NIST SPECIAL PUBLICATION 1800-23C

Energy Sector Asset Management

For Electric Utilities, Oil & Gas Industry

Volume C:
How-To Guides

James McCarthy
Glen Joy
National Cybersecurity Center of Excellence
Information Technology Laboratory

Lauren Acierto
Jason Kuruvilla
Titilayo Ogunyale
Nikolas Urlaub
John Wiltberger
Devin Wynne
The MITRE Corporation
McLean, Virginia

September 2019

DRAFT

This publication is available free of charge from
https://www.nccoe.nist.gov/projects/use-cases/energy-sector/asset-management

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 1800-23C, Natl. Inst. Stand. Technol. Spec. Publ. 1800-23C, 76 pages, (September 2019), 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: energy_nccoe@nist.gov.

Public comment period: September 23, 2019 through November 25, 2019

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

Industrial control systems (ICS) compose a core part of our nation's critical infrastructure. Energy sector companies rely on ICS to generate, transmit, and distribute power and to drill, produce, refine, and transport oil and natural gas. Given the wide variety of ICS assets, such as programmable logic controllers and intelligent electronic devices, that provide command and control information on operational technology (OT) networks, it is essential to protect these devices to maintain continuity of operations. These assets must be monitored and managed to reduce the risk of a cyber attack on ICS-networked environments. Having an accurate OT asset inventory is a critical component of an overall cybersecurity strategy.

The NCCoE at NIST is responding to the energy sector's request for an automated OT asset management solution. To remain fully operational, energy sector entities should be able to effectively identify, control, and monitor their OT assets. This document provides guidance on how to enhance OT asset management practices, by leveraging capabilities that may already exist in an energy organization's operating environment as well as by implementing new capabilities.

KEYWORDS

energy sector asset management; ESAM; ICS; industrial control system; malicious actor; monitoring; operational technology; OT; SCADA; supervisory control and data acquisition

ACKNOWLEDGMENTS

We are grateful to the following individuals for their generous contributions of expertise and time.

Name	Organization
Matt Cowell	Dragos, Inc.
Tom VanNorman	Dragos, Inc.
Andrew Dunham	Forescout Technologies, Inc.
Tim Jones	Forescout Technologies, Inc.
John Norsworthy	Forescout Technologies, Inc.
Lindsey Hale	FoxGuard Solutions, Inc.
Steve Boyd	KORE Wireless, Inc.
Brian Hicks	KORE Wireless, Inc.
Adam Cohn	Splunk Inc.
Bill Wright	Splunk Inc.
Ray Erlinger	TDi Technologies, Inc.
Bill Johnson	TDi Technologies, Inc.

Name	Organization
Samantha Pelletier	TDi Technologies, Inc.
Gabe Authier	Tripwire, Inc.
Steven Sletten	Tripwire, Inc.
Jim Wachhaus	Tripwire, Inc.

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
Dragos, Inc.	Dragos Platform v1.5
Forescout Technologies, Inc.	ForeScout CounterACT v8.0.1
FoxGuard Solutions, Inc.	FoxGuard Solutions Patch and Update Management Program v1
KORE Wireless Group, Inc.	KORE Wireless Cellular Connectivity with Cellular Gateway v2.0
Splunk, Inc.	Splunk Enterprise v7.1.3
TDi Technologies, Inc.	TDi Technologies ConsoleWorks v5.2-0u1
Tripwire, Inc.	Tripwire Industrial Visibility v3.2.1

Contents

81 # List of Figures

90 # List of Tables

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 Practice Guide Structure

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 this asset management solution in the energy sector. This reference design is modular and can be deployed in whole or in part.

This guide contains three volumes:

- NIST SP 1800-23A: *Executive Summary*
- NIST SP 1800-23B: *Approach, Architecture, and Security Characteristics* – what we built and why
- NIST SP 1800-23C: *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:

Senior IT executives, including chief information security and technology officers, will be interested in the *Executive Summary, NIST SP 1800-23A*, which describes the following topics:

- challenges that enterprises face in operational technology (OT) asset management
- 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 1800-23B, which describes what we did and why. The following sections will be of particular interest:

- Section 3.4, Risk Assessment, provides a description of the risk analysis we performed.
- Section 3.4.4, Security Control Map, maps the security characteristics of this example solution to cybersecurity standards and best practices.

You might share the *Executive Summary,* NIST SP 1800-23A, with your leadership team members to help them understand the importance of adopting a standards-based solution to strengthen their OT asset management practices, by leveraging capabilities that may already exist within their operating environment or by implementing new capabilities.

IT professionals who want to implement an approach like this will find this whole practice guide useful. You can use this How-To portion of the guide, NIST SP 1800-23C, 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 the energy sector asset management (ESAM) 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. Volume B, Section 3.5, Technologies, lists the products that 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 energy_nccoe@nist.gov.

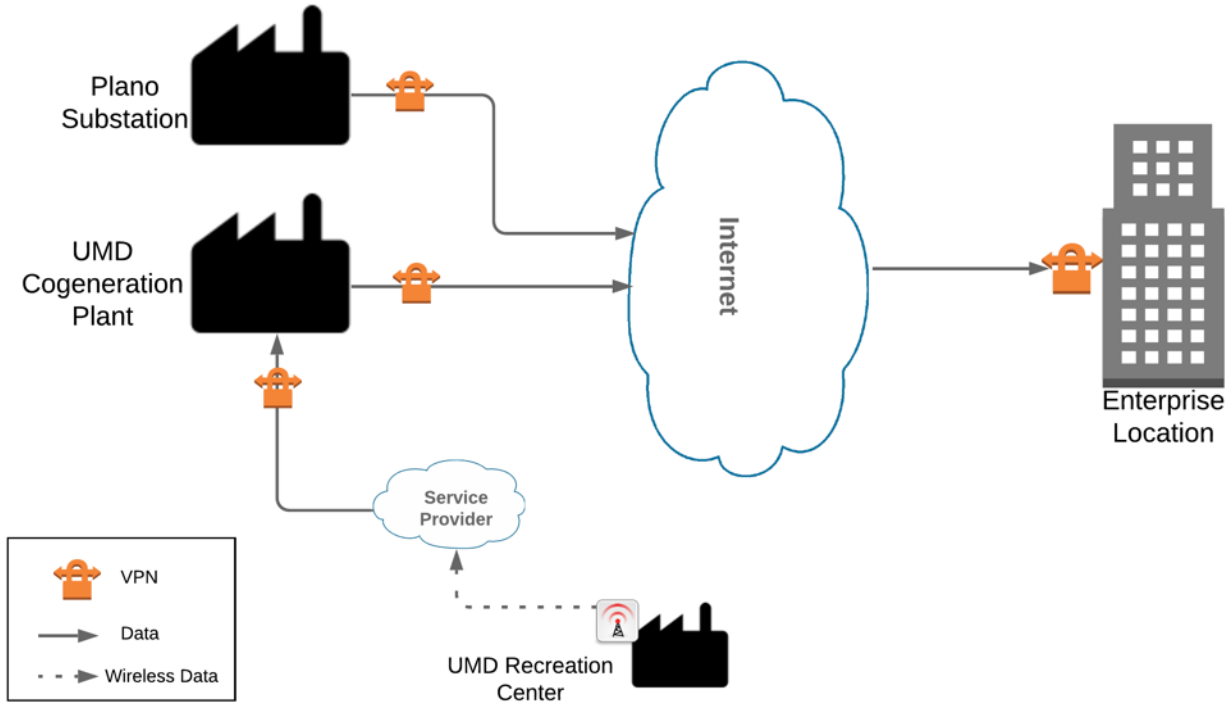
Acronyms used in figures can be found in the List of Acronyms appendix.

1.2 Build Overview

The example solution fulfills the need for an automated asset inventory. This example solution allows devices to be identified in multiple ways, depending on the needs of the organization. The architecture is intended as one solution.

The example solution makes use of two "remote" sites, while the National Cybersecurity Center of Excellence (NCCoE) serves as the enterprise location as shown in Figure 1-1 below. Having a central enterprise location provides flexibility to add multiple sites as well as the ability to collect all data in one place.

154 **Figure 1-1 High-Level Topology**



155

156 Different components in the build are installed at each location. However, some components preexist,
157 including the OT assets, networks, routers, and protocol converters. This guide will describe the
158 installation and configuration details of the components installed at each site but not preexisting
159 components. A detailed topology and description of each site can be found in Volume B, Section 4.2,
160 Example Solution.

1.3 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.

1.4 Logical Architecture Summary

A logical architecture summary can be found in Volume B of this practice guide, Section 4.1, Architecture Description.

2 Product Installation Guides

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

2.1 ConsoleWorks

ConsoleWorks performs as a data collection server and a data analysis server. The data collection server is located at the University of Maryland (UMD) and reads data from a steam meter via protocol converters. The data analysis server resides at the NCCoE and normalizes data collected from security information and event management (SIEM) software, for processing by the patch analysis and reporting tool.

2.1.1 ConsoleWorks Configurations at the NCCoE

The following subsections document the software, hardware/virtual machine (VM), and network configurations for the ConsoleWorks server at the NCCoE.

2.1.1.1 VM Configuration

The ConsoleWorks VM is given the following resources:

- CentOS 7.5
- Central processing unit (CPU) cores
- 100 gigabyte (GB) hard disk
- 10 GB random access memory (RAM)
- 1 network interface controller/card (NIC)

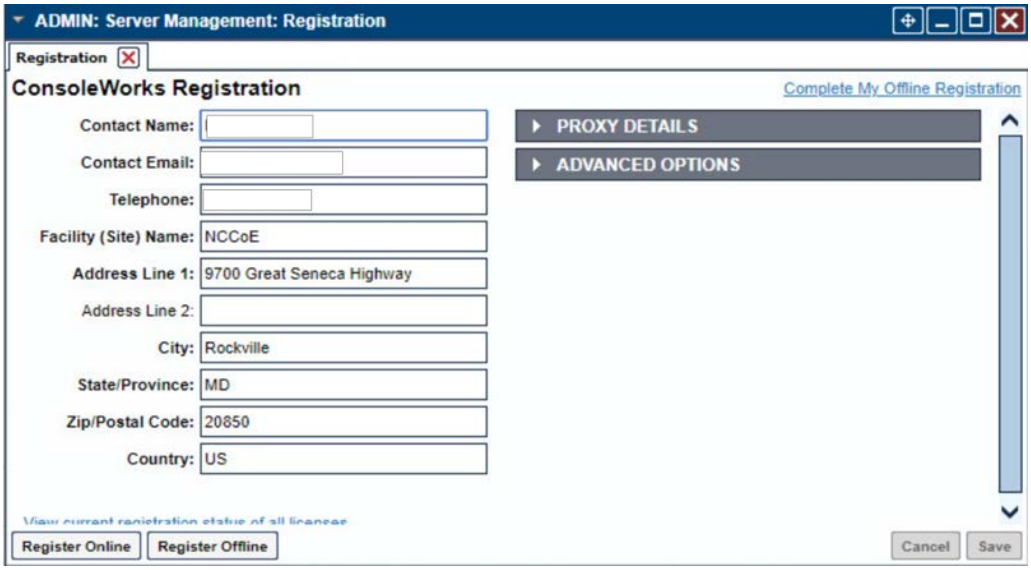
2.1.1.2 Network Configuration

- Dynamic Host Configuration Protocol (DHCP): disabled
- Internet protocol version (IPv)6: ignore
- IPv4: Manual
- IPv4 address: 10.100.100.6
- Netmask: 255.255.255.0

2.1.1.3 Installation

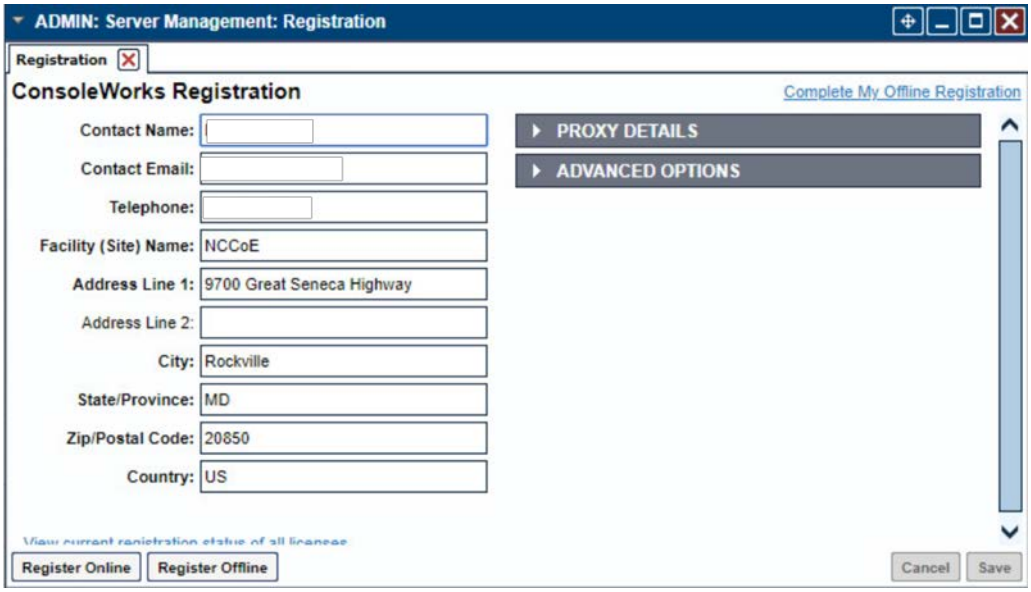
1. Download the installation kit from the http://support.tditechnologies.com website. A username and password are required, so contact TDi Support at support@tditechnologies.com to request them.
2. Create a directory to contain the ConsoleWorks installation files: `#mkdir temp/conworks`
3. Run the following command: `# yum local install consoleworkssssl-<version>_x86_64.rpm`
4. Extract the provided compressed license script to */tmp/conworks.*
5. Run the script from the extracted zip file.
6. Start ConsoleWorks with the following command: `# /opt/ConsoleWorks/bin/cw_start default`

199 7. Connect to the Console at *https://10.100.100.6:5176*. Log in using the default credentials.



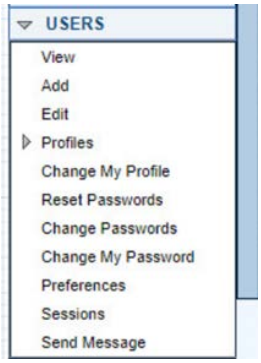
200

201 8. Fill in the details for Registration. Click **Register Online.** Click **Save.**



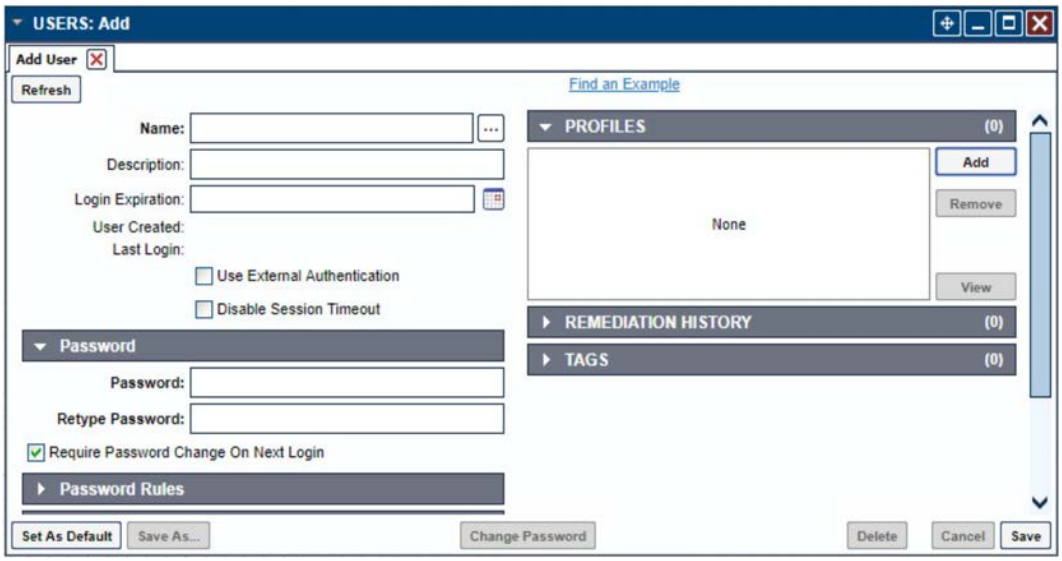
202

203 9. Create a new user. Navigate on the left to **Users > Add.**



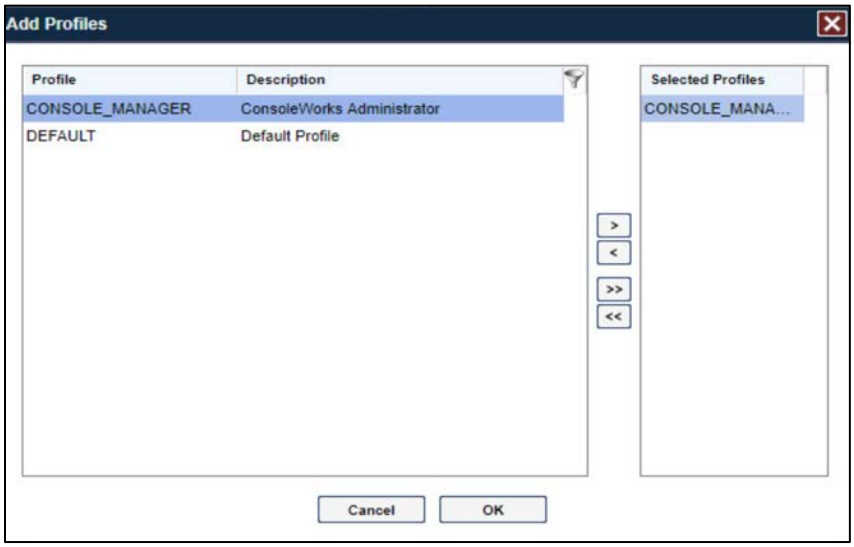
204

205 10. Enter the **Name** and **Password.** Select **Add.**



206

11. Add **CONSOLE_MANAGER** as a selected profile, as shown in the screenshot below. Select **OK.**

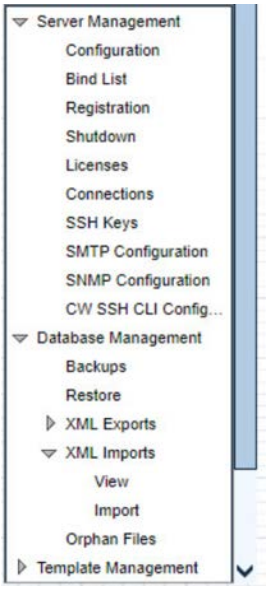


12. Click **Save.**

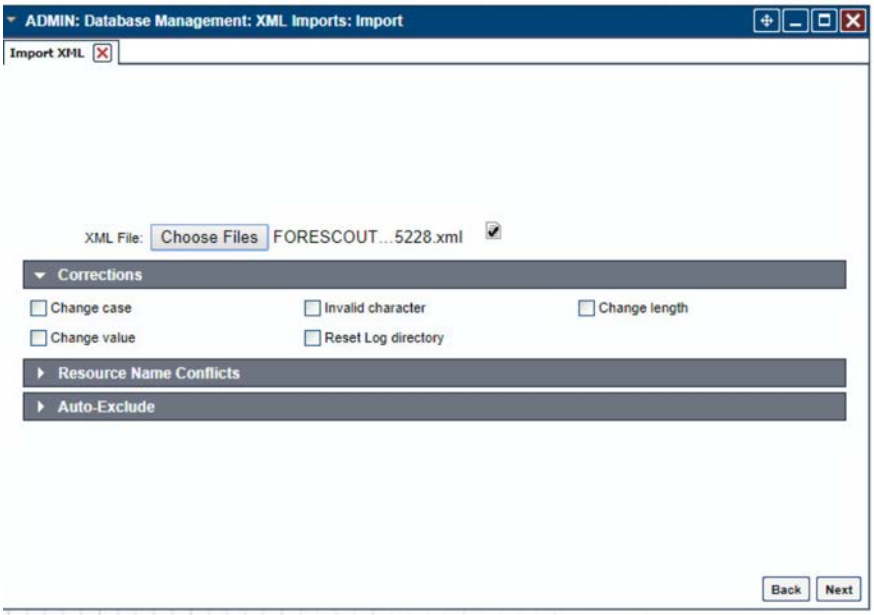
2.1.1.4 Configuration

ConsoleWorks provides the scripts to normalize data, for processing by FoxGuard Patch and Update Management Program (PUMP). The script provided is in extensible markup language (XML) format.

