NIST SPECIAL PUBLICATION 1800-25

Data Integrity

Identifying and Protecting Assets Against Ransomware and Other Destructive Events

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

Jennifer Cawthra
Michael Ekstrom
Lauren Lusty
Julian Sexton
John Sweetnam

DRAFT

This publication is available free of charge from https://www.nccoe.nist.gov/projects/building-blocks/data-integrity/identify-protect.

National Institute of Standards and Technology
U.S. Department of Commerce

NCCoE
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The MITRE Corporation
McLean, Virginia

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January 2020

U.S. Department of Commerce
Wilbur Ross, Secretary

National Institute of Standards and Technology
Walter Copan, NIST Director and Undersecretary of Commerce for Standards and Technology

NIST SPECIAL PUBLICATION 1800-25A

Data Integrity

Identifying and Protecting Assets Against Ransomware and Other Destructive Events

Volume A:
Executive Summary

Jennifer Cawthra
National Cybersecurity Center of Excellence
NIST

Michael Ekstrom
Lauren Lusty
Julian Sexton
John Sweetnam
Anne Townsend
The MITRE Corporation
McLean, Virginia

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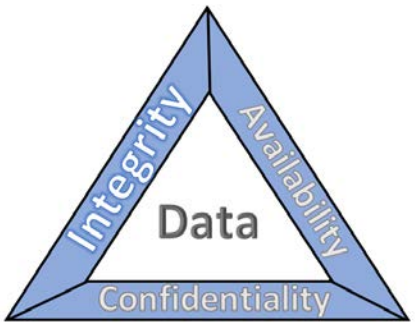
NIST National Institute of Standards and Technology U.S. Department of Commerce

NCCoE NATIONAL CYBERSECURITY CENTER OF EXCELLENCE

Executive Summary

The CIA triad represents the three pillars of information security: confidentiality, integrity, and availability, as follows:



- Confidentiality – preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information
- Integrity — guarding against improper information modification or destruction and ensuring information non-repudiation and authenticity
- Availability – ensuring timely and reliable access to and use of information

This series of practice guides focuses on data integrity: the property that data has not been altered in an unauthorized manner. Data integrity covers data in storage, during processing, and while in transit. (Note: These definitions are from National Institute of Standards and Technology (NIST) Special Publication (SP) 800-12 Rev 1, *An Introduction to Information Security*.)

- Destructive malware, ransomware, malicious insider activity, and even honest mistakes all set the stage for why organizations need to properly identify and protect against events that impact data integrity. Businesses must be confident that data is protected and safe.
- Attacks against an organization's data can compromise emails, employee records, financial records, and customer information—impacting business operations, revenue, and reputation.

- Examples of data integrity attacks include unauthorized insertion, deletion, or modification of data to corporate information such as emails, employee records, financial records, and customer data.
- The National Cybersecurity Center of Excellence (NCCoE) at the National Institute of Standards and Technology (NIST) built a laboratory environment to explore methods to effectively identify and protect against data integrity attacks in various information technology (IT) enterprise environments to prevent impacts to business operations.
- This NIST Cybersecurity Practice Guide demonstrates how organizations can develop and implement appropriate actions before a detected data integrity cybersecurity event.

CHALLENGE

Some organizations have experienced systemic attacks that force operations to cease. One variant of a data integrity attack–ransomware–encrypts data, rendering it unusable. This type of impact to data affects business operations and often leads them to shut down. Other variants of data integrity attacks can steer organizations to make decisions that can impact the bottom line or execute ill-fated decisions.

For example, adversarial actors could create backdoor accounts in company login systems, change payroll information to their benefit, or expose the company with unsafe software updates for their own benefit.

SOLUTION

NIST published version 1.1 of the Cybersecurity Framework in April 2018 to provide guidance on protecting and developing resiliency for critical infrastructure and other sectors. The framework core contains five functions, listed below.

- **Identify** – develop an organizational understanding to manage cybersecurity risk to systems, people, assets, data, and capabilities
- **Protect** – develop and implement appropriate safeguards to ensure delivery of critical services
- **Detect** – develop and implement appropriate activities to identify the occurrence of a cybersecurity event
- **Respond** – develop and implement appropriate activities to take action regarding a detected cybersecurity incident
- **Recover** – develop and implement appropriate activities to maintain plans for resilience and to restore any capabilities or services that were impaired due to a cybersecurity incident

For more information, see the *Framework for Improving Critical Infrastructure Cybersecurity*.

Applying the Cybersecurity Framework to data integrity, this practice guide informs organizations of how to identify and protect against a data integrity attack, and in turn understand how to manage data integrity risks and implement the appropriate safeguards.

The NCCoE developed and implemented a solution that incorporates multiple systems working in concert to identify and protect against detected data integrity cybersecurity events. The solution isolates the opportunities that would allow for the cybersecurity events to occur and implements strategies to remediate the opportunities. Also, the solution applies additional protections from cybersecurity events to IT infrastructure.

In developing this solution, the NCCoE sought existing technologies that provided the following capabilities:

- backups
- integrity monitoring
- inventory
- logging
- maintenance

- secure storage
- vulnerability management

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

This practice guide can help your organization:

- develop a strategy for identifying and protecting against a data integrity cybersecurity event
- facilitate comprehensive protection from adverse events to maintain operations and ensure the integrity of data critical to supporting business operations and revenue-generating activities
- manage enterprise risk (consistent with foundations of the NIST *Framework for Improving Critical Infrastructure Cybersecurity*)

SHARE YOUR FEEDBACK

You can view or download the guide at https://www.nccoe.nist.gov/projects/building-blocks/data-integrity/identify-protect. 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 ds-nccoe@nist.gov.

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 (CRADA) 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.

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 using commercially available technology.

LEARN MORE

Visit https://www.nccoe.nist.gov
nccoe@nist.gov
301-975-0200

NIST SPECIAL PUBLICATION 1800-25B

Data Integrity

Identifying and Protecting Assets Against Ransomware and Other Destructive Events

Volume B:
Approach, Architecture, and Security Characteristics

Jennifer Cawthra
National Cybersecurity Center of Excellence
NIST

Michael Ekstrom
Lauren Lusty
Julian Sexton
John Sweetnam
The MITRE Corporation
McLean, Virginia

January 2020

DRAFT

This publication is available free of charge from https://www.nccoe.nist.gov/projects/building-blocks/data-integrity/identify-protect.

DISCLAIMER

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.

National Institute of Standards and Technology Special Publication 1800-25B, Natl. Inst. Stand. Technol. Spec. Publ. 1800-25B, 50 pages, (January 2020), CODEN: NSPUE2

FEEDBACK

You can improve this guide by contributing feedback. As you review and adopt this solution for your own organization, we ask you and your colleagues to share your experience and advice with us.

Comments on this publication may be submitted to: ds-nccoe@nist.gov.

Public comment period: January 27, 2020 through February 25, 2020

All comments are subject to release under the Freedom of Information Act.

National Cybersecurity Center of Excellence
National Institute of Standards and Technology
100 Bureau Drive
Mailstop 2002
Gaithersburg, MD 20899
Email: nccoe@nist.gov

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 information technology 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 Cybersecurity Framework and details the steps needed for another entity to re-create the example solution. The NCCoE was established in 2012 by NIST in partnership with the State of Maryland and Montgomery County, Maryland.

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

NIST CYBERSECURITY PRACTICE GUIDES

NIST Cybersecurity Practice Guides (Special Publication 1800 series) 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

Ransomware, destructive malware, insider threats, and even honest user mistakes present ongoing threats to organizations. Organizations' data, such as database records, system files, configurations, user files, applications, and customer data, are all potential targets of data corruption, modification, and destruction. Formulating a defense against these threats requires two things: a thorough knowledge of the assets within the enterprise, and the protection of these assets against the threat of data corruption and destruction. The NCCoE, in collaboration with members of the business community and vendors of cybersecurity solutions, has built an example solution to address these data integrity challenges.

Multiple systems need to work together to identify and protect an organization's assets against the threat of corruption, modification, and destruction. This project explores methods to effectively identify assets (devices, data, and applications) that may become targets of data integrity attacks, as well as the vulnerabilities in the organization's system that facilitate these attacks. It also explores methods to protect these assets against data integrity attacks using backups, secure storage, integrity checking mechanisms, audit logs, vulnerability management, maintenance, and other potential solutions

KEYWORDS

attack vector; asset awareness; data integrity; data protection; malicious actor; malware; ransomware.

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Milissa McGinnis	The MITRE Corporation
Karri Meldorf	The MITRE Corporation
Denise Schiavone	The MITRE Corporation

Name	Organization
Anne Townsend	The MITRE Corporation

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
Symantec Corporation	Symantec Data Loss Prevention v15.1
Cisco Systems	Cisco ISE v2.4, Cisco Web Security Appliance v10.1
GreenTec USA	GreenTec WORMdisk v151228
Tripwire	Tripwire Log Center v7.3.1, Tripwire Enterprise v8.7, Tripwire IP360 v9.0.1
Micro Focus	Micro Focus ArcSight Enterprise Security Manager v7.0 Patch 2
Cryptonite	CryptoniteNXT v2.9.1
Semperis	Semperis Active Directory Forest Recovery v2.5, Semperis Directory Services Protector v2.7

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1 Summary

Businesses face a near-constant threat of destructive malware, ransomware, malicious insider activities, and even honest mistakes that can alter or destroy critical data. These types of adverse events ultimately impact data integrity (DI). It is imperative for organizations to be able to identify assets that may be impacted by a DI attack and to protect their enterprise against such attacks.

The National Cybersecurity Center of Excellence (NCCoE) at the National Institute of Standards and Technology (NIST) built a laboratory environment to explore methods to identify and protect assets from a data corruption event in various information technology (IT) enterprise environments. The example solution outlined in this guide describes the solution built in the NCCoE lab. It encourages identification of vulnerabilities and assets that may be present in the enterprise, as well as several protections that can significantly mitigate the effects of DI attacks before they occur.

The goals of this NIST Cybersecurity Practice Guide are to help organizations confidently:

- identify systems, users, data, applications, and entities on the network
- identify vulnerabilities in enterprise components and clients
- baseline the integrity and activity of enterprise systems, in preparation for an attack
- create backups of enterprise data in advance of an attack
- protect these backups and other potentially important data against alteration
- manage enterprise health by assessing machine posture

For ease of use, a short description of the different sections of this volume follows.

- Section 1: Summary presents the challenge addressed by the NCCoE project, with an in-depth look at our approach, the architecture, and the security characteristics we used; the solution demonstrated to address the challenge; benefits of the solution; and technology partners that participated in building, demonstrating, and documenting the solution. The Summary also explains how to provide feedback on this guide.
- Section 2: How to Use This Guide explains how readers—business decision makers, program managers, and IT professionals (e.g., systems administrators)—might use each volume of the guide.
- Section 3: Approach offers a detailed treatment of the scope of the project and describes the assumptions on which the security platform development was based, the risk assessment that informed platform development, and the technologies and components that industry collaborators gave us to enable platform development.
- Section 4: Architecture describes the usage scenarios supported by project security platforms, including Cybersecurity Framework [1] functions supported by each component contributed by our collaborators.

- Section 5: Security Characteristics Analysis provides details about the tools and techniques we used to perform risk assessments.
- Section 6: Future Build Considerations is a brief treatment of other Data Security implementations NIST considers consistent with Framework Core Functions: Identify, Protect, Detect and Respond, and Recovery.

1.1 Challenge

Thorough collection of quantitative and qualitative data is important to organizations of all types and sizes. It can impact all aspects of a business, including decision-making, transactions, research, performance, and profitability. When these data collections sustain a DI attack caused by unauthorized insertion, deletion, or modification of information, the attack can affect emails, employee records, financial records, and customer data, rendering them unusable or unreliable. Some organizations have experienced systemic attacks that caused a temporary cessation of operations. One variant of a DI attack—ransomware—encrypts data and holds it hostage while the attacker demands payment for the decryption keys.

Before DI events occur, organizations should identify their assets and vulnerabilities and have defenses and preparations in place to preemptively mitigate the events. This reduces the workload of actions to take during and after an attack occurs, as well as the enterprise's data loss and number of successful attacks.

1.2 Solution

The NCCoE implemented a solution that incorporates appropriate actions before the start of a DI event. The solution comprises systems working together to identify and protect assets against a data corruption event in standard enterprise components. These components include mail servers, databases, end user machines, virtual infrastructure, and file share servers. Essential to protection of assets is understanding of what those assets are and what vulnerabilities they have.

The NCCoE sought existing technologies that provided the following capabilities:

- Inventory
- Policy Enforcement
- Logging
- Backups
- Vulnerability Management
- Secure Storage
- Integrity Monitoring

In developing our solution, we used standards and guidance from the following sources, which can also provide your organization with relevant standards and best practices:

- NIST *Framework for Improving Critical Infrastructure Cybersecurity* (commonly known as the NIST Cybersecurity Framework) [1]
- NIST Interagency or Internal Report (NISTIR) 8050: *Executive Technical Workshop on Improving Cybersecurity and Consumer Privacy* [2]
- NIST Special Publication (SP) 800-30 Rev. 1: *Guide for Conducting Risk Assessments* [3]
- NIST SP 800-37 Rev. 1: *Guide for Applying the Risk Management Framework to Federal Information Systems: A Security Life Cycle Approach* [4]
- NIST SP 800-39: *Managing Information Security Risk* [5]
- NIST SP 800-40 Rev. 3: *Guide to Enterprise Patch Management Technologies* [6]
- NIST SP 800-53 Rev. 4: *Security and Privacy Controls for Federal Information Systems and Organizations* [7]
- Federal Information Processing Standard 140-3: *Security Requirements for Cryptographic Modules* [8]
- NIST SP 800-86: *Guide to Integrating Forensic Techniques into Incident Response* [9]
- NIST SP 800-92: *Guide to Computer Security Log Management* [10]
- NIST SP 800-100: *Information Security Handbook: A Guide for Managers* [11]
- NIST SP 800-34 Rev. 1: *Contingency Planning Guide for Federal Information Systems* [12]
- Office of Management and Budget, Circular Number A-130: Managing Information as a Strategic Resource [13]
- NIST SP 800-61 Rev. 2: *Computer Security Incident Handling Guide* [14]
- NIST SP 800-83 Rev. 1: *Guide to Malware Incident Prevention and Handling for Desktops and Laptops* [15]
- NIST SP 800-150: *Guide to Cyber Threat Information Sharing* [16]
- NIST SP 800-184: *Guide for Cybersecurity Event Recovery* [17]

1.3 Benefits

The NCCoE's practice guide can help your organization:

- develop a plan for identifying assets and vulnerabilities and protecting these assets from a cybersecurity event
- facilitate easier detection, response, and recovery from a DI event by collecting information about the enterprise before an attack occurs

- maintain integrity and availability of data critical to supporting business operations and revenue-generating activities
- manage enterprise risk (consistent with the foundations of the NIST Cybersecurity Framework)

2 How to Use This Guide

This NIST Cybersecurity Practice Guide demonstrates a standards-based reference design and provides users with the information they need to replicate the DI identify-and-protect solution. This reference design is modular and can be deployed in whole or in part.

This guide contains three volumes:

- NIST SP 1800-25A: *Executive Summary*
- NIST SP 1800-25B: *Approach, Architecture, and Security Characteristics* – what we built and why **(you are here)**
- NIST SP 1800-25C: *How-To Guides* – instructions for building the example solution

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

Business decision makers, including chief security and technology officers, will be interested in the *Executive Summary,* NIST SP 1800-25A, which describes the following topics:

- challenges that enterprises face in identifying assets and protecting them from DI events
- 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 1800-25B, which describes what we did and why. The following sections will be of particular interest:

- Section 3.4.1, Risk, provides a description of the risk analysis we performed.
- Section 3.4.2, 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 1800-25A, with your leadership team members to help them understand the importance of adopting a standards-based solution to identify and protect assets from DI attacks.

IT professionals who want to implement such an approach will find the whole practice guide useful. You can use the how-to portion of the guide, NIST SP 1800-25C, to replicate all or parts of the build created in our lab. The how-to portion of the guide provides specific product installation, configuration, and integration instructions for implementing the example solution. We do not re-create 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 DI identify-and-protect solution. 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 3.5, Technologies, lists the products we used and maps them to the cybersecurity controls provided by this reference solution.

A NIST Cybersecurity Practice Guide does not describe "the" solution, but a possible solution. This is a draft guide. We seek feedback on its contents and welcome your input. Comments, suggestions, and success stories will improve subsequent versions of this guide. Please contribute your thoughts to ds-nccoe@nist.gov.

Acronyms used in figures can be found in the Acronyms appendix.

2.1 Typographic Conventions

The following table presents typographic conventions used in this volume.

Typeface/Symbol	Meaning	Example
Italics	file names and path names; references to documents that are not hyperlinks; new terms; and placeholders	For language use and style guidance, see the *NCCoE Style Guide*.
Bold	names of menus, options, command buttons, and fields	Choose **File** > **Edit.**
`Monospace`	command-line input, onscreen computer output, sample code examples, and status codes	`mkdir`
`Monospace Bold`	command-line user input contrasted with computer output	**`service sshd start`**
blue text	link to other parts of the document, a web URL, or an email address	All publications from NIST's NCCoE are available at https://www.nccoe.nist.gov.

3 Approach

Based on key points expressed in NISTIR 8050, *Executive Technical Workshop on Improving Cybersecurity and Consumer Privacy* (2015), the NCCoE is pursuing a series of DI projects to map the Core Functions of the NIST Cybersecurity Framework. This project is centered on the Core Functions of Identify and Protect, which consist of identifying and protecting assets from DI attacks. For instance, the first step in building a strategy requires an organization to inventory its assets. This involves identifying systems, applications, data sources, users, and other relevant entities that may be targets or facilitators of DI attacks. Once this exercise is complete, an organization can then create a customized strategy to protect the identified assets against the possibility of data corruption, modification, and destruction. NCCoE engineers working with a community of interest (COI) defined the requirements for this DI project.

Members of the COI, which include participating vendors referenced in this document, contributed to development of the architecture and reference design, providing technologies that meet the project requirements and assisting in installation and configuration of those technologies. The practice guide highlights the approach used to develop the NCCoE reference solution. Elements include risk assessment and analysis, logical design, build development, test and evaluation, and security control mapping. This guide aims to provide practical guidance to any organization interested in implementing a solution for identifying and protecting assets against a cybersecurity event.

3.1 Audience

This guide is intended for individuals responsible for implementing security solutions in organizations' IT support activities. Current IT systems, particularly in the private sector, often lack the ability to comprehensively identify enterprise assets that need protection from integrity attacks, as well as the protections themselves. The platforms demonstrated by this project, and the implementation information provided in these practice guides, permit integration of products to implement a data identification and protection system. The technical components will appeal to system administrators, IT managers, IT security managers, and others directly involved in the secure and safe operation of business IT networks.

3.2 Scope

The guide provides practical, real-world guidance on developing and implementing a DI solution consistent with the principles in the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Volume 1 [1], specifically the Core Functions of Identify and Protect. The Identify Function emphasizes the development and implementation of the appropriate activities to discover and manage an organization's assets, services, and the threats to these assets and services. The Protect Function emphasizes development and implementation of activities that protect these assets and services from cybersecurity events. Examples of outcomes within these Functions include asset inventory, logging, backups, vulnerability management, policy enforcement, and file/system integrity management.

3.3 Assumptions

This project is guided by the following assumptions:

- The solution was developed in a lab environment. The environment is based on a generic organization's IT enterprise—it uses services found commonly across typical enterprises, such as a database, a domain controller, a mail/web server, etc. It does not reflect the complexity of a production environment, for example, building across numerous physical locations, accommodating for extreme working conditions, or configuring systems to meet specific network/user needs. These demands can all increase the level of complexity needed to implement a DI solution.
- An organization has access to the skills and resources required to implement an asset identification and protection system.
- An organization is seeking to preemptively mitigate the damage a DI event would cause.

3.4 Risk Assessment

NIST SP 800-30 Revision 1, *Guide for Conducting Risk Assessments* states that risk is "a measure of the extent to which an entity is threatened by a potential circumstance or event, and typically a function of: (i) the adverse impacts that would arise if the circumstance or event occurs; and (ii) the likelihood of occurrence." The guide further defines risk assessment as "the process of identifying, estimating, and prioritizing risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation, resulting from the operation of an information system. Part of risk management incorporates threat and vulnerability analyses, and considers mitigations provided by security controls planned or in place."

The NCCoE recommends that any discussion of risk management, particularly at the enterprise level, begins with a comprehensive review of NIST SP 800-37 Revision 2, *Risk Management Framework for Information Systems and Organizations*—material available to the public. The Risk Management Framework (RMF) guidance, as a whole, proved to be invaluable in giving us a baseline to assess risks, from which we developed the project, the security characteristics of the build, and this guide.

We performed two types of risk assessments:

- Initial analysis of the risk factors discussed with financial, retail, and hospitality institutions: this analysis led to creation of the DI project and desired security posture. See NISTIR 8050, *Executive Technical Workshop on Improving Cybersecurity and Consumer Privacy,* for additional participant information.
- Analysis of how to secure the components within the solution and minimize any vulnerabilities they might introduce: see Section 5, Security Characteristic Analysis.

3.4.1 Risk

Using the guidance in NIST's series of publications concerning risk, we worked with financial institutions and the Financial Sector Information Sharing and Analysis Center to identify the most compelling risk factors encountered by this business group. We participated in conferences and met with members of the financial sector to define the main security risks to business operations. From these discussions came identification of an area of concern—DI. We produced the practice guide *Data Integrity: Recovering from Ransomware and Other Destructive Events,* which primarily focused on the recovery aspect of DI. From responses to the recovery project, we also identified a need for guidance in identifying and protecting assets from DI attacks.

When considering risk from the perspective of identifying and protecting assets prior to a cybersecurity event, we must consider not only the impact of an event on an organization's assets but also the threats to those assets and the potential vulnerabilities these threats could exploit.

When discussing threats to an organization's assets from the perspective of DI, we consider the following factors:

- malware
- insider threats
- accidents caused by human error
- compromise of trusted systems

Types of vulnerabilities we consider in relation to these threats are:

- zero-day vulnerabilities
- vulnerabilities due to outdated or unpatched systems
- custom software vulnerabilities/errors
- social engineering and user-driven events
- poor access control

Finally, we consider the potential impact on an organization from a DI event:

- systems incapacitated
- modification/deletion of organization's assets
- negative impact on the organization's reputation

Analyses of the threats, vulnerabilities, and potential impact to an organization give us an understanding of the risk to an organization with respect to DI. NIST SP 800-39, *Managing Information Security Risk,* focuses on the business aspect of risk, namely at the enterprise level. This understanding is essential for

any further risk analysis, risk response/mitigation, and risk monitoring activities. The following summary lists the strategic risk areas we identified and their mitigations:

- Impact on system function: ensuring the availability of accurate data or sustaining an acceptable level of DI reduces the risk of systems' availability being compromised.
- Cost of implementation: implementing asset identification and protection from DI events once and using it across all systems may reduce system continuity costs.
- Compliance with existing industry standards contributes to the industry requirement to maintain a continuity of operations plan.
- Maintenance of reputation and public image helps reduce level and likelihood of impact as well as facilitates the information required for impact reduction.
- Increased focus on DI includes not just loss of confidentiality but also harm from unauthorized alteration of data (per NISTIR 8050).

We subsequently translated the risk factors identified to security Functions and Subcategories within the NIST Cybersecurity Framework. In Table 3-1, we mapped the categories to NIST SP 800-53 Rev. 4 controls.

3.4.2 Security Control Map

As explained in Section 3.4.1, we identified the Cybersecurity Framework Functions and Subcategories that we wanted the reference design to support, through a risk analysis process. This was a critical first step in designing the reference design and example implementation to mitigate the risk factors. Table 3-1 lists the addressed Cybersecurity Framework Functions and Subcategories and maps them to relevant NIST standards, industry standards, and controls and best practices. The references provide solution validation points in that they list specific security capabilities that a solution addressing the Cybersecurity Framework Subcategories would be expected to exhibit. Organizations can use Table 3-1 to identify the Cybersecurity Framework Subcategories and NIST SP 800-53 Rev. 4 controls they are interested in addressing.

When cross-referencing Functions of the Cybersecurity Framework with product capabilities used in this practice guide, it is important to consider:

- This practice guide, though primarily focused on Identify/Protect Functions also uses DE.CM-8 and RS.MI-3, Detect and Respond Subcategories respectively. This is primarily because these two Subcategories deal with vulnerability discovery and mitigation, which are techniques used to prevent future damage and are not as useful for preventing attacks previously exploited a given vulnerability. Often, it is unlikely that an organization will be able to resolve a newly discovered vulnerability during an attack; for attacks where patches are available, it can be dangerous to allow updates on a compromised system.

- Not all the guidance of Cybersecurity Framework Subcategories can be implemented using technology. Any organization executing a DI solution would need to adopt processes and organizational policies that support the reference design. For example, some of the Subcategories within the Cybersecurity Framework Function known as Identify are processes and policies that should be developed prior to implementing recommendations.

Table 3-1 DI Reference Design Cybersecurity Framework Core Components Map

Cybersecurity Framework v1.1				Standards and Best Practices	
Function	**Category**	**Subcategory**	**NIST SP 800-53 R4**	**ISO/IEC 27001:2013**	**NIST SP 800-181**
IDENTIFY (ID)	Asset Management (ID.AM)	ID.AM-1: Physical devices and systems within the organization are inventoried.	CM-8, PM-5	A.8.1.1, A.8.1.2	OM-STS-001
		ID.AM-2: Software platforms and applications within the organization are inventoried.	CM-8, PM-5	A.8.1.1, A.8.1.2, A.12.5.1	OM-STS-001
	Risk Assessment (ID.RA)	ID.RA-1: Asset vulnerabilities are identified and documented.	CA-2, CA-7, CA-8, RA-3, RA-5, SA-5, SA-11, SI-2, SI-4, SI-5	A.12.6.1, A.18.2.3	PR-VAM-001
		ID.RA-2: Cyber threat intelligence is received from information sharing forums and sources.	SI-5, PM-15, PM-16	A.6.1.4	CO-OPL-002
		ID.RA-5: Threats, vulnerabilities, likelihoods, and impacts are used to determine risk.	RA-2, RA-3, PM-16	A.12.6.1	SP-SYS-001

Cybersecurity Framework v1.1				Standards and Best Practices	
Function	**Category**	**Subcategory**	**NIST SP 800-53 R4**	**ISO/IEC 27001:2013**	**NIST SP 800-181**
PROTECT (PR)	Access Control (PR.AC)	PR.AC-1: Identities and credentials are issued, managed, verified, revoked, and audited for authorized devices, users, and processes.	AC-1, AC-2, IA-1, IA-2, IA-3, IA-4, IA-5, IA-6, IA-7, IA-8, IA-9, IA-10, IA-11	A.9.2.1, A.9.2.2, A.9.2.3, A.9.2.4, A.9.2.6, A.9.3.1, A.9.4.2, A.9.4.3	SP-DEV-001, OV-PMA-003
		PR.AC-3: Remote access is managed.	AC-1, AC-17, AC-19, AC-20, SC-15	A.6.2.1, A.6.2.2, A.11.2.6, A.13.1.1, A.13.2.1	SP-SYS-001, OM-ADM-001
		PR.AC-4: Access permissions and authorizations are managed, incorporating the principles of least privilege and separation of duties.	AC-1, AC-2, AC-3, AC-5, AC-6, AC-14, AC-16, AC-24	A.6.1.2, A.9.1.2, A.9.2.3, A.9.4.1, A.9.4.4, A.9.4.5	OM-STS-001
		PR.AC-5: Network integrity is protected (e.g., network segregation, network segmentation).	AC-4, AC-10, SC-7	A.13.1.1, A.13.1.3, A.13.2.1, A.14.1.2, A.14.1.3	OM-NET-001
	Data Security (PR.DS)	PR.DS-1: Data-at-rest is protected.	MP-8, SC-12, SC-28	A.8.2.3	OM-DTA-002
		PR.DS-2: Data-in-transit is protected.	SC-8, SC-11, SC-12	A.8.2.3, A.13.1.1, A.13.2.1, A.13.2.3, A.14.1.2, A.14.1.3	OM-DTA-002, PR-CDA-001

Cybersecurity Framework v1.1				Standards and Best Practices	
Function	**Category**	**Subcategory**	**NIST SP 800-53 R4**	**ISO/IEC 27001:2013**	**NIST SP 800-181**
		PR.DS-6: Integrity checking mechanisms are used to verify software, firmware, and information integrity.	SC-16, SI-7	A.12.2.1, A.12.5.1, A.14.1.2, A.14.1.3, A.14.2.4	OM-DTA-001
	Information Protection Processes and Procedures (PR.IP)	PR.IP-1: A baseline configuration of information technology/industrial control systems is created and maintained, incorporating security principles (e.g., concept of least functionality).	CM-2, CM-3, CM-4, CM-5, CM-6, CM-7, CM-9, SA-10	A.12.1.2, A.12.5.1, A.12.6.2, A.14.2.2, A.14.2.3, A.14.2.4	SP-ARC-001
		PR.IP-3: Configuration change control processes are in place.	CM-3, CM-4, SA-10	A.12.1.2, A.12.5.1, A.12.6.2, A.14.2.2, A.14.2.3, A.14.2.4	SP-DEV-001, OM-ANA-001
		PR.IP-4: Backups of information are conducted, maintained, and tested.	CP-4, CP-6, CP-9	A.12.3.1, A.17.1.2, A.17.1.3, A.18.1.3	SP-SYS-001
		PR.IP-9: Response plans (Incident Response and Business Continuity) and recovery plans (Incident Recovery and Disaster Recovery) are in place and managed.	CP-2, CP-7, CP-12, CP-13, IR-7, IR-8, IR-9, PE-17	A.16.1.1, A.17.1.1, A.17.1.2, A.17.1.3	PR-CIR-001
		PR.IP-10: Response and recovery plans are tested.	CP-4, IR-3, PM-14	A.17.1.3	SP-SYS-001

Cybersecurity Framework v1.1				Standards and Best Practices	
Function	**Category**	**Subcategory**	**NIST SP 800-53 R4**	**ISO/IEC 27001:2013**	**NIST SP 800-181**
		PR.IP-12: A vulnerability management plan is developed and implemented.	RA-3, RA-5, SI-2	A.12.6.1, A.14.2.3, A.16.1.3, A.18.2.2, A.18.2.3	SP-RSK-002
	Maintenance (PR.MA)	PR.MA-1: Maintenance and repair of organizational assets are performed and logged, with approved and controlled tools.	MA-2, MA-3, MA-5, MA-6	A.11.1.2, A.11.2.4, A.11.2.5, A.11.2.6	OM-ADM-001
		PR.MA-2: Remote maintenance of organizational assets is approved, logged, and performed in a manner that prevents unauthorized access.	MA-4	A.11.2.4, A.15.1.1, A.15.2.1	SP-TRD-001
	Protective Technology (PR.PT)	PR.PT-1: Audit/log records are determined, documented, implemented, and reviewed in accordance with policy.	AU Family	A.12.4.1, A.12.4.2, A.12.4.3, A.12.4.4, A.12.7.1	OV-LGA-002
		PR.PT-3: The principle of least functionality is incorporated by configuring systems to provide only essential capabilities.	AC-3, CM-7	A.9.1.2	PR-CDA-001, OM-ANA-001

Cybersecurity Framework v1.1				Standards and Best Practices	
Function	**Category**	**Subcategory**	**NIST SP 800-53 R4**	**ISO/IEC 27001:2013**	**NIST SP 800-181**
		PR.PT-4: Communications and control networks are protected.	AC-4, AC-17, AC-18, CP-8, SC-7, SC-19, SC-20, SC-21, SC-22, SC-23, SC-24, SC-25, SC-29, SC-32, SC-36, SC-37, SC-38, SC-39, SC-40, SC-41, SC-43	A.13.1.1, A.13.2.1, A.14.1.3	SP-ARC-002
DETECT (DE)	Security Continuous Monitoring (DE.CM)	DE.CM-8: Vulnerability scans are performed.	RA-5	A.12.6.1	SP-TRD-001
RESPOND (RS)	Mitigation (RS.MI)	RS.MI-3: Newly identified vulnerabilities are mitigated or documented as accepted risks.	CA-7, RA-3, RA-5	A.12.6.1	PR-CIR-001

3.5 Technologies

Table 3-2 lists all the technologies used in this project and provides a mapping among the generic application term, the specific product used, and the security control(s) the product provides. Refer to Table 3-1 for an explanation of the NIST Cybersecurity Framework Subcategory codes.

Please note that PR.AC-4 is not included in this table. Access controls are detailed more thoroughly in other NCCoE practice guides [18], [19]. For the purposes of this practice guide, we assume a minimal Active Directory setup with an administrator and several users.

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Component	Product	Function	Cybersecurity Framework Subcategories
Inventory	Cisco ISE v2.4 Symantec Data Loss Prevention (DLP) v15.1	• Identification and status information for users • Identification and status information for devices • Identification and status information for software • Identification and status information for data assets	ID.AM-1, ID.AM-2, PR.AC-1, PR.PT-2
Vulnerability Management	Tripwire IP360 v9.0.1	• Identification for vulnerabilities on various systems in the enterprise • An interface for managing/prioritizing vulnerabilities, based on organizational needs	ID.RA-1, ID.RA-5, PR.IP-12, DE.CM-8, RS.MI-3
Policy Enforcement	Cisco ISE v2.4	• Enforce machine posture across an enterprise • Quarantine machines that do not comply with organizational policy	ID.RA-1, PR.AC-3, PR.MA-1, PR.MA-2, RS.MI-3
Integrity Monitoring	Tripwire Enterprise v8.7 Semperis Directory Services Protector (DSP) v2.7	• Baselines integrity activity for data • Baselines integrity activity for Active Directory • Provides file hashes and integrity baselines for files and software, regardless of file type	PR.DS-6, PR.IP-3, PR.PT-1
Logging	Micro Focus ArcSight Enterprise Security Manager (ESM) v7.0 Patch 2	• Provides auditing and logging capabilities configurable to corporate policy • Provides logs of baseline network operations	PR.IP-1, PR.IP-3, PR.PT-1

Component	Product	Function	Cybersecurity Framework Subcategories
	Tripwire Log Center v7.3.1	• Provides logs of database activity and database backup operations • Provides logs of integrity changes • Provides logs of some user activity of monitored systems	
Backups	Semperis Active Directory Forest Recovery (ADFR) v2.5 FileZilla v0.9.60.2 OPEN SOURCE Duplicati v2.0.3.3 OPEN SOURCE	• Backs up Active Directory information • Backs up systems • Backs up configurations • Backs up organizational data	PR.DS-1, PR.IP-3, PR.IP-4, PR.IP-9, PR.IP-10
Secure Storage	GreenTec WORMdisk v151228	• Provides immutable storage • Provides configurable prevention of backup modification	PR.DS-1, PR.IP-4
Network Protection	CryptoniteNXT v2.9.1	• Prevents unapproved network communication • Prevents malicious reconnaissance • Quarantines unauthorized machines on the network	ID.AM-1, PR.AC-1, PR.AC-3, PR.AC-5, PR.DS-2, PR.PT-4
Blacklisting	Cisco Web Security Appliance v10.1	• Provides capability to blacklist websites • Provides capability to blacklist communication with malicious or disallowed IP addresses	PR.AC-3, PR.AC-5, PR.DS-2, PR.PT-4

4 Architecture

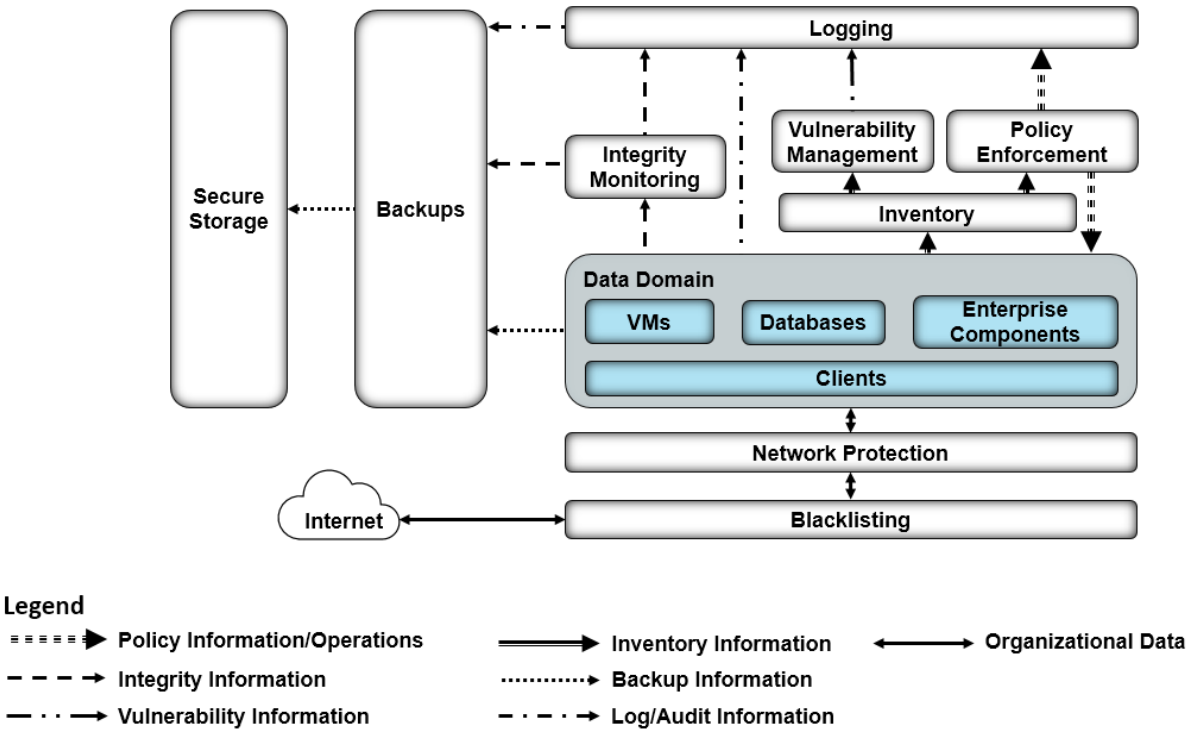
This section presents the high-level architecture used for implementation of a DI solution that identifies and protects assets from ransomware and other destructive events.

4.1 Architecture Description

4.1.1 High-Level Architecture

The DI solution is designed to address the security Functions and Subcategories described in Table 3-1 and is composed of the capabilities illustrated in Figure 4-1.

Figure 4-1 DI Identify and Protect High-Level Architecture



- Inventory allows discovering and keeping track of devices connected to the enterprise.
- Vulnerability Management provides a mechanism for analyzing various system and network components, for a better understanding of resolved and unresolved vulnerabilities in the enterprise.
- Policy Enforcement uses feedback from logs and vulnerability management to target machines with unresolved vulnerabilities and maintain overall enterprise health.

- Integrity Monitoring establishes baselines of file/system integrity.
- Logging records and stores all the log files produced by the components within the enterprise.
- Backups allow components within the enterprise to produce backups.
- Secure Storage allows data storage with additional data protection measures, such as Write Once Read Many (WORM) technologies. Data encryption can also be used, but this will not inherently protect data against corruption.
- Network Protection can defend an enterprise network against both intrusion and lateral movement of malicious actors and programs.
- Blacklisting can filter allowed programs or network communications. Often, this may be provided in the form of a firewall or even a white list, but products exist that allow finer-grained control over these filters.

These capabilities work together to provide the Functions of Identify and Protect for the reference architecture. The Inventory capability allows accurate and complete discovery and status reporting of all network assets. The Inventory capability feeds into Vulnerability Management, which analyzes the assets and network for vulnerabilities. Vulnerability Management feeds its information into Logging, which aggregates and collects logs from various sources for use as a baseline of normal system operations. Policy Enforcement uses information from Logging and Vulnerability Management, to repair vulnerabilities found in the enterprise and maintain the system with up-to-date patches. Integrity Monitoring records normal file/system integrity information to be used as a baseline in the event of an attack and forwards this information to the Logging capability as part of the organization's baseline. Backups create periodic backups of organizational data to be used in a cybersecurity event. Secure Storage allows storing files—such as backups, gold images, logs, or configuration files—in a format that cannot be corrupted, because files cannot be altered or changed while in storage.

4.1.2 Architecture Components

4.1.2.1 Inventory

The Inventory capability allows discovering and visualizing the enterprise's network as well as the present network devices. This component also informs the other components in the enterprise, providing information such as what systems to monitor, back up, and scan for vulnerabilities. This component provides the basic knowledge of what assets there are to protect.

For the Inventory capability, we use a combination of two products: Cisco ISE and Symantec DLP. Cisco ISE provides inventory capabilities for machines, devices, and users on its network and can use that information in tandem with other capabilities. Symantec DLP provides data asset inventory, allowing organizations to identify potentially sensitive data.

4.1.2.2 Vulnerability Management

The Vulnerability Management capability allows scanning and managing vulnerabilities across the enterprise. It provides a priority system for these vulnerabilities, as well as logs on existing vulnerabilities and potentially resolved vulnerabilities. The information produced by this capability informs the Policy Enforcement capability, which aims to fix the discovered vulnerabilities or quarantine the machine until they are fixed.

For the Vulnerability Management capability, we use Tripwire IP360. Tripwire IP360 is a vulnerability scanner and management tool, which can scan a variety of hosts for known vulnerabilities and report on the results. Furthermore, the tool can manage and assign risk levels to these vulnerabilities, allowing security teams to effectively manage vulnerabilities throughout the enterprise.

4.1.2.3 Policy Enforcement

Through various mechanisms, the Policy Enforcement capability maintains the health of the enterprise. Policy Enforcement acts on log information provided by the Inventory and Vulnerability Management capabilities, often with the help of a security team, to ensure the health and compliance of enterprise systems. This can include mechanisms such as pushing software updates, resolving vulnerabilities, or quarantining noncompliant machines, but the capabilities of policy enforcement tools vary from product to product.

For Policy Enforcement, we use Cisco ISE. Cisco ISE can identify machines on its network and perform a posture check on these machines. This can entail checking that certain services are enabled, that anti-malware is installed, or that certain files are present. Using this information, Cisco ISE can then disable network access to noncompliant machines.

4.1.2.4 Integrity Monitoring

Integrity monitoring provides the ability to test, understand, and measure attacks that occur on files and components within the enterprise. When considering DI from the perspective of protecting assets prior to an attack, it is important to establish an integrity baseline for files and systems across the enterprise, to be used in comparison with daily operations. The value of integrity monitoring becomes clear both during and after an attack. Alerts can be set to notify the security team to act when abnormal changes are detected to a file or system, such as changes made at abnormal times or by users who typically do not make changes to these assets. Furthermore, the information produced by integrity monitoring systems can be used to inform a recovery process; they provide information about what changes happened, when changes began to take place, as well as what programs were involved in the changes.

For Integrity Monitoring, we use a combination of two tools: Tripwire Enterprise and Semperis Directory Services Protector. Tripwire Enterprise is a file integrity monitoring tool that establishes a baseline for integrity activity within the enterprise. This baseline is used in the event of an attack, to detect and alert on changes within the enterprise as well as aid recovery should it be necessary. Semperis Directory

Services Protector also provides integrity monitoring, but for Active Directory it allows granular rollbacks of Active Directory changes and provides a baseline for any attacks on the enterprise account configuration.

4.1.2.5 Logging

Logging from each enterprise component serves several functions in an architecture that aims to identify and protect assets. Logs are produced through Integrity Monitoring, which aids in establishing a baseline for the enterprise's daily activity. Logs are also produced through vulnerability scanning and asset inventory, which inform Policy Enforcement: maintaining up-to-date systems requires information about what systems exist in the enterprise and their status.

For Logging, we use a combination of two tools: Micro Focus ArcSight and Tripwire Log Center (TLC). While TLC's purpose in this build is primarily to collect, transform, and forward logs from Tripwire IP360 and Tripwire Enterprise to ArcSight, ArcSight performs a wider function. ArcSight collects logs from various sources in the enterprise, such as Vulnerability Management, Backups, Network Protection, Blacklisting, Inventory, Integrity Monitoring, as well as Windows event logs and Ubuntu syslogs. This widespread collection aims to provide a baseline for activity throughout the enterprise. ArcSight can analyze and alert, which can be used in the event of an attack, but it requires thorough log collection from all components of the enterprise.

4.1.2.6 Backups

The Backups capability backs up both the organization's data and data from other components, such as logs and integrity information. These backups are most often used as part of the Recover Function as part of the restoration process. Backups must be taken prior to an event to be useful, though; the restoration process requires backups from before the event to adequately restore a system.

The configuration of this capability needs to align with the tempo of the enterprise. For example, if an enterprise performs thousands of transactions per hour per day, then a backup solution that performs a backup only once a day would not adequately provide for the enterprise. This type of configuration would allow a potentially large data loss. If backups occur every morning and a loss of DI happened at the end of the day, then a full day's worth of transactions would be lost. The decision for the correct configuration of backups is determined by an organization's risk tolerance.

For the Backups capability, we use a combination of two open-source tools: FileZilla and Duplicati. FileZilla is a user-based File Transfer Protocol (FTP) server with the option to force FTP over TLS. It allows control over where individual users/groups store files, and its primary purpose in this build is as a receptacle for backups produced by Duplicati. Duplicati is a client-based backup system configured on individual hosts to back up to a provided FTP server. It packages and encrypts backups before sending them to the FTP server, potentially on a schedule.

We also use Semperis ADFR to provide more fine-grained backups for Active Directory. As Active Directory is often critical to enterprise operations, Semperis ADFR is designed to work off-site in the event of a disaster.

4.1.2.7 Secure Storage

Secure Storage stores the most critical files for an enterprise. These include backup data, configuration files, logs, golden images, and other files critical to both system operation and the organization's mission. Additional measures need to be applied to provide increased security to these files so they are not subject to attacks or corruption.

For Secure Storage, we use GreenTec's WORMdisk, a transparent hard disk that can prevent any data deletion and modification at a firmware level. WORMdisks provide an easy-to-use graphical user interface and a command line interface for automating locking and disk rotation. In this architecture they are used primarily to store backups to prevent any damage to the backups, but they can be used at the discretion of the organization to store other critical files.

4.1.2.8 Network Protection

Network Protection defends the network against threats that require network movement. This should preemptively protect against lateral movement, in which malware or a malicious actor attempts to spread across machines in the network. Furthermore, it should also protect against external threats attempting to gain access to the network.

For Network Protection, we use CryptoniteNXT. CryptoniteNXT provides zero-trust moving-target defense for the network it protects. This means that all enterprise communication goes through the CryptoniteNXT device, which provides granular access control for allowed types of communication. This allows defense against lateral propagation. Furthermore, as internet protocol (IP) addresses are dynamic and managed by CryptoniteNXT, reconnaissance is significantly more difficult for attackers on and outside the network.

4.1.2.9 Blacklisting

Blacklisting enables control of allowed communications and applications within an enterprise. This may include restricting installed software on enterprise machines to a predefined list or specifically disallowing software. Furthermore, it should restrict network communication with websites, servers, or external actors as well as restrict based on protocol or port usage. Some of these capabilities are covered by firewalls, but further control can allow more complex policies based on the organization's needs.

For the Blacklisting capability we use Cisco Web Security Appliance (WSA). Cisco WSA enables enterprises to blacklist web traffic through a proxy. This allows for prevention of malware downloads from known malicious websites as identified by site reputation updates from Cisco Talos threat

intelligence. These websites can also be identified through the implementation of a Detect and Respond build and can also be provided by an integration with other information sharing services.

5 Security Characteristic Analysis

The purpose of the security characteristic analysis is to understand the extent to which the project meets its objective of demonstrating a DI identify-and-protect solution. In addition, it seeks to understand the security benefits and drawbacks of the example solution.

5.1 Assumptions and Limitations

The security characteristic analysis has the following limitations:

- It is neither a comprehensive test of all security components nor a red-team exercise.
- It cannot identify all weaknesses.
- It does not include the lab infrastructure. It is assumed that devices are hardened. Testing these devices would reveal only weaknesses in implementation that would not be relevant to those adopting this reference architecture.

5.2 Build Testing

The purpose of the security characteristic analysis is to understand the extent to which the building block meets its objective of identifying enterprise assets and vulnerabilities. Furthermore, the project aims to protect these assets prior to the start of an attack. In addition, it seeks to understand the security benefits and drawbacks of the reference design. To accomplish this, we created a set of use cases—each an individual attack on DI with different aspects to test various parts of the build.

When doing this, we aim not to test individual components for their capabilities but rather for the ability of the architecture to deal with these use cases. Furthermore, as this architecture is focused on defending against attacks before they happen, the resolutions to these use cases are primarily preventative rather than responsive.

5.3 Scenarios and Findings

One aspect of our security evaluation involved assessing how well the reference design addresses the security characteristics it was intended to support. The Cybersecurity Framework Subcategories were used to provide structure to the security assessment by consulting the specific sections of each standard that are cited in reference to a Subcategory. The cited sections provide validation points that the example solution would be expected to exhibit. Using the Cybersecurity Framework Subcategories as a basis for organizing our analysis allowed us to systematically consider how well the reference design supports the intended security characteristics.

Below is a list of the scenarios created to test various aspects of this architecture. More detailed resolutions and mappings of these scenarios' requirements to the Cybersecurity Framework can be found in Appendix D.

5.3.1 Ransomware via Web Vector and Self-Propagation

5.3.1.1 Scenario

The following scenario was simulated to test the architecture's defense against ransomware.

A user mistakenly downloads ransomware from an external web server. When the user executes this malicious software, it generates a cryptographic key, which is sent back to the external web server. The malware then utilizes a privilege escalation exploit to propagate across the network. The malicious software encrypts files on the machines it propagated to, and it demands payment in exchange for decrypting these files.

5.3.1.2 Resolution

This build provides a significant defense in depth against this use case to prevent the majority of its functions from taking place.

The **Blacklisting** capability is used to prevent the user from reaching the malicious site that hosts the ransomware, preventing the download before it happens.

The **Vulnerability Management** capability is used to detect the vulnerability exploited by the ransomware to propagate, allowing resolution before the attack occurs.

The **Network Protection** capability is used to prevent the ransomware's propagation by disallowing network traffic between computers on the network, through a traffic white-list policy.

The **Inventory** capability is used to identify the enterprise's assets for backup and monitoring.

The **Backups** capability is used to take backups of potential ransomware targets before the attack hits, nullifying the effects of potential attacks on files.

The **Integrity Monitoring** capability, in tandem with the **Logging** capability, is used to take a baseline of the file system, so that an attack on the file system is detected and the scope can be identified.

5.3.1.3 Other Considerations

Malware comes in many forms and from many places, and as a result, requires a defense in depth against it. For example, though preventing a piece of malware from getting on enterprise systems may be as simple as blacklisting a website, it is often impossible to have full knowledge of all malicious websites before an attack happens. Because of this, other tools are necessary to prevent the effects of malware at every step of its potential execution, and preparation is necessary to mitigate effects.

It is important to improve upon these capabilities over time by learning from attacks on the enterprise and from attacks on other enterprises. Both information-sharing technologies and after-the-fact analysis of attacks can inform capabilities to prevent future attacks.

5.3.2 Destructive Malware via USB Vector

5.3.2.1 Scenario

The following scenario was simulated to test the architecture's defense against destructive malware.

A user finds an unmarked Universal Serial Bus (USB) device and inserts it into his or her system. The USB device contains malicious software that may run automatically or with user interaction. The malicious software modifies and deletes the user's files, removing text from text files and entirely deleting any media files it finds. The software does not offer a recovery mechanism as ransomware might, aiming only to corrupt files.

5.3.2.2 Resolution

This build provides two main layers of defense against this scenario: Backups and Integrity baselining.

The **Integrity Monitoring** capability provides a baseline for file system activity as a point of comparison post-modification/deletion.

The **Logging** capability provides a baseline for events across the enterprise, including typical USB and file modification activity.

The **Backups** capability provides the ability to take backups of the file system, allowing restoration of files after the incident is resolved.

5.3.2.3 Other Considerations

A use case involving USBs is often best prevented through organizational training. In some cases, just the action of inserting the USB is enough to destroy an entire system on a physical level. Furthermore, not all malicious USBs will be simple file systems with auto-run malware on them—they can come disguised as keyboards or use lower-level attacks. Because of this, it is important for organizations to educate members on the dangers of unknown USB insertion, while also preparing if the attack occurs anyway.

5.3.3 Accidental VM Deletion via Maintenance Script

5.3.3.1 Scenario

The following scenario was simulated to test the architecture's defense against DI events that occur on virtual machines (VMs).

A routine maintenance script on the system causes an error. During a move operation in the Hyper-V system, the script deletes an important VM. A maintenance script with an error of this type could be a side effect of a normal system function or an error made by a member of the organization. The build is expected to mitigate the damage caused to VMs in such an incident.

5.3.3.2 Resolution

This build provides two main layers of defense against this scenario: Backups and Integrity baselining.

The **Integrity Monitoring** capability provides a baseline for virtual machine activity, as a point of comparison post-deletion.

The **Logging** capability provides a baseline for events across the enterprise, including typical Hyper-V activity.

The **Backups** capability enables backups of entire VMs. In the event of a deletion, these backups can be used to restore the VMs.

5.3.3.3 Other Considerations

The Backups capability can also be installed on individual VMs, given proper networking, to back up the contents of VMs if desired. This will likely depend on the needs of the organization.

5.3.4 Backdoor Creation via Email Vector

5.3.4.1 Scenario

The following scenario was simulated to test the architecture's defense against malicious email attachments.

A user unknowingly opens a malicious attachment they received in an email. When opened, the attachment quietly fetches files from an external web server. It then creates several unapproved backdoor accounts on the authentication server. The build is expected to mitigate the impacts of such an incident.

5.3.4.2 Resolution

The build provides several layers of defense against this use case. The **Integrity Monitoring** capability provides a baseline for Active Directory as a point of comparison against a compromised system. Furthermore, it also provides a baseline of the file system, to aid in identifying the malicious file during and after the attack has happened.

The **Logging** capability provides a baseline for activity across the enterprise, including the name of the account used to create the backdoors.

Lastly, the **Blacklisting** capability is used to prevent web requests to the malicious web server. This capability is informed by capabilities in the Respond Category of the Cybersecurity Framework.

5.3.4.3 Other Considerations

Note that for this scenario, prevention of the downloads before an attack happens requires organizations to know what web servers are "known bad." Organizations can acquire this knowledge in two ways: through threat-sharing services and through self-information as part of the Respond Category of the Cybersecurity Framework. The former refers to services that collect the names of malicious domains and share them with customers. The latter refers to the addition of known-bad websites to the blacklist after they are detected as malicious through the organization's own logs and analytics during or after an event. This build allows protecting against attacks given this knowledge, but the knowledge must be gained in some way first.

Another defense that can partially prevent this use case is simply blacklisting the sender of the phishing email or sorting it into spam. However, as this is typically a function of the email provider and not a separate security solution, it is out of scope for this build.

5.3.5 Database Modification via Malicious Insider

5.3.5.1 Scenario

The following scenario was simulated to test the architecture's defense against unwanted database modification.

A malicious insider has access to an enterprise database through a web page. The insider leverages a vulnerability in the web page to delete a large portion of the database. Though this scenario deals with a web vulnerability, other vulnerabilities could be used to modify the database undesirably. The build is expected to mitigate a user's potential impact on the database.

5.3.5.2 Resolution

This build provides two main layers of defense against this scenario: Backups and Integrity baselining.

The **Integrity Monitoring** capability provides a baseline for database activity as a point of comparison post-deletion.

The **Logging** capability provides a baseline for events across the enterprise, including typical database activity.

The **Backup** capability enables backups of the entire database. In the event of a deletion, these backups can be used to restore the database.

5.3.5.3 Other Considerations

Creating backups of the entire database may, in some cases, be undesirable, particularly for enterprises that heavily use the database. For these cases, we recommend built-in database backups. Microsoft Structured Query Language databases have built-in backups that can be more granular than a full database backup.

For many applications, though, a periodic backup of the entire database is sufficient and potentially can be used in tandem with built-in database backups.

5.3.6 File Modification via Malicious Insider

5.3.6.1 Scenario

The following scenario was simulated to test the architecture's defense against malicious file and backup modification.

A malicious insider is assumed to have stolen administrator-level credentials through nontechnical means. The insider, using these credentials, uses remote Windows PowerShell sessions to uniformly modify employee stock information across several machines, to the insider's benefit. This attack will also target the enterprise's backups system, to modify all records of the previous stock information. The aspects of the build described above are expected to mitigate the ability of the user to target and modify enterprise data and backups. The method of securing administrator credentials will be considered out of scope for this solution.

5.3.6.2 Resolution

The build provides several layers of defense against this use case. Because this use case specifically targets the backups, the solution includes mechanisms for protecting and monitoring the backups.

The **Inventory** capability is used to identify potentially sensitive information across the enterprise.

The **Integrity Monitoring** capability is used to baseline file activity, both for backups and for organizational files.

This information is forwarded to the **Logging** capability for analysis.

The **Backups** capability is used to take encrypted backups of the file system, preventing targeted attacks against information in the backups.

The **Secure Storage** capability is used to prevent write-access to the backups once taken, allowing a guarantee of modification/deletion protection for backups stored on the disk.

5.3.6.3 Other Considerations

A significant trade-off between memory and frequency of backups occurs when implementing a secure storage solution for backups. As WORM space may be limited by the number of disks purchased or by a cloud service's limitations, it is important for organizations to consider the cost of storing all backups in secure storage, especially for organizations that frequently take backups to reduce the loss of data.

5.3.7 Backdoor Creation via Compromised Update Server

5.3.7.1 Scenario

The following scenario was simulated to test the architecture's defense against compromised update servers.

An update server that services an enterprise machine is compromised and provides an update to the enterprise machine that contains a backdoor. The update contains a vulnerable version of vsftpd, allowing a malicious actor root access into the machine updated by the compromised server. The build is expected to mitigate the impact of a compromised update server.

5.3.7.2 Resolution

The build provides several layers of defense against this use case. The **Integrity Monitoring** capability is used to baseline the integrity of both files and programs, as an intrusion via compromised update server can potentially affect both. This aids in early detection and recovery.

The **Backups** capability is used to back up the file system, to preemptively mitigate the damage done by the intrusion.

The **Blacklisting** capability is used to blacklist the compromised update server, to prevent use of the update server by other machines.

5.3.7.3 Other Considerations

To prevent updates through Blacklisting, organizations should either use their blacklisting capability as a transparent proxy or ensure that the update mechanism uses the proxy; the process for configuring this will differ between update mechanisms. The Blacklisting and Network Protection capabilities are especially important in the event of a breach, as these two can help prevent the spread of the intrusion.

5.3.8 New Employee

5.3.8.1 Scenario

The following scenario was simulated to test the architecture's identification capabilities with respect to machines and vulnerabilities.

A new employee joins the organization and connects his or her machine to the network. The machine, however, is not up-to-date on its patches and poses a security risk to the organization. The build is expected to be able to identify the machine and its noncompliance with organizational maintenance policy.

5.3.8.2 Resolution

The build provides several layers of defense against this use case. The **Inventory** capability provides logs and information about newly connected machines, including operating system, MAC address, IP address, and date of login. It also generates logs for the **Logging** capability to collect and use for comparison against a baseline in the event of an incident.

The **Policy Enforcement** capability provides the ability to grant or deny network access based on the machine's posture—essentially, this verifies existence of security software and machine update status before the machine is ever allowed to use the network.

Lastly, the **Vulnerability Management** capability detects and keeps track of vulnerabilities on the newly discovered machine, allowing better understanding of the machine's vulnerabilities before and after it is allowed onto the network.

5.3.8.3 Other Considerations

Though this use case primarily targets desktops, similar considerations should be taken for enterprises that aim to include employee-owned mobile devices. These devices should be inventoried and scanned for relevant security posture, before being allowed to join the network.

6 Future Build Considerations

The NCCoE is creating an overarching guide to combining the architectures of the various DI projects: Identify and Protect, Detect and Respond, and Recover. These architectures have some commonalities, such as integrity monitoring, as well as some potential integrations and cycles that could not be expressed in just one of the practice guides. The different functions of the Cybersecurity Framework are intended to prepare and inform one another, and the overarching guide addresses those issues.

The NCCoE is also considering additional data security projects that map to the Cybersecurity Framework Core Functions of Identify, Protect, Detect, Respond, and Recover. These projects will focus on data confidentiality—the defense of enterprise systems from attacks that would compromise the secrecy of data.

Appendix A List of Acronyms

COI	community of interest
DI	data integrity
DSP	Directory Services Protector
ESM	Enterprise Security Manager
IT	Information Technology
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
NCCoE	National Cybersecurity Center of Excellence
NIST	National Institute of Standards and Technology
NIST IR	NIST Interagency Report
RMF	Risk Management Framework
SP	Special Publication
TLC	Tripwire Log Center
USB	Universal Serial Bus
VM	Virtual Machine
vsftpd	Very Secure File Transfer Protocol Daemon
WORM	Write Once Read Many
WSA	Web Security Appliance

Appendix B Glossary

Access Control	The process of granting or denying specific requests to: 1) obtain and use information and related information processing services; and 2) enter specific physical facilities (e.g., federal buildings, military establishments, border crossing entrances) SOURCE: Federal Information Processing Standard (FIPS) 201; CNSSI-4009
Architecture	A highly structured specification of an acceptable approach within a framework for solving a specific problem. An architecture contains descriptions of all the components of a selected, acceptable solution while allowing certain details of specific components to be variable to satisfy related constraints (e.g., costs, local environment, user acceptability). SOURCE: FIPS 201-2
Audit	Independent review and examination of records and activities to assess the adequacy of system controls and ensure compliance with established policies and operational procedures SOURCE: CNSSI 4009-2015
Backdoor	An undocumented way of gaining access to a computer system. A backdoor is a potential security risk. SOURCE: National Institute of Standards and Technology (NIST) Special Publication (SP) 800-82 Rev. 2
Backup	A copy of files and programs made to facilitate recovery if necessary SOURCE: NIST SP 800-34 Rev. 1
Compromise	Disclosure of information to unauthorized persons, or a violation of the security policy of a system in which unauthorized intentional or unintentional disclosure, modification, destruction, or loss of an object may have occurred SOURCE: NIST SP 800-32

Continuous Monitoring	Maintaining ongoing awareness to support organizational risk decisions SOURCE: NIST SP 800-137
Cybersecurity	Prevention of damage to, protection of, and restoration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communication, including information contained therein, to ensure its availability, integrity, authentication, confidentiality, and nonrepudiation SOURCE: CNSSI 4009-2015 (NSPD-54/HSPD-23)
Data	A subset of information in an electronic format that allows it to be retrieved or transmitted SOURCE: CNSSI-4009
Data Integrity	The property that data has not been changed, destroyed, or lost in an unauthorized or accidental manner SOURCE: CNSSI-4009
Information Security	The protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide confidentiality, integrity, and availability SOURCE: FIPS 199 (44 U.S.C., Sec. 3542)
Information Security Risk	The risk to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation due to the potential for unauthorized access, use, disclosure, disruption, modification, or destruction of information and/or information systems SOURCE: CNSSI 4009-2015 (NIST SP 800-30 Rev. 1)
Information System	A discrete set of information resources organized for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information SOURCE: FIPS 200 (44 U.S.C., Sec. 3502)
Insider	An entity inside the security perimeter that is authorized to access system resources but uses them in a way not approved by those who granted the authorization

	SOURCE: NIST SP 800-82 Rev. 2 (RFC 4949)
Kerberos	An authentication system developed at the Massachusetts Institute of Technology (MIT). Kerberos is designed to enable two parties to exchange private information across a public network. SOURCE: NIST SP 800-47
Log	A record of the events occurring within an organization's systems and networks SOURCE: NIST SP 800-92
Malware	A program that is inserted into a system, usually covertly, with the intent of compromising the confidentiality, integrity, or availability of the victim's data, applications, or operating system SOURCE: NIST SP 800-111
Privacy	Assurance that the confidentiality of, and access to, certain information about an entity is protected SOURCE: NIST SP 800-130
Risk	The level of impact on organizational operations (including mission, functions, image, or reputation), organizational assets, or individuals resulting from the operation of an information system given the potential impact of a threat and the likelihood of that threat occurring SOURCE: FIPS 200
Risk Assessment	The process of identifying the risks to system security and determining the probability of occurrence, the resulting impact, and additional safeguards that would mitigate this impact. Part of Risk Management and synonymous with Risk Analysis SOURCE: NIST SP 800-63-2
Risk Management Framework	The Risk Management Framework (RMF), presented in NIST SP 800-37, provides a disciplined and structured process that integrates information security and risk management activities into the system development life cycle. SOURCE: NIST SP 800-82 Rev. 2 (NIST SP 800-37)

Security Control	A protection measure for a system SOURCE: NIST SP 800-123
Virtual Machine	Software that allows a single host to run one or more guest operating systems SOURCE: NIST SP 800-115
Vulnerability	Weakness in an information system, system security procedures, internal controls, or implementation that could be exploited or triggered by a threat source SOURCE: FIPS 200 (Adapted adapted from CNSSI 4009)

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Appendix D Functional Evaluation

A functional evaluation of the data integrity (DI) example implementation, as constructed in our laboratory, was conducted to verify that it meets its objective of identifying assets and vulnerabilities within the enterprise. Furthermore, the project aims to protect these assets prior to an attack. The evaluation verified that the example implementation could perform the following functions:

- discover assets on the network
- discover and mitigate vulnerabilities in assets on the network
- protect data from modification prior to an attack
- provide a baseline for daily activity and asset integrity

Section D.1 describes the format and components of the functional test cases. Each functional test case is designed to assess the capability of the example implementation to perform the functions listed above and detailed in Section D.1.

D.1 Data Integrity Functional Test Plan

One aspect of our security evaluation involved assessing how well the reference design addresses the security characteristics it was intended to support. The Cybersecurity Framework Subcategories were used to provide structure to the security assessment by consulting the specific sections of each standard that are cited in reference to that Subcategory. The cited sections provide validation points that the example solution is expected to exhibit. Using the Cybersecurity Framework Subcategories as a basis for organizing our analysis allowed us to systematically consider how well the reference design supports the intended security characteristics.

This plan includes the test cases necessary to conduct the functional evaluation of the DI example implementation, which is currently deployed in a lab at the National Cybersecurity Center of Excellence. The implementation tested is described in Section 4.

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 describes 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. Specifies the capability to be evaluated.

Test Case Field	Description
Description	Describes the objective of the test case
Associated Cybersecurity Framework Subcategories	Lists the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-53 Rev. 4 controls addressed by the test case
Preconditions	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.
Procedure	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 expected results for each variation in the test procedure
Actual results	The observed results
Overall result	The overall result of the test as pass/fail. In some test cases, determination of the overall result may be more involved, such as determining pass/fail based on a percentage of errors identified.

D.2 Data Integrity Use Case Requirements

Table 6-2 identifies the DI functional requirements addressed in the test plan and associated test cases.

Table 6-2 Capability Requirements

Capability Requirement (CR) ID	Parent Requirement	Sub requirement 1	Test Case
CR 1	The DI example implementation shall identify and protect assets against malware that encrypts files and displays notice demanding payment.		
CR 1.a		Vulnerability in Active Directory server is identified.	Data Integrity IP-1
CR 1.b		User is blocked from visiting malicious site.	Data Integrity IP-1

Capability Requirement (CR) ID	Parent Requirement	Sub requirement 1	Test Case
CR 1.c		Downloads from site are blocked.	Data Integrity IP-1
CR 1.d		Vulnerability is patched.	Data Integrity IP-1
CR 1.e		Ransomware cannot send information to home server.	Data Integrity IP-1
CR 1.f		Backups are taken.	Data Integrity IP-1
CR 1.g		File integrity information is baselined.	Data Integrity IP-1
CR 2	The DI example implementation shall identify and protect assets against malware inserted via Universal Serial Bus (USB) that modifies and deletes user data.		Data Integrity IP-2
CR 2.a		Backups are taken.	Data Integrity IP-2
CR 2.b		File integrity information is baselined.	Data Integrity IP-2
CR 3	The DI example shall identify and protect virtual machines against deletion.		Data Integrity IP-3
CR 3.a		Backups of virtual machines are taken.	Data Integrity IP-3
CR 4	The DI example implementation shall identify and protect assets against malware received via phishing email.		Data Integrity IP-4

Capability Requirement (CR) ID	Parent Requirement	Sub requirement 1	Test Case
CR 4.a		Downloads from the spreadsheet are blocked.	Data Integrity IP-4
CR 4.b		Backups of configurations are taken.	Data Integrity IP-4
CR 4.c		Configuration integrity information is baselined.	Data Integrity IP-4
CR 5	The DI example implementation shall identify and protect the database against changes made through a web server vulnerability in custom code.		Data Integrity IP-5
CR 5.a		Vulnerability is identified.	Data Integrity IP-5
CR 5.b		Vulnerability is resolved.	Data Integrity IP-5
CR 5.c		Backups of database are taken.	Data Integrity IP-5
CR 5.d		Database integrity information is baselined.	Data Integrity IP-5
CR 6	The DI example implementation shall identify and protect assets against targeted modification by malicious insiders with elevated privileges.		Data Integrity IP-6
CR 6.a		Backups are taken.	Data Integrity IP-6
CR 6.b		File integrity information is baselined.	Data Integrity IP-6

Capability Requirement (CR) ID	Parent Requirement	Sub requirement 1	Test Case
CR 6.c		Backups are encrypted.	Data Integrity IP-6
CR 6.d		Backups are stored securely.	Data Integrity IP-6
CR 7	The DI example implementation shall identify and protect assets against an intrusion via compromised update server.		Data Integrity IP-7
CR 7.a		Downloads from site are temporarily blocked.	Data Integrity IP-7
CR 7.b		Backups are taken.	Data Integrity IP-7
CR 7.c		Program integrity information is baselined.	Data Integrity IP-7
CR 7.d		File integrity information is baselined.	Data Integrity IP-7
CR 8	The DI example implementation shall identify new and unmaintained assets on the network.		Data Integrity IP-8
CR 8.a		Machines that are new to the network are identified.	Data Integrity IP-8
CR 8.b		Machines that are not up-to-date are identified.	Data Integrity IP-8

D.3 Test Case: Data Integrity IP-1

Table 6-3 Test Case ID: Data Integrity IP-1

Parent requirement	(CR 1) The DI example implementation shall identify and protect assets against malware that encrypts files and displays notice demanding payment.
Testable requirement	(CR 1.a) Vulnerability identification, (CR 1.b, 1.c, 1.e) Blacklisting, (CR 1.d) Maintenance, (CR 1.f) Backups, (CR 1.g) Integrity Baselining
Description	Show that the DI solution can identify and resolve vulnerabilities and protect against ransomware.
Associated Cybersecurity Framework Subcategories	ID.AM-1, ID.AM-2, ID.RA-1, ID.RA-2, ID.RA-6, DE.CM-8, PR.IP-12, RS.MI-3, PR.IP-4, PR.DS-1, PR.DS-6, PR.PT-1, PR.MA-2
Preconditions	User navigates to a malicious website and clicks on an ad for a virus cleaner. The virus cleaner is actually ransomware, which propagates across the domain and encrypts user files.
Procedure	The **Blacklisting** capability is used to prevent access to and downloads from known malicious sites. The **Inventory** capability is used to identify organizational assets and devices. The **Network Protection** capability is used to prevent the propagation of ransomware across the enterprise. The **Vulnerability Management** capability is used to identify vulnerabilities that allow malware to propagate. The **Integrity Monitoring** and **Logging** collect integrity information and baseline the file system. The **Backups** capability is used to take backups of the file system.
Expected Results (pass)	The vulnerability that allows the ransomware to propagate is identified (CR 1.a). The user cannot access the site when it is blocked (CR 1.b).

	The user cannot download the ransomware from the site when it is blocked (CR 1.c). The build can identify (and possibly execute) a fix for the vulnerability. When the fix is made, the ransomware is unable to propagate (CR 1.d). The ransomware is unable to communicate with its home server when the site is blocked (CR 1.e). The build can take backups of file systems (CR 1.f). The build can take and log integrity baselines of file systems (CR 1.g).
Actual Results	**Cisco WSA (Blacklisting)** stops the user from accessing the site when it is blocked. **Cisco ISE (Inventory)** is used to identify devices on the network. **Symantec DLP (Inventory)** is used to identify organizational data assets on monitored machines. **CryptoniteNXT (Network Protection)** prevents propagation of ransomware through a white list of allowed communications in the enterprise. **Tripwire IP360 (Vulnerability Management)** detects vulnerabilities in Active Directory that allow ransomware to propagate. **Tripwire Enterprise (Integrity Monitoring)** and **ArcSight ESM (Logging)** baseline critical data assets across the enterprise. **Duplicati** and **FileZilla (Backups)** create backups of organizational data as a contingency, should ransomware be able to affect any systems.
Overall Result	Pass. All requirements for this use case are met.

D.4 Test Case: Data Integrity IP-2

Table 6-4 Test Case ID: Data Integrity IP-2

Parent requirement	(CR 2) The DI example implementation shall identify and protect assets against malware inserted via USB that modifies and deletes user data.

Testable requirement	(CR 2.a) Backups, (CR 2.b) Integrity Baselining
Description	Show that the DI solution can preemptively protect against destructive malware.
Associated Cybersecurity Framework Subcategories	PR.IP-4, PR.DS-1, PR.DS-6, PR.PT-1
Preconditions	A user inserts an unidentified USB drive into their computer. They click on a file on the drive, which immediately destroys any files on their machine.
Procedure	**Backups** schedules and creates backups of the user's documents. The **Integrity Monitoring** capability is used to take integrity baselines of the file system. **Logging** collects logs and baselines system activity.
Expected Results (pass)	The build can take backups of file systems (CR 2.a). The build can take and log integrity baselines of file systems (CR 2.b).
Actual Results	**Duplicati** and **FileZilla (Backups)** are used to take and store backups of the user's documents. **Tripwire Enterprise (Integrity Monitoring)** is used to take an integrity baseline of the user's file system prior to the malicious USB drive being inserted into the computer. **ArcSight ESM (Logging)** takes a baseline of system activity prior to the USB drive being inserted into the computer.
Overall Result	Pass. All requirements for this use case are met.

D.5 Test Case: Data Integrity IP-3

Table 6-5 Test Case ID: Data Integrity IP-3

Parent requirement	(CR 3) The DI example implementation shall identify and protect virtual machines against deletion.
Testable requirement	(CR 3.a) Backups
Description	Show that the DI solution can preemptively protect against data integrity events that involve virtual machines (VMs).

Associated Cybersecurity Framework Subcategories	PR.IP-4, PR.DS-1
Preconditions	A routine maintenance script contains an error that accidentally deletes a VM.
Procedure	The **Backups** capability is used to schedule and create backups of a VM.
Expected Results (pass)	The build can take backups of VMs (CR 3.a).
Actual Results	**Duplicati** and **FileZilla (Backups)** take and store backups of VMs.
Overall Result	Pass. All requirements for this use case are met.

D.6 Test Case: Data Integrity IP-4

Table 6-6 Test Case ID: Data Integrity IP-4

Parent requirement	(CR 4) The DI example implementation shall identify and protect against malware received via phishing email.
Testable requirement	(CR 4.a, CR 4.b) Blacklisting, (CR 4.c) Backups, (CR 4.d) Integrity Baselining
Description	Show that the DI solution can identify phishing emails and protect against configuration changes made by malicious attachments.
Associated Cybersecurity Framework Subcategories	ID.AM-2, ID.AM-3, ID. RA-1, ID.RA-2, ID.RA-5, DE.CM-8, PR.IP-4, PR.DS-1, PR.PT-1
Preconditions	The user receives a phishing email with a malicious attached spreadsheet. The spreadsheet is downloaded and opened, causing account changes in Active Directory.
Procedure	The **Integrity Monitoring** capability is used to baseline Active Directory activity. This information is forwarded to the **Logging** capability, along with other available Active Directory information. The **Backups** capability is used to take backups of the Active Directory configuration.

	The malicious web server is added to the **Blacklisting** capability to prevent downloads.
Expected Results (pass)	The spreadsheet cannot download files (CR 4.a). The build can take backups of configurations (CR 4.c). The build can take and log integrity baselines of configurations (CR 4.d).
Actual Results	**Semperis DSP (Integrity Monitoring)** successfully baselines Active Directory activity. **ArcSight ESM (Logging)** successfully logs activity from Active Directory, including log-ons and changes. When the external web server is added to the blacklist, **Cisco WSA (Blacklisting)** prevents the Excel sheet from downloading malicious files. **Semperis ADFR (backups)** is used to successfully take backups of the Active Directory configuration.
Overall Result	Pass. All requirements for this use case are met.

D.7 Test Case: Data Integrity IP-5

Table 6-7 Test Case ID: Data Integrity IP-5

Parent requirement	(CR 5) The DI example implementation shall identify and protect the database against changes made through a web server vulnerability in custom code.
Testable requirement	(CR 5.c) Backups, (CR 5.d) Integrity Baselining
Description	Show that the DI solution can protect the database against a vulnerability in the custom code of a web server.
Associated Cybersecurity Framework Subcategories	PR.IP-4, PR.DS-1, PR.PT-1, PR.DS-6
Preconditions	A vulnerability in the source code of an intranet webpage is discovered by a malicious insider. The insider exploits this vulnerability to delete significant portions of the database.
Procedure	The **Backups** capability is used to take backups of the database.

	The **Integrity Monitoring** and **Logging** capabilities take baselines of the database, for comparison post-modification.
Expected Results (pass)	The build can take backups of the database (CR 5.c). The build can take and log integrity baselines of the database (CR 5.d).
Actual Results	**Duplicati** and **FileZilla (Backups)** successfully backs up the database. **Tripwire Enterprise (Integrity Monitoring)** successfully detects changes in the database. **ArcSight ESM (Logging)** successfully logs changes to the database.
Overall Result	Pass. All requirements for this use case are met.

D.8 Test Case: Data Integrity IP-6

Table 6-8 Test Case ID: Data Integrity IP-6

Parent requirement	(CR 6) The DI example implementation shall identify and protect assets against targeted modification by malicious insiders with elevated privileges.
Testable requirement	(CR 6.a) Backups, (CR 6.b) Integrity Baselining, (CR 6.c) Encrypted backups, (CR 6.d) Secure Storage
Description	Show that the DI solution can protect assets and backups against targeted modification by malicious insiders.
Associated Cybersecurity Framework Subcategories	PR.IP-4, PR.DS-1, PR.PT-1, PR.DS-6
Preconditions	A malicious insider attempts to modify targeted information in both the enterprise systems and the backup systems, using elevated credentials obtained extraneously.
Procedure	The **Inventory** capability is used to identify data assets. The **Backups** capability provides encrypted backups. **Secure Storage** prevents modification or deletion of backups. **Integrity Monitoring** and **Logging** collect integrity information and baseline the file system.

Expected Results (pass)	The build can take backups of the file system (CR 6.a). The build can take and log integrity baselines of the file system (CR 6.b). Backups are encrypted (CR 6.c). Backups are stored securely and cannot be modified or deleted (CR 6.d).
Actual Results	**Symantec DLP (Inventory)** identifies critical data assets across the enterprise. **Duplicati** and **FileZilla (Backups)** provide encrypted backups of the file system. **GreenTec WORMdisks (Secure Storage)** provide write-protection for backups, preventing them from being modified or deleted. **Tripwire Enterprise (Integrity Monitoring)** and **ArcSight ESM (Logging)** baseline critical data assets across the enterprise.
Overall Result	Pass. All requirements of this use case are met.

D.9 Test Case: Data Integrity IP-7

Table 6-9 Test Case ID: Data Integrity IP-7

Parent requirement	(CR 7) The DI example implementation shall identify and protect assets against an intrusion via compromised update server.
Testable requirement	(CR 7.a) Blacklisting, (CR 7.b) Backups, (CR 7.c, 7.d) Integrity Baselining
Description	Show that the DI solution can protect against compromised update server as well as intrusion made possible by vulnerable programs.
Associated Cybersecurity Framework Subcategories	ID.RA-1, ID.RA-2, ID.RA-5, DE.CM-8, PR.IP-12, RS.MI-3, PR.IP-4, PR.DS-1, PR.PT-1, PR.DS-6, PR.MA-2
Preconditions	An external update server has been compromised, and a user workstation attempts to update from this server.
Procedure	**Integrity Monitoring** capability is used to take baselines of the integrity of both the programs and the file systems. The **Backups** capability is used to back up the file system.

	The **Blacklisting** capability is used to prevent communication between the update server and the machine.
Expected Results (pass)	Machines cannot update from this site while it is blacklisted (CR 7.a). The build can take backups of file systems (CR 7.b). The build can take integrity baselines of programs (CR 7.c). The build can take integrity baselines of file systems (CR 7.d).
Actual Results	**Tripwire Enterprise (Integrity Monitoring)** successfully takes an integrity baseline of both programs and files. **Duplicati** and **FileZilla (Backups)** successfully takes backups of the file system. **Cisco WSA (Blacklisting)** successfully prevents communication between the update server and workstations.
Overall Result	Pass. All requirements for this use case are met.

D.10 Test Case: Data Integrity IP-8

Table 6-10 Test Case ID: Data Integrity IP-8

Parent requirement	(CR 8) The DI example implementation shall identify new and unmaintained assets on the network.
Testable requirement	(CR 8.a) Asset Identification, (CR 8.b) Vulnerability Identification
Description	Show that the DI solution can identify machines new to the network, as well as unpatched machines.
Associated Cybersecurity Framework Subcategories	ID.AM-1, ID.AM-2, ID.RA-1, ID.RA-2, ID.RA-5, DE.CM-8
Preconditions	A new machine with several critical patches missing is connected to the network for the first time.
Procedure	The **Inventory** capability is used to identify various aspects about the machine.

	The **Policy Enforcement** identifies the existence of security solutions on the machine and grants/denies access to the network, based on their presence. The **Vulnerability Management** capability is used to scan for vulnerabilities on the new machine.
Expected Results (pass)	New machine is identified on the network (CR 8.a). New machine is identified as unmaintained, and required fixes are identified (CR 8.b).
Actual Results	**Cisco ISE (Inventory)** successfully logs information about new connections, including the user, date, device, and network information. **Cisco ISE (Policy Enforcement)** successfully prevents the new machine without 50 security software from connecting to the network. **Tripwire IP360 (Vulnerability Management)** successfully identifies vulnerabilities on the new machine.
Overall Result	Pass. All requirements for this use case are met.

NIST SPECIAL PUBLICATION 1800-25C

Data Integrity

Identifying and Protecting Assets Against Ransomware and Other Destructive Events

Volume C:
How-To Guides

Jennifer Cawthra
National Cybersecurity Center of Excellence
NIST

Michael Ekstrom
Lauren Lusty
Julian Sexton
John Sweetnam
The MITRE Corporation
McLean, Virginia

January 2020

DRAFT

This publication is available free of charge from https://www.nccoe.nist.gov/projects/building-blocks/data-integrity/identify-protect.

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National Institute of Standards and Technology Special Publication 1800-25C, Natl. Inst. Stand. Technol. Spec. Publ. 1800-25C, 487 pages, (January 2020), CODEN: NSPUE2

FEEDBACK

You can improve this guide by contributing feedback. As you review and adopt this solution for your own organization, we ask you and your colleagues to share your experience and advice with us.

Comments on this publication may be submitted to: ds-nccoe@nist.gov.

Public comment period: January 27, 2020 through February 25, 2020

All comments are subject to release under the Freedom of Information Act.

National Cybersecurity Center of Excellence
National Institute of Standards and Technology
100 Bureau Drive
Mailstop 2002
Gaithersburg, MD 20899
Email: nccoe@nist.gov

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 information technology 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 Cybersecurity Framework and details the steps needed for another entity to re-create the example solution. The NCCoE was established in 2012 by NIST in partnership with the State of Maryland and Montgomery County, Maryland.

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

NIST CYBERSECURITY PRACTICE GUIDES

NIST Cybersecurity Practice Guides (Special Publication 1800 series) 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

Ransomware, destructive malware, insider threats, and even honest user mistakes present ongoing threats to organizations. Organizations' data, such as database records, system files, configurations, user files, applications, and customer data, are all potential targets of data corruption, modification, and destruction. Formulating a defense against these threats requires two things: a thorough knowledge of the assets within the enterprise, and the protection of these assets against the threat of data corruption and destruction. The NCCoE, in collaboration with members of the business community and vendors of cybersecurity solutions, has built an example solution to address these data integrity challenges.

Multiple systems need to work together to identify and protect an organization's assets against the threat of corruption, modification, and destruction. This project explores methods to effectively identify assets (devices, data, and applications) that may become targets of data integrity attacks, as well as the vulnerabilities in the organization's system that facilitate these attacks. It also explores methods to protect these assets against data integrity attacks using backups, secure storage, integrity checking mechanisms, audit logs, vulnerability management, maintenance, and other potential solutions

KEYWORDS

attack vector; asset awareness; data integrity; data protection; malicious actor; malware; ransomware.

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Darren Mar-Elia	Semperis
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Mickey Bresman	Semperis
Jim Wachhaus	Tripwire
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Jon Christmas	Symantec Corporation
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Chelsea Deane	The MITRE Corporation
Sallie Edwards	The MITRE Corporation
Milissa McGinnis	The MITRE Corporation
Karri Meldorf	The MITRE Corporation
Denise Schiavone	The MITRE Corporation

Name	Organization
Anne Townsend	The MITRE Corporation

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
Symantec Corporation	Symantec Data Loss Prevention v15.1
Cisco Systems	Cisco ISE v2.4, Cisco Web Security Appliance v10.1
GreenTec USA	GreenTec WORMdisk v151228
Tripwire	Tripwire Log Center v7.3.1, Tripwire Enterprise v8.7, Tripwire IP360 v9.0.1
Micro Focus	Micro Focus ArcSight Enterprise Security Manager v7.0 Patch 2
Cryptonite	CryptoniteNXT v2.9.1
Semperis	Semperis Active Directory Forest Recovery v2.5, Semperis Directory Services Protector v2.7

Contents

1 Introduction

The following volumes of this guide 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 re-create the product manufacturers' documentation, which is presumed to be widely available. Rather, these volumes 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 How to Use this Guide

This National Institute of Standards and Technology (NIST) Cybersecurity Practice Guide demonstrates a standards-based reference design and provides users with the information they need to replicate the data integrity identify-and protect-solution. This reference design is modular and can be deployed in whole or in part.

This guide contains three volumes:

- NIST SP 1800-25A: *Executive Summary*
- NIST SP 1800-25B: *Approach, Architecture, and Security Characteristics* – what we built and why
- NIST SP 1800-25C: *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:

Business decision makers, including chief security and technology officers, will be interested in the *Executive Summary* (NIST SP 1800-25A), which describes the following topics:

- challenges that enterprises face in identifying assets and protecting them from data integrity events
- 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 NIST SP 1800-25B, which describes what we did and why. The following sections will be of particular interest:

- Section 3.4.1, Assessing Risk Posture, provides a description of the risk analysis we performed.
- Section 3.4.2, 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 1800-25A*,* with your leadership team members to help them understand the importance of adopting standards-based data integrity solutions.

IT professionals who want to implement an approach like this will find the whole practice guide useful. You can use this How-To portion of the guide, NIST SP 1800-25C, to replicate all or parts of the build created in our lab. This How-To portion of the 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 data integrity identify-and-protect solution. Your organization's security experts should identify the products that will best integrate with your existing tools and IT system infrastructure. We hope that you will seek products that are congruent with applicable standards and best practices. Section 3.5 of Volume B, Technologies, lists the products we used and maps them to the cybersecurity controls provided by this reference solution.

A NIST Cybersecurity Practice Guide does not describe "the" solution, but a possible solution. This is a draft guide. We seek feedback on its contents and welcome your input. Comments, suggestions, and success stories will improve subsequent versions of this guide. Please contribute your thoughts to ds-nccoe@nist.gov.

1.2 Build Overview

The National Cybersecurity Center of Excellence (NCCoE) built a hybrid virtual-physical laboratory environment to explore methods to effectively identify assets and protect them against a data corruption event in various IT enterprise environments. The NCCoE also explored identifying vulnerabilities in advance of an incident. The servers in the virtual environment were built to the hardware specifications of their specific software components.

The NCCoE worked with members of the Data Integrity Community of Interest to develop a diverse but noncomprehensive set of use case scenarios against which to test the reference implementation. These are detailed in Volume B, Section 5.2. For a detailed description of our architecture, see Volume B, Section 4.

Typographic Conventions

The following table presents typographic conventions used in this volume.

Typeface/Symbol	Meaning	Example
Italics	file names and pathnames; references to documents that are not hyperlinks; new terms; and placeholders	For language use and style guidance, see the *NCCoE Style Guide.*
Bold	names of menus, options, command buttons, and fields	Choose **File > Edit.**
`Monospace`	command-line input, on-screen computer output, sample code examples, and status codes	`mkdir`
`Monospace Bold`	command-line user input contrasted with computer output	**`service sshd start`**
blue text	link to other parts of the document, a web URL, or an email address	All publications from NIST's NCCoE are available at https://nccoe.nist.gov.

2 Product Installation Guides

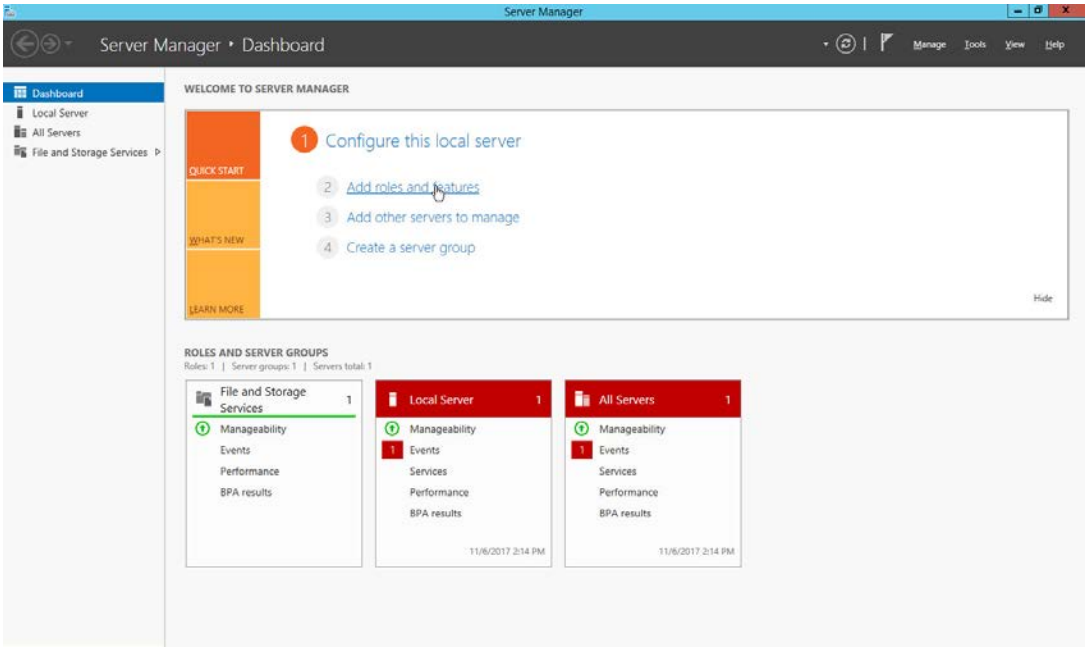
This section of the practice guide contains detailed instructions for installing and configuring all of the products used to build an instance of the example solution.

2.1 Active Directory and Domain Name System (DNS Server)

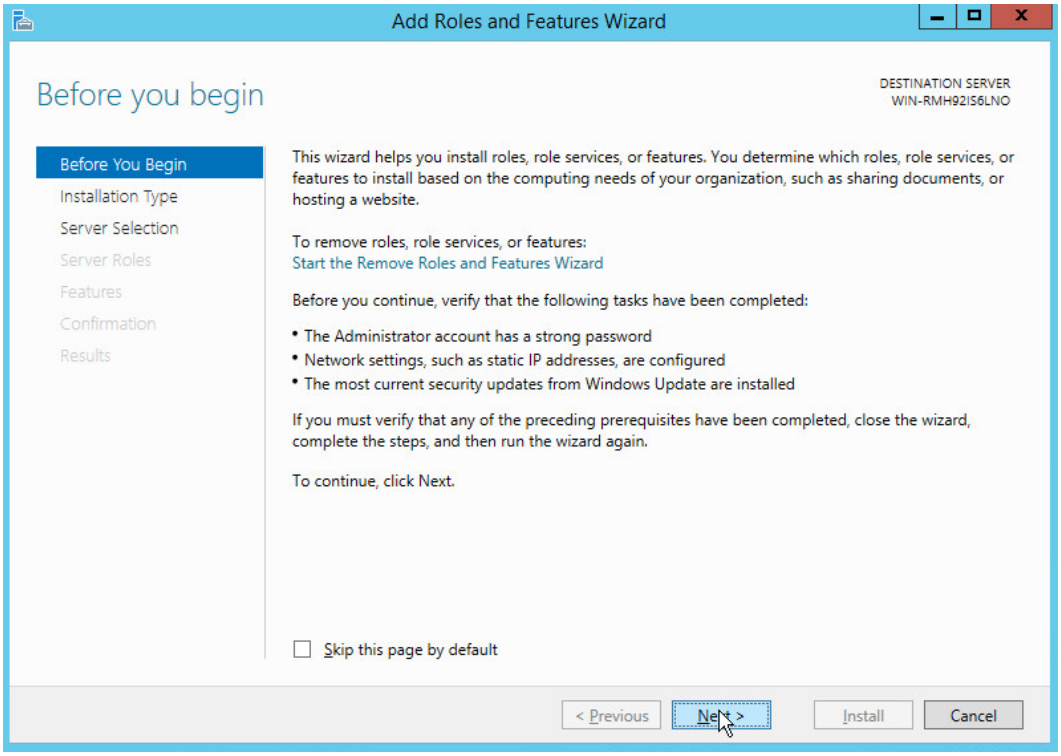
As part of our enterprise emulation, we included an Active Directory server that doubles as a DNS server. This section covers the installation and configuration process used to set up Active Directory and DNS on a Windows Server 2012 R2 machine.

2.1.1 Installing Features

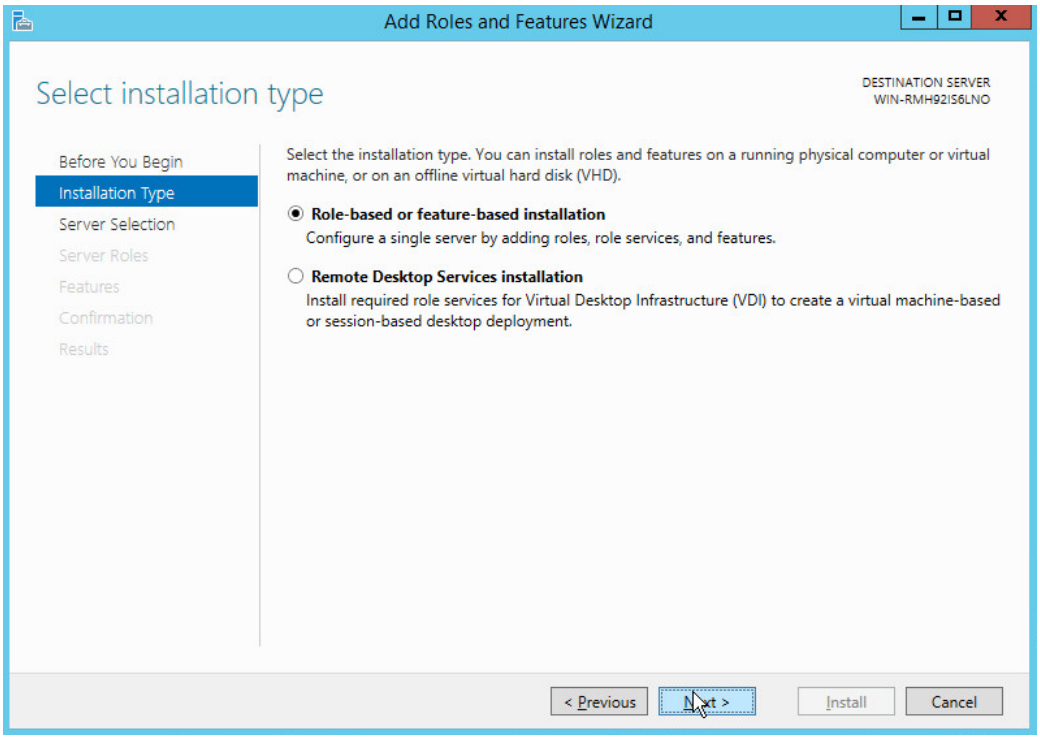
1. Open **Server Manager.**



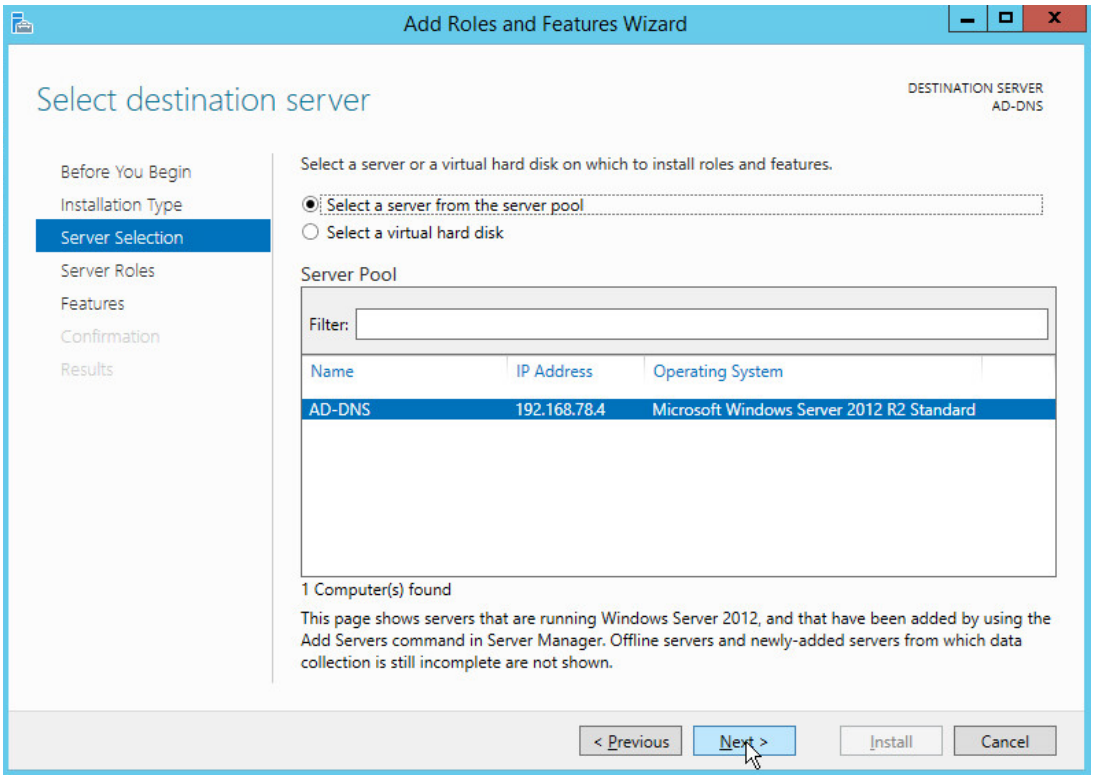
2. Click the link **Add roles and features.**



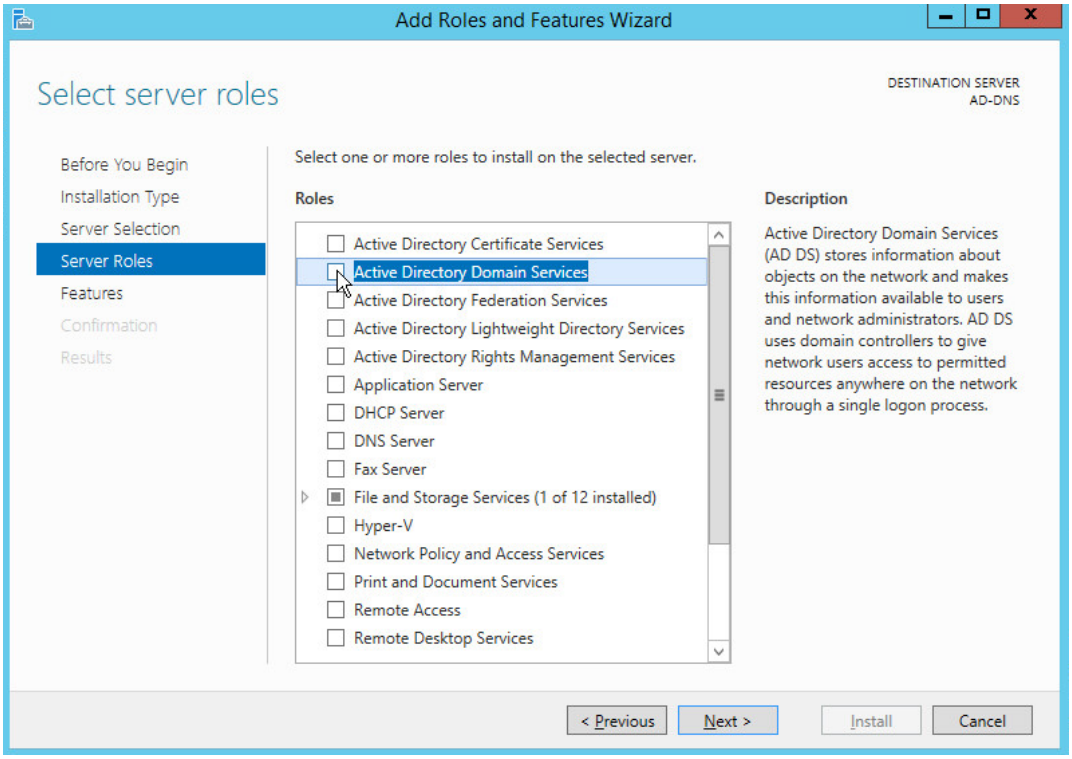
3. Click **Next.**
4. Select **Role-based or feature-based installation.**



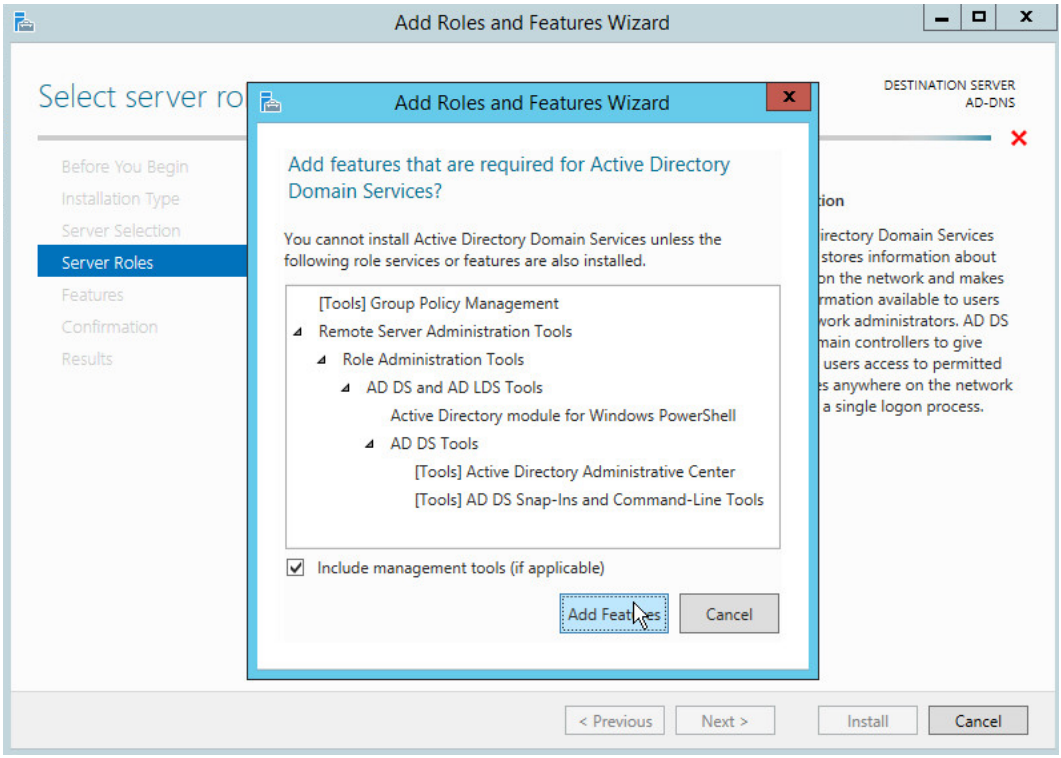
5. Click **Next.**
6. Select **Select a server from the server pool.**
7. Select the intended Active Directory server.


Add Roles and Features Wizard
Select destination server
DESTINATION SERVER
AD-DNS
Before You Begin
Installation Type
Server Selection
Server Roles
Features
Confirmation
Results
Select a server or a virtual hard disk on which to install roles and features.
Select a server from the server pool
Select a virtual hard disk
Server Pool
Filter:
Name
IP Address
Operating System
AD-DNS
192.168.78.4
Microsoft Windows Server 2012 R2 Standard
1 Computer(s) found
This page shows servers that are running Windows Server 2012, and that have been added by using the Add Servers command in Server Manager. Offline servers and newly-added servers from which data collection is still incomplete are not shown.
< Previous
Next >
Install
Cancel

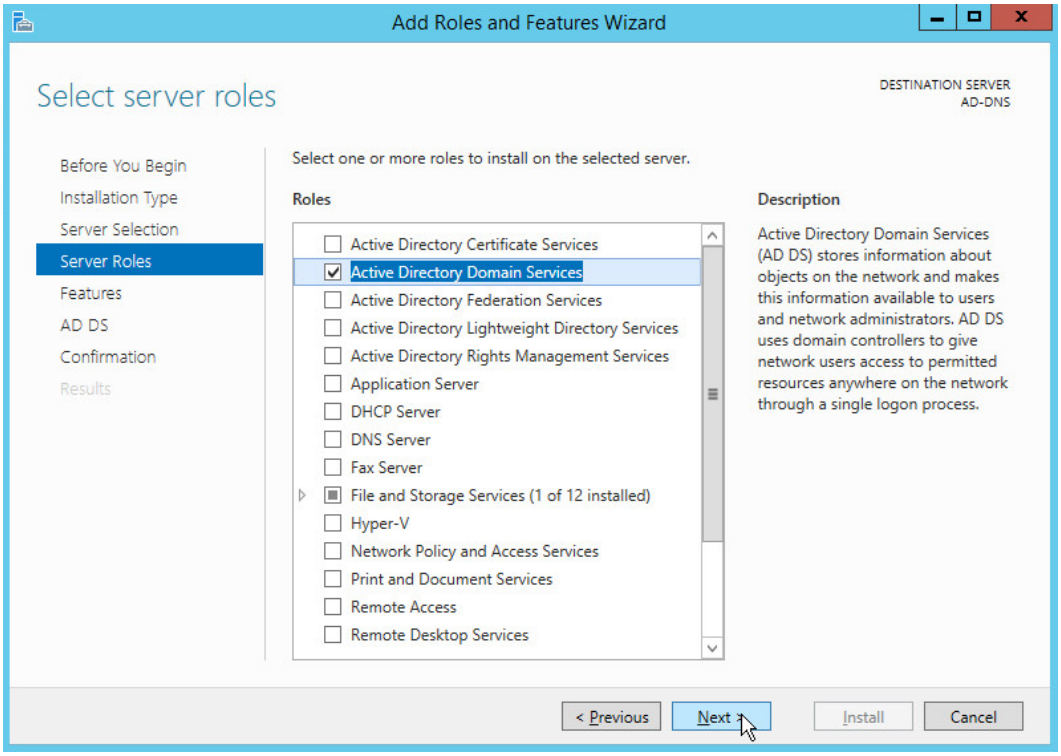
8. Click **Next.**



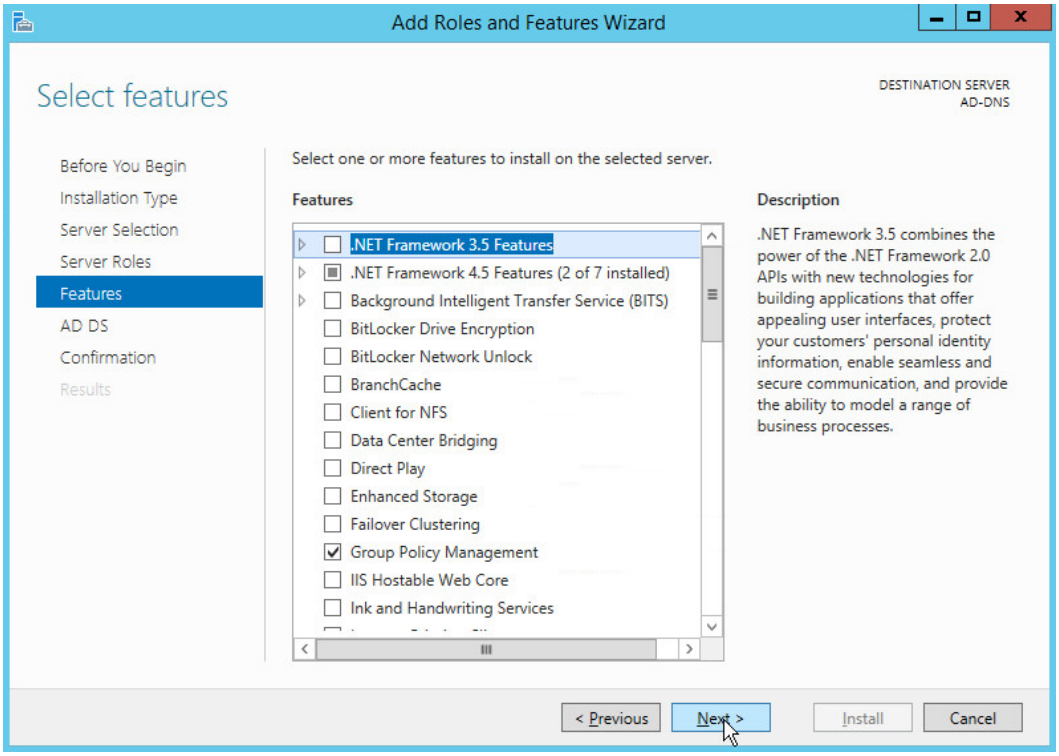
306 9. Check the box next to **Active Directory Domain Services.**



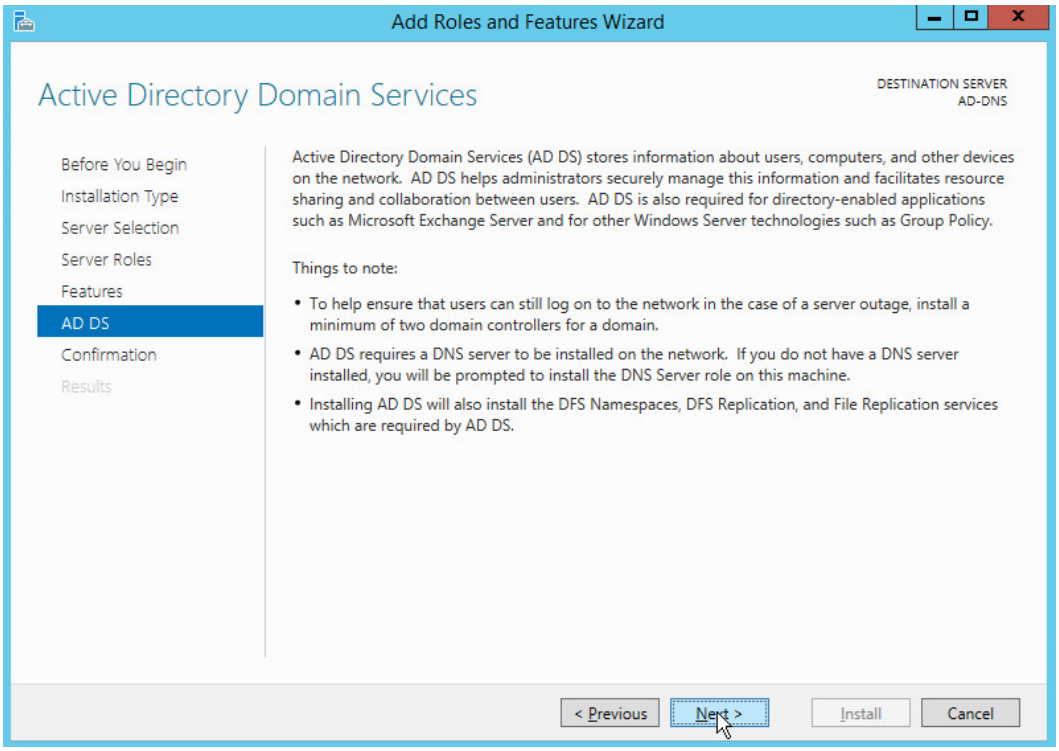
307 10. Click **Add Features.**



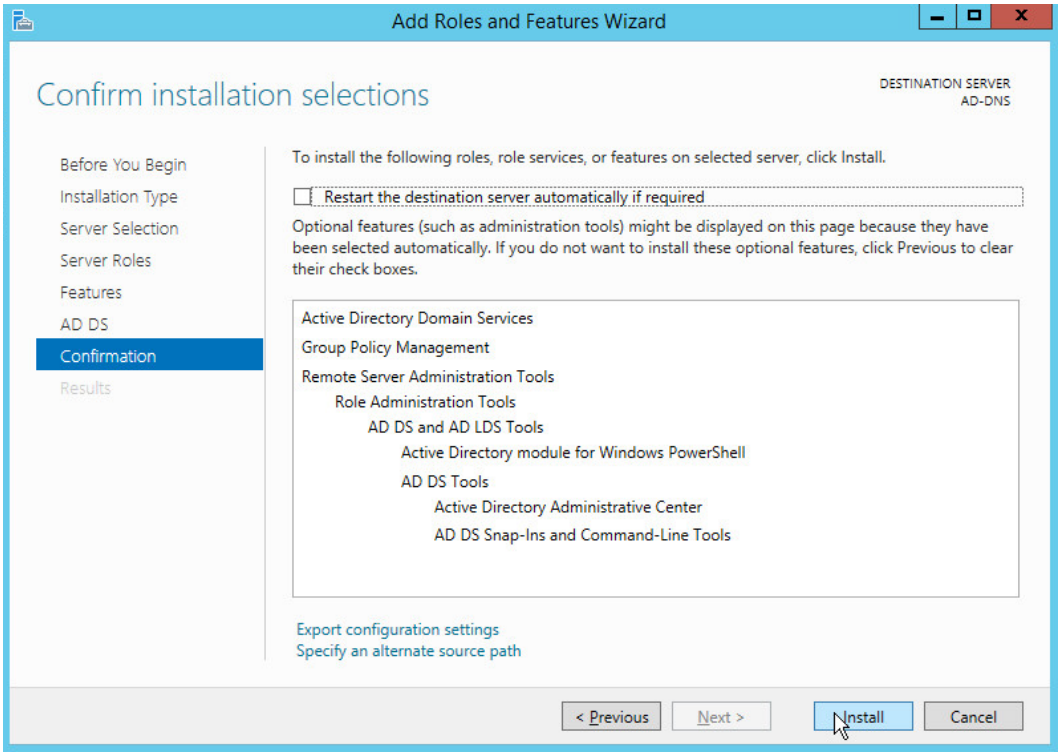
308 11. Click **Next.**



309 12. Click **Next.**

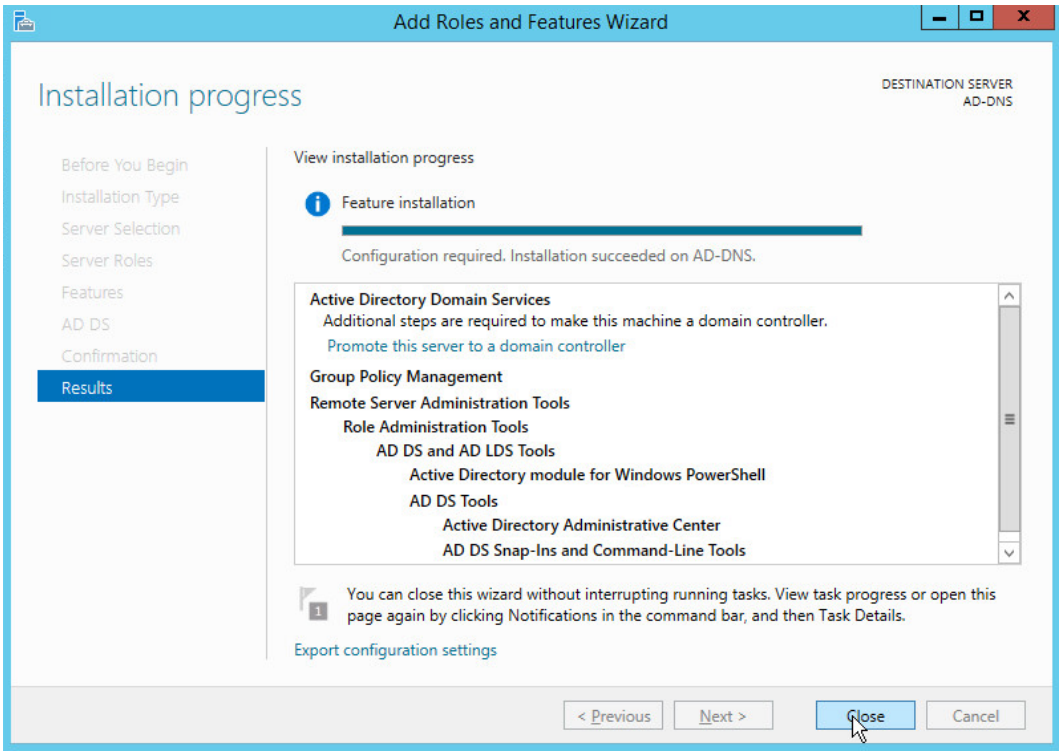


13. Click **Next.**

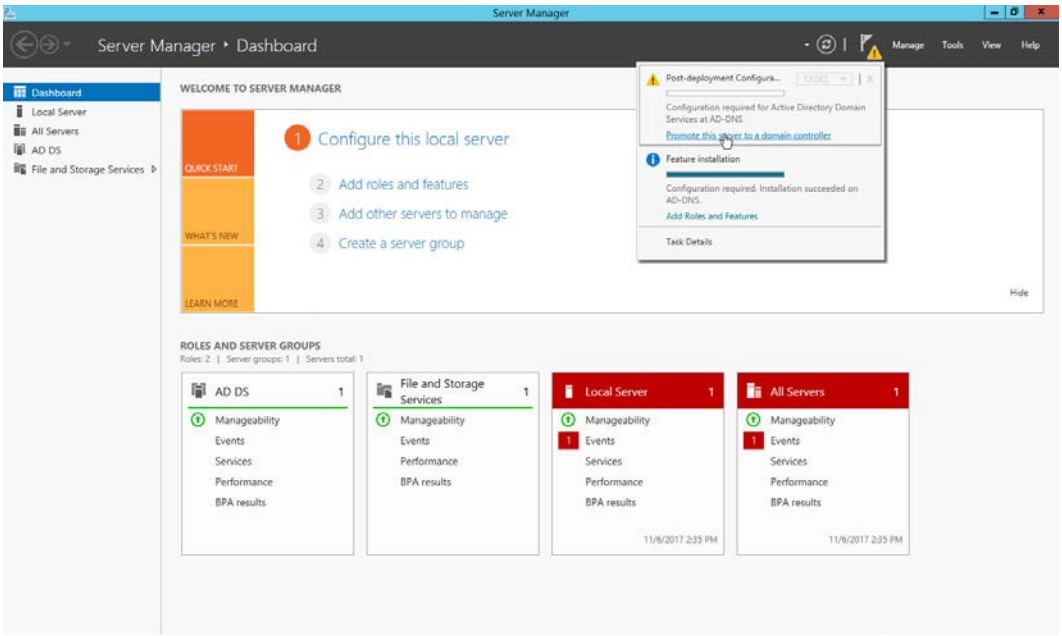


311 14. Click **Install.**

312 15. Wait for the installation to complete.



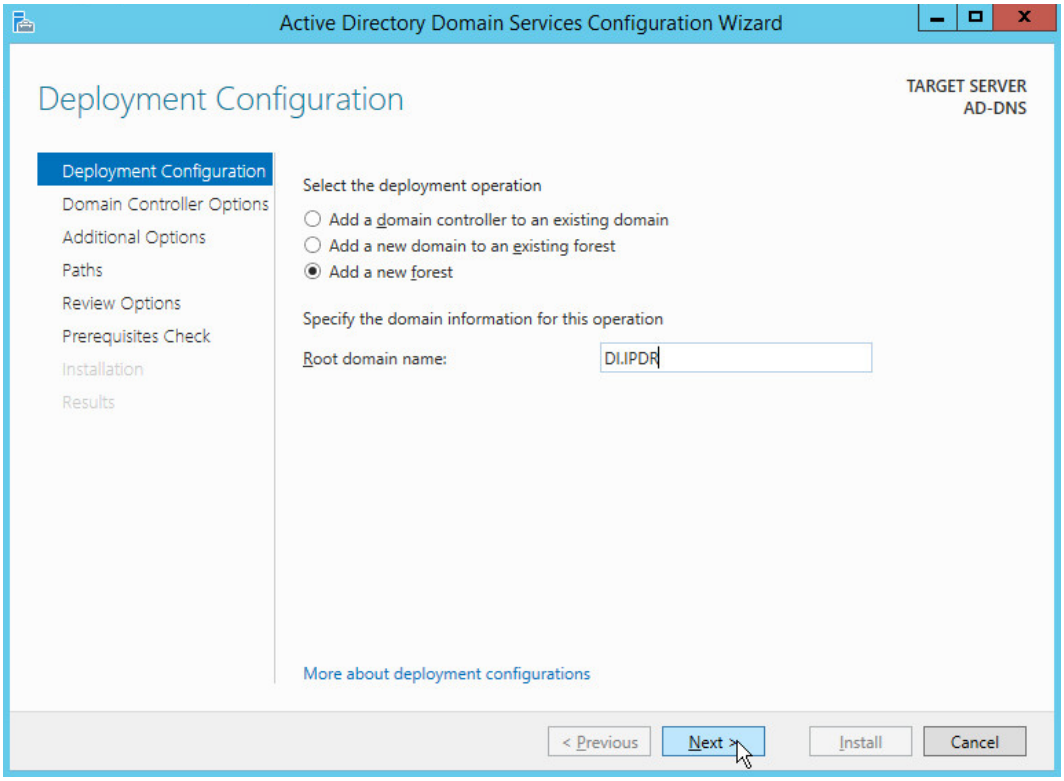
313 16. Click **Close.**



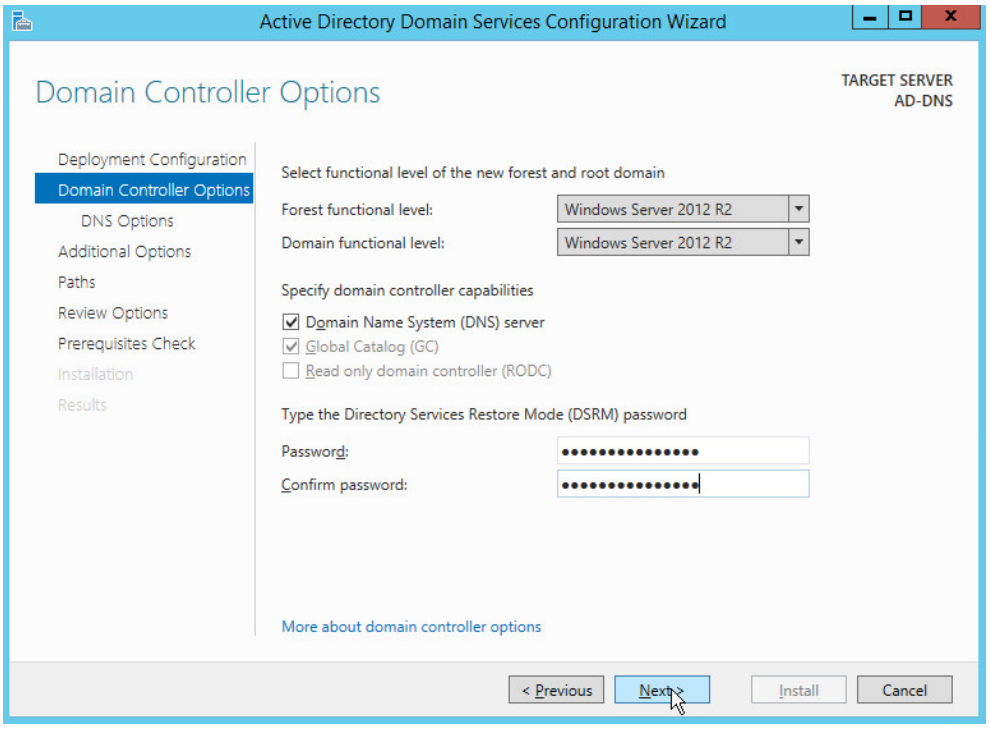
314 17. Click **Promote this server to a domain controller.**

315 18. Select **Add a new forest.**

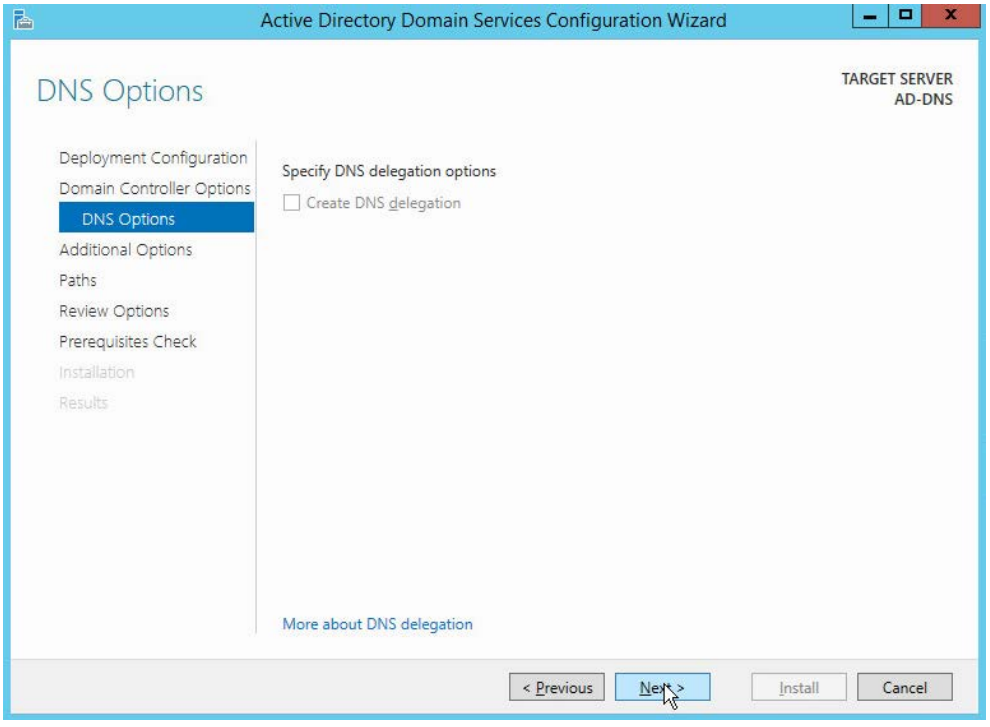
19. Enter a **Root domain name.**



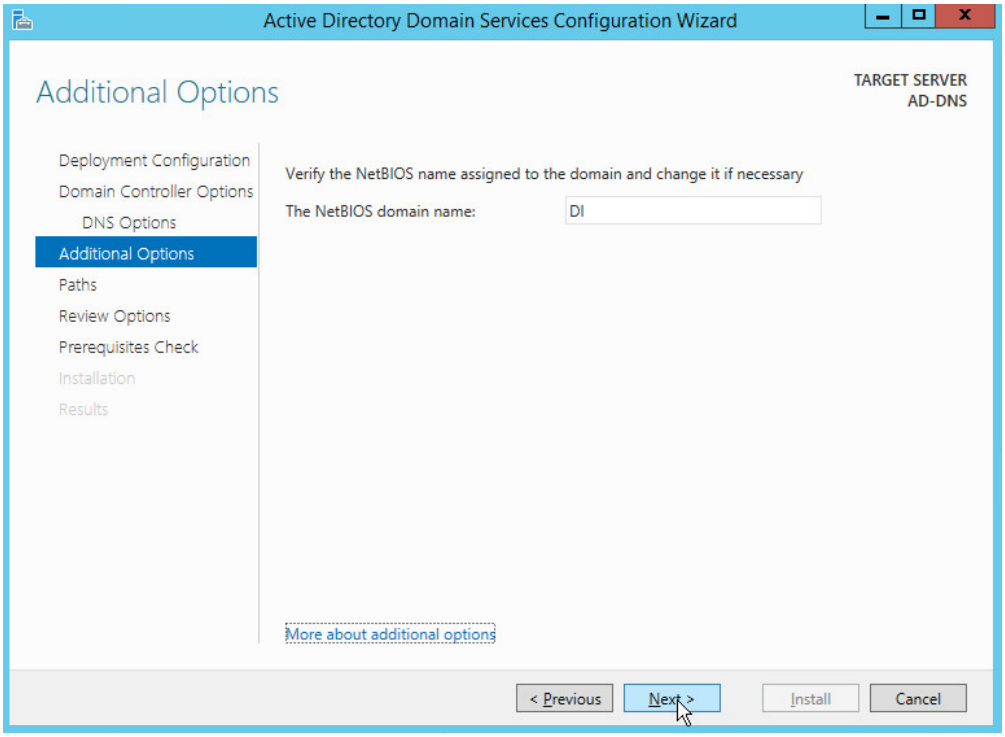
20. Click **Next.**
21. Select **Windows Server 2012 R2** for **Forest functional level** and **Domain functional level.**
22. Check the box next to **Domain Name System (DNS) server.**
23. Enter a **password**.



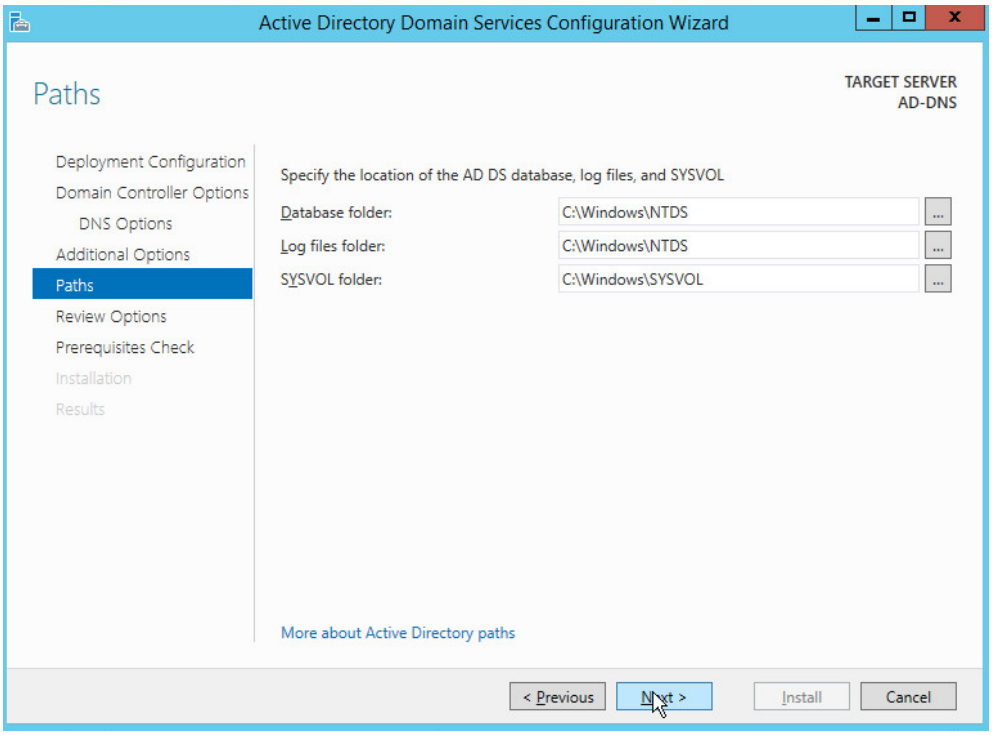
321 24. Click **Next.**



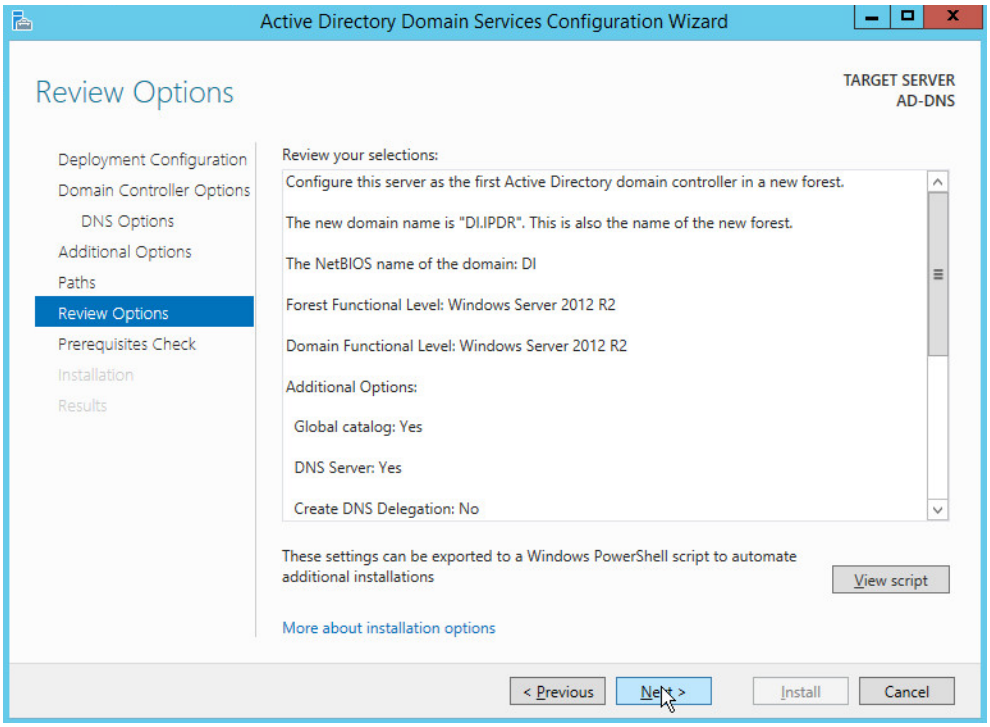
25. Click **Next.**
26. Verify the domain name.



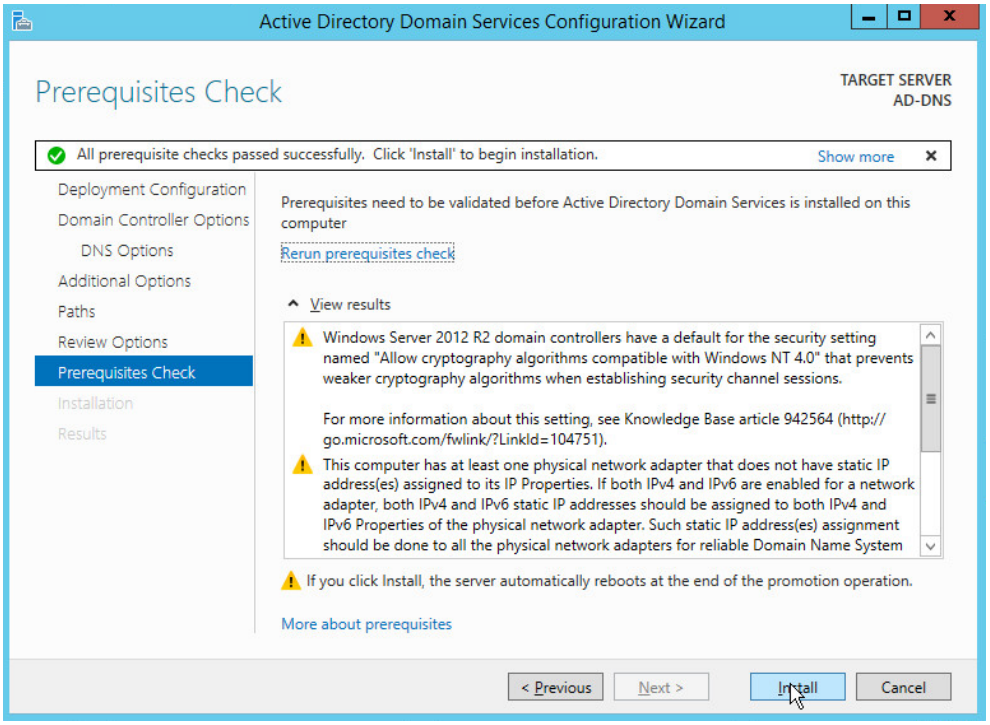
27. Click **Next.**



325 28. Click **Next.**



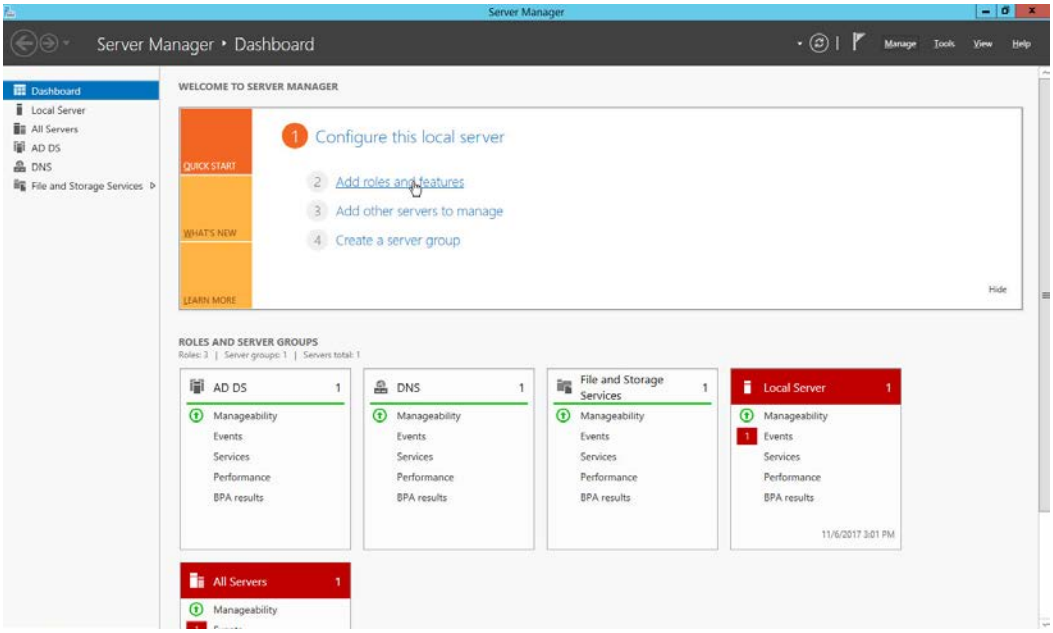
29. Click **Next.**



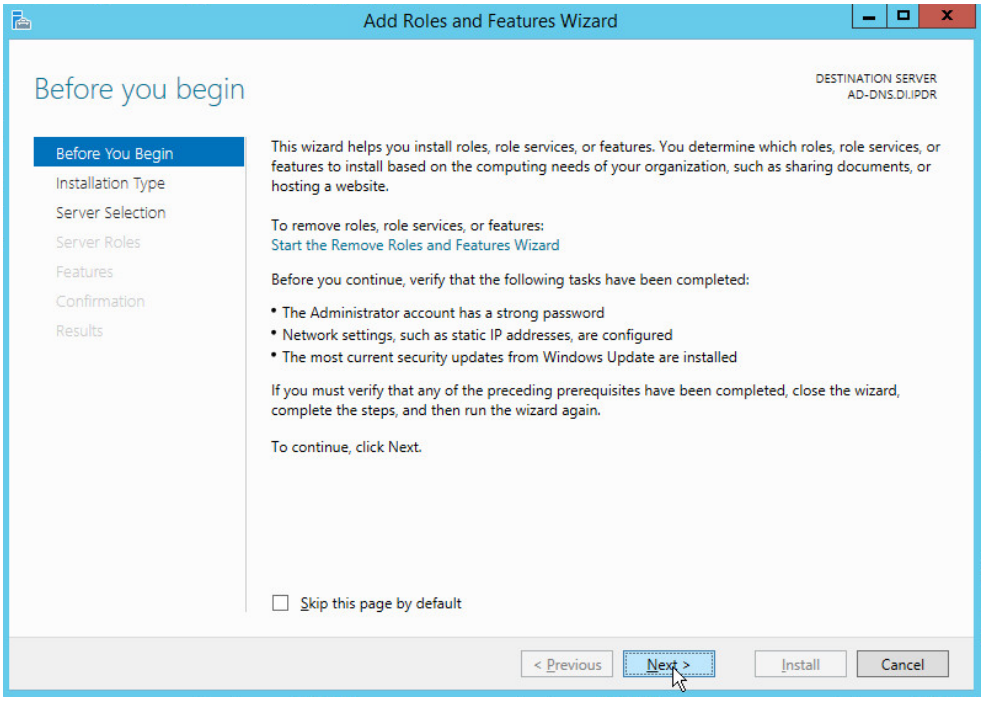
30. Click **Install.**
31. Wait for the installation to complete.
32. The server automatically reboots.

2.1.2 Creating a Certificate Authority

1. Open **Server Manager.**

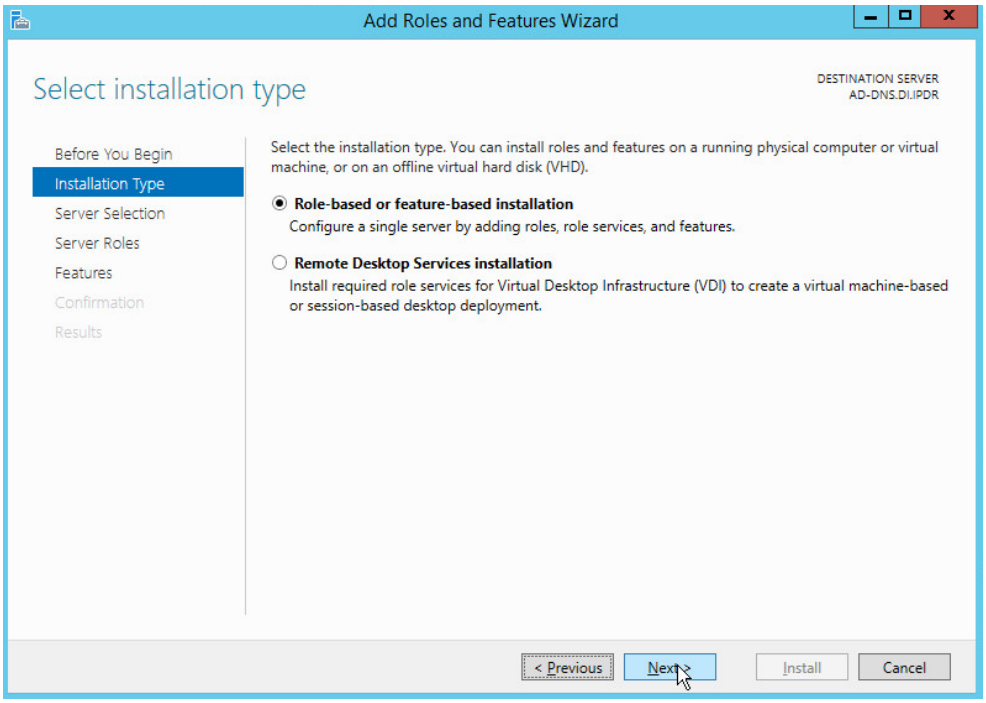


332 2. Click **Add roles and features.**

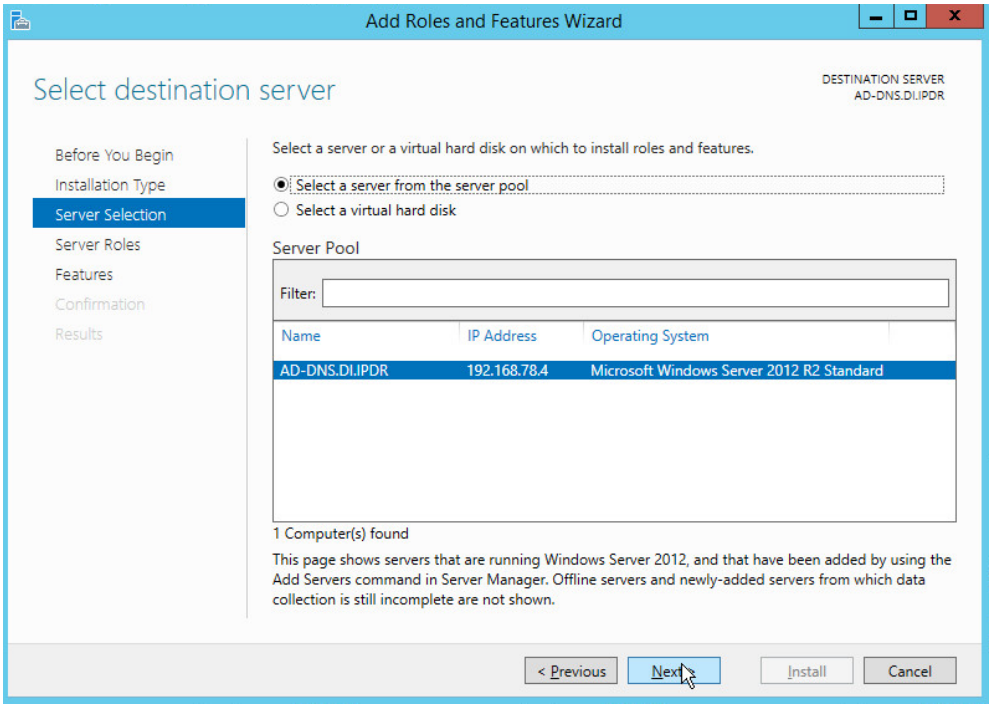


333 3. Click **Next.**

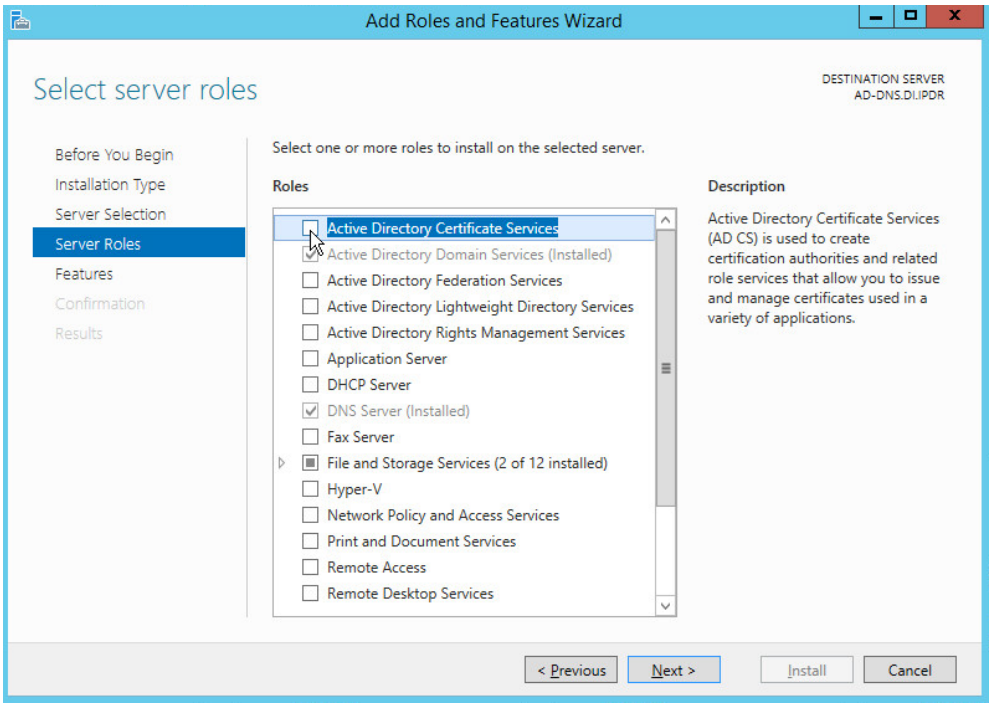
334 4. Select **Role-based or feature-based installation.**



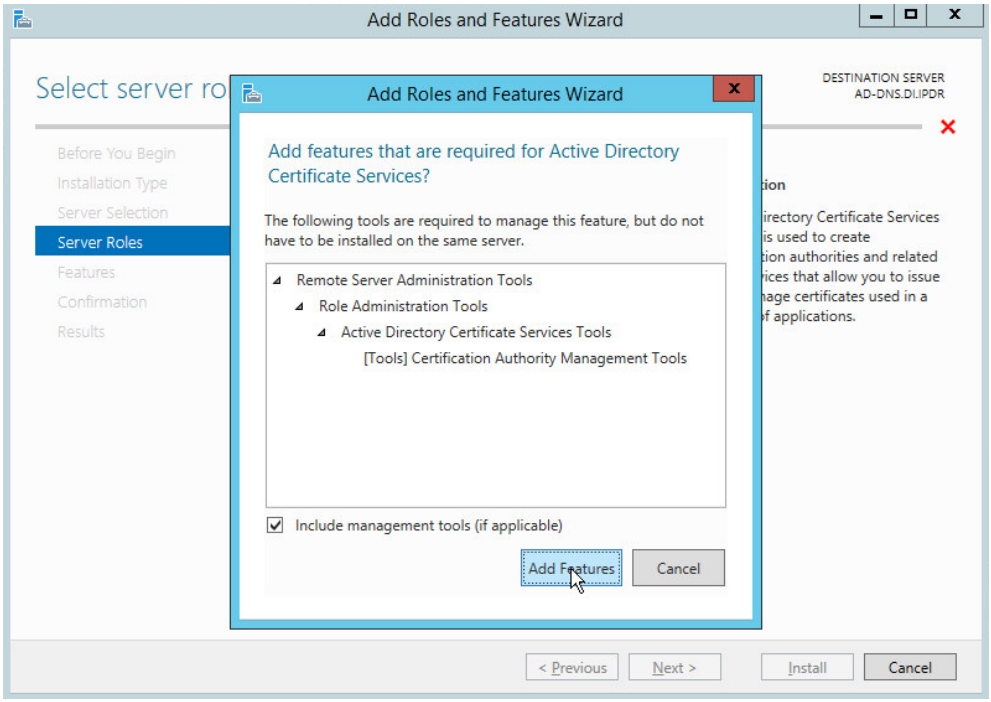
5. Click **Next.**
6. Select **Select a server from the server pool.**
7. Select the intended Active Directory server.



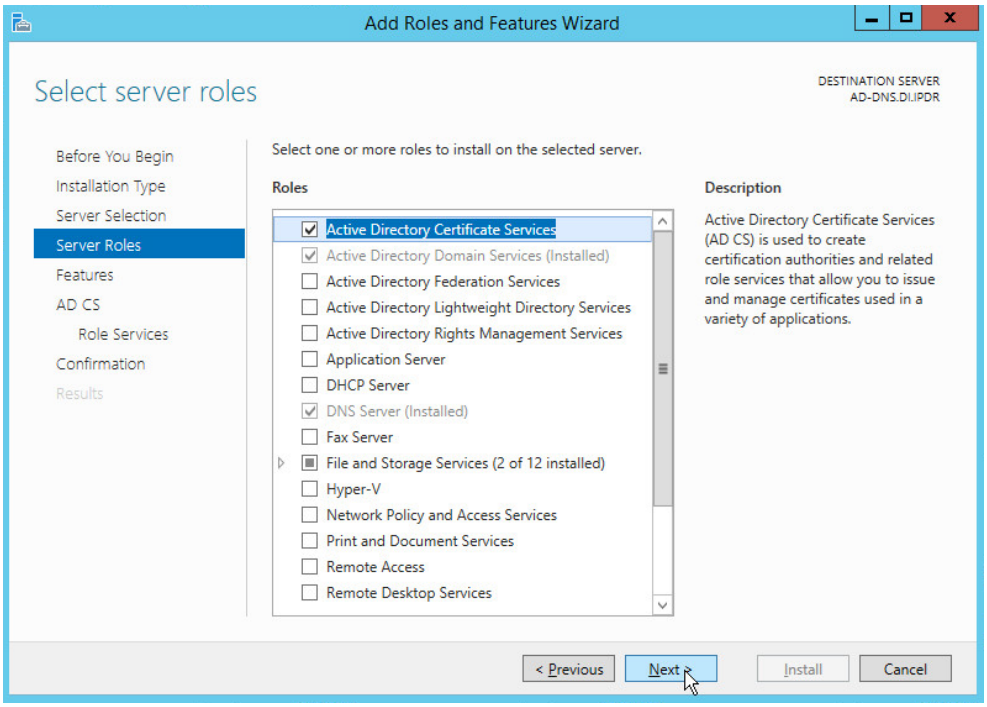
338 8. Click **Next.**



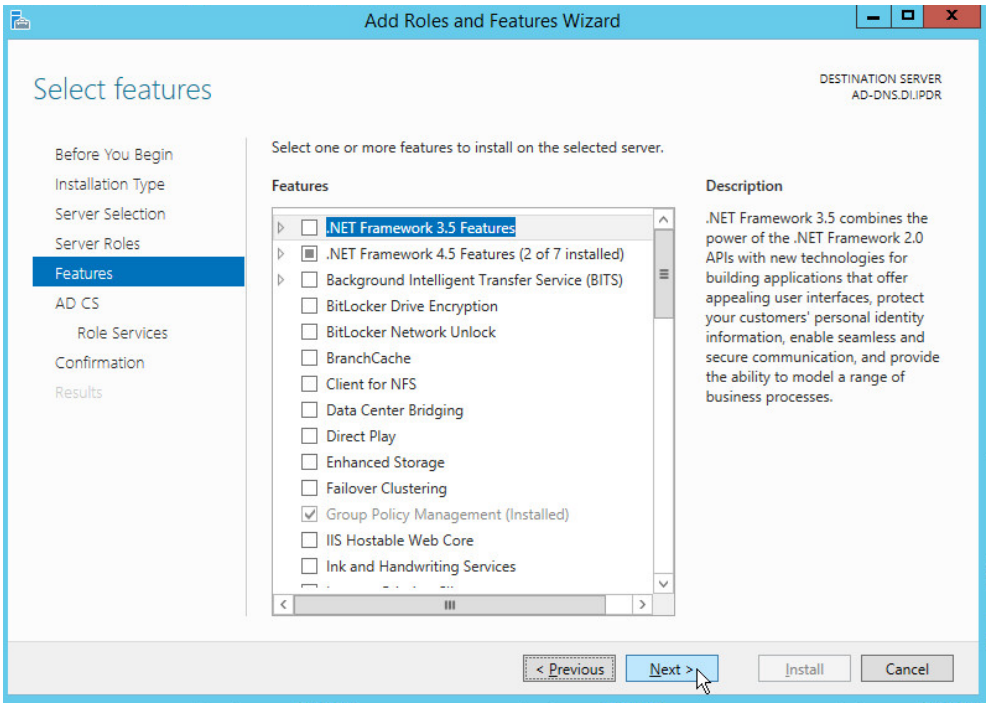
339 9. Check the box next to **Active Directory Certificate Services.**



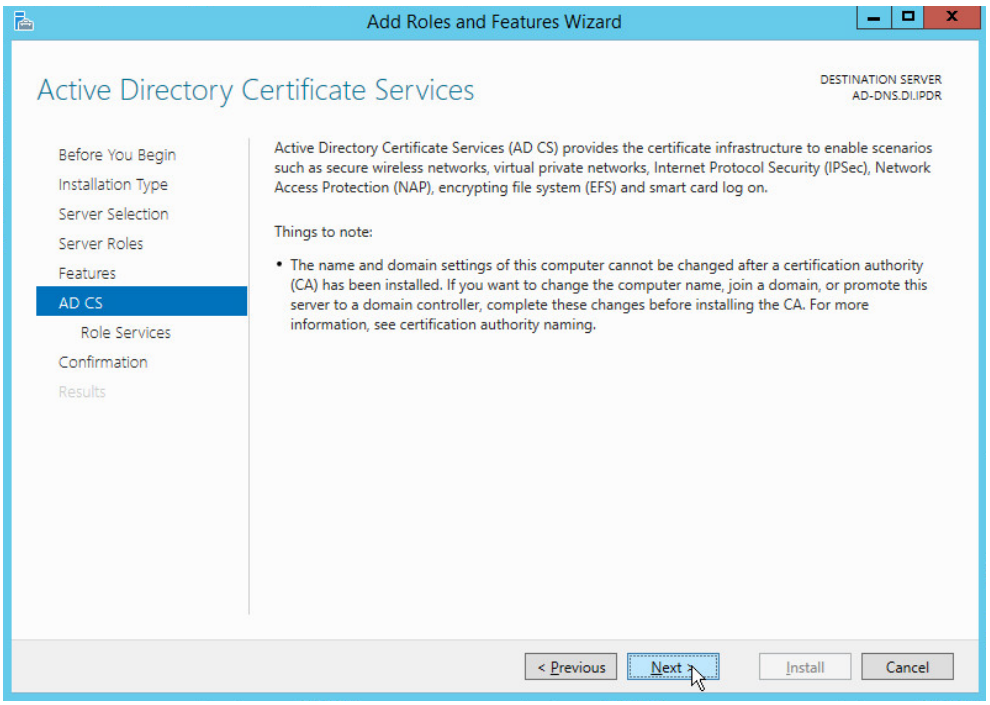
340 10. Click **Add Features.**



341 11. Click **Next.**

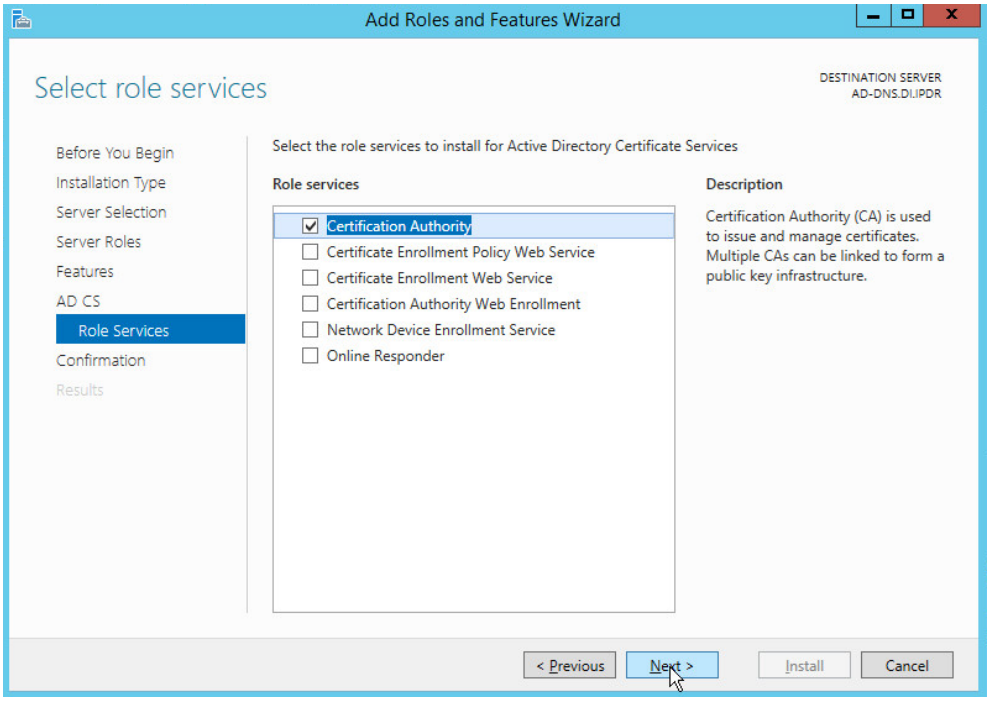


342 12. Click **Next.**

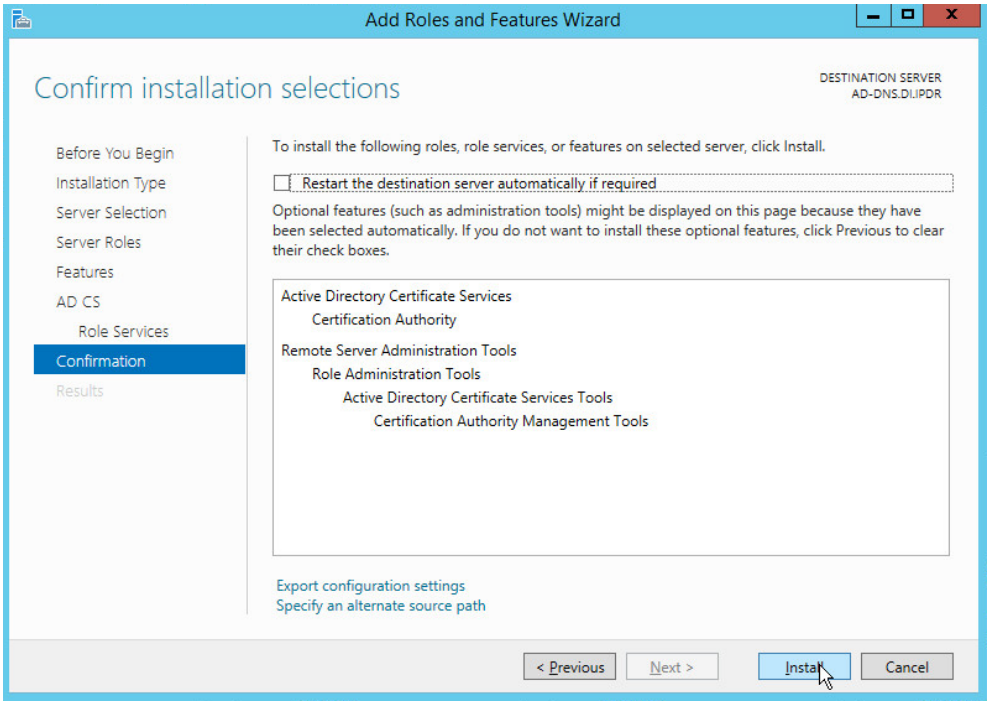


343 13. Click **Next.**

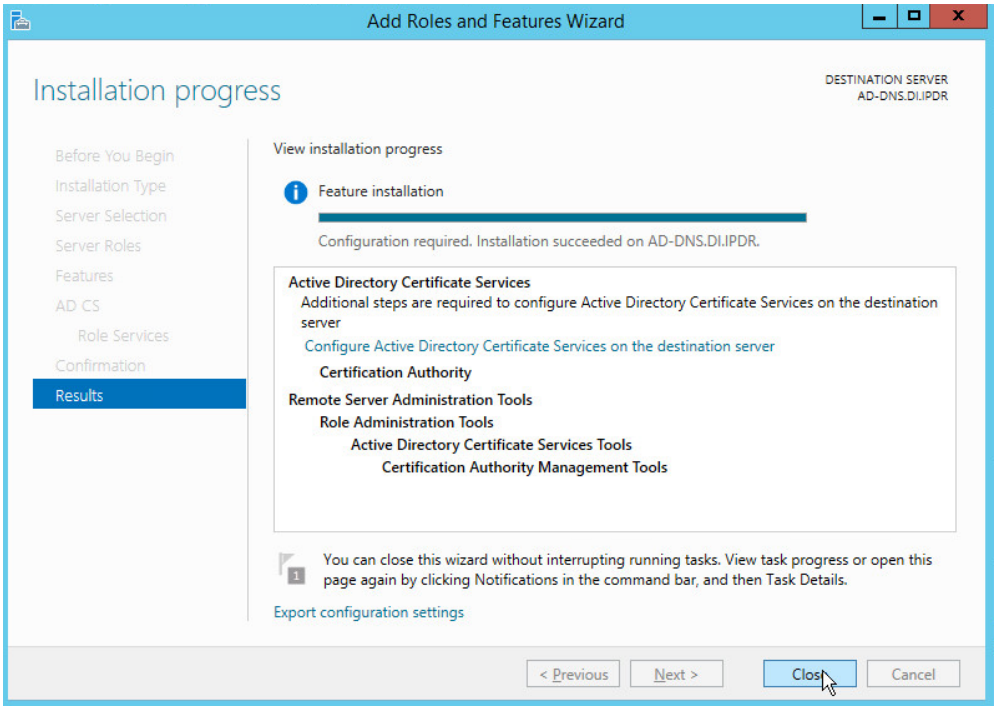
344 14. Check the box next to **Certification Authority.**



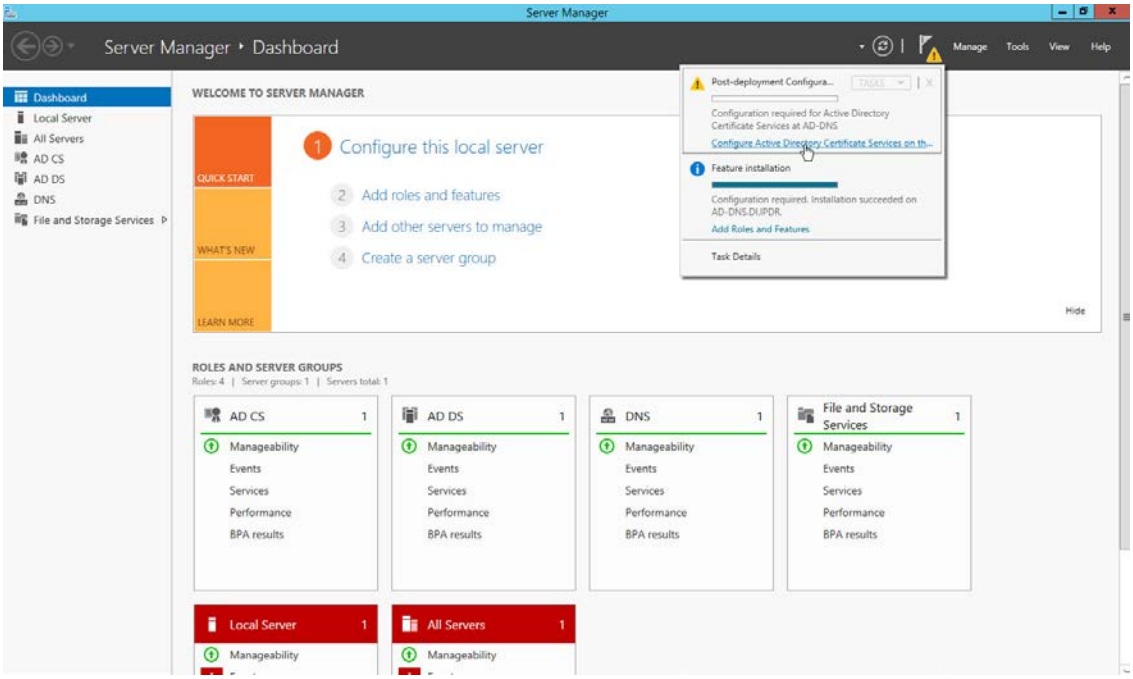
345 15. Click **Next.**



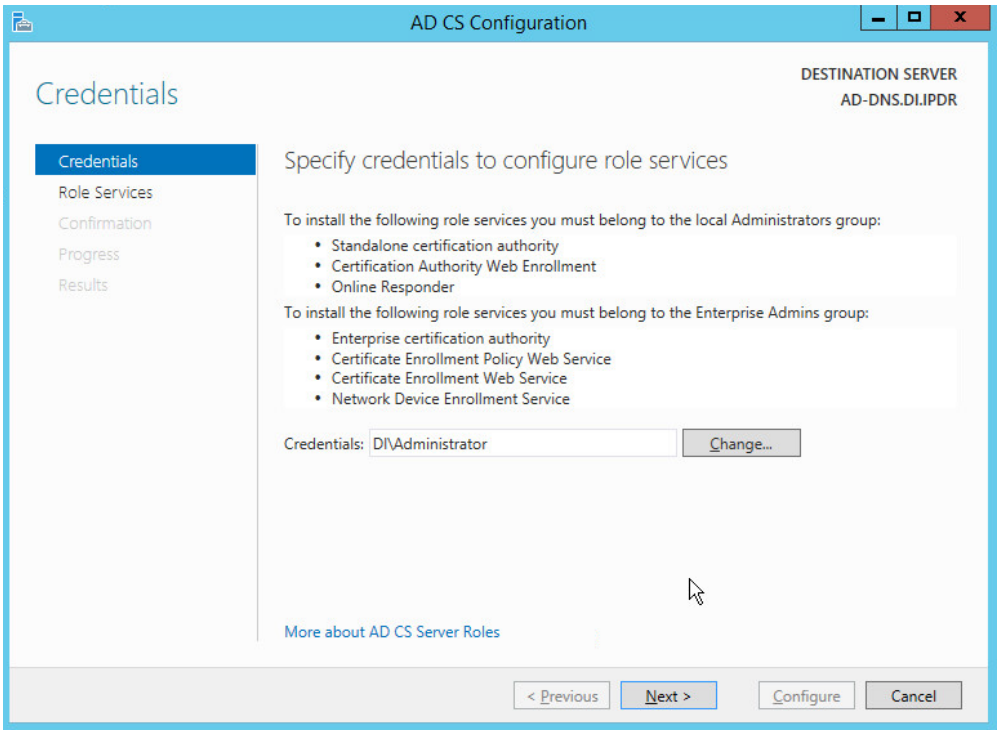
16. Click **Install.**
17. Wait for the installation to complete.



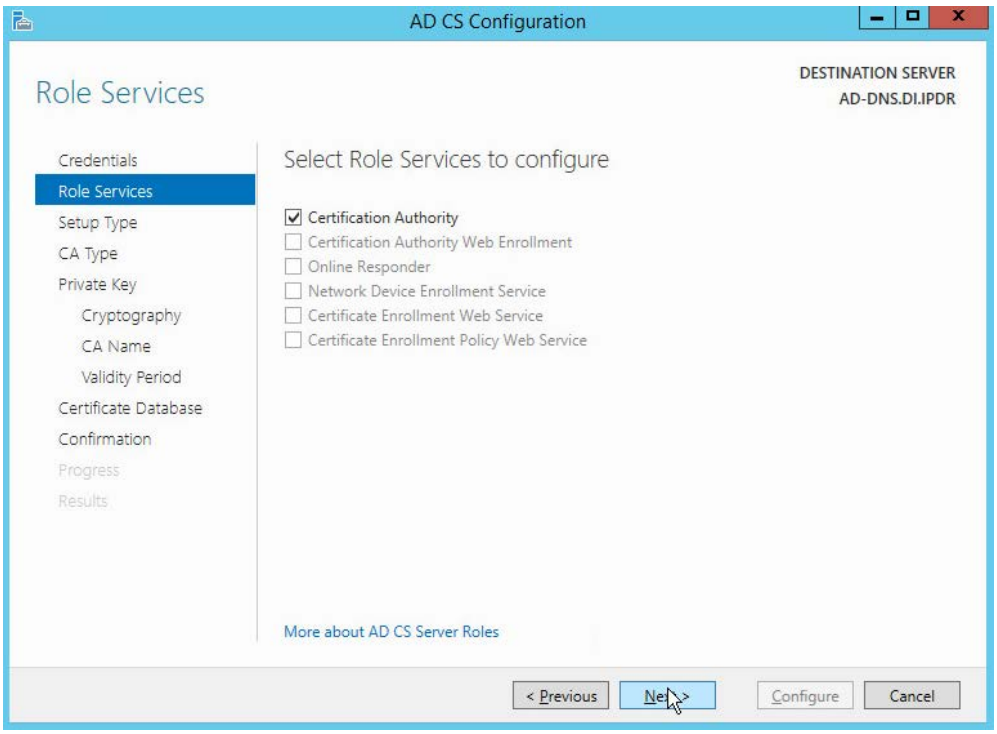
18. Click **Close.**



19. Click **Configure Active Directory Certificate Services on the destination server.**

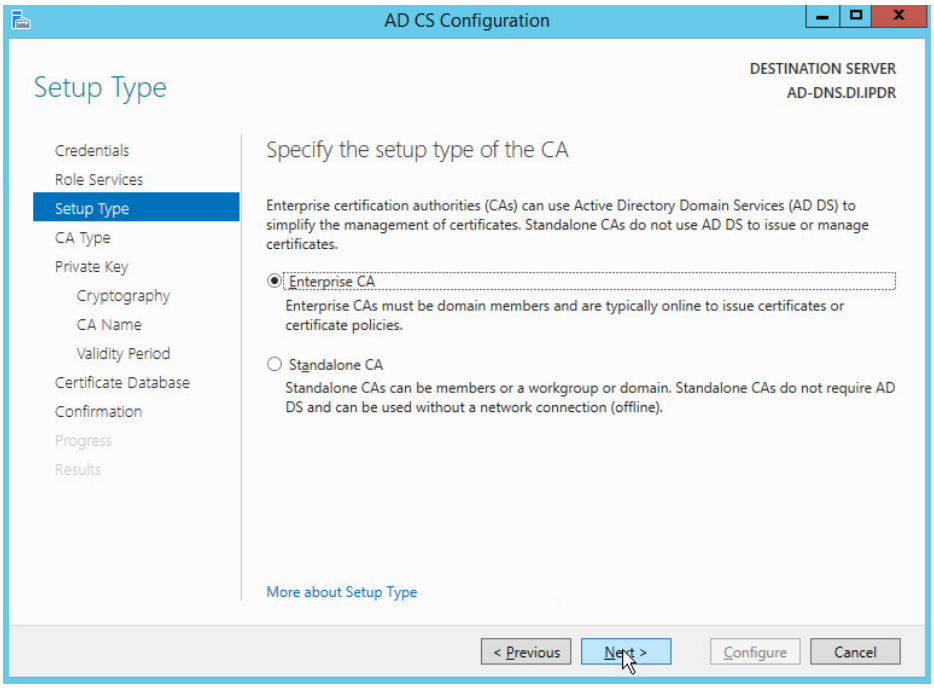


20. Click **Next.**
21. Check the box next to **Certification Authority.**



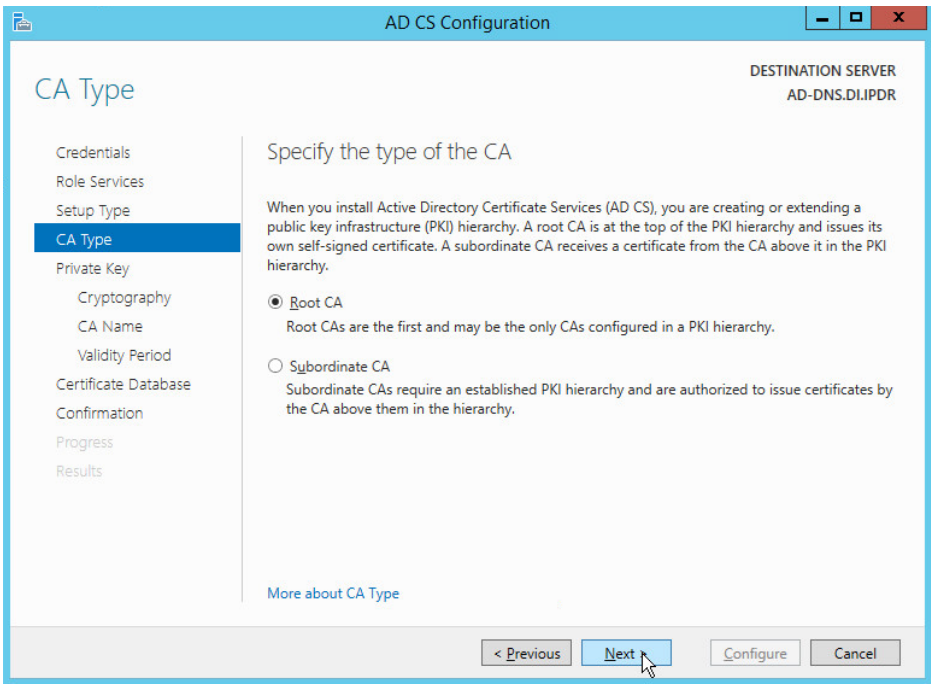
352 22. Click **Next.**

353 23. Select **Enterprise CA.**



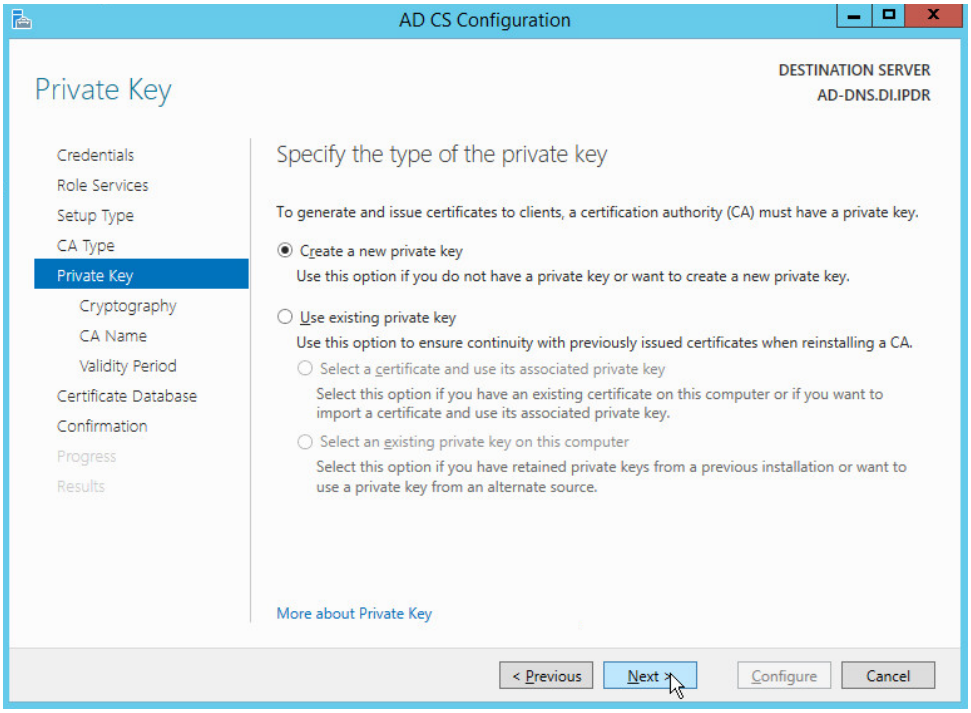
354 24. Click **Next.**

355 25. Select **Root CA.**

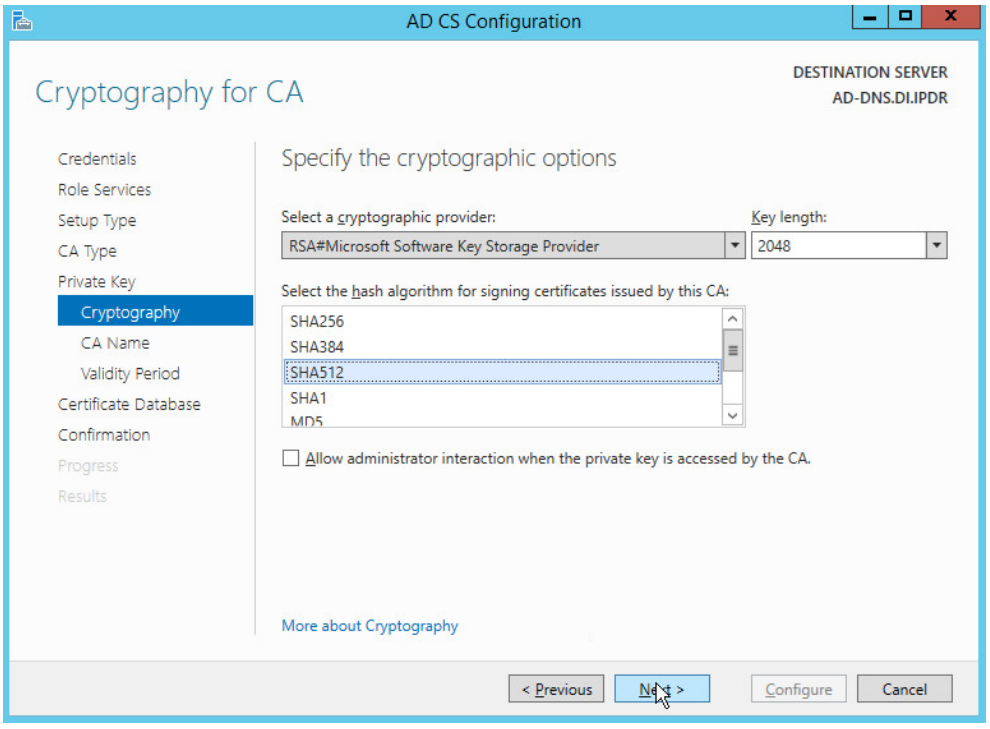


356 26. Click **Next.**

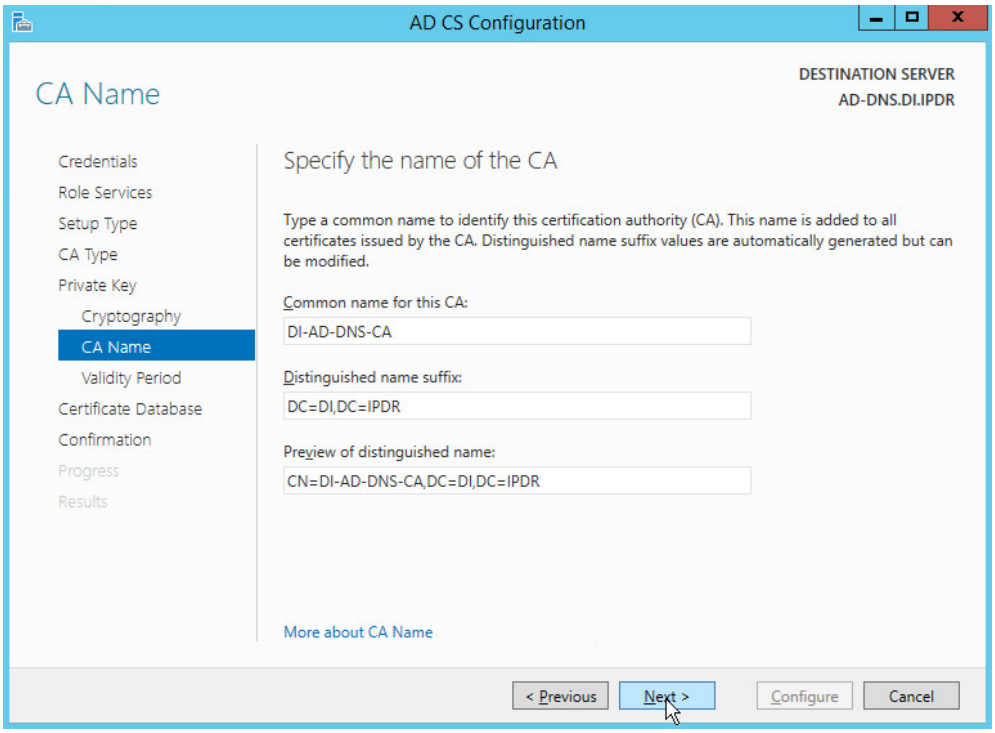
27. Select **Create a new private key.**



28. Click **Next.**
29. Select **RSA#Microsoft Software Key Storage Provider.**
30. Set the **Key length** to **2048.**
31. Select **SHA512** from the list.

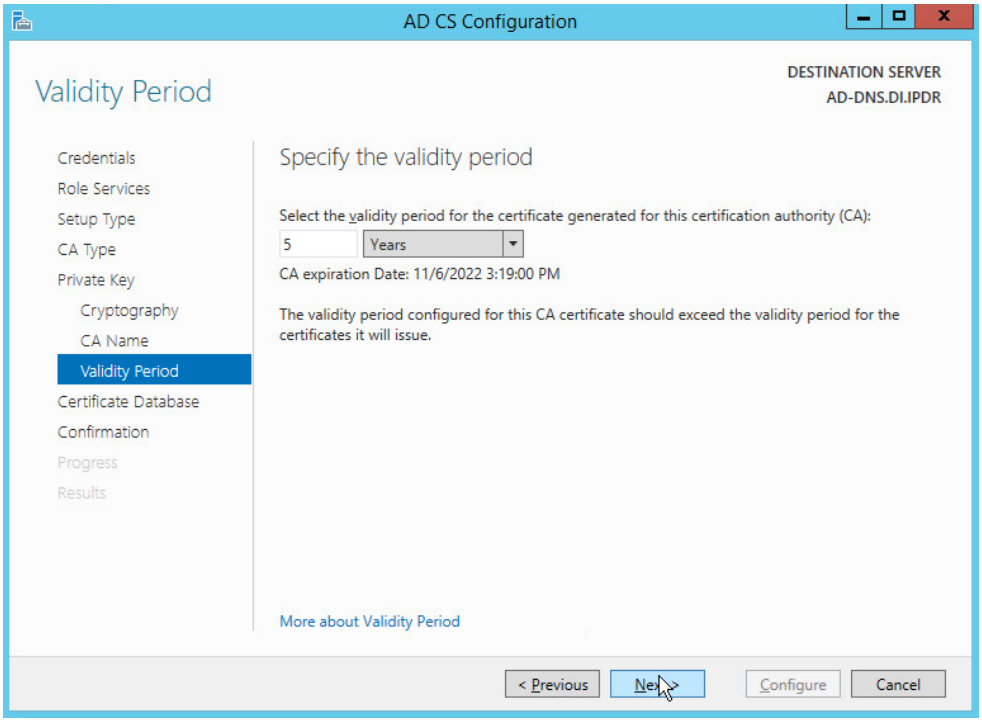


362 32. Click **Next.**

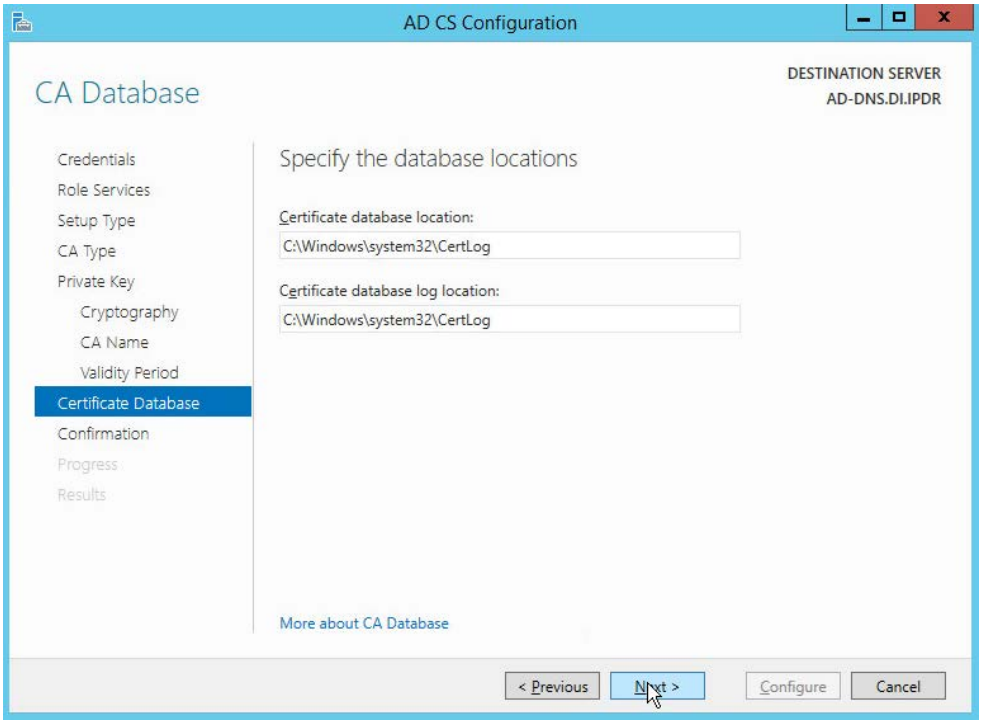


363 33. Click **Next.**

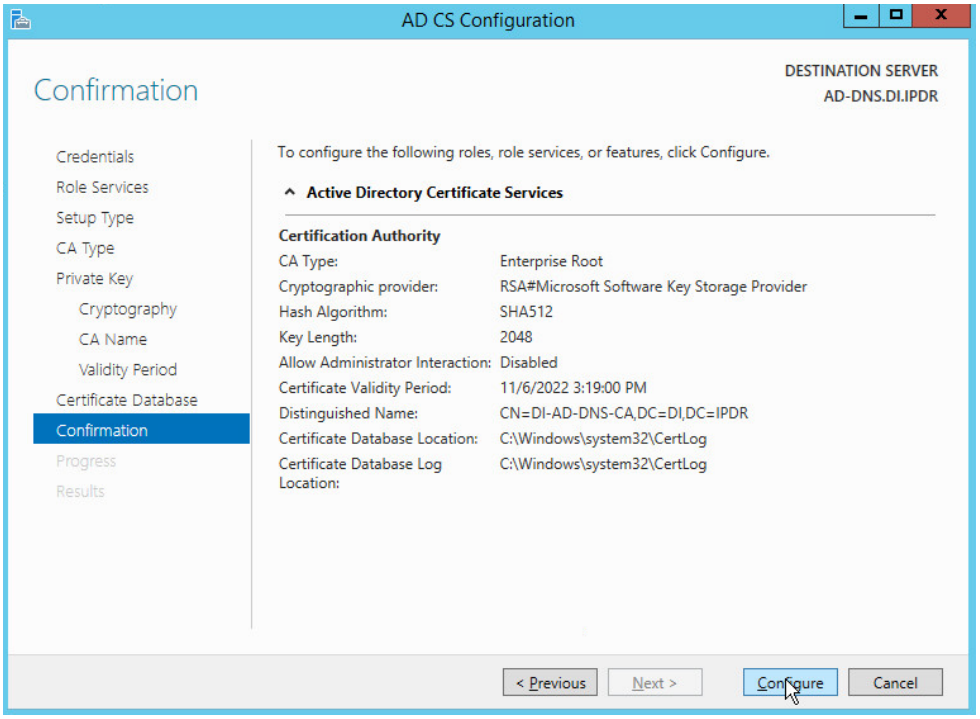
364 34. Set the time to 5 years.



