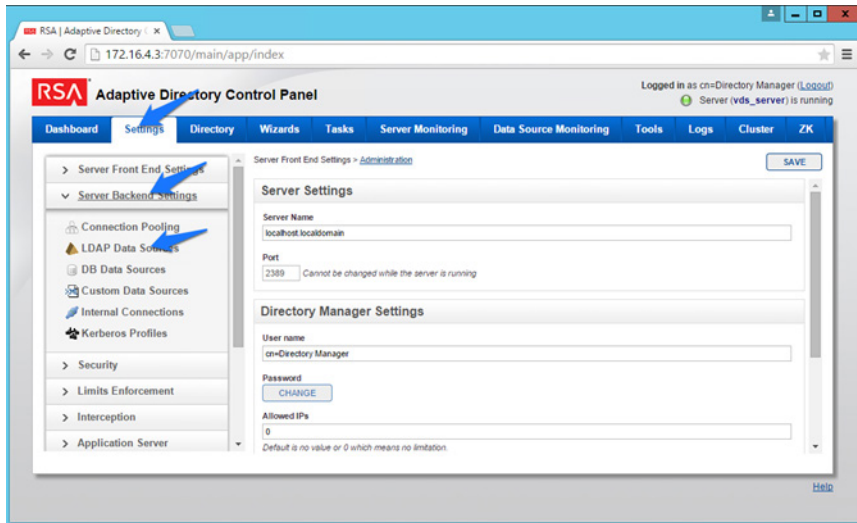
10. On the **Tools** tab, click **Start it** to start the Persistent Cache service (Figure 8-3).

Figure 8-3 Adaptive Directory Tools Page



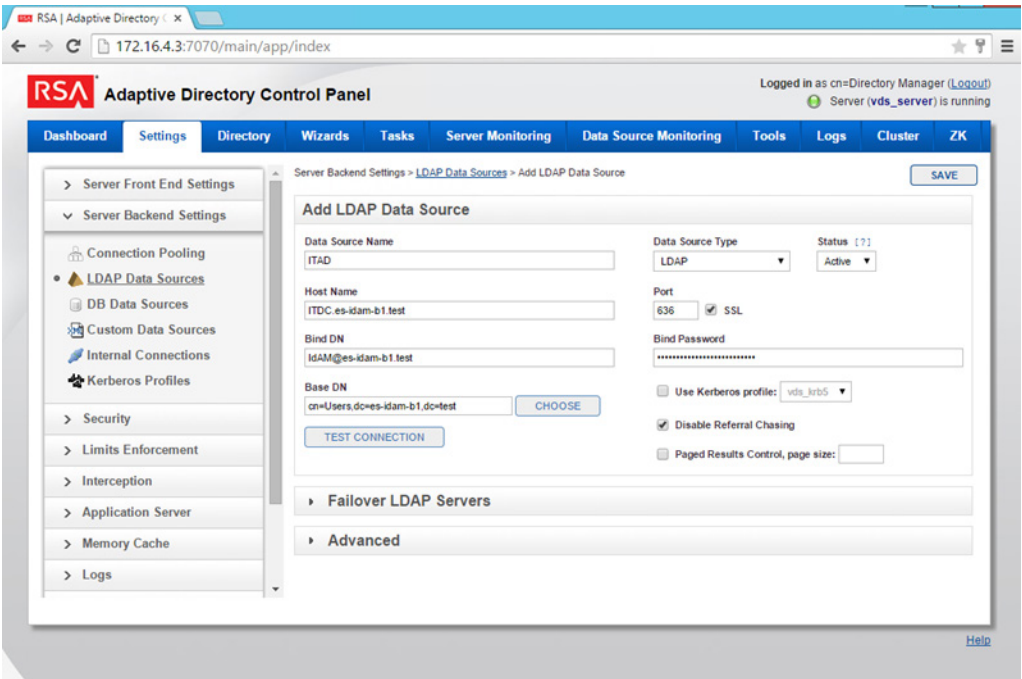
11. Go to the **Settings** tab, click **Server Backend Settings**, and then click **LDAP Data Sources** (Figure 8-4).

Figure 8-4 Adaptive Directory Server Backend Settings



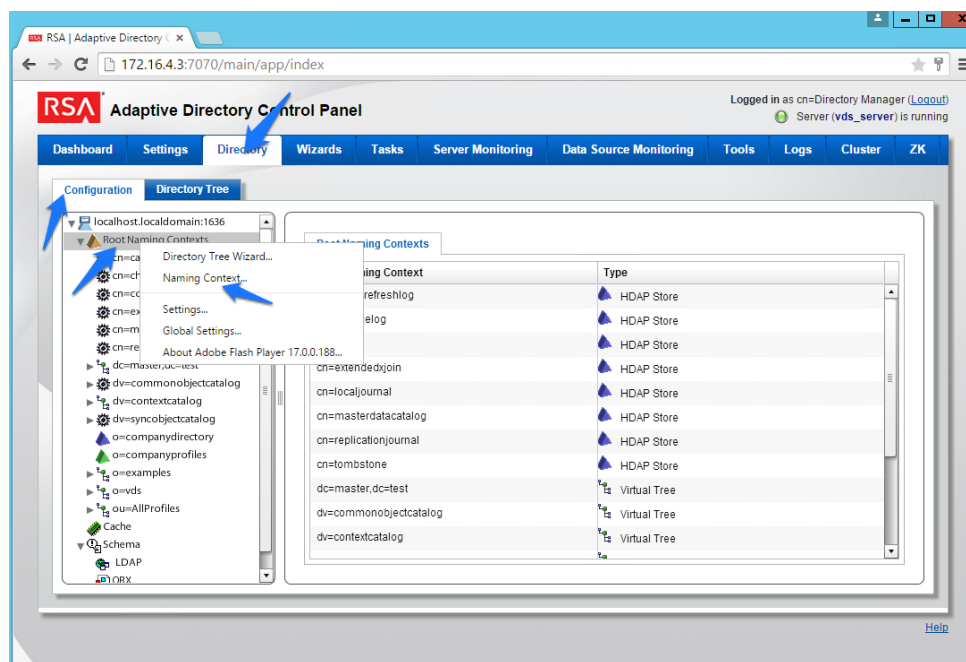
12. Click **Add**.
13. Enter details for your “backend AD,” as shown in Figure 8-5. Click the **TEST CONNECTION** button to make sure that your settings are correct (Figure 8-5). Repeat this process for all of the AD clusters (i.e., for the backend ADs on the IT, OT, and PACS networks). You can clone your first connection to make repeat additions easier.

Figure 8-5 Adaptive Directory LDAP Data Source



14. Click on **Directory > Configuration**, right-click on **Root Naming Contexts**, and then select **Naming Context**, as shown in Figure 8-6.

Figure 8-6 Adaptive Directory Configuration of Naming Context



15. You will be presented with the screen shown in Figure 8-7. Enter the name that you would like your new Virtual LDAP directory to be configured with. Select **Virtual Tree**, and then click **Next**.

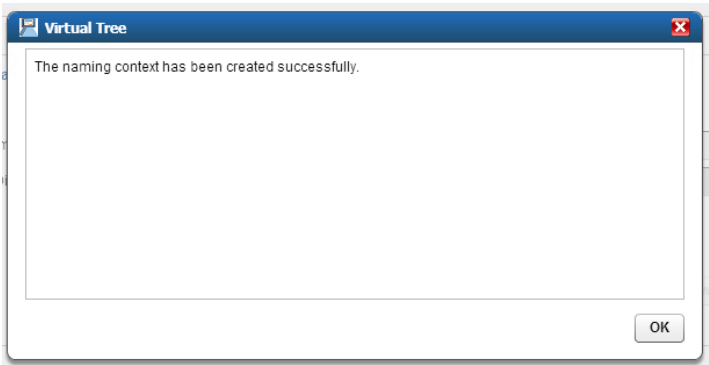
Figure 8-7 Adaptive Directory New Naming Context

16. Leave the defaults selected, as shown in Figure 8-8, and then click **OK**.

Figure 8-8 Adaptive Directory Configure Virtual Tree

You now have a virtual directory naming context. You will see the screen shown in Figure 8-9.

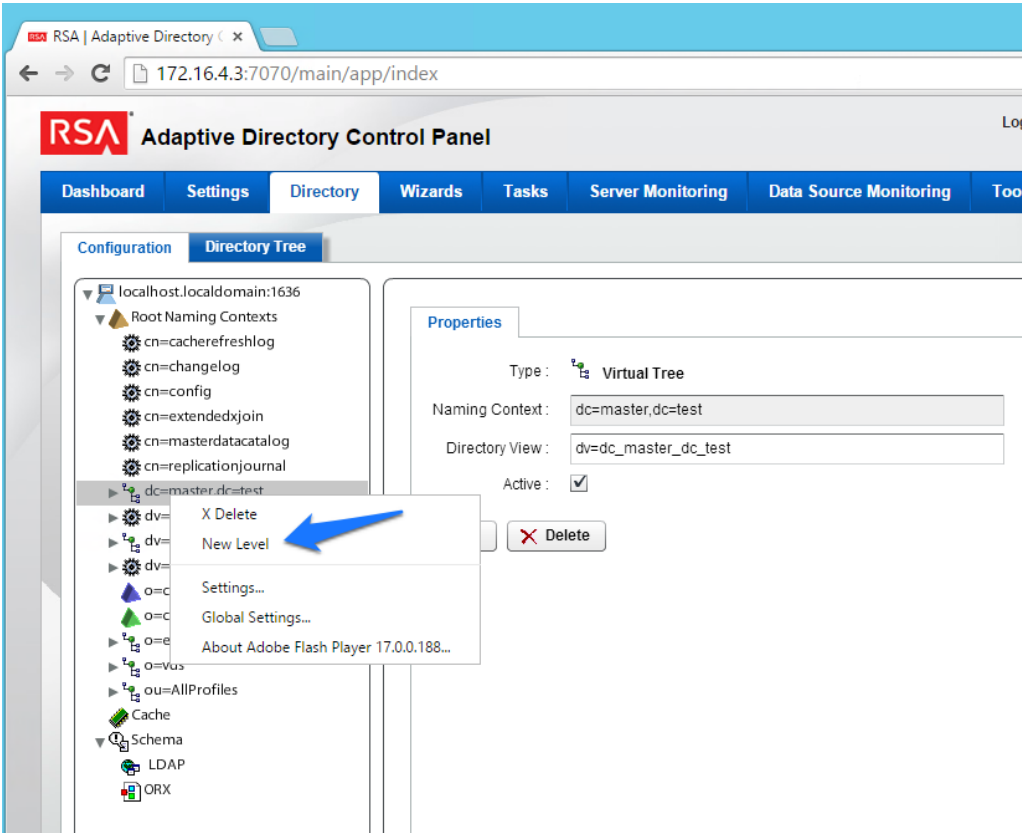
Figure 8-9 Adaptive Directory Virtual Tree



The next step is to configure this virtual directory to include all of the backend AD clusters.

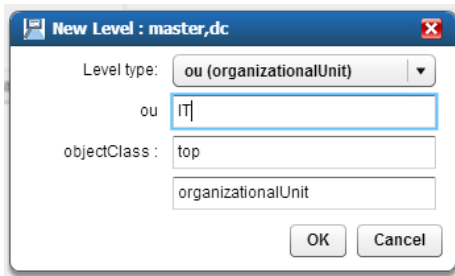
1. Right-click on your newly created Virtual Directory, and select **New Level**, as shown in Figure 8-10.

Figure 8-10 Adaptive Directory Create New Level



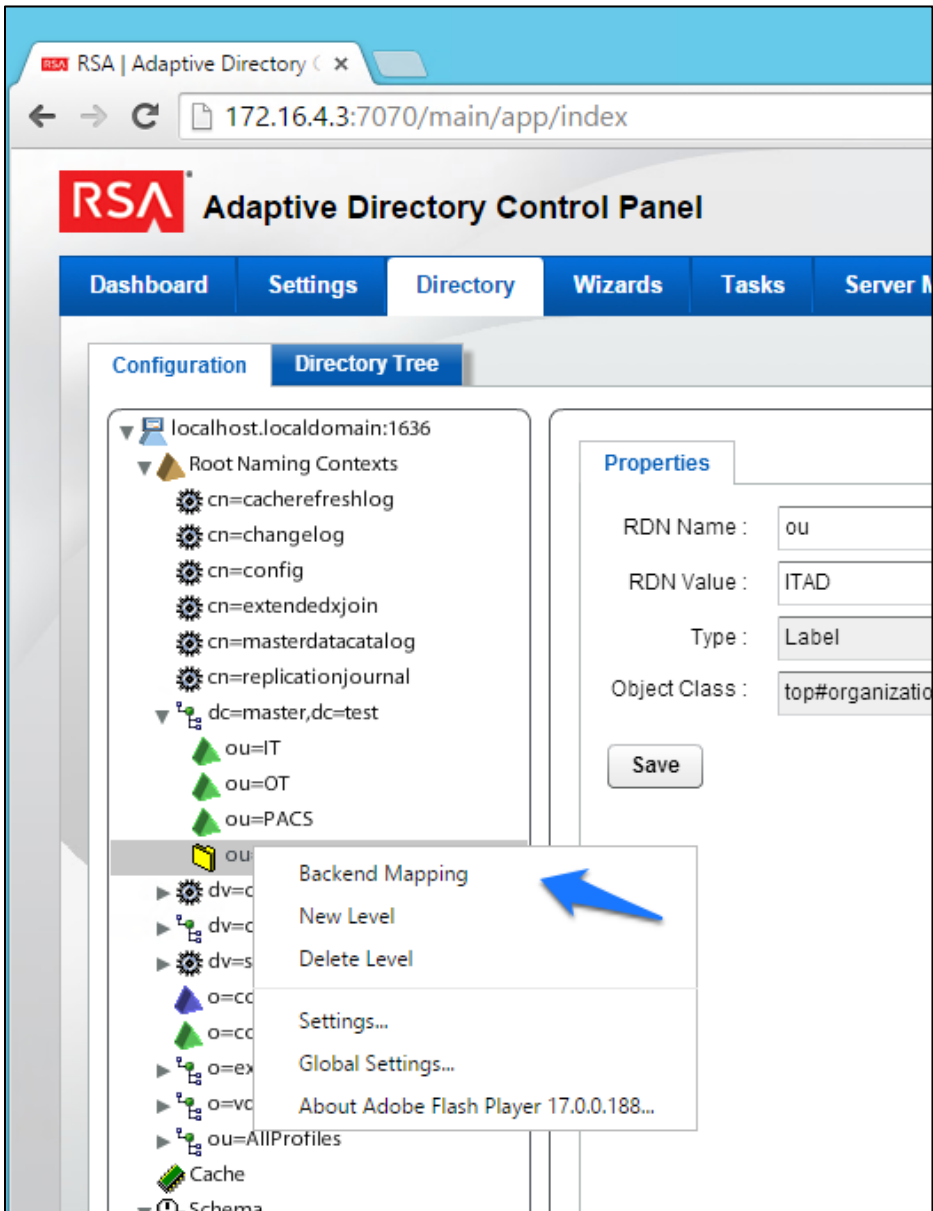
2. Enter a name for this LDAP backend mapping. This name will be an **OU** in the Virtual Directory, as shown in Figure 8-11.

**Figure 8-11 Adaptive Directory New Level Name**



3. Right-click this new **OU** in your Virtual Directory, and select **Backend Mapping**, as shown in Figure 8-12.

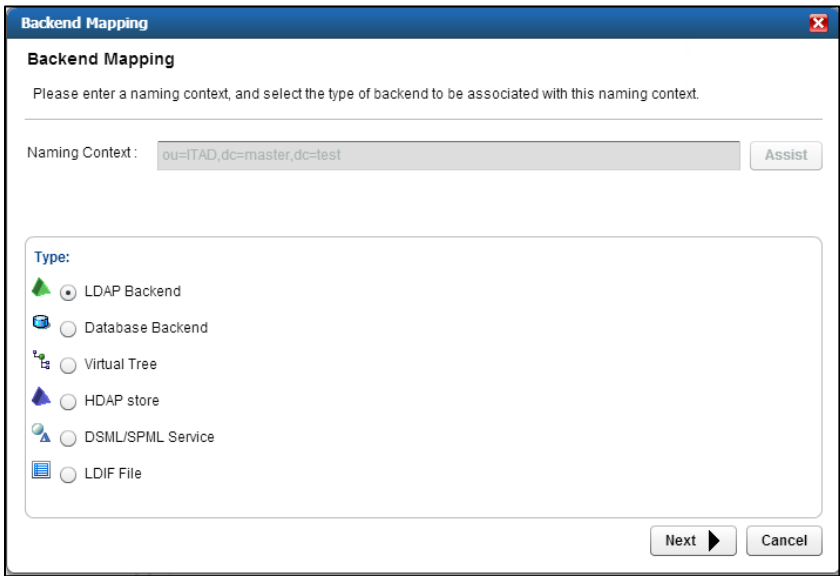
Figure 8-12 Adaptive Directory Backend Mapping



4. Leave **LDAP Backend** selected, and click **Next**, as shown in Figure 8-13.

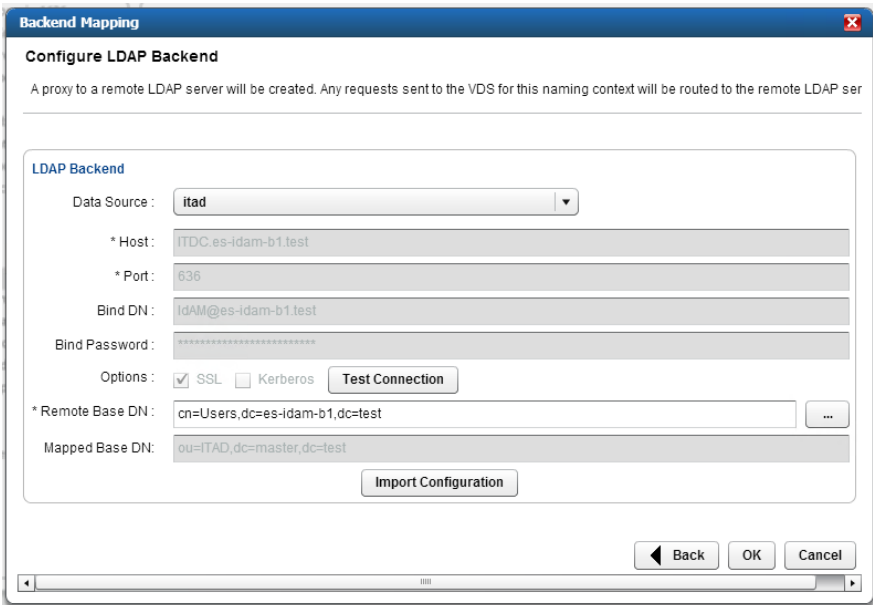


Figure 8-13 Adaptive Directory Backend Mapping



5. Select one of the backend AD clusters that you configured earlier, and then click **OK**, as shown in Figure 8-14.

Figure 8-14 Adaptive Directory Configure LDAP Backend



Repeat this procedure for all of your backend AD clusters (i.e., for the backend ADs on the IT, OT, and PACS networks).

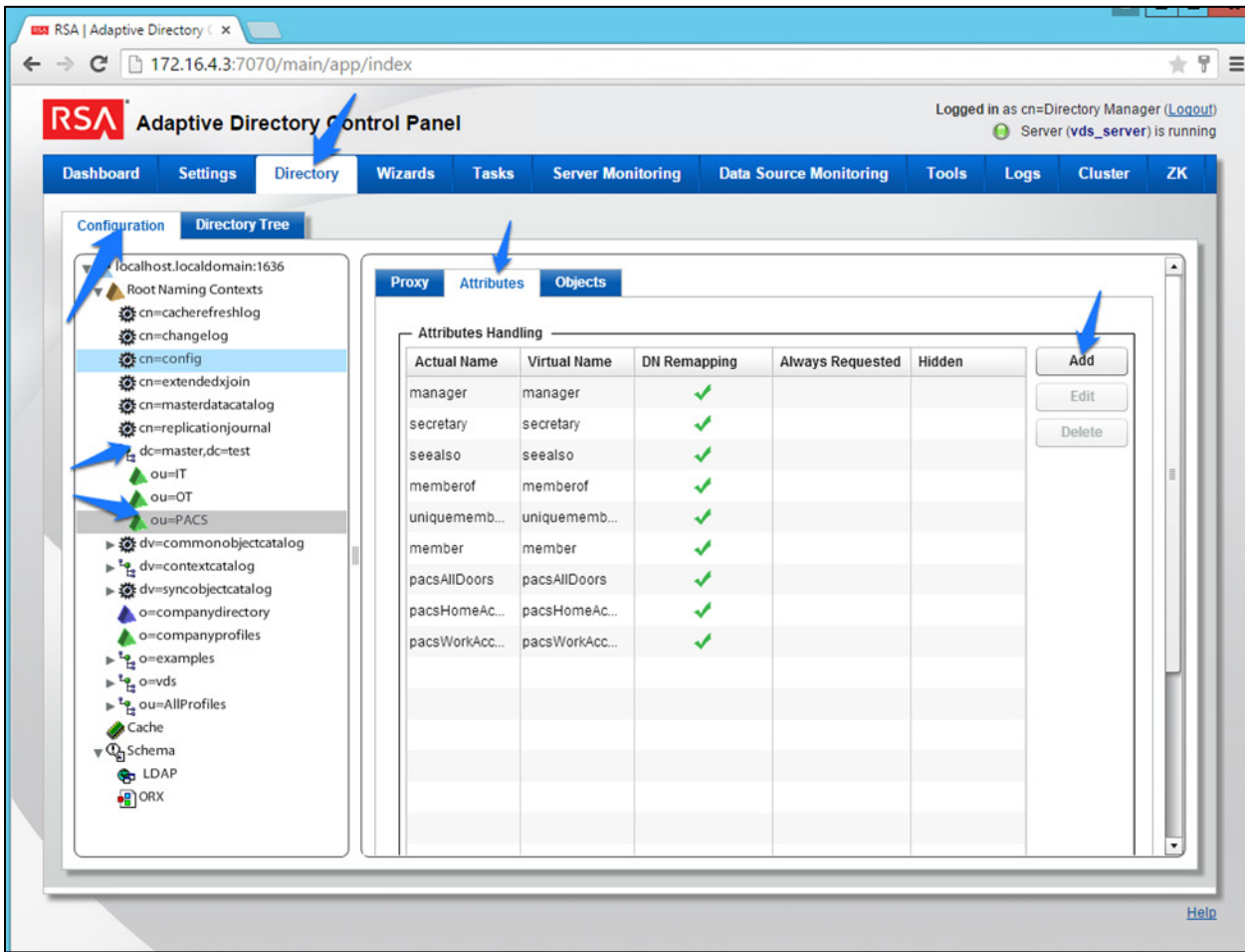
By default, the Adaptive Directory server will return default AD attributes. If you need to configure it to return custom attributes, you can configure it by using the instructions provided in Section 8.4.

## 8.4 Custom Attribute Configuration

Custom attributes are required and are configured as follows:

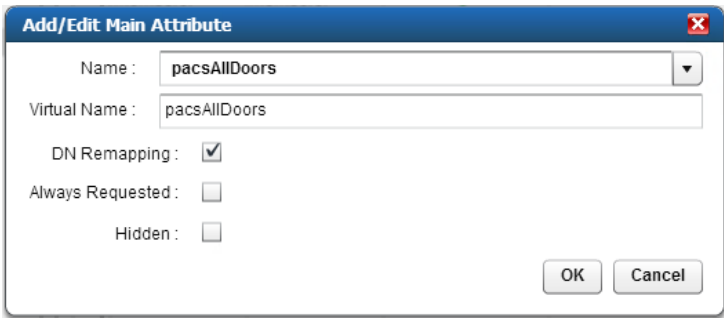
1. Click on **Directory > Configuration**. You will be presented with the screen shown in Figure 8-15. Expand the virtual directory that you are working with, and then select the backend mapping to the AD to which you want to make changes. Click **Attributes > Add**.

Figure 8-15 Adaptive Directory Addition Attributes



2. Find the attribute that you would like to add in the top drop-down list (**Name**), and then enter a **Virtual Name** (it can be the same as, or different from, the **Name**) for the attribute that you want Adaptive Directory to return (Figure 8-16). Select **DN Remapping**, and then click **OK**.

Figure 8-16 Adaptive Directory Add/Edit Main Attribute

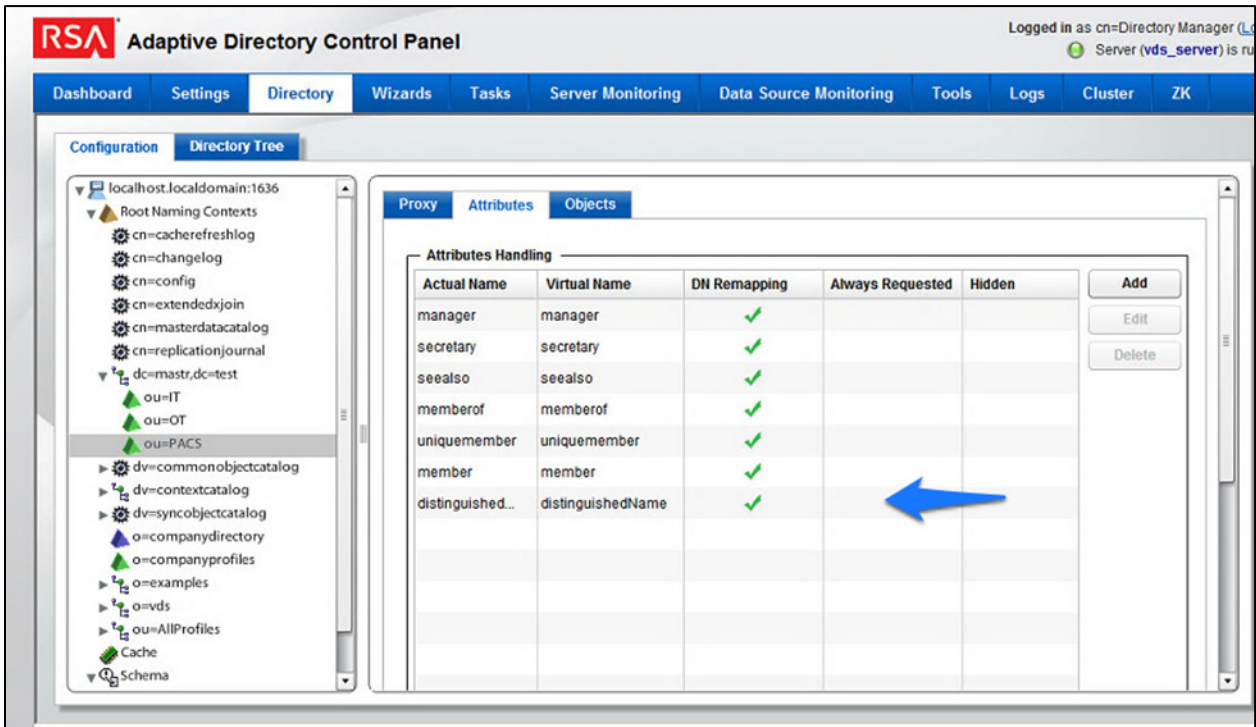


The dialog box titled "Add/Edit Main Attribute" has a blue header bar with a close button. It contains the following fields and controls:

- Name :** A dropdown menu with "pacsAllDoors" selected.
- Virtual Name :** A text field containing "pacsAllDoors".
- DN Remapping :** A checkbox that is checked.
- Always Requested :** An unchecked checkbox.
- Hidden :** An unchecked checkbox.
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

3. Add the **distinguishedName** attribute to each backend, as shown in Figure 8-17.

Figure 8-17 Adaptive Directory Add Attribute



The screenshot shows the "Adaptive Directory Control Panel" with the "Directory" tab selected. The "Directory Tree" on the left shows a hierarchy of LDAP objects, with "ou=PACS" selected. The "Attributes Handling" table on the right lists attributes for the selected object. A blue arrow points to the "distinguishedName" attribute row.

Actual Name	Virtual Name	DN Remapping	Always Requested	Hidden
manager	manager	✓		
secretary	secretary	✓		
seealso	seealso	✓		
memberof	memberof	✓		
uniquemember	uniquemember	✓		
member	member	✓		
distinguished...	distinguishedName	✓		

Repeat this procedure for any additional custom attributes that are required and for any additional AD backends to which you may need to add attributes.

Your Adaptive Directory virtual directory is now complete and can be accessed from RSA IMG / Aveksa or from any other application that can access LDAP directories.

You can address this virtual directory by configuring the connecting application with the IP address or DNS name of the Adaptive Directory server and by using Port 2389. For the base DN, you would use the name of your virtual directory—in the above example, *dc=master,dc=test* and the relevant OU (backend AD cluster) that you want to access. You would use the same username (*cn=Directory Manager*) and password that you use to log into the application.

For example, Figure 8-18 and Figure 8-19 show the connection information from RSA IMG to Adaptive Directory.

**Figure 8-18 Adaptive Directory Edit Collector**

The screenshot shows a window titled "Edit Collector: RSA AD Directory Account". Under the "Connection" tab, the following fields are visible:

- Host\***: 172.16.4.3
- Port\***: 2389
- Bind DN\***: cn=Directory Manager
- Bind Password\***: [masked with dots]
- Use SSL**: ☐
- Disable Paging**: ☐

**Figure 8-19 Adaptive Directory Search Configuration for Accounts**

The screenshot shows a window titled "Search Configuration for Accounts". It includes a note: "Accounts will be created by the User Account Mapping, unless the Accounts option is selected in this collector." The configuration fields are:

- Account Base DN\***: dc=master,dc=test
- Account Search Scope\***: Subtree (selected from a dropdown menu)
- Account Search Filter\***: (&(objectCategory=person)(objectClass=user)(sAMAccountName=\*))

## 8.5 RSA Adaptive Directory Optimization and Tuning

### 8.5.1 Disable Referral Chasing

By default, RSA Adaptive Directory will attempt to chase referrals that have been configured in the underlying LDAP server. If you do not want RSA Adaptive Directory to chase referrals when searching the underlying LDAP server, you should check the **Disable Referral Chasing** option when you define the LDAP data source. Chasing referrals can affect the overall performance of RSA Adaptive Directory because, if the referral server is not responding (or is responding slowly), RSA Adaptive Directory could take a long time to respond to the client. For example, in the case of RSA Adaptive Directory querying an underlying Active Directory (with a base DN starting at the root of Active Directory), you may get entries like the following returned:

```
ldaps://ForestDnsZones.na.radiantlogic.com:636...
ldaps://DomainDnsZones.na.radiantlogic.com:636...
```

RSA Adaptive Directory will attempt to “chase” these referrals, which can result in an extreme degradation in response times. Therefore, it is recommended that you disable referral chasing if you need RSA Adaptive Directory to connect to Active Directory starting at the root of the Active Directory tree, or if you need to connect to any other directory where you do not care about following referrals.

### 8.5.2 Limit Attributes Requested from the LDAP Backend

Whenever RSA Adaptive Directory queries a backend LDAP, the default behavior is to ask for all attributes (although *only* the attributes requested in the query will be returned to the client). This default behavior of RSA Adaptive Directory is for the following reasons:

- Joins have been configured, and the filter in the search request involves attributes from both the primary and secondary sources (i.e., the query filter contains conditions on both primary and secondary objects).
- Interception scripts may involve logic that is based on attributes from the backend, and therefore require these attributes. These attributes may not be specifically requested or searched for by the client. However, RSA Adaptive Directory must retrieve these attributes from the backend for the script logic to be valid.
- Access Control List (ACL) checking: You can set up ACLs based on attributes/values of an entry (e.g., `mystatus=hidden`); RSA Adaptive Directory may need the whole entry to check the authorization.
- For entry caching, the entire entry needs to be in the entry cache.

If your virtual view does not require all attributes to be requested for any of the conditions mentioned above, you can enable the option to limit the attributes that are requested, for better performance. If this option is enabled, RSA Adaptive Directory will query the backend server only for attributes

requested from the client, in addition to the attributes that are set as **Always Requested** on the **Attributes** tab.

### 8.5.3 Process Joins and Computed Attributes Only When Necessary

The default behavior of RSA Adaptive Directory is to process associated joins and to build computed attributes whenever a virtual object is reached from a query, regardless of whether the requested attributes come from a secondary source or a computation. If you enable the option to process joins and computed attributes only when necessary, RSA Adaptive Directory will not perform joins or computations when a client requests or searches for attributes from a primary object only. If a client requests or searches for attributes from secondary objects or computed attributes, RSA Adaptive Directory will process the join(s) and computations accordingly. Use caution when enabling this option, if you have interception scripts defined on these objects, or if access controls based on filters are being used (both of which may require other attributes returned from secondary sources or from computations, regardless of whether or not the client requested or searched for them).

### 8.5.4 Use the Client Sizelimit Value to Query the Backend

Whenever Adaptive Directory queries a backend LDAP, the default behavior is to ask for all entries (sizelimit=0), even if the client to Adaptive Directory indicates a size limit. This is the default behavior because the entries that are returned by the backend are possible candidates, but may not be retained for the final result that is sent to the client. For example, if an ACL has been defined in Adaptive Directory, not all entries from the backend may be authorized for the user (who is connected to Adaptive Directory) to access. As another example, when joins or interception scripts are involved with the virtual view, they may also alter the entries that match the client's search. To limit the number of entries from the backend, the recommended approach is to use paging. If the backend supports paging, Adaptive Directory will not get all of the results at once; rather, it will get only one page at a time (the page size is indicated in the configuration). In this case, if Adaptive Directory has returned, to the client, the size limit that is required, Adaptive Directory will not go to the next page.

If your virtual view does not involve any of the conditions mentioned above (joins, interceptions, ACL), and if using paging between Adaptive Directory and the backend is not possible, you can enable the **Client Sizelimit** value option to limit the number of entries requested from the backend. If this option is enabled, Adaptive Directory will use the size limit specified by the client, instead of using sizelimit=0, when querying the backend.

## 9 Enterprise Guardian: AlertEnterprise

AlertEnterprise Enterprise Guardian (Guardian) is installed on the IdAM network, in a VM running the Windows Server 2012 R2 OS. Guardian is used to control privileged user access to the components located on the network OT systems. Guardian collects user authorization information from the AD located within the OT network. There are three parts to the Guardian How-To guide, each of which is

provided in the sections below. [Section 9.2](#) provides information on the general product installation and set-up. [Section 9.3](#) provides information on the Guardian configuration, as configured in the RSA build. [Section 9.4](#) provides information on the AlertEnterprise configuration, as configured in the CA build.

## 9.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-1: Identities and credentials are managed for authorized devices and users.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-2, IA Family

## 9.2 Installation on Tomcat and Windows

This section describes the detailed procedure of installing AlertEnterprise products on Tomcat on a Windows platform. It lists the hardware and software prerequisites as well as the steps to install and use the AlertEnterprise suite of applications.

When copying text from this guide, it is recommended that you first paste text to a Notepad file and then copy it from there to use it for running scripts. You should use the “Notepad++” application for this purpose.

### 9.2.1 Installation Prerequisites

The AlertEnterprise Suite is delivered as a Web Application Archive (WAR) file that needs to be deployed on the client’s application server. Before you actually start deploying on your application server, you must check for the prerequisites. Refer to the AlertEnterprise Systems Requirements document included in the installation package.

### 9.2.2 Pre-Installation Verification

Before you start installing the AlertEnterprise product, verify the proper functioning of the underlying software systems:

- Your system meets all of the software and hardware prerequisites as described in the Systems Requirement Specification document.
- A compatible version of Java Runtime Environment (JRE) is installed and working on the system.
- A compatible version of the web server is installed and running.
- A compatible version of the database server is installed and running.
- A supported internet browser (e.g., Microsoft Internet Explorer) is working properly.

Zip extracting software is required. You can download WinZip from [http://www.winzip.com/win/en/prod\\_down.html](http://www.winzip.com/win/en/prod_down.html).

### 9.2.3 Installing Mandatory Software Applications

Before deploying the AlertEnterprise application, install JRE and a web application server (e.g., Tomcat). You must also install the latest version of Adobe Flash Player to enable the internet browser that you will be using to access the AlertEnterprise application.

#### 9.2.3.1 Installing JRE

To install JRE, follow the steps below:

1. Download the application-server-compatible JRE.
2. Double-click the setup launcher to start the installation process.

Setting Java Home

1. Make sure that the `JAVA_HOME` variable is set to the folder where Java is installed, and that `%JAVA_HOME%/bin` is in the system's path.
2. Open the Command Prompt in Administrator Mode (right-click > **Run As Administrator**), and then issue the following command:

```
Set JAVA_HOME=<PATH OF JDK/JRE>
```

Where, `<PATH OF JDK/JRE>` is the path where Java is installed (e.g., `C:\Program Files\Java\JDK1.6`)

3. Set `PATH`:

```
PATH= C:\Program Files\Java\JDK1.6.0-21\bin;%PATH%
```

4. Check `JAVA_HOME` and `PATH`:

```
Echo %JAVA_HOME%
Echo %PATH%
Checking JAVA Version: Java -version
```

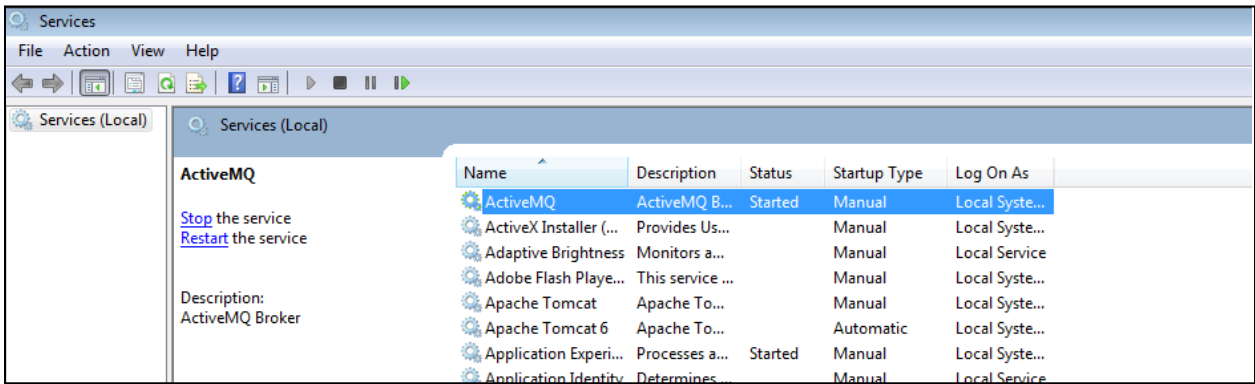
#### 9.2.3.2 Running ActiveMQ as Windows Service

After extracting the folder, the folder name appears as “apache-activemq” at the specified location.

1. Go to the folder *apache-activemq*, and move to *bin/win32* in Windows Explorer. Right-click on the *InstallService.bat* file, and select **Run as Administrator**.
2. Once the above batch file gets executed, verify that the ActiveMQ is added as a Windows Service.
3. Go to the **Run** command, and enter `services.msc`. The **Services (Local)** window appears, as shown in Figure 9-1.

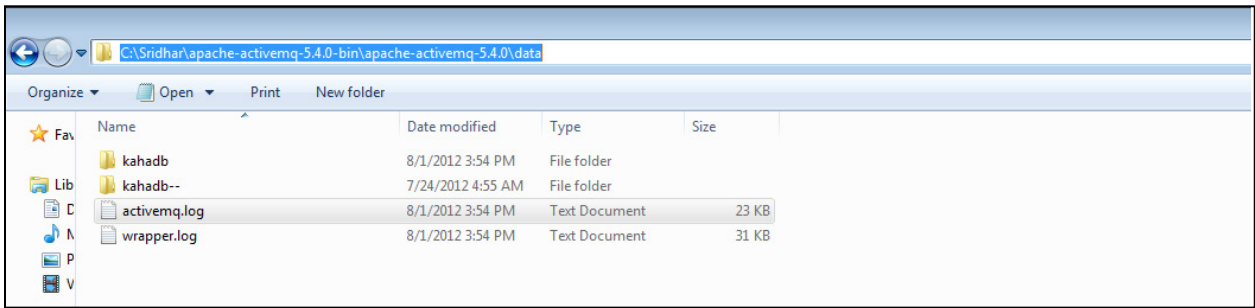


Figure 9-1 Adaptive Directory Search Configuration for Accounts



4. The Apache ActiveMQ service has an administrative console. To check if the service is running correctly, you simply need to connect to the admin console:  
  
URL: <IP address of the server where Active MQ is installed>:8161/admin
5. Perform the following if ActiveMQ is on a server other than the AlertEnterprise server:
  - a. Search for the URL that starts with “TCP ://<IP Address>:61616” in *activemq.log*, located in the Apache ActiveMQ home-directory/data folder (Figure 9-2).

Figure 9-2 Guardian ActiveMQ Home/Data Directory



- b. Copy the URL, and update the *context.xml* file in the <Tomcat Home>/conf and *appContextDB.properties* file located in <Tomcat Home/webapps/AlertEnterprise/WEB-INF/classes>.

### 9.2.3.3 Steps for Failure Case

If the system throws an error message while executing the bat file, or if the ActiveMQ Services screen does not appear, follow these steps:

1. Navigate to the folder <ActiveMQ home directory>\bin\win32.

2. Open the *InstallService.bat* file in a local text editor.
3. Modify the bottom part of the script to look like the following script. Note that your `JAVA_HOME` environment variable needs to already be set and also needs to be passed as a variable to the wrapper.

```
:conf
set WRAPPER_CONF="%ACTIVE MQ_HOME%\bin\win32\wrapper.conf"
set ACTIVE MQ_HOME="set.ACTIVE MQ_HOME=%ACTIVE MQ_HOME%"
set ACTIVE MQ_BASE="set.ACTIVE MQ_BASE=%ACTIVE MQ_BASE%"
set JAVA_HOME="set.JAVA_HOME=%JAVA_HOME%"
rem
rem Install the Wrapper as an NT service.
Rem
:startup
"%ACTIVE MQ_HOME%\bin\win32\wrapper.exe" -i %_WRAPPER_CONF%
%_ACTIVE MQ_HOME% %_ACTIVE MQ_BASE% %_JAVA_HOME%
if not errorlevel 1 goto :eof
pause
```

4. Open the `<ActiveMQ home directory>\bin\win32\wrapper.conf` in a local text editor, and make the following change:

Change this code:

```
# Java Application
wrapper.java.command=java
```

to this code:

```
# Java Application
wrapper.java.command=%JAVA_HOME%\bin\java.exe
```

After you have performed these steps, you should be able to run the *InstallService.bat* successfully.

5. To also use the *UninstallService.bat* file, open it, and then hard-code the path to the wrapper:

```
rem
rem Uninstall the Wrapper as an NT service.
rem
:startup
"%ACTIVE MQ_HOME%\bin\win32\wrapper.exe" -r %_WRAPPER_CONF%
if not error level 1 goto : eof
pause
```

After executing the *InstallService.bat* file, you can see the ActiveMQ in Services.

6. If the ActiveMQ server is not up, and the system throws the following error, perform the solution below.

```
| WARN | tmpdir | org.eclipse.jetty.util.log |
WrapperSimpleAppMainjava.io.IOException: The system cannot find the path
specified

at java.io.WinNTFileSystem.create File Exclusively (Native Method)
at java.io.File.check And Create (File.java:1343)
at java.io.File.create Temp File (File.java:1431)
```

**Solution:**

You must manually create two folders: <ActiveMQ home directory>/work and <ActiveMQ home directory>/temp.

