Cisco ISE for BYOD and Secure Unified Access

Second Edition

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Aaron T. Woland

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Aaron is the author of many Cisco white papers and design guides and is co-author of *CCNP Security SISAS 300-208 Official Cert Guide*; *Cisco Next-Generation Security Solutions: All-in-one Cisco ASA Firepower Services, NGIPS, and AMP*; and *CCNA Security 210-260 Complete Video Course*.

Aaron is one of only five inaugural members of the Hall of Fame Elite for Distinguished Speakers at Cisco Live, and is a security columnist for *Network World*, where he blogs on all things related to secure network access. His other certifications include GHIC, GSEC, Certified Ethical Hacker, MCSE, VCP, CCSP, CCNP, CCDP, and many other industry certifications. You can follow Aaron on Twitter: @aaronwoland.

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Epaminondas "Pete" Karelis, CCIE Emeritus #8068, is the director of enterprise architecture for Venable LLP, an AmLaw 100 law firm, and has been in IT for more than 20 years. He views himself as a technologist, and has a strong focus on the integration of systems, storage, security, virtualization, and networking. In addition to the Cisco certifications (CCNA, CCDA, CCNP, CCIE R&S) he has held Microsoft (MCSE, MCT) and Checkpoint (CCSE) certifications. Coupled with his strong scripting, programming, and API integration skills, as well as his storage and virtualization experience, he is uniquely enabled to create tightly integrated solutions that incorporate the network with the application and server infrastructure. The ISE Anycast solution mentioned in this book is one of his examples of integrating network awareness with application and service delivery to allow for high availability without the use of load balancers. In his spare time, Pete enjoys spending time with his wife and two beautiful children, as well as reading tech blogs and keeping up to date on future technologies and open-source developments.

Dedications

From Aaron: First and foremost, this book is dedicated to my amazing best friend, fellow adventurer, and wife, Suzanne. This book would surely not exist without your continued support, encouragement, and patience, as well as the sheer number of nights you took care of our newborn twins so I could write. Thank you for putting up with all the long nights and weekends I had to be writing. You are beyond amazing.

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Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italic* indicates arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([ ]) indicate an optional element.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.

Introduction

Today's networks have evolved into a system without well-defined borders/perimeters that contain data access from both trusted and untrusted devices. Cisco broadly calls this trend *borderless networking*. The Cisco Secure Access architecture and Cisco Identity Services Engine (ISE) were developed to provide organizations with a solution to secure and regain control of borderless networks in a Bring Your Own Device (BYOD) world.

A few basic truths become apparent when trying to secure a borderless network. First, you can no longer trust internal data traffic. There are just too many ingress points into the network and too many untrusted devices/users inside the network to be able to trust it implicitly. Second, given the lack of internal trust, it becomes necessary to authenticate and authorize all users into the network regardless of their connection type: wired, wireless, or VPN. Third, because of the proliferation of untrusted and unmanaged devices connecting to your internal network, device control and posture assessment become critical. Each device must be checked for security compliance before it is allowed access to your network resources. These checks vary according to your security policy, but usually involve checking the device type, location, management status, and operating-system patch level, and ensuring that antimalware software is running and up to date.

This book addresses the complete lifecycle of protecting a modern borderless network using Cisco Secure Access and ISE solutions. Secure access and ISE design, implementation, and troubleshooting are covered in depth. This book explains the many details of the solution and how it can be used to secure borderless networks. At its heart, this solution allows organizations to identify and apply network security policies based on user identity, device type, device behavior, and other attributes, such as security posture. Technologies such as 802.1X, profiling, guest access, network admission control, RADIUS, device administration, TACACS+, and TrustSec are covered in depth.

The goal is to boil down and simplify the architectural details and present them in one reference without trying to replace the existing design, installation, and configuration guides already available from Cisco.

Who Should Read This Book?

This book is targeted primarily to a technical audience involved in architecting, deploying, and delivering secure networks and enabling mobile services. It can help them make informed choices, and enable them to have an engaging discussion with their organization, on how they can achieve their security and availability goals, while reaping the benefits of a secure access solution.

This book is helpful to those looking to deploy Cisco ISE to secure your wired, wireless, and VPN access. It is also useful for those moving to a BYOD IT model.

How This Book Is Organized

This book is organized into 31 chapters distributed across 7 different parts, each based on a main theme. As a bonus, four appendixes are included as Part VIII to provide added value to readers. Although this book can be read cover to cover, readers can move between chapters and parts, covering only the content that interests them. The seven parts of the book are described first:

Part I, "Identity-Enabled Network: Unite!": Examines the evolution of identity-enabled networks. It provides an overview of security issues facing today's networks and what has been the history of trying to combat this problem. This part covers a foundation-building review of AAA, 802.1X, the NAC framework, NAC appliance, the evolution into Secure Access, and the creation of Cisco ISE. It discusses the issues faced with the consumerization of information technology, the mass influx of personal devices, ensuring only the correct users, correct devices, with the correct software are allowed to access the corporate network unfettered.

Part II, "The Blueprint, Designing an ISE-Enabled Network": Covers the high-level design phase of a secure network access project. Solution diagrams are included. This part covers the different ISE functions available, how to distribute these functions, and the solution taxonomy. It discusses the enforcement devices that are part of this solution and ones that are not. Change of Authorization (CoA) is introduced. All these concepts are clarified and reinforced throughout the other parts.

Part III, "The Foundation, Building a Context-Aware Security Policy": Describes how to create a context-aware security policy for the network and devices. This is often the hardest part of a secure network access project. This part covers the departments that need to be involved, the policies to be considered, and best practices. Coverage includes some lessons learned and landmines to watch out for. Screenshots and flow diagrams are included in this part to aid in the readers' understanding of the process, how communication occurs and in what order, and how to configure the miscellaneous device supplicants.

Part IV, "Let's Configure!": Details the step-by-step configuration of ISE, the network access devices (NAD), and supplicants. The goal of this part is to have the entire infrastructure and policy management configured and ready to begin the actual deployment. Technology and complex topics are explained along with the configuration steps, aiding in the understanding of the configuration steps by tying them together with the technological explanation.

Part V, "Advanced Secure Access Features": Dives into some of the more advanced solution features that truly differentiate the ISE secure access system. This part covers advanced configurations of the ISE profiling engine, Cisco TrustSec, high availability, backups, passive identity capabilities, EasyConnect, and context sharing with the Platform eXchange Grid (pxGrid).

Part VI, "Monitoring, Maintenance, and Troubleshooting for Network Access AAA": Examines the maintenance of ISE, backups, and upgrades. It covers how to troubleshoot not only ISE, but the entire secure access system, and how to use the tools provided in the ISE product. Common monitoring and maintenance tasks, as well as troubleshooting tools, are explained from a help-desk support technician's point of view.

Part VII, "Device Administration": All new material for this second edition, this part covers the principles of device administration AAA and TACACS+, how to design it with ISE, and the step-by-step configuration of key Cisco network devices: Catalyst switches, Wireless LAN Controllers, and Nexus data center switches.

Here is an overview of each of the 31 chapters:

- **Chapter 1, "Regain Control of Your IT Security":** This chapter introduces the concepts that brought us to the current evolutionary stage of network access security. It discusses the explosion of mobility, virtualization, social networking, and ubiquitous network access coupled with the consumerization of information technology.
- **Chapter 2, "Fundamentals of AAA":** This chapter reviews the critical security concept of authentication, authorization, and accounting (AAA); compares and contrasts the two main AAA types of network access and device administration; and dives into the foundations of RADIUS and TACACS+.
- **Chapter 3, "Introducing Cisco Identity Services Engine":** Cisco ISE makes up the backbone of Cisco's next-generation, context-aware, identity-based security policy solution. This chapter introduces this revolutionary product and provides an overview of its functions and capabilities.
- **Chapter 4, "The Building Blocks in an Identity Services Engine Design":** This chapter covers the components of the secure access solution, including ISE personas, licensing model, and the policy structure.
- **Chapter 5, "Making Sense of the ISE Deployment Design Options":** This chapter examines all the available personas in ISE and design options with the combination of those personas.
- **Chapter 6, "Quick Setup of an ISE Proof of Concept":** This chapter provides a high-level overview of the ISE personas, walks you through the initial configuration (called bootstrapping) of ISE itself, and introduces role-based access control (RBAC).
- **Chapter 7, "Building a Cisco ISE Network Access Security Policy":** This chapter guides you through the process of creating a comprehensive network access security policy (NASP) that you can use in an environment that is safeguarded by Cisco ISE.
- **Chapter 8, "Building a Device Security Policy":** This chapter explores ISE device profiling and Threat-Centric NAC features in some detail. The goal is to disclose the different ways in which ISE can identify device types and other contextual information about devices for use in an ISE policy.
- **Chapter 9, "Building an ISE Accounting and Auditing Policy":** This chapter covers why you need accounting and auditing for ISE; using PCI DSS as your ISE auditing

framework; and Cisco ISE user accounting. Understanding and keeping track of what is happening inside the network and inside of ISE is critical to achieving a successful ISE deployment.

- **Chapter 10, "Profiling Basics and Visibility":** This chapter introduces the concepts of profiling and configuration choices needed to create a foundation to build upon. It examines the different profiling mechanisms and the pros and cons related to each, discussing best practices and configuration details.
- **Chapter 11, "Bootstrapping Network Access Devices":** This key chapter examines the configuration of the NADs themselves and focuses on best practices to ensure a successful ongoing deployment.
- **Chapter 12, "Network Authorization Policy Elements":** This chapter examines the logical roles within an organization and how to create authorization results to assign the correct level of access based on that role.
- **Chapter 13, "Authentication and Authorization Policies":** This chapter explains the distinct and important difference between authentication and authorization policies, presents the pieces that make up the policies, and provides examples of how to create a policy in ISE that enforces the logical policies created in Chapter 12.
- **Chapter 14, "Guest Lifecycle Management":** Guest access has become an expected resource at companies in today's world. This chapter explains the full secure guest lifecycle management, from Web Authentication (WebAuth) to sponsored guest access and self-registration options.
- **Chapter 15, "Client Posture Assessment":** This chapter examines endpoint posture assessment and remediation actions, the configuration of the extensive checks and requirements, and how to tie them into an authorization policy.
- **Chapter 16, "Supplicant Configuration":** This chapter looks at configuration examples of the most popular supplicants.
- **Chapter 17, "BYOD: Self-Service Onboarding and Registration":** This critical chapter goes through a detailed examination of BYOD concepts, policies, and flows. Both the user and administrative experiences are detailed, as well as the integration between ISE and third-party MDM vendors and ISE's internal certificate authority (CA).
- **Chapter 18, "Setting Up and Maintaining a Distributed ISE Deployment":** Cisco ISE can be deployed in a scalable distributed model or as a standalone device. This chapter examines how ISE can be deployed in this distributed model, and the caveats associated. It also details high availability (HA) with technologies such as load balancing.
- **Chapter 19, "Remote Access VPN and Cisco ISE":** This chapter details the integration of ISE with remote access VPNs using the Cisco ASA.

