NETGEAR®

Networking Solutions for VoIP

Application Notes

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INTRODUCTION

Voice over IP (VoIP) has become a mainstream technology with quality of service (QoS) as the most important factor underlying this change. Businesses that previously held back because of the early reputation for poor VoIP quality need no longer be concerned about quality. Today, excellent quality of service can be achieved with VoIP, though it is not guaranteed. QoS ultimately depends on the switches that control the VoIP traffic, and of course, the network over which that traffic travels.

Regardless of the size of a VoIP network, it will always include one or more of the following components:

- **User agents**. These may be commercial IP phones, or "soft phones" residing in a desktop or laptop PC.
- **Voice gateway.** The gateway acts as the bridge between a VoIP network and the PSTN network of the "outside world."
- **IPBX**. The IPBX (sometimes referred to as an IP PBX) replaces the conventional PBX of the past, and performs all its functions (voice mail, call forwarding, conference calling and many, many more). It connects to the PSTN network via the voice gateway. The IPBX is available in three deployment options:
  - Dedicated, on-site hardware device
  - Software that runs on a standard on-site server
  - Managed service via the cloud
- **Switches to manage network traffic**. The switches are crucial, because if they lack the appropriate capabilities or bandwidth capacity, QoS will suffer, leading to user complaints, poor customer service and problems with external telephone communication in general.
- **Cabling**. For adequate performance, Cat5E or better cabling is recommended.

HOW TO USE THIS DOCUMENT

The N*etworking Solutions for VoIP Solution Guide* provides technical guidance and details about reference designs for installations with 20, 200 and 1000 phones. Use the Solution Guide to plan your solution architecture and determine the needed equipment.

This Application Note is a companion document to the Solution Guide. After you have planned and have the equipment for your network, use this guide to configure your VoIP solution. Example configurations are provided for 20-phone, 200-phone, and 1000-phone deployments.

REFERENCE CONFIGURATIONS AND ASSUMPTIONS

The following figures show reference configurations for 20-phone, 200-phone, and 1000-phone solutions.

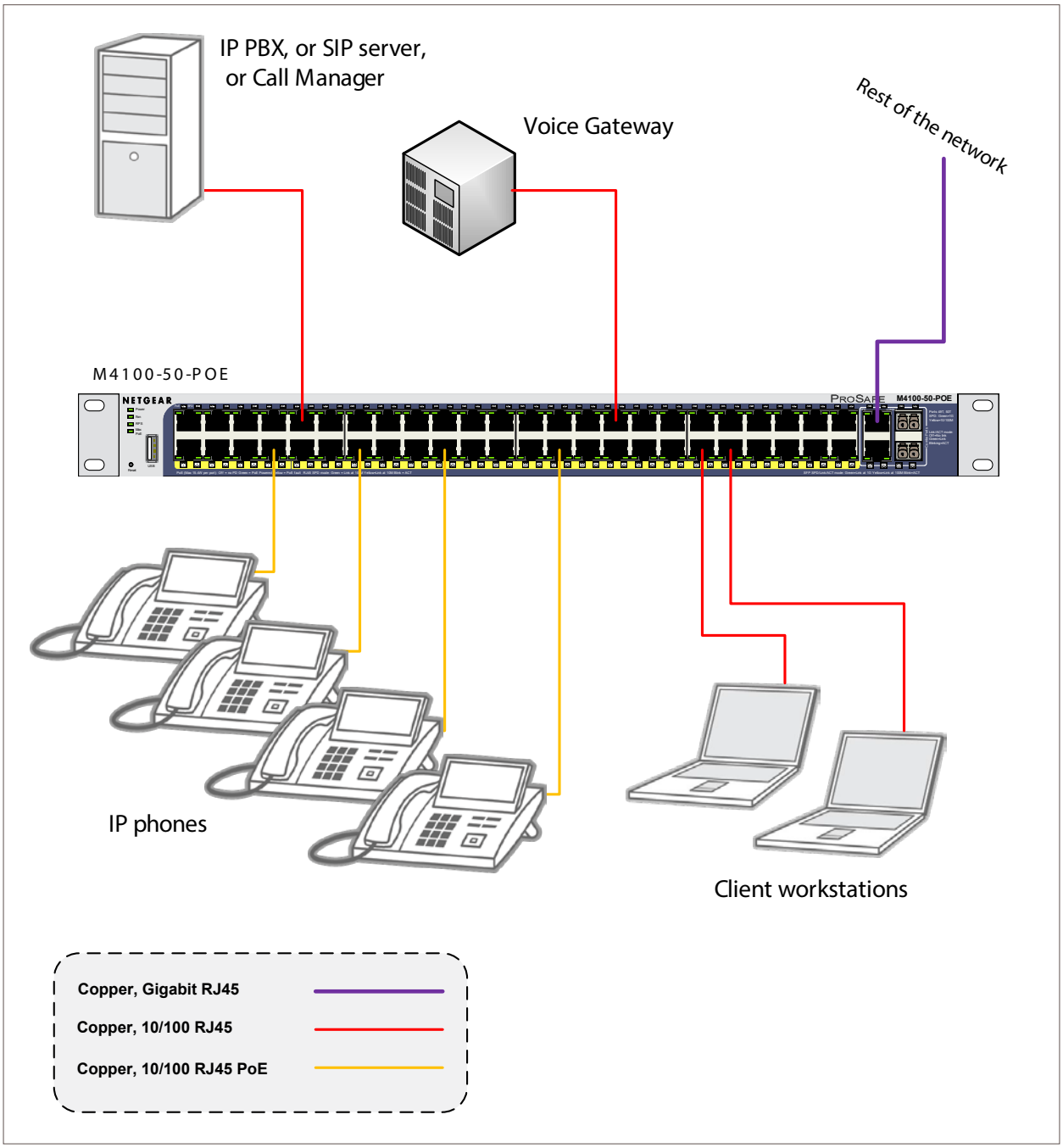


Figure 1. Sample Solution – 20 Phones

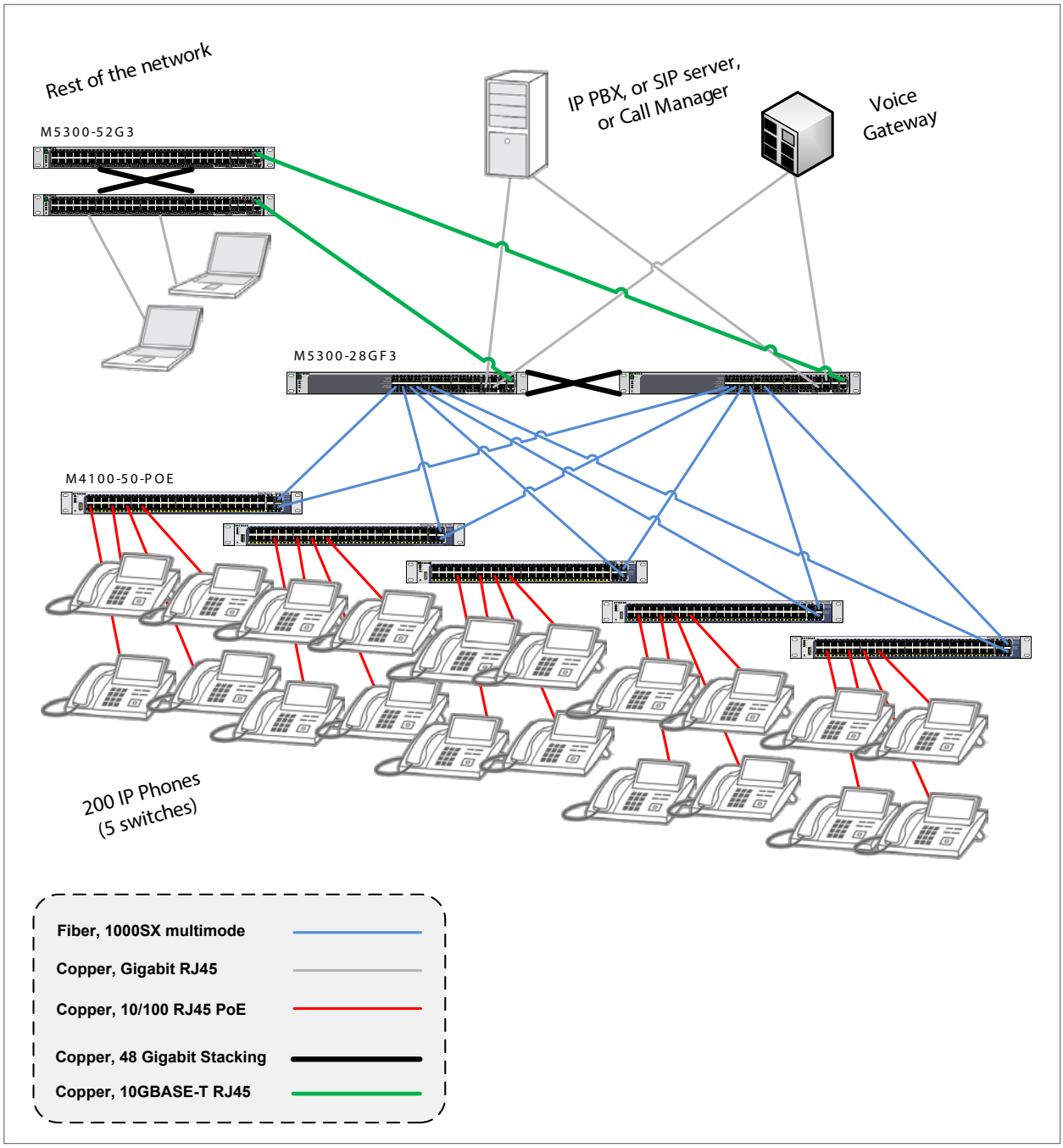


Figure 2. Sample Solution – 200 Phones

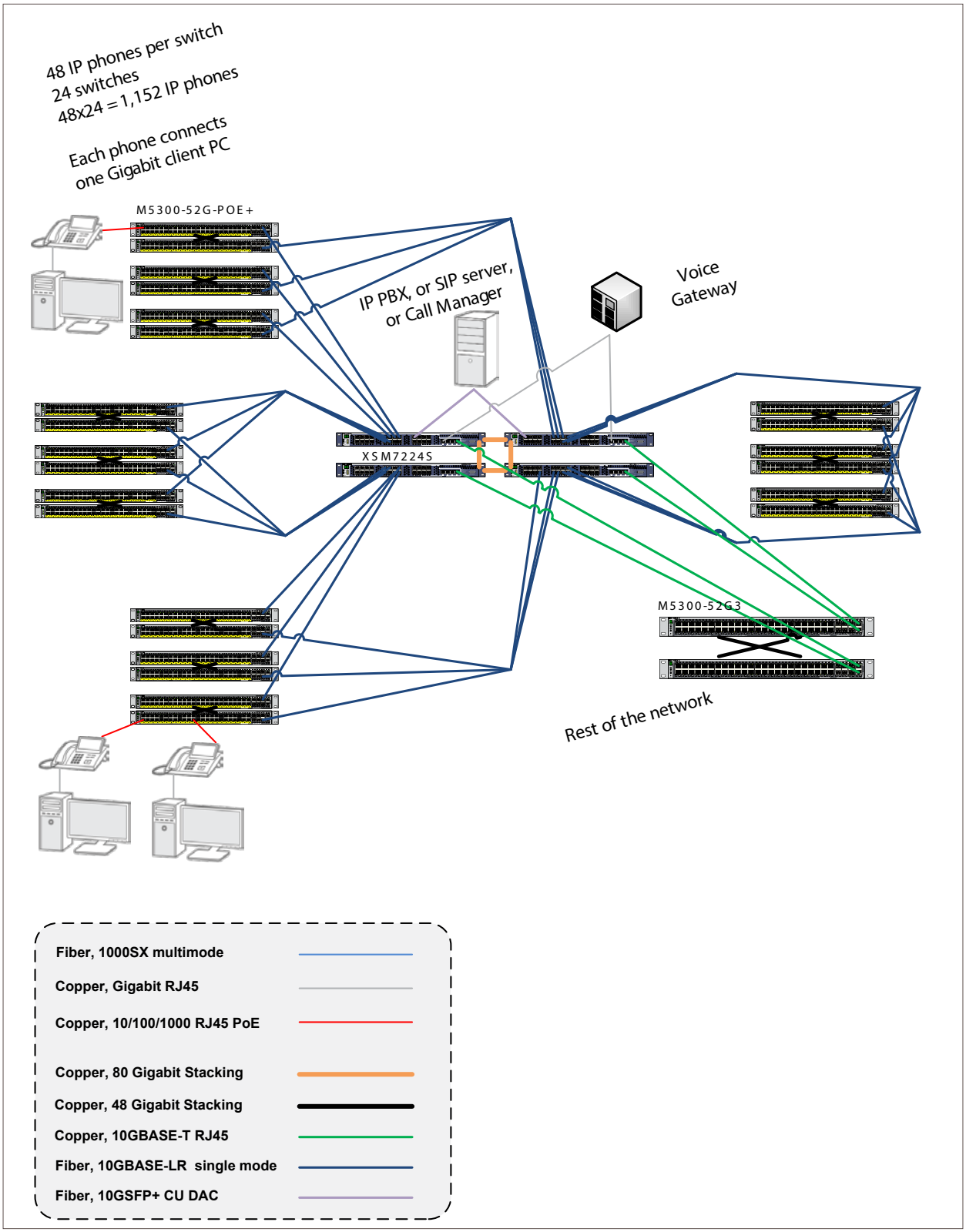


Figure 3. Sample Solution – 1000 Phones

CONFIGURATION FOR THE 20-PHONE SOLUTION

Refer to Figure 1 for a diagram of the solution. You can use the CLI or Web GUI for configuration.

Assumptions for the 20-Phone Solution

- A DHCP server on the switch will be used. If a third-party DCHP solution is used, refer to the vendor's documentation and the documentation for the phone backend to configure DHCP options.
- The VoIP network is a dedicated, isolated network with a single uplink to the customer's enterprise network.
- VoIP backend systems will be protected by security measures local to the individual systems. ACLs can be used to further restrict access but are not configured in this application note. Visit support.netgear.com for further information.
- The tested VoIP phones have an internal switch to support a second device connected to a secondary port on the phone, allowing a voice and data VLAN to be configured on the switch port.
- Tested phones are SIP-enabled Cisco 79x5 series phones, and the tested PBX system is an AsteriskNOW VM installation. Refer to vendor documentation for further configuration guidance on these platforms.
- Best practices are used to implement switch stacking and failover/redundancy.

Global Configuration Notes

- Be sure to save your configuration using the **save** or **write memory** CLI command. Alternatively, choose **Maintenance > Save Config** in the GUI. Select the box, and click **APPLY**.
- Physical interfaces are referred to interfaces and ports interchangeably throughout this document.

Sample Configuration Values

The following values are used in the sample configuration:

- Voice VLAN: 100
- Voice VLAN subnet: 192.168.100.0/24
- Data VLAN: 200
- Data VLAN subnet: 192.168.200.0/24

CLI Configuration Steps: 20-Phone Solution

These steps provide an example CLI configuration for the 20-phone solution. To use the Web GUI for configuration, see Web GUI Configuration Steps: 20-Phone Solution on page 12.

1. Create voice VLAN 100 and data VLAN 200 and their respective interfaces using subnet 192.168.100.0/24 for VLAN 100 and 192.168.200.0/24 for VLAN 200.

```
(M4100-50-POE) #vlan database
(M4100-50-POE) (Vlan)#vlan 100
(M4100-50-POE) (Vlan)#vlan 200
(M4100-50-POE) (Vlan)#vlan routing 100
(M4100-50-POE) (Vlan)#vlan routing 200
(M4100-50-POE) (Vlan)#exit
(M4100-50-POE) #configure
(M4100-50-POE) (Config)#interface vlan 100
(M4100-50-POE) (Interface vlan 100)#routing
(M4100-50-POE) (Interface vlan 100)#ip address 192.168.100.1 255.255.255.0
(M4100-50-POE) (Interface vlan 100)#exit
(M4100-50-POE) (Config)#interface vlan 200
(M4100-50-POE) (Interface vlan 200)#routing
(M4100-50-POE) (Interface vlan 200)#ip address 192.168.200.1 255.255.255.0
(M4100-50-POE) (Interface vlan 200)#exit
```

2. Enable the DHCP server and configure DHCP pools for each VLAN. Add DHCP option 66 for the TFTP server on VLAN 100 to allow the phones to download their images and configuration files. In this example, the TFTP server has an address of 192.168.100.100.

```
(M4100-50-POE) (Config)#service dhcp
(M4100-50-POE) (Config)#ip dhcp pool pool100
(M4100-50-POE) (Config-dhcp-pool)#network 192.168.100.0 255.255.255.0
(M4100-50-POE) (Config-dhcp-pool)#default-router 192.168.100.1
(M4100-50-POE) (Config-dhcp-pool)#option 66 ascii 192.168.100.100
(M4100-50-POE) (Config-dhcp-pool)#exit
(M4100-50-POE) (Config)#ip dhcp pool pool200
(M4100-50-POE) (Config-dhcp-pool)#network 192.168.200.0 255.255.255.0
(M4100-50-POE) (Config-dhcp-pool)#default-router 192.168.200.1
(M4100-50-POE) (Config-dhcp-pool)#exit
```

3. Enable auto-VoIP on VLAN 100.

```
(M4100-50-POE) (Config)#auto-voip vlan 100
```

4. By default, the auto-voip feature prioritizes voice traffic in queue 6. This step raises the priority to class 3.

```
(M4100-50-POE) (Config)# auto-voip protocol-based traffic-class 3
```

5. Enable the Voice VLAN feature globally.

```
(M4100-50-POE) (Config)#voice vlan
```

6. Configure the phone ports for voice VLAN 100 and data VLAN 200. Select all the desired interfaces to support VoIP devices. Tag the traffic on phone interfaces, but leave the data VLAN 200 traffic untagged on these ports. For all VoIP device interfaces, set the configured PVID to data VLAN 200.

```
(M4100-50-POE) (Config)#interface 0/1-0/20
(M4100-50-POE) (Interface 0/1-0/20)#vlan participation exclude 1
(M4100-50-POE) (Interface 0/1-0/20)#vlan participation include 100,200
(M4100-50-POE) (Interface 0/1-0/20)#vlan tagging 100
(M4100-50-POE) (Interface 0/1-0/20)#voice vlan 100
(M4100-50-POE) (Interface 0/1-0/20)#vlan pvid 200
(M4100-50-POE) (Interface 0/1-0/20)#exit
```

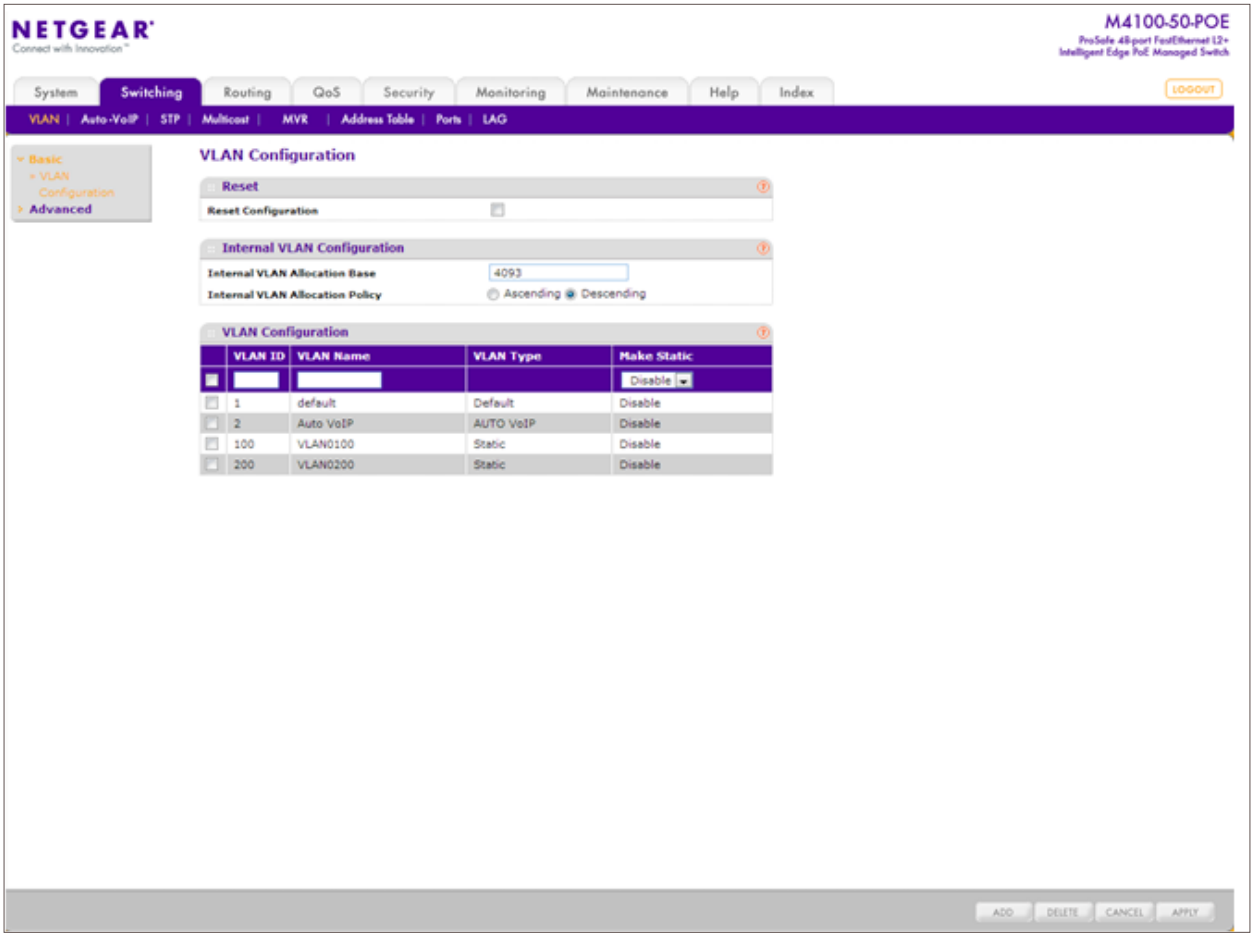
7. Configure infrastructure ports on VLAN 100. For each interface on each unit that will support a VoIP phone, include voice VLAN 100.

```
(M4100-50-POE) (Config)#interface 0/23
(M4100-50-POE) (Interface 0/23)#vlan participation exclude 1
(M4100-50-POE) (Interface 0/23)#vlan participation include 100
(M4100-50-POE) (Interface 0/23)#vlan pvid 100
(M4100-50-POE) (Interface 0/23)#exit
```

