EXTREME VALIDATED DESIGN

Extreme Automated Campus

Version 1.1

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Contents

Preface

This document provides design and guidance for implementing an Extreme Networks Automated Campus using Extreme Networks hardware and software. An Extreme Automated Campus consists of ExtremeSwitching products, ExtremeWireless, Extreme Management, ExtremeControl, and ExtremeAnalytics.

Extreme Validated Designs

Helping customers consider, select, and deploy network solutions for current and planned needs is our mission. Extreme Validated Designs offer a fast track to success by accelerating that process.

Validated designs are repeatable reference network architectures that have been engineered and tested to address specific use cases and deployment scenarios. They document systematic steps and best practices that help administrators, architects, and engineers plan, design, and deploy physical and virtual network technologies. Leveraging these validated network architectures accelerates deployment speed, increases reliability and predictability, and reduces risk.

Extreme Validated Designs incorporate network and security principles and technologies across the ecosystem of service provider, data center, campus, and wireless networks. Each Extreme Validated Design provides a standardized network architecture for a specific use case, incorporating technologies and feature sets across Extreme products and partner offerings.

All Extreme Validated Designs follow best-practice recommendations and allow for customer-specific network architecture variations that deliver additional benefits. The variations are documented and supported to provide ongoing value, and all Extreme Validated Designs are continuously maintained to ensure that every design remains supported as new products and software versions are introduced.

By accelerating time-to-value, reducing risk, and offering the freedom to incorporate creative, supported variations, these validated network architectures provide a tremendous value-add for building and growing a flexible network infrastructure.

Purpose of This Document

This Extreme validated design provides guidance for designing and implementing an Extreme Automated Campus using Extreme hardware and software, detailing the Extreme reference architecture and its configuration.

It should be noted that not all features such as automation practices, zero-touch provisioning, and monitoring of the Extreme Automated Campus with ExtremeWireless are included in this document. Future versions of this document are planned to include these aspects of the Automated Campus solution.

The design practices documented here follow the best-practice recommendations, but there are variations to the design that are supported as well.

Target Audience

This document is written for Extreme systems engineers, partners, and customers who design, implement, and support campus networks. This document is intended for experienced network architects and engineers. This document assumes that the reader has a good understanding of switching and routing features.

Authors

The authors have extensive experience testing Extreme Automated Campus products and solutions. At Extreme, they focus on developing and validating solution architectures that customers can use in deployments.

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Document History

Future revisions of this document will include upcoming Automated Campus products and technologies.

Date	Part Number	Description
October 2018	9035775	1.0 - Initial release
December 2018	9035775-01	1.1 – ERS Access support

About Extreme Networks

Extreme Networks® (NASDAQ: EXTR) networking solutions help the world's leading organizations transition smoothly to a world where applications and information reside anywhere. This vision is designed to deliver key business benefits such as unmatched simplicity, non-stop networking, application optimization, and investment protection.

Innovative Ethernet and storage networking solutions for data center, campus, and service provider networks help reduce complexity and cost while enabling virtualization and cloud computing to increase business agility.

To help ensure a complete solution, Extreme Networks (www.extremenetworks.com) partners with world-class IT companies and provides comprehensive education, support, and professional services offerings. (www.ExtremeNetworks.com)

Introduction

The Extreme Automated Campus design detailed in this document is targeted for both single and multi-site campuses. The configurations and design practices documented here are fully validated and conform to Extreme Best Practices and recommendations. The intention of this Extreme Validated Design document is to provide reference configurations and instruction for building a managed, secure campus network using Extreme Fabric Connect, Extreme Fabric Attach access switches, ExtremeWireless architectures and Extreme Management.

Other reference materials should be reviewed for a deeper understanding of the concepts described in this document.

Note
Refer to the Automated Campus At-A-Glance and Solutions Brief for overall solution information.

Technology Overview

Terminology

Term	Description
802.1X	IEEE Standard for port-based Network Access Control
AD	Active Directory
AP	Access Point
ARP	Address Resolution Protocol
BCB	Backbone Core Bridge
BEB	Backbone Edge Bridge
B-VLAN/B-VID	Backbone VLAN
CLI	Command-Line Interface
CoS	Class of Service for Layer 2
CVLAN	Customer VLAN
DHCP	Dynamic Host Configuration Protocol
DDD	Domain Data Distribution
EAPOL	Extensible Authentication Protocol Over LAN
ECMP	Equal Cost Multi-Path
EXOS	Extreme eXtensible Operating System (also ExtremeXOS)
FDB	Forwarding Database
GRT	Global Routing Table
IGMP	Internet Group Management Protocol
IP	Internet Protocol
I-SID	Individual Service Identifier
ISL	Inter-Switch Link
L2VSN	Layer 2 Virtual Service Network
L3VSN	Layer 3 Virtual Service Network
LACP	Link Aggregation Control Protocol
LAG	Link Aggregation Group
LDAP	Lightweight Directory Access Protocol
LLDP	Link Layer Discovery Protocol
MAC	Media Access Control
NAC	Network Access Control
NNI	Network to Network Interface
PoE	Power over Ethernet
QoS	Quality of Service
sFlow	Sampled Flow
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
SPBM	Shortest Path Bridging (MAC)
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UNI	User to Network Interface
VLAN	Virtual Local Area Network
VM	Virtual Machine
VOSS	VSP Operating System
VPN	Virtual Private Network
VRF	Virtual Routing and Forwarding

Extreme Automated Campus - Introduction

The key benefit of an Extreme Automated Campus solution is the inherent end-to-end automation capabilities reducing installation and operations complexities dramatically. The zero-touch core capabilities together with the end-point-provisioning model simplifies network tasks greatly. It allows network operators to focus on new projects rather than spending time “keeping the lights on”. The Automated Campus spans from the wireless to the wired edge into the core aggregation layer and can also be extended into the server rooms.

Enterprise network operators are providing connectivity services to their internal customers. Like telecom service providers they can benefit from a model where there is a clear separation of infrastructure and connectivity services. With Automated Campus (AC), connectivity services are called Virtual Services Networks (VSNs). There are VSNs available for extending VLANs across an AC (L2 VSNs) as well as extending routing domains (VRFs) across an AC (L3 VSNs). Those services can run IPv4 and IPv6 routing functions. Also, it is very easy to provide a highly scalable and robust IP multicast solution, that is very easy to configure and maintain.

The tight integration of Extreme Access Switches and Extreme wireless and its consistent powerful role-based policy framework enables a highly capable end-to-end solution. Wireless or wired users can connect anywhere to the network and will get their appropriate network role and rules assigned as well as end up in the predefined network segment. This is particularly important when network segmentation has been deployed for security and or compliance purposes.

Interfacing an Automated Campus with any third-party network infrastructure can easily be achieved by connecting VLANs over 802.1Q tagged links and adding routing protocols such as RIP, OSPF or BGP to exchange IPv4 or IPv6 routes, or using PIM-SM with MSDP for Multicast domain connections.

In this EVD, the Extreme Automated Campus provides QOS, bandwidth, POE, Network Access Control, redundancy, and visibility across local or remote geographical locations. This gives the IT operator an opportunity to provide appropriate levels of access for different user groups without disrupting connectivity on a shared network.

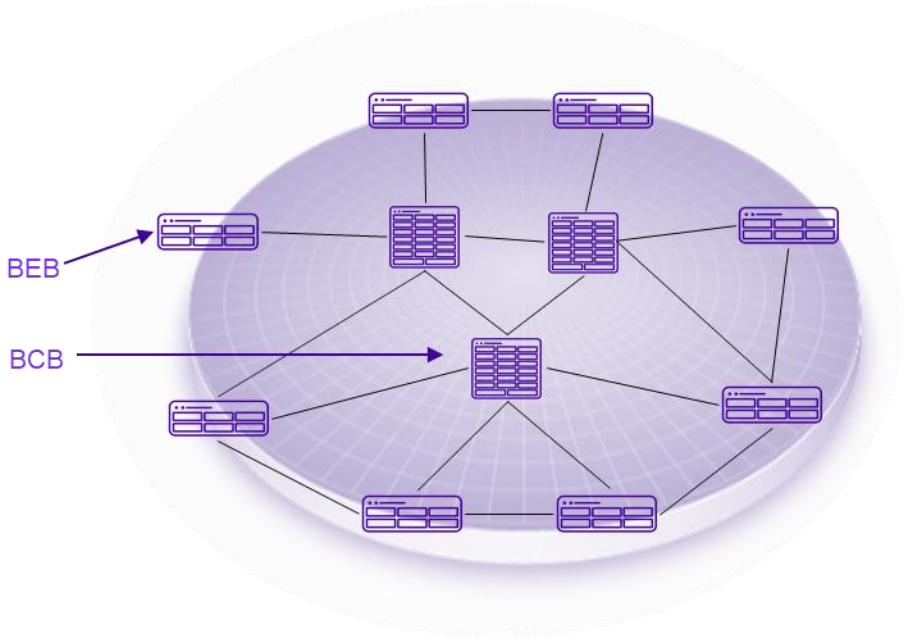
Functional Components of Extreme Automated Campus

An Extreme Automated Campus consists of three main functional areas:

- Extreme Fabric Connect and Fabric Attach
- ExtremeWireless
- Extreme Management Center's Policy and Network Access Control with Analytics

Extreme Fabric Connect: Core and Aggregation

The Automated Campus, utilizing Extreme's Fabric Connect technology, is comprised of two functional elements: An edge switch function, called a Backbone Edge Bridge (BEB) and a core switch function, called a Backbone Core Bridge (BCB). The fabric connecting these switches is SPB (Shortest Path Bridging), based on the IEEE 802.1aq standard. SPB uses IS-IS (RFC 6329) as the control plane routing protocol. A Fabric Connect capable switch supports all traditional network protocols and in addition the Fabric Connect SPB function. In typical designs switches operate as BEBs and BCBs concurrently.



Fabric Connect supports Layer 2 and Layer 3 virtualization. These virtualized Layer 2 (L2) and Layer 3 (L3) instances are referred to as Virtual Services Networks (VSNs). A Service Identifier (I-SID) is used to uniquely identify each of these service instances in a Fabric Connect domain and a User Network Interface (UNI) is the boundary or demarcation point between the "service layer" of traditional networks i.e. VLANs, VRFs and the Fabric Connect "service layer" i.e. L2 & L3 VSNs.

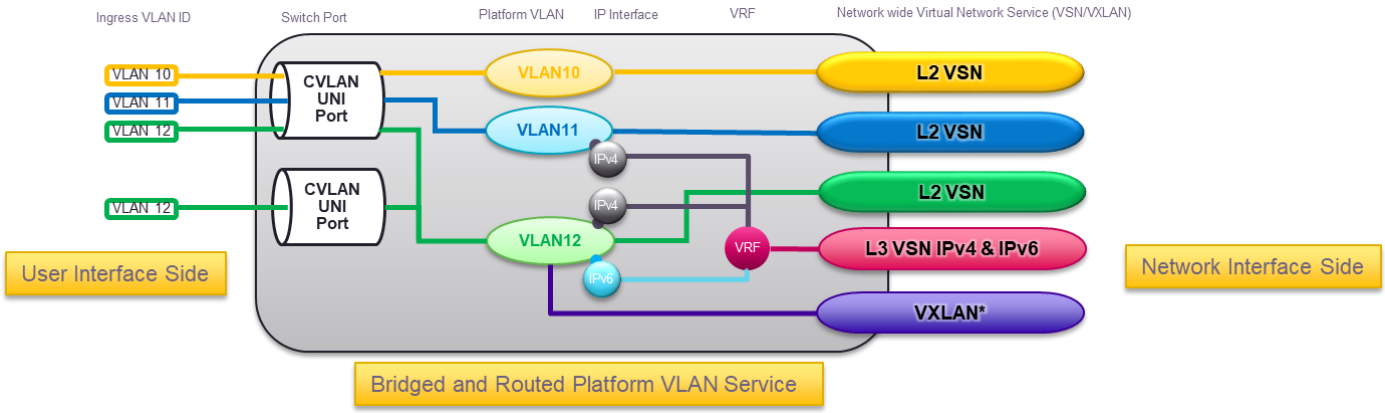
- Layer 2 VSNs form a virtual broadcast domain between UNI members that share the same L2 VSN ISID. MAC learning/aging is applied to all L2 VSNs individually.
- Layer 3 VSNs form a virtual routed L3 network (L3 VPN) leveraging IS-IS as the routing protocol between VRFs that share the same L3 VSN ISID.

Once the SPB infrastructure is created, the SPB network connectivity services (VLAN or VRF extensions) are configured on the BEB's at the edge of the network only. There is no provisioning required on the core SPB switches for network connectivity services. This provides an architecture where the configuration on the core switches never needs to be modified when adding any new services.

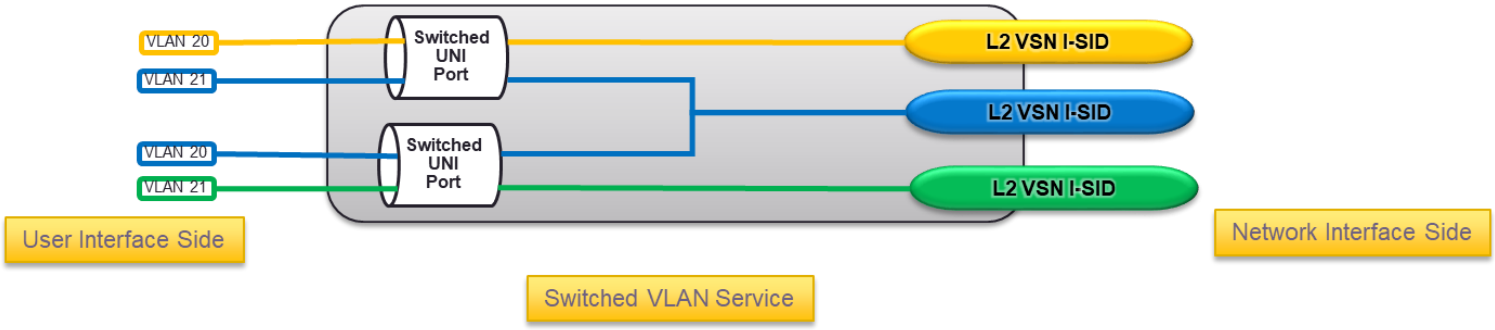
The boundary between the core SPB domain, which consist of Network-to-Network (NNI) interfaces and the access interfaces, is handled by a so-called User Network Interface (UNI). UNI interfaces tie VLANs or VRFs to Service Instance Identifier (I-SID). An I-SID is provisioned on the BEB UNI interface.

Fabric connect devices support the following UNI types:

- VLAN UNI (CVLAN) a Platform VLAN-ID maps to a L2 VSN I-SID – all ports that are members of the VLAN are associated with the UNI.
    - CVLAN UNI interface can have an IPv4 or IPv6 address assigned to it to enable a routing function.



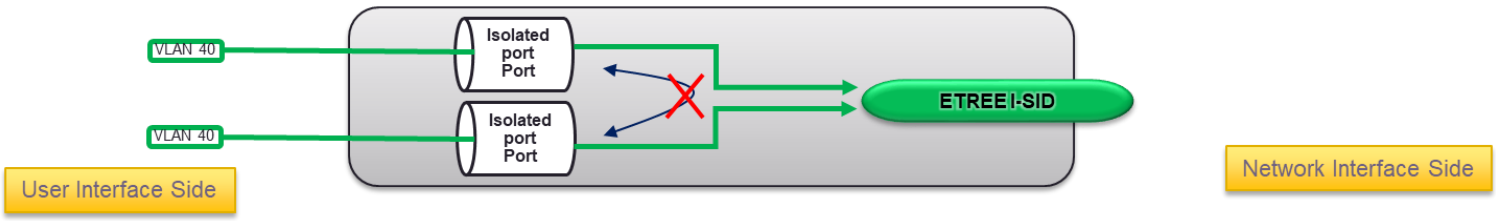
- Flex UNI interface has the following sub-types:
    - Switched UNI: maps a VLAN-ID on a given port (VID, port) into a L2 VSN ISID. With this UNI type VLAN-IDs can be re-used on other ports and map to different ISIDs.



- Transparent Port UNI- a port maps to a L2 VSN I-SID (all traffic through that port, 802.1Q tagged or untagged, ingress and egress is part of the I-SID).

Warning
All VLANs on a transparent port UNI interface share the same SINGLE MAC learning table of the Transparent UNI ISID.

- E-Tree UNIs allow extending Private VLANs beyond one switch to form a network wide E-Tree service infrastructure. An E-Tree UNI is a L2 VSN where traffic flows from hub to spokes and from spokes to hubs, but not from spoke to spoke. E-Tree hub ports can be formed with a CVLAN or Switched VLAN UNI. E-Tree spokes need to be configured as private VLAN UNIs.



- L3 VSN UNI - a VRF maps to an I-SID. A L3 I-SID identifies, in the control plane, all L3 routes belonging to the same I-SID. All VRFs in a network sharing the same L3 I-SID form a L3 VSN. L3 VSNs support IP Unicast as well as IP Multicast simultaneously if configured to do so. A special case is VRF=0 which corresponds to the Global Routing Table (GRT), SPB based routing for GRT is called IP Shortcut routing.

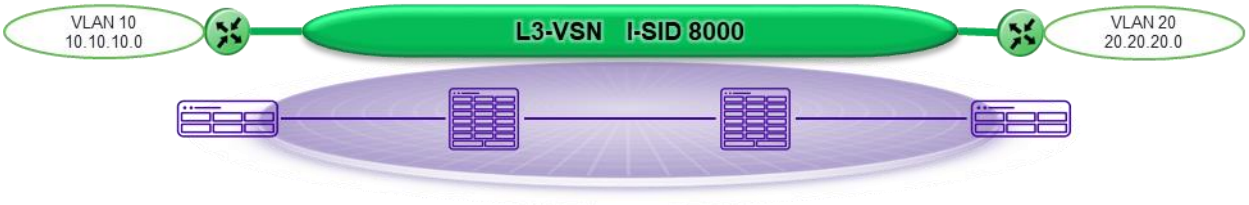


Figure 1 L3 VSN

I-SID configuration is required only for virtual services such as L2 VSN and L3 VSN. With IP Shortcuts, no I-SID is required as forwarding is performed by utilizing the Global Routing Table (GRT).

Default Gateway Redundancy:

There are multiple ways to provide default gateway redundancy to users and hosts.

- VRRP
- RSMLT
- Distributed Virtual Routing

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Note
In this EVD we have chosen to use RSMLT and DVR. They provide optimized traffic flows and robust deployment models, over a traditional chatty VRRP approach. But nothing is precluding the use of VRRP instead of RSMLT or DVR, especially in smaller deployments.

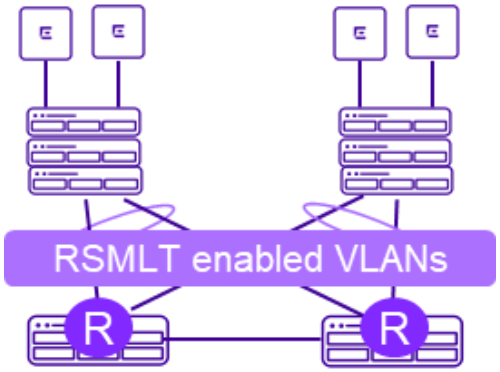
In this document, two of the three core switches, are also configured as DVR Controllers which distribute a routing instance to the switches in the server areas. Virtual machines, which can roam freely across any server, use their first hop Top of the Rack (ToR) switches (DVR Leaf nodes) to be their default gateways. In the wireless deployments, users can roam between "buildings" and each building provides default gateway routing capabilities for the users, thus distributing the load and optimizing traffic patterns. DVR avoids traffic "tromboning" and optimizes traffic paths and thus effectively reduces latency in real-time applications such as voice and video.

Each server area is comprised of two VSP-7xxx ToR switches, which are directly connected to the services required by all the clients connected to either campus. These services include production servers, storage, video servers as well as DHCP/DNS servers. These units are also configured as DVR Leaf nodes, which provide the flexible, low latency IP access roaming users require. In addition, this segment of the testbed contains the management application for the entire testbed, which is performed by XMC.

DVR controllers and DVR Leaf nodes can be extended based on port connectivity and bandwidth needs.

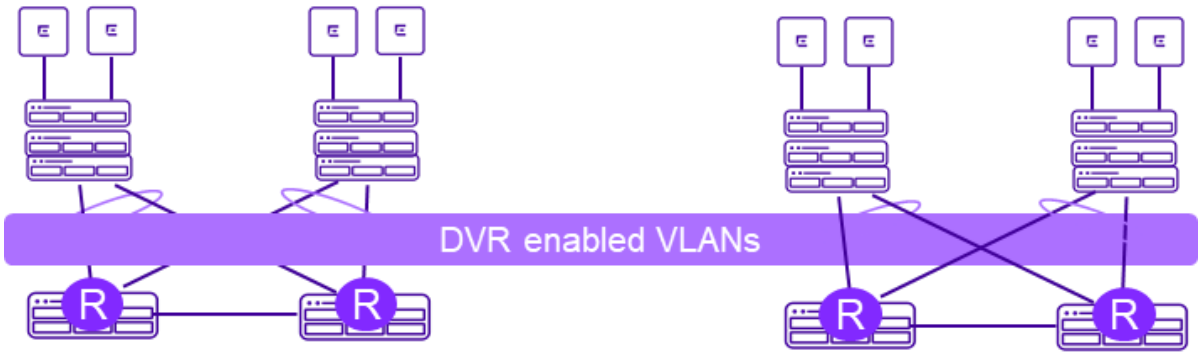
Routed Split Multi-Link Trunking (RSMLT)

One method for IP Gateway redundancy is available within each switch cluster at the campuses for VLAN's/hosts which do not require mobility. RSMLT ensures traffic can be routed off the VLAN by adding routed VLAN redundancy. RSMLT is similar in functionality to VRRP (providing router gateway redundancy), however it can scale beyond the maximum number of VRRP instances, it is a considerably less "chatty" protocol, thus reducing network overhead and it can provide sub-second failover performance without the need to modify any L3 protocol timers. RSMLT has a limit of two nodes per switch cluster.



Distributed Virtual Routing (DVR)

Distributed Virtual Routing (DVR) is a technology that provides a distributed default gateway functionality for access VLANs/IP subnets. It distinguishes itself from VRRP or RSMLT in the fact that it is highly effective when more than 2 default gateway routers are available in a VLAN/IP subnet.



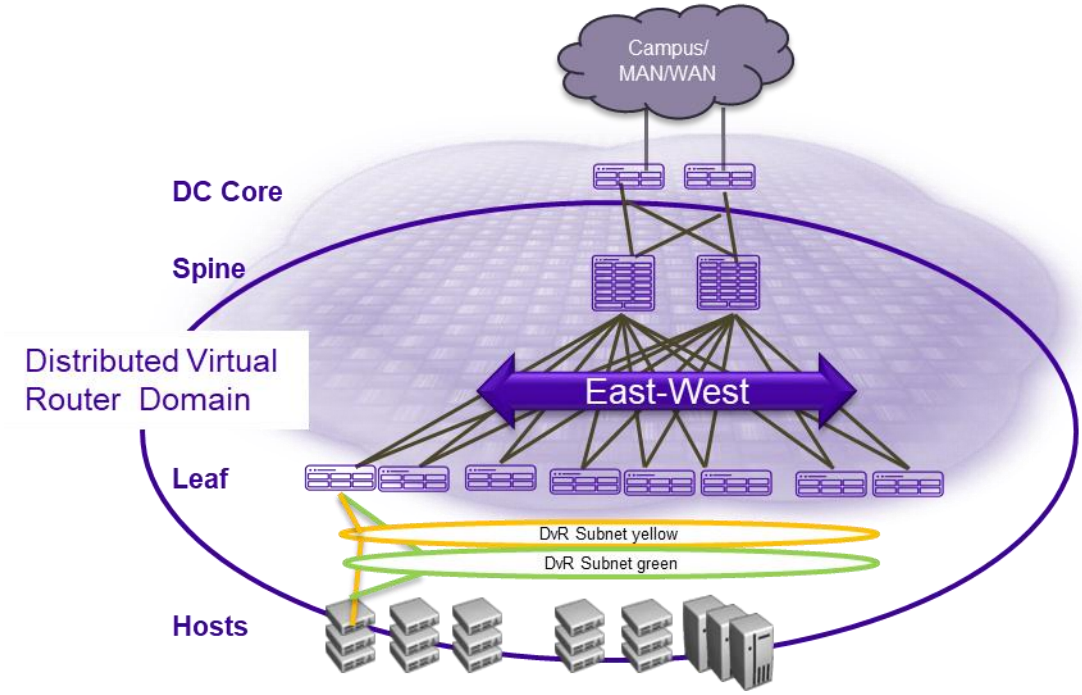
In addition, DVR optimizes traffic flows to avoid traffic "tromboning" due to inefficient routing, thereby increasing the total routing throughput. DVR also simplifies large scale server room deployments by introducing a Controller-Leaf architecture. In this architecture, Layer 3 IPv4 default gateway and VRF configuration is required only on the Controller nodes, whereas the Leaf nodes require only Layer 2 configuration. All Layer 3 configuration, including IP multicast configuration, is automatically distributed to the Leaf nodes by the Controller nodes.

DVR Domains

A DVR domain is a logical group of switches or nodes that are DVR enabled. These nodes are not physically connected but are connected over the SPB Fabric such that each node is aware of the BMAC addresses of all other nodes within the domain. A logical DVR domain cannot contain nodes that are not DVR enabled. However, those nodes can co-exist with other DVR enabled nodes within the same SPB Fabric network.

A common DVR domain ID is configured for all nodes belonging to a DVR domain. This domain ID translates internally to a Domain Data Distribution (DDD) I-SID. All switch nodes that share the same DVR domain ID or DDD ISID receive the Layer 3 information that is distributed from all other nodes belonging to that DVR domain.

A DVR domain can contain multiple Layer 3 VSNs and Layer 2 VSNs. Layer 2 and Layer 3 VSNs can span multiple DVR domains. DVR domains are typically introduced when multiple buildings come into play. Typically, a DVR domain spans one building which includes an access and distribution layer, this could be campus or data center. A remote building would be its own DVR domain. This ensures that the DVR controllers are local to the building and thus only local DVR Leaf nodes are served by the controllers. Up to 8 controllers can be used per domain. Up to 16 domains can be built with DVR. A DVR backbone is automatically established between the DVR controllers and is responsible for traffic and host information forwarding between domains.



Although not always, a DVR domain typically has the following components:

1. DVR Controllers

2. DVR Leaf nodes

DVR Controller

In a DVR domain, the Controller nodes are the central nodes on which Layer 3 is configured. They own all the Layer 3 configuration and push the configuration information to the Leaf nodes within the SPB network. A DVR domain can have one or more controllers for redundancy and you must configure every Layer 2 VSN (VLAN) and Layer 3 VSN within the domain, on the Controller(s). A node configured as a DVR Controller is considered the controller for all the Layer 2 and Layer 3 VSNs configured in its DVR domain. A Controller is configured with its own subnet IP address, for every DVR enabled Layer 2 VSN within the domain.

All Layer 2 VSNs on a DVR Controller need **not** be DVR enabled. A controller can be configured with individual Layer 2 VSNs that are DVR disabled and use VRRP for example. The Layer 3 configuration data that is pushed to the Leaf nodes include the Layer 3 IP subnet information for all Layer 2 VSNs within the DVR domain. Controllers also send information on whether Multicast is enabled on a specific DVR enabled Layer 2 VSN, and the version of IGMP. A Controller can only belong to one DVR domain, based on the domain ID configured on the node.

DVR Leaf

DVR Leaf nodes are typically data center top of the rack (ToR) Fabric switches that aggregate physical and virtual servers or storage devices. DVR Leaf nodes operate in a reduced configuration mode, where Layer 3 is not configured locally, but pushed to them from the DVR Controller(s) within the domain. You need to configure only the IS-IS infrastructure and the Layer 2 VSNs on the Leaf nodes.

Once on a controller a DVR virtual default gateway IP address is configured for a L2 VSN, DVR Leaf nodes monitor local host attachments and communicate updates about the current state of those host attachments to the DVR domain. All DVR nodes exchange host attachment information using the DVR host distribution protocol, which leverages a DVR domain ISID. DVR leaf nodes are managed in-band through a local loopback address, and management traffic is IP Shortcut routed.

A Leaf node will also distribute host route information within the DVR domain that it owns (i.e. ARPs). A Leaf node learns ARPs on its own UNI ports. It will own this locally learned ARP and will distribute those as host routes to all other DVR enabled nodes (all Controller nodes and Leaf nodes) within the DVR Domain. In this way, all the DVR enabled nodes will have all the L3 host reachability information of the entire DVR Domain. Hosts connected to Leaf nodes (ToRs) will know how to reach all other hosts in the DVR Domain directly via this distributed L3 data path. The Fabric is used to enable short cut routing.

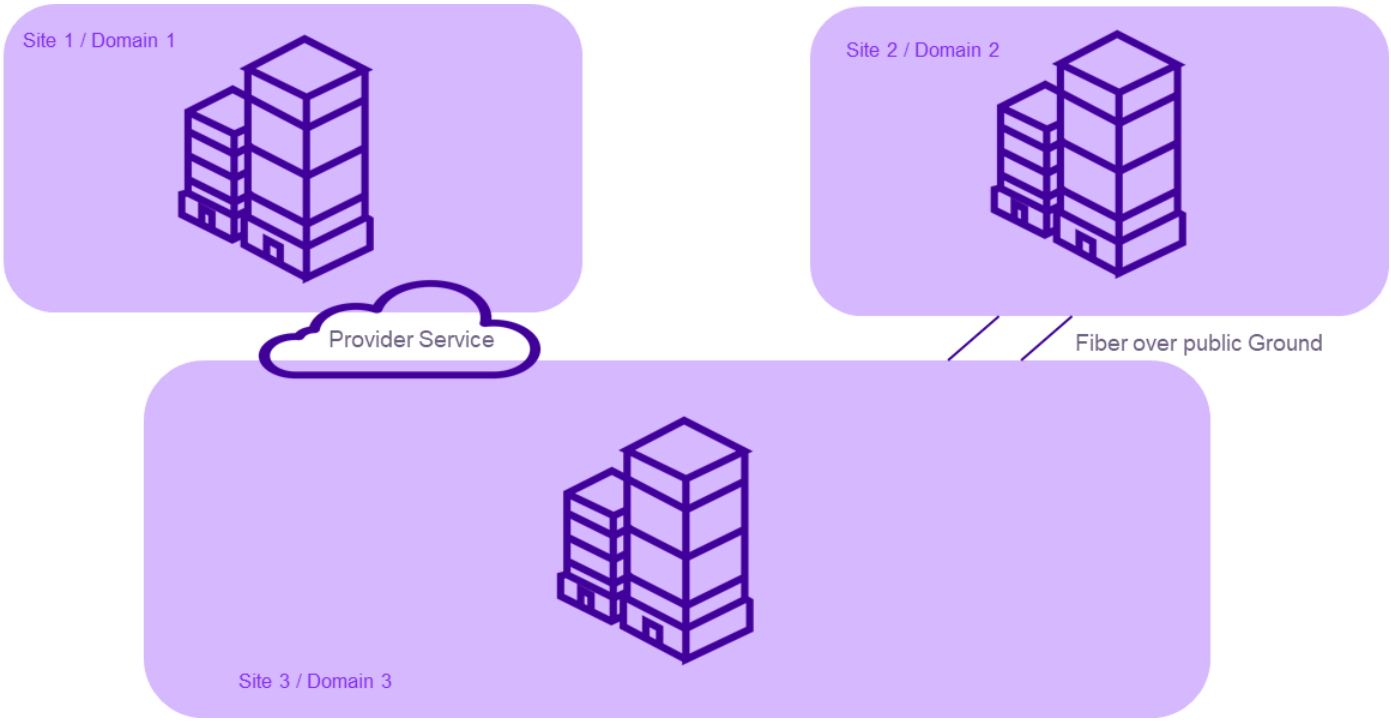
Leaf nodes will have limited manual configuration. SPB infrastructure will be manually configured. ISIDs will be manually configured for L2VSNs. There will be no platform VLANs configured on a Leaf that is DVR enabled. L3 configuration data will be learned from the Controller for IPv4 Unicast and IPv4 Multicast. For every L2VSN configured on the Leaf, it must also be configured on the Controllers in that DVR Domain.

DVR Backbone

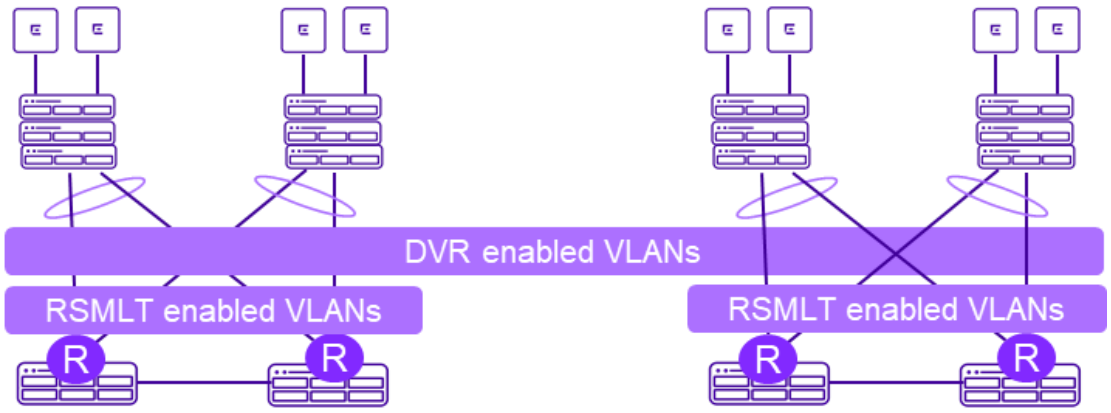
The DVR backbone is automatically established between all DVR controllers in a fabric. The DVR controllers exchange all host route information among themselves to ensure short-cut switching to the domains and hosts wherever they might connect. DVR controllers either forward directly to their local Leaf nodes, if the hosts are local to their domain, or forward traffic to the remote domain controllers, if the hosts are remote. The leaf nodes in contrary only know about their local hosts in their domain and forward to their controllers if traffic is not local to their domain.

The Automated Campus EVD DVR domains:

The Automated Campus EVD has three DVR domains: one encompassing both server rooms and one in each campus. As mentioned previously, it is best to create DVR domains so that controllers for a domain are local to their corresponding Leaf nodes if possible, such that in case of an isolation of a building, controllers are local to the building.

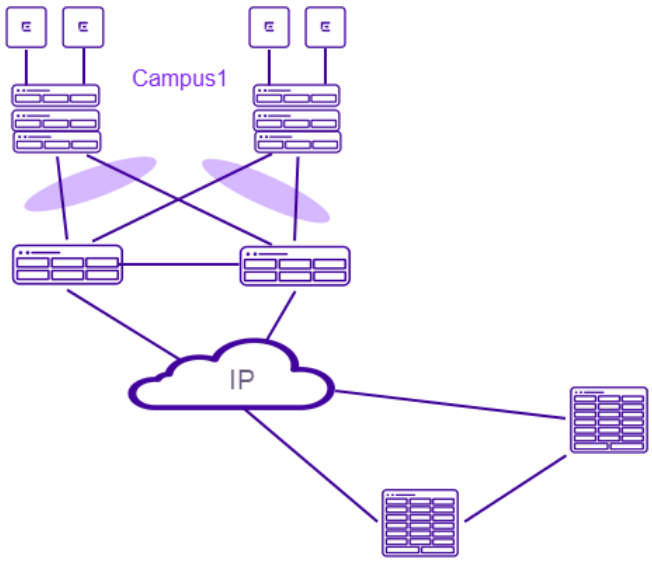


The IoT, Administrator and Campus User wireless VLANs are members of the DVR domains in the campuses. All subnets in the server rooms are members of the DVR Domain spanning across both server room locations.



Fabric Extend

Fabric Extend provides the ability to extend the Fabric Connect Ethernet Fabric over an IP routed network. This IP routed network can be any type of IP routed connectivity for example a campus router or an MPLS IP VPN connectivity. What must be ensured is that this routed network supports larger IP packets with minimum frame size of 1594 bytes. A good guidance is to ensure that minimum packet size support is 1600 bytes. If a third-party device is used for connecting Fabric Connect over the internet, it should support encryption as well as fragmentation and reassembly. It is necessary to ensure IP packets are not only fragmented but also re-assembled after the secure tunnel to ensure that Fabric Connect Ethernet packets are reconstructed after the secure tunnels.



Access Layer

The Access layer for the Automated Campus EVD can be comprised of Summit or ERS access switches. Both access switch models in this EVD support stacking mode and are operating as FA proxy devices.

Summit Access

The Summit access switches are in separate stack formations. Combining the switches in stack formation allowed for easier administration of the switches.

Among other features, the Summit access switch supports Policy and Fabric Attach, both of which are required in the overall functionality of this topology. With defined Policy roles, rules can be created based upon up to 15 traffic classification types for traffic drop or forwarding. A CoS (Class of Service) can be associated with each role for purposes of setting priority, forwarding queue, rate limiting, and rate shaping. The Extreme Management Center is ideal for creating and maintaining Policy rules within the access switches and is used in this topology. Fabric Attach facilitates automated network device discovery and the automatic configuration and teardown of Network Services Identifier (NSI)/Individual Service Identifier (ISID) to VLAN associations at the edge of the network, which eliminates time-consuming hop-by-hop provisioning.

At least one switch in each stack is capable of PoE (Power over Ethernet). PoE supplies 48 VDC power to certain types of powered devices through Category 5, Category 5E and Category 6 twisted pair Ethernet cables. Devices such as wireless access points, IP telephones, laptop computers, and web cameras do not require separate power cabling and supply with these PoE-capable switches.

ERS Access

The ERS access series integrates Fabric Attach and Extensible Authentication Protocol (EAP) capabilities in an efficient and easy way. Fabric Attach (FA) provides automated VLAN and SPB virtual service connection from ERS switches running in FA Proxy mode or from any end device supporting FA Client mode of operation, such as Extreme WLAN Access Points.

The ERS series is also offered with the Universal Power-over-Ethernet models that can offer twice the power of PWR+ providing up to 60 Watts of power on access ports. This capability can be used to support a greater range of high power devices through a single standard Ethernet cable, such as premium telepresence systems, multi-radio Wireless Access Points, VDI Thin Clients and monitors, downstream compact Switches, and even PoE-power smart lighting systems.

Note
Although not part of this EVD, the ERS 36xx access switch has full FA proxy functionality, and would also be supported in this design. ERS 59xx/ERS 49xx are SPBM-capable network devices and can also run as a FA Server or FA Proxy. For the purpose of this EVD, ERS access switches are configured as FA Proxy devices.

ExtremeWireless

ExtremeWireless is simple, fast, and smart, delivering a user experience in unmatched scale and density at an exceptional level. Intuitive Dashboards allow effortless management of the network. With a single click, deliver services and new applications with ease. Enable fast roaming with seamless mobility while delivering more throughput with fewer APs. Able to be agile through an advanced architecture that assures security with enforcement. Through analytics, user experience can be measured in true detail.

Access Points can initialize and configure themselves from a centralized appliance. Deployed APs automatically discover the appliance through DHCP and retrieve its configuration. Policy and QoS are performed at the AP for clients connecting to a SSID. RF Characteristics can be automatically configured by the AP through automatic power or channel selection. Band-Steering and Airtime Fairness are also controlled by the AP.

The ExtremeWireless designs provide the same availability that everyone has come to expect with wired networks. Appliances have built-in resiliency through the ability to pair controllers together for full redundancy.

Extreme Management Center

What makes the Extreme Automated Campus possible is the deployment of Extreme Management Center, consisting of Extreme Management, ExtremeControl, and ExtremeAnalytics. These tools are the backbone to managing and configuring the functionality of the Extreme Automated Campus solution.

Extreme Management
Extreme Management Center is a single pane of glass management system that provides wired/wireless visibility and control from the data center to the mobile edge. The intelligence, automation, and integration of this management software enables the IT organization to optimize the efficiency of network operations and reduce total cost of ownership. Most important, Extreme Management Center provides advanced network configuration and change management for the wired and wireless infrastructure and allows centralized creation of policies that follow users and devices across the network. These are not tied to the physical network and can change based on user, device, time of day, location, and connection type.

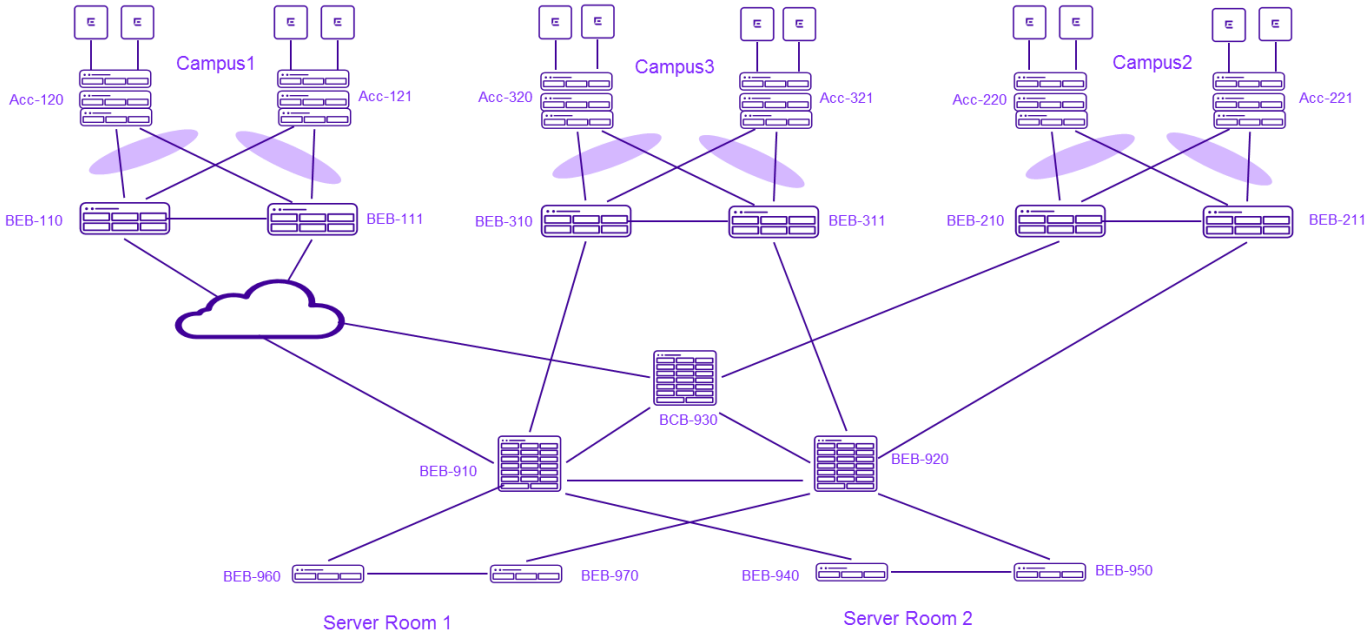
ExtremeControl
Extreme's Network Access Control engine, or ExtremeControl, lets you manage secure and automated access for both BYOD and IoT devices from one convenient dashboard. It makes it easy to roll out granular policies across your wired and wireless networks to meet industry and company compliance obligations. Identity-based network access control keeps unauthorized users and devices from accessing your network. ExtremeControl is integrated with Extreme Management Center to allow for simple and seamless authentication control and modification in one single application.

ExtremeAnalytics
ExtremeAnalytics helps administrators understand what applications are running on the network, who is using them and what the response time is for each application. It gives granular visibility into network and application performance, users, locations, and devices. Information from the network and the applications empowers you to make data-driven decisions.

Validated Designs – Infrastructure & Topology

Automated Campus Reference Topology

The reference topology is comprised of three “campus” areas and two “server room” areas. The key technology is Extreme Fabric Connect with Fabric Attach and Fabric Extend. Each of the campuses are composed of two, linked VSP-8xxx units, configured as BEB’s, which are directly connected to dual homed Summit or ERS switches, functioning as the Access layer.



The uplinks of the access switches to the VSP BEB’s is accomplished via the configuration of link aggregation. Fabric Attach technology fully automates the process of client authentication and service (L2VSN/L3VSN) assignment. Routing redundancy is also enhanced via the use of both DVR (Distributed Virtual Routing) as well as RSMLT (Routed Split Multilink Trunk).

The connectivity to the core on each campus varies and encompasses different Fabric Connect capabilities. Campus 1 is linked to the core BCB switches via technology known as Fabric Extend, which is in effect an L3 tunnel used to facilitate connectivity of two SPB networks over a traditional IP network.

The core area utilizes three VSP-8xxx units, configured as BCB’s and linked directly via point-to-point 40Gb connections, except for the L3 tunnel links to Campus 1 which are configured via 10Gb links. The core topology can consist of any number of backbone nodes, depending on the actual fiber plant layout and port count requirements. The three-node core setup has only been chosen to illustrate the topology flexibility.

Hardware and Software Matrix

Product	FW Version	Enabled License Level	Enabled Feature Packs
X460-G2	22.6.1.4	Advanced Edge	Direct Attach
ERS-4950GTS	7.6.1.033		
ERS-5928GTS	7.6.1.033		
VSP-8404C	7.1.0.0.GA	Premier	
VSP-8284	7.1.0.0.GA	Premier	
VSP-7200	7.1.0.0.GA	Premier	
EWC V2110	10.41.11.0009		
AP3912i-FCC	10.41.11.0009		
AP3915e-FCC	10.41.11.0009		
AP3915i-FCC	10.41.11.0009		
AP3916ic-FCC	10.41.11.0009		
AP3917e-FCC	10.41.11.0009		
AP3935e-FCC	10.41.11.0009		
AP3935i-FCC	10.41.11.0009		
Extreme Management Center	8.1.4.40		
ExtremeControl	8.1.4.40		
ExtremeAnalytics	8.1.4.40		

Preconditions

Before beginning the configuration of any device in the Extreme Automated Campus Validated Design, verify that the following preconditions have been met:

Summit Access Switches

```
Slot-1 Stack.1 # show license
Enabled License Level:
        Advanced Edge
Enabled Feature Packs:
        DirectAttach
Effective License Level:
        Advanced Edge
```

There is no minimum license level requirement on Summit switches for this EVD.

ERS Access Switches

```
5900_STACK(config)#show license
No license installed
5900_STACK(config)#
```

No minimum license level requirement on ERS switches for this EVD.

Fabric Connect Switches

The Premier license is required on Fabric Connect switches for this EVD.

```
BEB-8284-110:1(config)#show license

        License file name       :    /intflash/VSP8284_B0ADAA47BC00.xml
        License Type            :    PREMIER (includes Base features) +PORT
        MD5 of Key              :    00000000 00000000 00000000 00000000
        MD5 of File             :    00000000 00000000 00000000 00000000
        Generation Time         :    2018/05/22 02:21:13
        Expiration Time         :
        Base Mac Addr           :    b0:ad:aa:47:bc:00
        flags                   :    0x00000001 SINGLE
        memo                    :
```

```
BEB-7254-960:1(config)#show license

        License file name       :    /intflash/VSP7254_D47856945C00.xml
        License Type            :    PREMIER (includes Base features) +PORT
        MD5 of Key              :    00000000 00000000 00000000 00000000
        MD5 of File             :    00000000 00000000 00000000 00000000
        Generation Time         :    2018/05/22 02:21:13
        Expiration Time         :
        Base Mac Addr           :    d4:78:56:94:5c:00
        flags                   :    0x00000001 SINGLE
        memo                    :
```

Campus VLAN/I-SID and Subnet Scheme

Several functional groups were created to simulate common generic services on the network. It's also a common best practice to have separate VLANs for wired and wireless networks to avoid unneeded broadcasts saturating the wireless network, illustrated in the campus/common VLAN scheme.

The same VLAN services are available in both campuses, however different features are illustrated to demonstrate levels of redundancy and mobility for these services.

I-SID scheme

It's a good practice to have a VLAN/I-SID scheme that is logically laid out in a way that easily identifies the network/services and allows growth. The 24-bit I-SID header field allows for 16 million services.

Digit 1: Campus System Identifier

- This Automated Campus EVD is designating the first digit to identify this particular autonomous system or fabric (which includes both Server rooms and Campuses = 1).
- If another large campus is acquired or created, and some delineation wanted to be made between them, this digit could be increased to "2" to identify it.

Digits 2-3: Service Type/Location

- Services tied to specific sites are denoted "0x" (campuses = 01/02/03, server rooms = 09).
    - Services extending from the campuses to the Server Rooms (i.e. Wired IoT-Bridged, Guest) will use the location id of the Server Room (09), as that is their common point.
- "Common" VLANs (existing in both campuses) as a result of DVR = 50.
- VRF I-SID = 80

Digits 4-7: VLAN id

- A 4-digit value was allocated for the VLAN.
- The VLAN IDs within a VRF I-SID will reflect the corresponding VLAN ID in the server rooms.

Campus 1 (VLAN 1xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt. VLAN	100	1010100	172.10.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	101	1010101	172.10.20.0/22	RSMLT	VRF 1	1800911
Net Admin (wired)	102	1010102	172.10.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	103	1010103	172.10.28.0/22	RSMLT	GRT	N/A
Surveillance	104	1010104	172.10.32.0/22	RSMLT	VRF 2	1800904

Campus 2 (VLAN 2xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt. VLAN	200	1020200	172.20.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	201	1020201	172.20.20.0/22	RSMLT	VRF 1	1800911
Net Admin (wired)	202	1020202	172.20.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	203	1020203	172.20.28.0/22	RSMLT	GRT	N/A
Surveillance	204	1020204	172.20.32.0/22	RSMLT	VRF 2	1800904

Campus 3 (VLAN 3xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt. VLAN	300	1030300	172.30.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	301	1030301	172.30.20.0/22	RSMLT	VRF 1	1800911
Net Admin (wired)	302	1030302	172.30.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	303	1030303	172.30.28.0/22	RSMLT	GRT	N/A
Surveillance	304	1030304	172.30.32.0/22	RSMLT	VRF 2	1800904

Server Room (VLAN 9xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Production Servers	900	1090900	172.90.1.0/24	DVR	GRT	N/A
Test Servers	901	1090901	172.90.2.0/24	DVR	GRT	N/A
Storage Servers	902	1090902	172.90.3.0/24	DVR	GRT	N/A
Storage Test	903	1090903	172.90.4.0/24	DVR	GRT	N/A
Network Mgmt.	999	1090999	172.9.99.0/24	DVR	GRT	N/A
Network Mgmt. (EWC)	998	1090998	172.9.98.0/24	DVR	GRT	N/A
Wired IoT (routed)	911	1090911	172.90.20.0/22	DVR	VRF 1	1800911

Surveillance	904	1090904	172.90.14.0/22	DVR	VRF 2	1800904
Wired IoT (bridged)	907	1090907	N/A	N/A	L2VSN	N/A

Common Services:

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Net Admin(wireless)	1050	1501050	172.105.0.0/24	DVR	GRT	N/A
Campus Users (wireless)	1051	1501051	172.105.1.0/24	DVR	GRT	N/A
IoT Devices (wireless)	1052	1501052	172.105.2.0/24	DVR	VRF 1	1800911
Guest (wireless)	906	1090906	172.90.40.0/24	EWC	Tunnel	N/A
Wired IoT(bridged)	907	1090907	N/A	N/A	L2VSN	N/A

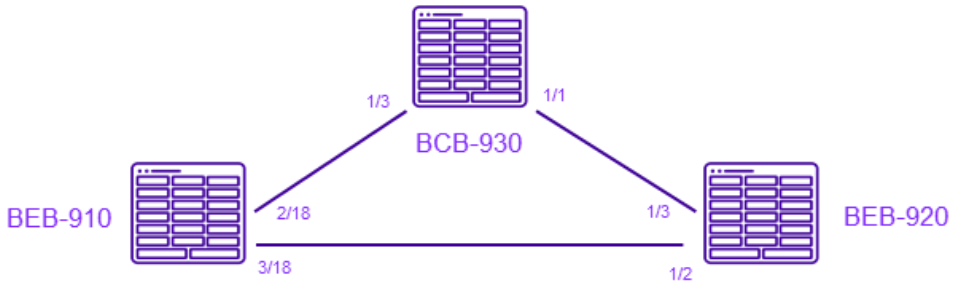
Fabric Connect - Core Configuration

Overview

The initial SPBM/IS-IS configuration is identical for both BCB and BEB switches. Most Ethernet-based networks use 802.1Q tagged interfaces between the routing switches. SPBM uses two Backbone VLANs (B-VLANs) that are used as the transport instance. A B-VLAN is not a traditional VLAN in the sense that it does not flood unknown, broadcast or multicast traffic, but only forwards based on IS-IS provisioned backbone MAC (B-MAC) tables. After configuring the B-VLANs and the IS-IS protocol is operational, services can be mapped to service instances.

The Fabric Connect switches are managed via XMC in-band through the default routing instance (GRT), using configured loopback addresses, illustrated in the following sections. Network discovery/management will be performed using these addresses, by means of the "**clipId-topology-IP**" command.

Note
Please refer to **Design Considerations** for other features that are required or will enhance and optimize the Automated Campus Solution.



BCB-930 Configuration

1. Globally enable 'SPBM', and configure a loopback interface used for in-band management of the switch:

```
config terminal
 prompt "CORE-8404-930"
 spbm

interface loopback 1
ip address 1 10.0.0.30/255.255.255.255
exit
```

Globally enable SPBM.

Configure the loopback IP address to be used for in-band

2. Configure IS-IS parameters:

```
router isis
spbm 1
spbm 1 nick-name 0.09.30
spbm 1 b-vid 4051-4052 primary 4051

ip-source-address 10.0.0.30
spbm 1 ip enable

sys-name "CORE-8404-930"
system-id 00bb.0000.3000
manual-area 49.0000
exit
```

Enter an IS-IS instance and "nick-name" for this switch (format: x.xx.xx).

Assign the Backbone VLANs to SPBM.

Enable IP on SPBM to allow IP Shortcut routing across the GRT.

Set the switch's sys-name and change the IS-IS system ID from the default B-MAC value to a recognizable address (format: xxxx.xxxx.xxxx).

Configure the SPBM autonomous system number for this Fabric

3. Create a loopback interface which will be used for in-band management of the switch, and enable IP Shortcut functionality:

```
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/1-1/3

sys clipId-topology-ip  1
sys force-topology-ip-flag
```

Create and identify the Backbone VLANs to be used for SPBM instance 1.

Remove ISL interfaces from the default VLAN.

Sets loopback as the topology IP for XMC, and activating it via the flag setting,

4. Enable 802.1Q and IS-IS on the participating Ethernet interfaces:

```
interface GigabitEthernet 1/1
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 1/3
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
router isis enable
```

Assign 802.1q and the SPBM instance and enable IS-IS on all ISL interfaces.

Globally enable IS-IS.

BEB-910 Configuration

As noted in the overview, BEB-910 and BEB-920 will be configured identically, with the exception of switch "identifiers" (sys-name, nick-name, IP addresses, etc.).

```
config terminal
 prompt "CORE-8404-910"
 spbm

interface loopback 1
ip address 1 10.0.0.10/255.255.255.255
exit

router isis
 spbm 1
 spbm 1 nick-name 0.09.10
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "CORE-8404-910"
 system-id 00bb.0000.0910
 manual-area 49.0000
 ip-source-address 10.0.0.10
 spbm 1 ip enable
 exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 2/18,3/18

sys clipId-topology-ip 1
sys force-topology-ip-flag

interface GigabitEthernet 2/18
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 3/18
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
router isis enable
```

BEB-920 Configuration

As noted in the overview, BEB-910 and BEB-920 will be configured identically, with the exception of switch "identifiers" (sys-name, nick-name, IP addresses, etc.).

```
config terminal
prompt "BEB-8404-920"
spbm

interface loopback 1
ip address 1 10.0.0.20/255.255.255.255
exit

router isis
spbm 1
spbm 1 nick-name 0.09.20
sys-name "BEB-8404-920"
system-id 00bb.0000.0920
spbm 1 b-vid 4051-4052 primary 4051
manual-area 49.0000
ip-source-address 10.0.0.20
spbm 1 ip enable
exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/2,1/3
sys clipId-topology-ip 1
sys force-topology-ip-flag


interface GigabitEthernet 1/2
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 1/3
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit

router isis enable
```

- Verification

When complete, the IS-IS adjacencies between the core devices should be up:

```
CORE-8404-930:1(config)#show isis adjacencies

================================================================================================
                                ISIS Adjacencies
================================================================================================
INTERFACE         L STATE        UPTIME PRI HOLDTIME SYSID            HOST-NAME         STATUS
------------------------------------------------------------------------------------------------
Port1/1           1 UP         04:40:30 127       23 00bb.0000.0920   BEB-8404-920      ACTIVE
Port1/3           1 UP         04:37:51 127       26 00bb.0000.0910   BEB-8404-910      ACTIVE
```

Fabric Connect – Campus 2 Configuration

Overview

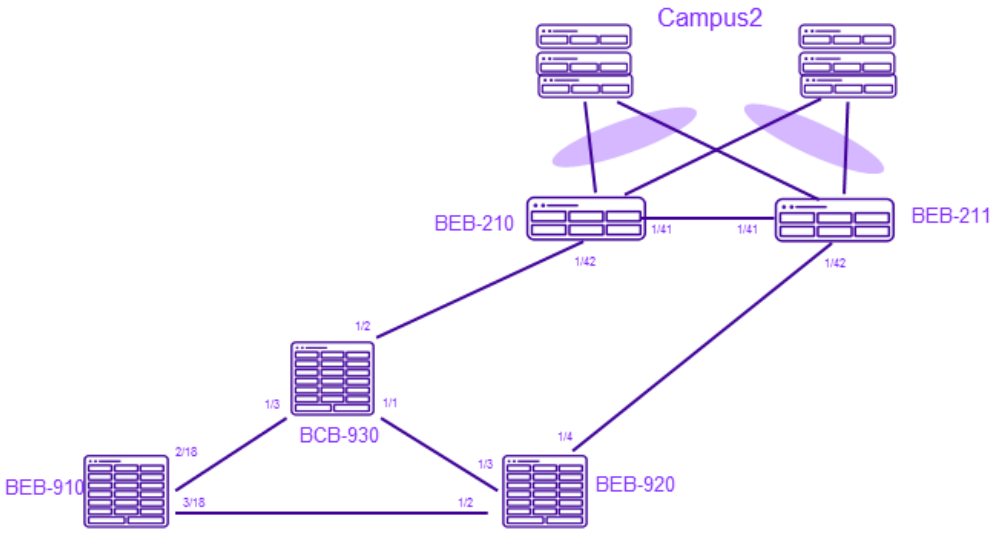
This section will illustrate configuring the Campus 2 BEB switches (-210 and -211), and the interconnection to the Fabric Connect core.

The BEB Fabric nodes are where the access data VLANs are created and assigned to a service. There are no L2/L3 configurations on the BCB switch, which allows for the core to be totally independent of any changes or modifications on the edge of the network.

After the initial SPB configuration, the process consists of the following steps:

- VRF creation for L3VSN services.
- VLAN creation, I-SID mapping, and VRF assignment.
- Enabling global VRF I-SID and VSN.
- Default Gateway protocol configuration (RSMLT and DVR).
- Redistribution/routing policies.

Note
- An L2VSN will be used for the Wired IOT Bridged VLAN (907). - L3VSNs will be used for the IoT and Surveillance VLANs. - The remaining VLANs will be routed on the Global Routing Table via IP Shortcuts.



Campus 2 (VLAN 2xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt. VLAN	200	1020200	172.20.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	201	1020201	172.20.20.0/22	RSMLT	VRF 1	1800911
Administrator (wired)	202	1020202	172.20.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	203	1020203	172.20.28.0/22	RSMLT	GRT	N/A
Surveillance	204	1020204	172.20.32.0/22	RSMLT	VRF 2	1800904

Common Services:

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Administrator(wireless)	1050	1501050	172.105.0.0/24	DVR	GRT	N/A
Campus Users (wireless)	1051	1501051	172.105.1.0/24	DVR	GRT	N/A
IoT Devices (wireless)	1052	1501052	172.105.2.0/24	DVR	VRF 1	1800911
Guest (wireless)	906	1090906	172.90.40.0/24	EWC	Tunnel	N/A
Wired IoT(bridged)	907	1090907	N/A	N/A	L2VSN	N/A

Core Interface Configuration

As the base IS-IS configuration is already complete on the core Fabric Connect switches, all that's required on the core switches to connect the campus is to enable IS-IS on the connecting interfaces.

- To connect Campus 2 to the core Fabric Connect nodes:

BCB-930 Configuration:

```
Vlan member remove 1 1/2
interface GigabitEthernet 1/2
encapsulation dot1q
isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

BEB-920 Configuration:

```
Vlan member remove 1 1/4
interface GigabitEthernet 1/4
encapsulation dot1q
isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

BEB-210 Configuration

Note

An L2 VSN will be used for VLAN 907. The L2 VSN in the Automated Campus is created dynamically based on Fabric Attach requests from the FA client, therefore no manual configuration is necessary on the BEBs. When an end-user authenticates and is assigned to this VLAN/ISID, VLAN 907 will dynamically be added to the access and uplink ports.

As FA is not used in the server room, L2VSN configuration is required on those switches.

IS-IS and VLAN Configuration

1. Enter the base IS-IS configuration (from previous section) and loopback interfaces:

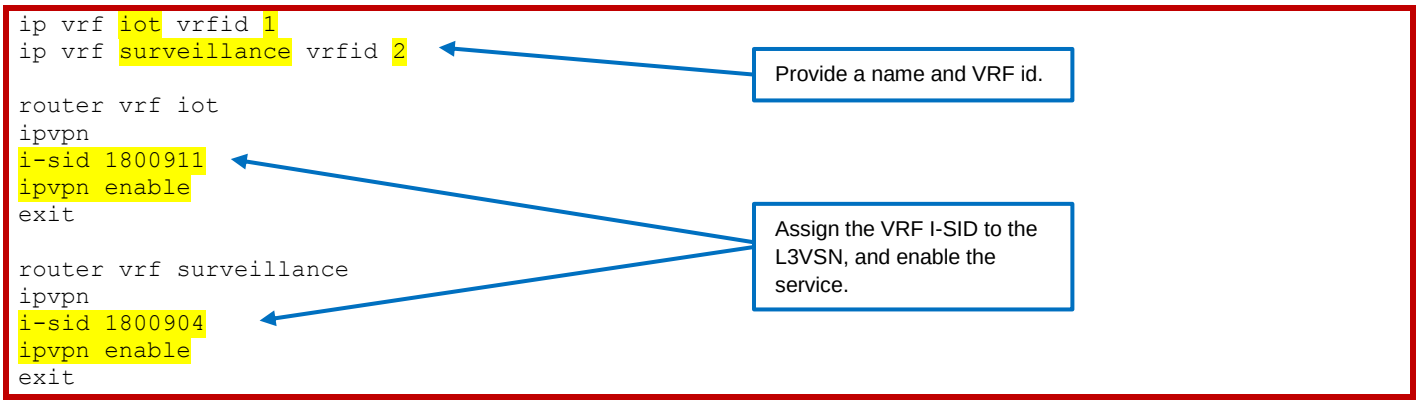
```
config terminal
 prompt "BEB-8284-210"
spbm
interface loopback 1
ip address 1 10.0.0.210/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:210/128
exit

router isis
 spbm 1
 spbm 1 nick-name 0.02.10
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "BEB-8284-210"
 system-id 00bb.0000.0210
manual-area 49.0000
ip-source-address 10.0.0.210
ipv6-source-address 8200:0:0:0:0:0:0:210
spbm 1 ip enable
spbm 1 ipv6 enable
exit
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/1-1/2,1/41-1/42
sys clipId-topology-ip  1
sys force-topology-ip-flag

interface GigabitEthernet 1/41
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 1/42
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

As both IPv4/v6 are requirements for the Campus User VLAN, enable IPv6 and set an IPv6 loopback on fabric nodes routing IPv6 subnets.

Set advertised IP addresses and globally enable IP Shortcut functionality.

2. Create the VRFs and enable the L3VSN services:

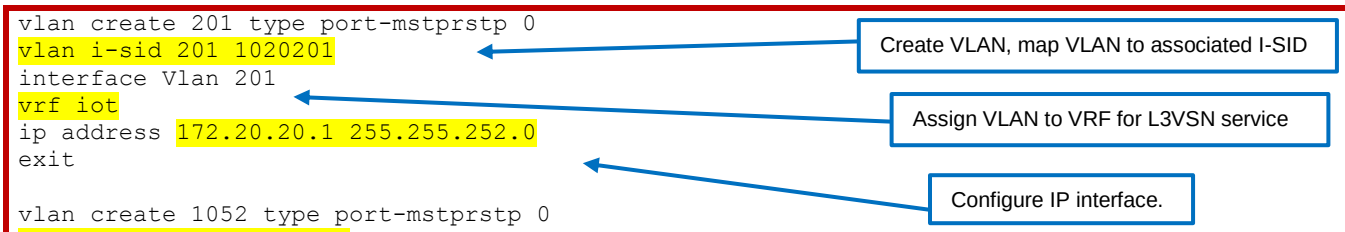
```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit

router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```



3. Create VLANs, I-SIDs and IP interfaces for the L3VSNs:

   - The IoT Campus wired (201) and wireless (1052) VLANs are created and added to the IoT VRF.
   - The Surveillance (204) VLAN is created and added to the Surveillance VRF.

```
vlan create 201 type port-mstprstp 0
vlan i-sid 201 1020201
interface Vlan 201
vrf iot
ip address 172.20.20.1 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.4 255.255.255.0
exit

vlan create 204 type port-mstprstp 0
vlan i-sid 204 1020204
interface Vlan 204
vrf surveillance
ip address 172.20.32.1 255.255.252.0
exit
```



4. Create the VLANs and interfaces for networks that will use the Global Routing Table:

   - The Device Mgmt (200), Administrator (202,1050) and Campus User (203,1051) VLANs are created and I-SIDs assigned.

```
vlan create 200 type port-mstprstp 0
vlan i-sid 200 1020200
interface Vlan 200
ip address 172.20.10.1 255.255.255.0
exit

vlan create 202 type port-mstprstp 0
vlan i-sid 202 1020202
interface Vlan 202
ip address 172.20.24.1 255.255.252.0
exit

vlan create 203 type port-mstprstp 0
vlan i-sid 203 1020203
interface Vlan 203
ip address 172.20.28.1 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:203:0:0:0:0:0:1/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.4 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
interface Vlan 1051
ip address 172.105.1.4 255.255.255.0
exit
```

Create VLAN, map VLAN to associated I-SID

Configure IPv6 interfaces on VLAN 203, as this VLAN requires dual-stack support.

Configure IP interfaces on the VLANs.

   - Verification of VLAN I-SIDs:

```
BEB-8284-210:1#show vlan i-sid

================================================================================================
                                    Vlan I-SID
================================================================================================
VLAN_ID    I-SID
------------------------------------------------------------------------------------------------
1
200        1020200
201        1020201
202        1020202
203        1020203
204        1020204
1050       1501050
1051       1501051
1052       1501052
4051
4052
```

RSMLT Configuration

- Configure RSMLT on BEB-210 to peer to BEB-211 in Campus2, forming a redundant router gateway for the specified VLANs from the access switches.

```
vlan create 2 type port-mstprstp 0
vlan i-sid 2 2000
interface Vlan 2
ip address 2.1.1.1 255.255.255.0
exit

virtual-ist peer-ip 2.1.1.2 vlan 2

router isis
spbm 1 smlt-virtual-bmac 00:00:82:00:21:10
spbm 1 smlt-peer-system-id 00bb.0000.0211
exit

router isis enable

interface GigabitEthernet 1/1
no spanning-tree mstp
no shutdown
exit

interface GigabitEthernet 1/2
no spanning-tree mstp
no shutdown
exit

mlt 1 enable
mlt 1 member 1/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

Configure VLAN/IP/I-SID used for vIST control communication between the MLT peers. This is locally significant for the MLT only.

Configure BEB-211's IP, designated as the vIST IP address.

Configure shared MLT virtual MAC (same on both peers) and the MLT peer system id address of BEB-211.

Once smlt parameters are configured, globally enable ISIS.

Disable spanning tree on the gig interfaces to be used for the MLT.

Configure the MLT instances, and assign the corresponding ports to each.

Under each MLT interface, configure Split multi-link trunking (smlt) to allow the LAG to be distributed across both BEBs to the access switch.

- Enable RSMLT on the desired VLANs:

```
interface vlan 200
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 201
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 202
ip rsmlt
ip rsmlt holdup-timer 9999
exit
```

Enable RSMLT on associated VLANs, indicating these VLANs will function as an RSMLT gateway.

Configure RSMLT holdup-timer to "9999" (infinity). This allows the redundant switch to forward the other switch's traffic indefinitely if its unreachable.

```
interface Vlan 203
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 204
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

When enabling Edge-Support, each RSMLT peer will learn the other's IP and MAC address information, allowing one to resume the routing duties for the other in case of an outage.

- Once the peer switch is also configured on the corresponding VLANs, they will communicate over the vIST to discover the peer's information:

```
BEB-8284-210:1(config)#show ip rsmlt local

================================================================================================
                        Ip Rsmlt Local Info - GlobalRouter
================================================================================================

VID   IP              MAC               ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
----
200   172.20.10.1     b0:ad:aa:47:bd:01  Enable  Up    60     infinity
202   172.20.24.1     b0:ad:aa:47:bd:03  Enable  Up    60     infinity
203   172.20.28.1     b0:ad:aa:47:bd:04  Enable  Up    60     infinity

VID   SMLT ID
------------------------------------------------------------------------------------------------
----
200      1,  2
202      1,  2
203      1,  2

VID   IPv6            MAC               ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
203                   b0:ad:aa:47:bd:04  Enable  Up    60     infinity
      8200:203:0:0:0:0:0:0/64
      8200:203:0:0:0:0:0:1/64
      fe80:0:0:0:b2ad:aaff:fe47:bd04/128


VID   SMLT ID
------------------------------------------------------------------------------------------------
203      1,  2
```

```
BEB-8284-210:1(config)#show ip rsmlt peer

================================================================================================
                        Ip Rsmlt Peer Info - GlobalRouter
================================================================================================

VID   IP              MAC               ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
200   172.20.10.2     e4:5d:52:42:0d:01  Enable  Up    60     infinity
202   172.20.24.2     e4:5d:52:42:0d:03  Enable  Up    60     infinity
203   172.20.28.2     e4:5d:52:42:0d:04  Enable  Up    60     infinity

VID   HDT REMAIN  HUT REMAIN  SMLT ID
------------------------------------------------------------------------------------------------
```

```
200   60          infinity      1,  2
202   60          infinity      1,  2
203   60          infinity      1,  2

VID   IPv6            MAC                ADMIN   OPER  HDTMR  HUTMR
-------------------------------------------------------------------------------------------
203                   e4:5d:52:42:0d:04  Enable  Up    60     infinity
      8200:203:0:0:0:0:0:0/64
      8200:203:0:0:0:0:0:2/64
      fe80:0:0:0:e65d:52ff:fe42:d04/128


VID   HDT REMAIN  HUT REMAIN  SMLT ID
```

DVR Configuration (Controllers only)

DVR is configured in both campuses for the wireless networks (IoT, Administrator and Campus User), specifying the BEBs as Controllers. Although the Server Rooms will have a full Controller-Leaf configuration, no Leaf configuration is required for the Campus DVR deployment.

Configuring DVR in the campuses for wireless networks extends those VLANs and subnets across the campuses, allowing for seamless roaming.

- Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 20

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

From Global mode, configure the DVR domain id. BEB-210 and -211 will share this id. The BEBs in Campus1 will have a different domain id.

Enable DVR for each Access VLAN, specifying the shared Default GW IP to be used,

- Verification:

```
BEB-8284-210:1#show dvr interfaces

=========================================================================================================
                                        DVR Interfaces
=========================================================================================================
                                                                                  Admin        SPBMC
IGMP
Interface       Mask            L3ISID     VRFID    L2ISID     VLAN     GW IPv4           State
State      Version
---------------------------------------------------------------------------------------------------------
172.105.0.4     255.255.255.0   0          0        1501050    1050     172.105.0.1       enable
disable    2
172.105.1.4     255.255.255.0   0          0        1501051    1051     172.105.1.1       enable
disable    2
172.105.2.4     255.255.255.0   1800911    1        1501052    1052     172.105.2.1       enable
disable    2

3 out of 3 Total Num of DVR Interfaces displayed
---------------------------------------------------------------------------------------------------------
```

Routing Policies - Overview

One of the benefits of Virtual Service Networks is the security and traffic isolation that occurs between them. However, network environments still require some controlled access between subnets, VRFs and DVR domains. Route Maps and IS-IS accept policies allow routes to be advertised across these boundaries.

The following are the current route policies applied on BEBs in the Automated Campus EVD.

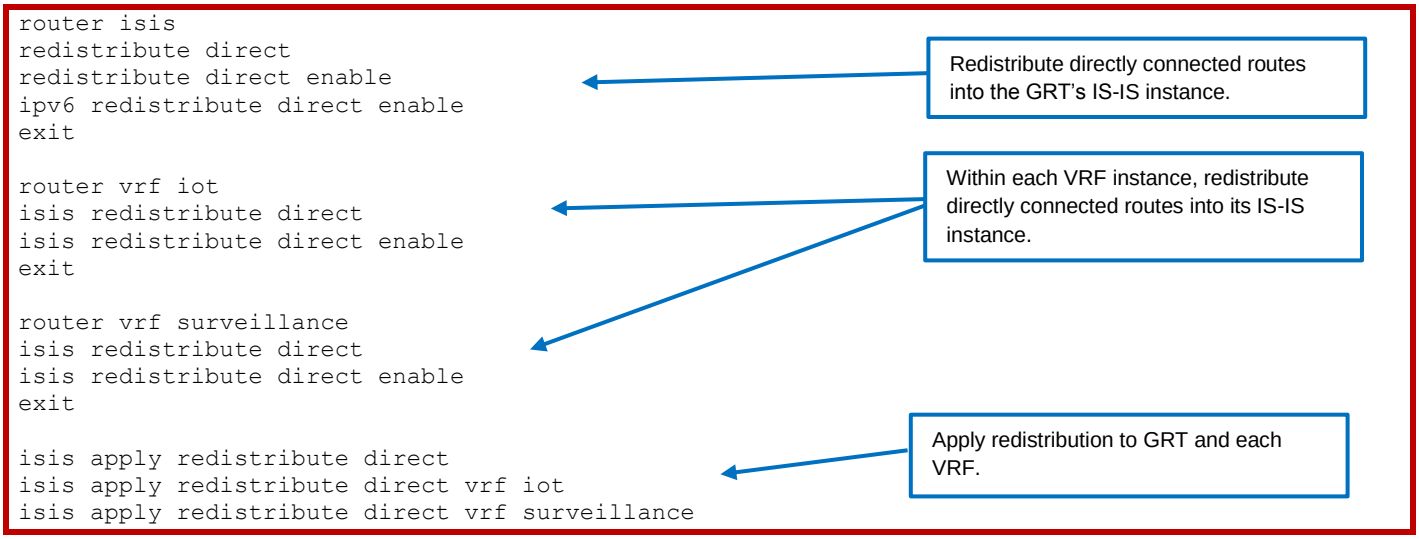
Note
Given the security and traffic isolation inherent in Fabric Connect, routing policy and redistribution are vital concepts in allowing inter-domain communication and may require further research and assistance than the overview in this document.

The GRT and VRF instances that are created become separate routing domains and therefore have separate, isolated routing tables. DVR domains (which are created within one or both) also act as a separate routing domain (i.e. a domain within a domain).

Routing Policies - Redistribution

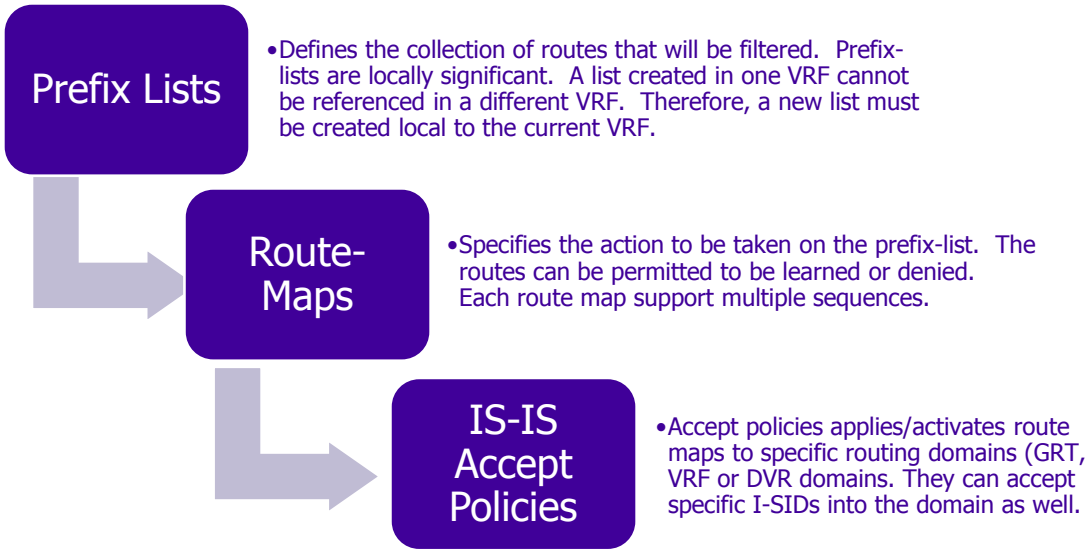
Fabric Connect uses one global IS-IS instance for reachability information. When vlan interfaces are created on fabric nodes within the same domain (GRT or VRF) in different parts of the network, those directly connected routes need to be redistributed into IS-IS for reachability WITHIN that routing domain.

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```



Route-Maps and IS-IS Accept Policies

For routes to be advertised or "leaked" between the GRT, VRFs, or DVR domains, prefix-lists, route-maps and IS-IS accept policies are configured.



For example, the DVR domains created in the campuses and server rooms are separate domains, and by default, do not share routing information. For the domains to exchange routing information, route-policies must be configured to share them across the DVR backbone.

GRT Routing Policy:

- The Global Routing Table on BEB-210 has the following requirements:
    - Reachability to networks in VRFs requiring centralized services located in the GRT (DHCP, production servers, etc.).
    - The Wireless Administrator (1050) and Campus User (1051) VLANS, which have DVR enabled, needs to be advertised to the DVR backbone, allowing route information to be shared with other corresponding networks in the DVR backbone (in Campus 1, for example).
- Configure IS-IS Accept policies, to import routes from the specified VRFs:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

Imports global I-SIDs for Surveillance and IoT VRF. No route-map needed, as all routes in these VRFs are being accepted.

VRF "IoT" Routing Policy:

- **The VRF IoT** has the following requirements:
  - Reachability between all IoT VLANs in the campuses and server rooms. This is accomplished when the IoT VLANs in these locations are added to the IoT VRF (L3VSN).
  - Access to the Production Server network and the Network Management subnet (both in the Server Room on the GRT).
  - The Wireless IoT VLAN (1052) which has DVR enabled, needs to be advertised to VRF IoT's DVR backbone, allowing route information to be shared with other IoT networks in the DVR backbone (in Campus 1, for example).
- Within VRF iot, create prefix-lists identifying the routes above:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24
```

- Create route-maps matching/permitting the corresponding prefix-lists:

```
route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit
```

Permit routes matching both the GRT_mgmt and GRT_910 prefix-lists.

Deny all other routes being learned.

- Configure IS-IS Accept policies, importing specific GRT routes matching the route-map:

```
router vrf iot
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

Imports the GRT_mgmt prefix-list from GRT (I-SID 0).

VRF "Surveillance" Routing Policy:

- **The VRF Surveillance** has the following requirements:
  - Reachability from the Surveillance VLANs in the campuses to the server rooms. This is accomplished when the Surveillance VLANs in these locations are added to the Surveillance VRF (L3VSN).
  - Access to the Network Mgmt subnet (for DHCP) and the Storage subnet (for video recordings).

- Configure prefix-lists, route-maps and accept policies for the “surveillance” VRF:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Define the routes to import from the GRT.

Permit routes matching those prefix-lists.

Accept the routes from the GRT defined in the route-map.

Apply the accept policies to the GRT and both VRFs.

Fabric Attach

Fabric Attach uses the IEEE802.1ab *LLDP (Link Layer Discovery Protocol)* extensions to automatically attach network devices to individual services in a Fabric Connect network. These network devices typically do not support SPB, MAC-in-MAC (802.1ah) or Network Services Identifier (NSI)/Individual Service Identifier (I-SID) usage, and therefore cannot easily take advantage of the Fabric infrastructure without manual configuration of VLAN attachments to NSIs or ISIDs in multiple locations. Fabric Attach deals with this issue by facilitating automated network device discovery and the automatic configuration and teardown of NSI/ISID to VLAN associations at the edge of the network.

Upon connection and detection of an FA Client, the FA Server (BEB) will advertise (via LLDP) the management I-SID/VLAN to the FA-Proxy switch.

The FA Proxy on the access switch communicates directly with the FA server on the BEB to request VLAN to I-SID mappings for user traffic.

Enter the following on BEB-210:

```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1020200 c-vid 200
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1020200 c-vid 200
exit
```

Under each MLT interface (connecting to the access switches), enable Fabric Attach.

Set the Management I-SID and VLAN that will be advertised to the FA client.

Feature disabled until released on EXOS.

BEB-211 Configuration (Peer)

BEB-211, acting as the RSMLT peer to BEB-210 will follow the same steps for configuration as BEB-210. Once both BEBs are configured, they can be connected to each other and to the core fabric nodes.

IS-IS and VLAN Configuration

- Enter the base IS-IS configuration and loopback interfaces:

```
config terminal
 prompt "BEB-8284-211"
spbm

interface loopback 1
ip address 1 10.0.0.211/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:211/128
exit

router isis
 spbm 1
 spbm 1 nick-name 0.02.11
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "BEB-8284-211"
 system-id 00bb.0000.0211
 ip-source-address 10.0.0.211
 ipv6-source-address 8200:0:0:0:0:0:0:211
 spbm 1 ip enable
 spbm 1 ipv6 enable
 manual-area 49.0000
 exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
sys clipId-topology-ip  1
sys force-topology-ip-flag
vlan member remove 1 1/1-1/2,1/41-1/42
interface GigabitEthernet 1/41
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 1/42
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

- Create the VRFs and enable the L3VSN services:

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit
router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```

- Create VLANs, I-SIDs and IP interfaces for the L3VSNs:
  - The IoT Campus wired (201) and wireless (1052) VLANs are created and added to the IoT VRF.
  - The Surveillance (204) VLAN is created and added to the Surveillance VRF.

```
vlan create 201 type port-mstprstp 0
vlan i-sid 201 1020201
interface Vlan 201
vrf iot
ip address 172.20.20.2 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.5 255.255.255.0
exit

vlan create 204 type port-mstprstp 0
vlan i-sid 204 1020204
interface Vlan 204
vrf surveillance
ip address 172.20.32.2 255.255.252.0
exit
```

- Create the VLANs and interfaces for networks that will use the Global Routing Table:
  - The Device Mgmt (200), Administrator (202,1050) and Campus User (203,1051) VLANs are created and I-SIDs assigned.

```
vlan create 200 type port-mstprstp 0
vlan i-sid 200 1020200
interface Vlan 200
ip address 172.20.10.2 255.255.255.0
exit

vlan create 202 type port-mstprstp 0
vlan i-sid 202 1020202
interface Vlan 202
ip address 172.20.24.2 255.255.252.0
exit

vlan create 203 type port-mstprstp 0
vlan i-sid 203 1020203
interface Vlan 203
ip address 172.20.28.2 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:203:0:0:0:0:0:2/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.5 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
interface Vlan 1051
ip address 172.105.1.5 255.255.255.0
exit
```

RSMLT Configuration

- Configure RSMLT to peer the BEB-211 and -210 BEBs. Be sure to specify the -210 values where called for.

```
vlan create 2 type port-mstprstp 0
vlan i-sid 2 2000
interface Vlan 2
ip address 2.1.1.2 255.255.255.0
exit

virtual-ist peer-ip 2.1.1.1 vlan 2

router isis
spbm 1 smlt-virtual-bmac 00:00:82:00:21:10
spbm 1 smlt-peer-system-id 00bb.0000.0210
exit

router isis enable

interface GigabitEthernet 1/1
no spanning-tree mstp
yes
no shutdown
exit

interface GigabitEthernet 1/2
no spanning-tree mstp
yes
no shutdown
exit

mlt 1 enable
mlt 1 member 1/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

Once smlt parameters are configured, globally enable ISIS.

- Enable RSMLT on the desired VLANs:

```
interface vlan 200
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 201
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 202
ip rsmlt
ip rsmlt holdup-timer 9999
exit
```

```
interface Vlan 203
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 204
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

DVR Configuration (Controllers only)

Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 20

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

The DVR gateway IP will be the same address as configured in BEB-210 to allow for inter-campus roaming

Routing Policies - Redistribution

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Route-Maps and IS-IS Accept Policies

GRT Policy:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

VRF “IoT” Routing Policy:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

VRF “Surveillance” Routing Policy:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_routes" 1
permit
enable

match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_routes" 2
no permit
enable
exit
exit

router vrf surveillance
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_routes"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Fabric Attach

- The FA management VLAN in Campus 2 is VLAN id 200

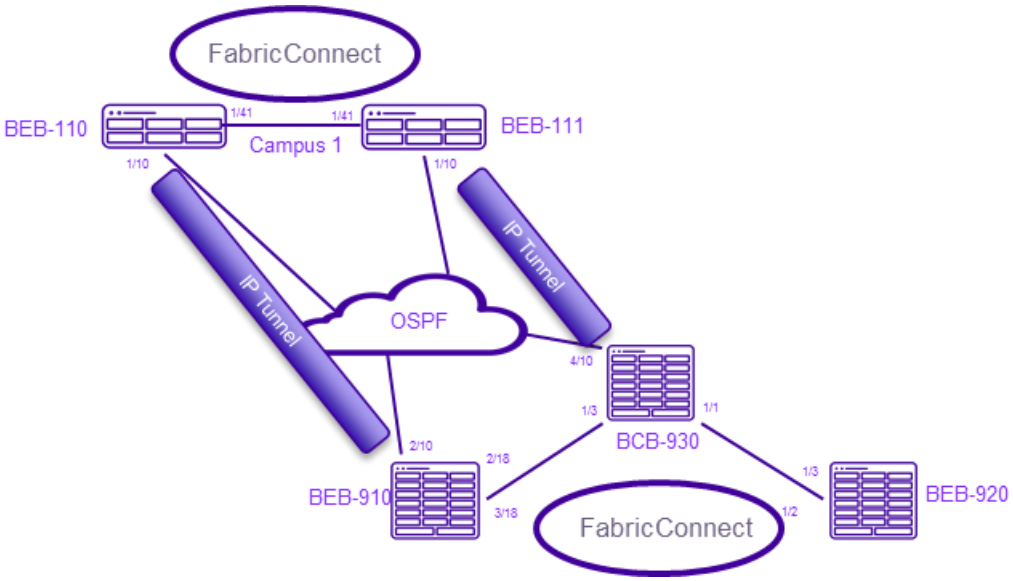
```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1020200 c-vid 200
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1020200 c-vid 200
exit
```

Fabric Extend (Fabric Connect over IP) – Campus 1 Configuration

Overview

Fabric Extend allows us to extend the Fabric Connect technology over Layer 2 or Layer 3 core networks. The logical IS-IS interface is the mechanism that enables Fabric Extend to connect SPB fabric nodes. Logical IS-IS interfaces create virtual tunnels and encapsulate SPB traffic by adding a Virtual Extensible LAN (VXLAN) header to SPB packets.

To illustrate this, the Automated Campus utilizes Fabric Extend, using two L3 tunnels, connecting the core fabric nodes (BCB-930 and BEB-910) to the Campus-1 BEBs (-110 and -111) over an intermediate IP network. The intermediate network can consist of any configuration if there is connectivity between the sites. This EVD uses OSPF.



This deployment uses a separate VRF strictly for the tunneling, so the tunnel source IP address must be present on the VRF.

Core Interface (Tunnel) Configuration

BCB-930 Configuration:

- Configure IP interface and OSPF to peer with non-Fabric network:

```
router ospf enable
router ospf
router-id 10.0.0.30
exit

ip vrf tunnel vrfid 3
router vrf tunnel
ip ospf
ip ospf admin-state
exit

interface GigabitEthernet 4/10
encapsulation dot1q
```

Globally enable OSPF, set the loopback as the router id.

Create VRF to configure tunnel in.

```
name "OSPF_link_to_Cloud"
no shutdown
vrf tunnel
brouter port 4/10 vlan 2501 subnet 197.1.2.4/255.255.255.0
no spanning-tree mstp
yes
ip ospf enable
yes
exit
```

Within vrf Tunnel, configure IP interface connecting to OSPF network, and enable OSPF.

- Configure the L3 Tunnel to connect to Campus 1, BEB-111:

```
router isis
ip-tunnel-source-address 197.1.2.4 vrf tunnel
exit

logical-intf isis 255 dest-ip 197.1.12.2 name "Tunnel_to_8284-111"
isis
isis spbm 1
isis enable
exit
```

Configure tunnel source IP (same as IP interface in previous step).

Configure tunnel destination IP (IP of BEB-111 in Campus-1), and set the IS-IS instance id to match local instance.

BCB-910 Configuration:

- Configure IP interface and OSPF to peer with non-Fabric network:

```
router ospf enable
router ospf
router-id 10.0.0.10
exit

ip vrf tunnel vrfid 3
router vrf tunnel
ip ospf
exit

interface GigabitEthernet 2/10
encapsulation dot1q
name "OSPF_link_to_Cloud2"
no shutdown
vrf tunnel
brouter port 2/10 vlan 2500 subnet 197.1.1.2/255.255.255.0
no spanning-tree mstp
yes
ip ospf enable
yes
exit
```

Globally enable OSPF, set the loopback as the router id.

Create VRF to configure tunnel in.

Within vrf Tunnel, configure IP interface connecting to OSPF network, and enable

- Configure the L3 Tunnel to connect to Campus 1, BEB-110:

```
router isis
ip-tunnel-source-address 197.1.1.2 vrf tunnel
exit

logical-intf isis 255 dest-ip 197.1.6.2 name "Tunnel_to_8284-110"
isis
isis spbm 1
isis enable
exit
```

Configure tunnel source IP (same as IP interface in previous step).

Configure tunnel destination IP (IP of BEB-110 in Campus-1), and set the IS-IS instance id to match local instance.

BEB-111 Configuration

Campus 1 (VLAN 1xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt.VLAN	100	1010100	172.10.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	101	1010101	172.10.20.0/22	RSMLT	VRF 1	1800911
Administrator (wired)	102	1010102	172.10.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	103	1010103	172.10.28.0/22	RSMLT	GRT	N/A
Surveillance	104	1010104	172.10.32.0/22	RSMLT	VRF 2	1800904

Common Services:

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Administrator(wireless)	1050	1501050	172.105.0.0/24	DVR	GRT	N/A
Campus Users (wireless)	1051	1501051	172.105.1.0/24	DVR	GRT	N/A
IoT Devices (wireless)	1052	1501052	172.105.2.0/24	DVR	VRF 1	1800911
Guest (wireless)	906	1090906	172.90.40.0/24	EWC	Tunnel	N/A
Wired IoT(bridged)	907	1090907	N/A	N/A	L2VSN	N/A

IS-IS Configuration

BEB-111, the tunnel peer to BCB-930 will be configured similarly, except specifying the BCB-930 as its tunnel end-point:

- Configure the base ISIS configuration:

```
config terminal
prompt "BEB-8284-111"
spbm

interface loopback 1
ip address 1 10.0.0.111/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:111/128
exit

router isis
spbm 1
spbm 1 nick-name 0.01.11
spbm 1 b-vid 4051-4052 primary 4051
sys-name "BEB-8284-111"
system-id 00bb.0000.0111
ip-source-address 10.0.0.111
ipv6-source-address 8200:0:0:0:0:0:0:111
spbm 1 ip enable
spbm 1 ipv6 enable
manual-area 49.0000
exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/1-1/2,1/10,1/41
sys clipId-topology-ip  1
sys force-topology-ip-flag

interface GigabitEthernet 1/41
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no spanning-tree mstp
 yes
 no shutdown
 exit
```

Fabric Extend (tunnel) Configuration

- Configure the IP Tunnel to BCB-930:

```
router ospf enable
router ospf
router-id 10.0.0.111
exit

ip vrf tunnel vrfid 3
router vrf tunnel
ip ospf
ip ospf admin-state
exit

interface GigabitEthernet 1/10
name "ospf_vlan_to_cloud"
no shutdown
vrf tunnel
brouter port 1/10 vlan 3501 subnet 197.1.12.2/255.255.255.0
```

```
no spanning-tree mstp
yes
ip ospf enable
yes
exit

router isis
ip-tunnel-source-address 197.1.12.2 vrf tunnel
exit

logical-intf isis 255 dest-ip 197.1.2.4 name "Tunnel_to_Core"
isis
isis spbm 1
isis enable
exit
```

- Once connected, ensure the OSPF neighbor state between the Campus BEBs and Core Fabric nodes to their respective OSPF neighbors is established.

```
CORE-BEB-8284-111:1(config)#show ip ospf neighbor vrf tunnel

================================================================================================
                          OSPF Neighbors - VRF tunnel
================================================================================================
INTERFACE        NBRROUTERID     NBRIPADDR       PRIO    STATE     RTXQLEN PERM TTL
------------------------------------------------------------------------------------------------
197.1.12.2       82.60.189.0     197.1.12.3      1       Full      0       Dyn    32

Total ospf neighbors: 1
H = Helping a Restarting neighbor
```

The OSPF state to the intermediate OSPF network router should be “FULL”.

- Verify that the tunnel to Campus1 is operational and Fabric Extend is working.

```
BEB-8284-111:1(config)#show isis logical-interface

================================================================================================================
                                    ISIS Logical Interfaces
================================================================================================================
IFIDX    NAME             ENCAP       L2_INFO                    TUNNEL           L3_TUNNEL_NEXT_HOP_INFO
                          TYPE        PORT/MLT   VIDS(PRIMARY)   DEST-IP          PORT/MLT   VLAN      VRF
----------------------------------------------------------------------------------------------------------------
255      Tunnel_to_Core   IP          --         --              197.1.2.4        Port1/10   3501    tunnel
----------------------------------------------------------------------------------------------------------------
 1 out of 1 Total Num of Logical ISIS interfaces
```

If the tunnel is operational, the interface will be listed. Otherwise, it will state “NULL”.

VLAN and I-SID Configuration

VLANs and services for Campus 1 are configured in this section based on the VLAN/I-SID scheme illustrated at the beginning of this section.

1. Create the VRFs and enable the L3VSN services:

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2
router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit
router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```

2. Create VLANs, I-SIDs and IP interfaces for the L3VSNs:
   - The IoT Campus wired (101) and wireless (1052) VLANs are created and added to the IoT VRF.
   - The Surveillance (104) VLAN is created and added to the Surveillance VRF.

```
vlan create 101 type port-mstprstp 0
vlan i-sid 101 1010101
interface Vlan 101
vrf iot
ip address 172.10.20.2 255.255.252.0
exit

vlan create 104 type port-mstprstp 0
vlan i-sid 104 1010104
interface Vlan 104
vrf surveillance
ip address 172.10.32.2 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.3 255.255.255.0
exit
```

3. Create the VLANs and interfaces for networks that will use the Global Routing Table:
   - The Device Mgmt (100), Administrator (102,1050) and Campus User (103,1051) VLANs are created and I-SIDs assigned.

```
vlan create 100 type port-mstprstp 0
vlan i-sid 100 1010100
interface Vlan 100
ip address 172.10.10.2 255.255.255.0
exit

vlan create 102 type port-mstprstp 0
vlan i-sid 102 1010102
interface Vlan 102
ip address 172.10.24.2 255.255.252.0
exit

vlan create 103 type port-mstprstp 0
vlan i-sid 103 1010103
interface Vlan 103
ip address 172.10.28.2 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:103:0:0:0:0:0:2/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.3 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
interface Vlan 1051
ip address 172.105.1.3 255.255.255.0
exit
```

RSMLT Configuration

- Configure RSMLT to peer the BEB-110 and -111 in Campus1, forming a redundant router gateway for the specified VLANs from the access switches.

```
vlan create 2 type port-mstprstp 0
vlan i-sid 2 2200
interface Vlan 2
ip address 2.2.2.2 255.255.255.0 0
exit

virtual-ist peer-ip 2.2.2.1 vlan 2

router isis
spbm 1 smlt-virtual-bmac 00:bb:00:01:10:11
spbm 1 smlt-peer-system-id 00bb.0000.0110
exit

router isis enable

interface GigabitEthernet 1/1
no spanning-tree mstp
yes
no shutdown
exit

interface GigabitEthernet 1/2
no spanning-tree mstp
yes
no shutdown
exit

mlt 1 enable
mlt 1 member 1/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

- Enable RSMLT on the desired VLANs:

```
interface vlan 100
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 101
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 102
ip rsmlt
ip rsmlt holdup-timer 9999
exit
```

```
interface Vlan 103
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 104
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

DVR Configuration

- Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 10

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

From Global mode, configure the DVR domain id for Campus 1. BEB-110 and -111 will share this id.

Routing Policies - Redistribution

- The redistribution configuration will be the same as the Campus 2 configuration:

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Route-Maps and IS-IS Accept Policies

The route policy configuration will be the same as the Campus 2 configuration.

- GRT Policy:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

- VRF “IoT” Routing Policy:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

- VRF “Surveillance” Routing Policy:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_mgmt" 2
no permit
enable
exit
exit

router vrf surveillance
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Fabric Attach

- The FA management VLAN in Campus 1 is VLAN id 100

```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1010100 c-vid 100
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1010100 c-vid 100
exit
```

BEB-110 Configuration

IS-IS Configuration

BEB-110, the tunnel peer to BEB-910 will be configured similarly, except specifying the BEB-910 as its tunnel end-point:

- Configure the base ISIS configuration:

```
config terminal
 prompt "BEB-8284-110"
spbm
interface loopback 1
ip address 1 10.0.0.110/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:110/128
exit

router isis
 spbm 1
 spbm 1 nick-name 0.01.10
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "BEB-8284-110"
 system-id 00bb.0000.0110
ip-source-address 10.0.0.110
ipv6-source-address 8200:0:0:0:0:0:0:110
spbm 1 ip enable
spbm 1 ipv6 enable
manual-area 49.0000
exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/1-1/2,1/10,1/41
sys clipId-topology-ip  1
sys force-topology-ip-flag

interface GigabitEthernet 1/41
encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no spanning-tree mstp
 yes
 no shutdown
 exit
```

Fabric Extend (tunnel) Configuration

- Configure the IP Tunnel to BCB-910:

```
router ospf enable
router ospf
router-id 10.0.0.110
exit

ip vrf tunnel vrfid 3
router vrf tunnel
ip ospf
ip ospf admin-state
exit

interface GigabitEthernet 1/10
name "ospf_vlan_to_cloud"
no shutdown
vrf tunnel
brouter port 1/10 vlan 3500 subnet 197.1.11.2/255.255.255.0
no spanning-tree mstp
yes
ip ospf enable
yes
exit

router isis
ip-tunnel-source-address 197.1.11.2 vrf tunnel
exit

logical-intf isis 255 dest-ip 197.1.1.2 name "Tunnel-8404-910"
isis
isis spbm 1
isis enable
exit
```

- Once connected, ensure the OSPF neighbor state between the Campus BEBs and Core Fabric nodes to their respective OSPF neighbors is established.

The OSPF state to the intermediate OSPF network router should be “FULL”.

```
BEB-8284-110:1(config)#show ip ospf neighbor vrf tunnel

================================================================================================
                          OSPF Neighbors - VRF tunnel
================================================================================================
INTERFACE       NBRROUTERID     NBRIPADDR       PRIO    STATE     RTXQLEN PERM TTL
------------------------------------------------------------------------------------------------
197.1.11.2      82.60.189.0     197.1.11.3      1       Full      0       Dyn    35
```

- Verify that the tunnel to Campus1 is operational and Fabric Extend is working.

```
BEB-8284-110:1(config)#show isis logical-interface

================================================================================
                                ISIS Logical Interfaces
================================================================================
IFIDX    NAME              ENCAP        L2_INFO                    TUNNEL
L3_TUNNEL_NEXT_HOP_INFO
                           TYPE         PORT/MLT   VIDS(PRIMARY)   DEST-IP      PORT/MLT   VLAN
VRF
--------------------------------------------------------------------------------
255      Tunnel-8404-910   IP           --         --              197.1.1.2    Port1/10   3500
tunnel
```

If the tunnel is operational, the interface will be listed. Otherwise, it will state "NULL".

VLAN and I-SID Configuration

VLANs and services for Campus 1 are configured in this section based on the VLAN/I-SID scheme illustrated at the beginning of this section.

1. Create the VRFs and enable the L3VSN services:

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit
router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```

2. Create VLANs, I-SIDs and IP interfaces for the L3VSNs:
   - The IoT Campus wired (101) and wireless (1052) VLANs are created and added to the IoT VRF.
   - The Surveillance (104) VLAN is created and added to the Surveillance VRF.

```
vlan create 101 type port-mstprstp 0
vlan i-sid 101 1010101
interface Vlan 101
vrf iot
ip address 172.10.20.1 255.255.252.0
exit

vlan create 104 type port-mstprstp 0
vlan i-sid 104 1010104
interface Vlan 104
vrf surveillance
ip address 172.10.32.1 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.2 255.255.255.0
exit
```

3. Create the VLANs and interfaces for networks that will use the Global Routing Table:

   - The Device Mgmt (100), Administrator (102,1050) and Campus User (103,1051) VLANs are created and I-SIDs assigned.

```
vlan create 100 type port-mstprstp 0
vlan i-sid 100 1010100
interface Vlan 100
ip address 172.10.10.1 255.255.255.0
exit

vlan create 102 type port-mstprstp 0
vlan i-sid 102 1010102
interface Vlan 102
ip address 172.10.24.1 255.255.252.0
exit

vlan create 103 type port-mstprstp 0
vlan i-sid 103 1010103
interface Vlan 103
ip address 172.10.28.1 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:103:0:0:0:0:0:1/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.2 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
interface Vlan 1051
ip address 172.105.1.2 255.255.255.0
exit
```

RSMLT Configuration

- Configure RSMLT to peer the BEB-110 and -111 in Campus1, forming a redundant router gateway for the specified VLANs from the access switches.

```
vlan create 2 type port-mstprstp 0
vlan i-sid 2 2200
interface Vlan 2
ip address 2.2.2.1 255.255.255.0 0
exit

virtual-ist  peer-ip 2.2.2.2 vlan 2

router isis
spbm 1 smlt-virtual-bmac 00:bb:00:01:10:11
spbm 1 smlt-peer-system-id 00bb.0000.0111
exit

router isis enable

interface GigabitEthernet 1/1
no spanning-tree mstp
yes
no shutdown
exit

interface GigabitEthernet 1/2
```

```
no spanning-tree mstp
yes
no shutdown
exit

mlt 1 enable
mlt 1 member 1/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

- Enable RSMLT on the desired VLANs:

```
interface vlan 100
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 101
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 102
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 103
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 104
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

DVR Configuration

- Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 10

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

From Global mode, configure the DVR domain id for Campus 1. BEB-110 and -111 will share this id.

Routing Policies - Redistribution

- The redistribution configuration will be the same as the Campus 2 configuration:

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Route-Maps and IS-IS Accept Policies

GRT Policy:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

VRF “IoT” Routing Policy:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

VRF “Surveillance” Routing Policy:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_mgmt" 2
no permit
enable
exit
exit

router vrf surveillance
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Fabric Attach

```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1010100 c-vid 100
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1010100 c-vid 100
exit
```

Fabric Connect – Campus 3 Configuration

Overview

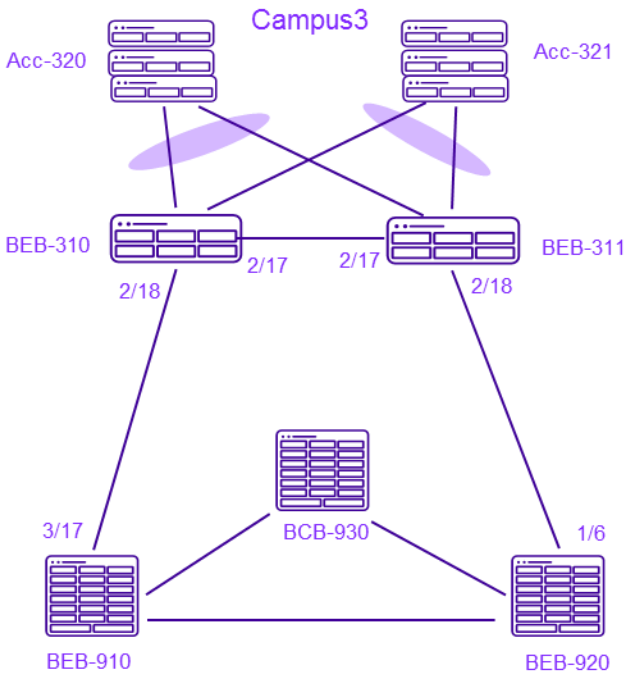
This section will illustrate configuring the Campus 3 BEB switches (-310 and -311), and the interconnection to the Fabric Connect core. The access layer in Campus 3 utilizes ERS Access switches.

The BEB Fabric nodes are where the access data VLANs are created and assigned to a service. There are no L2/L3 configurations on the BCB switch, which allows for the core to be totally independent of any changes or modifications on the edge of the network.

After the initial SPB configuration, the process consists of the following steps:

- VRF creation for L3VSN services.
- VLAN creation, I-SID mapping, and VRF assignment.
- Enabling global VRF I-SID and VSN.
- Default Gateway protocol configuration (RSMLT and DVR).
- Redistribution/routing policies.

Note
- An L2VSN will be used for the Wired IOT Bridged VLAN (907). - L3VSNs will be used for the IoT and Surveillance VLANs. - The remaining VLANs will be routed on the Global Routing Table via IP Shortcuts.



Campus 3 (VLAN 3xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
FA Mgmt. VLAN	300	1030300	172.30.10.0/24	RSMLT	GRT	N/A
Wired IoT (routed)	301	1030301	172.30.20.0/22	RSMLT	VRF 1	1800911
Administrator (wired)	302	1030302	172.30.24.0/22	RSMLT	GRT	N/A
Campus User(wired)	303	1030303	172.30.28.0/22	RSMLT	GRT	N/A
Surveillance	304	1030304	172.30.32.0/22	RSMLT	VRF 2	1800904

Common Services:

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Administrator(wireless)	1050	1501050	172.105.0.0/24	DVR	GRT	N/A
Campus Users (wireless)	1051	1501051	172.105.1.0/24	DVR	GRT	N/A
IoT Devices (wireless)	1052	1501052	172.105.2.0/24	DVR	VRF 1	1800911
Guest (wireless)	906	1090906	172.90.40.0/24	EWC	Tunnel	N/A
Wired IoT(bridged)	907	1090907	N/A	N/A	L2VSN	N/A

Core Interface Configuration

As the base IS-IS configuration is already complete on the core Fabric Connect switches, all that's required on the core switches to connect the campus is to enable IS-IS on the connecting interfaces.

- To connect Campus 3 to the core Fabric Connect nodes:

BEB-910 Configuration:

```
Vlan member remove 1 3/17
interface GigabitEthernet 3/17
encapsulation dot1q
isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

BCB-920 Configuration:

```
Vlan member remove 1 1/6
interface GigabitEthernet 1/6
encapsulation dot1q
isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

BEB-310 Configuration

Note

An L2 VSN will be used for VLAN 907. The L2 VSN in the Automated Campus is created dynamically based on Fabric Attach requests from the FA client, therefore no manual configuration is necessary on the BEBs. When an end-user authenticates and is assigned to this VLAN/ISID, VLAN 907 will dynamically be added to the access and uplink ports.

As FA is not used in the server room, L2VSN configuration is required on those switches.

IS-IS and VLAN Configuration

1. Enter the base IS-IS configuration (from previous section) and loopback interfaces:

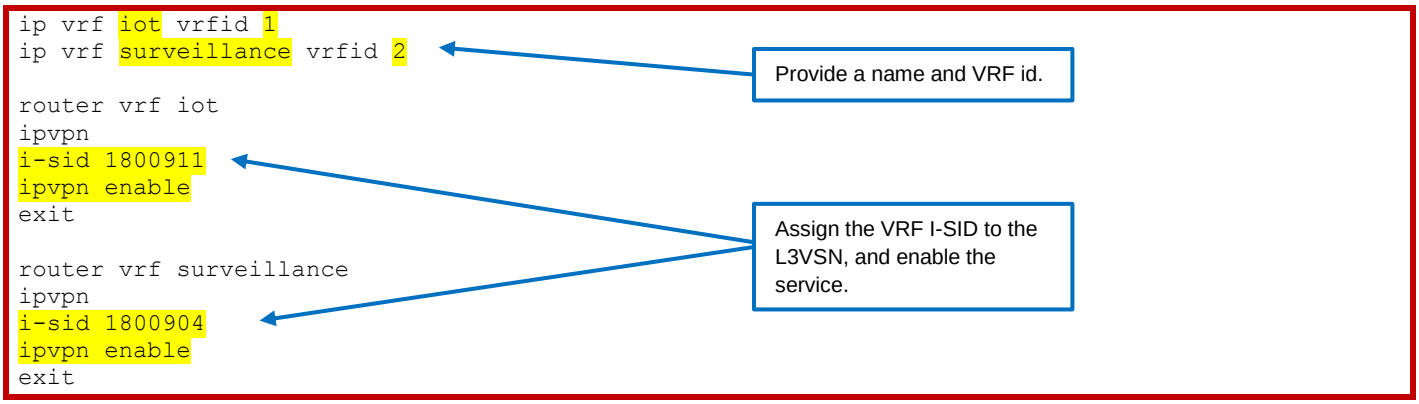
```
config terminal
 prompt "BEB-8404-310"
spbm
interface loopback 1
ip address 1 10.0.0.210/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:210/128
exit

router isis
 spbm 1
 spbm 1 nick-name 0.03.10
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "BEB-8284-310"
 system-id 00bb.0000.0310
manual-area 49.0000
ip-source-address 10.0.3.10
ipv6-source-address 8200:0:0:0:0:0:0:310
spbm 1 ip enable
spbm 1 ipv6 enable
exit
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
vlan member remove 1 1/1-1/2,1/41-1/42
sys clipId-topology-ip  1
sys force-topology-ip-flag

interface GigabitEthernet 2/17
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 2/18
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

As both IPv4/v6 are requirements for the Campus User VLAN, enable IPv6 and set an IPv6 loopback on fabric nodes routing IPv6 subnets.

Set advertised IP addresses and globally enable IP Shortcut functionality.

2. Create the VRFs and enable the L3VSN services:

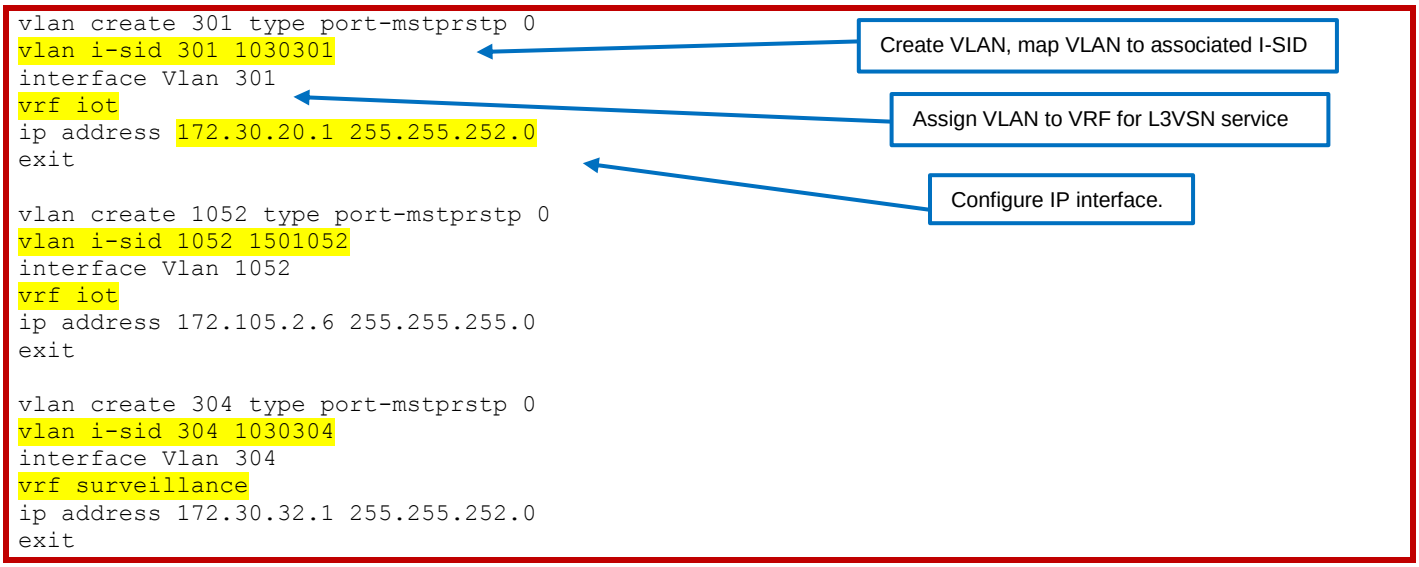
```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit

router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```



3. Create VLANs, I-SIDs and IP interfaces for the L3VSNs:

   - The IoT Campus wired (301) and wireless (1052) VLANs are created and added to the IoT VRF.
   - The Surveillance (304) VLAN is created and added to the Surveillance VRF.

```
vlan create 301 type port-mstprstp 0
vlan i-sid 301 1030301
interface Vlan 301
vrf iot
ip address 172.30.20.1 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.6 255.255.255.0
exit

vlan create 304 type port-mstprstp 0
vlan i-sid 304 1030304
interface Vlan 304
vrf surveillance
ip address 172.30.32.1 255.255.252.0
exit
```



4. Create the VLANs and interfaces for networks that will use the Global Routing Table:

   - The Device Mgmt (300), Administrator (302,1050) and Campus User (303,1051) VLANs are created and I-SIDs assigned.

```
vlan create 300 type port-mstprstp 0
vlan i-sid 300 1030300
interface Vlan 300
ip address 172.30.10.1 255.255.255.0
exit

vlan create 302 type port-mstprstp 0
vlan i-sid 302 1030302
interface Vlan 302
ip address 172.30.24.1 255.255.252.0
exit

vlan create 303 type port-mstprstp 0
vlan i-sid 303 1030303
interface Vlan 303
ip address 172.30.28.1 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:303:0:0:0:0:0:1/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.6 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
interface Vlan 1051
ip address 172.105.1.6 255.255.255.0
exit
```

Create VLAN, map VLAN to associated I-SID

Configure IPv6 interfaces on VLAN 303, as this VLAN requires dual-stack support.

Configure IP interfaces on the VLANs.

   - Verification of VLAN I-SIDs:

```
BEB-8404-310:1(config)#show vlan i-sid

================================================================================================
                                    Vlan I-SID
================================================================================================
VLAN_ID    I-SID
------------------------------------------------------------------------------------------------
1
300        1030300
301        1030301
302        1030302
303        1030303
304        1030304
1050       1501050
1051       1501051
1052       1501052
4051
4052
```

RSMLT Configuration

- Configure RSMLT on BEB-310 to peer to BEB-311, forming a redundant router gateway for the specified VLANs from the access switches.

```
vlan create 3 type port-mstprstp 0
vlan i-sid 3 3300
interface Vlan 3
ip address 3.3.3.1 255.255.255.0
exit

virtual-ist peer-ip 3.3.3.2 vlan 3

router isis
spbm 1 smlt-virtual-bmac 00:bb:00:03:10:11
spbm 1 smlt-peer-system-id 00bb.0000.0311
exit

router isis enable

interface GigabitEthernet 2/1
no spanning-tree mstp
no shutdown
exit

interface GigabitEthernet 2/2
no spanning-tree mstp
no shutdown
exit

mlt 1 enable
mlt 1 member 2/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 2/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

Configure VLAN/IP/I-SID used for vIST control communication between the MLT peers. This is locally significant for the MLT only.

Configure BEB-311's IP, designated as the vIST IP address.

Configure shared MLT virtual MAC (same on both peers) and the MLT peer system id address of BEB-311.

Once smlt parameters are configured, globally enable ISIS.

Disable spanning tree on the gig interfaces to be used for the MLT.

Configure the MLT instances, and assign the corresponding ports to each.

Under each MLT interface, configure Split Multi-Link Trunking (SMLT) to allow the LAG to be distributed across both BEBs to the access switch.

- Enable RSMLT on the desired VLANs:

```
interface vlan 300
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 301
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 302
ip rsmlt
ip rsmlt holdup-timer 9999
exit
```

Enable RSMLT on associated VLANs, indicating these VLANs will function as an RSMLT gateway.

Configure RSMLT holdup-timer to "9999" (infinity). This allows the redundant switch to forward the other switch's traffic indefinitely if its unreachable.

```
interface Vlan 303
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 304
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

When enabling Edge-Support, each RSMLT peer will learn the other's IP and MAC address information, allowing one to resume the routing duties for the other in case of an outage.

- Once the peer switch is also configured on the corresponding VLANs, they will communicate over the vIST to discover the peer's information:

```
BEB-8404-310:1#show ip rsmlt local

================================================================================================
                        Ip Rsmlt Local Info - GlobalRouter
================================================================================================

VID   IP              MAC                ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
300   172.30.10.1     64:6a:52:ce:0d:00  Enable  Up    60     infinity
302   172.30.24.1     64:6a:52:ce:0d:02  Enable  Up    60     infinity
303   172.30.28.1     64:6a:52:ce:0d:03  Enable  Up    60     infinity

VID   SMLT ID
------------------------------------------------------------------------------------------------
300      1,  2
302
303      1,  2

VID   IPv6            MAC                ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
303                   64:6a:52:ce:0d:03  Enable  Up    60     infinity
      8200:303:0:0:0:0:0:0/64
      8200:303:0:0:0:0:0:1/64
      fe80:0:0:0:666a:52ff:fece:d03/128


VID   SMLT ID
------------------------------------------------------------------------------------------------
303      1,  2
```

```
BEB- BEB-8404-310:1#show ip rsmlt peer

================================================================================================
                        Ip Rsmlt Peer Info - GlobalRouter
================================================================================================

VID   IP              MAC                ADMIN   OPER  HDTMR  HUTMR
------------------------------------------------------------------------------------------------
----
300   172.30.10.2     64:6a:52:c5:39:01  Enable  Up    60     infinity
302   172.30.24.2     64:6a:52:c5:39:03  Enable  Up    60     infinity
303   172.30.28.2     64:6a:52:c5:39:04  Enable  Up    60     infinity

VID   HDT REMAIN  HUT REMAIN  SMLT ID
------------------------------------------------------------------------------------------------
300   60          infinity      1,  2
```

```
302    60          infinity
303    60          infinity      1,  2

VID    IPv6            MAC                 ADMIN    OPER   HDTMR   HUTMR
-------------------------------------------------------------------------------------------
303                    64:6a:52:c5:39:04   Enable   Up     60      infinity
       8200:303:0:0:0:0:0:0/64
       8200:303:0:0:0:0:0:2/64
       fe80:0:0:0:666a:52ff:fec5:3904/128


VID    HDT REMAIN   HUT REMAIN   SMLT ID
-------------------------------------------------------------------------------------------
303    60           infinity      1,  2
```

DVR Configuration (Controllers only)

DVR is configured in all campuses for the wireless networks (IoT, Administrator and Campus User), specifying the BEBs as Controllers. Although the Server Rooms will have a full Controller-Leaf configuration, no Leaf configuration is required for the Campus DVR deployment.

Configuring DVR in the campuses for wireless networks extends those VLANs and subnets across the campuses, allowing for seamless roaming.

- Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 30

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

From Global mode, configure the DVR domain id. BEB-310 and -311 will share this id. The BEBs in other Campuses will have different domain id's.

Enable DVR for each Access VLAN, specifying the shared Default GW IP to be used,

- Verification:

```
BEB- BEB-8404-310:1#show dvr interfaces

=============================================================================================
                                          DVR Interfaces
=============================================================================================
                                                                                    Admin
SPBMC      IGMP
Interface       Mask           L3ISID     VRFID    L2ISID     VLAN     GW IPv4          State
State      Version
---------------------------------------------------------------------------------------------
172.105.0.6     255.255.255.0  0          0        1501050    1050     172.105.0.1      enable
disable    2
172.105.1.6     255.255.255.0  0          0        1501051    1051     172.105.1.1      enable
disable    2
172.105.2.6     255.255.255.0  1800911    1        1501052    1052     172.105.2.1      enable
disable    2

3 out of 3 Total Num of DVR Interfaces displayed
```

Routing Policies - Overview

One of the benefits of Virtual Service Networks is the security and traffic isolation that occurs between them. However, network environments still require some controlled access between subnets, VRFs and DVR domains. Route Maps and IS-IS accept policies allow routes to be advertised across these boundaries.

The following are the current route policies applied on BEBs in the Automated Campus EVD.

Note
Given the security and traffic isolation inherent in Fabric Connect, routing policy and redistribution are vital concepts in allowing inter-domain communication and may require further research and assistance than the overview in this document.

The GRT and VRF instances that are created become separate routing domains and therefore have separate, isolated routing tables. DVR domains (which are created within one or both) also act as a separate routing domain (i.e. a domain within a domain).

Routing Policies - Redistribution

Fabric Connect uses one global IS-IS instance for reachability information. When vlan interfaces are created on fabric nodes within the same domain (GRT or VRF) in different parts of the network, those directly connected routes need to be redistributed into IS-IS for reachability WITHIN that routing domain.

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

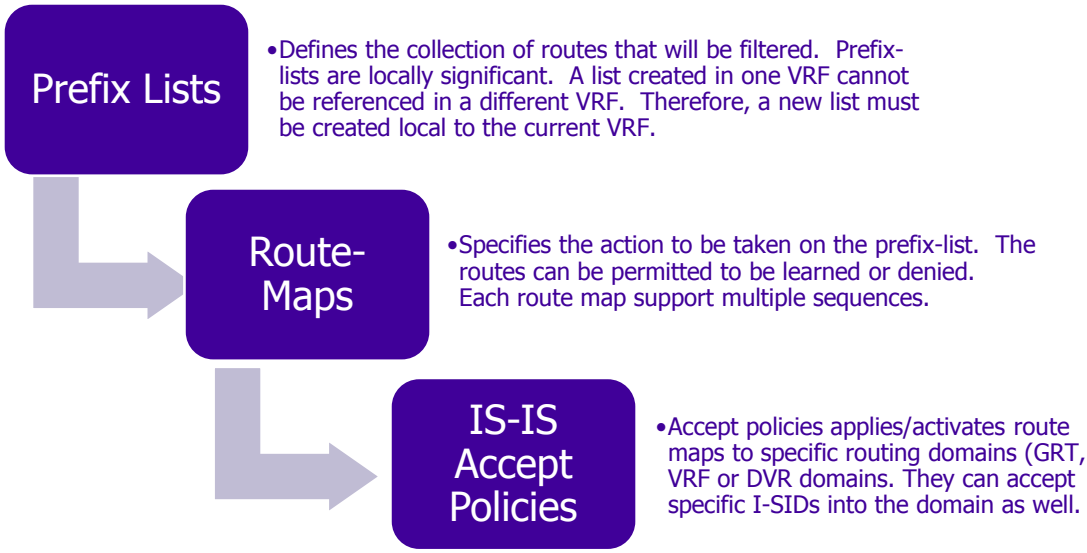
Redistribute directly connected routes into the GRT's IS-IS instance.

Within each VRF instance, redistribute directly connected routes into its IS-IS instance.

Apply redistribution to GRT and each VRF.

Route-Maps and IS-IS Accept Policies

For routes to be advertised or "leaked" between the GRT, VRFs, or DVR domains, prefix-lists, route-maps and IS-IS accept policies are configured.



For example, the DVR domains created in the campuses and server rooms are separate domains, and by default, do not share routing information. For the domains to exchange routing information, route-policies must be configured to share them across the DVR backbone.

GRT Routing Policy:

- The Global Routing Table on BEB-310 has the following requirements:
    - Reachability to networks in VRFs requiring centralized services located in the GRT (DHCP, production servers, etc.).
    - The Wireless Administrator (1050) and Campus User (1051) VLANS, which have DVR enabled, needs to be advertised to the DVR backbone, allowing route information to be shared with other corresponding networks in the DVR backbone (in Campus 1, for example).
- 9Configure IS-IS Accept policies, to import routes from the specified VRFs:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

Imports global I-SIDs for Surveillance and IoT VRF. No route-map needed, as all routes in these VRFs are being accepted.

VRF "IoT" Routing Policy:

- **The VRF IoT** has the following requirements:
  - Reachability between all IoT VLANs in the campuses and server rooms. This is accomplished when the IoT VLANs in these locations are added to the IoT VRF (L3VSN).
  - Access to the Production Server network and the Network Management subnet (both in the Server Room on the GRT).
  - The Wireless IoT VLAN (1052) which has DVR enabled, needs to be advertised to VRF IoT's DVR backbone, allowing route information to be shared with other IoT networks in the DVR backbone (in Campus 1, for example).
- Within VRF iot, create prefix-lists identifying the routes above:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24
```

- Create route-maps matching/permitting the corresponding prefix-lists:

```
route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit
```

Permit routes matching both the GRT_mgmt and GRT_910 prefix-lists.