1. Import the provided XML file at **Admin > Database Management > XML Imports > Import.**



215 2. Click **Choose Files.** Locate the provided XML file. Select **Next.**

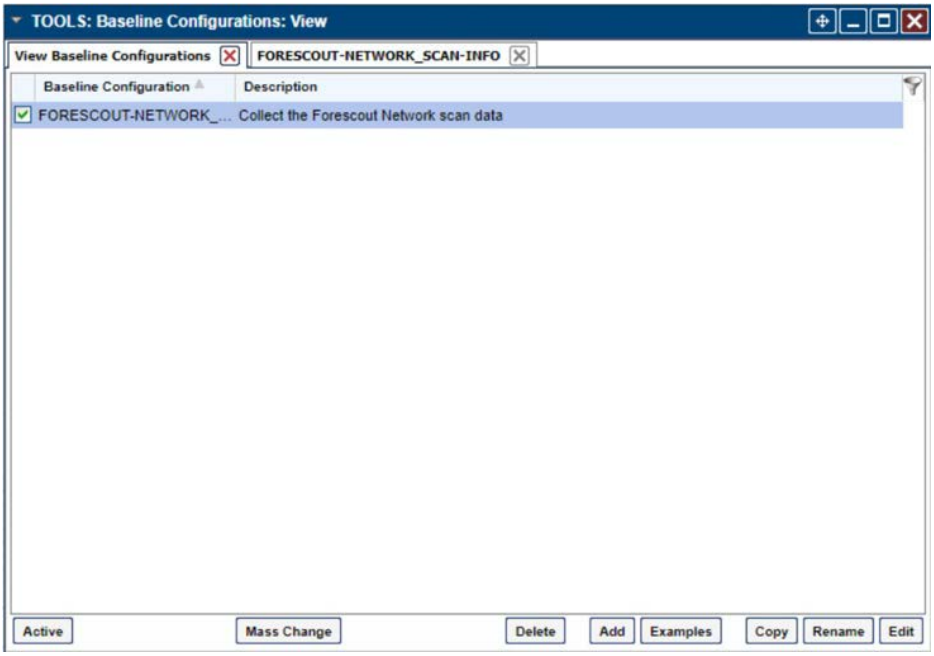


216

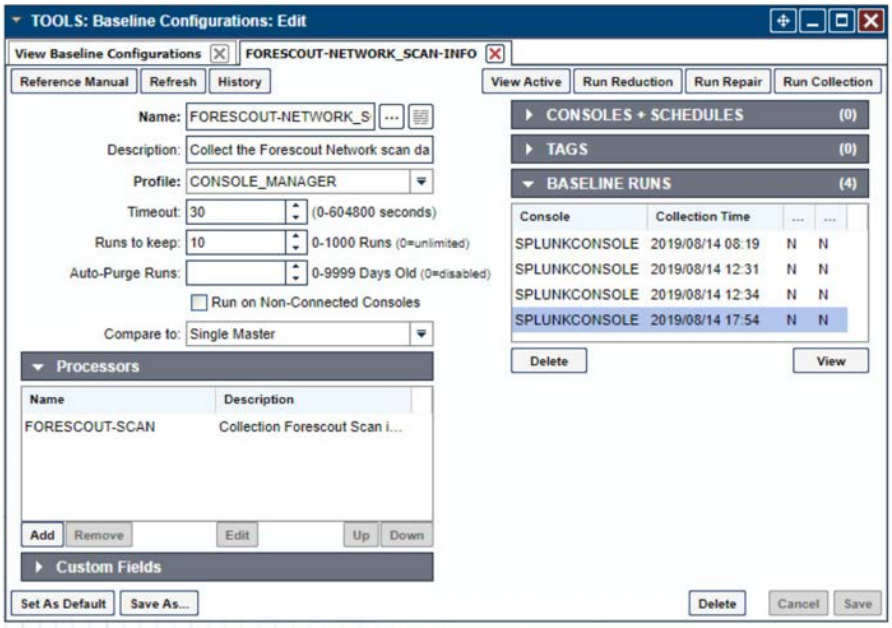
217 3. Select **Next.** The import is complete.

218

4. Open the baseline configuration at **Tools > Baseline Configurations > View.** Select **Edit.**



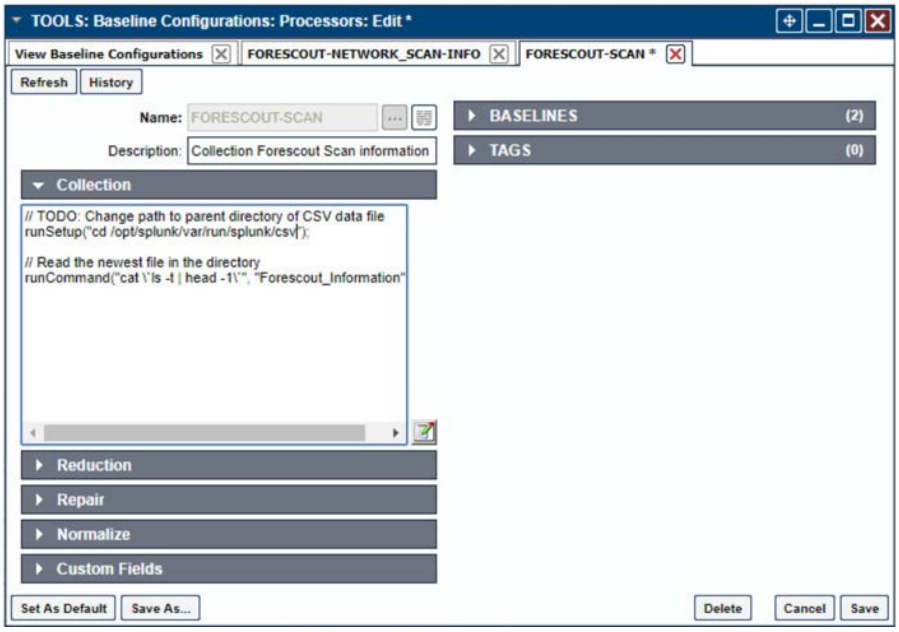
5. Under **Processors,** select the scan, and click **Edit.**



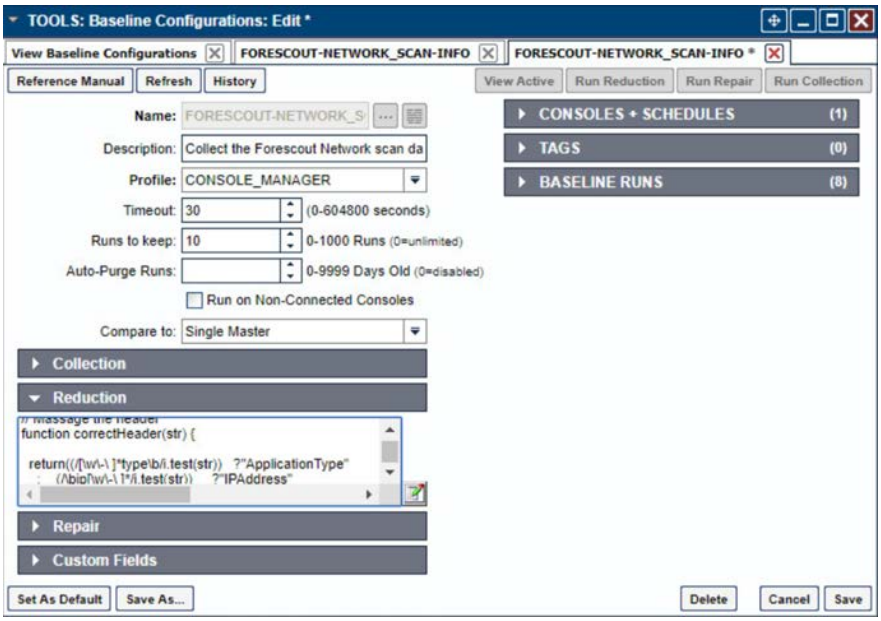
6. Under **Collection,** update the path to match where Splunk saves the inventory, as shown in the screenshot.

```
// TODO: Change path to parent directory of CSV data file
```

```
        runSetup("cd /opt/splunk/var/run/splunk/csv");
        // Read the newest file in the directory
        runCommand("cat \`ls -t | head -1\`", "Forescout_Information", 5);
```



7. Under **Reduction,** enter the following script, as shown in the screenshot below.



```
232         include("UTIL");
233         include("UTIL_CUSTOM_FILE");
234         include("UTIL_JSON");
235         ////////////////////////////////////////////////////////////////////////////
236         //////////////////////////
237         // Massage the header
238         function correctHeader(str) {
239         return((/[\w\-\ ]*type\b/i.test(str))  ?"ApplicationType"
240          :   (/\bip[\w\-\ ]*/i.test(str))    ?"IPAddress"
241             :   (/\bmac[\w\-\ ]*/i.test(str))   ?"MACAddress"
242             :   (/\bmodel[\w\-\ ]*/i.test(str))  ?"ModelNumber"
243             :   (/\bpart[\w\-\ ]*/i.test(str))  ?"PartNumber"
244             :   (/\basset.?id\b/i.test(str))    ?"PK"
245         :   (/\bproduct[\w\-\ ]*/i.test(str))?"ProductName"
246             :   (/\bserial[\w\-\ ]*/i.test(str)) ?"SerialNumber"
247             :   (/\bvendor/i.test(String(str)))  ?"VendorName"
248             :   (/version/i.test(String(str)))  ?"VersionName"
249             :                                 String(str).replace(/[\W\_]+/g, "
250         ").camelSpaced().toCapCase().replace(/\ +/g, ""));
251         }
252         ////////////////////////////////////////////////////////////////////////////
253         //////////////////////////
254         // ref: http://stackoverflow.com/a/1293163/2343
255         function CSVToArray(strData, strDelimiter) {
256           // Check to see if the delimiter is defined. If not, then default to comma.
257           strDelimiter=(typeof strDelimiter!='undefined')?strDelimiter:",";
258           // Create a regular expression to parse the CSV values.
259           //                    Delimiters                     Quoted fields
260         Standard fields.
261           var objPattern=new
262         RegExp(("(\\"+strDelimiter+"|\\r?\\n|\\r|^)(?:\"([^\"]*(?:\"\"[^\"]*)*)\"|([^\"
263         \\"+strDelimiter+"\\r\\n]*))"), "gi");
264           // Create an array to hold our data. Give the array a default empty first row.
```

```
265           var arrData=[[]];
266           // Create an array to hold our individual pattern matching groups.
267           var arrMatches=null;
268           // Keep looping over the regular expression matches until we can no longer
269         find a match.
270           while(arrMatches=objPattern.exec(strData)) {
271             // Get the delimiter that was found.
272             var strMatchedDelimiter=arrMatches[1];
273             // Check to see if the given delimiter has a length (is not the start of
274         string) and if it matches field delimiter.
275             // If it does not, then we know that this delimiter is a row delimiter.
276             if(strMatchedDelimiter.length && strMatchedDelimiter!==strDelimiter) {
277               // Since we have reached a new row of data, add an empty row to our data
278         array.
279               arrData.push([]);
280             }
281             var strMatchedValue;
282             // Now that we have our delimiter out of the way, let's check to see which
283         kind of value we captured (quoted or unquoted).
284             if(arrMatches[2]) {
285               // We found a quoted value. When we capture this value, unescape any
286         double quotes.
287               //strMatchedValue=arrMatches[2].replace(new RegExp( "\"\"", "g" ), "\"");
288               strMatchedValue=arrMatches[2].replace(/\"{2}/g, '"');
289             } else {
290               // We found a non-quoted value.
291               strMatchedValue=arrMatches[3];
292             }
293             // Now that we have our value string, let's add it to the data array.
294             arrData[arrData.length-1].push(strMatchedValue);
295           }
296           // Return the parsed data.
```

```
297           return(arrData);
298         }
299         ////////////////////////////////////////////////////////////////////////////
300         ////////////////////////
301         function procCSV(csv) {
302           // Convert string to YYYYMMDD_HHMMSS for readability
303           var outputDir="/FOXGUARD/"+(now.slice(0,8));
304           var outputFile=""+outputDir+"/"+(now.slice(8,14));
305           var result=[];
306           // Default of negative feedback
307           var tracker=false;
308           if(typeof csv!='undefined' && csv.length>0) {
309             try {
310               var lines=CSVToArray(csv);
311               lines.shift();
312               if(lines.length>1) {
313                 try {
314                   // Header names
315                   var props=lines[0];
316                   if(props.length>0) {
317                     // Massage header names
318                     for(var k=0;k<props.length;k++) {
319                       if(props[k].length>0) {
320                         props[k]=correctHeader(props[k]);
321                       }
322                     }
323                     for(i=1;i<lines.length;i++) {
324                       var j=lines[i];
325                       if(j.length>0) {
326                         var obj={
327                           "ApplicationType": "Firmware",
```

```
                        "ModelNumber": "unspecified",
                        "PartNumber": "unspecified",
                        "PK": "unspecified",
                        "ProductName": "unspecified",
                        "SerialNumber": "unspecified",
                       "VendorName": "unspecified",
                        "VersionName": "unspecified"
                      };

    if(String(ServerConfig.getList()[0].conwrksinvo).split("/")[3]!="default") {

    obj.Site=String(ServerConfig.getList()[0].conwrksinvo).split("/")[3];
                     }
                     for(var k=0;k<props.length;k++) {
                    if(Boolean(j[k]) && j[k]!="-") {
                      switch(props[k]) {
                        case "IPAddress":

  //obj.IPAddress=(rEIPv4.test(j[k]))?j[k].match(rEIPv4)[1]:(rEIPv6.test(j[k]))?j[k].
  match(rEIPv6)[1]:"unspecified";
                          break;
                        case "MACAddress":

  //obj.MACAddress=(rEMAC.test(j[k]))?j[k].match(rEMAC)[1]:"unspecified";
                          break;
                        case "OperatingSystem":
                          obj.ApplicationType="Operating System";
                          obj.OperatingSystem=j[k];
                          obj.ProductName=j[k];
                          break;
                        case "VendorName":
                          if(obj.VendorName=="unspecified") {
```

```
                        obj.VendorName=j[k];
                      }
                      break;
                    case "VersionName":
                      obj.VersionName=j[k];
                      if(rESEL.test(j[k])) {
                        obj.ModelNumber=j[k].match(rESEL)[1];
                        obj.VendorName="Schweitzer";
                      }
                      break;
                    default:
                      obj[props[k]]=j[k];
                      break;
                  }
                }
              }
              if(obj.hasOwnProperty('OperatingSystem')) {
                obj.OperatingSystemVersion=obj.VersionName;
                //delete obj.VersionName;
              }
              for(var p in obj) {
                // These are required properties
                if(["ProductName", "VendorName", "VersionName"].indexOf(p)<0) {
                  // Not a required property, and no useful data, get rid of it!
                  if(Boolean(obj[p])==false || obj[p]=="unspecified") {
                    delete obj[p];
                  }
                }
              }
              result.push({
```

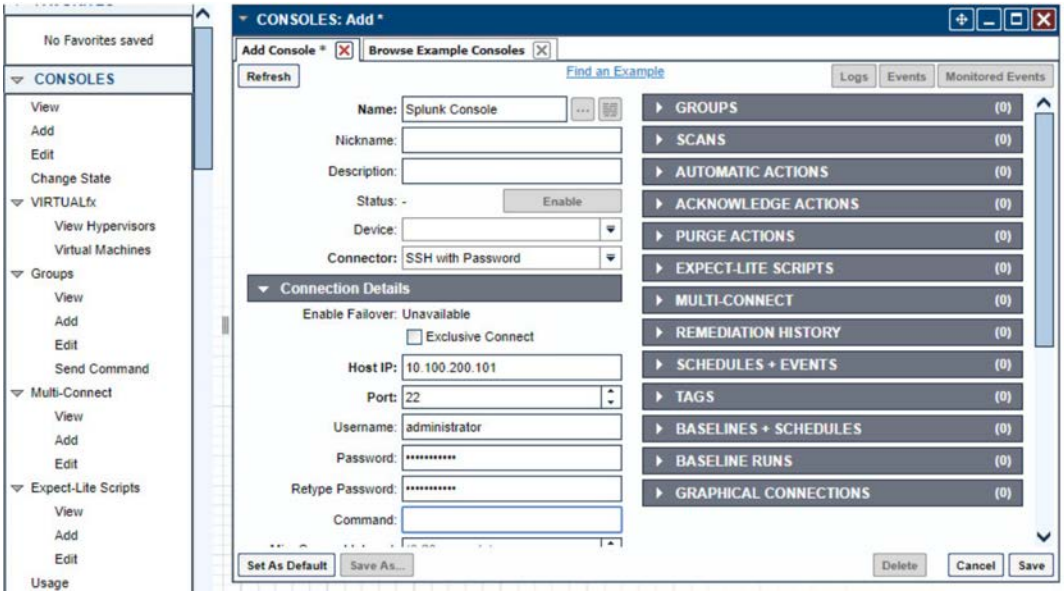
```
                    "AssetIdentifiers": obj,
                    "FUI": null
                  });
                }
              }
              try {
                setReduction("Forescout_Information", JSON.stringify(result, null, 2));
                makeDirectory(""+outputDir);
                // File for FoxGuard
                setCustomFileContents(""+outputFile+".txt", JSON.stringify(result,
null, 2));
                // Copy of original input
                //setCustomFileContents(""+outputFile+".csv", csv);
                // If everything goes great, return with positive feedback
                tracker=true;
              } catch(ex) {
                print("ERROR: "+ex);
              }
            } else {
              print("ERROR: Missing header data");
            }
          } catch(ex) {
            print("ERROR: "+ex);
          }
        } else {
          print("ERROR: Going to need more data than this");
        }
      } catch(ex) {
        print("ERROR: "+ex);
      }
    } else {
```

```
421         print("ERROR: We got nothing!");
422       }
423       return(tracker);
424     }
425     ////////////////////////////////////////////////////////////////////////////////
426     ////////////////////
427     // value for TZ offset
428     var d=0;
429     try {
430       d=new Date().getTimezoneOffset();
431     } catch(ex) {
432       print("ERROR: "+ex);
433     }
434     // Create string of YYYYMMDDHHMMSS
435     var now=String(new Date(Date.now()-(d*60000)).toJSON()).replace(/\D/g,
436     "").slice(0,14);
437     // IPv4
438     var rEIPv4=/\b((?:(?:25[0-5]|2[0-4][0-9]|1[0-9][0-9]|[1-9]?[0-9])\.){3}(?:25[0-
439     5]|2[0-4][0-9]|1[0-9][0-9]|[1-9]?[0-9]))\b/;
440     // IPv6
441     var rEIPv6=/\b([\da-fA-F]{1,4}(?:\:[\da-fA-F]{0,4}){2,6}[\da-fA-F]{1,4})\b/;
442     // MAC
443     var rEMAC=/\b((?:[\da-fA-F]{2}\:){5}[\da-fA-F]{2})\b/;
444     // SEL
445     var rESEL=/\b(SEL-.+)-R/;
446     try {
447       procCSV(getOutput("Forescout_Information"));
448     } catch(ex) {
449       print("ERROR: "+ex);
450         }
```

451 8. Select **Save.**

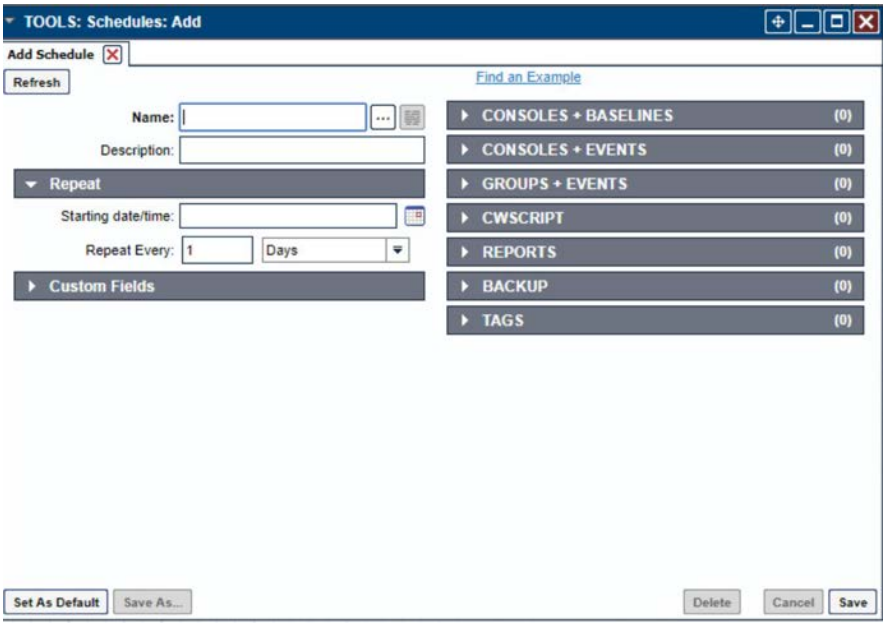
9. Navigate to **Consoles > Add.**

10. Enter a name and connection details for the Splunk server. Select **Save.**

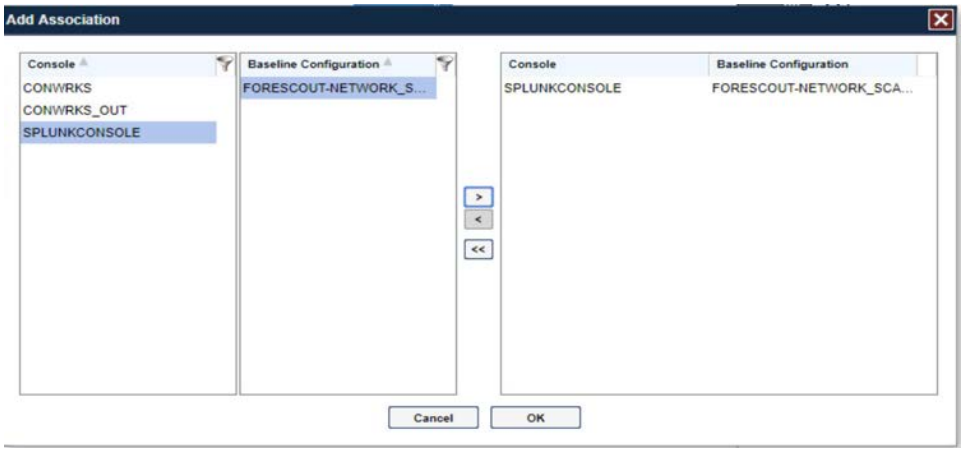


11. Navigate to **Tools > Schedule.** Click **Add.**

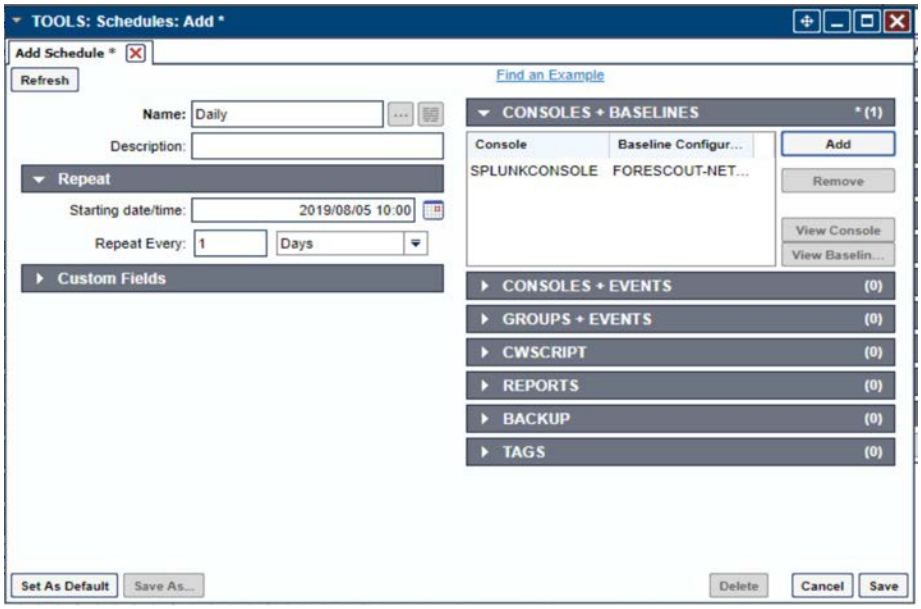
12. Name the schedule. Set the time to run at an acceptable interval (this build set the interval to repeat daily). Under **CONSOLES + BASELINES,** click **Add.**



13. Select the previously created Splunk console and the imported baseline configuration. Click the arrow. Click **OK.**



14. Click **Save.**



2.1.1.5 ConsoleWorks Configurations UMD

The following subsections document the software, hardware/VM, and network configurations for the ConsoleWorks server at UMD.