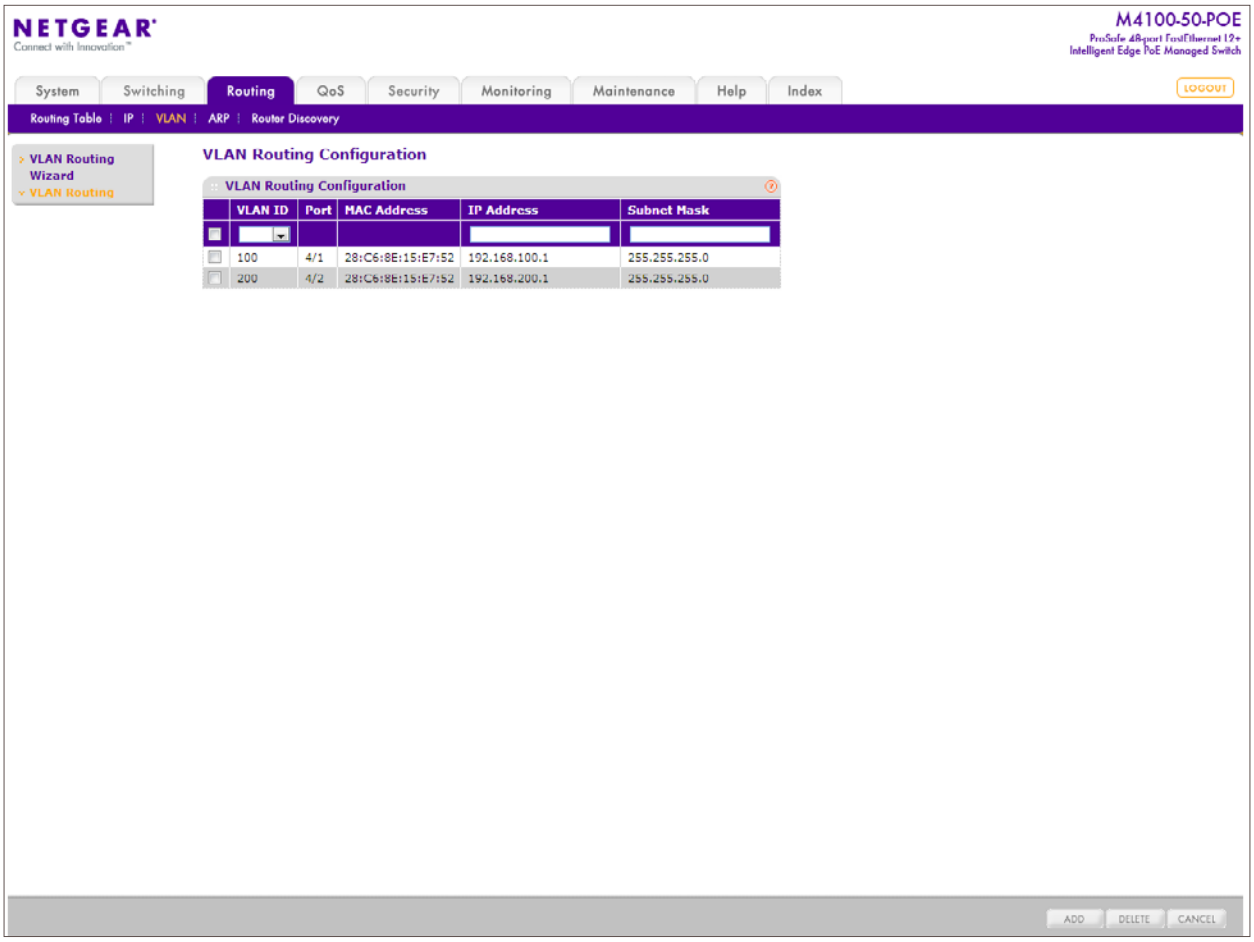
Web GUI Configuration Steps: 20-Phone Solution

These steps provide an example Web GUI configuration for the 20-phone solution. To use the CLI for configuration, see CLI Configuration Steps: 20-Phone Solution on page 8.

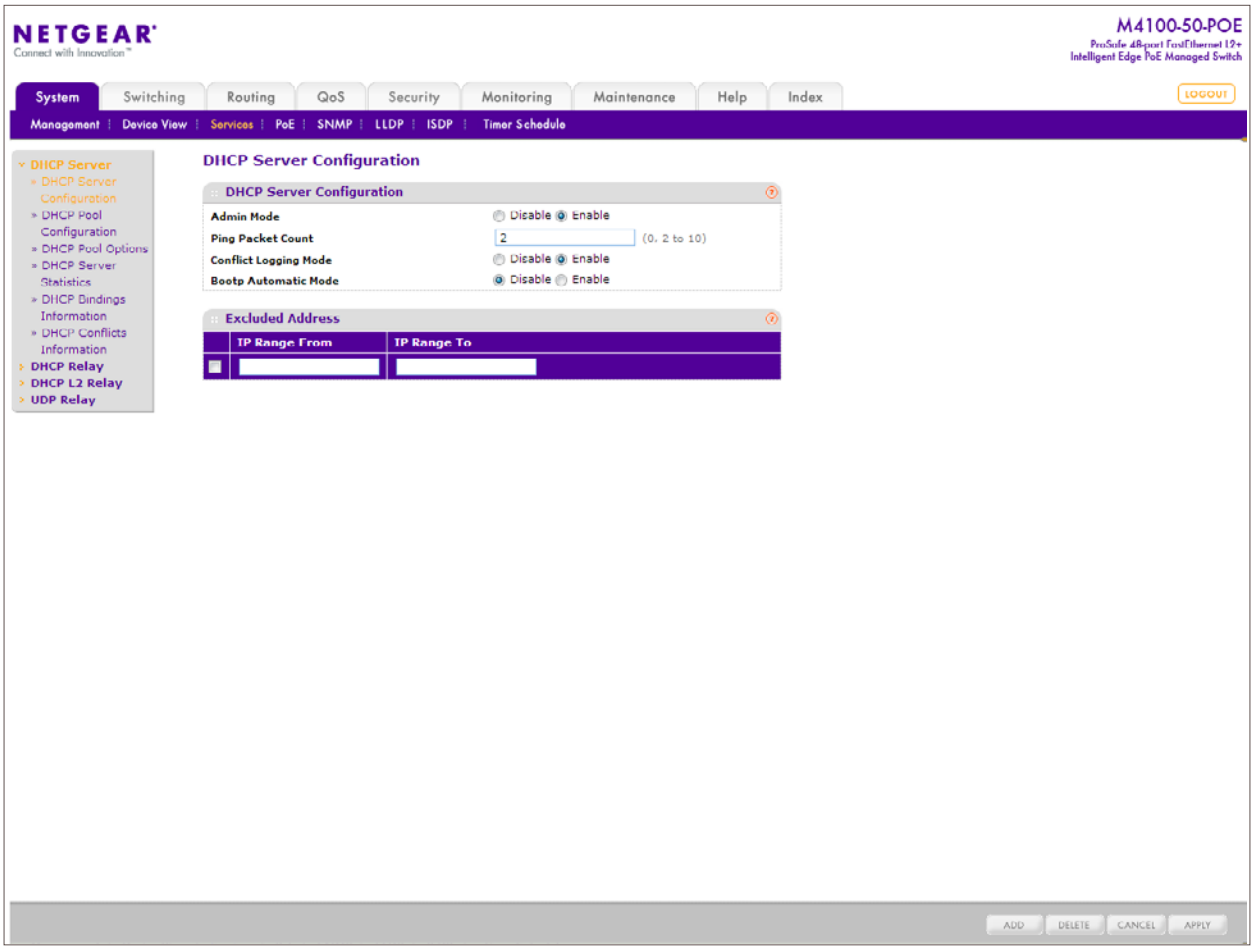
1. Specify voice VLAN 100 and data VLAN 200. Choose **Switching > VLAN > Advanced > VLAN Configuration**. Enter each VLAN ID and name, and click **ADD** to add the VLAN.



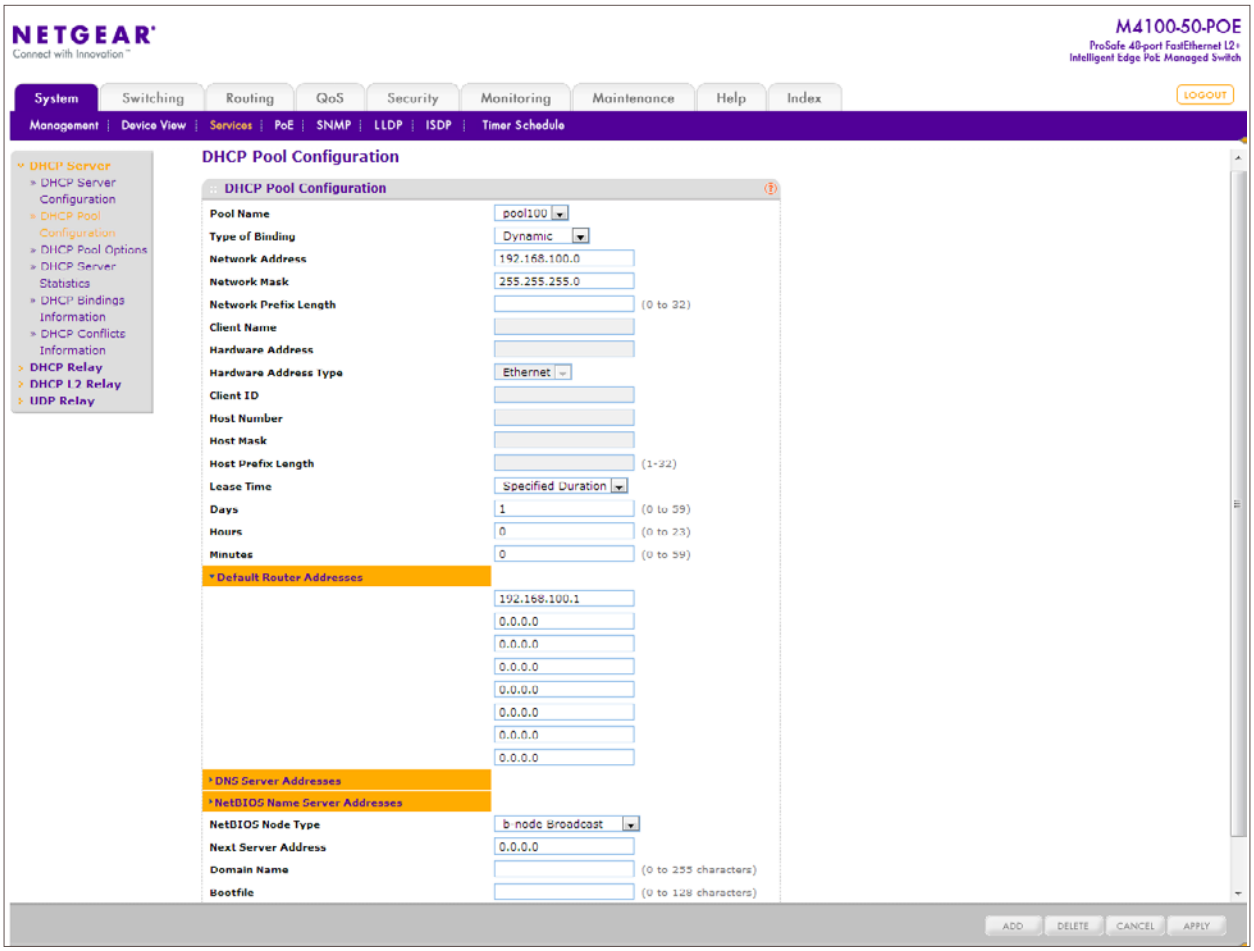
2. Enable routing on the VLAN interfaces and configure their respective subnets (192.168.100.0/24 for VLAN 100 and 192.168.200.0/24 for VLAN 200). Choose **Routing > VLAN > VLAN Routing**. For each VLAN, enter the VLAN ID and the first available IP address (also the gateway) for the subnet with the correct subnet mask. Click **ADD** after each full entry.



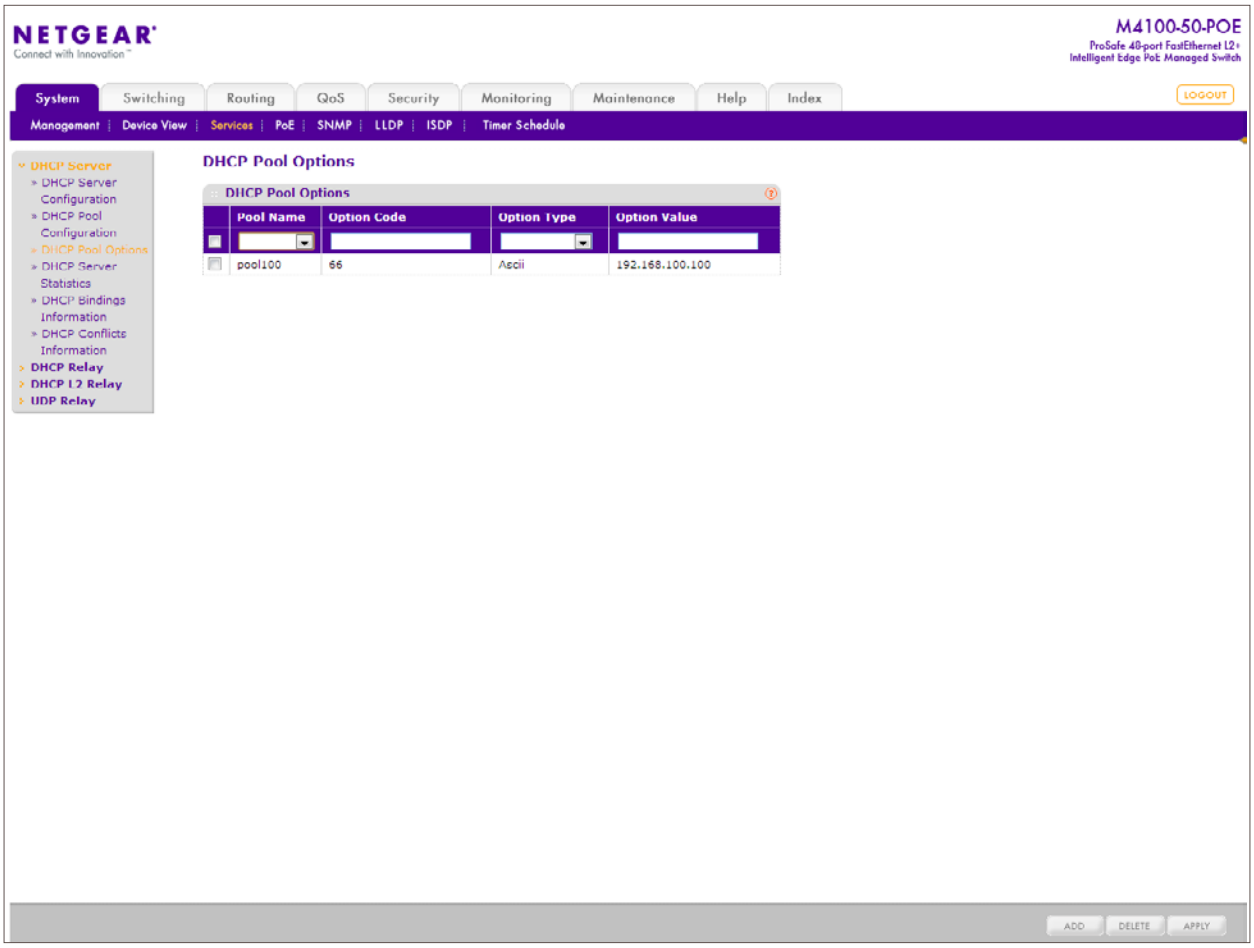
3. Enable the DHCP server. Choose **System > Services > DHCP Server > DHCP Server Configuration**. Enable Admin Mode and click **APPLY**.



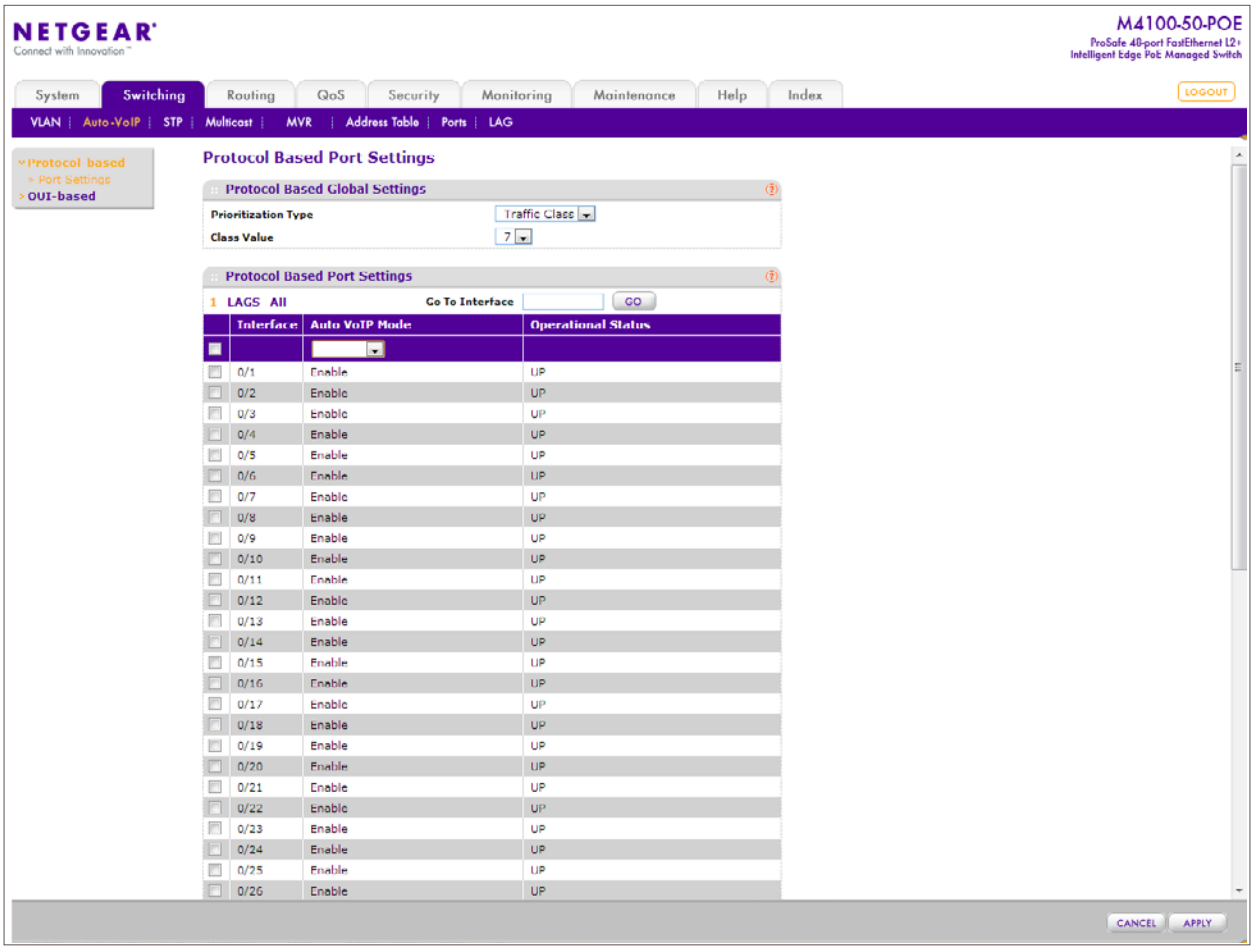
4. Choose S**ystem > Services > DHCP Server > DHCP Pool Configuration**. Select Create for Pool Name and specify “pool<VLANID>” as the name for each VLAN. Enter the network address for each VLAN and the network mask. Under Default Router Addresses, enter the gateway you configured for each VLAN interface. You can also optionally change the least time value. Click **ADD** to create the pool.



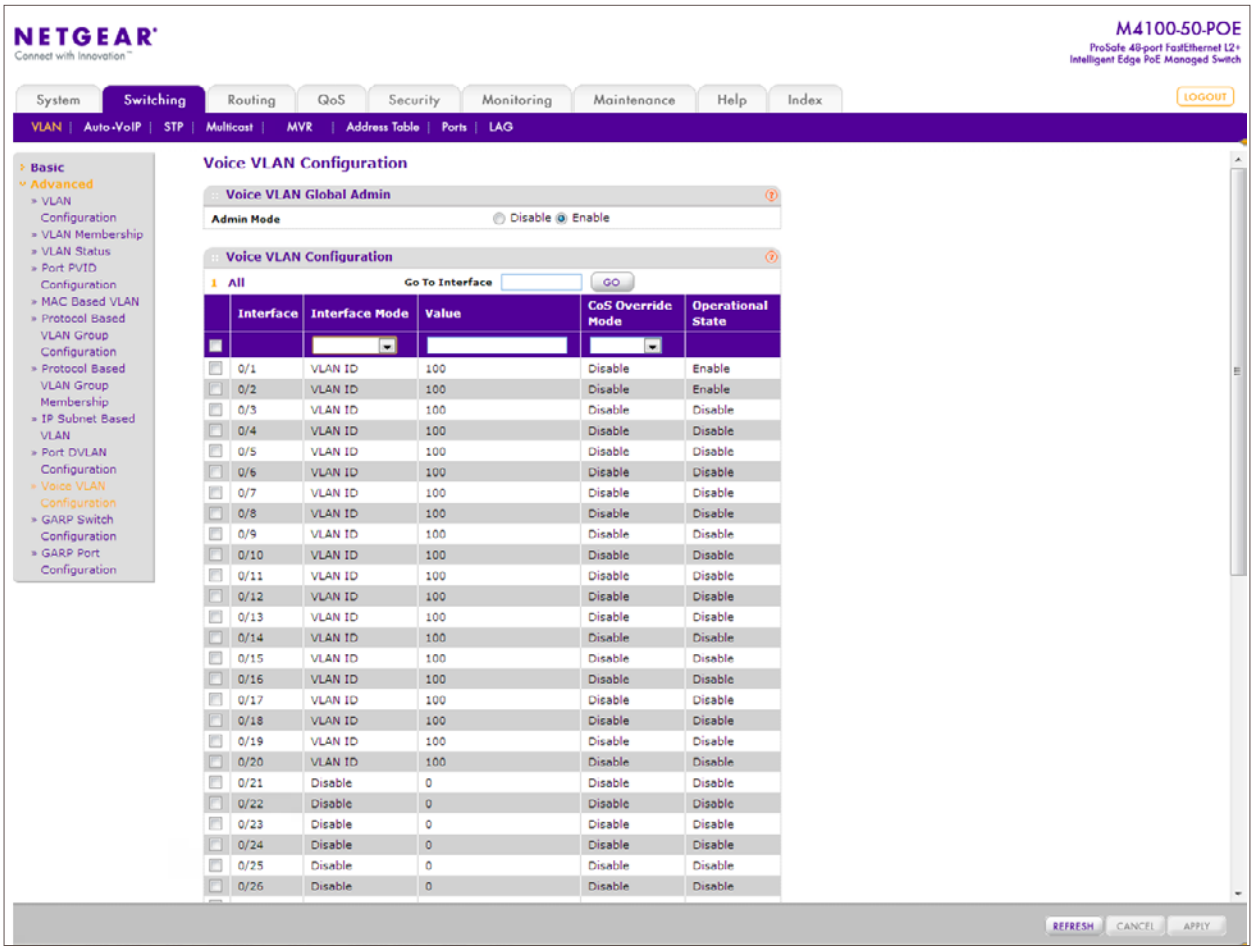
5. Configure the DHCP option to allow the phones to reach the TFTP server containing the phones' necessary firmware images and configuration files. Choose **System > Services > DHCP Server > DHCP Pool Options**. Select the VLAN 100 pool and enter Option Code 66 with Option Type Ascii and Option Value 192.168.100.100 (your TFTP server's IP address). Click **ADD**.