- **Chapter 20, "Deployment Phases":** This chapter explains the best practices related to phasing in a secure network access deployment. The chapter goes through the phases of Monitor Mode, Low-Impact Mode, and Closed Mode deployments.
- **Chapter 21, "Advanced Profiling Configuration":** This chapter builds on what was learned and configured in Chapter 10, examining how to profile unknown endpoints and looking deeper into the profiling policies themselves.
- **Chapter 22, "Cisco TrustSec AKA Security Group Access":** This chapter introduces the next-generation policy model known as Cisco TrustSec and Security Group Tags.
- **Chapter 23, "Passive Identities, ISE-PIC, and EasyConnect":** Brand new for this second edition, this chapter compares and contrasts active versus passive identities, and the EasyConnect method of network access control.
- **Chapter 24, "ISE Ecosystems: The Platform eXchange Grid (pxGrid)":** Also brand new for this edition, this chapter discusses the use of ISE as the center of a security ecosystem, the importance of context sharing, and the best practices for deploying the Platform eXchange Grid (pxGrid).
- **Chapter 25, "Understanding Monitoring, Reporting, and Alerting":** This chapter explains the extensive and redesigned monitoring, reporting, and alerting mechanisms built into the ISE solution.
- **Chapter 26, "Troubleshooting":** This chapter aids the reader when having to troubleshoot the ISE identity-enabled network and its many moving parts.
- **Chapter 27, "Upgrading ISE":** This chapter focuses on the upgrading of ISE nodes using both the graphical tool and the command line, with a heavy focus on the secondary PAN first (SPF) method of upgrade.
- **Chapter 28, "Device Administration Fundamentals":** This chapter details the integration of device administration AAA and TACACS+ into the ISE solution and the design options for deploying it in parallel or in conjunction with network access AAA.
- **Chapter 29, "Configuring Device Admin AAA with Cisco IOS":** Building on Chapter 29, this chapter details the configuration of ISE and Cisco IOS–based Catalyst switches for the purposes of device administration AAA with TACACS+.
- **Chapter 30, "Configuring Device Admin AAA with Cisco WLC:** This chapter details the configuration of ISE and Cisco Wireless LAN Controllers for the purposes of device administration AAA with TACACS+.
- **Chapter 31, "Configuring Device Admin AAA with Cisco Nexus Switches":** This chapter details the configuration of ISE and Cisco Wireless LAN Controllers for the purposes of device administration AAA with TACACS+.

Chapter 18

Setting Up and Maintaining a Distributed ISE Deployment

This chapter covers the following topics:

- Configuring ISE nodes in a distributed environment
- Understanding the HA options available
- Using load balancers
- IOS load balancing
- Maintaining ISE deployments

Chapter 5, “Making Sense of the ISE Deployment Design Options,” discussed the many options within ISE design. At this point, you should have an idea of which type of deployment will be the best fit for your environment, based on the number of concurrent endpoints and the number of Policy Service Nodes (PSN) that will be used in the deployment. This chapter focuses on the configuration steps required to deploy ISE in a distributed design. It also covers the basics of using a load balancer and includes a special bonus section on a very cool high-availability (HA) configuration that uses Anycast routing, and covers patching distributed ISE deployments.

Configuring ISE Nodes in a Distributed Environment

All ISE nodes are installed in a standalone mode by default. When in a standalone mode, the ISE node is configured to run all personas by default. That means that the standalone node runs Administration, Monitoring, and Policy Service personas. Also, all ISE standalone nodes are configured as their own root certificate authority (CA).

It is up to you, the ISE administrator, to promote the first node to be a primary administration node and then join the additional nodes to this new deployment. At the time of joining, you also determine which services will run on which nodes; in other words, you determine which persona the node will have.

You can join more than one ISE node together to create a multinode deployment, known commonly in the field as an *ISE cube*. It is important to understand that before any ISE nodes can be joined together, they must trust each other's administrative certificate. Without that trust, you will receive a communication error stating that the "node was unreachable," but the root cause is the lack of trust.

Similar to a scenario of trying to connect to a secure website that is not using a trusted certificate, you would see an SSL error in your web browser. This is just like that, only it is based on Transport Layer Security (TLS).

If you are still using the default self-signed certificates in ISE, you'll be required to import the public certificate of each ISE node into each other ISE node's **Administration > System > Certificates > Trusted Certificates** screen, because they are all self-signed (untrusted) certificates and each ISE node needs to trust the primary node, and the primary node needs to trust each of the other nodes.

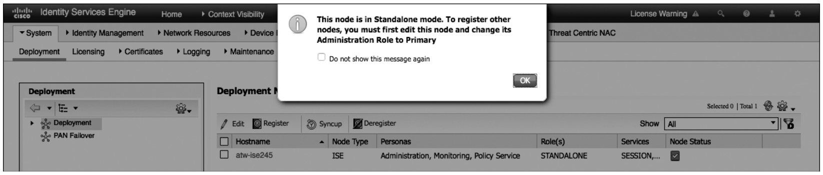
Instead of dealing with all this public key import for these self-signed certificates, the best practice is to always use certificates issued from the same trusted source. In that case, only the root certificates need to be added to the Trusted Certificates list.

Make the Policy Administration Node a Primary Device

Because all ISE nodes are standalone by default, you must first promote the ISE node that will become the Primary Policy Administration Node (PAN) to be a primary device instead of a standalone.

From the ISE GUI, perform the following steps:

Step 1. Choose **Administration > System > Deployment**. Figure 18-1 shows an example of the Deployment screen.



This node is in Standalone mode. To register other nodes, you must first edit this node and change its Administration Role to Primary

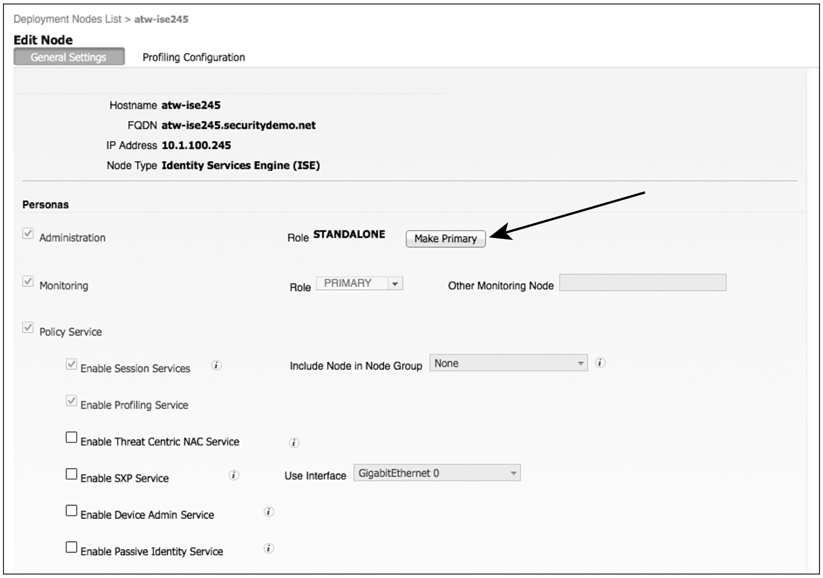
□ Do not show this message again

□	Hostname	Node Type	Personas	Role(s)	Services	Node Status
□	atw-ise245	ISE	Administration, Monitoring, Policy Service	STANDALONE	SESSION,...	☑

Figure 18-1 *Deployment Screen*

Step 2. Select the ISE node (there should only be one at this point).

Step 3. Click the **Make Primary** button, as shown in Figure 18-2.



Deployment Nodes List > atw-ise245

Edit Node

General Settings | Profiling Configuration

Hostname **atw-ise245**
FQDN **atw-ise245.securitydemo.net**
IP Address **10.1.100.245**
Node Type **Identity Services Engine (ISE)**

Personas

☑ Administration — Role **STANDALONE** [Make Primary]

☑ Monitoring — Role PRIMARY — Other Monitoring Node

☑ Policy Service

- ☑ Enable Session Services — Include Node in Node Group: None
- ☑ Enable Profiling Service
- ☐ Enable Threat Centric NAC Service
- ☐ Enable SXP Service — Use Interface: GigabitEthernet 0
- ☐ Enable Device Admin Service
- ☐ Enable Passive Identity Service

Figure 18-2 *Make Primary Button*

Step 4. At this point, the Monitoring and Policy Service check boxes on the left have become selectable. If the primary node will not also be providing any of these services, uncheck them now. (You can always return later and make changes.)

Step 5. Click **Save**.

After saving the changes, the ISE application restarts itself. This is a necessary process, as the sync services are started and the node prepares itself to handle all the responsibilities of the primary PAN persona. Once the application server has restarted, reconnect to the GUI, log in again, and proceed to the next section.

Note You can monitor the status of the application server by using the **show application status ise** command from the command-line interface through either the console or a Secure Shell (SSH) session to the ISE node, as shown in Example 18-1. When the application server state changes from initializing to running, then ISE will be ready for you to log in to.