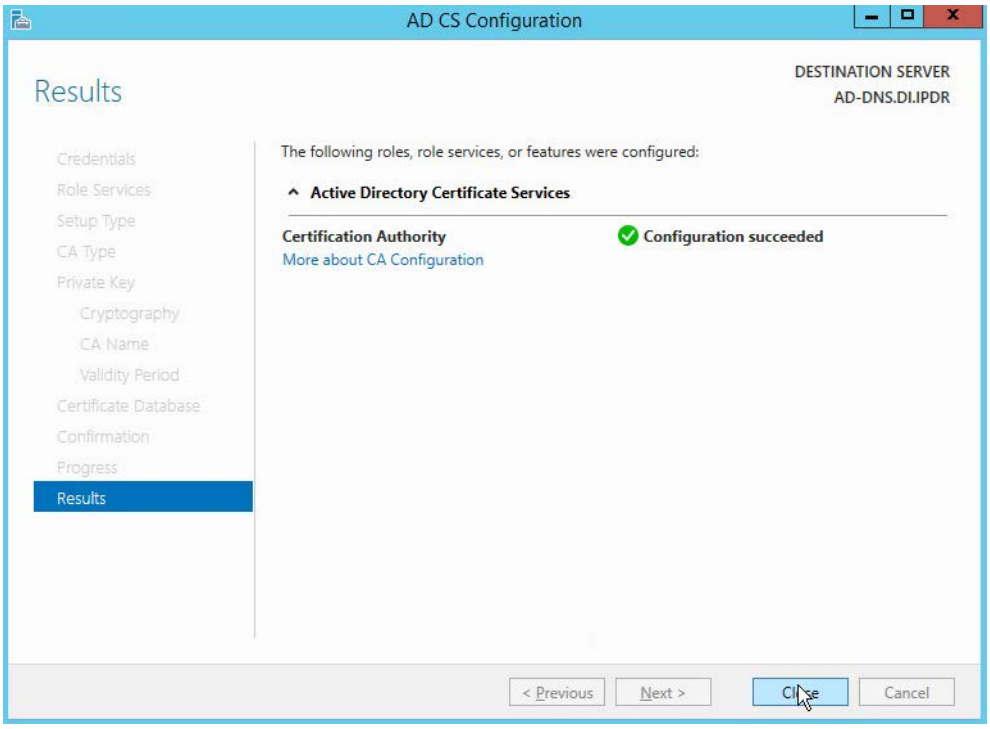
365 35. Click **Next.**



366 36. Click **Next.**



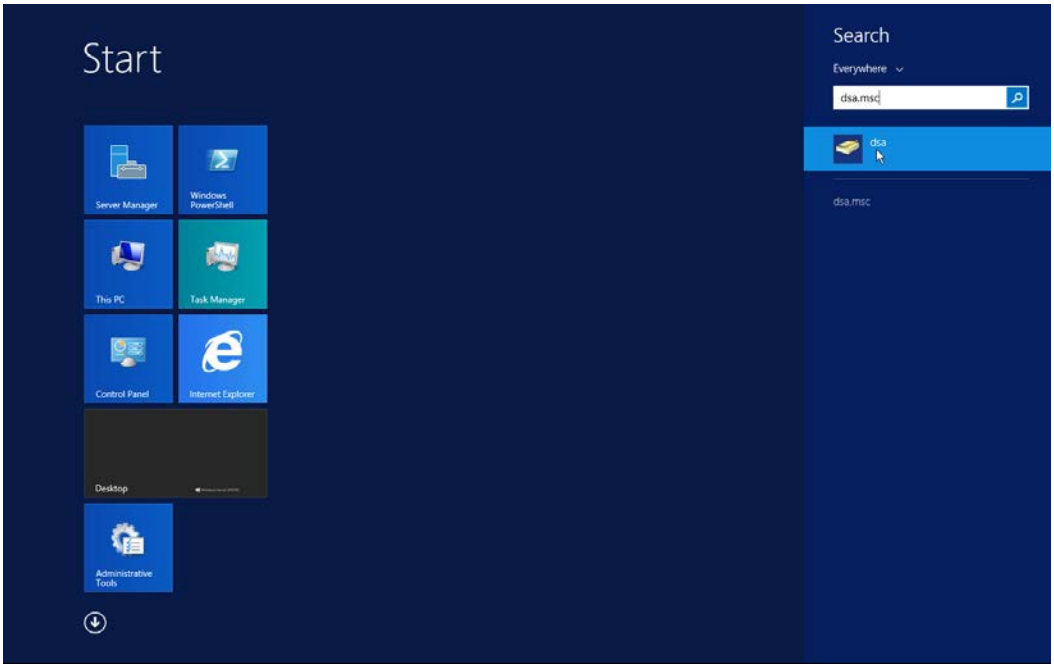
367 37. Click **Configure.**



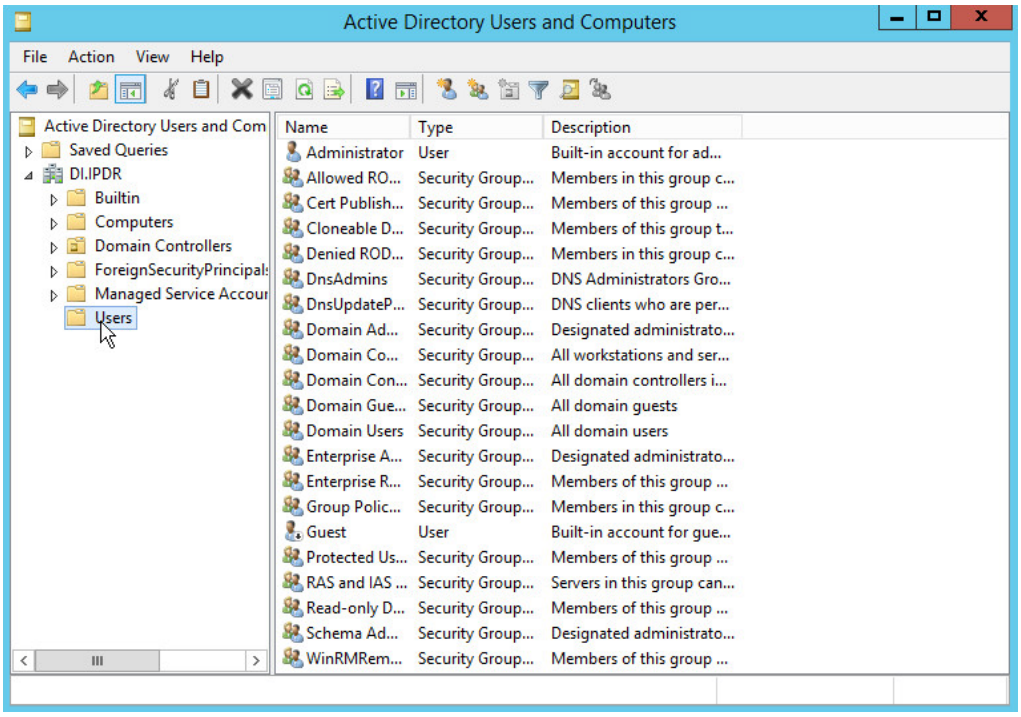
368 38. Click **Close.**

369 2.1.3 Configure Account to Add Computers to Domain

370 1. Open the Start menu.
371 2. Enter **dsa.msc** and run the program.

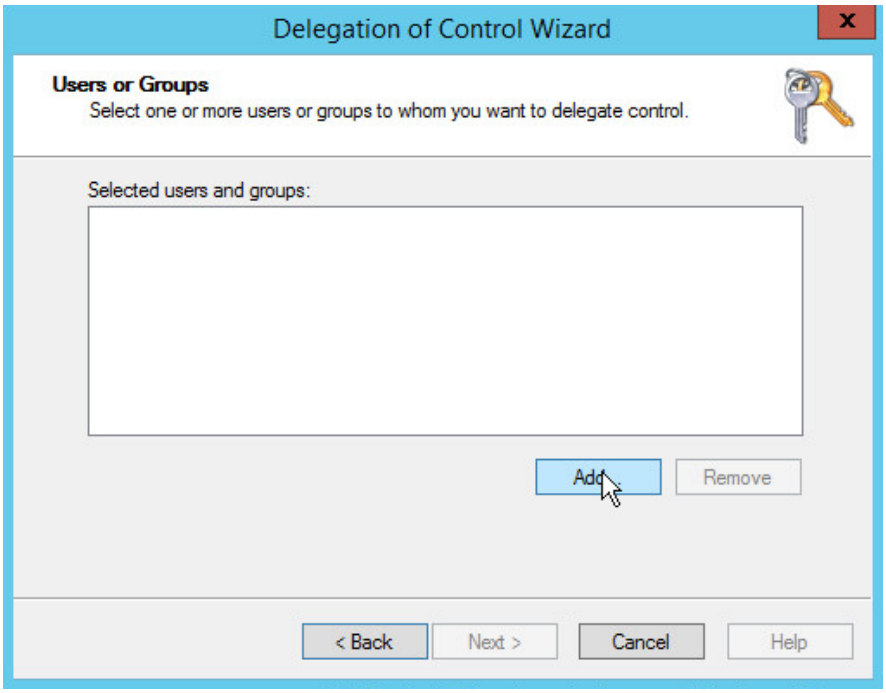


372 3. Right-click on **Users** in the left panel.



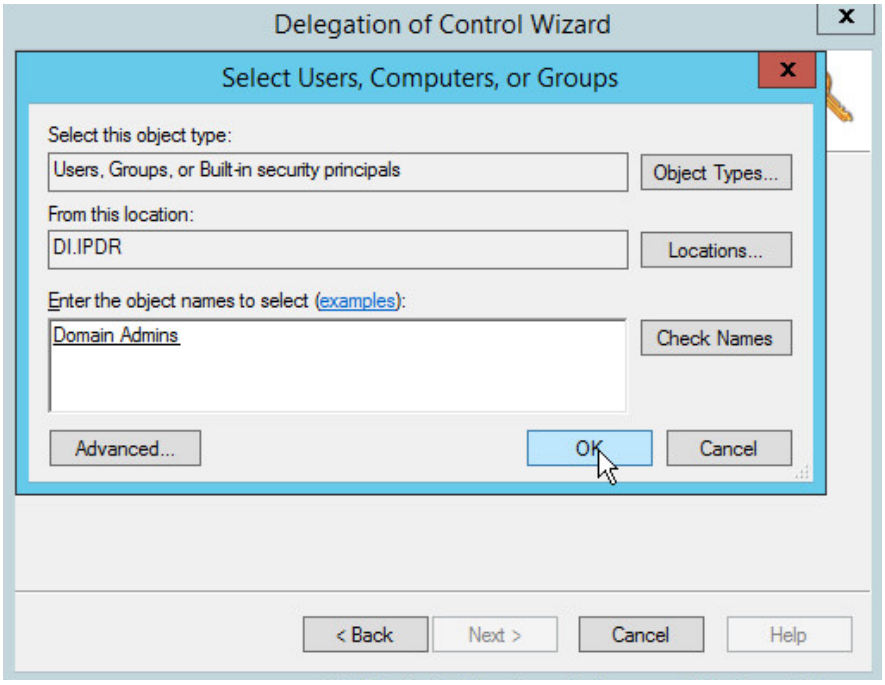
373 4. Click **Delegate Control.**

374 5. Click **Next.**

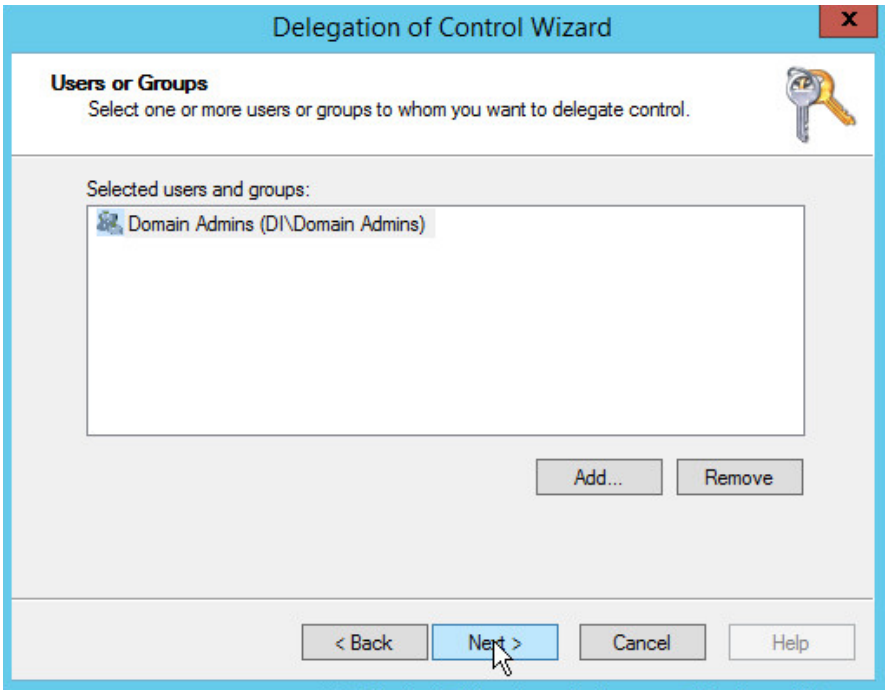


375 6. Click **Add** to select users or groups.

376 7. Add users or groups.

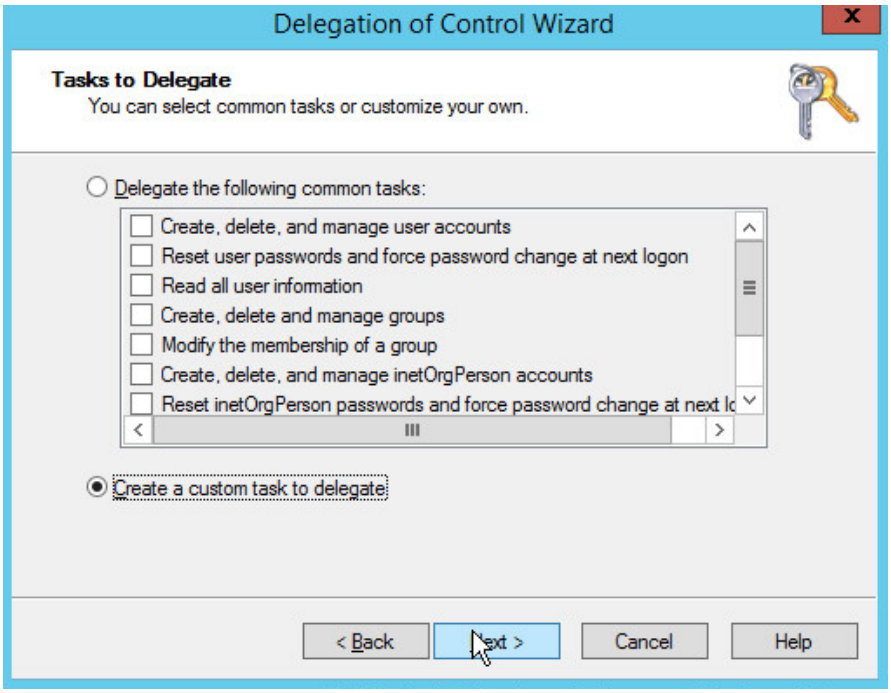


377 8. Click **OK.**

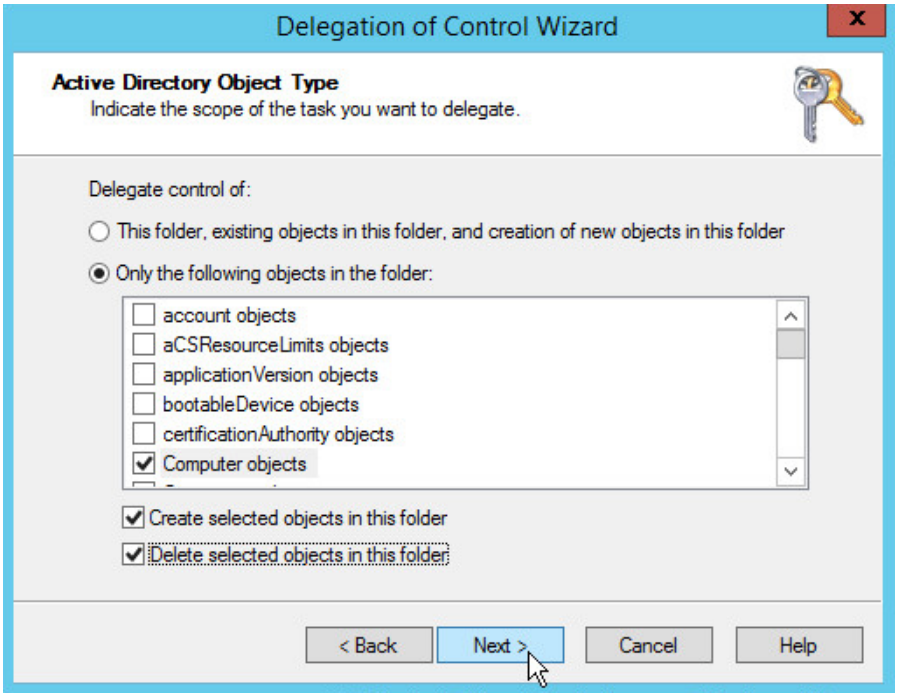


378 9. Click **Next.**

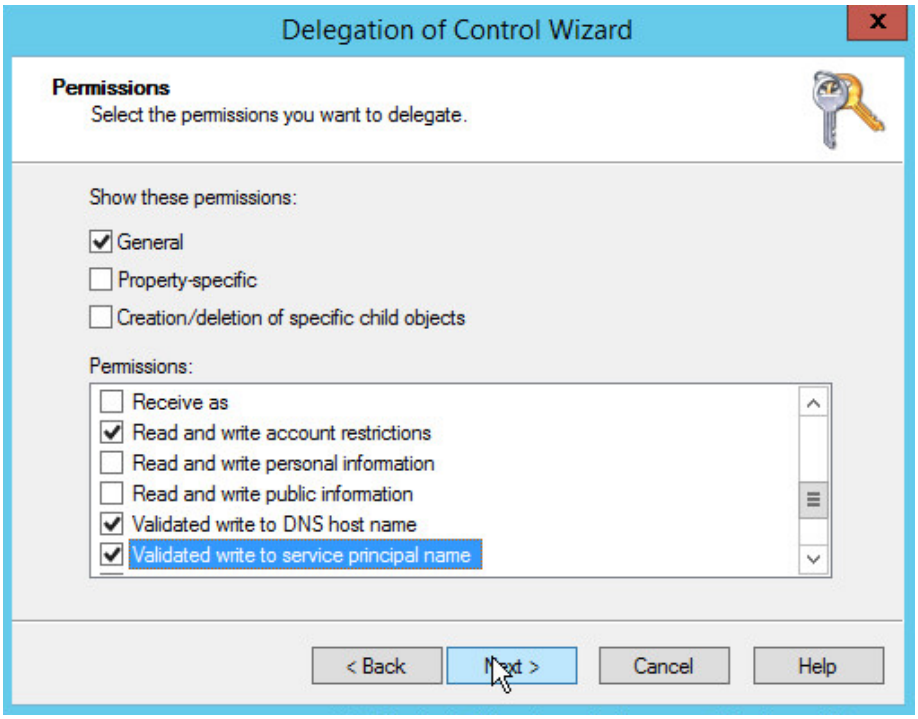
10. Choose **Create a custom task to delegate**.



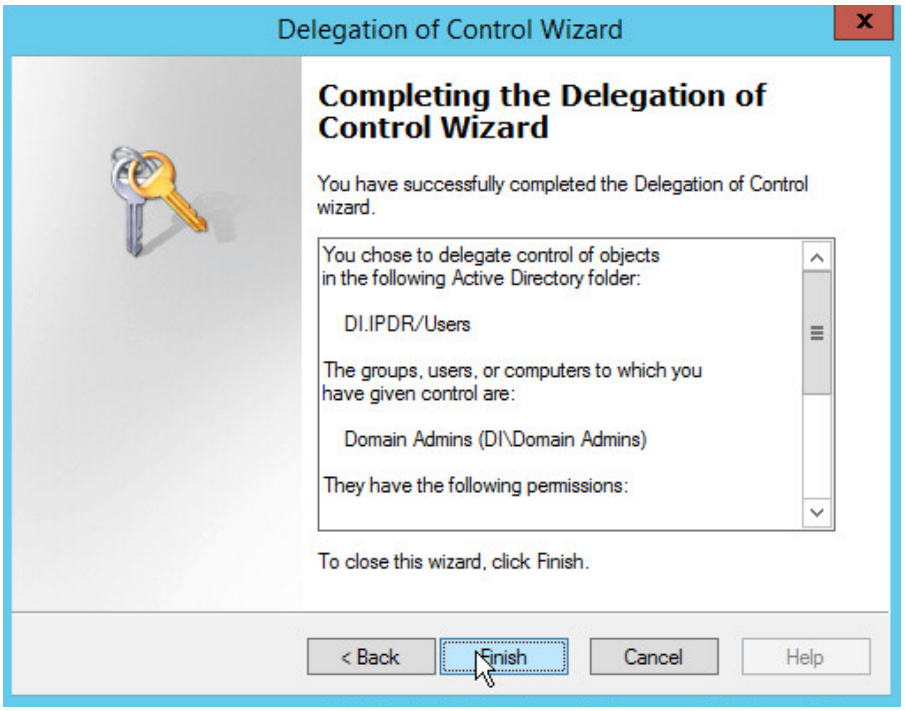
11. Click **Next.**
12. Choose **Only the following objects in the folder.**
13. Check the box next to **Computer objects.**
14. Check the box next to **Create selected objects in this folder.**
15. Check the box next to **Delete selected objects in this folder.**



16. Click **Next.**
17. Check the boxes next to **Reset password, Read and write account restrictions, Validated write to DNS host name,** and **Validated write to service principal name.**



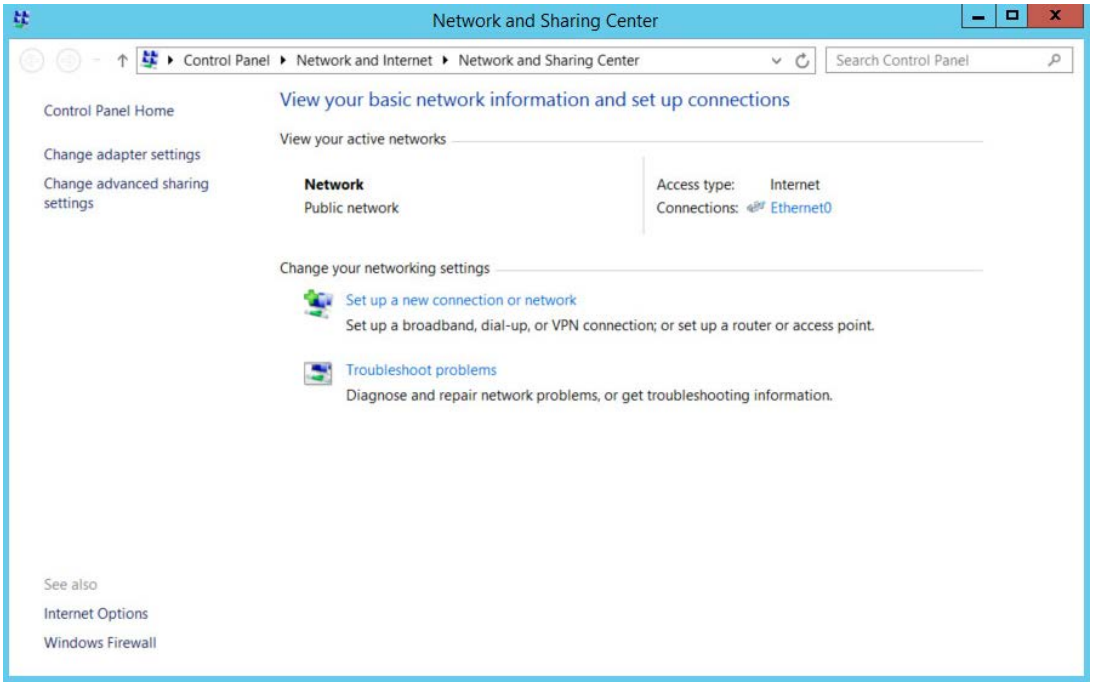
388 18. Click **Next.**



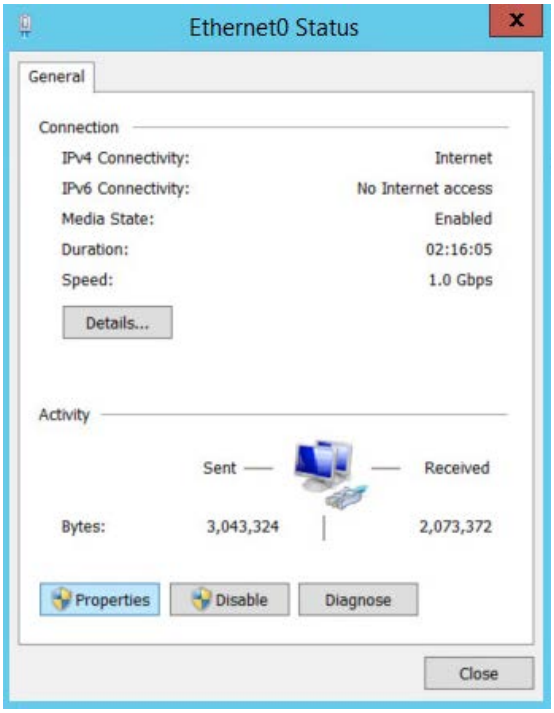
389 19. Click **Finish.**

2.1.4 Adding Machines to the Domain

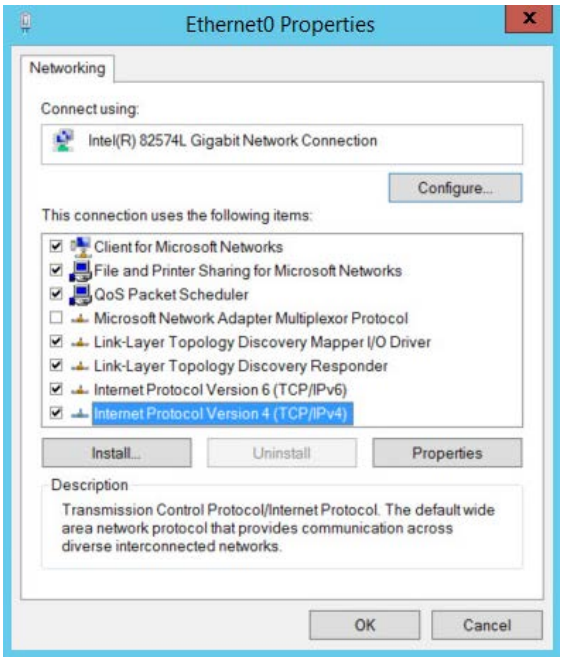
1. Right-click the network icon in the task bar on a computer that you wish to add to the domain.
2. Click **Open Network and Sharing Center.**



3. Click the name of the internet adapter.



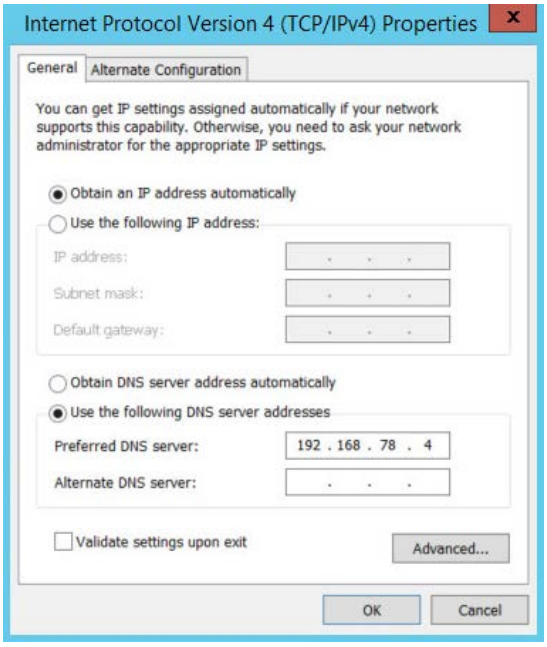
394 4. Click **Properties.**



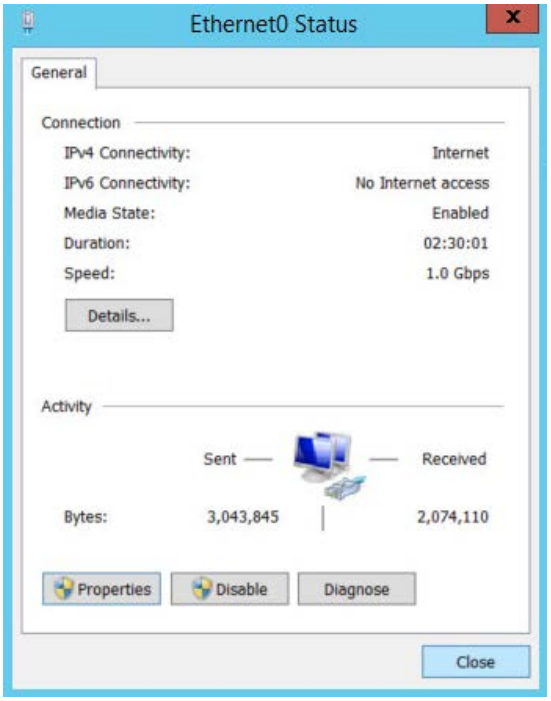
395 5. Double-click **Internet Protocol Version 4 (TCP/IPv4).**

396 6. Select **Use the following DNS server addresses.**

7. Enter the **IP address** of the DNS server.

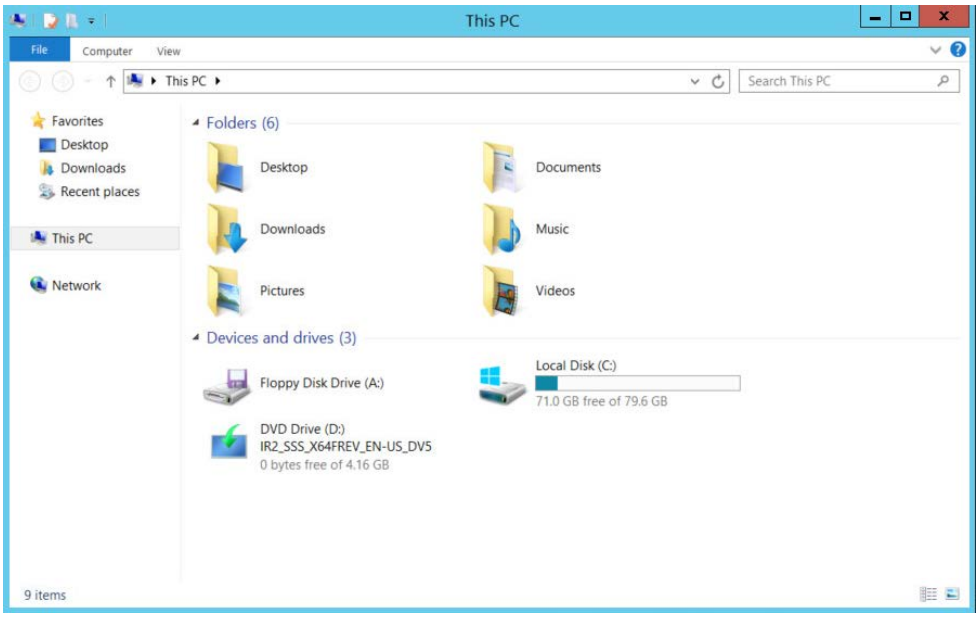


8. Click **OK.**
9. Click **OK.**



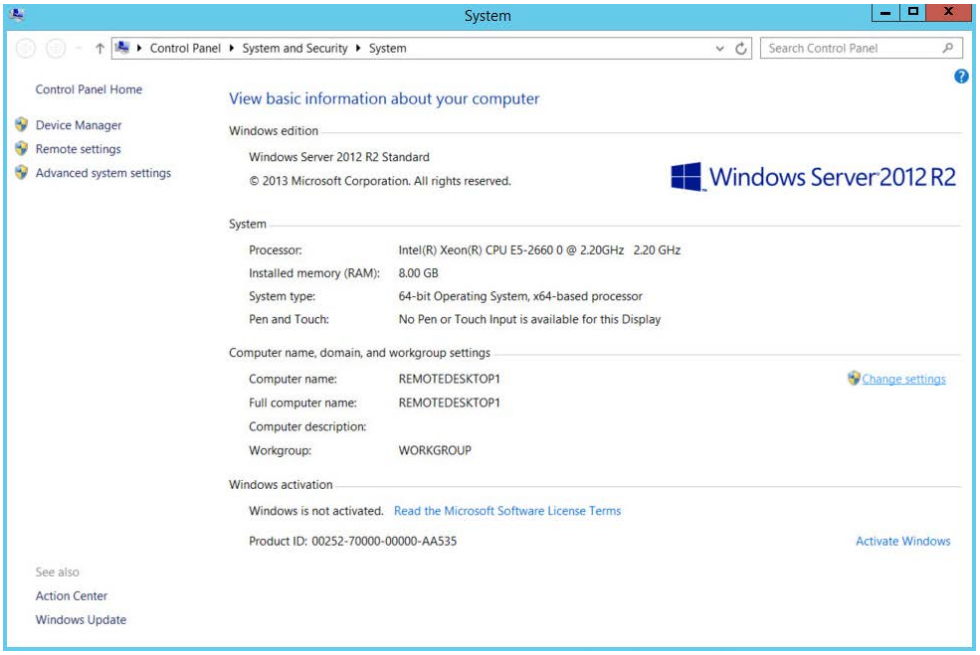
10. Click **Close.**

403 11. Navigate to **This PC.**



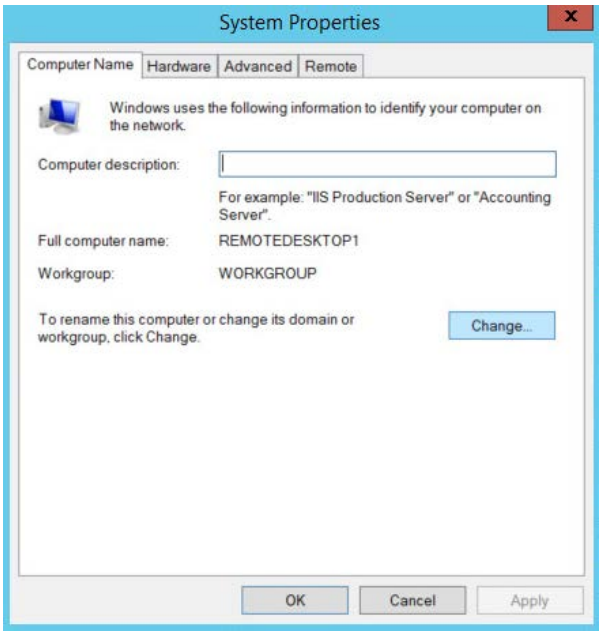
404

405 12. Right-click in the window and click **Properties**.



406

407 13. Click **Change Settings.**



408

409 14. Click **Change.**

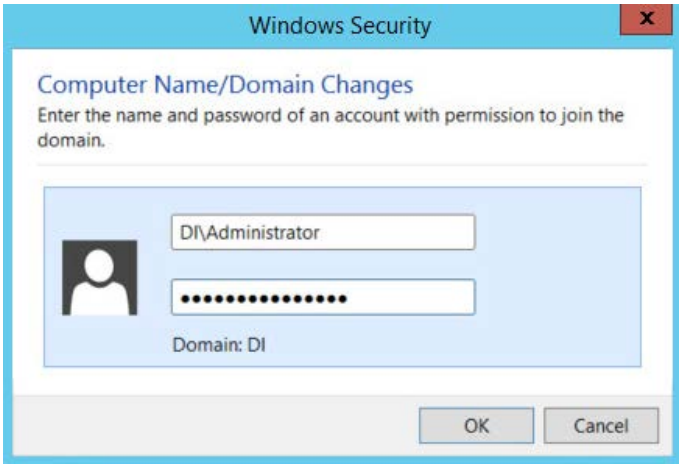
410 15. Select **Domain.**

411 16. Enter the domain.

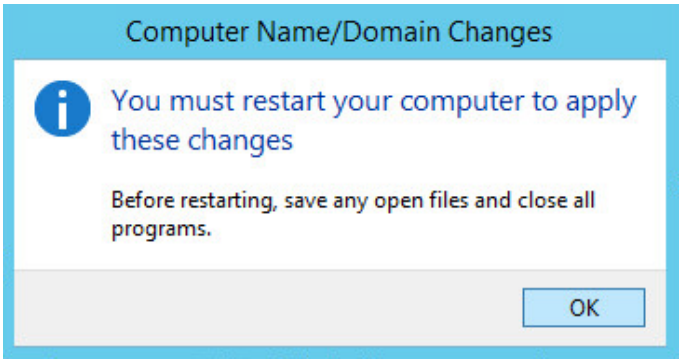
412

413 17. Click **OK.**

18. Enter the **username** and **password** of an account with privileges to add computers to the domain.



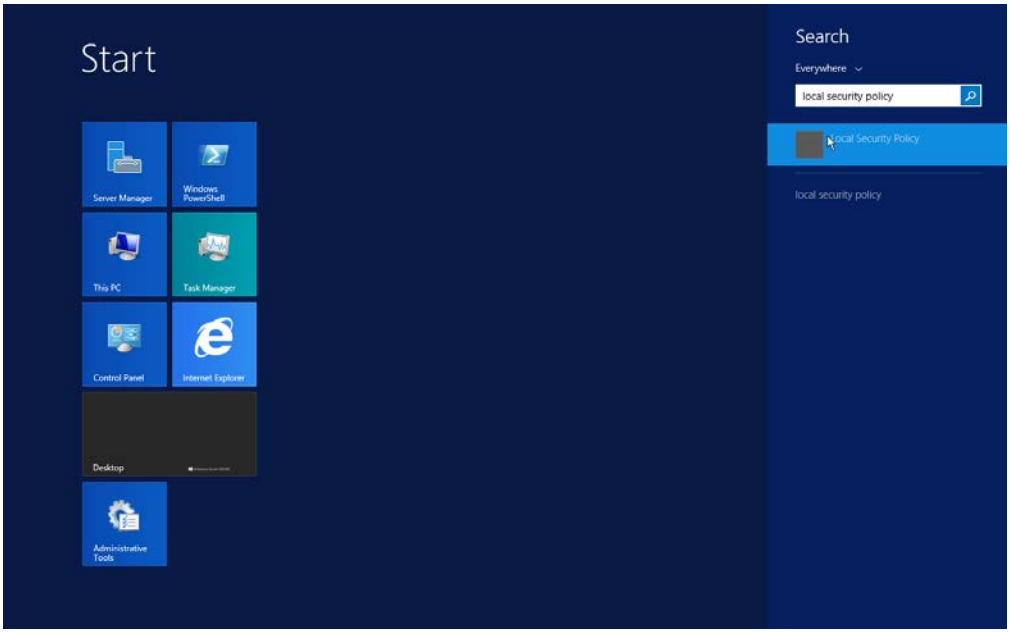
19. Click **OK.**



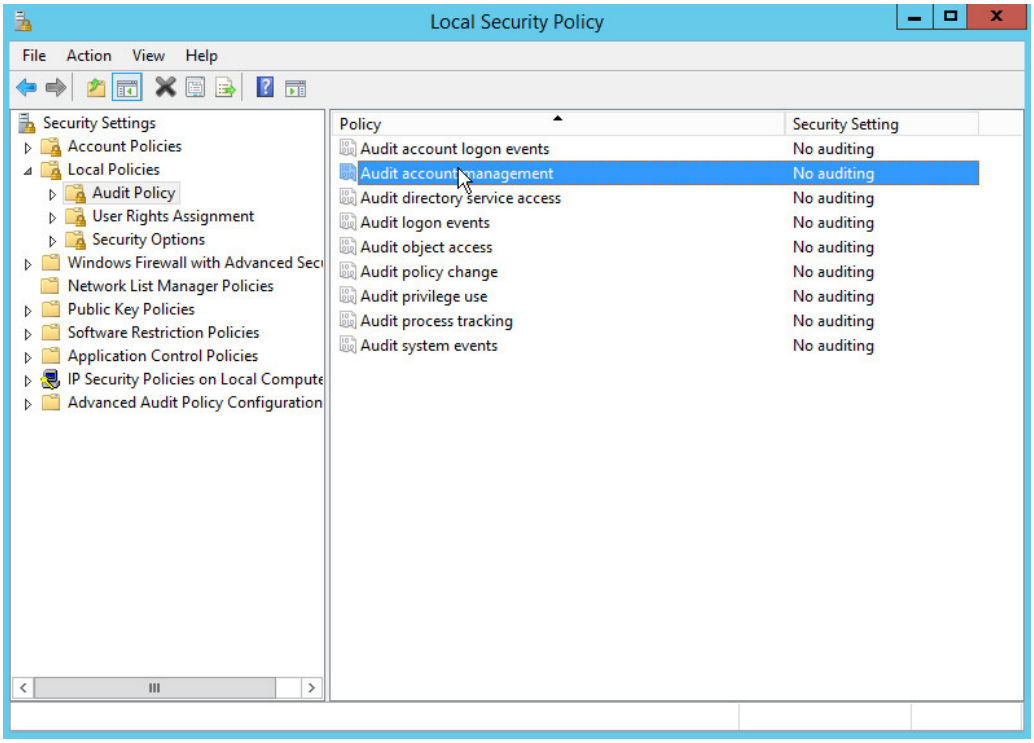
20. Click **OK** when prompted to restart the computer.

2.1.5 Configure Active Directory to Audit Account Activity

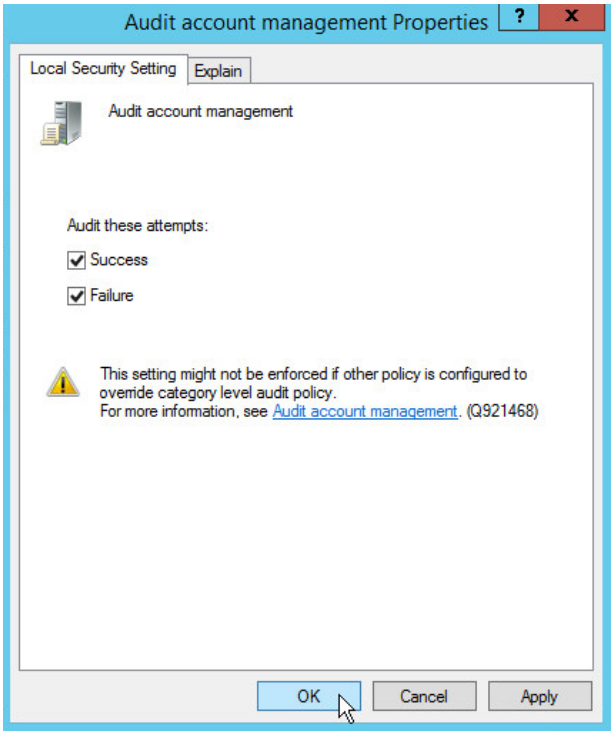
1. Open the Start menu.



2. Enter “Local Security Policy” in the search bar and open the program.
3. Navigate to **Local Policies > Audit Policy.**
4. Right-click **Audit account management.**



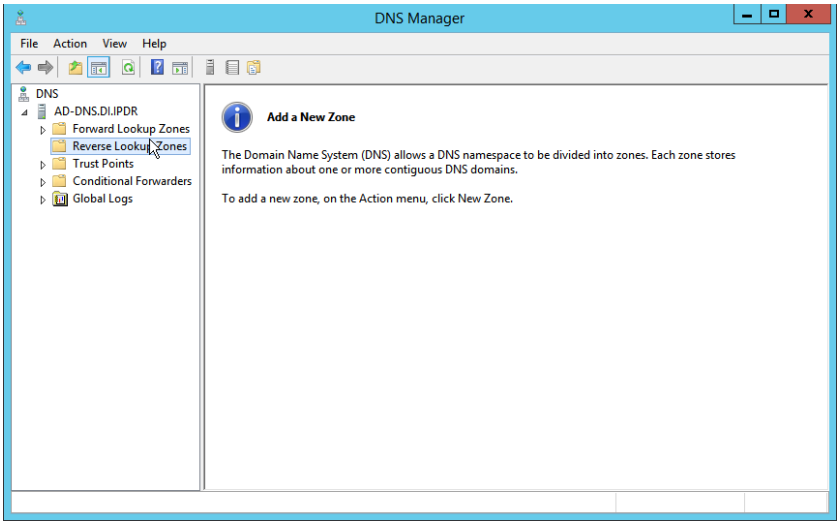
5. Click **Properties.**
6. Check the boxes next to **Success** and **Failure.**



7. Click **OK.**

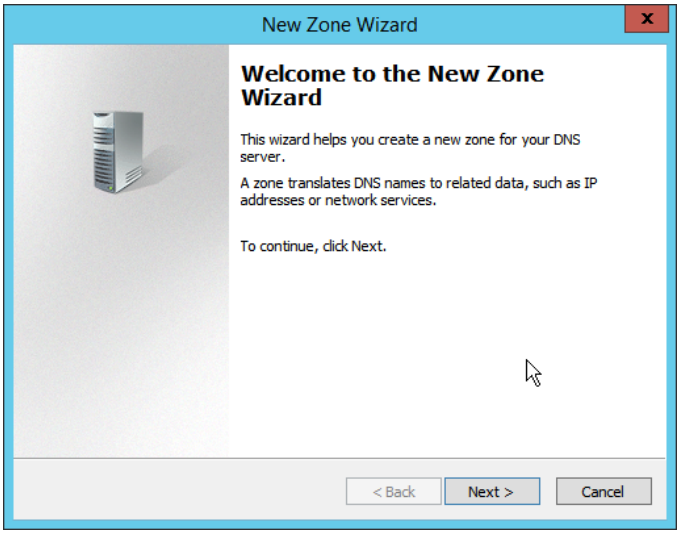
2.1.6 Configure Reverse Lookup Zones

1. Open **DNS Manager** by right-clicking the DNS server in **Server Manager.**
2. Click **Reverse Lookup Zones.**



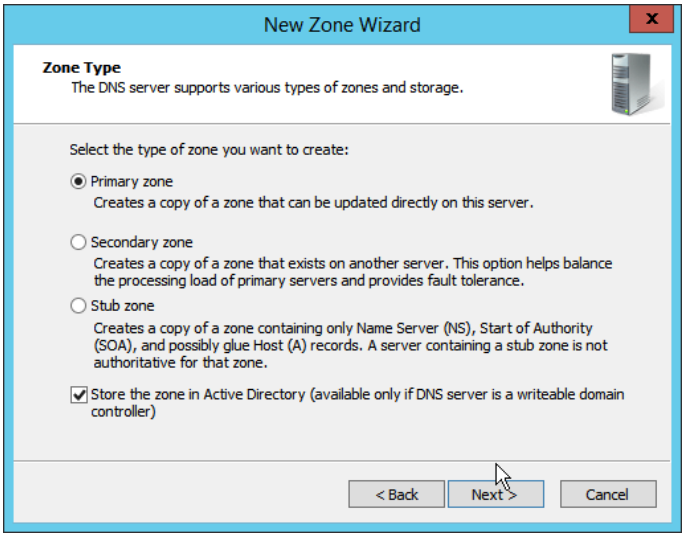
434

435 3. Click **Action > New Zone.**



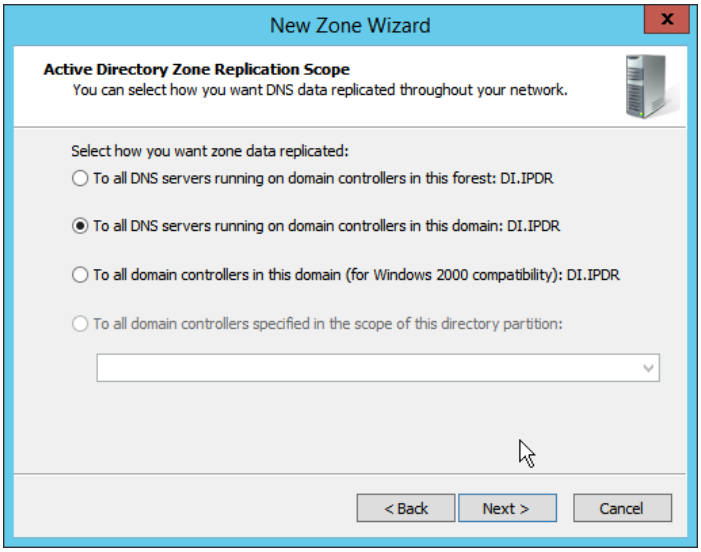
436

437 4. Click **Next.**



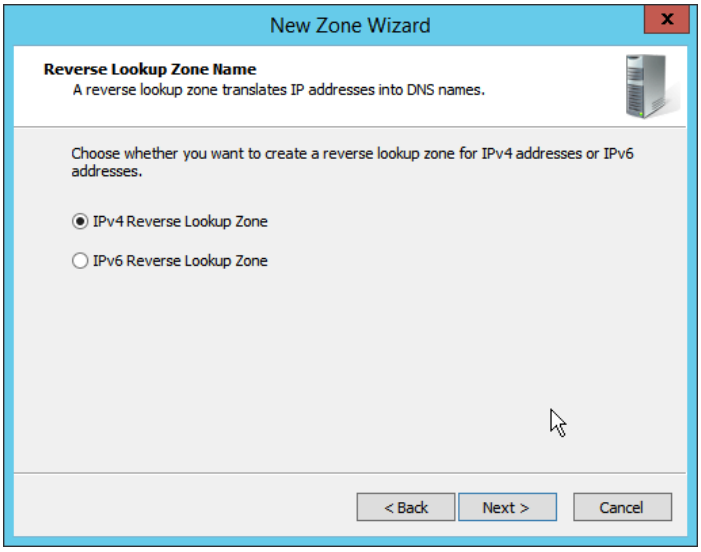
438

439 5. Click **Next.**



440

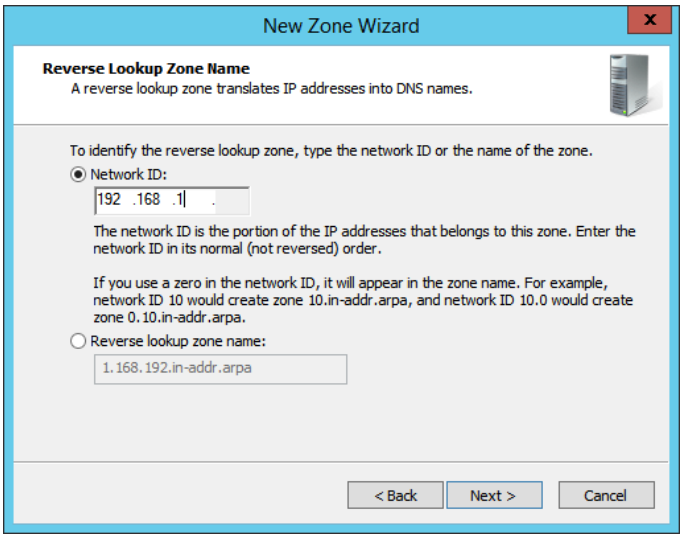
441 6. Click **Next.**



442

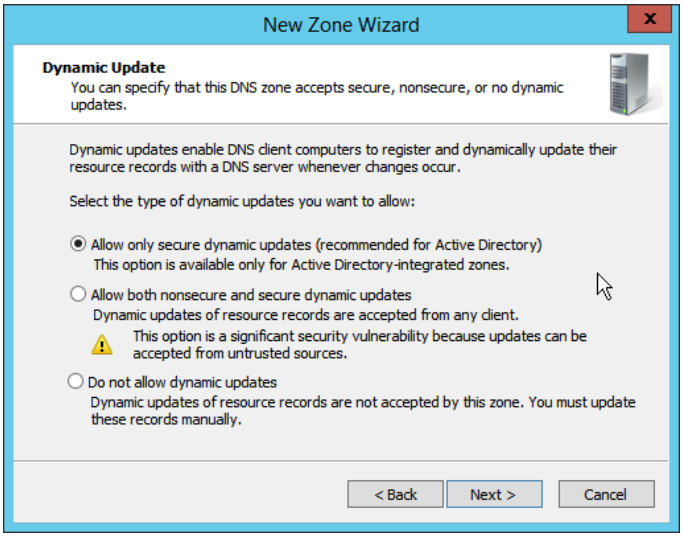
443 7. Click **Next.**

444 8. Enter the first three parts of the IP address of the Active Directory (AD)/DNS server (for
445 example, 192.168.1).



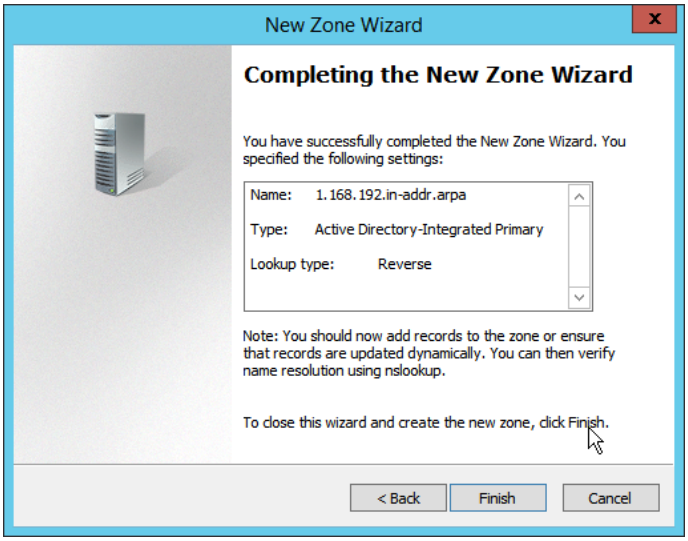
446

447 9. Click **Next.**



448

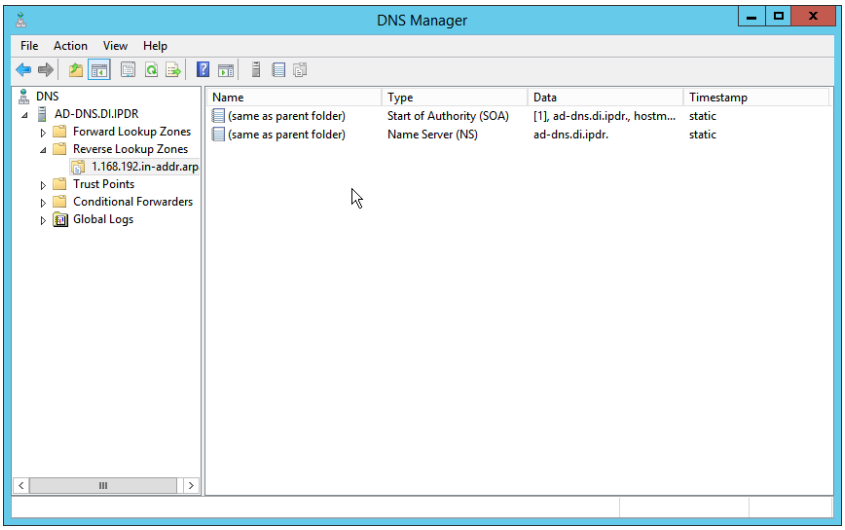
449 10. Click **Next.**



450

451 11. Click **Finish.**

452 12. Click on the newly created reverse lookup zone.

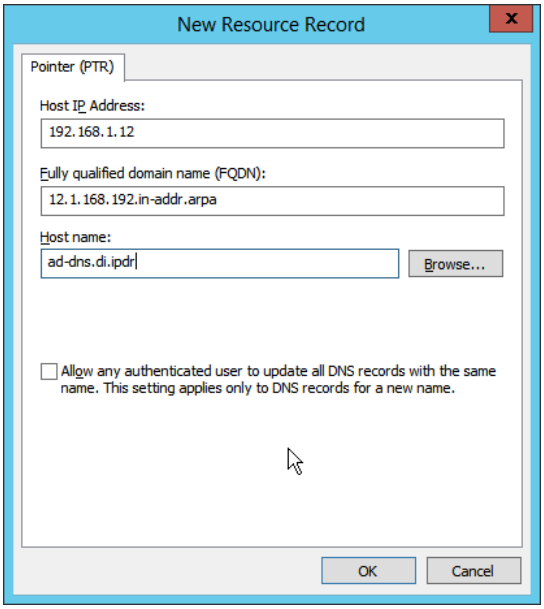


453

454 13. Right-click in the window and select **New Pointer (PTR)….**

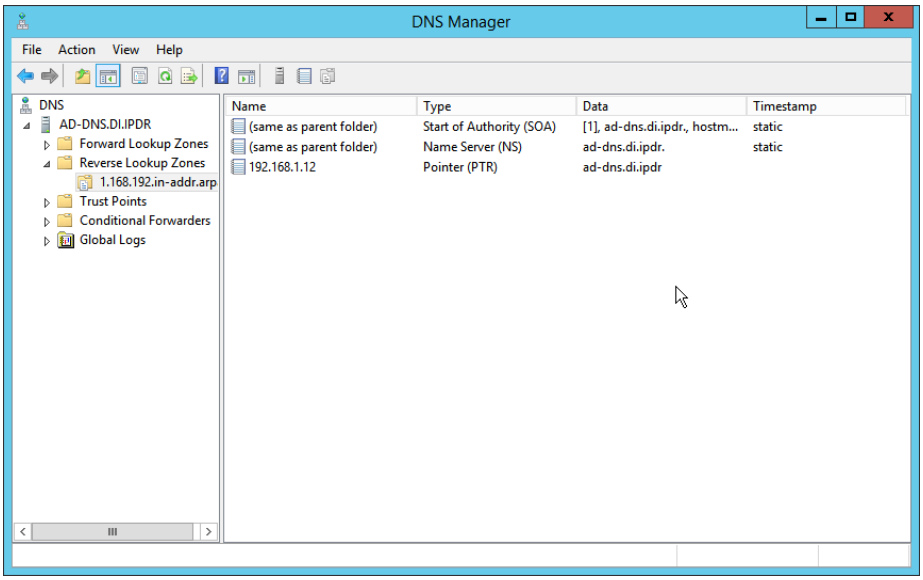
455 14. Enter the **IP address** of the AD/DNS server.

456 15. Enter the **hostname** of the AD/DNS server.



457

458 16. Click **OK.**

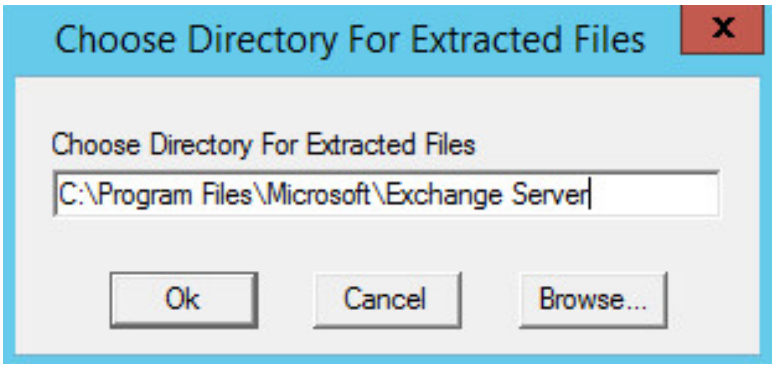


2.2 Microsoft Exchange Server

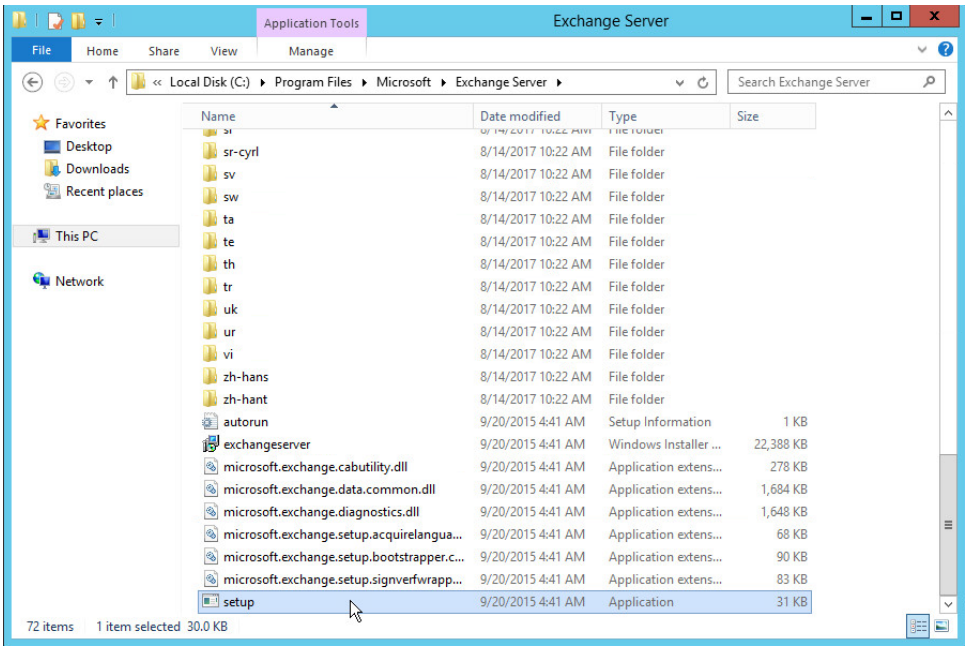
As part of our enterprise emulation, we include a Microsoft Exchange server. This section covers the installation and configuration process used to set up Microsoft Exchange on a Windows Server 2012 R2 machine.

2.2.1 Install Microsoft Exchange

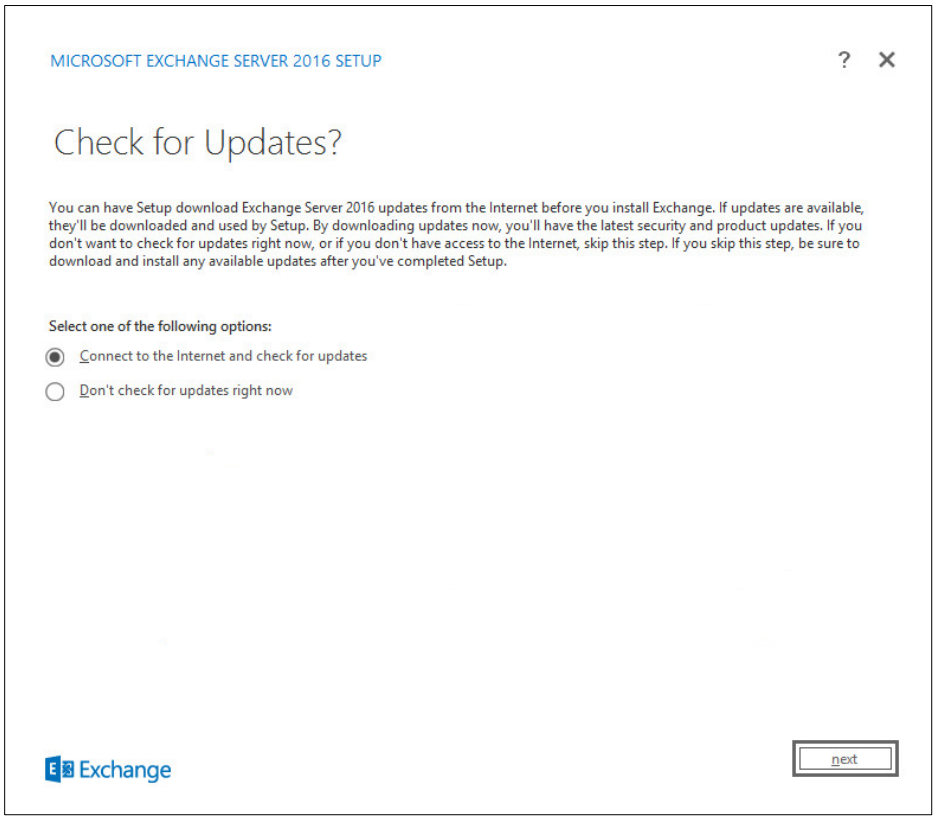
1. Run **Exchange2016-x64.exe.**
2. Choose the directory for the extracted files.



3. Click **OK.**



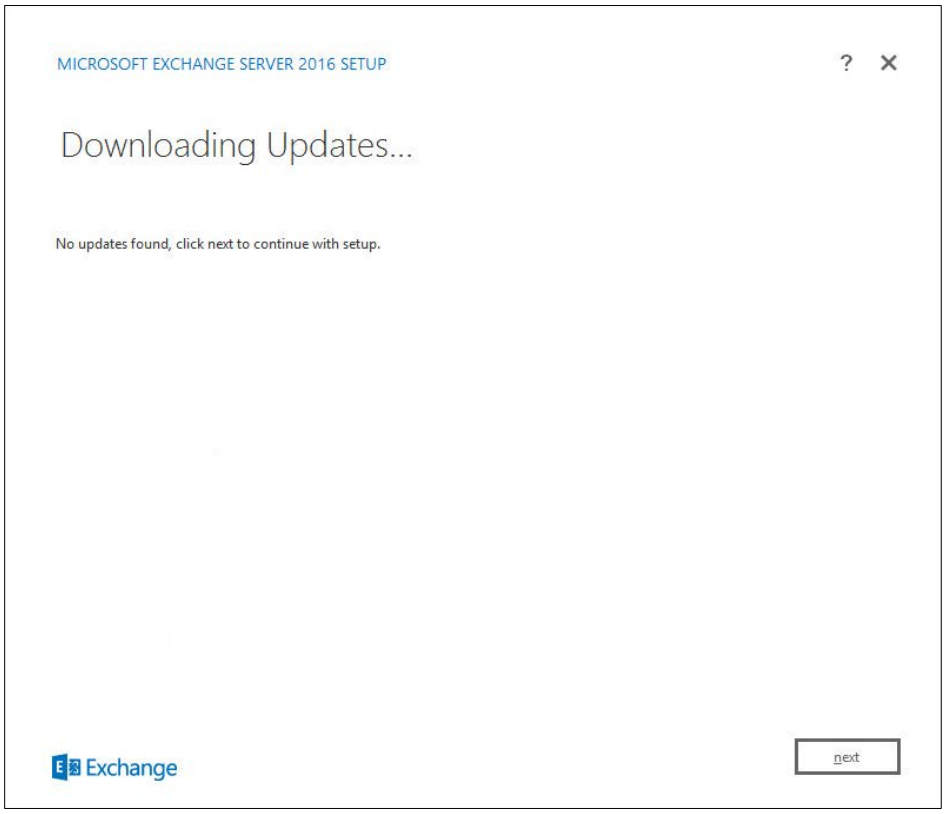
4. Enter the directory and run **setup.exe.**
5. Select **Connect to the Internet and check for updates.**



472

473 6. Click **Next.**

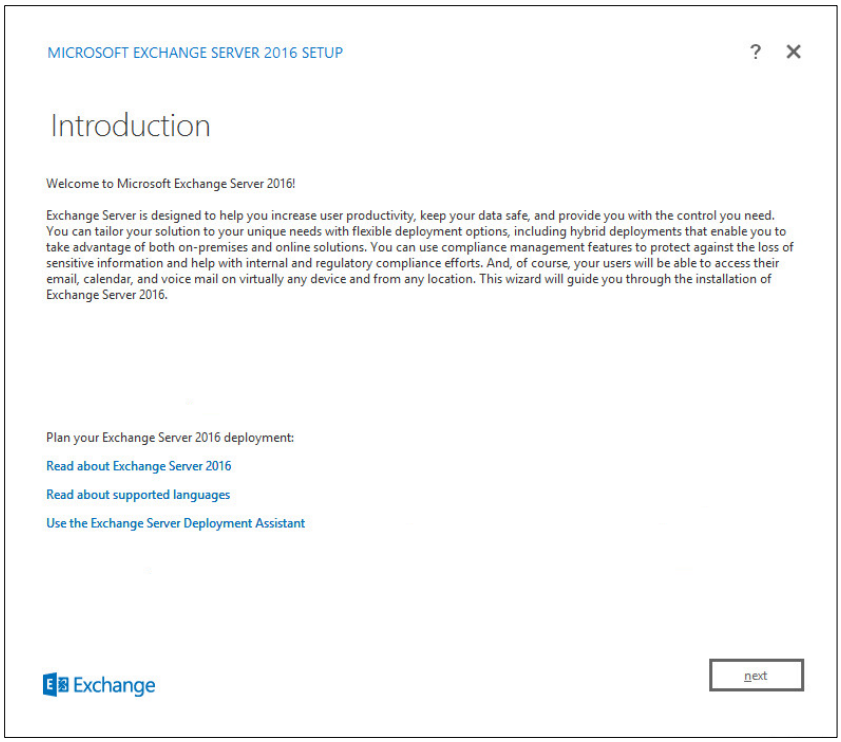
474 7. Wait for the check to finish.



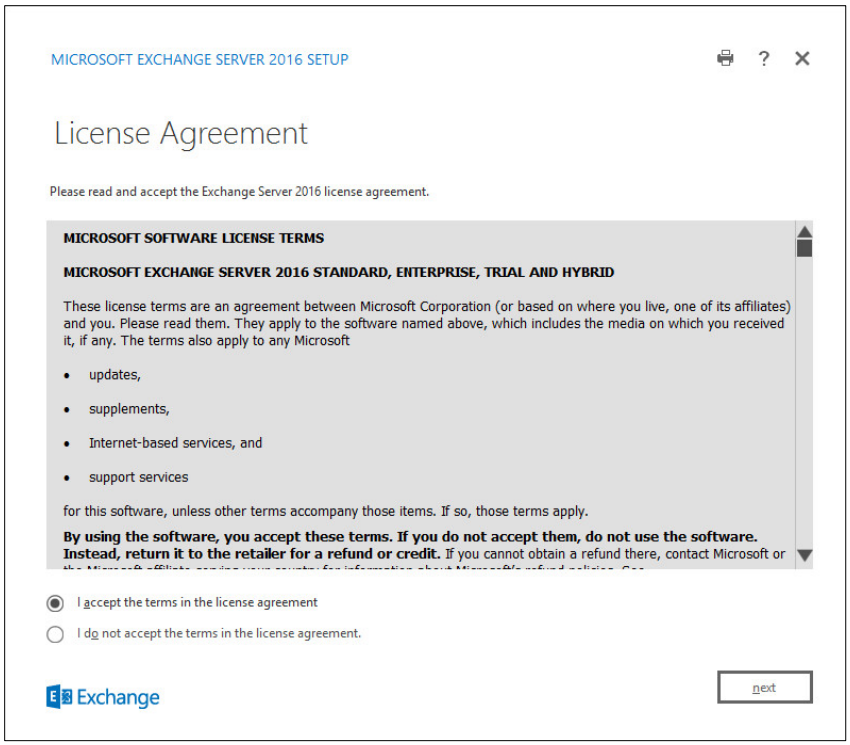
475

476 8. Click **Next.**

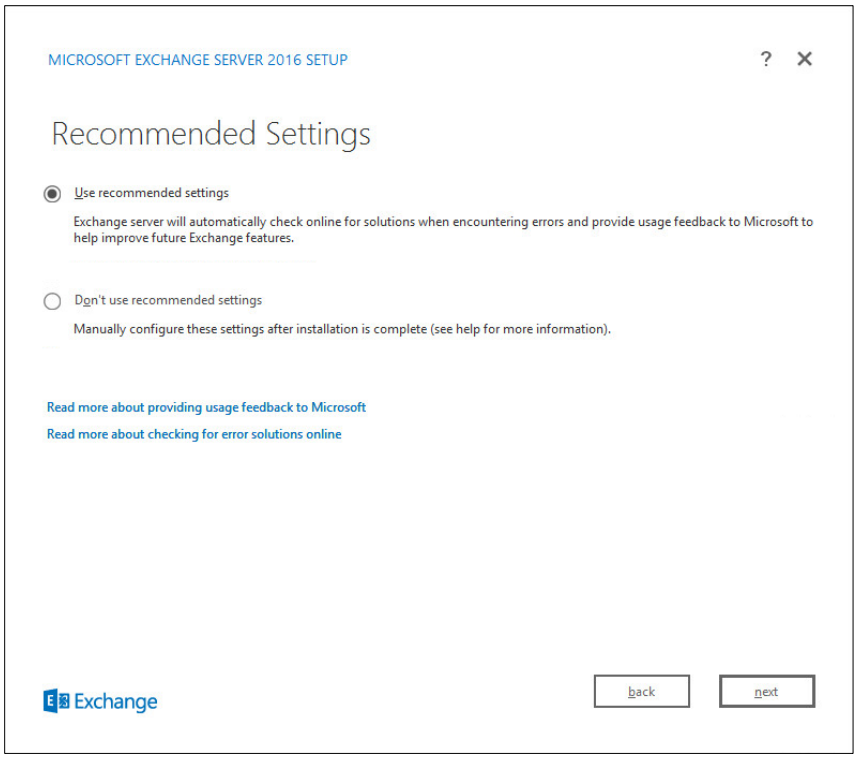
477 9. Wait for the copying to finish.



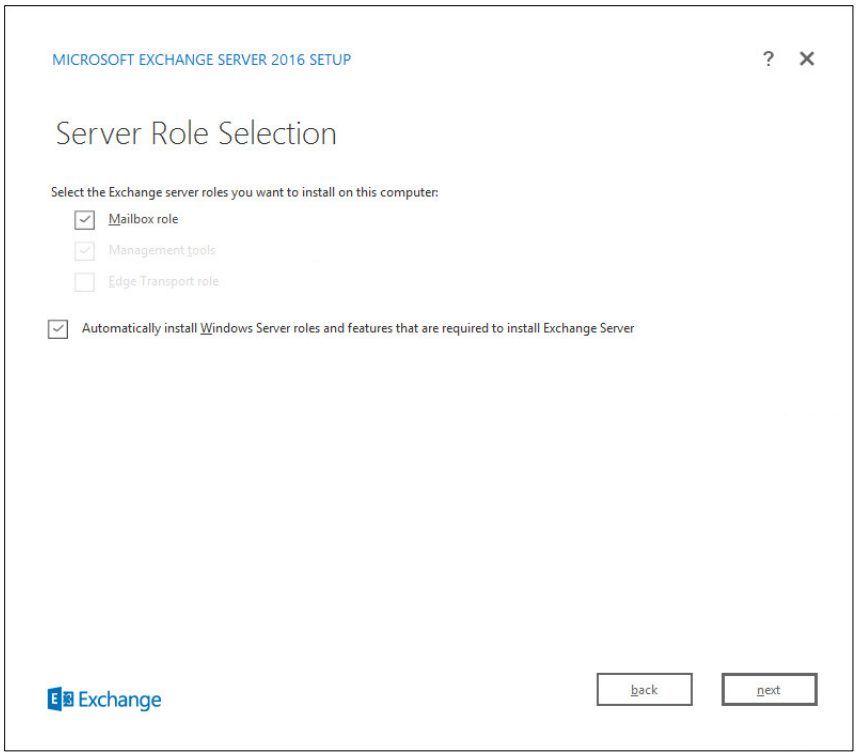
10. Click **Next.**
11. Click **I accept the terms in the license agreement.**



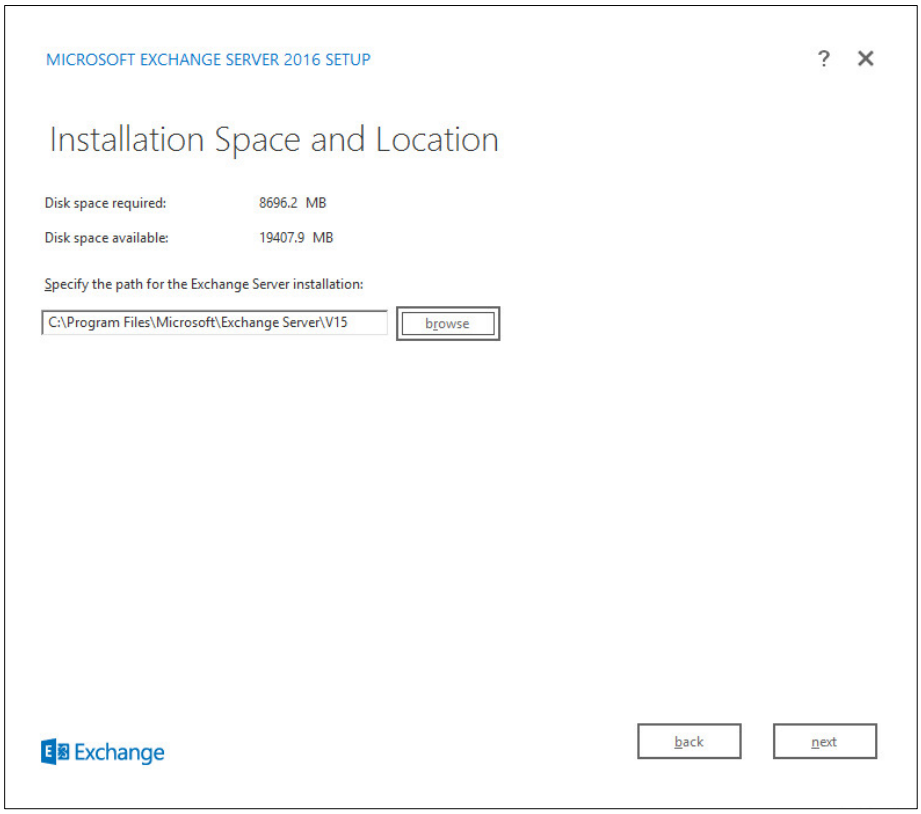
12. Click **Next.**
13. Click **Use Recommended Settings.**



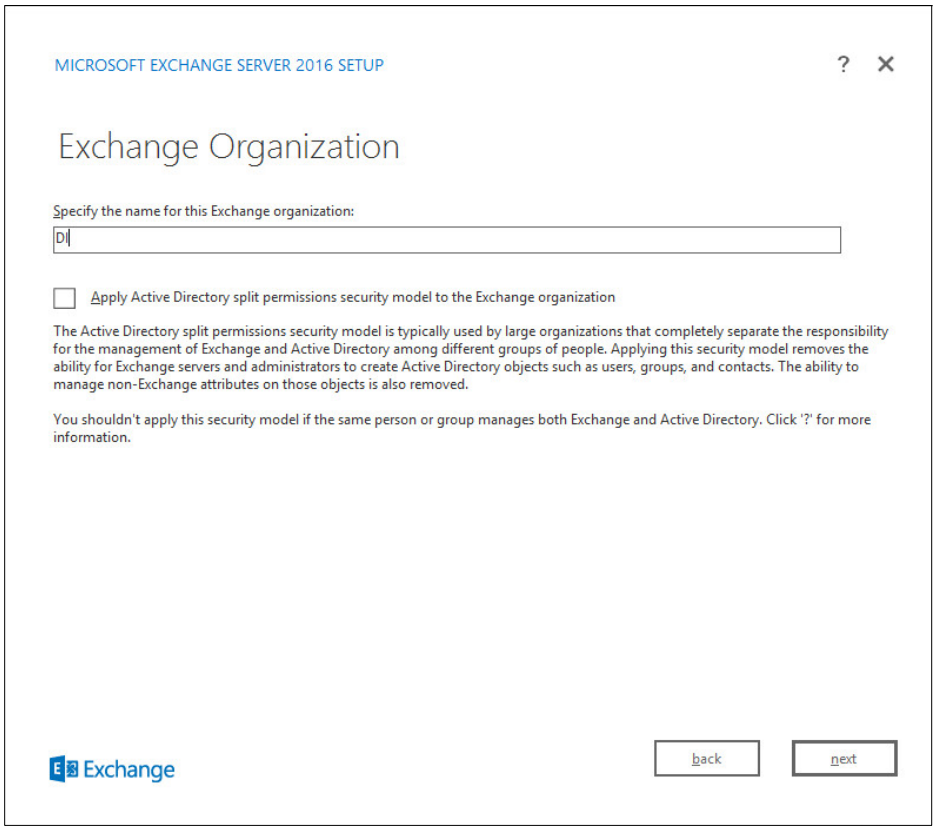
14. Click **Next.**
15. Check **Mailbox role.**
16. Check **Automatically install Windows Server roles and features that are required to install Exchange Server.**



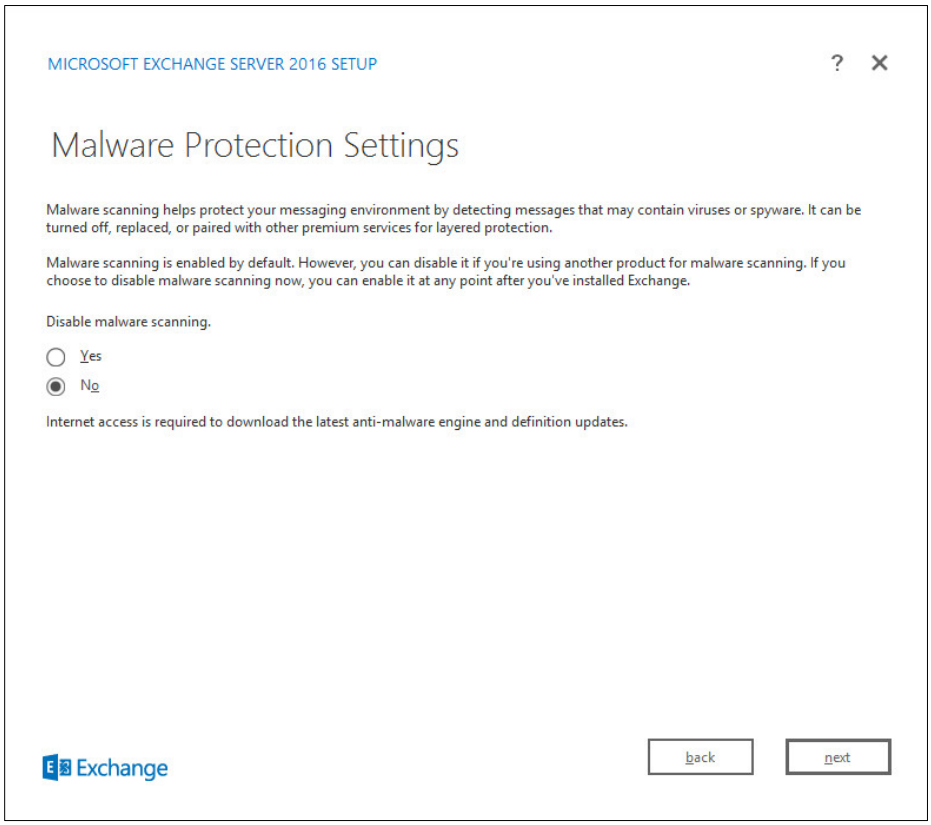
17. Click **Next.**
18. Specify the installation path for MS Exchange.



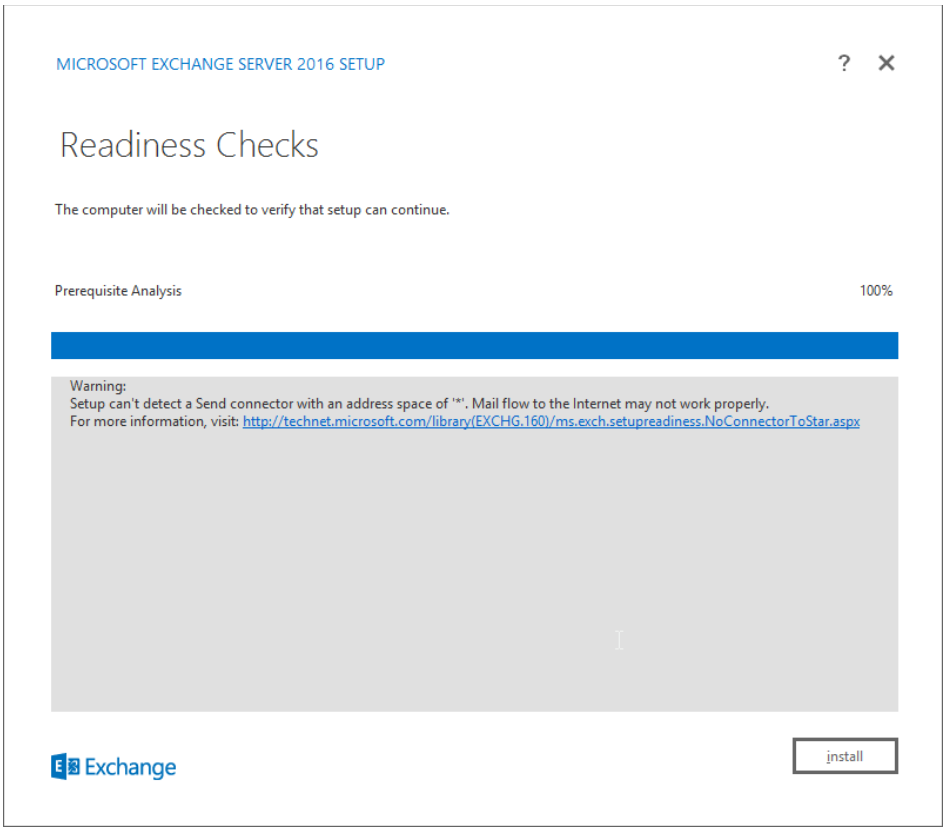
19. Click **Next.**
20. Specify the name for the Exchange organization, e.g., DI.
21. Decide whether to apply split permissions based on the needs of the enterprise.



22. Click **Next.**
23. Select **No.**



24. Click **Next.**
25. Install any **prerequisites** listed.
26. If necessary, restart the server and rerun **setup.exe,** following through steps 3–22 again.



27. Click **Install.**

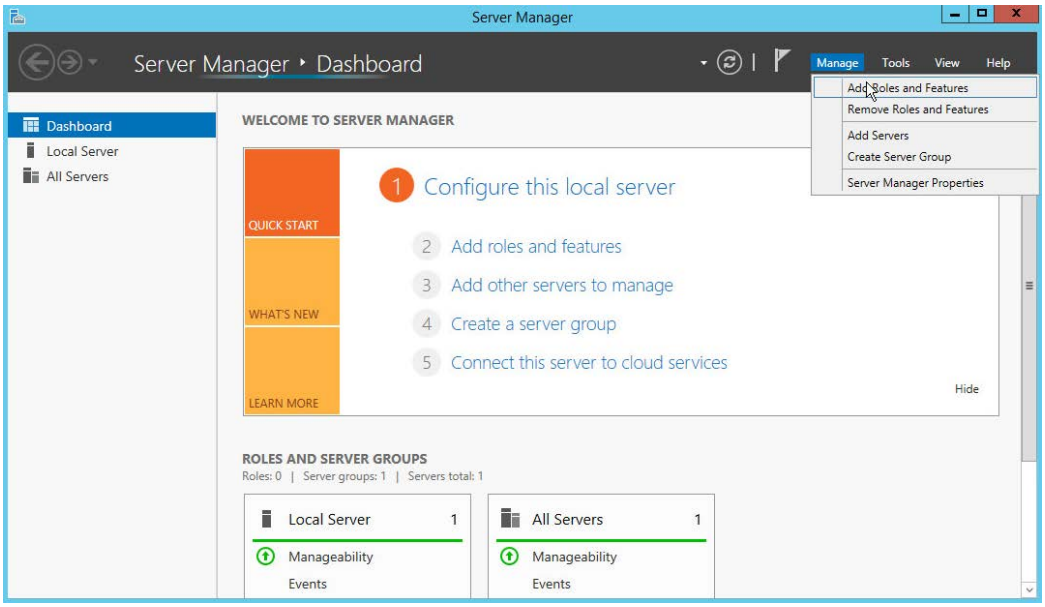
2.3 Windows Server Hyper-V Role

As part of our simulated enterprise, we include a Windows Hyper-V server. This section covers the instructions for installing the Windows Server Hyper-V Role on a Windows Server 2012 R2 machine.

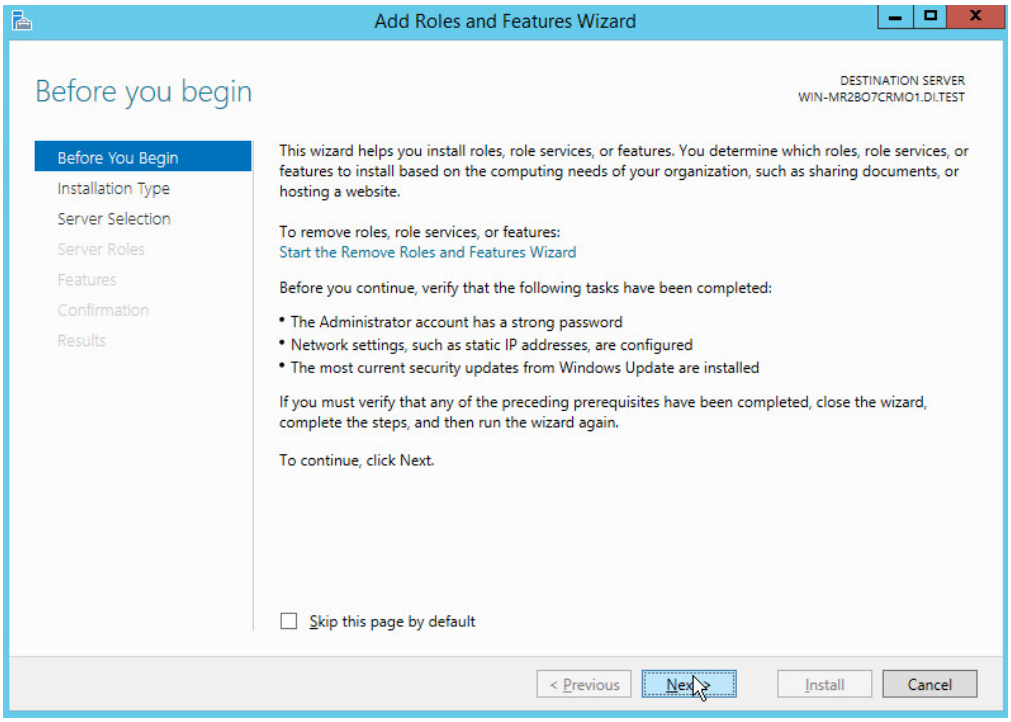
The instructions for enabling the Windows Server Hyper-V Role are retrieved from https://technet.microsoft.com/en-us/library/hh846766(v=ws.11).aspx and are replicated below for preservation and ease of use.

2.3.1 Production Installation

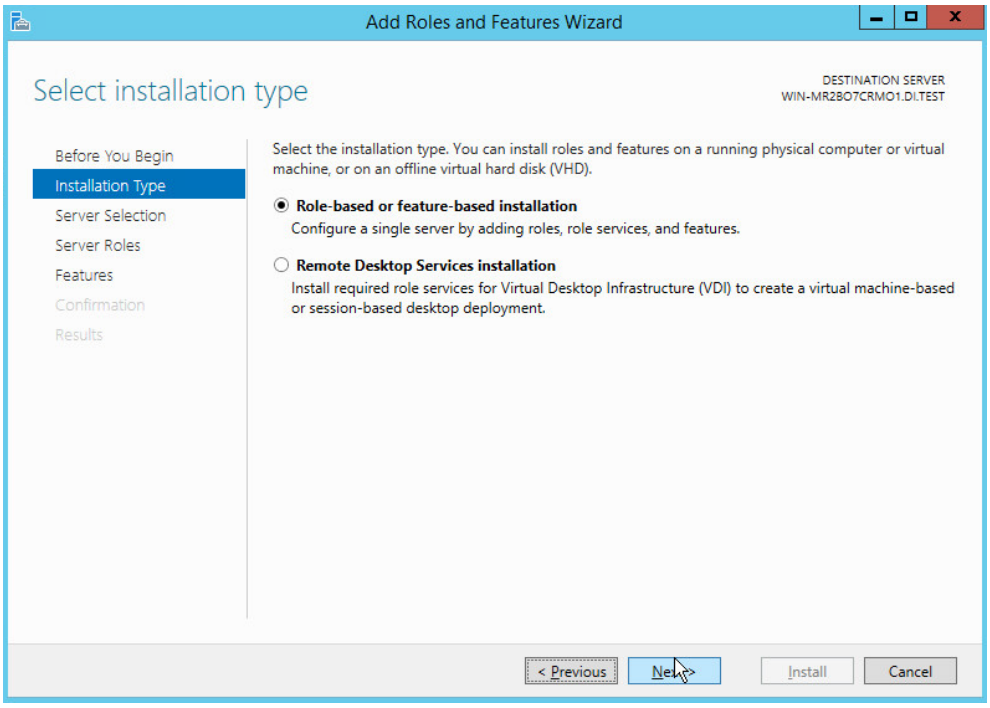
1. In **Server Manager** on the **Manage** menu, click **Add Roles and Features.**



2. On the **Before you begin** page, verify that your destination server and network environment are prepared for the role and feature you want to install.



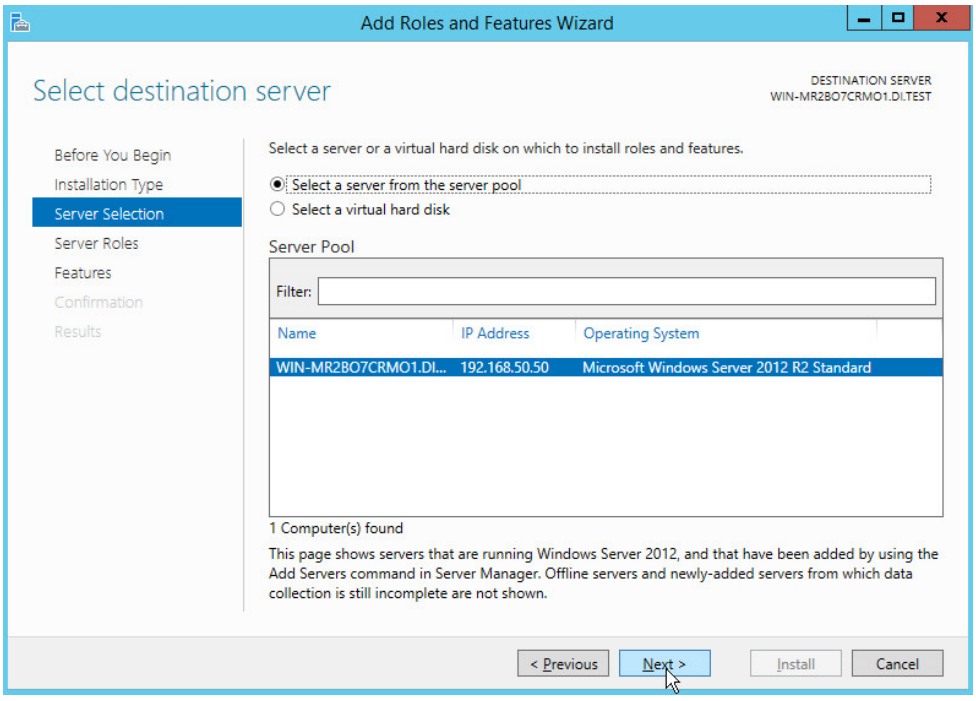
3. Click **Next.**
4. On the **Select installation type** page, select **Role-based or feature-based installation.**



519

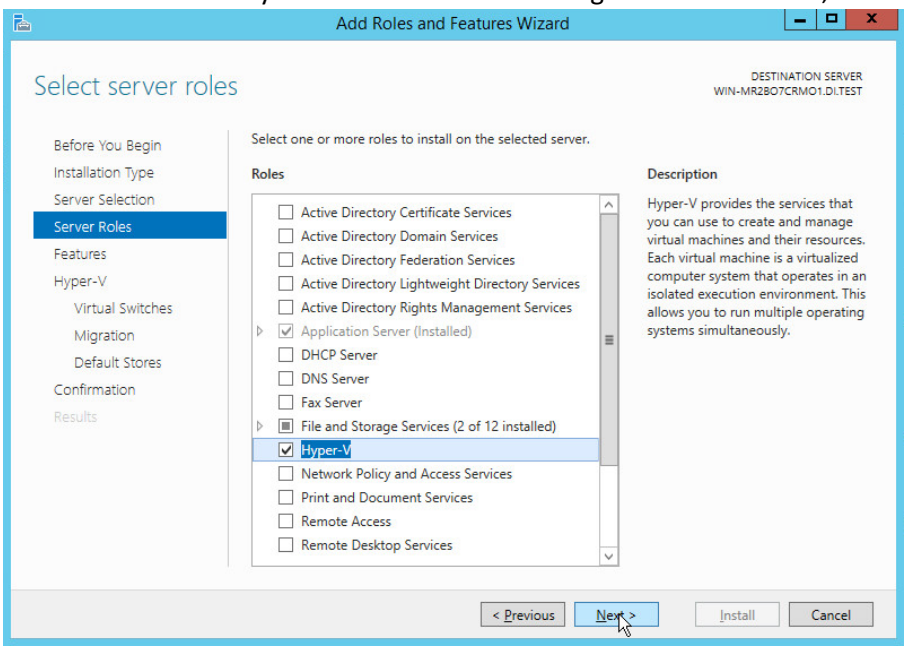
520 5. Click **Next.**

521 6. On the **Select destination server** page, select a server from the server pool.

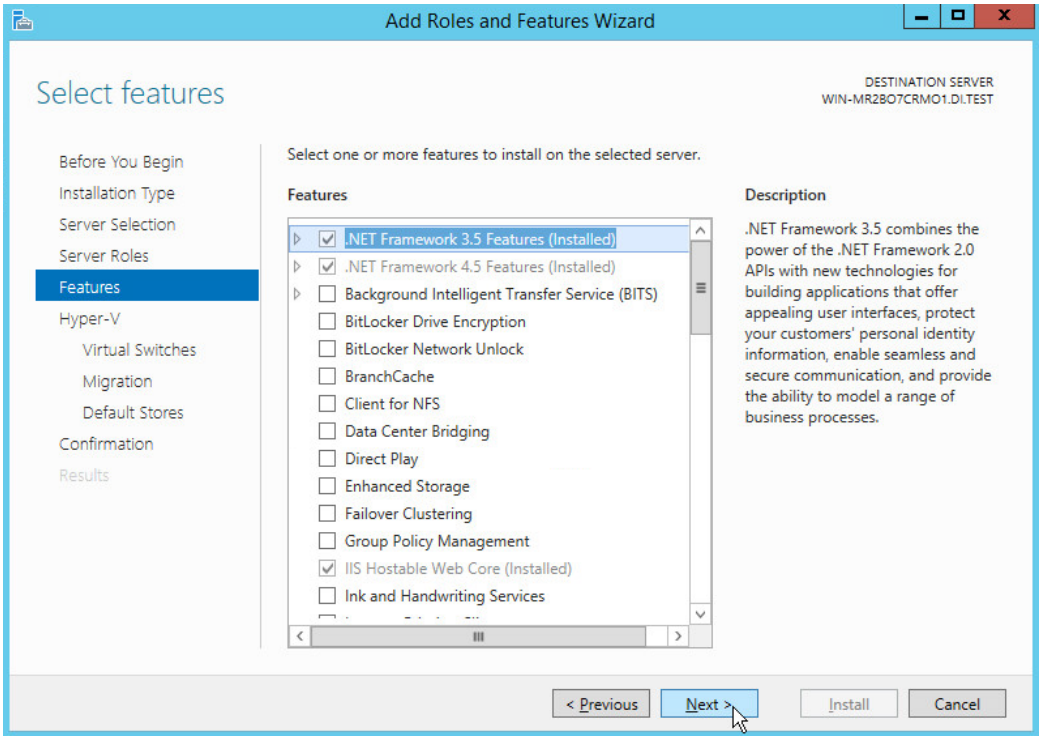


522

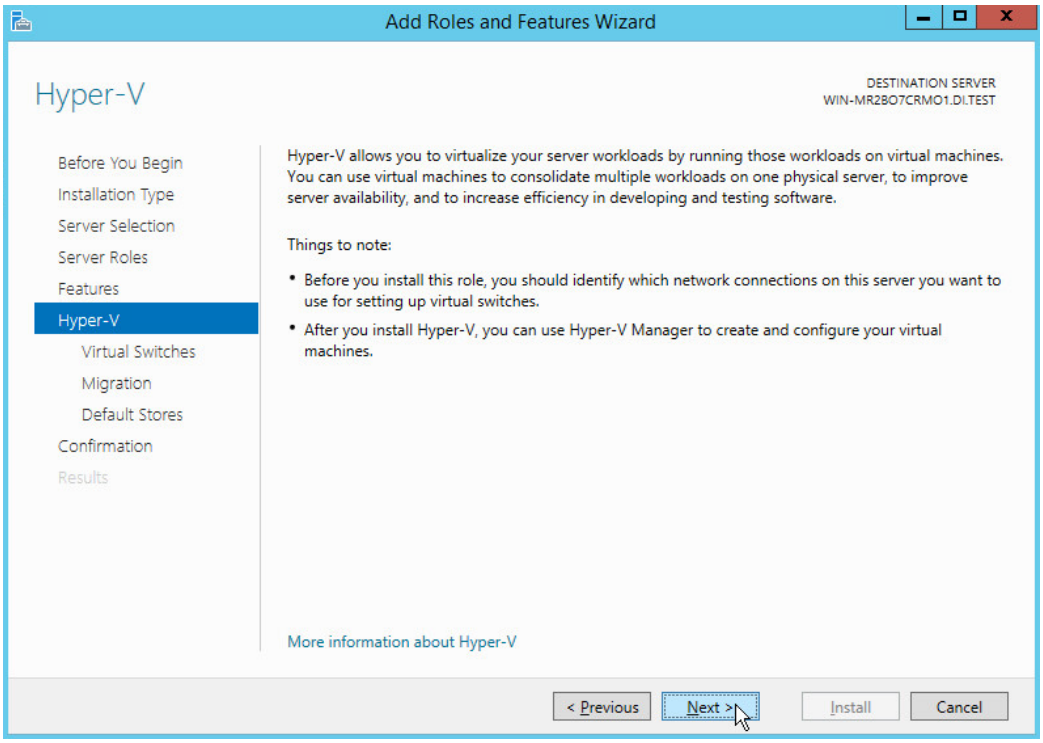
7. Click **Next.**
8. On the **Select server roles** page, select **Hyper-V.**
9. To add the tools that you use to create and manage virtual machines, click **Add Features.**



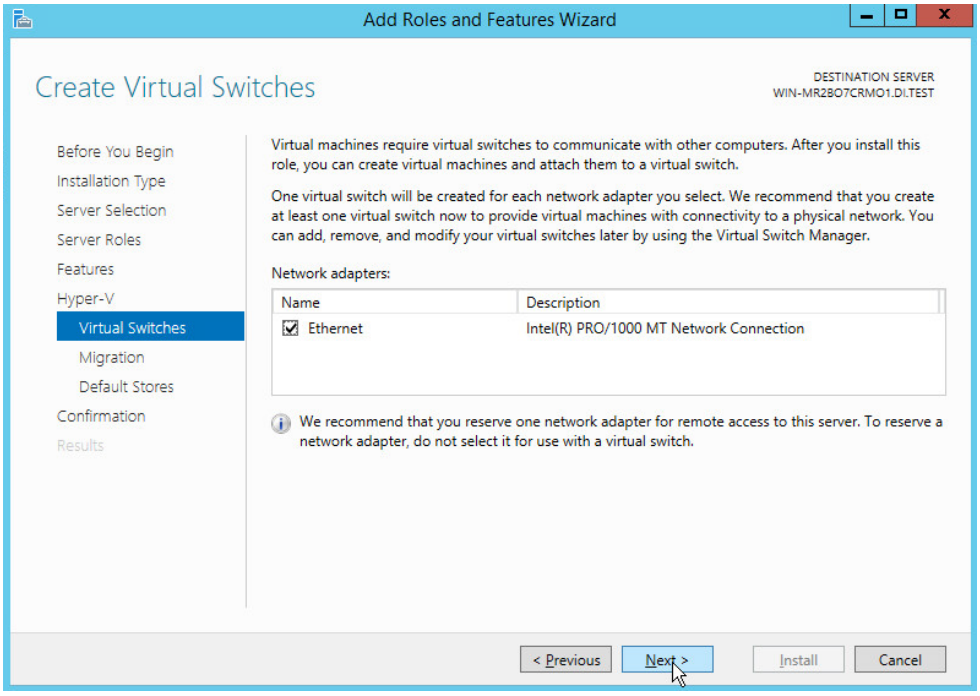
10. Click **Next.**



11. Click **Next.**



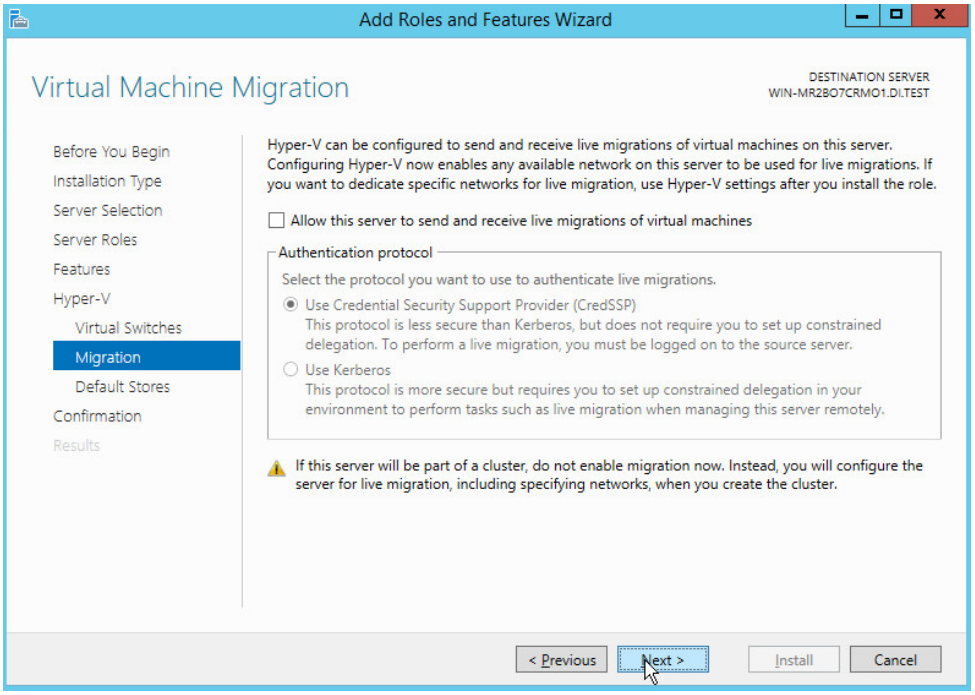
12. Click **Next.**
13. On the **Create Virtual Switches** page, select the appropriate options.



533

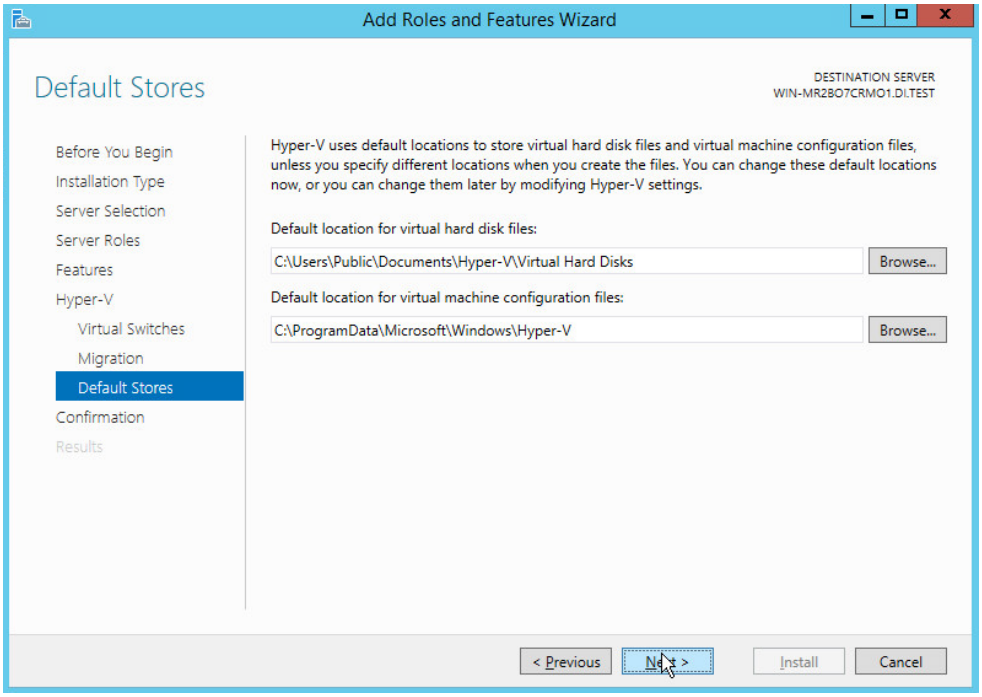
534 14. Click **Next.**

535 15. On the **Virtual Machine Migration** page, select the appropriate options.

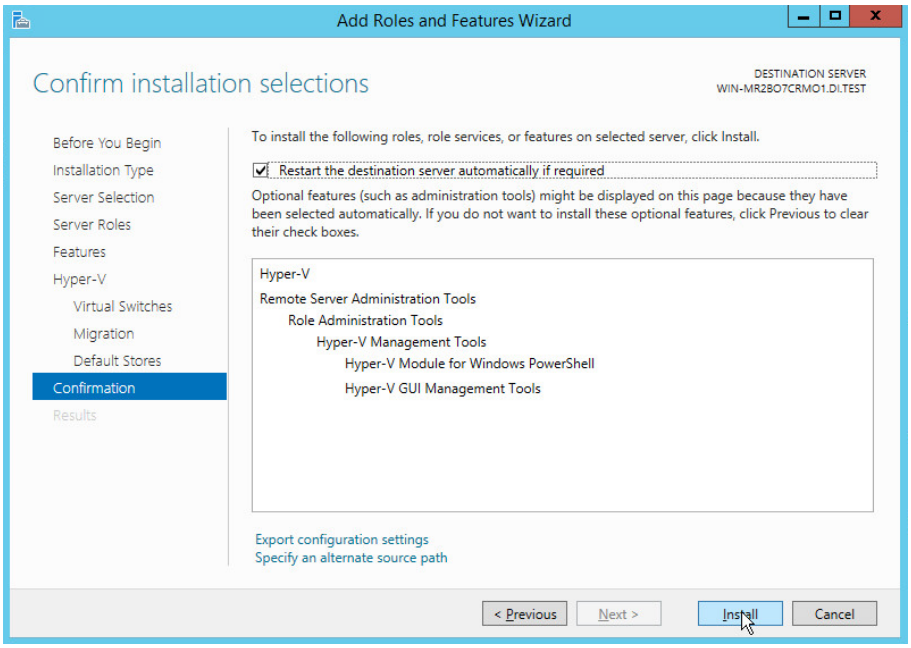


536

16. Click **Next.**
17. On the **Default Stores** page, select the appropriate options.



18. Click **Next.**
19. On the **Confirm installation selections** page, select **Restart the destination server automatically if required.**



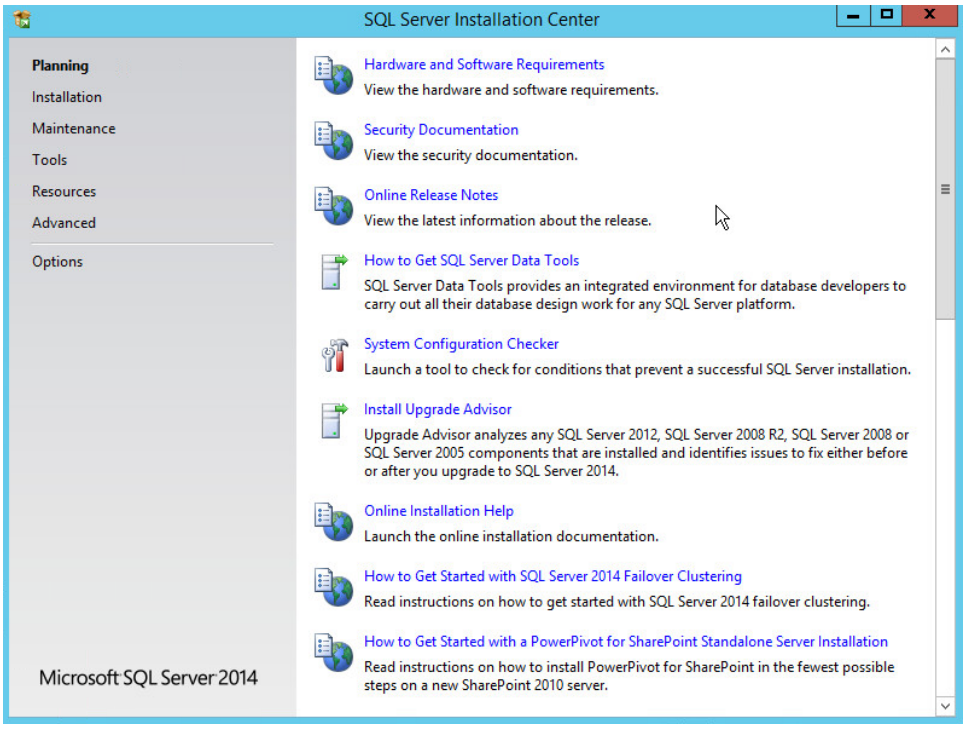
20. Click **Install.**
21. When installation is finished, verify that Hyper-V installed correctly. Open the **All Servers** page in Server Manager, and select a server on which you installed Hyper-V. Check the **Roles and Features** tile on the page for the selected server.

2.4 MS SQL Server

As part of both our enterprise emulation and data integrity solution, we include a Microsoft SQL Server. This section covers the installation and configuration process used to set up Microsoft SQL Server on a Windows Server 2012 R2 machine.

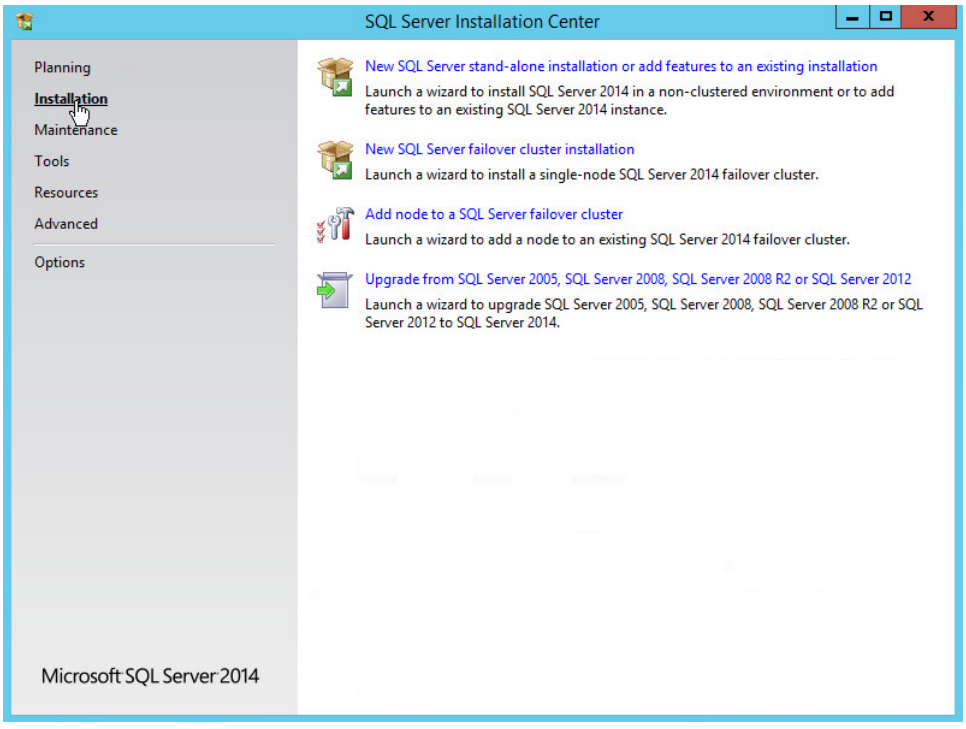
2.4.1 Install and Configure MS SQL

1. Acquire **SQL Server 2014 installation media**.
2. Locate the installation media in the machine and click on **SQL2014_x64_ENU** to launch **SQL Server Installation Center.**



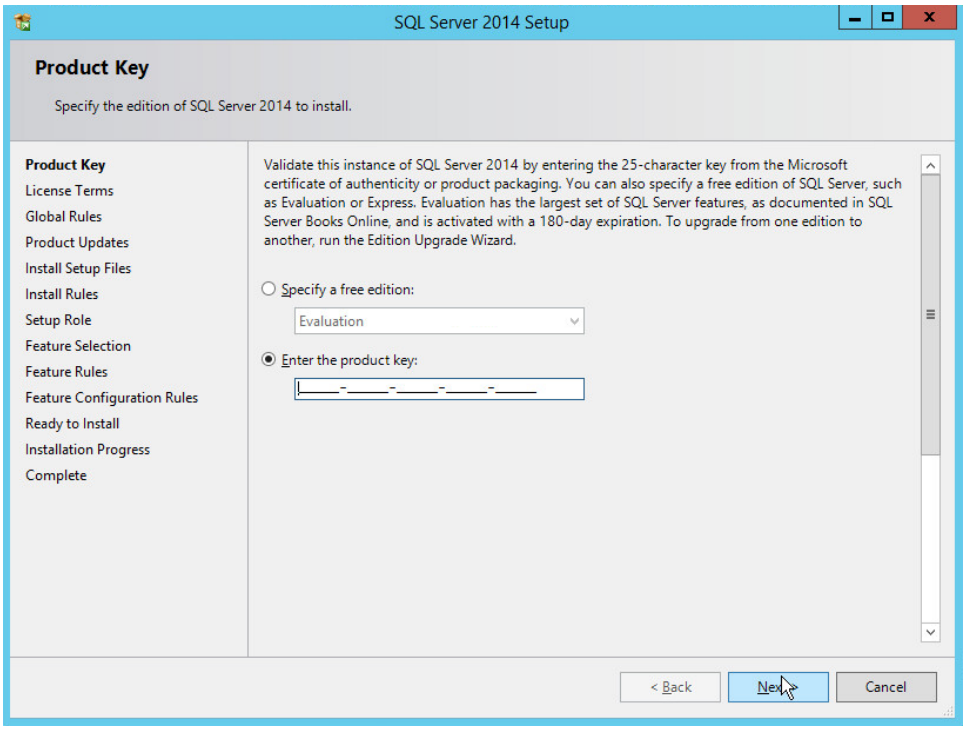
556

557 3. On the left menu, select **Installation.**

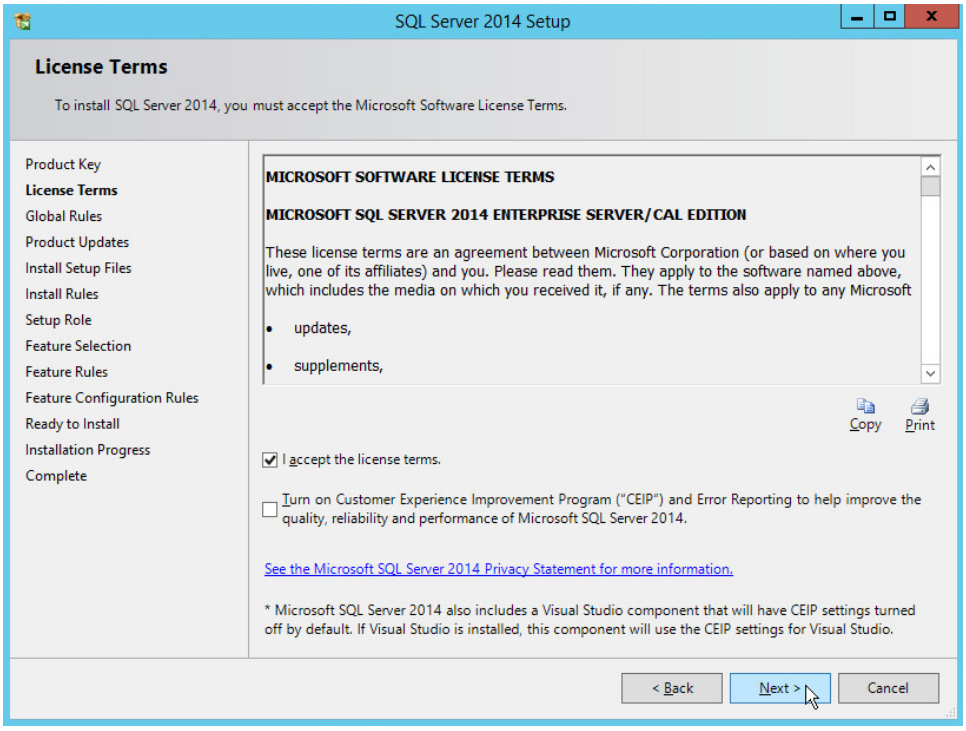


558

559 4. Select **New SQL Server stand-alone installation or add features to an existing installation.** This
560 will launch the SQL Server 2014 setup.
561 5. In the **Product Key** section, enter your product key.



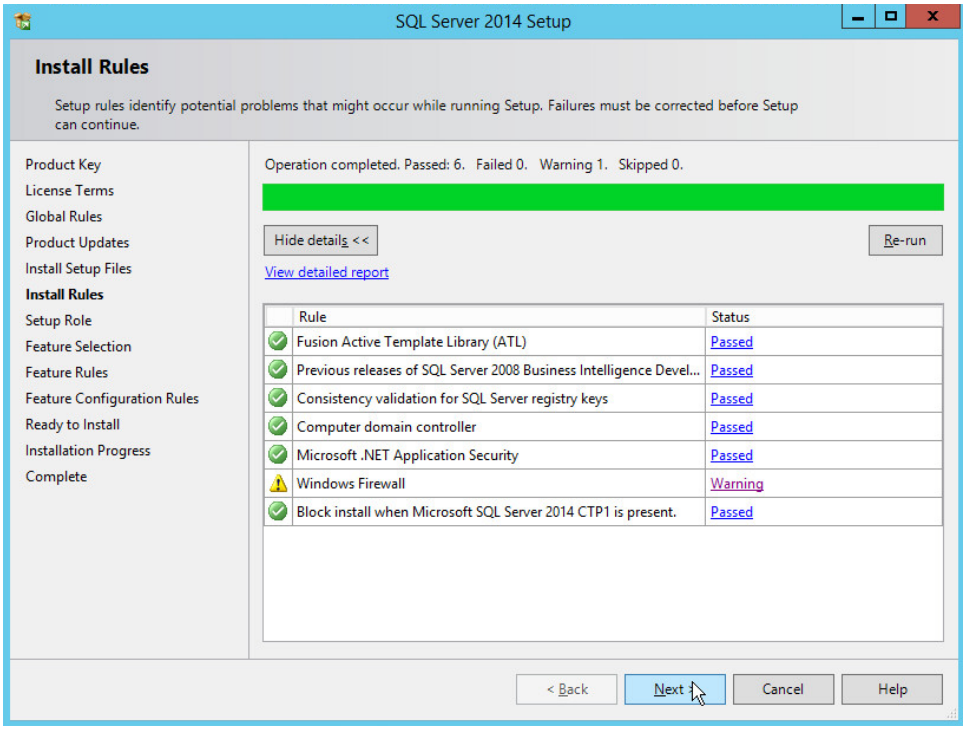
562
563 6. Click **Next.**
564 7. In the **License Terms** section, read and click **I accept the license terms.**



565

566 8. Click **Next.**

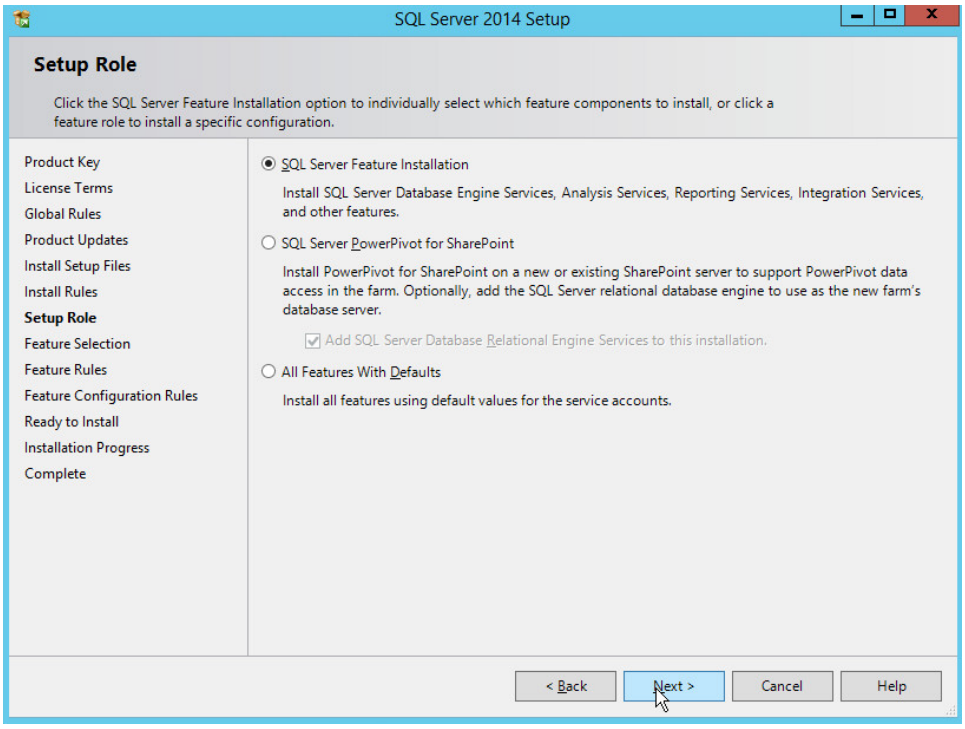
567 9. In the **Install Rules** section, note and resolve any further conflicts.



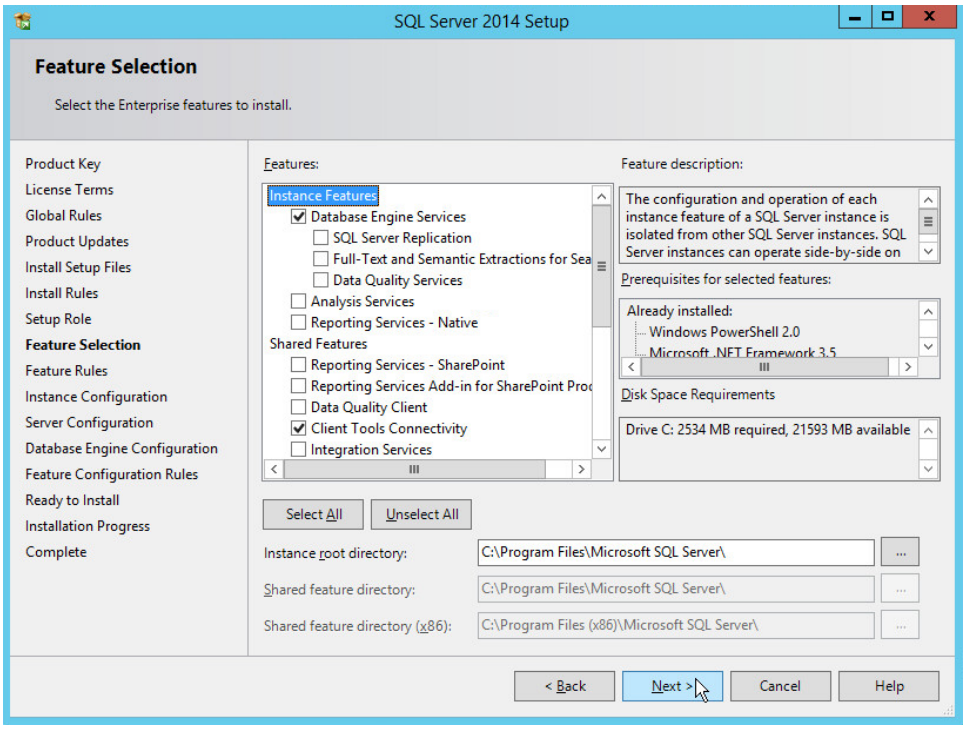
568

569 10. Click **Next.**

570 11. In the **Setup Role** section, select **SQL Server Feature Installation.**



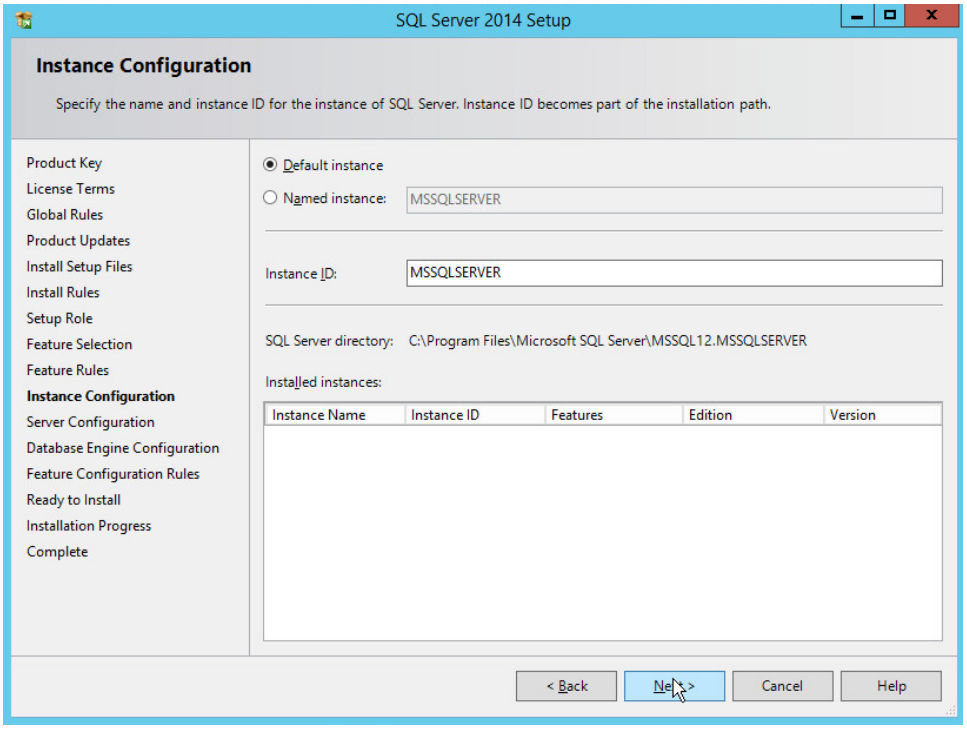
12. Click **Next.**
13. In the **Feature Selection** section, select the following options:
    a. **Database Engine Services**
    b. **Client Tools Connectivity**
    c. **Client Tools Backwards Compatibility**
    d. **Client Tools SDK**
    e. **Management Tools – Basic**
    f. **Management Tools – Complete**
    g. **SQL Client Connectivity SDK**
    h. **Any other desired features**



582

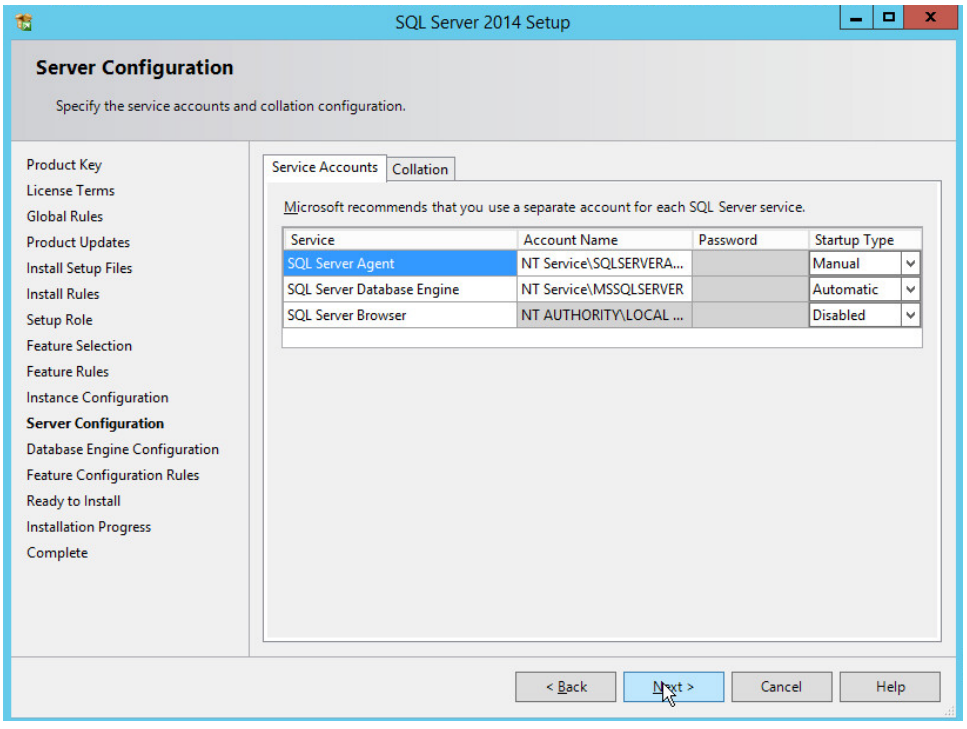
583 14. Click **Next.**

584 15. In the **Instance Configuration** section, select **Default instance.**



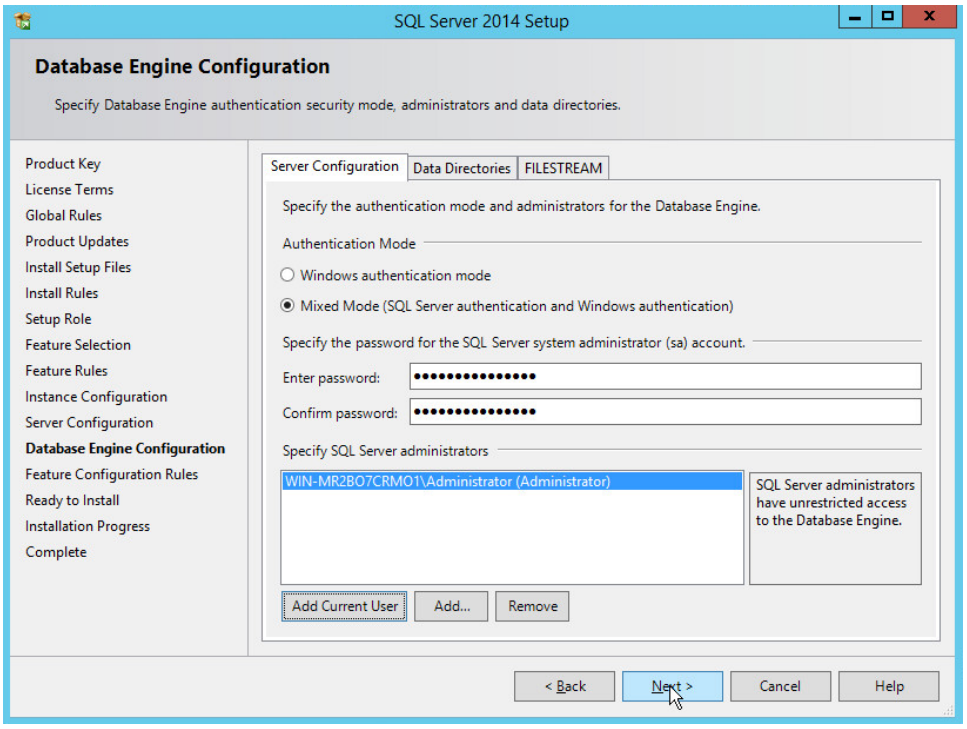
585

586 16. Click **Next.**

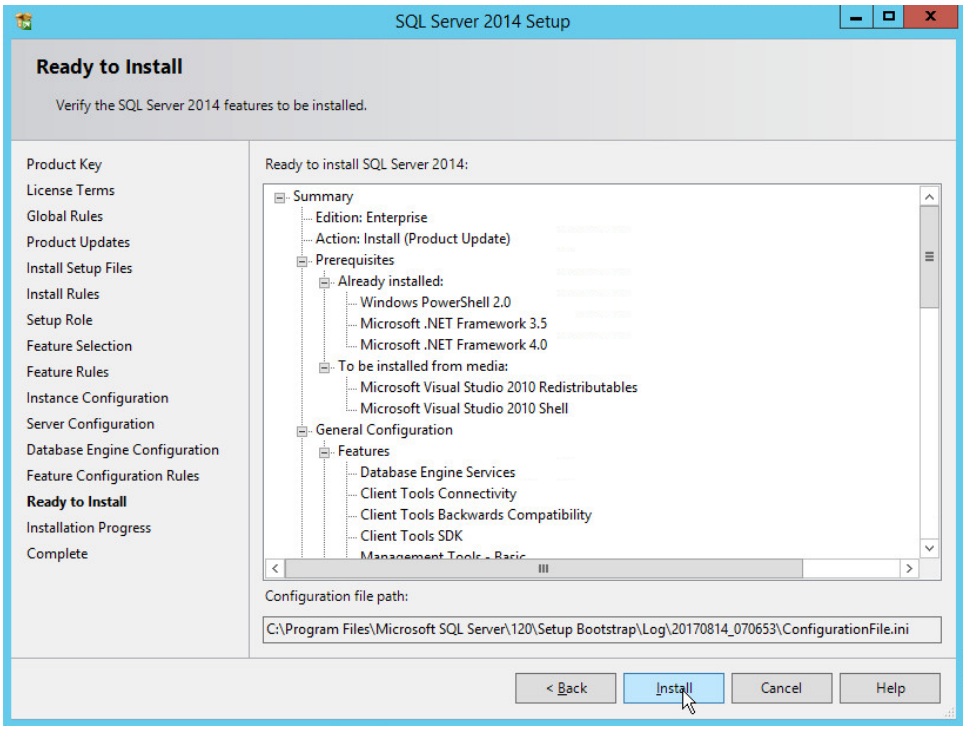


587

17. In the **Server Configuration** section, click **Next.**
18. In the **Database Engine Configuration** section, make sure **Mixed Mode** is selected.
19. Add all desired users as Administrators under **Specify SQL Server Administrators** by pressing **Add Current User.**
    a. For Domain accounts, simply type in **$DOMAINNAME\$USERNAME** into **Enter the object names to select** text box.
    b. Click **OK.**
    c. For local computer accounts, click on **locations** and select the computer's name.
    d. Click **OK.**
    e. Type the username into the **Enter the object names to select** text box.
    f. Once you are finished adding users, click **Next.**

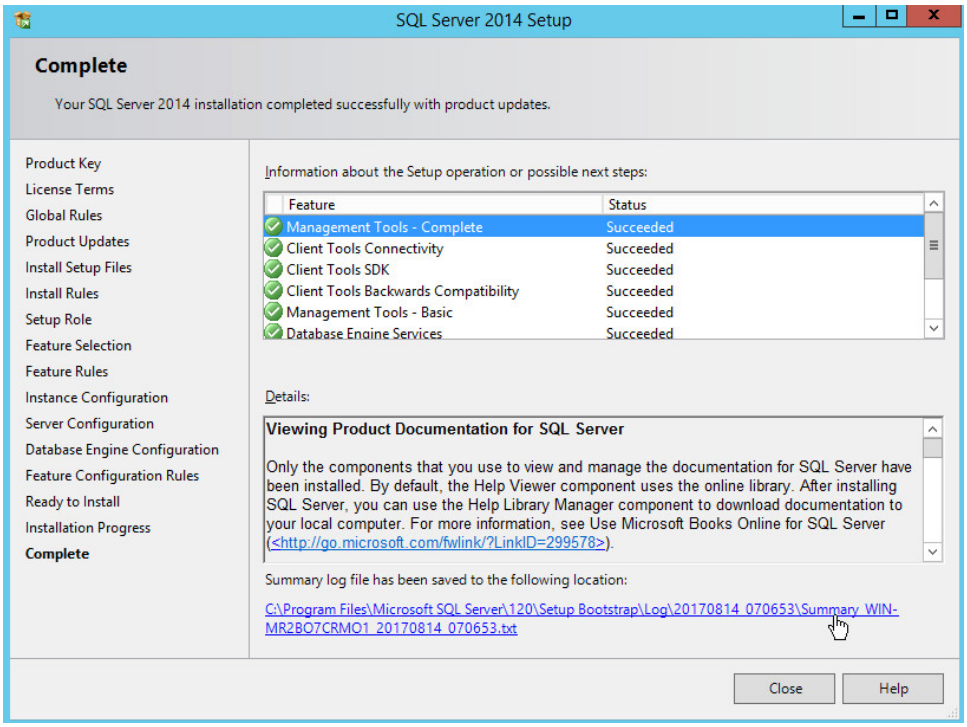


20. In the **Ready to install** section, verify the installation and click **Install.**



601

602 21. Wait for the installation to finish.

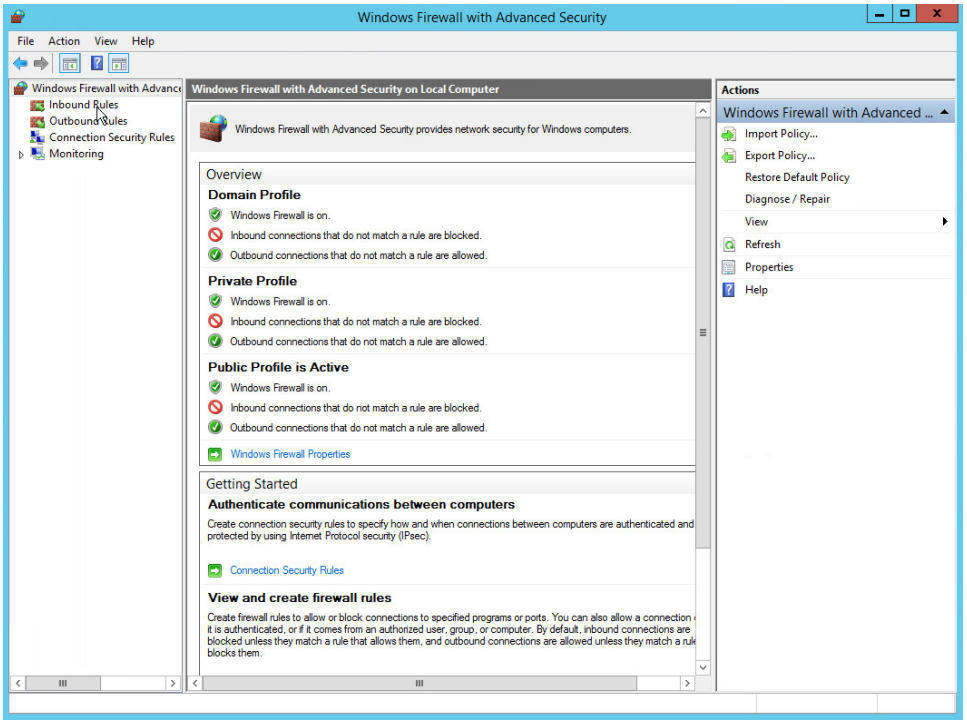


603

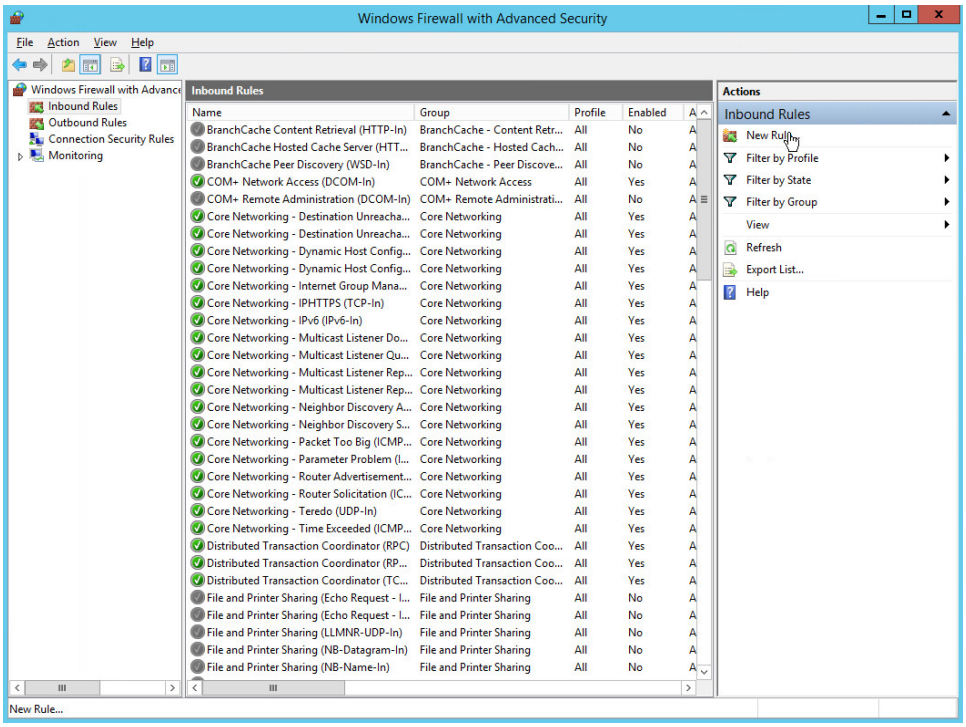
22. Click **Close.**

2.4.2 Open Port on Firewall

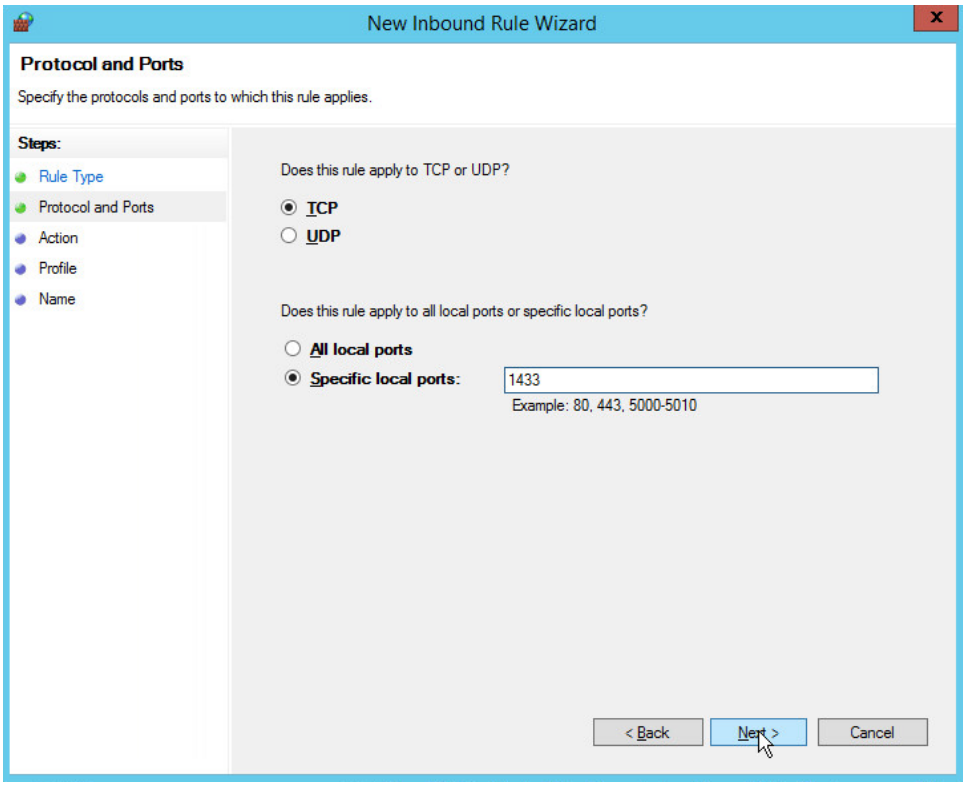
1. Open **Windows Firewall with Advanced Security.**



2. Click **Inbound Rules.**



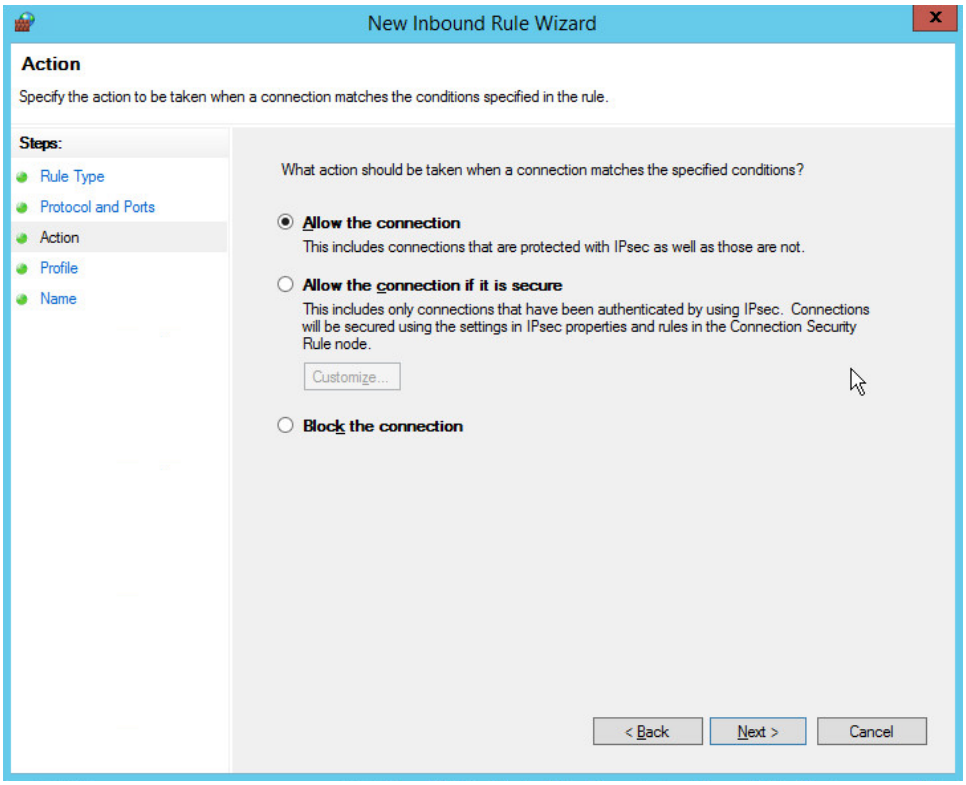
3. Click **New Rule.**
4. Select **Port.**
5. Click **Next.**
6. Select **TCP** and **Specific local ports.**
7. Type **1433** into the text field.



615

616 8. Click **Next.**

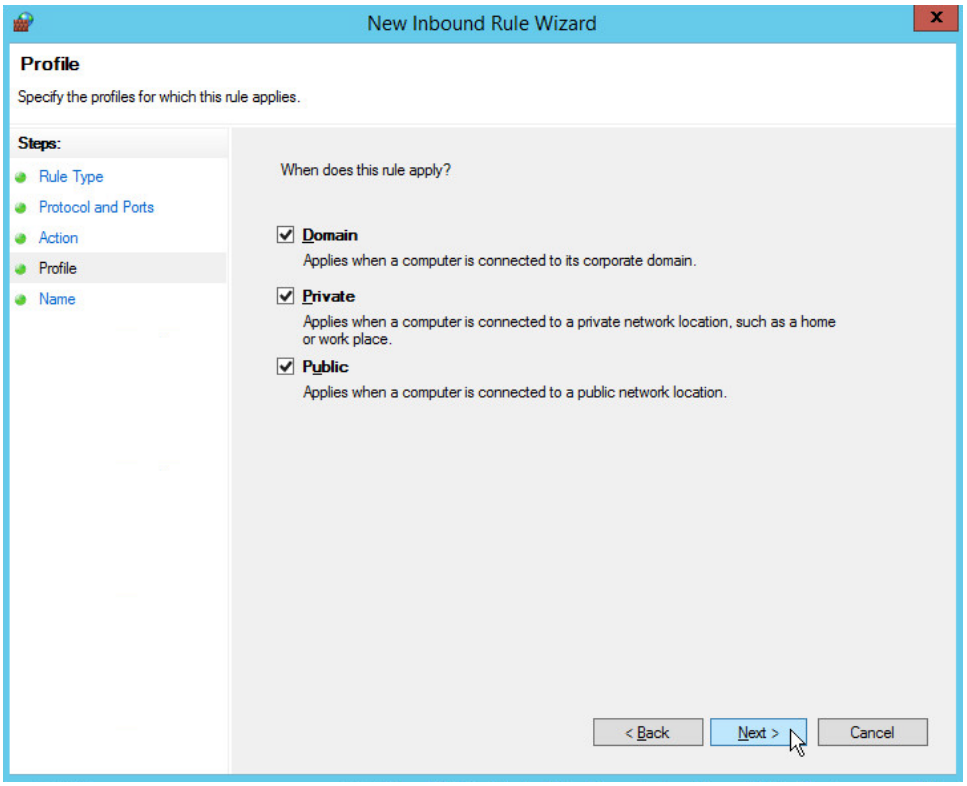
617 9. Select **Allow the connection.**



618

619 10. Click **Next.**

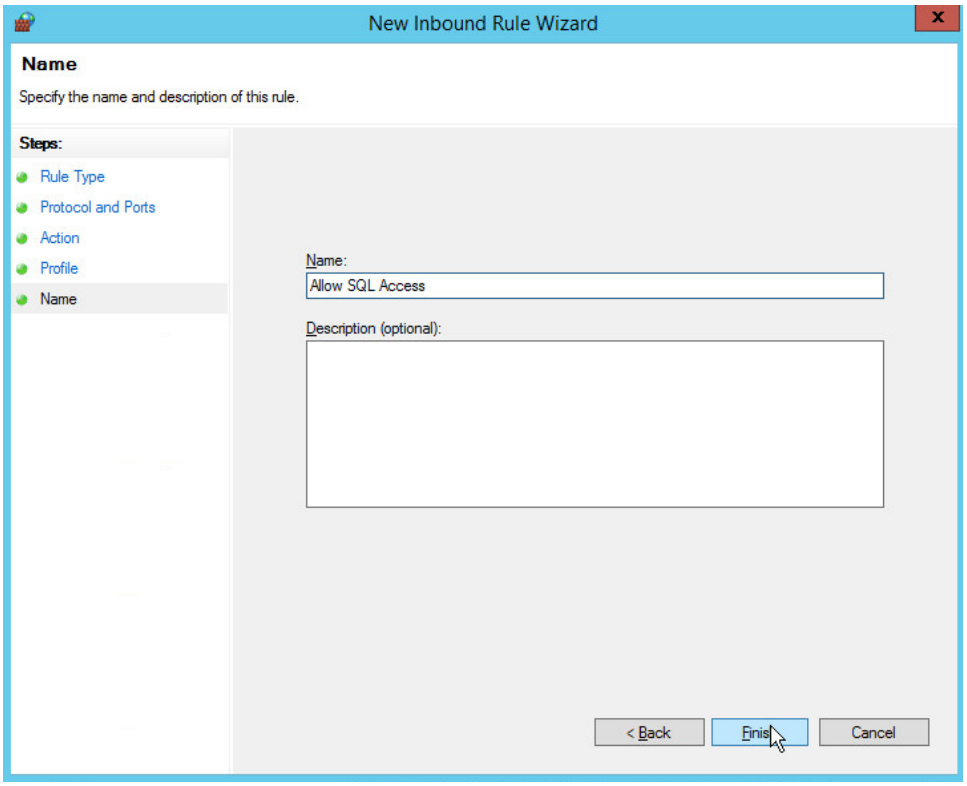
620 11. Select all applicable locations.



621

622 12. Click **Next.**

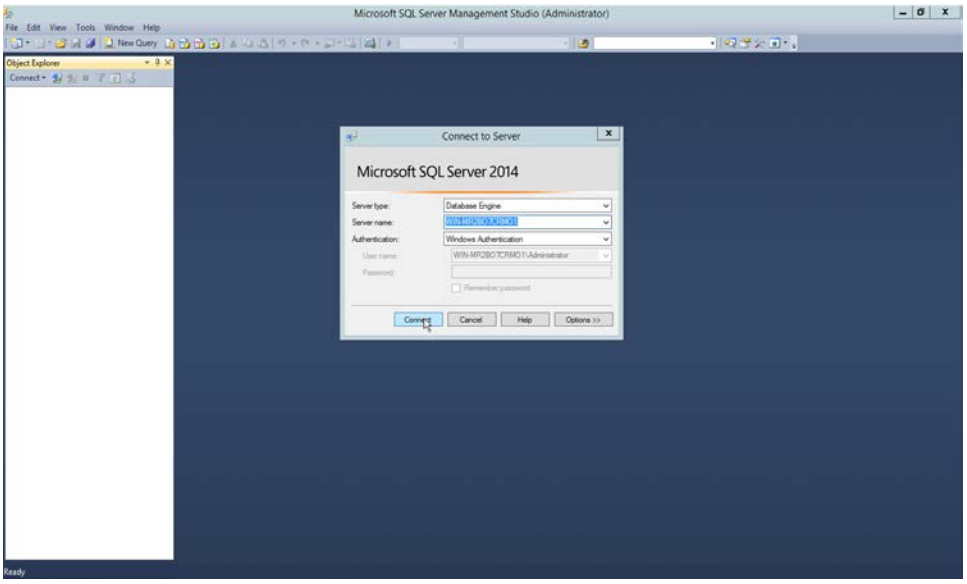
623 13. Name the rule **Allow SQL Access.**



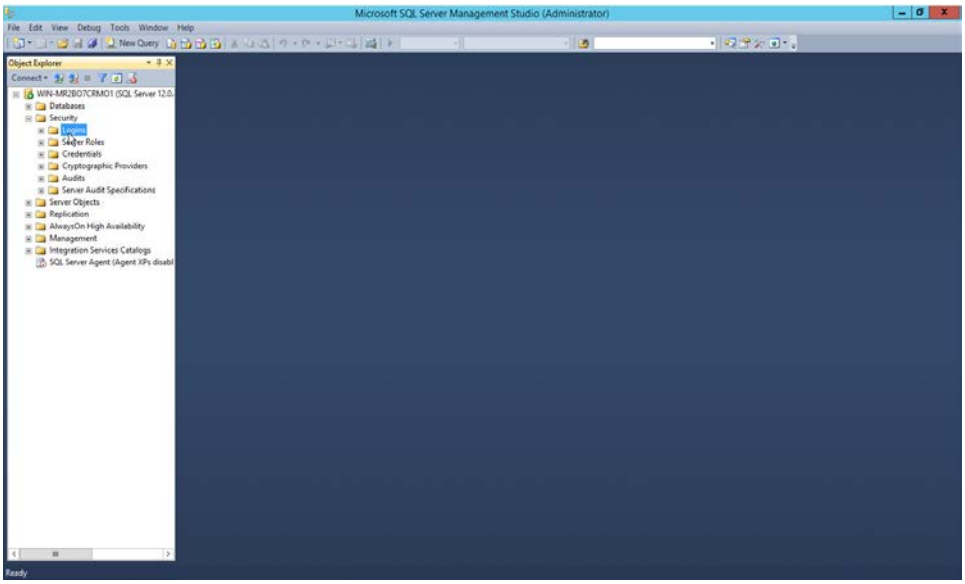
14. Click **Finish.**

2.4.3 Add a New Login to the Database

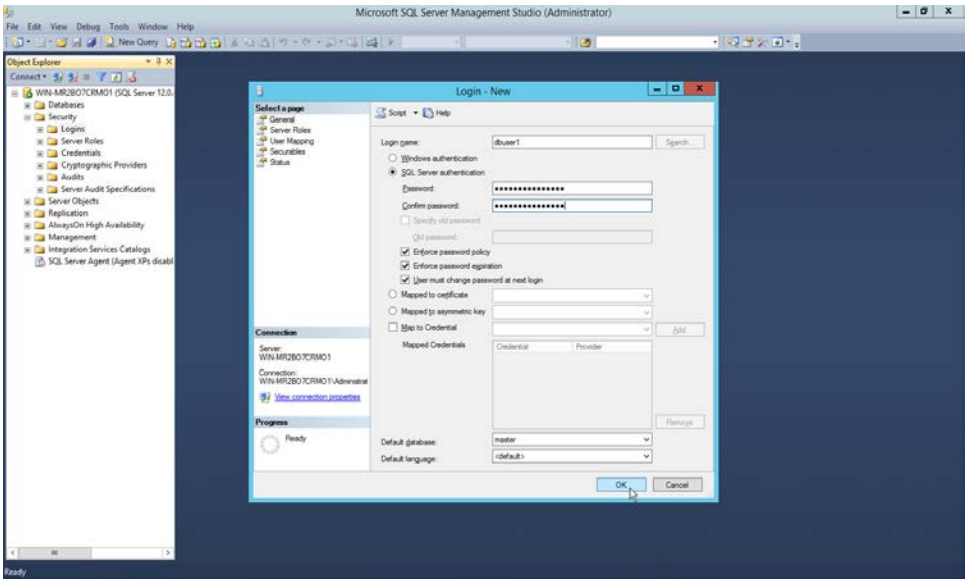
1. Open **SQL Server Management Studio.**



2. Click **Connect** to connect to the database.
3. In the **Object Explorer** window, expand the **Security** folder.



4. Right-click on the **Logins** folder and click **New Login….**
5. Input the desired user.



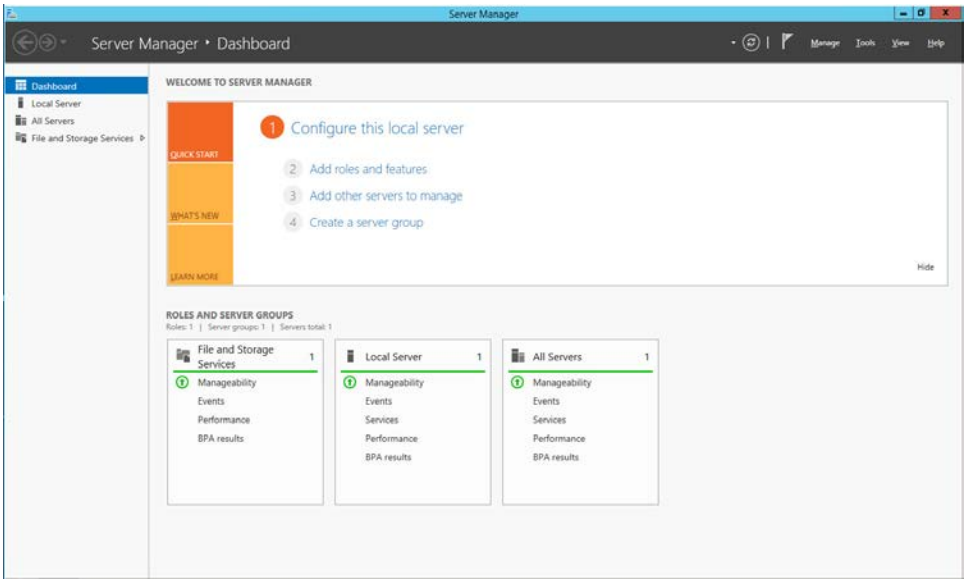
6. Click **OK.**

2.5 Microsoft IIS Server

As part of our enterprise emulation, we include a Microsoft IIS server. This section covers the installation and configuration process used to set up Microsoft Exchange on a Windows Server 2012 R2 machine. This was conducted on the same machine as in Section 2.4.

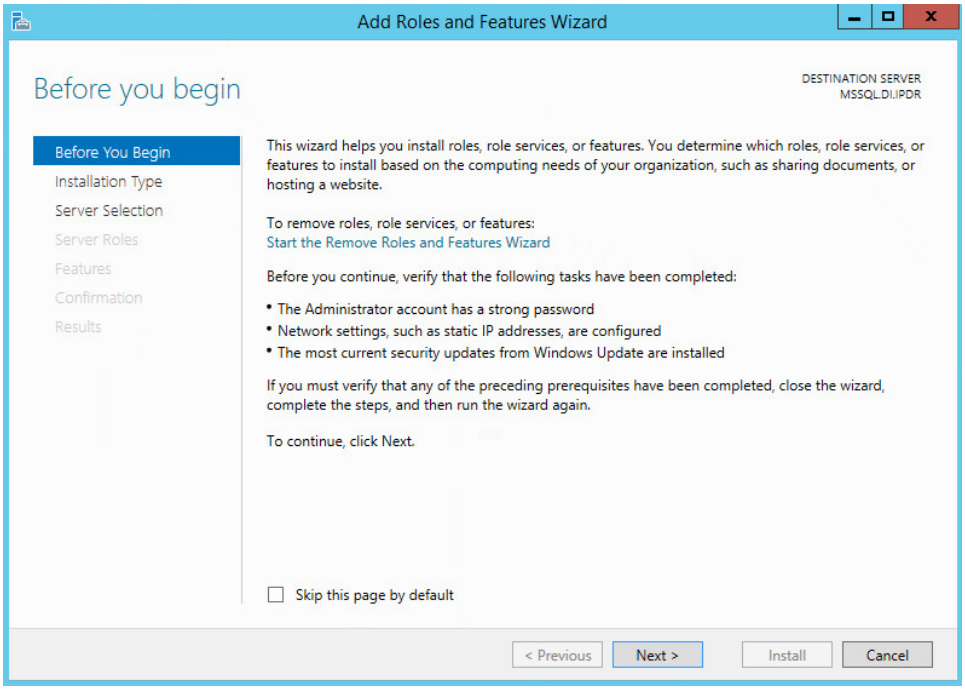
2.5.1 Install IIS

1. Open **Server Manager.**



642

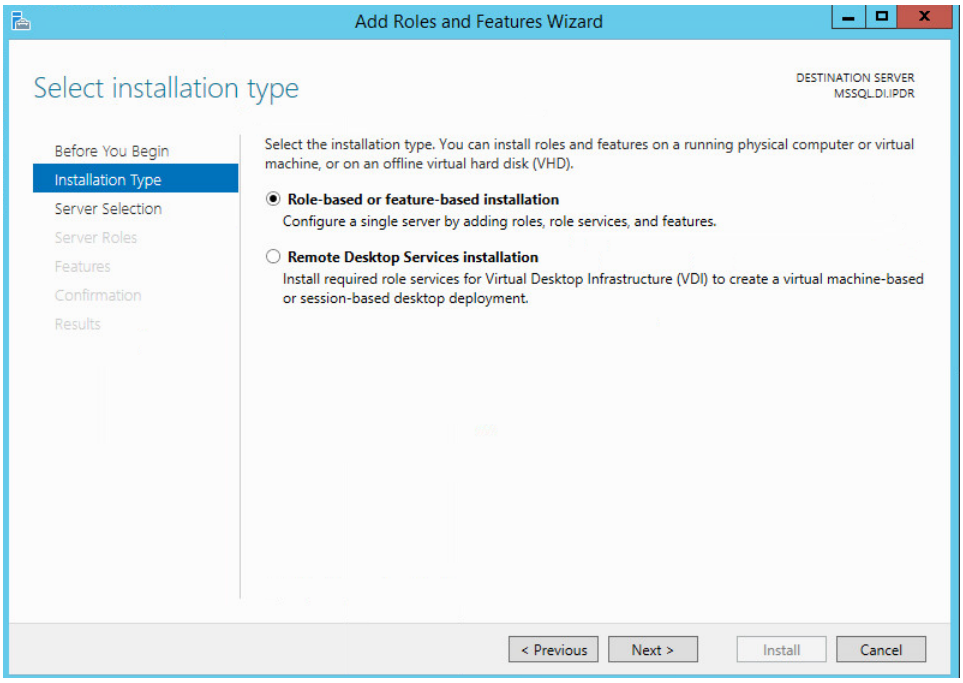
643 2. Click **Add Roles and Features.**



644

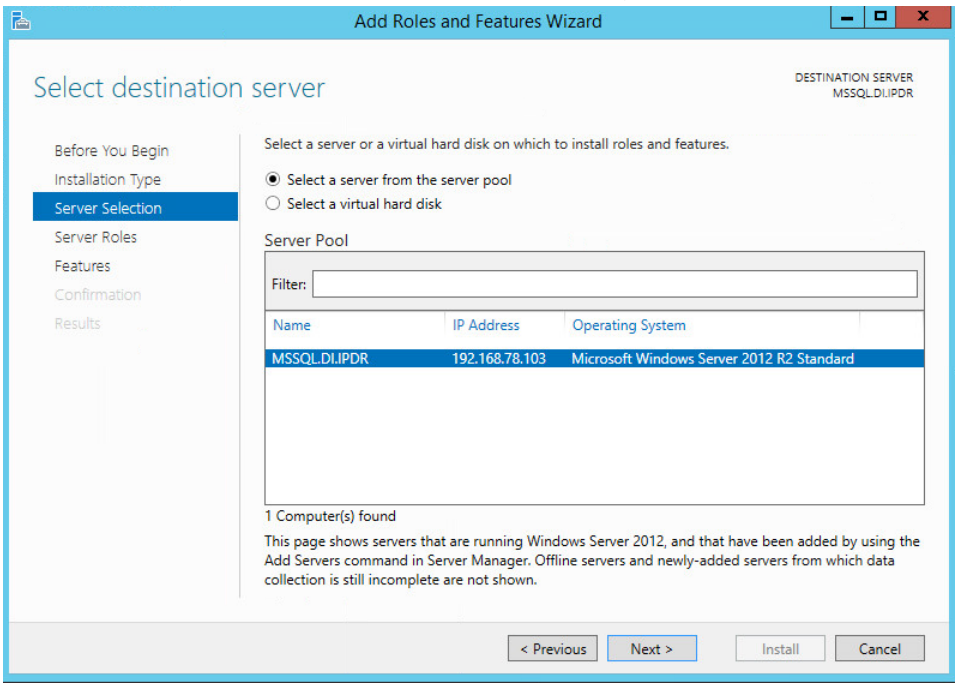
645 3. Click **Next.**

4. Select **Role-based or feature-based installation.**

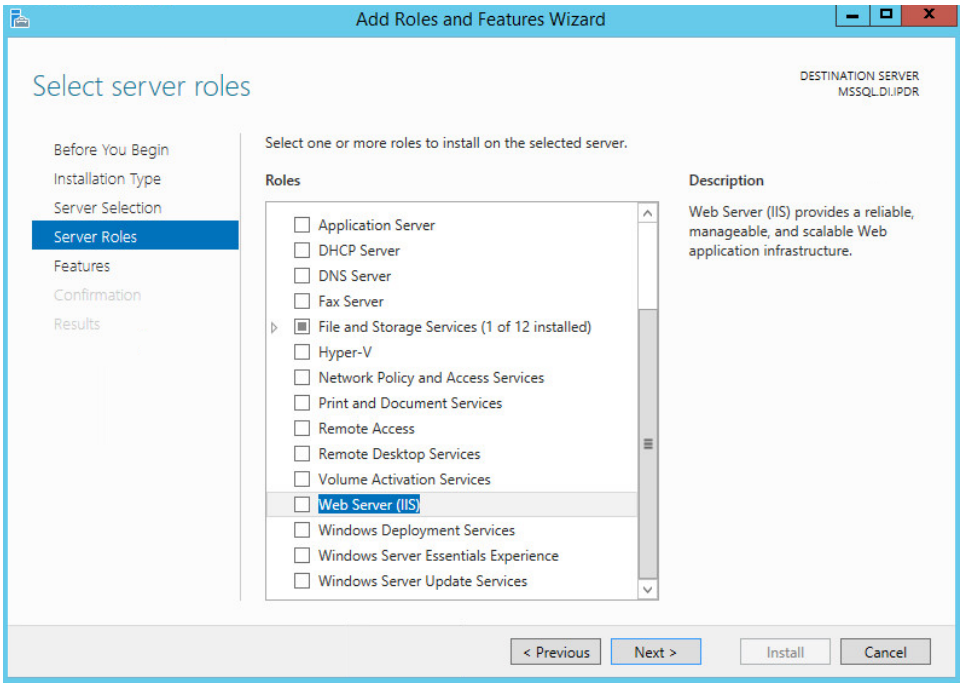


5. Click **Next.**

6. Select **MSSQL** (or the correct Windows Server name) from the list.

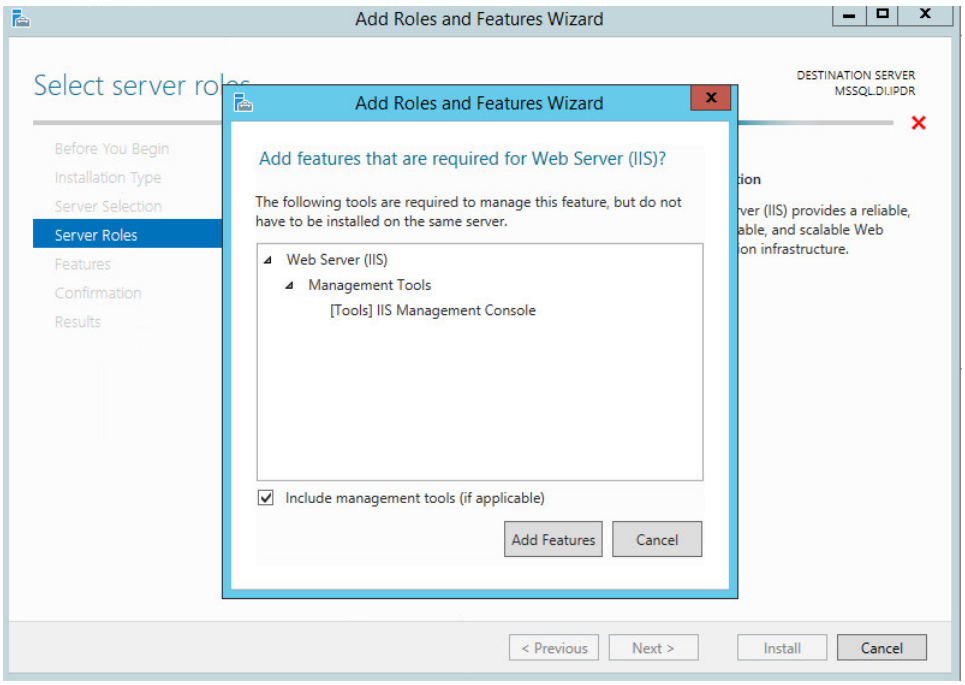


7. Click **Next.**



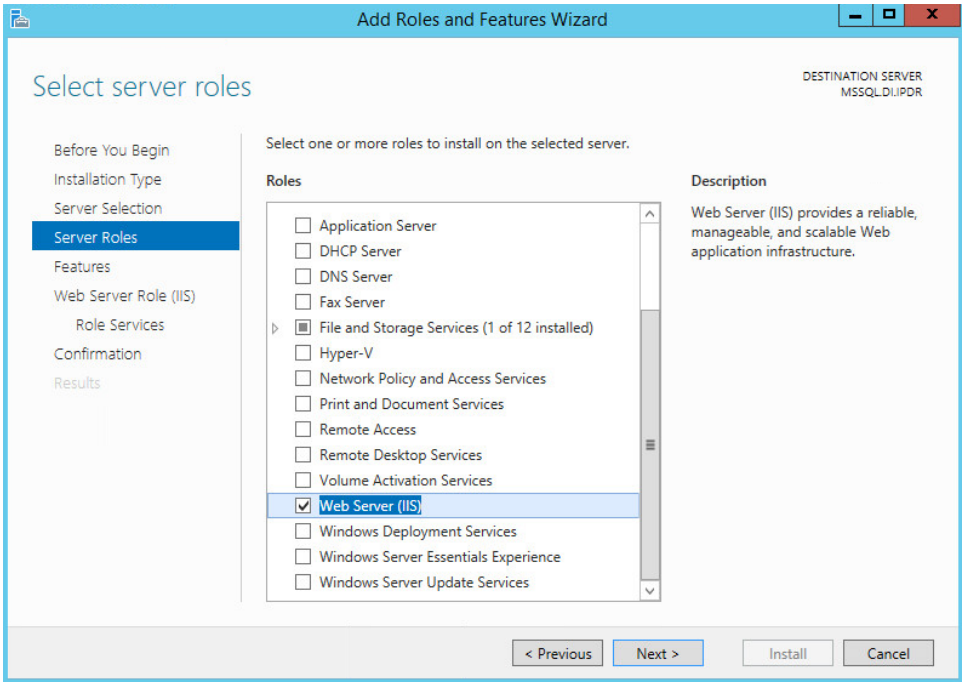
652

653 8. Check the box next to **Web Server (IIS).**



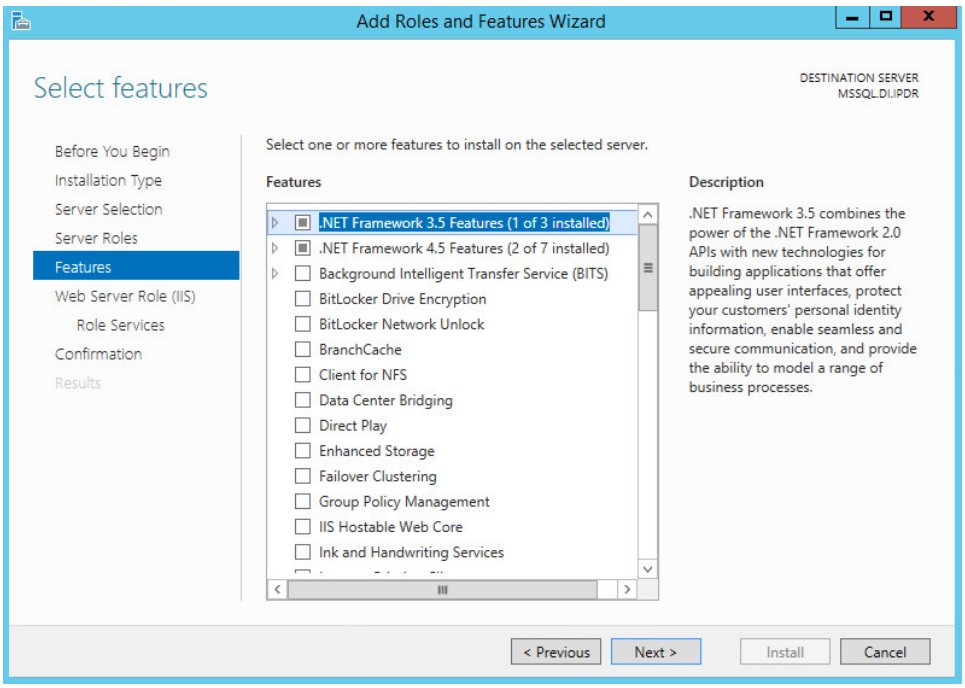
654

9. Click **Add Features.**

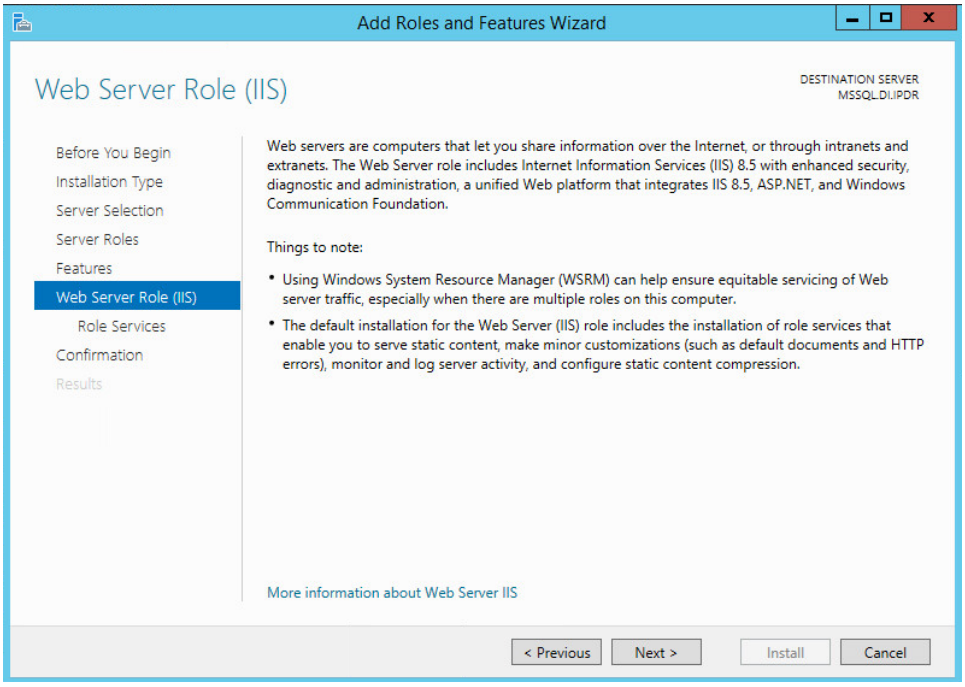


10. Click **Next.**

11. Ensure that all desired features are selected.



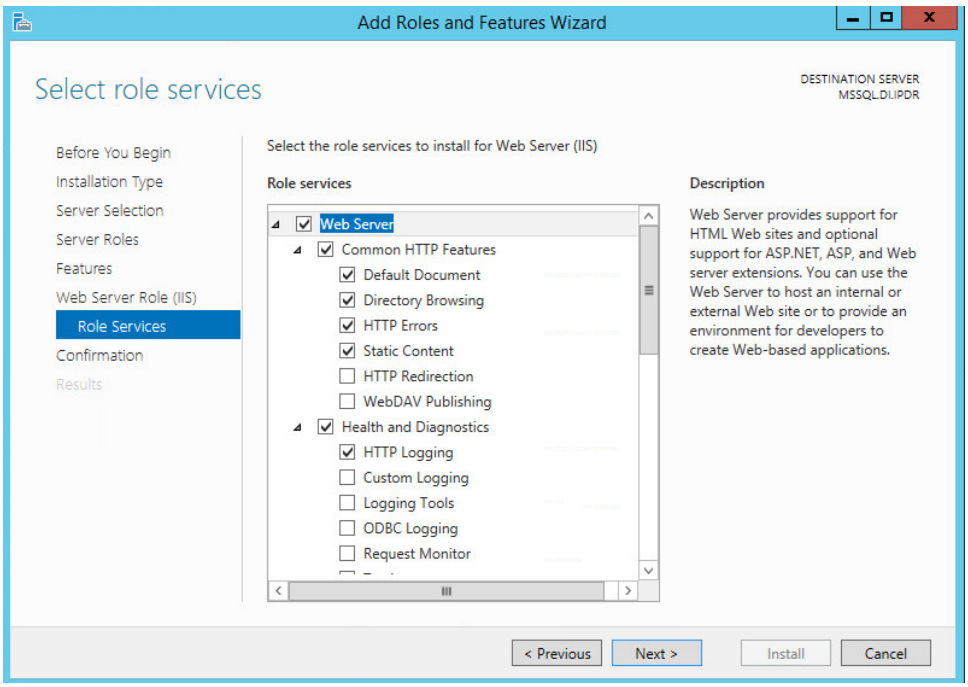
12. Click **Next.**



661

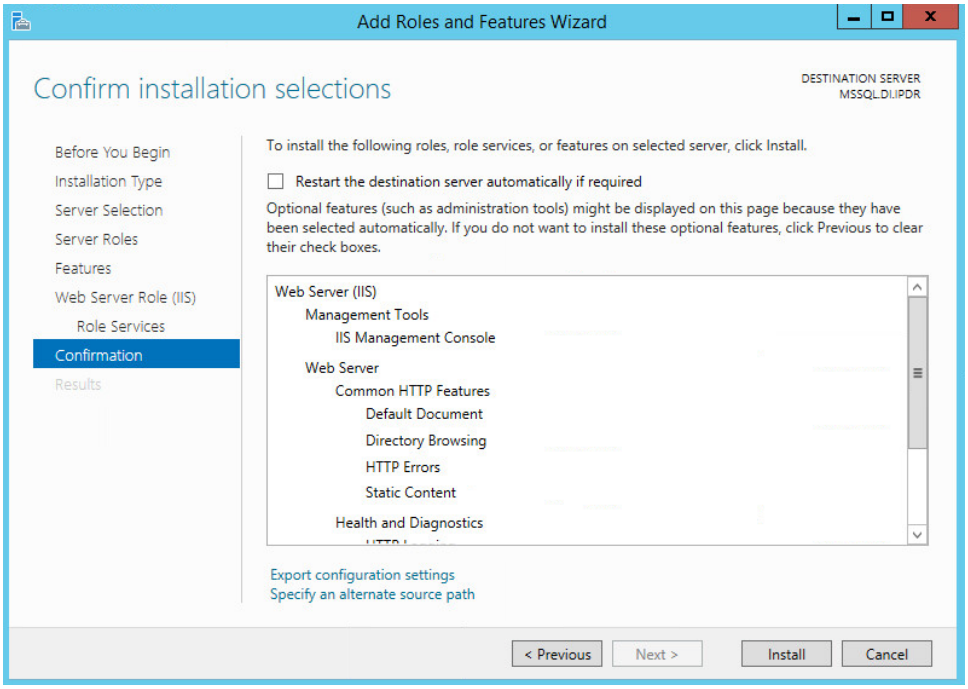
662 13. Click **Next.**

663 14. Ensure that **Default Document, Directory Browsing, HTTP Errors, Static Content, HTTP Logging,**
664 and any other desired Role services are selected.

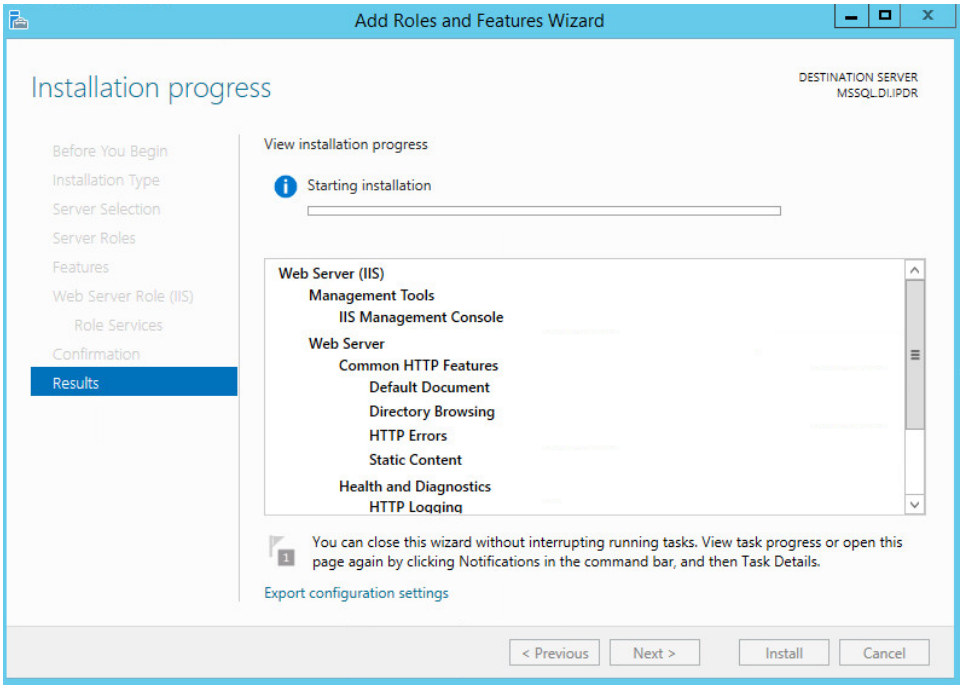


665

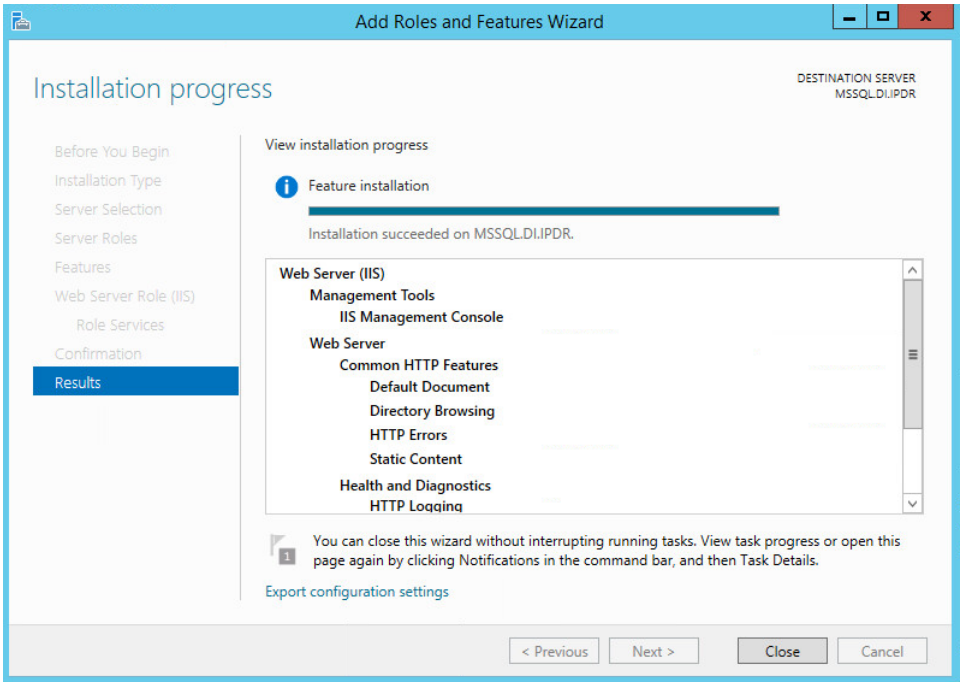
15. Click **Next.**



16. Click **Install.**



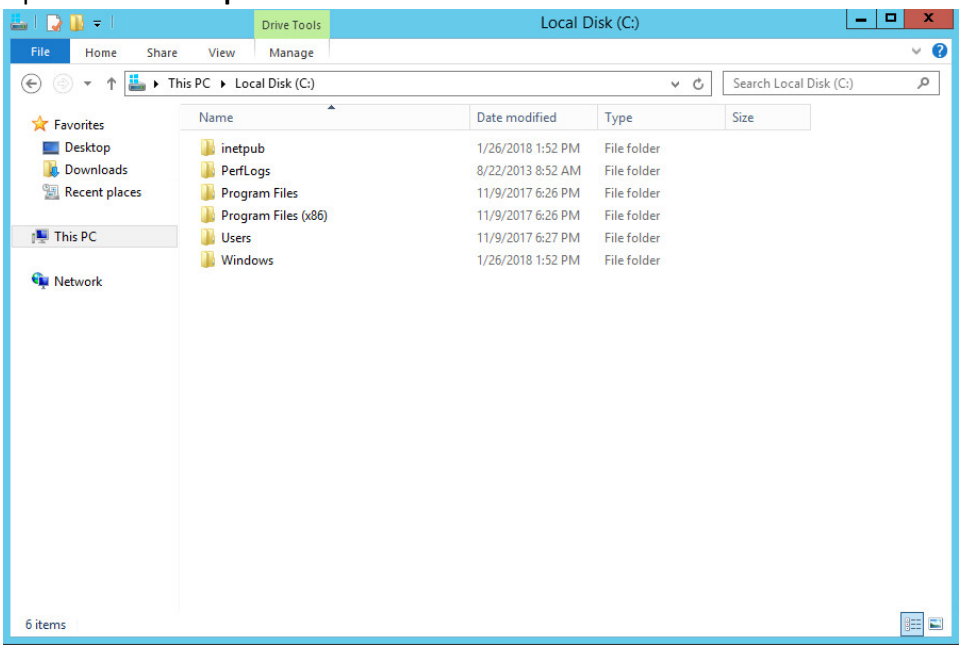
17. Wait for the installation to complete.