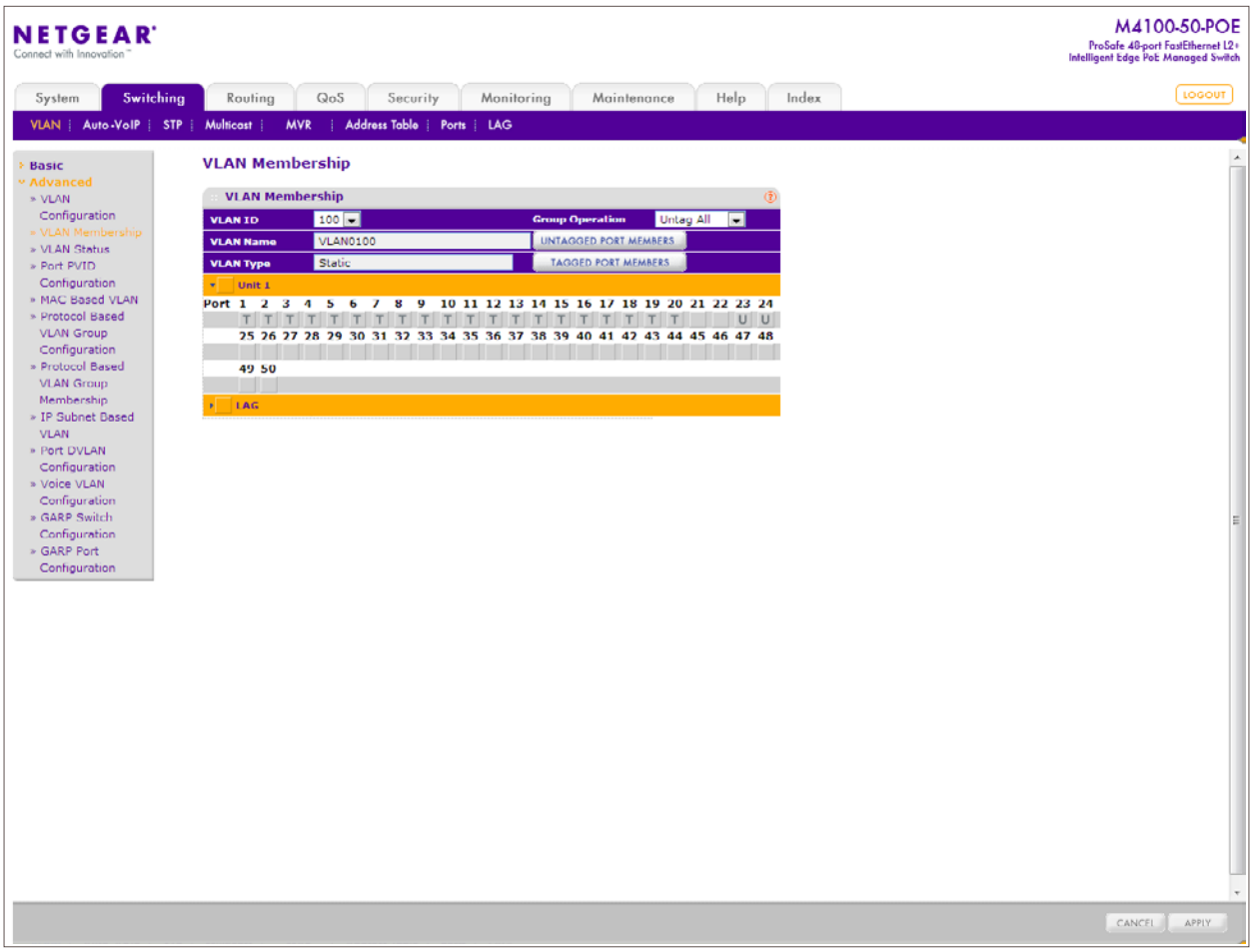
6. Choose **Switching > Auto-VoIP > Protocol based > Port Settings**. Set the Prioritization Type to Traffic Class and Class Value to 3. Select all the interfaces and select Enable for Auto VoIP Mode. Click **APPLY.**



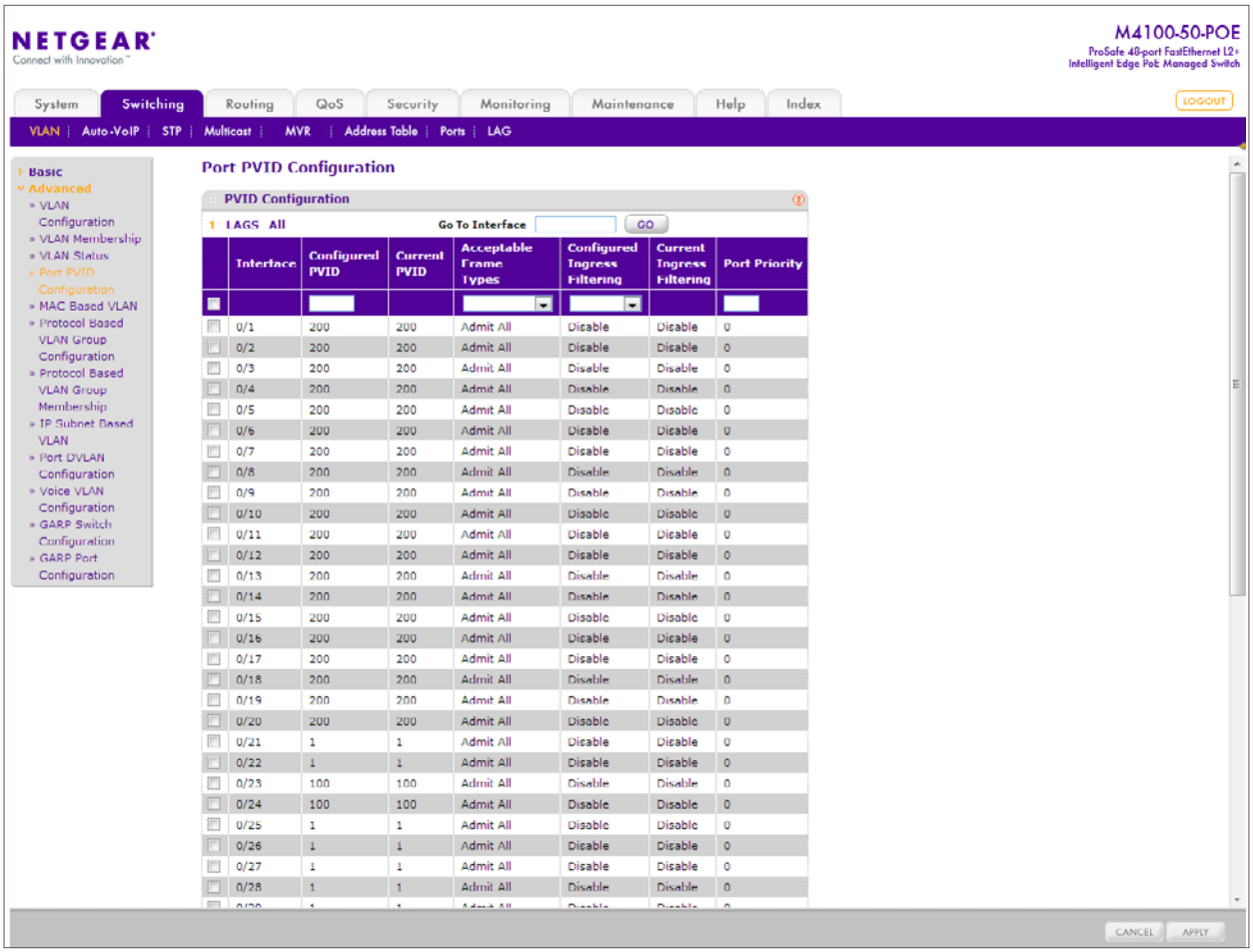
7. Set up the voice VLAN feature on the phone ports. Choose S**witching > VLAN > Advanced > Voice VLAN Configuration**. Enable Admin Mode. Select all the desired interfaces to support VoIP devices. Set the Interface Mode to VLAN ID and enter 100 as the Value. Click **APPLY**.



8. Finish setting up the phone interfaces to support the voice and data VLANs. Choose **Switching > VLAN > VLAN Membership**. For voice VLAN 100, tag the traffic on phone interfaces, but leave the data VLAN 200 traffic untagged on these ports. For each interface on each unit that will support a VoIP phone, select the VLAN from the drop-down menu and cycle through clickable options on each interface until the correct option is reached. All non-VoIP device interfaces will have only 1 VLAN untagged and no tagged VLANs. Click **APPLY** after each VLAN is completed.



9. Choose **Switching > VLAN > Port PVID Configuration.** For all VoIP device interfaces, set the Configured PVID to data VLAN 200. All infrastructure ports must be set to Configured PVID 100. Click **APPLY**.



CONFIGURATION FOR THE 200-PHONE SOLUTION

Refer to Figure 2 for a diagram of the solution. You can use the CLI or Web GUI for configuration.

Assumptions for the 200-Phone Solution

- A DHCP server on the switch will be used. If a third-party DCHP solution is used, refer to the vendor's documentation and the documentation for the phone backend to configure DHCP options.
- The VoIP network is a dedicated, isolated network with a single uplink to the customer's enterprise network.
- VoIP backend systems will be protected by security measures local to the individual systems. ACLs can be used to further restrict access but are not configured in this application note. Visit support.netgear.com for further information.
- The tested VoIP phones have an internal switch to support a second device connected to a secondary port on the phone, allowing a voice and data VLAN to be configured on the switch port.
- Tested phones are SIP-enabled Cisco 79x5 series phones, and the tested PBX system is an AsteriskNOW VM installation. Refer to vendor documentation for further configuration guidance on these platforms.
- Best practices are used to implement switch stacking and failover/redundancy.

Global Configuration Notes

- Be sure to save your configuration using the **save** or **write** memory CLI command. Alternatively, choose **Maintenance > Save Config** in the GUI. Select the box, and click **APPLY**.
- Physical interfaces are referred to interfaces and ports interchangeably throughout this document.

Sample Configuration Values

The following values are used in the sample configuration:

- Infrastructure VLAN: 10
- Infrastructure VLAN subnet: 192.168.1.0/24
- Voice VLAN: 200
- Voice VLAN subnet: 192.168.100.0/24

CLI Configuration Steps: 200-Phone Solution

These steps provide an example CLI configuration for the 200-phone solution. For the Web GUI configuration, see Web GUI Configuration Steps: 200-Phone Solution on page 24.

1. Configure the M5300-28GF3 stack. Create VLAN interfaces on this stack and trunk them out to neighboring stacks as necessary. Allocate VLAN and subnets as follows: infrastructure VLAN 10 (192.168.1.0/24), voice VLAN 100 (192.168.100.0/24), and data VLAN 200 (192.168.200.0/24).

```
(M5300-28GF3) #vlan data
(M5300-28GF3) (Vlan)#vlan 10,100,200
(M5300-28GF3) (Vlan)#vlan routing 10
(M5300-28GF3) (Vlan)#vlan routing 100
(M5300-28GF3) (Vlan)#vlan routing 200
(M5300-28GF3) (Vlan)#exit
(M5300-28GF3) #configure
(M5300-28GF3) (Config)#interface vlan 10
(M5300-28GF3) (Interface vlan 10)#ip address 192.168.1.1 255.255.255.0
(M5300-28GF3) (Interface vlan 10)#routing
(M5300-28GF3) (Interface vlan 10)#exit
(M5300-28GF3) (Config)#interface vlan 100
(M5300-28GF3) (Interface vlan 100)#ip address 192.168.100.1 255.255.255.0
(M5300-28GF3) (Interface vlan 100)#routing
(M5300-28GF3) (Interface vlan 100)#exit
(M5300-28GF3) (Config)#interface vlan 200
(M5300-28GF3) (Interface vlan 200)#routing
(M5300-28GF3) (Interface vlan 200)#ip address 192.168.200.1 255.255.255.0
(M5300-28GF3) (Interface vlan 200)#exit
```

2. Enable the built-in DHCP server and set up DHCP pools for subnets.

```
(M5300-28GF3) (Config)#ip dhcp pool pool10
(M5300-28GF3) (Config-dhcp-pool)#default-router 192.168.1.1
(M5300-28GF3) (Config-dhcp-pool)#network 192.168.1.0 255.255.255.0
(M5300-28GF3) (Config-dhcp-pool)#exit
(M5300-28GF3) (Config)#ip dhcp pool pool100
(M5300-28GF3) (Config-dhcp-pool)#default-router 192.168.100.1
(M5300-28GF3) (Config-dhcp-pool)#network 192.168.100.0 255.255.255.0
(M5300-28GF3) (Config-dhcp-pool)#exit
(M5300-28GF3) (Config)#ip dhcp pool pool200
(M5300-28GF3) (Config-dhcp-pool)#default-router 192.168.200.1
(M5300-28GF3) (Config-dhcp-pool)#network 192.168.200.0 255.255.255.0
(M5300-28GF3) (Config-dhcp-pool)#exit
```

3. Add DHCP option 66 to the voice VLAN DHCP pool so that the phones can reach the TFTP server to download necessary firmware and configuration files upon boot-up. In this case, the TFTP server has an IP address of 192.168.1.100.

```
(M5300-28GF3) (Config)#ip dhcp pool pool100
(M5300-28GF3) (Config-dhcp-pool)#option 66 ascii 192.168.100.100
(M5300-28GF3) (Config-dhcp-pool)#exit
```

4. Enable IP routing globally.

```
(M5300-28GF3) (Config)#ip routing
```

5. Configure uplink ports to the neighboring switches. Configurations will be the same on both sides of the uplink. Add or remove VLANs as needed. All transported VLANs must be tagged to create the trunk.

```
(M5300-28GF3) (Config)#interface 1/0/25
(M5300-28GF3) (Interface 1/0/25)#vlan participation exclude 1
(M5300-28GF3) (Interface 1/0/25)#vlan participation include 10,100,200
(M5300-28GF3) (Interface 1/0/25)#vlan tagging 10,100,200
(M5300-28GF3) (Interface 1/0/25)#exit
```

6. Configure the infrastructure ports. For each interface on each unit that will support a VoIP phone, include infrastructure VLAN 10.

```
(M5300-28GF3) (Config)#interface 1/0/21
(M5300-28GF3) (Interface 1/0/25)#vlan participation exclude 1
(M5300-28GF3) (Interface 1/0/25)#vlan participation include 10
(M5300-28GF3) (Interface 1/0/25)#vlan pvid 10
(M5300-28GF3) (Interface 1/0/25)#exit
```

7. Move to the M4100-50-POE stacks to replicate the configuration on each one. Start by declaring the VLANs 10, 100, and 200.

```
(M4100-50-POE) #vlan database
(M4100-50-POE) (Vlan)#vlan 10,100,200
(M4100-50-POE) (Vlan)#exit
```

8. Enable IP routing on each M4100-50-POE stack.

```
(M4100-50-POE) #configure
(M4100-50-POE) (Config)#ip routing
```

9. Configure each uplink to the M5300-28GF3 stack. Both sides of the uplink must have the same configuration. All transported VLANs must be tagged to create the trunk.

```
(M4100-50-POE) (Config)#interface 0/49
(M4100-50-POE) (Interface 0/49)#vlan participation exclude 1
(M4100-50-POE) (Interface 0/49)#vlan participation include 10,100,200
(M4100-50-POE) (Interface 0/49)#vlan tagging 10,100,200
(M4100-50-POE) (Interface 0/49)#exit
```

10. Raise the VoIP traffic priority and enable the voice VLAN feature. Send VoIP traffic with a dot1p priority of 5 and map priority 5 to queue 5.

```
(M4100-50-POE) (Config)# classofservice dot1p-mapping 5 5
(M4100-50-POE) (Config)#cos-queue strict 5
(M4100-50-POE) (Config)#voice vlan
```

11. Create a DiffServ class map policy to provide QoS for voice traffic on the phone ports. This policy will be copied onto all stacks in the LAN network supporting VoIP devices.

```
(M4100-50-POE) (Config)#diffserv
(M4100-50-POE) (Config)#class-map match-all class_voip
(M4100-50-POE) (Config-classmap)#match protocol udp
(M4100-50-POE) (Config-classmap)#match ip dscp ef
(M4100-50-POE) (Config-classmap)#exit
(M4100-50-POE) (Config)#policy-map pol_voip in
(M4100-50-POE) (Config-policy-map)#class class_voip
(M4100-50-POE) (Config-policy-classmap)#assign-queue 5
(M4100-50-POE) (Config-policy-classmap)#exit
(M4100-50-POE) (Config-policy-map)#exit
```

12. Configure the phone ports with voice VLAN 100 and data VLAN 200 and apply the VoIP policy to the phone ports.

```
(M4100-50-POE) (Config)#interface 0/1
(M4100-50-POE) (Interface 0/1)#vlan participation exclude 1
(M4100-50-POE) (Interface 0/1)#vlan participation include 100,200
(M4100-50-POE) (Interface 0/1)#vlan tagging 100
(M4100-50-POE) (Interface 0/1)#voice vlan 100
(M4100-50-POE) (Interface 0/1)#vlan pvid 200
(M4100-50-POE) (Interface 0/1)#service-policy in pol_voip
(M4100-50-POE) (Interface 0/1)#exit
```

13. Move to the M5300-52G3 stack to replicate the configuration. Declare the VLANs, enable IP routing, and enable the voice VLAN features globally.

```
(M5300-52G3) #vlan database
(M5300-52G3) (Vlan)#vlan 10,100,200
(M5300-52G3) (Vlan)#exit
(M5300-52G3) #configure
(M5300-52G3) (Config)#ip routing
(M5300-52G3) (Config)#voice vlan
```

14. Configure the uplink to the M5300-28GF3 stack. Both sides of the uplink must have the same configuration. All transported VLANs must be tagged to create the trunk.

```
(M5300-52G3) (Config)#interface 1/0/25
(M5300-52G3) (Interface 1/0/25)#vlan participation exclude 1
(M5300-52G3) (Interface 1/0/25)#vlan participation include 10,100,200
(M5300-52G3) (Interface 1/0/25)#vlan tagging 10,100,200
(M5300-52G3) (Interface 1/0/25)#exit
```

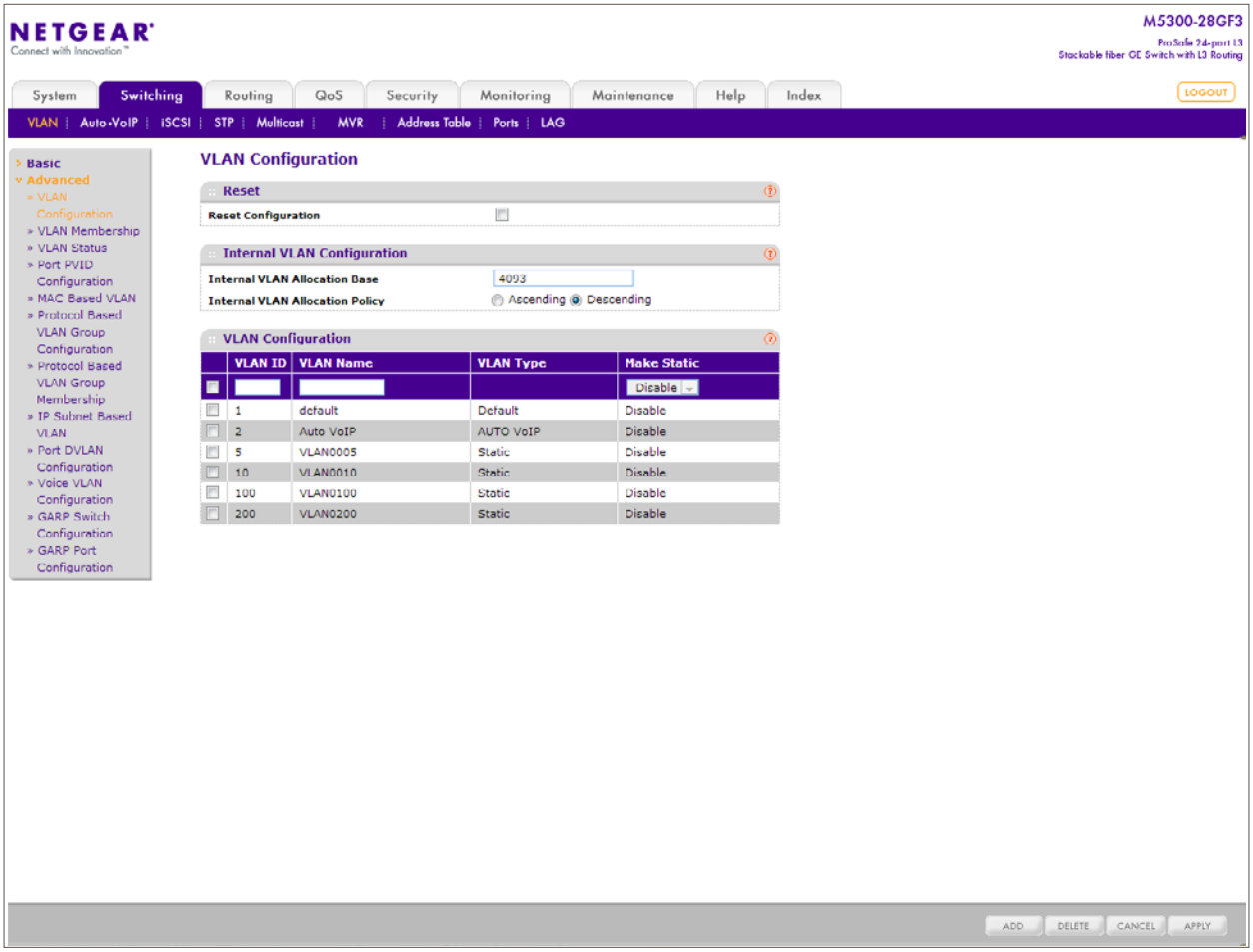
15. Finish the configuration by setting up ports on the other endpoints with the appropriate VLAN, in this case, data VLAN 200.

```
(M5300-52G3) (Config)#interface 1/0/1
(M5300-52G3) (Interface 1/0/1)#vlan participation exclude 1
(M5300-52G3) (Interface 1/0/1)#vlan participation include 200
(M5300-52G3) (Interface 1/0/1)#vlan pvid 200
(M5300-52G3) (Interface 1/0/1)#exit
(M5300-52G3) (Config)#exit
```