2.1.1.6 VM Configuration

The UMD ConsoleWorks VM is given the following resources:

- Windows Server 2016

- 2 CPU cores
- 100 GB hard Disks
- 12 GB RAM
- 2 NIC

2.1.1.7 Network Configuration

Network Configuration (Interface 1):

- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: 10.100.1.6
- Netmask: 255.255.255.0

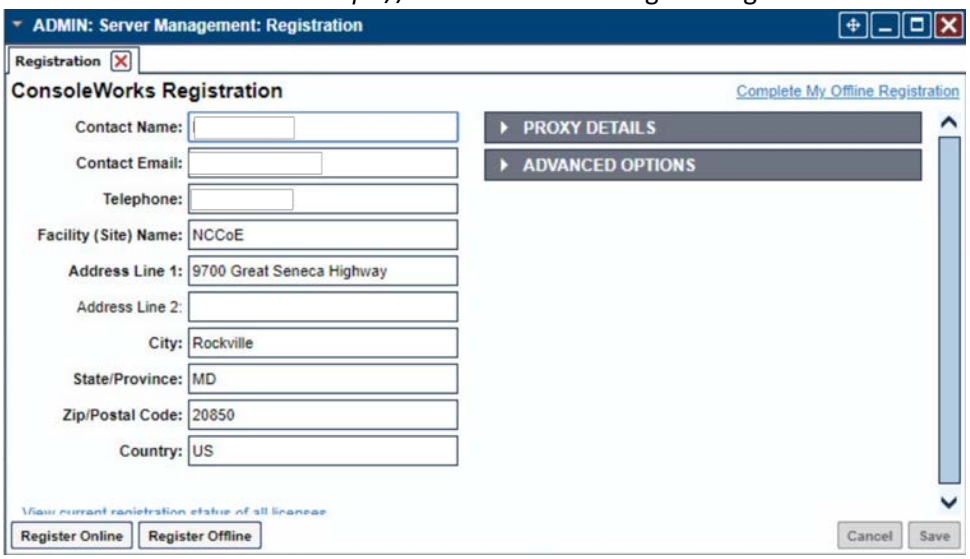
Network Configuration (Interface 2):

- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: 172.16.2.82
- Netmask: 255.255.255.248

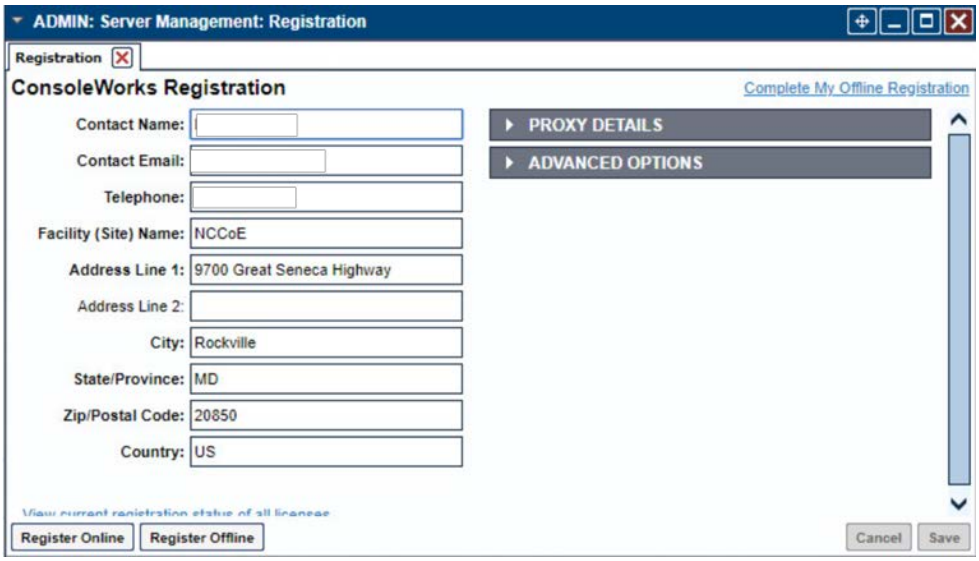
2.1.1.8 Installation

1. Download the installation kit from the http://support.tditechnologies.com website. A username and password are required, so contact TDi Support at support@tditechnologies.com to request them.
2. Run the installer *cw_server_<version>.exe.*
3. Download the Splunk universal forwarder installer from the https://www.splunk.com/en_us/download/universal-forwarder.html website. A username and password are required. An account can be created on the Splunk website.
4. Use the splunkforwarder-<version>-x64-release.msi installer to install the Splunk Universal Forwarder on the machine running the ConsoleWorks.

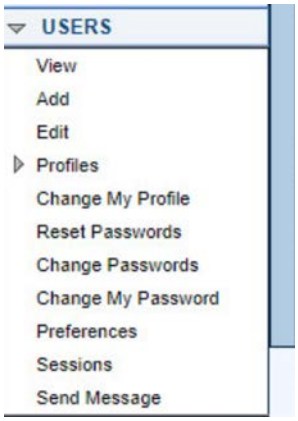
5. Connect to the Console at *https://10.100.1.6:5176*. Log in using the default credentials.



6. Fill in the details for **Registration**. Click **Register Online.** Click **Save.**

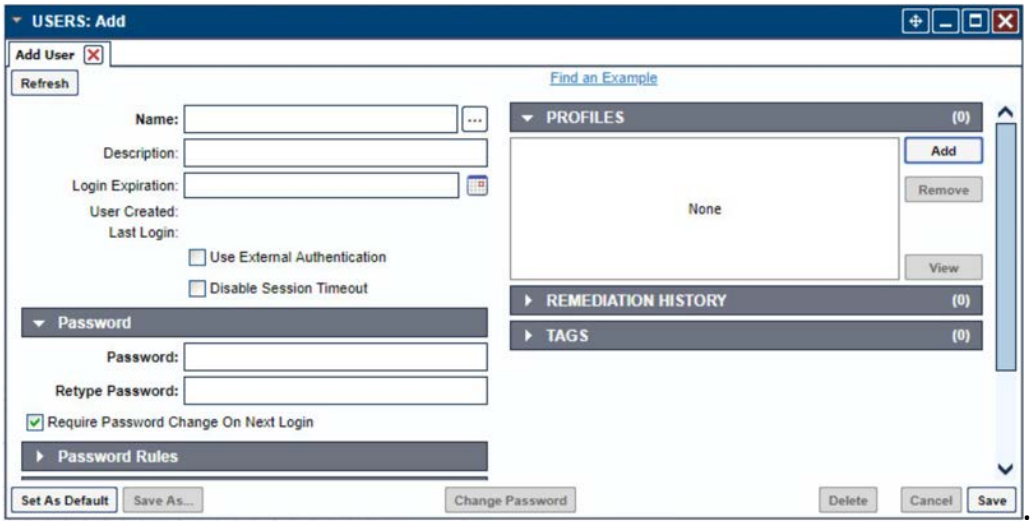


500 7. Create a new user. Navigate on left to **Users > Add.**



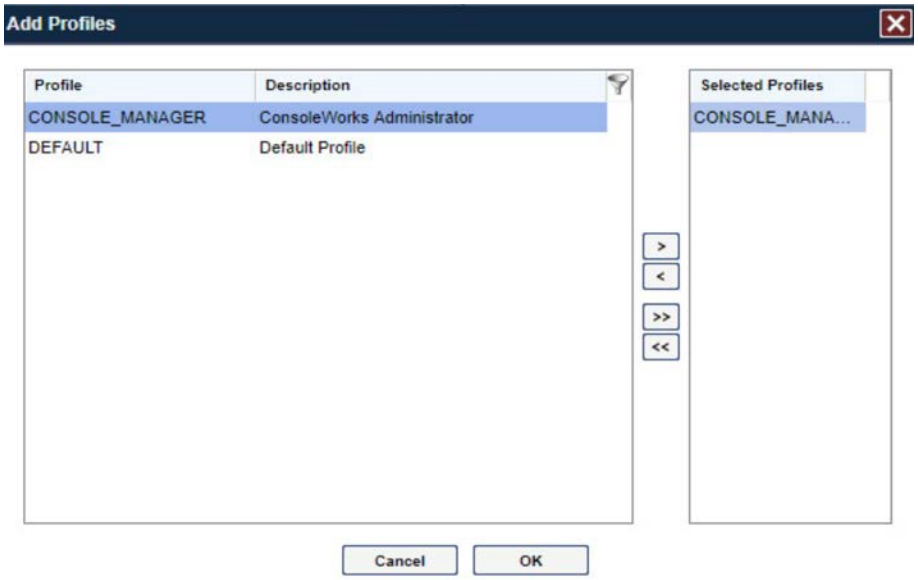
501

502 8. Enter the name and password. Select **Add.**



503 .

9. Add **CONSOLE_MANAGER** as a selected profile, as shown in the screenshot below. Select **OK.**

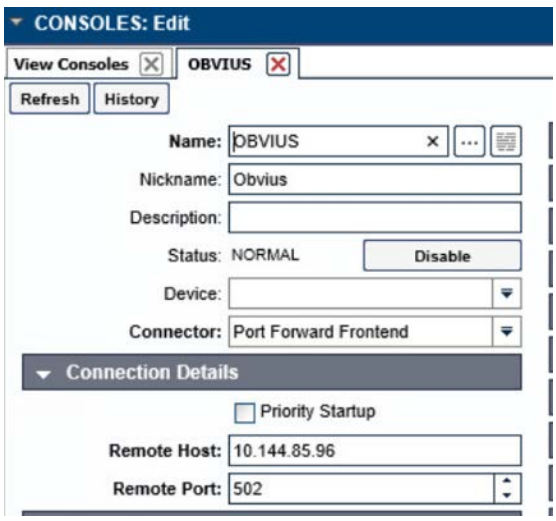


10. Click **Save.**

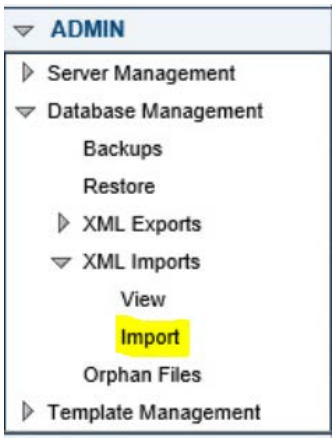
2.1.1.9 Configuration

ConsoleWorks provides the scripts to query the Modbus server. The script provided is in XML format.

1. Navigate to **Consoles > Add.**
2. Enter a name and connection details that will be used to connect to the Obvius data acquisition server. Select **Save.**



3. Navigate to **Admin > Database Management > XML Imports > Import.**

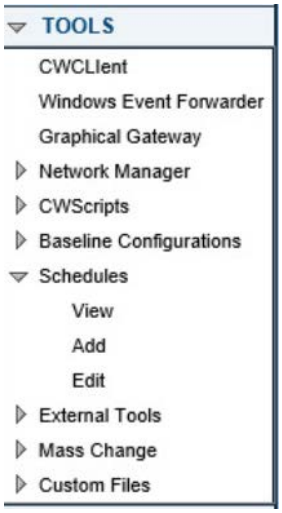


4. Select **Upload a file,** then click **Next.**

5. Click **Browse,** then find the XML file.

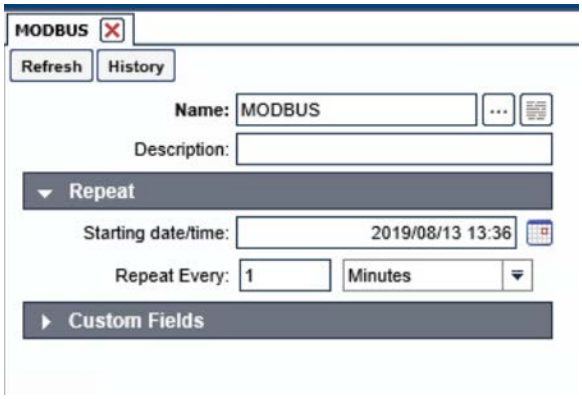
6. Click **Next.** ConsoleWorks will import the two CWScripts: *UTIL_MODBUS* and *UTIL_MODBUS_GE.*

7. Navigate to **Tools > Schedule.** Click **Add.**



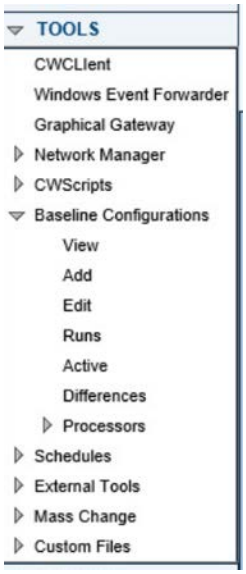
522

523 8. Name the schedule. Set the time to run at an acceptable interval, then **save.**



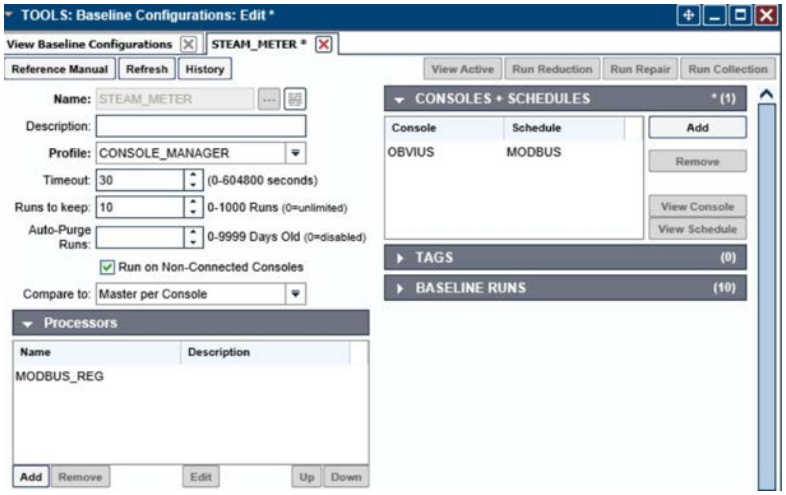
524

525 9. Navigate to **Tools > Baseline Configurations > Add.**



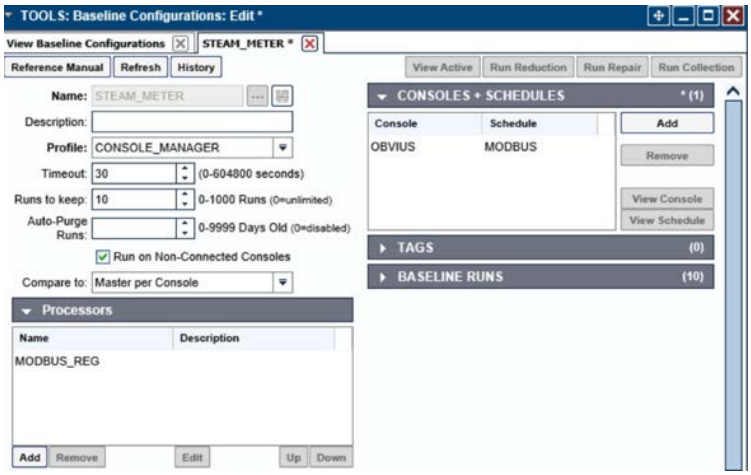
526

527 10. Name the baseline, and set the Profile to **CONSOLE_MANAGER.**

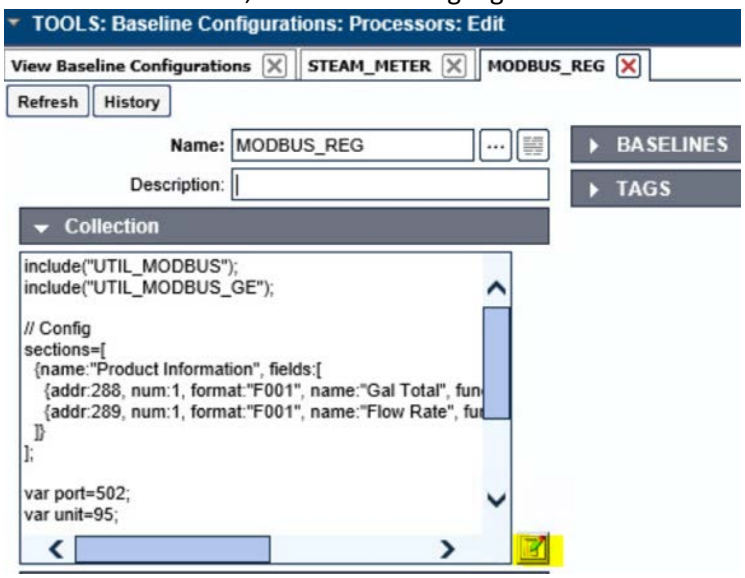


528

11. Create a Processor to collect the information from the OBVIUS server. Click **Add** under **Processors.**



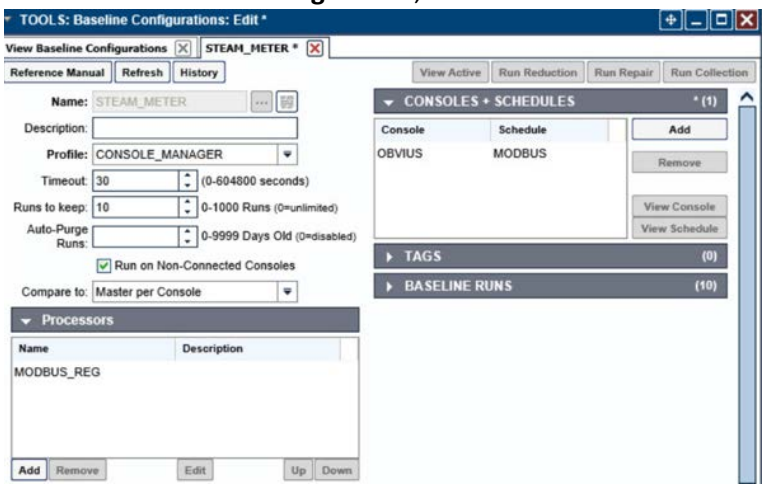
12. Name the Processor, then click the highlighted button. Enter the text that follows, then click **Save.**



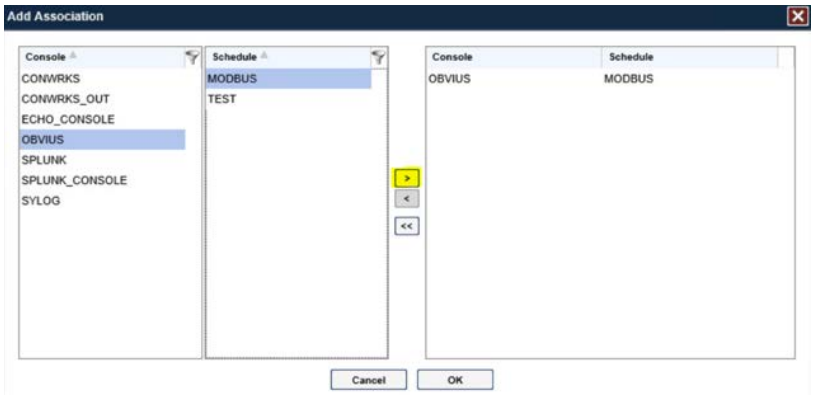

```
include("UTIL_MODBUS");
include("UTIL_MODBUS_GE");

// Config
sections=[
  {name:"Product Information", fields:[
    {addr:288, num:1, format:"F001", name:"Gal Total", functionName:
readHoldingRegisters},
    {addr:289, num:1, format:"F001", name:"Flow Rate", functionName:
readHoldingRegisters},
  ]}
];
```

```
var port=502;
var unit=95;

// Execute
var server=console.port;

for(var s=0;s<sections.length;s++) {
  setOutput(sections[s].name, formatGEOutput(modbusConnection(server, port, unit,
sections[s].fields)));
  log("SPLUNK",formatGEOutput(modbusConnection(server, port, unit,
sections[s].fields)));
}
```

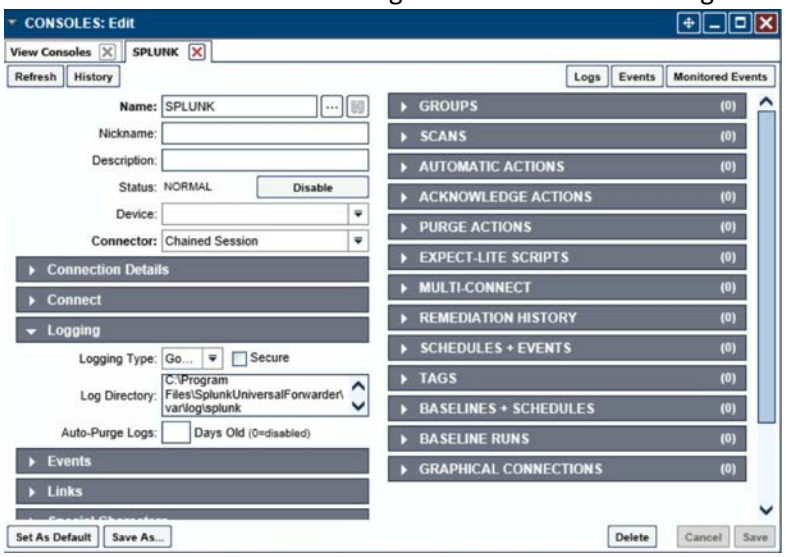
13. Return the **Baseline Configuration**, then under **CONSOLE + SCHEDULES**, select **Add.**



14. Under **Console**, select **OBVIUS,** and select **MODBUS**, then click **>.**



15. Create the SPLUNK console to log the collected Modbus registers at **Console > Add.**



16. Name the **Console**, and set the connector to **Chain Session**, the log type to **Governed**, and the Log Directory to the below location:

```
C:\Program Files\SplunkUniversalForwarder\log\splunk
```

17. Navigate to *C:\Program Files\SplunkUniversalForwarder\etc\system\local*

18. Add the following lines to the *outputs.conf* file:

```
[tcpout:default-autolb-group]
server = 10.100.200.101:9997
[tcpout-server://10.100.200.101:9997]
```

19. Add the following lines to the *inputs.conf* file:

```
[monitor://$SPLUNK_HOME\var\log\splunk\SPLUNK.LOG*]
index = modbus
```

2.2 Forescout CounterACT

Forescout CounterACT is used as a data collection and inventory tool. The CounterACT appliance actively collects data from the ICS lab in Plano, Texas. The appliance reports back to the CounterACT Enterprise Manager on the enterprise network in Rockville, Maryland. Once installed, the appliance is configured and managed through the enterprise manager.