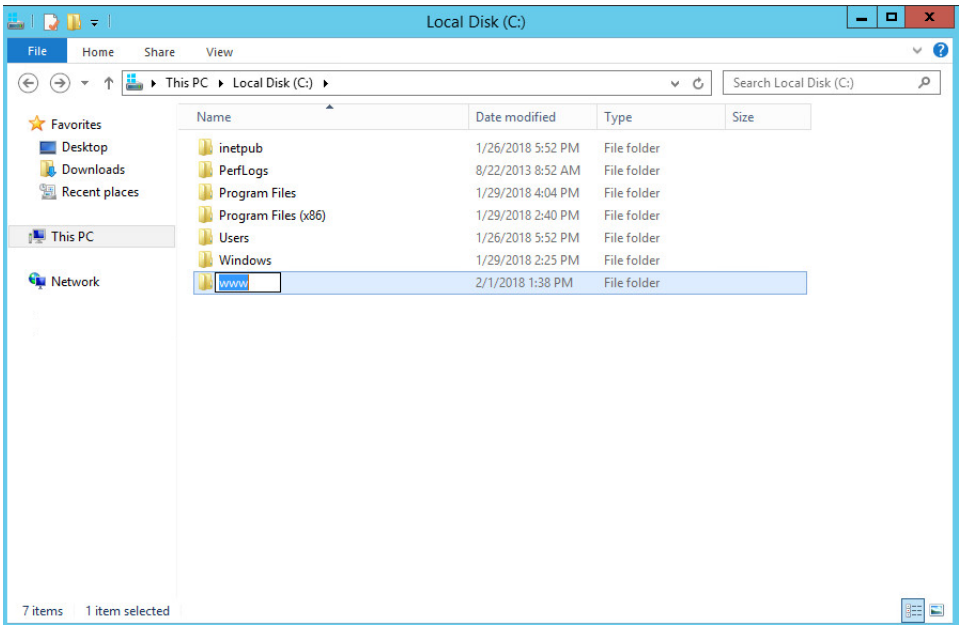
18. Click **Close.**

2.5.2 IIS Configuration

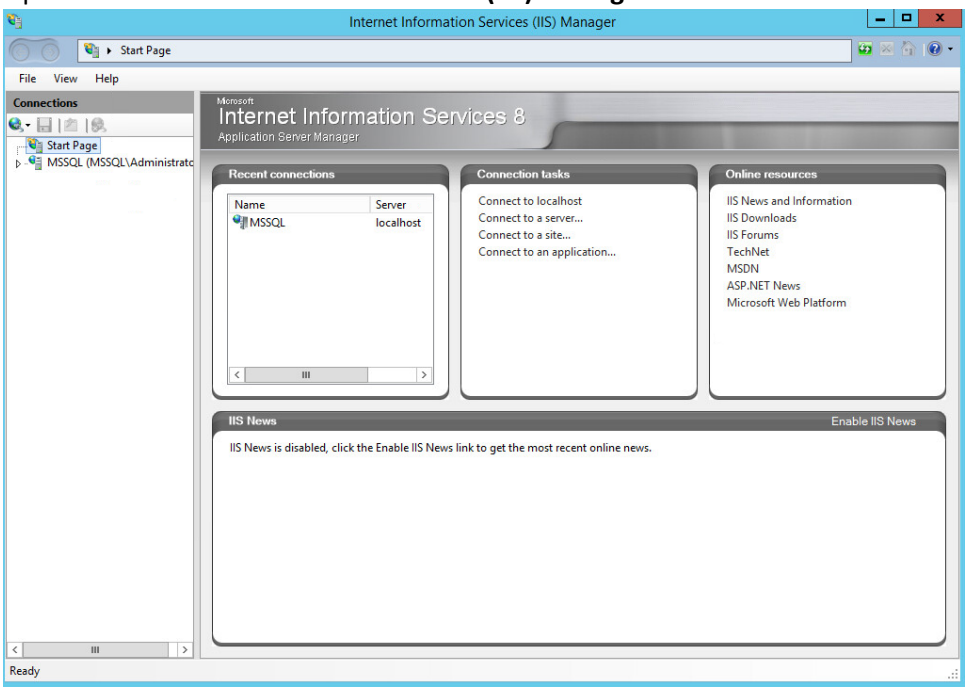
1. Open **Windows Explorer** and click **This PC.**



2. Right-click and select **Create Folder.**
3. Name the folder **www.**



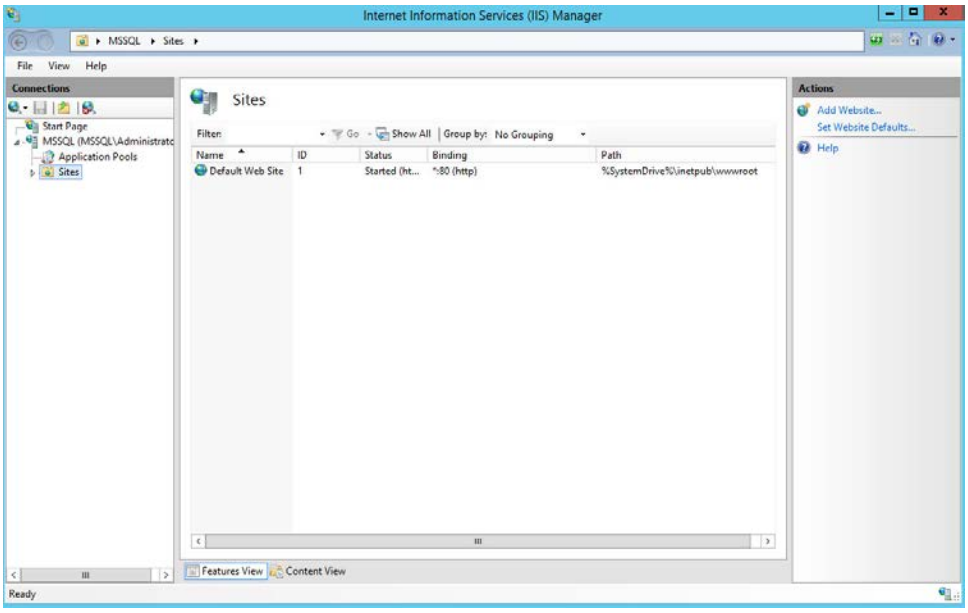
679 4. Open the **Internet Information Services (IIS) Manager.**



680

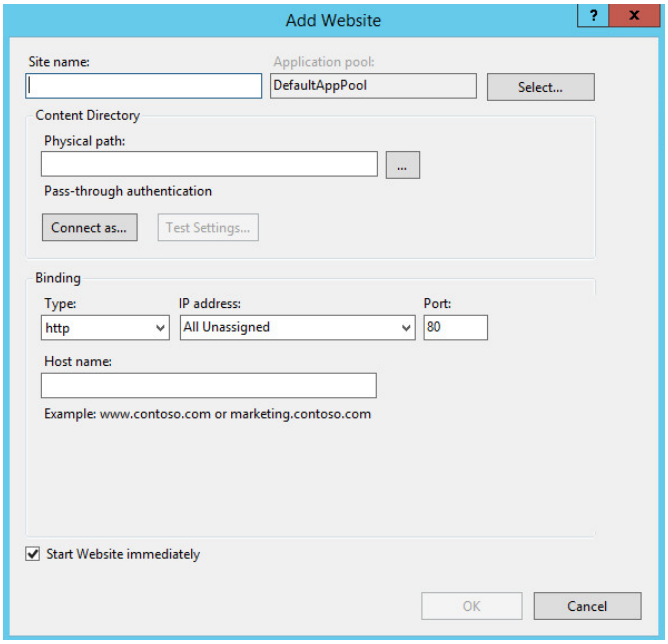
681 5. Click the arrow next to **MSSQL** (or the chosen name of the server).

682 6. Click **Sites.**

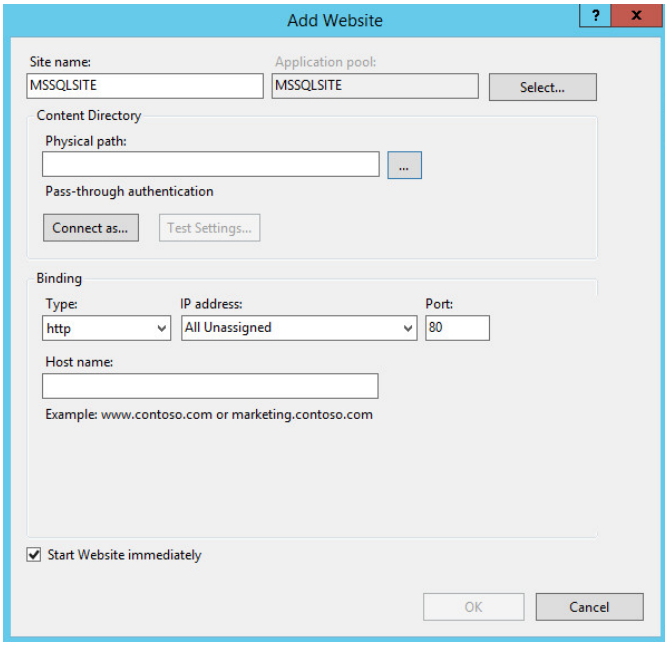


683

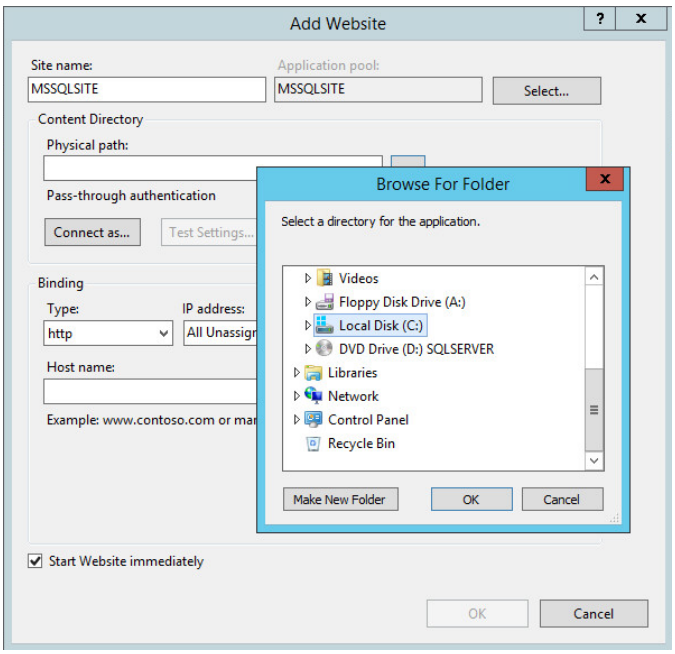
684 7. Click **Add Website….**



685
686 8. Enter the desired site name.

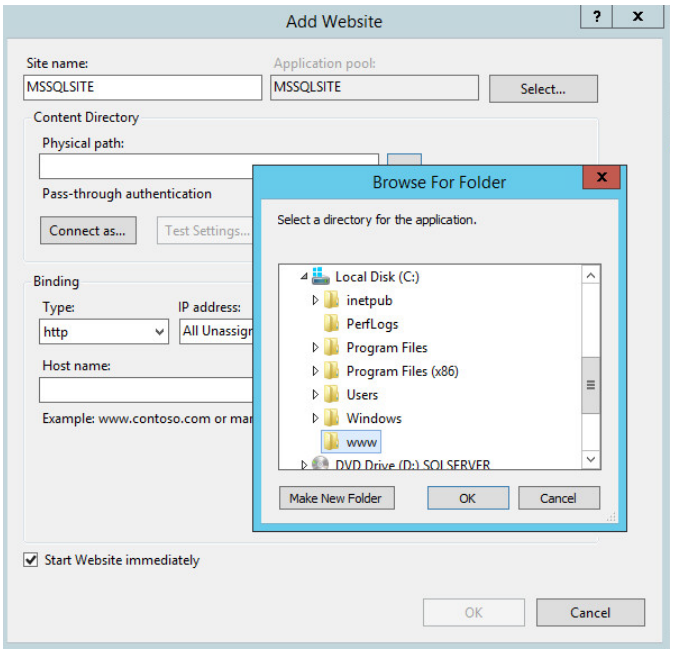


687
688 9. Click **…** under **Physical path:.**



689

690 10. Locate and select the folder created in step 3.

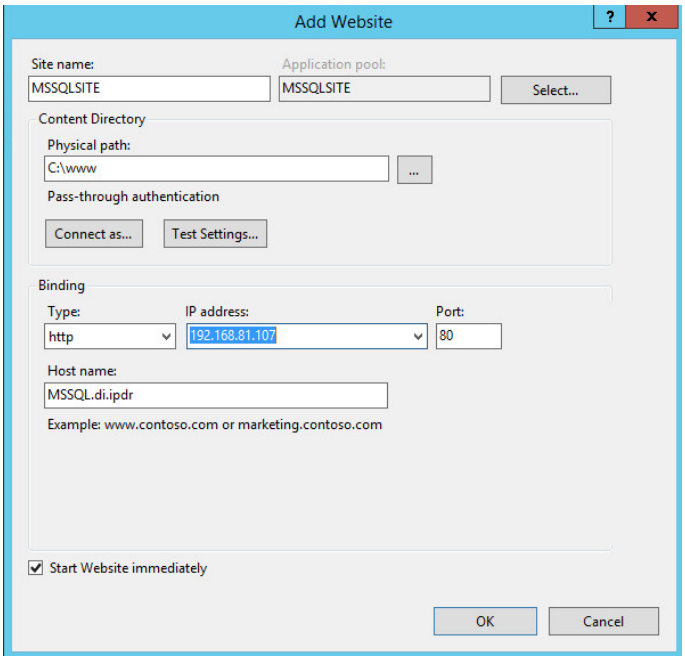


691

692 11. Click **OK.**

693 12. Set **Type** to **http** and **Port** to **80.**

13. Ensure that the **IP address** and **Host name** fields are filled in with the correct information for the machine.
14. Ensure that **Start Website immediately** is selected.



15. Click **OK.**

2.6 GreenTec WORMdisks

See the *Installation of GreenTec Command Line Utilities* document, which should accompany the installation disk, for a detailed guide on how to install the GreenTec command line utilities. Furthermore, refer to the *GT_WinStatus User Guide*, which should also accompany the installation disk, for instructions on how to effectively use GreenTec WORMdisks to preserve data. Read these instructions *carefully*, as locking GreenTec WORMdisks can result in making some or all of the disk or the entire disk unusable. Having portions of the disk or the entire disk permanently locked is sometimes desirable, but it is dependent on the needs of your organization, e.g., if you want to store backup information or logs securely.

The *GT_WinStatus User Guide* provides instructions for locking and temporarily locking disk sectors. In this practice guide, we will not include instructions on when to lock GreenTec WORMdisks. However, we will provide instructions detailing how to save data to these disks and various commands used in

manipulating the disks. Below, find descriptions of some commands useful for automation of GreenTec WORMdisks. Actual automation of these disks will vary per organization.

2.6.1 Format GreenTec WORMdisks

To format GreenTec WORMdisks for use, the following command can be used.

```
> gt_format.exe <disk number> /parts:<number of parts> /label:<id>
```

This command can be used to split a disk into a specified number of partitions, with each partition being labeled according to the label id specified.

For example, this command will split drive 1 into four parts, labeled DI001, DI002, DI003, and DI004:

```
> gt_format.exe 1 /parts:4 /label:DI
Formatting drive 1 partition 1 file system NTFS label "DI001"
Format successful
Formatting drive 1 partition 2 file system NTFS label "DI002"
Format successful
Formatting drive 1 partition 3 file system NTFS label "DI003"
Format successful
Formatting drive 1 partition 4 file system NTFS label "DI004"
Format successful
```

2.6.2 Obtain Status Information About GreenTec WORMdisks

To verify information about GreenTec WORMdisks, use the following command.

```
> wvlist.exe <drive number>
```

This command can be used to display basic information about a drive, such as the amount of space of each partition, whether it is a WORMdisk, whether they have been locked, and what drive letter to which they are mapped.

For example, this command will list the characteristics of drive 1.

```
> wvlist.exe 1
  WVLIST: List WORM Volume (WDV) Status on Physical WORMdisks(tm).
    Copyright (C) 2015 GreenTec-USA, Inc. All rights reserved.
         Drive#=1   Type=ATA    F/W=GT5G   Size=500{GB)
            > IS WORM         > IS *NOT* Finalized
              ****  WORMdisk Volume (WDV) Info  ****
              WDV #   TB  ENFORCED  GREENTEC  TLOCKED
              <---> <---> <------>  <------>  <----->
               001  0.125      NO       YES      NO G:\
               002  0.125      NO       YES      NO H:\
               003  0.125      NO       YES      NO I:\
               004  0.125      NO       YES      NO J:\
```

2.6.3 Map GreenTec WORMdisks to Drive Letters

1. To unmap a partition from a drive letter, use the following command:

   > wvmap.exe <drive letter>:

   For example,

   > wvmap.exe H:

   will unmap *H:*, making it available for mapping to another partition.

2. To map a partition to a drive letter, use the following command:

   > wvmap.exe <drive letter>: <drive number>.<partition number>

   For example,

   > wvmap.exe H: 1.2

   will map the second partition of drive 1 to *H:*, making files available through accessing that drive letter.

3. To map the next partition to a drive letter, use the following command:

   > wvnext.exe <drive letter>:

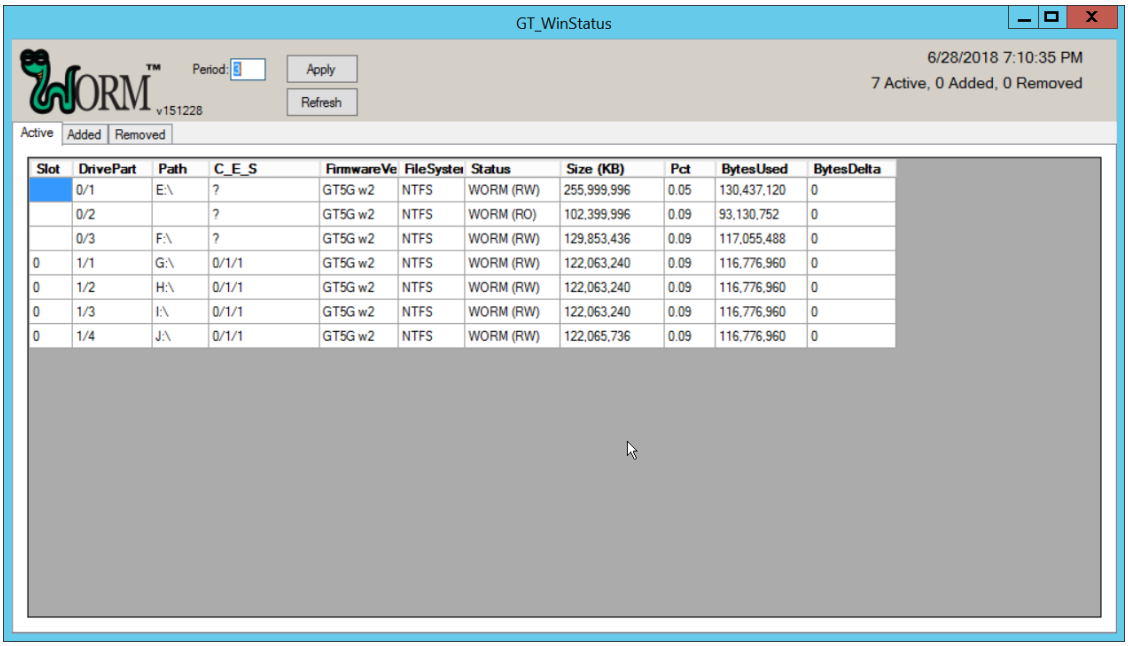
762 For example, if *H:* is mapped to partition 2 of drive 1 (1.2)

763 **`> wvnext.exe H:`**

764 will attempt to map *H:* to partition 3 of drive 1 (1.3).

765 2.6.4 Activate Write Protection in GreenTec WORMdisks

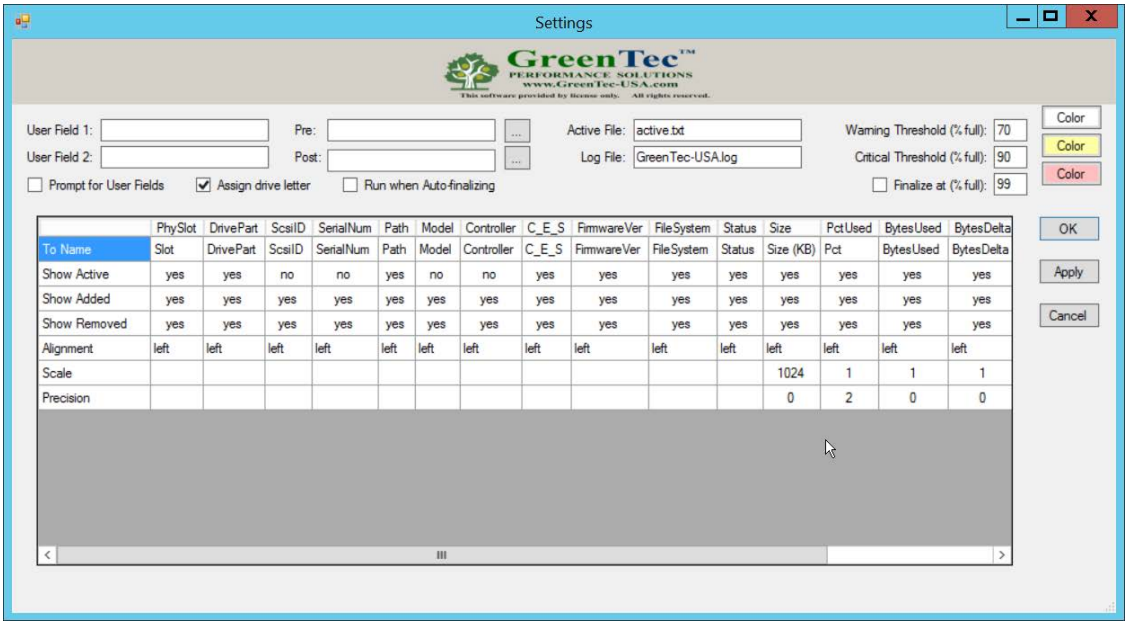
766 1. Running GT_WinStatus.exe will open the Graphical User Interface (GUI), which displays various
767 information such as drive mappings, partitions, total space, and space used, as well as a range
768 of other options.



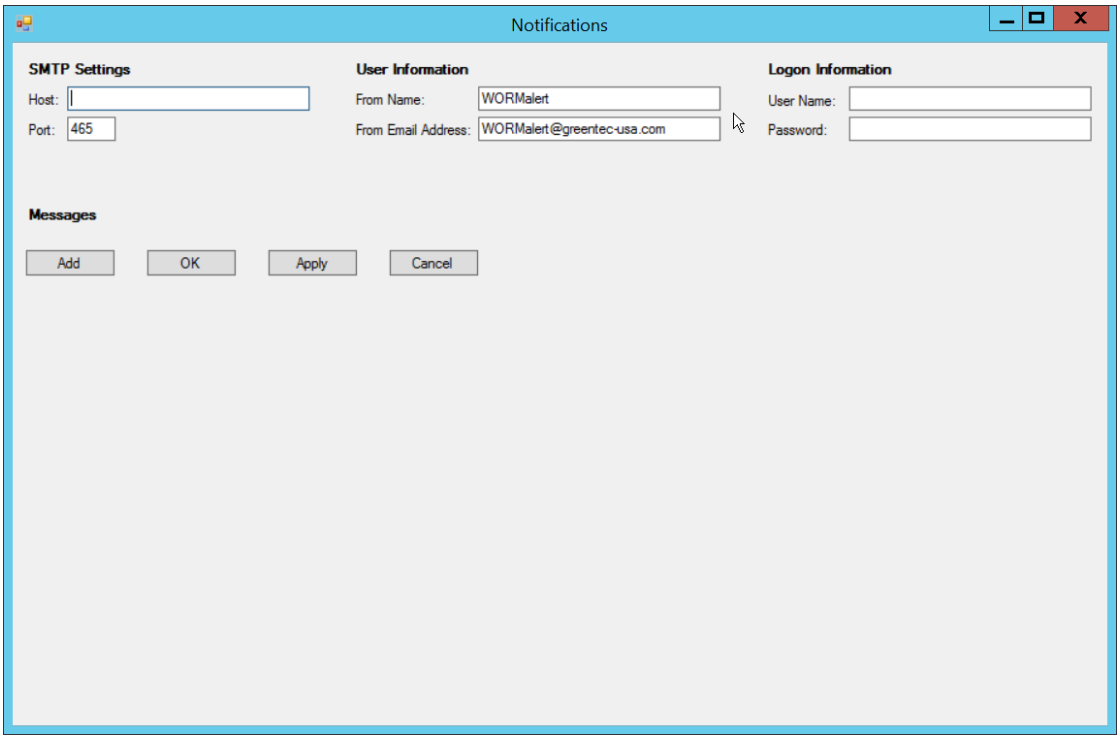
Slot	DrivePart	Path	C_E_S	FirmwareVe	FileSyster	Status	Size (KB)	Pct	BytesUsed	BytesDelta
	0/1	E:\	?	GT5G w2	NTFS	WORM (RW)	255,999,996	0.05	130,437,120	0
	0/2		?	GT5G w2	NTFS	WORM (RO)	102,399,996	0.09	93,130,752	0
	0/3	F:\	?	GT5G w2	NTFS	WORM (RW)	129,853,436	0.09	117,055,488	0
0	1/1	G:\	0/1/1	GT5G w2	NTFS	WORM (RW)	122,063,240	0.09	116,776,960	0
0	1/2	H:\	0/1/1	GT5G w2	NTFS	WORM (RW)	122,063,240	0.09	116,776,960	0
0	1/3	I:\	0/1/1	GT5G w2	NTFS	WORM (RW)	122,063,240	0.09	116,776,960	0
0	1/4	J:\	0/1/1	GT5G w2	NTFS	WORM (RW)	122,065,736	0.09	116,776,960	0

769

770 2. More columns can be added by right-clicking anywhere in the **Active** window, opening the
771 **Settings** window.



3. In the Settings window, **User Field 1** and **User Field 2** are for any metadata to be stored for a drive. **Pre:** runs a script prior to finalizing a drive, and **Post:** runs a script after finalizing a drive.
4. Also, from the **Settings** window, right-clicking on **Critical Threshold** or **Warning Threshold** will allow the user to set up alert preferences for drives that are nearly full (at a configurable percent value).

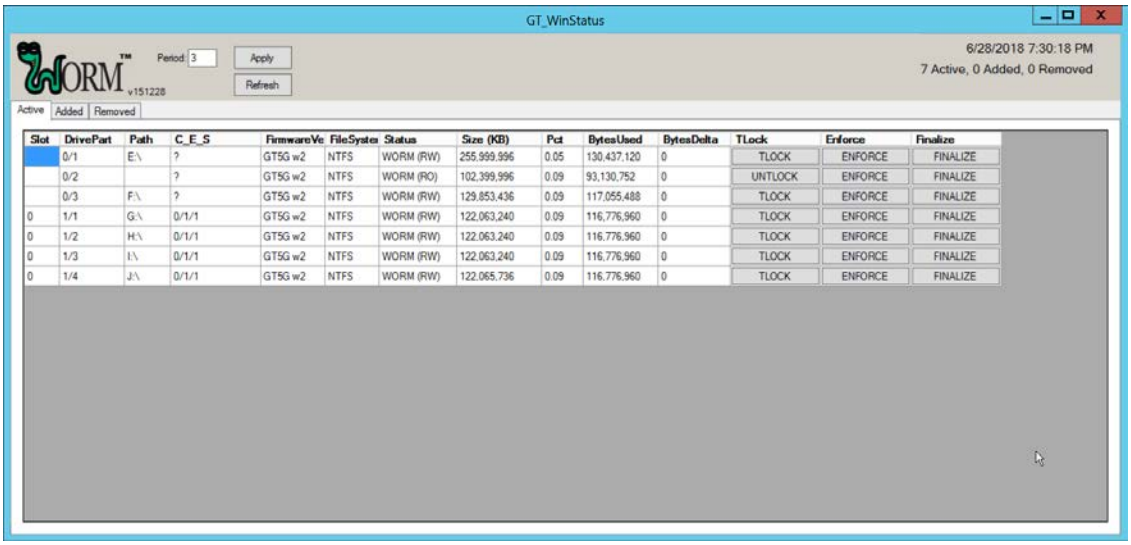


778

779 5. To display the GUI with options to lock and enforce locks on drives, the following command
780 must be used to start the GUI:

781 **> GT_WinStatus.exe /tlock /enf**

6. This will add columns called **TLock** and **Enforce** (as well as the ability to use the **Finalize** column).



7. The **TLock** column temporarily locks/unlocks a partition of the drive. This is useful to prevent modification during times when modification should be disallowed.

> **Important: The following functions in steps 8 and 9 will permanently lock portions of the drive, making them read-only.**
>
> **The Enforce function permanently locks all volumes up to the enforced volume.**
>
> **The Finalize function permanently locks the entire drive.**

8. The **Enforce** column is a *permanent incremental lock*. This means that it permanently prevents modification for the selected volume of a drive as well as all volumes that come before that volume on the drive. Once these sections are enforced, they cannot be written to ever again. This functionality is particularly useful in protecting data or backups that must never be modified, but as the enforce function is permanent, it must be used carefully.
9. The **Finalize** column permanently locks the entire drive. This is useful when a drive is full and no longer needs to be written to. Data can still be read and copied from this drive to other places, but no write actions will be possible after this is used, so it also must be used carefully.

2.7 CryptoniteNXT

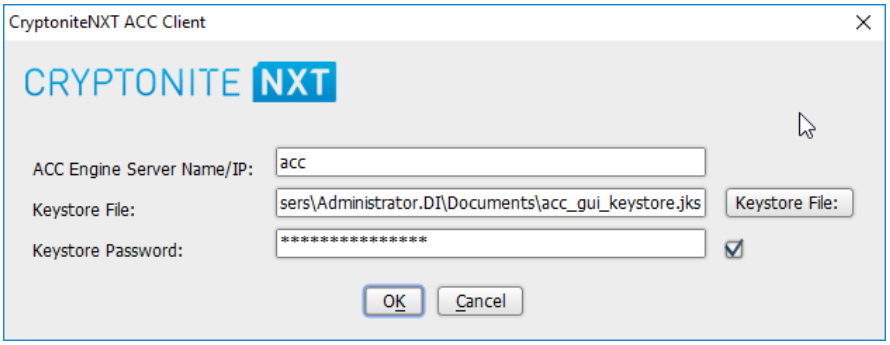
See the *CryptoniteNXT 2.6.2 Unified Installation Guide,* which should accompany the device for a detailed guide on how to install **CryptoniteNXT** on the provided device.

The *CryptoniteNXT 2.6.2 Unified Installation Guide* provides a full installation on both the **CryptoniteNXT** device and the management workstation. When finished, it should be possible to log in on the management workstation and interact with the **CryptoniteNXT ACC GUI.** Instructions are provided below for performing various useful functions, including adding new devices/users, as well as creating policy, but specific recommendations for policy are not provided, as those will be specific to the organization. Some integrations with other security products used in this guide will be provided, as exceptions for those products in CryptoniteNXT are often necessary for their functionality.

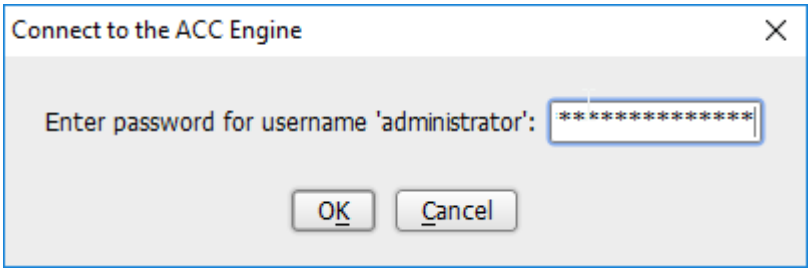
2.7.1 Configure Cryptonite NXT

2.7.1.1 Verify a New Device

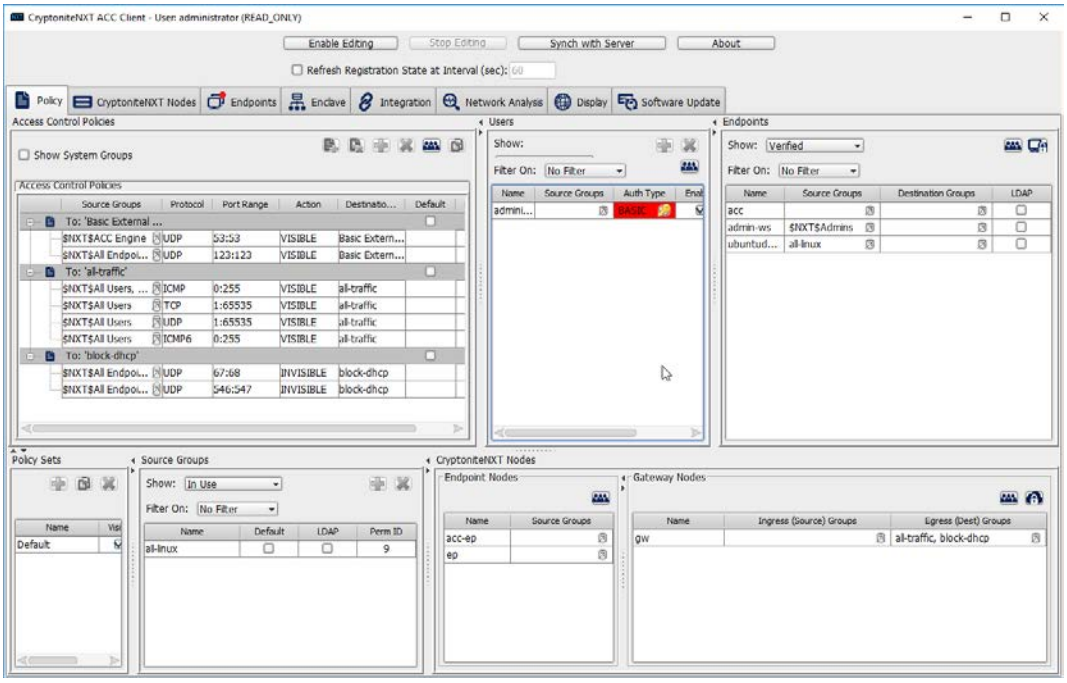
1. Open the **CryptoniteNXT ACC GUI** application.



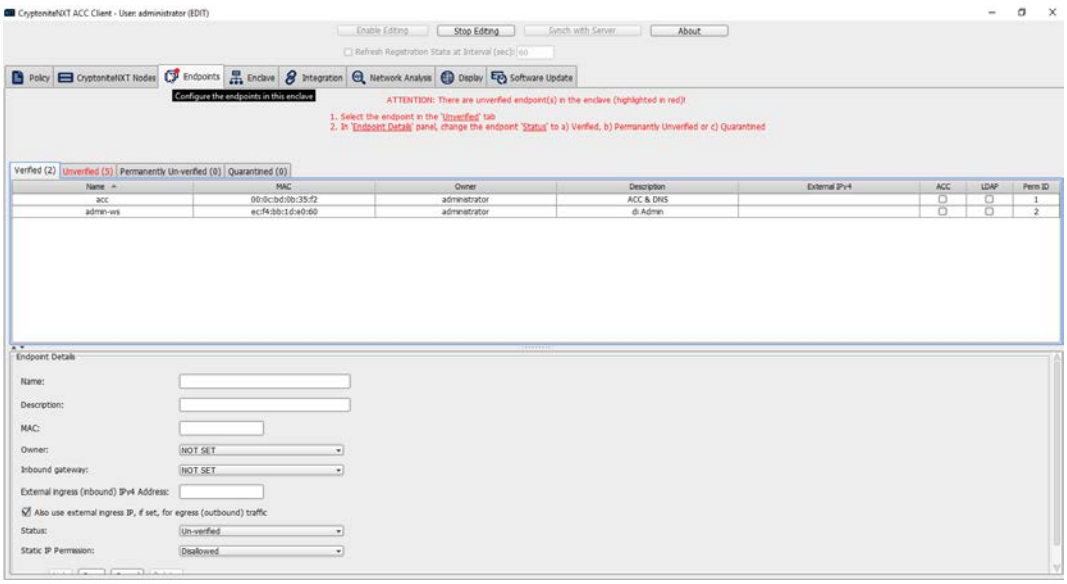
2. Click **OK.**
3. Enter the **password** for the account created during the installation.



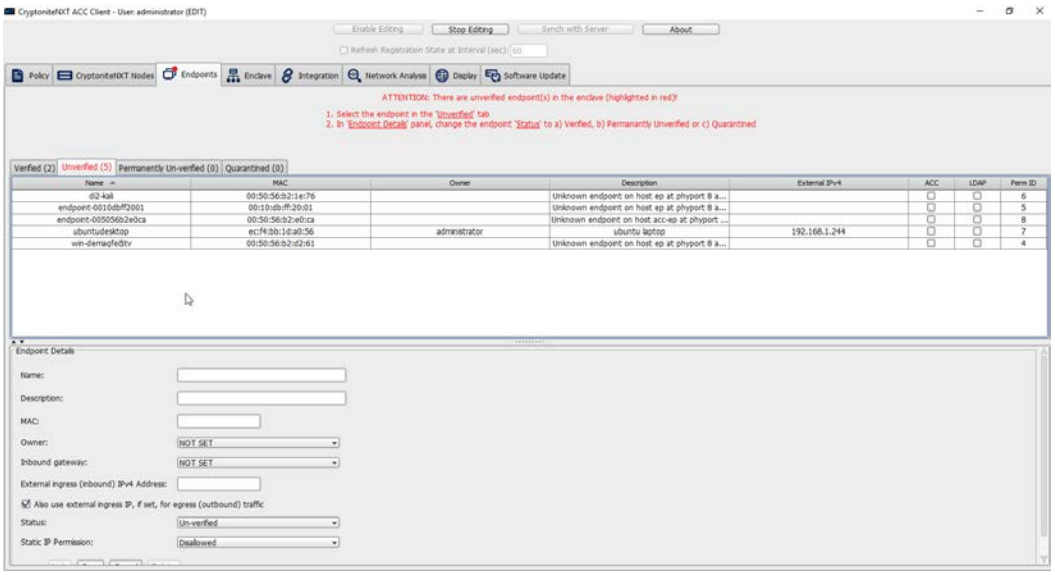
4. Click **OK.**



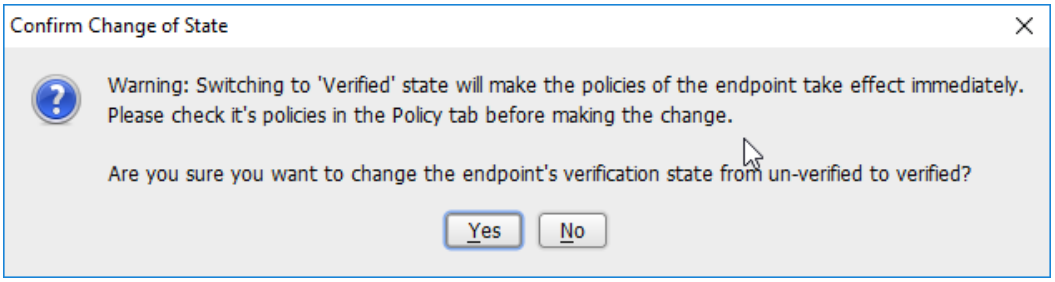
5. Click **Enable Editing** at the top of the application.
6. Click the **Endpoints** tab.



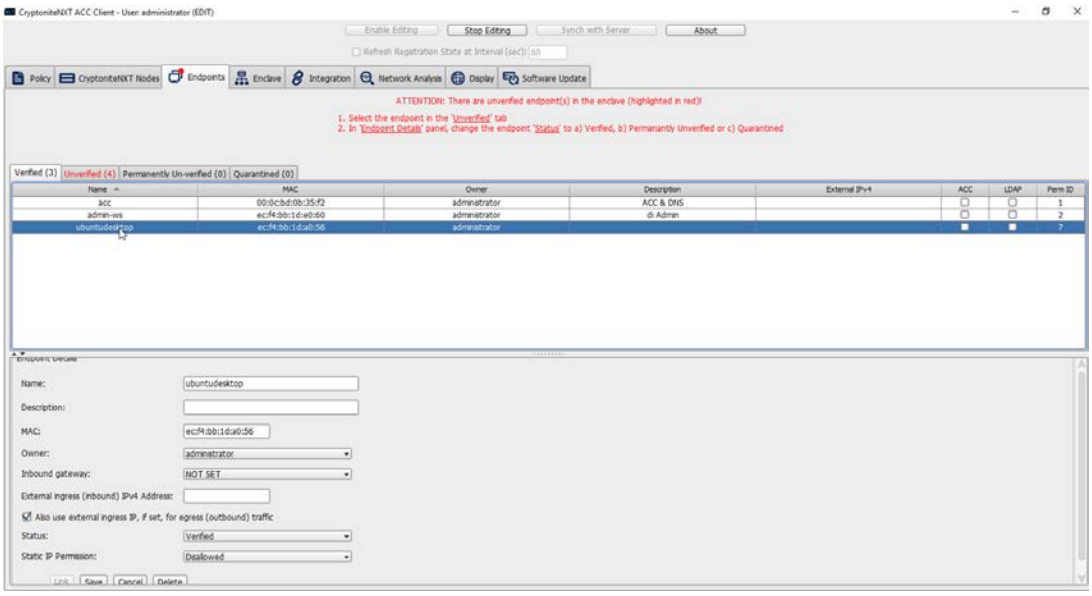
7. Click the **Unverified** tab. Any new devices connected to the network should appear here, if configured to use Dynamic Host Configuration Protocol (DHCP).



8. Click the machine to verify.
9. Enter a **name.**
10. Enter a **description** of the machine.
11. Select an **owner** if desired. If not selected, the owner will be the first user to log in to CryptoniteNXT on the machine.
12. Leave **Inbound gateway:** as **NOT SET** to have it choose a default gateway.
13. Leave **External ingress (inbound) IPv4 Address:** blank.
14. Ensure the box next to **Also use external ingress IP, if set, for egress (outbound) traffic** is checked.
15. Set **Status:** to **Verified.**

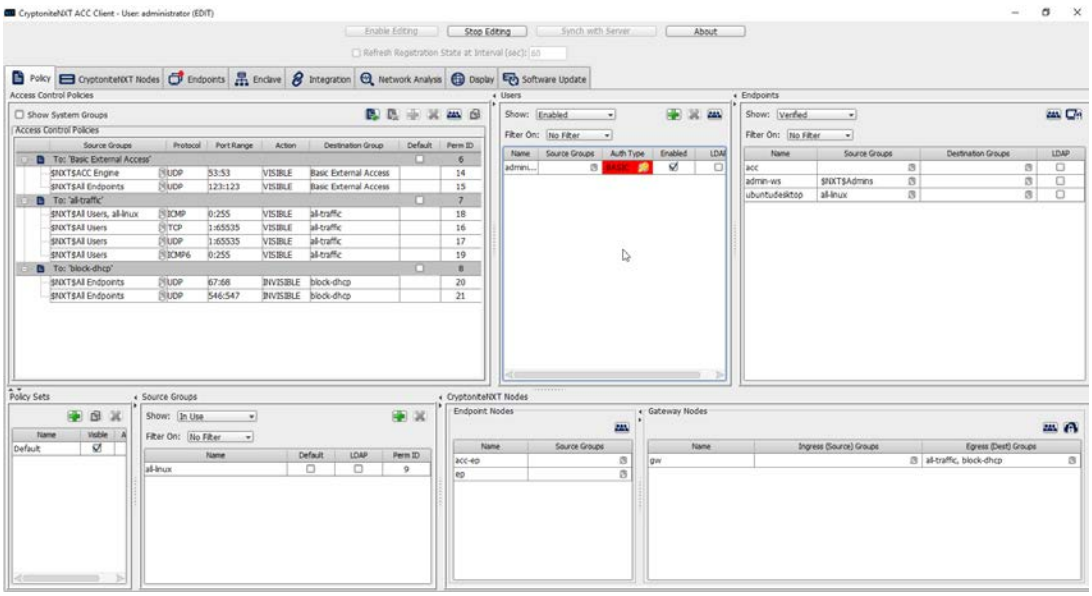


16. Click **Yes.**
17. Click **Save.**
18. The machine should now appear in the **Verified** tab.

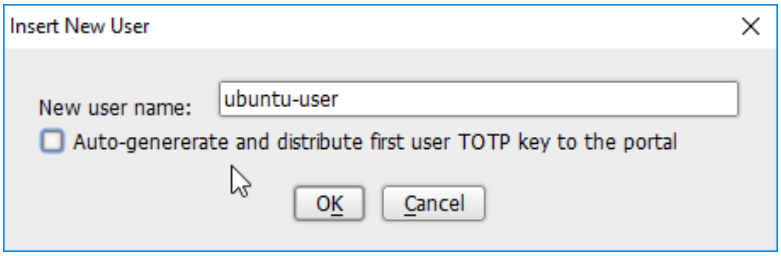


2.7.1.2 Create a New User

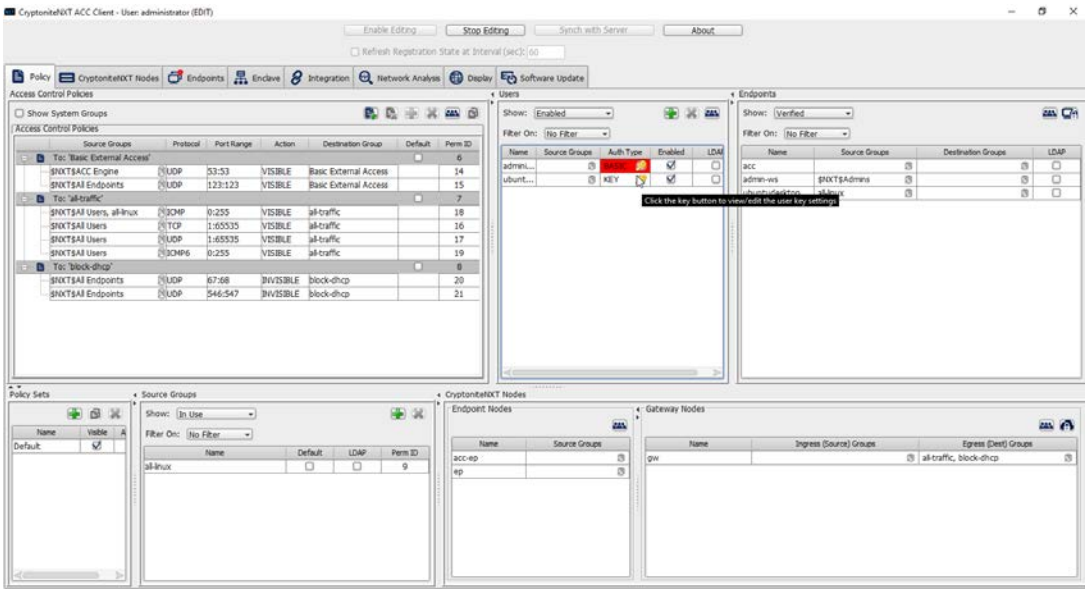
1. Go to the **Policy** tab.



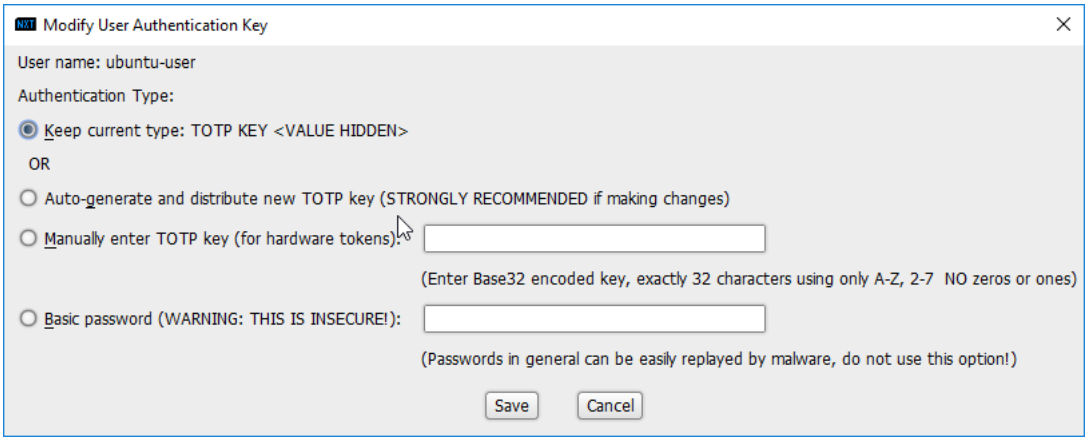
2. Right-click in the **Users** window and select **New User.**
3. Enter the username, and uncheck the box next to **Auto-generate and distribute first user TOTP key to the portal.**



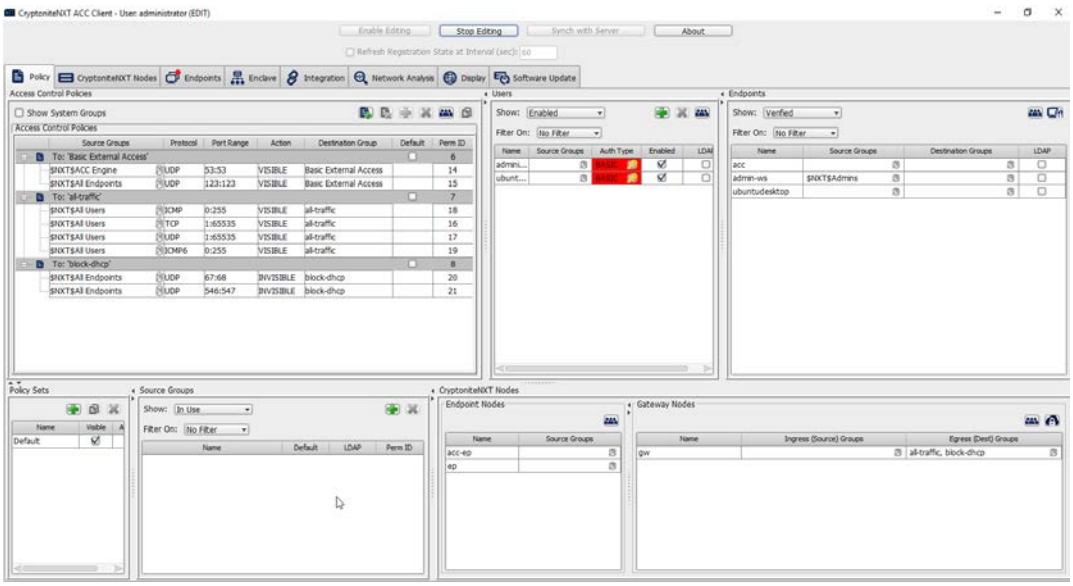
4. Click **OK.**



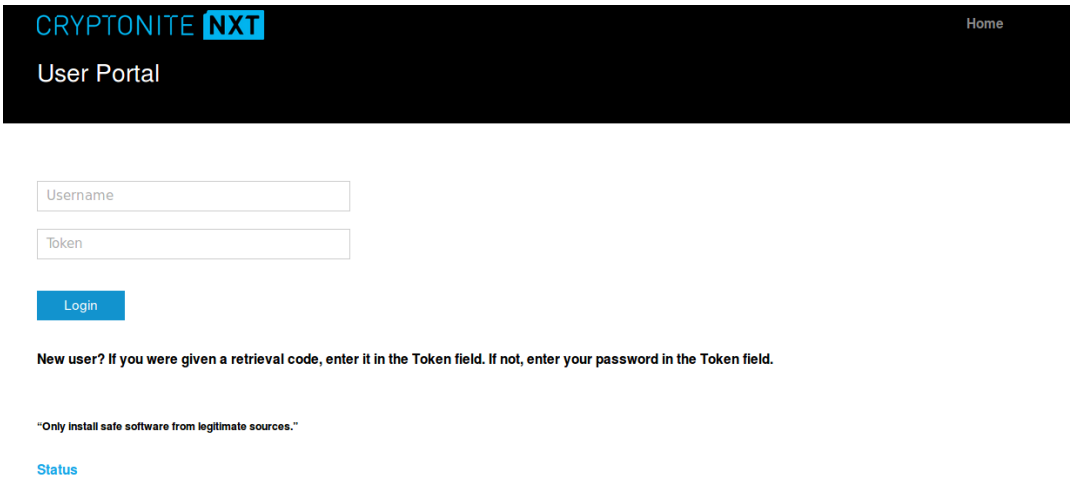
5. The new user should show up in the **Users** window. Click the key icon for the newly created user under **Auth Type.**
6. Decide on an authentication method for the user. (Note: It is not recommended to use passwords, but as this authentication decision depends on the needs of the organization, passwords are used for the purposes of this practice guide.)



7. Click **Save.**



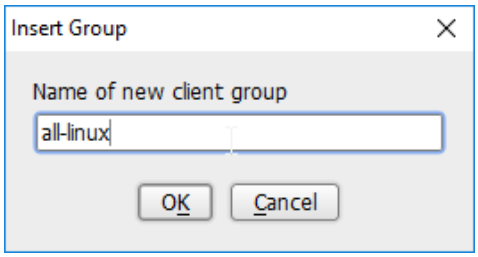
8. On the client machine, the user should be required to sign in on the CryptoniteNXT portal to access the internet. Authenticate using the newly created user.



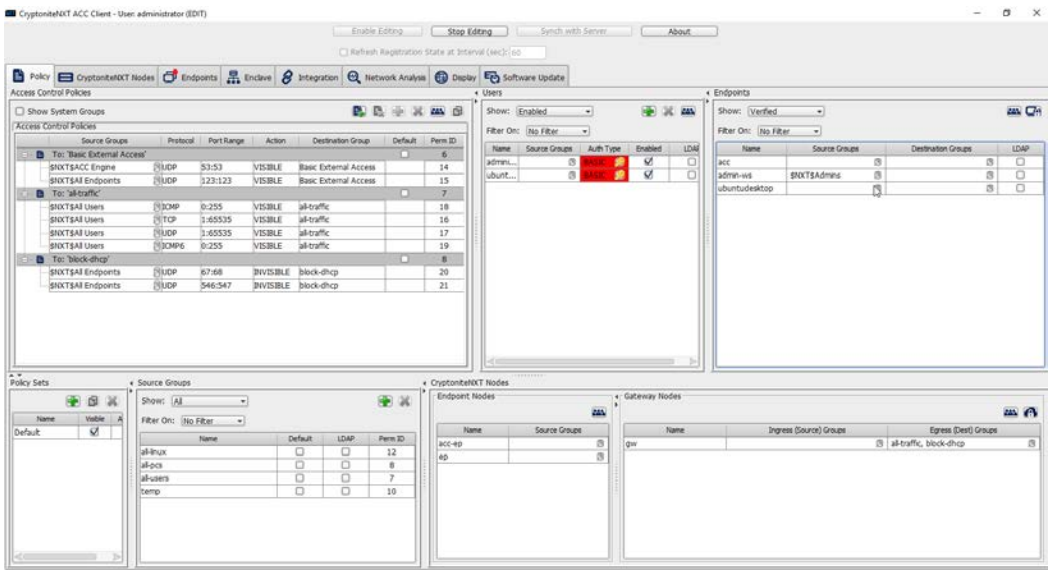
2.7.1.3 Create a New Policy

Creating policy in CryptoniteNXT essentially requires specifying allowed types of traffic. To do this, source groups and destination groups are created.

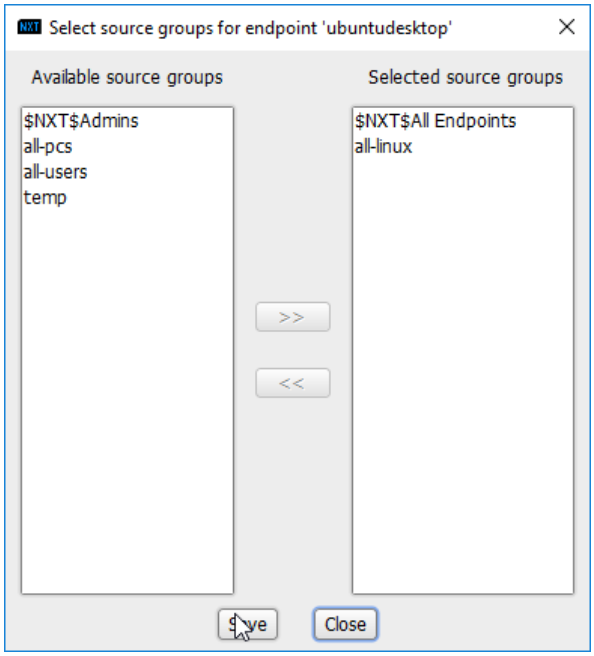
1. To create a source group, right-click in the **Source Groups** window and select **New Source Group.**
2. Enter the name of the group.



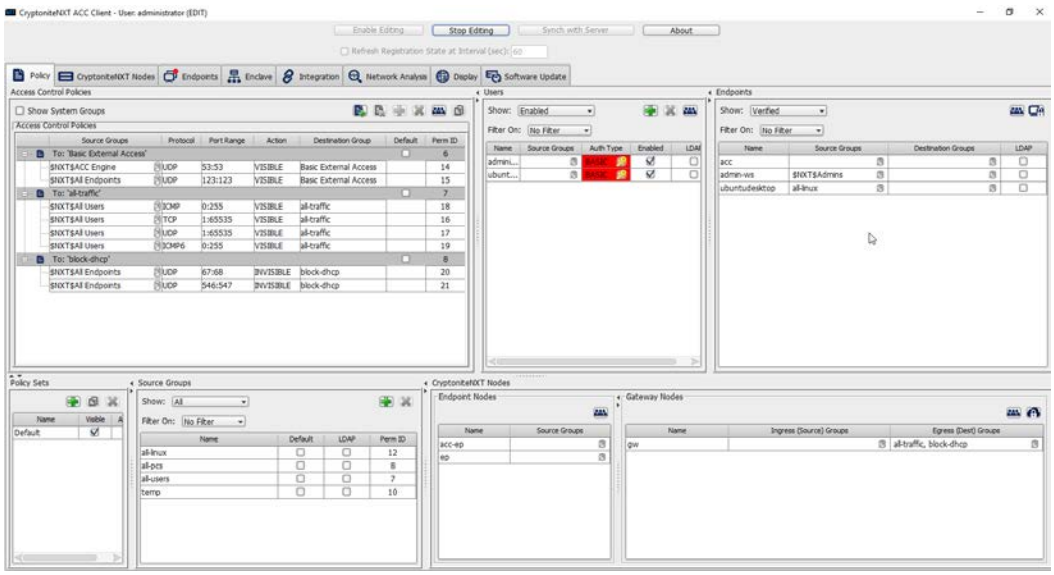
3. Click **OK.**
4. The newly created group should appear in the **Source Groups** window.



5. In the **Endpoints** window, click the arrow button under the **Source Groups** column for any machines to be added to this **Source Group.**
6. Select the newly created group (or groups).
7. Click the **>>** button to add the endpoint to this group.



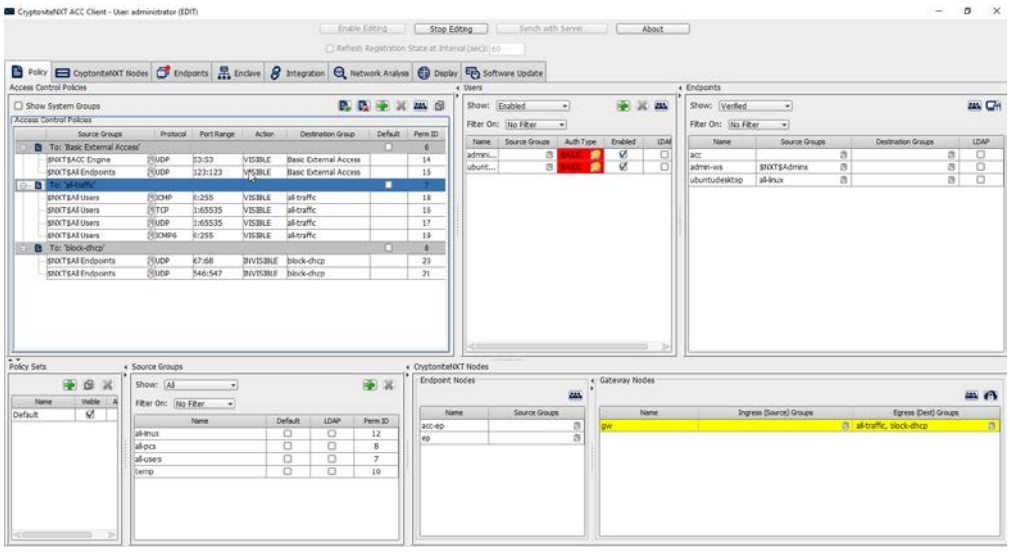
8. Click **Save.**
9. The group should show under the **Source Groups** column for those endpoints.



868

869 Destination groups are used to govern the allowed destinations of endpoints within certain source
870 groups. While destination groups can be created according to organizational property, this example
871 uses an existing group, **all-traffic.**

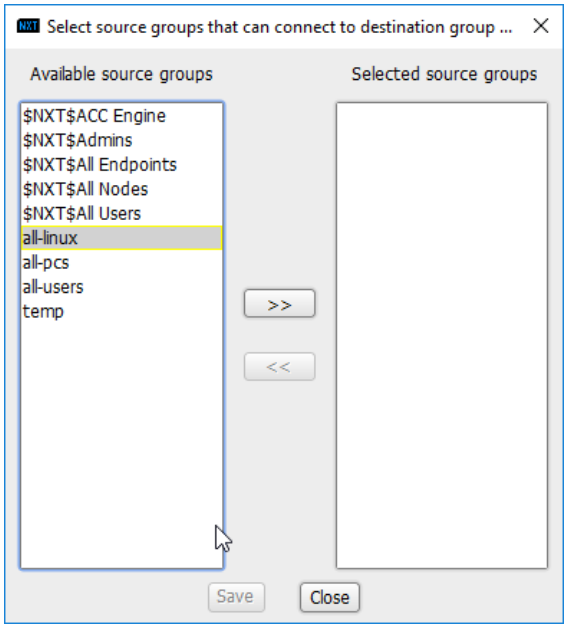
872 1. To allow or prevent the use of ping, we add it to the **all-traffic** group. In the A**ccess Control**
873 **Policies** window, right-click on the row labeled **To: 'all-traffic'** and select **New Access**
874 **Control Policy Entry.**



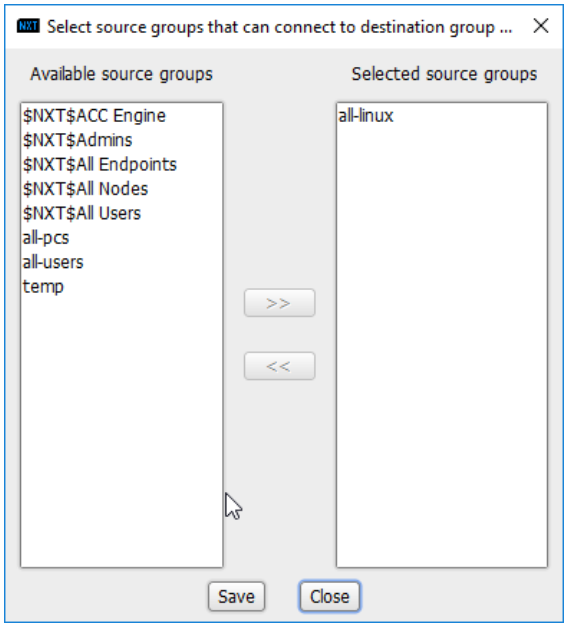
875

876 2. Click the arrow button under the **Source Groups** column.

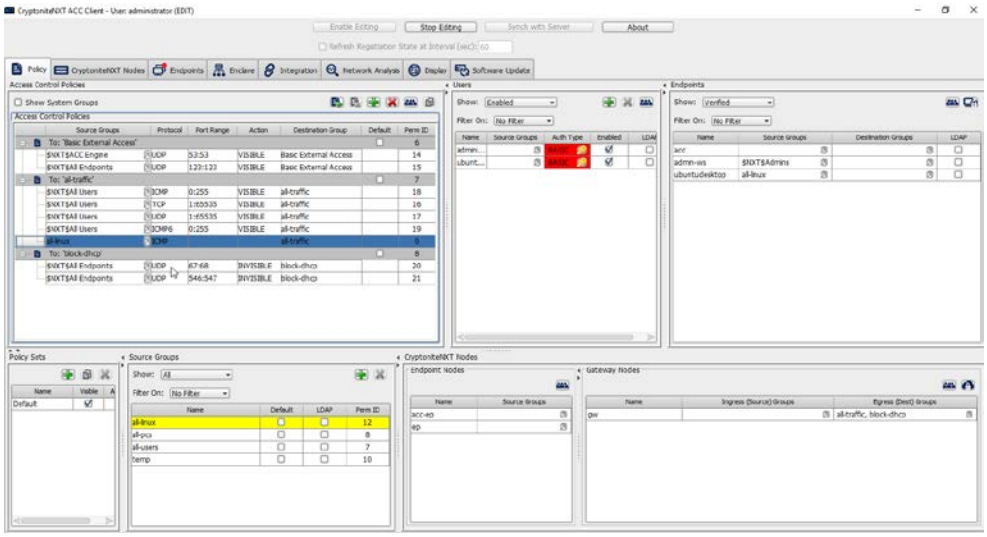
877 3. Select the newly created source group.
878



879
880 4. Click the **>>** button.

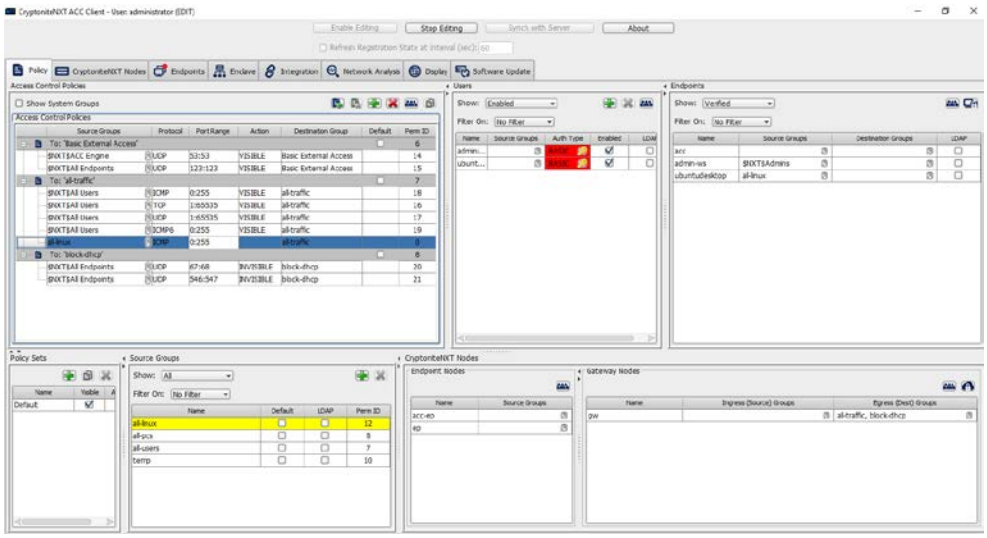


881
882 5. Click **Save.**
883 6. Select the **Protocol.** In this case, to prevent the machine from using ping, we choose **ICMP.**



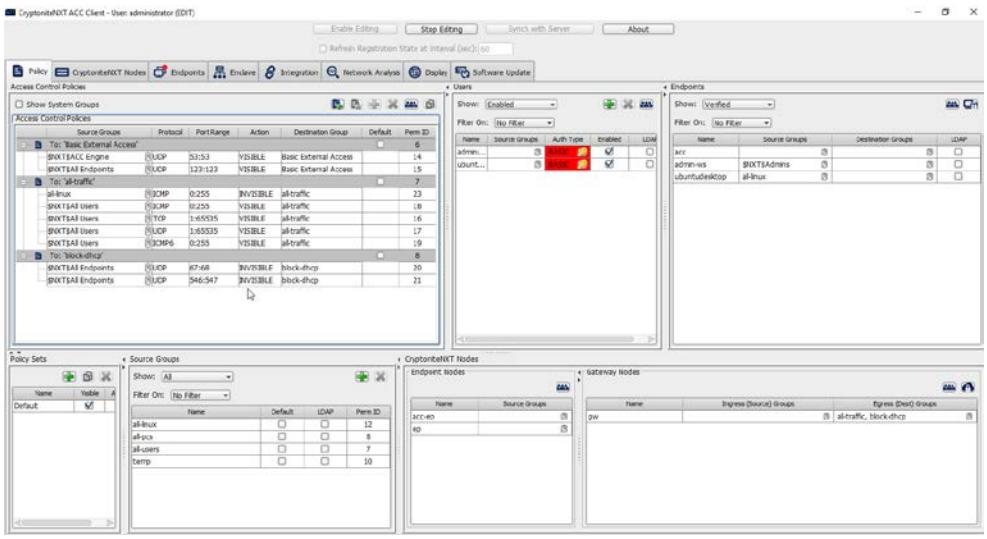
884

885 7. Enter the port range that this traffic can operate on.

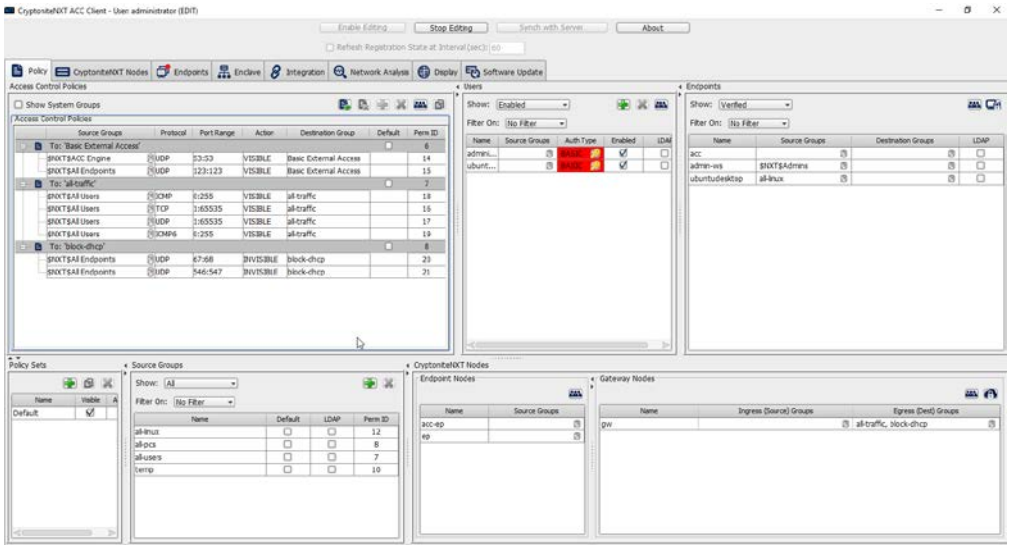


886

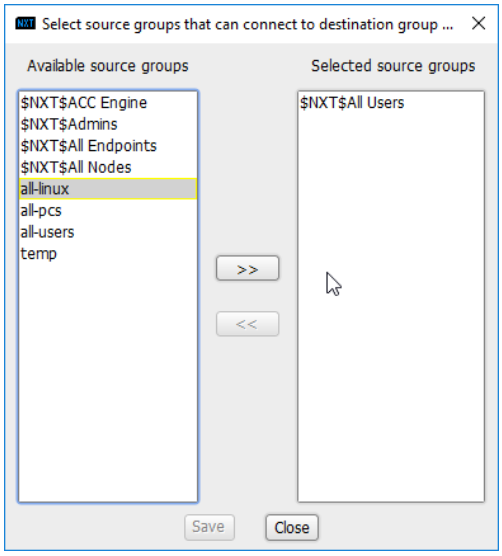
887 8. Select **INVISIBLE** for the **Action** column.



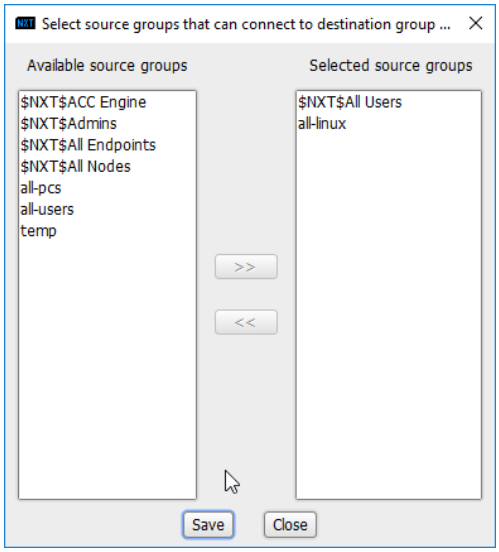
9. This will prevent the members of this group from using ping.
10. To allow the members of this group to use ping, delete this rule. Right-click the entry and select **Delete Access Control Policy Entries.**



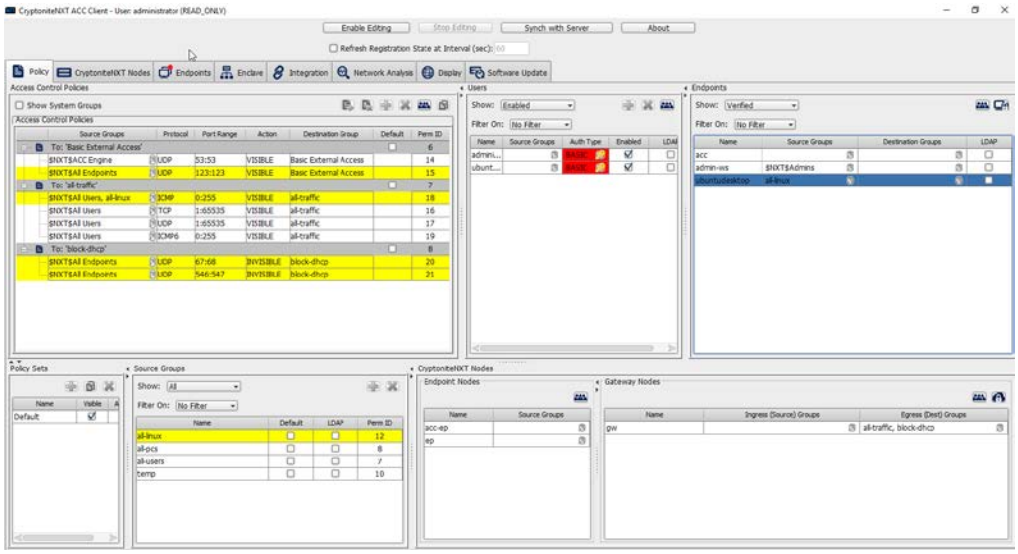
11. Add the newly created group to the existing policy entry by clicking the arrow for that entry under **Source Groups.**
12. Select the newly created group.



13. Click the **>>** button.



14. Click **Save.**
15. Click **Stop Editing** when finished.



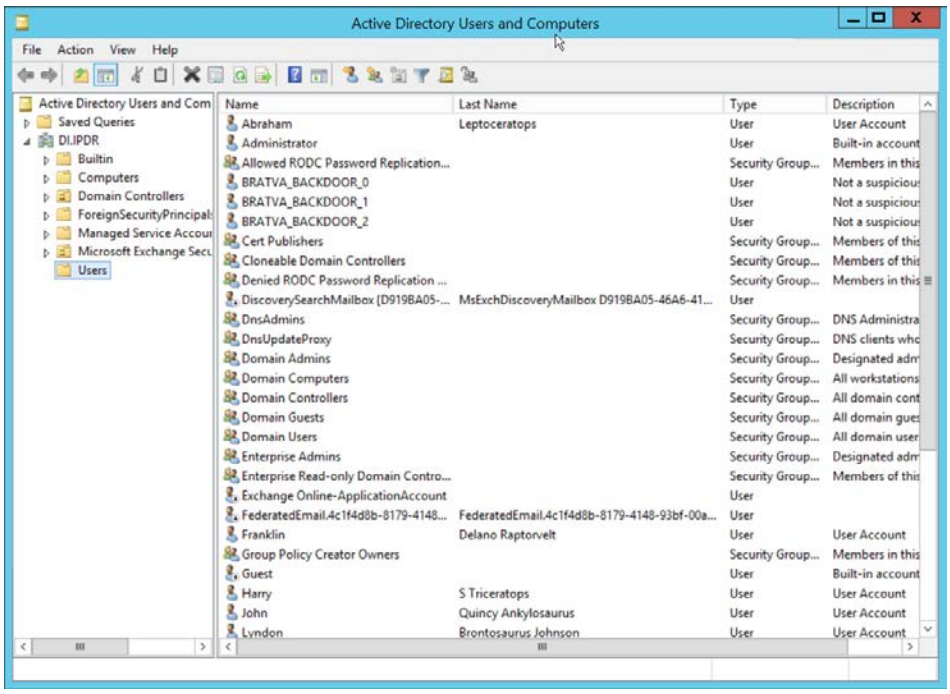
16. Now, the new machine should be allowed to use ping. With these policies it is possible to manage all traffic through the specification of groups, ports, and protocols.

2.7.2 Integrate CryptoniteNXT with Active Directory

In this section, devices listed in Active Directory will be imported into CryptoniteNXT. For this to be successful, the DNS server must have reverse lookup zones configured for the AD server. Please see Section 2.1.6 for setting up reverse lookup zones on the AD/DNS server.

2.7.2.1 Generate a Keytab File

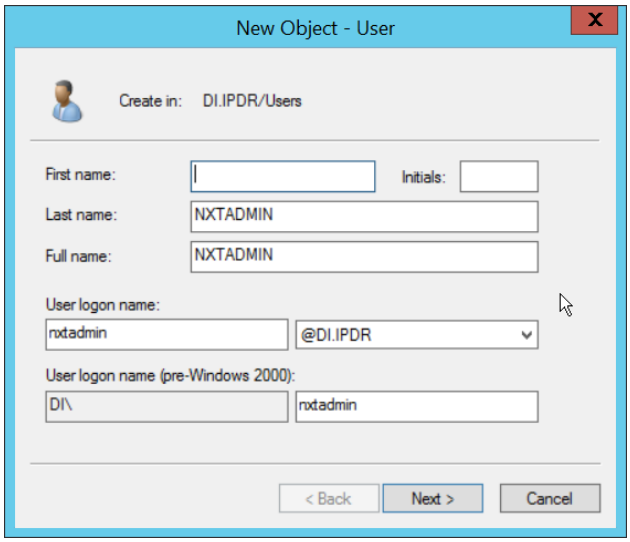
1. Open **Active Directory Users and Computers.**



910

911 2. Right-click the **Users** folder in the left pane and select **New > User.**

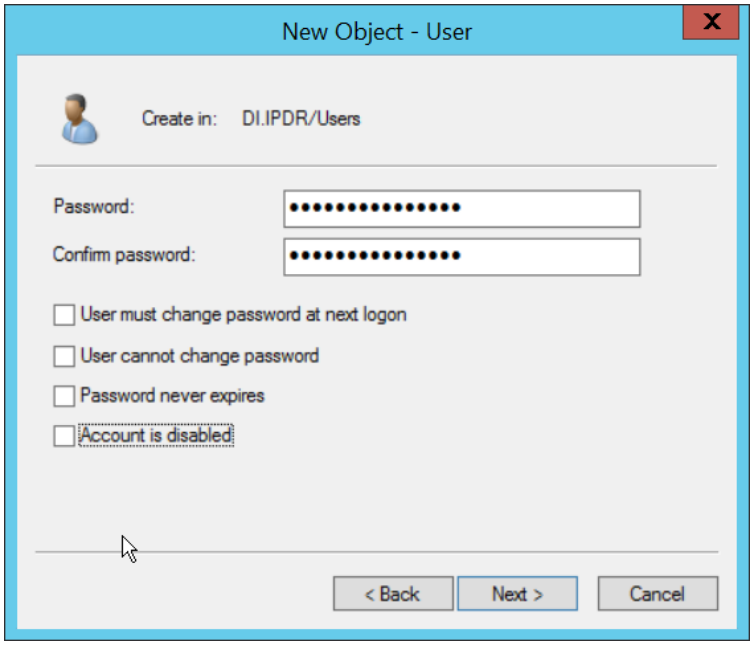
912 3. Enter a **name** for this user, such as nxtadmin.



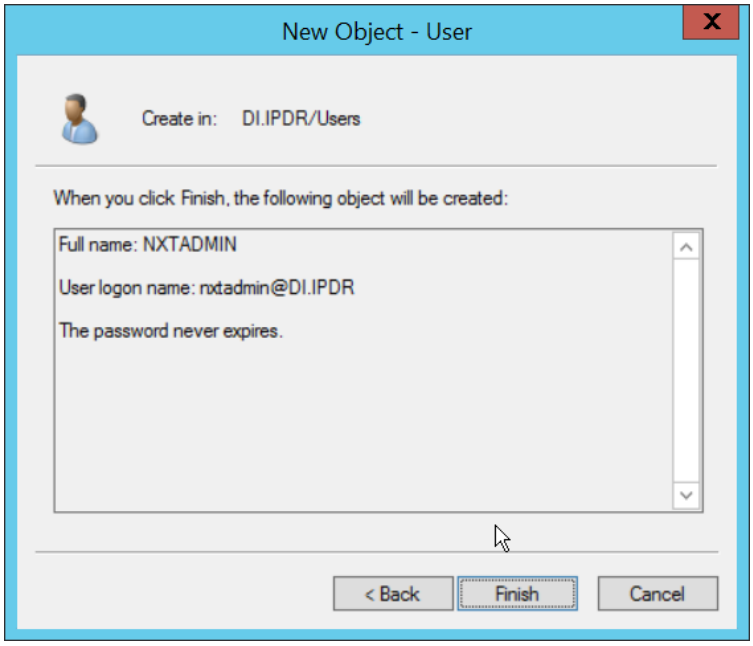
913

914 4. Click **Next.**

915 5. Enter a **password** for this user, and set the password policy.



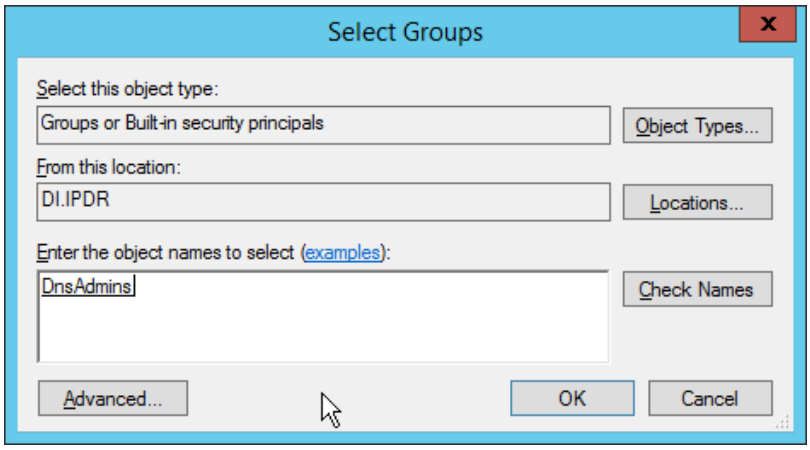
916
917 6. Click **Next.**



918
919 7. Click **Finish.**

920 8. Right-click the newly created user and select **Add to a group….**

921 9. Enter **DnsAdmins.**

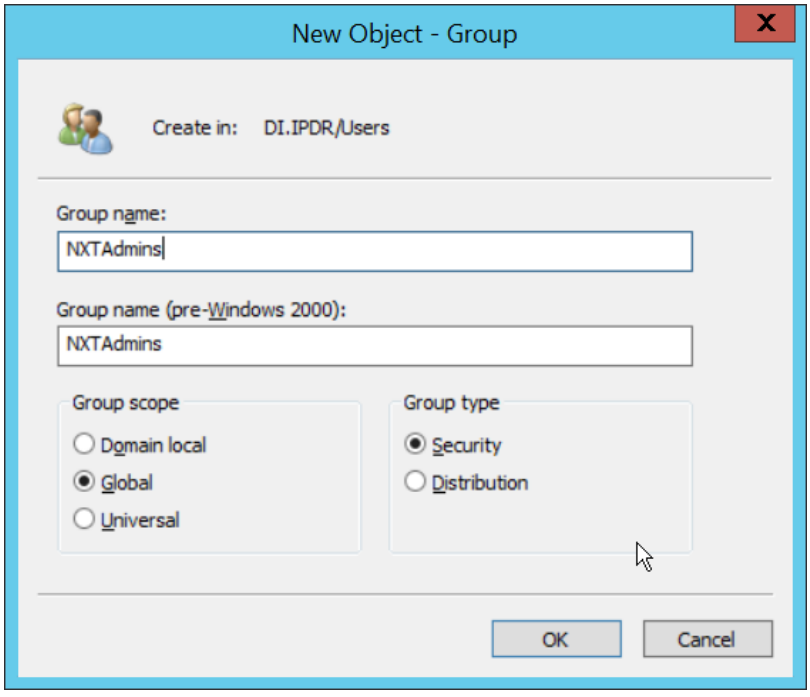


922

923 10. Click **OK.**

924 11. Right-click the **Users** folder in the left pane and select **New > Group.**

925 12. Enter **NXTAdmins** as the group name.

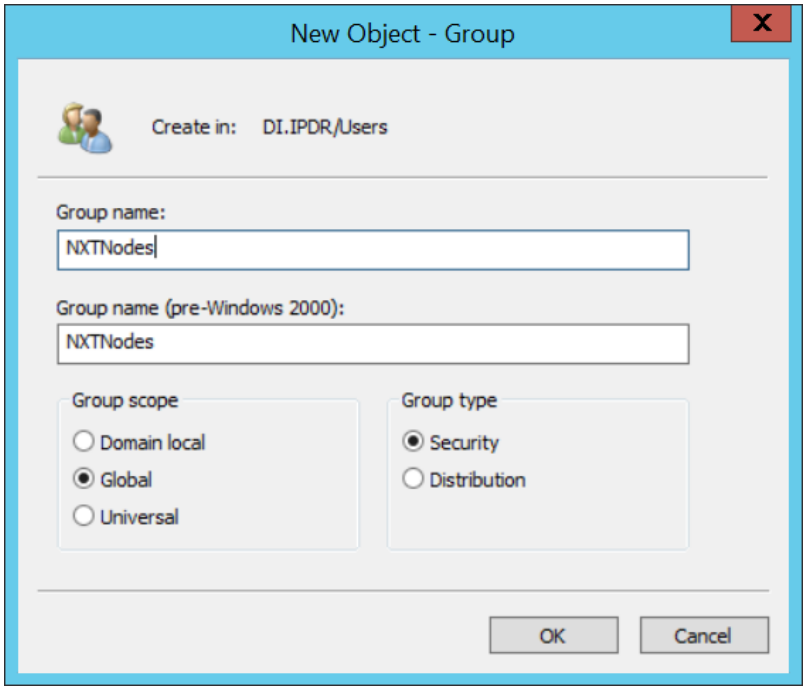


926

927 13. Click **OK.**

928 14. Right-click the **Users** folder in the left pane and select **New > Group.**

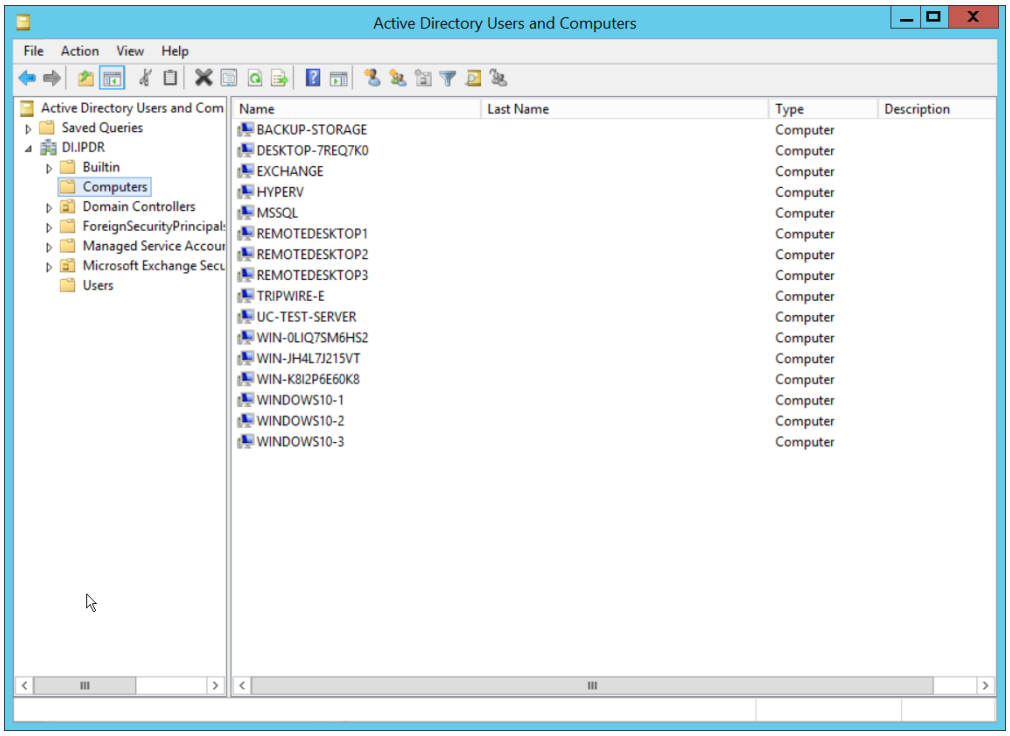
929 15. Enter **NXTNodes** as the group name.



930

931 16. Click **OK.**

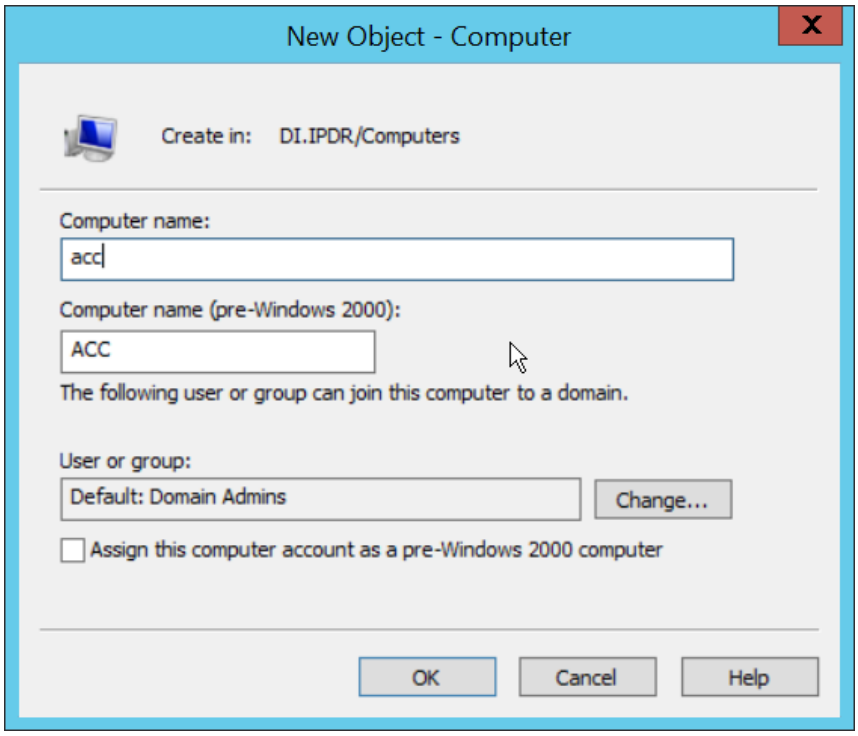
932 17. Click **Computers** in the left pane.



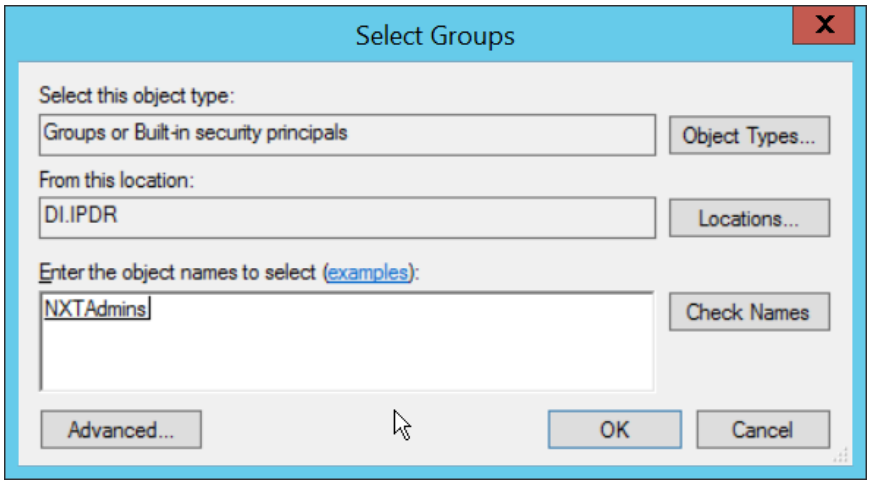
933

934 18. Right-click **Computers** in the left pane and select **New > Computer.**

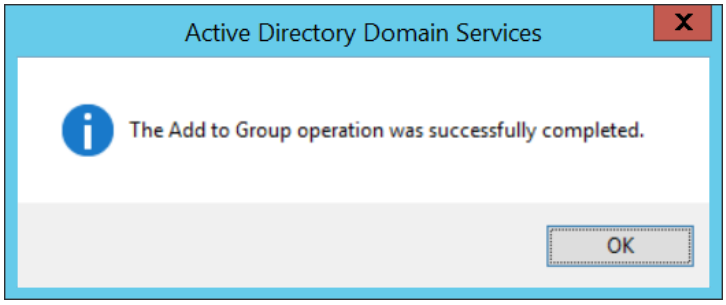
935 19. Enter the name of the **acc** server for **CryptoniteNXT** (Node A).



20. Click **OK.**
21. Right-click the newly created computer and select **Add to a group….**
22. Enter **NXTAdmins** in the box labeled **Enter the object names to select (examples):.**



23. Click **OK.**



24. Click **OK.**
25. Open a new Administrator **PowerShell** window.
26. Enter the following command, using the newly created user in the **DnsAdmins** group:

```
> ktpass -princ DNS/<user>.<domain>@<DOMAIN> -mapuser
<user>@<domain> -pass <user password> -out .\<keytab filename>
-ptype krb5_nt_principal -crypto all
```

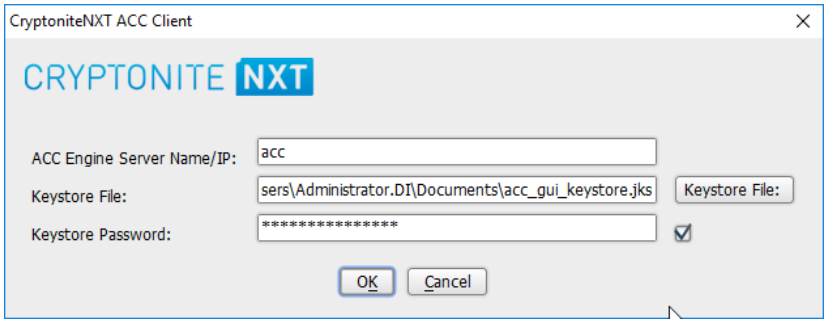
For example:

```
> ktpass -princ DNS/nxtadmin.di.ipdr@DI.IPDR -mapuser
nxtadmin@di.idpr -pass password123 -out .\keytab.out -ptype
krb5_nt_principal -crypto all
```

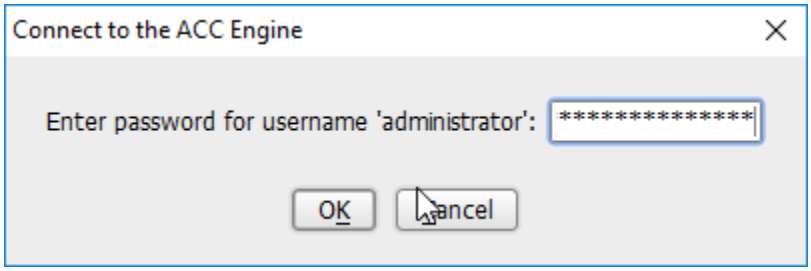
27. This will produce a keytab file. Copy this file to the CryptoniteNXT Management workstation.

2.7.2.2 Import Keytab File to ACC

1. On the management workstation, open the **CryptoniteNXT ACC GUI.**

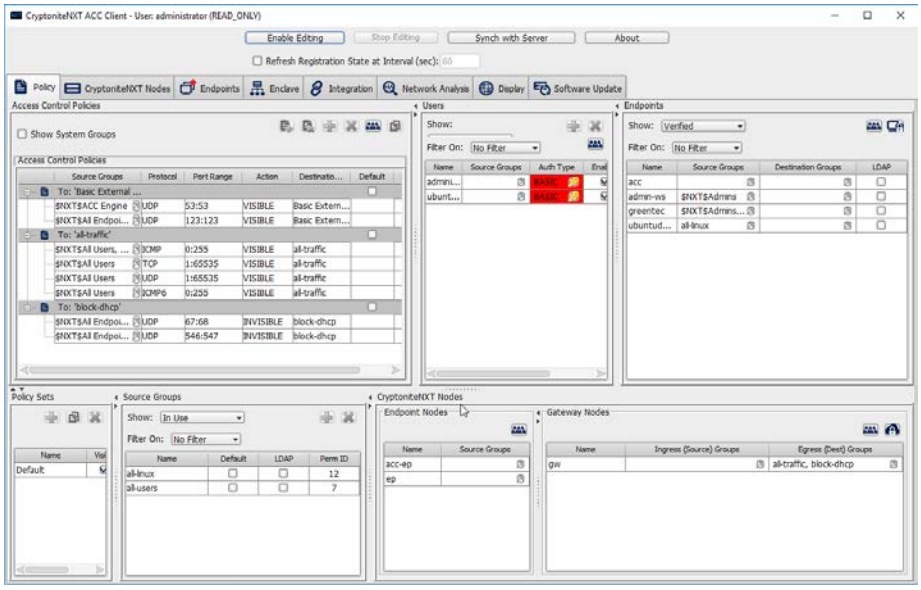


2. Click **OK.**
3. Enter the **password** configured during installation.



962

963 4. Click **OK.**

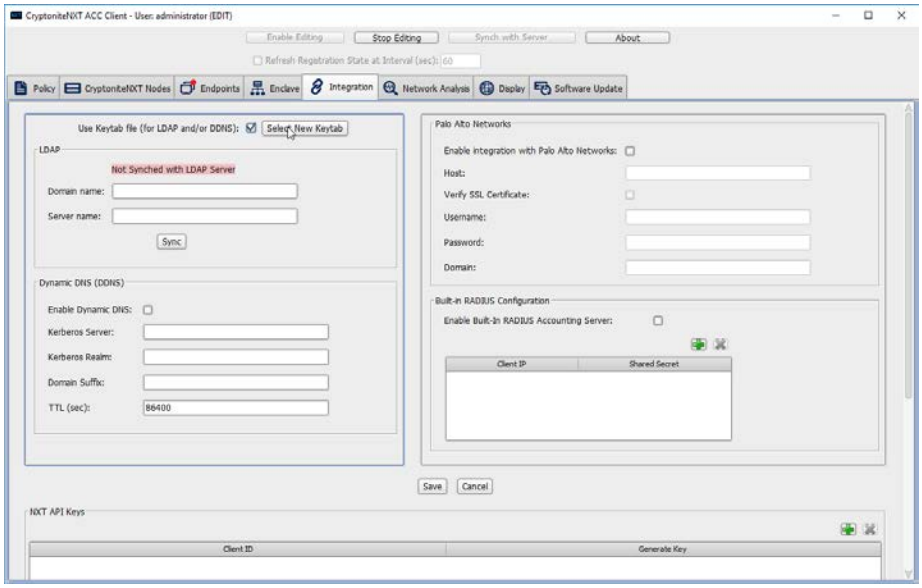


964

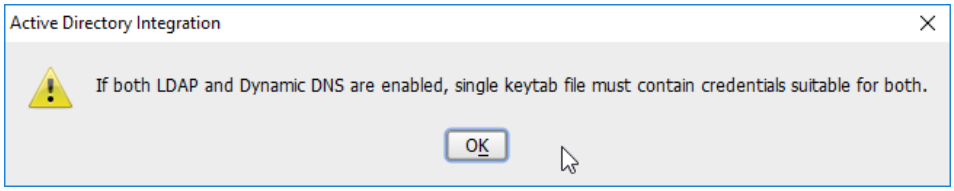
965 5. Click **Enable Editing.**

966 6. Click the **Integration** tab.

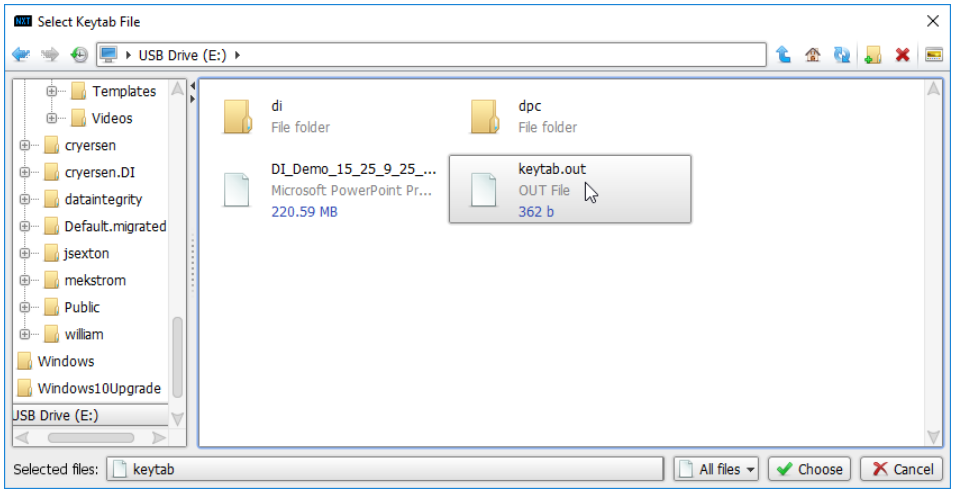
967 7. Check the box next to **Use Keytab file (for LDAP and/or DDNS):.**



8. Click **Select New Keytab.**

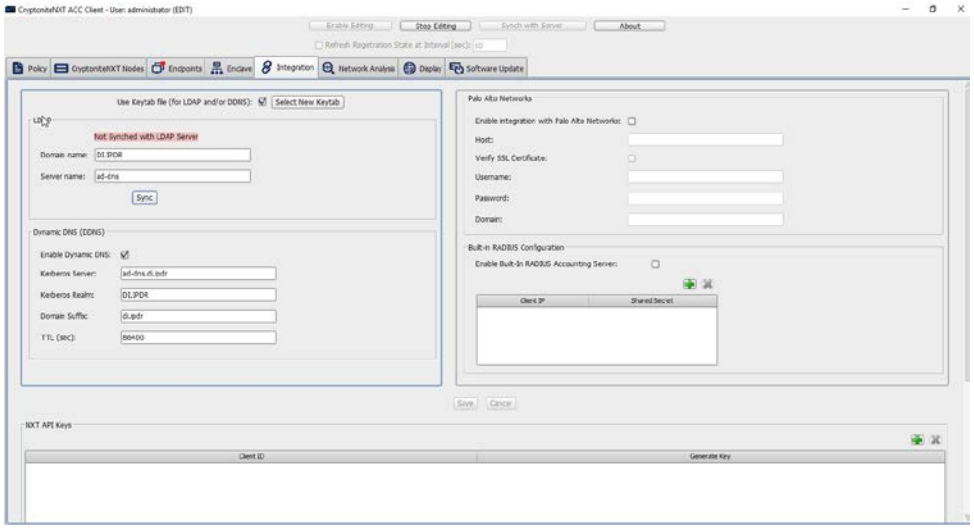


9. Click **OK.**
10. Navigate to the keytab file.

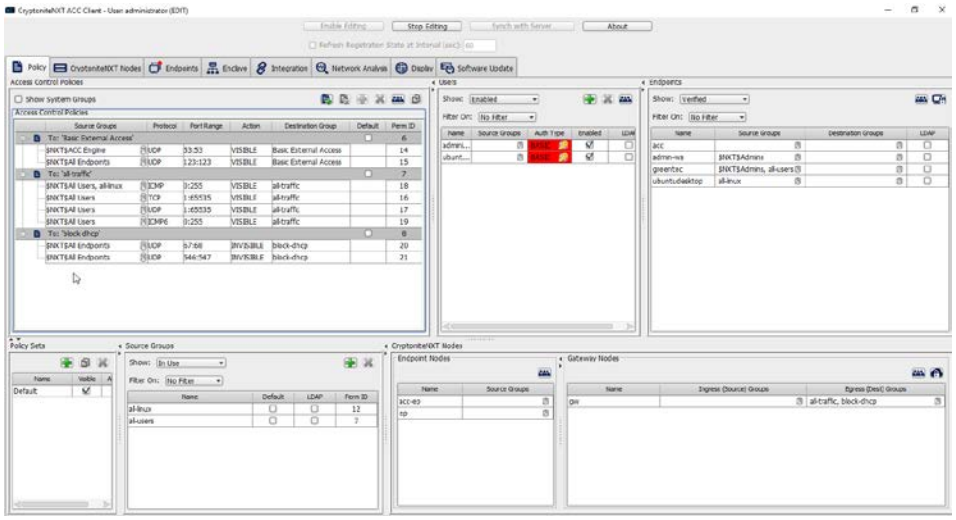


11. Click **Choose.**
12. Click **Save.**

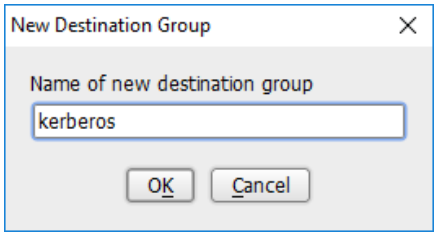
13. Under **LDAP,** enter the **Domain name** (such as DI.IPDR) and the **Server name** (such as ad-dns).
14. Check the box next to **Enable Dynamic DNS:.**
15. Enter the **fully qualified domain name** of the DNS server (such as ad-dns.di.ipdr).
16. Enter the **Kerberos realm** (such as DI.IPDR).
17. Enter the **domain suffix** (such as di.ipdr).



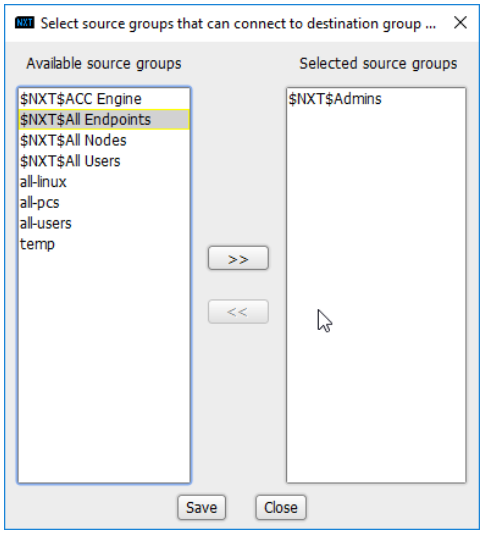
18. Click **Save.**
19. Click the **Policies** tab.



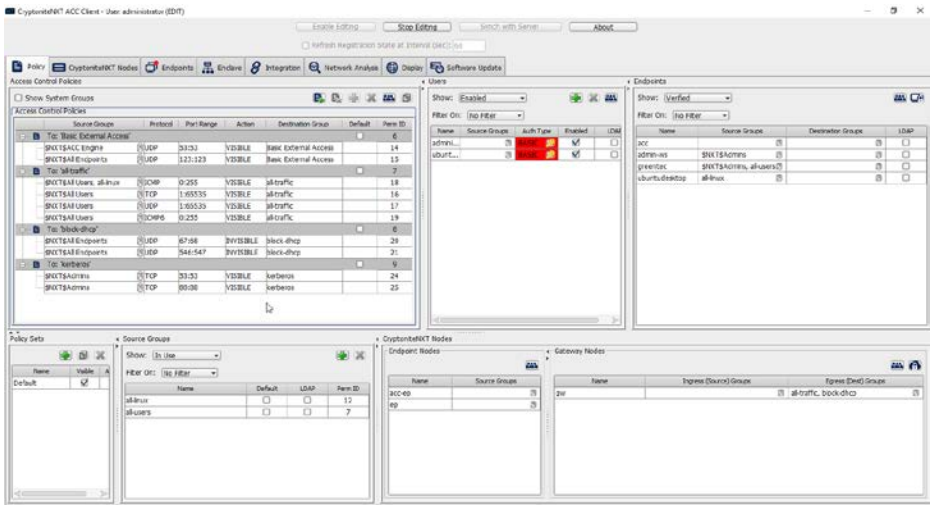
20. Right-click in the **Access Control Policies Window** and select **New Destination Group.**
21. Enter **kerberos.**



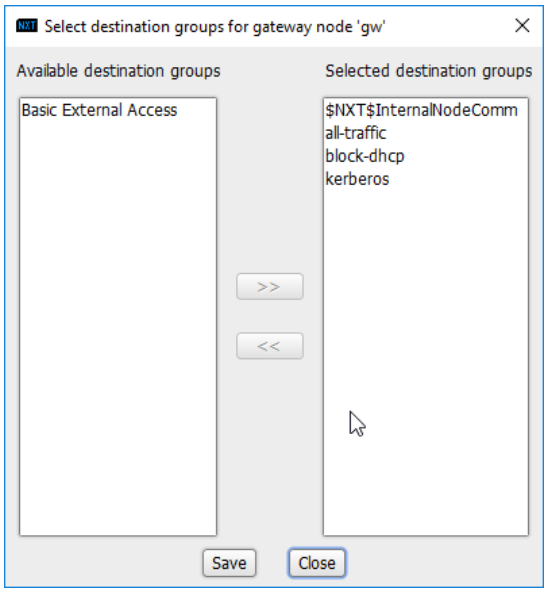
22. Click **OK.**
23. Select **TCP** under **Action.**
24. Enter 53:53 under **Port Range.**
25. Select **VISIBLE** under **Action.**
26. Click the arrow under **Source Groups.**
27. Select **NXTAdmins.**
28. Click the **>>** button.



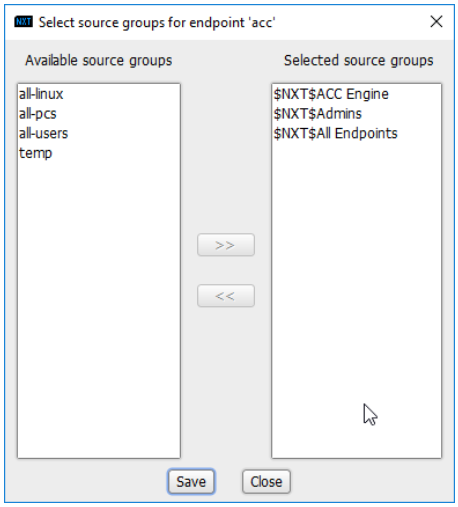
29. Click **Save.**
30. Right-click the **To: 'kerberos'** destination group, and select **New Access Control Policy Entry.**



31. Repeat steps 21–29, but replace 53:53 with 88:88.
32. In the **Gateway Nodes** window, click the arrow under **Egress (Dest) Groups.**
33. Select “kerberos”.
34. Click the **>>** button.

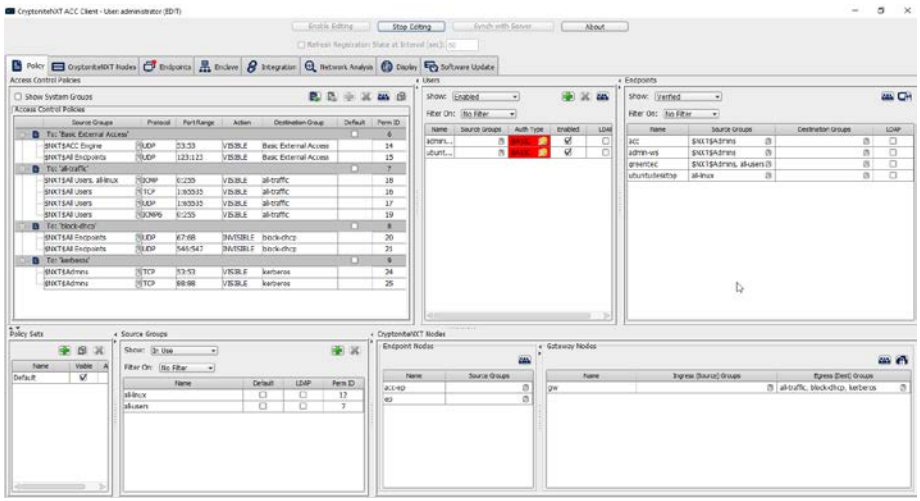


35. Click **Save.**
36. In the **Endpoints** window, click the arrow under **Source Groups** associated with the Administration Control Center (ACC).
37. Select **NXTAdmins.**
38. Click the **>>** button.



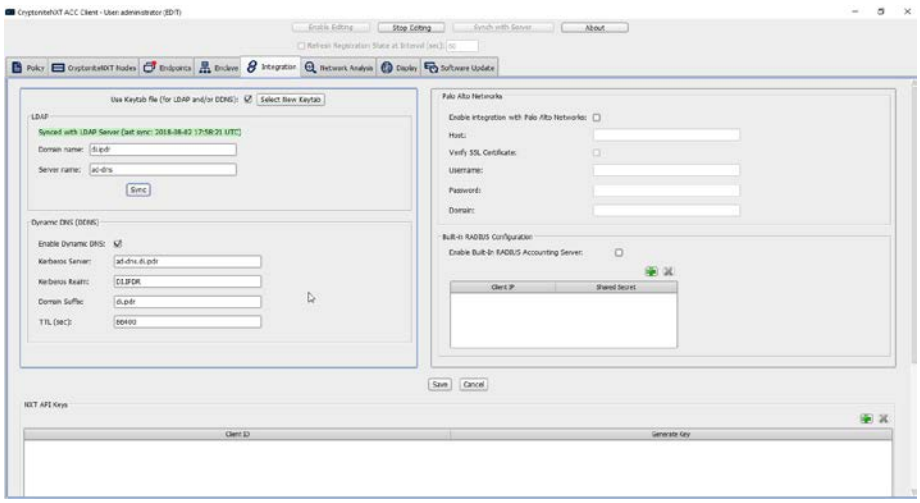
1011

1012 39. Click **Save.**



1013

1014 40. Return to the **Integration** tab.



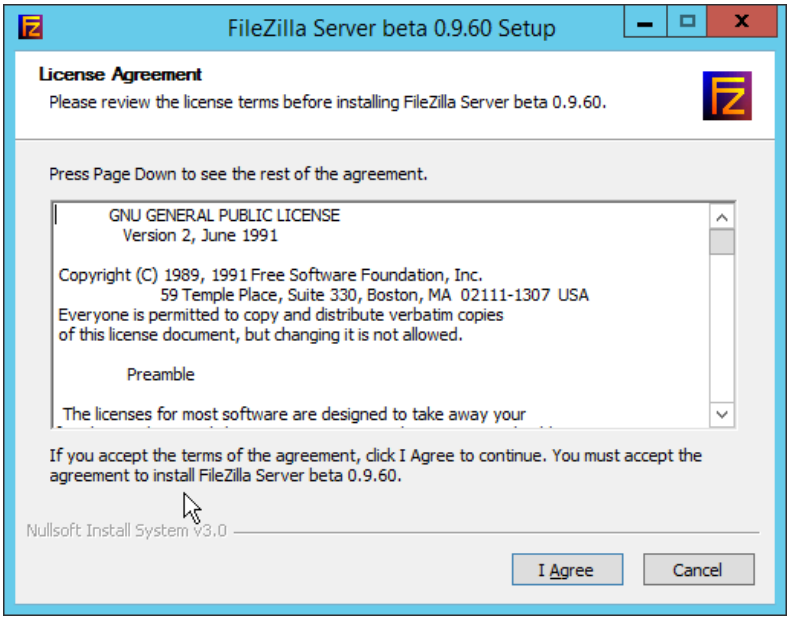
41. Click **Sync.**

2.8 Backups

For this capability we use an integration of two open-source tools: **Duplicati** and **FileZilla. FileZilla** acts as a File Transfer Protocol (FTP) (over TLS) server component, while **Duplicati** acts as an encrypted backup client. This section details the installation and integration of both tools, as well as the process for creating a backup schedule, but does not provide specific recommendations on backup frequency or backup targets as those are specific to the organization.

2.8.1 FileZilla FTPS Server Setup

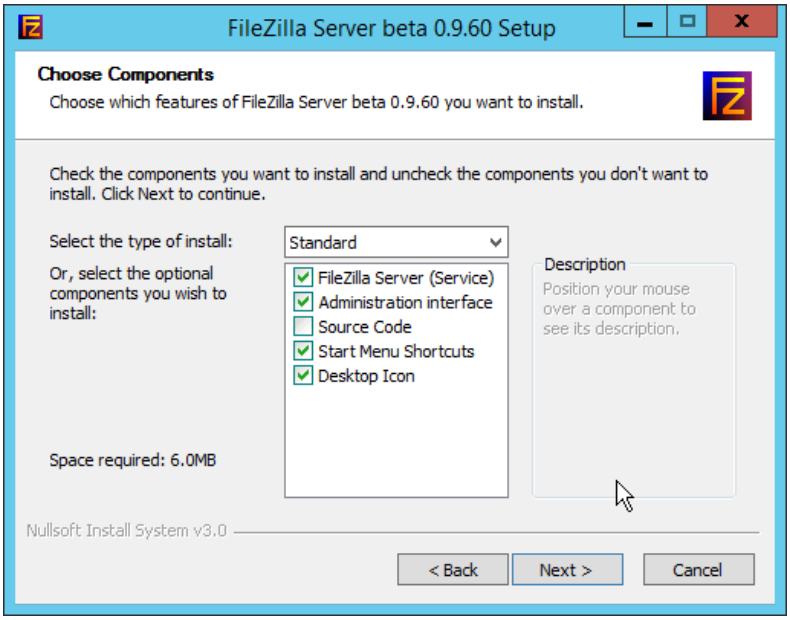
1. Run **FileZilla_Server-0_9_60_2.exe.**



1025

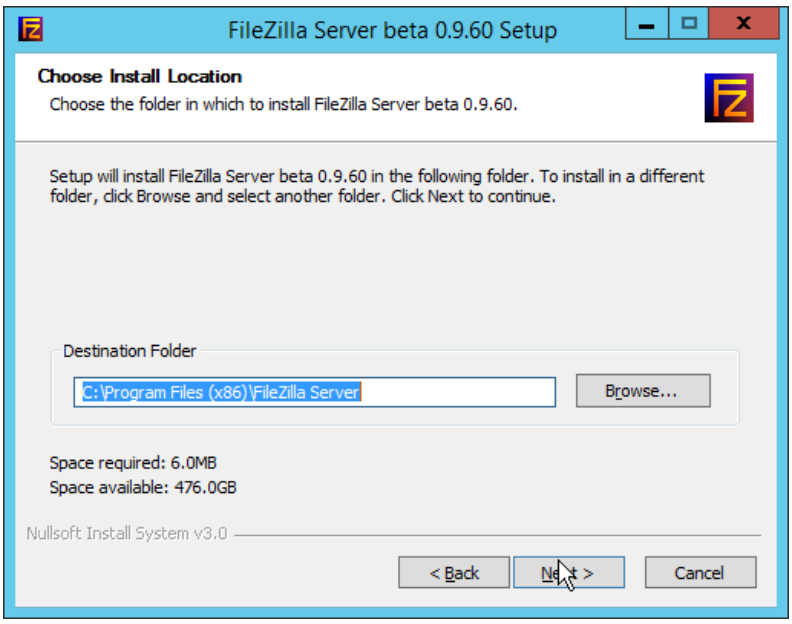
1026 2. Click **I Agree.**

1027 3. Select **Standard** from the drop-down menu.

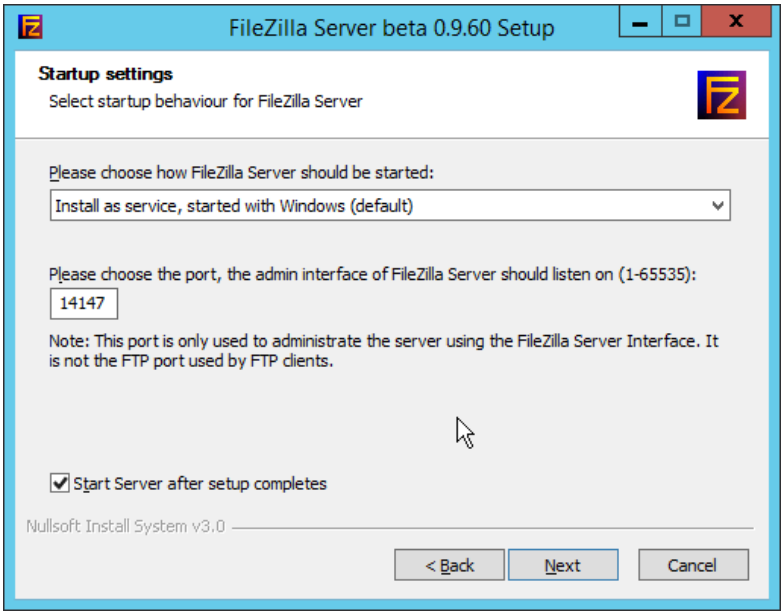


1028

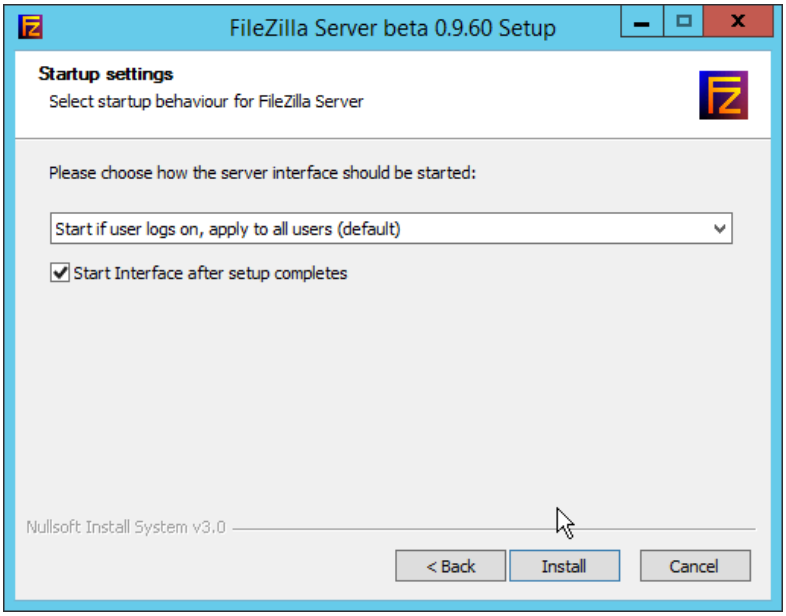
1029 4. Click **Next.**



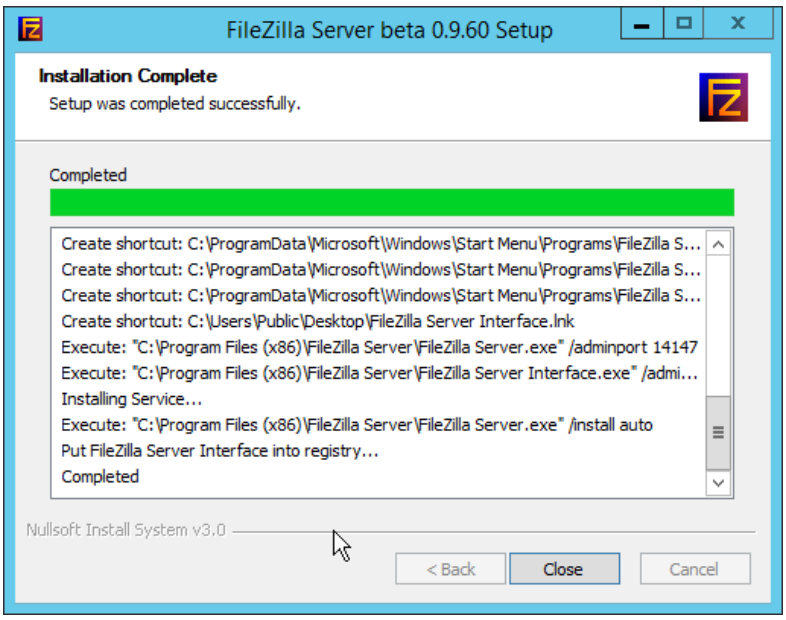
5. Click **Next.**
6. Select **Install as service, started with Windows (default)** from the drop-down.
7. Specify a port (for the administrator interface to run on) if desired (the default is 14147).
8. Ensure the box next to **Start Server after setup completes** is checked.



9. Click **Next.**



10. Click **Install.**

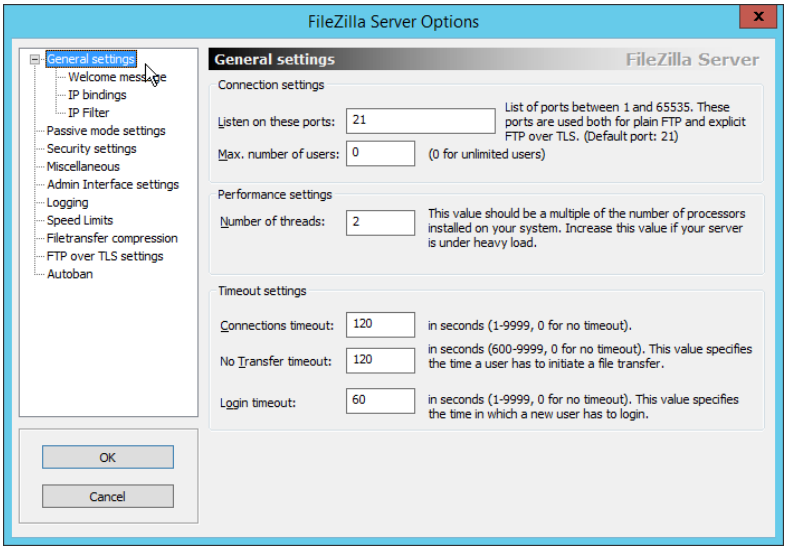


11. Click **Close.**

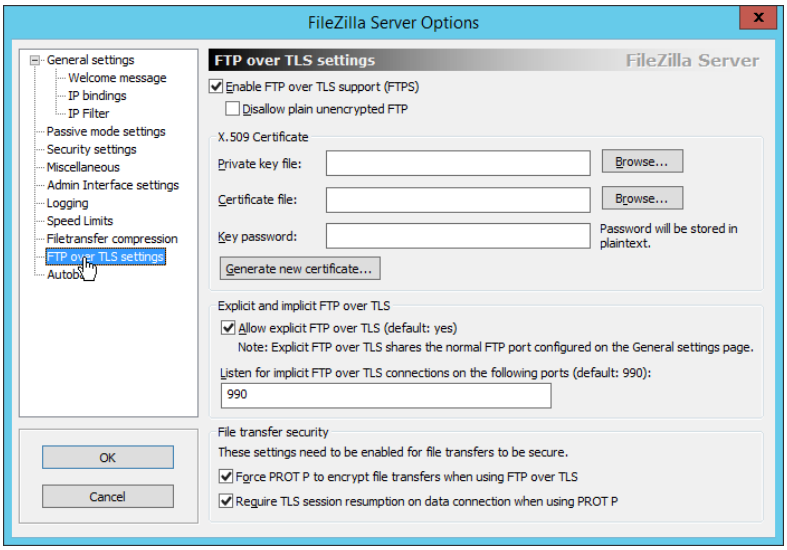
2.8.2 FileZilla Configuration

1. When the administrator interface comes up, ensure that the port is correct and click **Connect.**

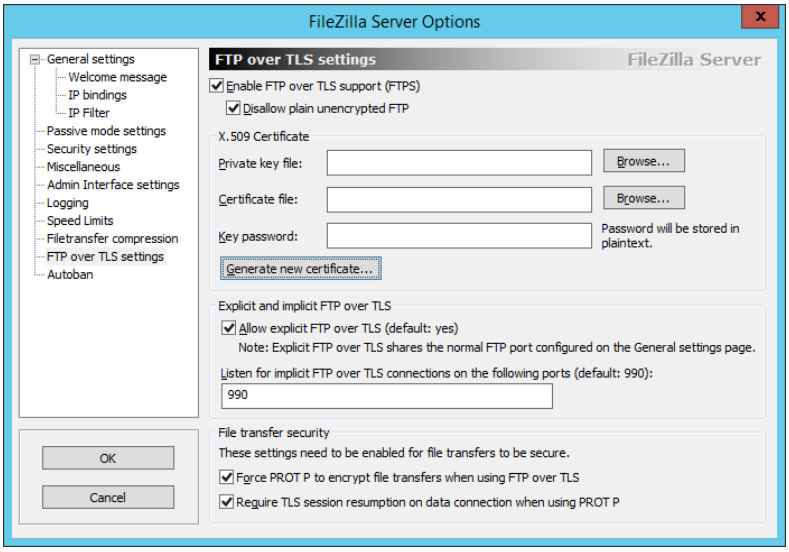
2. Click **Edit > Settings.**



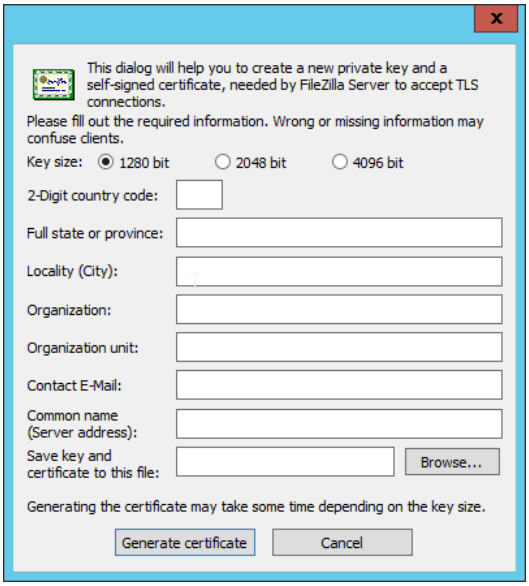
3. Click **FTP over TLS settings.**



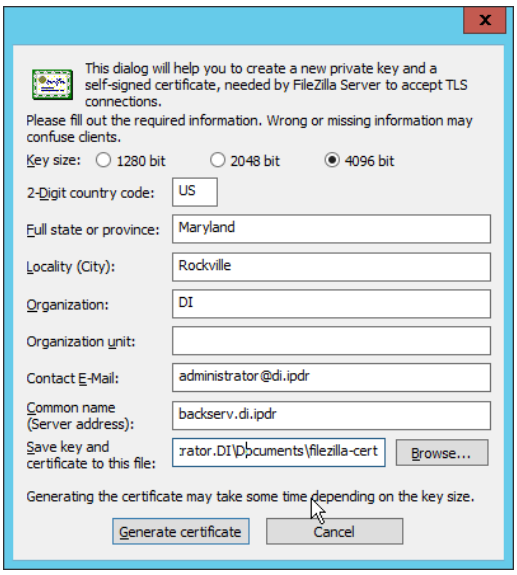
4. Check the box next to **Enable FTP over TLS support (FTPS).**
5. Check the box next to **Disallow plain unencrypted FTP.**



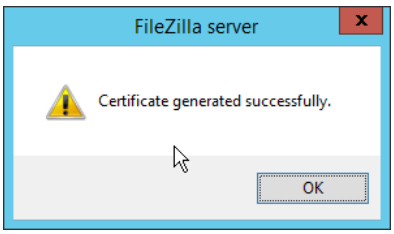
6. Click **Generate new certificate.**



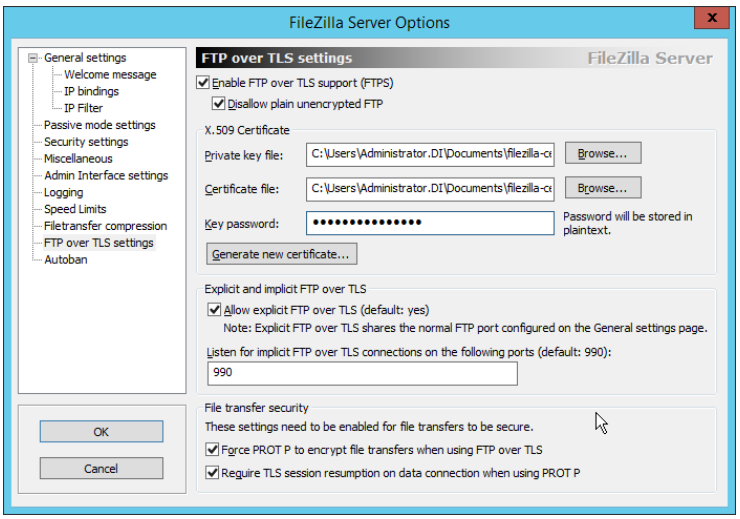
7. Select **4096 bit** for **Key Size.**
8. Enter the information for the certificate specific to your organization.
9. For the **common name,** enter the address of the server on which this is installed.
10. Click **Browse** and specify a file location for the certificate.



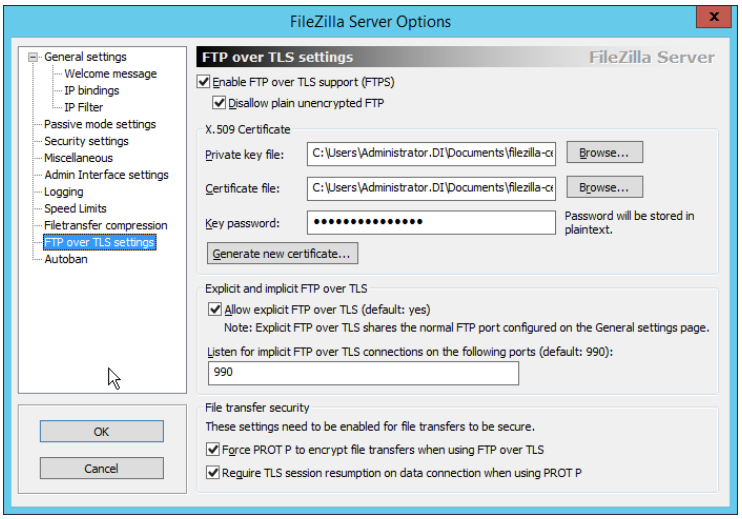
11. Click **Generate certificate.** (The file now contains both the private key and the certificate. These can be separated, for ease of use, as long as the correct file locations are specified in the settings.)



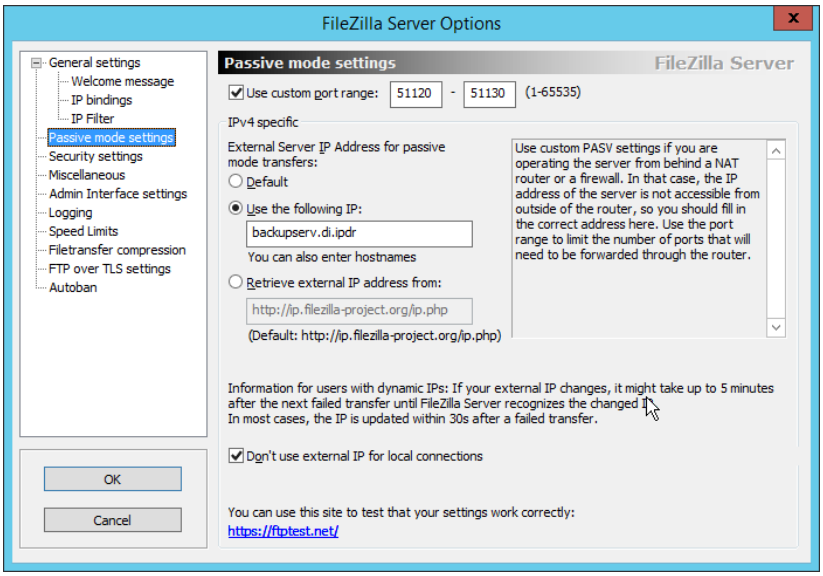
12. Click **OK.**



13. Enter a **password** for the key.
14. Ensure the box next to **Force PROT P to encrypt file transfers when using FTP over TLS** is checked.
15. Ensure the box next to **Require TLS session resumption on data connection when using PROT P** is checked.



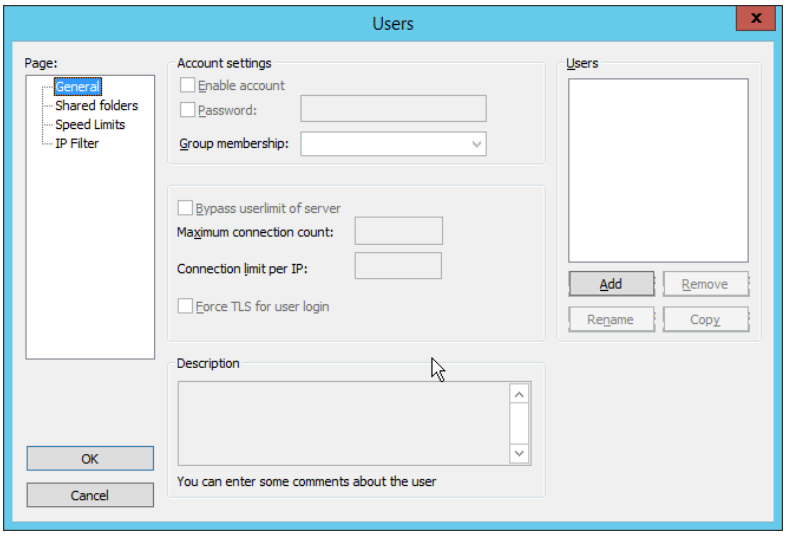
16. Click **Passive mode settings.** Check the box next to **Use custom port range.** (This is necessary in cases of a local server behind Network Address Translation (NAT) or a firewall.)
17. Enter a range of ports for passive mode to use. Ensure that these ports are allowed through the firewall.
18. Select **Use the following IP.**
19. Enter the server address.



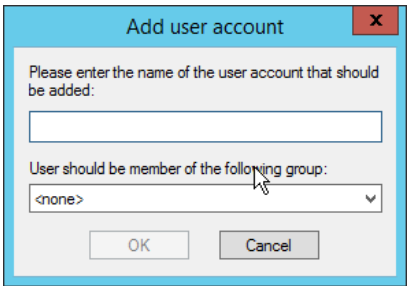
20. Click **OK.**

2.8.3 Add a User to FileZilla

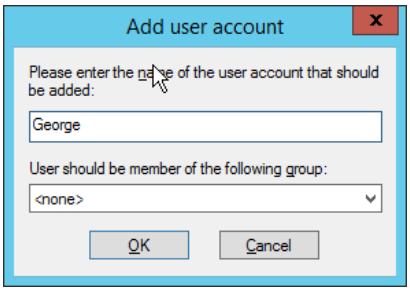
1. In the FileZilla administrator interface, click **Edit > Users.**



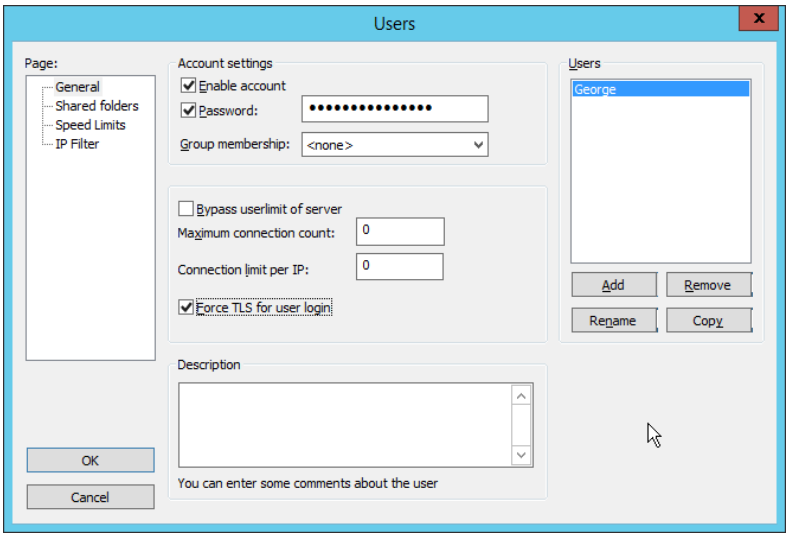
2. Click **Add.**



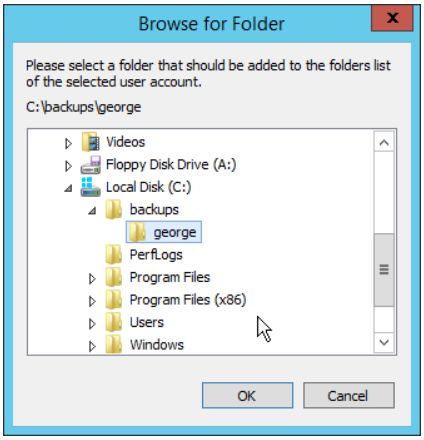
3. Enter a **name** for the user.



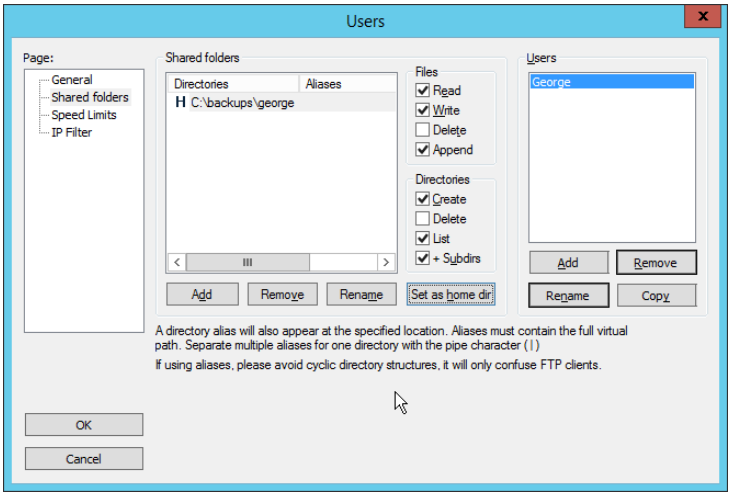
4. Click **OK.**
5. Check the box next to **Password.**
6. Enter a **password** for the user.



7. Check the box next to **Force TLS for user login.**
8. Click **Shared Folders.**
9. Click **Add,** under **Shared Folders.**



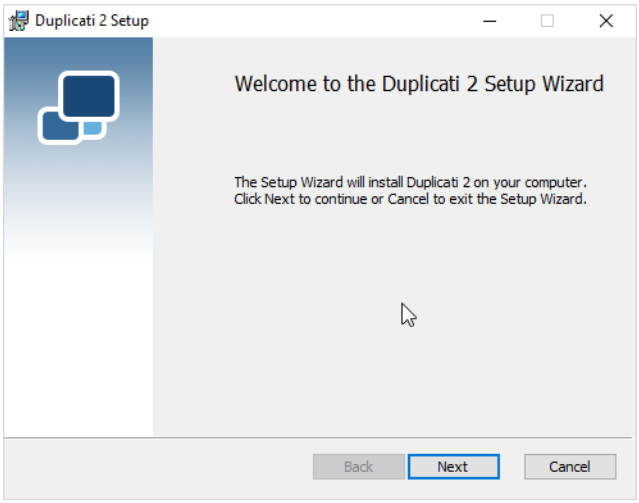
10. Select a place for backups *for this user* to be stored.
11. Check the boxes next to **Write** and **Append,** under **Files.**
12. Check the box next to **Create,** under **Directories.**
13. Select this entry and click **Set as home dir.**



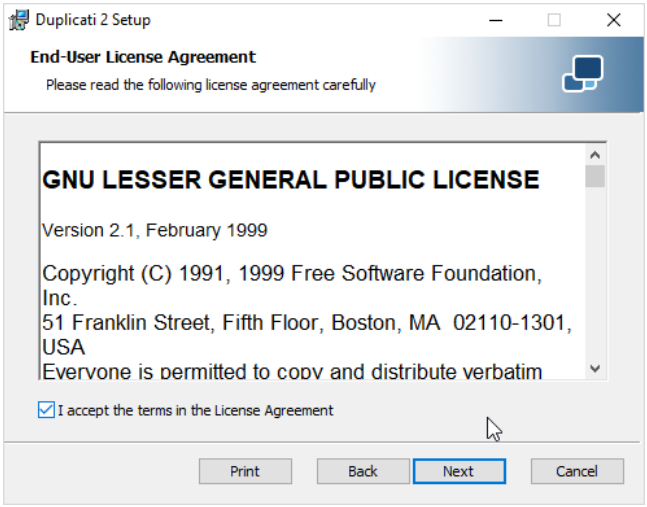
14. Click **OK.**

2.8.4 Duplicati Client Installation (Windows)

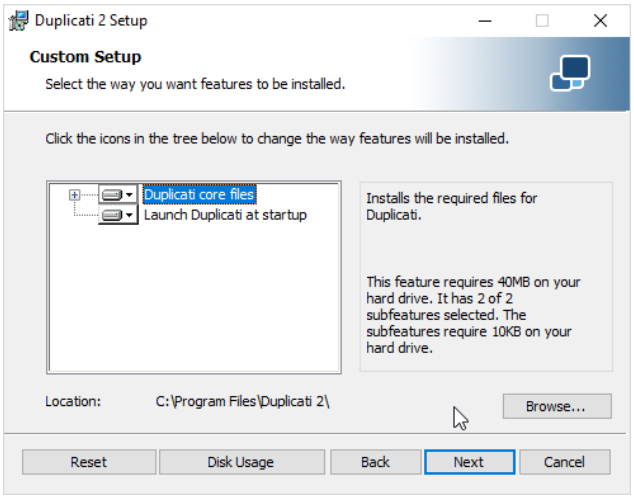
1. On the client machine, run **duplicati-2.0.3.3_beta_2018-04-02-x64.msi.**



2. Click **Next.**
3. Check the box next to **I accept the terms in the License Agreement.**

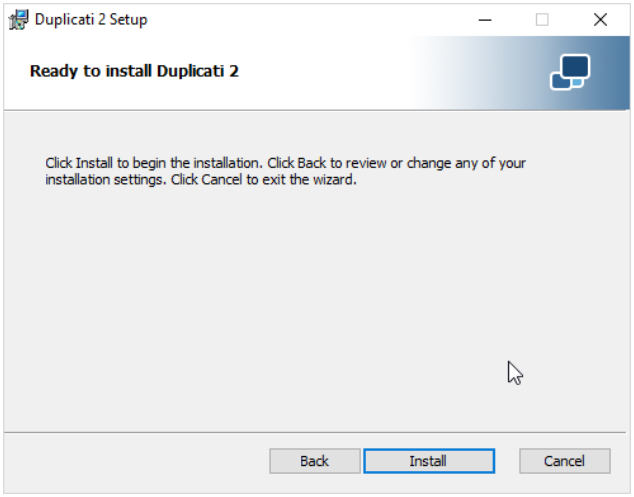


4. Click **Next.**



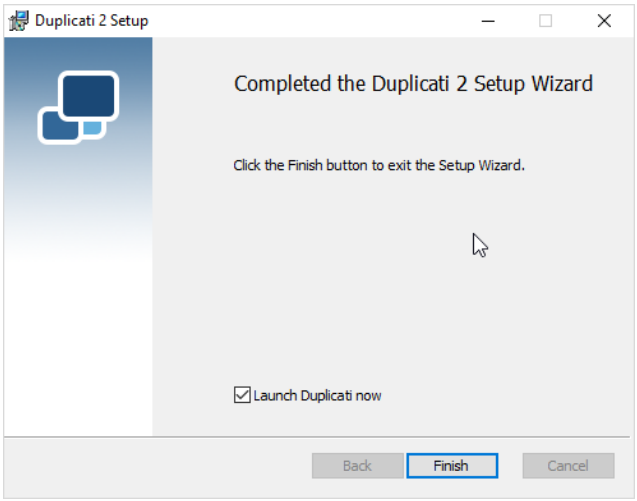
1104

1105 5. Click **Next.**



1106

1107 6. Click **Install.**



7. Click **Finish.**
8. Start **Duplicati** by going to **localhost:8200.**

2.8.5 Duplicati Client Installation (Ubuntu)

1. Install mono by using the following command:

```
> sudo apt install mono-runtime
```

2. Download the Duplicati package by running the following command:

```
> wget
https://github.com/duplicati/duplicati/releases/download/v2.0.3.9
-2.0.3.9_canary_2018-06-30/duplicati_2.0.3.9-1_all.deb
```

3. Install Duplicati by using the following command:

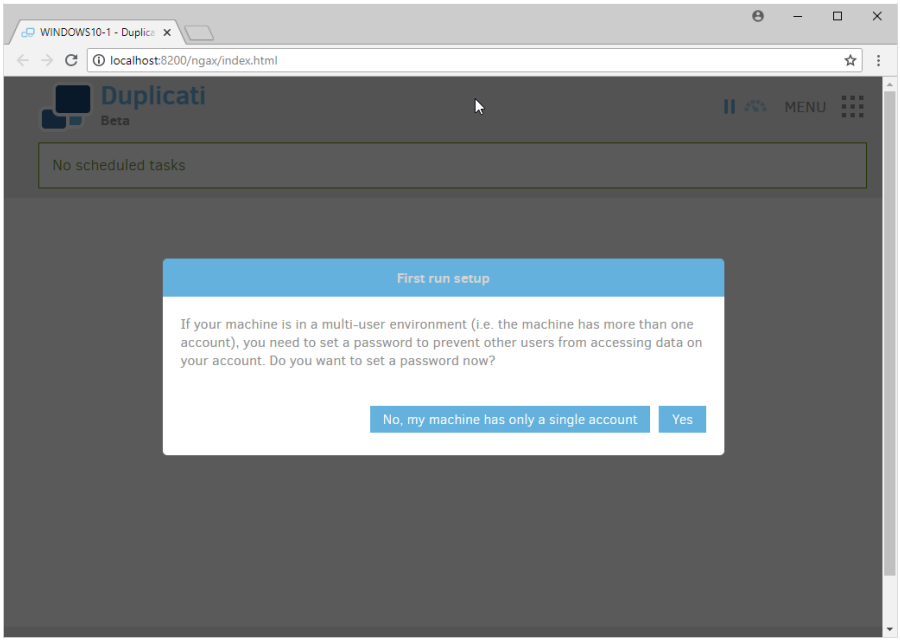
```
> sudo dpkg -i duplicati_2.0.3.9-1_all.deb
```

4. Run Duplicati as a service by running the following command:

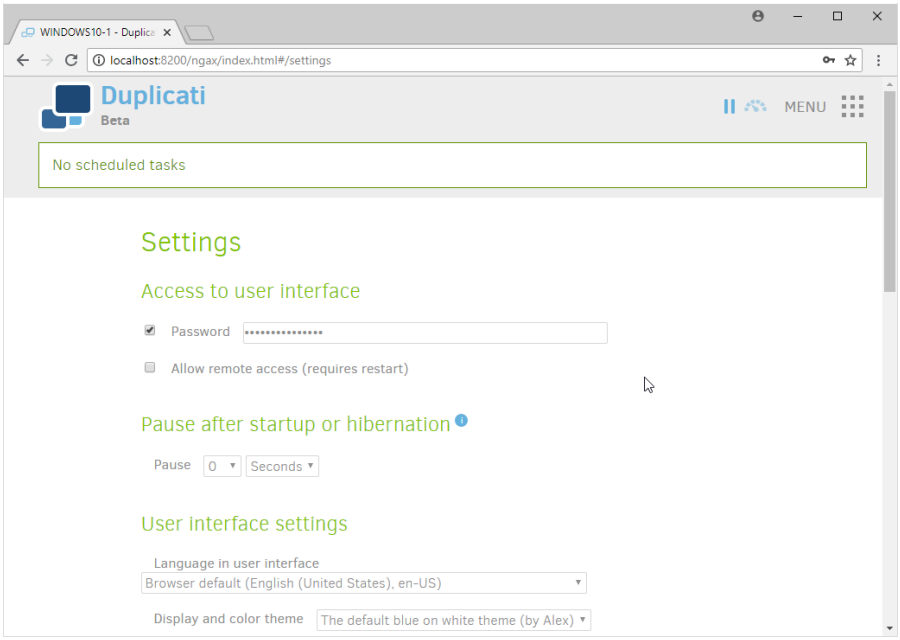
```
> sudo systemctl enable duplicati
```

2.8.6 Configure Duplicati

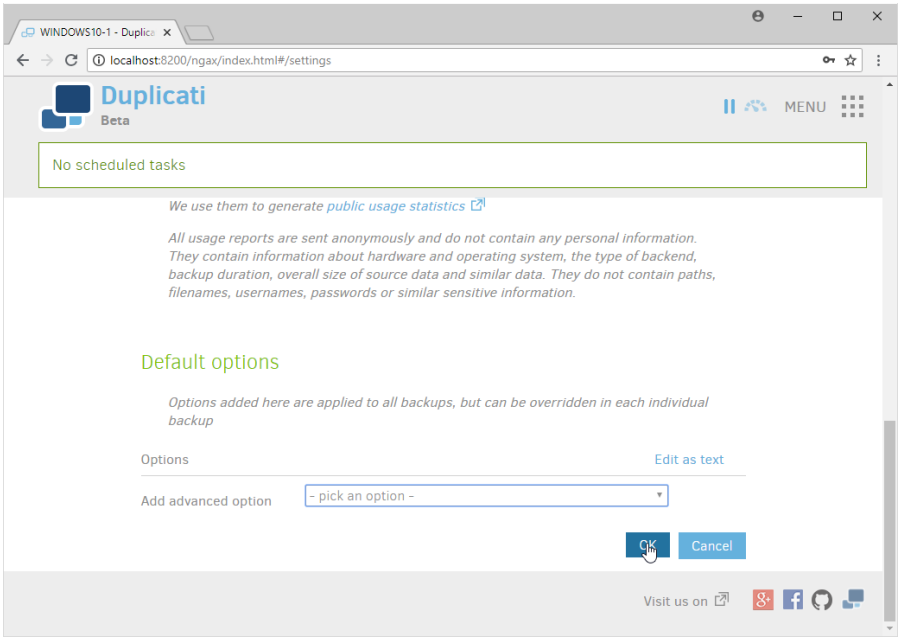
1. When it first starts, **Duplicati** will have a **First run setup.**



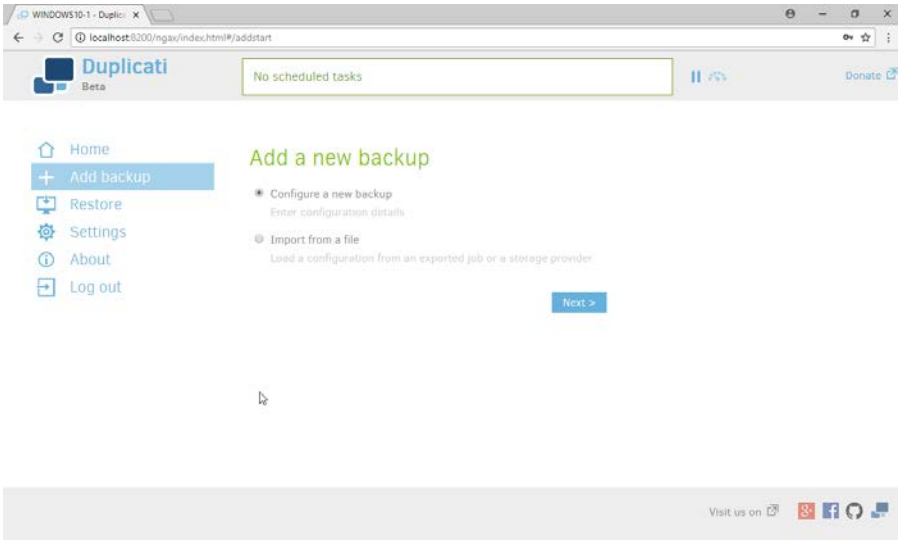
2. Click **Yes.**
3. Check the box next to **Password.**



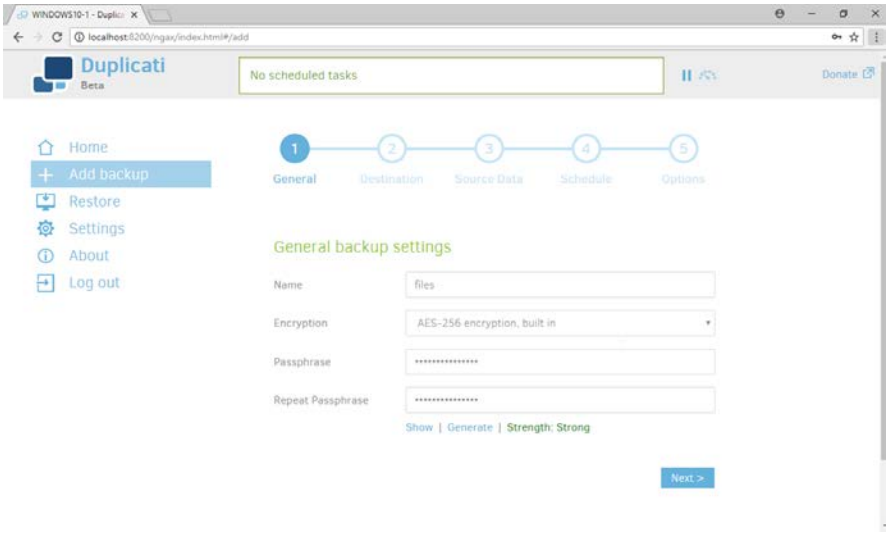
4. Enter a **password.**



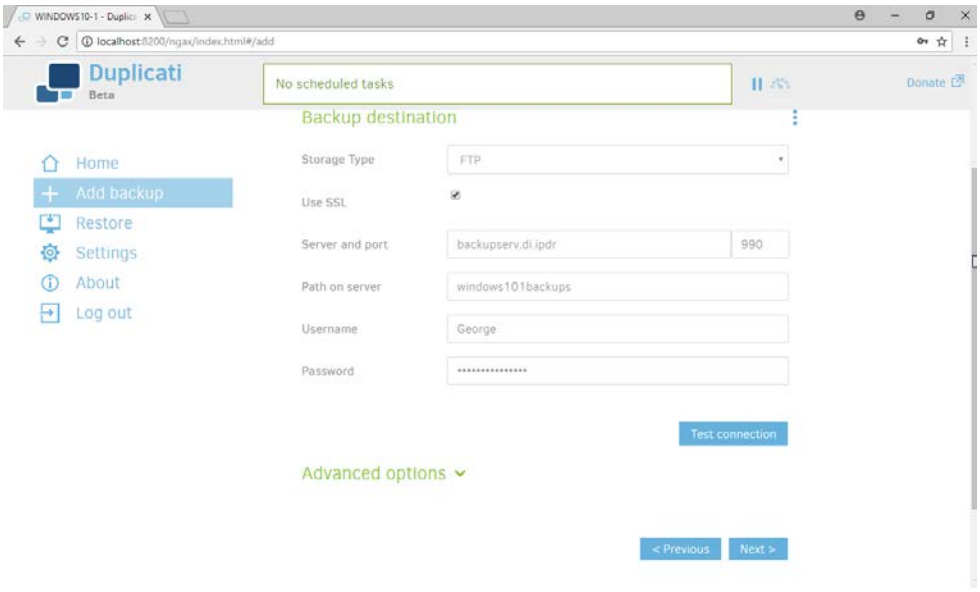
5. Click **OK.**
6. On the home page, click **Add backup.**
7. Select **Configure a new backup.**



8. Click **Next.**
9. Enter a **name** for the backup.
10. Select **AES-256 encryption, built in** from the drop-down menu.
11. Enter a **password.**

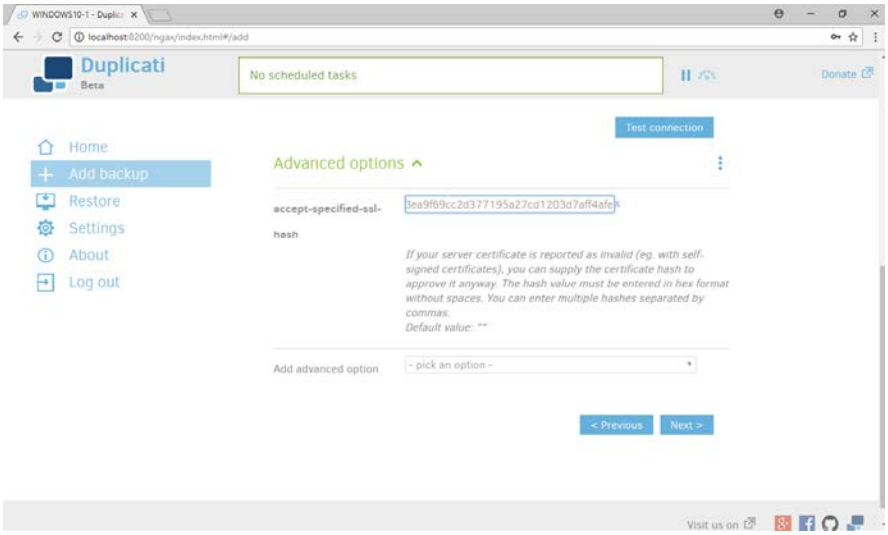


12. Click **Next.**
13. Select **FTP** for **Storage Type.**
14. Check the box next to **Use SSL.**
15. Enter the **server name** and **port** (default: 21) of the server running **FileZilla.**
16. Enter a **path** for the backup to be stored in (within the specified shared directory of the user).
17. Enter the **username** and **password** created for **FileZilla.**

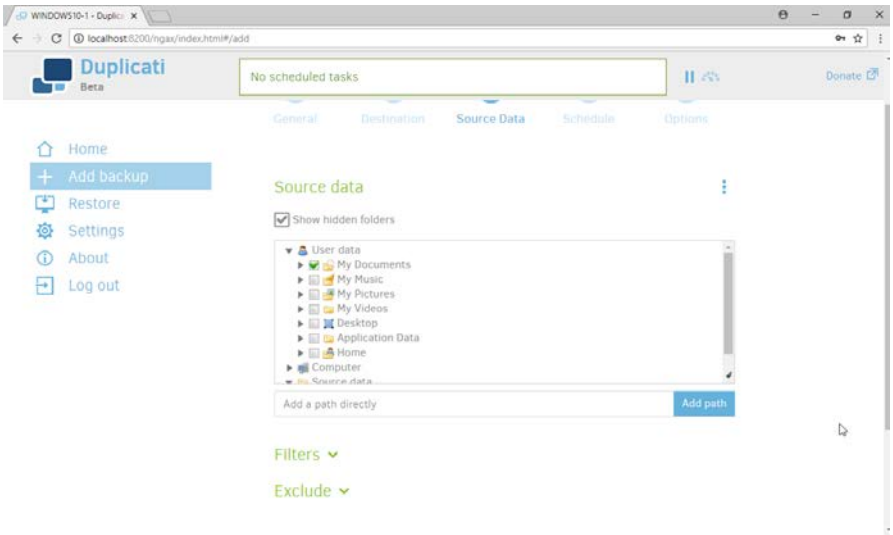


18. Click **Test Connection** (if the connection fails, ensure that the port is allowed in your server's firewall).

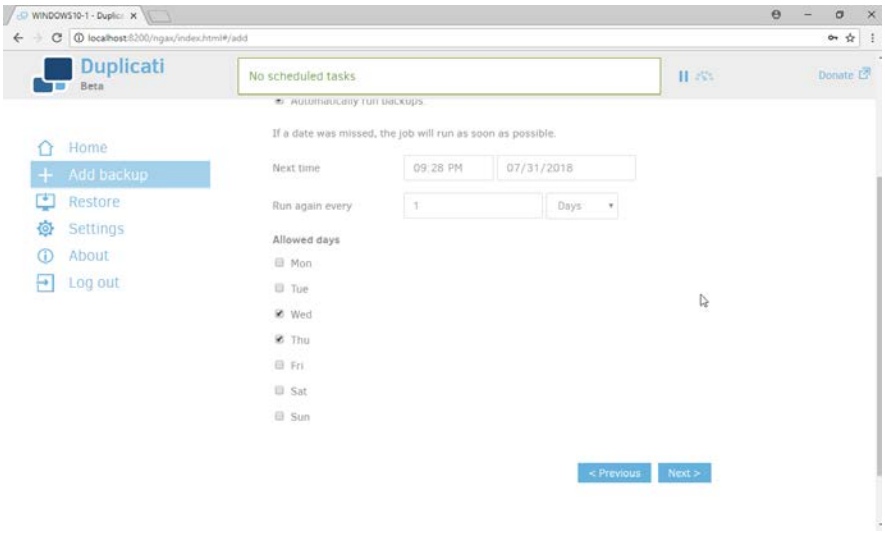
19. If you receive an error about a certificate, you can go to **Advanced Options,** select **accept-specified-ssl-hash,** and enter the **thumbprint** from the server's certificate.



20. Click **Next.**
21. Select the folders on the local machine to be backed up to the server according to your organization's needs.



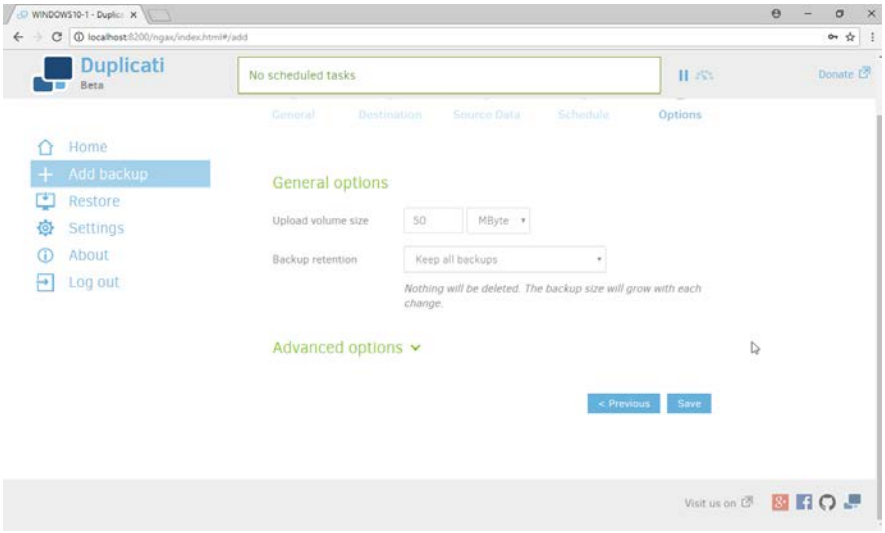
22. Click **Next.**
23. Select a backup schedule according to your organization's needs.



1165

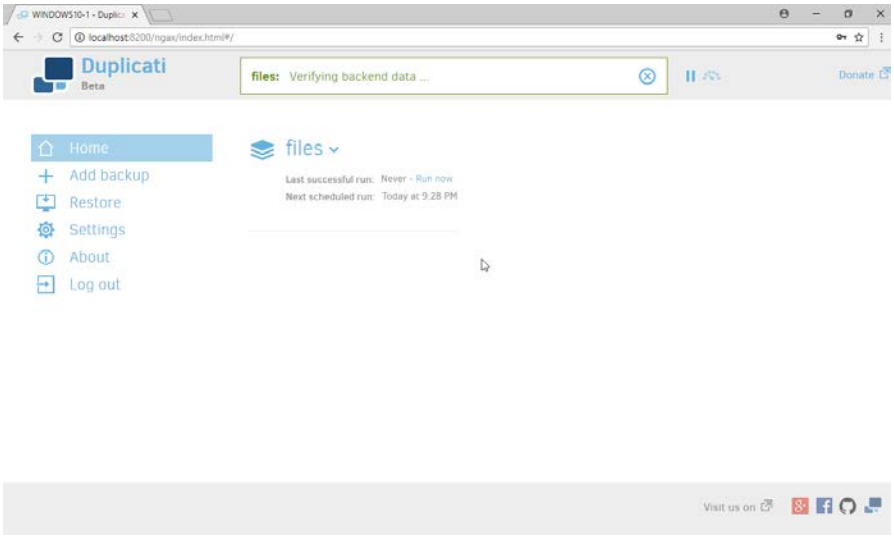
1166 24. Click **Next.**

1167 25. Select any other options according to your organization's needs.



1168

1169 26. Click **Save.**



27. When finished, you can choose to **Run now** to start a backup immediately.

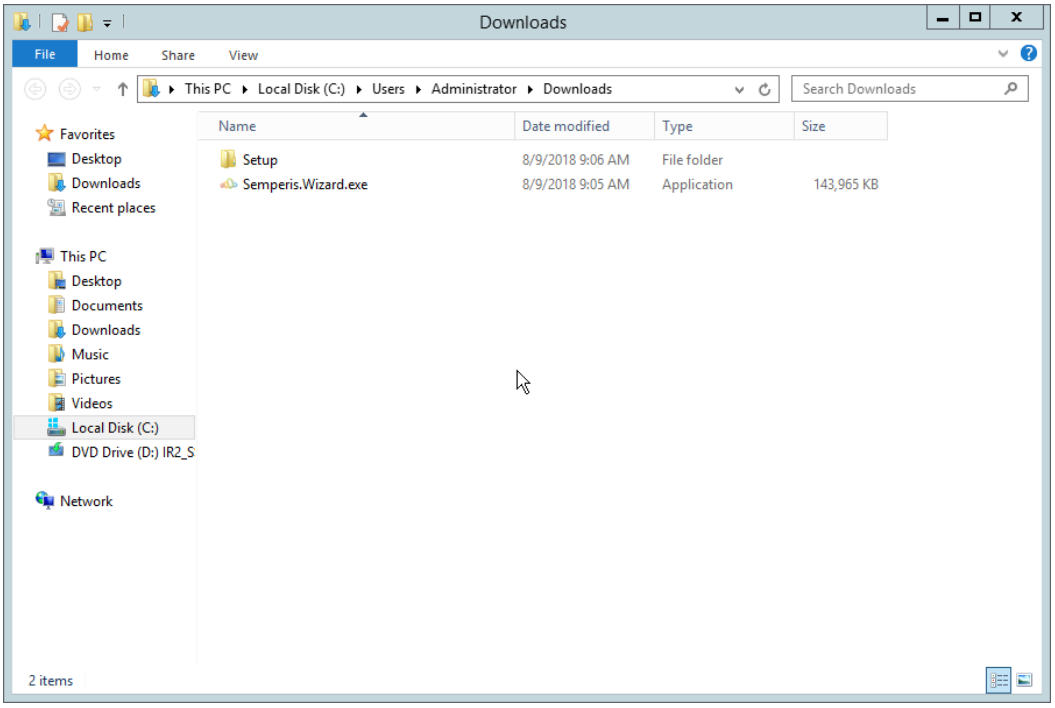
2.9 Semperis Active Directory Forest Recovery

This section details the installation of **Semperis Active Directory Forest Recovery (ADFR),** a tool used for backing up and restoring Active Directory forests. This installation requires both a copy of SQL Server Express as well as the **Semperis Wizard.** See the **Semperis ADFR v2.5 Technical Requirements** document for specifics on the requirements. For a Windows Server 2012 R2 installation, simply meet the following requirements:

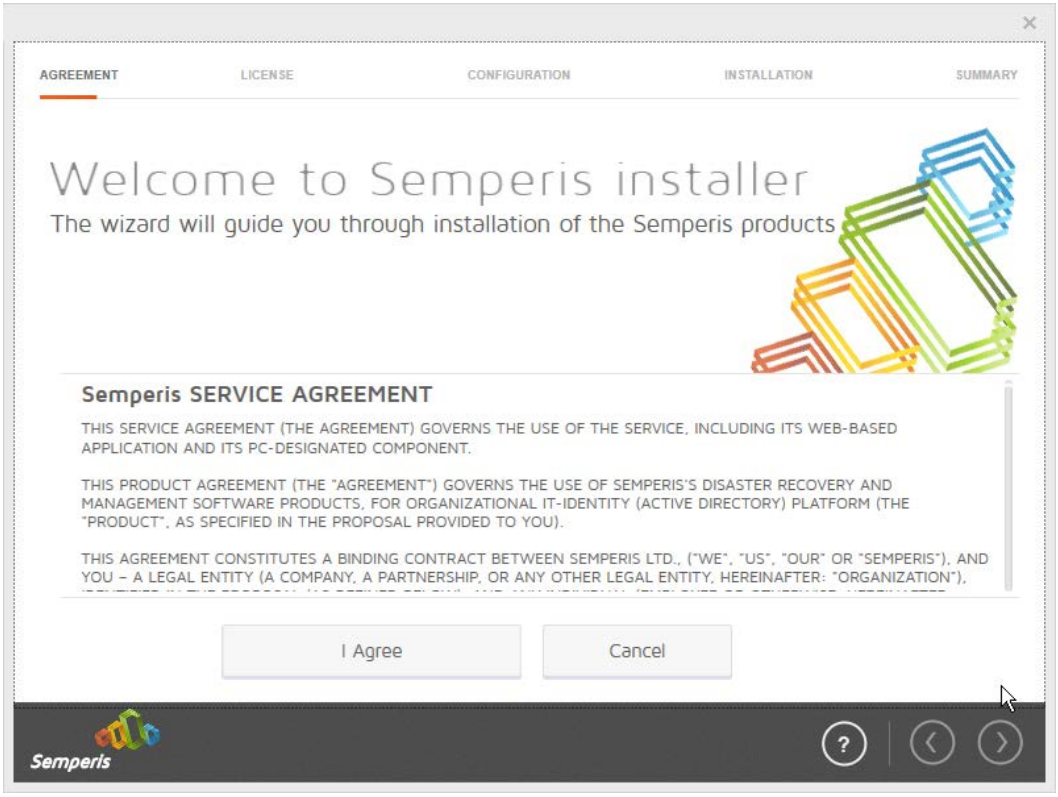
- .NET Framework Version 3.5 SP1
- .NET Framework Version 4.5.2 or later
- not joined to the Active Directory domain it is protecting
- SQL Express is not installed on the machine, but the installer SQLEXPR_x64_ENU.exe is downloaded.

2.9.1 Install Semperis ADFR

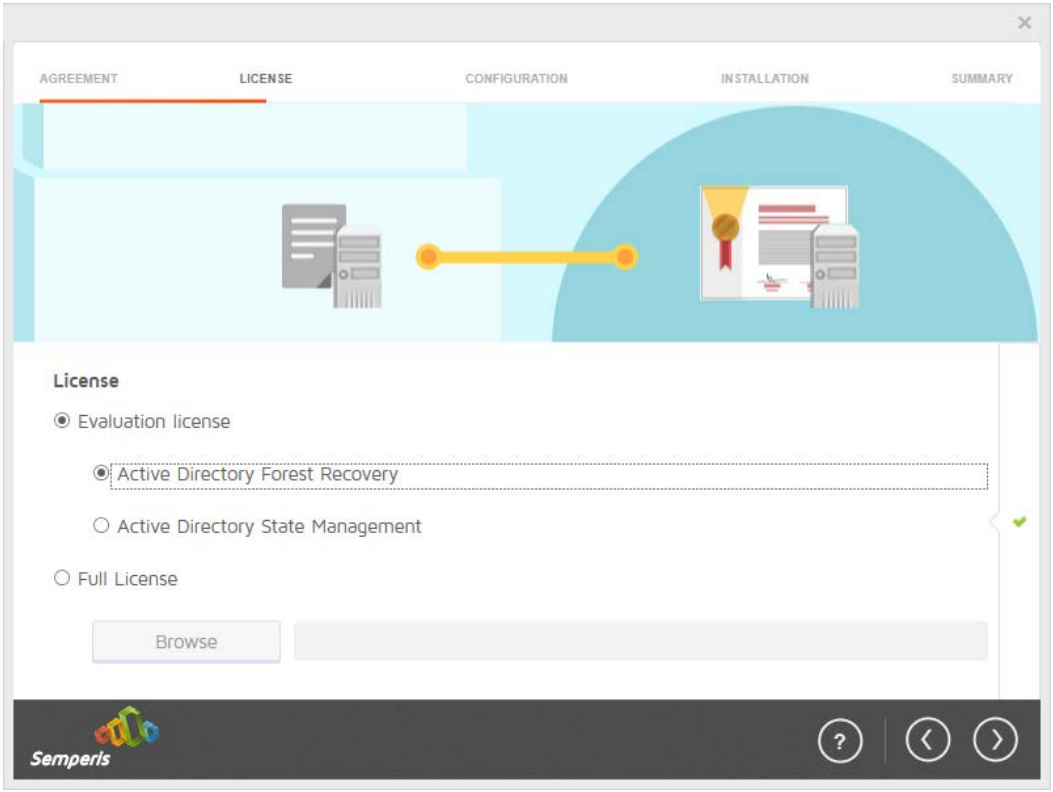
1. Place the **SQLEXPR_x64_ENU.exe** installer in a directory called Setup, and ensure that the **Semperis Wizard** is adjacent to the **Setup** folder (not inside it).



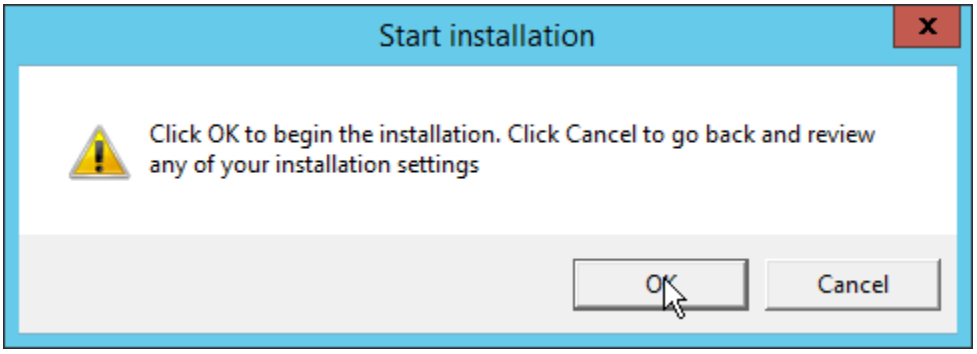
2. If prompted to restart the computer, do so.



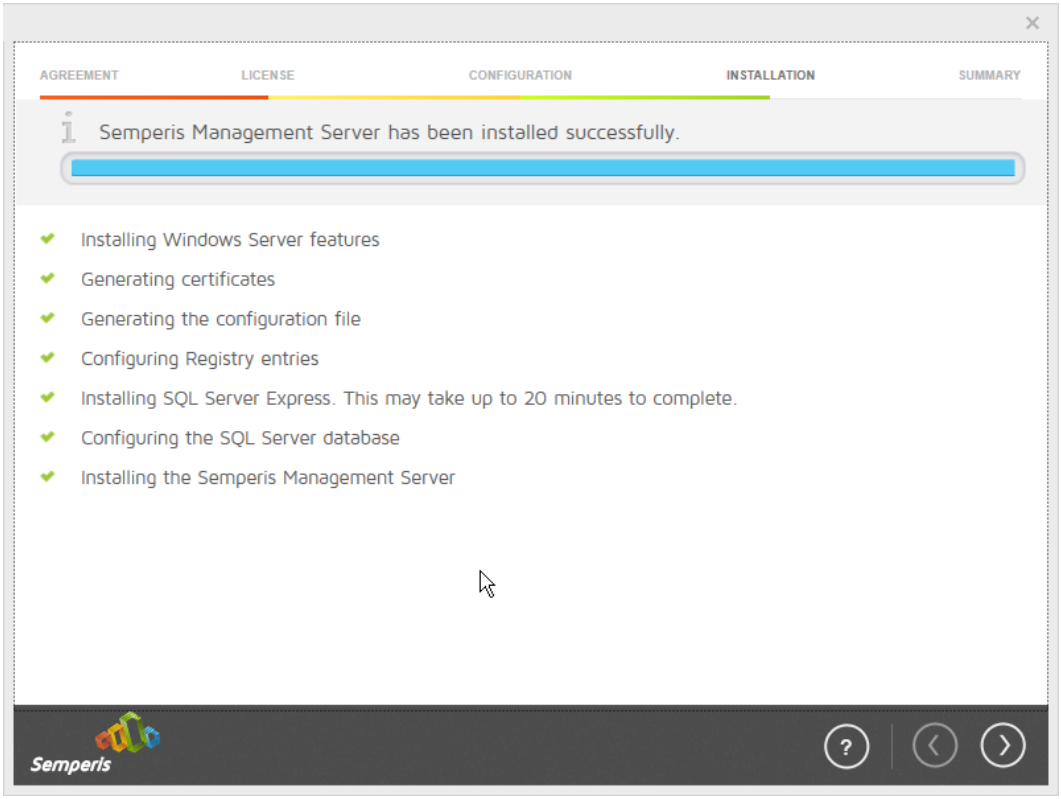
3. Click **I Agree.**
4. Select **Evaluation License.**
5. Select **Active Directory Forest Recovery.**



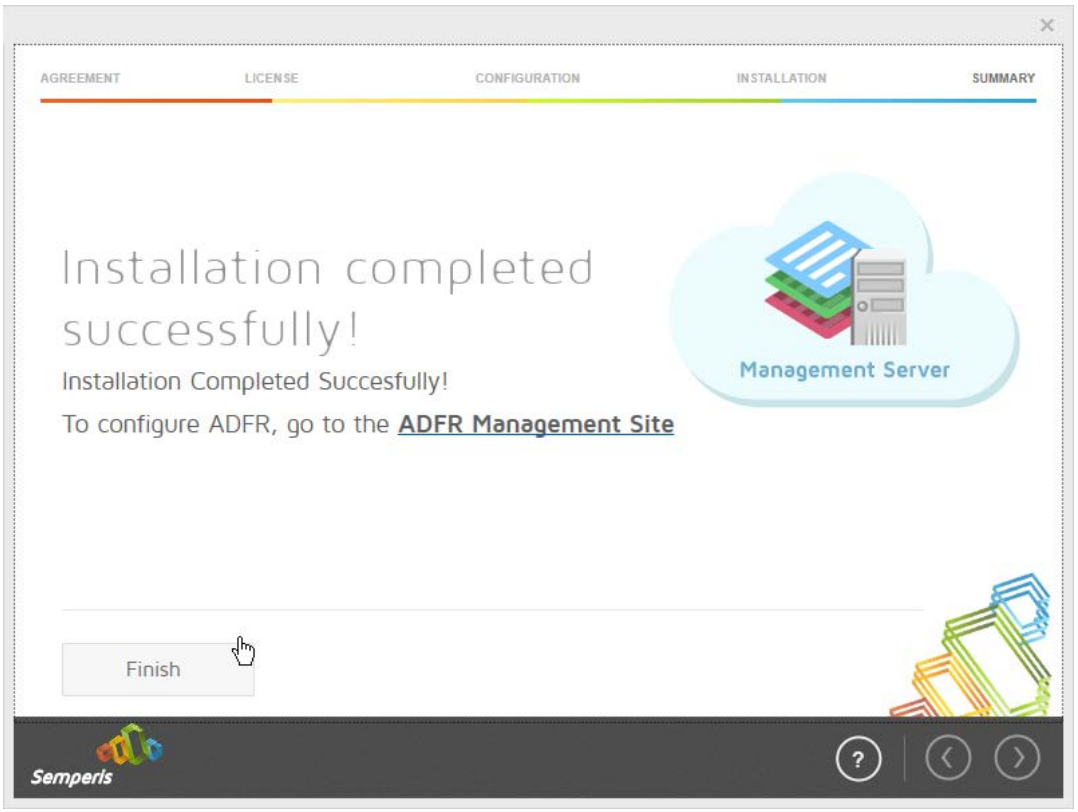
6. Click the **>** button.



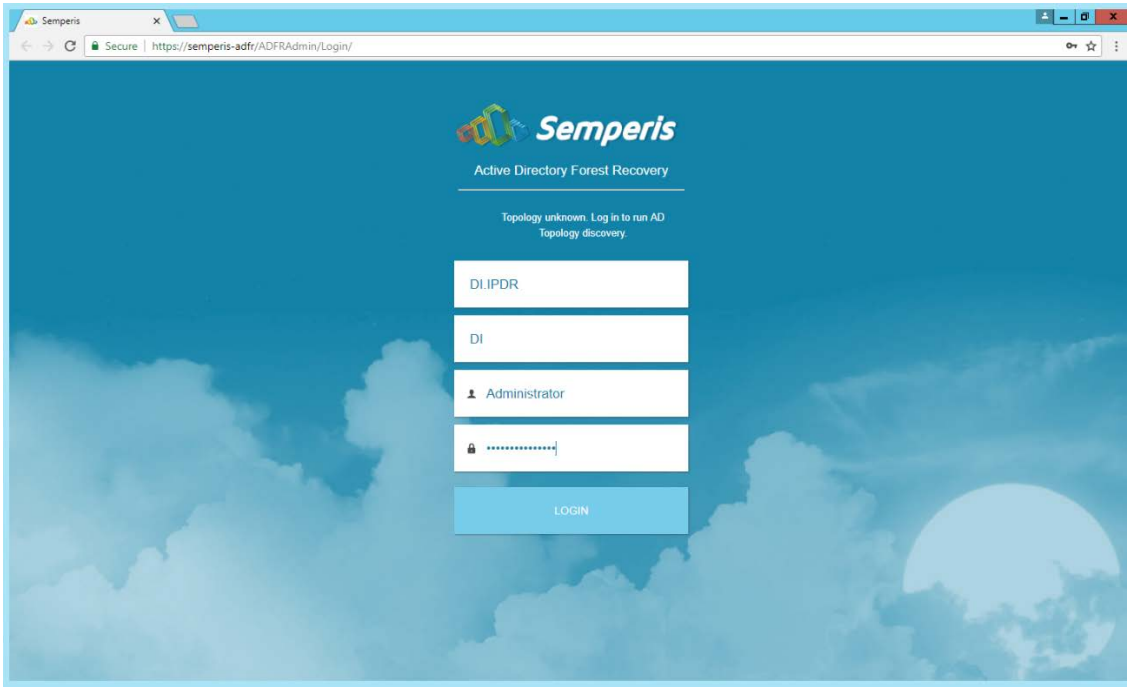
7. Click **OK.**
8. Wait for the installation to complete.



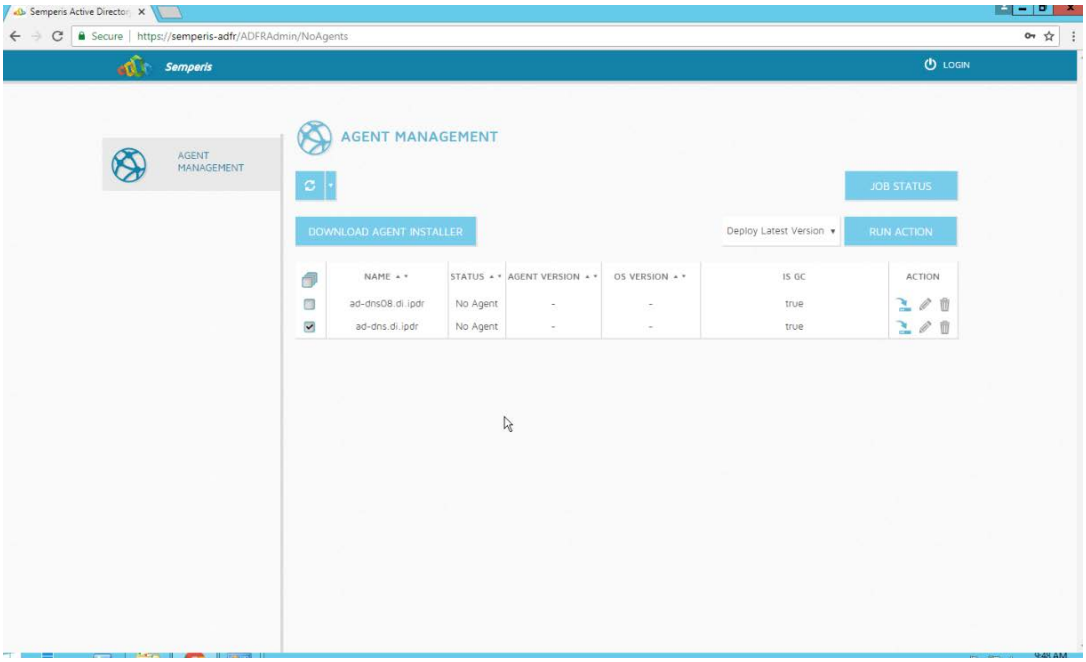
9. Click the **>** button.



10. Click **Finish.**
11. There should now be a shortcut on the desktop linking to the web console for **Semperis ADFR.**
12. On the login page, enter the full domain as well as the NetBIOS name.
13. Enter the **username** and **password** of an administrator on the domain.

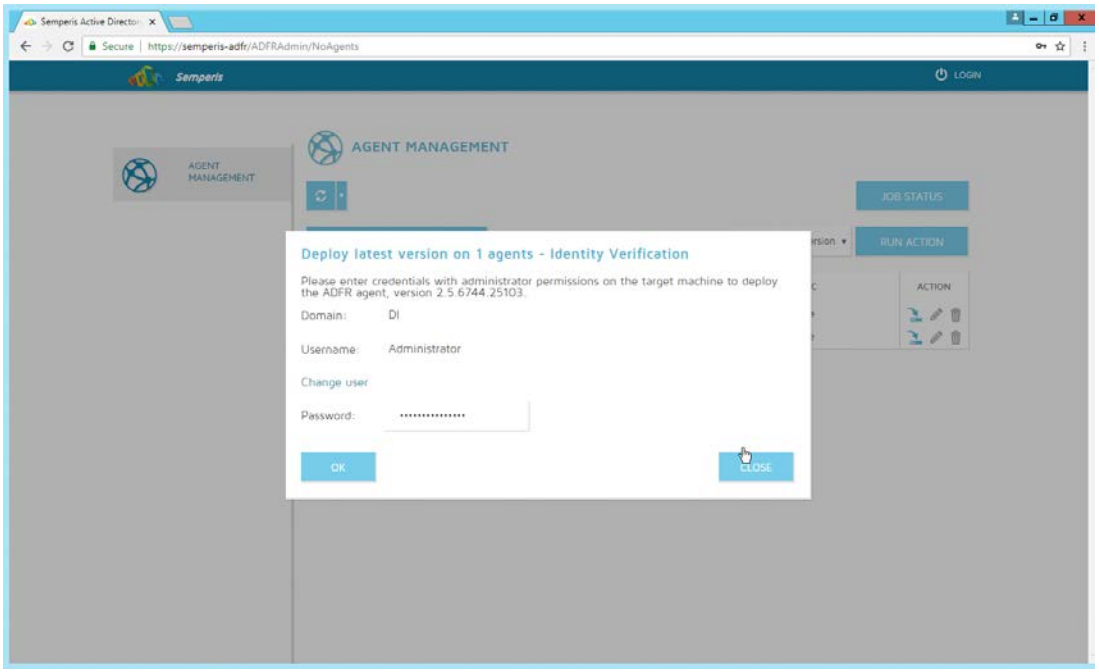


14. Click **Login.**
15. Check the box next to any domain controllers that should be backed up.

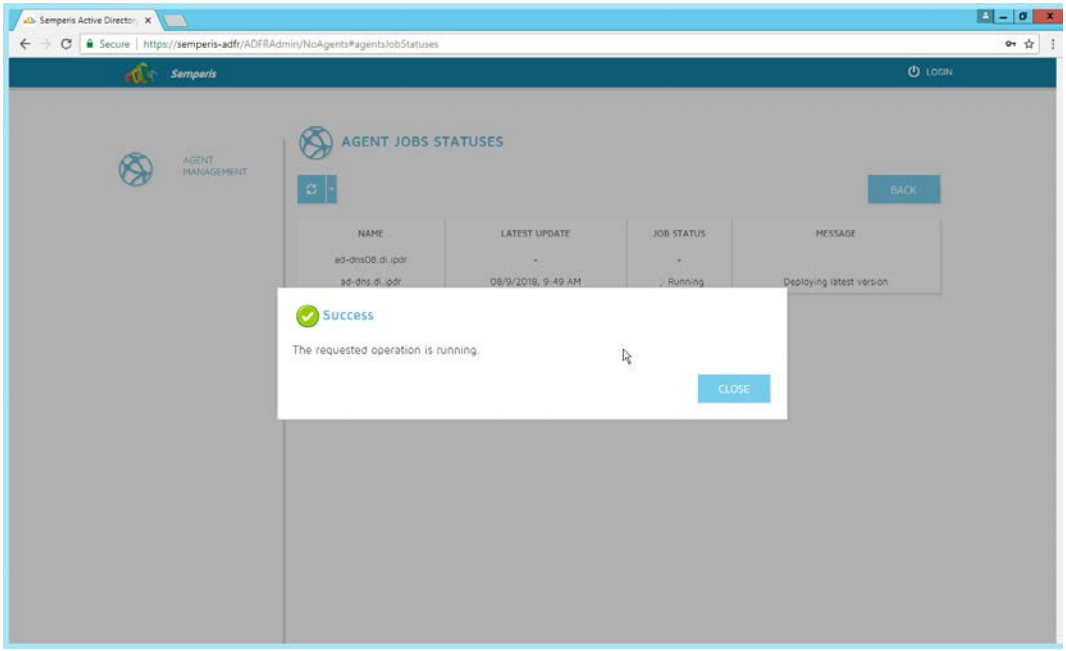


16. Click **Run Action.**

17. Enter the **password** in the prompt.



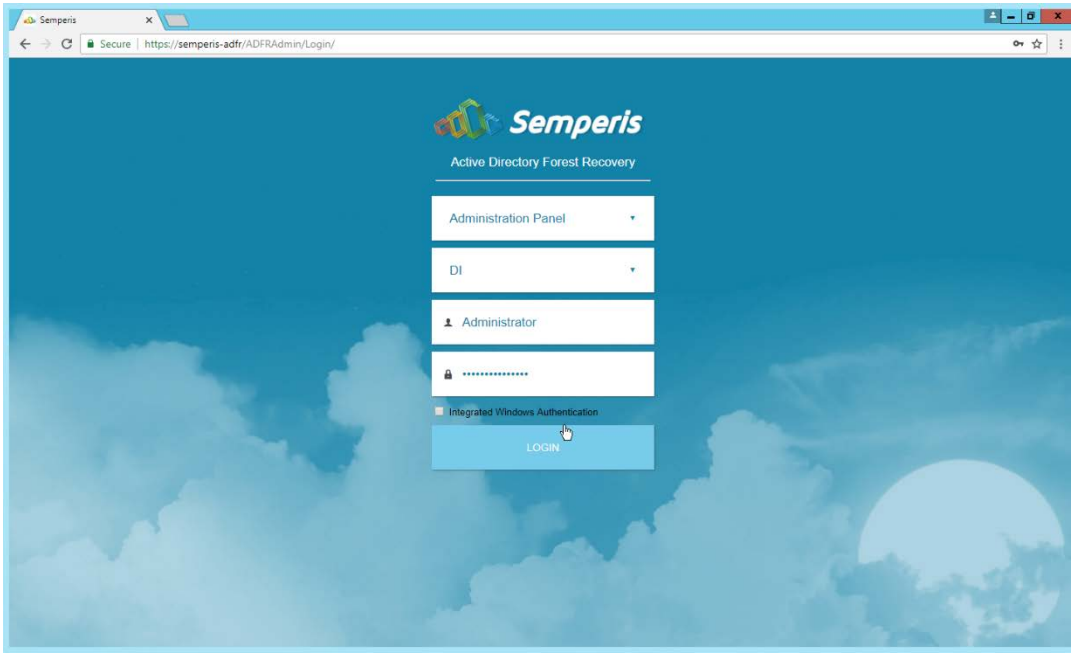
18. Click **OK.**



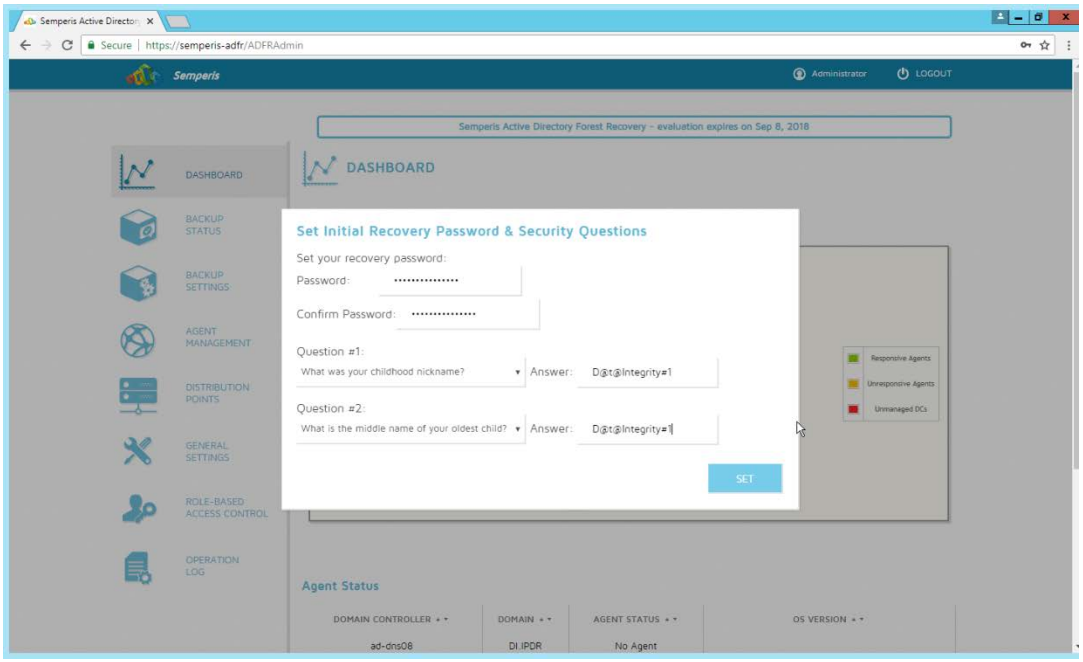
19. Click **Close.**

20. After the installation finishes, click **Login** at the top of the page.

21. Enter the login credentials for the domain.



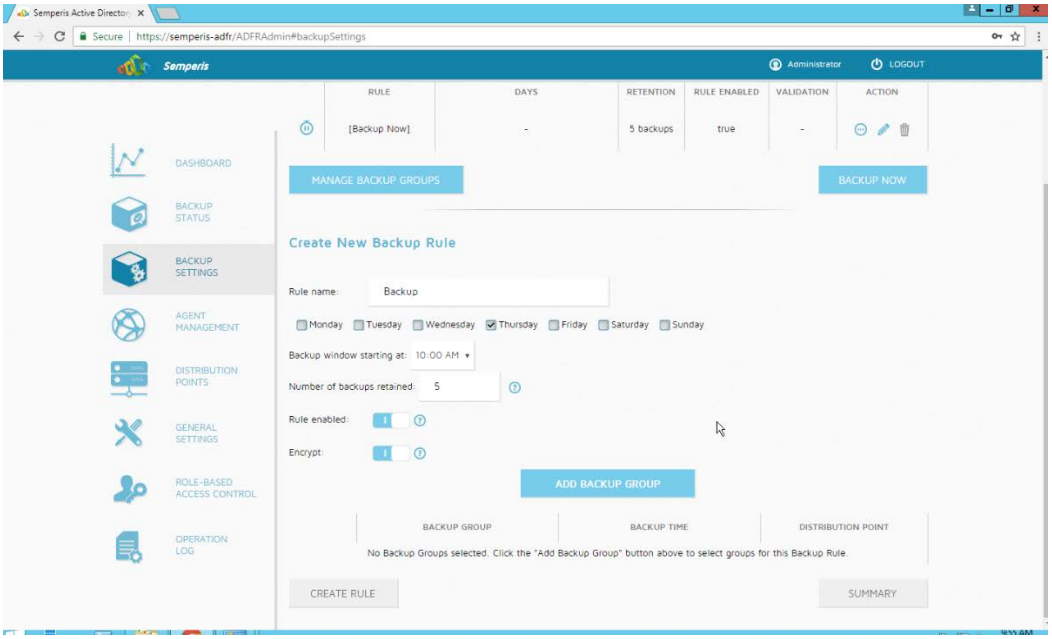
22. Click **Login.**
23. Create a recovery **password**. (Note: In the event of a restoration, Active Directory will potentially be unavailable, so a separate password that is not domain-associated is needed here for restorations.)