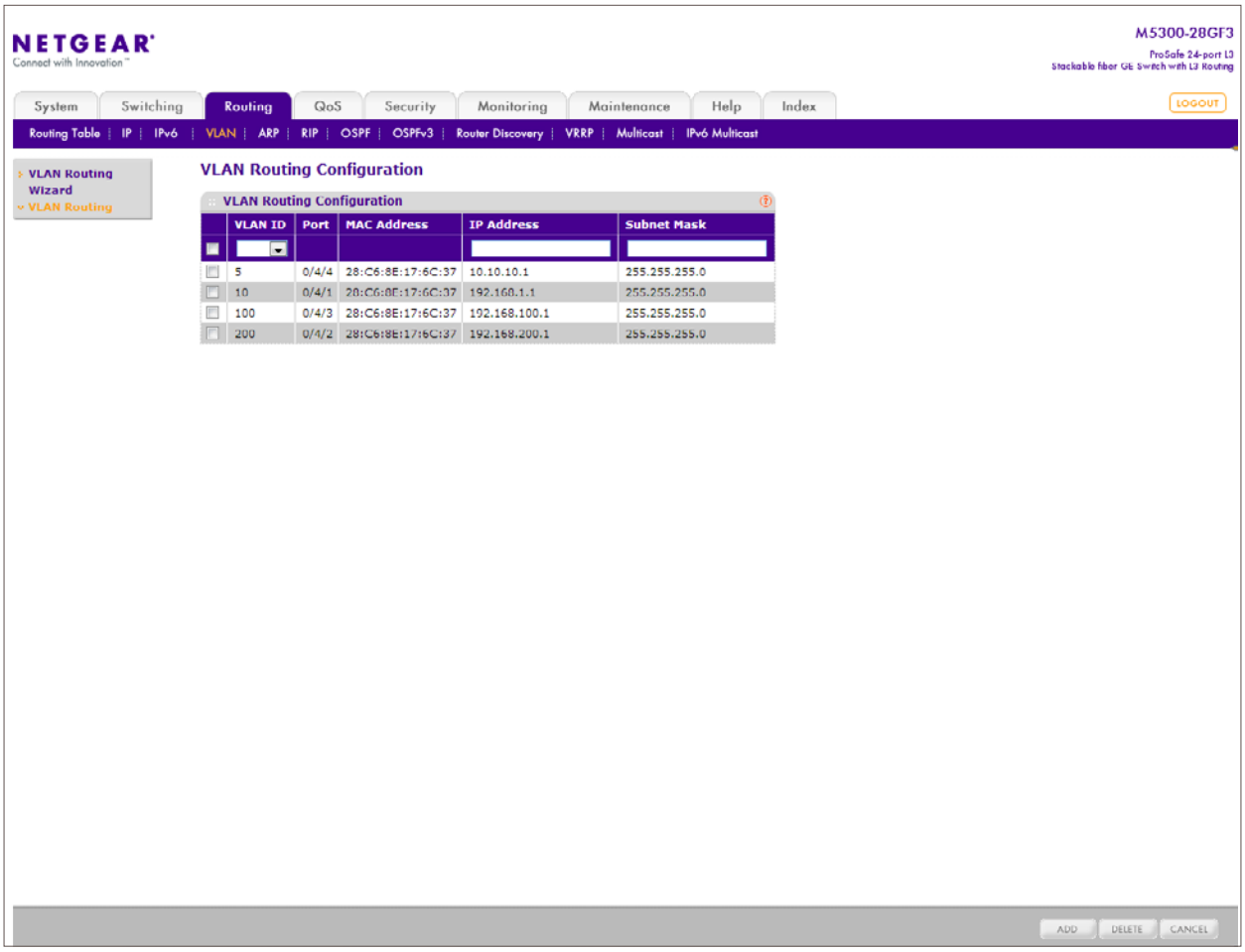
Web GUI Configuration Steps: 200-Phone Solution

These steps provide an example Web GUI configuration for the 200-phone solution. For the CLI configuration, see CLI Configuration Steps: 200-Phone Solution on page 20.

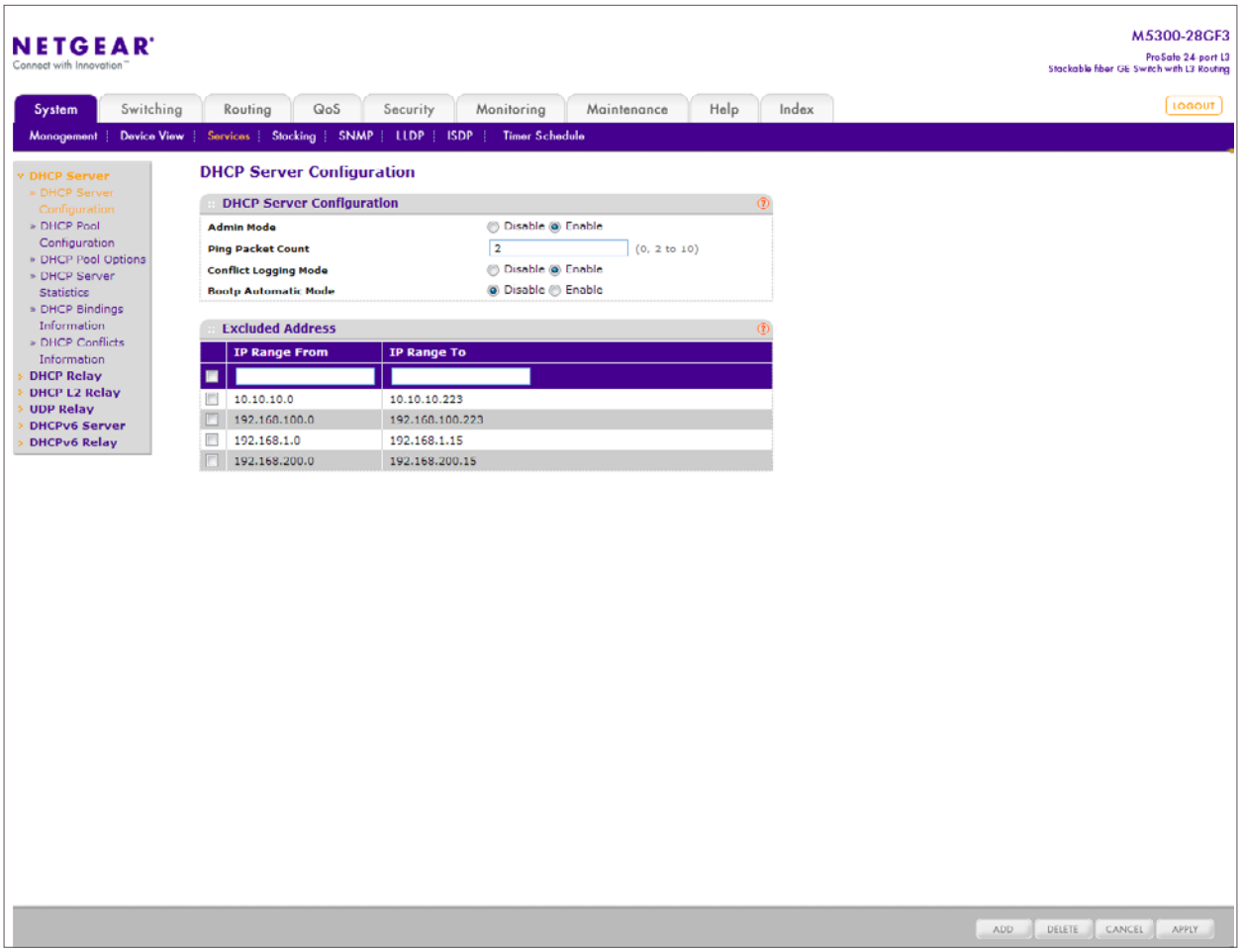
1. Create the VLAN interfaces for the three subnets. Choose **Switching > VLAN > Advanced > VLAN Configuration**. Enter each VLAN ID, its name, and click ADD to add the VLAN to the configuration.



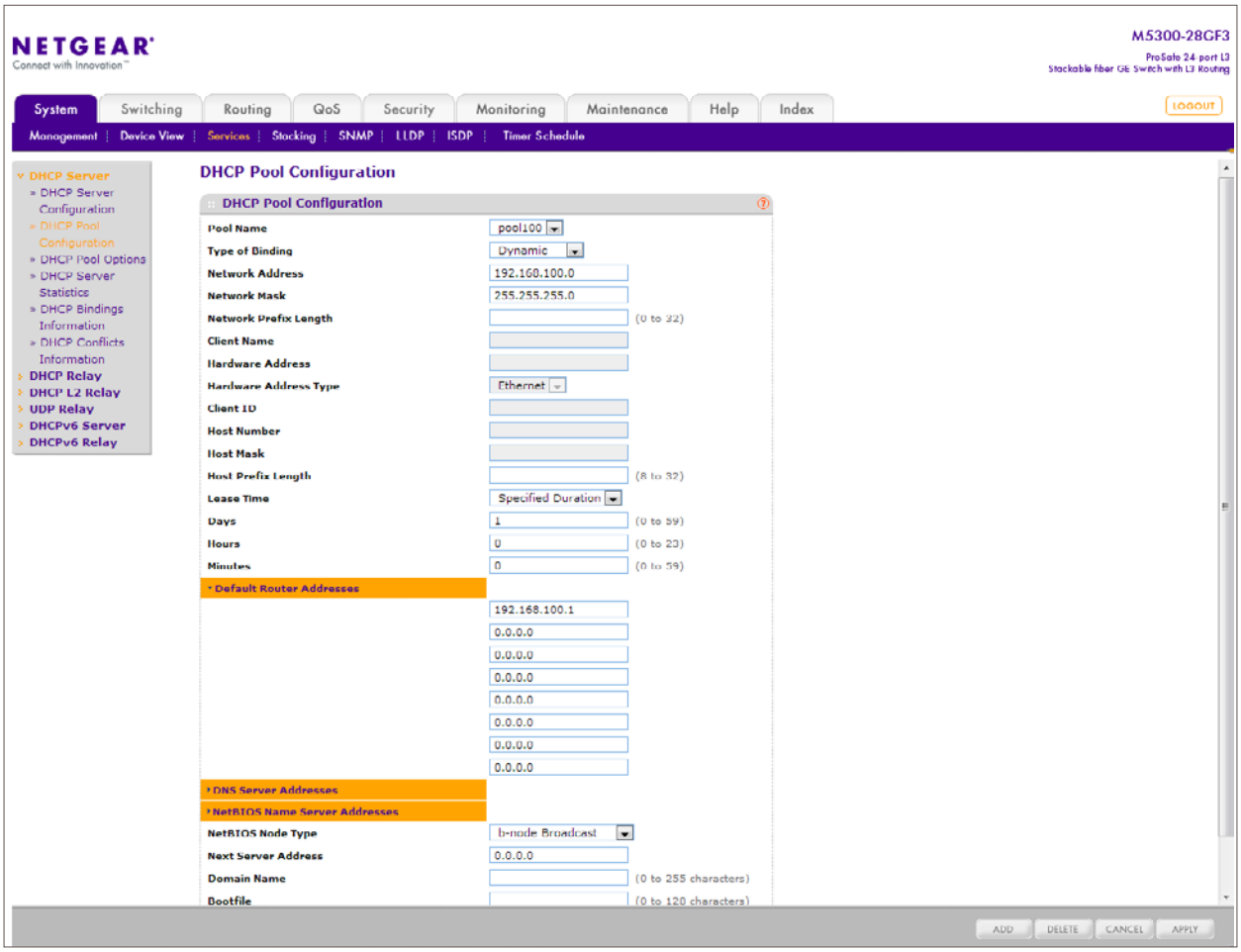
2. Choose **Routing > VLAN > VLAN Routing**. Configure each VLAN interface and enable routing on it. Allocate VLANs and subnets as follows: infrastructure VLAN 10 (192.168.1.0/24), voice VLAN 100 (192.168.100.0/24), and data VLAN 200 (192.168.200.0/24). Select the VLAN ID and enter the corresponding gateway IP address and subnet mask for each. Click **ADD** after completing each entry.



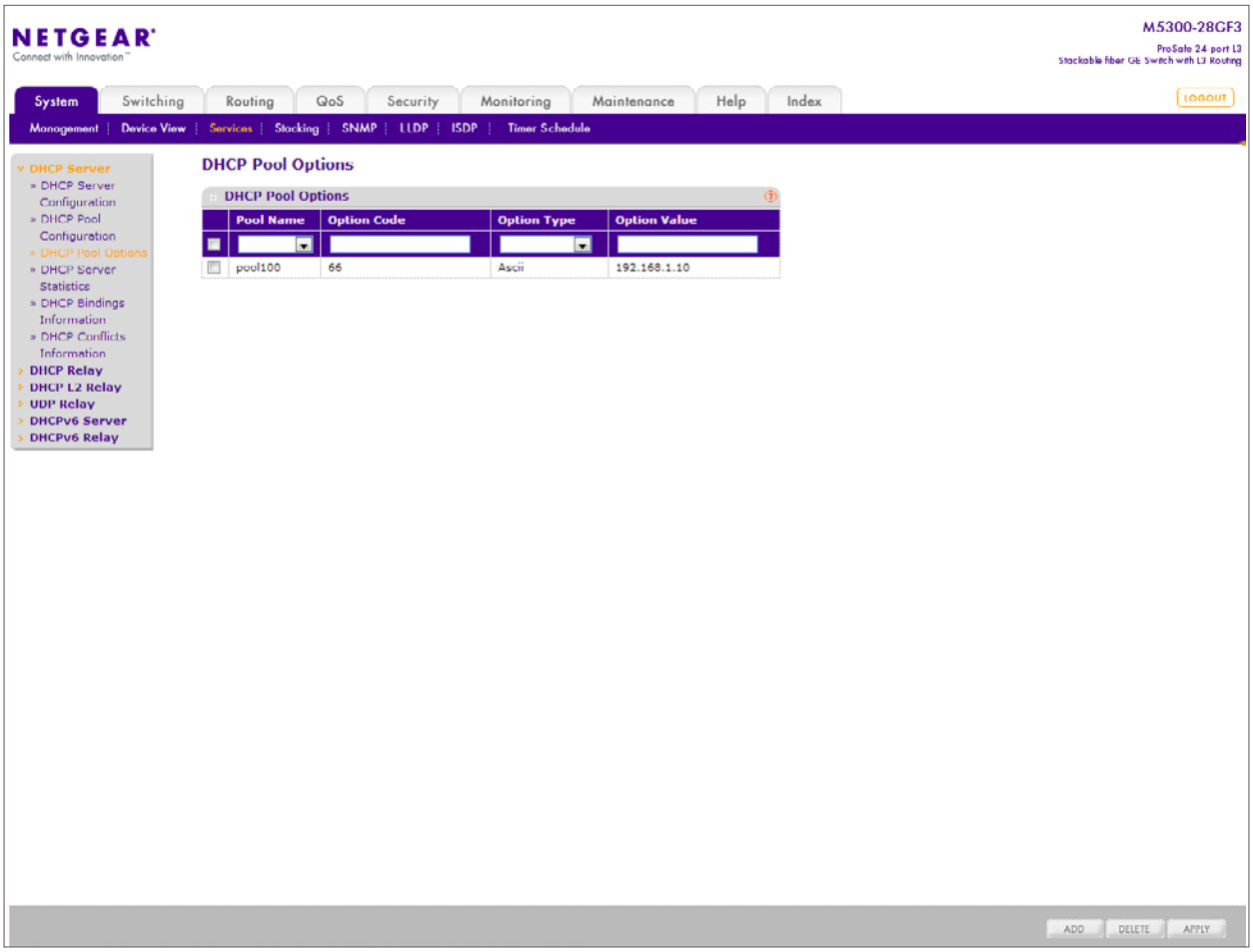
3. Choose **System > Services > DHCP Server > DHCP Server Configuration**. Enable Admin Mode and click **APPLY**. Set up any IP address ranges you want to exclude from the DHCP pools. Click **ADD** after configuring any excluded ranges for static IP addresses.



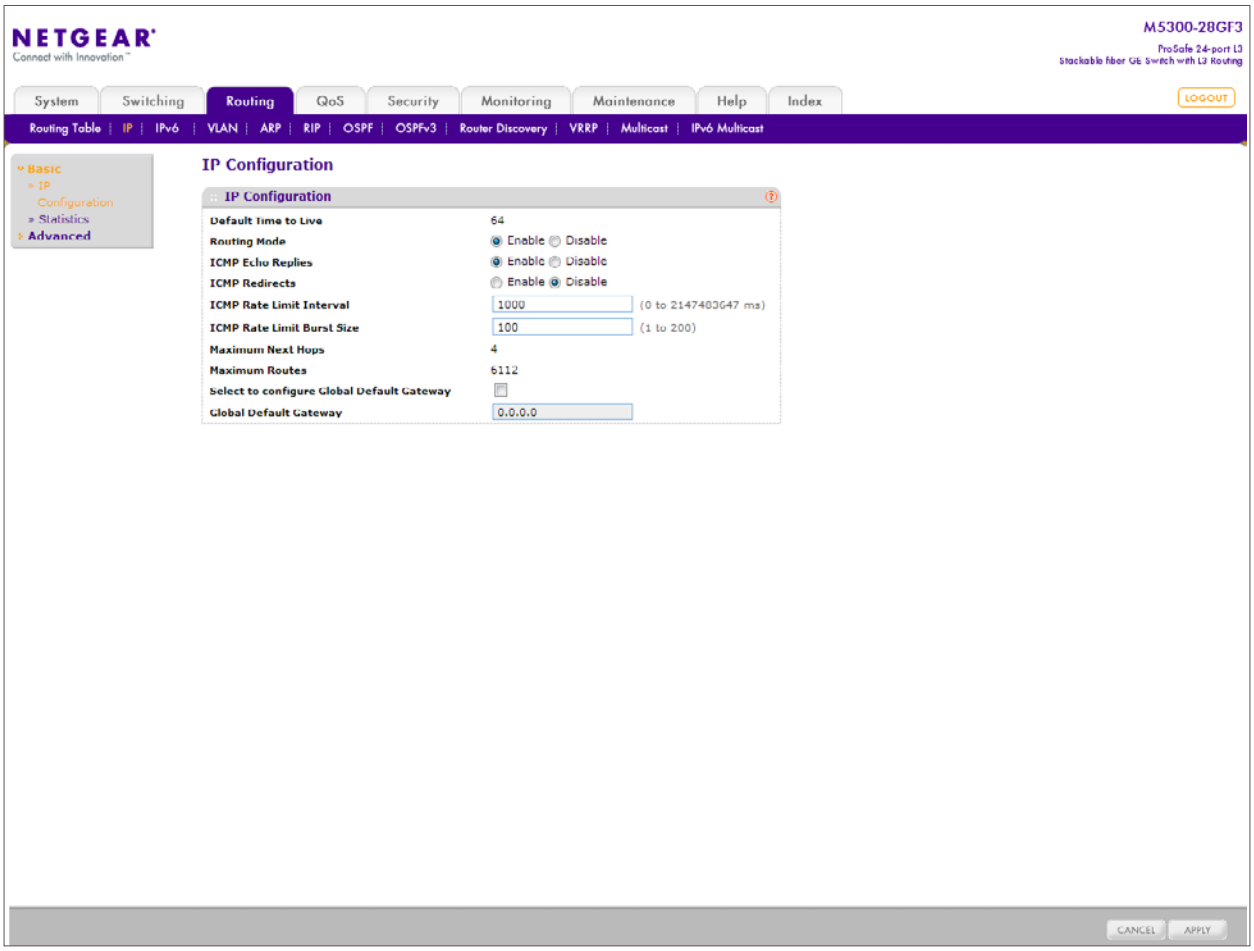
4. Choose S**ystem > Services > DHCP Server > DHCP Pool Configuration**. Create a pool for each subnet associated with the VLANs. Set Type of Binding to Dynamic and enter the address and gateway for each. Set Default Router Address to the IP address of the subnet gateway. You can optionally change the lease time. Click **ADD**.