Forescout CounterACT can be deployed on virtual or physical appliances. For virtualized environments, VMware ESXi, Microsoft Hyper-V, and KVM hypervisors are supported. Large networks that require multiple physical or virtual appliances can be centrally managed by the Enterprise Manager.

https://www.forescout.com/platform/specifications/#virtual-appliance

Note: Some network-related information has been redacted.

2.2.1 CounterACT Enterprise Manager Configuration

2.2.1.1 VM Configuration

The CounterACT Enterprise Manager is configured as follows:

- Red Hat Enterprise Linux 7
- CPU cores
- 16 GB of RAM
- 200 GB of storage
- 1 NIC

2.2.1.2 Network

Network Configuration (Interface 1):

- IPv4: Manual
- IPv6: disabled
- IPv4 address: 10.100.100.33
- Netmask: 255.255.255.0
- Gateway: 10.100.100.1

2.2.1.3 Installation

To install CounterACT Enterprise Manager, refer to the installation guide available at https://www.forescout.com/company/resources/forescout-installation-guide-8-1/.

2.2.1.4 Configuration

The following steps contain configuration instructions for scanning devices at the Plano location. For additional CounterACT configuration details, refer to the administration guide at https://www.forescout.com/wp-content/uploads/2018/11/counteract-administration-guide-8.0.1.pdf.

603 The CounterACT Enterprise Manager and CounterACT Appliance can be managed through the
604 CounterACT console. Complete the following steps to install the console on a Windows desktop:

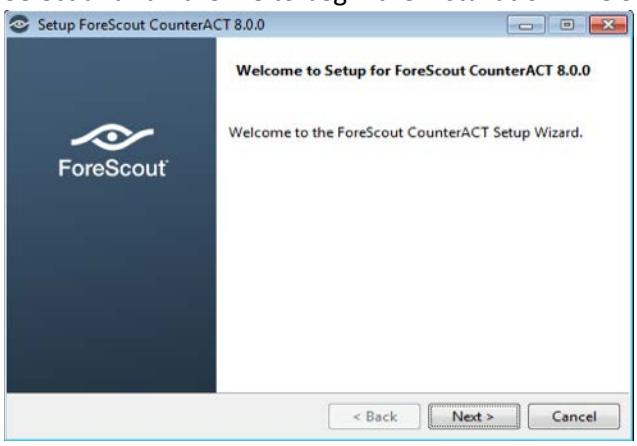
605 1. Download the executable from a Forescout portal.

606 2. Select the CounterACT Console Setup file. The CounterACT Console software download screen
607 opens.

608

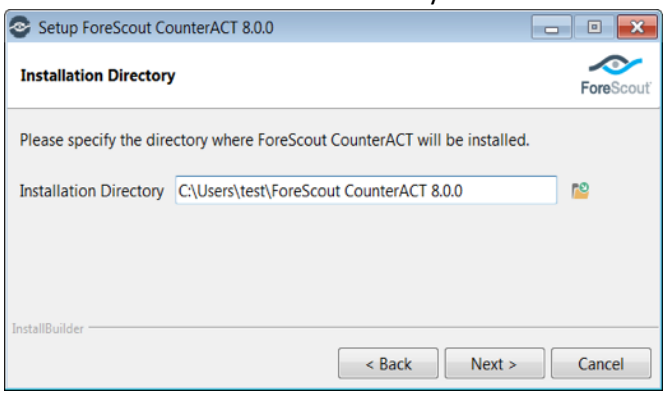
609 3. Select the download link required, and save the EXE file.

610 4. Select and run the file to begin the installation. The **Setup Wizard** opens. Select **Next.**



611

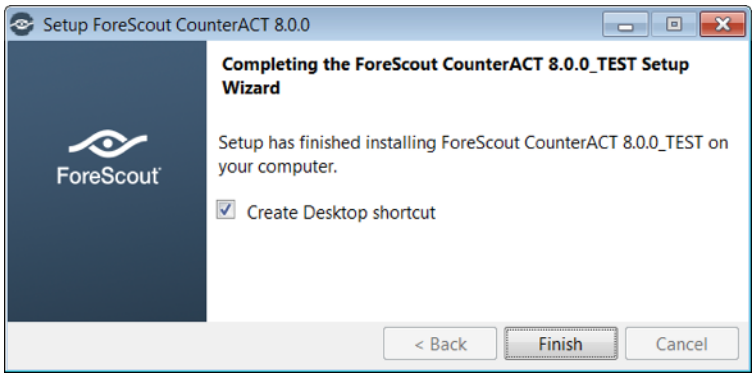
612 5. Use the default installation directory. Click **Next.**



613

614 6. Click **Next.**

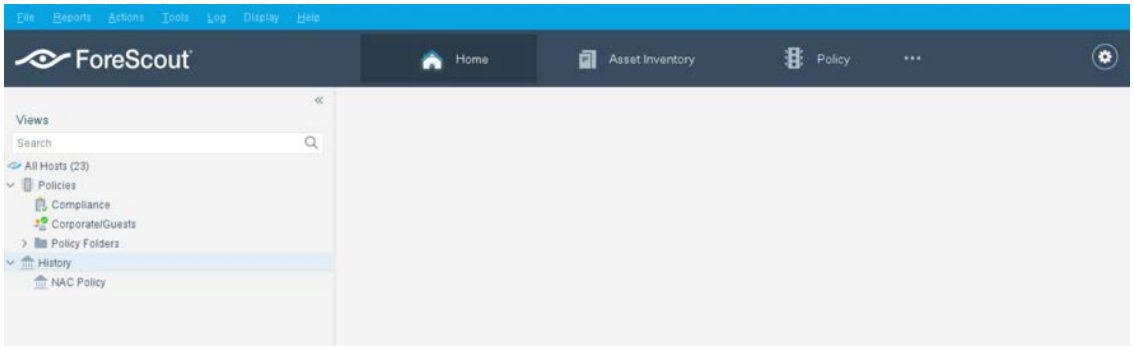
615 7. The installation begins. When completed, click **Finish.**



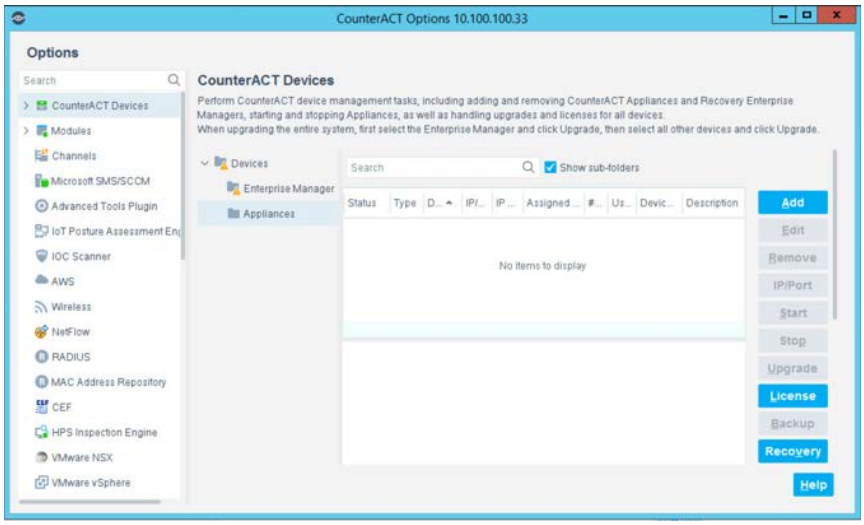
616

8. Connect to the Enterprise Manager with the Console and the password used during the CounterACT Enterprise Manager installation.

9. Select the gear icon in the top right of console.



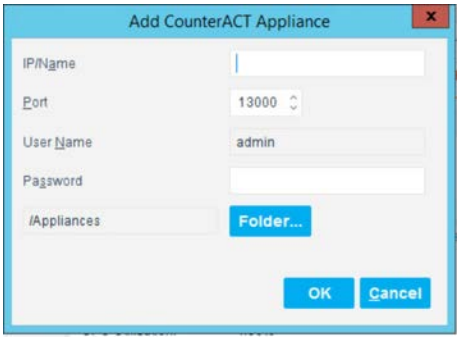
622 10. Select **Add.**



623

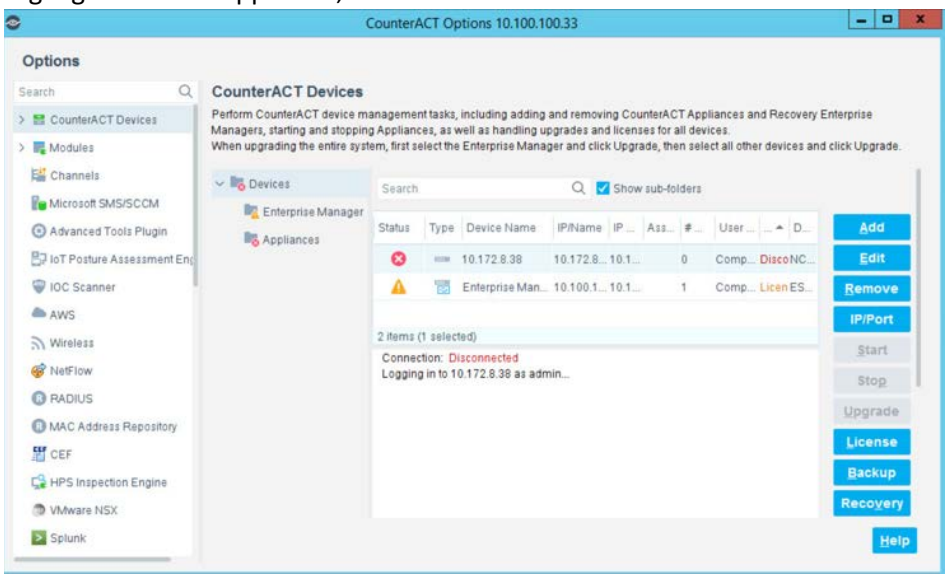
624 11. Enter the internet protocol (IP) address of the appliance, and the admin password used in setup.

625 12. Select **OK.**



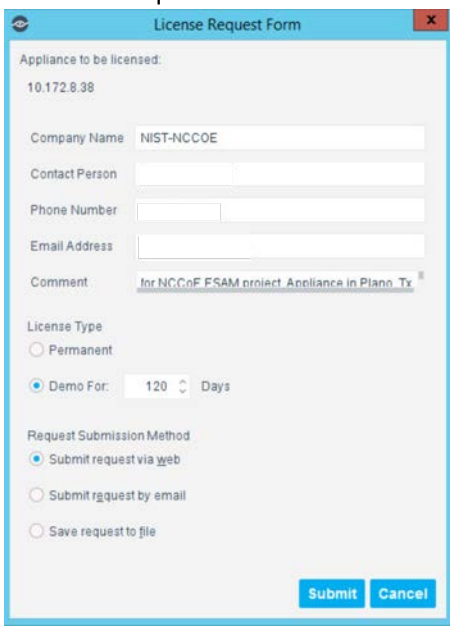
626

627 13. Highlight the new appliance, and select **License.**



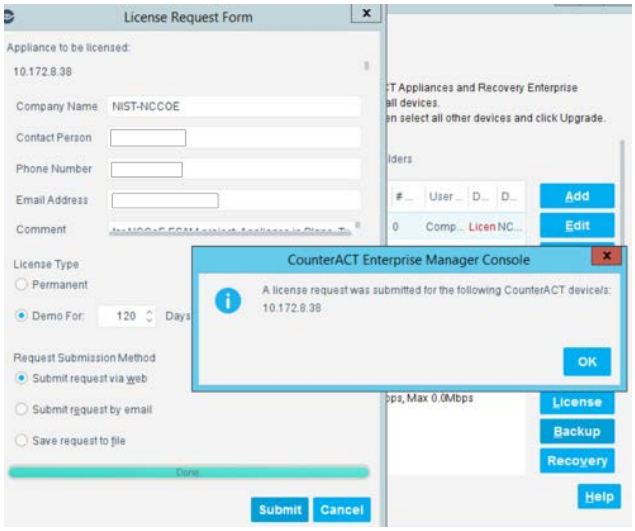
628

629 14. Enter the required information. Select **Submit.**



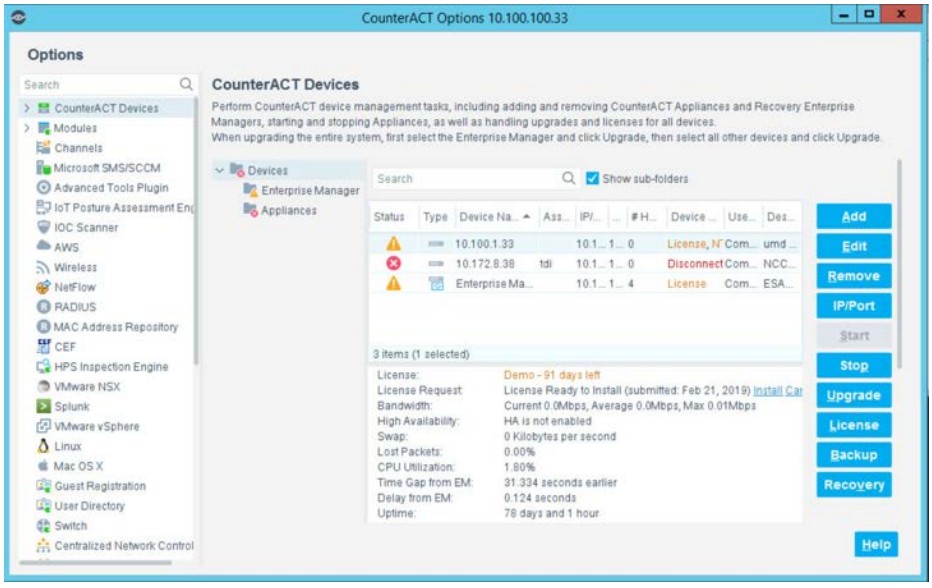
630

15. Select **OK.**

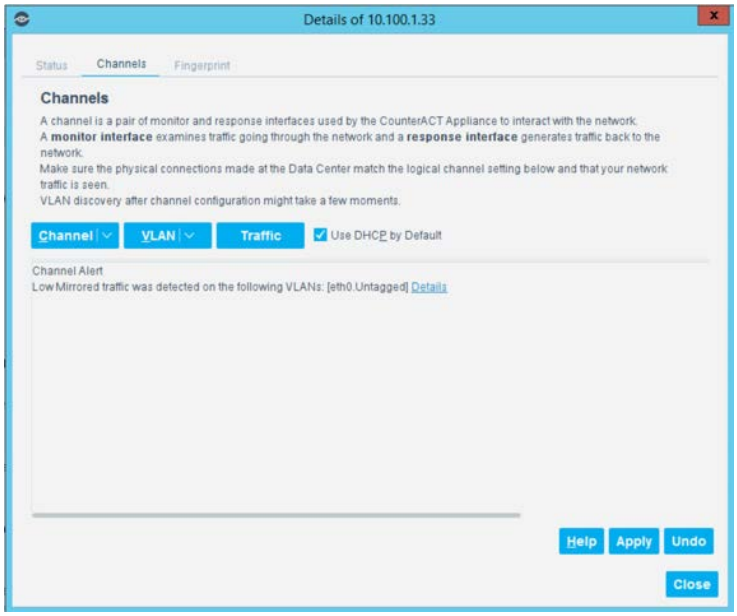


2.2.1.4.1 Appliance Interfaces Configurations

1. Under **Options**, highlight the appliance, and select **Edit.**

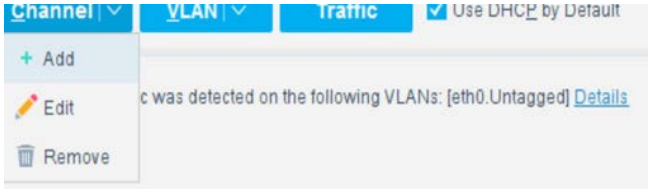


636 2. Select the **Channels** tab.



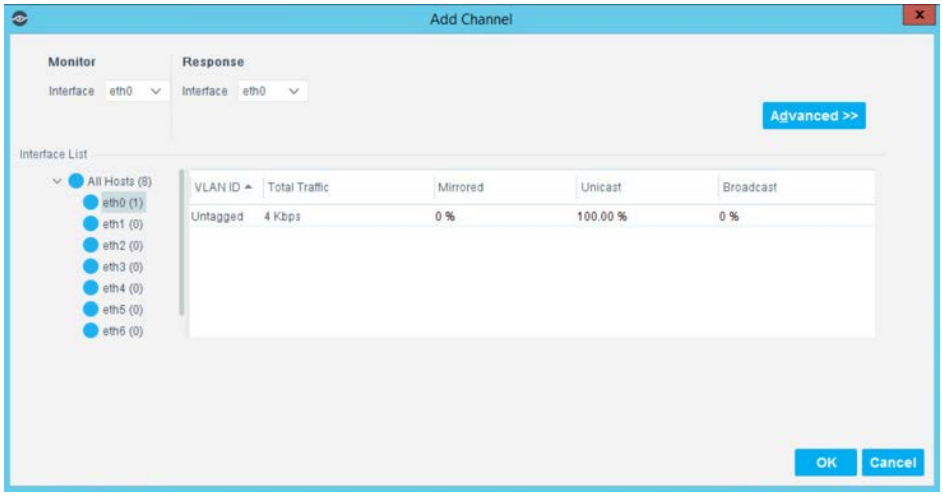
637

638 3. Under **Channel,** select **Add.**



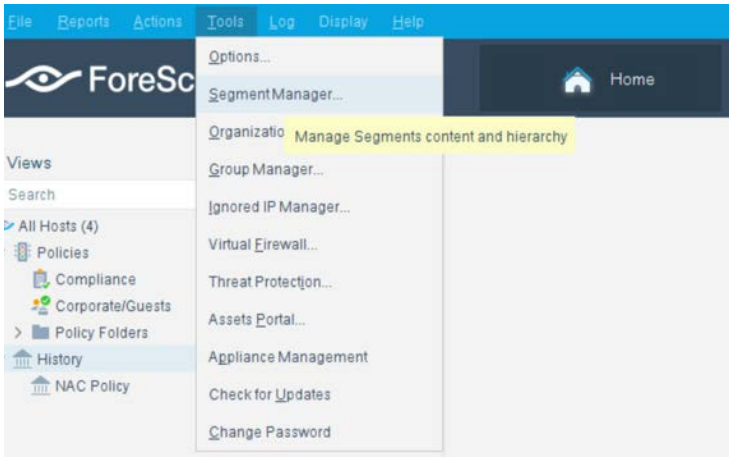
639

640 4. Use the drop-down to select the interface listening on a switched port analyzer (SPAN) switch for
641 both **Monitor** and **Response.** Select **OK.**



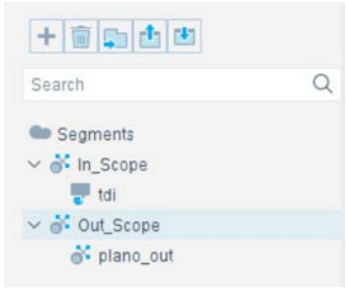
642

643 5. Under **Tools,** select **Segment Manager.**



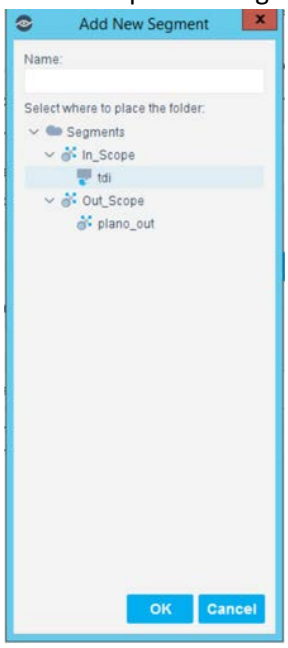
644

645 6. Select the **+** to add and name two segments called *In_Scope* and *Out_Scope*. Click **OK.** These will
646 indicate which IP range should be scanned and which should not be scanned.