To check whether ActiveMQ is started, access the following link, as shown in Figure 9-3:  
<http://<Server IP Address>:8161/admin/>

**Figure 9-3 Guardian ActiveMQ**



#### 9.2.3.4 Installing Apache Tomcat

You must install hardware and OS versions specific to Apache Tomcat:

1. Double-click the setup launcher to start the setup. It will start the installation process.
2. Click **Next** to start the installation process.

3. Click **I Agree** to accept the license terms. It displays the **Choose Components** screen.
4. Select **Custom** as the install type, and uncheck the **Examples** option.
5. Click **Next** to specify the destination folder for installation. We strongly recommend using the *D:\AlertEnterprise\Tomcat* location.
6. Click **Next** to specify the configuration parameters.
7. Enter the desired port in the **Connector Port** text area. The default port is 8080.
8. Specify the **User Name** and **Password** in the respective fields.
9. Click **Next** to select the path of the JRE installed on the system.
10. Select the path of the JDK/JRE that you just installed (e.g., *C:\Program Files\Java\jre1.6*).
11. Click **Install** to start the file copying process. Uncheck the **Run Apache Tomcat** and **Show Readme** options in the final dialog box.
12. Click **Finish** to finish the installation.

### 9.2.3.5 Apache Tomcat Configuration

You need to specify the Tomcat configuration, as described in the following steps:

1. Click **Start > Programs > Apache Tomcat > Configure Tomcat**.
2. Click the **Java** tab in the Apache Tomcat Properties dialog box.
3. Enter the following settings:
  - a. Initial memory pool: 1024
  - b. Maximum memory pool: 1024
  - c. Thread stack size: 300

Note: These settings may vary with the volume of random access memory (RAM) in the server.

4. Click **Apply > OK** to close the dialog box.

### 9.2.3.6 Configuring Database Server

You need to perform some configurations in the database server to install AlertEnterprise applications. You must perform these configurations through the database administrator login. The current version of AlertEnterprise products supports Oracle and Microsoft SQL Server databases. The NCCoE build also supports MySQL server database.

To configure the database server, follow these steps:

1. Create a schema / system identifier (SID) per your naming convention in the database server. The steps to create a schema can be different with different database management systems. Refer to the administrators guide for the database management system installed at your landscape.
2. Create a new user with full access to the created schema.
3. Run the included SQL files, `AlertReport471.ddl` or `AlertReport471.sql` and `AlertQuartz.sql`, on the new schema created. This step should be performed while installing the AlertEnterprise application for the first time.

### 9.2.3.7 Avoiding Case-Sensitivity Issues in Alert DB

To avoid case-sensitivity issues while using the search and sort functionalities in the AlertEnterprise applications, enable a “Case Insensitiveness” search in the database. By default, it is set as case-sensitive.

Follow these steps to avoid case-sensitivity issues:

1. Create a trigger to support case insensitiveness.

```

/*****/
create or replace
trigger set_nls_onlogon
AFTER LOGON ON SCHEMA
DECLARE
BEGIN
EXECUTE IMMEDIATE 'ALTER SESSION SET NLS_SORT="BINARY_CI"';
EXECUTE IMMEDIATE 'ALTER SESSION SET NLS_COMP="LINGUISTIC"';
END set_nls_onlogon;
/*****/

```

2. Restart the AlertEnterprise Application server.

The effect may not be visible in some client tools, such as SQL Developer. To see the effect in the SQL Developer tool, follow these steps:

1. Open SQL Developer, and click **Tools > Preferences**.
2. Click **Database > NLS**, and perform the following actions:
  - a. Set the **Sort** option to **BINARY\_CI**.
  - b. Set the **Comparison** option to **LINGUISTIC**.

### 9.2.3.8 Enabling Support for International Characters

Storage of character data is controlled by a character-set setting at the database level. It is recommended to have the following database settings to support international characters:

For Oracle:

```
NLS_CHARACTERSET = AL32UTF8
NLS_NCHAR_CHARACTERSET = AL16UTF16
```

For SQL Server:

```
Server Collation = SQL_Latin1_General_CP1_CI_AS
```

## 9.2.4 Deploying the Application

After you have successfully configured the database, proceed to deploy the AlertEnterprise product on your web application server. The following deployment steps are required for the Tomcat 6.0 version:

1. Use the Windows service control panel to stop the Tomcat server service if it is already running. Click **Start** > **Run**, type `services.msc`, and then click **OK**. Select **Apache Tomcat**, and click the **Stop Service** icon to stop the service.
2. Copy the `AlertEnterprise.war`, `AccessMap.war` (if you have an AlertInsight license), and `AlertEnterpriseHelp.war`, and `jasperserver-pro.war` files to the `<Tomcat installation folder>\webapps\` path.
3. You need to copy password management WAR file `AIPM.war` to `<Tomcat installation folder>/webapps` if you have a license for the Password Management application.
4. Create a new folder `AlertCommonLib` and `AlertExternalLib` under the `<Tomcat Installation Folder>`.
5. Extract `AlertCommonLib.zip` under the `AlertCommonLib` folder. You will see many new files in this folder.
6. Edit the `<Tomcat Installation Folder>\conf\catalina.properties` by using any editor, and append the following to the `common.loader`, as described below:
 

```
common.loader=${catalina.base}/lib,${catalina.base}/lib/*.jar,${catalina.home}/lib,${catalina.home}/lib/*.jar,${catalina.home}/AlertCommonLib/*.jar,${catalina.home}/AlertExternalLib/*.jar
```
7. Save the file, and close the editor.
8. Add a database connection. Add a new `<resource>` entry, as shown below, with the name `"jdbc/alntdb"` in `<Tomcat installation folder>\conf\context.xml`. Replace the code in `<>` with relevant information.

For MySQL Server:

```
<Resource
description="DB Connection"
```

```

name="jdbc/alntdb" auth="Container"
type="com.mchange.v2.c3p0.ComboPooledDataSource"
factory="org.apache.naming.factory.BeanFactory"
user="username"
password="password"
jdbcUrl="jdbc:mysql://<IP of DB Server>:3306/<DB Instance Name>"
driverClass="com.mysql.jdbc.Driver"
maxPoolSize="100" minPoolSize="5" acquireIncrement="5"
numHelperThreads="20" maxIdleTime="600"
maxIdleTimeExcessConnections="300"
debugUnreturnedConnectionStackTraces="true"
unreturnedConnectionTimeout="900"
/>

```

For repository setting in the same context.xml, add the following entry:

```

<ResourceLink name="AlertEnterpriseRepo" global="AlertEnterpriseRepo"
type="javax.jcr.Repository" />

```

For ActiveMQ settings in same context.xml, add the following entry:

```

<Resource name="jms/connectionFactory"
    auth="Container"
    type="org.apache.activemq.ActiveMQConnectionFactory"
    description="JMS Connection Factory"
    factory="org.apache.activemq.jndi.JNDIReferenceFactory"
    brokerURL="tcp://localhost:61616"
    brokerName="LocalActiveMQBroker"
    useEmbeddedBroker="false"/>

<Resource name="jms/requestSubmissionQueue"
    auth="Container"
    type="org.apache.activemq.command.ActiveMQQueue"
    description="JMS Queue requestSubmissionQueue"
    factory="org.apache.activemq.jndi.JNDIReferenceFactory"
    physicalName="requestSubmissionQueue"/>

<Resource name="jms/requestApprovalQueue"
    auth="Container"
    type="org.apache.activemq.command.ActiveMQQueue"
    description="JMS Queue requestApprovalQueue"
    factory="org.apache.activemq.jndi.JNDIReferenceFactory"
    physicalName="requestApprovalQueue"/>

```

```
<Resource name="jms/autoApprovalQueue"
  auth="Container"
  type="org.apache.activemq.command.ActiveMQQueue"
  description="JMS Queue autoApprovalQueue"
  factory="org.apache.activemq.jndi.JNDIReferenceFactory"
  physicalName="autoApprovalQueue"/>

<Resource name="jms/queue/taskSubmissionQueue"
  auth="Container"
  type="org.apache.activemq.command.ActiveMQQueue"
  description="JMS Queue taskSubmissionQueue"
  factory="org.apache.activemq.jndi.JNDIReferenceFactory"
  physicalName="taskSubmissionQueue"/>
  <Resource name="jms/queue/taskRejectionQueue"
    auth="Container"
    type="org.apache.activemq.command.ActiveMQQueue"
    description="JMS Queue taskRejectionQueue"
    factory="org.apache.activemq.jndi.JNDIReferenceFactory"
    physicalName="taskRejectionQueue"/>

<Resource name="jms/queue/projectCancelQueue"
  auth="Container"
  type="org.apache.activemq.command.ActiveMQQueue"
  description="JMS Queue projectCancelQueue"
  factory="org.apache.activemq.jndi.JNDIReferenceFactory"
  physicalName="projectCancelQueue"/>

<Resource name="jms/queue/projectCompleteQueue"
  auth="Container"
  type="org.apache.activemq.command.ActiveMQQueue"
  description="JMS Queue projectCompleteQueue"
  factory="org.apache.activemq.jndi.JNDIReferenceFactory"
  physicalName="projectCompleteQueue"/>

<Resource name="jms/eventRequestQueue"
  auth="Container"
  type="org.apache.activemq.command.ActiveMQQueue"
  description="JMS Queue eventRequestQueue"
  factory="org.apache.activemq.jndi.JNDIReferenceFactory"
  physicalName="eventRequestQueue"/>
```



```
<Resource auth="Container" description="my Queue"
factory="org.apache.activemq.jndi.JNDIReferenceFactory"
name="jms/reqQueue" physicalName="requestQueue"
type="org.apache.activemq.command.ActiveMQQueue"/>
```

```
<Resource auth="Container" description="my Queue"
factory="org.apache.activemq.jndi.JNDIReferenceFactory"
name="jms/resQueue" physicalName="responseQueue"
type="org.apache.activemq.command.ActiveMQQueue"/>
```

1. Edit <Tomcat installation folder>\conf\server.xml. Replace the code in <> with relevant information:

```
<GlobalNamingResources>
  <!-- Editable user database that can also be used by
    UserDatabaseRealm to authenticate users
  -->
  <Resource auth="Container"
configFile="/AlertEnterpriseRepo/repository.xml"
description="AlertEnterprise Repository"
factory="com.alnt.repository.jndi.JackrabbitRepositoryFactory"
homeDir="/AlertEnterpriseRepo" name="AlertEnterpriseRepo"
type="javax.jcr.Repository"/>

  <Resource auth="Container" description="Rule Engine Service"
factory="com.sae.ruleengine.jndi.RuleEngineFactory"
name="Sedna" password="MANAGER" type="com.sae.ruleEngine.RuleEngine"
username="SYSTEM"/>
  <Resource name="UserDatabase" auth="Container"
type="org.apache.catalina.UserDatabase"
description="User database that can be updated and saved"
factory="org.apache.catalina.users.MemoryUserDatabaseFactory"
pathname="conf/tomcat-users.xml"/>
</GlobalNamingResources>
```

2. Open the <Webserver installation folder>\bin location, and double-click *tomcat5w.exe*. Click the **Java** tab, and, under Java options, add the following lines of code at the end:

```
-XX:PermSize=512m
-XX:MaxPermSize=512m
-Xms1024m
-Xmx1024m
-Djs.license.directory=C:\AlertApplication\Tomcat
6.0\webapps\jasperserver-pro
-Dcom.alnt.fabric.loadInitData=force
-Dalert.db.update=update
```

Note: These settings may vary with the volume of RAM in the server.

3. Start the Tomcat server.
4. Start the AlertEnterprise application by using the address, which is of the form *http://<Server IP Address>:8080/AlertEnterprise*.

Note: The name and contents of the init script will vary depending on the database management system of the organization. The default port on local host is 8080. If you want to change it, then change it in the *sever.xml*.

5. Log onto the application by using admin credentials. You should be able to view the home screen of the application.

## 9.3 AlertEnterprise Application Configurations for the RSA Build

### 9.3.1 System Type Import of DB Connector

1. Log into Application.
2. Go to **Setup > Manual Configuration > Import/Export**.
3. Check **System Types**, and click on **Import**.
4. Select the CSV files, which are in the software build package under the connector *\ALNTDbconnector\InitDataFiles* folder.
5. After selecting all of the files, click the **Upload** button.
6. Refresh the page until it shows as a success or failure.
7. Restart the server if required.

### 9.3.2 System Type Parameters of DB Connector

1. Log into Application.
2. Go to **Setup > Manual Configuration > Systems > System Types**.
3. Search for the connector named “DBConnector,” and click the **Modify** button.
4. Click **Next**.
5. Add the following attributes, one by one, and then click the **ADD** button.

For the attributes, the **Name** and **Label** fields can be any user-friendly name, as shown in Table 9-1. If the **Name** and **Label** fields already exist, do not create a duplicate.

Table 9-1 Attributes

Name	Label
<b>jndiName</b>	Jndi Name
<b>DATE_TIME_FORMAT</b>	Date and Time Format
<b>DATE_TIME</b>	Date Format
<b>passwordColumnName</b>	Passwrđ Column Name
<b>userIdColumnName</b>	UserId Column Name
<b>EXTERNAL_USER_ID_ATTRIBUTE</b>	External UserId Attribute
<b>MODIFIED_ENTITLEMENTS</b>	Fetch User Entitlement based on last modified date(not by user)
<b>GET_ALL_USERS0</b>	GET_ALL_USERS0
<b>GET_INCREMENTAL_USERS0</b>	GET_INCREMENTAL_USERS0
<b>CREATE_USER0</b>	Create CardHolder Query
<b>UPDATE_USER0</b>	Update CardHolder Query
<b>LOCK_USER0</b>	Lock CardHolder Query
<b>UNLOCK_USER0</b>	Unlock Card Holder Query
<b>DELIMIT_USER0</b>	Change CardHolder Validity Query
<b>USER_PROVISIONED0</b>	Check Card Holder Provisioned Query
<b>ADD_ROLES0</b>	Assign Roles to Card Holder Query
<b>DEPROVE_ROLES0</b>	Remove Roles From Card Holder Query
<b>GET_GENERATED_USERID0</b>	Retrieve User Id Query
<b>driverName</b>	driverName
<b>url</b>	URL
<b>username</b>	userName
<b>Password</b>	password
<b>CREATE_USER1</b>	CREATE_USER1
<b>LOCK_USER1</b>	LOCK_USER1

**Figure 9-4 Guardian DB Connector Attributes**

<input type="checkbox"/>	Name	Label	Parameter Level
<input type="checkbox"/>	jndiName	Jndi Name	Mandatory
<input type="checkbox"/>	DATE_TIME_FORMAT	Date and Time Forma...	Mandatory
<input type="checkbox"/>	DATE_TIME	Date Format	Mandatory
<input type="checkbox"/>	passwordColumnName	Passwrđ Column Name	Mandatory
<input type="checkbox"/>	userIdColumnName	UserId Column Name	Mandatory
<input type="checkbox"/>	EXTERNAL_USER_ID_AT...	External UserId Att...	Mandatory

<input type="checkbox"/>	MODIFIED_ENTITLEMEN...	Fetch User Entitlem...	Mandatory
<input type="checkbox"/>	GET_ALL_USERS0	GET_ALL_USERS0	Mandatory
<input type="checkbox"/>	GET_INCREMENTAL_USE...	GET_INCREMENTAL_USE...	Mandatory
<input type="checkbox"/>	CREATE_USER0	Create CardHolder Q...	Mandatory
<input type="checkbox"/>	UPDATE_USER0	Update CardHolder Q...	Mandatory
<input type="checkbox"/>	LOCK_USER0	Lock CardHolder Que...	Mandatory

<input type="checkbox"/>	UNLOCK_USER0	Unlock Card Holder ...	Mandatory
<input type="checkbox"/>	DELIMIT_USER0	Change CardHolder V...	Mandatory
<input type="checkbox"/>	USER_PROVISIONED0	Check Card Holder P...	Mandatory
<input type="checkbox"/>	ADD_ROLES0	Assign Roles to Car...	Mandatory
<input type="checkbox"/>	DEPROVE_ROLES0	Remove Roles From C...	Mandatory
<input type="checkbox"/>	GET_GENERATED_USERI...	Retrieve User Id Qu...	Mandatory

**6. CONFIGURATION: Create “PACS AD” System**

- a. **Setup > Manual Configuration > Systems > System.**
- b. Click **New** to create a new system.
- c. Definition...Enter the following:
  - i. **System Type:** LDAP from the drop-down
  - ii. **Connector Name:** PACS AD
  - iii. **Connector Description:** PACS AD
  - iv. **Connector Long Description:** PACS AD
  - v. **Connector Type:** LDAP (default)
- d. Click **Next**.
- e. **Parameters:** Enter the parameters listed in Table 9-2.

Table 9-2 Guardian PACS AD Parameters

System Parameter Name	System Parameter Value
bindPass	***** (Password for Dod_Admin User)o60ypIUQT3IOqHmbuRWeuw==
useSSL	FALSE
baseDns	DC=pacs-es-idam-b1,DC=test
groupBaseDn	DC=pacs-es-idam-b1,DC=test
reconBaseDN	
getIncrementGrpChanges	FALSE
wsdlURL	
wsUserName	
wsPwd	
rootLevelDomain	
cookieLocation	
adUserName	
SYS_CON_ATTR_POST_CREATE_SCRIPT	
SYS_CON_ATTR_POST_CREATE_SCRIPT_PARAMS	
objectClass	User
Skipprovisioning	Yes
lastModifiedColumnRole	whenChanged
lastModifiedColumn	whenChanged
Host	172.16.7.2
Port	389
bindDn	CN= DoD_Admin,AlertEnterprise, CN=Users,DC=pacs-es-idam-b1,DC=test

- f. Click **Next**.
- g. **Attributes:** Enter the following:
  - i. Application: Alert Access

- ii. Check the following boxes: **Provisioning, Role Management, Offline System**.
- iii. Leave the Connector Category as **Production**.
- iv. **Time Zone: Greenwich Mean Time** from the drop-down
- h. Click **Next**, and then click **Save**.

## 7. **CONFIGURATION:** Create “Identity DB” System

This connector is required for internal purposes. Ignore this step (7) if the Identity DB connector is already setup.

Steps to create this connector:

- a. **Setup > Manual Configuration > Systems > System**.
- b. Click **New** to create a new system.
- c. Definition...Enter the following:
  - i. **System Type: Database (JDBC J2EE)** from the drop-down
  - ii. **Connector Name:** IDENTITYDB
  - iii. **Connector Description:** IDENTITYDB
  - iv. **Connector Long Description:** IDENTITYDB
  - v. **Connector Type: Database (JDBC J2EE)** (default)
- d. Click **Next**.
- e. **Parameters:** Enter the parameters listed in Table 9-3.

**Table 9-3 Guardian Identity DB Parameters**

System Parameter Name	System Parameter Value
driverName	Use default
url	Use default
username	Use default
Password	Use default
whereClause	Use default
jndiName	java:comp/env/jdbc/alntdb

- f. Click **Next**.
- g. Attributes: Enter the following:
  - Application:** All
    - i. Check the following boxes: **Provisioning**, **Certification**, **Identity Provider**, **Allow Modify Role**, and **Allow Time Change**.
    - ii. Leave the Connector Category as **Production**.
    - iii. **Time Zone:** **Eastern Daylight Time** from the drop-down
- h. Click **Next**, and then click **Save**.

8. **CONFIGURATION:** Create “ACCESSIT PACS” System

This connector is required to integrate with RS2 PACS systems and to perform various provisioning operations.

Steps to create this connector:

- a. **Setup > Manual Configuration > Systems > System.**
- b. Click **New** to create a new system.
- c. Definition...Enter the following:
  - i. **System Type:** **DBConnector** from the drop-down
  - ii. **Connector Name:** ACCESSIT PACS
  - iii. **Connector Description:** ACCESSIT PACS
  - iv. **Connector Long Description:** ACCESSIT PACS
  - v. **Connector Type:** **DBConnector** (default)
- d. Click **Next**.
- e. **Parameters:** Enter the parameters listed in Table 9-4.

Table 9-4 Guardian ACCESSIT PACS DBConnector Parameters

System Parameter Name	System Parameter Value
driverName	com.microsoft.sqlserver.jdbc.SQLServerDriver

System Parameter Name	System Parameter Value
URL	jdbc:sqlserver://<HOST_NAME>:<PORT>;databaseName=AIUniversal <HOST_NAME> should be replaced with the hostname of the RS2 PACS system I
Username	The value of the parameter is the name of the user that is used to log in and connect to RS2 PACS database
Password	The value of the parameter is the password of the user that is used to log in and connect to RS2 PACS database
Date and Time Format	MM/dd/yyyy HH:mm:ss
External UserId Attribute	CardholderID
Create CardHolder Query	<pre> INSERT INTO [AIUniversal].[dbo].[Cardholders] ([CardholderID], [Last Name], [FirstName], [MiddleInitial], [CompanyID], [Notes], [LastModified], [LastModifiedByUser], [DateCreated], [Cre atedByUser], [MemberOfAllSites], [UserText1], [UserText2] , [UserText3], [UserText4], [UserText5], [UserText6], [User Text7], [UserText8], [UserText9], [UserText10], [UserText1 1], [UserText12], [UserText13], [UserText14], [UserText15] , [UserText16], [UserText17], [UserText18], [UserText19], [ UserText20], [Department], [UserData1], [UserData2], [User Date3], [UserData4], [UserData5], [UserNumeric1], [UserNum eric2], [UserNumeric3], [UserNumeric4], [UserNumeric5], [C ardholderStatus], [CardholderActiveDate], [CardholderExp ireDate]) VALUES (NEWID(), \$LastName, \$FirstName, \$MiddleInitial, \$CompanyI D, \$Notes, GetUTCDate(), 'alertent', GetUTCDate(), 'alerten t', '1', \$UserText1, \$UserText2, \$UserText3, \$UserText4, \$Us erText5, \$UserText6, \$UserText7, \$UserText8, \$UserText9, \$U serText_10, \$UserText_11, \$UserText_12, \$UserText_13, \$Use rText_14, \$UserText_15, \$UserText_16, \$UserText_17, \$UserT ext_18, \$UserText_19, \$UserText_20, \$Department, \$UserData 1, \$UserData2, \$UserData3, \$UserData4, \$UserData5, \$UserNum eric1, \$UserNumeric2, \$UserNumeric3, \$UserNumeric4, \$UserN umeric5, '1', \$CardholderActiveDate, \$CardholderExpireDat e) </pre>
Update CardHolder Query	<pre> BEGIN IF NOT EXISTS (SELECT [CardNumber] FROM [AIUniversal].[dbo].[Cards] WHERE [CardNumber]=\$CardNumber) BEGIN INSERT INTO [AIUniversal].[dbo].[Cards] ([CardID], [CardholderID], [CardNumber], [FacilityCode], [ PINNumber], [PINExempt], [APBExempt], [UseExtendedAccessT imes], [CardStatus], [ActiveDate], [ExpireDate], [UserLeve l], [UseCustomReporting], [EventInfo], [Notes], [LastModif ied], [LastModifiedByUser], [DateCreated], [CreatedByUser] , [IssueLevel], [DeactivateExempt], [VacationDate], [Vaca tionDuration], [UseCount], [TempDeactivateStart], [TempDe activateEnd], [Classification], [IPLocksetUserType], [IPL </pre>



System Parameter Name	System Parameter Value
	<pre> ocksetAccessMode],[IPLocksetCredentialFormat],[IPLocks etAccessAlways],[RawPrimaryCredential],[LargeEncodedCa rdID],[EmbossedNumber]) VALUES (NEWID(),\$UserText1,\$CardNumber,\$FacilityCode,\$PIN,'0' ,'0','0','1',NULL,NULL,'0','0',NULL,NULL,SYSDATETIME() ,'alertent',SYSDATETIME(),'alertent','0','0',NULL,'0', '255',NULL,NULL,'Active',NULL,NULL,NULL,NULL,NULL,NU LL,'') END END;</pre>
Lock CardHolder Query	<pre> update [dbo].[Cardholders] set CardholderStatus='0' where CardholderID=\$CardholderID</pre>
Unlock Card Holder Query	<pre> update [dbo].[Cardholders] set CardholderStatus='1' where CardholderID=\$CardholderID</pre>
Check Card Holder Provisioned Query	<pre> select CardholderID from [dbo].[Cardholders] where CardholderID =\$CardholderID</pre>
Assign Roles to Card Holder Query	<pre> INSERT INTO [dbo].[CardholderAccessLevels] ( [CardholderAccessLevelID],[CardholderID], [AccessLevelID],[LastModified],[ActivateDate],[Deactiv ateDate]) VALUES ( NEWID(), \$CardholderID,(select AccessLevelID from [dbo].[AccessLevels] where AccessLevelName=\$ROLE_NAME),GetUTCDate(), NULL, NULL)</pre>
Remove Roles From Card Holder Query	<pre> delete from [dbo].[CardholderAccessLevels] where CardholderID=\$CardholderID and AccessLevelID=(select AccessLevelID from [dbo].[AccessLevels] where AccessLevelName=\$ROLE_NAME)</pre>
Retrieve User Id Query	<pre> select CardholderID from [dbo].[Cardholders] where UserText1=\$UserText1</pre>
CREATE_USER1	<pre> BEGIN IF \$CardNumber is null BEGIN update [dbo].[Cardholders] set CardholderStatus='1' where UserText1=\$UserText1 END ELSE BEGIN INSERT INTO [AIUniversal].[dbo].[Cards] ([CardID],[CardholderID],[CardNumber],[FacilityCode],[ PINNumber],[PINExempt],[APBExempt],[UseExtendedAccessT imes],[CardStatus],[ActiveDate],[ExpireDate],[UserLeve l],[UseCustomReporting],[EventInfo],[Notes],[LastModif ied],[LastModifiedByUser],[DateCreated],[CreatedByUser ],[IssueLevel],[DeactivateExempt],[VacationDate],[Vaca tionDuration],[UseCount],[TempDeactivateStart],[TempDe activateEnd],[Classification],[IPLocksetUserType],[IPL ocksetAccessMode],[IPLocksetCredentialFormat],[IPLocks etAccessAlways],[RawPrimaryCredential],[LargeEncodedCa rdID],[EmbossedNumber]) VALUES (NEWID(),(select CardholderID from [dbo].[Cardholders] where UserText1=\$UserText1),\$CardNumber,\$FacilityCode,\$PIN,' 0','0','0','1',NULL,NULL,'0','0',NULL,NULL,SYSDATETIME (),'alertent',SYSDATETIME(),'alertent','0','0',NULL,'0 ','255',NULL,NULL,'Active',NULL,NULL,NULL,NULL,NULL,NU LL,'') END END;</pre>
LOCK_USER1	<pre> update [AIUniversal].[dbo].[Cards] set CardStatus='0',Classification='Inactive' where [CardNumber]=\$CardNumber</pre>

- f. Click **Next**.
- g. Attributes: Enter the following:  
Application: All
  - i. Check the following boxes: **Provisioning**, **Role Management**, and **Offline System**.
  - ii. Leave the Connector Category as **Production**.
  - iii. **Time Zone: Eastern Daylight Time** from the drop-down
- h. Click **Next**, and then click **Save**.

#### 9.3.2.1 Create ACCESSIT PACS System Roles

1. Click the **Roles** menu, and click **Create New Role**.
2. On the popup window, select the option **Create completely new role from Start**.
3. Select the option **Physical System** from the System category drop-down list.
4. Enter **ACCESSIT PACS** under the **System Name** field, and then click the **Search** button.
5. From the search results, select the **ACCESSIT PACS** system, and then click **Continue**.
6. On the next page, provide details for the following fields, and then click **Next Step**.
  - a. **Role Name:** All Doors
  - b. **Description:** All Doors
  - c. **Alias:** All Doors
  - d. **Active for Provisioning:** Yes
  - e. **Provisioning Assigned:** Yes
7. Click **Next Step > Next Step > Next Step**, and then click the **Save** button on the last page.
8. Repeat the above steps, and create the following roles:
  - a. Home Access Level
  - b. Work Order Access Level

Note: The above roles are created manually, but this is only one of the ways to create PACS system roles in the Alert application. The PACS system roles can also be imported from a flat file, or they can be directly fetched from the PACS system through a reconciliation process (**Form customization > Attributes**).

### 9.3.2.2 Create New Custom Form Attributes

1. **Setup > Manual Configuration > Form customization > Attributes**.
2. Click the **New** button.
3. Create a new attribute called **PacsAllDoors**, based on the information provided in Table 9-5.

Table 9-5 New Custom Form Attributes

Field Name	Field Value
<b>Name</b>	PacsAllDoors
<b>Label</b>	PacsAllDoors
<b>Description</b>	PacsAllDoors
<b>Visible</b>	Yes
<b>Mandatory</b>	No
<b>Read Only</b>	No
<b>Field Type</b>	TextField (Select this value from drop down)
<b>USS Create Request</b>	Yes(Select Checkbox)
<b>USS User Information</b>	No(Select Checkbox)
<b>Approver View</b>	No(Select Checkbox)
<b>Provisioning</b>	Yes(Select Checkbox)
<b>Create Request Sequence</b>	10
<b>User Info Sequence</b>	10
<b>Approver Sequence</b>	10
<b>Group Name</b>	Personnel Information (Select this value from drop down)

4. Click **Save**.

5. Repeat Steps 1 through 4 to create the following custom form attributes (Table 9-6 through Table 9-9).

**Table 9-6 Create PacsHomeAccess Attribute**

Field Name	Field Value
<b>Name</b>	PacsHomeAccess
<b>Label</b>	PacsHomeAccess
<b>Description</b>	PacsHomeAccess
<b>Visible</b>	Yes
<b>Mandatory</b>	No
<b>Read Only</b>	No
<b>Field Type</b>	TextField (Select this value from drop down)
<b>USS Create Request</b>	Yes(Select CheckBox)
<b>USS User Information</b>	Yes(Select CheckBox)
<b>Approver View</b>	Yes(Select CheckBox)
<b>Provisioning</b>	Yes(Select CheckBox)
<b>Create Request Sequence</b>	11
<b>User Info Sequence</b>	11
<b>Approver Sequence</b>	11
<b>Group Name</b>	Personnel Information (Select this value from drop down)

**Table 9-7 Create PacsWorkAccess Attribute**

Field Name	Field Value
<b>Name</b>	PacsWorkAccess
<b>Label</b>	PacsWorkAccess
<b>Description</b>	PacsWorkAccess
<b>Visible</b>	Yes
<b>Mandatory</b>	No
<b>Read Only</b>	No

Field Name	Field Value
<b>Field Type</b>	TextField (Select this value from drop down)
<b>USS Create Request</b>	Yes(Select CheckBox)
<b>USS User Information</b>	Yes(Select CheckBox)
<b>Approver View</b>	Yes(Select CheckBox)
<b>Provisioning</b>	Yes(Select CheckBox)
<b>Create Request Sequence</b>	12
<b>User Info Sequence</b>	12
<b>Approver Sequence</b>	12
<b>Group Name</b>	Personnel Information (Select this value from drop down)

**Table 9-8 Create FacilityCode Attribute**

Field Name	Field Value
<b>Name</b>	FacilityCode
<b>Label</b>	Facility Code
<b>Description</b>	Facility Code
<b>Visible</b>	Yes
<b>Mandatory</b>	Yes
<b>Read Only</b>	No
<b>Field Type</b>	TextField (Select this value from drop down)
<b>USS Create Request</b>	No
<b>USS User Information</b>	No
<b>Approver View</b>	No
<b>Provisioning</b>	Yes(Select CheckBox)
<b>Create Request Sequence</b>	
<b>User Info Sequence</b>	
<b>Approver Sequence</b>	

Field Name	Field Value
Group Name	Personnel Information (Select this value from drop down)

Table 9-9 Create PIN Attribute

Field Name	Field Value
Name	PIN
Label	PIN
Description	PIN
Visible	Yes
Mandatory	No
Read Only	No
Field Type	TextField (Select this value from drop down)
USS Create Request	Yes(Select CheckBox)
USS User Information	No(Select CheckBox)
Approver View	No(Select CheckBox)
Provisioning	Yes(Select CheckBox)
Create Request Sequence	12
User Info Sequence	
Approver Sequence	
Group Name	Personnel Information (Select this value from drop down)

### 9.3.2.3 Modify statusLDAP Attribute

1. **Setup > Manual Configuration > Form customization > Attributes.**
2. Select the **Status** field from list of Attributes, and then click **Modify**.
3. If **statusLDAP** is not present, create a new attribute for statusLDAP by following the steps mentioned in the section **Create New Custom Form Attributes**.
4. Click the **DropDown Values** icon.

- 5. On the popup window, click **New**, and provide **514** in the **Name** field, and **0** (zero) in the **Label** field (Figure 9-5).

Figure 9-5 Create DropDown Values

Create DropDownValues

\*Name 514 \*Label 0

Cancel Save

- 6. Click **Save** to save the mapping.
- 7. Similarly, enter the following values for the **Name** and **Label** fields (Figure 9-6).

Figure 9-6 DropDown Values

<input type="checkbox"/>	Name	Label
<input type="checkbox"/>	514	0
<input type="checkbox"/>	66050	0
<input type="checkbox"/>	U	0
<input type="checkbox"/>	544	1
<input type="checkbox"/>	66048	1
<input type="checkbox"/>	546	1
<input type="checkbox"/>	512	1
<input type="checkbox"/>	66080	1
<input type="checkbox"/>	66082	1
<input type="checkbox"/>	L	1

Cancel New Modify Delete Save << < 1 2 > >>

- 8. Click **Save > Save** to save the configuration.

9.3.2.4 Identity & Access– Enable Identity

- 1. **Setup > Manual Configuration > Identity & Access > Enable Identity.**
- 2. Enable the following for the “Identity DB” system (Figure 9-7).

Figure 9-7 Guardian Identify Configuraton

Identity Configuration

\* Maintain Identities Yes

\* Connector IDENTITYDB

Reset Save

### 9.3.3 Identity & Access– User Field Mapping

1. **Setup > Manual Configuration > Identity & Access > User Field Mapping.**
2. Select User = Identity (from the drop-down), and then click on **Go**.
3. Click the **Create New** button.
4. Select the **Custom Field**, **Primary Key**, **Visible In List**, and **Is Searchable** fields, based on Table 9-10. Select the checkbox for each field that is identified with a “Yes” in Table 9-10. For each field that is identified with a “No” in Table 9-10, ensure that the checkbox is unchecked (cleared).
5. Repeat Steps 1 through 4 for all fields in Table 9-10. If a field already has the correct values, leave it as-is.

**Table 9-10 User Field Mapping**

Custom Field	Primary Key	Visible In List	Is Searchable
UserId	No	Yes	No
ValidFrom	No	Yes	No
ValidTo	No	Yes	No
FirstName	No	Yes	Yes
LastName	No	Yes	Yes
Email	No	No	No
Building	No	No	No
ManagerId	No	No	No
BadgeStatus	No	No	No
BadgeType	No	No	No
BadgeValidFrom	No	No	No
BadgeValidTo	No	No	No
Location	No	No	No
BadgeId	No	No	No
EmployeeType	No	No	No
Department	No	No	No
Password	No	No	No
Groups	No	No	No
ManagerName	No	No	No



Custom Field	Primary Key	Visible In List	Is Searchable
ManagerLN	No	No	No
Manager	No	No	No
ManagerId	No	Yes	No
Status	No	No	No
Telephone	No	No	No
ImageUpload	No	No	No
Password_AD	No	No	No
PacsAllDoors	No	Yes	No
PacsHomeAccess	No	Yes	No
PacsWorkAccess	No	Yes	No

### 9.3.3.1 Identity & Access > Recon Authoritative Fields

1. **Setup > Manual Configuration > Identity & Access > Recon Authoritative Fields** (Figure 9-8).
2. Click **New**.
3. Select **PACS AD** from the **Systems** drop-down, and select **PacsAllDoors** from the **Authoritative Field** drop-down.
4. Click the **Save** button to save the mapping.

Figure 9-8 Create Recon Authoritative Fields

The screenshot shows a web-based dialog box titled "Create Recon Authoritative Fields". It contains two dropdown menus. The first dropdown, labeled "\* Systems", has "PACS AD" selected. The second dropdown, labeled "\* Authoritative Field", has "PacsAllDoors" selected. At the bottom left of the dialog are two buttons: "Cancel" and "Save".

5. Repeat Steps 1 through 4 to configure mapping other fields, such as **PacsWorksAccess** and **PacsHomeAccess**, as listed in Figure 9-9.

Figure 9-9 Guardian Recon Authoritative Fields

<input type="checkbox"/>	PACS AD	PacsHomeAccess
<input type="checkbox"/>	PACS AD	PacsWorkAccess
<input type="checkbox"/>	PACS AD	PacsAllDoors
<input type="checkbox"/>	PACS AD	BadgeId
<input type="checkbox"/>	PACS AD	FacilityCode
<div>New   Modify   Delete</div>		

9.3.3.2 Identity & Access > Request Categories

1. **Setup > Manual Configuration > Identity & Access > Request Categories.**
2. Select **ChangeAccess Category** name, and click **Modify**.
  - a. On the **Modify** screen, make the following changes:
  - b. In the **Provisioning Actions** section, un-select the **Delimit User** and **Change Validity Dates** checkboxes, if they are selected, and select the **Change User** option.
  - c. Go to the **Add Existing** section, and select the system and **Remove Role** option from the **Resources/Roles** drop-down field.
3. Click **Save** to save the configuration.

Figure 9-10 Create External Provisioning Attribute

Create External Provisioning Attribute

Name

LastName

Description

LastName

Cancel

Save

4. Repeat Steps 1 and 2 to configure the fields listed in Figure 9-11.
- Note: Field names are case-sensitive.

Figure 9-11 Field Names

<input type="checkbox"/>	Name	Description
<input type="checkbox"/>	LastName	LastName
<input type="checkbox"/>	FirstName	FirstName
<input type="checkbox"/>	MiddleInitial	MiddleInitial
<input type="checkbox"/>	CompanyID	CompanyID
<input type="checkbox"/>	UserText1	UserText1
<input type="checkbox"/>	CardholderID	CardholderID
<input type="checkbox"/>	CardNumber	CardNumber
<input type="checkbox"/>	FacilityCode	FacilityCode
<input type="checkbox"/>	PIN	PIN

9.3.3.3 Identity & Access>Provisioning>Provisioning Mapping

1. **Setup > Manual Configuration > Identity & Access > Provisioning > Provisioning Mapping.**
2. Select **ACCESSIT PACS**, and click **Configure**.
3. On the next screen, click the **New** button, and select **UserText1** for the **DB Connector Attribute Name** (Figure 9-12).

Figure 9-12 Provisioning Mapping

DB Connector Attribute Name

AlertEnterprise Attribute Name

Derived Attribute Name

Mandatory

Editable

Visible

Default Value

Show Auto Generate

Validation Flag

Is User-Id attribute

UserText1

UserId

No

Yes

Yes

☐

☐

☐

Cancel

Save

4. Click **Save** to save the mapping.
5. Repeat Steps 1 through 4 to configure the other fields shown in Figure 9-13.

Figure 9-13 Guardian DB Connector Attribute Mapping

<input type="checkbox"/>	DB Connector Attribute	Mandatory	AlertEnterprise Attrib...	Default Value	Editable	Visible	Validati...	Is User...
<input type="checkbox"/>	UserText1	No	UserId		No	No	No	No
<input type="checkbox"/>	FirstName	Yes	FirstName		Yes	Yes	No	No
<input type="checkbox"/>	LastName	Yes	LastName		Yes	Yes	No	No
<input type="checkbox"/>	CompanyID	No	Priority		No	No	No	No
<input type="checkbox"/>	CardholderID	Yes	UserId		Yes	Yes	No	No
<input type="checkbox"/>	CardNumber	Yes	BadgeId		Yes	Yes	No	No
<input type="checkbox"/>	FacilityCode	No	FacilityCode	20	Yes	Yes	No	No
<input type="checkbox"/>	PIN	No	PIN		Yes	Yes	No	No

Cancel

New

Modify

Delete

<< < 1 > >>

### 9.3.3.4 Policy Engine> Rules

1. **Setup > Manual Configuration > Policy Engine > Rules.**
2. Click the **New** button.
3. On the next screen, provide the information shown in Figure 9-14.

Figure 9-14 Define Rules

**Define Rules**

\* **Rule Name** All Door Access New

**Entity Type** ☒ Workflow ☐ Entity

**Rule Type** AlertAccess ▼

\* **Description** All Door Access New

\* **Applicable To**

- ☐ Initiator
- ☐ Decision
- ☒ Suggest/Default
- ☐ Role Model
- ☐ Policy
- ☐ Master User Search
- ☐ Groups
- ☐ Role Certification
- ☐ unMitigatedRiskAllowed

\* **Attributes:**

**And/Or:** ☒ and ☐ or

PacsAllDoors ▼ Request Category ▼

**Next** **Cancel**

4. Click the **Next** button.
5. On the next screen, click **New** to define a new rule condition for the **NewHire** request category (Figure 9-15).

Figure 9-15 Define Condition

Define Condition

If

PacsAllDoors

equals

True

and

Request Category

equals

NewHire

Add

Cancel

6. Repeat Step 5 to define a new rule condition for the other request categories (**Remove User Access** and **ChangeAccess**), as shown in Figure 9-16.

Figure 9-16 Define Rule Conditions for Other Request Categories

<input type="checkbox"/>	If	PacsAllDoors	and	Request Category
<input type="checkbox"/>		= True		= NewHire
<input type="checkbox"/>		= True		= Remove User Access
<input type="checkbox"/>		= True		= ChangeAccess
<input type="checkbox"/>		= true		= ChangeAccess

7. Repeat Steps 1 through 6 to configure **All Door Access New**, **Home Access Level New** and **WO Access Level New**, as shown in Table 9-11.

Table 9-11 Rule Name Table

Rule Name	Entity Type	Rule Type	Description	Applicable to	Attributes	Selection Value
All Door Access New	Workflow	AlertAccess	All Door Access New	Suggest/ Default	PacsALLDoors AND Request Category	1. True and NewHire 2. True and Remove User Access 3 . True and ChangeAccess

Rule Name	Entity Type	Rule Type	Description	Applicable to	Attributes	Selection Value
Home Access Level New	Workflow	AlertAccess	Home Access Level New	Suggest/ Default	PacsHomeAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess
WO Access Level New	Workflow	AlertAccess	WO Access Level New	Suggest/ Default	PacsWorkAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess

### 9.3.3.5 Policy Engine > Rule Action Handler

1. **Setup > Manual Configuration > Policy Engine > Rule Action Handler.**
2. Click **New**, and create the Action Handlers listed in Table 9-12.

**Table 9-12 Guardian Policy Engine Rule Action Handler**

Action Handler Name	Workflow	Task Type	Value	Priority	Update Identity Info.?	Evaluate Enterprise Role?
Recon New Hire	AlertAccess	Recon Create Request	New Hire	0	Yes	No
Recon Terminate Handler	AlertAccess	Recon Create Request	Terminate	0	Yes	No
Recon Error Handler	AlertAccess	Recon Exception Record Task		0		
ReconChangeHandler	AlertAccess	Recon Create Request	Change Access	0	Yes	No

9.3.3.6 Policy Engine > Suggest/Default Access

- 1. Setup > Manual Configuration > Policy Engine > Suggest/Default Access.
- 2. Click **New**, and enter the following information to create the **All Door Access** criteria (Figure 9-17).