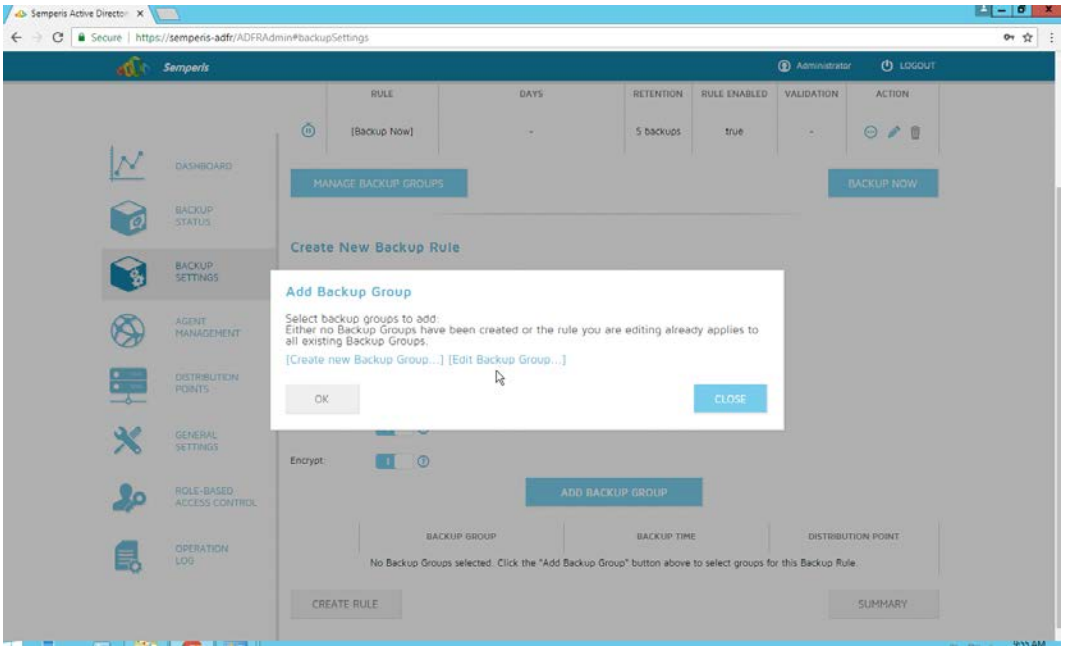
24. Set recovery questions for the password.
25. Click **Set.**

2.9.2 Create a Backup Schedule for the Domain Controller

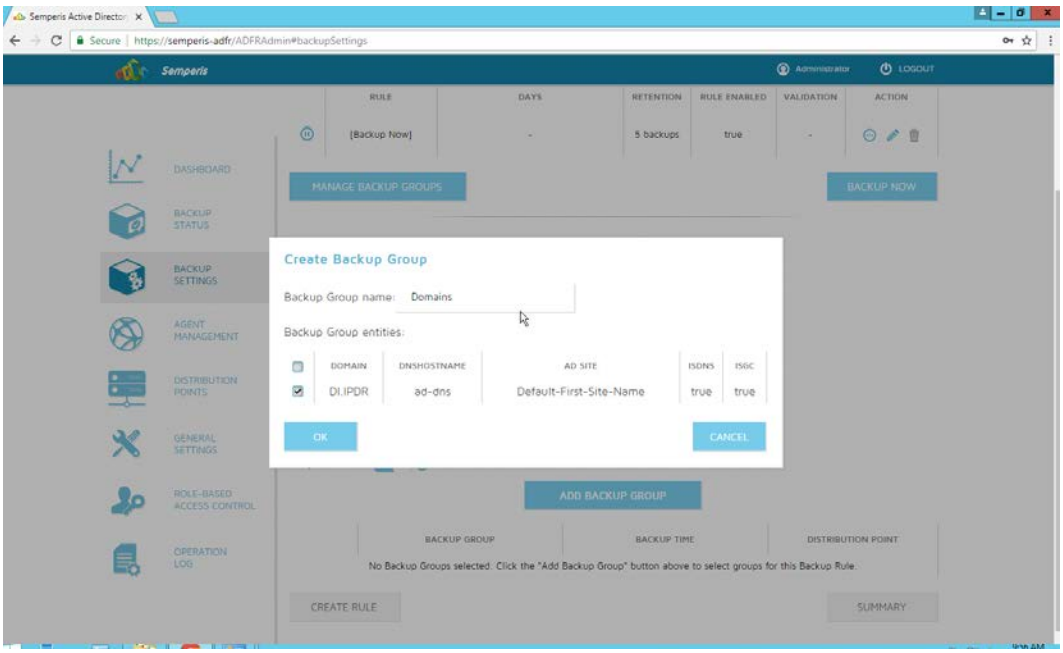
1. Click the **Backup Settings** tab.
2. Enter a **name** for the rule.
3. Select the days and times that the domain controller should be backed up.
4. Enter the maximum number of backups that should be kept. (Note: The oldest backup will be deleted upon creation of a new backup, which would exceed this maximum.)
5. Ensure that **Encrypt** and **Rule enabled** are both turned on.



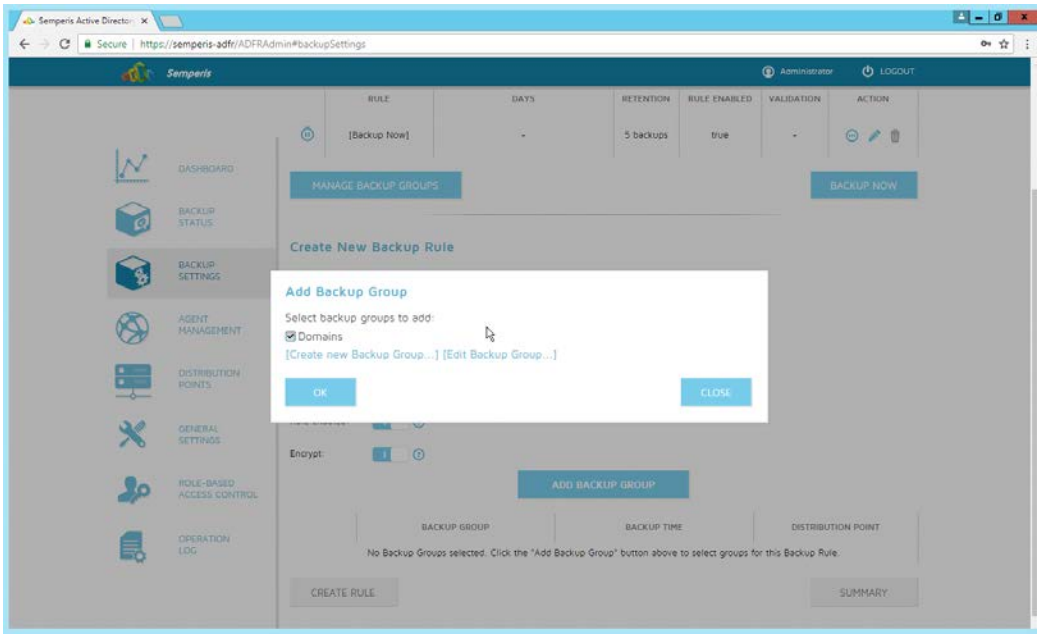
6. Click **Add Backup Group.**



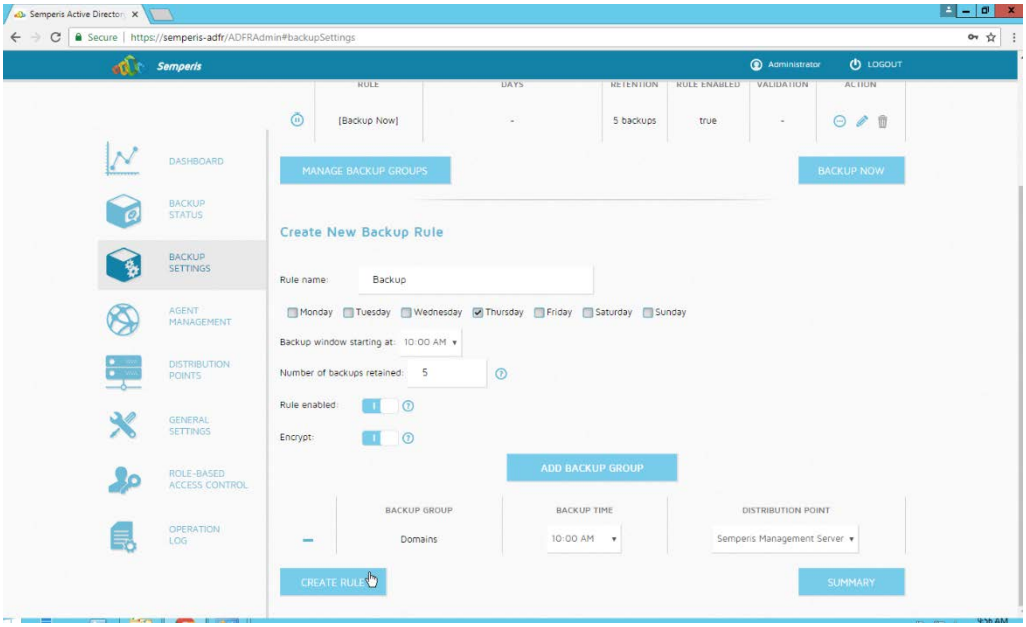
7. Click **Create new Backup Group.**
8. Enter a **name** for the backup group.
9. Select the domain controllers to be part of the backup group.



10. Click **OK.**
11. Select the newly created backup group.



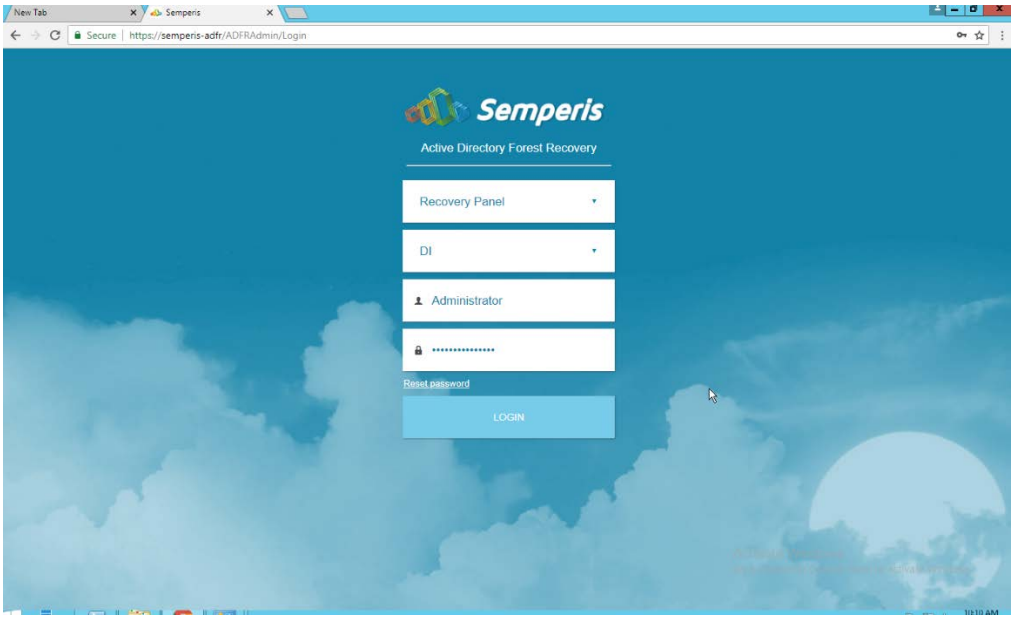
12. Click **OK.**



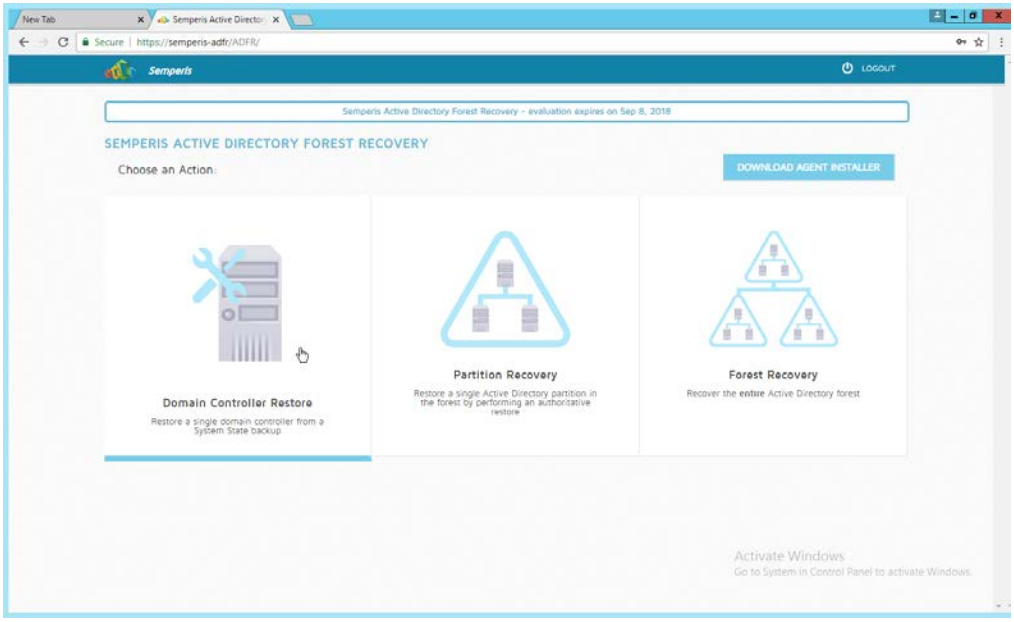
13. Click **Create Rule.**

2.9.3 Recover the Active Directory Forest from a Backup

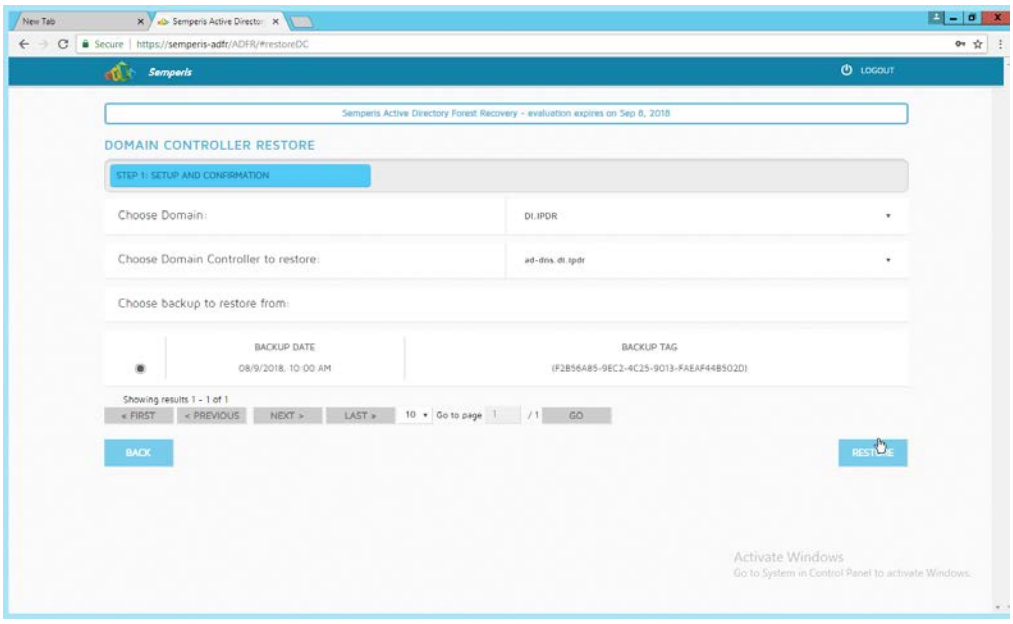
1. Open the **Semperis ADFR** web console.
2. Select **Recovery Panel** from the drop-down.
3. Select the **Domain** that you wish to recover.
4. Enter the **username** and **password.**



5. Click **Login.**

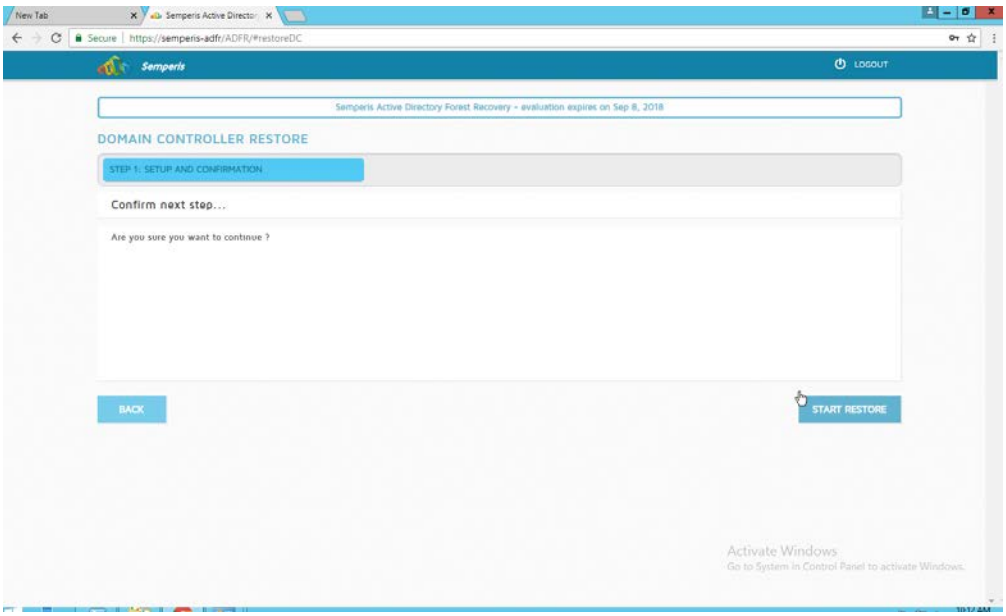


6. Select an action based on the recovery needs of the organization. In this example we select **Domain Controller Restore.**
7. Provide the information for the restoration, namely the **domain,** the **domain controller,** and which backup to use.



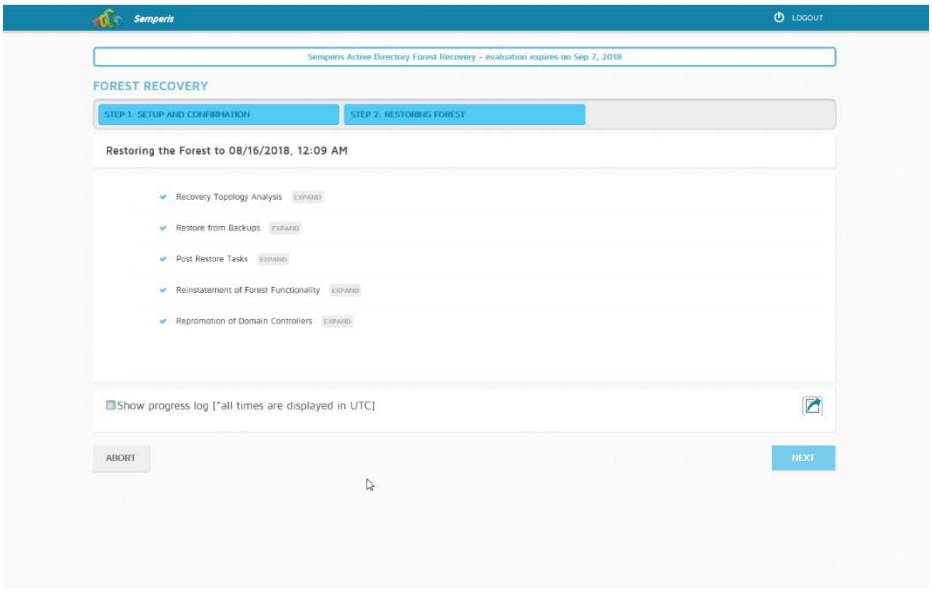
1257

1258 8. Click **Restore.**



1259

1260 9. Click **Start Restore** to begin the restoration process.



10. Click **Next** when the restoration finishes.

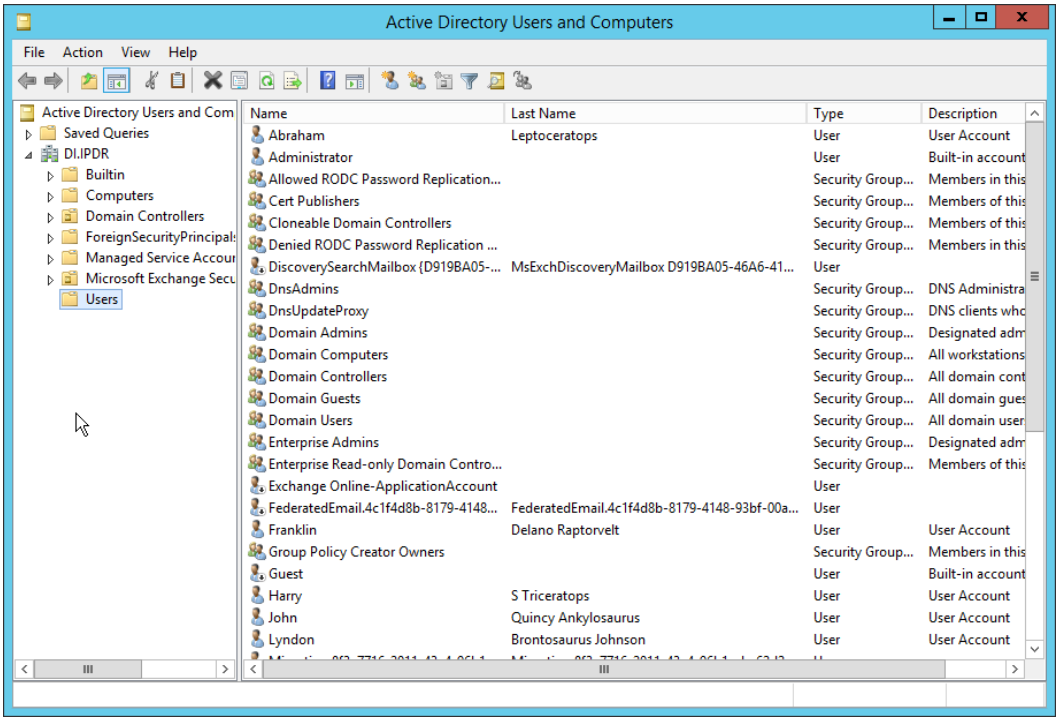
2.10 Semperis Directory Services Protector

This section details the installation of **Semperis Directory Services Protector (DSP),** a tool used for monitoring Active Directory environments. This installation requires both a copy of SQL Server Express as well as the **Semperis Wizard.** See the **Semperis DS Protector v2.5 Technical Requirements** document for specifics on the requirements. For a Windows Server 2012 R2 installation, simply meet the following requirements:

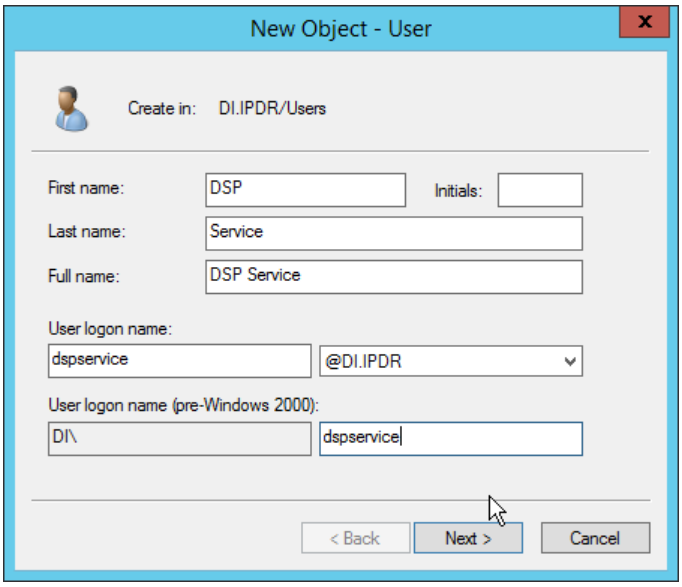
- .NET Framework Version 3.5 SP1
- .NET Framework Version 4.5.2 or later
- joined to the Active Directory domain it is protecting
- either the installer for SQL Express Advanced or connection information and credentials for a full version of Microsoft SQL (MSSQL)

2.10.1 Configure Active Directory for Semperis DSP

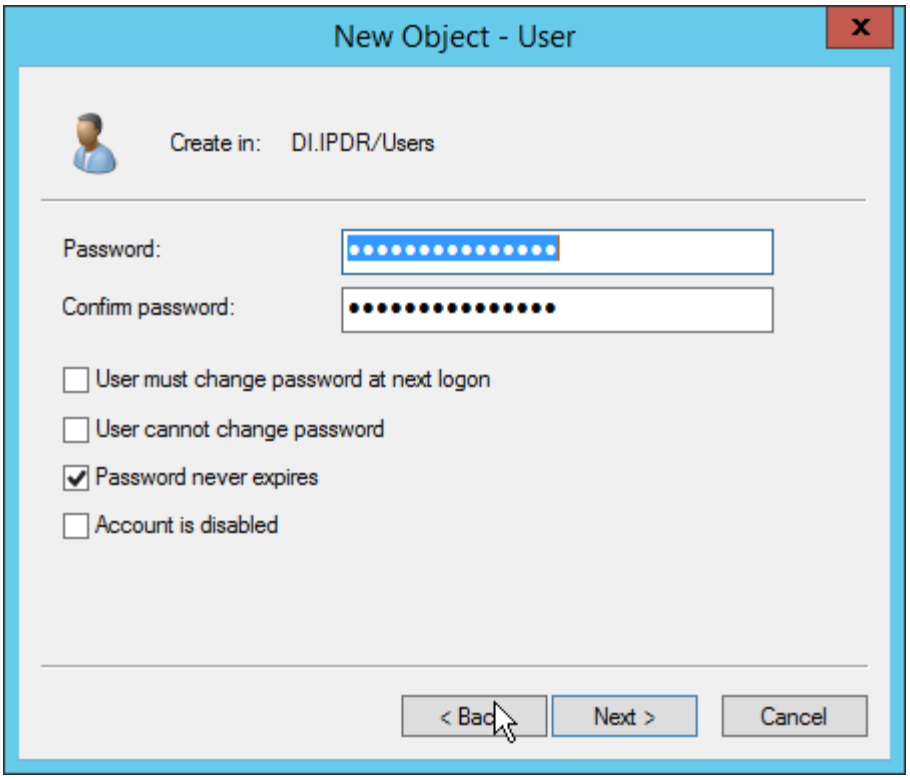
1. Open **Active Directory Users and Computers.**



2. Right-click **Users** in the left pane and select **New > User.**
3. Enter the information for a new user for the DSP service.

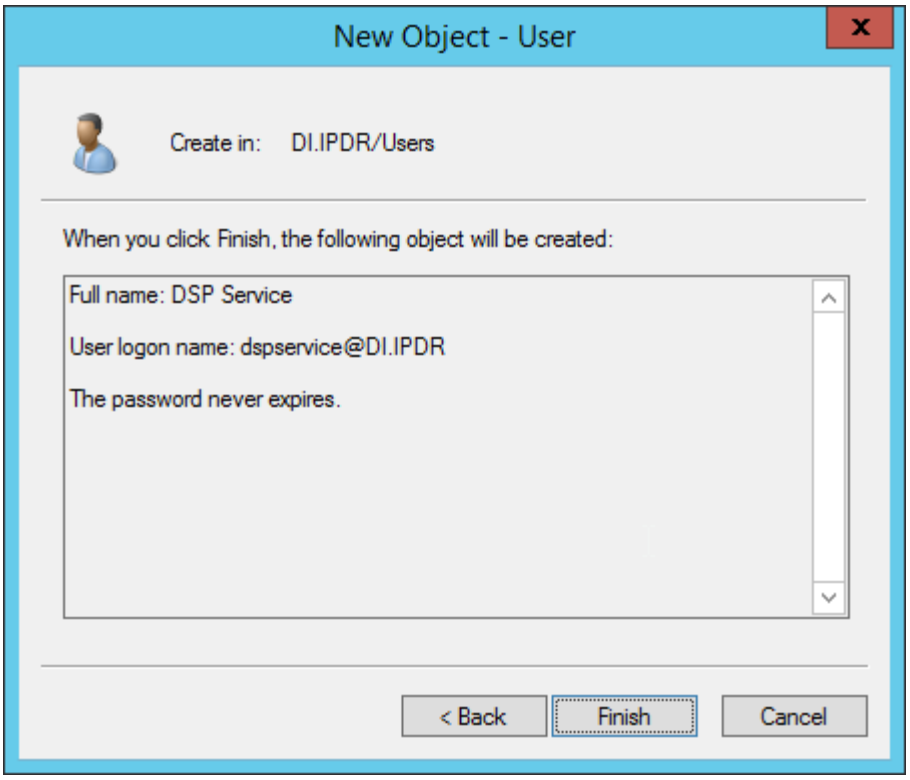


4. Click **Next.**
5. Enter a **password** twice for this user.
6. Set the password policy.

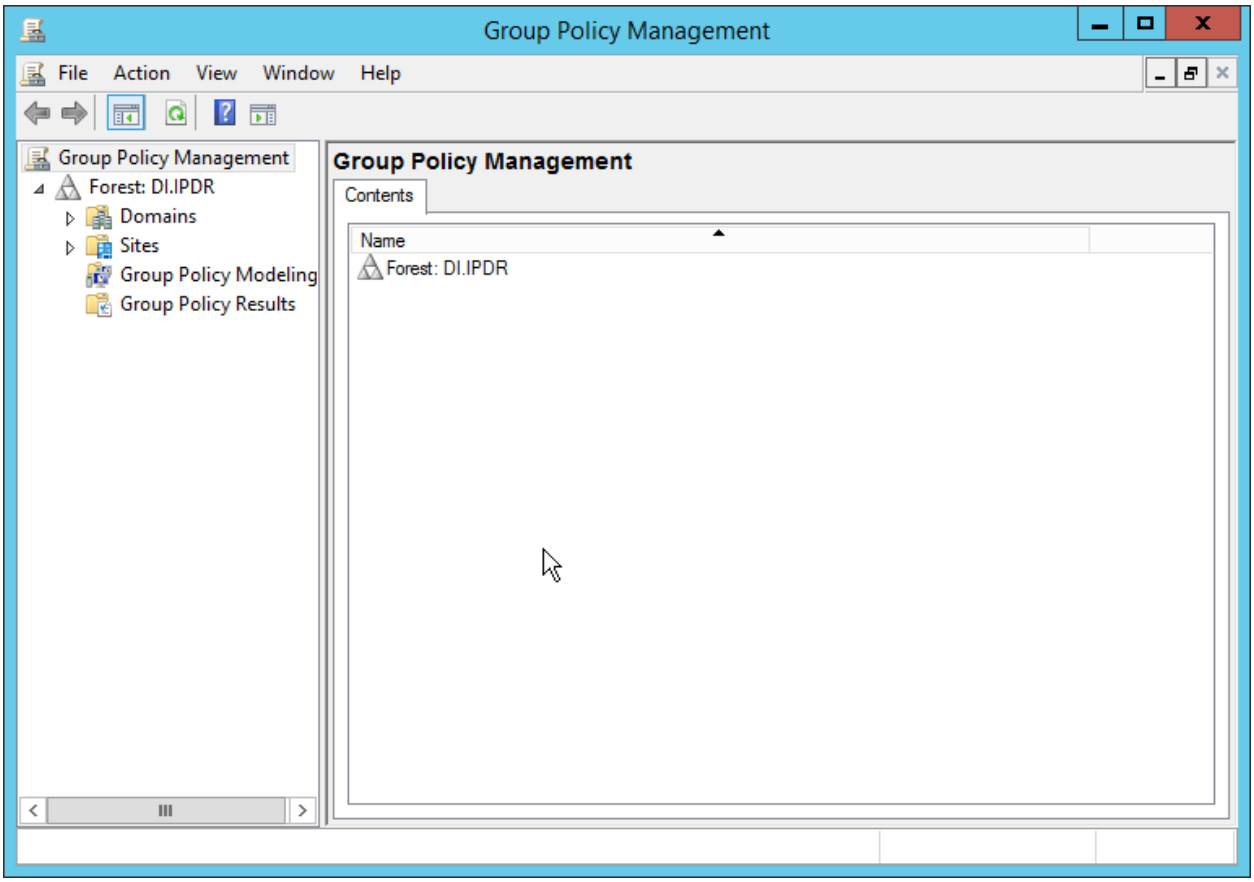


1283

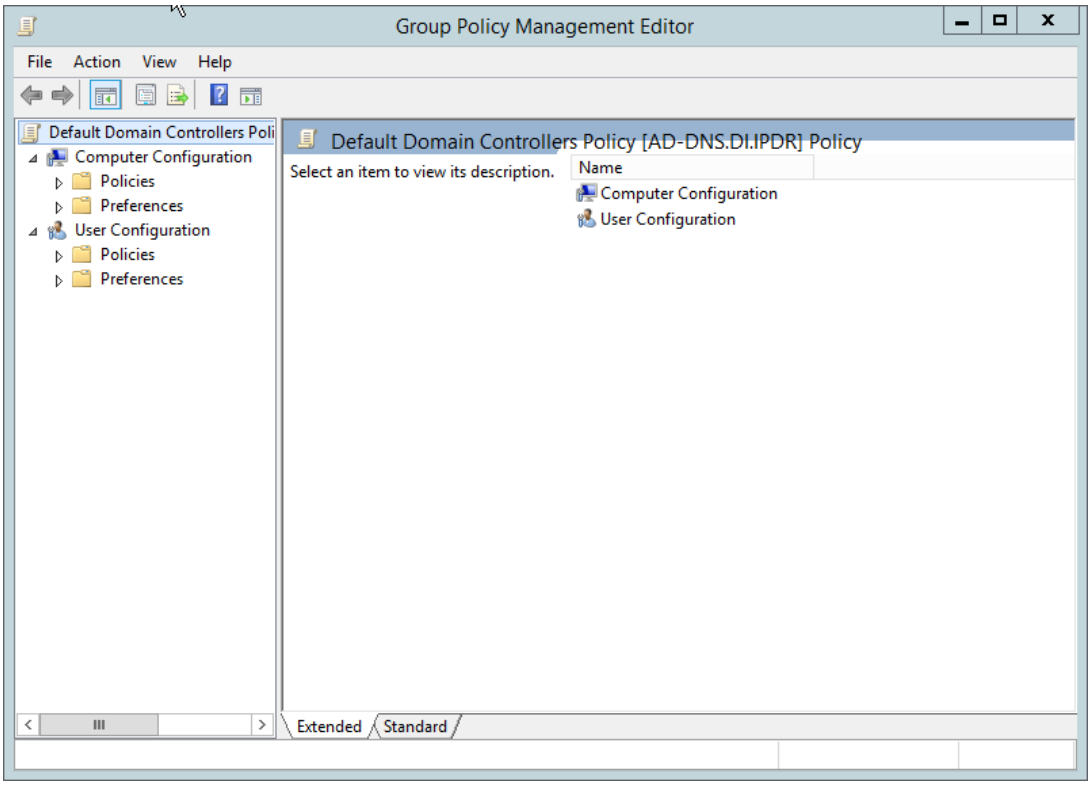
1284 7. Click **Next.**



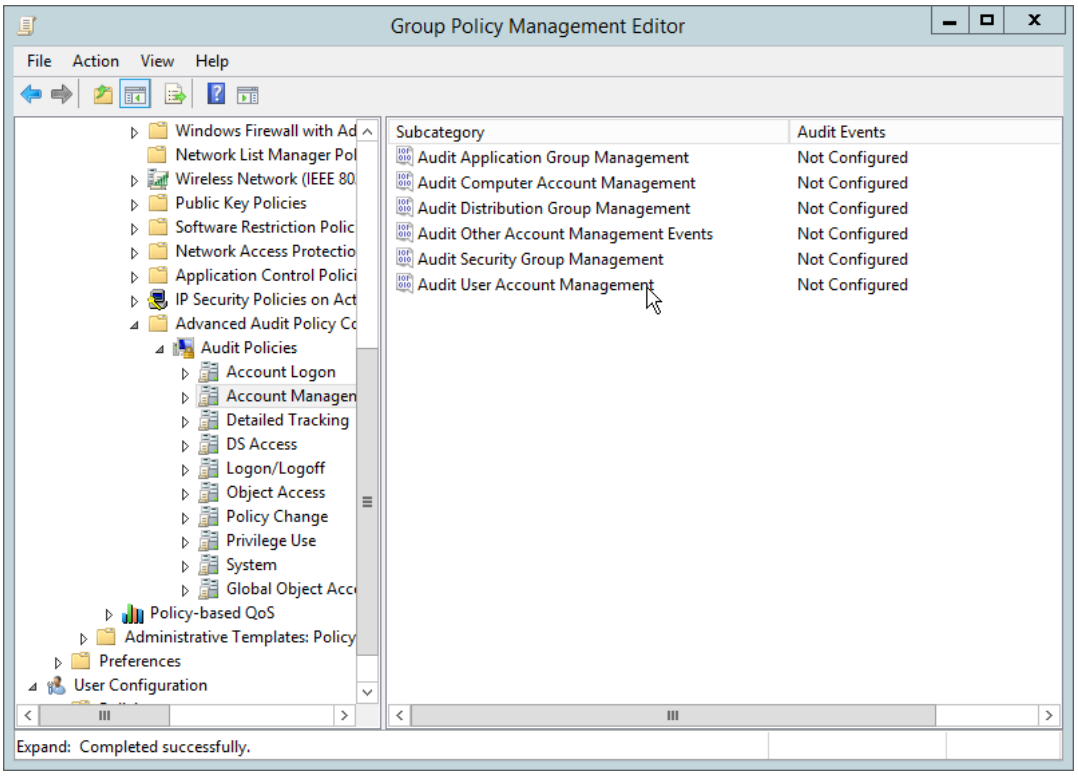
8. Click **Finish.**
9. Open **Group Policy Management.**



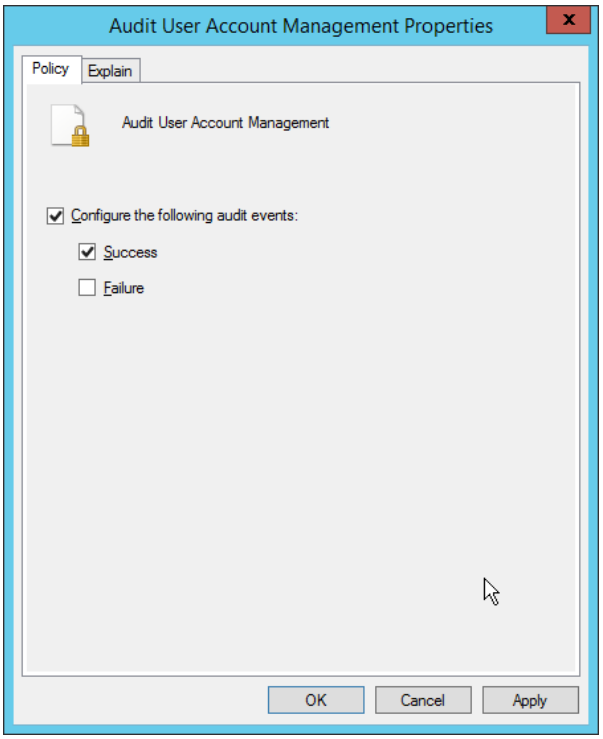
10. Right-click **Domains > DI.IPDR > Domain Controllers > Default Domain Controllers Policy** and click **Edit.**



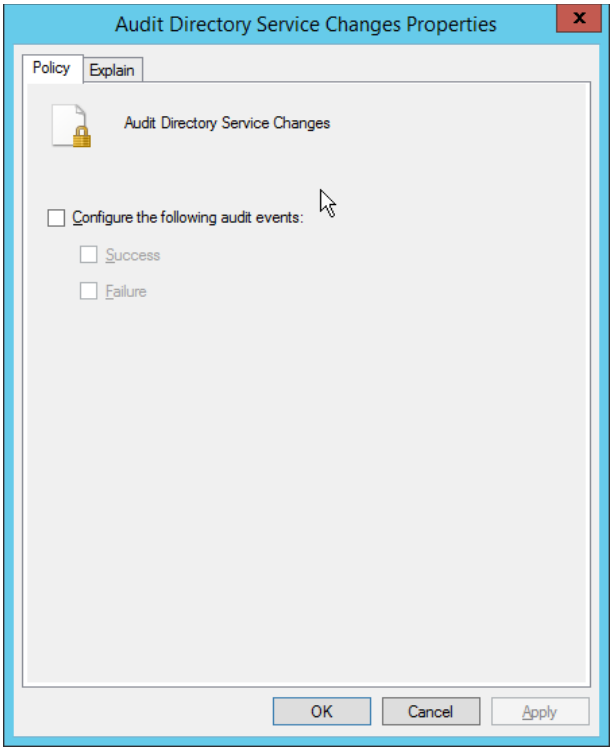
11. Navigate to **Computer Configuration > Policies > Windows Settings > Security Settings > Advanced Audit Policy Configuration > Audit Policies > Account Management.**



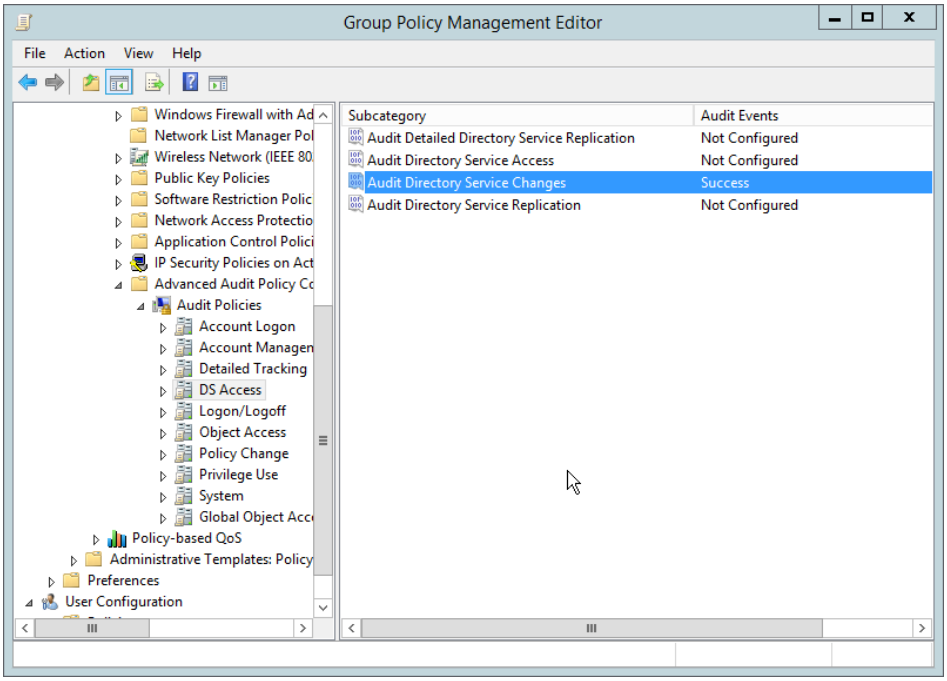
12. Edit the **Audit User Account Management** field by double-clicking it.
13. Check the box next to **Configure the following audit events.**
14. Check the box next to **Success.**



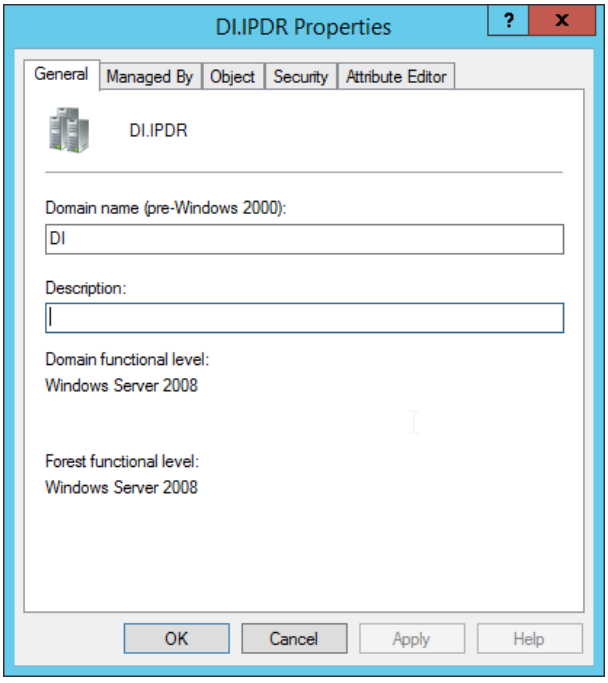
15. Click **OK.**
16. Go to **Audit Policies > DS Access.**
17. Double-click **Audit Directory Service Changes.**



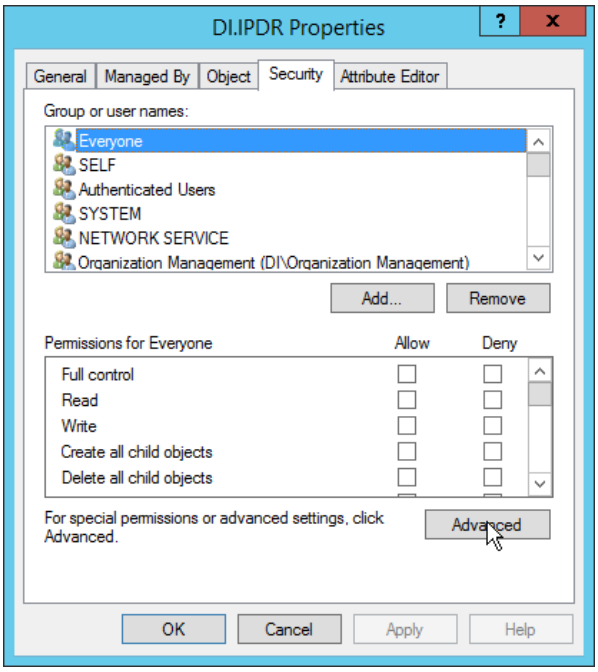
18. Check the box next to **Configure the following audit events.**
19. Check the box next to **Success.**
20. Click **OK.**



21. Open **Active Directory Users and Computers.**
22. Ensure that **View > Advanced Features** is enabled.
23. Right-click the **domain** (for example, DI.IPDR) created earlier and click **Properties.**

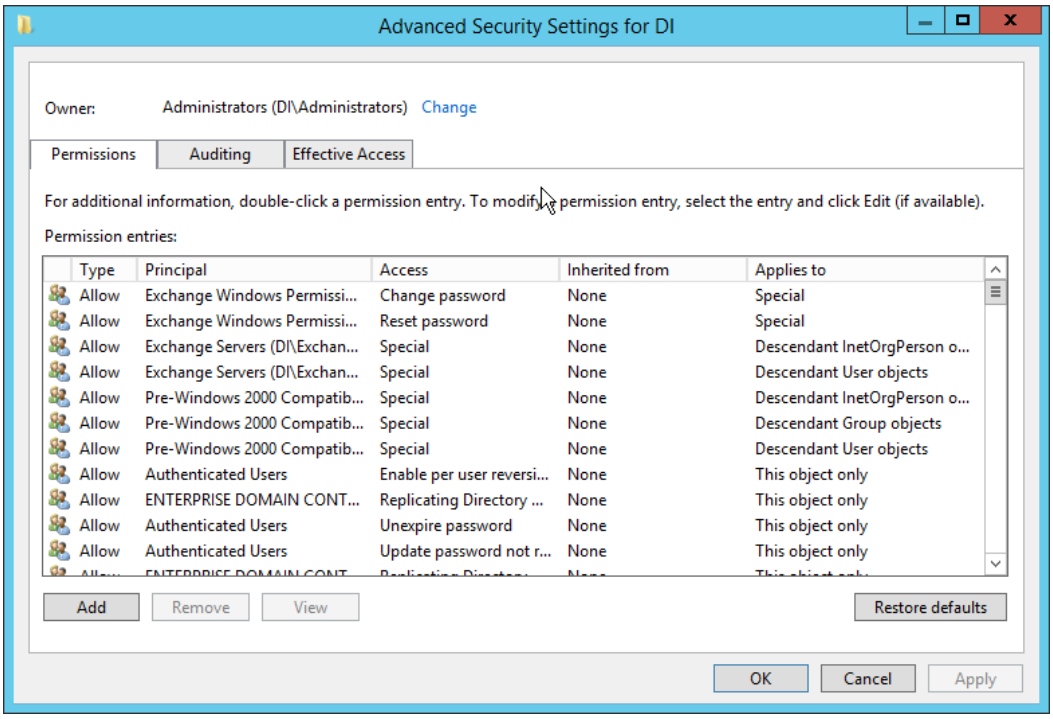


24. Click the **Security** tab.



1312

1313 25. Click **Advanced.**

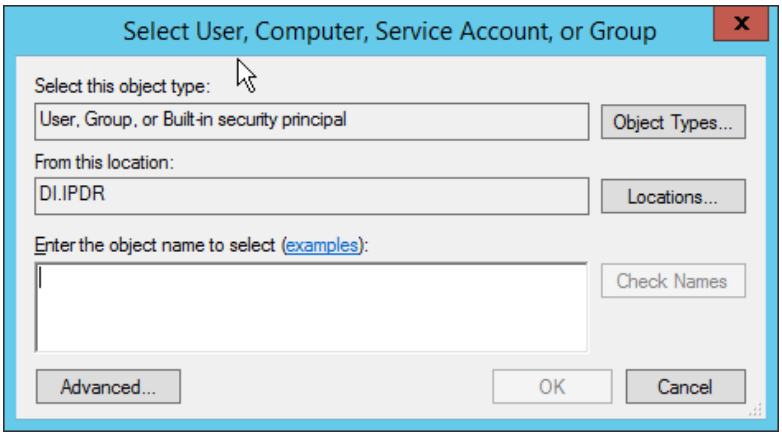


1314

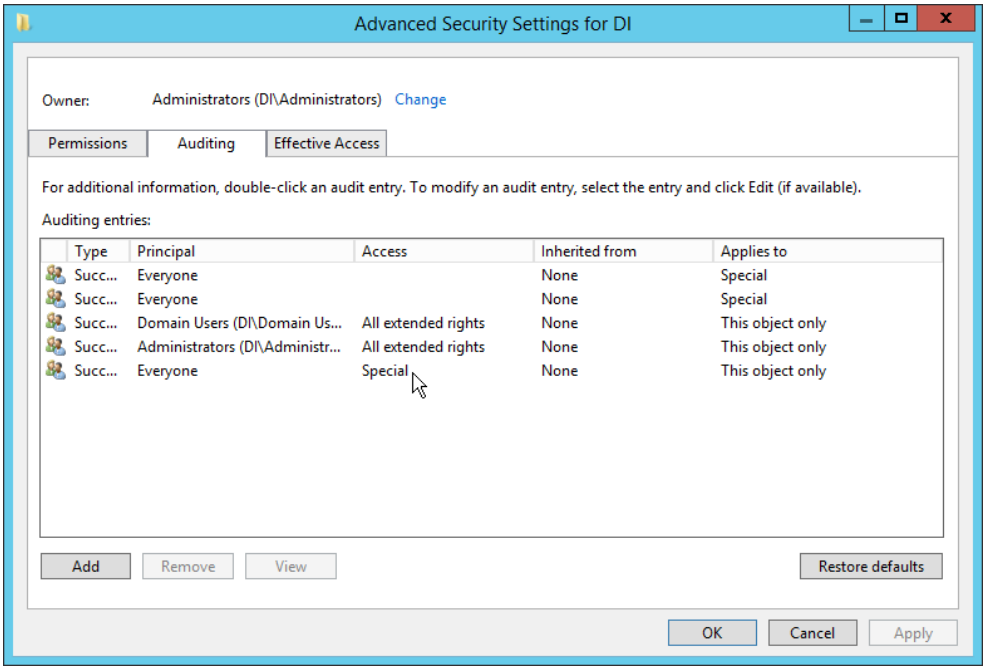
1315 26. Click the **Auditing** tab.

1316 27. Click **Add.**

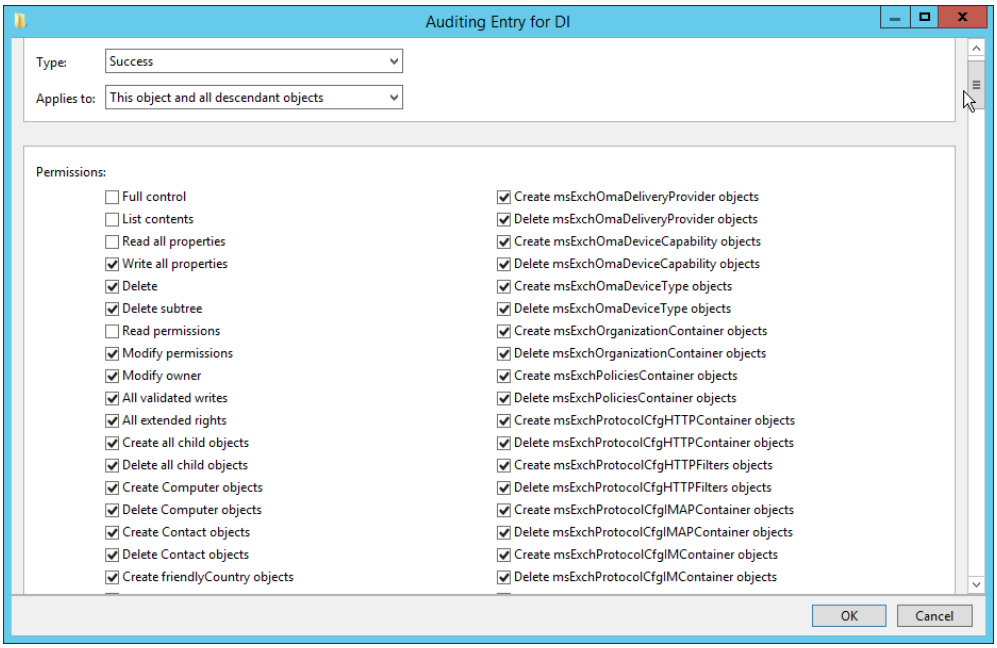
28. Enter **Everyone.**



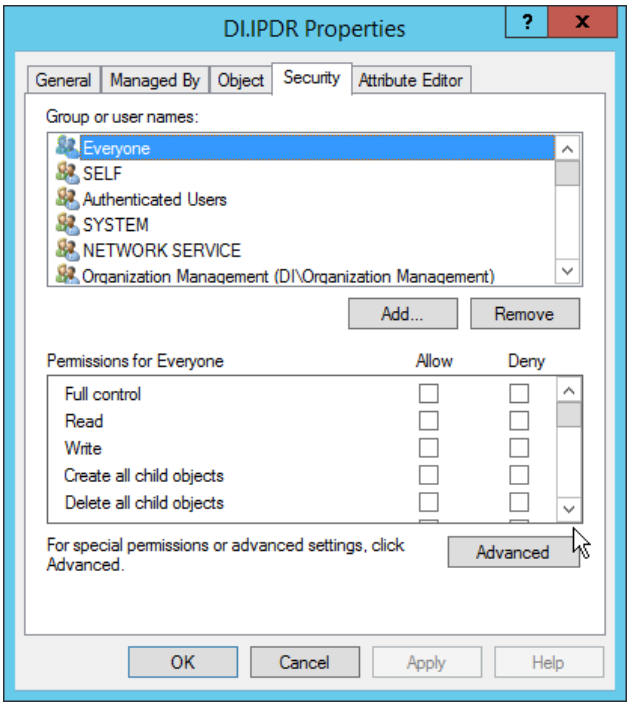
29. Click **OK.**



30. Double-click **Everyone.**
31. Check the boxes next to **Write all properties, Delete, Delete subtree, Modify permissions, Modify owner, All validated writes, All extended rights, Create all child objects, Delete all child objects.**



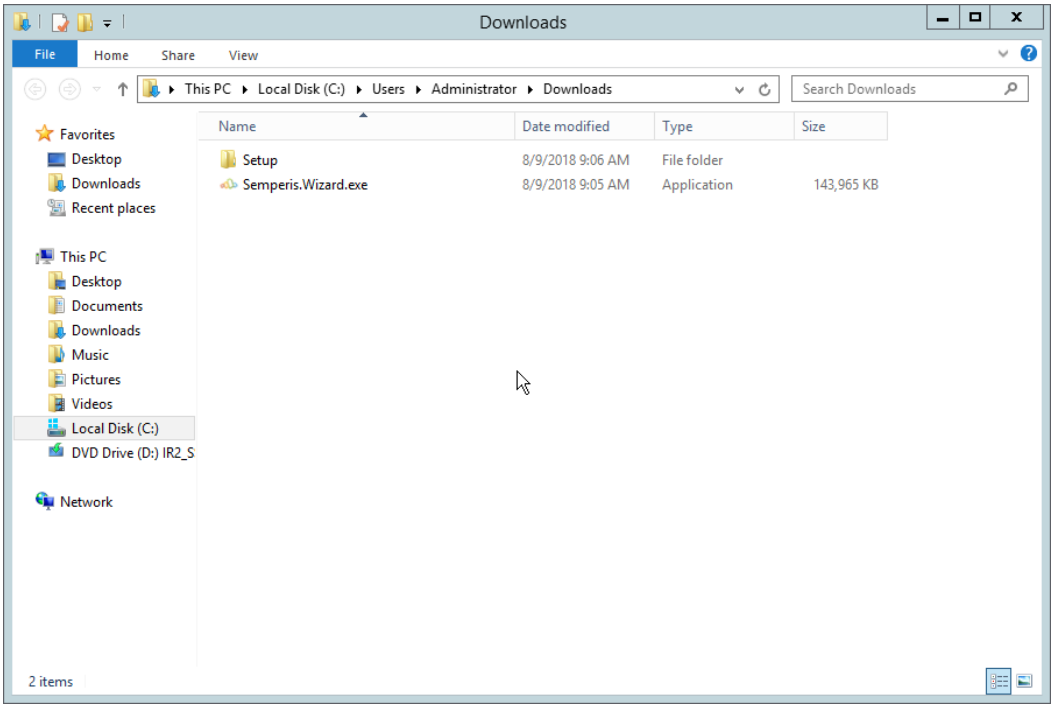
32. Click **OK.**



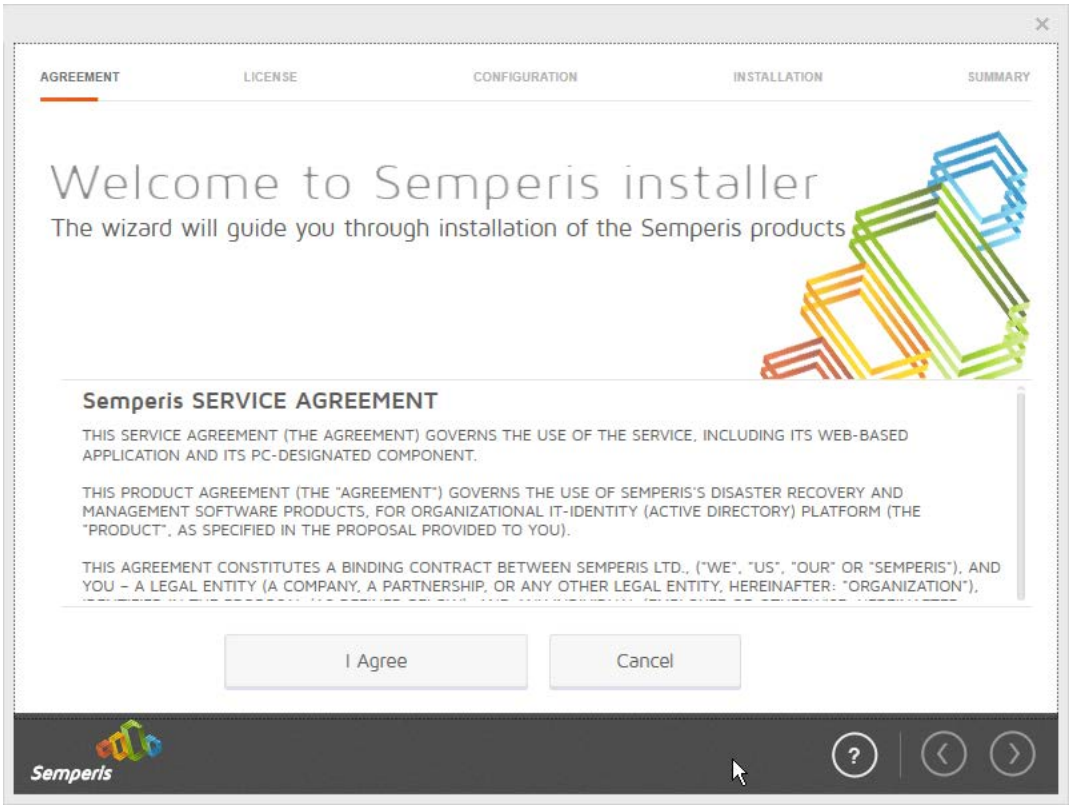
33. Click **OK.**

2.10.2 Install Semperis DSP

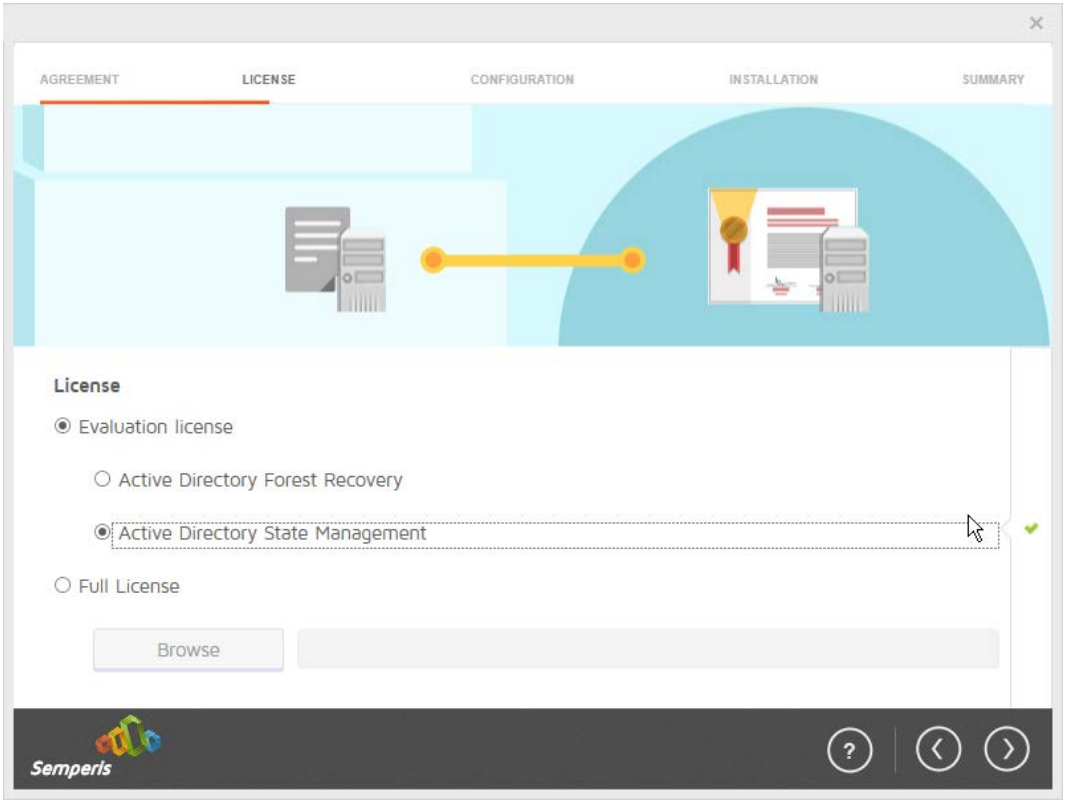
1. If you are using a local SQL Express Advanced server, place the **SQLEXPRADV_x64_ENU.exe** installer in a directory called Setup, and ensure that the **Semperis Wizard** is adjacent to the **Setup** folder (not inside it). If an SQL Express Advanced server is not being used, no **Setup** folder is required.



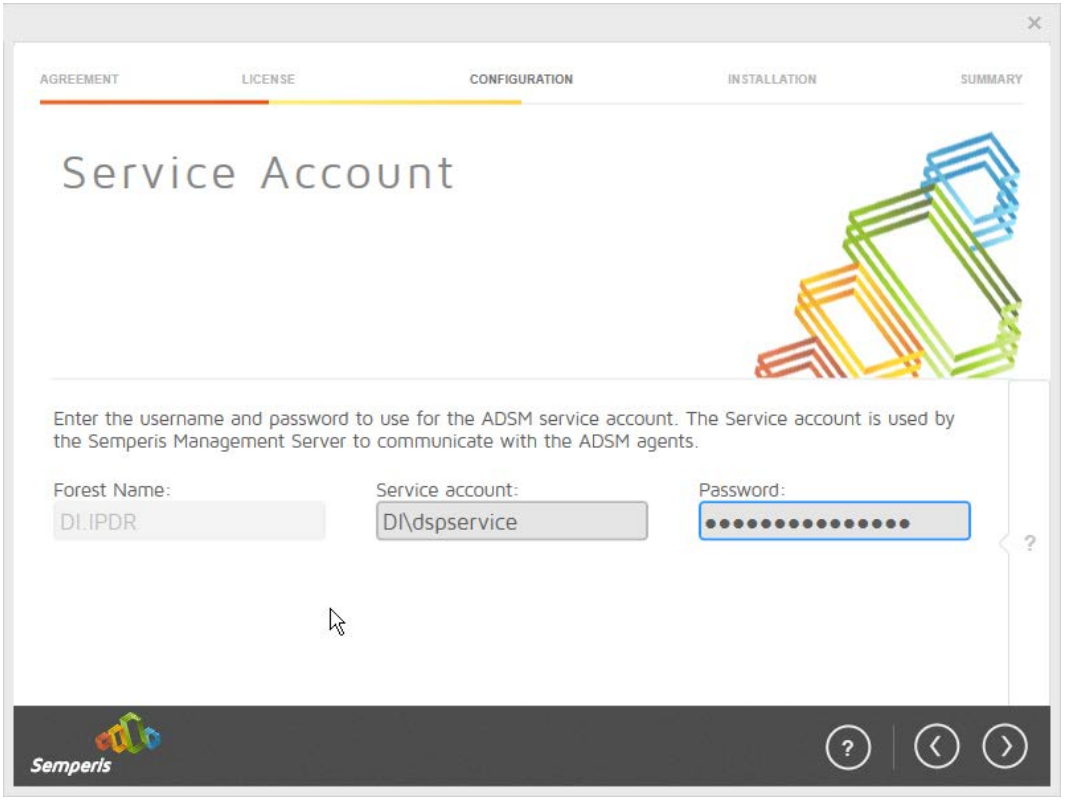
2. If prompted to restart the computer, do so.



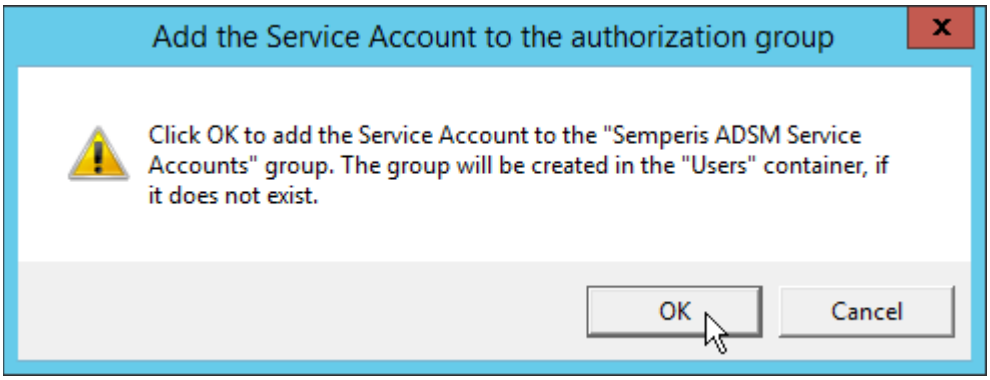
3. Click **I Agree.**
4. Select **Evaluation License.**
5. Select **Active Directory State Management.**



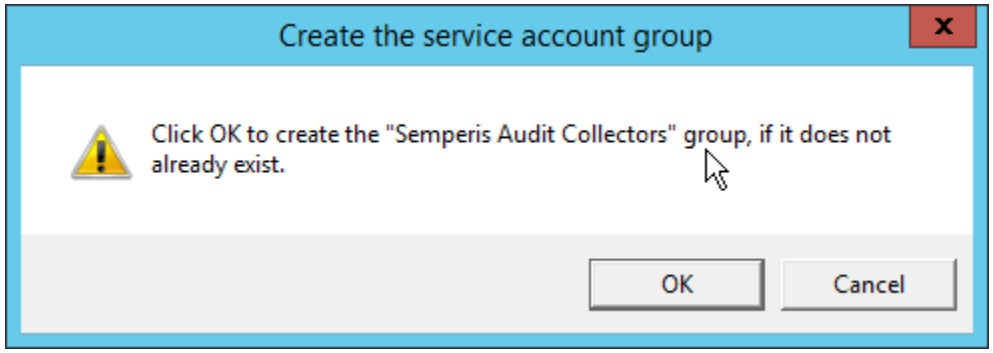
6. Click the **>** button.
7. Enter the **username** and **password** of the account created earlier.



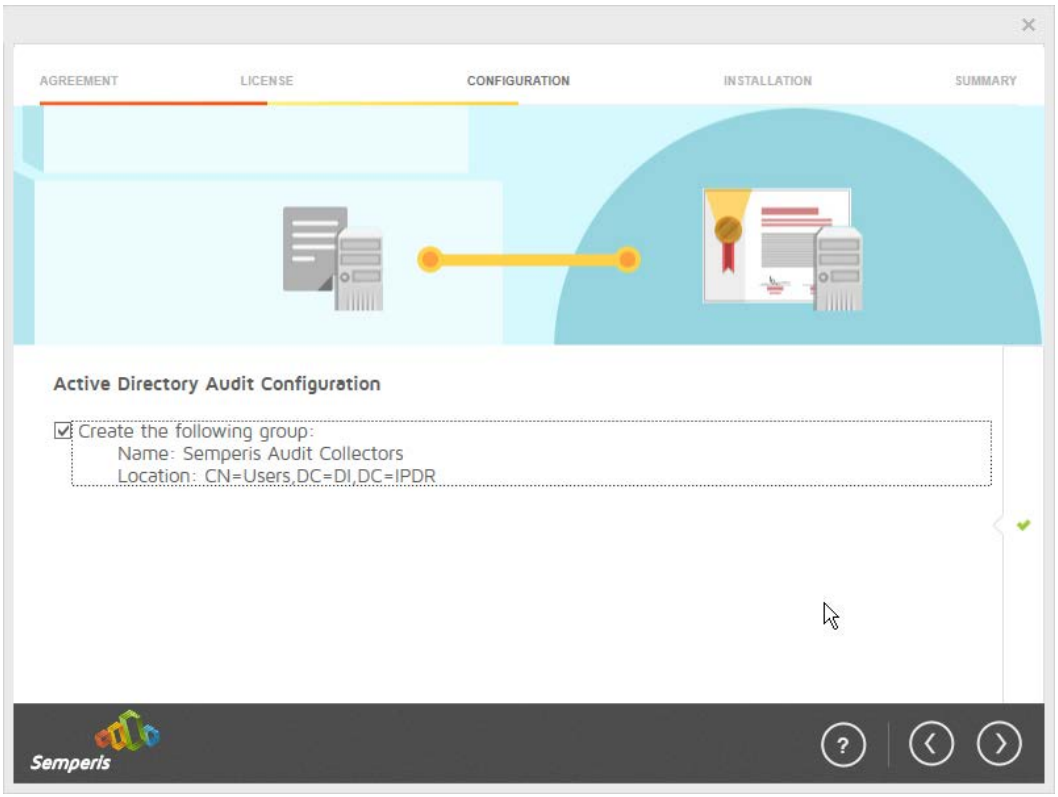
8. Click the **>** button.



9. Click **OK.**
10. Check the box next to **Create the following group.**

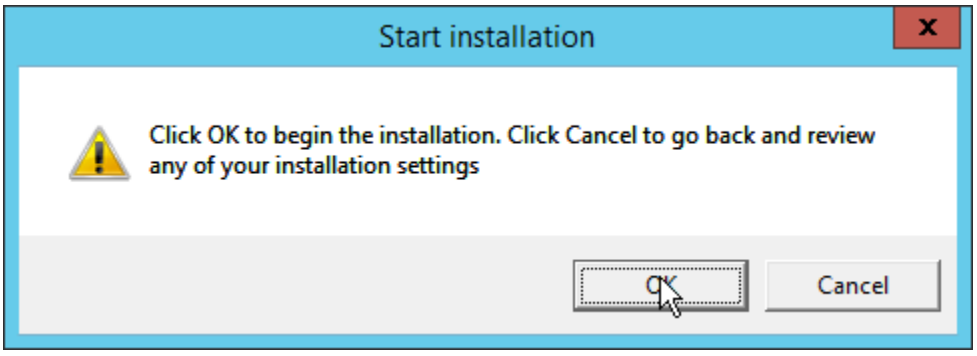


11. Click **OK.**

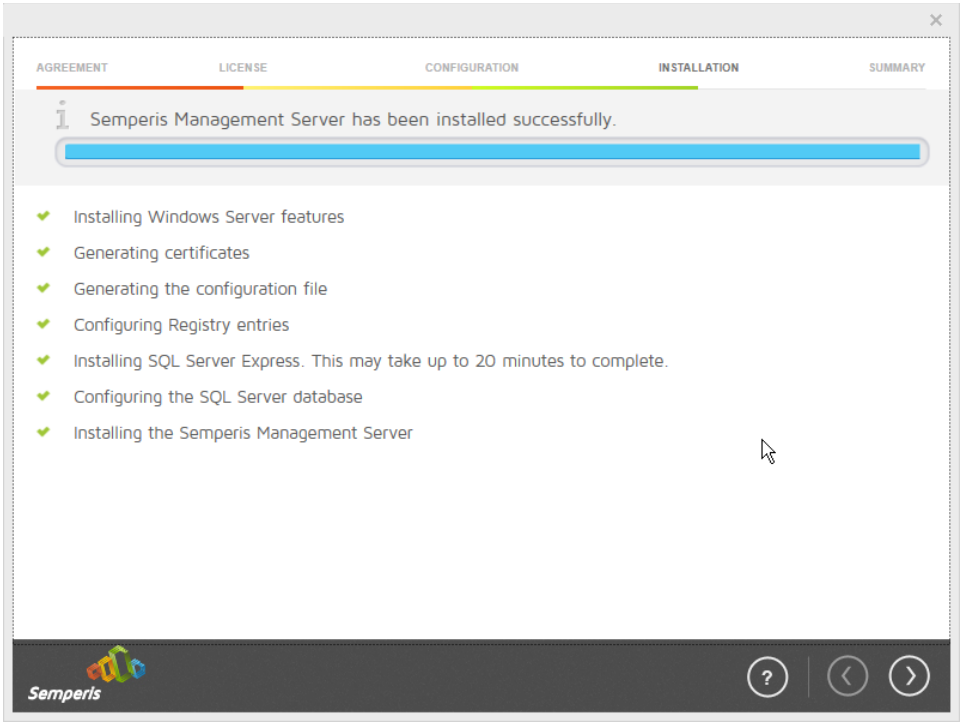


12. Click the **>** button.
13. Select the appropriate database option, and enter any required information.

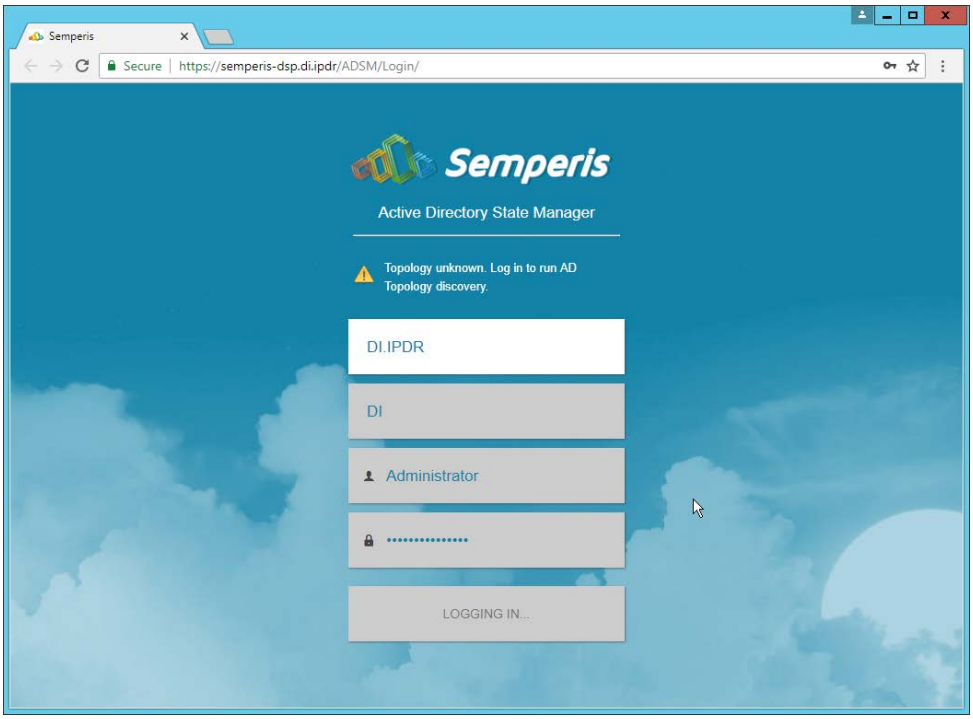
14. Click the **>** button.



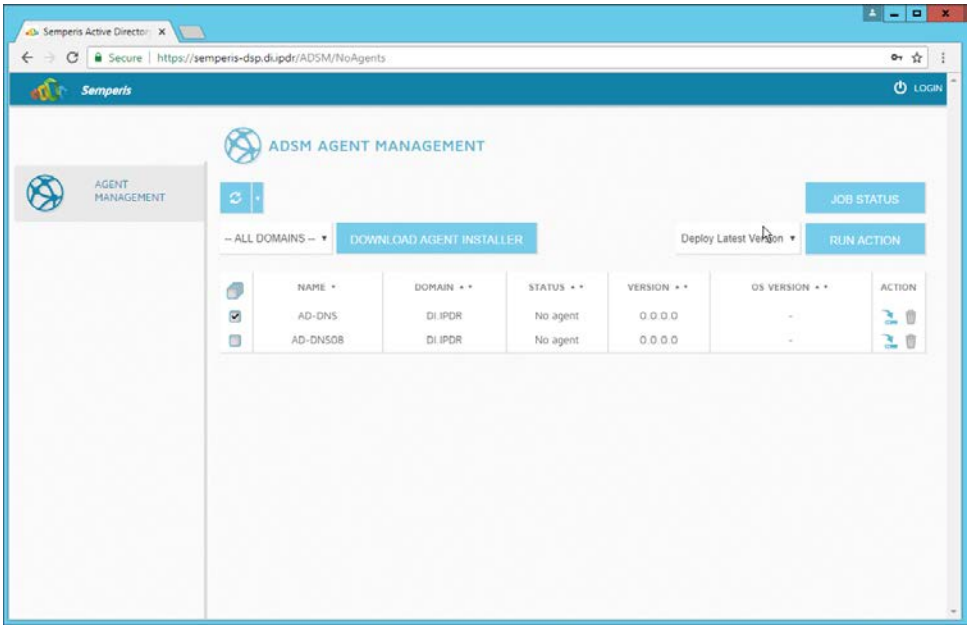
15. Click **OK.**



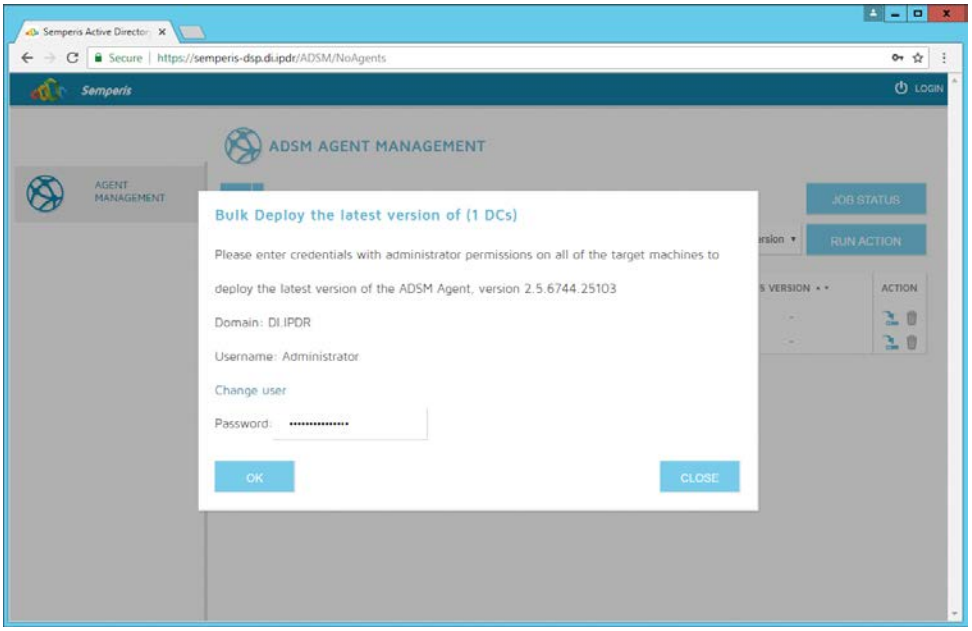
16. Click the **>** button after the installation completes.
17. There should now be a shortcut on the desktop linking to the web console for **Semperis DS Protector.**
18. On the login page, enter the full domain as well as the NetBIOS name.
19. Enter the **username** and **password** of an administrator on the domain.



20. Click **Login.**
21. Check the box next to the domain controllers that should be monitored by DSP.

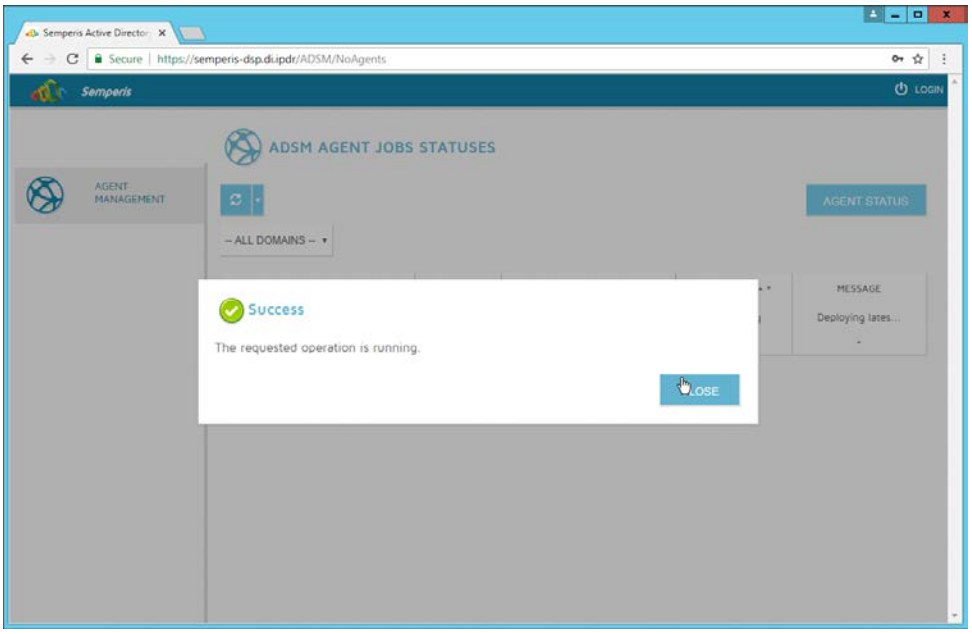


22. Click **Run Action.**
23. Enter the **password** for the account.



1369

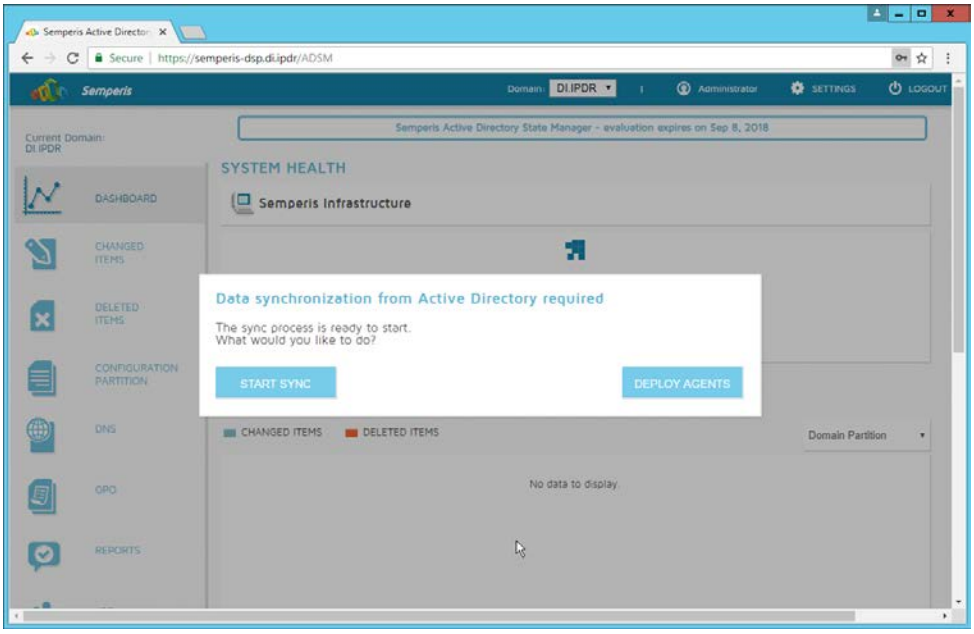
1370 24. Click **OK.**



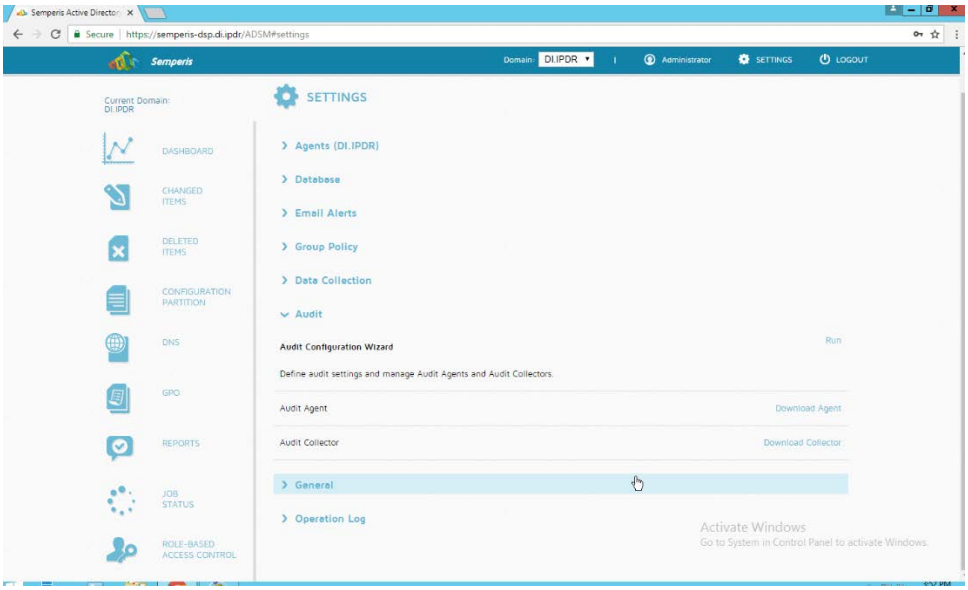
1371

1372 25. Click **Close.**

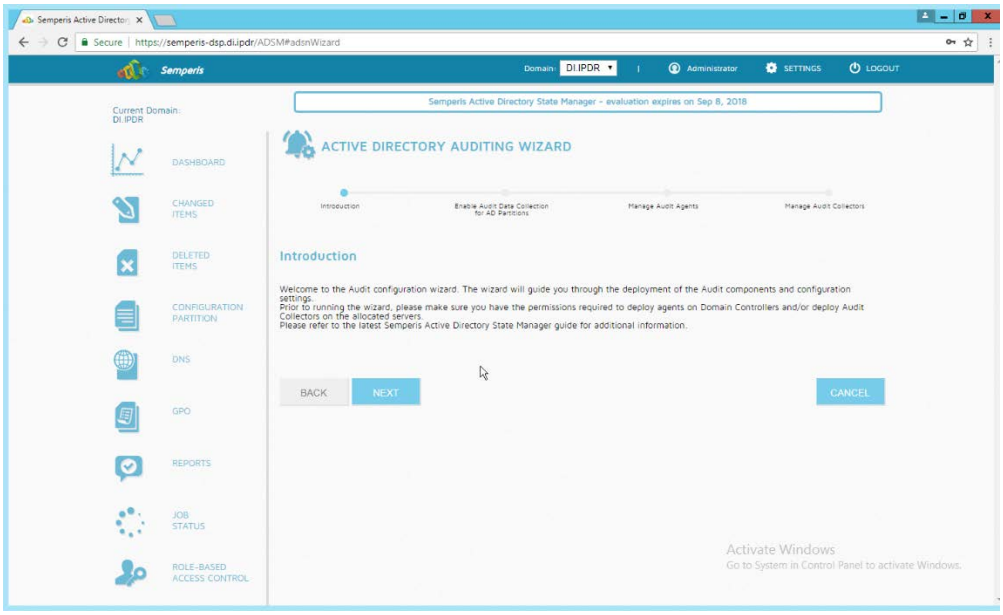
1373 26. After the agent finishes deploying, click **Login** at the top of the page and log in.



27. Click **Start Sync.**
28. After this completes, click **Settings** at the top of the page.

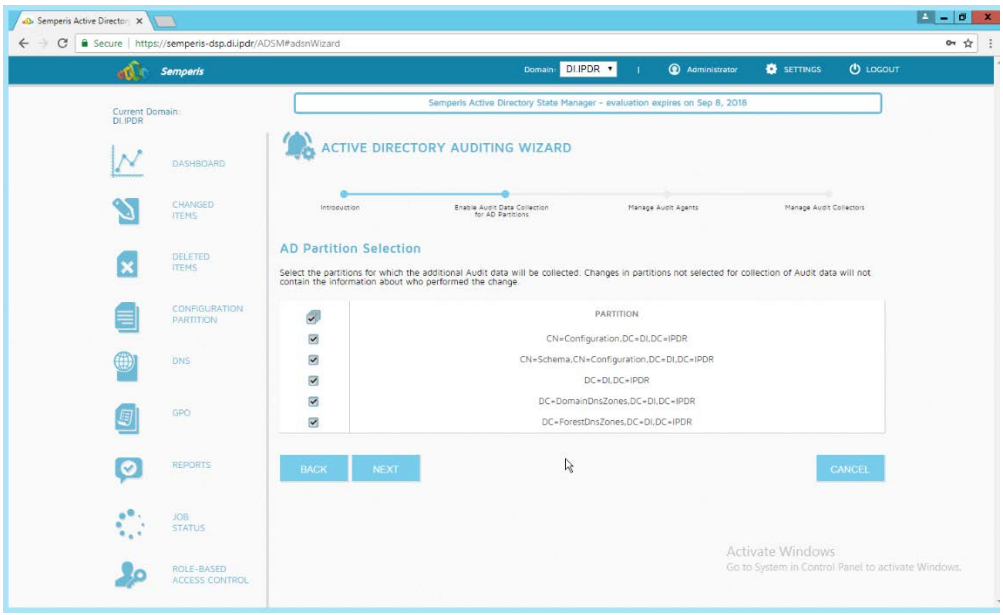


29. Click **Audit.**
30. Click **Run.**



1380

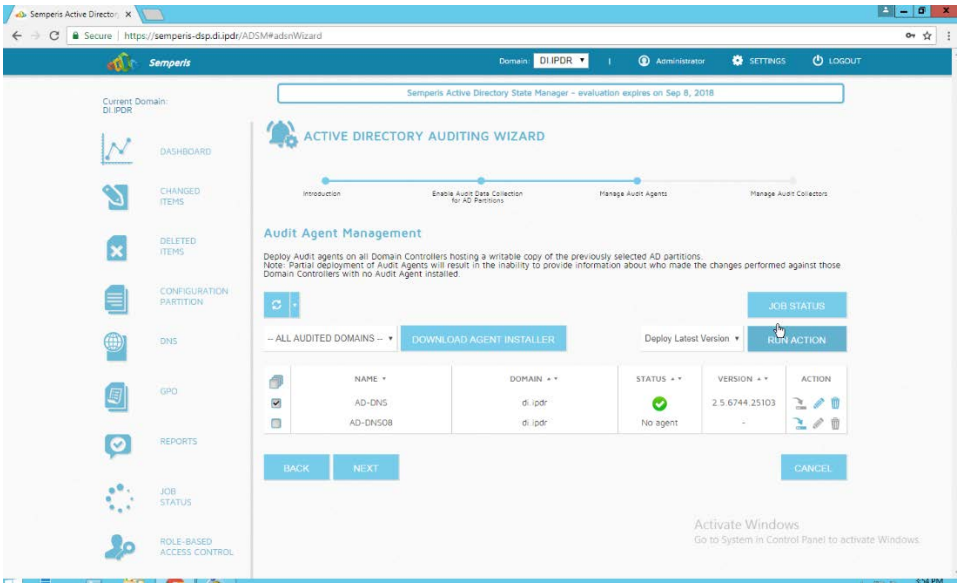
1381 31. Click **Next.**



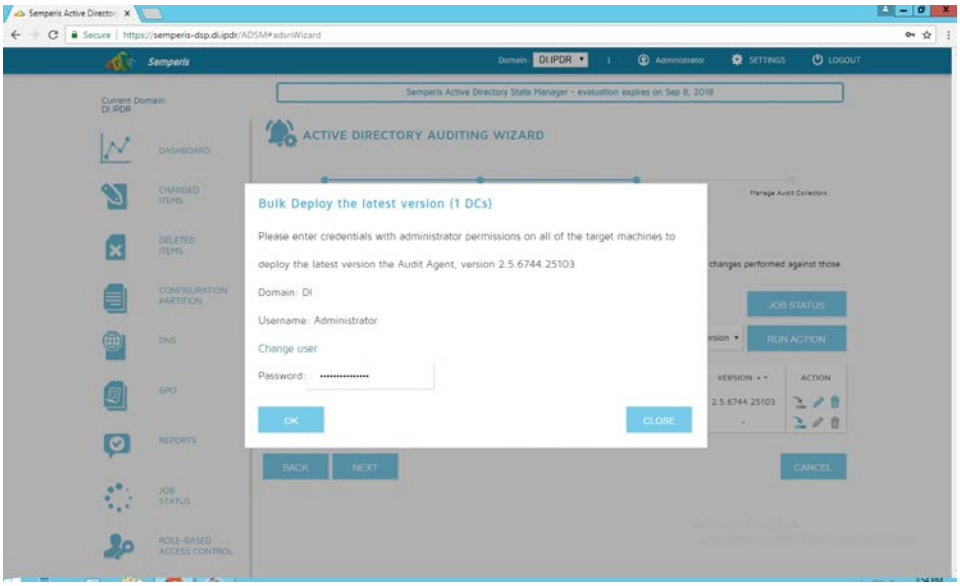
1382

1383 32. Click **Next.**

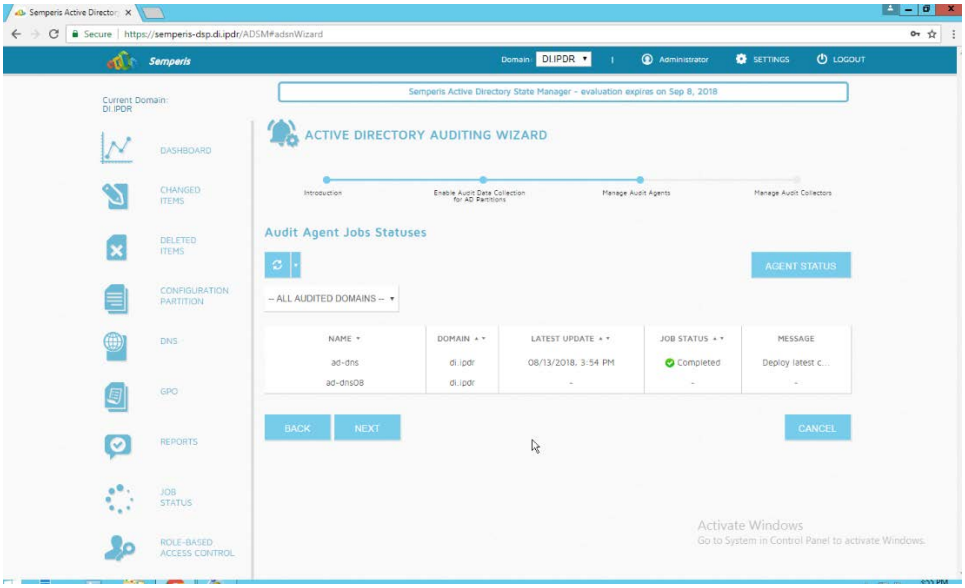
1384 33. Check the boxes next to any Domain Controllers that should be monitored.



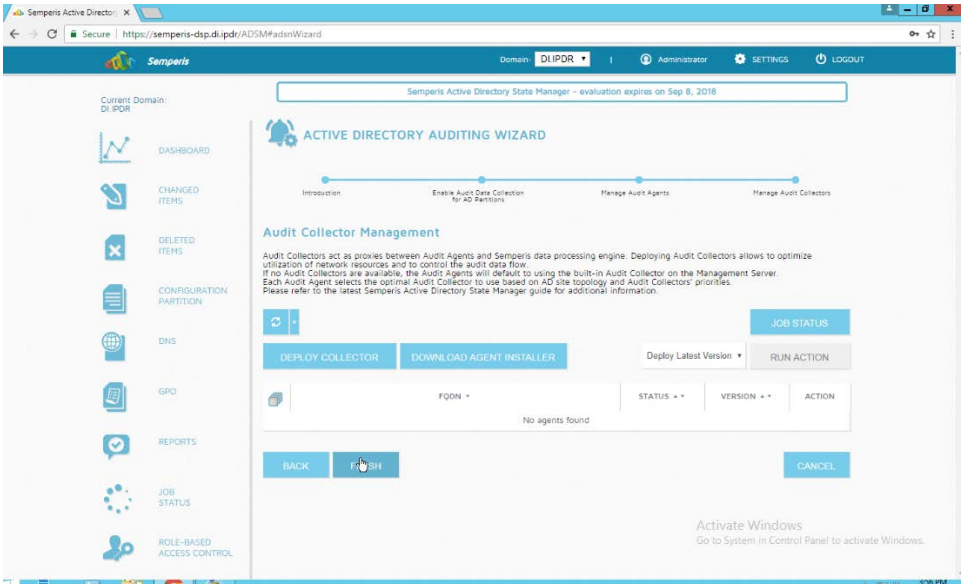
34. Click **Run Action.**
35. Enter the **password.**



36. Click **OK.**
37. Wait for the deployment to finish.



38. Click **Next.**



39. Click **Finish.**

2.11 Micro Focus ArcSight Enterprise Security Manager

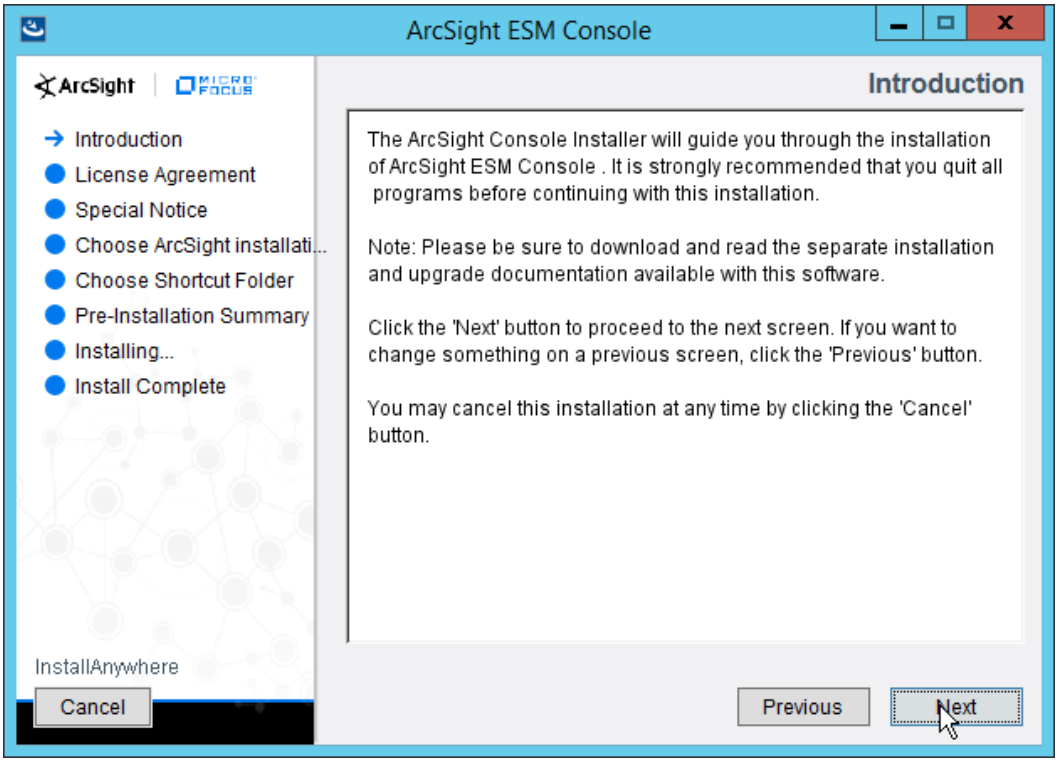
Micro Focus ArcSight Enterprise Security Manager is primarily a log collection/analysis tool with features for sorting, filtering, correlating, and reporting information from logs. It is adaptable to logs generated by various systems, applications, and security solutions.

1399 This installation guide assumes a preconfigured CentOS 7 machine with Enterprise Security Manager
1400 (ESM) already installed and licensed. This section covers the installation and configuration process used
1401 to set up ArcSight agents on various machines, as well as some analysis and reporting capabilities.

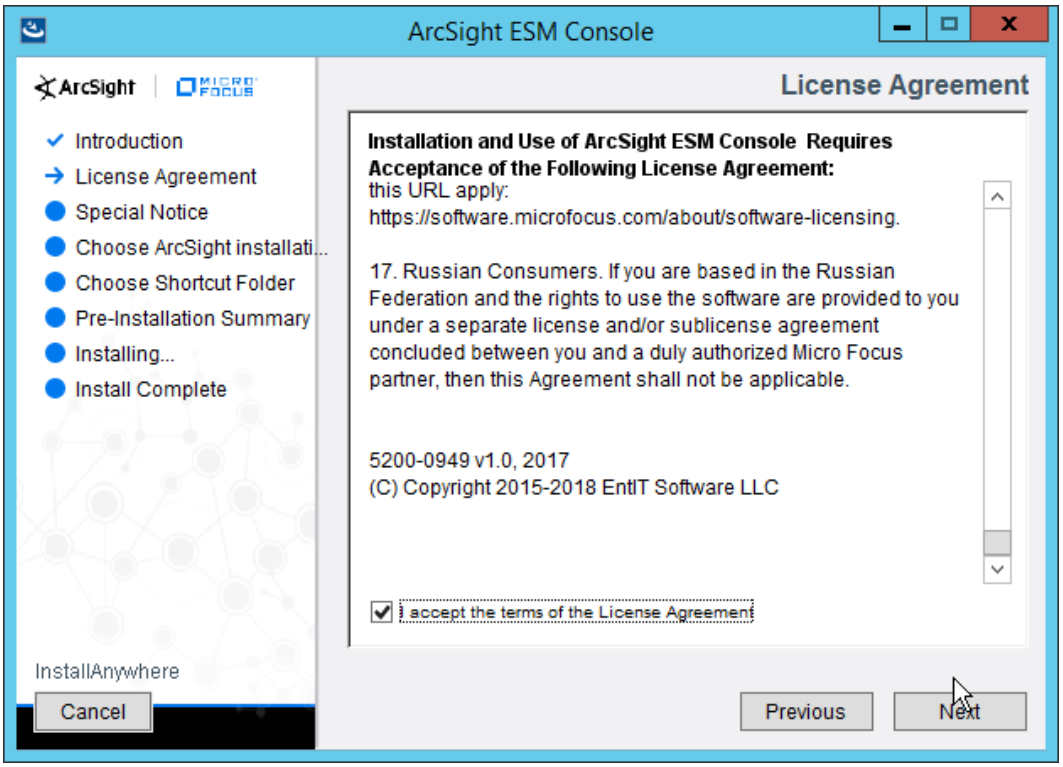
1402 Installation instructions are included for both Windows and UNIX machines, as well as for collecting
1403 from multiple machines. Furthermore, integrations with other products in the build are included in later
1404 sections.

1405 2.11.1 Install the ArcSight Console

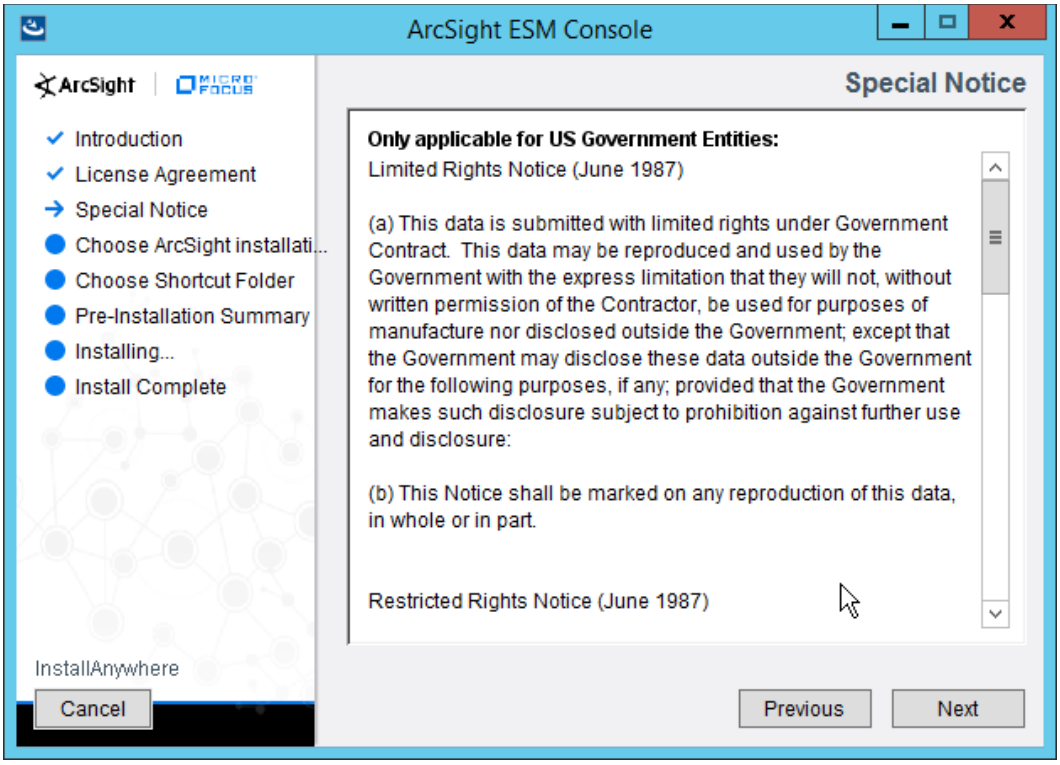
1406 1. Run **ArcSight-7.0.0.2436.1-Console-Win.exe.**



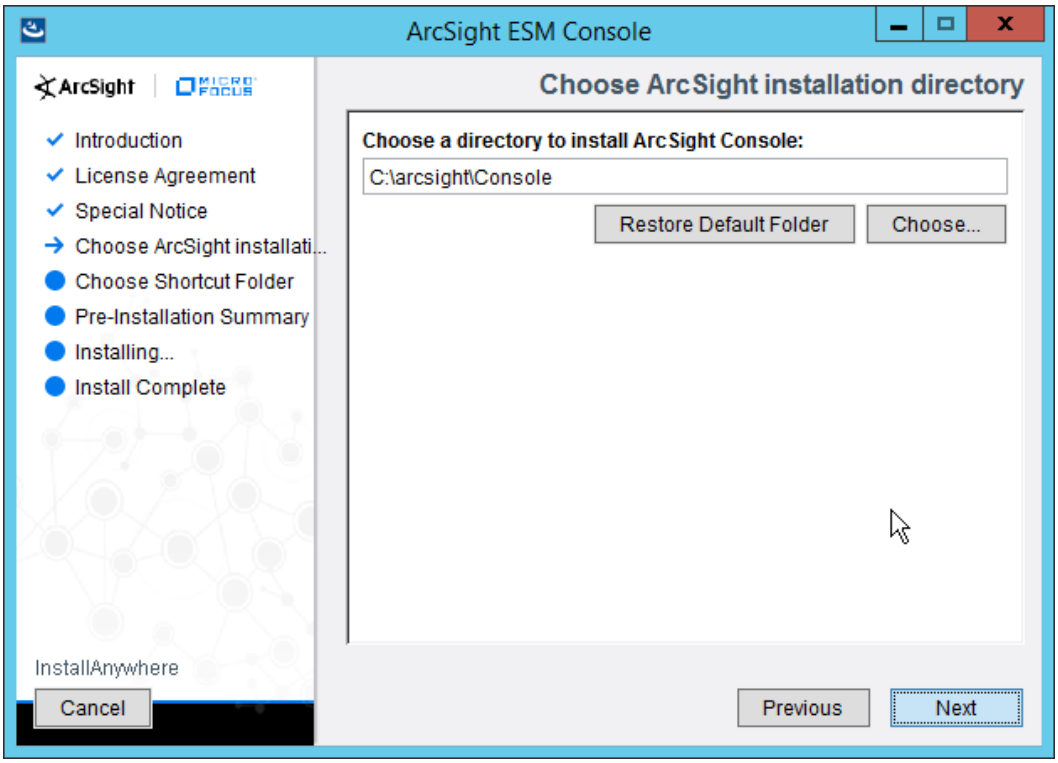
1407
1408 2. Click **Next.**
1409 3. Check the box next to **I accept the License Agreement.**


ArcSight ESM Console
ArcSight
Introduction
License Agreement
Special Notice
Choose ArcSight installati...
Choose Shortcut Folder
Pre-Installation Summary
Installing...
Install Complete
InstallAnywhere
Cancel
License Agreement
Installation and Use of ArcSight ESM Console Requires Acceptance of the Following License Agreement:
this URL apply:
https://software.microfocus.com/about/software-licensing.
17. Russian Consumers. If you are based in the Russian Federation and the rights to use the software are provided to you under a separate license and/or sublicense agreement concluded between you and a duly authorized Micro Focus partner, then this Agreement shall not be applicable.
5200-0949 v1.0, 2017
(C) Copyright 2015-2018 EntIT Software LLC
I accept the terms of the License Agreement
Previous
Next

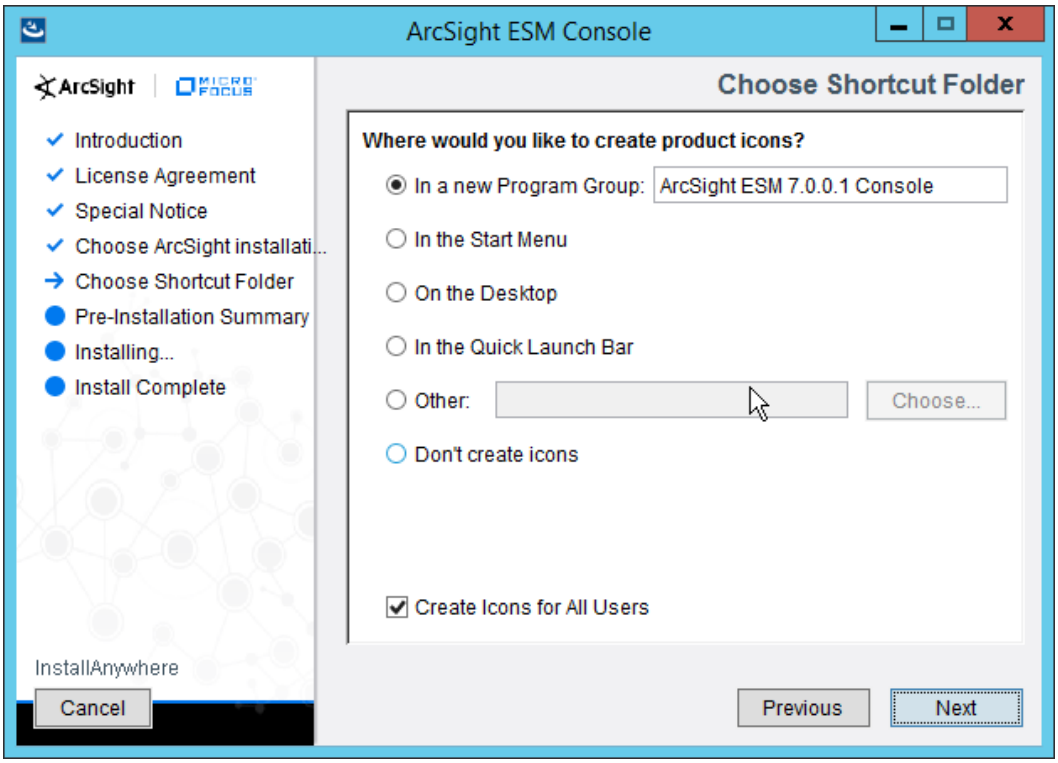
4. Click **Next.**


ArcSight ESM Console
ArcSight
Introduction
License Agreement
Special Notice
Choose ArcSight installati...
Choose Shortcut Folder
Pre-Installation Summary
Installing...
Install Complete
InstallAnywhere
Cancel
Special Notice
Only applicable for US Government Entities:
Limited Rights Notice (June 1987)
(a) This data is submitted with limited rights under Government Contract. This data may be reproduced and used by the Government with the express limitation that they will not, without written permission of the Contractor, be used for purposes of manufacture nor disclosed outside the Government; except that the Government may disclose these data outside the Government for the following purposes, if any; provided that the Government makes such disclosure subject to prohibition against further use and disclosure:
(b) This Notice shall be marked on any reproduction of this data, in whole or in part.
Restricted Rights Notice (June 1987)
Previous
Next

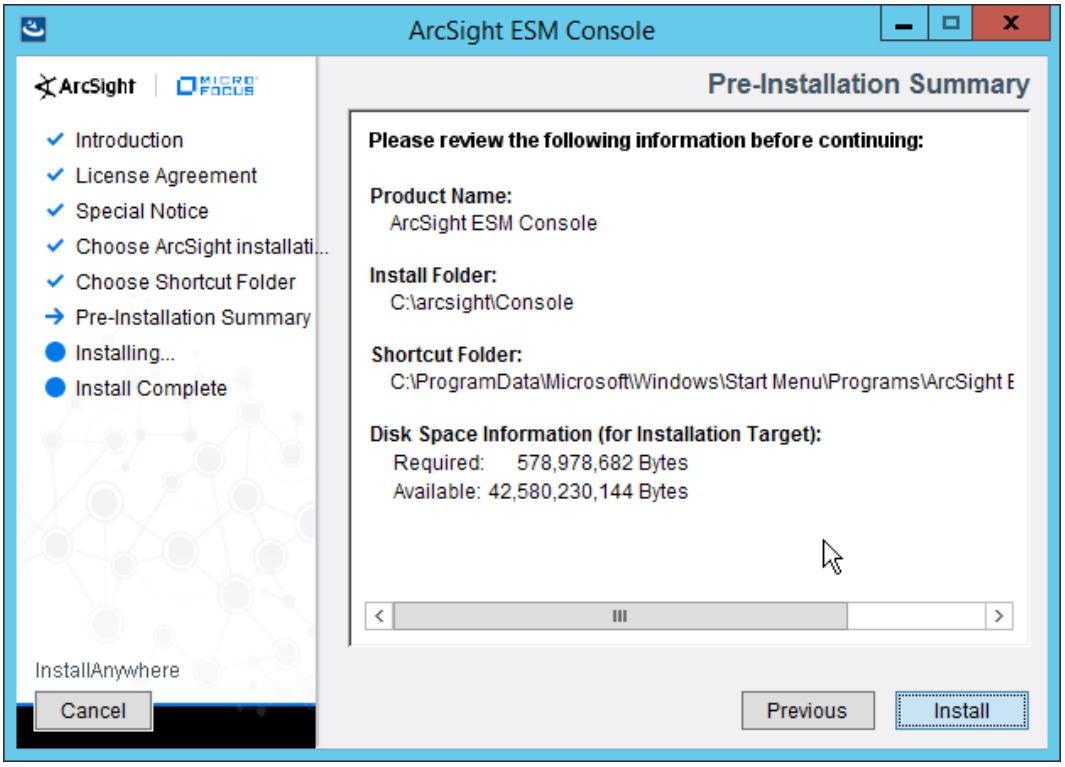
5. Click **Next.**


ArcSight ESM Console
ArcSight
Introduction
License Agreement
Special Notice
Choose ArcSight installati...
Choose Shortcut Folder
Pre-Installation Summary
Installing...
Install Complete
InstallAnywhere
Cancel
Choose ArcSight installation directory
Choose a directory to install ArcSight Console:
C:\arcsight\Console
Restore Default Folder
Choose...
Previous
Next

6. Click **Next.**


ArcSight ESM Console
ArcSight
Introduction
License Agreement
Special Notice
Choose ArcSight installati...
Choose Shortcut Folder
Pre-Installation Summary
Installing...
Install Complete
InstallAnywhere
Cancel
Choose Shortcut Folder
Where would you like to create product icons?
In a new Program Group:
ArcSight ESM 7.0.0.1 Console
In the Start Menu
On the Desktop
In the Quick Launch Bar
Other:
Choose...
Don't create icons
Create Icons for All Users
Previous
Next

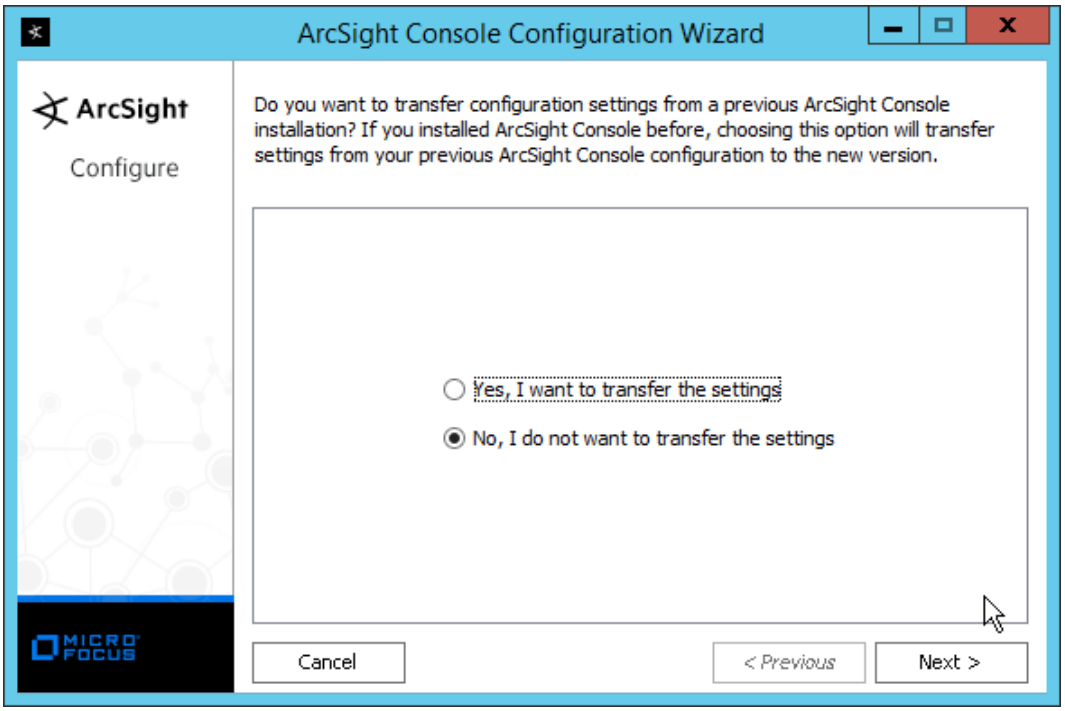
7. Click **Next.**



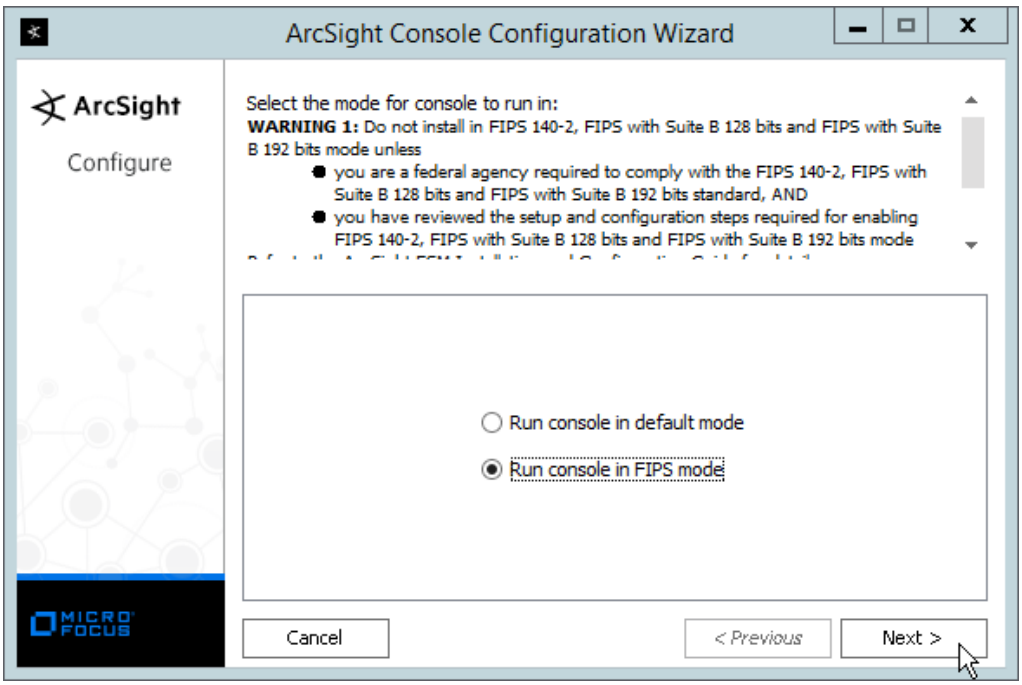
1418

1419 8. Click **Install.**

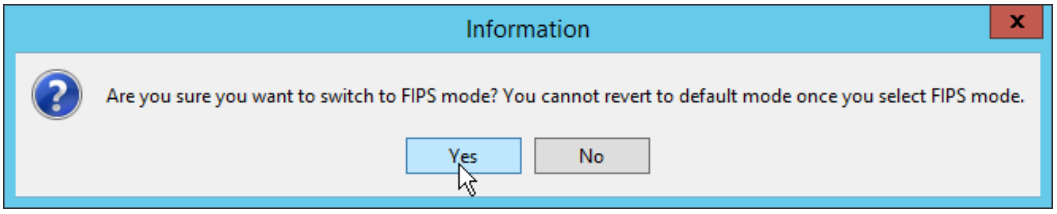
1420 9. Select **No, I do not want to transfer the settings.**



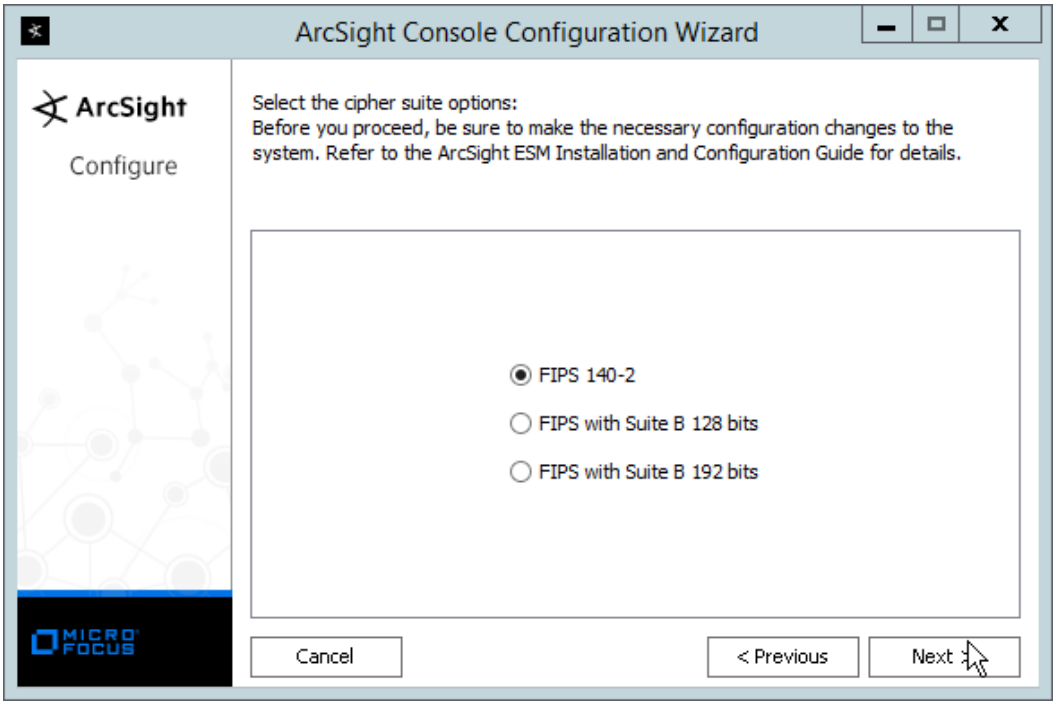
10. Click **Next.**
11. Select **Run console in default mode.** (This can be changed later according to your organization's compliance requirements.)



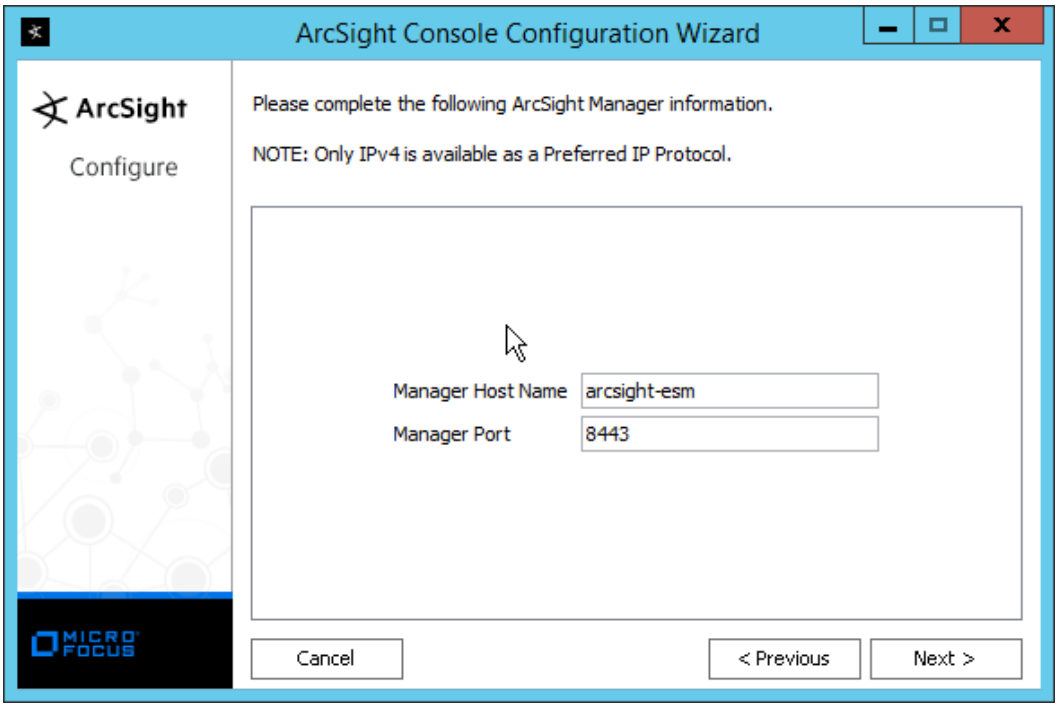
12. Click **Next.**



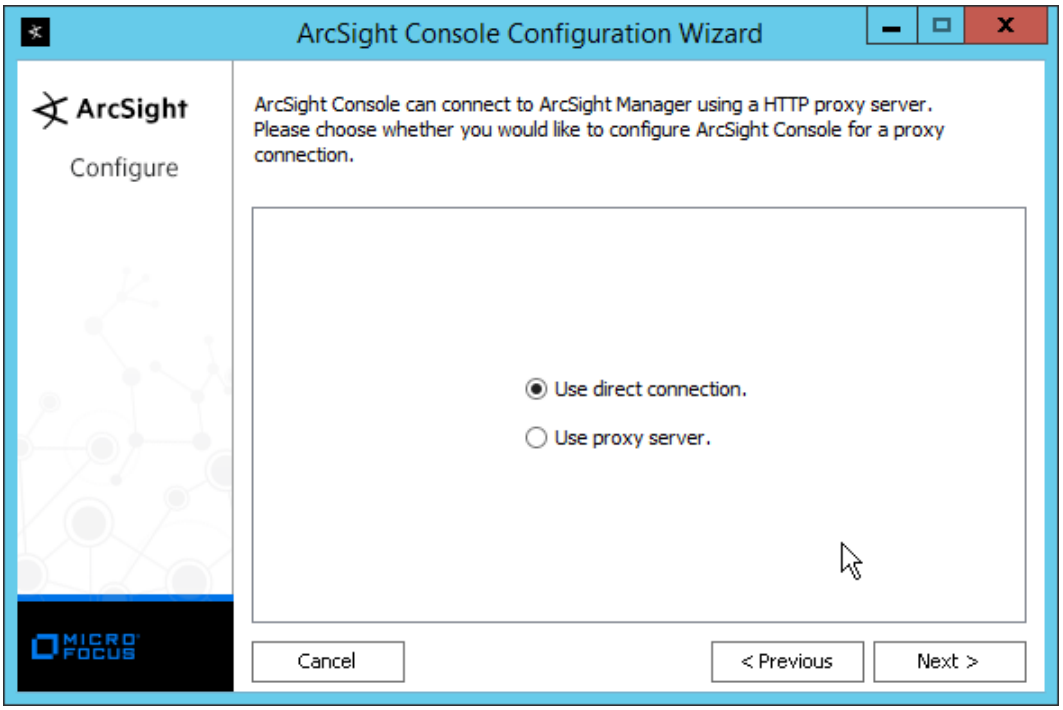
13. Click **Yes.**
14. Select **FIPS 140-2.**



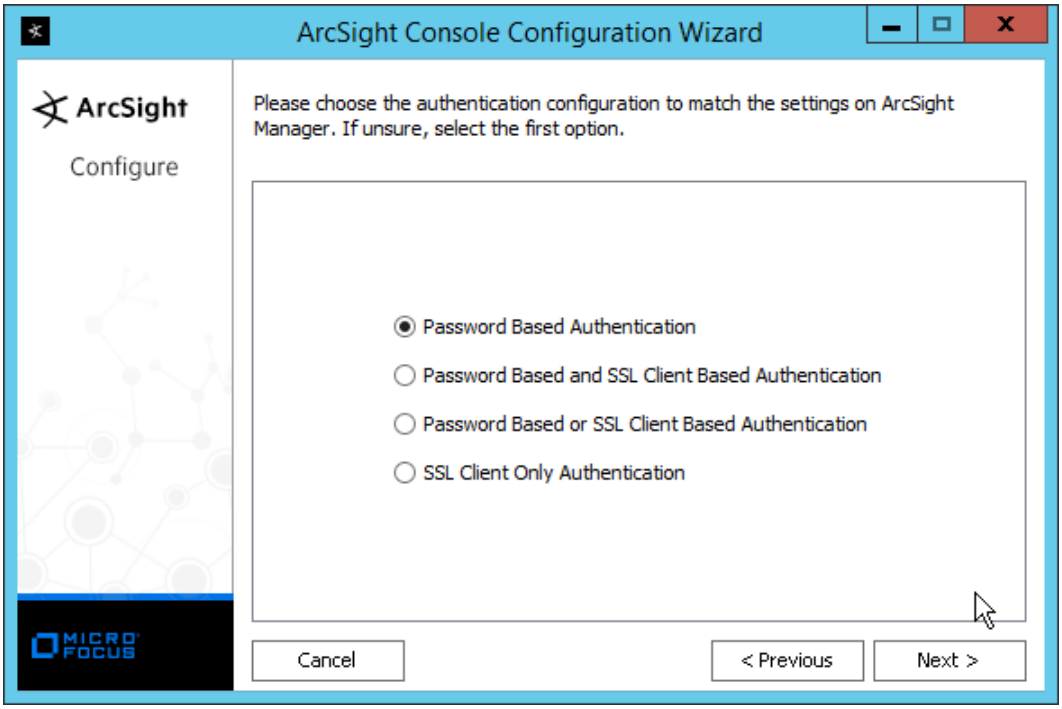
15. Click **Next.**
16. Enter the **hostname** of the ESM server for **Manager Host Name.**
17. Enter the **port** that ESM is running on for **Manager Port** (default: 8443).



18. Click **Next.**
19. Select **Use direct connection.**

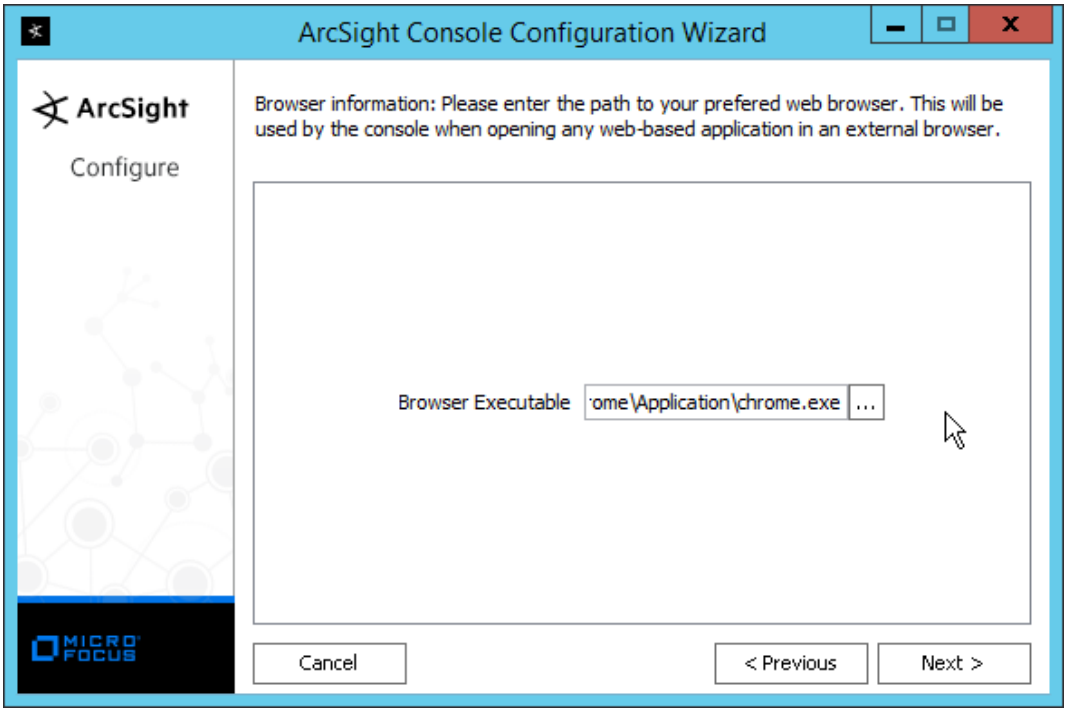


20. Click **Next.**



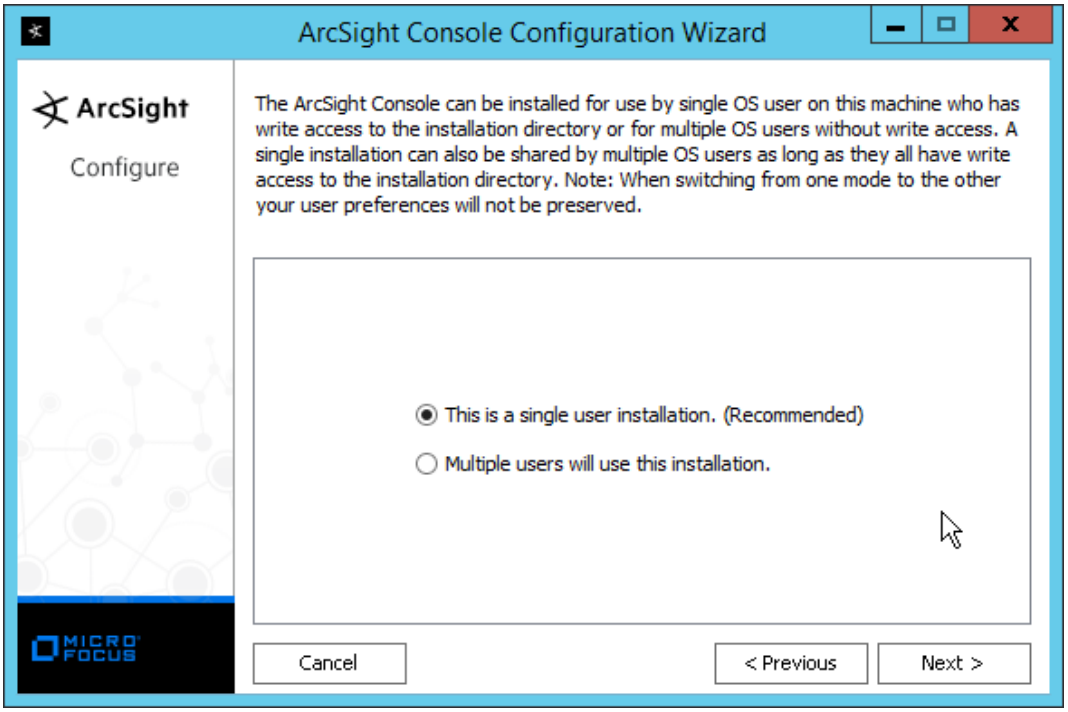
21. Click **Next.**

22. Select your preferred browser.



1442

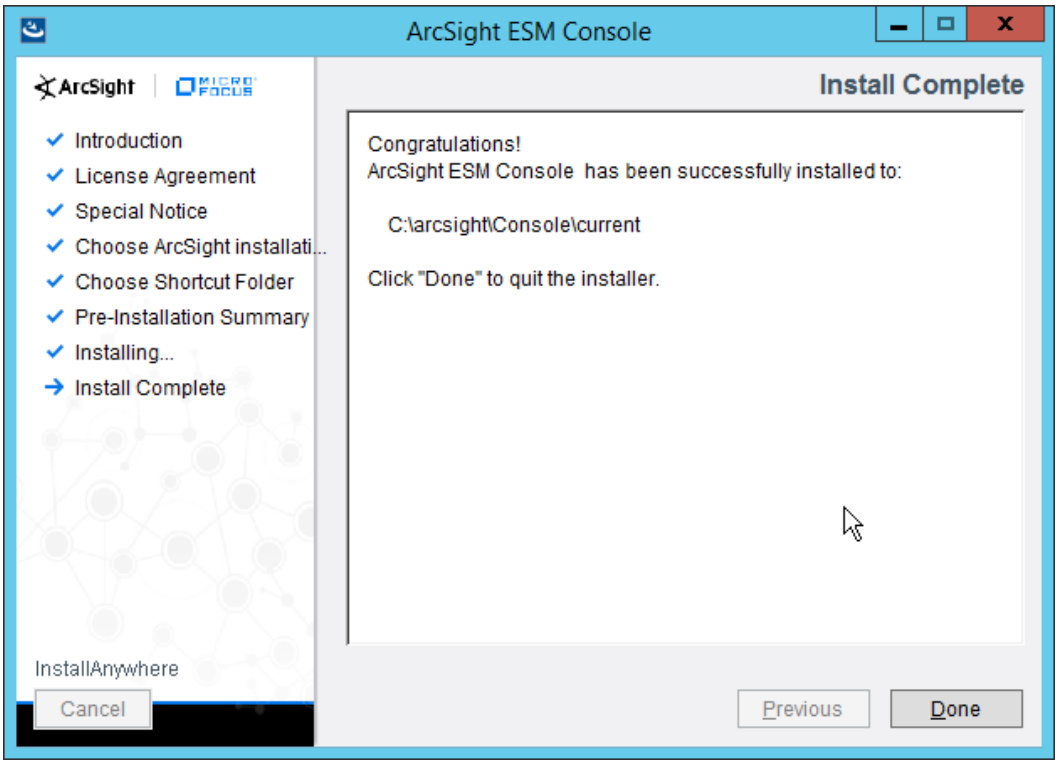
1443 23. Click **Next.**



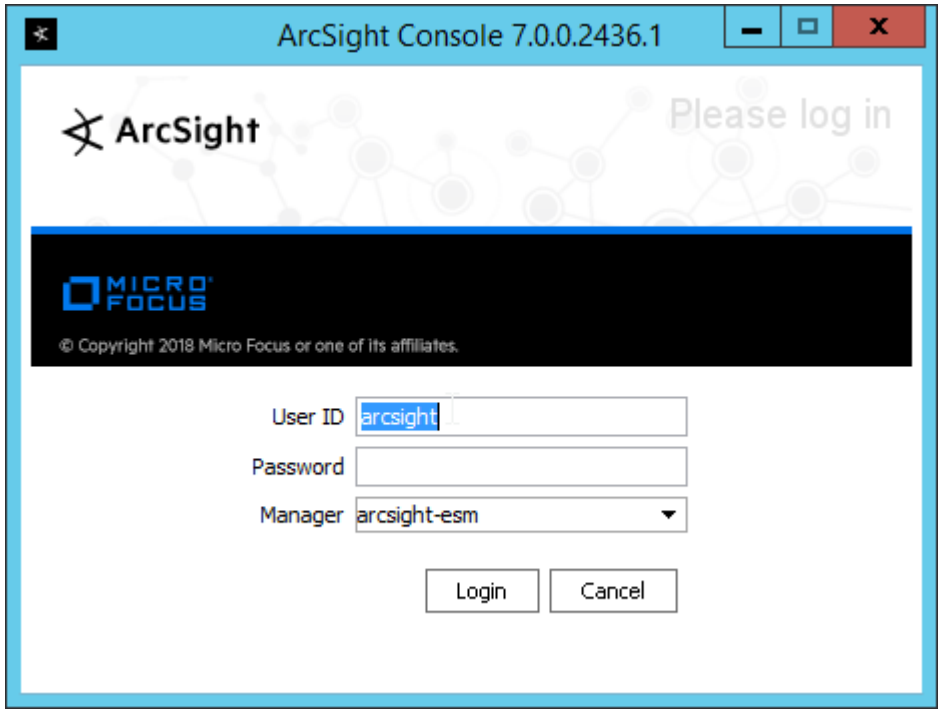
1444

1445 24. Click **Next.**

25. Click **Finish.**



26. Click **Done.**
27. Run **ArcSight Console** from the Start menu.
28. Enter the **username** and **password.**

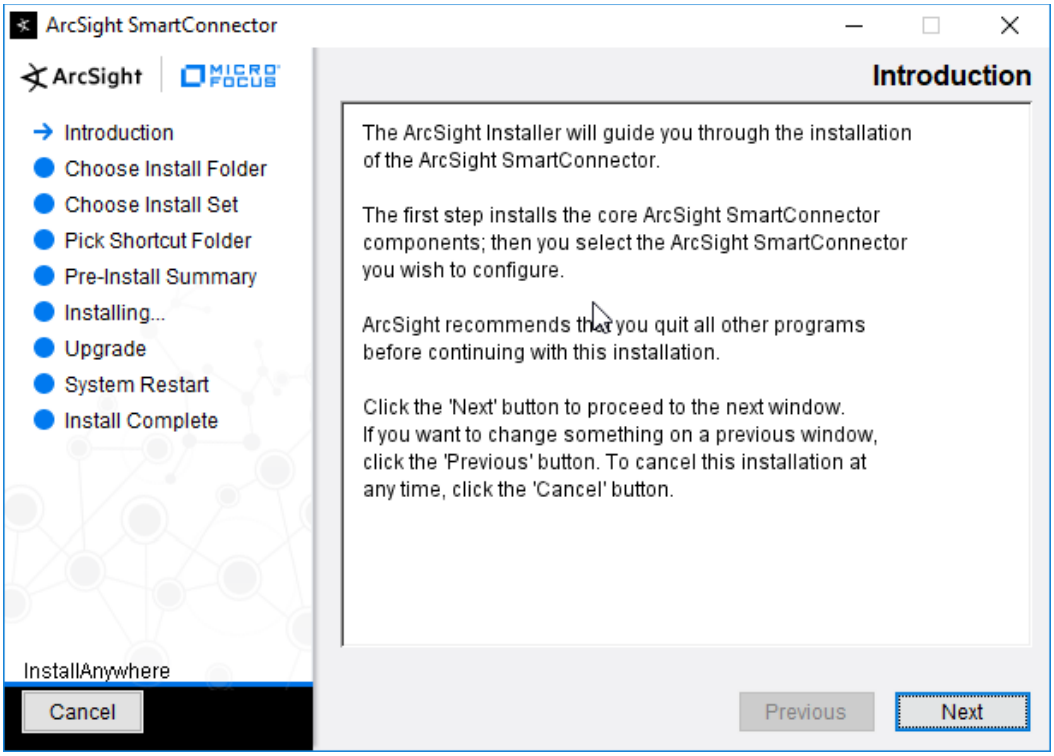


29. Click **Login.** (If you are unable to connect, ensure that the hostname of the ESM server is present in your DNS server.)

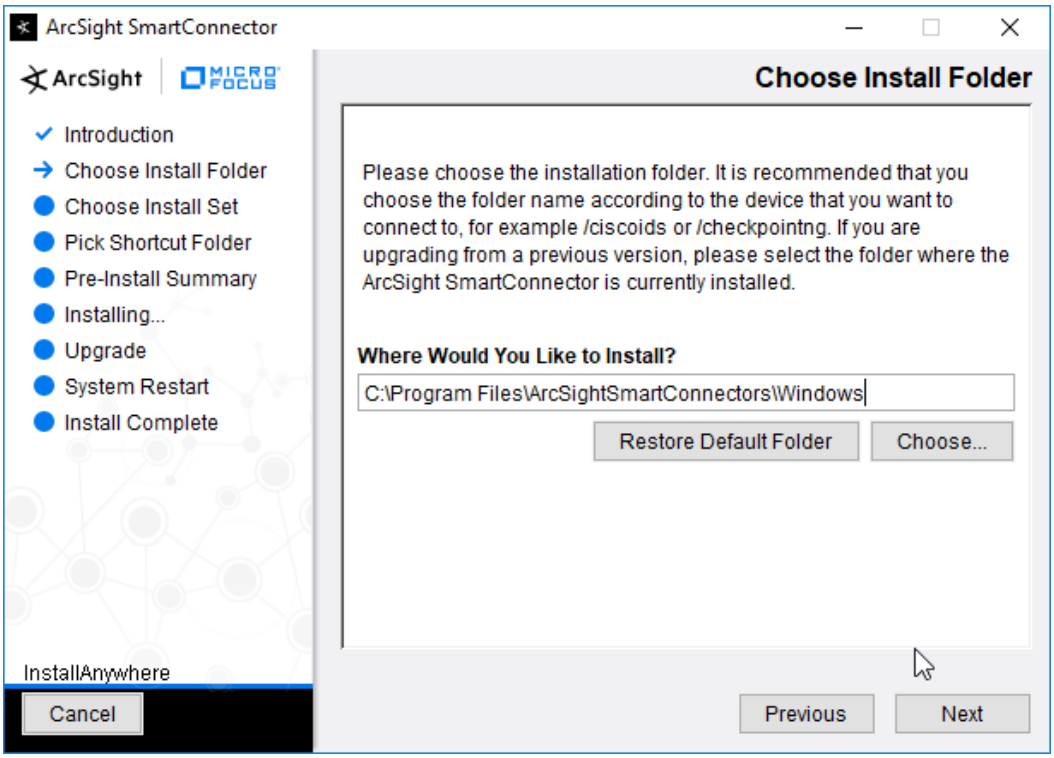
30. Click **OK.**

2.11.2 Install Individual ArcSight Windows Connectors

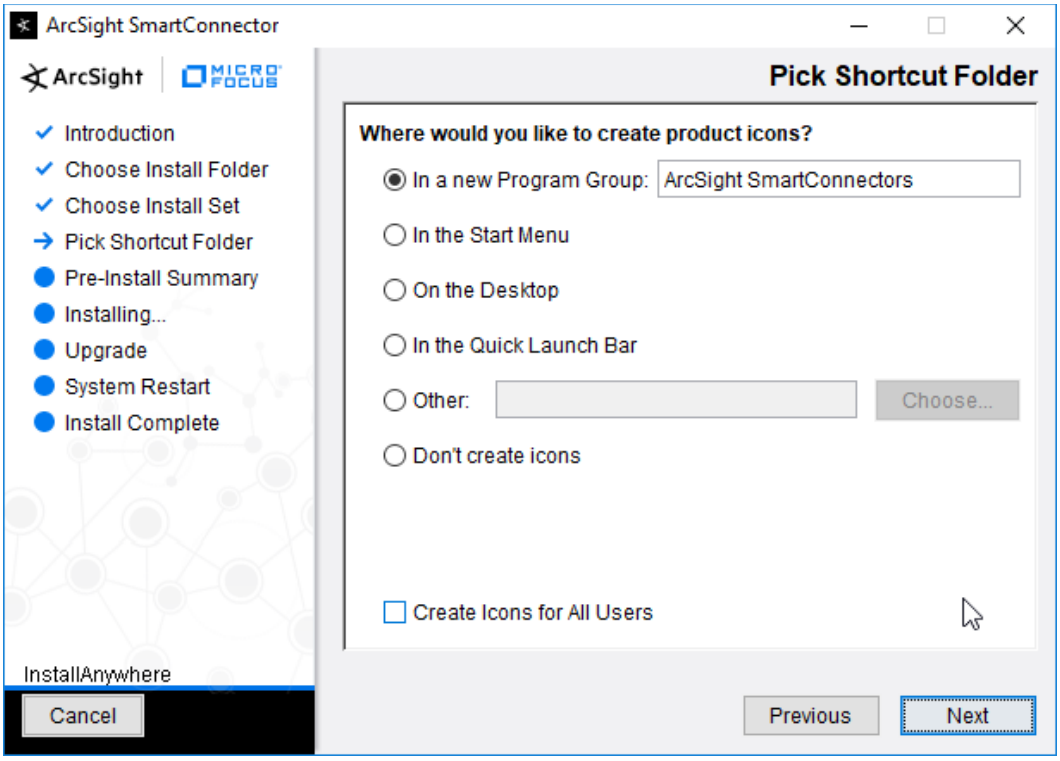
1. Run **ArcSight-7.9.0.8084.0-Connector-Win64.exe.**



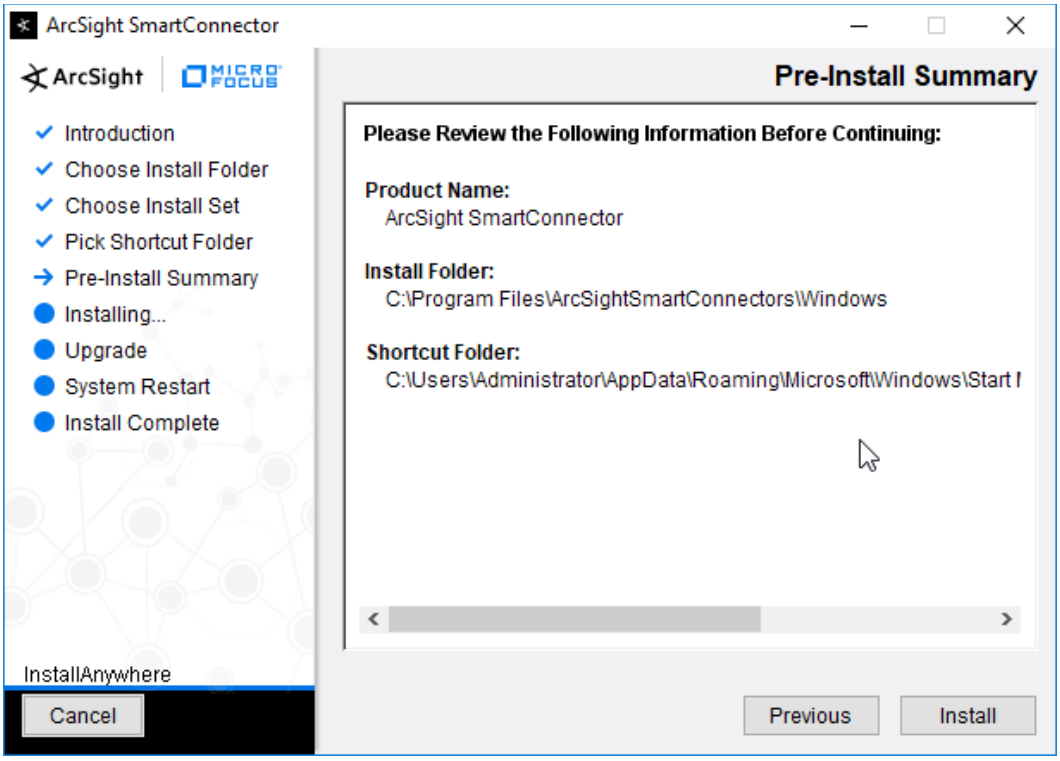
2. Click **Next.**
3. Enter C:\Program Files\ArcSightSmartConnectors\Windows.


ArcSight SmartConnector
ArcSight
MICRO FOCUS
Introduction
Choose Install Folder
Choose Install Set
Pick Shortcut Folder
Pre-Install Summary
Installing...
Upgrade
System Restart
Install Complete
InstallAnywhere
Cancel
Choose Install Folder
Please choose the installation folder. It is recommended that you choose the folder name according to the device that you want to connect to, for example /ciscoids or /checkpointng. If you are upgrading from a previous version, please select the folder where the ArcSight SmartConnector is currently installed.
Where Would You Like to Install?
C:\Program Files\ArcSightSmartConnectors\Windows
Restore Default Folder
Choose...
Previous
Next

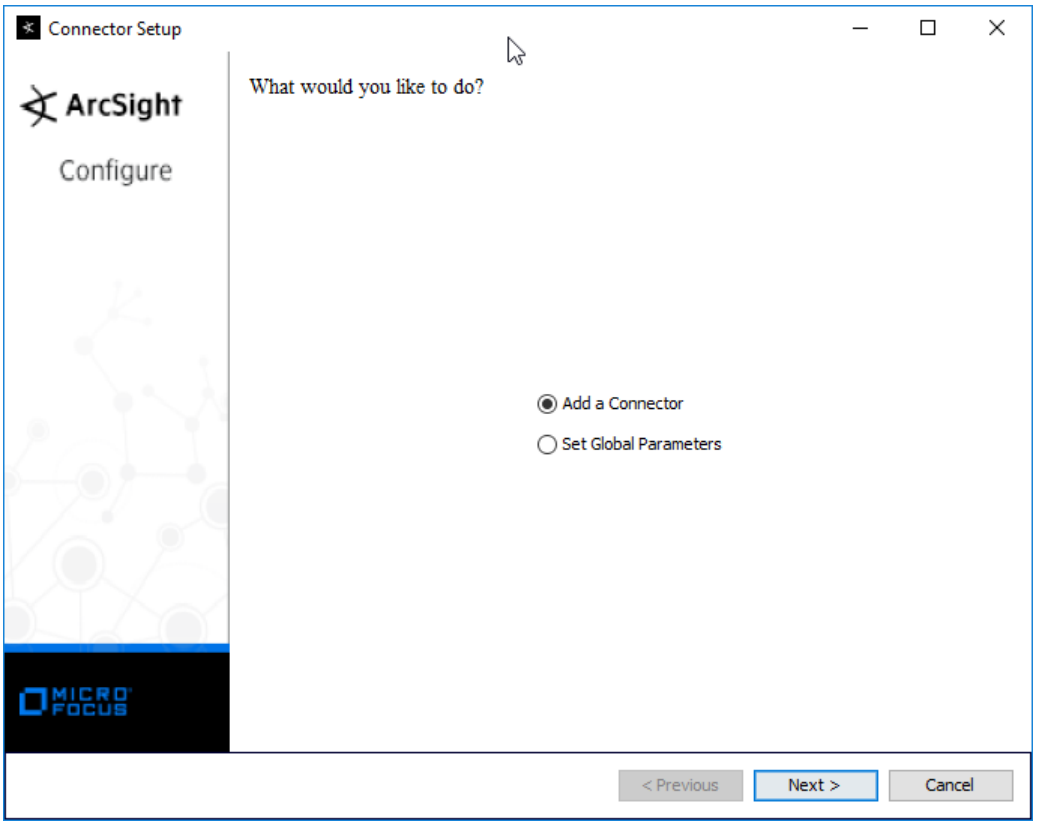
4. Click **Next.**


ArcSight SmartConnector
ArcSight
MICRO FOCUS
Introduction
Choose Install Folder
Choose Install Set
Pick Shortcut Folder
Pre-Install Summary
Installing...
Upgrade
System Restart
Install Complete
InstallAnywhere
Cancel
Pick Shortcut Folder
Where would you like to create product icons?
In a new Program Group:
ArcSight SmartConnectors
In the Start Menu
On the Desktop
In the Quick Launch Bar
Other:
Choose...
Don't create icons
Create Icons for All Users
Previous
Next

5. Click **Next.**



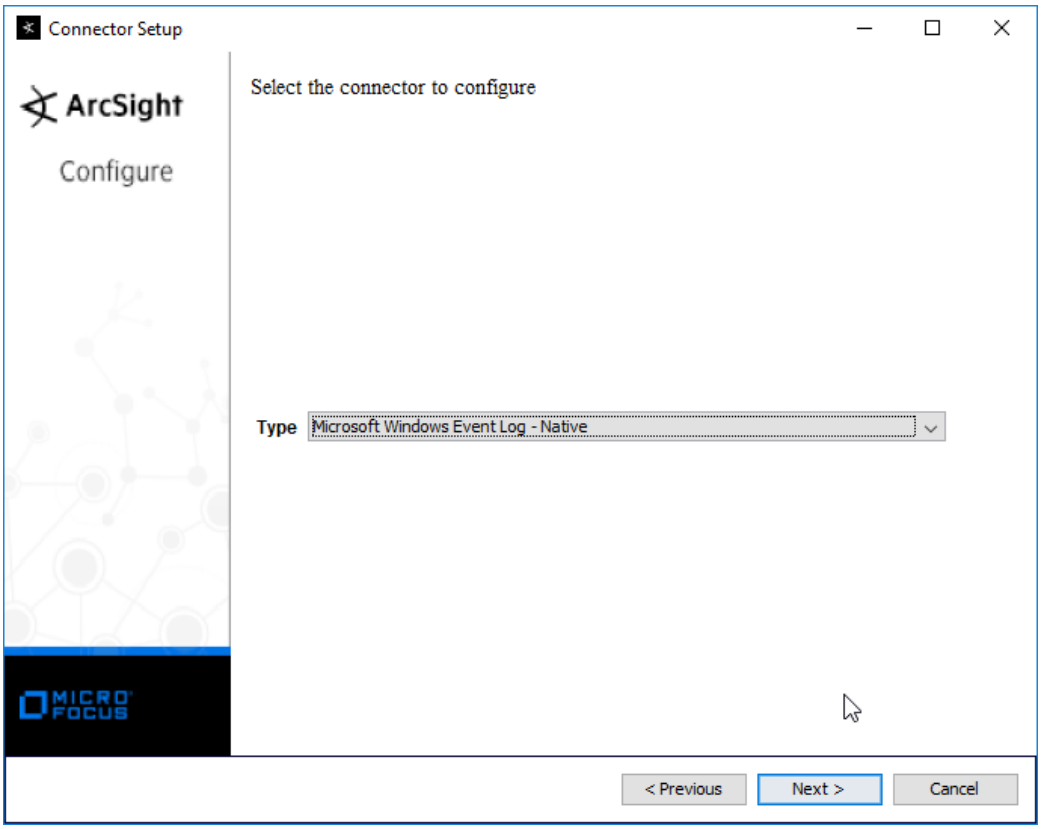
6. Click **Install.**
7. Select **Add a Connector.**



1468

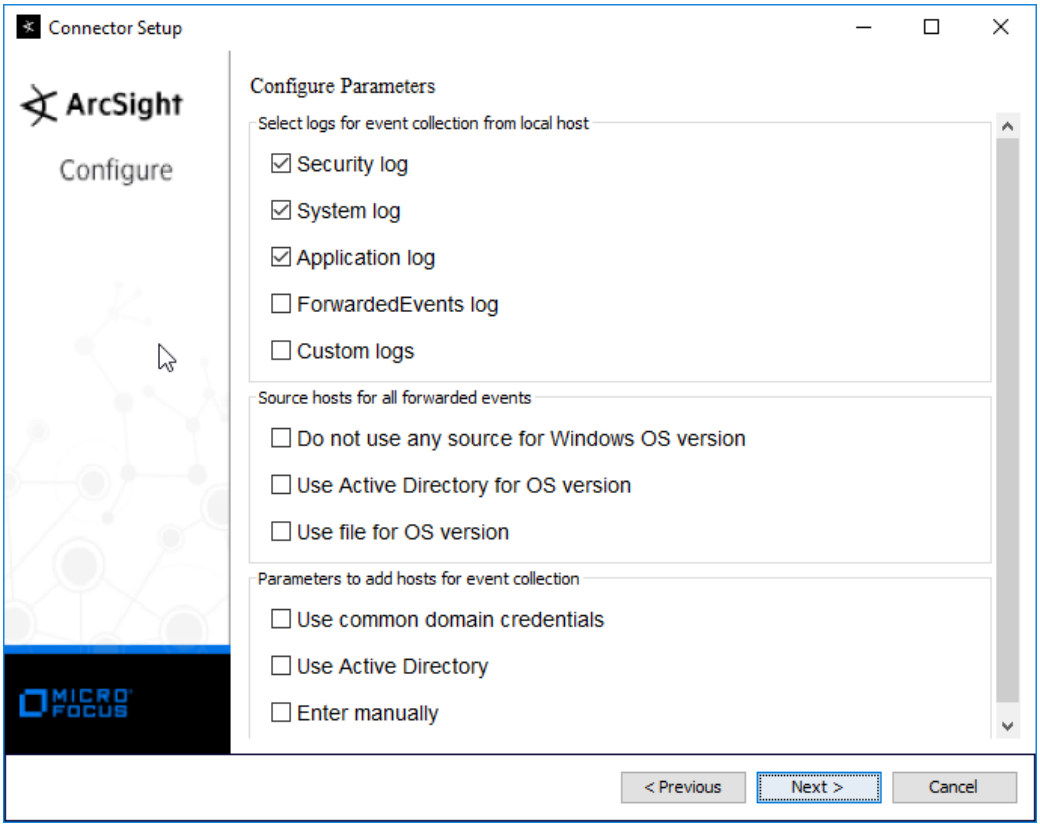
1469 8. Click **Next.**

1470 9. Select **Microsoft Windows Event Log–Native.**



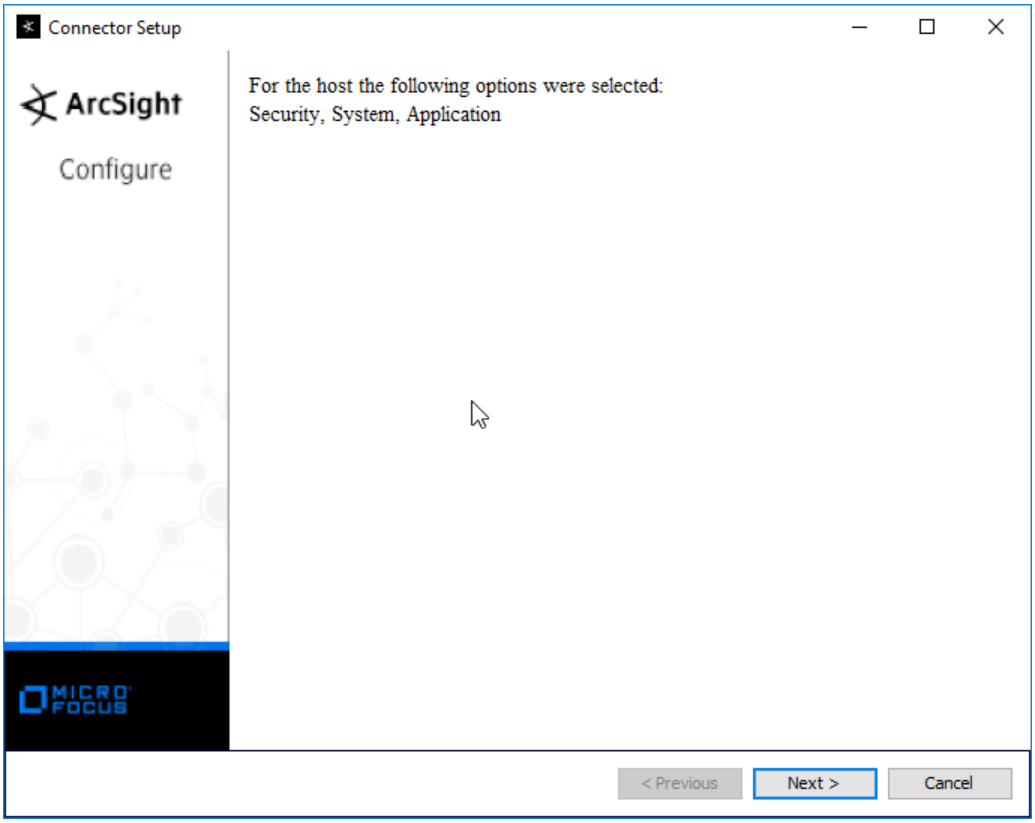
1471

1472 10. Click **Next.**

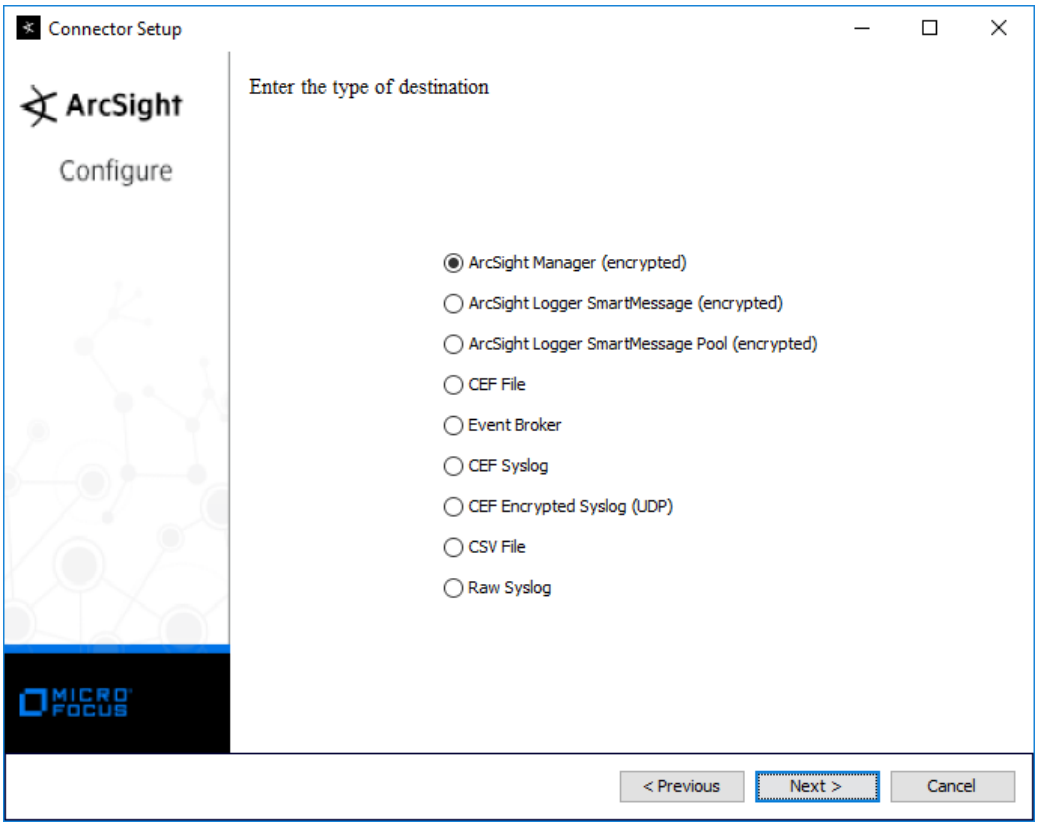


1473

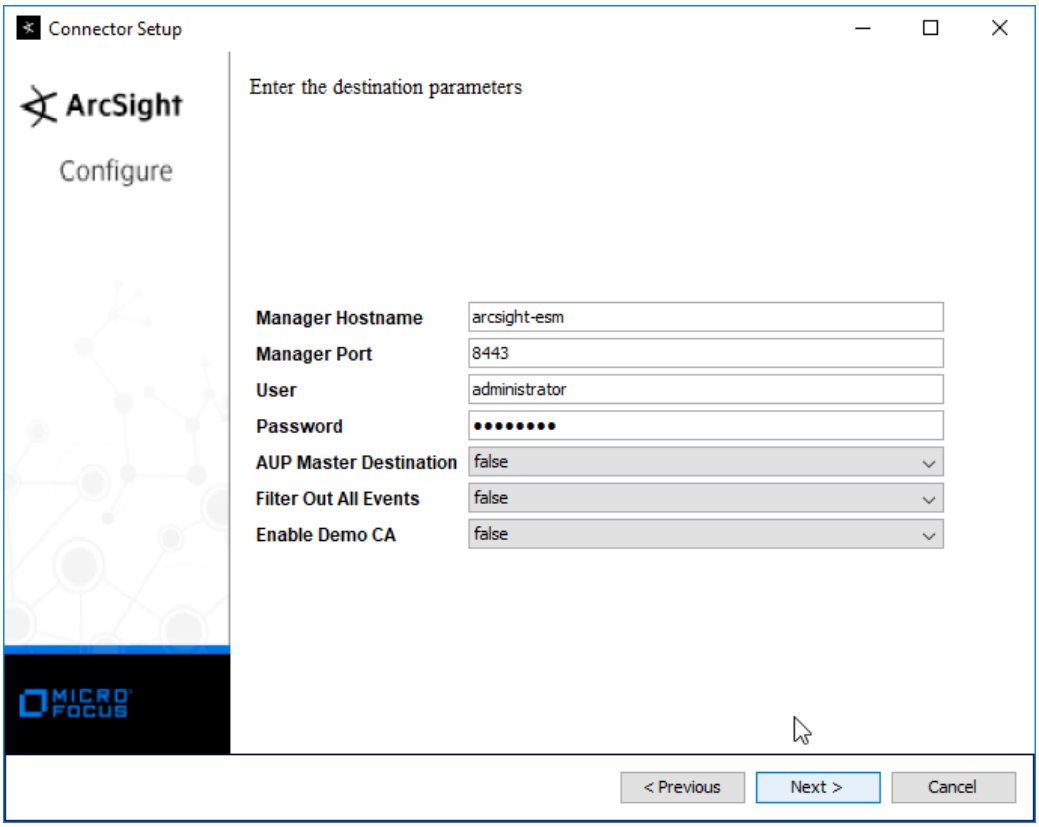
1474 11. Click **Next.**



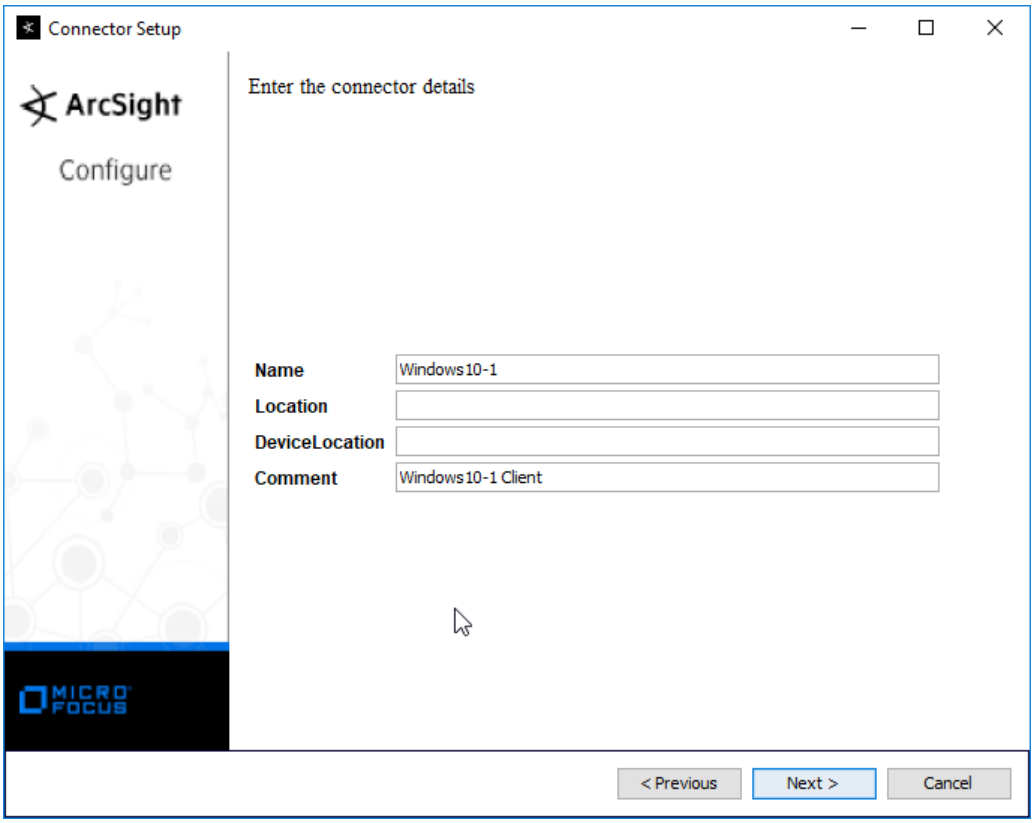
12. Click **Next.**
13. Select **ArcSight Manager (encrypted).**



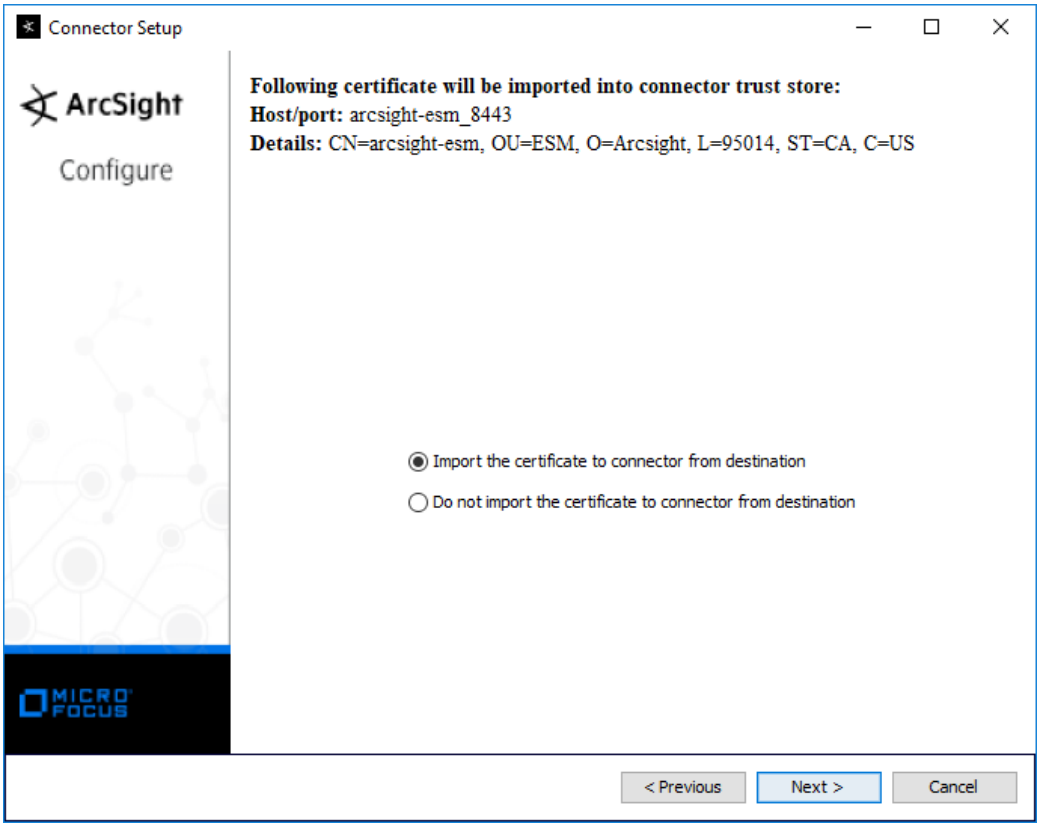
14. Click **Next.**
15. Enter the **hostname, port, username,** and **password** for the ArcSight ESM server.



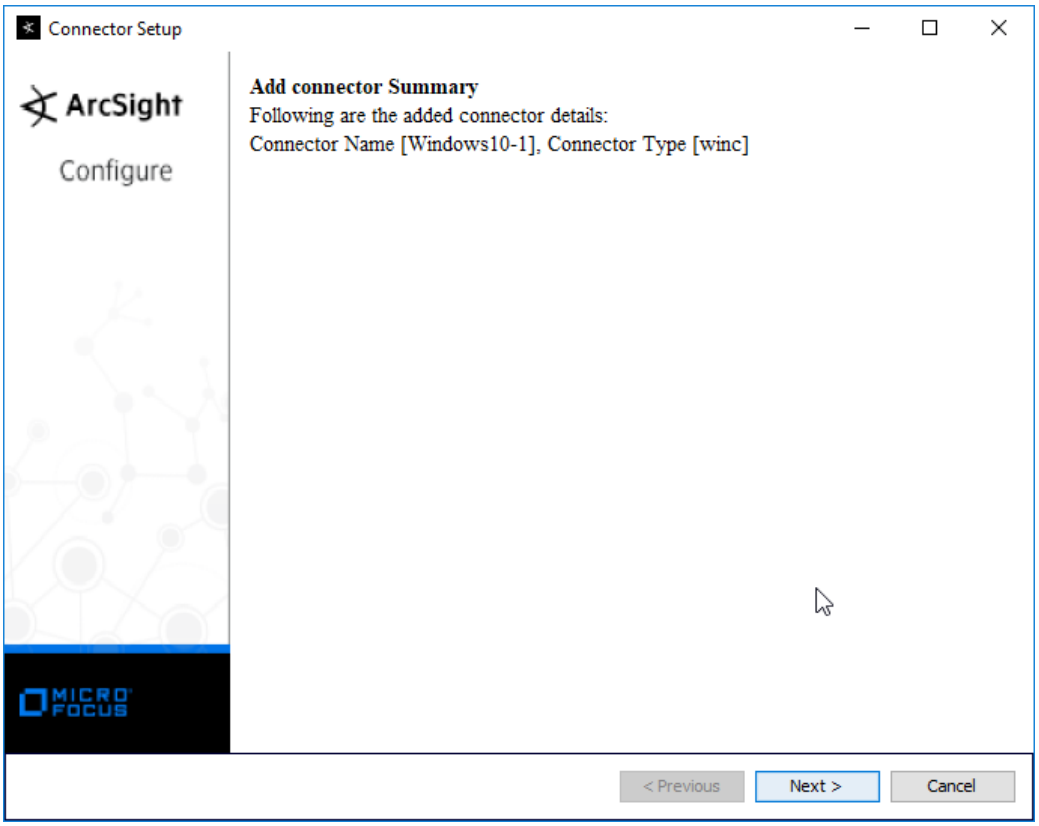
16. Click **Next.**
17. Enter identifying details about the system (only **Name** is required).