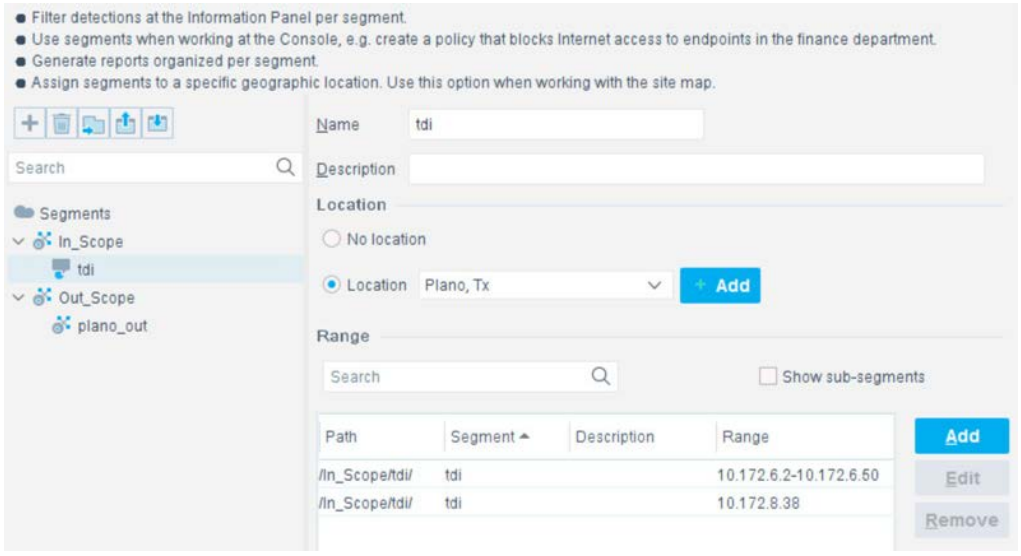


647

7. Select the plus icon again to add two subsegments shown in the screenshot below. Click **OK.**



8. Highlight the *tdi* segment. Click **Add** to add the range of IP addresses to scan. Click **OK.**

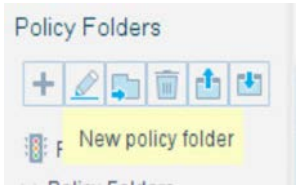


9. Repeat for the *plano_out* segment for IP address to not scan. Click **OK.**

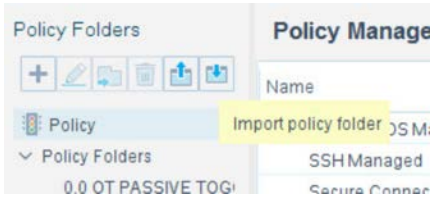
2.2.1.4.2 Upload Network Scan Policies

Forescout network scan policies are prewritten and delivered as an XML file.

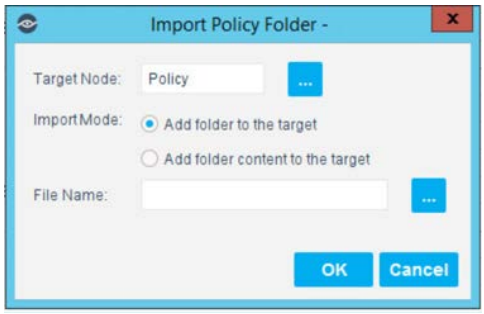
1. First, create a folder to house the polices. From the **Enterprise Manager** Console, select the **Policy** tab.
2. Select the plus icon to create a new folder.



3. Name the folder. Click **OK.**
4. Select the **import policy** icon.



5. Select **…** to locate the XML file.



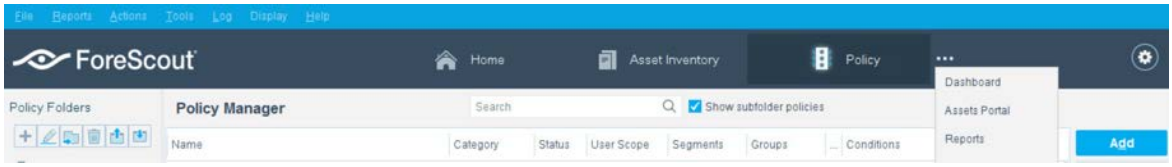
6. Select the XML file.
7. Select **OK.**
8. Repeat Steps 27–30 for each XML policy file.
9. Select **Start.** Select **Apply** to start and apply the changes.

2.2.1.4.3 Splunk Integration

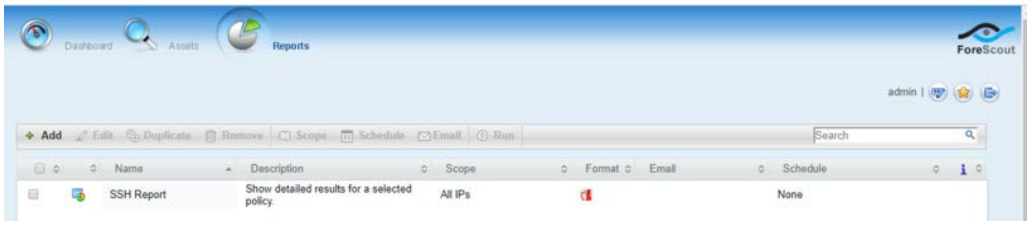
To complete Forescout Integration with Splunk, follow Forescout documentation found at https://www.forescout.com/platform/forescout-app-guide-splunk-2-7-0 and https://www.forescout.com/company/resources/extended-module-for-splunk-configuration-guide-2-8/.

2.2.1.4.4 Schedule Reporting

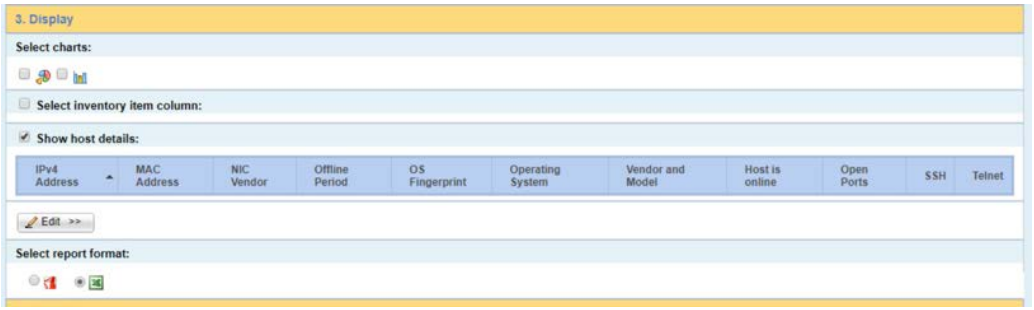
1. From the **Enterprise Manager** Console, select the ellipsis next to **Policy.** Select **Reports.**



2. Log in using the same credentials as the **Enterprise Manager** Console.
3. Select **Reports.**
4. Select **Add.**



5. Select the **Asset Inventory** template. Click **Next.**
6. Name the report. Select the **All IPs** toggle**.**
7. Select only the **Show host details.**
8. Edit the host details to show the following properties:



9. Set a schedule. Enter an email address. Select **Save.**

2.2.2 CounterACT Appliance Configuration

2.2.2.1 Host Configuration

The CounterACT Appliance is delivered on a Dell PowerEdge R640 server with version 8.0.0.

2.2.2.2 Network

Network Configuration (Interface 1):

- IPv4: Manual
- IPv6: disabled
- IPv4 address: 10.172.8.38
- Netmask: 255.255.255.0
- Gateway: 10.172.8.1

2.2.2.3 Installation

To install the CounterACT Appliance, follow the installation steps found at https://www.forescout.com/wp-content/uploads/2018/10/CounterACT_Installation_Guide_8.0.1.pdf.

2.2.2.4 Configuration

After the CounterACT Appliance is installed, follow the steps outlined in Section 2.2.1, to connect the appliance to the enterprise manager and complete the configuration.

2.3 Dragos Platform

The Dragos Platform is an industrial control system cybersecurity-monitoring platform based around threat-behavior analytics. It is being used in this build to provide asset discovery and monitoring. A Dragos Sitestore is installed at the NCCoE enterprise site, and a midpoint sensor is installed at the Plano site. The Dragos sensor is managed by the site store.

2.3.1 Dragos Sitestore Configuration

In the example implementation, Dragos Sitestore is deployed as a pre-built appliance from the vendor. The appliance was still configured with parameters necessary for our environment. Connect to the Dragos appliance by navigating the web browser to *https://<IP address>*.

2.3.1.1 Host Configuration

The Dragos Platform is delivered to the customer, preconfigured for the environment. The NCCoE received a Dell server utilizing iDRAC for virtualization. On the iDRAC server, VMware ESXi was installed and utilized for creating the server.

The VMs created to house the product have the following specifications:

- Operating system (OS) Version: CentOS 7 (64-bit)
- CPU: 48 cores

- Memory: 192 GB
- Hard disc drive (HDD) 1: 200 GB
- HDD 2: 10 terabytes (TB)

2.3.1.2 Network

Networking for the device included a single network within ESXi to which the VM was connected. The Dell iDRAC server housing the Dragos Sitestore Puppet Server was connected to the ESAM network with the following IP addresses:

- iDRAC: 10.100.200.6
- ESXi: 10.100.200.7
- Dragos Sitestore Puppet: 10.100.200.8

2.3.1.3 Installation

Installation began with setting up a VM. Utilizing the specifications in Section 2.3.1.1, Host Configuration, a VM was created for the Sitestore/Puppet server. Then the product ISO was added to the CD/DVD Drive 1 location (*DragosCustom-2019-06-18-CentOS-7-x86_64-Everything-1810.iso*).

1. Power on the VM, and open a console. The **Dragos installation** screen will start, allowing options to be selected for installation type.
2. With the Dell R730 server used for the NCCoE, select **Install Dragos Sitestore Kickstart.** The installer automatically installs the Dragos Platform without interaction from the user.

2.3.1.4 Configuration

Once the installation has completed, the Sitestore will be configured with the needed files listed in Table 2-1.

Table 2-1 Dragos Required Files

Dragos Files	
sitestore-orchestration-1.5.1.1-1.noarch.rpm.gpg	*midpoint-images-1.5.1.1-1.x86_64.rpm.gpg*
midpoint-configs-1.5.1.1-1.x86_64.rpm.gpg	*midpoint-manager-1.1.2-1.el7.x86_64.rpm.gpg*
midpoint-1.5.1.1-1.x86_64.rpm.gpg	*mms-cli-1.1.0-1.x86_64.rpm.gpg*
upgrade-1.5.1-3.tar.gz.gpg	*containerd.io-1.2.0-3.el7.x86_64.rpm*
container-selinux-2.68-1.el7.noarch.rpm	*docker-ce-18.09.0-3.el7.x86_64.rpm*
docker-ce-cli-18.09.0-3.el7.x86_64.rpm	

1. Upload these files to the Sitestore VM in */var/opt/releases/.*

2. Change directory to */var/opt/releases/* and run the command `gpg --decrypt-file *.gpg`. Enter the password supplied from Dragos for the installation. This will create all the files required for the installation.

3. Change directory to */root/* and, as root user, run `./puppet_server_setup.sh`

2.3.2 Dragos Midpoint Sensor

Dragos Midpoint Sensor is also deployed as a pre-built appliance from the vendor. Options for the midpoint sensor consist of configurations for small, medium, and large deployments. The appliance is configured with parameters necessary for our environment. The Dragos Midpoint Sensor can be managed from the Sitestore.

2.3.2.1 Network

The midpoint sensor has multiple interfaces. One interface will collect traffic via SPAN port. Another will serve as the management interface to communicate with the device.

Dragos Midpoint Sensor Management Interface:

- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: 10.172.6.10
- Netmask: 255.255.255.0

2.3.2.2 Configuration

After the midpoint sensor is deployed and listening on the correct interface, the midpoint sensor can connect back to the Sitestore for further configurations.

2.3.3 Dragos Splunk Integration

The Dragos Splunk application allows data integration from the Dragos Sitestore into the Splunk dashboard. This allows Splunk to aggregate data from Dragos and other products into a central location for analyst visualization. This process assumes the reader has downloaded the Dragos Splunk application from https://splunkbase.splunk.com/app/4601/.

1. To begin, log in to the Splunk instance, and select the gear icon on the top left of the screen next to **Apps,** to configure the applications.

2. On the top right of the screen, select **Install app from the file.**

3. Follow the on-screen instructions to upload the downloaded application.
4. Restart Splunk (either prompted by the installation process or self-directed).
5. From the Splunk **Settings** menu on the top right, select the **Data Inputs** option.
6. Select **Add New** under **Local Inputs** for a transmission control protocol (TCP) listener. (User datagram protocol [UDP] is not recommended, because it will cut off longer messages.)
7. Set the port to the one that you want to transfer data on. (NCCoE build used **10514**.)
8. Select **Next** to configure the Input Settings.
9. Choose **dragos_alert** as the source type.
10. Set the **App Context** to **Dragos Splunk App.**
11. Set the **Index** to **dragos_alerts.** (Create a new index if it does not exist.)
12. Click **Submit.**

Once this process is completed, Splunk is ready to receive data from Dragos. The following instructions will be for configuring the Dragos Sitestore for sending information to Splunk:

1. Navigate to the **Servers** tab at https://<sitestore>/syslog/app/#/servers.
2. Click **+ Add Server** to create a new server.
3. Configure the connection information to point to the Splunk server configured previously.
4. Set the following options:
    a. Protocol: TCP
    b. Message Format: RFC 5424 Modern Syslog
    c. Message Delimiter: Use newline delimiter for TCP and transport layer security (TLS) streams.
5. Click **NEXT: SET TEMPLATE.**
6. Set the following value (must be on one line for Splunk to properly process) as **Message:**

```
{ "app": "dragos:platform", "body": "${content}", "category": "${summary}",
"created_at": "#{createdAt}", "dest": "${dest_asset_ip}",
"dest_dragos_id": "${dest_asset_id}", "dest_host":
"${dest_asset_hostname}", "dest_ip": "${dest_asset_ip}", "dest_mac":
"${dest_asset_mac}", "dest_name": "${dest_asset_domain}",
"dragos_detection_quad": "${detection_quad}", "dragos_detector_id":
"${detector_id}", "dvc": "${asset_ip}", "dvc_dragos_id":
"${dest_asset_id}", "dvc_host": "${dest_asset_hostname}", "dvc_ip":
"${asset_ip}", "dvc_mac": "${dest_asset_mac}", "dvc_name":
```

```
"${dest_asset_domain}", "id": "${id}", "ids_type": "network",
"occurred_at": "#{occurredAt}", "severity_id": "${severity}",
"signature": "${source}", "src": "${src_asset_ip}", "src_dragos_id":
"${src_asset_id}", "src_host": "${src_asset_hostname}", "src_ip":
"${src_asset_ip}", "src_mac": "${src_asset_mac}", "src_name":
"${src_asset_domain}", "subject": "${type}", "type": "alert",
"vendor_product": "Dragos Platform" }
```

7. Select **Save.**

2.4 FoxGuard Patch and Update Management Program

The solution utilizes the FoxGuard PUMP to provide patch availability and vulnerability notifications for identified assets. For this build, ConsoleWorks collects asset data from Splunk then converts that data into the JavaScript object notation (JSON) format required for PUMP. The resulting JSON file includes asset information such as vendor, product, and version, as well as serial and model information about devices from the asset inventory. Asset data often contains critical details. However, PUMP does not require sensitive data, such as asset location and IP address. The file is encrypted and provided to the PUMP team via secure delivery. FoxGuard's preferred method of file transfer is secure file transfer protocol and does not require direct access to an entities network.

Once the asset data is received, the FoxGuard team analyzes the file for completeness. Any missing data, such as a serial number, version, or access to private patch data, is collected during the onboarding process with the end user. The final report is provided back to ConsoleWorks in a JSON file format and includes available patches and vulnerability notifications for each device. The data is then ingested back into Splunk for viewing and reporting. Reports are also available outside of the ConsoleWorks integration in portable document format (PDF) and comma separated value (CSV) format.

PUMP is a service managed by the FoxGuard team. The patch availability and vulnerability notification report does not require an installation. See Section 2.1 for configuring ConsoleWorks to automatically create the required JSON input file for the integration described in this guide.

2.4.1 Patch Report

Below are screenshots from the final patch report for this build.

828 **Figure 2-1 Update Availability Summary**

Update Availability Summary

The following table outlines a summary of all devices, patches and updates. This list includes all devices and/or applications within the scope of this document. Where devices manufacturers have released an update in a particular month, the reader will be advised to refer to a more detailed write-up subsequently listed in the report. All entries in the summary tables will be entered in alphabetical order by vendor, then device/software application starting with available patches first.

Devices & Applications

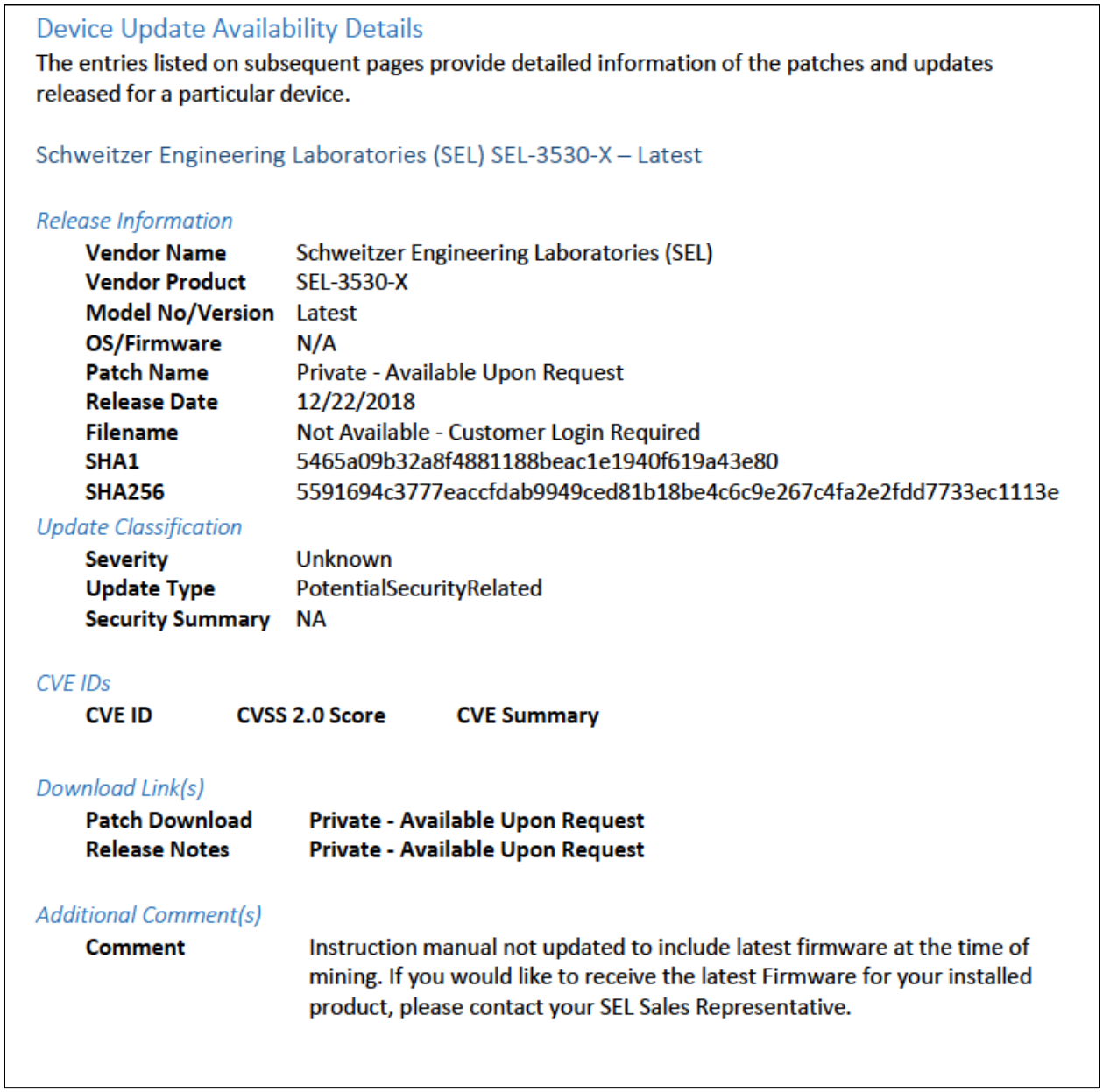
Vendor	Device	Model No.	Patch/Update Released?	Patch Name	FoxGuard Review Date	Vendor Release Date	Update Type	Error Message
Schweitzer Engineering Laboratories (SEL)	SEL-3530-X	Latest	Yes	Private - Available Upon Request	1/14/2019	12/22/2018	Potential Security Related	N/A
Schweitzer Engineering Laboratories (SEL)	SEL-3530-X	Latest	Yes	Private- Available Upon Request	2/5/2019	01/15/2019	Non-Security	N/A
Schweitzer Engineering Laboratories (SEL)	SEL-3530-X	Latest	Yes	Private Available Upon Request	3/26/2019	03/12/2019	Non-Security	N/A
Schweitzer Engineering Laboratories (SEL)	SEL-3530-X	Latest	Yes	Private - Available Upon Request	6/6/2019	05/18/2019	Non-Security	N/A
Schweitzer Engineering Laboratories (SEL)	SEL-451-X	R3XX	Yes	Private - Available Upon Request	1/15/2019	12/28/2018	Non-Security	N/A

829

Vendor	Device	Model No.	Patch/Update Released?	Patch Name	FoxGuard Review Date	Vendor Release Date	Update Type	Error Message
Schweitzer Engineering Laboratories (SEL)	SEL-3610XX	N/A	No	N/A	8/21/2019	N/A	N/A	N/A
Schweitzer Engineering Laboratories (SEL)	SEL-362XX	N/A	No	N/A	8/21/2019	N/A	N/A	N/A
Siemens	RSG-XXXX	4.x	No	N/A	9/6/2019	N/A	N/A	N/A
Siemens	RuggedCom RSXXX	Latest	No	N/A	9/4/2019	N/A	N/A	N/A

830

831 **Figure 2-2 Device Update Availability Details-1**



Device Update Availability Details

The entries listed on subsequent pages provide detailed information of the patches and updates released for a particular device.