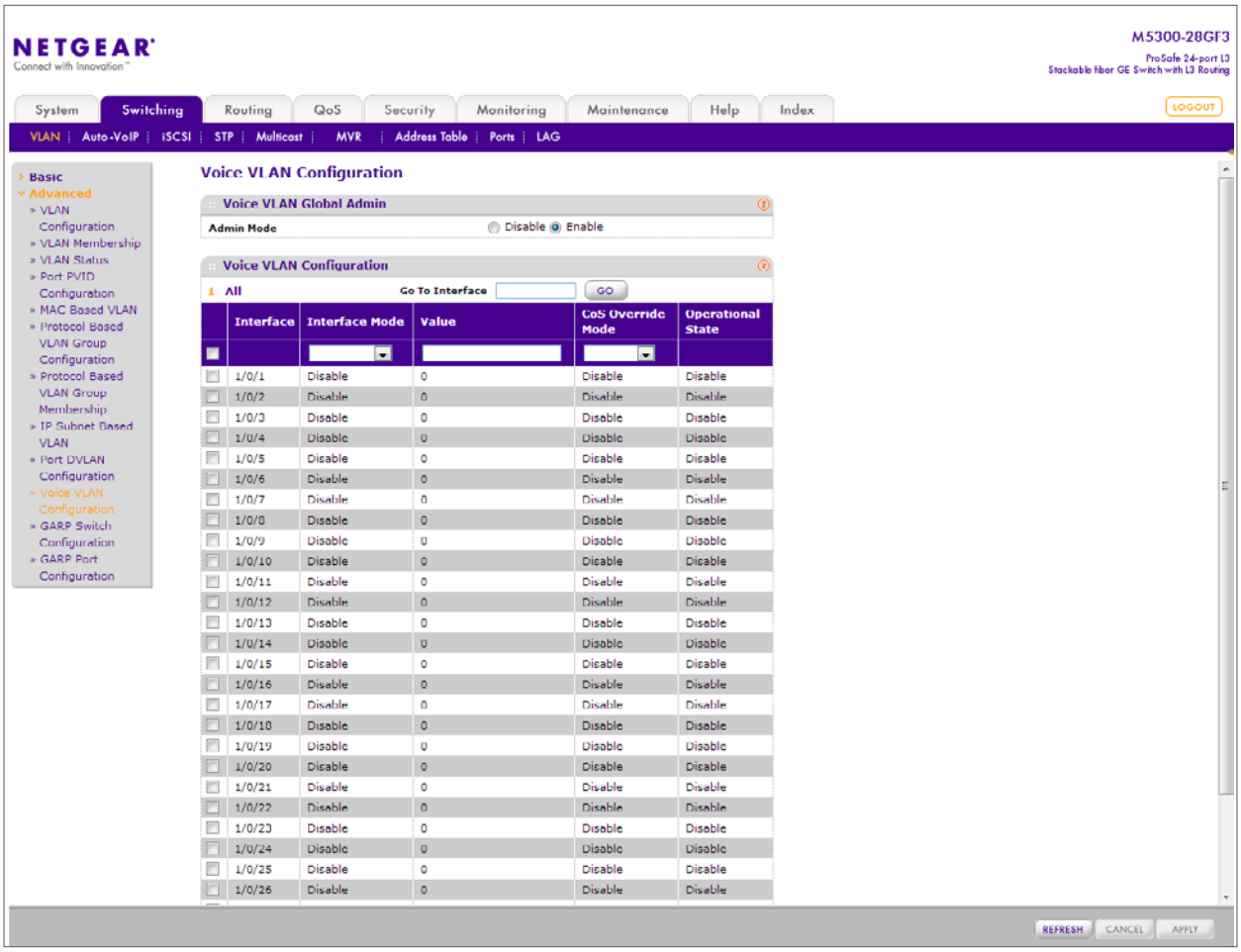
5. Set DHCP option 66 on the voice VLAN 100 so that the phones can download firmware and configuration files from a TFTP server. Choose **System > Services > DHCP Server > DHCP Pool Options**. Select the pool name for the VLAN 100 DHCP pool. Enter 66 for Option Code, select Ascii as Option Type, and enter the TFTP server IP address as Option Value. In this example, the TFTP server's address is 192.168.1.10. Click **ADD**.



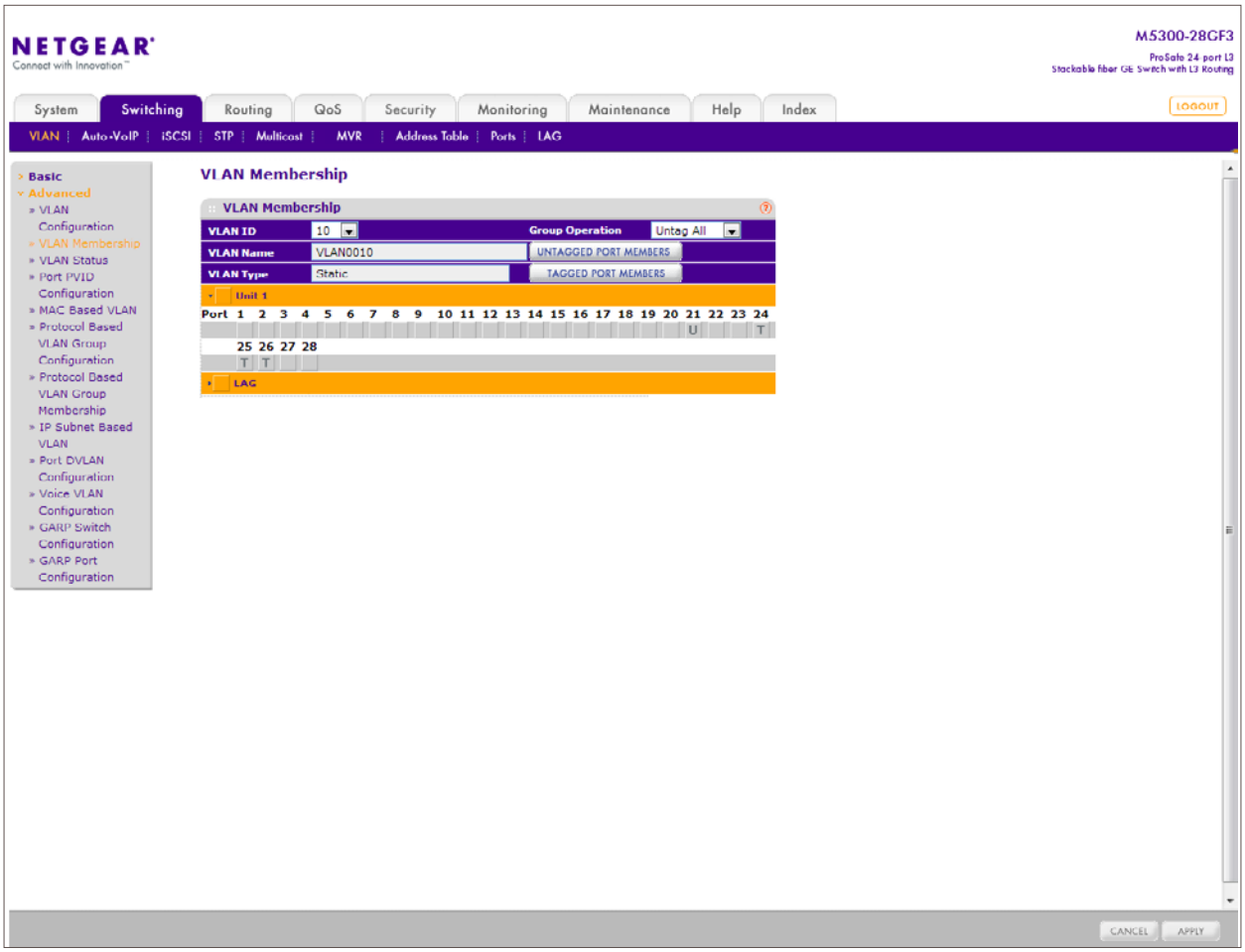
6. Choose **Routing > IP > Basic > IP Configuration** to enable routing globally. Enable Routing Mode and click **APPLY.**



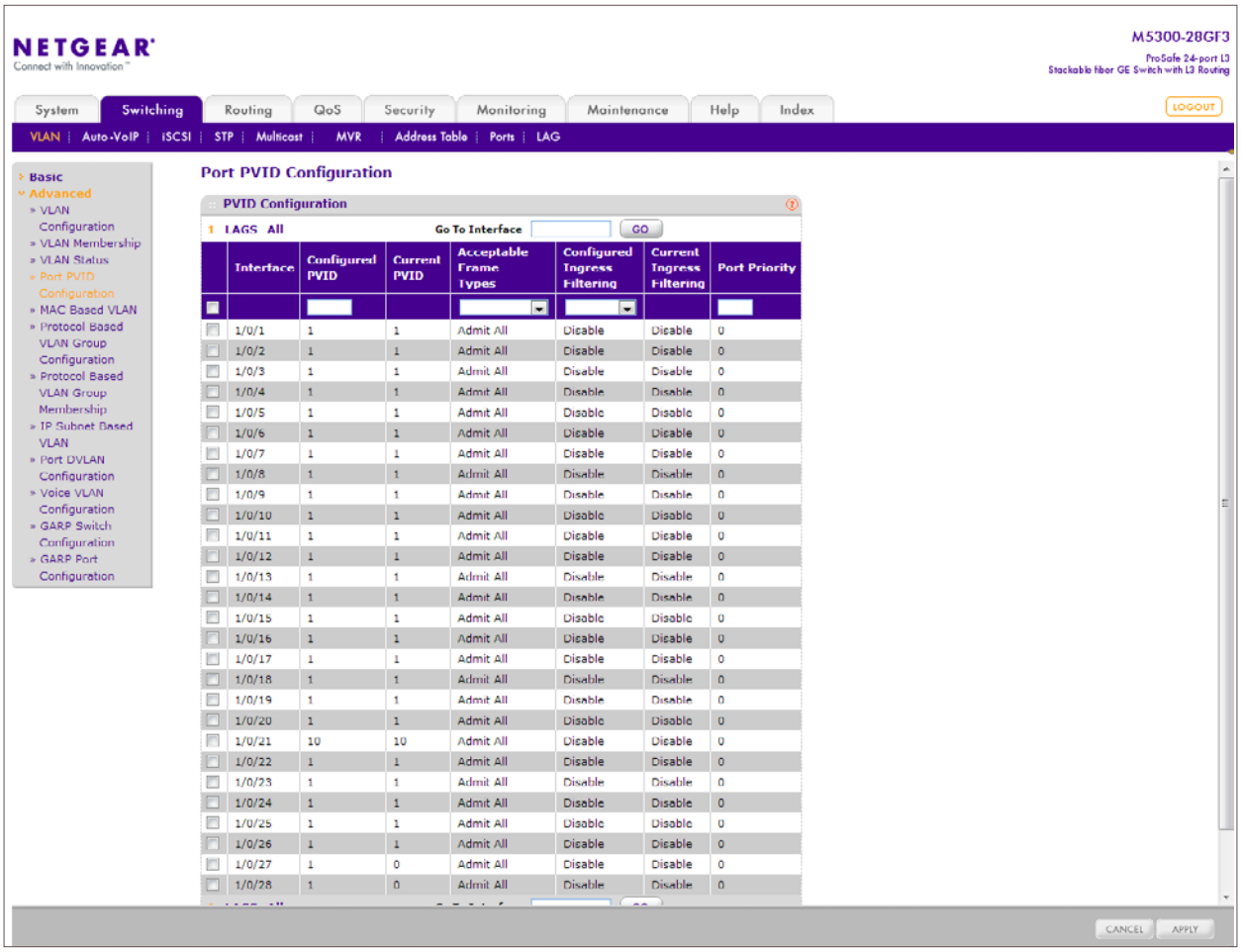
7. Enable the voice VLAN feature globally. Choose **Switching > VLAN > Advanced > Voice VLAN Configuration**. Enable Admin Mode and click **APPLY**.



8. Configure the switch ports. Choose S**witching > VLAN > Advanced > VLAN Membership**. For each of the three VLANs, set all uplink ports to neighboring stacks as T for tagged. For the infrastructure ports, set all ports to U for untagged. Click **APPLY** after configuring ports for each of the VLANs.

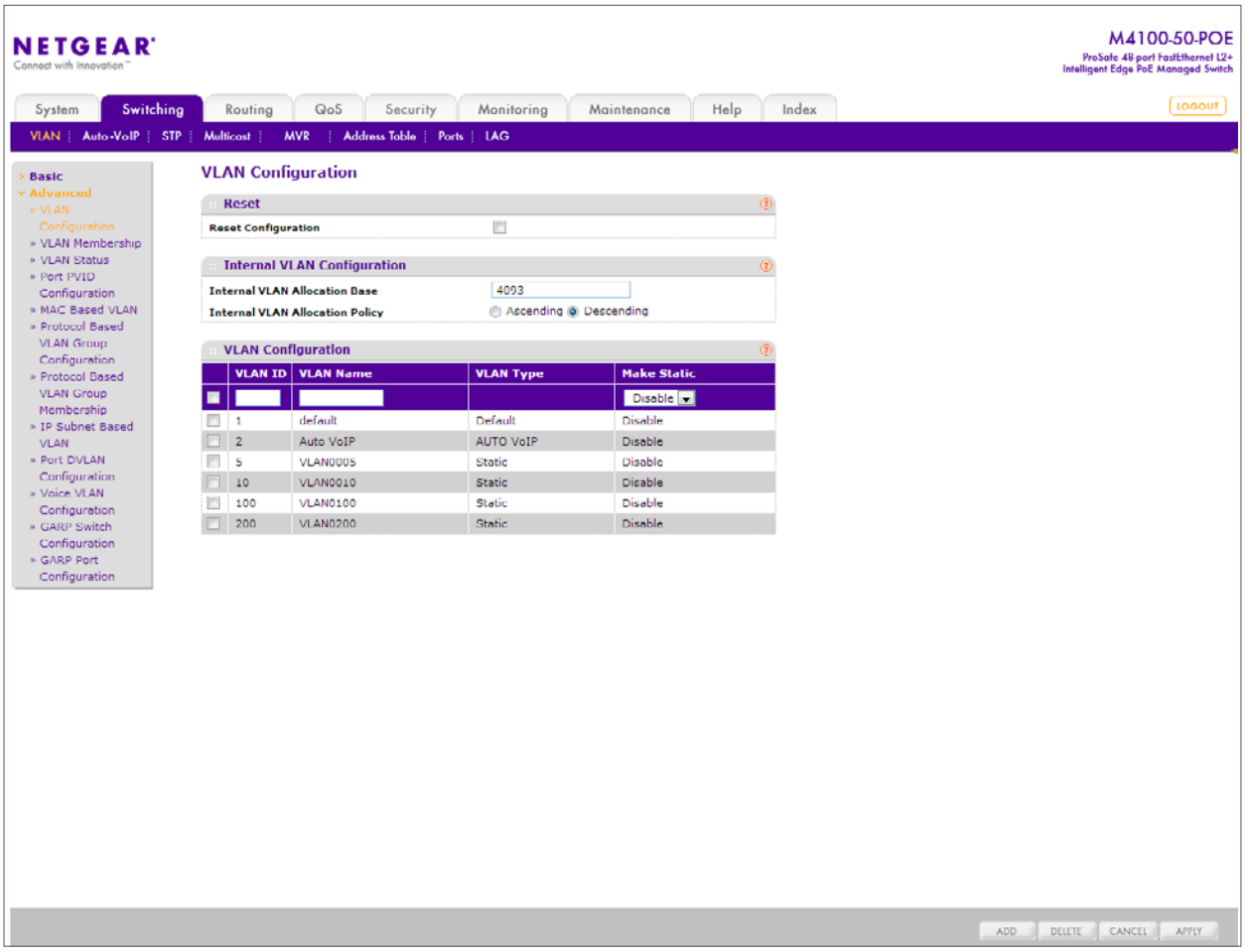


9. For infrastructure ports, configure the port PVID. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. Enter infrastructure VLAN ID 10 as Configured PVID for all infrastructure ports. Click **APPLY**.

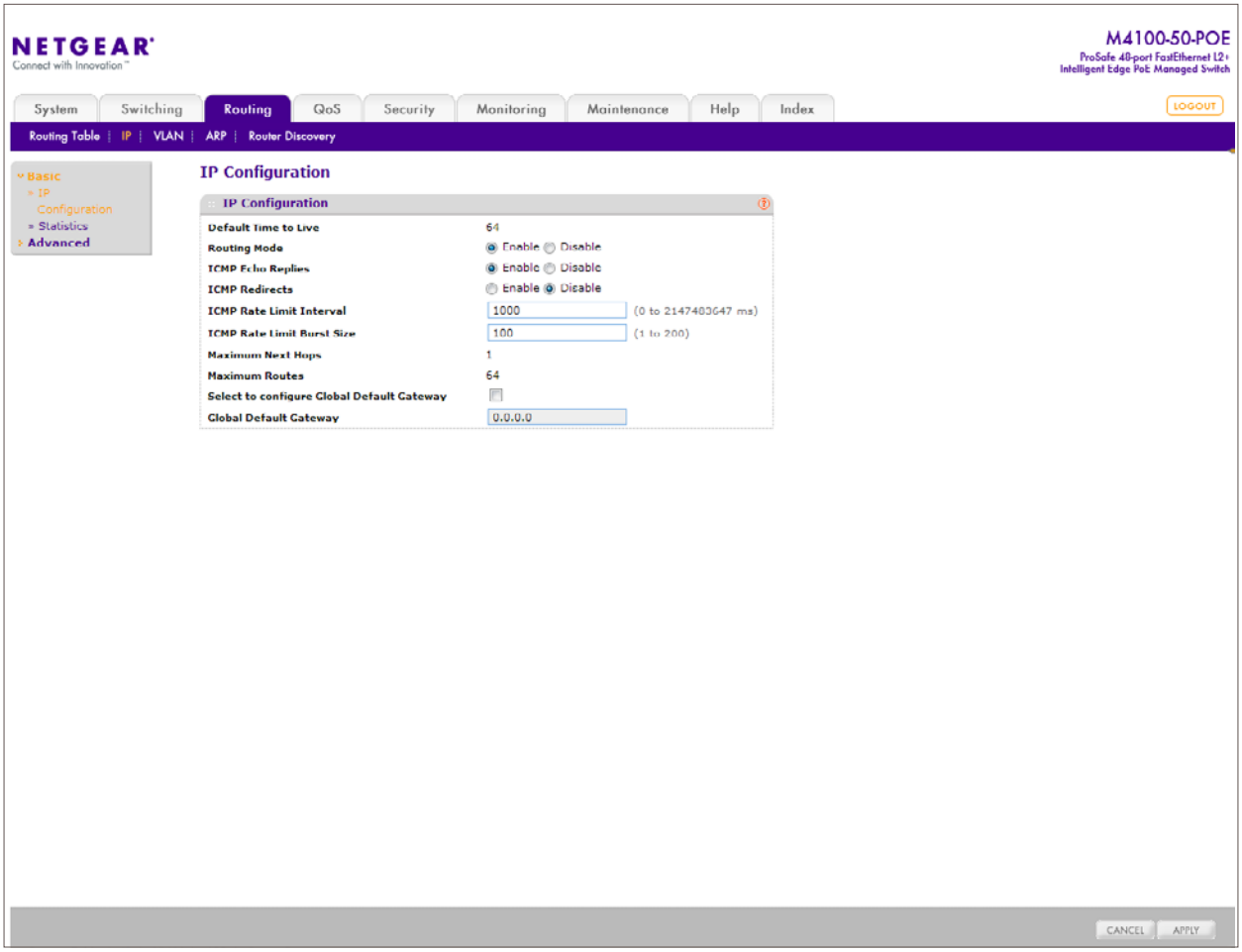


Switch – M4100-50-POE

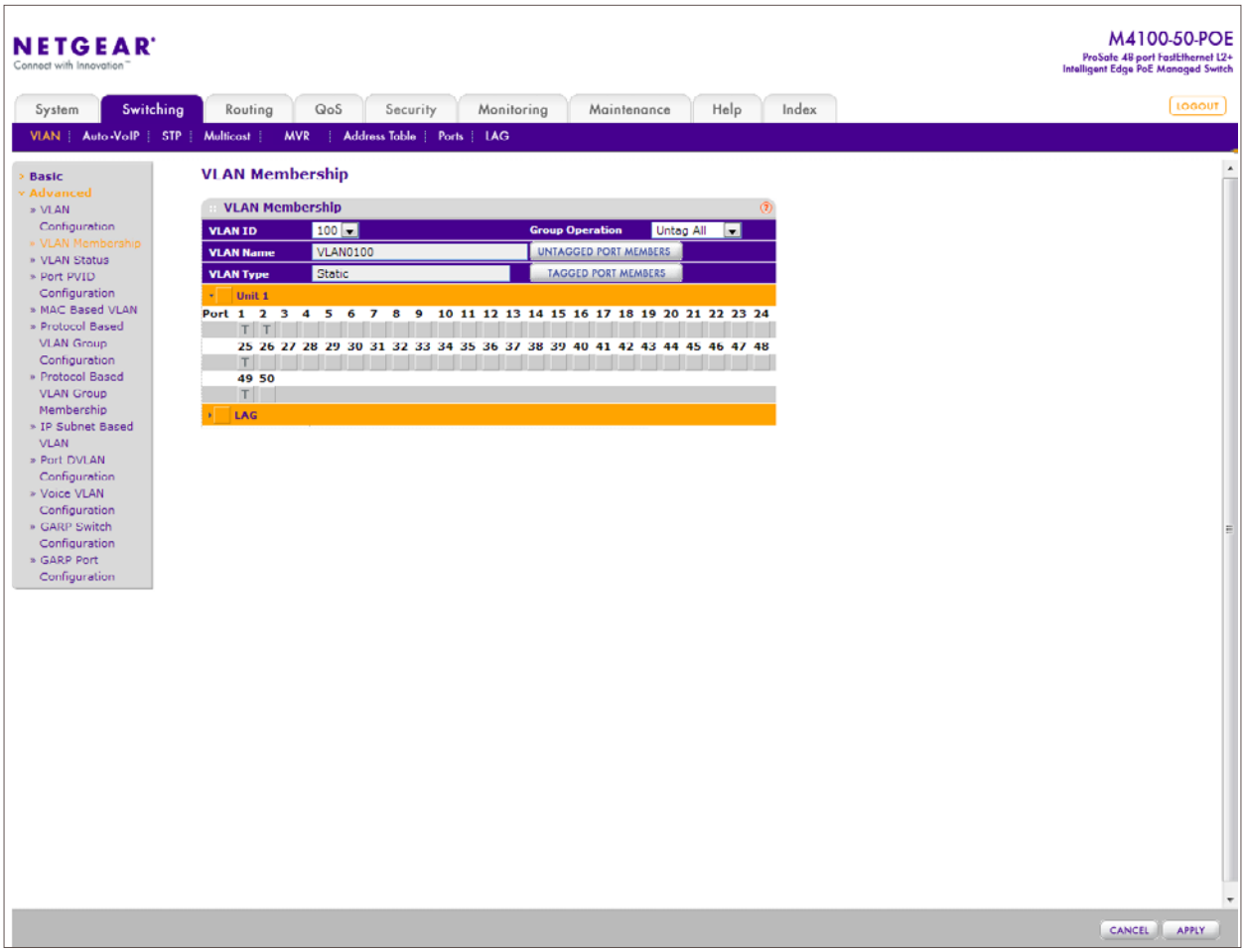
1. Create the VLAN interfaces for the three subnets. Choose **Switching > VLAN > Advanced > VLAN Configuration**. Declare each VLAN ID and click **ADD** after each one.