Example 18-1 show application status ise *Command Output*

```
atw-ise245/admin# show application status ise

ISE PROCESS NAME                       STATE            PROCESS ID
--------------------------------------------------------------------
Database Listener                      running          5851
Database Server                        running          75 PROCESSES
Application Server                     initializing
Profiler Database                      running          6975
ISE Indexing Engine                    running          1821
AD Connector                           running          10338
M&T Session Database                   running          1373
M&T Log Collector                      running          2313
M&T Log Processor                      running          2219
Certificate Authority Service          disabled
EST Service                            disabled
SXP Engine Service                     disabled
TC-NAC Docker Service                  disabled
TC-NAC MongoDB Container               disabled
TC-NAC RabbitMQ Container              disabled
TC-NAC Core Engine Container           disabled
VA Database                            disabled
VA Service                             disabled
pxGrid Infrastructure Service          disabled
pxGrid Publisher Subscriber Service    disabled
pxGrid Connection Manager              disabled
pxGrid Controller                      disabled
PassiveID Service                      disabled
DHCP Server (dhcpd)                    disabled
DNS Server (named)                     disabled

atw-ise245/admin#
```

Register an ISE Node to the Deployment

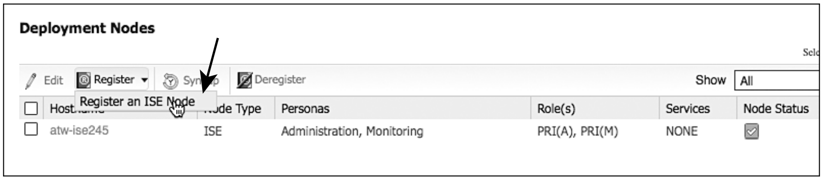
Now that there is a primary PAN, you can implement a multinode deployment. From the GUI on the primary PAN, you will register and assign personas to all ISE nodes.

From the ISE GUI on the primary PAN, perform the following steps:

Step 1. Choose **Administration > System > Deployment**.

Step 2. Choose **Register > Register an ISE Node**, as shown in Figure 18-3.

Note As with all other operations with ISE, DNS is a critical component.

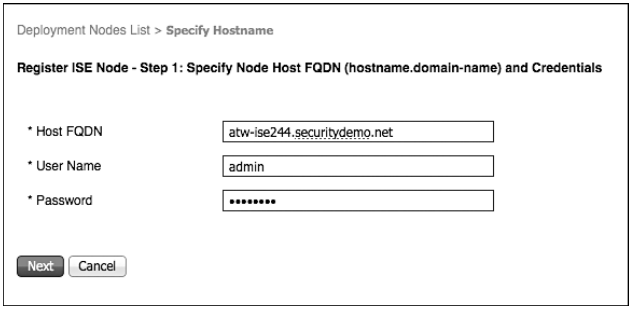


Deployment Nodes

□	Host	de Type	Personas	Role(s)	Services	Node Status
□	atw-ise245	ISE	Administration, Monitoring	PRI(A), PRI(M)	NONE	☑

Figure 18-3 *Choosing to Register an ISE Node*

Step 3. In the Host FQDN field, enter the IP address or DNS name of the first ISE node you will be joining to the deployment, as shown in Figure 18-4.



Deployment Nodes List > **Specify Hostname**

Register ISE Node - Step 1: Specify Node Host FQDN (hostname.domain-name) and Credentials

* Host FQDN: atw-ise244.securitydemo.net

* User Name: admin

* Password: ••••••••

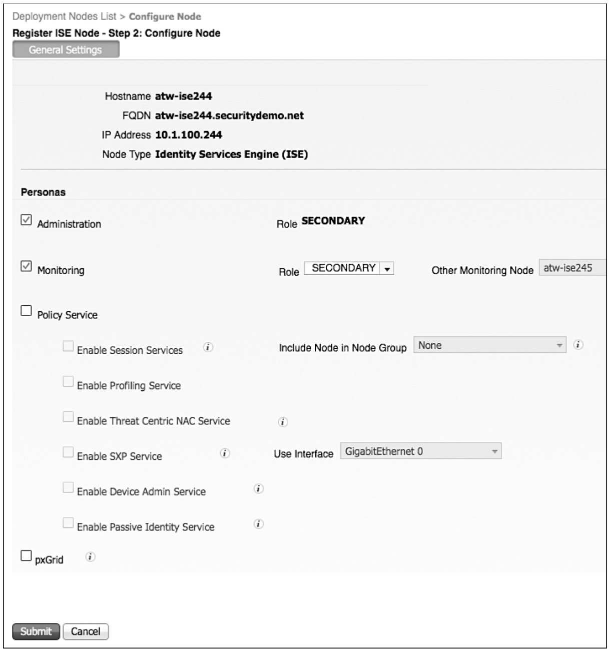
Figure 18-4 *Specifying Hostname and Credentials*

Step 4. In the User Name and Password fields, enter the administrator name (admin by default) and password.

Step 5. Click **Next**.

Note If you have not installed valid certificates from a trusted root, you will receive an error. You'll be required to install the certificate of each ISE node as a trusted root, because they are all self-signed certificates. Best practice is to always use certificates issued from a trusted source.

Step 6. On the Configure Node screen, shown in Figure 18-5, you can pick the main persona of the ISE node, including enabling of profiling services. You cannot, however, configure which probes to enable yet. Choose the persona for this node. Figure 18-5 shows adding a secondary Administration and Monitoring node, while Figure 18-6 shows adding a Policy Service Node.



Deployment Nodes List > **Configure Node**

Register ISE Node - Step 2: Configure Node

General Settings

Hostname **atw-ise244**
FQDN **atw-ise244.securitydemo.net**
IP Address **10.1.100.244**
Node Type **Identity Services Engine (ISE)**

Personas

☑ Administration — Role **SECONDARY**

☑ Monitoring — Role SECONDARY ▾ — Other Monitoring Node atw-ise245

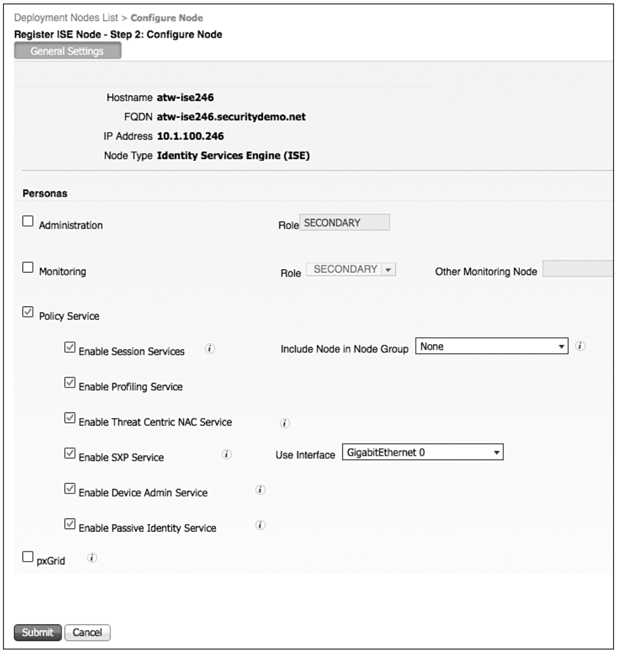
□ Policy Service

- □ Enable Session Services — Include Node in Node Group None ▾
- □ Enable Profiling Service
- □ Enable Threat Centric NAC Service
- □ Enable SXP Service — Use Interface GigabitEthernet 0 ▾
- □ Enable Device Admin Service
- □ Enable Passive Identity Service

□ pxGrid

Submit Cancel

Figure 18-5 *Configure Node Screen Secondary Admin and MnT Addition*



Deployment Nodes List > **Configure Node**

Register ISE Node - Step 2: Configure Node

General Settings

Hostname **atw-ise246**
FQDN **atw-ise246.securitydemo.net**
IP Address **10.1.100.246**
Node Type **Identity Services Engine (ISE)**

Personas

□ Administration — Role SECONDARY

□ Monitoring — Role SECONDARY ▾ — Other Monitoring Node

☑ Policy Service

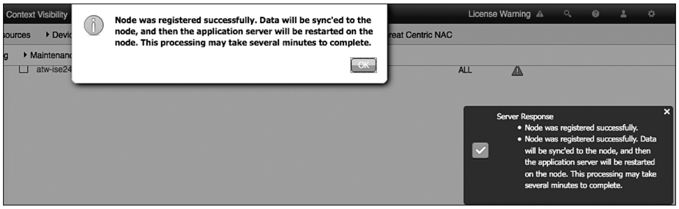
- ☑ Enable Session Services — Include Node in Node Group None ▾
- ☑ Enable Profiling Service
- ☑ Enable Threat Centric NAC Service
- ☑ Enable SXP Service — Use Interface GigabitEthernet 0 ▾
- ☑ Enable Device Admin Service
- ☑ Enable Passive Identity Service

□ pxGrid

Submit Cancel

Figure 18-6 *Configure Node Screen Policy Service Node Addition*

Step 7. Click **Submit.** At this point, the Policy Administration Node syncs the entire database to the newly joined ISE node, as you can see in Figure 18-7.



Node was registered successfully. Data will be sync'ed to the node, and then the application server will be restarted on the node. This processing may take several minutes to complete.

Server Response

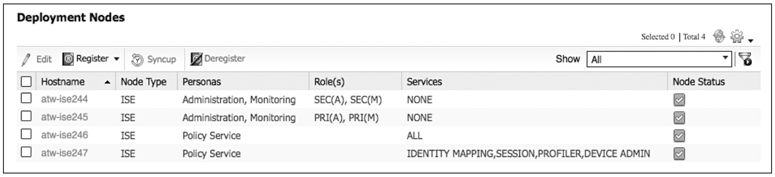
- Node was registered successfully.
- Node was registered successfully. Data will be sync'ed to the node, and then the application server will be restarted on the node. This processing may take several minutes to complete.

Figure 18-7 *Sync Initiated*

Step 8. Repeat these steps for all the ISE nodes that should be joined to the same deployment.

Ensure the Persona of All Nodes Is Accurate

Now that all of your ISE nodes are joined to the deployment, you can ensure that the correct personas are assigned to the appropriate ISE nodes. Table 18-1 shows the ISE nodes in the sample deployment and the associated persona(s) that will be assigned. Figure 18-8 shows the final Deployment screen, after the synchronization has completed for all nodes (a check mark in the Node Status column indicates a node that is healthy and in sync).