Deny all other routes being learned.

- Configure IS-IS Accept policies, importing specific GRT routes matching the route-map:

```
router vrf iot
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

Imports the GRT_mgmt prefix-list from GRT (I-SID 0).

VRF "Surveillance" Routing Policy:

- **The VRF Surveillance** has the following requirements:
  - Reachability from the Surveillance VLANs in the campuses to the server rooms. This is accomplished when the Surveillance VLANs in these locations are added to the Surveillance VRF (L3VSN).
  - Access to the Network Mgmt subnet (for DHCP) and the Storage subnet (for video recordings).

- Configure prefix-lists, route-maps and accept policies for the “surveillance” VRF:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Define the routes to import from the GRT.

Permit routes matching those prefix-lists.

Accept the routes from the GRT defined in the route-map.

Apply the accept policies to the GRT and both VRFs.

Fabric Attach

Fabric Attach uses the IEEE802.1ab *LLDP (Link Layer Discovery Protocol)* extensions to automatically attach network devices to individual services in a Fabric Connect network. These network devices typically do not support SPB, MAC-in-MAC (802.1ah) or Network Services Identifier (NSI)/Individual Service Identifier (I-SID) usage, and therefore cannot easily take advantage of the Fabric infrastructure without manual configuration of VLAN attachments to NSIs or ISIDs in multiple locations. Fabric Attach deals with this issue by facilitating automated network device discovery and the automatic configuration and teardown of NSI/ISID to VLAN associations at the edge of the network.

Upon connection and detection of an FA Client, the FA Server (BEB) will advertise (via LLDP) the management I-SID/VLAN to the FA-Proxy switch.

The FA Proxy on the access switch communicates directly with the FA server on the BEB to request VLAN to I-SID mappings for user traffic.

Enter the following on BEB-310:

```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1030300 c-vid 300
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1030300 c-vid 300
exit
```

Under each MLT interface (connecting to the access switches), enable Fabric Attach.

Set the Management I-SID and VLAN that will be advertised to the FA client.

Feature disabled until released on EXOS.

BEB-311 Configuration (Peer)

BEB-311, acting as the RSMLT peer to BEB-310 will follow the same steps for configuration as BEB-310. Once both BEBs are configured, they can be connected to each other and to the core fabric nodes.

IS-IS and VLAN Configuration

- Enter the base IS-IS configuration and loopback interfaces:

```
config terminal
 prompt "BEB-8404-311"
spbm

interface loopback 1
ip address 1 10.0.3.11/255.255.255.255
ipv6 interface address 8200:0:0:0:0:0:0:311/128
exit

router isis
 spbm 1
 spbm 1 nick-name 0.03.11
 spbm 1 b-vid 4051-4052 primary 4051
 sys-name "BEB-8284-311"
 system-id 00bb.0000.0311
 ip-source-address 10.0.3.11
 ipv6-source-address 8200:0:0:0:0:0:0:311
 spbm 1 ip enable
 spbm 1 ipv6 enable
 manual-area 49.0000
 exit

vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan
sys clipId-topology-ip 1
sys force-topology-ip-flag
vlan member remove 1 1/1-1/2,2/1-2/18,3/1-3/24
interface GigabitEthernet 2/17
 encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
interface GigabitEthernet 2/18
 encapsulation dot1q
 isis
 isis spbm 1
 isis enable
 no shutdown
 exit
```

- Create the VRFs and enable the L3VSN services:

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit
router vrf surveillance
ipvpn
i-sid 1800904
```

```
ipvpn enable
exit
```

- Create VLANs, I-SIDs and IP interfaces for the L3VSNs:
  - The IoT Campus wired (301) and wireless (1052) VLANs are created and added to the IoT VRF.
  - The Surveillance (304) VLAN is created and added to the Surveillance VRF.

```
vlan create 301 type port-mstprstp 0
vlan i-sid 301 1030301
interface Vlan 301
vrf iot
ip address 172.30.20.2 255.255.252.0
exit

vlan create 1052 type port-mstprstp 0
vlan i-sid 1052 1501052
interface Vlan 1052
vrf iot
ip address 172.105.2.5 255.255.255.0
exit

vlan create 304 type port-mstprstp 0
vlan i-sid 304 1030304
interface Vlan 304
vrf surveillance
ip address 172.30.32.2 255.255.252.0
exit
```

- Create the VLANs and interfaces for networks that will use the Global Routing Table:
  - The Device Mgmt (300), Administrator (302,1050) and Campus User (303,1051) VLANs are created and I-SIDs assigned.

```
vlan create 300 type port-mstprstp 0
vlan i-sid 300 1030300
interface Vlan 300
ip address 172.30.10.2 255.255.255.0
exit

vlan create 302 type port-mstprstp 0
vlan i-sid 302 1030302
interface Vlan 302
ip address 172.30.24.2 255.255.252.0
exit

vlan create 303 type port-mstprstp 0
vlan i-sid 303 1030303
interface Vlan 303
ip address 172.30.28.2 255.255.252.0
ipv6 interface enable
ipv6 interface address 8200:303:0:0:0:0:0:2/64
exit

vlan create 1050 type port-mstprstp 0
vlan i-sid 1050 1501050
interface Vlan 1050
ip address 172.105.0.5 255.255.255.0
exit

vlan create 1051 type port-mstprstp 0
vlan i-sid 1051 1501051
```

```
interface Vlan 1051
ip address 172.105.1.5 255.255.255.0
exit
```

RSMLT Configuration

- Configure RSMLT to peer the BEB-311 and -310 BEBs. Be sure to specify the -310 values where called for.

```
vlan create 3 type port-mstprstp 0
vlan i-sid 3 3300
interface Vlan 3
ip address 3.3.3.2 255.255.255.0
exit

virtual-ist peer-ip 3.3.3.1 vlan 3

router isis
spbm 1 smlt-virtual-bmac 00:bb:00:03:10:11
spbm 1 smlt-peer-system-id 00bb.0000.0310
exit

router isis enable

interface GigabitEthernet 2/1
no spanning-tree mstp
yes
no shutdown
exit

interface GigabitEthernet 2/2
no spanning-tree mstp
yes
no shutdown
exit

mlt 1 enable
mlt 1 member 2/1
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 2/2
mlt 2 encapsulation dot1q

interface mlt 1
smlt
exit

interface mlt 2
smlt
exit
```

Once smlt parameters are configured, globally enable ISIS.

- Enable RSMLT on the desired VLANs:

```
interface vlan 300
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 301
ip rsmlt
ip rsmlt holdup-timer 9999
exit
```

```
interface Vlan 302
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 303
ip rsmlt
ip rsmlt holdup-timer 9999
exit

interface Vlan 304
ip rsmlt
ip rsmlt holdup-timer 9999
exit

ip rsmlt edge-support
```

DVR Configuration (Controllers only)

- Configure the DVR instance and enable DVR on the desired IP interfaces.

```
dvr controller 30

interface Vlan 1050
dvr gw-ipv4 172.105.0.1
dvr enable
exit

interface Vlan 1051
dvr gw-ipv4 172.105.1.1
dvr enable
exit

interface vlan 1052
dvr gw-ipv4 172.105.2.1
dvr enable
exit
```

The DVR gateway IP will be the same address as configured in BEB-310 to allow for inter-campus roaming

Routing Policies - Redistribution

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Route-Maps and IS-IS Accept Policies

- GRT Policy:

```
router isis
accept i-sid 1800904 enable
accept i-sid 1800911 enable
exit
```

- VRF “IoT” Routing Policy:

```
router vrf iot
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_910" 172.90.1.0/24 id 2 ge 24 le 24

route-map "accept_GRT_mgmt" 1
permit
enable
match network "GRT_mgmt,GRT_910"

route-map "accept_GRT_mgmt" 2
no permit
enable
exit

isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_mgmt"
exit
```

- VRF “Surveillance” Routing Policy:

```
router vrf surveillance
ip prefix-list "GRT_mgmt" 172.9.99.0/24 id 1 ge 24 le 24
ip prefix-list "GRT_stor" 172.90.3.0/24 id 2 ge 24 le 24

route-map "accept_GRT_routes" 1
permit
enable

match network "GRT_mgmt,GRT_stor"
route-map "accept_GRT_routes" 2
no permit
enable
exit
exit

router vrf surveillance
isis accept i-sid 0 enable
isis accept i-sid 0 route-map "accept_GRT_routes"
exit

isis apply accept
isis apply accept vrf iot
isis apply accept vrf surveillance
```

Fabric Attach

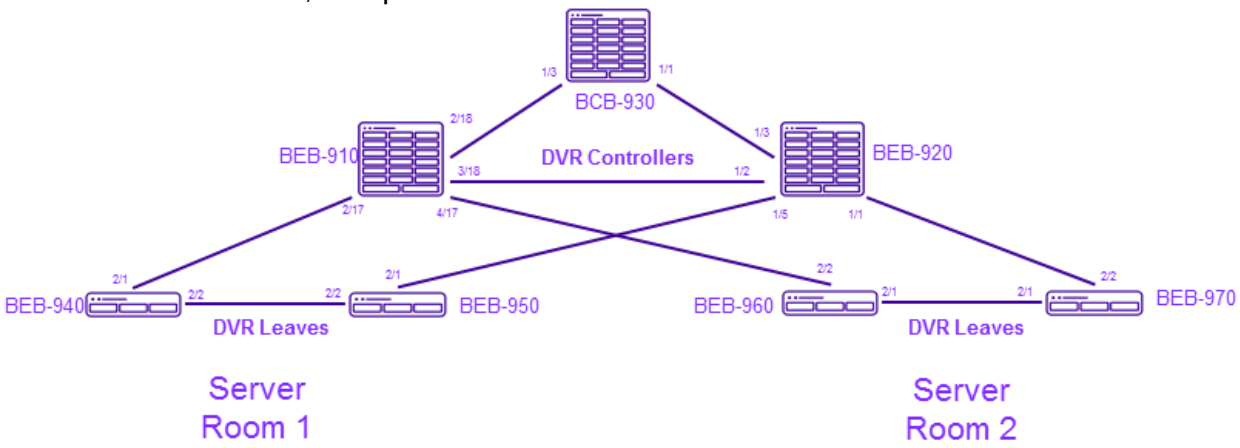
```
interface mlt 1
fa
fa enable
no fa message-authentication
fa management i-sid 1030300 c-vid 300
exit

interface mlt 2
fa
fa enable
no fa message-authentication
fa management i-sid 1030300 c-vid 300
exit
```

Fabric Connect - Server Room Configuration

Overview

The two server rooms will be the home for the Extreme network management assets, including XMC, ExtremeControl, Extreme Analytics, Extreme Wireless controllers, DHCP/Radius servers, and other centralized server assets.

The server rooms are each front-ended by a pair of VSP-7200 switches, configured as DVR Leaves. The core switches (BEB-910 and BEB-920) will be configured as the DVR controllers for this domain. Although not all are members of L3VSNs, all VLANs in the server rooms will be DVR-enabled to allow seamless migration between server rooms, if required.



Server Room (VLAN 9xx):

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Production Servers	900	1090900	172.90.1.0/24	DVR	GRT	N/A
Test Servers	901	1090901	172.90.2.0/24	DVR	GRT	N/A
Storage Servers	902	1090902	172.90.3.0/24	DVR	GRT	N/A
Storage Test	903	1090903	172.90.4.0/24	DVR	GRT	N/A
Network Mgmt.	999	1090999	172.9.99.0/24	DVR	GRT	N/A
Network Mgmt. (EWC)	998	1090998	172.9.98.0/24	DVR	GRT	N/A
Wired IoT (routed)	911	1090911	172.90.20.0/22	DVR	VRF 1	1800911
Surveillance	904	1090904	172.90.14.0/22	DVR	VRF 2	1800904
Wired IoT (bridged)	907	1090907	N/A	N/A	L2VSN	N/A

Common Services:

Role/Segment	VLAN	ISID	Subnet	Def Gateway	VRF	VRF ISID
Guest (wireless)	906	1090906	172.90.40.0/24	EWC	Tunnel	N/A
Wired IoT(bridged)	907	1090907	N/A	N/A	L2VSN	N/A

BEB-910 Configuration (DVR Controller)

IS-IS Configuration to Server Rooms

As the initial IS-IS configuration was already done during core configuration, only the interfaces connecting to the server rooms are required.

```
interface GigabitEthernet 2/17
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

interface GigabitEthernet 4/17
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit
```

Configure the interfaces connecting to the leaves.

VRF and VSN Creation

- On BEB-910, create the VRFs and configure the L3VSN services.

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit

router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```

Create the VRFs and the corresponding L3VSN service. Assign the global I-SID, and enable the VPN for each.

The VRF I-SIDs correspond with the VSNs in the campus BEBs, creating an isolated virtual service for those VRFs.

VLAN Configuration

- Configure the Server VLANs hosted in the server rooms, residing on the GRT:

```
vlan create 900 type port-mstprstp 0
vlan i-sid 900 1090900
interface Vlan 900
ip address 172.90.1.2 255.255.255.0
exit

vlan create 901 type port-mstprstp 0
vlan i-sid 901 1090901
interface Vlan 901
ip address 172.90.2.2 255.255.255.0
exit

vlan create 902 type port-mstprstp 0
vlan i-sid 902 1090902
interface Vlan 902
ip address 172.90.3.2 255.255.255.0
exit

vlan create 903 type port-mstprstp 0
vlan i-sid 903 1090903
interface Vlan 903
ip address 172.90.4.2 255.255.255.0
exit
```

Create required VLANs for server room applications (Production, Prod Test, Storage, Storage Test). Map to corresponding I-SID.

- Configure the IoT, Surveillance, Guest and Network Management VLANs:

```
vlan create 904 type port-mstprstp 0
vlan i-sid 904 1090904
interface Vlan 904
vrf surveillance
ip address 172.90.14.2 255.255.252.0
exit

vlan create 906 type port-mstprstp 0
vlan i-sid 906 1090906
interface Vlan 906
ip address 172.90.40.2 255.255.255.0
exit

vlan create 911 type port-mstprstp 0
vlan i-sid 911 1090911
interface Vlan 911
vrf iot
ip address 172.90.20.2 255.255.252.0
exit

vlan create 998 type port-mstprstp 0
vlan i-sid 998 1090998
interface Vlan 998
ip address 172.9.98.2 255.255.255.0
exit

vlan create 999 type port-mstprstp 0
vlan i-sid 999 1090999
interface Vlan 999
ip address 172.9.99.2 255.255.255.0 0
exit
```

Surveillance VLAN/IP interface, assigned to the VRF.

Guest VLAN/interface for traffic emerging from the wireless tunnel between AP and the EWC.

IoT Server VLAN/interface, assigned to the VRF.

Extreme Wireless Controller VLAN/interface

Network Mgmt VLAN (XMC, ExtremeControl, DHCP/Radius servers)

DVR Configuration

- Configure the DVR instance, and enable DVR on the desired IP interfaces, specifying the IP that will act as default gateway for that VLAN. As VLAN 907 is an L2VSN, no default gateway is configured.

```
dvr controller 90

interface Vlan 900
dvr gw-ipv4 172.90.1.1
dvr enable
exit

interface Vlan 901
dvr gw-ipv4 172.90.2.1
dvr enable
exit

interface Vlan 902
dvr gw-ipv4 172.90.3.1
dvr enable
exit

interface Vlan 903
dvr gw-ipv4 172.90.4.1
dvr enable
exit

interface Vlan 904
dvr gw-ipv4 172.90.14.1
dvr enable
exit

interface Vlan 906
dvr gw-ipv4 172.90.40.1
dvr enable
exit

interface Vlan 911
dvr gw-ipv4 172.90.20.1
dvr enable
exit

interface Vlan 998
dvr gw-ipv4 172.9.98.1
dvr enable
exit

interface Vlan 999
dvr gw-ipv4 172.9.99.1
dvr enable
exit
```

From Global mode, configure the DVR domain id for the Server Room. BEB-910 and -920 will share this id.

Specify the IP interface that will be each subnet's default gateway.

All VLANs in the server rooms (with the exception of 907) will have DVR enabled.

Redistribution

- Redistribute directly connected networks and static routes for GRT and all VRFs present on the controller into their respective IS-IS instances and apply.

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit
isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Redistribute direct routes into GRT ISIS Domain.

Redistribute direct routes from each VRF into each VRF ISIS Domain.

Route Maps and Accept Policies

- Configure routing policy for the GRT VLANs:

```
router isis
accept i-sid 1800911 enable
exit
```

Accepting routes from VRF IoT, which includes Server Room2 as well as the Campus IoT VRFs.

BEB-920 Configuration (DVR Controller)

As BEB-920 is a paired controller with -910, the configuration will be, except for the IP interface configuration, almost identical.

IS-IS Configuration to Server Rooms

As the initial IS-IS configuration was already done during core configuration, only the interfaces connecting to the server rooms are required.

```
Vlan member remove 1 1/1,1/5

interface GigabitEthernet 1/1
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit
interface GigabitEthernet 1/5
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit
```

VRF and VSN Creation

- On BEB-920, create the VRFs and configure the L3VSN services.

```
ip vrf iot vrfid 1
ip vrf surveillance vrfid 2

router vrf iot
ipvpn
i-sid 1800911
ipvpn enable
exit

router vrf surveillance
ipvpn
i-sid 1800904
ipvpn enable
exit
```

VLAN Configuration

- Configure the Server VLANs hosted in the server rooms.

```
vlan create 900 type port-mstprstp 0
vlan i-sid 900 1090900
interface Vlan 900
ip address 172.90.1.3 255.255.255.0
exit

vlan create 901 type port-mstprstp 0
vlan i-sid 901 1090901
interface Vlan 901
ip address 172.90.2.3 255.255.255.0
exit

vlan create 902 type port-mstprstp 0
vlan i-sid 902 1090902
interface Vlan 902
ip address 172.90.3.3 255.255.255.0
exit

vlan create 903 type port-mstprstp 0
vlan i-sid 903 1090903
interface Vlan 903
ip address 172.90.4.3 255.255.255.0
exit
```

Create required VLANs for server room applications (Production, Prod Test, Storage, Storage Test). Map to corresponding I-SID.

- Configure the IoT, Surveillance, Guest and Network Management VLANs:

```
vlan create 904 type port-mstprstp 0
vlan i-sid 904 1090904
interface Vlan 904
vrf surveillance
ip address 172.90.14.3 255.255.252.0
exit

vlan create 906 type port-mstprstp 0
vlan i-sid 906 1090906
interface Vlan 906
ip address 172.90.40.3 255.255.255.0
exit

vlan create 911 type port-mstprstp 0
vlan i-sid 911 1090911
```

The same VLAN and I-SID values are assigned as on BEB-910, with a different IP interface configured.

```
interface Vlan 911
vrf iot
ip address 172.90.20.3 255.255.252.0
exit

vlan create 998 type port-mstprstp 0
vlan i-sid 998 1090998
interface Vlan 998
ip address 172.9.98.3 255.255.255.0
exit

vlan create 999 type port-mstprstp 0
vlan i-sid 999 1090999
interface Vlan 999
ip address 172.9.99.3 255.255.255.0
exit
```

- Enable IPv6 Shortcut functionality at the global level.

DVR Configuration

- Configure the DVR instance, and enable DVR on the desired IP interfaces, specifying the IP that will act as default gateway for that VLAN. As VLAN 907 is an L2VSN, no default gateway is configured.

```
dvr controller 90

interface Vlan 900
dvr gw-ipv4 172.90.1.1
dvr enable
exit

interface Vlan 901
dvr gw-ipv4 172.90.2.1
dvr enable
exit

interface Vlan 902
dvr gw-ipv4 172.90.3.1
dvr enable
exit

interface Vlan 903
dvr gw-ipv4 172.90.4.1
dvr enable
exit

interface Vlan 904
dvr gw-ipv4 172.90.14.1
dvr enable
exit

interface Vlan 906
dvr gw-ipv4 172.90.40.1
dvr enable
exit

interface Vlan 911
dvr gw-ipv4 172.90.20.1
dvr enable
exit

interface Vlan 998
dvr gw-ipv4 172.9.98.1
dvr enable
```

From Global mode, configure the DVR domain id for the Server Room. BEB-910 and -920 will share this id.

Specify the IP interface that will be each subnet's default gateway

All VLANs in the server rooms (with the exception of 907) will have DVR enabled.

```
exit

interface Vlan 999
dvr gw-ipv4 172.9.99.1
dvr enable
exit
```

Redistribution

- Redistribute directly connected networks and static routes for GRT and all VRFs present on the controller into their respective IS-IS instances and apply.

```
router isis
redistribute direct
redistribute direct enable
ipv6 redistribute direct enable
exit

router vrf iot
isis redistribute direct
isis redistribute direct enable
exit

router vrf surveillance
isis redistribute direct
isis redistribute direct enable
exit

isis apply redistribute direct
isis apply redistribute direct vrf iot
isis apply redistribute direct vrf surveillance
```

Redistribute direct routes into GRT ISIS Domain.

Redistribute direct routes from each VRF into each VRF ISIS Domain.

Route Maps and Accept Policies

- Configure routing policy for the GRT VLANs:

```
router isis
accept i-sid 1800911 enable
exit
```

Accepting routes from VRF IoT, which includes Server Room2 as well as the Campus IoT VRFs.

BEB-960 (DVR Leaf)

Each server room will have 2 Leaf nodes clustered together in an SMLT for Extreme Management, the Extreme Wireless Controllers, and other appliance redundancy. The following section illustrates the steps to configure BEB-960. The same steps will apply to all the Leaf nodes.

Attaching hosts to the Leaf requires a specific interface setting option:

- Switched UNI (Flex) – a combination of VLAN ID and a Port maps to a L2 VSN. With this UNI type, VLAN IDs can be re-used on other ports and therefore mapped to different VSNs.
- Transparent Port UNI – a physical port maps to a L2 VSN. All traffic through that port, 802.1Q tagged or untagged, ingress and egress is mapped to the VSN.

For the purposes of the EVD, all host-attached interfaces will be set to Flex-UNI.

IS-IS Configuration

- Enable the DVR-leaf-mode flag.

Warning

Setting this flag will prompt the user to save the configuration and reboot the system. Much of the system's current configuration will be cleared, so its highly recommended to follow this step first.

```
boot config flags dvr-leaf-mode
y
save config
reset
```

- After reset, configure the switch for IS-IS.

```
config terminal
 prompt "BEB-7254-960"
 spbm

router isis
spbm 1
spbm 1 nick-name 0.09.60
spbm 1 b-vid 4051-4052 primary 4051
sys-name "BEB-7254-960"
inband-mgmt-ip 10.0.9.60
system-id 00bb.0000.0960
manual-area 49.0000
exit

vlan members remove 1 1/1-1/48,2/1-2/6 portmember
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan

interface GigabitEthernet 2/1
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

interface GigabitEthernet 2/2
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

sys force-topology-ip-flag
```

In DVR Leaf mode, setting the management IP address only requires the **inband-mgmt-ip** command.

Remove network ports from default VLAN before configuring.

MLT, DVR and Interface Configuration

- Configure SMLT between the Leaf pairs for dual-attached hosts.
- DVR Leaves in this EVD are configured as clusters (via a vIST), with one cluster of two Leaf nodes in each server room. Both server rooms are configured in the same DVR domain.

```
router isis
spbm 1 smlt-virtual-bmac 00:bb:00:00:60:70
spbm 1 smlt-peer-system-id 00bb.0000.0970
exit

dvr leaf 90
dvr leaf virtual-ist 90.90.90.1 255.255.255.0 peer-ip 90.90.90.2 cluster-id 90

router isis enable

mlt 1 enable
mlt 1 member 1/3
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/5
mlt 2 encapsulation dot1q

mlt 3 enable
mlt 3 member 1/25
mlt 3 encapsulation dot1q
```

Set shared SMLT gateway MAC and SMLT peer id.

Set the DVR domain id and vIST IP interface, and specify the SMLT peer leaf IP (BEB-970).

Bind BEB-960's MLT instances to physical interfaces.

- Configure Flex-UNI mode on host-connected ports.

```
interface mlt 1
smlt
flex-uni enable
exit
interface mlt 2
smlt
flex-uni enable
exit
interface mlt 3
smlt
flex-uni enable
exit

interface GigabitEthernet 1/13
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/20
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/22
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit
```

Enable SMLT feature on MLT interfaces.

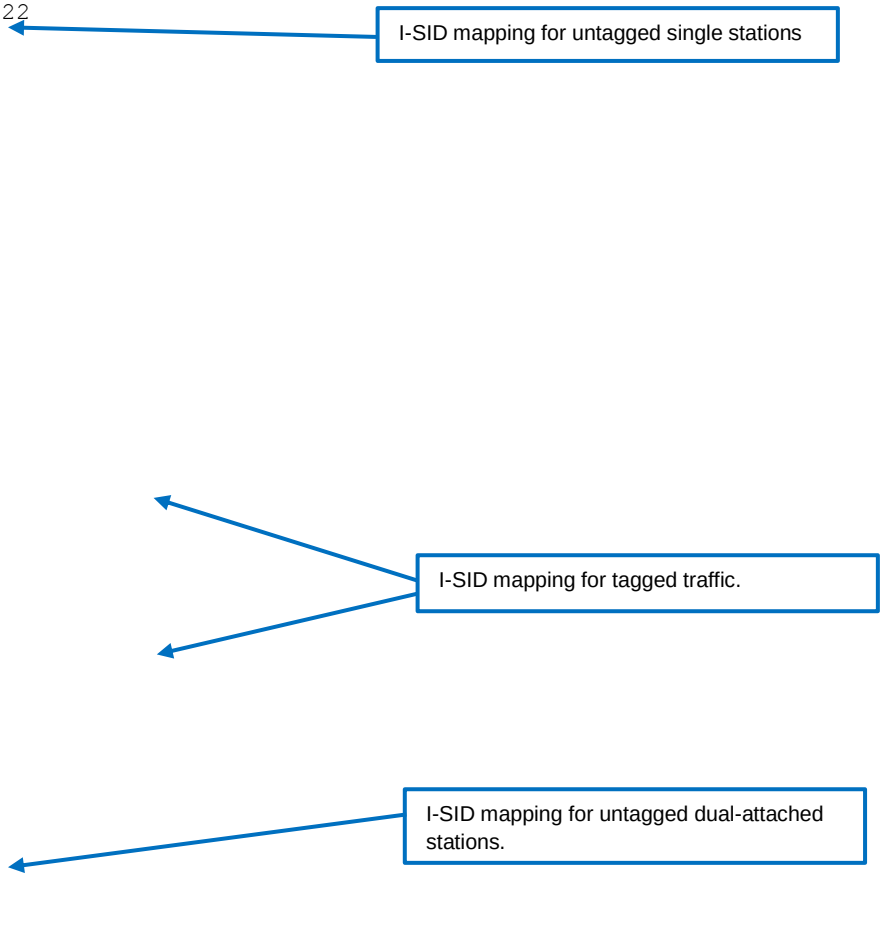
Enable Flex-UNI mode on MLT interfaces (connecting to dual-attached hosts) and other interfaces (connecting to single-connection servers).

```
interface GigabitEthernet 1/24
default-vlan-id 0
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit
```

VLAN/I-SID Configuration

- Configure VLAN/I-SID to physical or logical port where server(s) are connected.

```
i-sid 1090900 elan
untagged-traffic port 1/13,1/22
exit

i-sid 1090901 elan
c-vid 901 port 1/35
exit

i-sid 1090902 elan
c-vid 902 port 1/36
exit

i-sid 1090903 elan
c-vid 903 port 1/37
exit

i-sid 1090904 elan
c-vid 904 port 1/33
exit

i-sid 1090906 elan
c-vid 906 mlt 2
exit

i-sid 1090911 elan
c-vid 911 port 1/13,1/33
exit

i-sid 1090998 elan
untagged-traffic mlt 2
exit

i-sid 1090999 elan
untagged-traffic mlt 1
untagged-traffic mlt 3
exit
```



- Confirm I-SID mappings.

VLAN ID on Leaf nodes is only logical value, not actual C-VID.

Indicates the physical or MLT interface bound to each I-SID

```
7254-960:1(config)#show i-sid

================================================================================
                                  Isid Info
================================================================================
ISID        ISID                          PORT                MLT                 ORIGIN
ID          TYPE        VLANID            INTERFACES          INTERFACES
--------------------------------------------------------------------------------
1090900     ELAN        2                 u:1/22              -                   CONFIG
1090901     ELAN        3                 c901:1/40           -                   CONFIG
1090902     ELAN        4                 c902:1/41           -                   CONFIG
1090903     ELAN        5                 c903:1/42           -                   CONFIG
1090904     ELAN        10                c904:1/33           -                   CONFIG
1090906     ELAN        6                 -                   c906:2              CONFIG
1090911     ELAN        9                 c911:1/13,1/33      -                   CONFIG
1090998     ELAN        7                 -                   u:2                 CONFIG
1090999     ELAN        8                 -                   u:1,3               CONFIG
16677305    CVLAN       4002              -                   -                   CONFIG
16777001    ELAN        N/A               -                   -                   CONFIG
```

BEB-970 (DVR Leaf)

The Leaf cluster configuration will be, other than IP configuration, identical.

IS-IS Configuration

- Enable the DVR-leaf-mode flag.

Warning

Setting this flag will prompt the user to save the configuration and reboot the system. Much of the system's current configuration will be cleared, so its highly recommended to follow this step first.

```
boot config flags dvr-leaf-mode
```

- Configure the switch for IS-IS.

```
config terminal
 prompt "BEB-7254-970"
 spbm

router isis
spbm 1
spbm 1 nick-name 0.09.70
spbm 1 b-vid 4051-4052 primary 4051
sys-name "BEB-7254-970"
inband-mgmt-ip 10.0.9.70
system-id 00bb.0000.0970
manual-area 49.0000
exit

vlan members remove 1 1/1-1/48,2/1-2/6 portmember
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan

interface GigabitEthernet 2/1
```

In DVR Leaf mode, setting the management IP address only requires the inband-mgmt-ip command.

```
encapsulation dot1q
default-vlan-id 0
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

interface GigabitEthernet 2/2
encapsulation dot1q
default-vlan-id 0
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

sys force-topology-ip-flag
```

MLT, DVR and Interface Configuration

- Configure SMLT between the Leaf pairs for dual-attached hosts.
- DVR Leaves in this EVD are configured as clusters (via a vIST), with one cluster of two Leaf nodes in each server room. Both server rooms are configured in the same DVR domain.

```
router isis
spbm 1 smlt-virtual-bmac 00:bb:00:00:60:70
spbm 1 smlt-peer-system-id 00bb.0000.0960
exit

dvr leaf 90
dvr leaf virtual-ist 90.90.90.2 255.255.255.0 peer-ip 90.90.90.1 cluster-id 90

router isis enable

mlt 1 enable
mlt 1 member 1/3
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/5
mlt 2 encapsulation dot1q

mlt 3 enable
mlt 3 member 1/25
mlt 3 encapsulation dot1q
```

Set shared SMLT gateway MAC and SMLT peer id.

Bind BEB-970's MLT instances to physical interfaces.

- Configure Flex-UNI mode on host-connected ports.

```
interface mlt 1
smlt
flex-uni enable
exit
interface mlt 2
smlt
flex-uni enable
exit
interface mlt 3
smlt
```

```
flex-uni enable
exit

interface GigabitEthernet 1/13
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/20
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/22
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/35
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/36
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/37
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/40
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit
```

VLAN/I-SID Configuration

- Configure VLAN/I-SID to physical or logical port where server(s) are connected.

```
i-sid 1090900 elan
untagged-traffic port 1/13,1/22
exit

i-sid 1090901 elan
c-vid 901 port 1/35
exit

i-sid 1090902 elan
```

```
c-vid 902 port 1/36
exit

i-sid 1090903 elan
c-vid 903 port 1/37
exit

i-sid 1090904 elan
c-vid 904 port 1/40
exit

i-sid 1090906 elan
c-vid 906 mlt 2
exit

i-sid 1090907 elan
untagged-traffic port 1/20,1/40
exit

i-sid 1090911 elan
c-vid 911 port 1/13
exit

i-sid 1090998 elan
untagged-traffic mlt 2
exit

i-sid 1090999 elan
untagged-traffic mlt 1
untagged-traffic mlt 3
exit
```

- Confirm I-SID mappings.

```
BEB-7254-970:1(config)#show i-sid

================================================================================================
                                        Isid Info
================================================================================================
ISID        ISID                  PORT               MLT                ORIGIN
ID          TYPE       VLANID     INTERFACES         INTERFACES
------------------------------------------------------------------------------------------------
1090900     ELAN       2          u:1/13,1/22        -                  CONFIG
1090901     ELAN       3          c901:1/35          -                  CONFIG
1090902     ELAN       4          c902:1/36          -                  CONFIG
1090903     ELAN       5          c903:1/37          -                  CONFIG
1090904     ELAN       10         c904:1/40          -                  CONFIG
1090906     ELAN       6          -                  c906:2             CONFIG
1090907     ELAN       N/A        u:1/20,1/40        -                  CONFIG
1090911     ELAN       9          c911:1/13          -                  CONFIG
1090998     ELAN       7          -                  u:2                CONFIG
1090999     ELAN       8          -                  u:1,3              CONFIG
16677305    CVLAN      4002       -                  -                  CONFIG
16777001    ELAN       N/A        -                  -                  CONFIG
c: customer vid    u: untagged-traffic
```

BEB-940 (DVR Leaf)

The Leaf nodes in Server Room 2 will also be clustered together and follow the same configuration steps.

IS-IS Configuration

- Set switch to DVR Leaf mode:

```
config terminal
boot config flags dvr-leaf-mode
save config
reset
```

- Configure the switch for IS-IS.

```
config terminal
prompt "BEB-7254-940"
spbm

router isis
spbm 1
spbm 1 nick-name 0.09.40
spbm 1 b-vid 4051-4052 primary 4051
sys-name "BEB-7254-940"
inband-mgmt-ip 10.0.9.40
system-id 00bb.0000.0940
manual-area 49.0000
exit

vlan members remove 1 1/1-1/48,2/1-2/6 portmember
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan

interface GigabitEthernet 2/1
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

interface GigabitEthernet 2/2
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

sys force-topology-ip-flag
```

MLT, DVR and Interface Configuration

- Configure SMLT between the Leaf pairs for dual-attached hosts.

```
router isis
spbm 1 smlt-virtual-bmac 00:bb:00:00:11:50
spbm 1 smlt-peer-system-id 00bb.0000.0950
exit

dvr leaf 90
dvr leaf virtual-ist 91.91.91.1 255.255.255.0 peer-ip 91.91.91.2 cluster-id 91

router isis enable

mlt 1 enable
mlt 1 member 1/5
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/25
mlt 2 encapsulation dot1q
```

- Configure Flex-UNI mode on host-connected ports.

```
interface mlt 1
smlt
flex-uni enable
exit
interface mlt 2
smlt
flex-uni enable
exit

interface GigabitEthernet 1/13
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/20
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/22
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/35
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/36
flex-uni enable
no shutdown
no spanning-tree mstp
yes
```

```
exit

interface GigabitEthernet 1/37
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit
```

VLAN/I-SID Configuration

- Configure VLAN/I-SID to physical or logical port where server(s) are connected.

```
i-sid 1090900 elan
untagged-traffic port 1/13
exit

i-sid 1090901 elan
c-vid 901 port 1/35
exit

i-sid 1090902 elan
c-vid 902 port 1/36
exit

i-sid 1090903 elan
c-vid 903 port 1/37
exit

i-sid 1090904 elan
c-vid 904 port 1/20
exit

i-sid 1090906 elan
c-vid 906 mlt 1
exit

i-sid 1090907 elan
untagged-traffic port 1/20
exit

i-sid 1090998 elan
untagged-traffic mlt 1
exit

i-sid 1090999 elan
untagged-traffic mlt 2
exit
```

- Confirm I-SID mappings:

```
BEB-7254-940:1(config)#show i-sid

================================================================================================
                                        Isid Info
================================================================================================
ISID        ISID                  PORT               MLT                ORIGIN
ID          TYPE       VLANID     INTERFACES         INTERFACES
------------------------------------------------------------------------------------------------
1090900     ELAN       10         u:1/13             -                  CONFIG
1090901     ELAN       11         c901:1/35          -                  CONFIG
1090902     ELAN       12         c902:1/36          -                  CONFIG
1090903     ELAN       13         c903:1/37          -                  CONFIG
1090904     ELAN       18         c904:1/20          -                  CONFIG
1090906     ELAN       14         -                  c906:1             CONFIG
1090907     ELAN       N/A        c907:1/20          -                  CONFIG
1090911     CVLAN      17         -                  -                  CONFIG
1090998     ELAN       15         -                  u:1                CONFIG
1090999     ELAN       16         -                  u:2                CONFIG
16677306    CVLAN      4002       -                  -                  CONFIG
16777001    ELAN       N/A        -                  -                  CONFIG

c: customer vid    u: untagged-traffic
```

BEB-950 (DVR Leaf)

The Leaf cluster configuration will be, other than IP configuration, identical.

IS-IS Configuration

- Set switch to DVR Leaf mode:

```
config terminal
boot config flags dvr-leaf-mode
save config
reset
```

- Configure the switch for IS-IS.

```
config terminal
prompt "BEB-7254-950"
spbm

router isis
spbm 1
spbm 1 nick-name 0.09.50
spbm 1 b-vid 4051-4052 primary 4051
sys-name "BEB-7254-950"
inband-mgmt-ip 10.0.9.50
system-id 00bb.0000.0950
manual-area 49.0000
exit

vlan members remove 1 1/1-1/48,2/1-2/6 portmember
vlan create 4051 name "B-VLAN-1" type spbm-bvlan
vlan create 4052 name "B-VLAN-2" type spbm-bvlan

interface GigabitEthernet 2/1
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

interface GigabitEthernet 2/2
encapsulation dot1q
no shutdown
isis
isis spbm 1
isis enable
no spanning-tree mstp
yes
exit

sys force-topology-ip-flag
```

In DVR Leaf mode, setting the management IP address only requires the inband-mgmt-ip command.

MLT, DVR and Interface Configuration

- Configure SMLT between the Leaf pairs for dual-attached hosts.

```
 router isis
spbm 1 smlt-virtual-bmac 00:00:00:00:11:50
spbm 1 smlt-peer-system-id 00bb.0000.0940
exit

dvr leaf 90
dvr leaf virtual-ist 91.91.91.2 255.255.255.0 peer-ip 91.91.91.1 cluster-id 91

router isis enable

mlt 1 enable
mlt 1 member 1/5
mlt 1 encapsulation dot1q

mlt 2 enable
mlt 2 member 1/25
mlt 2 encapsulation dot1q
```

- Configure Flex-UNI mode on host-connected ports.

```
interface mlt 1
smlt
flex-uni enable
exit
interface mlt 2
smlt
flex-uni enable
exit

interface GigabitEthernet 1/13
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/20
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/22
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/35
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/36
flex-uni enable
no shutdown
no spanning-tree mstp
```

```
yes
exit

interface GigabitEthernet 1/37
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit

interface GigabitEthernet 1/40
flex-uni enable
no shutdown
no spanning-tree mstp
yes
exit
```

VLAN/I-SID Configuration

- Configure VLAN/I-SID to physical or logical port where server(s) are connected.

```
i-sid i-sid 1090900 elan
c-vid 900 port 1/22
exit

i-sid 1090901 elan
c-vid 901 port 1/35
exit

i-sid 1090902 elan
c-vid 902 port 1/36
exit

i-sid 1090903 elan
c-vid 903 port 1/37
exit

i-sid 1090904 elan
c-vid 904 port 1/13,1/20
exit

i-sid 1090906 elan
c-vid 906 mlt 1
exit

i-sid 1090907 elan
c-vid 907 port 1/13
exit

i-sid 1090998 elan
untagged-traffic mlt 1
exit

i-sid 1090999 elan
untagged-traffic mlt 2
exit
```

- Confirm I-SID mappings.

```
BEB-7254-950:1(config)#show i-sid

================================================================================================
                                        Isid Info
================================================================================================
ISID        ISID                  PORT                MLT                 ORIGIN
ID          TYPE       VLANID     INTERFACES          INTERFACES
------------------------------------------------------------------------------------------------
1090900     ELAN       10         c900:1/22           -                   CONFIG
1090901     ELAN       11         c901:1/35           -                   CONFIG
1090902     ELAN       12         c902:1/36           -                   CONFIG
1090903     ELAN       13         c903:1/37           -                   CONFIG
1090904     ELAN       18         c904:1/13,1/20      -                   CONFIG
1090906     ELAN       14         -                   c906:1              CONFIG
1090907     ELAN       N/A        c907:1/13           -                   CONFIG
                                  u:1/20              -
1090911     CVLAN      17         -                   -                   CONFIG
1090998     ELAN       15         -                   u:1                 CONFIG
1090999     ELAN       16         -                   u:2                 CONFIG
16677306    CVLAN      4002       -                   -                   CONFIG
16777001    ELAN       N/A        -                   -                   CONFIG

c: customer vid    u: untagged-traffic
```

- Confirm DVR Domain members. BEB-910 and -920 should show as controllers for the four leaves:

```
BEB-7254-950:1(config)#show dvr members

================================================================================================
                                        DVR Members (Domain ID: 90)
================================================================================================
System Name                             Nick-Name        Nodal MAC                 Role
------------------------------------------------------------------------------------------------
--------------
BEB-8404-910                            0.09.10          00:bb:00:00:09:10         Controller
BEB-8404-920                            0.09.20          00:bb:00:00:09:20         Controller
BEB-7254-940                            0.09.40          00:bb:00:00:09:40         Leaf
BEB-7254-950                            0.09.50          00:bb:00:00:09:50         Leaf
BEB-7254-960                            0.09.60          00:bb:00:00:09:60         Leaf
BEB-7254-970                            0.09.70          00:bb:00:00:09:70         Leaf

6 out of 6 Total Num of DVR Members displayed
------------------------------------------------------------------------------------------------
```

- Connect the Extreme Management Assets and network servers to their corresponding ports in the server rooms.

Route Table Verification

With the Fabric Connect network configured, the following are illustrations of the resulting route tables.

- BEB-210 Global Routing Table:

```
BEB- BEB-8284-210:1(config)#show ip route
================================================================================================
                                    IP Route - GlobalRouter
================================================================================================
                                                 NH                        INTER
DST             MASK            NEXT            VRF/ISID        COST      FACE      PROT AGE TYPE PRF
------------------------------------------------------------------------------------------------
2.1.1.0         255.255.255.0   2.1.1.1         -               1         2         LOC  0   DB   0
10.0.0.10       255.255.255.255 BEB-8404-910    GlobalRouter    30        4051      ISIS 0   IBS  7
10.0.0.20       255.255.255.255 BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
10.0.0.110      255.255.255.255 BEB-8284-110    GlobalRouter    20030     4051      ISIS 0   IBS  7
10.0.0.111      255.255.255.255 BEB-8284-111    GlobalRouter    20040     4051      ISIS 0   IBS  7
10.0.0.210      255.255.255.255 10.0.0.210      -               1         0         LOC  0   DB   0
10.0.0.211      255.255.255.255 BEB-8284-211    GlobalRouter    10        4051      ISIS 0   IBS  7
10.0.3.10       255.255.255.255 BEB-8404-310                                        ISIS 0   IBS  7
10.0.3.11       255.255.255.255 BEB-8404-311                                        ISIS 0   IBS  7
10.0.9.40       255.255.255.255 BEB-7254-940                                        ISIS 0   IBS  7
10.0.9.50       255.255.255.255 BEB-7254-950                                        ISIS 0   IBS  7
10.0.9.60       255.255.255.255 BEB-7254-960    GlobalRouter    40        4051      ISIS 0   IBS  7
10.0.9.70       255.255.255.255 BEB-7254-970    GlobalRouter    30        4051      ISIS 0   IBS  7
172.9.98.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.9.99.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.10.10.0     255.255.255.0   BEB-8284-110    GlobalRouter
172.10.20.0     255.255.252.0   BEB-8284-110    iot
172.10.24.0     255.255.252.0   BEB-8284-110    GlobalRouter
172.10.28.0     255.255.252.0   BEB-8284-110    GlobalRouter    20030     4051      ISIS 0   IBS  7
172.10.32.0     255.255.252.0   BEB-8284-110    surveillance    20030     4051      ISIS 0   IBSV 200
172.20.10.0     255.255.255.0   172.20.10.1     -               1         200       LOC  0   DB   0
172.20.20.0     255.255.252.0   172.20.20.1     iot             1         4051      ISIS 0   IBSV 200
172.20.24.0     255.255.252.0   172.20.24.1     -               1         202       LOC  0   DB   0
172.20.28.0     255.255.252.0   172.20.28.1     -               1         203       LOC  0   DB   0
172.20.32.0     255.255.252.0   172.20.32.1     surveillance    1         4051      ISIS 0   IBSV 200
172.30.10.0     255.255.255.0   BEB-8404-311    GlobalRouter    30        4051      ISIS 0   IBS  7
172.30.20.0     255.255.252.0   BEB-8404-311    iot             30        4051      ISIS 0   IBSV 200
172.30.24.0     255.255.252.0   BEB-8404-311    GlobalRouter    30        4051      ISIS 0   IBS  7
172.30.28.0     255.255.252.0   BEB-8404-311    GlobalRouter    30        4051      ISIS 0   IBS  7
172.30.32.0     255.255.252.0   BEB-8404-311    surveillance    30        4051      ISIS 0   IBSV 200

172.90.1.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.90.2.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.90.3.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.90.4.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.90.5.0      255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.90.12.0     255.255.252.0   BEB-8404-920    surveillance    20        4051      ISIS 0   IBSV 200
172.90.20.0     255.255.252.0   BEB-8404-920    iot             20        4051      ISIS 0   IBSV 200
172.90.40.0     255.255.255.0   BEB-8404-920    GlobalRouter    20        4051      ISIS 0   IBS  7
172.105.0.0     255.255.255.0   172.105.0.4     -               1         1050      LOC  0   DB   0
172.105.1.0     255.255.255.0   172.105.1.4     -               1         1051      LOC  0   DB   0
172.105.2.0     255.255.255.0   172.105.2.4     iot             1         4051      ISIS 0   IBSV 200

51 out of 51 Total Num of Route Entries, 51 Total Num of Dest Networks displayed.
------------------------------------------------------------------------------------------------
TYPE Legend:
I=Indirect Route, D=Direct Route, A=Alternative Route, B=Best Route, E=Ecmp Route,
U=Unresolved Route, N=Not in HW, F=Replaced by FTN, V=IPVPN Route, S=SPBM Route
PROTOCOL Legend:
v=Inter-VRF route redistributed
```

Redistributed routes within the GRT from Server Rooms and Campus 1 and 3.

Routes received via Route-maps from VRF IOT and Surveillance.

- BEB-210 VRF IOT:

```
BEB-8284-210:1(config)#show ip route vrf iot
================================================================================================
                                        IP Route - VRF iot
================================================================================================
                                                  NH                          INTER
DST             MASK            NEXT            VRF/ISID        COST        FACE      PROT AGE TYPE PRF
------------------------------------------------------------------------------------------------
172.9.99.0      255.255.255.0   BEB-8404-910    GlobalRouter    20          4051      ISIS 0   IBSV 200
172.10.20.0     255.255.252.0   BEB-8284-111    iot             20010       4051      ISIS 0   IBSV 7
172.20.20.0     255.255.252.0   172.20.20.1     -               1           201       LOC  0   DB   0
172.30.20.0     255.255.252.0   BEB-8404-310    iot             30          4051      ISIS 0   IBSV 7
172.90.1.0      255.255.255.0   BEB-8404-910    GlobalRouter    20          4051      ISIS 0   IBSV 200
172.90.20.0     255.255.252.0   BEB-8404-910    iot             20          4051      ISIS 0   IBSV 7
172.105.2.0     255.255.255.0   172.105.2.4     -               1           1052      LOC  0   DB   0

14 out of 14 Total Num of Route Entries, 14 Total Num of Dest Networks displayed.
------------------------------------------------------------------------------------------------
TYPE Legend:
I=Indirect Route, D=Direct Route, A=Alternative Route, B=Best R
U=Unresolved Route, N=Not in HW, F=Replaced by FTN, V=IPVPN Rou
PROTOCOL
v=Inter-V
```

As a result of redistribution within the VRF, BEB-210 has route information on Campus1, 3 and Server Room IOT subnets.

As a result of route-map policies, VRF IOT on BEB-210 has route information for the Network Mgmt and Production Servers subnet in the GRT.

- BEB-210 VRF Surveillance:

```
BEB-8284-210:1(config)#show ip route vrf surveillance
================================================================================
                                  IP Route - VRF surveillance
================================================================================
                                                  NH                          INTER
DST             MASK            NEXT            VRF/ISID        COST        FACE      PROT AGE TYPE PRF
------------------------------------------------------------------------------------------------
172.9.99.0      255.255.255.0   BEB-8404-910    GlobalRouter    20          4051      ISIS 0   IBSV 200
172.10.32.0     255.255.252.0   BEB-8284-111    surveillance    20010       4051      ISIS 0   IBSV 7
172.20.32.0     255.255.252.0   172.20.32.1     -               1           204       LOC  0   DB   0
172.30.32.0     255.255.252.0   BEB-8404-310    surveillance    30          4051      ISIS 0   IBSV 7
172.90.3.0      255.255.255.0   BEB-8404-910    GlobalRouter    20          4051      ISIS 0   IBSV 200
172.90.12.0     255.255.252.0   BEB-8404-910    surveillance    20          4051      ISIS 0   IBSV 7

6 out of 6 Total Num of Route Entries, 6 Total Num of Dest Networks displayed.
------------------------------------------------------------------------------------------------
TYPE Legend:
I=Indirect Route, D=Direct Route, A=Alternative Route, B=Best Route,
U=Unresolved Route, N=Not in HW, F=Replaced by FTN, V=IPVPN Route, S=
PROTOCOL Legend:
v=Inter-VRF route redistributed
```

Redistribution within the VRF, BEB-210 has route information on Campus1, 3 and Server Room Surveillance subnets.

As a result of route-map policies, BEB-210 has route information for the Network Mgmt network and the Storage subnet in the Server Room GRT.

- BEB-960 DVR Leaf Table:

```
BEB-7254-960:1(config)#show dvr database

================================================================================================
                                        DVR DATABASE
================================================================================================
                                NEXT                        L3VSN     L2VSN     OUTGOING          SPB   PR
DEST            MASK            HOP             VRFID       ISID      ISID      INTERFACE         COST  COST
------------------------------------------------------------------------------------------------
0.0.0.0         0.0.0.0         BEB-8404-920    0           0         0         2/1               10    1
1 day(s), 02:12:30
0.0.0.0         0.0.0.0         BEB-8404-910    0           0         0         2
1 day(s), 02:12:30
0.0.0.0         0.0.0.0         BEB-8404-920    2           1800904   0         2
1 day(s), 02:12:30
0.0.0.0         0.0.0.0         BEB-8404-910    2           1800904   0         2/1               10    1
1 day(s), 02:12:30
```

If unknown packet that's member of the GRT(0) or this VRF, its sent to DVR controller.

```
0.0.0.0         0.0.0.0         BEB-8404-920       1      1800911   0         2/1                10   1
1 day(s), 02:12:30
0.0.0.0         0.0.0.0         BEB-8404-910       1      1800911   0         2/1                10   1
1 day(s), 02:12:30
172.9.98.0      255.255.255.0   BEB-8404-920       0      0         1090998   2/1                10   1
1 day(s), 02:12:30
172.9.98.0      255.255.255.0   BEB-8404-910       0      0         1090998   2/1                10   1
1 day(s), 02:12:30
172.9.98.2      255.255.255.255 BEB-8404-910       0      0         1090998   2/1                10   1
1 day(s), 02:12:30
172.9.98.3      255.255.255.255 BEB-8404-920       0      0         1090998   2/1                10   1
1 day(s), 02:12:30
172.9.98.106    255.255.255.255 BEB-7254-970       0      0         1090998   MLT-2              10   1
1 day(s), 01:51:49
172.9.98.106    255.255.255.255 BEB-7254-960       0      0         1090998   MLT-2              10   1
1 day(s), 01:51:49
172.9.98.107    255.255.255.255 BEB-7254-950       0      0         1090998   2/1                10   1
0 day(s), 04:07:42
172.9.98.107    255.255.255.255 BEB-7254-940       0      0         1090998   2/1                10   1
0 day(s), 04:07:42
172.9.99.0      255.255.255.0   BEB-840                                      9 2/1                10   1
1 day(s), 02:12:30
172.9.99.0      255.255.255.0   BEB-840                                      9 2/1                10   1
1 day(s), 02:12:30
```

Known hosts connected to Leaf nodes, connected to specified port/MLT.

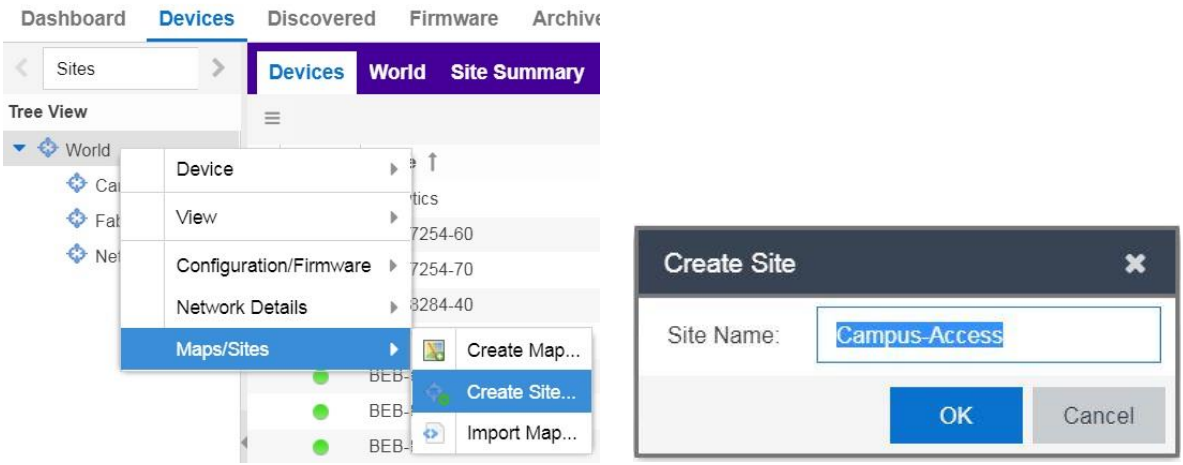
Known hosts learned from other Leaf nodes across DVR domain.

Extreme Management Center Configuration

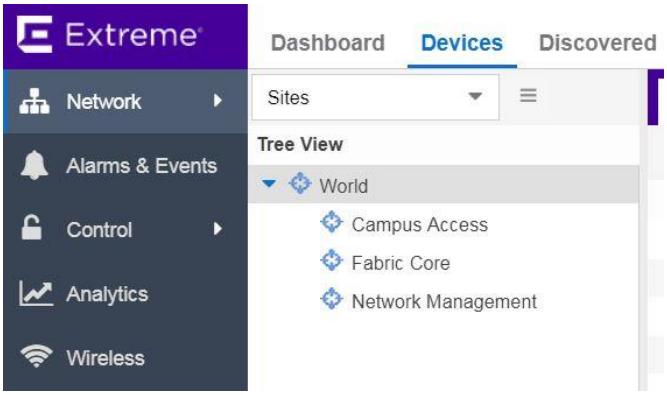
Site Configuration

Extreme Management Center provides the possibility to break a larger network into smaller, more manageable pieces by grouping switches and appliances under Sites. This logical separation, which can be done based on physical location or purpose, can help users understand more complex networks by allowing them to concentrate on smaller segments.

- To create a site, go to the **Devices** tab, right click on **World site**, go to **Maps/Sites** and select **Create Site**. Enter a site name and click **OK**.

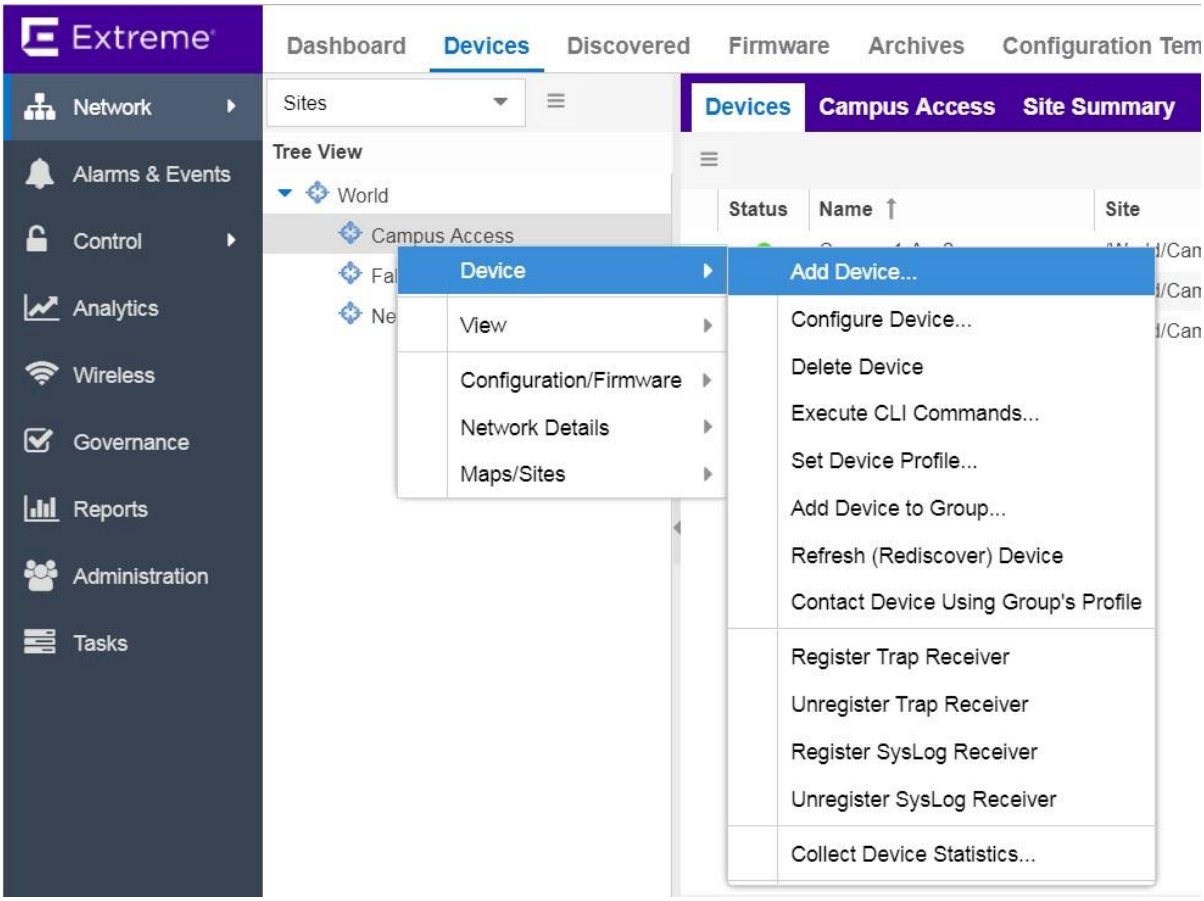


- Three sites were created in the Automated Campus to group devices based on their function.



Adding a Device to the Site Configuration

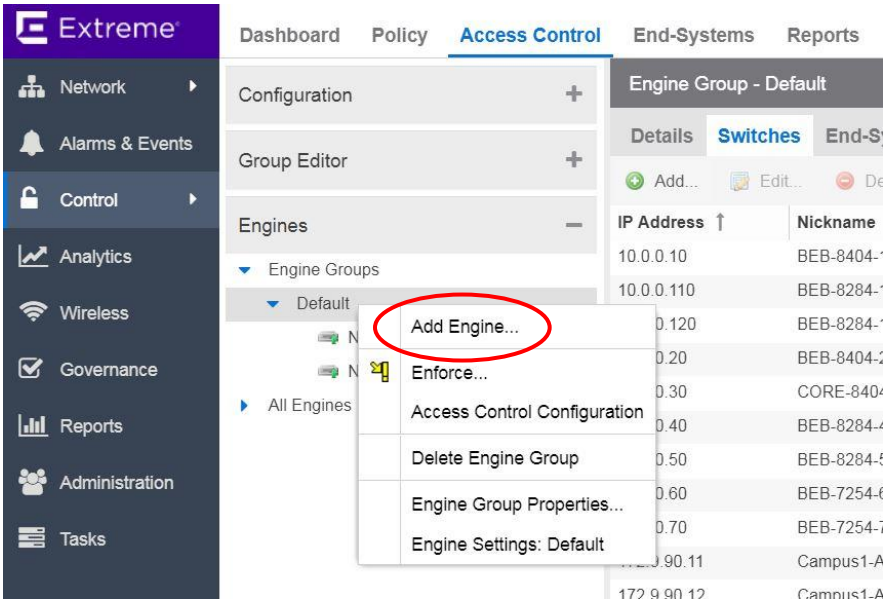
To add a device to a site, right-click on the site name and select **Add Device**.



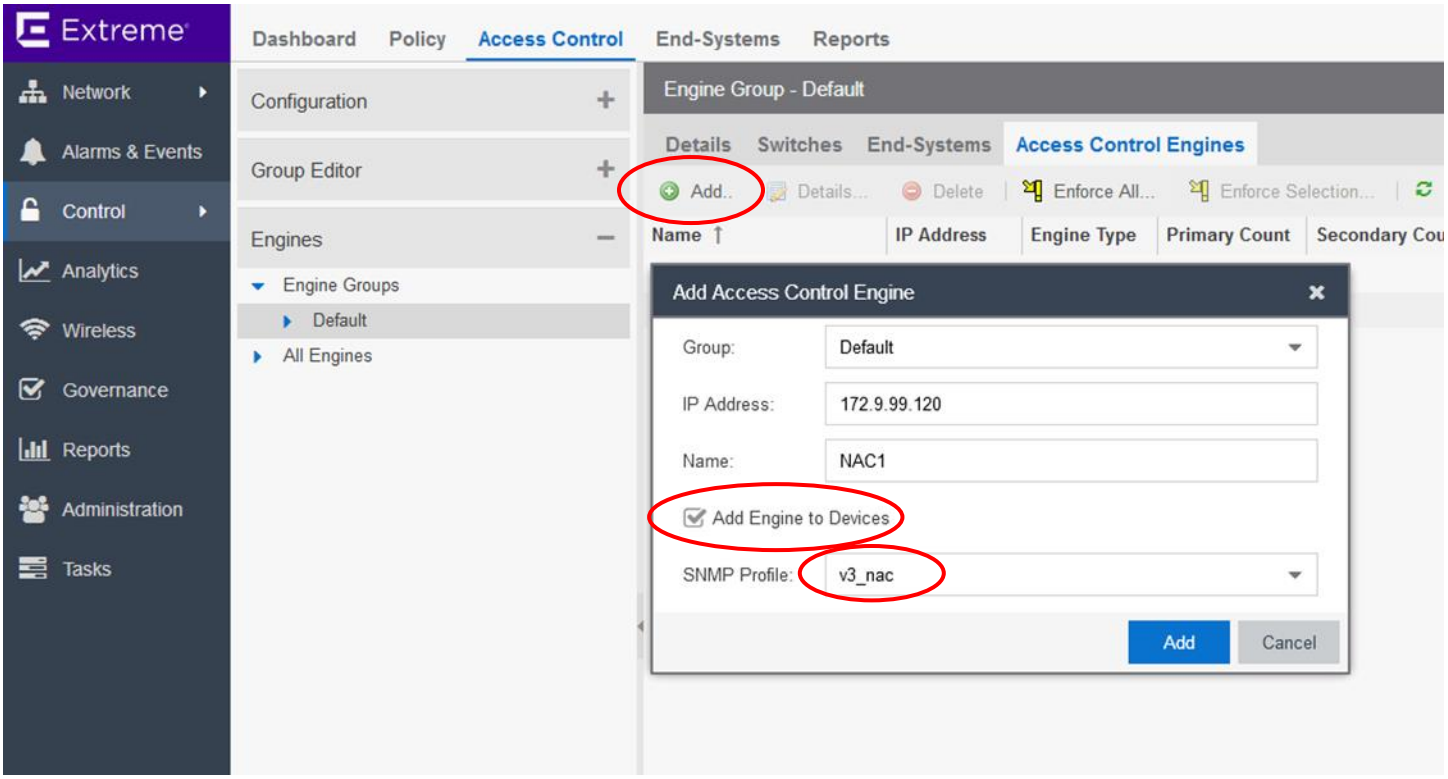
- The **Campus Access** site contains all the access switches deployed at the Campus edge:

Adding an ExtremeControl Appliance to Extreme Management Center

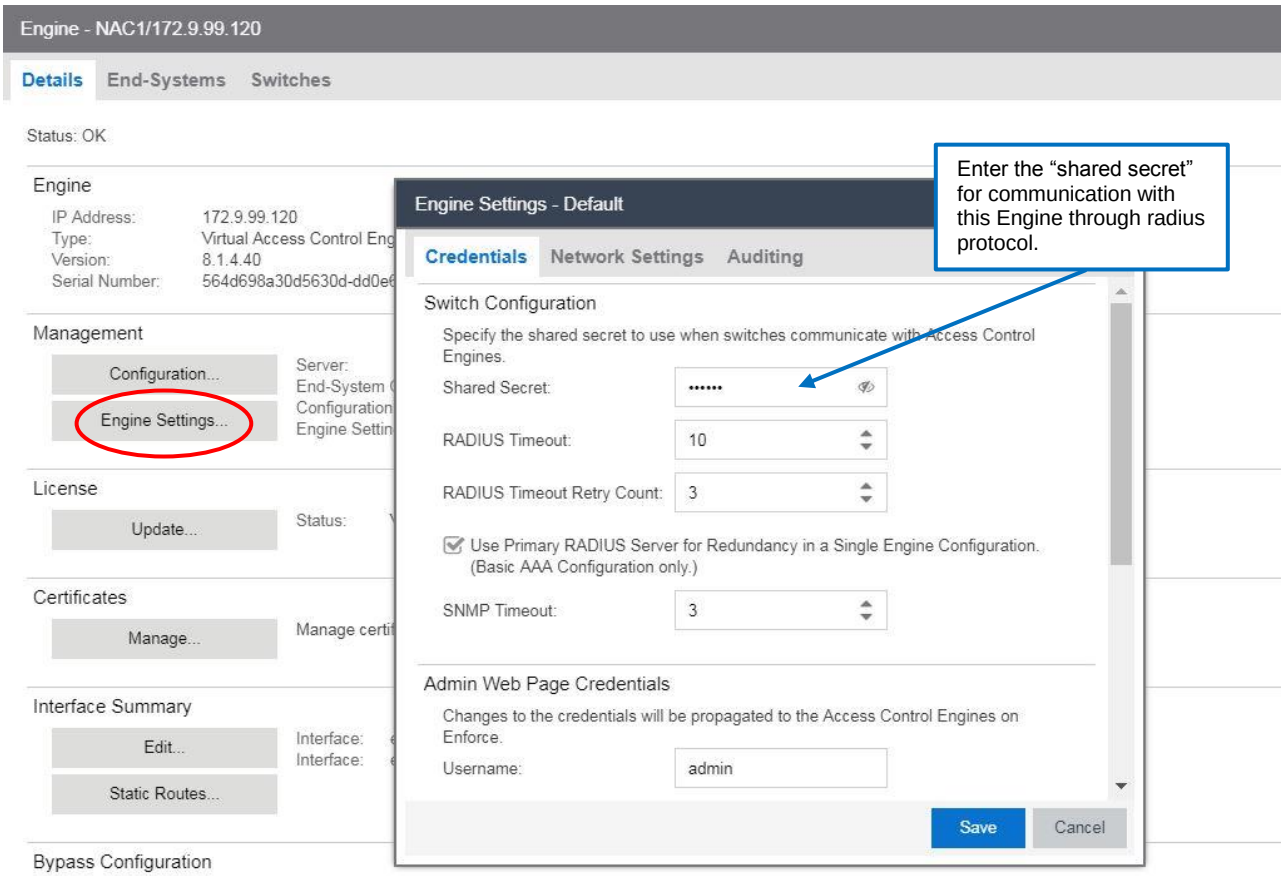
- To add a new ExtremeControl engine to Extreme Management Center, go to **Control → Access Control→ Engines→ Engine Groups→ Default**, right-click on **Default**, and click **Add Engine**.



- Enter the IP address of the engine. The Engine will also automatically be added to Devices with the **Add Engine to Devices** check box. Select the desired SNMP profile:

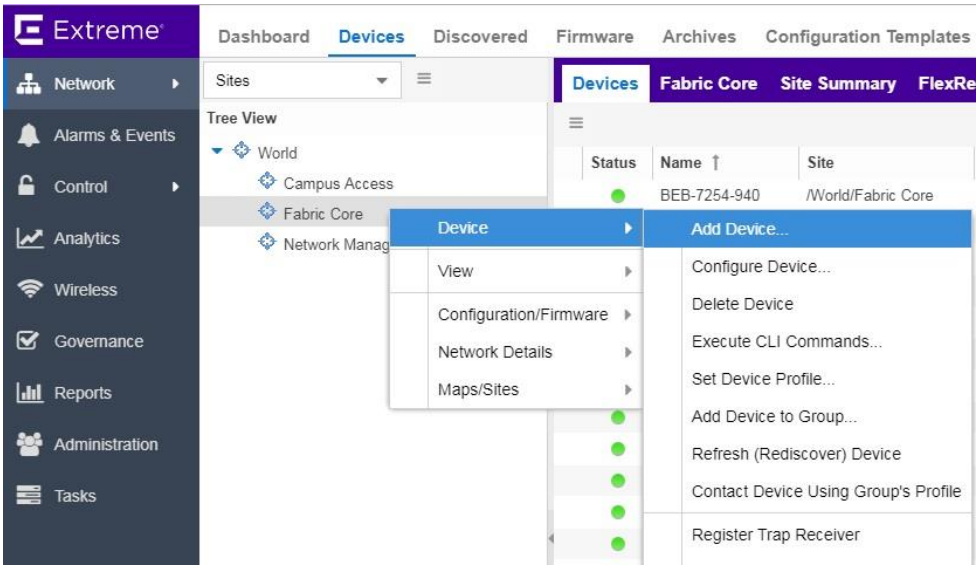


- Highlight the Engine, click Engine Settings:

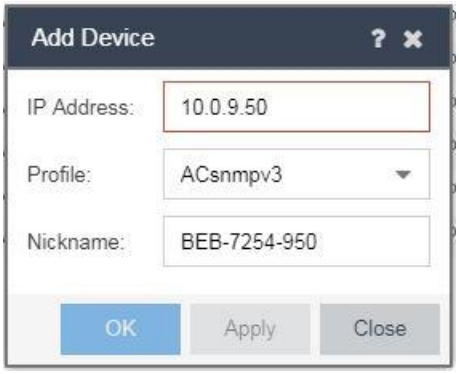


Adding Fabric Switches to Extreme Management Center

The VSP switches comprising the Fabric Connect network can be added to Extreme Management Center for SNMP management, polling and to manage secure access. To add a device to Extreme Management Center, go to **Network → Devices → Devices.** Then, right-click (under either the Devices list or within the corresponding Site created in Tree View), selecting **Add Device**. This step uses the same SNMPv3 profile used previously.



- Enter the parameters for the switch, and click OK:

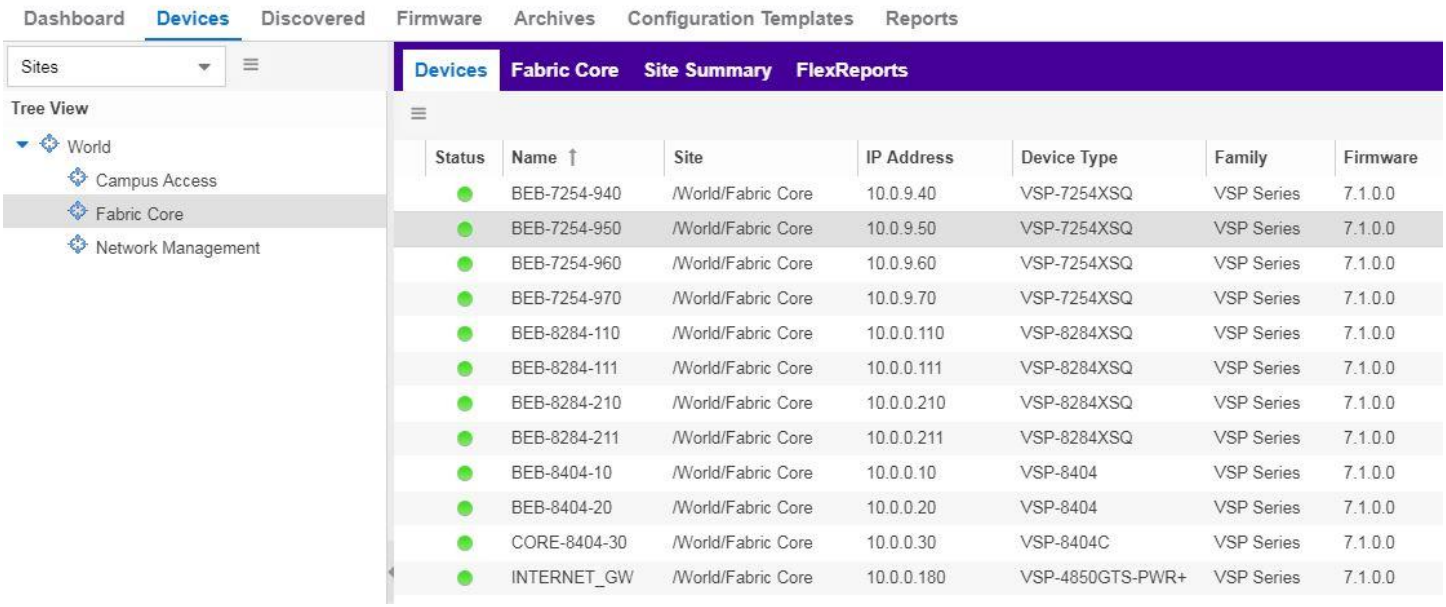


1. Enter the IP address of the VSP switch.
2. Select the desired SNMP profile.
3. Optional: Provide a nickname for how the device will be displayed.

Note

Refer to the **Design Considerations** for procedures on configuring an SNMPv3 profile in XMC.

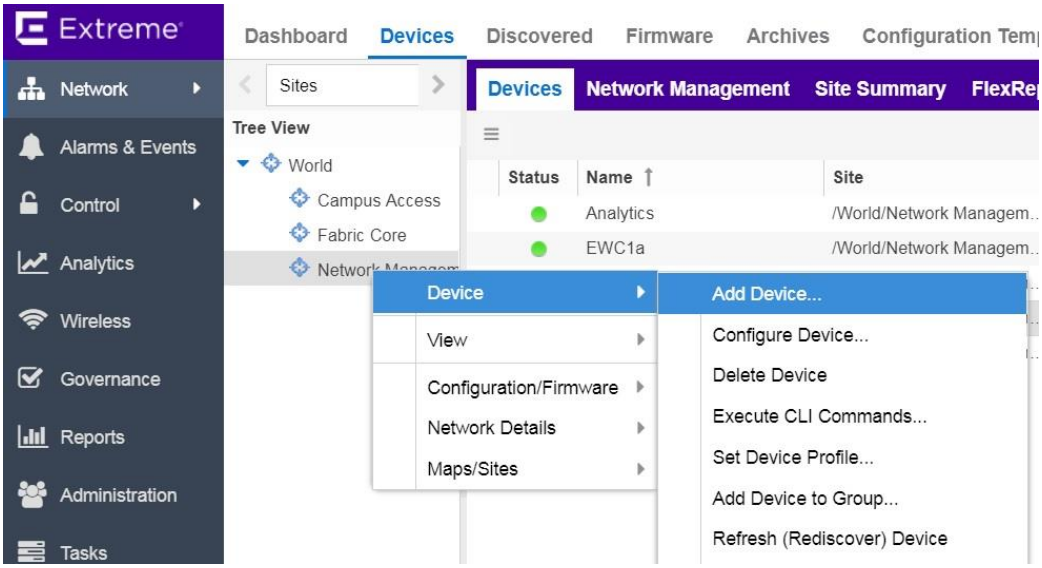
- Repeat this process for the other VSP switches in the network. Check their status in the Devices view:



Status	Name	Site	IP Address	Device Type	Family	Firmware
	BEB-7254-940	/World/Fabric Core	10.0.9.40	VSP-7254XSQ	VSP Series	7.1.0.0
	BEB-7254-950	/World/Fabric Core	10.0.9.50	VSP-7254XSQ	VSP Series	7.1.0.0
	BEB-7254-960	/World/Fabric Core	10.0.9.60	VSP-7254XSQ	VSP Series	7.1.0.0
	BEB-7254-970	/World/Fabric Core	10.0.9.70	VSP-7254XSQ	VSP Series	7.1.0.0
	BEB-8284-110	/World/Fabric Core	10.0.0.110	VSP-8284XSQ	VSP Series	7.1.0.0
	BEB-8284-111	/World/Fabric Core	10.0.0.111	VSP-8284XSQ	VSP Series	7.1.0.0
	BEB-8284-210	/World/Fabric Core	10.0.0.210	VSP-8284XSQ	VSP Series	7.1.0.0
	BEB-8284-211	/World/Fabric Core	10.0.0.211	VSP-8284XSQ	VSP Series	7.1.0.0
	BEB-8404-10	/World/Fabric Core	10.0.0.10	VSP-8404	VSP Series	7.1.0.0
	BEB-8404-20	/World/Fabric Core	10.0.0.20	VSP-8404	VSP Series	7.1.0.0
	CORE-8404-30	/World/Fabric Core	10.0.0.30	VSP-8404C	VSP Series	7.1.0.0
	INTERNET_GW	/World/Fabric Core	10.0.0.180	VSP-4850GTS-PWR+	VSP Series	7.1.0.0

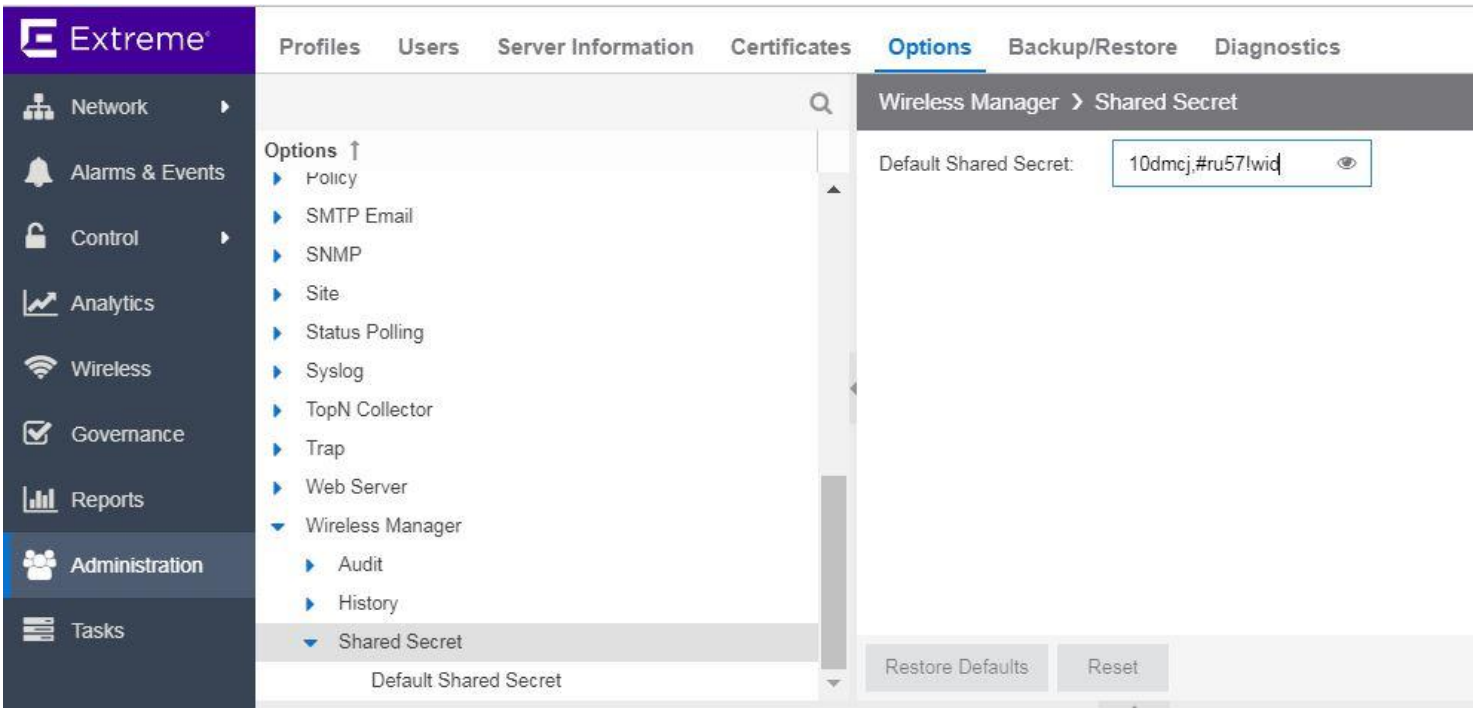
Adding Wireless Controllers to Extreme Management Center

Like all network devices, the wireless controllers can be managed from Extreme Management Center. This step is necessary for the access control configuration. To add a device to Extreme Management Center, go to **Network → Devices → Devices.** Then, right-click (under either the Devices list or within the corresponding Site created in Tree View), selecting **Add Device**. This step uses the same SNMPv3 profile used previously.

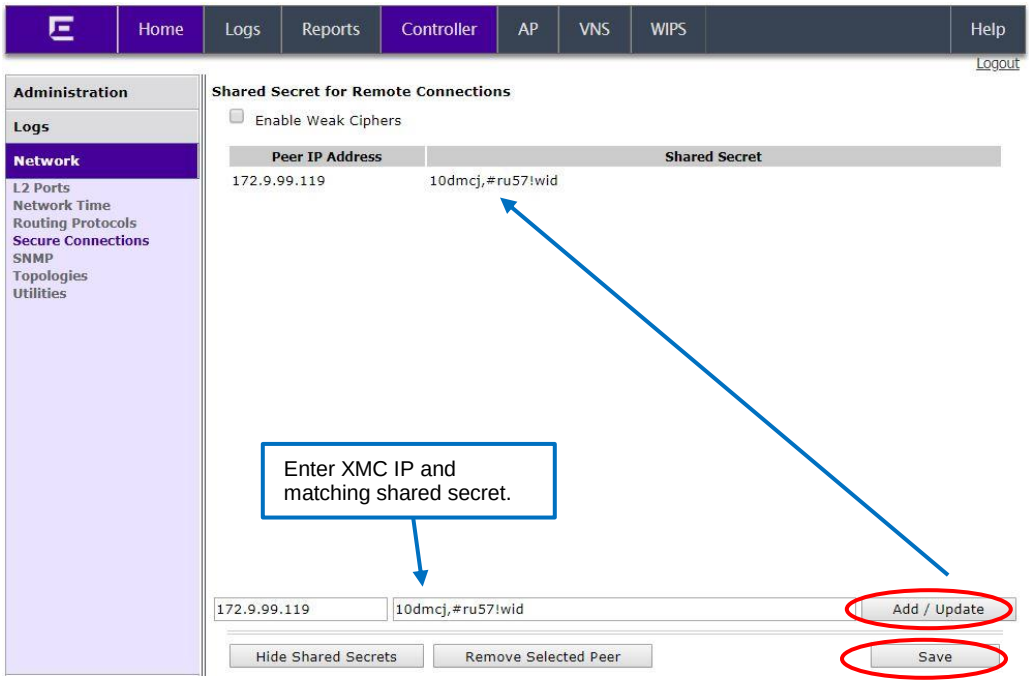


- The wireless controllers are added under the **Network Management** site.

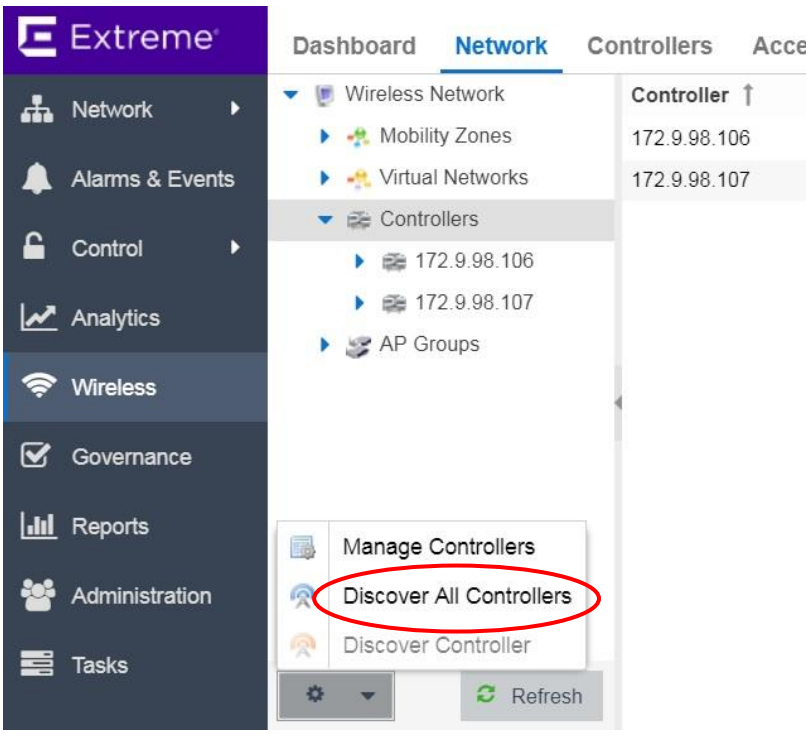
- Ensure that the XMC and the Wireless Controllers are using the same Shared Secret to ensure a secured connection for communication. This shared secret is a default value in XMC under **Administration→Options→Wireless Manager**:



- Log into the EWC and navigate to **Controller→Network→Secure Connections**. Enter the XMC IP address, and the same shared secret found in the XMC. Then click Add/Update:



- To discover a controller, navigate to **Wireless → Network → Wireless Network → Controllers →**  and select **Discover All Controllers** from the drop-down list.



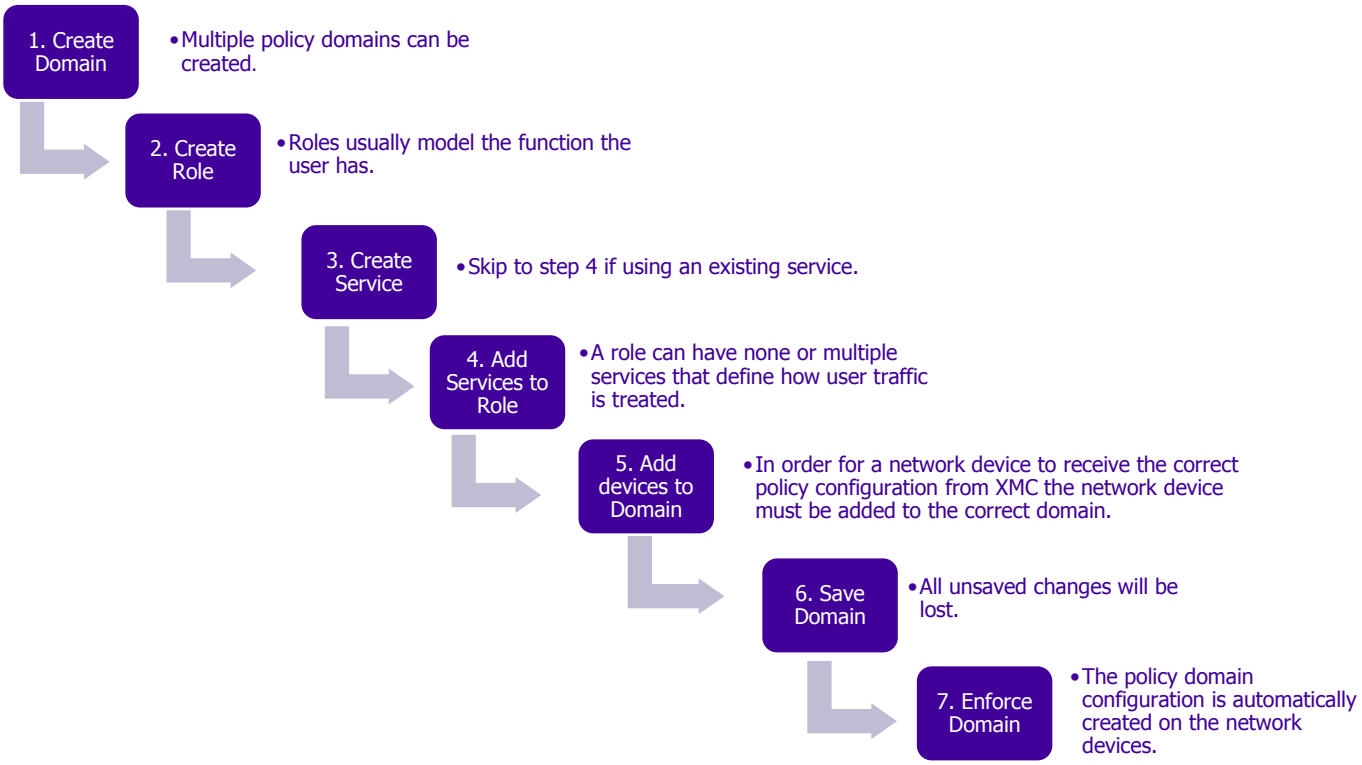
Extreme Policy and Extreme Control Configuration

Extreme Policy

Policy provides for the configuration of role-based profiles on Summit access switches for securing and provisioning network resources based upon the role the user or device plays within the enterprise. By first defining the user or device role, network resources can be granularly tailored to a specific user, system, service, or port-based context by configuring and assigning rules to the policy role. A policy role can be configured for any combination of Class of Service, VLAN/NSI assignment, or default behavior based upon L2, L3, and L4 packet fields. Hybrid authentication allows either policy or dynamic VLAN assignment, or both, to be applied through RADIUS (Remote Authentication Dial In User Service) authorization.

Warning
Make note of the service rule limitations for each platform in the policy domain. If there is a set (or sets) of service rules common to multiple roles, this quickly multiplies the total number of rules configured. One way to avoid this is to create multiple policy domains.

The configuration flow can be reduced to the steps below:



This section assumes that SNMPv3 has been configured. To configure SNMPv3 on the switches, wireless controllers, and Extreme Management appliances, refer to the Simple Network Management Protocol (SNMPv3) section in **Design Considerations**.

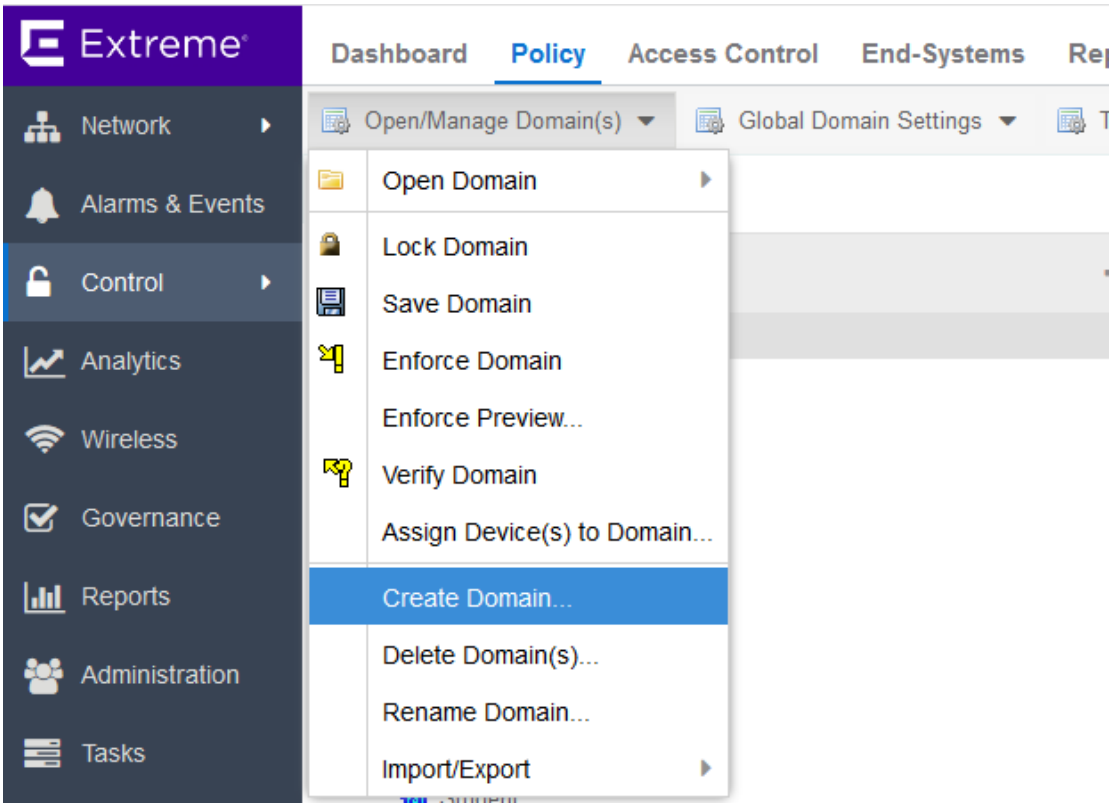
Policy Domain Configuration

The Automated Campus Validated Design contains three main domains created with Extreme Management Center, each containing a subset of associated roles and sets of rules for each role. These three domains work to organize the network in an efficient manner, allowing specific policies and rules to apply only across desired domains. The domains are:

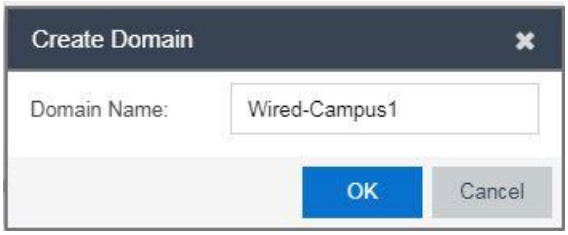
- **Wired-Campus1** (Acc120, Acc121)
- **Wired-Campus2** (Acc220, Acc221)
- **Wireless-Campus** (Wireless controllers in the server rooms, which push policies to the APs in the campuses)

The "**Wired-Campus**" domains enforce the roles and services assigned to the wired users accessing the campus Summit access switches, with each campus its own domain. The "**Wireless-Campus**" domain contains the roles and services enforced on the wireless controllers for the APs on the network.

- To create new domains, go to **Control → Policy → Open/Manage Domain(s)**. Select **Create Domain** from the drop-down list and name the new domain:



- Create the three required domains for this validated design: **Wired-Campus1, Wired-Campus2** and **Wireless-Campus.**



- Click **OK** to complete domain configuration.

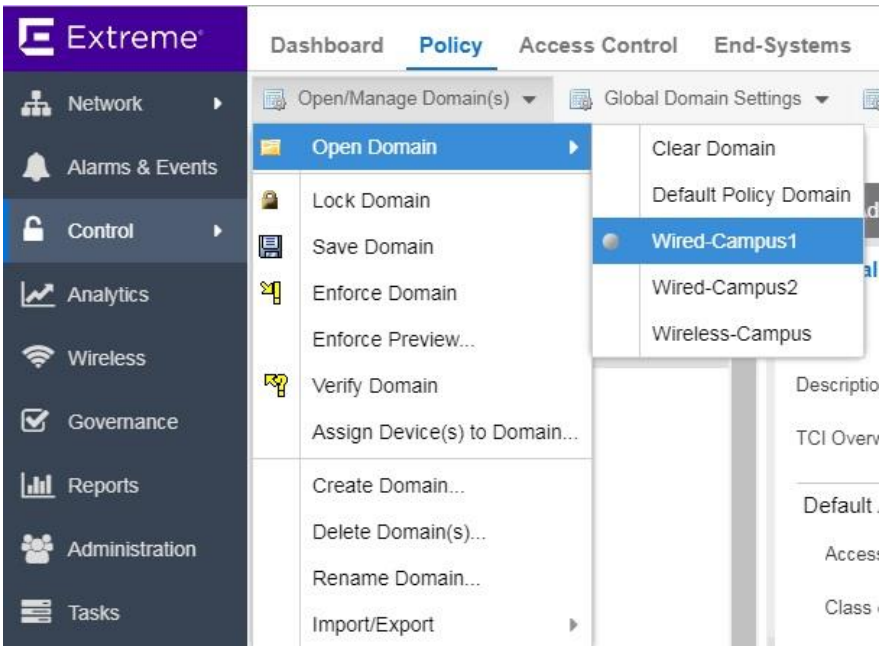
Role Configuration – Wired-Campus1 Domain

Eight unique policy roles are configured for wired campus traffic.

A role has two components that define how user traffic is treated: The Default Actions and the Services. Only the Access Control, Class of Service, and AP Aware actions are configured in the roles defined for this solution. The configuration steps for the Administrator role are presented in this section. All roles are configured in the same manner.

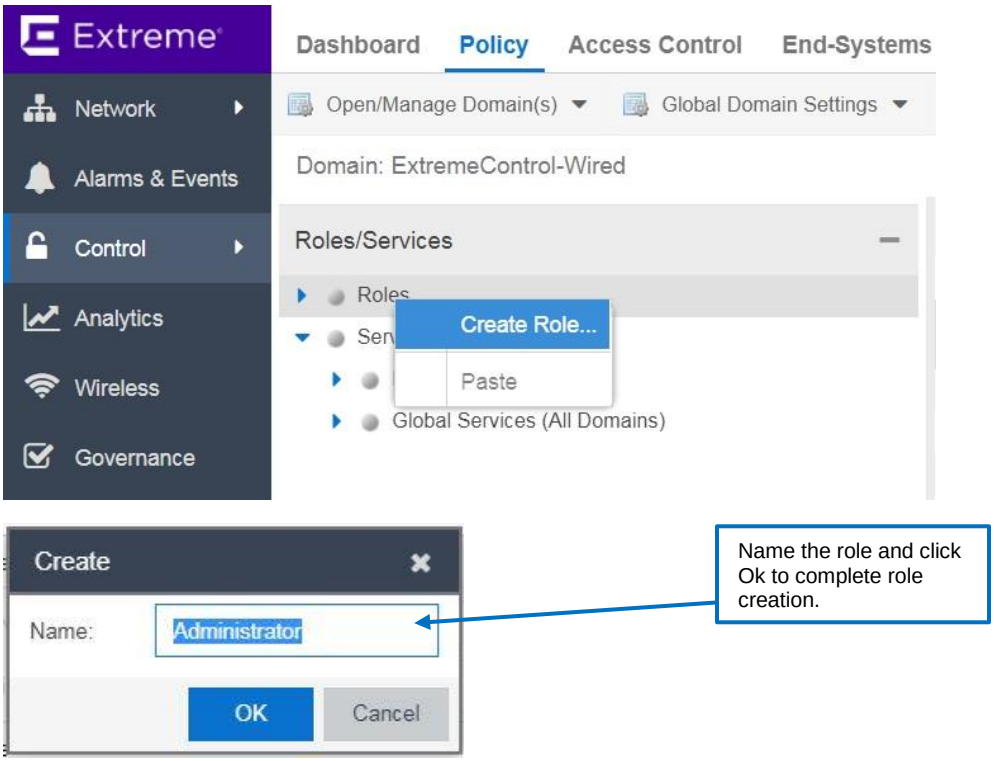
Note
The roles illustrated in this section are examples only. Policy roles are created specifically for the needs of each network and can vary greatly.

To configure the policy roles, open the **Wired-Campus1** policy domain:

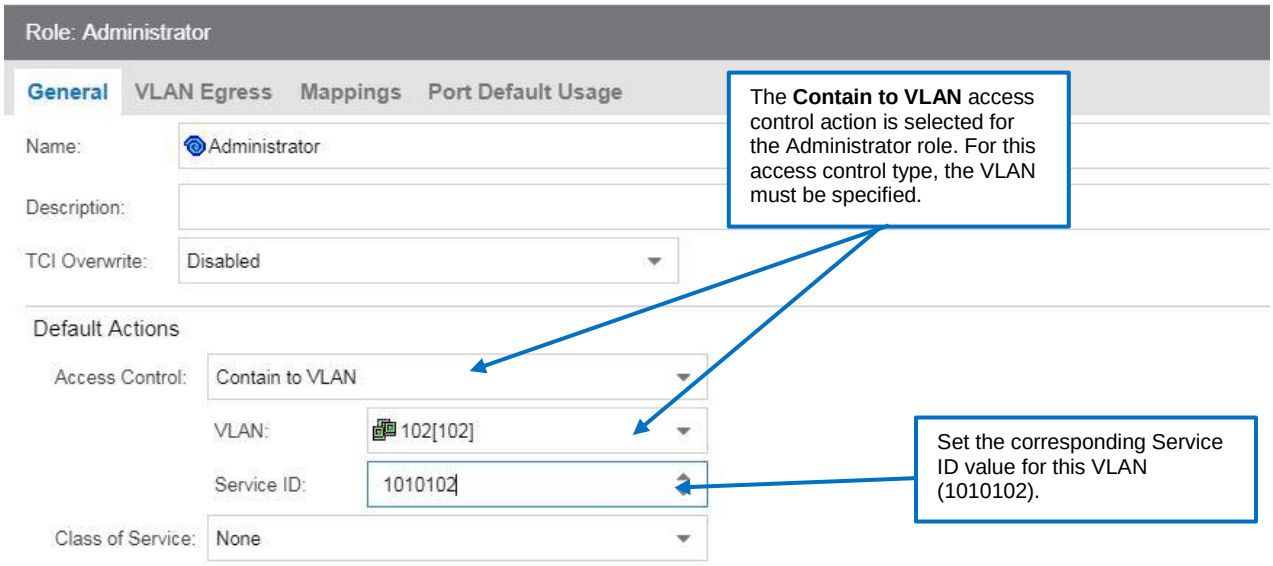


1. Administrator (VLAN 102/ NSI: 1010102)

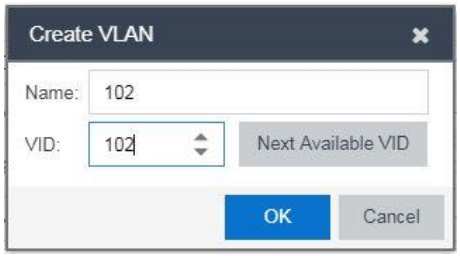
- The Administrator role is intended for administrative users who have no limitations of services or network use. The Administrator role is important for allowing IT Administrators complete access to the network so that they can conduct the required analysis, development, and troubleshooting processes that belong to their role in the enterprise. There are no rules for this role. In addition, Class of Service (CoS) is untouched to provide administrators an unbiased network experience. If this were set to a high value, the administrator's monitoring tools may not reflect network latency accurately. If the administrators require a higher priority to ensure network access, then we recommend creating an additional Administrator role for that purpose.
- This role is used by all wired administrator users/assets across both campuses, and, other than the VLAN/Service ID mapping, is identical to the Administrator role used in the **Wired-Campus2** and **Wireless-Campus** policy domains.
- To create a new role, go to **Control →Policy → Roles/Services,** and right-click on **Roles**:



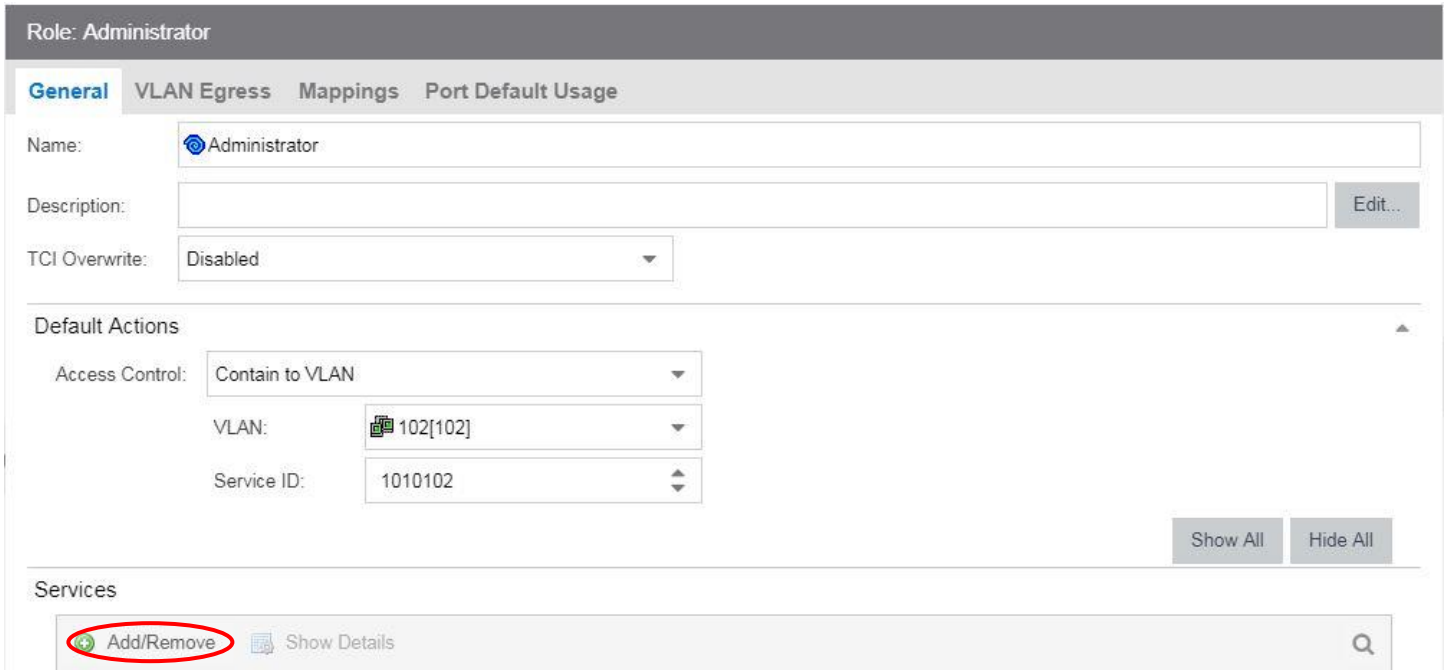
- To configure the default actions for the Administrator role, go to **Control →Policy → Roles/Services** and select **Role**. If the options are not displayed, click **Show All**.

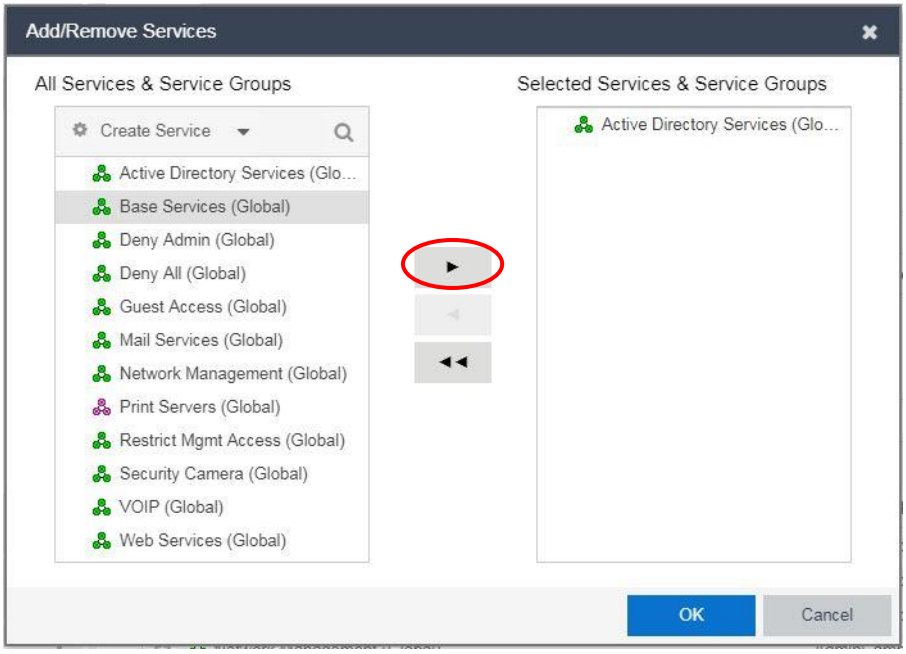


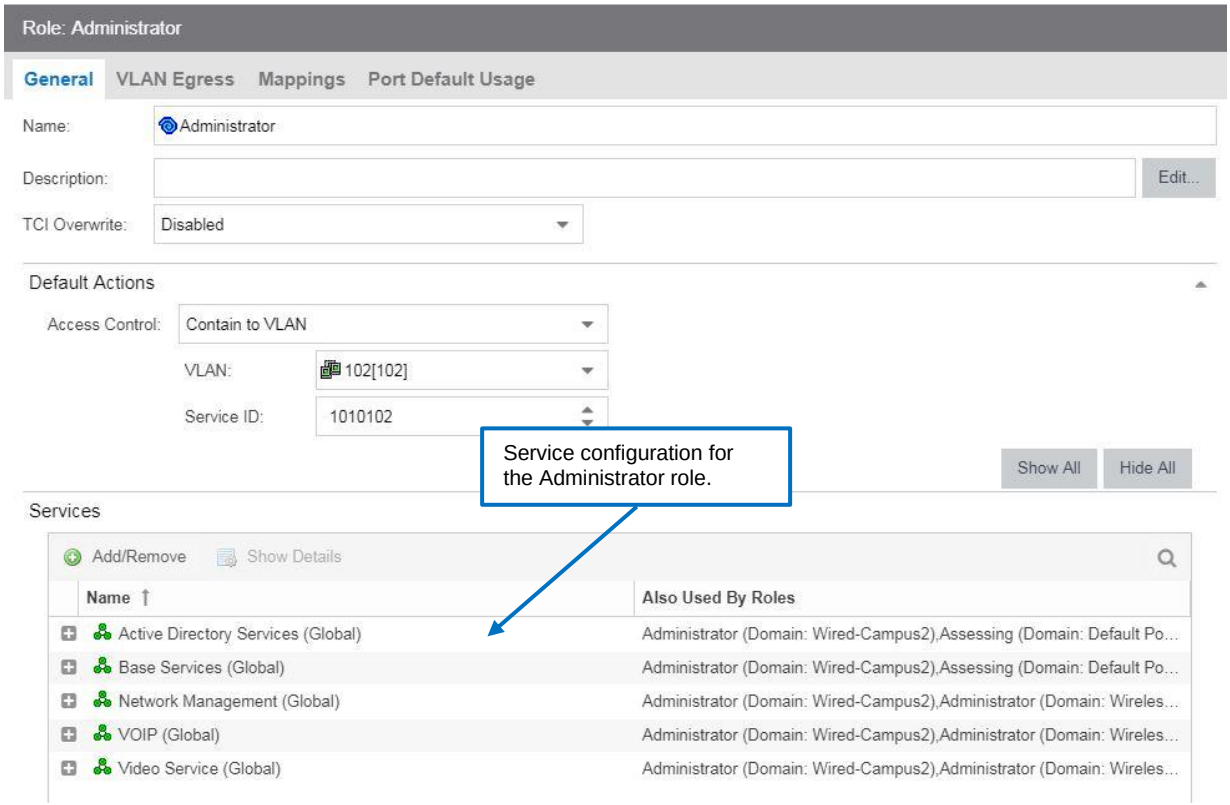
- If the VLAN doesn't exist, click **New VLAN** in the drop-down, and enter VLAN name and ID:



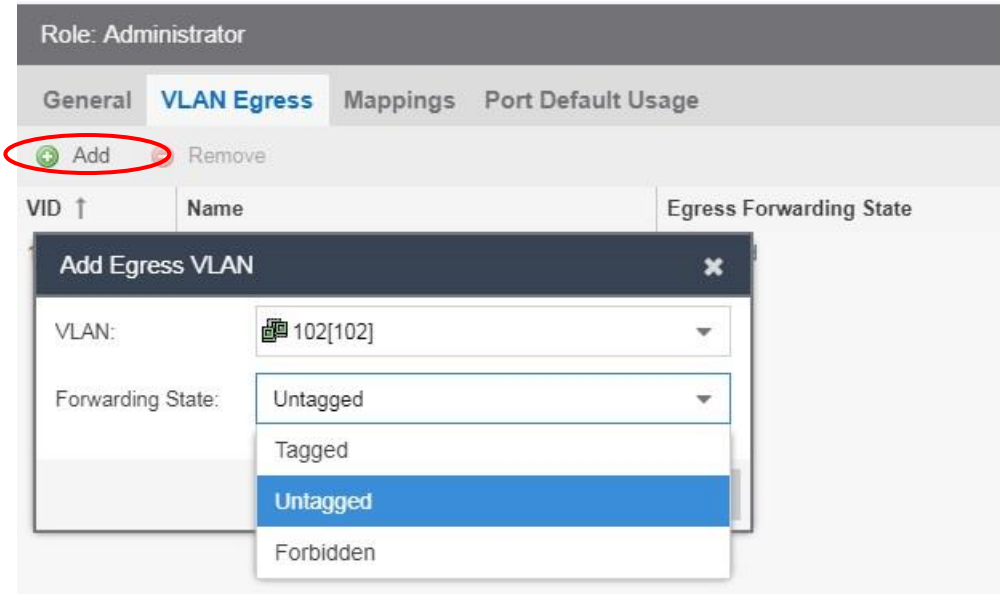
- To add services to the Administrator role, click **Add/Remove** and select from the existing default services. Click OK.




Add/Remove Services
All Services & Service Groups
Create Service
Active Directory Services (Glo...
Base Services (Global)
Deny Admin (Global)
Deny All (Global)
Guest Access (Global)
Mail Services (Global)
Network Management (Global)
Print Servers (Global)
Restrict Mgmt Access (Global)
Security Camera (Global)
VOIP (Global)
Web Services (Global)
Selected Services & Service Groups
Active Directory Services (Glo...
OK
Cancel


Role: Administrator
General
VLAN Egress
Mappings
Port Default Usage
Name:
Administrator
Description:
Edit...
TCI Overwrite:
Disabled
Default Actions
Access Control:
Contain to VLAN
VLAN:
102[102]
Service ID:
1010102
Service configuration for the Administrator role.
Show All
Hide All
Services
Add/Remove
Show Details
Name
Also Used By Roles
Active Directory Services (Global)
Administrator (Domain: Wired-Campus2),Assessing (Domain: Default Po...
Base Services (Global)
Administrator (Domain: Wired-Campus2),Assessing (Domain: Default Po...
Network Management (Global)
Administrator (Domain: Wired-Campus2),Administrator (Domain: Wireles...
VOIP (Global)
Administrator (Domain: Wired-Campus2),Administrator (Domain: Wireles...
Video Service (Global)
Administrator (Domain: Wired-Campus2),Administrator (Domain: Wireles...

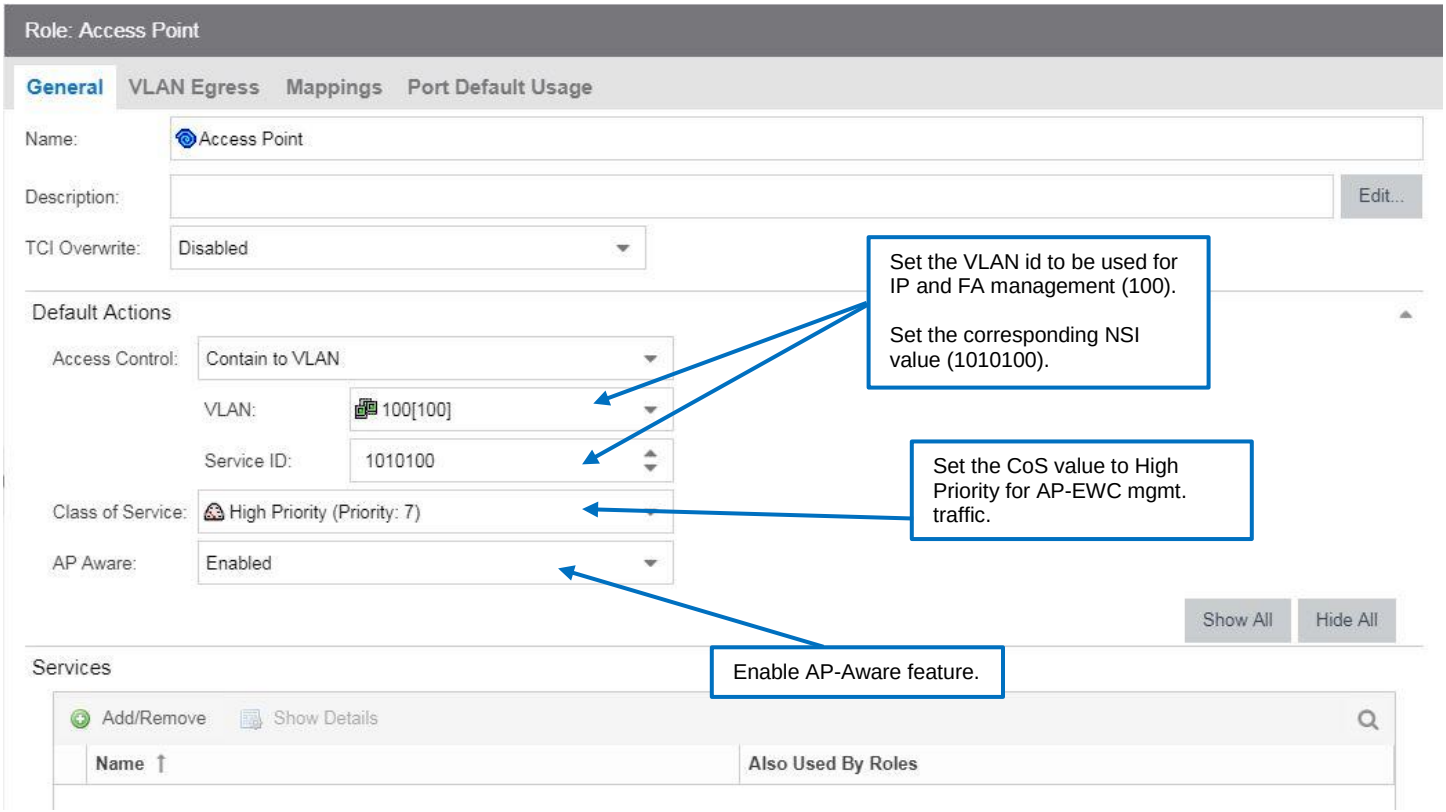
- The Egress VLAN must also be configured for the roles that have access control set to Contain to VLAN and for roles applied to devices that have other users connected behind them, like an AP or a VoIP phone. To configure the Egress VLAN entries, go to the VLAN Egress tab and click **Add**. Select the desired VLAN and the forwarding state for the port from the drop-down lists.

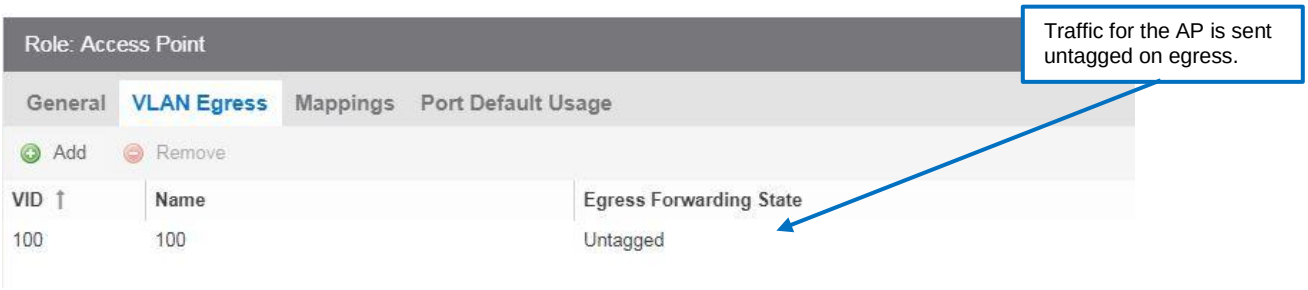


2. Access Point Role (VLAN 100/ NSI: 1010100)

- This role is applied to any port where Extreme Access Points are detected. The **AP Aware** feature allows all other MACs ingressing this port to be passed through without authentication (as the APs themselves will serve this function). This is specifically useful when bridging wireless client traffic at the AP. Although the Access Point role does not contain any associated services, it does use the Class of Service setting of High Priority. This CoS value is the highest available in the network. For Fabric Attach wireless topologies, the AP switch port is used to forward user traffic into the network. The VLANs associated with the traffic can be assigned dynamically using the VLAN Egress functionality of the role.