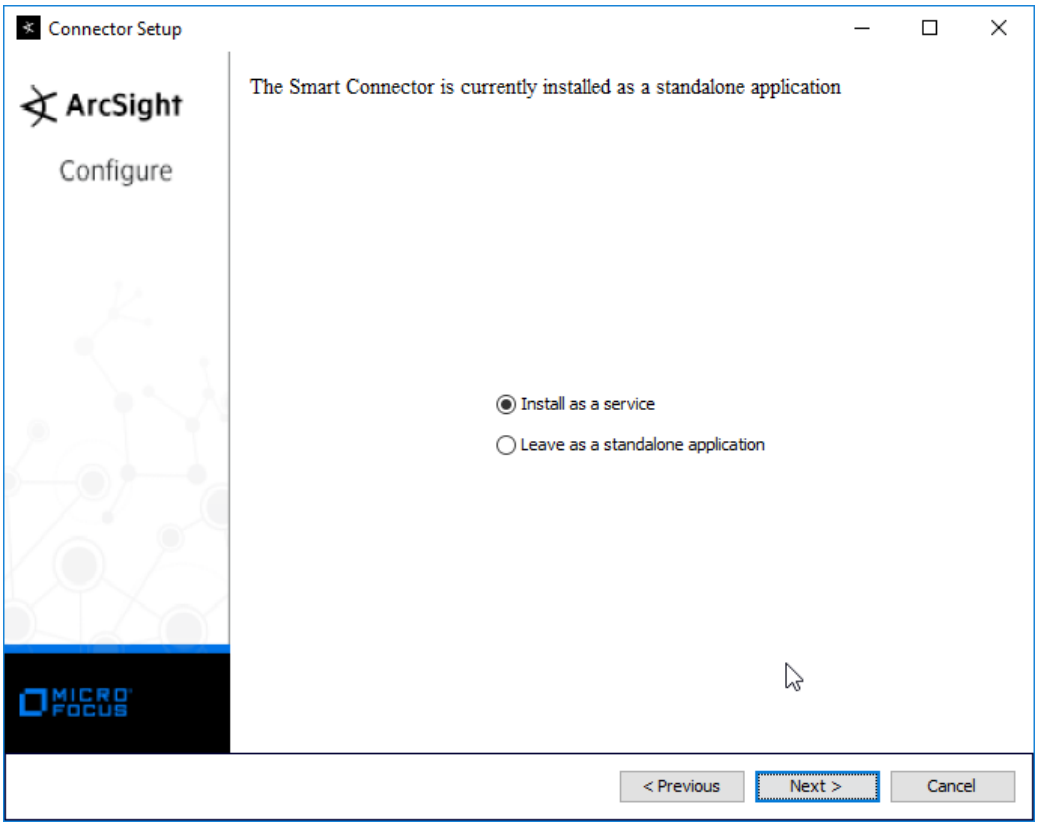
18. Click **Next.**
19. Select **Import the certificate to connector from destination.**



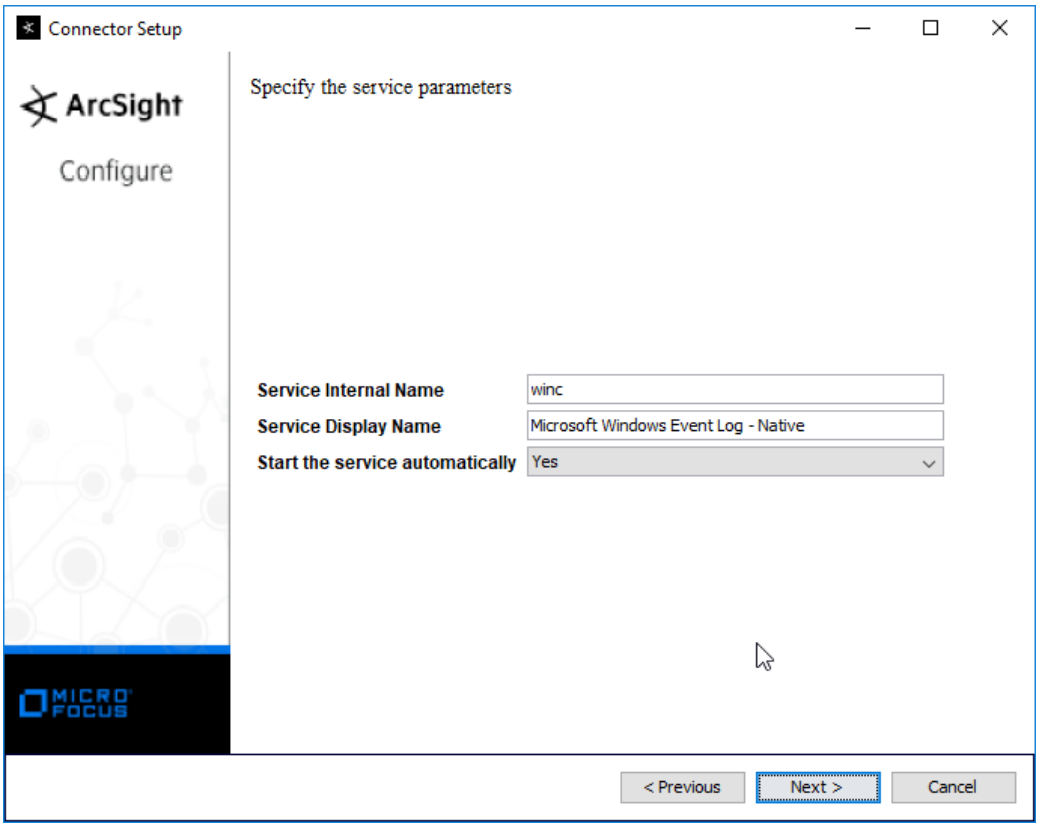
20. Click **Next.**



21. Click **Next.**
22. Select **Install as a service.**

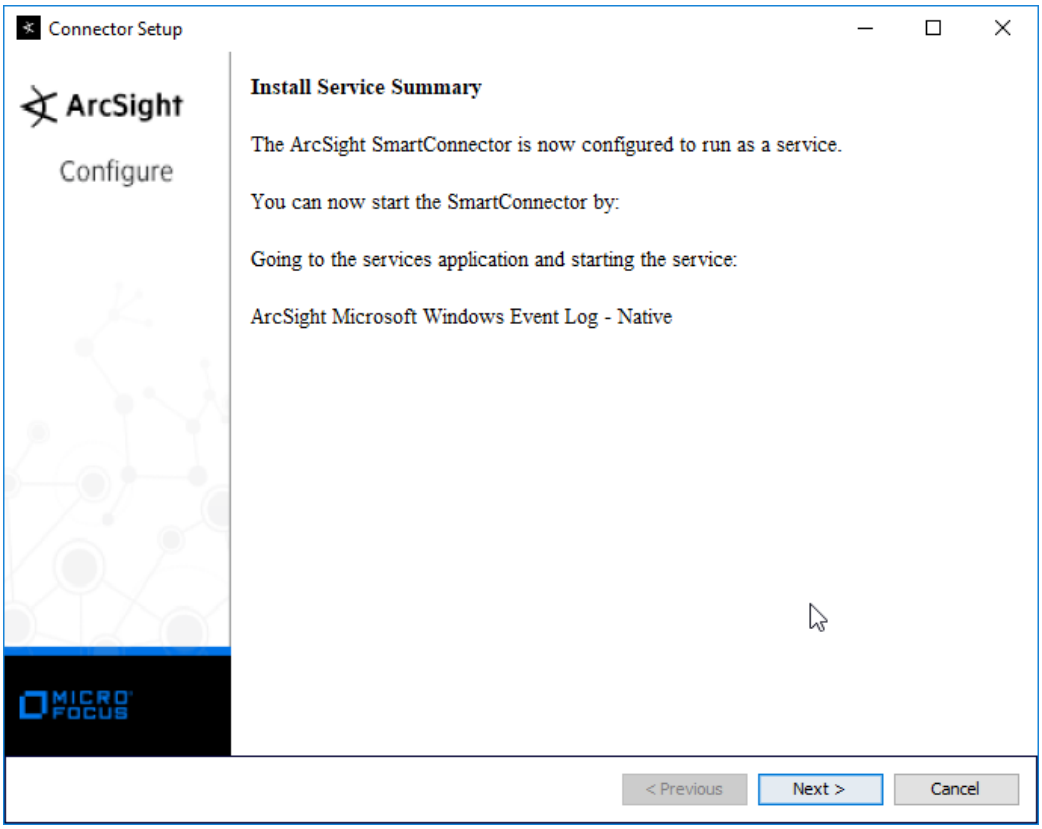


23. Click **Next.**

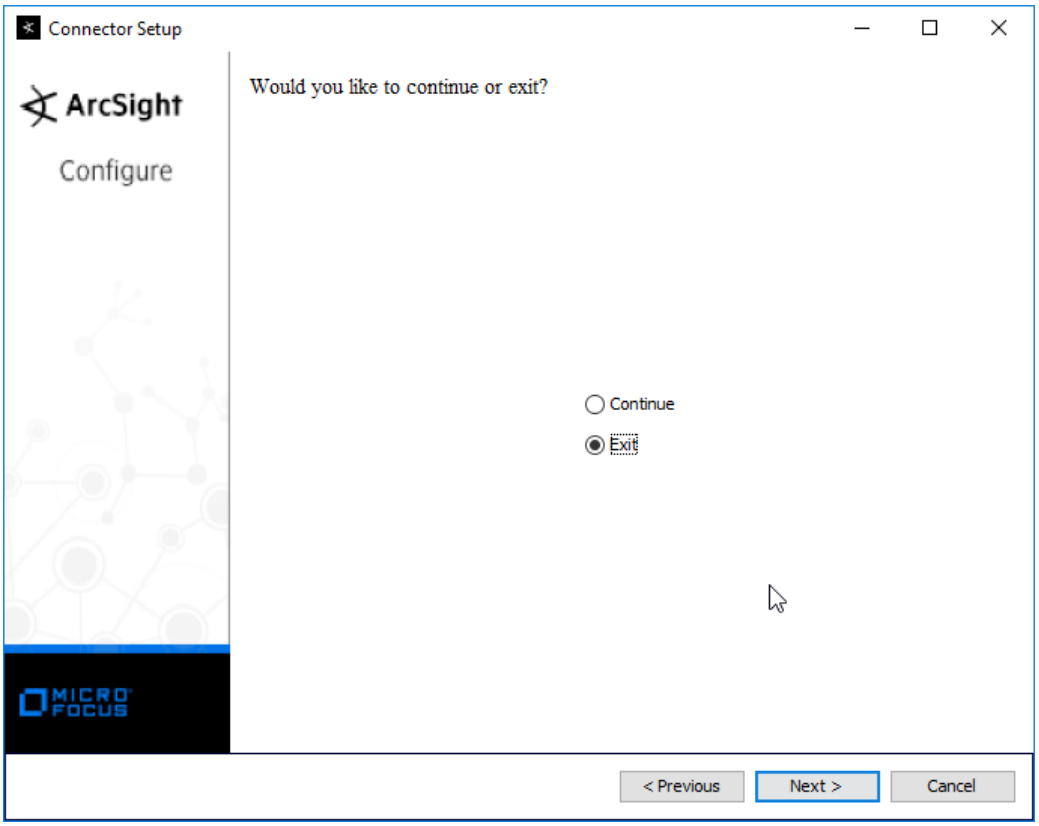


1494

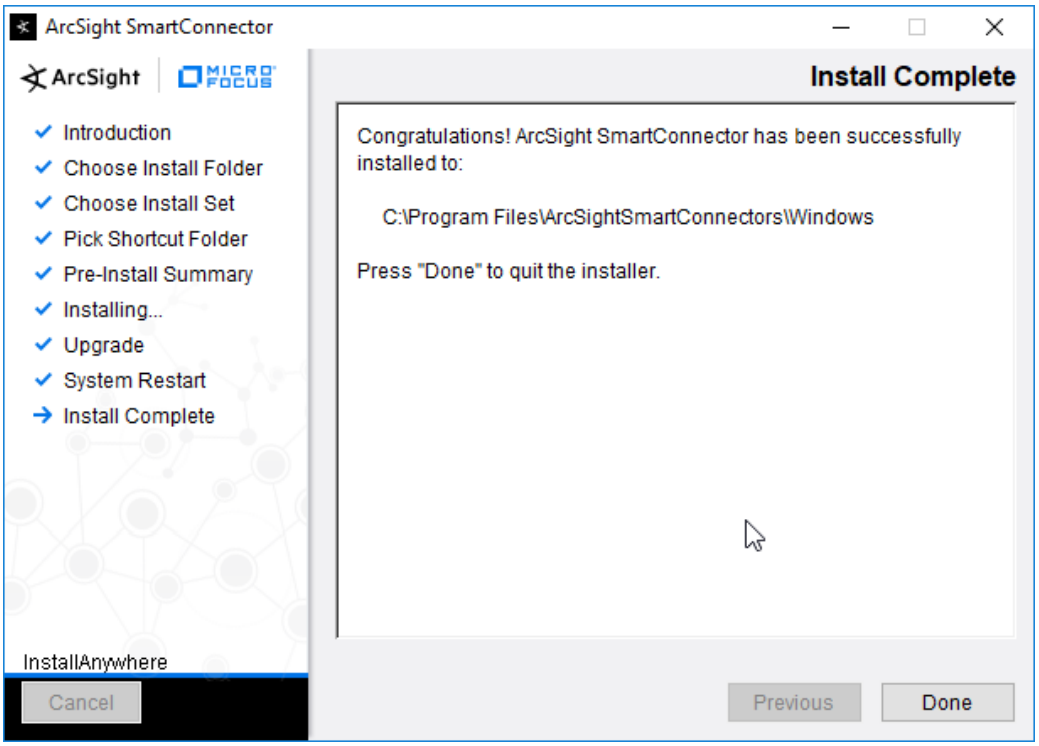
1495 24. Click **Next.**



25. Click **Next.**
26. Select **Exit.**



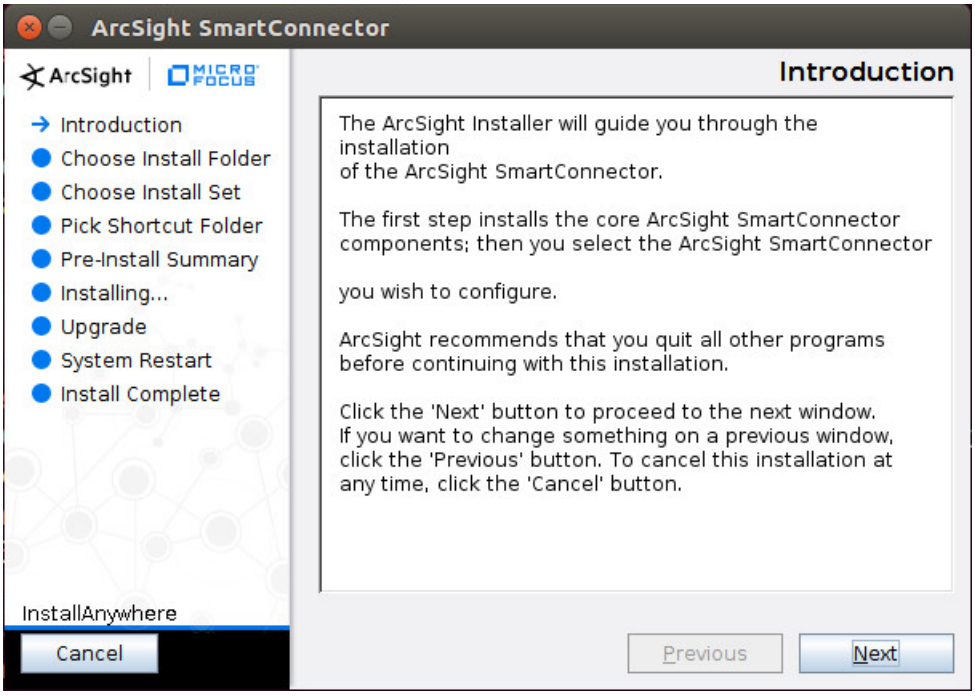
27. Click **Next.**



28. Click **Done.**

2.11.3 Install Individual ArcSight Ubuntu Connectors

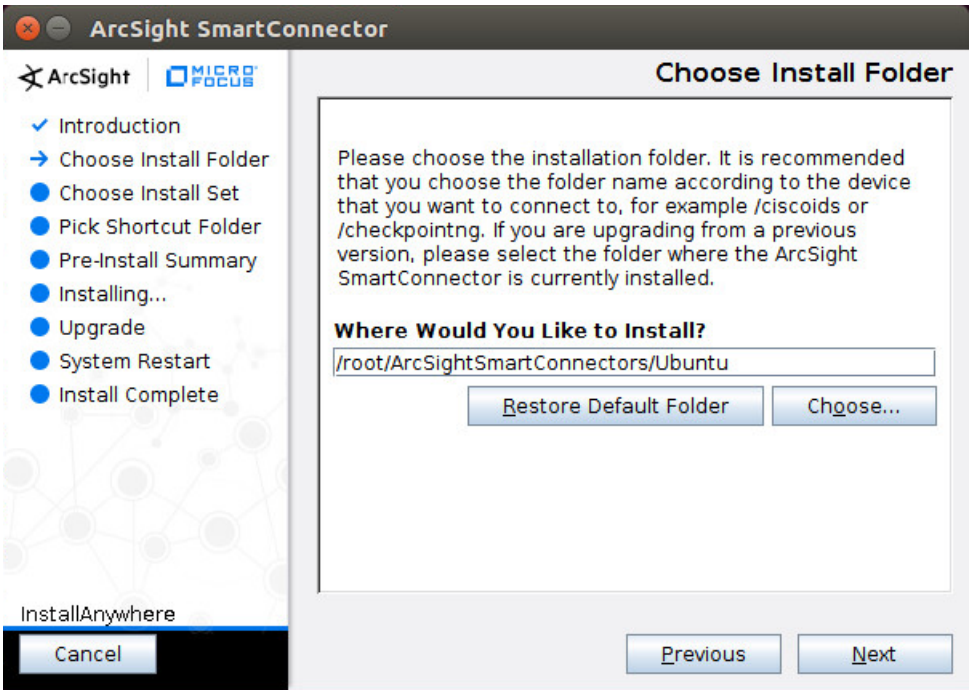
1. From the command line, run:
   > sudo ./ArcSight-7.9.0.8084.0-Connector-Linux64.bin
2. Enter the password if prompted.



1507

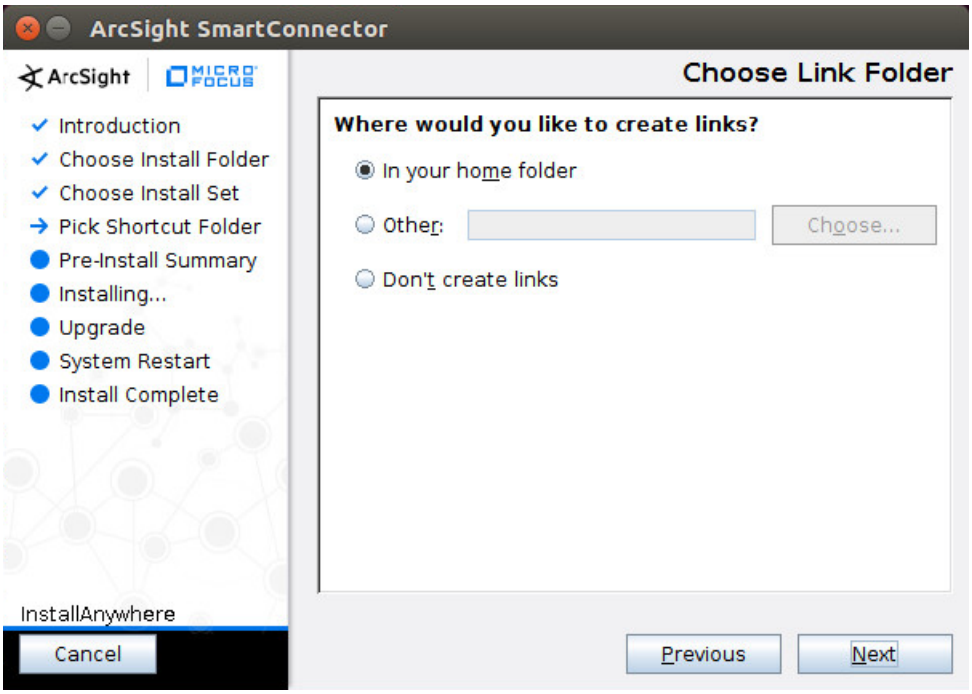
1508 3. Click **Next.**

1509 4. Enter /root/ArcSightSmartConnectors/Ubuntu.

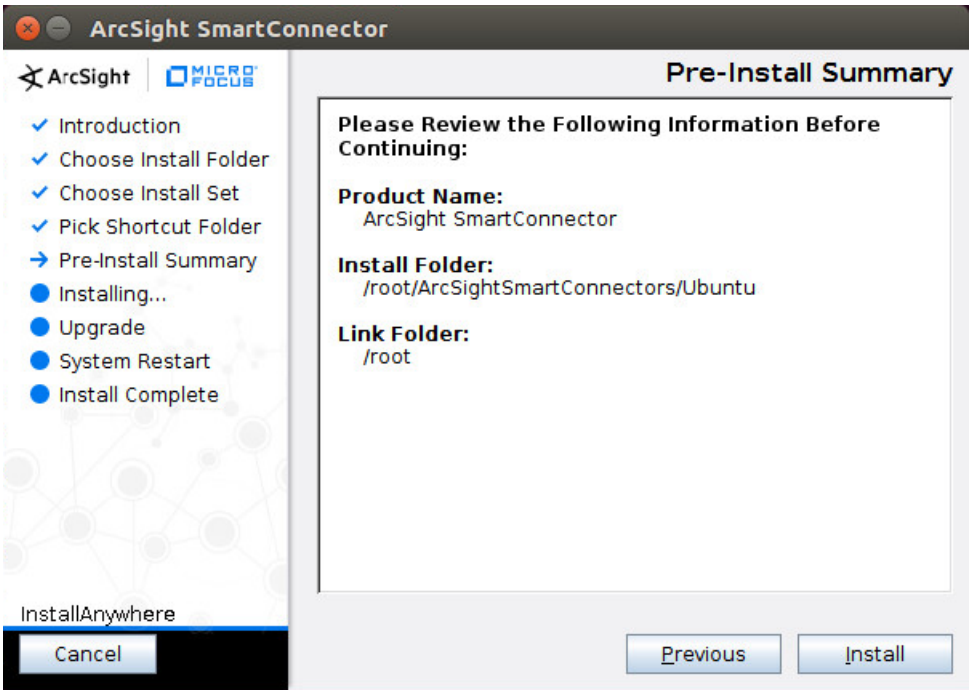


1510

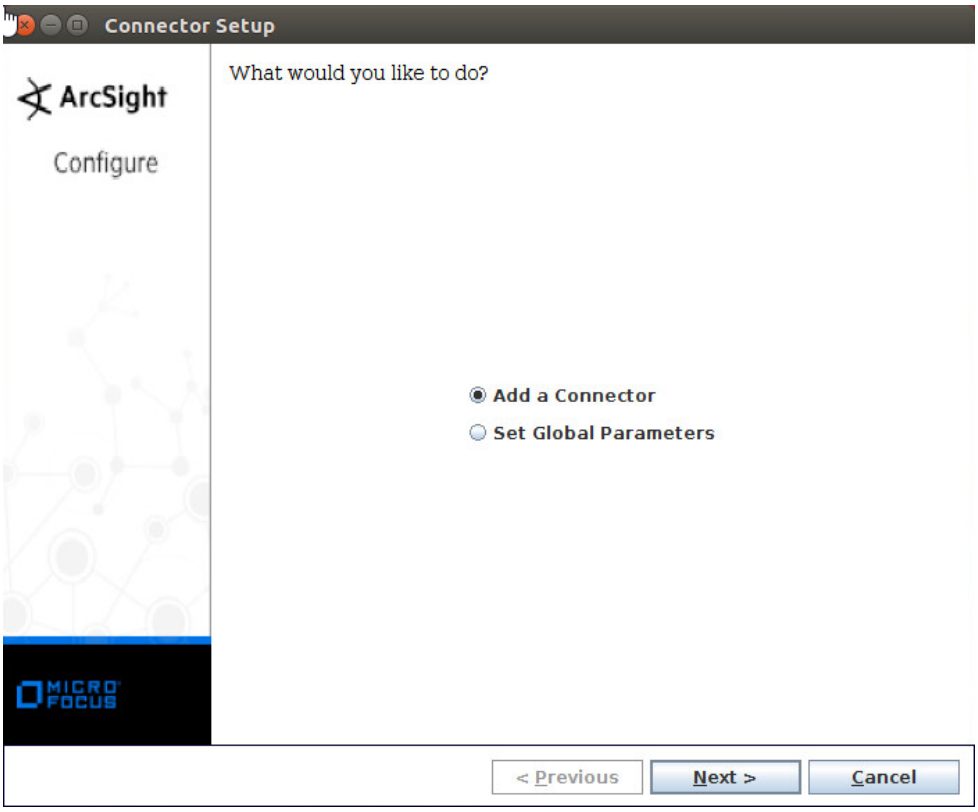
5. Click **Next.**



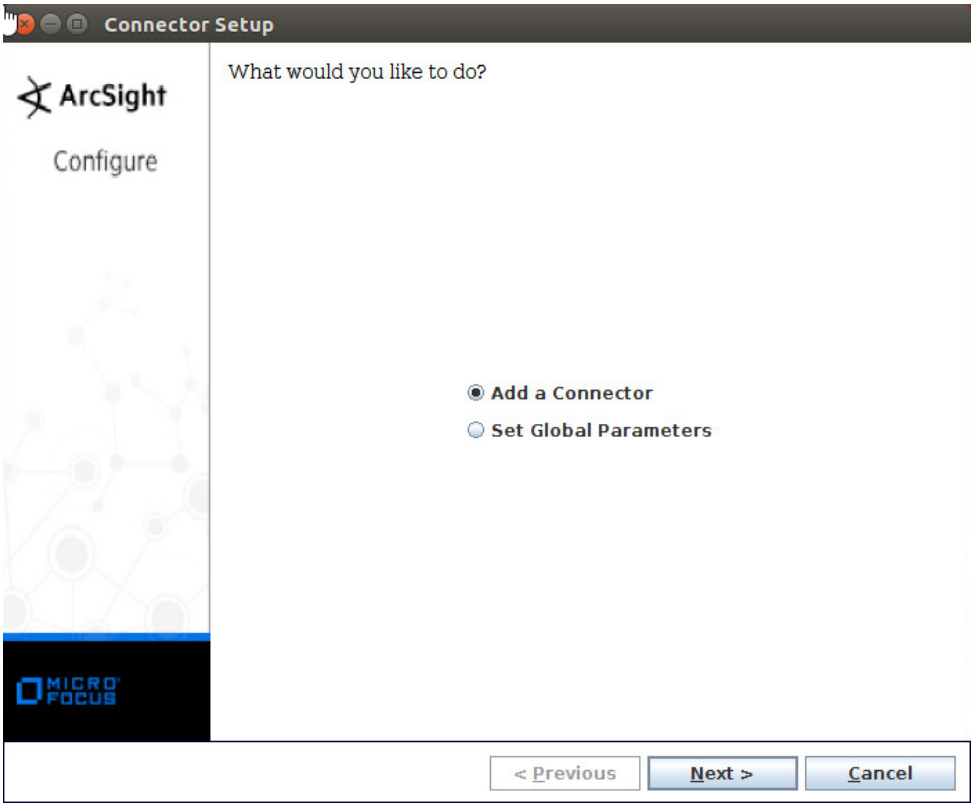
6. Click **Next.**



7. Click **Install.**
8. Select **Add a Connector.**



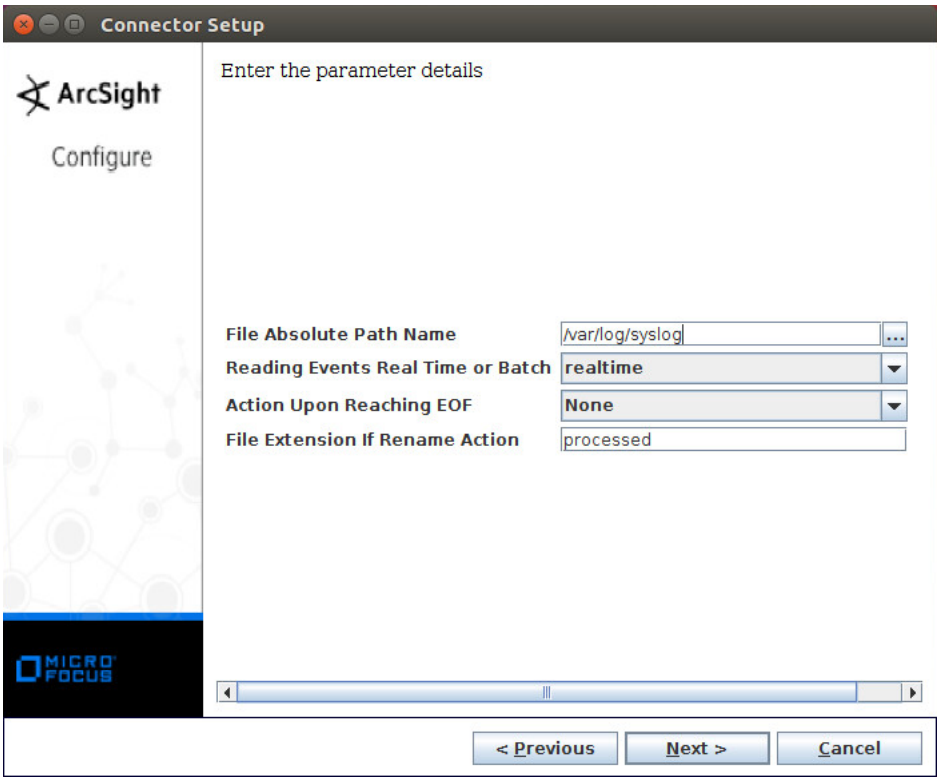
9. Click **Next.**
10. Select **Syslog File.**



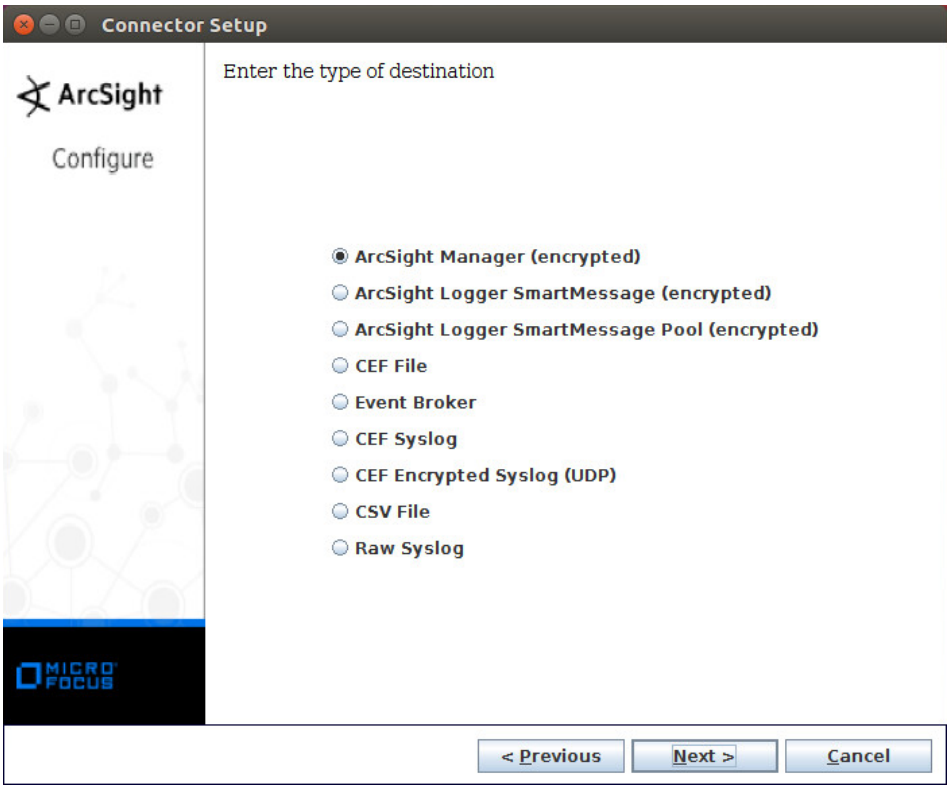
1520

1521 11. Click **Next.**

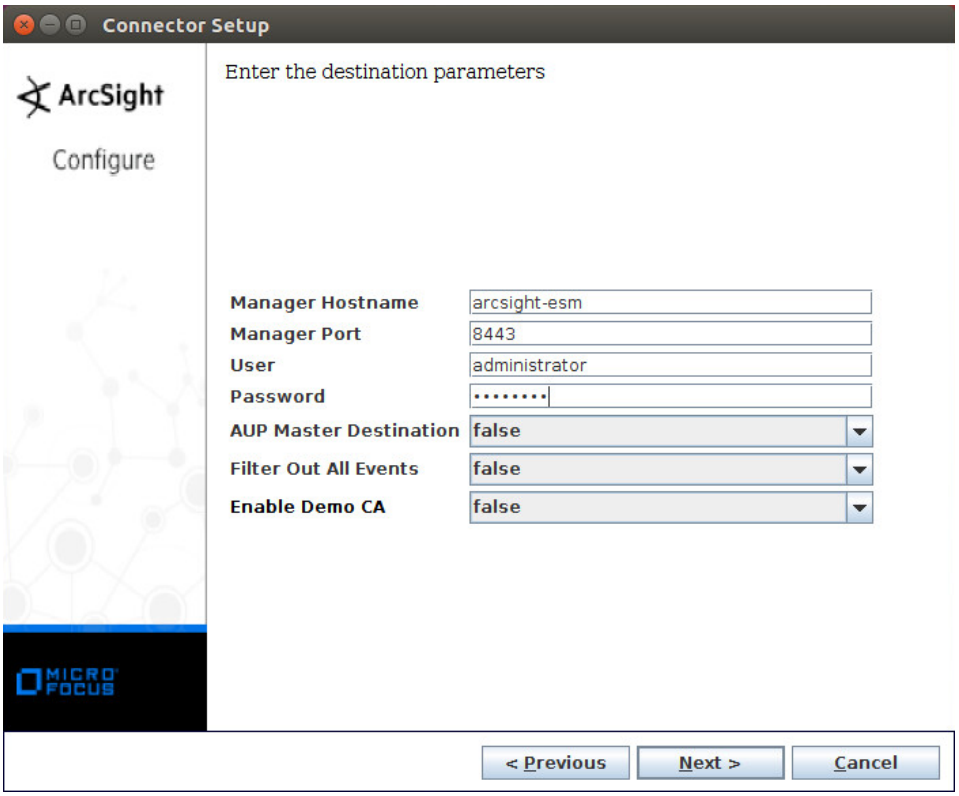
1522 12. Enter /var/log/syslog for the File Absolute Path Name.



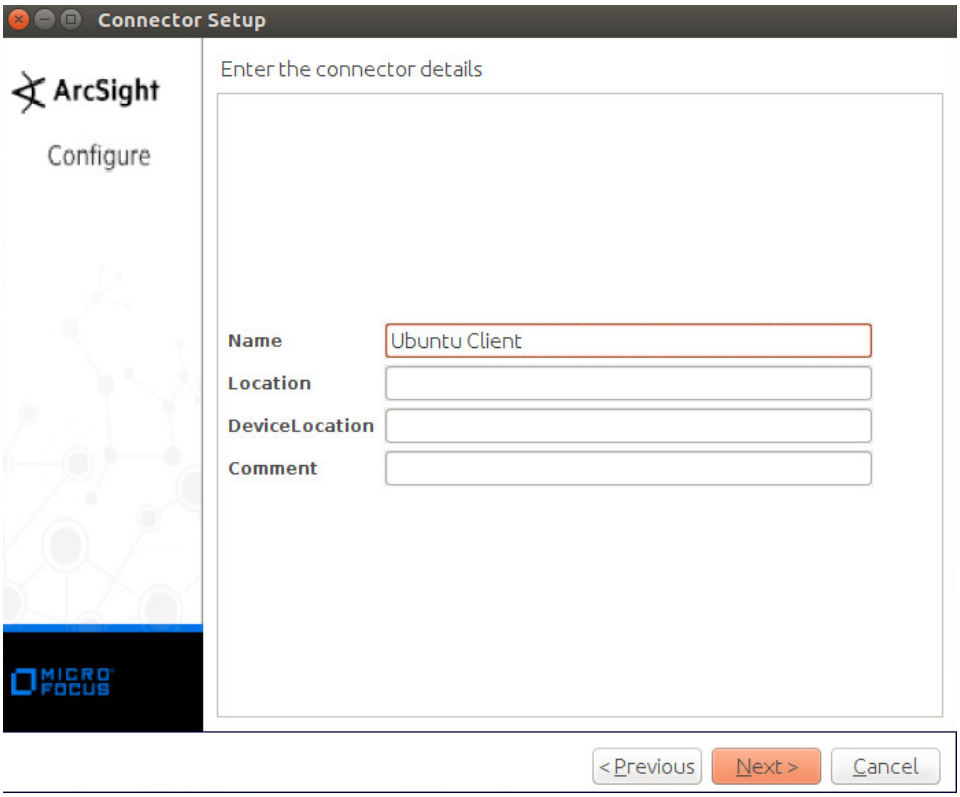
13. Click **Next.**
14. Select **ArcSight Manager (encrypted).**



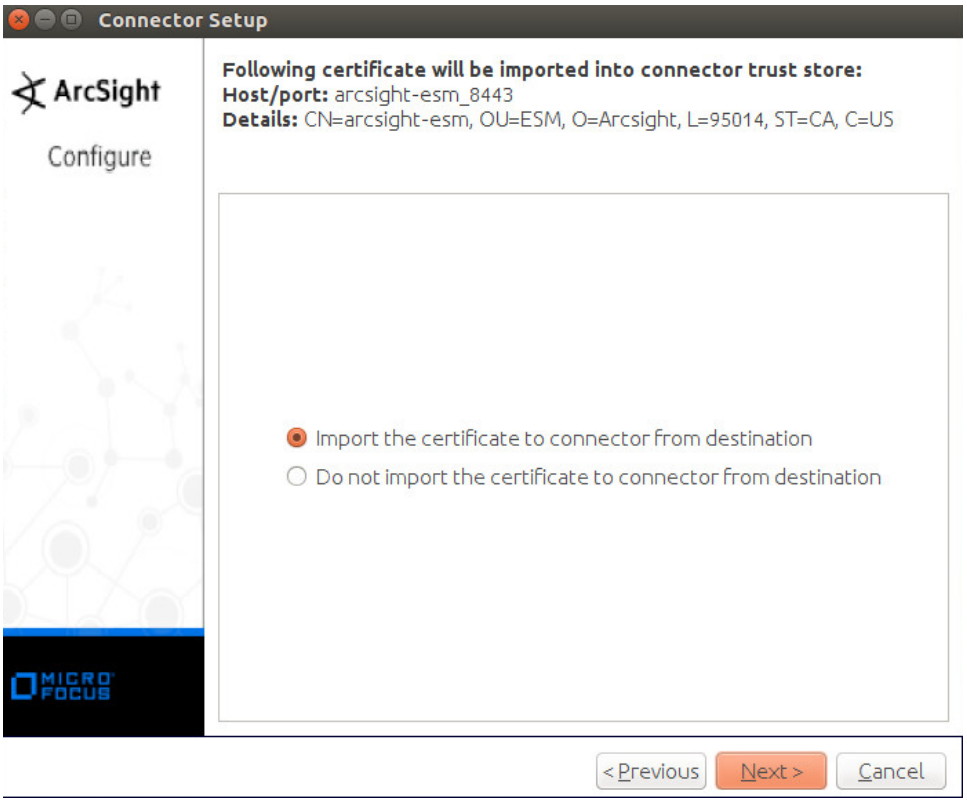
15. Click **Next.**
16. Enter the **hostname, port, username,** and **password** for ArcSight ESM.



17. Click **Next.**
18. Enter identifying details about the system (only **Name** is required).

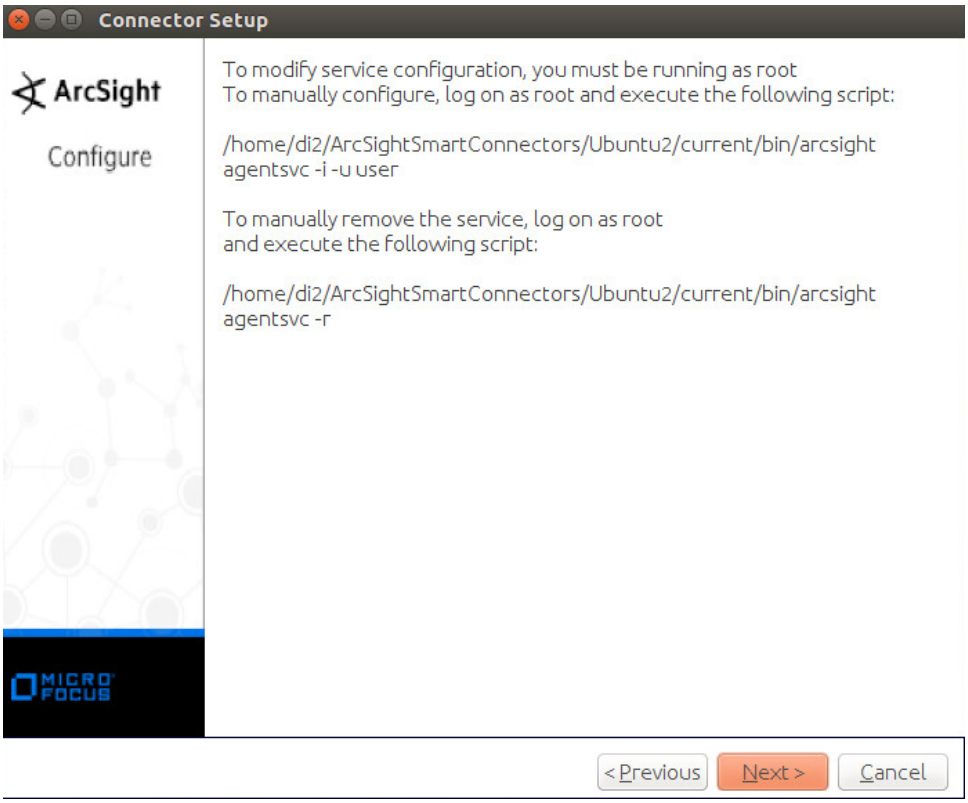


19. Click **Next.**
20. Select **Import the certificate to connector from destination.**



21. Click **Next.**

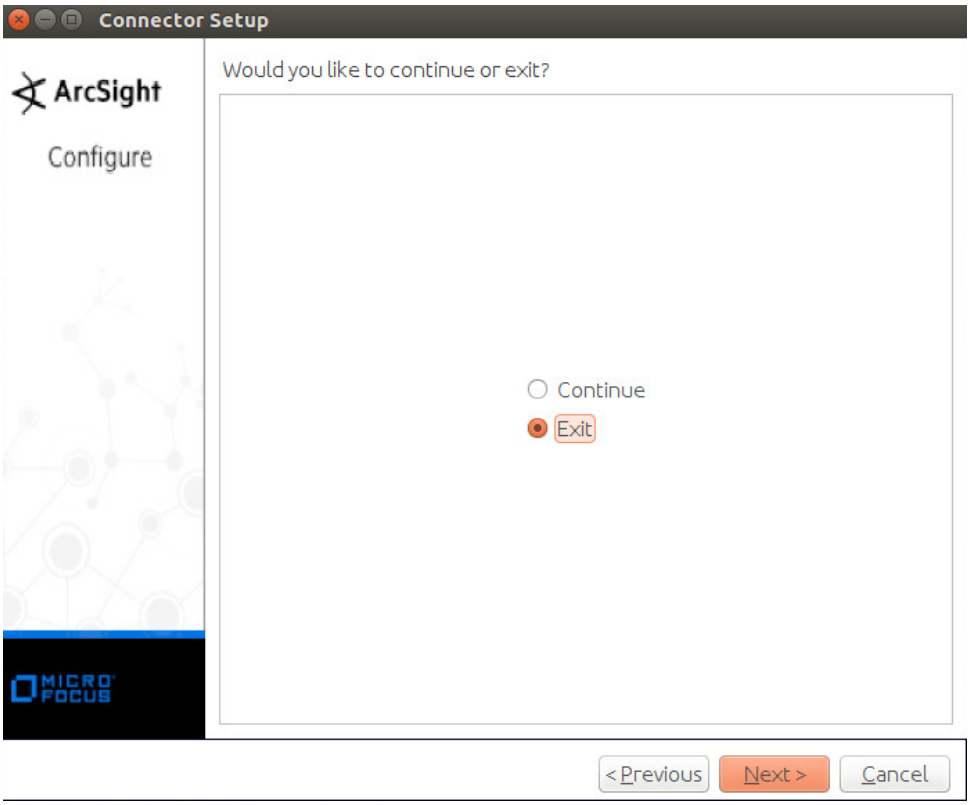
22. Click **Next.**



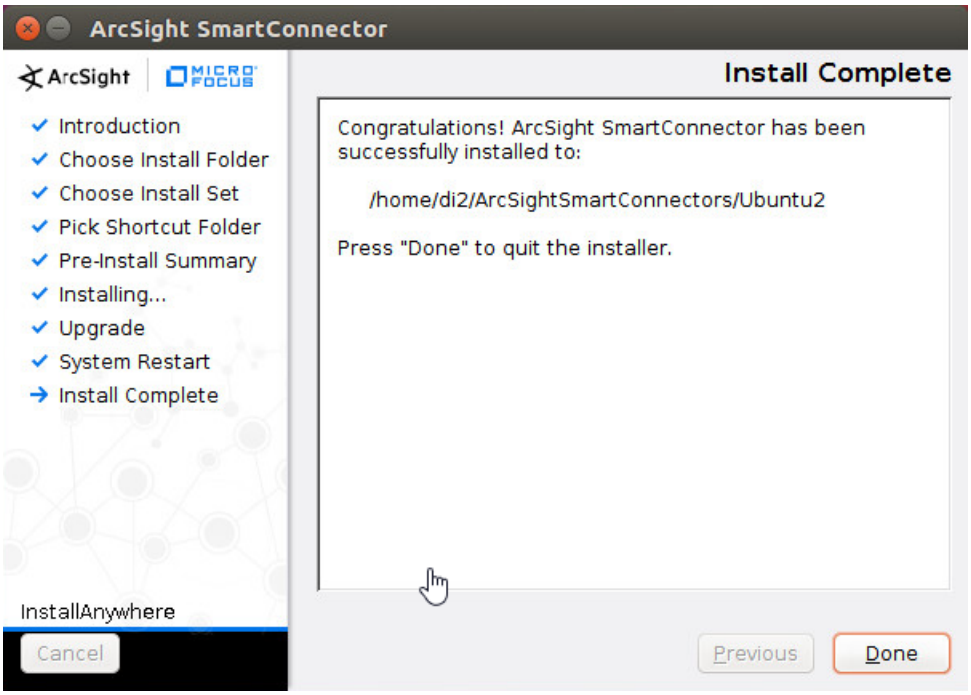
1539

1540 23. Click **Next.**

1541 24. Select **Exit.**



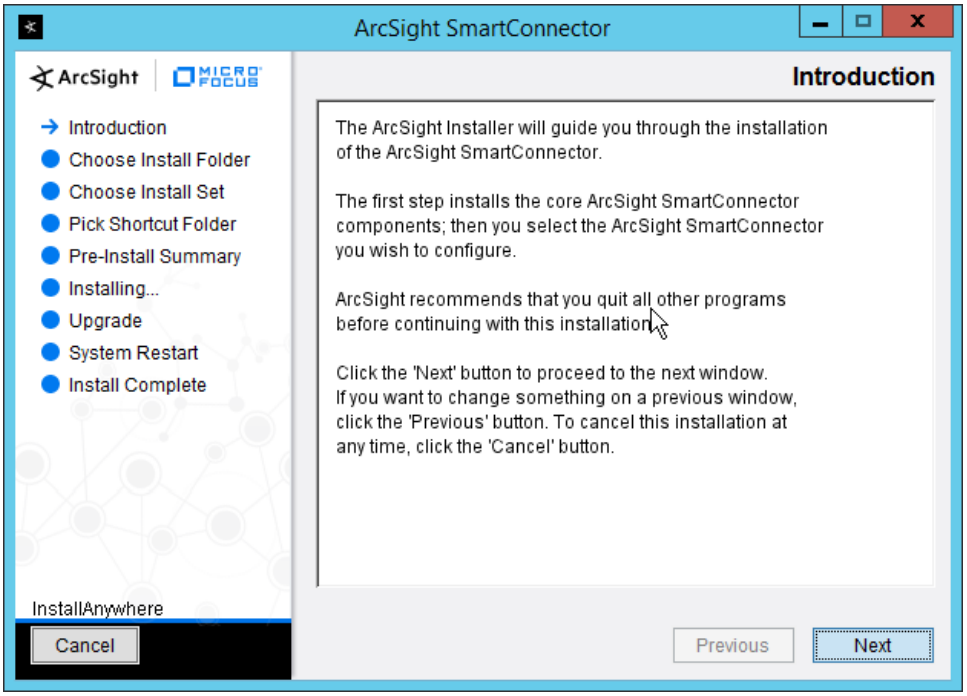
25. Click **Next.**



26. Click **Done.**

2.11.4 Install a Connector Server for ESM on Windows 2012 R2

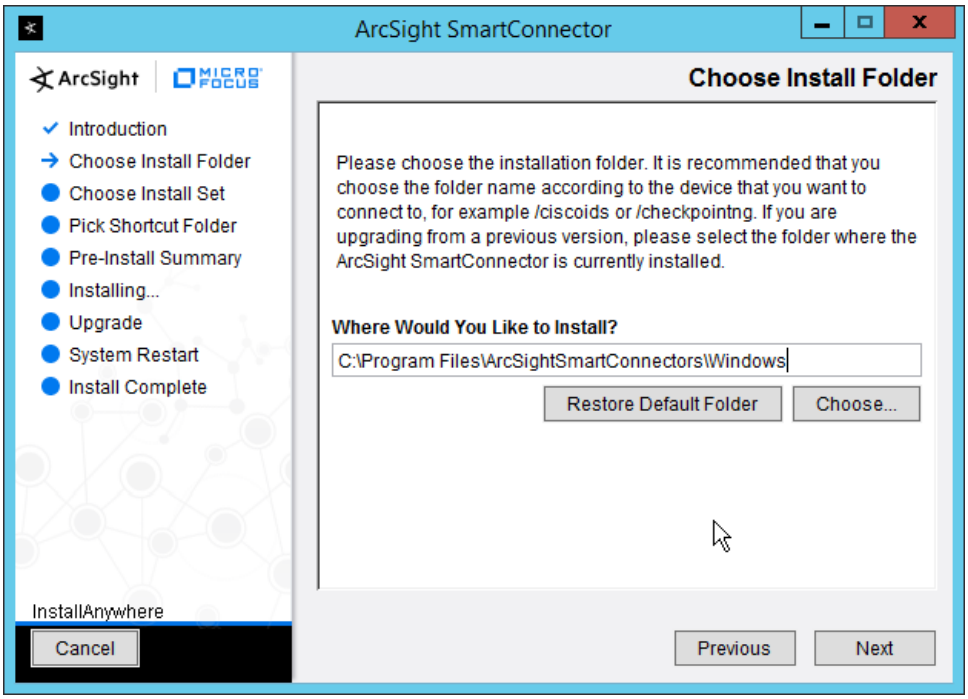
1. Run **ArcSight-7.9.0.8084.0-Connector-Win64.exe.**



1548

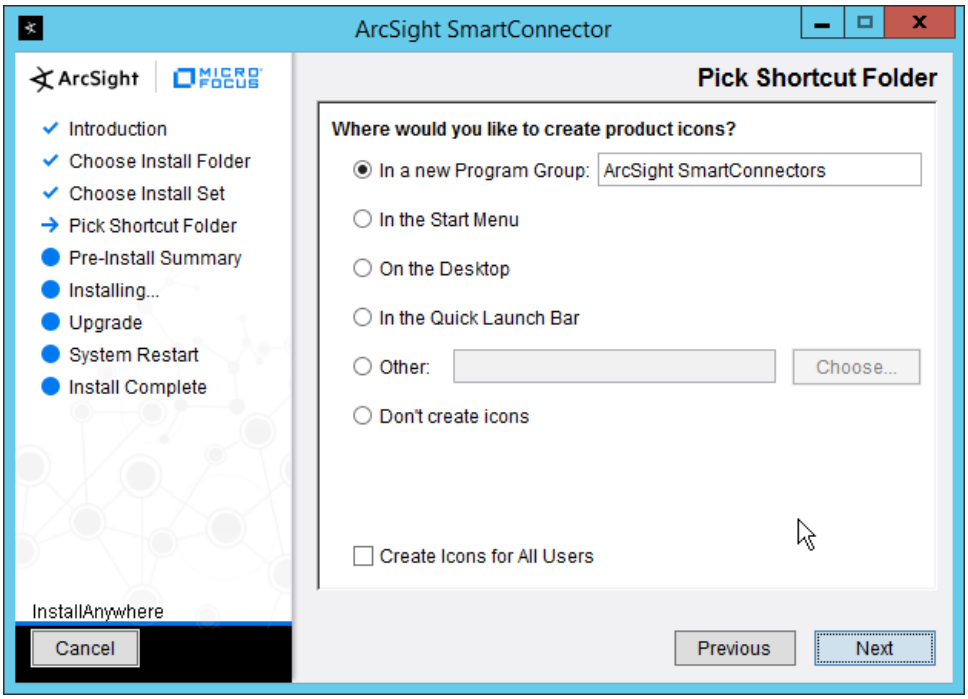
1549 2. Click **Next.**

1550 3. Enter C:\Program Files\ArcSightSmartConnectors\Windows.

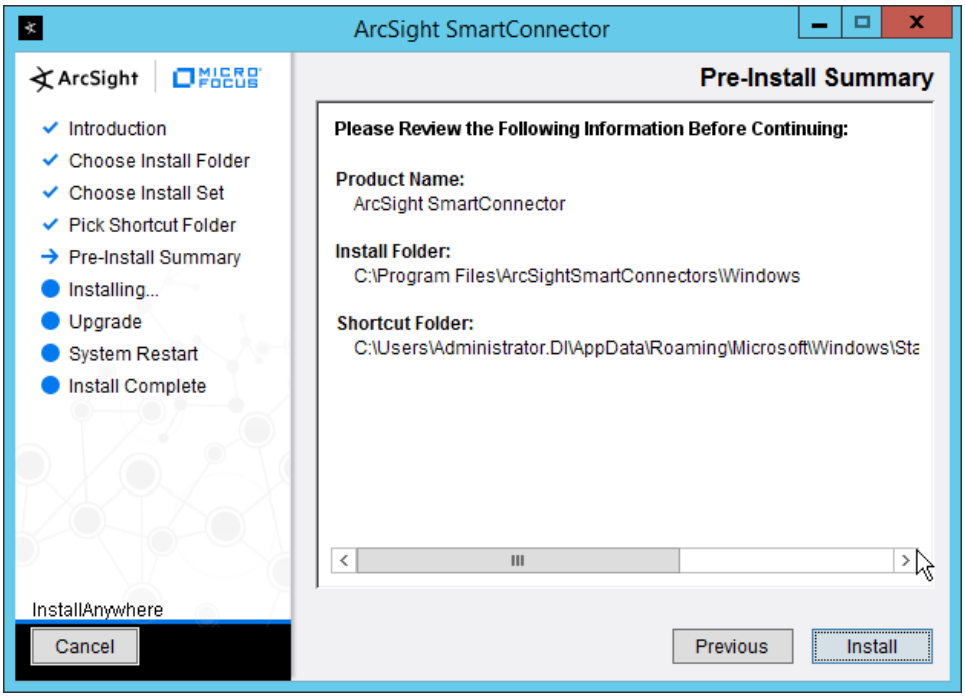


1551

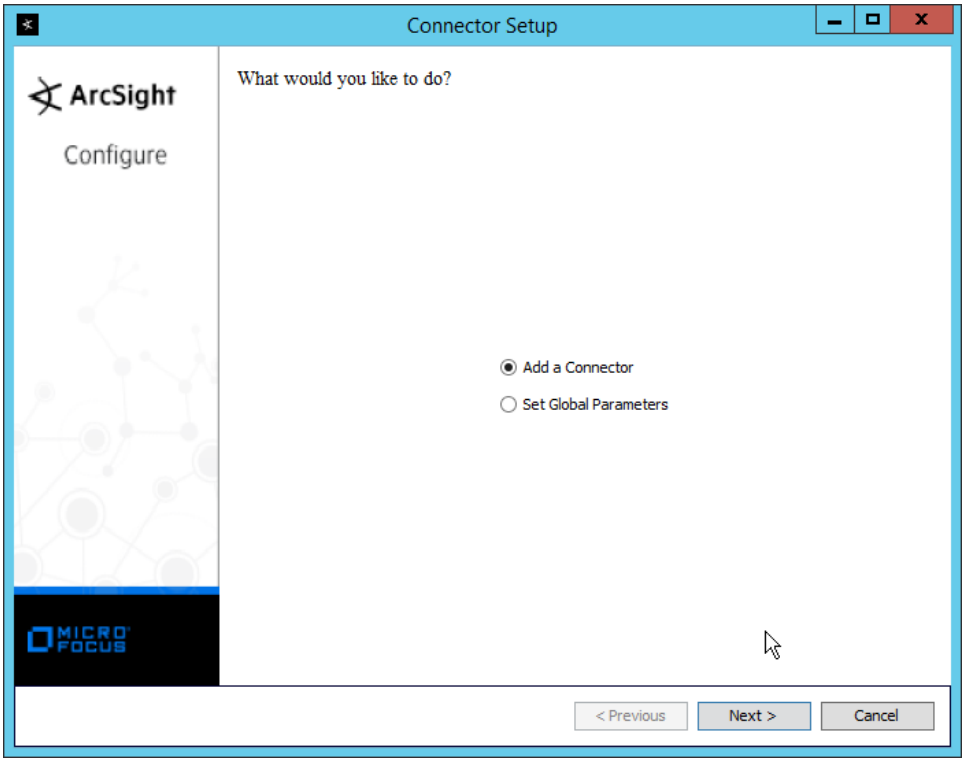
4. Click **Next.**



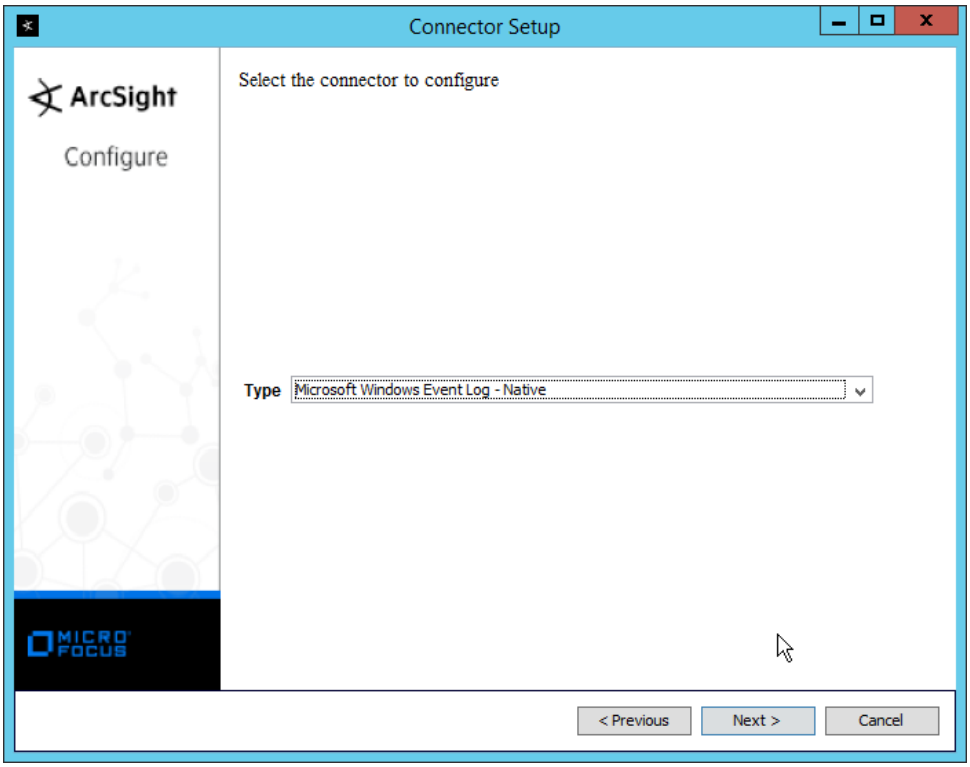
5. Click **Next.**



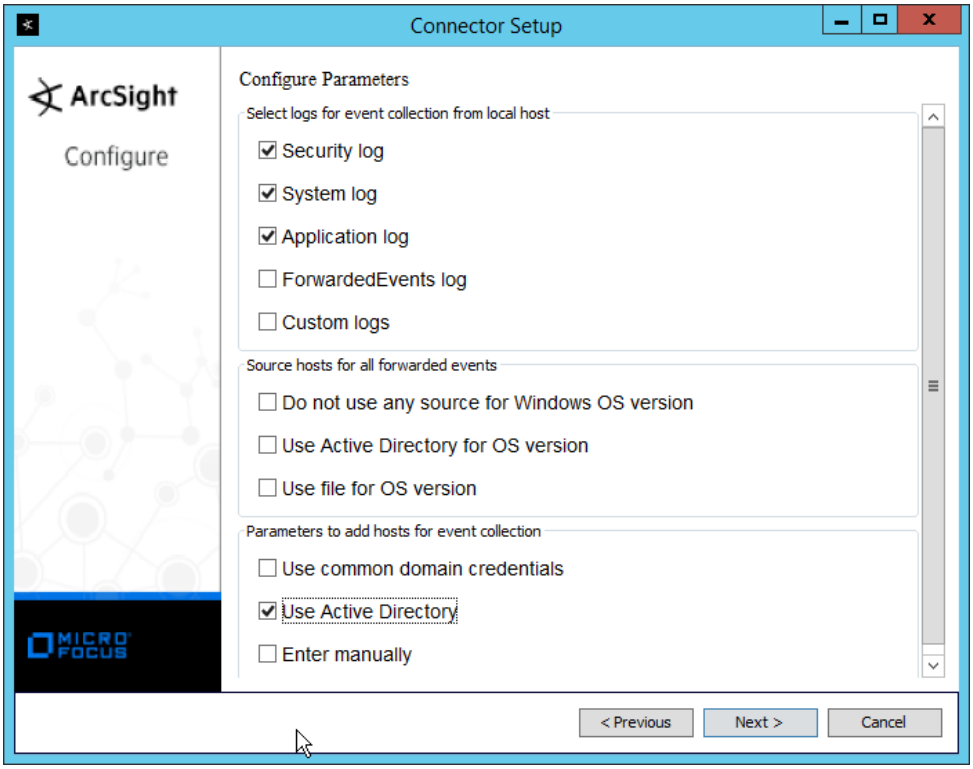
6. Click **Install.**
7. Select **Add a Connector.**



8. Click **Next.**
9. Select **Microsoft Windows Event Log–Native.**



10. Click **Next.**
11. Check the box next to **Use Active Directory.**

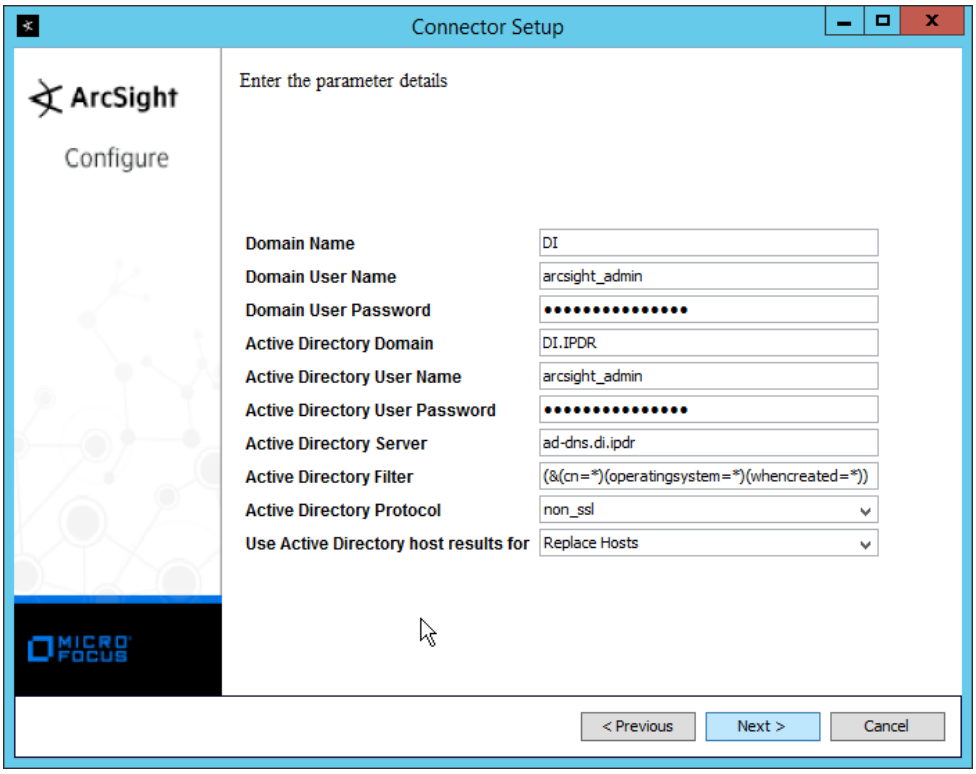


1564

1565 12. Click **Next.**

1566 13. Enter information about your Active Directory server. (It is recommended to create a new
1567 administrator account for ArcSight to use.)

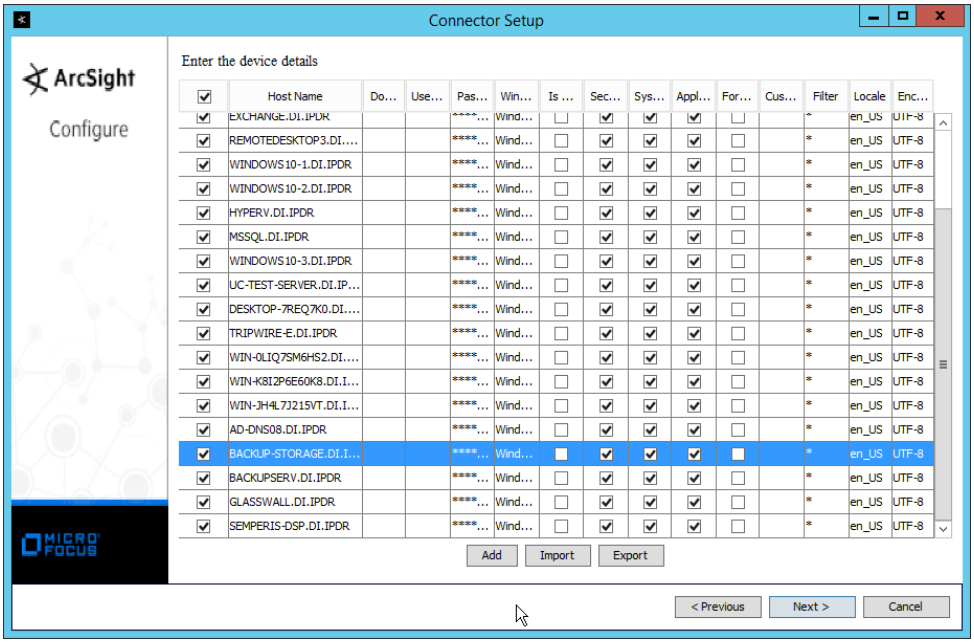
1568 14. Set **Use Active Directory host results for** to **Replace Hosts.**



1569

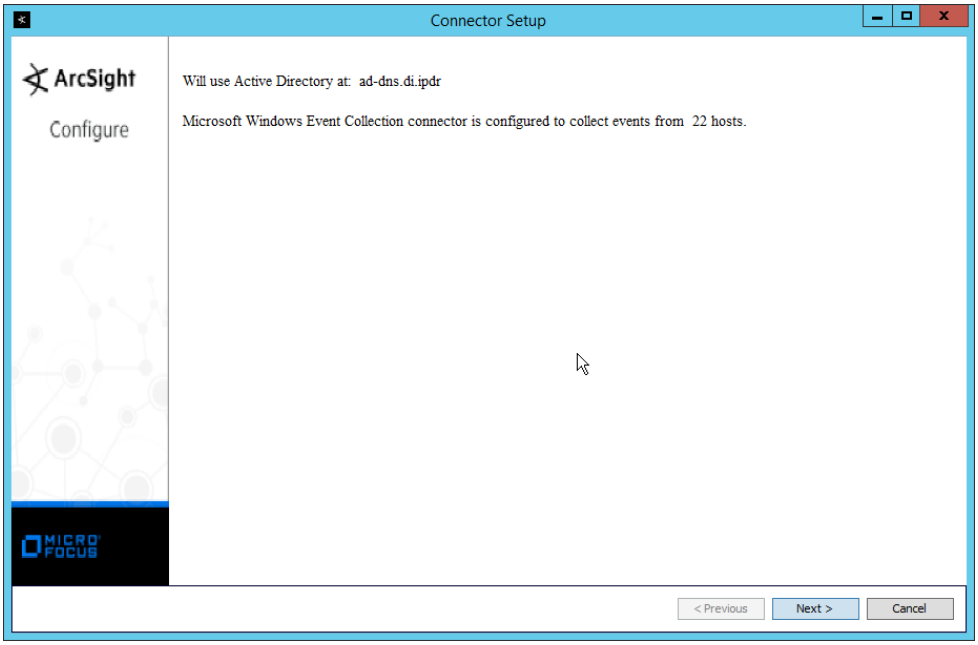
1570 15. Click **Next.**

1571 16. Check the boxes under any event types that should be forwarded to this connector, for each
1572 individual host, e.g., **Security, System, Application.**



1573

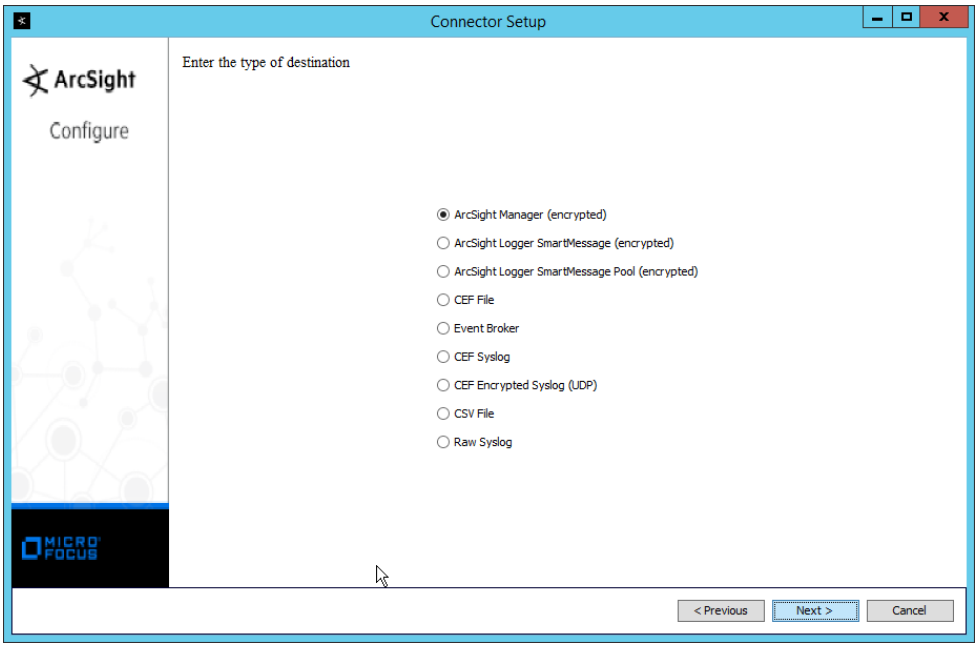
1574 17. Click **Next.**



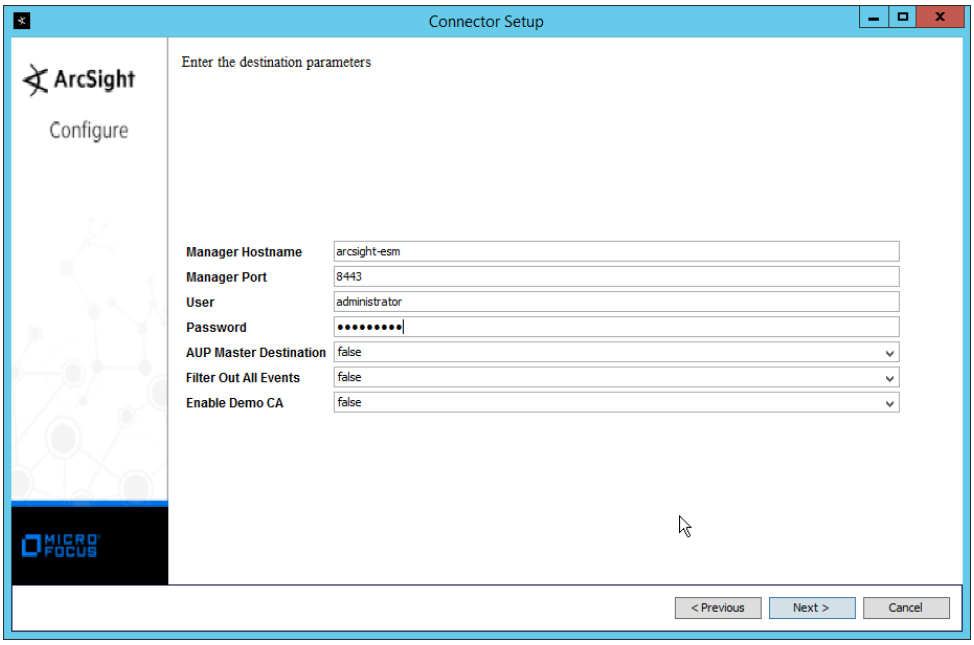
1575

1576 18. Click **Next.**

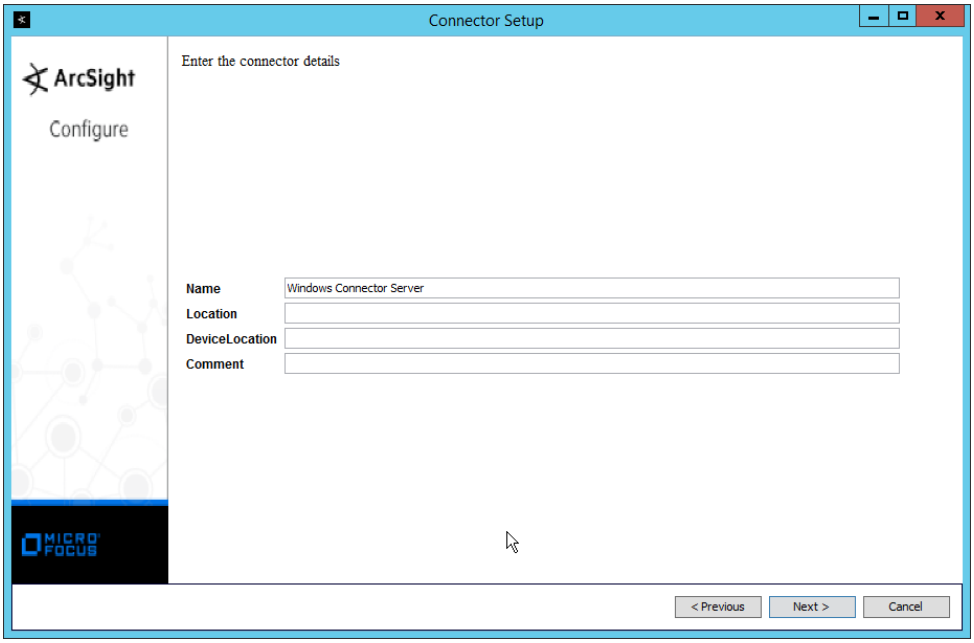
1577 19. Select **ArcSight Manager (encrypted).**



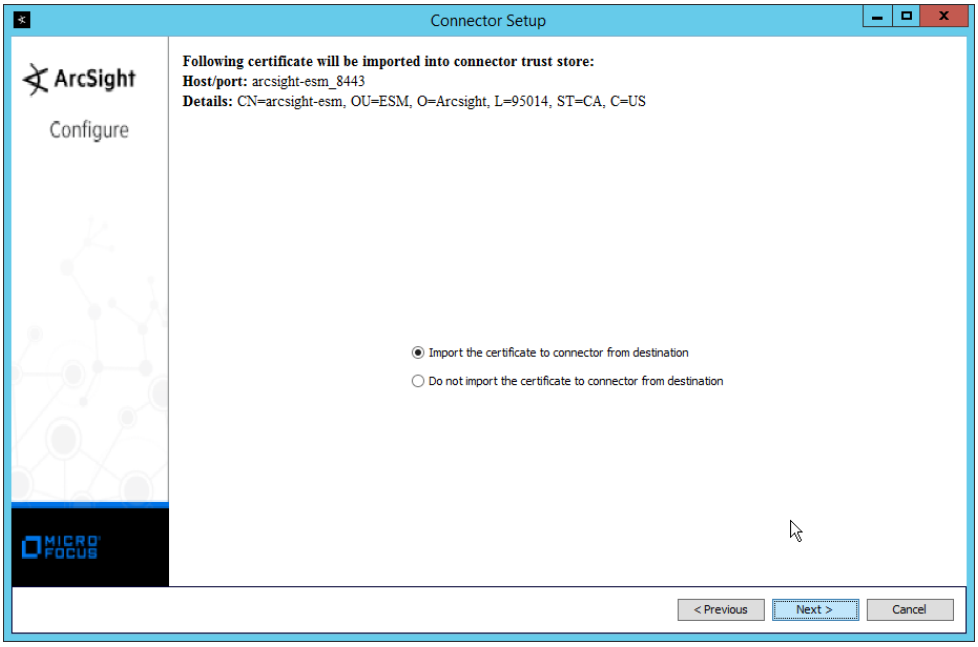
20. Click **Next.**
21. Enter the **hostname, port, username,** and **password** for the ArcSight ESM server.



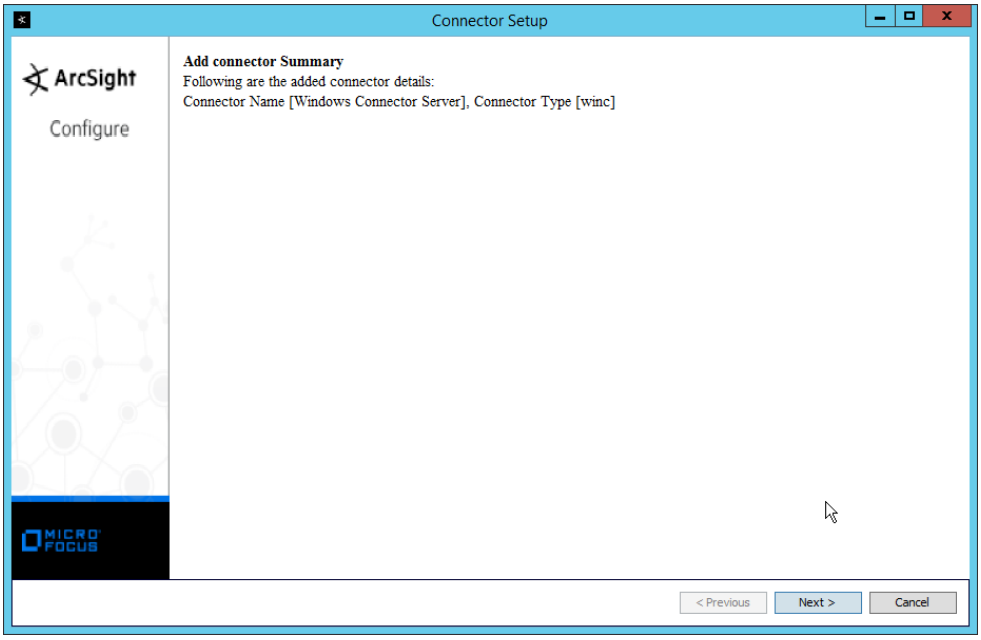
22. Click **Next.**
23. Enter identifying details about the system (only **Name** is required).



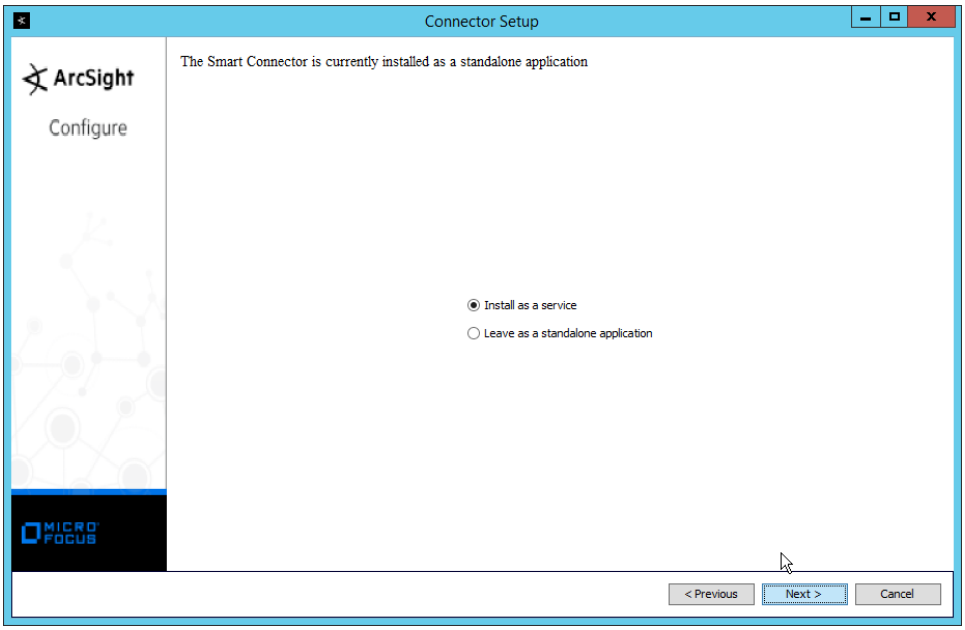
24. Click **Next.**
25. Select **Import the certificate to connector from destination.**



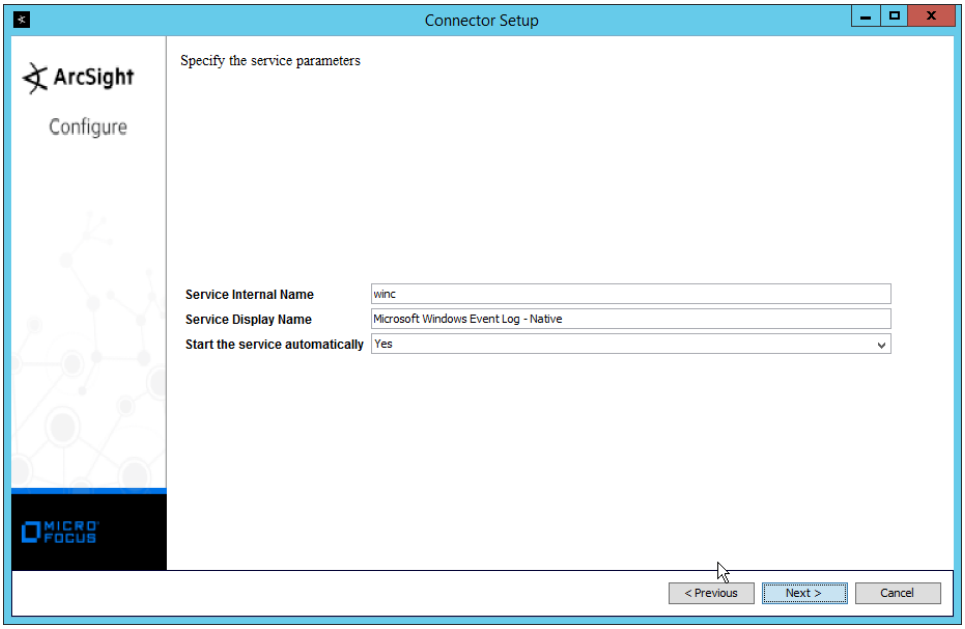
26. Click **Next.**



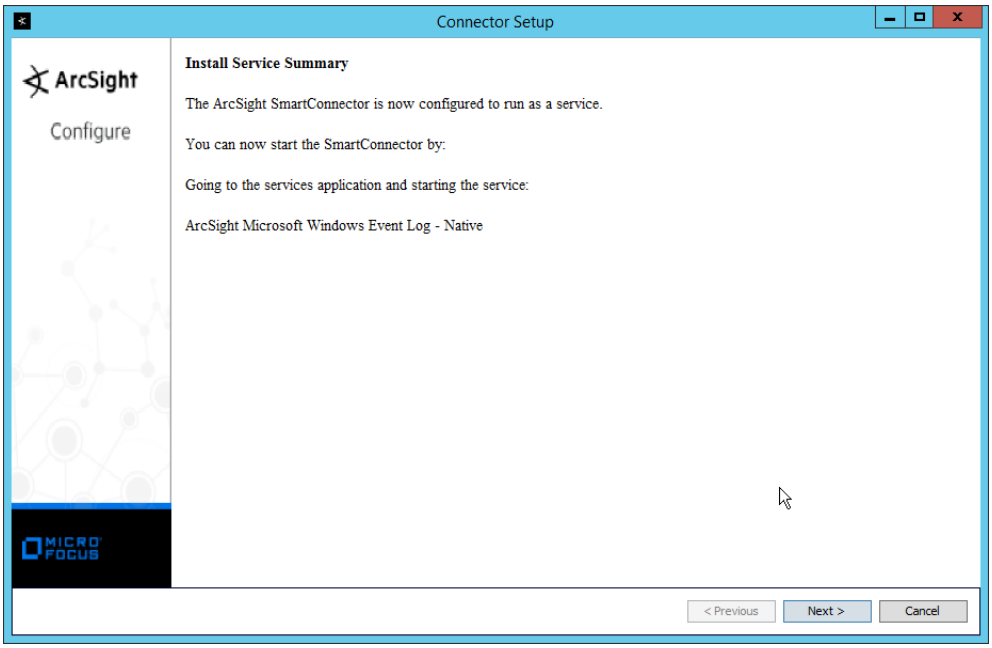
27. Click **Next.**
28. Select **Install as a service.**



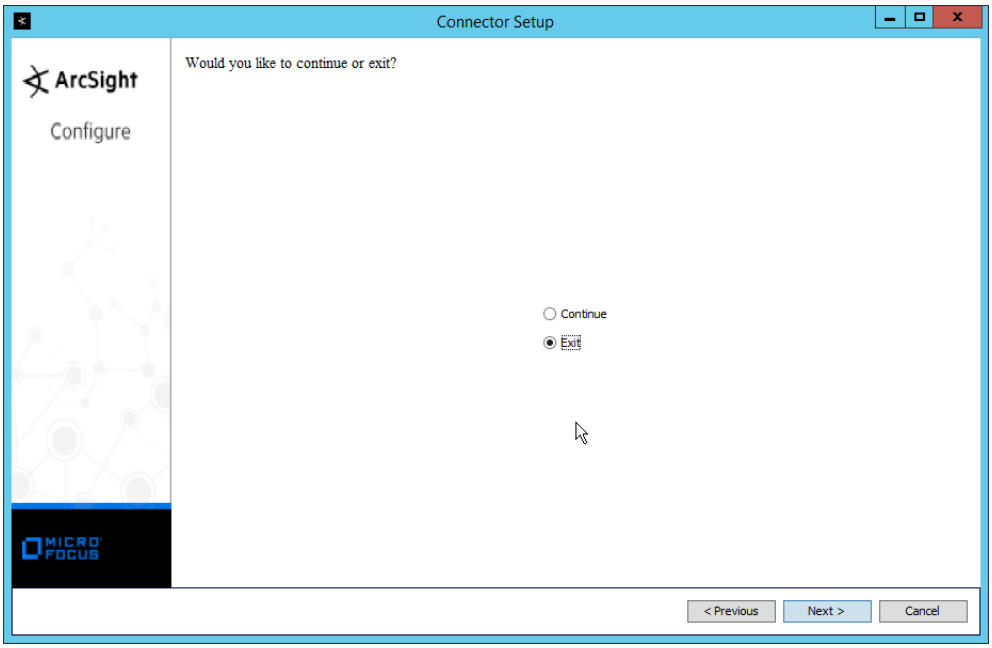
29. Click **Next.**



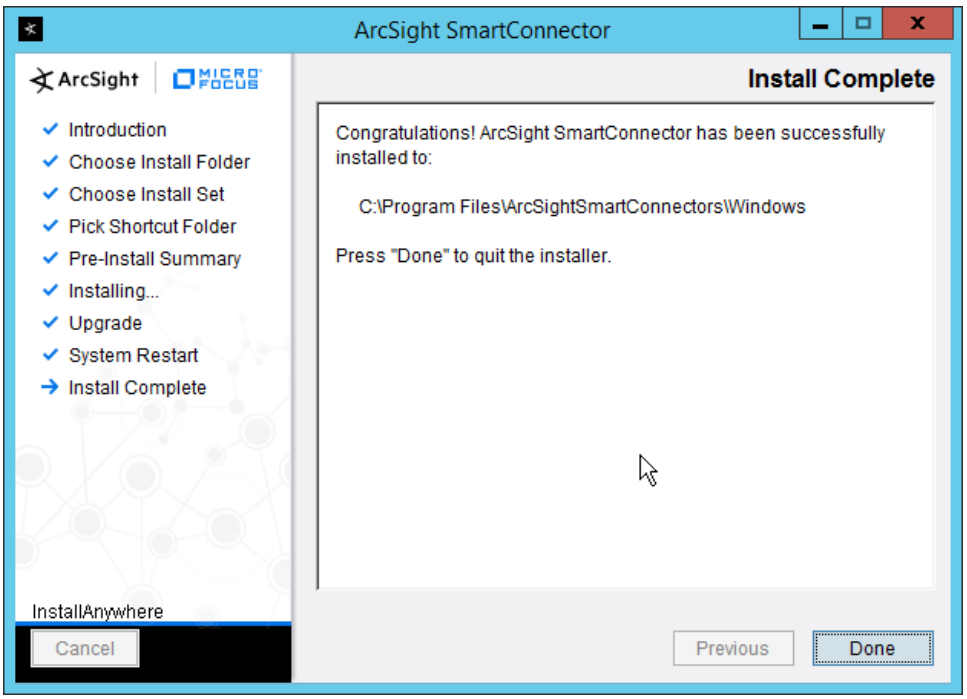
30. Click **Next.**



31. Click **Next.**
32. Select **Exit.**



33. Click **Next.**

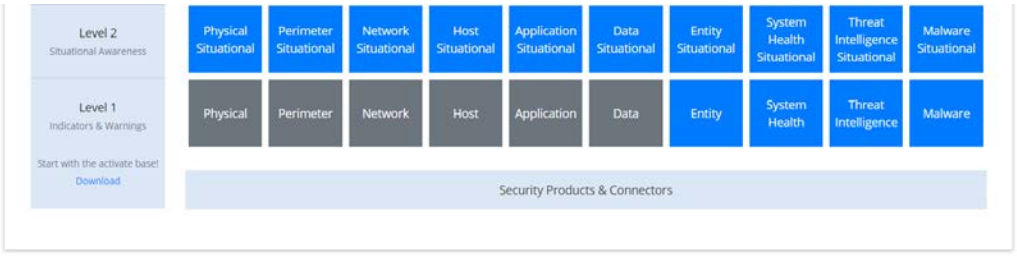


34. Click **Done.**
35. Note: Ensure that all machines selected do not block traffic from this device through their firewalls.

2.11.5 Install Preconfigured Filters for ArcSight

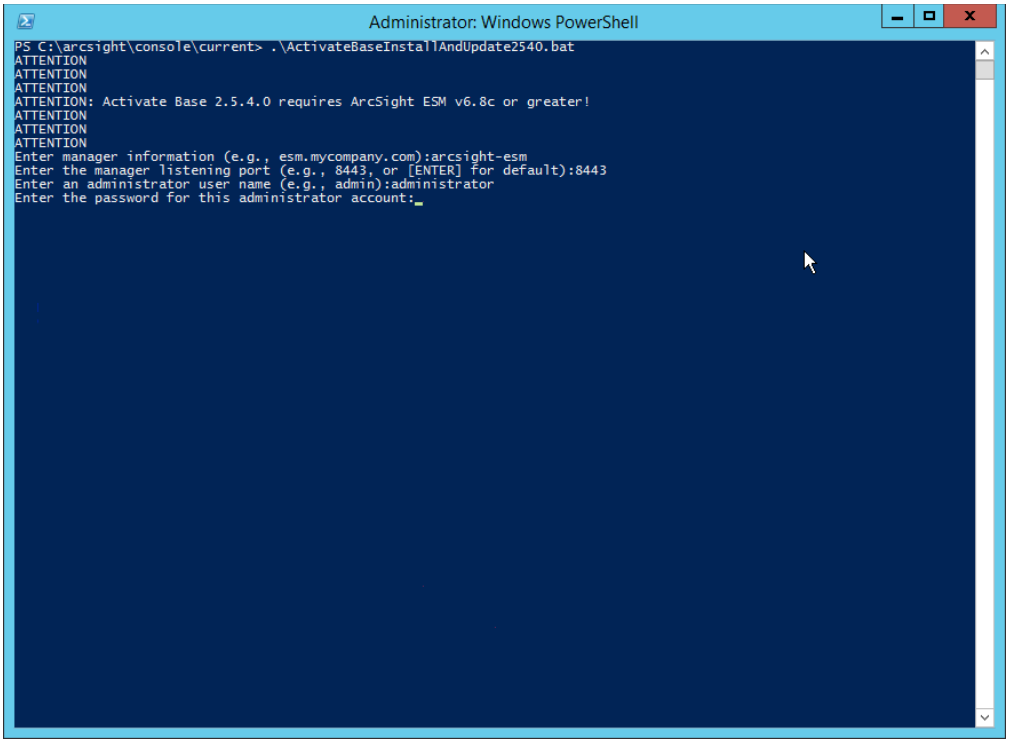
2.11.5.1 Install Activate Base

1. Go to the ArcSight Content Brain web application (https://arcsightcontentbrain.com/app/) and log in. This page allows you to keep track of packages to be installed–what packages should be installed depends on the needs of the organization, but the "Activate Base" is required for all products.

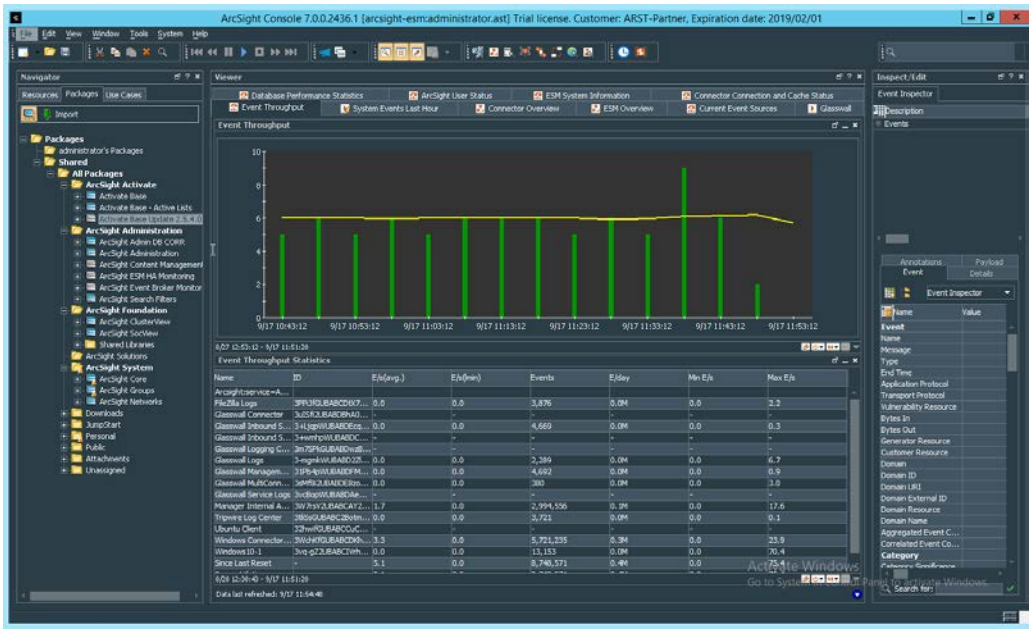


2. Click the **Download** link for the Activate Base. (Note: This package should be installed on the ArcSight Console, not on the ESM.)
3. Copy the contents of the zip file to ARCSIGHT_HOME. The default for this is C:\arcsight\Console\current, assuming a Windows Server.
4. In PowerShell, navigate to the ARCSIGHT_HOME directory (C:\arcsight\Console\current) and run:

```
> .\ActivateBaseInstallAndUpdate2540.bat
```



5. Enter the **hostname** of the ArcSight machine, the **port** (default: 8443), and the **username** and **password** used to connect to the **ESM.**
6. Delete **Activate_Base_Updated_2.5.4.0.arb** from the ARCSIGHT_HOME directory.
7. Log in to **ArcSight Console.**

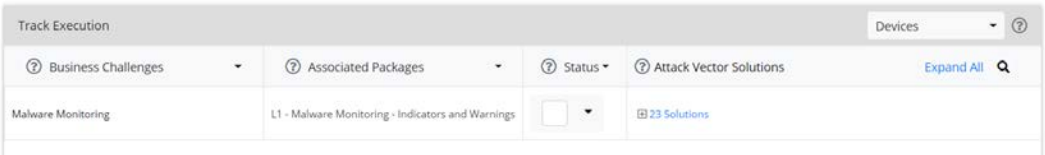


8. Under **Packages > Shared > All Packages > ArcSight Activate,** right-click **Activate Base Update 2.5.4.0,** and select **Delete Package.**

2.11.5.2 Install Packages

Once the Activate Base is installed, packages can be installed to monitor for specific types of events. As an example, find below instructions for the Malware Monitoring package.

1. Navigate to the **ArcSight Content Brain** web application.
2. Select the **Level 1** box labeled **Malware.**

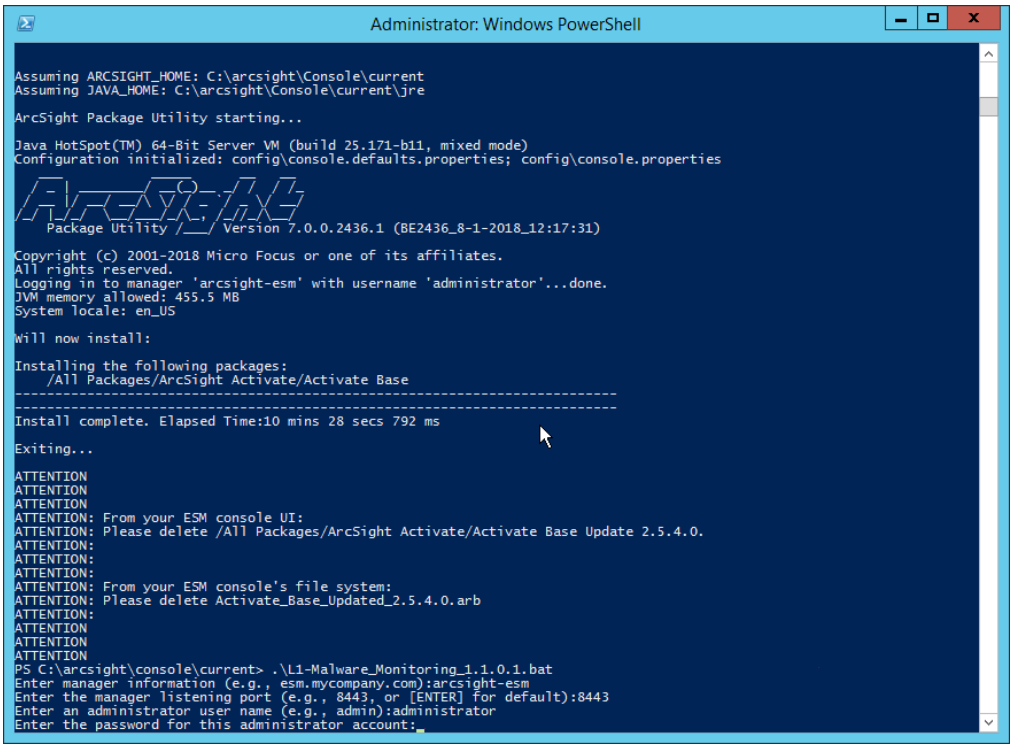


3. In the Track Execution section, under Associated Packages, you can see the list of packages used to address the challenge of Malware Monitoring. In this case, there is just one package, L1–

Malware Monitoring–Indicators and Warnings. Click the link to be taken to a download page for the package, and download it. (Note: This package should be installed on the ArcSight Console, not on the ESM.)

4. Copy the contents of the zip file to ARCSIGHT_HOME. The default for this is C:\arcsight\Console\current, assuming a Windows Server.
5. In PowerShell, navigate to the ARCSIGHT_HOME directory (C:\arcsight\Console\current) and run:

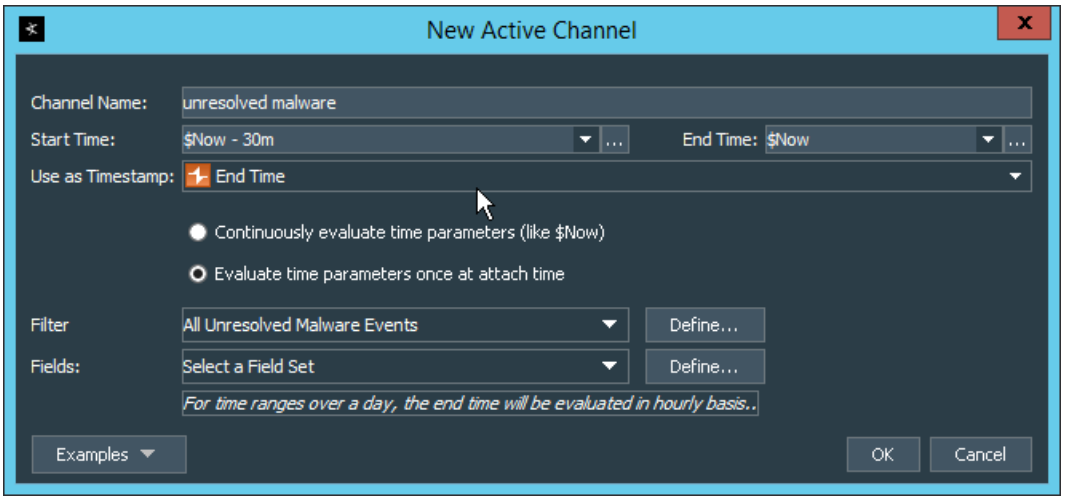
```
> .\L1-Malware_Monitoring_1.1.0.1.bat
```



6. Enter the **hostname** of the ArcSight machine, the **port** (default: 8443), and the **username** and **password** used to connect to the **ESM.**

2.11.6 Apply Filters to a Channel

1. In the **ArcSight Console,** click **File > New > Active Channel.**
2. Enter a **name** for the channel.
3. Select a time frame.
4. For **Filter,** select one the filters that was imported from the packages you installed.



5. Click **OK.** All events that match the filter can be displayed in the newly created channel. Filters from imported packages can be found under **Filters > Shared > All Filters > ArcSight Activate > Solutions.**

2.12 Tripwire Enterprise

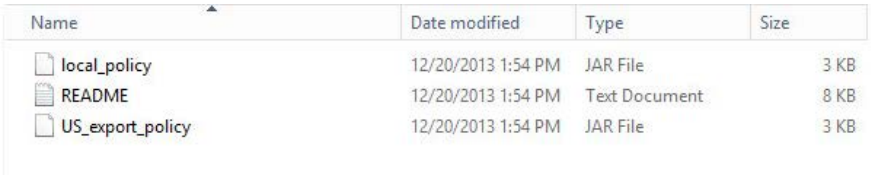
Notes:

This installation requires MSSQL to be installed on a remote server and configured according to the instructions in the ***Tripwire Enterprise 8.6.2 Installation and Maintenance Guide*.**

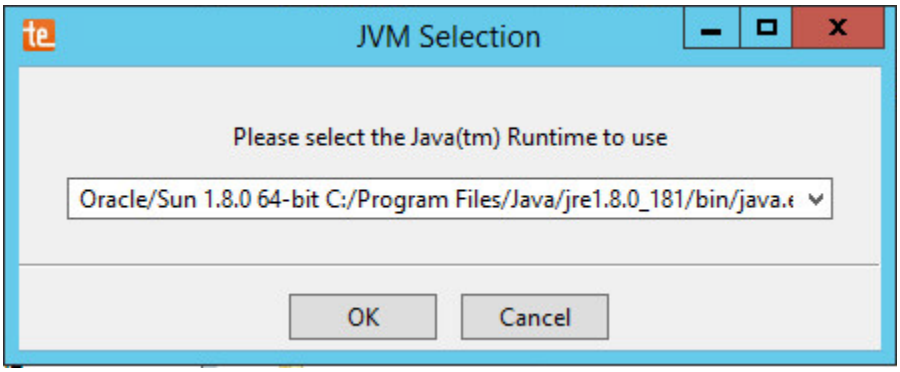
2.12.1 Install Tripwire Enterprise

1. Ensure that you have an up-to-date version of Oracle Java. You must install both the Java Runtime Environment (JRE) and the Java Cryptography Extension (JCE).
2. Download and run the **JRE installer.**

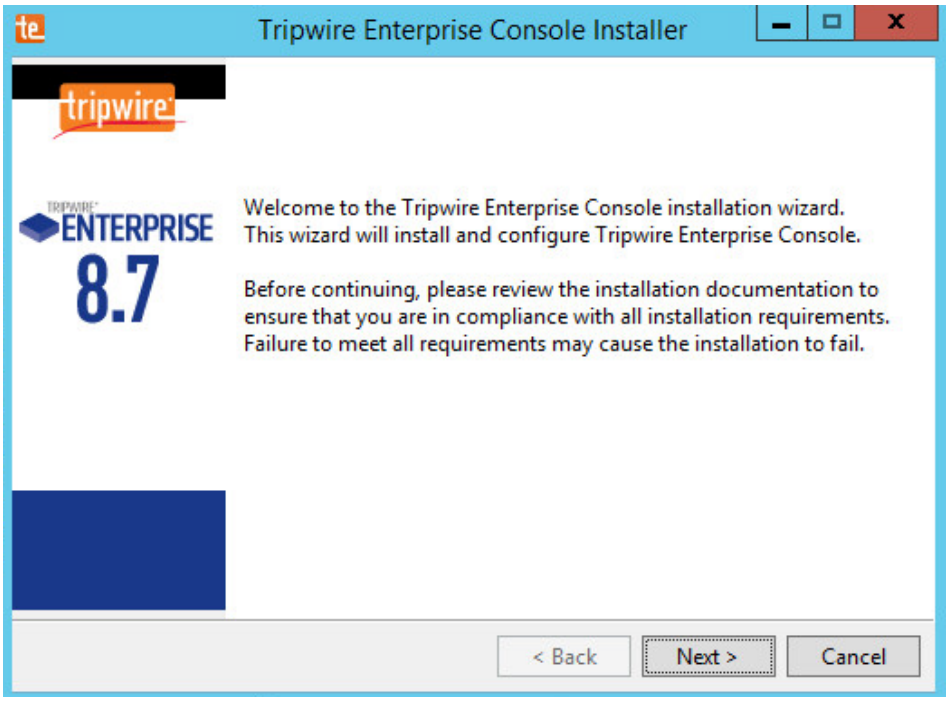
3. Click **Install.**
4. Download the JCE and extract the files.



5. Copy the ***local_policy.jar*** *and* ***US_export_policy.jar*** files to /lib/security/Unlimited/ and /lib/security/Limited in the Java installation directory.
6. Run **install-server-windows-amd64.**
7. Select the Java runtime that was just installed.



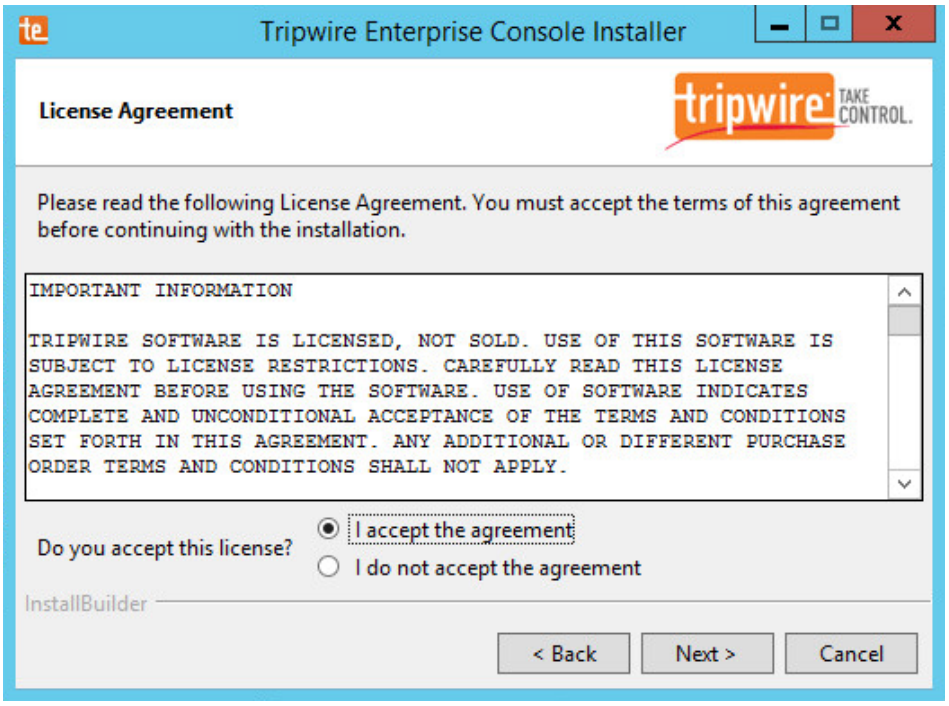
8. Click **OK.**



1673

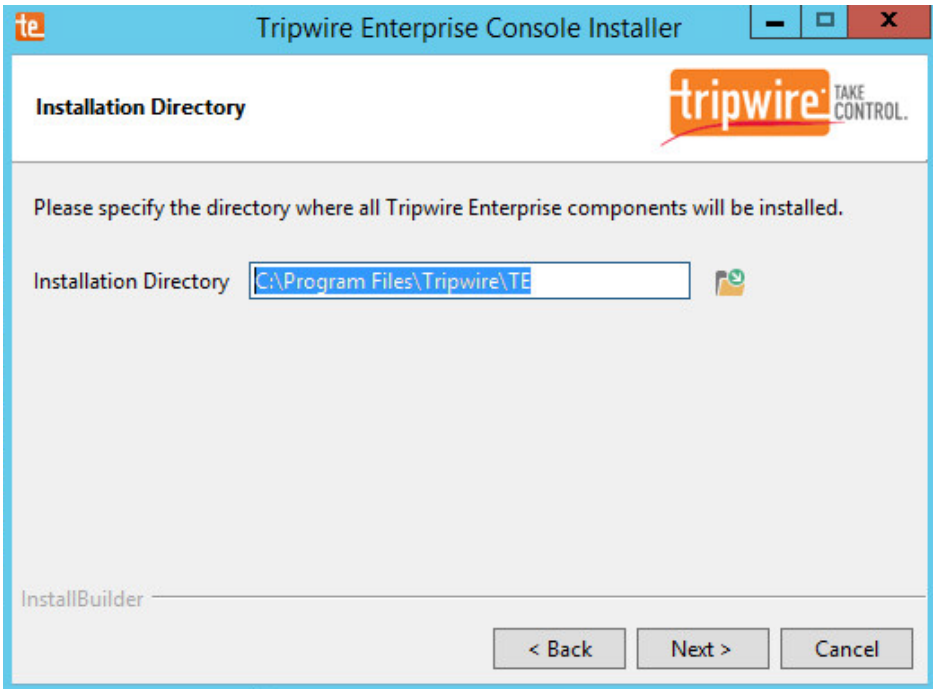
1674 9. Click **Next.**

1675 10. Select **I accept the agreement.**

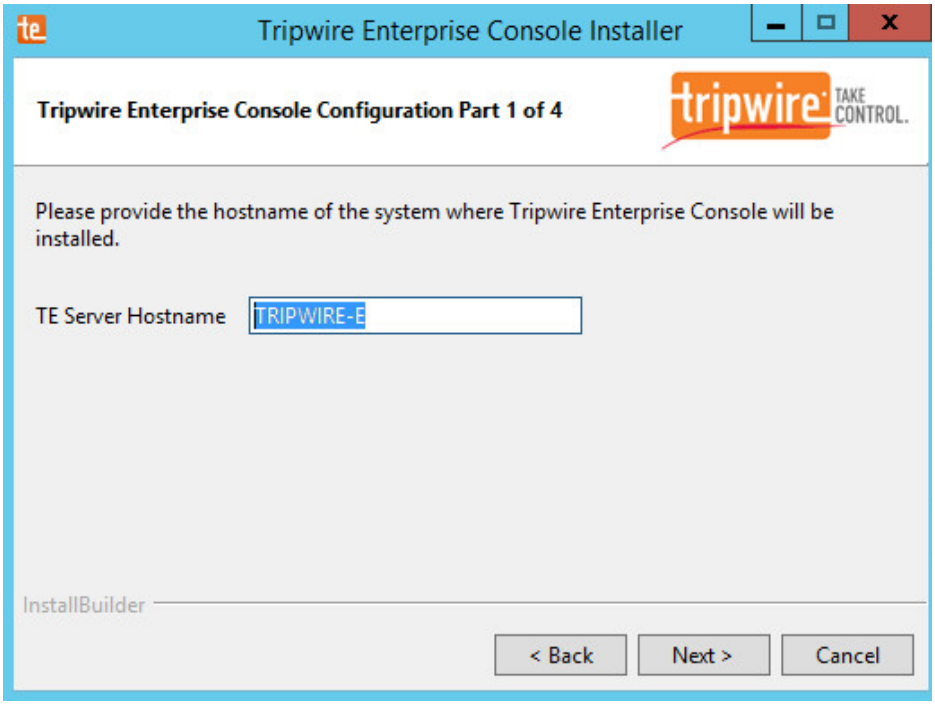


1676

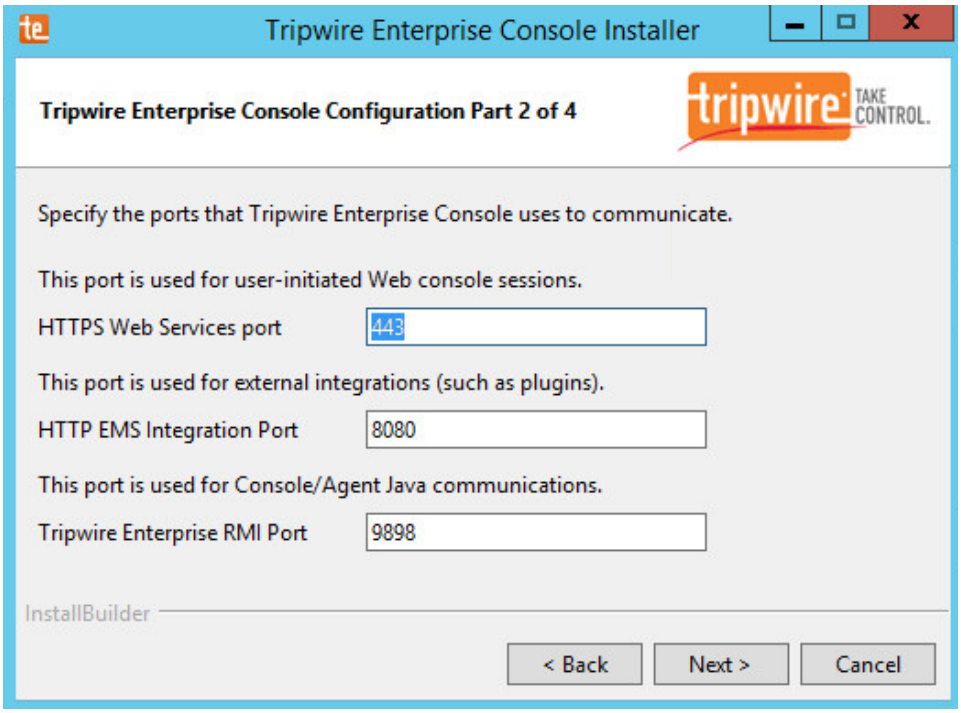
11. Click **Next.**



12. Click **Next.**
13. The installer should automatically detect the hostname of the system on which Tripwire Enterprise is being installed. If it does not, enter the hostname here.



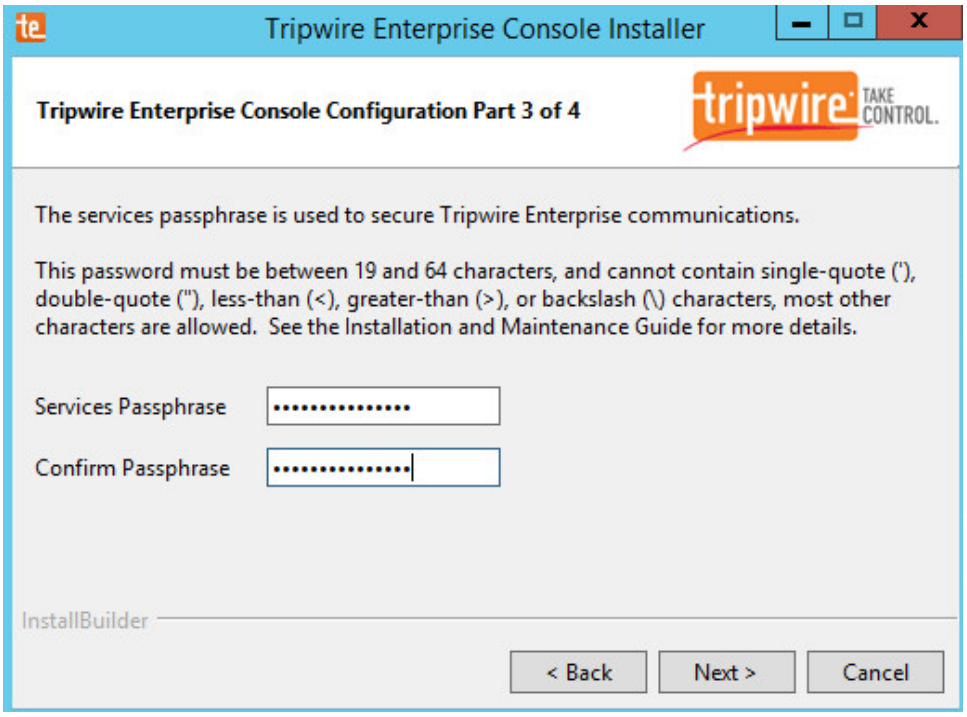
14. Click **Next.**
15. Enter each port number to use for the HTTPS Web Services port, HTTP EMS Integration Port, and Tripwire Enterprise RMI port. The RMI port is used for inbound communication from Tripwire agents to the server, so ensure that it is allowed through the firewall.



1687

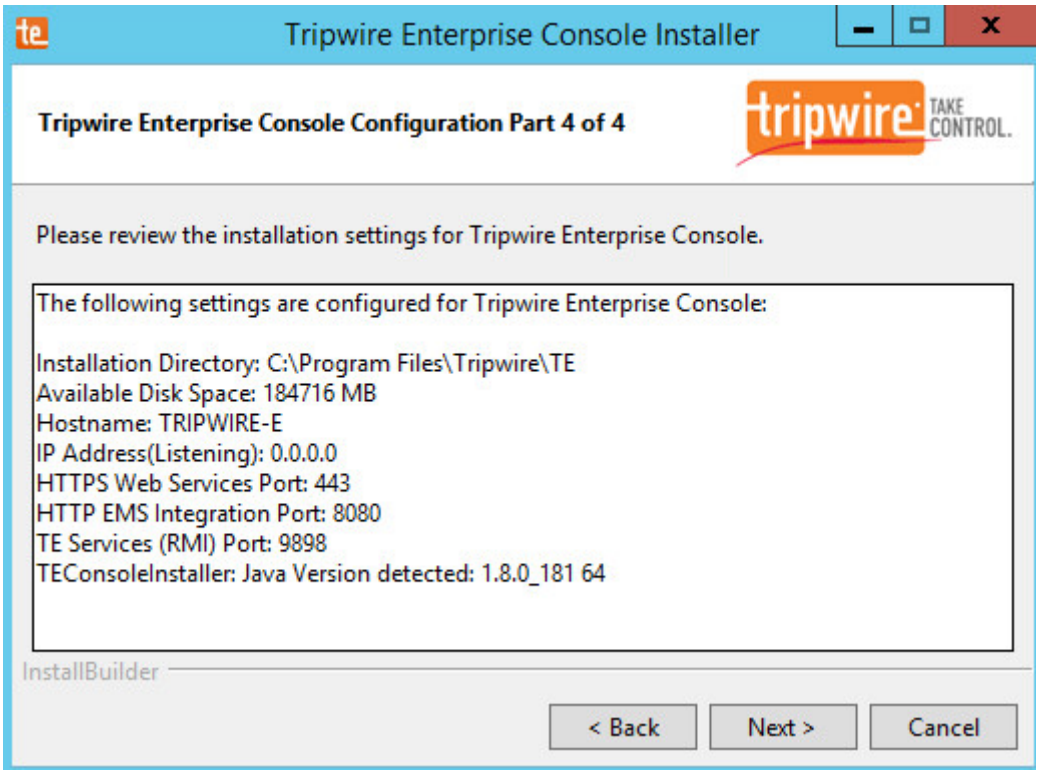
1688 16. Click **Next.**

1689 17. Enter a passphrase to use.

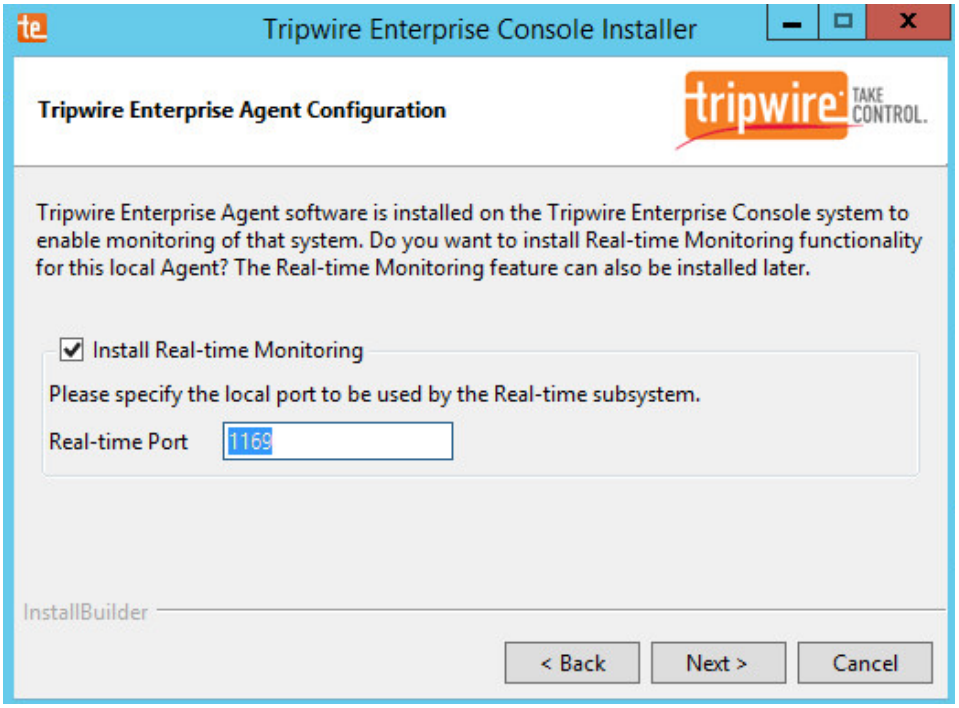


1690

18. Click **Next.**

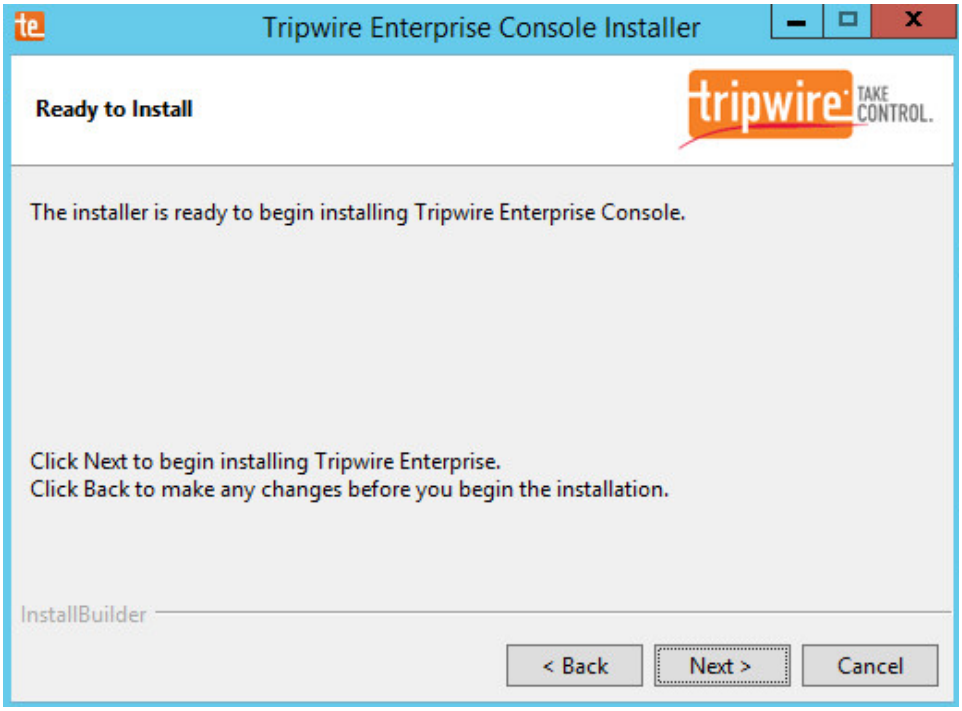


19. Click **Next.**
20. Check the box next to **Install Real-time Monitoring.**
21. Enter **1169** for **Real-time Port.**



1696

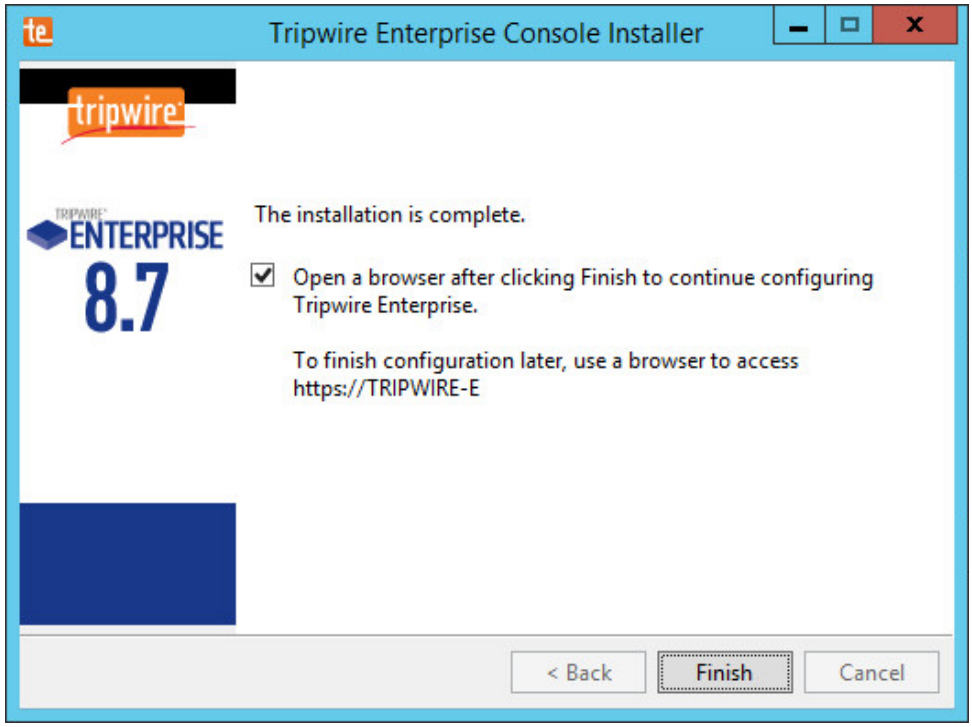
1697 22. Click **Next.**



1698

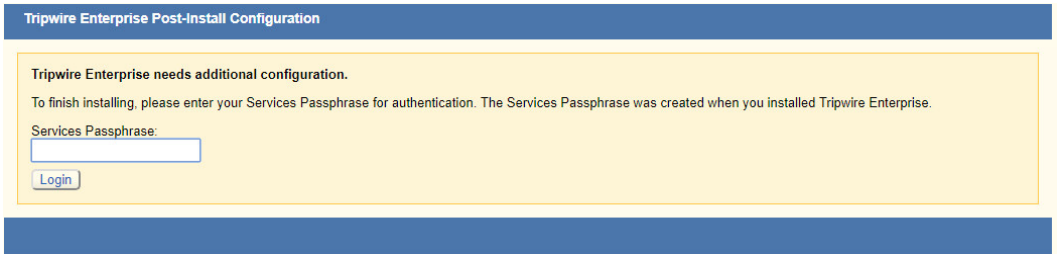
1699 23. Click **Next.**

24. Check the box next to **Open a browser after clicking Finish to continue configuring Tripwire Enterprise.**

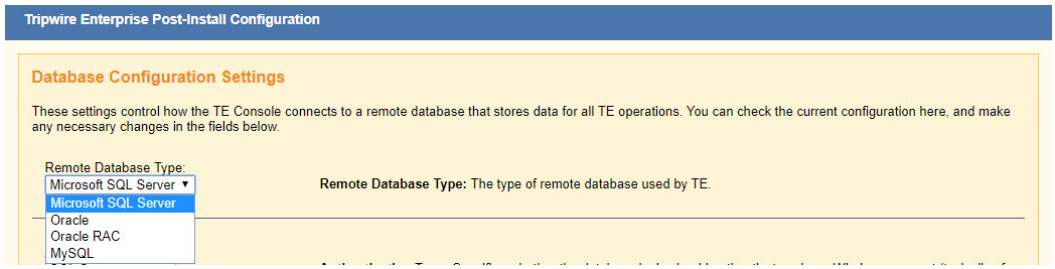


25. Click **Finish.**

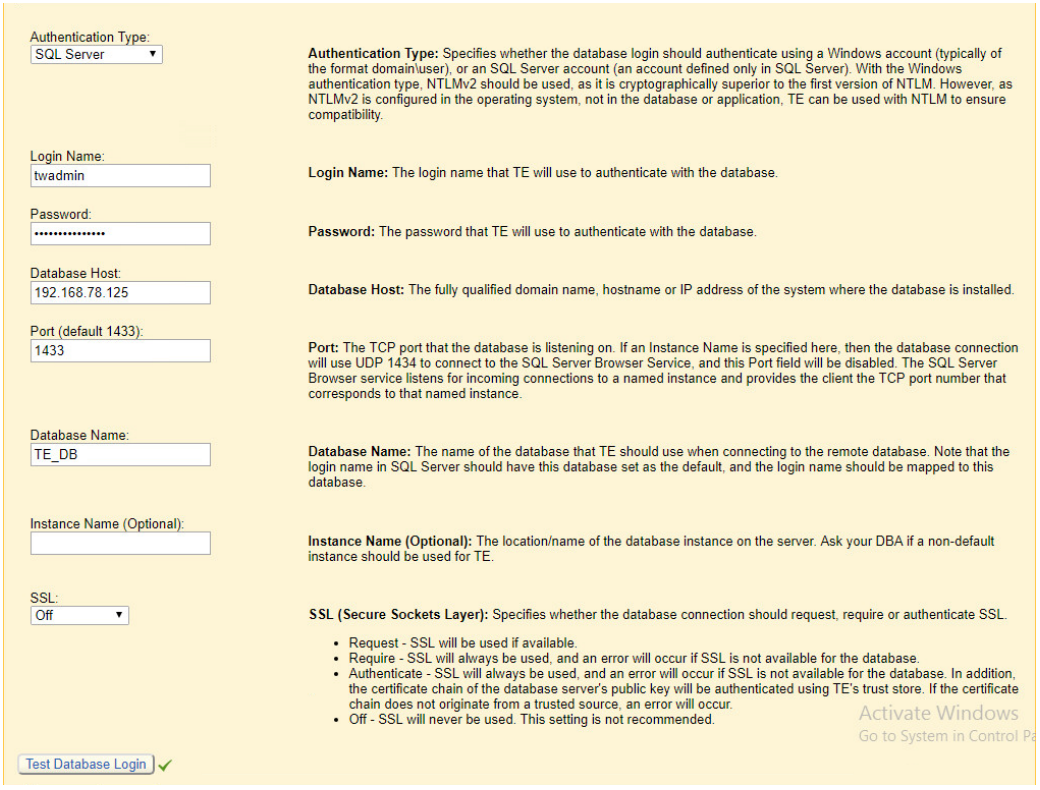
26. Once at the web address, enter the **Services passphrase** chosen earlier.



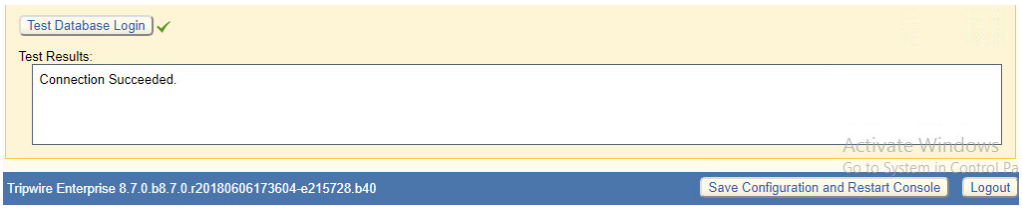
27. Click **Login.**



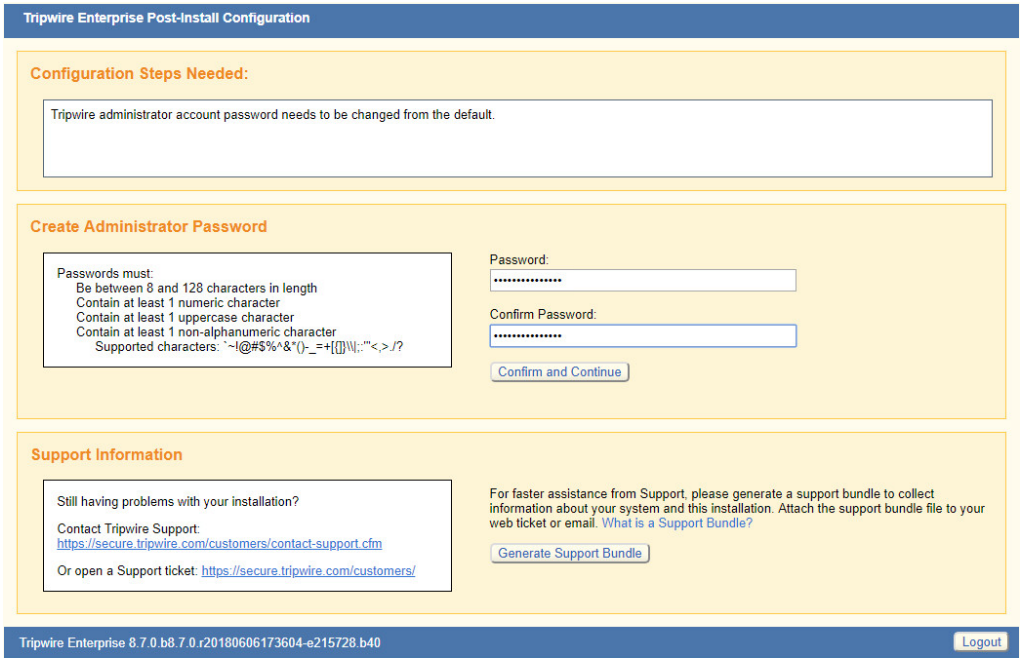
28. Select **Microsoft SQL Server** for **Remote Database Type.**
29. Select **SQL Server** for **Authentication Type.**
30. Enter login details for the account created during the MSSQL setup.
31. Enter the **hostname** or **IP** of the database server.
32. Enter the **port** on which the database is operating.
33. Enter the **name** of the database to be used for Tripwire Enterprise.
34. Select the appropriate setting for **SSL** according to your organization's needs.



35. Click **Test Database Login** to ensure the connection is functional.



36. Click **Save Configuration and Restart Console.**
37. After the reboot, enter a new administrator **password**.

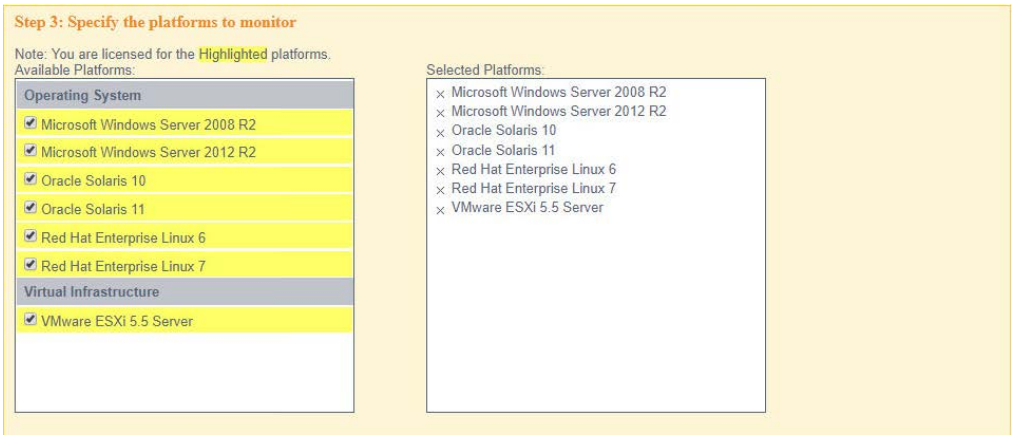


38. Click **Confirm and Continue.**

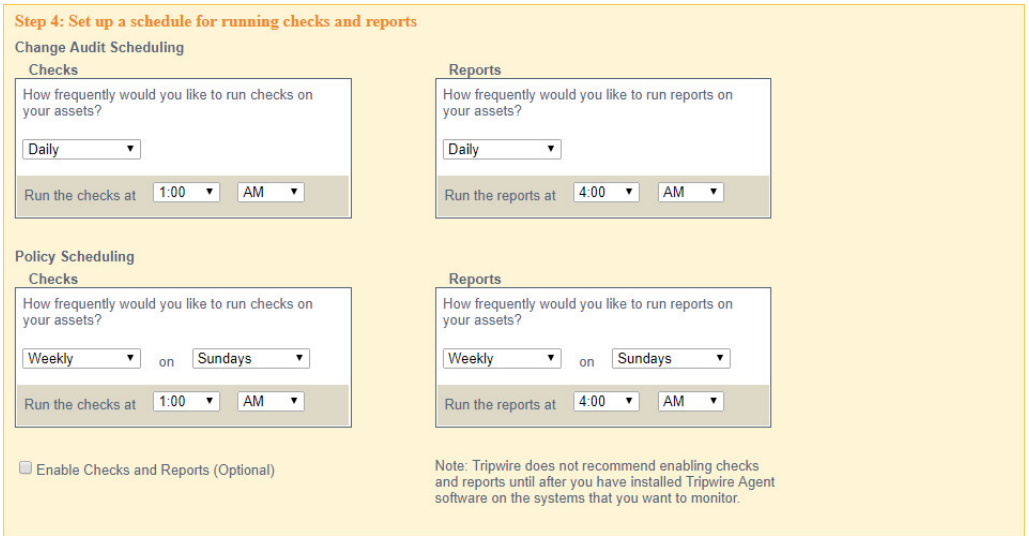
39. Click **Configure Tripwire Enterprise.**

40. Click **Choose File** and select the Tripwire Enterprise license file, which should be a *.cert* file.
41. Check the boxes next to **Change Auditing** and **Policy Management.**

42. Select any available policies desired.



43. Select all the operating systems that you wish to monitor with Tripwire Enterprise.



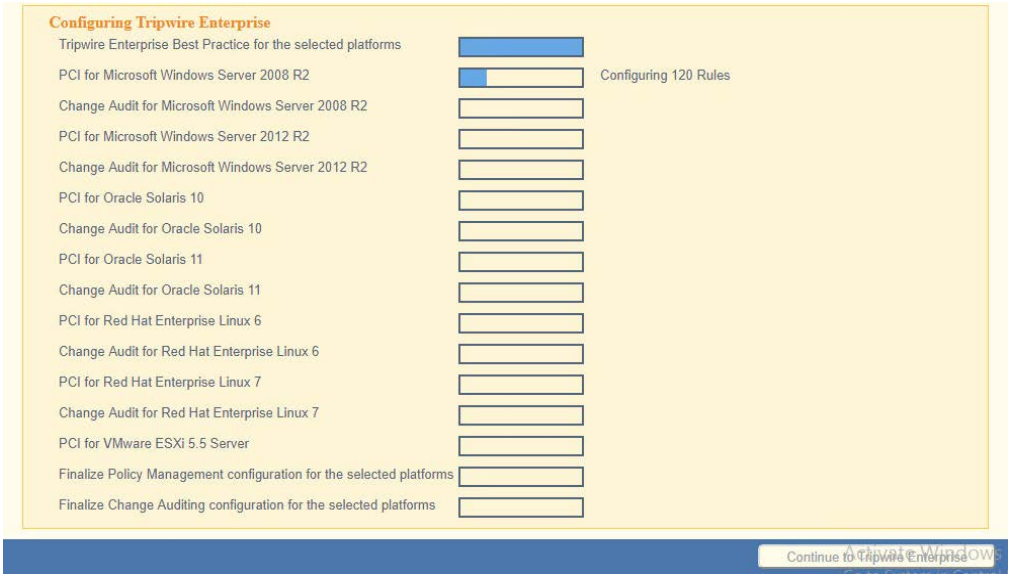
44. Set up a schedule for running checks and reports according to your organization's needs. Leave the box next to **Enable Checks and Reports** unchecked for now.

45. Select **Set up the email server at another time.**

46. Enter a **username** and **password** for a new administrator account for Tripwire Enterprise Console.

47. Click **Preview Configuration.**

48. Click **Apply Configuration.**



49. Click **Continue to Tripwire Enterprise** when the installation finishes.

2.12.2 Install the Axon Bridge

1. Ensure that TCP traffic on port 5670 is allowed through the firewall.
2. Navigate to the Tripwire Enterprise Console installation directory to the /server/data/config folder. Copy *bridge_sample.properties* to *bridge.properties***.**
3. In the *bridge.properties* file, find the line that says:
   `#tw.cap.bridge.registrationPreSharedKey=`
   Remove the "#" character. After the "=" character, enter a **password**. The password has some restrictions, so ensure that it meets the requirements in case the connection fails later.
4. Restart the TE console by running the following command from an administrative command prompt, where <te_root> is the TE installation directory:

```
> <te_root>/server/bin/twserver restart
```

2.12.3 Install the Axon Agent (Windows)

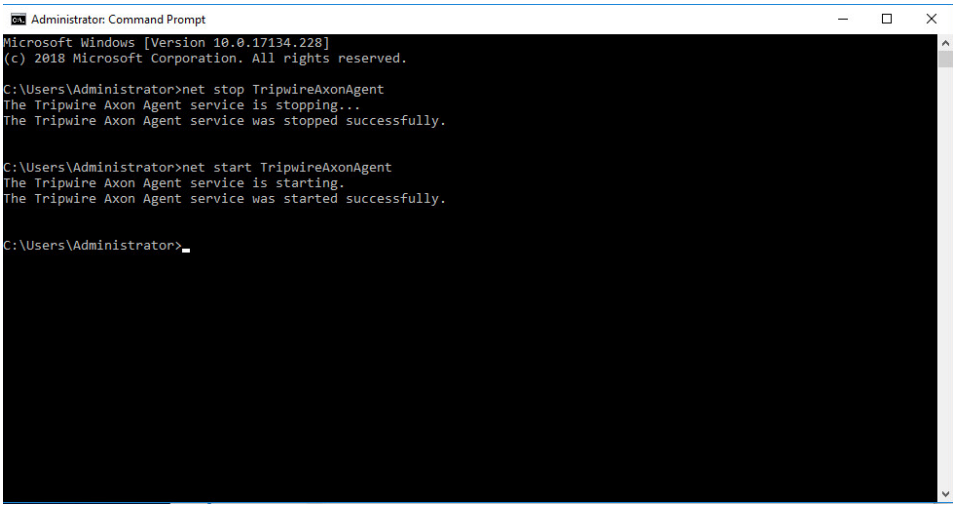
1. Download the Axon Agent zip file from the Tripwire customer website (https://tripwireinc.force.com/customers), under the Product Downloads tab.
2. Unzip the file.
3. To begin the installation, double-click the *.msi* file in the extracted folder. Note: No installation wizard will appear; the installation happens automatically.

4. After the Axon Agent is installed, navigate to C:\ProgramData\Tripwire\agent\config, and copy *twagent_sample.conf* to *twagent.conf***.**

```
#
# HOST based agent configuration:
#     Instead of using a DNS SRV record, the agent may be configured
#     to talk to a specific host, or list of hosts. Lists use a comma separator and
#     can optionally specify a port. The default of port 5670 will be used if a port
#     is not specified.
#
#    Example: host1, host2:5900, 10.123.0.15, [feac:ba80:6fff:93fe]:7582
#
#      The agent may be configured to connect to hosts in a randomized or textual order
#         (default: true)
#
bridge.host=192.168.1.136
#bridge.port=5670
#bridge.randomize.hosts=true
#
```

5. Open **twagent.conf** and find the line that says `bridge.host`. Remove the "#" character, and enter the hostname or IP address of the Axon Bridge server.
6. In a file called ***registration_pre_shared_key,*** enter the value of the preshared key that was set in the Axon Bridge.
7. Restart the Axon Agent Service by opening a command prompt and running the following commands:

```
> net stop TripwireAxonAgent
> net start TripwireAxonAgent
```



2.12.4 Install the Axon Agent (Linux)

1. Download the Axon Agent *.tgz* file from the Tripwire customer website (https://tripwireinc.force.com/customers), under the Product Downloads tab.
2. To install the software, run the following commands:

RHEL or CentOS: `> rpm -ivh <installer_file>`

Debian or Ubuntu: `> dpkg -i <installer_file>`

3. Navigate to /etc/tripwire/ and copy **twagent_sample.conf** to **twagent.conf.**
4. Open **twagent.conf** and find the line that says `bridge.host`. Remove the "#" character and enter the hostname or IP address of the Axon Bridge server.
5. In a file called ***registration_pre_shared_key.txt,*** enter the value of the preshared key that was set in the Axon Bridge.
6. Restart the Axon Agent Service by opening a command prompt and running the following commands:

RHEL or CentOS:

```
> /sbin/service tripwire-axon-agent stop
> /sbin/service tripwire-axon-agent start
```

Debian or Ubuntu:

```
> /usr/sbin/service tripwire-axon-agent stop
> /usr/sbin/service tripwire-axon-agent start
```

2.12.5 Configure Tripwire Enterprise

2.12.5.1 Terminology

Node: a monitored system, such as a file system, directory, network device, database, or virtual infrastructure component

Element: a monitored object, which is a component or property of a node being audited by TE

Element Version: a record of an element's state at specific points in time. Multiple element versions create a historical archive of changes made to the element.

Rule: A rule identifies one or more elements to the TE Console.

Action: an object that initiates a response to either changes detected by TE or by failures generated from policy tests

Task: a TE operation that runs on a scheduled or manual basis

TE Policy: a measurement of the degree to which elements comply with a policy

Policy Test: a determination of whether elements comply with the requirements of a policy

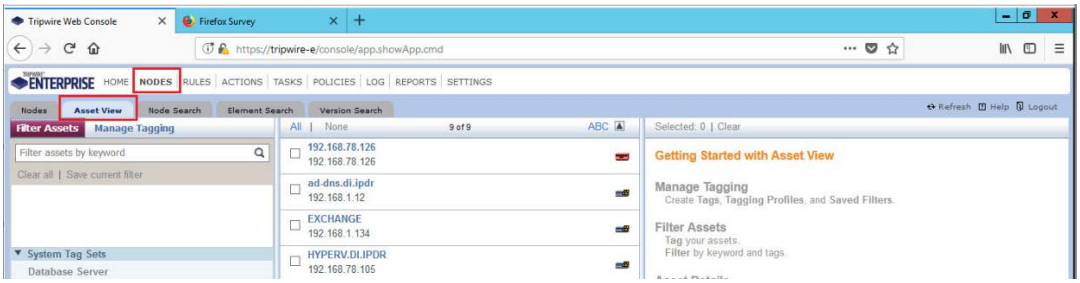
Baseline: the act of creating an element that reflects the current state of a monitored object (also called the **current baseline).** When a node's baseline is promoted, TE saves the former baseline as a **historic baseline.**

Version Check: a check on monitored objects/elements. It is a comparison of the current state of the element against its already recorded baseline for changes.

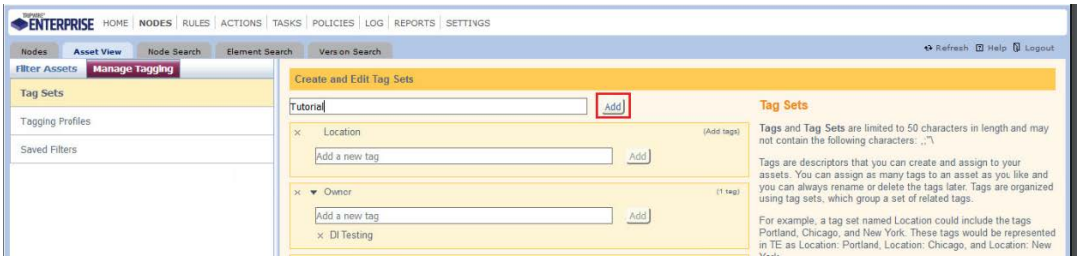
2.12.5.2 Tags

In Tripwire Enterprise, tags can be used to label and target specific nodes. Tags are not required but allow for targeting nodes more granularly than by the operating system. This section describes how to create and assign tags.

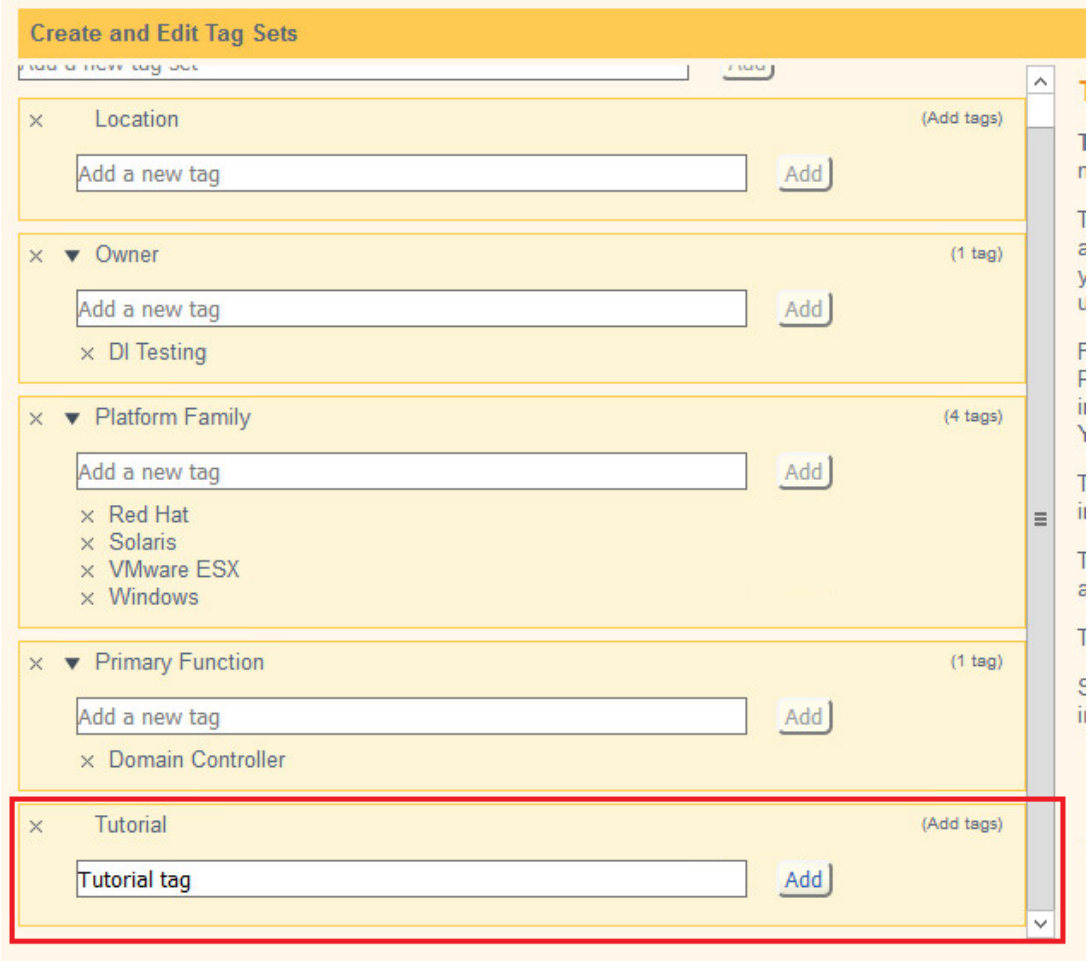
1. Navigate to the TE Console in your browser.
2. Click **Asset View.**



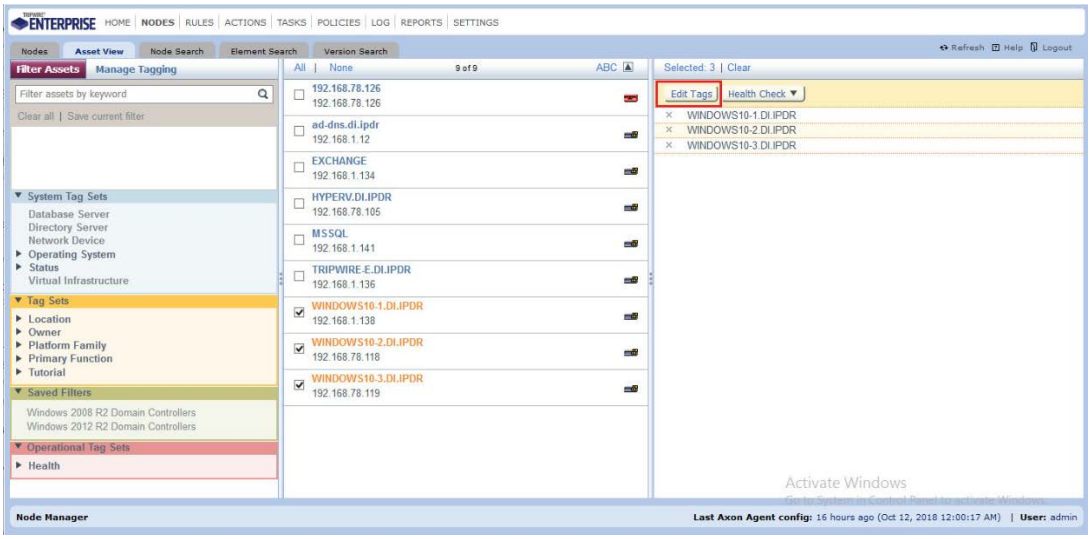
3. Click the **Manage Tagging** tab.
4. Enter the name of a tag set, or use one of the four existing ones (Location, Owner, Platform Family, Primary Function). Click **Add** if adding your own tag set.



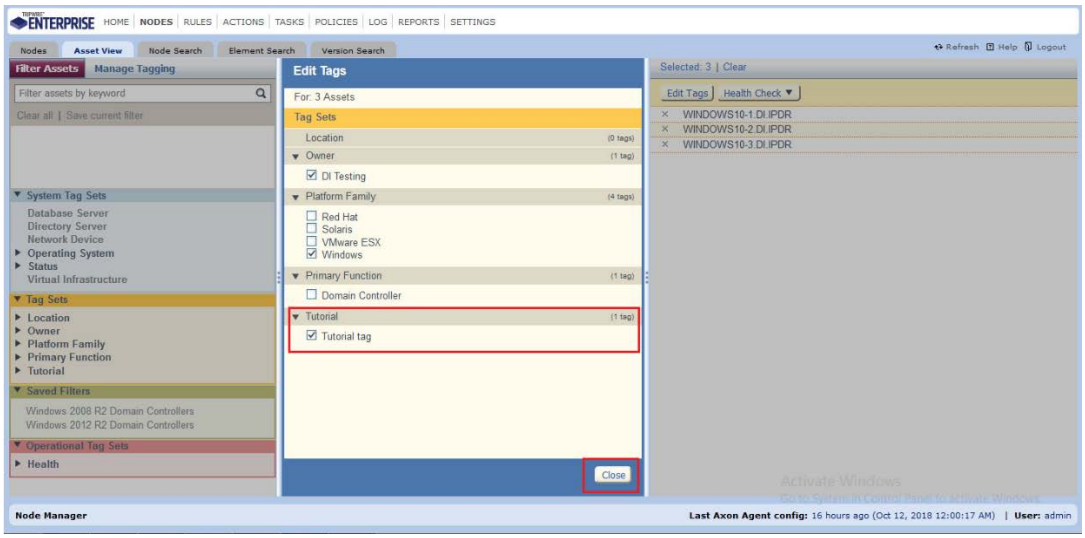
5. Under the tag set to which you wish to add a tag, enter the name of the tag.



6. Click **Add.**
7. Navigate to **Nodes > Asset View > Filter Assets.**
8. Check the boxes next to the nodes to which you wish to add this tag.



9. Click **Edit Tags.**
10. Check the boxes next to any tags you wish to add to these nodes.



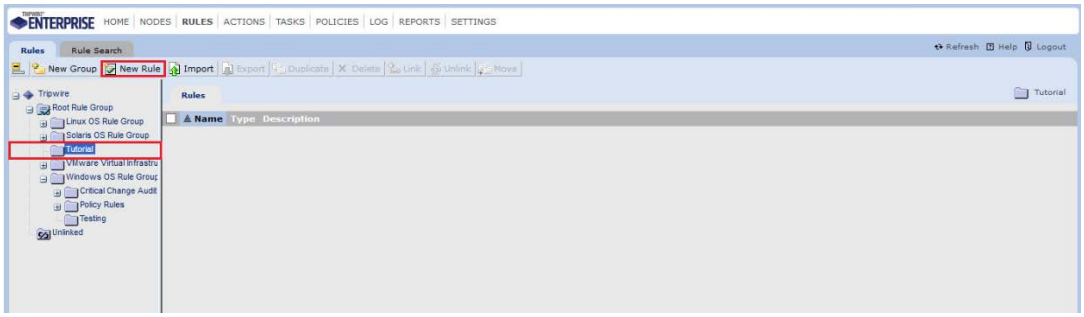
11. Click **Close.**

2.12.5.3 Rules

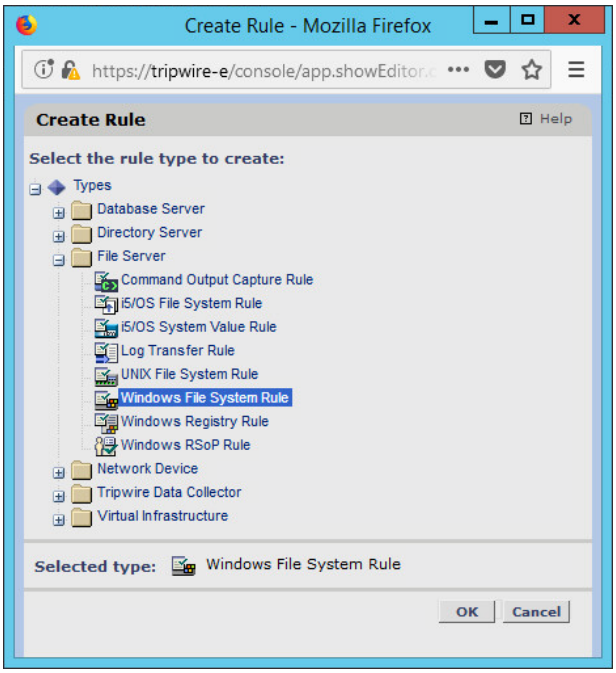
This section describes how to create a rule.

1. Click **Rules.**

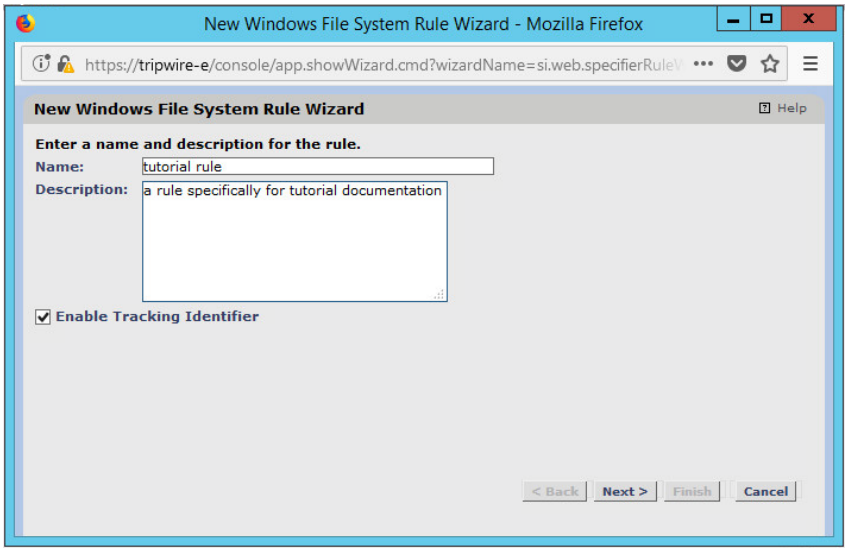
2. Select or create a rule group into which the new rule should be put.



3. Click **New Rule.**
4. Select the type of rule. For monitoring Windows file systems, we choose **Windows File System Rule.**

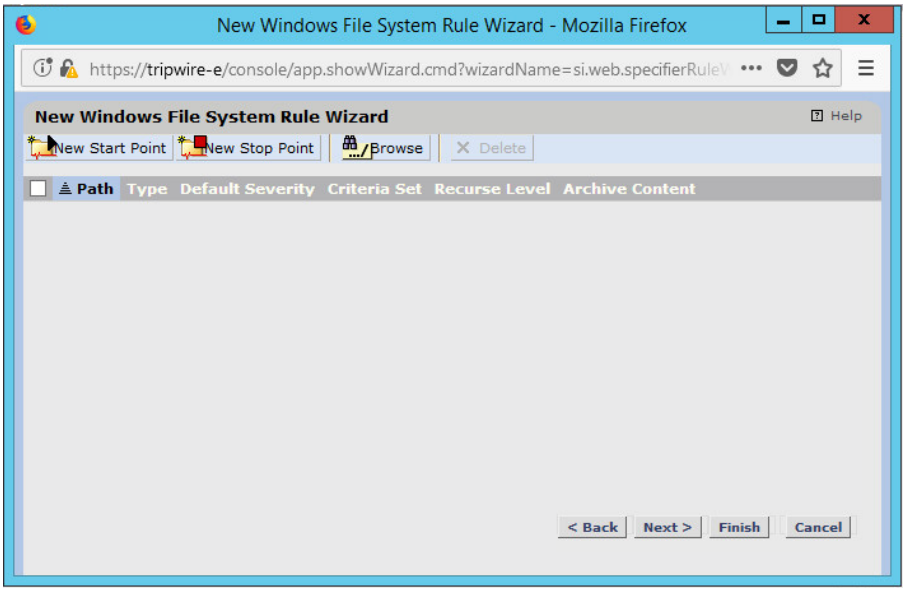


5. Click **OK.**
6. Enter a **name** and **description** for the rule.



1846

1847 7. Click **Next.**

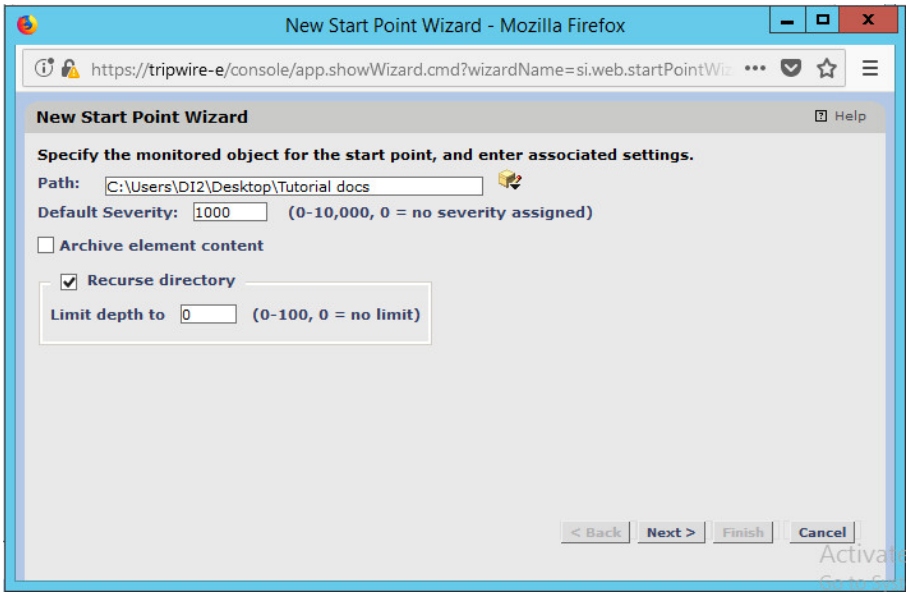


1848

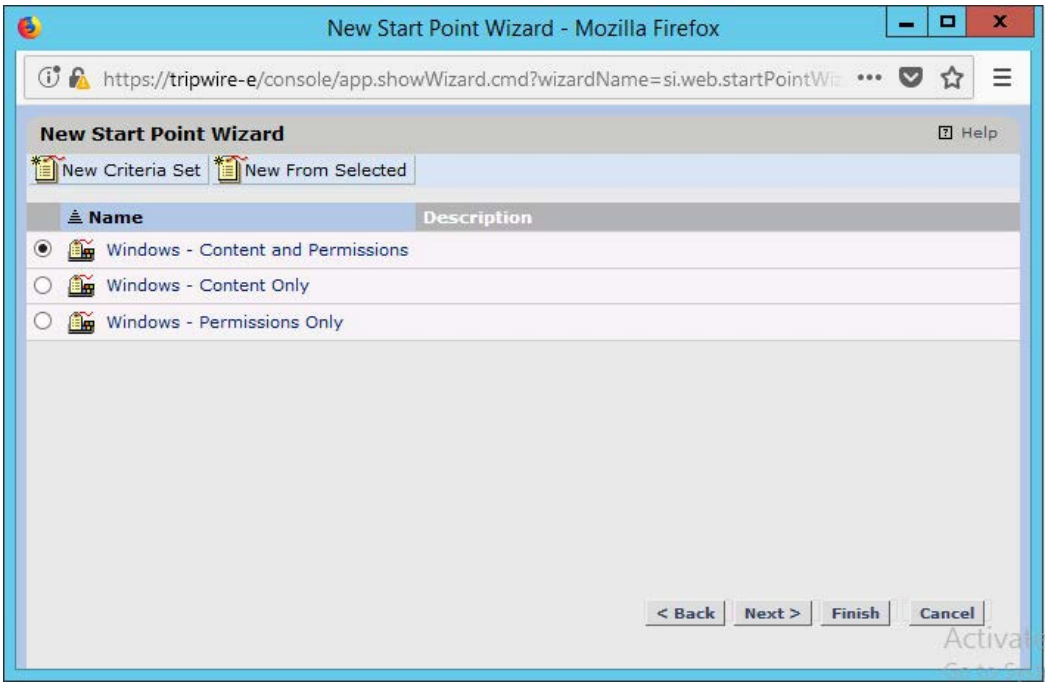
1849 8. Click **New Start Point.**

1850 9. For **Path,** enter a directory that represents the scope of the scan. It can be limited to the
1851 documents folder or be wide enough to encompass all the files on a system. Note that the latter
1852 will take much longer to scan.

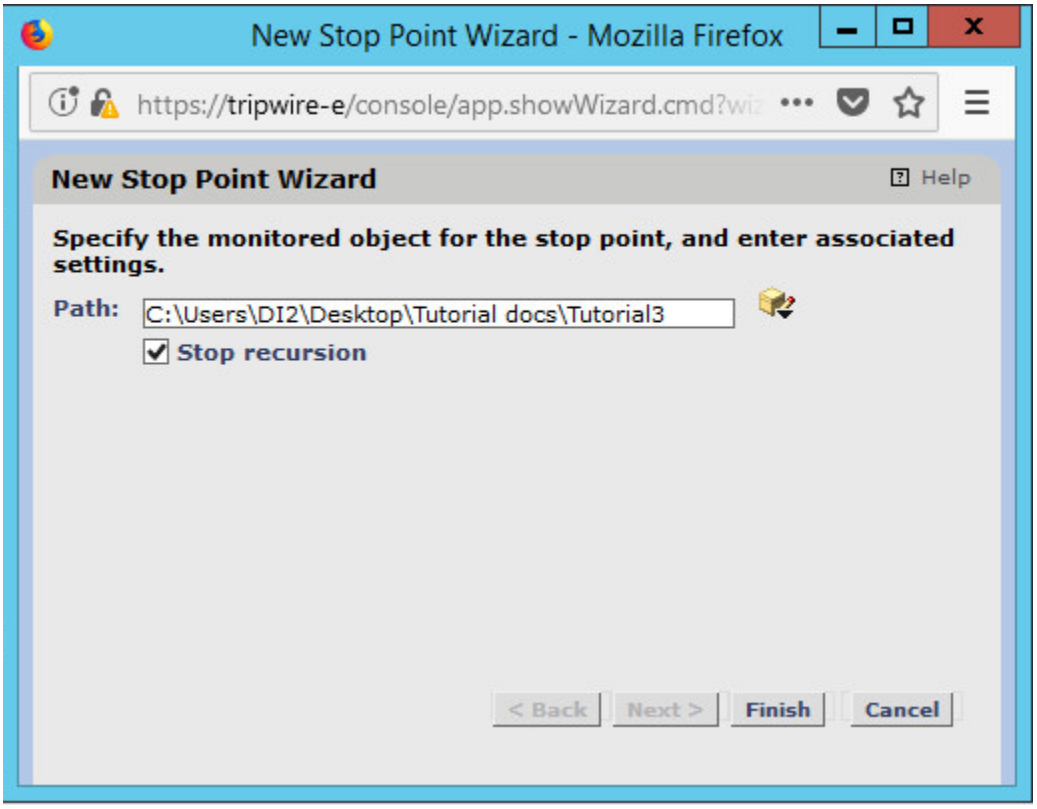
1853 10. Check the box next to **Recurse directory** if you also wish to scan all subfolders.



11. Click **Next.**
12. Select **Windows Content and Permissions.**



13. Click **Finish.**
14. Click **New Stop Point.**
15. Enter the path of any folders or files that should not be included in the scan, and indicate whether they should end the recursion.



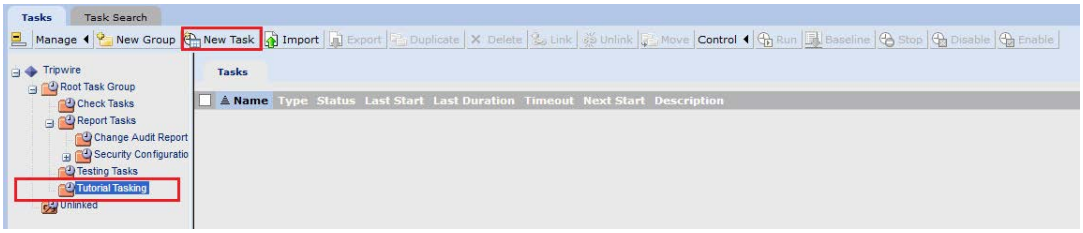
16. Click **Finish.**
17. Click **Next.**
18. Click **Next.**
19. Click **Finish.**

2.12.5.4 Tasks

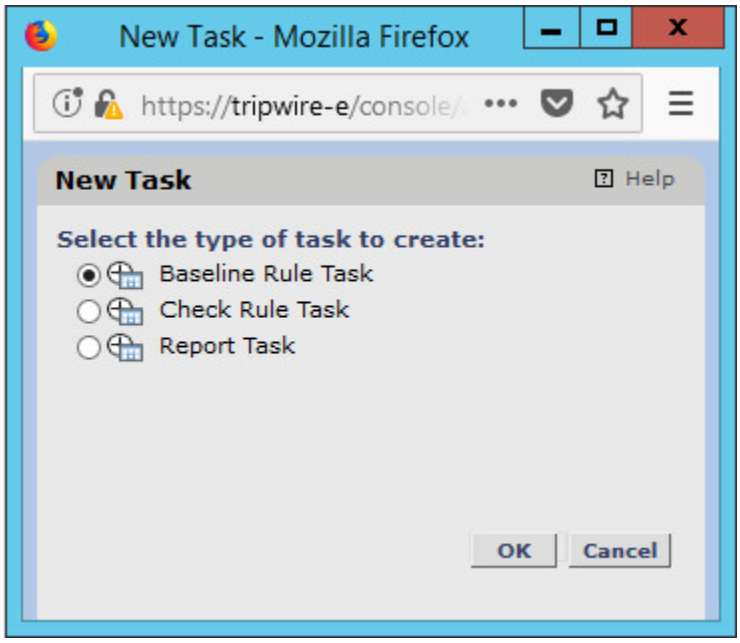
This section describes how to create a task on a schedule. These tasks can also be run manually if necessary.

1. Click **Tasks.**

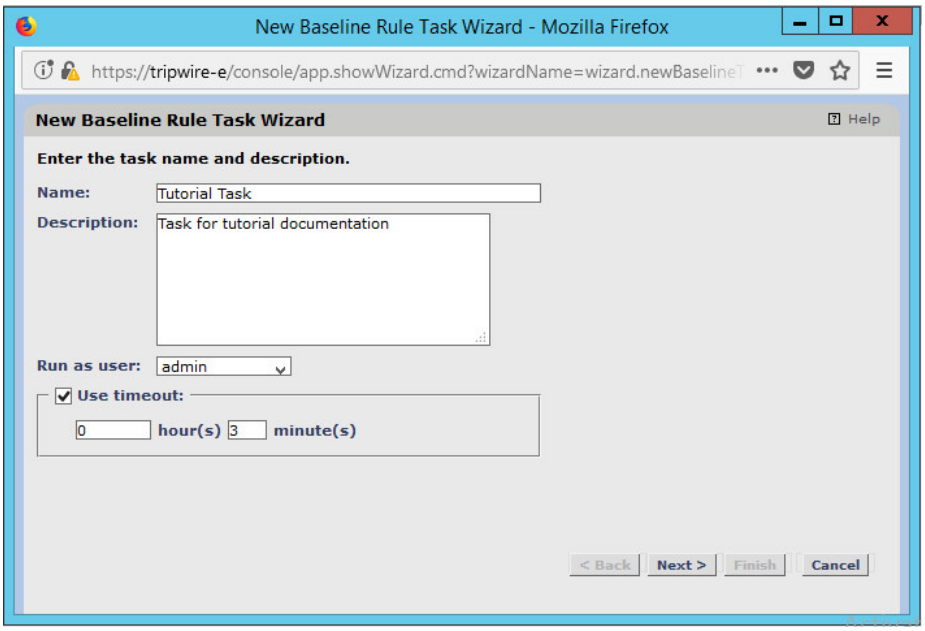
2. Select a folder for a new task, or create one.



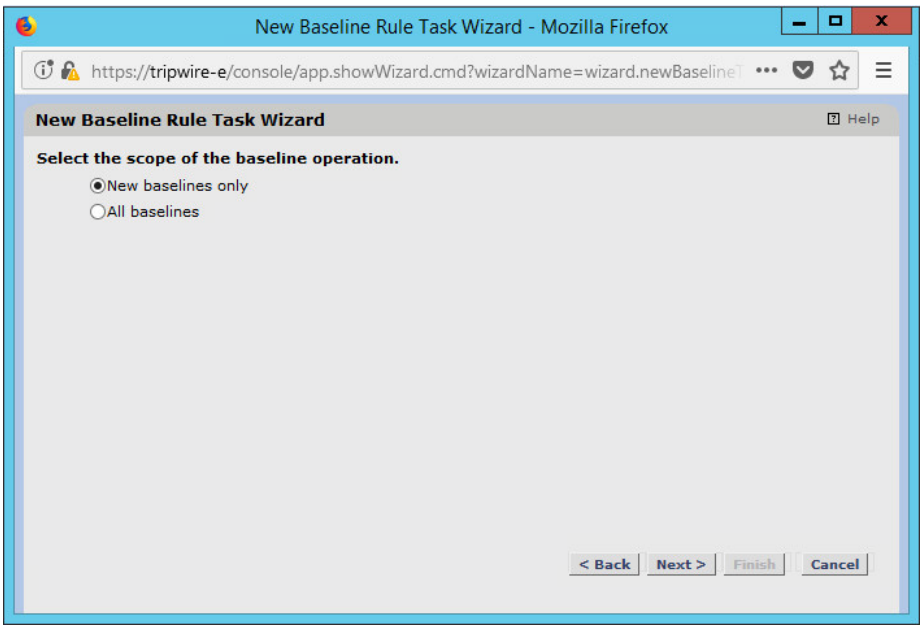
3. Click **New Task.**
4. Select **Baseline Rule Task** or **Check Rule Task.** (Note: Both are needed–baseline creates the initial state of the monitored object, and check updates the state and reports any changes.)



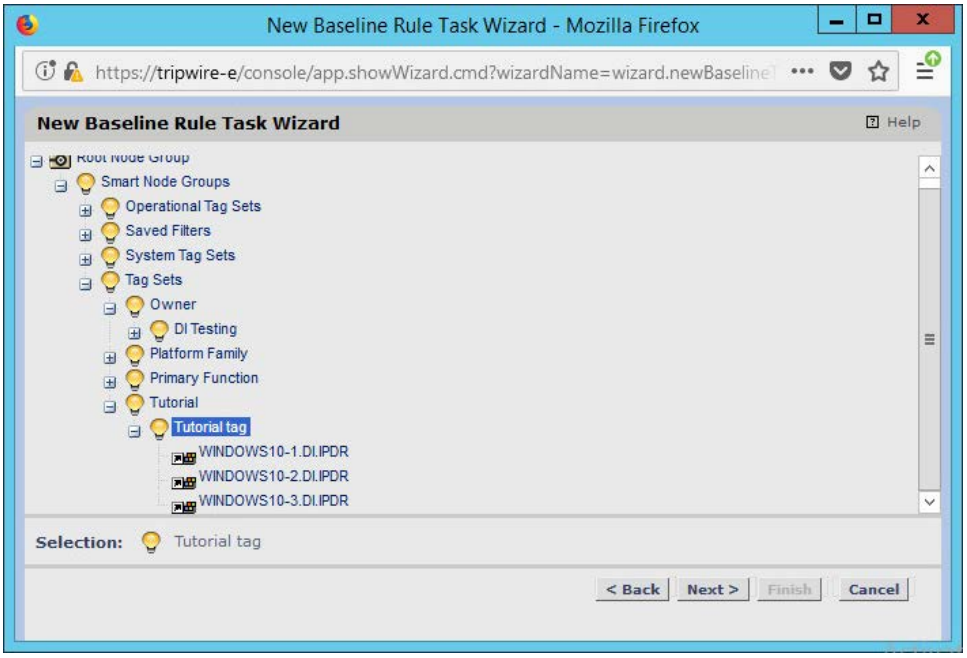
5. Click **OK.**
6. Enter a **name** and **description** for the task.



7. Click **Next.**
8. Select whether you want all baselines to be updated or to only create new baselines.



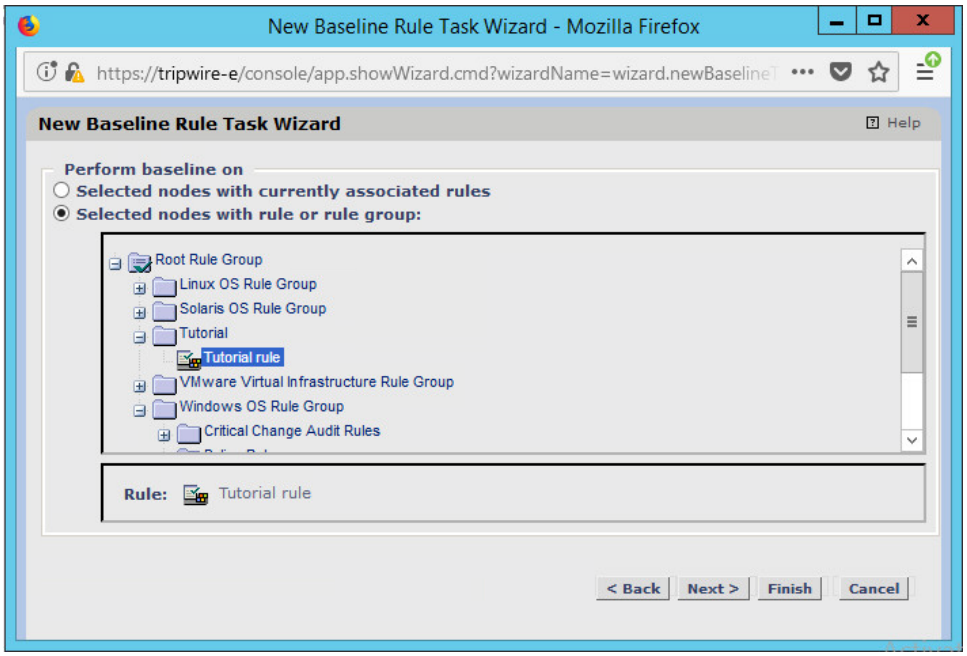
9. Click **Next.**
10. Select the systems to be included in the task. You can use tags or select by operating system (or other defaults).



1887

1888 11. Click **Next.**

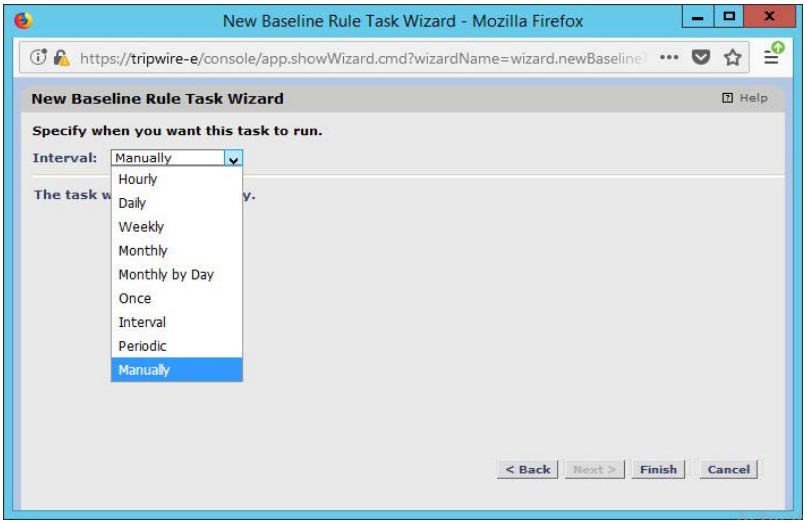
1889 12. Select the rule created earlier.



1890

1891 13. Click **Next.**

1892 14. Set the schedule of this task according to your organization's needs.



15. Click **Finish.**

2.13 Tripwire Log Center

2.13.1 Install Tripwire Log Center Manager

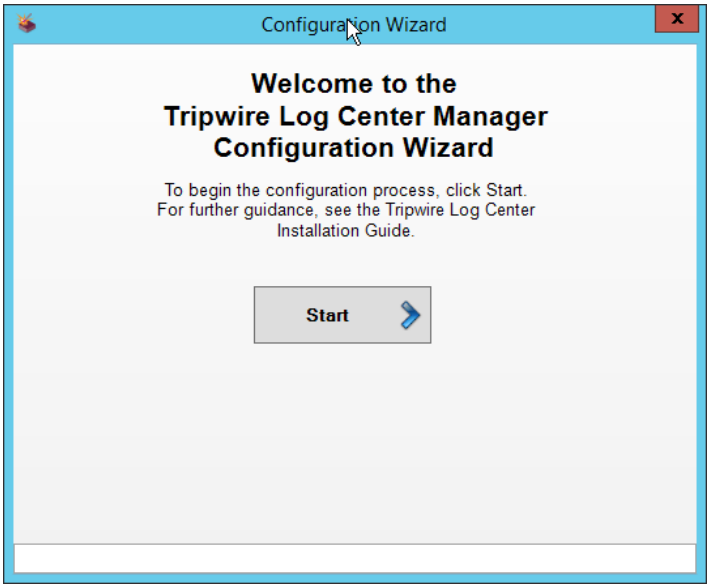
See the *Tripwire Log Center 7.3.1 Installation Guide,* which should accompany the installation media, for instructions on how to install **Tripwire Log Center.** Use the **Tripwire Log Center Manager** installer.

Notes:

a. It is recommended that you install **Tripwire Log Center** on a separate system from **Tripwire Enterprise.**
b. You will need to install **JRE8** and the **Crypto** library. Instructions are also in the *Tripwire Log Center 7.3.1 Installation Guide*.
c. .NET Framework 3.5 is required for this installation–install this from the Server Manager.
d. You may need to unblock port 9898 on your firewall for the Tripwire Enterprise agents.
e. Do not install PostgreSQL if you wish to use a database on another system–this guide will use a local PostgreSQL database, however.
f. When it finishes installing, there should be a configuration wizard (see below for configuration steps).

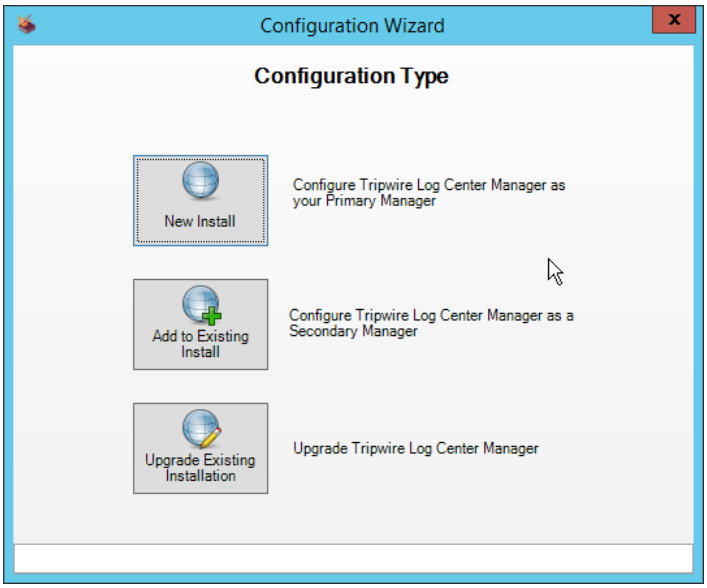
2.13.2 Configure Tripwire Log Center Manager

1. The configuration wizard should start after the installation is complete.



1912

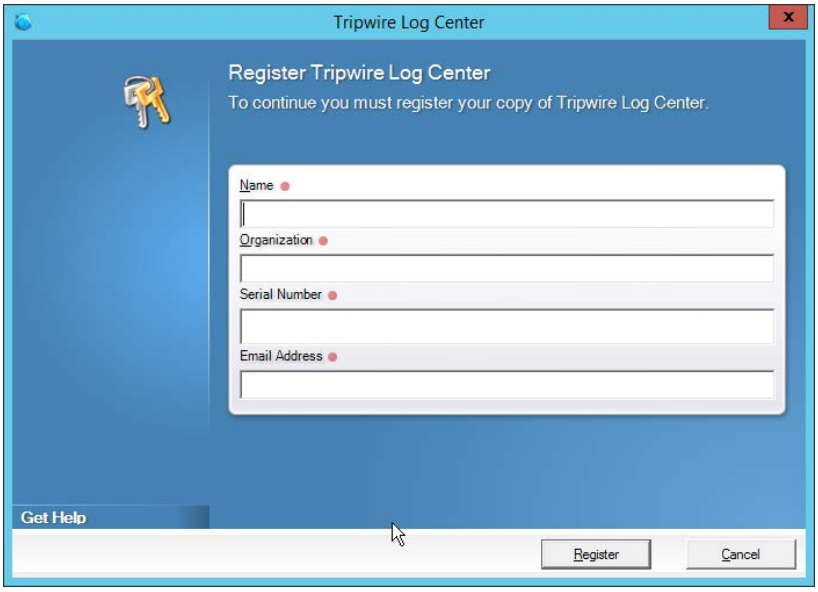
1913 2. Click **Start.**



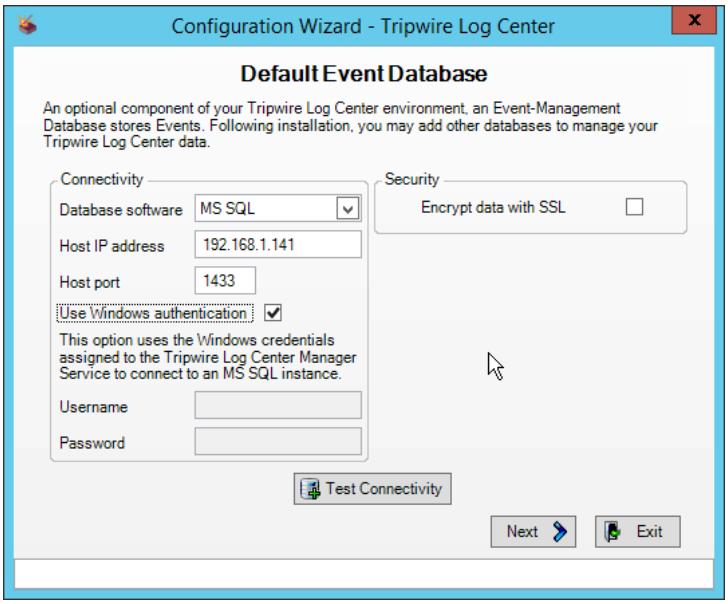
1914

1915 3. Click **New Install.**

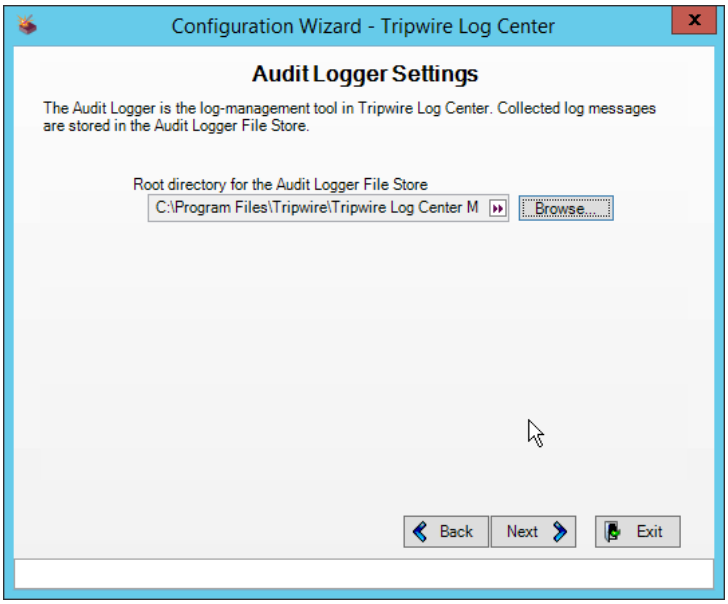
1916 4. Enter the registration details for your **Tripwire Log Center** license.



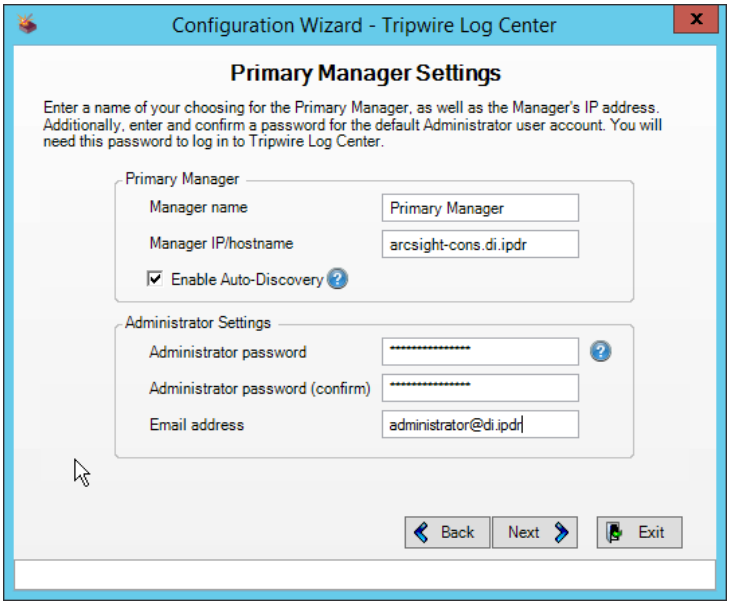
5. Click **Register.**
6. Enter details about the database that **Tripwire Log Center** should use.



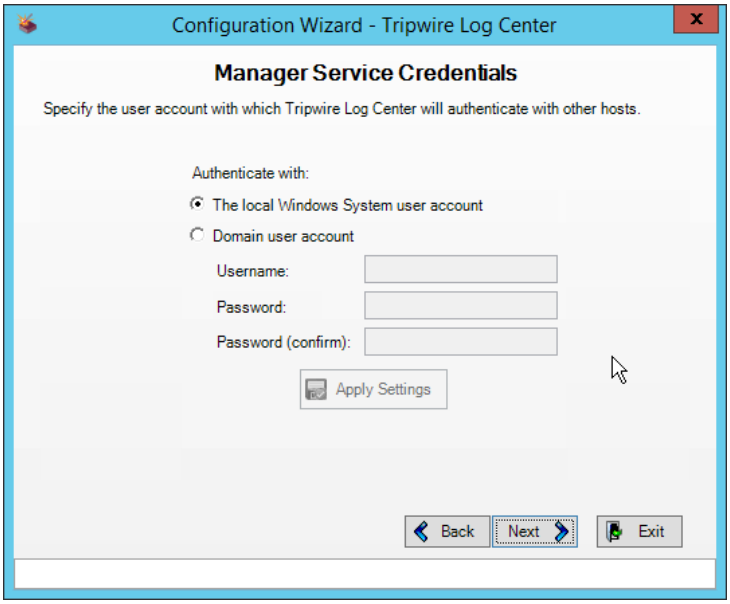
7. Click **Next.**
8. Select a directory in which to store log messages, such as C:\Program Files\Tripwire\Tripwire Log Center Manager\Logs\AUDIT.



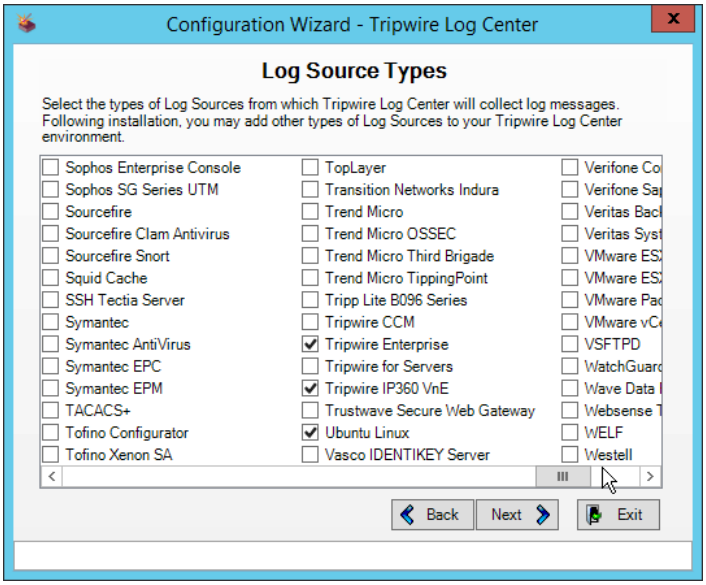
9. Click **Next.**
10. Enter a **password** and an **email.**
11. Change the IP to a hostname if preferred.



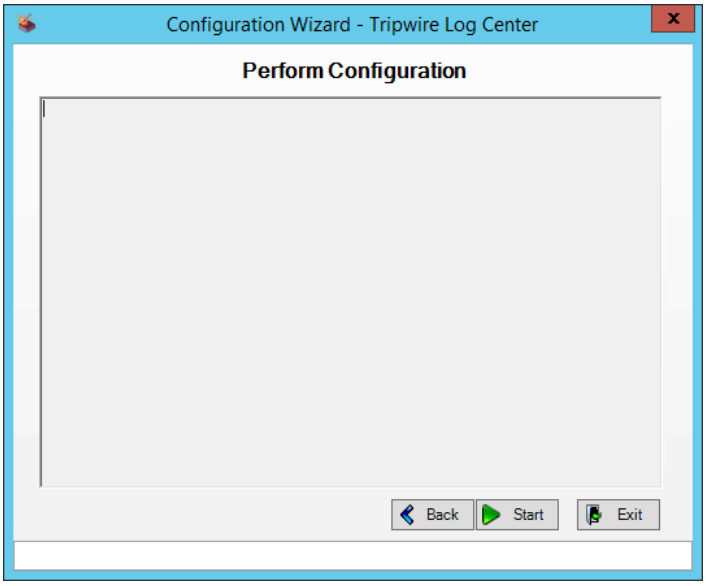
12. Click **Next.**



13. Click **Next.**
14. Select any log sources that you expect to collect with **Tripwire Log Center.** Examples: Tripwire Enterprise, Microsoft Windows 10, Tripwire IP360 VnE, Linux Debian, Ubuntu Linux, Microsoft Exchange, Microsoft SQL Server.