Deployment Nodes

Selected 0 | Total 4

Show All

□	Hostname	Node Type	Personas	Role(s)	Services	Node Status
□	atw-ise244	ISE	Administration, Monitoring	SEC(A), SEC(M)	NONE	☑
□	atw-ise245	ISE	Administration, Monitoring	PRI(A), PRI(M)	NONE	☑
□	atw-ise246	ISE	Policy Service		ALL	☑
□	atw-ise247	ISE	Policy Service		IDENTITY MAPPING,SESSION,PROFILER,DEVICE ADMIN	☑

Figure 18-8 *Final Personas and Roles*

Note This is also a good time to double-check that all the desired probes are enabled on the PSNs.

Table 18-1 *ISE Nodes and Personas*

ISE Node	Persona
atw-ise244	Administration, Monitoring
atw-ise245	Administration, Monitoring
atw-ise246	Policy Service
atw-ise247	Policy Service

Understanding the HA Options Available

There are many different items to note when it comes to high availability (HA) within a Secure Access deployment. There are the concerns of communication between the PANs and the other ISE nodes for database replications and synchronization, and communication between the PSNs and Monitoring nodes for logging. There is also the issue of authentication sessions from the network access devices (NAD) reaching the PSNs in the event of a WAN outage, as well as a NAD recognizing that a PSN may no longer be active, and sending authentication requests to the active PSN instead.

Primary and Secondary Nodes

PANs and Monitoring & Troubleshooting (MnT) nodes both employ the concept of primary and secondary nodes, but they operate very differently. Let's start with the easiest one first, the MnT node.

Monitoring & Troubleshooting Nodes

As you know, the MnT node is responsible for the logging and reporting functions of ISE. All PSNs will send their logging data to the MnT node as syslog messages (UDP port 20514).

When there are two monitoring nodes in an ISE deployment, all ISE nodes send their audit data to both monitoring nodes at the same time. Figure 18-9 displays this logging flow.

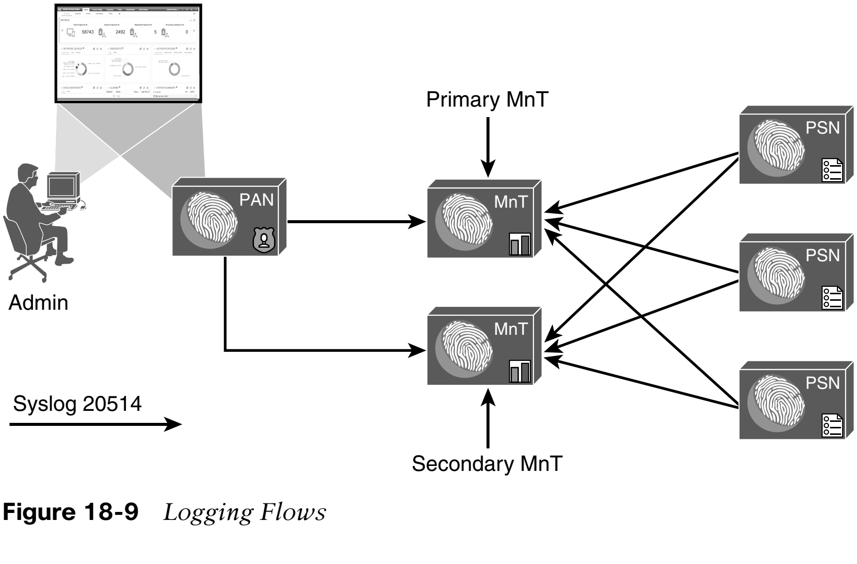
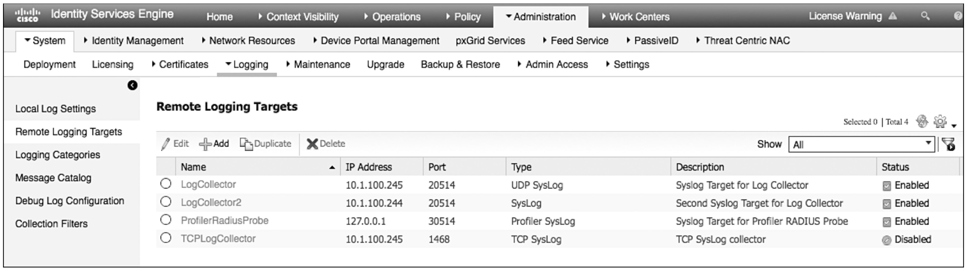


Figure 18-9 *Logging Flows*

The active/active nature of the MnT nodes can be viewed easily in the administrative console, as the two MnTs get defined as LogCollector and LogCollector2. Figures 18-10 and 18-11 display the log collector definitions and the logging categories, respectively.

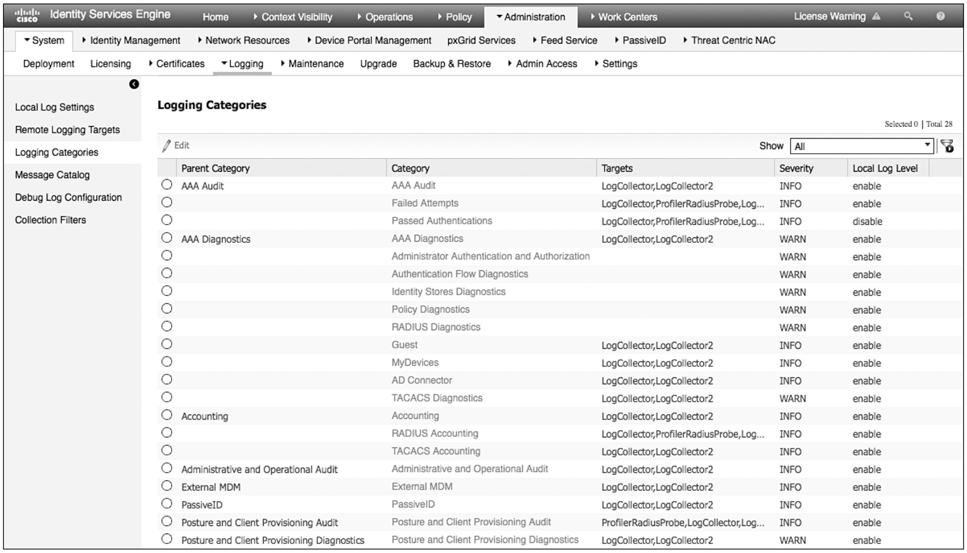


Remote Logging Targets

Selected 0 | Total 4

	Name	IP Address	Port	Type	Description	Status
○	LogCollector	10.1.100.245	20514	UDP SysLog	Syslog Target for Log Collector	☑ Enabled
○	LogCollector2	10.1.100.244	20514	SysLog	Second Syslog Target for Log Collector	☑ Enabled
○	ProfilerRadiusProbe	127.0.0.1	30514	Profiler SysLog	Syslog Target for Profiler RADIUS Probe	☑ Enabled
○	TCPLogCollector	10.1.100.245	1468	TCP SysLog	TCP SysLog collector	⊘ Disabled

Figure 18-10 *Logging Targets*



Logging Categories

Selected 0 | Total 28

	Parent Category	Category	Targets	Severity	Local Log Level
○	AAA Audit	AAA Audit	LogCollector,LogCollector2	INFO	enable
○		Failed Attempts	LogCollector,ProfilerRadiusProbe,Log...	INFO	enable
○		Passed Authentications	LogCollector,ProfilerRadiusProbe,Log...	INFO	disable
○	AAA Diagnostics	AAA Diagnostics	LogCollector,LogCollector2	WARN	enable
○		Administrator Authentication and Authorization		WARN	enable
○		Authentication Flow Diagnostics		WARN	enable
○		Identity Stores Diagnostics		WARN	enable
○		Policy Diagnostics		WARN	enable
○		RADIUS Diagnostics		WARN	enable
○		Guest	LogCollector,LogCollector2	INFO	enable
○		MyDevices	LogCollector,LogCollector2	INFO	enable
○		AD Connector	LogCollector,LogCollector2	INFO	enable
○		TACACS Diagnostics	LogCollector,LogCollector2	WARN	enable
○	Accounting	Accounting	LogCollector,LogCollector2	INFO	enable
○		RADIUS Accounting	LogCollector,ProfilerRadiusProbe,Log...	INFO	enable
○		TACACS Accounting	LogCollector,LogCollector2	INFO	enable
○	Administrative and Operational Audit	Administrative and Operational Audit	LogCollector,LogCollector2	INFO	enable
○	External MDM	External MDM	LogCollector,LogCollector2	INFO	enable
○	PassiveID	PassiveID	LogCollector,LogCollector2	INFO	enable
○	Posture and Client Provisioning Audit	Posture and Client Provisioning Audit	ProfilerRadiusProbe,LogCollector,Log...	INFO	enable
○	Posture and Client Provisioning Diagnostics	Posture and Client Provisioning Diagnostics	LogCollector,LogCollector2	WARN	enable

Figure 18-11 *Logging Categories*

Upon an MnT failure, all nodes continue to send logs to the remaining MnT node. Therefore, no logs are lost. The PAN retrieves all log and report data from the secondary MnT node, so there is no administrative function loss, either. However, the log database is not synchronized between the primary and secondary MnT nodes. Therefore, when the MnT node returns to service, a backup and restore of the monitoring node is required to keep the two MnT nodes in complete sync.

Note The best practice for logging is to also send logging data to a security information and event manager (SIEM) tool, for long-term data archiving and reporting.

Policy Administration Nodes

The PAN is responsible for providing not only an administrative GUI for ISE but also the critical function of database synchronization of all ISE nodes. All ISE nodes maintain a full copy of the database, with the master database existing on the primary PAN.

A PSN may receive data about a guest user, and when that occurs it must sync that data to the primary PAN. The primary PAN then synchronizes that data out to all the ISE nodes in the deployment.