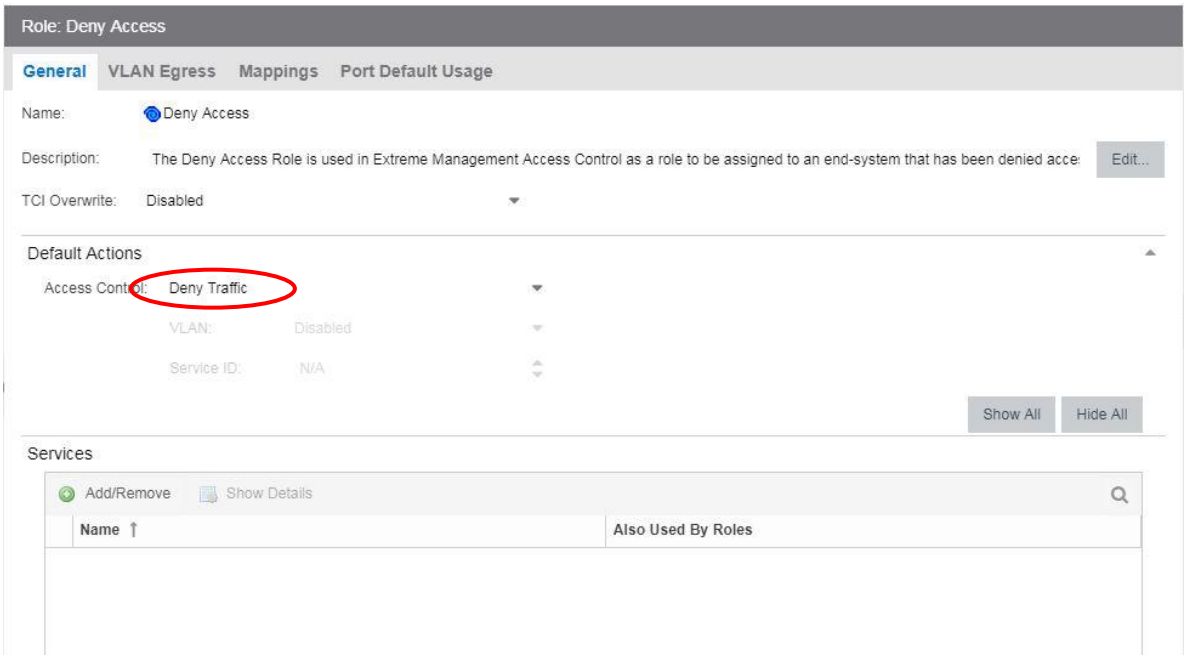
Note
This role is used by wired domains only and does not exist on the Wireless-Campus domain.


Role: Access Point
General
VLAN Egress
Mappings
Port Default Usage
Name:
Access Point
Description:
Edit...
TCI Overwrite:
Disabled
Default Actions
Access Control:
Contain to VLAN
VLAN:
100[100]
Service ID:
1010100
Class of Service:
High Priority (Priority: 7)
AP Aware:
Enabled
Show All
Hide All
Services
Add/Remove
Show Details
Name
Also Used By Roles
Set the VLAN id to be used for IP and FA management (100).
Set the corresponding NSI value (1010100).
Set the CoS value to High Priority for AP-EWC mgmt. traffic.
Enable AP-Aware feature.


Role: Access Point
General
VLAN Egress
Mappings
Port Default Usage
Add
Remove
VID
Name
Egress Forwarding State
100
100
Untagged
Traffic for the AP is sent untagged on egress.

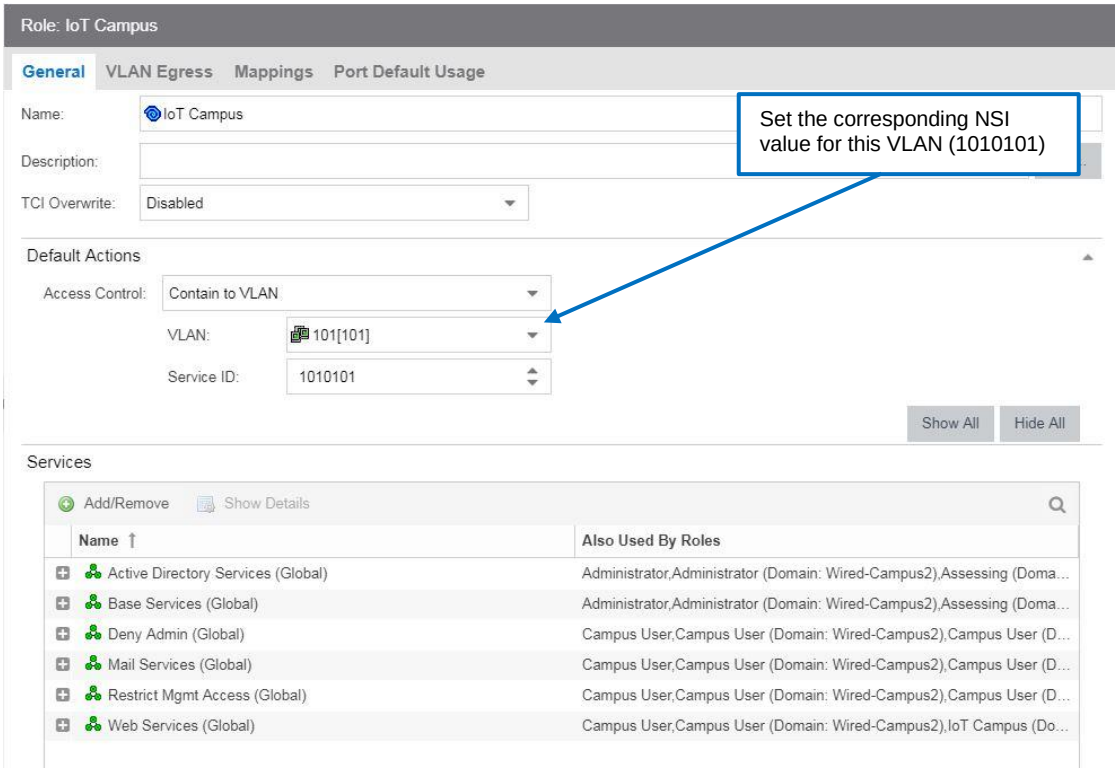
3. Deny Access

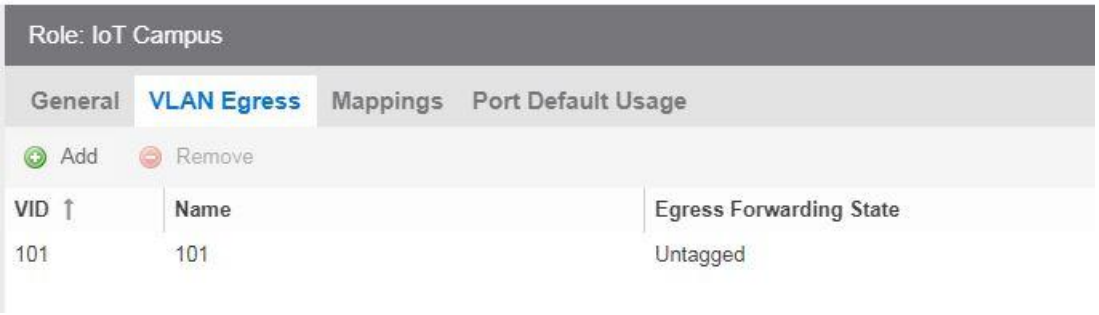
- The Deny Access Role is used in ExtremeControl to assign to an end-system that has been denied access through MAC Registration. The definition of the Deny Access role may vary depending on the customer environment.



4. IoT Campus Role (VLAN 101/ NSI: 1010101)

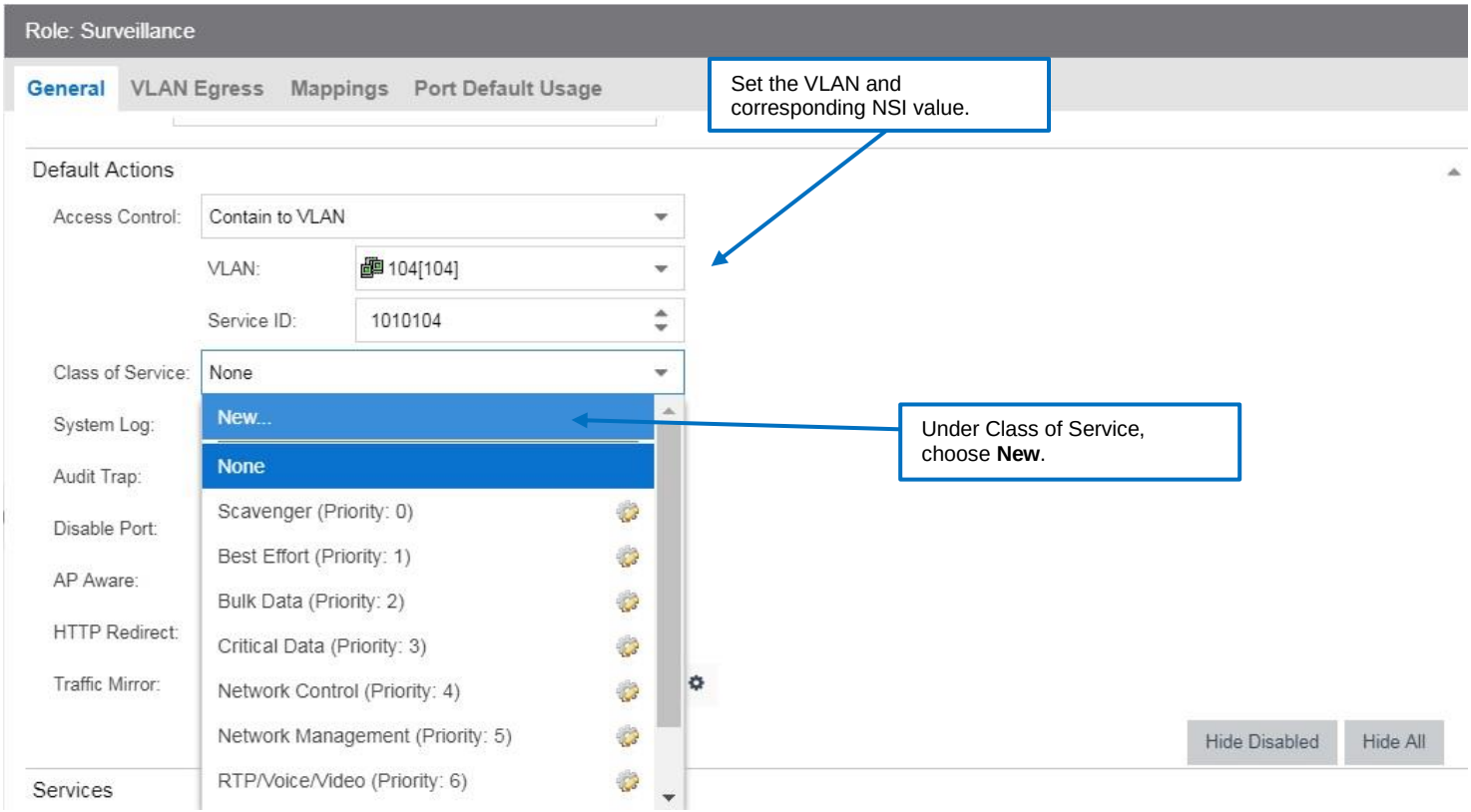
- The IoT Device role represents a dedicated VLAN for IoT computing devices requiring communication with other IoT devices and systems within the campus or with other campuses.



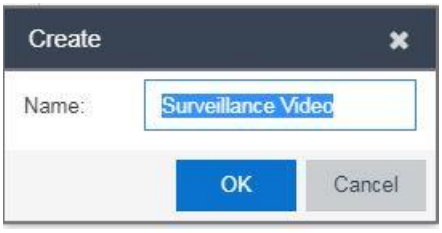


5. Surveillance Role (VLAN 104/ NSI: 1010104)

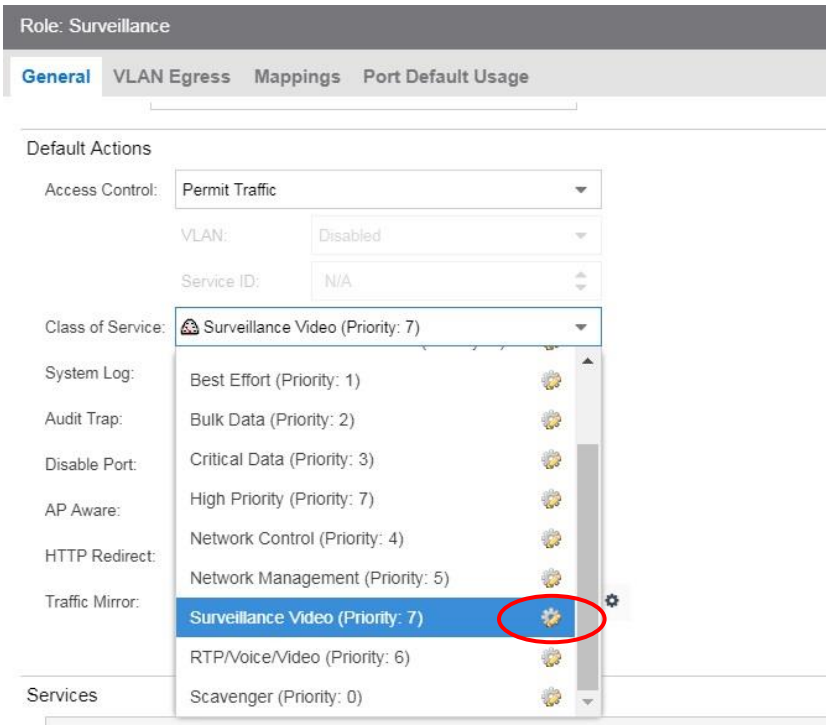
- The Surveillance role in this design is to represent dedicated applications using multicast, such as security cameras. A Class of Service profile will be created for this role.



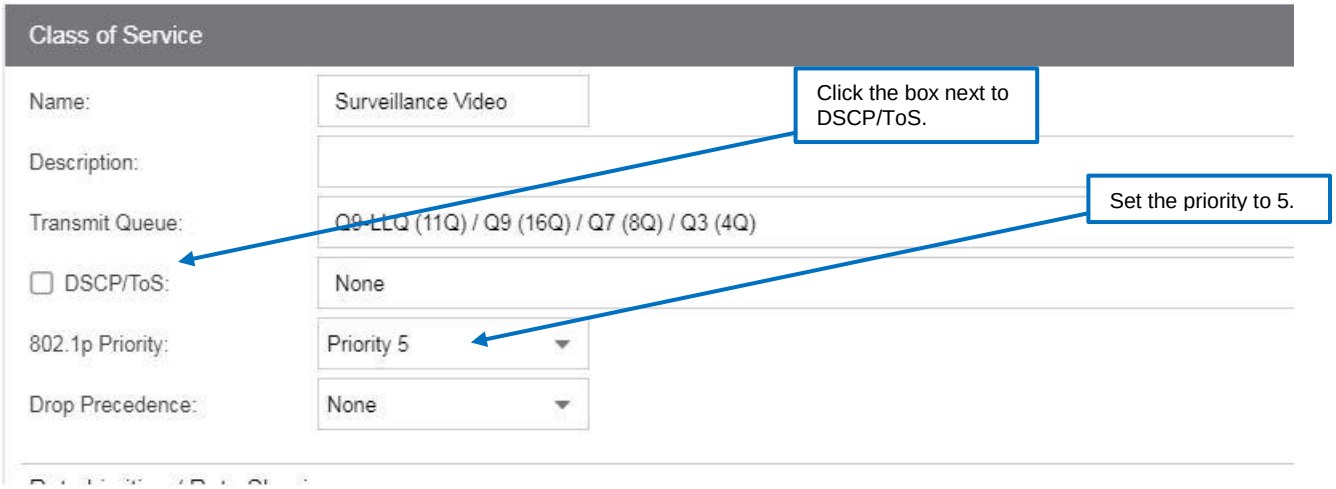
- Give the CoS service a name, and click OK, which will assign it to this Role:



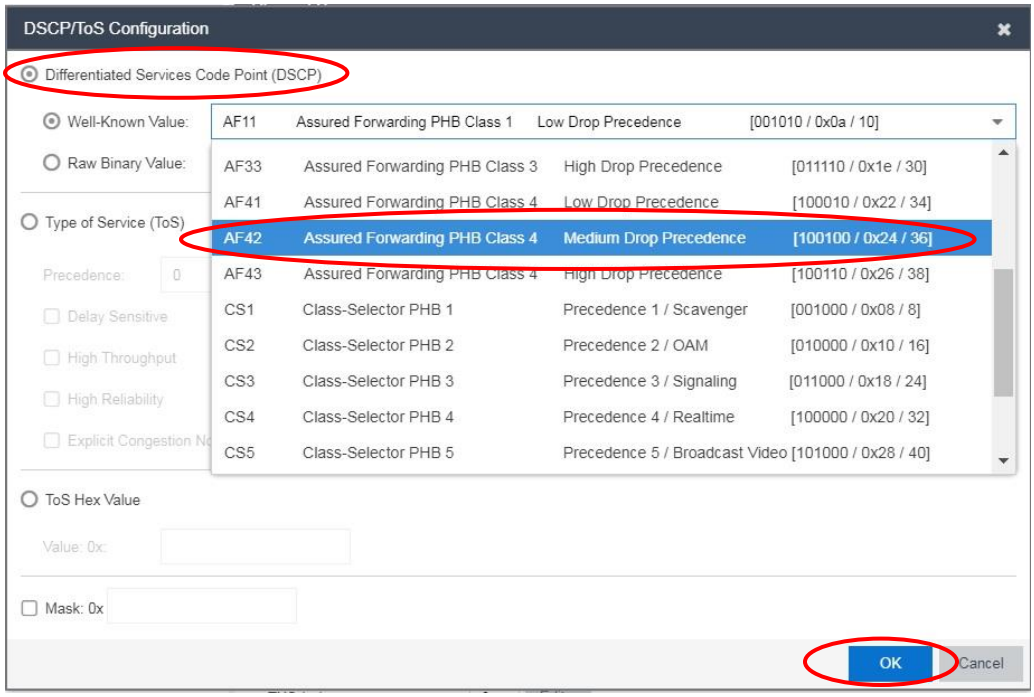
- In the CoS drop-down menu, choose the gear icon next to the CoS profile created:



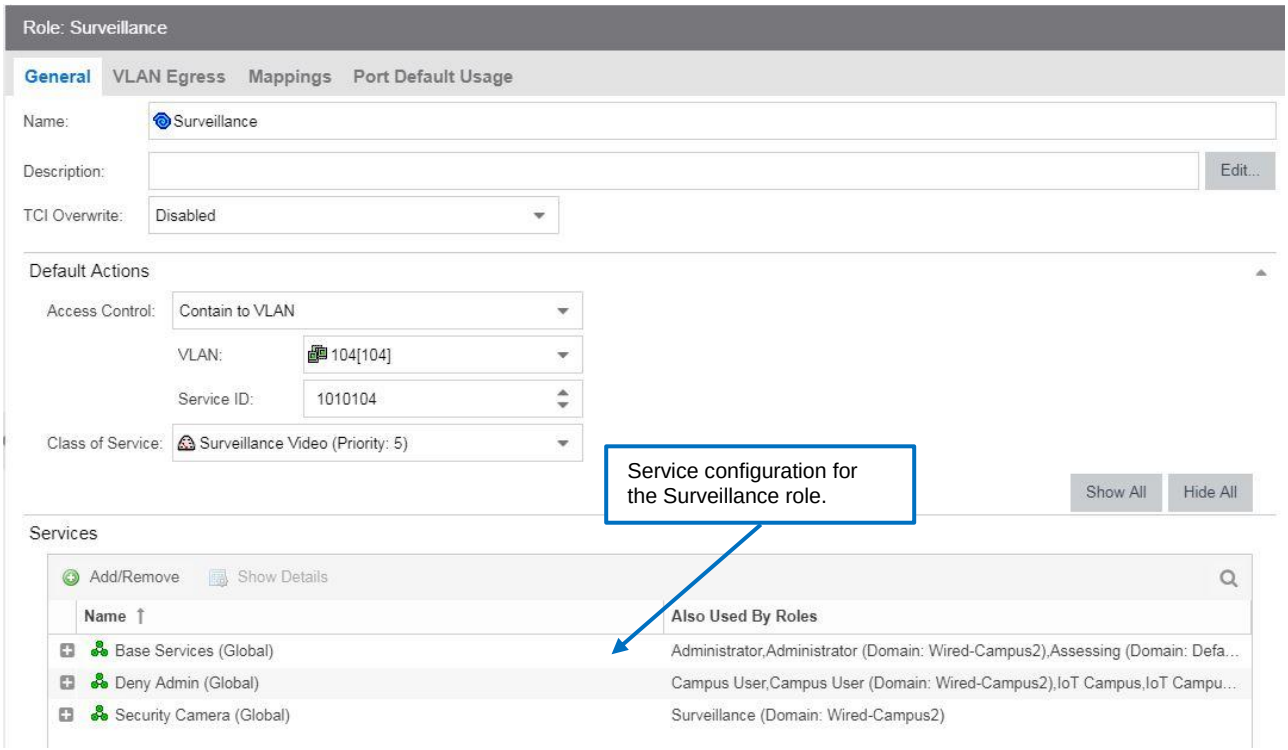
- Select the dot1p priority and DSCP values for this profile:



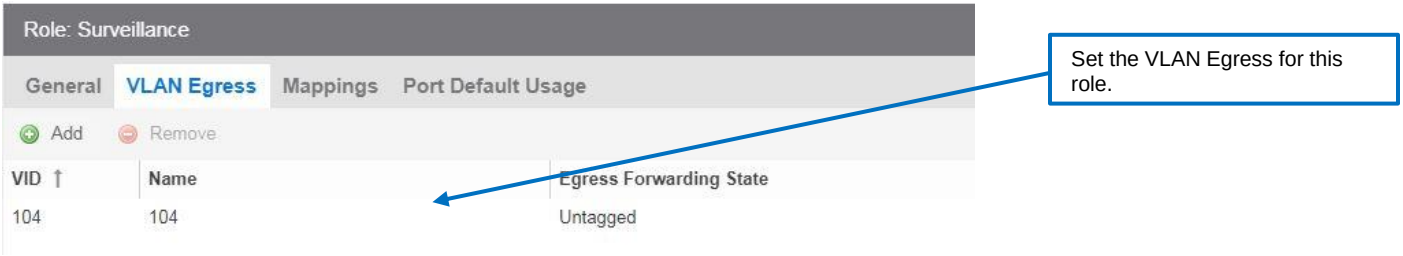
- Set the desired DSCP value (in this EVD, the DSCP will be AF42, DSCP 36):



- Navigate back to the Surveillance role, and add any services desired:

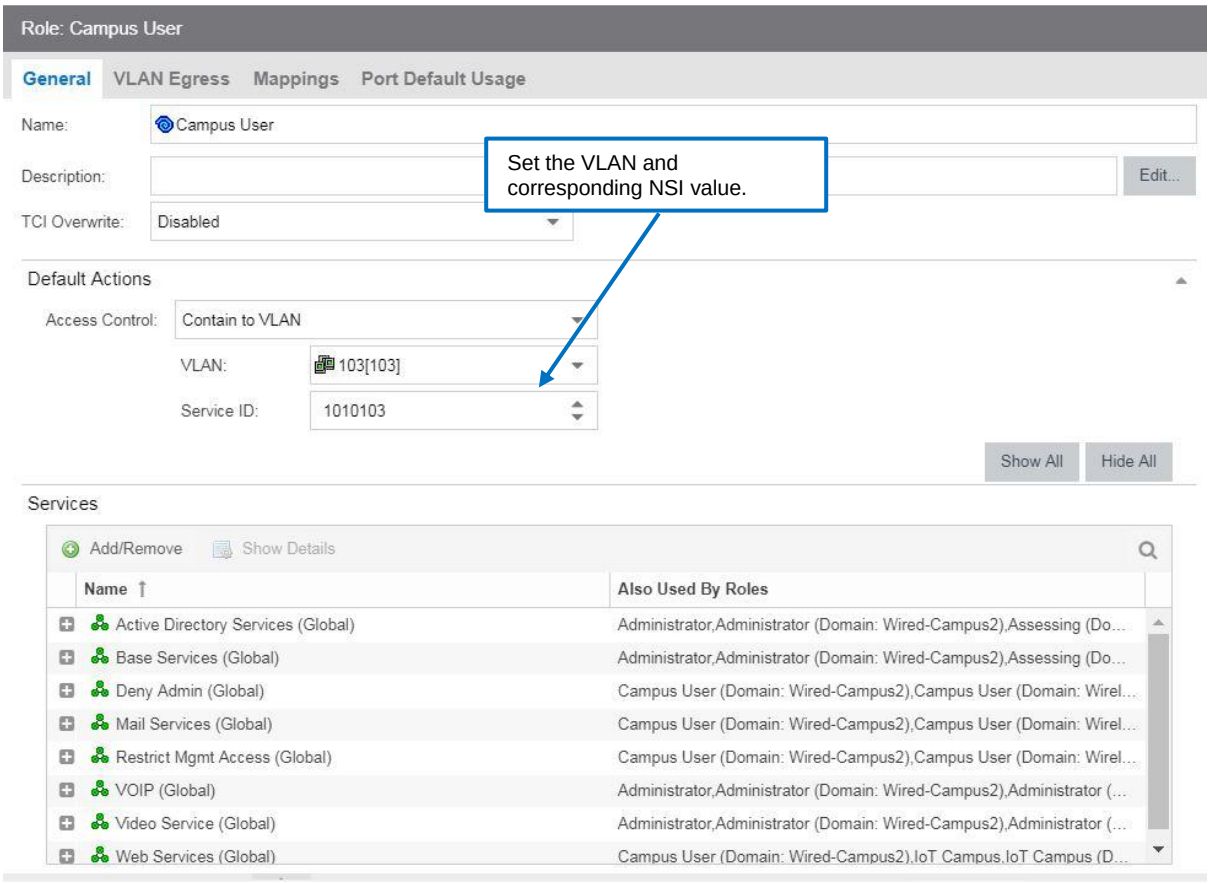


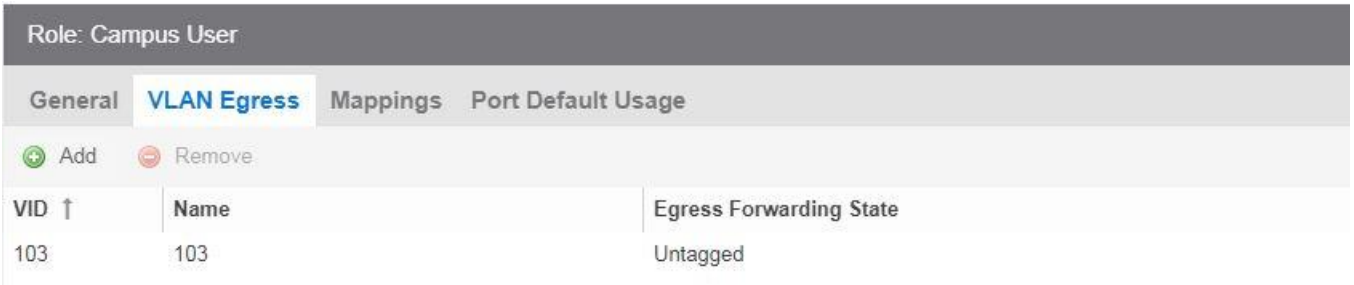
- Set the VLAN Egress for this role.



6. Campus User Role (VLAN 101/ NSI: 1010101)

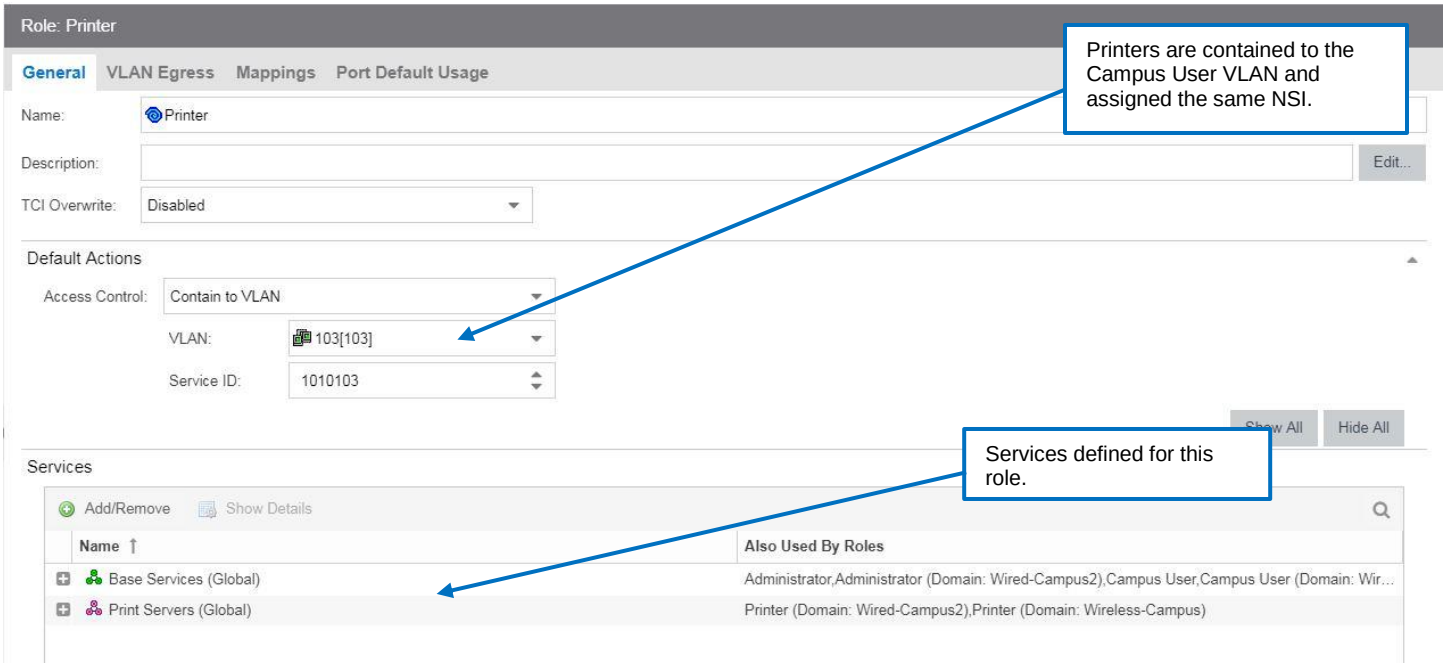
- The Campus User role in this EVD represent any user traffic that is not Administrator or is lower priority.



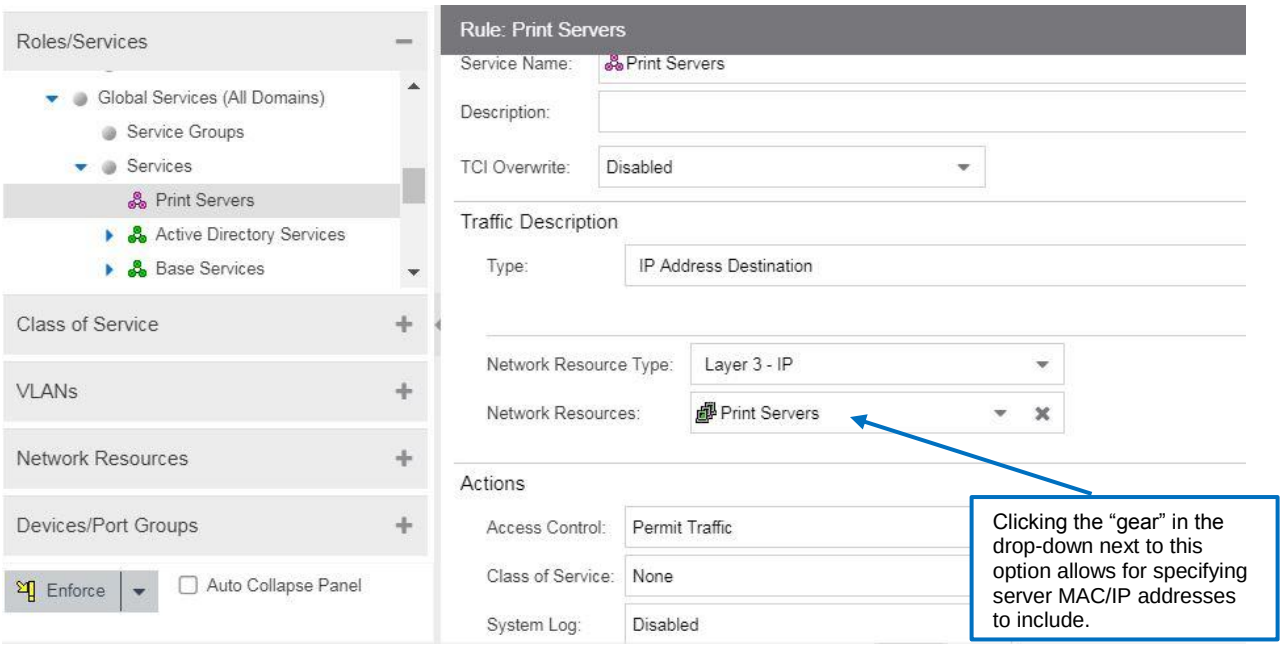


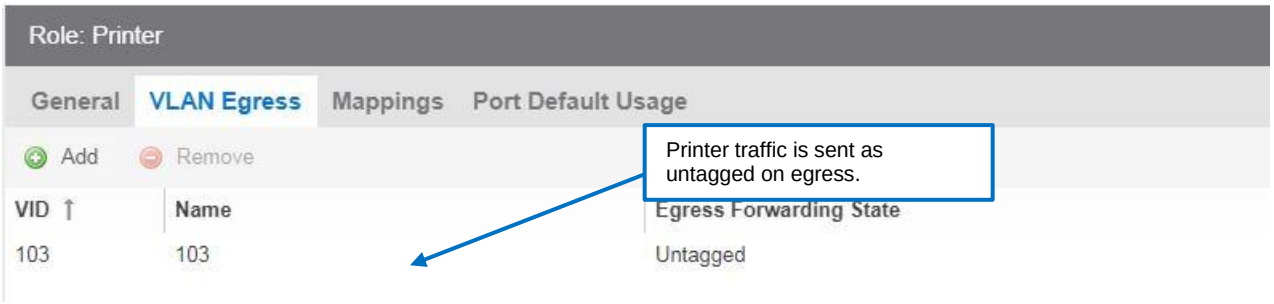
7. Printer Role (VLAN 101/ NSI: 1010101)

- The Printer Role is simply used to define a subset of services that should be applied to any related printer devices on the network.



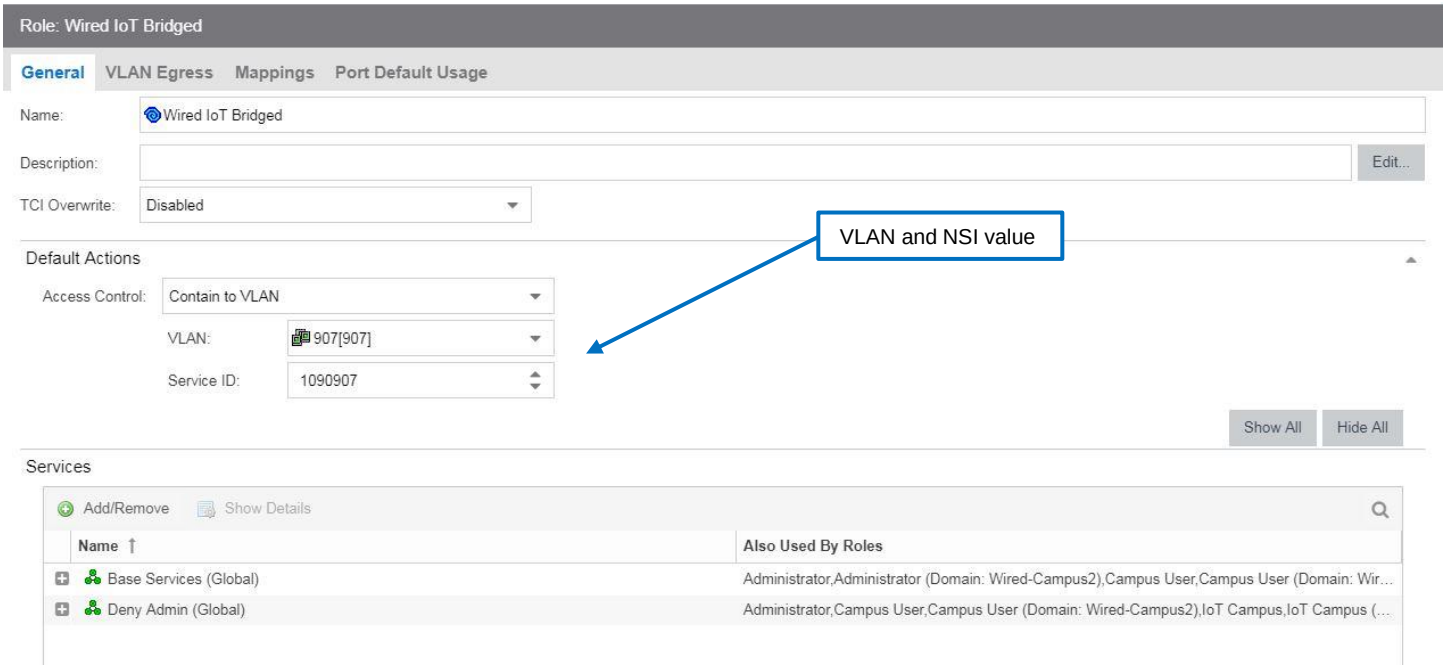
- The “Print Servers” service is predefined under Services. Under Network Resources, Print Servers can be selected and edited, specifying the MAC or IP addresses of the servers in the network to be included in this service and applied to this role.



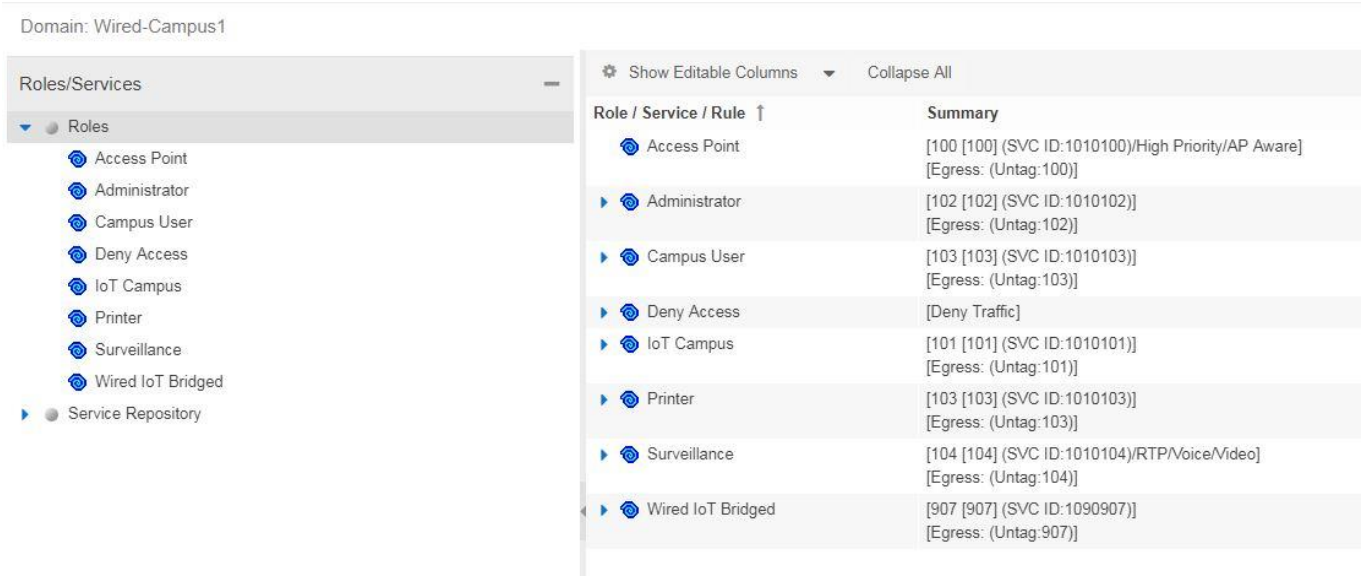


8. Wired IoT Bridged Role (Legacy IoT - VLAN 907/ NSI: 1090907)

- This role is applied to devices that may not support newer authentication methods, network addressing, etc, and require a Layer 2 connection across the fabric to its corresponding server. When a client authenticates to this role, the access switch (FA client) will request this VLAN/NSI value and is created dynamically on the FA Server as an L2VSN.



9. The final list of Policy Roles for Wired-Campus1:

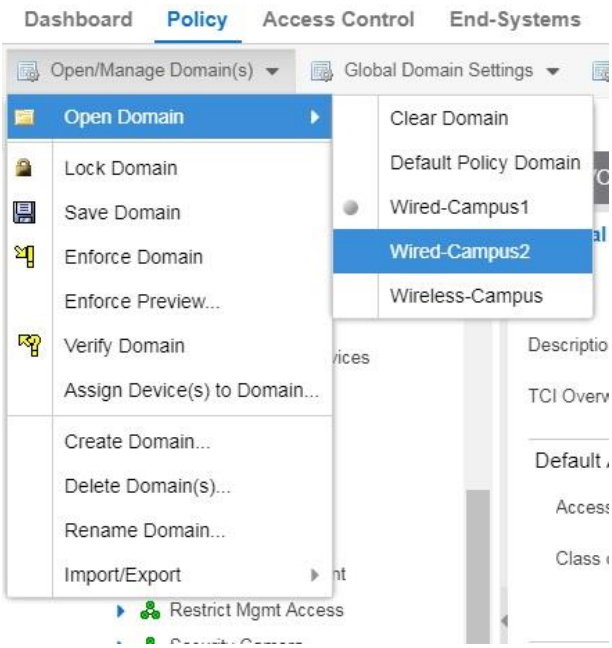


10. Save the policy domain and enforce to the access switches in this domain.

Role Configuration – Wired-Campus2 Domain

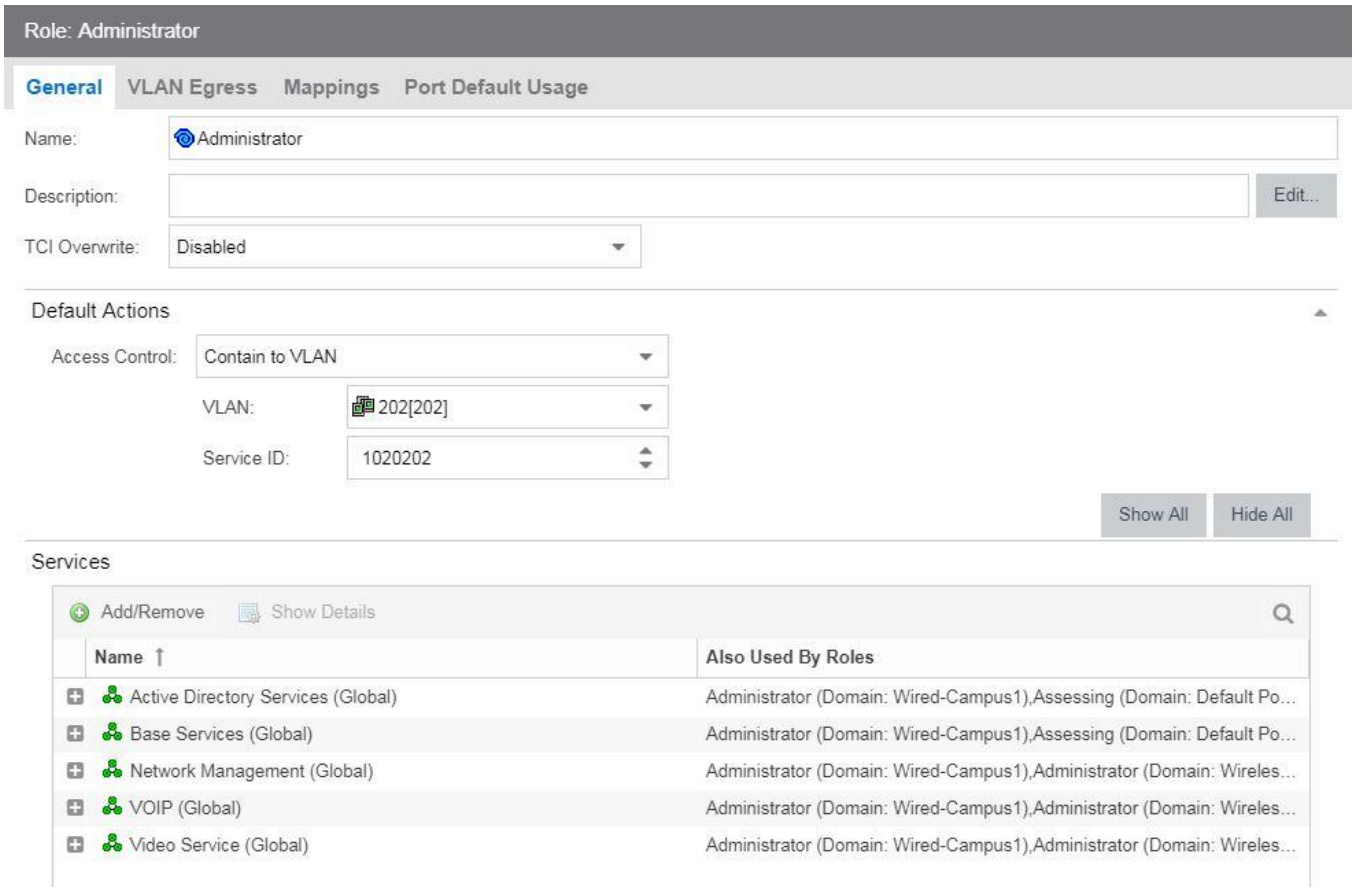
Although the role names between the wired campuses are the same, the actual VLAN and NSI values are different and will be applied based on the policy domain the access switch is a member of.

Create the same roles as was in Wired-Campus1, editing the roles that require different network parameters. To configure the roles, open the **Wired-Campus2** policy domain:

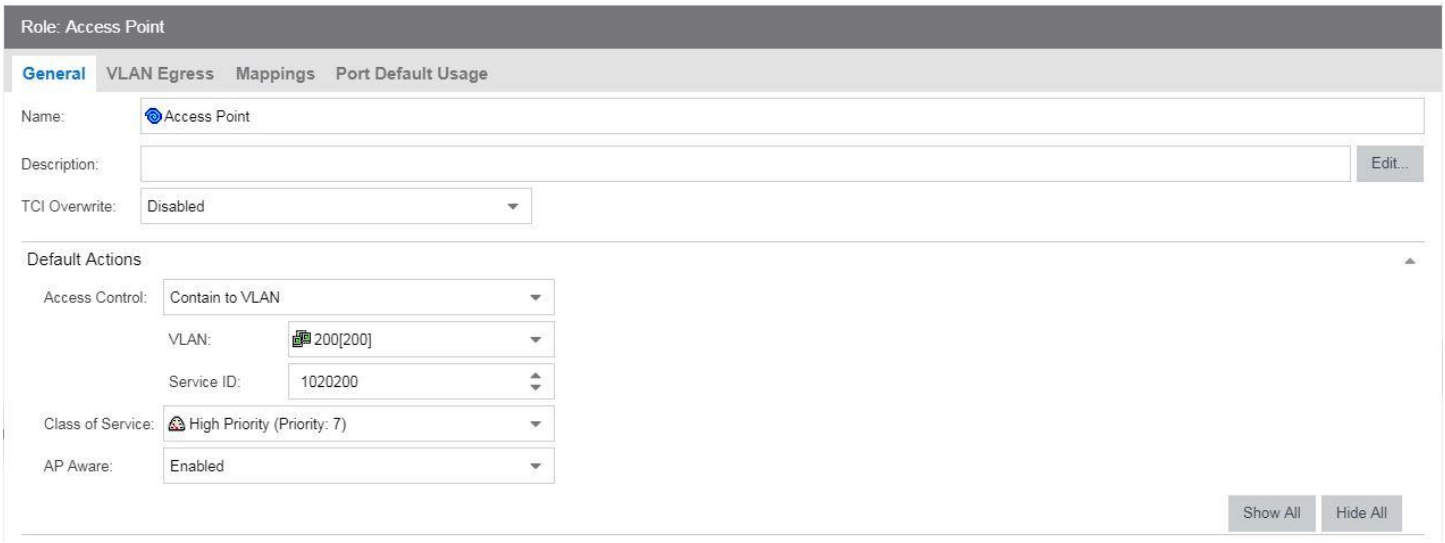


1. Administrator Role

The Administrator role in Campus 2 uses VLAN 202/ NSI: 1020202.

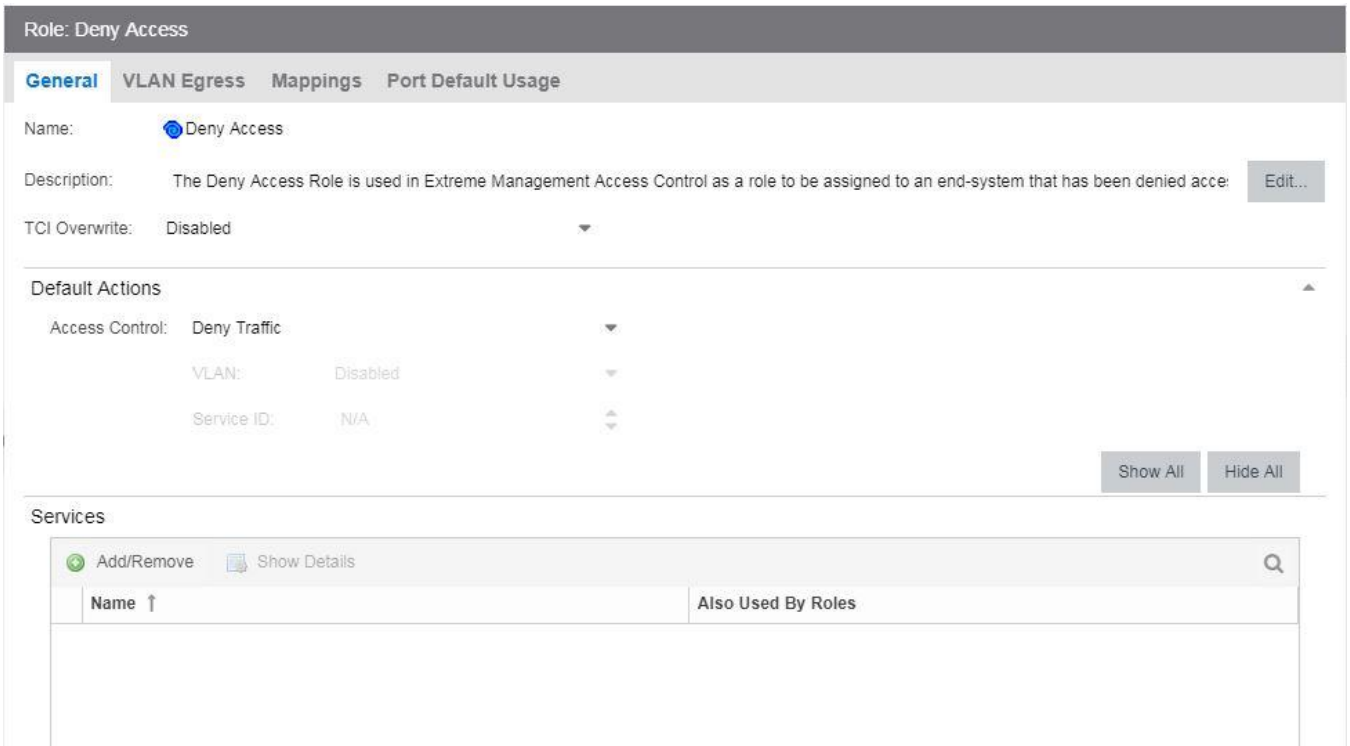


2. **Access Point Role** (VLAN: 200 / NSI: 1020200)

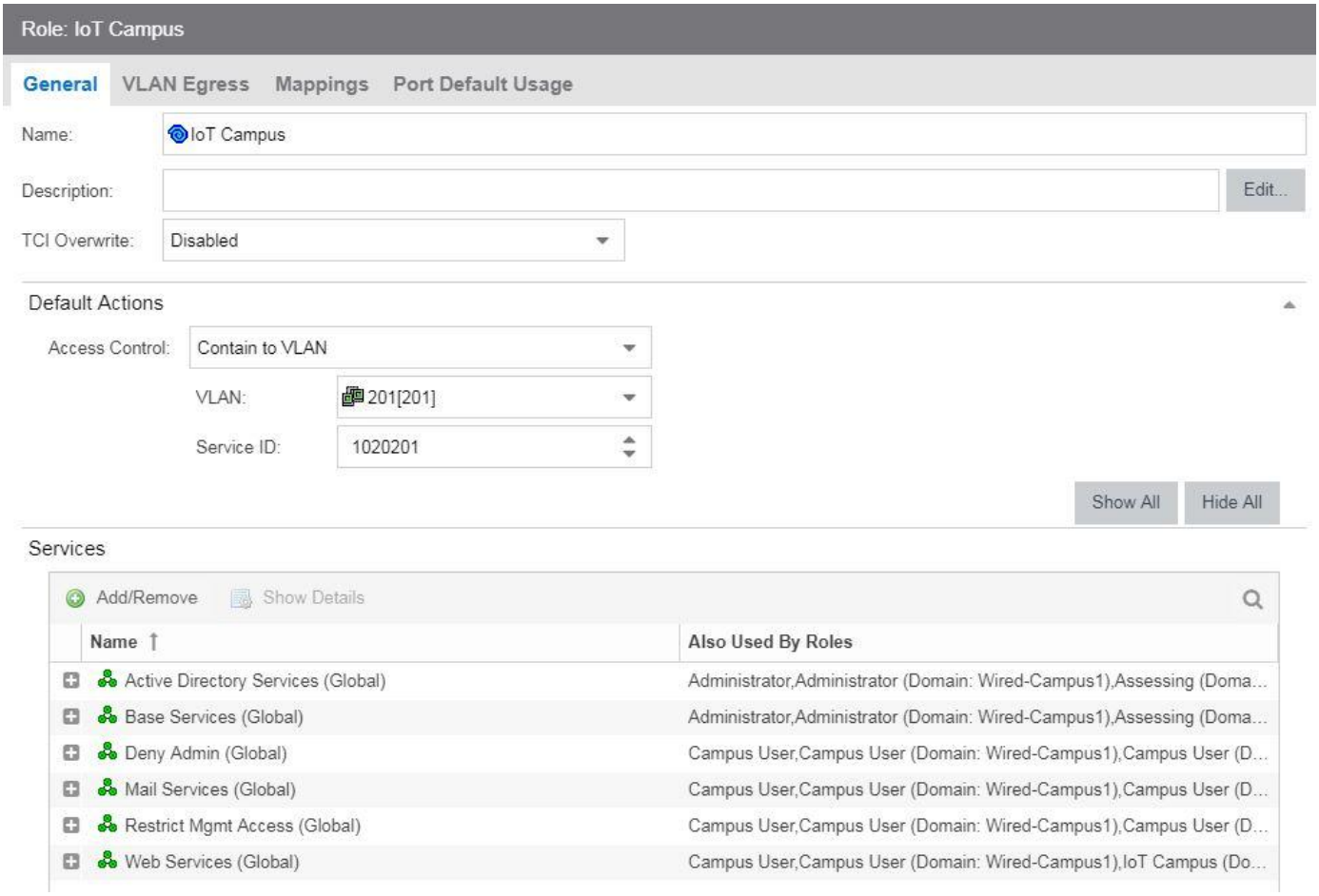


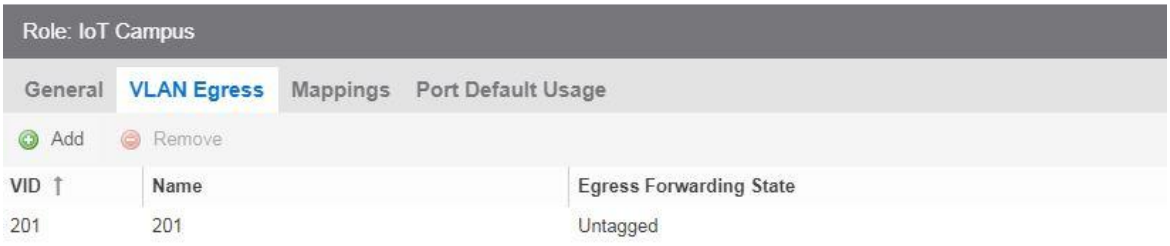
3. Deny Access Role

The Deny Access Role is identical between the policy domains.



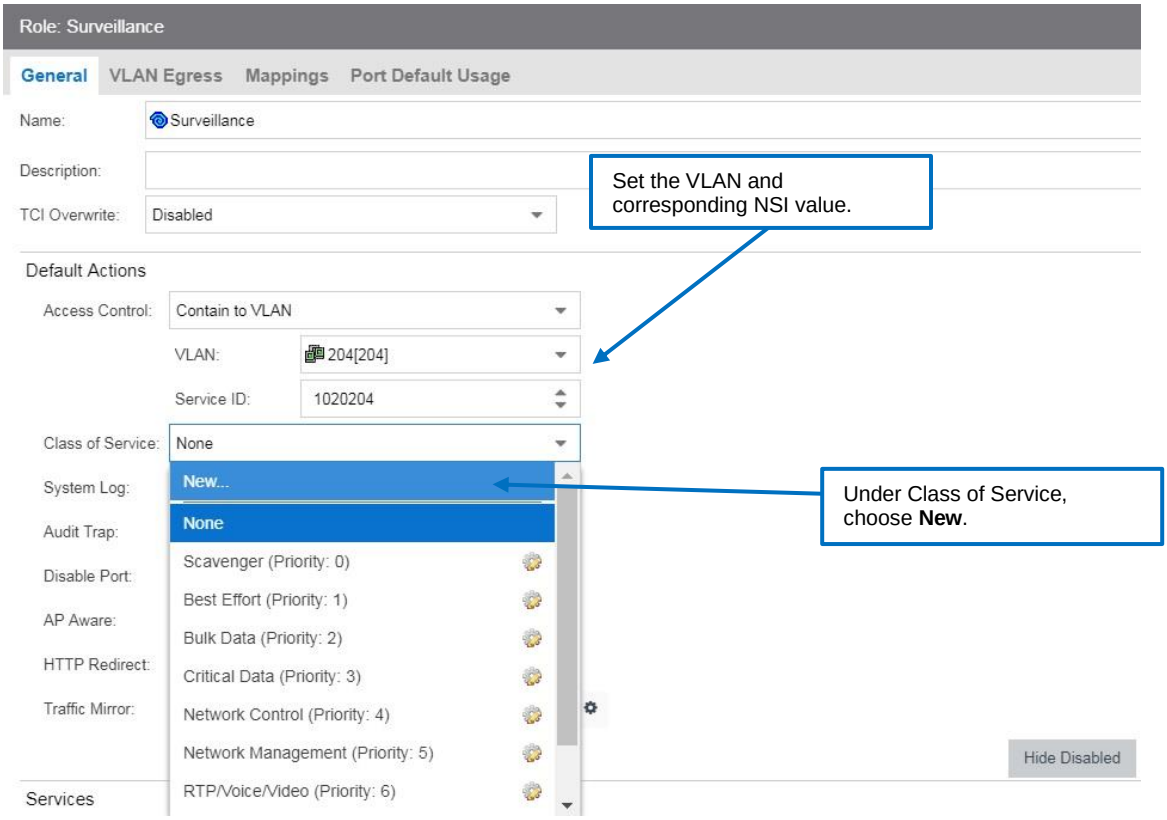
4. **IoT Campus Role** (VLAN: 201 / NSI: 1020201)



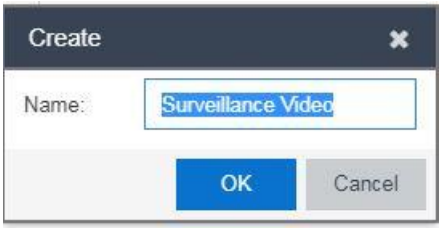


5. Surveillance Role (VLAN: 204 / NSI: 1020204)

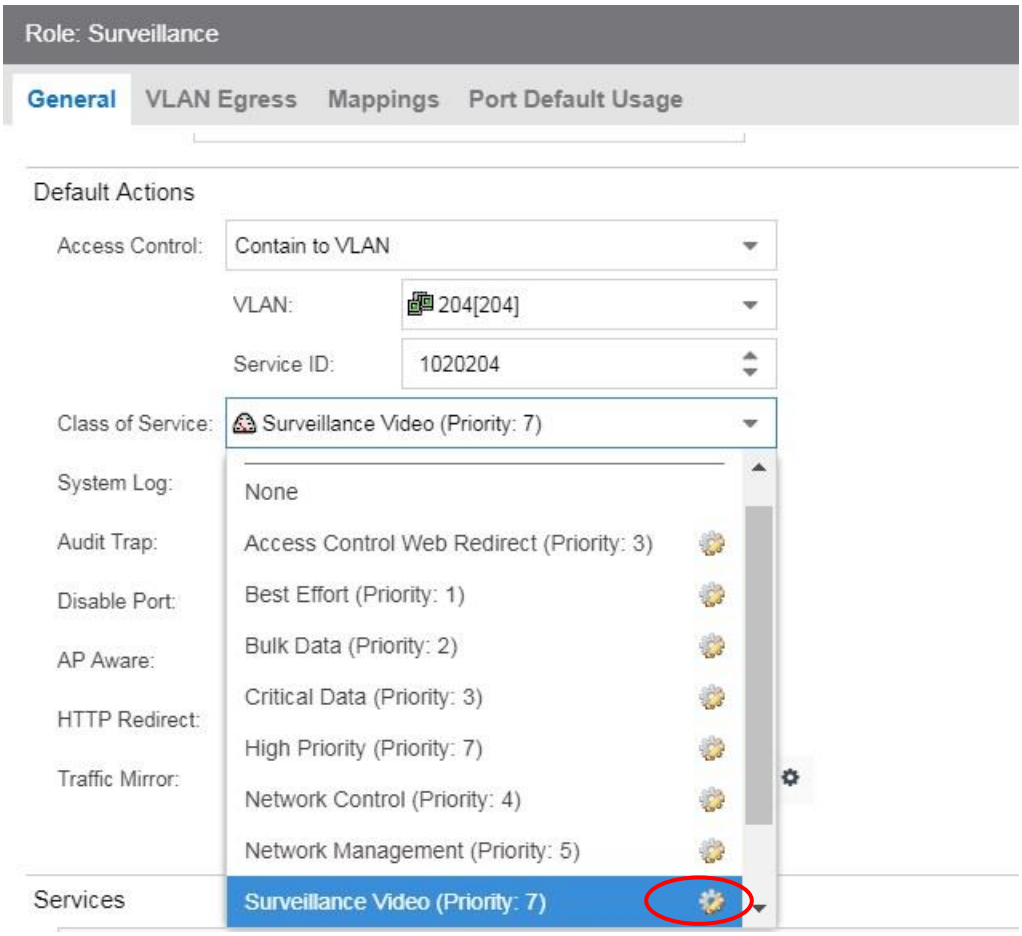
- The Surveillance role in Campus 2 will be configured in the same manner as Campus 1, with the creation of a Class of Service for this role.



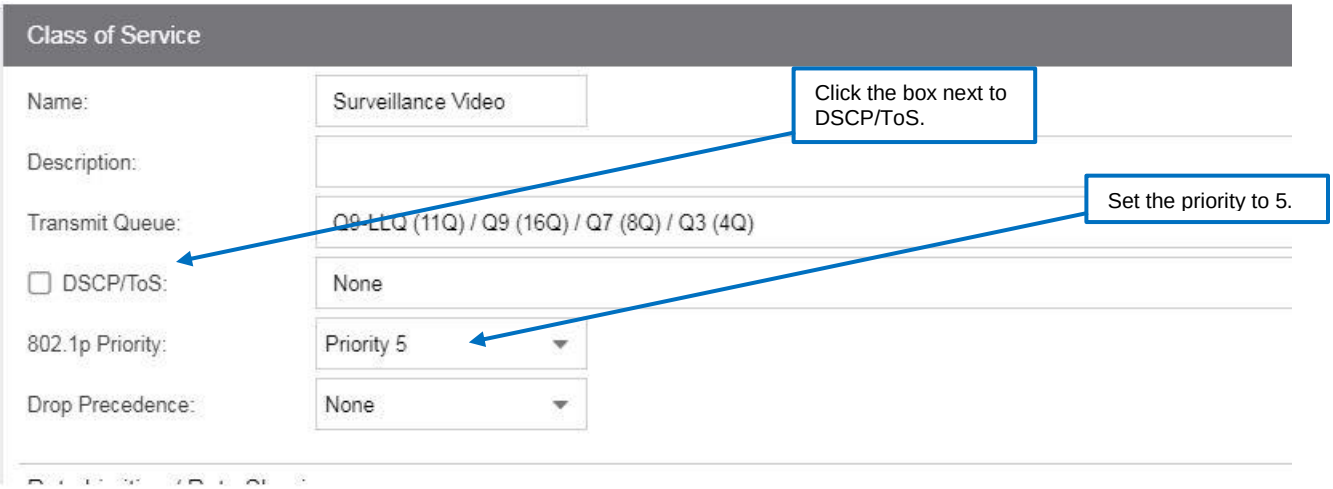
- Give the CoS service a name, and click OK, which will assign it to this Role:



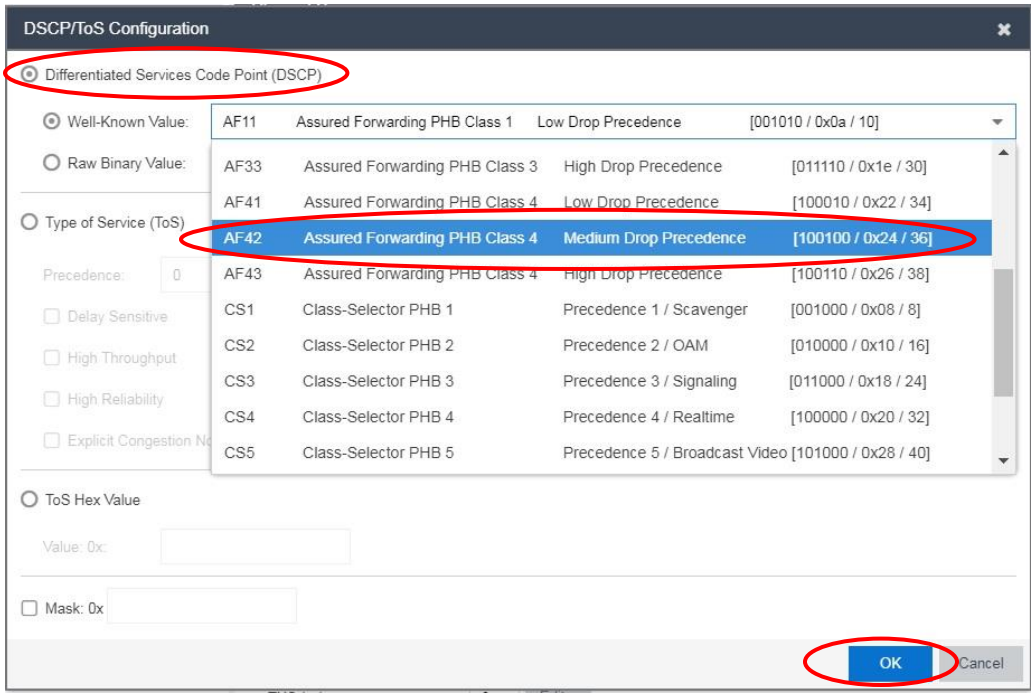
- In the CoS drop-down menu, choose the gear icon next to the CoS profile created:



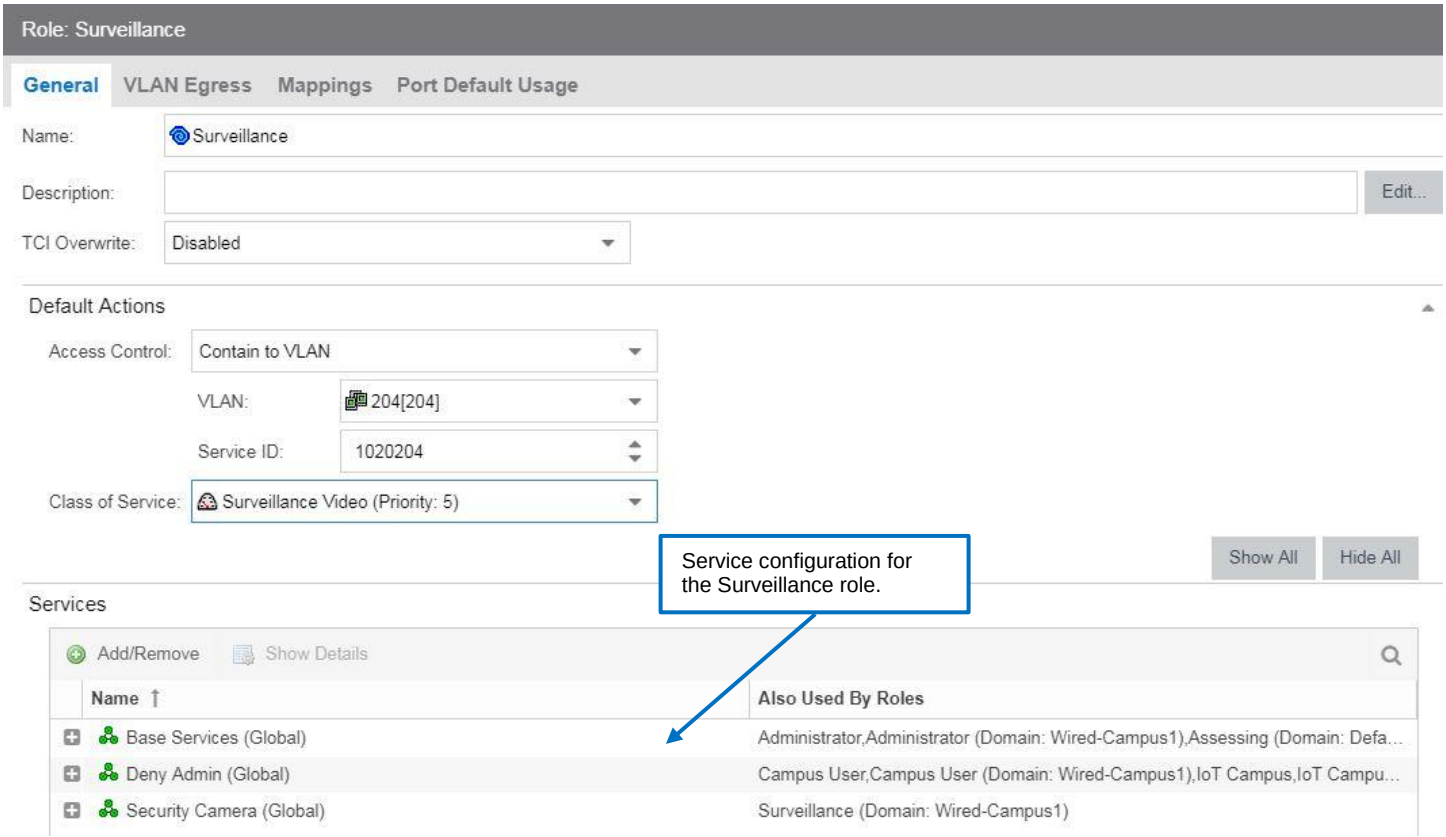
- Select the dot1p priority and DSCP values for this profile:



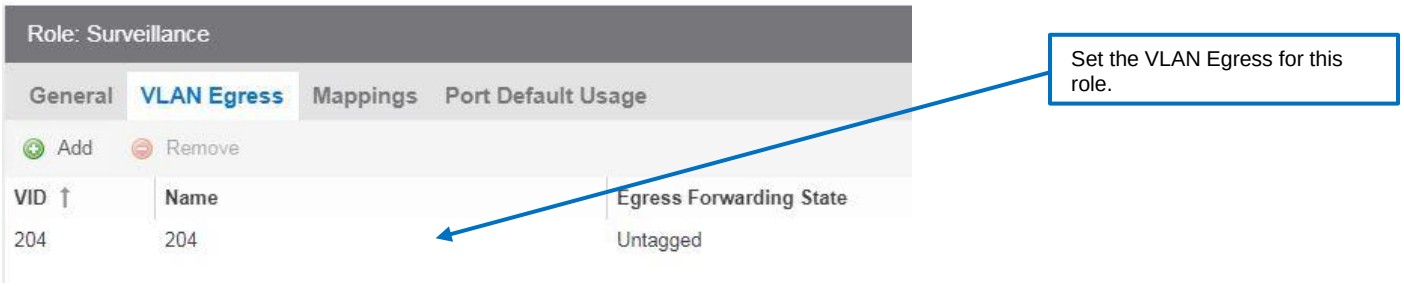
- Set the desired DSCP value (in this EVD, the DSCP will be AF42, DSCP 36):



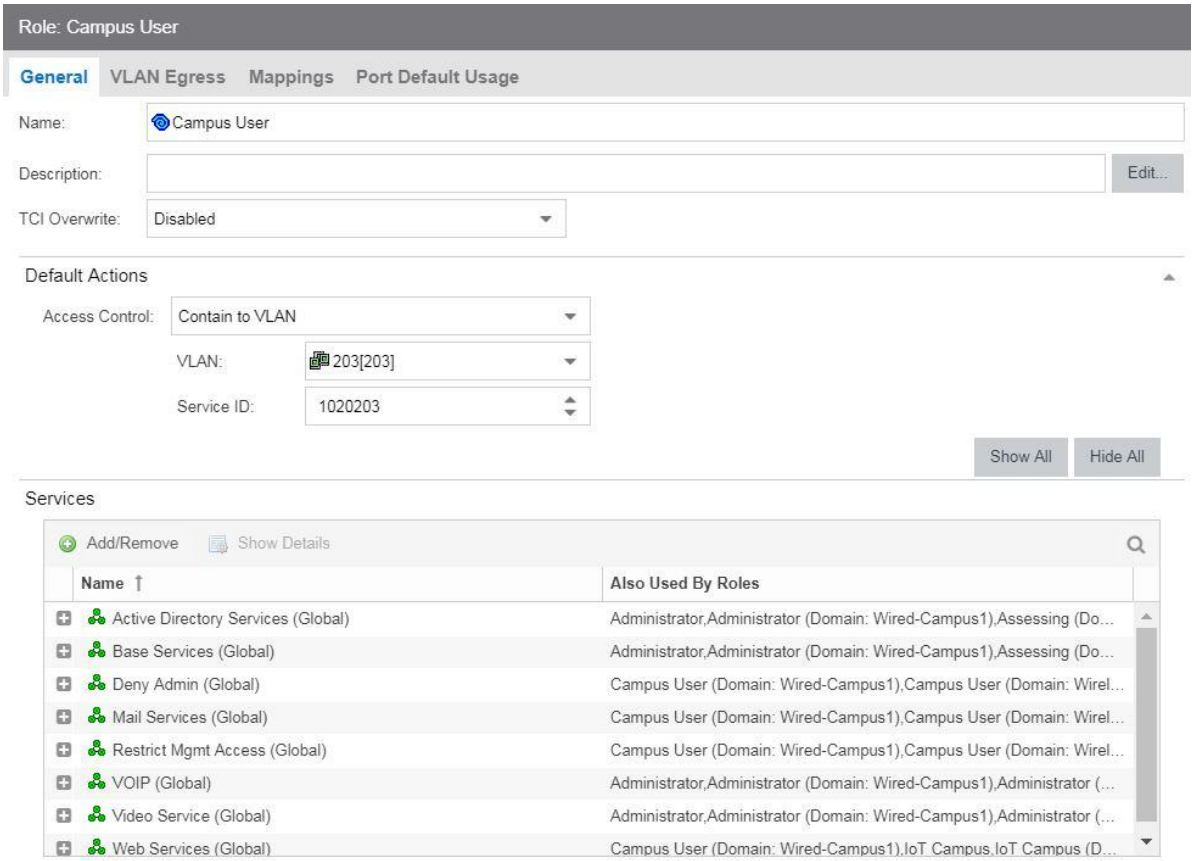
- Navigate back to the Surveillance role, and add any services desired:

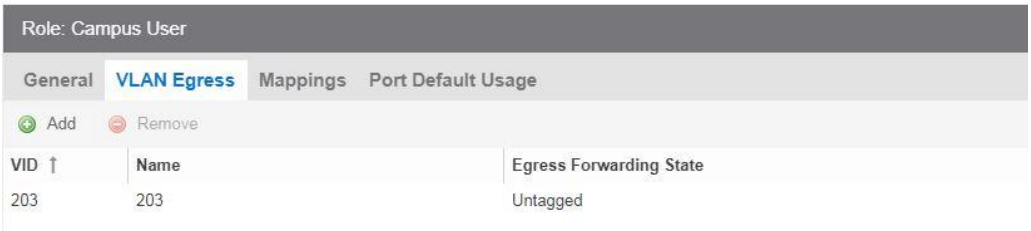


- Set the VLAN Egress for this role.

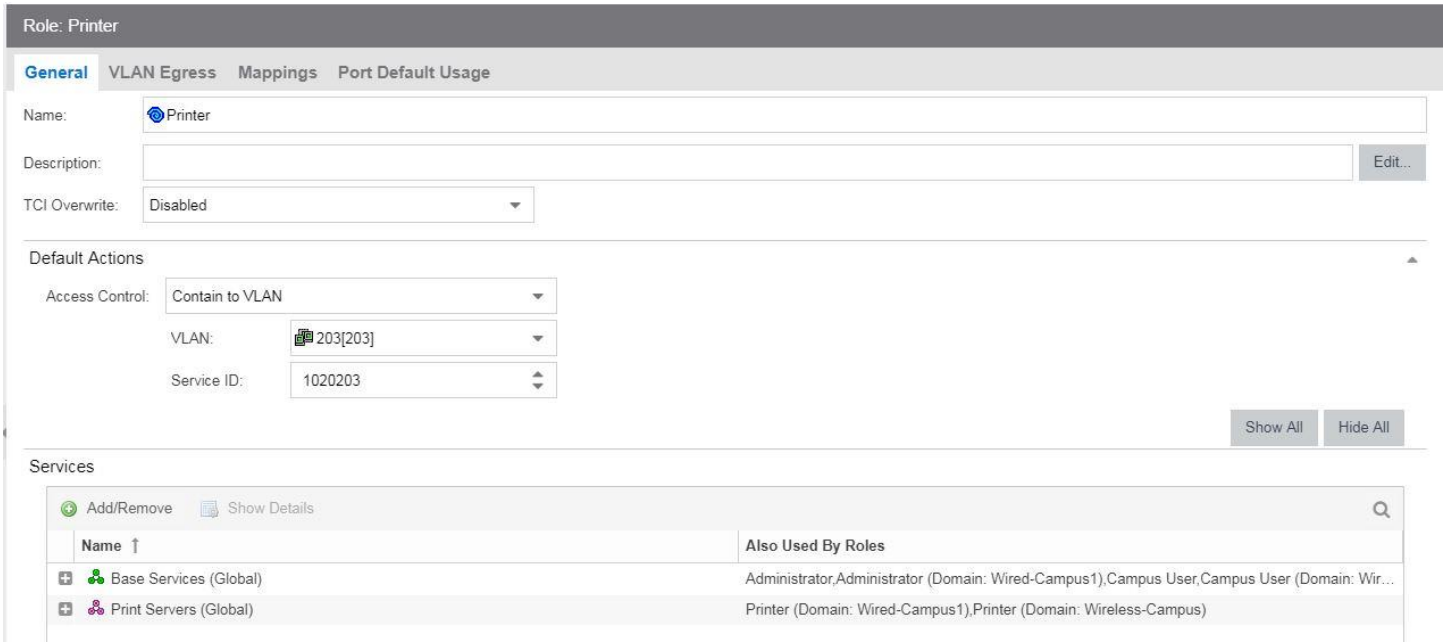


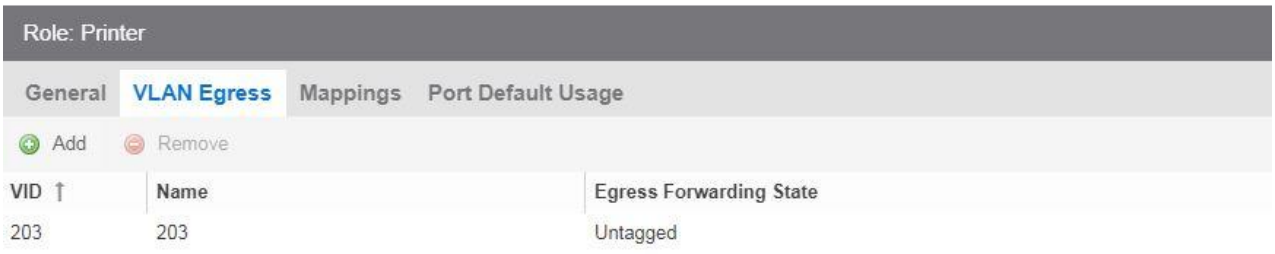
6. Campus User Role (VLAN: 203 / NSI: 1020203)





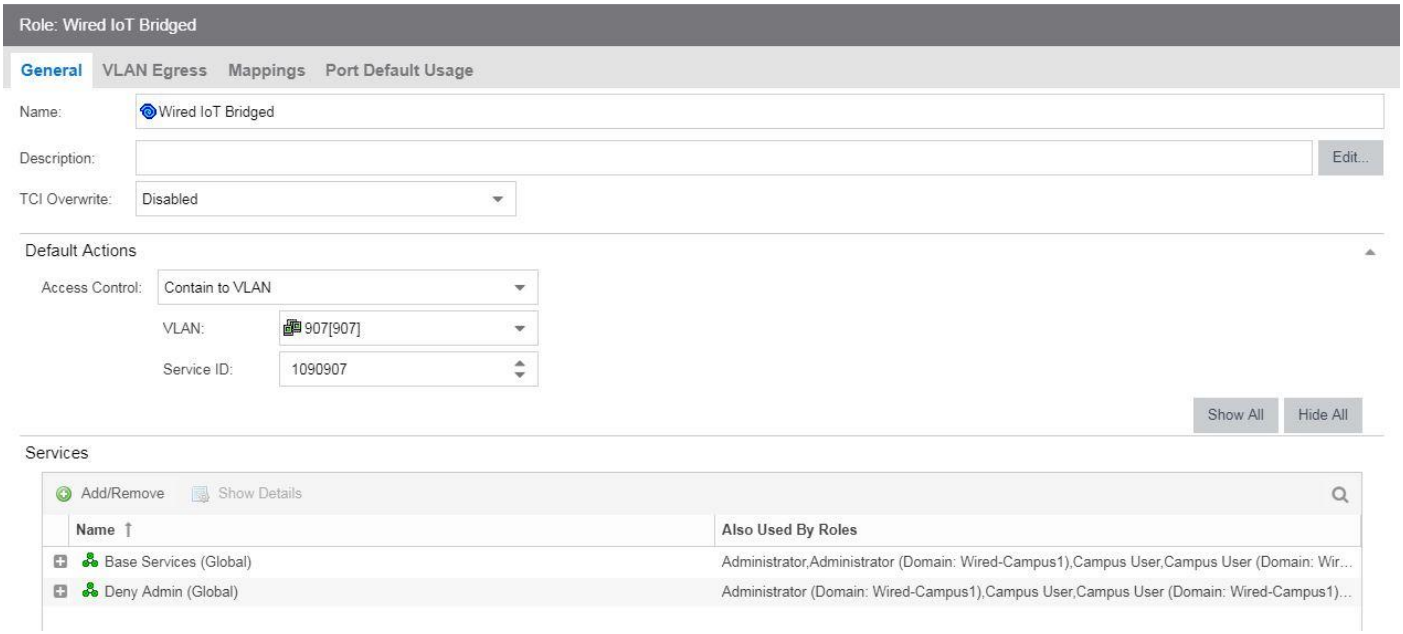
7. Printer Role (VLAN: 203 / NSI: 1020203)

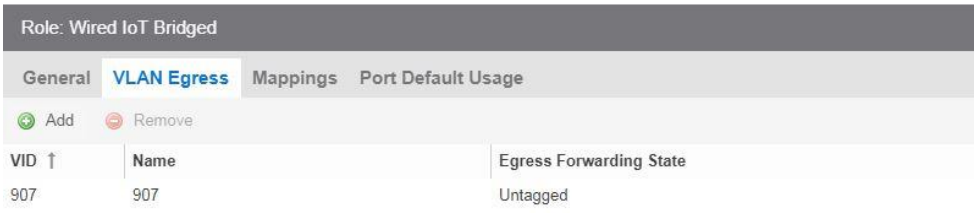




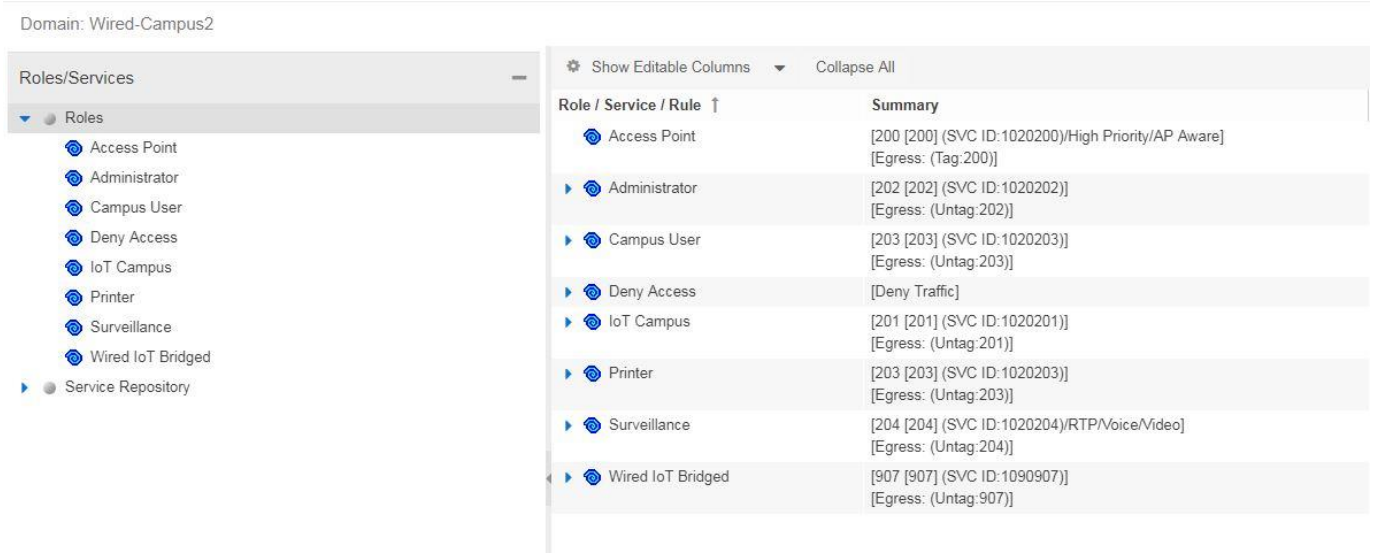
8. **Wired IoT Bridged Role (VLAN: 907 / NSI: 1090907)**

This role is applied to devices that may not support newer authentication methods, network addressing, etc, and require a Layer 2 connection across the fabric to its corresponding server. When a client authenticates to this role, the access switch (FA client) will request this VLAN/NSI value and is created dynamically on the FA Server as an L2VSN.





9. The final list of Policy roles for Wired-Campus2:



10. Save the Policy Domain and enforce to the access switches in this domain.

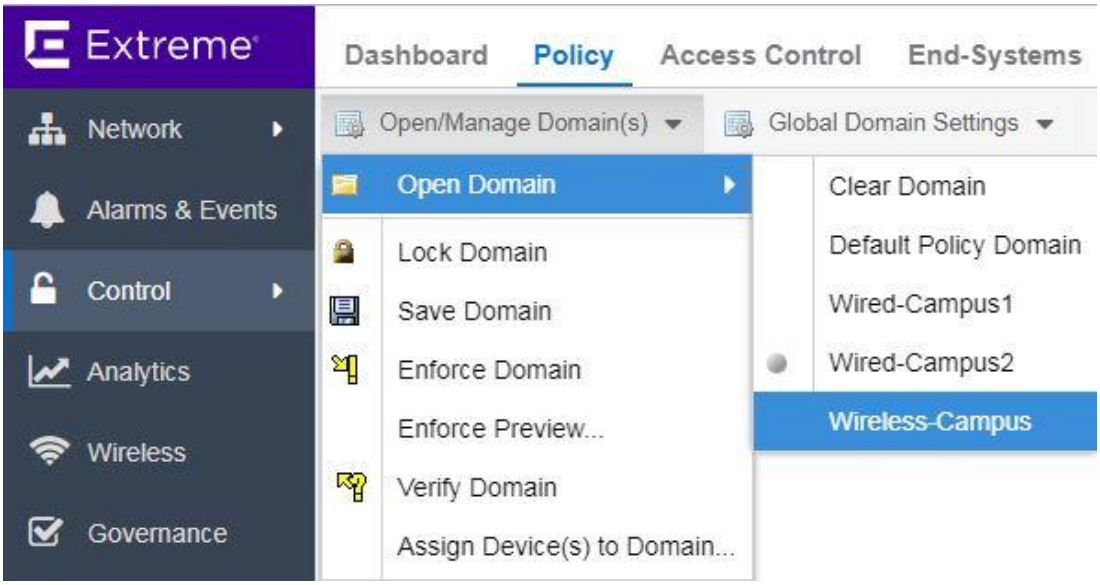
Role Configuration – Wireless Domains

As the two wireless controllers in this EVD are redundant, there will be one wireless domain covering both campuses. Therefore, roles for both campuses will be created in this domain. The roles and services created on the wireless domain are enforced on the wireless controllers, and subsequently pushed to the Access Points.

Many of the roles defined in the Wireless-Campus policy domain are identical in purpose and configuration to their wired version, however wireless networks are kept on a different vlan from the wired. This is done to better allocate the number of supported rules per platform, as well as protecting the wireless network from unnecessary broadcast/multicast traffic.

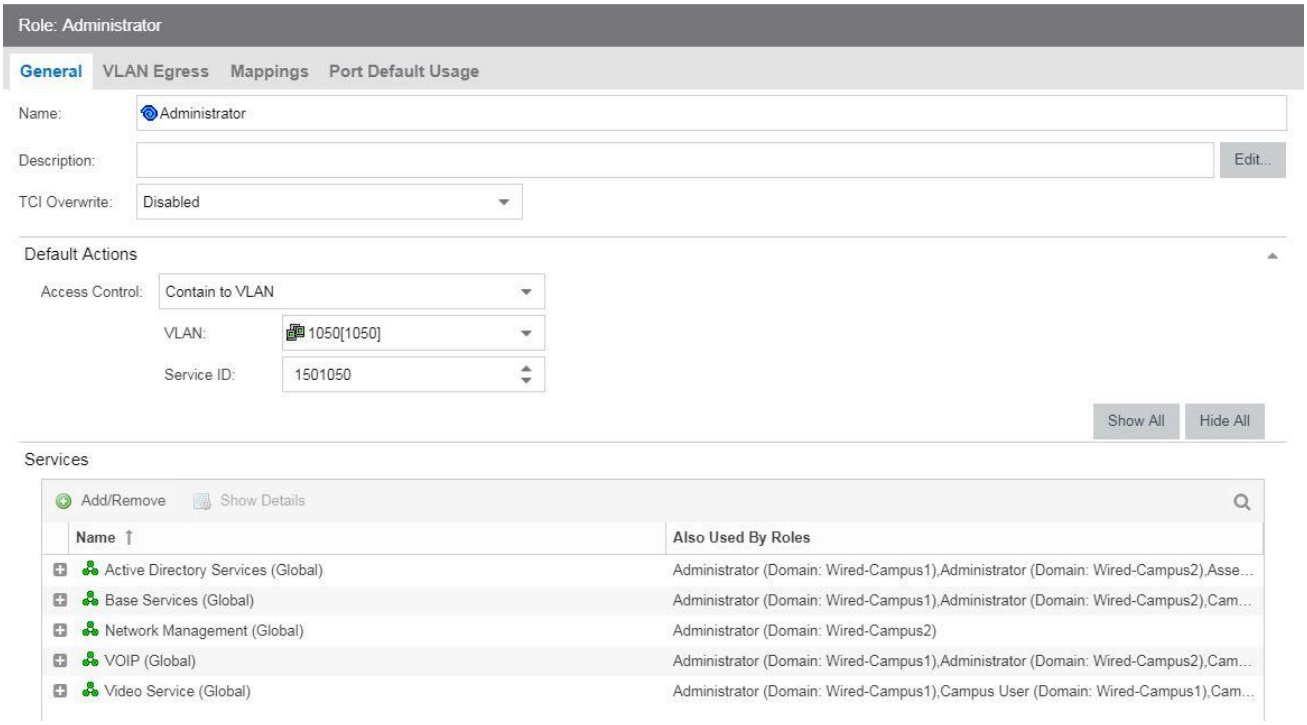
To allow for wireless roaming between the campuses, the wireless networks have been configured as part of the Fabric Connect DVR domain spanning both campuses, so the same wireless VLAN and subnet is used in both locations.

The roles configured for wireless networks are configured in the same way as for wired networks. To configure the roles, open the Wireless-Campus policy domain:



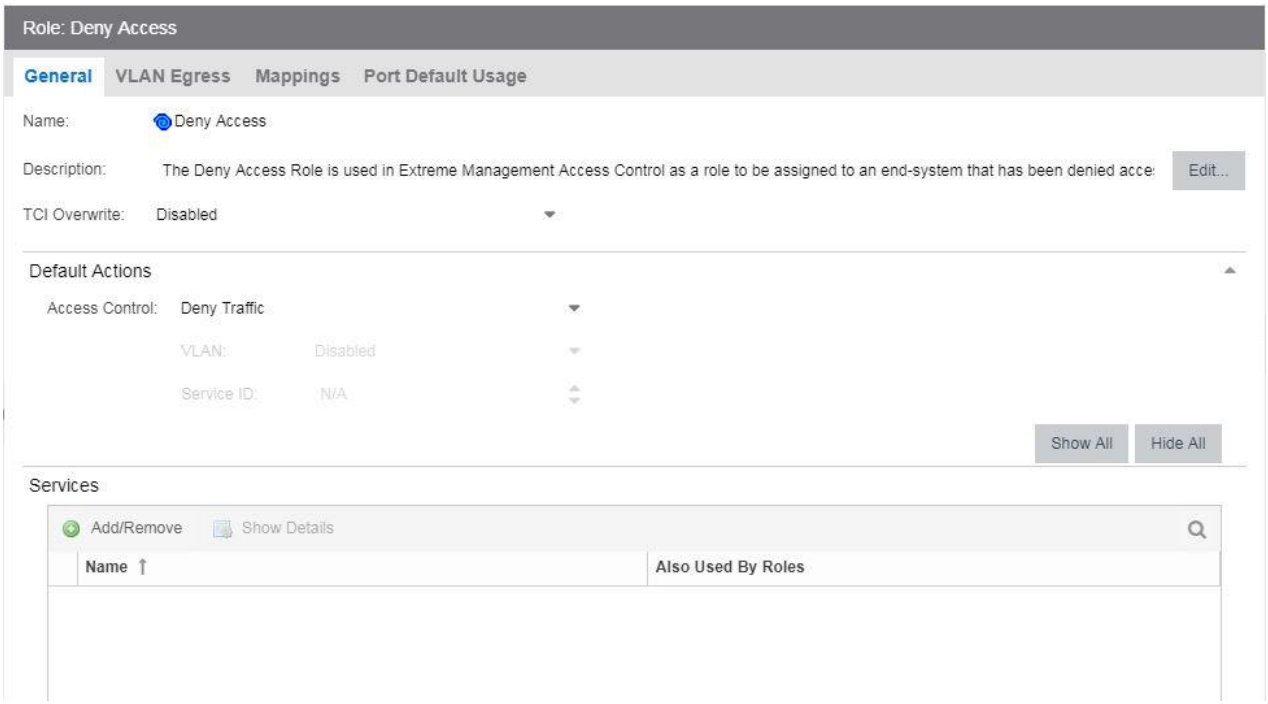
1. Administrator Role (VLAN: 1050 / NSI: 1501050)

- The wireless Administrator role serves the same function as the wired Admin role.



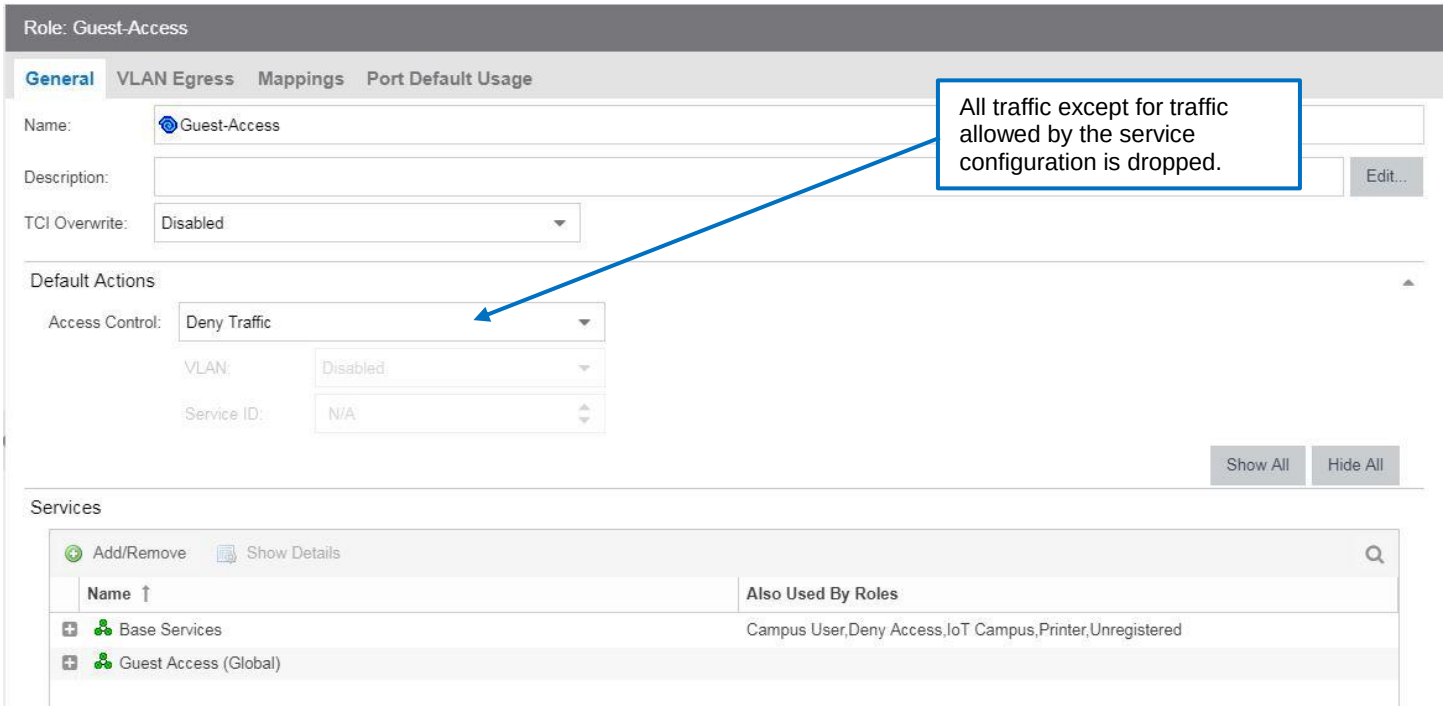
2. Deny Access Role (Deny Access)

- The Deny Access role is used in Wireless-Campus as a role to be assigned to an end-system that has been denied access through failed authentication. The definition of the Deny Access role may vary depending on the customer environment.



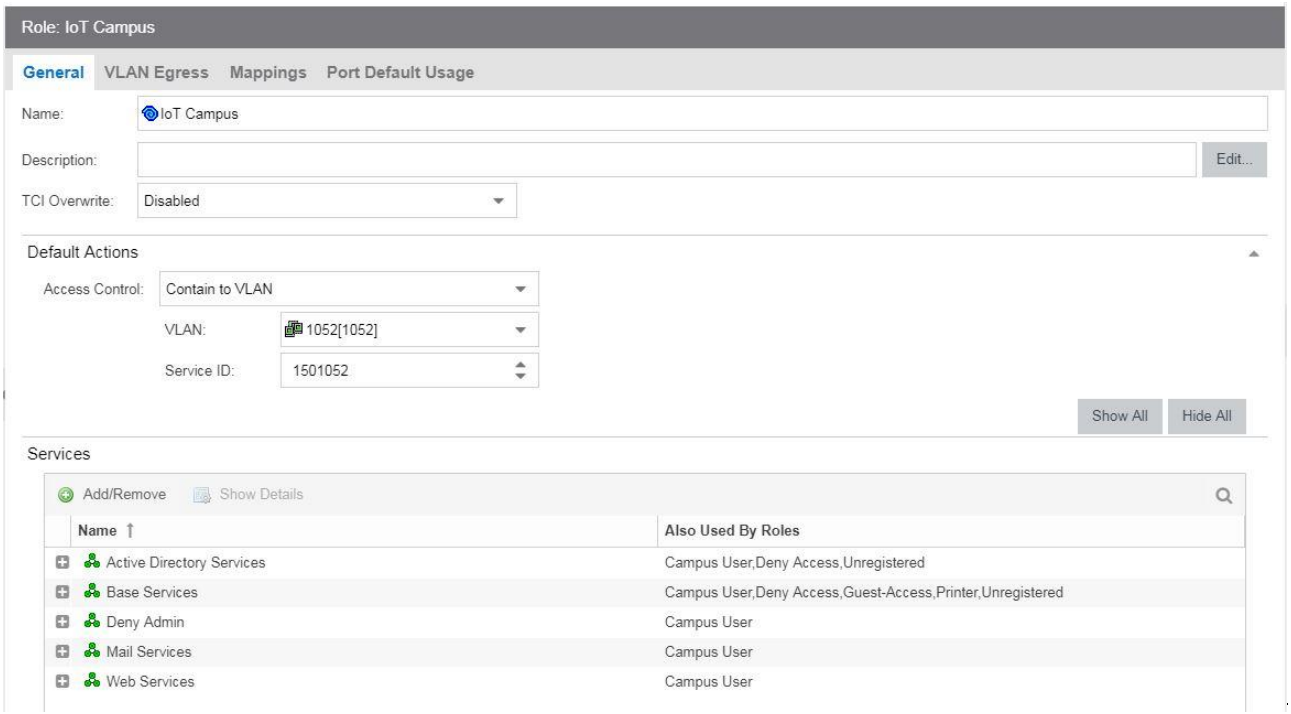
3. Guest Access Role (Guest-Access)

- The Guest Access role is intended for guests or other unknown users connecting to the enterprise network infrastructure. The Guest Access role will be used to enforce the high security of IT assets and the limited availability of IT resources as determined by the business policy. No VLAN/NSI value is required for Guest, as this traffic will be tunneled directly back to the EWC, based on the topology mode.



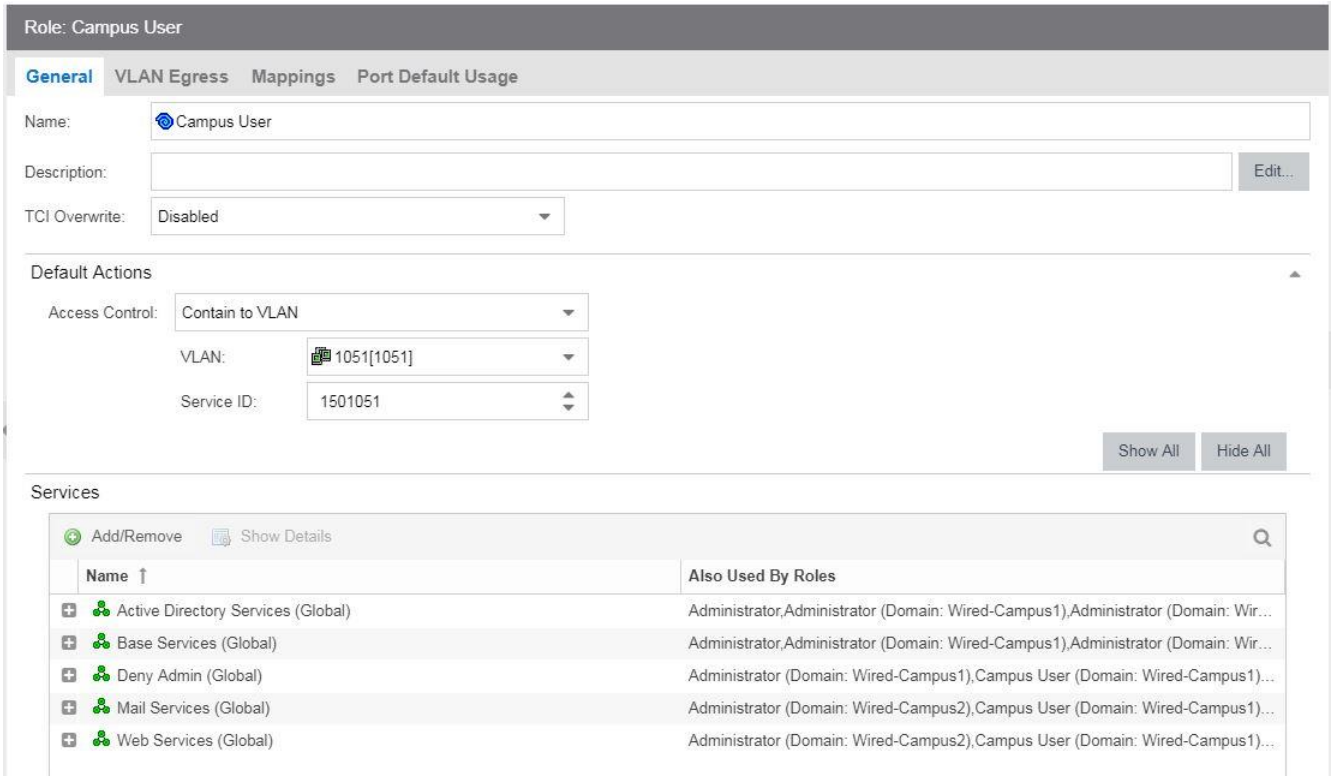
4. IoT Campus (VLAN: 1052 / NSI: 1501052)

- The IoT Device role represents a dedicated wireless VLAN for IoT computing devices requiring communication with other IoT devices and systems within the campus or with other campuses. The VLANs associated with the traffic can be assigned dynamically using the VLAN Egress functionality of the role.



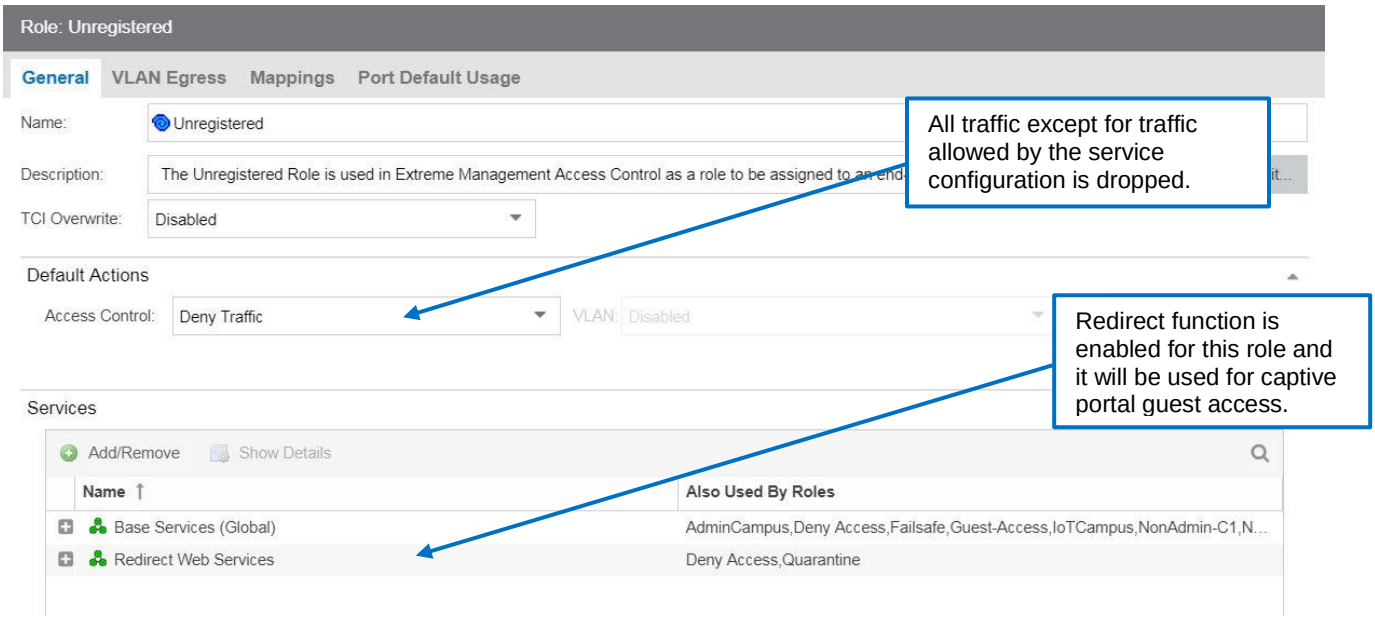
5. Campus User (VLAN id: 1051 / NSI: 1501051):

- The wireless Campus User role serves the same function as the wired Campus role.

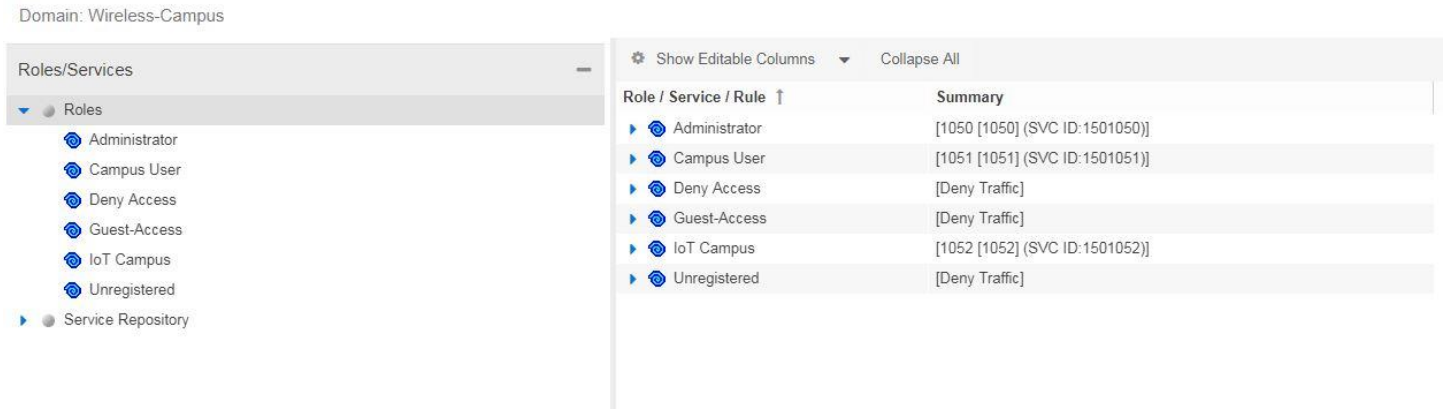


6. Unregistered Role

- The Unregistered Role is used in the Wireless-Campus policy domain for end-systems that have joined the Guest wireless network and have yet to pass through authentication or guest registration. The definition of the Unregistered role may vary depending on the customer environment.



7. The final list for policy roles from the Wireless-Campus domain:



Services Configurations

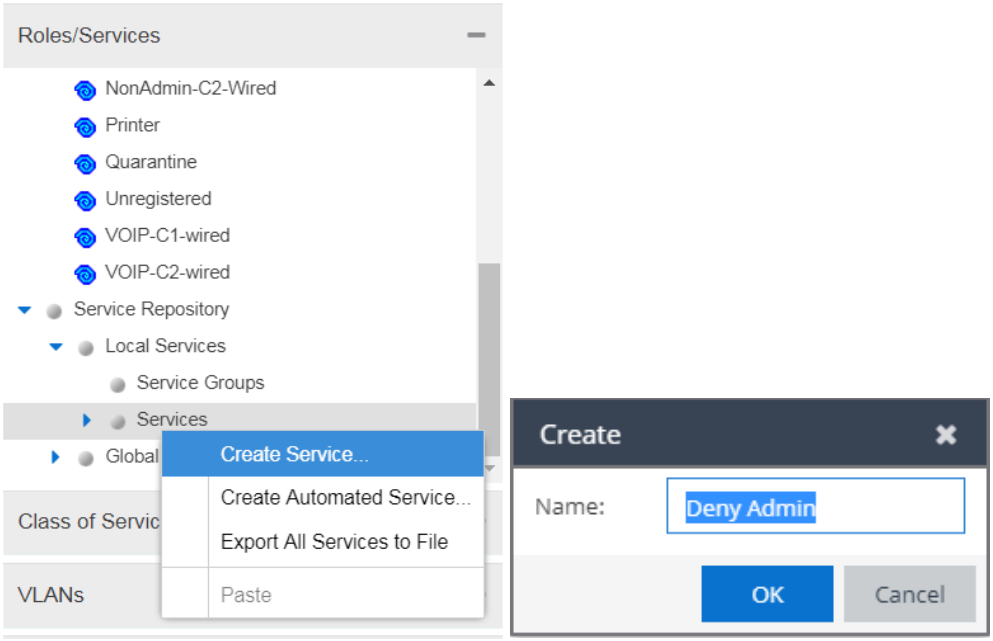
Extreme Management Center provides a set of default services that cover a wide range of protocols and applications. Custom services can be added to match specific requirements, and rules can be added to the existing services. Creating a global role means it is visible and it can be used by all policy domains.

The following non-default services were added for Campus 1. Detailed configuration steps are added for the Deny Admin service. All services are configured in the same manner.

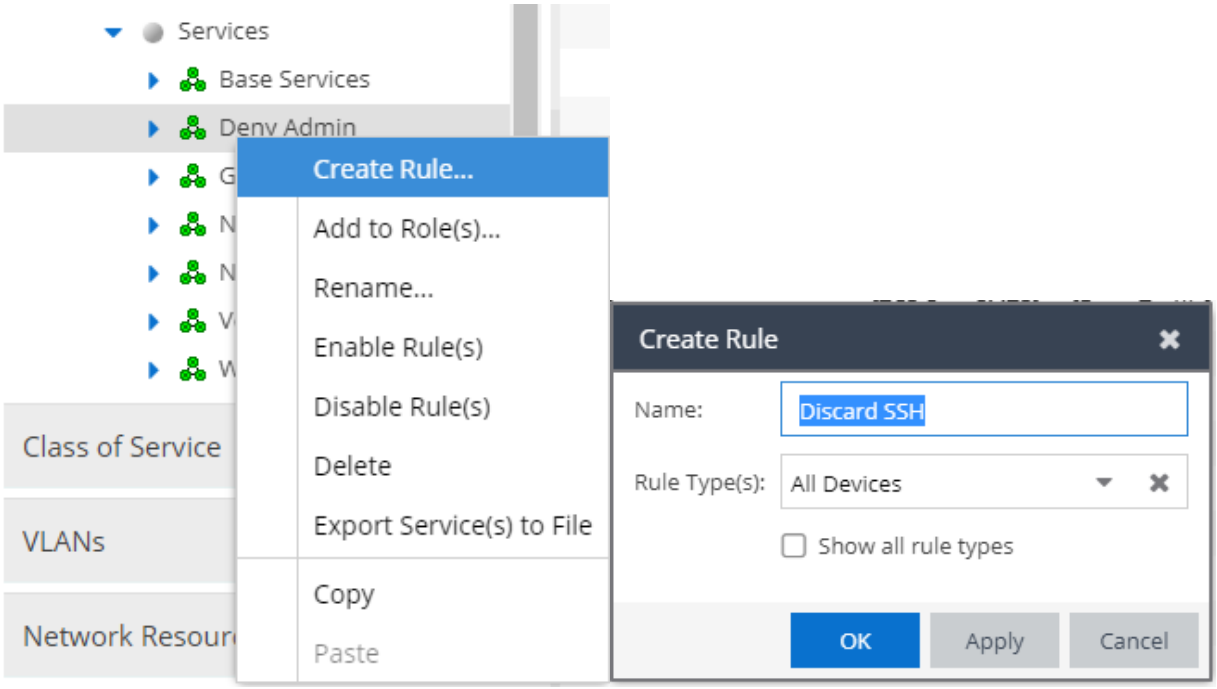
1. Deny Admin Service

The purpose of this service is to deny all management traffic and applications and it is applied to all roles that are not Administrator.

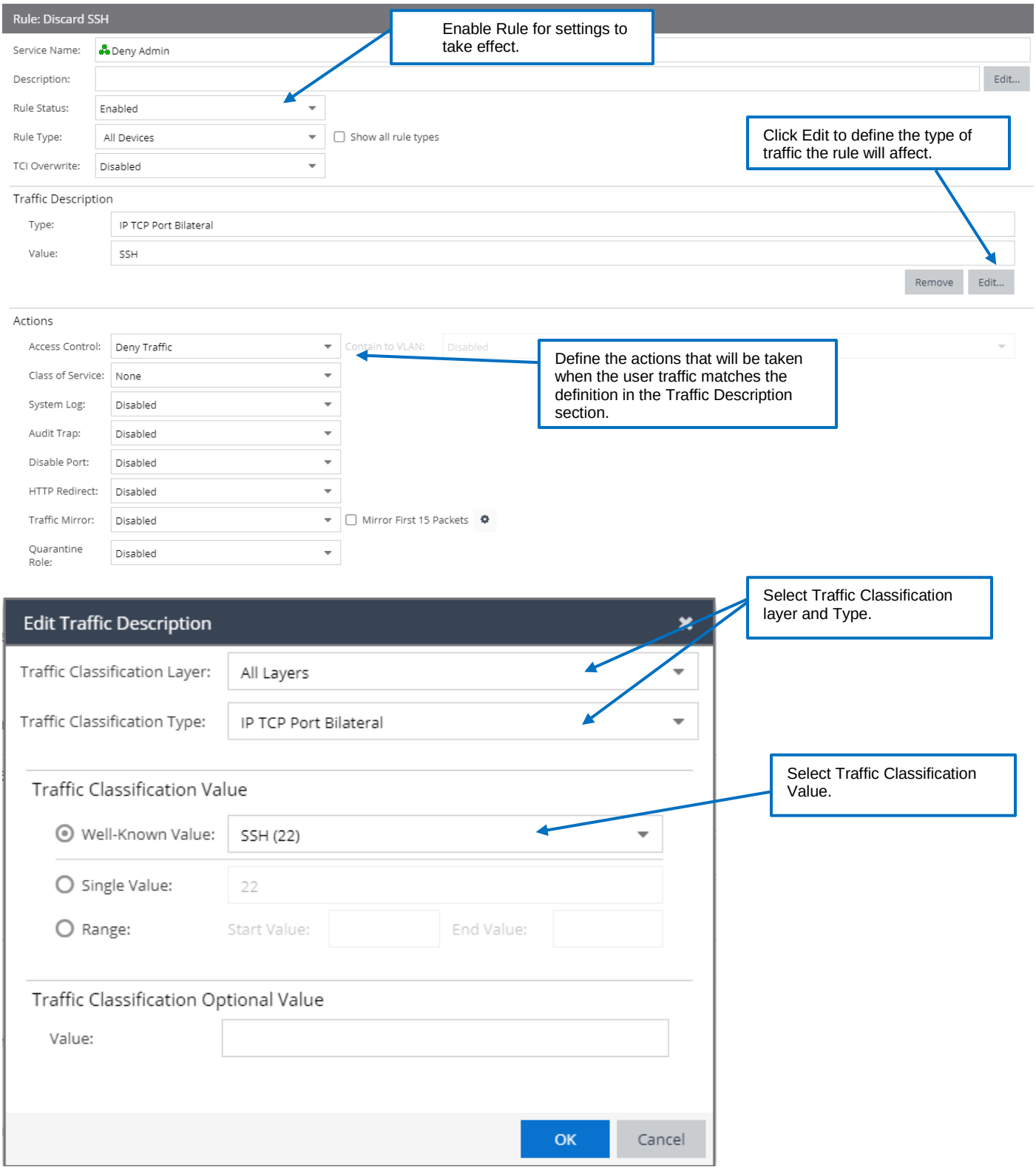
- New services can be added from **Policy tab →Roles/Services → Service Repository →Local Services**, right click on **Services** and select **Create Service**:



- Each service is formed of one or more rules. To add a rule to a service, right click on the service name and select **Create Rule**.



- Once created, the rule will appear under the service. To configure the rule, click on its name to open the configuration panel.



- The Deny Admin service has the following rules defined. In addition to specific applications being blocked, entire subnets can also be denied access:

Rule	Summary
Deny Storage Test network	[IPDST : 172.90.4.0/24] -> [Deny Traffic]
Deny Storage network	[IPDST : 172.90.3.0/24] -> [Deny Traffic]
Deny Test network	[IPDST : 172.90.2.0/24] -> [Deny Traffic]
Discard SSH	[TCP Bil : SSH] -> [Deny Traffic]
Discard Src 443	[TCP Src : HTTPS]
Discard TCP Src 20 - FTP Data	[TCP Src : FTP Data] -> [Deny Traffic]
Discard TCP Src 21 - FTP	[TCP Src : FTP Data] -> [Deny Traffic]
Discard TCP Src 25 - SMTP	[TCP Src : SMTP] -> [Deny Traffic]
Discard TCP Src 53 - DNS	[TCP Src : DNS] -> [Deny Traffic]
Discard TCP Src 80 - HTTP	[TCP Src : HTTP] -> [Deny Traffic]
Discard TCP Src SQL Server	[TCP Src : 1433] -> [Deny Traffic]
Discard Telnet	[TCP Src : Telnet] -> [Deny Traffic]
Discard UDP 161 - SNMP	[TCP Bil : SNMP] -> [Deny Traffic]
Discard UDP 162 - SNMP Traps	[TCP Bil : 162] -> [Deny Traffic]
Discard UDP 53 - DNS Imposters	[UDP Src : DNS] -> [Deny Traffic]
Discard UDP 69 - TFTP	[TCP Bil : TFTP] -> [Deny Traffic]
Discard UDP Src 1812 - Radius	[UDP Src : RADIUS] -> [Deny Traffic]
Discard UDP Src 1813 Radius Acct	[UDP Src : RADIUS Accounting] -> [Deny Traffic]
Discard UDP Src 67 - Bootps	[UDP Src : BootP Server] -> [Deny Traffic]
Discard UDP Src SQL Server	[UDP Src : 1433] -> [Deny Traffic]

2. Guest Access Service

- This service was created to allow DHCP, DNS, HTTP and ICMP traffic and it is assigned to Guest Access role.