Figure 9-17 Suggest/Default Access

* Name	All Door Access	Description	All Door Access
* Type	Default	* Condition	All Door Access New
Use identity old values	<input type="checkbox"/>	Search By Role Attributes	<input type="checkbox"/>
Provisioning Action	<input type="checkbox"/>	Search by Systems	<input checked="" type="checkbox"/>
		Search by Training Roles	<input type="checkbox"/>
		Search by Training Attributes	<input type="checkbox"/>
		Search by Enterprise Roles	<input type="checkbox"/>
<div>CancelBackNext</div>			

- 3. On the next screen, click the **Enter** button.
- 4. On the next screen, enter ACCESSIT PACS in the **System Name** field, and then click the **Search** button.
- 5. The system will appear in the **Search Results** pane. Click the **Add** link under the **Action** column to add the system to the **Selected Systems** section.
- 6. Click the **Next** button
- 7. On the next screen, enter ALL DOORS in the **Role Name** field, and then click the **Search** button.
- 8. The Role will appear in the **Search Results** pane. Click the **Add** link under the **Action** column to add the role to the **Selected Roles** section.
- 9. Click the **Save** button to save the configuration.
- 10. Repeat Steps 1 through 9 to configure other criterias for **Home Access Level**, **WO Access Level**, and **NewHireDefaultSystems**, as listed in Table 9-13.



**Table 9-13 Manual Configuration Policy Engine Suggest/Default Access**

Name	Type	Condition	Search by System	Selected System	Selected Role
All Door Access	Default	All Door Access NEW	Yes (select checkbox)	ACCESSIT PACS	ALL DOORS
Home Access Level	Default	Work Access Level New	Yes (select checkbox)	ACCESSIT PACS	Home Access Level
WO Access Level	Default	Home Access Level New	Yes (select checkbox)	ACCESSIT PACS	WO Access Level
NewHireDefaultSystems	Default	NewHireDefaultRule	Yes (select checkbox)	ACCESSIT PACS	

11. Select all existing **Suggest Default Access** criteria, other than the ones listed in Table 9-13, and click **Delete** to delete them.

### 9.3.3.7 Policy Engine > Rule Action Handler

1. **Setup > Manual Configuration > Policy Engine > Rule Action Handler.**
2. In the **Action Handlers List** page, select **ReconChangeHandler**, and Click **Modify**.
3. On the next screen, select **Recon Create Request** for the **Task type** drop-down field, and click **Update Task**.
4. On the popup window, click the **Value** drop-down field, and select **ChangeAccess** (Figure 9-18).

Figure 9-18 Modify Task

The 'Modify Task' dialog box contains the following fields:

- Task type:** Recon Create Request
- Value:** ChangeAccess
- Priority:** 0
- Update Identity Info:** Yes
- Evaluate Enterprise Role:** No

Buttons: Cancel, Save Task

5. Click **Save Task**, and then Click the **Save**.

#### 9.3.3.8 Policy Engine > Policy Designer

1. **Setup > Manual Configuration > Policy Engine > Policy Designer.**
2. Select **New** to create a new policy designer as follows (Figure 9-19):
  - a. **Name:** User Policy New
  - b. **Rule type:** AlertAccess
  - c. **Description:** User Policy New

**Figure 9-19 Policy Designer**

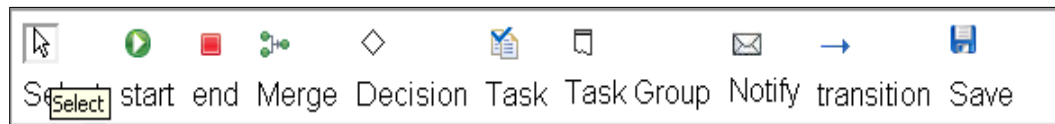
The screenshot shows a form titled "Policy Designer" with the following fields:


- \* Name:** User Policy New
- \* Rule Type:** AlertAccess (dropdown menu)
- Description:** User Policy New (text area)


At the bottom of the form are three buttons: **Back**, **Next**, and **Cancel**.


3. Click **Next**.
4. Drag the elements from the toolbar section that is available at the top of the page, place the elements onto the layout page, and then connect each node as mentioned in Figure 9-20.

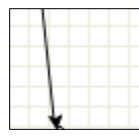
**Figure 9-20 Toolbar Section**



 represents the start button

 represents the end button

 represents a decision

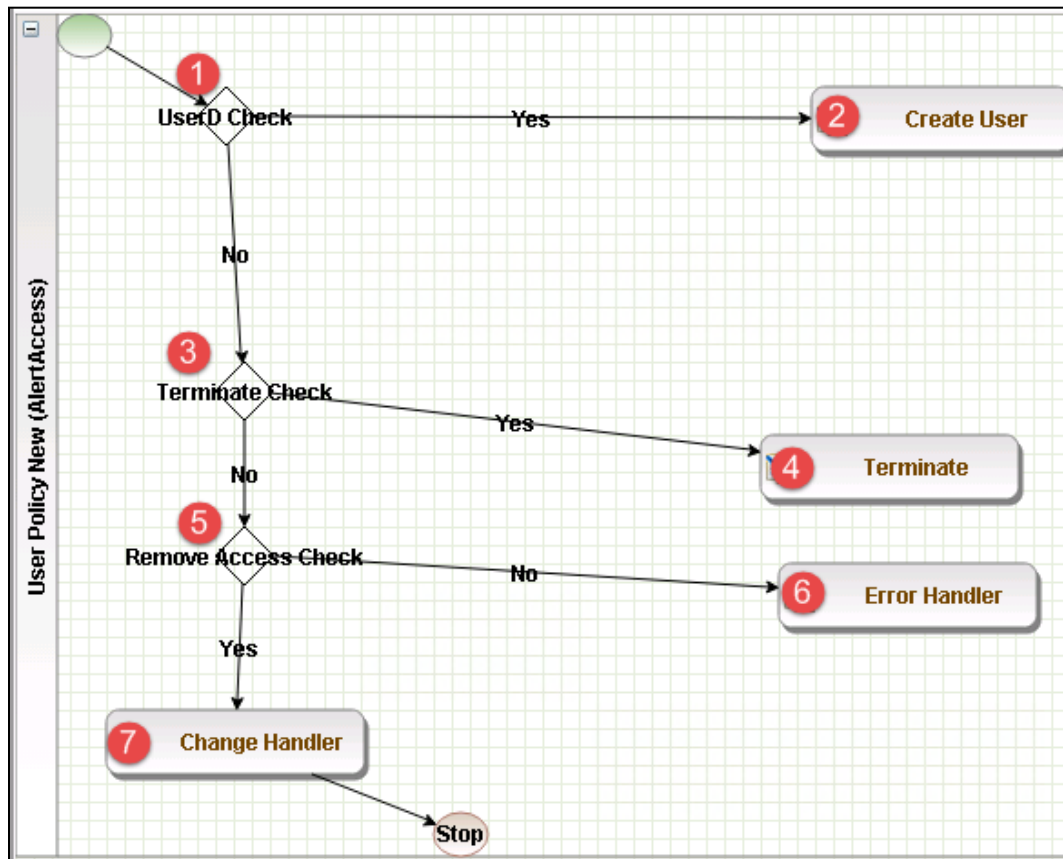
 represents a transition

 represents a task

Guidelines to configure the policy:

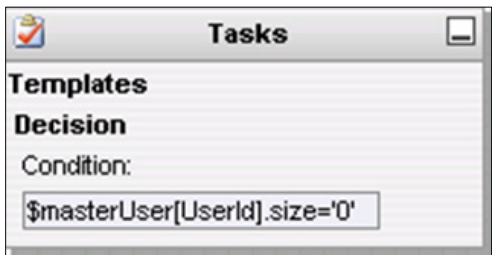
1. To place an element/node on the layout page, drag it from the toolbar, and then place it on the layout page.
2. To connect two nodes, select the transition icon from the toolbar, and then mouse over to the first node and connect it to the other node in the same direction specified in Figure 9-21.

Figure 9-21 Guardian User Policy



3. Click on the Step 1 decision box, and it will open a popup window with some fields (Figure 9-22).
4. Enter `$masterUser[UserId].size='0'` in the **Condition** field, and then press **Enter**.

Figure 9-22 Tasks



5. Similarly, click on the other steps (2 through 7), and configure the data based on Table 9-14. For decision nodes, provide the **Condition** value; for task nodes, like **Create User**, **Terminate**, **Change Handler**, and **Error Handler**, provide the **Is Task Handler** and **Task Handler** fields.

Table 9-14 Guardian User Policy

Step	Name	Type	Condition	Is Task Handler	Task Handler	Update Query
1	User ID Check	Decision	\$masterUser[UserId].size='0'			
2	Create User	Task Handler		Yes	<b>Recon New Hire</b>	
3	Terminate Check	Decision	\$checkStatus[statusLDAP,512;546;66048;544;UserStatus,Active,514;66050;Inactive].action='LOCK'			
4	Terminate	Task Handler		Yes	<b>Recon Terminate Handler</b>	
5	Remove Access Check	Decision	\$checkAuthFields[].status='Yes'			
6	Error Handler	Task Handler		Yes	<b>Recon Error Handler</b>	
7	Change Handler	Task Handler		Yes	<b>Recon Change Handler</b>	

### 9.3.3.9 Job Scheduler > Triggers Field Map

1. **Setup > Manual Configuration > Job Scheduler > Triggers Field Map.**
2. Click **New**.
3. Enter the following fields:
  - a. **Group Name:** PACSAD Field Map
  - b. **Description:** PACSAD Field Mapping
  - c. **Select Type:** Reconciliation
4. After creating a field map, select the newly created map, and then select **Configure**.
5. Click **New**, and create a mapping according to Figure 9-23.

Figure 9-23 Guardian Job Scheduler Triggers Field Map

AE Attribute	mappedKey	userType	roleType	userRole	userBadge	userEntRoleType	userTrainingType
Userid	Userid	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
FirstName	FirstName	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
LastName	LastName	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Email	Email	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Telephone	WorkPhone	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Mobile	HomePhone	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
EmployeeType	EmployeeType	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsAllDoors	PacsAllDoor	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsHomeAccess	PacsHomeAccess	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsWorkAccess	PacsWorkAccess	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Badgeld	CardNumber	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Format	FacilityCode	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
ValidFrom	ValidFrom	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
ValidTo	ValidTo	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Title	Title	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Status	UserStatus	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PIN	PIN	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
AlertDepartment	Department	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE

### 9.3.3.10 Job Scheduler > Triggers

1. **Setup > Manual Configuration > Job Scheduler > Triggers.**
2. Click **New**, and create the PACSAD Trigger (Table 9-15).

Table 9-15 Guardian Job Scheduler Triggers

Name	PACSAD Trigger
Description	PACSAD Trigger
Type	Reconciliation

Name	PACSAD Trigger
Batch Size	100
Number of Attempts	3
Policy Designer for Users/Roles	User policy New
System: Reconciliation From	PACS AD
Reconciliation System	PACS AD
Field Mapping Group	PACSAD Field Map
User Type	True
User Role	True

#### 9.3.3.11 Job Scheduler > Scheduler

1. **Setup > Manual Configuration > Job Scheduler > Scheduler.**
2. Click **New**, and enter the following fields, as shown in Figure 9-24.
  - a. **Job Type: Reconciliation Job**
  - b. **Job Name:** <Job Name>
  - c. Select the **Global** checkbox
  - d. **Reconciliation for: Users**
  - e. **Reconciliation Type: Incremental Reconciliation**
  - f. **Reconciliation Triggers: PACSAD Trigger**
  - g. Select the schedule as **Immediate**, **Once**, **Periodically**, or **Advance**. For **Periodically**, specify the **Start At**, **End At**, and **Rerun every** (duration of job frequency, which should be no less than every 2 minutes).

Figure 9-24 Guardian Reconciliation Job

The screenshot shows the 'Guardian Reconciliation Job' configuration window. The top section contains the following fields:

- \* Job Type:** Reconciliation Job (dropdown)
- \* Job Name:** PACS AD User Reconciliation (text input)
- Global:** ☒
- Job Visibility:** private (dropdown)
- Notification Templates:** Choose One (dropdown)
- \* Reconciliation For:** Users, Roles, User Training (list box)
- \* Reconciliation Type:** Incremental Reconciliation (dropdown)
- \* Reconciliation Triggers:** PACSAD Trigger (dropdown)
- Init Date Load:** No (dropdown)

The bottom section is titled 'Create/Update Scheduled Jobs' and contains the following fields:

- Frequency:** Immediate, Once, Periodically (selected), Advance (radio buttons)
- Time Zone:** (GMT-05:00) America/New\_York (dropdown)
- Start At:** 06/08/2015 [date], 20 [hrs], 58 [minutes]
- End At:** 06/08/2016 [date], 20 [hrs], 58 [minutes]
- Rerun every:** 2 [Repeat Duration], Minutes [Repeat Unit]

At the bottom of the window are 'Save' and 'Cancel' buttons.

3. Click **Save**.

## 9.4 AlertEnterprise Enterprise Guardian Configuration for the CA Build

### 9.4.1 System Type Import of DB Connector

1. Log into the application.
2. Go to **Setup > Manual Configuration > Import/Export**.
3. Check **System Types**, and then click **Import**.
4. Select the CSV files, which are in software build package under the Connector `\ALNTDbconnector\InitDataFiles` folder.
5. After selecting all of the files, click the **Upload** button.



6. Refresh the page until it shows as a success or failure.
7. Restart the server if required.

#### 9.4.2 System Type Parameters of DB Connector

1. Log into the application.
2. Go to **Setup > Manual Configuration > Systems > System Types**.
3. Search for the connector named “DBConnector,” and then click the **Modify** button.
4. Click **Next**.
5. Add the following attributes, one by one, and then click the **ADD** button.

For the attributes, the **Name** and **Label** fields can be any user-friendly names, as shown in Table 9-16. If the **Name** and **Label** fields already exist, do not create a duplicate.

Table 9-16 DB Connector Name and Label Fields

Name	Label
<b>jndiName</b>	Jndi Name
<b>DATE_TIME_FORMAT</b>	Date and Time Format
<b>DATE_TIME</b>	Date Format
<b>passwordColumnName</b>	Passwrđ Column Name
<b>userIdColumnName</b>	UserId Column Name
<b>EXTERNAL_USER_ID_ATTRIBUTE</b>	External UserId Attribute
<b>MODIFIED_ENTITLEMENTS</b>	Fetch User Entitlement based on last modified date(not by user)
<b>GET_ALL_USERS0</b>	GET_ALL_USERS0
<b>GET_INCREMENTAL_USERS0</b>	GET_INCREMENTAL_USERS0
<b>CREATE_USER0</b>	Create CardHolder Query
<b>UPDATE_USER0</b>	Update CardHolder Query
<b>LOCK_USER0</b>	Lock CardHolder Query
<b>UNLOCK_USER0</b>	Unlock Card Holder Query
<b>DELIMIT_USER0</b>	Change CardHolder Validity Query
<b>USER_PROVISIONED0</b>	Check Card Holder Provisioned Query
<b>ADD_ROLES0</b>	Assign Roles to Card Holder Query

Name	Label
<b>DEPROVE_ROLES0</b>	Remove Roles From Card Holder Query
<b>GET_GENERATED_USERID0</b>	Retrieve User Id Query
<b>driverName</b>	driverName
<b>url</b>	URL
<b>userName</b>	userName
<b>password</b>	password
<b>CREATE_USER1</b>	CREATE_USER1
<b>LOCK_USER1</b>	LOCK_USER1

Figure 9-25 Guardian DB Connector Attributes

<input type="checkbox"/>	Name	Label	Parameter Level
<input type="checkbox"/>	jndiName	Jndi Name	Mandatory
<input type="checkbox"/>	DATE_TIME_FORMAT	Date and Time Forma...	Mandatory
<input type="checkbox"/>	DATE_TIME	Date Format	Mandatory
<input type="checkbox"/>	passwordColumnName	Passwrđ Column Name	Mandatory
<input type="checkbox"/>	userIdColumnName	UserId Column Name	Mandatory
<input type="checkbox"/>	EXTERNAL_USER_ID_AT...	External UserId Att...	Mandatory

<input type="checkbox"/>	MODIFIED_ENTITLEMEN...	Fetch User Entitlem...	Mandatory
<input type="checkbox"/>	GET_ALL_USERS0	GET_ALL_USERS0	Mandatory
<input type="checkbox"/>	GET_INCREMENTAL_USE...	GET_INCREMENTAL_USE...	Mandatory
<input type="checkbox"/>	CREATE_USER0	Create CardHolder Q...	Mandatory
<input type="checkbox"/>	UPDATE_USER0	Update CardHolder Q...	Mandatory
<input type="checkbox"/>	LOCK_USER0	Lock CardHolder Que...	Mandatory

<input type="checkbox"/>	UNLOCK_USER0	Unlock Card Holder ...	Mandatory
<input type="checkbox"/>	DELIMIT_USER0	Change CardHolder V...	Mandatory
<input type="checkbox"/>	USER_PROVISIONED0	Check Card Holder P...	Mandatory
<input type="checkbox"/>	ADD_ROLES0	Assign Roles to Car...	Mandatory
<input type="checkbox"/>	DEPROVE_ROLES0	Remove Roles From C...	Mandatory
<input type="checkbox"/>	GET_GENERATED_USERI...	Retrieve User Id Qu...	Mandatory

### 9.4.3 Create System Connectors for all Target Systems

#### 9.4.3.1 CONFIGURATION: Create Connector for “Alert User Database (External)”

This connector is required to connect the Alert user table that is exposed to third-party systems (CA in this case) and to get the data.

Steps to create this connector:

1. **Setup > Manual Configuration > Systems > System.**
2. Click **New** to create a new system.
3. **Definition...** Enter the following:
  - a. **System Type:** DBConnector from the drop-down
  - b. **Connector Name:** ALERTDBCONNECTOR
  - c. **Connector Description:** ALERT DBCONNECTOR
  - d. **Connector Long Description:** ALERT DBCONNECTOR
  - e. **Connector Type:** DbConnector (Label)
4. Click **Next**.
5. **Parameters:** Enter the parameters listed in Table 9-17.

**Table 9-17 Guardian Manual Configuration System Parameters**

System Parameter Name	System Parameter Value
Jndi Name	java:comp/env/jdbc/alertdb
Date and Time Format	MM/dd/yyyy HH:mm:ss
GET_ALL_USERS0	select UserId, FirstName, LastName, Email, WorkPhone, HomePhone, Department, EmployeeType, PacsAllDoor, Case WHEN PacsAllDoor='1' then 'TRUE' Else 'FALSE' END as PacsAllDoor, CASE WHEN PacsHomeAccess='1' then 'TRUE' else 'FALSE' END as PacsHomeAccess , CASE WHEN PacsWorkAccess='1' then 'TRUE' else 'FALSE' END as PacsWorkAccess, CardNumber, FacilityCode, LastModifiedDate, ValidFrom, ValidTo, Title, UserStatus, PIN from alnt_idm_user_dtls
GET_INCREMENTAL_USE RSO	select UserId, FirstName, LastName, Email, WorkPhone, HomePhone, Department, EmployeeType, PacsAllDoor, Case WHEN PacsAllDoor='1' then 'TRUE' Else 'FALSE' END as PacsAllDoor, CASE WHEN PacsHomeAccess='1' then

System Parameter Name	System Parameter Value
	'TRUE'else 'FALSE' END as PacsHomeAccess , CASE WHEN PacsWorkAccess='1' then 'TRUE' else 'FALSE' END as PacsWorkAccess,CardNumber,FacilityCode,LastModifiedDate,ValidFrom,ValidTo,Title,UserStatus,PIN from alnt_idm_user_dtls where LastModifiedDate>STR_TO_DATE(\$LAST_RUN_DATE,'%m/%e/%Y %H:%i:%s') and UserStatus='Active'
External UserId Attribute	UserId
UserId Column Name	UserId

6. Click **Next**.

7. **Attributes:** Enter the following:

- a. **Application:** **Alert Access**
- b. Check the following boxes: **Provisioning, Role Management, Offline System**.
- c. Leave the Connector Category as **Production**
- d. **Time Zone:** **Eastern Daylight Time** from the drop-down

Note: **Time Zone** should be same as the time zone of where the application is hosted.

8. Click **Next**, and then click **Save**.

#### 9.4.3.2 CONFIGURATION: Create “Identity DB” System

This connector is required for internal purposes. Ignore this step if the **Identity DB** Connector is already setup.

Steps to create this connector:

1. **Setup > Manual Configuration > Systems > System**.
2. Click **New** to create a new system.
3. **Definition...** Enter the following:
  - a. **System Type:** **Database (JDBC J2EE)** from the drop-down
  - b. **Connector Name:** `IDENTITYDB`
  - c. **Connector Description:** `IDENTITYDB`
  - d. **Connector Long Description:** `IDENTITYDB`

- e. **Connector Type: Database (JDBC J2EE)** (default)
4. Click **Next**.
5. **Parameters:** Enter the parameters listed in Table 9-18.

**Table 9-18 Guardian Identity DB Parameters**

System Parameter Name	System Parameter Value
driverName	(use default)
url	(use default)
userName	(use default)
password	(use default)
whereClause	(use default)
jndiName	java:comp/env/jdbc/alntdb

6. Click **Next**.
7. **Attributes:** Enter the following:
  - a. **Application: All**
  - b. Check the following boxes: **Provisioning, Certification, Identity Provider, Allow Modify Role, and Allow Time Change**.
  - c. Leave **Connector Category** as **Production**.
  - d. **Time Zone: Eastern Daylight Time** from the drop-down
8. Click **Next**, and then click **Save**.

#### 9.4.3.3 CONFIGURATION: Create “ACCESSIT PACS” System

This connector is required for integrating with RS2 PACS system and performing various provisioning operations.

Steps to create this connector:

1. **Setup > Manual Configuration > Systems > System**.
2. Click **New** to create a new system.
3. **Definition...** Enter the following:
  - a. **System Type: DBConnector** from the drop-down

- b. **Connector Name:** ACCESSIT PACS
  - c. **Connector Description:** ACCESSIT PACS
  - d. **Connector Long Description:** ACCESSIT PACS
  - e. **Connector Type:** DBConnector (default)
4. Click **Next**.
  5. **Parameters:** Enter the parameters listed in Table 9-19.

**Table 9-19 Guardian PACS DBConnector Parameters**

System Param Name	System Param Value
driverName	com.microsoft.sqlserver.jdbc.SQLServerDriver
URL	jdbc:sqlserver://<HOST_NAME>:<PORT>;databaseName=AIUniversal  <HOST_NAME> should be replaced with the hostname of the RS2 PACS system
Username	Login User Name to connect to RS2 PACS database
Password	Login password to connect to RS2 PACS database
Date and Time Format	MM/dd/yyyy HH:mm:ss
External UserId Attribute	CardholderID
Create CardHolder Query	<pre> INSERT INTO [AIUniversal].[dbo].[Cardholders] ([CardholderID] ,[LastName],[FirstName],[MiddleInitial],[Company ID],[Notes],[LastModified],[LastModifiedByUser], [DateCreated],[CreatedByUser],[MemberOfAllSites] ,[UserText1],[UserText2],[UserText3],[UserText4] ,[UserText5],[UserText6],[UserText7],[UserText8] ,[UserText9],[UserText10],[UserText11],[UserText 12],[UserText13],[UserText14],[UserText15],[User Text16],[UserText17],[UserText18],[UserText19],[ UserText20],[Department],[UserDate1],[UserDate2] ,[UserDate3],[UserDate4],[UserDate5],[UserNumeri c1],[UserNumeric2],[UserNumeric3],[UserNumeric4] ,[UserNumeric5],[CardholderStatus],[CardholderAc tiveDate],[CardholderExpireDate]) VALUES (NEWID(),\$LastName,\$FirstName,\$MiddleInitial,\$Co mpanyID,\$Notes,GetUTCDate(),'alertent',GetUTCDat e(),'alertent','1',\$UserText1,\$UserText2,\$UserTe xt3,\$UserText4,\$UserText5,\$UserText6,\$UserText7, \$UserText8,\$UserText9,\$UserText_10,\$UserText_11, \$UserText_12,\$UserText_13,\$UserText_14,\$UserText _15,\$UserText_16,\$UserText_17,\$UserText_18,\$User Text_19,\$UserText_20,\$Department,\$UserDate1,\$Use rDate2,\$UserDate3,\$UserDate4,\$UserDate5,\$UserNum </pre>

System Param Name	System Param Value
	eric1,\$UserNumeric2,\$UserNumeric3,\$UserNumeric4,\$UserNumeric5,'1',\$CardholderActiveDate,\$CardholderExpireDate)
Update CardHolder Query	update [dbo].[Cardholders] set LastModified=GetUTCDate() where CardholderID=\$CardholderID
Lock CardHolder Query	update [dbo].[Cardholders] set CardholderStatus='0' where CardholderID=\$CardholderID
Unlock Card Holder Query	update [dbo].[Cardholders] set CardholderStatus='1' where CardholderID=\$CardholderID
Check Card Holder Provisioned Query	select CardholderID from [dbo].[Cardholders] where CardholderID =\$CardholderID
Assign Roles to Card Holder Query	INSERT INTO [dbo].[CardholderAccessLevels] ( [CardholderAccessLevelID], [CardholderID], [AccessLevelID], [LastModified], [ActivateDate], [DeactivateDate]) VALUES ( NEWID(), \$CardholderID, (select AccessLevelID from [dbo].[AccessLevels] where AccessLevelName=\$ROLE_NAME), GetUTCDate(), NULL, NULL)
Remove Roles From Card Holder Query	delete from [dbo].[CardholderAccessLevels] where CardholderID=\$CardholderID and AccessLevelID=(select AccessLevelID from [dbo].[AccessLevels] where AccessLevelName=\$ROLE_NAME)
Retrieve User Id Query	select CardholderID from [dbo].[Cardholders] where UserText1=\$UserText1
CREATE_USER1	INSERT INTO [AIUniversal].[dbo].[Cards] ([CardID], [CardholderID], [CardNumber], [FacilityCode], [PINNumber], [PINExempt], [APBExempt], [UseExtendedAccessTimes], [CardStatus], [ActiveDate], [ExpireDate], [UserLevel], [UseCustomReporting], [EventInfo], [Notes], [LastModified], [LastModifiedByUser], [DateCreated], [CreatedByUser], [IssueLevel], [DeactivateExempt], [VacationDate], [VacationDuration], [UseCount], [TempDeactivateStart], [TempDeactivateEnd], [Classification], [IPLocksetUserType], [IPLocksetAccessMode], [IPLocksetCredentialFormat], [IPLocksetAccessAlways], [RawPrimaryCredential], [LargeEncodedCardID], [EmbossedNumber]) VALUES (NEWID(), (select CardholderID from [dbo].[Cardholders] where UserText1=\$UserText1), \$CardNumber, \$FacilityCode, \$PIN, '0', '0', '0', '1', NULL, NULL, '0', '0', NULL, NULL, SYSDATETIME(), 'alertent', SYSDATETIME(), 'alertent', '0', '0', NULL, '0', '255', NULL, NULL, 'Active', NULL, NULL, NULL, NULL, NULL, NULL, '')

System Param Name	System Param Value
LOCK_USER1	update [AIUniversal].[dbo].[Cards] set CardStatus='0',Classification='Inactive' where [CardNumber]=\$CardNumber

6. Click **Next**.
7. **Attributes:** Enter the following:
  - a. **Application:** All
  - b. Check the following boxes: **Provisioning**, **Role Management**, and **Offline System**.
  - c. Leave Connector Category as **Production**.
  - d. **Time Zone:** **Eastern Daylight Time** from the drop-down
8. Click **Next**, and then click **Save**.

#### 9.4.3.4 Create ACCESS It! PACS System Roles

1. Click the **Roles** menu, and then click **Create New Role**.
2. On the popup window, select the option **Create completely new role from Start**.
3. Select the option **Physical System** from the System category drop-down list.
4. Enter **ACCESSIT PACS** under the **System Name** field, and then click the **Search** button.
5. From the search results, select the **ACCESSIT PACS** system, and then click **Continue**.
6. On the next page, provide details for the following fields, and then click **Next Step**.
  - a. **Role Name:** All Doors
  - b. **Description:** All Doors
  - c. **Alias:** All Doors
  - d. **Active for Provisioning:** Yes
  - e. **Provisioning Assigned:** Yes
7. Click **Next Step > Next Step > Next Step**, and then click the **Save** button on the last page.
8. Repeat the preceding steps, and create the following roles:
  - a. Home Access Level



b. Work Order Access Level

Note: The roles are created manually. However, there are many ways to create PACS system roles in the Alert application. The PACS system roles can be imported from a flat file, or they can be directly fetched from the PACS system through a reconciliation process (**Form customization > Attributes**).

#### 9.4.3.5 Create New Custom Form Attributes

1. **Setup > Manual Configuration > Form customization > Attributes.**
2. Click the **New** button.
3. Create a new attribute called **PacsAllDoors**, based on the information provided in Table 9-20.

Table 9-20 New Custom Form Attributes

Field Name	Field Value
<b>Name</b>	PacsAllDoors
<b>Label</b>	PacsAllDoors
<b>Description</b>	PacsAllDoors
<b>Visible</b>	<b>Yes</b>
<b>Mandatory</b>	<b>No</b>
<b>Read Only</b>	<b>No</b>
<b>Field Type</b>	<b>TextField</b> (select this value from the drop-down)
<b>USS Create Request</b>	<b>Yes</b> (select checkbox)
<b>USS User Information</b>	<b>Yes</b> (select checkbox)
<b>Approver View</b>	<b>Yes</b> (select checkbox)
<b>Provisioning</b>	<b>Yes</b> (select checkbox)
<b>Create Request Sequence</b>	10
<b>User Info Sequence</b>	10
<b>Approver Sequence</b>	10
<b>Group Name</b>	<b>Personnel Information</b> (select this value from the drop-down)

4. Click **Save**.
5. Repeat the Steps 1 through 4 to create the following custom attributes:

## a. PacsHomeAccess

- i. Create a **PacsHomeAccess** attribute based on the information in Table 9-21.

Table 9-21 Create PacsHomeAccess Attribute

Field Name	Field Value
<b>Name</b>	PacsHomeAccess
<b>Label</b>	PacsHomeAccess
<b>Description</b>	PacsHomeAccess
<b>Visible</b>	<b>Yes</b>
<b>Mandatory</b>	<b>No</b>
<b>Read Only</b>	<b>No</b>
<b>Field Type</b>	<b>TextField</b> (select this value)
<b>USS Create Request</b>	<b>Yes</b> (select checkbox)
<b>USS User Information</b>	<b>Yes</b> (select checkbox)
<b>Approver View</b>	<b>Yes</b> (select checkbox)
<b>Provisioning</b>	<b>Yes</b> (select checkbox)
<b>Create Request Sequence</b>	11
<b>User Info Sequence</b>	11
<b>Approver Sequence</b>	11
<b>Group Name</b>	<b>Personnel Information</b> (select this value)

## b. PacsWorkAccess

- i. Create a **PacsWorkAccess** attribute based on the information in Table 9-22.

Table 9-22 Create PacsWorkAccess Attribute

Field Name	Field Value
<b>Name</b>	PacsWorkAccess
<b>Label</b>	PacsWorkAccess
<b>Description</b>	PacsWorkAccess
<b>Visible</b>	<b>Yes</b>
<b>Mandatory</b>	<b>No</b>
<b>Read Only</b>	<b>No</b>

Field Name	Field Value
Field Type	<b>TextField</b> (select this value)
USS Create Request	<b>Yes</b> (select checkbox)
USS User Information	<b>Yes</b> (select checkbox)
Approver View	<b>Yes</b> (select checkbox)
Provisioning	<b>Yes</b> (select checkbox)
Create Request Sequence	12
User Info Sequence	12
Approver Sequence	12
Group Name	<b>Personnel Information</b> (select this value)

c. FacilityCode

- i. Create a **FacilityCode** attribute based on the information in Table 9-23.

Table 9-23 Create FacilityCode Attribute

Field Name	Field Value
<b>Name</b>	FacilityCode
<b>Label</b>	FacilityCode
<b>Description</b>	FacilityCode
<b>Visible</b>	<b>Yes</b>
<b>Mandatory</b>	<b>Yes</b>
<b>Read Only</b>	<b>No</b>
<b>Field Type</b>	<b>TextField</b> (select this value)
USS Create Request	<b>No</b>
USS User Information	<b>No</b>
Approver View	<b>No</b>
Provisioning	<b>Yes</b> (select Checkbox)
Create Request Sequence	
User Info Sequence	
Approver Sequence	
Group Name	<b>Personnel Information</b> (select this value)

## d. PIN

- i. Create a **PIN** attribute based on the information in Table 9-24.

Table 9-24 Create PIN Attribute

Field Name	Field Value
<b>Name</b>	PIN
<b>Label</b>	PIN
<b>Description</b>	PIN
<b>Visible</b>	<b>Yes</b>
<b>Mandatory</b>	<b>No</b>
<b>Read Only</b>	<b>No</b>
<b>Field Type</b>	<b>TextField</b> (select this value)
<b>USS Create Request</b>	<b>Yes</b> (select checkbox)
<b>USS User Information</b>	<b>No</b> (select checkbox)
<b>Approver View</b>	<b>No</b> (select checkbox)
<b>Provisioning</b>	<b>Yes</b> (select checkbox)
<b>Create Request Sequence</b>	12
<b>User Info Sequence</b>	
<b>Approver Sequence</b>	
<b>Group Name</b>	<b>Personnel Information</b> (select this value)

Note: The above roles are created manually. However, there are multiple ways to create PACS system roles in the Alert application. The PACS system roles can be imported from a flat file, or they can be directly fetched from the PACS system through the reconciliation process (**Form customization > Attributes**).

#### 9.4.3.6 Modify Employee Type Attribute

1. **Setup > Manual Configuration > Form customization > Attributes**.
2. Select the **Employee Type** field from the list of Attributes, and then click **Modify**. If the values are already correct, continue to make the rest of the change.
3. Click the **DropDown Values** icon.
4. On the popup window, click **New**, and then enter `Employee` in both the **Name** and **Label** fields (Figure 9-26).

Figure 9-26 Create DropDown Values

Create DropDownValues

\*Name Employee \*Label Employee

Cancel Save

- 5. Click **Save**.
- 6. Configure the values for the **Contractor** field in the same way (Figure 9-27).

Figure 9-27 DropDown Values

Name	Label
Contractor	Contractor
Employee	Employee

- 7. Click **Save > Save** to save the configuration.

9.4.3.7 Modify Status Attribute

- 1. **Setup > Manual Configuration > Form customization > Attributes**.
- 2. Select the **Status** field from the list of Attributes, and then click **Modify**.
- 3. Click the **DropDown Values** icon.
- 4. On the popup window, click **New**, and enter **Active** in both the **Name** and **Label** fields (Figure 9-28).

Figure 9-28 Create DropDown Values

Create DropDownValues

\*Name Active \*Label Active

Cancel Save

- 5. Configure the values for **InActive** field in the same way (Figure 9-29).

Figure 9-29 DropDown Values

Name	Label
Active	Active
InActive	InActive

- 6. Click **Save > Save** to save the configuration.

9.4.3.8 Identity & Access– Enable Identity

- 1. **Setup > Manual Configuration > Identity & Access > Enable Identity**
- 2. Enable the following configuration for the “Identity DB” system (Figure 9-30).

Figure 9-30 Guardian Identity Configuration



9.4.4 Identity & Access > User Field Mapping

- 1. **Setup > Manual Configuration > Identity & Access > User Field Mapping.**
- 2. Select **User = Identity** (from the drop-down), and then click **Go**.
- 3. Click the **Create New** button.
- 4. Select the **Custom Field**, **Primary Key**, **Visible In List**, and **Is Searchable** fields, based on Table 9-25. Select the checkboxes for each field that is identified with a “Yes” in Table 9-25. For each field that is identified with a “No” in Table 9-25, ensure that the checkbox is unchecked (cleared).
- 5. Click the **Save** button to save the record.
- 6. Repeat Steps 1 through 5 for all fields in Table 9-25. If a mapping already exists for a particular field, leave the mapping as-is.

Table 9-25 User Field Mapping

Custom Field	Primary Key	Visible In List	Is Searchable
UserId	No	Yes	No
ValidFrom	No	Yes	No
ValidTo	No	Yes	No
FirstName	No	Yes	Yes
LastName	No	Yes	Yes
Email	No	No	No
Building	No	No	No
ManagerId	No	No	No

Custom Field	Primary Key	Visible In List	Is Searchable
BadgeStatus	No	No	No
BadgeType	No	No	No
BadgeValidFrom	No	No	No
BadgeValidTo	No	No	No
Location	No	No	No
Badgeld	No	No	No
EmployeeType	No	No	No
Department	No	No	No
Password	No	No	No
Groups	No	No	No
ManagerName	No	No	No
ManagerLN	No	No	No
Manager	No	No	No
ManagerId	No	Yes	No
Status	No	No	No
Telephone	No	No	No
ImageUpload	No	No	No
Password_AD	No	No	No
PacsAllDoors	No	Yes	No
PacsHomeAccess	No	Yes	No
PacsWorkAccess	No	Yes	No

#### 9.4.4.1 Identity & Access > Recon Authoritative Fields

1. **Setup > Manual Configuration > Identity & Access > Recon Authoritative Fields.**
2. Click **New**.
3. Select **ALERTDBCONNECTOR** from the **Systems** drop-down list, and select **PacsAllDoors** from the **Authoritative Field** drop-down list (Figure 9-31).
4. Click **Save** to save the mapping.





2. Select the **ACCESSIT PACS** system from the list, and then click **Configure**.
3. On the next screen, click **New**, and provide `LastName` in both the **Name** and **Description** fields (Figure 9-33).
4. Click **Save** to save the configurations

Figure 9-33 Create External Provisioning Attribute

Create External Provisioning Attribute

Name

LastName

Description

LastName

Cancel

Save

5. Repeat Steps 1 through 4 to configure the fields listed in Figure 9-34.

Figure 9-34 Configuring Fields

<input type="checkbox"/>	Name	Description
<input type="checkbox"/>	LastName	LastName
<input type="checkbox"/>	FirstName	FirstName
<input type="checkbox"/>	MiddleInitial	MiddleInitial
<input type="checkbox"/>	CompanyID	CompanyID
<input type="checkbox"/>	UserText1	UserText1
<input type="checkbox"/>	CardholderID	CardholderID
<input type="checkbox"/>	CardNumber	CardNumber
<input type="checkbox"/>	FacilityCode	FacilityCode
<input type="checkbox"/>	PIN	PIN

Note: The field names are case-sensitive.

#### 9.4.4.4 Identity & Access > Provisioning > Provisioning Mapping

1. **Setup > Manual Configuration > Identity & Access > Provisioning > Provisioning Mapping**.
2. Select **ACCESSIT PACS**, and then click **Configure**.
3. On the next screen, click **New**, and then select **UserText1** for the **DB Connector Attribute Name** (Figure 9-35).



3. On the next screen, provide the information shown in Figure 9-37.

Figure 9-37 Define Rules

**Define Rules**

\* **Rule Name** All Door Access New

**Entity Type** ☒ Workflow ☐ Entity

**Rule Type** AlertAccess ▼

\* **Description** All Door Access New

\* **Applicable To**

- ☐ Initiator
- ☐ Decision
- ☒ Suggest/Default
- ☐ Role Model
- ☐ Policy
- ☐ Master User Search
- ☐ Groups
- ☐ Role Certification
- ☐ unMitigatedRiskAllowed

\* **Attributes:**

**And/Or:** ☒ and ☐ or

PacsAllDoors ▼ Request Category ▼

**Next** **Cancel**

4. Click **Next**.
5. On the next screen, click **New** to define a new rule condition for the **NewHire** request category (Figure 9-38).

Figure 9-38 Define Condition

**Define Condition**

If PacsAllDoors equals ▼ True and

Request Category equals ▼ NewHire ▼

**Add** **Cancel**

- Repeat Step 5 to define rule conditions for the other request categories (**Remove User Access** and **ChangeAccess**), as shown in Figure 9-39.

**Figure 9-39 Remove User Access and ChangeAccess**

<input type="checkbox"/>	If	<b>PacsAllDoors</b>	and	<b>Request Category</b>
<input type="checkbox"/>		= True		= NewHire
<input type="checkbox"/>		= True		= Remove User Access
<input type="checkbox"/>		= True		= ChangeAccess
<input type="checkbox"/>		= true		= ChangeAccess

- Repeat Steps 1 through 6 to configure **Home Access Level New** and **WO Access Level New**, as shown in Table 9-26.

**Table 9-26 Guardian Manual Configuration Policy Engine Rules**

Rule Name	Entity Type	Rule Type	Description	Applicable to	Attributes	Selection Value
All Door Access New	Workflow	AlertAccess	All Door Access New	Suggest/ Default	PacsALLDoors AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess
Home Access Level New	Workflow	AlertAccess	Home Access Level New	Suggest/ Default	PacsHomeAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess
WO Access Level New	Workflow	AlertAccess	WO Access Level New	Suggest/ Default	PacsWorkAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess

9.4.4.6 Policy Engine > Suggest/Default Access

- 1. Setup > Manual Configuration > Policy Engine > Suggest/Default Access.
- 2. Click **New**, and enter the following information to create the **All Door Access** criteria (Figure 9-40).

Figure 9-40 All Door Access

* Name	All Door Access	Description	All Door Access
* Type	Default	* Condition	All Door Access New
Use identity old values	<input type="checkbox"/>	Search By Role Attributes	<input type="checkbox"/>
Provisioning Action	<input type="checkbox"/>	Search by Systems	<input checked="" type="checkbox"/>
		Search by Training Roles	<input type="checkbox"/>
		Search by Training Attributes	<input type="checkbox"/>
		Search by Enterprise Roles	<input type="checkbox"/>
<div>CancelBackNext</div>			

- 3. Click **Next**.
- 4. On the next screen, enter ACCESSIT PACS in the **System Name** field, and then click **Search**.
- 5. The System will appear in **Search Results** pane. Click the **Add** link under the **Action** column to add the system to the **Selected Systems** section.
- 6. Click **Next**.
- 7. On the next screen, enter ALL DOORS in **Role Name** field, and then click **Search**.
- 8. The Role will appear in **Search Results** pane. Click the **Add** link under the **Action** column to add the role to the **Selected Roles** section.
- 9. Click **Save** to save the configuration.
- 10. Repeat Steps 1 through 9 to configure other criteria for **Home Access Level New** and **WO Access Level New** as listed in Table 9-27.

**Table 9-27 Guardian Manual Configuration Policy Engine Rules**

Rule Name	Entity Type	Rule Type	Description	Applicable to	Attributes	Selection Value
All Door Access New	Workflow	AlertAccess	All Door Access New	Suggest/Default	PacsALLDoors AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess
Home Access Level New	Workflow	AlertAccess	Home Access Level New	Suggest/Default	PacsHomeAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3 True and ChangeAccess
WO Access Level New	Workflow	AlertAccess	WO Access Level New	Suggest/Default	PacsWorkAccess AND Request Category	1. True and NewHire 2. True and Remove User Access 3. True and ChangeAccess

11. Select all existing **Suggest Default** Access criteria, other than the one listed in Table 9-27, and click **Delete** to delete them.

#### 9.4.4.7 Policy Engine > Rule Action Handler

1. **Setup > Manual Configuration > Policy Engine > Rule Action Handler.**
2. In the **Action Handlers List** page, select **ReconChangeHandler**, and then click **Modify**.
3. On the next screen, select **Recon Create Request** for the **Task type** drop-down field, and then click **Update Task**.
4. On the popup window, click the **Value** drop-down field, and then select **ChangeAccess** (Figure 9-41).

Figure 9-41 Modify Task

The 'Modify Task' dialog box contains the following fields and options:

- Task type:** Recon Create Request
- Value:** ChangeAccess
- Priority:** 0
- Update Identity Info:** Yes
- Evaluate Enterprise Role:** No

Buttons: Cancel, Save Task

5. Click **Save Task**, and then click **Save**.

#### 9.4.4.8 Policy Engine > Policy Designer

1. **Setup > Manual Configuration > Policy Engine > Policy Designer.**
2. Select **New** to create a new policy designer as follows (Figure 9-42):
  - a. **Name:** User Policy New
  - b. **Rule Type:** AlertAccess
  - c. **Description:** User Policy New

Figure 9-42 New Policy Designer

\* Name: User Policy New

\* Rule Type: AlertAccess

Description: User Policy New

Back Next Cancel

3. Click **Next**.
4. Drag the elements from the toolbar section that is available at the top of the page, place the elements onto the layout page, and then connect each node as illustrated in Figure 9-43.