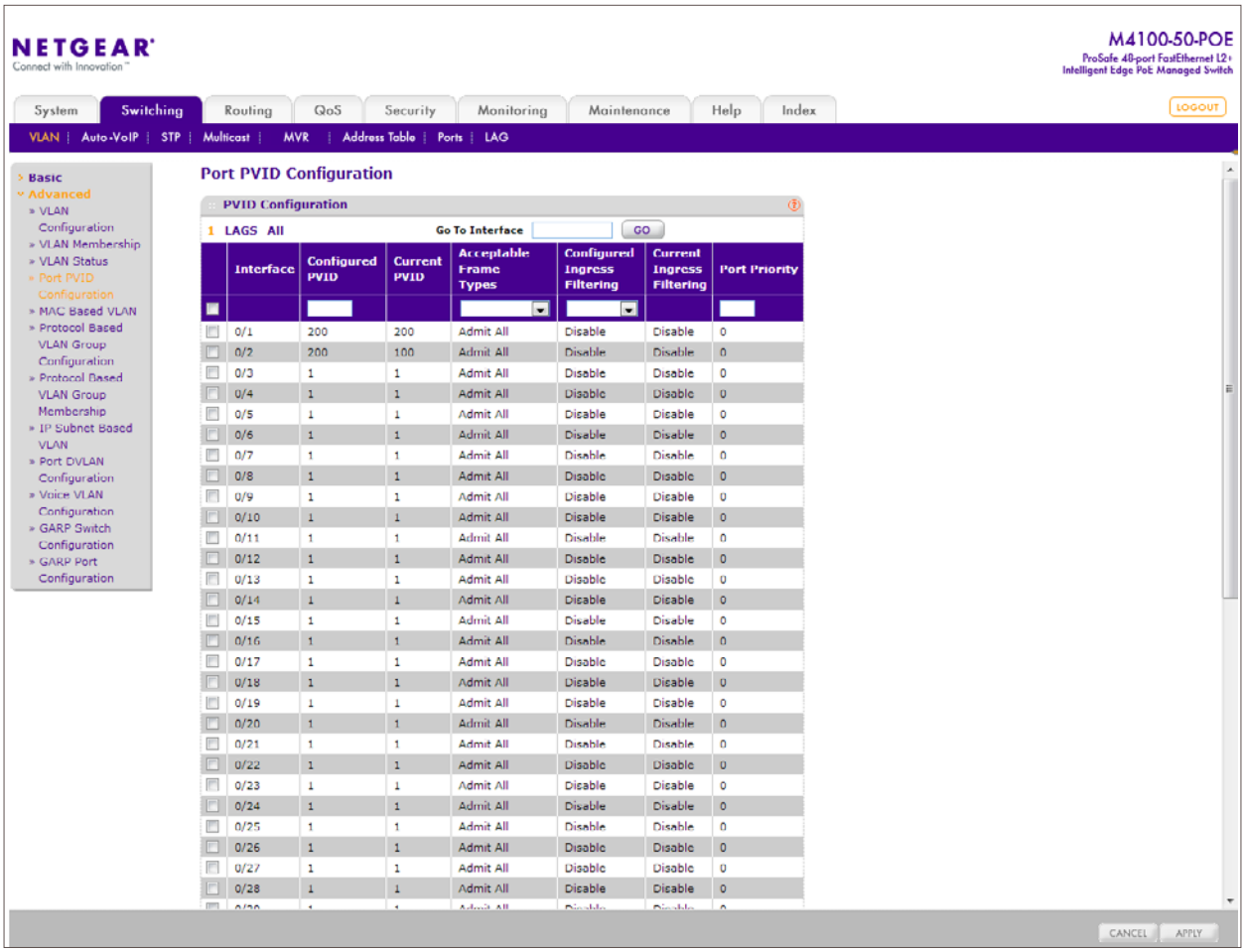
2. Choose **Routing > IP > Basic > IP Configuration** to enable routing globally. Enable Routing Mode and click **APPLY**.



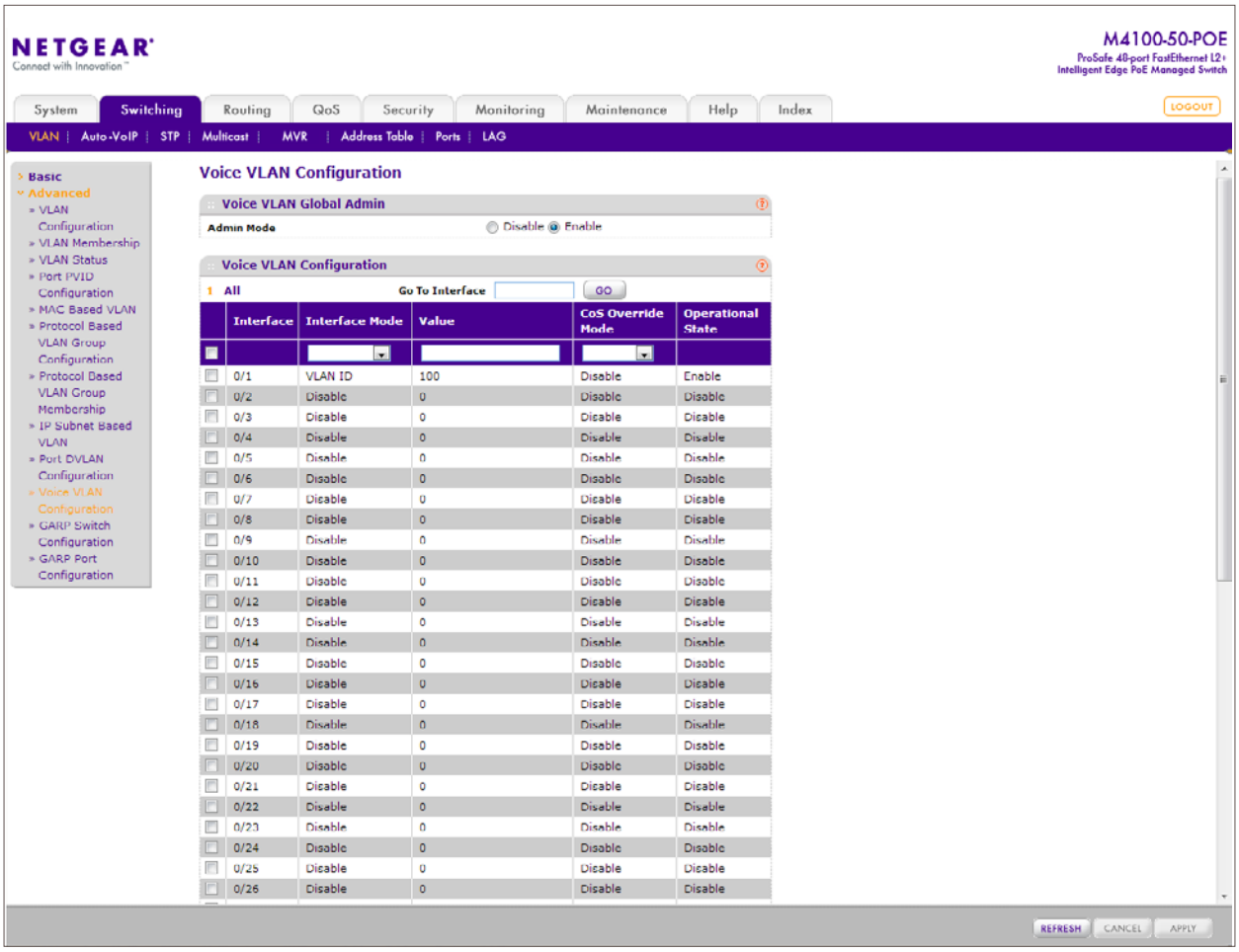
3. Configure the switch ports. Choose **Switching > VLAN > Advanced > VLAN Membership**. For each of the three VLANs, set all uplink ports to neighboring stacks as T for tagged. For the phone ports, set VLAN 100 as T for tagged and VLAN 200 as U for untagged. Click **APPLY** after configuring the ports for each VLAN.



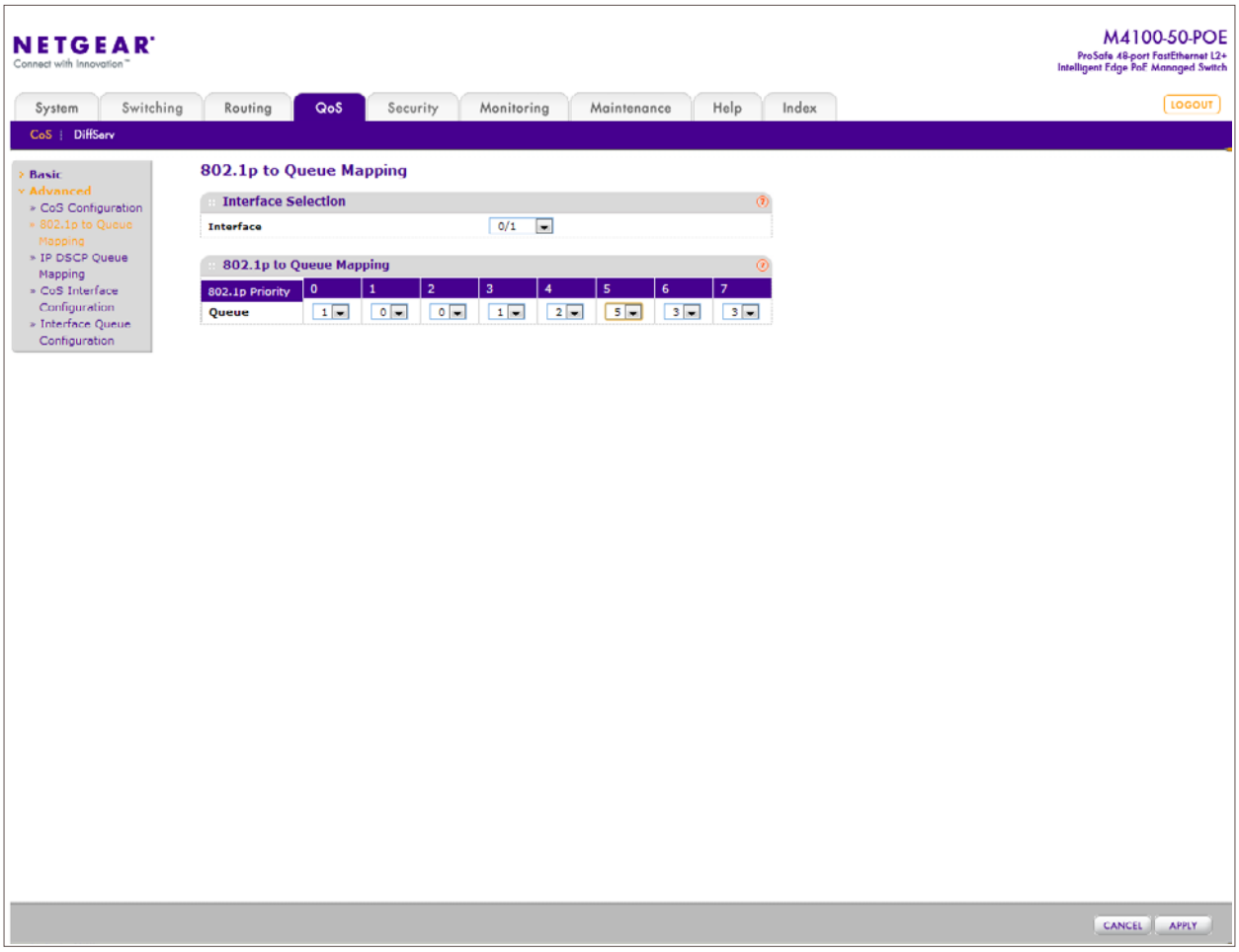
4. Configure the PVID for the data VLAN to pass through the phone's internal switch. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. For all of the phone ports, set Configured PVID to 200 for the data VLAN. Click **APPLY**.



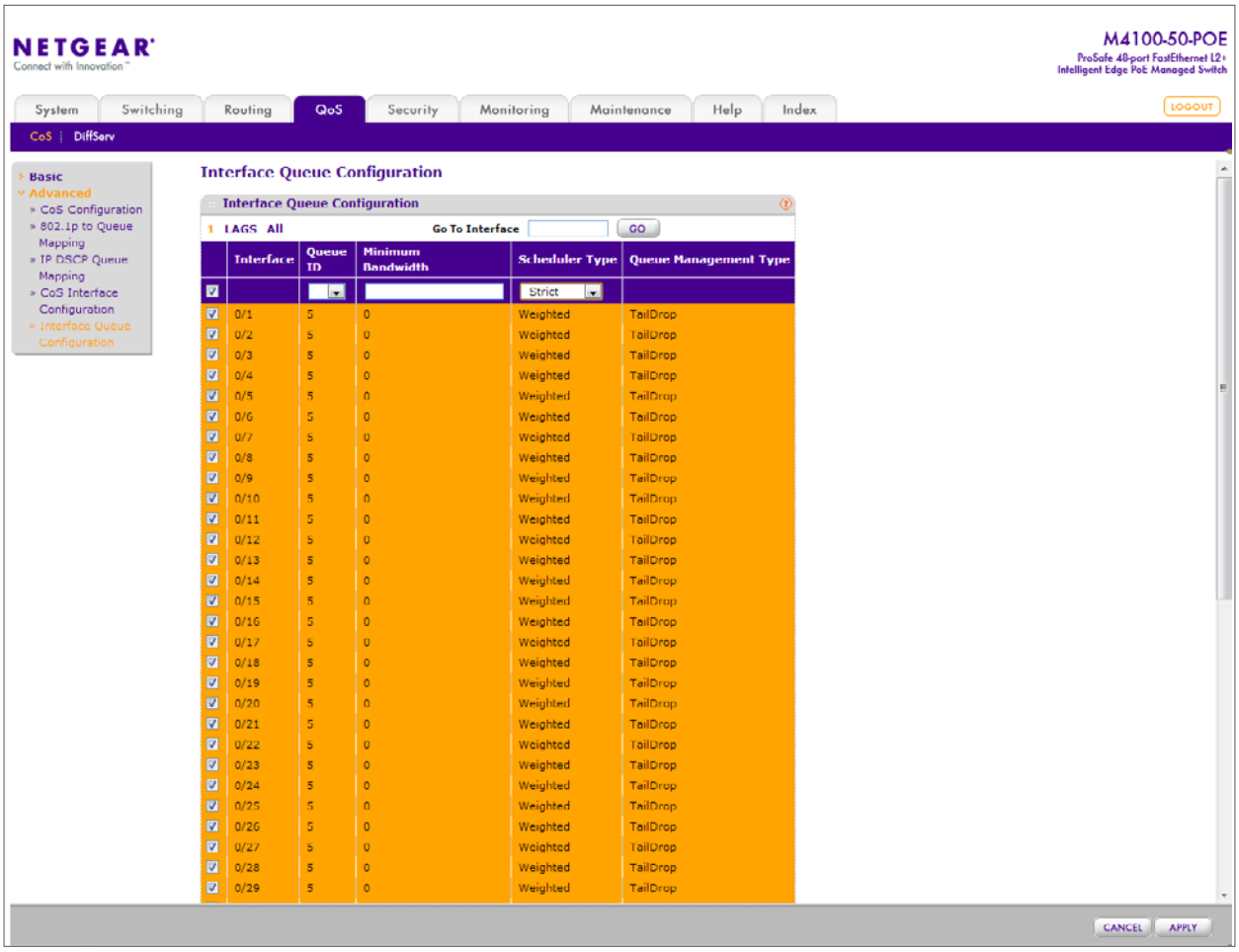
5. Enable the voice VLAN feature globally. Choose **Switching > VLAN > Advanced > Voice VLAN Configuration**. Enable Admin Mode and select all interfaces to support phones. Change the Interface Mode to VLAN ID and set Value to voice VLAN 100. Click **APPLY** to commit the changes.



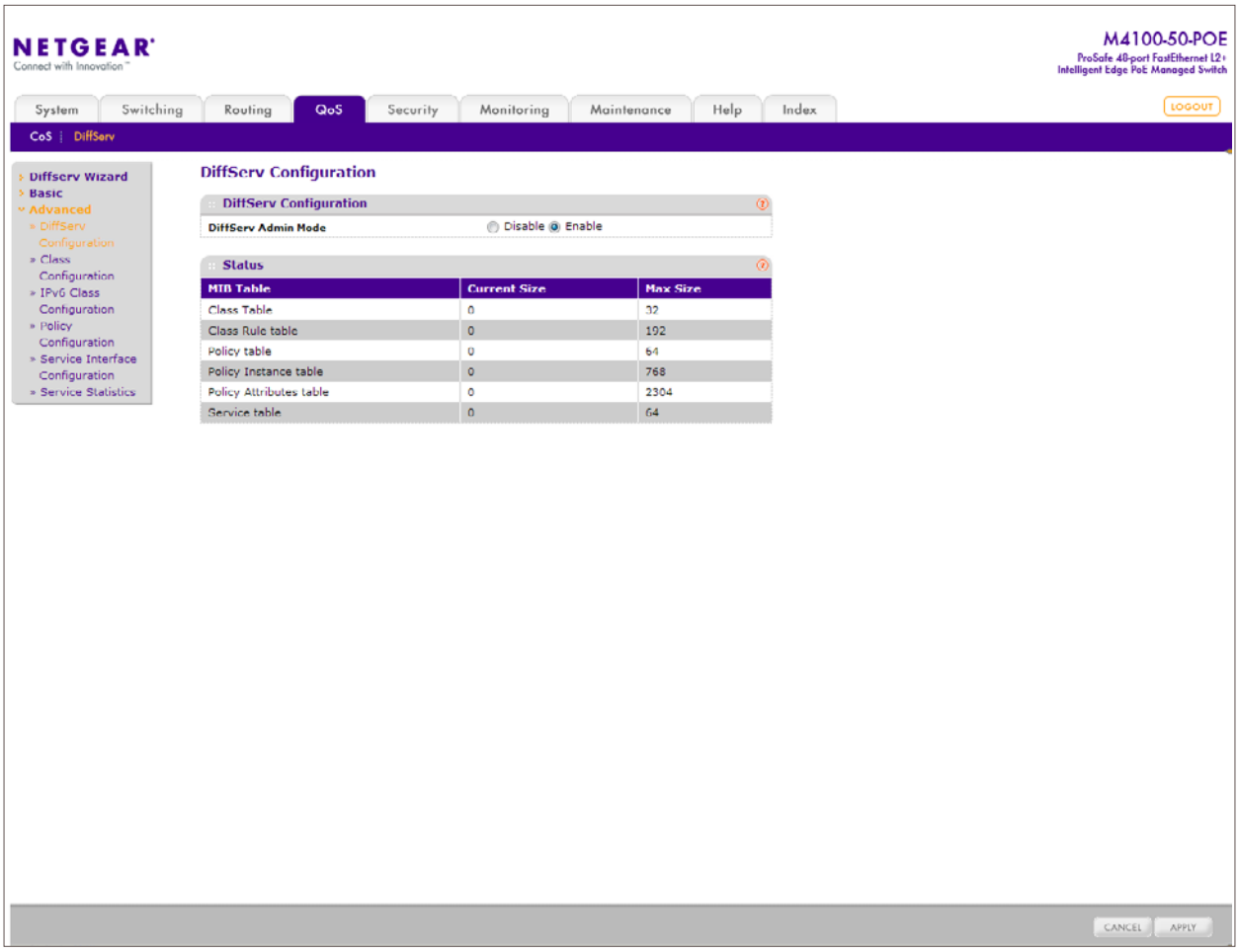
6. To queue and prioritize VoIP traffic properly, change the 802.1p queue mapping. Choose **QoS > CoS > Advanced > 802.1p to Queue Mapping**. Select All from the Interface Selection drop-down menu and change the Queue value to 5 for 802.1p Priority 5. Click **APPLY**.



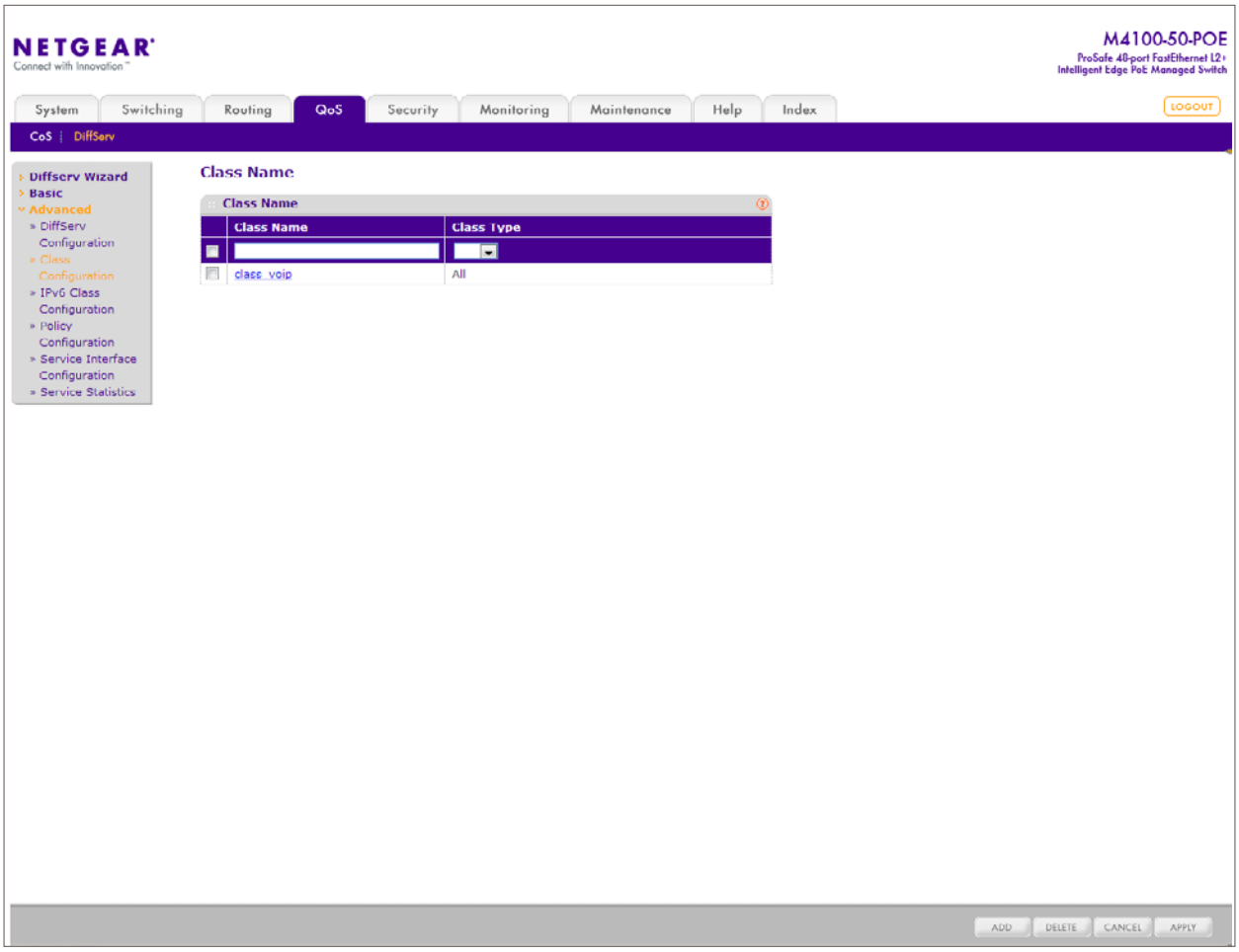
7. Assign queue priority to the phone ports. Choose **QoS > CoS > Advanced > Interface Queue Configuration**. Select all phone ports, change the Queue ID to 5, and change the Scheduler Type to Strict. Click **APPLY**.