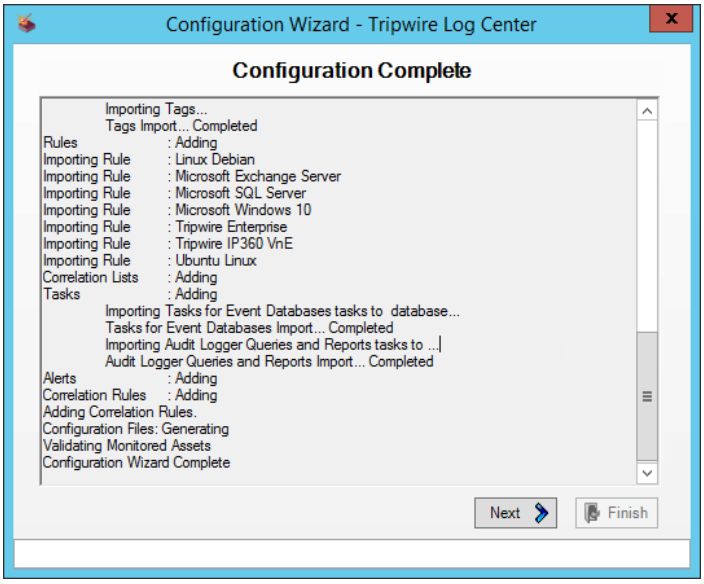


15. Click **Next.**



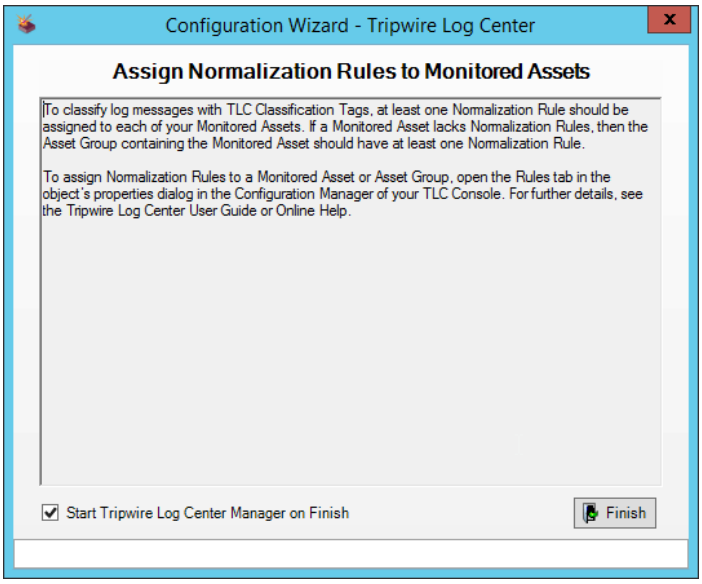
1937

1938 16. Click **Start.**



1939

1940 17. Click **Next.**



18. Click **Finish.**

2.13.3 Install Tripwire Log Center Console

Chapter 4 of the *Tripwire Log Center 7.3.1 Installation Guide* details installation of the **Tripwire Log Center Console.** Use the **Tripwire Log Center Console** installer.

You can install this on the same machine as the Tripwire Log Center Manager, if desired.

2.14 Cisco Web Security Appliance

This section details installation and some configurations for the Cisco Web Security Appliance (WSA). It assumes the use of the WSA virtual machine.

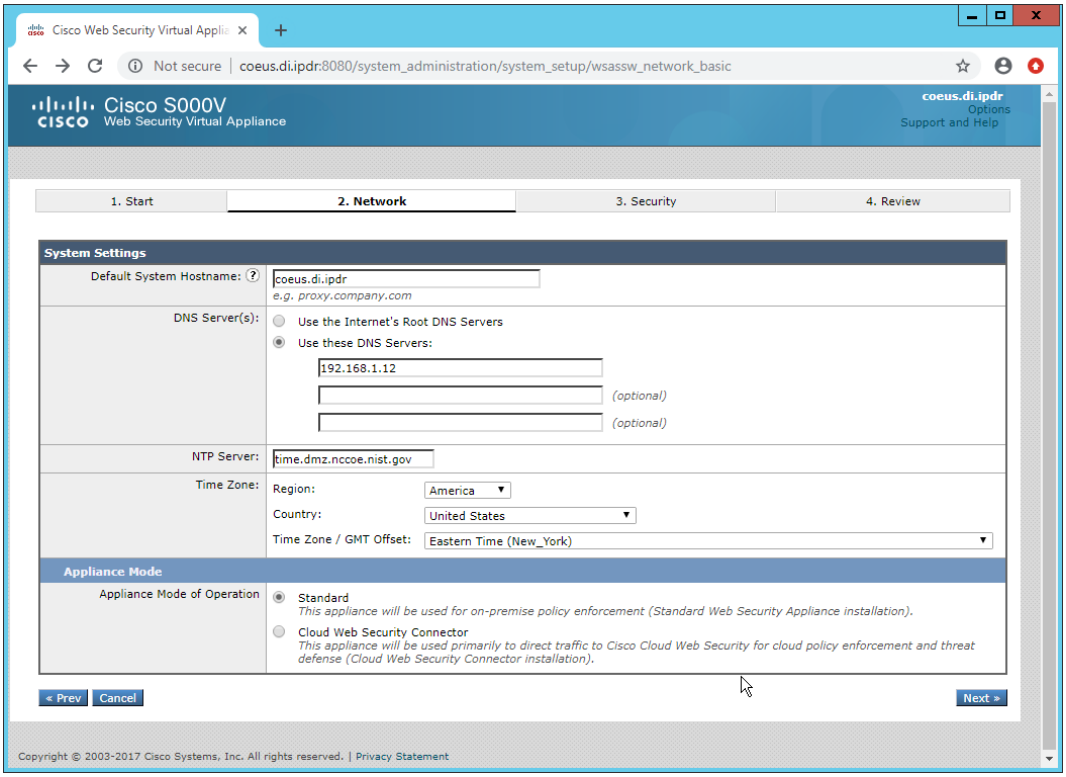
2.14.1 Network Configuration

1. Log in to WSA by using the default **username** and **password** (admin/ironport).
2. Use the command `sethostname` to set the hostname of the machine.
3. Use the command `dnsconfig` to set the DNS server. Enter **SETUP** when prompted, and then enter DNS information specific to your organization's needs.
4. Use the command `interfaceconfig` to set the IP of the machine. Enter **EDIT** when prompted, and then enter IP information specific to your organization's needs.
5. Use the command `passwd` to change the default password of the machine.

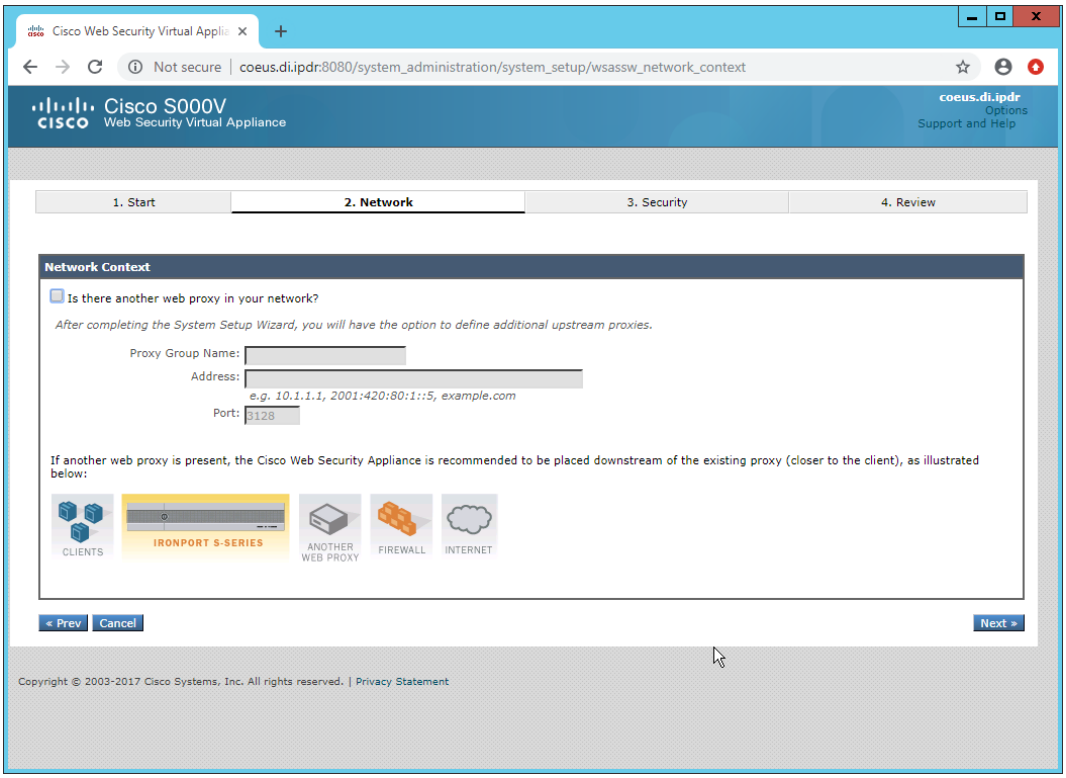
6. Use the command `commit` to commit all of these changes.
7. Use the command `reboot` to reboot the machine.
8. Use the command `loadlicense` to either paste the license file contents or select a license file uploaded via FTP. You can enable FTP in the `interfaceconfig` command.
9. You should be prompted at the console to visit a web page in the browser, usually http://<ip_address>:8080. The setup wizard will be here.

2.14.2 System Setup

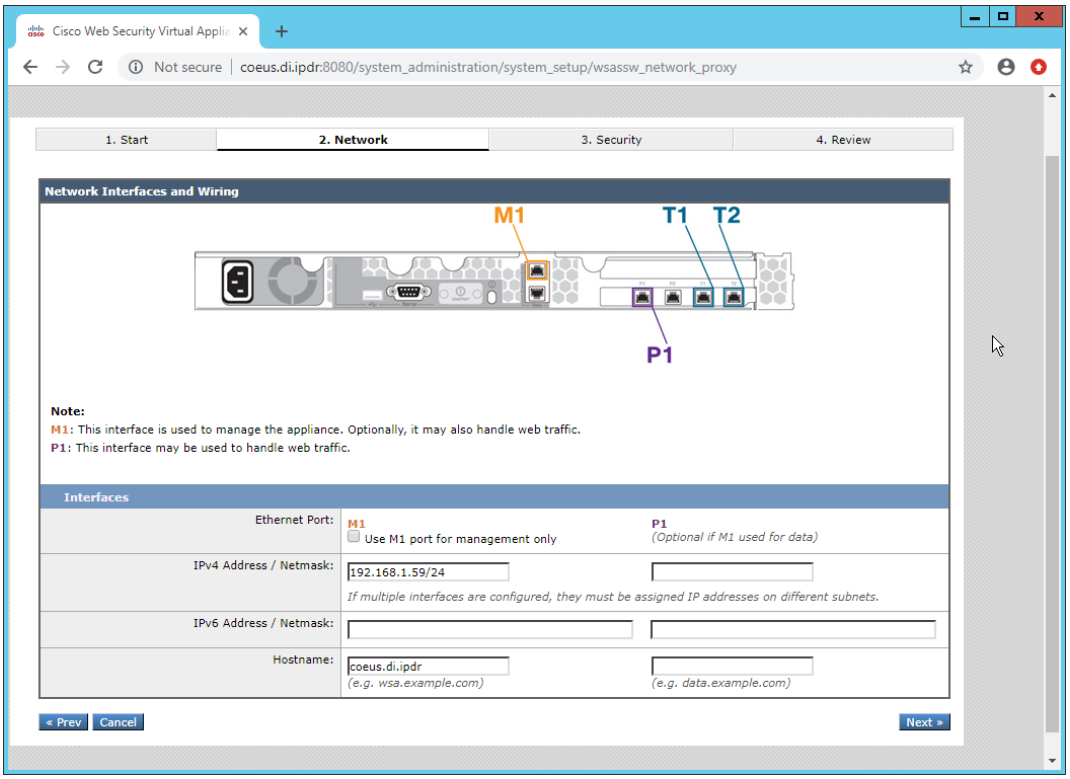
1. In the web console, click **System Administration > System Setup Wizard.**
2. Verify that the hostname matches the desired hostname.
3. Enter the desired **DNS servers.**
4. Enter a **time server** if desired.
5. Select the time zone.
6. Select **Standard** for an on-premise setup.



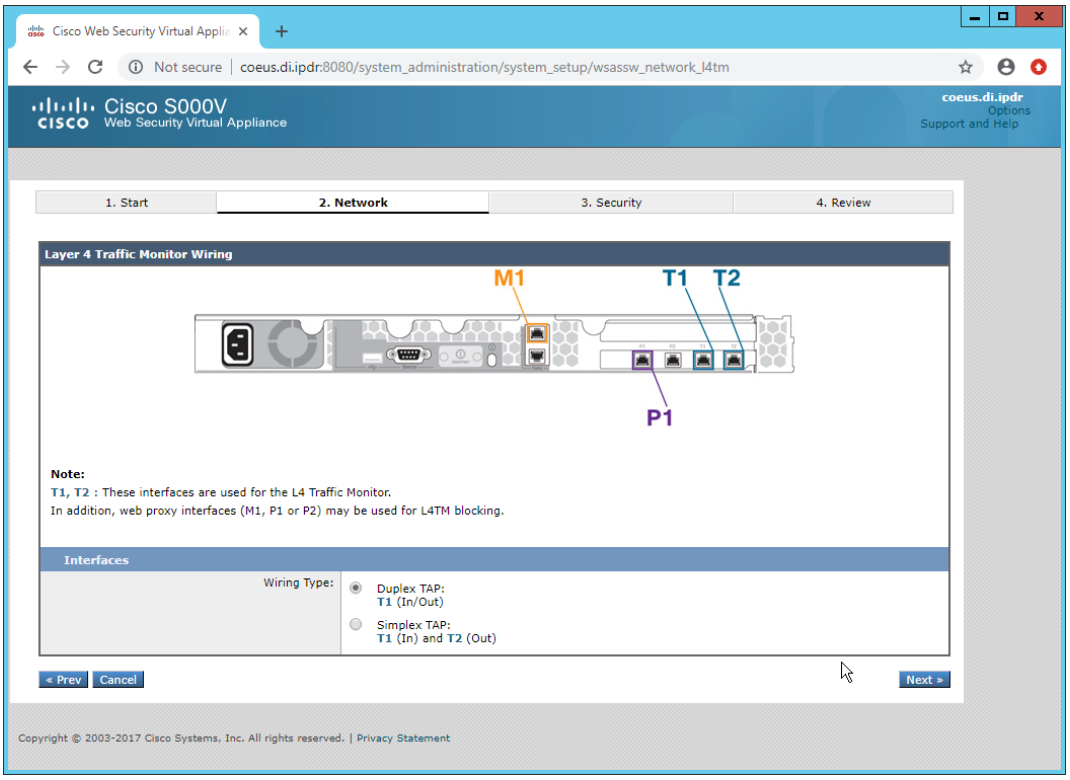
7. Click **Next.**



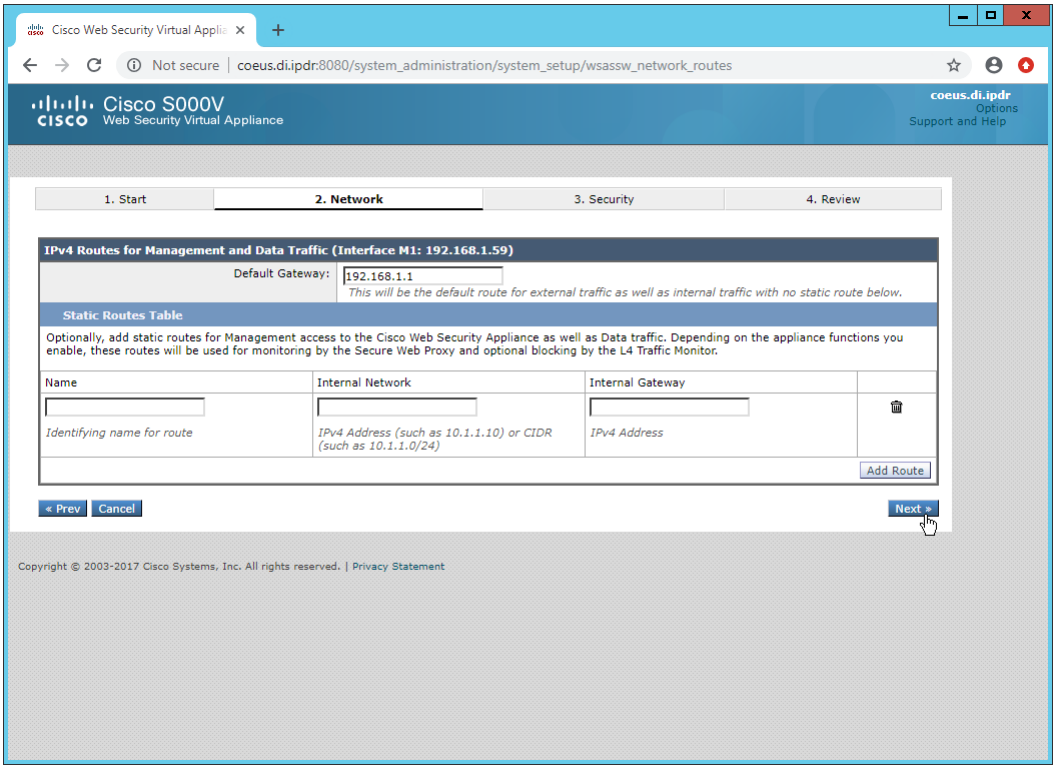
8. Click **Next.**
9. Verify that the interface is correctly configured.



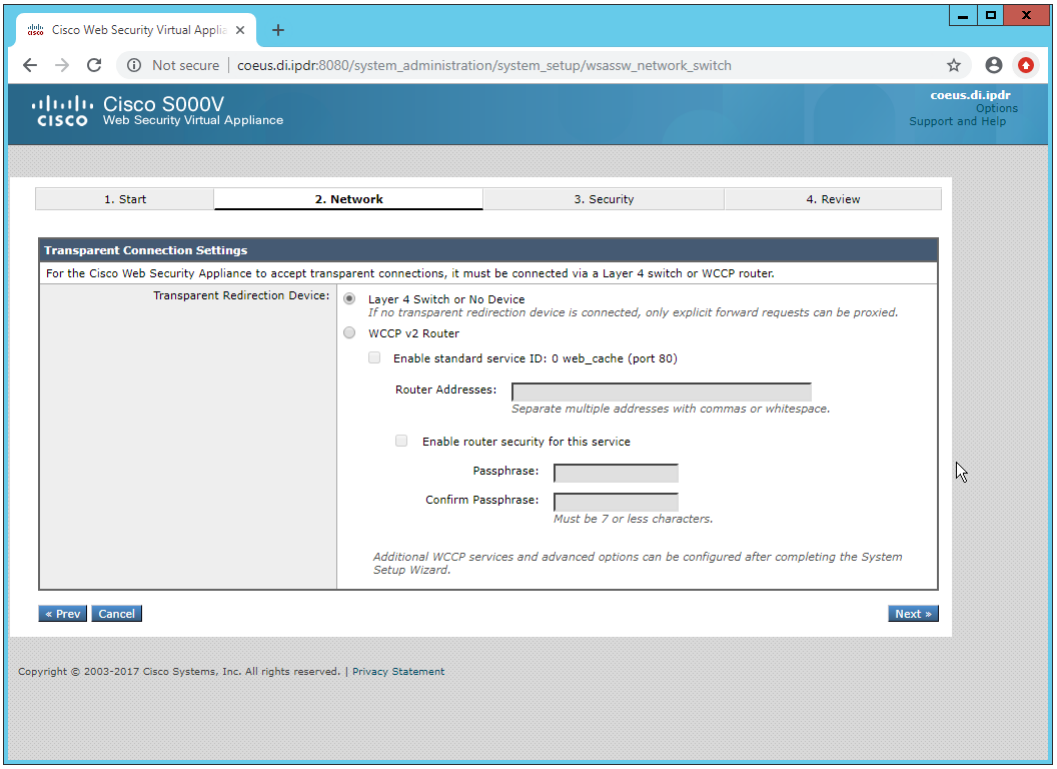
10. Click **Next.**



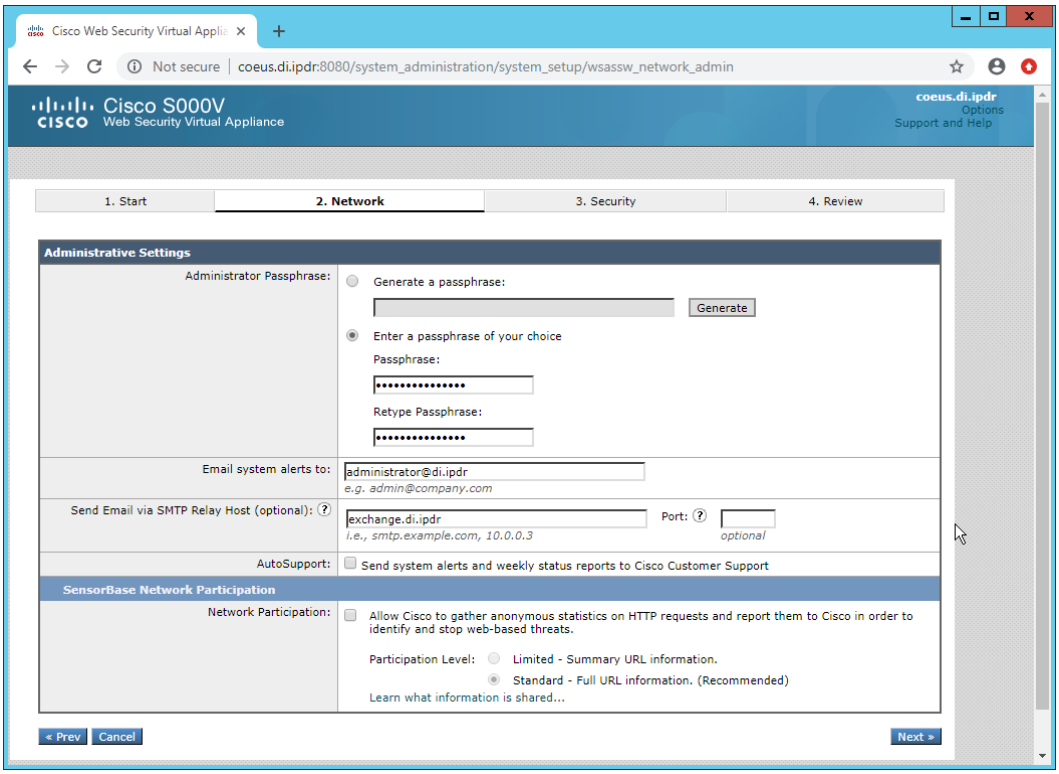
11. Click **Next.**
12. Enter the **default gateway** and any additional gateways to use for routing.



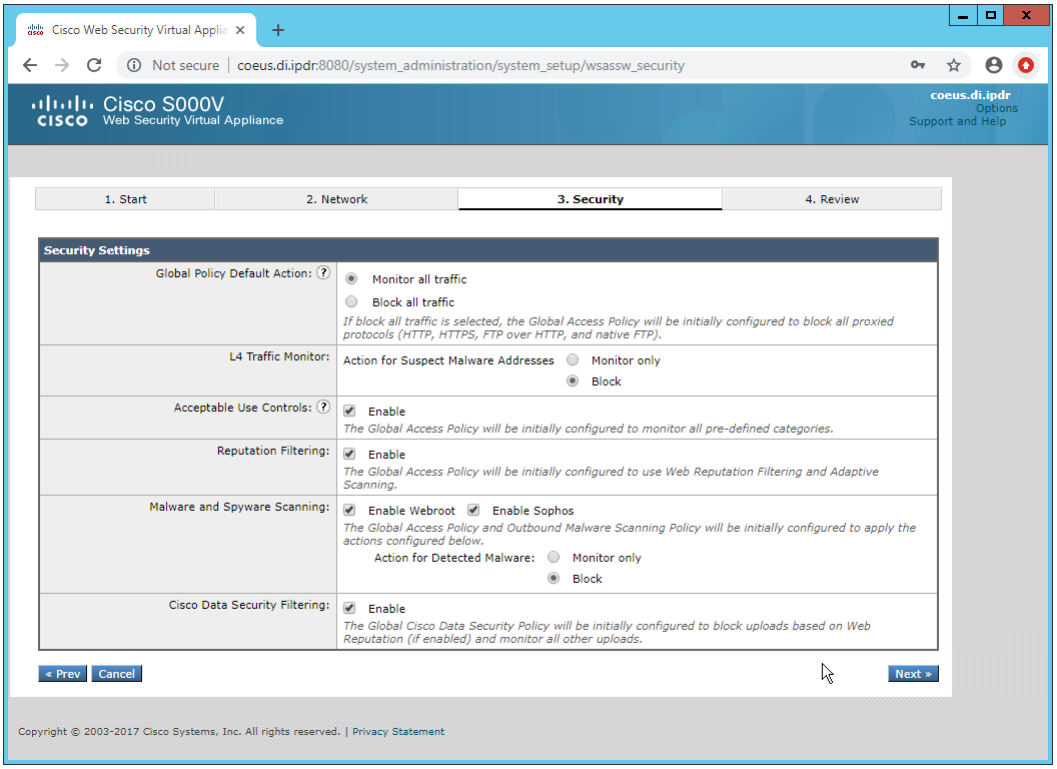
13. Click **Next.**



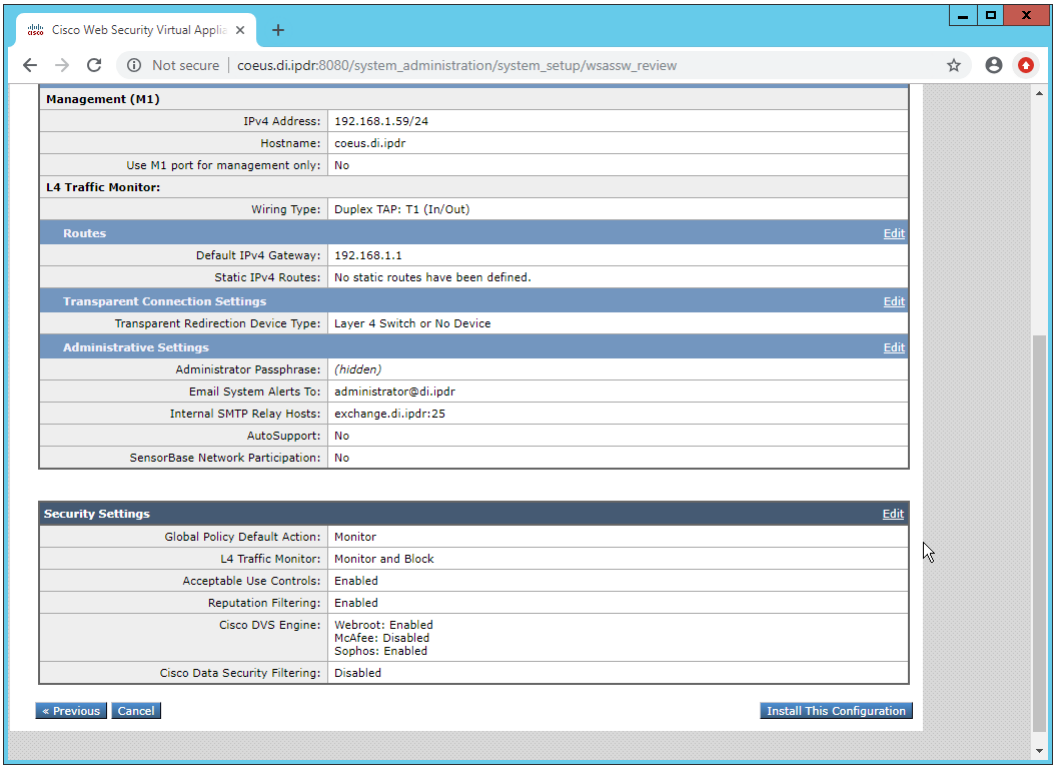
14. Click **Next.**
15. Set a **passphrase** for the administrator.
16. Enter an **email address** to which alerts should be sent.
17. Enter the **hostname** of the email server.
18. Decide whether to forward alerts and reports to Cisco Customer Support, as well as whether to share anonymous statistics based on the needs of your organization.



19. Click **Next.**
20. Select **Monitor All Traffic.**
21. Select **Block** for **Action for Suspect Malware Addresses.**
22. Select **Block** for **Action for Detected Malware.**
23. Configure the rest of the malware policy according to your organization's needs.



24. Click **Next.**



25. Click **Install This Configuration.**

2.14.3 Using WSA to Proxy Traffic

Cisco WSA is intended to act as a proxy between clients and the internet, to prevent malicious traffic and software from reaching the client systems before they can do any damage. The appliance must have a way of intercepting traffic from the clients to the internet.

To achieve this, we used a Proxy Auto Config (PAC) file on our DNS server (Windows 2012 DNS), and this section details how to set up a simple PAC file to forward all traffic to WSA. This may not be an ideal setup for every environment, particularly in environments that use an external DNS server.

2.14.3.1 Creating a PAC File

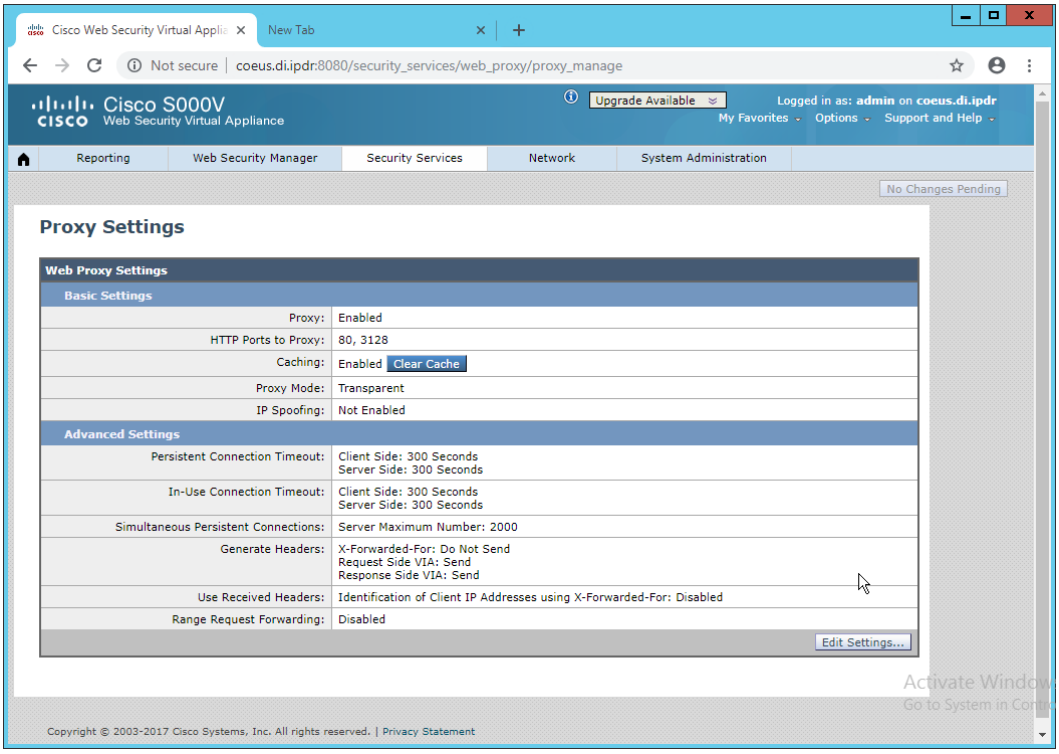
1. Create a new file named **wpad.dat** and enter the following JavaScript function:

```
function FindProxyForURL(url, host) {
      return "PROXY coeus.di.ipdr:3128";
}
```

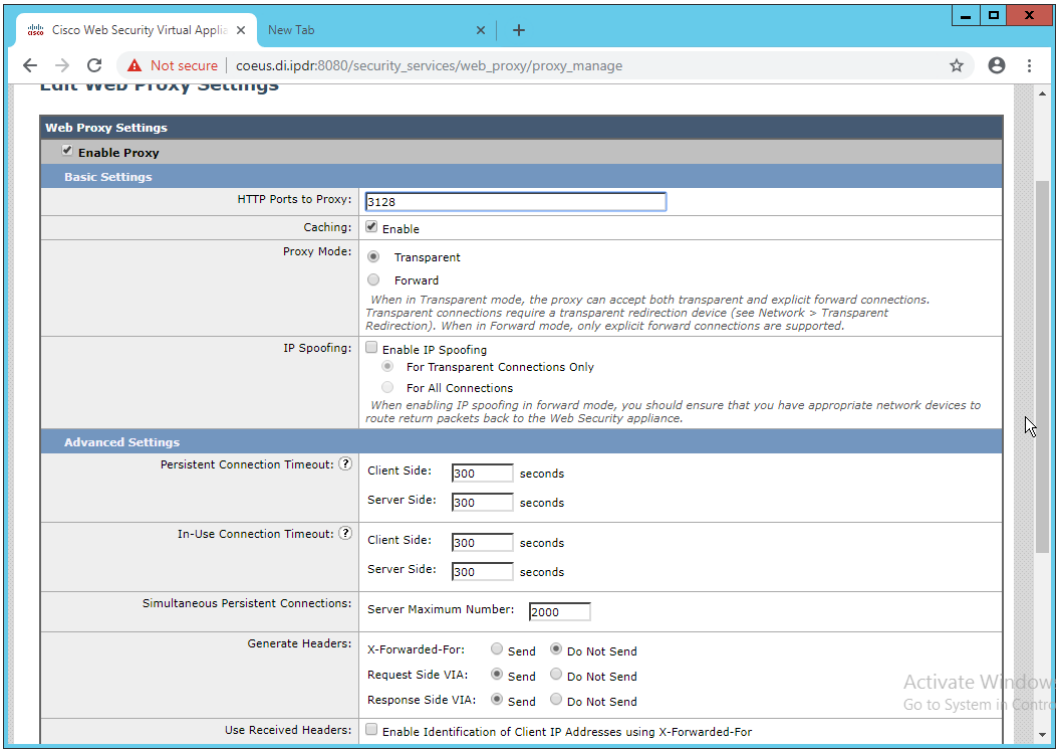
This is the most basic template for a proxy that directs all traffic to the host coeus.di.ipdr. The return value of this function can take the form "`PROXY <hostname1>; PROXY <hostname2>`" if you wish to have fail-over proxies, or "`DIRECT`" to not use any proxy. You can also add rules to allow certain types of traffic through the proxy or direct them to other proxies. For more information, see https://findproxyforurl.com.

For the purposes of our setup, we will simply direct all traffic to Cisco WSA, but be aware that PAC files can be more complex and designed according to the needs of the organization.

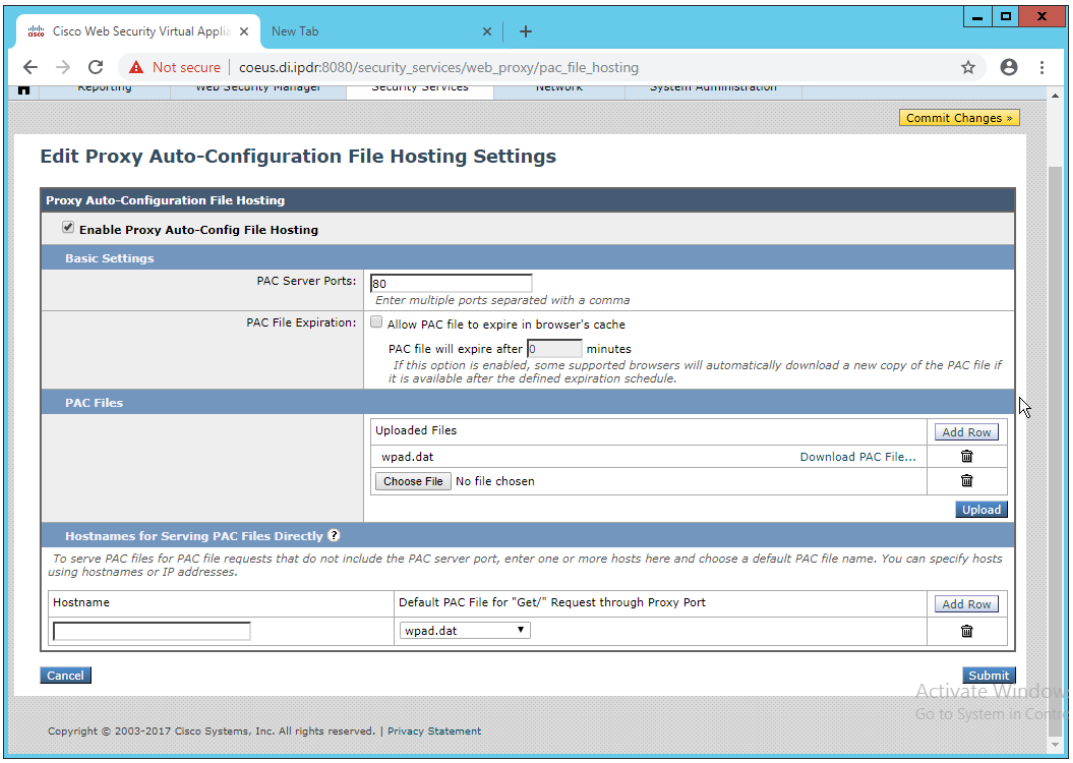
2. In the web console, navigate to **Security Services > Web Proxy.**



3. Click **Edit Settings.**
4. Remove port 80 from **HTTP Ports to Proxy** (ensure that **3128** is in this field).



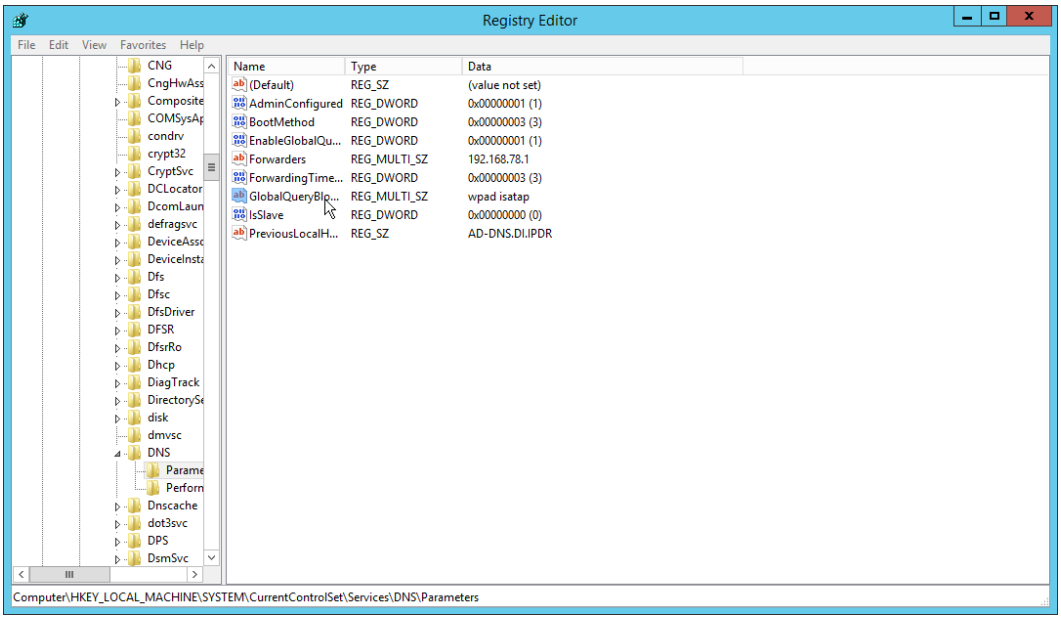
5. Click **Submit.**
6. Navigate to **Security Services > PAC File Hosting.**
7. Click **Enable and Edit Settings.**
8. Under **PAC Files,** click **Choose File.**
9. Select the ***wpad.dat*** file created earlier.
10. Click **Open.**
11. Click **Upload.**
12. Enter **80** for **PAC Server Ports.**



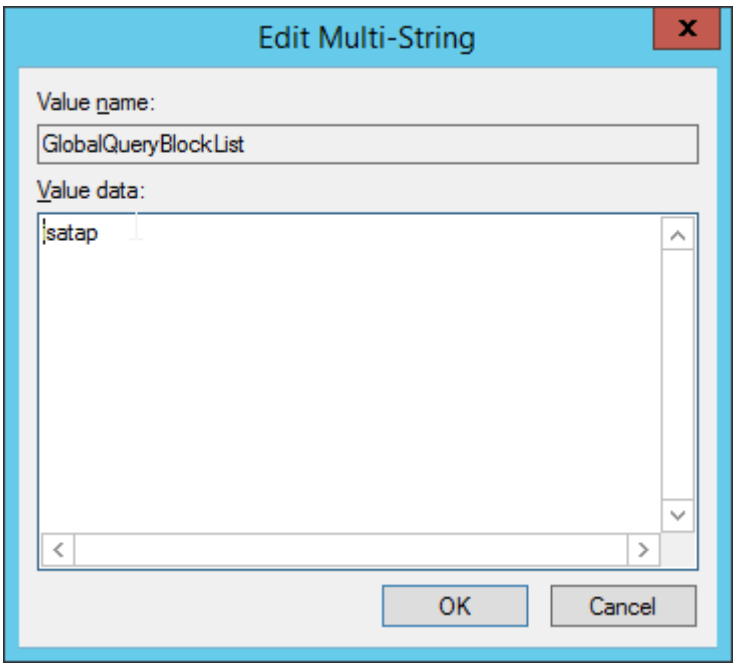
13. Click **Submit.**
14. Click **Commit Changes.**
15. Enter a comment if desired.
16. Click **Commit Changes.**

2.14.3.2 Setting Up Web Proxy Auto Discovery (WPAD)

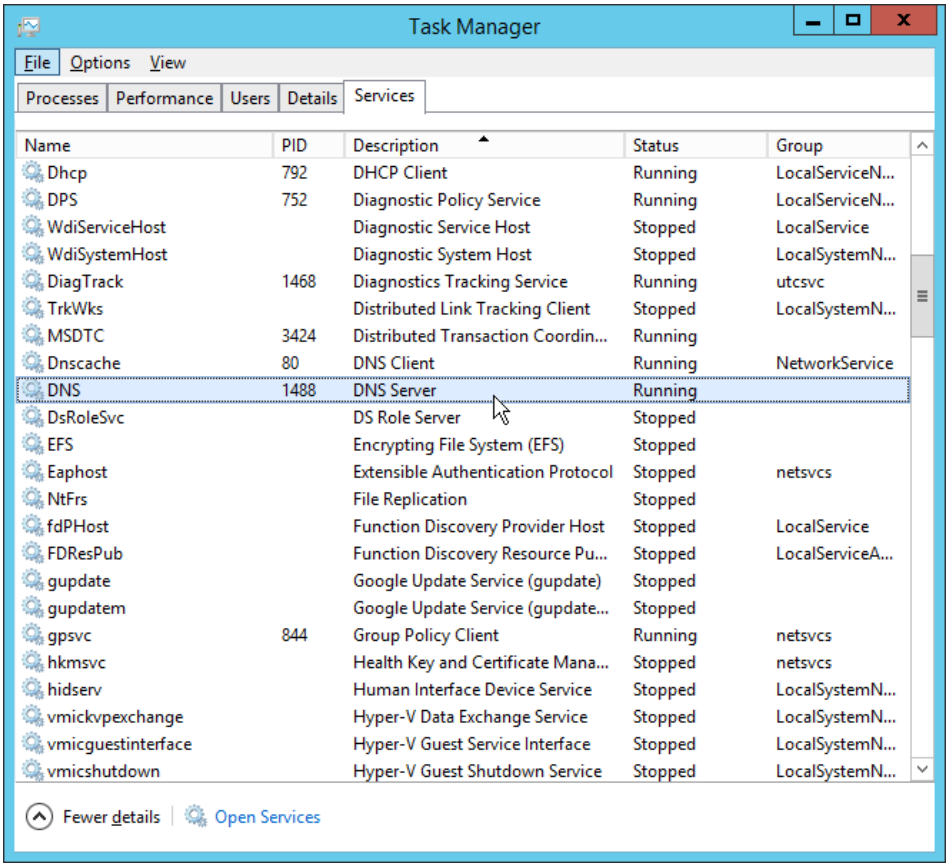
1. On the DNS server, open **regedit.exe**.
2. Navigate to **HKEY_LOCAL_MACHINE > SYSTEM > CurrentControlSet > Services > DNS > Parameters.**



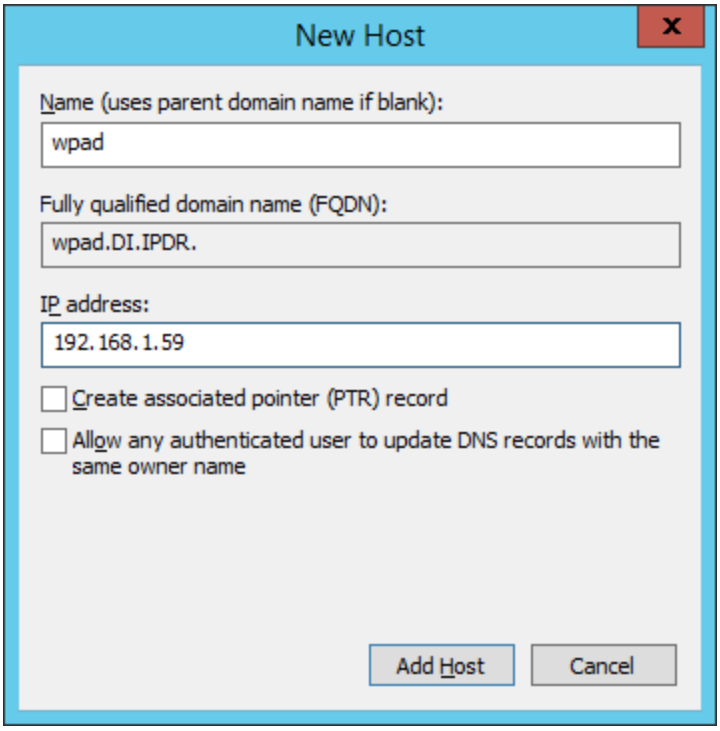
3. Double-click **GlobalQueryBlockList.**
4. Remove wpad from the list but leave isatap on the list.



5. Click **OK.**
6. Open **Task Manager.**
7. Click **Services.**



8. Restart the **DNS Server** service.
9. Open **DNS Manager.**
10. Right-click on your enterprise's domain, and click **New Host (A or AAAA).**
11. Enter **wpad** for **Name.**
12. Enter the **IP address** of WSA.



13. Click **Add Host.**

This will set up the WPAD proxy file as the default proxy–so browsers that are using "Automatically detect settings" for their proxy setting will find this file. Be aware that this is not sufficient for a secure setup but will allow you to quickly test the proxy's functionality.

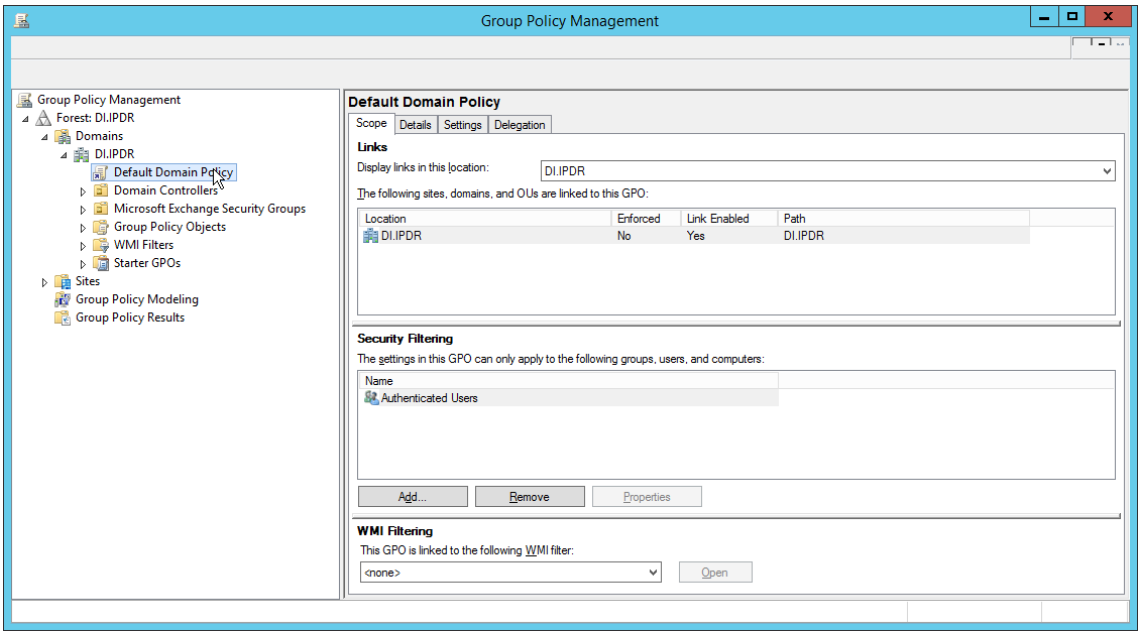
2.14.3.3 Configure Group Policy to Use Explicit Proxy

Note that, at this point, WPAD is vulnerable to an attack where the server hosting WPAD is brought down and the browser automatically attempts to find the next WPAD proxy, which may be controlled by an attacker.

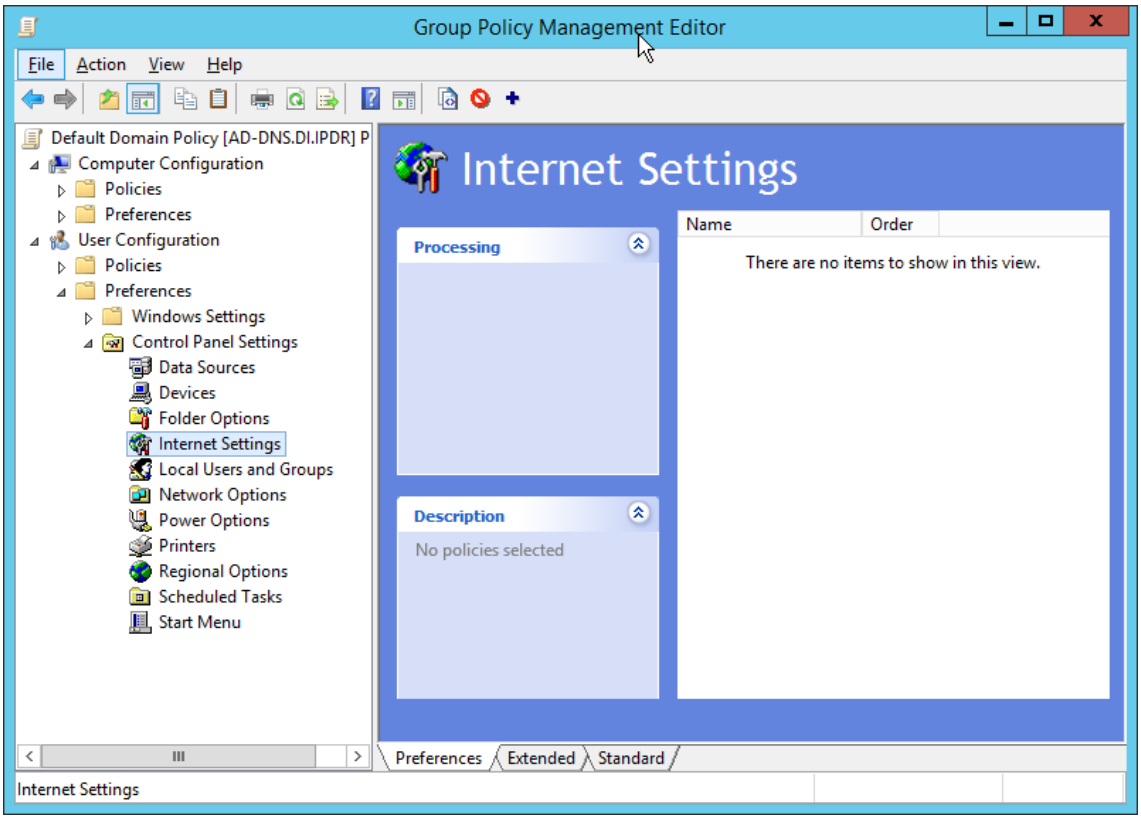
To mitigate this vulnerability, we explicitly point to this proxy file with any browsers used by clients. For Internet Explorer and Google Chrome, it is sufficient to change group policy in Active Directory to direct the change across all systems.

For Mozilla Firefox, see this link (https://support.mozilla.org/en-US/kb/connection-settings-firefox) for configuration, including how to set it to "Use system proxy settings."

1. In **Group Policy Management,** right-click the **Default Domain Policy** and click **Edit.**



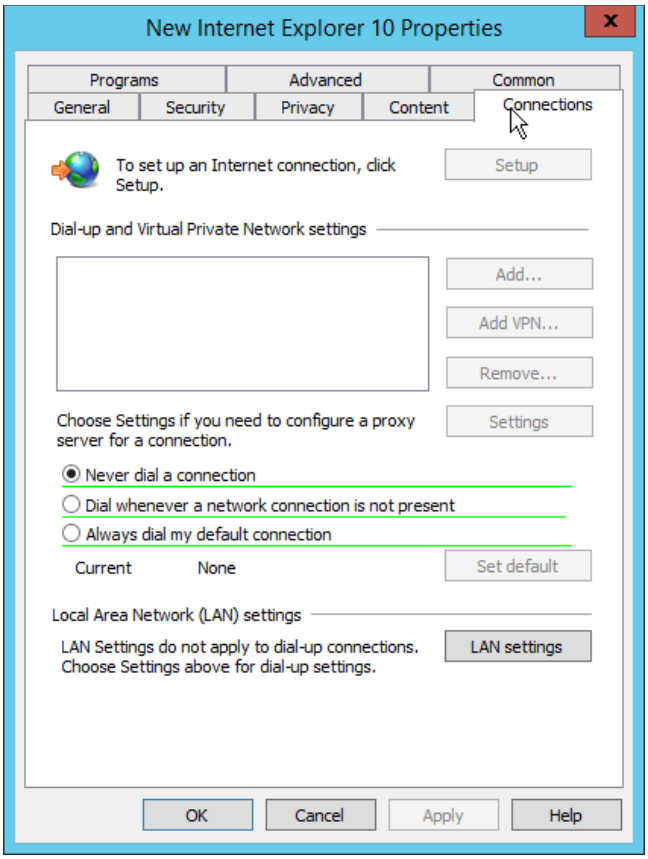
2. In **Group Policy Management Editor,** navigate to **User Configuration > Preferences > Control Panel Settings > Internet Settings.**



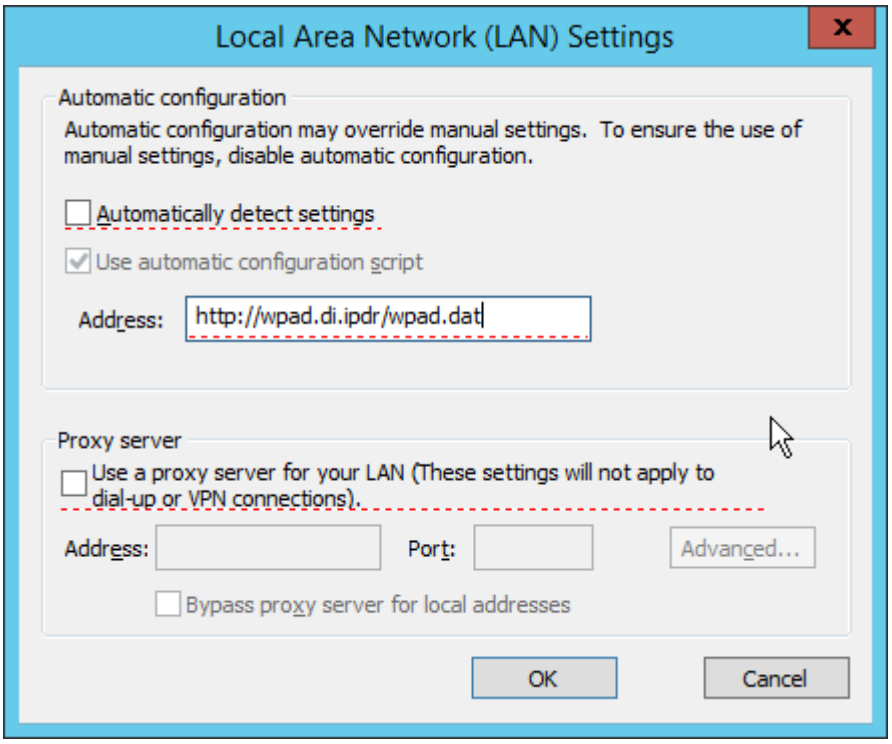
2070

2071 3. Right-click **Internet Settings** and select **New > Internet Explorer 10.**

2072 4. Click the **Connections** tab.

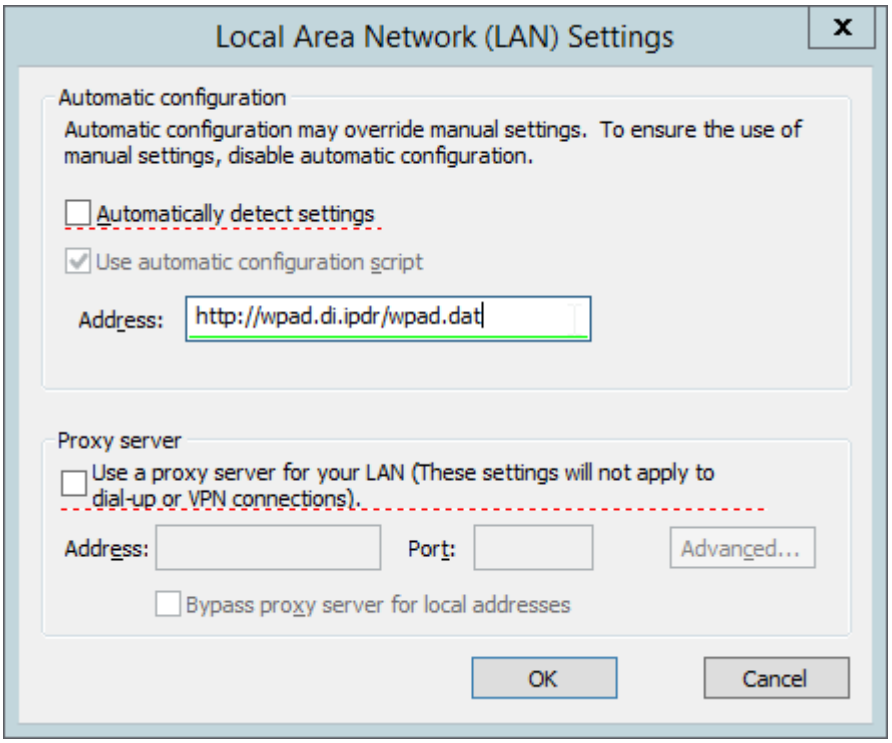


5. Click **LAN Settings.**
6. Enter the **address** of the WPAD file for address. This will likely take the form http://wpad.my.domain/wpad.dat if you followed these instructions for configuring the proxy file.
7. Press the **F8** key to disable all settings in this dialogue box. (Note: This should underline everything in the box in red.)



2080

2081 8. Select the **Address** you just entered.

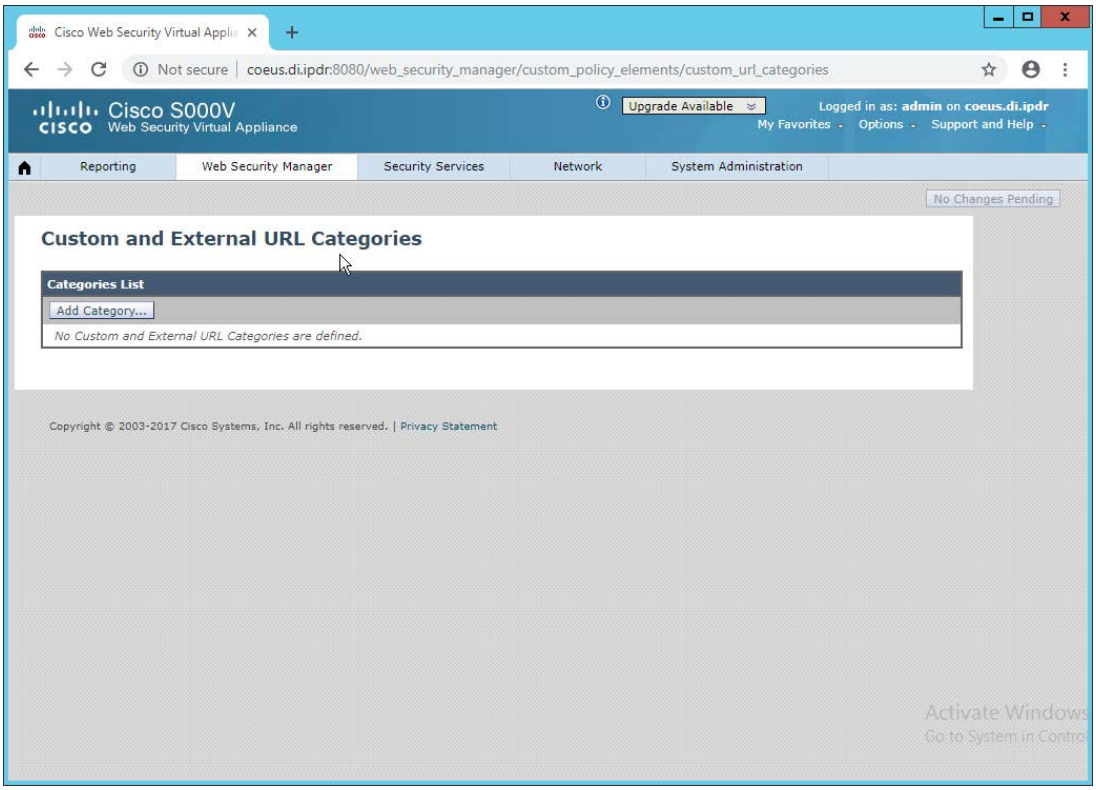


9. Press **F6** to enable this setting. (Note: The explicit WPAD address should now be underlined in green.)
10. Click **OK.**
11. Click **OK.**

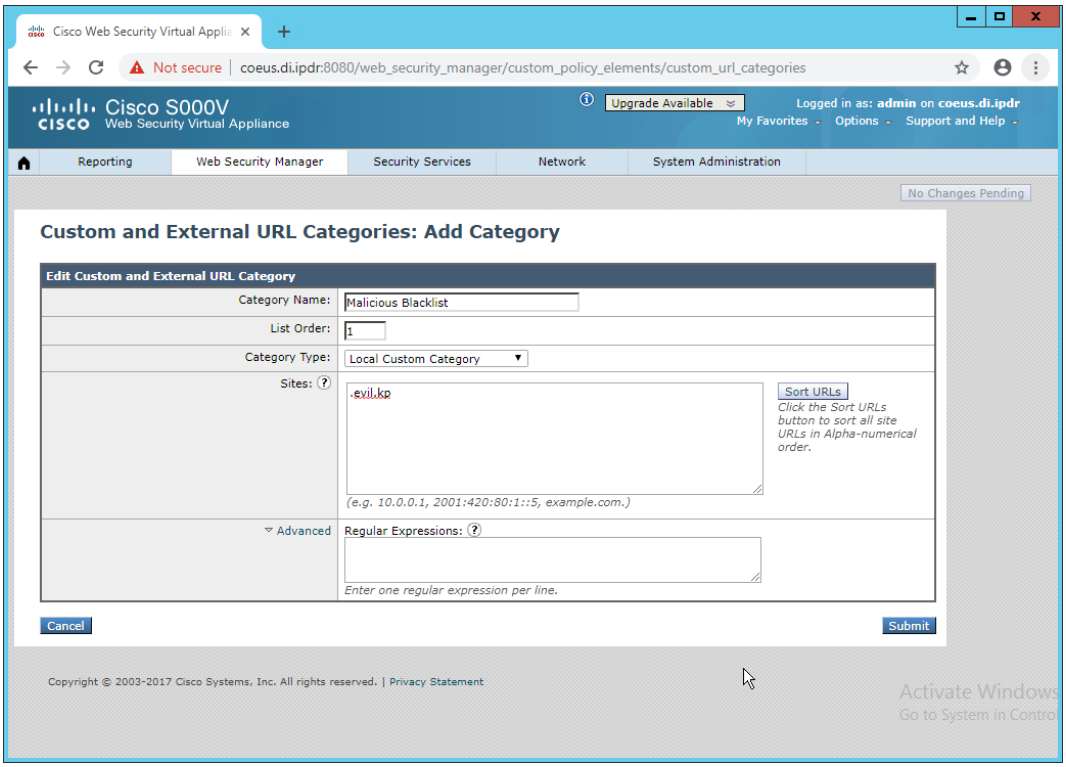
This Group Policy Object will update across all Windows systems whenever gpupdate.exe runs. An insider or technically capable user could manually disable this to avoid using the proxy, but benign clients who do not attempt to circumvent it will be protected from external (internet-based) threats by Cisco WSA. Protection from insiders and local threats on the network is provided by other products in the architecture, such as the network protection component (CryptoniteNXT).

2.14.4 Blacklisting

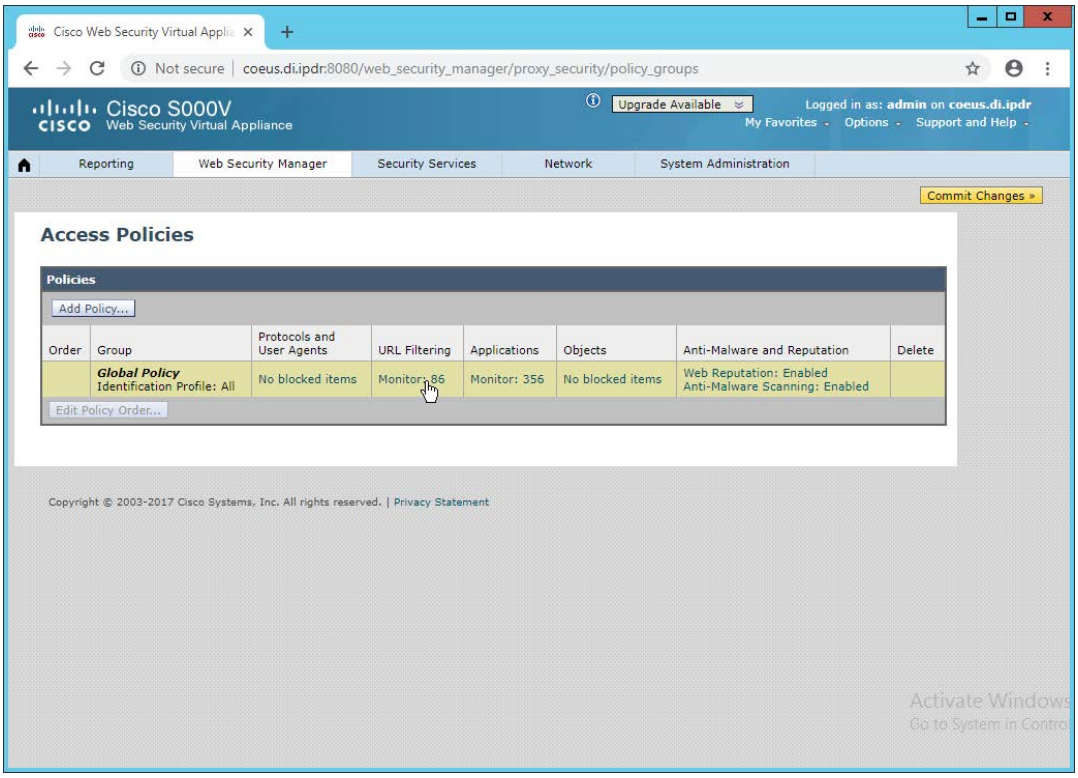
1. Navigate to **Web Security Manager > Custom and External URL Categories.**



2. Click **Add Category.**
3. Enter a **name** for **Category Name.**
4. Select **Local Custom Category.** (The other option, **External Live Feed Category,** allows WSA to use a list of websites hosted somewhere else, potentially externally. For this demonstration we will simply enter websites in the **Sites** field, but note that this other option is available for convenience.)
5. For **Sites,** enter any sites to blacklist. (Note: Entering **.mysite.abc** will include any subdomains of **mysite.abc.**)

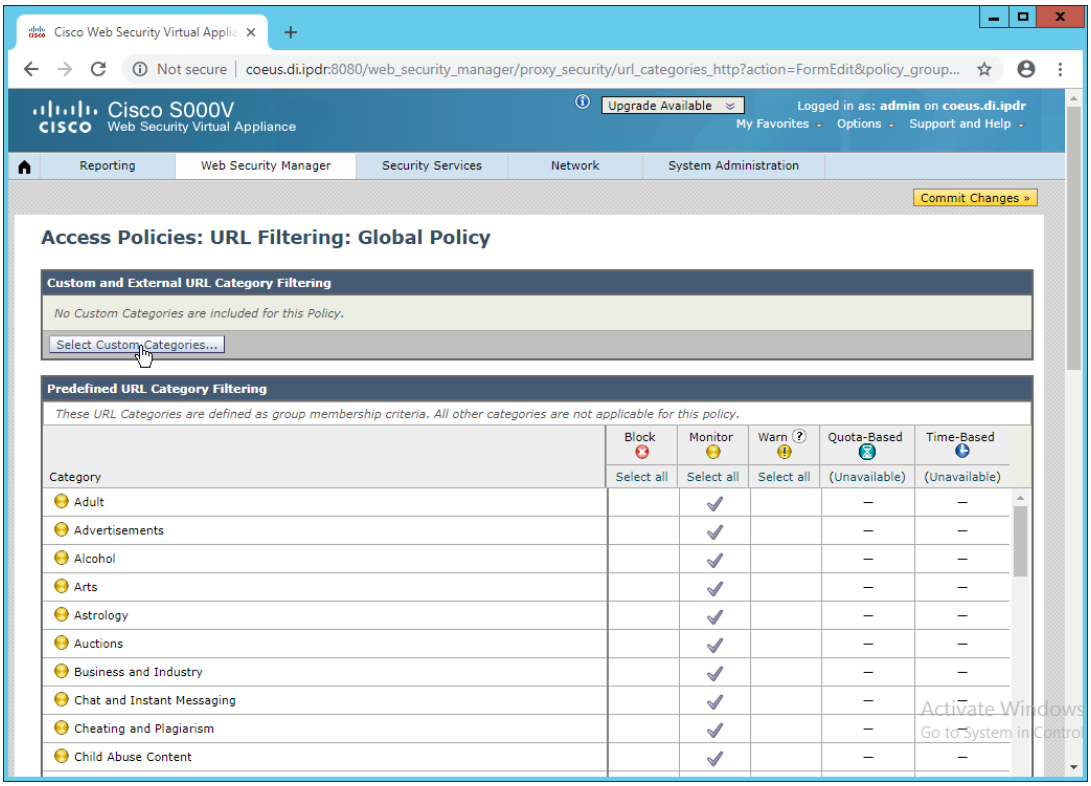


6. Click **Submit.**
7. Navigate to **Web Security Manager > Access Policies.**

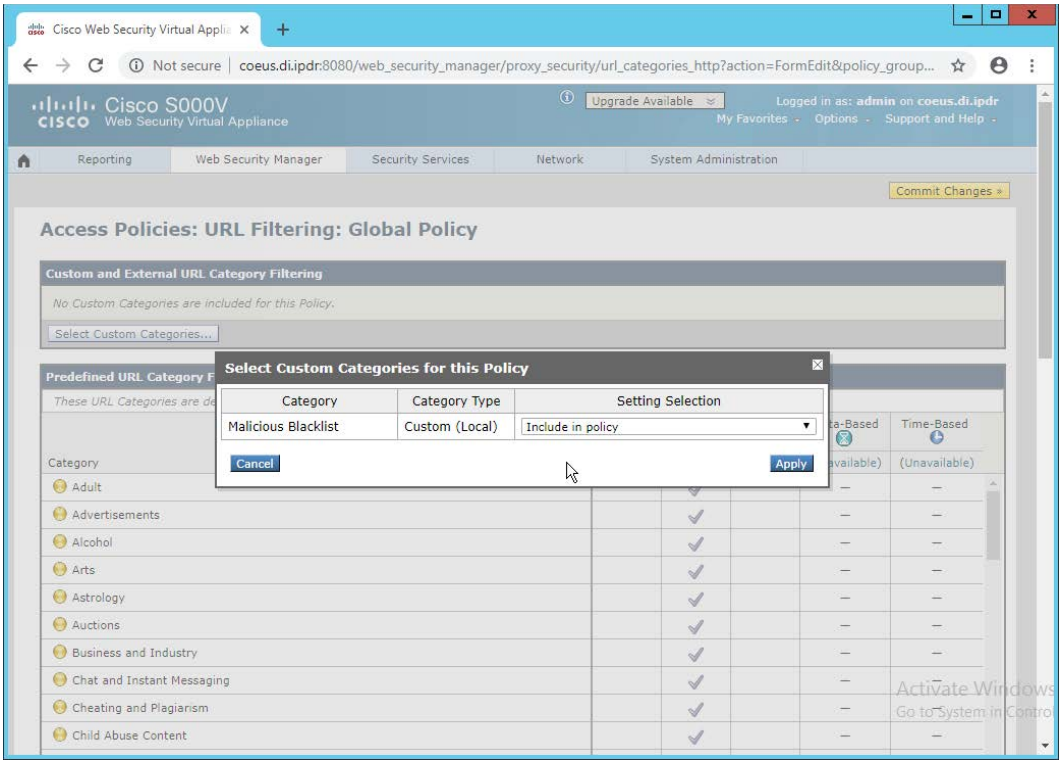


2106

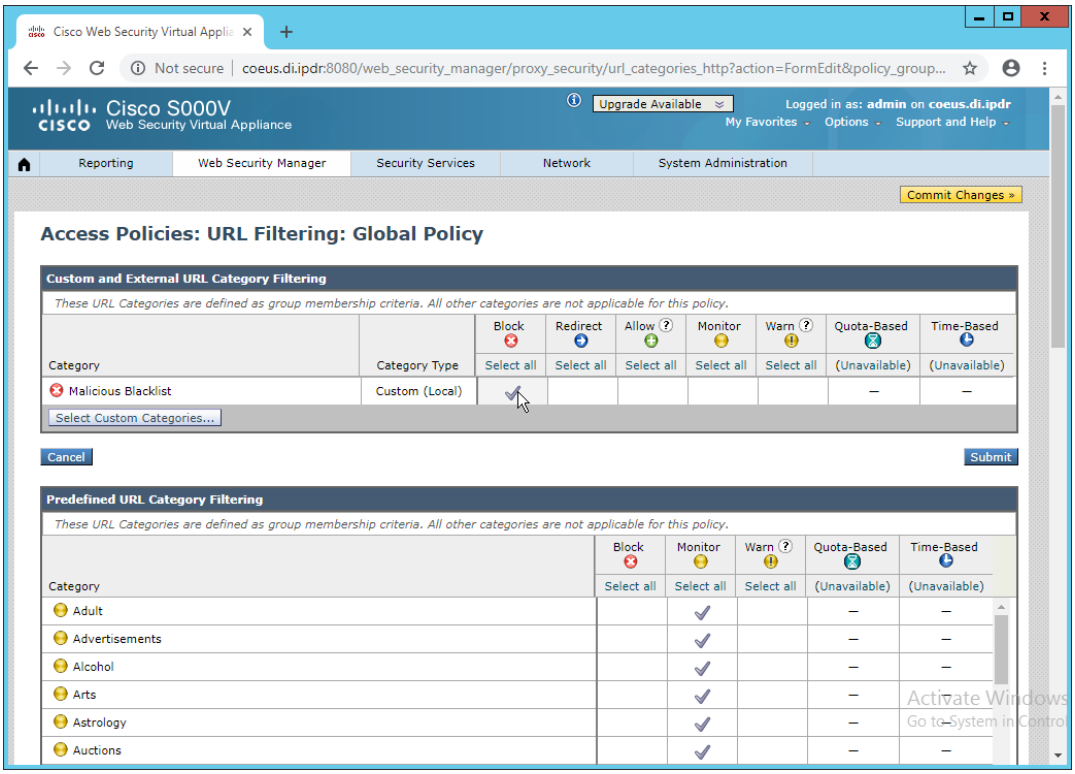
2107 8. Click the link under **URL Filtering.**



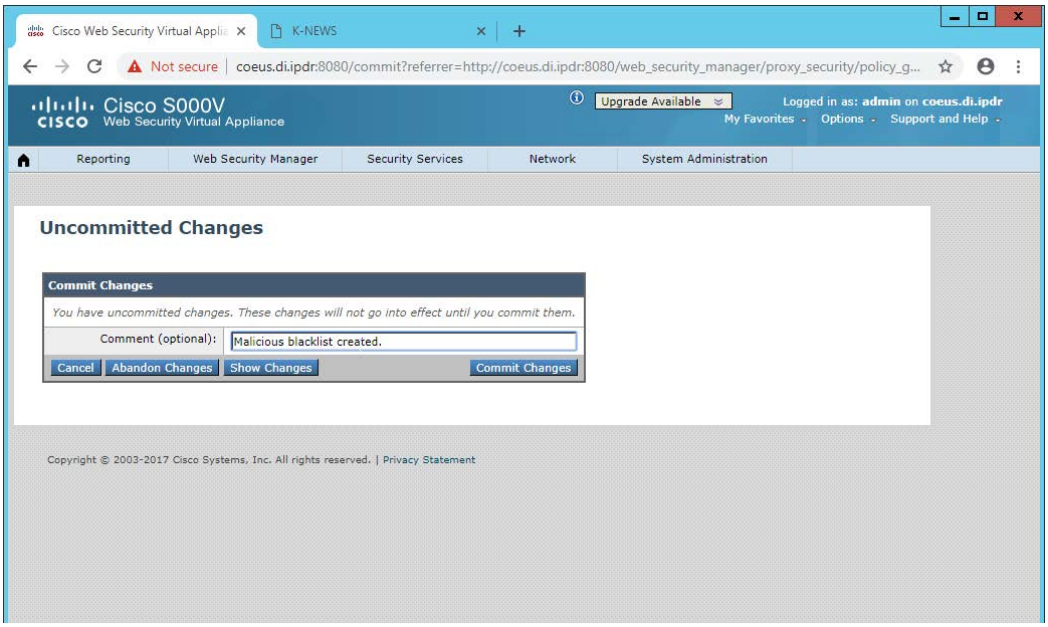
9. Click **Select Custom Categories.**
10. For the category just created, select **Include in policy** under **Setting Selection.**



11. Click **Apply.**



12. The category should now show under **Custom and External URL Category Filtering.** Put a checkmark in the **Block** box. (Selecting **Allow** lets you white-list domains that are being incorrectly classified as malicious.)
13. Click **Submit.**
14. Click **Commit Changes.**
15. Enter a comment if desired.



16. Click **Commit Changes.**

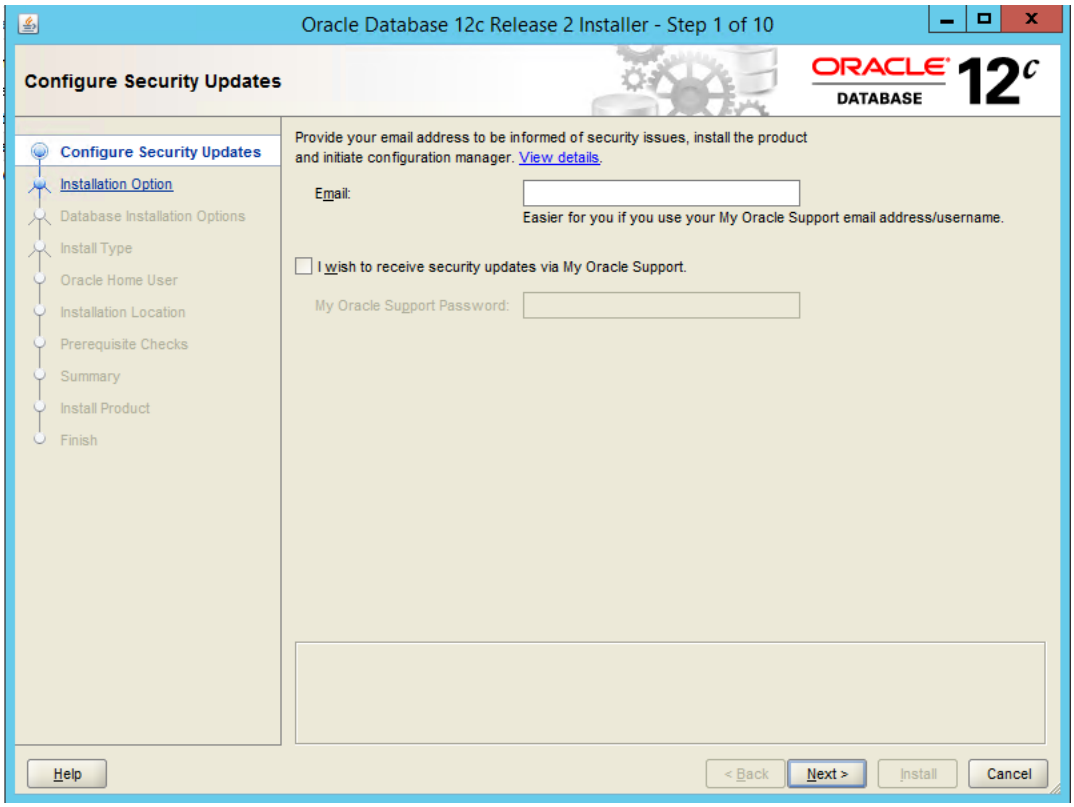
2.15 Symantec Data Loss Prevention

2.15.1 Install Oracle 12c Enterprise

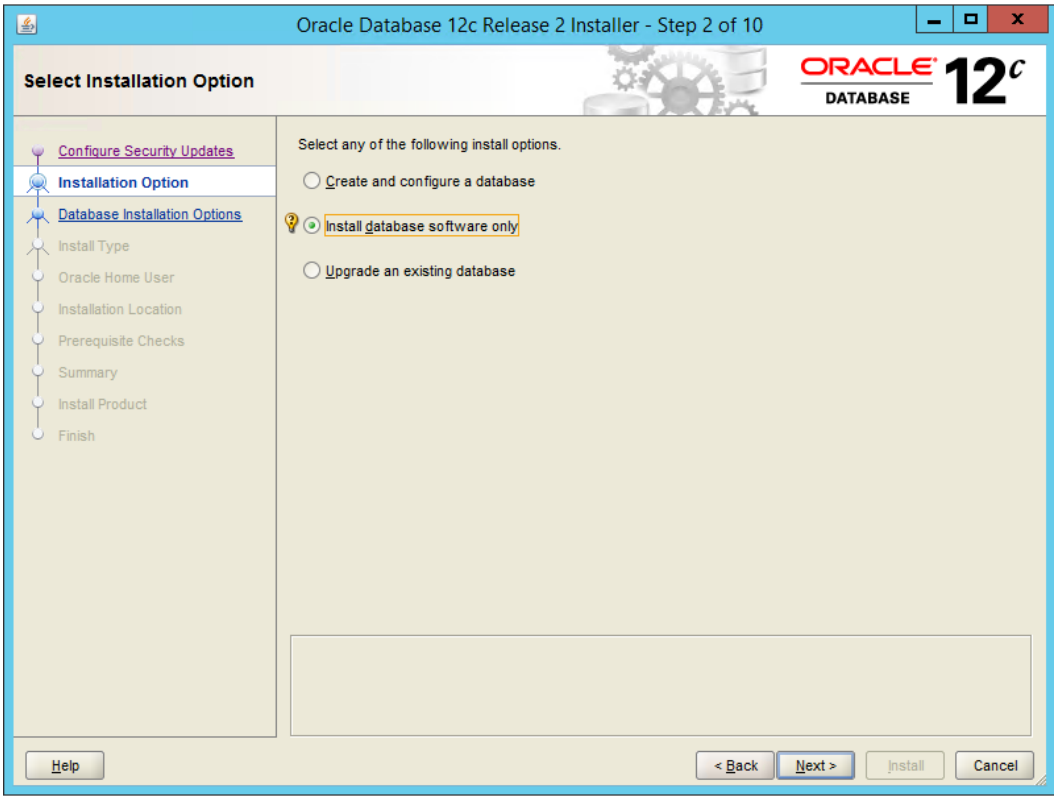
1. Unzip the Symantec DLP installation files.
2. Download the Oracle 12c installation files from https://www.oracle.com if they are not included with the Symantec DLP installation files.
3. Move both sets of installation files to a temporary directory, such as **C:\temp.**
4. Copy the Symantec **12.2.0.1_64_bit_Installation_Tools** folder to **C:\temp\Oracle\tools.**
5. From a command prompt, navigate to **C:\temp\Oracle\database,** assuming the Oracle installation files were unzipped to **C:\temp\Oracle.**
6. Run the following command:

```
> C:\temp\Oracle\database\setup.exe -noconfig -responsefile
C:\temp\Oracle\tools\responsefiles\Oracle_12.2.0.1_Enterprise_Edi
tion_Installation_WIN.rsp
```

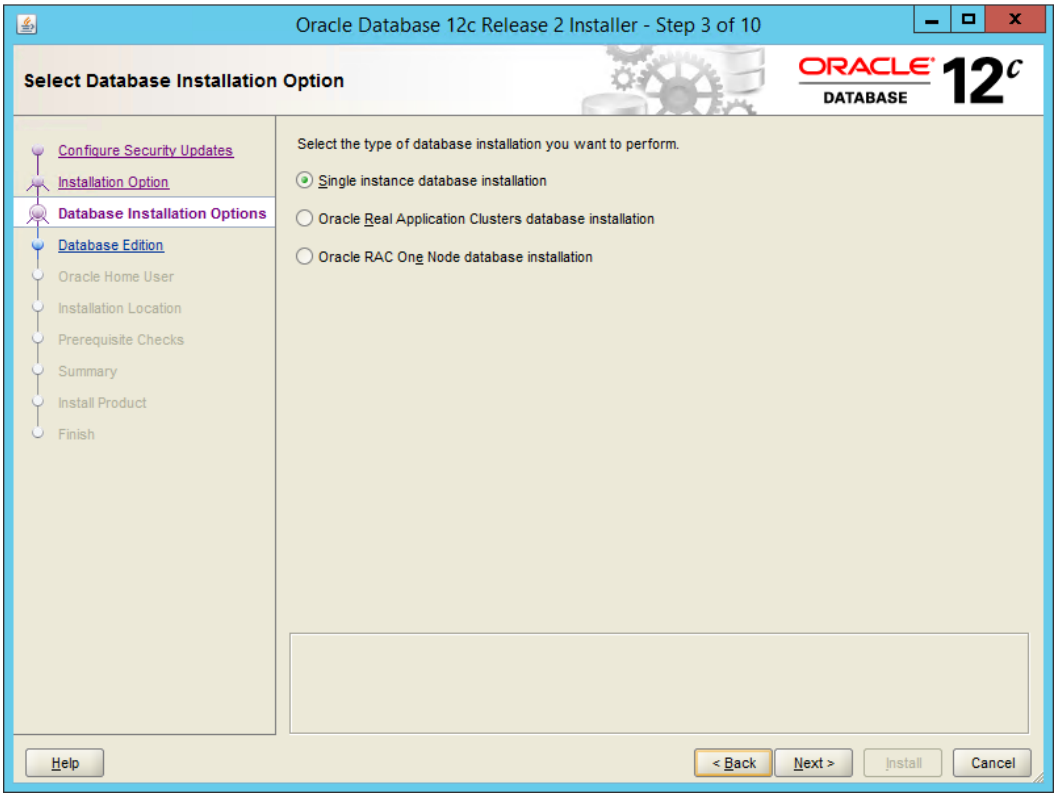
7. Once the wizard opens, you will be asked to configure security updates. If you do not possess a My Oracle Support account, leave the box unchecked and provide an **email.**



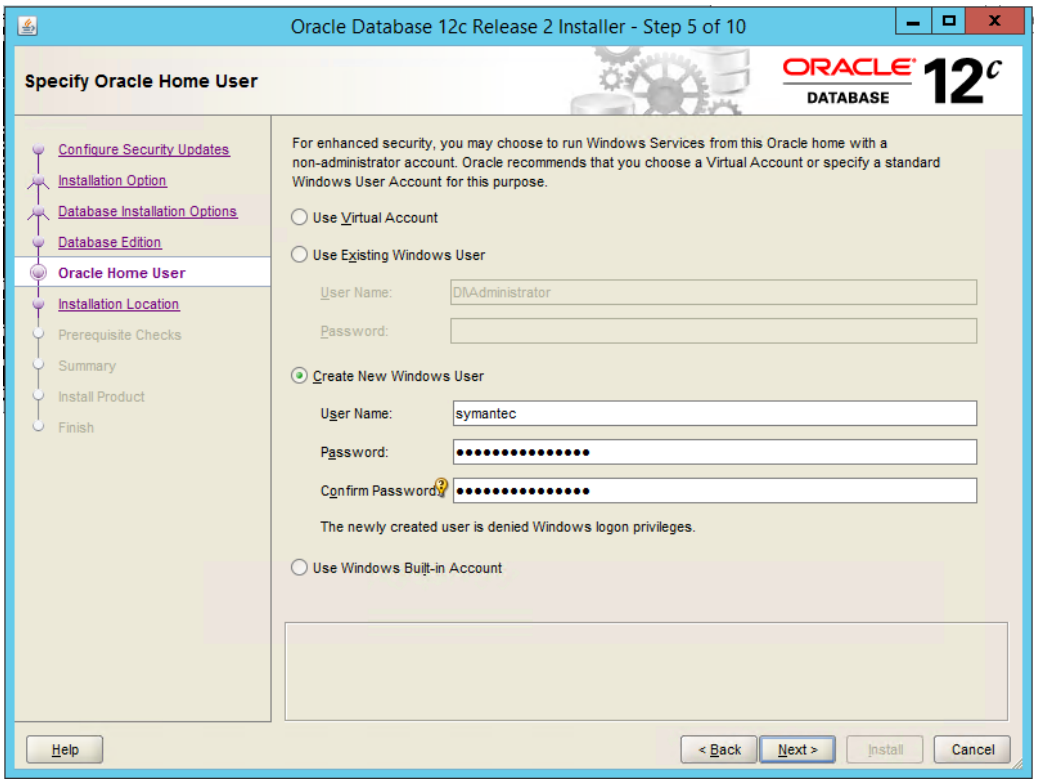
8. Click **Next.**
9. Select **Install database software only.**



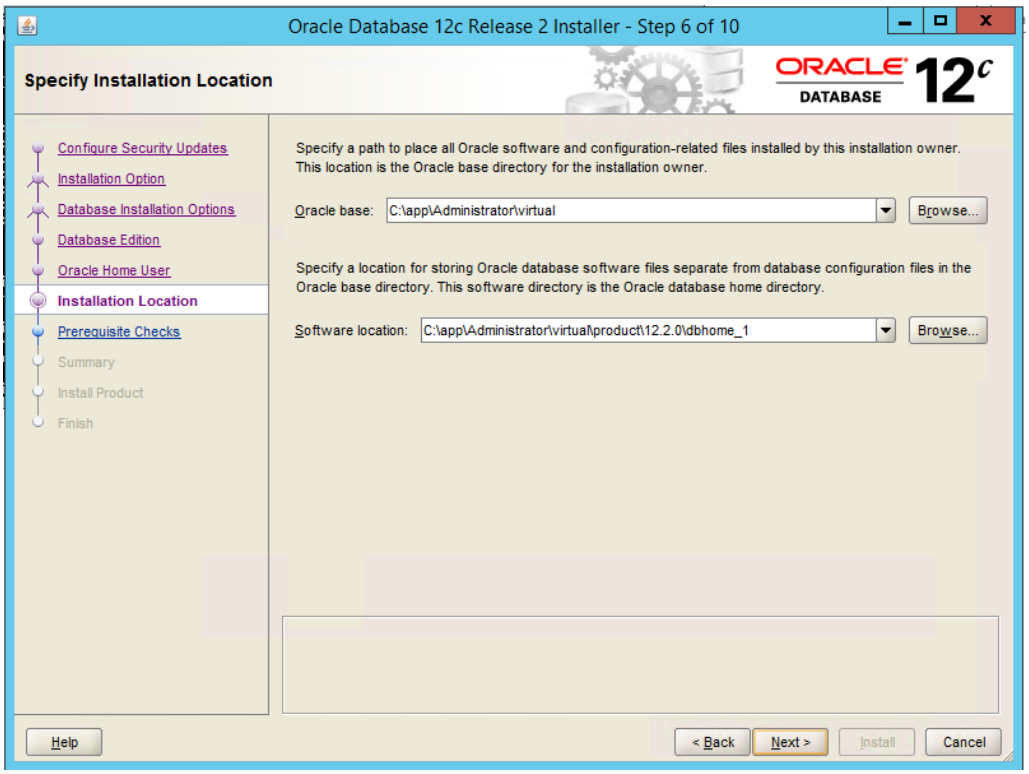
10. Click **Next.**
11. Select **Single instance database installation.**



12. Click **Next.**
13. Select **Standard Edition.**
14. Click **Next.**
15. Select **Create New Windows User.**
16. Enter the **username** and **password** of a new user for Active Directory.

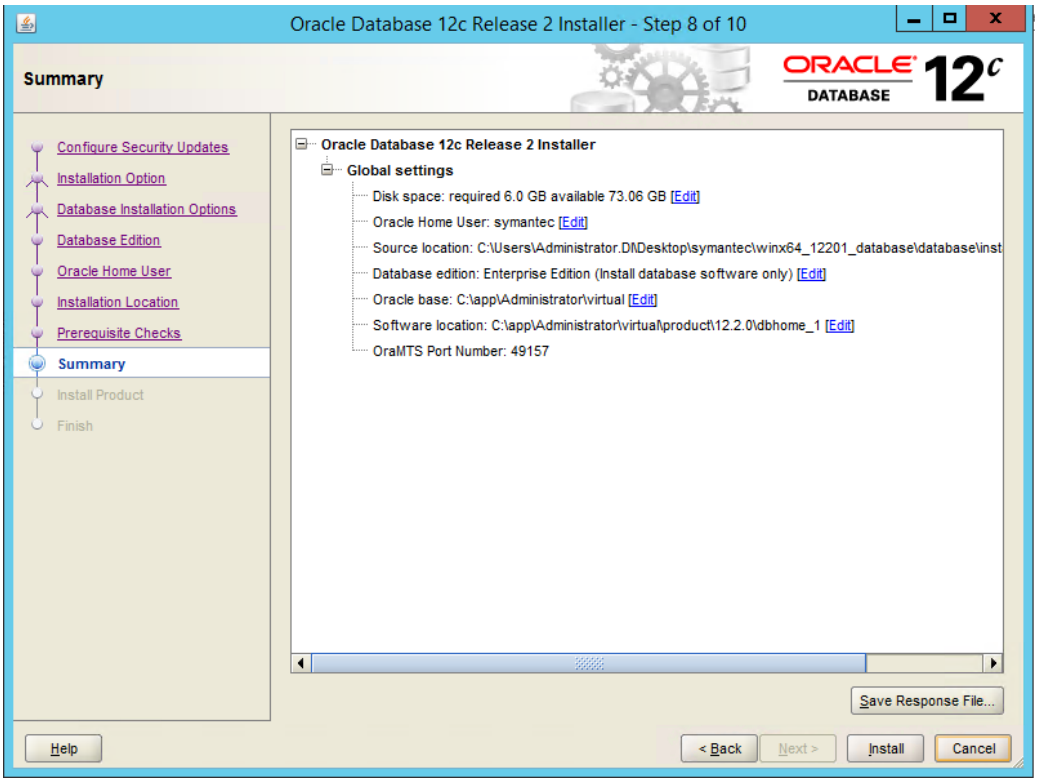


17. Click **Next.**
18. Select a location to install the software, if desired.



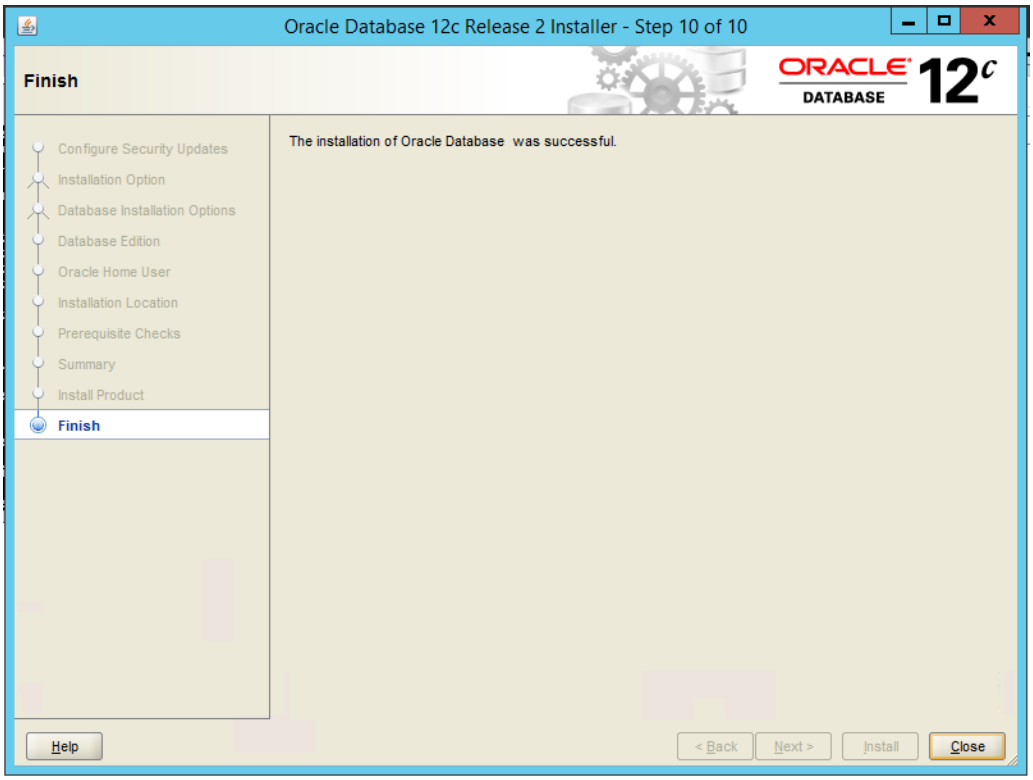
2153

2154 19. Click **Next.**



2155

2156 20. Verify the information and click **Install.** The installation may take a long time.



21. Click **Close** when the installation is complete.

2.15.2 Create an Oracle Database for Symantec DLP

1. Set the ORACLE_HOME environment variable by running the following command. Adjust the path accordingly if using a version other than 12.2.0.

```
> set
ORACLE_HOME=C:\app\Administrator\virtual\product\12.2.0\dbhome_1
```

2. Copy the Oracle database template named **Oracle_12.2.0.1_Template_for_64_bit_WIN.dbt** from the Symantec DLP zip file into **C:\app\Administrator\virtual\product\12.2.0\dbhome_1\assistants\dbca\templates.**
3. Ensure that the response file **Oracle_12.2.0.1_DBCA_WIN.rsp** is located in the folder **C:\temp\Oracle\database\tools\responsefiles.**
4. Run the following command.

```
> %ORACLE_HOME%\bin\dbca -createDatabase -progressOnly -
responseFile
```

```
C:\temp\Oracle\database\tools\responsefiles\Oracle_12.2.0.1_DBCA_
WIN.rsp
```

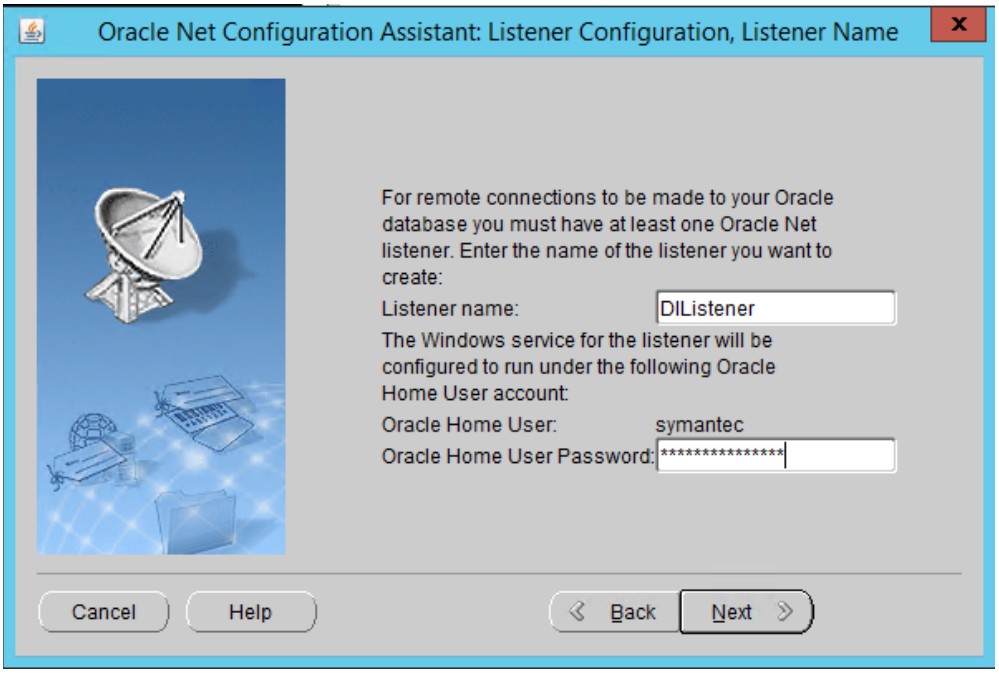
5. Enter a **password** for the **SYS** user. (Only the special characters _, #, or $ are allowed.)
6. Enter a **password** for the **SYSTEM** user. (Only the special characters _, #, or $ are allowed.)
7. Enter a **password** for the **Oracle Home User.**

2.15.3 Configuring the Oracle Listener

1. Ensure that the database services OracleServicePROTECT and DistributedTransactionCoordinator are running.
2. In the file ***%ORACLE_HOME%\network\admin\sqlnet.ora,*** change the line SQLNET.AUTHENTICATION_SERVICES=(NTS) to SQLNET.AUTHENTICATION_SERVICES=(none).
3. Navigate to **Start > All Programs > Oracle 12.2.0 > Configuration and Migration Tools > Net Configuration Assistant** and run the program.
4. Select **Listener configuration.**

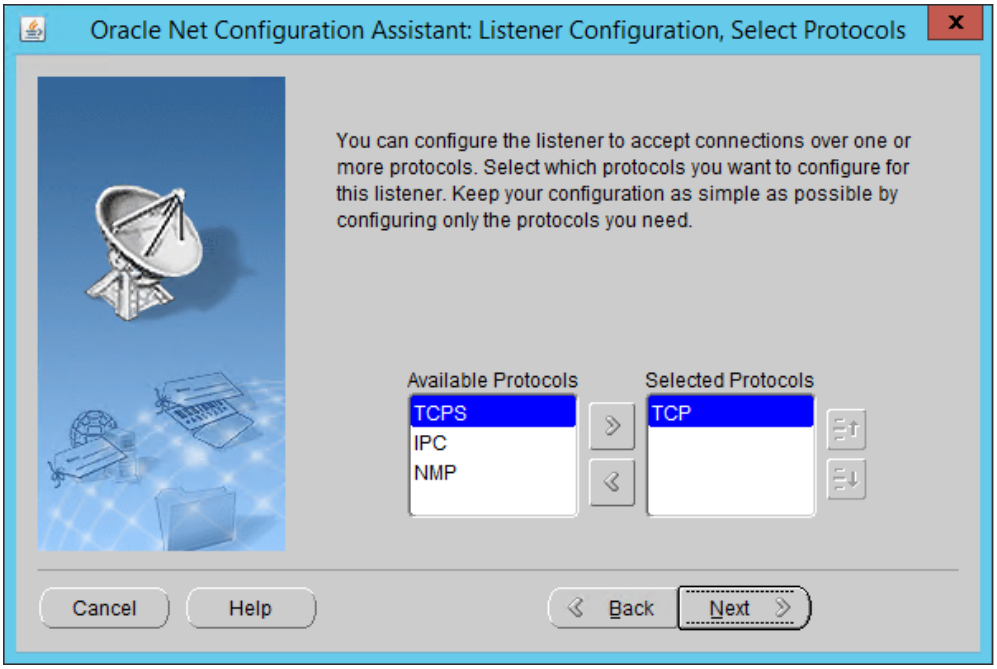
5. Click **Next.**
6. Select **Add.**

7. Click **Next.**
8. Enter a **name** for the listener.
9. Enter a **password.**



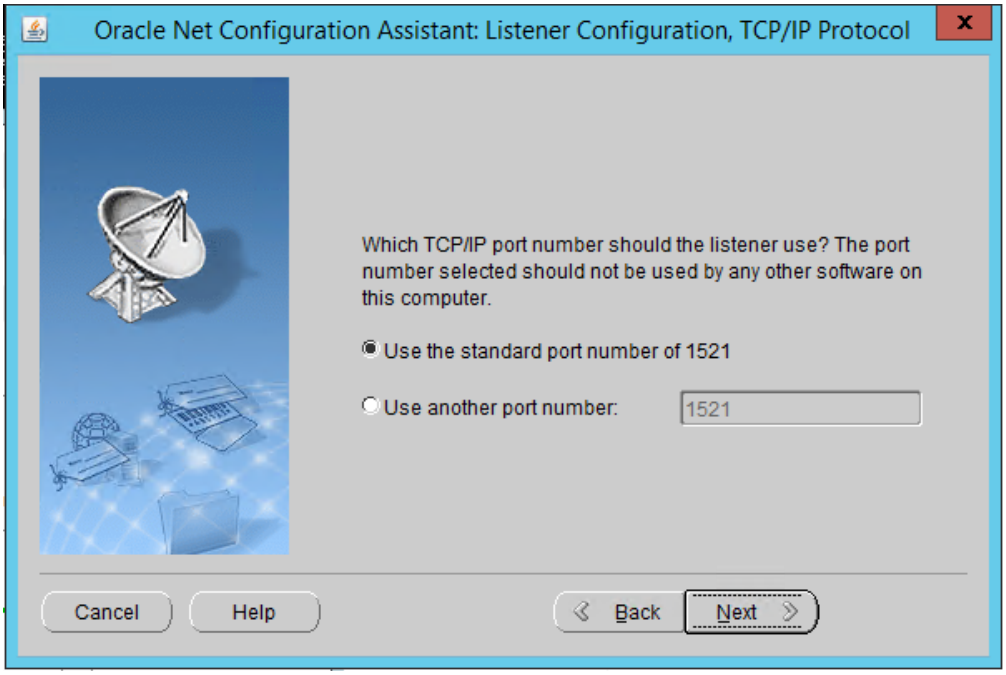
10. Click **Next.**

11. Move the **TCP** protocol to the **Selected Protocols** column.



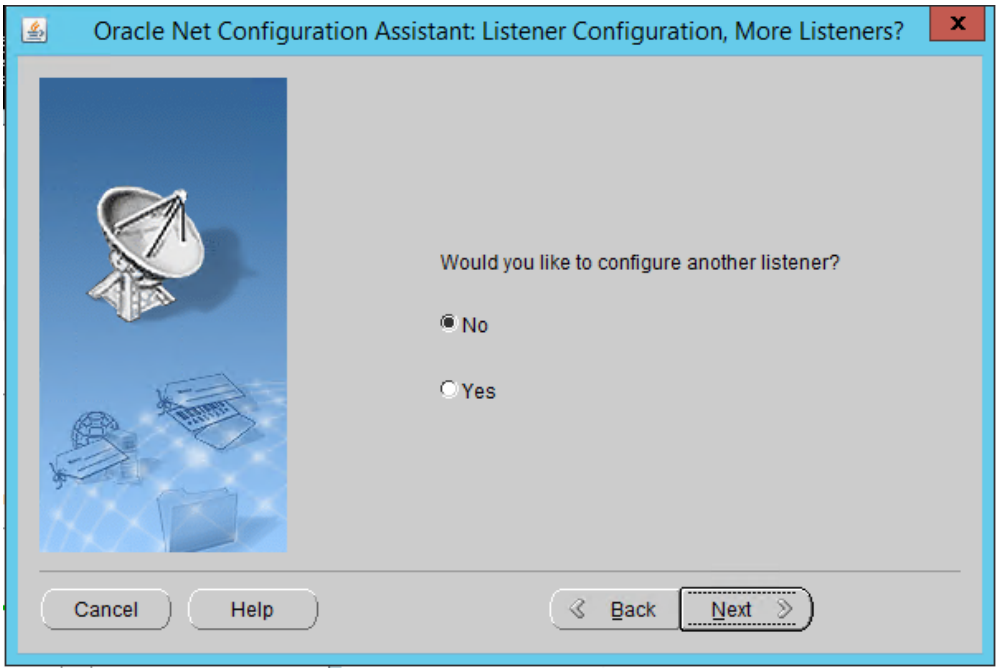
12. Click **Next.**

13. Select **Use the standard port number of 1521.**

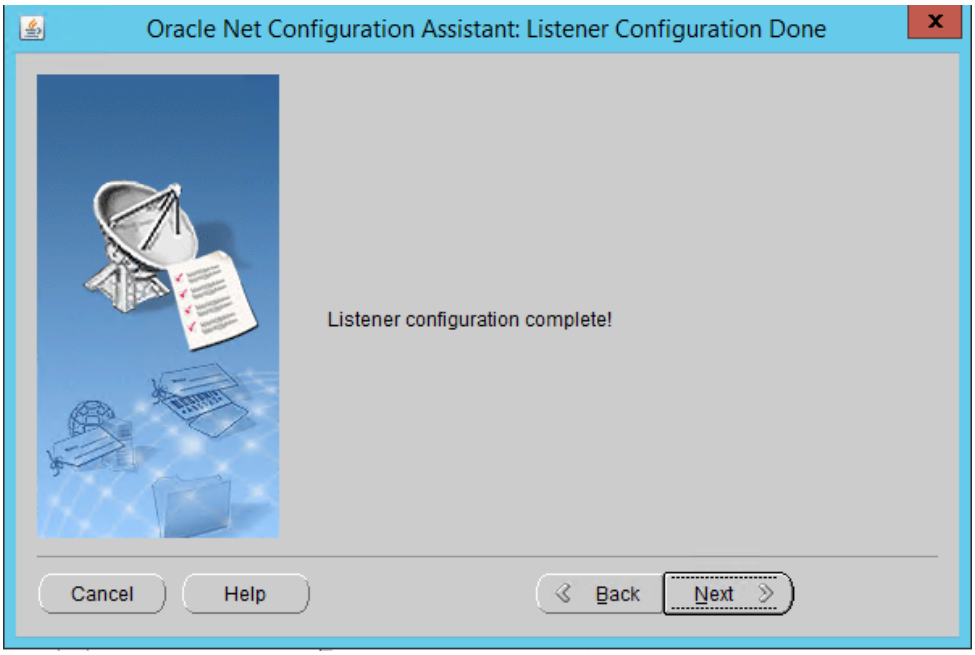


14. Click **Next.**

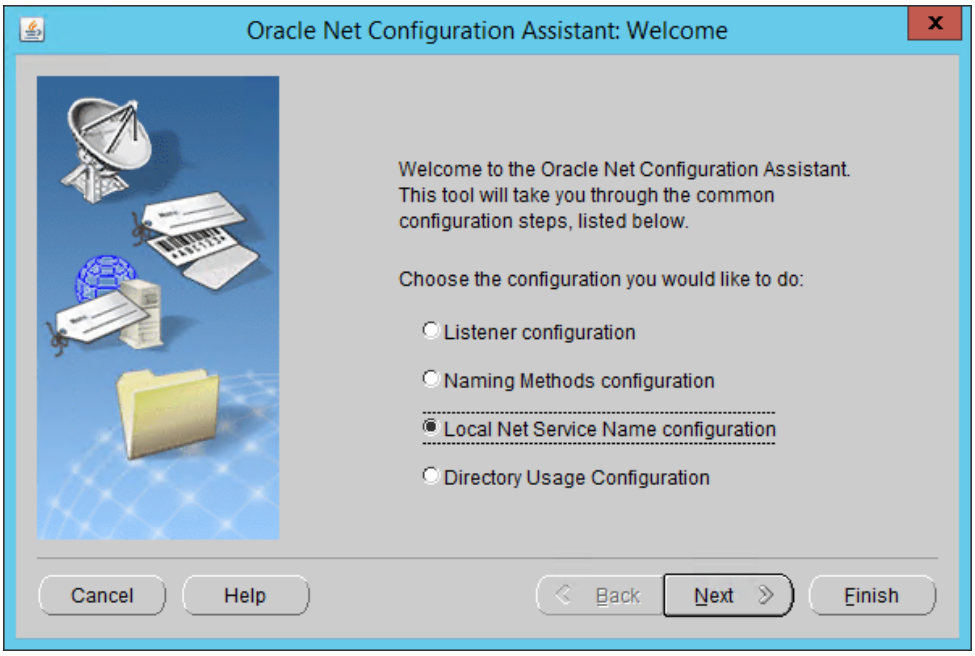
15. Select **No.**



16. Click **Next.**



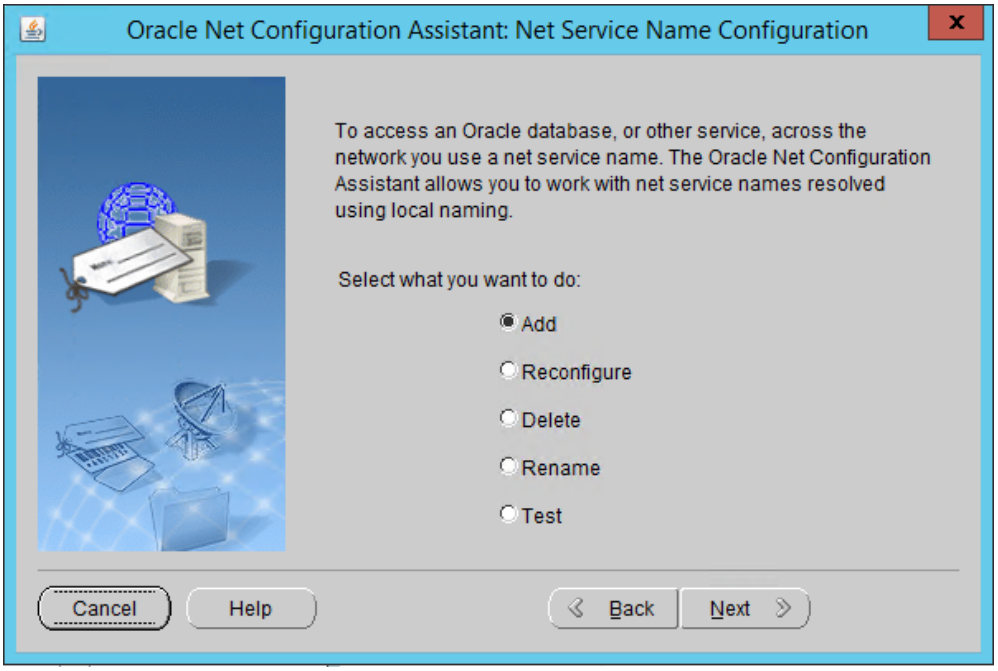
17. Click **Next.**
18. Select **Local Net Service Name configuration.**



2206

2207 19. Click **Next.**

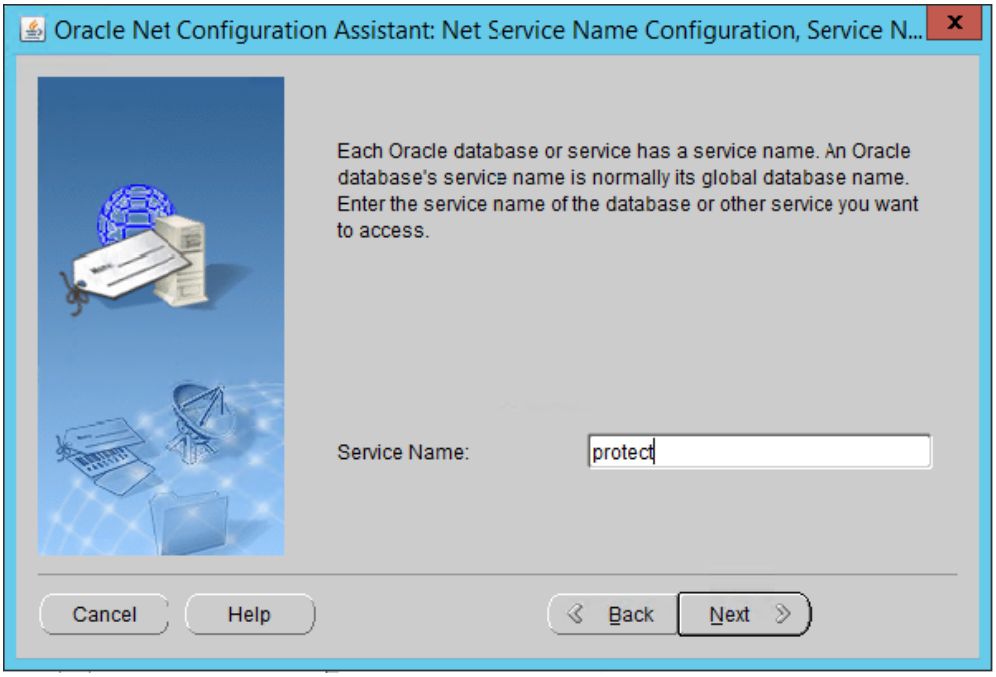
2208 20. Select **Add.**



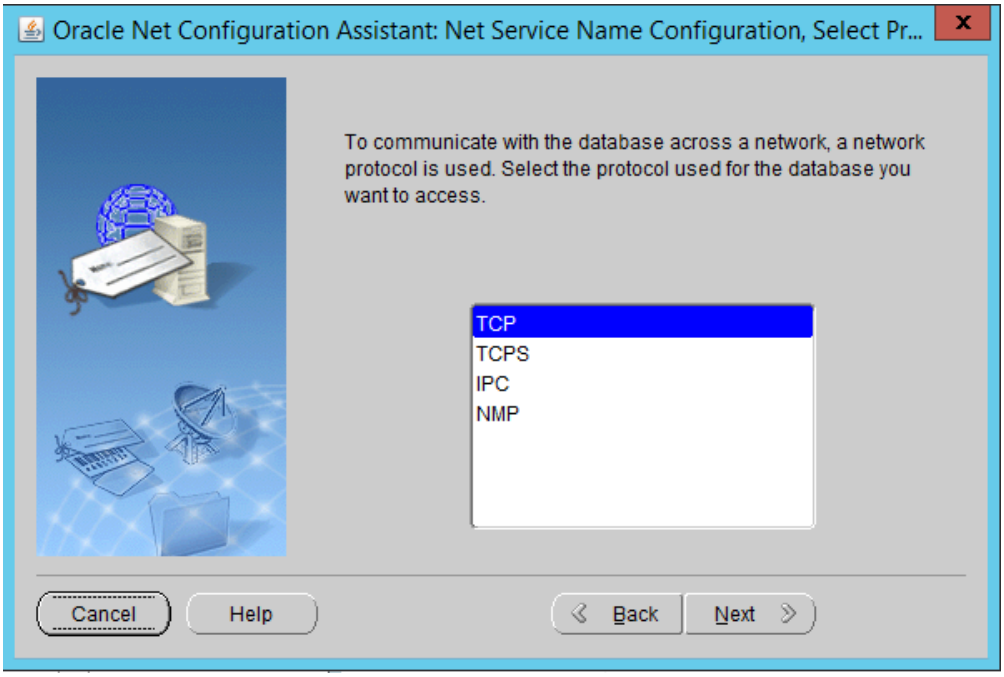
2209

2210 21. Click **Next.**

2211 22. Enter the word “protect” for the **name.**

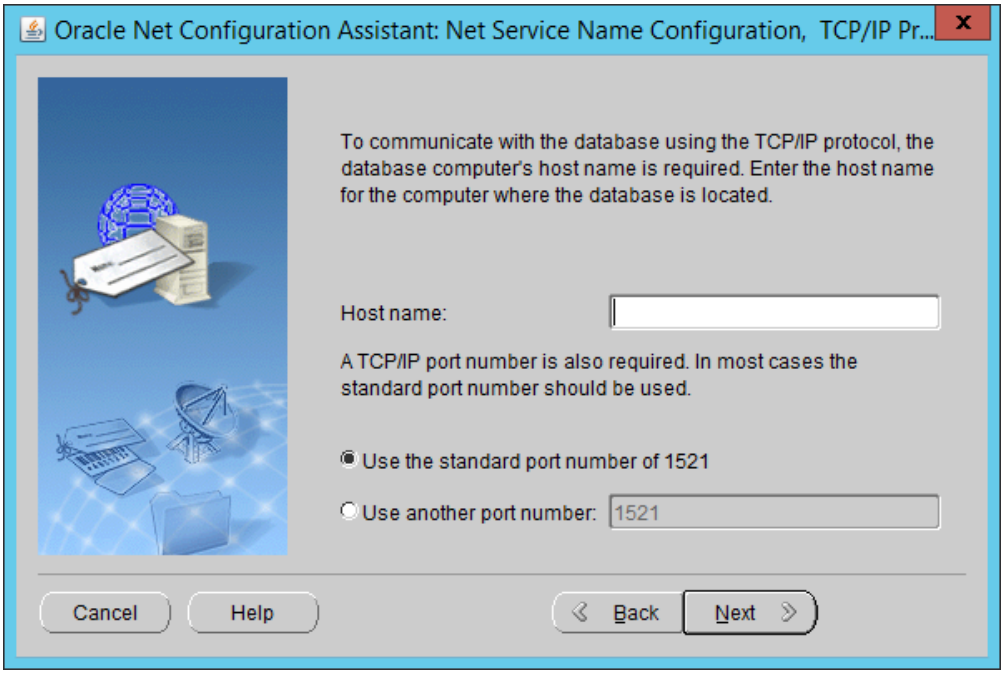


23. Click **Next.**
24. Select **TCP.**



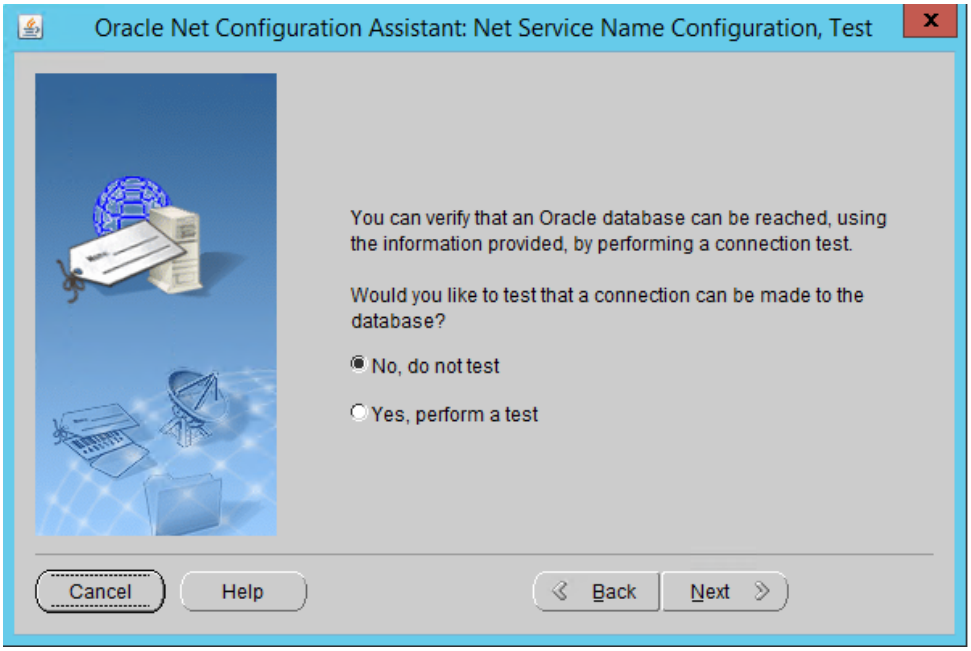
25. Click **Next.**
26. Enter the **IP address** of the system hosting the Oracle Database.

27. Select **Use the standard port number of 1521.**

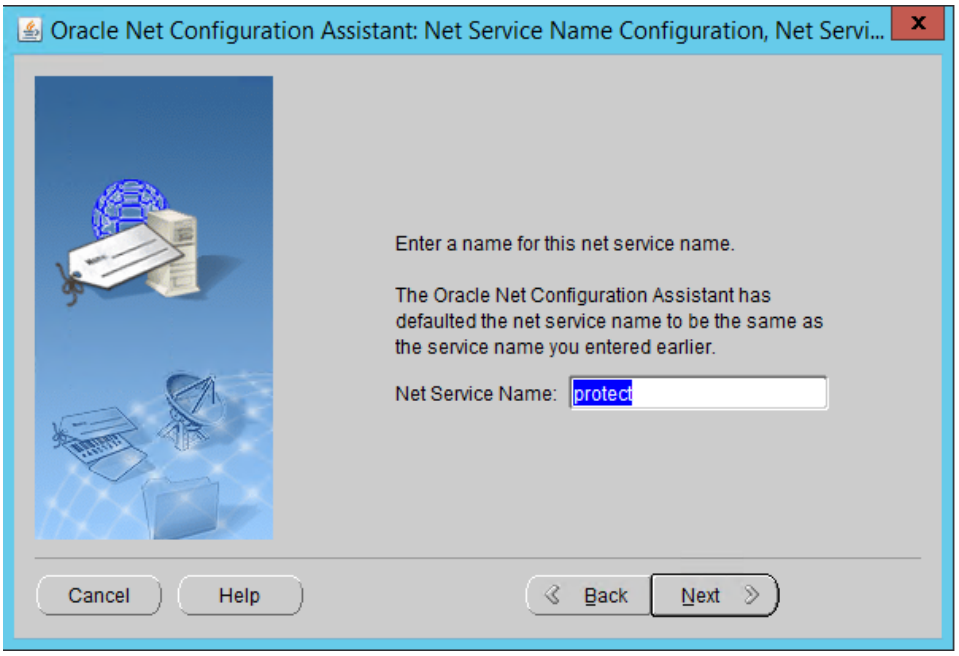


28. Click **Next.**

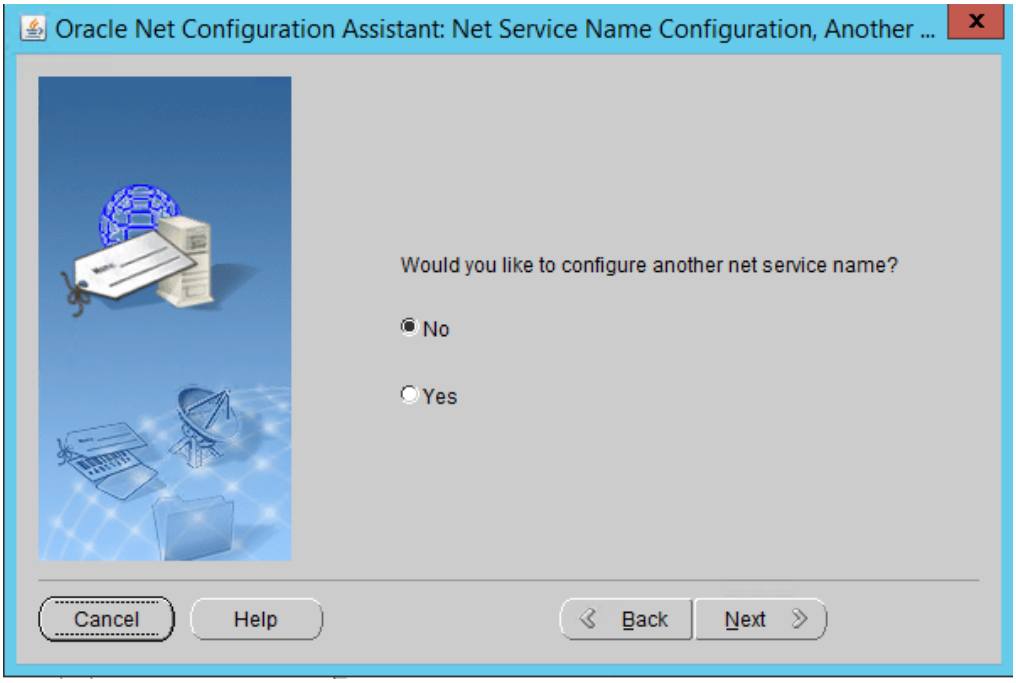
29. Select **No, do not test.**



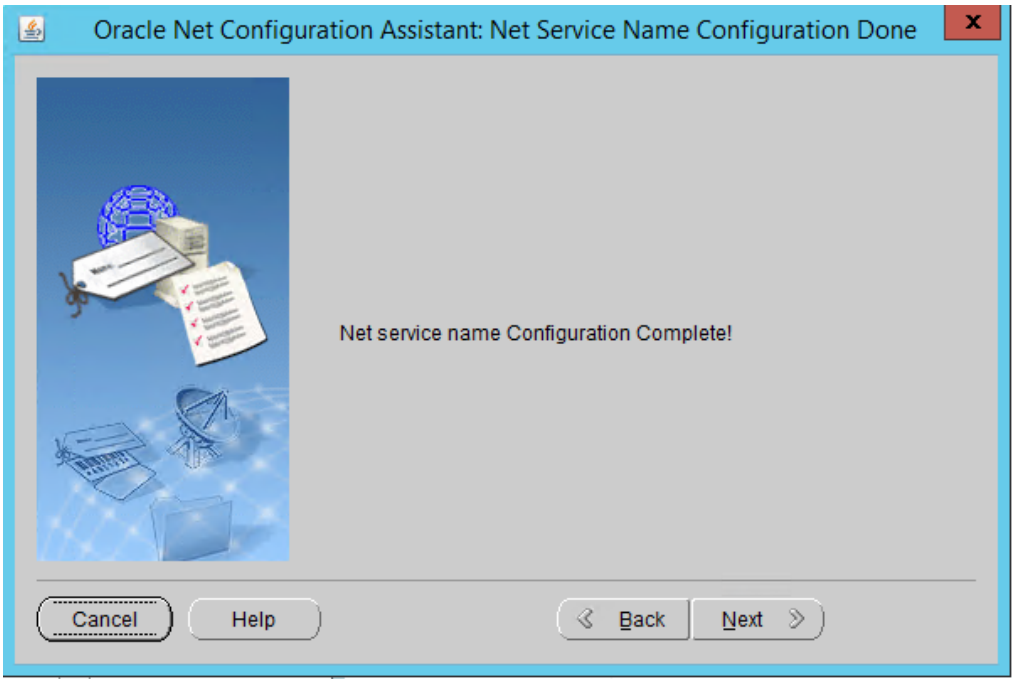
30. Click **Next.**



31. Click **Next.**
32. Select **No.**



33. Click **Next.**

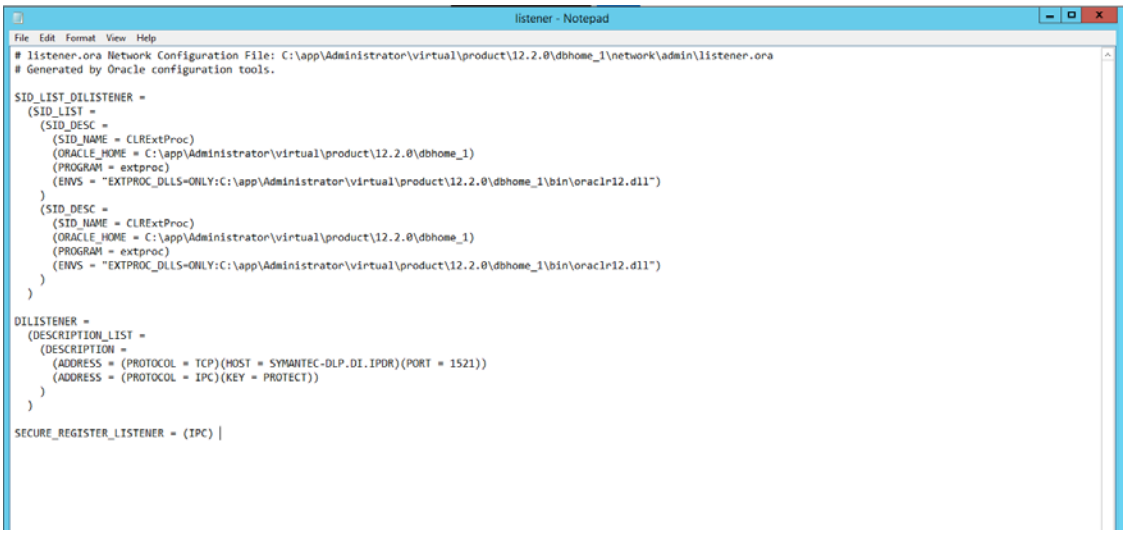


34. Click **Next.**

35. Click **Finish.**
36. In an administrative command prompt, run the following command to stop the listener.

```
> lsnrctl stop
```

37. Open the file ***%ORACLE_HOME%\network\admin\listener.ora.***
38. Change (ADDRESS = (PROTOCOL = IPC)(KEY = <key_value>)) to (ADDRESS = (PROTOCOL = IPC)(KEY = PROTECT)).
39. Add the line SECURE_REGISTER_LISTENER=(IPC) to the end of the file.



40. Save the file and exit the editor.
41. Ensure that OracleServicePROTECT and OracleVssWriterPROTECT services are running in Task Manager.
42. In an administrative command prompt, run the following command to start the listener. Replace dilistener with the name given to your listener.

```
> lsnrctl start dilistener
```

43. Run the following commands to connect the listener to the database using SQL Plus. Replace password with the password used for the SYS user.

```
> sqlplus /nolog
```

```
> conn sys/password as sysdba
```

44. Run the following commands in the SQL prompt. (Note: If errors occur relating to the SPFILE, try replacing ORACLE_HOME or ORACLE_base values in %ORACLE_HOME%\dbs\init.ora with the

absolute path. Then run CREATE SPFILE FROM PFILE='%ORACLE_HOME%\dbs\init.ora' and CREATE PFILE FROM SPFILE='%ORACLE_HOME%\dbs\init.ora'. Restart the database after doing this.)

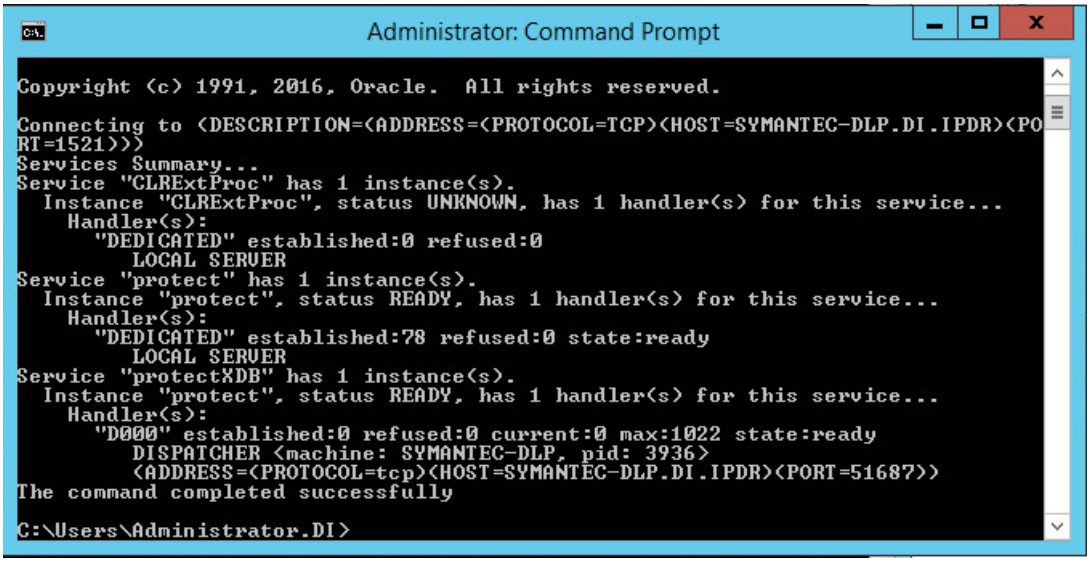
```
> ALTER SYSTEM SET local_listener = '(DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=PROTECT)))' SCOPE=both;
```

```
> ALTER SYSTEM REGISTER;
```

```
> exit
```

45. Run the following command to verify the status of the listeners:

```
> lsnrctl services
```



46. Open a new administrative command window.
47. Navigate to **C:\Temp\Oracle\database\tools.**
48. Run the following command:

```
> sqlplus /nolog
```

```
> @oracle_create_user.sql
```

49. Enter the **password** for the **SYS** user.
50. For **sid**, enter "protect".
51. For a **username**, enter "protect".

52. Enter a **password** for the “protect” user. (The special characters &, $, and # are not allowed.)
53. When this process is finished, open a new administrative command window and run the following command.

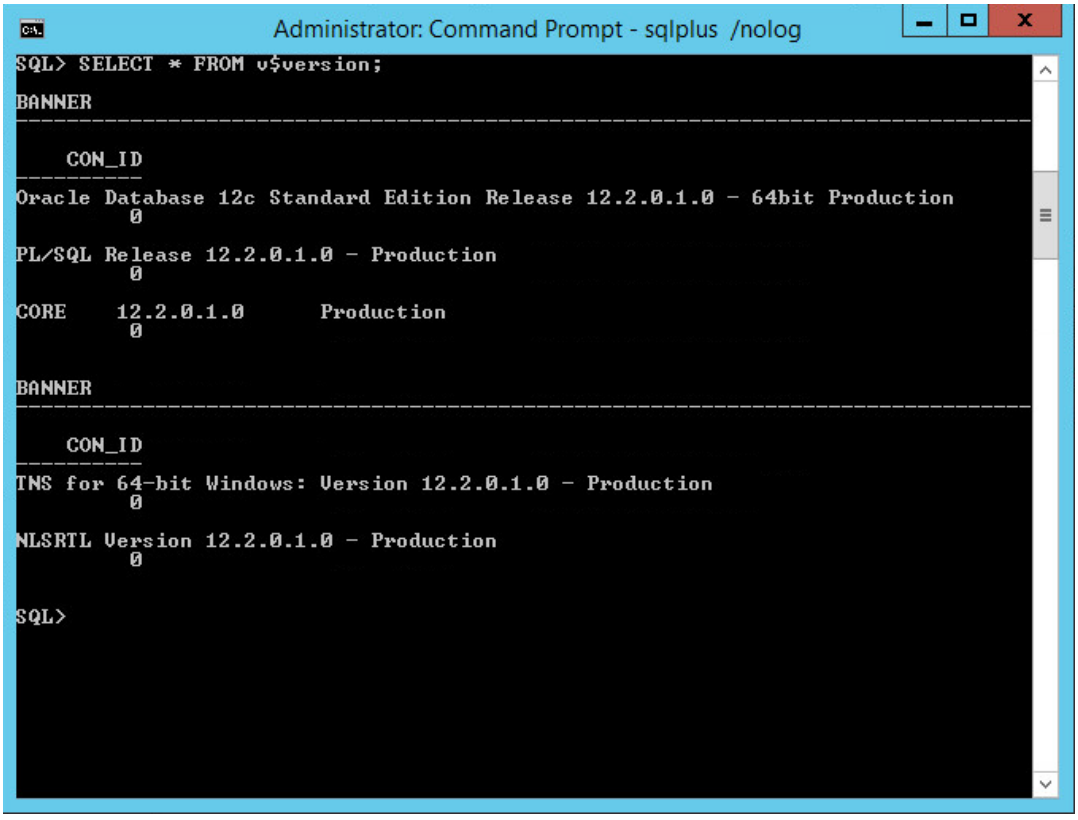
```
> sqlplus /nolog
```

54. Log in as the **SYS** user with the following command (replace “password” with the password for the **SYS** user).

```
> connect sys/password@protect as sysda
```

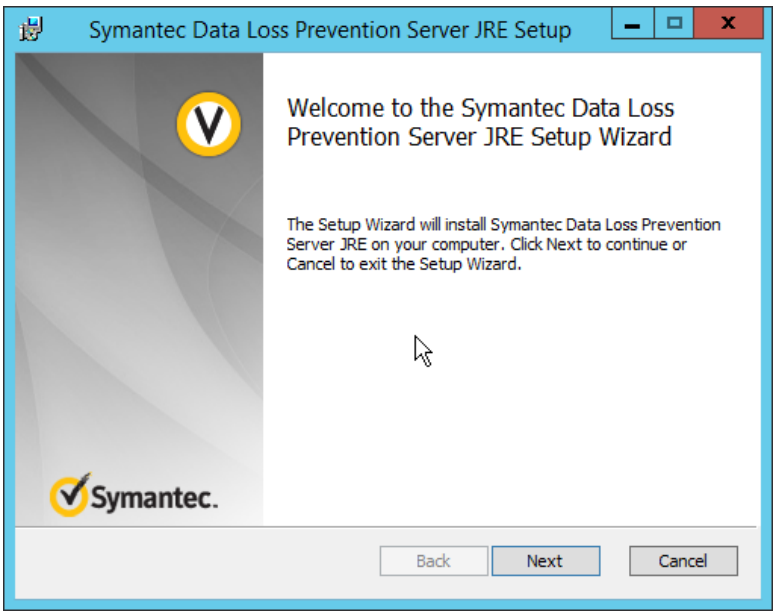
55. Verify the version information with the following command.

```
> SELECT * FROM v$version;
```

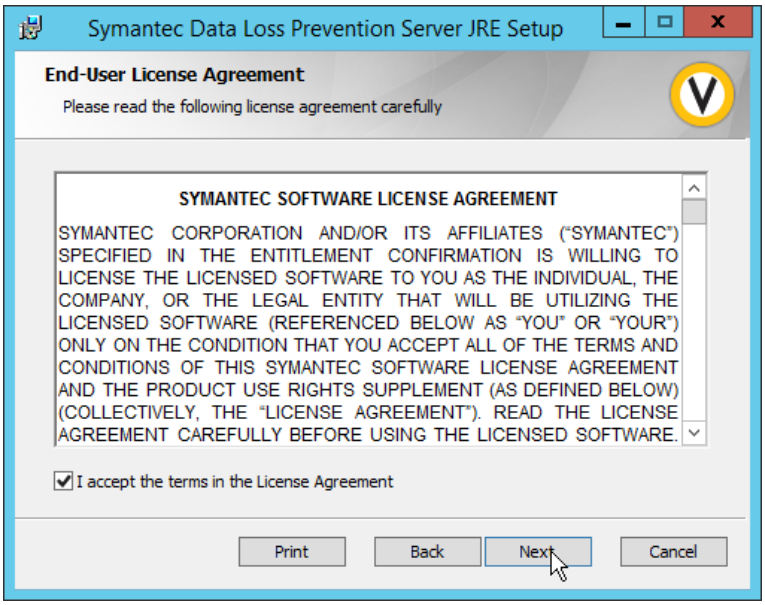


2.15.4 Install Symantec DLP

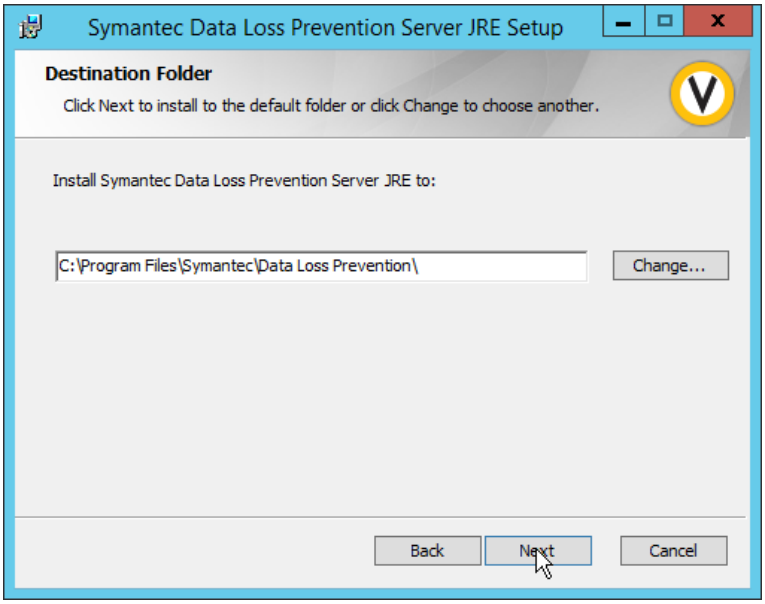
1. In the folder **DLP Installs\DLP 15.1\Symantec_DLP_15.1_Platform_Win-IN_15.1.0.25021\DLP\15.1\New_Installs\x64\Release,** located in the download folder for the DLP files, run **ServerJRE.msi.**



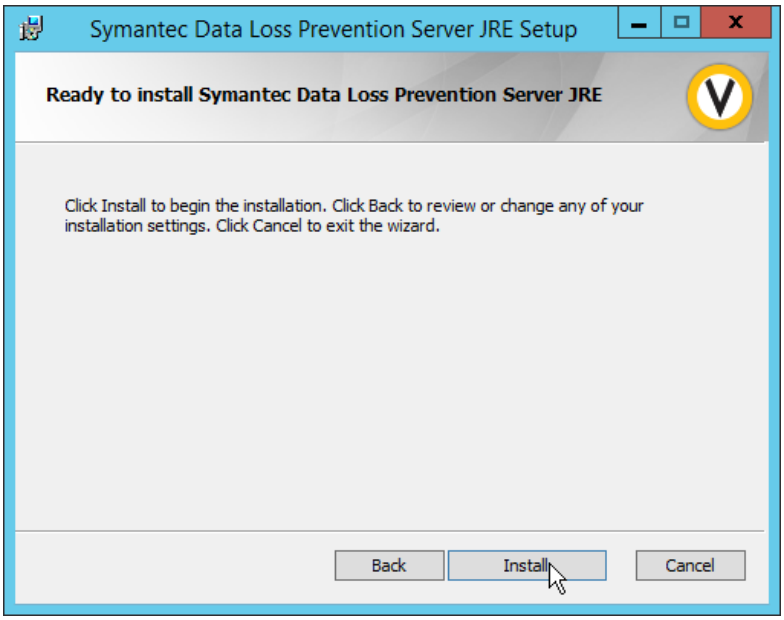
2. Click **Next.**
3. Select **I agree to the terms in the license agreement.**



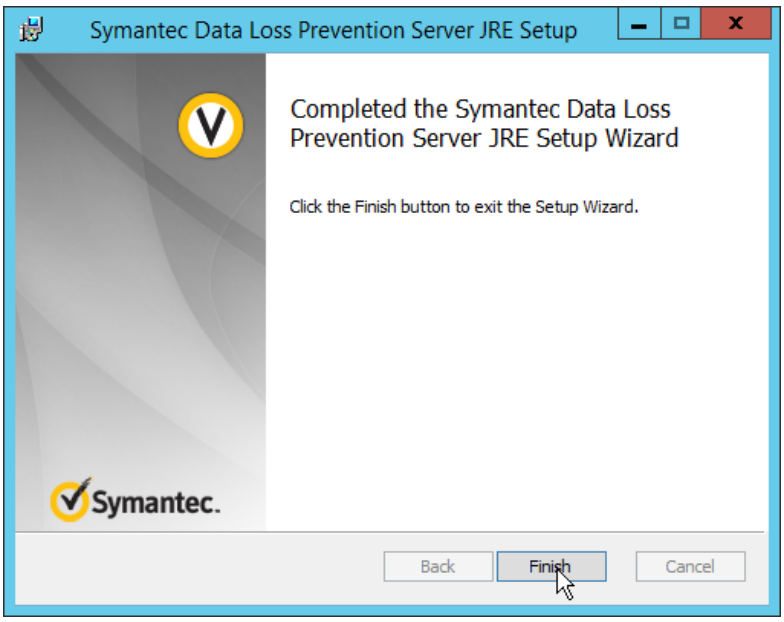
4. Click **Next.**



5. Click **Next.**



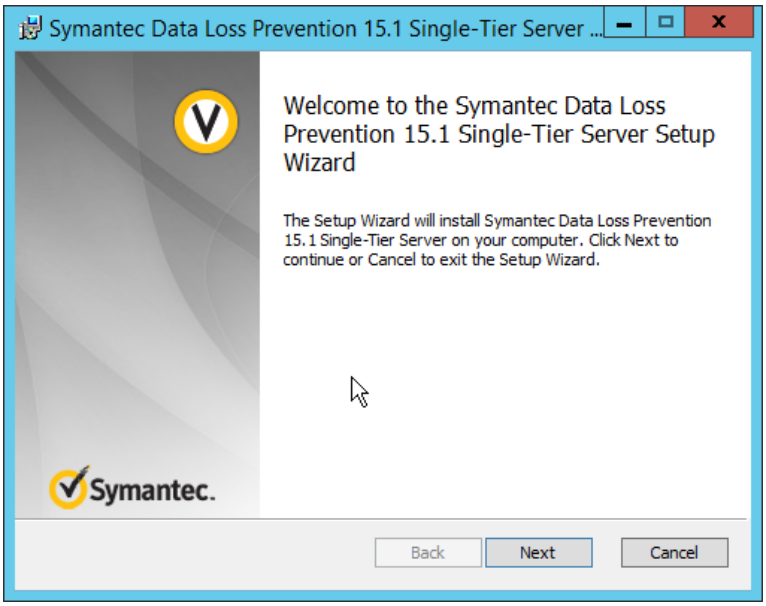
6. Click **Install.**



2293

2294 7. Click **Finish.**

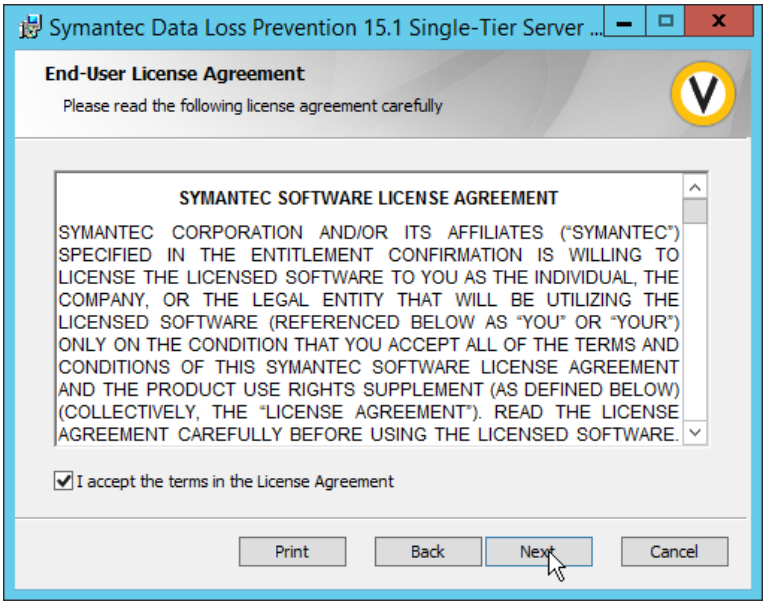
2295 8. Run **SingleTierServer.msi** (located in the same folder as **ServerJRE.msi**).



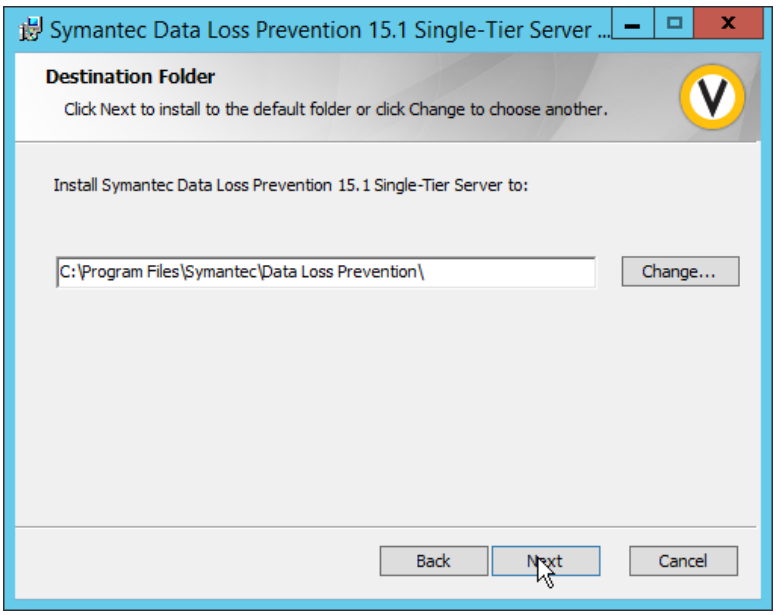
2296

2297 9. Click **Next.**

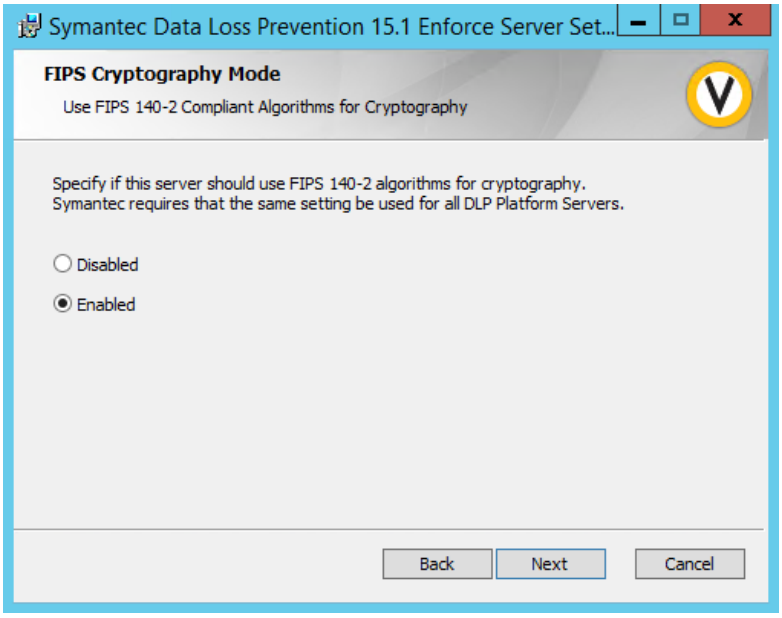
2298 10. Check the box to accept the license agreement.



11. Click **Next.**

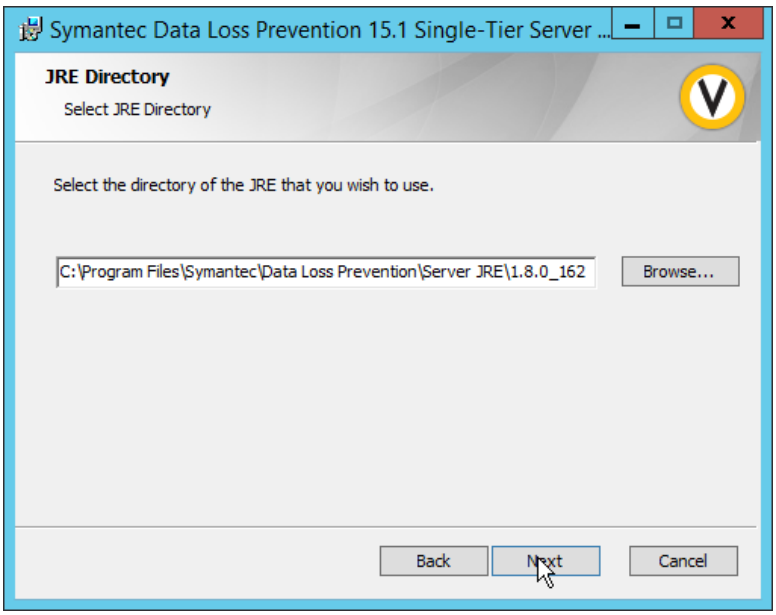


12. Click **Next.**
13. Select **Enabled** for **FIPS 140-2 Compliant Algorithms.**



2304

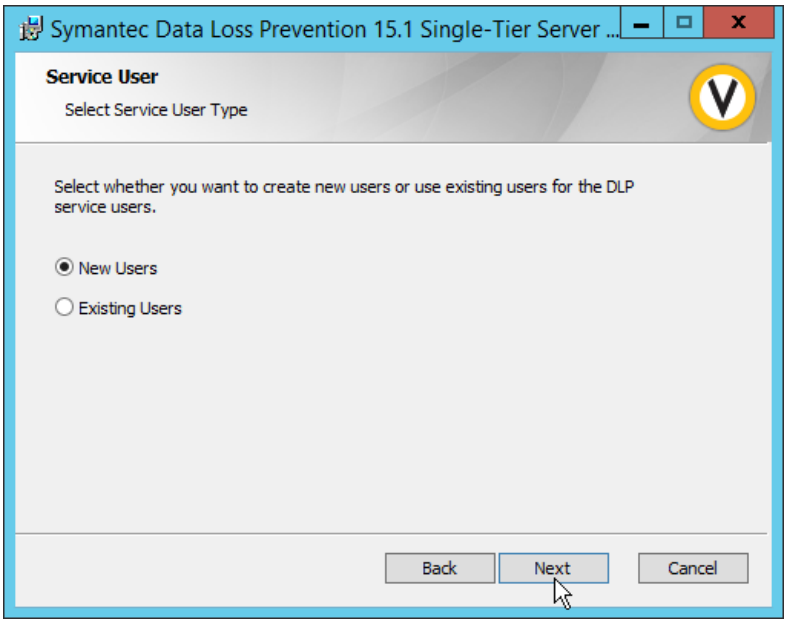
2305 14. Click **Next.**



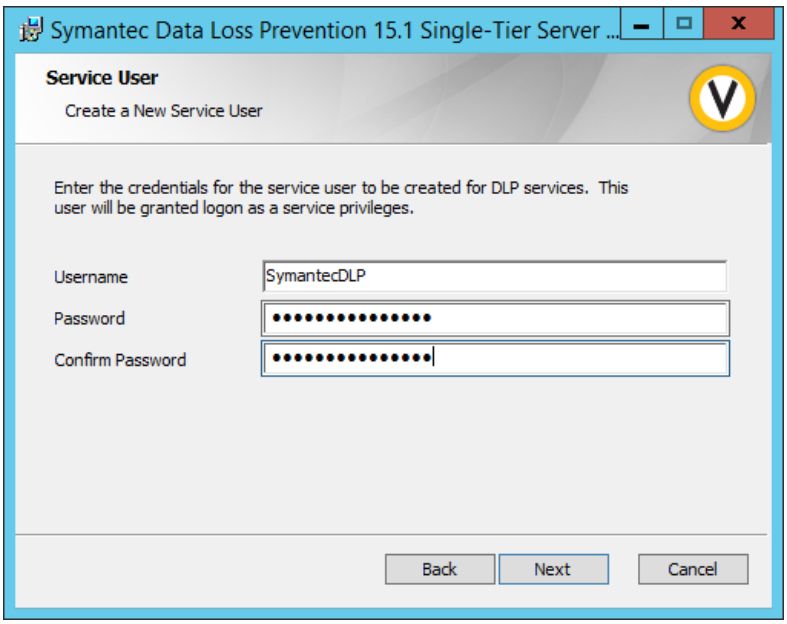
2306

2307 15. Click **Next.**

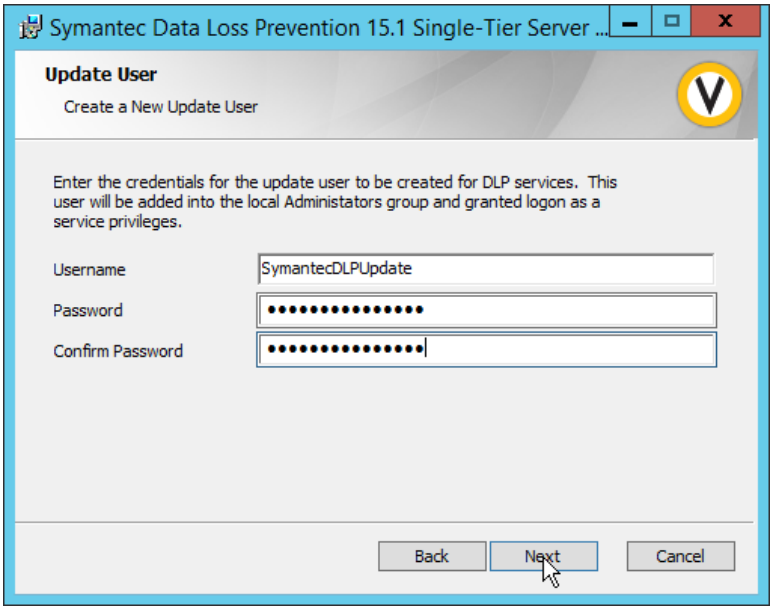
2308 16. Click on **New Users.**



17. Click **Next.**
18. Enter a **password** and optionally a **username.**



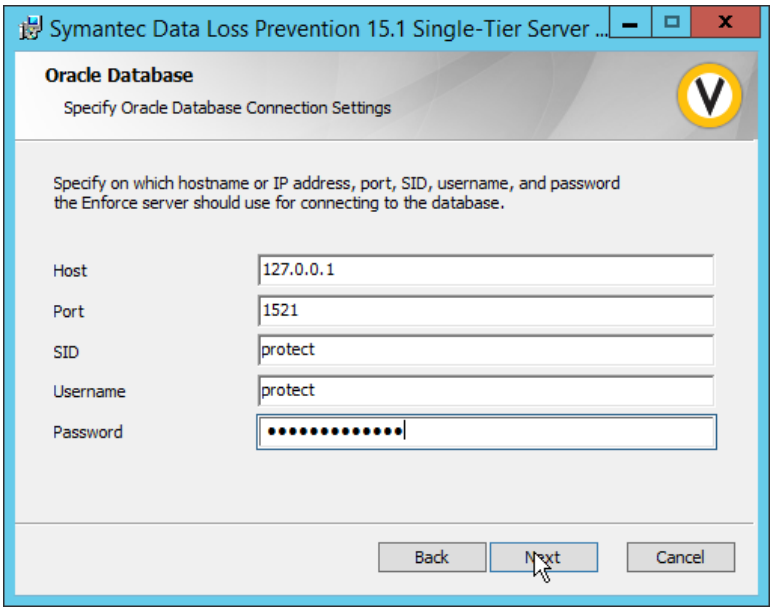
19. Click **Next.**
20. Enter a **password** and optionally a **username.**



2315

2316 21. Click **Next.**

2317 22. Enter the **password** used for the "protect" user.



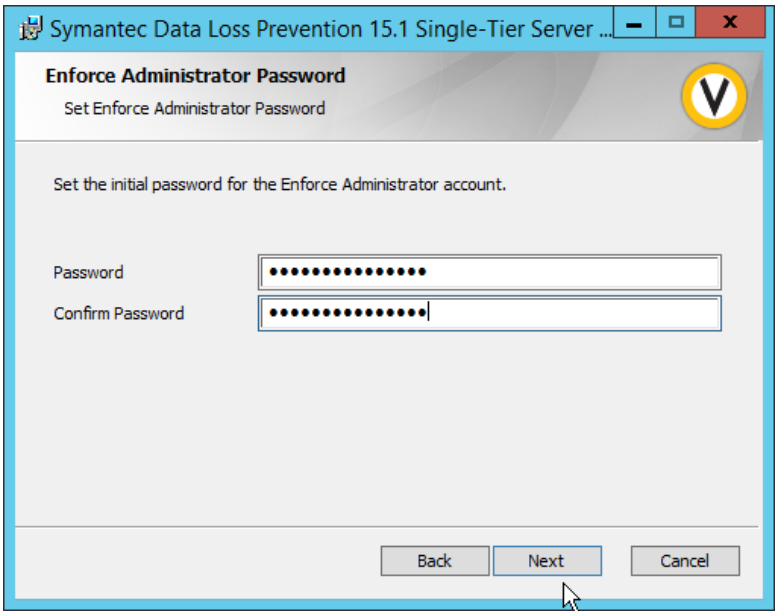
2318

2319 23. Click **Next.**

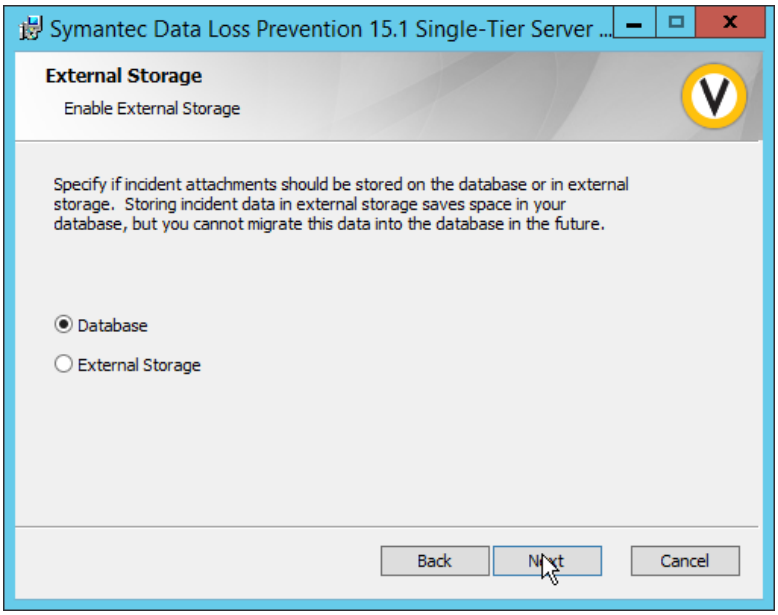
2320 24. Select **Initialize Database.**

2321 25. Click **Next.**

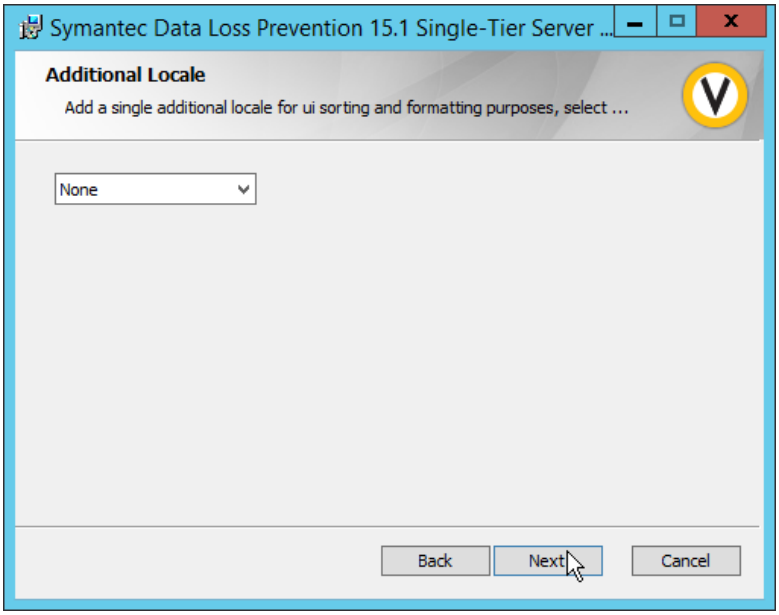
2322 26. Set the initial **password** for logging into the Enforce Administrator account.



27. Click **Next.**
28. Select **Database.**

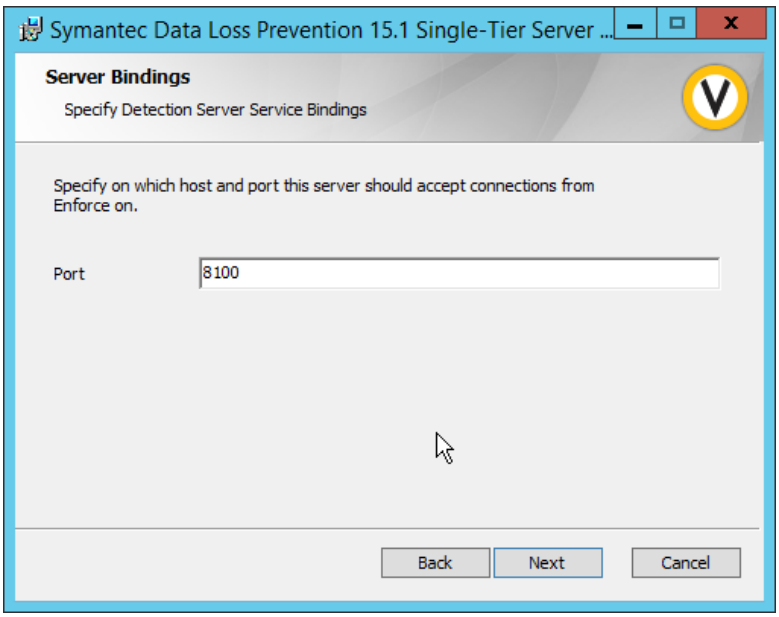


29. Click **Next.**
30. Select **None.**



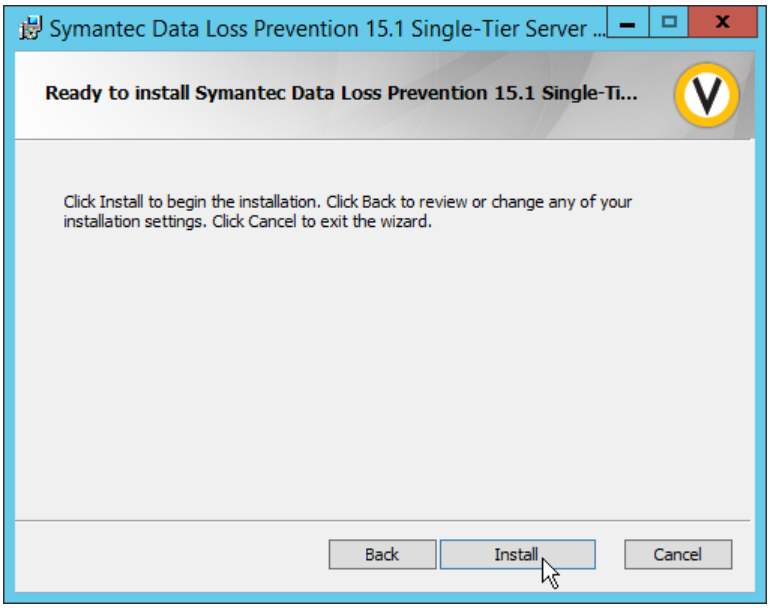
2329

2330 31. Click **Next.**



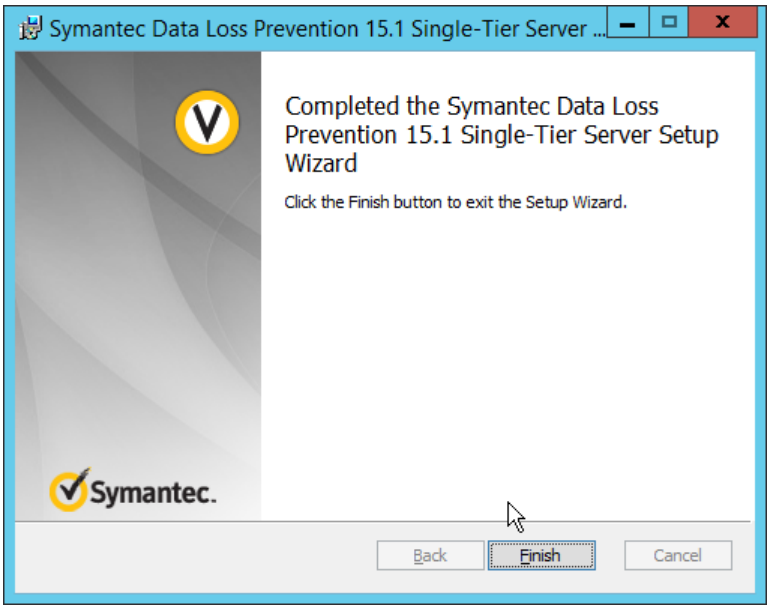
2331

2332 32. Click **Next.**



2333

2334 33. Click **Install.**



2335

2336 34. Click **Finish.**

2337 35. Ensure that the services are running in Task Manager:

2338 a. SymantecDLPManager

2339 b. SymantecDLPIncidentPersister

2340 c. SymantecDLPNotifier

d. SymantecDLPDetectionServer

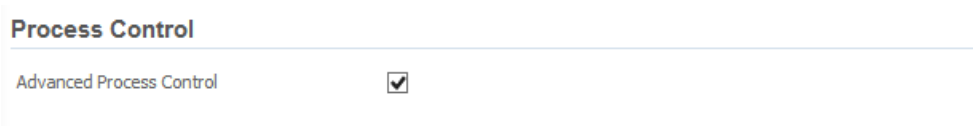
2.15.5 Configure Symantec DLP

1. Navigate to https://127.0.0.1 in the browser to get to the Symantec DLP web console.
2. Navigate to **System > Settings > General** and click **Configure.**
3. In the **Edit General Settings** screen, upload your license file provided by Symantec.
4. Click **Save.**
5. In Task Manager, stop the **SymantecDLPManager** service.
6. Copy the *classpath.txt* file located in **<DLP Download Home>\DLP\15.1\Solution_Packs** and overwrite the *classpath.txt* located at **C:\Program Files\Symantec\Data Loss Prevention\Enforce Server\15.1\Protect\Config\SolutionPackInstaller.**
7. In an administrative command window, use the following commands to import the chosen solution pack. For example, to import the financial solution pack, use:

```
> cd "C:\Program Files\Symantec\Data Loss Prevention\Enforce
Server\15.1\protect\bin"

> .\SolutionPackInstallerexe import "C:\Program
Files\Symantec\Data Loss Prevention\Financial_v15.1.vsp"
```

8. After this is installed, restart the **SymantecDLPManager** service.
9. Log on to the Enforce Web Console as Administrator.
10. Navigate to **System > Servers > Overview.**
11. Click **Add Server.**
12. Select the type of Detection Server to add.
13. Click **Next.**
14. Enter a **name.**
15. Enter the **hostname** of the DLP server.
16. Enter **8100** for the **port.**
17. Navigate to **System > Settings > General.**



18. Check the box next to **Advanced Process Control.**
19. Specify any configuration options according to the needs of your organization.
20. Click **Save.**

2.16 Cisco Identity Services Engine

This section details the installation and some configurations for the Cisco Identity Services Engine (ISE). It assumes the use of the ISE virtual machine.

2.16.1 Initial Setup

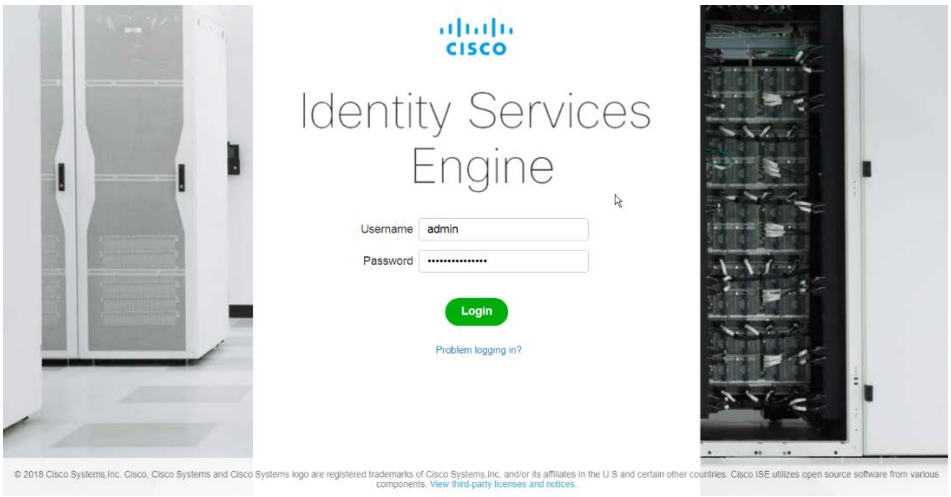
1. When prompted to log in for the first time, enter `setup`. (You can use the command `reset-config` to change these values later.)
2. Enter the desired **hostname** for the machine.
3. Enter the desired **IP address** for the machine. (Ensure that the specified hostname is associated with this IP address in your DNS.)
4. Enter the **netmask** for the machine.
5. Enter the **default gateway.**
6. Enter the **default DNS domain** (the name of your domain).
7. Enter the **primary nameserver** (the IP address of your DNS).
8. Enter a second nameserver if desired.
9. Enter a **Network Time Protocol (NTP) time server.**
10. Enter the **timezone.**
11. Enter **Y** for **SSH service.**
12. Enter an administrator **username** for the machine.
13. Enter a **password** twice.

2.16.2 Inventory: Configure SNMP on Routers/Network Devices

See the corresponding vendor documentation for the correct way to enable Simple Network Management Protocol (SNMP) on your network device. Ensure that the community string you choose is considered sensitive, like a password.

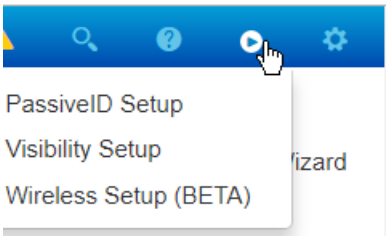
2.16.3 Inventory: Configure Device Detection

1. Log in to the web client by visiting https://hostname/admin but replace **hostname** with the hostname of the ISE machine.



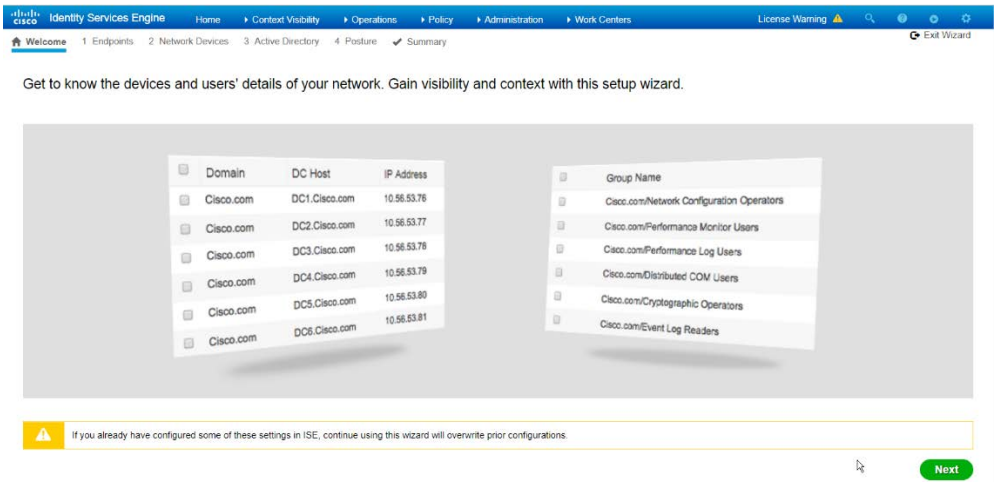
2397

2398 2. On the top right, use the small Play button to select **Visibility Setup.**



2399

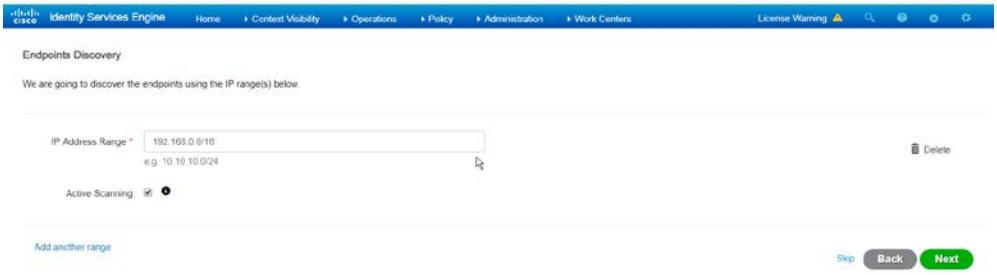
2400 3. Click **Next.**



2401

2402 4. Enter the range of IP addresses to add to ISE's inventory.

2403 5. Ensure that **Active Scanning** is checked.



2404

2405 6. Click **Next.**

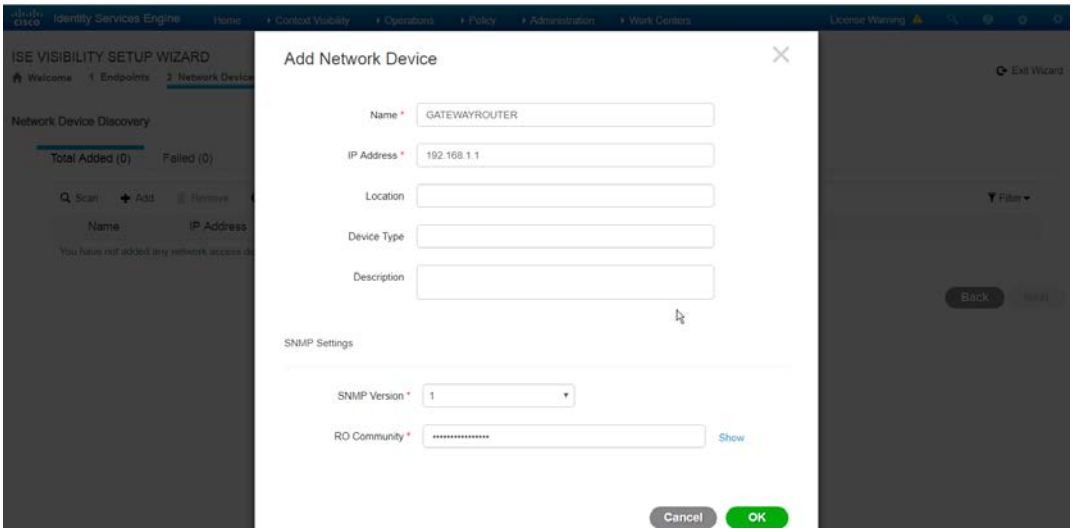
2406 7. Click the **Add Device Manually** link.

2407 8. Enter a **name.**

2408 9. Enter the **IP address** of the network device you configured for SNMP.

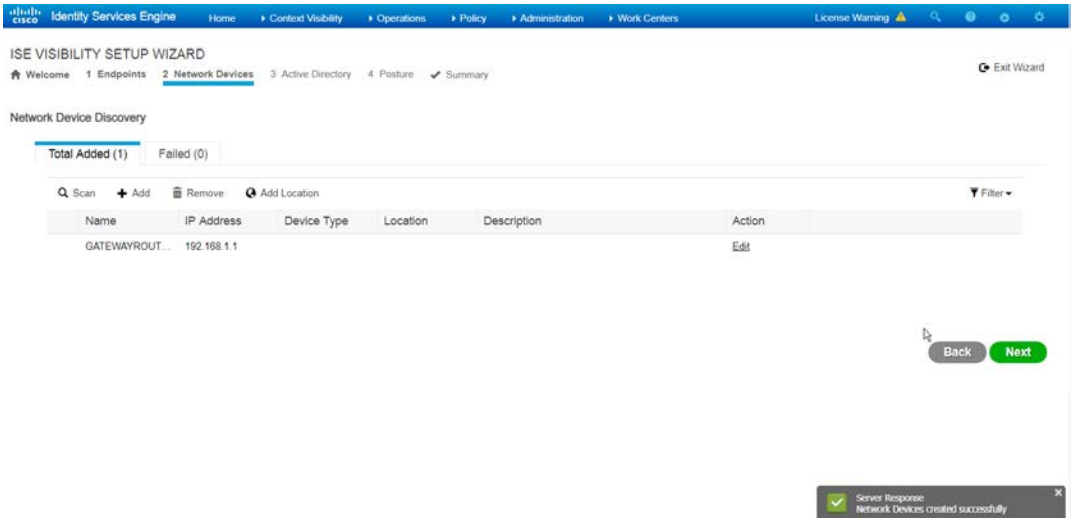
2409 10. Select **1** for **SNMP version.**

2410 11. Enter the **community string** you created.

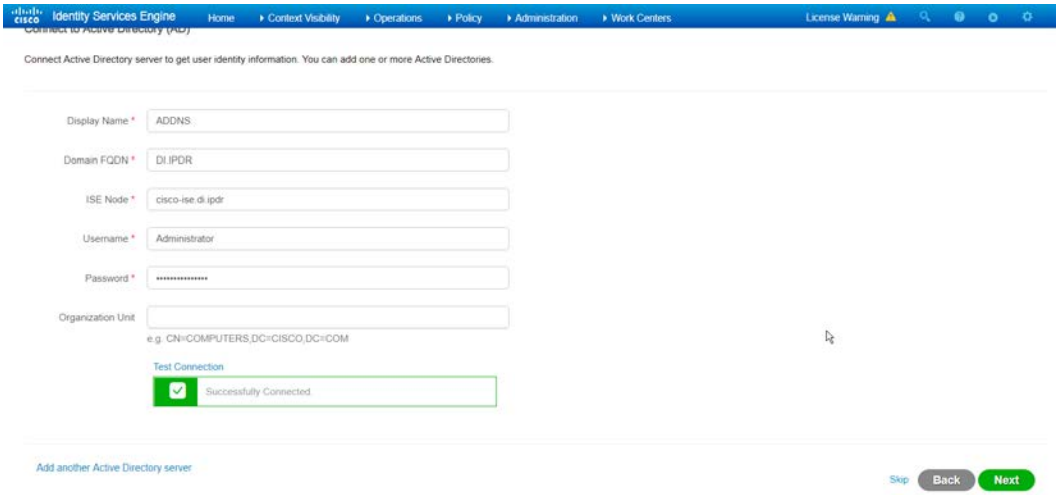


2411

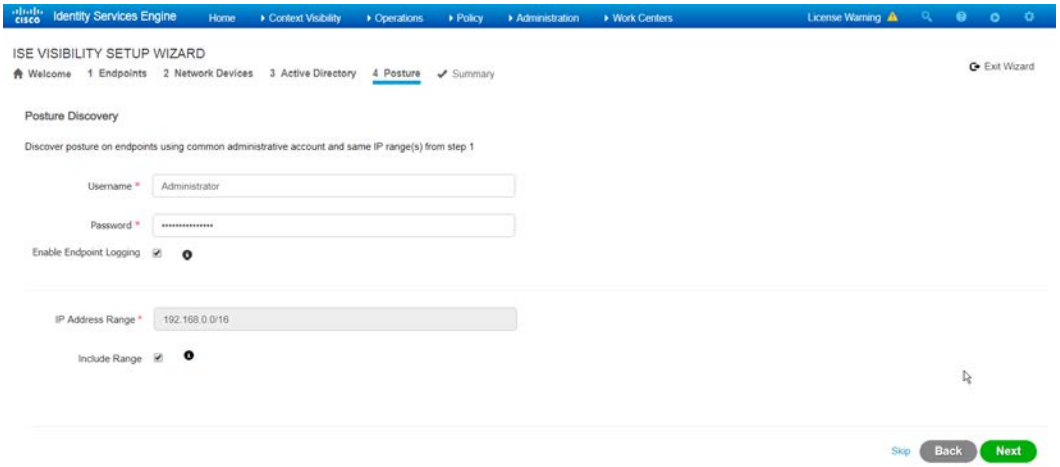
2412 12. Click **OK.**



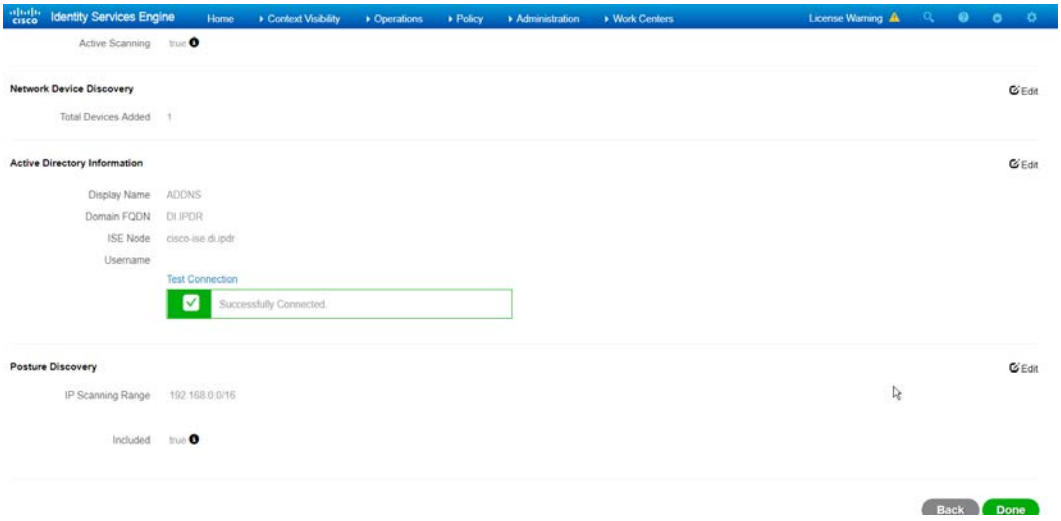
13. Click **Next.**
14. Enter a **display name.**
15. Enter the **domain name.**
16. Enter the **hostname** of **Cisco ISE.**
17. Enter a **username** and **password.**
18. Click **Test Connection** to ensure that this works.



19. Click **Next.**
20. Enter a **username** and **password.**
21. Check the box next to **Enable Endpoint Logging.**
22. Check the box next to **Include Range.**



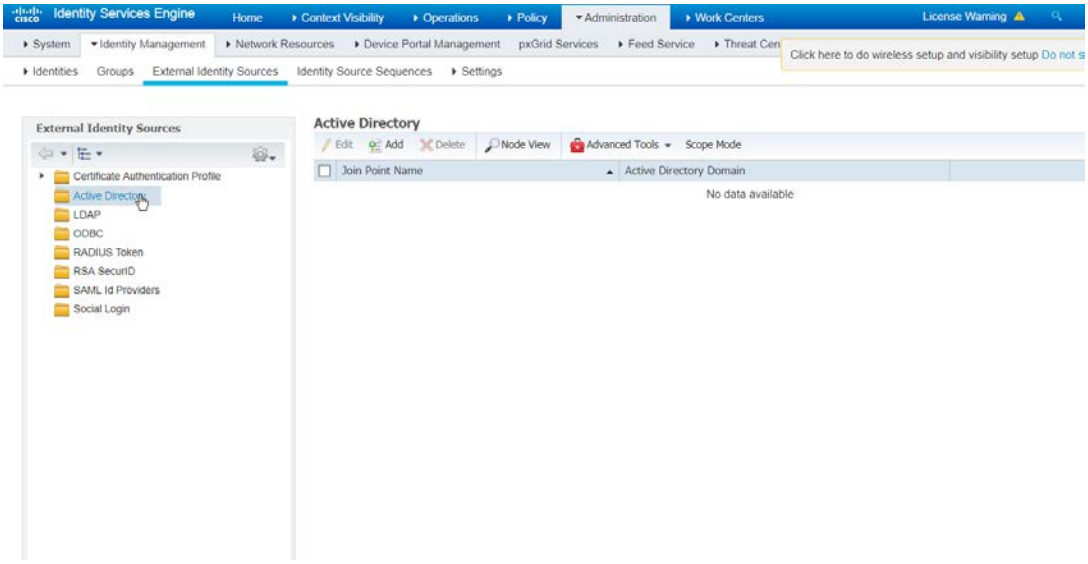
23. Click **Next.**



24. Verify the settings and click **Done.** (This should begin importing endpoints connected to the network device, and they will be visible on the ISE dashboard.)