Schweitzer Engineering Laboratories (SEL) SEL-3530-X – Latest

Release Information

Vendor Name	Schweitzer Engineering Laboratories (SEL)
Vendor Product	SEL-3530-X
Model No/Version	Latest
OS/Firmware	N/A
Patch Name	Private - Available Upon Request
Release Date	12/22/2018
Filename	Not Available - Customer Login Required
SHA1	5465a09b32a8f4881188beac1e1940f619a43e80
SHA256	5591694c3777eaccfdab9949ced81b18be4c6c9e267c4fa2e2fdd7733ec1113e

Update Classification

Severity	Unknown
Update Type	PotentialSecurityRelated
Security Summary	NA

CVE IDs

CVE ID	CVSS 2.0 Score	CVE Summary

Download Link(s)

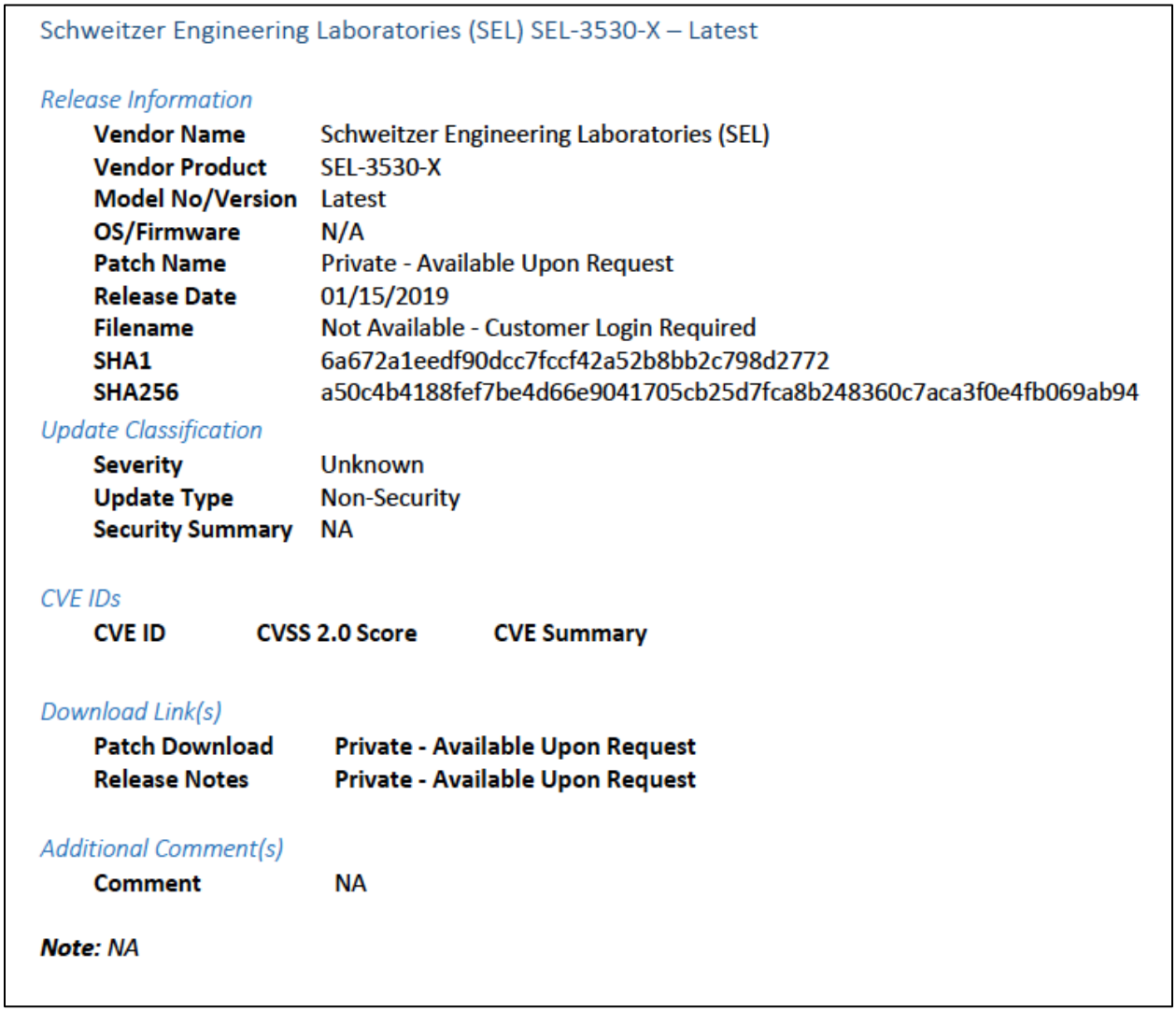
Patch Download	**Private - Available Upon Request**
Release Notes	**Private - Available Upon Request**

Additional Comment(s)

Comment	Instruction manual not updated to include latest firmware at the time of mining. If you would like to receive the latest Firmware for your installed product, please contact your SEL Sales Representative.

832

833 **Figure 2-3 Device Update Availability Details-2**



Schweitzer Engineering Laboratories (SEL) SEL-3530-X – Latest

Release Information

Vendor Name	Schweitzer Engineering Laboratories (SEL)
Vendor Product	SEL-3530-X
Model No/Version	Latest
OS/Firmware	N/A
Patch Name	Private - Available Upon Request
Release Date	01/15/2019
Filename	Not Available - Customer Login Required
SHA1	6a672a1eedf90dcc7fccf42a52b8bb2c798d2772
SHA256	a50c4b4188fef7be4d66e9041705cb25d7fca8b248360c7aca3f0e4fb069ab94

Update Classification

Severity	Unknown
Update Type	Non-Security
Security Summary	NA

CVE IDs

CVE ID	CVSS 2.0 Score	CVE Summary

Download Link(s)

Patch Download	**Private - Available Upon Request**
Release Notes	**Private - Available Upon Request**

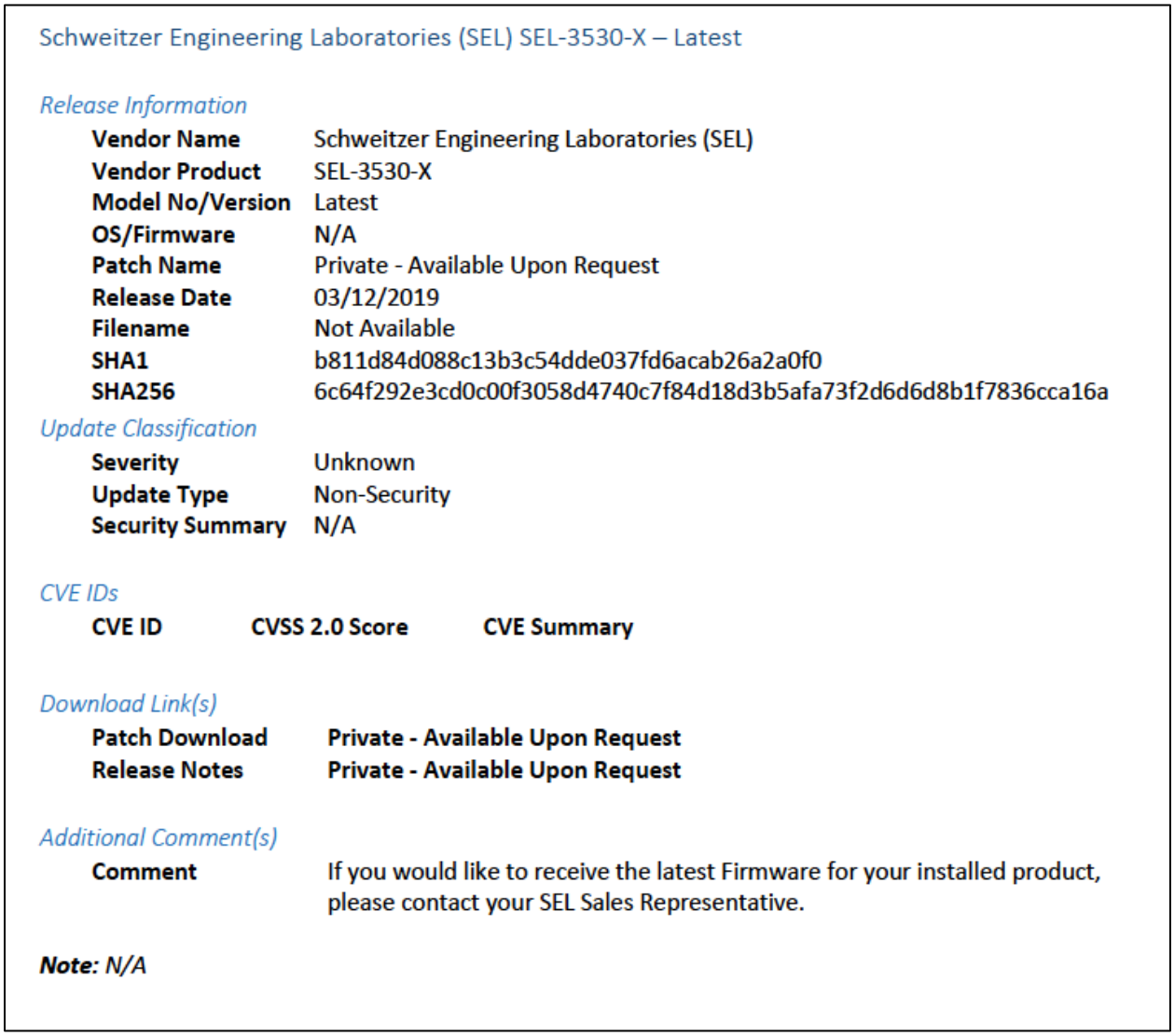
Additional Comment(s)

Comment	NA

Note: *NA*

834

835 **Figure 2-4 Device Update Availability Details-3**



Schweitzer Engineering Laboratories (SEL) SEL-3530-X – Latest

Release Information

Vendor Name	Schweitzer Engineering Laboratories (SEL)
Vendor Product	SEL-3530-X
Model No/Version	Latest
OS/Firmware	N/A
Patch Name	Private - Available Upon Request
Release Date	03/12/2019
Filename	Not Available
SHA1	b811d84d088c13b3c54dde037fd6acab26a2a0f0
SHA256	6c64f292e3cd0c00f3058d4740c7f84d18d3b5afa73f2d6d6d8b1f7836cca16a

Update Classification

Severity	Unknown
Update Type	Non-Security
Security Summary	N/A

CVE IDs

CVE ID	CVSS 2.0 Score	CVE Summary

Download Link(s)

Patch Download	**Private - Available Upon Request**
Release Notes	**Private - Available Upon Request**

Additional Comment(s)

Comment	If you would like to receive the latest Firmware for your installed product, please contact your SEL Sales Representative.

***Note:** N/A*

836

837 **Figure 2-5 Device Update Availability Details-4**

Schweitzer Engineering Laboratories (SEL) SEL-3530-X – Latest

Release Information

Vendor Name	Schweitzer Engineering Laboratories (SEL)
Vendor Product	SEL-3530-X
Model No/Version	Latest
OS/Firmware	N/A
Patch Name	Private - Available Upon Request
Release Date	05/18/2019
Filename	Not Available
SHA1	70a1285fb6a711a29a710f0cc5f45af69694f087
SHA256	409b8fa17f8989d5e75a1f4a4a8aab27e511eb2cd8b5fdc653117d9dd27064bb

Update Classification

Severity	Unknown
Update Type	Non-Security
Security Summary	N/A

CVE IDs

CVE ID	CVSS 2.0 Score	CVE Summary

Download Link(s)

Patch Download	**Private - Available Upon Request**
Release Notes	**Private - Available Upon Request**

Additional Comment(s)

Comment	If you would like to receive the latest Firmware for your installed product, please contact your SEL Sales Representative.

Note: *N/A*

838

839 **Figure 2-6 Device Update Availability Details-5**

Schweitzer Engineering Laboratories (SEL) SEL-451-X – R3XX

Release Information

Vendor Name	Schweitzer Engineering Laboratories (SEL)
Vendor Product	SEL-451-X
Model No/Version	R3XX
OS/Firmware	N/A
Patch Name	Private - Available Upon Request
Release Date	12/28/2018
Filename	Not Available-Customer login required
SHA1	956351bd948001301a1c3726a0ece25a638aa4d0
SHA256	212ac18155b2b7a5d7cdabb7897c3b5cea1ebe84fb4c1bf31bd604ea5193a924

Update Classification

Severity	Unknown
Update Type	Non-Security
Security Summary	NA

CVE IDs

CVE ID	CVSS 2.0 Score	CVE Summary

Download Link(s)

Patch Download	**Private - Available Upon Request**
Release Notes	**Private - Available Upon Request**

Additional Comment(s)

Comment	NA

840

841 **Figure 2-7 Patch Evidence Documentation**

Patch Evidence Documentation

The following table outlines a list of all devices with links to evidence of all patches released. This list includes all devices and/or applications within the scope of this document. Where devices manufacturers have released an update in a particular month, the evidence listed within the link will validate the patch information in this report. Where devices manufacturers have not released an update in a particular month, the evidence listed within the link will validate that no patches were released.

Vendor	Device	Model No.	Patch/Update Released?	FoxGuard Review Date	Patch Quantity Evidence Documentation Link
Schweitzer Engineering Laboratories (SEL)	**SEL-3530-X**	**Latest**	**Yes**	**1/14/2019**	**https://portal.icsupdate.com/PatchEvidence/8267e758-edcb-a6e2-4340-525c4264XXX**
Schweitzer Engineering Laboratories (SEL)	**SEL-3530-X**	**Latest**	**Yes**	**2/5/2019**	**https://portal.icsupdate.com/PatchEvidence/8267e758-edcb-a6e2-4340-525c4264cXXX**
Schweitzer Engineering Laboratories (SEL)	**SEL-3530-X**	**Latest**	**Yes**	**3/26/2019**	**https://portal.icsupdate.com/PatchEvidence/8267e758-edcb-a6e2-4340-525c4264cXXX**
Schweitzer Engineering Laboratories (SEL)	**SEL-3530-X**	**Latest**	**Yes**	**6/6/2019**	**https://portal.icsupdate.com/PatchEvidence/8267e758-edcb-a6e2-4340-525c4264cXXX**
Schweitzer Engineering Laboratories (SEL)	**SEL-451-X**	**R3XX**	**Yes**	**1/15/2019**	**https://portal.icsupdate.com/PatchEvidence/9441285c-afc0-73cf-9acc-7084d9c45XXX**
Schweitzer Engineering Laboratories (SEL)	SEL-361XX	N/A	No	8/21/2019	https://portal.icsupdate.com/PatchEvidence/f263af0a-86c3-d608-464e-7b849f89cXXX
Schweitzer Engineering Laboratories (SEL)	SEL-362XX	N/A	No	8/21/2019	https://portal.icsupdate.com/PatchEvidence/62e1621a-5310-b484-9c6f-fcf958a5eXXX

842

Vendor	Device	Model No.	Patch/Update Released?	FoxGuard Review Date	Patch Quantity Evidence Documentation Link
Siemens	RSG-XXX	4.x	No	9/6/2019	https://portal.icsupdate.com/PatchEvidence/ca85e557-3317-2012-4b9f-c4cde2313XXX
Siemens	RuggedCom RSXXX	Latest	No	9/4/2019	https://portal.icsupdate.com/PatchEvidence/81923124-e84c-9446-2fcc-83115646eXXX

843

844 2.5 Kore Wireless

845 This solution leverages a Kore Wireless virtual private network (VPN) to provide secure remote access to
846 remote assets. In this case, the remote asset is an Obvius A8812 Data Acquisition Server that provides
847 access to data from a Yokogawa flow meter.

848 Note: Some network information is excluded for security.

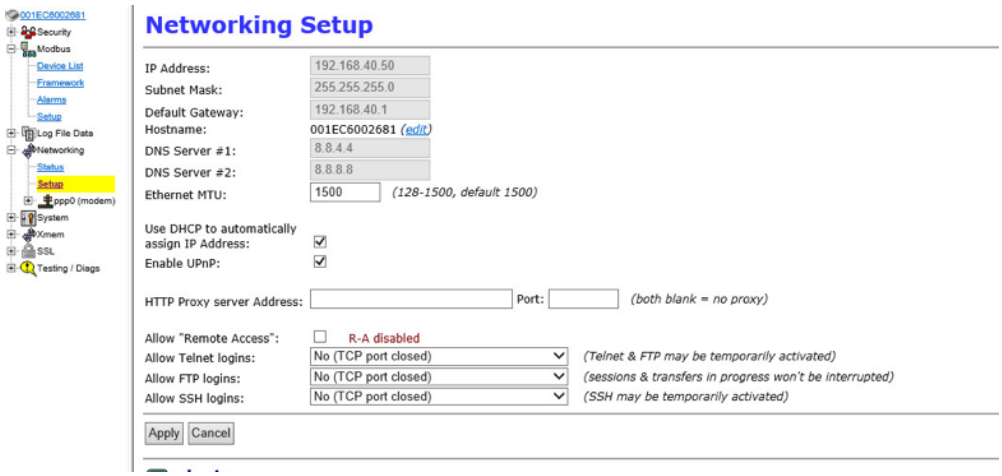
2.5.1 Bridge Configuration

2.5.1.1 Installation

1. Connect the MultiConnect eCell Ethernet port to the Ethernet port on the Obvius A8812 Data Acquisition Server.
2. Connect the Obvius A8812 RS485 to the multidrop Modbus network with the remote steam meter asset.

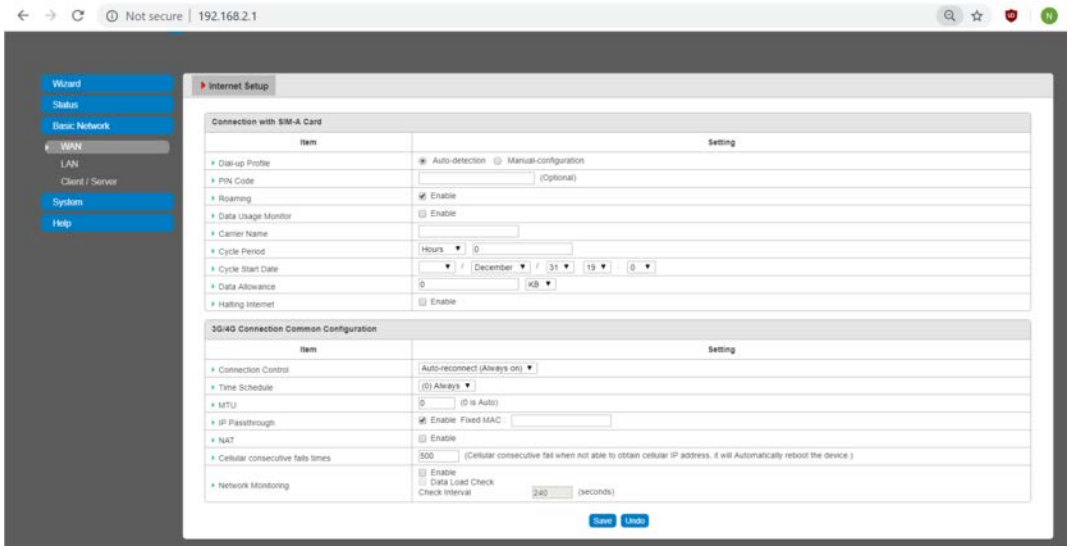
2.5.1.2 Network

1. Set Obvius A8812 to **DHCP.**
    a. Navigate the IP address of the Obvius A8812. Default is *192.168.40.50*.
    b. Open the **Networking** drop-down menu, and select **Setup**.
    c. Check the **Use DHCP to automatically assign IP Address** checkbox.