Rule	Summary
Allow HTTPS	[TCP Dst : HTTPS] -> [Permit Traffic]
Permit HTTP	[TCP Dst : HTTP] -> [Permit Traffic]
Permit ICMP	[IPProto : ICMP] -> [Permit Traffic]
Permit- Ethertype ARP	[Ether : ARP] -> [Permit Traffic]
Permit- IP UDP Port Destination B...	[UDP Dst : BootP Server] -> [Permit Traffic]
Permit- IP UDP Port Destination D...	[UDP Dst : DNS] -> [Permit Traffic]

3. Network Management Service

- This service is applied only to the Administrator role and allows management traffic having as its destination the network devices in the Automated Campus Validated Design, and a CoS Priority 5.

Rule	Summary
Campus1-Acc1 switch	[IPBIL : 172.9.90.11/32] -> [Permit Traffic/Network Management]
Campus1-Acc2 switch	[IPBIL : 172.9.90.12/32] -> [Permit Traffic/Network Management]
Campus1-BEB-40	[IPBIL : 10.0.0.40/32] -> [Permit Traffic/Network Management]
Campus1-BEB-50	[IPBIL : 10.0.0.50/32] -> [Permit Traffic/Network Management]
Campus2-Acc1 switch	[IPBIL : 172.9.90.13/32] -> [Permit Traffic/Network Management]
Campus2-Acc2 switch	[IPBIL : 172.9.90.14/32] -> [Permit Traffic/Network Management]
Campus2-BEB-110	[IPBIL : 10.0.0.110/32] -> [Permit Traffic/Network Management]
Campus2-BEB-120	[IPBIL : 10.0.0.120/32] -> [Permit Traffic/Network Management]
EWC appliances	[IPBIL : 172.9.98.0/24] -> [Permit Traffic/Network Management]
FabricCore-BCB-30	[IPBIL : 10.0.0.30/32] -> [Permit Traffic/Network Management]
FabricCore-BEB-10	[IPBIL : 10.0.0.10/32] -> [Permit Traffic/Network Management]
FabricCore-BEB-20	[IPBIL : 10.0.0.20/32] -> [Permit Traffic/Network Management]
Internet-GW	[IPBIL : 10.0.0.180/32] -> [Permit Traffic/Network Management]
Server1-BEB-60	[IPBIL : 10.0.0.60/32] -> [Permit Traffic/Network Management]
Server1-BEB-70	[IPBIL : 10.0.0.70/32] -> [Permit Traffic/Network Management]
Server2-BEB-150	[IPBIL : 10.0.0.150/32] -> [Permit Traffic/Network Management]
Server2-BEB-160	[IPBIL : 10.0.0.160/32] -> [Permit Traffic/Network Management]
XMC appliances	[IPBIL : 172.9.99.0/24] -> [Permit Traffic/Network Management]

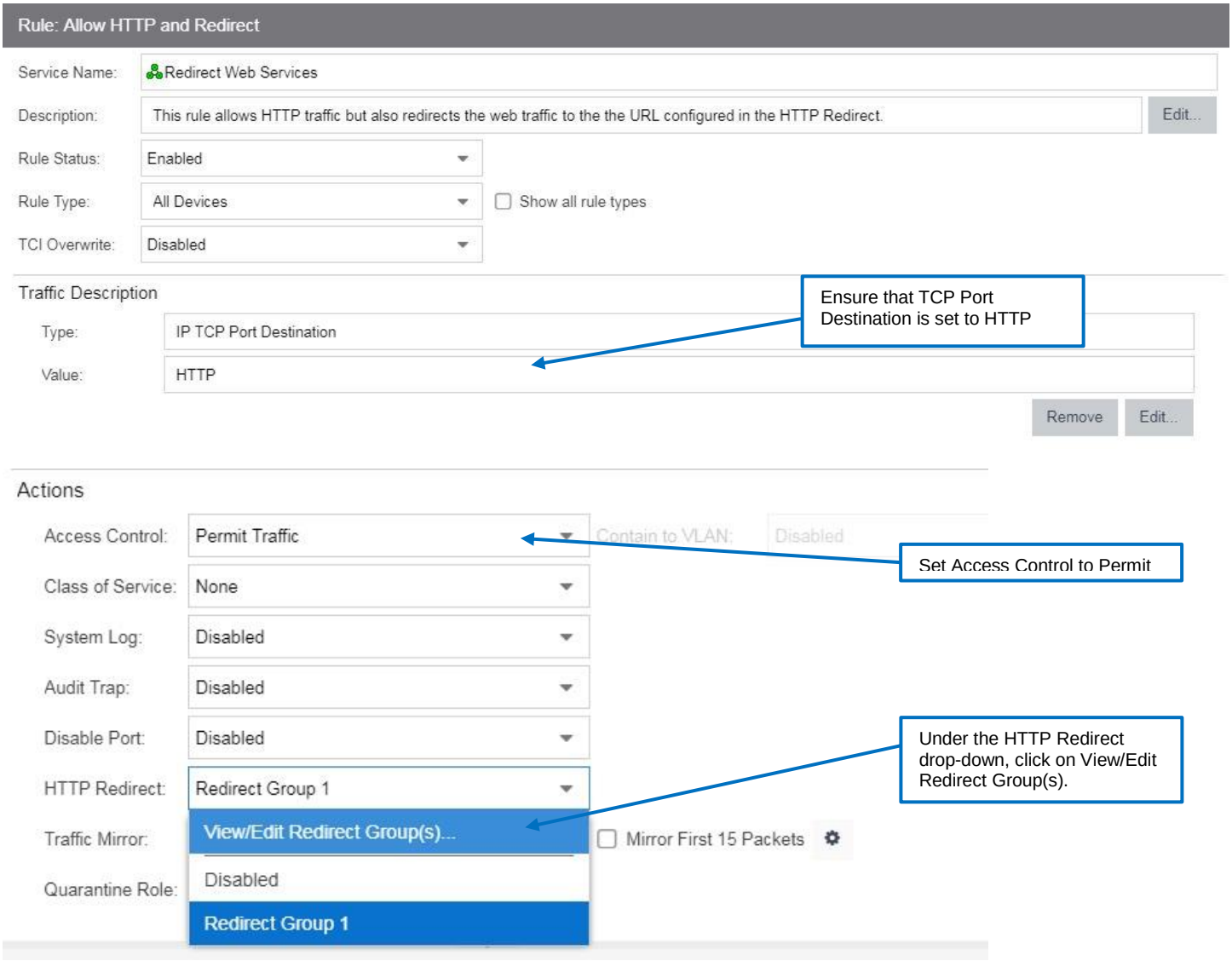
4. VoIP Phone Service

- The VoIP Phone service is created to allow voice applications access and if desired, priority. Rules can be created to match VoIP services on several criteria and set corresponding CoS profiles, including specific L4 ports, VoIP phone DSCP values, or the MAC OUI of the VoIP vendor:

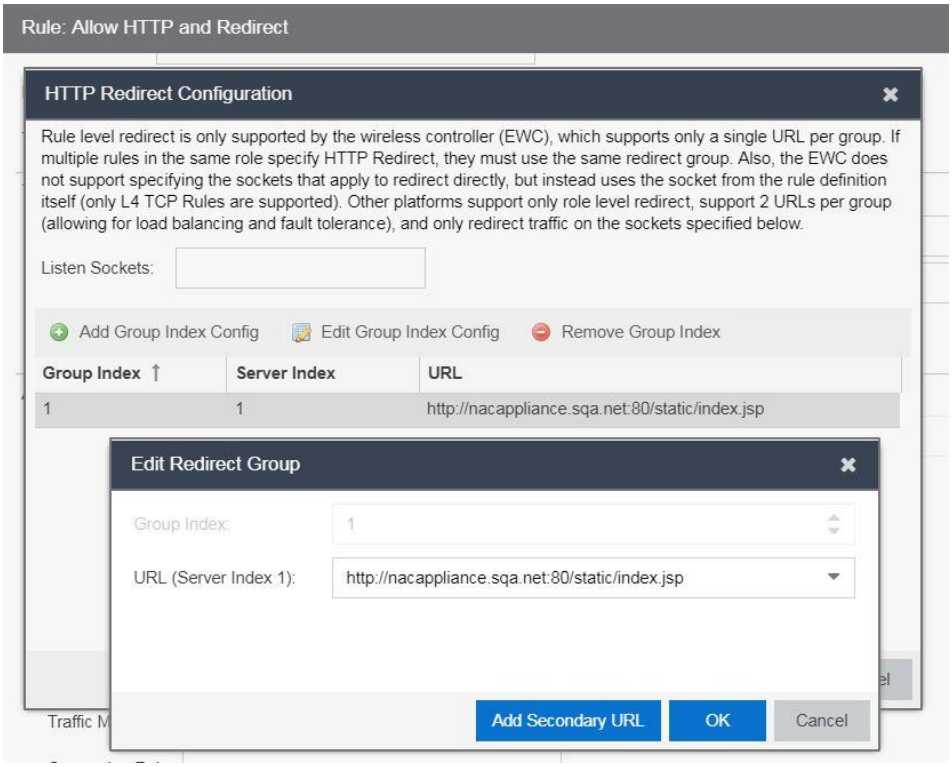
Rule	Summary
Allow DSCP 46	[IPToS : 0xB8] -> [Permit Traffic/RTP/Voice/Video]
SIP	[TCP Dst : 5060] -> [Permit Traffic/RTP/Voice/Video]
VOIP OUI	[MAC Src : 00:54:01:00:00:00/24] -> [Permit Traffic/RTP/Voice/Video]

5. Redirect Web Services

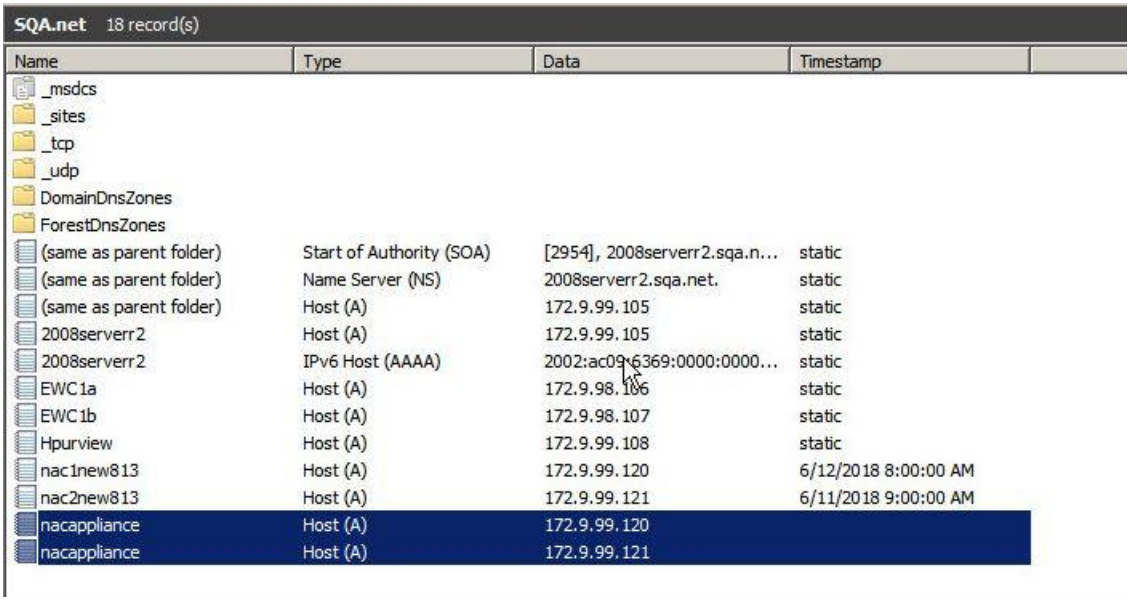
- Redirect Web Services is used to redirect HTTP traffic of unregistered users to the Captive Portal for authentication.



- Click **Add Group Index Config**. To have Captive Portal Redundancy between two ExtremeControl engines, use a single FQDN address for the captive portal redirect configuration.



- In the DNS server(s), add both ExtremeControl IPs to the FQDN address. Make sure that all hardware and applications use the DNS server where the entries reside.

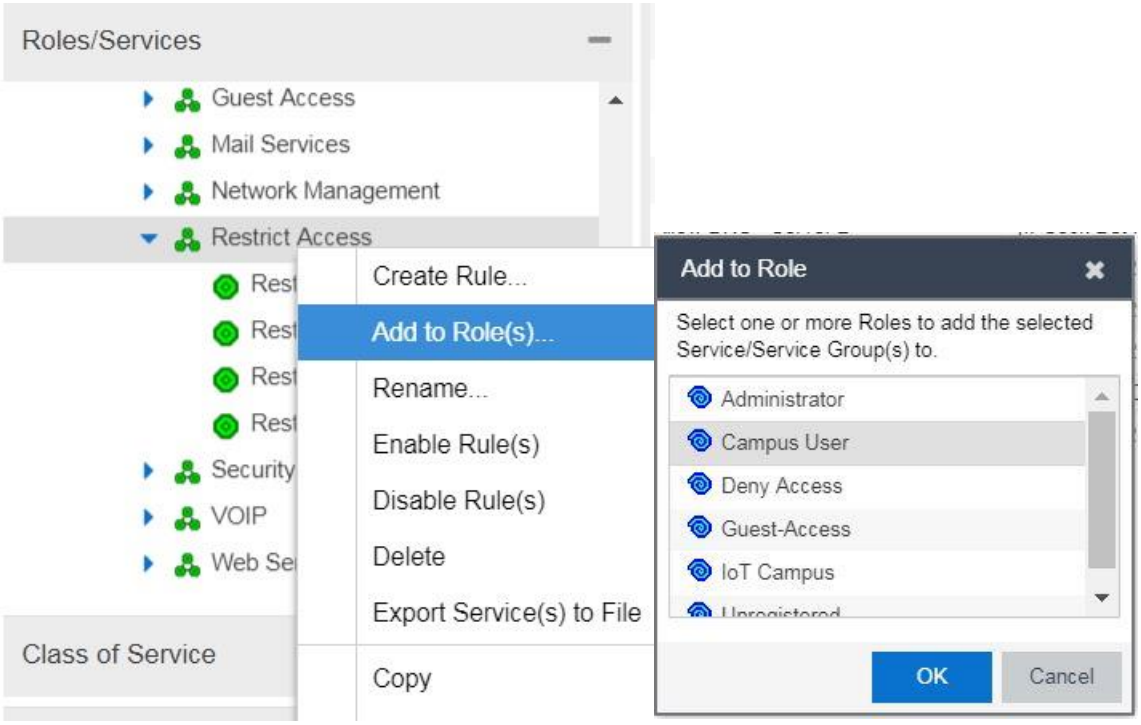


6. Switch and Appliance Restricted Access

- Security of the network devices and appliances is of the utmost importance. To block access to the switches and appliances, a Global Security Service can be created with a rule to either deny or allow limited access to those devices. A subnet or single IP can be entered if a Layer 3 Traffic Classification is chosen. Layers 2, 4 and 7 can also be selected with the appropriate configuration.

Rule	Summary
Allow DHCP - Server 1	[IPSock Dst : 172.9.99.105:BootP Server] -> [Permit Traffic]
Allow DHCP - Server 2	[IPSock Dst : 172.9.99.115:BootP Server] -> [Permit Traffic]
Allow DNS - Server 1	[IPSock Dst : 172.9.99.105:DNS] -> [Permit Traffic]
Allow DNS - Server 2	[IPSock Dst : 172.9.99.115:DNS] -> [Permit Traffic]
Restrict Campus1 Summit Access	[IPDST : 172.10.10.0/24] -> [Deny Traffic]
Restrict Campus2 Summit Access	[IPDST : 172.20.10.0/24] -> [Deny Traffic]
Restrict EWC	[IPDST : 172.9.98.0/24] -> [Deny Traffic]
Restrict VSP Access	[IPDST : 10.0.0.0/24] -> [Deny Traffic]
Restrict XMC	[IPDST : 172.9.99.0/24] -> [Deny Traffic]

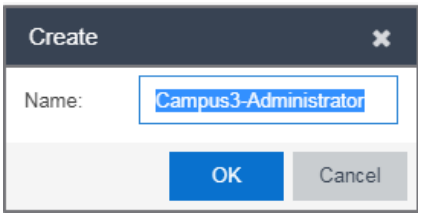
- Once the Services and Rules are created, it must be added to the appropriate Roles within their respective Domains. To add to the appropriate Roles, right-click on the Service and select add to Roles. Multiple Roles can be selected as well.

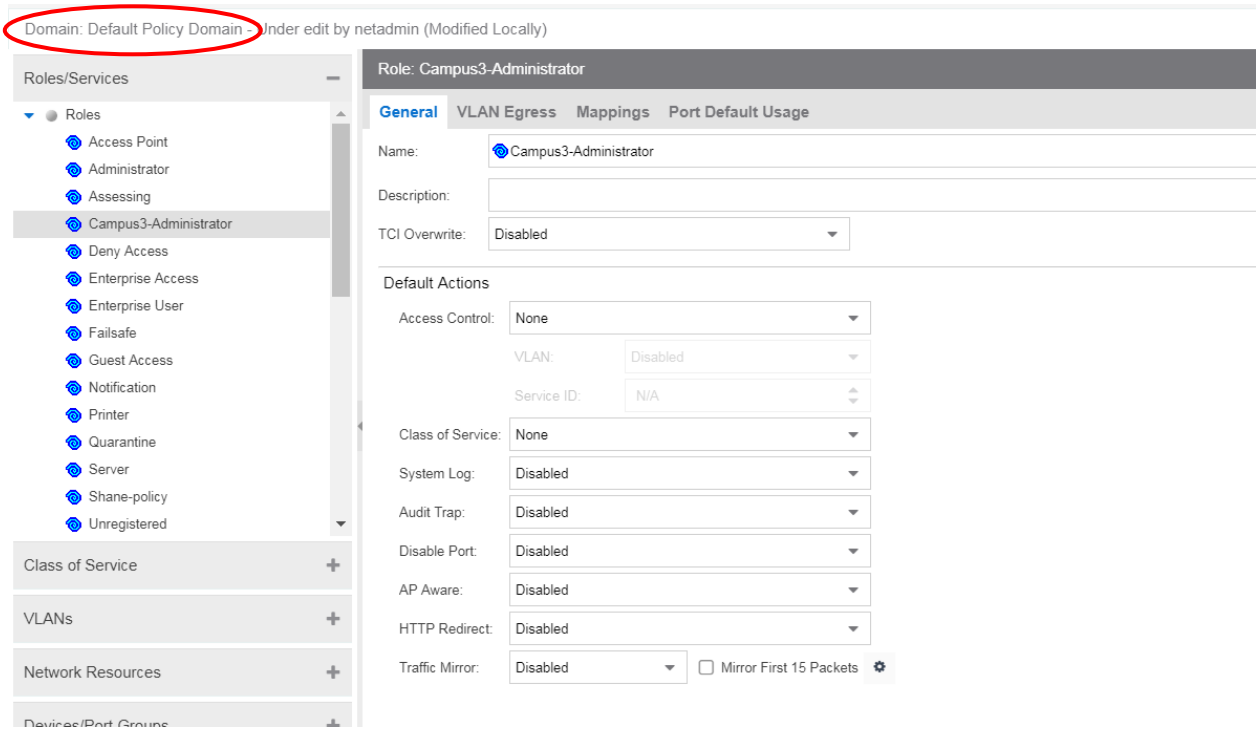


Role Configuration – ERS Access Switches

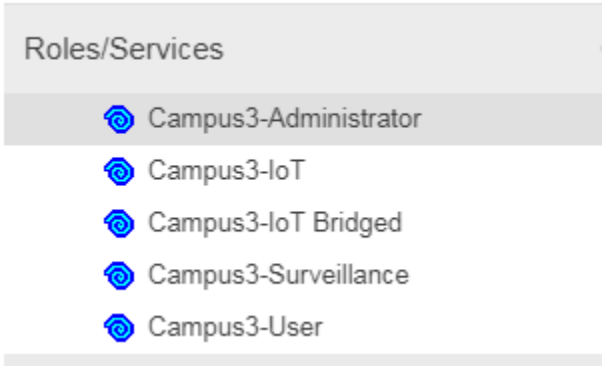
Although ERS access switches do not support Extreme Policy, the same policy profile structure is used to assign the authorized profile to authenticated users.

- From the Default Policy domain, create the required roles, as illustrated in previous section. **No parameter settings are required in this step**.

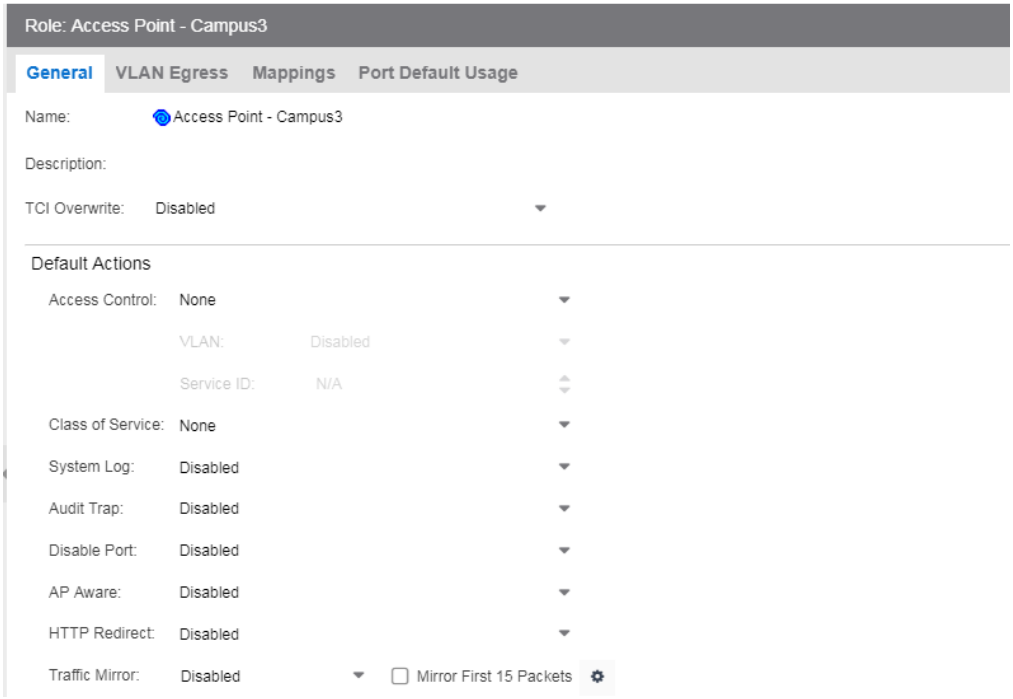




- Create any remaining roles required for users connecting to ERS access switches.

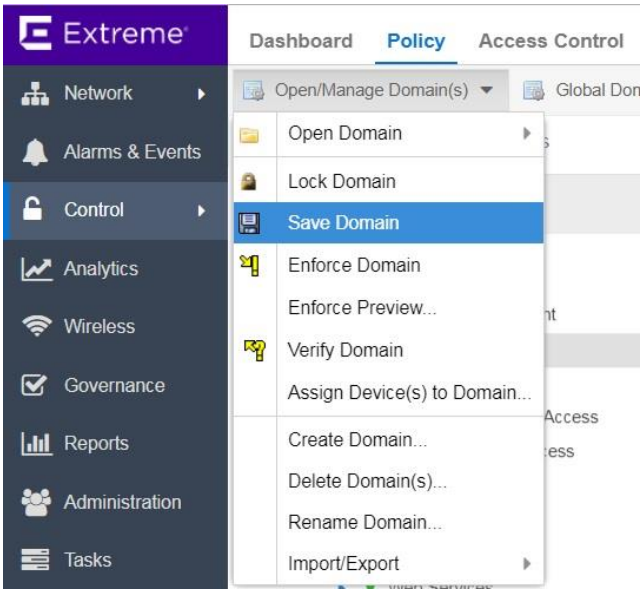


- An Access Point role is also created to assign the required RADIUS attributes to the ERS to facilitate wireless functionality:



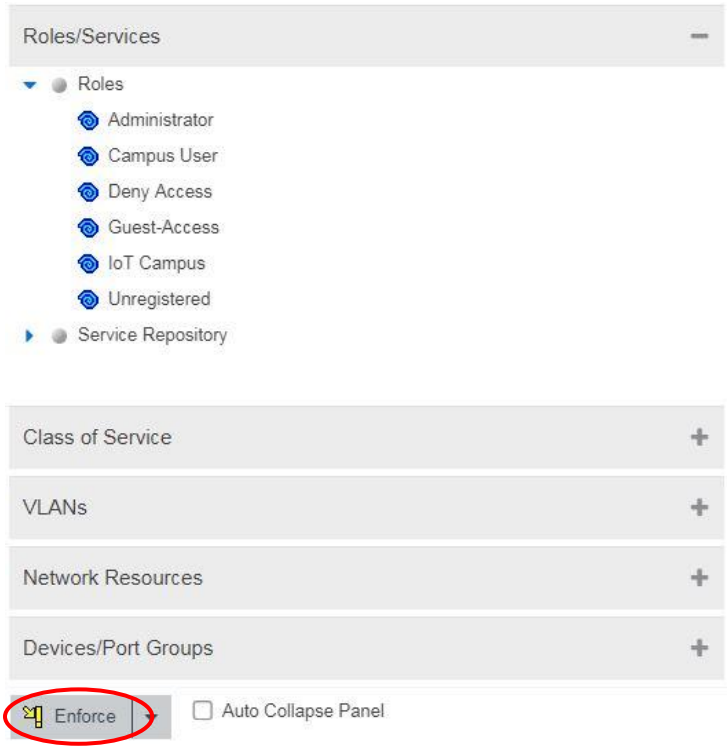
Saving and Enforcing Domain

- Go to the Control → Policy tab and click **Open/Manage Domain(s)**. Select **Save Domain** from the drop-down list.



- Once the access switches have been deployed (See **Wired User Access**), enforce policy configuration on the domain member network devices. Policy settings will be created automatically.

Note
When using ERS access switches, saving the domain is all that is required. No enforcement is needed.



Warning

If using more than one Policy Domain, ensure the proper Policy Domain is selected before enforcing the domain.

ExtremeControl Configuration

The Access Control tab provides support for controlling the user connection experience and network access based on a variety of criteria including authentication, user name, MAC-address, time of day, or location.

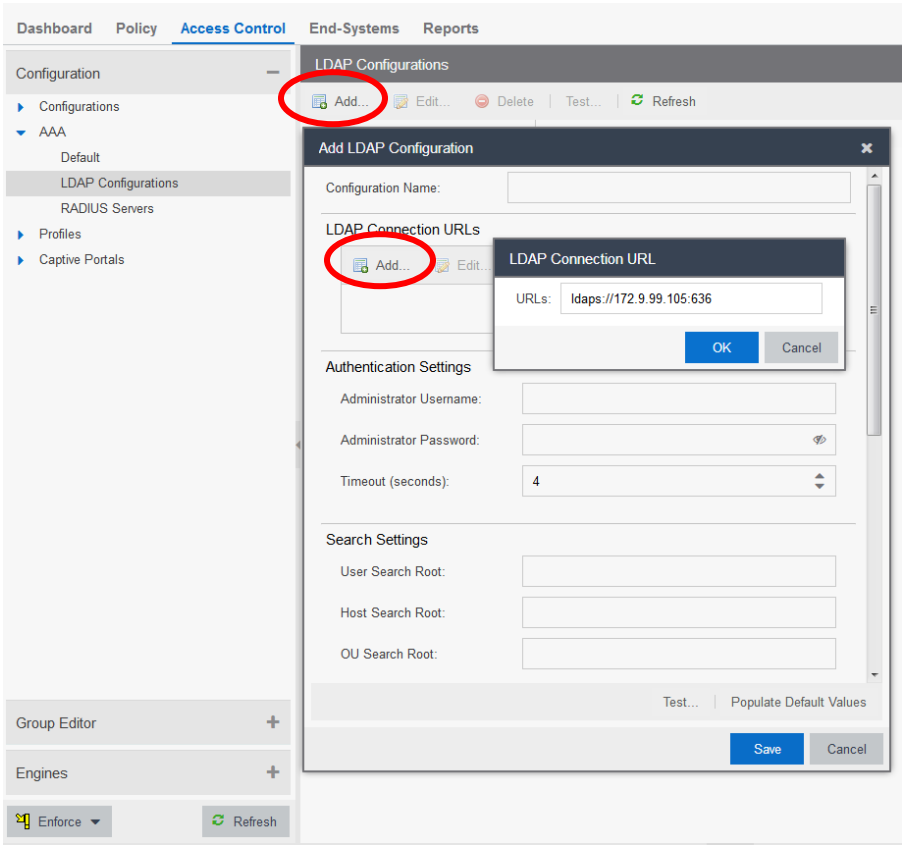
LDAP Configuration

This solution uses LDAP together with RADIUS and netlogin to control user access to network resources. LDAP is an application protocol used for accessing and maintaining distributed directory information. LDAP can be configured through Extreme Management Center via **Control → Access Control → Configuration →AAA → LDAP Configurations**. To display all the necessary LDAP configuration options, the **Make Advanced** option must be selected from the menu under the **AAA** drop-down menu, by right-clicking on the **Default** profile option and select **Make Advanced**.

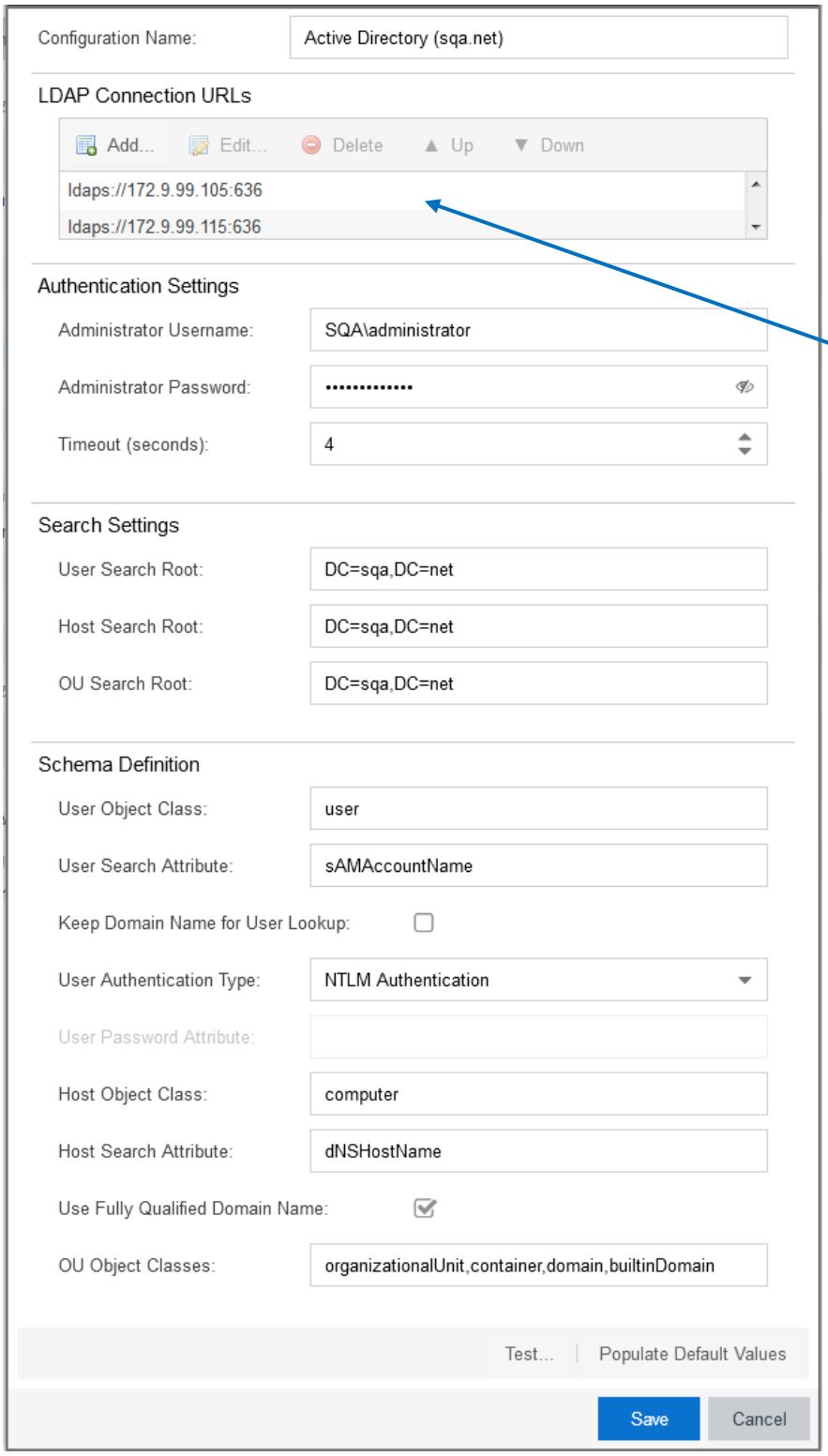
Note

Once selected, the “Make Advanced” option is no longer available, and the Default page will retain and display the Advanced options.

1. Click **Add** to add a new LDAP configuration. Click **Add** again to add a new LDAP URL.

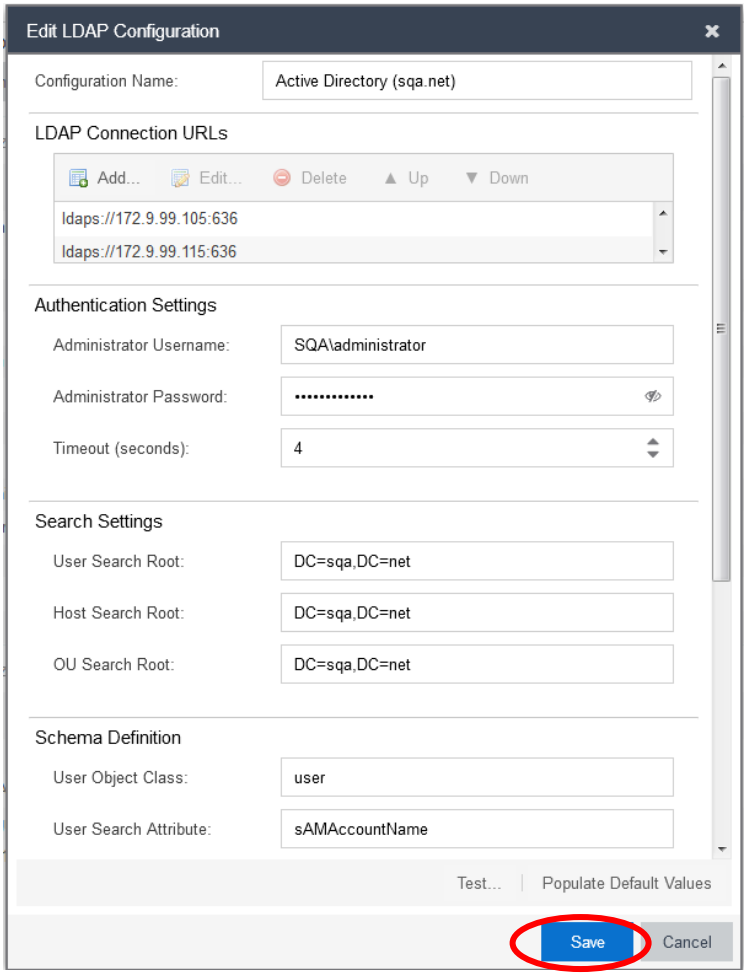


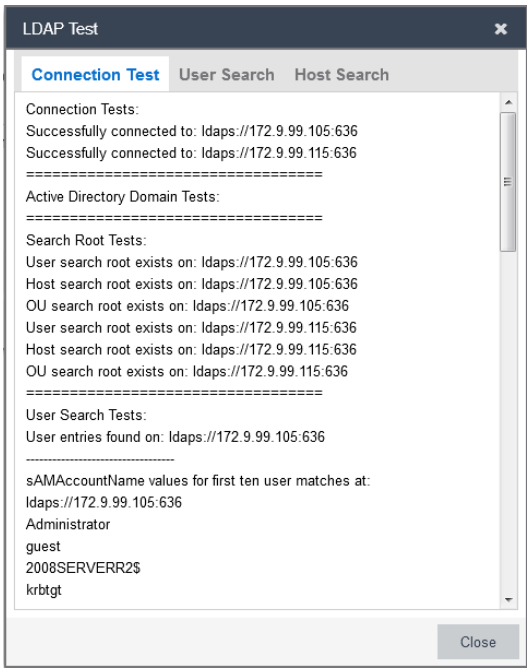
2. Fill in the rest of the fields as shown and click **Save** to finish the configuration:



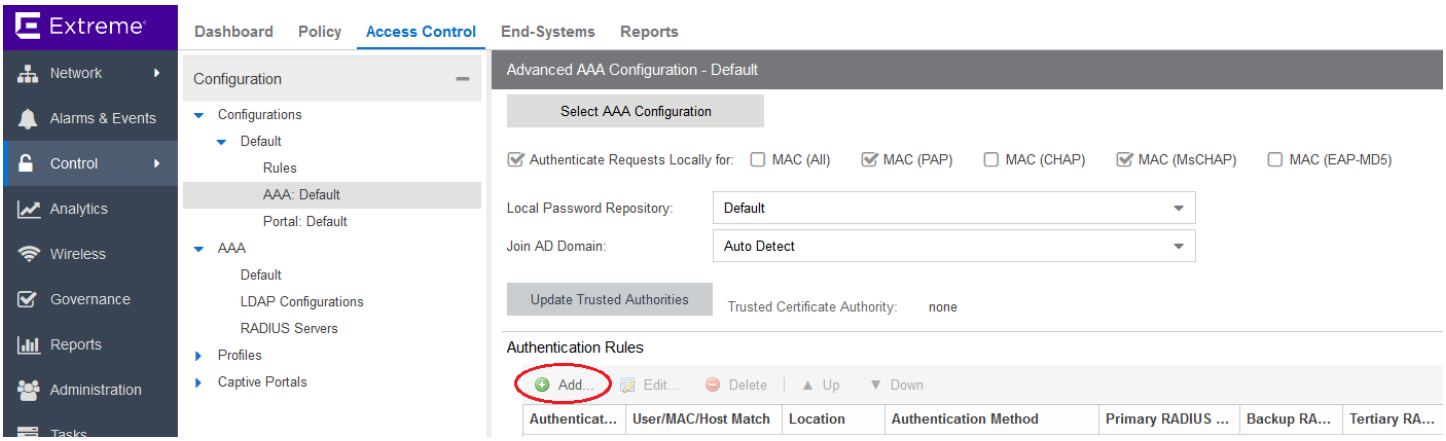
For redundancy, two LDAP URLs are made. Each entry points to a different third-party LDAP server, also called Directory System Agent (DSA)

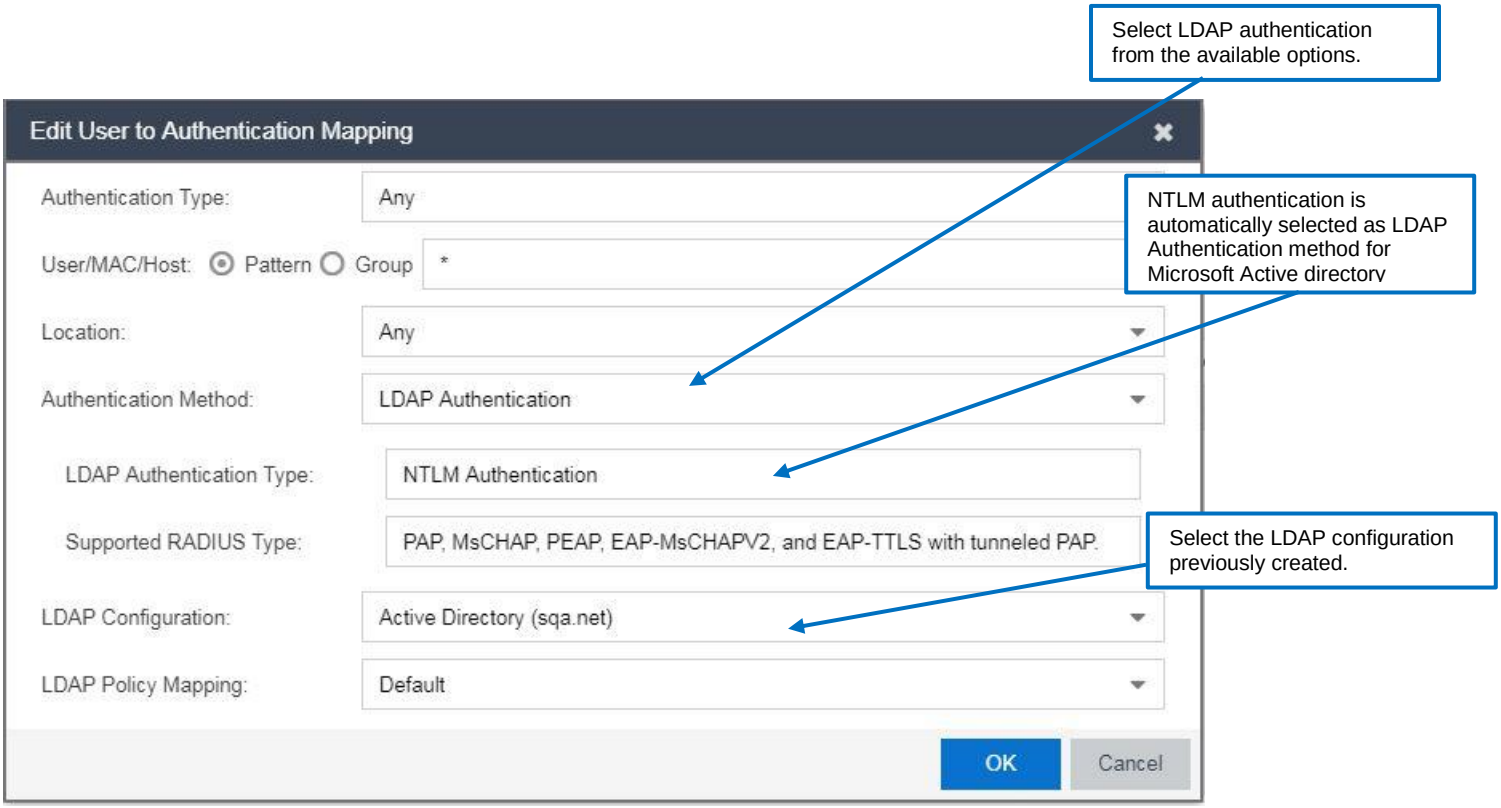
- You can use the **Test** option to verify that the LDAP server is configured correctly and answering the request. One way to test an LDAP configuration is to select the desired entry, click **Edit**, and then click **Test**. The test might take a few minutes to complete.

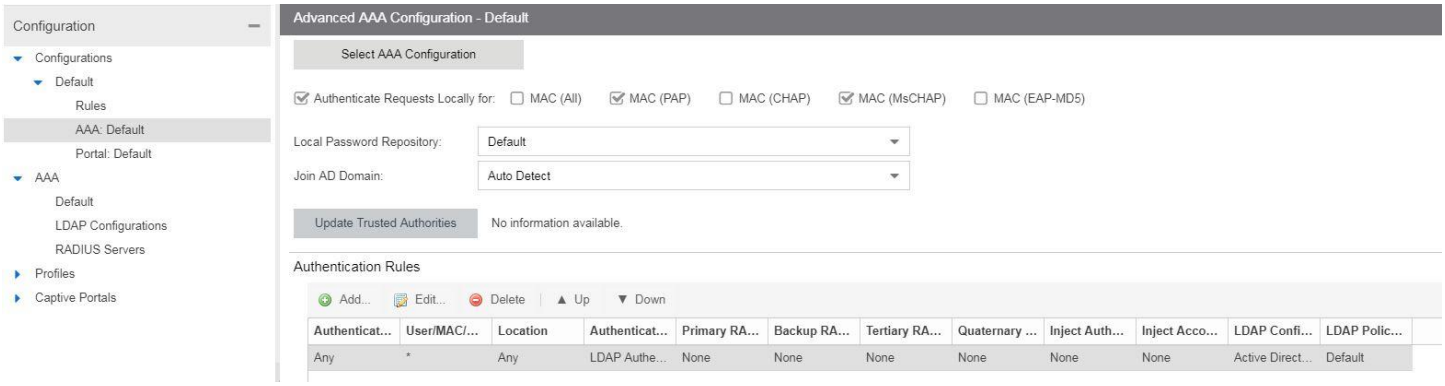




3. Configure ExtremeControl to use LDAP for interrogating user credentials. To accomplish this, you must create a new authentication rule to set LDAP as the authentication method. You can add an authentication rule from **Control → Access Control → Configuration→ Configurations→ Default→ AAA: Default** by clicking **Add** in the **Authentication Rules** section. The rules for Automated Campus were configured as shown in the following pictures.







RADIUS Configuration

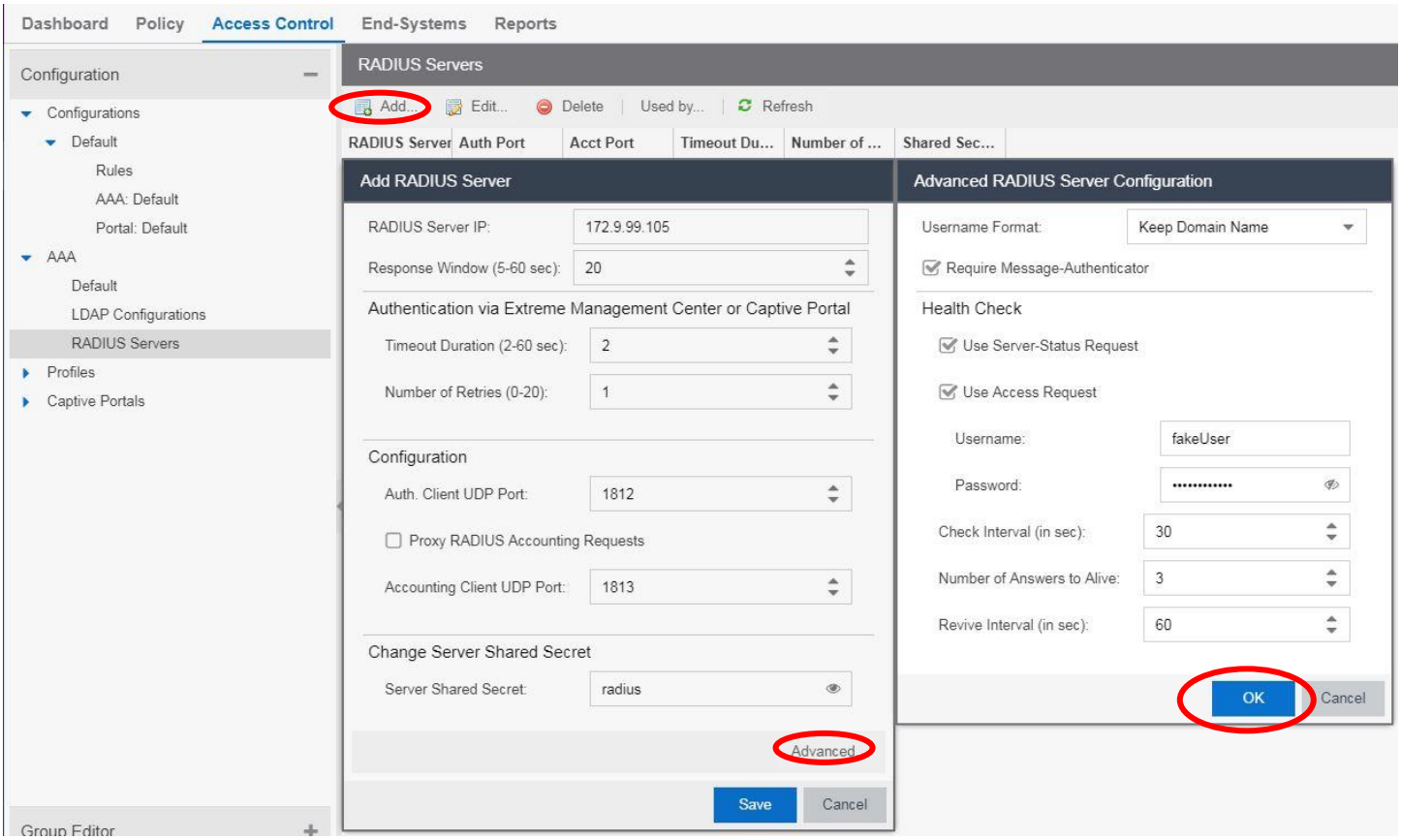
Two RADIUS servers are configured for redundancy. In case the primary server fails, the second one is used for authentication. There's a radius server connected in each server room.

The Timeout and Number of Retries have the default values. The shared secret must be configured and must be the same on ExtremeControl and on the RADIUS server. ExtremeControl will check the RADIUS server is up at every check interval. Verification is done by using a "fakeUser" RADIUS request with a username and password. The username may or may not exist on the RADIUS server. The ExtremeControl considers the RADIUS server to be alive whenever the ExtremeControl receives a RADIUS response, either Reject or Accept. MS Radius servers may log an error for this process. The Health Check parameters can be modified from the Advanced section of the RADIUS configuration window. The default values are used here.

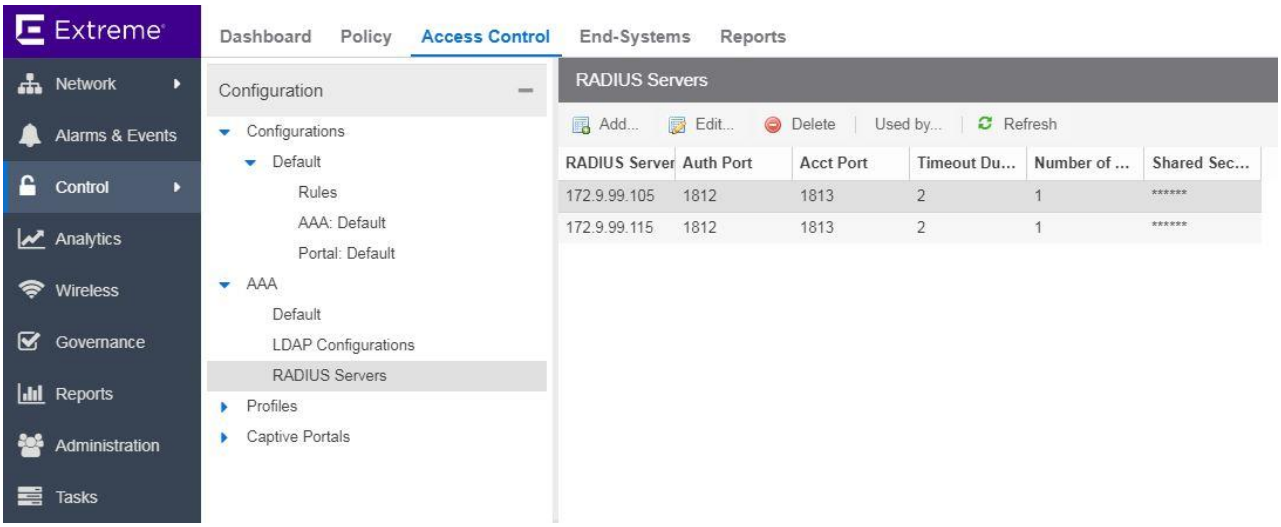
Note

To avoid accumulating log errors because of the Health Check process that may occur for topologies using a Microsoft-based RADIUS server, the Health Check feature can be disabled by unchecking the **Use Server-Status Request** box and the **Use Access Request** box, click **OK**, then **Save**. Alternatively, a replacement user already entered in the RADIUS server can be configured to replace the **fakeUser** configuration.

- To configure a RADIUS server, go to **Control → Access Control → Configuration → AAA → RADIUS Servers** and click **Add** to create a new entry:



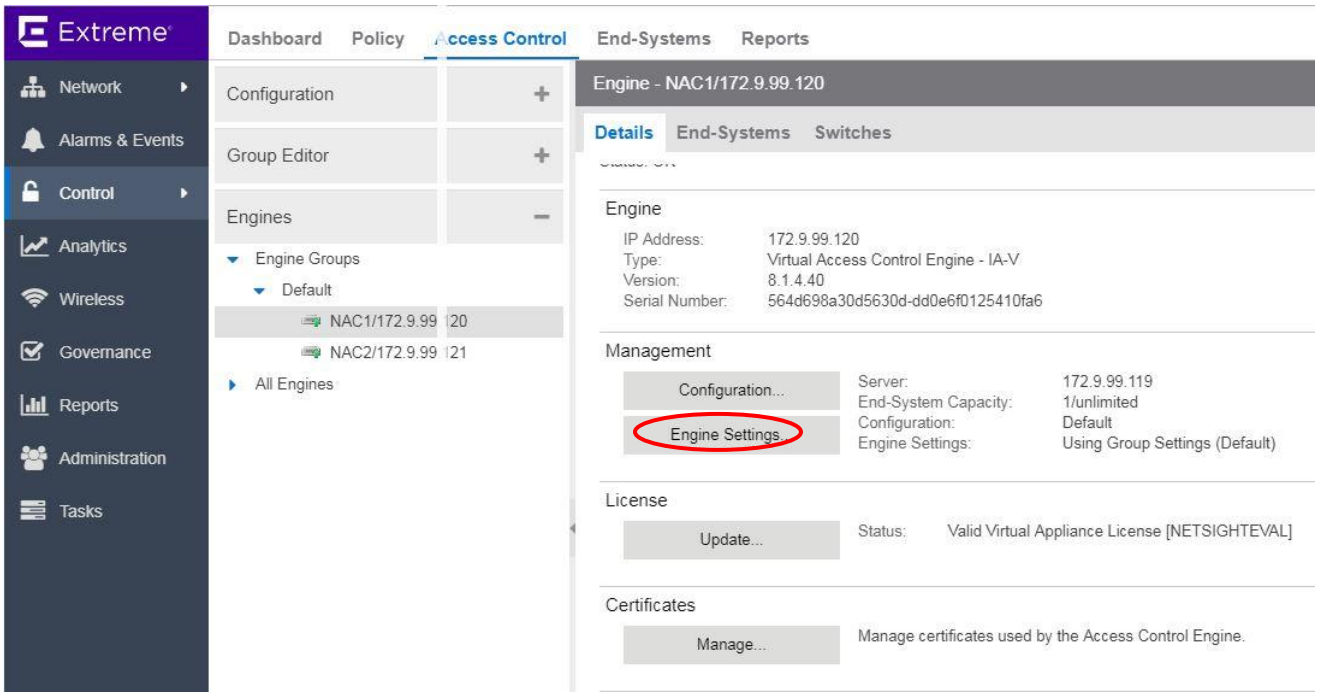
- The configured RADIUS servers are listed:

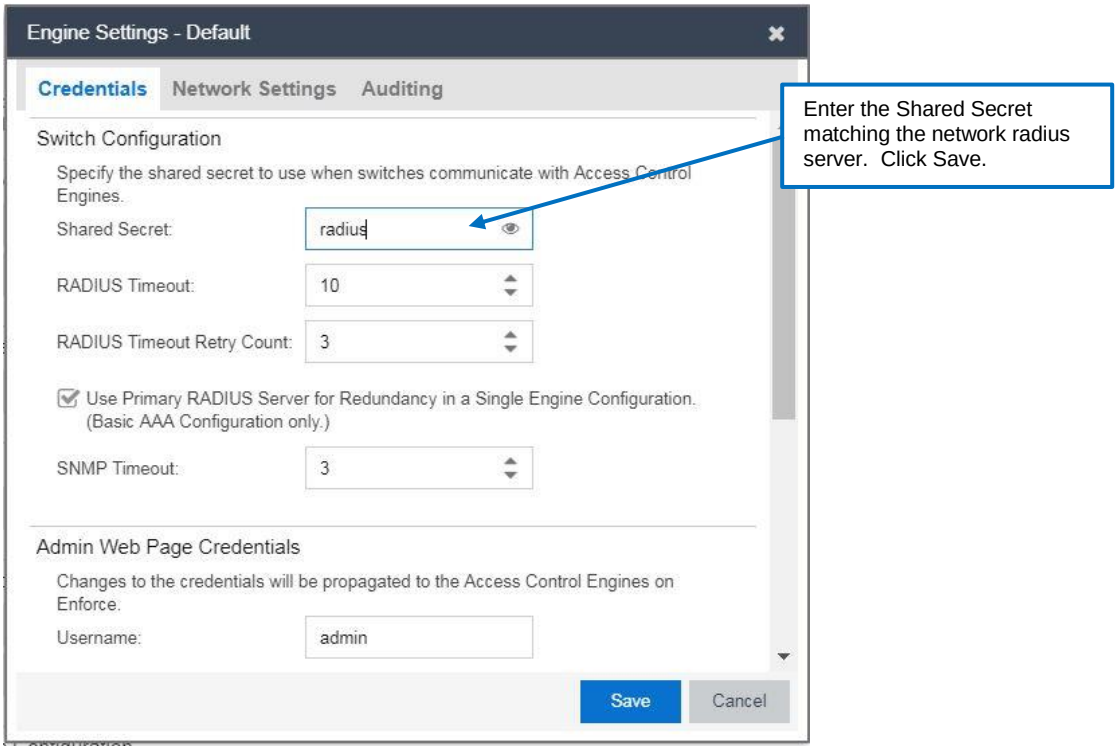


ExtremeControl Engine Configuration

Two ExtremeControl engines are in the server rooms connected to different switches. The use of two engines assures redundancy. Both ExtremeControl engines are configured identically, and if the primary ExtremeControl fails the secondary ExtremeControl will take over its attributions without affecting users. Both engines have authentication and assessment enabled.

To configure ExtremeControl engines, go to **Control → Access Control→ Engines→ Engine Groups→ Default**, highlight an engine, and select **Engine Settings**:



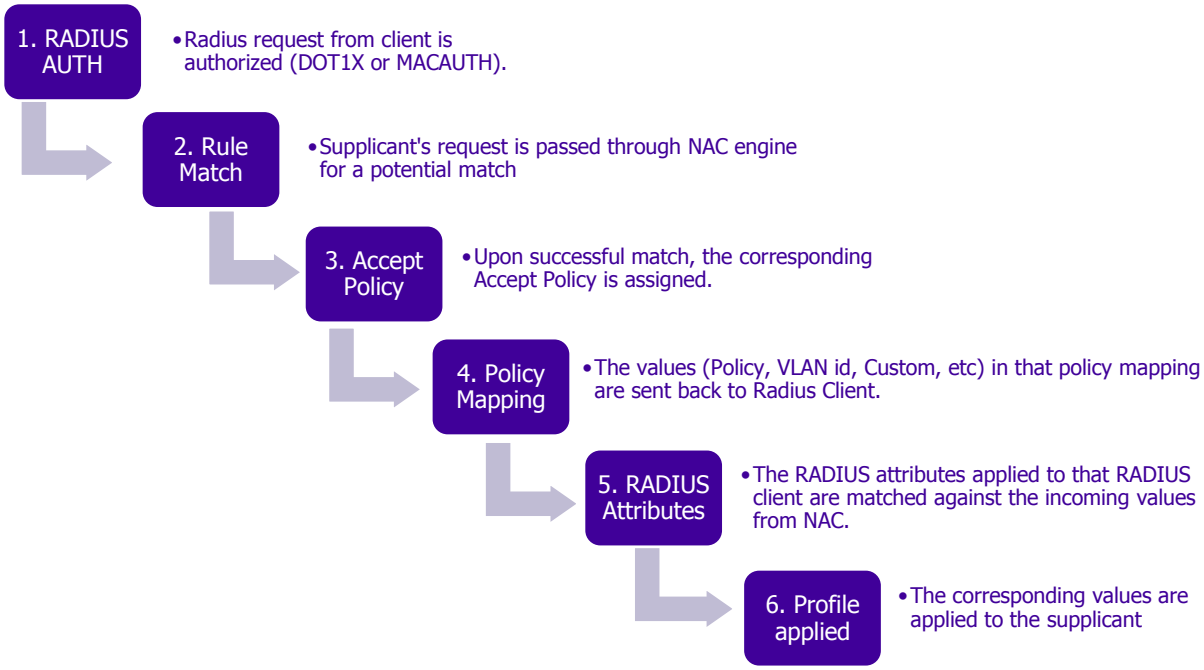


ExtremeControl Profiles and Policy Mapping

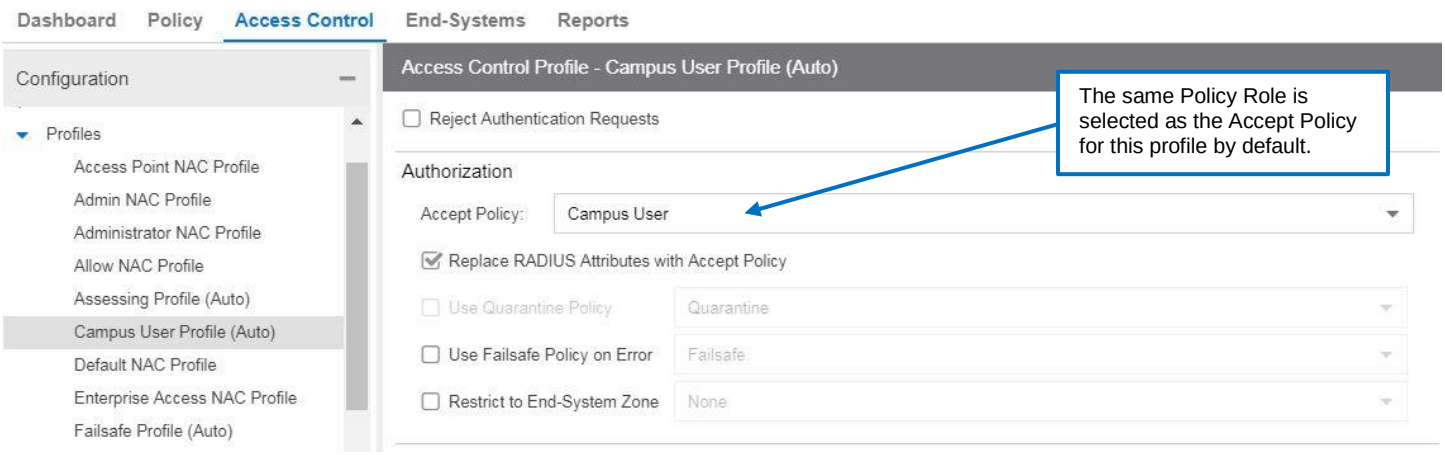
ExtremeControl Profiles define the authorization requirements for the end-systems connecting to the network. Each profile has an Accept Policy which is applied to an end-system when it has been authorized locally by the ExtremeControl engine and authentication is configured to replace the attributes returned from the RADIUS server with the Accept Policy.

Each Accept Policy is associated with a Policy Mapping, which defines exactly how end-system traffic is handled on the network. Each mapping specifies a Policy Role (created in the Policy tab) and/or any additional RADIUS attributes included as part of a response to a RADIUS client.

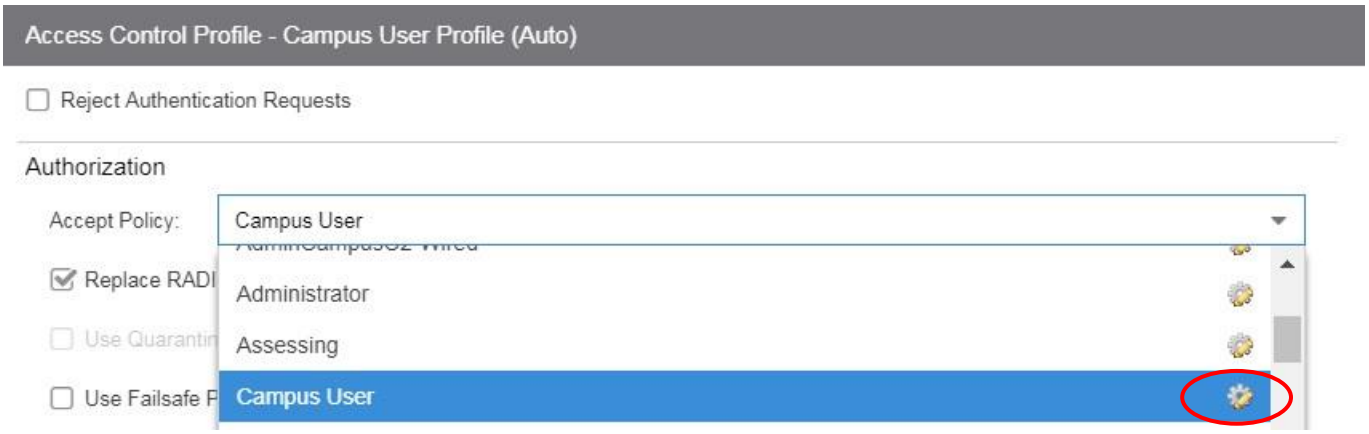
When an end-system authenticates to the network, the ExtremeControl profile is applied and the appropriate RADIUS response attributes are extracted from the mapping and returned in the RADIUS Accept response.



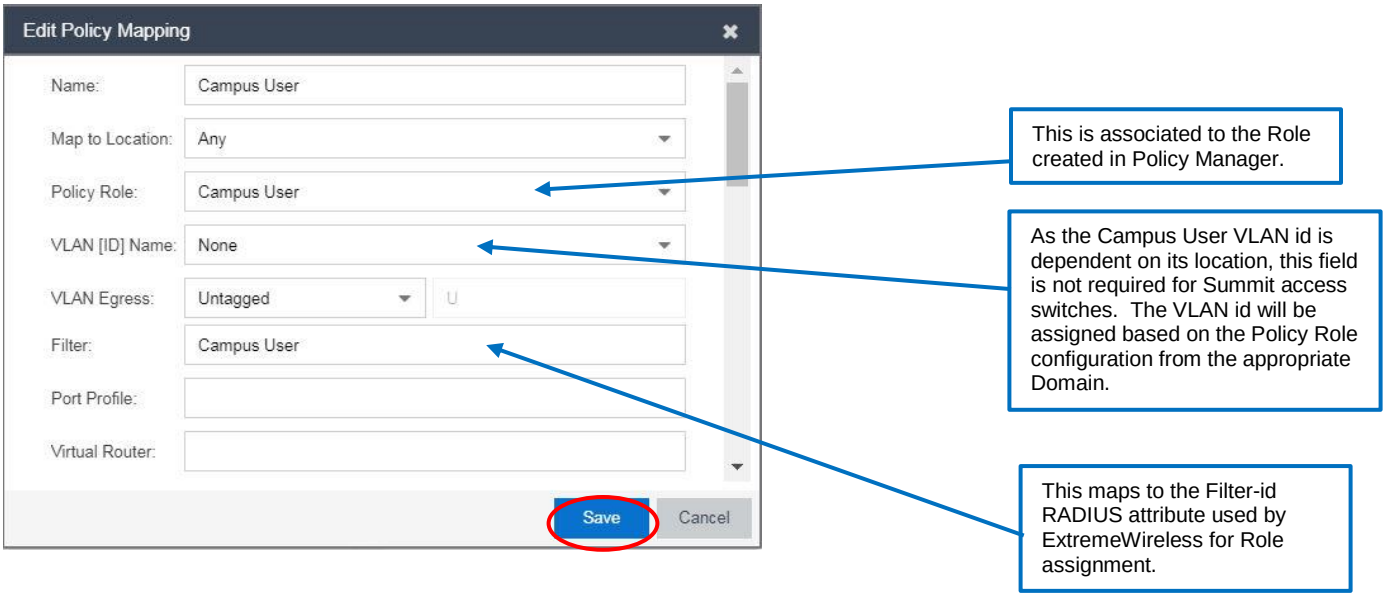
- When a Policy Role (ex: “Campus User”) is created in any Policy Domain, a corresponding Access Control Profile is automatically created under **Control→Access Control → Configuration→Profiles**.



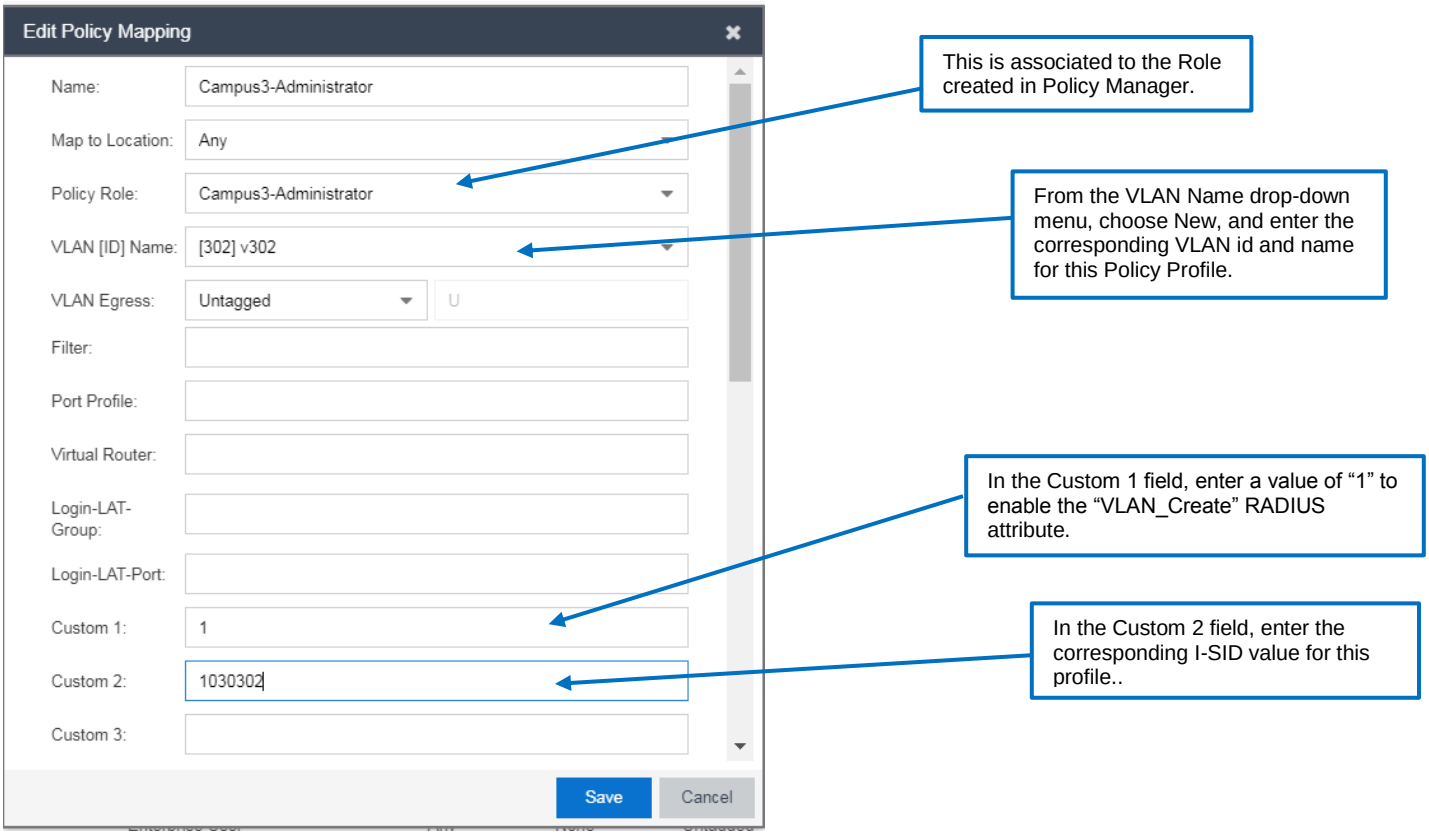
- From the Accept Policy drop-down, click on the gear icon for this Accept Policy to access the Policy Mapping:



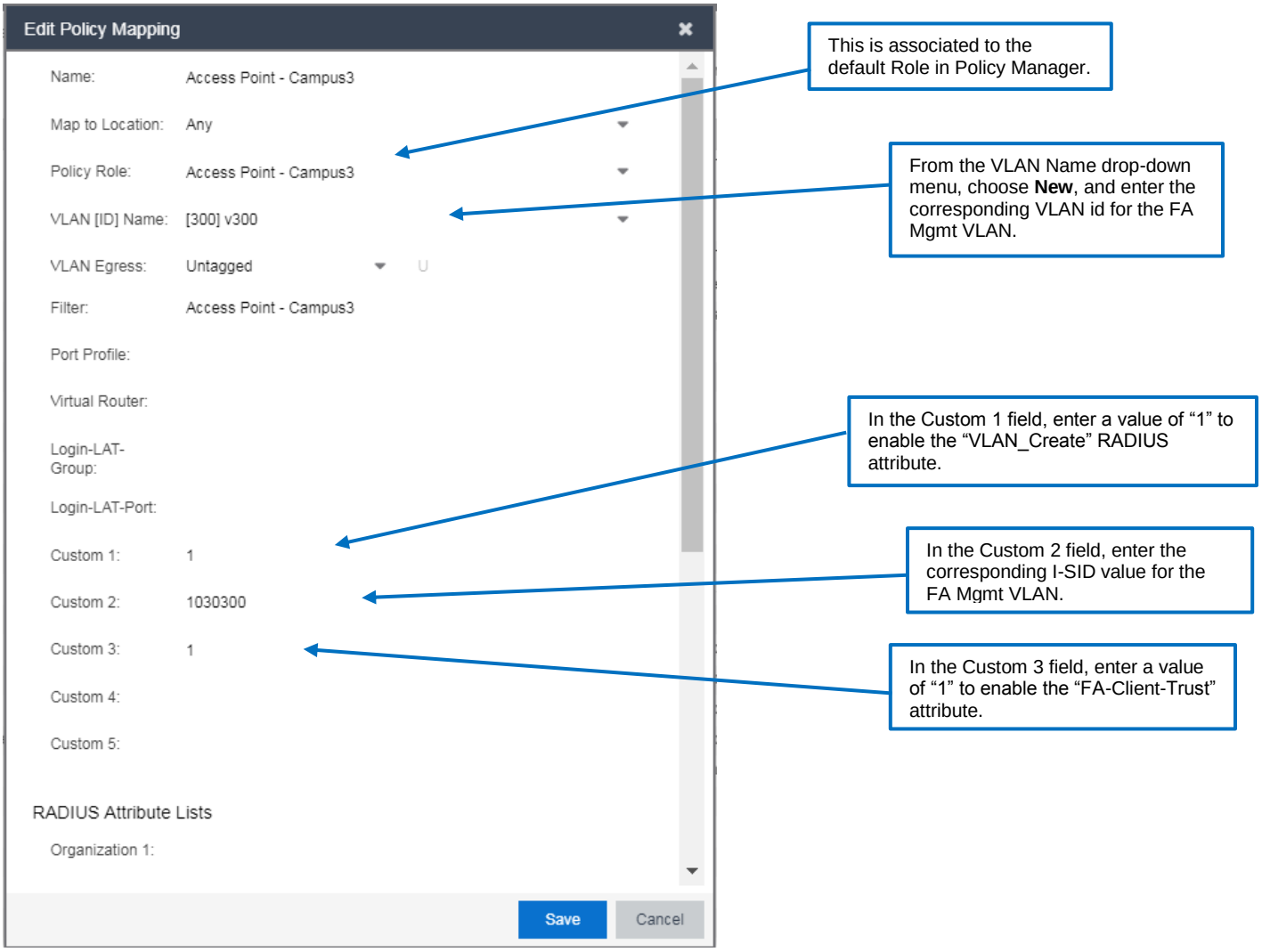
- **Summit switches**: From the Policy Mapping Edit screen, ensure the Filter field has the exact Policy Role name entered:



- **ERS switches**: The Policy Mappings for ERS switches should specify values that match against the corresponding ERS RADIUS Attributes configuration.

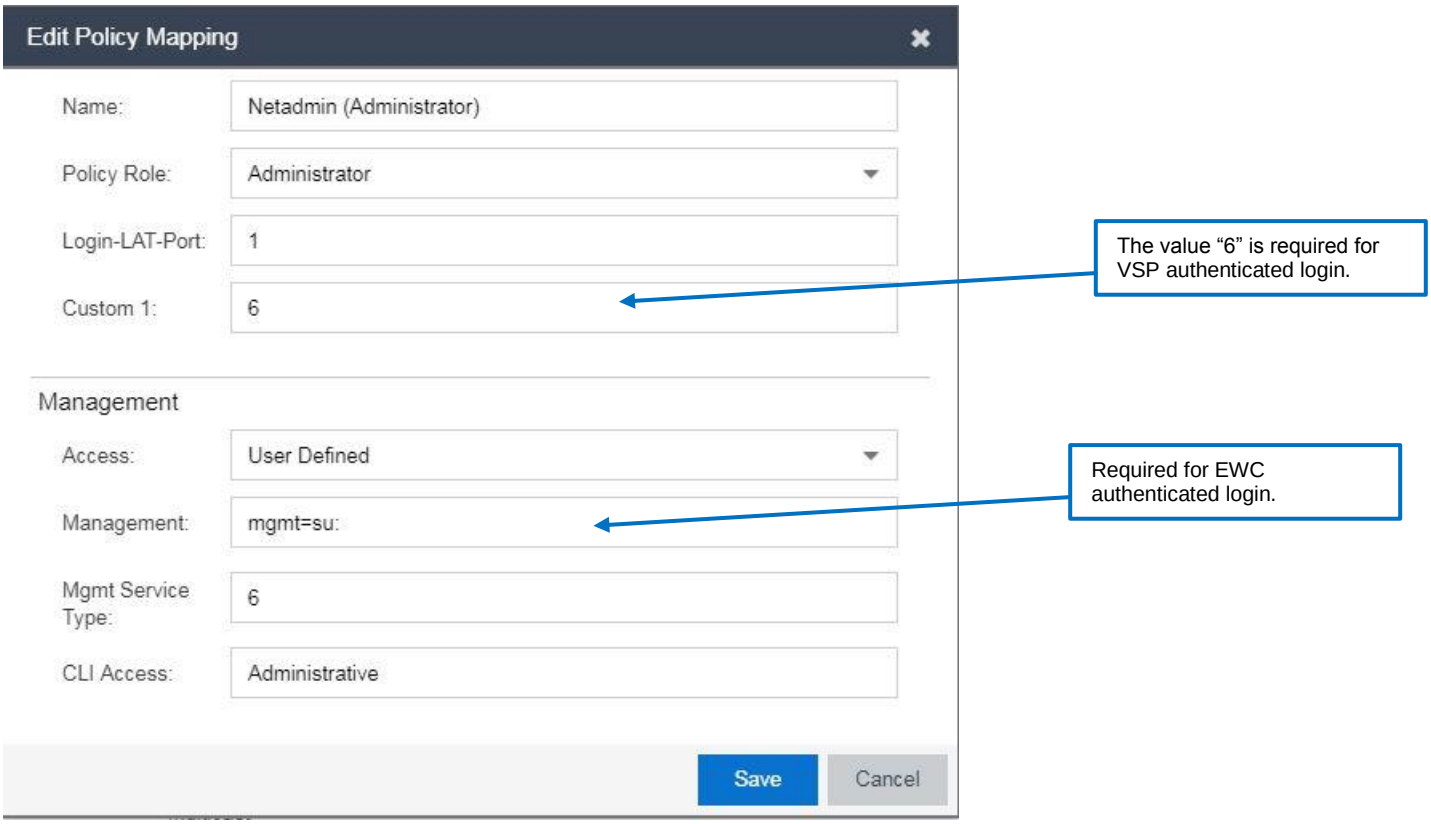


- **ERS-Connected Access Points**: A profile is required for Extreme Access Points connecting to ERS switches to indicate that a trusted FA Client is connected:



Repeat this process for each Policy Mapping required on the network.

- **Network Management Login**: For authenticated management access to network devices, a separate policy profile/mapping (such as “Netadmin” below) can be created containing the necessary attributes for authenticated login. Some network devices in this EVD require specific attributes for login access. The Fabric Connect switches and the Wireless Controllers are highlighted below:



Access Control Rule Configuration

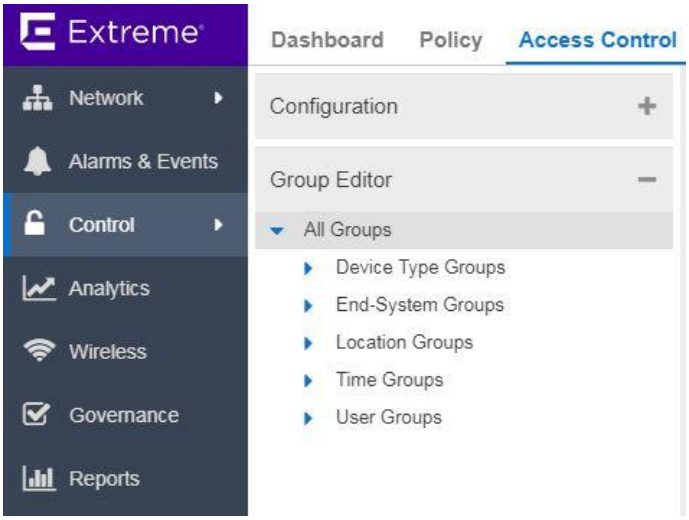
This solution requires the use of the ExtremeControl engines, which are configured with unique rules for user authentication and traffic classification. Each rule consists of a name, a set of conditions, and a set of actions that associates it with an Accept Policy. Each Accept Policy is mapped to a role from the Policy tab. Multiple Accept Policies can point to the same role. All conditions defined for a rule must be met; otherwise the rule is not matched.

When ExtremeControl receives an authentication request, all rules are verified in order until one is matched. When a rule is matched, the existing RADIUS attributes are replaced with the rule's Accept policy. The Unregistered rule is placed at the bottom of the access rules list and has a catch-all purpose. It will be matched by default by all traffic that doesn't meet all conditions of any of the previous rules.

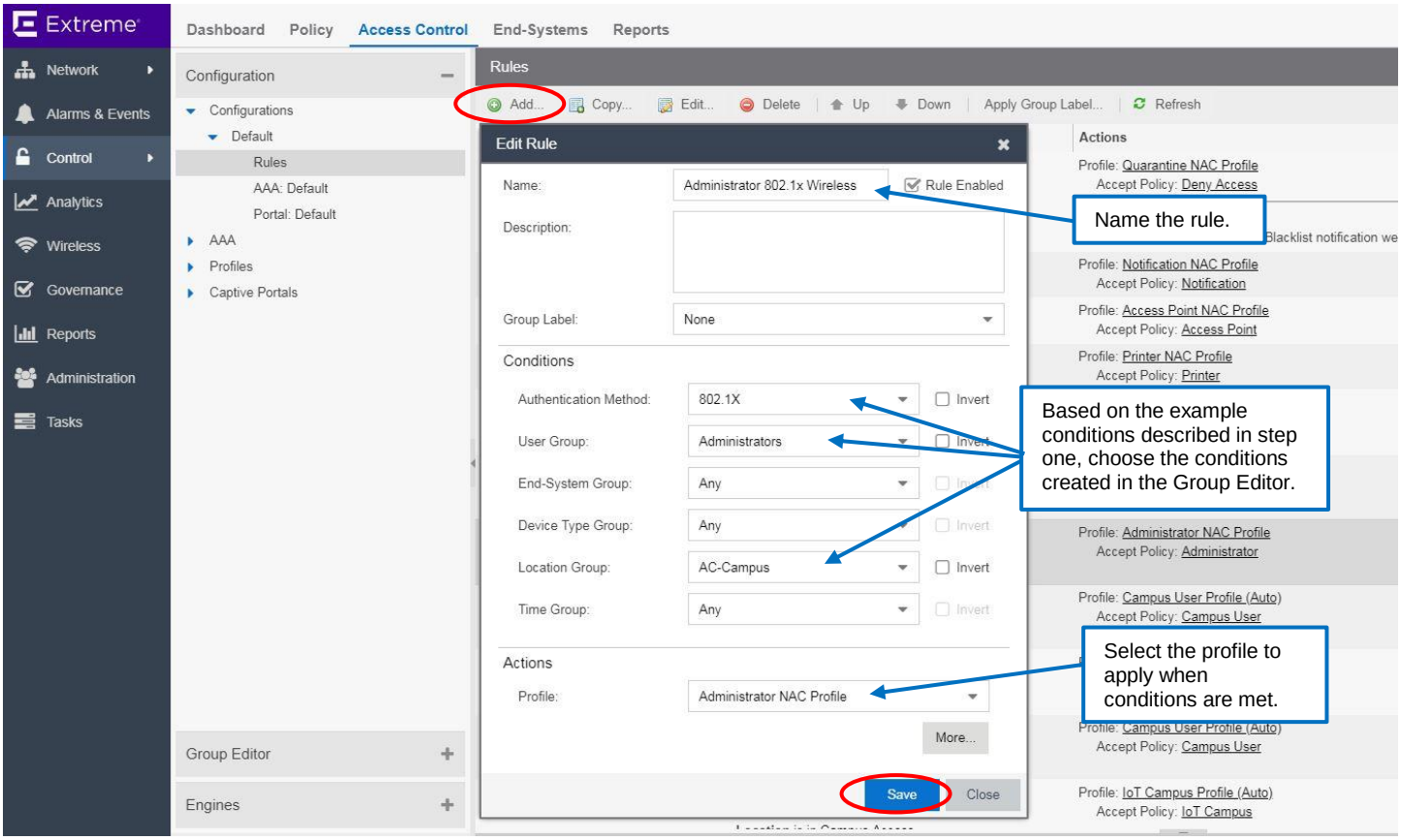
Note
This section details the creation of rules for the ExtremeControl engine to enforce. These are examples, and every customer environment has different security requirements. Its recommended to review the implementation of these requirements with Extreme Networks.

1. Before creating a rule, determine the conditions that must be met to assign a role to an end-system attempting access. This can be one condition or several. For example, an end-system authenticating must pass the following criteria:
    - Using 802.1X authentication.
    - Passed login credentials for the Administrator group.
    - Attempted to join the SSID "AC-Campus".
2. Each of these conditions can be created in the **Group Editor**, which is used to define the criteria for the rules used in the ExtremeControl configuration. This can be accessed under **Control→Access Control:**

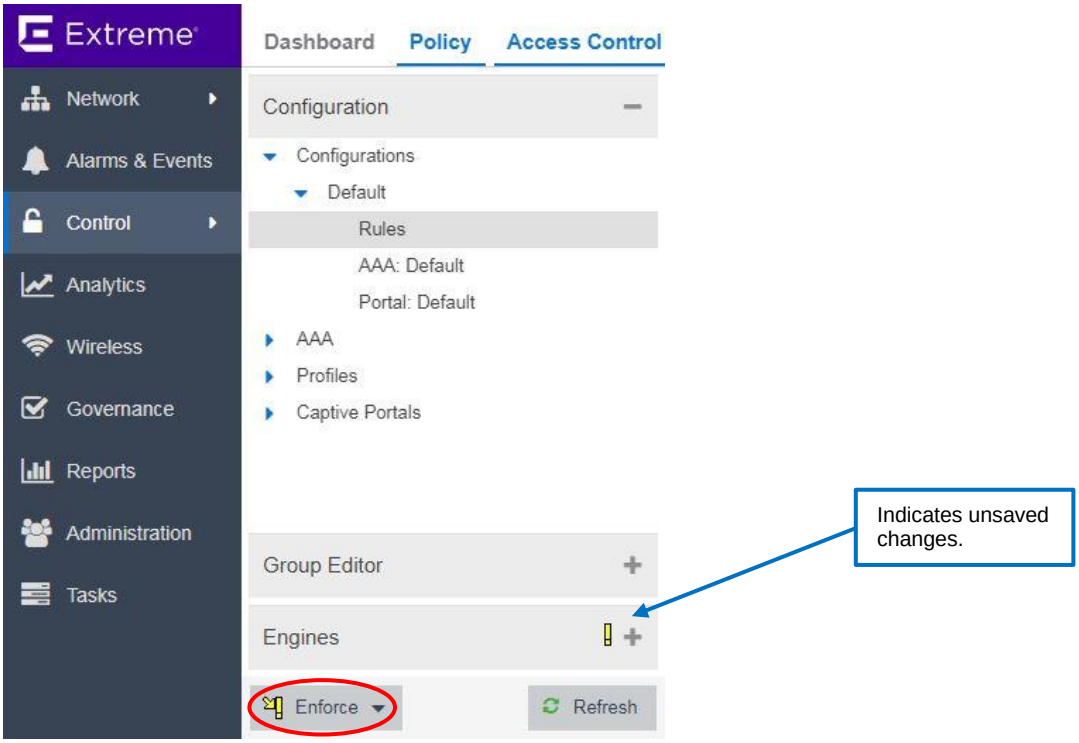
Note
The creation of Group Editor profiles is beyond the scope of this document. Please refer to ExtremeControl documentation for further information on Group configuration.

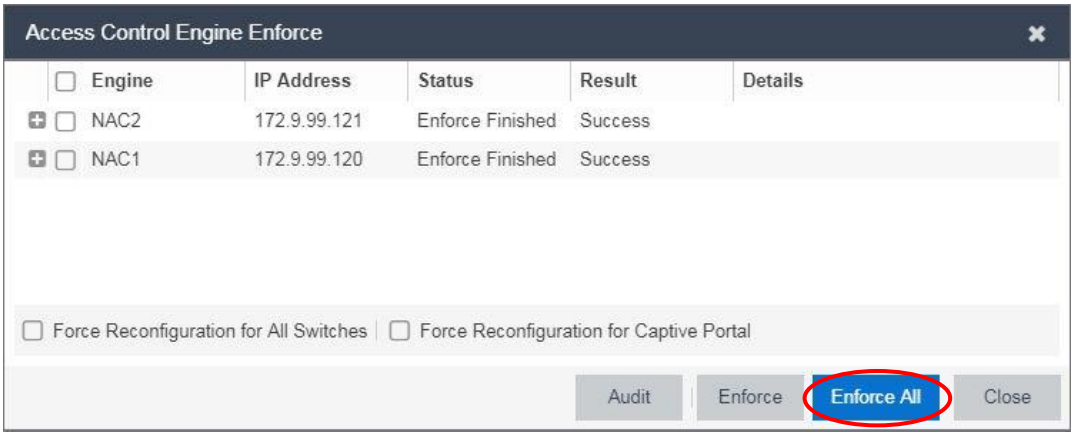


3. To create a new rule, go to **Control → Access Control → Configuration → Rules** and click **Add**:



4. After changes are made on the Access Control tab, the configuration must be enforced on the ExtremeControl engines.





5. The following are the ExtremeControl rules configuration for Automated Campus:

Rules

Add... | Copy... | Edit... | Delete | Up | Down | Apply Group Label... | Refresh

Ena...	Rule Name	Conditions	Actions
✓	Blacklist	**End-System** is in Blacklist	Profile: Quarantine NAC Profile Accept Policy: Deny Access Portal: Default User will be redirected to the Blacklist notification web page.
✓	Assessment Warning	**End-System** is in Assessment Warning	Profile: Notification NAC Profile Accept Policy: Notification
✓	Access Point	**End-System** is in Access Points	Profile: Access Point NAC Profile Accept Policy: Access Point
✓	Printer	**End-System** is in Printers	Profile: Printer NAC Profile Accept Policy: Printer
✓	Administrator MAC Wired	**Authentication** is MAC *and* **End-System** is in Admin MACs *and* **Location** is in Campus Access	Profile: Administrator NAC Profile Accept Policy: Administrator
✓	Administrator 802.1x Wired	**Authentication** is 802.1X *and* **User** is in Administrators *and* **Location** is in Campus Access	Profile: Administrator NAC Profile Accept Policy: Administrator
✓	Administrator 802.1x Wireless	**Authentication** is 802.1X *and* **User** is in Administrators *and* **Location** is in AC-Campus	Profile: Administrator NAC Profile Accept Policy: Administrator
✓	Campus User 802.1x Wired	**Authentication** is 802.1X *and* **User** is in Technician *and* **Location** is in Campus Access	Profile: Campus User Profile (Auto) Accept Policy: Campus User
✓	Campus User MAC Wired	**Authentication** is MAC *and* **End-System** is in Campus MACs *and* **Location** is in Campus Access	Profile: Campus User Profile (Auto) Accept Policy: Campus User
✓	Campus User 802.1x Wireless	**Authentication** is 802.1X *and* **User** is in Technician *and* **Location** is in AC-Campus	Profile: Campus User Profile (Auto) Accept Policy: Campus User

✓	Deny Access	**Authentication** is MAC *and* **End-System** is Not in IOT-Legacy *and* **Location** is in Open	Profile: Quarantine NAC Profile Accept Policy: Deny Access
✓	IoT Campus MAC Wired	**Authentication** is MAC *and* **End-System** is in IoT MACs *and* **Location** is in Campus Access	Profile: IoT Campus Profile (Auto) Accept Policy: IoT Campus
✓	IoT Campus 802.1x Wired	**Authentication** is 802.1X *and* **User** is in IOT *and* **Location** is in Campus Access	Profile: IoT Campus Profile (Auto) Accept Policy: IoT Campus
✓	IoT Campus 802.1x Wireless	**Authentication** is 802.1X *and* **User** is in IOT *and* **Location** is in AC-Campus	Profile: IoT Campus Profile (Auto) Accept Policy: IoT Campus
✓	IoT-Legacy	**Authentication** is MAC *and* **End-System** is in IOT-Legacy *and* **Location** is in Open	Profile: IoT Campus Profile (Auto) Accept Policy: IoT Campus
✓	Surveillance MAC wired	**Authentication** is MAC *and* **End-System** is in Multicast-MAC	Profile: Surveillance Profile (Auto) Accept Policy: Surveillance
✓	Netadmin	**User** is in Netadmin	Profile: Netadmin NAC Profile Accept Policy: Netadmin (Administrator)
✓	Wired IoT Bridged MAC	**Authentication** is MAC *and* **End-System** is in Medical Devices	Profile: Wired IoT Bridged Profile (Auto) Accept Policy: Wired IoT Bridged
✓	Registration Denied Access	**End-System** is in Registration Denied Access	Profile: Registration Denied Access NAC Profile Accept Policy: Deny Access Portal: Default User will be notified that they were denied access to the network.
✓	Web Authenticated Users	**End-System** is in Web Authenticated Users	Profile: Guest-Access Profile (Auto) Accept Policy: Guest-Access Portal: Default The user will be granted access and accepted onto the network.
✓	Registered Guests	**End-System** is in Registered Guests	Profile: Guest-Access Profile (Auto) Accept Policy: Guest-Access Portal: Default The user will be granted access and accepted onto the network.
✓	Registration Pending Access	**End-System** is in Registration Pending Access	Profile: Unregistered NAC Profile Accept Policy: Unregistered Portal: Default User will be denied full access until sponsored.
✓	Unregistered	catch-all rule	Profile: Unregistered NAC Profile Accept Policy: Unregistered Portal: Default Unregistered user will be redirected to Registration web page.
✓	Default Catchall	catch-all rule	Profile: Default NAC Profile Accept Policy: Unregistered

6. Rules for wired users in a campus of ERS switches are configured in much the same manner. The rest of the rules above still apply:

✓	Access Point - Campus3	**End-System** is in Access Points *and* **Location** is in Campus3	Profile: Access Point - Campus3 Profile (Auto) Accept Policy: Access Point - Campus3, v300[300]
✓	Campus3-Admin-MAC	**Authentication** is MAC *and* **End-System** is in Campus3-Admin *and* **Location** is in Campus3	Profile: Campus3-Administrator Profile (Auto) Accept Policy: Campus3-Administrator, v302[302]
✓	Campus3-Admin-dot1x	**Authentication** is 802.1X *and* **User** is in Administrators *and* **Location** is in Campus3	Profile: Campus3-Administrator Profile (Auto) Accept Policy: Campus3-Administrator, v302[302]
✓	Campus3-IoT-MAC	**Authentication** is MAC *and* **End-System** is in Campus3-IoT *and* **Location** is in Campus3	Profile: Campus3-IoT Profile (Auto) Accept Policy: Campus3-IoT, v301[301]
✓	Campus3-IoT-dot1x	**Authentication** is 802.1X *and* **User** is in IOT *and* **Location** is in Campus3	Profile: Campus3-IoT Profile (Auto) Accept Policy: Campus3-IoT, v301[301]
✓	Campus3-User-MAC	**Authentication** is MAC *and* **End-System** is in Campus3-User *and* **Location** is in Campus3	Profile: Campus3-User Profile (Auto) Accept Policy: Campus3-User, v303[303]
✓	Campus3-User-dot1x	**Authentication** is 802.1X *and* **User** is in Technician *and* **Location** is in Campus3	Profile: Campus3-User Profile (Auto) Accept Policy: Campus3-User, v303[303]
✓	Campus3-Surveillance-MAC	**Authentication** is MAC *and* **End-System** is in Campus3-Surveillance *and* **Location** is in Campus3	Profile: Campus3-Surveillance Profile (Auto) Accept Policy: Campus3-Surveillance, v304[304]
✓	Campus3-IoTBridged-MAC	**Authentication** is MAC *and* **End-System** is in Campus3-IoTBridged *and* **Location** is in Campus3	Profile: Campus3-IoT Bridged Profile (Auto) Accept Policy: Campus3-IoT Bridged, v907[907]

A summary of the Non-Default rules:

- **Administrator**: Three rules are created - two for Wired and one for Wireless. Wired users can access the network through MAC authentication or 802.1X, whereas Wireless Administrator users may only access via 802.1X. When the conditions of a rule are met the corresponding Profile (which contains the Accept Policy Role) is assigned to that user.
- **Campus User** and **IoT Campus**: These rules are set up the same way as Administrator, with three rules each, with successful matching of conditions resulting in assignment to their corresponding Role and VLAN.
- **IoT-Legacy** and **Wired IoT Bridged MAC:** These rules are for 3rd party or legacy devices that may not be compatible with the supported authentication methods. In these cases, MAC authentication is used to assign them to the appropriate Role.
- **Deny Access:** Any MACs not authorized under IoT Legacy is assigned to the Quarantine role and denied access.
- **Surveillance MAC wired:** MAC authentication is used to identify the Vendor OUI of the IP Cameras.
- **Netadmin**: This is an 802.1X rule for administrators to authenticate when accessing network devices via SSH. When administrators authenticate via the LDAPs User Group “Netadmin”, the Netadmin Policy Mapping (noted in Profiles and Policy Mappings) is applied allowing CLI access.

- **Unregistered**: This rule is used as a catch-all for unauthenticated users, who are redirected to the Captive Portal for Registration to the network.
- **Registered Guests:** Upon successful registration via the Portal, Guest Users then match this rule and are assigned the Guest-Access Role.

7. Upon successful passing of an ExtremeControl rule, the corresponding Accept Policy is sent back to the Radius Client (access switch or Access Point) to be applied to the end user.

Extreme Wireless Configuration

ExtremeWireless Controller Configuration

This section includes an easily implemented, efficient solution to service wireless users that require access to the network. The ExtremeWireless User Access uses two wireless controllers and multiple APs for redundancy. Each wireless controller is connected to separate Fabric Connect switches in the server rooms. This provides redundancy, so that if one of the controllers, switches, or server rooms fails, the other can assume control.

At all locations, access points are connected to the ExtremeSwitching access stacks. This architecture allows a pair of controllers to control many APs, making the administration and management of large networks much easier and adding a layer of protection for network availability.

This solution implements two ExtremeWireless Controller virtual appliances, to maximize flexibility, ease of installation, and support for a wide variety of APs. Extreme's virtual appliances have resiliency built in from the start. Running as active-active pairs, if an appliance happens to fail the other appliance can take over the full load while maintaining AP connectivity. Failover occurs within milliseconds; APs continue running without interruption to existing or new client connections.

Virtual Wireless Controller Configuration

Before configuring wireless network access, some basic accessibility settings must be made on the wireless controllers.

The ExtremeWireless appliance can be managed from a console, from a graphical interface, and from Extreme Management Center. For this Validated Design, only the graphical interface and Extreme Management Center configurations are presented. After the initial installation, the management IP address must be configured from the console. For more details on how to configure the virtual wireless controller from the console, see the GTAC Knowledge documentation.

To access the configuration graphical interface, enter the following address into the browser https://<ip_adddress>:5825 .

All configurations are executed only on the primary wireless controller; they are automatically mirrored on the secondary wireless controller.

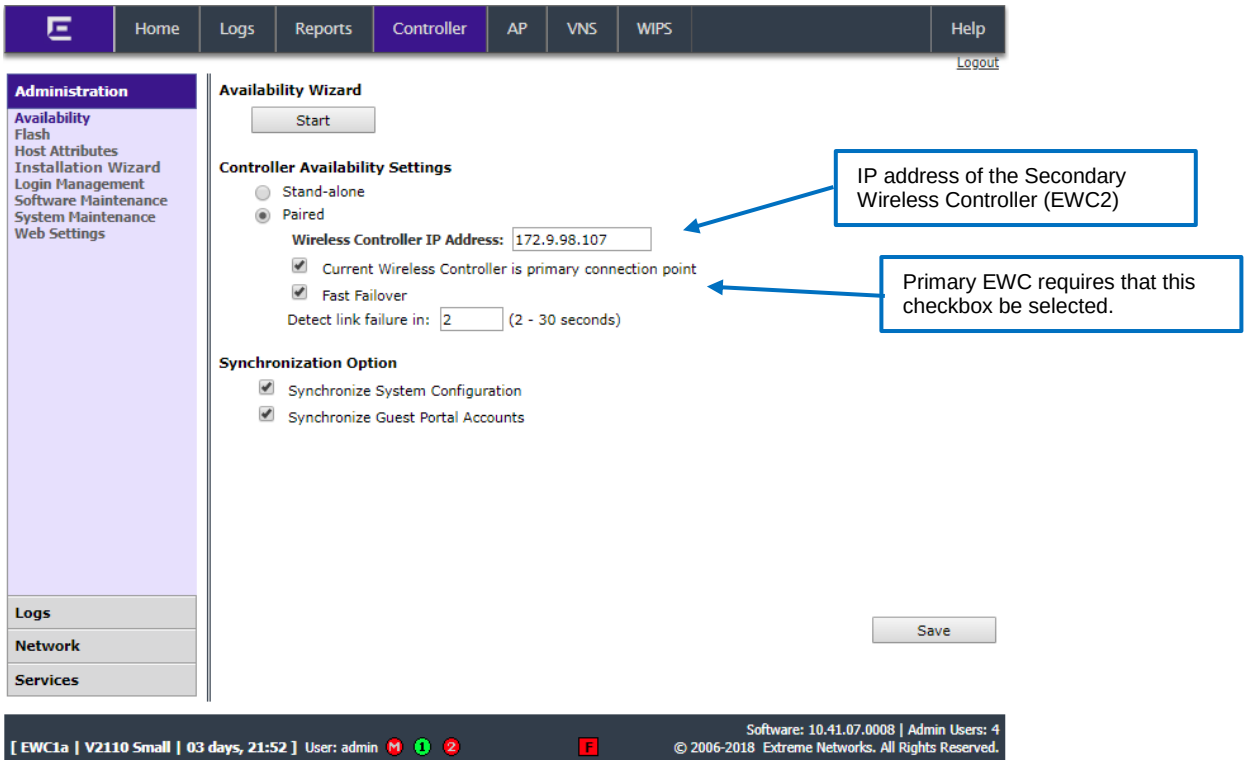
The NTP server must be configured to ensure that both wireless controllers have the same time. If the times are not synchronized, an error will be generated, and the pairing will not be completed. For details, refer to Network Time Protocol (NTP) in Design Considerations.

Wireless controllers should be added to Extreme Management Center for Policy and ExtremeControl rules enforcement.

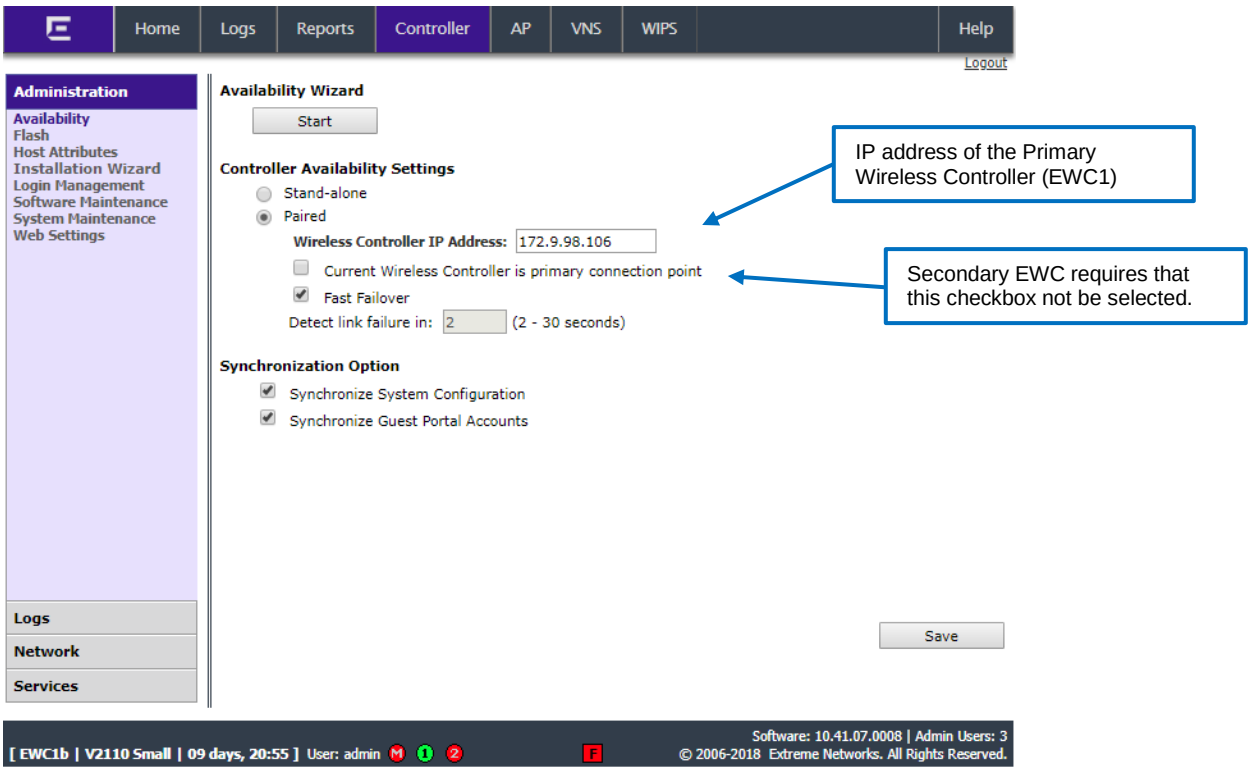
Pairing Configuration

To ensure redundancy, the two wireless controllers must maintain the same configuration. This is achieved by configuring pairing. To configure pairing, go to **Controller → Administration → Availability**.

ExtremeWireless Controller 1 (EWC1):



ExtremeWireless Controller 2 (EWC2):



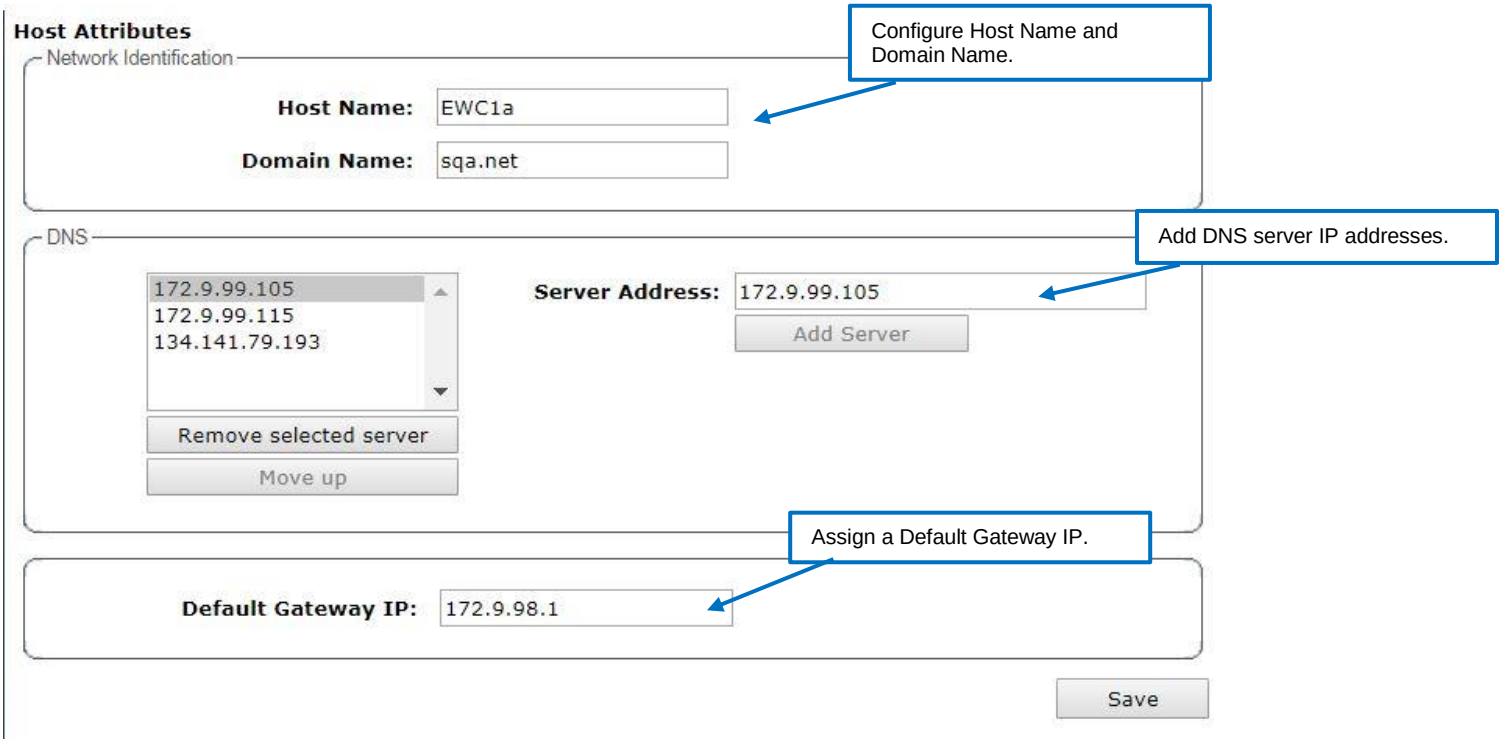
Host Attributes Configurations

The wireless controller's DNS host name, default gateway, DNS server address(es), and domain name are configured on the **Host Attributes** page. The Automated Campus solution uses two DNS servers for redundancy. **The settings must be made on both wireless controllers because they are not automatically mirrored.**

The controller sends the host name query to the first DNS server in the list. If this is not reachable then the controller sends the host name query to the second DNS server.

The **Host Attributes** page can be found under **Controller → Administration**.

EWC1 and EWC2



Routing Configuration

The virtual wireless controllers are network devices and must be able to route user traffic to the different appliances and servers used in the Validated Design (ExtremeControl engines, DHCP, DNS, NTP servers). Also, the wireless controllers have networks directly connected, that must be advertised to the rest of the setup. For the Automated Campus solution, static routing was implemented.

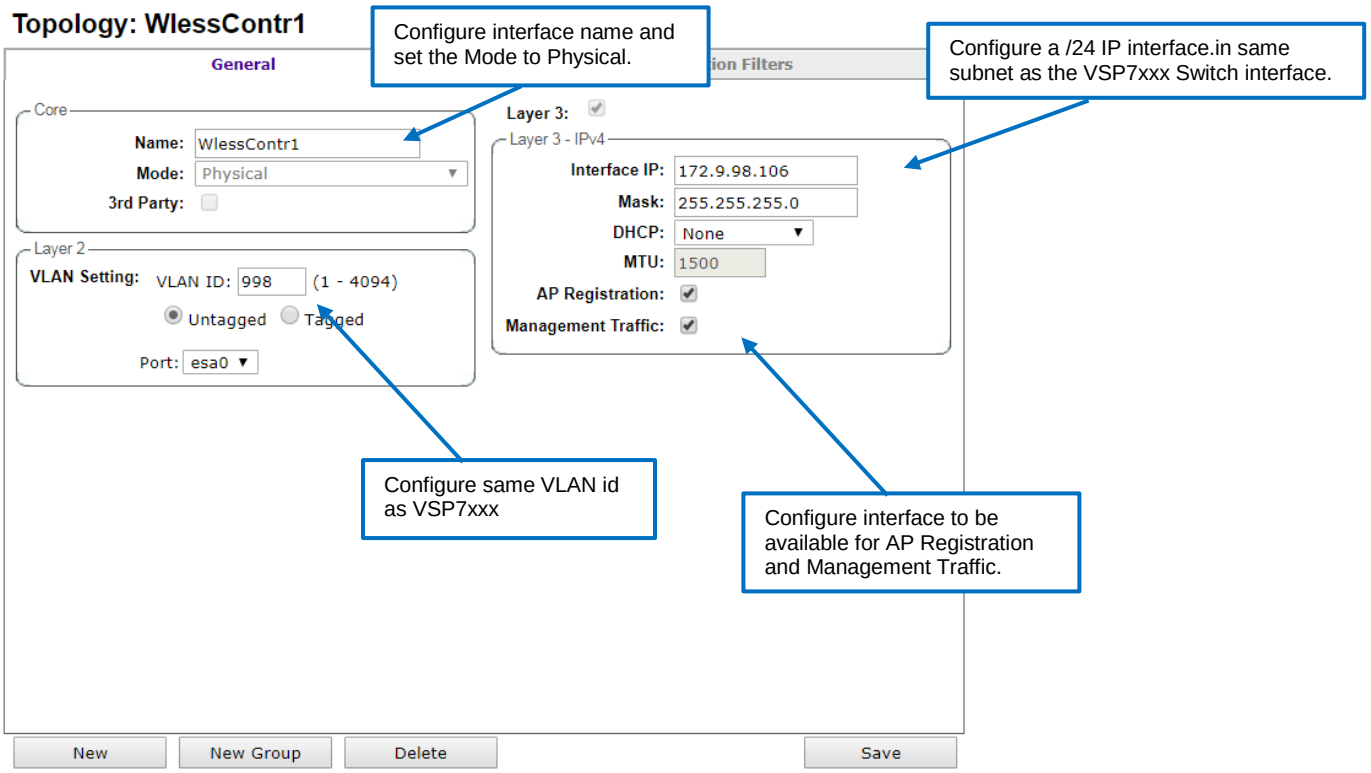
First, the **esa0** interface must be created on both wireless controllers and on the VSP7xxx switches.

Refer to the DVR Configuration (Leaf) section for the IP interface configuration to connect the wireless controllers to the setup.

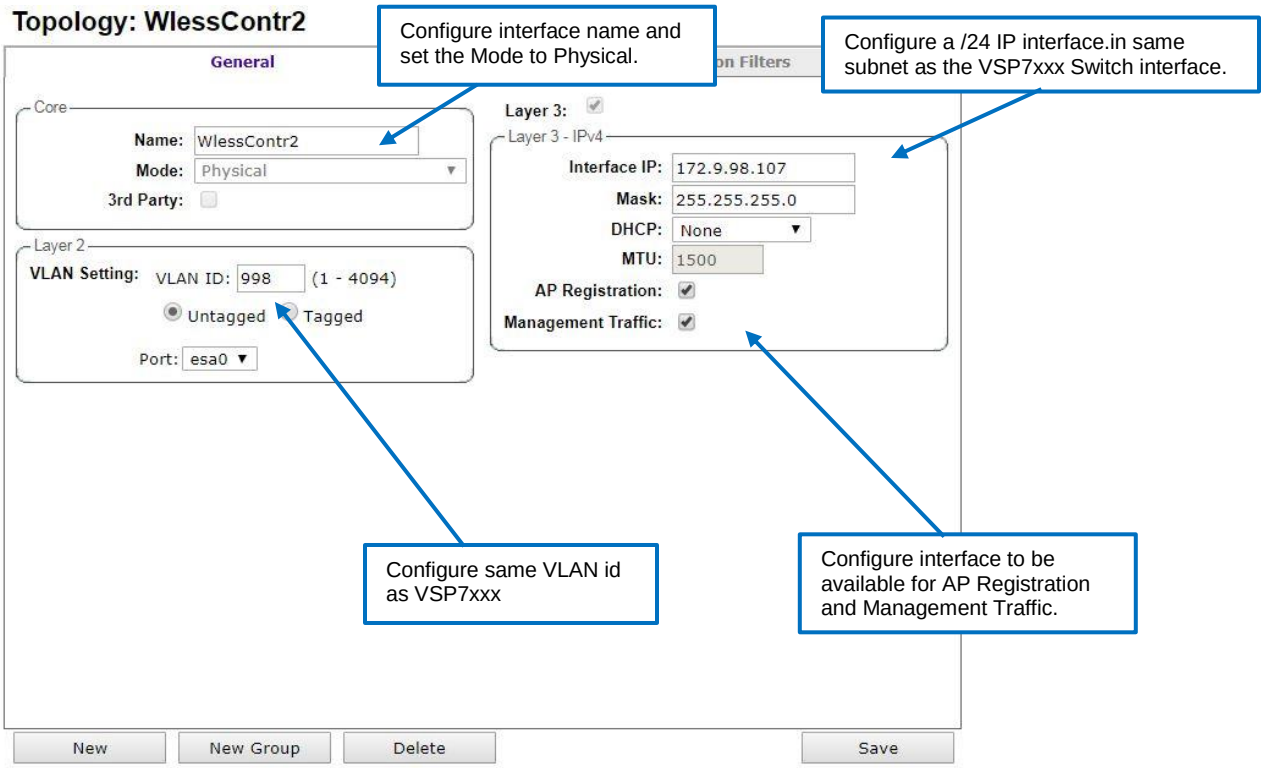
1. **Configure an interface on Wireless Controllers to connect to the VSP 7200s.**

   To create the interface on the Wireless appliance, go to **Controller → Network** and click **New**.

EWC1



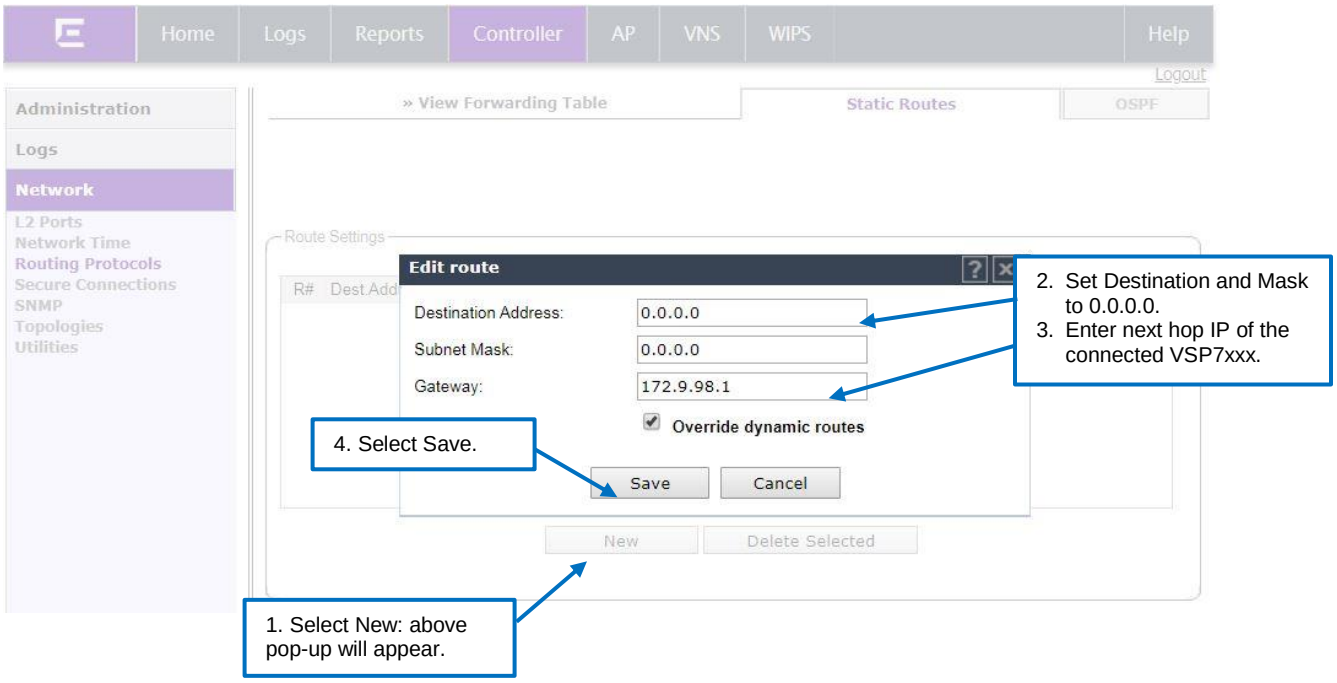
EWC2



2. **Configure Default Route on Wireless Controllers to establish connectivity with network:**

   - To configure a static route on the esa0 interface go to **Controller → Network → Routing Protocols → Static Routes**.
   - Click the **New** button to enter route configuration.

EWC1 and EWC2:

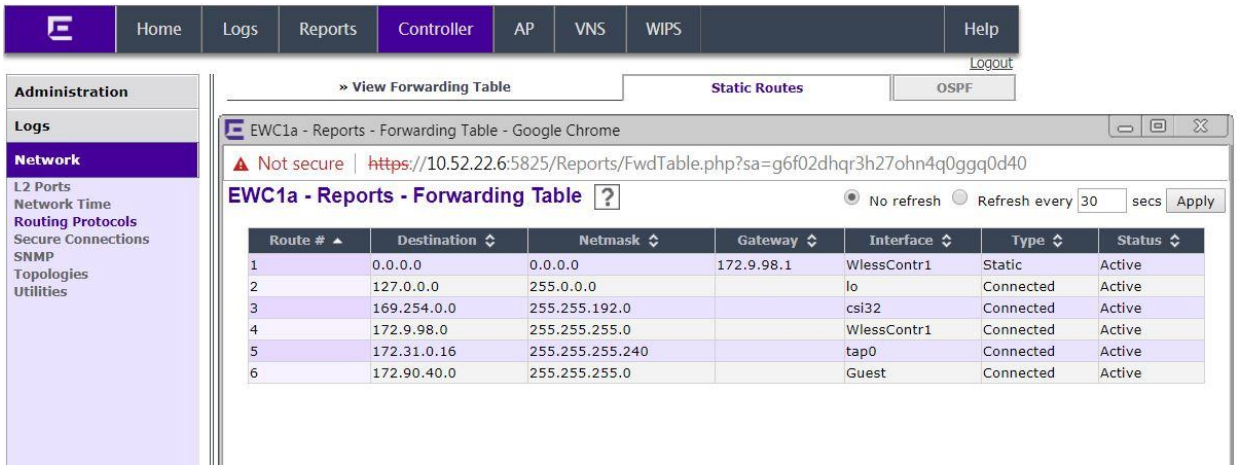


Note
Due to the DVR Domain configuration in the server rooms, the next hop gateway IP address will be the same on each EWC.