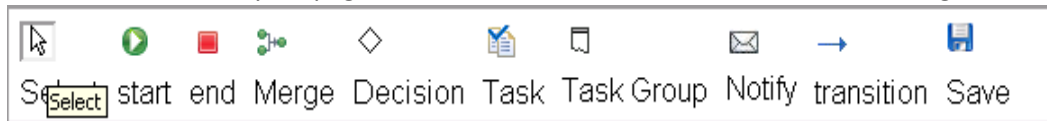
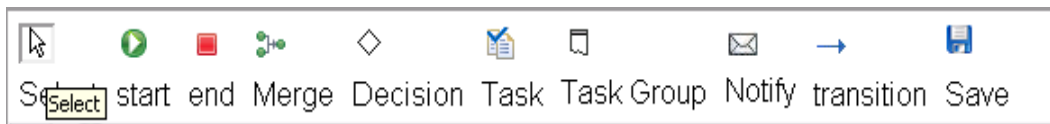


Figure 9-43 Tool Bar Section



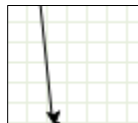
represents the start button



represents the end button



represents a decision



represents a transition



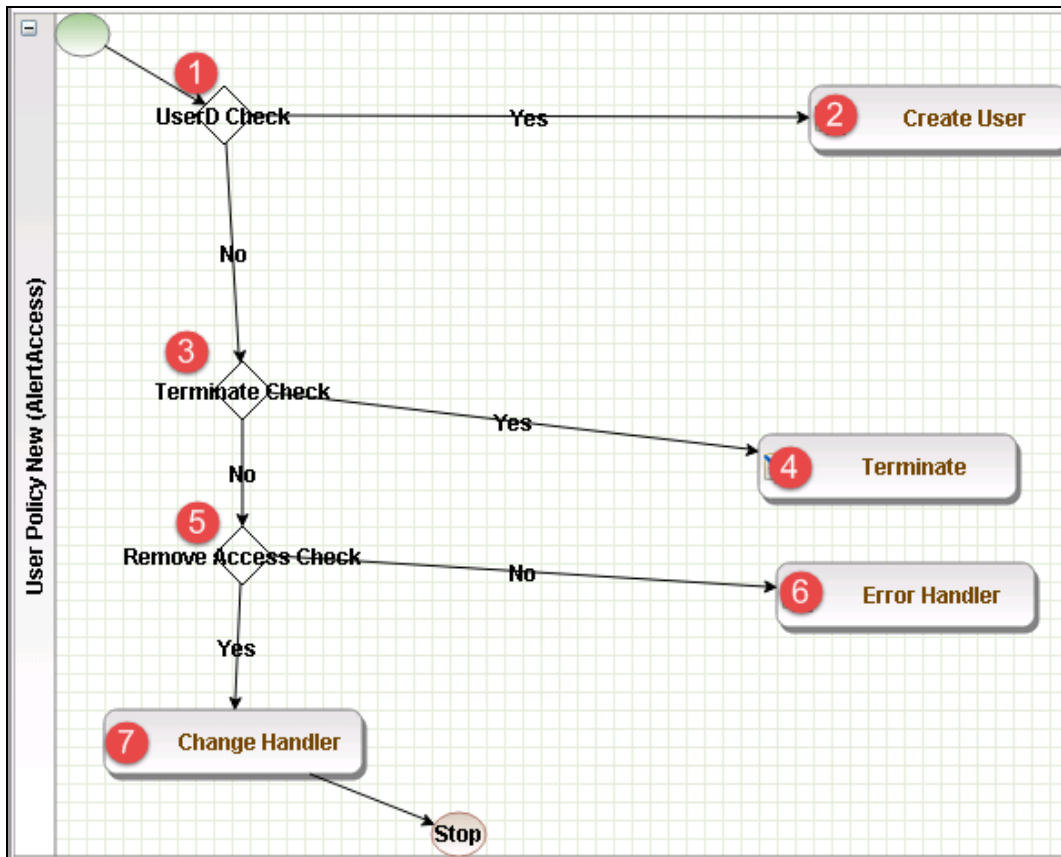


represents a task

5. Guidelines to configure the policy:

- To place an element/node on the layout page, drag it from the toolbar, and then place it on the layout page.
- To connect two nodes, select the transition icon from the toolbar, and then mouse over to the first node and connect it to the other node in the same direction specified in Figure 9-44.
- To provide text for a decision, task, or transition line, double-click on the corresponding node, and enter the text. After entering the text, press **Enter** to exit the edit mode.

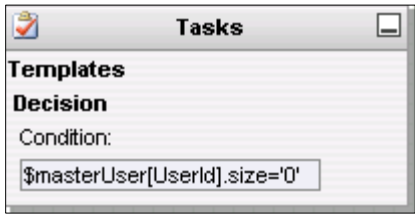
Figure 9-44 Guardian User Policy



6. Click on the Step 1 decision box, and it will open popup window with some fields (Figure 9-45).

7. Enter `$masterUser[UserId].size='0'` in the **Condition** field, and then press **Enter**.

Figure 9-45 Tasks



8. Similarly, click on other steps (2 through 7), and configure the data based on Table 9-28. For decision nodes, provide the **Condition** value; for task nodes, like **Create User**, **Terminate User**, **Change Handler**, and **Error Handler**, provide the **Is Task Handler** and **Task Handler** fields.

Table 9-28 Guardian User Policy

Step	Name	Type	Condition	Is Task Handler	Task Handler	Update Query
1	User ID Check	Decision	<code>\$masterUser[UserId].size='0'</code>			
2	Create User	Task Handler		Yes	Recon New Hire	
3	Terminate Check	Decision	<code>\$checkStatus[UserStatus,Active,Inactive].action='LOCK'</code>			
4	Terminate	Task Handler		Yes	Recon Terminate Handler	
5	Remove Access Check	Decision	<code>\$checkAuthFields[].status='Yes'</code>			
6	Error Handler	Task Handler		Yes	Recon Error Handler	
7	Change Handler	Task Handler		Yes	Recon Change Handler	

9.4.4.9 Job Scheduler > Triggers Field Map

1. **Setup > Manual Configuration > Job Scheduler > Triggers Field Map.**
2. Click **New**.

3. Enter the following fields:

- a. **Group Name:** Alert DbConnector Field Mapping
- b. **Description:** Alert DbConnector Field Mapping
- c. **Select Type:** Reconciliation

4. After creating a field map, select the newly created map, and then select **Configure**.

5. Click **New**, and then create a mapping per Figure 9-46.

**Figure 9-46 Guardian Job Scheduler Triggers Field Map**

AE Attribute	mappedKey	userType	roleType	userRole	userBadge	userEntRoleType	userTrainingType
UserId	UserId	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
FirstName	FirstName	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
LastName	LastName	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Email	Email	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Telephone	WorkPhone	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Mobile	HomePhone	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
EmployeeType	EmployeeType	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsAllDoors	PacsAllDoor	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsHomeAccess	PacsHomeAccess	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PacsWorkAccess	PacsWorkAccess	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Badgeld	CardNumber	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Format	FacilityCode	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
ValidFrom	ValidFrom	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
ValidTo	ValidTo	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Title	Title	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Status	UserStatus	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
PIN	PIN	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
AlertDepartment	Department	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE

#### 9.4.4.10 Job Scheduler > Triggers

- 1. **Setup > Manual Configuration > Job Scheduler > Triggers.**
- 2. Click **New**, and then create the following triggers in Table 9-29.

**Table 9-29 Guardian AlertEnterprise DB Trigger**

<b>Name</b>	AlertDbConnectorTrigger
<b>Description</b>	AlertDbConnectorTrigger
<b>Type</b>	Reconciliation
<b>Batch Size</b>	100
<b>Number of Attempts</b>	3

Policy Designer for Users/Roles	User policy New
System: Reconciliation From	ALERTDBCONNECTOR
Reconciliation System	ALERTDBCONNECTOR
Field Mapping Group	ALERTDBCONNECTOR Field Mapping
User Type	True
User Role	True

#### 9.4.4.11 Job Scheduler > Scheduler

1. **Setup > Manual Configuration > Job Scheduler > Scheduler.**
2. Click **New**, and then enter the following fields (Figure 9-47):
  - a. Job Type: **Reconciliation Job**
  - b. Job Name: <Job Name>
  - c. Select the **Global** checkbox
  - d. **Reconciliation for: Users**
  - e. **Reconciliation Type: Incremental Reconciliation**
  - f. **Reconciliation Triggers: AlertDbConnectorTrigger**
  - g. Select the schedule as **Immediate**, **Once**, **Periodically**, or **Advance**. For **Periodically**, specify the **Start At**, **End At**, and **Rerun every** (duration of job frequency, which should be no less than every 2 minutes).

Figure 9-47 Guardian Reconciliation Job

**\* Job Type** Reconciliation Job

**\* Job Name** Alert External DB User Reconciliation

**Global** ☒

**Job Visibility** private

**Notification Templates** Choose One

**\* Reconciliation For** Users  
Roles  
User Training

**\* Reconciliation Type** Incremental Reconciliation

**\* Reconciliation Triggers** AlertDbConnectorTrigger

**Init Date Load** No

**Create/Update Scheduled Jobs**

☐ Immediate  
☐ Once  
☒ Periodically  
☐ Advance

**Time Zone** (GMT-05:00) America/New\_York

**Start At** 06/08/2015 [date] 20 [hrs] 58 [minutes]

**End At** 06/08/2016 [date] 20 [hrs] 58 [minutes]

**Rerun every** 2 [Repeat Duration] Minutes [Repeat Unit]

**Save** **Cancel**

3. Click **Save**.

## 10 PACS Server: RS2 Access It! Universal Server Installation

The Access It! Universal RS2 Technologies PACS Server is installed on the PACS Network to help control physical access to simulated facilities, rooms, etc. RS2 Technologies cards and card readers were also included in both builds. The RS2 Technologies PACS Server is installed on a VM that is running the Windows Server 2012 R2 OS.

### 10.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-2: Physical access to assets is managed and protected.

[NIST SP 800-53 Revision 4 Security Controls](#): PE-2, PE-3, PE-4, PE-5, PE-6, PE-9

## 10.2 System Environment

The system for the PACS-Console Server configured by the NCCoE contains the following configuration settings and environmental constraints:

- Windows Server 2012 R2
- VM with CPU Quad Core 2.199 GHz
- VM with 8,192 MB of memory
- virtual hard disk containing 240 GB of storage

## 10.3 AIUNIVERSAL Installation

1. Insert the AIUNIVERSAL compact disc (CD) into the compact disc read-only memory (CD-ROM) drive.
2. Launch Setup64.exe as an administrator.
3. Follow the install instructions:
  - Select **I do not have a SQL Server installed**.
  - When prompted to install SQL Server 2008 R2 Express Edition, select **Yes**.
  - After the installation of SQL Server, select **Install Access It! Universal**.
  - When prompted to install a **Stand-Alone Server** version of Access It!, select **OK**.
  - When prompted by the install wizard, select **Next**.
  - Read the license agreement, and then select **Next** if you agree with the terms of the agreement.
  - Use the default installation folder *C:\Program Files(x86)\RS2 Technologies\Access It! Universal\*, and then select **Next**.
  - When the installer is ready, select **Next** to continue.
  - Select **Close** to exit the installer after completion.

## 10.4 Post Installation

1. Launch Access It! by selecting it from the start menu.
2. When prompted to select a server, enter the hostname of the server: **PACS-CONSOLE**.
3. Log in with the default username and password.

### 10.4.1 Connect Access It! Universal to Door Controller

1. **Main > Hardware > Channels.**
2. Create a new channel.
3. For the **Channel Type**, select **IP Server**.
4. Ensure that the **Protocol Type** is **SCP**.
5. Select **Save**.
6. Create a new SCP.
7. Under the **General** tab, ensure that the **Model** is set to **EP-1501Plus**.
8. Under the **Comm** tab, ensure that the **Channel** is set to **Channel 000** (the channel that was just created).
9. Verify the following settings:
  - a. TCP/IP Settings:
    - i. **IP Address:** 172.16.7.101
    - ii. **Port Number:** 3001
  - b. **Encryption Settings:** None.
  - c. Under the **Card Formats** tab:
    - i. **Format Name:** 26 Bit Wiegand Facility code: 20
    - ii. **Format Name:** 26 Bit Wiegand Facility code: 219
10. Save changes to SCP 000.
11. Under **SIOs**, edit **SCP 000 – SIO 00**.
12. Under the **General** tab, ensure that the **Model** is set to **EP-1501**.
13. Edit **SCP 000 – SIO 01**.
14. Under the **General** tab, ensure that the **Model** is set to **MR-52**.
15. Under **Main > Hardware**, select **Installed Readers**.
16. Create **SCP 000 – SIO 00-Reader 1**.
17. Create **SCP 000 – SIO 01-Card Reader**.

18. Create **SCP 000 –SIO 01-MRDT Keypad**.
19. Under **Configuration > Access Levels**, create New Access Level.
20. Create a new access level:
  - a. **Access Level Name: All Doors**
  - b. **Assigned Readers for All Doors: SCP 000 – SIO 01-Card Reader and SCP 000 – SIO 01-MRDT Keypad**
  - c. **Access Level Name: Home Access Level**
  - d. **Assigned Reader for Home Access Level: SCP 000 – SIO 01-MRDT Keypad**
  - e. **Access Level Name: Work Order Access Level**
  - f. **Assigned Reader for Work Order Access Level: SCP 000 – SIO-Card Reader**

#### 10.4.2 Enable TCP/IP to SQL 2008 R2 Server

1. Launch Microsoft SQL Server Configuration Manager.
2. Expand SQL Server Network Configuration (32-bit).
3. Select **Protocols** for AIUNIVERSAL.
4. Right-click on **TCP/IP**, and then select **Properties**.
5. Select tab **IP Addresses**.
6. Under **IP1**, ensure that IP Address is set to 0.0.0.0, and that TCP Port is set to 1433.
7. Under **IPALL**, ensure that **TCP Dynamic Ports** is set to 52839, and that **TCP Port** is set to 1433.
8. Restart the SQL server by selecting **SQL Server Services**, and then right-click on **SQL Server (AIUNIVERSAL)** and select **Restart**.

## 11 Privileged User Access Control: TDi ConsoleWorks Server Installation

The TDi ConsoleWorks server was installed in two different locations in the builds. It was installed on the OT network to control and monitor access between OT technicians and physical devices, such as the RTUs and the RADiFlow ICS firewall. The following subsections provide details on the steps that are needed to install and configure each of these servers.



## 11.1 Security Characteristics

### Cybersecurity Framework Categories:

- PR.PT-1: Audit/log records are determined, documented, implemented, and reviewed in accordance with policy.
- PR.PT-3: Access to systems and assets is controlled, incorporating the principle of least functionality.

NIST SP 800-53 Revision 4 Security Controls: AU Family, AC-3, CM-7

## 11.2 ConsoleWorks Server Installation

ConsoleWorks was installed on the OT network to control and monitor access between OT technicians and physical devices, such as the RTUs and the RADiFlow ICS firewall. ConsoleWorks uses the OT directory to authenticate users who are requesting access to these devices. It also establishes a permanent SSH or telnet connection to each of the RTUs and ICS firewall by using pre-established usernames and passwords. As users request access and are authenticated, ConsoleWorks makes the cross-connection from the user to the specific SSH or telnet session to allow access. Once the cross-connection is established, the user has access to the device to make any changes needed. When users complete their task, they log off the connection, and ConsoleWorks removes the cross-connect between the user and the SSH or telnet session.

ConsoleWorks logs all user access requests and all of the traffic on the session, and can alert on any pre-defined aspect of the traffic. Directory-based authentication is used to manage the user access in near-real-time.

On the OT network, the ConsoleWorks Server is installed on a VM that is running the Windows Server 2012 R2 (hardened server OS) image, as explained in [Section 3.1.1](#).

### 11.2.1 System Environment

The system for the OT Network ConsoleWorks Server configured by the NCCoE contains the following configuration settings and environmental constraints:

- Windows Server 2012 R2 OS
- VM with CPU Quad Core 2.199 GHz
- VM with 8,192 MB of memory
- virtual hard disk containing 240 GB of storage

### 11.2.2 ConsoleWorks Server Installation on the OT Network

1. After installing the OS, download the TDi Technologies Installer from [http://support.tditechnologies.com/get\\_consoleworks](http://support.tditechnologies.com/get_consoleworks).
2. Launch the `cw_server_v4.9-0u0.exe` application. The installer requires administrative privileges to execute.
3. When prompted by Windows User Account Control, select **Yes** to continue.
4. The ConsoleWorks Server InstallShield wizard should display a welcome message. Select **Next** to continue.
5. When prompted by the InstallShield wizard to accept the license agreement, read carefully. If you agree with the license terms, select **Next** to continue with the installation.
6. Enter the **User Name** and **Organization** fields, then select **Next** to continue.
7. Select **Complete** when prompted for setup type, then select **Next** to continue.
8. Click **Install** to begin the installation of the ConsoleWorks Server.
9. After the InstallShield wizard has completed, ensure that **Launch upgrade script** (if upgrading from 32-bit) is unchecked.
10. Select **Finish**.

### 11.2.3 Post-Installation Configuration of ConsoleWorks on the OT Network

1. Copy TDi Technologies license key files into  
`C:\ProgramData\ConsoleWorks/Server/LMF/TDI_Licenses`
2. Go to **Start > Run > services.msc**.
3. Right-click on the **ConsoleWorks Server** Service, and then select **Properties**.
4. Select **Start** to start the service, and then change the **Startup Type** from **Manual** to **Automatic**.
5. Select **Apply** to save the changes. Both the **ConsoleWorks Server** and **ConsoleWorks LMF Server** services should be running.
6. Test the browser connectivity by going to `http://localhost:5176`. The default account is `CONSOLE_MANAGER`. The default password is: `Setup`.

### 11.2.4 Configuring External Authentication for the OT Network ConsoleWorks Server

1. From the left menu, select the **SECURITY** tab.
2. Select **External Authentication**.
3. Ensure that the **Enable External Authentication** checkbox has been selected.
4. Select **Add**.
5. **Parameter 1:** OT-ES-IDAM-B1
6. **Parameter 2:** CW\_
7. **Required Profile:** CONSOLE\_WORKS
8. **Template User:** CONSOLE\_MANAGER
9. Leave all other fields blank.
10. Select **Next**.
11. Enter a Username and Password to test External Authentication settings.
12. Select **Next**, and then select **Save**.

## 12 ICS/SCADA Firewall: RADiFlow

A RADiFlow switch is installed on the physical network that represents the ICS component that can be accessed and controlled via the OT network. A RADiFlow management workstation is installed on the OT network. The RADiFlow Management Workstation is installed on a VM that is running the Windows 7 Enterprise OS.

### 12.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.PT-3: Access to systems and assets is controlled, incorporating the principle of least functionality.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-3, CM-7

## 12.2 OT Network RADiFlow Management Workstation Installation

### 12.2.1 Installing iSIM

1. Launch the iSIM installer as an administrator.
2. Set the Destination Directory to *C:\Program Files (x86)*.
3. Leave the default settings for all other options.

### 12.2.2 iEMS

1. Launch iEMS from the start menu.
2. From the menu items, select **System > Switch Initialization > Force Switch Model > 3180**.
3. In the main windows dialog box, enter the switches IP address *172.16.6.4*, and then select **Refresh**.
4. From the menu items, select **Configuration > Interfaces > Serial Ports....**
5. Select the **Terminal Server** tab, and ensure that the Service 1 and Service 2 dialog boxes are checked.
6. Under Service 1, enter these settings:
  - a. **Service ID:** 1
  - b. **Local IP Address:** *172.16.6.100*
  - c. **Telnet Port:** 2050
  - d. **Null CR Bit Mode:** OFF
7. Under Service 2, enter these settings:
  - a. **Service ID:** 2
  - b. **Local IP Address:** *172.16.6.100*
  - c. **Telnet Port:** 2051
  - d. **Null CR Bit Mode:** OFF
8. Select **Create/Update**.
9. Select the **Serial Ports** tab; ensure that the Port-1 and Port-2 dialog boxes are checked.

10. Under Port 1, enter these settings:

- a. **Application: Terminal Server**
- b. **Local Position: Slave**
- c. **Service-id: 1**
- d. **Operation Mode: Transparent**
- e. **Buffer Mode: byte**
- f. **Protocol: any**
- g. **Baudrate: 9600**
- h. **Databits: 8**
- i. **Stopbits: 1**
- j. **Parity: no**
- k. **Allowed-latency: 6**
- l. **Bus-idle-time: 30**
- m. **Dtr-dsr: enable**
- n. **Rts-cts: enable**
- o. **Local-dsr-delay: 0**
- p. **Local-cts-delay: 0**
- q. **Tx-delay: 10**
- r. **Bits-for-sync1: 28**
- s. **Bits-for-sync2: 1**
- t. **Unit-id length: 2**
- u. **Iec101-link-address-len: 2**

11. Under Port 2, enter these settings:

- a. **Application: Terminal Server**
- b. **Local Position: Slave**
- c. **Service-id: 2**

- d. **Operation Mode: Transparent**
- e. **Buffer Mode: byte**
- f. **Protocol: any**
- g. **Baudrate: 9600**
- h. **Databits: 8**
- i. **Stopbits: 2**
- j. **Parity: no**
- k. **Allowed-latency: 6**
- l. **Bus-idle-time: 30**
- m. **Dtr-dsr: enable**
- n. **Rts-cts: enable**
- o. **Local-dsr-delay: 0**
- p. **Local-cts-delay: 0**
- q. **Tx-delay: 10**
- r. **Bits-for-sync1: 28**
- s. **Bits-for-sync2: 1**
- t. **Unit-id length: 2**
- u. **Iec101-link-address-len: 2**

12. Select **Create/Update**.

## 13 Ozone: MAG Installation

Four Ozone components are installed on the IdAM network: Console, Authority, Server, and Envoy. These components are installed on VMs running the CentOS 7 image.

### 13.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-4: Access permissions are managed, incorporating the principles of least privilege and separation of duties.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-2, AC-3, AC-5, AC-6, AC-16

## 13.2 Ozone Console Installation and Authority Configuration

1. Install CA Certificate into Trusted Root store (**MAG\_DEV\_CA.crt**).
2. Install Ozone Authority Certificate into Trusted People store (**ozoneauthority.crt**).
3. Install Administrator keys into Personal store (**admin1.crt** and **admin2.crt**).
4. Run Setup Ozone Console.exe.
  - a. Run Ozone Console.
  - b. Go to **Configuration>Ozone Authority>New** (Figure 13-1).
  - c. In the **Proof Settings** tab:
    - i. Select **SHA256** for the **Entity Digest Algorithm**.
    - ii. Select **SHA256withRSA** for the **Proof Signature Algorithm**.

Figure 13-1 Ozone Proof Settings

Ozone Authority Configuration

Proof Settings | Authority Web Service | Database Tuning

Entity Digest Algorithm: SHA256

Proof Signature Algorithm: SHA256withRSA

☐ Enable Logically Massive Proofs

Number of entities required for Logically Massive Proof: 10000

Change percentage required before full republish: 50

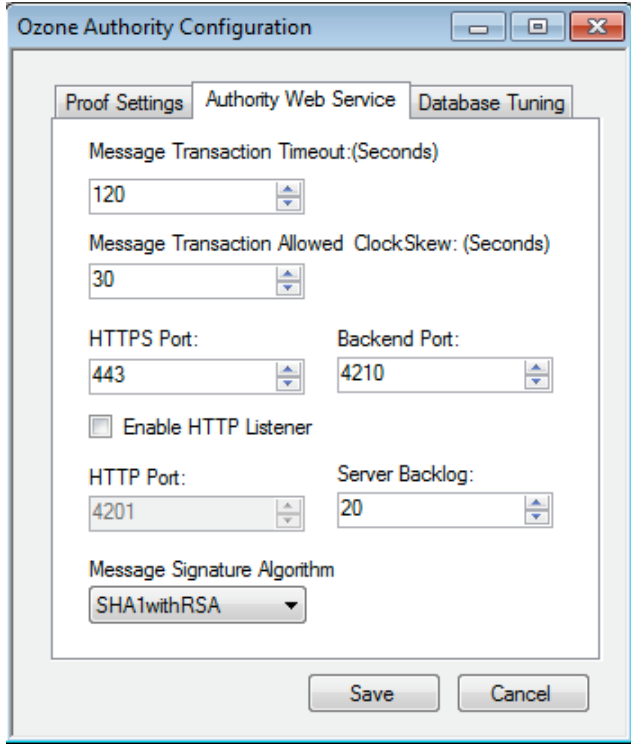
Logically Massive Proof republication schedule: 7

How long should the LMP sub-proofs remain valid?: 7

Save Cancel

5. In the **Authority Web Service** tab (Figure 13-2):
  - a. Set the **HTTPS Port** to 443.
  - b. Select **SHA1withRSA** for the **Message Signature Algorithm**.

Figure 13-2 Ozone Authority Web Service



- c. Click **Save**.
6. Select a certificate to be used to digitally sign the configuration (**Admin 1**).
7. Save the file as *AuthorityConfiguration.xml*.
8. Secure Copy the file to Ozone Authority machine.

### 13.3 Ozone Authority Installation

Create keys and certificates, and store them in Java Keystore (JKS).

```
[root@ozone ~]# yum install java
[root@ozone ~]# yum install mariadb-server
[root@ozone ~]# reboot
```



```
[root@ozone ~]# systemctl start mariadb
[root@ozone ~]# systemctl enable mariadb
[root@ozone ~]# mysql_secure_installation
[root@ozone ~]# mysql -u root -p
```

```
MariaDB> create database ozone;
```

```
Query OK, 1 row affected (0.02 sec)
```

```
MariaDB> create user 'ozone'@'localhost' identified by 'password';
```

```
Query OK, 0 rows affected (0.00 sec)
```

```
MariaDB> grant all privileges on ozone.* to 'ozone'@'localhost';
```

```
Query OK, 0 rows affected (0.00 sec)
```

```
MariaDB> flush privileges;
```

```
Query OK, 0 rows affected (0.00 sec)
```

```
[root@ozone local]# cd /usr/local/
```

```
[root@ozone local]# tar -xzf ~/Ozone\ Authority-2014.tar.gz
```

```
[root@ozone local]# mv ~/AuthorityConfiguration.xml authority/conf/
```

```
[root@ozone local]# mv ~/AuthorityLicense.xml authority/conf/
```

```
[root@ozone local]# mv ~/authority.jks authority/keystores/
```

```
[root@ozone local]# mv ~/admin1.cer authority/bin/
```

```
[root@ozone local]# mv ~/admin2.cer authority/bin/
```

```
[root@ozone local]# cd authority/bin/
```

```
[root@ozone bin]# ./startAuthority.sh
```

```
Configuration file not found, would you like to create a new
installation? [Y] Y
```

```
***WARNING***
```

This product MUST be installed by an Ozone Certified Engineer. Pericore, Inc. cannot be held liable for damages resulting from negligent or fraudulent actions of unauthorized or unqualified administrators. Please review all documentation thoroughly before continuing. Continuation of this configuration process represents an agreement to abide by the Pericore EULA.

Do you wish to continue? [N] : **y**

Please select the license file for this Ozone Authority.:

1: /usr/local/authority/conf/AuthorityLicense.xml

2: Other...

Choice [1] : **1**

Please select the configuration file for this Ozone Authority.:

1: /usr/local/authority/conf/AuthorityConfiguration.xml

2: Other...

Choice [1] : **1**

Do you wish to set any passphrase complexity requirements? [N] : **N**

Note: If you require passphrase at start, you will not be able to restart this Ozone Authority without user intervention.

Do you wish to require a passphrase to start this Ozone Authority? [N] **N**

Using keystore type: RSA

Do you have an existing keystore you wish to use for this Ozone Authority? [Y] : **Y**

Please select the keystore file for this Ozone Authority.:

1: /usr/local/authority/kestores/authority.jks

2: Other...

Choice [1] : **1**

Please enter the passphrase. : **123456**

May 15, 2015 1:24:22 PM com.pericore.util.PericoreProvider jsafeJCEinit

POST: [FIPS] FIPS-140 compliance self-test passed.

What type of database do you wish to use?:

1: SQLSERVER

2: ORACLE

3: MYSQL

Choice [1] : **3**

Please enter the hostname or IP address of the database server: [ozone] : **localhost**

Please enter the port number for the database: [3306] **3306**

Please enter the username for the database: [] : **ozone**

Please enter the database password: **password**

Using only available database: **ozone**

How many initial administrators would you like to create? [2] : **2**

Page 1 | Current Directory:

[00] ../

[01] lib/

[02] admin1.cer

[03] admin2.cer

Please select the file containing the administrators certificate: [ # ] : **2**

3Page 1 | Current Directory:

[00] ../

[01] lib/

[02] admin1.cer

[03] admin2.cer

```

Please select the file containing the administrators certificate: [ # ] : 1
Please enter distinguished name(DN) of the starting Organizational
Unit (OU) for this proof tree: [OU=Ozone] : ou=Ozone, dc=NCCOE, dc=test
Is: ou=Ozone, dc=NCCOE, dc=test correct? [Y] : Y
Please enter the minimum number of administrators required to approve
changes to the initial proofs: [1] : 1
Please enter a name for the initial publication schedule: [Primary Schedule] : Daily
Please enter the publication interval: [12] : 12
Please select the time unit::
1: Minute
2: Hour
3: Day
Choice [1] : 2
Please enter the validity period after publication: [12] : 12
Please select the validity period time unit::
1: Minute
2: Hour
3: Day
Choice [1] : 2

Please enter a name for the initial distribution point for proofs. [File Distribution
Point] : LDAP Distribution Point

Please enter the initial distribution point for proofs. This may be changed later.
[file:///usr/local/authority/proofs/] : ldap://ozoneauthority/

Configuration File: /usr/local/authority/conf/AuthorityConfiguration.xml

May 15, 2015 1:25:16 PM com.pericore.util.ObjectIdentifierFactory$OIDDataLoader debug
INFO: ObjectIdentifierFactory Read 240.165 kb in 2.511 ms; Indexed 2,415 Arcs in
51.731 ms; 2,310(1,054:5) keys => 2.003 kb

Created proof ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in the
database.

```

Created proof ou=Applications, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in the database.

Created proof ou=Groups, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in the database.

Created proof ou=Attribute Types, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in the database.

Allowing a user certificate to be associated with a directory GUID allows for a migration path from username and password to a PKI based authentication and authorization mechanism. However, this method lowers the initial security settings by relying on a directory for the association. Please be sure you understand the risks associated with this method before allowing this mechanism to be used.

Would you like to allow users certificates to be associated with a directory GUID? [N] : **N**

Do you wish to display a logon message? [N] : **N**

Ozone Authority

Version: 2014 - 4.0.1 (Build: 475)

Copyright Pericore, Inc. 2014

-----

Started at: May 15, 2015 1:24:13 PM EDT

Licensed to: NCCOE

-----

Built: ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in 0:00:00.304.

Built: ou=Applications, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in 0:00:00.243.

Built: ou=Groups, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in 0:00:00.215.

Built: ou=Attribute Types, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test in 0:00:00.214.

Push Certificates loaded with: 0 certificates

Started HTTPS Listener on port: 443

Ozone Authority>

```
[root@ozone ~]# yum install 389-ds-base
```

```
[root@ozone ~]# vi /etc/hosts
```

Modify the first line of hosts file so that it is the same as below:

```
127.0.0.1  ozoneauthority.nccoe.test localhost localhost.localdomain localhost4
localhost4.localhostdomain4
```

### Configure the directory server

```
[root@ozone ~]# setup-ds.pl
```

```
=====
```

This program will set up the 389 Directory Server.

It is recommended that you have "root" privilege to set up the software.

Tips for using this program:

- Press "Enter" to choose the default and go to the next screen
- Type "Control-B" or the word "back" then "Enter" to go back to the previous screen
- Type "Control-C" to cancel the setup program

Would you like to continue with set up? [yes]: **yes**

```
=====
```

Your system has been scanned for potential problems, missing patches, etc. The following output is a report of the items found that need to be addressed before running this software in a production environment.

389 Directory Server system tuning analysis version 23-FEBRUARY-2012.

NOTICE : System is x86\_64-unknown-linux3.8.13-68.2.2.el7uek.x86\_64 (1 processor).

NOTICE : The net.ipv4.tcp\_keepalive\_time is set to 7200000 milliseconds  
(120 minutes). This may cause temporary server congestion from lost  
client connections.

WARNING: There are only 1024 file descriptors (soft limit) available, which  
limit the number of simultaneous connections.

WARNING : The warning messages above should be reviewed before proceeding.

Would you like to continue? [no]: **yes**

=====

Choose a setup type:

1. Express

Allows you to quickly set up the servers using the most  
common options and pre-defined defaults. Useful for quick  
evaluation of the products.

2. Typical

Allows you to specify common defaults and options.

3. Custom

Allows you to specify more advanced options. This is  
recommended for experienced server administrators only.

To accept the default shown in brackets, press the Enter key.

Choose a setup type [2]: **2**

=====

Enter the fully qualified domain name of the computer  
on which you're setting up server software. Using the form  
<hostname>.<domainname>

Example: eros.example.com.

To accept the default shown in brackets, press the Enter key.

Warning: This step may take a few minutes if your DNS servers  
cannot be reached or if DNS is not configured correctly. If  
you would rather not wait, hit Ctrl-C and run this program again  
with the following command line option to specify the hostname:

General.FullMachineName=your.hostname.domain.name

Computer name [ozone.mountaireygroup.com]: **ozoneauthority.nccoe.test**

=====

The server must run as a specific user in a specific group.  
It is strongly recommended that this user should have no privileges  
on the computer (i.e. a non-root user). The setup procedure  
will give this user/group some permissions in specific paths/files  
to perform server-specific operations.

If you have not yet created a user and group for the server,  
create this user and group using your native operating



system utilities.

System User [nobody]: **nobody**

System Group [nobody]: **nobody**

=====

The standard directory server network port number is 389. However, if you are not logged as the superuser, or port 389 is in use, the default value will be a random unused port number greater than 1024. If you want to use port 389, make sure that you are logged in as the superuser, that port 389 is not in use.

Directory server network port [389]: **389**

=====

Each instance of a directory server requires a unique identifier. This identifier is used to name the various instance specific files and directories in the file system, as well as for other uses as a server instance identifier.

Directory server identifier [ozoneauthority]: **ozoneauthority**

=====

The suffix is the root of your directory tree. The suffix must be a valid DN. It is recommended that you use the dc=domaincomponent suffix convention. For example, if your domain is example.com, you should use dc=example,dc=com for your suffix. Setup will create this initial suffix for you, but you may have more than one suffix. Use the directory server utilities to create additional suffixes.

```
Suffix [dc=nccoe, dc=test]: dc=nccoe, dc=test
```

```
=====
```

Certain directory server operations require an administrative user.

This user is referred to as the Directory Manager and typically has a bind Distinguished Name (DN) of cn=Directory Manager.

You will also be prompted for the password for this user. The password must be at least 8 characters long, and contain no spaces.

Press Control-B or type the word "back", then Enter to back up and start over.

```
Directory Manager DN [cn=Directory Manager]: cn=Directory Manager
```

```
Password: password
```

```
Password (confirm): password
```

Your new DS instance 'ozoneauthority' was successfully created.

Exiting . . .

Log file is '/tmp/setup\_C4mdK.log'

## Setup the directory structure

Modify the file */usr/local/authority/bin/389SetupDirectory.ldif*

Set the correct DN structure and passwords for the ozone authority user and tree

### *389SetupDirectory.ldif*

```
#Create the User for Ozone Authority
```

```
dn: uid=ozone, ou=Special Users, dc=nccoe, dc=test
```

```
changetype: add
```

```
objectClass: inetorgperson
```

```
objectClass: organizationalPerson
```

```
objectClass: person
objectClass: top
cn: Ozone Authority
sn: Authority
givenName: Ozone
uid: ozone
userPassword: P@$sword

#make the people writable by ozone
dn: ou=People, dc=nccoe, dc=test
changetype: modify
add: aci
aci: (targetattr="*)(version 3.0;acl "ozone authority";allow (all)(userdn =
"ldap:///uid=ozone, ou=Special Users, dc=nccoe, dc=test");)

#Create the Ozone OU
dn: ou=Ozone, dc=nccoe, dc=test
changetype: add
objectClass: organizationalUnit
objectClass: top
ou: Ozone
aci: (targetattr="*)(version 3.0;acl "ozone authority";allow (all)(userdn =
"ldap:///uid=ozone, ou=Special Users, dc=nccoe, dc=test");)

#Create required Attributes and Object Classes
dn: cn=schema
changetype: modify
add: attributetypes
attributetypes: ( 1.3.6.1.4.1.26135.1.1.1.2 NAME 'authorizationProof' DESC 'Ozone
Authorization Proof' SYNTAX 1.3.6.1.4.1.1466.115.121.1.40 SINGLE-VALUE X-ORIGIN 'user
defined' )
```

```
attributetypes: ( 2.23.136.1.1.2 NAME 'cscaMasterList' DESC 'CSCA Master List' SYNTAX
1.3.6.1.4.1.1466.115.121.1.40 SINGLE-VALUE X-ORIGIN 'user defined' )
```

```
dn: cn=schema
```

```
changeType: modify
```

```
add: objectclasses
```

```
objectclasses: ( 1.3.6.1.4.1.26135.1.1.3 NAME 'ozoneAuthority' DESC '' SUP top
STRUCTURAL MAY (authorizationProof $ cscaMasterList) X-ORIGIN 'user defined' )
```

### Modify the directory using the LDIF

```
[root@ozone bin]# ldapmodify -x -D "cn=Directory Manager" -W -f
/usr/local/authority/bin/389SetupDirectory.ldif
```

```
Enter LDAP Password:
```

```
adding new entry "uid=ozone, ou=Special Users, dc=nccoe, dc=test"
```

```
modifying entry "ou=People, dc=nccoe, dc=test"
```

```
adding new entry "ou=Ozone, dc=nccoe, dc=test"
```

```
modifying entry "cn=schema"
```

```
modifying entry "cn=schema"
```

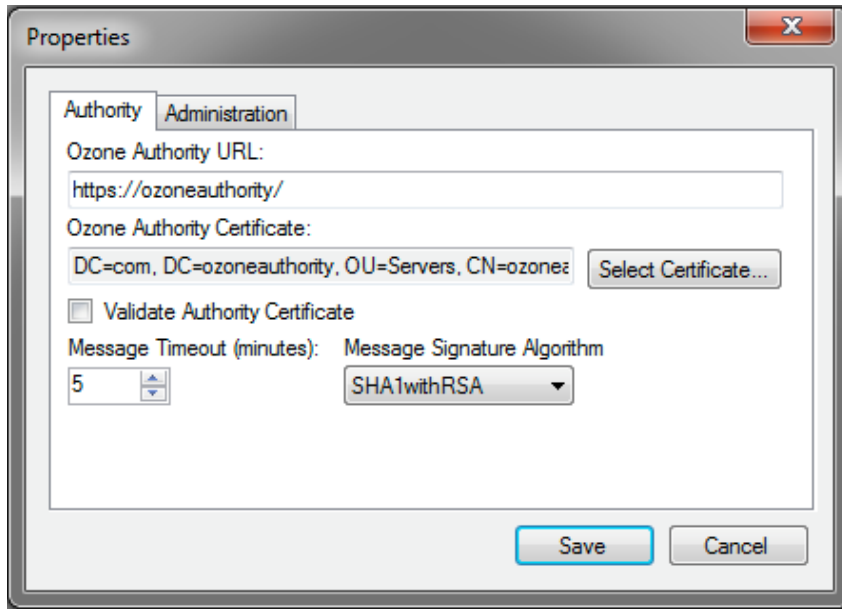
## 13.4 Ozone Console Server Configuration

Before proceeding, ensure that OzoneAuthority has been started by running `startauthority.sh` on the OzoneAuthority machine.

1. Open Ozone Console.
2. Go to **File > Properties** (Figure 13-3).
3. Enter the Ozone Authority URL.
4. Click **Select Certificate**, and then select the Ozone Authority Certificate.
5. Select **SHA1withRSA** as the **Message Signature Algorithm**.

6. Click **Save** to the connection information.

**Figure 13-3 Ozone Authority Connection Information**



Create the publication point for the proofs:

1. Select **Publication > Add Publication Point > Add LDAP Publication Point** (Figure 13-4).
2. Enter a name for the publication point.
3. Enter the hostname or IP address of the directory server.
4. Enter a base context, if any.
5. Select the port.
6. Enter the name of the user who has permissions to write to the directory.
7. Enter the password for the user.
8. Confirm the password.

Figure 13-4 Ozone LDAP Publication Point

Import the desired groups from RSA Adaptive Directory:

1. Right-click on the **Groups** proof.
2. Select **Import Group from Active Directory** (Figure 13-5).
3. Enter the directory connection information.

Figure 13-5 Ozone Directory Connection Information

Directory Connection

Hostname or IP Address: 172.16.4.3 Port Number: 2389

☐ Connect Anonymously ☐ Secure Connection

Username: cn=directory manager

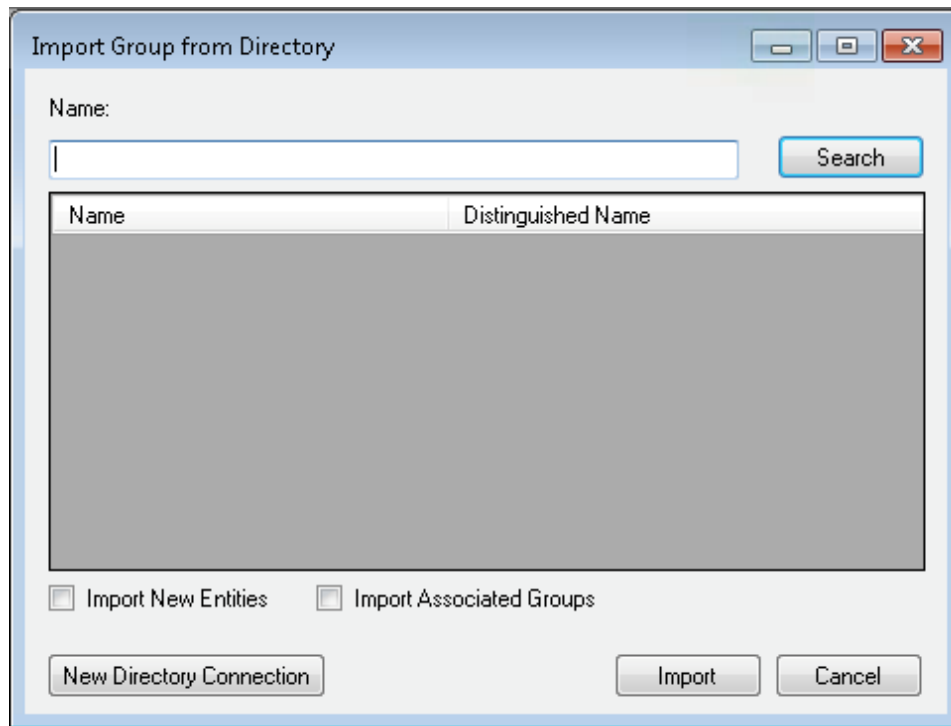
Password: xxxxxxxxxx

Root Context: ou=IT, dc=master, dc=test

Connect Cancel

4. Select a group to import (Figure 13-6).
5. Check the box to Import New Entities.
6. Check the box to Import Associated Groups.
7. Select **Import**.