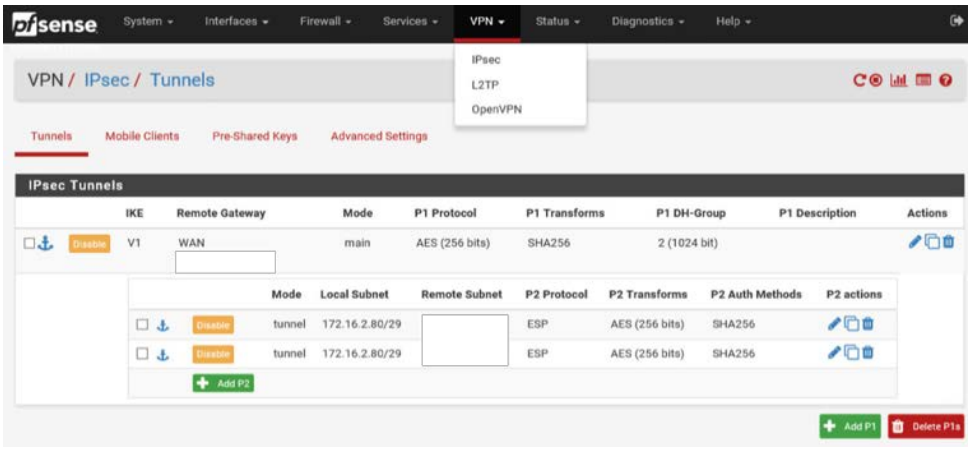
2. Set MultiConnect eCell to Auto-detect Dialup profiles.
    a. Navigate the IP address of the MultiConnect eCell. Default is *192.168.40.50*.
    b. Open the **WAN** menu.

c. Set the Dial-up Profile to **Auto-detection.**



2.5.2 Virtual Private Network Configuration

1. Navigate to **VPN > IPsec** in pfsense.



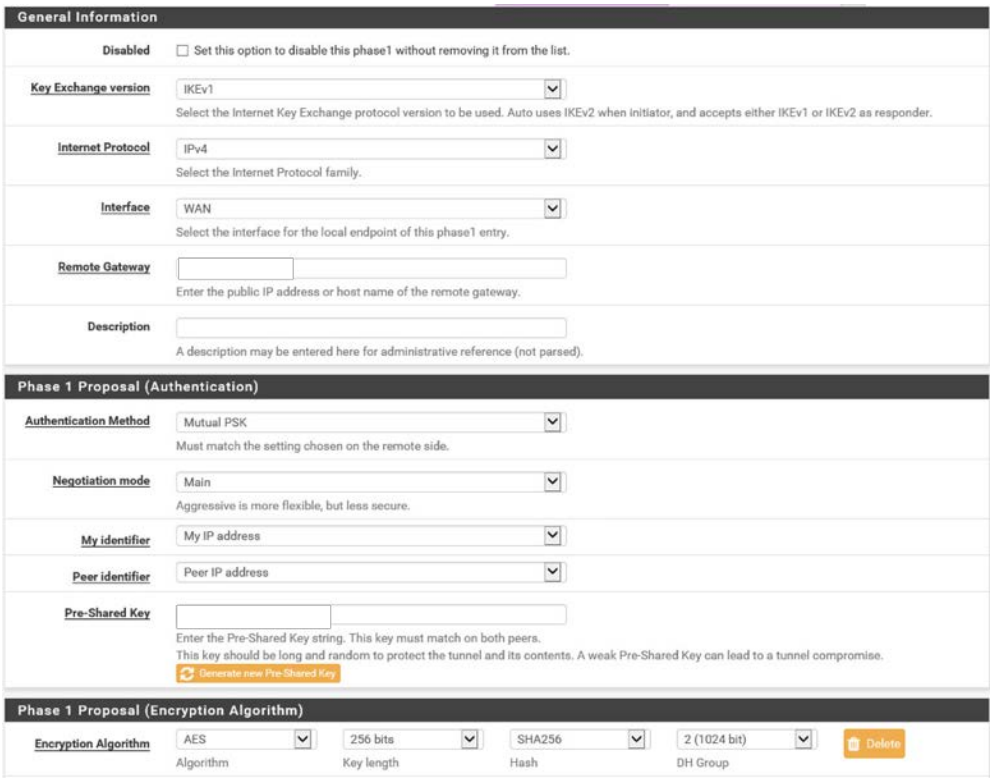
2. Click the **Add P1** button.
3. Set **Remote Gateway.**
4. Set **Authentication Method** to `Mutual PSK`.
5. Set **Pre-Shared Key.**
6. Set **Encryption Algorithm** settings:

a. **Algorithm:** AES

b. **Key Length:** 256 bits

c. **Hash:** SHA256

d. **Diffie-Hellman Group:** 2 (1024 bit)



7. Return to **VPN > IPsec.**

8. Click the **Add P2** button.

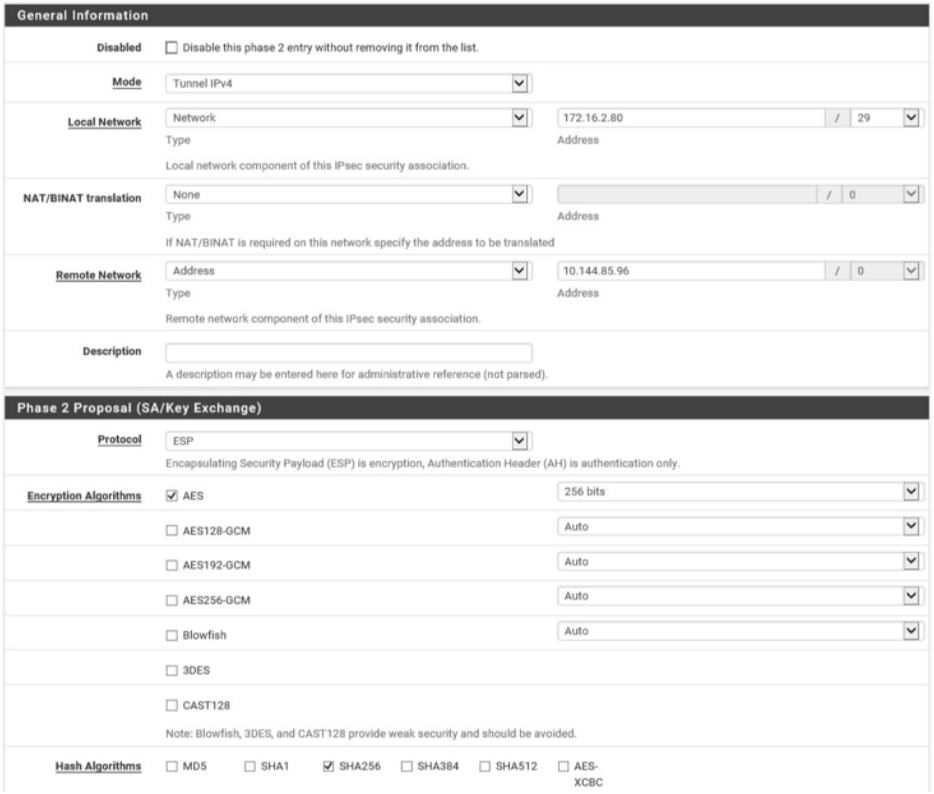
9. Set **Local Network** to 172.16.2.80/29.

10. Set **Remote Network.**

11. Set **Protocol** to ESP.

12. Set **Encryption Algorithm** to AE 256 bits.

13. Set **Hash Algorithm** to SHA256.



2.6 pfSense VPN

pfSense is an open-source firewall/router used to create both site-to-site VPN tunnels. The following configuration file can be used to upload all configurations to the enterprise location edge router. Both the UMD and Plano edge routers are excluded for security purposes.

2.6.1 Plano and UMD VPN Configuration

To configure a site-to-site OpenVPN connection, refer to https://docs.netgate.com/pfsense/en/latest/vpn/openvpn/index.html.

2.7 Splunk

Splunk is a security information and event management (SIEM) system that allows collecting and parsing logs and data from multiple systems.

2.7.1 Splunk Enterprise Configuration

2.7.1.1 VM Configuration

The Splunk VM is configured as follows:

- Ubuntu Mate 16.04.2
- 2 CPU cores
- 10 GB of RAM
- 2 TB of storage
- 1 NIC

2.7.1.2 Network

Network Configuration (Interface 1):

- IPv4: Manual
- IPv6: disabled
- IPv4 address: *10.100.200.101*
- Netmask: *255.255.255.0*
- Gateway: *10.100.200.1*

2.7.1.3 Installation

Note: A Splunk account will be needed to download Splunk Enterprise. The account is free and can be set up at https://www.splunk.com/page/sign_up.

Download Splunk Enterprise from https://www.splunk.com/en_us/download/splunk-enterprise.html. This build uses Version 7.1.3. Splunk can be installed on Windows, Linux, Solaris, and Mac OS X. Each of these installation instructions is provided at http://docs.splunk.com/Documentation/Splunk/7.1.3/Installation/Beforeyouinstall.

2.7.1.4 Universal Forwarder

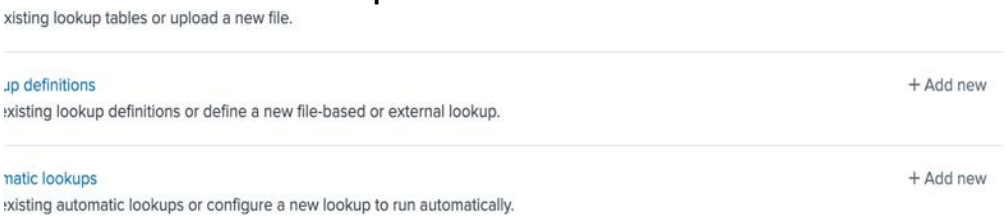
To install the universal forwarder, refer to documentation found at https://docs.splunk.com/Documentation/Forwarder/7.3.1/Forwarder/Installtheuniversalforwardersoftware.

Refer to each individual product to configure the universal forwarder or another means of integration with Splunk.

2.7.1.5 Reports and Alerts

If desired, lookup tables can be used to cross-check automated detections with human knowledge of a device. Some properties are cross-checked with human knowledge at both the UMD and Plano sites. Patch information from PUMP also uses a lookup table to cross-check results with devices. To upload lookup tables:

1. Log in to Splunk.
2. Go to **Settings > Lookups.**
3. Select **+ Add New** under **Lookup table files.**



4. Choose **Search** as the **Destination App.**
5. Browse for the CSV file. Name the Lookup file. Select **Save.**

The UMD lookup CSV file contains the following fields:

```
Asset Id,IP,Device,Platform
```

The Plano lookup CSV file contains the following fields:

```
Asset Id,IP,Vendor,Product Name,Serial Number,Version
```

Once integrations are complete, the following Splunk queries will create the desired reports:

2.7.1.5.1 Asset Report for Both Sites

```
index=_* OR index=* sourcetype=CTD_csv | table asset_id site_id name_ ip_ mac_ type_
vendor_ criticality_ risk_level is_ghost | sort site_id | where isnum(asset_id)
```

2.7.1.5.2 Asset Report for UMD

```
index=_* OR index=* sourcetype=CTD_csv | where isnum(asset_id)  | table asset_id
site_id name_ ip_ mac_ type_ vendor_ criticality_ risk_level is_ghost Device Platform
| sort site_id | search ip_=206.189.122* | lookup umd_lookup.csv "Asset Id" AS
asset_id OUTPUT "Device" AS Device, Platform AS Platform
```

2.7.1.5.3 Asset Report for Plano (Static)

```
index=_* OR index=* sourcetype=CTD_csv | where isnum(asset_id)  | table asset_id
site_id name_ ip_ mac_ type_ vendor_ criticality_ risk_level is_ghost Serial_Number
Version | sort site_id | search ip_=10.172.6* | lookup plano_lookup.csv "Asset Id" AS
asset_id OUTPUT "Serial Number" AS Serial_Number, Version AS Version
```

2.7.1.5.4 Asset Report for Plano (Dynamic)

```
index=forescout

|table ip mac "host_properties.nmap_banner7{}.value" nbthost
"host_properties.nmap_def_fp5{}.value" "host_properties.user_def_fp{}.value"
"host_properties.server_session{}.value"

|stats
values(mac),values("host_properties.nmap_banner7{}.value"),values(nbthost),values("hos
t_properties.nmap_def_fp5{}.value"),values("host_properties.user_def_fp{}.value"),valu
es("host_properties.server_session{}.value") by ip

|rename values(mac) as mac_address, values(host_properties.nmap_banner7{}.value) as
ports_and_services, values(nbthost) as hostname,
values(host_properties.nmap_def_fp5{}.value) as device_footprints,
values(host_properties.user_def_fp{}.value) as device_footprints2,
values(host_properties.server_session{}.value) as server_session_properties
```

2.7.1.5.5 UMD Steam Meter Data

```
index=modbus |rex "CWScript BCM:(?<name>.\w+)" | rex field=_raw "Flow Rate :
(?<flowRate>.*)" | rex field=_raw "Gal Total : (?<GalTotal>.*)" | transaction
maxspan=30s | table name _time flowRate GalTotal
```

2.7.1.5.6 UMD Device Data Calls

```
(index=* OR index=_*) (index=main host="10.100.100.111" NOT "cs2=UP") | table shost
src smac dhost dst dmac cs6 cs3 cs7 cs8 msg
```

2.7.1.5.7 Patch Report for FoxGuard PUMP

```
index=test sourcetype="csv" | lookup plano_lookup.csv "Asset Id" AS Asset_Id OUTPUT
"Serial Number" AS Serial_Number, Version AS Version | table Asset_Id IP Mac Vendor
"Operating System" Serial_Number Version Criticality Protocols | join IP type=left
[search index=test sourcetype=CTD_csv_report] | fields "Asset Id" IP Mac Vendor
"Operating System" Serial_Number Version | where isnotnull(Serial_Number) OR
isnotnull(Version) | sort IP | outputcsv patchreport.csv
```

2.8 Tripwire Industrial Visibility

Tripwire Industrial Visibility is used to passively scan the industrial control environments at both the College Park and Plano locations in the build. Tripwire Industrial Visibility builds a baseline of assets and network traffic between those assets then alerts on anomalous activity. Logs and alerts are reported up to the SIEM.

Tripwire Industrial Visibility is installed at three locations: Plano, Texas (TDi); UMD; and the NCCoE. This section describes how to deploy Tripwire Industrial Visibility 3.0.0.

Tripwire Industrial Visibility taps into OT network communication by listening through the SPAN port of routers and switches connected to the network segment, opening data packets, and interpreting protocols without disrupting normal operations.

By reading network traffic, it isolates all assets on the network and maps the flow of traffic between them. This data is then used to create graphical network maps.

2.8.1 Tripwire Industrial Visibility Configuration UMD

The following subsections document the software, hardware/VM, and network configurations for the Tripwire Industrial Visibility servers.

2.8.1.1 VM Configuration

The Tripwire Industrial Visibility VM was given the following resources:

- CentOS 7.5
- 4 CPU cores
- 100 GB hard disk
- 32 GB RAM
- 2 NICs

2.8.1.2 Network Configuration

Network Configuration:

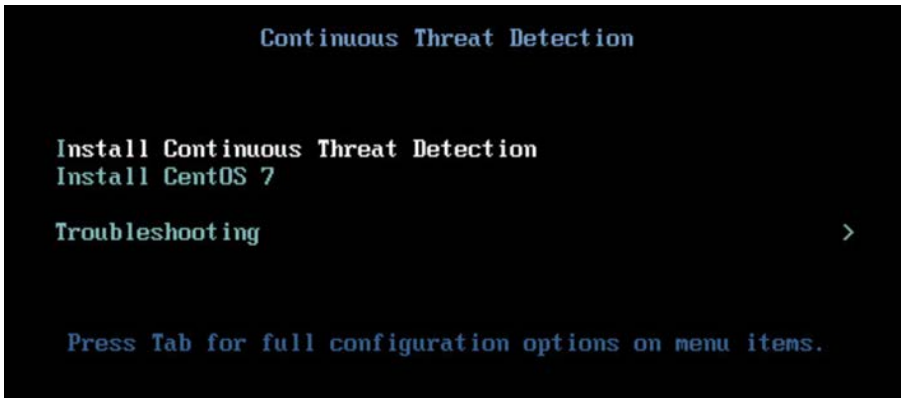
- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: *10.100.100.111*
- Netmask: *255.255.255.0*
- Gateway: *10.100.100.1*

2.8.1.3 Installation

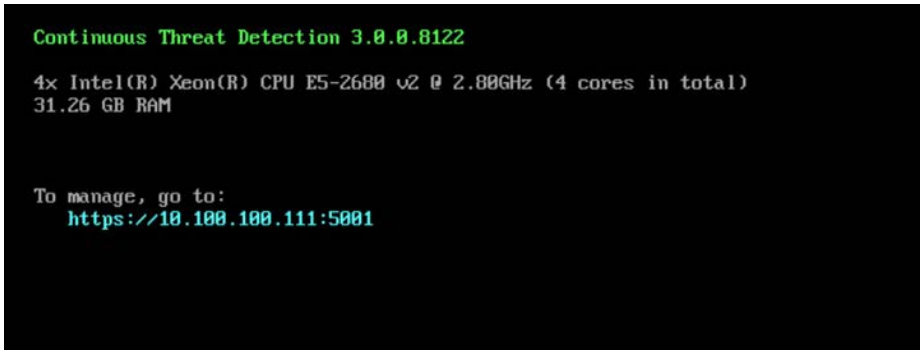
Tripwire supplied the Tripwire Industrial Visibility as an ISO installer. To configure TIV, use the ISO installer for each instance at Plano, UMD, and the NCCoE. Tripwire Industrial Visibility is configured in a sensor-server architecture. Plano and UMD instances act as sensors, and the NCCoE instance is the central server.

To begin installation, mount the provided image to the VM, and complete the following steps:

1. From the boot menu, select **Install Continuous Threat Detection.**



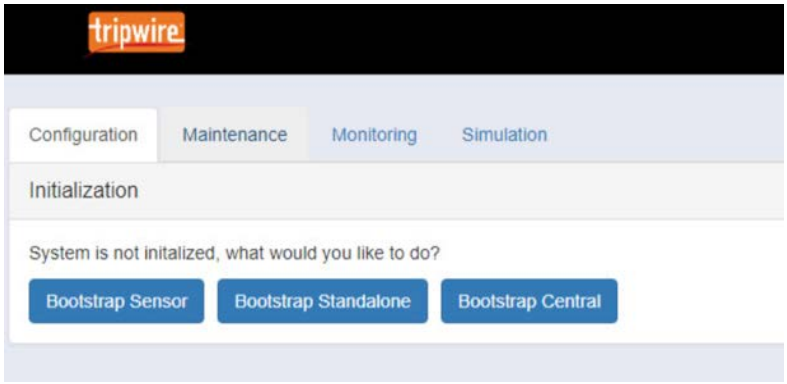
2. When the system is up, navigate to the configurator tool by using a browser.



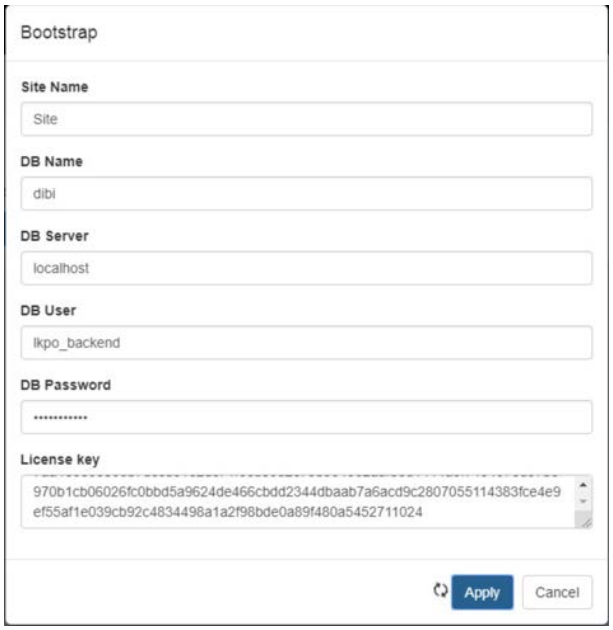
2.8.1.4 Configuration

Configure the Tripwire Industrial Visibility sensors.

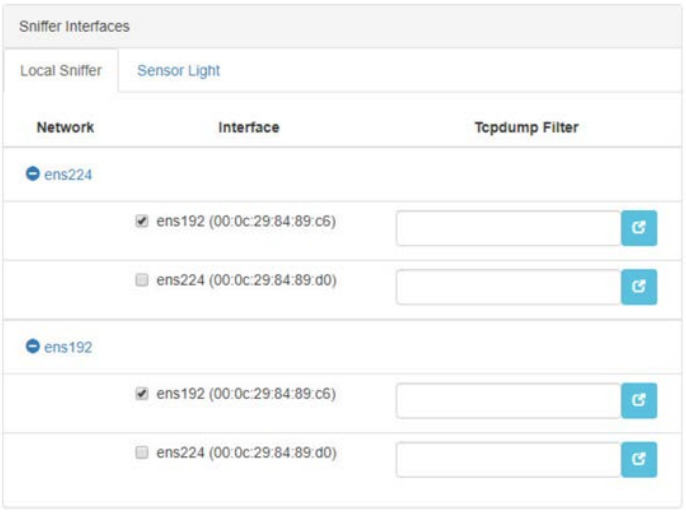
1. Connect to the configuration tool by entering the following URL into the browser: *https://10.100.100.11:5001.*
2. Enter the default credentials.
3. On the **Configuration** tab, the system will need to be initialized. Select **Bootstrap Sensor** (for Plan and UMD sites).



4. Enter the details and License Key. Select **Apply.**

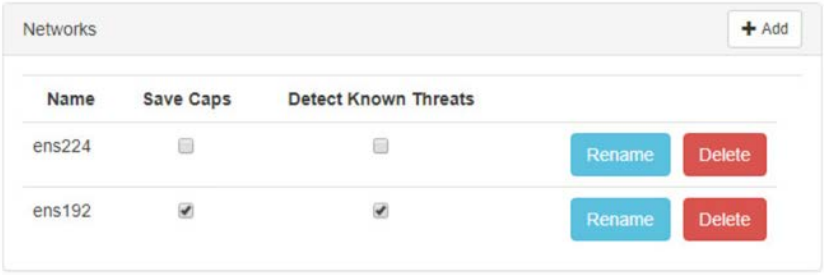


5. Set the Sniffer Interface on the **Configuration** tab. Select the interfaced used as the SPAN port. Select **Apply.**



1034

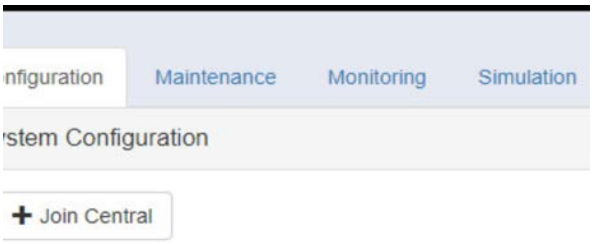
1035 6. Under **Networks,** select **Save Caps** and **Detect Known Threats** for the appropriate interface.



1036

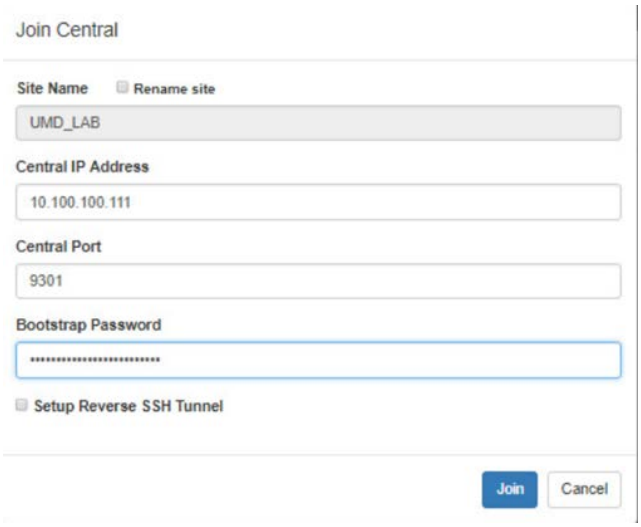
1037 7. Next, Join the Sensor to the Sensor Server. Set up the Central Server in Section 2.8.3 before
1038 completing these steps.