3. **Verify forwarding table on EWCs.**

   To verify the status of the static route, click the forwarding table tab. A new browser page will open, and the routing table of the wireless controller is displayed.

   Controller → Network → Routing Protocols → View Forwarding Table



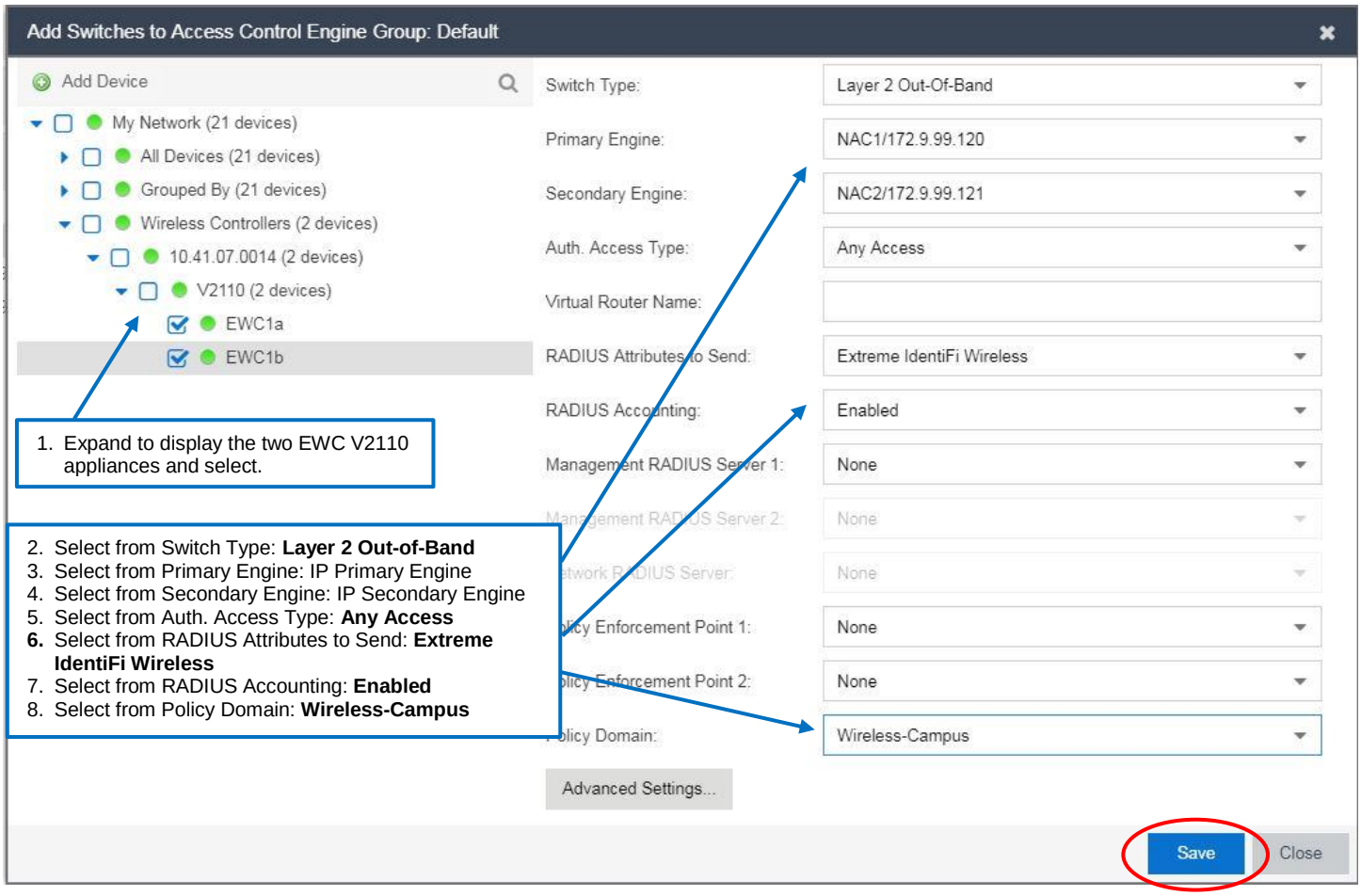
Wireless Controller Access Control Configuration

The wireless controllers use the ExtremeControl servers to provide multiple services like authentication, role-based management for users, CoS marking, access control policies, and captive portal. Because of the VLAN's role and policy requirements, the wireless controllers have their own domain.

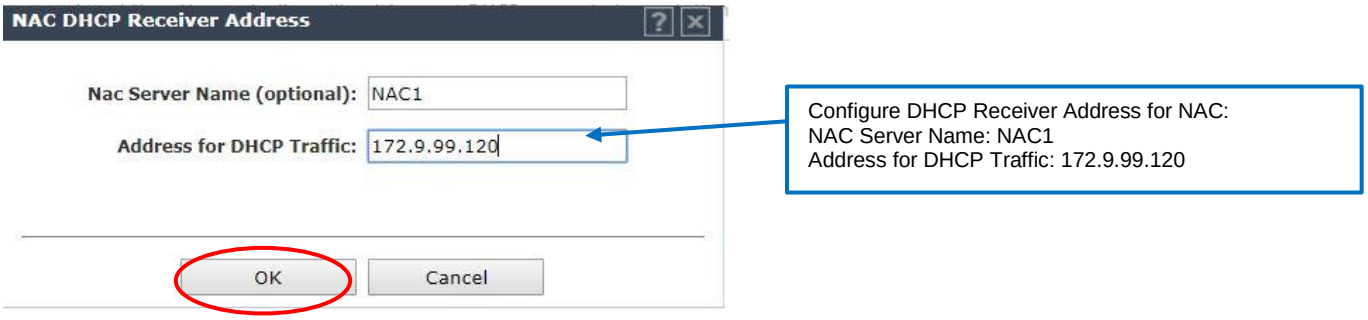
The wireless controllers will use the ExtremeControl engines as RADIUS servers, and both wireless controllers need to be added in the Switches list.

Note
To add the EWCs to the ExtremeControl engine, they must first be manageable via XMC.

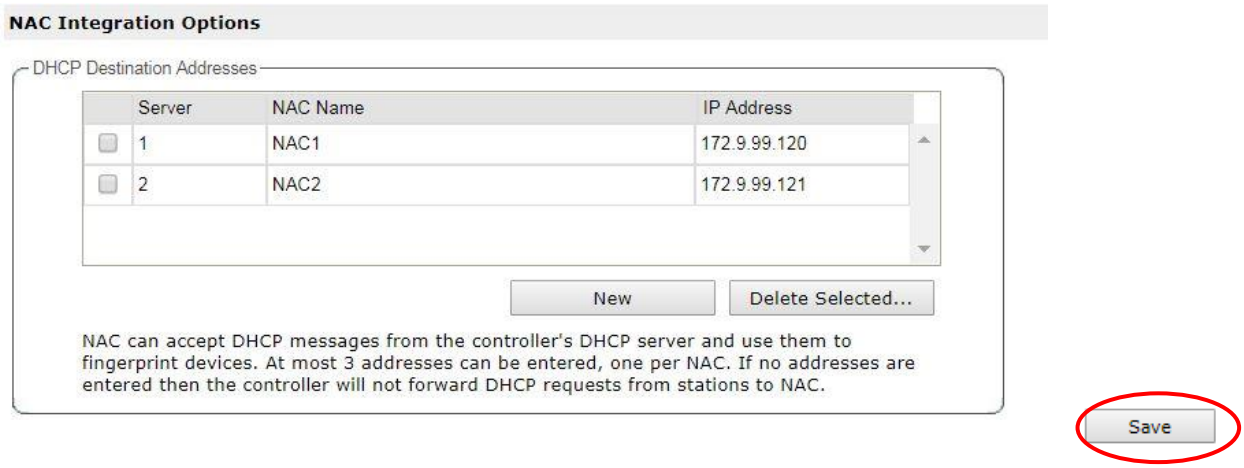
1. To add the EWCs to ExtremeControl, navigate to **Control → Access Control → Engines → Engine Groups → Default → Switches → Add**



1. The wireless controllers will use the ExtremeControl engines as RADIUS servers, to authenticate users connecting to the secured wireless networks and for integration with DHCP. To define the ExtremeControl engines for DHCP integration go to **VNS → Global → NAC Integration → New** and add both ExtremeControl engines:

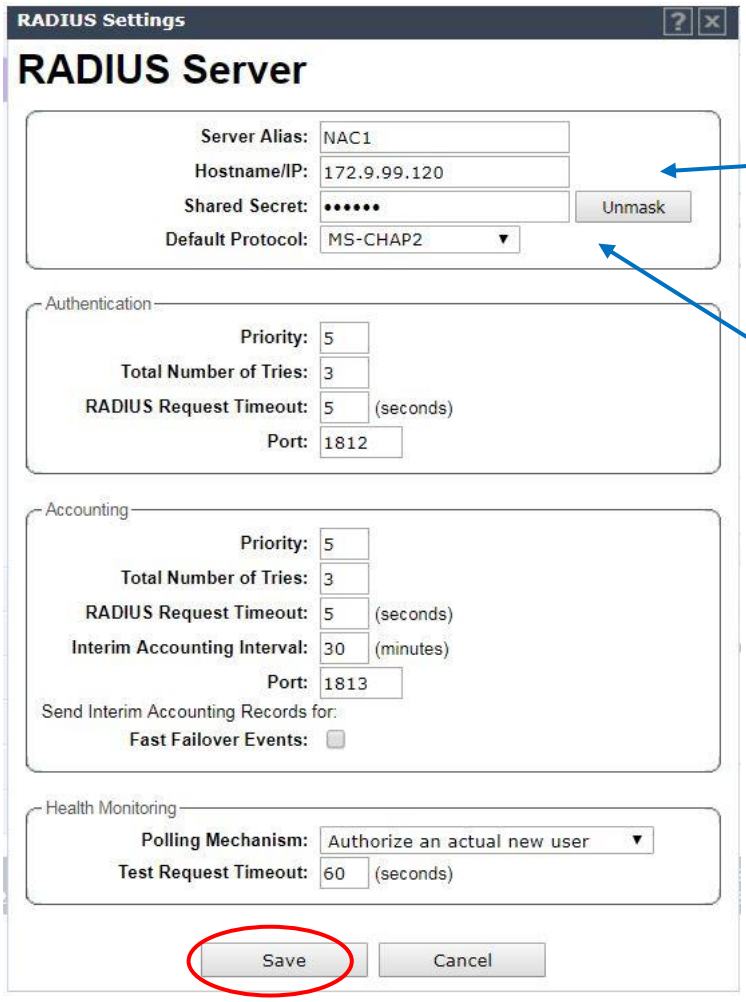


- Both ExtremeControl engines are added, for redundancy.



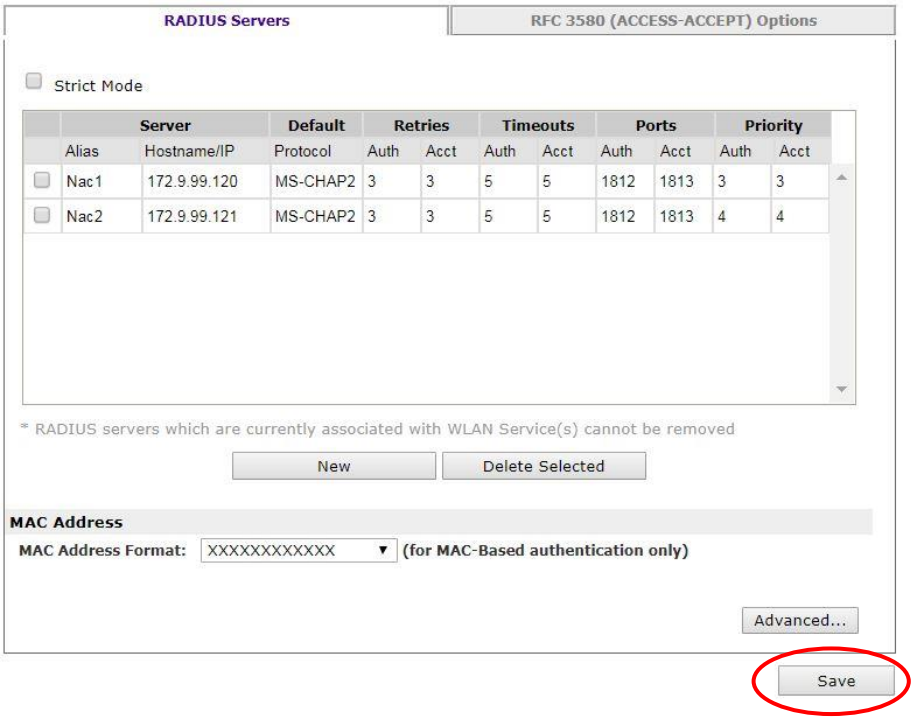
2. To define the ExtremeControl engines as RADIUS servers, go to **VNS → Global → Authentication → RADIUS Servers → New**

   Both ExtremeControl engines are added, for redundancy.



Add/Configure RADIUS Server for both NAC engines:
NAC Server Name: NAC1 /NAC2
Hostname/IP: 172.9.99.120/172.9.99.121

Configure a shared secret password that matches the shared secret in the ExtremeControl AAA setting **(Access Control→Configuration→AAA→Radius Servers)**

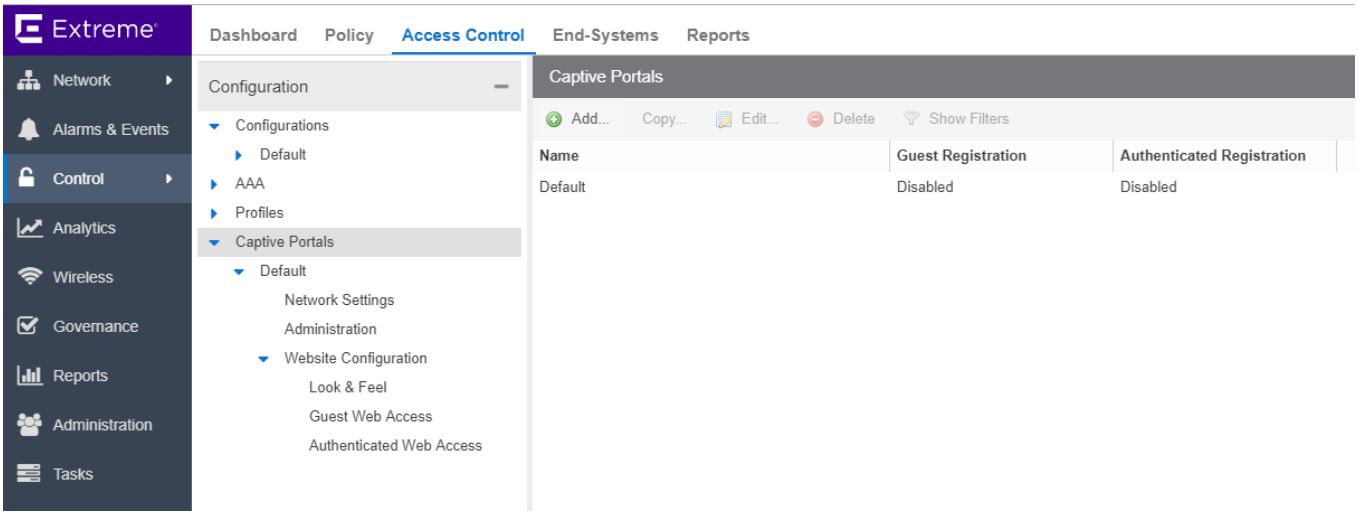


Captive Portal Configuration

Captive portal is used by the wireless users connecting to the network as guests.

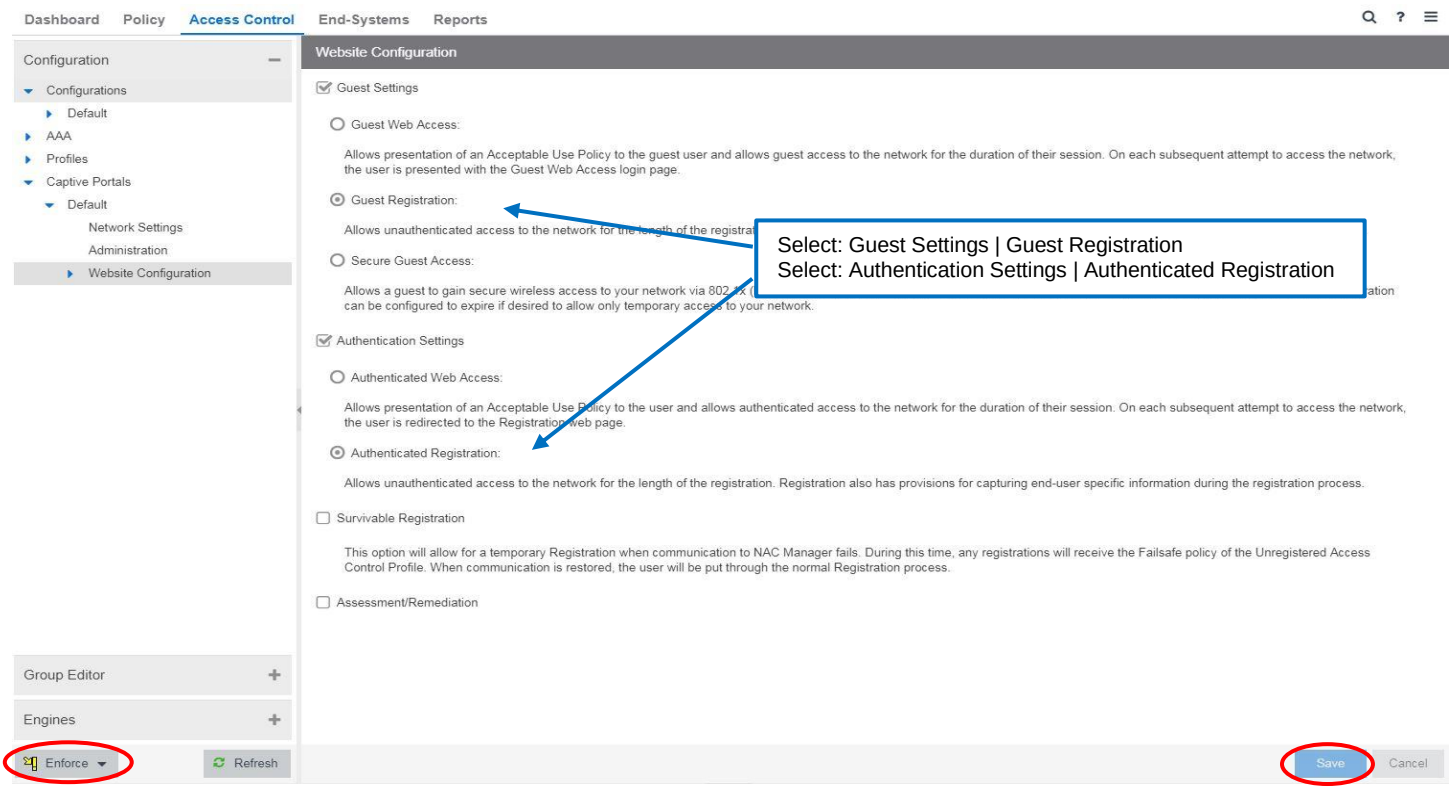
Captive portal must be configured on the ExtremeControl engines. The <Default> captive portal profile is used for the Automated Campus Validated Design and requires minimum configuration from the Extreme Management Center Control tab.

Control → Access Control → Configuration → Captive Portals



Guest Web Access and **Authenticated Registration** were selected. The default settings were used for the rest of the parameters. Enforce configuration on the ExtremeControl engines for the settings to take effect.

Control → Access Control → Configuration → Captive Portals → Website Configuration

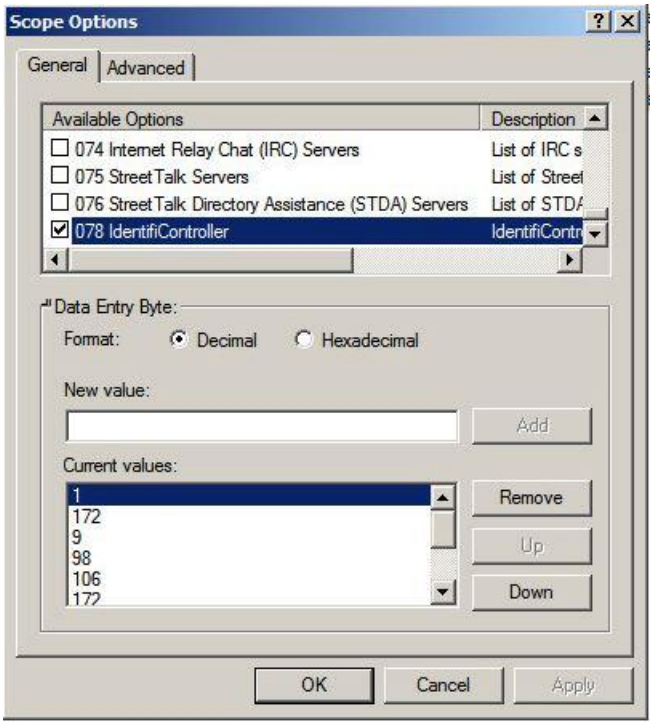


Wireless AP Discovery

Ensure that the appropriate services on your enterprise network are prepared to support the discovery process. To use a DHCP server for wireless AP discovery, ensure that it supports option 78 (DHCP for SLP RFC2610). The APs use this method to discover the controller(s), and option 78 must be set for the subnets connected to the ports of the controller and the subnets connected to the APs.

Below is an example of how this might be configured in Windows Server 2008.

To configure DHCP option 78 on the DHCP server, right click on the **Scope Options** for the scope meant to service the APs and select **Configure Options**. Select option 78 and configure the IP addresses of both wireless controllers. Besides redundancy, this also ensures load balancing between the two appliances. The first value introduced must be 1. This value announces that the following fields represent IP addresses for wireless controllers. Use the **New Value** box to enter the addresses, byte by byte. For the Automated Campus solution, the **esa0** interface is used for AP connection.



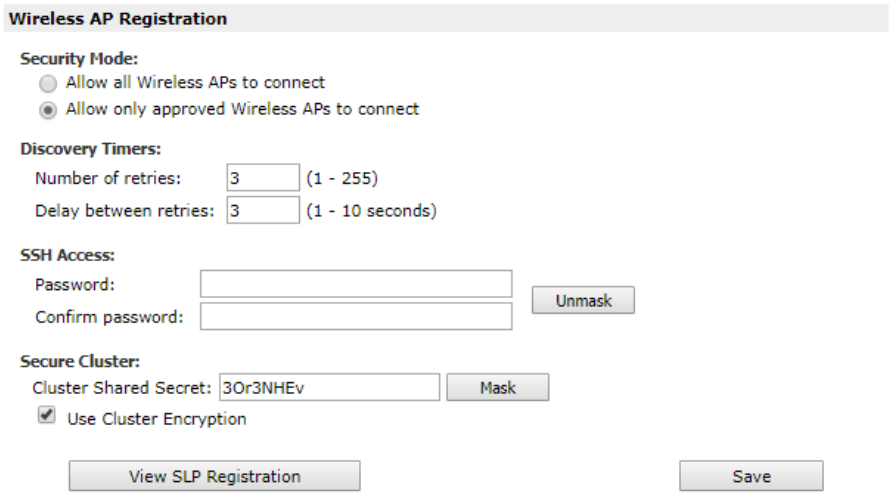
The AP does not use the DNS information from the initial DHCP offer supplied from the DHCP server. After the IP setup stage, the AP decides whether to use the static controller IP or start its discovery methods. If SLP/DNS/VCI discovery is started, the AP sends periodic DHCP informs to get more data to complete its boot discovery methods. If the DHCP server does not reply to the inform, the process to contact the controller will fail and start over.

Wireless AP Registration

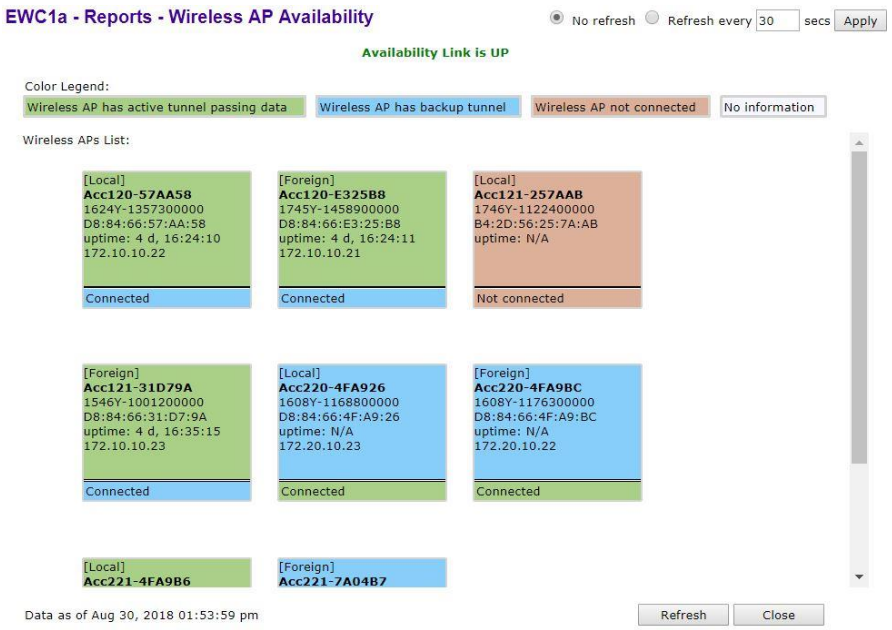
When the discovery process is successful, the AP registers with the wireless controller. At this point, the controller can be configured with one of the following security modes, which defines how the controller behaves when registering new/unknown devices:

- Allow all Wireless APs to connect: If the controller does not recognize the registering serial number, a new registration record is automatically created for the AP and receives a default configuration. If the controller recognizes the serial number, it indicates that the registering device is pre-registered with the controller and uses the existing registration record to authenticate the AP and the existing configuration record to configure the AP
- Allow only approved Wireless APs to connect (secure mode): If the controller does not recognize the AP, the AP's registration record is created in pending state and the administrator is required to manually approve a pending AP for it to provide active service. The pending AP receives minimum configuration only, which allows it to maintain an active link with the controller for future state change.

AP → Global → Registration

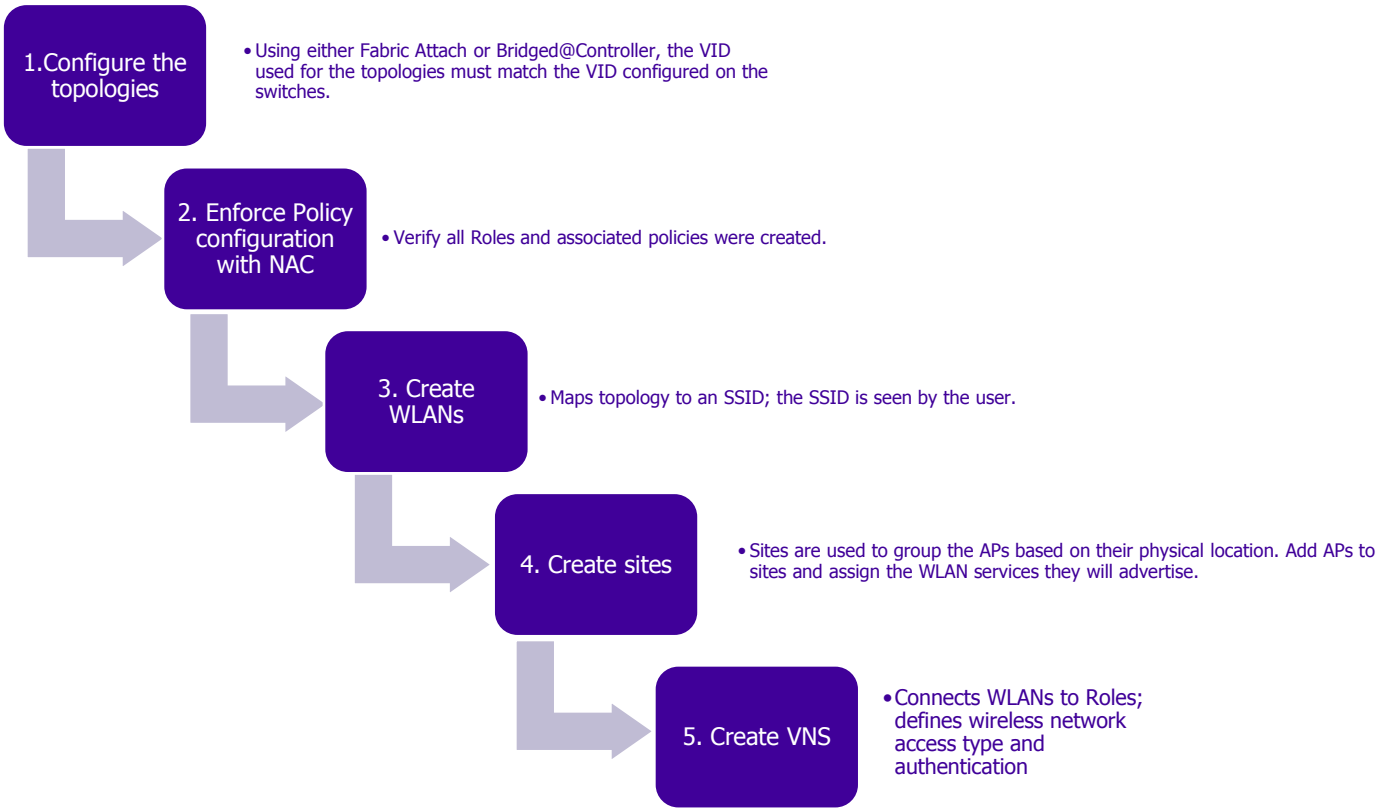


- To verify the AP availability, go to Reports → **APs → AP Availability**



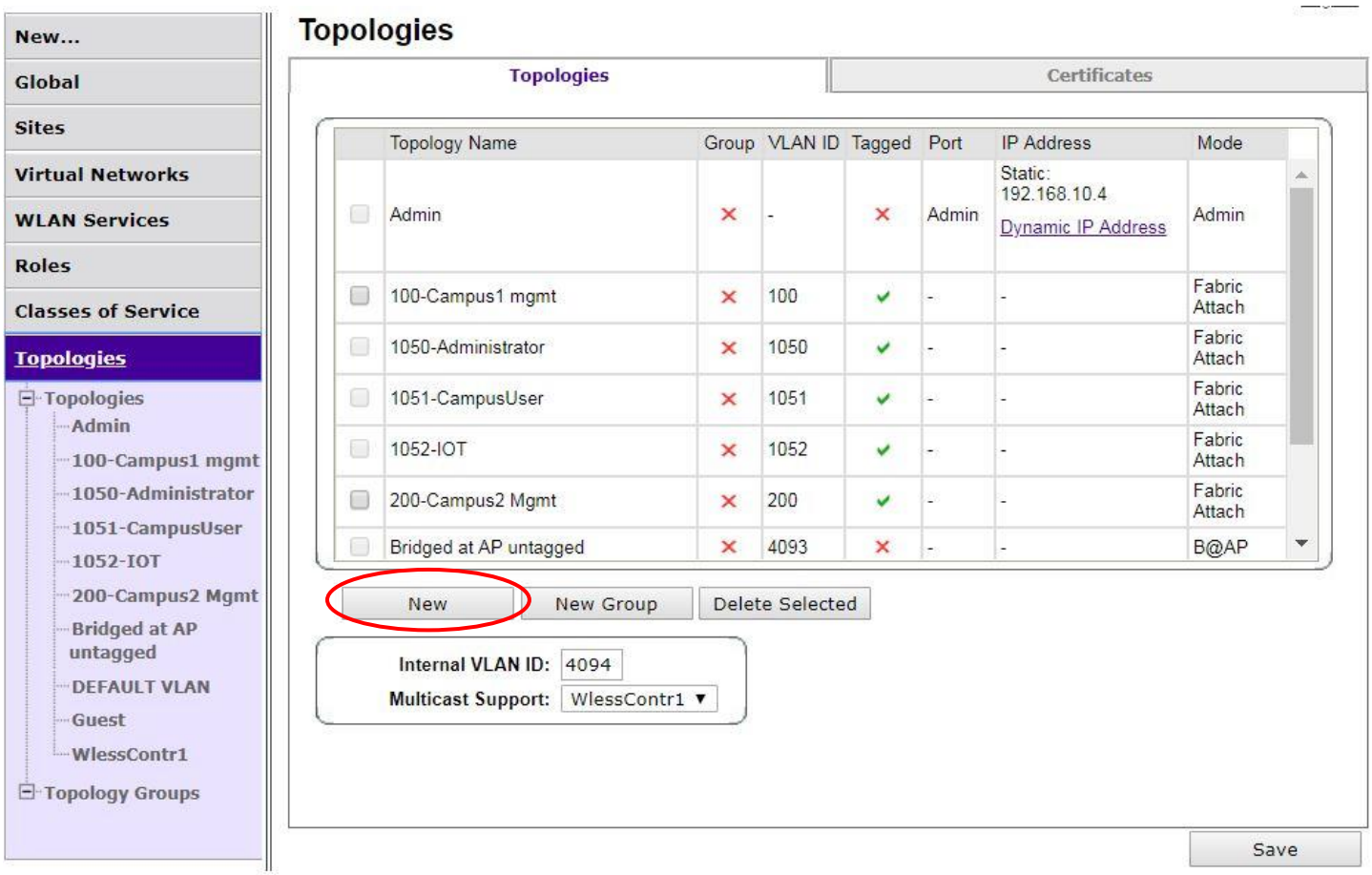
Wireless Network Configuration

For a wireless network to become accessible to users, configurations must be created in the following sections: **Topologies, Roles, WLAN Services, Virtual Networks and Sites.** There is a dependency between the sections and a configuration order must be followed.



1. Topology Configuration

In this section, the physical access provisioning for the user access is created. Every topology is essentially a VLAN. To add a new topology, go to **VNS →Topologies** and click **New**.



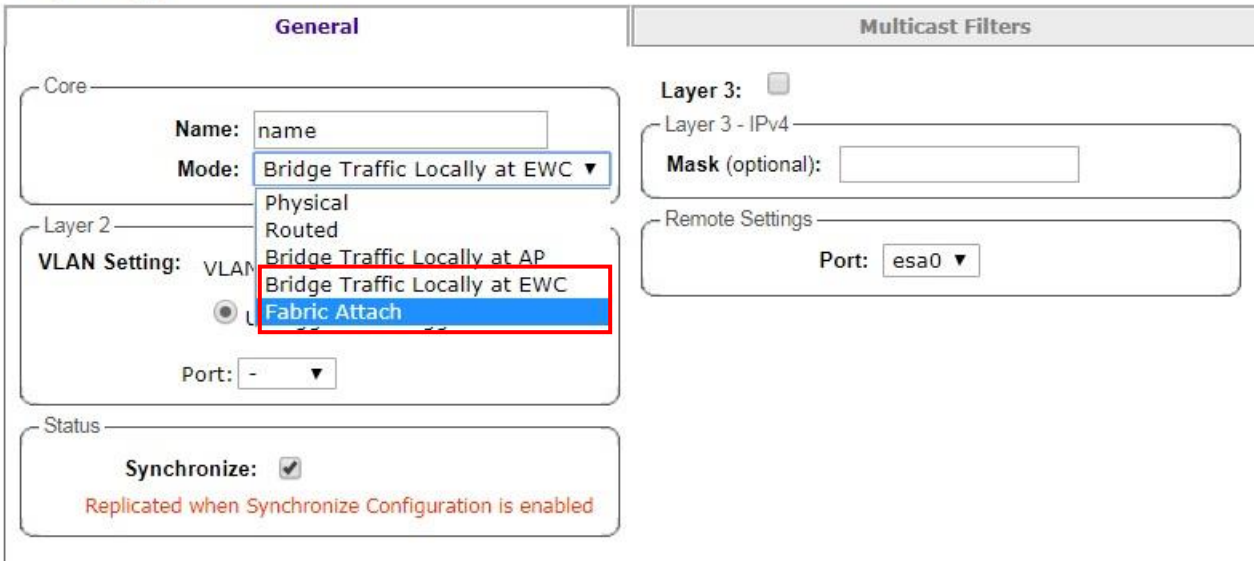
For the topologies that wireless users will use to connect to the network, one of two modes must be selected: **Bridge Traffic Locally at EWC** or **Fabric Attach**. The topology mode dictates how the traffic from the clients is going to be treated.

Bridge Traffic Locally at EWC - Users connecting to the wireless network send the traffic to the AP. The AP encapsulates the traffic and tunnels it to the controller. The controller de-encapsulates the traffic, processes it and sends to the network over the physical 1 interface in the user access VLAN.

Fabric Attach - The Fabric Attach topology type is similar to B@AP with the added I-SID parameter. Upon boot up with this topology mode set, the AP will send the configured VLAN/I-SID value to the FA Proxy, informing its requirement for communication.

- Fabric Attach can be configured on a controller anywhere a B@AP topology can be configured. Users connecting to the wireless network send the traffic to the AP. The AP sends the traffic to the network over its management port in the user access VLAN.

Topology:

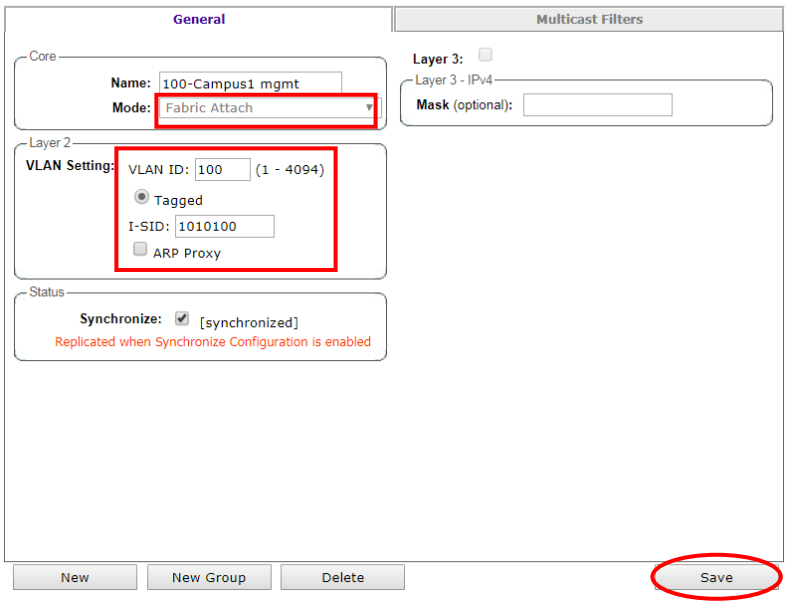


In the Automated Campus solution, Guest and authenticated wireless user access is possible from all campuses. All Guest users are provisioned with a **Bridged@EWC** topology and are placed in the same network. All authenticated users are provisioned with **Fabric Attach** topologies and are placed in different VLAN/subnets, based on the campus they are connected to.

The following user access topologies were configured for the solution:

- **100-Campus1 Mgmt:**

Topology: 100-Campus1 mgmt



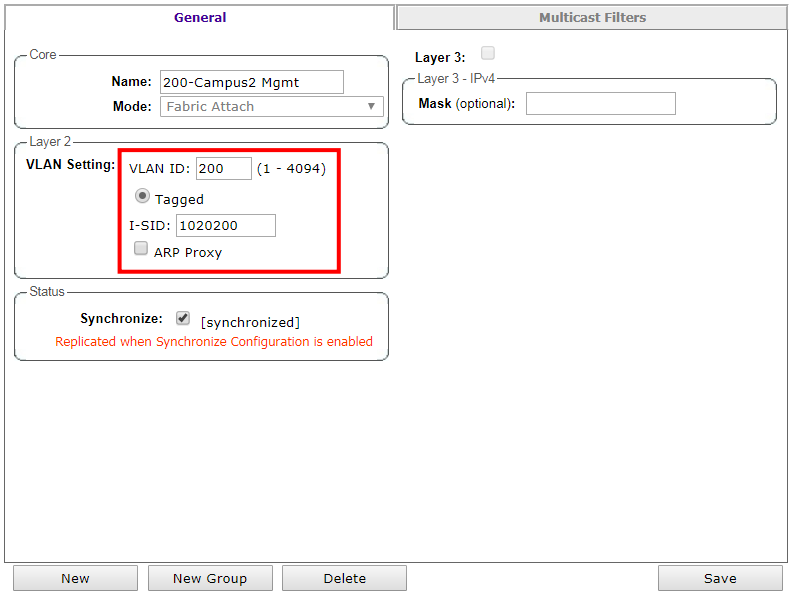
Used by Access Points (FA clients) and access switches (FA Proxies) for FA management to request I-SID information via LLDP, and also used for IP management of the Access Points by the EWCs. The routing is done on the VSP switch acting as the FA server. This VLAN is for use in Campus 1.

The IoT topology is configured as:

- Name: 100-Campus1 Mgmt
- Mode: Fabric Attach
- VLAN ID: 100

- **200-Campus2 Mgmt:**

Topology: 200-Campus2 Mgmt



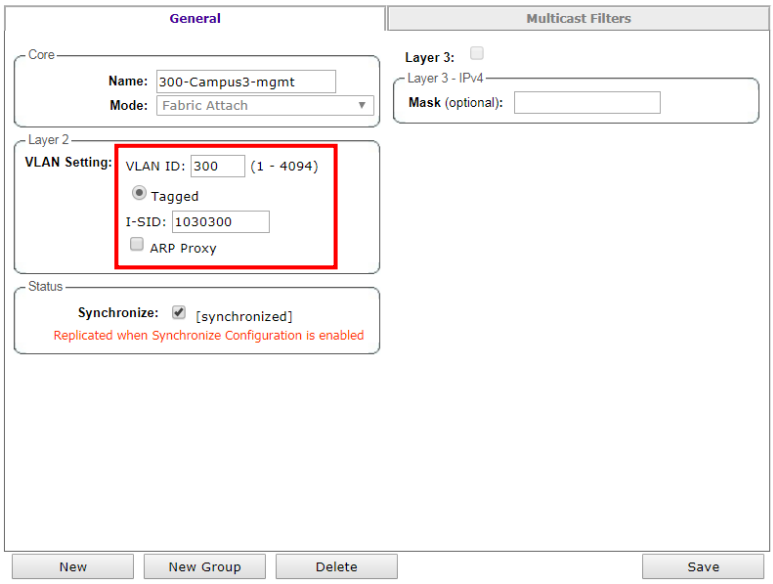
Used by Access Points (FA clients) and access switches (FA Proxies) for FA management to request I-SID information via LLDP, and also used for IP management of the Access Points by the EWCs. The routing is done on the VSP switch acting as the FA server. This VLAN is for use in Campus 2.

The IoT topology is configured as:

- Name: 200-Campus2 Mgmt
- Mode: Fabric Attach
- VLAN ID: 200

- **300-Campus3-Mgmt:**

Topology: 300-Campus3-mgmt



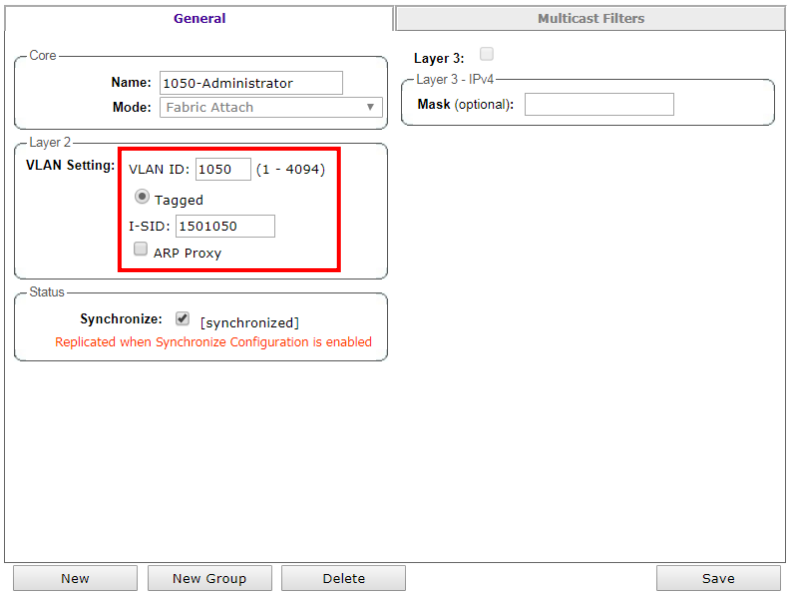
Wireless topologies connecting to ERS access switches are configured identically as for Summits. Used by Access Points (FA clients) and access switches (FA Proxies) for FA management to request I-SID information via LLDP, and also used for IP management of the Access Points by the EWCs. The routing is done on the VSP switch acting as the FA server. This VLAN is for use in Campus 3.

The IoT topology is configured as:

- Name: 300-Campus3 Mgmt
- Mode: Fabric Attach
- VLAN ID: 300
- I-SID: 1030300

- **1050-Administrator:**

Topology: 1050-Administrator



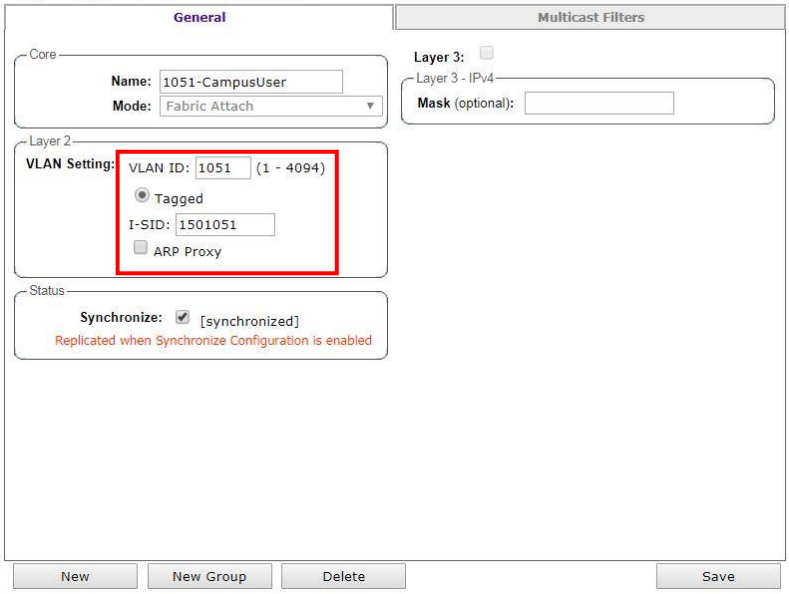
Used by Administrator users connecting to the network and are given the Administrator role. This topology is active in both campuses to allow wireless roaming. The routing is done on the VSP switches acting as the FA server.

The Administrator topology is configured as:

- Name: 1050-Administrator
- Mode: Fabric Attach
- VLAN ID: 1050
- I-SID: 1501050

- **1051-CampusUser:**

Topology: 1051-CampusUser



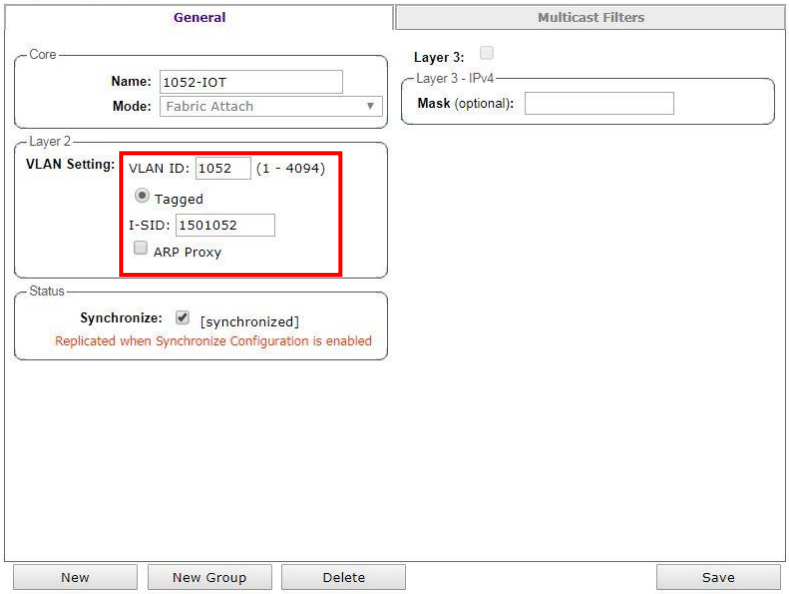
Used by end users with limited access connecting to the network and are given the Campus User role. This topology is active in both campuses to allow wireless roaming. The routing is done on the VSP switches acting as the FA server.

The Administrator topology is configured as:

- Name: 1051-CampusUser
- Mode: Fabric Attach
- VLAN ID: 1051
- I-SID: 1501051

- **1052-IOT:**

Topology: 1052-IOT



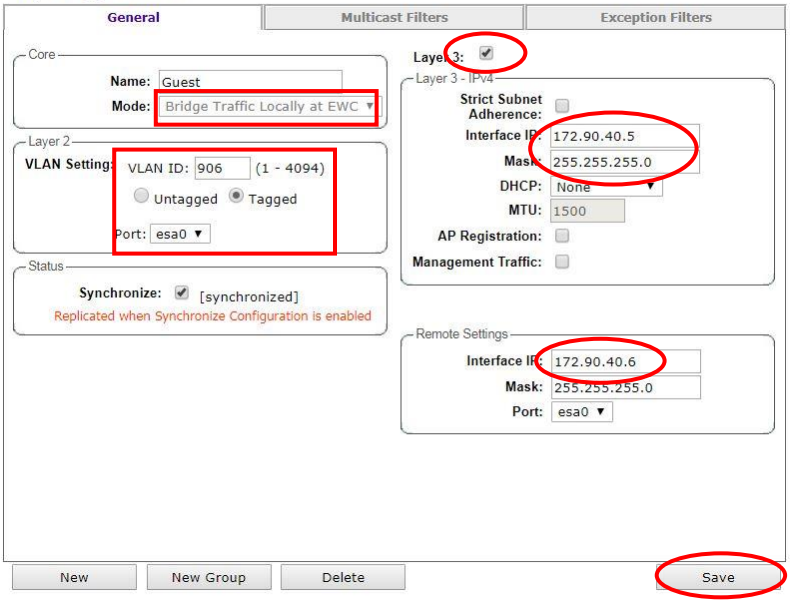
Used by IoT devices and users connecting to the network and are given the IoT-Campus role. This topology is active in both campuses to allow wireless roaming. The routing is done on the VSP switches acting as the FA server.

The Administrator topology is configured as:

- Name: 1052-IOT
- Mode: Fabric Attach
- VLAN ID: 1052
- I-SID: 1501052

- **Guest:**

Topology: Guest



Used by Guest users connecting to the network and are given the Guest-Access role. Access control is performed by the wireless controllers. User traffic is directly routed/tunneled to the EWCs rather than forwarded at the switch via I-SIDs. The EWCs de-encapsulate the tunnel header and egress the original packet back out that interface on VLAN 906. The Guest Wireless VLAN vid 906 is configured on the Server Room switches only.

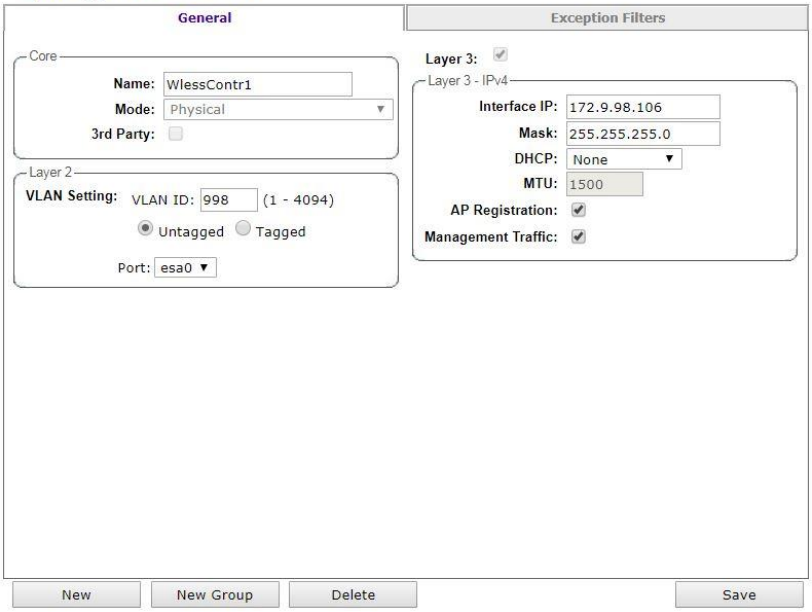
The Layer 3 configuration allows for services (DHCP, captive portal, etc) to be accessed over this network segment in the server rooms. Configure an IP interface for VLAN 906 that corresponds to the EWC's own point of presence on the VLAN. In this case, the EWC interface is typically not the gateway for the Guest subnet, as that resides on the VSPs in the server rooms. For example, the VSP Controllers 910 and 920 have the physical interface of 172.90.40.2 and .3 configured, and they share the virtual gateway IP of 40.1 between them. Therefore, the redundant EWCs' interfaces are configured as 40.5 and 40.6, respectively. Specify the IP of the redundant EWC's Guest IP in the Remote Settings field of each EWC.

The Guest topology is configured as:

- Name: Guest
- Mode: Bridge Traffic Locally at EWC
- VLAN ID: 906 Tagged

- **WlessContr1**:

Topology: WlessContr1



Used by the EWC as the management interface, this topology corresponds to VLAN Wireless WlessContr1 (vid 998). The routing is done on the VSP switch.

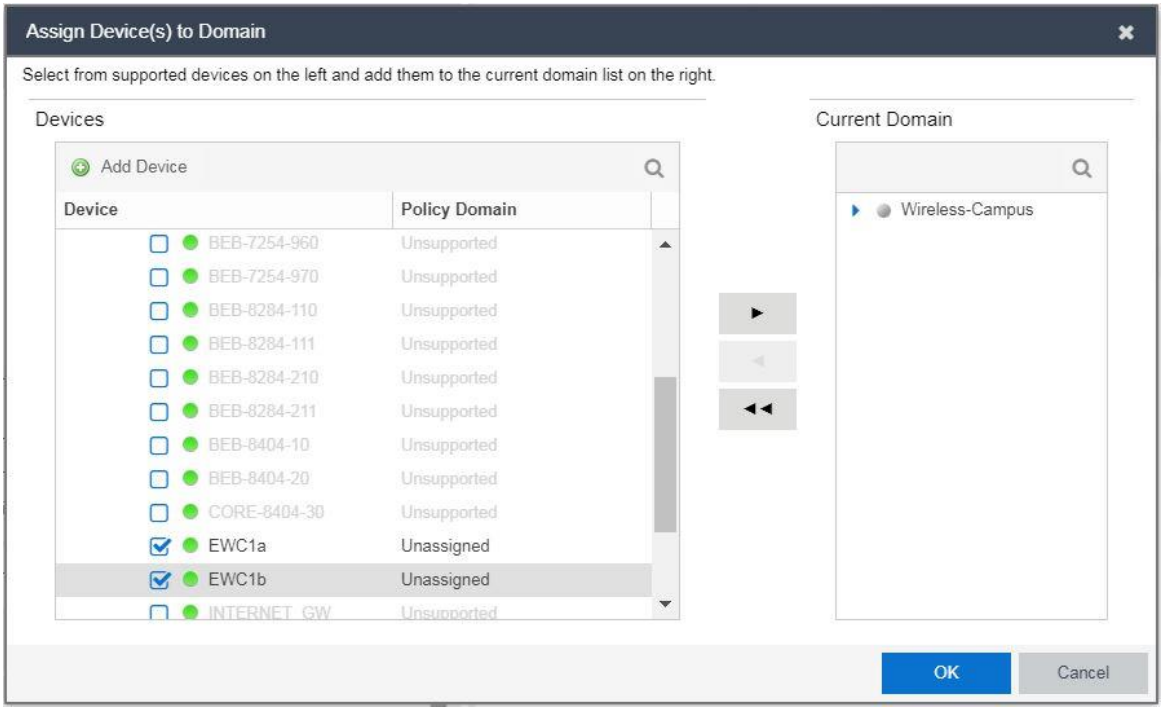
This VLAN is used as the mgmt. IP for the EWCs and AP discovery, as well as the tunnel endpoint for Guest traffic.

The WlessContr1 topology is configured as:

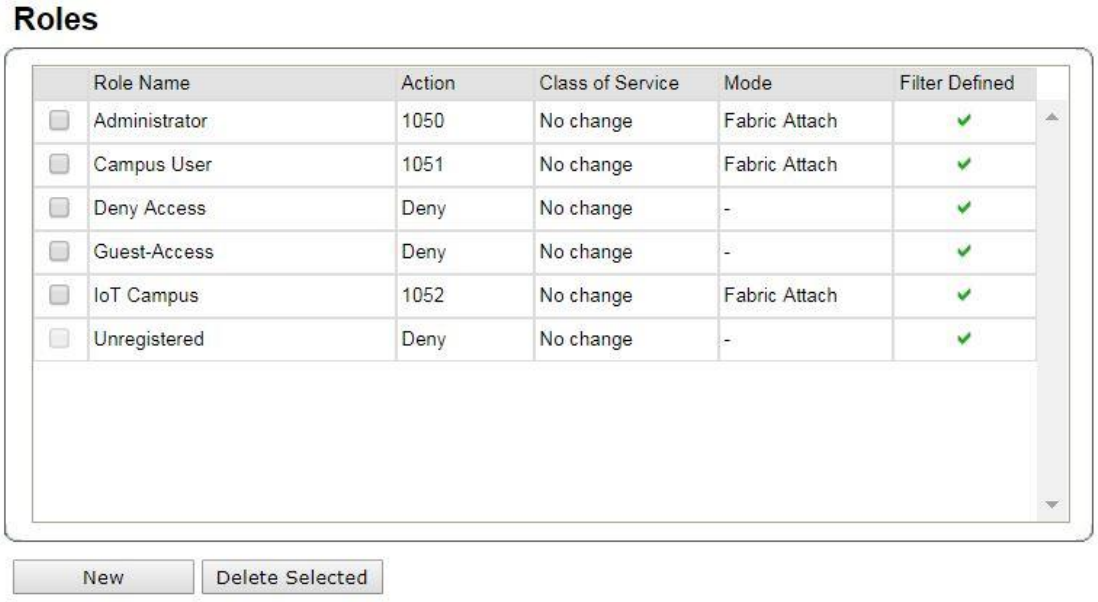
- Name: WlessContr1
- Mode: Physical
- VLAN: 998 Untagged

2. **Enforce Policy Role Configuration**:

The Roles are used for Access Control and will be enforced when ExtremeControl is configured. From **Control →Policy→Open Domain→Assign Devices to Domain**, add the EWCs to the **Wireless-Campus** policy domain:



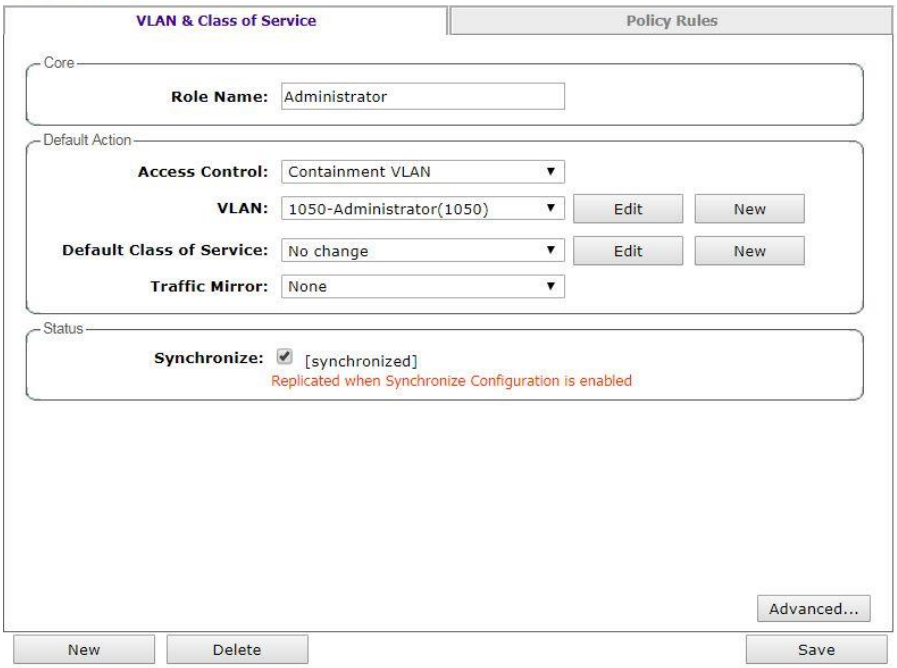
- To verify the settings from Extreme Management Center after Policy Enforce completion, go to **VNS → Roles** and click on each role for detailed configuration:



The following roles were created in XMC and enforced to the controllers:

- **Administrator Role**

Role: Administrator

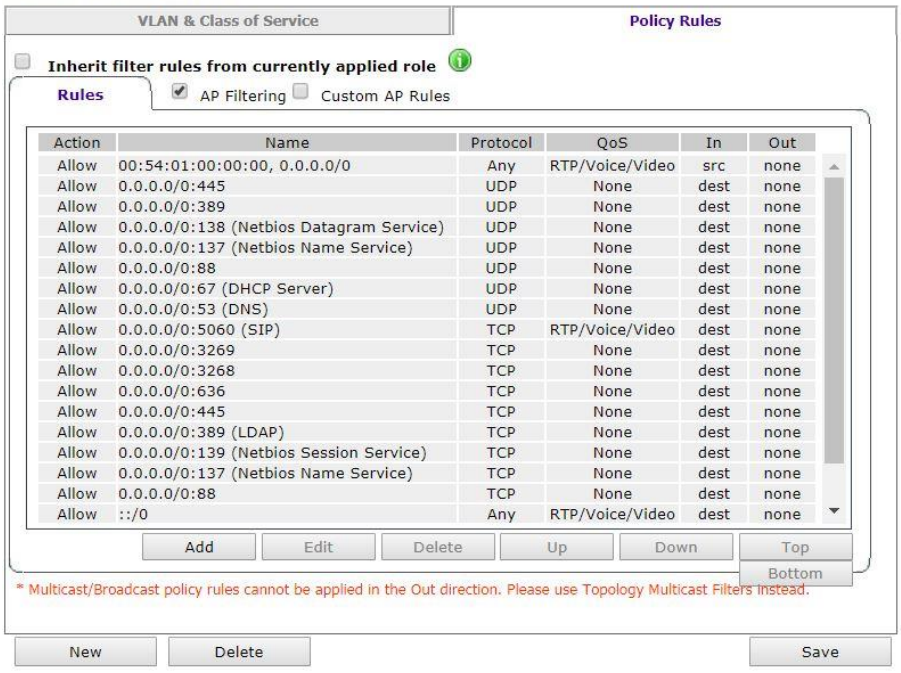


This role is applied to the Administrator users connecting to the network and is assigned to users authenticated as "Administrator". The access control is set to contain traffic to Administrator topology and to mark traffic with CoS priority 5.

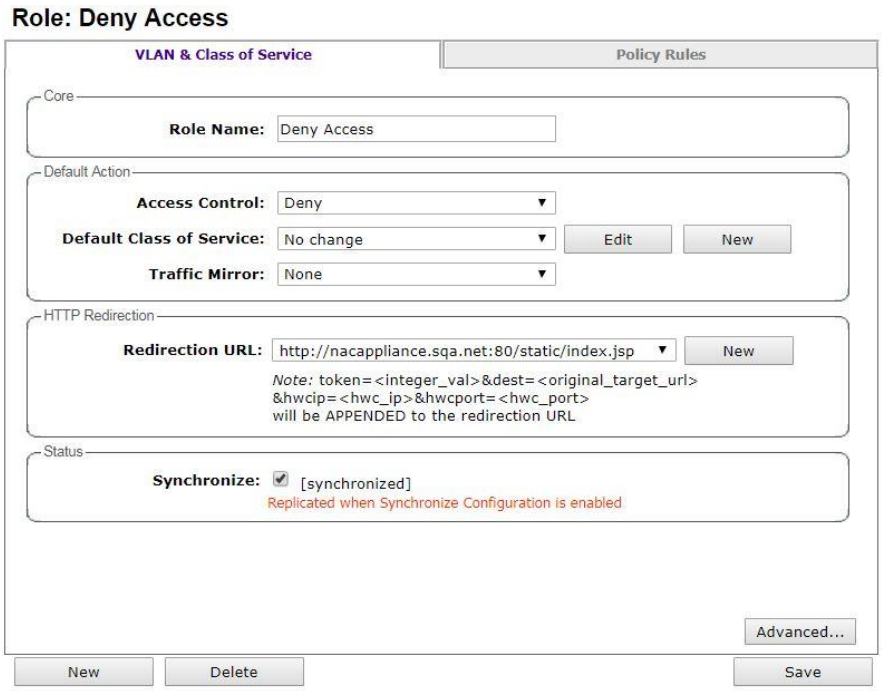
Configure in the following manner:

- Role Name: Administrator
- Access Control: Containment VLAN
- VLAN: admin(1050)

Role: Administrator



- **Deny Access Role**

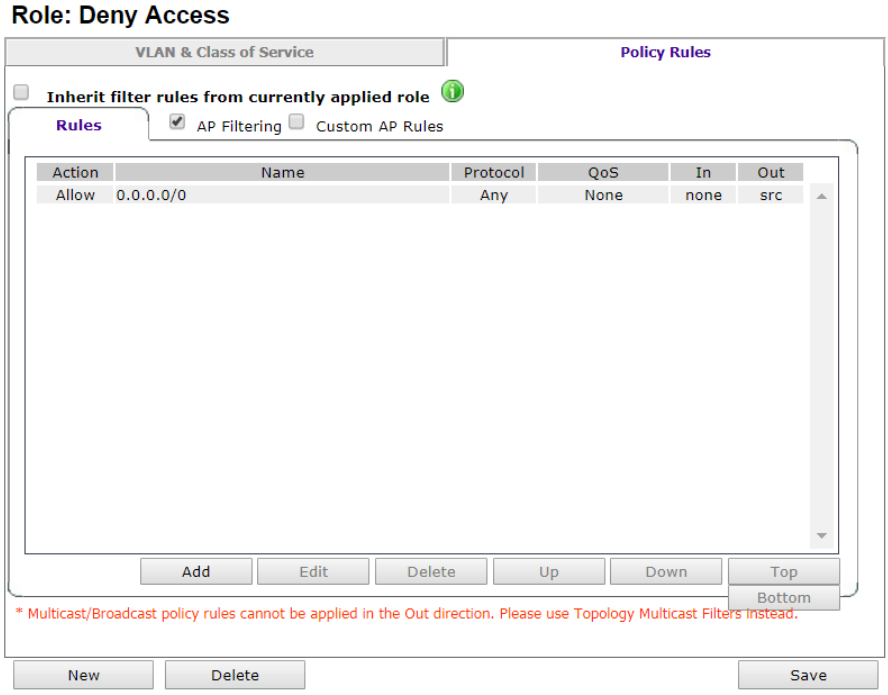


This role is assigned to users who fail authentication. All traffic is dropped, except for the traffic explicitly allowed by the policy rules.

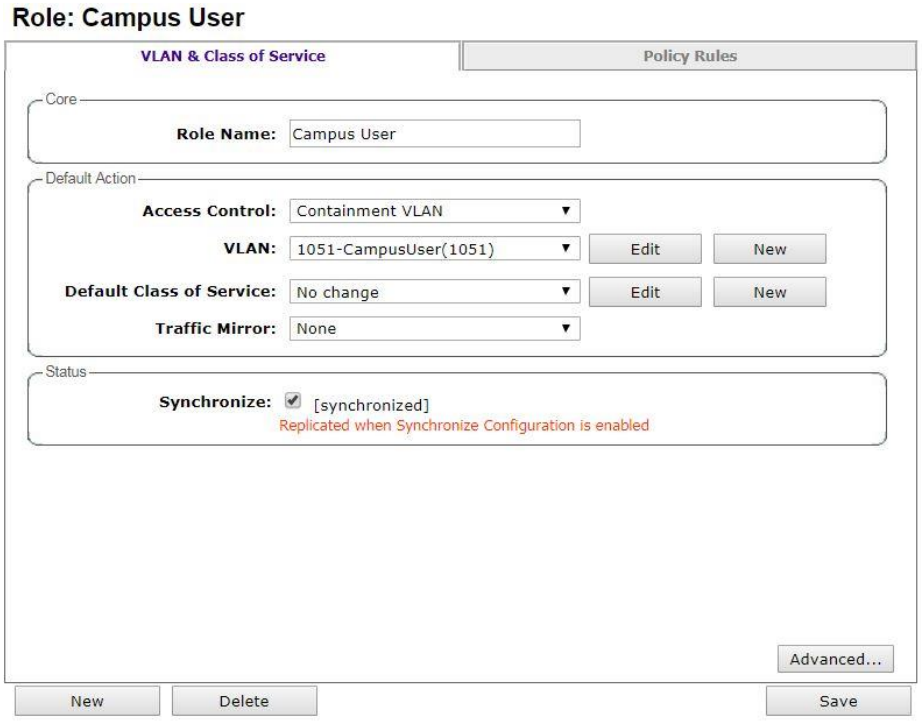
Configure in the following manner:

- Role Name: Deny Access
- Access Control: Deny
- Default CoS: No Change

Depending on the network's requirements, some traffic may need to be allowed by the **Deny Access** rule, whereas other networks require it to drop all traffic. The services allowed for this role can be defined in the Policy Rules section. All traffic except for the traffic explicitly allowed by the policy rules is dropped.



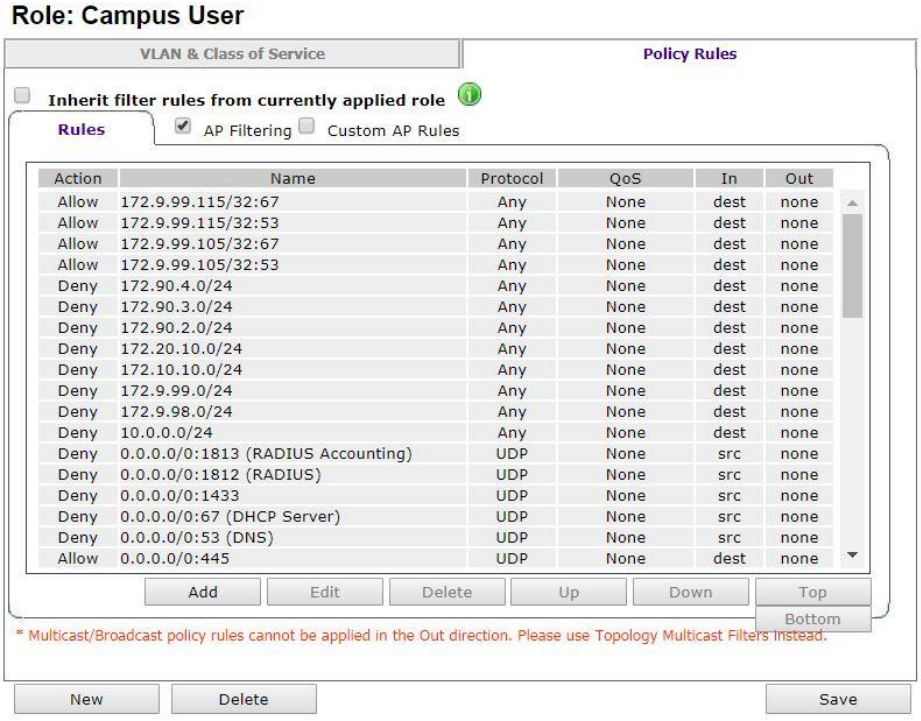
- **Campus User Role**



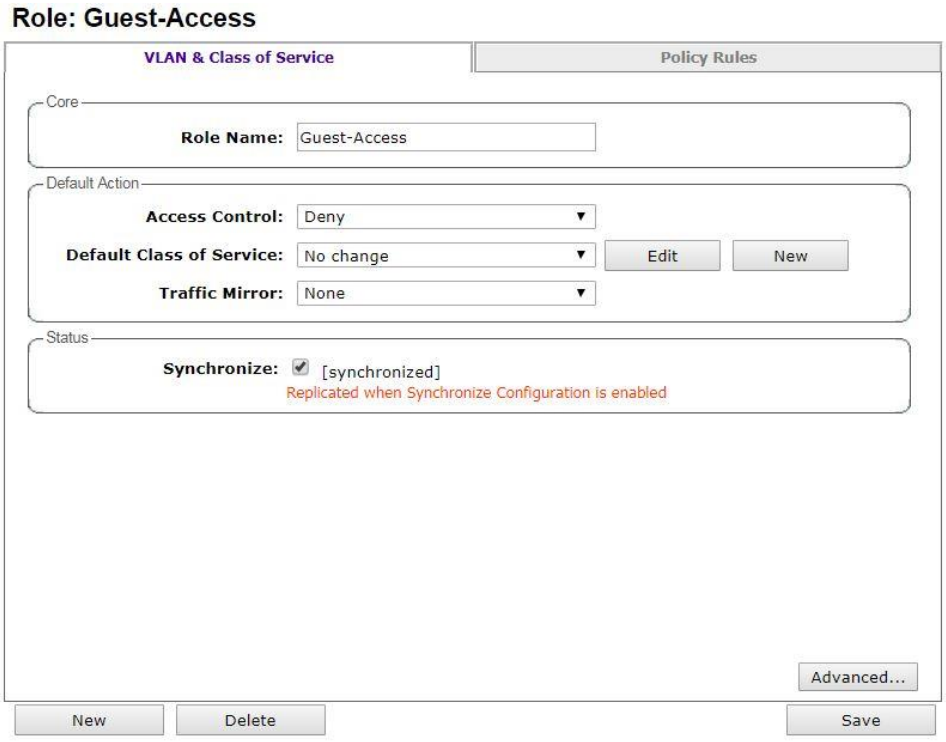
This role is assigned to users authenticated as Campus User. The access control is set to contain traffic to this topology.

Configure in the following manner:

- Role Name: Campus User
- Access Control: Containment VLAN
- VLAN: Campus User (1051)



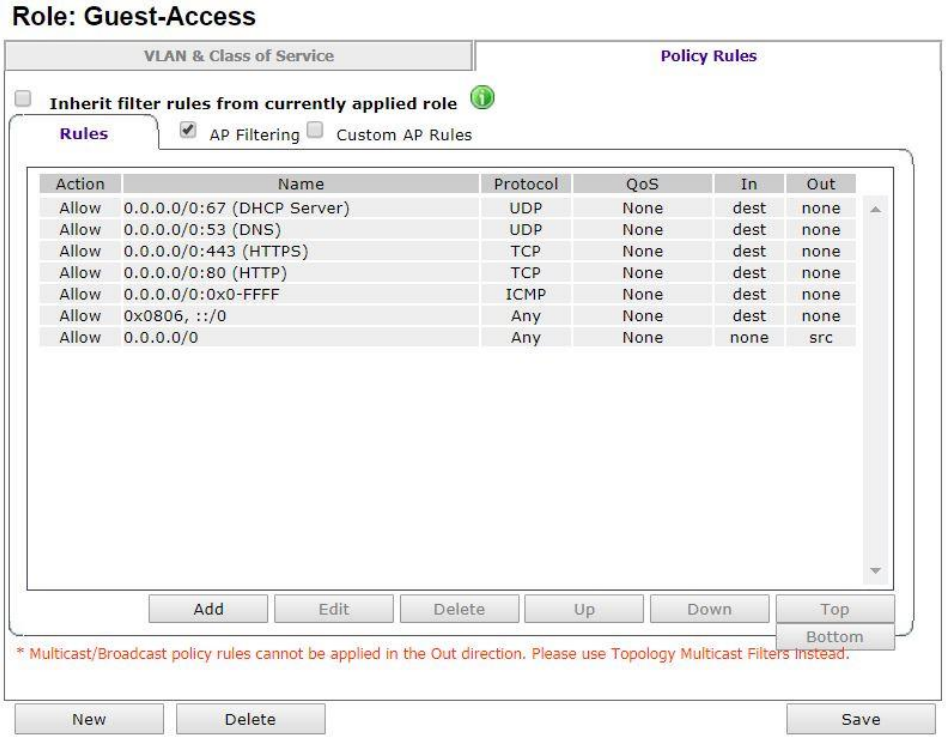
- **Guest-Access Role**



This role is assigned to users connecting to the network as guests through captive portal. Default Access Control is set to Deny for maximum security.

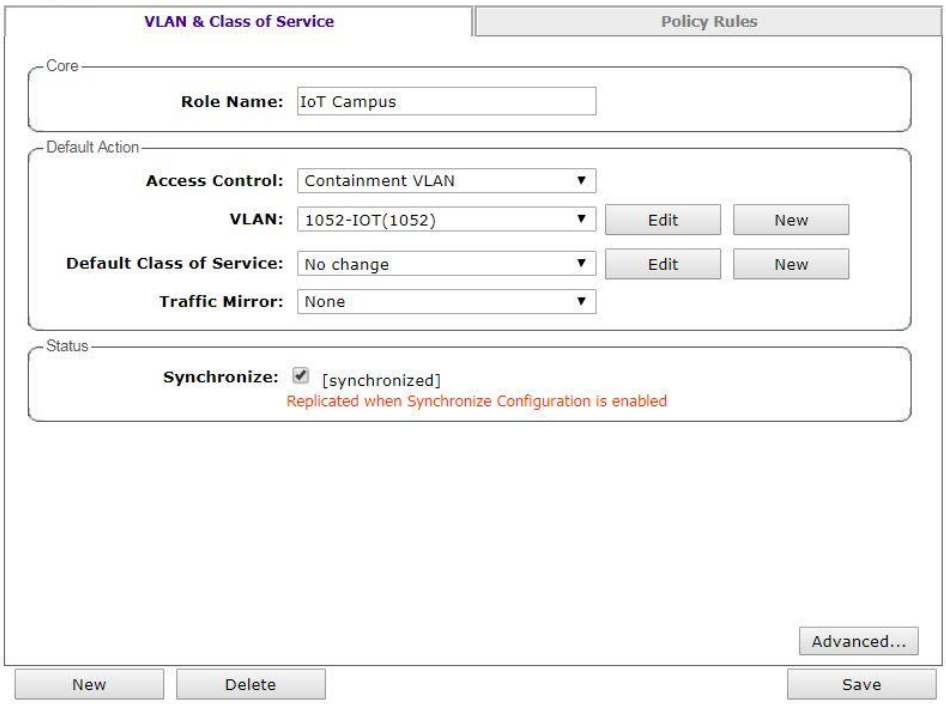
Configure in the following manner:

- Role Name: Guest-Access
- Access Control: Deny
- VLAN: Guest (906)



- **IoT Campus Role**

Role: IoT Campus

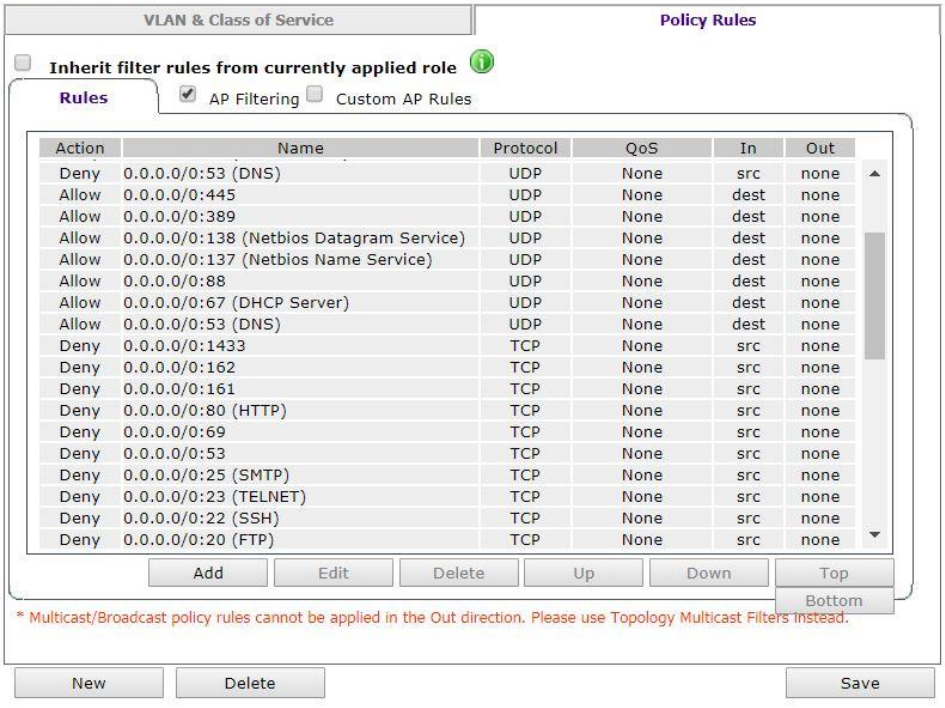


This role is assigned to users and devices authenticating to the network as 'IoT". Default Access Control is set containment to IoT Campus topology.

Configure in the following manner:

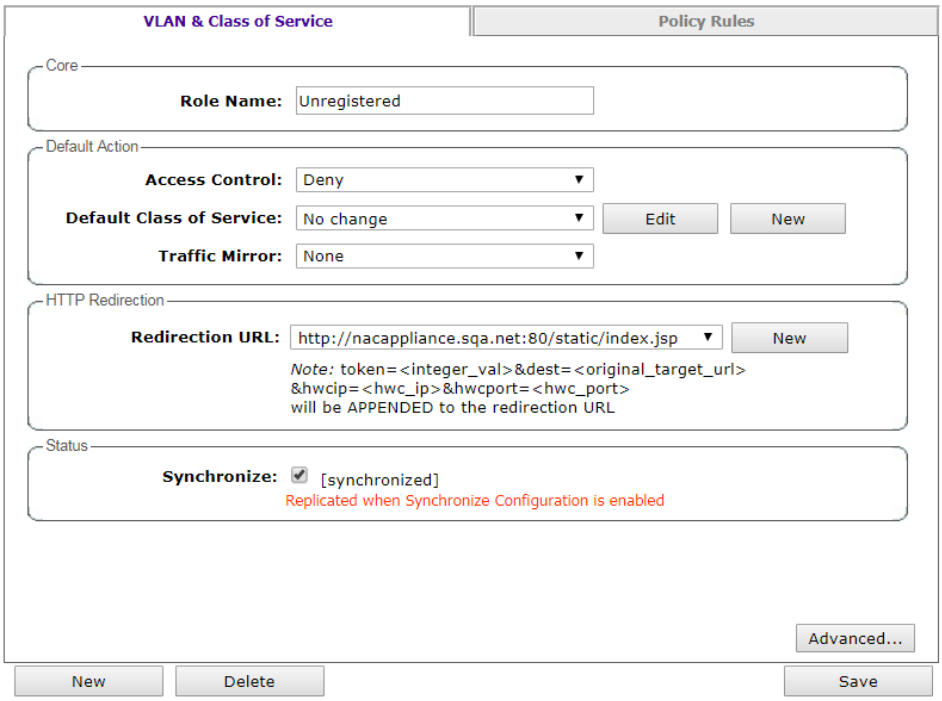
- Role Name: IoT Campus
- Access Control: Containment VLAN
- VLAN: Guest(1052)

Role: IoT Campus



- **Unregistered Role**

Role: Unregistered

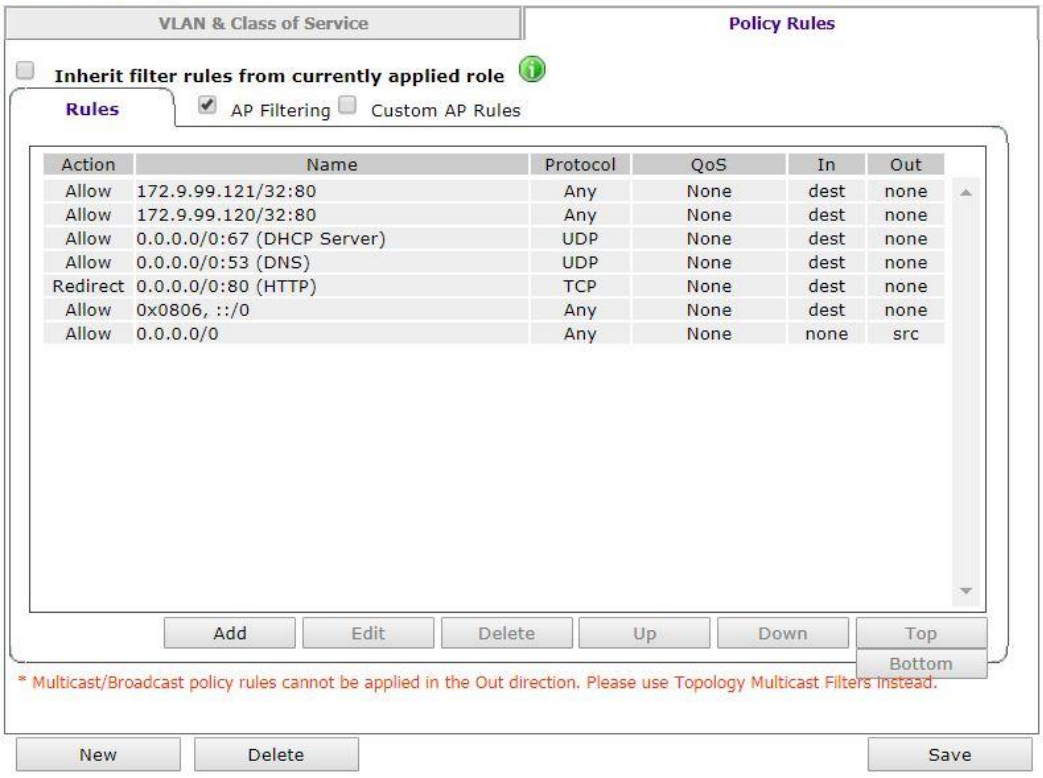


This is the initial role allocated to all wireless users attempting to join the Guest network. Users can move from this role to the Guest role through captive portal, or to Deny Access if authentication fails. A set of policies are configured to allow a user connecting to the network to obtain an IP address, to reach the DNS server, and to access the captive portal.

Configure in the following manner:

- Role Name: Unregistered
- Access Control: Deny

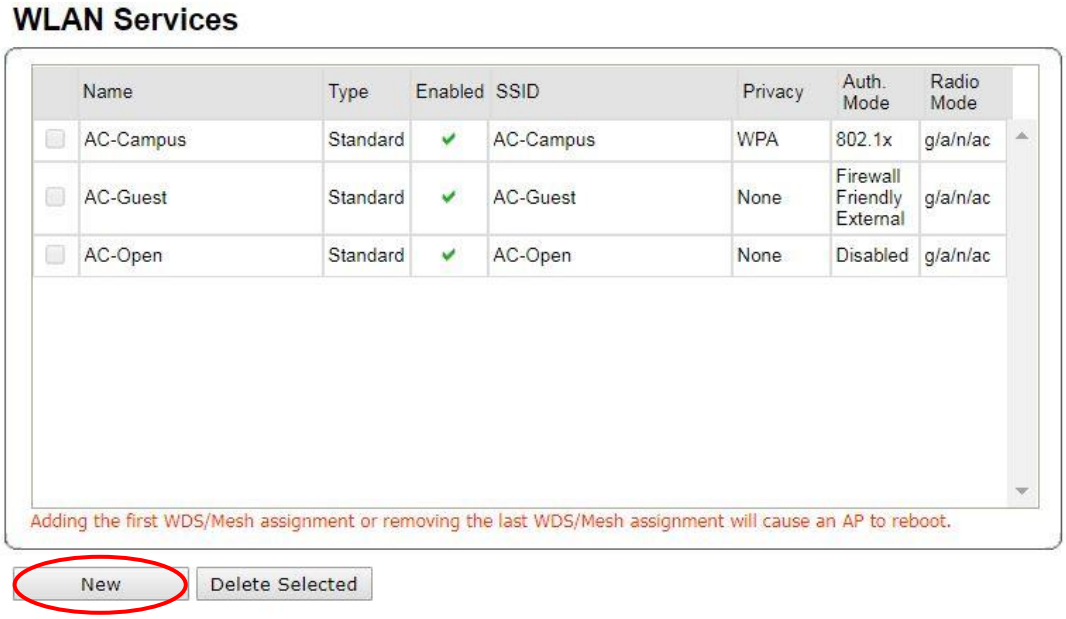
Role: Unregistered



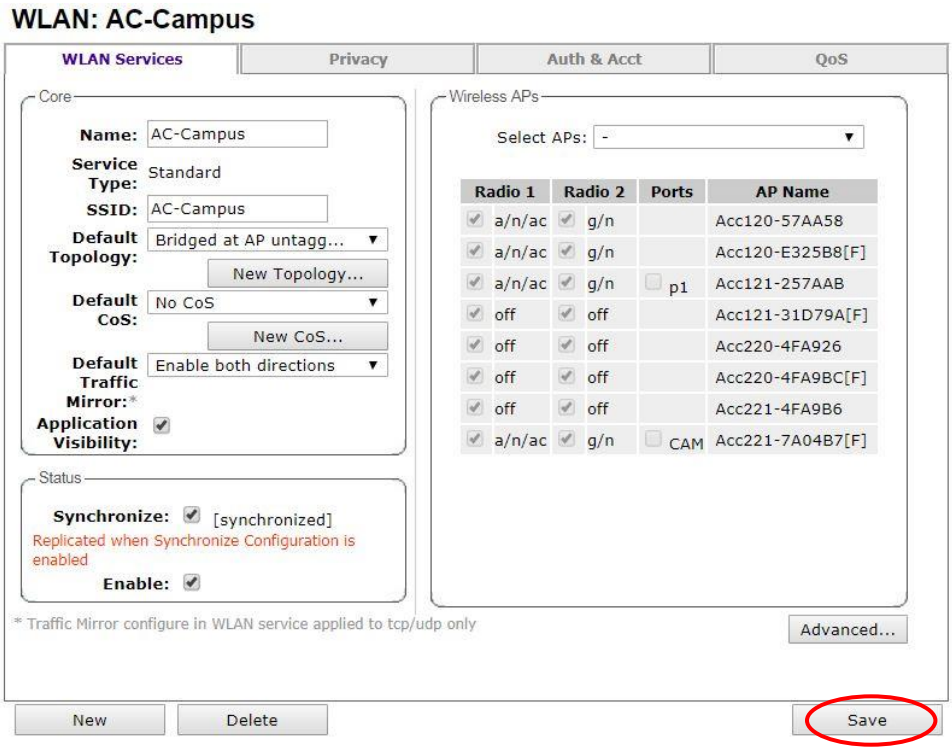
3. WLAN Services Configuration

The RF configuration, authentication settings, and QoS attributes for a wireless network can be managed under a WLAN service. For the Automated Campus, three WLAN services are defined. The **AC-Guest** SSID, which uses the captive portal registration through policies enforced from Extreme Management Center, the **AC-Campus** SSID configured for 802.1X authentication, and an **AC-Open** SSID, which has authentication mode disabled, and uses MAC-based authentication.

- To Add a new WLAN service, go to **VNS → WLAN Services** and click **New**.



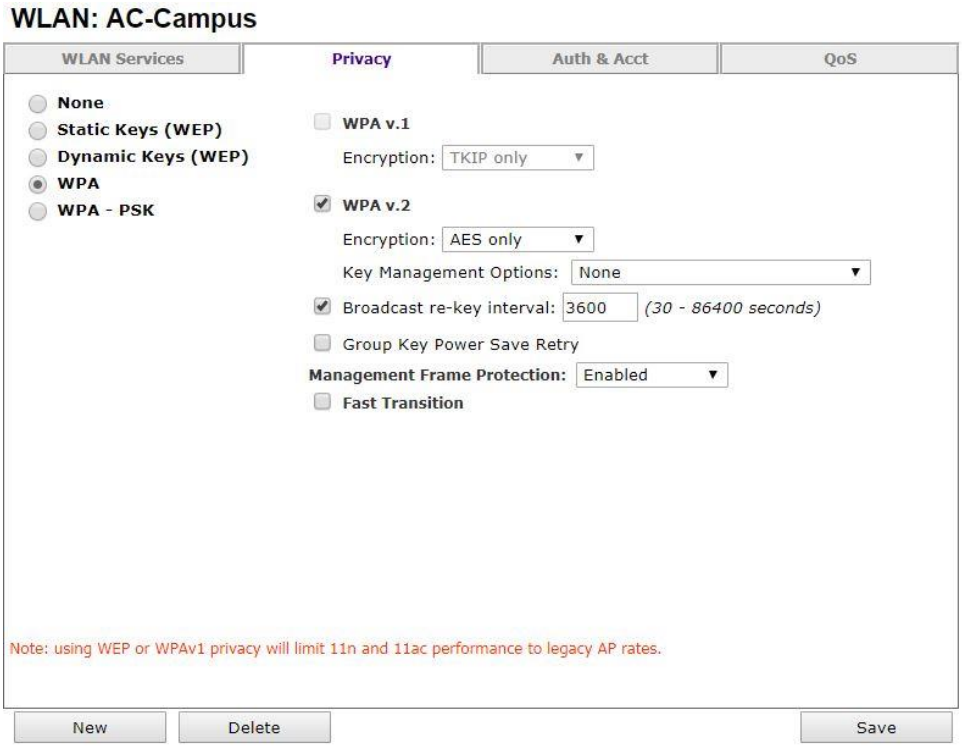
- Configure **AC-Campus** WLAN service:



This WLAN binds the AC-Campus SSID to the corresponding topology based on the client's 802.1X authentication credentials.

Configure in the following manner:

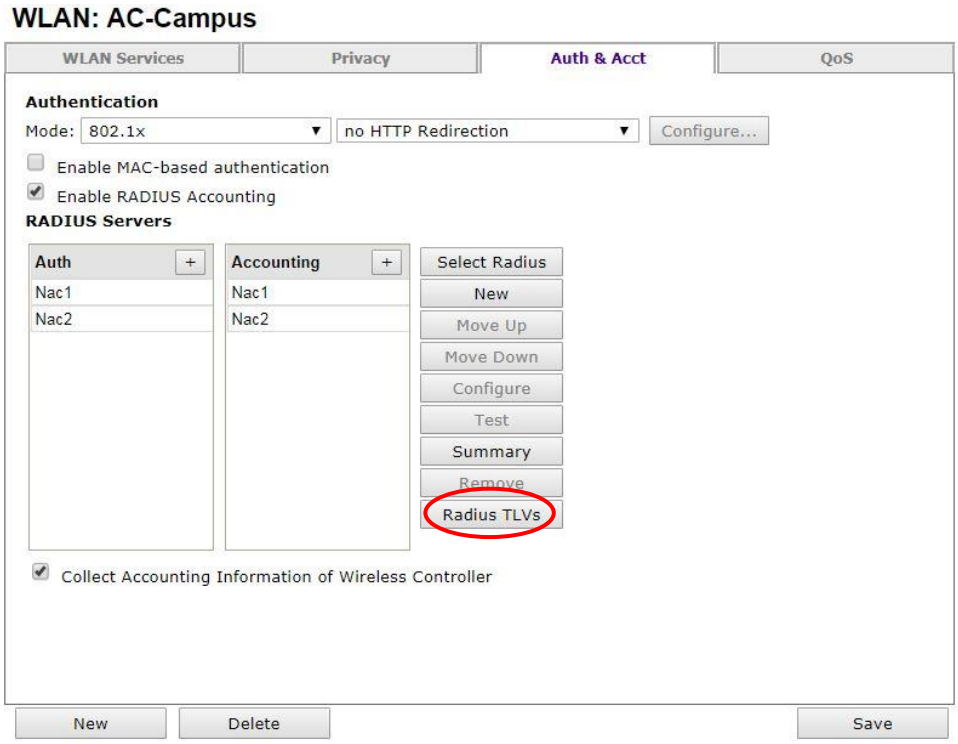
- Name: AC-Campus
- SSID: AC-Campus
- Default Topology: Bridged at AP untagged
- Default CoS: No CoS



WPA privacy is configured for this SSID.

Configure in the following manner:

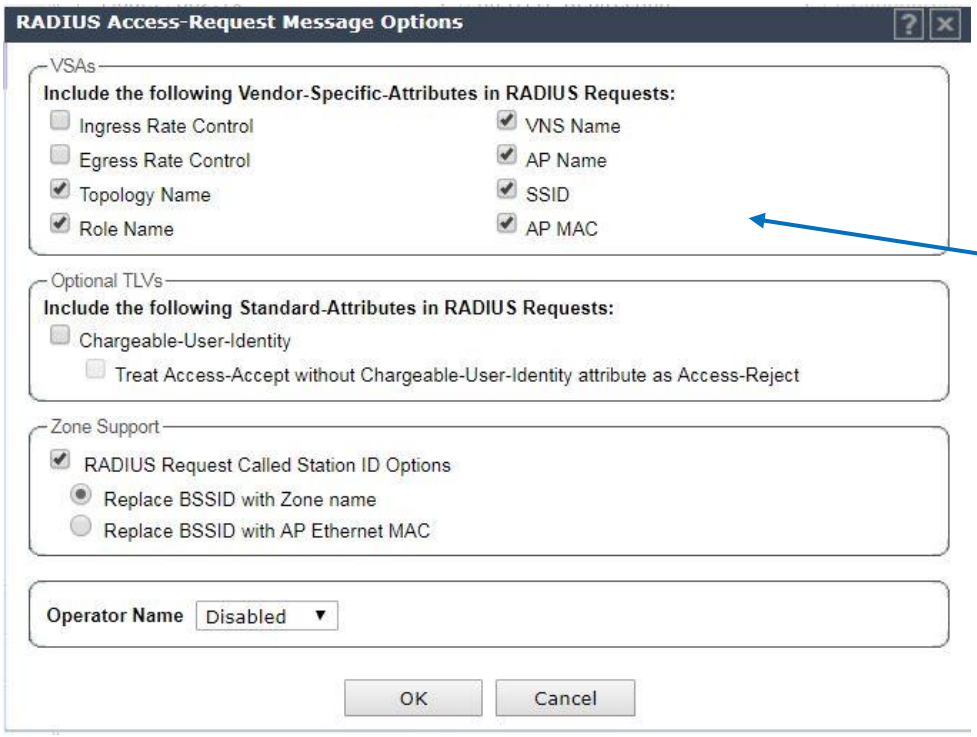
- Select WPA radio button
- Select WPA v.2 checkbox
- Encryption: AES Only



802.1X authentication is configured for the AC-Campus SSID. The two ExtremeControl engines are configured as the RADIUS servers on the EWC (which then use LDAP to query the actual server).

Configure in the following manner:

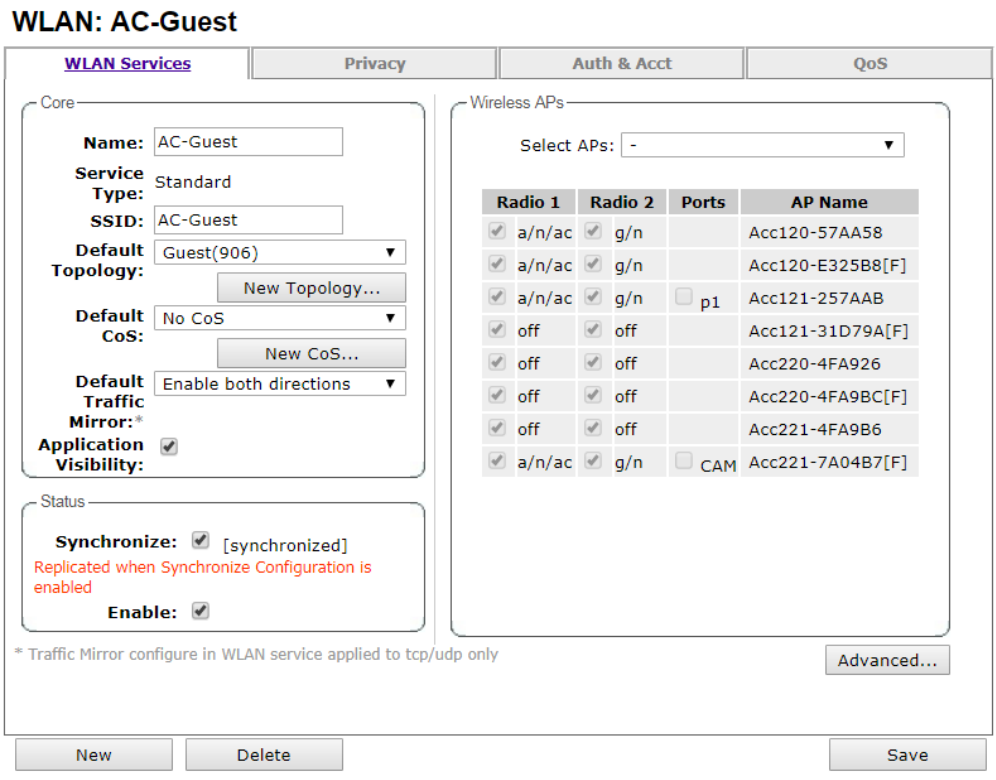
- Select 802.1X authentication mode
- Select no HTTP Redirection
- Select RADIUS Accounting checkbox
- Add ExtremeControl 1 and 2 for Authentication
- Add ExtremeControl 1 and 2 for Accounting
- Click “Radius TLVs” to configure.



Select the Vendor-Specific-Attributes to be included in the Radius requests.

Click OK, then Save the VNS

- Configure **AC-Guest** WLAN service:

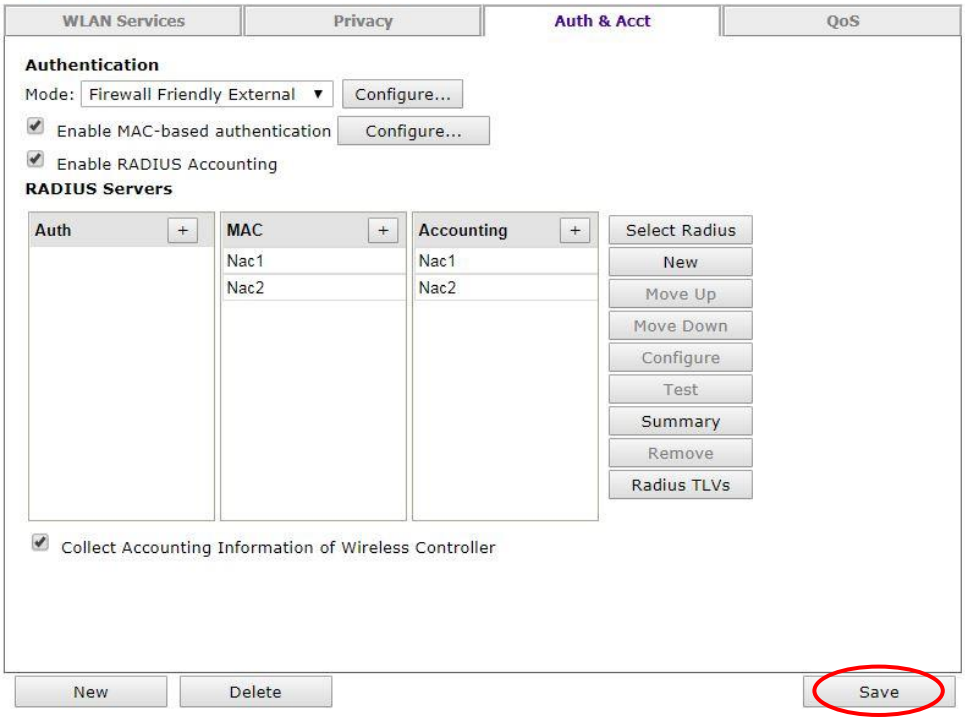


This WLAN binds the AC-Guest SSID to the Guest topology and is intended to be used by Guest users connecting to the network. No privacy is provided, and access is through captive portal.

Configure in the following manner:

- Name: AC-Guest
- SSID: AC-Guest
- Default Topology: Guest(906)

WLAN: AC-Guest



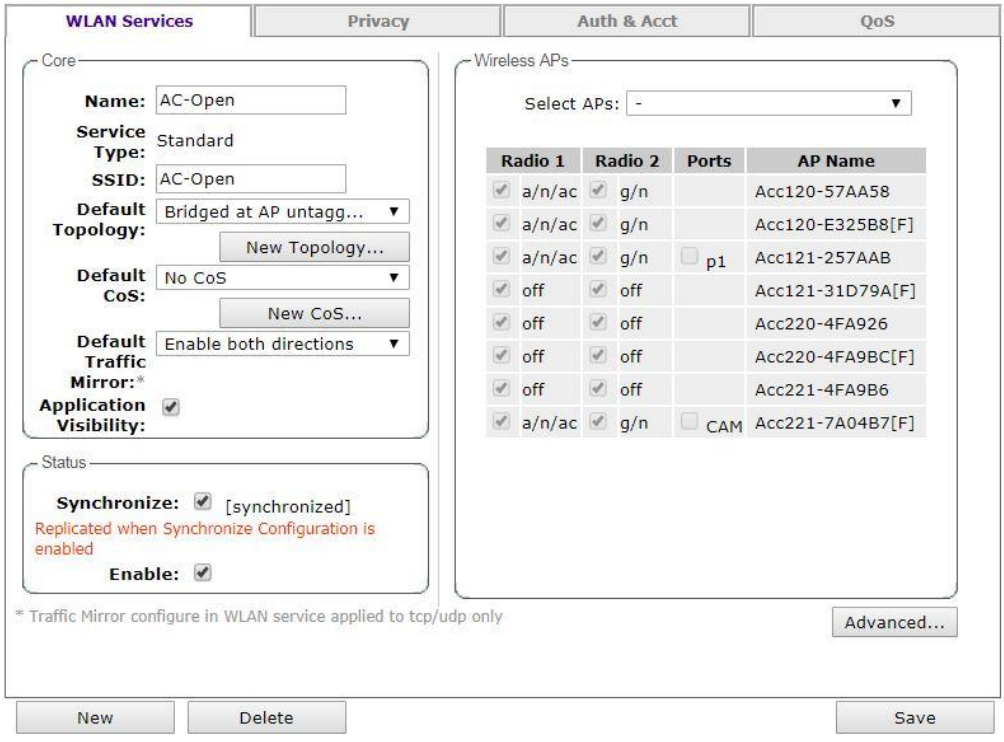
Guest Access uses the captive portal through policies enforced from Extreme Management Center to initially register the device that is used to connect to the network. The Auth&Acct tab is configured in the following manner:

- Authentication mode: Firewall Friendly External*
- Enable MAC-based authentication checkbox
- Enable RADIUS Accounting checkbox
- Add ExtremeControl 1 and 2 for MAC-based
- Add ExtremeControl 1 and 2 for Accounting

*This mode allows for better compatibility with firewalls that ExtremeControl may be positioned behind.

- Configure **AC-Open** WLAN service:

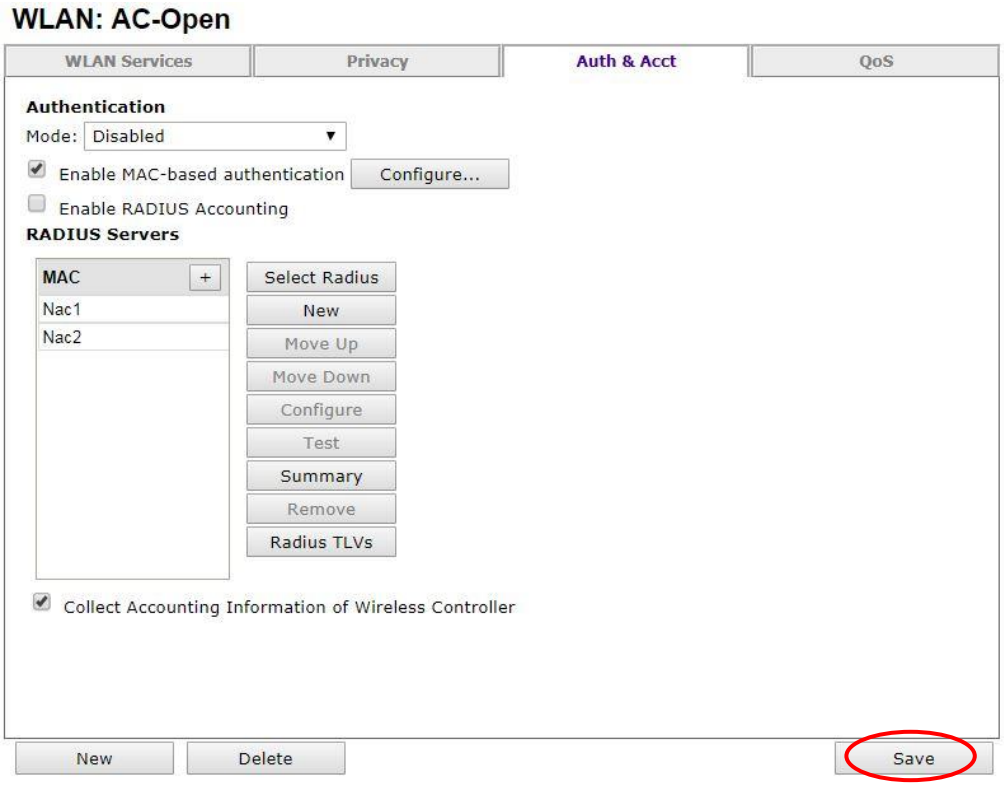
WLAN: AC-Open



This WLAN binds the AC-Open SSID to the corresponding topology based on the client's MAC authentication credentials.

Configure in the following manner:

- Name: AC-Open
- SSID: AC-Open
- Default Topology: Bridged at AP untagged
- Default CoS: No CoS



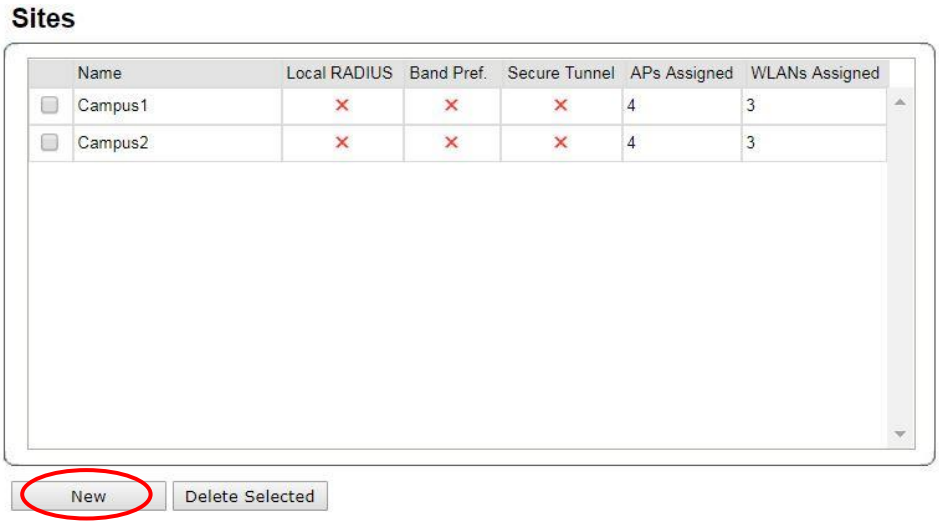
MAC Authentication is configured for the AC-Open SSID. The two ExtremeControl engines are configured as the RADIUS servers on the EWC (which handle the MAC authentication via configured ExtremeControl rules).

Configure in the following manner:

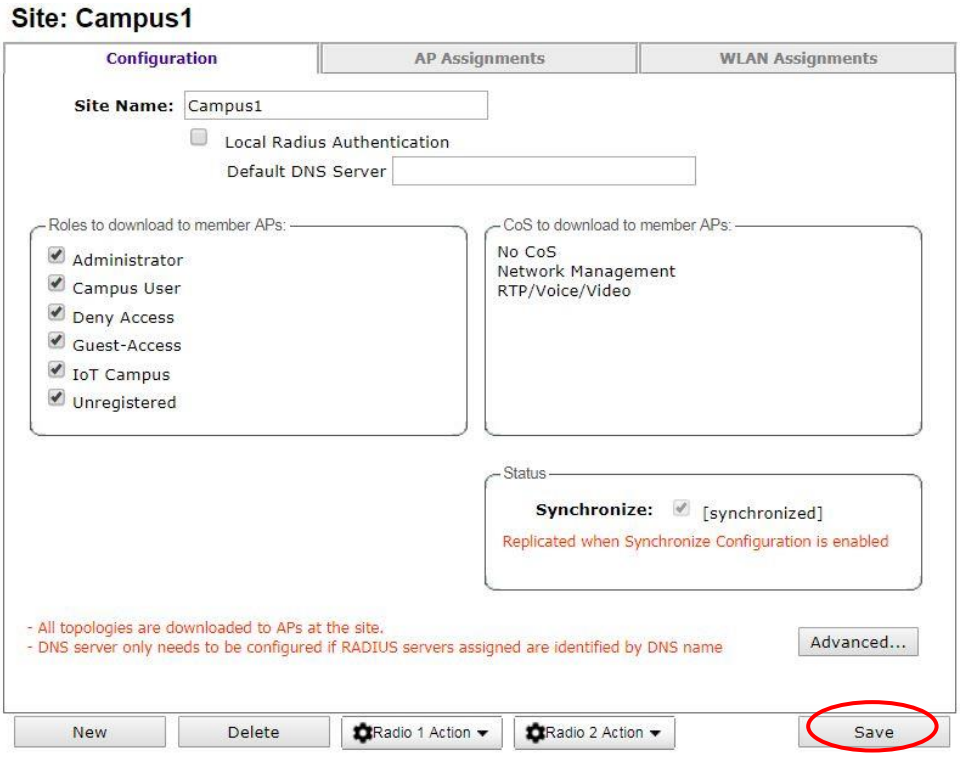
- Select Disabled authentication mode
- Select Enable MAC-based

4. Site Configuration

- A site provides a way to group Roles, WLANs, and APs under one logical entity for easier management. For the Automated Campus solution, two sites were created based on location. To create a new site, go to **VNS → Sites** and click **New**.



- The Campus 1 site was configured as below. The Campus 2 site was configured the same way.

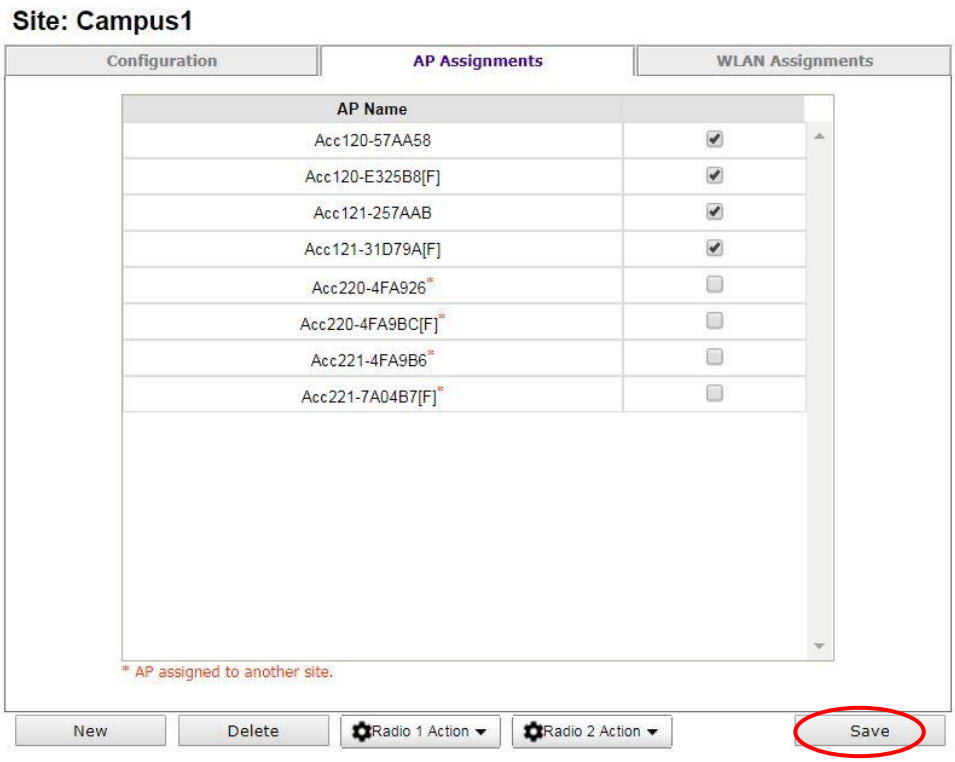


All roles are selected to be downloaded to the APs connected to Campus 1.

Configure in the following manner:

- Site Name: Campus 1
- Uncheck the Local RADIUS Authentication checkbox
- Select all checkboxes: Roles to download to member APs

- On the **AP Assignments** tab, all APs physically connected to Campus 1 are selected:

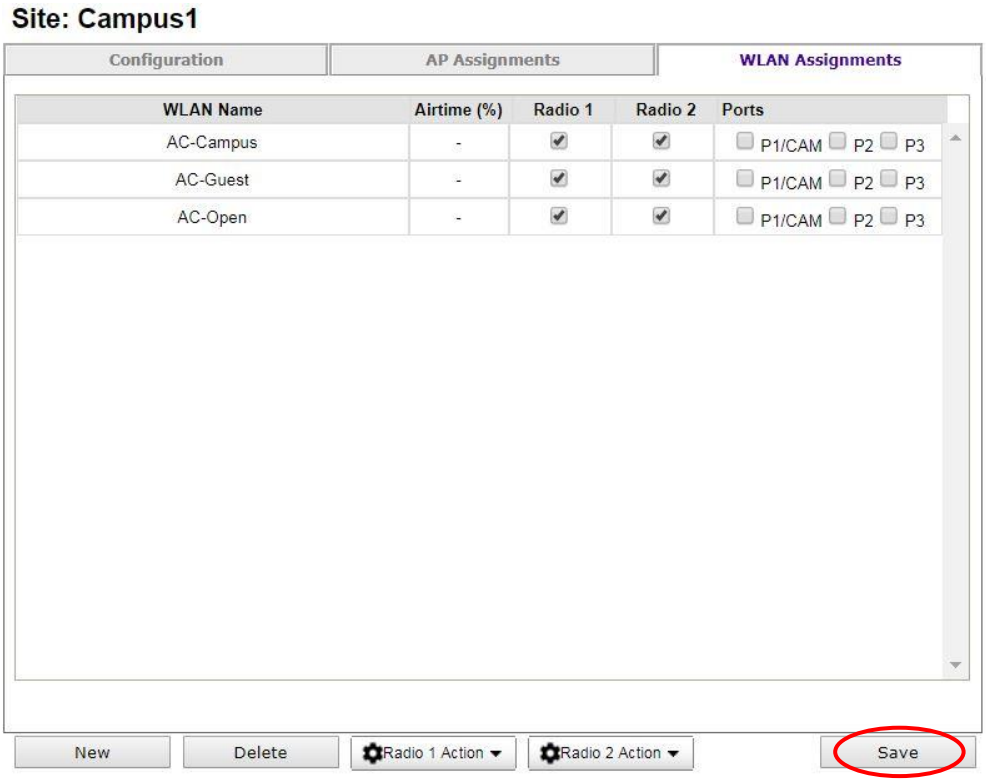


These APs will have the same role and WLAN settings.

Configure in the following manner:

- Select checkboxes of desired APs in this campus site

- On the **WLAN Assignments** tab, select the WLAN services that are supposed to be accessible from Campus 1. This selection also enables the APs selected in the **AP Assignments** tab to advertise these WLANs:



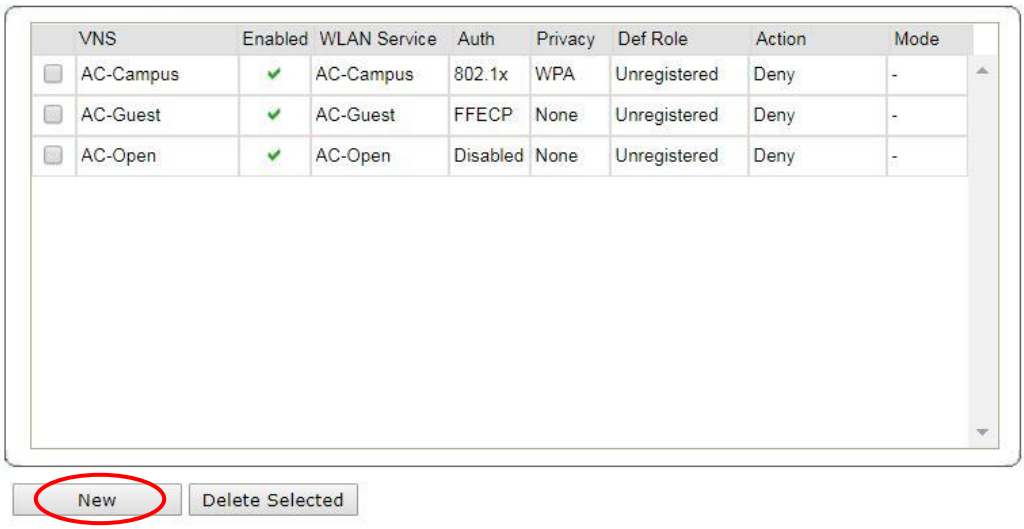
Configure in the following manner:
- Select AP Radio Checkboxes
- Select AP Port Checkboxes

5. Virtual Network Services Configuration

The virtual network configuration binds together the WLANs and the roles, for access control. There are conceptually hierarchical dependencies on the configuration elements of a VNS and for service activation, all the pieces will need to be in place, or defined during VNS configuration.

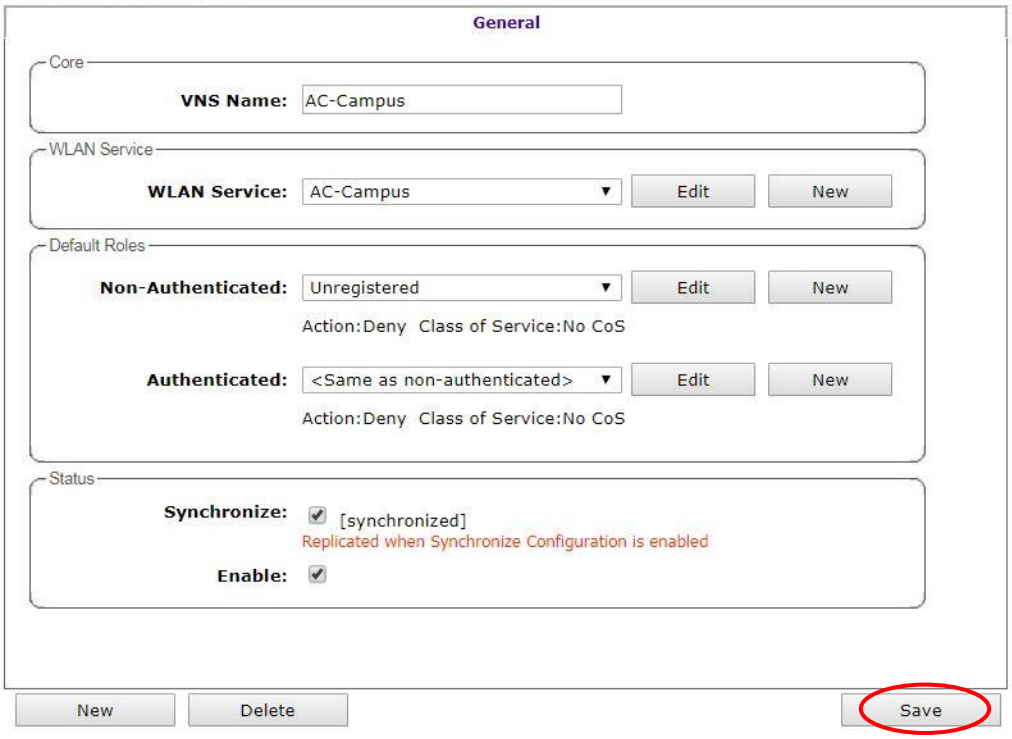
- To create a new VNS entry, go to **VNS → Virtual Networks** and click **New**.