Figure 13-6 Ozone Import Group from Directory



8. Select the **Schedule**, **Publication Points**, and **Distribution Points**, as shown in Figure 13-7.



**Figure 13-7 Ozone New Proof Information**

New Proof: Domain Users

Information | Peers | Entities | Administrators | Usage Periods | Authentication | Attributes | Contacts

Name  
Domain Users , ou=Groups, ou=Master Authorization Group, ou=Ozone, dc=mountaireygroup, dc=com

Superior Proof  
ou=Groups, ou=Master Authorization Group, ou=Ozone, dc=mountaireygroup, dc=com

Description

Schedule  
Daily

Digest Type  
GUID

Publication Points  
LDAP

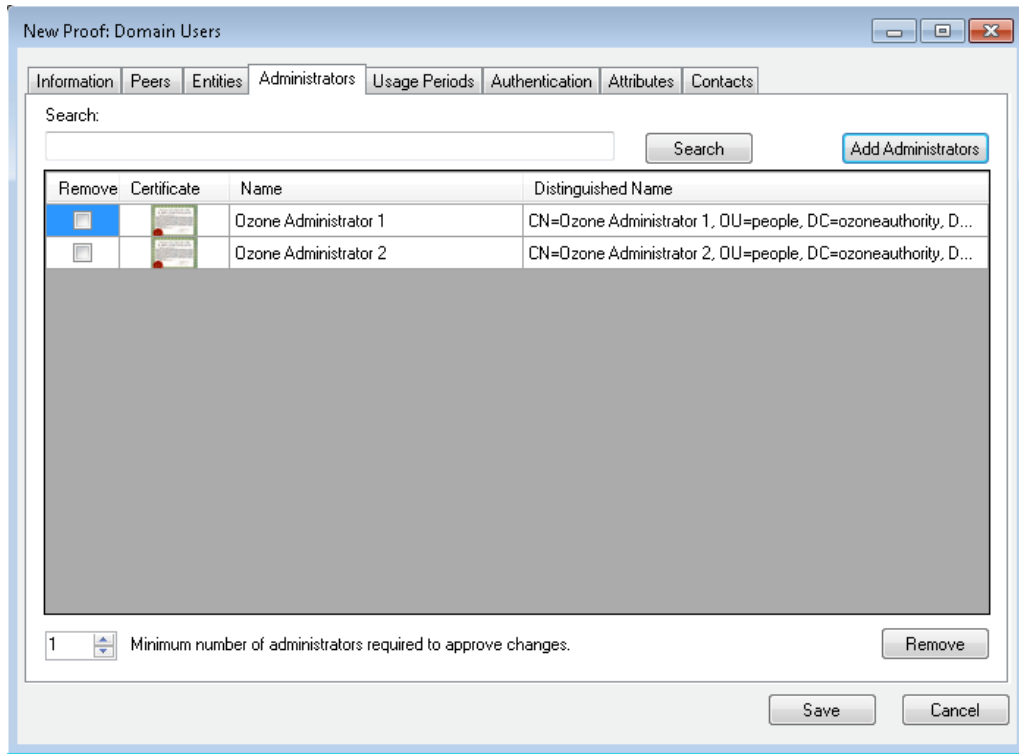
Distribution Points  
LDAP

Proof Type  
☒ Standard
 ☐ Black List
 ☐ Gateway

Save Cancel

9. Click the **Administrators** tab, as shown in Figure 13-8.
10. Click the **Add Administrators** button.
11. Select the users who will administer the proof.
12. Select **Add Entities**.

**Figure 13-8 Ozone New Proof Administrators**

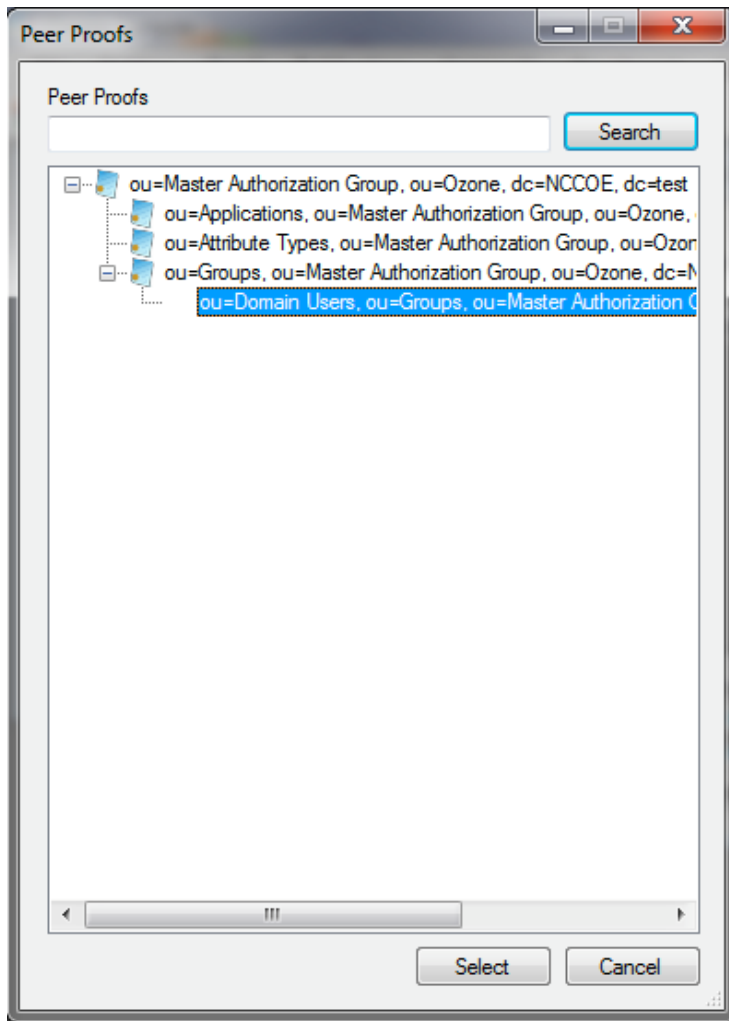


13. Click **Save**.

Create the Ozone Server Configuration:

1. Select **Configuration > Ozone Server > New....**
2. Click **Add proof from tree....**
3. Select a proof that the Ozone Server should use for authorizations, as shown in Figure 13-9.

Figure 13-9 Ozone Peer Proofs



4. Set the number of proof references (depth) that the proof may follow to authorize a credential, as shown in Figure 13-10.
5. Ensure that the locations where the Ozone Server will retrieve the proof are correct.

Figure 13-10 Ozone Add Authorization Proof

**Add Authorization Proof**

Proof Name  
OU=Domain Users, OU=Groups, OU=Master Authorization Group, OU=Ozone, DC=NCCOE, D

Proof ID  
3081840416041478839f5db439fa83d34409d9d6ce6847883b1add306231233021060355040

Depth  
2

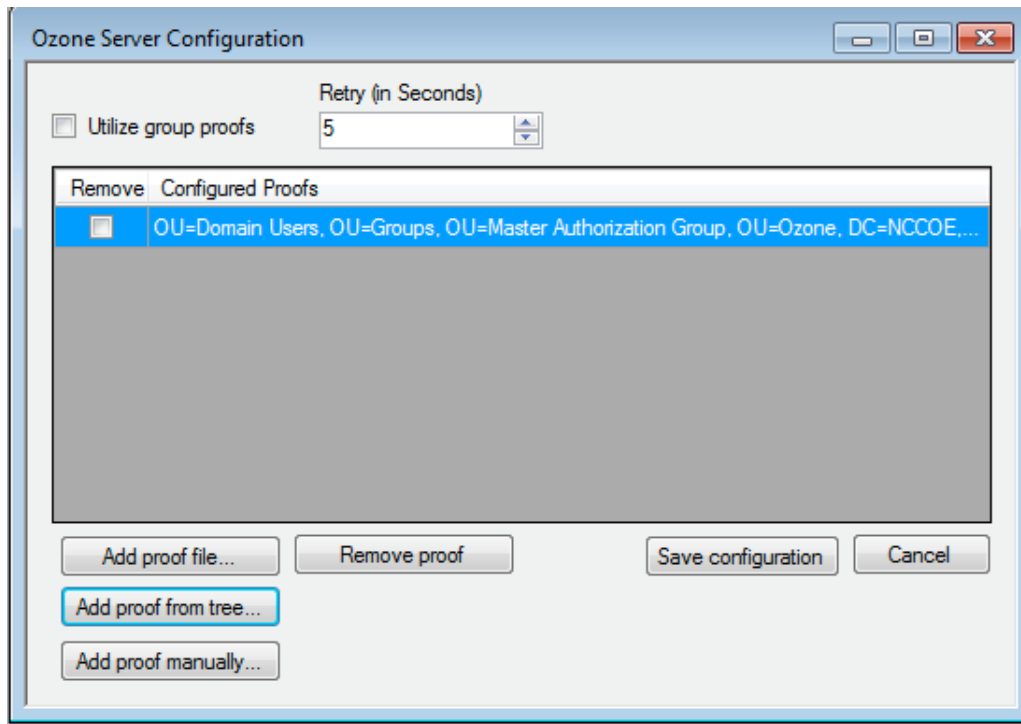
Ozone Authority Certificate:  
DC=com, DC=ozoneauthority, OU=Servers, CN=ozoneauthc

View... Select...

Remove	Protocol	Source
<input checked="" type="checkbox"/>	ldap://	ozoneauthority/
<input type="checkbox"/>		

Remove Save Cancel

6. Click **Save**.
7. Repeat Steps 2 through 6 until you have selected all of the proofs that the Ozone Server should initially retrieve for authorizations.
8. Click **Save configuration**, as shown in Figure 13-11.

**Figure 13-11 Ozone Server Configuration**

9. Select a certificate to be used to digitally sign the configuration.
10. Save the file as *ServerConfiguration.xml*.
11. Secure copy the file to the Ozone Server machine.

## 13.5 Ozone Server Installation

Create keys and certificates, and store them in JKS.

```
[root@ozone ~]# yum install java
[root@ozoneserver ~]# cd /usr/local/
[root@ozoneserver local]# tar -xzf ~/Ozone\ Server-2014.tar.gz
[root@ozoneserver local]# mkdir /usr/local/server/bin/conf/
[root@ozoneserver local]# cp ~/server.jks server/bin/conf/
[root@ozoneserver local]# cp ~/ServerConfiguration.xml server/bin/conf/
[root@ozoneserver local]# cp ~/ServerLicense.xml server/bin/conf/
```

```
[root@ozoneserver bin]# ./startServer.sh
```

```
POST [MAIN] v2.1.301
```

```

_____
/  _  \  _  //  _  \  |  \  |  |  _  | (R)
| /  \  | /  /  | /  \  ||  \  \  |  |
| | | | /  /  | | | | | \  \  |  |  _
| | | | /  /  | | | | | \  \  |  |  _
| | | | /  /  | | | | | \  \  |  |
\  \_ /  //  /  _  \  \_ /  /  |  \  \  |  |  _
\  _  //  _  \  _  \  /  |  \  \  |  _  |

_____
/  _  |
| (  _  _  _  _  _  _  _
\  _  \  /  _  \  '  _  \  \  /  /  _  \  '  _
_  )  |  _  /  |  \  v  /  _  /  |
|  _  /  \  _  |  _  \  /  \  _  |  _


```

```
Ozone(R) Server copyright (c) Pericore, Inc. 2007-2011
```

```
-----
Fri May 15 14:31:33 EDT 2015
```

May 15, 2015 2:31:35 PM com.pericore.util.PericoreProvider jsafeJCEinit

POST: [FIPS] FIPS-140 compliance self-test passed.

Found Java version: 1.8.0\_31

Working in: /usr/local/server/bin

/usr/local/server/bin/conf/server.cfg not found. Run setup [Y] : **Y**

env.work/usr/local/server/bin

Found Java Version: 1.8.0\_31

Ozone Server Setup Utility

\*\*\*WARNING\*\*\*

This product MUST be installed by a Pericore Certified Engineer. Pericore, Inc. cannot be held liable for damages resulting from negligent or fraudulent actions of unauthorized or unqualified administrators. Please review all documentation thoroughly before continuing. Continuation of this configuration process represents an agreement to abide by the Pericore EULA.

I agree to all terms and conditions set forth by Pericore, Inc. [N] : **y**

Enable Startup Password? [N] : **n**

May 15, 2015 2:31:37 PM com.pericore.util.ObjectIdentifierFactory\$OIDDataLoader debug

INFO: ObjectIdentifierFactory Read 240.165 kb in 3.313 ms; Indexed 2,415 Arcs in 52.438 ms; 2,310(1,054:5) keys => 2.003 kb

Server Configuration Directory:

1: /usr/local/server/bin/conf

2: Other...

Choice [1] : **1**

Select the XML License File:

1: /usr/local/server/bin/conf/ServerLicense.xml

2: Other...

Choice [1] : **1**

Select the XML Configuration File:

1: /usr/local/server/bin/conf/ServerConfiguration.xml

2: Other...

Choice [1] : **1**

Page 1 | Current Directory: /usr/local/server/bin

[00] ../

[01] lib/

[02] conf/

Select Server Identity Keystore [ # ] : **2**

Page 1 | Current Directory: /usr/local/server/bin/conf

[00] ../

[01] server.jks

Select Server Identity Keystore [ # ] : **1**

Enter password for server.jks : **123456**

Is the Private Key Alias 'server' correct? [Y] : **Y**

Enable logging? [Y] : **Y**

Log File Roll Size (Kb) [512] : **512**

Configured Client Services: **0**

Choose an option:

1: Configure Authorization Service

2: Configure a Proof Proxy

3: Configure an Info Page

4: Configure a Push Service

5: Done Configuring Web Services

Choice [1] : **1**

Configuring XACML Authorization Service

Service Port [8080] : **443**



```
Service Context [/AuthorizationService] : /AuthorizationService

Enable WS-Security? [Y] : Y

SOAP Signature Method:

1: RSA_SHA1
2: RSA_SHA256
3: RSA_SHA384
4: RSA_SHA512
Choice [1] : 2

Enable WS-Security Client Authentication? [N] : N

Configured Client Services: 1


Choose an option:

1: Configure Authorization Service
2: Configure a Proof Proxy
3: Configure an Info Page
4: Configure a Push Service
5: Done Configuring Web Services
Choice [1] : 5


Enable SSL? [N] : Y

Service Port [8080] : 443

Enable SSL Client Authentication? [N] : N

Enable SSL? [N] : N

Modify Advanced Performance Options? [N] : N


Writing server configuration...

Thank you for choosing Ozone Server

Goodbye.


[root@ozoneserver local]# /usr/local/server/bin/startServer.sh
```

## 13.6 Ozone Envoy Installation

Ozone Envoy was installed, but was not utilized in the builds. The functions that it provides (automated certificate revocation lists [CRLs] and certificate collection) were not required in the solution.

Create keys and certificates, and store them in JKS.

```
[root@ozoneenvoy ~]# yum install java
[root@ozoneenvoy ~]# cd /usr/local/
[root@ozoneenvoy local]# tar -xzf ~/Ozone\ Envoy-2014.tar.gz
[root@ozoneenvoy local]# cp ~/envoy.jks envoy/bin/
```

Edit the envoy.txt file to set configuration options

```
### Ozone Suite (c) Pericore, Inc. 2007-2014.
### All rights reserved.

#####
### envoy.txt - Ozone Envoy 2014 Configuration File ###
###
### Author: Jacob Dilles <jdilles@mountaireygroup.com> ###
###
### Date: 1 Jan 2014   ###
###
### Notes: This is a sample Ozone Envoy 4.1.0 Setup Configuration File ###
### demonstrating configuration options for Mobile Enrollment. ###
###
### In a production environment, you should exclude the /pass= ###
### properties and provide them on the command line during setup.###
### After installation is complete, this file should be deleted ###
### or 'chown root; chgrp 0; chmod 000' to secure it. ###
#####

### General Envoy Configuration
```

```
#####
##### Identity Keystore Configuration #####
#####

### This keystore is used for:

### - Authenticating with Ozone Authority
### - Secure log signing
system/identity/store=envoy.jks

##### Authority Listener Configuration

### This web service endpoint listens for push configuration and fetch requests
### from Ozone Authority. It should match what you entered in Ozone Console

#authority/host.name=
authority/port=4242
authority/path=/
authority/mode=ANY

### Authority Web Service Endpoint Logging
authority/log/enable=true
authority/log/path=var/log
authority/log/rollsize=10485760
authority/log/format=CLF

#####
##### Enrollment Configuration #####
#####

### Enable enrollment
enroll/enable=false
```

```
[root@ozoneenvoy bin]# ./startEnvoy.sh
```

May 15, 2015 3:09:04 PM com.pericore.util.ObjectIdentifierFactory\$OIDDataLoader debug

```
INFO: ObjectIdentifierFactory Read 240.165 kb in 14.366 ms; Indexed 2,415 Arcs in 63.198 ms; 2,310(1,054:5) keys => 2.003 kb
```

May 15, 2015 3:09:06 PM com.pericore.util.PericoreProvider jsafeJCEinit

```
POST: [FIPS] FIPS-140 compliance self-test passed.
```

\_\_\_\_\_

| \_\_\_\_\_|

| | \_ \_ \_ \_ \_ \_ \_ \_ \_ \_

| \_ \_| | ' \_ \ \ / / \_ \ | | | |

| | \_ \_ \_ \_| | | | \ v / ( \_ ) | | \_ \_|

| \_ \_ \_ \_ \_ \_ \_ \_| \_ \_| | \_ \_| \ \_ / \ \_ \_ / \ \_ ,

\_ \_ \_ / |

2014 Mobile Edition | \_\_\_/

Ozone(R) Envoy copyright (c) Pericore, Inc. 2007-2014

Fri May 15 15:09:04 EDT 2015

Ozone Envoy Mobile 2014 Setup Utility

Ozone Suite copyright (c) Pericore, Inc. 2007-2014.

All rights reserved.

\*\*\*WARNING\*\*\*

This product MUST be installed by a Pericore Certified Engineer.

Improper configuration of Ozone Envoy Tool may cause security vulnerabilities.

I agree to all terms and conditions set forth by Pericore, Inc. [N] : **y**

envoy.jks

system/identity/store [/usr/local/envoy/bin/envoy.jks] :

Enter password for envoy.jks :

Is the Private Key Alias 'envoy' correct? [Y] : **y**

[POST] Starting Authority Listener: https://ozoneenvoy:4242/ ..... [ OK ]

> :

Return to Ozone Console to complete Ozone Envoy Configuration

## 13.7 Ozone Console Envoy Configuration

Create a proof to store the certificates retrieved by Ozone Envoy:

1. Open Ozone Console.
2. Select an administrator certificate to log in, as shown in Figure 13-12.
3. Select **Proof > New Proof...**
4. Enter a name for the proof.
5. Select the **Schedule**, **Publication Points**, and **Distribution Points**, as shown in Figure 13-12.

Figure 13-12 Ozone New Proof Information

New Proof: Domain Certificates

Information | Peers | Entities | Administrators | Usage Periods | Authentication | Attributes | Contacts

Name  
Domain Certificates , ou=Applications, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test

Superior Proof  
ou=Applications, ou=Master Authorization Group, ou=Ozone, dc=NCCOE, dc=test

Description

Schedule  
Primary Schedule

Digest Type  
Certificate

Publication Points  
Ozone Authority LDAP

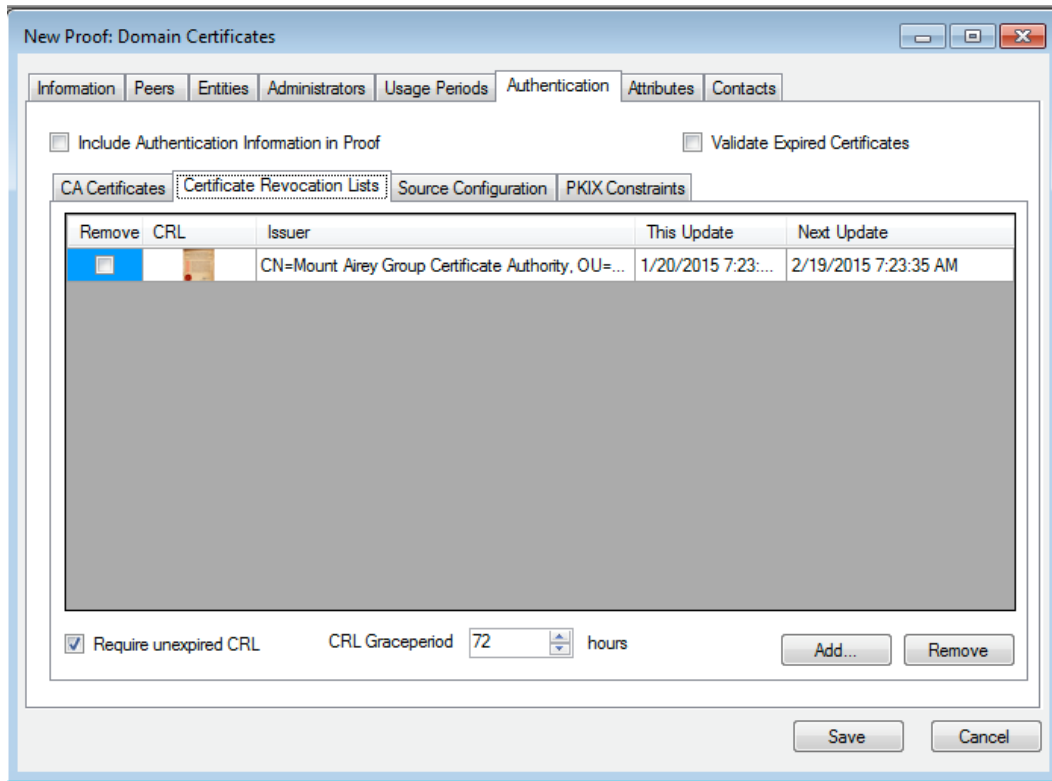
Distribution Points  
LDAP Distribution Point

Proof Type  
☒ Standard 
 ☐ Black List 
 ☐ Gateway

Save Cancel

6. Click the **Administrators** tab.
7. Select the administrators to manage the proof.
8. Click the **Authentication** tab.
9. Click **Add from file....**
10. Select the CA and intermediate CA certificates to be used to authenticate certificates retrieved.
11. Select the **Certificate Revocation Lists** tab, as shown in Figure 13-13.
12. Enter the **CRL Graceperiod**, which is the number of hours that a CRL can be considered valid after its next update time.
13. Click **Add...** to add a CRL.

Figure 13-13 Ozone New Proof Authentication CRLs



14. Select the **Source Configuration** tab, as shown in Figure 13-14.
15. Enter the **Hostname or IP Address** of the LDAP server.
16. Enter the **Port Number** on which the LDAP server is listening.
17. Check the box for LDAPS.
18. Enter the **Entity base context** of where user certificates can be obtained.
19. Enter the **Attribute Name** for the certificates, either `userCertificate` or `userCertificate;binary`.
20. Enter the **CRL Base Context** of where updated CRLs can be obtained.
21. Enter the CRL Attribute Name for the CRLs, typically `certificateRevocationList`, as shown in Figure 13-14.
22. Enter the connection information:
  - a. If connecting anonymously, check the box for **Connect Anonymously**.

- b. If a **Username** and **Password** are required for the connection, enter them.
23. Enter the number of hours after which Ozone Envoy should check the directory for new certificates.

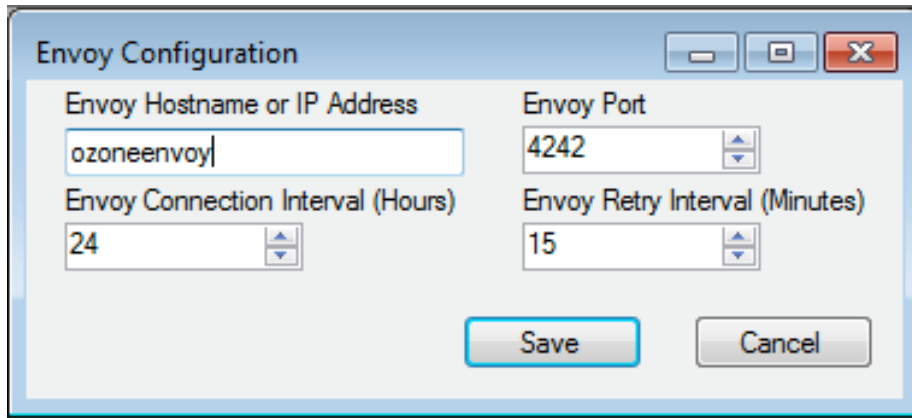
**Figure 13-14 Ozone New Proof Authentication Source Configuration**

24. Click **Save**.

Configure Ozone Authority to connect to Ozone Envoy:

1. Select **Enrollment > Envoy Configuration**.
2. Enter the **Envoy Hostname or IP Address**, as shown in Figure 13-15.
3. Enter the **Port Number** on which Ozone Envoy is listening.
4. Enter the number of hours that should elapse between connections to Ozone Envoy to check for new information (**Envoy Connection Intervals (Hours)**).
5. Enter the number of minutes that should elapse before attempting to reconnect to Ozone Envoy if the connection fails (**Envoy Retry Interval (Minutes)**).
6. Click **Save**.



**Figure 13-15 Ozone Envoy Configuration**

Field	Value
Envoy Hostname or IP Address	ozoneenvoy
Envoy Port	4242
Envoy Connection Interval (Hours)	24
Envoy Retry Interval (Minutes)	15

## 14 Physical Access Control: XTec XNode

The XNode was installed in the DMZ network. The XNode is a standalone IdAM demonstration capability that includes a personal identification verification (PIV) card reader, PIV Interoperable (PIV-I) cards, a keypad, and an electric door strike. The XNode was preconfigured to poll the IP address of the cloud-based IdAM system at the XTec control center. No additional configuration information is required. The identities on the PIV cards each included the access-allowed or access-denied status, for demonstration purposes.

### 14.1 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-1: Identities and credentials are managed for authorized devices and users.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-2, IA Family, PE-2, PE-3, PE-4, PE-5, PE-6, PE-9

## 15 Enterprise Public-Key-Infrastructure Platform: GlobalSign

### 15.1 Overview

The NCCoE used the GlobalSign Enterprise Public Key Infrastructure (PKI) platform to issue and manage North American Energy Standards Board (NAESB) WEQ-12 digital certificates that are used for secure network access for both internal and external users (Figure 15-1). The certificates were used in conjunction with the MAG Ozone product to provide high-assurance attributes for the Personal Profile Application. The application has three main information groups for which actions can be authorized: Personal Information, Credit Reports, and Criminal History. Based on the authorizations associated with a credential, results pages are dynamically populated.



life-cycle functions, including issuance, re-issuance, renewal, and revocation, are available to the administrator.

### 15.1.1 Managing the Account

The account is managed using the [GlobalSign Certificate Center \(GCC\)](#). GCC is a web-based interface allowing members to access their certificates anywhere where they have an internet connection. Within the platform, administrators may add additional users and may delegate some or all certificate management functions.

### 15.1.2 What Is a Profile? / Profile Management

A profile, or certificate profile, contains the organization's identity information that will be used for all NAESB WEQ-12 digital certificates issued from the account. Organization identity information includes the organization legal name, country code, and optionally locality, state, and up to three fixed organization units, as well as assurance level.

### 15.1.3 What Is a License?

GlobalSign NAESB digital certificates are sold in "license packs" (i.e., in quantities of 5, 10, 25, 50, etc.). GlobalSign NAESB digital certificates are valid for either one or two years, and must be issued within 12 months of license ordering.

## 15.2 Security Characteristics

[Cybersecurity Framework Categories](#): PR.AC-1: Identities and credentials are managed for authorized devices and users.

[NIST SP 800-53 Revision 4 Security Controls](#): AC-2, IA Family

## 15.3 How To Order Certificates

### 15.3.1 Step 1: Get a GlobalSign GCC Account

Request a GCC account at <https://www.globalsign.com/en/verticals/energy/>.

### 15.3.2 Step 2: Order Certificate License Pack

Once you have your GCC account credentials, use the following link to log in: [www.globalsign.com/en/login/](http://www.globalsign.com/en/login/) (Figure 15-2).

Figure 15-2 GlobalSign Login Page

Ordering Certificates from GlobalSign is Quick & Easy

User Name :

\* English one byte characters  
e.g) PAR\*\*\*\*\*admin

Password :

\* English one byte characters

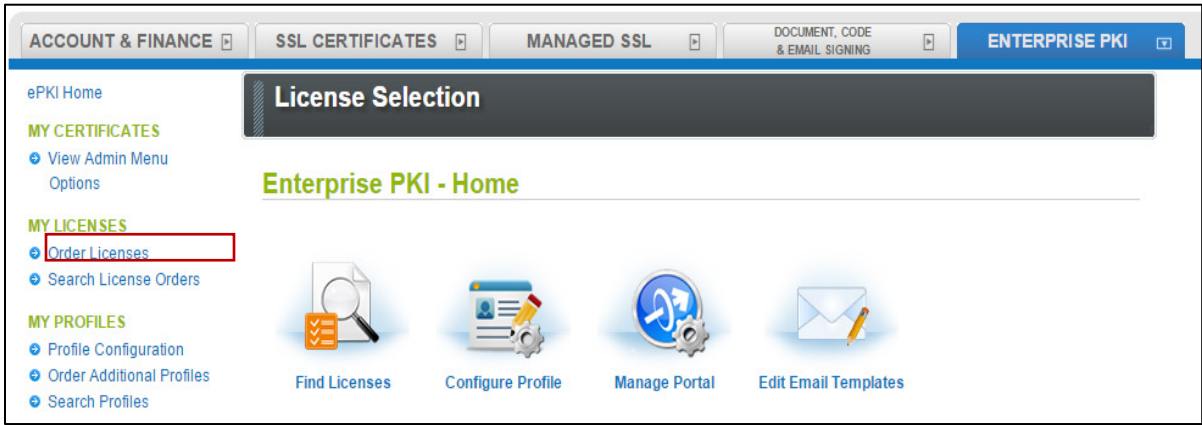
1. Click on the **ENTERPRISE PKI** tab, as shown in Figure 15-3.

Figure 15-3 GlobalSign Enterprise PKI Tab



2. Click **Order Licenses** from the left-side menu, as shown in Figure 15-4.

Figure 15-4 GlobalSign Order Licenses Page



3. Choose the **Enterprise PKI Pro For Personal Digital ID** license pack that you intend to purchase, and then click **Next**, as shown in Figure 15-5.

Figure 15-5 GlobalSign License Selection Page

License Selection

Product Details

Personal Sign

☐ Enterprise PKI Pro For Personal Digital ID 5 pack

☐ Enterprise PKI Pro For Personal Digital ID 10 pack

☐ Enterprise PKI Pro For Personal Digital ID 25 pack

☒ Enterprise PKI Pro For Personal Digital ID 50 pack

Next

4. Choose your validity period (one-year or two-year certificate), as shown in Figure 15-6.

Figure 15-6 GlobalSign Product Details

1. Product Details

2. Completed

Select Product

Payment

Confirm Details

Product Details - Enterprise PKI Pro For Personal Digital ID 50 pack

Certificate Validity Required

Multi-year offers significant per annum savings

☒ 1 year

☐ 2 year

Campaign Code

Redeem code

If you have a Campaign Code please enter and click "Redeem Code". This page will be reloaded with your appropriate discount.

Coupon Code

Redeem code

If you have a one-off Coupon Code for a particular promotion please enter and click "Redeem Code". This page will be reloaded with your appropriate discount.

TOTAL COST (inc. Tax)

\$ 0




5. Provide payment details, as shown in Figure 15-7.

Figure 15-7 GlobalSign Payment Details

**Payment Details**

Purchase Order Number	<input type="text"/> <small>Enter if you have a PO Number. This will be displayed in your Invoice</small>
Payment Method	<input type="radio"/> Payment in arrears <input checked="" type="radio"/> Credit Card

Credit Card Details & Billing Address



6. Confirm your order details, and check the required box to confirm that you understand that the license pack will expire 12 months from the order date (Figure 15-8).

Figure 15-8 GlobalSign Confirm Details

**Confirm Details**

License Details

Product	Enterprise PKI Pro For Personal Digital ID 50 pack
Certificate Validity	1 year
Campaign Code	
Coupon Code	
TOTAL COST (inc. Tax)	\$ 0

Payment Details

Purchase Order Number	<input type="text"/>
-----------------------	----------------------

Others

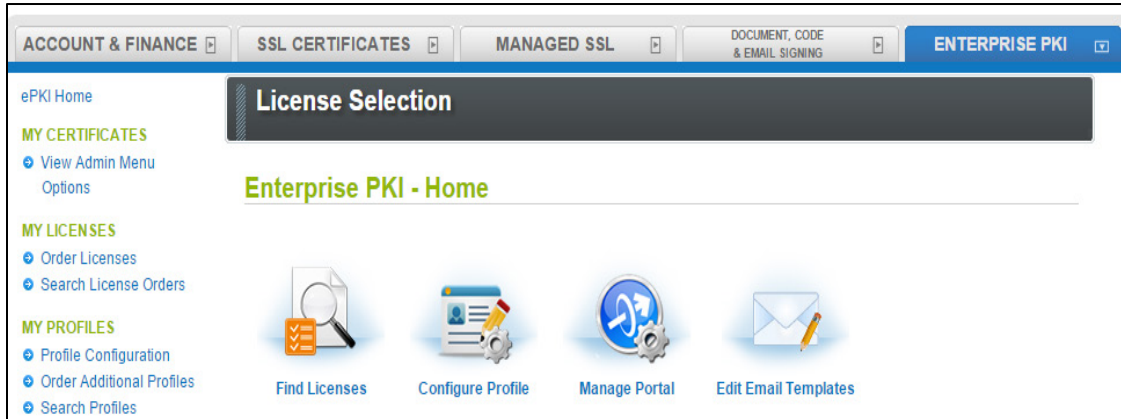
Special Instructions	<input type="text"/>
----------------------	----------------------

☒ **Required** I understand that this license pack will expire 12 months from the order date.

### 15.3.3 Step 3: Set Up Organization Profile

1. Click **Order Additional Profiles** from the left navigation menu, as shown in Figure 15-9.

**Figure 15-9 GlobalSign Order Additional Profiles**



2. Enter your Organization Profile details. Note that the details that you enter will be vetted and included as the certificate identity within your issued certificate (Figure 15-10).
3. Select the **Assurance Level** that is appropriate for the risk associated with the transaction (Figure 15-10). Contact GlobalSign NAESB experts for additional guidance on this topic.

Figure 15-10. GlobalSign Certificate Profile Details

### Certificate Profile Details

These details will be vetted and included as the certified identity within your issued Certificate. Make sure the details entered are correct - we will vet the details you include. To assist you, some details will be pre-populated from previous pages or from your GCC account details, you may overwrite these if needed.

Note: Within the form below you have the ability to define the certificates DistinguishedName (DN). One optional element is a freeform Organizational Unit (OU) description. The OU field allows you to enter a value that suits your business needs with a description such as "Marketing Team Building 5" for example. It is not mandatory to enter this but please note that if you choose to 'Lock a unique OU' then this means that the description you have chosen cannot be used again and is unique to this profile. An example of where you might choose to do this is for client authentication situations where each certificate needs one or two fixed unique strings to allow access such as 'O' and 'OU'.

<b>Organization</b> <small>Required</small>	<input type="text" value="Your company legal name"/>
<b>Organizational Unit</b> <small>Optional unless locked as unique</small>	<input type="text"/> <input type="text"/> <input type="checkbox"/> Lock a unique OU
<b>Locality</b> <small>Optional</small>	<input type="text"/>
<b>State or Province</b> <small>Optional</small>	<input type="text"/>
<b>Country</b> <small>Required</small>	<input type="text" value="United States - US"/>
<b>Assurance Level</b>	<input type="radio"/> RUDIMENTARY <input checked="" type="radio"/> BASIC <input type="radio"/> MEDIUM <input type="radio"/> HIGH

Next

- Confirm your profile details (Figure 15-11), and then review and accept the EPKI Service Agreement, which includes important NAESB WEQ-012 obligations. Note that the EPKI Service Agreement binds you to obligations, as outlined in the GlobalSign Certificate Policy and Certificate Practice Statements, including Local Registration Authority, end user, and relying party, as defined in the NAESB PKI Standards – WEQ-012.

Certificate Practice Statements can be found at <http://www.globalsign.com/repository/>.



Figure 15-11 GlobalSign Confirm Details

### Confirm Details

Lock a unique OU	
Organization	Your company legal name
Organizational Unit	
State or Province	NH
Locality	Portsmouth
Country	United States - US
Assurance Level	RUDIMENTARY

ePKI Service Agreement

GlobalSign ePKI Service Agreement - Version 2.4

#### 15.3.4 Step 4: Vetting

Once you have placed your order, all of your information will be sent to GlobalSign’s vetting department. The organization details that you provided for your profile will be vetted by GlobalSign, using third-party checks.

#### 15.3.5 Step 5: Register for Your EPKI Administrator Certificate

Once your company profile has been approved, you will need to register for an EPKI Administrator Certificate. An EPKI Administrator Certificate is required for authentication to secure areas of the EPKI service to register and manage end-user certificates.

1. Log into GCC.
2. Select **View Admin Menu Options** in the left-side menu to start the enrollment process (Figure 15-12).

Figure 15-12 GlobalSign View Admin Menu Options

ACCOUNT & FINANCE
SSL CERTIFICATES
MANAGED SSL
DOCUMENT, CODE & EMAIL SIGNING
ENTERPRISE PKI

ePKI Home

MY CERTIFICATES
View Admin Menu Options

License Selection
Enterprise PKI - Home

3. Choose a certificate password. It is very important to remember this password.
4. Download your administrator certificate, and follow the on-screen prompts to install your certificate.

- Follow the guide at <http://www.globalsign.com/support/ordering-guides/epki-authentication-user-guide.pdf> for step-by-step instructions on how to order, install, and use your Administrator Certificate.

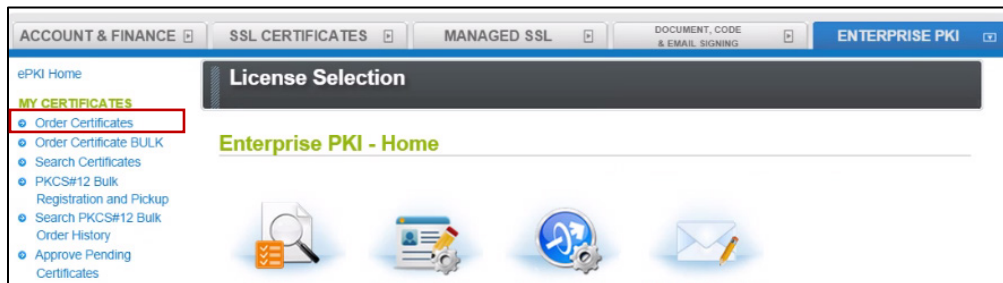
CAUTION: If you need to access the EPKI administrator menu options from multiple machines, you can copy your .pfx file to other computers and repeat the import process. Instructions for importing your certificate can be found at <https://support.globalsign.com/customer/portal/articles/1211387>.

### 15.3.6 Step 6: Register and Issue Certificates to Individual Users

- Click **Order Certificates** in the left-side menu, as shown in Figure 15-13.

Note: If you haven't already authenticated to the secure section of the portal with your Administrator Certificate, you may see **View Admin Menu Options**, instead of the menu options that are shown in Figure 15-13. If this is the case, then click the **View Admin Menu Options** link, and then select the appropriate certificate to gain access to this section of the portal.

Figure 15-13 GlobalSign Oder Certificates



- Select the profile and license that you want to use, and then click **Next** (Figure 15-14).

Figure 15-14 GlobalSign Product Selection

ACCOUNT & FINANCESSL CERTIFICATESMANAGED SSLDOCUMENT, CODE & EMAIL SIGNINGENTERPRISE PKI

ePKI Home

MY CERTIFICATES

Order Certificates

Order Certificate BULK

Search Certificates

PKCS#12 Bulk

Registration and Pickup

Search PKCS#12 Bulk

Order History

Approve Pending Certificates

MY LICENSES

Order Licenses

Search License Orders

MY PROFILES

Profile Configuration

Order Additional Profiles

Search Profiles

MY ORDERING PORTAL

Portal Configuration

EMAILS

Manage E-mail

Templates

Product Selection

1. Product Details

2. Completed

Select Profile

Certificate Identity Details

Confirm Details

Product Details

Profile

Profile ID	BaseDN	Organization	Organization Unit	Assurance Level
<input checked="" type="radio"/> MPP201410132058	Disabled	GMO GlobalSign Inc.	GSUS NCCoE NIST Energy IDaM test account	BASIC

License

Service	License Unused number
<input checked="" type="radio"/> Enterprise PKI Pro For Personal Digital ID 1 year	57

Next

3. Complete the **Certificate Identity details** (Figure 15-15) for the end user of the certificate, including the **Common Name** (i.e., the individual’s first name and last name) and the **Email Address**. The organization name and other fields will be pre-populated from the profile that you selected.

Figure 15-15 GlobalSign Certificate Identity Details

Certificate Identity Details

Common Name <small>Required</small>	<input type="text"/>
Organization	GMO GlobalSign Inc.
Organizational Unit [Profile]	GSUS NCCoE NIST Energy IDaM test account
Organizational Unit	<input type="text"/>
Locality	Portsmouth
State or Province	NH
Country	United States - US
Email Address <small>Required</small>	<input type="text"/>

Option certificate delivery method - Select only 1

<div>I have an externally generated CSR</div> <div>Check only if you are an Advanced User and have an externally generated Certificate Signing Request (CSR)</div>	<input type="checkbox"/>
--	--------------------------

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You will also need to choose a pick-up password. The pick-up password is a unique password that you will give to the end user of the certificate. After you have completed the registration process, the end user will receive an email invitation to pick up their certificate; at that time, the end user will be prompted for the pick-up password (you gave to them in an out-of-band method), and will be provided with details of how to install his/her new certificate.

4. Finally, confirm the details of your certificate request, as shown in Figure 15-16.

**Figure 15-16 GlobalSign Confirm Details**

### Confirm Details

#### Product Details

Profile ID	MPP201410132058
License ID	MPL201410133096

#### Certificate Identity Details

Common Name	Julie O
Organization	GMO GlobalSign Inc.
Organizational Unit	GSUS NCCoE NIST Energy IDaM test account
Locality	Portsmouth
State or Province	NH
Country	United States - US
Email Address	julie0@globalsign.com
Encrypting File System	Disabled
MS SmartCard Logon	
I have an externally generated CSR	Disabled
PKCS12 Option	Disabled
Memo	

5. Repeat this process until you have requested certificates for all of your end users.

For further information on the features available in the GlobalSign Certificate Center, see <http://www.globalsign.com/support/ordering-guides/globalsign-epki-admin-guide.pdf>.

## 15.4 GlobalSign's Identity and Access Management Solution for Managing External Users

For use cases involving external users (e.g., Independent System Operators) operating wholesale electric marketplaces, GlobalSign PKI can provide an IdAM solution that enables the management of external user (customer and collaborator) identities, and the online services and applications that they can access.

## 15.5 Getting Help

GlobalSign provides technical support through its Client Service departments around the world. Visit <https://support.globalsign.com/> for detailed instructions on installing and managing certificates, or contact [support@globalsign.com](mailto:support@globalsign.com) or 1-877-467-7543 with specific questions.