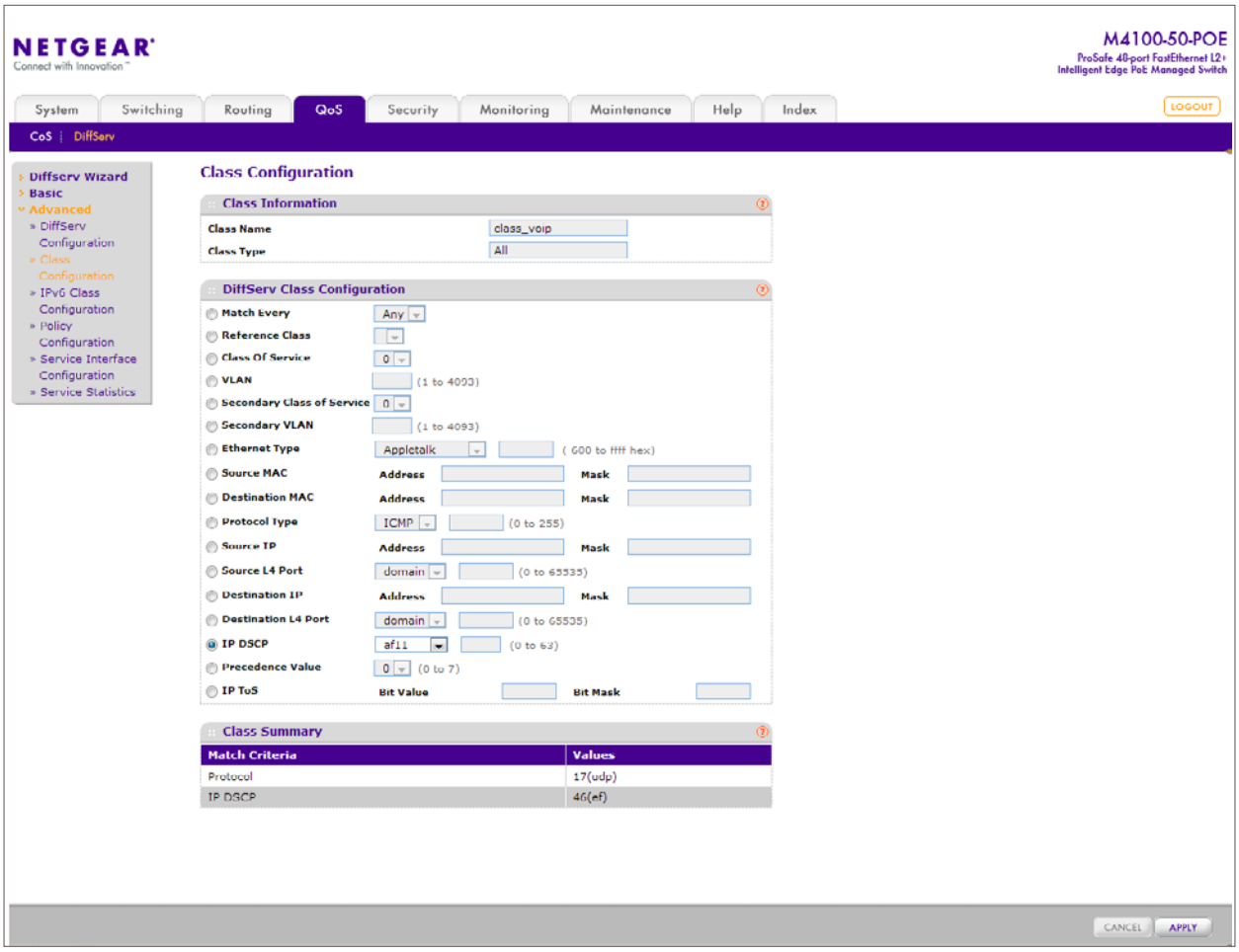
8. Enable the DiffServ feature. Choose Q**oS > DiffServ > Advanced > DiffServ Configuration.** Enable DiffServ Admin Mode and click **APPLY**.



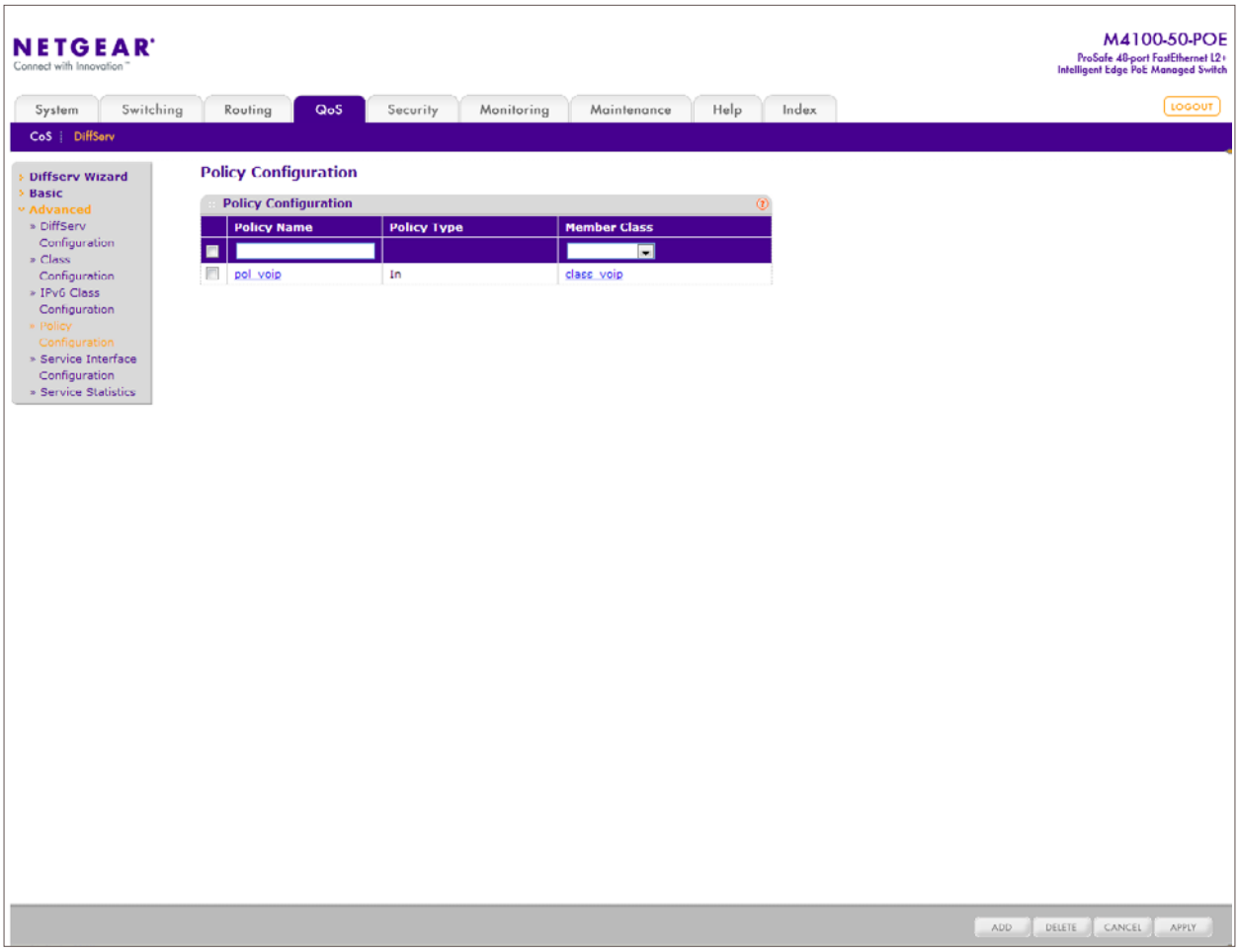
9. Create a DiffServ class for the DiffServ policy and queue VoIP traffic on the protocol level. Choose **QoS > DiffServ > Advanced > Class Configuration**. Enter the VoIP class name, change the Class Type to All, and click **ADD**. When the class is created, click athe class to open the VoIP class configuration page.



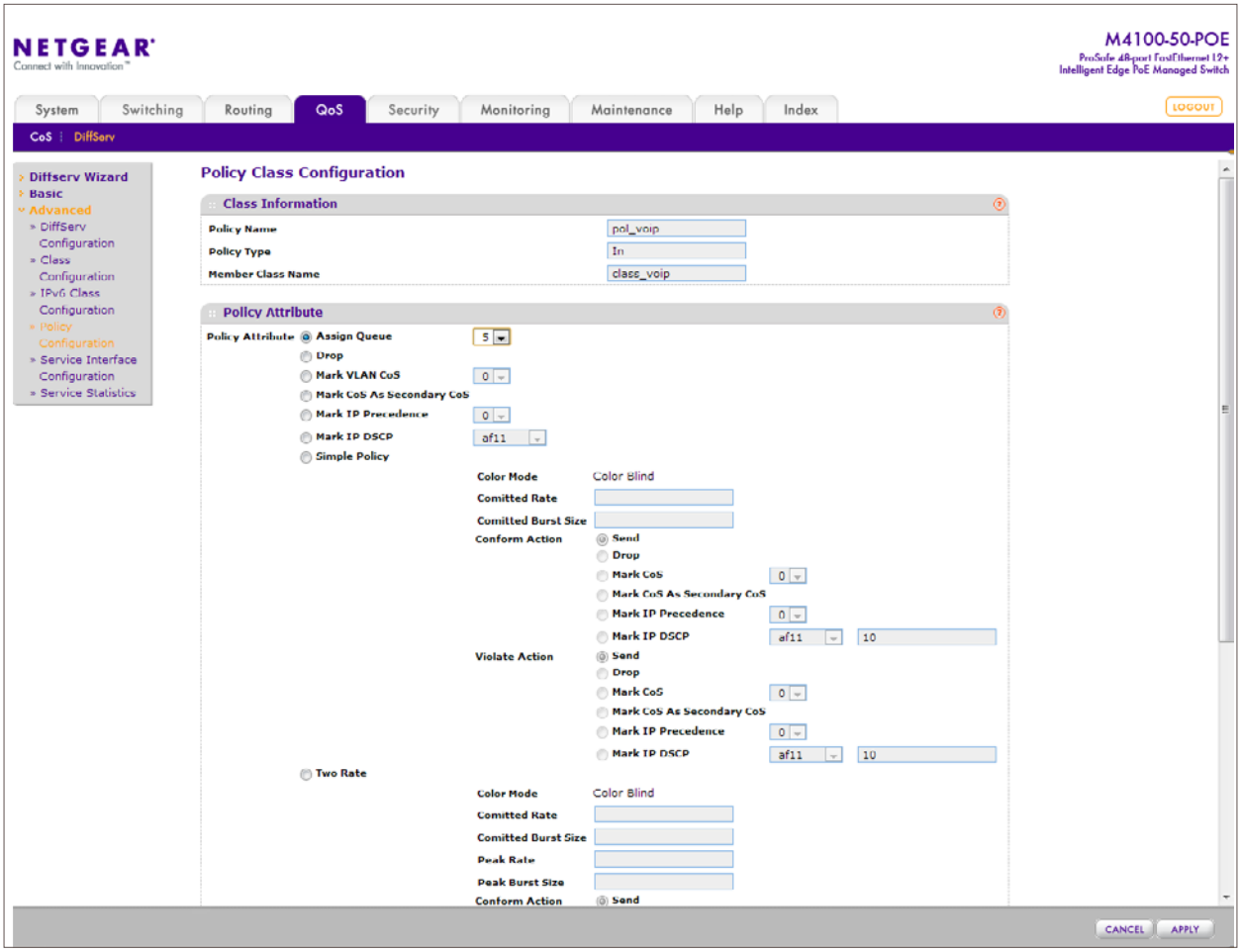
10. On the VoIP class configuration page, notice the various settings that can be applied to the class. Click Protocol Type and select UDP from the drop-down menu. Click **APPLY**. Then click IP DSCP and select EF from the drop-down menu. Click **APPLY**. Next, click Class of Service and select 5 from the drop-down menu. Click **APPLY**.



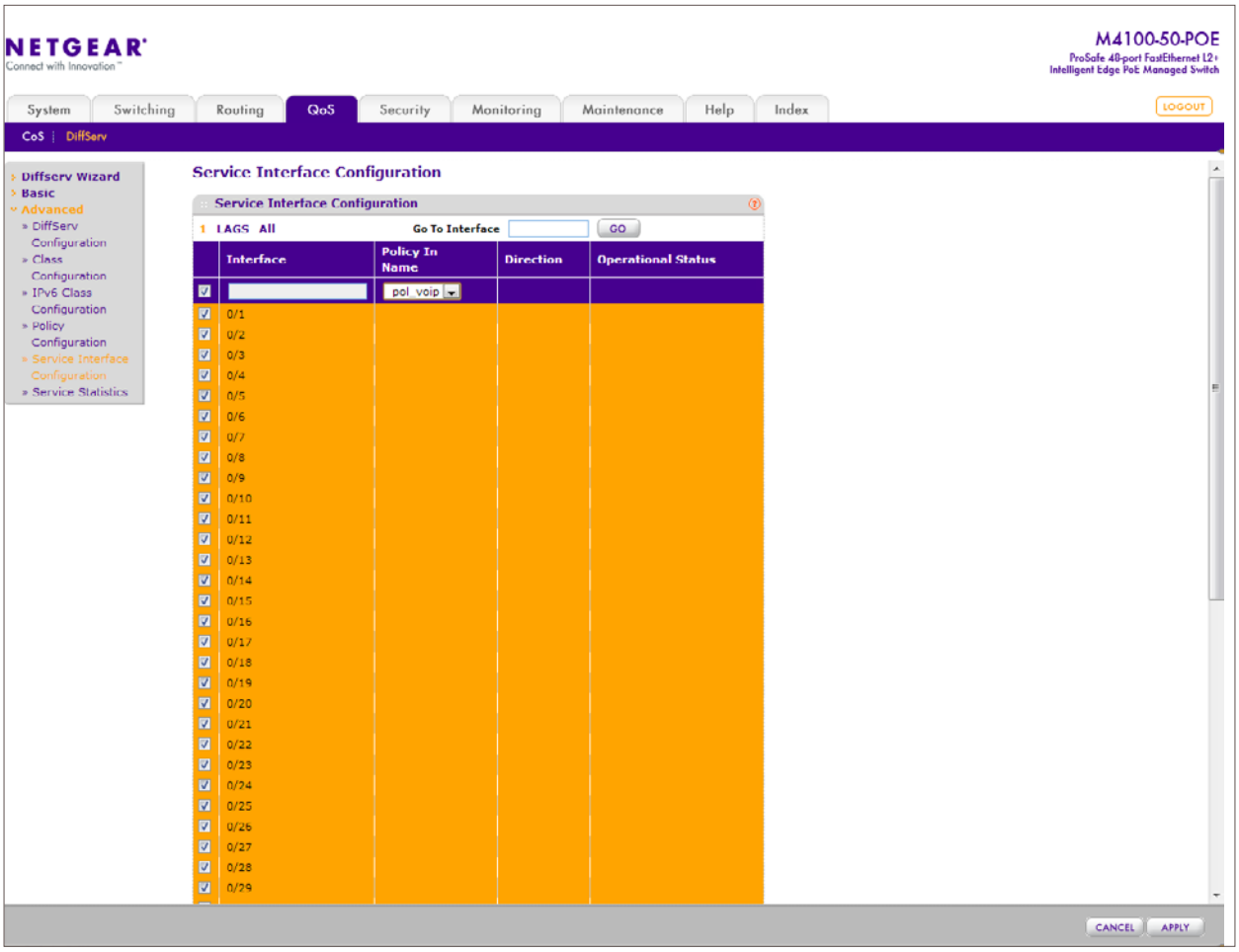
11. Apply the class to a policy map. To create the policy map, choose **QoS > DiffServ > Advanced > Policy Configuration**. Enter the VoIP policy name, change the Policy Type to In, and change the Member Class to the VoIP class you created. Click **ADD.** When the policy is created, click the VoIP policy to enter its configuration page.



12. On the VoIP policy configuration page, change the Assign Queue value to 5 and click **APPLY.**

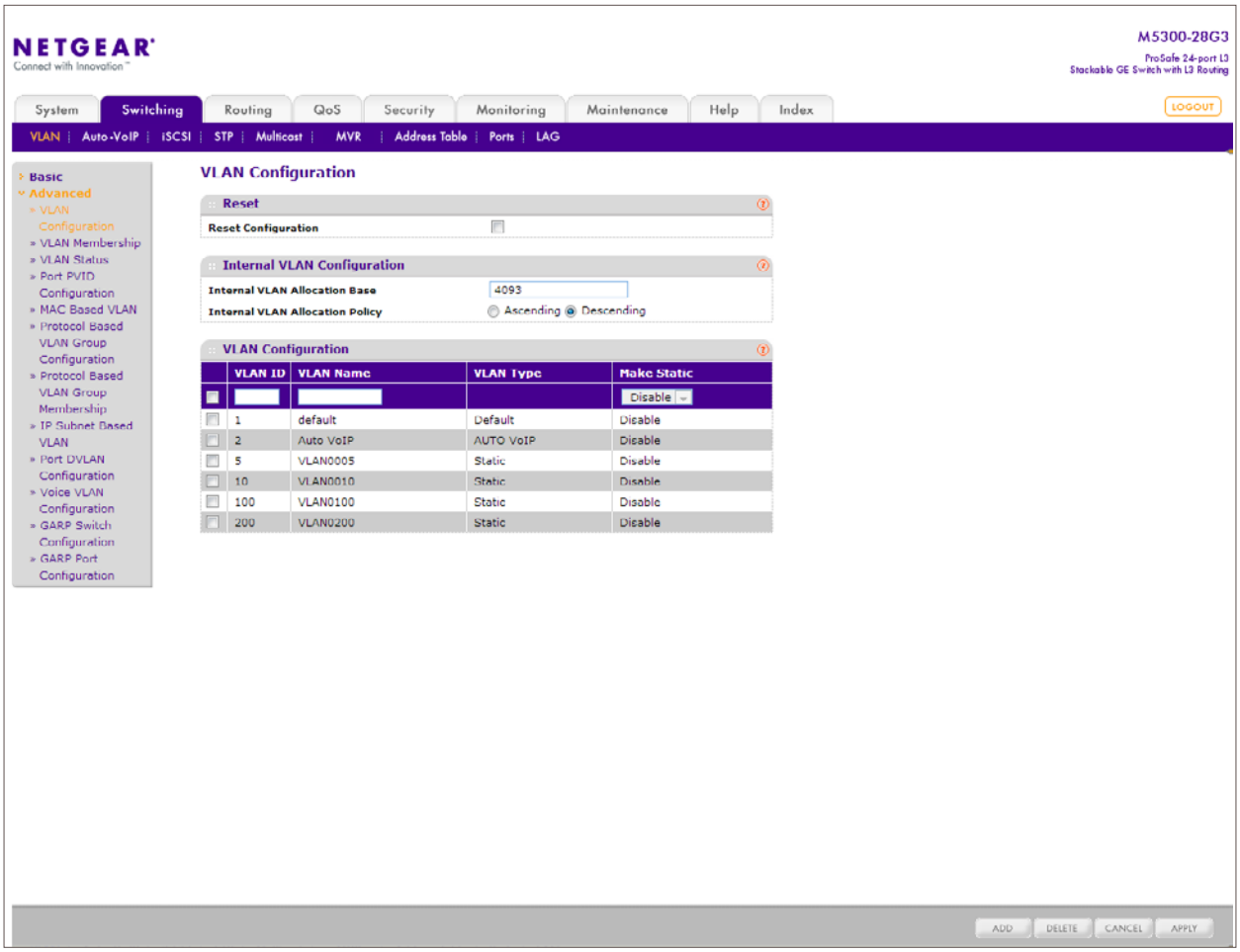


13. Apply the policy to all the phone ports. Choose **QoS > DiffServ > Advanced > Service Interface Configuration**. Select all phone ports and change the Policy In Name to the VoIP policy created. Click **APPLY**.