Defined VNS



The following virtual networks are configured for both Campuses:

VNS: AC-Campus

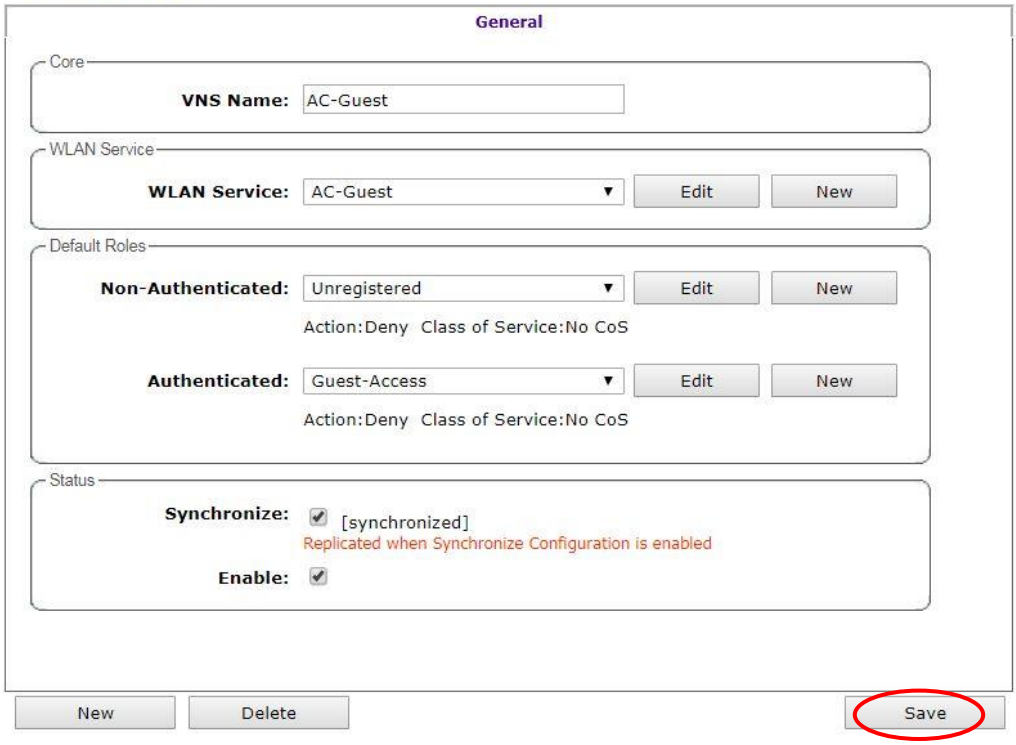


This VNS is bound to the AC-Campus WLAN. The default role for non-authenticated users can be set to Unregistered. After authentication, the role is assigned by ExtremeControl (via the Filter id field) and access control will be done on the switch because the topologies are set to Fabric Attach.

Configure in the following manner:

- VNS Name: AC-Campus
- WLAN Service: AC-Campus
- Non-Authenticated: Unregistered
- Authenticated: Same as non-auth
- **Enable Checkbox** Checked

VNS: AC-Guest

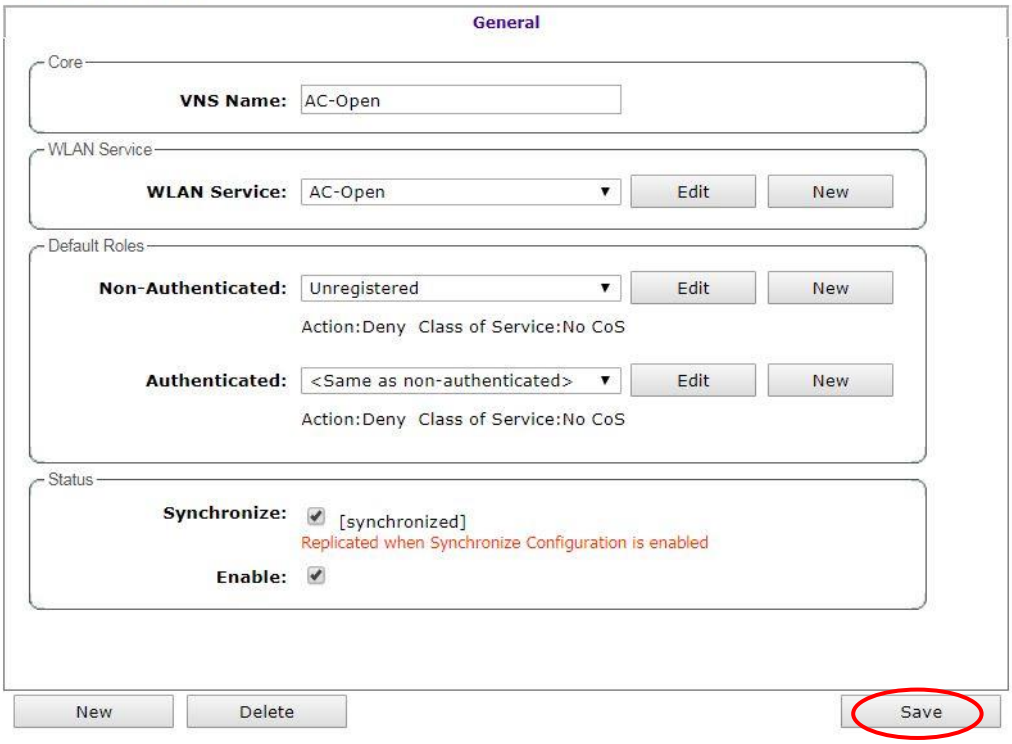


This VNS is bound to the AC-Guest WLAN. The default role for non-authenticated users is Unregistered. After users connect to captive portal, they are considered authenticated and ExtremeControl assigns the Guest Access role (via the Filter id field).

Configure in the following manner:

- VNS Name: AC-Guest
- WLAN Service: AC-Guest
- Non-Authenticated: Unregistered
- Authenticated: Guest Access
- **Enable** Checkbox Checked

VNS: AC-Open



This VNS is bound to the AC-Open WLAN. The default role for non-authenticated users is Unregistered. After users MAC-authenticated, ExtremeControl assigns the corresponding role (via the Filter id field).

Configure in the following manner:

- VNS Name: AC-Open
- WLAN Service: AC-Open
- Non-Authenticated: Unregistered
- Authenticated: Same as non-auth
- **Enable** Checkbox Checked

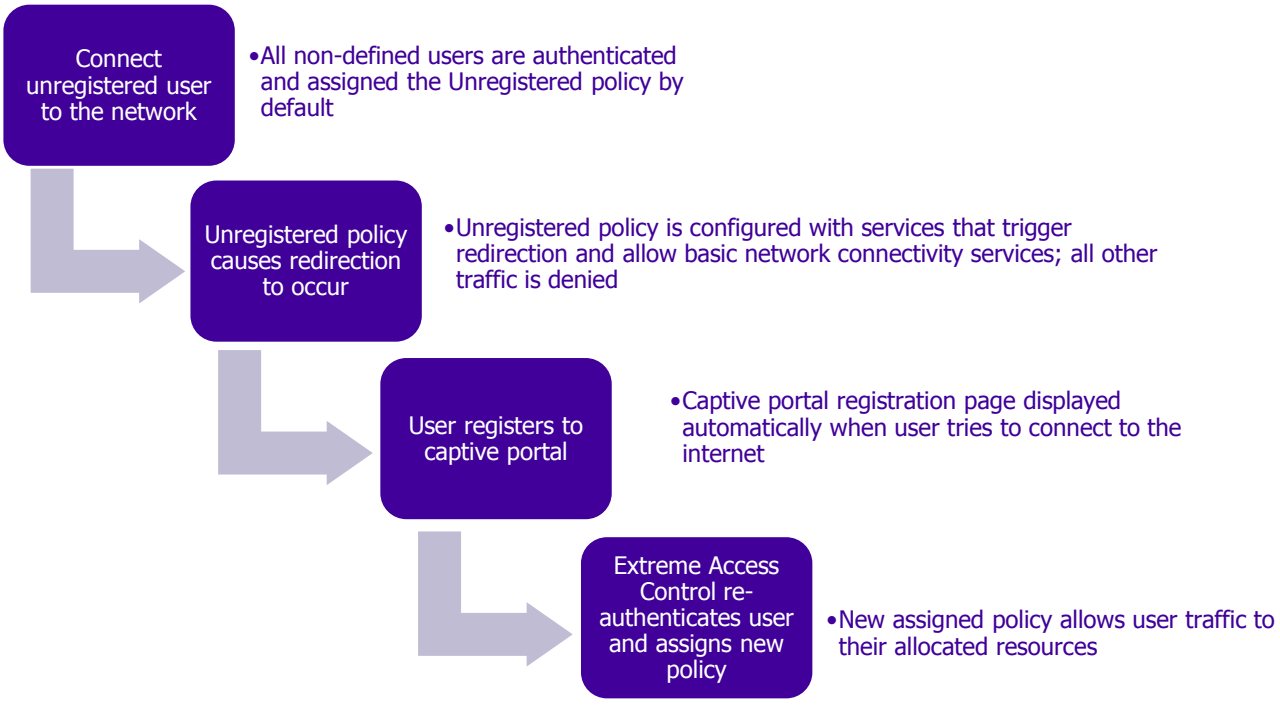
Guest Access (Captive Portal)

Captive portal provides a way to allow unregistered users to connect to the network as guests. All guests are redirected to a registration page before being allowed access.

In order for redirection to occur, the network must be able to identify a guest user's traffic and assign a policy that triggers the redirection. In this instance, traffic is assigned the "Unregistered" policy, configured to redirect web traffic to a specific URL where the policy is applied. The DNS, DHCP, ARP, and http/https redirect rules for the "Unregistered" Role are configured in Extreme Management Center via Policy, then enforced onto the corresponding platform.

When an unregistered user attempts to access the internet, the HTTP traffic is intercepted and redirected to the Extreme Access Control captive portal. In a wired environment, this is the physical switch port. In a wireless environment, this is either the AP or the controller, depending on the deployment. The user is then able to fill in the required information that will yield access to the network. Once the captive portal process is complete, the user is removed from the policy that triggered redirection and assigned a new policy to allow normal traffic flow.

General Flow required for captive portal redirection:



Wired User Access

With Fabric Connect and the Extreme Management appliances in place and configured, the access switches can now be deployed and provisioned to allow wired users to authenticate and access the network.

Summit Access Switch

The Summit access switches were used in separate stack formations in two campus segments. A variety of stack-heights were incorporated into the topology, connected to form a ring within each stack. Combining the switches in stack formation allowed for easier administration of the switches.

The stack operates as if it were a single switch with a single IP address and a single point of authentication. One switch – called the master switch – is responsible for running network protocols and managing the stack. The master runs ExtremeXOS software and maintains all the software tables for all the switches in the stack. All switches in the stack, including the master switch, are also referred to as nodes.

The nodes can be physically connected within a server rack to create a stack in one of two ways:

- Native Stacking - switches are connected using either designated Ethernet data ports or dedicated stacking connectors.
- Alternate Stacking - switches are connected using 10-Gbps Ethernet data ports that have been configured for stacking. These ports are located either on the switch itself or on option cards installed on the rear of the switch

Note that in this EVD, **Alternate Stacking in a ring topology** is used with 10-Gbps links connecting the individual switches to form a stack. The high-speed stacking links function like the backplane links of a chassis.

The procedure for creating a Summit access stack is outside the scope of this document. This information can be found in existing GTAC knowledgebase articles and other CLI documentation. The GTAC Knowledgebase documentation can be found at the following link below.

How to Create a Stack with Summit Switches

The resulting stack should appear similar to the output below.

```
Slot-1 Stack.1 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address    Slot  Stack State  Role     Flags
------------------  ----  -----------  -------  ---
*00:04:96:a0:ad:fe  1     Active       Master   CA-
 00:04:96:a0:ae:67  2     Active       Backup   CA-
 00:04:96:a1:bf:67  3     Active       Standby  CA-
* - Indicates this node
Flags:  (C) Candidate for this active topology, (A) Active Node
        (O) node may be in Other active topology
(Software Update Required) Slot-1 Stack.2 #
```

A successfully configured stack will assign each switch within the stack a unique slot number and will be given one of three assignments: master, backup, or standby. Each stack only has one master and one backup but can have more than one standby. The backup node will take the place of the master node if the master node fails. A standby node will take the place of the backup node if the backup node becomes the master node.

In this EVD, the access switches are managed in-band via a static IP configured on the FA Management VLAN for each campus.

Summit Access Switch Provisioning/Fabric Attach

After the stacking configuration is complete, it is provisioned for user network access.

Warning

To avoid potential network issues, it's recommended to enter the base configuration below before connecting to the network.

- Before deploying, configure the access switch with basic commands to establish initial IP and SNMP connectivity to the XMC and allow network provisioning.

```
create vlan 100
configure vlan 100 ipaddress 172.10.10.11 255.255.255.0
enable ipforwarding vlan 100
configure iproute add default 172.10.10.1
enable sharing 1:50 grouping 1:50,2:50

config snmpv3 add user xmc_v3 authentication sha extreme11 privacy aes 128 extreme12extreme
config snmpv3 add group snmpv3group user xmc_v3 sec-model usm
config snmpv3 add access snmpv3group sec-model usm sec-level priv read-view defaultAdminView
write-view defaultAdminView notify-view defaultAdminView
configure snmpv3 add community "private" name "private" user "v1v2c_rw"
configure snmpv3 add community "public" name "public" user "v1v2c_ro"
enable snmp acc snmpv3

enable policy
save config
```

Configure the FA mgmt. VLAN, setting the IP address and gateway.

Configure uplink for static LAG.

Configure SNMPv3 parameters. Refer to **Design Considerations** for more information.

Enable policy to allow dynamic Role assignment upon authentication.

Note

For more information on the commands used below, including configuring an SNMPv3 profile in XMC, refer to **Design Considerations**

- Configure netlogin and network tools settings:

```
enable netlogin dot1x mac
configure netlogin authentication protocol-order dot1x mac web-based
enable netlogin ports 1:1-49,2:1-49,3:1-49 dot1x
enable netlogin ports 1:1-49,2:1-49,3:1-49 mac
configure netlogin add mac-list ff:ff:ff:ff:ff:ff 48

configure dns-client add name-server 172.9.99.105 vr VR-Default
configure dns-client add name-server 172.9.99.115 vr VR-Default

configure timezone name EST -300 autodst
configure sntp-client primary 134.141.79.190 vr VR-Default
configure sntp-client secondary 134.141.79.191 vr VR-Default
configure sntp-client update-interval 60
enable sntp-client
disable telnet
```

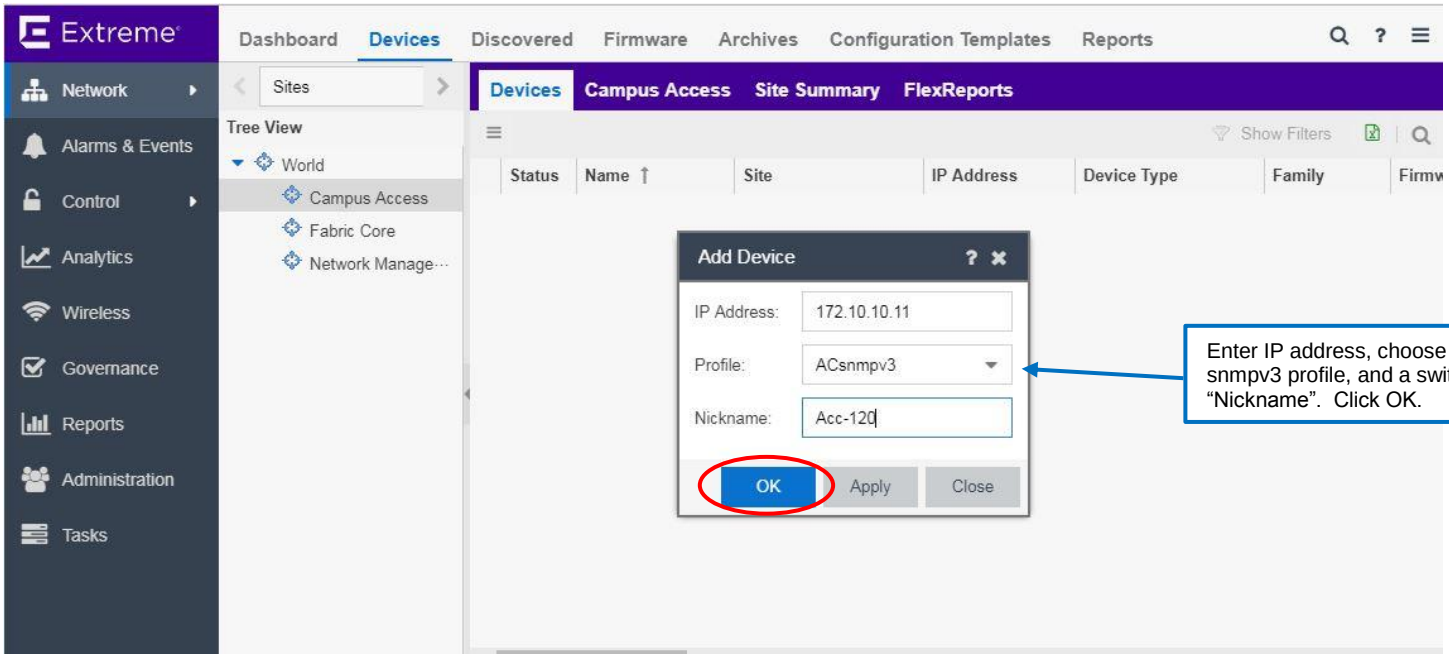
Configure netlogin authentication methods, enable on desired ports and set mac mask for MACAUTH.

Configure DNS and SNTP client parameters.

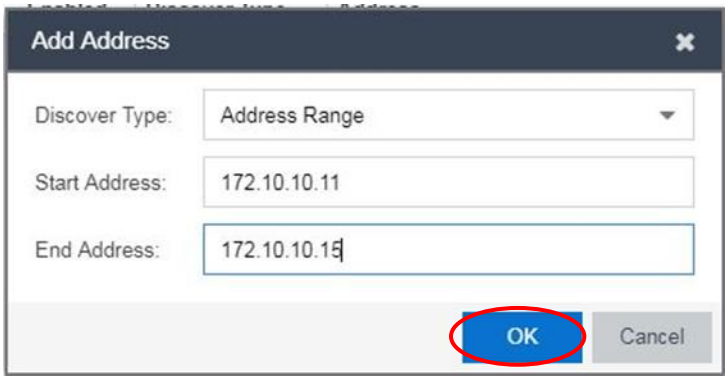
Disable telnet, then enable SSH2 to allow secure mgmt. login via ExtremeControl. NOTE: Enabling SSH will prompt a "yes" response.

```
enable ssh
yes
save config
```

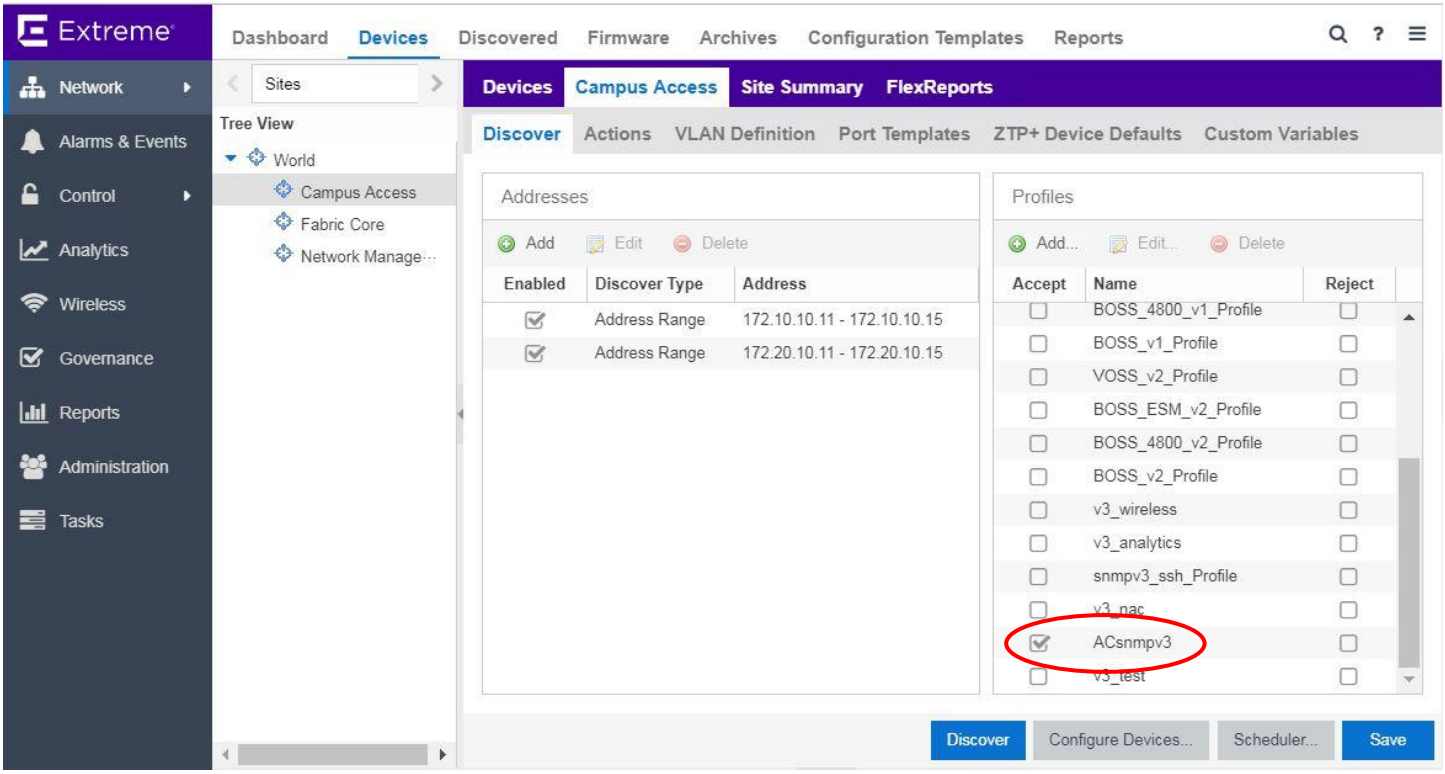
- In XMC, under **Network→Devices**, right-click the **Campus Access** Site and choose **Add Device**:



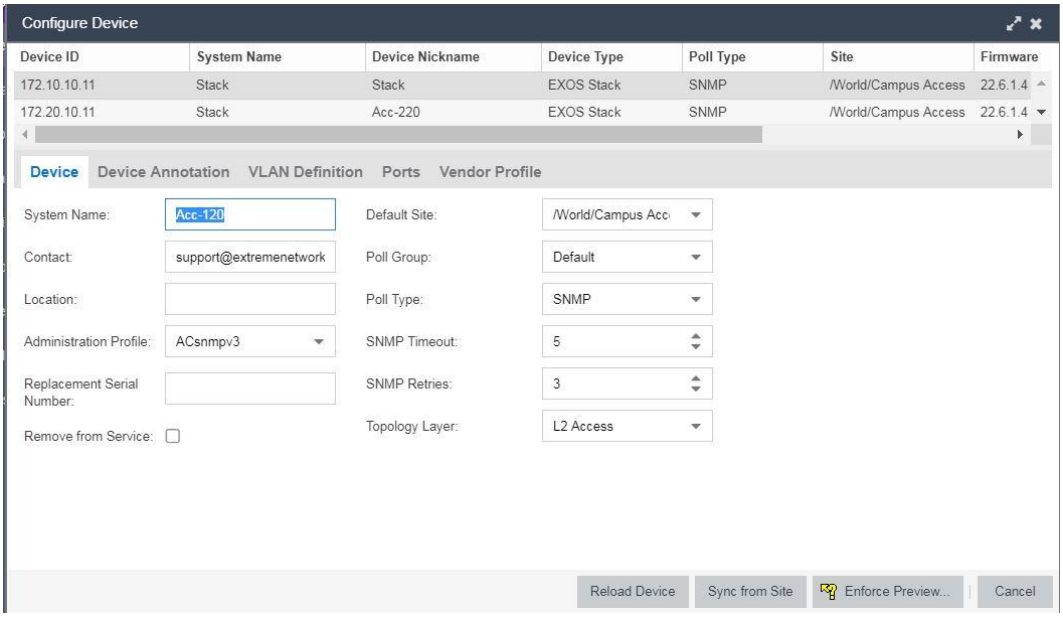
- Repeat this for any other deployed access switches in this Policy Domain.
    - To discover multiple access switches at once, an address range can be specified. Navigate to **Network→Devices→Sites→Campus Access→Discover.** Under **Addresses,** click **Add:**
    - Choose **Address Range** from the drop-down, and fill in parameters**.** Click **OK:**

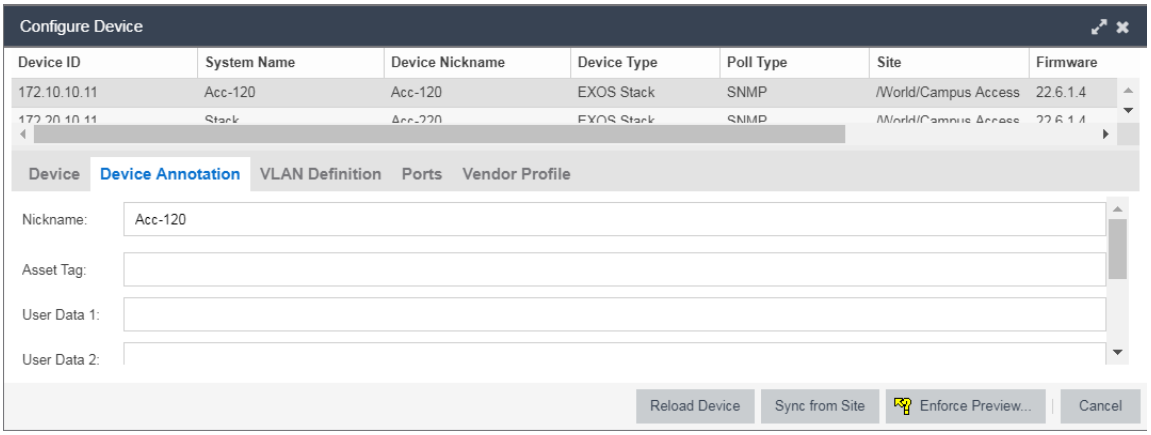


- Under **Profiles**, check the desired SNMP profile to apply. Click Save, then Discover:

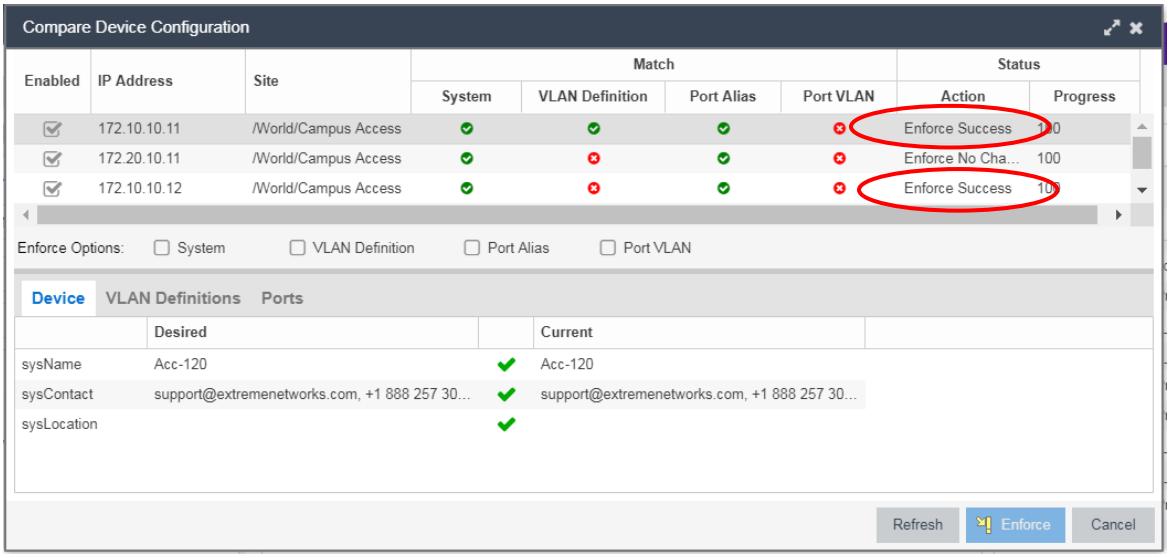


- When Discover complete, click **Configure Devices**. Highlight each of the newly discovered switches, and give each a System Name and (under Device Annotation tab) a Nickname:

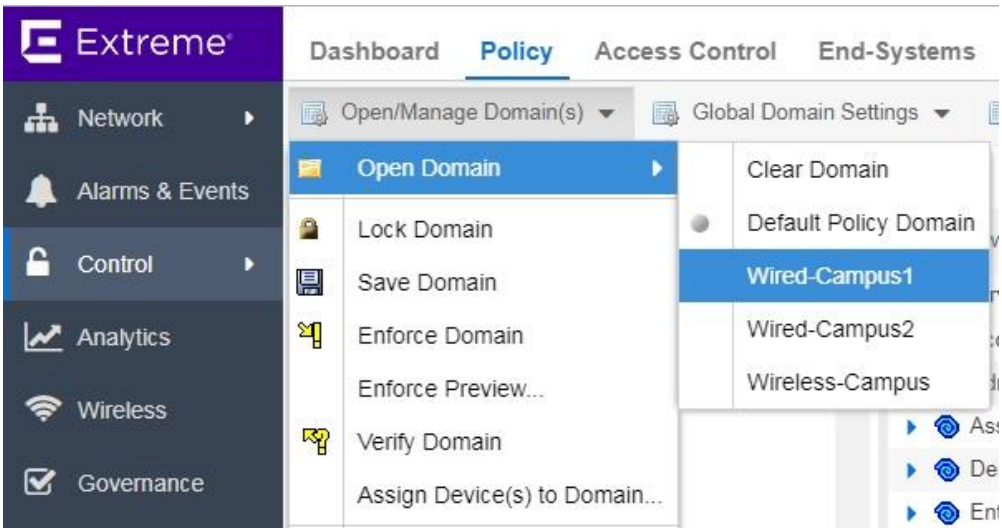




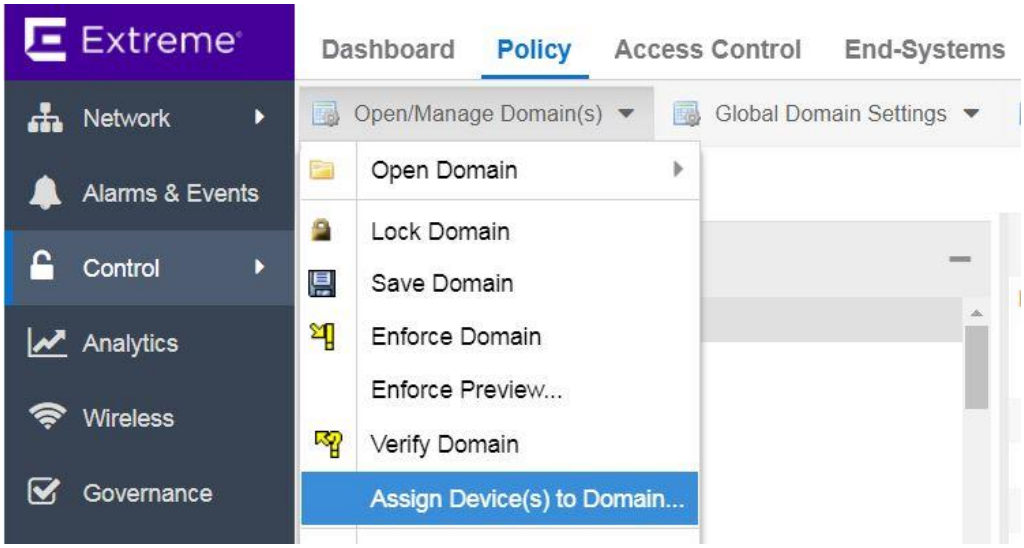
- Click **Enforce Preview**, then **Enforce** to apply these settings:

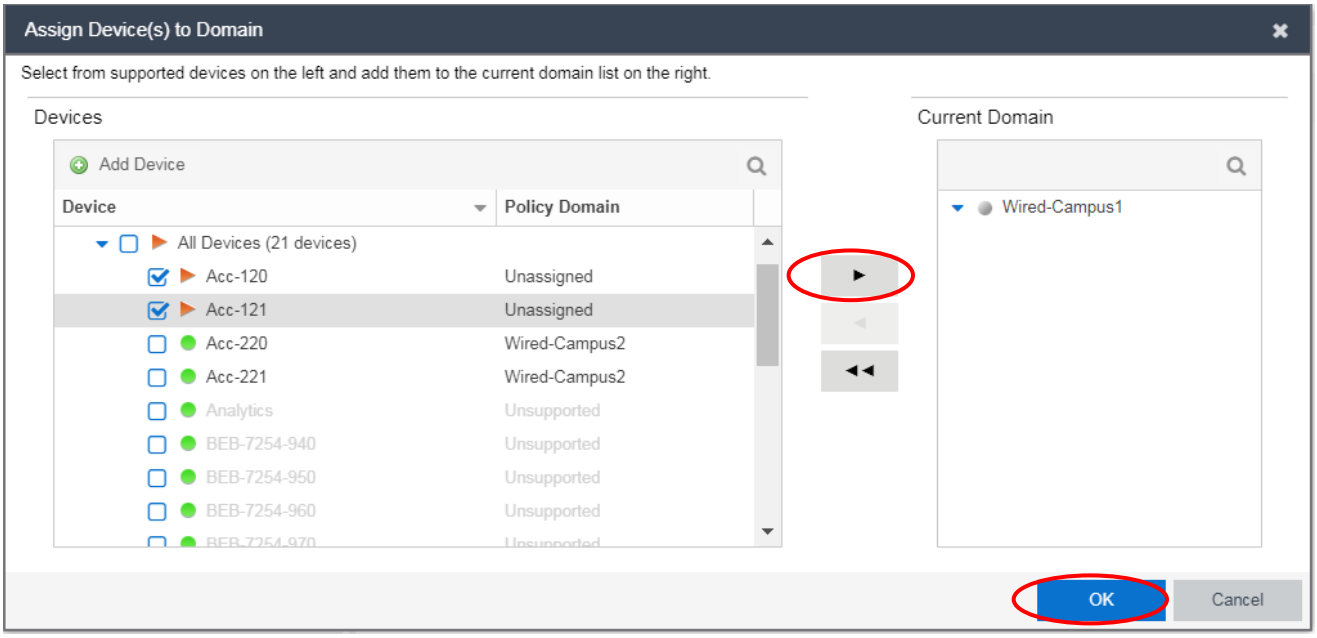


- Navigate to **Control→Policy**, and Open the "**Wired-Campus1**" policy domain:

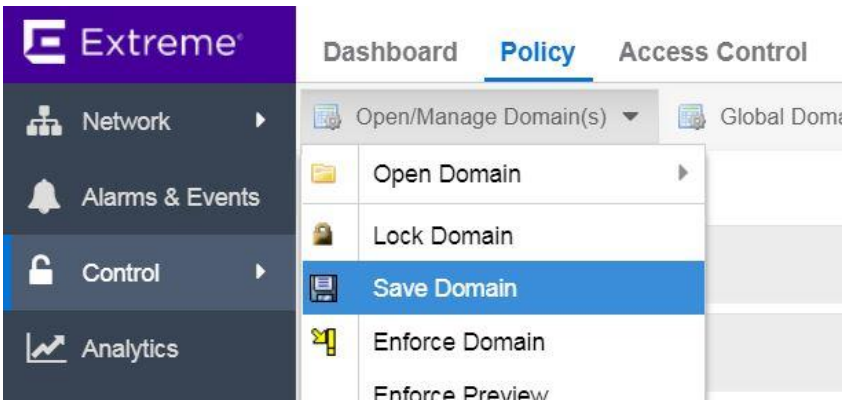


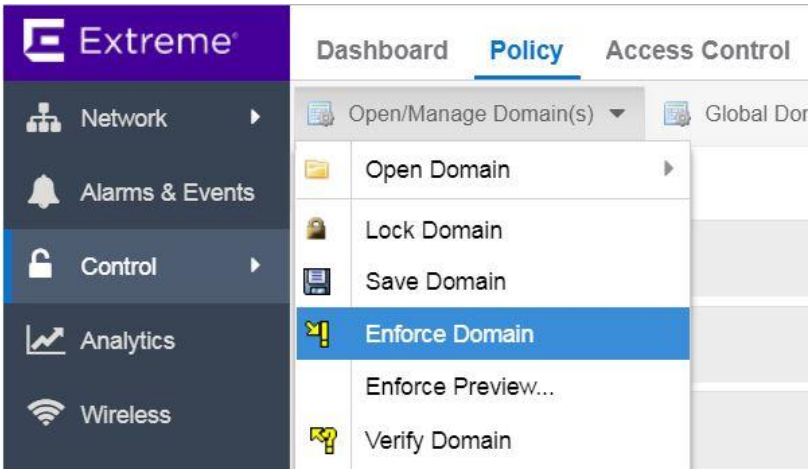
- Add the access switch(s) provisioned in Campus 1 from the left column to the policy domain, and click **OK**:

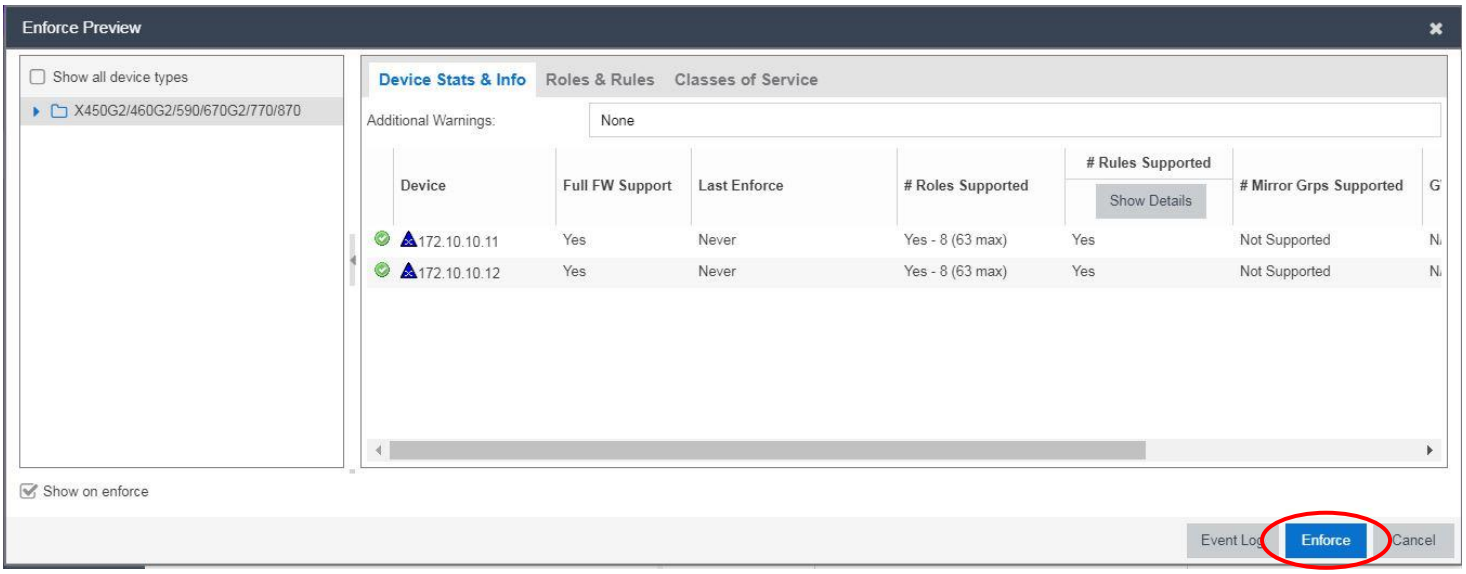


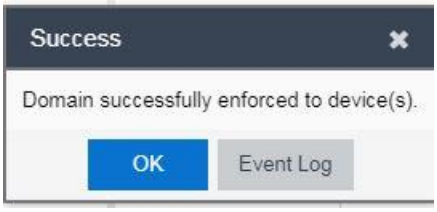


- Once added, **Save Domain**, and then enforce/sync the current policy profiles to the switches in this wired policy domain:



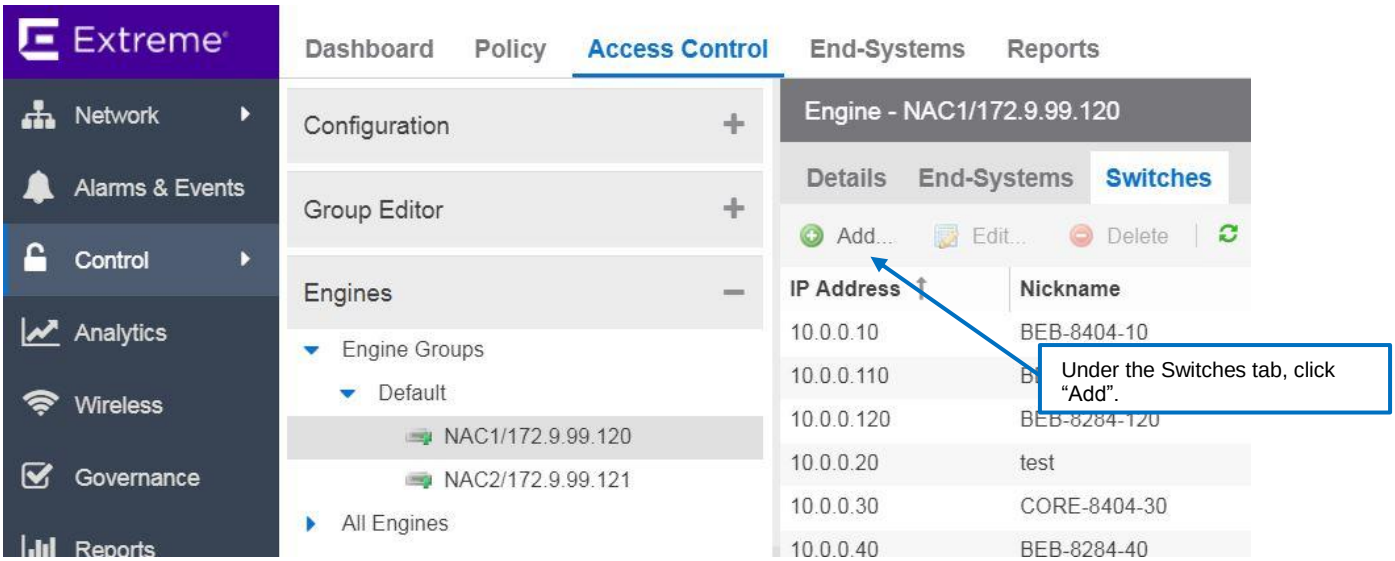




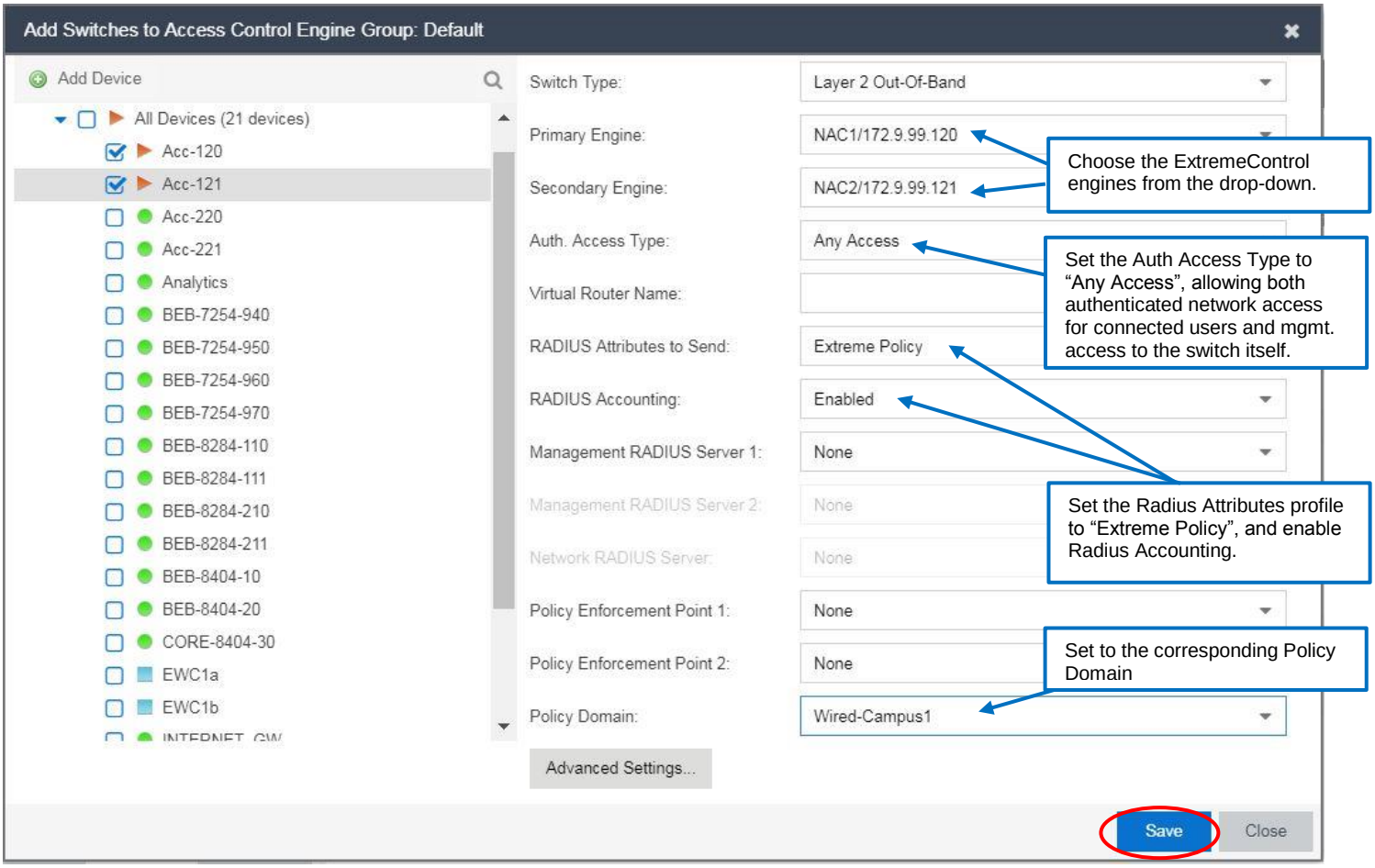


- Repeat the previous steps to add newly deployed Summit switches to other Campus Policy Domain(s).

- Click on the **Access Control** tab and add the switch to the ExtremeControl engines:

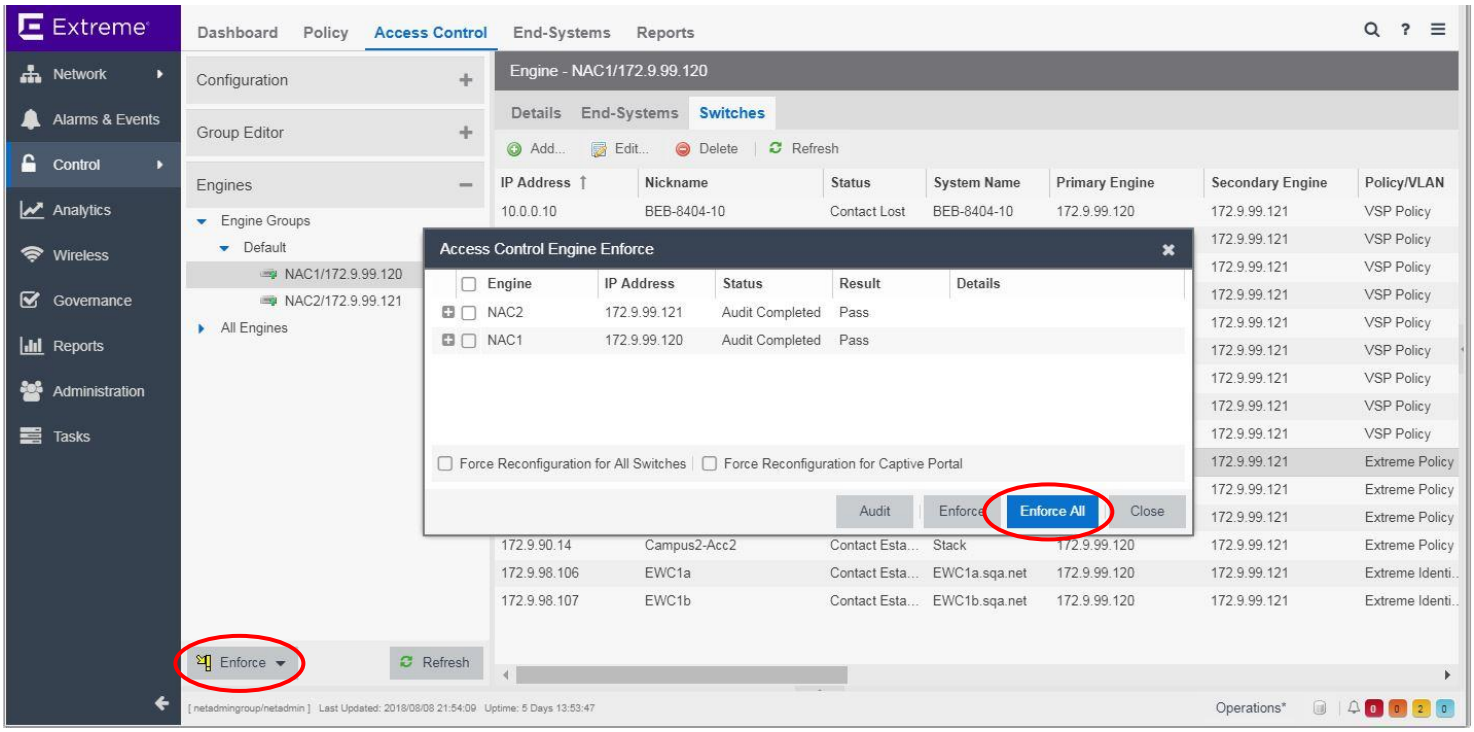


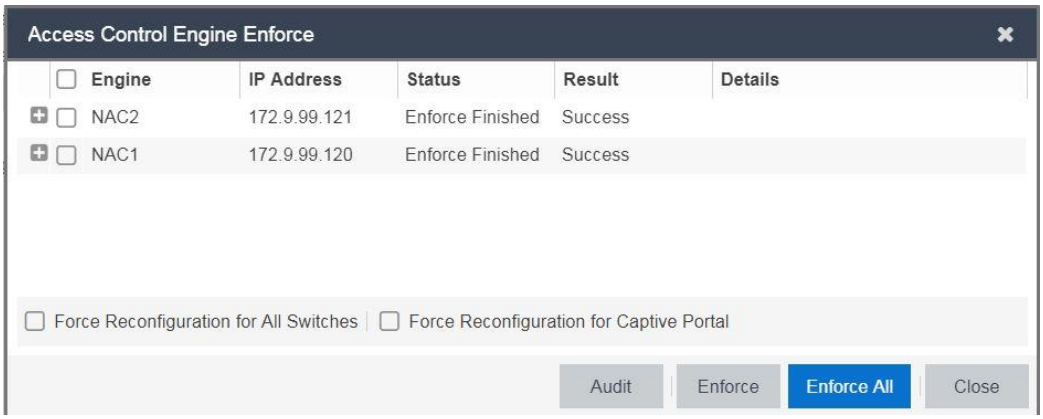
- Enter the ExtremeControl parameters for the switch, and click **Save**:



- Upon prompt to enforce the domain to the new switch(es), click **Yes**:

- Click "**Enforce**" at the bottom left of the screen to enforce the current rule base to the ExtremeControl Engine:





- Verify that the Fabric Attach Mgmt VLAN (from the FA Server) was assigned to the access switch:

```
(Private) Slot-1 Stack.2 # show fabric attach element
Fabric Attach Mode: Proxy

                                                        Mgmt     Auto
System Id                      Port    Type             VLAN Tag Provision
------------------------------ ------- ---------------- ---- --- --------------
00-bb-00-01-10-11-30-02-00-02 1:50    Server (No Auth)  100 Mix Disabled
00-bb-00-01-10-11-30-02-00-02 2:50    Server (No Auth)  100 Mix Disabled
(Private) Slot-1 Stack.3 #
```

- Upon connection, wired user traffic will be authenticated via ExtremeControl, and the corresponding Role will be sent to the access switch. The access switch will assign that role to the end user via netlogin:

```
(Private) Slot-1 Stack.4 # show netlogin session port 1:3
Multiple authentication session entries
---------------------------------------

Port            : 1:3          Station address   : 00:41:01:00:01:cd
Auth status     : success      Last attempt      : Wed Aug 22 20:53:04 2018
Agent type      : mac          Session applied   : true
Server type     : radius       VLAN-Tunnel-Attr  : None
Policy index    : 1            Policy name       : IoT Campus (active)
Session timeout : 0            Session duration  : 0:03:37
Idle timeout    : 300          Idle time         : 0:00:00
Auth-Override   : disabled     Termination time  : Not Terminated
```

The end user authenticated MAC.

Assigned role

- The policy profile is assigned, along with its corresponding parameters:

```
Slot-1 Stack.10 # show policy profile 1
Profile Index            :1
Profile Name             :IoT Campus
Row Status               :active
Port VID Status          :enabled
Port VID Override        :101
CoS Status               :enabled
CoS                      :0
Web Redirect Index       :0
Disable ingress port     :disabled
Replace TCI Status       :disabled
Auth Override Status     :disabled
NSI                      :1010101
Tagged Egress            :
Untagged Egress          :101
Forbidden Egress         :
Rule Precedence          :1-2,10,12-19,23,20-22,25,31
                         :MACSource (1), MACDest (2), IPv6Dest (10),
                         :IPSource (12), IPDest (13), IPFrag (14),
                         :UDPSrcPort (15), UDPDestPort (16), TCPSrcPort (17),
                         :TCPDestPort (18), ICMPType (19), ICMP6Type (23),
                         :TTL (20), IPTOS (21), IPProto (22), Ether (25),
                         :Port (31)
Admin Profile Usage      :none
Oper Profile Usage       :1:3
Dynamic Profile Usage    :1:3
```

Policy role

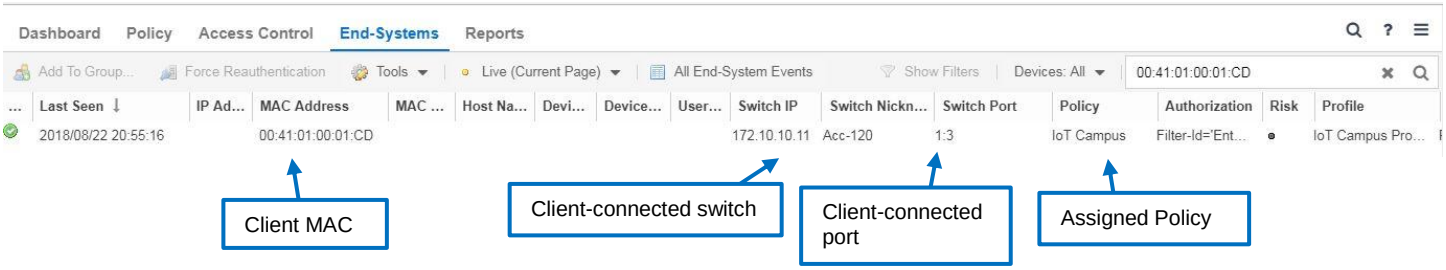
VLAN assignment for this role.

Corresponding COS value

ISID assignment for this role.

Port(s) assigned to policy.

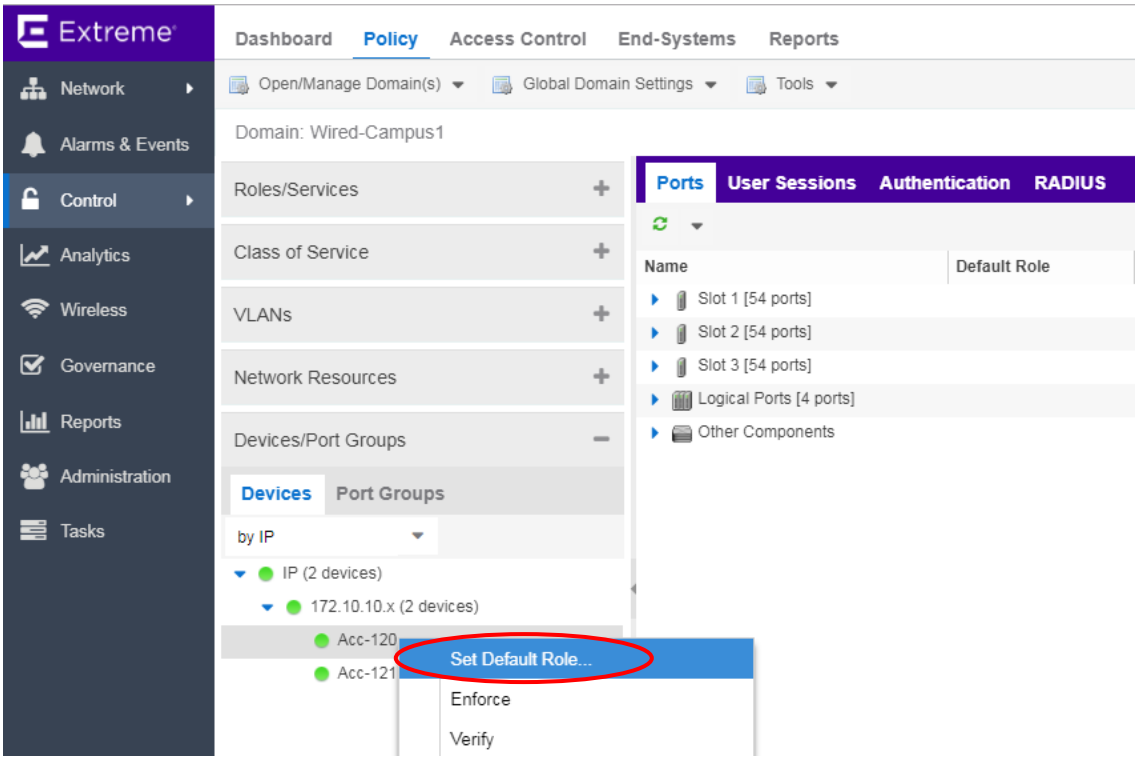
- Verification via ExtremeControl: **Navigate to Control →End Systems**



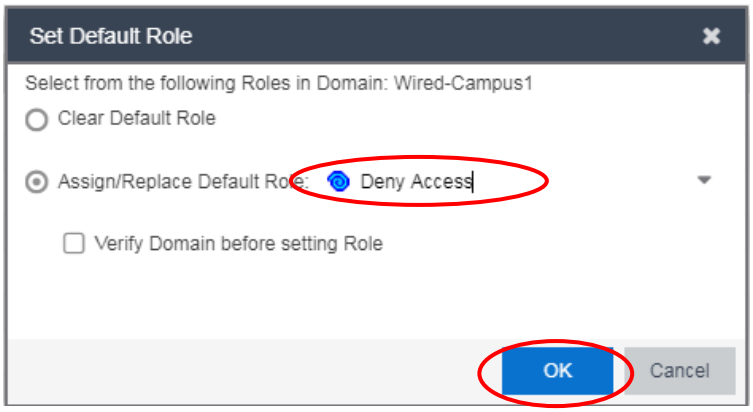
Default Role

A Default Policy role can be applied to wired ports. This can be useful if the authenticated user is assigned an unknown or invalid role, the NAC is unreachable during authentication, or a user fails authentication to an assigned Accept Policy. A Default Role is generally restrictive in nature, but will vary depending on the security requirements of the network.

A Default Role can be applied at the port or switch level on Summit access switches:



Policy Manager will prompt to skip applying this role to interswitch ports and ports where Access Points are detected. This is reccommended.



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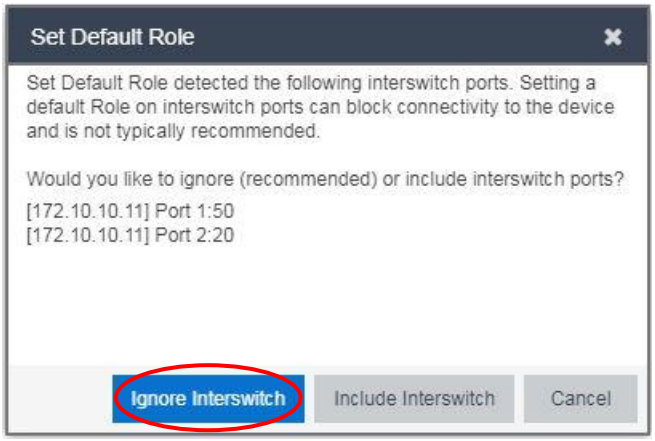


ERS Access Switch

The ERS access switches were used in two separate stack formations in Campus 3. These are both 3-switch stacks connected to form a ring within each stack. Combining the switches in stack formation allowed for easier administration of the switches.

The stack operates as if it were a single switch with a single IP address and a single point of authentication. One switch – called the Base switch – is responsible for running network protocols and managing the stack. The Base runs BOSS software and maintains all the software tables for all the switches in the stack. All switches in the stack, including the Base switch, are also referred to as units.

The procedure for creating an ERS access stack is outside the scope of this document. This information can be found in existing GTAC knowledgebase articles and other CLI documentation. The ERS documentation can be found at the following link below.

How to Create a Stack with ERS Switches

The resulting stack should appear similar to the output below.

```
5900_STACK#show stack health

--------------------------------------------------------------------------------
UNIT#             Switch Model       Cascade Up             Cascade Down
--------------------------------------------------------------------------------
1 (Base)           5928GTS-uPWR      OK                     OK
2                  5928GTS-uPWR      OK                     OK
3                  5928GTS-uPWR      OK                     OK

--------------------------------------------------------------------------------
Switch Units Found = 3
Stack Health Check = OK - RESILIENT
Stack Diagnosis = Stack in full resilient mode.
```

A successfully configured stack will assign each switch within the stack a unique unit number and one will be given one of three assignments: master, backup, or standby. Each stack only has one master and one backup but can have more than one standby. The backup node will take the place of the master node if the master node fails. A standby node will take the place of the backup node if the backup node becomes the master node.

In this EVD, the access switches are managed in-band via a static IP configured on the FA Management VLAN for each campus.

ERS Access Switch Provisioning/Fabric Attach

After the stacking configuration is complete, it is provisioned for user network access.

Warning

To avoid potential network issues, it's recommended to enter the base configuration below before connecting to the network.

Note

For more information on the commands used below, including configuring an SNMPv3 profile in XMC, refer to **Design Considerations**

- Before deploying, configure the access switch to establish initial IP connectivity and FA functionality to the XMC and allow network provisioning.

```
ip default-gateway 172.30.10.1
ip address stack 172.30.10.12
ip address source configured-address
telnet-access disable
ssh

mlt 1 name "Trunk #1" enable member 1/25,2/25

no fa message-authentication 1/ALL,2/ALL,3/ALL
fa zero-touch-option auto-port-mode-fa-client client-type 6-7
fa zero-touch-option auto-trusted-mode-fa-client client-type 6-7

interface ethernet 2/22
spanning-tree mstp edge-port true
exit

vlacp enable
interface Ethernet ALL
vlacp port 1/25,2/25 timeout short
vlacp port 1/25,2/25 timeout-scale 5
exit

logging remote address 172.9.99.119
logging remote enable
logging remote facility local4

sntp server primary address 134.141.79.190
sntp server secondary address 134.141.79.191
sntp enable
sntp sync-interval 1
clock source sntp
clock time-zone EST -5
```

Configure the IP, and default gateway. Disable Telnet and enable SSH.

Configure the MLT trunk ports connecting to the BEBs.

Configure FA options to allow APs to connect as trusted clients (wap-type 1 / 2).

Configure interfaces APs will be connected to with the “edge-port” option set to “true”, indicating MSTP edge-port status.

Enable VLACP to allow for fast failover, and configure the MLT trunk ports

Configure syslog commands pointed to XMC, and SNTP configuration.

- Enter RADIUS configuration:

```
radius server host 172.9.99.120 key acct-enable
<shared secret>
<shared secret>
radius server host 172.9.99.121 secondary
radius server host 172.9.99.120 key used-by eapol acct-enable
<shared secret>
<shared secret>
radius server host 172.9.99.121 secondary used-by eapol
radius server host 172.9.99.120 key used-by non-eapol acct-enable
<shared secret>
<shared secret>
radius server host 172.9.99.121 secondary used-by non-eapol
radius-server encapsulation ms-chap-v2
radius-server password fallback

cli password telnet radius
cli password serial radius
```

Configure RADIUS host for mgmt. access login, specifying ExtremeControl IP addresses. When prompted, enter/confirm the RAIUS shared secret.

Configure the same parameters for dot1x (eapol) and MACauth (non-eapol).

Enable encryption of RADIUS packets.

Enable password authentication for telnet/SSH/serial.

- Configure the SNMPv3 configuration:

```
snmp-server name "Acc-321"
snmp-server view snmpView +1.3
snmp-server view adminView +1.3
snmp-server user xmc_v3 sha aes read-view adminView write-view adminView notify-view adminView
<SHA password>
<SHA password>
<AES password>
<AES password>

snmp-server user engine-id 80:00:1f:88:80:c5:04:f2:24:d6:ac:d0:5a xmc_v3 sha aes
<SHA password>
<SHA password>
<AES password>
<AES password>


snmp-server host 172.9.99.119 port 162 v3 auth-priv "xmc_v3" inform
```

Use the SHA and AES passphrases to match XMC's SNMP profile.

Configure the SNMP engine-id, providing the SHA and AES passphrases. See SNMP Design Considerations on where to retrieve the engine-id.

Set the SNMP Trap target to the XMC.

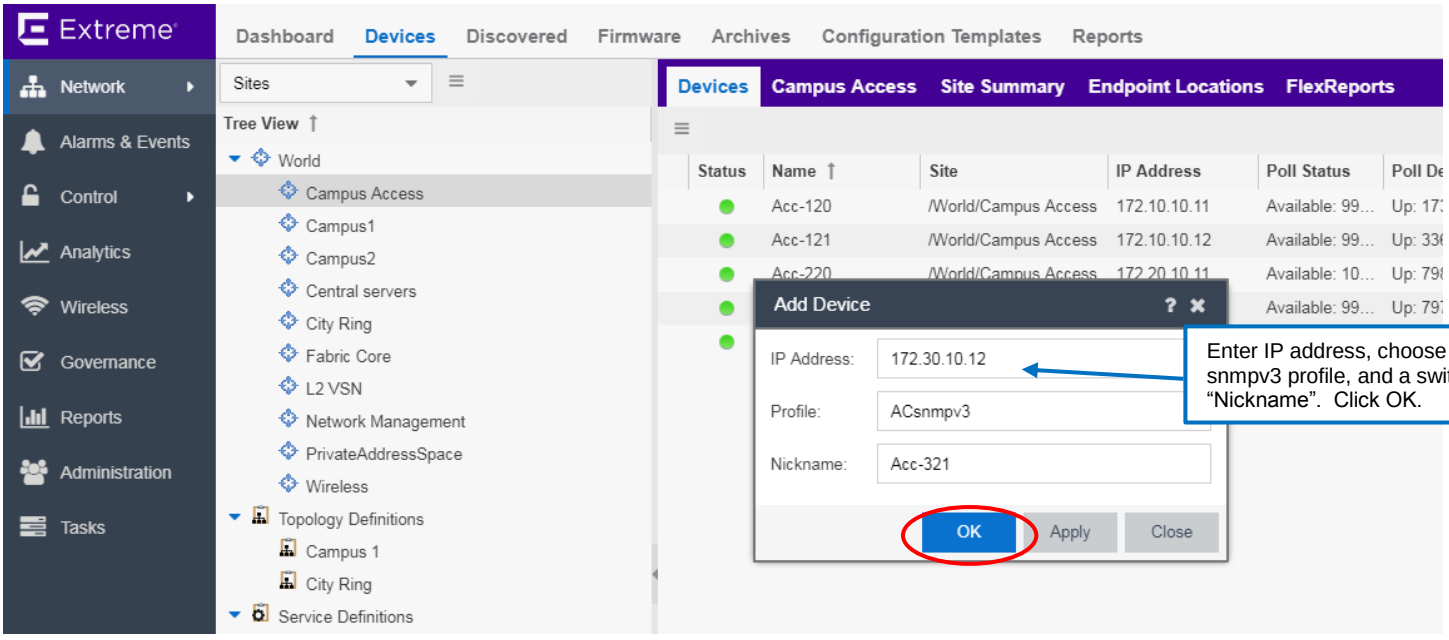
- Configure Extensible Authentication Protocol over LAN (EAPOL) settings:

```
eapol multivlan auto-config port 1/3,3/1,3/3,3/16
interface Ethernet ALL
eapol multihost eap-mac-max 32 non-eap-mac-max 32 mac-max 64
exit
eapol enable
save config
```

Enable authentication for eap and non-eap users on desired ports.

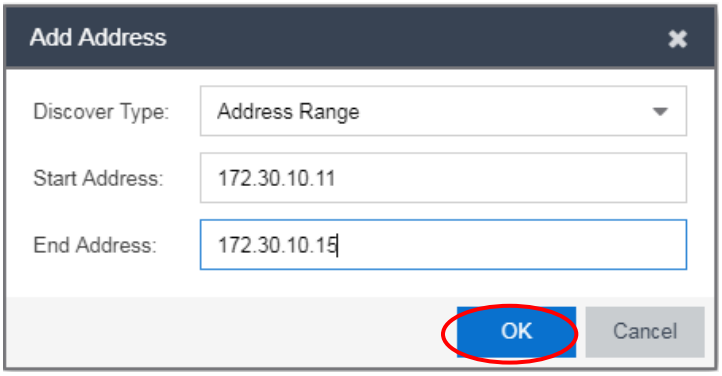
Save the configuration.

- In XMC, under **Network→Devices**, right-click the **Campus Access** Site and choose **Add Device**:

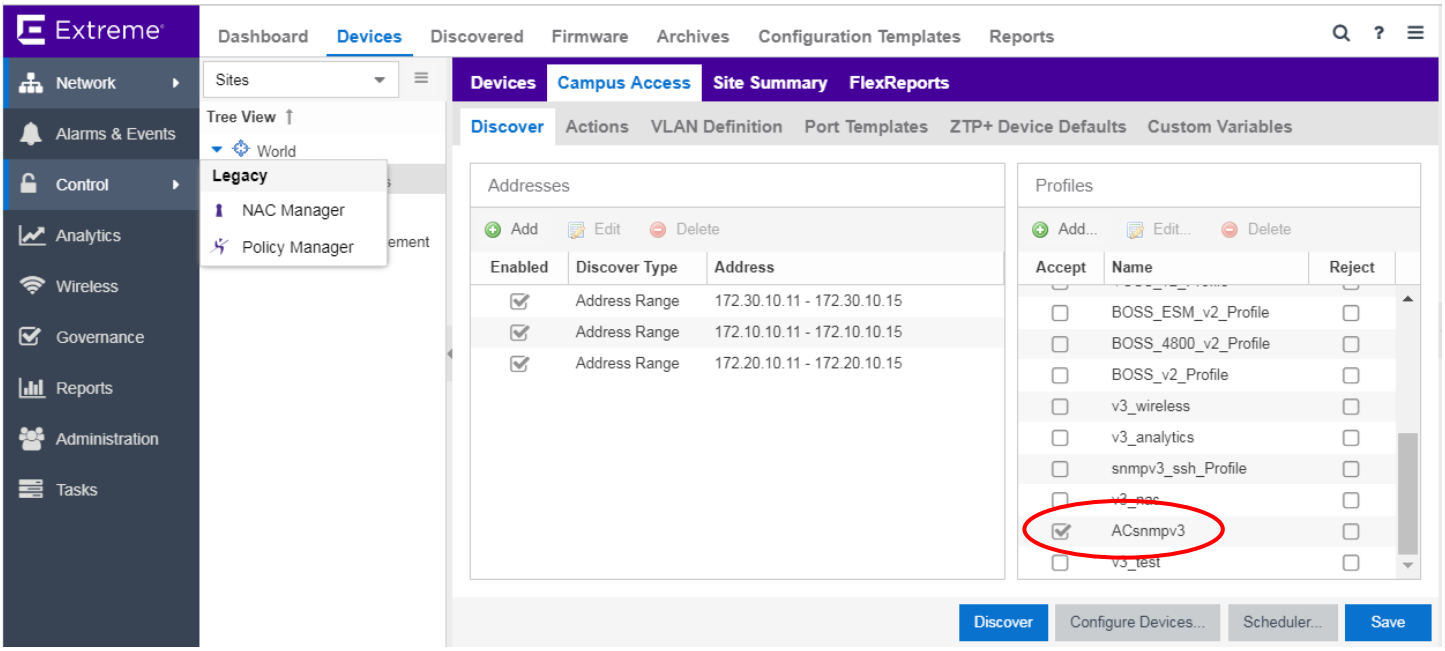


- Repeat this for any other deployed access switches in this campus.

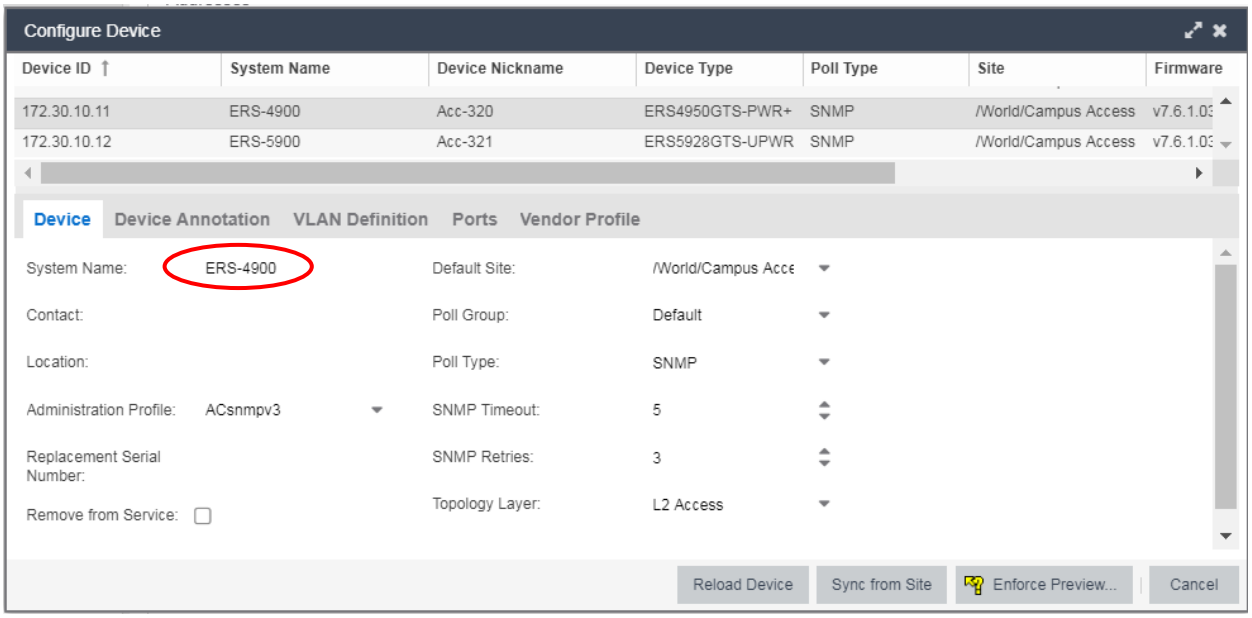
- To discover multiple access switches at once, an address range can be specified. Navigate to **Network→Devices→Sites→Campus Access→Discover.** Under **Addresses,** click **Add:**
- Choose **Address Range** from the drop-down, and fill in parameters**.** Click **OK:**

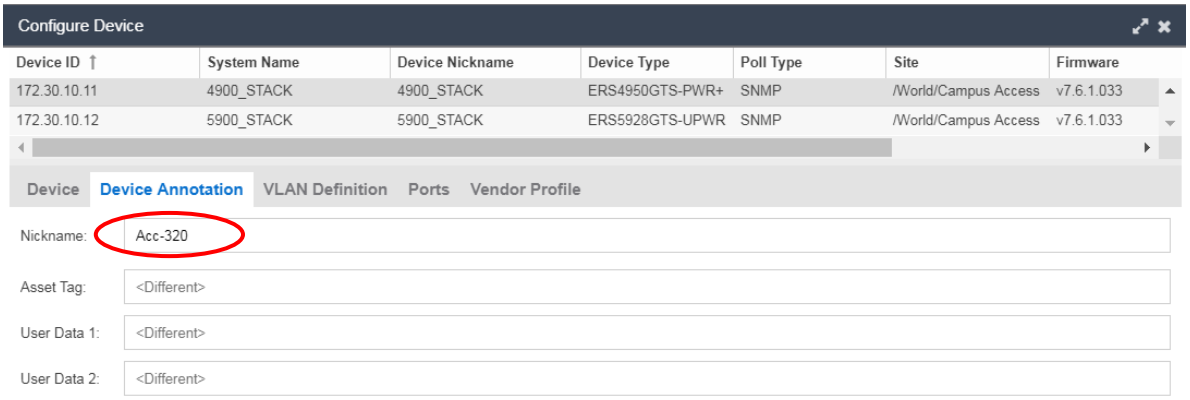


- Under **Profiles**, check the desired SNMP profile to apply. Click Save, then Discover:

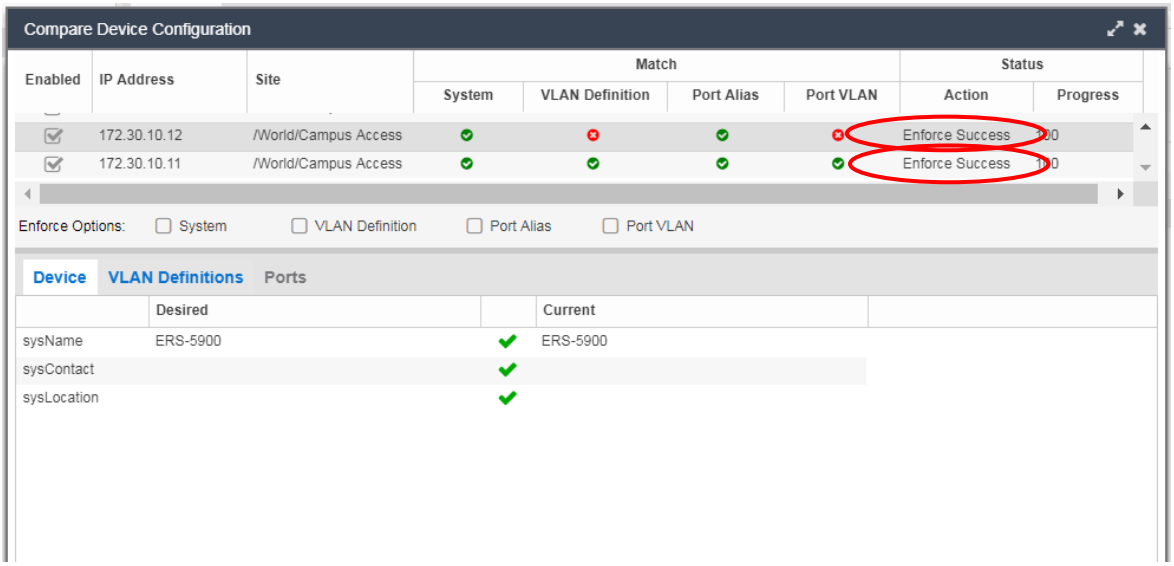


- When Discover complete, click **Configure Devices**. Highlight each of the newly discovered switches, and give each a System Name and (under Device Annotation tab) a Nickname:

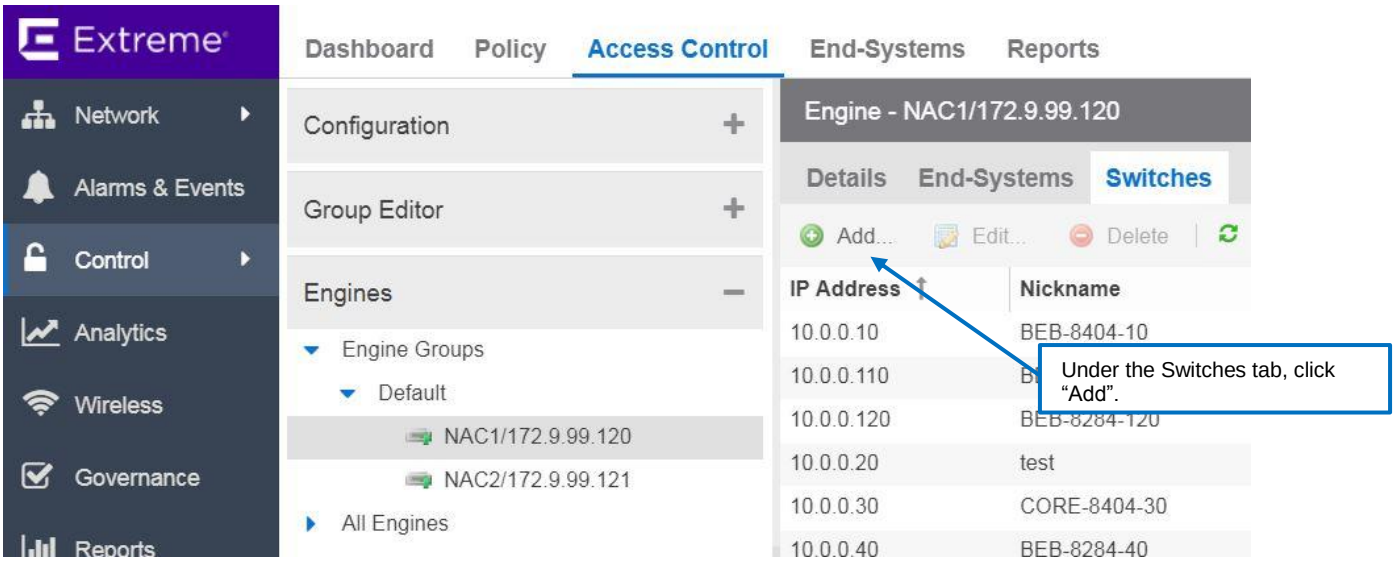




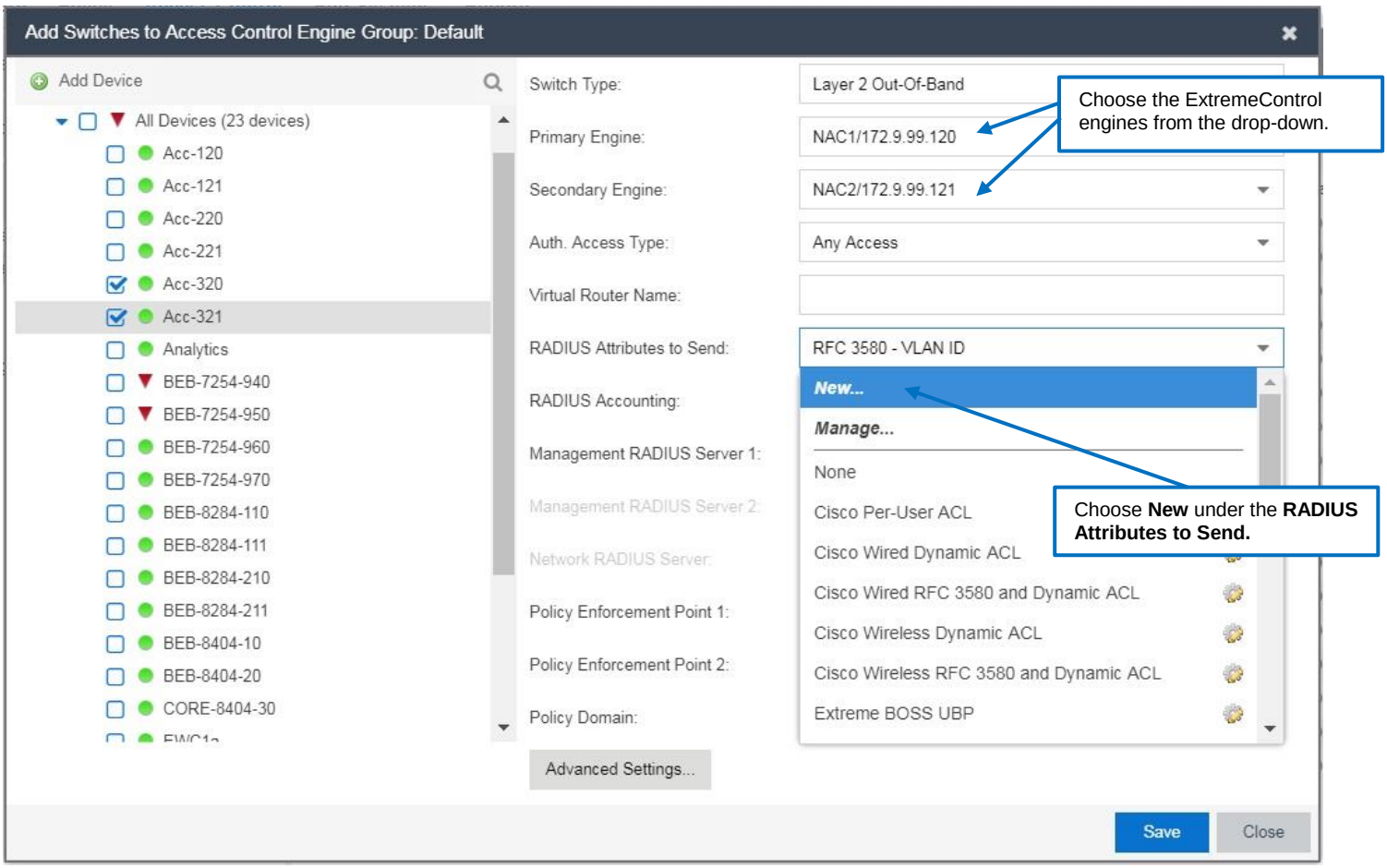
- Click **Enforce Preview**, then **Enforce** to apply these settings:



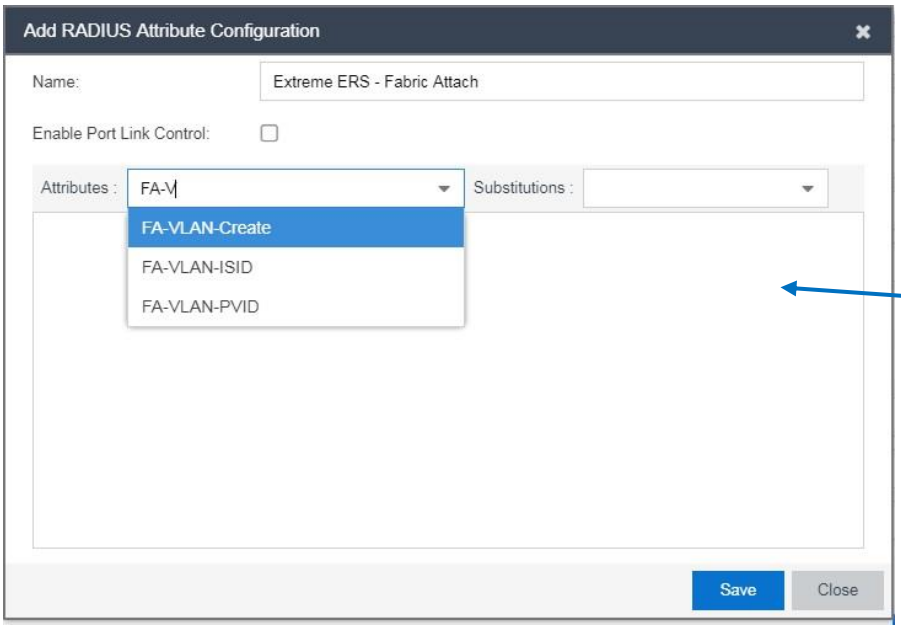
- Click on the **Access Control** tab and add the switch to the ExtremeControl engines:



- As the ERS access switches use RADIUS Attributes instead of Extreme Policy, an Attributes configuration file needs to be created that can be applied to all future-deployed ERS switches. Enter the ExtremeControl parameters for the switch, and click **Save**:

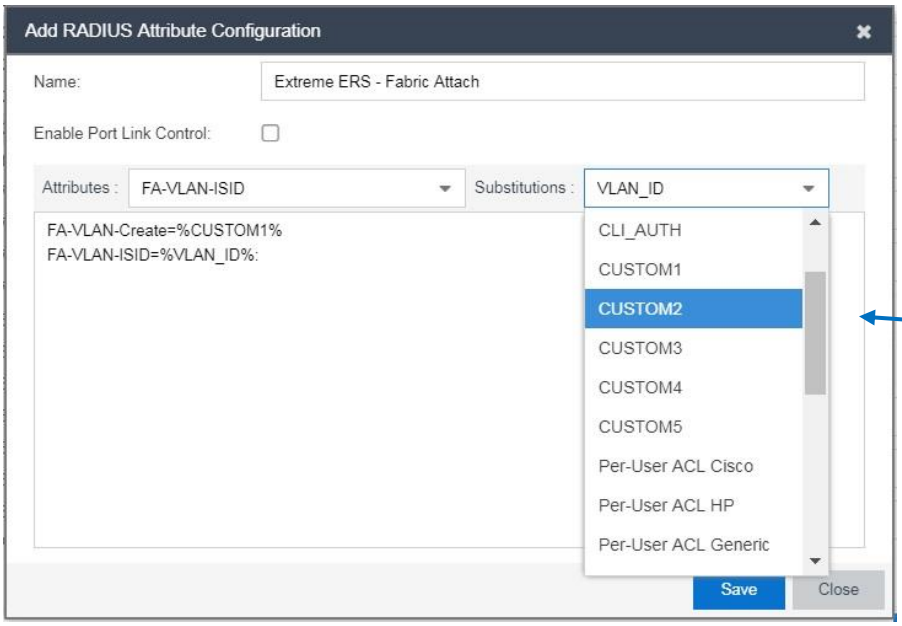


- Configure a name for the Attributes Configuration file.



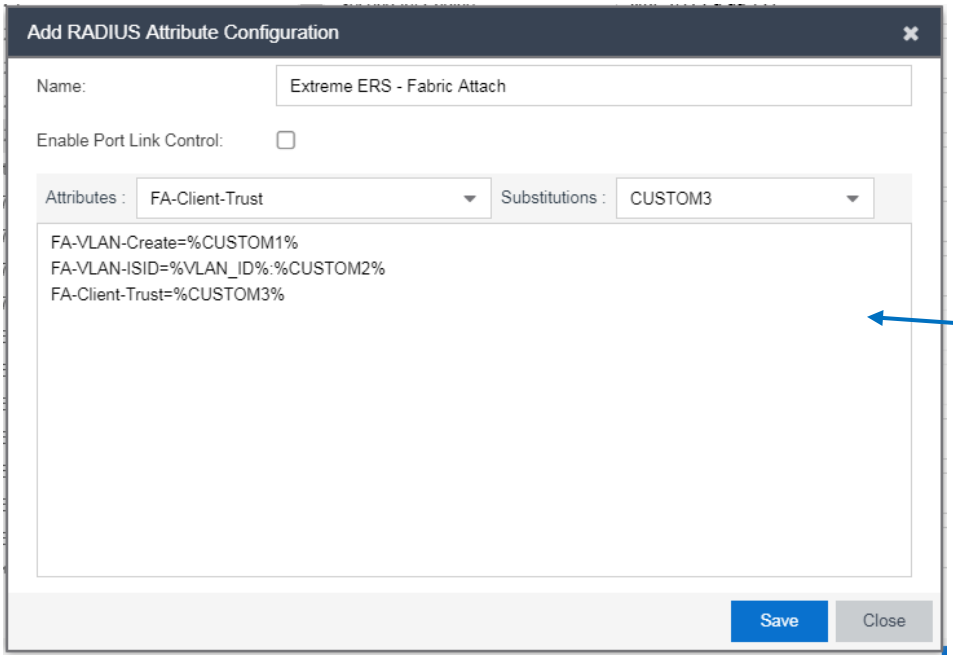
Choose the FA-VLAN-Create attribute from the drop-down. Then under Substitutions, choose **Custom 1**. This attribute will instruct the ERS to create VLANs upon successful authentication.

- Choose **FA-VLAN-ISID** for the next attribute. Under Substitutions, choose **VLAN_ID**. Enter a colon (":"), then choose the **CUSTOM2** substitution (%VLAN_ID%:%CUSTOM2%):



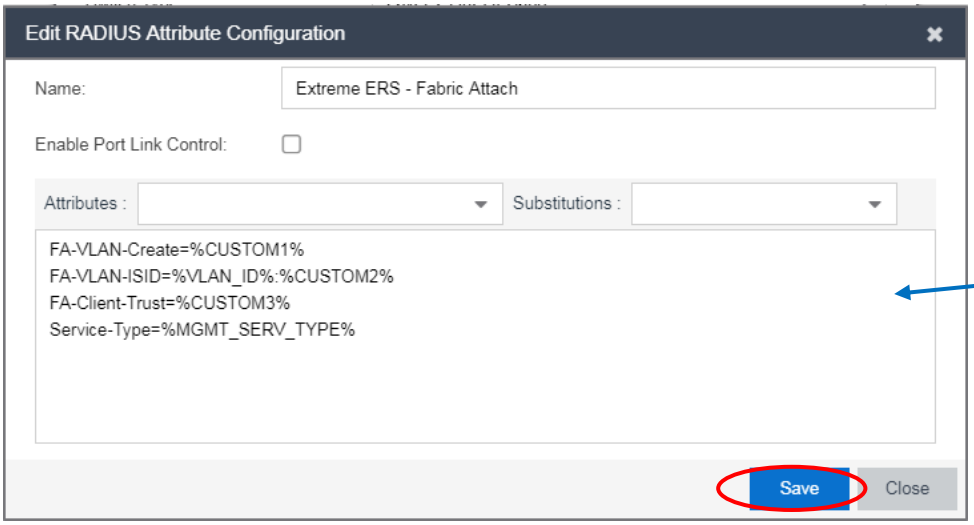
This attribute will allow the corresponding VLAN id and I-SID value to be assigned upon successful authentication.

- Choose **FA-Client-Trust**, then **CUSTOM3** for the Substitution:



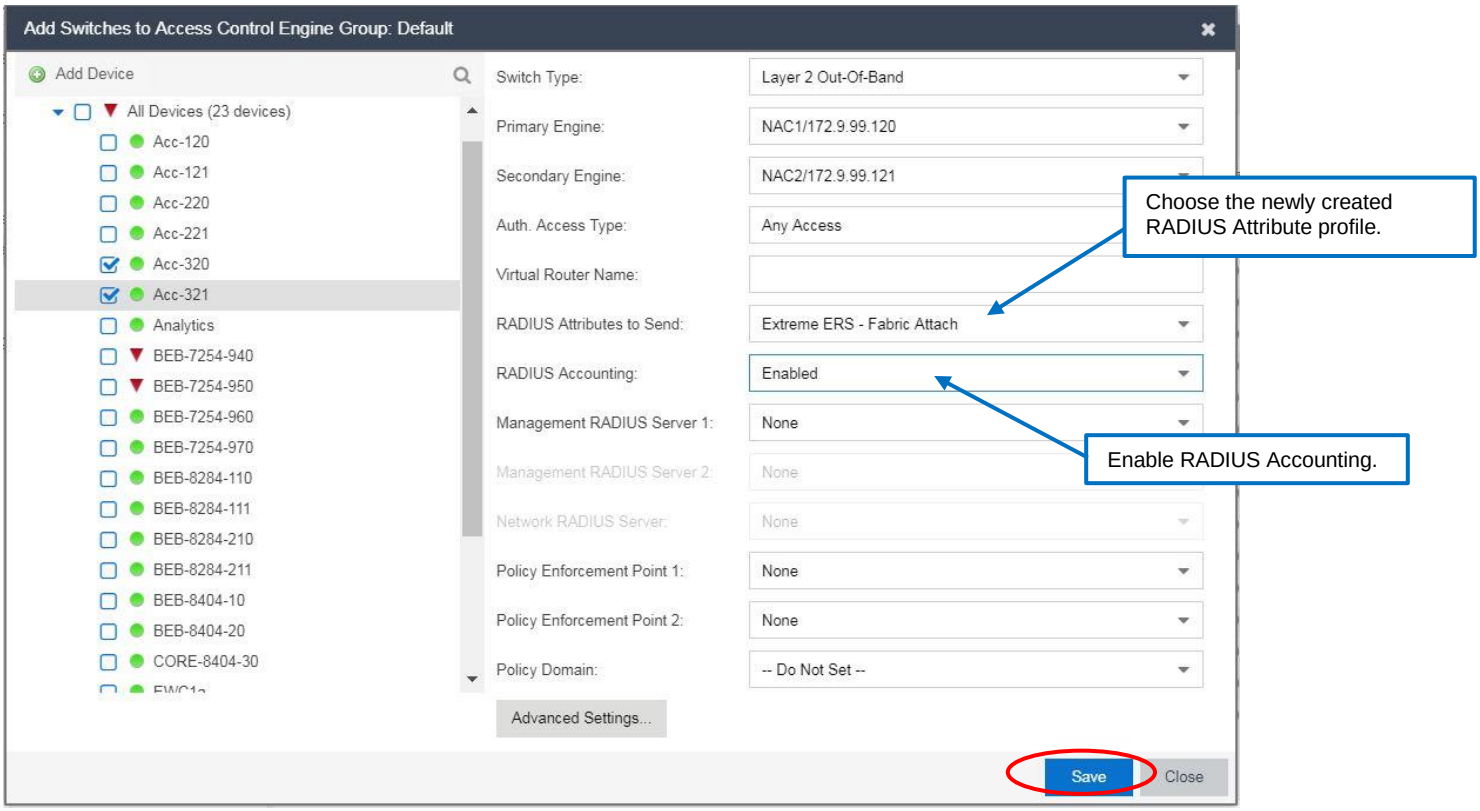
This attribute is used when an AP is authenticated and instructs the ERS to allow VLAN/ISID assignments from the AP.

- Finally, add the **Service_Type** attribute, with the **MGMT_SERV_TYPE** substitution. Click **Save**:

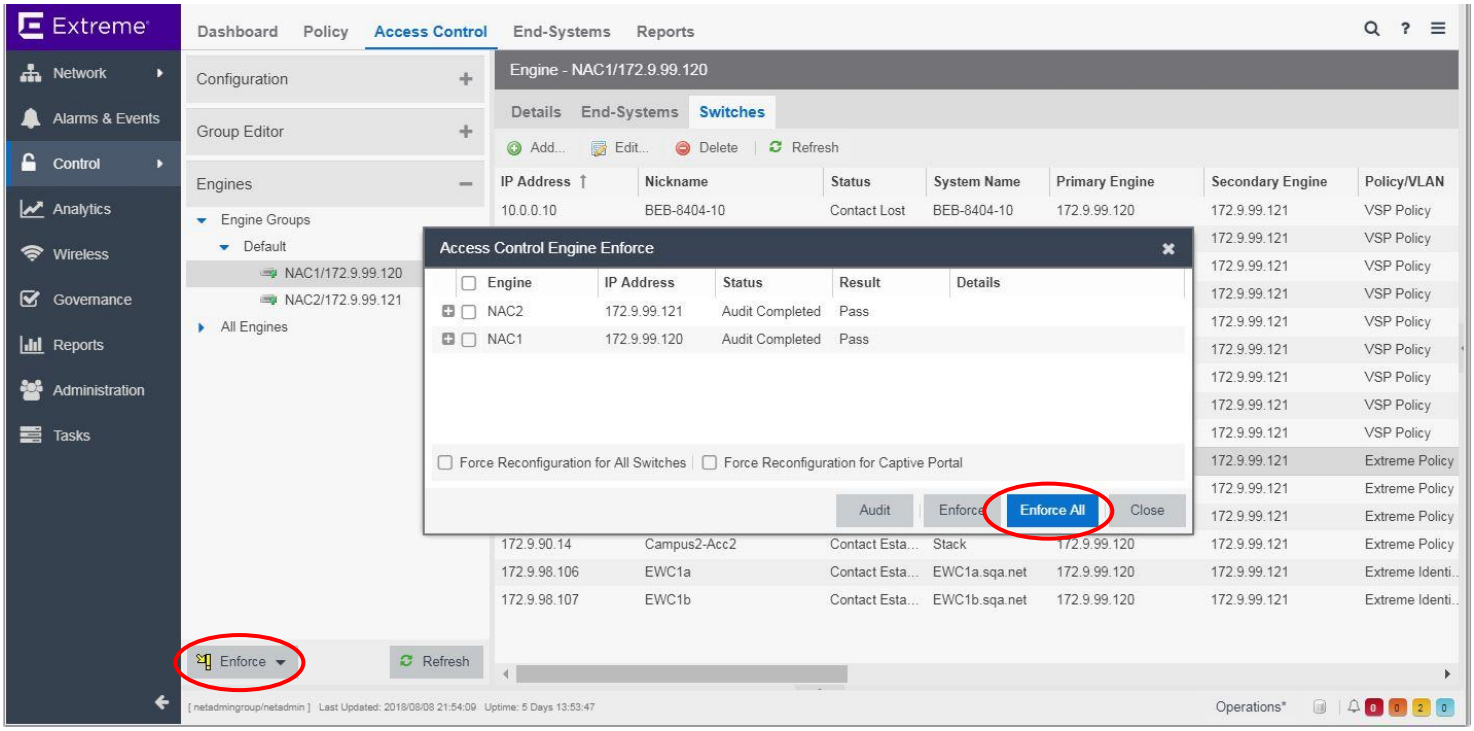


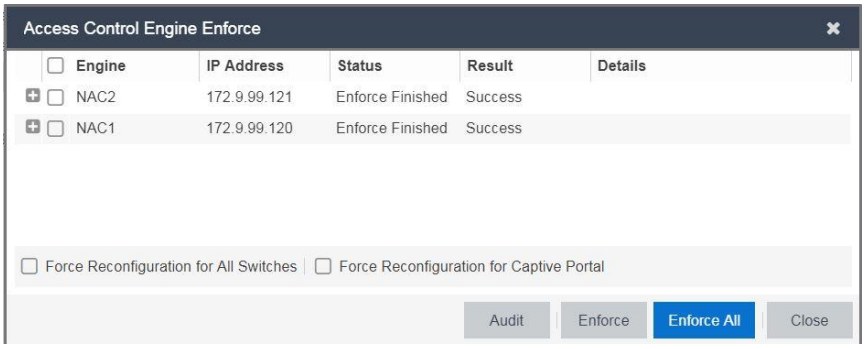
This attribute allows for authenticated management login to the switch.

- Finish the remaining config parameters for adding the switch to ExtremeControl:



- Click "**Enforce**" at the bottom left of the screen to enforce the current rule base to the ExtremeControl Engine:





- Verify that the Fabric Attach Mgmt VLAN (from the FA Server) was assigned to the access switch:

```
Acc-320(config)#show fa element

================================================================================
                        Fabric Attach Discovered Elements
================================================================================
UNIT/                   MGMT                                          ELEM ASGN
PORT    TYPE            VLAN  STATE  SYSTEM ID                        AUTH AUTH
--------------------------------------------------------------------------------
MLT1    Server          300   T / S  00:bb:00:03:10:11:30:01:00:01     NA   NA
```

- Upon connection, wired user traffic will be authenticated via ExtremeControl, and the corresponding Accept Policy will be sent to the access switch. The access switch will assign that role to the end user via netlogin:

```
Acc-321#show eapol session port 1/3

------------------------------ Non-EAP Clients -------------------------------
Unit/Port Client MAC Address State                                  Vid  Pri
--------- ------------------ ---------------------------------------- ---- ---
1/3       00:32:01:00:00:19  Authenticated By RADIUS                  302  0
Total number of DHCP phones: 0
Total number of EAP clients: 0
Total number of non-EAP clients: 1
Total number of unauthenticated clients: 0
```

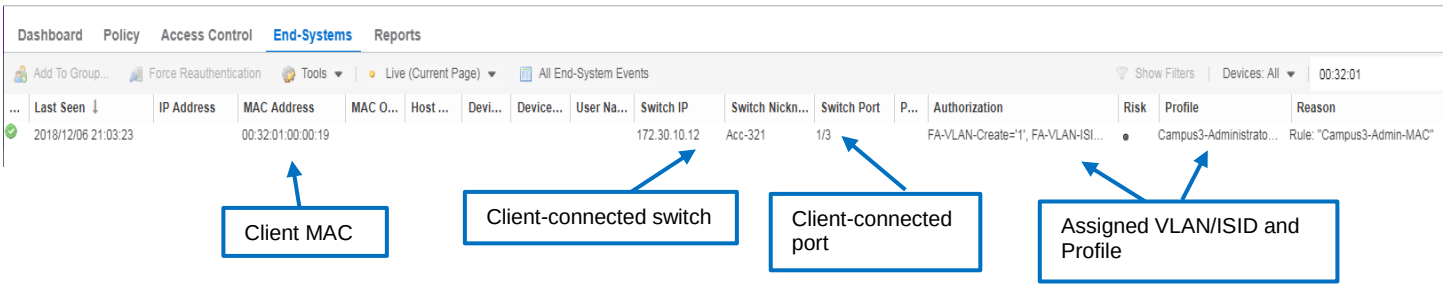
The end user authenticated MAC.

- The corresponding VLAN and ISID are assigned:

```
Acc-321#show fa ass

 I-SID     VLAN             Source                 Status
--------  ----  ------------------------------  --------
1030302    302   Radius                         Active

Binding Count: 1
```

The VLAN/ISID mapping

- Verification via ExtremeControl: **Navigate to Control →End Systems**



Authentication – Netlogin & RADIUS

Network login is a security feature that controls admission of user packets and access rights, preventing unauthorized access into the network. Netlogin offers three authentication types: MAC-based, dot1x and web-based. MAC-based authentication can be done locally or using a RADIUS server. MAC-based with RADIUS server and dot1x methods are implemented for this solution.

By itself, netlogin actions consist of allowing or filtering traffic on the ports it is enabled on. Its functionality can be further enhanced by using policies, which offer a greater variety of actions and granular control of user packets access to the network.

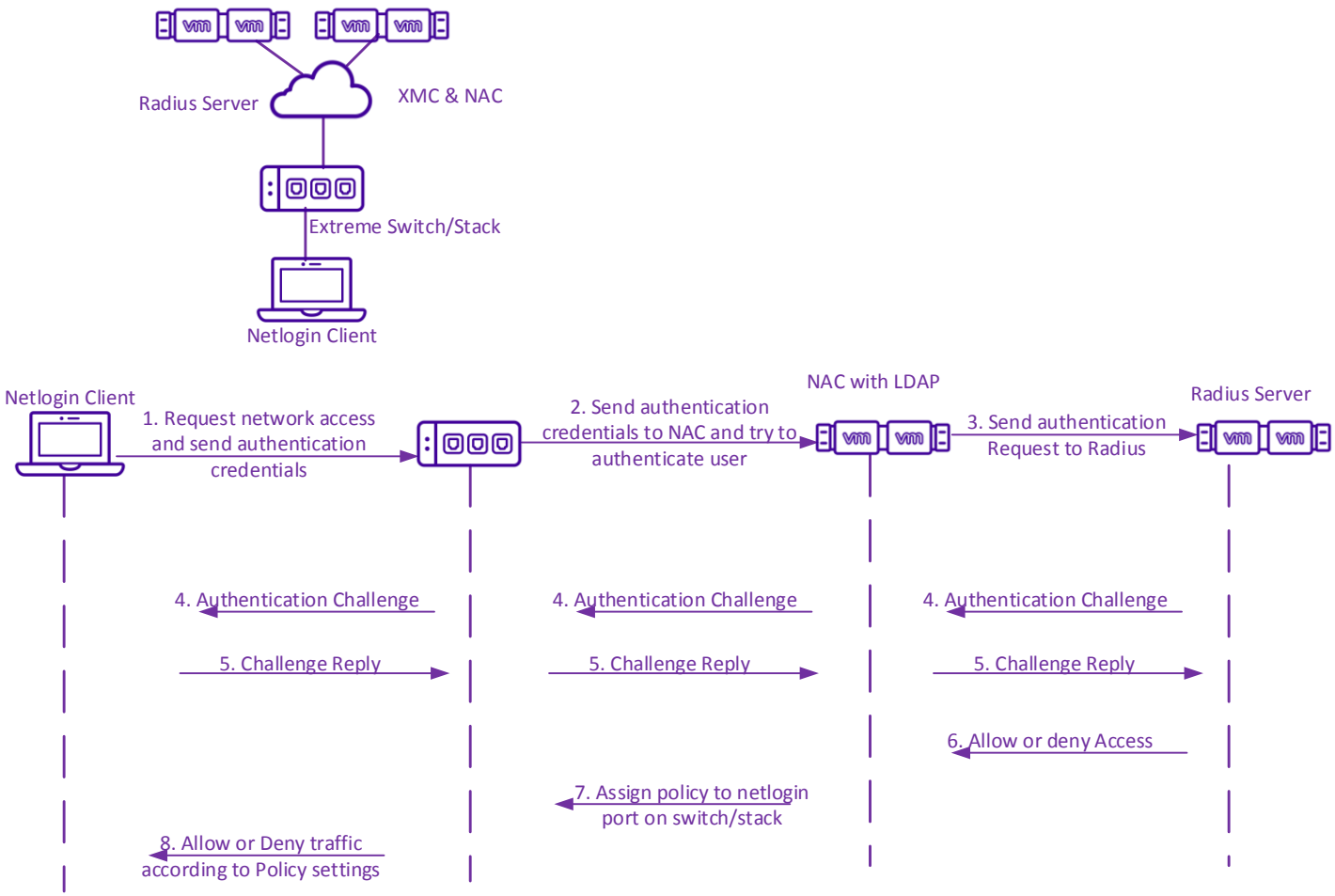
Netlogin dot1x authentication involves three parties: supplicant, authenticator and authentication server. The supplicant is the client machine, capable of running 802.1X authentication software. The authenticator is the network device the client is connected to, configured with netlogin. The authentication server is usually a third-party RADIUS server.

For clients that can't run authentication software – like printers, APs, and other wired devices connected to the network – MAC-based authentication can be used. In this case the supplicant is unaware that the authentication is taking place. The authenticator will use the device's MAC address to authenticate the user.

For a user to authenticate, the following conditions must be met:

1. The Extreme device is added to Extreme Management Center.
2. Controllers are added to Extreme Management Center and are configured.
3. LDAP configurations are made.
4. The device is added to the correct Control Domain.
5. Policies are created – roles and corresponding services are defined.
6. Policies are enforced on Extreme switches.
7. Access control rules and accept policies are defined.
8. Network devices are added as trusted RADIUS clients for ExtremeControl.
9. Access control settings are enforced on the controllers.

Authentication Process



Authentication Steps

1. A user connecting to the switch and requesting network access sends login credentials to the switch.
2. The switch sends the credentials in a RADIUS Request message to the ExtremeControl. Upon seeing the request, the ExtremeControl verifies its RADIUS server configuration. If a server is present, the authentication request is sent to it. If no server is found, the LDAP configuration conditions are verified. If the conditions are all met, the authentication request is sent to the RADIUS server. At this point ExtremeControl/LDAP is acting as authenticator.
3. When the RADIUS server receives an authentication request it first verifies that the authenticator is in its trusted client list and that the shared secret received matches the locally configured one, to determine if it can accept an authentication request from the client. Next, if the client verification passes, the RADIUS server searches for a Network Access policy whose access conditions are passed by the Request packet. If an access policy is found, the authentication process can continue. If not, the user's login attempt is rejected.
4. For PEAP and TLS authentication, a RADIUS Challenge message is sent to the user.
5. The user must respond to the challenge in order to complete the authentication process.

6. The RADIUS server either allows or denies the user access and sends the response to the ExtremeControl server.
7. If the user passes authentication, ExtremeControl starts verifying the LDAP attributes and Access Control Rules one by one until the conditions of one of them are met. A Profile and an Accept Policy for the matched rule are returned for the authenticated user and applied on the switch port to which the user is connected.
8. All traffic generated by the user will be treated according to the services configured for the Role corresponding to the Accept policy the user matched.

RADIUS Configuration

When user access control is done using policy and netlogin, at least one RADIUS server must be configured on the access switches. At the access layer of the Automated Campus solution, two RADIUS servers are configured—one primary and one secondary – for redundancy. If the primary server fails, the authentication requests will be sent to the second RADIUS server. On the switches, the ExtremeControl engines are configured as RADIUS servers.

When the access switch is added as a Switch to ExtremeControl, the resulting auto-configuration should look similar to the one below:

Summit Access switches:

```
Slot-1 Stack.1 # show config aaa
#
# Module aaa configuration.
#
configure radius 1 server 172.9.99.120 1812 client-ip 172.9.90.11 vr VR-Default
configure radius 1 shared-secret encrypted "#$PRLoiBq3oT81gwfTQRzSQhR8yaZhYQ=="
configure radius 2 server 172.9.99.121 1812 client-ip 172.9.90.11 vr VR-Default
configure radius 2 shared-secret encrypted "#$1XDtAvhCUB7v5akv9X97TG0r1VDK+Q=="
configure radius-accounting 1 server 172.9.99.120 1813 client-ip 172.9.90.11 vr VR-Default
configure radius-accounting 1 shared-secret encrypted "#$UriT+Zu2oRu4Yj6PA1Ss8lU/b/9a3Q=="
configure radius-accounting 1 timeout 10
configure radius-accounting 2 server 172.9.99.121 1813 client-ip 172.9.90.11 vr VR-Default
configure radius-accounting 2 shared-secret encrypted "#$t4+vv1g0kNXIq2X39Fmv5ONPXUP3RQ=="
configure radius-accounting 2 timeout 10
enable radius
enable radius mgmt-access
enable radius netlogin
configure radius timeout 10
configure radius mgmt-access timeout 15
configure radius netlogin timeout 15
enable radius-accounting
enable radius-accounting mgmt-access
enable radius-accounting netlogin
```

ERS Access switches: When the ERS is configured with the commands from the provisioning section, the resulting configuration should look similar to the one below:

```
Acc-321(config)#show run module radius
!
! *** RADIUS ***
!
radius-server encapsulation ms-chap-v2
no radius use-management-ip
radius server host 172.9.99.120 acct-enable
radius server host 172.9.99.121 secondary
radius server host 172.9.99.120 used-by eapol acct-enable
radius server host 172.9.99.121 secondary used-by eapol
radius server host 172.9.99.120 used-by non-eapol acct-enable
radius server host 172.9.99.121 secondary used-by non-eapol
!
! *** RADIUS Dynamic Server ***
!
```

Netlogin Configuration (Summit)

Authentication with netlogin dot1x and MAC is enabled on all Summit ports except for the uplink and server ports. The authentication order is dot1x MAC.

When complete, the configuration should look similar to the one below:

Summit Access switches

```
Slot-1 Stack.2 # show config netlogin
#
# Module netLogin configuration.
#
enable netlogin dot1x mac
configure netlogin authentication protocol-order dot1x mac web-based
enable netlogin ports 1:1-49,2:1-49,3:1-49 dot1x
enable netlogin ports 1:1-49,2:1-49,3:1-49 mac
configure netlogin add mac-list ff:ff:ff:ff:ff:ff 48
```

EAPOL Configuration (ERS)

Authentication with EAPOL dot1x and MAC can be enabled on all ERS ports except for the uplink and server ports.

When complete, the configuration should look similar to the one below:

```
Acc-321(config)#show run module EAP
! *** EAP ***
eapol multihost radius-non-eap-enable
eapol multihost auto-non-eap-mhsa-enable
interface Ethernet ALL
eapol multihost port 1/1-2,1/4-28,2/ALL eap-mac-max 32 non-eap-mac-max 32 mac-max 64
eapol multihost port 3/1 eap-mac-max 32 non-eap-mac-max 32 radius-non-eap-enable mac-max 64
eapol multihost port 3/2 eap-mac-max 32 non-eap-mac-max 32 mac-max 64
eapol multihost port 3/3 eap-mac-max 32 non-eap-mac-max 32 radius-non-eap-enable mac-max 64
eapol multihost port 3/4-15 eap-mac-max 32 non-eap-mac-max 32 mac-max 64
eapol multihost port 3/16 eap-mac-max 32 non-eap-mac-max 32 radius-non-eap-enable mac-max 64
eapol multihost port 3/17-28 eap-mac-max 32 non-eap-mac-max 32 mac-max 64
exit
interface Ethernet ALL
eapol port 3/1,3/3,3/16 status auto
exit
```

Wireless User Access

Once the Wireless Controllers have been configured and the access switches have been provisioned in XMC, the deployment of Extreme Wireless Access Points for user access is fairly simple.

AP Provisioning / Fabric Attach

1. Connect a new AP to an access switch port.
2. Once the AP boots up, LLDP is exchanged between the AP and the access switch, discovering each other as Fabric Attach elements. The AP will automatically reboot in FA mode.
3. The access switch, acting as the FA proxy, will advertise (via LLDP) the FA management VLAN to the AP: To verify this, enter the following:

   Summits in Campus 1:

FA Mgmt VLAN 100 is received from FA Server port and advertised to all detected FA element ports (APs).

```
Slot-1 Stack.1 # show fabric attach elements
Fabric Attach Mode: Proxy

                                                    Mgmt      Auto
System Id                      Port    Type             VLAN Tag Provision
------------------------------ ------- ---------------- ---- --- ----------
00-bb-00-01-10-11-30-02-00-02 1:50    Server (No Auth)  100 Mix Disabled
d8-84-66-e3-25-b8-00-00-00-00 2:20    WAP Type 1        100 Mix Disabled
d8-84-66-57-aa-58-00-00-00-00 2:22    WAP Type 1        100 Mix Disabled
00-bb-00-01-10-11-30-02-00-02 2:50    Server (No Auth)  100 Mix Disabled
```

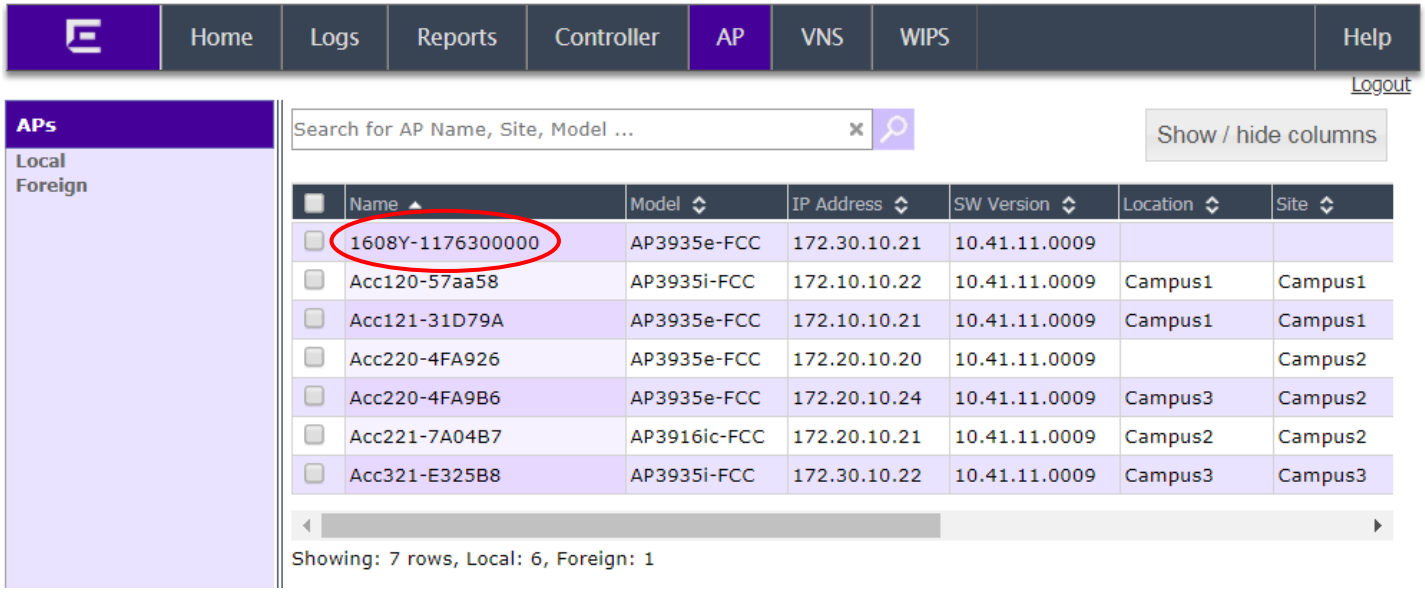
   ERS in Campus 3:

FA Mgmt VLAN 300 is received from FA Server port and advertised to all detected FA element ports (APs).