1039 8. Select **Join Central,** from the **Configuration** tab.



1040

1041 9. Name the Sensor, and enter the IP address of the Central Server. Enter the Bootstrap password
1042 found on the Central Server. Select **Join.**

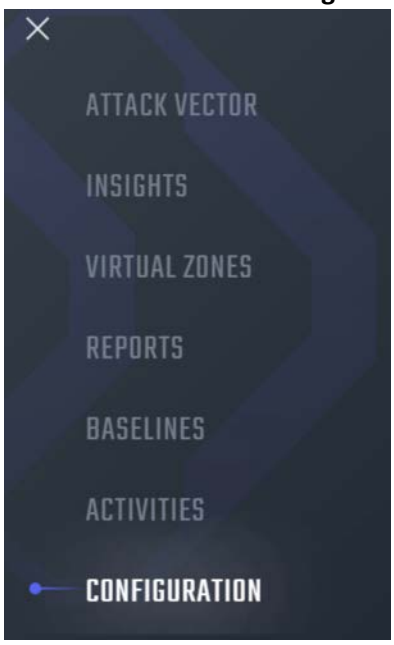


10. Connect to the continuous threat detection (CTD) Dashboard: *https://10.100.1.17:5000*.

The system is started in Training Mode. After an acceptable amount of time passes, place the system in Operational Mode. This build used one month as the training period.

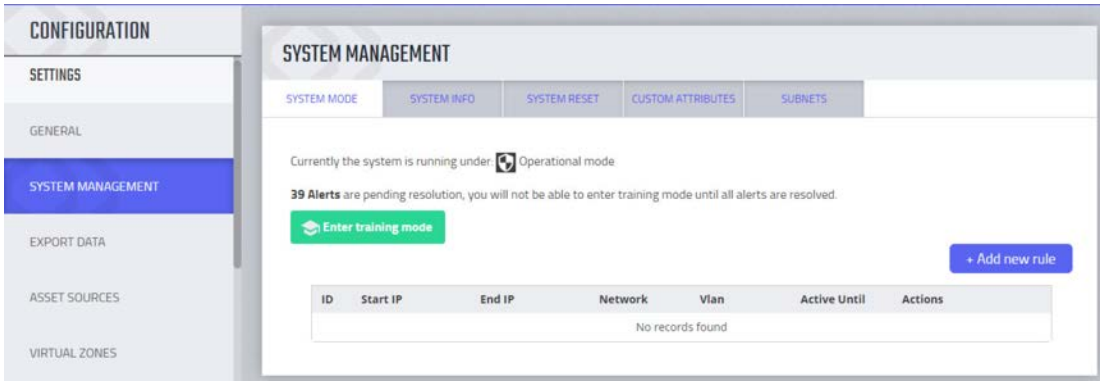
1. Select the hamburger icon in the top left corner.

2. Scroll down to select **Configuration**.

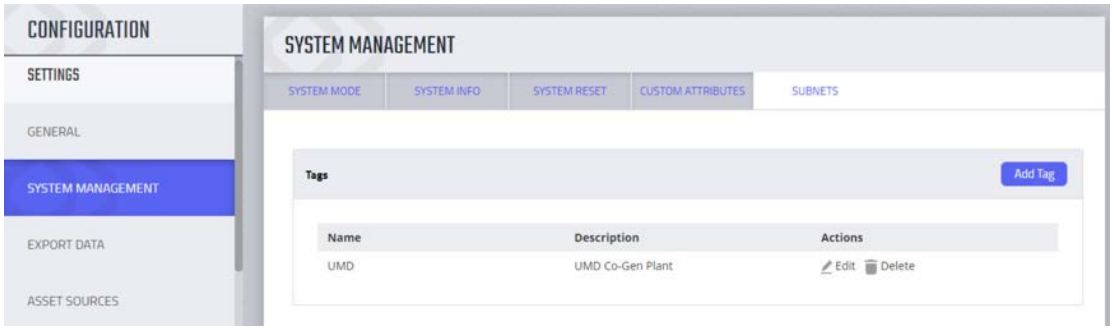


3. Select **System Management.**

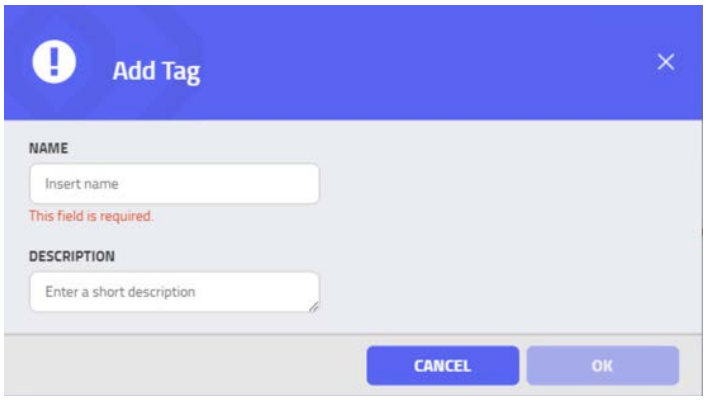
4. Select the **System Mode** tab. Click **Enter Operational Mode.** Note: The screen will show **Enter Training Mode,** if the system is already in Operational Mode.



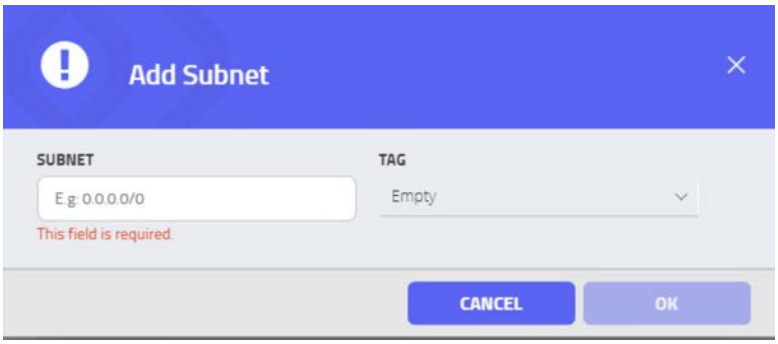
5. Select the **Subnets** tab. Click **Add Tag.**



6. Name a new Tag, and add the description. Select **OK.**



7. Click **Add Subnet.** Enter the Subnet that the assets are on and the previously created TAG. Select **OK.**



8. Repeat Steps 16 and 17 for multiple subnets.

2.8.2 Tripwire Industrial Visibility Configuration Plano

The following subsections document the software, hardware/VM, and network configurations for the Tripwire Industrial Visibility servers.

2.8.2.1 VM Configuration

The Tripwire Industrial Visibility VM was given the following resources:

- CentOS 7.5
- 1 CPU Core
- 8 GB RAM
- 200 GB hard disk
- 3 NICs

2.8.2.2 Network Configuration

Network Configuration:

- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: *10.100.100.111*
- Netmask: *255.255.255.0*
- Gateway: *10.100.100.1*

2.8.2.3 Installation

Repeat steps in Section 2.8.1.3.

2.8.2.4 Configurations

Repeat steps in Section 2.8.1.4.

2.8.3 Tripwire Industrial Visibility Configuration National Cybersecurity Center of Excellence

Tripwire Industrial Visibility at the NCCoE serves as the central server.

2.8.3.1 VM Configuration

The Tripwire Industrial Visibility VM was given the following resources:

- CentOS 7.5
- 4 CPU cores
- 80 GB hard disk
- 32 GB RAM
- 1 NIC

2.8.3.2 Network Configuration

Network Configuration:

- DHCP: disabled
- IPv6: ignore
- IPv4: Manual
- IPv4 address: *10.100.100.111*
- Netmask: *255.255.255.0*
- Gateway: *10.100.100.1*

2.8.3.3 Installation

Repeat steps in Section 2.8.1.3.

2.8.3.4 Configurations

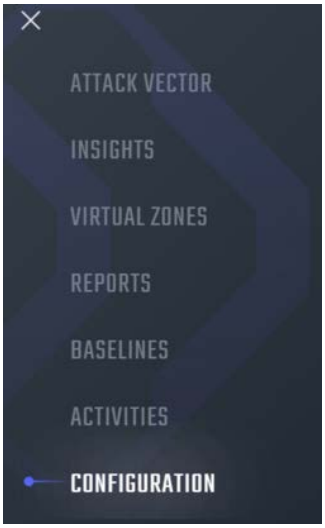
Repeat Steps 1–4 in Section 2.8.1.4.

In Step 3, select **Bootstrap Central.**

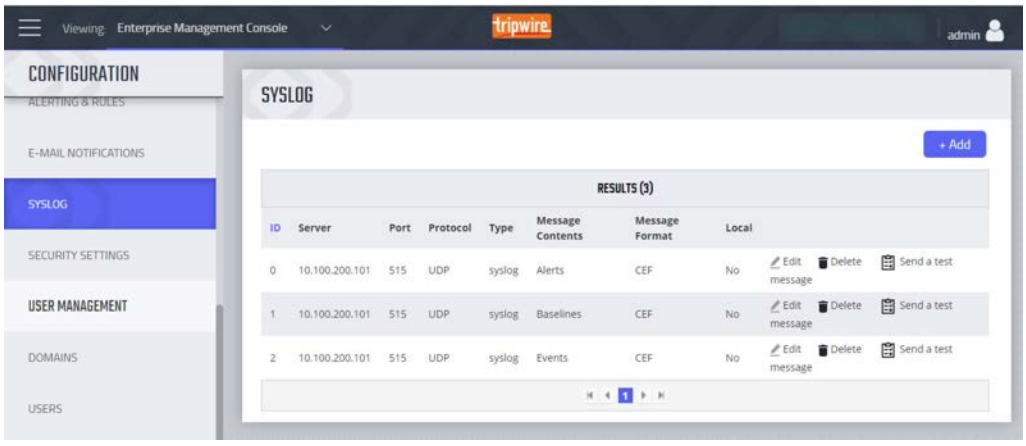
To complete the configuration: set up syslog, schedule a report, and install the Claroty application on Splunk.

1. Connect to the CTD Dashboard: *https://10.100.100.1111:5000.*
2. Select the hamburger menu in the top left corner.

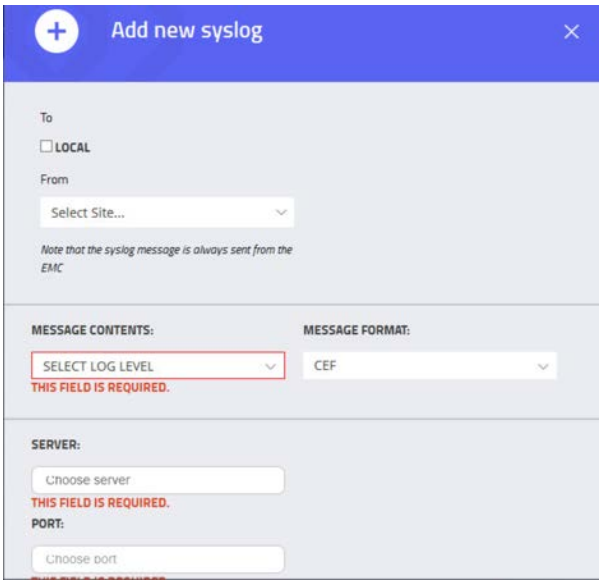
3. Scroll down to select **Configuration.**



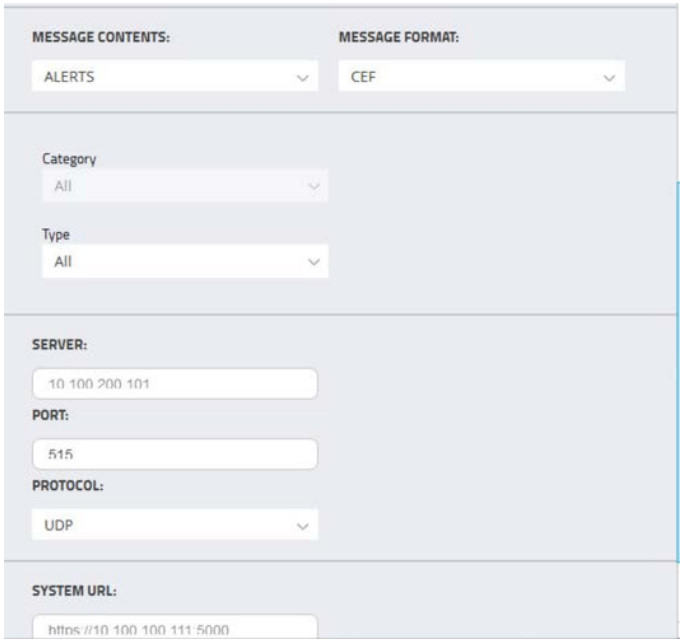
4. Select **Syslog.** Select **Add.**



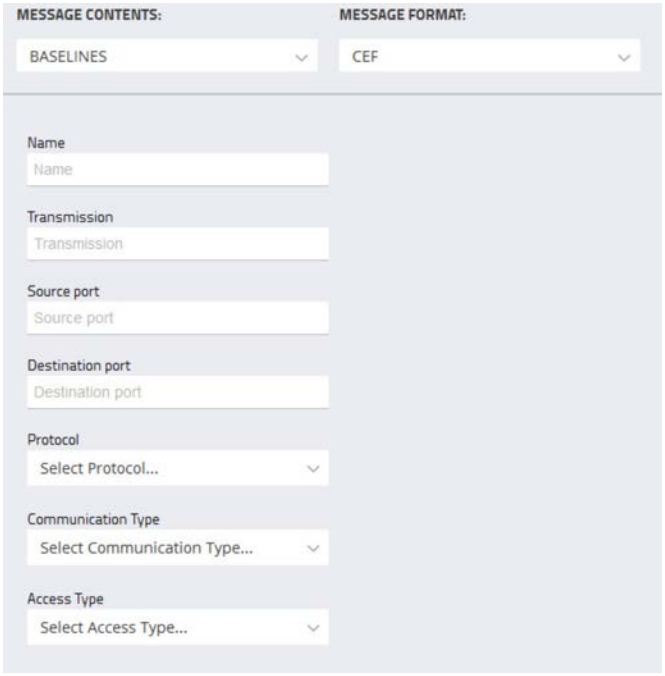
5. Uncheck **Local.** Do not Select a Site.



6. Select Alerts for the **Log Level.** Enter the IP address for the Splunk server under **Server.** Enter **Port** 515 and **Protocol** UDP**.** Select all boxes under **Category** and all boxes under **Type.** Leave the **System URL** and the **Message Format** as the default.



7. Select **Save**.
8. Select **Add** to add another.
9. Select **Baselines** under **Message Contents.**



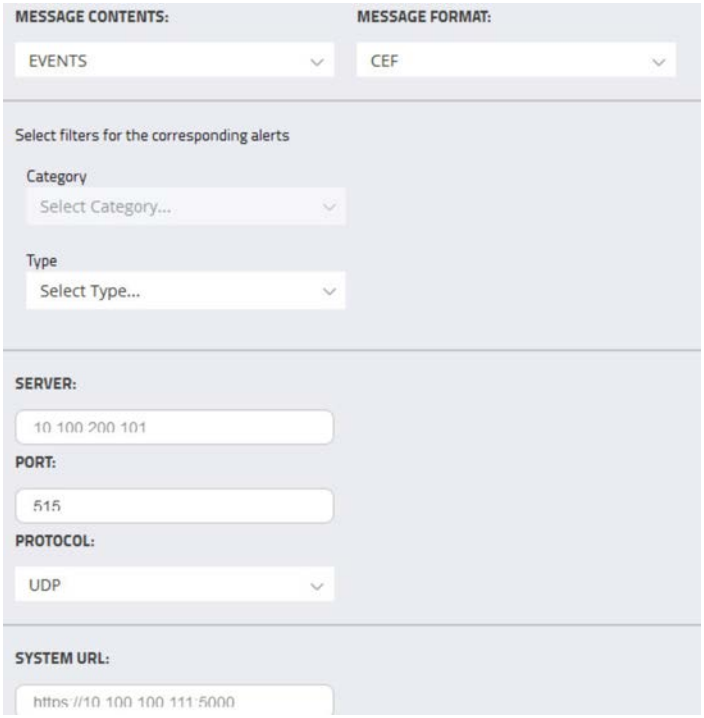
1126

1127 10. Enter the Splunk IP for **Server, Port** 515, and **Protocol** UDP. Leave **System URL** as the default. Click
1128 **Save.**

1129

1130 11. Select **Add** to add another.

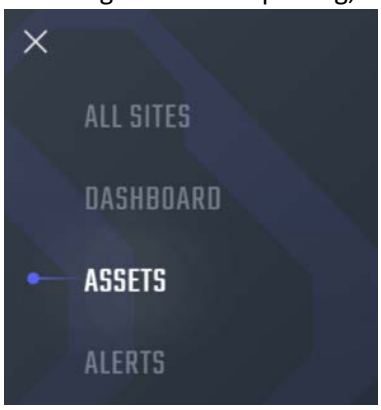
1131 12. Select **EVENTS** for **Message Contents**. Enter the Splunk IP for **Server, Port** 515, and **Protocol** UDP.
1132 Leave the **System URL** as default.



1133

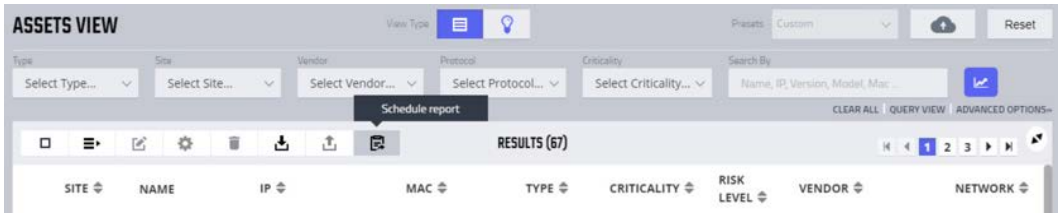
1134 13. Click **Save.**

1135 14. To configure Asset Reporting, select **Assets** from the hamburger menu.



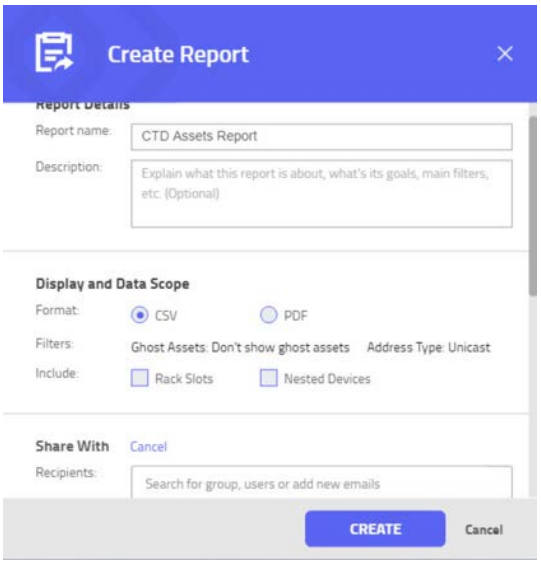
1136

1137 15. From the **Assets** list, select the report icon in the menu bar, to schedule a report.



1138

16. Name the report, and select **CSV** as the **Format.** Enter a recipient to receive and download the report. Schedule the report to run at an acceptable interval. This build scheduled the report to run daily. Click **Create.**



2.8.3.5 Tripwire Splunk Integration

To integrate Tripwire with Splunk, install the Claroty Continuous Detection Application for Splunk. Additionally, install the Splunk Universal Forwarder to forward the CSV report.

1. Download the Claroty Continuous Detection Application for Splunk from https://splunkbase.splunk.com/app/4529/.
2. Log in to Splunk.
3. On the **Apps** menu, click **Manage Apps.**
4. Click **Install app** from file.
5. In the **Upload app** window, click **Choose File.**
6. Locate the downloaded *.tar.gz* file, and then click **Open** or **Choose.**
7. Click **Upload.**
8. Click **Restart Splunk,** and then confirm the restart.
9. To install Splunk Universal Forwarder, follow the steps in Section 2.7.1.4.
10. Place the following text in the */opt/splunkforwarder/etc/system/local/outputs.conf* file:

```
[tcpout]
defaultGroup = default-autolb-group
[tcpout:default-autolb-group]
Server = 10.100.200.101:9997
[tcpout-server://10.100.200.101:9997]
```

11. Place the following text in the */opt/splunkforwarder/etc/system/local/deploymentclient.conf* file:

```
[target-broker:deploymentserver]
targetURI = 10.100.200.101:8089
```

14. Log in to Splunk. Go to **Settings > Data Inputs > Files & Directories.**
15. Select **New Remote File & Directory.**
16. Select the host on which the forwarder is installed. Name the Server Class. Click **Next.**
17. Input the CSV file to monitor, i.e., /home/esam/attachments/report.csv.
18. Select **Next.**
19. Select **Review.**
20. Select **Submit.**

Appendix A List of Acronyms

CSV	Comma Separated Value
CPU	Central Processing Unit
CTD	Continuous Threat Detection
DHCP	Dynamic Host Configuration Protocol
DVD	Digital Versatile Disc
ESAM	Energy Sector Asset Management
ESP	Encapsulating Security Payload
GB	Gigabyte
HDD	Hard Disk Drive
IP	Internet Protocol
IPv	Internet Protocol version
ISO	Optical Disc Image
IT	Information Technology
NCCoE	National Cybersecurity Center of Excellence
NIC	Network Interface Controller/Card
NIST	National Institute of Standards and Technology
OS	Operating System
OT	Operational Technology
PUMP	Patch and Update Management Program
RAM	Random Access Memory
SIEM	Security Information and Event Management
SPAN	Switched Port Analyzer
TB	Terabyte
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UDP	User Datagram Protocol
UMD	University of Maryland
VM	Virtual Machine
VPN	Virtual Private Network
XML	Extensible Markup Language