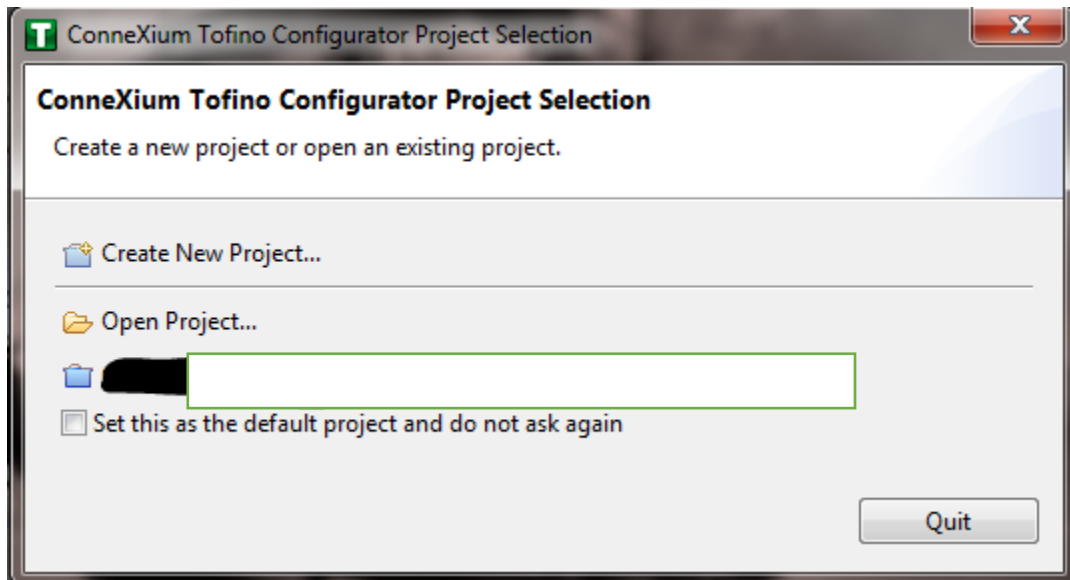
## 16 Industrial Firewall: Schneider Electric

A Schneider Electric industrial firewall is installed on the physical network that contains the ICS/SCADA components that can be accessed and controlled via the OT network. The firewall is configured to monitor the data passing between the RADiFlow SCADA firewall and the OT network. The Schneider Electric industrial firewall will alert if out-of-policy traffic is detected on the network segment connecting the OT network and the SCADA network of devices.

To install and configure the Schneider Tofino firewall, follow these steps:

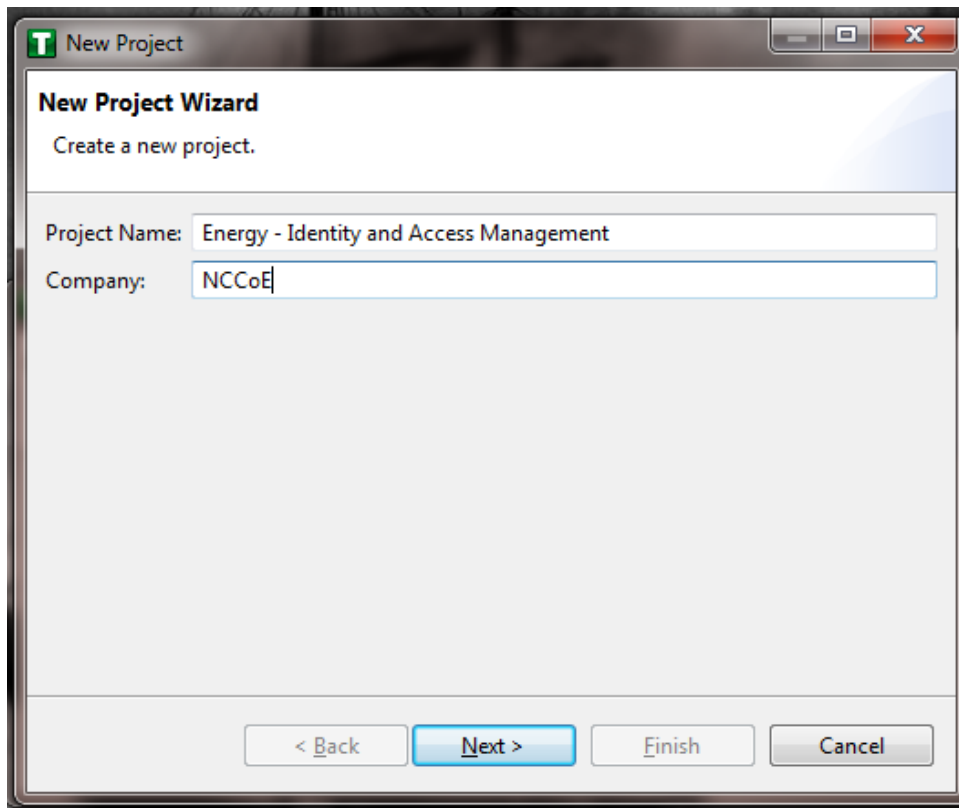
1. Download the ConneXium software from the Schneider site, as stated in the instructions accompanying the firewall, and then start the ConneXium Tofino Configurator.
2. In the startup screen, click **Create New Project...** (Figure 16-1).

Figure 16-1 Create New Project



3. In the **Project name** field, enter the name that you would like to use for the project, as shown in Figure 16-2. Also fill in the **Company** field. When finished, click **Next**.

Figure 16-2 New Project Wizard



**New Project Wizard**  
Create a new project.

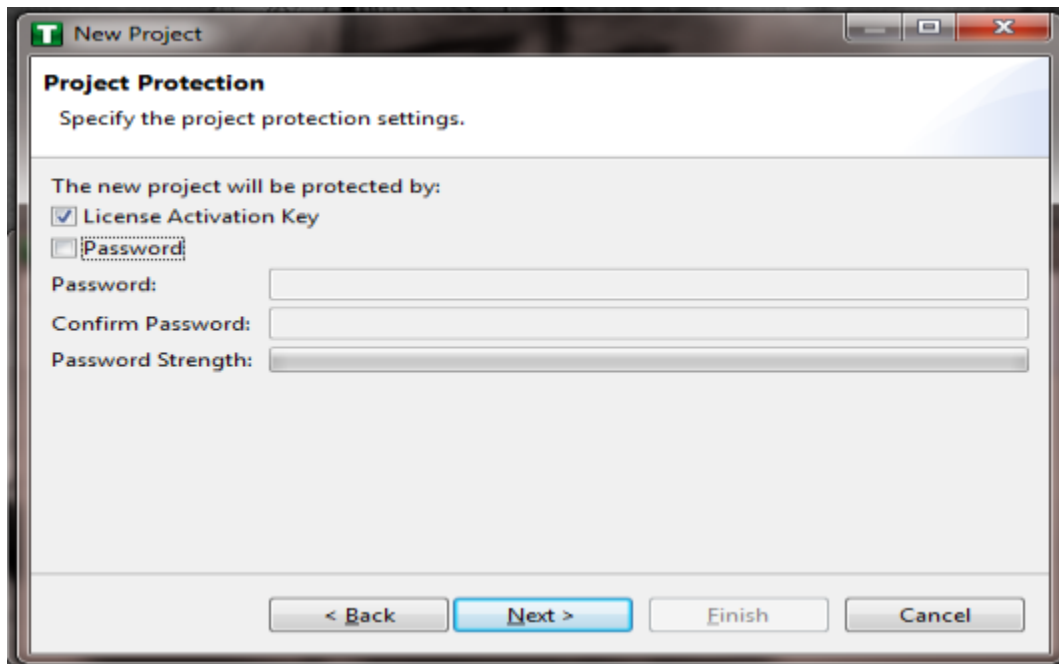
Project Name: Energy - Identity and Access Management

Company: NCCoE

< Back   Next >   Finish   Cancel

4. In the **Project Protection** screen (Figure 16-3), choose a password to protect the project, and then click **Next**.

Figure 16-3 Project Protection



5. In the Administrator Password screen (Figure 16-4), choose the administrator password, and then click **Finish**.



Figure 16-4 Administrator Password

**New Project**

**Administrator Password**

Specify the project Administrator Password.

☐ Use Administrator Password

Password:

Confirm Password:

Password Strength:

**IMPORTANT: You cannot use the administrator password to recover a lost project password.**

Use the administrator password feature to prevent specific changes to the project file. When set, the administrator password will be required to move the project file or change the project protection settings.

< Back   Next >   Finish   Cancel

6. In the Project Explorer Window (Figure 16-5), right-click **Tofino SAs**, and then click **New Tofino SA**.

Note: You can also choose to create a folder for the SAs to help organize multiple areas.



Figure 16-6 Tofino SA/MAC Address

**New Tofino SA**

**Tofino SA**  
Create a new Tofino SA

Tofino ID:

Name:

Description:

General Location:

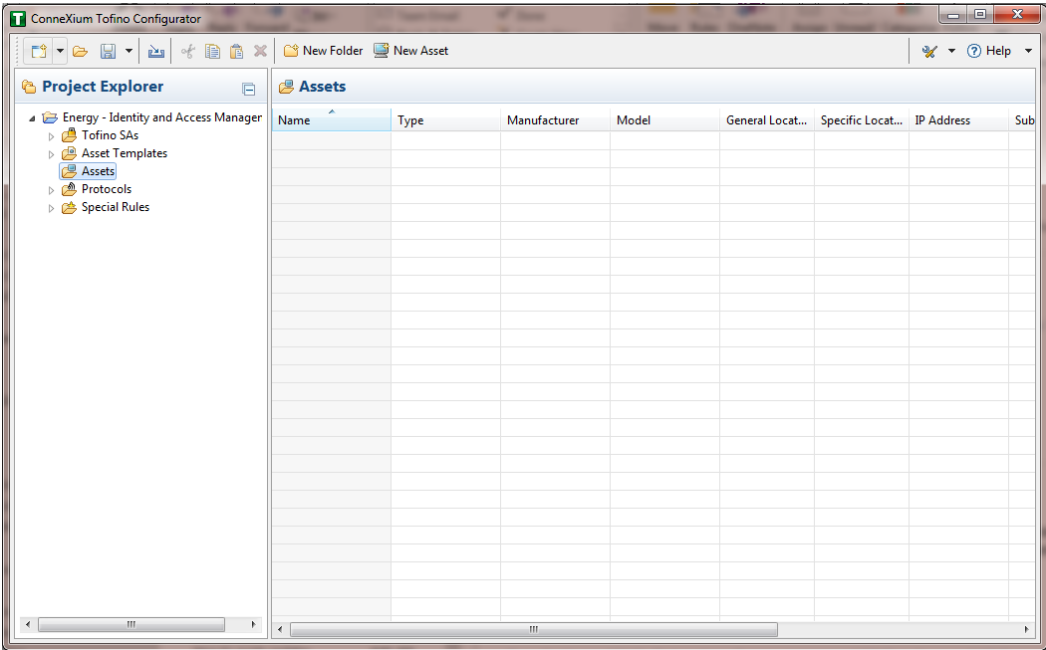
Specific Location:

Mode:

< Back   Next >   **Finish**   Cancel

8. Right-click on the **Assets** icon in the Project Explorer frame (Figure 16-7), and then click **New Asset**.

Figure 16-7 Project Explorer



9. In the New Asset window (Figure 16-8), set the **Name** of the device and the **Type** of the device. Complete all other necessary fields, and then click **Next**.

Figure 16-8 New Asset

**Asset**  
Create a new asset.

Name: New Asset

Type: Computer

Description:

Manufacturer:

Model:

General Location:

Specific Location:

Asset Tag:

< Back Next > Finish Cancel

10. Fill in the IP address and/or the MAC address fields (refer back to [Figure 16-6](#)), and then click **Finish**.
11. Repeat Steps 8 through 10 for all devices on the network. When all devices are configured, click the **Assets** icon in the **Project Explorer** frame (Figure 16-9), if it is not already selected, and then there should be a list of all of the configured assets.

### Figure 16-9 Project Explorer Assets Icon

**ConneXium Tofino Configurator**

Project Explorer

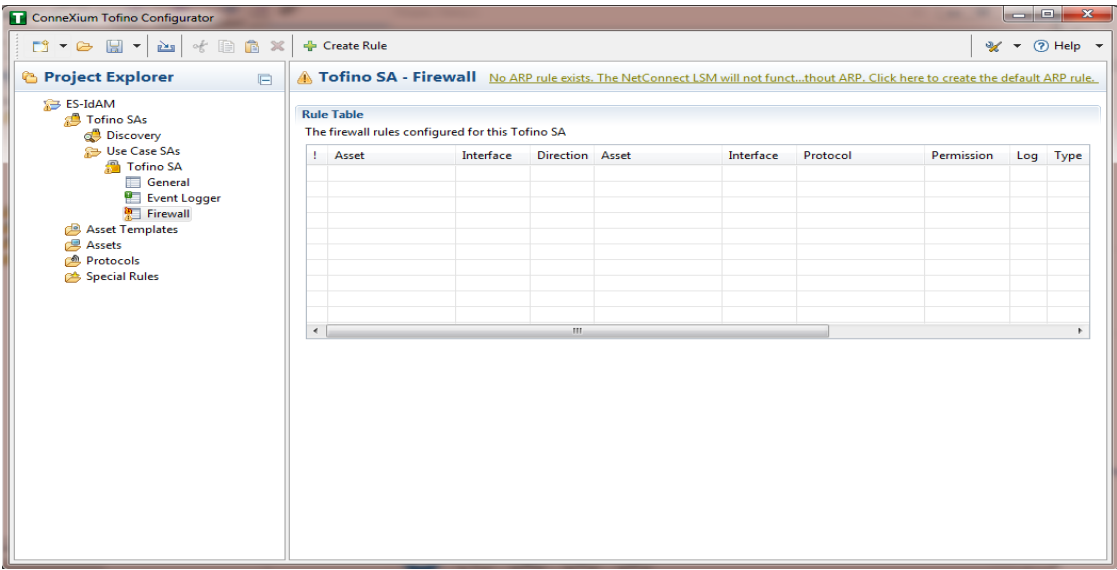
- ES-IdAM
  - Tofino SAs
  - Asset Templates
  - Assets**
  - Protocols
  - Special Rules

Assets

Name	Type	Manufacturer	Model	General Locat...	Specific Locat...	IP Address
OT - HMI Workstation	Computer			VM Network	OT Network	172.16.6.6
RADiFlow 3180	Network Equipm...	RADiFlow	3180	Lab 2	On top of rack	172.16.6.4
RaspberryPi Modbus	Controller	??	??	Lab2	On Desk?	172.16.6.10
SEL-2411	Controller	Schweitzer	SEL-2411	Lab2	On top of Net...	172.16.6.100

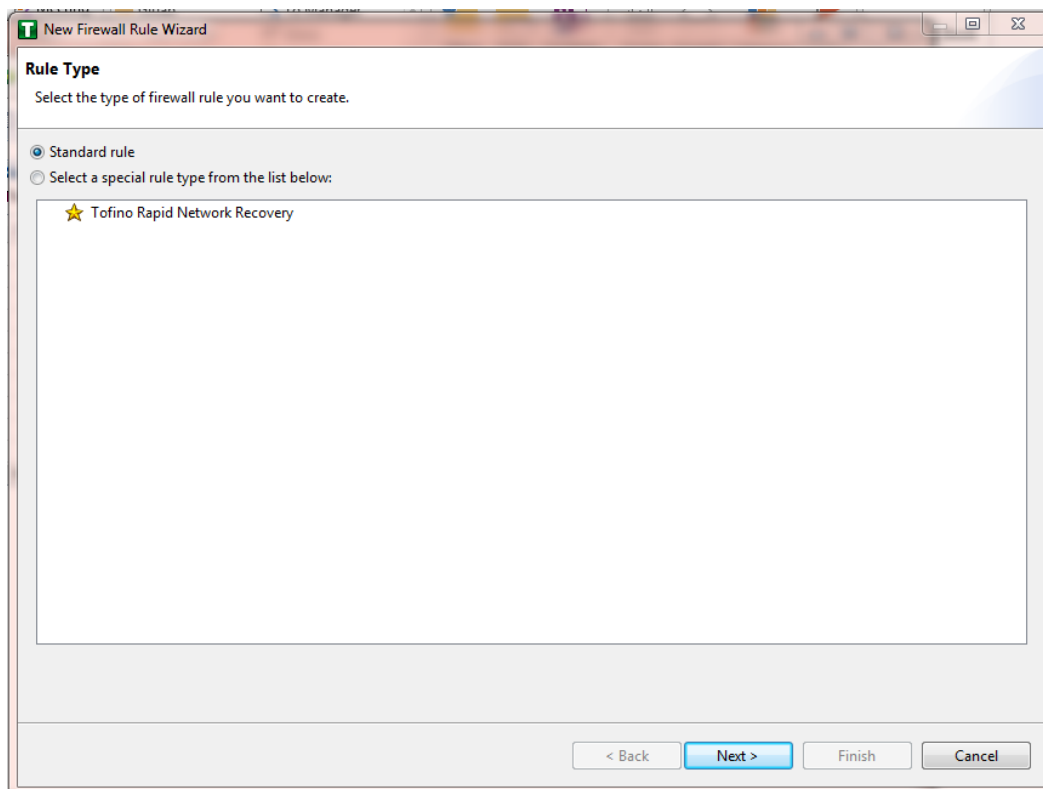
- Under the Project Explorer frame, click the drop-down arrow next to **Tofino SAs**, and then choose the SA that was created earlier (Figure 16-10). From there, click **Firewall** in the Project Explorer frame to display the current firewall rules. This should be empty currently (Figure 16-10).

Figure 16-10 Project Explorer Tofino SA Icon



13. To create the first rule, click the + **Create Rule** button above the Tofino SA – Firewall title (refer back to [Figure 16-6](#)). Ensure that the **Standard rule** radio button is selected, and then click **Next** (Figure 16-11).

Figure 16-11 Rule Type



14. On the next screen (Figure 16-12), there are a few options to determine. The first is Asset 1; you must choose the interface. This will be where the traffic is coming from into the device. In the Lab Build, Asset 1 is the OT Workstation, which is connected to a network that is connected to the External interface on the firewall. Select the **Select an asset from the list below** radio button for both Asset 1 and Asset 2, and then select the systems to create a rule between the assets. Also, select the direction of the traffic by using the arrow buttons in the middle of the screen, between the assets. When finished, select **Next**.



Figure 16-12 Firewall Rule Wizard

**Assets**  
Select the assets involved in this firewall rule.

**Asset 1**  
Interface: External

☐ Any  
☐ IP Address: . . .  
☐ MAC Address: : : : : :  
☒ Select an asset from the list below:

Name	IP Address	MAC Address
OT - HMI Worl	172.16.6.6	00:00:00:00:00:00
RADiFlow 3180	172.16.6.4	00:00:00:00:00:00
RaspberryPi M	172.16.6.10	00:00:00:00:00:00
SEL-2411	172.16.6.100	00:00:00:00:00:00

**Direction**

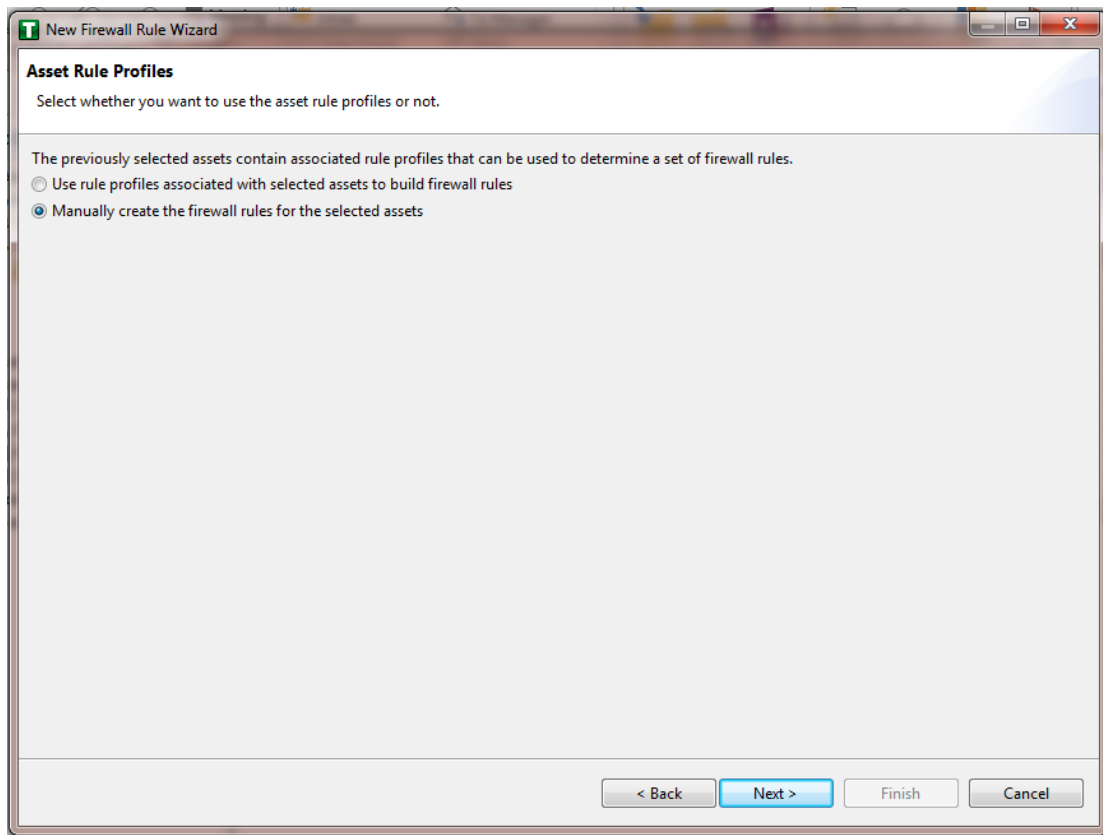
☐ Any  
☐ IP Address: . . .  
☐ MAC Address: : : : : :  
☒ Select an asset from the list below:

Name	IP Address	MAC Address
OT - HMI Worl	172.16.6.6	00:00:00:00:00:00
RADiFlow 3180	172.16.6.4	00:00:00:00:00:00
RaspberryPi M	172.16.6.10	00:00:00:00:00:00
SEL-2411	172.16.6.100	00:00:00:00:00:00

< Back   Next >   **Finish**   Cancel

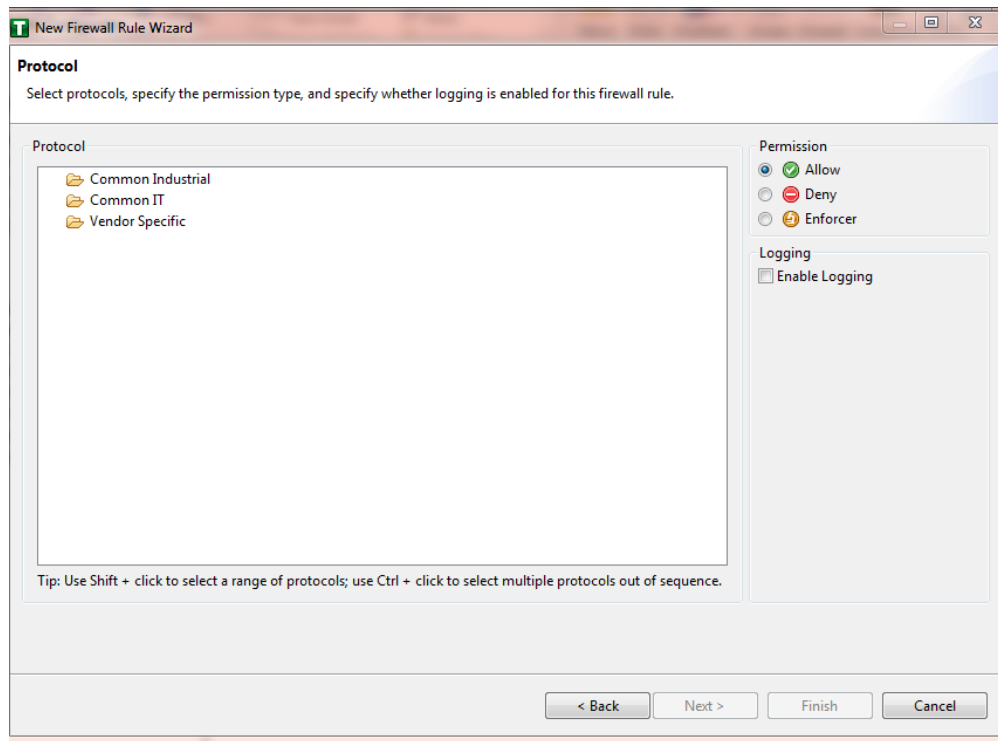
15. On the Asset Rule Profiles (Figure 16-13), select the **Manually create the firewall rules for the selected assets** radio button, and then click **Next**.

Figure 16-13 Asset Rule Profiles



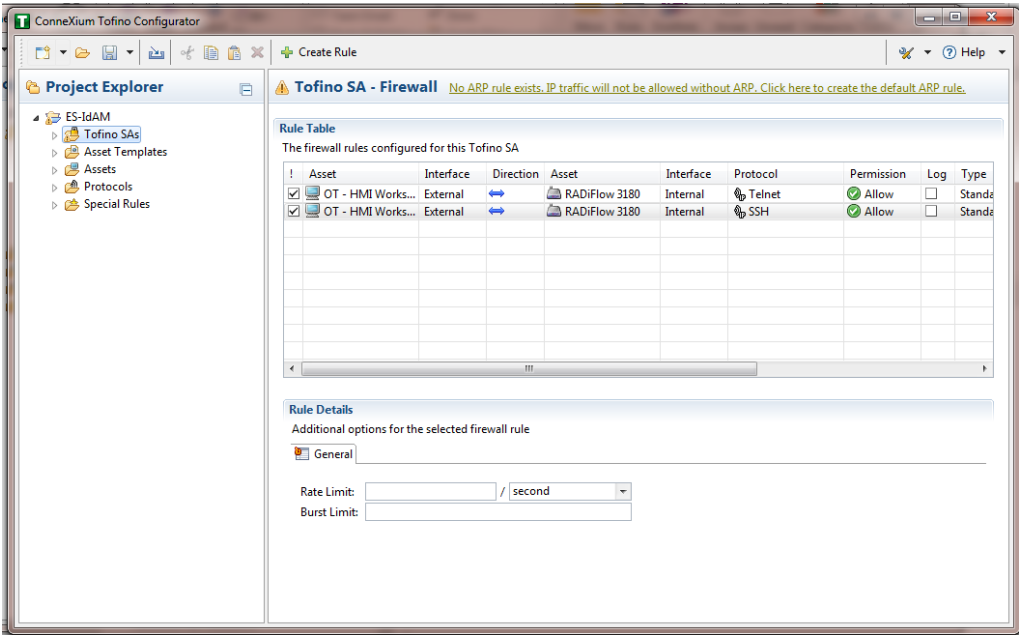
16. On the Protocol screen (Figure 16-14), choose the protocol to be checked against. There are drop-down menus for **Common Industrial**, **Common IT**, and **Vendor Specific**. For this example, we are choosing **SSH** and **Telnet** (By holding the CTRL key, you can select multiple protocols.). Choose the permission on the right side of the screen, as well as whether or not to enable logging. Click **Finish**.

Figure 16-14 Protocol Window



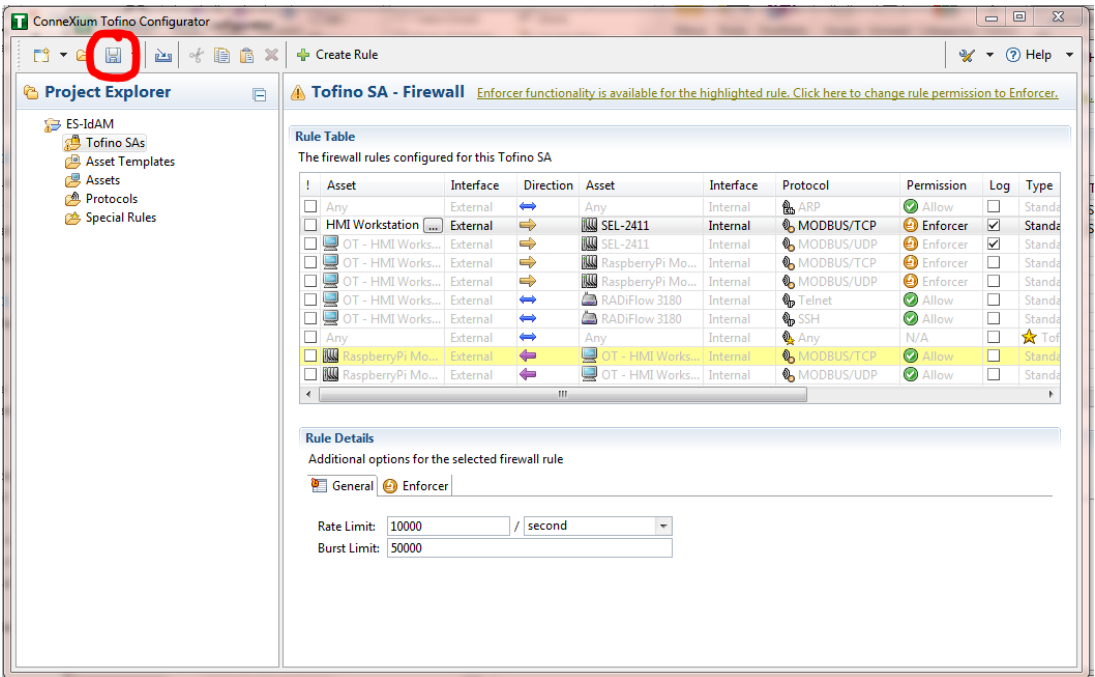
Note: By default, any traffic that does not match the rules in the firewall will automatically be denied. After that is completed, the firewall rule should be listed in the Rule Table (Figure 16-15).

Figure 16-15 Rule Table



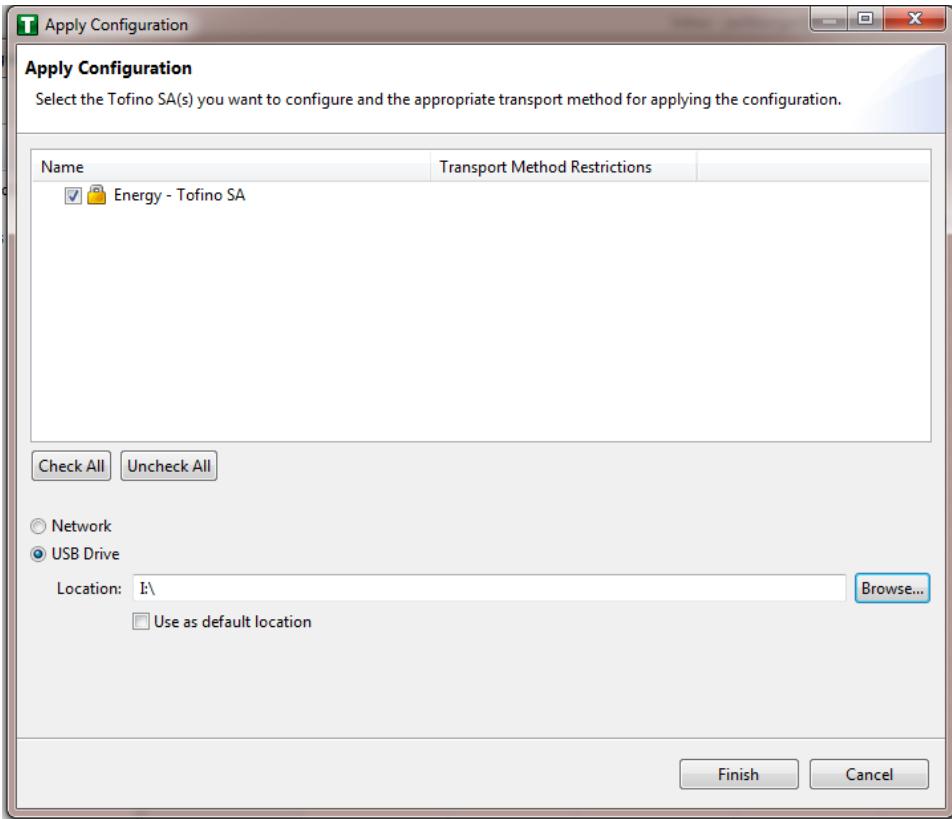
- 17. Repeat Steps 13 through 17 for the remainder of the rules needed.
- 18. Finally, click the save icon on the menu bar (circled in red below in Figure 16-16).

Figure 16-16 Save Rules in Project Explorer



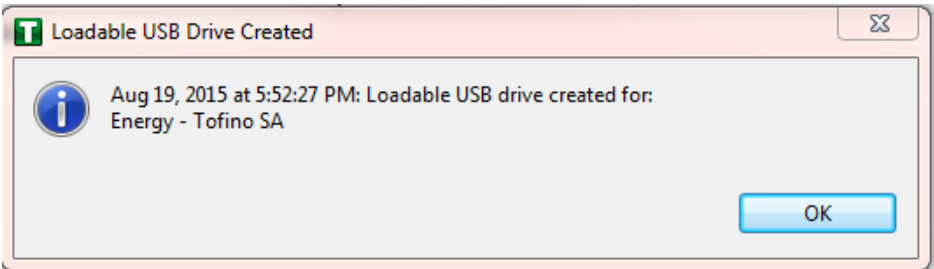
19. Place a FAT/FAT32 formatted USB device into the computer running the ConneXium Tofino Configurator, right-click Tofino SAs in the Project Explorer pane, and then select **Apply**. If the project asks you to save, click **OK**.

Figure 16-17 Apply Configuration Pane



20. In the Apply Configuration pane (Figure 16-17), ensure that your SA is selected in the table at the top, and that the **USB Drive** radio button is selected. Browse to the top-level directory of your USB drive, and then click **Finish**.
21. A popup window (Figure 16-18) will notify you of successful completion.

Figure 16-18 Loadable USB Drive Popup



22. Ensure that the firewall has been powered on and has been running for at least one minute, and then plug the USB device that was used to copy the Tofino configuration into the USB port on the back of the firewall.
23. Press the **Save/Load/Reset** button twice, setting it to the Load setting (Pressing it once should turn the indicator light to green; pressing it again will change the indicator light from green to amber). After a few seconds, the device will begin displaying lights that move from right to left across the light-emitting diodes (LEDs) on the back, indicating that the configuration is being loaded.
24. Once the lights stop moving from right to left, wait a few seconds, and ensure that the Fault LED does not light up. Remove the USB drive, and place it back into the computer running the ConneXium Tofino Configurator software.
25. Right-click **Tofino SAs** in the Project Explorer pane, and then select **Verify**.
26. At the Verify Loaded Configuration window, select the Tofino SA in the table, and then select the **USB Drive** radio button. Select the USB drive by using the **Browse** button. Finally, click **Finish**. A popup window will notify you of successful verification, and that configuration is complete.

## 17 Operating System STIG Compliance Reports

STIG compliance reports were generated for the STIG-compliant OS installations used in the build. The reports for each installation are provided in the following subsections. Neither the Windows 7 Console on the IT network nor the OT Management Windows 7 Workstation on the OT network were STIG-compliant installations; therefore, compliance reports for those OSs are not provided.

The Linux implementations (except SUSE Linux) were configured to meet the DoD CentOS 6 STIG, as no CentOS 7 STIG was available at the time the build was implemented. The STIG guidelines are available at <http://iase.disa.mil/stigs/os/Pages/index.aspx>. The OS configurations for each Linux implementation are listed below. The compliance results reports identify the configuration items that do not conform to the STIG configuration guide.

This section provides compliance reports for the following Oss:

- [SQL Server on IdAM Network STIG Compliance Report](#)
- [RSA IMG SUSE Linux Server STIG Compliance Report](#)
- [RSA Adaptive Directory CentOS 7 Server STIG Compliance Report](#)
- [AlertEnterprise Microsoft Server STIG Compliance Report](#)
- [IT Domain Controller STIG Compliance Report](#)
- [IT Windows 7 Workstations STIG Compliance Report](#)

- [Ozone Authority and Ozone Server CentOS 6 Server STIG Compliance Report](#)
- [Ozone Envoy CentOS 6 Server STIG Compliance Report](#)
- [OT Domain Controller STIG Compliance Report](#)
- [OT ConsoleWorks Windows Server 2012 STIG Compliance Report](#)
- [OT Windows 7 Workstations STIG Compliance Report](#)
- [PACS Domain Controller STIG Compliance Report](#)
- [PACS Console Windows Server 2012 STIG Compliance Report](#)
- [Baseline CentOS 7 Linux Configuration](#)

## 17.1 SQL Server on IdAM Network STIG Compliance Report

Status	STIG ID	Rule ID	Vulnerability ID	Severity	Rule Title
N/A	SQL2-00-000300	SV-53912r1_rule	V-41389	CAT II	SQL Server must maintain and support organization-defined security labels on stored information.
N/A	SQL2-00-000400	SV-53914r1_rule	V-41391	CAT II	SQL Server must maintain and support organization-defined security labels on information in process.
N/A	SQL2-00-000500	SV-53916r1_rule	V-41392	CAT II	SQL Server must maintain and support organization-defined security labels on data in transmission.
N/A	SQL2-00-000900	SV-53917r1_rule	V-41393	CAT II	SQL Server must allow authorized users to associate security labels to information in the database.
N/A	SQL2-00-00920	SV-53920r1_rule	V-41395	CAT II	SQL Server must be protected from unauthorized access by developers.
N/A	SQL2-00-009300	SV-53921r1_rule	V-41396	CAT II	SQL Server must be protected from unauthorized access by developers on shared production/development host systems.
PASS	SQL2-00-00950	SV-53922r2_rule	V-41397	CAT II	Administrative privileges, built-in server roles, and built-in database roles must be assigned to the DBMS login accounts that require them via custom roles, and not directly.



Status	STIG ID	Rule ID	Vulnerability ID	Severity	Rule Title
PASS	SQL2-00-011050	SV-53918r2_rule	V-41394	CAT II	SQL Server utilizing Discretionary Access Control (DAC) must enforce a policy that limits propagation of access rights.
UNKNOWN What is considered auditable?	SQL2-00-011200	SV-53928r2_rule	V-41402	CAT II	SQL Server must provide an audit-record-generation capability for organization-defined auditable events within the database.

## 17.2 RSA IMG SUSE Linux Server STIG Compliance Report

### *OpenSCAP Evaluation Report*

#### 17.2.1 Evaluation Characteristics

- Target machine: dvd-acm
- Benchmark URL: U\_RedHat\_6\_V1R6\_STIG\_SCAP\_1-1\_Benchmark-xccdf.xml
- Performed by: root

#### 17.2.2 Compliance and Scoring

**The target system did not satisfy the conditions of 107 rules!** Furthermore, the results of 12 rules were inconclusive. Please review the rule results (Section 17.2.3) and consider applying remediation.