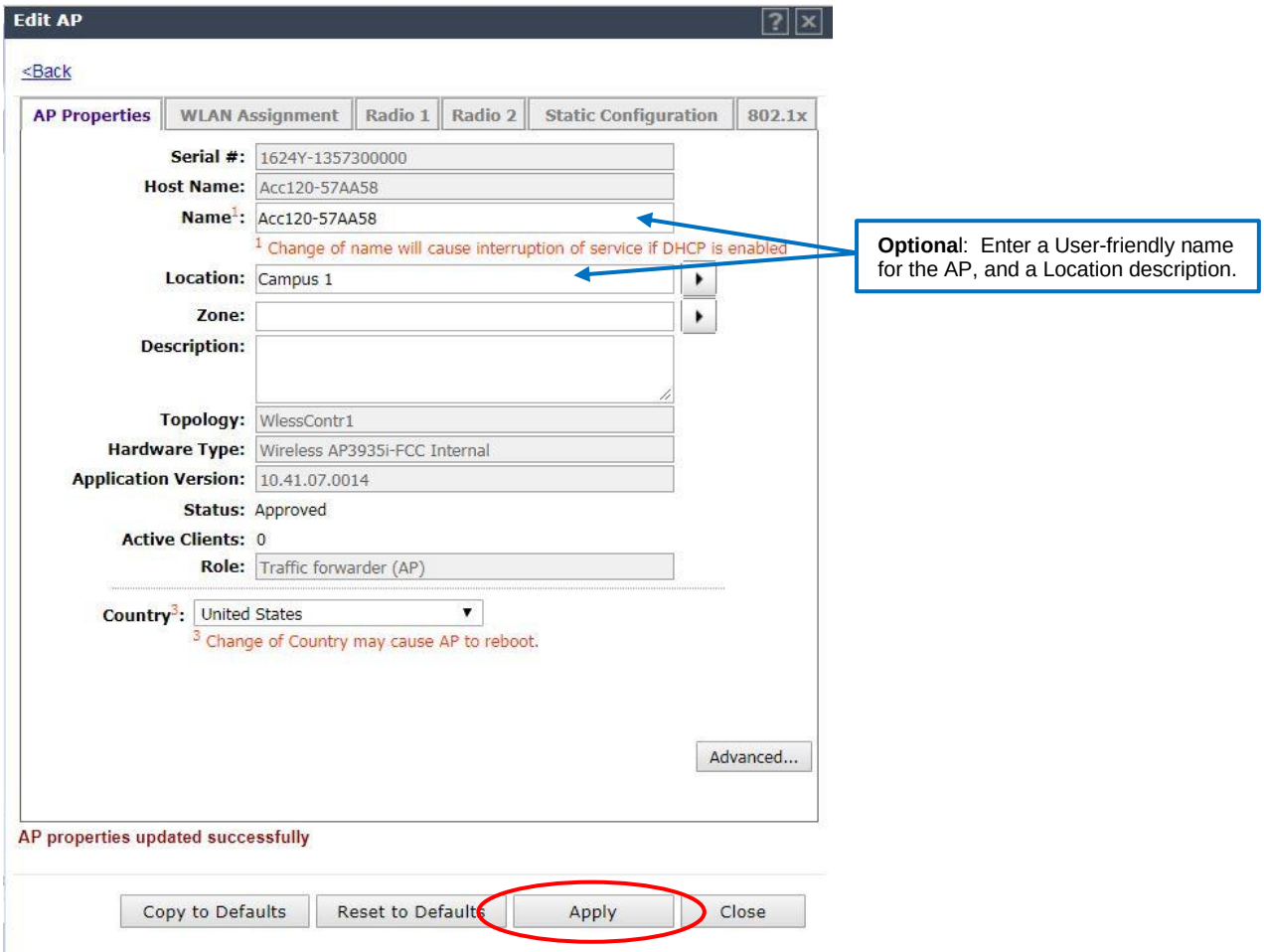
```
ERS-4900(config)#show fa elements

================================================================================
                      Fabric Attach Discovered Elements
================================================================================
UNIT/                 MGMT                                          ELEM ASGN
PORT    TYPE          VLAN  STATE  SYSTEM ID                        AUTH AUTH
--------------------------------------------------------------------------------
MLT1    Server        300   T / S  00:bb:00:03:10:11:30:01:00:01     NA   NA
2/22    Client        0     T / D  d8:84:66:4f:a9:bc:00:00:00:00     NA   N
```

4. The AP will acquire an IP address (via DHCP) from the network server, along with DHCP scope option 78, which provides the IP addresses for the EWCs.

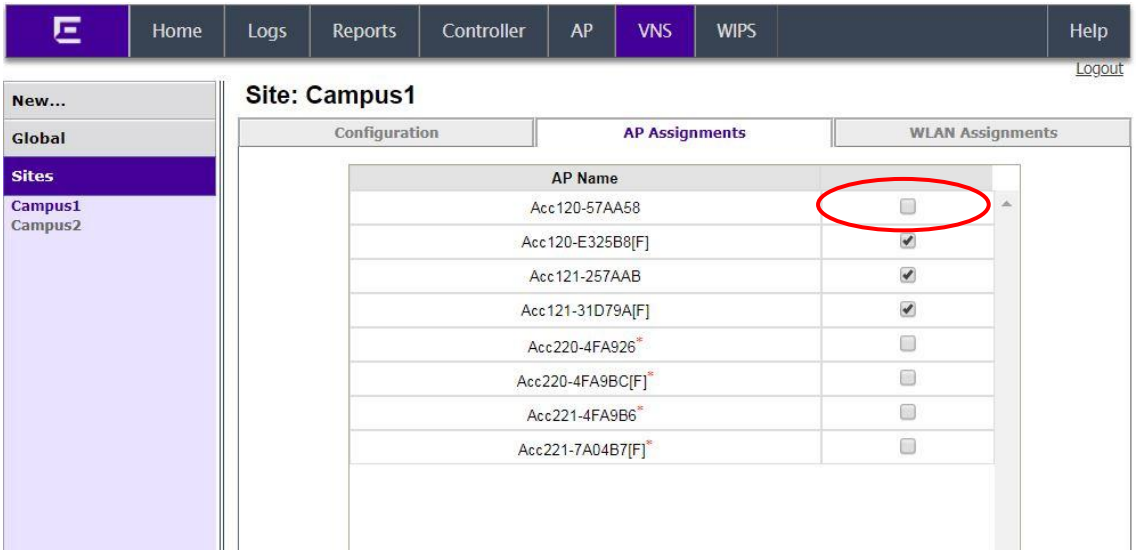
5. The AP will then register with the EWCs, and its serial number will appear in its list:



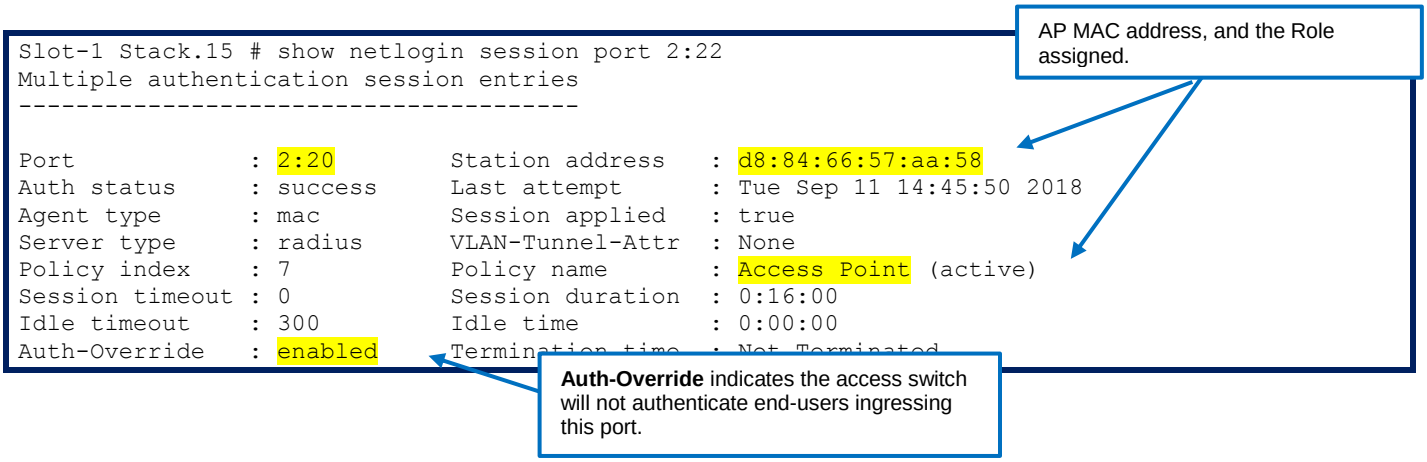
6. Click on the new AP, then **Configure**:



7. On the EWC (**VNS→Sites**), add the AP to the appropriate site. This AP will inherit all the configuration parameters (Roles, WLAN assignments, etc) associated with the Site. Click **Save**:



8. The "Access Point" Policy Role enforced to the Summit access switches identifies the port the AP is connected to based on its MAC OUI and applies the "AP Aware" rule, instructing the access switch to forego any authentication of end users ingressing that port. The AP will process authentication requests with ExtremeControl for connecting wireless users. The access switch will only have a netlogin authentication entry for the AP off that port:



9. With the ERS, the EAPOL and FA configuration will identify the AP as a connected FA client, foregoing any authentication of end users on that port. The RADIUS attributes for AP-connected ERS ports will also be applied from ExtremeControl to instruct the ERS to accept any FA requests from the connected client. The access switch will only have an EAPOL authentication entry for the AP off that port, with wireless clients showing as non-authenticated:

```
Acc-321(config)#sh eapol session port 2/22

----------------------------- Non-EAP Clients ------------------------------
Unit/Port Client MAC Address State                                    Vid  Pri
--------- ------------------ ---------------------------------------- ---- ---
2/22      D8:84:66:E3:25:B8  Authenticated By RADIUS                  300  0

-------------------------- Unauthorized Clients ----------------------------
Unit/Port Client MAC Address Type           Radius Status
--------- ------------------ -------------- ------------------------------
2/22      00:1B:77:15:46:09  MHSA Auth      No request
2/22      C0:BD:D1:AA:7E:35  MHSA Auth      No request
2/22      E8:4E:06:50:5D:1D  MHSA Auth      No request
```

10. The AP (FA Client) will request to the access switch (FA Proxy) the required I-SID assignments based on the configured wireless topologies:

- **Summit**:

```
Slot-1 Acc-120.1 # show vlan fab att ass
Fabric Attach Mode: Proxy
Port     VLAN  VLAN Name                         Type     ISID/NSI  Status
-------  ----  -------------------------------  -------  --------  --------
          101  VLAN_101                         Dynamic   1010101  Active
          104  VLAN_104                         Dynamic   1010104  Active
2:20      100  VLAN_100                         Dynamic   1010100  Active
2:20      200  SYS_VLAN_0200                    Dynamic   1020200  Active
2:20     1050  SYS_VLAN_1050                    Dynamic   1501050  Active
2:20     1051  SYS_VLAN_1051                    Dynamic   1501051  Active
2:20     1052  SYS_VLAN_1052                    Dynamic   1501052  Active
```

VLAN and associated I-SID requested

AP-connected port

- **ERS**:

```
ERS-4900(config)#show fa assignment

 I-SID    VLAN             Source                Status
--------  ----  ----------------------------  --------
1010100   100   Client                        Active
1020200   200   Client                        Active
1030300   300   Radius                        Active
1030301   301   Radius                        Active
1030303   303   Radius                        Active
1090907   907   Radius                        Active
1501050   1050  Client                        Active
1501051   1051  Client                        Active
1501052   1052  Client                        Active

Binding Count: 9
```

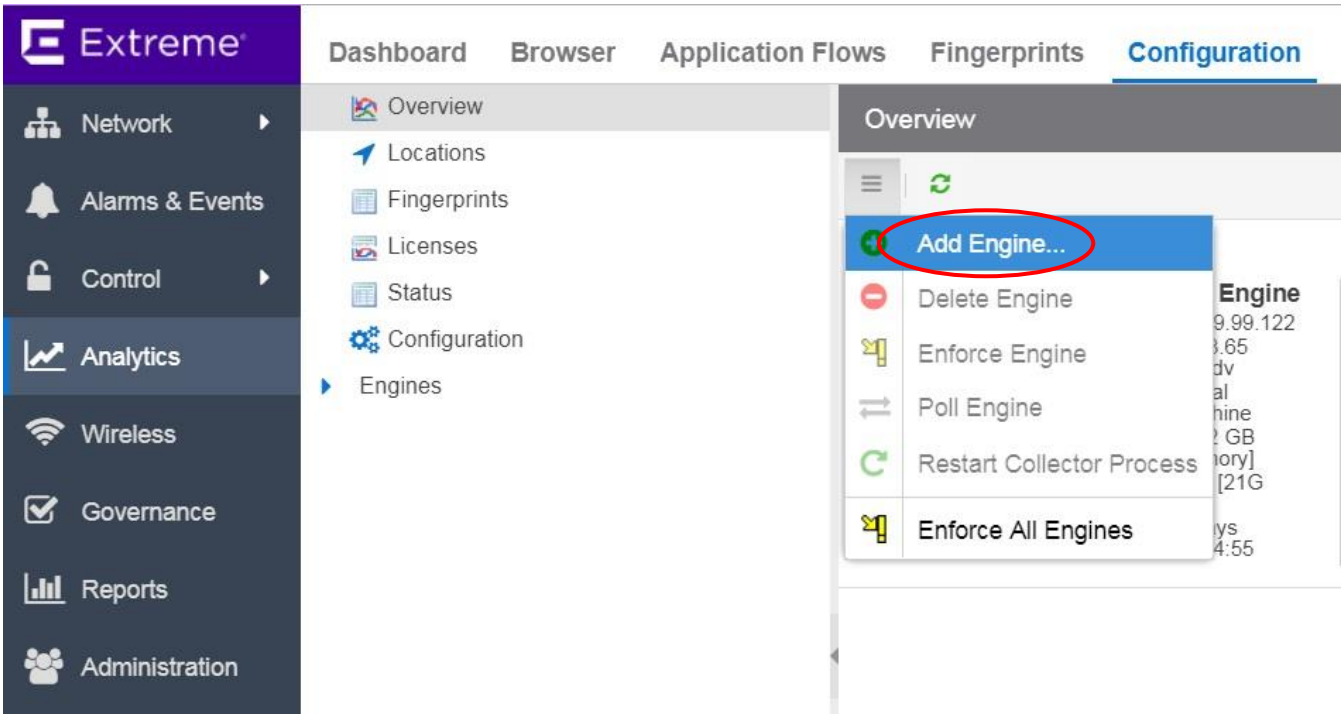
VLAN and associated I-SID requested

ExtremeAnalytics Configuration

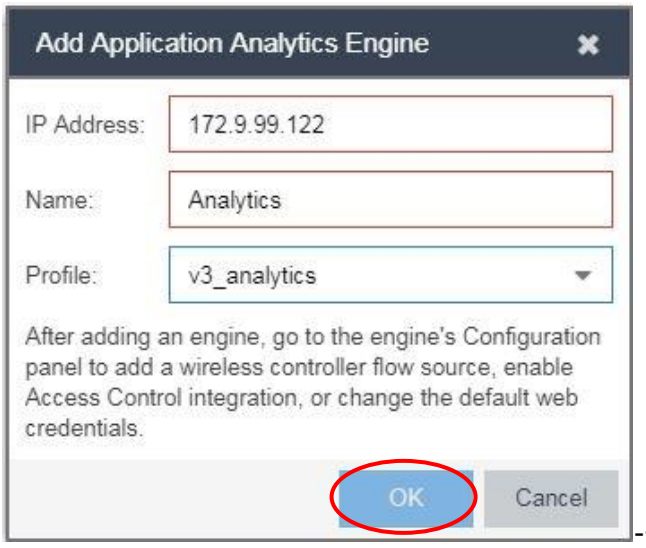
Adding Analytics to Extreme Management Center

From Extreme Management Center, navigate to:

Extreme Management → Analytics → Overview →  **→ Add Engine**

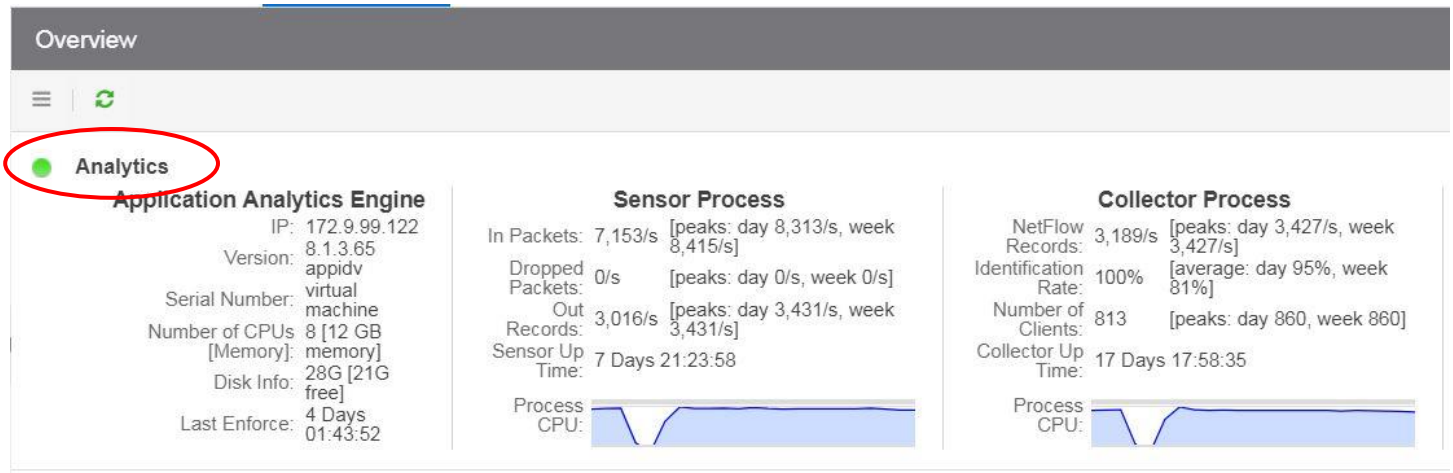


- Provide the IP address of the ExtremeAnalytics Engine, a user-friendly name, and configured SNMP profile. Click **OK**

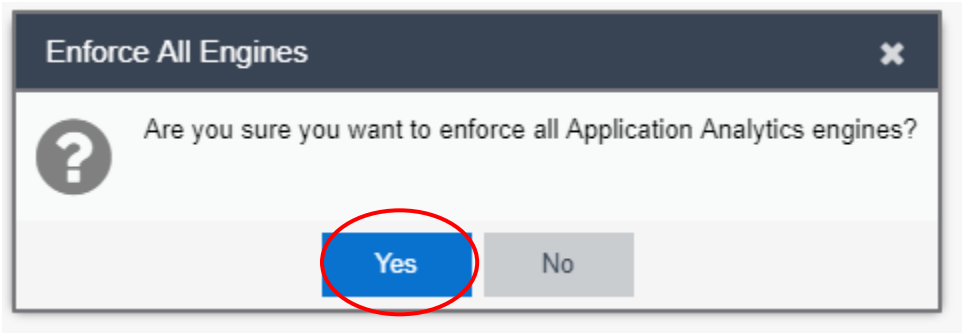


-+-

- The ExtremeAnalytics engine will appear in the Overview Pane. Locate the green indicator, confirming that the engine is operational. You should also see basic engine processing data.

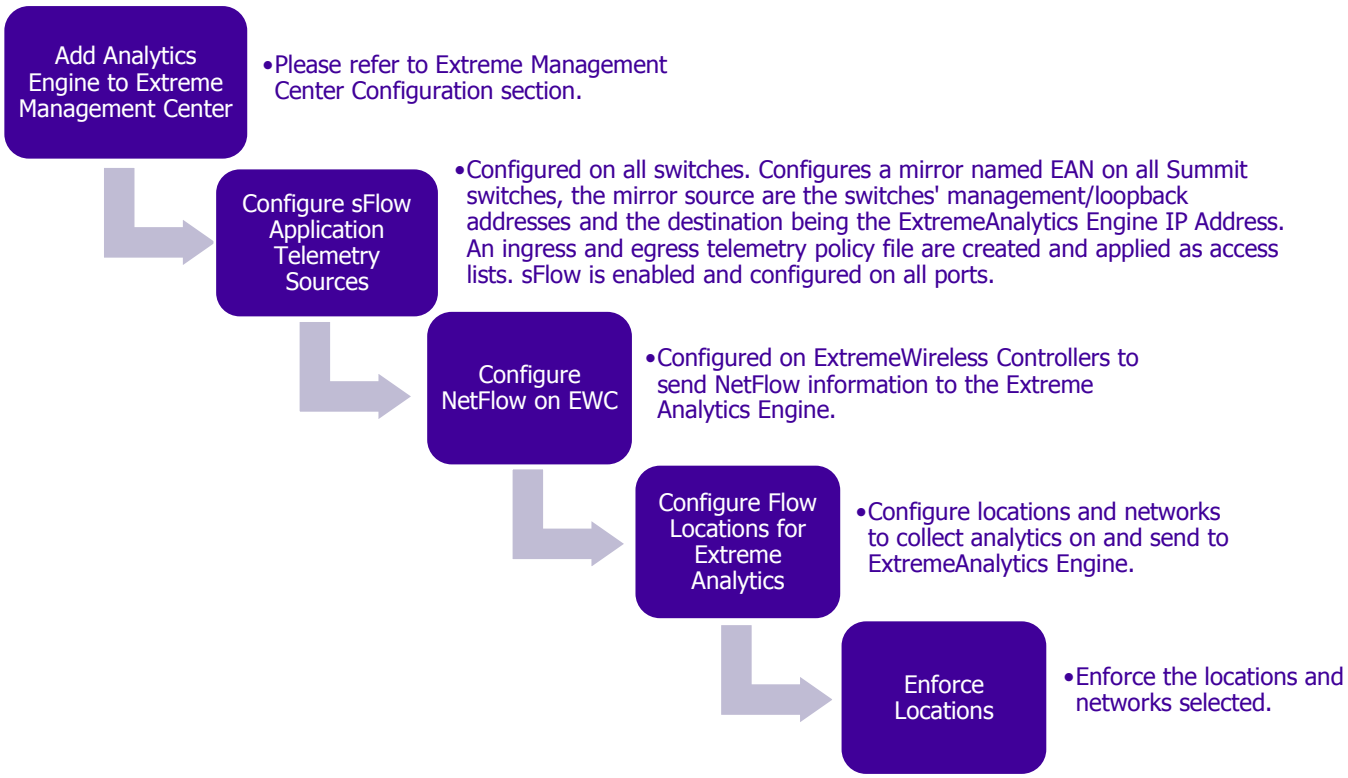


- Click the enforce button at the bottom of the web page to fully deploy the ExtremeAnalytics Engine.



ExtremeAnalytics Configuration

Extreme Analytics will be configured to provide detailed flow information. Refer to the flow chart below:



Flow collection in this topology is handled by the uplink ports to the Analytics engine. If an ExtremeSwitching access switch is utilized, the ability to collect analytics at the stack or standalone switch are dependent on the models utilized. Please refer to product documents to determine hardware capabilities of the access switches.

Warning

The following sections detail how to configure Analytics on both access devices (Summits and APs) and on core devices (Fabric Connect switches), however only ONE option should be chosen to avoid duplicate reporting.

Note

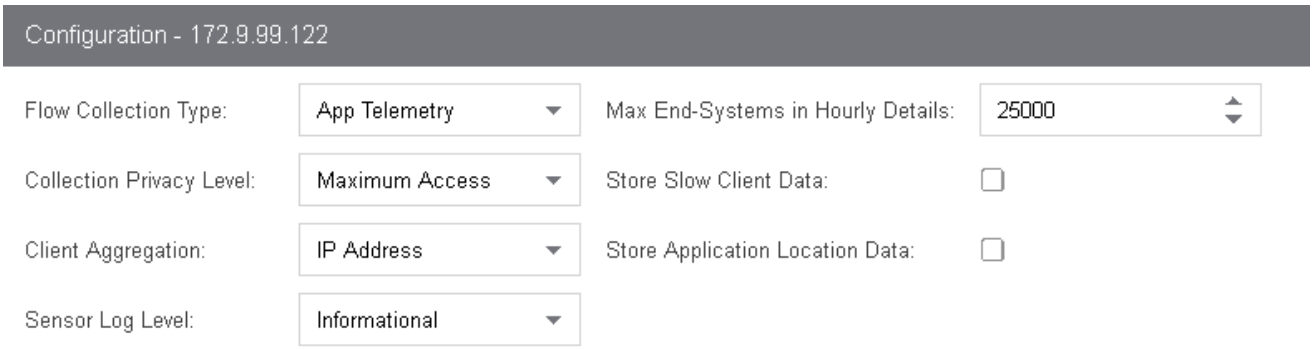
The lower the sampling rate is set to, the more accurate the reporting will be. However, keep in mind that low sampling rate will increase CPU usage to some degree.

Extreme Analytics SFLOW Configuration (Summit Access Switches)

In this section, the user will add Summit access switches as Mirror Sources for sending the flow information to the Extreme Analytics Engine.

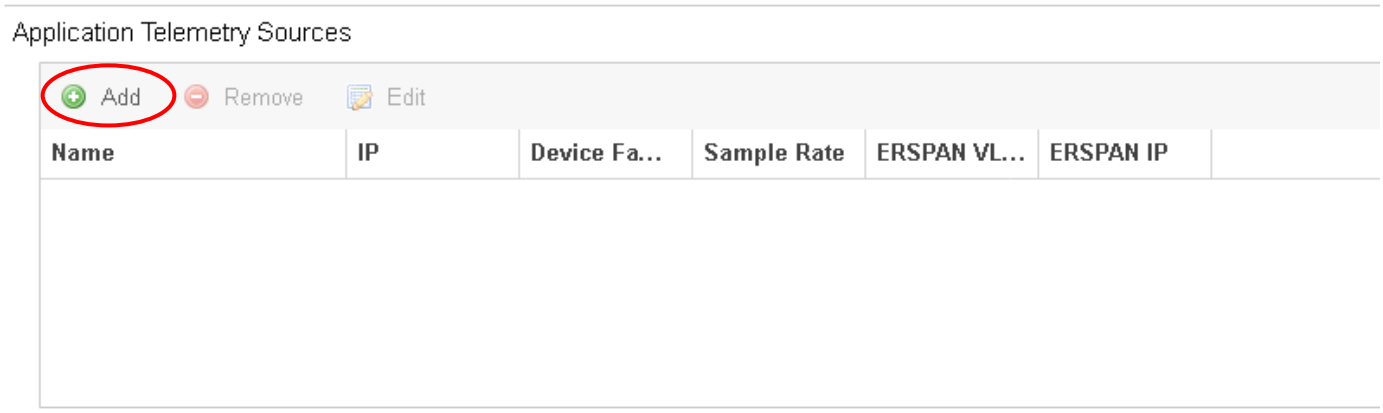
- Navigate to this menu location and enter the following information.

  Analytics → Configuration → Engines → Analytics → Configuration

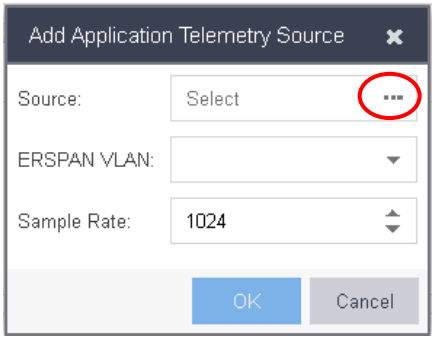


- Each Access switch will be added as the mirror source. The source IP address will be the switch management address, and the destination of the mirror will be the ExtremeAnalytics Engine. The Access switch does not have the resources necessary to collect flow data for ExtremeAnalytics. However, the flow data will be aggregated at the switch's uplink ports.

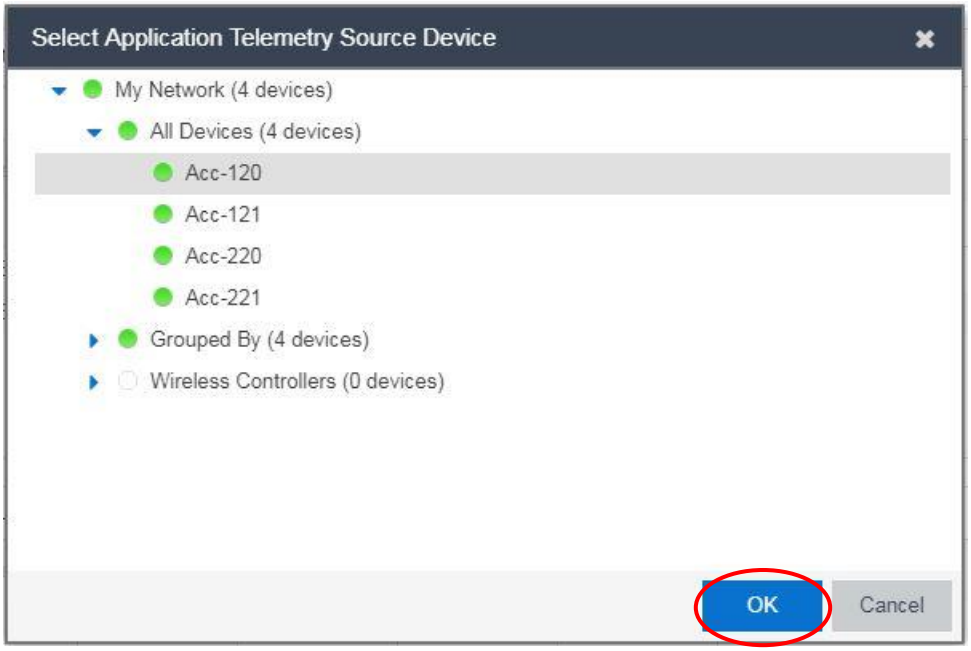
  Analytics → Configuration → Engines → Analytics → Configuration → Application Telemetry Sources → Add



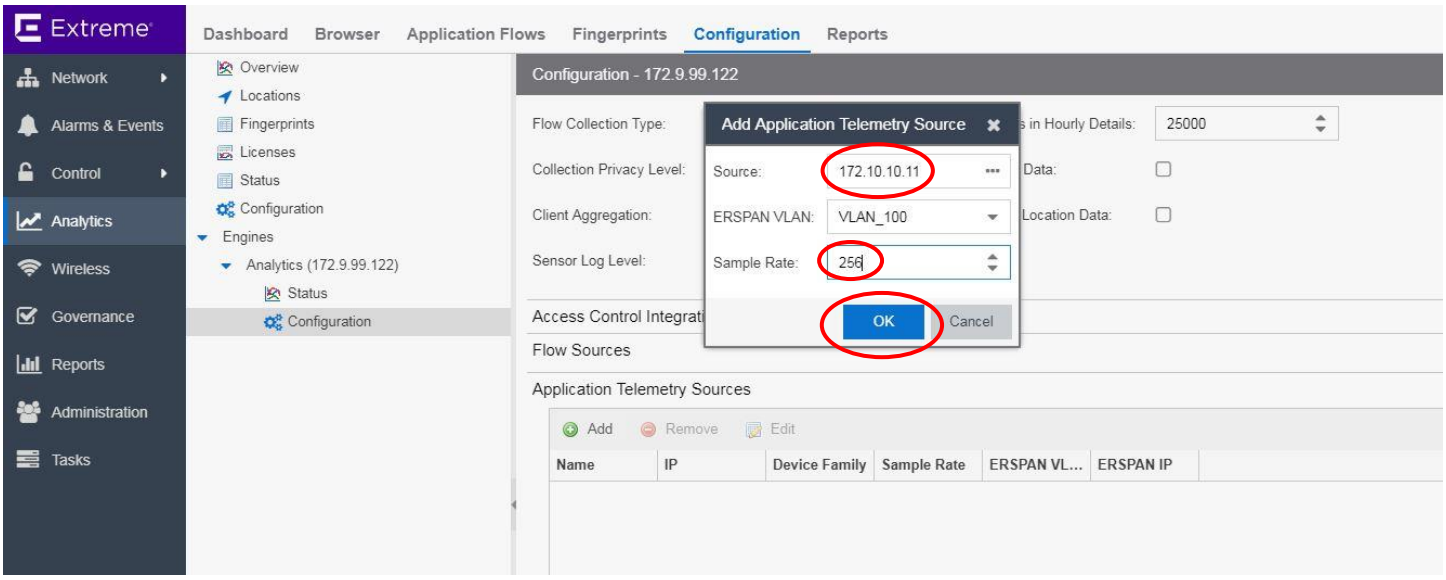
- Under **Source** field, click the ellipsis icon "**…**" to bring up **Source Device** view:



- Select All Devices → **Acc-120** → Click **OK:**



- Verify that **Source** IP address is the device management address. Optionally you can set **Sample Rate** to a different setting, minimum rate is **256**. Click **OK:**



- Depending on port density, this process can take several minutes. After adding all Access switches, Application Telemetry Sources should be configured. Final output should look something like below:

Application Telemetry Sources

Add Remove Edit

Name	IP	Device Family	Sample Rate	ERSPAN VL...	ERSPAN IP
Acc-121	172.10.10.12	Summit Series	256	VLAN_100	172.10.10.12
Acc-120	172.10.10.11	Summit Series	256	VLAN_100	172.10.10.11
Acc-220	172.20.10.11	Summit Series	256	VLAN_200	172.20.10.11
Acc-221	172.20.10.12	Summit Series	256	VLAN_200	172.20.10.12

Extreme Analytics SFLOW Configuration (Fabric Connect Switches)

Configuring Analytics for Fabric Connect switches will be a future feature of XMC. However, support can be configured via the switch cli. This will enable flow-sample information to be forwarded to the Analytics engine so that data can be compiled and displayed in XMC. This document will not describe all of the variables for adding Analytics to a Fabric Connect switch. This information can be found in existing GTAC knowledge base articles and other CLI documentation.

Note

This illustrates how to enable SFLOW on BEB-910. This configuration should also be executed on any core BEBs with links to the access layer.

Some useful points to keep in mind:

- App-telemetry is enabled and SFlow is used as the flow type.
- The switch supports only ingress sampling.
- The switch does not support enabling sFlow on a link aggregation group (LAG) interface. However, you can enable sFlow on the member interfaces of a LAG.
- Order of Operations: Enable sFlow globally, add the sFlow collector; then enable app-telemetry.

Note that up to two collectors can be configured. SFlow configurations can be verified with **show sflow**; **show sflow collector**; and **show sflow interface enabled**. App-telemetry can be verified with **show app-telemetry status**, while **show app-telemetry counters** will show packet/byte statistics of protocol types.

BEB-910

- Enter Global Configuration mode
- Configure agent IP address (switch management)
- Enable sFlow

```
BEB-8404-910:1>enable
BEB-8404-910:1#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
BEB-8404-910:1(config)#sflow agent-ip 10.0.0.10
INFO: Please be aware that sFlow agent IP address is only supported in MGMT or GRT VRF.
BEB-8404-910:1(config)#sflow enable
BEB-8404-910:1(config)#show sflow

================================================================================
                          sFlow Global Configuration
================================================================================
Global State                    : Enabled
Agent  IP                       : 10.0.0.10
```

BEB-910

```
BEB-8404-910:1(config)#sflow collector 1 address 172.9.99.122
BEB-8404-910:1#show sflow collector

================================================================================
                        sFlow Collector Configuration Info
================================================================================
Id    Owner                 Collector-IP          Port       Timeout(secs)
--------------------------------------------------------------------------------
1     -                     172.9.99.122          6343       0
2     -                     0.0.0.0               6343       0
--------------------------------------------------------------------------------

All 2 out of 2 Total Num of sflow collector entries displayed
BEB-8404-910:1#
```

- Configure collector IP address

- Configure the interfaces with the sampling rate (range of 8192-1000000):

BEB-910

```
BEB-8404-910:1(config)#int gigabitEthernet 2/10
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
BEB-8404-910:1(config)#int gigabitEthernet 2/17
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
BEB-8404-910:1(config)#int gigabitEthernet 2/18
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
BEB-8404-910:1(config)#int gigabitEthernet 3/10
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
BEB-8404-910:1(config)#int gigabitEthernet 3/17
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
BEB-8404-910:1(config)#int gigabitEthernet 4/17
BEB-8404-910:1(config-if)#sflow collector 1
BEB-8404-910:1(config-if)#sflow sampling-rate 8192
BEB-8404-910:1(config-if)#exit
```

- Enter Interface Configuration mode
- Configure collector ID
- Configure sampling-rate

- Verification:

BEB-910

```
BEB-8404-910:1(config)#show sflow interface enabled

================================================================================
                        sFlow Port Configuration Info
================================================================================Port
Packet-Sample-Rate  Max-Header-Size Counter-interval  Collector-list
                                    (in secs)
--------------------------------------------------------------------------------
2/10   8192                128            0                1
2/17   8192                128            0                1
2/18   8192                128            0                1
3/10   8192                128            0                1
3/17   8192                128            0                1
4/17   8192                128            0                1
--------------------------------------------------------------------------------
All 6 out of 6 Total Num of sflow port entries displayed
BEB-8404-910:1(config)#
```

BEB-910

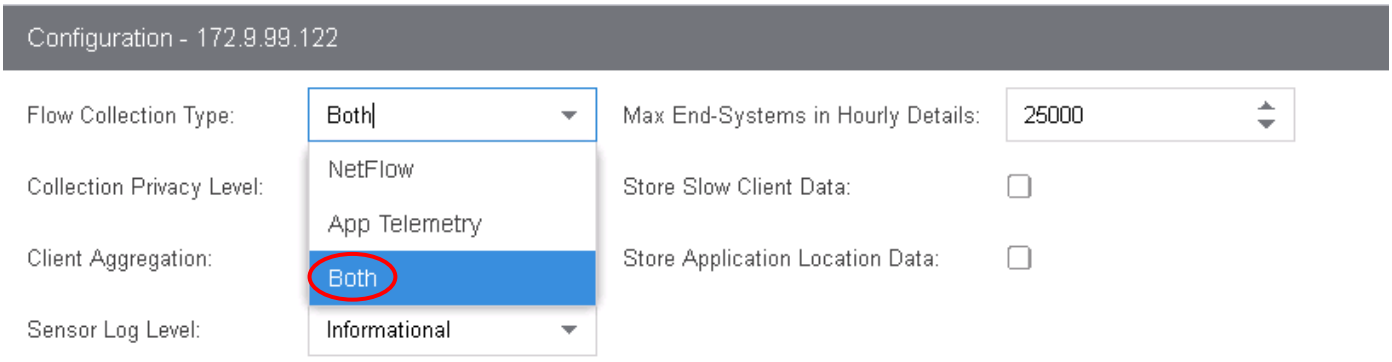
```
BEB-8404-910:1(config)#app-telemetry enable
BEB-8404-910:1#show app-telemetry status
Application Telemetry is enabled
Collector is reachable via 172.9.99.122
BEB-8404-910:1#show app-telemetry counter

================================================================================
                        Application Telemetry Counter
================================================================================
EntryId  Name                                    Packets          Bytes
--------------------------------------------------------------------------------
1        dhcpv4                                  14754            6810146
2        dhcpv6                                  2435             416385
3        dnstcp                                  0                0
4        dnstcp1                                 0                0
5        dnsudp                                  2404             303631
6        dnsudp1                                 7302             751554
7        tcpsyn                                  131704200        10272927656
8        tcpsynack                               131714232        10273710096
9        tcpfinack                               263419495        19493036890
10       bjnp                                    0                0
11       quicd                                   0                0
12       radius1                                 6709             1207152
13       radius4                                 7634             1277650
...
126      ZOOM-TCP1                               4                4440
127      ZOOM-TCP2                               9158             679988
128      ZOOM-UDP1                               0                0
129      ZOOM-UDP2                               0                0
130      RADIUS-5                                10717            750190
131      RADIUS-2                                6626             766460
132      RADIUS-3                                256624           34515226
133      RADIUS-11                               2477             242746

Displayed 133 of 133 entries
BEB-8404-910:1(config)#
```

Enable app-telemetry in Configuration mode

Extreme Analytics NetFlow Configuration (Wireless)

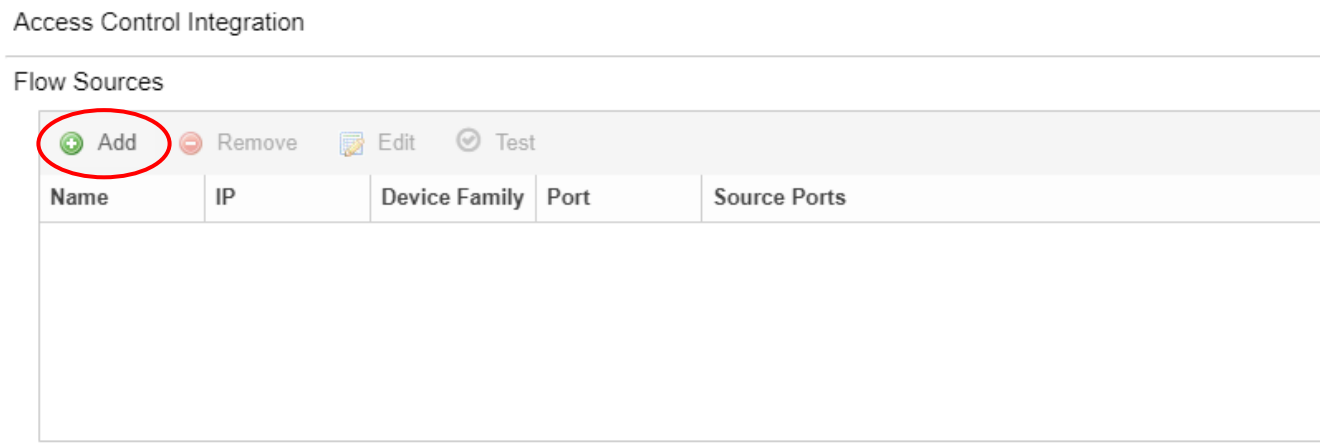
Extreme Analytics can also be configured for the ExtremeWireless controllers. In this case NetFlow is utilized rather than sFlow. In order to support both sFlow and NetFlow simultaneously the Flow Collection Type will need to be changed to **Both**.

Analytics → Configuration → Engines → Analytics → Configuration

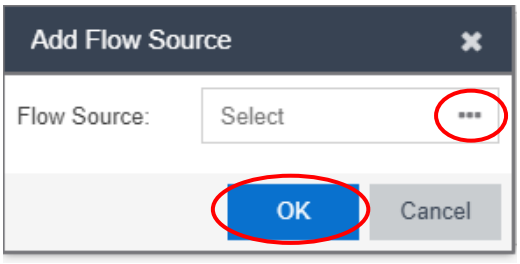


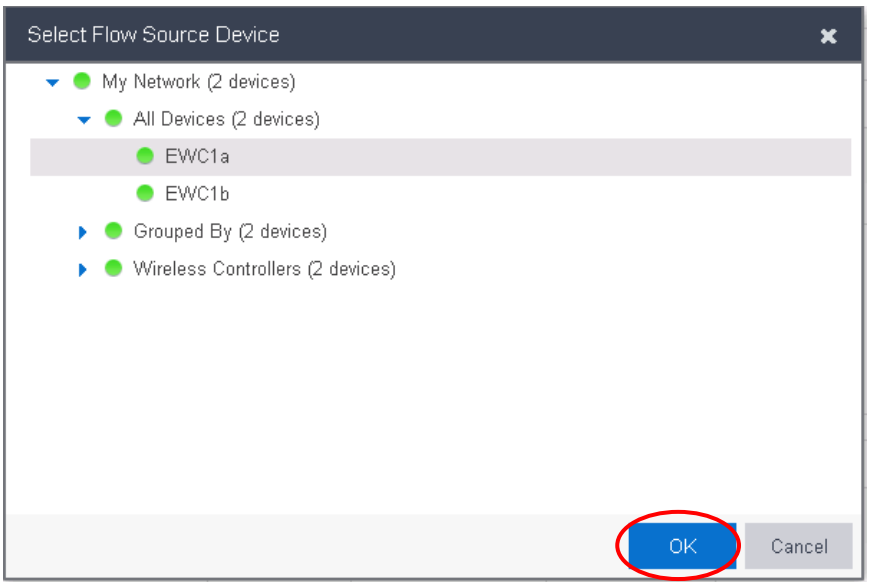
- After changing the Flow Sources Dialog should open within the Access Control Integration pane. Select **Add.**

  Analytics → Configuration → Engines → Analytics → Configuration → Application Telemetry Sources → Add

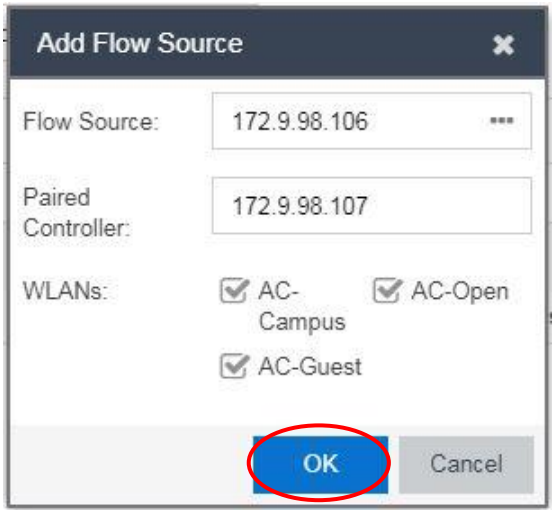


- Under **Flow Source** click "**…**" and navigate to **My Network → All Devices → EWC1a,** then click **OK.**





- Select all the WLANs and click **OK**. Notice that if a controller is paired to another controller it will perform the configuration in one step. There will be no need to perform this step for the second controller.



- Once controllers are added, the Access Control Integration | Flow Sources pane should look like the one below.

Flow Sources

Add Remove Edit Test

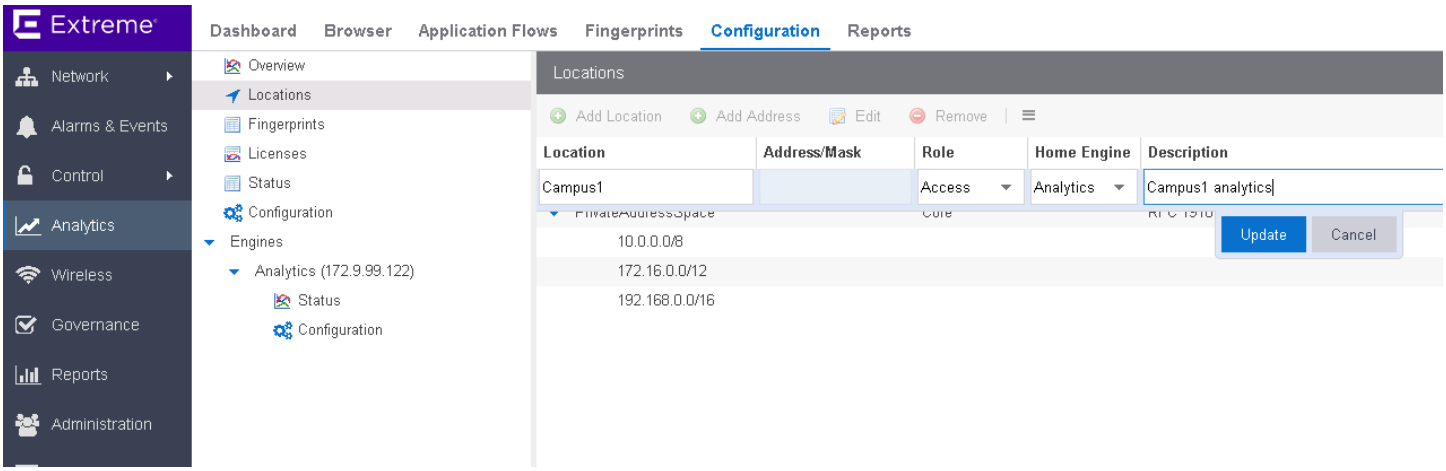
Name	IP	Device Family	Port	Source Ports	WLANs
EWC1a	172.9.98.106	Wireless Co...	none		AC-Campus,AC-Guest,AC-Open
EWC1b	172.9.98.107	Wireless Co...	none		AC-Campus,AC-Guest,AC-Open

Extreme Analytics Location Configuration

Finally, select the networks from which flow information will be collected. This can be quite broad or narrow depending on your administrative requirements.

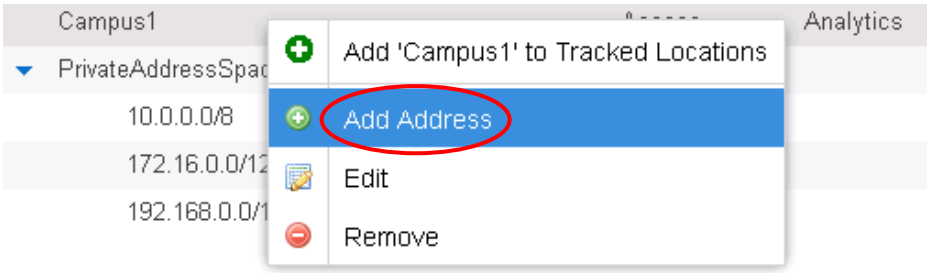
- Select a location. This is just a label and there is no requirement that it be a Role. Below it is identified as **Campus1 analytics**.

  Analytics → Configuration → Locations

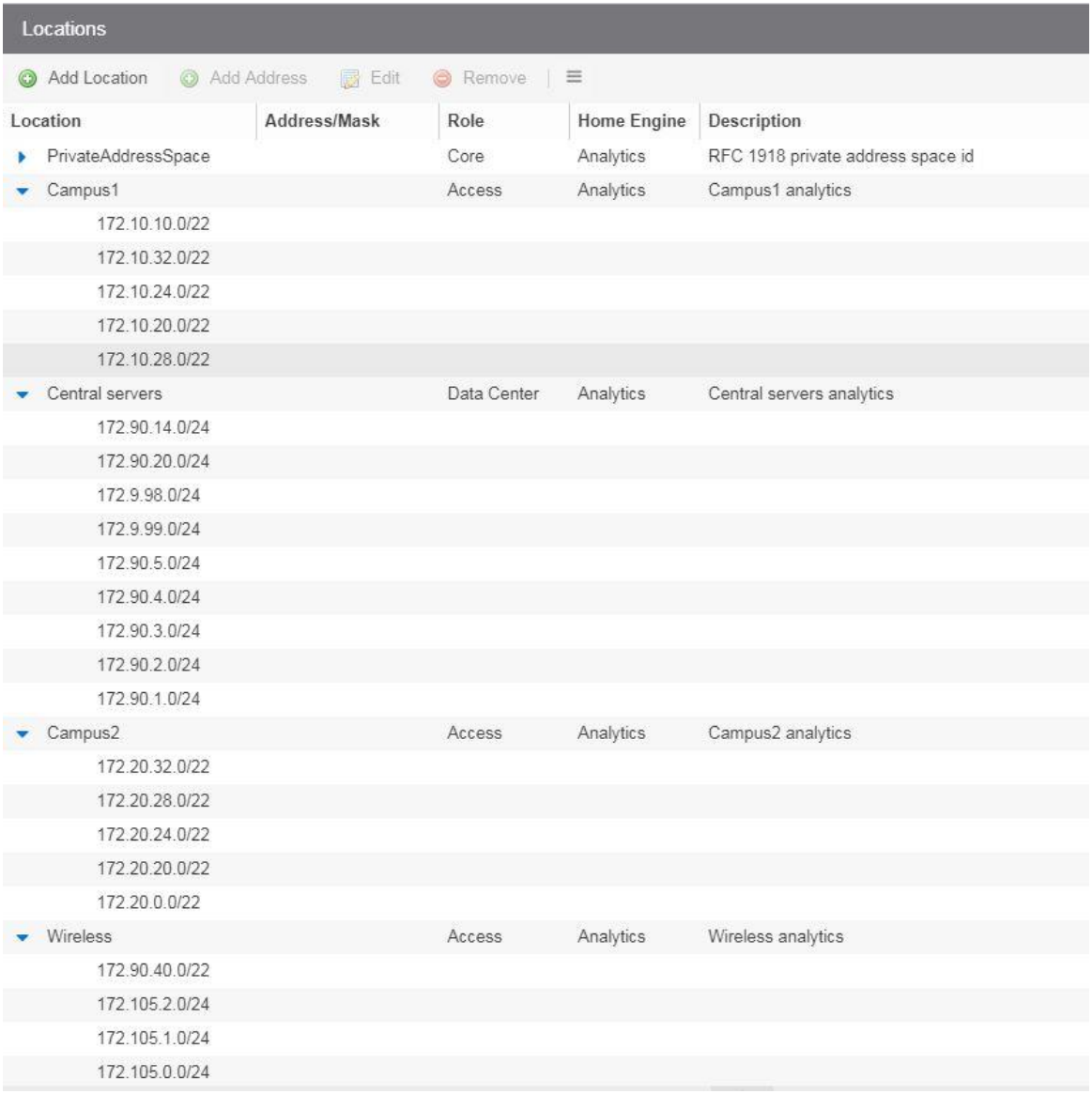


- Add the subnets which flow collection should monitor.

  Analytics → Configuration → Locations → Highlight created Location → Right Click → Add Address



- After locations and subnets are added, user may have something that resembles below. Locations are based off of roles. User could have created locations based on physical locations. The important thing to remember is that locations are just a group of subnets, not an actual physical location.

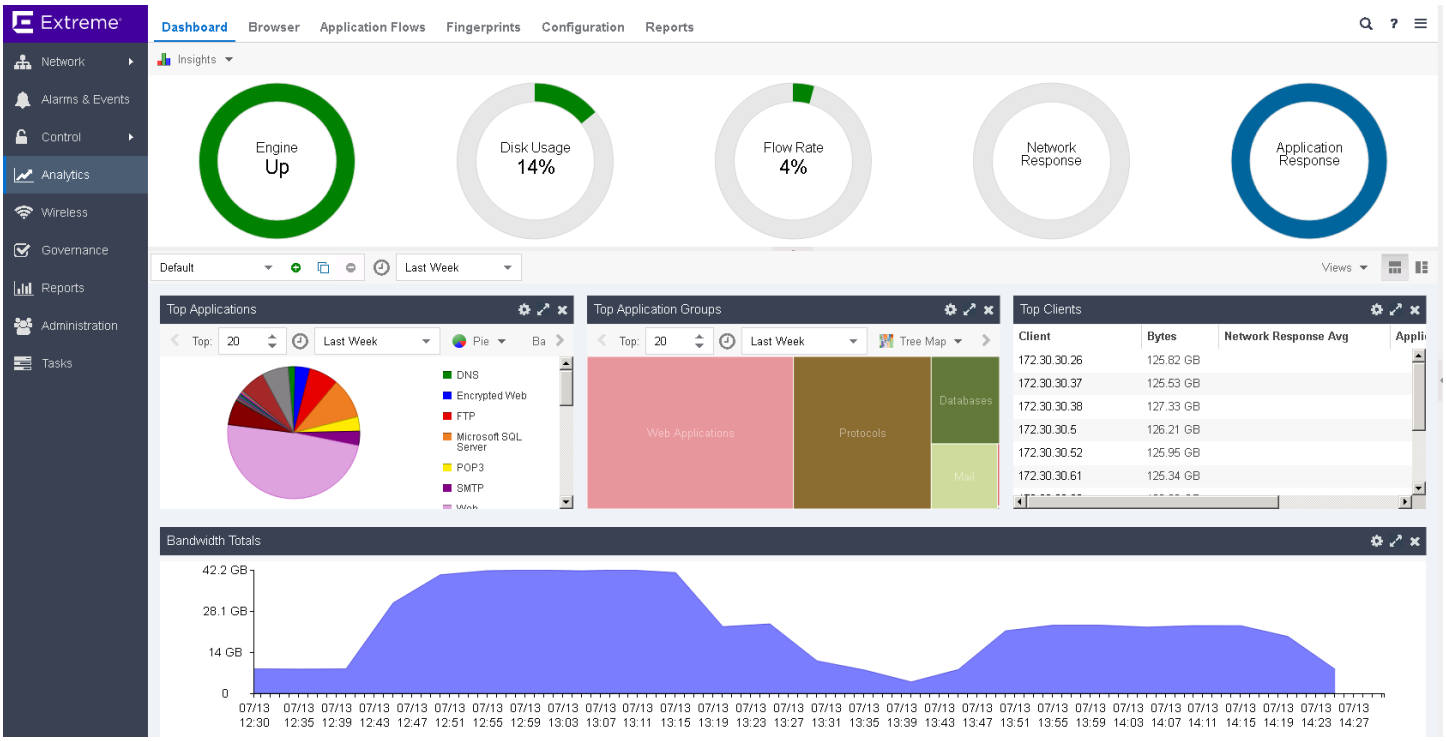


Location	Address/Mask	Role	Home Engine	Description
PrivateAddressSpace		Core	Analytics	RFC 1918 private address space id
Campus1		Access	Analytics	Campus1 analytics
172.10.10.0/22				
172.10.32.0/22				
172.10.24.0/22				
172.10.20.0/22				
172.10.28.0/22				
Central servers		Data Center	Analytics	Central servers analytics
172.90.14.0/24				
172.90.20.0/24				
172.9.98.0/24				
172.9.99.0/24				
172.90.5.0/24				
172.90.4.0/24				
172.90.3.0/24				
172.90.2.0/24				
172.90.1.0/24				
Campus2		Access	Analytics	Campus2 analytics
172.20.32.0/22				
172.20.28.0/22				
172.20.24.0/22				
172.20.20.0/22				
172.20.0.0/22				
Wireless		Access	Analytics	Wireless analytics
172.90.40.0/22				
172.105.2.0/24				
172.105.1.0/24				
172.105.0.0/24				

Extreme Analytics Verification

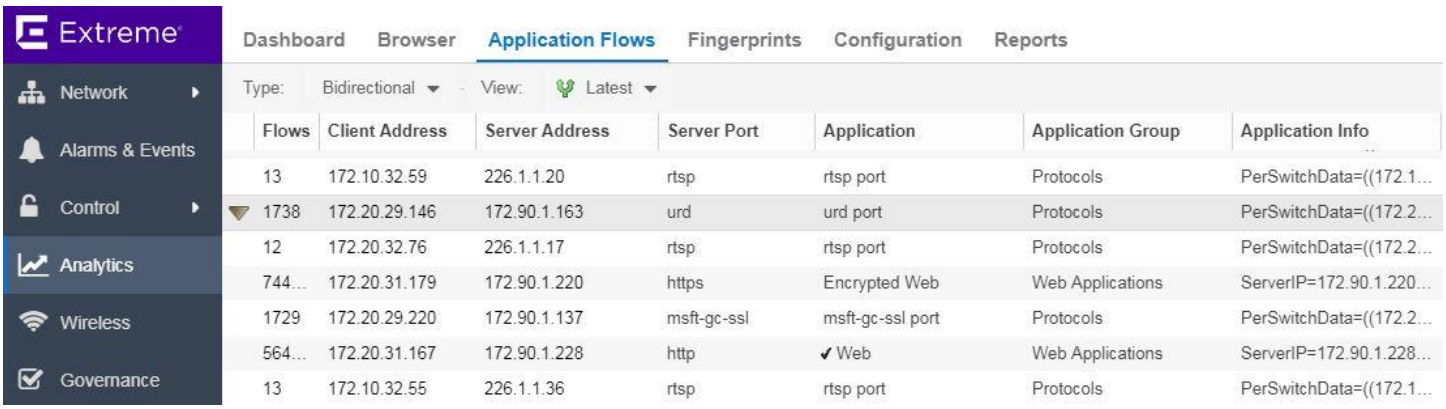
The Analytics will start collecting information. The polling interval is every 5 minutes. Be sure to give the dashboard enough time to begin populating information.

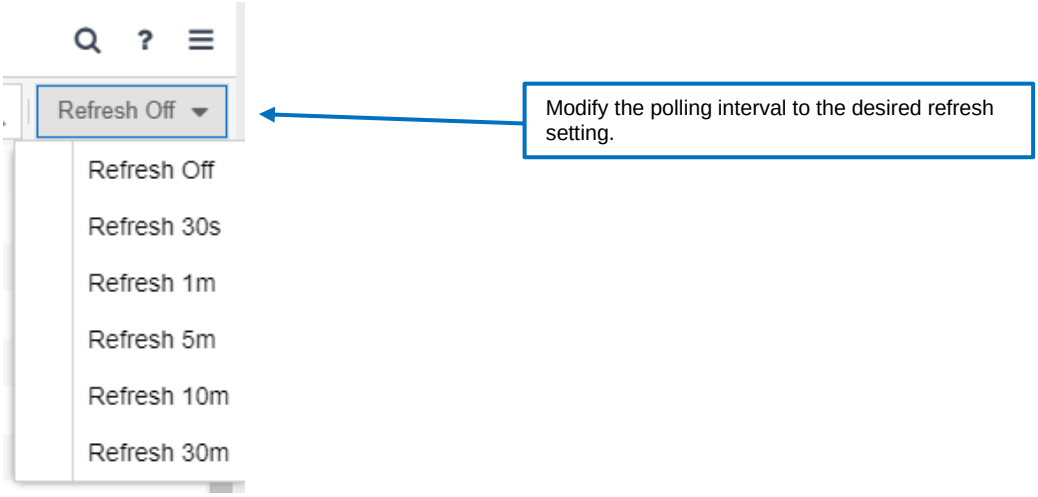
Analytics → Dashboard



- Even though the dashboard might not be collecting information, the Application Flows window should begin to collect information. You can change the polling interval if you want to see updates in real time.

Analytics → Application Flows





- From the switch CLI the App Telemetry mirror can be observed with the `show mirror` command. Verify the IP addresses for the Analytics Engine and the Switch Management and that the Status = Up.

Summit Access Switch

```
Slot-1 Stack.1 # show mirror

DefaultMirror   (Disabled)
    Description:    Default Mirror Instance, created automatica
    Mirror to port: -

EAN   (Enabled)
    Description:
    Mirror to remote IP: 172.9.99.122       VR        : VR-Default
    From IP            : 172.20.10.11       Ping check: On
    Status             : Up

Mirrors defined:          2
Mirrors enabled:          1 (Maximum 4)
HW filter instances used: 0 (Maximum 128)
HW mirror instances used: 0 ingress, 0 egress (Maximum 4 total, 2 egress)
```

- Tunnel EAN is enabled.
- Mirror to Remote IP = Analytic Engine IP
- From IP = Management address of the switch
- Status = Up

- Below is an example of an sflow configuration. Issue `show conf etmon` to display sflow configuration.

Summit Access Switch

```
Slot-1 Stack.5 # show config etmon
#
# Module etmon configuration.
#
configure sflow sample-rate 256
configure sflow poll-interval 60
enable sflow
configure sflow collector 172.9.99.122 port 6343 vr "VR-Default"
configure sflow agent ipaddress 172.20.10.11
configure sflow ports 1:1 sample-rate 256
enable sflow ports 1:1 ingress
configure sflow ports 1:2 sample-rate 256
enable sflow ports 1:2 ingress
configure sflow ports 1:3 sample-rate 256
enable sflow ports 1:3 ingress
configure sflow ports 1:4 sample-rate 256
enable sflow ports 1:4 ingress
```

```
configure sflow ports 1:5 sample-rate 256
enable sflow ports 1:5 ingress
...
configure sflow ports 2:49 sample-rate 256
enable sflow ports 2:49 ingress
configure sflow ports 2:50 sample-rate 256
enable sflow ports 2:50 ingress
configure sflow ports 2:51 sample-rate 256
enable sflow ports 2:51 ingress
configure sflow ports 2:52 sample-rate 256
enable sflow ports 2:52 ingress
configure sflow ports 2:53 sample-rate 256
enable sflow ports 2:53 ingress
configure sflow ports 2:54 sample-rate 256
enable sflow ports 2:54 ingress
```

- When SFLOW App Telemetry is configured in XMC, two ACLs are configured and applied. Issue `show config acl` and verify the two access-lists are applied. Also, user can verify the access-lists by issuing an `ls` at the prompt to list present file.

Summit Access Switch

```
configure access-list telemetry any ingress
configure access-list telemetryegress any egress

-rw-r--r--    1 admin           33450 Jul 13 11:02 telemetry.pol
-rw-r--r--    1 admin             125 Jul 13 11:02 telemetryegress.pol
```

- User can also SSH into the Extreme Analytics and verify that SFLOW and GRE packets are being sent to the Analytics Engine. User should see both SFLOW and GRE packets being sent from all configured SFLOW sources.

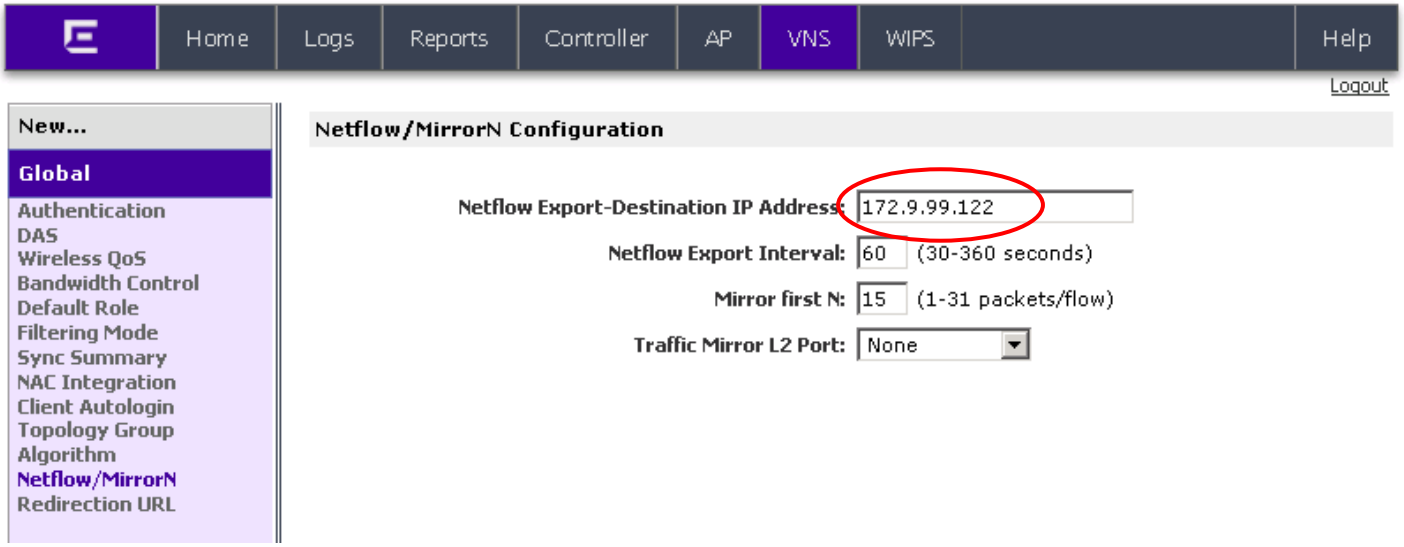
Extreme Analytics Appliance

```
root@purviewnew813:~$ tcpdump -i eth0 proto gre -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
11:36:01.021962 IP 172.20.10.11 > 172.9.99.122: GREv0, length 64: gre-proto-0x88be

root@purviewnew813:~$ tcpdump -i eth0 port 6343 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
11:40:38.049317 IP 172.20.10.11.35586 > 172.9.99.122.6343: sFlowv5, IPv4 agent 172.9.90.13,
agent-id 0, length 1372
```

- Netflow configuration can be verified from the ExtremeWireless Controller graphical user interface. Within the wireless controller navigate to;

  VNS → Global → Netflow/MirrorN

- Verify: Netflow Export-Destination IP Address = Extreme Analytics Engine.



- User can also SSH into the Extreme Analytics and verify that IPFIX packets are being sent to the Analytics Engine from the EWC controllers.

Extreme Analytics Appliance

```
root@purviewnew813:~$ tcpdump -i eth0 port 2095 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
13:17:52.222947 IP 172.9.98.107.2095 > 172.9.99.122.2095: UDP, length 388
13:18:20.075153 IP 172.9.98.106.2095 > 172.9.99.122.2095: UDP, length 388
```

RF-Planning

When designing a wireless network, a thorough RF plan is vital to the success of the deployment. This process involves an extensive site survey and use of the Extreme Networks™ Planning Tool. Extreme Wireless RF-Planning can further be enhanced with the use of the Ekahau Site Survey tool and hardware.

Site Survey

Site Survey is perhaps the most important step in RF design. It validates the wireless deployment's expected coverage experience. A thorough site survey analyzes sufficient signal strength throughout the covered area and allows for channel planning to reduce co-channel interference.

Site Surveys are extremely important to new wireless deployments and when replacing or upgrading installed wireless gear. Products from different vendors or even across product generations of the same vendor often have different transmission characteristics. These changes can include; technological advances, the number of transmit and receive chains, and differences in radiation pattern. Never assume that replacing one piece of equipment for another, at the same installation points, will result in the same experience as the previous install.

An AP-on-a-stick physical site survey is the preferred method to thoroughly assess a site's RF design requirements. Testing an AP's proposed location provides true measurement and representation of the signal propagation and coverage to be expected. This method considers actual site characteristics such as obstructions to the RF signal, absorption by walls, and impact of any other architectural materials.

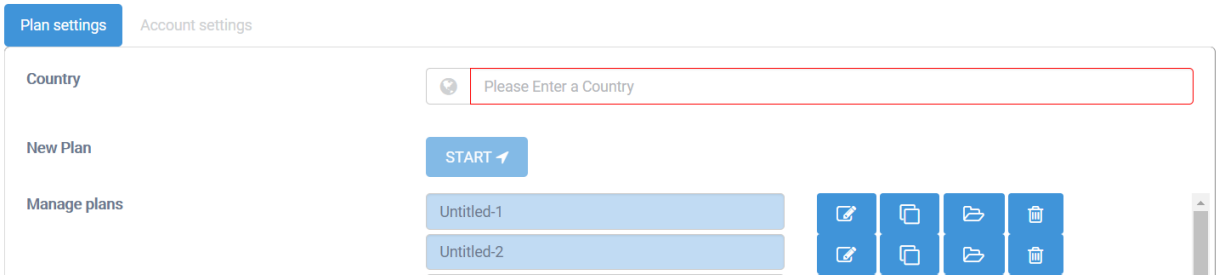
If a physical site survey is not possible, at minimum, a predictive survey should be performed. The predictive model often provides a first-pass view of the number of APs required to cover a site or a first-pass validation of whether installing a target AP family in pre-existing spots will provide the required coverage. The predictive model also provides greater insight into proper channel configuration, to obtain a performance optimized experience.

ExtremeWireless RF Planning Tool

The ExtremeWireless RF Planning Tool is a predictive survey tool made available to Extreme Network customers. The RF Planning tool is available online at https://wirelessplanner.extremenetworks.com.

Access to the tool is free, but user registration is required. Users can create a set of access credentials for the tool. Registration provides storage of saved models for later reference.

Once registered, the user is directed to provide the country of installation. Country selection is very important because the tool can customize requirements to applicable regulatory restrictions of the country identified. Regulatory restrictions can apply to channel availability, power levels, or even equipment availability. If country certification is required but not yet available for a device, it may not be available for selection.



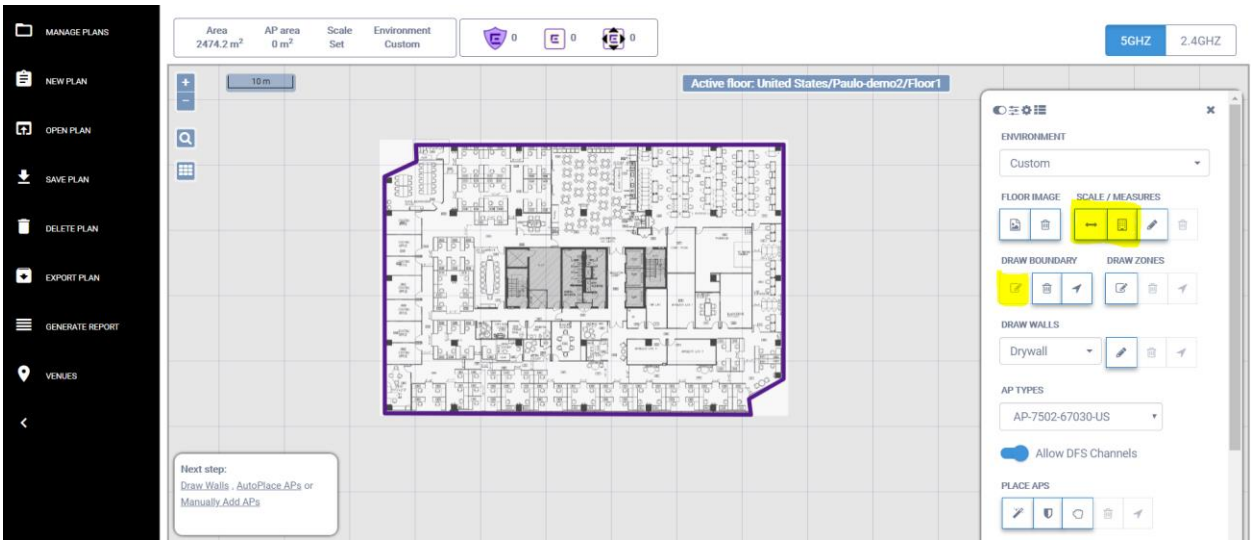
After providing a few more details, you are provided with the working Canvas. Modeling steps include;

1. Floor Plan Outline and Scale

    a. You can either design a floor plan outline or upload a floor plan image representative of the site being designed.

    b. The tool allows for multi-floor designs within the same project, but note that it only considers one floor at a time. It does not consider or model cross-floor propagation.

    c. Scale can be defined by mapping a line of pixels into a corresponding distance. A simple way to determine an approximate scale is to determine the width of a doorway. In the United States the typical width of doorway is 3 feet, which can be used as reference for a 1-meter (3 ft.) line.

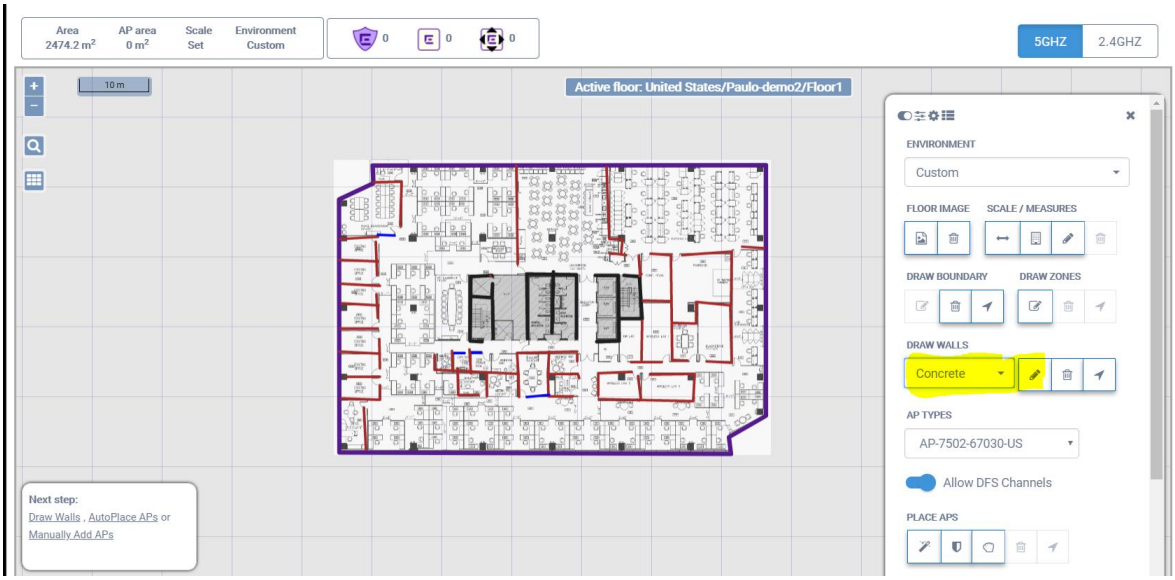


2. Identify and map any known RF obstructions.

    a. Consider include wall materials, escape routes (stairways), and restrooms (washrooms).

    b. The more detailed your model is, the more accurate the predictive model will be.

    c. Do not assume free-space (no walls) unless you are in fact planning for a true open area.



3. Access Point Placement

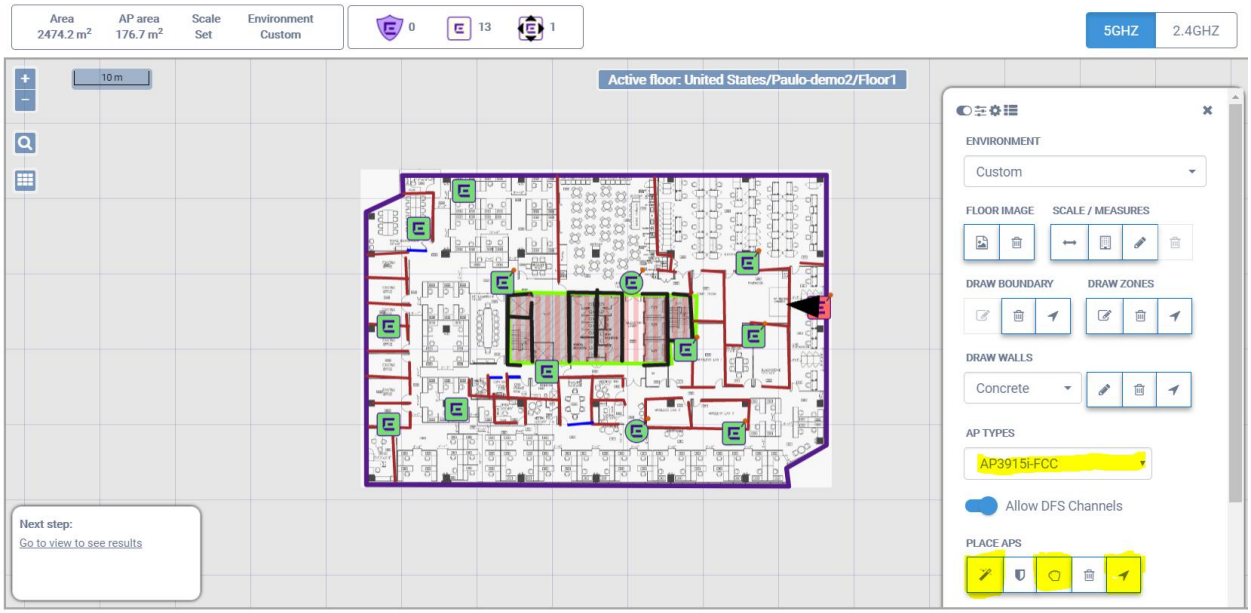
    a. The tool support for the entire portfolio of Wave 1 and Wave 2 access points from ExtremeWireless and ExtremeWireless WiNG is available. (Due to regulatory restrictions, not all APs are available in all regions.)

    b. Placement is primarily assessed based on a coverage objective.

    c. Automatic AP placement is available for a set of devices, primarily internal-antenna models, using a set of heuristic algorithms to determine the best placement for the APs from an RF coverage perspective. Only one AP model type at a time can be selected for auto-placement, but models can share with other available AP models that already pre-determined (pinned). This method provides the simplest way to determine how many APs will be required to cover a floor-plan area. After the automatic wizard runs, APs locations can be manually adjusted to a more correct installation location. When this is done, the AP is pinned to the selected location.

    d. Manual placement provides a more fine-controlled method for AP placements: you individually place each AP into its corresponding installation point. This can be the starting step for a model that starts from an existing installation design. You can manually select from the available models to complete the coverage to the desired targets.

    e. Automatic AP placement can be rerun after APs are manually placed or pinned. This ensures that the proposed installation model does not require any additional devices for fine tuning. Alternatively, you can also define exclusion areas in which to the algorithm will not attempt to place APs.



Visualization

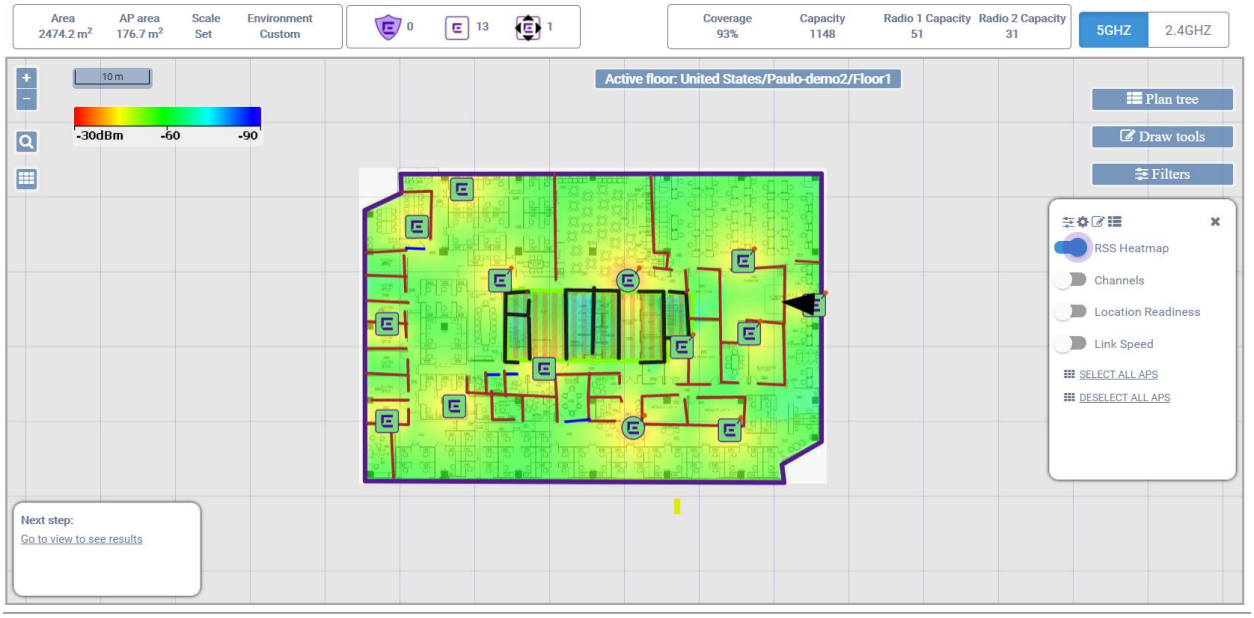
Several visualization tools are available to help you visualize the resulting coverage on both 2.4GHz and 5.0Ghz frequencies:

1. RF Coverage Heat map – provides assessment of signal strength coverage of the floor plan.

2. Channel Plan – provides an optimized view of a representative channel plan to reduce co-channel interference.

3. Location Visualization – provides an assessment of the deployment's readiness to support fidelity in triangulation. The tool provides the ability to recommend where to install full-size sensors to improve location fidelity, augmenting without impacting the current deployment for coverage. The additional added benefit of full-time sensors is that they can perform double-duty by complementing optional Wireless Intrusion Detection and Prevention integration solutions.

4. Link Speed – provides a generalized link speed estimate for typical clients based on the signal coverage metrics.



5. Provides visualization of the angle of orientation for the AP-Camera model (AP3916i).

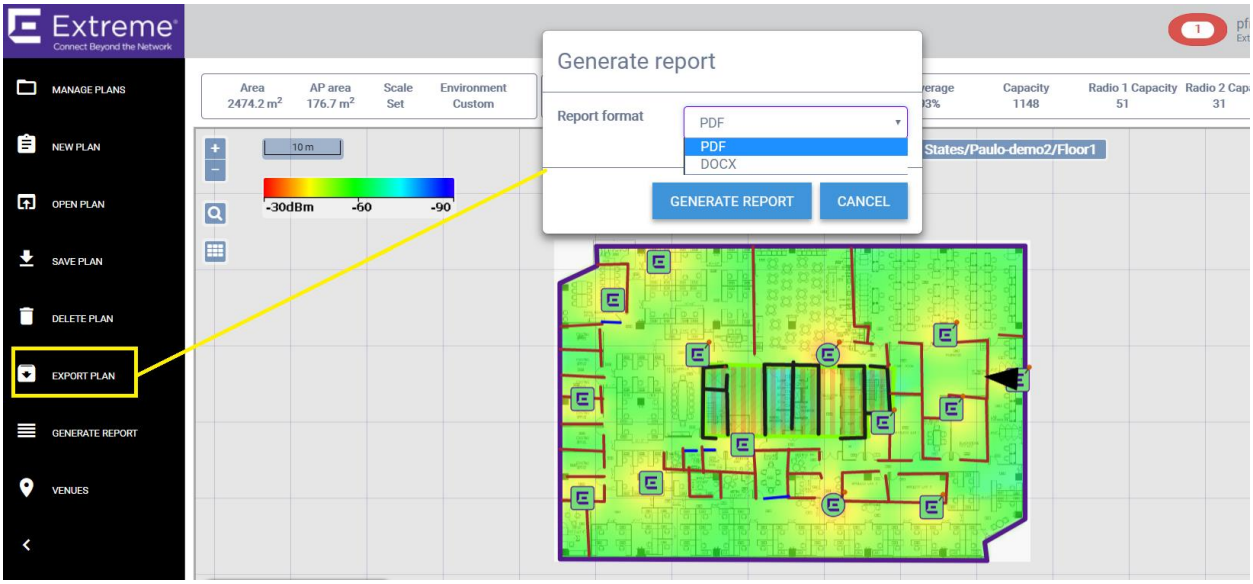
6. Provides an assessment of Bluetooth Low Energy coverage for models that support iBeacon transmit functions (for example, AP391xx and AP7632/62).

Sharing and Exporting

After the model provides your desired coverage characteristics, installed devices, and placement suggestions, you can conveniently share this information – with a partner or customer, or for placing orders – by exporting the model as a PDF or as a Microsoft Word document.

The resulting document includes all of the details provided in the model: the criteria used as input for the model, the representative floor plan of installation locations, the snapshot of RF coverage, and Channel Plan heat maps.

More important, these documents provide a summarized Bill of Materials (BOM) listing the corresponding types and number of APs determined for site coverage. The PDF document is Extreme Networks branded and can be shared directly with the customer or partner. The Microsoft Word document allows for editing, re-arranging, or even branding of the final report.



APs by Country, Building and Floor

United States - Paulo-demo2

Floor	Product Name	Product Part Number	Quantity
Floor1	WS-AP3915i-FCC	31028	11
Floor1	WS-AP3916ic-FCC	31034	2
Floor1	WS-AP3935e-FCC	31014	1
		Total APs for 'Paulo-demo2':	14
		Total APs in Plan:	14

Product Lifecycle – Exporting into Other Products

The model representation can be directly exported for use by ExtremeWireless management tools such as ExtremeCloud, ExtremeCloud Appliance, and Extreme Management Center. This capability allows reuse of a predictive model into an actual deployed model. This allows users to map actual deployed equipment into the predicted installation instances. The details of the floor plans are preserved – saving time in getting visibility of the actual installation deployment.

RF Survey Tools

Conducting a site survey with the ExtremeWireless™ RF Planning Tool can be enhanced with the use of third-party survey tools. The key part to a new deployment is providing a predictive or active survey assessment as part of the design.

Predictive and active site surveys can be done using a variety of third-party tools such as Ekahau, Netscout's AirMagnet tool, and others. Attributes from an Ekahau survey can be imported directly into the ExtremeWireless and ExtremeCloud products.

Design Considerations

Network Time Protocol (NTP)

Deploying the Extreme Networks' Automated Campus solution requires time synchronization between Extreme's applications, switches, and other network components to function properly and communicate efficiently. Log and syslog events also benefit when all network applications and components are synchronized, along with synchronization of alarm events generated within Extreme Management Center.

Effective synchronization often means faster and easier resolution of network problems.

To maintain optimal synchronization within the ecosystem of Extreme's Automated Campus Solution, we recommend the use of NTP for Extreme Management Center, Extreme Access Control, ExtremeAnalytics, ExtremeWireless Controllers, Extreme switches, and any third-party servers (such as RADIUS servers).

Note
Configuration for third-party RADIUS servers is not documented in this section.

Extreme Management Center

Extreme Management Center NTP configuration is executed during installation using the command-line interface. Once the appliance is installed, log in to the console as root. The install process starts with a series of configuration questions. The administrator is prompted for NTP configuration under the **<Configure Date And Time Settings>** section of the install. If the administrator chooses to change the settings after install, a simple run of the **dateconfig** script can be executed. The **dateconfig** script is located in /usr/postinstall.

```
Please enter a NTP Server IP Address (Required): <ntp_ip_address_2>

Would you like to add another server (y/n) [n]?
================================================================================
NTP Servers
================================================================================
These are the currently specified NTP servers:

<ntp_ip_address_1>
<ntp_ip_address_2>

Enter 0 or any key other than a valid selection to complete NTP configuration and continue.
If you need to make a change, enter the appropriate number from the
choices listed below.

0. Accept the current settings and continue
1. Restart NTP server selection
2. Set date and time manually
================================================================================

Enter selection [0]:
================================================================================
Set Time Zone
================================================================================
You will now be asked to enter the time zone information for this system.
Available time zones are stored in files in the /usr/share/zoneinfo directory.
Please select from one of the following example time zones:

1. US Eastern
```

```
2. US Central
3. US Mountain
4. US Pacific
5. Other - Shows a graphical list
================================================================================

Enter selection [1]:

Current default time zone: 'America/New_York'
Local time is now:      Thu Jun 21 15:30:00 EDT 2018.
Universal Time is now:  Thu Jun 21 19:30:00 UTC 2018.
```

- Print the following to the console if synchronization is successful after the selection of the timezone with the post install script <dateconfig>:

```
The time was successfully synchronized to the server at <ntp_ip_address_1>
rsyslog start/running, process 21801
 * Starting NTP server ntpd                                          [ OK ]
```

The command `<ntpq -np>` will also display pertinent information about NTP daemon operation and performance – including statistics about delay, offset, and jitter.

```
root@XMC:/# ntpq -np
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
 0.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 1.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 2.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 3.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 ntp.ubuntu.com  .POOL.          16 p    -   64    0    0.000    0.000   0.000
*<ntp_ip_address_1>  129.6.15.29      2 u   45   64  377    2.867    1.833   0.751
+<ntp_ip_address_2>  129.6.15.29      2 u   37   64  377    2.669    2.899   3.512
                                       [ OK ]
```

ExtremeControl

ExtremeControl NTP configuration is executed during installation within the command-line interface. Once the appliance is installed, log in to the console as root. The install process starts with a series of configuration questions. The administrator is prompted for NTP configuration under the **<Configure Date And Time Settings>** section of the install. If the administrator chooses to change the settings after install, a simple run of the dateconfig script can be executed. The dateconfig script is located in /usr/postinstall.

```
================================================================================
Configure Date And Time Settings
================================================================================
The engine date and time can be set manually or using an external
Network Time Protocol (NTP) server. It is strongly recommended that
NTP is used to configure the date and time to ensure accuracy of time
values for SNMP communications and logged events. Up to 5
server IP addresses may be entered if NTP is used.
================================================================================

Do you want to use NTP (y/n) [y]? y

Please enter a NTP Server IP Address [<ntp_ip_address_1>]: <ntp_ip_address_1>

Would you like to add another server (y/n) [y]?


Please enter a NTP Server IP Address [<ntp_ip_address_2>]: <ntp_ip_address_2>
```

```
Would you like to add another server (y/n) [n]?
================================================================================
NTP Servers
================================================================================
These are the currently specified NTP servers:

<ntp_ip_address_1>
<ntp_ip_address_2>

Enter 0 or any key other than a valid selection to complete NTP configuration and continue.
If you need to make a change, enter the appropriate number from the
choices listed below.

0. Accept the current settings and continue
1. Restart NTP server selection
2. Set date and time manually
================================================================================

Enter selection [0]:
================================================================================
Set Time Zone
================================================================================
You will now be asked to enter the time zone information for this system.
Available time zones are stored in files in the /usr/share/zoneinfo directory.
Please select from one of the following example time zones:

1. US Eastern
2. US Central
3. US Mountain
4. US Pacific
5. Other - Shows a graphical list
================================================================================

Enter selection [1]:

Current default time zone: 'America/New_York'
Local time is now:      Thu Jun 21 19:38:04 EDT 2018.
Universal Time is now:  Thu Jun 21 23:38:04 UTC 2018.d
```

Print the following to the console if synchronization is successful after the selection of the timezone with the post install script <dateconfig>:

```
The time was successfully synchronized to the server at <ntp_ip_address_1>
rsyslog start/running, process 2123

* Starting NTP server ntpd                                          [ OK ]
```

The command <ntpq -np> will also display pertinent information about the NTP daemon operation and performance – including statistics about delay, offset, and jitter.

```
root@NAC:/# ntpq -np
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
 0.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 1.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 2.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 3.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 ntp.ubuntu.com  .POOL.          16 p    -   64    0    0.000    0.000   0.000
#<ntp_ip_address_1>  129.6.15.29      2 u   48   64  377    2.445  -11.077   0.910
#<ntp_ip_address_2>  129.6.15.29      2 u   42   64  377    2.715   -2.139   2.747
```

ExtremeAnalytics

ExtremeAnalytics NTP configuration is executed during installation within the command-line interface. Once the appliance is installed, log in to the console as root. The install process starts with a series of configuration questions. The administrator is prompted for the NTP configuration under the **<Configure Date And Time Settings>** section of the install. If the administrator chooses to change the settings after install, a simple run of the dateconfig script can be executed. The dateconfig script is located in /usr/postinstall.

```
Configure Date And Time Settings
================================================================================
The engine date and time can be set manually or using an external
Network Time Protocol (NTP) server. It is strongly recommended that
NTP is used to configure the date and time to ensure accuracy of time
values for SNMP communications and logged events. Up to 5
server IP addresses may be entered if NTP is used.
================================================================================

Do you want to use NTP (y/n) [n]? y

Please enter a NTP Server IP Address (Required): <ntp_ip_address_1>

Would you like to add another server (y/n) [n]? y

Please enter a NTP Server IP Address (Required): <ntp_ip_address_2>

Would you like to add another server (y/n) [n]?
================================================================================
NTP Servers
================================================================================
These are the currently specified NTP servers:

<ntp_ip_address_1>
<ntp_ip_address_2>

Enter 0 or any key other than a valid selection to complete NTP configuration and continue.
If you need to make a change, enter the appropriate number from the
choices listed below.

0. Accept the current settings and continue
1. Restart NTP server selection
2. Set date and time manually
================================================================================
Enter selection [0]:
================================================================================
Set Time Zone
================================================================================
You will now be asked to enter the time zone information for this system.
Available time zones are stored in files in the /usr/share/zoneinfo directory.
Please select from one of the following example time zones:

1. US Eastern
2. US Central
3. US Mountain
4. US Pacific
5. Other - Shows a graphical list
================================================================================
Enter selection [1]:

Current default time zone: 'America/New_York'
Local time is now:      Thu Jun 21 21:10:23 EDT 2018.
Universal Time is now:  Fri Jun 22 01:10:23 UTC 2018.
================================================================================
```

Print the following to the console if synchronization is successful after the selection of the timezone with the post install script <dateconfig>:

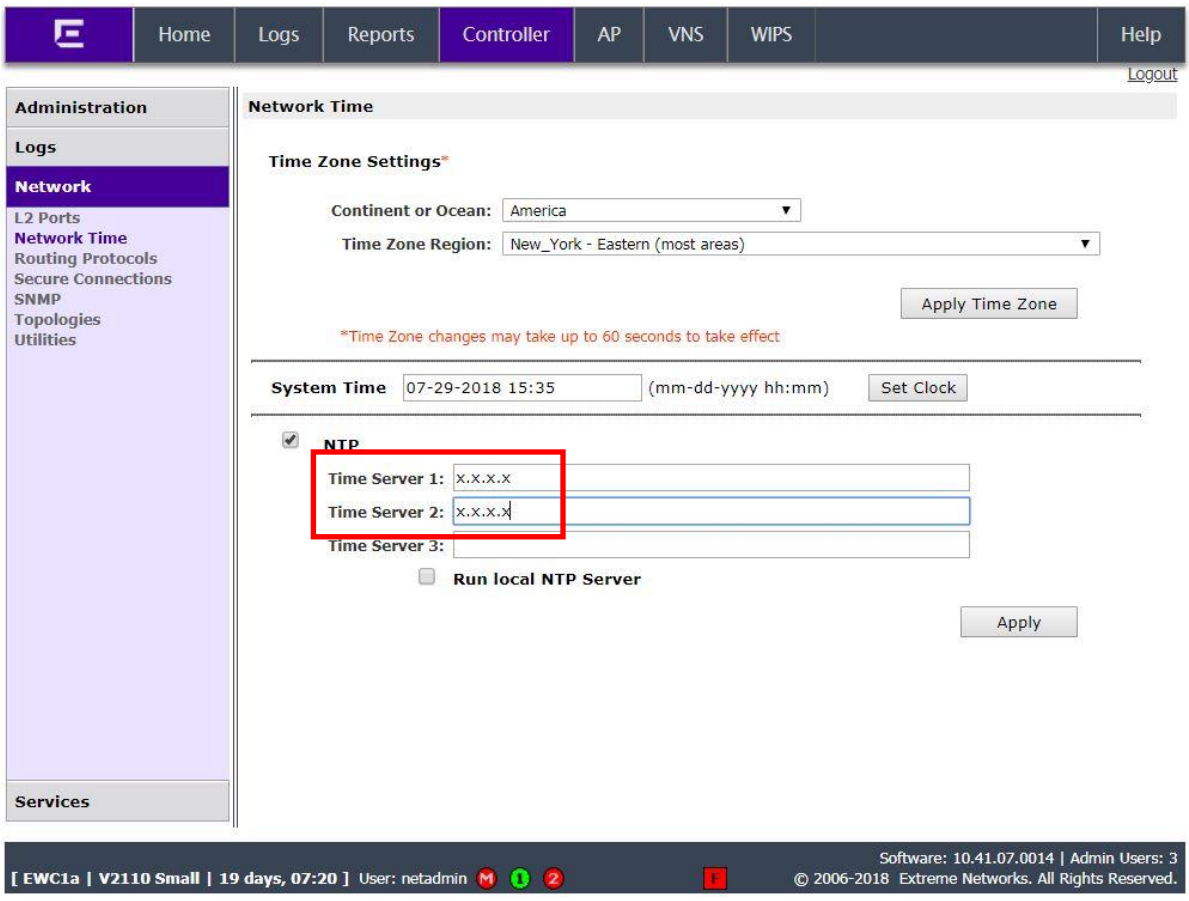
```
The time was successfully synchronized to the server at <ntp_ip_address_1>
rsyslog start/running, process 27186

* Starting NTP server ntpd                                          [ OK ]
```

The command <ntpq -np> will also display pertinent information about the NTP daemon operation and performance – including statistics about delay, offset, and jitter.

```
root@EA:/# ntpq -np
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
 0.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 1.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 2.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 3.ubuntu.pool.n .POOL.          16 p    -   64    0    0.000    0.000   0.000
 ntp.ubuntu.com  .POOL.          16 p    -   64    0    0.000    0.000   0.000
+<ntp_ip_address_1>  132.163.96.2     2 u   48   64  377    2.359  -26.569   8.534
*<ntp_ip_address_2>  132.163.96.2     2 u   37   64  377    2.530  -27.124  28.495
```

ExtremeWireless Controllers

ExtremeWireless Controller NTP configuration is accessed through the User Interface located at **Controller → Network → Network Time**. In the Network Time panel, the timezone and up to 3 NTP servers can be added. After filling in the fields, click **Apply**.



To verify NTP server settings, log in to the console and enter the command <time>. Then enter the command <show ntpip>. The following output should be displayed:

```
EWC1a.SQA.net:time# show ntpip
ntpip 1 <ntp_ip_address_1>
ntpip 2 <ntp_ip_address_2>
```

Extreme Switches

Extreme Switch SNTP configuration is executed through the command-line-interface. SNTP is enabled on the VR level. The following are examples of the SNTP configuration within this Validated Design:

Summit Access Switches

```
config timezone name EST -300 autodst
configure sntp-client primary <ntp_ip_address_1> vr VR-Default
configure sntp-client secondary <ntp_ip_address_2> vr VR-Default
configure sntp-client update-interval 60
enable sntp-client
```

To verify the SNTP daemon is synched with the NTP server, enter the command <show sntp>:

```
(Private) Slot-1 Stack.1 # show sntp
SNTP client is enabled
SNTP time is valid
Primary server: <ntp_ip_address_1>  VR-Default
Secondary server: tp_ip_adderss_2>  VR-Default
Broadcasts: VR-Mgmt
Query interval:60
Last valid SNTP update: From server:<ntp_ip_address_1>, on Mon Jul 30 08:53:57 2018

SNTPC Statistics:
 Packets transmitted:
  to primary server:            4923
  to secondary server:          9
 Packets received with valid time:
  from Primary server:          4914
  from Secondary server:        8
  from Broadcast server:        0
 Packets received without valid time:
  from Primary server:          0
  from Secondary server:        0
  from Broadcast server:        0
 Replies not received to requests:
  from Primary server:          9
  from Secondary server:        1
```

ERS Access Switches

```
sntp server primary address 134.141.79.190
sntp server secondary address 134.141.79.191
sntp enable
sntp sync-interval 1
clock source sntp
clock time-zone EST -5
```

To verify the SNTP daemon is synched with the NTP server, enter the command <show sntp>:

```
ERS-4900(config)#show sntp
SNTP Status:                    Enabled
Primary server address:         134.141.79.190
Secondary server address:       134.141.79.191
Sync interval:                  1 hours
Last sync source:               134.141.79.190
Primary server sync failures:   0
Secondary server sync failures: 0
Last sync time:                 2018-12-08 19:30:48 GMT-05:00
Next sync time:                 2018-12-08 20:30:48 GMT-05:00
Current time:                   2018-12-08 20:24:33 GMT-05:00
```

Fabric Connect Switches

```
clock time-zone EST
no ntp
ntp server <ntp_ip_address_1>
ntp server <ntp_ip_address_2>
ntp interval 60
ntp
```

To verify the NTP daemon is synched with the NTP server, enter the command <show ntp>:

```
BEB-8284-50:1(config)#show ntp

================================================================================
                                    NTP
================================================================================
Version   Enabled        Interval    Last Update Time                Synchronized To
--------------------------------------------------------------------------------
3         True           60       Mon Jul 30 07:47:33 2018 EST      <ntp_ip_address_1>
```

DHCP/BOOTP Relay Agent

A DHCP Relay agent relays DHCP requests from the client to the DHCP server, and relays the DHCP replies from the server to the client. It acts as a proxy and can reduce the number of DHCP servers required in the network. The DHCP relay agent inserts its own IP address in the giaddr field (gateway address) of the DHCP request. The DHCP server looks into this IP address, identifies the DHCP client's subnet, and assigns an IP address accordingly.

DHCP Relay is configured in the domain the IP interface was created (GRT or VRF) and must also be enabled on the IP interface. Redundant DHCP servers are present in this design. The following is the DHCP Relay configuration for this Validated Design:

Fabric Connect Switches (BEB-110):

- Global configuration:

```
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.105
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.115
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.10.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.105
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.105  mode bootp_dhcp
```

```
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.115
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.24.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.105
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.115
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.28.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.2 172.9.99.115  mode bootp_dhcp

router vrf iot
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.105
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.115
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.20.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.2 172.9.99.115  mode bootp_dhcp
exit

router vrf surveillance
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.105
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.115
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.32.1 172.9.99.115  mode bootp_dhcp
exit
```

- Interface configuration:

```
interface vlan 100
ip dhcp-relay
exit

interface vlan 102
ip dhcp-relay
exit

interface vlan 103
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
```

```
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 101
vrf iot
ip dhcp-relay
exit

interface vlan 104
vrf surveillance
ip dhcp-relay
exit
```

Fabric Connect Switches (BEB-111):

- Global configuration:

```
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.105
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.115
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.10.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.24.2 172.9.99.105
ip dhcp-relay fwd-path 172.10.24.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.24.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.24.2 172.9.99.115

ip dhcp-relay fwd-path 172.10.24.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.24.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.105
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.115
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.28.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.3 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.3 172.9.99.115  mode bootp_dhcp


router vrf iot
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.105
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.115
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.20.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.105  enable
```

```
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.3 172.9.99.115  mode bootp_dhcp
exit
router vrf surveillance
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.105
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.115
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.10.32.2 172.9.99.115  mode bootp_dhcp
exit
```

- Interface configuration:

```
interface vlan 100
ip dhcp-relay
exit

interface vlan 102
ip dhcp-relay
exit

interface vlan 103
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 101
vrf iot
ip dhcp-relay
exit

interface vlan 104
vrf surveillance
ip dhcp-relay
exit
```

Fabric Connect Switches (BEB-210):

- Global configuration:

```
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.105
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.115
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.10.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.105
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.115
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.24.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.105
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.115
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.28.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.4 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.4 172.9.99.115  mode bootp_dhcp

router vrf iot
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.105
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.115
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.20.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.4 172.9.99.115  mode bootp_dhcp
exit

router vrf surveillance
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.105
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.115
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.32.1 172.9.99.115  mode bootp_dhcp
exit
```

DHCP relay configured on each VLAN interface in the GRT, pointed to both DHCP servers.

- Interface configuration:

```
interface vlan 200
ip dhcp-relay
exit

interface vlan 202
ip dhcp-relay
exit

interface vlan 203
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 201
vrf iot
ip dhcp-relay
exit

interface vlan 204
vrf surveillance
ip dhcp-relay
exit
```

DHCP relay enabled on VLAN interfaces in the GRT.

DHCP relay enabled on VLAN interfaces in the VRFs.

Fabric Connect Switches (BEB-211):

- Global configuration:

```
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.105
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.115
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.10.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.105
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.115
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.24.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.105
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.115
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.28.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.5 172.9.99.115  mode bootp_dhcp
```

```
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.5 172.9.99.115  mode bootp_dhcp

router vrf iot
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.105
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.115
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.20.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.5 172.9.99.115  mode bootp_dhcp
exit

router vrf surveillance
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.105
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.115
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.20.32.2 172.9.99.115  mode bootp_dhcp
exit
```

- Interface configuration:

```
interface vlan 200
ip dhcp-relay
exit

interface vlan 202
ip dhcp-relay
exit

interface vlan 203
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 201
vrf iot
ip dhcp-relay
exit
interface vlan 204
vrf surveillance
ip dhcp-relay
exit
```

Fabric Connect Switches (BEB-310):

- Global configuration:

```
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.105
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.115
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.10.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.105
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.115
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.24.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.28.1 172.9.99.105
ip dhcp-relay fwd-path 172.30.28.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.28.1 172.9.99.105  mode bootp_dhcp

ip dhcp-relay fwd-path 172.30.28.1 172.9.99.115
ip dhcp-relay fwd-path 172.30.28.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.28.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.6 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.6 172.9.99.115  mode bootp_dhcp

router vrf iot
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.105
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.115
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.20.1 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.6 172.9.99.115  mode bootp_dhcp
exit

router vrf surveillance
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.105
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.115
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.32.1 172.9.99.115  mode bootp_dhcp
exit
```

- Interface configuration:

```
interface vlan 300
ip dhcp-relay
exit

interface vlan 302
ip dhcp-relay
exit

interface vlan 303
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 301
vrf iot
ip dhcp-relay
exit

interface vlan 304
vrf surveillance
ip dhcp-relay
exit
```

Fabric Connect Switches (BEB-311):

- Global configuration:

```
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.105
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.115
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.10.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.105
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.115
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.24.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.105
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.115
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.28.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.105
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.115
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.0.7 172.9.99.115  mode bootp_dhcp
```

```
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.105
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.115
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.1.7 172.9.99.115  mode bootp_dhcp

router vrf iot
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.105
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.115
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.20.2 172.9.99.115  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.105
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.105  enable
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.115
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.115  enable
ip dhcp-relay fwd-path 172.105.2.7 172.9.99.115  mode bootp_dhcp
exit

router vrf surveillance
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.105
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.115
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.30.32.2 172.9.99.115  mode bootp_dhcp
exit
```

- Interface configuration:

```
interface vlan 300
ip dhcp-relay
exit

interface vlan 302
ip dhcp-relay
exit

interface vlan 303
ip dhcp-relay
exit

interface vlan 1050
ip dhcp-relay
exit

interface vlan 1051
ip dhcp-relay
exit

interface vlan 1052
vrf iot
ip dhcp-relay
exit

interface vlan 301
vrf iot
ip dhcp-relay
exit
 interface vlan 304
vrf surveillance
ip dhcp-relay
exit
```

Fabric Connect switches (BEB-910):

- Global Configuration: As Guest traffic from the campuses egresses the EWC, the DVR controllers need to be configured to relay the DHCP requests to the DHCP server:

```
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.105
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.105  enable
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.115
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.115  enable
ip dhcp-relay fwd-path 172.90.40.2 172.9.99.115  mode bootp_dhcp
```

- Interface Configuration:

```
interface Vlan 906
ip dhcp-relay
exit
```

Fabric Connect switches (BEB-920):

- Global Configuration: As Guest traffic from the campuses egresses the EWC, the DVR controllers need to be configured to relay the DHCP requests to the DHCP server:

```
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.105
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.105  enable
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.105  mode bootp_dhcp
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.115
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.115  enable
ip dhcp-relay fwd-path 172.90.40.3 172.9.99.115  mode bootp_dhcp
```

- Interface Configuration:

```
interface Vlan 906
ip dhcp-relay
exit
```

- Verification: To view statistics on requests relayed, enter the command `<show ip dhcp-relay counters>`:

```
Slot-BEB-8284-210:1(config)#show ip dhcp-relay counters

================================================================================================
                          DHCP Counters - GlobalRouter
================================================================================================
INTERFACE       IP_ADDRESS            REQUESTS        REPLIES
------------------------------------------------------------------------------------------------
----
Vlan200         172.20.10.1           86              161
Vlan202         172.20.24.1           6               12
Vlan203         172.20.28.1           0               0
Vlan1050        172.105.0.4           0               0
Vlan1051        172.105.1.4           47              0
```

Link Layer Discover Protocol (LLDP)

LLDP is enabled by default in Summit and Fabric Connect and is an integral part of the process for the initial discovery of Fabric Attach elements. Fabric Attach uses the IEEE802.1ab LLDP (Link Layer Discovery Protocol) extensions to automatically attach network devices to individual services in a Fabric Connect network.

The Link Layer Discovery Protocol (LLDP), defined by IEEE standard 802.1ab, provides a standard method for discovering physical network devices and their capabilities within a given network management domain. Upon connection and detection of an FA Client, the FA Server (BEB) will advertise (via LLDP) the management I-SID/VLAN to the FA Client.

- The FA client component on the access switches communicates directly with the FA server on the BEB to request VLAN-to-I-SID mappings for user traffic.
- Access switches also support FA Proxy, allowing other FA clients (such as APs) to connect to the FA server through it.
- Both FA client and FA proxy functionality is enabled by default on the access switches.

To view LLDP neighbors on VSP, enter the command `<show lldp neighbor summary>`:

```
BEB-8284-50:1(config)#show lldp neighbor summ

================================================================================================================
                                              LLDP Neighbor Summary
================================================================================================================
LOCAL            IP              CHASSIS            REMOTE
PORT       PROT  ADDR            ID                 PORT         SYSNAME       SYSDESCR
----------------------------------------------------------------------------------------------------------------
1/1        LLDP  0.0.0.0         02:04:96:a1:bf:74  2:50         Campus1-Acc2  ExtremeXOS (Stack) version 22~
1/2        LLDP  0.0.0.0         02:04:96:a0:ad:fe  1:50         Stack         ExtremeXOS (Stack) version 22~
1/10       LLDP  160.10.100.52   e4:5d:52:3c:bc:00  1/10         IP_CLOUD_1    VSP-8284XSQ (6.1.50.0)
1/41       LLDP  10.0.0.40       e4:5d:52:43:b8:00  1/41         BEB-8284-40   VSP-8284XSQ (7.1.0.0_B034) (P~
----------------------------------------------------------------------------------------------------------------
Total Neighbors : 4
```

To view LLDP neighbors on Summit switches, enter the command `<show lldp neighbor>`:

```
Slot-1 Stack.1 # show lldp neighbor

        Neighbor           Neighbor                              Neighbor
Port    Chassis ID         Port ID            TTL     Age        System Name
================================================================================
1:50    B0:AD:AA:48:18:00  1/2                120     20         BEB-8284-50
2:20    D8:84:66:E3:25:B8  eth0               120     17         C1A1-E325B8
2:22    D8:84:66:57:AA:58  eth0               120     16         C1A1-57AA58
2:50    E4:5D:52:43:B8:00  1/2                120     3          BEB-8284-40
================================================================================
NOTE: The Chassis ID and/or Port ID might be truncated to fit the screen.
```

To view the LLDP neighbors on ERS switches, enter the command <show lldp neighbor>:

```
4900_STACK(config)#show lldp neighbor
--------------------------------------------------------------------------------
                            LLDP neighbor
--------------------------------------------------------------------------------
Port: 2/22  Index: 3                  Time: 5 days, 16:14:02
        ChassisId: MAC address        d8:84:66:e3:25:b8
        PortId:    Interface alias    eth0
        SysName:   Acc321-E325B8
        SysCap:    W / W              (Supported/Enabled)
--------------------------------------------------------------------------------
```

```
Port: 1/50  Index: 2                  Time: 5 days, 16:14:21
        ChassisId: MAC address        64:6a:52:ce:0c:00
        PortId:    Interface name     2/1
        SysName:   BEB-8404-310
        SysCap:    rB / rB            (Supported/Enabled)
        PortDesc:  Extreme Networks Virtual Services Platform 8404C Module 8418XSQ - 10GbCX Port
2/1
        SysDescr:  VSP-8404C (7.1.0.0)
```

Simple Network Management Protocol (SNMPv3)

SNMPv3 is an enhanced standard for SNMP that improves the security and privacy of SNMP access to managed devices and provides sophisticated control of access to the device MIB. The prior standard versions of SNMP, SNMPv1, and SNMPv2c, provided no privacy and little security.

SNMPv3 is designed to be secure against:

- Modification of information, where an in-transit message is altered.
- Masquerades, where an unauthorized entity assumes the identity of an authorized entity.
- Message stream modification, where packets are delayed and/or replayed.
- Disclosure, where packet exchanges are sniffed (examined) and information is learned about the contents.

You can use the access control subsystem to configure whether access to a managed object in a local MIB is allowed for a remote principal. The access control scheme allows you to define access policies based on MIB views, groups, and multiple security levels. In addition, the SNMPv3 target and notification MIBs provide a more procedural approach for generating and filtering of notifications. SNMPv3 objects are stored in non-volatile memory unless specifically assigned to volatile storage. Objects defined as permanent cannot be deleted.

SNMP is disabled by default. If you choose to enable SNMP, the switch follows the interactive script asking you if you want to enable SNMPv1/v2c and/or SNMPv3. SNMP access for a VR has global SNMP status that includes all SNMPv1v2c, SNMPv3 default users and default group status. However, trap receiver configuration and trap enabling/disabling are independent of global SNMP access and are still forwarded on a VR that is disabled for SNMP access.

In order for Extreme Management Center to take advantage of the more secure and robust SNMPv3 XMC, the switches and wireless controllers must be configured for the proper matching credentials and user name. On Extreme Management Center, administration profiles are required to communicate to the network devices and wireless controllers. Following are the steps required to create an Administration Profile (CLI **Credentials → Profiles → SNMP Credentials**).

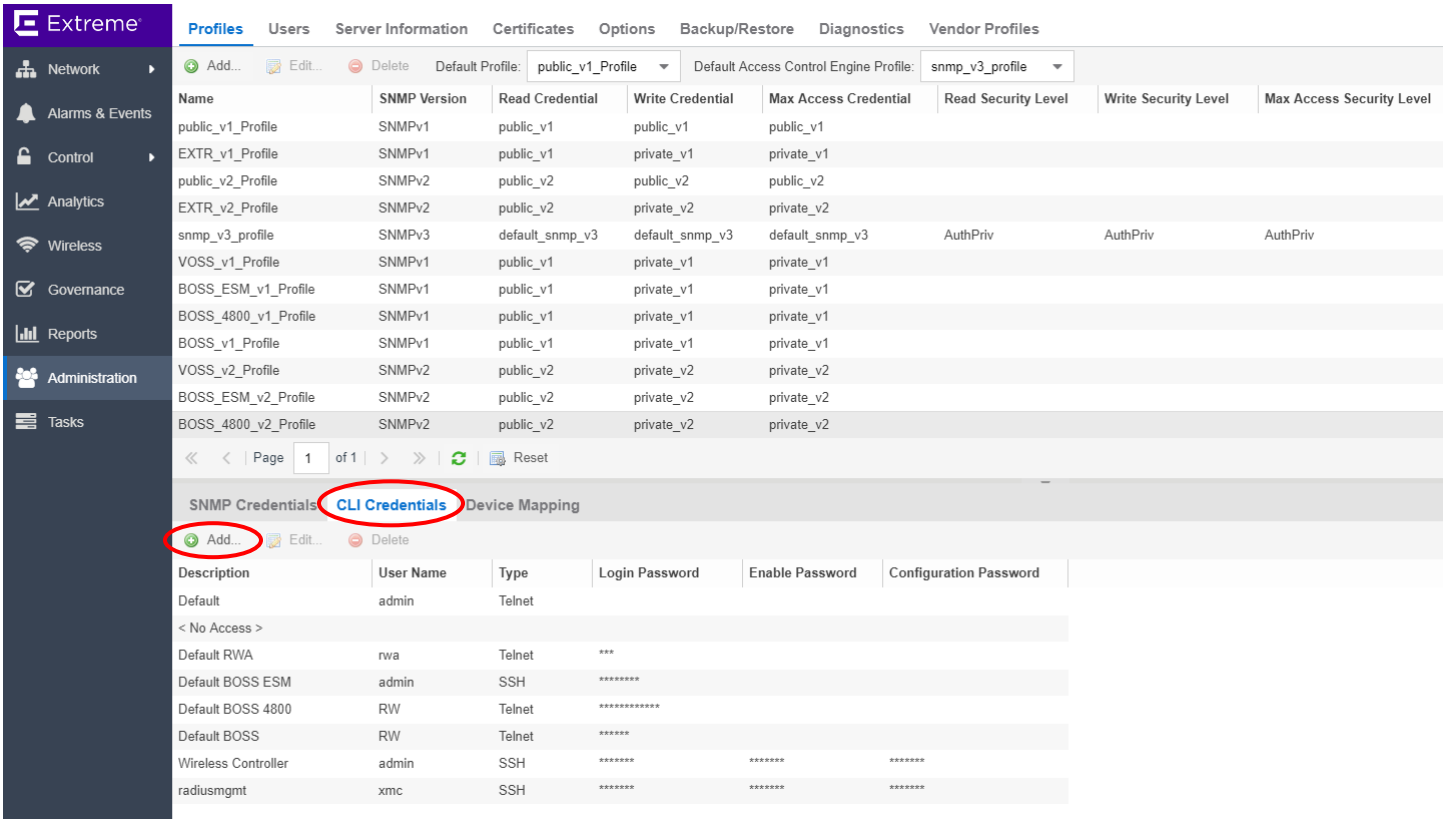
Extreme Management Center Profile Configuration - Switching

Profiles are used to define access to the devices in the network by creating identities used for authentication when performing SNMP queries and sets and identities for CLI operations.

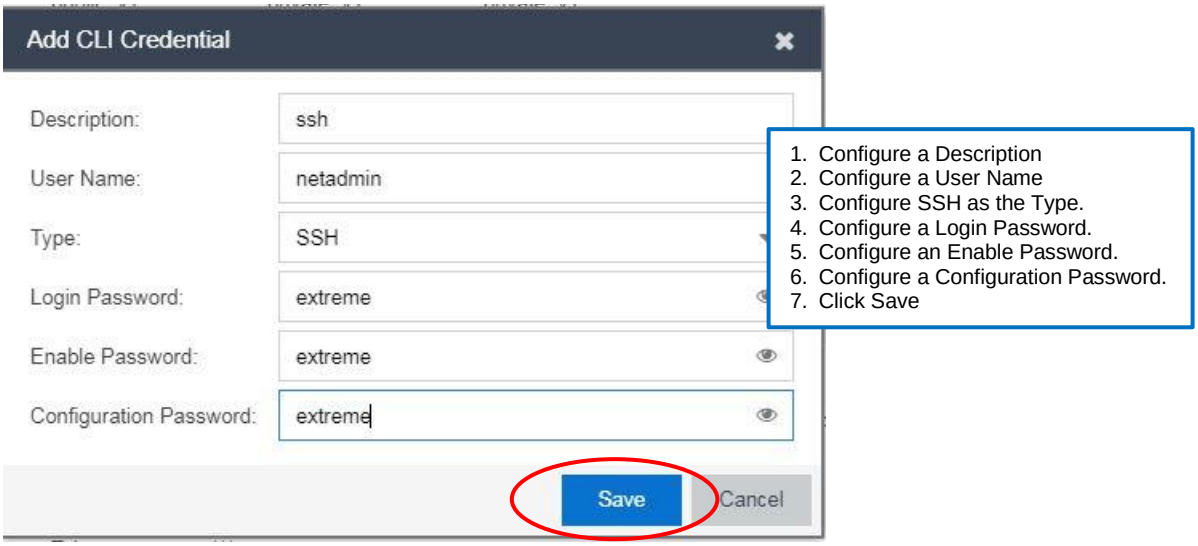
A profile can be configured with the SNMP version to be used and the read and write user and security level. It also points to a set of CLI credentials.

In the Automated Campus EVD, a profile that uses SNMPv3 was created and is used by all network devices. For CLI, SSH access is enabled. Authentication for CLI is done via LDAP/RADIUS server. A different SNMPv3 profile is used by the wireless controllers.

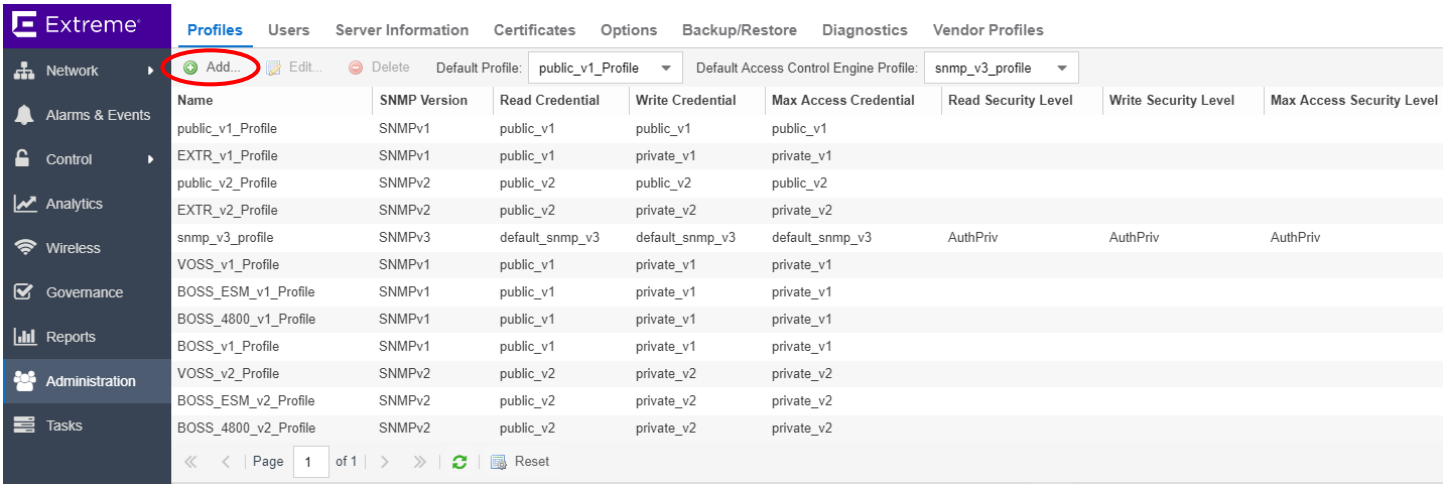
- To create new CLI credentials, go to **Administration → Profiles→ CLI Credentials** and click **Add**.