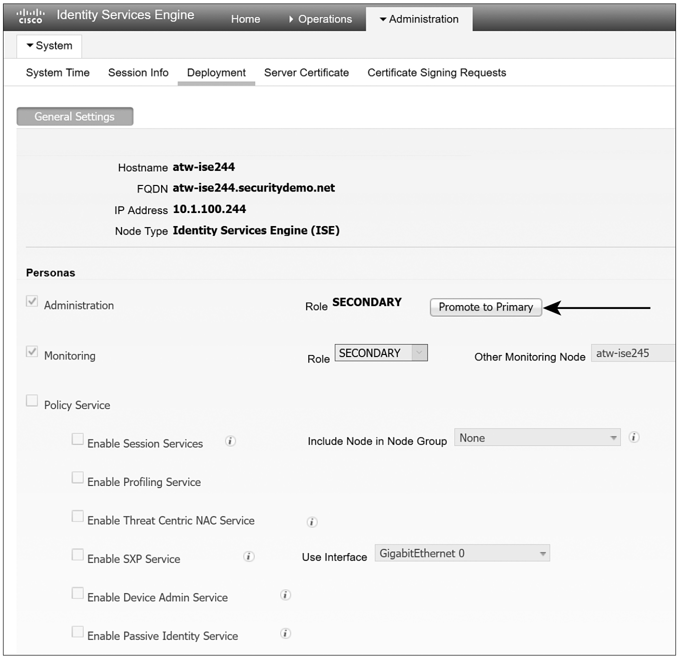
Because the functionality is so arduous, and having only a single source of truth for the data in the database is so critical, failing over to the secondary PAN is usually a manual process. In the event of the primary PAN going offline, no synchronizations occur until the secondary PAN is promoted to primary. Once it becomes the primary, it takes over all synchronization responsibility. This is sometimes referred to as a "warm spare" type of HA.

Promote the Secondary PAN to Primary

To promote the secondary PAN to primary, connect to the GUI on the secondary PAN and perform the following steps:

Step 1. Choose **Administration > System > Deployment**.

Step 2. Click **Promote to Primary**. Figure 18-12 illustrates the Promote to Primary option available on the secondary node.



Hostname **atw-ise244**
FQDN **atw-ise244.securitydemo.net**
IP Address **10.1.100.244**
Node Type **Identity Services Engine (ISE)**

Personas

☑ Administration — Role **SECONDARY**

☑ Monitoring — Role SECONDARY — Other Monitoring Node atw-ise245

□ Policy Service

□ Enable Session Services — Include Node in Node Group None

□ Enable Profiling Service

□ Enable Threat Centric NAC Service

□ Enable SXP Service — Use Interface GigabitEthernet 0

□ Enable Device Admin Service

□ Enable Passive Identity Service

Figure 18-12 *Promoting a Secondary PAN to Primary*

Auto PAN Failover

An automated promotion function was added to ISE beginning with version 1.4. It requires there to be two admin nodes (obviously) and at least one other non-admin node in the deployment.

The non-admin node will act as a health check function for the admin node(s), probing the primary admin node at specified intervals. The Health Check Node will promote the secondary admin node when the primary fails a configurable number of probes. Once the original secondary node is promoted, it is probed. Figure 18-13 illustrates the process.

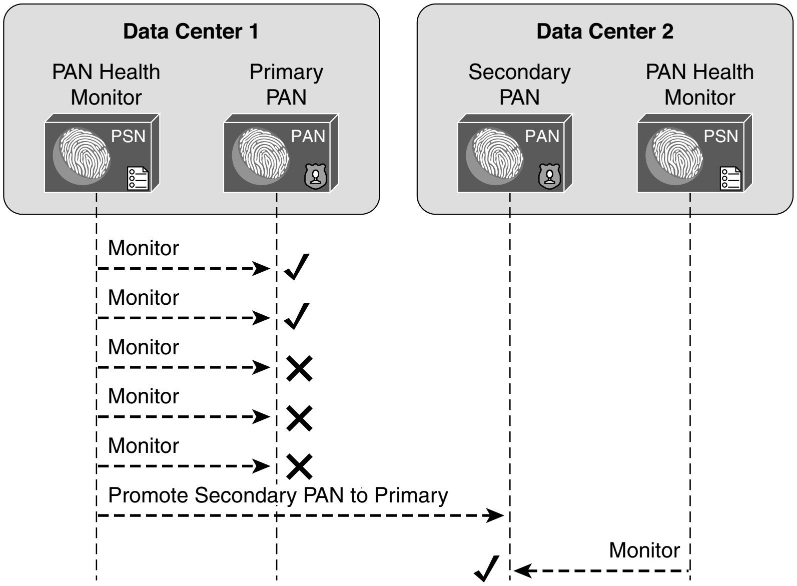


Figure 18-13 *Promoting a Secondary PAN to Primary with Automated Promotion*

As of ISE version 2.1, there is no ability to automatically sync the original primary PAN back into the ISE cube. That is still a manual process.

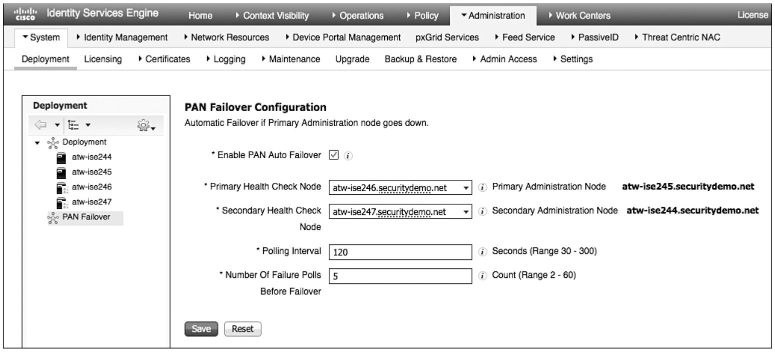
Configure Automatic Failover for the Primary PAN

For the configuration to be available, there must be two PANs and at least one non-PAN in the deployment.

From the ISE GUI, perform the following steps:

Step 1. Navigate to **Administration > System > Deployment**.

Step 2. Click **PAN Failover** in the left pane, as shown in Figure 18-14.



PAN Failover Configuration

Automatic Failover if Primary Administration node goes down.

* Enable PAN Auto Failover ☑

* Primary Health Check Node: atw-ise246.securitydemo.net — Primary Administration Node **atw-ise245.securitydemo.net**

* Secondary Health Check Node: atw-ise247.securitydemo.net — Secondary Administration Node **atw-ise244.securitydemo.net**

* Polling Interval: 120 — Seconds (Range 30 - 300)

* Number Of Failure Polls Before Failover: 5 — Count (Range 2 - 60)

Figure 18-14 *PAN Failover*

Step 3. Check the **Enable PAN Auto Failover** check box.

Step 4. Select the **Health Check Nodes** from the drop-down lists. Notice the primary PAN and secondary are listed to the right of the selected Health Check Nodes, as shown in Figure 18-14.

Step 5. In the Polling Interval field, set the polling interval. The interval is in seconds and can be set between **30** and **300** (5 minutes).

Step 6. In the Number of Failure Polls Before Failover field, enter the number of failed probes that have to occur before failover is initiated. Valid range is anywhere from **2–60** consecutive failed probes.

Step 7. Click **Save**.

Policy Service Nodes and Node Groups

PSNs do not necessarily need to have an HA type of configuration. Every ISE node maintains a full copy of the database, and the NADs have their own detection of a “dead” RADIUS server, which triggers the NAD to send AAA communication to the next RADIUS server in the list.

However, ISE has the concept of a *node group*. Node groups are made up of PSNs, where the PSNs maintain a heartbeat with each other. Beginning with ISE 1.3, the PSNs can be in different subnets or can be Layer 2 adjacent. In older ISE versions, the PSNs required the use of multicast, but starting in version 1.3 they use direct encrypted TCP-based communication instead:

- **TCP/7800:** Used for peer communication
- **TCP/7802:** Used for failure detection

If a PSN goes down and orphans a URL-redirected session, one of the other PSNs in the node group sends a Change of Authorization (CoA) to the NAD so that the endpoint can restart the session establishment with a new PSN.

Node groups do have another function, which is entirely related to data replication. ISE used a serial replication model in ISE 1.0, 1.1, and 1.1.x, meaning that all data had to go through the primary PAN and it sent the data objects to every other node, waiting for an acknowledgement for each piece of data before sending the next one in line.

Beginning with ISE 1.2 and moving forward, ISE begins to use a common replication framework known as JGroups (http://bfy.tw/5vYC). One of the benefits of JGroups is the way it handles replications in a group or segmented fashion. JGroups enables replications with local peers directly without having to go back through a centralized master, and node groups are used to define those segments or groups of peers.

So, when a member of a node group learns endpoint attributes (profiling), it is able to send the information directly to the other members of the node group directly. However, when that data needs to be replicated globally (to all PSNs), then the JGroups communication must still go through the primary PAN, which in turn replicates it to all the other PSNs.

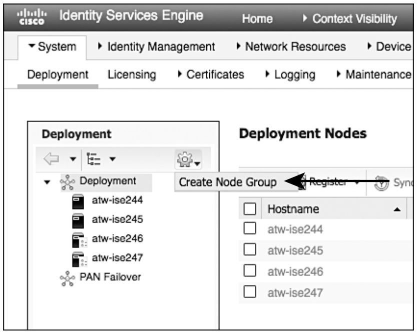
Node groups are most commonly used when deploying the PSNs behind a load balancer; however, there is no reason node groups could not be used with regionally located PSNs. You would not want to use a node group with PSNs that are geographically and logically separate.

Create a Node Group

To create a node group, from the ISE GUI, perform the following steps:

Step 1. Choose **Administration > System > Deployment.**

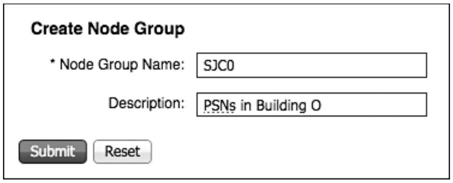
Step 2. In the Deployment pane on the left side of the screen, click the cog icon and choose **Create Node Group**, as shown in Figure 18-15.



☐ Hostname
☐ atw-ise244
☐ atw-ise245
☐ atw-ise246
☐ atw-ise247

Figure 18-15 *Choosing to Create a Node Group*

Step 3. On the Create Node Group screen, shown in Figure 18-16, enter in the Node Group Name field a name for the node group. Use a name that also helps describe the location of the group. In this example, SJCO was used to represent San Jose, Building O.