#### 17.2.3 Rule Results

- Passed: 60 rules
- Failed: 107 rules
- Other: 12 rules

#### 17.2.4 Severity of Failed Rules

- Other: 0 rules
- Low: 53 rules
- Medium: 53 rules
- High: 1 rule

## 17.2.5 Score

System	Score	Maximum Score	Score as Percentage	Bar
urn:xccdf:scoring:default	33.519554	100.000000	33.52%	

Search

Title	Severity	Result
<b>Red Hat Enterprise Linux 6 Security Technical Implementation Guide</b> 107x fail 12x error		
<b>SRG-OS-999999</b> 1x error		
Automated file system mounting tools must not be enabled unless needed.	low	error
<b>SRG-OS-000062</b> 1x fail		
Auditing must be enabled at boot by setting a kernel parameter.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The /etc/gshadow file must be owned by root.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The /etc/gshadow file must be group-owned by root.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The /etc/gshadow file must have mode 0000.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a separate file system for /tmp.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a separate file system for /var.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a separate file system for /var/log.	low	fail
<b>SRG-OS-000259</b> 1x fail		
Library files must be owned by root.	medium	fail
<b>SRG-OS-000044</b> 1x fail		
The system must use a separate file system for the system audit data path.	low	fail

Title	Severity	Result
<b>SRG-OS-000045</b> 1x fail		
The audit system must alert designated staff members when the audit storage volume approaches capacity.	medium	fail
<b>SRG-OS-000259</b> 1x fail		
All system command files must be owned by root.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a separate file system for user home directories.	low	fail
<b>SRG-OS-000078</b> 1x fail		
The system must require passwords to contain a minimum of 14 characters.	medium	fail
<b>SRG-OS-000075</b> 1x fail		
Users must not be able to change passwords more than once every 24 hours.	medium	fail
<b>SRG-OS-000076</b> 1x fail		
User passwords must be changed at least every 60 days.	medium	fail
<b>SRG-OS-000071</b> 1x fail		
The system must require passwords to contain at least one numeric character.	low	fail
<b>SRG-OS-000103</b> 1x fail		
The system package management tool must cryptographically verify the authenticity of system software packages during installation.	medium	fail
<b>SRG-OS-000232</b> 1x fail		
A file integrity tool must be installed.	medium	fail
<b>SRG-OS-000273</b> 1x fail		
The operating system must enforce requirements for the connection of mobile devices to operating systems.	medium	fail
<b>SRG-OS-000248</b> 1x fail		
There must be no .rhosts or hosts.equiv files on the system.	high	fail

Title	Severity	Result
<b>SRG-OS-000249</b> 1x fail		
The system must disable accounts after excessive login failures within a 15-minute interval.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The /etc/shadow file must be group-owned by root.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The /etc/shadow file must have mode 0000.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
IP forwarding for IPv4 must not be enabled, unless the system is a router.	medium	fail
<b>SRG-OS-000146</b> 1x error		
The operating system must prevent public IPv4 access into an organizations internal networks, except as appropriately mediated by managed interfaces employing boundary protection devices.	medium	error
<b>SRG-OS-000231</b> 1x fail		
The systems local IPv4 firewall must implement a deny-all, allow-by-exception policy for inbound packets.	medium	fail
<b>SRG-OS-000096</b> 1x fail		
The Datagram Congestion Control Protocol (DCCP) must be disabled unless required.	medium	fail
<b>SRG-OS-000096</b> 1x fail		
The Stream Control Transmission Protocol (SCTP) must be disabled unless required.	medium	fail
<b>SRG-OS-000096</b> 1x fail		
The Reliable Datagram Sockets (RDS) protocol must be disabled unless required.	low	fail
<b>SRG-OS-000096</b> 1x fail		
The Transparent Inter-Process Communication (TIPC) protocol must be disabled unless required.	medium	fail
<b>SRG-OS-000215</b> 1x fail		
The operating system must back up audit records on an organization-defined frequency, onto a different system or media than the system being audited.	medium	fail

Title	Severity	Result
<b>SRG-OS-000043</b> 1x fail		
The operating system must support the requirement to centrally manage the content of audit records generated by organization-defined information system components.	medium	fail
<b>SRG-OS-000062</b> 1x fail		
The audit system must be configured to audit all attempts to alter system time through <code>settimeofday</code> .	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not accept IPv4 source-routed packets on any interface.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not accept ICMPv4 redirect packets on any interface.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not accept ICMPv4 secure redirect packets on any interface.	medium	fail
<b>SRG-OS-000062</b> 1x fail		
The audit system must be configured to audit all attempts to alter system time through <code>clock_settime</code> .	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must log Martian packets.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not accept IPv4 source-routed packets by default.	medium	fail
<b>SRG-OS-000062</b> 1x fail		
The audit system must be configured to audit all attempts to alter system time through <code>/etc/localtime</code> .	low	fail
<b>SRG-OS-000004</b> 1x fail		
The operating system must automatically audit account creation.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not accept ICMPv4 secure redirect packets by default.	medium	fail

Title	Severity	Result
<b>SRG-OS-999999</b> 1x fail		
The system must ignore ICMPv4 redirect messages by default.	low	fail
<b>SRG-OS-000239</b> 1x fail		
The operating system must automatically audit account modification.	low	fail
<b>SRG-OS-999999</b>		
The system must not respond to ICMPv4 sent to a broadcast address.	low	pass
<b>SRG-OS-000240</b> 1x fail		
The operating system must automatically audit account disabling actions.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must ignore ICMPv4 bogus error responses.	low	fail
<b>SRG-OS-000241</b> 1x fail		
The operating system must automatically audit account termination.	low	fail
<b>SRG-OS-000142</b> 1x fail		
The system must be configured to use TCP syncookies.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The audit system must be configured to audit modifications to the systems Mandatory Access Control (MAC) configuration (SELinux).	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using chmod.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a reverse-path filter for IPv4 network traffic when possible by default.	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using chown.	low	fail

Title	Severity	Result
<b>SRG-OS-999999</b> 1x fail		
The IPv6 protocol handler must not be bound to the network stack unless needed.	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fchmod.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must ignore ICMPv6 redirects by default.	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fchmodat.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fchown.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fchownat.	low	fail
<b>SRG-OS-000152</b> 1x error		
The system must employ a local IPv4 firewall.	medium	error
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fremovexattr.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using fsetxattr.	low	fail

Title	Severity	Result
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using lchown.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using lremovexattr.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using lsetxattr.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using removexattr.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit all discretionary access-control permission modifications using setxattr.	low	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit successful file system mounts.	low	fail
<b>SRG-OS-000069</b> 1x fail		
The system must require passwords to contain at least one uppercase alphabetic character.	low	fail
<b>SRG-OS-000266</b> 1x fail		
The system must require passwords to contain at least one special character.	low	fail
<b>SRG-OS-000070</b> 1x fail		
The system must require passwords to contain at least one lowercase alphabetic character.	low	fail



Title	Severity	Result
<b>SRG-OS-000072</b> 1x fail		
The system must require at least four characters be changed between the old and new passwords during a password change.	low	fail
<b>SRG-OS-000021</b> 1x fail		
The system must disable accounts after three consecutive unsuccessful logon attempts.	medium	fail
<b>SRG-OS-000120</b> 1x fail		
The system must use a FIPS 140-2 approved cryptographic hashing algorithm for generating account password hashes (system-auth).	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit user deletions of files and programs.	low	fail
<b>SRG-OS-000120</b> 1x fail		
The system must use a FIPS 140-2 approved cryptographic hashing algorithm for generating account password hashes (login.defs).	medium	fail
<b>SRG-OS-000120</b> 1x fail		
The system must use a FIPS 140-2 approved cryptographic hashing algorithm for generating account password hashes (libuser.conf).	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit changes to the /etc/sudoers file.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system boot loader configuration file(s) must be owned by root.	medium	fail
<b>SRG-OS-000064</b> 1x fail		
The audit system must be configured to audit the loading and unloading of dynamic kernel modules.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system boot loader configuration file(s) must be group-owned by root.	medium	fail

Title	Severity	Result
<b>SRG-OS-000096</b> 1x error		
The xinetd service must be disabled if no network services utilizing it are enabled.	medium	error
<b>SRG-OS-999999</b> 1x fail		
The system boot loader configuration file(s) must have mode 0600 or less permissive.	medium	fail
<b>SRG-OS-000096</b> 1x fail		
The xinetd service must be uninstalled if no network services utilizing it are enabled.	low	fail
<b>SRG-OS-000080</b> 1x fail		
The system boot loader must require authentication.	medium	fail
<b>SRG-OS-000080</b> 1x fail		
The system must require authentication upon booting into single-user and maintenance modes.	medium	fail
<b>SRG-OS-000080</b> 1x fail		
The system must not permit interactive boot.	medium	fail
<b>SRG-OS-000022</b> 1x fail		
The system must require administrator action to unlock an account locked by excessive failed login attempts.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not send ICMPv4 redirects by default.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must not send ICMPv4 redirects from any interface.	medium	fail
<b>SRG-OS-000096</b> 1x error		
The ypbind service must not be running.	medium	error
<b>SRG-OS-999999</b> 1x fail		
The cron service must be running.	medium	fail
<b>SRG-OS-999999</b> 1x error		
The avahi service must be disabled.	low	error

Title	Severity	Result
<b>SRG-OS-000056</b> 1x error		
The system clock must be synchronized continuously, or at least daily.	medium	error
<b>SRG-OS-999999</b> 1x fail		
The system must set a maximum audit log file size.	medium	fail
<b>SRG-OS-000062</b> 1x fail		
The audit system must be configured to audit all attempts to alter system time through adjtimex.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must retain enough rotated audit logs to cover the required log retention period.	medium	fail
<b>SRG-OS-000096</b> 1x error		
The atd service must be disabled.	low	error
<b>SRG-OS-999999</b> 1x fail		
The system default umask for daemons must be 027 or 022.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system default umask in /etc/login.defs must be 077.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system default umask in /etc/profile must be 077.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system default umask for the csh shell must be 077.	low	fail
<b>SRG-OS-000096</b> 1x error		
The rdisc service must not be running.	low	error
<b>SRG-OS-999999</b> 1x fail		
The system default umask for the bash shell must be 077.	low	fail
<b>SRG-OS-999999</b> 1x error		
The postfix service must be enabled for mail delivery.	low	error
<b>SRG-OS-000096</b> 1x error		
The netconsole service must be disabled unless required.	low	error
<b>SRG-OS-000248</b> 1x fail		
X Windows must not be enabled unless required.	medium	fail

Title	Severity	Result
<b>SRG-OS-999999</b> 1x fail		
Process core dumps must be disabled unless needed.	low	fail
<b>SRG-OS-000027</b> 1x fail		
The system must limit users to 10 simultaneous system logins, or a site-defined number, in accordance with operational requirements.	low	fail
<b>SRG-OS-000160</b> 1x fail		
The system must provide VPN connectivity for communications over untrusted networks.	low	fail
<b>SRG-OS-000024</b> 1x fail		
A login banner must be displayed immediately prior to, or as part of, graphical desktop environment login prompts.	medium	fail
<b>SRG-OS-000034</b> 1x error		
The Bluetooth service must be disabled.	medium	error
<b>GEN006660</b> 1x fail		
Accounts must be locked upon 35 days of inactivity.	low	fail
<b>SRG-OS-000118</b> 1x fail		
The operating system must manage information system identifiers for users and devices by disabling the user identifier after an organization defined time period of inactivity.	low	fail
<b>SRG-OS-999999</b> 1x fail		
All public directories must be owned by a system account.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a Linux Security Module configured to enforce limits on system services.	medium	fail
<b>SRG-OS-999999</b> 1x fail		
The system must use a Linux Security Module configured to limit the privileges of system services.	low	fail
<b>SRG-OS-999999</b> 1x fail		
The operating system, upon successful logon/access, must display to the user the number of unsuccessful	medium	fail

Title	Severity	Result
logon/access attempts since the last successful logon/access.		
<b>SRG-OS-999999</b> 1x fail		
The audit system must switch the system to single-user mode when available audit storage volume becomes dangerously low.	medium	fail

## 17.3 RSA Adaptive Directory CentOS 7 Server STIG Compliance Report

### XCCDF Test Result

#### Introduction

#### 17.3.1 Test Result

Result ID	Profile	Start Time	End Time	Benchmark	Benchmark Version
xccdf_org.open-scap_testresult_default-profile	(Default profile)	2015-04-08 08:16	2015-04-08 08:17	embedded	1

#### 17.3.2 Target Information

Target	Addresses	Platform
adaptivedir	<ul style="list-style-type: none"> <li>127.0.0.1</li> <li>172.16.4.3</li> <li>0:0:0:0:0:0:1</li> <li>fe80:0:0:0:250:56ff:fe89:8965</li> </ul>	cpe:/o:redhat:enterprise_linux:6

#### 17.3.3 Score

System	Score	Maximum Score	Score as Percentage	Bar
urn:xccdf:scoring:default	96.65	100.00	96.65%	

#### 17.3.4 Rule Results Summary

Pass	Fixed	Fail	Error	Not Selected	Not Checked	Not Applicable	Inform-ational	Unknown	Total
173	0	6	0	0	0	0	0	0	179

Title	Result
Auditing must be enabled at boot by setting a kernel parameter.	fail
The audit system must be configured to audit modifications to the systems Mandatory Access Control (MAC) configuration (SELinux).	fail
The system boot loader configuration file(s) must be owned by root.	fail
The system boot loader configuration file(s) must be group-owned by root.	fail
The system boot loader configuration file(s) must have mode 0600 or less permissive.	fail
The system boot loader must require authentication.	fail

## 17.4 AlertEnterprise Microsoft Server STIG Compliance Report

Non-Compliance Report – U\_Windows\_2008\_R2\_MS\_V1R15\_STIG\_SCAP\_1-0\_Benchmark

SCAP Compliance Checker – 3.1.2

### 17.4.1 Score

Adjusted Score:	30.04%
Original Score:	30.04%
Compliance Status:	RED

Pass:	79	Not Applicable:	0	BLUE:	Score equals 100
Fail:	184	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	263	RED:	Score is greater than or equal to 0

### 17.4.2 System Information

Target	WIN-IPERGL2ELUD
Operating System	Windows Server 2008 R2 Standard
OS Service Pack	

Domain	
--------	--

### 17.4.3 Results

- Unsupported Service Packs
  - Systems must be at supported service pack or release levels. – Fail
- Legal Notice Display
  - The required legal notice will be configured to display before console logon. – (CCE-10673-2) – Fail
- Caching of logon credentials
  - Caching of logon credentials will be limited. – (CCE-10926-4) – Fail
- Anonymous shares are not restricted
  - Anonymous enumeration of shares will be restricted. – (CCE-10557-7) – Fail
- Bad Logon Attempts
  - The number of allowed bad-logon attempts will meet minimum requirements. – (CCE-11046-0) – Fail
- Bad Logon Counter Reset
  - The time before the bad-logon counter is reset will meet minimum requirements. – (CCE-11059-3) – Fail
- Lockout Duration
  - The lockout duration will meet minimum requirements. – (CCE-10399-4) – Fail
- Rename Built-in Guest Account
  - The built-in guest account will be renamed. – (CCE-10747-4) – Fail
- Rename Built-in Administrator Account
  - The built-in administrator account will be renamed. – (CCE-10976-9) – Fail
- LanMan Authentication Level
  - The LanMan authentication level will be set to Send NTLMv2 response only \ refuse LM & NTLM. – (CCE-10984-3) – Fail
- Deny Access from the Network
  - The deny access to this computer from the network user right on member servers must be configured to prevent access from highly privileged domain accounts and local

- administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-10733-4) – Fail
- Smart Card Removal Option
  - The smart card removal option will be configured to Force Logoff or Lock Workstation. – (CCE-10573-4) – Fail
- Format and Eject Removable Media
  - Ejection of removable NTFS media is not restricted to Administrators. – (CCE-10637-7) – Fail
- Password Expiration Warning
  - Users will be warned in advance that their passwords will expire. – (CCE-10930-6) – Fail
- Disable Media Autoplay
  - Autoplay will be disabled for all drives. – (CCE-11126-0) – Fail
- Anonymous Access to Named Pipes
  - Named pipes that can be accessed anonymously will be configured to contain no values. – (CCE-10944-7) – Fail
- Remote Assistance – Solicit Remote Assistance
  - Solicited Remote Assistance will not be allowed. – (CCE-11723-4) – Fail
- Undock Without Logging On
  - A system must be logged onto before removing from a docking station. – (CCE-10883-7) – Fail
- Storage of Passwords and Credentials
  - The system will be configured to prevent the storage of passwords and credentials – (CCE-10292-1) – Fail
- Force Logoff When Logon Hours Expire
  - The system will be configured to force users to log off when their allowed logon hours expire. – (CCE-10588-2) – Fail
- Session Security for NTLM SSP Based Clients
  - The system will be configured to meet the minimum session security requirement for NTLM SSP based clients. – (CCE-10035-4) – Fail
- FIPS Compliant Algorithms
  - The system will be configured to use FIPS-compliant algorithms for encryption, hashing, and signing. – (CCE-10789-6) – Fail



- TS/RDS – Session Limit
  - Remote Desktop Services will limit users to one remote session. – (CCE-12016-2) – Fail
- TS/RDS – Password Prompting
  - Remote Desktop Services will always prompt a client for passwords upon connection. – (CCE-11299-5) – Fail
- TS/RDS – Set Encryption Level
  - Remote Desktop Services will be configured with the client connection encryption set to the required level. – (CCE-11677-2) – Fail
- TS/RDS – Do Not Use Temp Folders
  - Remote Desktop Services will be configured to use session-specific temporary folders. – (CCE-10669-0) – Fail
- TS/RDS – Delete Temp Folders
  - Remote Desktop Services will delete temporary folders when a session is terminated. – (CCE-12046-9) – Fail
- TS/RDS – Time Limit for Disc. Session
  - Remote Desktop Services will be configured to set a time limit for disconnected sessions. – (CCE-11117-9) – Fail
- TS/RDS – Time Limit for Idle Session
  - Remote Desktop Services will be configured to disconnect an idle session after the specified time period. – (CCE-11506-3) – Fail
- Remote Assistance – Offer Remote Assistance
  - The system will be configured to prevent unsolicited remote assistance offers. – (CCE-11625-1) – Fail
- Error Reporting – Report Errors
  - The system will be configured to prevent automatic forwarding of error information. – (CCE-11750-7) – Fail
- Safe DLL Search Mode
  - The system will be configured to use Safe DLL Search Mode. – (CCE-10772-2) – Fail
- Media Player – Disable Automatic Updates
  - Media Player must be configured to prevent automatic checking for updates. – (CCE-11298-7) – Fail

- Session Security for NTLM SSP based Servers
  - The system will be configured to meet the minimum session security requirement for NTLM SSP based servers. – (CCE-10040-4) – Fail
- Audit Log Warning Level
  - The system will generate an audit event when the audit log reaches a percent full threshold. – (CCE-11011-4) – Fail
- Disable IP Source Routing
  - The system will be configured to prevent IP source routing. – (CCE-10732-6) – Fail
- Disable ICMP Redirect
  - The system will be configured to prevent ICMP redirects from overriding OSPF generated routes. – (CCE-10518-9) – Fail
- Disable Router Discovery
  - The system will be configured to disable the Internet Router Discover Protocol (IRDP). – (CCE-10768-0) – Fail
- TCP Connection Keep-Alive Time
  - The system will be configured to limit how often keep-alive packets are sent. – (CCE-10381-2) – Fail
- Name-Release Attacks
  - The system will be configured to ignore NetBIOS name release requests except from WINS servers. – (CCE-10653-4) – Fail
- TCP Data Retransmissions
  - The system will limit how many times unacknowledged TCP data is retransmitted. – (CCE-10941-3) – Fail
- Screen Saver Grace Period
  - The system will be configured to have password protection take effect within a limited timeframe when the screen saver becomes active. – (CCE-10019-8) – Fail
- Remotely Accessible Registry Paths and Sub-Paths
  - Unauthorized remotely accessible registry paths and sub-paths will not be configured. – (CCE-10935-5) – Fail
- Strong Key Protection
  - Users will be required to enter a password to access private keys. – (CCE-11035-3) – Fail

- Optional Subsystems
  - Optional subsystems will not be permitted to operate on the system. – (CCE-10913-2) – Fail
- Software Restriction Policies
  - Software certificate restriction policies will be enforced. – (CCE-10900-9) – Fail
- TS/RDS – Secure RPC Connection.
  - The Remote Desktop Session Host will require secure RPC communications. – (CCE-11368-8) – Fail
- Group Policy – Registry Policy Processing
  - Group Policy objects will be reprocessed even if they have not changed. – (CCE-12754-8) – Fail
- SMB Client Packet Signing (Always)
  - The Windows SMB client will be enabled to always perform SMB packet signing. – (CCE-10970-2) – Fail
- Minimum Password Length
  - For systems utilizing a logon ID as the individual identifier, passwords will, at a minimum, be 14 characters. – (CCE-10372-1) – Fail
- Display of Last Username
  - The system will be configured to prevent the display of the last username on the logon screen. – (CCE-10788-8) – Fail
- Audit Policy Subcategory Setting
  - Audit policy using subcategories will be enabled. – (CCE-10112-1) – Fail
- IPsec Exemptions
  - IPsec exemptions will be limited. – (CCE-10018-0) – Fail
- UAC – Admin Approval Mode
  - User Account Control approval mode for the built-in administrator will be enabled. – (CCE-11028-8) – Fail
- UAC – Admin Elevation Prompt
  - User Account Control will, at a minimum, prompt administrators for consent. – (CCE-11023-9) – Fail
- UAC – User Elevation Prompt
  - User Account Control will automatically deny standard user requests for elevation. – (CCE-10807-6) – Fail

- Enumerate Administrator Accounts on Elevation
  - The system will require a username and password to elevate a running application. – (CCE-11450-4) – Fail
- TS/RDS – Prevent Password Saving
  - Passwords will not be saved in the Remote Desktop Client. – (CCE-11905-7) – Fail
- TS/RDS – Drive Redirection
  - Local drives will be prevented from sharing with Remote Desktop Session Hosts (Remote Desktop Services Role). – (CCE-11709-3) – Fail
- RPC – Unauthenticated RPC Clients
  - Unauthenticated RPC clients will be restricted from connecting to the RPC server. – (CCE-10881-1) – Fail
- RPC – Endpoint Mapper Authentication
  - Client computers will be required to authenticate for RPC communication. – (CCE-10715-1) – Fail
- Internet Download / Online Ordering
  - Web publishing and online ordering wizards will be prevented from downloading a list of providers. – (CCE-11136-9) – Fail
- Printing Over HTTP
  - Printing over HTTP will be prevented. – (CCE-11360-5) – Fail
- HTTP Printer Drivers
  - Downloading print driver packages over HTTP will be prevented. – (CCE-11563-4) – Fail
- Windows Update Device Drive Searching
  - Windows will be prevented from using Windows Update to search for drivers. – (CCE-10357-2) – Fail
- IPv6 Transition
  - IPv6 will be disabled until a deliberate transition strategy has been implemented. – Fail
- Windows Peer to Peer Networking
  - Windows Peer-to-Peer networking services will be turned off. – (CCE-11604-6) – Fail
- Prohibit Network Bridge
  - Network Bridges will be prohibited in Windows. – (CCE-12074-1) – Fail

- Root Certificates Update
  - Root Certificates will not be updated automatically from the Microsoft site. – (CCE-11264-9) – Fail
- Event Viewer Events.asp Links
  - Event Viewer Events.asp links will be turned off. – (CCE-10693-0) – Fail
- Internet File Association Service
  - The Internet File Association service will be turned off. – (CCE-10697-1) – Fail
- Order Prints Online
  - The Order Prints Online wizard will be turned off. – (CCE-11243-3) – Fail
- Classic Logon
  - The classic logon screen will be required for user logons. – (CCE-11256-5) – Fail
- RSS Attachment Downloads
  - Attachments will be prevented from being downloaded from RSS feeds. – Fail
- Windows Explorer – Shell Protocol Protected Mode
  - Windows Explorer shell protocol will run in protected mode. – (CCE-11530-3) – Fail
- Windows Installer – IE Security Prompt
  - Users will be notified if a web-based program attempts to install software. – (CCE-10343-2) – Fail
- Windows Installer – User Control
  - Users will be prevented from changing installation options. – (CCE-10906-6) – Fail
- Windows Installer – Vendor Signed Updates
  - Non-administrators will be prevented from applying vendor signed updates. – (CCE-11468-6) – Fail
- Media Player – First Use Dialog Boxes
  - Users will not be presented with Privacy and Installation options on first use of Windows Media Player. – (CCE-11596-4) – Fail
- Network – Mapper I/O Driver
  - The Mapper I/O network protocol driver will be disabled. – (CCE-10484-4) – Fail
- Network – Responder Driver
  - The Responder network protocol driver will be disabled. – (CCE-11304-3) – Fail

- Network – WCN Wireless Configuration
  - The configuration of wireless devices using Windows Connect Now will be disabled. – (CCE-11242-5) – Fail
- Network – Windows Connect Now Wizards
  - The Windows Connect Now wizards will be disabled. – (CCE-11155-9) – Fail
- Device Install – PnP Interface Remote Access
  - Remote access to the Plug and Play interface will be disabled for device installation. – (CCE-11248-2) – Fail
- Device Install – Drivers System Restore Point
  - A system restore point will be created when a new device driver is installed. – (CCE-10546-0) – Fail
- Device Install – Generic Driver Error Report
  - An Error Report will not be sent when a generic device driver is installed. – (CCE-12274-7) – Fail
- Driver Install – Device Driver Search Prompt
  - Users will not be prompted to search Windows Update for device drivers. – (CCE-11319-1) – Fail
- Handwriting Recognition Error Reporting
  - Errors in handwriting recognition on Tablet PCs will not be reported to Microsoft. – (CCE-11030-4) – Fail
- Power Mgmt – Password Wake on Battery
  - Users will be prompted for a password on resume from sleep (on battery). (Applicable to Server 2008 R2 if the system is configured to sleep.) – (CCE-12088-1) – Fail
- Power Mgmt – Password Wake When Plugged In
  - The user will be prompted for a password on resume from sleep (Plugged In). (Applicable on Server 2008 R2 if the system is configured to sleep.) – (CCE-11651-7) – Fail
- Remote Assistance – Session Logging
  - Remote Assistance log files will be generated. – (CCE-11263-1) – Fail
- Game Explorer Information Downloads
  - Game explorer information will not be downloaded from Windows Metadata Services. – (CCE-11739-0) – Fail

- Error Reporting – Logging
  - Error Reporting events will be logged in the system event log. – (CCE-11621-0) – Fail
- Error Reporting – Windows Error Reporting
  - Windows Error Reporting to Microsoft will be disabled. – (CCE-11708-5) – Fail
- Error Reporting – Additional Data
  - Additional data requests in response to Error Reporting will be declined. – (CCE-11584-0) – Fail
- Windows Explorer – Heap Termination
  - Windows Explorer heap termination on corruption will be disabled. – (CCE-10981-9) – Fail
- Logon – Report Logon Server
  - Users will be notified if the logon server was inaccessible and cached credentials were used. – (CCE-12260-6) – Fail
- Media DRM – Internet Access
  - Windows Media Digital Rights Management will be prevented from accessing the internet. – (CCE-11052-8) – Fail
- TS/RDS – COM Port Redirection
  - The system will be configured to prevent users from mapping local COM ports and redirecting data from the Remote Desktop Session Host to local COM ports. (Remote Desktop Services Role) – (CCE-10600-5) – Fail
- TS/RDS – LPT Port Redirection
  - The system will be configured to prevent users from mapping local LPT ports and redirecting data from the Remote Desktop Session Host to local LPT ports. (Remote Desktop Services Role) – (CCE-11623-6) – Fail
- TS/RDS – PNP Device Redirection
  - The system will be configured to prevent users from redirecting Plug and Play devices to the Remote Desktop Session Host. (Remote Desktop Services Role) – (CCE-11128-6) – Fail
- TS/RDS – Smart Card Device Redirection
  - The system will be configured to ensure that smart card devices can be redirected to the Remote Desktop Session. (Remote Desktop Services Role) – (CCE-11517-0) – Fail
- TS/RDS – Printer Redirection
  - The system will be configured to allow only the default client printer to be redirected in the Remote Desktop Session. (Remote Desktop Services Role) – (CCE-10977-7) – Fail

- TS/RDS – Remove Disconnect Option
  - The system will be configured to remove the Disconnect option from the Shut Down Windows dialog box on the Remote Desktop Client. (Remote Desktop Services Role) – (CCE-11997-4) – Fail
- Windows Customer Experience Improvement Program
  - The Windows Customer Experience Improvement Program will be disabled. – (CCE-11354-8) – Fail
- SPN Target Name Validation Level
  - The service principal name (SPN) target name validation level will be turned off. – (CCE-10617-9) – Fail
- Computer Identity Authentication for NTLM
  - Services using Local System that use negotiate when reverting to NTLM authentication will use the computer identity vs. authenticating anonymously. – (CCE-10817-5) – Fail
- NTLM NULL Session Fallback
  - NTLM will be prevented from falling back to a Null session. – (CCE-10812-6) – Fail
- PKU2U Online Identities Authentication
  - PKU2U authentication using online identities will be prevented. – (CCE-10839-9) – Fail
- Kerberos Encryption Types
  - Kerberos encryption types will be configured to prevent the use of DES encryption suites. – (CCE-10843-1) – Fail
- IPv6 Source Routing
  - IPv6 source routing will be configured to highest protection. – (CCE-10888-6) – Fail
- IPv6 TCP Data Retransmissions
  - IPv6 TCP data retransmissions will be configured to prevent resources from becoming exhausted. – (CCE-10804-3) – Fail
- Elevate when setting a network's location
  - Domain users will be required to elevate when setting a network's location. – (CCE-11610-3) – Fail
- Direct Access – Route Through Internal Network
  - All Direct Access traffic will be routed through the internal network. – (CCE-11300-1) – Fail



- Windows Update Point and Print Driver Search
  - Windows Update will be prevented from searching for point and print drivers. – (CCE-11976-8) – Fail
- Prevent device metadata retrieval from internet
  - Device metadata retrieval from the internet will be prevented. – (CCE-11589-9) – Fail
- Prevent Windows Update for device driver search
  - Device driver searches using Windows Update will be prevented. – (CCE-11787-9) – Fail
- MSDT Interactive Communication
  - Microsoft Support Diagnostic Tool (MSDT) interactive communication with Microsoft will be prevented. – (CCE-10855-5) – Fail
- Windows Online Troubleshooting Service
  - Access to Windows Online Troubleshooting Service (WOTS) will be prevented. – (CCE-11161-7) – Fail
- Disable PerfTrack
  - Responsiveness events will be prevented from being aggregated and sent to Microsoft. – (CCE-11889-3) – Fail
- Application Compatibility Program Inventory
  - The Application Compatibility Program Inventory will be prevented from collecting data and sending the information to Microsoft. – (CCE-11043-7) – Fail
- Autoplay for non-volume devices
  - Autoplay will be turned off for non-volume devices. – (CCE-11375-3) – Fail
- Turn Off Game Updates
  - Downloading of game update information will be turned off. – (CCE-11807-5) – Fail
- Prevent Joining Homegroup
  - The system will be prevented from joining a homegroup. – (CCE-10691-4) – Fail
- Windows Anytime Upgrade
  - Windows Anytime Upgrade will be disabled. – (CCE-10544-5) – Fail
- Explorer Data Execution Prevention
  - Explorer Data Execution Prevention will be enabled. – (CCE-12161-6) – Fail

- Default Autorun Behavior
  - The default autorun behavior will be configured to prevent autorun commands. – (CCE-11431-4) – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner will be configured. – (CCE-10010-7) – Fail
- Access this computer from the network
  - Unauthorized accounts will not have the "Access this computer from the network" user right. – (CCE-10086-7) – Fail
- Adjust memory quotas for a process
  - Unauthorized accounts will not have the "Adjust memory quotas for a process" user right. – (CCE-10849-8) – Fail
- Allow log on locally
  - Unauthorized accounts will not have the "Allow log on locally" user right. – (CCE-10853-0) – Fail
- Back up files and directories
  - Unauthorized accounts will not have the "Back up files and directories" user right. – (CCE-10880-3) – Fail
- Bypass traverse checking
  - Unauthorized accounts will not have the "Bypass traverse checking" user right. – (CCE-10369-7) – Fail
- Change the system time
  - Unauthorized accounts will not have the "Change the system time" user right. – (CCE-10122-0) – Fail
- Change the time zone
  - Unauthorized accounts will not have the "Change the time zone" user right. – (CCE-10897-7) – Fail
- Deny log on as a batch job
  - The “deny log on as a batch job” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-10596-5) – Fail

- Deny log on as service
  - The “deny log on as a service” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems. No other groups or accounts must be assigned this right. – (CCE-10226-9) – Fail
- Deny log on locally
  - The “deny log on locally” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-10750-8) – Fail
- Deny log on through Remote Desktop \ Terminal Services
  - The deny log on through Remote Desktop Services user right on member servers must be configured to prevent access from highly privileged domain accounts and local administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-10878-7) – Fail
- Force shutdown from a remote system
  - Unauthorized accounts will not have the "Force shutdown from a remote system" user right. – (CCE-10785-4) – Fail
- Generate security audits
  - Unauthorized accounts will not have the "Generate security audits" user right. – (CCE-10274-9) – Fail
- Impersonate a client after authentication
  - Unauthorized accounts will not have the "Impersonate a client after authentication" user right. – (CCE-9946-5) – Fail
- Increase a process working set
  - Unauthorized accounts will not have the "Increase a process working set" user right. – (CCE-10548-6) – Fail
- Load and unload device drivers
  - Unauthorized accounts will not have the "Load and unload device drivers" user right. – (CCE-10202-0) – Fail
- Log on as a batch job
  - Unauthorized accounts will not have the "Log on as a batch job" user right. – (CCE-10549-4) – Fail
- Replace a process level token

- Unauthorized accounts will not have the "Replace a process level token" user right. – (CCE-10599-9) – Fail
- Restore files and directories
  - Unauthorized accounts will not have the "Restore files and directories" user right. – (CCE-10805-0) – Fail
- Shut down the system
  - Unauthorized accounts will not have the "Shut down the system" user right. – (CCE-10439-8) – Fail
- Audit – Credential Validation – Failure
  - The system will be configured to audit "Account Logon > Credential Validation" failures. – Fail
- Audit – Computer Account Management – Failure
  - The system will be configured to audit "Account Management > Computer Account Management" failures. – Fail
- Audit – Other Account Management Events – Success
  - The system will be configured to audit "Account Management > Other Account Management Events" successes. – Fail
- Audit – Other Account Management Events – Failure
  - The system will be configured to audit "Account Management > Other Account Management Events" failures. – Fail
- Audit – Security Group Management – Failure
  - The system will be configured to audit "Account Management > Security Group Management" failures. – Fail
- Audit – User Account Management – Success
- Audit – User Account Management – Failure
  - The system will be configured to audit "Account Management > User Account Management" failures. – Fail
- Audit – Process Creation – Success
  - The system will be configured to audit "Detailed Tracking > Process Creation" successes. – Fail
- Audit – File System – Failure
  - The system will be configured to audit "Object Access > File System" failures. – Fail

- Audit – Registry – Failure
  - The system will be configured to audit "Object Access > Registry" failures. – Fail
- Audit – Audit Policy Change – Failure
  - The system will be configured to audit "Policy Change > Audit Policy Change" failures. – Fail
- Audit – Sensitive Privilege Use – Success
  - The system will be configured to audit "Privilege Use > Sensitive Privilege Use" successes. – Fail
- Audit – Sensitive Privilege Use – Failure
  - The system will be configured to audit "Privilege Use > Sensitive Privilege Use" failures. – Fail
- Audit – IPSec Driver – Success
  - The system will be configured to audit "System > IPSec Driver" successes. – Fail
- Audit – IPSec Driver – Failure
  - The system will be configured to audit "System > IPSec Driver" failures. – Fail
- Audit – Security State Change – Failure
  - The system will be configured to audit "System > Security State Change" failures. – Fail
- Audit – Security System Extension – Success
  - The system will be configured to audit "System > Security System Extension" successes. – Fail
- Audit – Security System Extension – Failure
  - The system will be configured to audit "System > Security System Extension" failures. – Fail
- 6to4 State
  - The 6to4 IPv6 transition technology will be disabled. – (CCE-11356-3) – Fail
- IP-HTTPS State
  - The IP-HTTPS IPv6 transition technology will be disabled. – (CCE-10832-4) – Fail
- ISATAP State
  - The ISATAP IPv6 transition technology will be disabled. – (CCE-11141-9) – Fail
- Teredo State
  - The Teredo IPv6 transition technology will be disabled. – (CCE-11865-3) – Fail
- Maximum Log Size – Application

- The Application event log will be configured to a minimum size requirement. – (CCE-11143-5) – Fail
- Maximum Log Size – Security
  - The Security event log will be configured to a minimum size requirement. – (CCE-11033-8) – Fail
- Maximum Log Size – Setup
  - The Setup event log will be configured to a minimum size requirement. – (CCE-11717-6) – Fail
- Maximum Log Size – System
  - The System event log will be configured to a minimum size requirement. – (CCE-11174-0) – Fail
- Device Install Software Request Error Report
  - Windows will be prevented from sending an error report when a device driver requests additional software during installation. – (CCE-11336-5) – Fail
- Always Install with Elevated Privileges Disabled
  - The Windows Installer Always install with elevated privileges must be disabled. – (CCE-12401-6) – Fail
- Local admin accounts filtered token policy enabled on domain systems.
  - Local administrator accounts must have their privileged token filtered to prevent elevated privileges from being used over the network on domain systems. – Fail
- WINCC-000078
  - The Enhanced Mitigation Experience Toolkit (EMET) system-wide Address Space Layout Randomization (ASLR) must be enabled and configured to Application Opt In. – Fail
- WINCC-000079
  - The Enhanced Mitigation Experience Toolkit (EMET) Default Protections for Internet Explorer must be enabled. – Fail
- WINCC-000080
  - The Enhanced Mitigation Experience Toolkit (EMET) Default Protections for Recommended Software must be enabled. – Fail
- WINCC-000081
  - The Enhanced Mitigation Experience Toolkit (EMET) Default Protections for Popular Software must be enabled. – Fail
- WINCC-000082

- The Enhanced Mitigation Experience Toolkit (EMET) system-wide Data Execution Prevention (DEP) must be enabled and configured to at least Application Opt Out. – Fail
- WINCC-000083
  - The Enhanced Mitigation Experience Toolkit (EMET) system-wide Structured Exception Handler Overwrite Protection (SEHOP) must be configured to Application Opt Out. – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail
- WINGE-000200
  - A group named DenyNetworkAccess must be defined on domain systems to include all local administrator accounts. – Fail

### 17.5 IT Domain Controller STIG Compliance Report

Non-Compliance Report – U\_Windows2012\_DC\_V1R3\_STIG\_SCAP\_1-1\_Benchmark

SCAP Compliance Checker – 3.1.2

#### 17.5.1 Score

	Adjusted Score:	91.13%
91.13%	Original Score:	91.13%
	Compliance Status:	GREEN

Pass:	267	Not Applicable:	0	BLUE:	Score equals 100
Fail:	26	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	293	RED:	Score is greater than or equal to 0

#### 17.5.2 System Information

Target	ITDC
Operating System	Windows Server 2012 R2 Standard

OS Service Pack	
Domain	ES-IDAM-B1

### 17.5.3 Results

- Bad Logon Attempts
  - The number of allowed bad logon attempts must meet minimum requirements. – (CCE-23909-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system must be configured to force users to log off when their allowed logon hours expire. – (CCE-25367-4) – Fail
- LDAP Signing Requirements
  - Domain controllers must require LDAP access signing. – (CCE-23587-9) – Fail
- Computer Account Password Change
  - Domain controllers must be configured to allow the reset of machine account passwords. – (CCE-24692-6) – Fail
- Remotely Accessible Registry Paths and Sub-Paths
  - Unauthorized remotely accessible registry paths and sub-paths must not be configured. – (CCE-25426-8) – Fail
- Minimum Password Length
  - Passwords must, at a minimum, be 14 characters. – (CCE-25317-9) – Fail
- Media DRM – Internet Access
- Software Certificate Installation Files
  - Software certificate installation files must be removed from a system. – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner must be configured. – (CCE-24020-0) – Fail
- Access this computer from the network
  - Unauthorized accounts must not have the “access this computer from the network” user right on domain controllers. – Fail



- Allow log on locally
  - Unauthorized accounts must not have the “allow log on locally” user right. – (CCE-25228-8) – Fail
- Back up files and directories
  - Unauthorized accounts must not have the “back up files and directories” user right. – (CCE-25380-7) – Fail
- Bypass traverse checking
  - Unauthorized accounts must not have the “bypass traverse checking” user right. – (CCE-25271-8) – Fail
- Change the system time
  - Unauthorized accounts must not have the “change the system time” user right. – (CCE-24185-1) – Fail
- Change the time zone
  - Unauthorized accounts must not have the “change the time zone” user right. – (CCE-24632-2) – Fail
- Force shutdown from a remote system
  - Unauthorized accounts must not have the “force shutdown from a remote system” user right. – (CCE-24734-6) – Fail
- Increase a process working set
  - Unauthorized accounts must not have the “increase a process working set” user right. – (CCE-24162-0) – Fail
- Increase scheduling priority
- Load and unload device drivers
  - Unauthorized accounts must not have the “load and unload device drivers” user right. – (CCE-24779-1) – Fail
- Log on as a batch job
  - Unauthorized accounts must not have the “log on as a batch job” user right. – (CCE-23386-6) – Fail
- Restore files and directories
  - Unauthorized accounts must not have the “restore files and directories” user right. – (CCE-25518-2) – Fail

- Shut down the system
  - Unauthorized accounts must not have the “shut down the system” user right. – (CCE-23500-2) – Fail
- Add workstations to domain
  - Unauthorized accounts must not have the “add workstations to domain” user right. – (CCE-23271-0) – Fail
- Audit Directory Service Access – Success
  - The system must be configured to audit DS Access – Directory Service Access successes. – Fail
- Audit – Directory Service Access – Failure
  - The system must be configured to audit DS Access – Directory Service Access failures. – Fail
- Audit – Directory Service Changes – Success
  - The system must be configured to audit DS Access – Directory Service Changes successes. – Fail
- Audit – Directory Service Changes – Failure
  - The system must be configured to audit DS Access – Directory Service Changes failures. – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail

17.6 IT Windows 7 Workstations STIG Compliance Report

Non-Compliance Report – U\_Windows\_7\_V1R23\_STIG\_SCAP\_1-0\_Benchmark

SCAP Compliance Checker – 3.1.2

17.6.1 Score

94.72%	Adjusted Score:	94.72%
	Original Score:	94.72%
	Compliance Status:	GREEN

Pass:	251	Not Applicable:	0	BLUE:	Score equals 100
Fail:	14	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	265	RED:	Score is greater than or equal to 0

### 17.6.2 System Information

Target	ITWORKS1
Operating System	Windows 7 Enterprise
OS Service Pack	Service Pack 1
Domain	ES-IDAM-B1
Processor	Intel(R) Xeon(R) CPU E5-2660 0 @ 2.20GHz
Processor Architecture	Intel64 Family 6 Model 45 Stepping 7
Processor Speed	2200 MHz
Physical Memory	6144 mb
Manufacturer	VMware, Inc.
Model	VMware Virtual Platform
Serial Number	VMware-42 09 b3 57 32 50 16 c6-cb 47 45 dd e3 a9 68 f1
BIOS Version	6.00
Interfaces	[00000007] Intel(R) PRO/1000 MT Network Connection <ul style="list-style-type: none"> <li>172.16.5.6</li> <li>00:50:56:89:A2:29</li> </ul>

### 17.6.3 Results

- Legal Notice Display
  - The required legal notice must be configured to display before console logon. – (CCE-8973-0) – Fail

- **Bad Logon Attempts**
  - Number of allowed bad-logon attempts does not meet minimum requirements. – (CCE-9136-3) – Fail
- **Secure Print Driver Installation**
  - Print driver installation privilege is not restricted to administrators. – (CCE-9026-6) – Fail
- **Deny Access from the Network**
  - The deny access to this computer from the network user right on workstations must be configured to prevent access from highly privileged domain accounts and local administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-9244-5) – Fail
- **Force Logoff When Logon Hours Expire**
  - The system is not configured to force users to log off when their allowed logon hours expire. – (CCE-9704-8) – Fail
- **Minimum Password Length**
  - For systems utilizing a logon ID as the individual identifier, passwords must be a minimum of 14 characters in length. – (CCE-9357-5) – Fail
- **TS/RDS – Remote User Connections**
  - Terminal Services / Remote Desktop Services – Prevent users from connecting using Terminal Services or Remote Desktop. – (CCE-9985-3) – Fail
- **Unnecessary Features Installed**
  - Unnecessary features are installed. – Fail
- **Deny log on as a batch job**
  - The “deny log on as a batch job” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-9212-2) – Fail
- **Deny log on as service**
  - The “deny log on as a service” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems. No other groups or accounts must be assigned this right. – (CCE-9098-5) – Fail
- **Deny log on locally**
  - The “deny log on locally” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-9239-5) – Fail

- Deny log on through Remote Desktop \ Terminal Services
  - The deny log on through Remote Desktop Services user right on workstations must prevent all access if RDS is not used by the organization. If RDS is used, it must be configured to prevent access from highly privileged domain accounts and local administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-9274-2) – Fail
- Enable accounts to be trusted for delegation
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail
- WINGE-000200
  - A group named DenyNetworkAccess must be defined on domain systems to include all local administrator accounts. – Fail

## 17.7 Ozone Authority and Ozone Server CentOS 6 Server STIG Compliance Report

### XCCDF Test Result

#### 17.7.1 Test Result

Result ID	Profile	Start Time	End Time	Benchmark	Benchmark Version
xccdf_org.open-scap_testresult_default-profile	(Default profile)	2015-04-08 07:58	2015-04-08 07:59	embedded	1

#### 17.7.2 Target Information

Target	Addresses	Platform
localhost.localdomain	<ul style="list-style-type: none"> <li>▪ 127.0.0.1</li> <li>▪ 172.16.4.11</li> <li>▪ 0:0:0:0:0:0:1</li> <li>▪ fe80:0:0:0:250:56ff:fe89:76dd</li> </ul>	cpe:/o:redhat:enterprise_linux:6

#### 17.7.3 Score

System	Score	Maximum	Score as Percentage	Bar
urn:xccdf:scoring:default	95.53	100.00	95.53%	

### 17.7.4 Rule Results Summary

Pass	Fixed	Fail	Error	Not Selected	Not Checked	Not Applicable	Inform-ational	Unknown	Total
171	0	8	0	0	0	0	0	0	179

Title	Result
Auditing must be enabled at boot by setting a kernel parameter.	fail
Library files must be owned by root.	fail
The audit system must be configured to audit modifications to the systems Mandatory Access Control (MAC) configuration (SELinux).	fail
The system boot loader configuration file(s) must be owned by root.	fail
The system boot loader configuration file(s) must be group-owned by root.	fail
The system boot loader configuration file(s) must have mode 0600 or less permissive.	fail
The system boot loader must require authentication.	fail
The system must provide VPN connectivity for communications over untrusted networks.	fail

## 17.8 Ozone Envoy CentOS 6 Server STIG Compliance Report

XCCDF Test Result

### 17.8.1 Test Result

Result ID	Profile	Start Time	End Time	Benchmark	Benchmark Version
xccdf_org.open-scap_testresult_default-profile	(Default profile)	2015-04-08 08:02	2015-04-08 08:03	embedded	1

### 17.8.2 Target Information

Target	Addresses	Platform
localhost.localdomain	<ul style="list-style-type: none"> <li>127.0.0.1</li> <li>172.16.4.12</li> <li>0:0:0:0:0:0:1</li> <li>fe80:0:0:0:250:56ff:fe89:980a</li> </ul>	cpe:/o:redhat:enterprise_linux:6

### 17.8.3 Score

System	Score	Maximum Score	Score as Percentage	Bar
urn:xccdf:scoring:default	96.09	100.00	96.09%	

### 17.8.4 Rule Results Summary

Pass	Fixed	Fail	Error	Not Selected	Not Checked	Not Applicable	Inform-ational	Unknown	Total
172	0	7	0	0	0	0	0	0	179

Title	Result
Auditing must be enabled at boot by setting a kernel parameter.	fail
The audit system must be configured to audit modifications to the systems Mandatory Access Control (MAC) configuration (SELinux).	fail
The system boot loader configuration file(s) must be owned by root.	fail
The system boot loader configuration file(s) must be group-owned by root.	fail
The system boot loader configuration file(s) must have mode 0600 or less permissive.	fail
The system boot loader must require authentication.	fail
The system must provide VPN connectivity for communications over untrusted networks.	fail