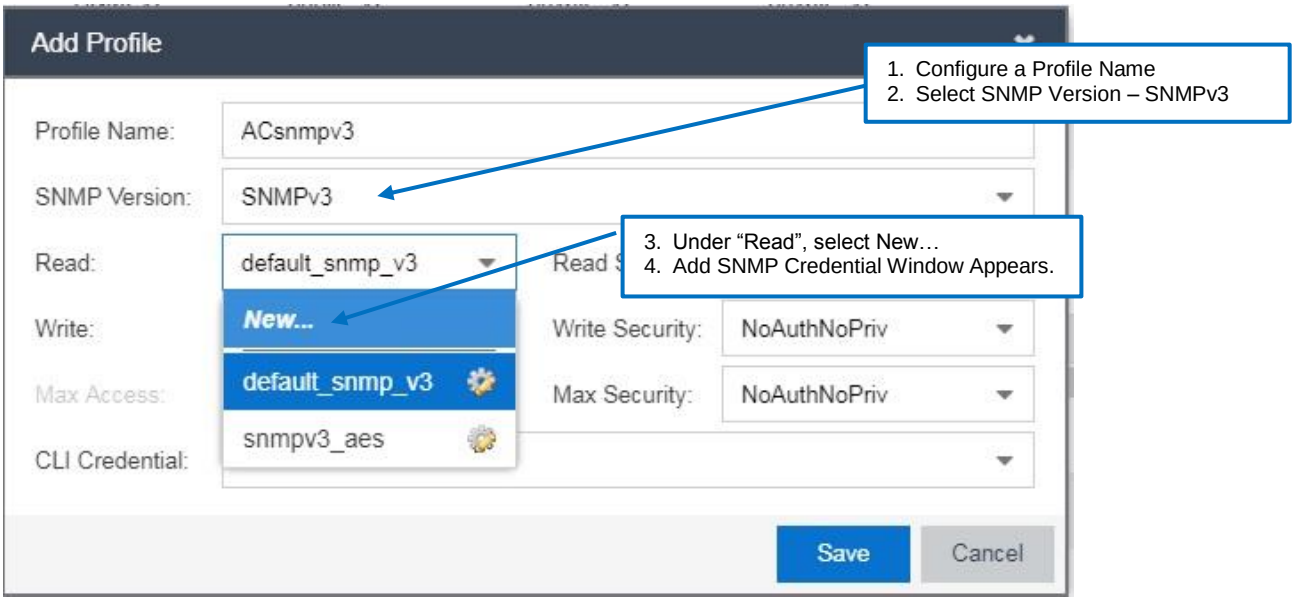


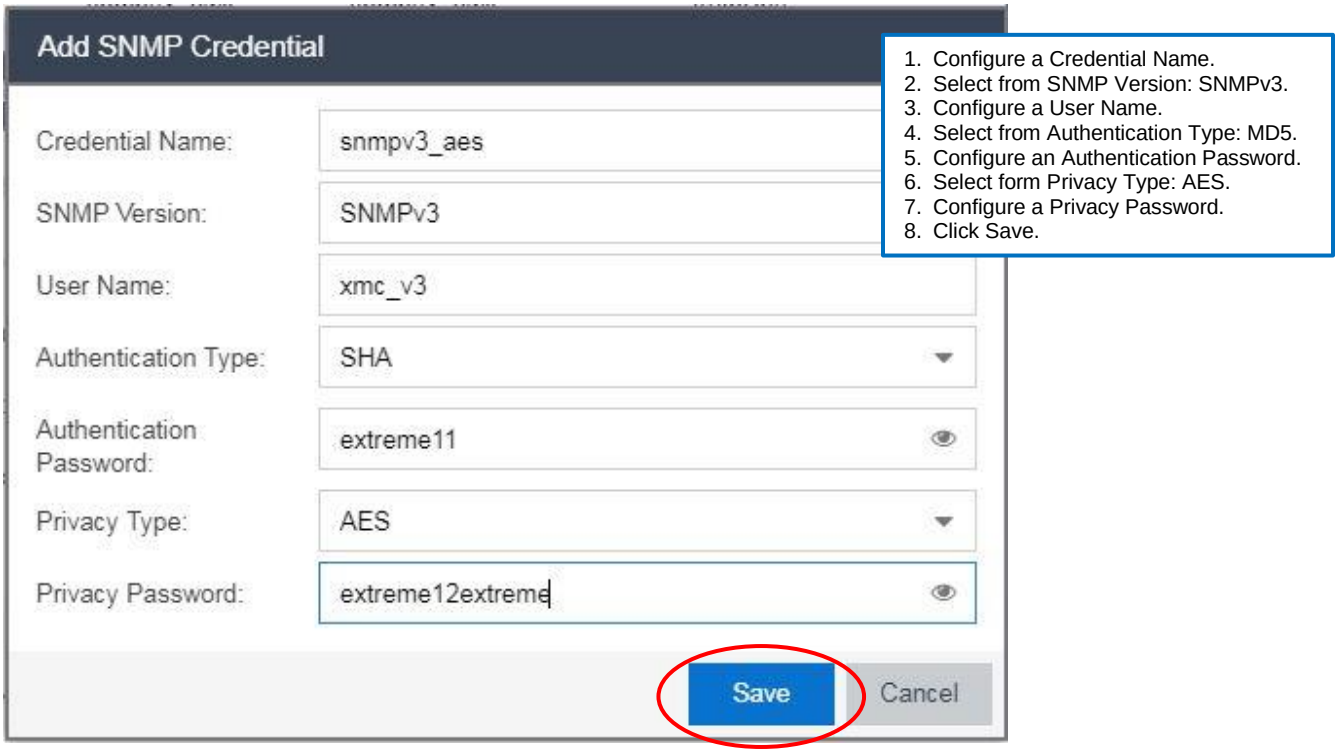
- Only SSH is permitted for management connections to the network devices. Telnet access is disabled.



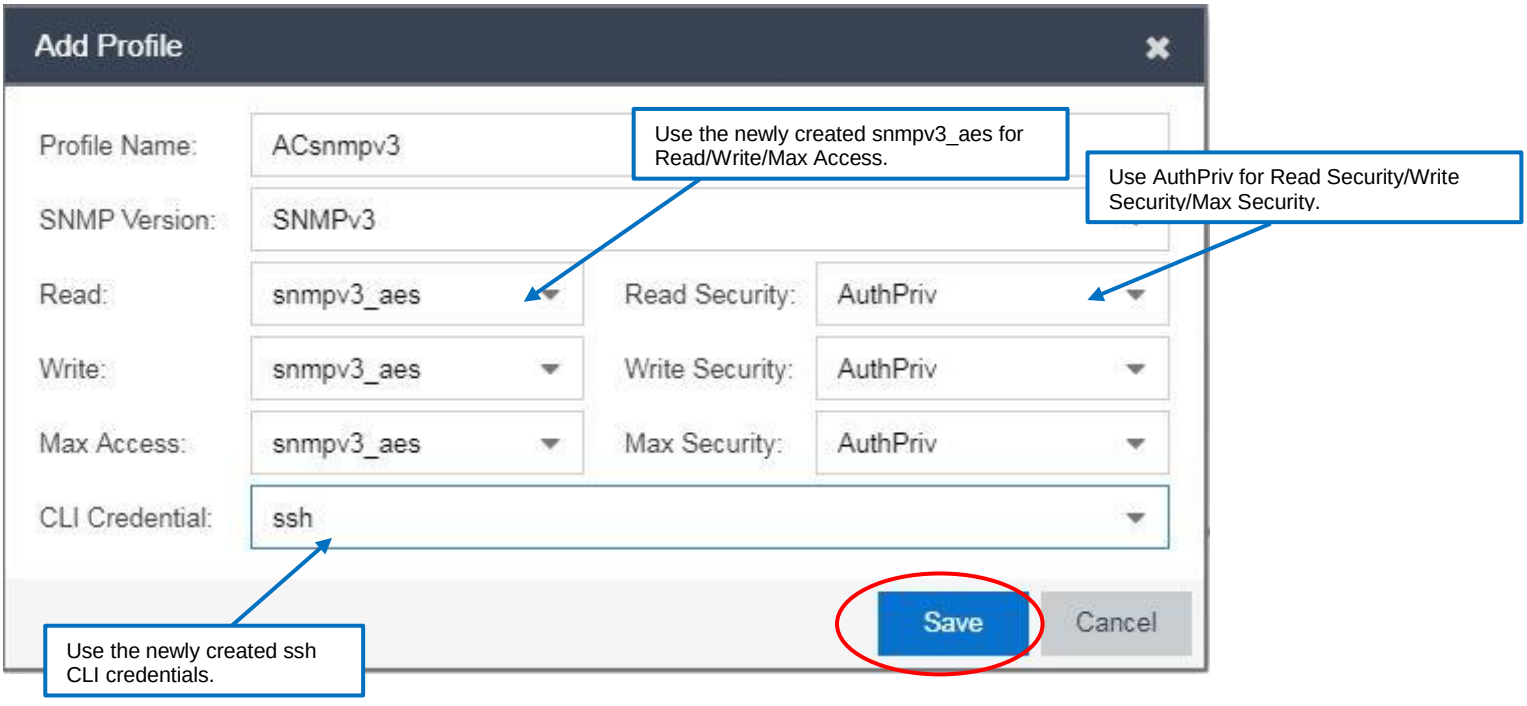
- To create a new profile, go to **Administration → Profiles** and select **Add** to create a custom SNMP profile:







- The same SNMPv3 user with the same authentication protocol and password and the same privacy protocol and password must be created on the network device.
- Configure the created profile with the new SNMP and CLI credentials:



Switch Configuration – Extreme Management Center Administration Profile

After the administration profile is configured in Extreme Management Center, the same credentials must be configured on the device in order for Extreme Management Center to manage and configure the device.

Summit Access Switch:

- By default, the SNMPv3 engine-ID is present within the <snmpMaster configuration> module. To match the credentials configured within the Extreme Management Center administrative profile, enter the command `<configure snmpv3 add user xmc_v3 authentication sha privacy aes 128>`. You will be prompted with a series of password entries that must match the passwords within the administrator profile for Authentication and Privacy.

```
Slot-1 Stack.3 #configure snmpv3 add user xmc_v3 authentication sha privacy aes 128
Authentication password: extreme11
Reenter authentication password: extreme11
Privacy password: extreme12extreme
Reenter privacy password: extreme12extreme
```

- After executing the above command, you should receive output similar to the following when you issue the command `<show configuration snmp>`:

```
Slot-1 Stack.3 # show config snmp
#
# Module snmpMaster configuration.
#
configure snmpv3 engine-id 03:02:04:96:a1:bf:74
configure snmpv3 add user "xmc_v3" engine-id 80:00:07:7c:03:02:04:96:a1:bf:74 authentication sha
auth-encrypted localized-key
23:24:70:53:44:6f:42:4c:66:74:31:74:4b:35:68:7a:6a:63:39:42:56:58:4c:4a:61:56:6d:68:49:2f:47:42:
74:75:36:6c:31:4a:59:38:37:4d:78:33:4b:45:30:4c:6c:4a:54:6e:51:3d privacy aes 128 privacy-
encrypted localized-key
23:24:67:64:65:6f:79:41:45:2b:59:68:66:63:34:61:67:6a:67:33:44:62:78:6a:37:4e:4d:49:4f:6f:7a:46:
31:34:53:43:79:36:6b:79:44:71:52:71:33:30:4b:41:50:51:56:78:49:3d
```

- Enter the following commands to complete the SNMPv3 configuration for this Validated Design. The following shows the commands and their output.

```
config snmpv3 add group snmpv3group user xmc_v3 sec-model usm
config snmpv3 add access snmpv3group sec-model usm sec-level priv read-view defaultAdminView
write-view defaultAdminView notify-view defaultAdminView
configure snmpv3 add community "private" name "private" user "v1v2c_rw"
configure snmpv3 add community "public" name "public" user "v1v2c_ro"
enable snmp acc snmpv3
disable snmp access snmp-v1v2c
disable snmpv3 default-group
```

- To show SNMP configuration, enter the command <show configuration snmp>:

```
Slot-1 Stack.5 # show config snmp
#
# Module snmpMaster configuration.
#
configure snmpv3 engine-id 03:02:04:96:a1:bf:74
configure snmpv3 add user "xmc_v3" engine-id 80:00:07:7c:03:02:04:96:a1:bf:74 authentication sha
auth-encrypted localized-key
23:24:70:53:44:6f:42:4c:66:74:31:74:4b:35:68:7a:6a:63:39:42:56:58:4c:4a:61:56:6d:68:49:2f:47:42:
74:75:36:6c:31:4a:59:38:37:4d:78:33:4b:45:30:4c:6c:4a:54:6e:51:3d privacy aes 128 privacy-
encrypted localized-key
23:24:67:64:65:6f:79:41:45:2b:59:68:66:63:34:61:67:6a:67:33:44:62:78:6a:37:4e:4d:49:4f:6f:7a:46:
31:34:53:43:79:36:6b:79:44:71:52:71:33:30:4b:41:50:51:56:78:49:3d
configure snmpv3 add group "snmpv3group" user "xmc_v3" sec-model usm
configure snmpv3 add access "snmpv3group" sec-model usm sec-level priv read-view
"defaultAdminView" write-view "defaultAdminView" notify-view "defaultAdminView"
configure snmpv3 add community "private" name "private" user "v1v2c_rw"
configure snmpv3 add community "public" name "public" user "v1v2c_ro"
enable snmp access
disable snmp access snmp-v1v2c
enable snmp access snmpv3
disable snmpv3 default-group
```

- **Configure parameters for SNMP traps:**

```
configure snmpv3 add target-addr "v3AdminAddr" param "v3adminParam" ipaddress 172.9.99.119
transport-port 162 tag-list "TVTrapTag"
configure snmpv3 add target-params "v3adminParam" user "xmc_v3" mp-model snmpv3 sec-model usm
sec-level priv
```

ERS Access Switch:

- Enter SNMPv3 configuration parameters:

```
5928GTS-uPWR(config)#snmp-server name "5900_STACK"
5900_STACK(config)#snmp-server view snmpView +1.3
5900_STACK(config)#snmp-server view adminView +1.3
5900_STACK(config)#snmp-server user xmc_v3 sha aes read-view adminView write-view adminView
notify-view adminView
Enter SHA pass-phrase: *********
Confirm SHA pass-phrase: *********
Enter Aes pass-phrase: ****************
Confirm Aes pass-phrase: ****************
```

When prompted, enter the SHA and AES passphrases to match XMC's SNMP profile.

To configure the XMC as a trap target:

```
5900_STACK(config)#snmp-server user engine-id 80:00:1f:88:80:c5:04:f2:24:d6:ac:d0:5a xmc_v3 sha
aes
Enter SHA pass-phrase: *********
Confirm SHA pass-phrase: *********
Enter Aes pass-phrase: ****************
Confirm Aes pass-phrase: ****************
```

Specify the XMC engine-id

When prompted, enter the SHA and AES passphrases to match XMC's SNMP profile.

Note

The ERS requires the engine id be entered into the CLI. This value can be retrieved from the XMC file:

/usr/local/Extreme_Networks/NetSight/services/snmptrapd.conf

- To show SNMP configuration, enter the command <show snmp user>:

```
Acc-321(config)#show snmp user
--------------------------------------------------------------------------------
User Name:  xmc_v3
SNMP Engine ID:  80:00:1F:88:80:C5:04:F2:24:D6:AC:D0:5A
Authentication Protocol:  SHA
Privacy Protocol:  AES
Storage Type:  Non Volatile (NVRAM)
Status:  Active
--------------------------------------------------------------------------------
User Name:  xmc_v3
SNMP Engine ID:  80:00:02:32:80:02:00:57:58:4C:49:52:37:32:34:50:35:33:30:30:30
:32
Authentication Protocol:  SHA
Privacy Protocol:  AES
Storage Type:  Non Volatile (NVRAM)
Status:  Active
Views for Unauthenticated Access:
    Read View:
    Write View:
    Notify View:
Views for Authenticated Access:
    Read View:
    Write View:
    Notify View:
Views for Authenticated and Encrypted Access:
    Read View:    adminView
    Write View:    adminView
    Notify View:    adminView
--------------------------------------------------------------------------------
Acc-321(config)#
```

Fabric Connect Switch:

- Enter the following commands to remove the default SNMP settings:

```
no snmp-server community public
no snmp-server community private
no snmp-server user initial
yes
no snmp-server group initial
```

Command will prompt for a **yes/no** confirmation.

- SNMPv3 Configuration:

Set the SNMPv3 Authentication and Privacy passwords.

```
snmp-server view adminView 1.3
snmp-server host 172.9.99.119 v3 authpriv xmc_v3
snmp-server user xmc_v3 group snmpv3group sha extreme11 aes extreme12extreme
snmp-server group snmpv3group "" auth-priv read-view adminView write-view adminView notify-view
adminView
snmp-server authentication-trap enable
```

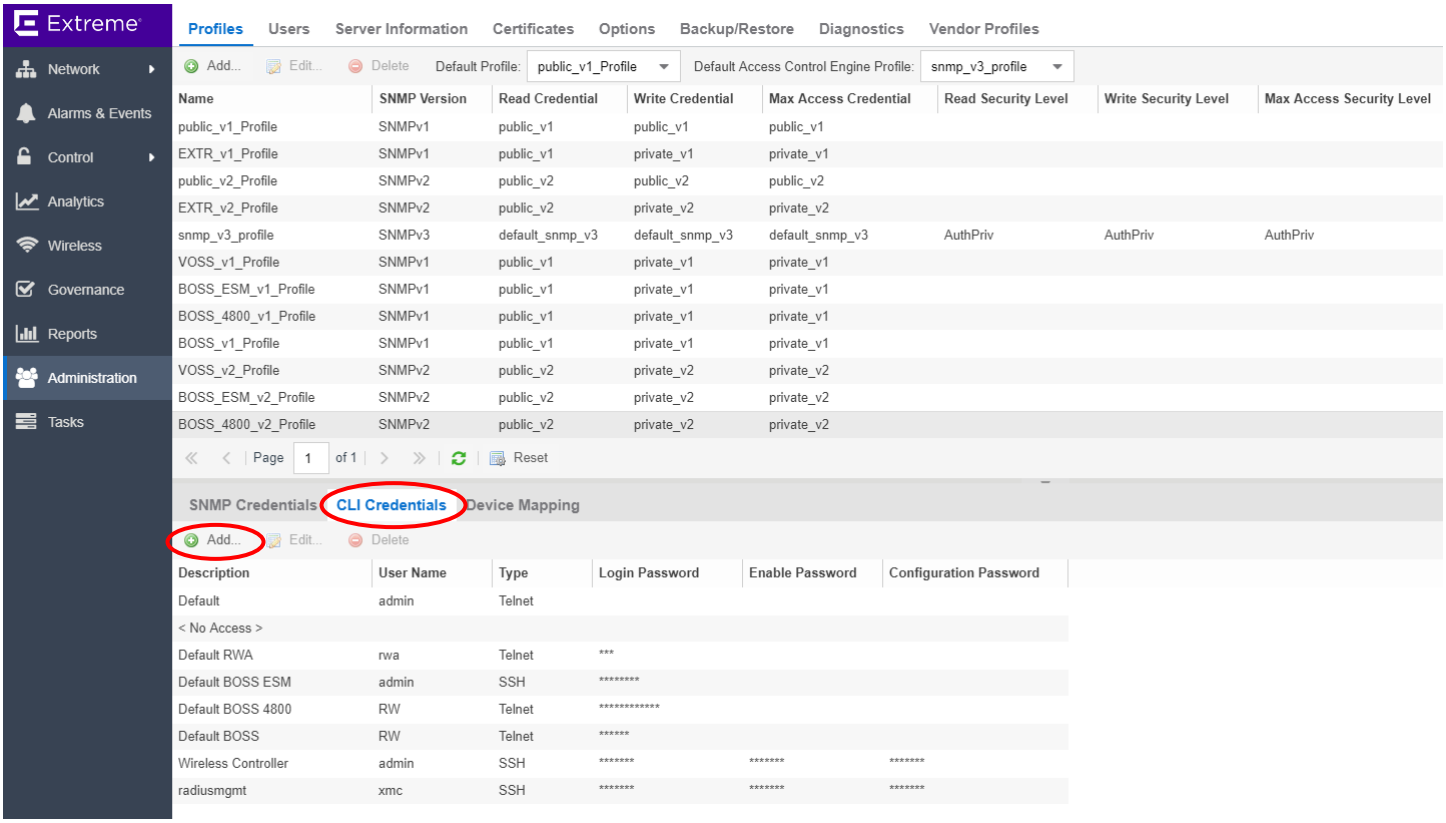
Extreme Management Center Profile Configuration - Wireless Controllers

Profiles are used to define access to the wireless controllers in the network by creating identities used for authentication when performing SNMP queries and sets and identities for CLI operations.

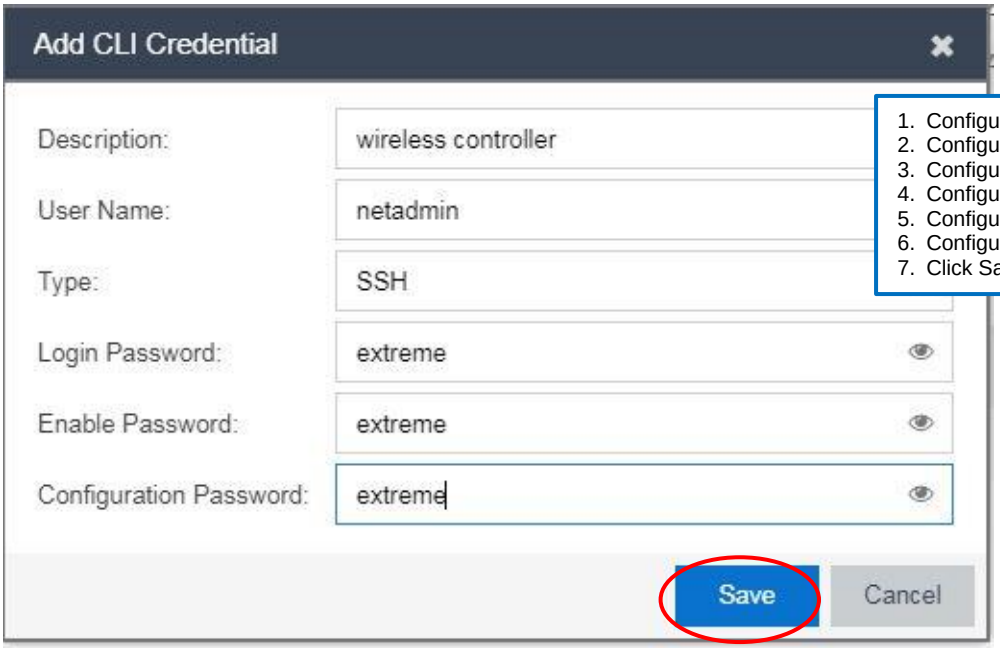
A profile can be configured with the SNMP version to be used for the read and write user and security level. It also points to a set of CLI credentials for the wireless controllers.

In the Automated Campus EVD, a profile that uses SNMPv3 was created and is used by Extreme Management Center for the wireless controllers. For CLI, SSH access is enabled. Authentication for CLI is done via RADIUS server.

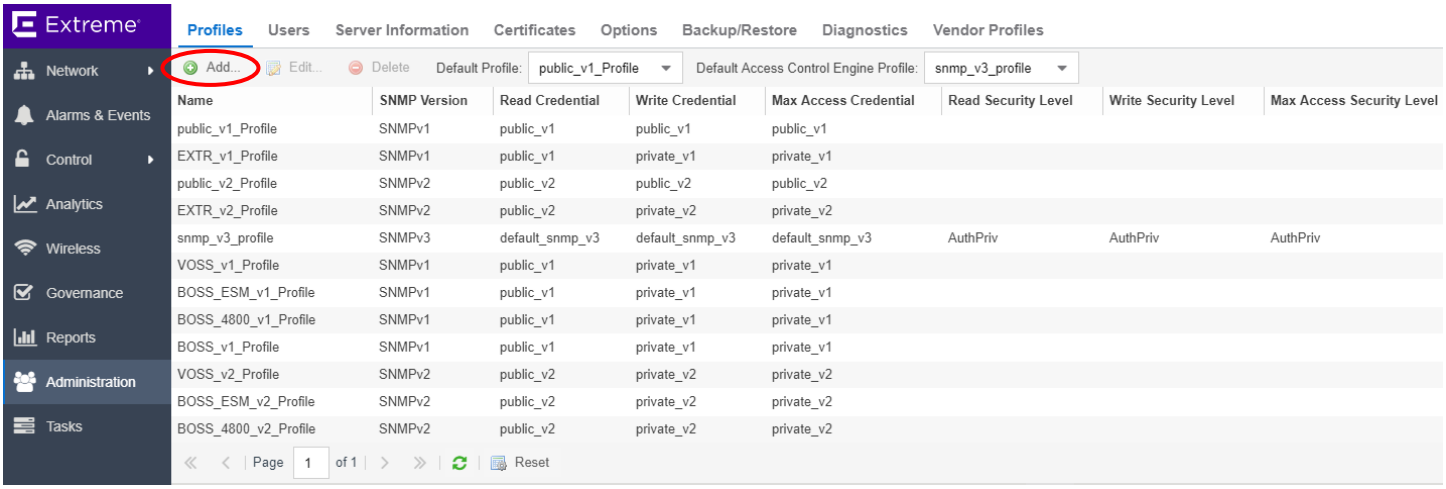
- To create new CLI credentials, go to **Administration → Profiles→ CLI Credentials** and click **Add**.

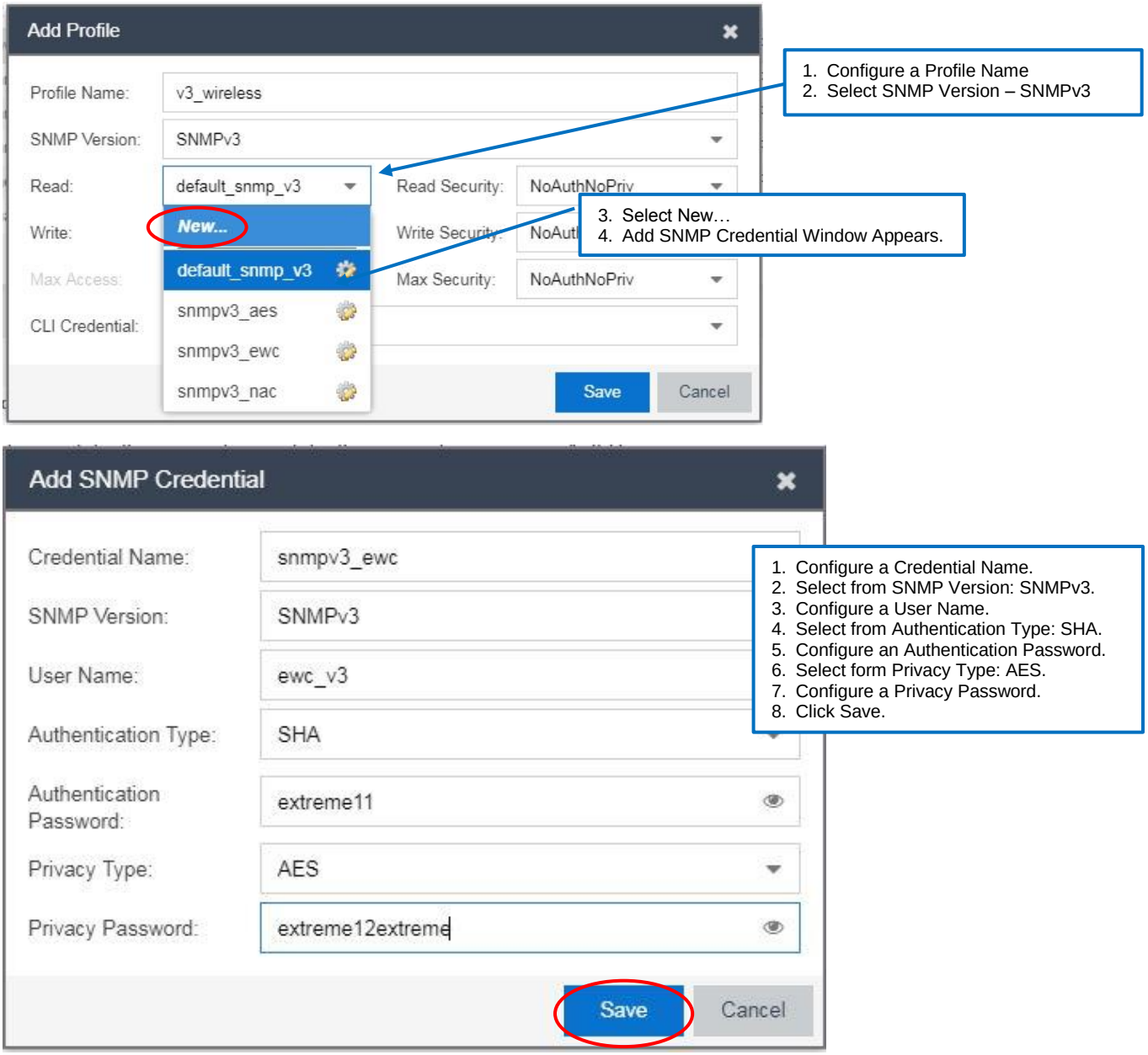


- Only SSH is permitted for management connections to the network devices. Telnet access is disabled.



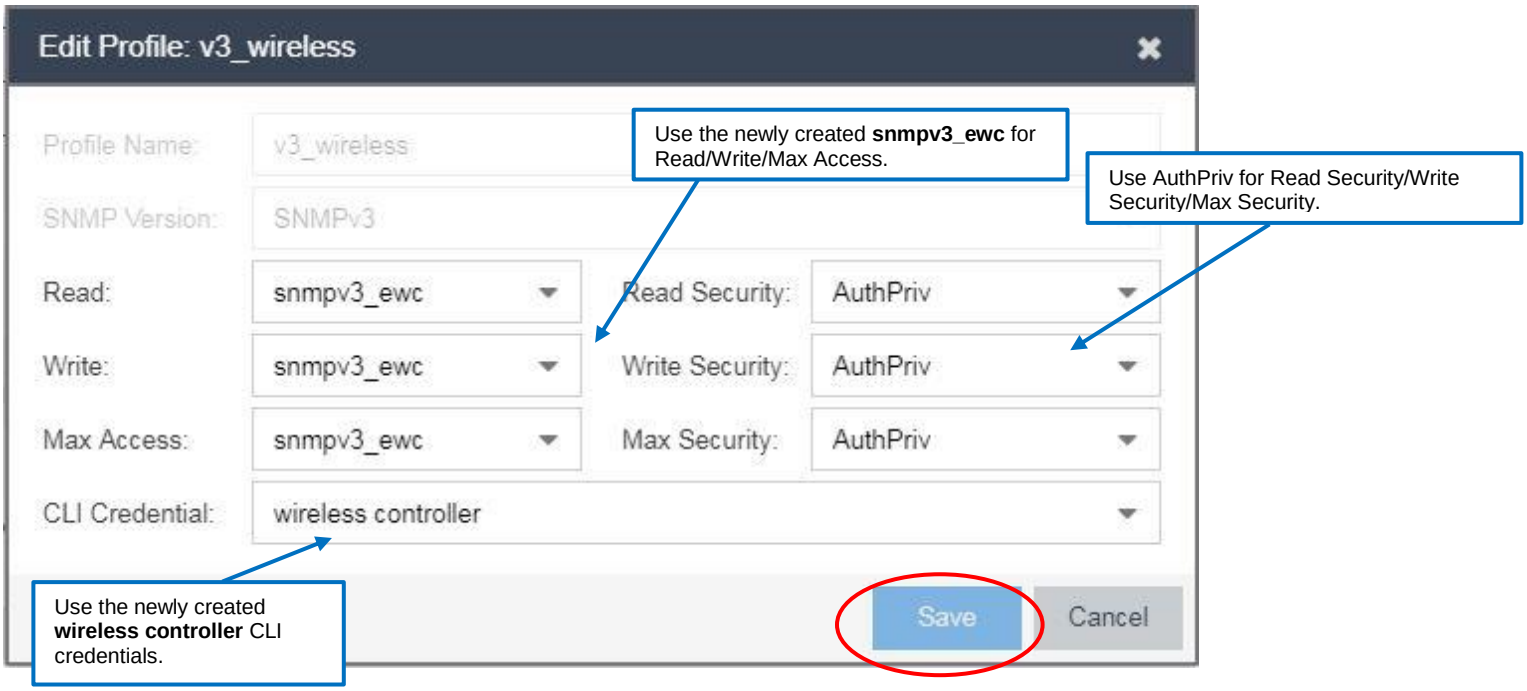
- To create a new Wireless Profile for the wireless controllers, go to **Administration → Profiles** and click **Add**.





- The same SNMPv3 user with the same authentication protocol and password and the same privacy protocol and password must be created on the ExtremeWireless Controllers.

- Configure the created profile with the new SNMP and CLI credential:

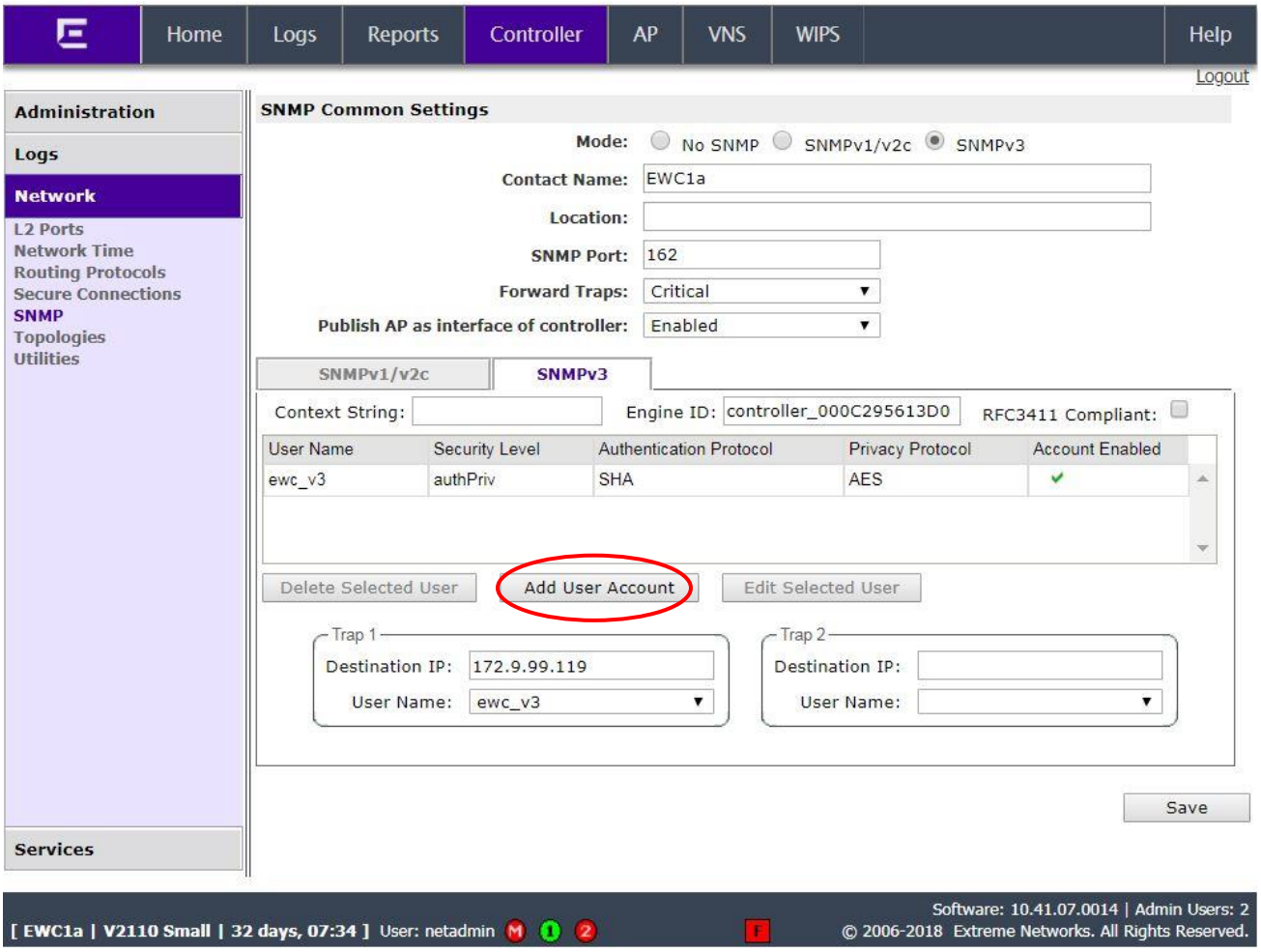


ExtremeWireless Controller SNMPv3 Configuration

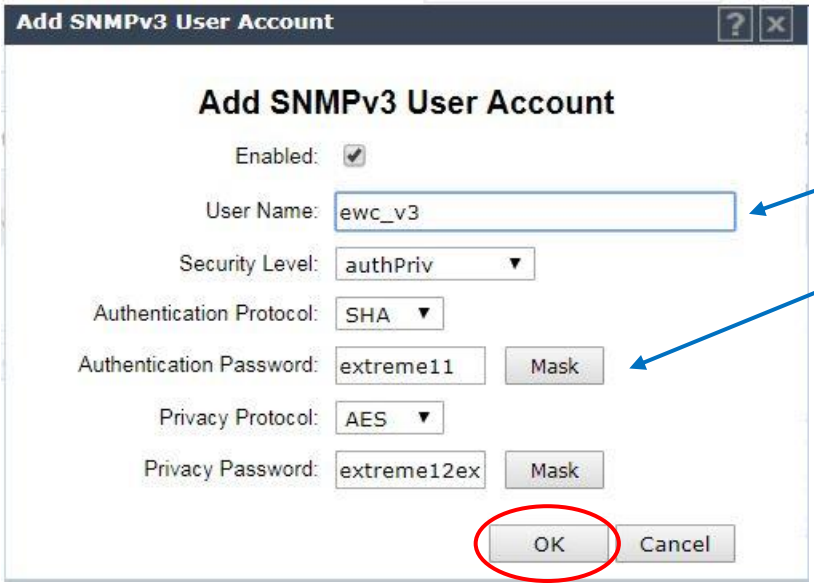
Extreme Management Center uses non-default SNMPv3 credentials to manage wireless controllers. The same SNMPv3 user, password, authentication, and privacy protocols must be configured on both Extreme Management Center and on the wireless controllers.

To configure SNMPv3 on the wireless controllers go to **Controller → Network → SNMP → SNMPv3 → Add User Account**.

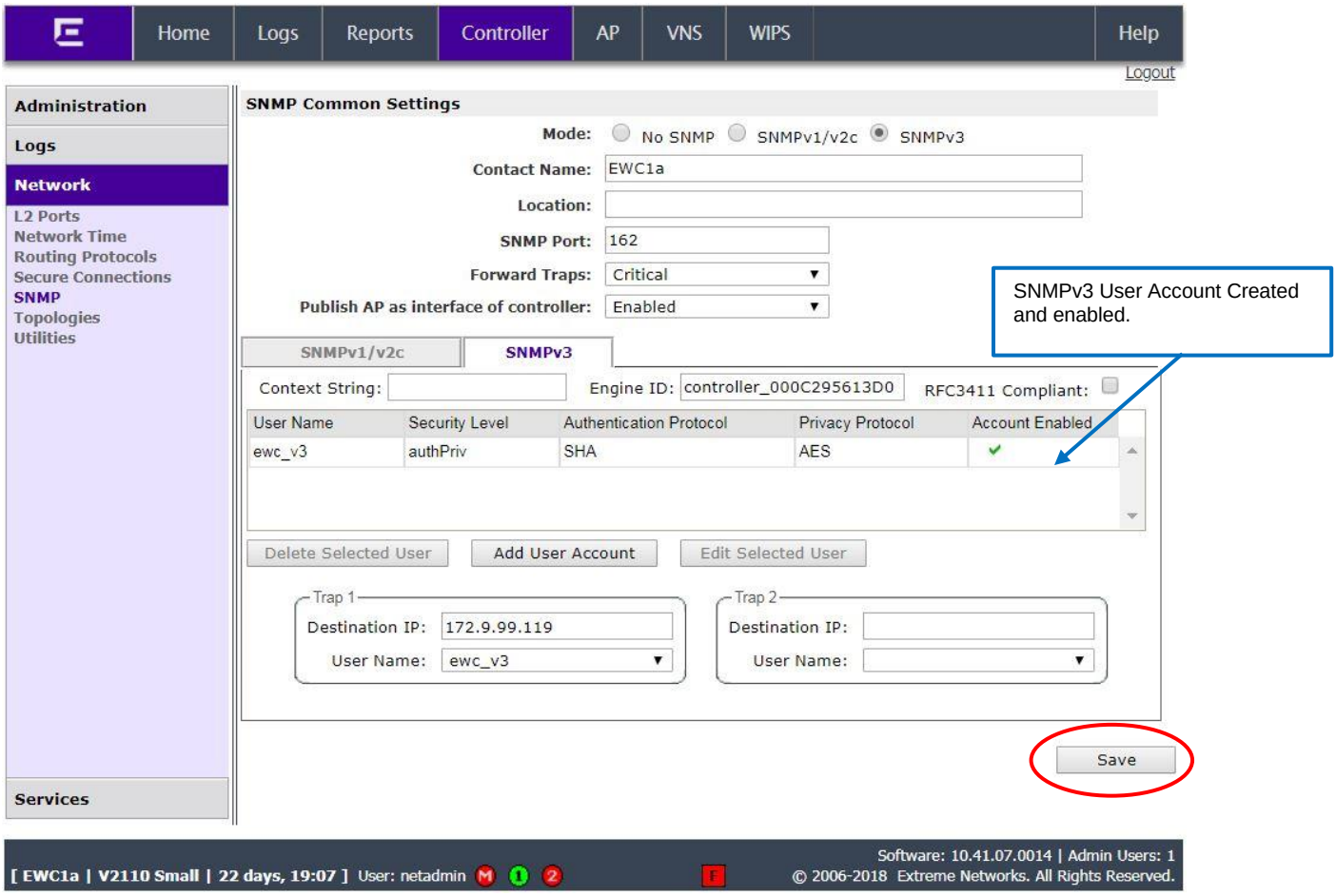
EWC1 and EWC2



The Add SNMPv3 User Account window appears.



Credentials must match those created in the Basic Extreme Management Center section of this document.
Authentication Password: **extreme11**
Privacy Password: **extreme12extreme**



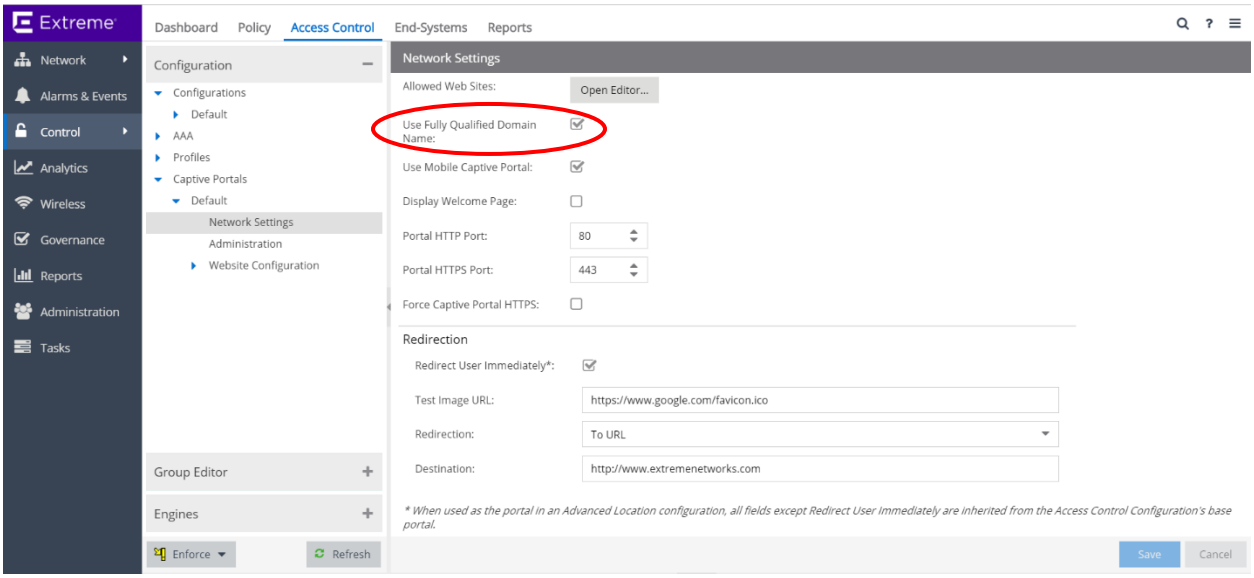
SNMPv3 User Account Created and enabled.

Domain Name System (DNS)

To obtain captive portal redundancy, DNS is used to provide one URL address for both ExtremeControl engines. If one engine is unreachable the second engine will take over because both are associated with the same FQDN.

Essentially, both ExtremeControl engine IPs are added to the same FQDN within the domain of the DNS server. Additional configuration is required on the external DHCP server which is detailed in the Captive Services Configuration subsection of the Extreme Policy section.

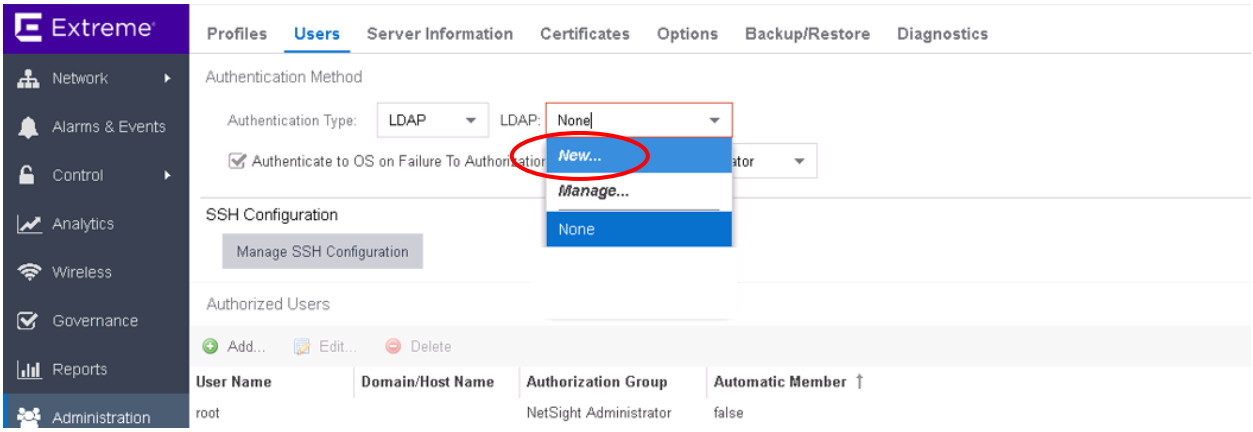
As an added layer of security, select the **Use Fully Qualified Domain Name** checkbox to hide the IP addresses of the ExtremeControl servers when an unregistered user is redirected. This is located in Extreme Management Center: **Access Control → Configuration → Captive Portals → Network Settings**.

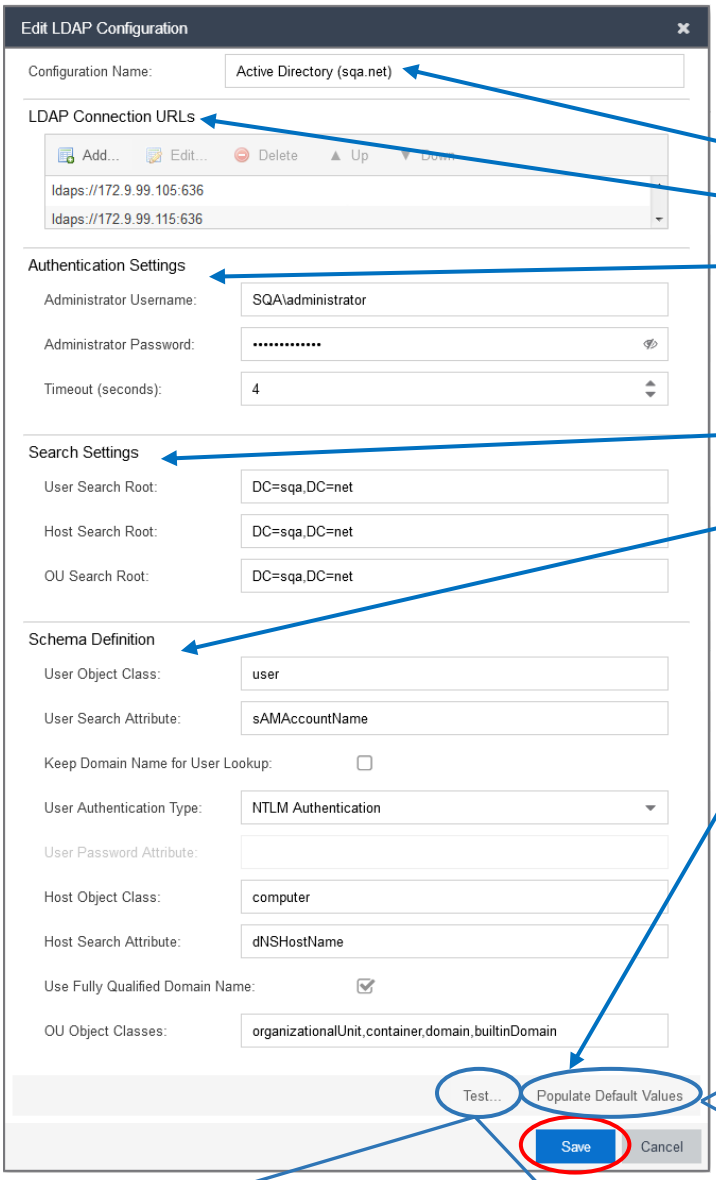


RADIUS (Login Management Configuration)

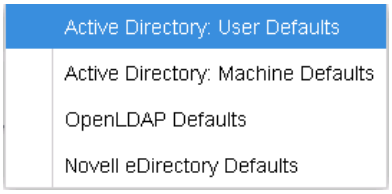
Access can be configured via several means. For full network administration security, we recommend RADIUS or LDAP authentication for Extreme Management Center, ExtremeWireless Controllers, and Extreme device login. The use of an external server is recommended to authenticate user access to Extreme's appliances and switches for administrative purposes. Configuration of the authentication server will need to be completed prior to configuring XMC settings. For the purposes of this EVD, LDAP is being configured using Windows 2008 server as the authentication server.

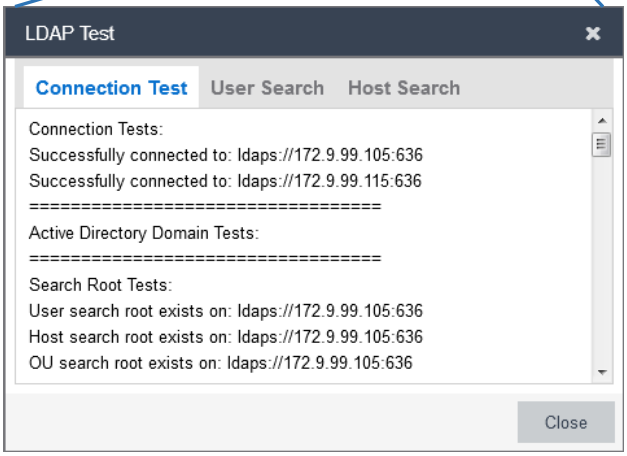
To configure login authentication for Extreme Management Center, go to **Administration → Users**, set the Authentication Method to **LDAP**, and select **New** in the LDAP drop down field.





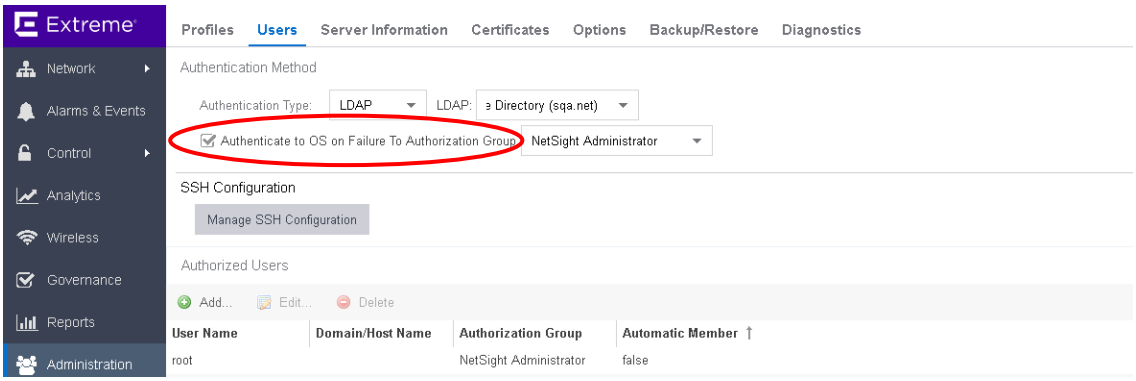
1. Enter **Configuration Name**.
2. Enter **LDAP Connection URLs** using the Authentication server URLs.
3. **Authentication Settings**: consists of the Administrator Username and Administrator password to access the Authentication server. Note that the Timeout settings default is 4 seconds, which may be increased depending on processing time and response of LDAP authentication requests.
4. **Search Settings**: Settings based on Authentication server settings.
5. **Schema Definition**: settings may readily appear by clicking “Populate Default Values” button (just above the Save button) and selecting the appropriate template, in our example “Active Directory User Defaults” is the correct template. Otherwise, the appropriate settings will need to be determined that is applicable to your authentication server.
6. Click **Save** to save your settings. Before or after saving, you can test your LDAP configuration by clicking the “Test” button.



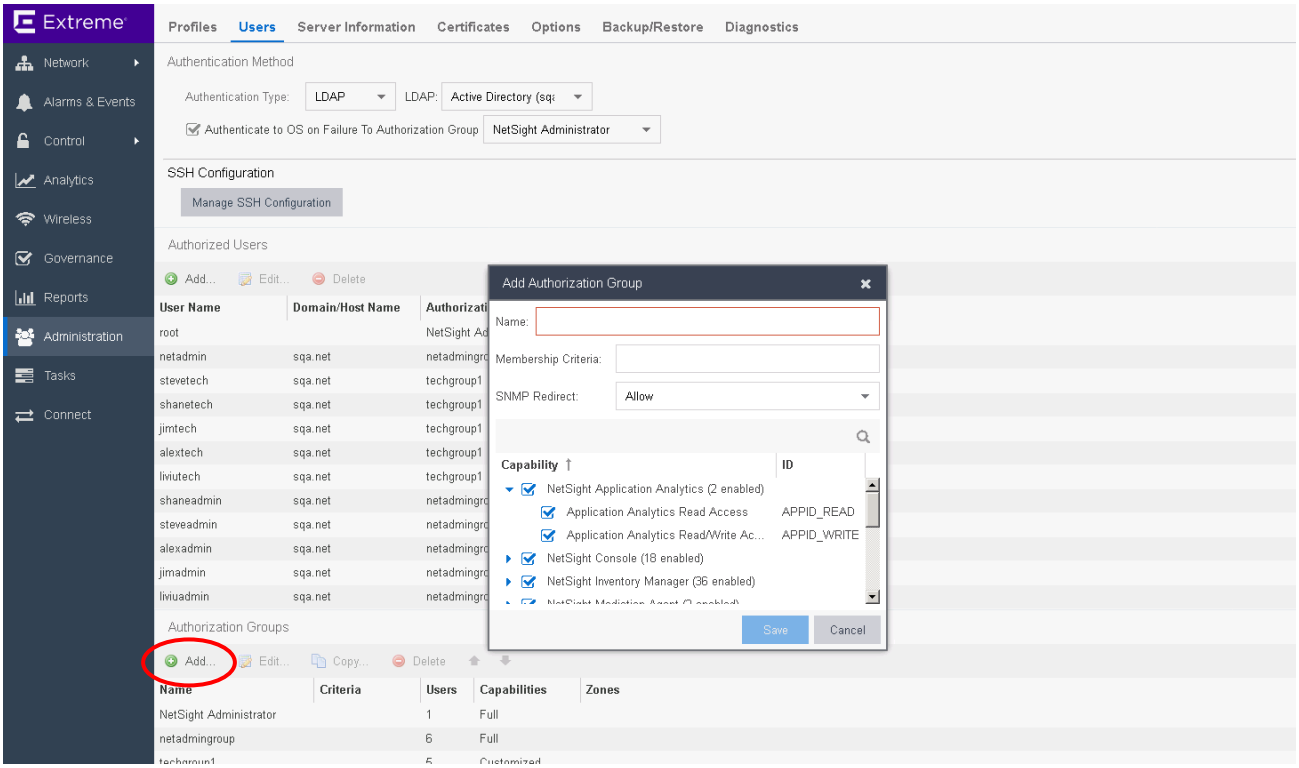


The LDAP configuration menu can also be accessed via **Control>Access Control>Configuration>AAA>LDAP Configurations**.

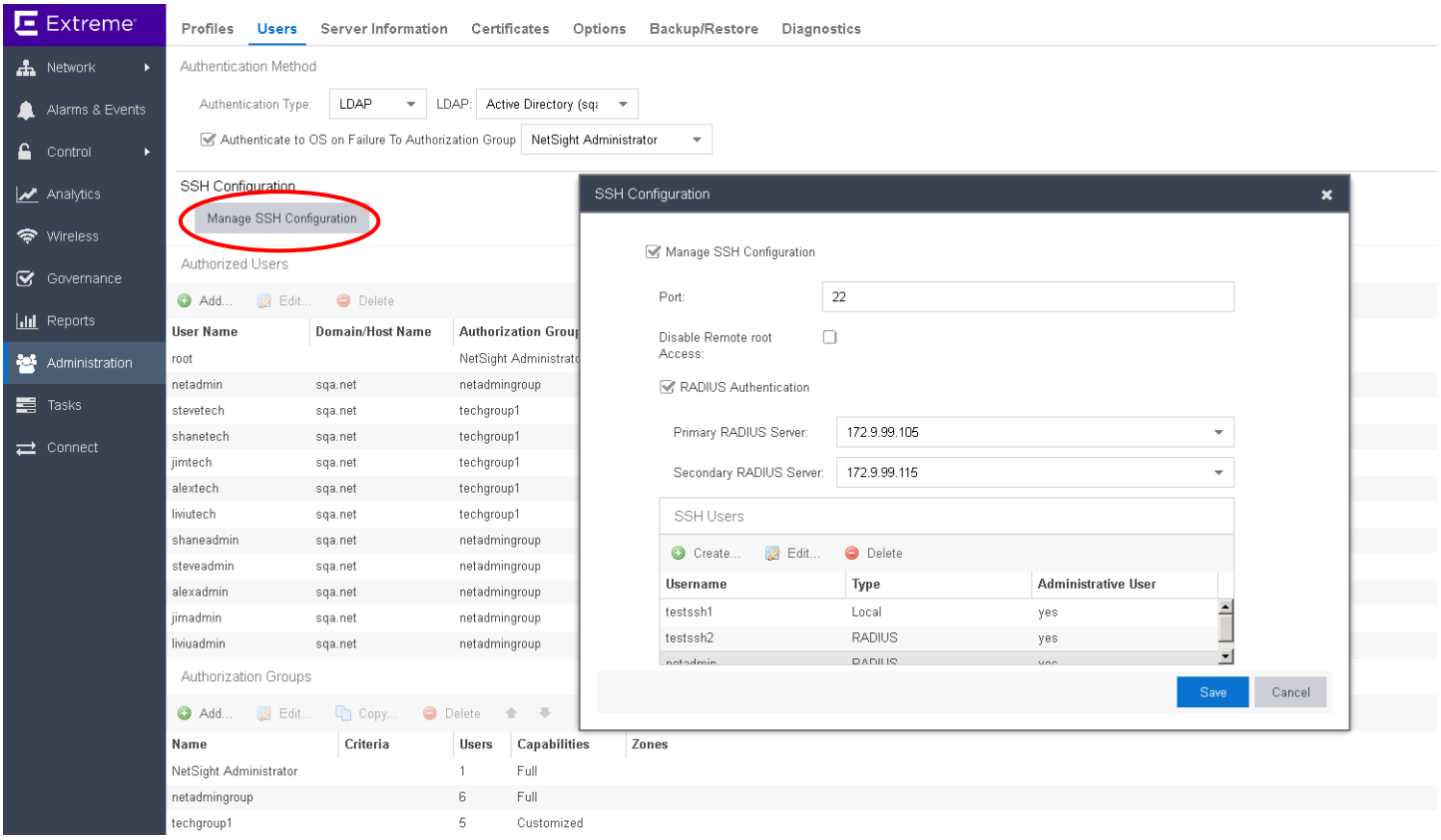
- The option to set the **Authenticate to OS on Failure to Authorization Group** checkbox allows the XMC server to still be accessible to a configured Authorization Group if authentication fails.



- When a new user is added, an associated Authorization Group – with the appropriate capabilities – must be created in the Authorization Groups window.



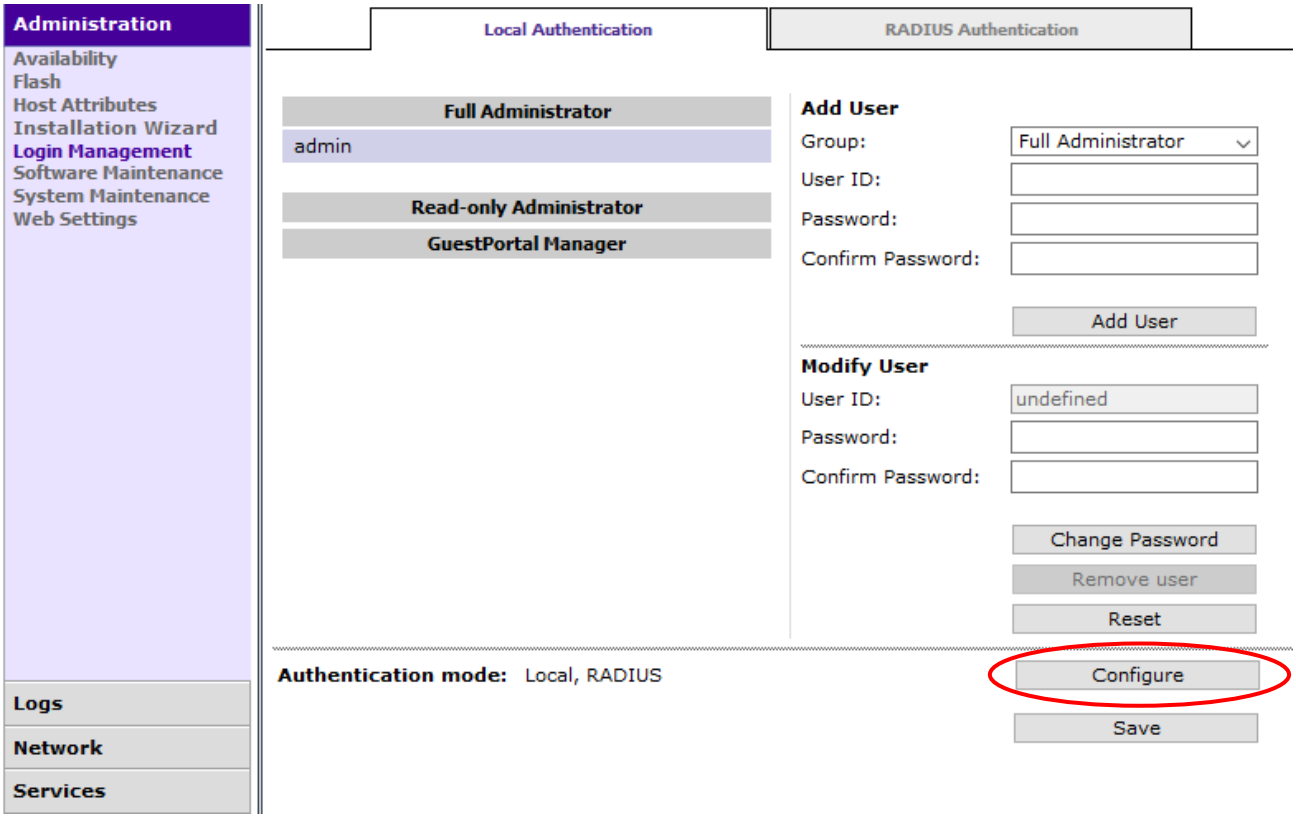
To configure SSH access to Extreme Management Center, click **Manage SSH Configuration** under SSH Configuration. A popup will appear with appropriate fields to configure the port, primary and secondary RADIUS servers, and the SSH user that should have access.



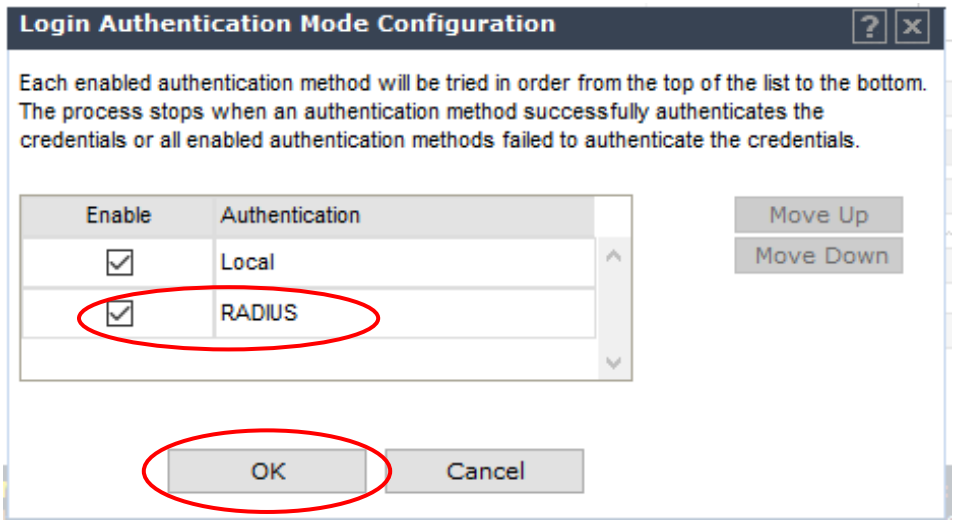
ExtremeWireless Controllers

Users connecting to the wireless controllers for management operations can be authenticated locally or by using a RADIUS server; the example below shows RADIUS requests forwarded to NAC servers which then uses LDAP to authenticate with the Active Directory server.

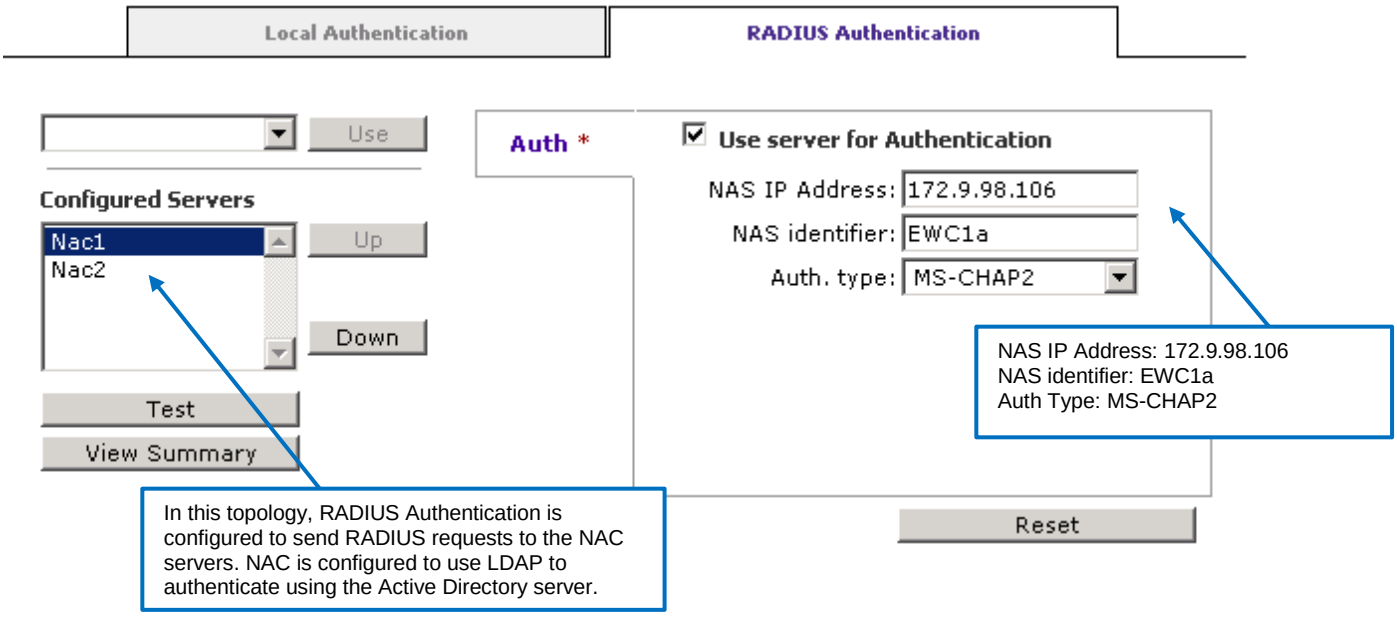
- To enable the use of a server, go to **Controller → Administration → Login Management**. Click the **Configure** button and enable RADIUS.



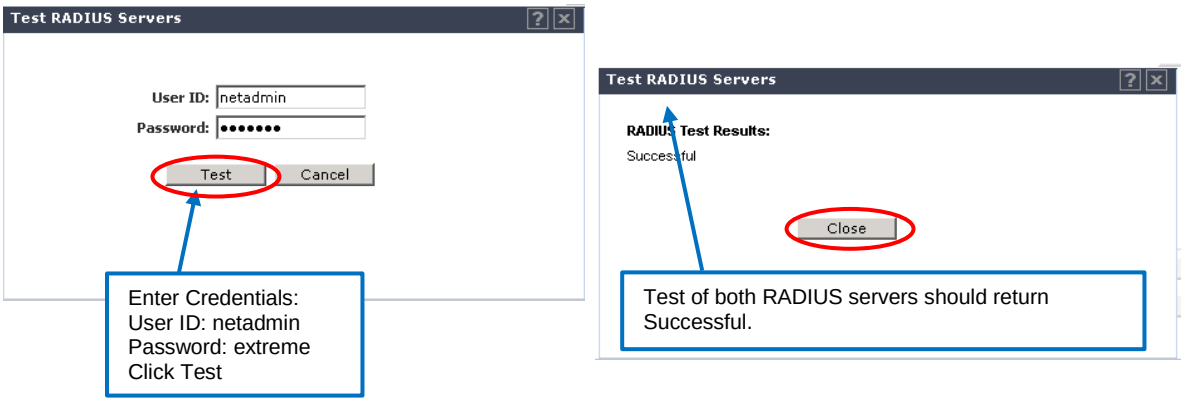
- In the **Login Authentication** dialog, verify that RADIUS is enabled.



- Go to the RADIUS Authentication tab to select the ExtremeControl engines as RADIUS servers. The NAS IP address is the IP address the wireless controller will use as a source when sending RADIUS requests. This address must be in the Switch list on ExtremeControl. Select the appropriate Authentication type configured for your topology; MS-Chap2 is used in this example. After configuring all fields, use the **Test** button to verify authentication.



- In ExtremeControl, ensure that the "**mgmt=su:**" attribute is added to the **Netadmin** Policy Mapping (noted in Profiles and Policy Mappings).
- To test RADIUS connectivity:



Summit Access Switch

To configure login authentication on ExtremeSwitching, <mgmt-access> must be configured on the switch. With RADIUS <mgmt-access> enabled within the <aaa> module, any Administrator user that tries to connect to the network device via SSH or console will be authenticated first against the ExtremeControl configuration.

- The command `<enable radius mgmt-access>` is required for this to work.

Note

The resulting configuration below is added automatically to the access switch upon adding it to ExtremeControl. This process is documented in the Wired User Access section.

```
configure radius 1 server 172.9.99.120 1812 client-ip 172.9.90.11 vr VR-Default
configure radius 1 shared-secret encrypted "#$9ARiatRiZpmB24IGZifDv71WKUt/ig=="
configure radius 2 server 172.9.99.121 1812 client-ip 172.9.90.11 vr VR-Default
configure radius 2 shared-secret encrypted "#$LK58QAj6bS/Yc3y36e+RrlRMjm+oGw=="
configure radius-accounting 1 server 172.9.99.120 1813 client-ip 172.9.90.11 vr VR-Default
configure radius-accounting 1 shared-secret encrypted "#$Lhw9XdTUKC1OhiRXjLFR3+YePeWjkQ=="
configure radius-accounting 1 timeout 10
configure radius-accounting 2 server 172.9.99.121 1813 client-ip 172.9.90.11 vr VR-Default
configure radius-accounting 2 shared-secret encrypted "#$/c/qfigRCQK5EeTeEvv3Pr+bqqh3Dg=="
configure radius-accounting 2 timeout 10
enable radius
enable radius mgmt-access
enable radius netlogin
configure radius timeout 10
enable radius-accounting
enable radius-accounting mgmt-access
enable radius-accounting netlogin
```

ERS Access Switch

To configure login authentication for ERS switches, three steps are involved:

- Configurations will need to be added to the appliance
- In XMC, the ERS switches need to be added and configured to the ExtremeControl engines.
- The User profile needs to be edited.

(Note: You may need to enforce the settings to ExtremeControl when complete.)

1. In the ERS switch:
   - Configure the ExtremeControl appliances as the primary and secondary radius servers, along with a secret key, for authenticated login:

```
radius server host 172.9.99.120 key acct-enable
<shared secret>
<shared secret>
radius server host 172.9.99.121 secondary
cli password telnet radius
cli password serial radius
```

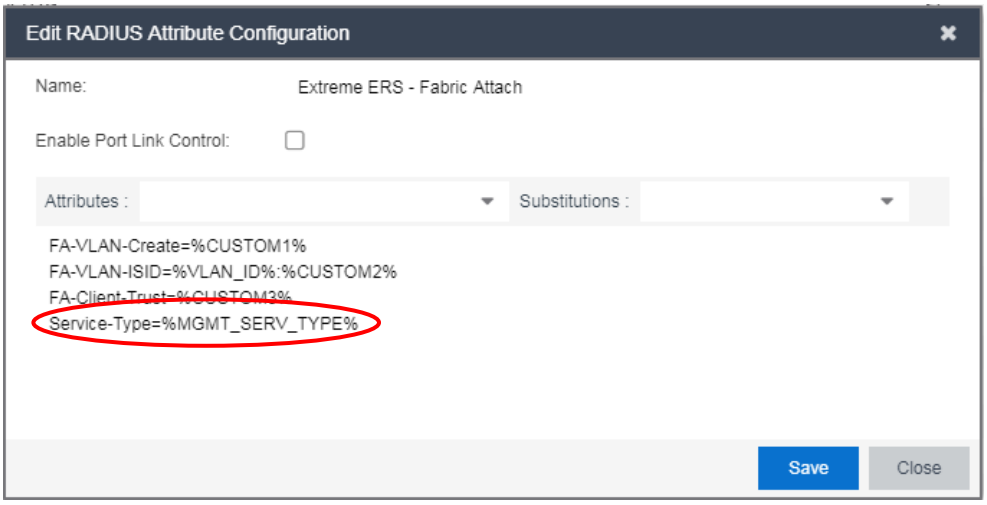
- Radius Password Fallback allows users to log in to ERS by using the locally configured password, if the RADIUS server is unavailable/unreachable for authentication. **It is highly recommended to verify the default login password has been changed when using RADIUS Fallback**. To ensure "fallback" is enabled, verify from the configuration:

```
4900_STACK#show radius-server
RADIUS Global Server
------------------------------------------------------------
Primary Host            : 172.9.99.120
Secondary Host          : 172.9.99.121
Port                    : 1812
Time-out                : 10
Key                     : ***************
Radius Accounting       : Enabled
Radius Accounting Port  : 1813
Radius Retry Limit      : 3
Current Status          : Reachable via Primary
Time Until Next Check   : 142

RADIUS EAP Server
------------------------------------------------------------
Primary Host            : 172.9.99.120
Secondary Host          : 172.9.99.121
Port                    : 1812
Time-out                : 10
Key                     : ***************
Radius Accounting       : Enabled
Radius Accounting Port  : 1813
Radius Retry Limit      : 3
Current Status          : Reachable via Primary
Time Until Next Check   : 142

RADIUS Non-EAP Server
------------------------------------------------------------
Primary Host            : 172.9.99.120
Secondary Host          : 172.9.99.121
Port                    : 1812
Time-out                : 10
Key                     : ***************
Radius Accounting       : Enabled
Radius Accounting Port  : 1813
Radius Retry Limit      : 3
Current Status          : Reachable via Primary
Time Until Next Check   : 142

Other Settings
------------------------------------------------------------
Password Fallback       : Enabled
RADIUS Encapsulation    : MS-CHAP-V2
```

RADIUS Fallback enabled.

2. In XMC, add the ERS switch to the ExtremeControl engine and configure parameters.This procedure is explained in the following section:
3. Edit the ERS Radius attributes file and add/ensure the following attribute is defined:
    - Items 2 and 3 are detailed in the following section:

Access Switch Provisioning/Fabric Attach



Fabric Connect Switch

To configure login authentication for VSP switches, three steps are involved:

- Configurations will need to be added to the switch.
- In XMC, the VSP switches need to be added and configured to the ExtremeControl engines.
- The User profile needs to be edited.

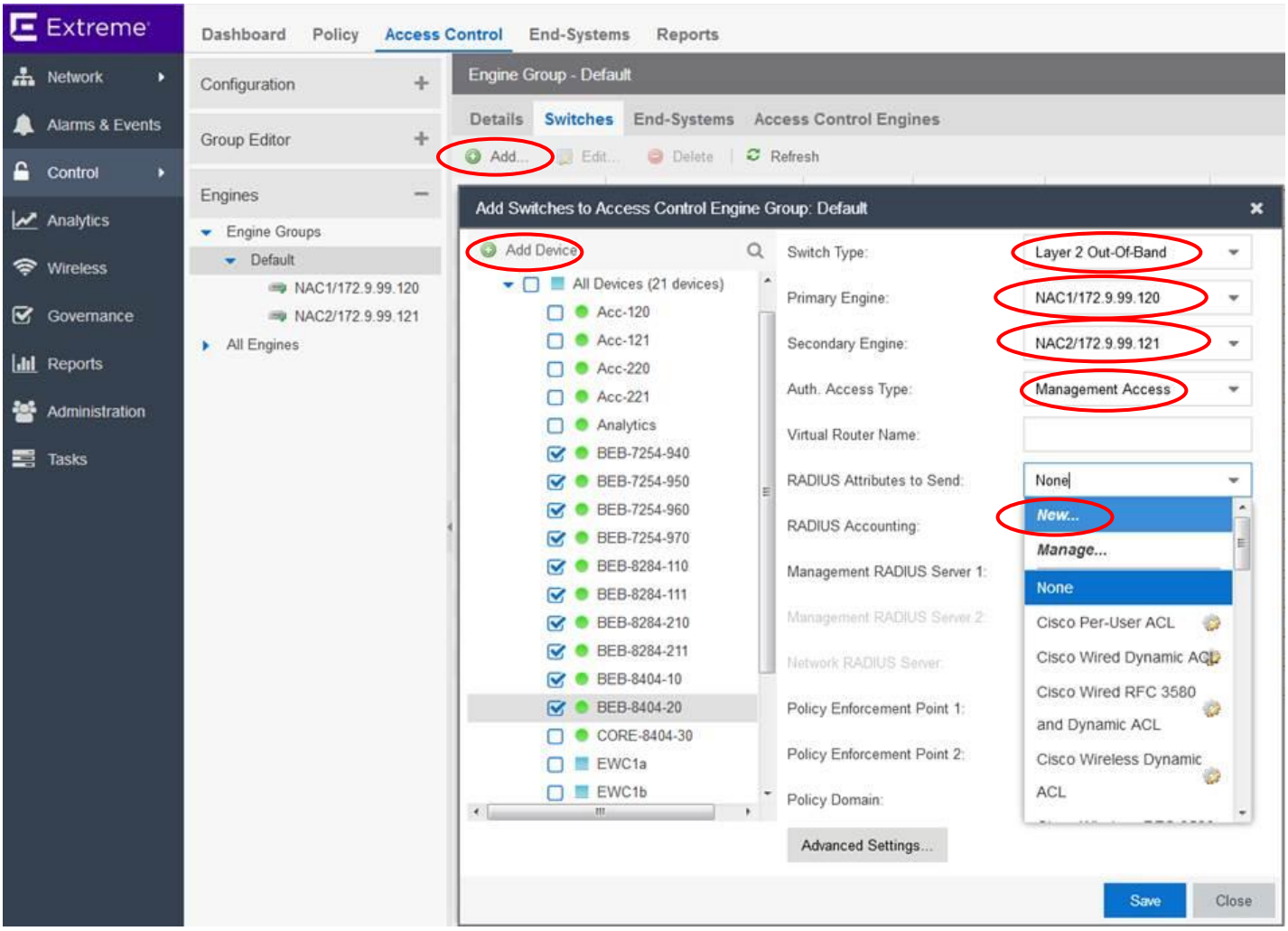
(Note: You may need to enforce the settings to ExtremeControl when complete.)

1. In the VSP switch:
   - Configure the ExtremeControl appliances as the primary and secondary radius servers, along with a secret key, for authenticated login:

```
radius server host 172.9.99.120 key ******  source-ip 10.0.0.210
radius server host 172.9.99.121 key ******  source-ip 10.0.0.210
radius enable
radius sourceip-flag
```

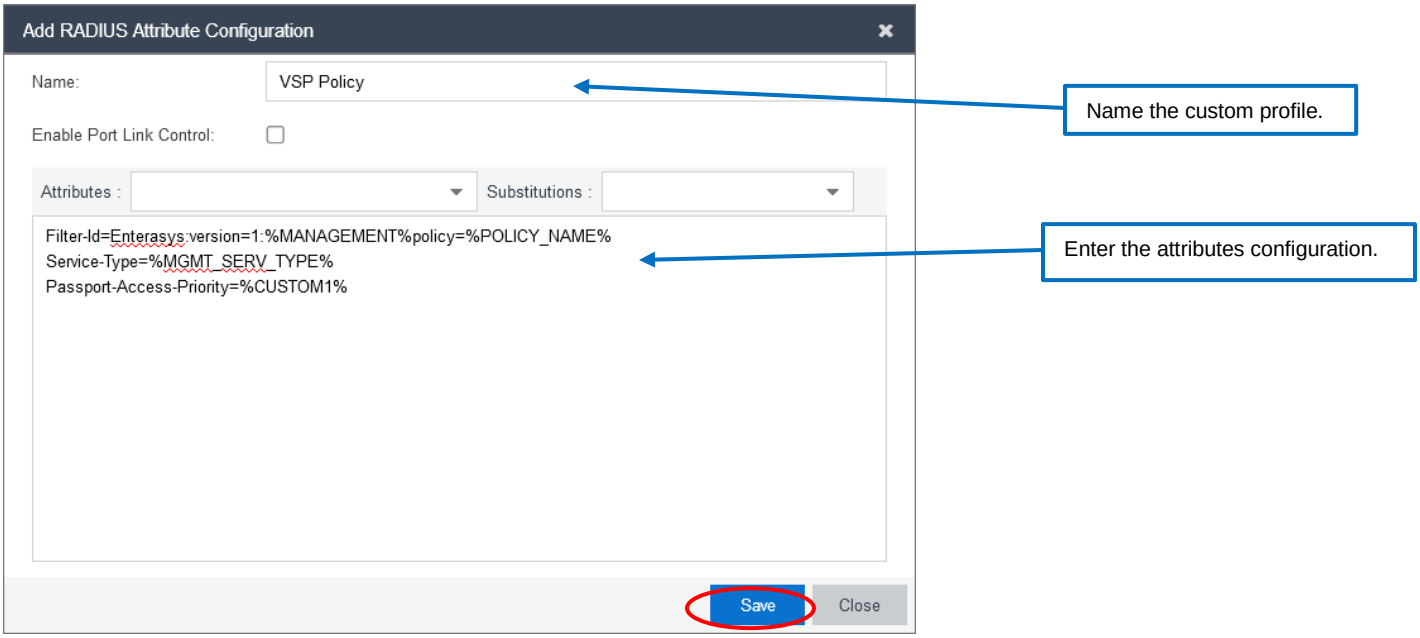
2. In XMC, add the VSP switches to the ExtremeControl engine and configure:

   - Go to **Control→Access Control→Engines→Engine Groups→Default→Switches→Add**.
   - Select the switches under **Add Device** to be configured.
   - Select the **Switch Type** that supports your topology.
   - Add the ExtremeControl **Primary Engine** (as well as a **Secondary Engine** if your topology includes it).
   - Set the **Auth. Access Type** to **Management Access**.
   - A custom RADIUS attribute profile can be created in the **RADIUS Attributes to Send** field by selecting **NEW** in the drop-down-field (Note: future XMC versions will include default VSP RADIUS attribute profiles).


Extreme
Dashboard
Policy
Access Control
End-Systems
Reports
Network
Alarms & Events
Control
Analytics
Wireless
Governance
Reports
Administration
Tasks
Configuration
Group Editor
Engines
Engine Groups
Default
NAC1/172.9.99.120
NAC2/172.9.99.121
All Engines
Engine Group - Default
Details
Switches
End-Systems
Access Control Engines
Add...
Edit...
Delete
Refresh
Add Switches to Access Control Engine Group: Default
Add Device
All Devices (21 devices)
Acc-120
Acc-121
Acc-220
Acc-221
Analytics
BEB-7254-940
BEB-7254-950
BEB-7254-960
BEB-7254-970
BEB-8284-110
BEB-8284-111
BEB-8284-210
BEB-8284-211
BEB-8404-10
BEB-8404-20
CORE-8404-30
EWC1a
EWC1b
Switch Type:
Layer 2 Out-Of-Band
Primary Engine:
NAC1/172.9.99.120
Secondary Engine:
NAC2/172.9.99.121
Auth. Access Type:
Management Access
Virtual Router Name:
RADIUS Attributes to Send:
None
RADIUS Accounting:
Management RADIUS Server 1:
Management RADIUS Server 2:
Network RADIUS Server:
Policy Enforcement Point 1:
Policy Enforcement Point 2:
Policy Domain:
New...
Manage...
None
Cisco Per-User ACL
Cisco Wired Dynamic ACL
Cisco Wired RFC 3580 and Dynamic ACL
Cisco Wireless Dynamic ACL
Advanced Settings...
Save
Close

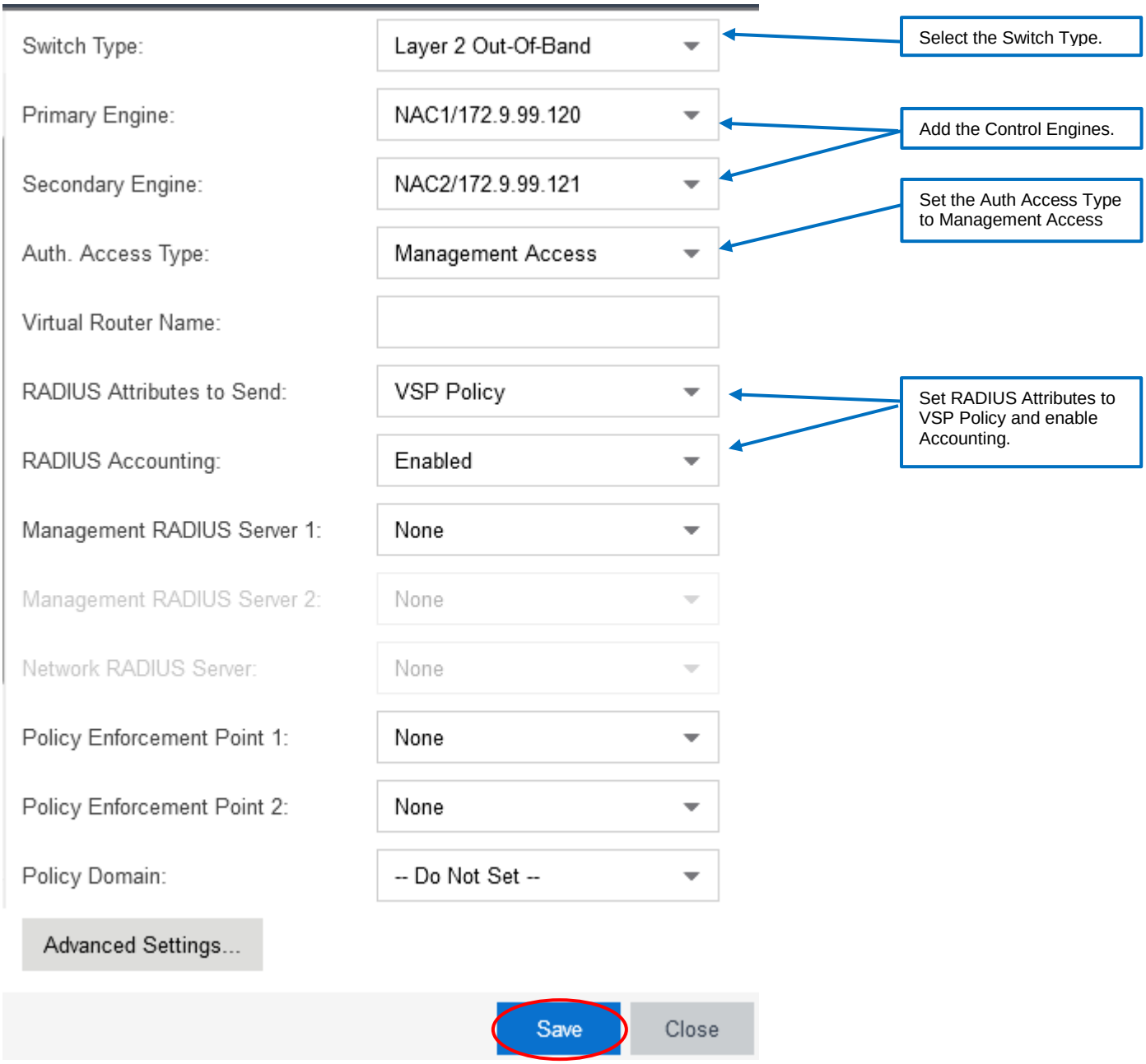
- In the new **Add RADIUS Attribute Configuration** window, name your profile; in this instance we used **VSP Policy**.
- Add the RADIUS attributes profile configuration. For the profile configuration, use the following values, then click **SAVE**:

  Filter-Id=Enterasys:version=1:%MANAGEMENT%policy=%POLICY_NAME%
  Service-Type=%MGMT_SERV_TYPE%
  Passport-Access-Priority=%CUSTOM1%



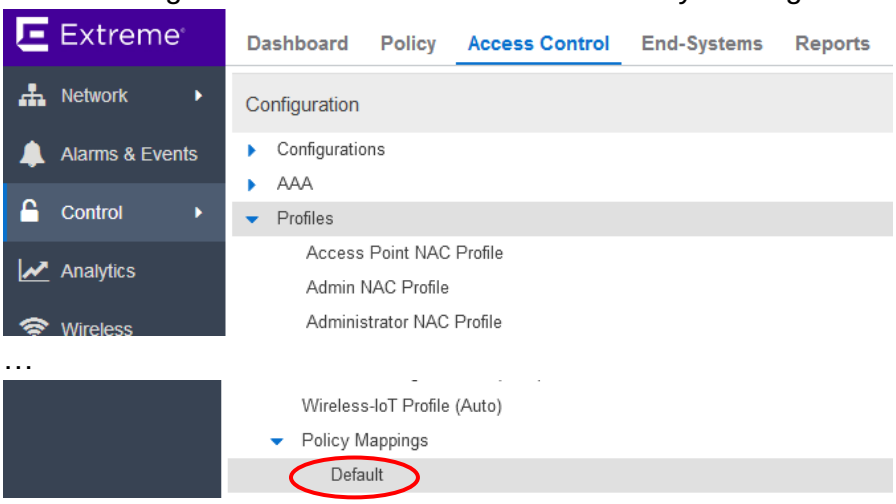
- You can set **RADIUS Accounting** to **Enabled** according to the needs of your topology.
- Subsequent fields can be configured to match your topology. In our topology:
  - **Management RADIUS Server 1** set to **None** since RADIUS requests are passed through the NAC engines already configured.
  - **Policy Enforcement Point 1** and **2 set to None.**
  - **Policy Domain** set to **Do Not Set** since we are only configuring **Management Access.**
- Then click **Save**.

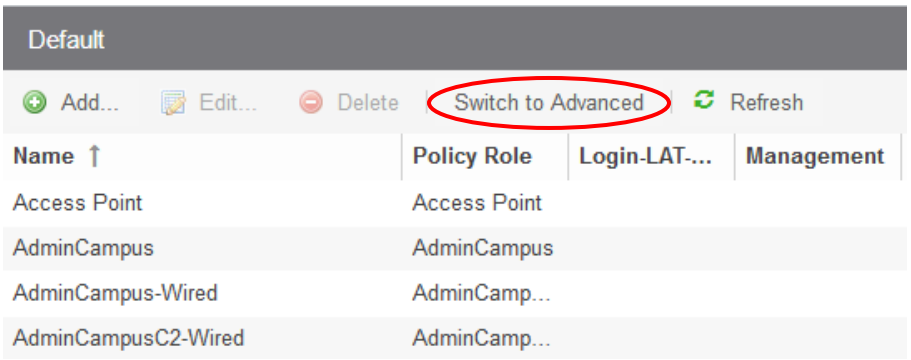
- Final configuration view for step 2 shown below:



3. In XMC, the User profile needs to be edited with one or more custom entries that maps to the RADIUS attribute values.

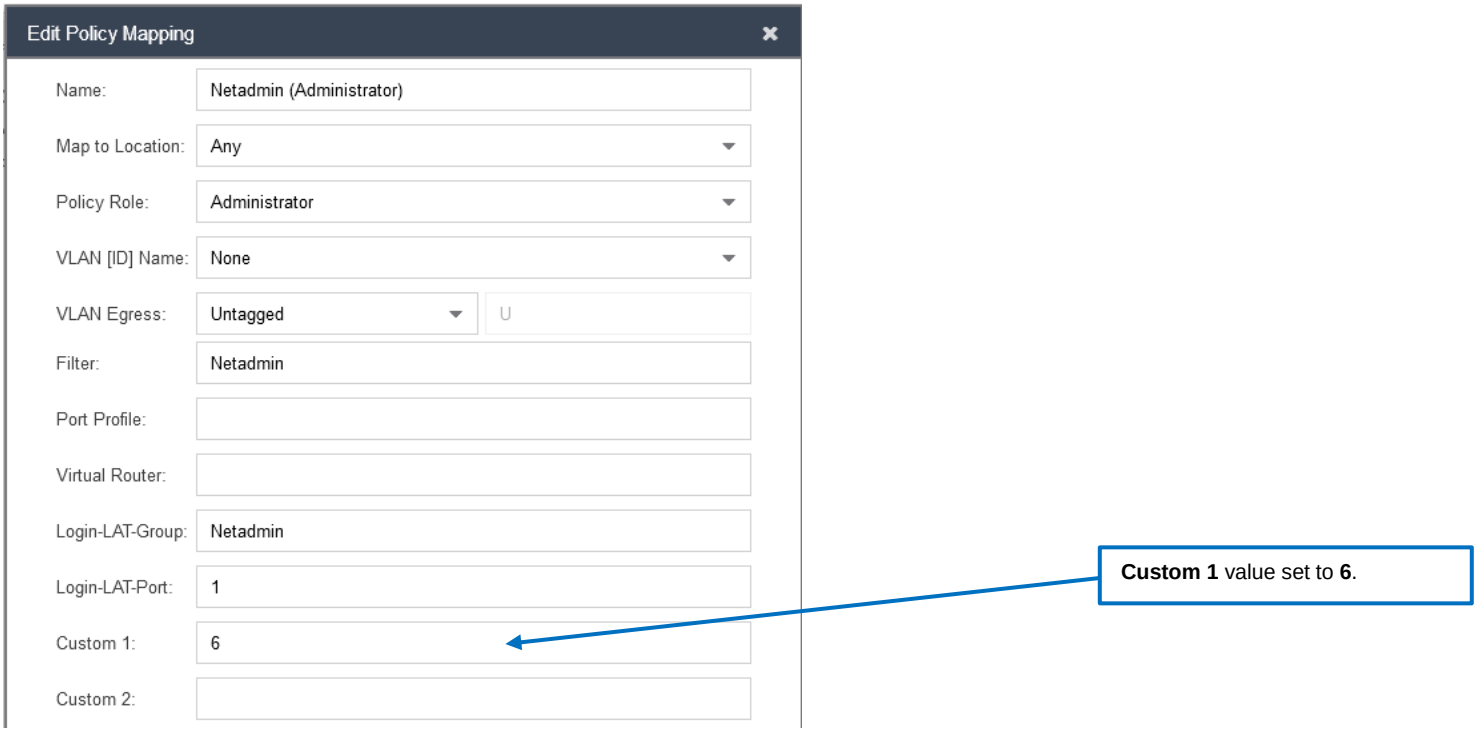
- Go to **Control→Access Control→ Configuration→ Profiles→ Policy Mappings→ Default** and change the view from Basic to Advanced by clicking on the **Switch to Advanced** button.



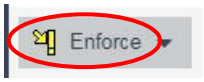


- Select the User profile/Policy mapping to be edited and click **Edit.** In this EVD, the **Netadmin (Administrator)** policy mapping is used for RADIUS authentication for all network devices.

- Add/verify the following values in the listed fields and **Save**:
  - **Custom 1** is set to **6** (which is an Administrator privilege).



- Enforce the settings to the ExtremeControl Engine, at bottom of page:



Secure Shell (SSH)

SSH is disabled by default. We recommend the disabling of Telnet access to network devices and enable SSH for security and authentication purposes.

Secure Shell 2 (SSH2) is a feature of the Summit and Fabric Connect software that enables you to encrypt session data between a network administrator using SSH2 client software and the switch, or to send encrypted data from the switch to an SSH2 client on a remote system.

Summit Access Switch

Enter the command <`enable ssh2`>. The following output will be generated:

```
Slot-1 Stack.1 #disable telnet
Slot-1 Stack.1 #enable ssh2
WARNING: Generating new server host key
This could take up to 1 minute and cannot be cancelled.  Continue? (y/N) Yes
.....................
Key Generated.
```

ERS Access Switch

Enter the following commands to disable Telnet and enable SSH configuration for this Validated Design.

```
telnet-access disable
ssh
```

Fabric Connect Switch

Enter the following commands to disable Telnet and enable SSH configuration for this Validated Design.

```
no boot config flags telnetd
boot config flags sshd
ssh
save config
```

Multicast (IGMP)

Multicast has many applications. However, for most campuses the primary use case is for video delivery and security camera applications. In this design, IGMP and IGMP snooping will be configured for Layer 2 multicast.

Internet Group Management Protocol

IGMP and IGMP snooping should be enabled by default. If they are not enabled, you can enable them by issuing the following commands:

Summit Access Switches

```
enable igmp
enable igmp snooping
```

- Display the status of the IGMP table:

```
Slot-1 Stack.2 # show igmp snooping cache
Snooping/MVR Cache Timeout: 300 sec

 Type Group              Sender               Age   InVlan

snoop 225.4.1.1          172.90.1.10          63    VLAN_202
      Vlan               Port         Vid
      VLAN_202           2:3          202
                         1:50         202

snoop 225.4.1.1          172.90.1.15          48    VLAN_202
      Vlan               Port         Vid
      VLAN_202           2:3          202
                         1:50         202

snoop 225.4.1.1          172.90.1.20          57    VLAN_202
      Vlan               Port         Vid
      VLAN_202           2:3          202
                         1:50         202
```

Source IP of stream.

Ports that the stream is seen on.

SPB-Multicast Forwarding

In order to route multicast traffic through the Automated Campus, IP Multicast Forwarding must be enabled on all forwarding VLANs in the campus.

Note

- As BCB-930 is a core switching node, no multicast configuration is required.
- As BEB-960/970 and BEB-940/950 are Leaf nodes and subordinate to the Controllers, no multicast configuration is required.

The multicast configuration should resemble the following:

Campus 1 – BEB-110 and BEB-111

```
router isis
spbm 1 multicast enable
exit

interface Vlan 101
ip spb-multicast enable
exit

interface Vlan 102
ip spb-multicast enable
exit

interface Vlan 103
ip spb-multicast enable
exit

interface Vlan 104
ip spb-multicast enable
exit

interface Vlan 1050
ip spb-multicast enable
exit

interface Vlan 1051
ip spb-multicast enable
exit

interface Vlan 1052
ip spb-multicast enable
exit

router vrf iot
mvpn enable
exit

router vrf surveillance
mvpn enable
exit
```

Enable multicast on the global IS-IS instance.

Enable multicast on the required VLAN interfaces.

Enable multicast on the required VRFs.

Campus 2 – BEB-210 and BEB-211

The same settings are applied to the required VLANs/VRFs in Campus 2:

```
router isis
spbm 1 multicast enable
exit

interface Vlan 201
ip spb-multicast enable
exit

interface Vlan 202
ip spb-multicast enable
exit

interface Vlan 203
ip spb-multicast enable
exit
interface Vlan 204
ip spb-multicast enable
```

```
exit

interface Vlan 1050
ip spb-multicast enable
exit

interface Vlan 1051
ip spb-multicast enable
exit

interface Vlan 1052
ip spb-multicast enable
exit

router vrf iot
mvpn enable
exit

router vrf surveillance
mvpn enable
exit
```

Campus 3 – BEB-310 and BEB-311

The same settings are applied to the required VLANs/VRFs in Campus 3:

```
router isis
spbm 1 multicast enable
exit

interface Vlan 301
ip spb-multicast enable
exit

interface Vlan 302
ip spb-multicast enable
exit

interface Vlan 303
ip spb-multicast enable
exit

interface Vlan 304
ip spb-multicast enable
exit

interface Vlan 1050
ip spb-multicast enable
exit

interface Vlan 1051
ip spb-multicast enable
exit

interface Vlan 1052
ip spb-multicast enable
exit

router vrf iot
mvpn enable
exit

router vrf surveillance
mvpn enable
exit
```

Server Room Controllers - BEB-910 and BEB-920

```
router isis
spbm 1 multicast enable
exit

interface Vlan 900
ip spb-multicast enable
exit

interface Vlan 902
ip spb-multicast enable
exit

interface Vlan 904
ip spb-multicast enable
exit

interface Vlan 911
ip spb-multicast enable
exit

router vrf iot
mvpn enable
exit

router vrf surveillance
mvpn enable
exit
```

Enable multicast on the global IS-IS instance.

Multicast servers reside on the Production VLAN.

Video Surveillance Receivers reside on the Surveillance VLAN, receiving camera streams from the campuses.

As surveillance cameras and receivers reside on their own L3VSN, it is kept separate from other services.

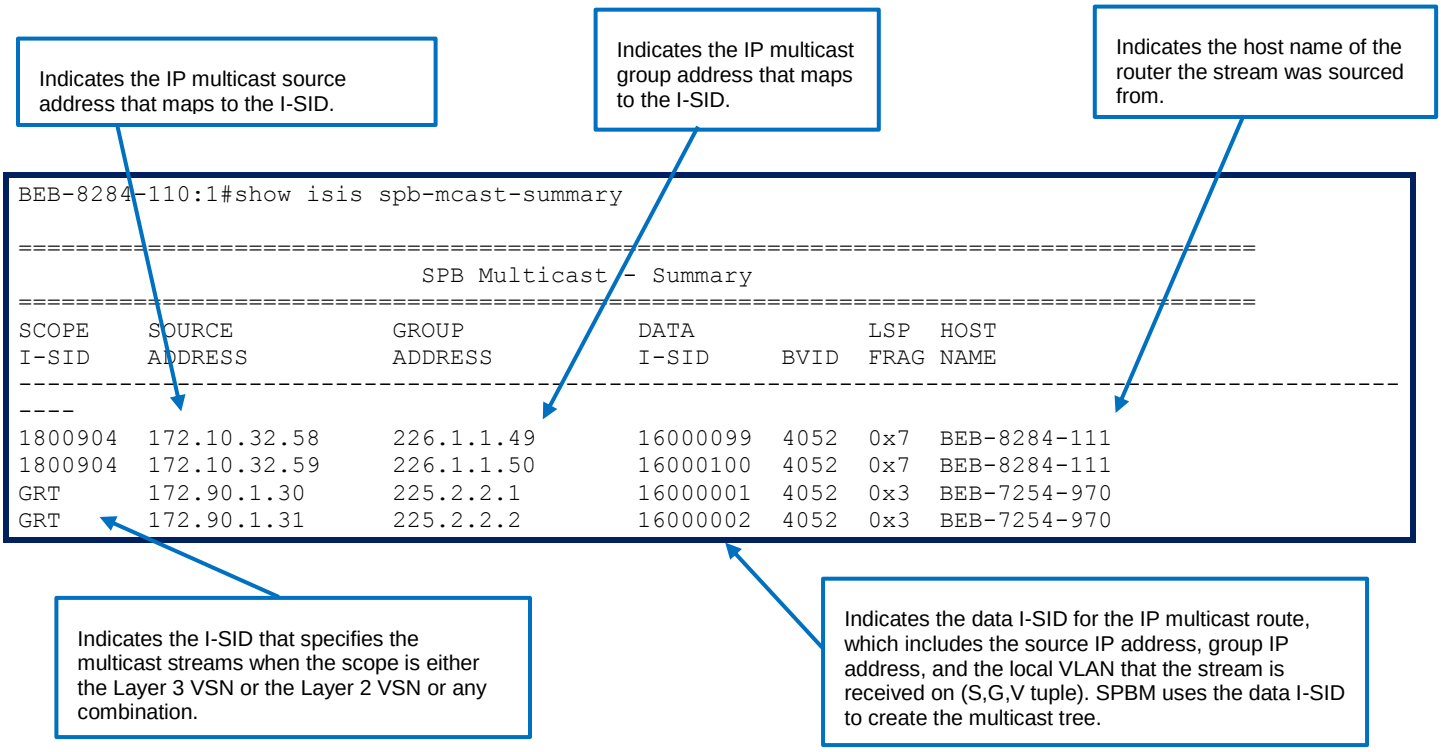
- Display the status of the global IP Multicast over Fabric Connect configuration:

```
BEB-8284-110:1(config)#show isis spbm multicast
                              multicast : enable
             fwd-cache-timeout(seconds) : 210
```

Specifies if multicast is enabled.

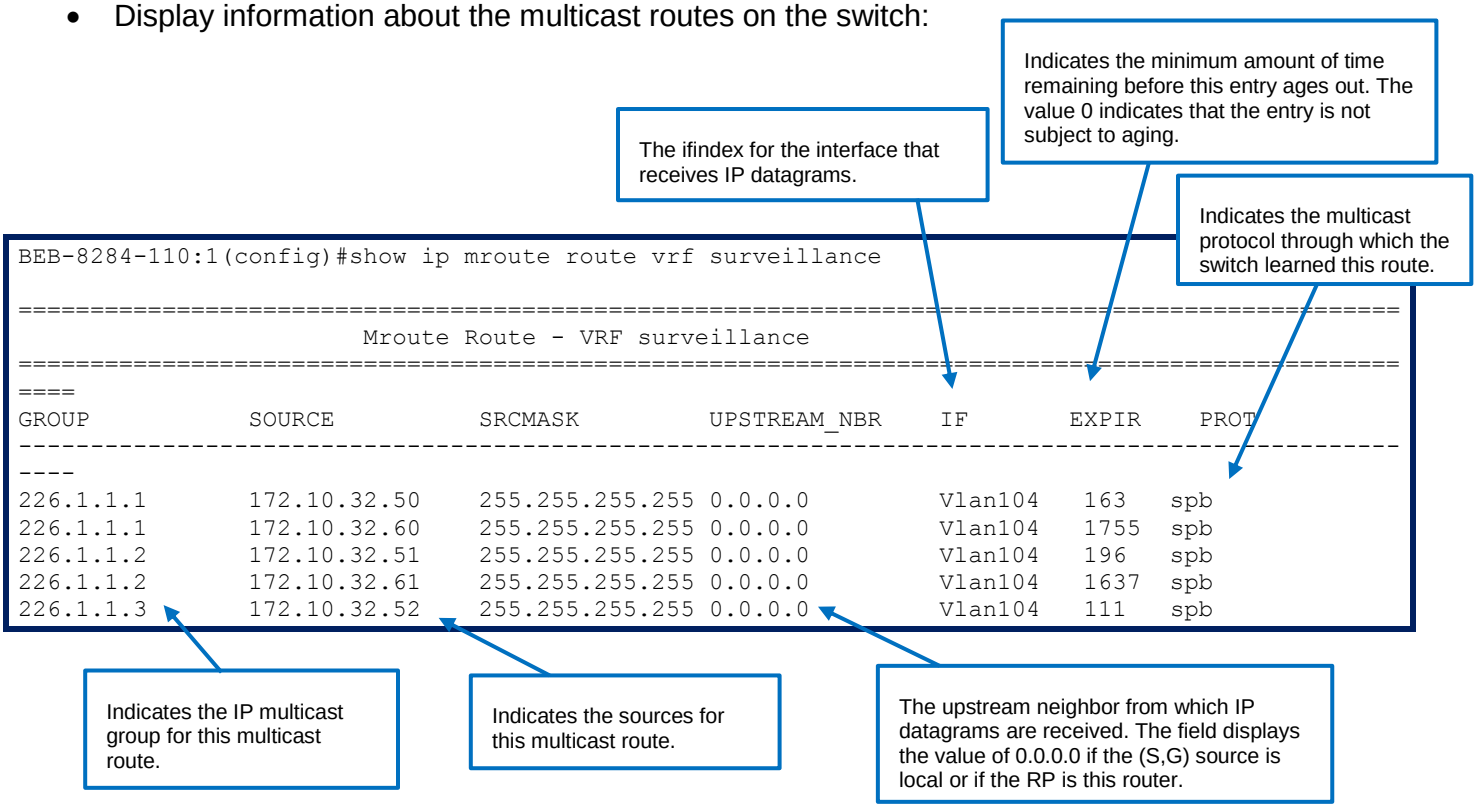
Specifies the forward cache timeout value in seconds.

- Display IP Multicast over Fabric Connect summary information for each S, G, V tuple:




```
BEB-8284-110:1#show isis spb-mcast-summary

================================================================================
                          SPB Multicast - Summary
================================================================================
SCOPE    SOURCE           GROUP            DATA            LSP  HOST
I-SID    ADDRESS          ADDRESS          I-SID     BVID  FRAG NAME
--------------------------------------------------------------------------------
----
1800904  172.10.32.58     226.1.1.49       16000099  4052  0x7  BEB-8284-111
1800904  172.10.32.59     226.1.1.50       16000100  4052  0x7  BEB-8284-111
GRT      172.90.1.30      225.2.2.1        16000001  4052  0x3  BEB-7254-970
GRT      172.90.1.31      225.2.2.2        16000002  4052  0x3  BEB-7254-970
```

- Display information about the multicast routes on the switch:



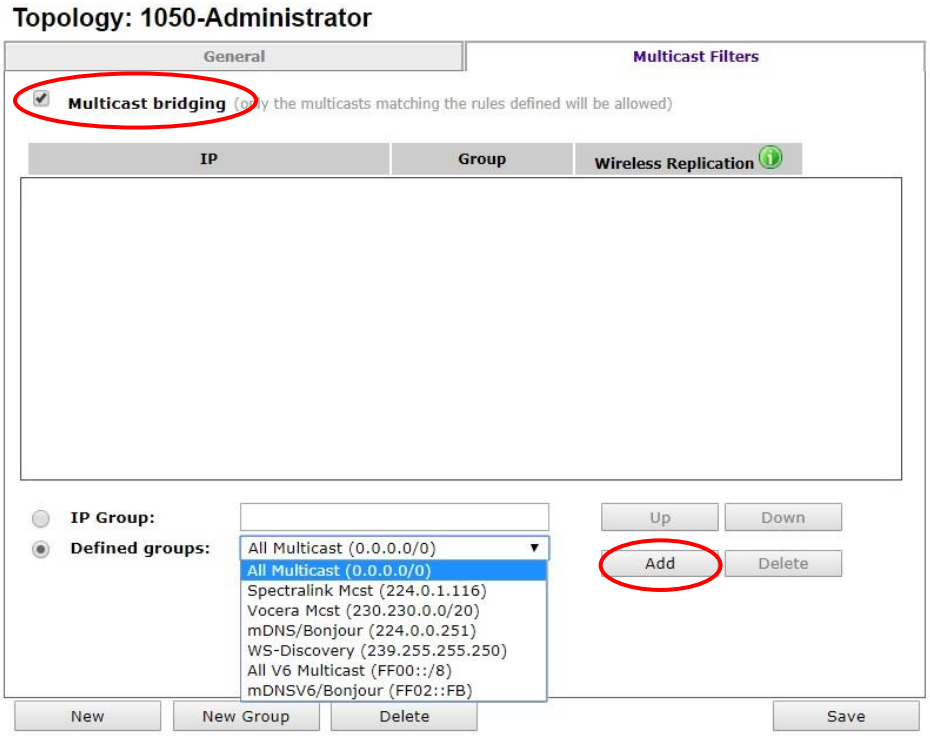

```
BEB-8284-110:1(config)#show ip mroute route vrf surveillance

================================================================================
                      Mroute Route - VRF surveillance
================================================================================
====
GROUP            SOURCE           SRCMASK          UPSTREAM_NBR     IF       EXPIR    PROT
--------------------------------------------------------------------------------
----
226.1.1.1        172.10.32.50     255.255.255.255 0.0.0.0          Vlan104   163    spb
226.1.1.1        172.10.32.60     255.255.255.255 0.0.0.0          Vlan104   1755   spb
226.1.1.2        172.10.32.51     255.255.255.255 0.0.0.0          Vlan104   196    spb
226.1.1.2        172.10.32.61     255.255.255.255 0.0.0.0          Vlan104   1637   spb
226.1.1.3        172.10.32.52     255.255.255.255 0.0.0.0          Vlan104   111    spb
```

Wireless Multicast Forwarding

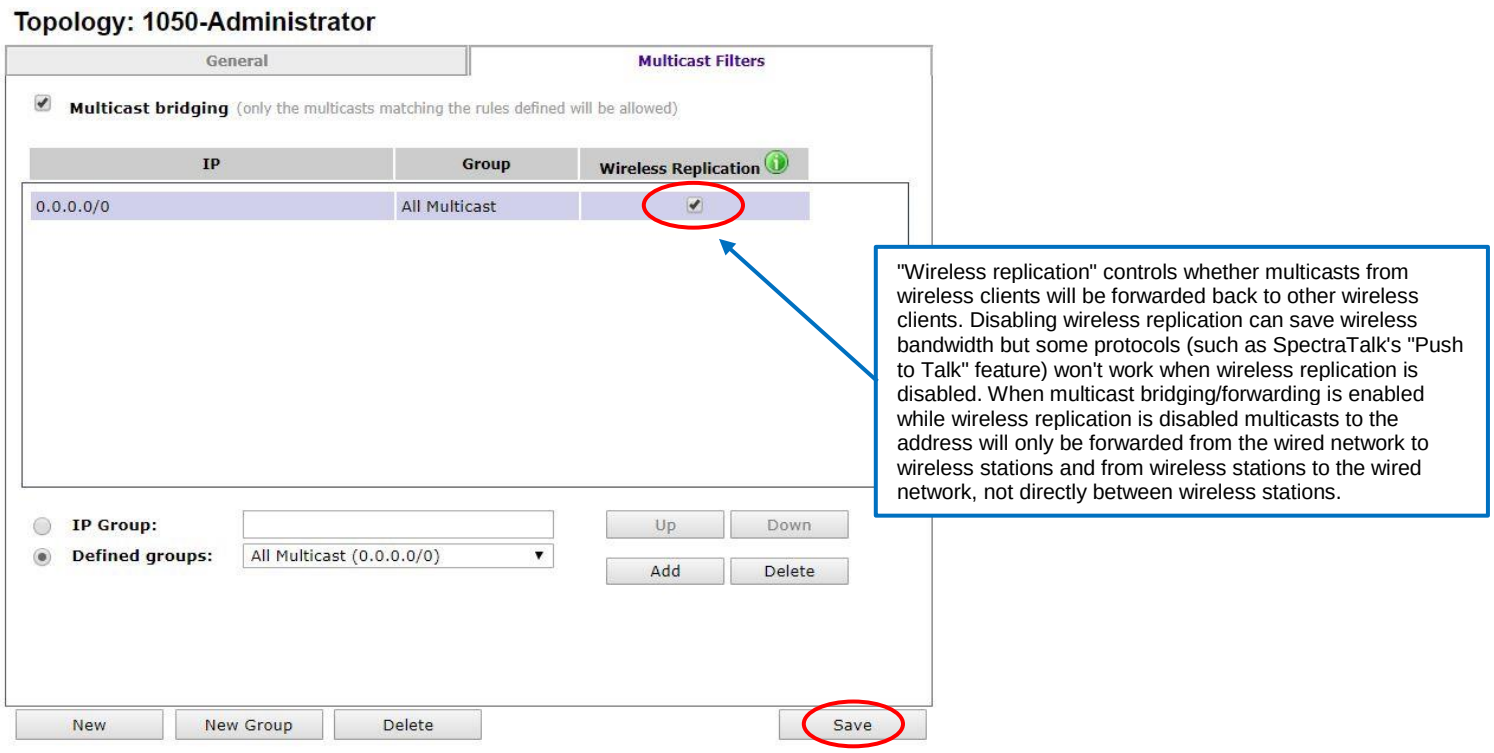
A mechanism that supports multicast traffic can be enabled as part of a topology definition. This mechanism is provided to support the demands of VoIP and IPTV network traffic, while still providing the network access control. Define a list of multicast groups whose traffic is allowed to be forwarded to and from the VNS using this topology. The default behavior is to drop the packets. For each group defined, you can enable Multicast Replication by group.

1. On the **VNS→Topologies** page, select the desired topology and click the **Multicast Filters** tab. Check the box for **Multicast bridging**:

2. Either manually enter a custom multicast group, or choose from one of the **Defined groups** in the drop-down, and click **Add**:



3. Determine whether wireless replication is required, then click Save. Repeat this on all topologies requiring multicast support.



Loop Protection

A Loop Protection mechanism should be in place to prevent inadvertent Layer 2 loops from occurring at the access layer.

Summit Access Switch

STP Edge Port with Safeguard

Loop prevention and detection on an edge port configured for RSTP is called Edge Safeguard. You can configure edge safeguard on RSTP edge ports to prevent accidental or deliberate misconfigurations (loops) resulting from connecting two edge ports together or by connecting a hub or other non-STP switch to an edge port. Edge safeguard also limits the impact of broadcast storms that might occur on edge ports. This advanced loop prevention mechanism improves network resiliency but does not interfere with the rapid convergence of edge ports.

An edge port configured with edge safeguard immediately enters the forwarding state and transmits BPDUs. If a loop is detected, STP blocks the port. By default, an edge port without edge safeguard configured immediately enters the forwarding state but does not transmit BPDUs unless a BPDU is received by that edge port.

- To configure, enable Edge Safeguard on the switch's access ports:

```
config stpd s0 ports link-type edge <access ports> edge-safeguard enable bpdu-restrict
```

- Show the status of the feature:

```
Slot-1 Stack.17 # show stpd s0 ports detail 2:15
Stpd: s0        Port: 2:15      PortId: 808f    Stp: ENABLED    Path Cost: 20000
Port Mode         : 802.1D              Port Role          : Designated
Port State        : FORWARDING          Topology Change Ack: FALSE
Port Priority     : 128
Designated Root   : 80:00:02:04:96:a1:bf:25     Designated Cost: 0, IntCost: 0
Designated Bridge : 80:00:02:04:96:a1:bf:25     Designated Port Id: 808f
Partner STP version     : MSTP
Restricted Role         : Disabled
Active Role             : Disabled
Edge Port Safe Guard    : Enabled
BPDU Restrict           : Enabled
maxAge: 20      msgAge: 0       fwdDelay: 15    helloTime: 2    maxHops: 20
Restricted TCN          : Off
Loop Protect            : Off
Loop Protect Partner    : Incapable
Operational Edge        : TRUE
Auto Edge               : On
Reflection BPDU         : On
Participating Vlans: Default
```

- When a loop is detected on enabled ports, the port that receives the BPDU is disabled:

```
Slot-1 Stack.22 # show stpd s0 ports 2:15,2:16
Port     Mode   State      Cost  Flags     Priority Port ID Designated Bridge
2:15   802.1D FORWARDING 20000 eDee-m-GI- 128      808f    80:00:02:04:96:a1:bf:25
2:16   802.1D DISABLED   20000 e?ee-m-GI- 128      8090    00:00:00:00:00:00:00:00

Total Ports: 2
```

```
Slot-1 Stack.23 # show stpd s0 ports 2:15,2:16 non-forwarding-reason
Port    State       Reason
--------------------------------------------------------------------------------
2:16    DISABLED    Placed in blocking state because a loopback condition
                    has been detected.
```

ERS Access Switch

Simple Loop Prevention Protocol (SLPP and SLPP-Guard)

Simple Loop Prevention Protocol (SLPP) provides active protection against Layer 2 network loops on a per-VLAN basis. SLPP uses a lightweight hello packet mechanism to detect network loops. SLPP packets are sent using Layer 2 multicast and a switch will only look at its own SLPP packets or at its peer SLPP packets. It will ignore SLPP packets from other parts of the network. Sending hello packets on a per VLAN basis allows SLPP to detect VLAN based network loops for un-tagged as well as tagged IEEE 802.1Q VLAN link configurations. Once a loop is detected, the port is shut down.

```
interface Ethernet ALL
slpp-guard port 1/1-24,2/1-24,3/1-24 enable
exit
```

```
4900_ 4900_STACK(config)#show slpp-guard
SLPP-guard Ethertype: 0x8102
Unit/Port Link Oper SLPP-guard State      Timeout TimerCount
--------- ---- ---- ---------- ---------- ------- ----------
1/1       Down Down Enabled    N/A        60      N/A
1/2       Down Down Enabled    N/A        60      N/A
1/3       Up   Up   Enabled    Monitoring 60      N/A
```

Fabric Connect Switch

Simple Loop Prevention Protocol (SLPP)

```
slpp enable
slpp vid  300
slpp vid  302
slpp vid  303
slpp vid  304

interface GigabitEthernet 2/1
slpp packet-rx
slpp packet-rx-threshold 5
exit

interface GigabitEthernet 2/2
slpp packet-rx
slpp packet-rx-threshold 5
exit
```

Its recommended to have one BEB in the SMLT pair set its SLPP interfaces to a higher threshold (5 vs 50). This will avoid both interfaces briefly going down when a loop is detected, resulting in less traffic loss.

```
BEB-8404-310:1(config)#show slpp

================================================================================================
                                    SLPP Info
================================================================================================
                   operation :  enabled
                tx-interval :  500 milliseconds
                       vlan :  300,302,303,304
```

References

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   https://documentation.extremenetworks.com/netsight/8.1/9035427_EMC_AC_AA_Virtual_Engine_Install_Guide.pdf

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   https://gtacknowledge.extremenetworks.com/