Create Node Group

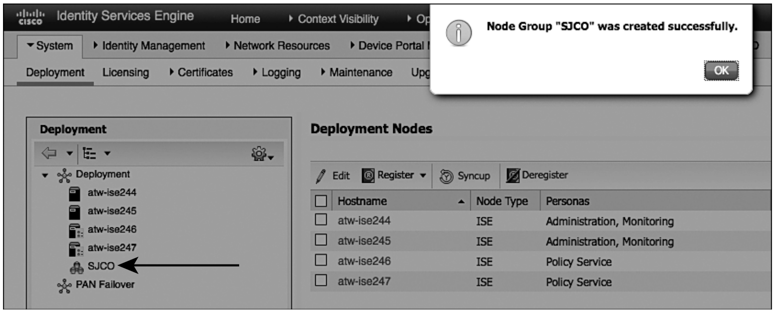
* Node Group Name: SJC0

Description: PSNs in Building O

Figure 18-16 *Node Group Creation*

Step 4. (Optional) In the Description field, enter a more detailed description that helps to identify exactly where the node group is (for example, PSNs in Building O). Click **Submit.**

Step 5. Click **OK** in the success popup window, as shown in Figure 18-17. Also notice the appearance of the node group in the left pane.



Node Group "SJCO" was created successfully.

Deployment Nodes

☐	Hostname	Node Type	Personas
☐	atw-ise244	ISE	Administration, Monitoring
☐	atw-ise245	ISE	Administration, Monitoring
☐	atw-ise246	ISE	Policy Service
☐	atw-ise247	ISE	Policy Service

Figure 18-17 *Success Popup*

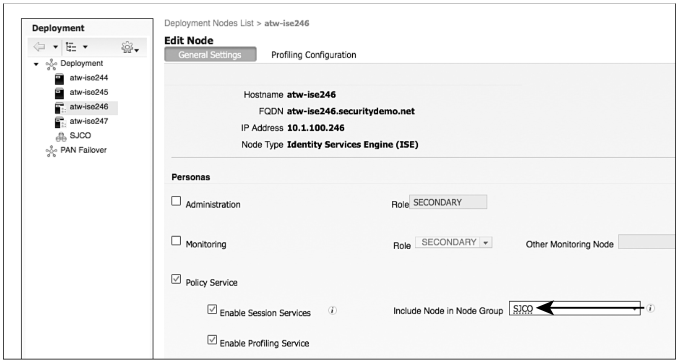
Add the Policy Service Nodes to the Node Group

To add the PSNs to the node group, from the ISE GUI, perform the following steps:

Step 1. Choose **Administration > System > Deployment.**

Step 2. Select one of the PSNs to add to the node group.

Step 3. Click the **Include Node in Node Group** drop-down arrow and select the newly created group, as shown in Figure 18-18.



Edit Node

Hostname **atw-ise246**
FQDN **atw-ise246.securitydemo.net**
IP Address **10.1.100.246**
Node Type **Identity Services Engine (ISE)**

Personas

□ Administration Role SECONDARY

□ Monitoring Role SECONDARY Other Monitoring Node

☑ Policy Service

☑ Enable Session Services Include Node in Node Group SJCO

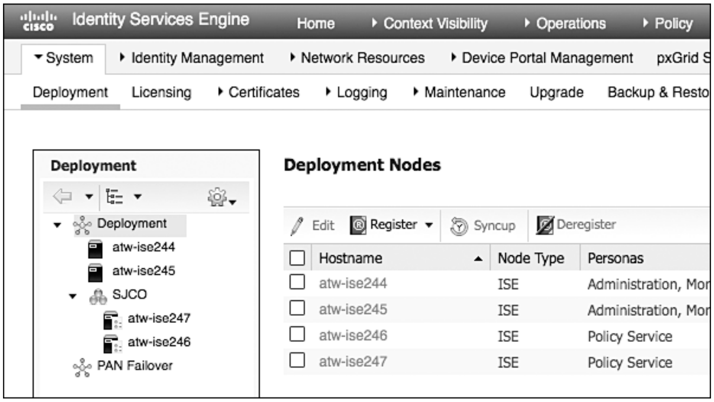
☑ Enable Profiling Service

Figure 18-18 *Assigning a Node Group*

Step 4. Click **Save**.

Step 5. Repeat the preceding steps for each PSN that should be part of the node group.

Figure 18-19 shows the reorganization of the PSNs within the node group in the Deployment navigation pane on the left side.



Deployment Nodes

□	Hostname	Node Type	Personas
□	atw-ise244	ISE	Administration, Mor
□	atw-ise245	ISE	Administration, Mor
□	atw-ise246	ISE	Policy Service
□	atw-ise247	ISE	Policy Service

Figure 18-19 *Reorganized Deployment Navigation Pane*

Using Load Balancers

One high-availability option that is growing in popularity for Cisco ISE deployments is the use of load balancers. Load balancer adoption with ISE deployments has skyrocketed over the years because it can significantly simplify administration and designs in larger deployments. As Figure 18-20 illustrates, with load balancing, the NADs have to be configured with only one IP address per set of ISE PSNs, removing a lot of the complexity in the NAD configuration. The load balancer itself takes care of monitoring the ISE PSNs and removing them from service if they are down and allows you to scale more nodes behind the virtual IP (VIP) without ever touching the network device configuration again.

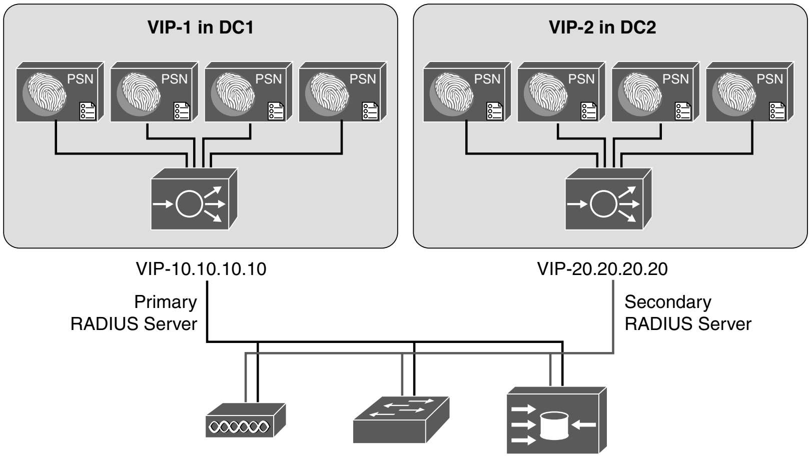


Figure 18-20 *Load-Balanced PSN Clusters*

Craig Hyps, a Principal Technical Marketing Engineer for ISE at Cisco, has written what is considered to be the definitive guide on load balancing with ISE, "How To: Cisco & F5 Deployment Guide: ISE Load Balancing Using BIG-IP." Craig wrote the guide based on using F5 load balancers, but the principles are identical regardless of which load balancer you choose to implement. You can find his guide here: https://communities.cisco.com/docs/DOC-68198.

Instead of replicating that entire large and detailed guide in this chapter, this section simply focuses on the basic principles that must be followed when using ISE with load balancers.

General Guidelines

When using a load balancer, you must ensure the following:

- Each PSN must be reachable by the PAN/MnT directly, without having to go through Network Address Translation (NAT). This sometimes is referred to as *routed mode* or *pass-through mode*.
- Each PSN must also be reachable directly from the endpoint.
  - When the PSN sends a URL-Redirection to the NAD, it uses the fully qualified domain name (FQDN) from the configuration, not the virtual IP (VIP) address.
  - You might want to use Subject Alternative Names (SAN) in the certificate to include the FQDN of the load-balancer VIP.
- The same PSN is used for the entire session. User persistence, sometimes called needs to be based on Calling-Station-ID.

- The VIP gets listed as the RADIUS server of each NAD for all 802.1X-related AAA.
    - Includes both authentication and accounting packets.
    - Some load balancers use a separate VIP for each protocol type.
- The list of RADIUS servers allowed to perform dynamic-authorizations (also known as Change of Authorization [CoA]) on the NAD should use the real IP addresses of the PSNs, not the VIP.

  The VIP could be used for the CoAs, if the load balancer is performing source NAT (SNAT) for the CoAs sent from the PSNs.

Note ISE uses the device's Layer 3 address to identity the NAD, not the NAS-IP-Address in the RADIUS packet. This is another reason to avoid SNAT for the incoming RADIUS requests.

- Load balancers should be configured to use test probes to ensure the PSNs are still "alive and well."
    - A probe should be configured to ensure RADIUS is responding.
    - HTTPS should also be checked.
    - If either probe fails, the PSN should be taken out of service.
    - A PSN must be marked dead and taken out of service in the load balancer before the NAD's built-in failover occurs.
- Since the load balancer(s) should be configured to perform health checks of the RADIUS service on the PSN(s), the load balancer(s) must be configured as NADs in ISE so their test authentications may be answered correctly.

Failure Scenarios

If a single PSN fails, the load balancer takes that PSN out of service and spreads the load over the remaining PSNs. When the failed PSN is returned to service, the load balancer adds it back into the rotation. By using node groups along with a load balancer, another of the node group members issues a CoA-reauth for any sessions that were establishing. This CoA causes the session to begin again. At this point, the load balancer directs the new authentication to a different PSN.

NADs have some built-in capabilities to detect when the configured RADIUS server is "dead" and automatically fail over to the next RADIUS server configured. When using a load balancer, the RADIUS server IP address is actually the VIP address. So, if the entire VIP is unreachable (for example, the load balancer has died), the NAD should quickly fail over to the next RADIUS server in the list. That RADIUS server could be another VIP in a second data center or another backup RADIUS server.

Anycast HA for ISE PSNs

This section exists thanks to a friend of the author who is also one of the most talented and gifted technologists roaming the earth today. E. Pete Karelis, CCIE No. 8068, designed this high-availability solution for a small ISE deployment that had two data centers. Figure 18-21 illustrates the network architecture.