2.16.4 Policy Enforcement: Configure Active Directory Integration

1. Navigate to **Administration > Identity Management > External Identity Sources > Active Directory.**

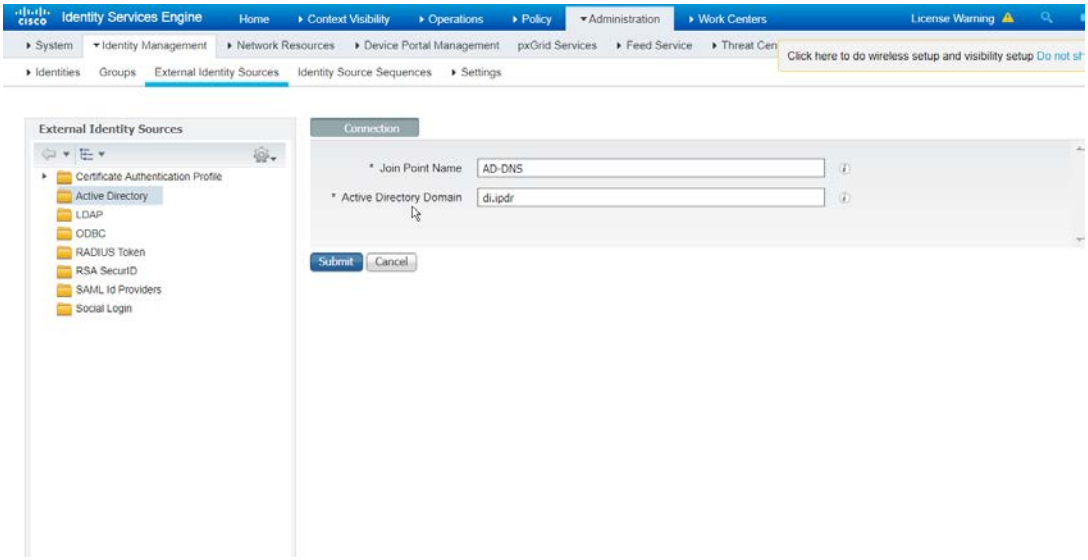


2433

2434 2. Click **Add.**

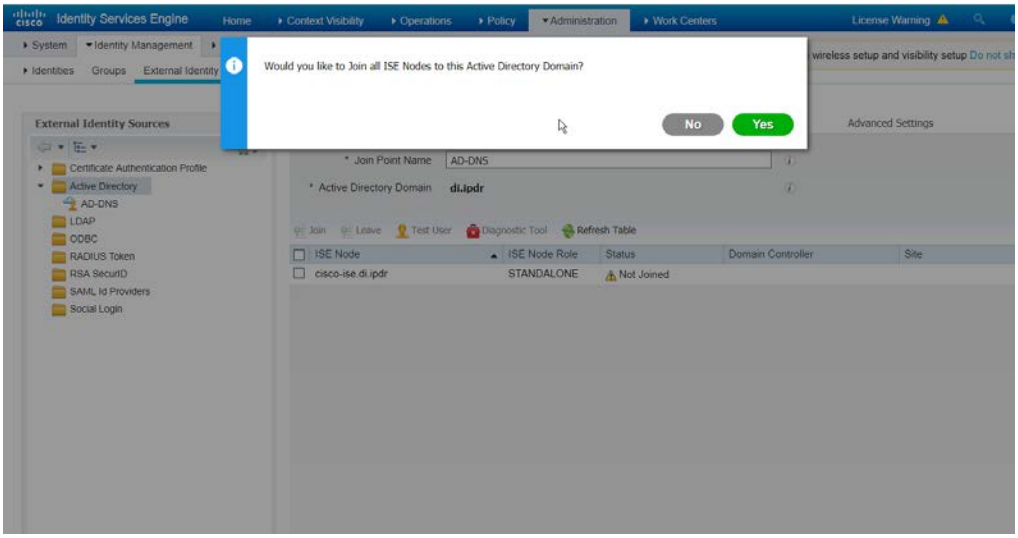
2435 3. Enter a **name.**

2436 4. Enter the **domain.**

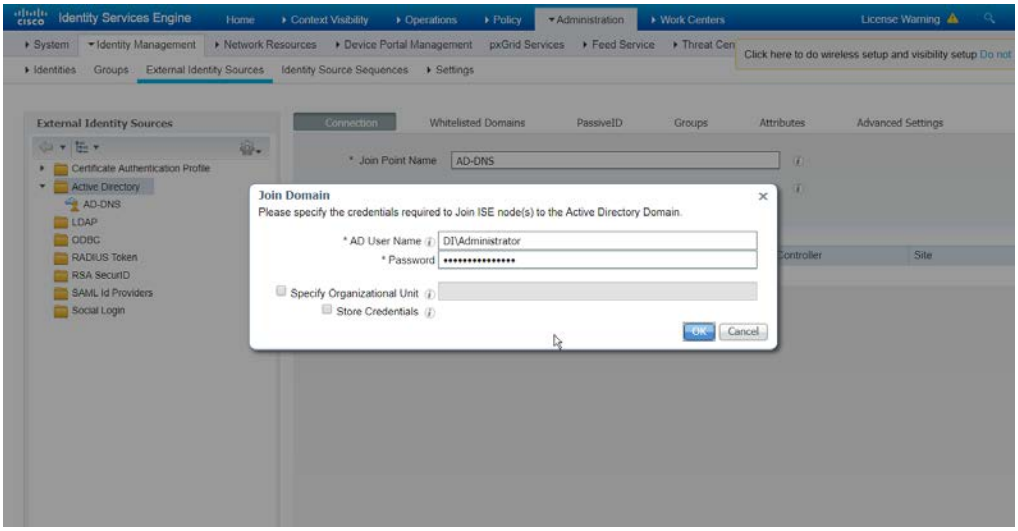


2437

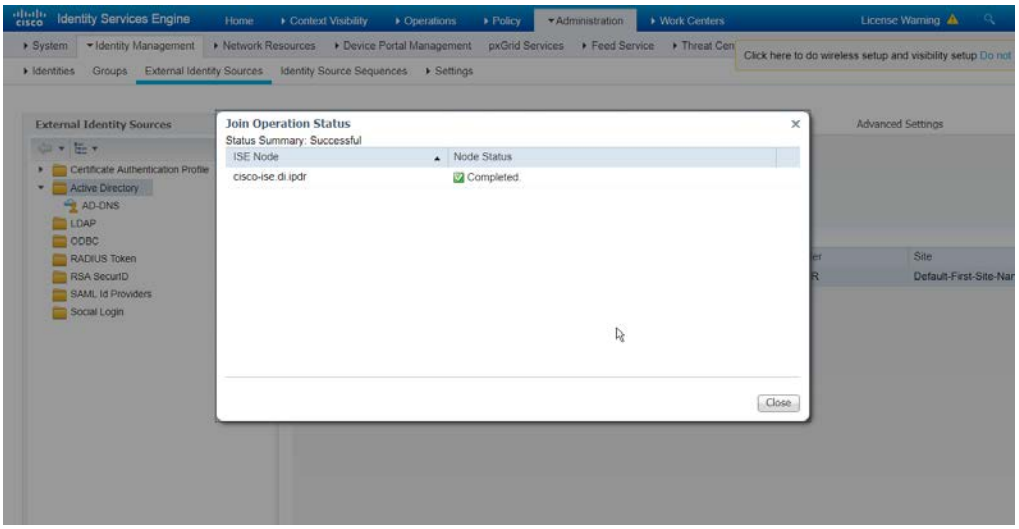
2438 5. Click **Submit.**



6. Click **Yes.**
7. Enter a **username** and **password** to join ISE to the domain.



8. Click **OK.**

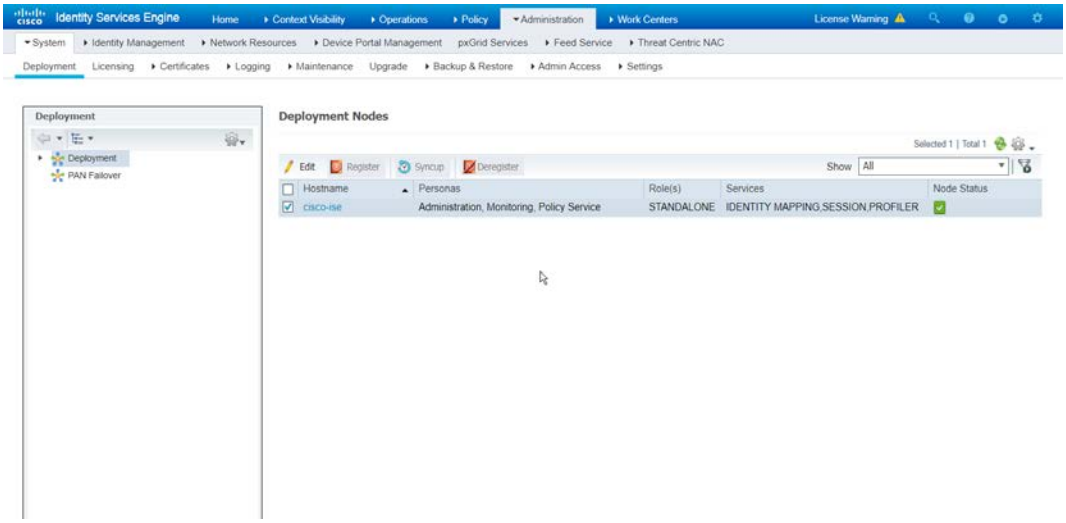


9. Click **Close** when the join is finished.

2.16.5 Policy Enforcement: Enable Passive Identity with AD

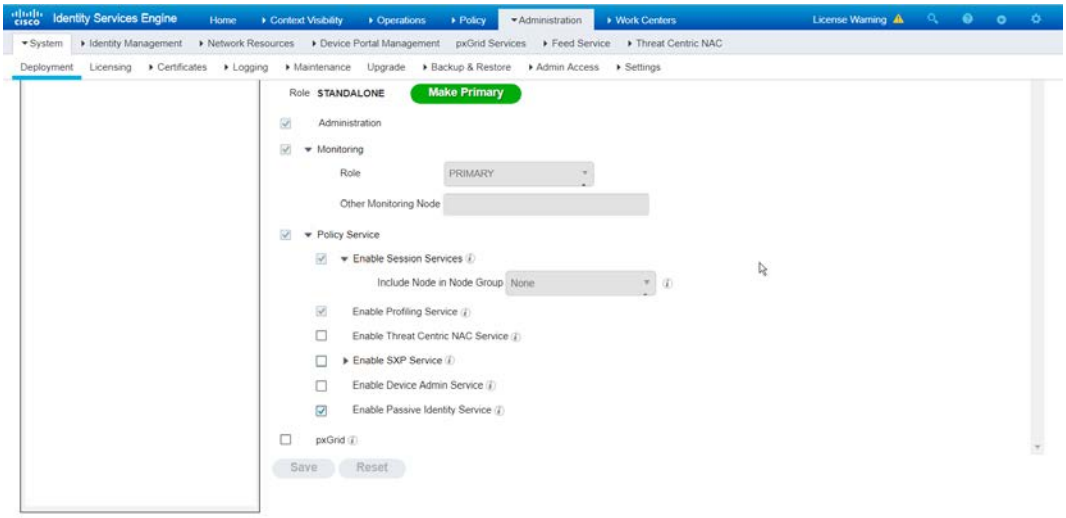
This configuration allows users to use Active Directory usernames/passwords as authentication for the portal. The web portal will allow clients to download profiling software to ensure that clients have up to date software and can be trusted on the network.

1. Navigate to **Administration > System > Deployment.**
2. Check the box next to ISE.

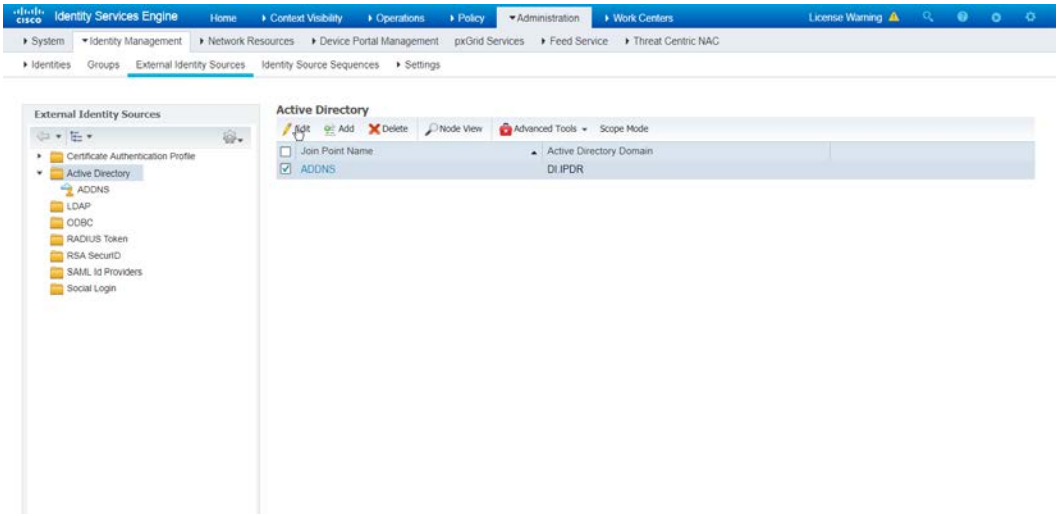


3. Click **Edit.**

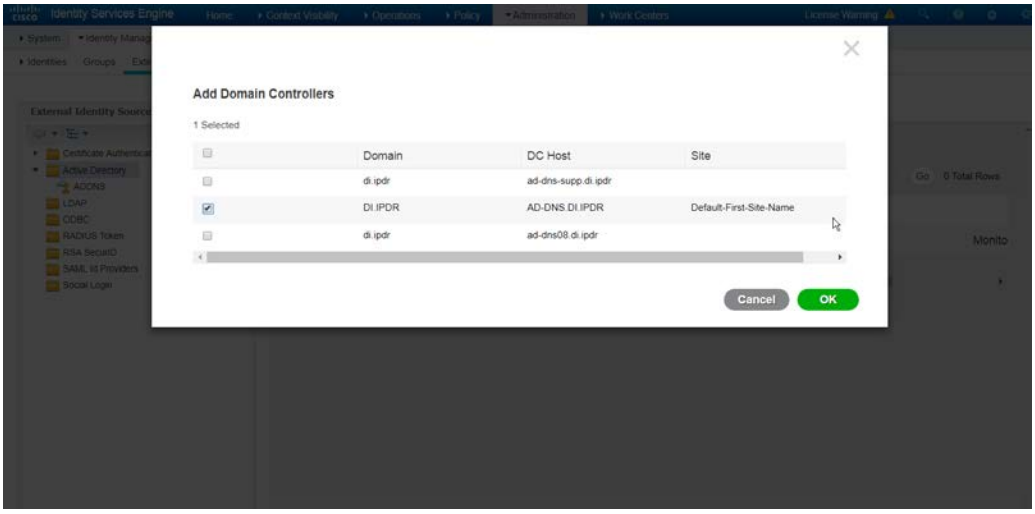
4. Check the box next to **Enable Passive Identity Service.**



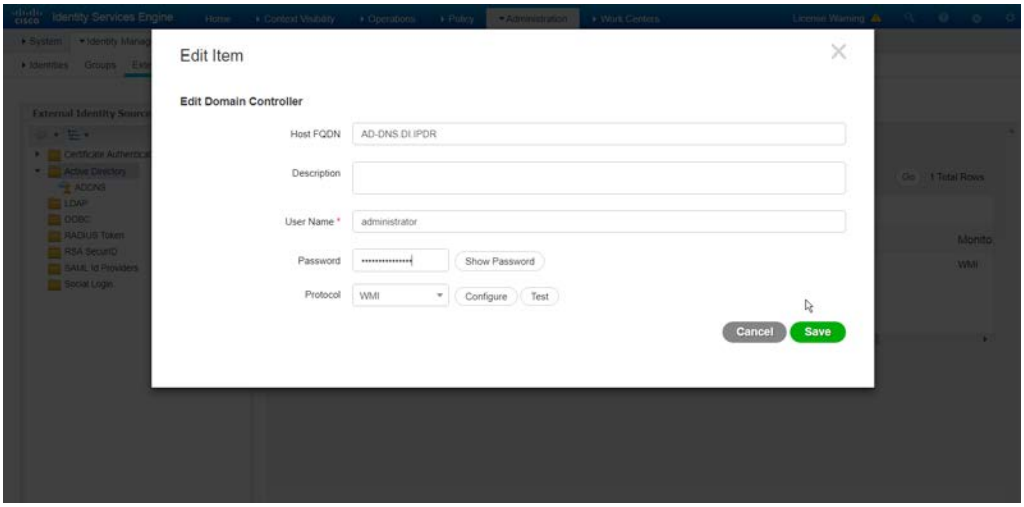
5. Click **Save.**
6. Navigate to **Administration > Identity Management > External Identity Sources > Active Directory.**
7. Click the name of the Active Directory machine.
8. Check the box next to the join point you just created.



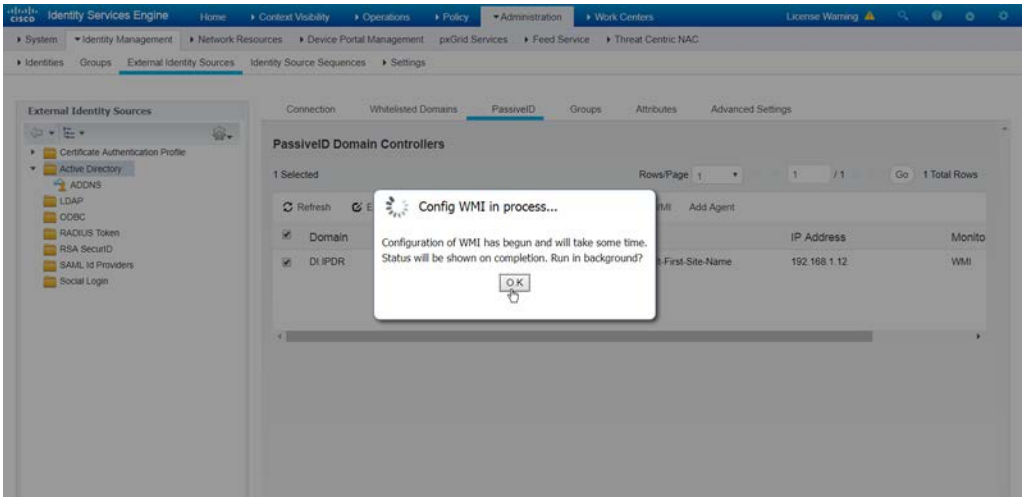
9. Click **Edit.**
10. Click the **PassiveID** tab.
11. Click **Add DCs** if there are no domain controllers listed.



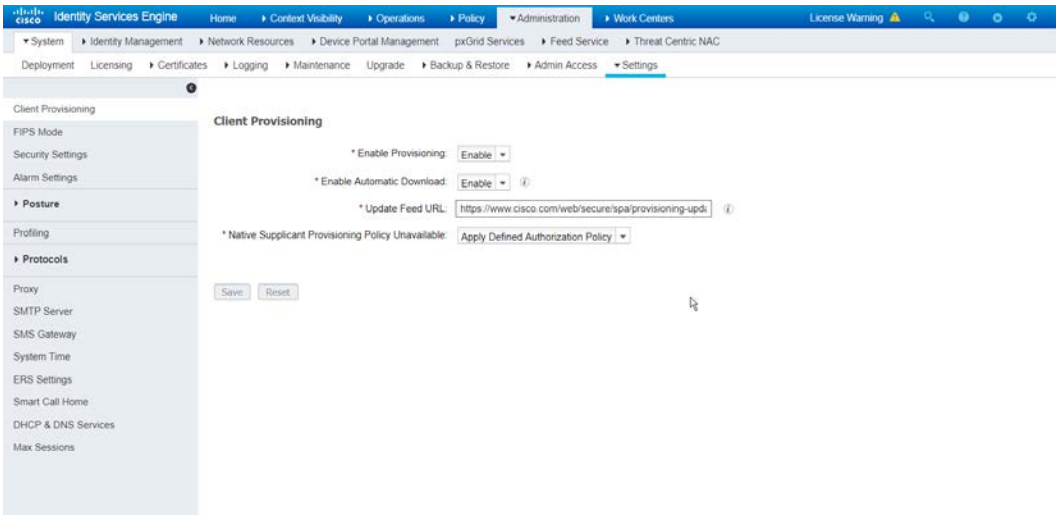
12. Select the Active Directory domain controller.
13. Click **OK.**
14. Check the box next to the selected domain controller.
15. Click **Edit.**
16. Enter credentials for an administrator account.



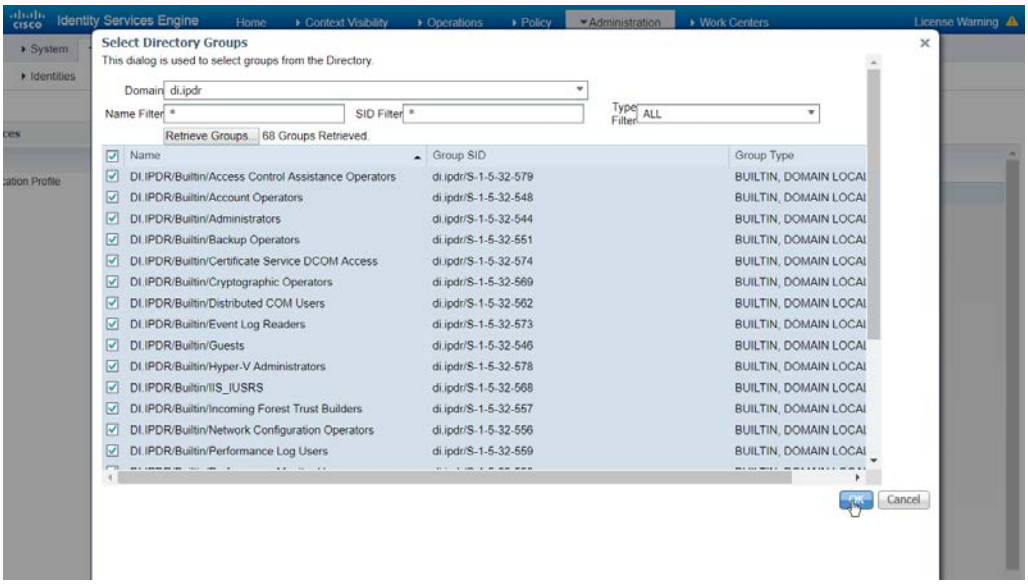
17. Click **Save.**
18. Click **Config WMI.**
19. Click **OK.**



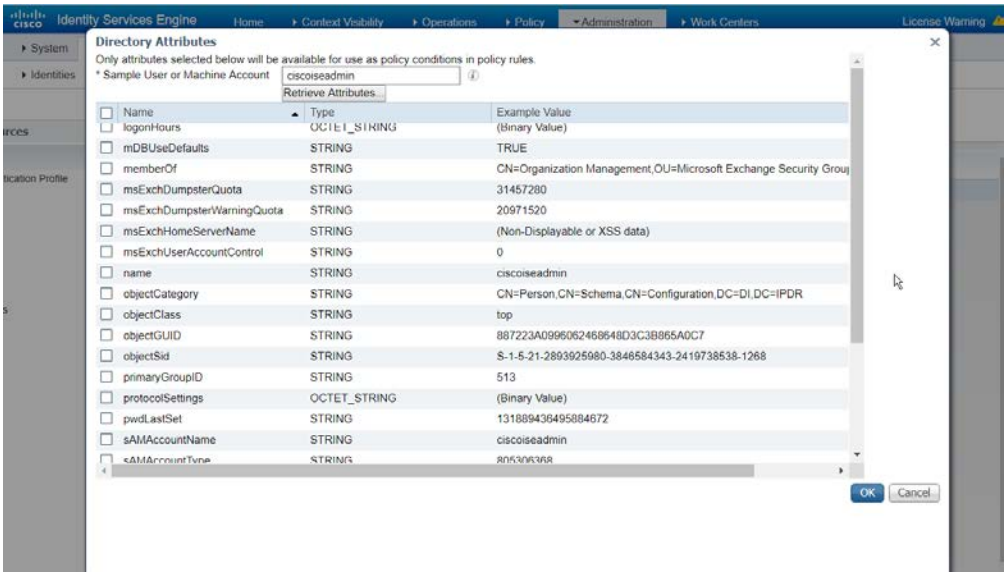
20. Click **OK** when this configuration finishes.
21. Navigate to **Administration > System > Settings > Client Provisioning.**
22. Set Enable **Automatic Download** to **Enable.**



23. Click **Save.**
24. Navigate to **Administration > Identity Management > External Identity Sources > Active Directory.**
25. Click the **Groups** tab.
26. Click **Add > Select Groups from Directory.**
27. Click **Retrieve Groups.** (This should populate the window with the groups from Active Directory.)
28. Select them all.



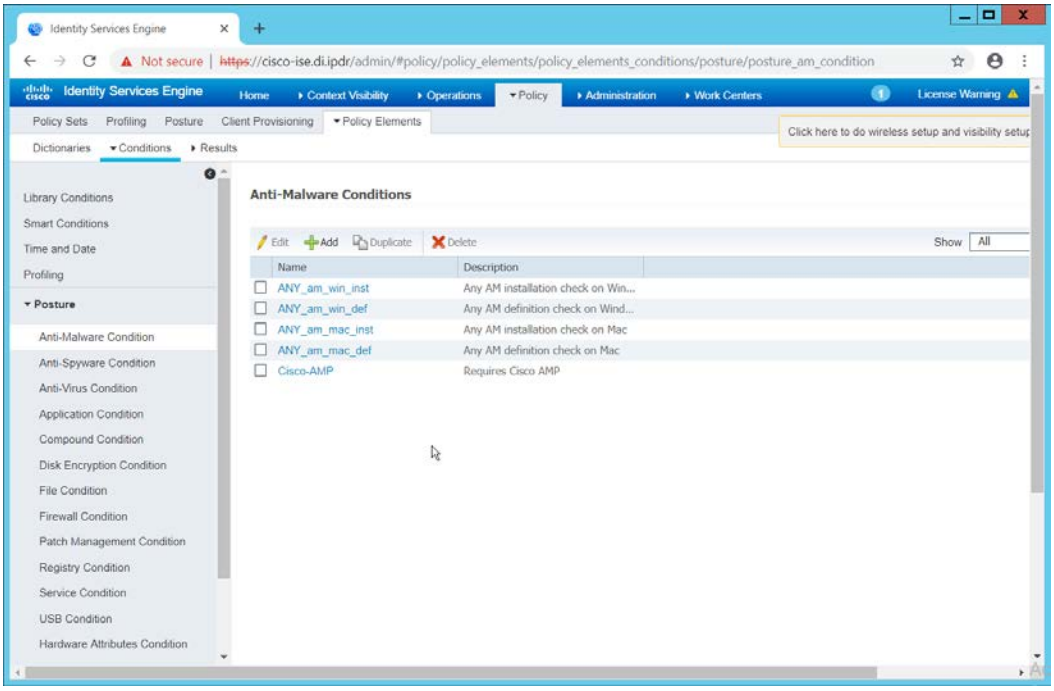
29. Click **OK.** (If you add more groups to Active Directory they can be imported in the same way in the future.)
30. Click the **Attributes** tab.
31. Click **Add > Select Attributes from Directory.**
32. Enter a **username.**
33. Click **Retrieve Attributes.** (This will populate the window with Active Directory's available attributes, so they can be used for policy in Cisco ISE.)
34. Click **OK.**
35. Select any desired attributes.



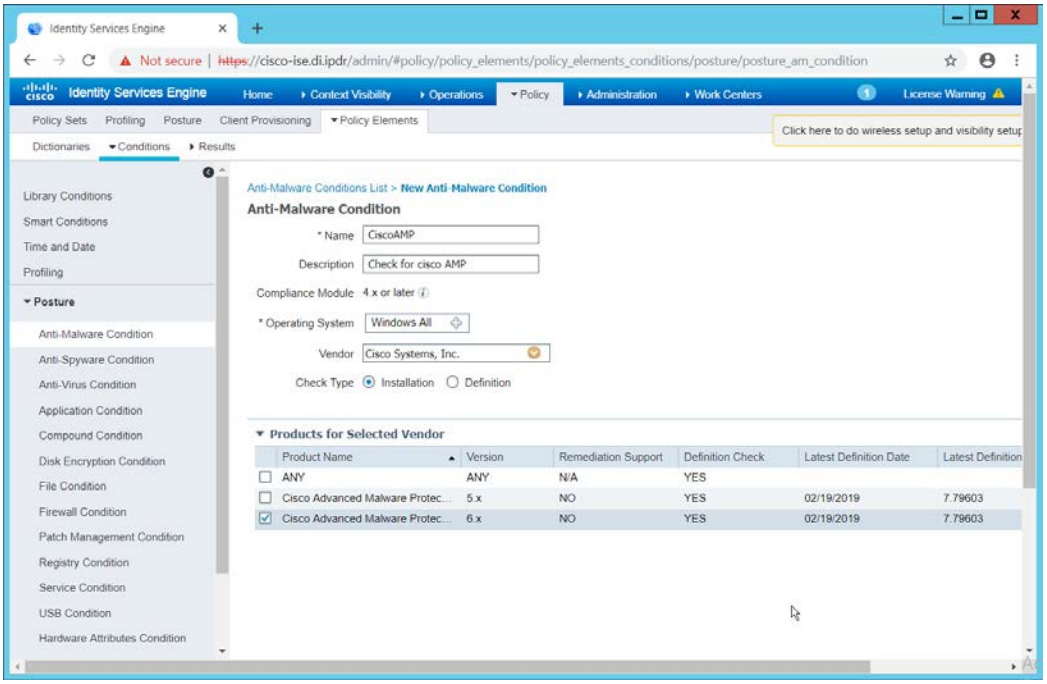
36. Click **OK.**
37. Click **Save.**

2.16.6 Policy Enforcement: Developing Policy Conditions

1. Navigate to **Policy > Policy Elements > Conditions > Posture.**
2. Expand the **Posture** section. This will reveal a list of categories for conditions. (Note: These conditions allow you to select or define requirements that endpoints should meet. In typical enterprises, these conditions can be used as requirements to gain network access–however, this strongly depends on the capabilities of your network device.)
3. As an example, we will require that Cisco AMP be installed on all Windows devices. If you are using a different anti-malware software, locate that instead. Click **Anti-Malware Condition.**



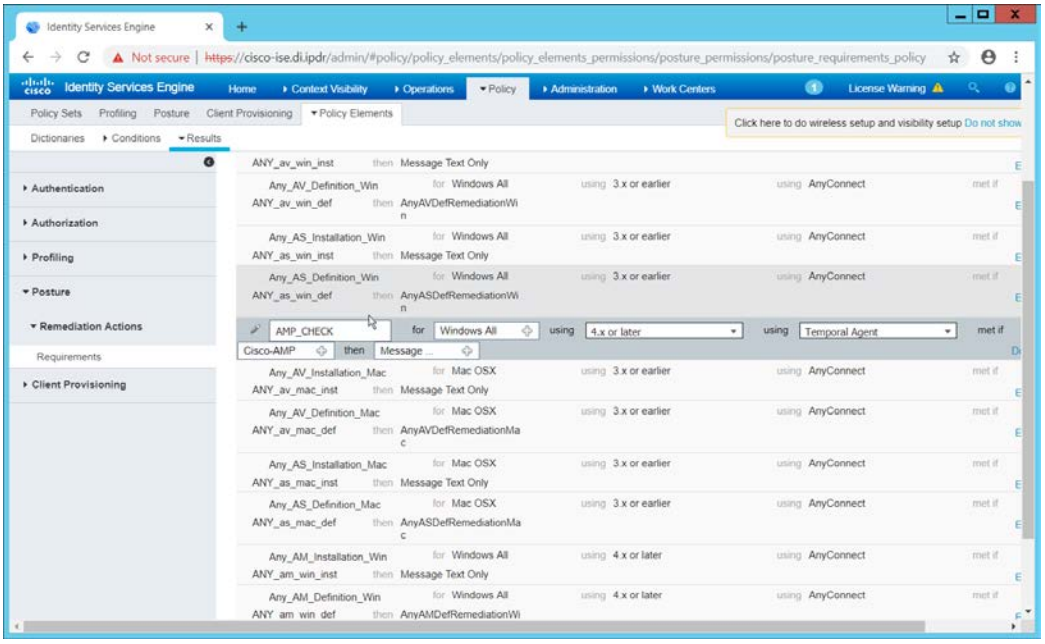
4. Click **Add.**
5. Enter a **name.**
6. Enter a **description** if desired.
7. Select **Windows All** for **Operating System.**
8. Select **Cisco Systems, Inc.** for **Vendor.**
9. Under **Products for Selected Vendor,** check the box next to **Cisco Advanced Malware Protection** with the version number you have installed.



10. Click **Submit.**

2.16.7 Policy Enforcement: Developing Policy Results

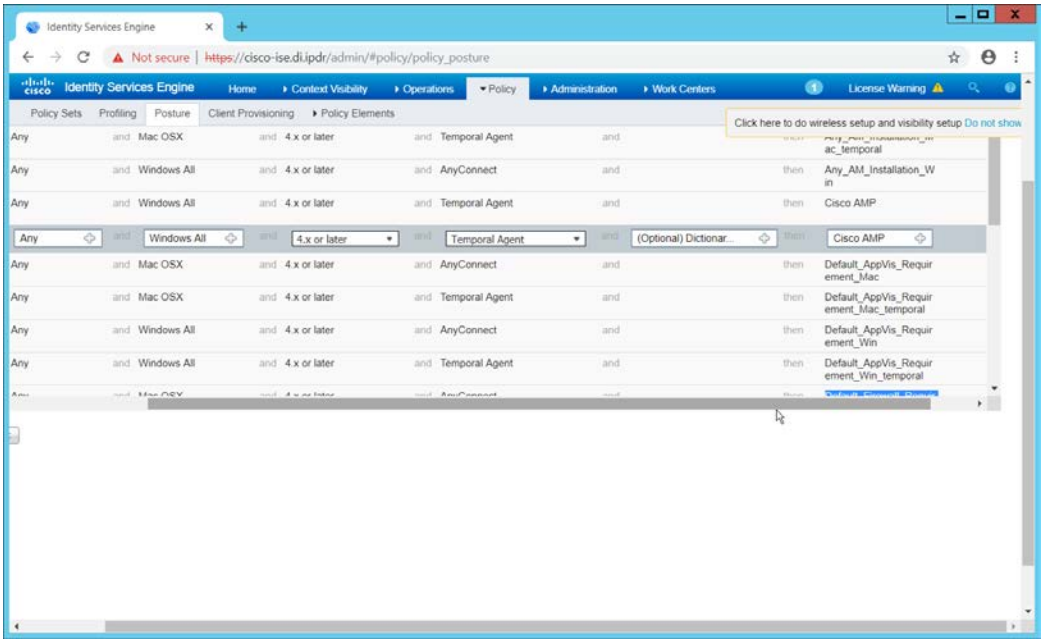
1. Navigate to **Policy > Policy Elements > Results > Posture > Requirements.**
2. Click one of the black arrows next to the **Edit** link, and select **Insert New Requirement.**
3. Enter a **name.**
4. Select **Windows All** for **Operating Systems.**
5. Select **4.x or later** for **Compliance Module.**
6. Select **Temporal Agent** for **Posture.**
7. Select **User Defined Conditions > Anti-Malware Condition > Cisco AMP** (substitute Cisco AMP with the name of the condition you just created).
8. Select **Message Text Only** for the **Remediation Action.** (Other remediation actions can be defined by going to **Policy > Policy Elements > Results > Posture > Remediation Actions,** but there is not an option for Cisco AMP to be installed, so we leave the default for now.)
9. Enter a **Message** to inform the user that they must install Cisco AMP.



10. Click **Save.**

2.16.8 Policy Enforcement: Enforcing a Requirement in Policy

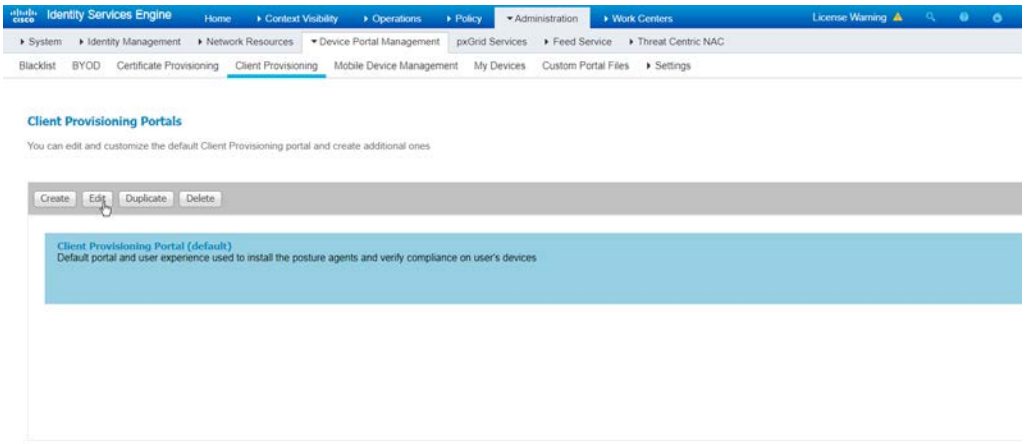
1. Navigate to **Policy > Posture.**
2. Click one of the black arrows next to the **Edit** link, and select **Insert New Policy.**
3. Enter a **name.**
4. Select **Windows All** for **Operating Systems.**
5. Select **4.x or later** for **Compliance Module.**
6. Select **Temporal Agent** for **Posture Type.**
7. Select **Cisco AMP** (substitute Cisco AMP with the name of the requirement you just created).



8. Click **Done.**
9. Ensure that the green checkboxes next to the rules you wish to apply are the only checkboxes enabled, as anything enabled will be enforced.

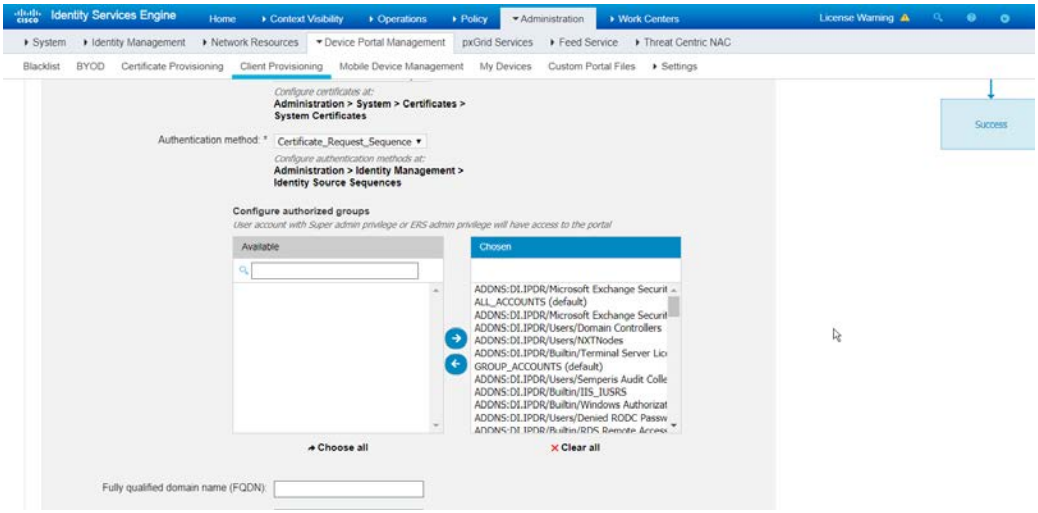
2.16.9 Policy Enforcement: Configuring a Web Portal

1. Navigate to **Administration > Device Portal Management > Client Provisioning.**
2. Select the **Client Provisioning Portal (default).**



3. Click **Edit.**

4. Under **Portal Settings,** go to **Configure authorized groups** and select the groups that should require a Cisco ISE client.
5. Enter a domain name for **FQDN,** and add it to your DNS.



6. Click **Save.**

2.16.10 Configuring RADIUS with Your Network Device

Cisco ISE requires a Remote Authentication Dial-In User Service (RADIUS) session for posture to function. Posture refers to ISE's ability to check that a machine complies with a specified policy, which may be based on the operating system (OS) and may contain requirements such as installation of certain security applications or the presence of configuration files. Machines that are not in compliance can be kept separated from the network. The process for setting this up varies widely among machines, but the overall requirements have commonalities among systems.

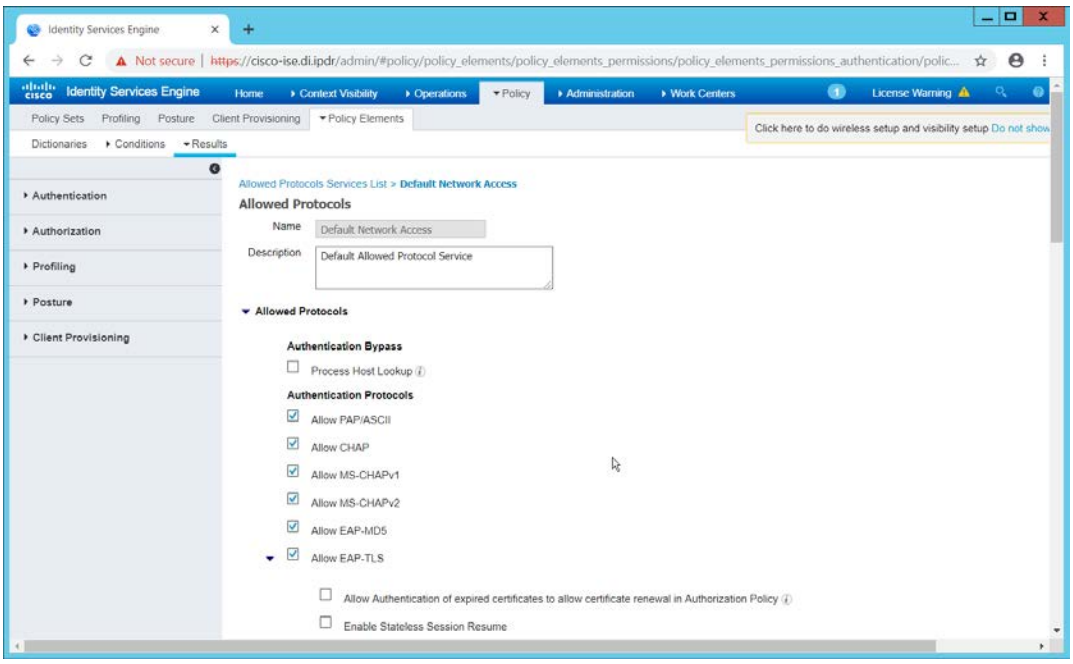
- The **Network Device** (i.e., the router or switch) must support RADIUS functions, specifically **Authentication, Authorization,** and **Accounting.** Furthermore, it must also support **CoA,** which is **Change of Authorization.** To configure this, you must configure your network device to use Cisco ISE as a RADIUS server. What this means is that your network device will forward authentication requests to Cisco ISE, and Cisco ISE will respond with an "accept" or "reject."
- The **Network Device** must support some form of **802.1x.** Note that this is not supported on certain routers, even if RADIUS is supported. **802.1x** is a mechanism for authenticating the end workstation to the network device, potentially over wireless or through Ethernet.

a. This can take various forms, such as a captive web portal, MAC address authentication, or user authentication. A captive web portal, if the device supports it, may be ideal for configuration without the correct hardware.
b. There are also many switches that provide direct 802.1x username/password authentication. Note that if you choose to use this mechanism, a client is still required, and it will not be in the web browser. Windows has a built-in 802.1x client, which can be configured on network adapters under the **Authentication** tab. To enable it, you must first start the service **Wired AutoConfig,** and then the **Authentication** tab will become available for configuration.
c. Whatever form of 802.1x is chosen, the request for authentication must be forwarded to Cisco ISE. Cisco ISE will process the request for authentication.

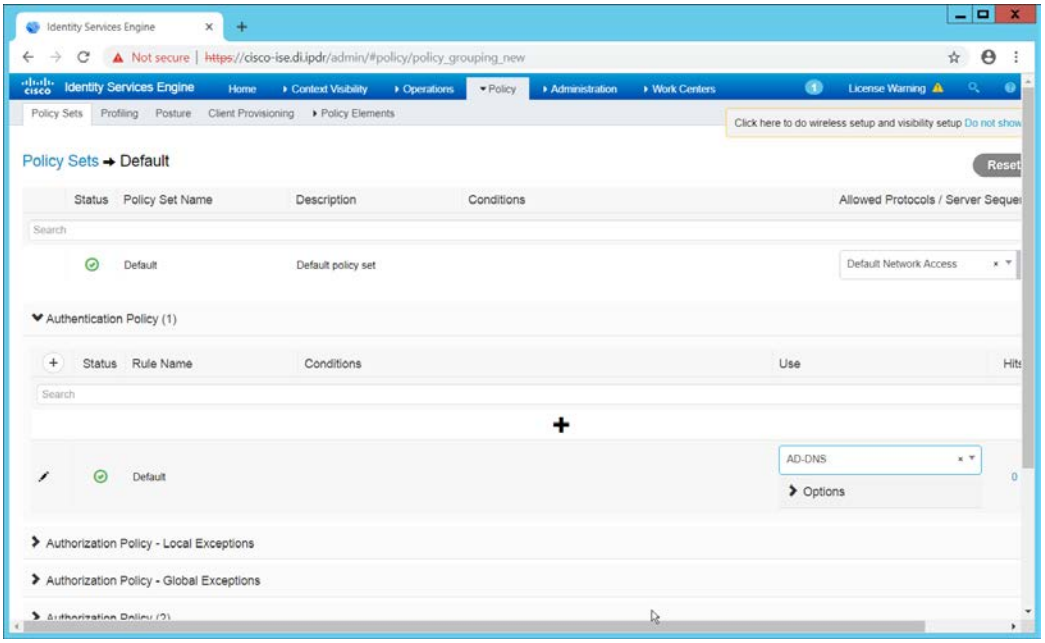
- The two steps above detail the **authentication** phase. Once authenticated, the network device must redirect the user to the client provisioning portal (or to a guest portal), depending on the setup. The URL for this can be acquired from the active **Authorization Profile** in ISE.
- The user will then authenticate to the **Guest Portal** or **Client Provisioning Portal** (depending on your setup). The portal will prompt the user to download an executable, which will run posture.
- The executable will *first* check for the existence of a RADIUS session in Cisco ISE for the user who downloaded the executable. It will primarily check the MAC address that visited the ISE web portal against the MAC addresses of existing sessions. *If and only if a session exists*, it will run posture based on the policy you set up. You can verify that a session exists by navigating to **Operations > RADIUS > Live Sessions.**

2.16.11 Configuring an Authentication Policy

1. Navigate to **Policy > Policy Elements > Results > Authentication > Allowed Protocols.**
2. Select the **Default Network Access** protocol or create your own.
3. Ensure that any protocols that need to be supported for your network setup are allowed. In particular, if using 802.1x, it is likely that you should check the box next to **Allow MS-CHAPv2.**



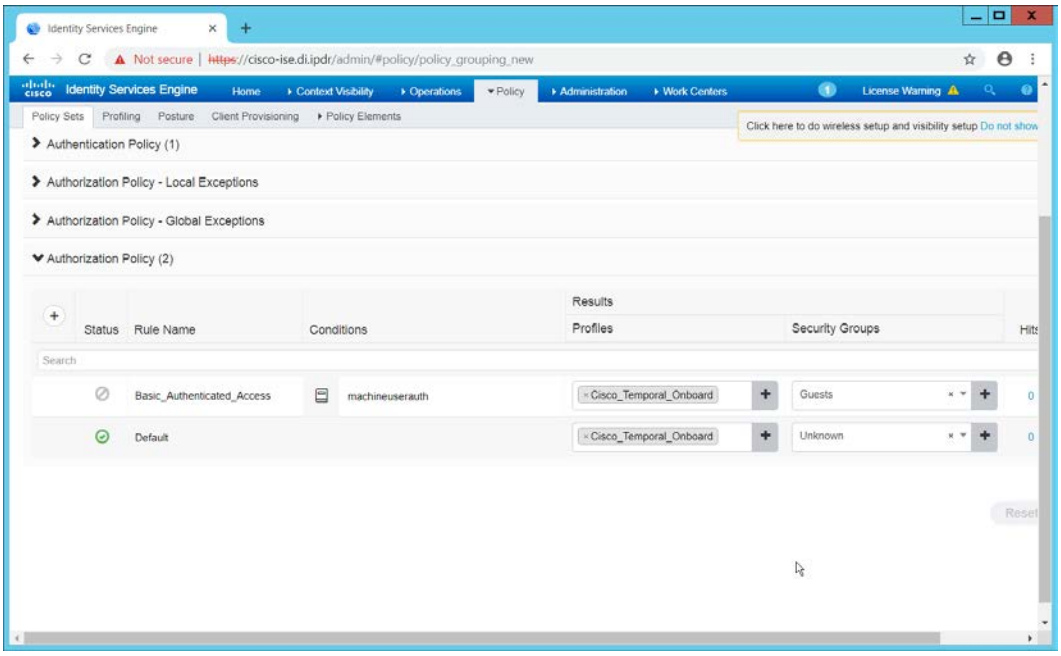
4. Click **Save.**
5. Navigate to **Policy > Policy Sets.**
6. Select the default policy.
7. Ensure that the **Allowed Protocol** selection matches the allowed protocol you just created/edited.
8. Expand the **Authentication Policy** section, and select the ID stores from which to authenticate users. For example, if you set up an Active Directory integration, it may be desirable to authenticate users from there.



9. Click **Save.**

2.16.12 Configuring an Authorization Policy

1. The Authorization Profile is likely dependent on your network device, but it is possible that the **Cisco_Temporal_Onboard** profile will work even for non-Cisco devices. You can edit the authorization policy by navigating to **Policy > Policy Elements > Results > Authorization > Authorization Profiles.**
2. The temporal onboard profile will attempt to redirect the user to a client-provisioning portal. This redirection will most likely happen only automatically on compatible Cisco network devices. If another device is used, the device may need to manually redirect the user to the client-provisioning portal after authentication. (We accomplished this in pfSense for our build by using a “post-authentication redirection” feature in the Captive Portal.)
3. Once you are finished configuring the **Authorization Profile,** navigate to **Policy > Policy Sets.**
4. Select the default policy.
5. Expand the **Authorization Policy** section.
6. Note that you can configure this for as many groups and conditions as desired, potentially specifying different authorization profiles for various user groups or levels of authentication, including unauthenticated access. Under **Results > Profiles,** you can select the authorization profiles you configured.



7. Click **Save.**

2.17 Tripwire IP360

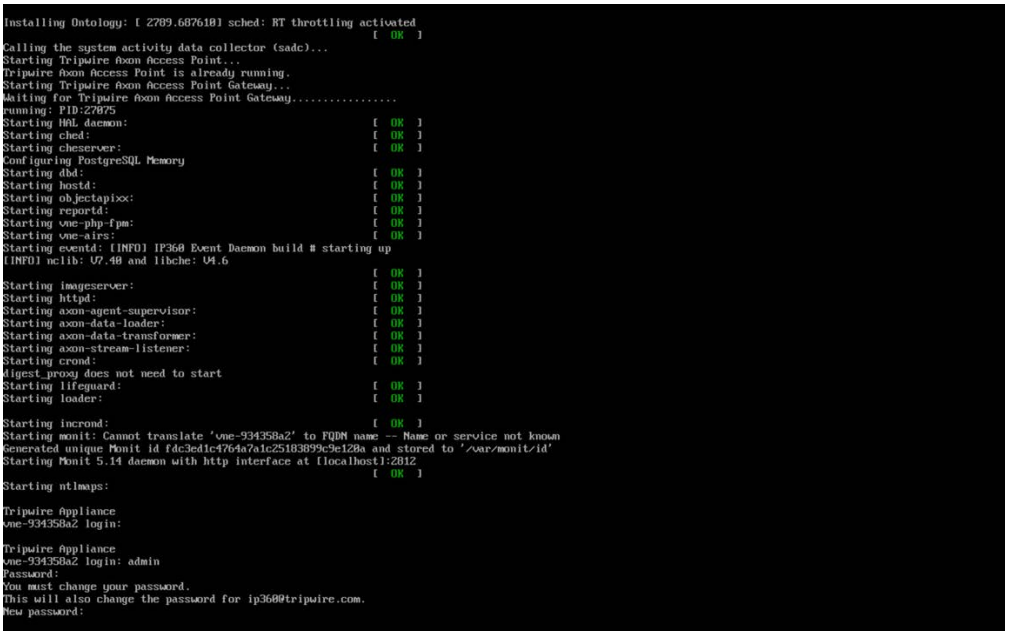
This section details installation and configuration for Tripwire IP360.

2.17.1 Installation

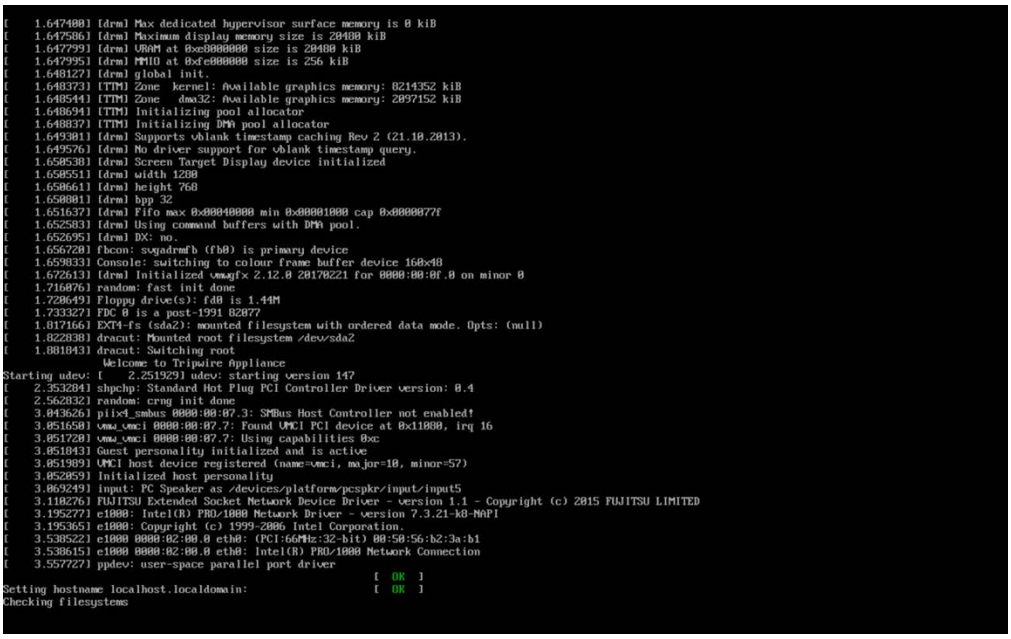
1. Move or copy the Tripwire IP360 Virtual Machine into your virtual environment; start Virtual Machine and observe its successful start-up.

2. Log in using default admin credentials.

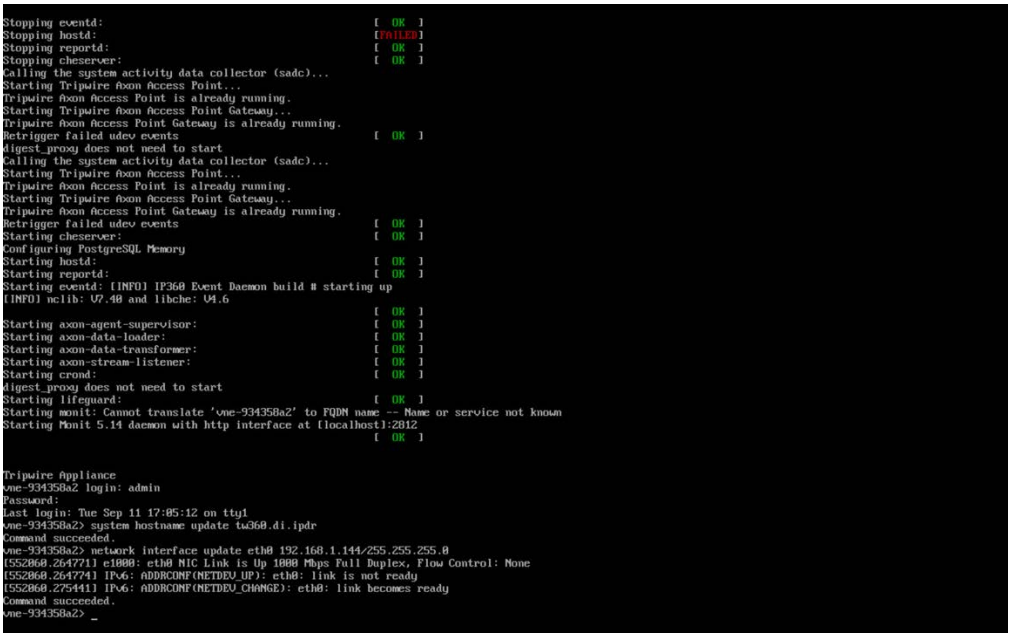
3. When prompted after initial login, set a new **password** and record it in a safe location.



4. Use the command **system hostname update <hostname>** to update the system's hostname in accordance with your environment's naming scheme.

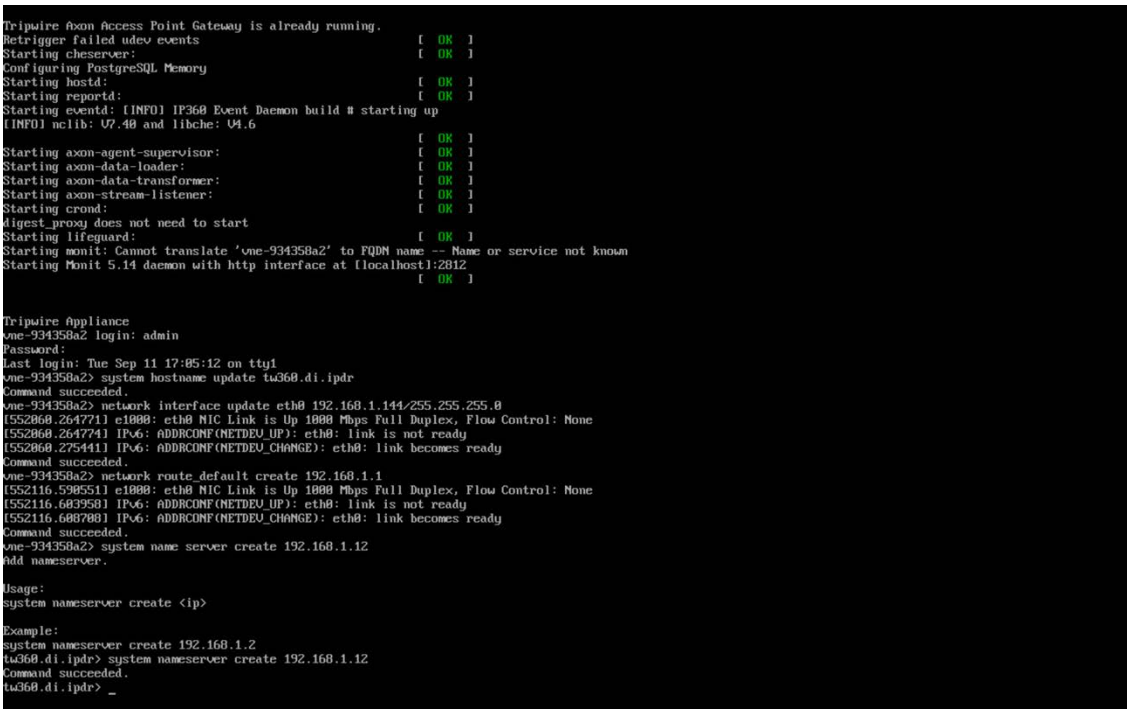


5. Use command **network interface update <interface> <IP>/<Broadcast IP>** to update network interface information in accordance with your environment's network.



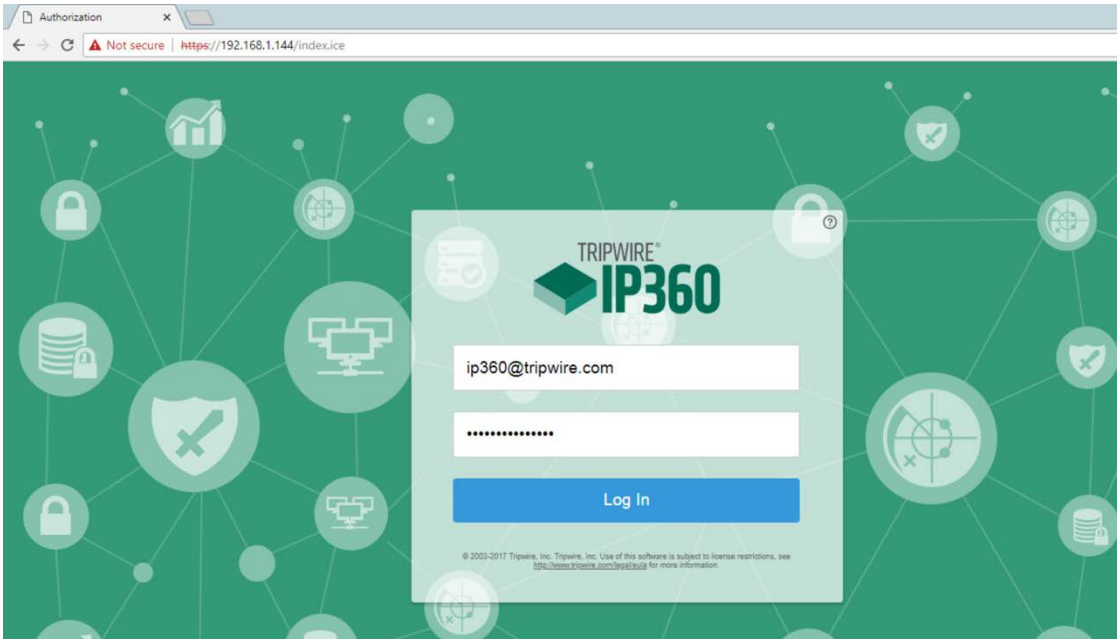
6. Use command **network route_default create <gateway>** to update the system's default gateway information in accordance with your environment's network.

7. Use command **system nameserver create <nameserver IP>** to set up the DNS server.

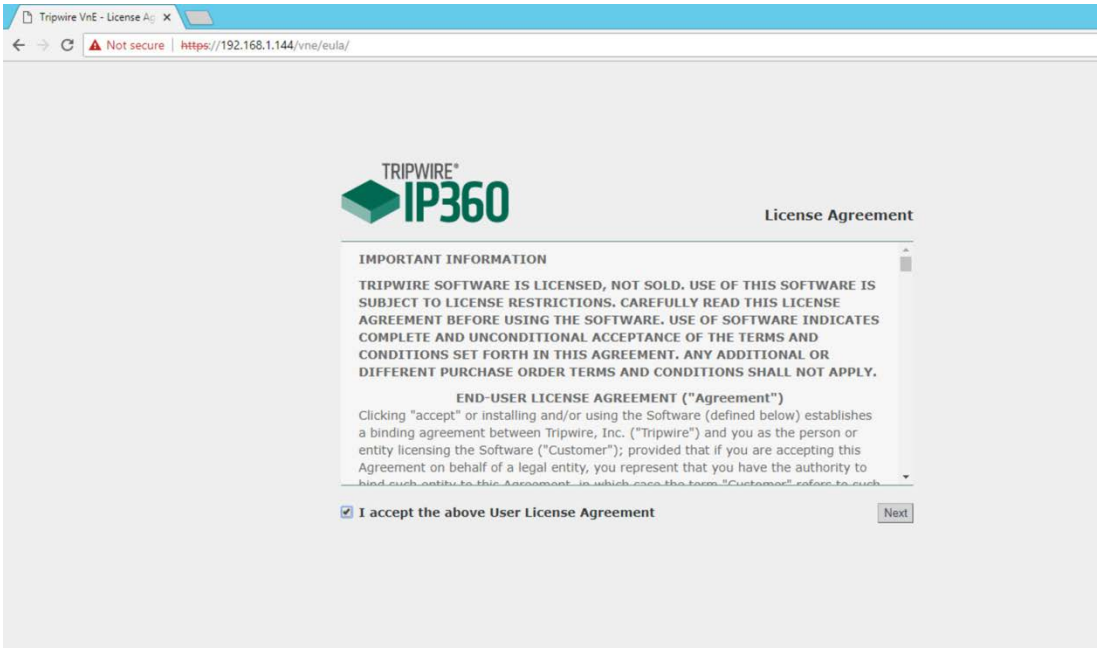


2.17.2 Web Portal

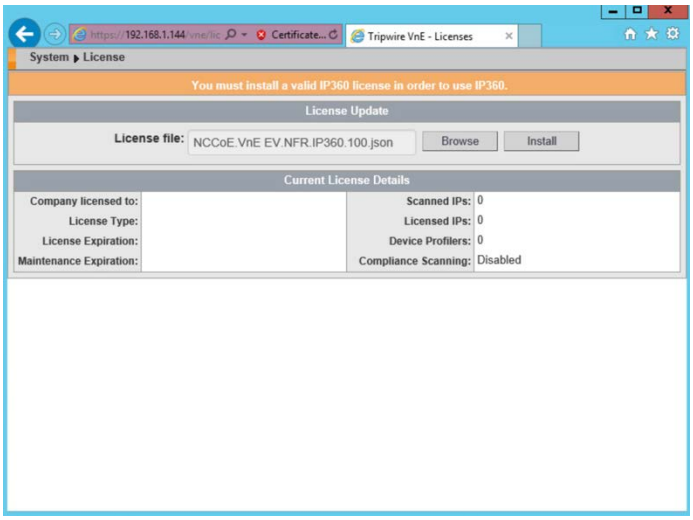
1. From a web browser that can access the newly installed machine's IP address, navigate to the IP address and log in using the updated credentials from the setup process.



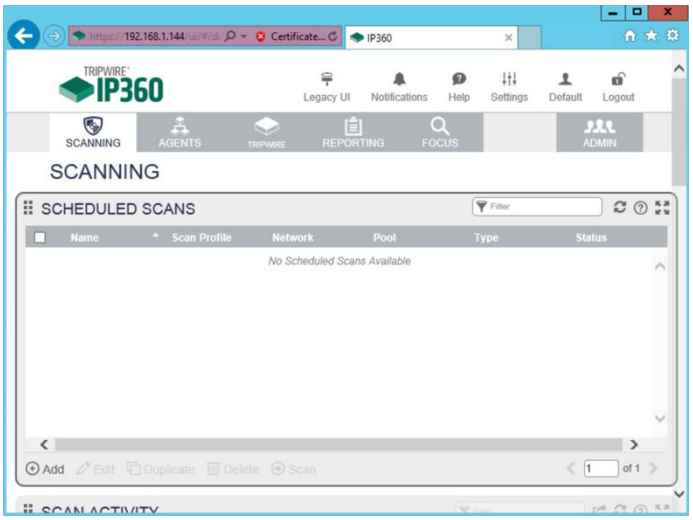
2. Check the box next to **I accept the above User License Agreement.**



3. Click **Next.**
4. Browse to location of downloaded license file.



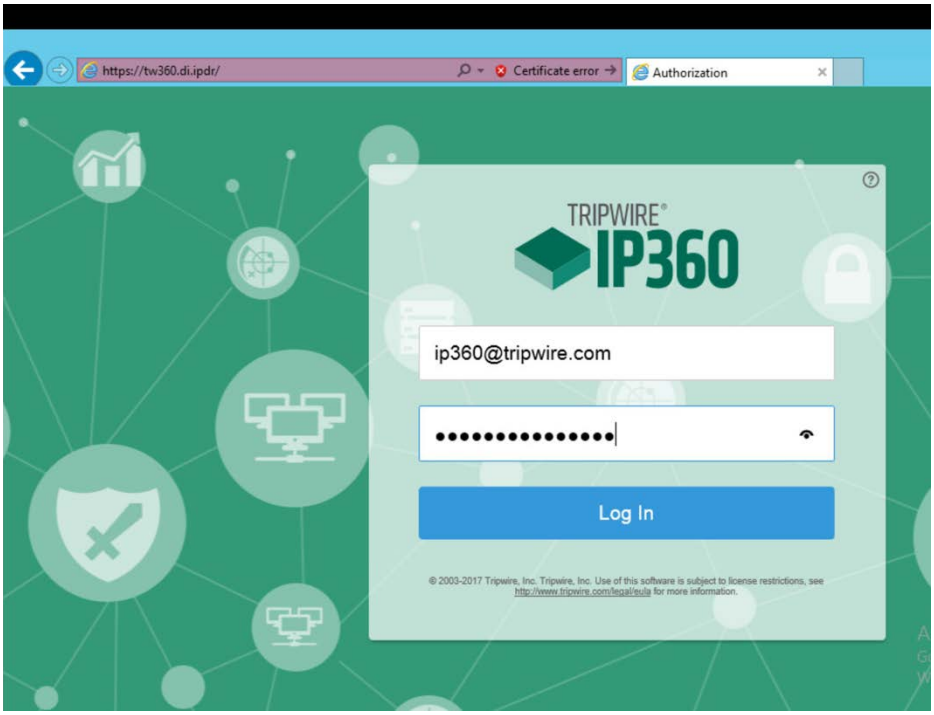
5. Click **Install.**
6. Tripwire IP360 should now be installed and running.



2.17.3 Scanning

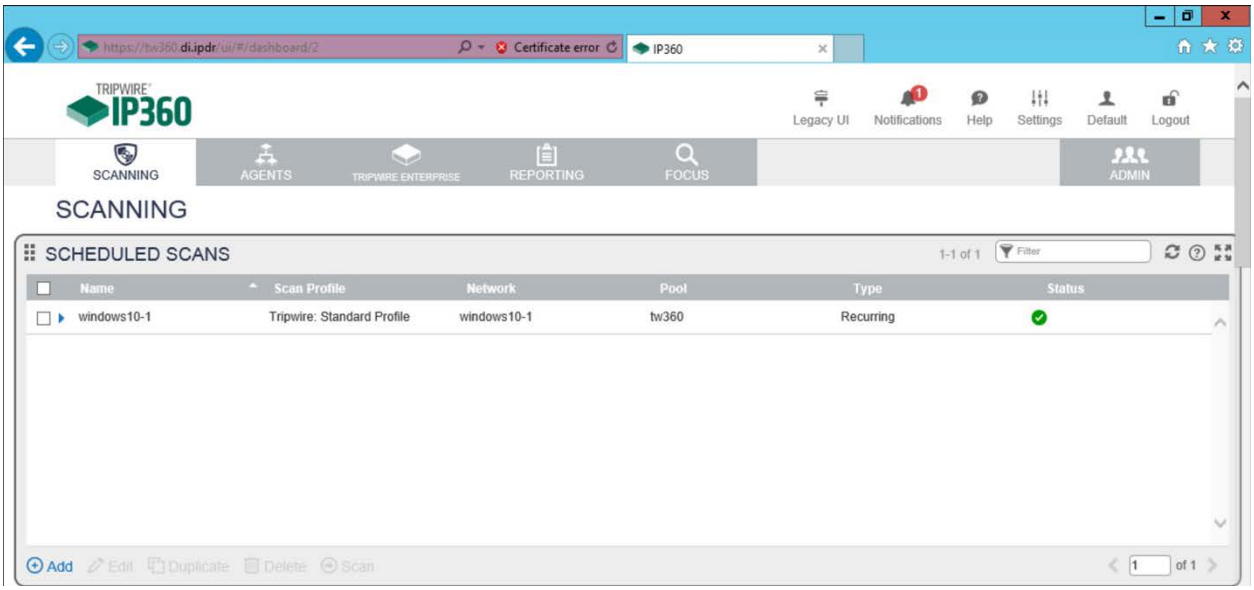
This section details instructions for using Tripwire IP360 to run a scan on enterprise systems. The specific details of the scan will vary based on each enterprise's security needs.

2653 1. Navigate to the web interface and log in.



2654

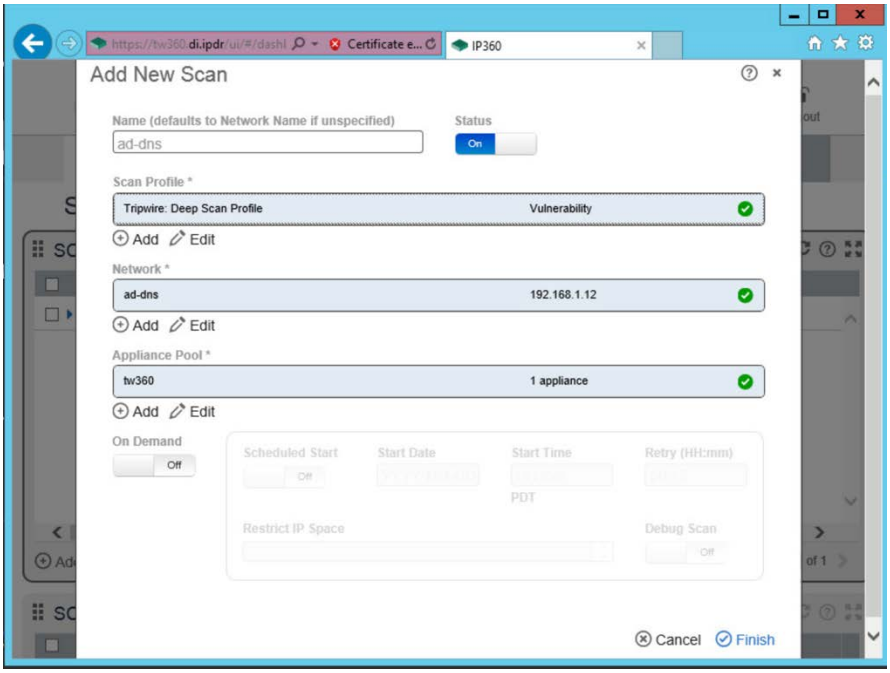
2655 2. Navigate to the **Scanning** tab.



2656

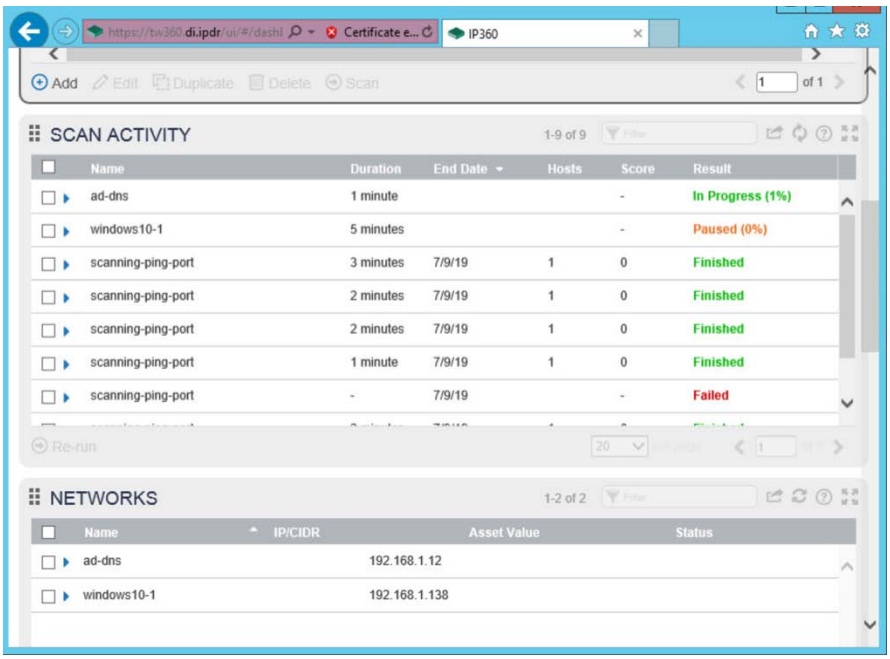
2657 3. Click **Add.**

2658 4. Complete the information regarding the new scan according to the preferences of your
2659 organization.



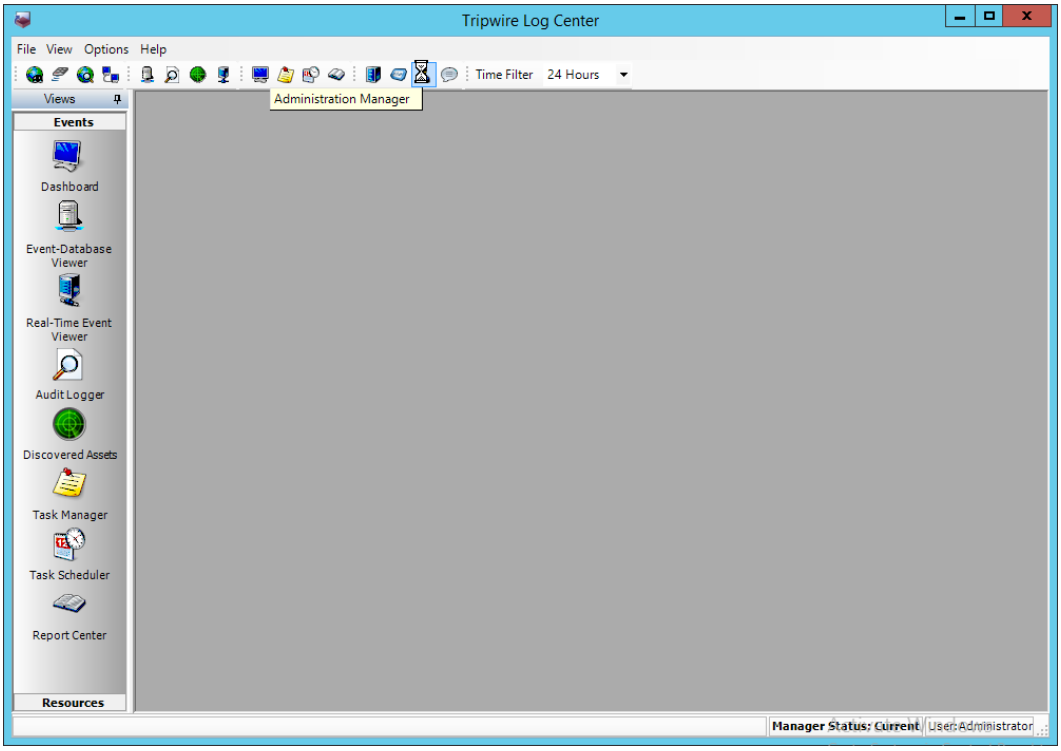
2660

2661 5. Observe successful scan activity.

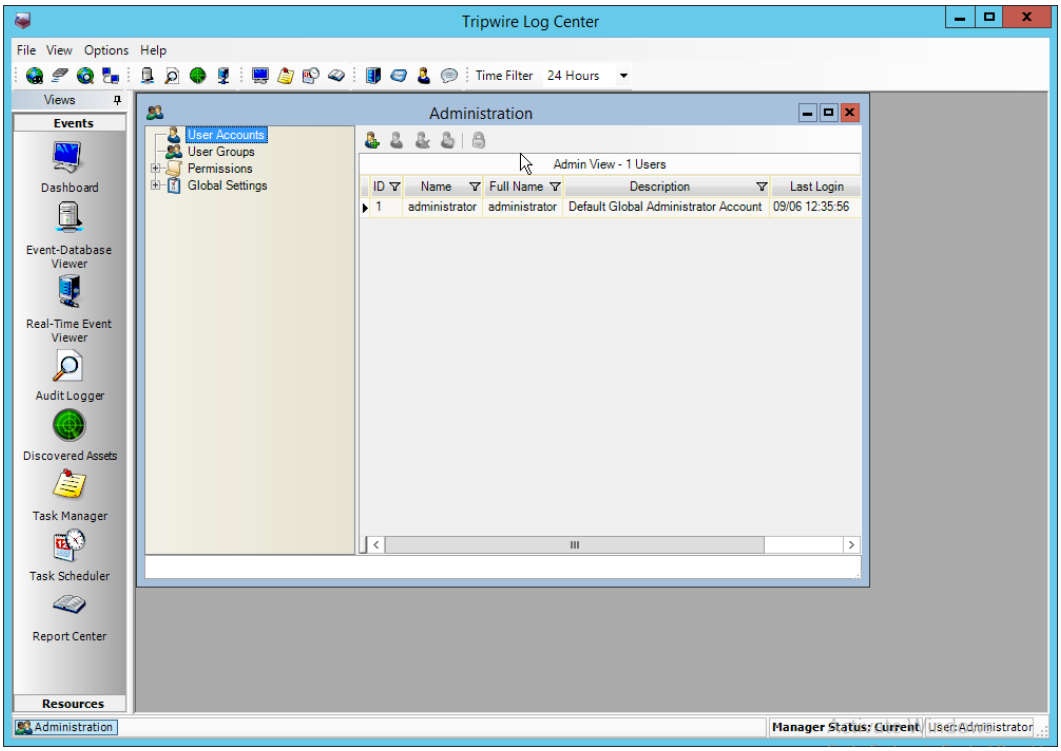


2.18 Integration: Tripwire Log Center and Tripwire Enterprise

1. Create a user account in **Tripwire Log Center** by logging into **Tripwire Log Center Console.**



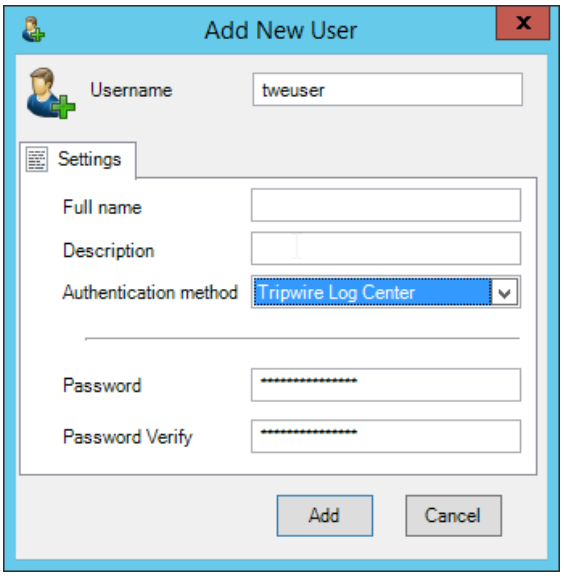
2. Click the **Administration Manager** button.
3. Click **User Accounts.**



2667

2668 4. Click the **Add** button.

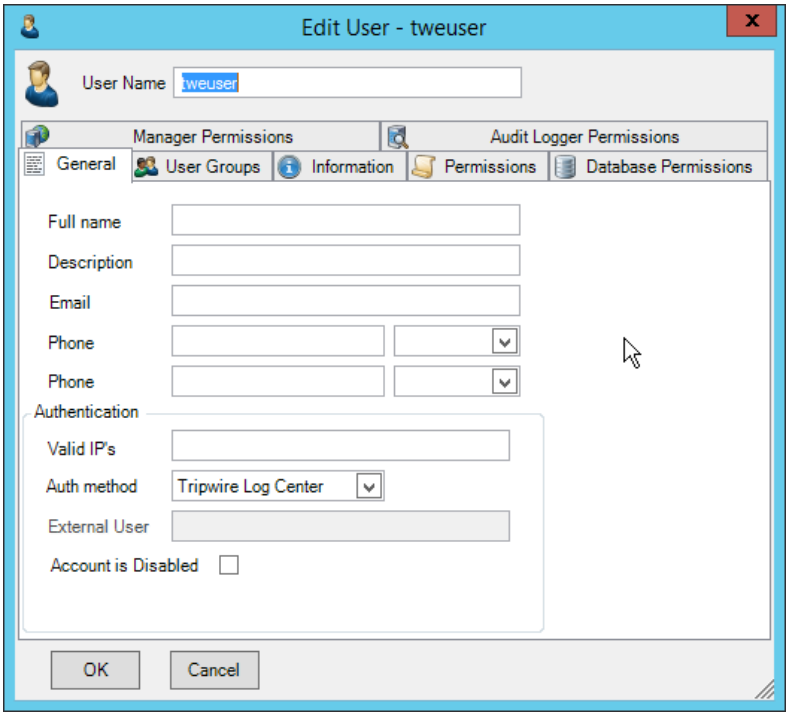
2669 5. Enter the details of the user.



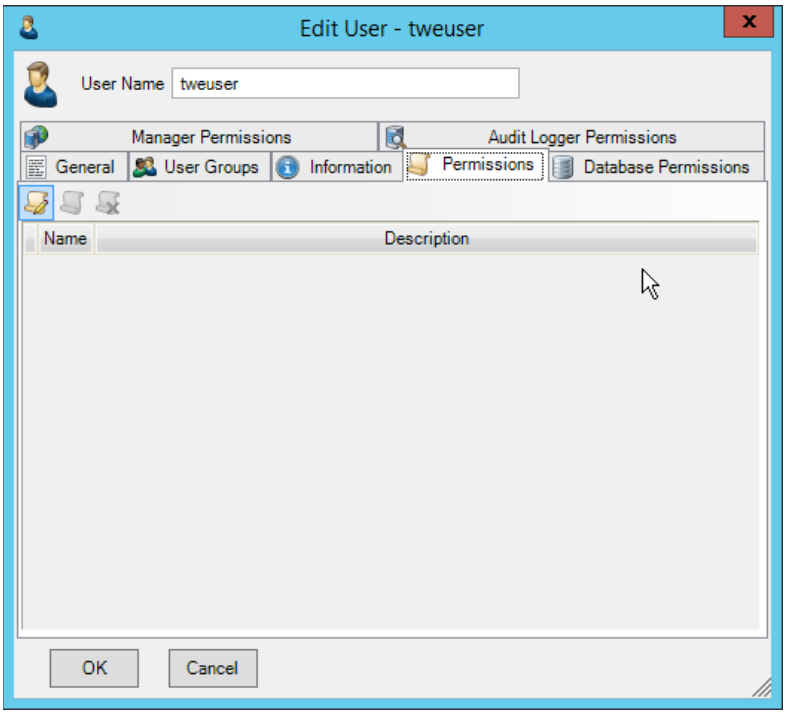
2670

2671 6. Click **Add.**

2672 7. Double-click the user account.

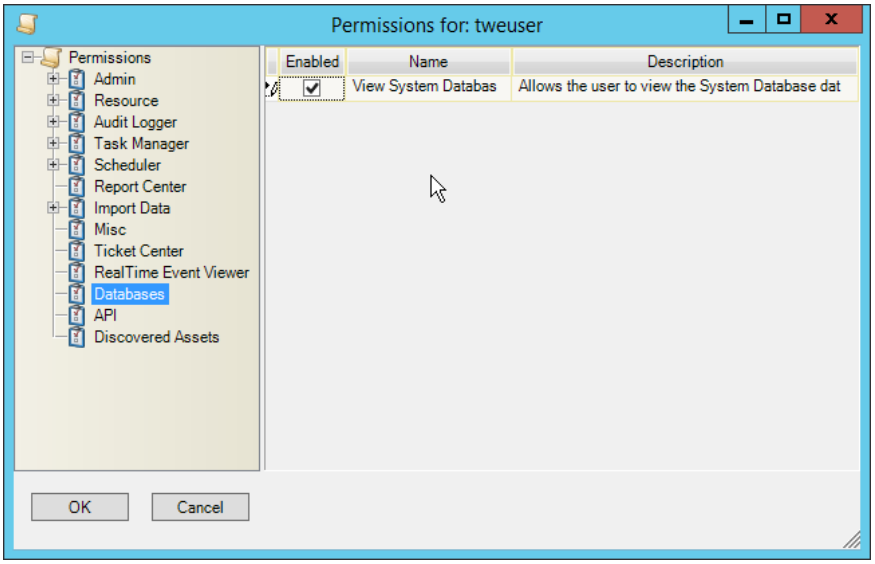


8. Click the **Permissions** tab.

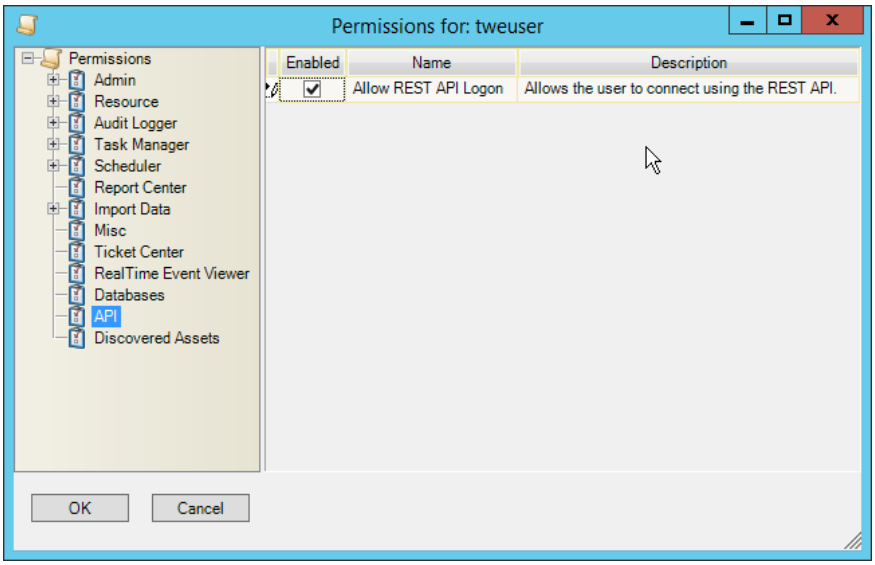


9. Click **Edit list of permissions.**

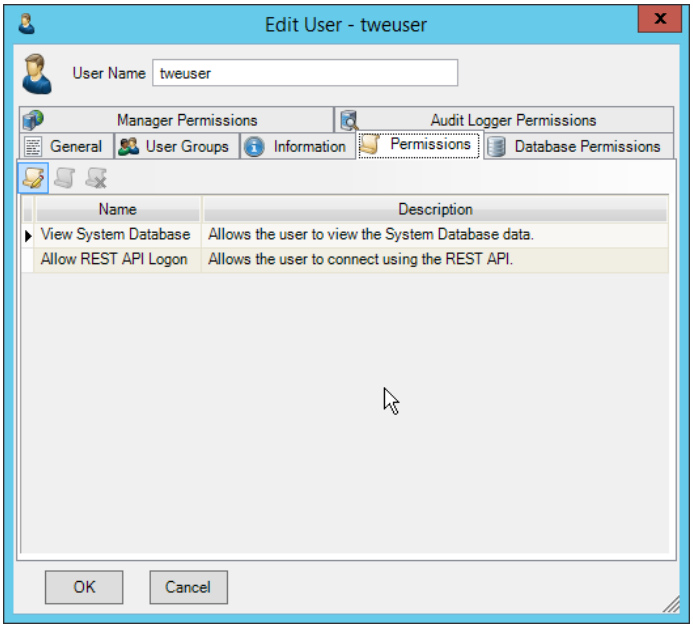
10. Select **Databases.**



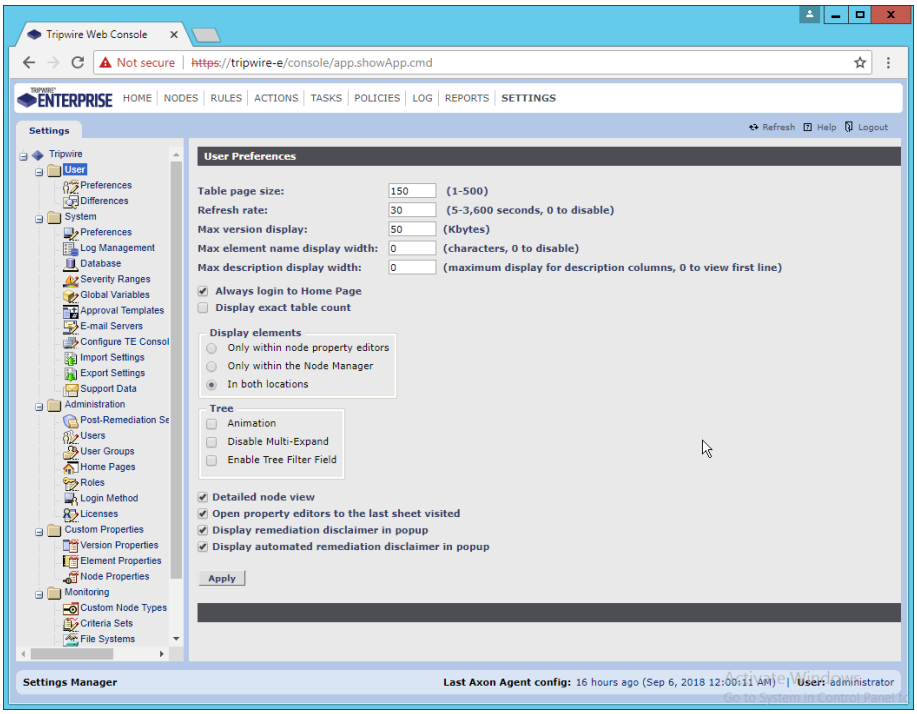
11. Check the box next to **View System Database.**
12. Select **API.**



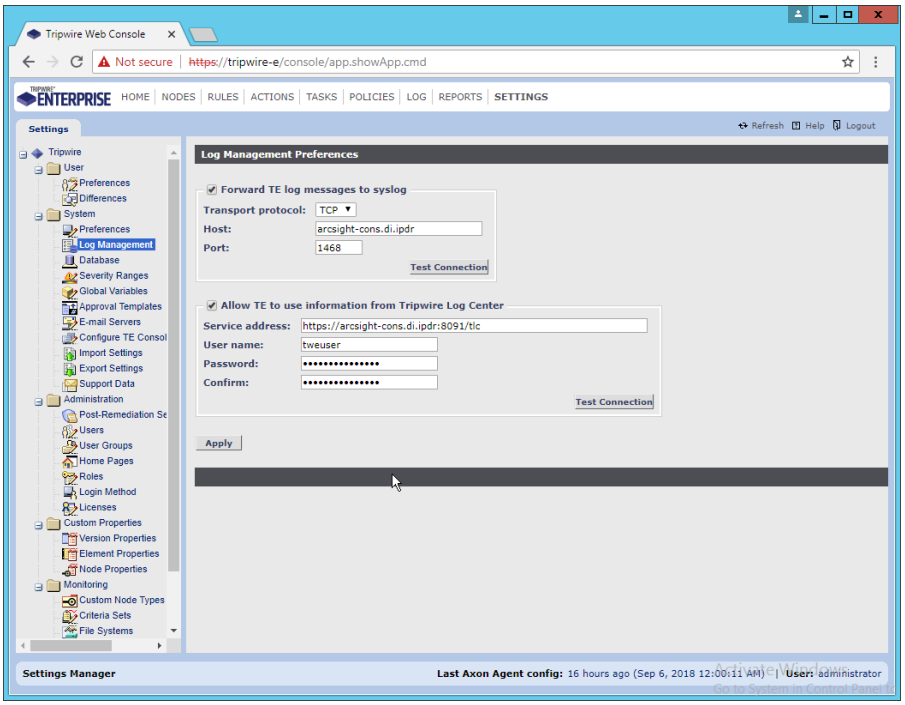
13. Check the box next to **Allow REST API Logon.**



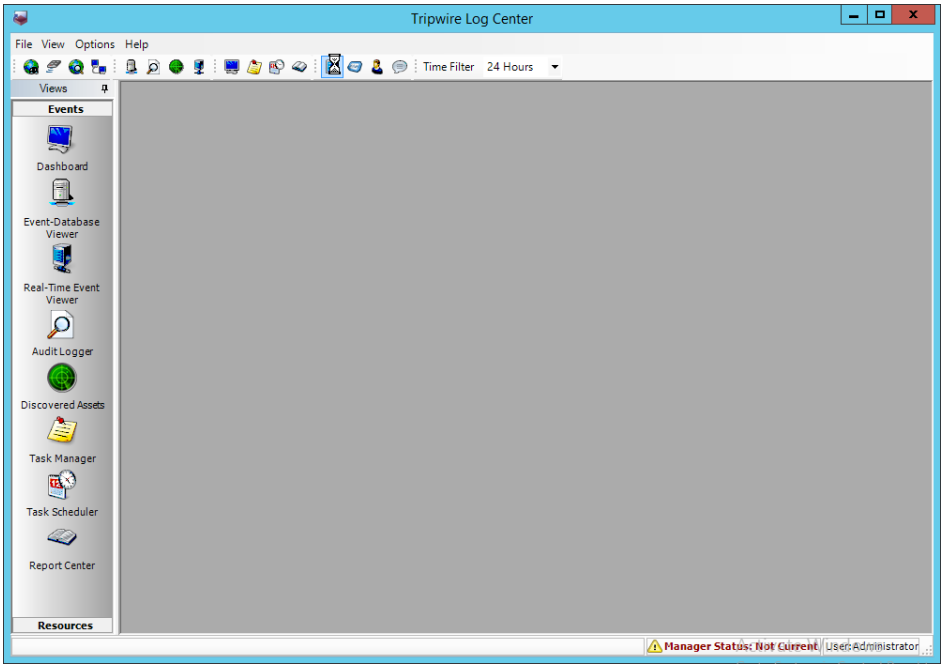
14. Click **OK.**
15. Click **OK.**
16. Log in to the **Tripwire Enterprise** web console.
17. Click **Settings.**



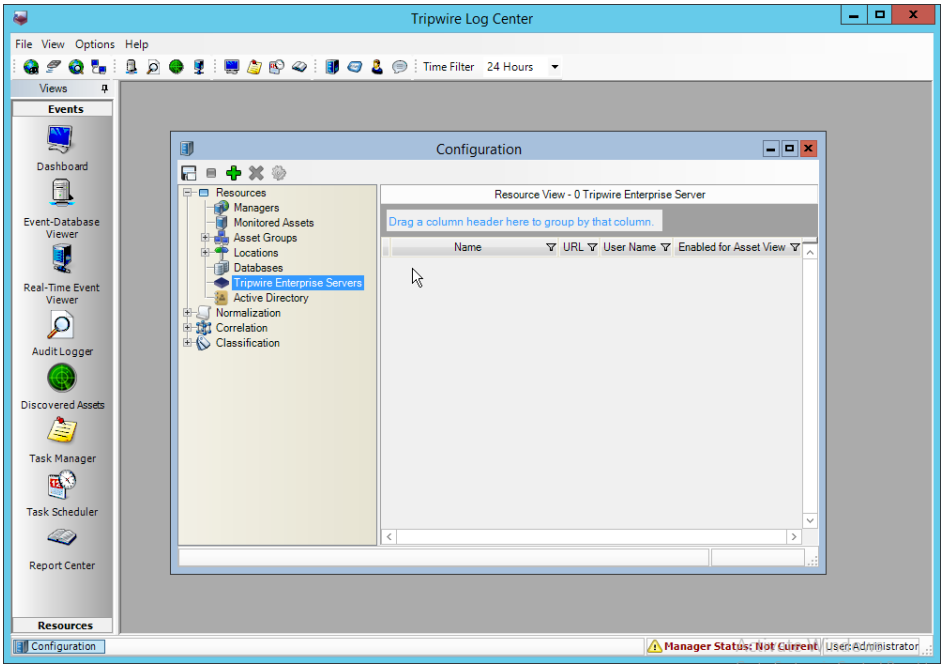
18. Go to **System > Log Management.**
19. Check the box next to **Forward TE log messages to syslog.**
20. Enter the **hostname** and **port** of the **Tripwire Log Center** server. The default port is 1468.
21. Check the box next to **Allow TE to use information from Tripwire Log Center.**
22. Enter the **service address** like this: https://arcsight-cons.di.ipdr:8091/tlc. Replace the **hostname** with the hostname of your **Tripwire Log Center** server.
23. Enter the account information of the account just created for **Tripwire Log Center.**
24. You can use **Test Connection** to verify that the connection is working.



25. Click **Apply** when finished.
26. Go back to the **Tripwire Log Center Console.**

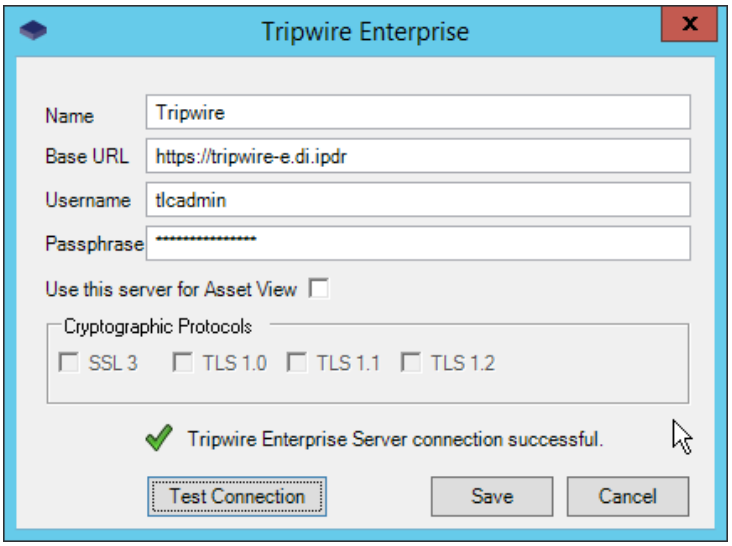


27. Click **Configuration Manager.**
28. Click **Resources > Tripwire Enterprise Servers.**



29. Click **Add.**
30. Enter a **name** for the server.

31. Enter the **URL** of the Tripwire Enterprise server.
32. Enter the **name** of a user account on the Tripwire Enterprise server. The account must have the following permissions: create, delete, link, load, update, view.



33. Click **Save.**

2.19 Integration: Tripwire Log Center and Tripwire IP360

2.19.1 Configure IP360 and Log Center

1. On the **Tripwire Log Center Manager** machine, navigate to C:\Program Files\Tripwire\Tripwire Log Center Manager\Agent Services\config.
2. Copy **bridge_sample.properties** to **bridge.properties.**
3. Modify the Pre-Shared Key to use a password by changing the following line (be sure to remove the "#" sign):

   ```
   tw.cap.bridge.registrationPreSharedKey=newpasswordhere
   ```

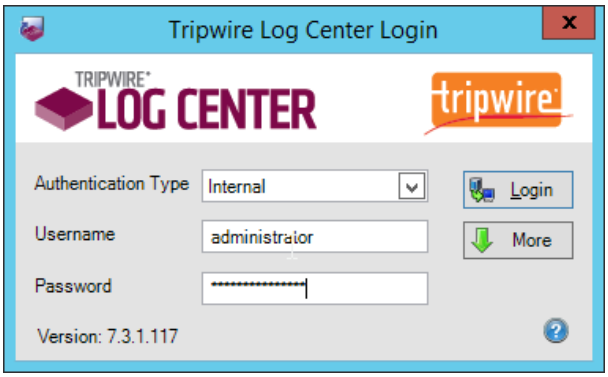
4. Save the file.
5. From the command line, run the following two commands:

   ```
   > net stop TripwireBridge
   > net start TripwireBridge
   ```

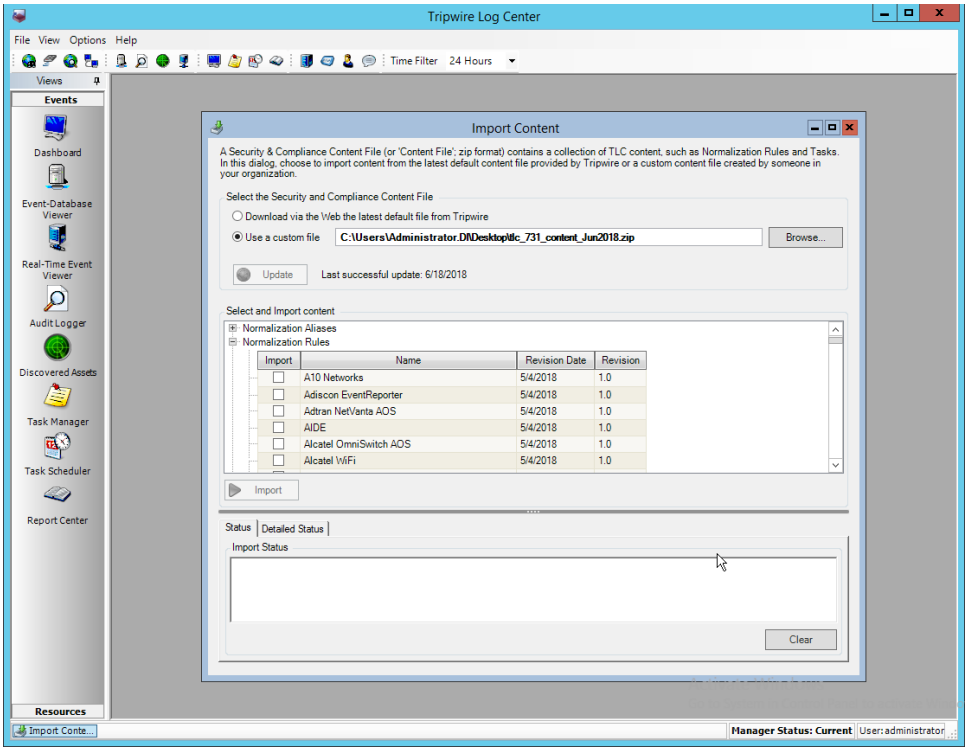
6. On the Tripwire IP360 machine, from the command line, enter the following command to specify the hostname of the Tripwire Log Center (TLC) machine:

   ```
   > tlc config bridge host update <hostname>
   ```

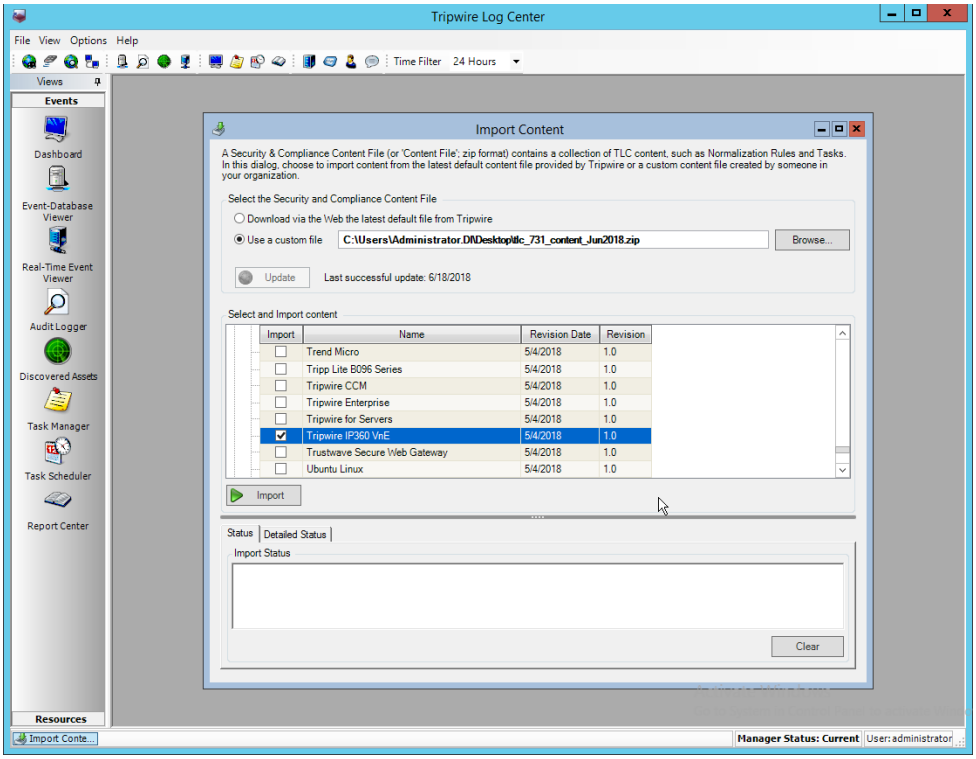
7. Enter the following command using the preshared key specified earlier:
   ```
   > tlc config bridge password update <password>
   ```
8. Enter the following command to start the TLC service on the IP360 machine (this will use port 5670 on the TLC machine by default):
   ```
   > system service tlc enable
   ```
9. Download the "Content update–June 2018" package from the **Tripwire Customer Center.**
10. Open the **Tripwire Log Center Console.**
11. Enter the **username** and **password.**



12. Click **Login.**
13. Click **Options > Import TLC Content > Content.**
14. Select **Use a custom file.**
15. Click **Browse,** and locate the zip file downloaded from the **Tripwire Customer Center.**



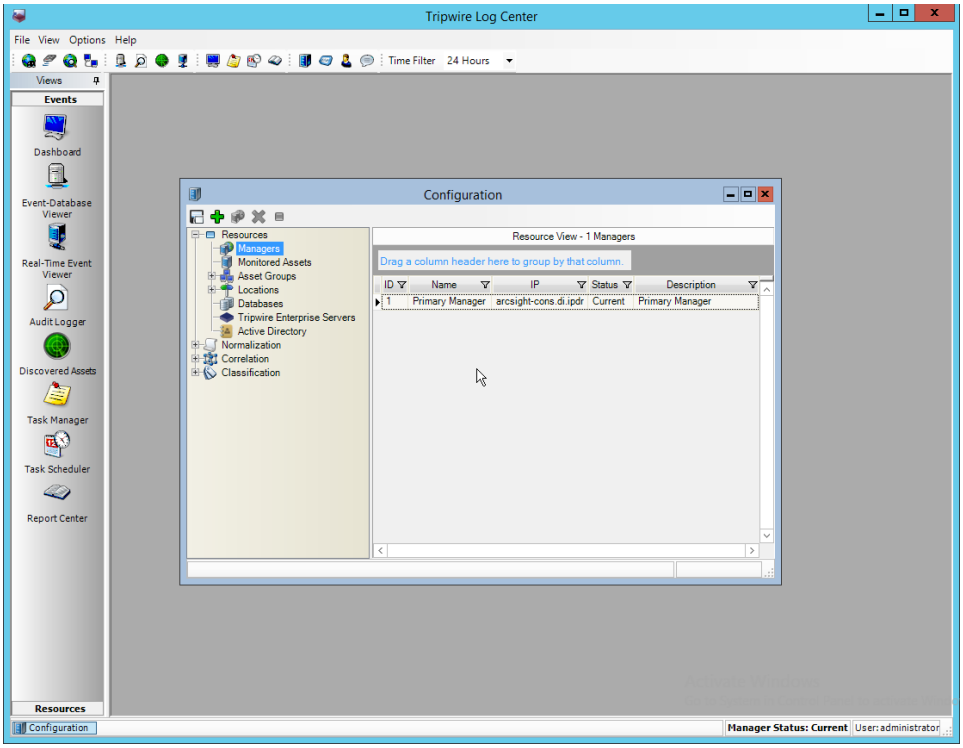
16. Expand the **Normalization Rules** section.
17. Check the box next to **Tripwire IP360 VnE.**



18. Click **Import.**

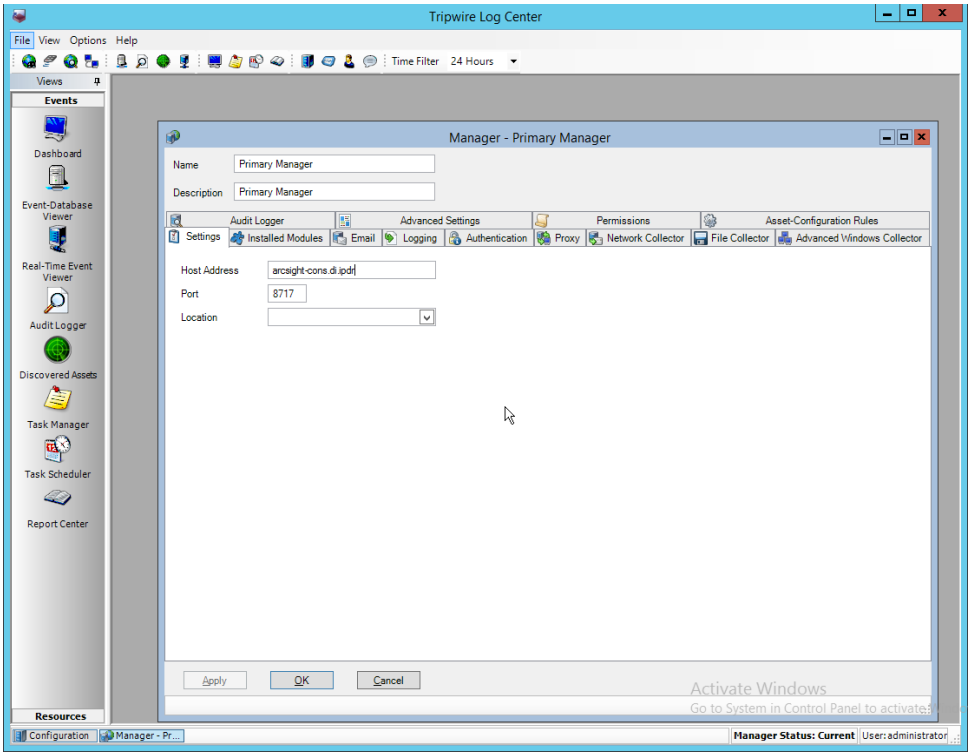
2.19.2 Collect Tripwire IP360 Operational Logs

1. Click **Configuration Manager.**
2. Click **Resources > Managers.**

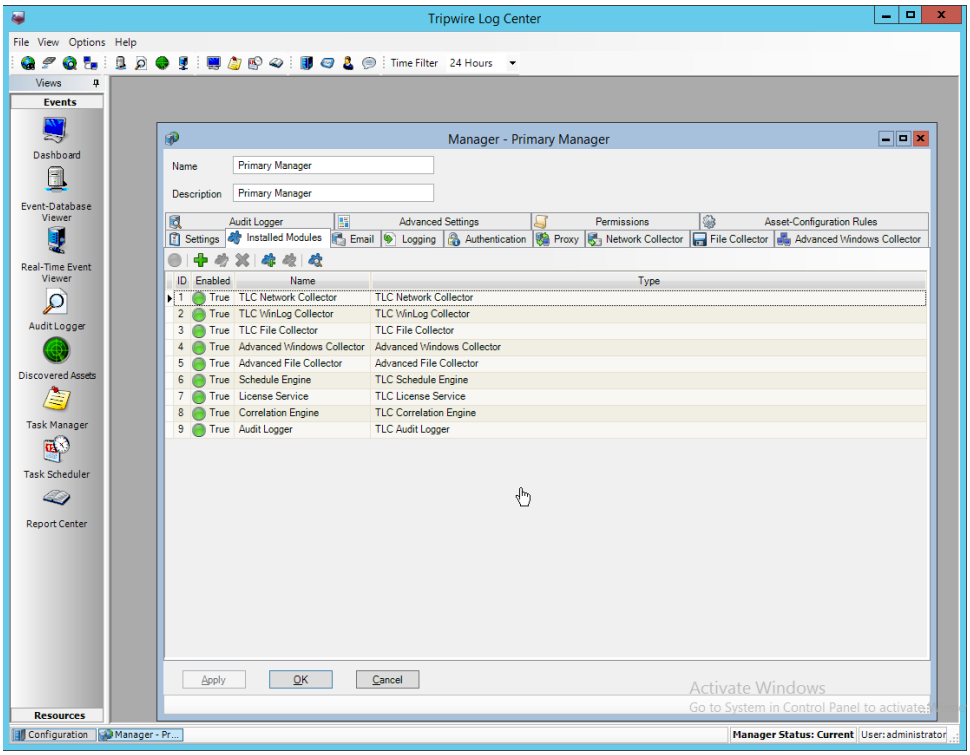


2746

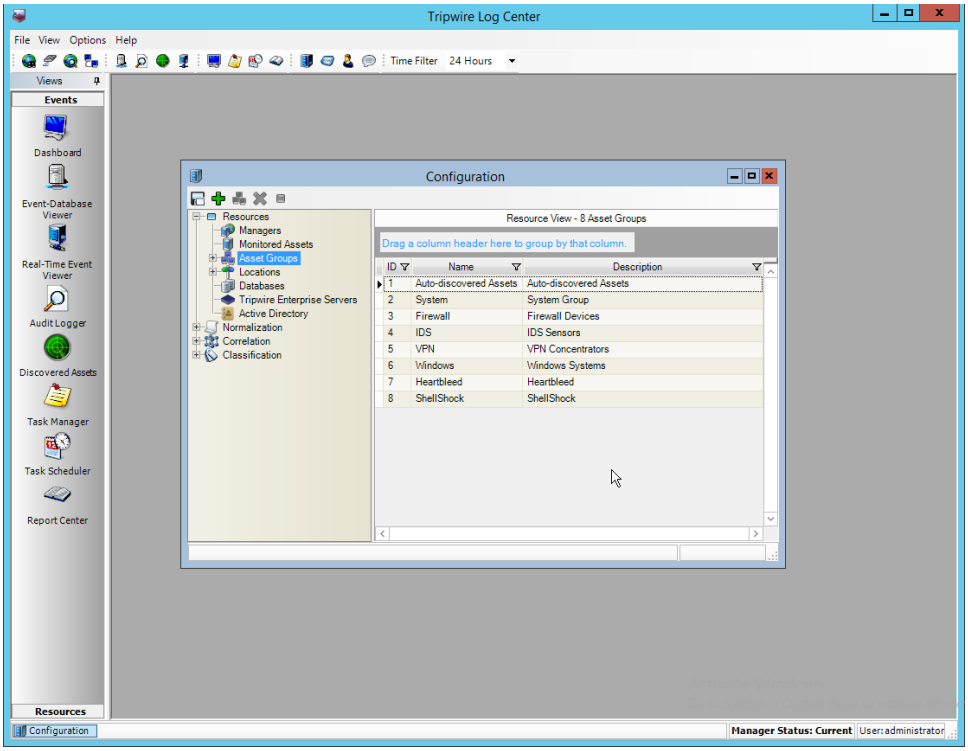
2747 3. Double-click the **Primary Manager.**



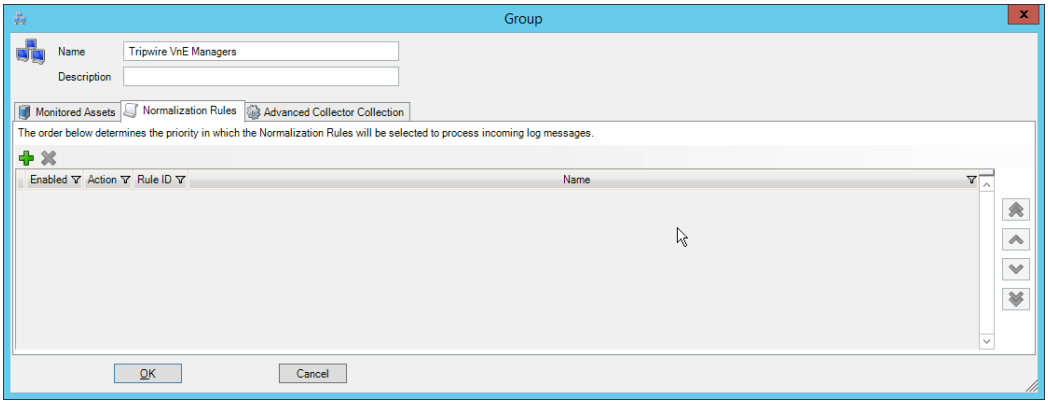
4. Click the **Installed Modules** tab.



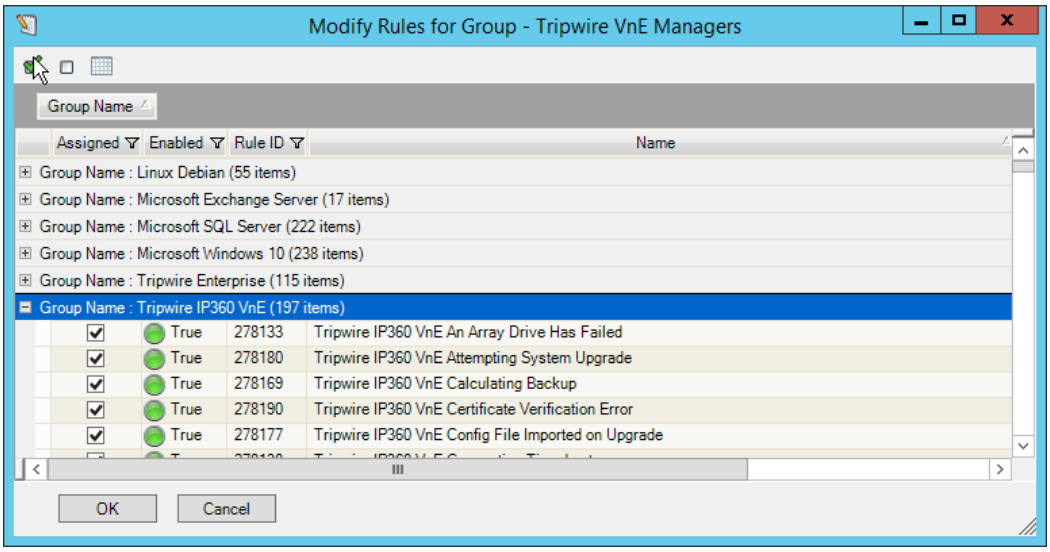
5. Ensure that there is an **Advanced File Collector.** If not, click the **Create new module** button, and specify a **name.** Set the type to **Advanced File Collector.** If there is an **Advanced File Collector,** skip this step.
6. Click **OK.**
7. Click **Resources > Asset Groups.**



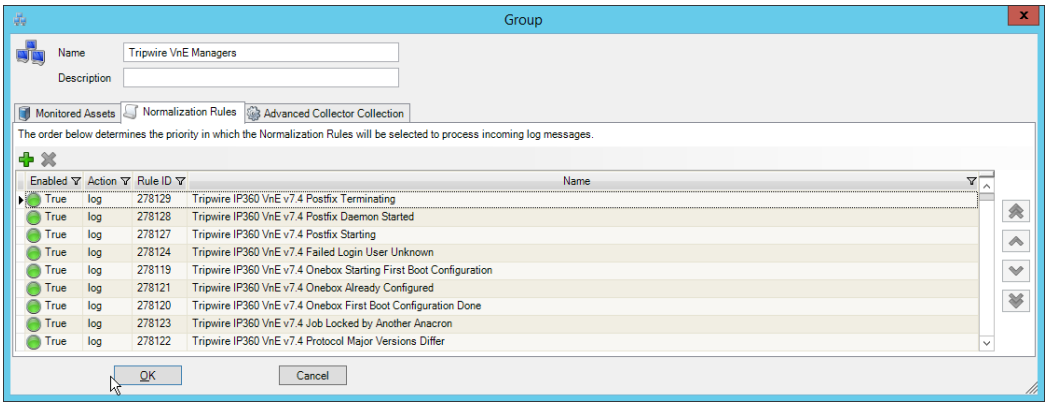
8. Click **Add.**
9. Enter **Tripwire VnE Managers** in the **Name** field.
10. Click the **Normalization Rules** tab.



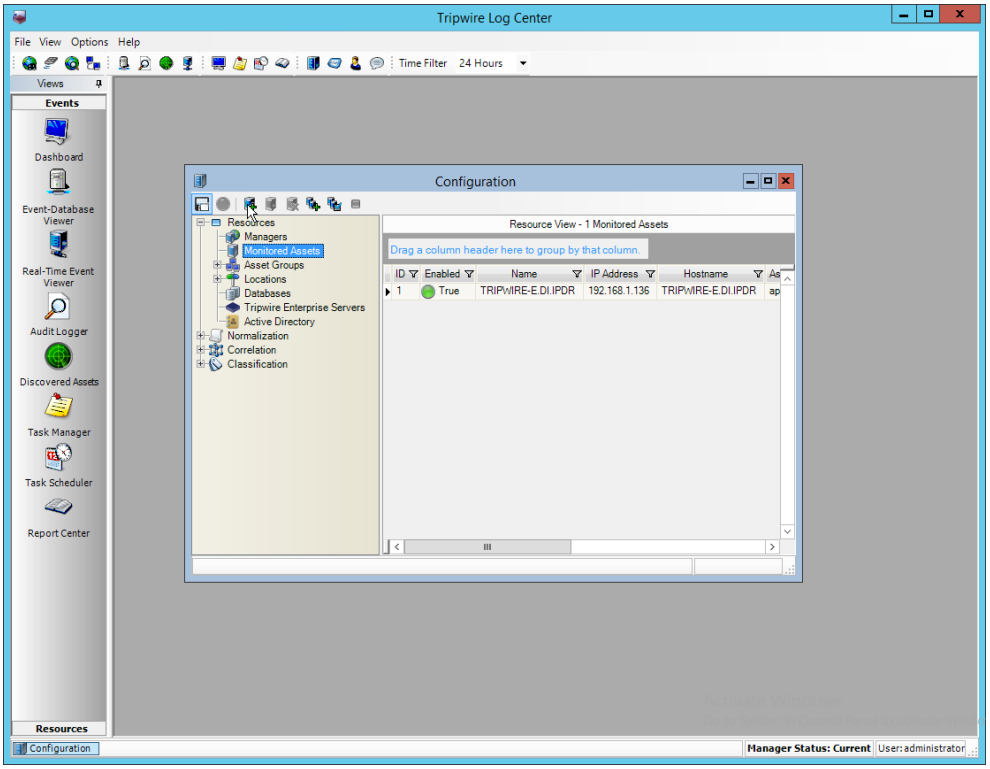
11. Click **Add.**
12. Expand the **Tripwire IP360 VnE** group.
13. Click the **Check selected rows** button at the top to check the box next to everything in this section.



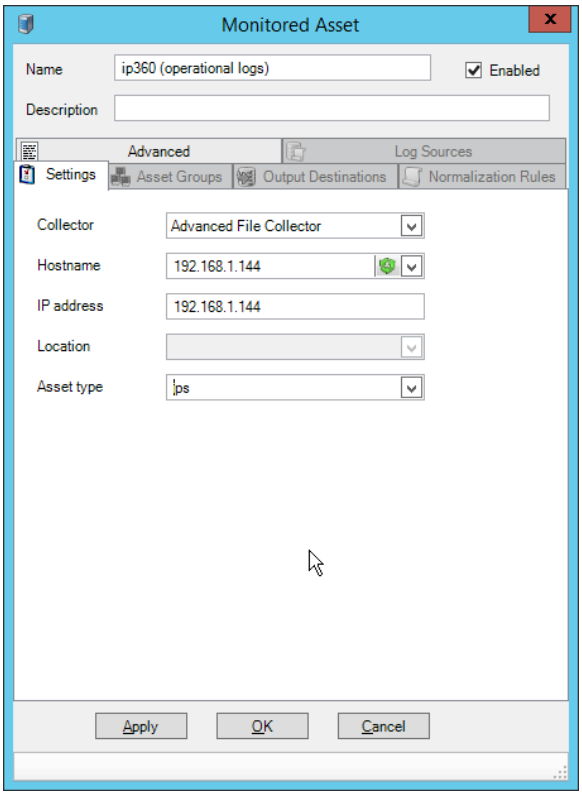
14. Click **OK.**



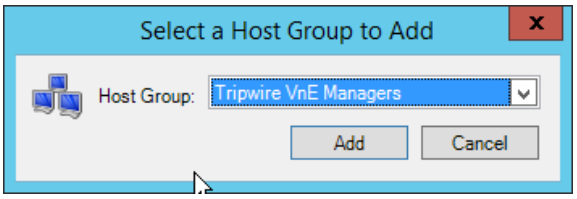
15. Click **OK.**
16. Click **Resources > Monitored Assets.**



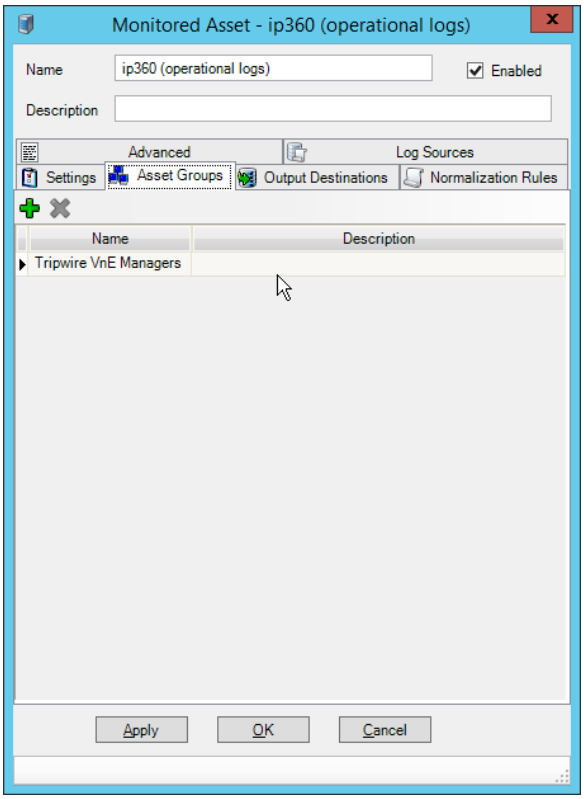
17. Click **Add Monitored Asset.**
18. Enter a **name.**
19. Select **Advanced File Collector** for **Collector.**
20. Select the IP360 server from the **Hostname** drop-down. It may appear as an IP address.
21. Enter the **IP address** of the server.
22. Select **ips** for **Asset type.**



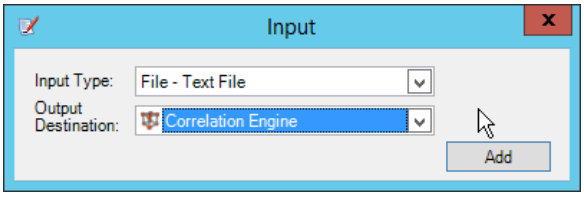
23. Click the **Asset Groups** tab.
24. Click **Add.**
25. Select **Tripwire VnE Managers.**



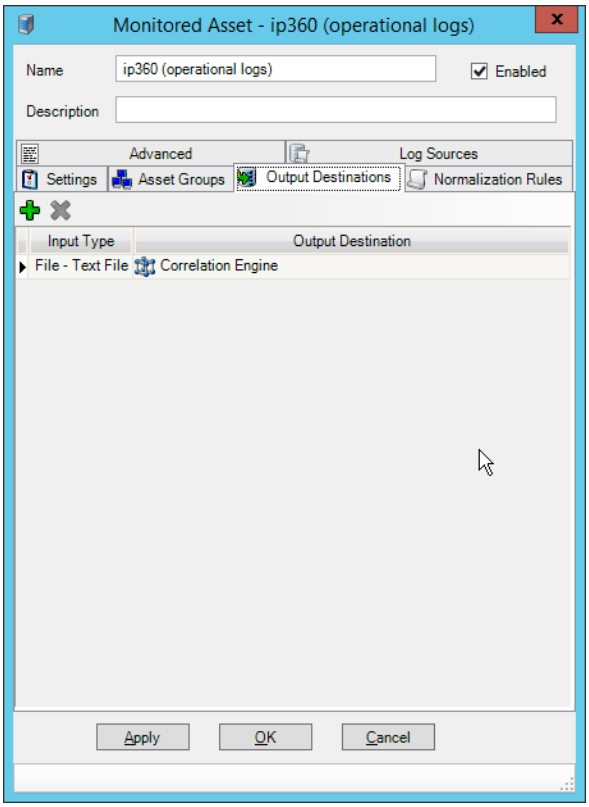
26. Click **Add.**



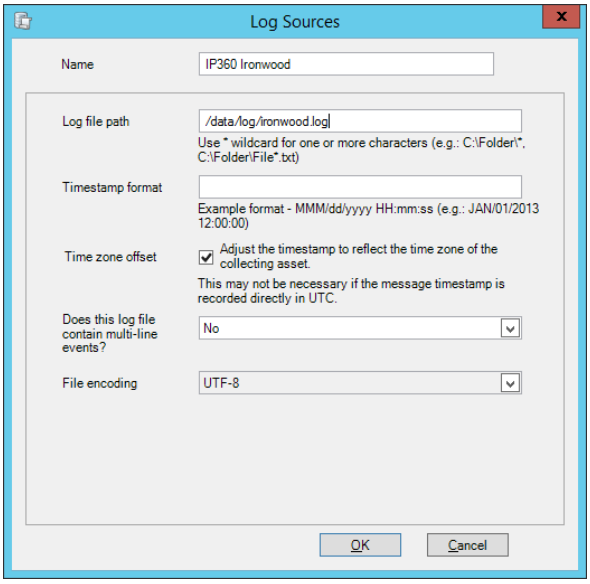
27. Click the **Output Destinations** tab.
28. Click **Add.**
29. Select **File–Text File** for **Input Type.**
30. Select **Correlation Engine** for Output Destination.



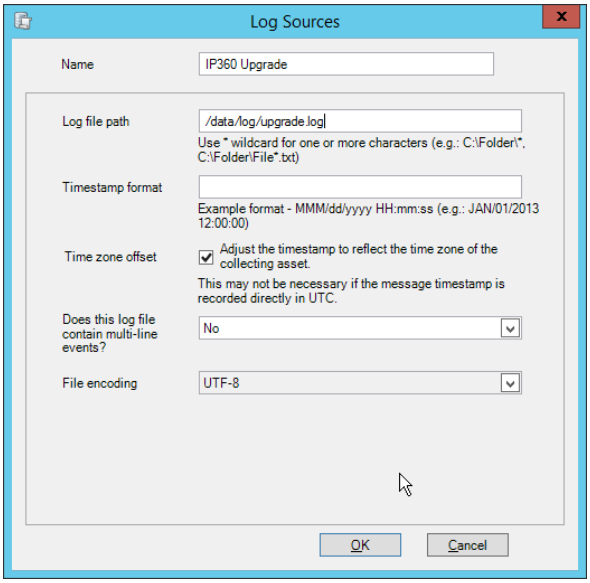
31. Click **Add.**



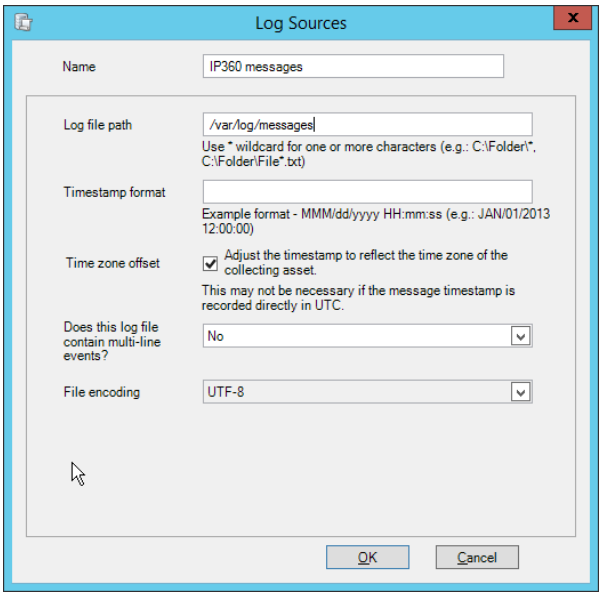
32. Click the **Log Sources** tab.
33. Click **Add.**
34. Enter a **name** for the log.
35. Enter /data/log/ironwood.log for **Log file path.**



36. Click **OK.**
37. Click **Add.**
38. Enter a **name** for the log.
39. Enter /data/log/upgrade.log for **Log file path.**

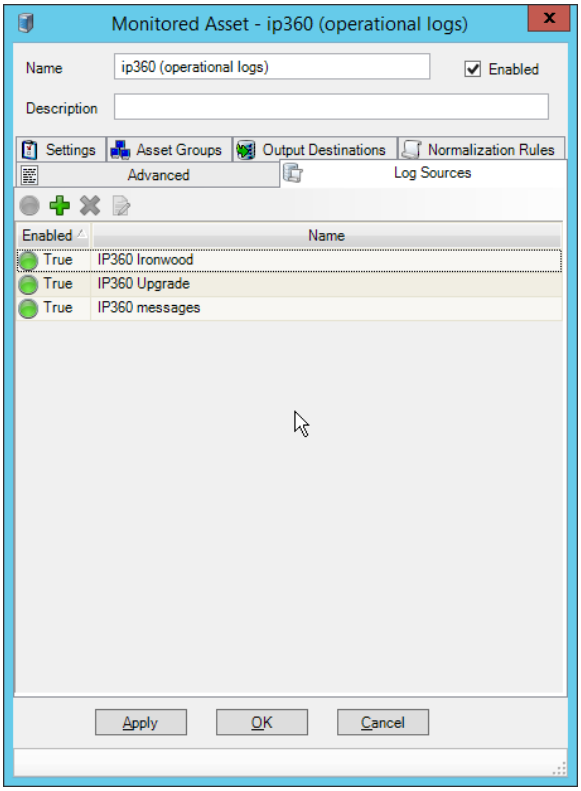


40. Click **OK.**
41. Click **Add.**
42. Enter a **name** for the log.
43. Enter /var/log/messages for **Log file path.**



2805

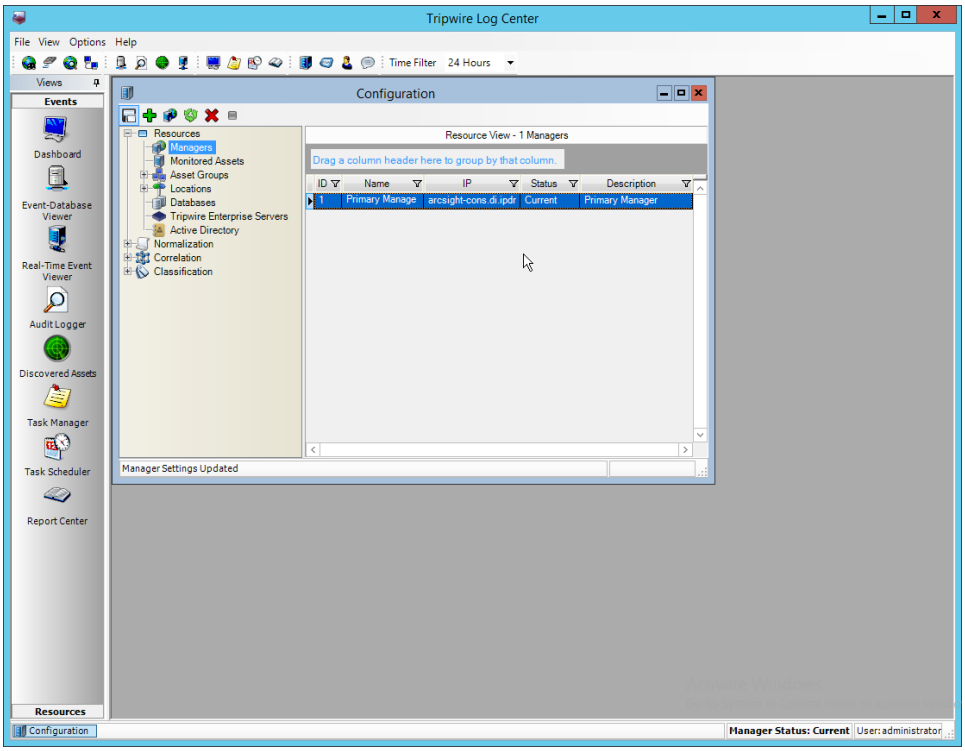
2806 44. Click **OK.**



2807

2808 45. Click **OK.**

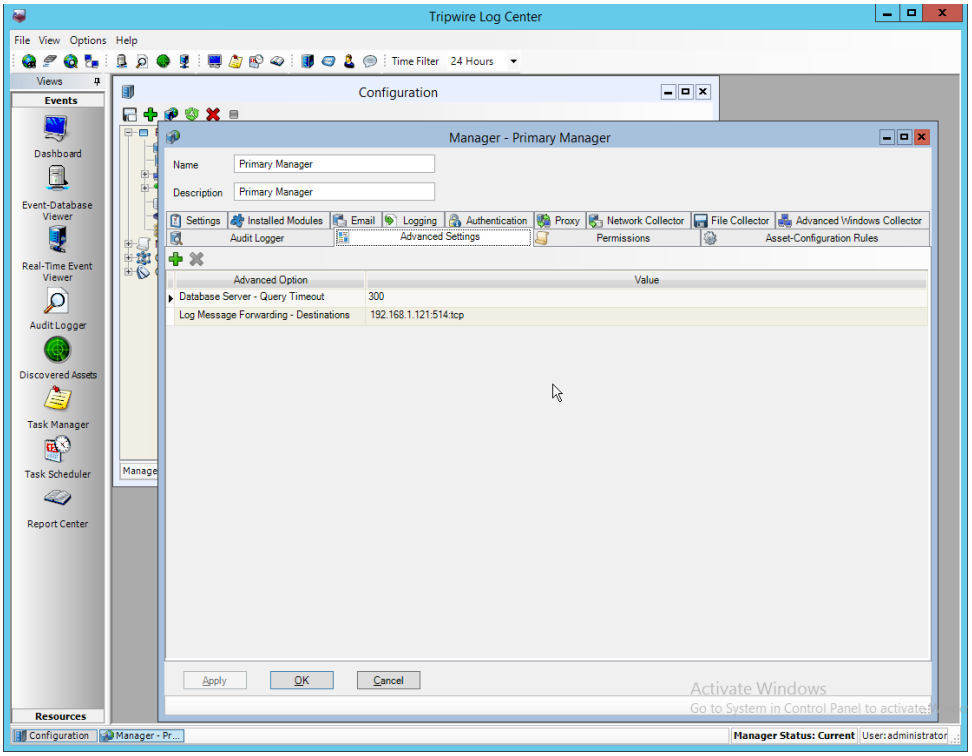
2809 46. Click **Resources > Managers.**



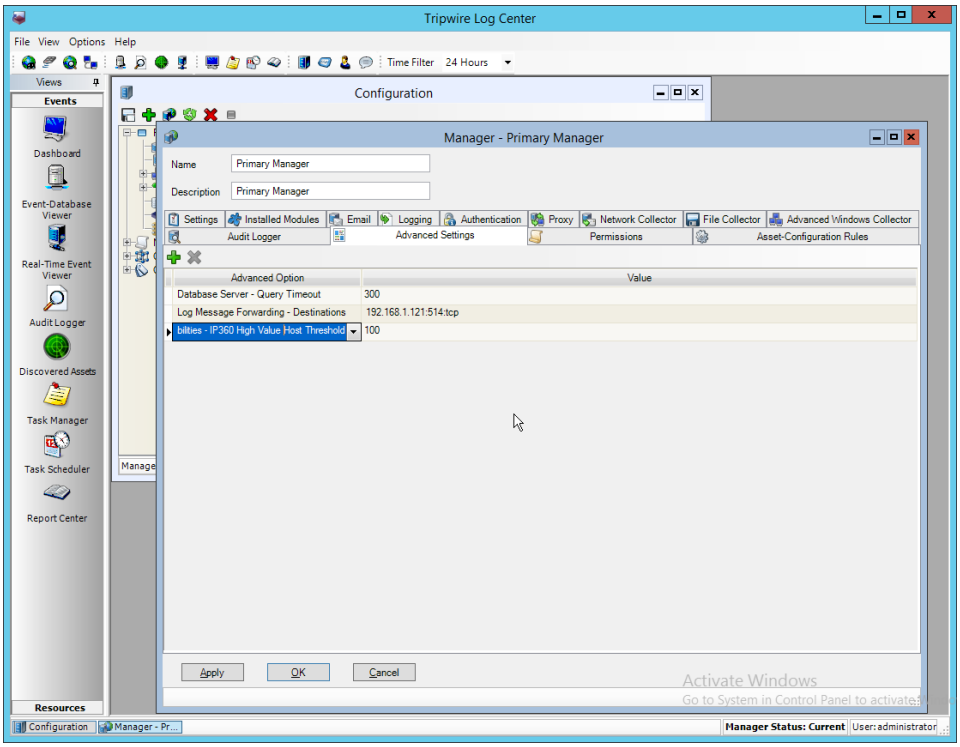
47. Select the **Primary** Manager and click **Push Updates to Manager.**

2.19.3 Configure Tripwire IP360 Scan Results Forwarding

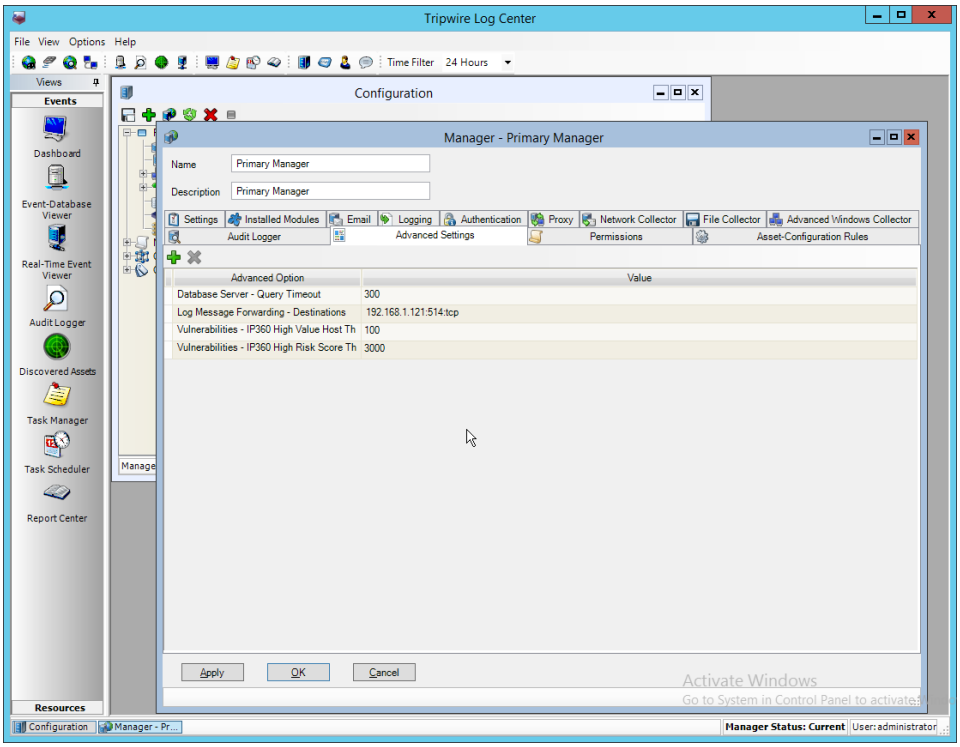
1. Click **Configuration Manager.**
2. Click **Resources > Manager.**
3. Double-click the **Primary Manager.**
4. Click the **Advanced Settings** tab.



5. Click **Add.**
6. Select **Vulnerabilities–IP360 High Value Host Threshold** for the **Advanced Option.**
7. Enter a number between 0 and 999,999,999 for the **Value.** This number corresponds to the priority level of the host system being scanned. The value entered will be the minimum value for a host machine to be considered high priority. Half of this value will be the minimum value for a host machine to be considered medium priority.



8. Click **Add.**
9. Select **Vulnerabilities–IP360 High Risk Score Threshold** for the **Advanced Option.**
10. Enter a number between 0 and 999,999,999 for the **Value.** This number corresponds to the risk level of a vulnerability event. The value entered will be the minimum value for an event to be considered high risk. Half of this value will be the minimum value for an event to be considered medium risk.

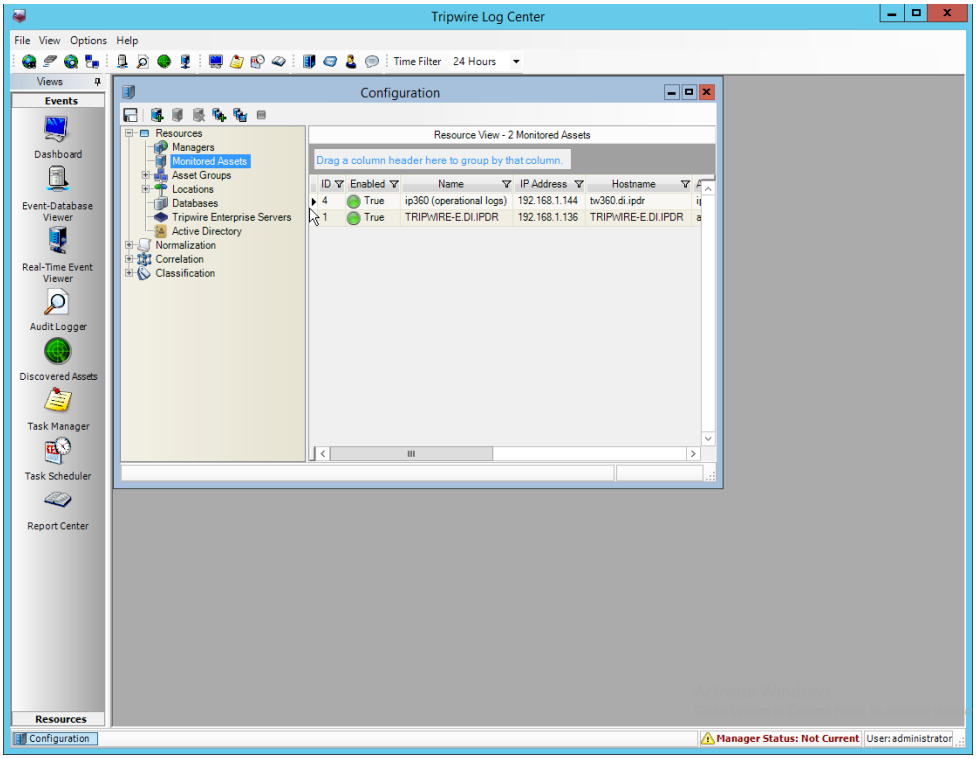


2831

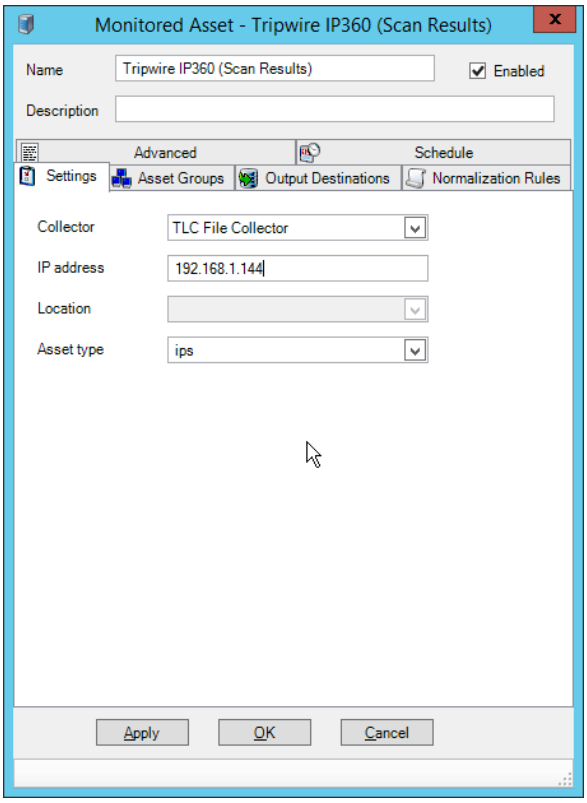
2832 11. Click **Apply.**

2833 12. Click **OK.**

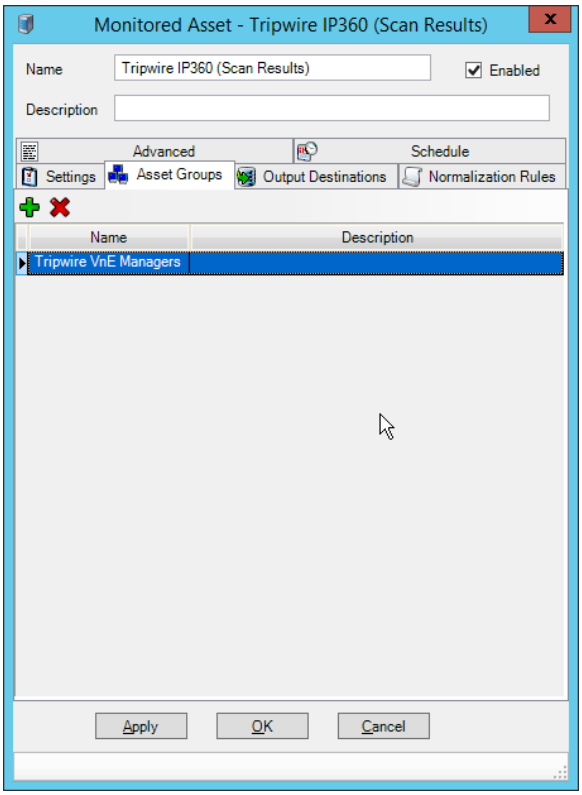
2834 13. Click **Resources > Monitored Assets.**



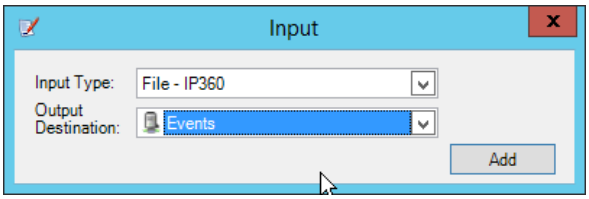
14. Click **Add Asset.**
15. Select **TLC File Collector** for **Collector.**
16. Enter the **IP address** of the **IP360** machine.
17. Select **ips** for **Asset type.**



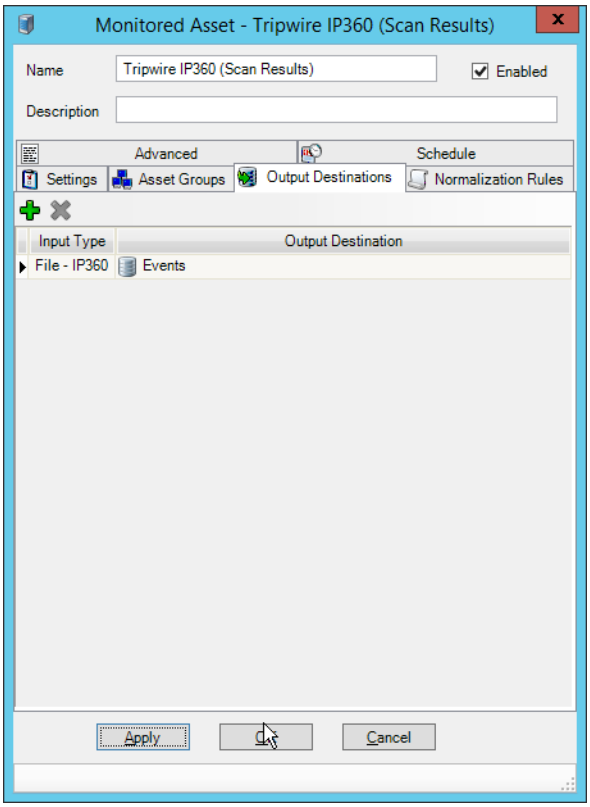
18. Click the **Asset Groups** tab.
19. Click **Add.**
20. Select **Tripwire VnE Managers** for **Host Group.**
21. Click **Add.**



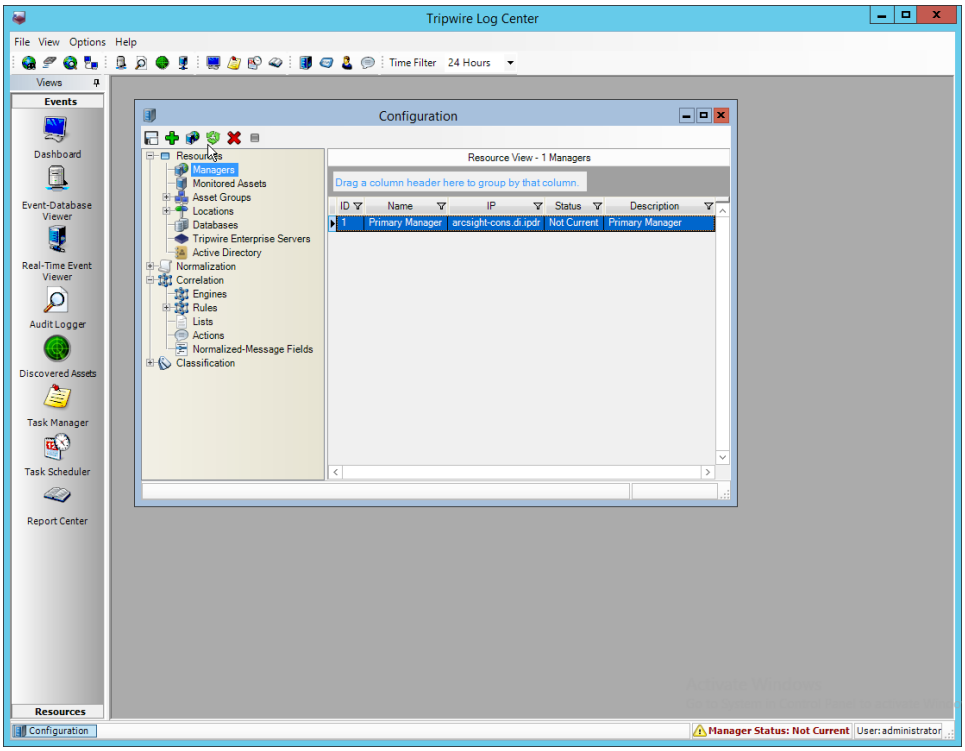
22. Click the **Output Destinations** tab.
23. Select **File–IP360** for **Input Type.**
24. Select **Events** for **Output Destination.**



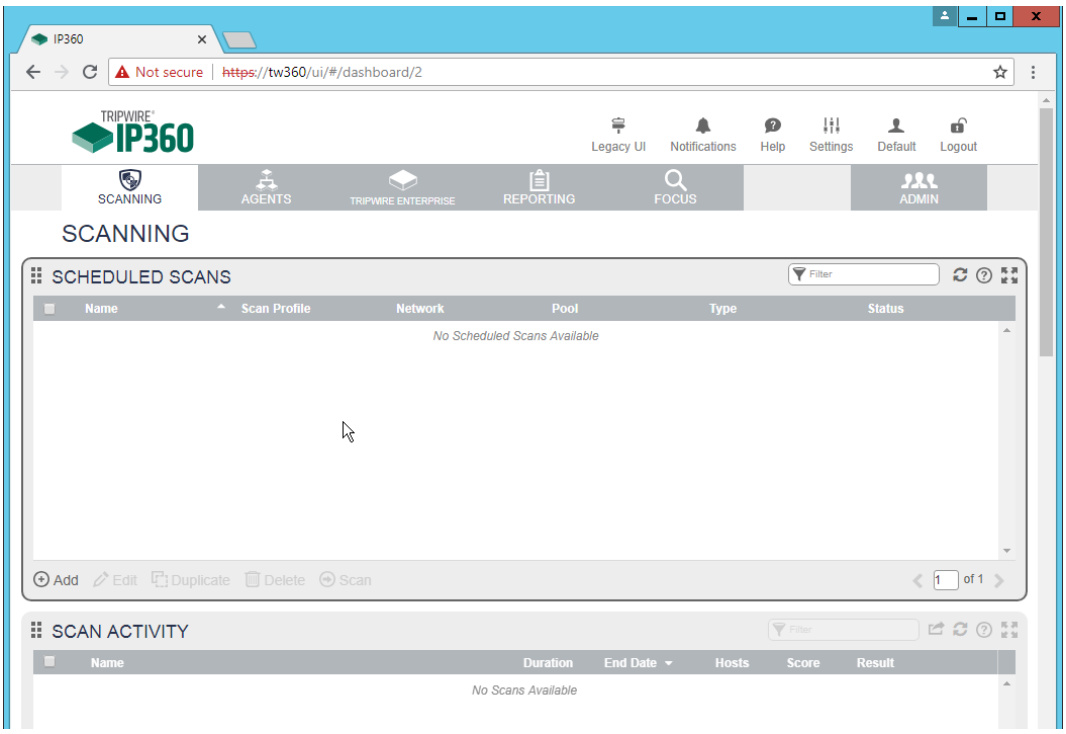
25. Click **Add.**



26. Click **OK.**
27. Click **Resources > Managers.**
28. Select the **Primary Manager.**



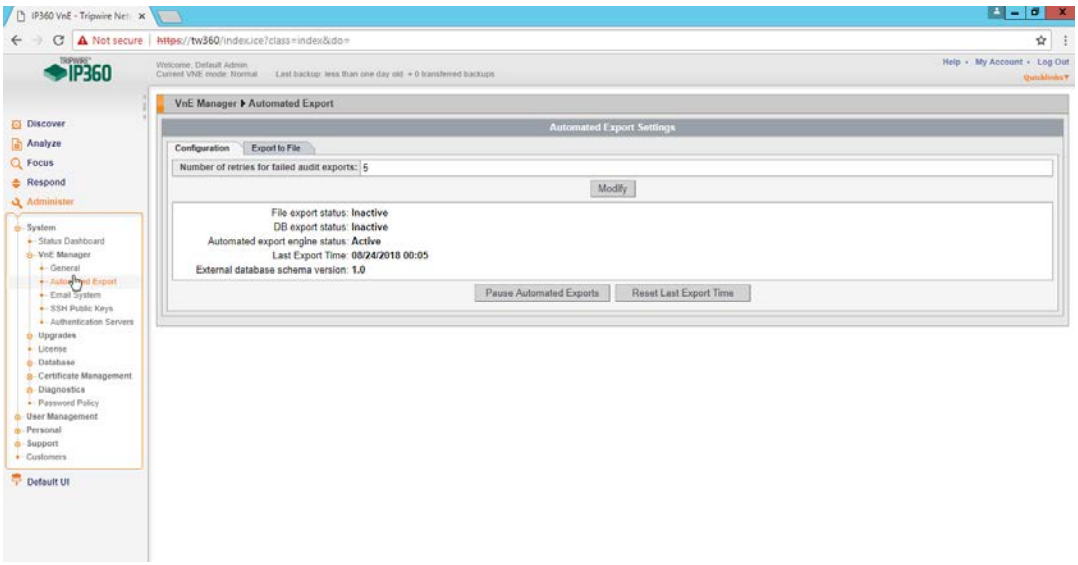
29. Click **Push Update to Manager.**
30. Log in to the **Tripwire IP360 Web Console.**



2858

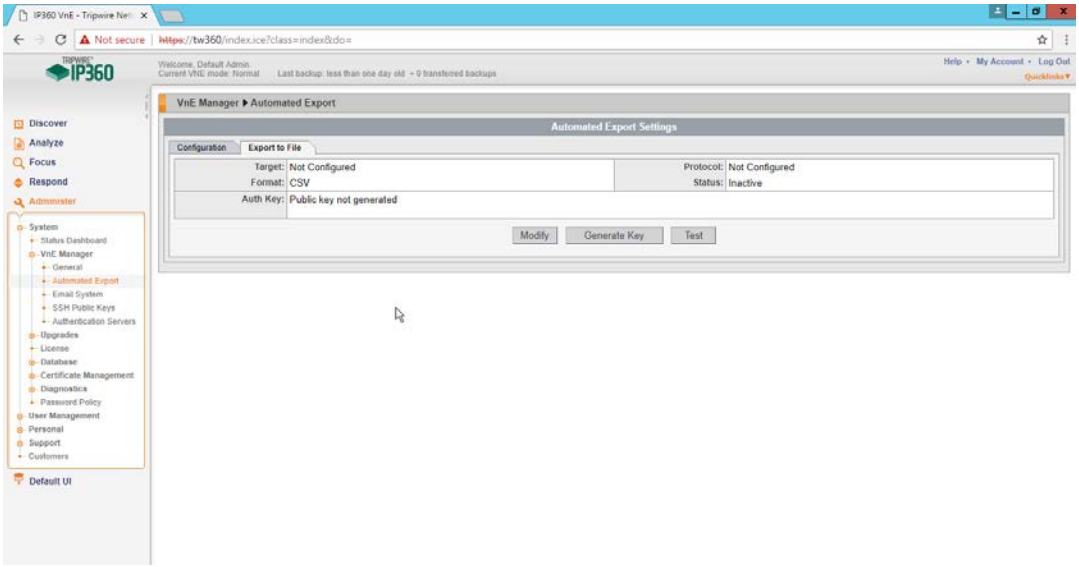
2859 31. Click **Legacy UI** at the top.

2860 32. On the left, click **Administer > System > VnE Manager > Automated Export.**

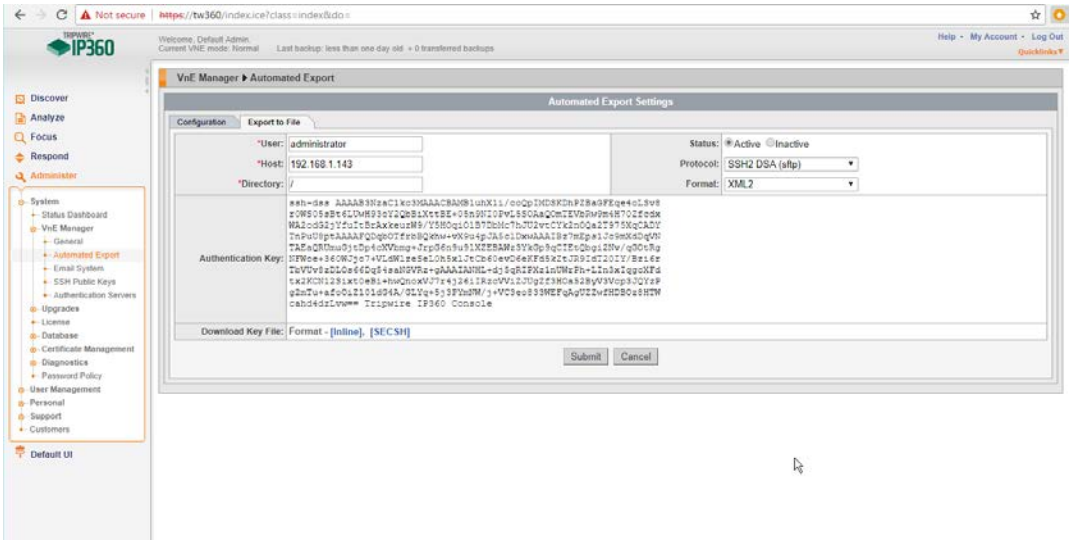


2861

2862 33. Click the **Export to File** tab.

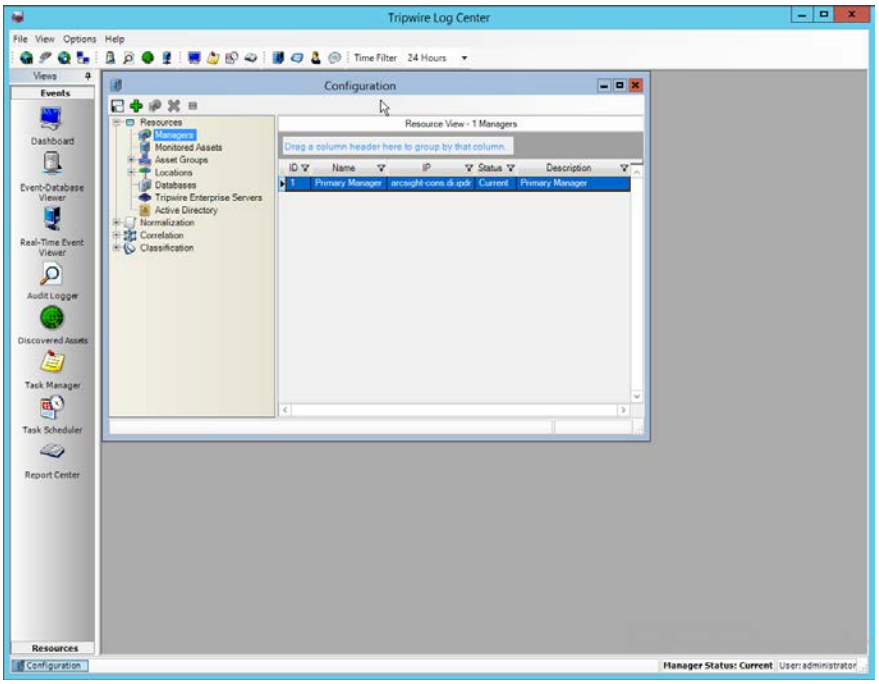


34. Click **Modify.**
35. Enter the **username** of a TLC user account for **User.**
36. Enter the **IP address** of the TLC Manager for **Host.**
37. Enter "/" for the **directory.**
38. Select **Active.**
39. Select **SSH2 DSA (sftp)** for **Protocol.**
40. Select **XML2** for **Format.**

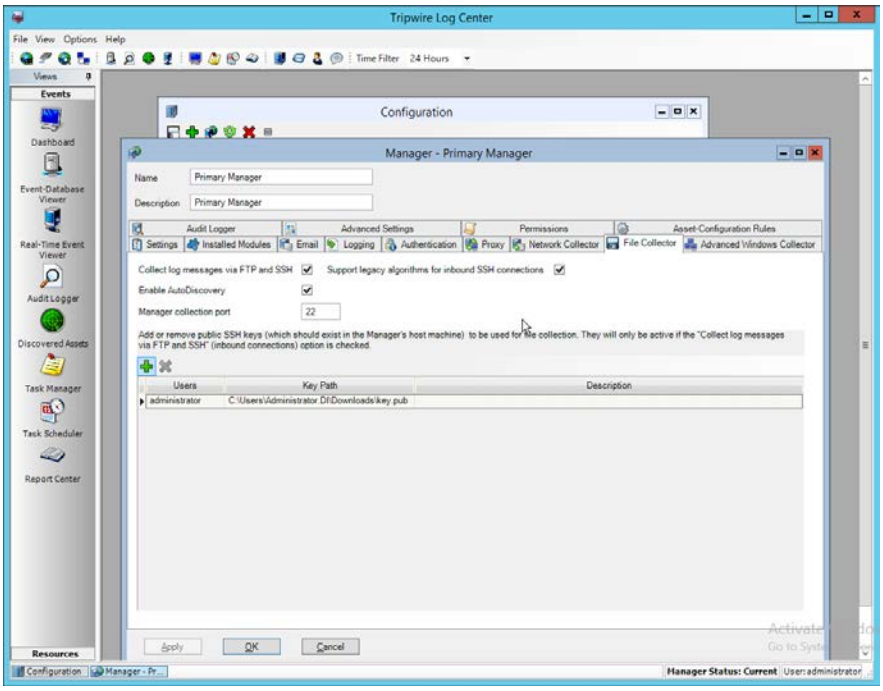


41. Click **Submit.**
42. Download the generated key by clicking **[Inline].**

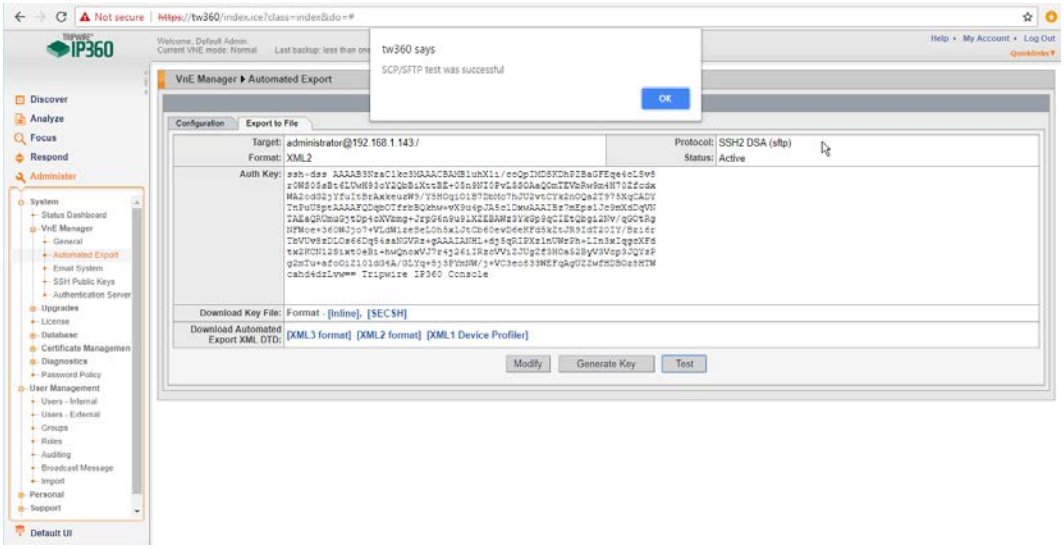
43. In **TLC Console,** click **Configuration Manager.**
44. Click **Resources > Managers.**



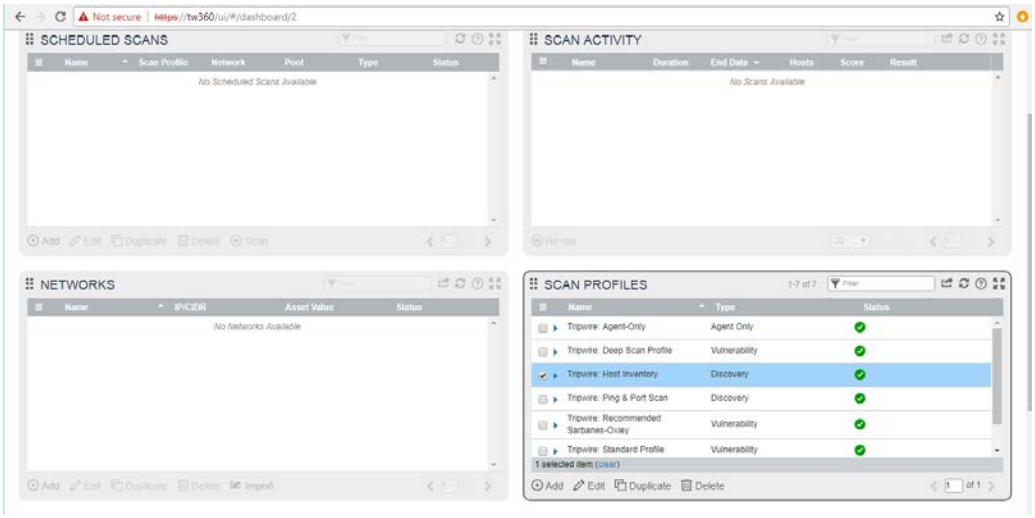
45. Double-click the **Primary Manager.**
46. Click the **File Collector** tab.
47. Ensure that the **Collect log messages via FTP and SSH** option is enabled.
48. Enter **22** for the **port.** (Note: The ***IP360 Integration Guide*** says to use a different port, but the IP360 system appears to be unable to use a port other than 22.)
49. Click **Add.**
50. Under **Users,** select the user for whom the key was generated.
51. Under **Key Path,** enter the path to the downloaded key.



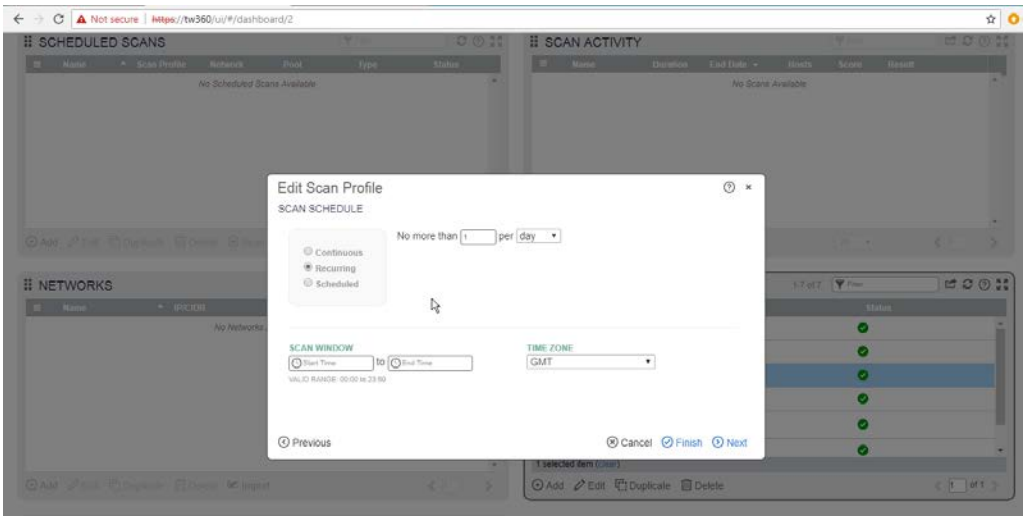
52. Click **OK.**
53. Select the **Primary Manager.**
54. Click **Push Updates to Manager.**
55. On the **IP360** web console, click **Test** to ensure that the connection is successful.



56. Any recurring scans will now forward the scan results to **Tripwire Log Center.** To ensure that a scan is recurring, select a scan in **Scan Profiles** on the main dashboard of the **IP360** web console.



57. Click **Edit.**
58. Click **Next** until the **Scan Schedule** page.
59. Select **Recurring,** and set a schedule for the scan according to the needs of the organization.



60. Click **Finish.**

2.20 Integration: Tripwire Enterprise and Backups

This section details how to back up **Tripwire Enterprise** configuration data.

To back up **Tripwire Enterprise** integrity information, refer to the database vendor's documentation for backing up data.

2.20.1 Export Configuration from Tripwire Enterprise

1. On the Tripwire Enterprise server, navigate to C:\Program Files\Tripwire\TE\Server\bin.
2. Run the following command to stop **Tripwire Services.**
   ```
   > twservices stop
   ```
3. Run the following command to export the configuration files to a backup (replace config.bak with the desired name of the backup).
   ```
   > tetool backup config.bak
   ```
4. Run the following command to restart **Tripwire Services.**
   ```
   > twservices start
   ```

2.20.2 Back Up the Tripwire Enterprise Configuration

The configuration backup will be stored in the file specified in step 3 of the previous section. To back this up to the enterprise backup server through a **Duplicati** client**,** see the documentation in Section 2.8.4 for how to set up a **Duplicati** instance on the **Tripwire Enterprise** server, and then simply select the configuration file.

2.21 Integration: Cisco ISE and CryptoniteNXT

This section details an integration between **Cisco ISE** and **CryptoniteNXT,** allowing ISE to dictate the Cryptonite registration process based on the posture of the client machine. Please see the *CryptoniteNXT Generic RADIUS Integration Guide* for more details about the integration.

2.21.1 Requirements for Integrating Cisco ISE and CryptoniteNXT

As described in the ISE installation section, ISE requires RADIUS to be configured to perform posture. As such, this guide assumes the use of some sort of switch to provide RADIUS functionality.

CryptoniteNXT requires the switch to use L2 technologies for the RADIUS server, which means a captive portal will not work for this scenario. The feasibility of this depends on your networking setup.

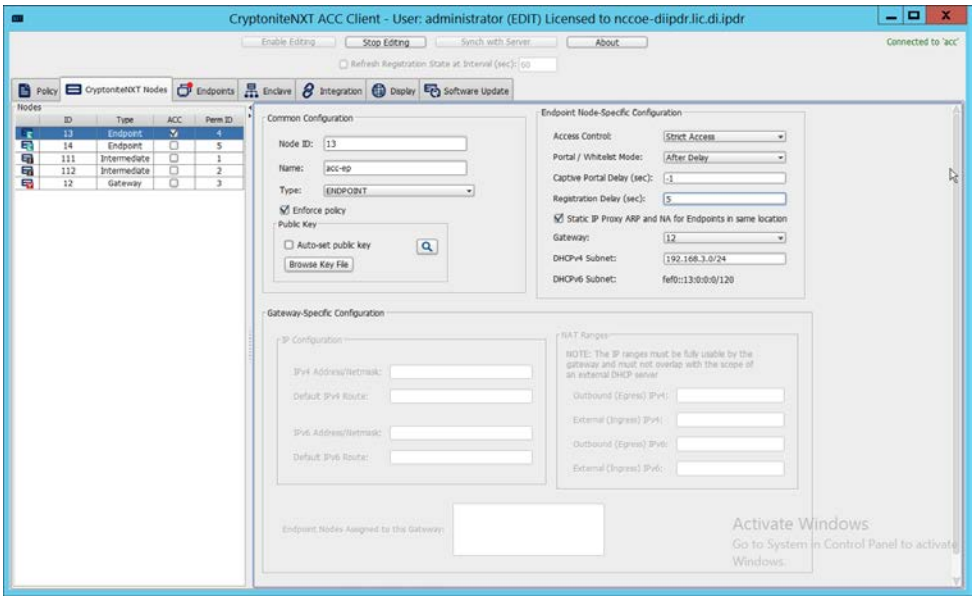
This integration requires the following:

1. The switch is bridged to CryptoniteNXT.
2. Cryptonite is configured to accept RADIUS packets from the switch (detailed below).
3. Clients on the switch's Local Area Network (LAN) authenticate to the switch via 802.1x (see your switch's documentation).

4. The switch is configured to accept CoA packets from ISE (see ISE installation).
5. The switch sends RADIUS accounting and authentication packets to Cisco ISE (see ISE installation).
6. ISE sends an authentication response to the switch and then later uses CoA to modify the authorization based on posture (see ISE installation).
7. If the authorization is successful, the switch tells the client and forwards the accounting packets to the CryptoniteNXT ACC node (see your switch's documentation).

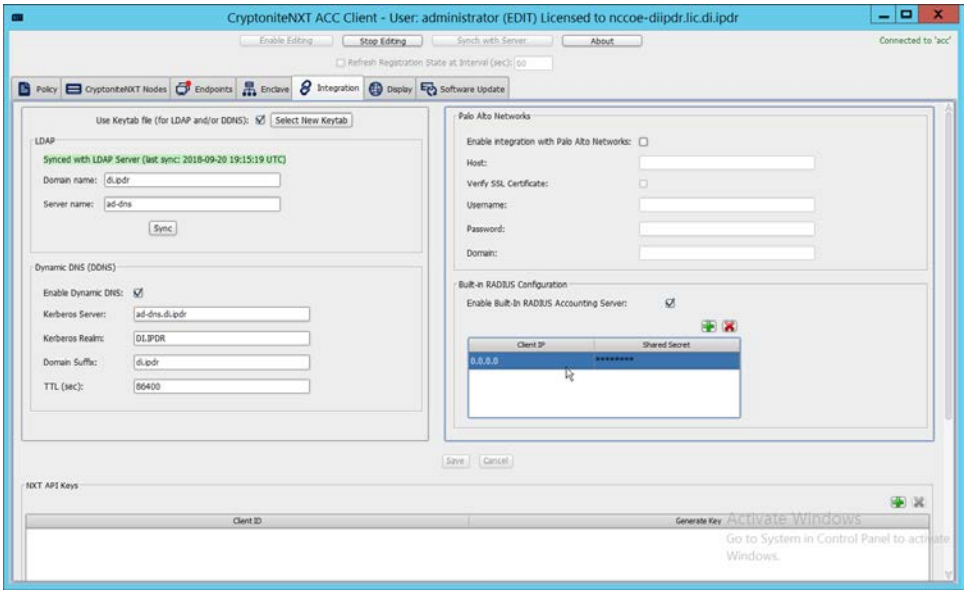
2.21.2 Configuring CryptoniteNXT for RADIUS

1. Open the CryptoniteNXT GUI and log in.
2. Navigate to the **CryptoniteNXT Nodes** tab.
3. Click **Enable Editing.**
4. Select the **Endpoint** node, which will have your switch attached to it.
5. Under **Endpoint Node-Specific Configuration,** select **Strict Access** for **Access Control.**
6. Select **After Delay** for the **Portal/Whitelist Mode.**
7. Enter -1 for **Captive Portal delay.**
8. Enter 5 for the **Registration delay.**
9. Select the **Gateway** node.



10. Click **Save.**
11. Navigate to the Integration tab.

12. Under **Built-In RADIUS Configuration,** check the box next to Enable Built-In RADIUS Accounting Server.



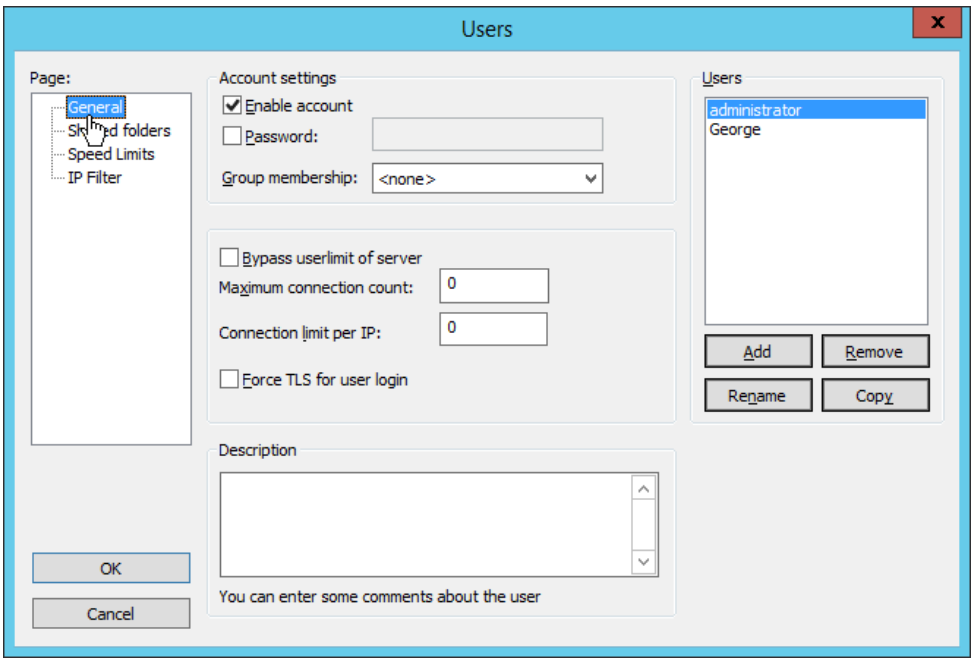
13. Click the **plus button** to add the IP of the switch as well as a shared secret. You can use 0.0.0.0/0 as the IP to accept RADIUS Accounting packets from all IPs, however this is not recommended in production.

2.22 Integration: Backups and GreenTec

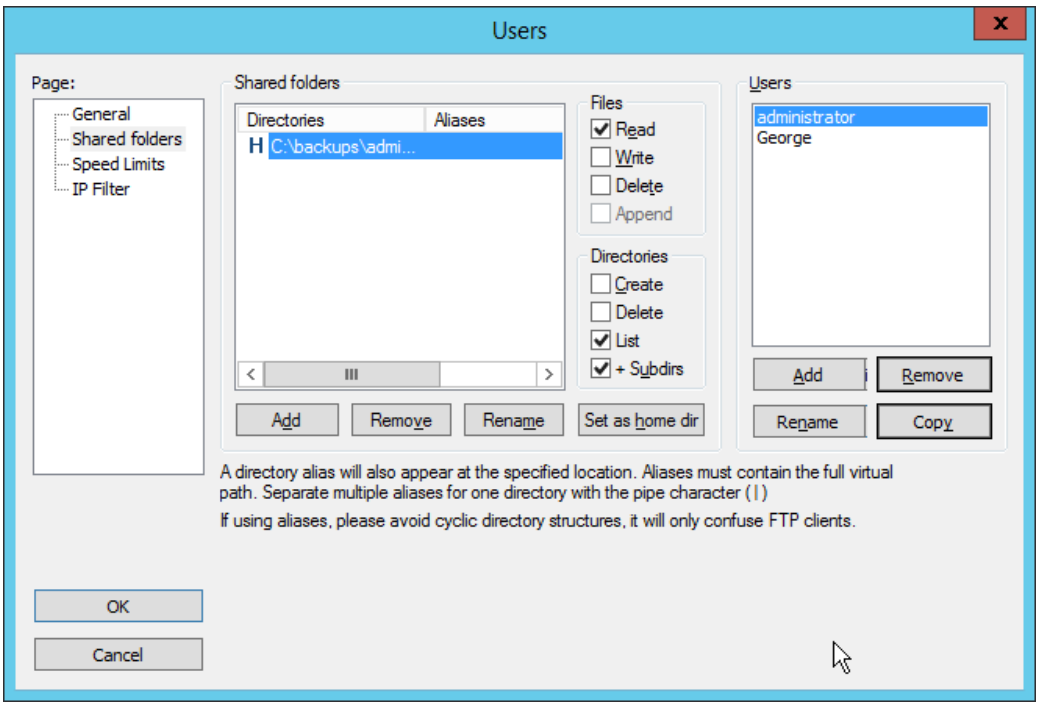
This section details integration between the backup capability and **GreenTec WORMdisks.** Because **GreenTec WORMdisks** provide write protection for files on the disk, they are an ideal place to store important backups. There are a couple options for this integration, but before these backups can be replicated onto secure storage, it is important to be able to identify the location of backups to be replicated.

2.22.1 Locate Backups with FileZilla and Duplicati

1. To locate backups in **FileZilla,** open the **FileZilla Server** console.
2. Click **Edit > Users.**

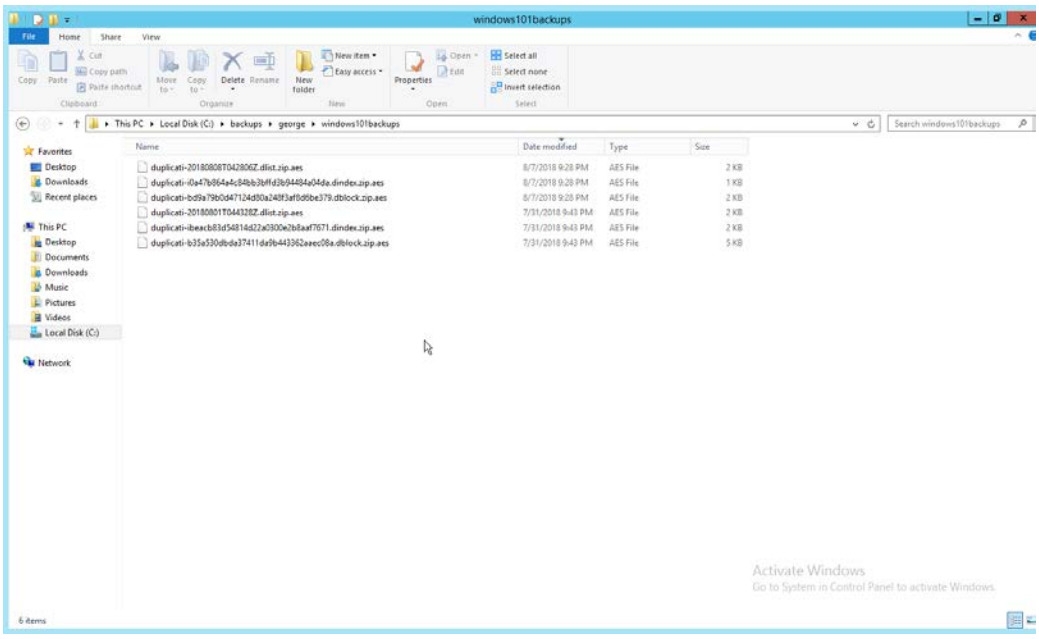


2965 3. Click **Shared folders** in the left pane.



2966 4. Under **Directories** is a list of directories in which the selected user can store backups. The one
2967 marked **H** is the default home directory.

5. The path to the backups from the home directory is specified in the **Path on server** field in **Duplicati** (see Section 2.8.6).



6. Each backup should have three associated files. An easy way to determine what files belong together is to check the **Date Modified** field. These files are encrypted.

2.22.2 Back Up to a GreenTec Disk

The first, most flexible option involves backing up the backup server to a separate server with **GreenTec WORMdisks.** Simply set up a **FileZilla** server on the **GreenTec** storage server and a **Duplicati** client on the backup server (see Section 2.8 for these installation processes). When choosing where to store files on FileZilla, indicate a folder on the **GreenTec WORMdisk.** Sectors of the disk can be locked using the mechanism in Section 2.6.4, providing firmware-level write security for any backups in the locked sectors.

There are some considerations when doing this. First, if this is done on a schedule and permanent locks are used, space will be consumed quickly and the **WORMdisks** will need replacements as the space cannot be reused. The trade-off between space and backup frequency must be considered–a lower backup frequency inevitably means more data loss in the event of a restoration, while higher backup frequency increases the cost of maintaining secure storage.

Alternatively, secure storage can be used for specific types of backups, such as “golden disks”–which would contain backups of the basic level of functionality required for the enterprise without necessarily

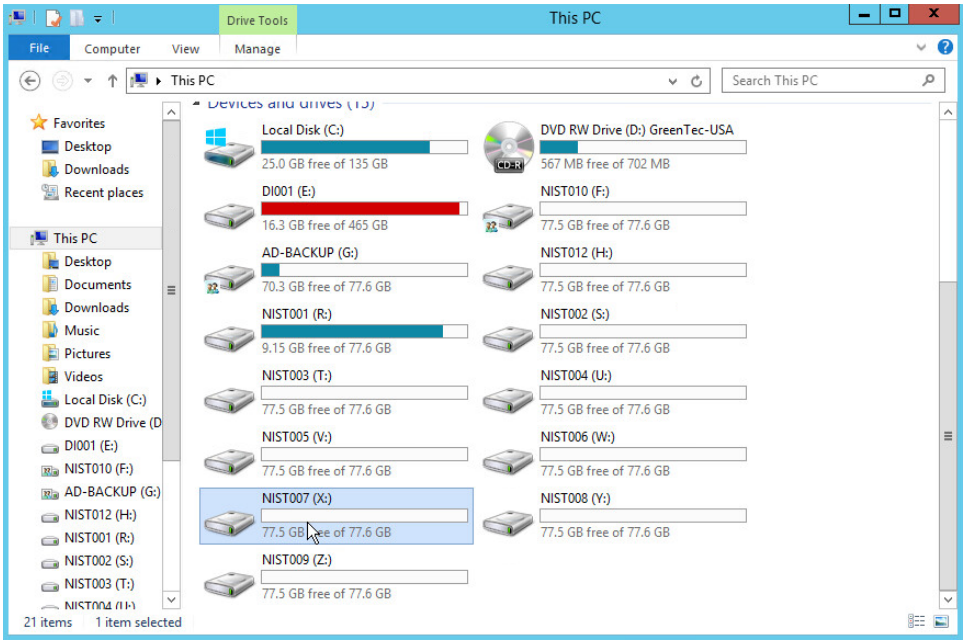
utilizing a backup schedule. This would afford protection for some basic functionality but would forfeit the secure storage capability for day-to-day data.