## 17.9 OT Domain Controller STIG Compliance Report

Non-Compliance Report – U\_Windows2012\_DC\_V1R3\_STIG\_SCAP\_1-1\_Benchmark

SCAP Compliance Checker – 3.1.2

### 17.9.1 Score

	Adjusted Score:	91.13%
91.13%	Original Score:	91.13%
	Compliance Status:	GREEN

Pass:	267	Not Applicable:	0	BLUE:	Score equals 100
Fail:	26	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	293	RED:	Score is greater than or equal to 0

### 17.9.2 System Information

Target	OTDC
Operating System	Windows Server 2012 R2 Standard
OS Service Pack	
Domain	OT-ES-IDAM-B1

### 17.9.3 Results

- Bad Logon Attempts
  - The number of allowed bad logon attempts must meet minimum requirements. – (CCE-23909-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system must be configured to force users to log off when their allowed logon hours expire. – (CCE-25367-4) – Fail
- LDAP Signing Requirements
  - Domain controllers must require LDAP access signing. – (CCE-23587-9) – Fail
- Computer Account Password Change
  - Domain controllers must be configured to allow the reset of machine account passwords. – (CCE-24692-6) – Fail
- Remotely Accessible Registry Paths and Sub-Paths
  - Unauthorized remotely accessible registry paths and sub-paths must not be configured. – (CCE-25426-8) – Fail
- Minimum Password Length
  - Passwords must, at a minimum, be 14 characters. – (CCE-25317-9) – Fail



- Software Certificate Installation Files
  - Software certificate installation files must be removed from a system. – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner must be configured. – (CCE-24020-0) – Fail
- Access this computer from the network
  - Unauthorized accounts must not have the “access this computer from the network” user right on domain controllers. – Fail
- Adjust memory quotas for a process
- Allow log on locally
  - Unauthorized accounts must not have the “allow log on locally” user right. – (CCE-25228-8) – Fail
- Allow log on through Remote Desktop Services
- Back up files and directories
  - Unauthorized accounts must not have the “back up files and directories” user right. – (CCE-25380-7) – Fail
- Bypass traverse checking
  - Unauthorized accounts must not have the “bypass traverse checking” user right. – (CCE-25271-8) – Fail
- Change the system time
  - Unauthorized accounts must not have the “change the system time” user right. – (CCE-24185-1) – Fail
- Change the time zone
  - Unauthorized accounts must not have the “change the time zone” user right. – (CCE-24632-2) – Fail
- Force shutdown from a remote system
  - Unauthorized accounts must not have the “force shutdown from a remote system” user right. – (CCE-24734-6) – Fail
- Increase a process working set
  - Unauthorized accounts must not have the “increase a process working set” user right. – (CCE-24162-0) – Fail

- Load and unload device drivers
  - Unauthorized accounts must not have the “load and unload device drivers” user right. – (CCE-24779-1) – Fail
- Log on as a batch job
  - Unauthorized accounts must not have the “log on as a batch job” user right. – (CCE-23386-6) – Fail
- Restore files and directories
  - Unauthorized accounts must not have the “restore files and directories” user right. – (CCE-25518-2) – Fail
- Shut down the system
  - Unauthorized accounts must not have the “shut down the system” user right. – (CCE-23500-2) – Fail
- Add workstations to domain
  - Unauthorized accounts must not have the “add workstations to domain” user right. – (CCE-23271-0) – Fail
- Audit Directory Service Access – Success
  - The system must be configured to audit DS Access – Directory Service Access successes. – Fail
- Audit – Directory Service Access – Failure
  - The system must be configured to audit DS Access – Directory Service Access failures. – Fail
- Audit – Directory Service Changes – Success
  - The system must be configured to audit DS Access – Directory Service Changes successes. – Fail
- Audit – Directory Service Changes – Failure
  - The system must be configured to audit DS Access – Directory Service Changes failures. – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail

### 17.9.4 OT ConsoleWorks Windows Server 2012 STIG Compliance Report

Non-Compliance Report – U\_Windows2012\_MS\_V1R3\_STIG\_SCAP\_1-1\_Benchmark

SCAP Compliance Checker – 3.1.2

#### 17.9.5 Score

Adjusted Score: 97.13%

97.13% Original Score: 97.13%

Compliance Status: GREEN

Pass:	271	Not Applicable:	0	BLUE:	Score equals 100
Fail:	8	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	279	RED:	Score is greater than or equal to 0

#### 17.9.6 System Information

Target	OT-CONSOLEWORKS
Operating System	Windows Server 2012 R2 Standard
OS Service Pack	
Domain	OT-ES-IDAM-B1
Processor	Intel(R) Xeon(R) CPU E5-2660 0 @ 2.20GHz
Processor Architecture	Intel64 Family 6 Model 45 Stepping 7
Processor Speed	2200 MHz
Physical Memory	8192 mb
Manufacturer	VMware, Inc.
Model	VMware Virtual Platform
Serial Number	VMware-42 09 c2 cc c1 37 31 5c-2d 94 63 96 80 d2 05 fe

BIOS Version	6.00
Interfaces	[00000010] Intel(R) 82574L Gigabit Network Connection <ul style="list-style-type: none"> <li>▪ 172.16.6.8</li> <li>▪ 00:50:56:89:56:86</li> </ul>

### 17.9.7 Results

- Bad Logon Attempts
  - The number of allowed bad logon attempts must meet minimum requirements. – (CCE-23909-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system must be configured to force users to log off when their allowed logon hours expire. – (CCE-25367-4) – Fail
- Minimum Password Length
  - Passwords must, at a minimum, be 14 characters. – (CCE-25317-9) – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner must be configured. – (CCE-24020-0) – Fail
- Deny log on as a batch job
  - The “deny log on as a batch job” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems, and from unauthenticated access on all systems. – (CCE-25215-5) – Fail
- Deny log on as service
  - The “deny log on as a service” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems. No other groups or accounts must be assigned this right. – (CCE-23117-5) – Fail
- Deny log on locally
  - The “deny log on locally” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems, and from unauthenticated access on all systems. – (CCE-24460-8) – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail

## 17.10 OT Windows 7 Workstations STIG Compliance Report

Non-Compliance Report – U\_Windows\_7\_V1R23\_STIG\_SCAP\_1-0\_Benchmark

SCAP Compliance Checker – 3.1.2

### 17.10.1 Score

	Adjusted Score:	95.47%
95.47%	Original Score:	95.47%
	Compliance Status:	GREEN

Pass:	253	Not Applicable:	0	BLUE:	Score equals 100
Fail:	12	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	265	RED:	Score is greater than or equal to 0

### 17.10.2 System Information

Target	OTWORKS1
Operating System	Windows 7 Enterprise
OS Service Pack	Service Pack 1
Domain	OT-ES-IDAM-B1
Processor	Intel(R) Xeon(R) CPU E5-2660 0 @ 2.20GHz
Processor Architecture	Intel64 Family 6 Model 45 Stepping 7
Processor Speed	2200 MHz
Physical Memory	4096 mb
Manufacturer	VMware, Inc.
Model	VMware Virtual Platform

Serial Number	VMware-42 09 49 1e 0a 42 38 8e-03 d2 8f e6 31 25 5a 63
BIOS Version	6.00
Interfaces	[00000007] Intel(R) PRO/1000 MT Network Connection <ul style="list-style-type: none"> <li>172.16.6.6</li> <li>00:50:56:89:0B:7A</li> </ul>

### 17.10.3 Results

- Legal Notice Display
  - The required legal notice must be configured to display before console logon. – (CCE-8973-0) – Fail
- Bad Logon Attempts
  - Number of allowed bad-logon attempts does not meet minimum requirements. – (CCE-9136-3) – Fail
- Secure Print Driver Installation
  - Print driver installation privilege is not restricted to administrators. – (CCE-9026-6) – Fail
- Deny Access from the Network
  - The deny access to this computer from the network user right on workstations must be configured to prevent access from highly privileged domain accounts and local administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-9244-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system is not configured to force users to log off when their allowed logon hours expire. – (CCE-9704-8) – Fail
- Minimum Password Length
  - For systems utilizing a logon ID as the individual identifier, passwords must be a minimum of 14 characters in length. – (CCE-9357-5) – Fail
- Deny log on as a batch job
  - The “deny log on as a batch job” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-9212-2) – Fail

- Deny log on as service
  - The “deny log on as a service” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems. No other groups or accounts must be assigned this right. – (CCE-9098-5) – Fail
- Deny log on locally
  - The “deny log on locally” user right on workstations must be configured to prevent access from highly privileged domain accounts on domain systems and unauthenticated access on all systems. – (CCE-9239-5) – Fail
- Deny log on through Remote Desktop \ Terminal Services
  - The deny log on through Remote Desktop Services user right on workstations must prevent all access if RDS is not used by the organization. If RDS is used, it must be configured to prevent access from highly privileged domain accounts and local administrator accounts on domain systems and unauthenticated access on all systems. – (CCE-9274-2) – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail
- WINGE-000200
  - A group named DenyNetworkAccess must be defined on domain systems to include all local administrator accounts. – Fail

17.11 PACS Domain Controller STIG Compliance Report

All Settings Report - U\_Windows2012\_DC\_V1R3\_STIG\_SCAP\_11\_Benchmark

SCAP Compliance Checker - 3.1.2

17.11.1 Score

91.47			%	Adjusted 91.% Original 91.% Compliance GREE	
Pas 26	Not	0		BLU Score equals GREE Score is greater than or	
Fai 2	Not	0			

Error: 0 Not Selected: 0 YELLOW: Score is greater than or equal to 80

Unknown: 0 Total: 293 RED: Score is greater than or equal to 0

### 17.11.2 System Information

Target	PACSDC
Operating System	Windows Server 2012 R2 Standard
OS Service Pack	
Domain	PACS-ES-IDAM-B1

### 17.11.3 Stream Information

Release Information	Release: 3 Benchmark Date: 28 Oct 2014
Stream	U_Windows2012_DC_V1R3_STIG_SCAP_1-1_Benchmark
Title	Windows Server 2012 / 2012 R2 Domain Controller Security Technical Implementation Guide
Description	The Windows Server 2012 / 2012 R2 Domain Controller Security Technical Implementation Guide (STIG) is published as a tool to improve the security of Department of Defense (DoD) information systems. Comments or proposed revisions to this document should be sent via e-mail to the following address: <a href="mailto:disa.letterkenny.FSO.mbx.stig-customer-support-mailbox@mail.mil">disa.letterkenny.FSO.mbx.stig-customer-support-mailbox@mail.mil</a> .
Notice	Developed_by_DISA_for_the_DoD
Target Platforms	cpe:/o:microsoft:windows_server_2012:-
Identity Authenticated	true

### 17.11.4 Results

- Bad Logon Attempts
  - The number of allowed bad logon attempts must meet minimum requirements. – (CCE-23909-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system must be configured to force users to log off when their allowed logon hours expire. – (CCE-25367-4) – Fail
- LDAP Signing Requirements



- Domain controllers must require LDAP access signing. – (CCE-23587-9) – Fail
- Computer Account Password Change
  - Domain controllers must be configured to allow the reset of machine account passwords. – (CCE-24692-6) – Fail
- Remotely Accessible Registry Paths and Sub-Paths
  - Unauthorized remotely accessible registry paths and sub-paths must not be configured. – (CCE-25426-8) – Fail
- Minimum Password Length
  - Passwords must, at a minimum, be 14 characters. – (CCE-25317-9) – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner must be configured. – (CCE-24020-0) – Fail
- Access this computer from the network
  - Unauthorized accounts must not have the “access this computer from the network” user right on domain controllers. – Fail
- Allow log on locally
  - Unauthorized accounts must not have the “allow log on locally” user right. – (CCE-25228-8) – Fail
- Back up files and directories
  - Unauthorized accounts must not have the “back up files and directories” user right. – (CCE-25380-7) – Fail
- Bypass traverse checking
  - Unauthorized accounts must not have the “bypass traverse checking” user right. – (CCE-25271-8) – Fail
- Change the system time
  - Unauthorized accounts must not have the “change the system time” user right. – (CCE-24185-1) – Fail
- Change the time zone
  - Unauthorized accounts must not have the “change the time zone” user right. – (CCE-24632-2) – Fail
- Force shutdown from a remote system

- Unauthorized accounts must not have the “force shutdown from a remote system” user right. – (CCE-24734-6) – Fail
- Increase a process working set
  - Unauthorized accounts must not have the “increase a process working set” user right. – (CCE-24162-0) – Fail
- Load and unload device drivers
  - Unauthorized accounts must not have the “load and unload device drivers” user right. – (CCE-24779-1) – Fail
- Log on as a batch job
  - Unauthorized accounts must not have the “log on as a batch job” user right. – (CCE-23386-6) – Fail
- Restore files and directories
  - Unauthorized accounts must not have the “restore files and directories” user right. – (CCE-25518-2) – Fail
- Shut down the system
  - Unauthorized accounts must not have the “shut down the system” user right. – (CCE-23500-2) – Fail
- Add workstations to domain
  - Unauthorized accounts must not have the “add workstations to domain” user right. – (CCE-23271-0) – Fail
- Audit Directory Service Access – Success
  - The system must be configured to audit DS Access - Directory Service Access successes. – Fail
- Audit - Directory Service Access – Failure
  - The system must be configured to audit DS Access - Directory Service Access failures. – Fail
- Audit - Directory Service Changes – Success
  - The system must be configured to audit DS Access - Directory Service Changes successes. – Fail
- Audit - Directory Service Changes – Failure
  - The system must be configured to audit DS Access - Directory Service Changes failures. – Fail
- WINGE-000100

- The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail

## 17.12 PACS Console Windows Server 2012 STIG Compliance Report

Non-Compliance Report – U\_Windows2012\_MS\_V1R3\_STIG\_SCAP\_1-1\_Benchmark

SCAP Compliance Checker – 3.1.2

### 17.12.1 Score

	Adjusted Score:	96.06%
96.06%	Original Score:	96.06%
	Compliance Status:	GREEN

Pass:	268	Not Applicable:	0	BLUE:	Score equals 100
Fail:	11	Not Checked:	0	GREEN:	Score is greater than or equal to 90
Error:	0	Not Selected:	0	YELLOW:	Score is greater than or equal to 80
Unknown:	0	Total:	279	RED:	Score is greater than or equal to 0

### 17.12.2 System Information

Target	PACS-CONSOLE
Operating System	Windows Server 2012 R2 Standard
OS Service Pack	
Domain	PACS-ES-IDAM-B1
Processor	Intel(R) Xeon(R) CPU E5-2660 0 @ 2.20GHz
Processor Architecture	Intel64 Family 6 Model 45 Stepping 7
Processor Speed	2200 MHz
Physical Memory	8192 mb
Manufacturer	VMware, Inc.

<b>Model</b>	VMware Virtual Platform
<b>Serial Number</b>	VMware-42 09 dc 00 da 26 44 78-07 ea f5 33 59 b9 af 46
<b>BIOS Version</b>	6.00
<b>Interfaces</b>	[00000010] Intel(R) 82574L Gigabit Network Connection <ul style="list-style-type: none"> <li>▪ 172.16.7.11</li> <li>▪ 00:50:56:89:F8:E0</li> </ul>

### 17.12.3 Results

- Bad Logon Attempts
  - The number of allowed bad logon attempts must meet minimum requirements. – (CCE-23909-5) – Fail
- Force Logoff When Logon Hours Expire
  - The system must be configured to force users to log off when their allowed logon hours expire. – (CCE-25367-4) – Fail
- Minimum Password Length
  - Passwords must, at a minimum, be 14 characters. – (CCE-25317-9) – Fail
- Legal Banner Dialog Box Title
  - The Windows dialog box title for the legal banner must be configured. – (CCE-24020-0) – Fail
- Adjust memory quotas for a process
  - Unauthorized accounts must not have the “adjust memory quotas for a process” user right. – (CCE-25112-4) – Fail
- Bypass traverse checking
  - Unauthorized accounts must not have the “bypass traverse checking” user right. – (CCE-25271-8) – Fail
- Deny log on as a batch job
  - The “deny log on as a batch job” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems, and from unauthenticated access on all systems. – (CCE-25215-5) – Fail
- Deny log on as service

- The “deny log on as a service” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems. No other groups or accounts must be assigned this right. – (CCE-23117-5) – Fail
- Deny log on locally
  - The “deny log on locally” user right on member servers must be configured to prevent access from highly privileged domain accounts on domain systems, and from unauthenticated access on all systems. – (CCE-24460-8) – Fail
- Replace a process level token
  - Unauthorized accounts must not have the “replace a process level token” user right. – (CCE-24555-5) – Fail
- WINGE-000100
  - The Enhanced Mitigation Experience Toolkit (EMET) V4.1 Update 1 or later must be installed on the system. – Fail

## 17.13 Baseline CentOS 7 Linux Configuration

### How To STIG/Configure CentOS 7

Install fresh CentOS 7 server image, using Minimal Install. The following are assumptions in the installation:

- separate partitions for /var, /var/log, /var/log/audit, /tmp, /home
- Networking is configured for your network.

```
yum update -y
yum install wget openscap-utiles aide libreswan iptables-service ntp
mkdir {reports,xml}
cd xml
wget http://iase.disa.mil/stigs/Documents/u_RedHat_6_V1R6_STIG_SCAP_1-
1_Benchmark.zip
unzip u_RedHat*
```

----- Run Initial Test -----

```
oscap xccdf eval --report ../reports/report.html --cpe *cpe-
dictionary.xml *Benchmark-xccdf.xml
python -m SimpleHTTPServer
```

Go to <http://<Centos 7 IP Address>:8000/> to view the results of the STIG test.

1. Add the following files to the following locations:

- a. `rules_d-audit.rules > /etc/audit/rules.d/audit.rules`
- b. `audit.rules > /etc/audit/audit.rules`
- c. `audit.conf > /etc/audit/audit.conf`
- d. `system-auth > /etc/pam.d/system-auth`
- e. `system-auth 0 0 * * * root /sbin/aide -checkth-ac > /etc/pam.d/system-auth-ac`
- f. `sysctl.conf > /etc/sysctl.conf`
- g. `password-auth-ac > /etc/pam.d/password-auth-ac`
- h. `iptables > /etc/sysconfig/iptables`

2. Edit the following files:

- a. In `/etc/logindefs`, add/change variables to:

```
PASS_MIN_LEN 14
PASS_MIN_DAYS 1
PASS_MAX_DAYS 60
```

- b. Add the following to `/etc/crontab`:

```
0 0 * * * root /sbin/aide -check
```

- c. In `/etc/modprobe.d/disabled.conf` (create if it doesn't exist), add:

```
install usb-storage /bin/false
install dccp /bin/false
install sctp /bin/false
install rds /bin/false
install tipc /bin/false
install ipv6 /bin/false
```

- d. Remove any line in `/etc/securetty` that starts with `vc` or `ttys`

- e. Add to `/etc/rsyslog.conf`:

```
*.* @@<any remote syslog server IP address>:514
```

- f. Add to `/etc/sysconfig/init`:

```
SINGLE=/sbin/sulogin
PROMPT=no
```

g. Edit `/etc/ntp.conf`:

- i. place '#' in front of any line that starts with 'server'
- ii. Add `server tick.usno.navy.mil`

h. For all files `/etc/csh.cshrc`, `/etc/profile`, `/etc/login.defs`, and `/etc/bashrc`:

- i. Change any `umask` line to `umask 077` and any `UMASK` line to `UMASK 077`

i. Add to `/etc/inittab`:

```
id:3:initdefault:
```

j. Add to `/etc/security/limits.conf`:

```
* hard core 0
* hard maxlogins 0
```

k. Edit `/etc/default/useradd`:

- i. Change `INACTIVE=-1` to `INACTIVE=35`

l. `yum remove firewalld`

m. `chkconfig ntpd on`

n. `service ntpd start`

o. `ln -sf /lib/systemd/system/multi-user.target  
/etc/systemd/system/default.target`

### 17.13.1 Baseline CentOS 7 Configuration Files

1. Audit.rules file contents
2. Audit.conf file contents
3. iptables file contents
4. Password\_auth-ac file contents
5. rules\_d-audi.rules file contents
6. Sysctl.conf files contents
7. system-auth file contents
8. system-auth-ac file contents

### 17.13.2 Audit.rules File Contents

```
#
# This file controls the configuration of the audit daemon
#

log_file = /var/log/audit/audit.log
log_format = RAW
log_group = root
priority_boost = 4
flush = INCREMENTAL
freq = 20
num_logs = 5
disp_qos = lossy
dispatcher = /sbin/audispd
name_format = NONE
##name = mydomain
max_log_file = 6
max_log_file_action = ROTATE
space_left = 75
space_left_action = email
action_mail_acct = root
admin_space_left = 50
admin_space_left_action = SINGLE
disk_full_action = SUSPEND
disk_error_action = SUSPEND
##tcp_listen_port =
tcp_listen_queue = 5
tcp_max_per_addr = 1
##tcp_client_ports = 1024-65535
tcp_client_max_idle = 0
enable_krb5 = no
krb5_principal = auditd
##krb5_key_file = /etc/audit/audit.key
```

### 17.13.3 Audit.conf File Contents

```
#
# This file controls the configuration of the audit daemon
#

log_file = /var/log/audit/audit.log
log_format = RAW
log_group = root
priority_boost = 4
flush = INCREMENTAL
freq = 20
num_logs = 5
disp_qos = lossy
dispatcher = /sbin/audispd
name_format = NONE
##name = mydomain
max_log_file = 6
```



```

max_log_file_action = ROTATE
space_left = 75
space_left_action = email
action_mail_acct = root
admin_space_left = 50
admin_space_left_action = SINGLE
disk_full_action = SUSPEND
disk_error_action = SUSPEND
##tcp_listen_port =
tcp_listen_queue = 5
tcp_max_per_addr = 1
##tcp_client_ports = 1024-65535
tcp_client_max_idle = 0
enable_krb5 = no
krb5_principal = auditd
##krb5_key_file = /etc/audit/audit.key

```

### 17.13.4 iptables File Contents

```

# Generated by iptables-save v1.4.21 on Tue Jan 27 13:28:25 2015
*nat
:PREROUTING ACCEPT [219:23061]
:INPUT ACCEPT [2:120]
:OUTPUT ACCEPT [125:7804]
:POSTROUTING ACCEPT [125:7804]
:OUTPUT_direct - [0:0]
:POSTROUTING_ZONES - [0:0]
:POSTROUTING_ZONES_SOURCE - [0:0]
:POSTROUTING_direct - [0:0]
:POST_public - [0:0]
:POST_public_allow - [0:0]
:POST_public_deny - [0:0]
:POST_public_log - [0:0]
:PREROUTING_ZONES - [0:0]
:PREROUTING_ZONES_SOURCE - [0:0]
:PREROUTING_direct - [0:0]
:PRE_public - [0:0]
:PRE_public_allow - [0:0]
:PRE_public_deny - [0:0]
:PRE_public_log - [0:0]
-A PREROUTING -j PREROUTING_direct
-A PREROUTING -j PREROUTING_ZONES_SOURCE
-A PREROUTING -j PREROUTING_ZONES
-A OUTPUT -j OUTPUT_direct
-A POSTROUTING -j POSTROUTING_direct
-A POSTROUTING -j POSTROUTING_ZONES_SOURCE
-A POSTROUTING -j POSTROUTING_ZONES
-A POSTROUTING_ZONES -o ens160 -g POST_public
-A POSTROUTING_ZONES -g POST_public
-A POST_public -j POST_public_log
-A POST_public -j POST_public_deny
-A POST_public -j POST_public_allow

```

```
-A PREROUTING_ZONES -i ens160 -g PRE_public
-A PREROUTING_ZONES -g PRE_public
-A PRE_public -j PRE_public_log
-A PRE_public -j PRE_public_deny
-A PRE_public -j PRE_public_allow
COMMIT
# Completed on Tue Jan 27 13:28:25 2015
# Generated by iptables-save v1.4.21 on Tue Jan 27 13:28:25 2015
*mangle
:PREROUTING ACCEPT [94235:148159541]
:INPUT ACCEPT [94155:148151187]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [43012:2796100]
:POSTROUTING ACCEPT [43027:2798919]
:FORWARD_direct - [0:0]
:INPUT_direct - [0:0]
:OUTPUT_direct - [0:0]
:POSTROUTING_direct - [0:0]
:PREROUTING_ZONES - [0:0]
:PREROUTING_ZONES_SOURCE - [0:0]
:PREROUTING_direct - [0:0]
:PRE_public - [0:0]
:PRE_public_allow - [0:0]
:PRE_public_deny - [0:0]
:PRE_public_log - [0:0]
-A PREROUTING -j PREROUTING_direct
-A PREROUTING -j PREROUTING_ZONES_SOURCE
-A PREROUTING -j PREROUTING_ZONES
-A INPUT -j INPUT_direct
-A FORWARD -j FORWARD_direct
-A OUTPUT -j OUTPUT_direct
-A POSTROUTING -j POSTROUTING_direct
-A PREROUTING_ZONES -i ens160 -g PRE_public
-A PREROUTING_ZONES -g PRE_public
-A PRE_public -j PRE_public_log
-A PRE_public -j PRE_public_deny
-A PRE_public -j PRE_public_allow
COMMIT
# Completed on Tue Jan 27 13:28:25 2015
# Generated by iptables-save v1.4.21 on Tue Jan 27 13:28:25 2015
*security
:INPUT ACCEPT [94003:148133781]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [43012:2796100]
:FORWARD_direct - [0:0]
:INPUT_direct - [0:0]
:OUTPUT_direct - [0:0]
-A INPUT -j INPUT_direct
-A FORWARD -j FORWARD_direct
-A OUTPUT -j OUTPUT_direct
COMMIT
# Completed on Tue Jan 27 13:28:25 2015
```

```
# Generated by iptables-save v1.4.21 on Tue Jan 27 13:28:25 2015
*raw
:PREROUTING ACCEPT [94236:148159577]
:OUTPUT ACCEPT [43012:2796100]
:OUTPUT_direct - [0:0]
:PREROUTING_direct - [0:0]
-A PREROUTING -j PREROUTING_direct
-A OUTPUT -j OUTPUT_direct
COMMIT
# Completed on Tue Jan 27 13:28:25 2015
# Generated by iptables-save v1.4.21 on Tue Jan 27 13:28:25 2015
*filter
:INPUT DROP [0:0]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
:FORWARD_IN_ZONES - [0:0]
:FORWARD_IN_ZONES_SOURCE - [0:0]
:FORWARD_OUT_ZONES - [0:0]
:FORWARD_OUT_ZONES_SOURCE - [0:0]
:FORWARD_direct - [0:0]
:FWDI_public - [0:0]
:FWDI_public_allow - [0:0]
:FWDI_public_deny - [0:0]
:FWDI_public_log - [0:0]
:FWDO_public - [0:0]
:FWDO_public_allow - [0:0]
:FWDO_public_deny - [0:0]
:FWDO_public_log - [0:0]
:INPUT_ZONES - [0:0]
:INPUT_ZONES_SOURCE - [0:0]
:INPUT_direct - [0:0]
:IN_public - [0:0]
:IN_public_allow - [0:0]
:IN_public_deny - [0:0]
:IN_public_log - [0:0]
:OUTPUT_direct - [0:0]
-A INPUT -m conntrack --ctstate RELATED,ESTABLISHED -j ACCEPT
-A INPUT -i lo -j ACCEPT
-A INPUT -j INPUT_direct
-A INPUT -j INPUT_ZONES_SOURCE
-A INPUT -j INPUT_ZONES
-A INPUT -p icmp -j ACCEPT
-A INPUT -j REJECT --reject-with icmp-host-prohibited
-A FORWARD -m conntrack --ctstate RELATED,ESTABLISHED -j ACCEPT
-A FORWARD -i lo -j ACCEPT
-A FORWARD -j FORWARD_direct
-A FORWARD -j FORWARD_IN_ZONES_SOURCE
-A FORWARD -j FORWARD_IN_ZONES
-A FORWARD -j FORWARD_OUT_ZONES_SOURCE
-A FORWARD -j FORWARD_OUT_ZONES
-A FORWARD -p icmp -j ACCEPT
-A FORWARD -j REJECT --reject-with icmp-host-prohibited
```

```

-A OUTPUT -j OUTPUT_direct
-A FORWARD_IN_ZONES -i ens160 -g FWDI_public
-A FORWARD_IN_ZONES -g FWDI_public
-A FORWARD_OUT_ZONES -o ens160 -g FWDO_public
-A FORWARD_OUT_ZONES -g FWDO_public
-A FWDI_public -j FWDI_public_log
-A FWDI_public -j FWDI_public_deny
-A FWDI_public -j FWDI_public_allow
-A FWDO_public -j FWDO_public_log
-A FWDO_public -j FWDO_public_deny
-A FWDO_public -j FWDO_public_allow
-A INPUT_ZONES -i ens160 -g IN_public
-A INPUT_ZONES -g IN_public
-A IN_public -j IN_public_log
-A IN_public -j IN_public_deny
-A IN_public -j IN_public_allow
-A IN_public_allow -p tcp -m tcp --dport 22 -m conntrack --ctstate NEW -j ACCEPT
COMMIT
# Completed on Tue Jan 27 13:28:25 2015

```

### 17.13.5 Password\_auth-ac File Contents

```

#%PAM-1.0
# This file is auto-generated.
# User changes will be destroyed the next time authconfig is run.
auth required pam_env.so
auth sufficient pam_unix.so nullok try_first_pass
auth [default=die] pam_faillock.so authfail deny=3 unlock_time=604800
fail_interval=900
auth required pam_faillock.so authsucc deny=3 unlock_time=604800 fail_interval=900
auth requisite pam_succeed_if.so uid >= 1000 quiet_success
auth required pam_deny.so

account required pam_unix.so
account sufficient pam_localuser.so
account sufficient pam_succeed_if.so uid < 1000 quiet
account required pam_permit.so

password requisite pam_pwquality.so try_first_pass local_users_only retry=3
authtok_type=
password sufficient pam_unix.so sha512 shadow nullok try_first_pass use_authtok
password required pam_deny.so

session optional pam_keyinit.so revoke
session required pam_limits.so
-session optional pam_systemd.so
session [success=1 default=ignore] pam_succeed_if.so service in crond quiet use_uid
session required pam_unix.so

```

### 17.13.6 rules\_d-audi.rules File Contents

```

# This file contains the auditctl rules that are loaded
# whenever the audit daemon is started via the initscripts.

```

```
# The rules are simply the parameters that would be passed
# to auditctl.

# First rule - delete all
-D

# Increase the buffers to survive stress events.
# Make this bigger for busy systems
-b 320

# Feel free to add below this line. See auditctl man page
# STIG Stuff Below

# audit_time_rules
-a always,exit -F arch=b64 -S adjtimex -S settimeofday -S clock_settime -k
audit_time_rules
-w /etc/localtime -p wa -k audit_time_rules

# audit_account_changes
-w /etc/group -p wa -k audit_account_changes
-w /etc/passwd -p wa -k audit_account_changes
-w /etc/gshadow -p wa -k audit_account_changes
-w /etc/shadow -p wa -k audit_account_changes
-w /etc/security/opasswd -p wa -k audit_account_changes

# MAC-policy
-w /etc/selinux -p wa -k MAC-policy

# export
-a always,exit -F arch=b64 -S mount -F auid>=500 -F auid!=4294967295 -k export
-a always,exit -F arch=b64 -S mount -F auid=0 -k export

# delete
-a always,exit -F arch=b64 -S rmdir -S unlink -S unlinkat -S rename -S renameat -F
auid>=500 -F auid!=4294967295 -k delete
-a always,exit -F arch=b64 -S rmdir -S unlink -S unlinkat -S rename -S renameat -F
auid=0 -k delete

# actions
-w /etc/sudoers -p wa -k actions

# modules
-w /sbin/insmod -p x -k modules
-w /sbin/rmmod -p x -k modules
-w /sbin/modprobe -p x -k modules
-a always,exit -F arch=b64 -S init_module -S delete_module -k modules

# perm_mod
-a always,exit -F arch=b32 -S chmod -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S chmod -F auid=0 -k perm_mod
-a always,exit -F arch=b32 -S fchmod -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S fchmod -F auid=0 -k perm_mod
```

```
-a always,exit -F arch=b64 -S chmod -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S chmod -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fchmod -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S fchmod -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S fchmodat -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S fchmodat -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fchmodat -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S fchmodat -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S fchown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S fchown -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fchown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S fchown -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S chown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S chown -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S chown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S chown -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S fchownat -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S fchownat -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fchownat -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S fchownat -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S fremovexattr -F auid>=500 -F auid!=4294967295 -k
perm_mod
-a always,exit -F arch=b32 -S fremovexattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fremovexattr -F auid>=500 -F auid!=4294967295 -k
perm_mod
-a always,exit -F arch=b64 -S fremovexattr -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S fsetxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S fsetxattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S fsetxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S fsetxattr -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S lchown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S lchown -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S lchown -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S lchown -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S lremovexattr -F auid>=500 -F auid!=4294967295 -k
perm_mod
-a always,exit -F arch=b32 -S lremovexattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S lremovexattr -F auid>=500 -F auid!=4294967295 -k
perm_mod
-a always,exit -F arch=b64 -S lremovexattr -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S lsetxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S lsetxattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S lsetxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
```

```

-a always,exit -F arch=b64 -S lsetxattr -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S removexattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S removexattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S removexattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S removexattr -F auid=0 -k perm_mod

-a always,exit -F arch=b32 -S setxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b32 -S setxattr -F auid=0 -k perm_mod
-a always,exit -F arch=b64 -S setxattr -F auid>=500 -F auid!=4294967295 -k perm_mod
-a always,exit -F arch=b64 -S setxattr -F auid=0 -k perm_mod

```

### 17.13.7 Sysctl.conf Files Contents

```

# System default settings live in /usr/lib/sysctl.d/00-system.conf.
# To override those settings, enter new settings here, or in an
/etc/sysctl.d/<name>.conf file
#
# For more information, see sysctl.conf(5) and sysctl.d(5).
net.ipv4.ip_forward = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.secure_redirects = 0
net.ipv4.conf.all.log_martians = 1
net.ipv4.conf.default.accept_source_route = 0
net.ipv4.conf.default.secure_redirects = 0
net.ipv4.conf.default.accept_redirects = 0
net.ipv4.icmp_echo_ignore_broadcasts = 1
net.ipv4.icmp_ignore_bogus_error_responses = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.conf.default.rp_filter = 1
net.ipv6.conf.default.accept_redirects = 0
net.ipv4.conf.default.send_redirects = 0
net.ipv4.conf.all.send_redirects = 0

```

### 17.13.8 system-auth File Contents

```

#%PAM-1.0
# This file is auto-generated.
# User changes will be destroyed the next time authconfig is run.
auth required pam_env.so
auth sufficient pam_unix.so try_first_pass
auth [default=die] pam_faillock.so authfail deny=3 unlock_time=604800
fail_interval=900
auth required pam_faillock.so authsucc deny=3 unlock_time=604800 fail_interval=900
auth requisite pam_succeed_if.so uid >= 1000 quiet_success
auth required pam_deny.so
account required pam_unix.so
account sufficient pam_localuser.so
account sufficient pam_succeed_if.so uid < 1000 quiet
account required pam_permit.so

```

```
password required pam_cracklib.so retry=3 minlen=14 dcredit=-1 ucredit=-1 ocredit=-1
lcredit=-1 difok=4
password requisite pam_pwquality.so try_first_pass local_users_only retry=3
authtok_type=
password sufficient pam_unix.so sha512 shadow try_first_pass use_authtok
password required pam_deney.so
```

```
session optional pam_keyinit.so revoke
session required pam_limits.so
-session optional pam_systemd.so
session [success=1 default=ignore] pam_succeed_if.so service in crond quiet use_uid
session required pam_unix.so
session required pam_lastlog.so showfailed
session required pam_limits.so
```

### 17.13.9 system-auth-ac File Contents

```
##PAM-1.0
# This file is auto-generated.
# User changes will be destroyed the next time authconfig is run.
auth required pam_env.so
auth sufficient pam_unix.so try_first_pass
auth [default=die] pam_faillock.so authfail deny=3 unlock_time=604800
fail_interval=900
auth required pam_faillock.so authsucc deny=3 unlock_time=604800 fail_interval=900
auth requisite pam_succeed_if.so uid >= 1000 quiet_success
auth required pam_deney.so

account required pam_unix.so
account sufficient pam_localuser.so
account sufficient pam_succeed_if.so uid < 1000 quiet
account required pam_permit.so

password required pam_cracklib.so retry=3 minlen=14 dcredit=-1 ucredit=-1 ocredit=-1
lcredit=-1 difok=4
password requisite pam_pwquality.so try_first_pass local_users_only retry=3
authtok_type=
password sufficient pam_unix.so sha512 shadow try_first_pass use_authtok
password required pam_deney.so

session optional pam_keyinit.so revoke
session required pam_limits.so
-session optional pam_systemd.so
session [success=1 default=ignore] pam_succeed_if.so service in crond quiet use_uid
session required pam_unix.so
session required pam_lastlog.so showfailed
session required pam_limits.so
```



## 17.14 Baseline CentOS 7 STIG Compliance

Note: The STIG compliance test is based on the CentOS 6 STIG compliance analysis. At the time when this testing was completed, the CentOS 7 STIG had not been published.

### 17.14.1 Test Result

Result ID	Profile	Start Time	End Time	Benchmark	Benchmark Version
xccdf_org.open-scap_testresult_default-profile	(Default profile)	2015-03-11 12:25	2015-03-11 12:26	embedded	1

### 17.14.2 Target Information

Target	Addresses	Platform
localhost.localdomain	<ul style="list-style-type: none"> <li>127.0.0.1</li> <li>10.32.2.59</li> <li>0:0:0:0:0:0:1</li> <li>fe80:0:0:0:250:56ff:fe89:5cab</li> </ul>	cpe:/o:redhat:enterprise_linux:6

### 17.14.3 Score

System	Score	Maximum Score	Score as Percentage	Bar
urn:xccdf:scoring:default	96.65	100.00	96.65%	

### 17.14.4 Rule Results Summary

Pass	Fixed	Fail	Error	Not Selected	Not Checked	Not Applicable	Informational	Unknown	Total
173	0	6	0	0	0	0	0	0	179

Title	Result
Auditing must be enabled at boot by setting a kernel parameter.	fail
The audit system must be configured to audit modifications to the systems Mandatory Access Control (MAC) configuration (SELinux).	fail
The system boot loader configuration file(s) must be owned by root.	fail
The system boot loader configuration file(s) must be group-owned by root.	fail
The system boot loader configuration file(s) must have mode 0600 or less permissive.	fail

Title	Result
The system boot loader must require authentication.	fail

## Appendix A List of Acronyms

<b>ACL</b>	Access Control List
<b>AD</b>	Active Directory
<b>ASLR</b>	Address Space Layout Randomization
<b>CA</b>	CA Technologies
<b>CD</b>	Compact Disc
<b>CD-ROM</b>	Compact Disc Read-Only Memory
<b>CIP</b>	Critical Infrastructure Protection
<b>CIS</b>	Center for Internet Security
<b>CPU</b>	Central Processing Unit
<b>CRADA</b>	Cooperative Research and Development Agreement
<b>CRL</b>	Certificate Revocation List
<b>CSV</b>	Comma-Separated Value
<b>DAC</b>	Discretionary Access Control
<b>DACL</b>	Discretionary Access Control List
<b>DBA</b>	Database Administrator
<b>DC</b>	Domain Controller
<b>DCCP</b>	Datagram Congestion Control Protocol
<b>DEP</b>	Data Execution Prevention
<b>DISA</b>	Defense Information Systems Agency
<b>DMZ</b>	Demilitarized Zone
<b>DNS</b>	Domain Name System
<b>DoD</b>	Department of Defense
<b>DSRM</b>	Directory Services Restore Mode
<b>EMET</b>	Enhanced Mitigation Experience Toolkit
<b>EMS</b>	Energy Management System
<b>FIPS</b>	Federal Information Processing Standards
<b>FTP</b>	File Transfer Protocol
<b>GB</b>	Gigabyte(s)
<b>GCC</b>	GlobalSign Certificate Center
<b>GHz</b>	Gigahertz
<b>HTTP</b>	Hypertext Transfer Protocol

<b>HTTPS</b>	Hypertext Transfer Protocol Secure
<b>ICS</b>	Industrial Control System
<b>IdAM</b>	Identity and Access Management
<b>IMG</b>	Identity Management and Governance
<b>IP</b>	Internet Protocol
<b>IRDP</b>	Internet Router Discover Protocol
<b>ISE</b>	Identity Services Engine
<b>IT</b>	Information Technology
<b>JDK</b>	Java Development Kit
<b>JKS</b>	Java Keystore
<b>JRE</b>	Java Runtime Environment
<b>LAN</b>	Local Area Network
<b>LDAP</b>	Lightweight Directory Access Protocol
<b>LDAPS</b>	Lightweight Directory Access Protocol Server
<b>LED</b>	Light-Emitting Diode
<b>MAC</b>	Mandatory Access Control
<b>MAG</b>	Mount Airey Group
<b>MB</b>	Megabyte(s)
<b>MSDT</b>	Microsoft Support Diagnostic Tool
<b>NAESB</b>	North American Energy Standards Board
<b>NAS</b>	Network Attached Storage
<b>NCCoE</b>	National Cybersecurity Center of Excellence
<b>NERC</b>	North American Electric Reliability Corporation
<b>NIST</b>	National Institute of Standards and Technology
<b>NTP</b>	Network Time Protocol
<b>OID</b>	Object Identification
<b>OS</b>	Operating System
<b>OT</b>	Operational Technology
<b>OU</b>	Organizational Unit
<b>OVA</b>	Open Virtualization Archive
<b>PACS</b>	Physical Access Control System
<b>PIN</b>	Personal Identification Number
<b>PIV</b>	Personal Identification Verification

<b>PIV-I</b>	Personal Identity Verification Interoperable
<b>PKI</b>	Public Key Infrastructure
<b>PPA</b>	Personal Profile Application
<b>RAM</b>	Random Access Memory
<b>RDP</b>	Remote Desktop Protocol
<b>RDS</b>	Reliable Datagram Sockets
<b>RS2</b>	RS2 Technologies
<b>RTU</b>	Remote Terminal Unit
<b>SCADA</b>	Supervisory Control and Data Acquisition
<b>SCTP</b>	Stream Control Transmission Protocol
<b>SEHOP</b>	Structured Exception Handler Overwrite Protection
<b>SEL</b>	Schweitzer Engineering Laboratories
<b>SID</b>	System Identifier
<b>SNMP</b>	Simple Network Management Protocol
<b>SP</b>	Special Publication
<b>SPN</b>	Service Principal Name
<b>SQL</b>	Structured Query Language
<b>SSH</b>	Secure Shell
<b>SSL</b>	Secure Sockets Layer
<b>STIG</b>	Security Technical Implementation Guideline
<b>TCP</b>	Transmission Control Protocol
<b>TIPC</b>	Transparent Inter-Process Communication
<b>UDP</b>	User Datagram Protocol
<b>URL</b>	Uniform Resource Locator
<b>UTC</b>	Coordinate Universal Time (also used for Utilities Telecom Council)
<b>VLAN</b>	Virtual Local Area Network
<b>VM</b>	Virtual Machine
<b>VNC</b>	Virtual Network Computing
<b>VPN</b>	Virtual Private Network
<b>WAN</b>	Wide Area Network
<b>WAR</b>	Web Application Archive
<b>WOTS</b>	Windows Online Troubleshooting Service
<b>XML</b>	EXtensible Markup Language