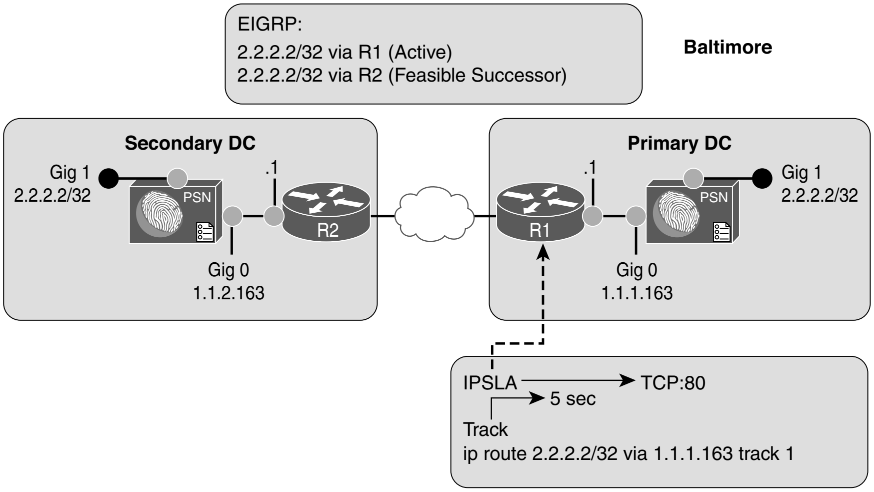


Figure 18-21 *Network Drawing and IPSLA*

Anycast is a networking technique where the same IP address exists in multiple places within the network. In this case, the same IP address (2.2.2.2) is assigned to the Gig1 interfaces on all the PSNs, which is connected to an isolated VLAN (or port group in VMware), so that the PSN sees the interface as "up" and connected with the assigned IP address (2.2.2.2). Each default gateway (router) in each data center is configured with a static route to 2.2.2.2/32 with the Gig0 IP address of the PSN as the next hop. Those static routes are redistributed into the routing protocol; in this case EIGRP is used. Anycast relies on the routing protocols to ensure that traffic destined to the Anycast address (2.2.2.2) is sent to the closest instance of that IP address.

After setting up Anycast to route 2.2.2.2 to the ISE PSN, Pete used EIGRP metrics to ensure that all routes preferred the primary data center, with the secondary data center route listed as the feasible successor (FS). With EIGRP, there is less than a 1-second delay when a route (the successor) is replaced with the backup route (the feasible successor).

Now, how do we make the successor route drop from the routing table when the ISE node goes down? Pete configured an IP service-level agreement (IPSLA) on the router that checked the status of the HTTP service on the ISE PSN in the data center every 5 seconds. If the HTTP service stops responding on the active ISE PSN, then the route is removed and the FS takes over, causing all the traffic for 2.2.2.2 to be sent to the PSN in the secondary data center. Figure 18-22 illustrates the IPSLA function, and when it occurs the only route left in the routing table is to the router at the secondary data center.

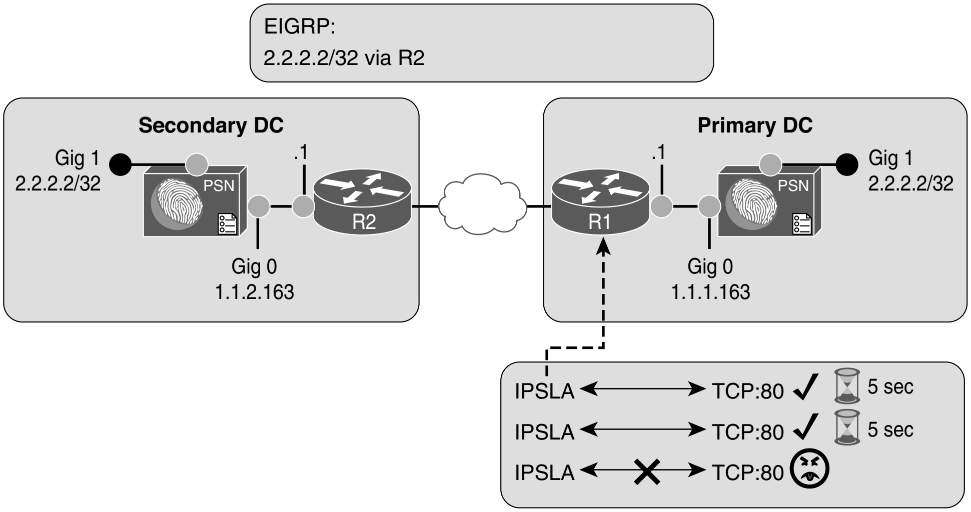


Figure 18-22 *IPSLA in Action*

All network devices are configured to use the Anycast address (2.2.2.2) as the only RADIUS server in their configuration. The RADIUS requests will always be sent to whichever ISE node is active and closest. Authentications originating within the secondary data center go to the local PSN.

Note The dynamic-authorization configuration of the NAD must still use the Gig0 interface IP addresses, as those will be the source when ISE sends a CoA to the switch.

Example 18-2 shows the interface configuration on the ISE PSN. The Gig0 interface is the actual routable IP address of the PSN, while Gig1 is in a VLAN to nowhere using the Anycast IP address.

Example 18-2 *ISE Interface Configuration*

```
interface gig 0
  !Actual  IP of Node
  ip address 1.1.1.163 255.255.255.0
interface gig 1
  !Anycast VIP assigned to all PSN nodes on G1
  ip address 2.2.2.2 255.255.255.255

ip default-gateway [Real Gateway for Gig0]
!note no static routes needed.
```

Example 18-3 shows the IPSLA configuration on the router, to test port 80 on the PSN every 5 seconds but to timeout after 1000 msec. When that timeout occurs, the IP SLA object will be marked as "down," which causes changed object tracking to remove the static route from the route table.

Example 18-3 *IPSLA Configuration*

```
ip sla 1
  !Test TCP to port 80 to the actual IP of the node.
  !"control disable" is necessary, since you are connecting to an
  !actual host instead of an SLA responder

  tcp-connect 1.1.1.163 80 control disable
  ! Consider the SLA as down if response takes longer than 1000msec

    threshold 1000
    ! Timeout after 1000 msec.
    timeout 1000
    !Test every 5 Seconds:
    frequency 5

ip sla schedule 1 life forever start-time now
track 1 ip sla 1
ip route 2.2.2.2 255.255.255.255 1.1.1.163 track 1
```

Example 18-4 shows the route redistribution configuration where the EIGRP metrics are applied. Pete was able to use the metrics that he chose specifically because he was very familiar with his network. His warning to others attempting the same thing is to be familiar with your network or to test thoroughly when identifying the metrics that would work for you.

Remember, you must avoid equal-cost, multiple-path routes, as this state could potentially introduce problems if RADIUS requests are not sticking to a single node. Furthermore, this technique is not limited to only two sites; Pete has since added a third location to the configuration and it works perfectly.

Note There is an obvious, albeit rare, flaw in the design. With this design, we are using HTTP to validate the status of the node, rather than validating the state of the RADIUS service itself, since the status of the RADIUS service cannot be queried by IOS Changed Object Tracking. This works very well in most cases, but in the rare event that the HTTP service on a PSN is operational and the RADIUS service is not operational, it could theoretically cause issues.

Example 18-4 *Route Redistribution*

```
router eigrp [Autonomous-System-Number]
  redistribute static route-map STATIC-TO-EIGRP

route-map STATIC-TO-EIGRP permit 20
  match ip address prefix-list ISE_VIP
  !Set metrics correctly
  set metric 1000000 1 255 1 1500

ip prefix-list ISE_VIP seq 5 permit 2.2.2.2/32
```

Cisco IOS Load Balancing

Cisco network devices have a lot of intelligence built into them to aid in an intelligent access layer for policy and policy enforcement. One such intelligence level is the capability to perform local load balancing of RADIUS servers. This does not mean using a Cisco switch as a server load balancer instead of a dedicated appliance. Instead, it refers to the capability of the access layer switch to load-balance the outbound authentication requests for endpoints that are authenticated to the switch itself.

Enabling IOS RADIUS server load balancing only takes one additional command. After all the PSNs are defined as AAA servers in the switch, use the **radius-server load-balance** global configuration command to enable it.

Example 18-5 shows use of a **show** command to verify that multiple ISE servers are configured.

Example 18-5 *Verifying All ISE PSNs Are Configured on Switch*

```
3750-X# show aaa server | include host
RADIUS: id 4, priority 1, host 10.1.100.232, auth-port 1812, acct-port 1813
RADIUS: id 5, priority 2, host 10.1.100.233, auth-port 1812, acct-port 1813
RADIUS: id 6, priority 3, host 10.1.100.234, auth-port 1812, acct-port 1813
```

Example 18-6 shows how to enable IOS load balancing

Example 18-6 *Enabling IOS Load Balancing*

```
3750-X(config)# radius-server load-balance method least-outstanding
  batch-size 5
```

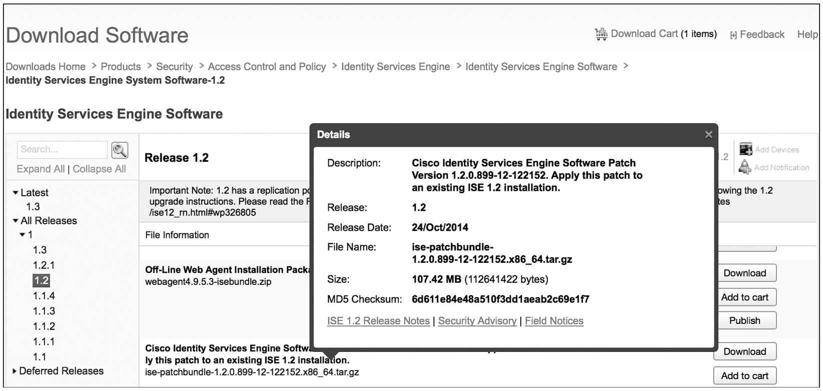
Maintaining ISE Deployments

Having a distributed deployment and load-balanced architecture are certainly critical items to scaling the deployment and ensuring it is highly available, but there are also critical basic maintenance items that should always be considered to ensure the most uptime and stability. That means having a patching strategy and a backup and restore strategy.