In addition to the options above, there are other ways to minimize wasted space on a GreenTec disk. Temporary Locks, or TLocks, can be employed after the data is backed up to a GreenTec disk to protect data integrity while making less space unavailable for future use. After the drive is full, a permanent lock should still be executed. Wasted space can also be minimized with the use of dynamic partitions, or with the Force-Field Write-Once File System, which can also reduce the overhead administration of the GreenTec disk.

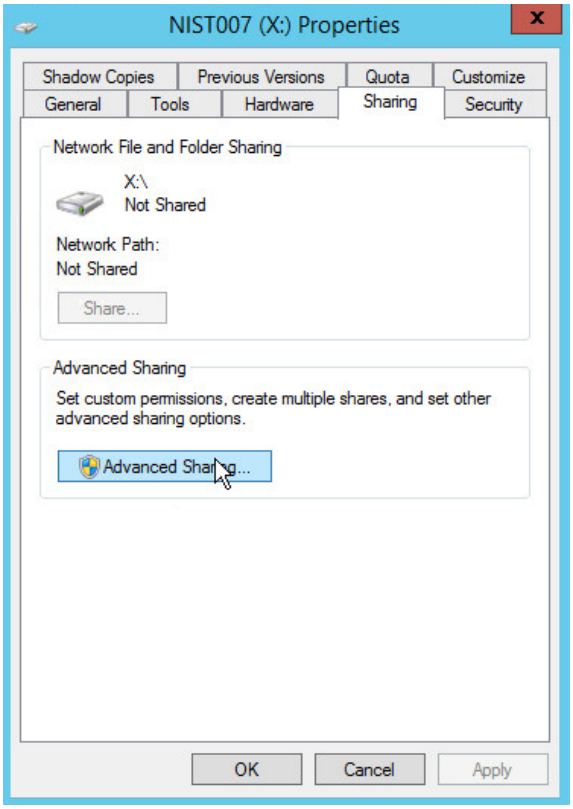
2.22.3 Configure Network-Accessible GreenTec Disk

Another option for GreenTec disks is to make them network accessible. This allows them to be used specifically in situations where secure storage protection is desired, and it makes them options for backup locations even on servers to which they are not necessarily physically connected.

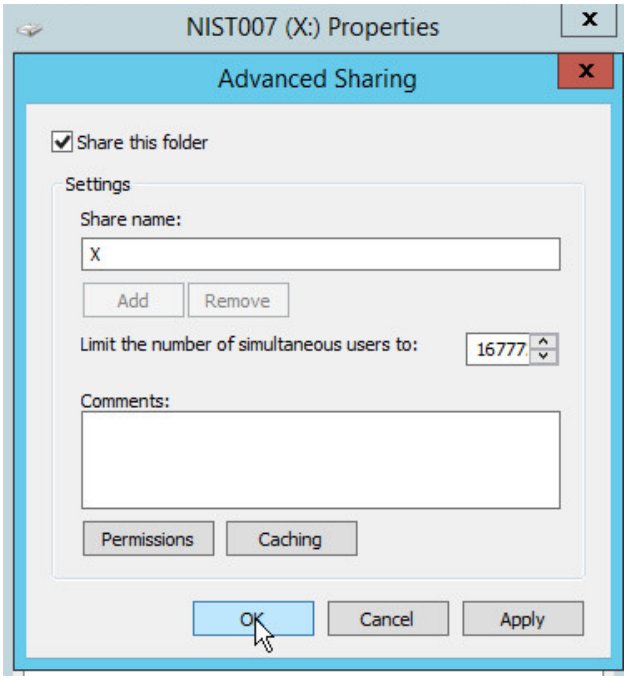
1. To configure a GreenTec disk to be network accessible, right-click the disk on the GreenTec server.



2. Click **Share With > Advanced Sharing.**



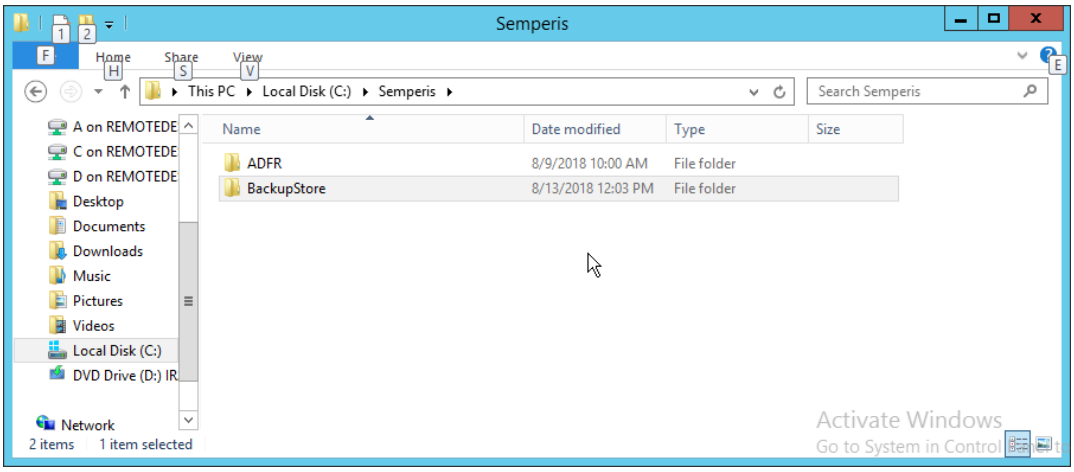
3. Click **Advanced Sharing.**
4. Check the box next to **Share this folder.**
5. Enter a name for the drive if desired.



6. Click **OK.**
7. Click **Close.**
8. The drive should now be accessible at **//SERVER-NAME/X.**

2.22.4 Secure Storage for Semperis ADFR

1. On the Semperis ADFR server, the default backup location is C:\Semperis.
2. In this folder there is metadata for the backups (C:\Semperis\ADFR) as well as the backups themselves (C:\Semperis\BackupStore).



It is important to consider the limitations of the backup software when considering whether to replicate backups to secure storage. Ideally, the replication of backups ensures that they can be used on a separate server when the original server is affected by an incident. The replication of backups in this case can offer some write protection for these specific backup files, but if the entire server is lost, it is not guaranteed that the backups will be usable on a new instance of ADFR. This risk can be mitigated by exporting the configuration of the ADFR server for the purpose of building a failover ADFR server.

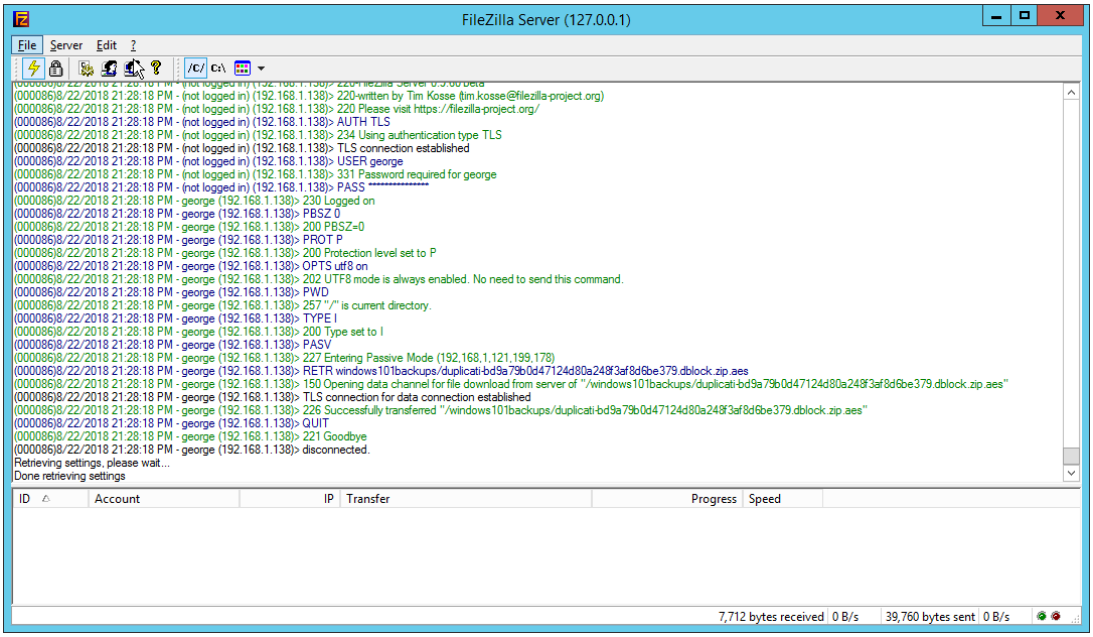
Though these backups can be replicated to WORMdisks, this is currently not supported by Semperis ADFR. Instead, Semperis ADFR offers a different type of "secure storage" by not joining to the domain, allowing the machine to be taken offline and brought online only during creation/application of a backup.

2.23 Integration: Micro Focus ArcSight and FileZilla

In this section an integration between ArcSight and FileZilla is detailed so that logs from FileZilla are forwarded to ArcSight by using an ArcSight syslog file connector.

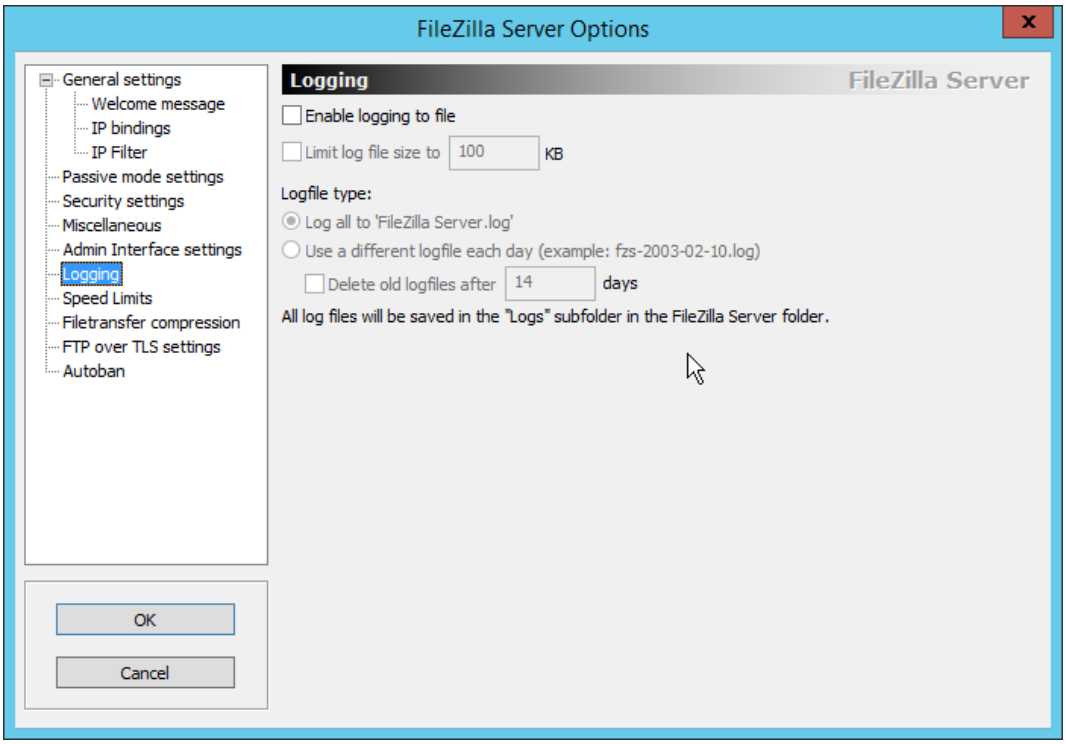
2.23.1 Enable Logs in FileZilla

1. On the server with **FileZilla** installed, open **FileZilla Server.**

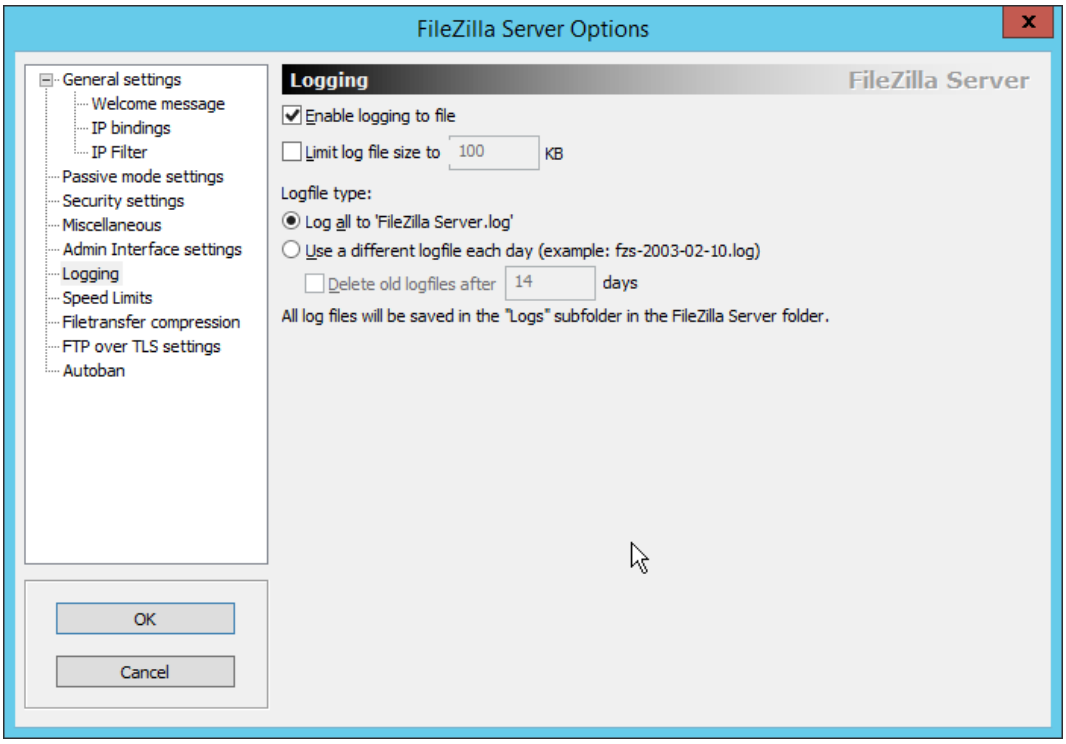


2. Click **Edit > Settings.**

3028 3. Click **Logging.**



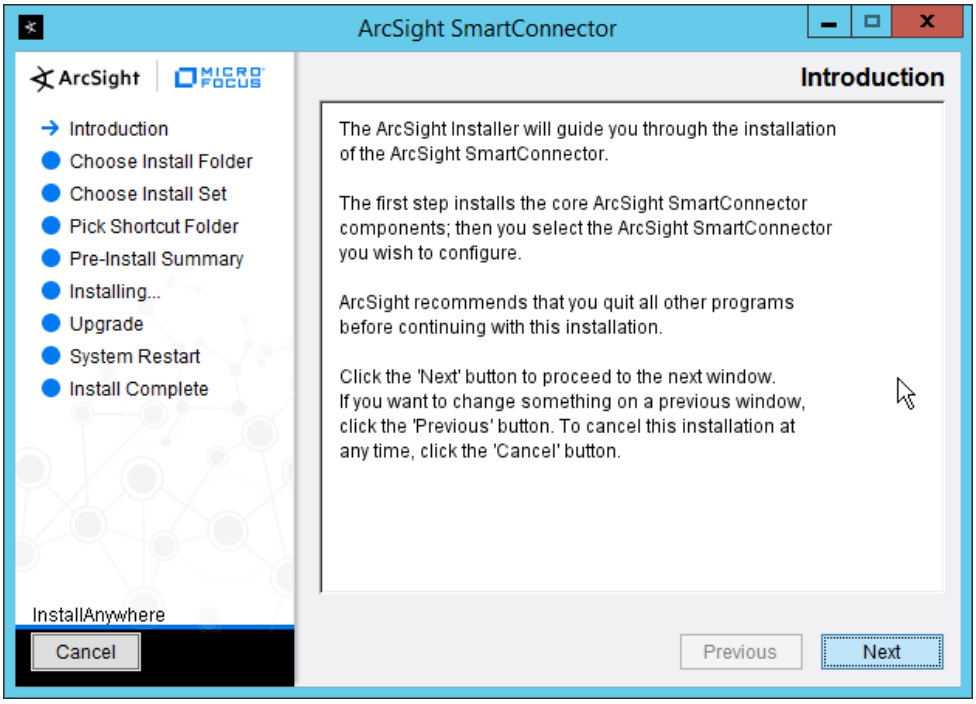
3029 4. Check the box next to **Enable logging to file.**



5. Click **OK.**

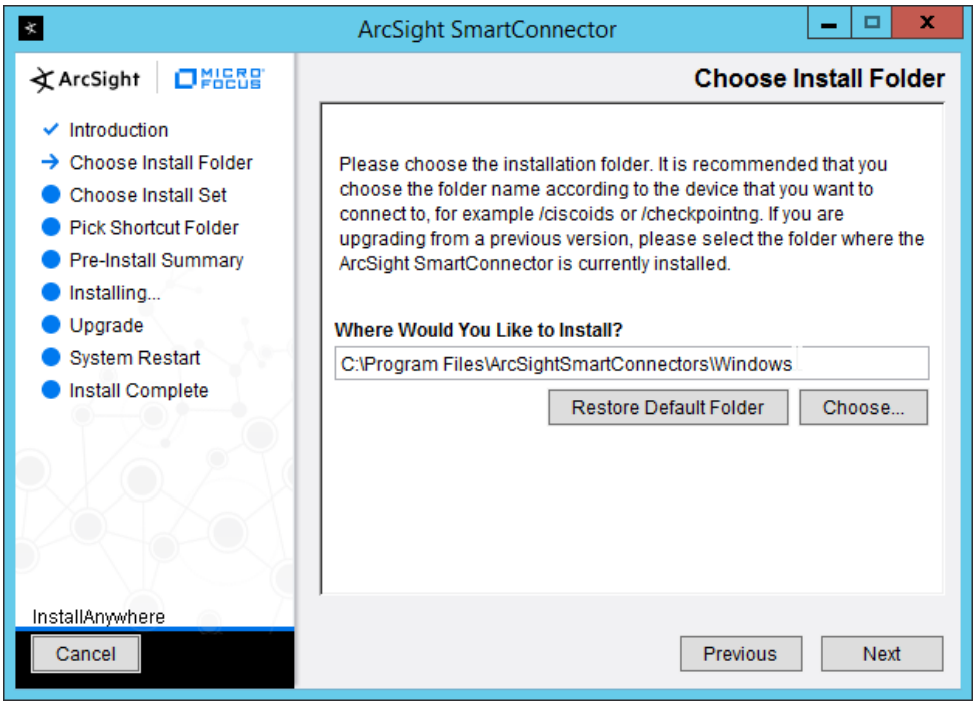
2.23.2 Install Micro Focus ArcSight

1. Run **ArcSight-7.9.0.8084.0-Connector-Win64.exe.**

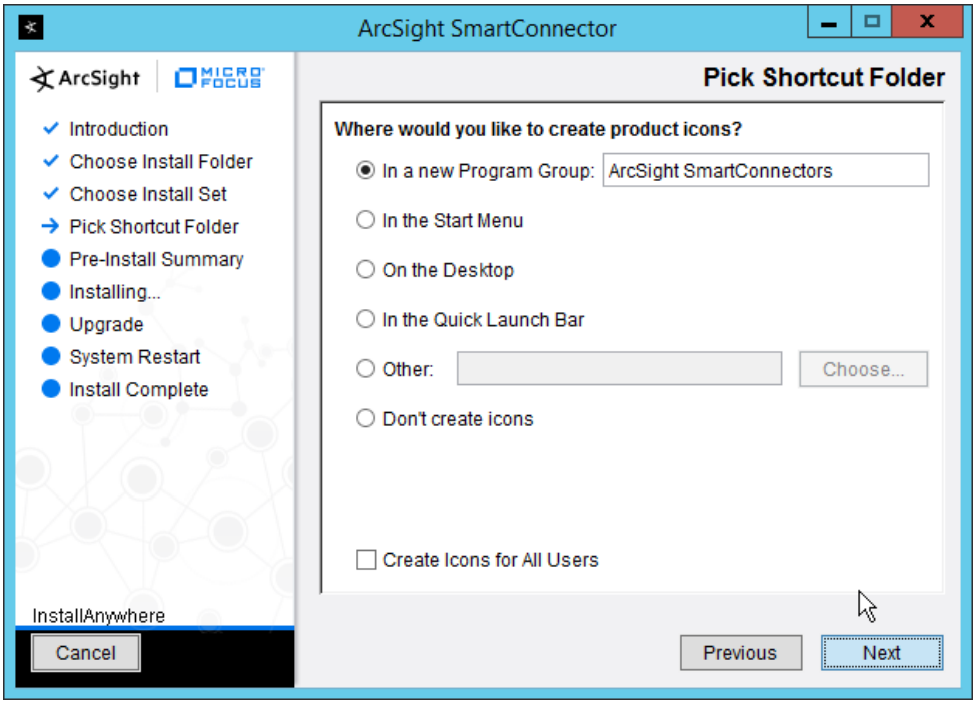


3033 2. Click **Next.**

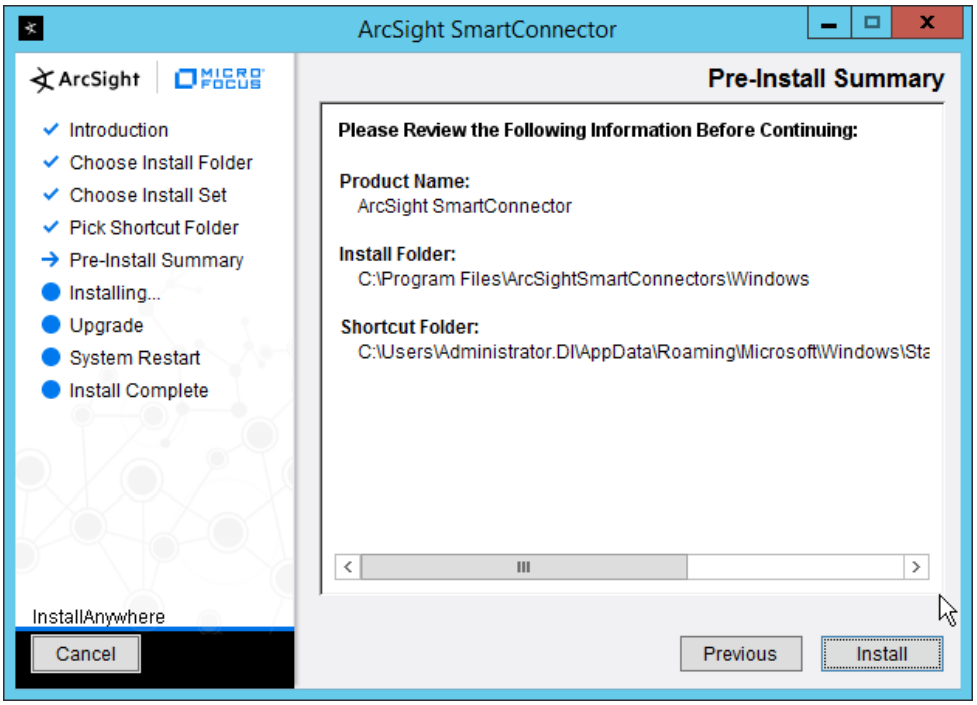
3034 3. Enter C:\Program Files\ArcSightSmartConnectors\Windows.



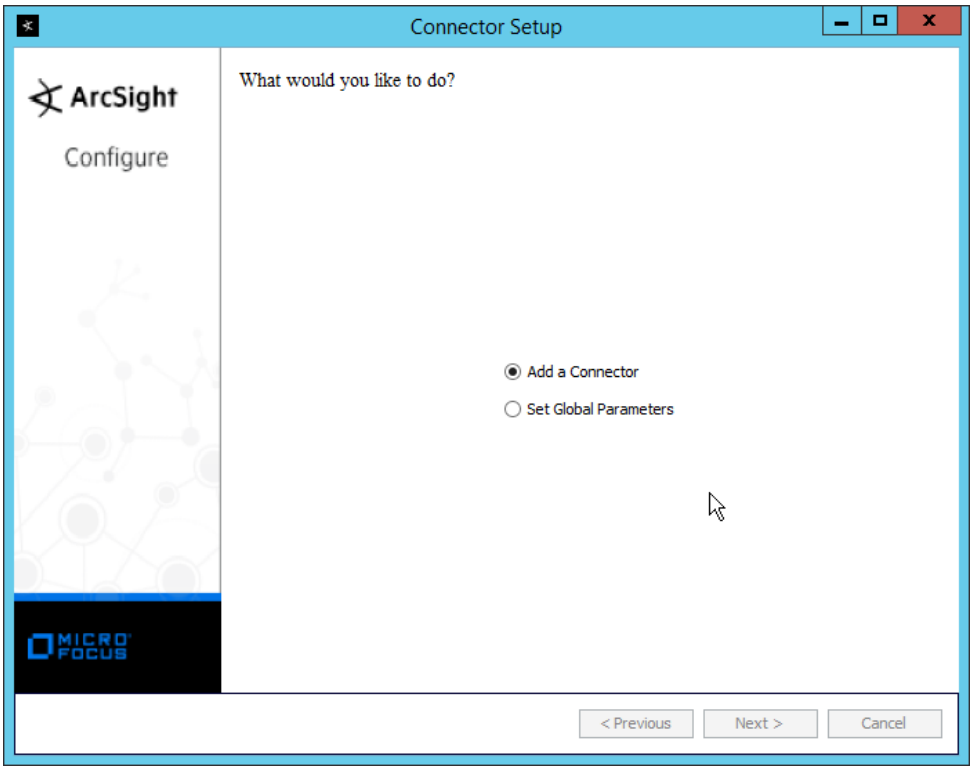
3035 4. Click **Next.**



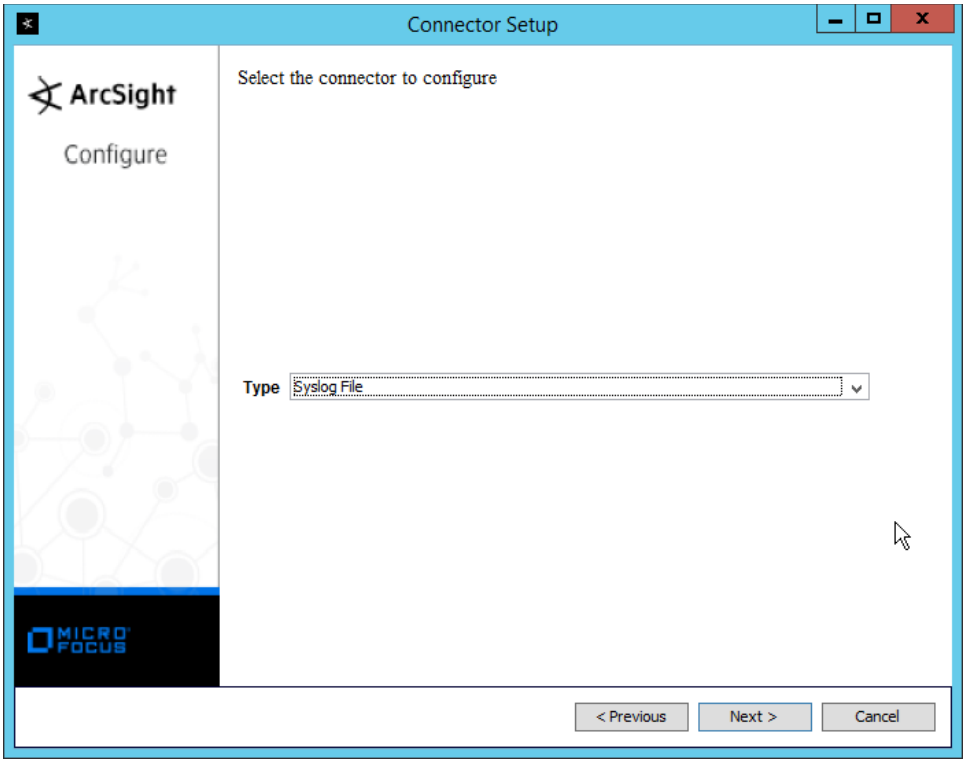
3036 5. Click **Next.**



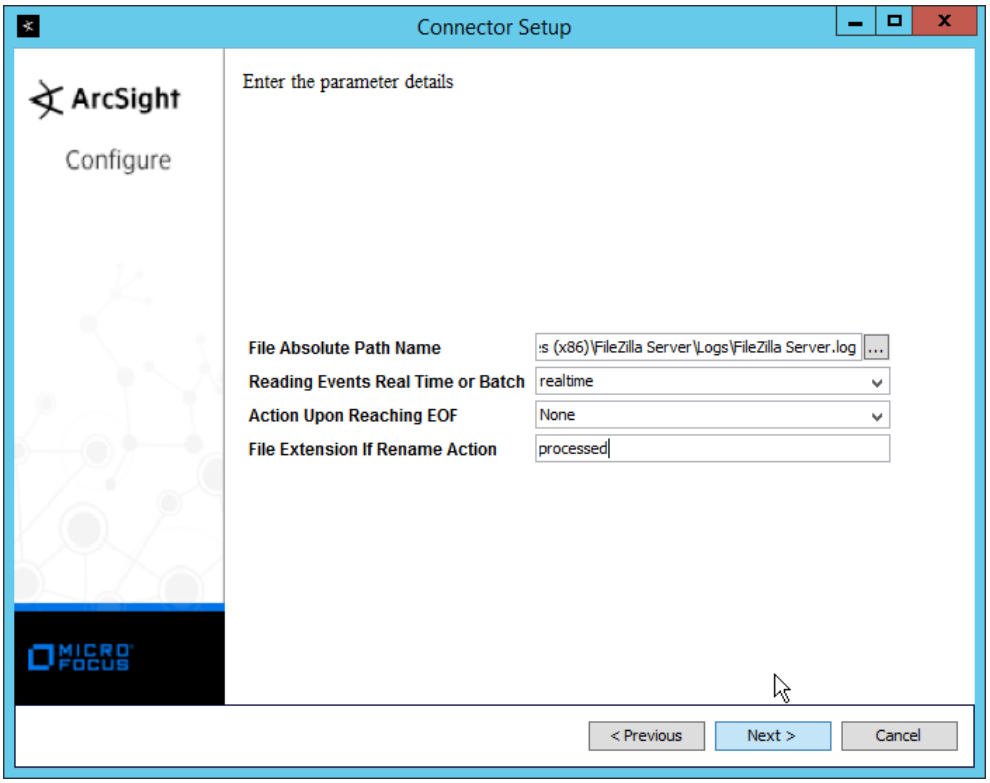
6. Click **Install.**
7. Select **Add a Connector.**



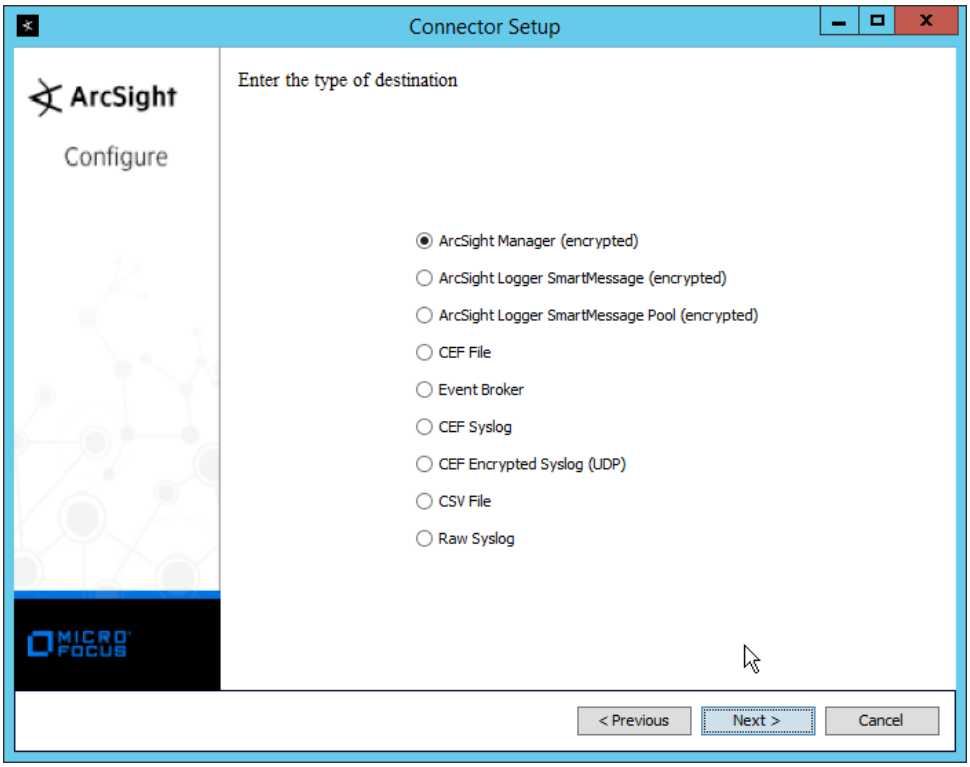
8. Click **Next.**
9. Select **Syslog File.**



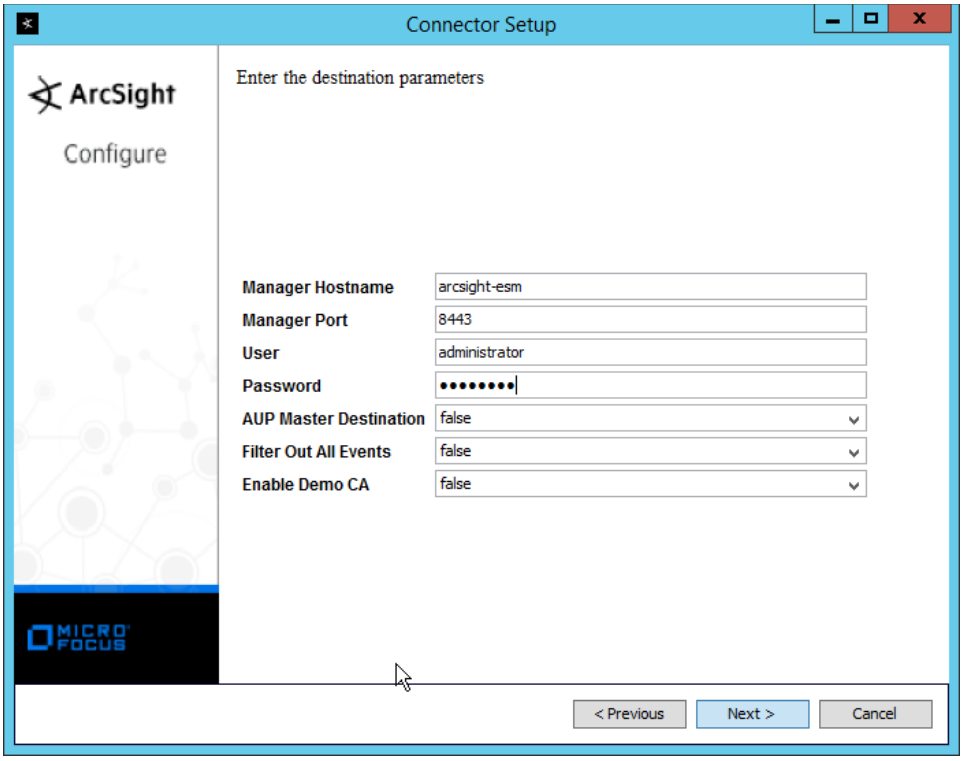
10. Click **Next.**
11. Enter C:\Program Files (x86)\FileZilla Server\Logs\FileZilla Server.log for **File Absolute Path Name.**



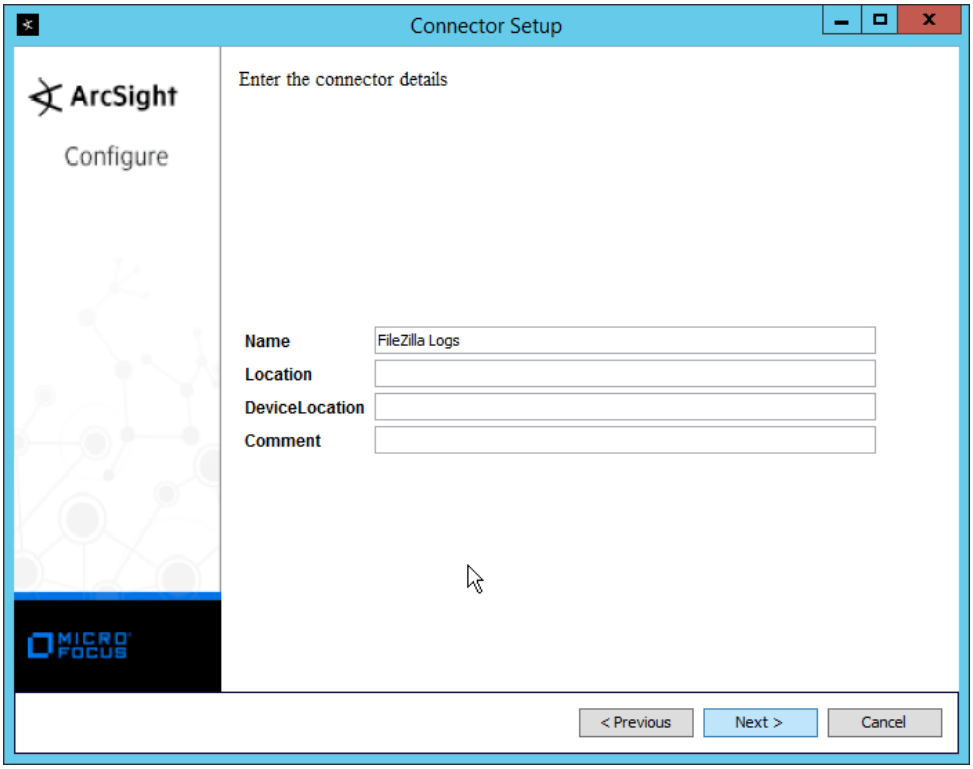
12. Click **Next.**
13. Select **ArcSight Manager (encrypted).**



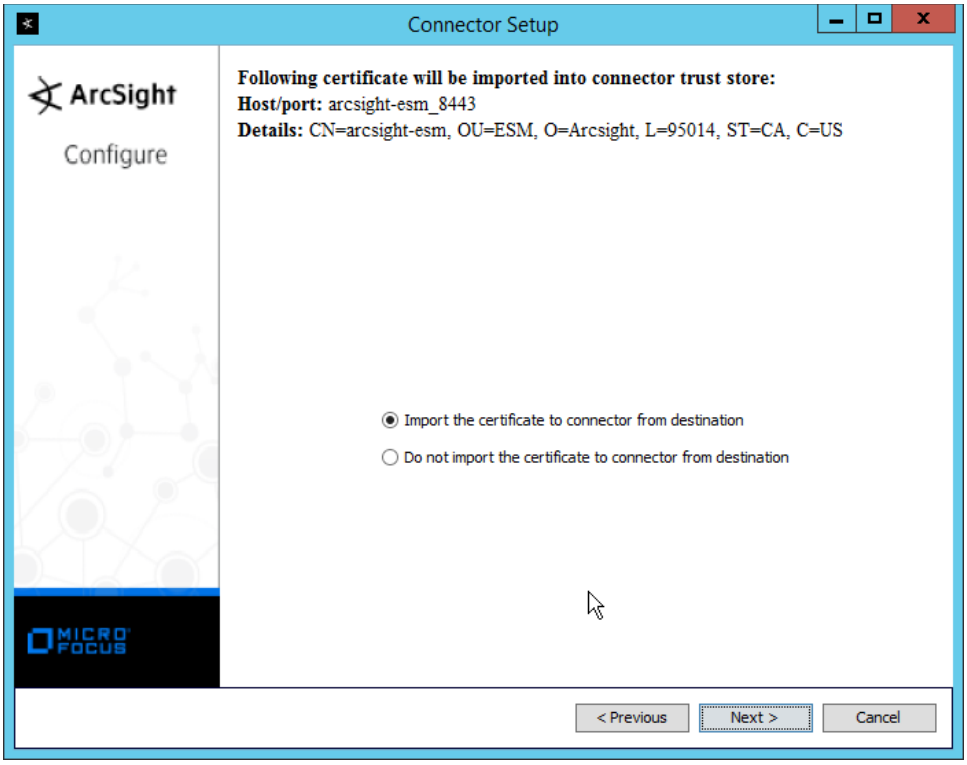
14. Click **Next.**
15. Enter the **hostname, port, username,** and **password** for the ArcSight ESM server.



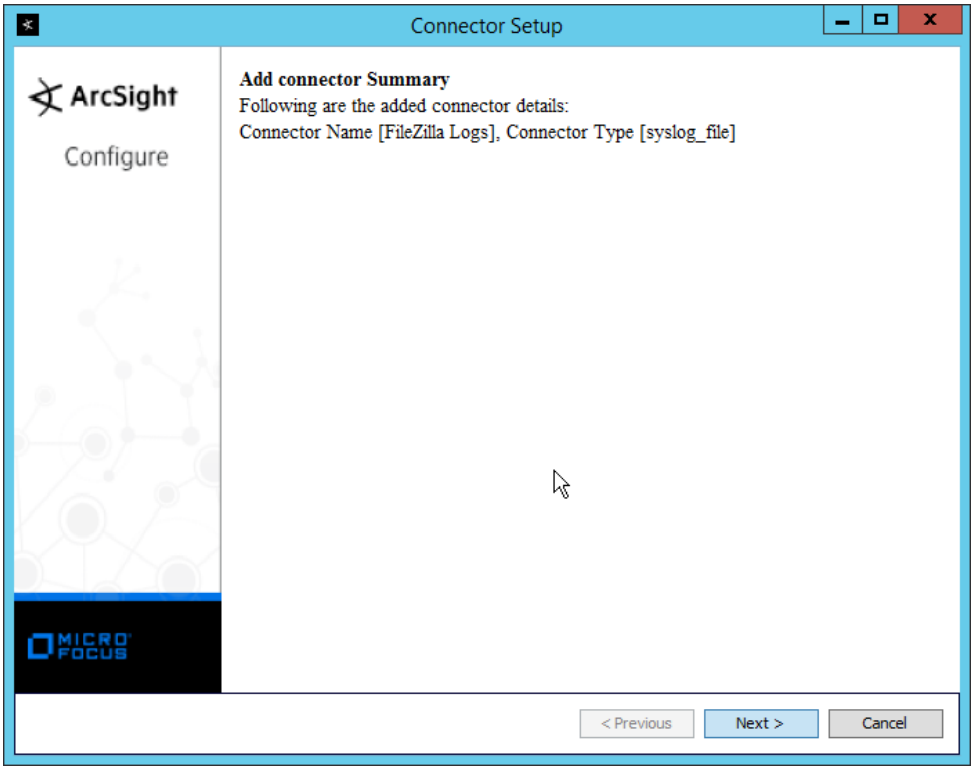
16. Click **Next.**
17. Enter identifying details about the system (only **Name** is required).



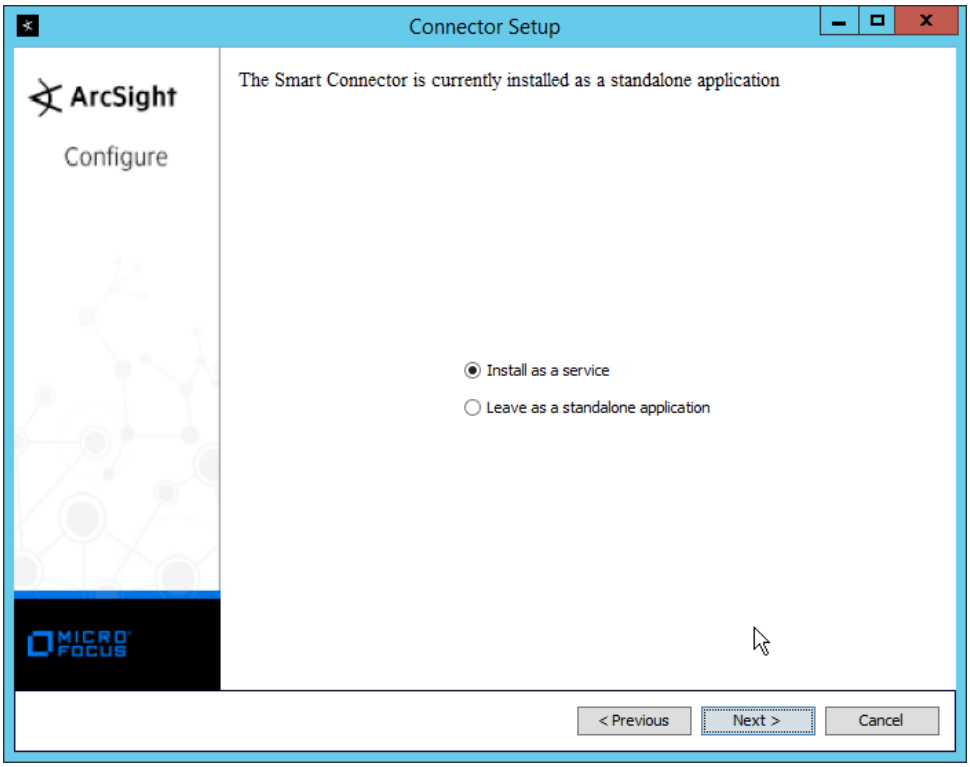
18. Click **Next.**
19. Select **Import the certificate to connector from destination.**



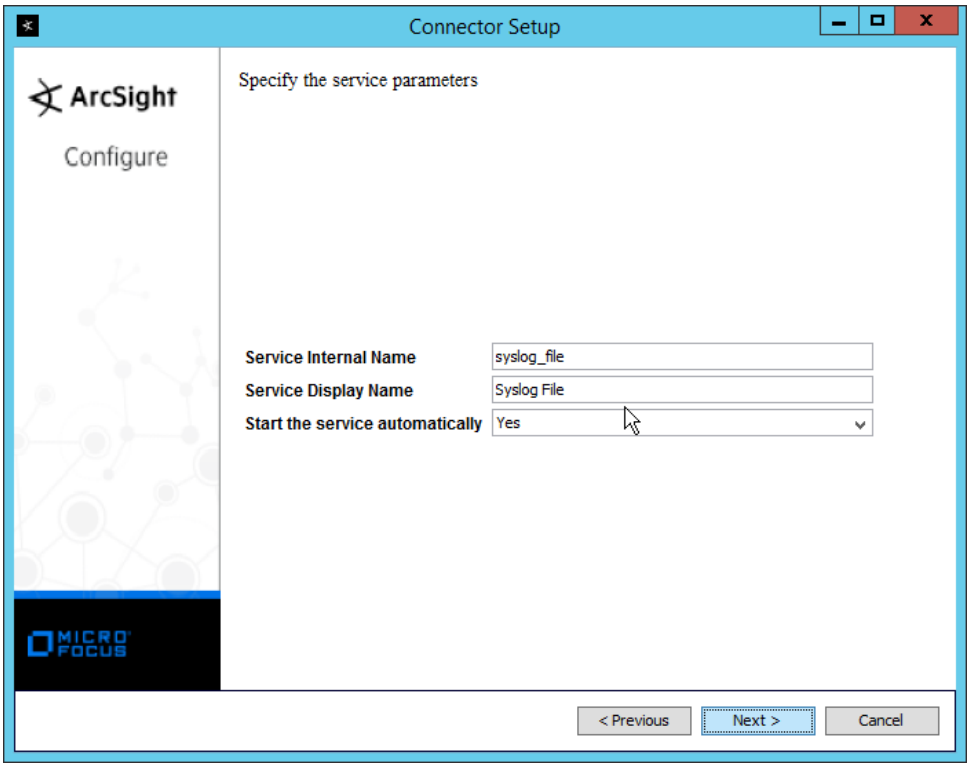
3052 20. Click **Next.**



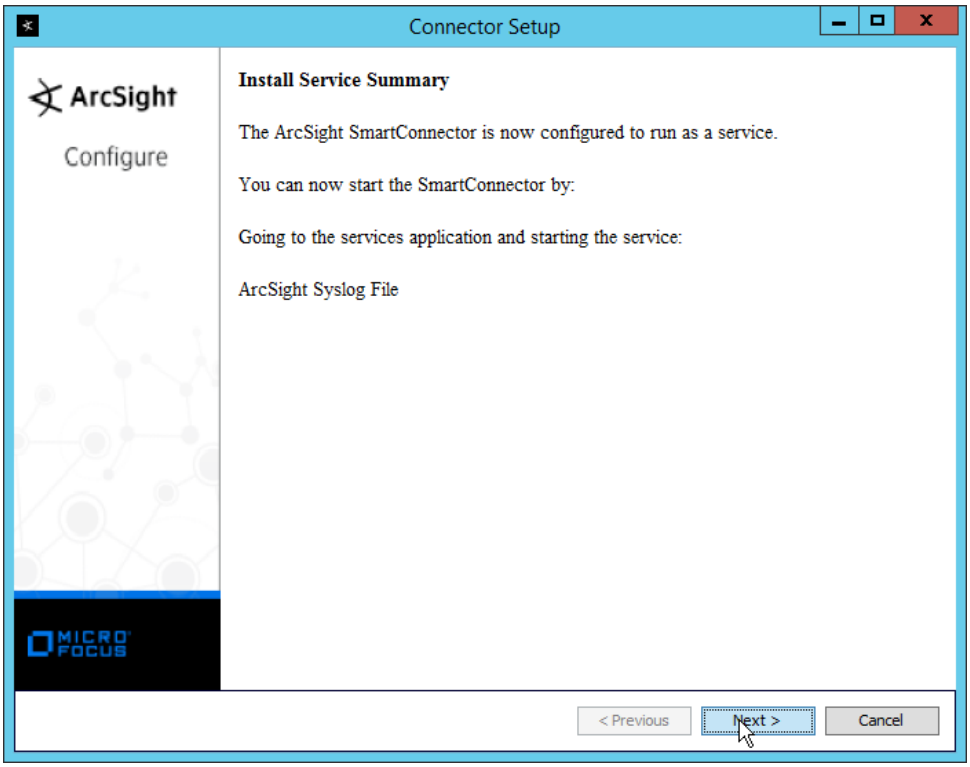
21. Click **Next.**
22. Select **Install as a service.**



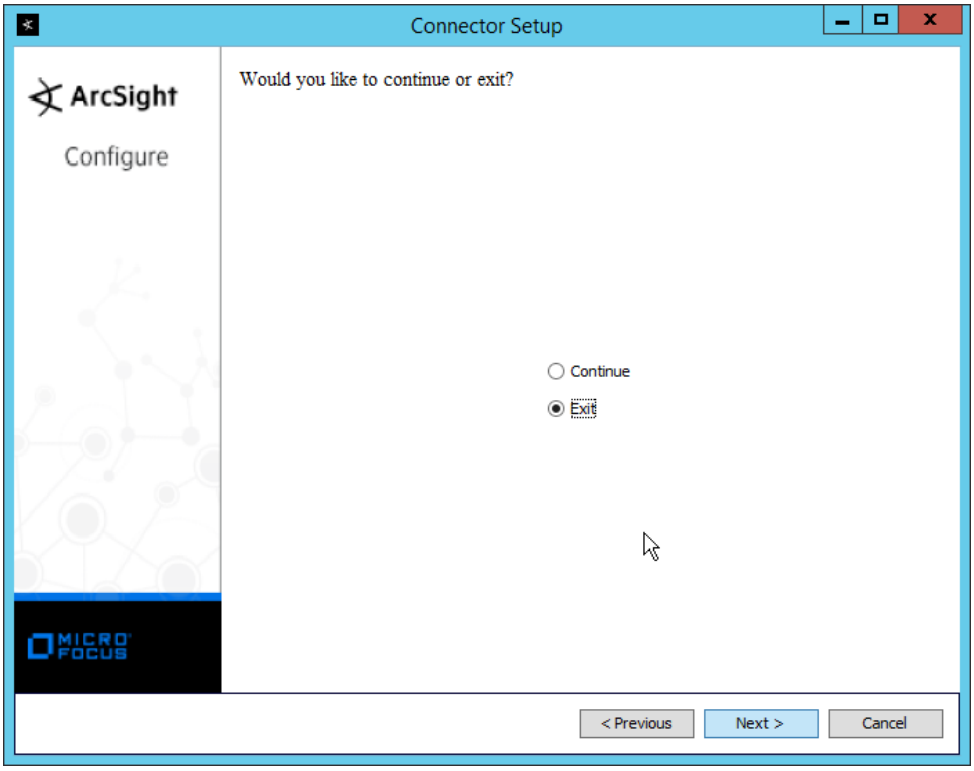
3055 23. Click **Next.**



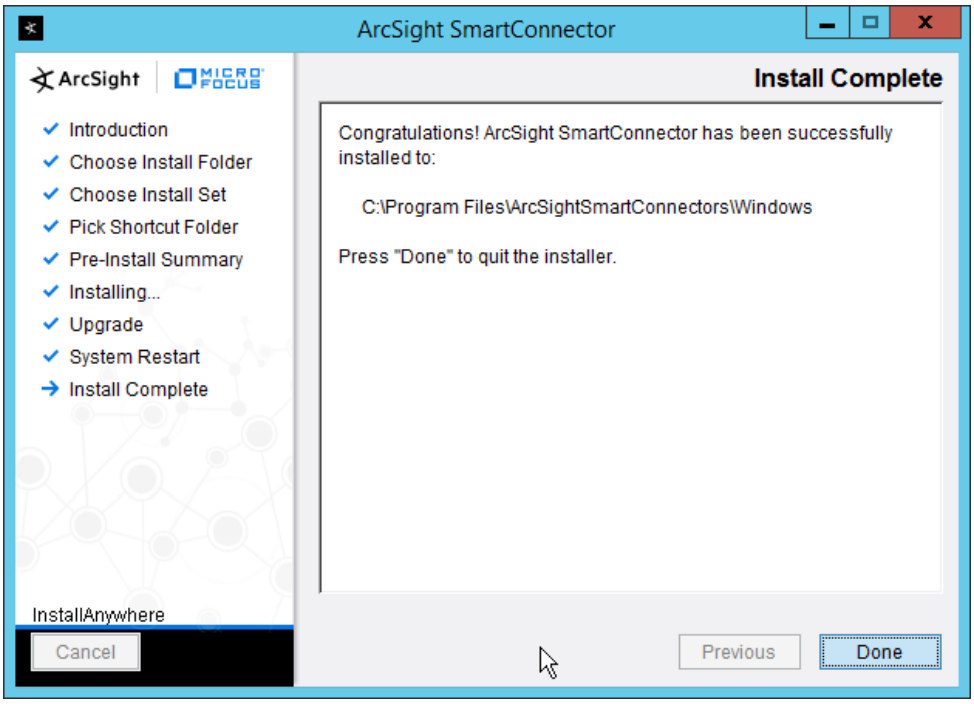
3056 24. Click **Next.**



25. Click **Next.**
26. Select **Exit.**



3059 27. Click **Next.**



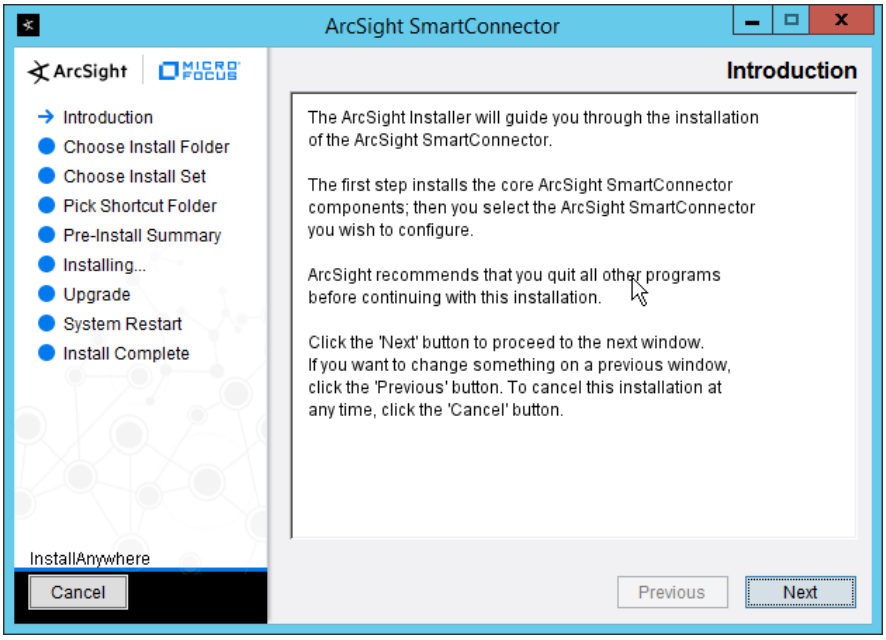
28. Click **Done.**

2.24 Integration: Micro Focus ArcSight and Tripwire

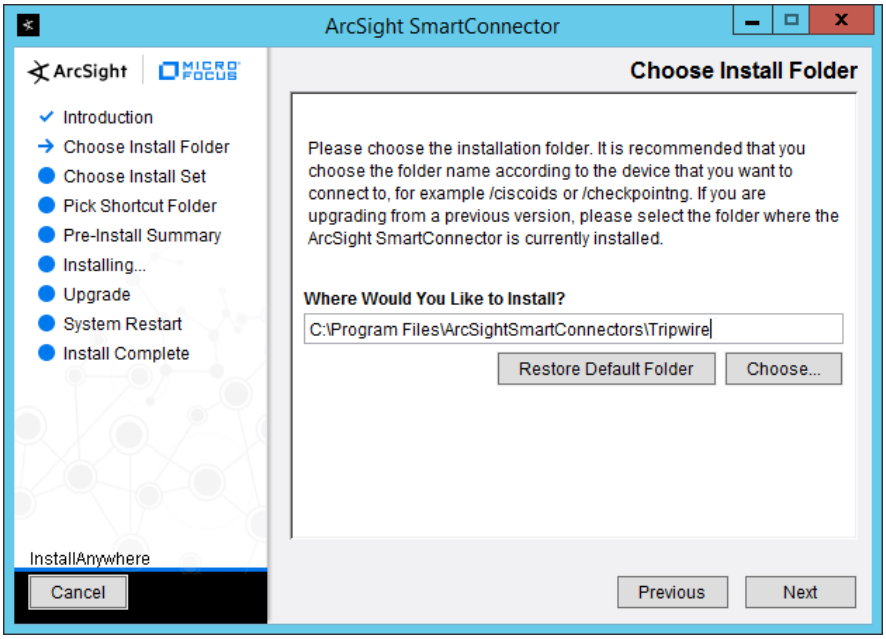
This section details forwarding logs from **Tripwire Log Center** to **Micro Focus ArcSight.** This will forward **Tripwire IP360** and **Tripwire Enterprise** logs to **ArcSight,** assuming those logs are being collected by **Tripwire Log Center.**

2.24.1 Install Micro Focus ArcSight

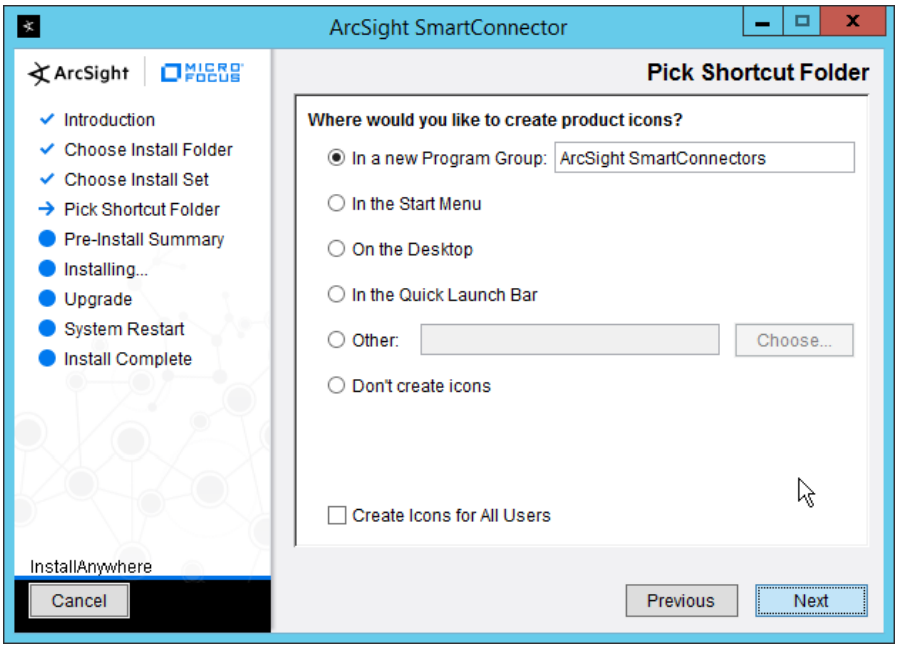
1. Run **ArcSight-7.9.0.8084.0-Connector-Win64.exe** on any server except the one running Tripwire Log Center.



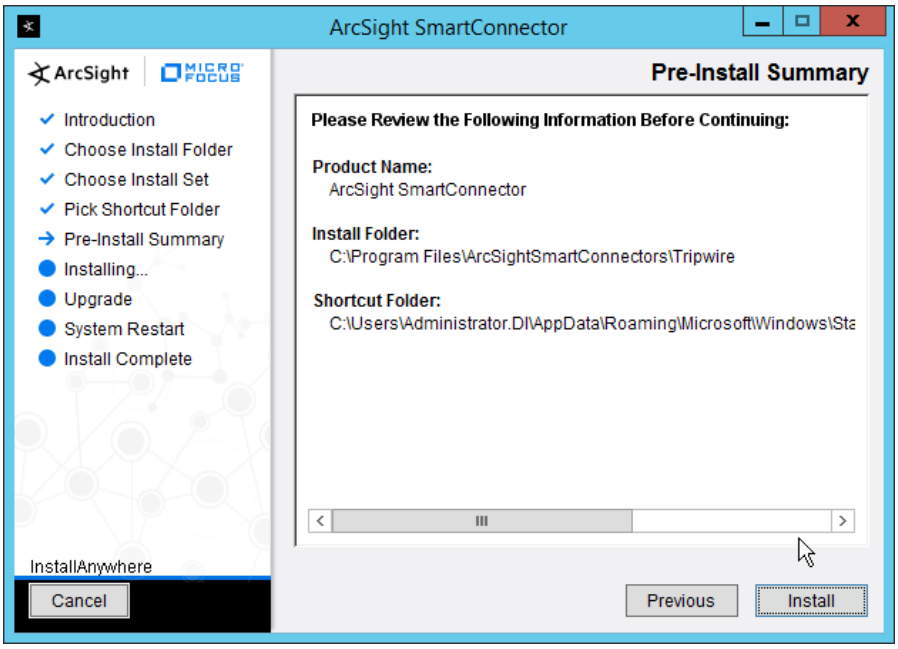
3068 2. Click **Next.**



3069 3. Enter C:\Program Files\ArcSightSmartConnectors\Tripwire.

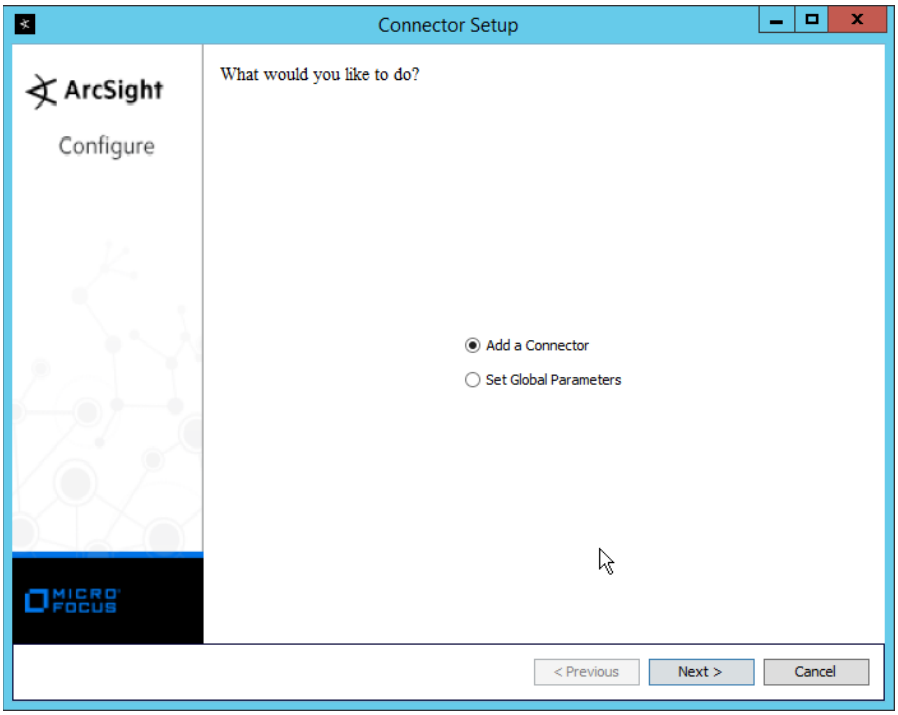


3070 4. Click **Next.**

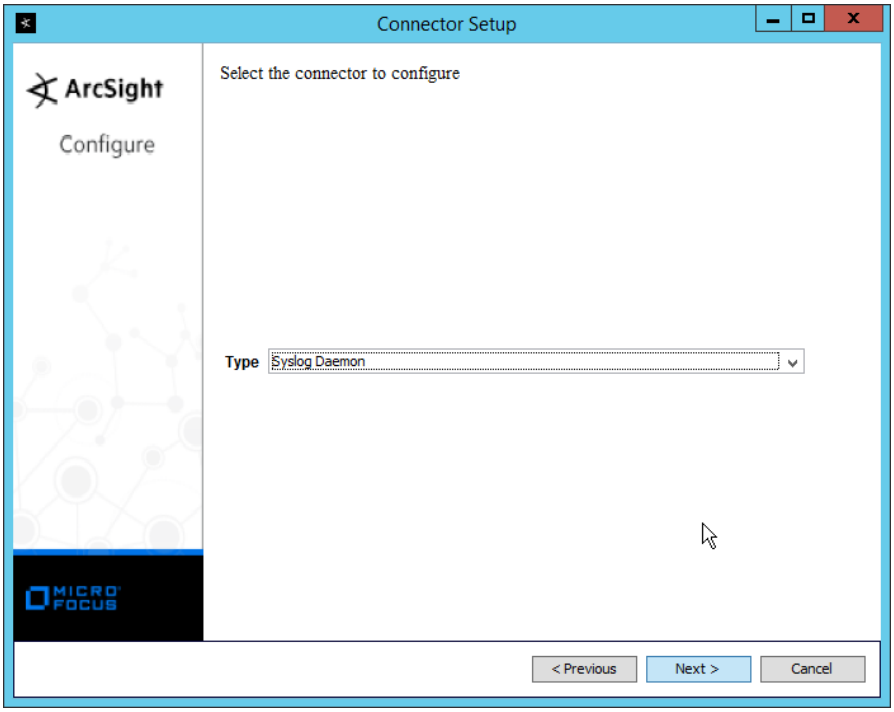


3071 5. Click **Install.**

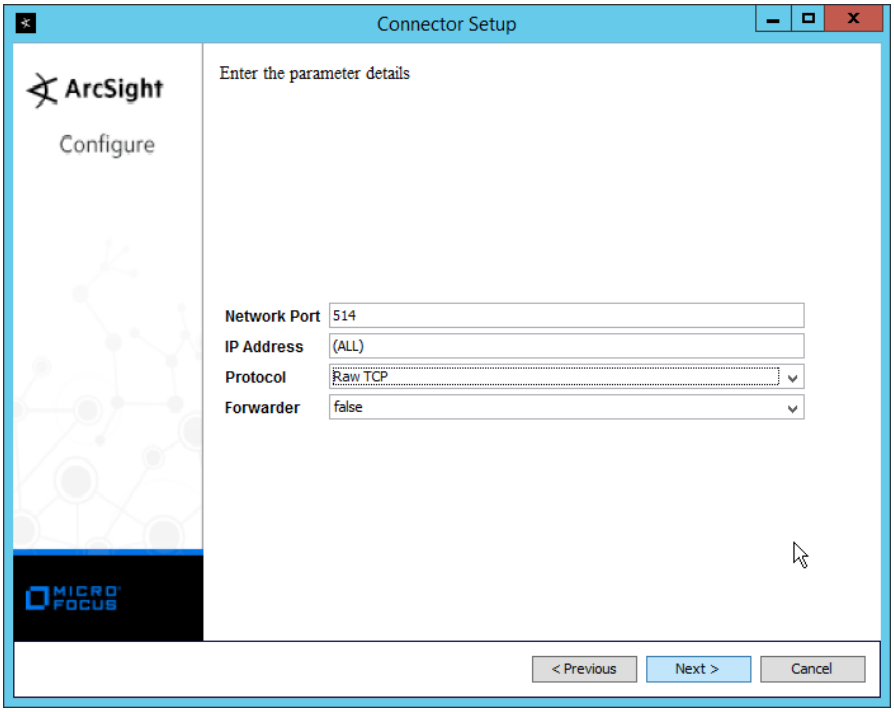
3072 6. Select **Add a Connector.**



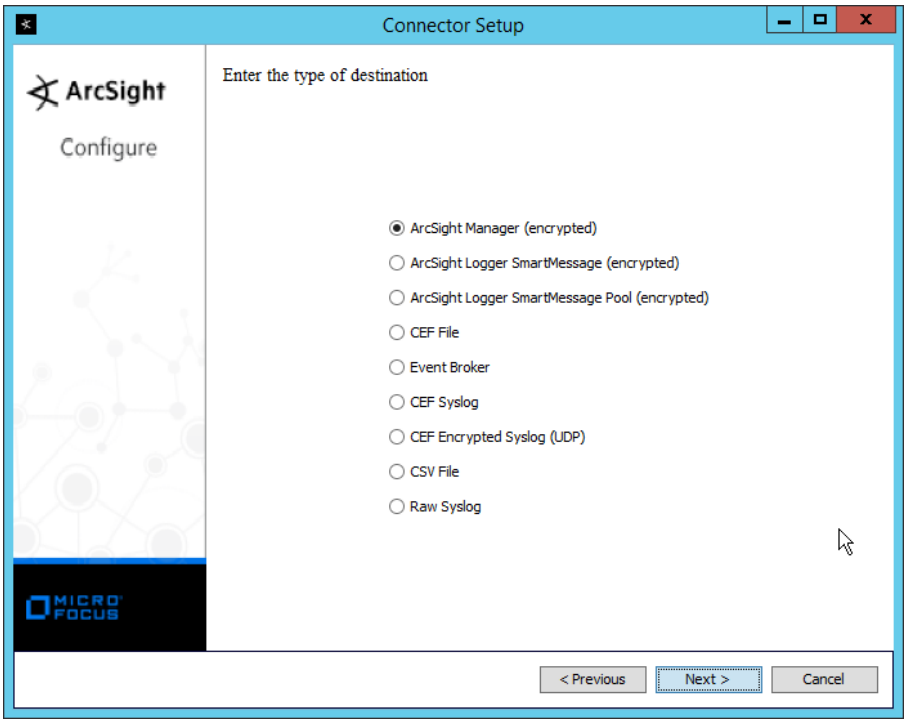
7. Click **Next.**
8. Select **Syslog Daemon.**



9. Click **Next.**
10. Enter a port for the daemon to run on.
11. Select **Raw TCP** for **Protocol.**

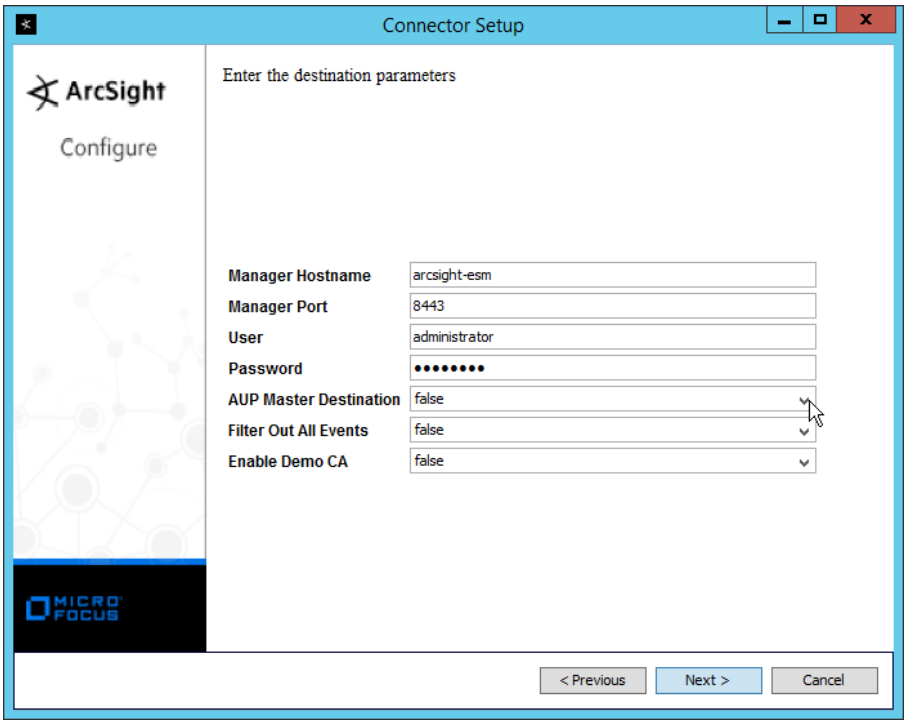


12. Click **Next.**
13. Select **ArcSight Manager (encrypted).**

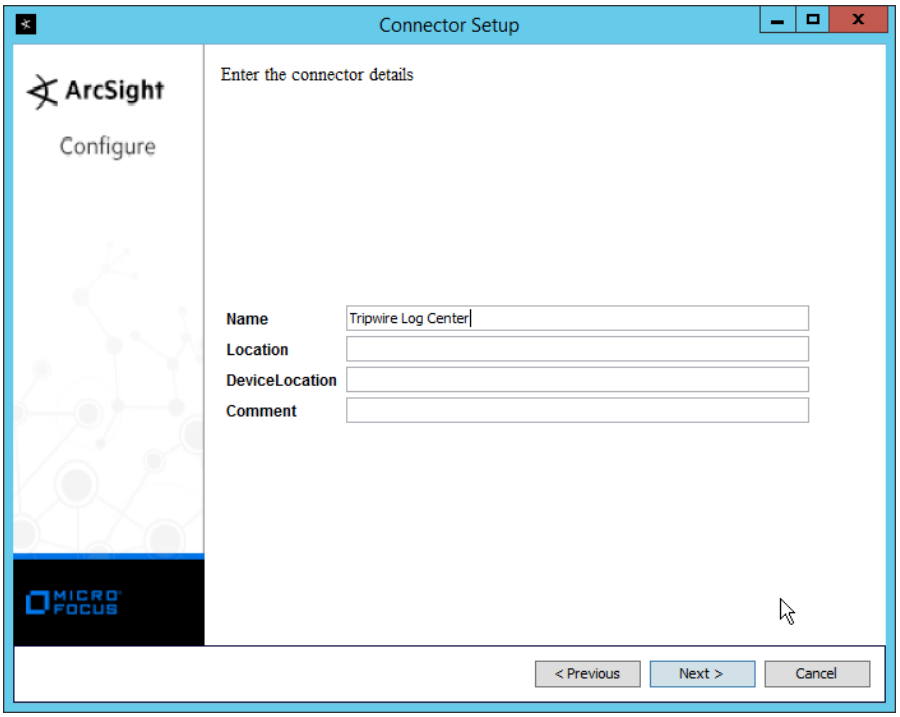


3080 14. Click **Next.**

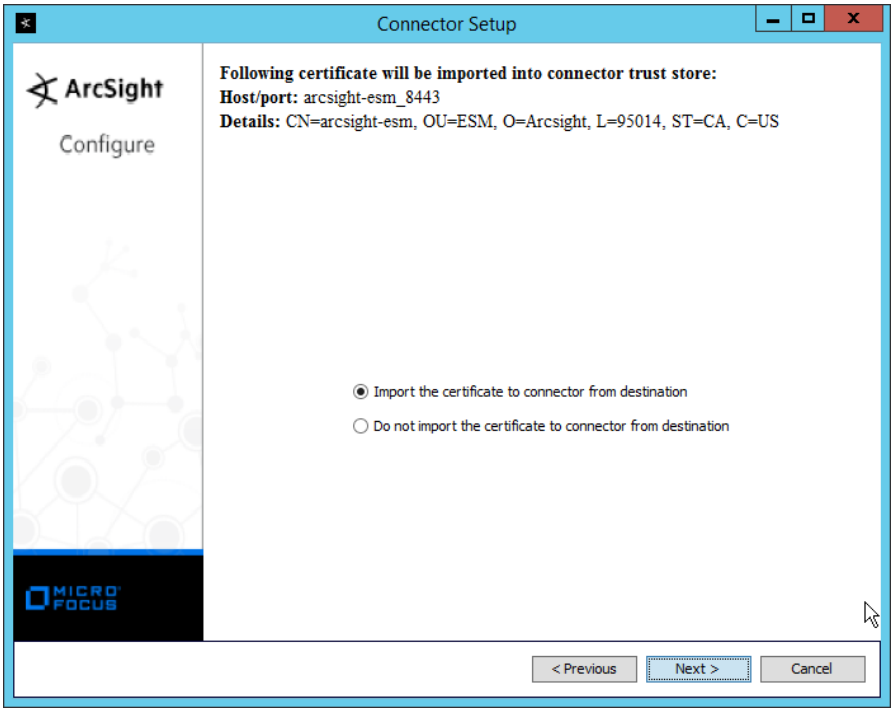
3081 15. Enter the **hostname, port, username,** and **password** for the ArcSight ESM server.



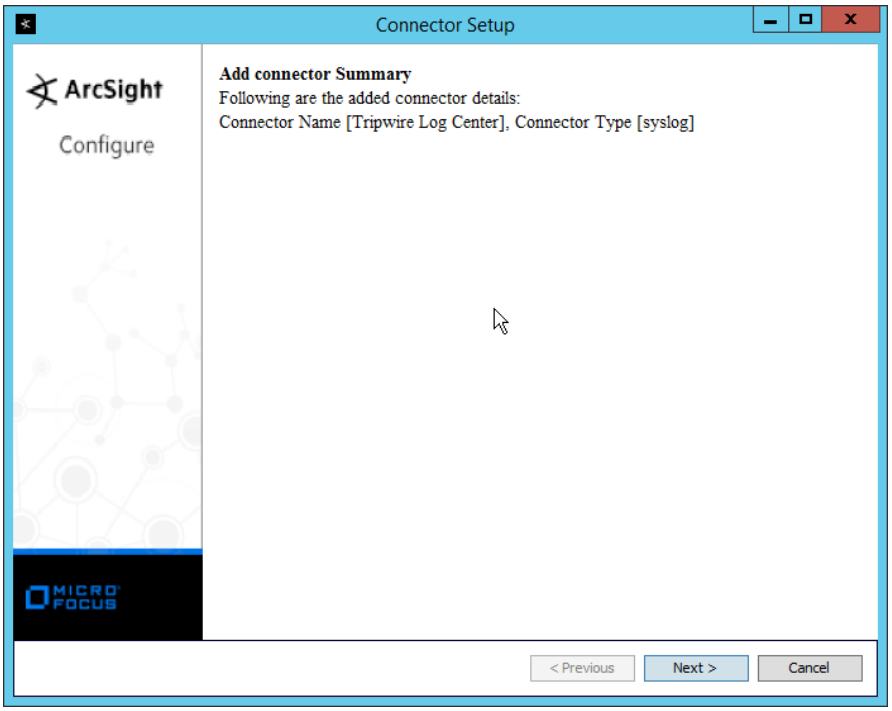
16. Click **Next.**
17. Enter identifying details about the system (only **Name** is required).



18. Click **Next.**
19. Select **Import the certificate to connector from destination.**

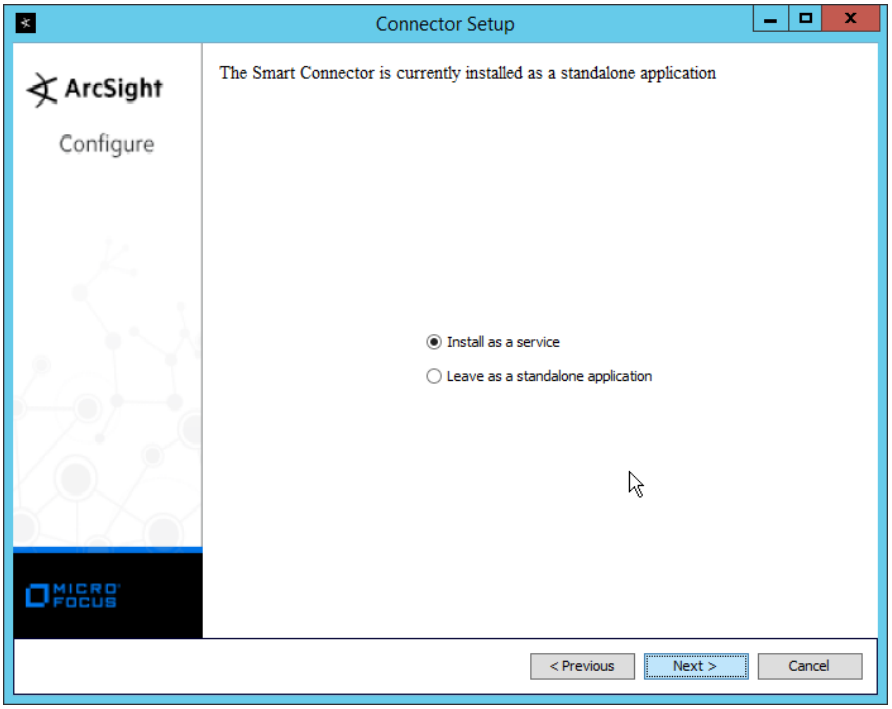


3086 20. Click **Next.**

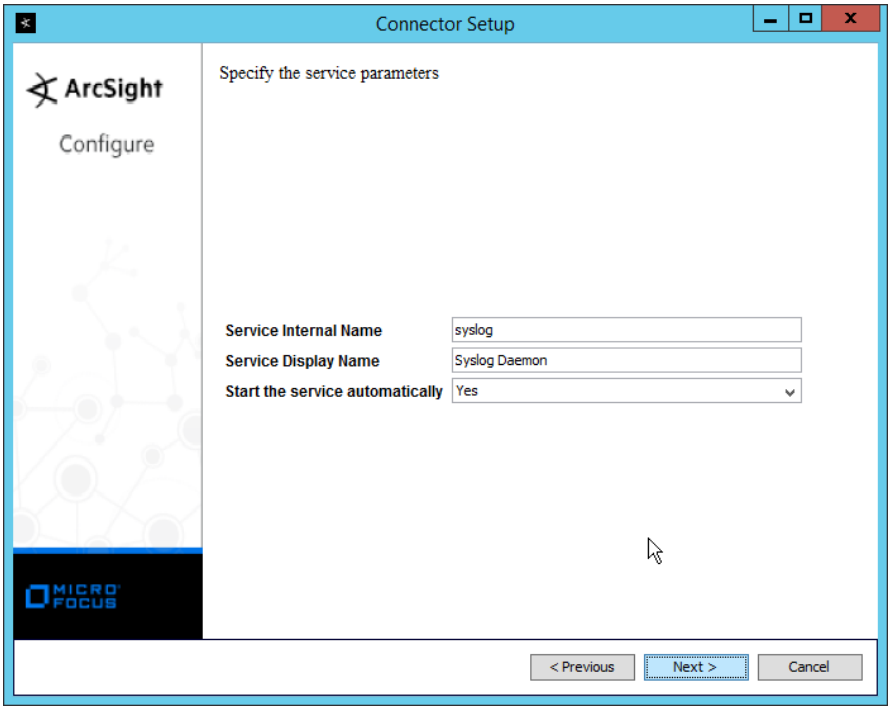


3087 21. Click **Next.**

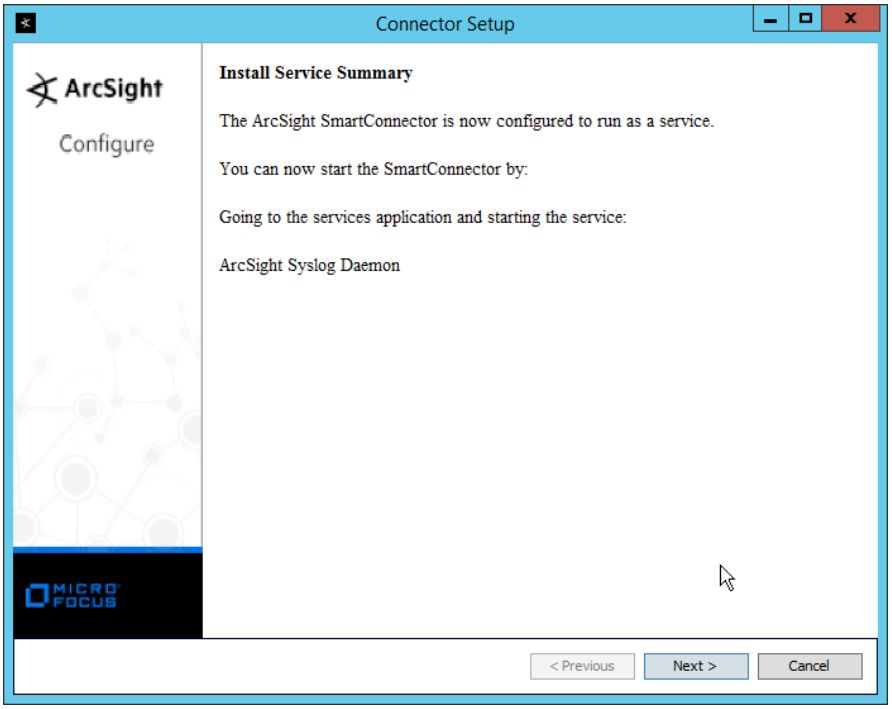
3088 22. Select **Install as a service.**



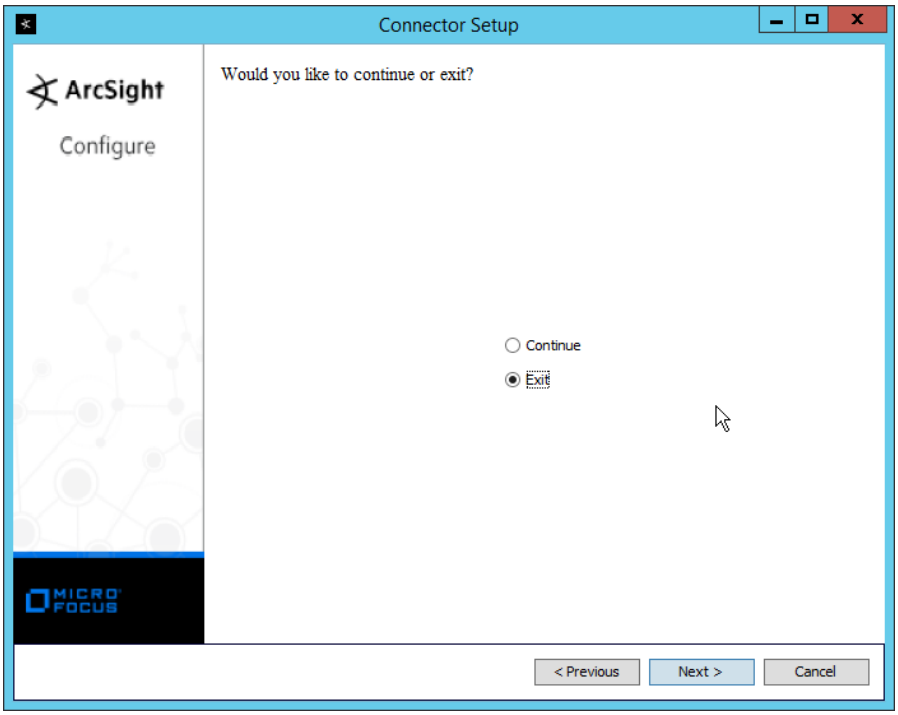
3089 23. Click **Next.**



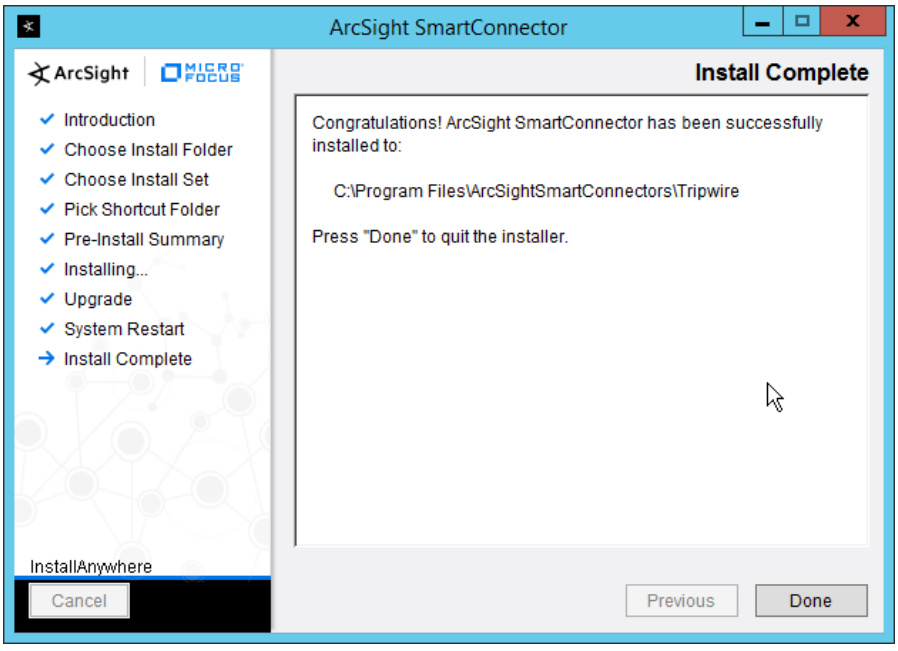
24. Click **Next.**



25. Click **Next.**
26. Select **Exit.**



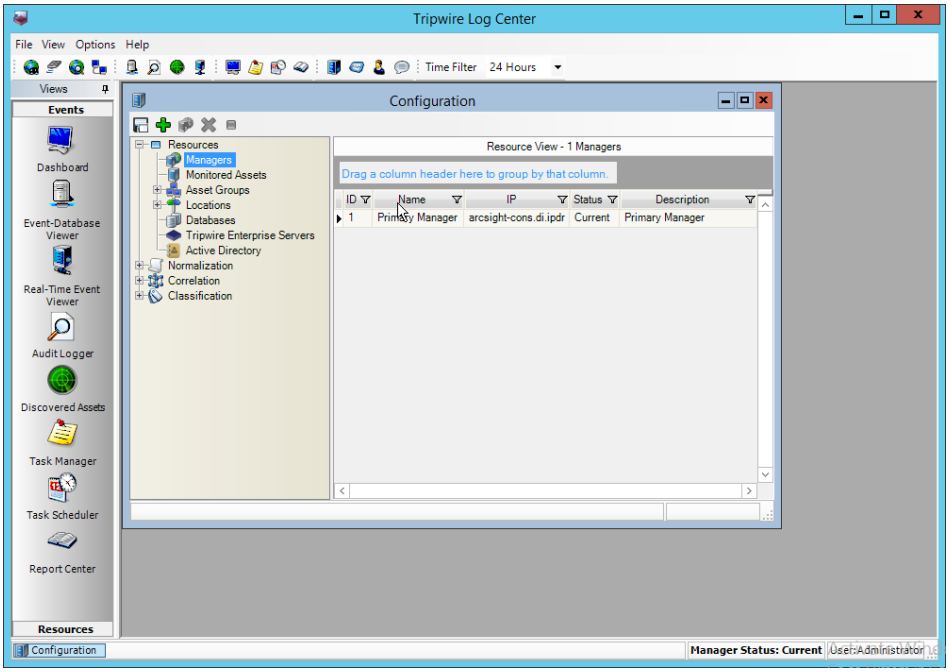
3093 27. Click **Next.**



3094 28. Click **Done.**

3095 29. Open the **Tripwire Log Center Console.**

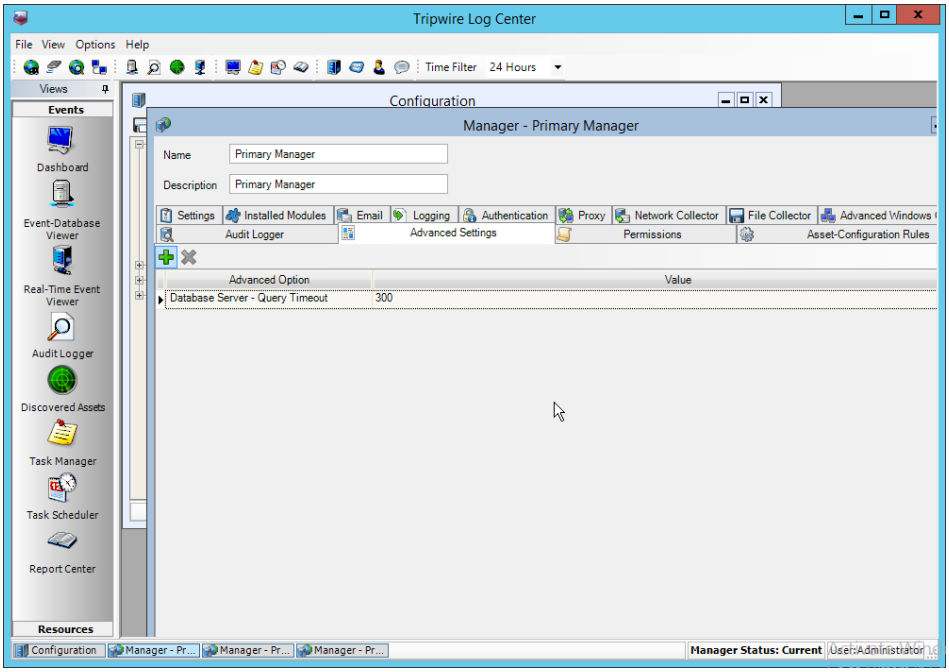
30. Go to the **Configuration Manager.**



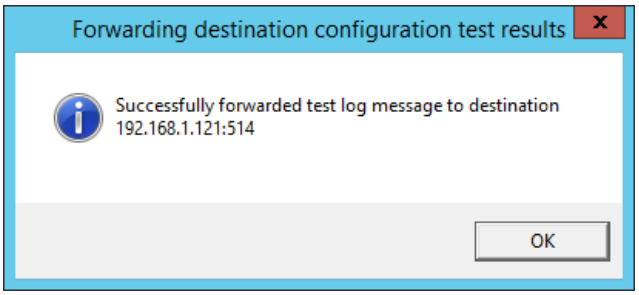
31. Select **Resources > Managers.**

32. Double-click the **Primary Manager.**

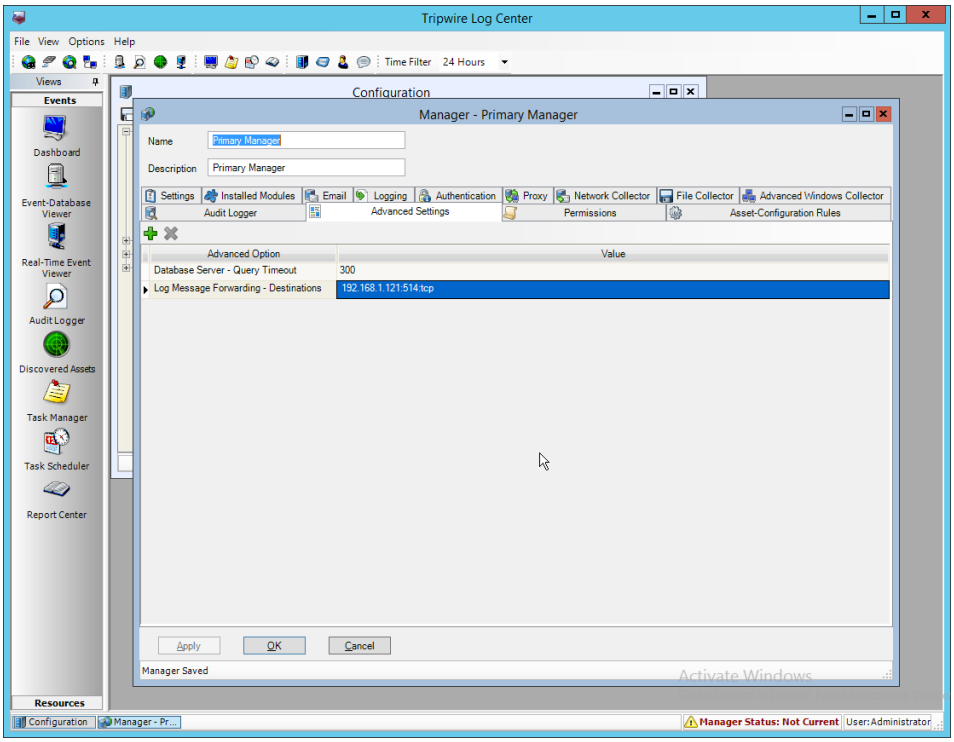
33. Click the **Advanced Settings** tab.



34. Click the **Add** button.
35. In the **Advanced Option** box select **Log Message Forwarding–Destinations.**
36. In the Value box next to it, type **<ip_address>:<port>:tcp** with the **IP address** and **port** of the syslog daemon just created.



37. Click **OK.**



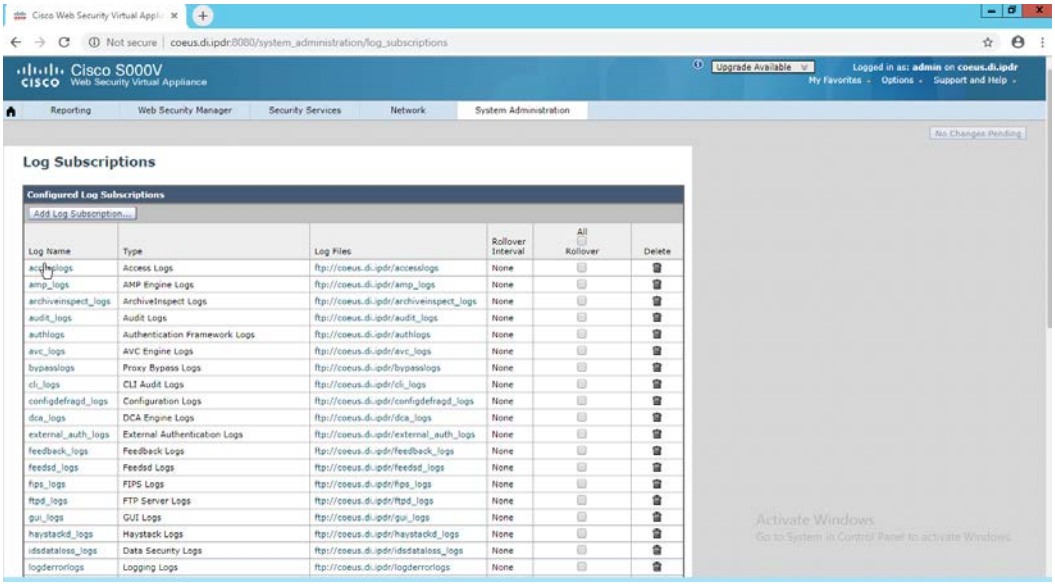
38. Click **OK.**
39. Restart the **Tripwire Log Center Manager.**

2.25 Integration: Micro Focus ArcSight and Cisco WSA

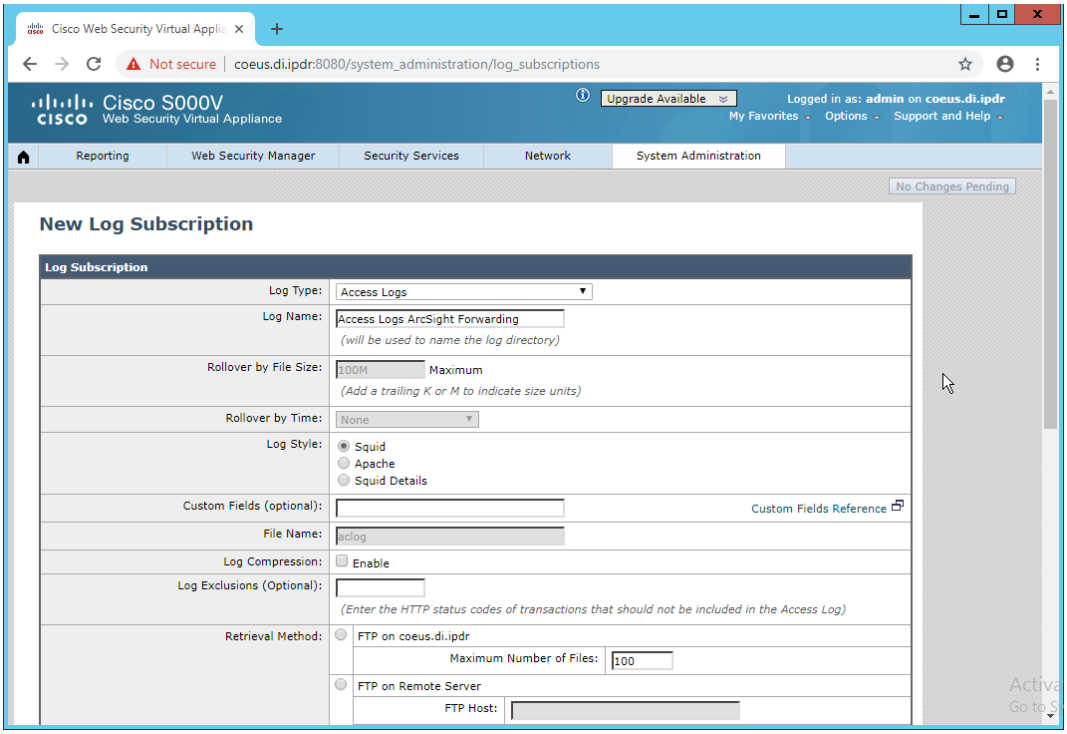
This integration briefly details how to send logs to an ArcSight syslog collector from Cisco WSA. Please see Section 2.24 for instructions for setting up an ArcSight syslog collector. If a server is already configured, you do not need to install a new one– simply forward logs to the address of that server.

2.25.1 Configure Cisco WSA to Forward Logs

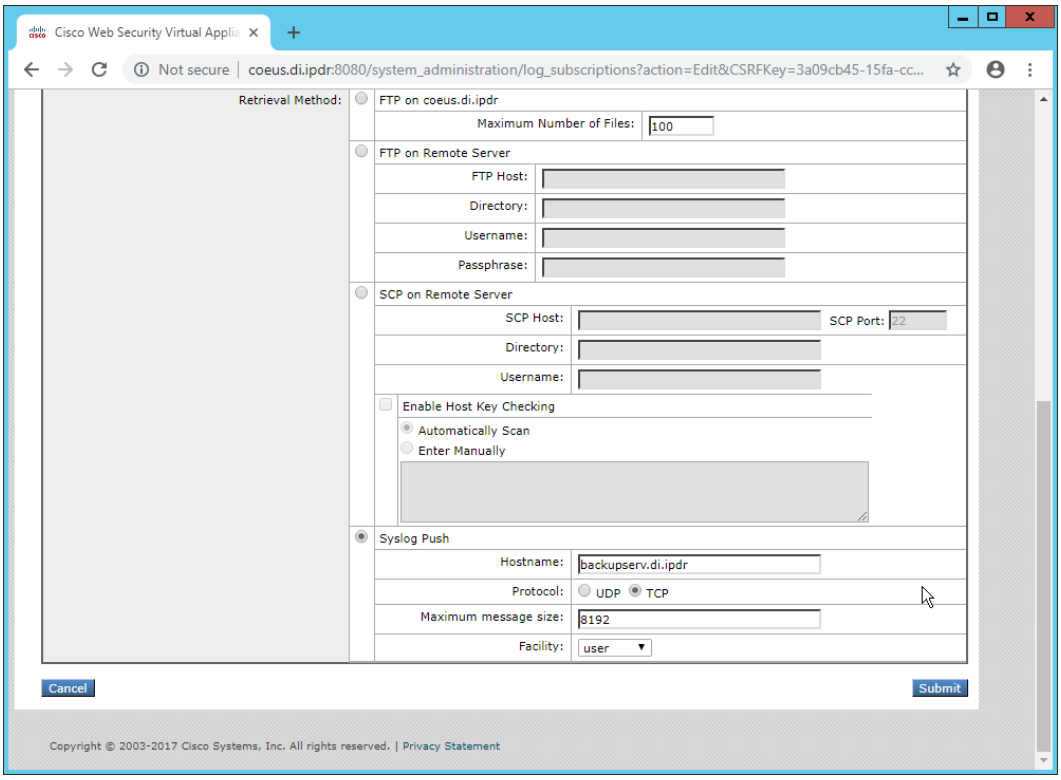
1. In the Cisco WSA web client, navigate to **System Administration > Log Subscriptions.**



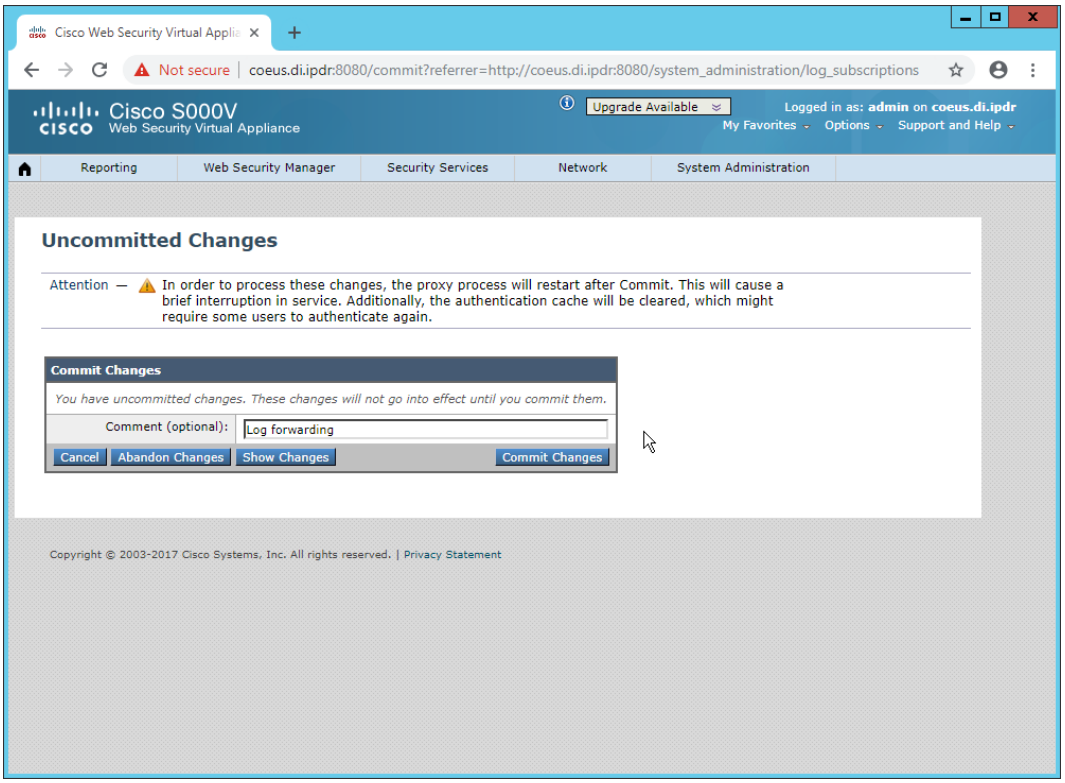
2. Click **Add Log Subscription.**
3. Select **Access Logs for Log Type.** (These are the logs of client web requests that have gone through the proxy.)
4. Enter a **name** for **Log Name.**



5. Select **Syslog Push.**
6. Enter the **hostname** of the ArcSight syslog collector server.
7. Select **TCP.** (Ensure that your syslog collector server is configured to use TCP.)
8. Enter **8192** or a custom message-size limit.



9. Click **Submit.**
10. Click **Commit Changes.**
11. Enter a **comment** if desired.



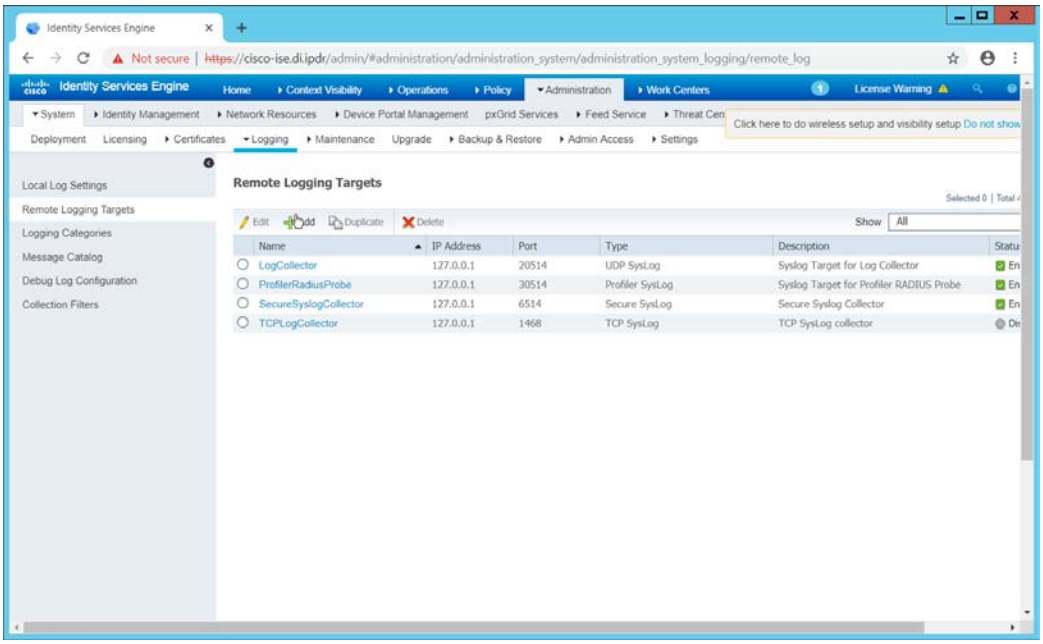
12. Click **Commit Changes.** The server will restart, so the web page connection will be temporarily lost.

2.26 Integration: Micro Focus ArcSight and Cisco ISE

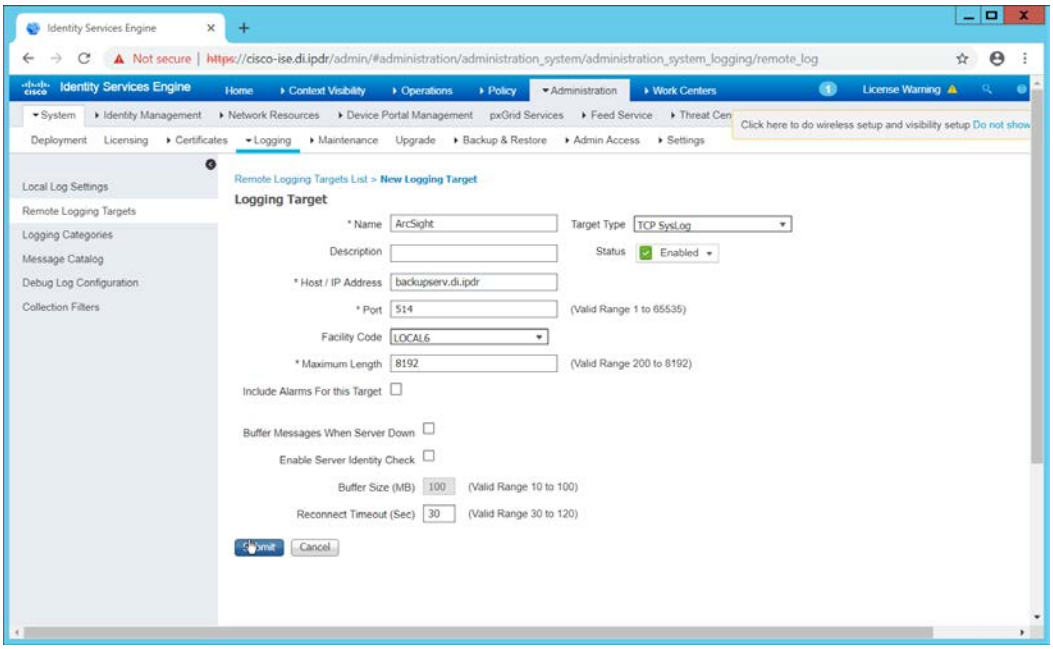
This integration briefly details how to send logs to an ArcSight syslog collector from Cisco ISE. Please see Section 2.24 for instructions for setting up an ArcSight syslog collector. If a server is already configured, you do not need to install a new one–simply forward logs to the address of that server.

2.26.1 Configure Cisco ISE to Forward Logs

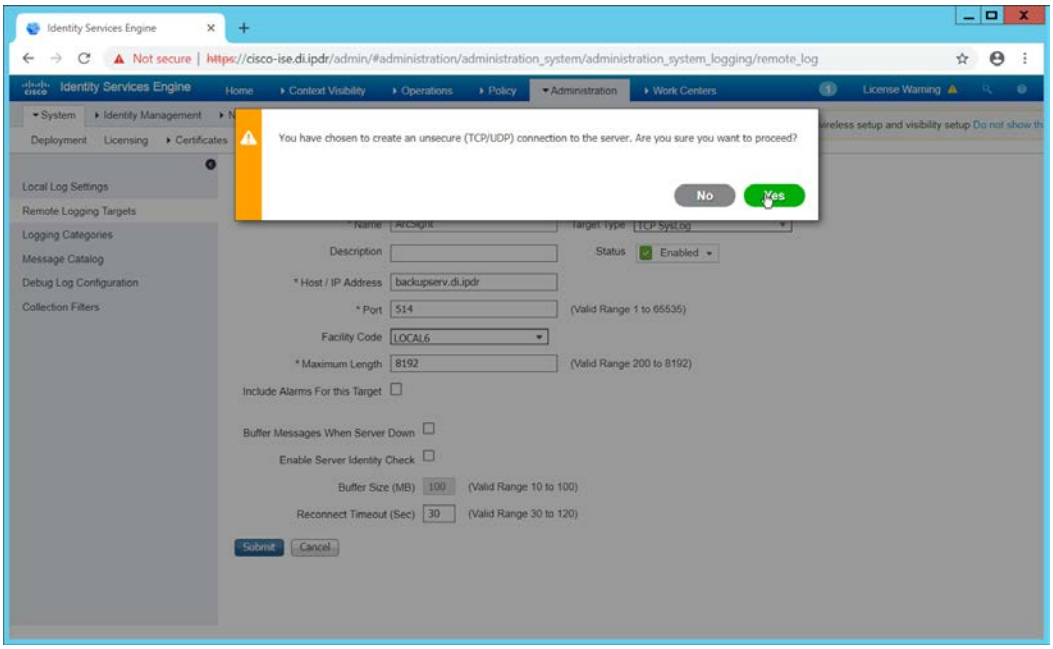
1. In the Cisco ISE web client, navigate to **Administration > System > Logging > Remote Logging Targets.**



2. Click **Add.**
3. Enter a **Name.**
4. Enter the **hostname** of the ArcSight syslog collector server for **Host/IP Address.**
5. Select **TCP SysLog** for Target Type. (Ensure that your syslog collector server is configured to use TCP.)
6. Enter **514** or the port used on the syslog server.
7. Enter **8192** or a custom message-size limit for **Maximum Length.**
8. Ensure that **Status** is set to **Enabled.**



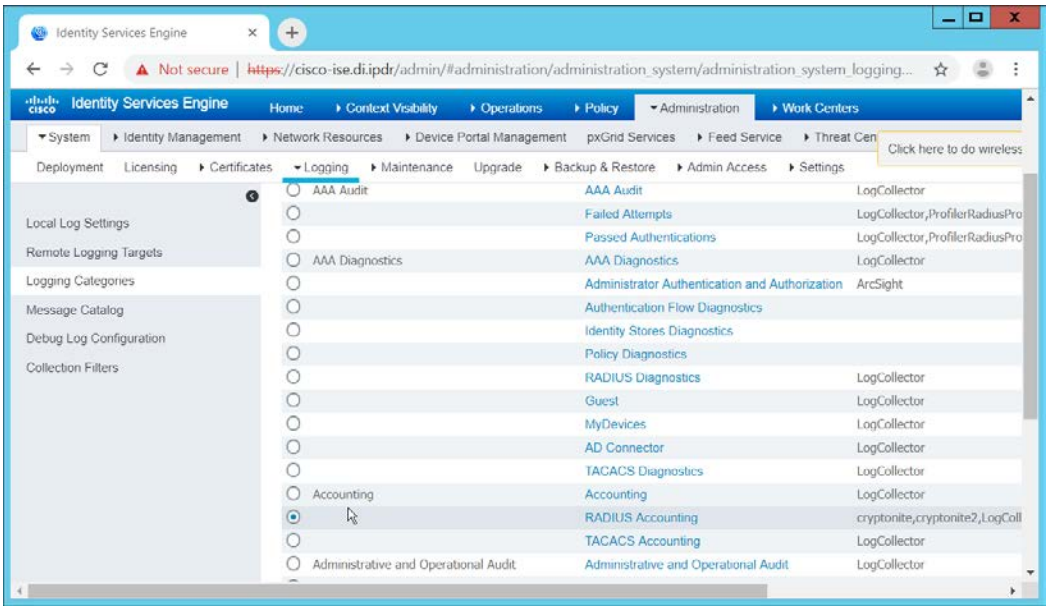
3140 9. Click **Submit.**



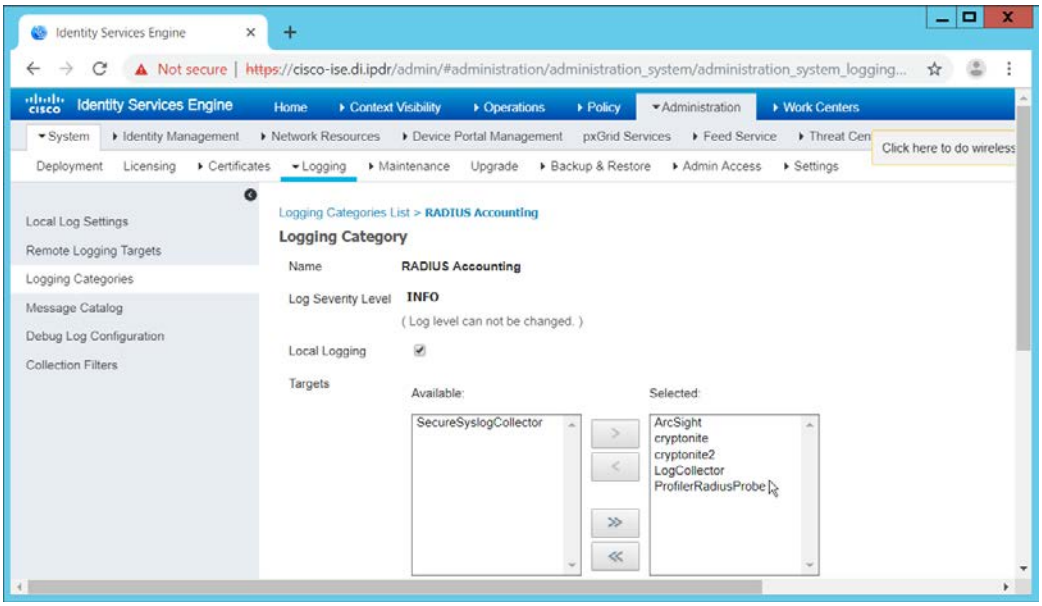
3141 10. Click **Yes**.

2.26.2 Select Logs for Forwarding

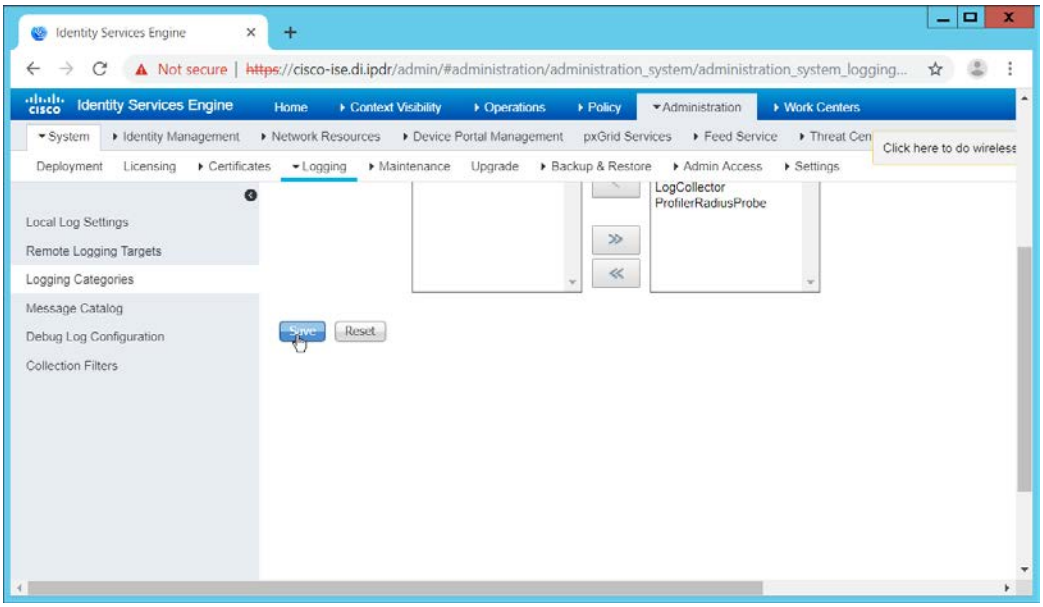
1. Navigate to **System > Logging > Logging Categories.**



2. Select a log file to forward to ArcSight.
3. Click **Edit.**



4. Move the ArcSight logging target you just created to the **Selected** box.



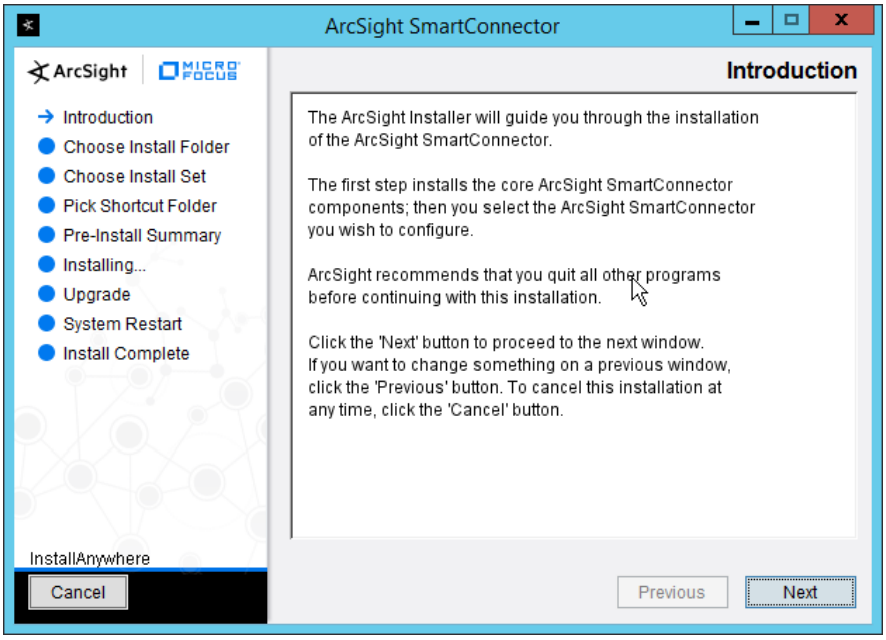
5. Click **Save.**
6. Repeat steps 1–5 for any log files you wish to forward to ArcSight.

2.27 Integration: Micro Focus ArcSight and Symantec DLP

This integration briefly details how to send logs to an ArcSight syslog collector from Symantec DLP. If a server is already configured, you do not need to install a new one–simply forward logs to the address of that server. It is important to note that DLP requires a UDP server, so a TCP syslog server will not work.

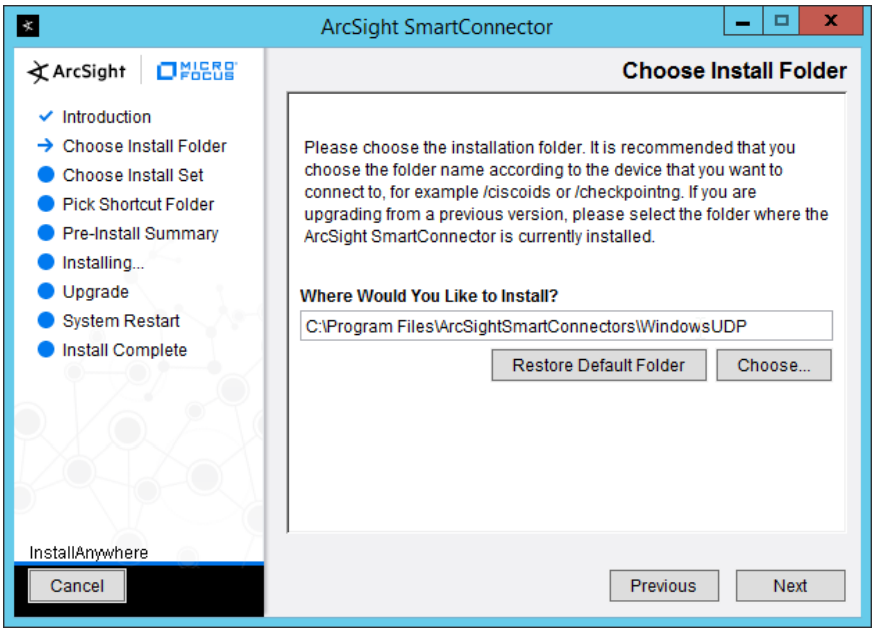
2.27.1 Install Micro Focus ArcSight

1. Run **ArcSight-7.9.0.8084.0-Connector-Win64.exe** on any server except the one running Cisco Stealthwatch.

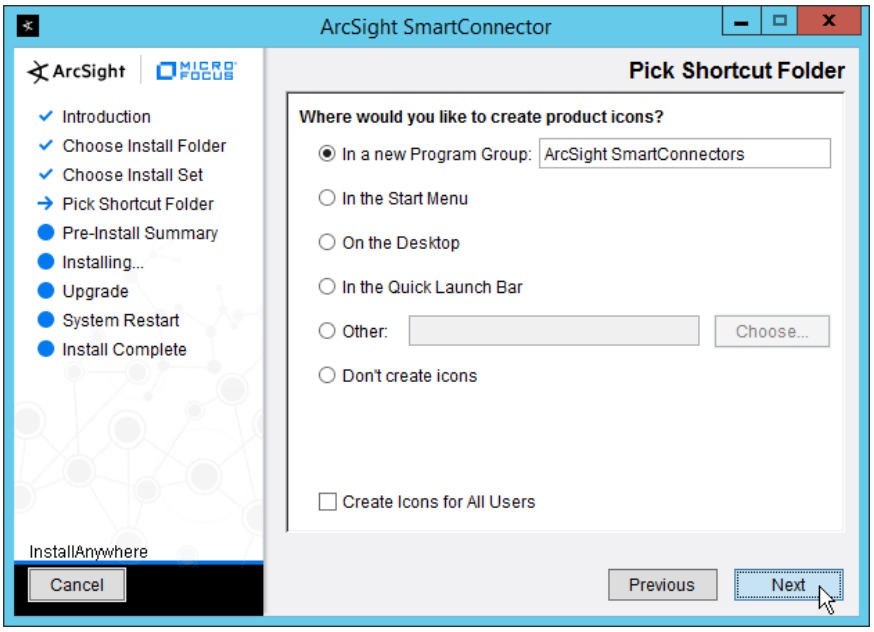


3156 2. Click **Next.**

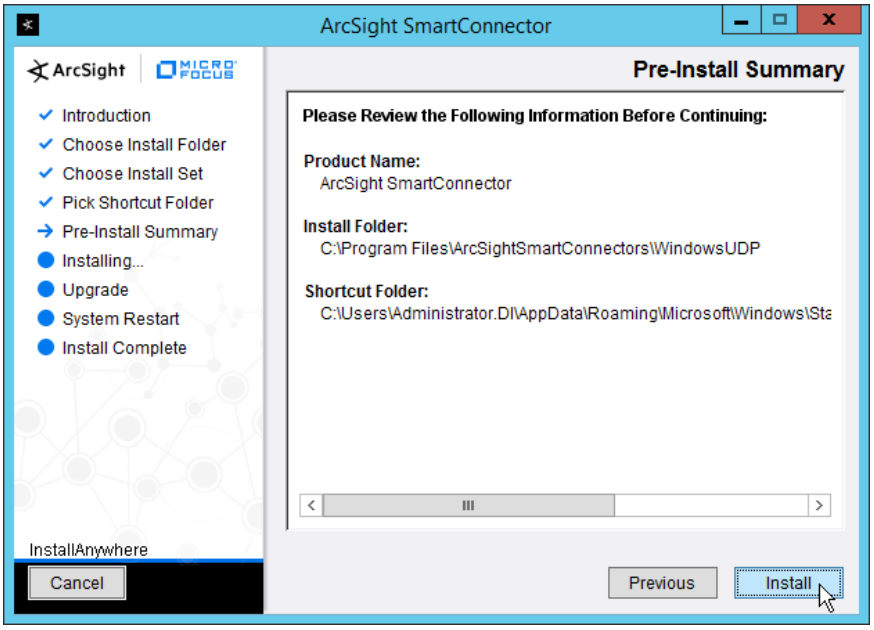
3157 3. Enter C:\Program Files\ArcSightSmartConnectors\WindowsUDP.



3158 4. Click **Next.**

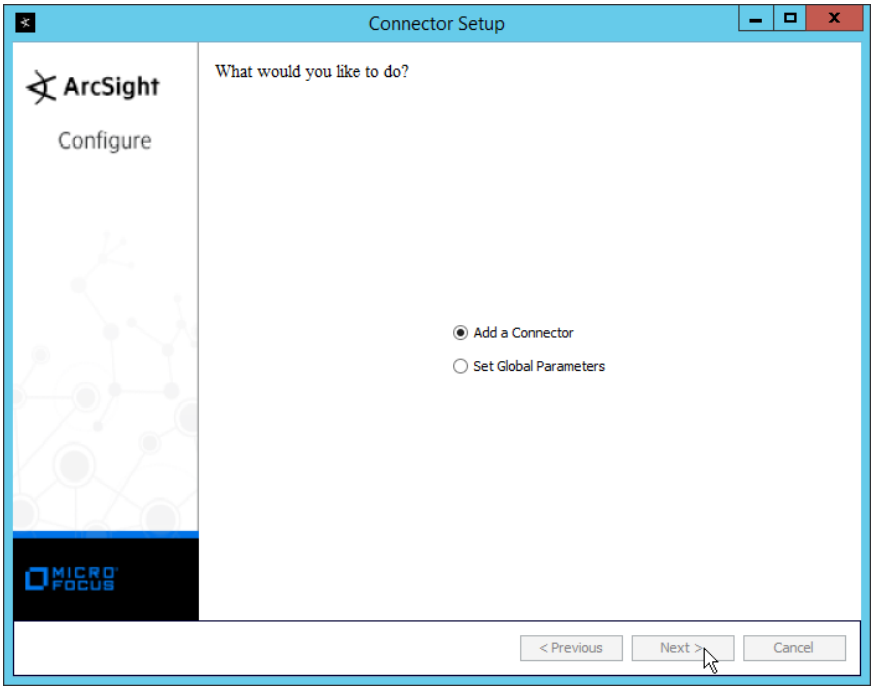


3159 5. Click **Next.**

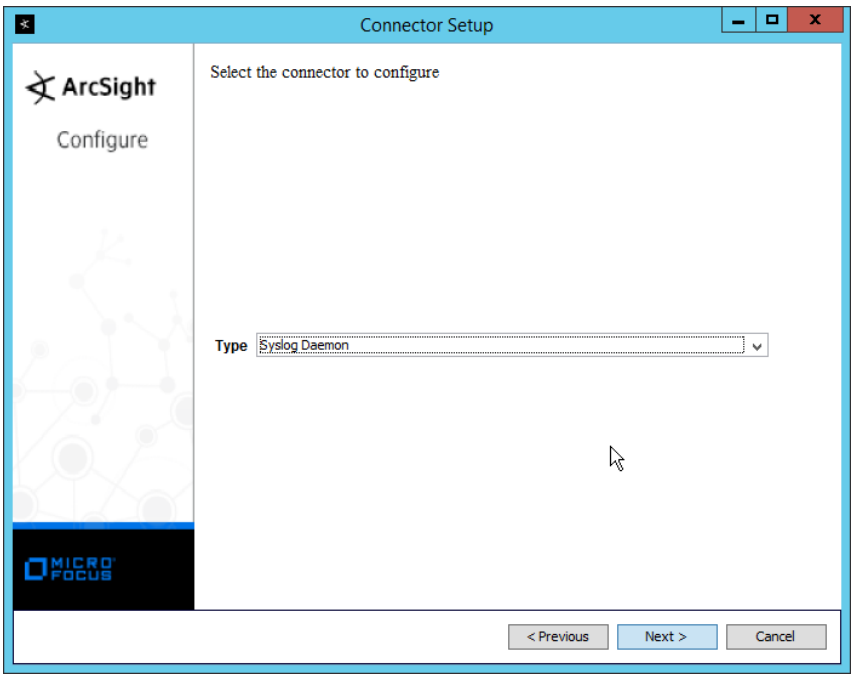


3160 6. Click **Install.**

3161 7. Select **Add a Connector.**

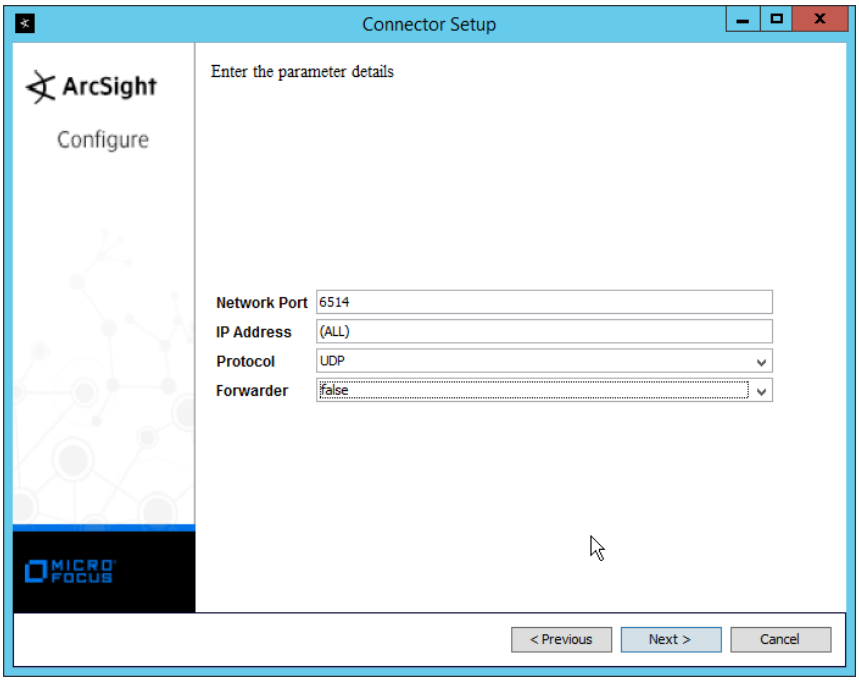


8. Click **Next.**
9. Select **Syslog Daemon.**

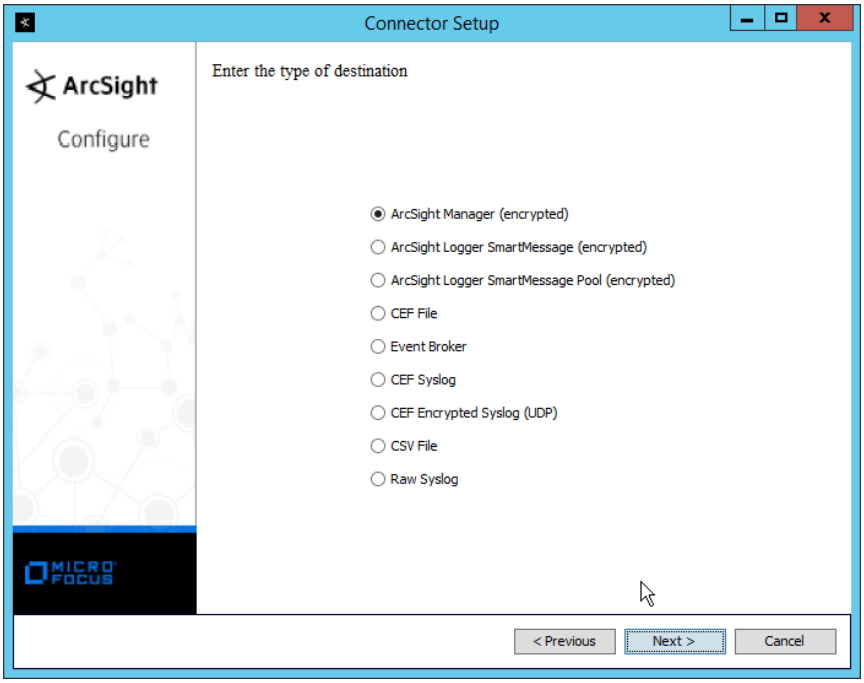


10. Click **Next.**

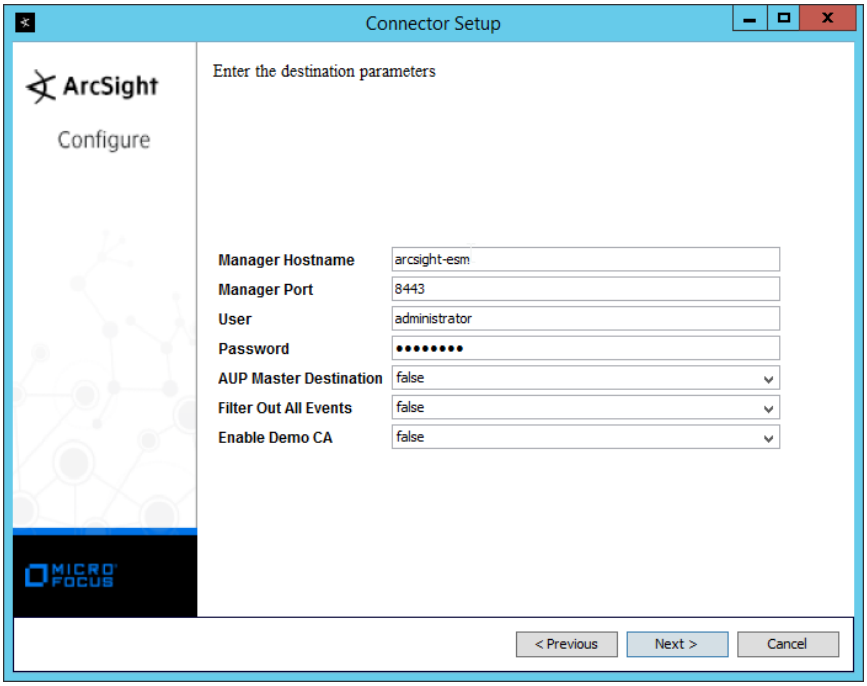
11. Enter an unused port on which the daemon can run. (Ensure that this port is allowed through the firewall.)
12. Select **UDP** for Protocol.



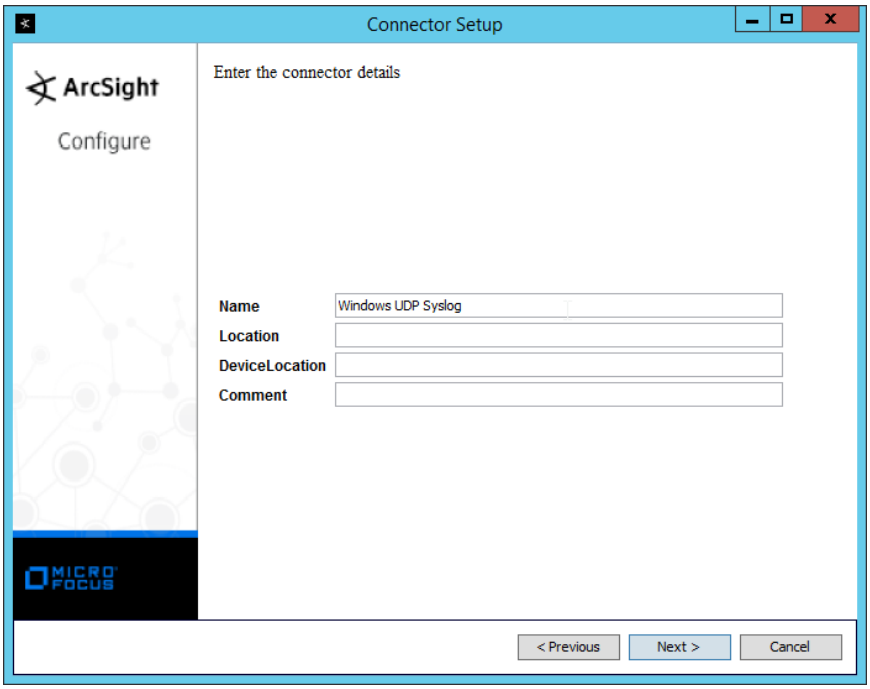
13. Click **Next.**
14. Select **ArcSight Manager (encrypted).**



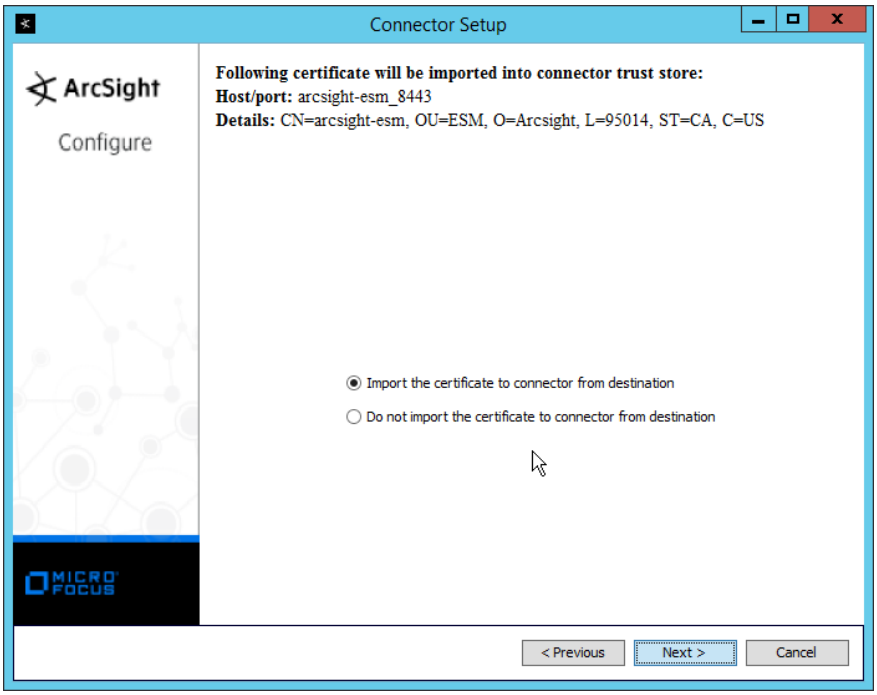
15. Click **Next.**
16. Enter the **hostname, port, username,** and **password** for the ArcSight ESM server.



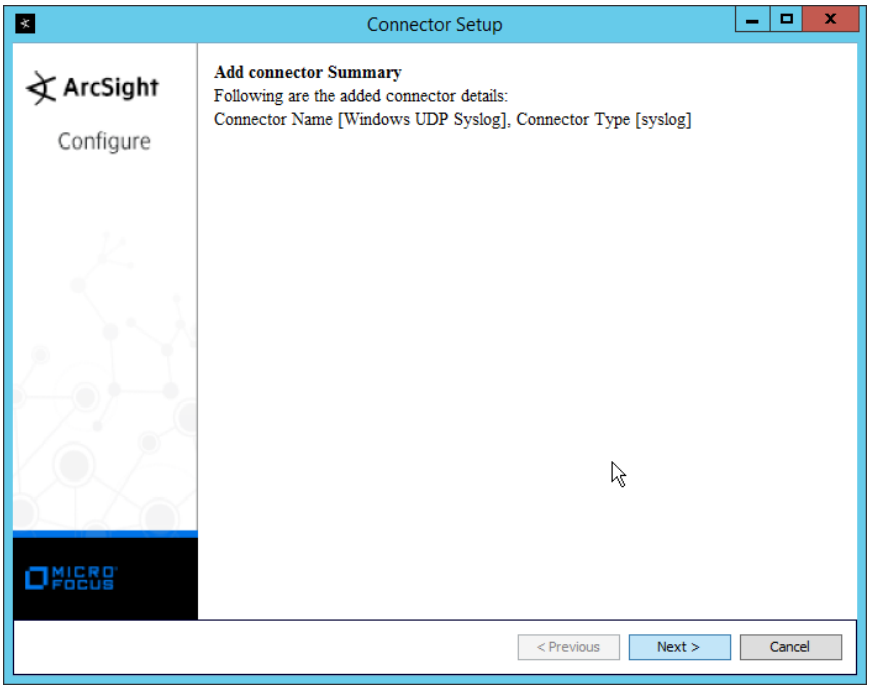
17. Click **Next.**
18. Enter identifying details about the system (only **Name** is required).



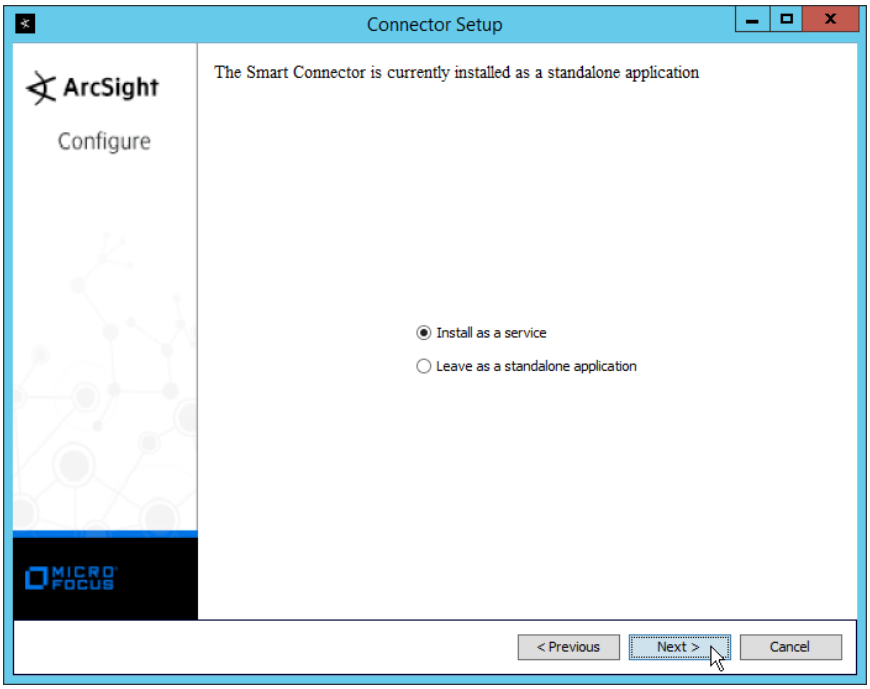
19. Click **Next.**
20. Select **Import the certificate to connector from destination.**



21. Click **Next.**

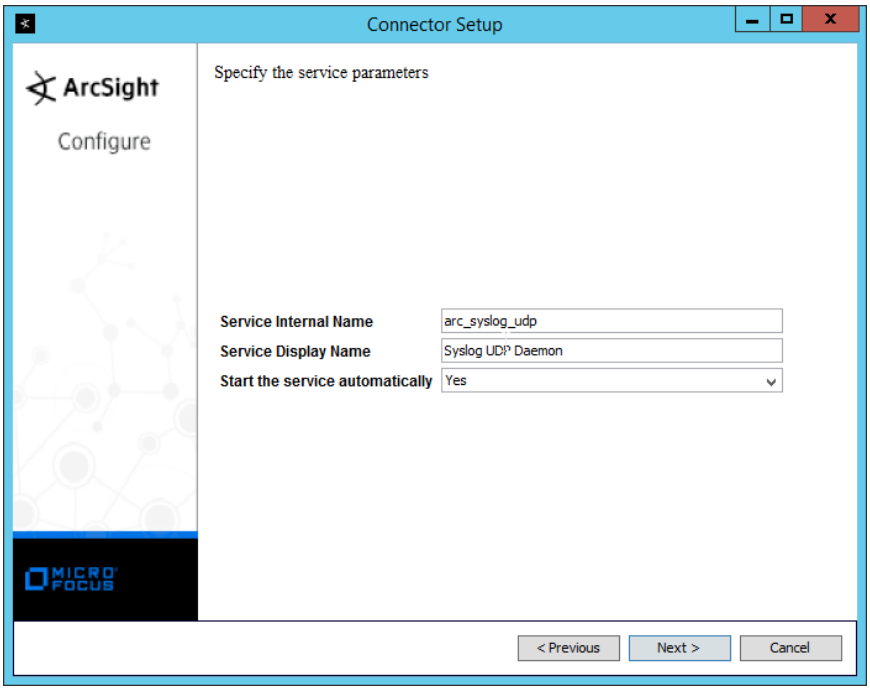


22. Click **Next.**
23. Select **Install as a service.**

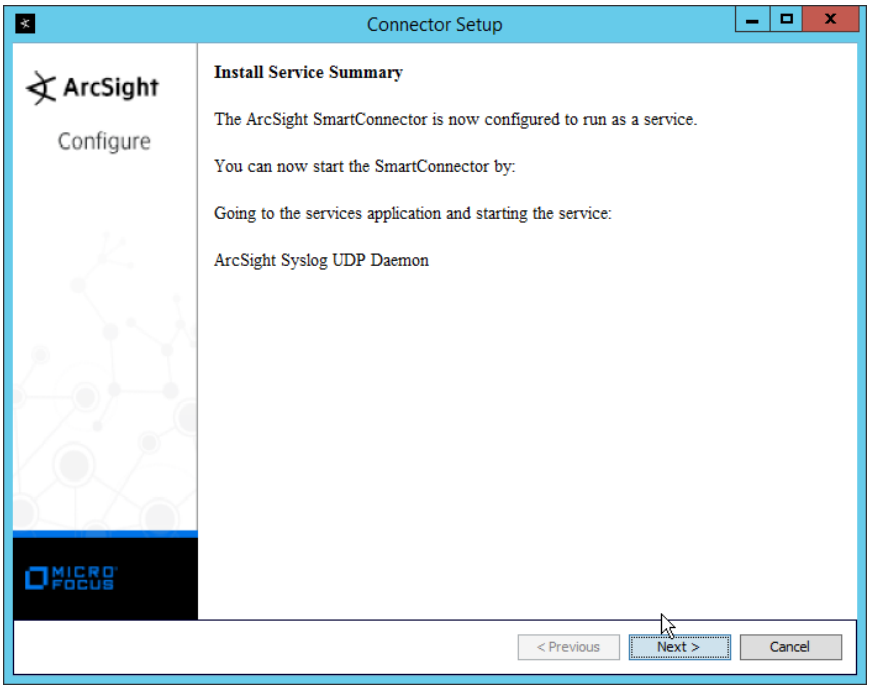


3179 24. Click **Next.**

3180 25. Enter a **service name** and **display name**.

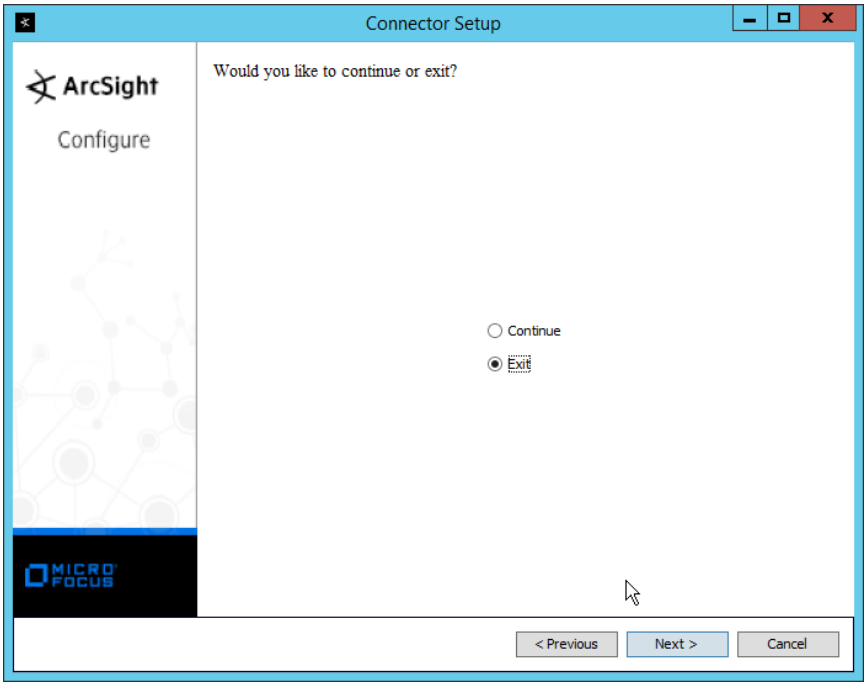


3181 26. Click **Next.**

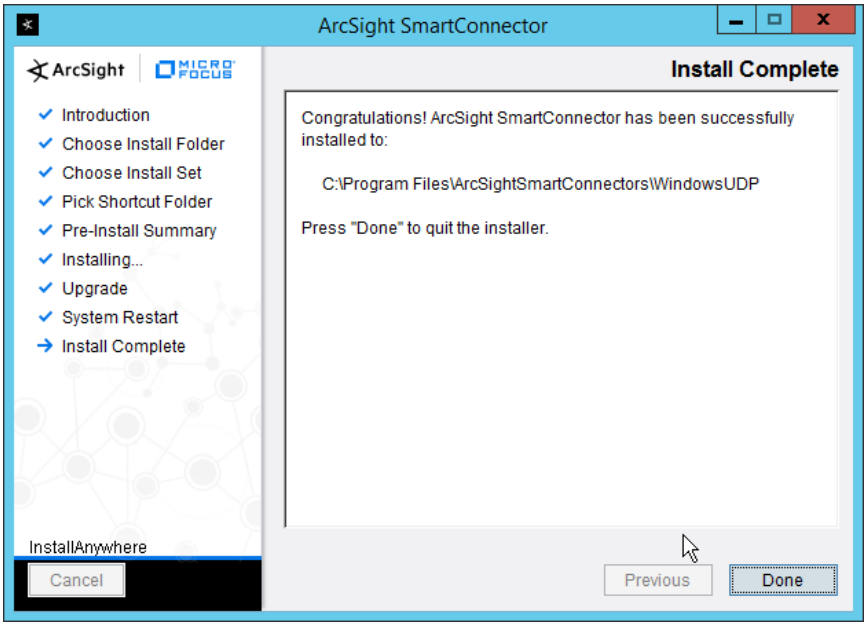


3182 27. Click **Next.**

3183 28. Select **Exit.**



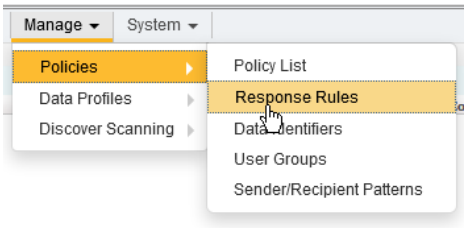
29. Click **Next.**



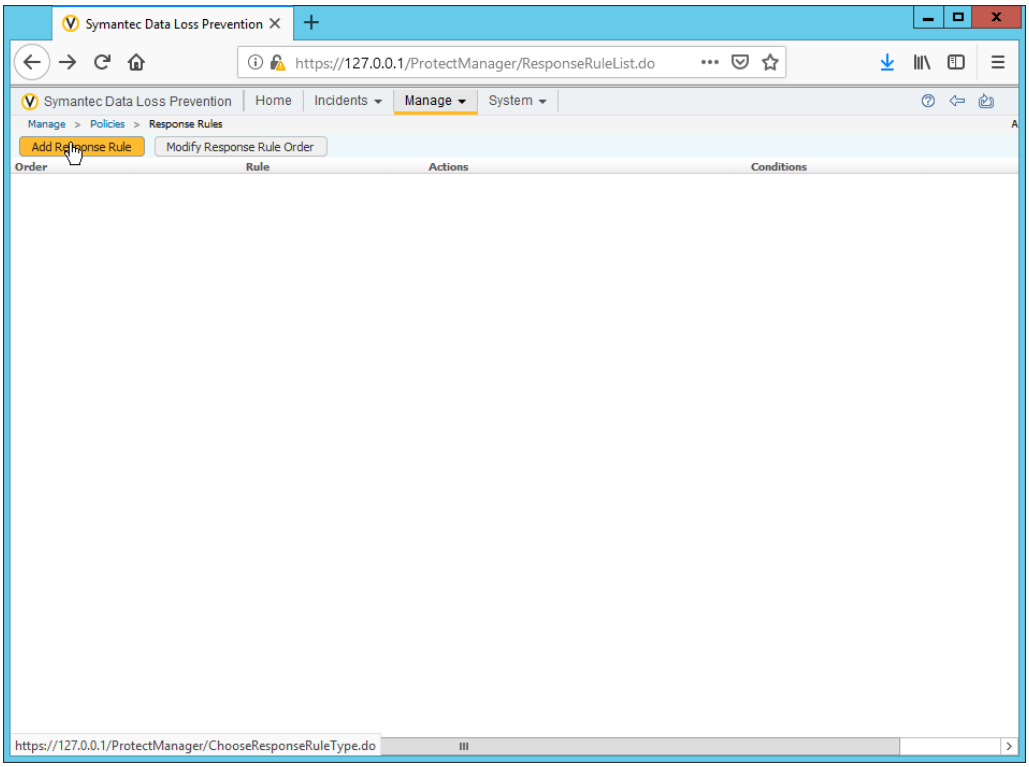
30. Click **Done.**

2.27.2 Configure Symantec DLP to Forward Logs

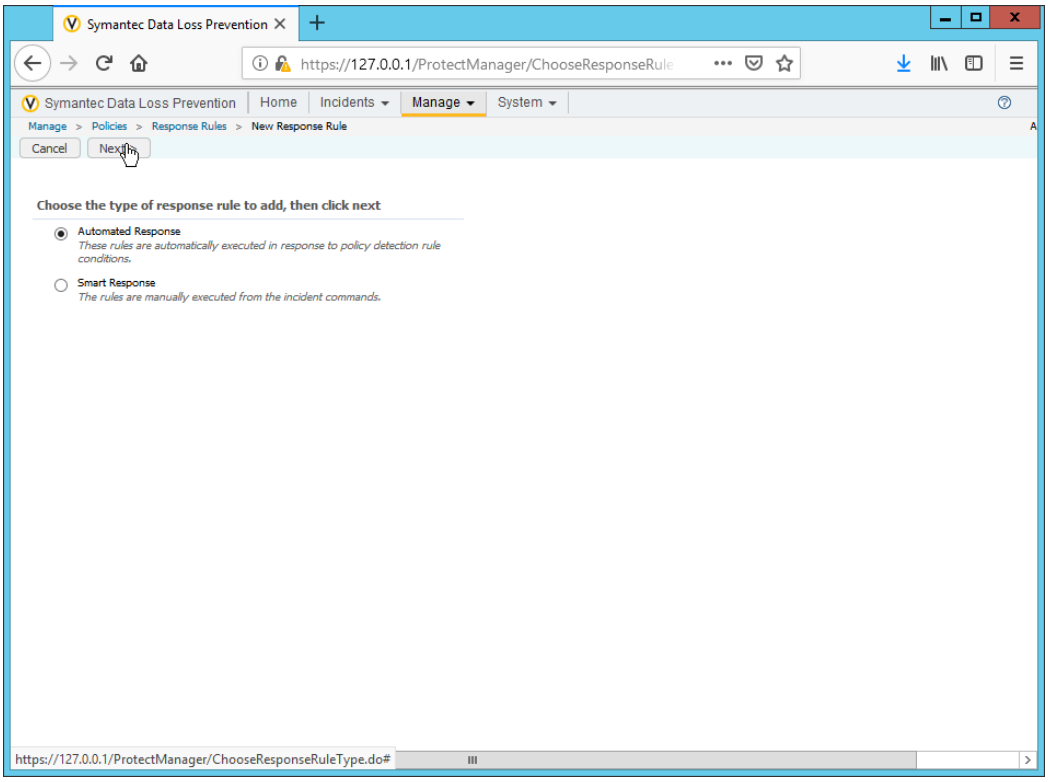
1. Log in to the Symantec DLP web console.



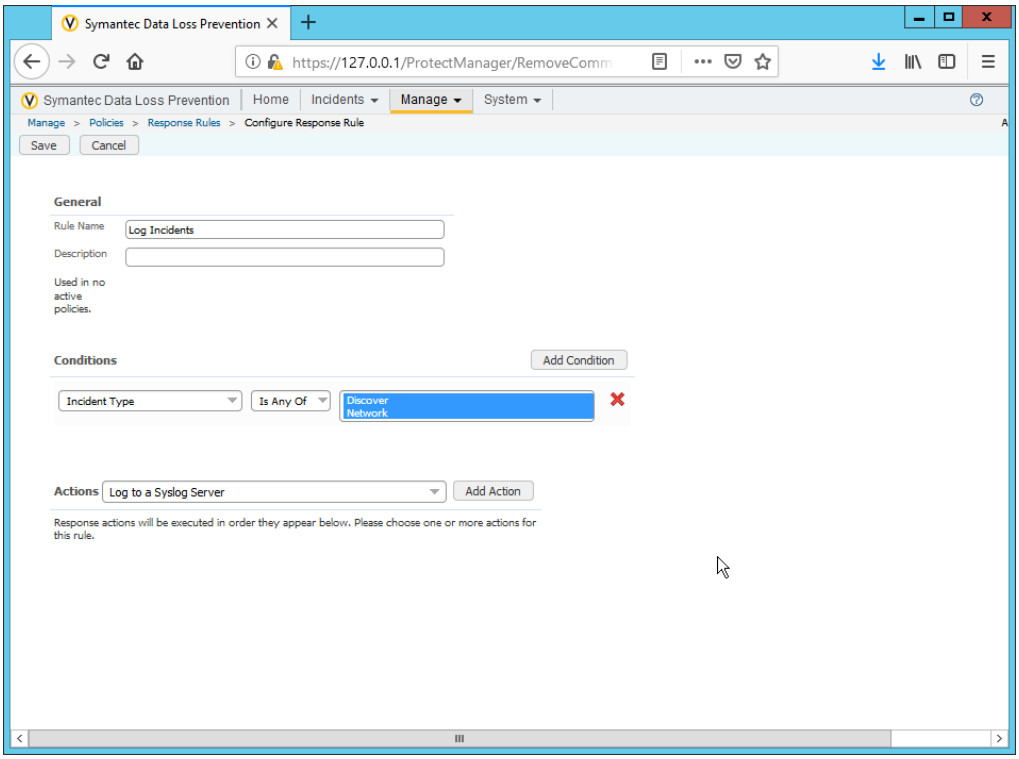
2. Navigate to **Manage > Policies > Response Rules.**



3189 3. Click **Add Response Rule.**

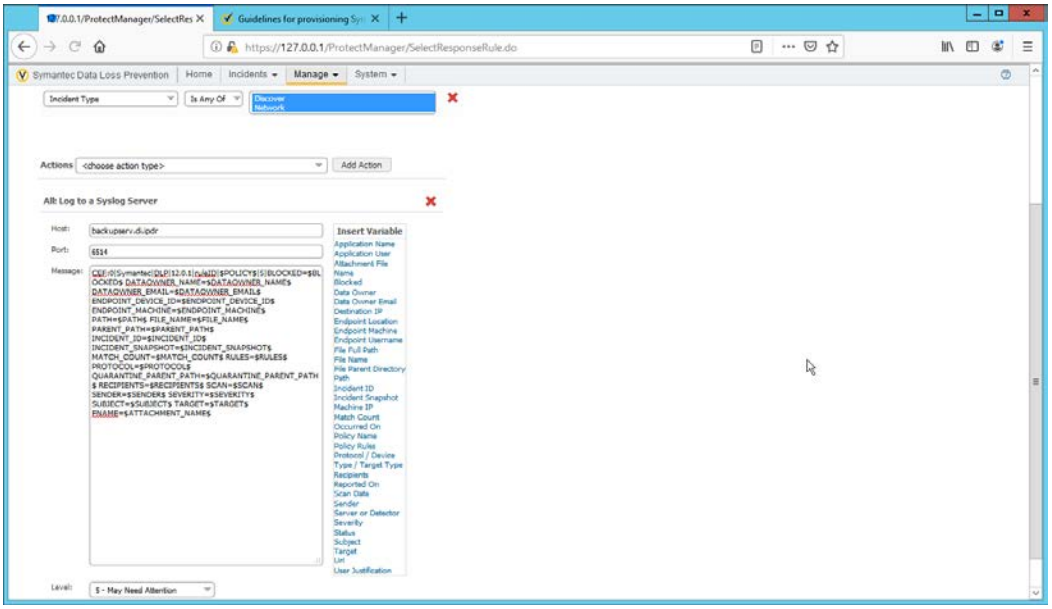


4. Click **Next.**
5. Enter a **name** for the rule.
6. Set any conditions for sending syslog messages. If you do not add conditions, all incidents will be forwarded.
7. Select **Log to a Syslog Server** for **Actions.**



8. Click **Add Action.**
9. Enter the **IP address** of the ArcSight syslog server.
10. Enter the **port** of the ArcSight syslog UDP server.
11. Select variables and format a log message to include all the information desired to be sent to the ArcSight server. Below is a sample format for the syslog message, which can potentially be parsed according to the needs of your organization.

```
CEF:0|Symantec|DLP|12.0.1|ruleID|$POLICY$|5|BLOCKED=$BLOCKED$
DATAOWNER_NAME=$DATAOWNER_NAME$ DATAOWNER_EMAIL=$DATAOWNER_EMAIL$
ENDPOINT_DEVICE_ID=$ENDPOINT_DEVICE_ID$
ENDPOINT_MACHINE=$ENDPOINT_MACHINE$ PATH=$PATH$
FILE_NAME=$FILE_NAME$ PARENT_PATH=$PARENT_PATH$
INCIDENT_ID=$INCIDENT_ID$ INCIDENT_SNAPSHOT=$INCIDENT_SNAPSHOT$
MATCH_COUNT=$MATCH_COUNT$ RULES=$RULES$ PROTOCOL=$PROTOCOL$
QUARANTINE_PARENT_PATH=$QUARANTINE_PARENT_PATH$
RECIPIENTS=$RECIPIENTS$ SCAN=$SCAN$ SENDER=$SENDER$
SEVERITY=$SEVERITY$ SUBJECT=$SUBJECT$ TARGET=$TARGET$
FNAME=$ATTACHMENT_NAME$
```



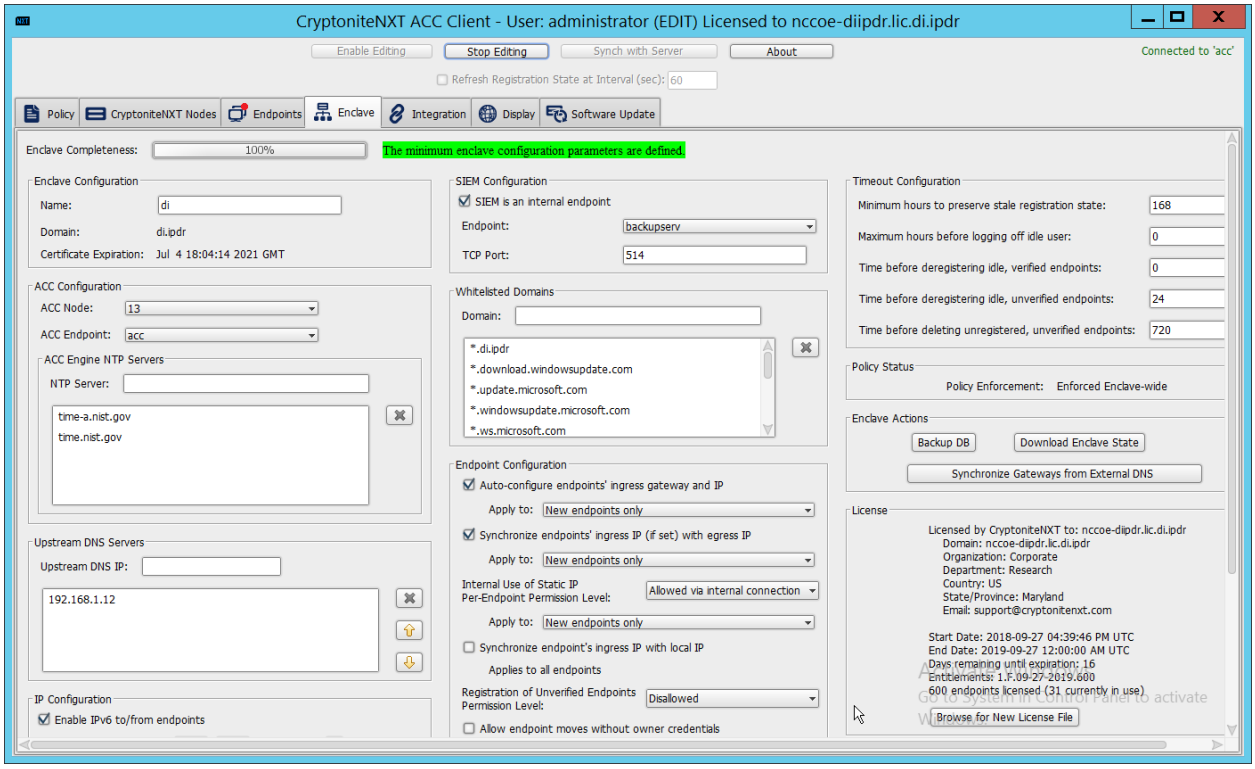
12. Click **Save.**

2.28 Integration: Micro Focus ArcSight and CryptoniteNXT

This integration briefly details how to send logs to an ArcSight syslog collector from CryptoniteNXT. Please see Section 2.24 for instructions for setting up an ArcSight syslog collector. If a server is already configured, you do not need to install a new one– simply forward logs to the address of that server. Ensure that you are using a TCP syslog collector. This section assumes that the collector is already under CryponiteNXT's network protection.

2.28.1 Configure CryptoniteNXT to Forward Logs to ArcSight

1. Navigate to the **Enclave** tab in the **CryptoniteNXT ACC GUI.**
2. Under **SIEM Configuration,** check the box next to **SIEM is an internal endpoint.**
3. Select the endpoint running the TCP syslog collector.
4. Enter the port used.



5. Click **Save.**

2.29 Integration: Micro Focus ArcSight and Semperis DSP

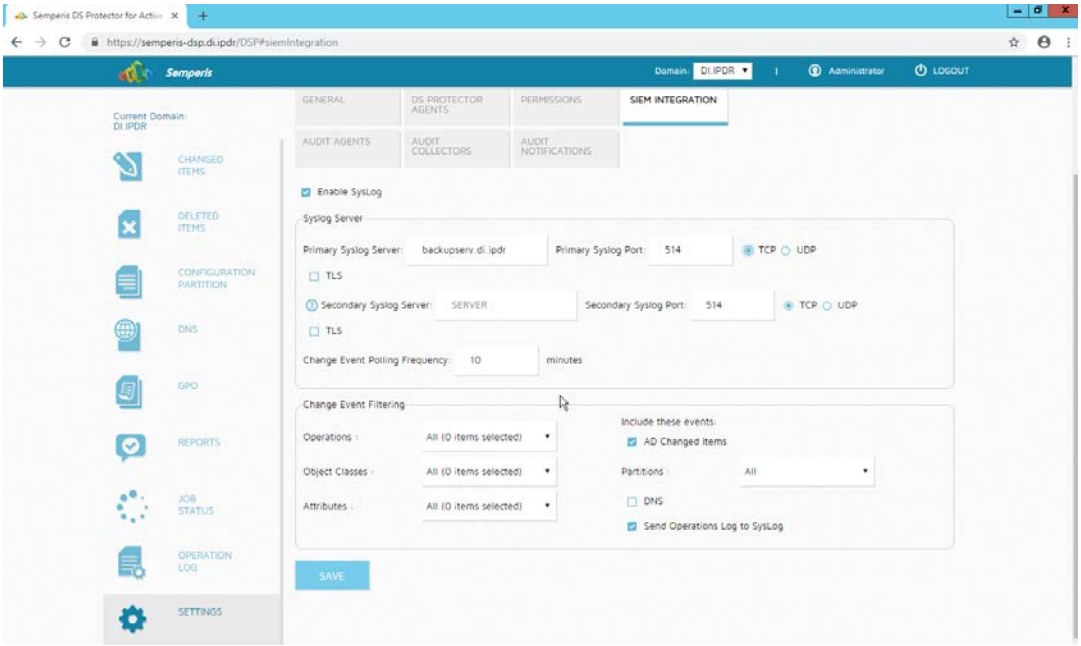
This integration briefly details how to send logs to an ArcSight syslog collector from Semperis DSP. Please see Section 2.24 for instructions for setting up an ArcSight syslog collector. If a server is already configured, you do not need to install a new one–simply forward logs to the address of that server.

Note: This integration requires Semperis DSP version 2.6.

2.29.1 Configure Semperis DSP to Forward Logs

1. In Semperis DSP, navigate to **Settings > SIEM Integration.**
2. Check the box next to **Enable SysLog.**
3. Under **Syslog Server,** enter the **hostname** for the ArcSight syslog collector, as well as the **port.**
4. Select **TCP.**
5. Enter a value for **Change Event Polling Frequency** based on the needs of your organization– this is how often it will poll for new logs to forward.

6. Under **Change Event Filtering,** select **AD Changed Items,** and **Send Operation Log to SysLog.** Ensure that **All** is selected for **Partitions.**
7. You can also select any specific **operations, classes,** and **attributes** to be forwarded or simply leave as **All.**



8. Click **Save.**

9. Click **Close.**

2.30 Integrations: CryptoniteNXT

For the architecture, it is necessary to create the following source groups. If your organization's desired architecture is different from the one described in this document, it is necessary to adapt the following instructions to avoid loss of network or security function. This section will describe the creation of source groups and destination groups used in this enterprise.

Create the following destination groups and source groups and apply them to the correct endpoints to allow these products and integrations to communicate under CryptoniteNXT.

2.30.1 Active Directory and DNS

This guide assumes the use of Active Directory and DNS on the same Windows 2012 server. The following ports may vary for other products.

Destination Group Name	Source Group Name	Protocol	Port Range
ad-dns	ad-dns-clients	TCP	389
ad-dns	ad-dns-clients	UDP	389
ad-dns	ad-dns-clients	UDP	53
ad-dns	ad-dns-clients	TCP	88
ad-dns	ad-dns-clients	UDP	88
ad-dns	ad-dns-clients	TCP	25
ad-dns	ad-dns-clients	TCP	42
ad-dns	ad-dns-clients	TCP	137
ad-dns	ad-dns-clients	TCP	139
ad-dns	ad-dns-clients	TCP	53
ad-dns	ad-dns-clients	TCP	636
ad-dns	ad-dns-clients	TCP	3268:3269
ad-dns	ad-dns-clients	TCP	445
ad-dns	ad-dns-clients	UDP	445
ad-dns	ad-dns-clients	TCP	9389
ad-dns	ad-dns-clients	TCP	5722
ad-dns	ad-dns-clients	TCP	464
ad-dns	ad-dns-clients	UDP	464
ad-dns	ad-dns-clients	UDP	123
ad-dns	ad-dns-clients	UDP	137:138
ad-dns	ad-dns-clients	UDP	67
ad-dns	ad-dns-clients	UDP	2535
ad-dns	ad-dns-clients	UDP	49152:65535
ad-dns	ad-dns-clients	TCP	49152:65535

Endpoint	Source Groups	Destination Groups
(all endpoints that need access to AD/DNS)	ad-dns-clients	
AD/DNS server		ad-dns

2.30.2 Microsoft Exchange

This guide assumes the use of Microsoft Exchange. The following ports may vary for other products.

Destination Group Name	Source Group Name	Protocol	Port Range
exchange	exchange-clients	TCP	443
exchange	exchange-clients	TCP	80
exchange	exchange-clients	TCP	25
exchange	exchange-clients	TCP	379
exchange	exchange-clients	TCP	3268:3269
exchange	exchange-clients	TCP	636
exchange	exchange-clients	TCP	143
exchange	exchange-clients	TCP	993
exchange	exchange-clients	TCP	110
exchange	exchange-clients	TCP	995
exchange	exchange-clients	TCP	119
exchange	exchange-clients	TCP	563
exchange	exchange-clients	TCP	465
exchange	exchange-clients	TCP	443691
exchange	exchange-clients	TCP	102
exchange	exchange-clients	TCP	135
exchange	exchange-clients	TCP	389:390
exchange	exchange-clients	TCP	53
exchange	exchange-clients	UDP	53
exchange	exchange-clients	TCP	2525
exchange	exchange-clients	TCP	475

Endpoint	Source Groups	Destination Groups
MS Exchange	exchange-clients	exchange
(all email clients)	exchange-clients	
AD/DNS server	exchange-clients	

3256 2.30.3 FileZilla

3257 The default port for FileZilla is 21.

3258 1. To determine the ports being used for your instance, open the FileZilla console.
3259 2. Navigate to **Edit > Settings > General Settings > Listen on these ports,** and allow any ports listed
3260 here.
3261 3. If your server listens in passive mode, navigate to **Edit > Settings > Passive mode settings > Use**
3262 **custom port range,** and allow any ports listed here.

Destination Group Name	Source Group Name	Protocol	Port Range
FileZilla	BackupClients	TCP	21 (default–see instructions)
FileZilla	BackupClients	TCP	51120-511230 (passive mode–see instructions)

Endpoint	Source Groups	Destination Groups
(any endpoints that need to perform backups)	BackupClients	
FileZilla server		FileZilla

3263 2.30.4 GreenTec

3264 If GreenTec is configured to use a FileZilla server, refer to the above section. If GreenTec is configured to
3265 use Windows Network Share, see below for ports required.

Destination Group Name	Source Group Name	Protocol	Port Range
NetworkShare	GreenTecClients	TCP	80
NetworkShare	GreenTecClients	TCP	135-139
NetworkShare	GreenTecClients	TCP	445

Endpoint	Source Groups	Destination Groups
(any endpoints that need access to GreenTec disks)	GreenTecClients	
GreenTec server		NetworkShare

3266 2.30.5 Tripwire Enterprise

3267 In Tripwire, the Axon Bridge is used for Tripwire Enterprise to contact endpoints. Therefore, the port
3268 5670 must be allowed on endpoints to allow TE to initiate communications. Furthermore, TE requires
3269 MSSQL to function, so it must be granted access to that as well.

Destination Group Name	Source Group Name	Protocol	Port Range
TripwireEnterprise	TEClients	TCP	443
TripwireEnterprise	TEClients	TCP	8080
TripwireEnterprise	TEClients	TCP	9898
TripwireEnterprise	TEClients	TCP	1169
TEAxon	TripwireE	TCP	5670
MSSQL	MSSQLClients	TCP	1433

Endpoint	Source Groups	Destination Groups
(any endpoints that need to be monitored by Tripwire Enterprise)	TEClients	TEAxon
Tripwire Enterprise server	TripwireE, MSSQLClients	TripwireEnterprise
MSSQL server		MSSQL

3270 2.30.6 ArcSight ESM

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSight	ArcSightConnectors	TCP	8443

Endpoint	Source Groups	Destination Groups
(any endpoints with an ArcSight Connector installed)	ArcSightConnectors	
ArcSight ESM server		ArcSight

3271 2.30.7 Cisco ISE

3272 Please see the *CryptoniteNXT Generic RADIUS Integration Guide* for instructions on how ISE should be
3273 integrated with CryptoniteNXT.

3274 To access the web console for ISE, allow port 443 for any machines that should be able to access the ISE
3275 administrative console.

3276 To access the portal for ISE, allow port 8443 (default) for any machines that will need to access the
3277 portal. You can find this value by looking at your portal configuration in ISE.

3278 Furthermore, if RADIUS is configured for the posture integration, you will need to add any ports used in
3279 RADIUS for both ISE and the internal switch. The default for these is 1812 (Authentication), 1813
3280 (Accounting), and 1700 (CoA). RADIUS can be TCP or UDP, so you can restrict this to your organization's
3281 configuration.

Destination Group Name	Source Group Name	Protocol	Port Range
ISE	ISEConsole	TCP	443
ISE	ISEClients	TCP	8443
radius	ISESwitch, ISEServer	TCP	1812
radius	ISESwitch, ISEServer	UDP	1812
radius	ISESwitch, ISEServer	TCP	1813
radius	ISESwitch, ISEServer	UDP	1813
radius	ISESwitch, ISEServer	TCP	1700
radius	ISESwitch, ISEServer	UDP	1700

Endpoint	Source Groups	Destination Groups
(any endpoints that need to do posture under ISE)	ISEClients	

(any endpoints that need to access the ISE web console)	ISEConsole	
ISE server	ISEServer	ISE, radius
(internal switches or RADIUS servers used for ISE Posture)	ISESwitch, ISEClients	radius
Cryptonite ACC Node		radius

3282 2.30.8 Semperis DSP

3283 Semperis DSP recommends allowing full network access during the initial database sync. After that, the
3284 following ports should be left open for communication.

Destination Group Name	Source Group Name	Protocol	Port Range
dsp	dsp-admin	TCP	443
dsp	dsp-agents	TCP	8903
dsp	dsp-agents	TCP	135
dsp	dsp-agents	TCP	445
dsp	dsp-agents	TCP	1024:1034
ad-dsp	dsp-client	TCP	8772
ad-dsp	dsp-client	TCP	8750
ad-dsp	dsp-client	ICMP	0:255

Endpoint	Source Groups	Destination Groups
(any endpoints that need admin access to DSP)	dsp-admin	
Semperis DSP	ad-dns-clients, dsp-client, exchange-clients	dsp
Active Directory server	dsp-agents	ad-dsp

3285 2.30.9 Symantec DLP

3286 This largely depends on how distributed the setup of DLP is. See here for a list of ports required by
3287 Symantec DLP: https://support.symantec.com/us/en/article.tech220846.html.

For this build, we used a single server that contained the database, so only the agents and administrative clients needed to be allowed to communicate through Cryptonite.

Destination Group Name	Source Group Name	Protocol	Port Range
dlp	dlp-admin	TCP	443
dlp	dlp-clients	TCP	10443

2.30.10 Cisco WSA

WSA uses a proprietary command line, which means it does not have a way of authenticating to the CryptoniteNXT portal. For devices such as this, there are two options.

1. The device can be left outside CryptoniteNXT.
2. The device can be placed under CryptoniteNXT on a CryptoniteNXT Endpoint Node with the portal disabled.

To prevent MAC spoofing, by default Cryptonite pins MAC addresses to the port + VLAN (Virtual LAN) to which a device is connected, so a malicious device connecting to the end-point node with the same MAC as an already connected IP360 would still be required to authenticate. Physical security for the end-point node can further mitigate concerns about MAC spoofing.

If you can find a way to authenticate WSA to CryptoniteNXT or decide to use the disabled portal option with strong physical security, we provide the ports below for integration.

To access the web console for WSA, allow port 8080 for any machines that should be able to access the ISE administrative console.

To access the proxy, allow port 80 and port 3128 for any machines that will need to go through the proxy, which will likely be most clients in the enterprise. Port 80 is for the *wpad.dat* file, and port 3128 is for the proxy itself.

Destination Group Name	Source Group Name	Protocol	Port Range
wsa	wsa-clients	TCP	80
wsa	wsa-clients	TCP	3128
wsa	wsa-admin	TCP	8080

Endpoint	Source Groups	Destination Groups
(any endpoints that need to use the proxy to connect to the internet)	wsa-clients	
(any endpoints that need to access the WSA web console)	wsa-admin	
Cisco WSA		wsa

2.30.11 Tripwire IP360

IP360 uses a proprietary command line, which means it does not have a way of authenticating to the CryptoniteNXT portal. For devices such as this, there are two options.

3. The device can be left outside CryptoniteNXT.
4. The device can be placed under CryptoniteNXT on a CryptoniteNXT Endpoint Node with the portal disabled.

To prevent MAC spoofing, by default Cryptonite pins MAC addresses to the port+VLAN to which a device is connected, so a malicious device connecting to the end-point node with the same MAC as an already connected IP360 would still be required to authenticate. Physical security for the end-point node can further mitigate concerns about MAC spoofing.

If you can find a way to authenticate IP360 to CryptoniteNXT or decide to use the disabled portal option with strong physical security, we provide the ports below for integration.

To access the web console for IP360, allow port 443 for any machines that should be able to access the IP360 administrative console.

IP360 should have access to all ports of the client machines it needs to scan. Another option is to simply add IP360 to all the source groups present in your enterprise, and it will give an overview of the vulnerabilities of clients on ports that CryptoniteNXT is not actively protecting. Alternatively, you can disable policy enforcement temporarily on the CryptoniteNXT Endpoint Node to which IP360 is connected, but you should do this only during scans.

Destination Group Name	Source Group Name	Protocol	Port Range
ip360	ip360admin	TCP	443
scantarget	ip360scanner	TCP	1:65535

scantarget	ip360scanner	UDP	1:65535
scantarget	ip360scsanner	ICMP	0:255

Endpoint	Source Groups	Destination Groups
(any endpoints need to access the IP360 web console)	ip360admin	
(any endpoints to be fully scanned by IP360)		scantarget
IP360	ip360scanner	ip360

2.30.12 Tripwire Log Center, Tripwire IP360, Tripwire Enterprise, and ArcSight ESM

The guide details an integration among Tripwire IP360, Tripwire Enterprise, Tripwire Log Center, and ArcSight ESM. This section describes the ports needed to allow the integrations through Cryptonite.

First, traffic must be allowed from Tripwire Log Center to the MSSQL server. To do this, ensure that Tripwire Log Center can access 1433 on the MSSQL server. (Note: Tripwire Enterprise also has access to this port, as described above in the Tripwire Enterprise section.)

Then traffic from Tripwire Enterprise to Tripwire Log Center should be allowed on ports 8091 and 1468.

Traffic from IP360 to Tripwire Log Center should be allowed on port 22 for the SFTP (Secure FTP) transfer. Also, traffic from Tripwire Log Center to 5670 on Tripwire IP360 should be allowed. If you chose to leave IP360 out of the Cryptonite NXT enclave, Tripwire Log Center will need to be able to reach it externally.

Traffic from Tripwire Log Center to the machine containing the ArcSight TCP syslog container should be allowed on the port configured (in the guide, we use port 514). As a last note, the server running the ArcSight syslog connector requires an IP and not a hostname for its integration with Tripwire Log Center–you must set a static IP for the connector server in Cryptonite and enter this IP in the appropriate place in Tripwire Log Center's configuration.

Destination Group Name	Source Group Name	Protocol	Port Range
MSSQL	MSSQLClients	TCP	1443
TLC	TLCClients	TCP	8091
TLC	TLCClients	TCP	1468

TLC	TLCClients	TCP	22
ArcSightTCPSysConn	TCPSysClients	TCP	514
ip360	ip360admin	TCP	5670

Endpoint	Source Groups	Destination Groups
Tripwire Log Center	TCPSysClients, MSSQLClients, ip360admin	TLC
Tripwire Enterprise	TLCClients	
(server running ArcSight TCP syslog connector)		ArcSightTCPSysConn
MSSQL		MSSQL
IP360	TLCClients	ip360

2.30.13 FileZilla and ArcSight

The guide details an integration between FileZilla and ArcSight ESM to forward logs from FileZilla to ArcSight. This section describes the ports needed to allow the integrations through Cryptonite.

Because this integration involves the use of an ArcSight Connector directly on the FileZilla server, only one port is needed. The FileZilla server should be able to directly communicate with 8443 on the ArcSight ESM server.

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSight	ArcSightConnectors	TCP	8443

Endpoint	Source Groups	Destination Groups
FileZilla	ArcSightConnectors	
ArcSight ESM		ArcSight

2.30.14 Cisco ISE and ArcSight

The guide details an integration between Cisco ISE and ArcSight ESM to forward logs from ISE to ArcSight. This section describes the ports needed to allow the integrations through Cryptonite.

Traffic from Cisco ISE to the machine containing the ArcSight TCP syslog container should be allowed on the port configured (in the guide, we use port 514).

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSightTCPSysConn	TCPSysClients	TCP	514

Endpoint	Source Groups	Destination Groups
Cisco ISE	TCPSysClients	
(server running ArcSight TCP syslog connector)		ArcSightTCPSysConn

2.30.15 Cisco WSA and ArcSight

The guide details an integration between Cisco WSA and ArcSight ESM to forward logs from WSA to ArcSight. This section describes the ports needed to allow the integrations through Cryptonite.

Traffic from Cisco WSA to the machine containing the ArcSight TCP syslog container should be allowed on the port configured (in the guide, we use port 514).

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSightTCPSysConn	TCPSysClients	TCP	514

Endpoint	Source Groups	Destination Groups
Cisco WSA	TCPSysClients	
(server running ArcSight TCP syslog connector)		ArcSightTCPSysConn

2.30.16 Semperis DSP and ArcSight

The guide details an integration between Semperis DSP and ArcSight ESM to forward logs from DSP to ArcSight. This section describes the ports needed to allow the integrations through Cryptonite.

Traffic from Semperis DSP to the machine containing the ArcSight TCP syslog container should be allowed on the port configured (in the guide, we use port 514).

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSightTCPSysConn	TCPSysClients	TCP	514

Endpoint	Source Groups	Destination Groups
Semperis DSP	TCPSysClients	
(server running ArcSight TCP syslog connector)		ArcSightTCPSysConn

2.30.17 Symantec DLP and ArcSight

The guide details an integration between Symantec DLP and ArcSight ESM to forward logs from DLP to ArcSight. This section describes the ports needed to allow the integrations through Cryptonite.

Traffic from Symantec DLP to the machine containing the ArcSight UDP syslog container should be allowed on the port configured (in the guide, we use UDP and port 6514).

Destination Group Name	Source Group Name	Protocol	Port Range
ArcSightTCPSysConn	TCPSysClients	UDP	6514

Endpoint	Source Groups	Destination Groups
Symantec DLP	TCPSysClients	
(server running ArcSight TCP syslog connector)		ArcSightTCPSysConn

Appendix A–List of Acronyms

ACC	Administration Control Center
AD	Active Directory
ADFR	Active Directory Forest Recovery
CoA	Change of Authorization
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DSP	Directory Services Protector
ESM	Enterprise Security Manager
FTP	File Transfer Protocol
FTPS	File Transfer Protocol over TLS
GUI	Graphical User Interface
IIS	Internet Information Services
ISE	Identity Services Engine
IT	Information Technology
JCE	Java Cryptography Extension
JRE	Java Runtime Environment
LAN	Local Area Network
MSSQL	Microsoft SQL
NAT	Network Address Translation
NCCoE	National Cybersecurity Center of Excellence
NIST	National Institute of Standards and Technology
OS	Operating System
PAC	Proxy Auto Config
RADIUS	Remote Authentication Dial-In User Service
SFTP	Secure FTP
SNMP	Simple Network Management Protocol
TE	Tripwire Enterprise
TLC	Tripwire Log Center
VLAN	Virtual LAN
WDV	WORM Disk Volume
WORM	Write Once Read Many
WPAD	Web Proxy Auto Discovery
WSA	Web Security Appliance