Patching ISE

Cisco releases ISE patches on a semi-regular basis. These patches contain bug fixes and, when necessary, security fixes. Think about the Heartbleed and Poodle vulnerabilities that were discovered with SSL. To ensure that bug fixes are applied, security vulnerabilities are plugged, and the solution works as seamlessly as possible, always have a planned patching strategy.

Patches are downloaded from Cisco.com, under **Downloads > Products > Security > Access Control and Policy > Identity Services Engine > Identity Services Engine Software**, as shown at the top of Figure 18-23.



Download Software

Downloads Home > Products > Security > Access Control and Policy > Identity Services Engine > Identity Services Engine Software >
Identity Services Engine System Software-1.2

Identity Services Engine Software

Release 1.2

Important Note: 1.2 has a replication po… owing the 1.2
upgrade instructions. Please read the F… tes
/ise12_rn.html#wp326805

File Information

Off-Line Web Agent Installation Packa…
webagent4.9.5.3-isebundle.zip

Cisco Identity Services Engine Softwa…
ly this patch to an existing ISE 1.2 installation.
ise-patchbundle-1.2.0.899-12-122152.x86_64.tar.gz

Details

Description: Cisco Identity Services Engine Software Patch Version 1.2.0.899-12-122152. Apply this patch to an existing ISE 1.2 installation.

Release: 1.2

Release Date: 24/Oct/2014

File Name: ise-patchbundle-1.2.0.899-12-122152.x86_64.tar.gz

Size: 107.42 MB (112641422 bytes)

MD5 Checksum: 6d611e84e48a510f3dd1aeab2c69e1f7

ISE 1.2 Release Notes | Security Advisory | Field Notices

Figure 18-23 *ISE Downloads Page*

Search the list of software available for your specific version of ISE. Figure 18-24 illustrates the naming convention for ISE patches. Cisco ISE patches are normally cumulative, meaning that installing 1.2 patch 12 will include all the fixes in patches 1 through 11 as well.

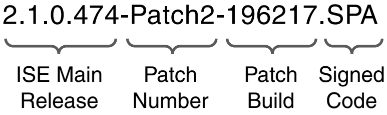


Figure 18-24 *Anatomy of ISE Patch Nomenclature*

After identifying the correct patch file, follow these steps:

Step 1. Download the required patch.

Step 2. From the ISE GUI, navigate to **Administration > System > Maintenance > Patch Management**.

Step 3. Click the **Install** button, as shown in Figure 18-25.

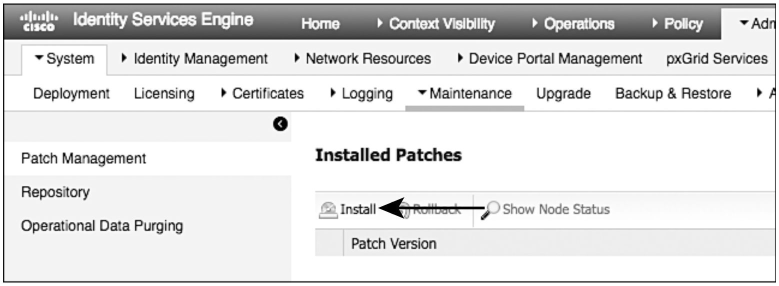
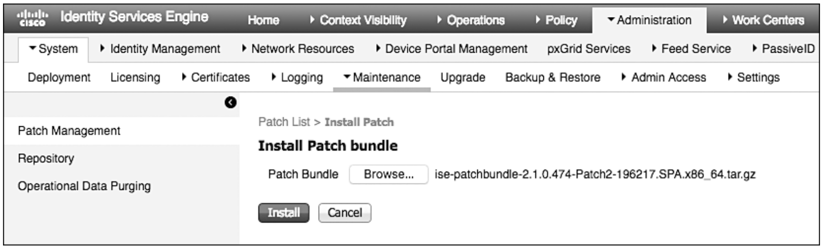


Figure 18-25 *Patch Management Screen*

Step 4. Click **Browse**, select the downloaded patch, and click **Install**, as shown in Figure 18-26.



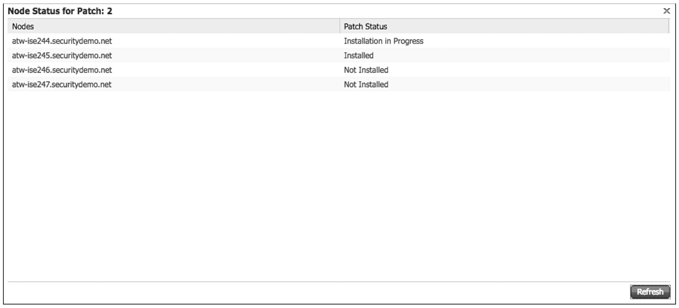
Patch Bundle Browse... ise-patchbundle-2.1.0.474-Patch2-196217.SPA.x86_64.tar.gz

Figure 18-26 *Installing the Selected Patch*

As the patch is installed on the PAN, you are logged out of the GUI and the patch is distributed from the PAN to all nodes in the ISE cube. After the patch is successfully installed on the PAN, it is applied to all nodes in the cube one at a time, in alphabetical order.

You can log back into the PAN when it's finished restarting services or rebooting. Click the **Show Node Status** button shown previously in Figure 18-25 to verify the progress of the patching. Figure 18-27 shows the resulting status of each node's progress for the patch installation.

Note PAN Auto Failover must be disabled before upgrading, and can be re-enabled after the upgrade is completed.



Node Status for Patch: 2

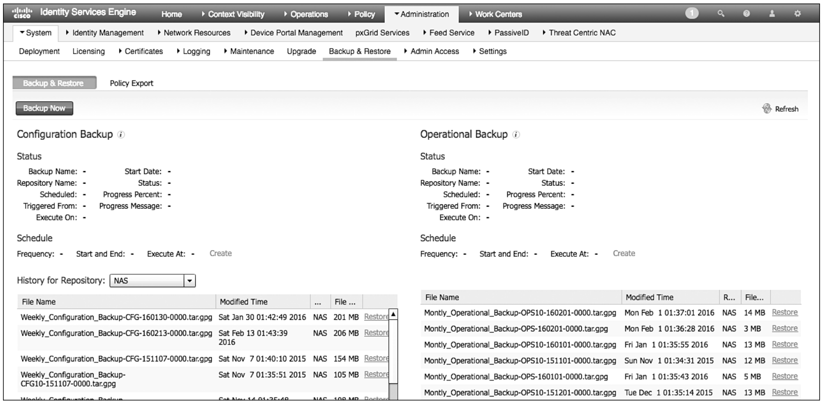
Nodes	Patch Status
atw-ise244.securitydemo.net	Installation in Progress
atw-ise245.securitydemo.net	Installed
atw-ise246.securitydemo.net	Not Installed
atw-ise247.securitydemo.net	Not Installed

Figure 18-27 *Node Status*

Backup and Restore

Another key strategy to assuring the availability of ISE in the environment is having a solid backup strategy. There are two types of ISE backups: configuration backup and operational backup. These two types are most easily related to backing up the product databases (configuration) and backing up the MnT data (operational).

Figure 18-28 shows the backup screen in ISE, located at **Administration > System > Backup & Restore**.



Configuration Backup

Status

Backup Name: - Start Date: -
Repository Name: - Status: -
Scheduled: - Progress Percent: -
Triggered From: - Progress Message: -
Execute On: -

Schedule

Frequency: - Start and End: - Execute At: - Create

History for Repository: NAS

File Name	Modified Time	...	File ...	
Weekly_Configuration_Backup-CFG-160130-0000.tar.gpg	Sat Jan 30 01:42:49 2016	NAS	201 MB	Restore
Weekly_Configuration_Backup-CFG-160213-0000.tar.gpg	Sat Feb 13 01:43:39 2016	NAS	206 MB	Restore
Weekly_Configuration_Backup-CFG-151107-0000.tar.gpg	Sat Nov 7 01:40:10 2015	NAS	154 MB	Restore
Weekly_Configuration_Backup-CFG10-151107-0000.tar.gpg	Sat Nov 7 01:35:51 2015	NAS	105 MB	Restore
Weekly_Configuration_Backup-	Sat Nov 14 01:35:48	NAS	108 MB	Restore

Operational Backup

Status

Backup Name: - Start Date: -
Repository Name: - Status: -
Scheduled: - Progress Percent: -
Triggered From: - Progress Message: -
Execute On: -

Schedule

Frequency: - Start and End: - Execute At: - Create

File Name	Modified Time	R...	File...	
Montly_Operational_Backup-OPS10-160201-0000.tar.gpg	Mon Feb 1 01:37:01 2016	NAS	14 MB	Restore
Montly_Operational_Backup-OPS-160201-0000.tar.gpg	Mon Feb 1 01:36:28 2016	NAS	3 MB	Restore
Montly_Operational_Backup-OPS10-160101-0000.tar.gpg	Fri Jan 1 01:35:55 2016	NAS	13 MB	Restore
Montly_Operational_Backup-OPS10-151101-0000.tar.gpg	Sun Nov 1 01:34:31 2015	NAS	12 MB	Restore
Montly_Operational_Backup-OPS-160101-0000.tar.gpg	Fri Jan 1 01:35:43 2016	NAS	5 MB	Restore
Montly_Operational_Backup-OPS10-151201-0000.tar.gpg	Tue Dec 1 01:35:14 2015	NAS	13 MB	Restore

Figure 18-28 *Backup & Restore Screen*

As shown in Figure 18-28, the backups are stored in a repository, and can be restored from the same repository. You can schedule backups to run automatically or you can run them manually on demand. You can view the status of a backup from either the GUI or the CLI, but you can view the status of a restore only from the CLI.

Summary

This chapter reviewed the basic principles of deploying distributed ISE nodes, high availability for ISE Policy Administration and Monitoring & Troubleshooting nodes. It examined the pillars of successful load balancing with ISE Policy Service Nodes, failover selection on Cisco Catalyst switches, and IOS load balancing.

This chapter also emphasized the importance of having regular backups in addition to a highly available design, and described where to configure those backups in addition to patching an ISE deployment.

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