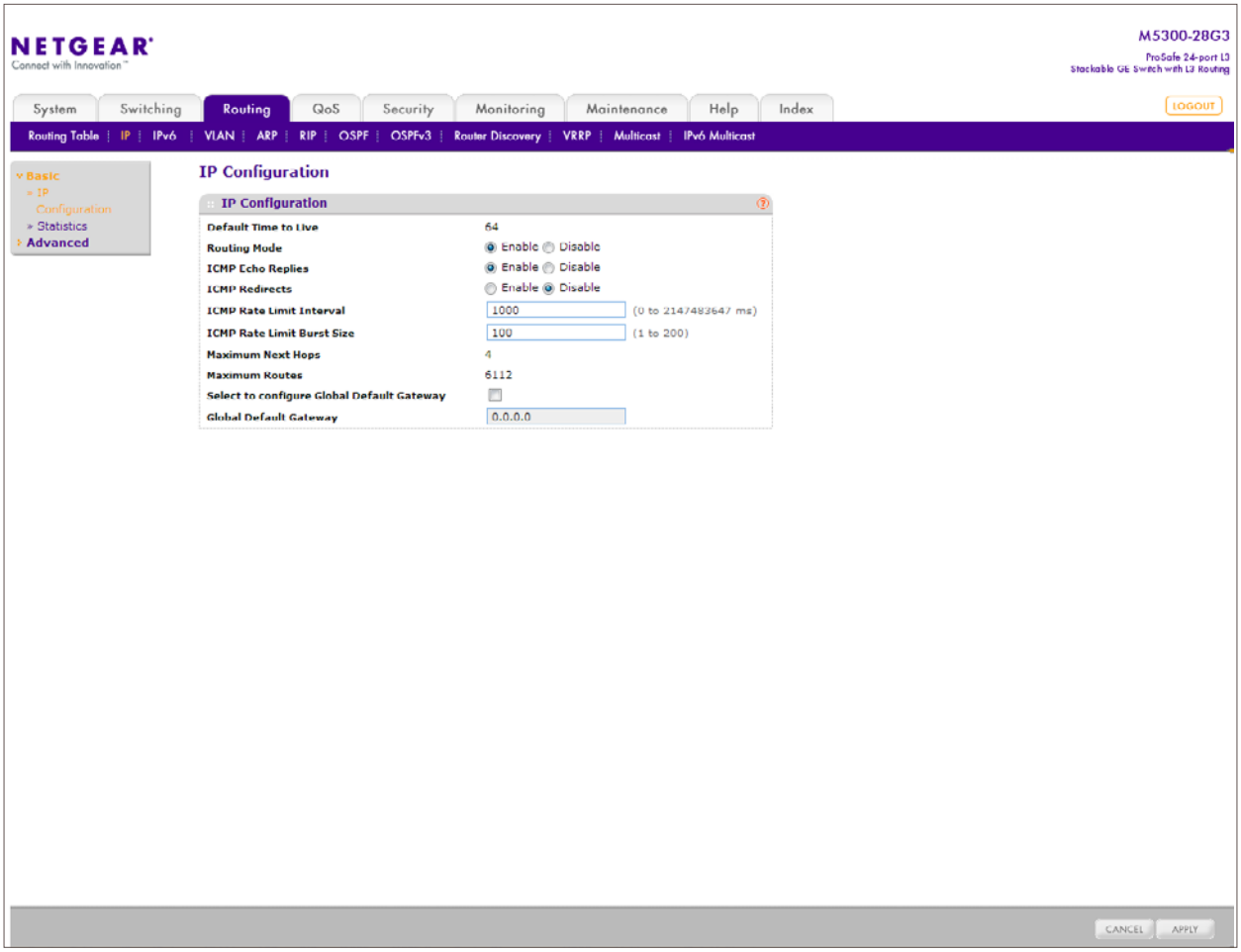


Switch – M5300-52G3

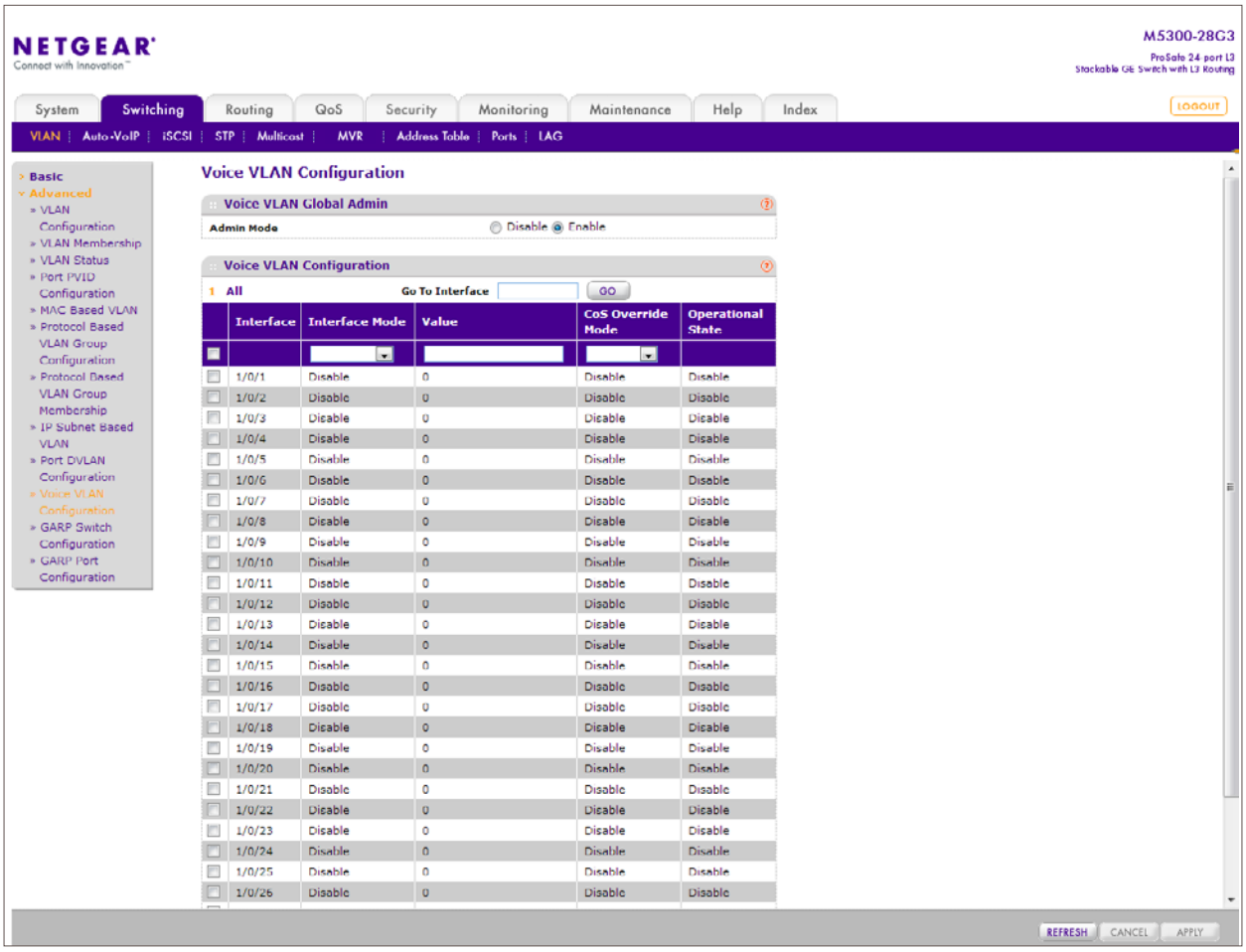
1. Create VLAN interfaces for the three subnets. Choose **Switching > VLAN > Advanced > VLAN Configuration**. Declare each VLAN ID and click **ADD** after each one.



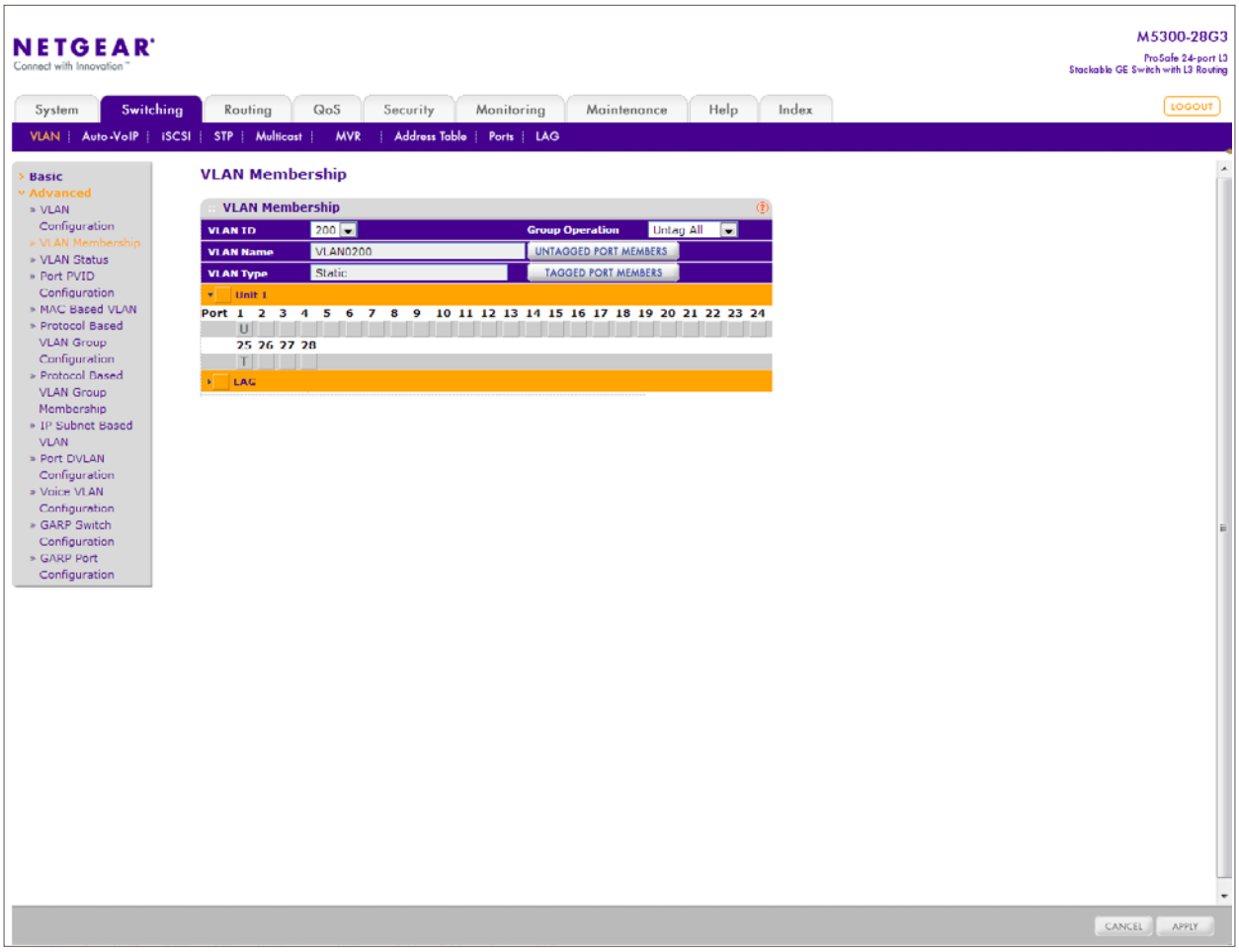
2. Choose **Routing > IP > Basic > IP Configuration** to enable routing globally. Enable Routing Mode and click **APPLY.**



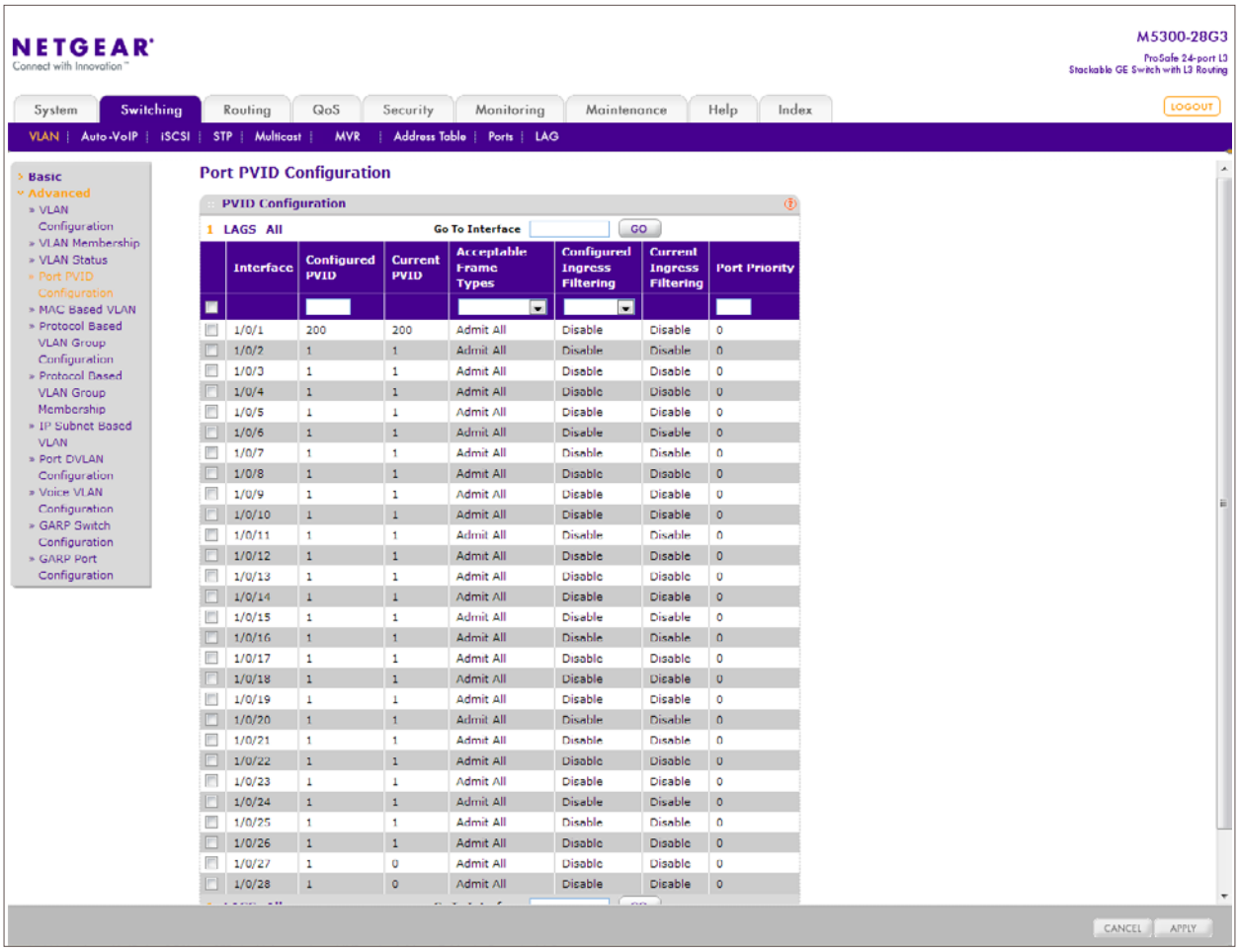
3. Enable the voice VLAN feature globally. Choose **Switching > VLAN > Advanced > Voice VLAN Configuration.** Enable Admin Mode and click **APPLY**.



4. Configure the switch ports. Choose **Switching > VLAN > Advanced > VLAN Membership**. For each of the three VLANs, set all uplink ports to neighboring stacks as T for tagged. For the other endpoints, set all ports to U for untagged on VLAN 200. Click **APPLY** after configuring the ports for each VLAN.



5. Configure the PVID for the endpoints on the data VLAN. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. For all of the phone ports, set Configured PVID to 200 and click **APPLY**.



CONFIGURATION FOR THE 1000-PHONE SOLUTION

Refer to Figure 3 for a diagram of the solution. You can use the CLI or Web GUI for configuration.

Assumptions for the 1000-Phone Solution

- A DHCP server on the switch will be used. If a third-party DCHP solution is used, refer to the vendor's documentation and the documentation for the phone backend to configure DHCP options.
- The VoIP network is a dedicated, isolated network with a single uplink to the customer's enterprise network.
- VoIP backend systems will be protected by security measures local to the individual systems. ACLs can be used to further restrict access but are not configured in this application note. Visit support.netgear.com for further information.
- The tested VoIP phones have an internal switch to support a second device connected to a secondary port on the phone, allowing a voice and data VLAN to be configured on the switch port.
- Tested phones are SIP-enabled Cisco 79x5 series phones, and the tested PBX system is an AsteriskNOW VM installation. Refer to vendor documentation for further configuration guidance on these platforms.
- Best practices are used to implement switch stacking and failover/redundancy.
- Layer 3 licenses have been installed on switches when necessary.

Global Configuration Notes

- Be sure to save your configuration using the **save** or **write** memory CLI command. Alternatively, choose **Maintenance > Save Config** in the GUI. Select the box, and click **APPLY**.
- Physical interfaces are referred to interfaces and ports interchangeably throughout this document.
- While the LLDP MED discovery protocol utilizes network policies, there is only one network policy available on these switches already assigned to the voice Vlan.
- While the management VLAN is used as the Layer 3 route between the switches in this application note, a separate VLAN can be used to further isolate communication.
- VoIP backend systems will be protected by security measures local to the individual systems. ACLs can be used to further restrict access but are not configured in this application note. Please visit support.netgear.com for further information.
- The default OSPF area ID is 0.0.0.0 but is stressed for technical purposes in this application note for more complex environments.
- While M5300-28G3 switches are used for illustrative purposes instead of the M5300-52G3 switches in the design, all configuration and features apply.

Sample Configuration Values

The following values are used in the sample configuration:

- Management VLAN: 5
- Management VLAN subnet: 192.168.10.0/24
- Infrastructure VLAN: 10
- Infrastructure VLAN subnet: 192.168.1.0/24
- Voice VLAN: 100
- Voice VLAN subnet: 192.168.100.0/24
- Data VLAN: 200
- Data VLAN subnet: 192.168.200.0/24

CLI Configuration Steps: 1000-Phone Solution

These steps provide an example CLI configuration for the 1000-phone solution. For the Web GUI configuration, see Web GUI Configuration Steps: 1000-Phone Solution on page 59.

Switch – XSM7224S

1. Create all of the VLAN interfaces on the XSM7224S stack and trunk them out to the neighboring stacks as necessary. Allocate VLANs and subnets as follows: management VLAN 5 (10.10.10.0/24) infrastructure VLAN 10 (192.168.1.0/24), voice VLAN 100 (192.168.100.0/22), and data VLAN 200 (192.168.200.0/21).

```
(XSM7224S) #vlan data
(XSM7224S) (Vlan)#vlan 5,10,100,20
(XSM7224S) (Vlan)#vlan routing
(XSM7224S) (Vlan)#vlan routing 1
(XSM7224S) (Vlan)#vlan routing 10
(XSM7224S) (Vlan)#vlan routing 20
(XSM7224S) (Vlan)#exit
(XSM7224S) #configure
(XSM7224S) (Config)#interface vlan 5
(XSM7224S) (Interface vlan 5)#ip address 10.10.10.1 255.255.255.0
(XSM7224S) (Interface vlan 5)#routing
(XSM7224S) (Interface vlan 5)#exit
(XSM7224S) (Config)#interface vlan 10
(XSM7224S) (Interface vlan 10)#ip address 192.168.1.1 255.255.255.0
(XSM7224S) (Interface vlan 10)#routing
(XSM7224S) (Interface vlan 10)#exit
(XSM7224S) (Config)#interface vlan 100
(XSM7224S) (Interface vlan 100)#ip address 192.168.100.1 255.255.252.0
(XSM7224S) (Interface vlan 100)#routing
(XSM7224S) (Interface vlan 100)#exit
(XSM7224S) (Config)#interface vlan 200
(XSM7224S) (Interface vlan 200)#routing
(XSM7224S) (Interface vlan 200)#ip address 192.168.200.1 255.255.248.0
(XSM7224S) (Interface vlan 200)#exit
```

2. Enable the built-in DHCP server and set up DHCP pools for the non-management subnets.

```
(XSM7224S) (Config)#service dhcp
(XSM7224S) (Config)#ip dhcp pool pool10
(XSM7224S) (Config-dhcp-pool)#default-router 192.168.1.1
(XSM7224S) (Config-dhcp-pool)#network 192.168.1.0 255.255.255.0
(XSM7224S) (Config-dhcp-pool)#exit
(XSM7224S) (Config)#ip dhcp pool pool100
(XSM7224S) (Config-dhcp-pool)#default-router 192.168.100.1
(XSM7224S) (Config-dhcp-pool)#network 192.168.100.0 255.255.255.0
(XSM7224S) (Config-dhcp-pool)#exit
(XSM7224S) (Config)#ip dhcp pool pool200
(XSM7224S) (Config-dhcp-pool)#default-router 192.168.200.1
(XSM7224S) (Config-dhcp-pool)#network 192.168.200.0 255.255.255.0
(XSM7224S) (Config-dhcp-pool)#exit
```

3. Add DHCP option 66 to the voice VLAN DHCP pool so that the phones can reach the TFTP server to download necessary firmware and configuration files upon boot-up. In this case, the TFTP server has an IP address of 192.168.1.100.

```
(XSM7224S) (Config)#ip dhcp pool pool100
(XSM7224S) (Config-dhcp-pool)#option 66 ascii 192.168.1.100
(XSM7224S) (Config-dhcp-pool)#exit
```

4. Enable IP routing globally.

```
(XSM7224S) (Config)#ip routing
```

5. Configure uplink ports to the neighboring switches. Configurations will be the same on both sides of the uplink. Add or remove VLANs as needed. All transported VLANs must be tagged to create the trunk.

```
(XSM7224S) (Config)#interface 1/0/25
(XSM7224S) (Interface 1/0/25)#vlan participation exclude 1
(XSM7224S) (Interface 1/0/25)#vlan participation include 5,10,100,200
(XSM7224S) (Interface 1/0/25)#vlan tagging 5,10,100,200
(XSM7224S) (Interface 1/0/25)#exit
```

6. After trunking the VLANS on the uplinks, configure the stack for OSPF routing. Enable OSPF and configure a router ID that is unique to each stack in the LAN. Configure OSPF to redistribute any connected routes.

```
(XSM7224S) (Config)#router ospf
(XSM7224S) (Config-router)#enable
(XSM7224S) (Config-router)#router-id 10.10.10.1
(XSM7224S) (Config-router)#redistribute connected
(XSM7224S) (Config-router)#exit
```

7. Configure the routable VLAN interfaces for the same OSPF area ID.

```
(XSM7224S) (Config)#interface vlan 5
(XSM7224S) (Interface vlan 5)#ip ospf area 0.0.0.0
(XSM7224S) (Interface vlan 5)#exit
(XSM7224S) (Config)#interface vlan 10
(XSM7224S) (Interface vlan 10)#ip ospf area 0.0.0.0
(XSM7224S) (Interface vlan 10)#exit
(XSM7224S) (Config)#interface vlan 100
(XSM7224S) (Interface vlan 100)#ip ospf area 0.0.0.0
(XSM7224S) (Interface vlan 100)#exit
(XSM7224S) (Config)#interface vlan 200
(XSM7224S) (Interface vlan 200)#ip ospf area 0.0.0.0
(XSM7224S) (Interface vlan 200)#exit
```

8. Configure infrastructure ports. For all VoIP device interfaces, set the configured PVID to infrastructure VLAN 10.

```
(XSM7224S) (Config)#interface 1/0/21
(XSM7224S) (Interface 1/0/21)#vlan participation exclude 1
(XSM7224S) (Interface 1/0/21)#vlan participation include 10
(XSM7224S) (Interface 1/0/21)#vlan pvid 10
(XSM7224S) (Interface 1/0/21)#exit
(XSM7224S) (Config)#exit
```

Switch – M5300-52G-POE+

1. Move to the M5300-52G-POE+ stacks to replicate the configuration on each one. Start by declaring VLANs 5, 10, 100, and 200.

```
(M5300-52G-POE+) #vlan database
(M5300-52G-POE+) (Vlan)#vlan 5,10,100,200
(M5300-52G-POE+) (Vlan)#exit
```

2. Enable routing and configure the management VLAN interface to be able to participate in OSPF routing. In this example, the switch has IP address 10.10.10.5.

```
(M5300-52G-POE+) #vlan database
(M5300-52G-POE+) (Vlan)#vlan routing 5
(M5300-52G-POE+) (Vlan)#exit
(M5300-52G-POE+) #configure
(M5300-52G-POE+) (Config)#vlan interface 5
(M5300-52G-POE+) (Interface vlan 5)#routing
(M5300-52G-POE+) (Interface vlan 5)#ip address 10.10.10.5 255.255.255.0
(M5300-52G-POE+) (Interface vlan 5)#exit
```

3. Enable IP routing.

```
(M5300-52G-POE+) #configure
(M5300-52G-POE+) (Config)#ip routing
```

4. Configure the uplink to the XSM7224S stack. Remember both sides of the uplink must have the same configuration. All transported VLANs must be tagged to create the trunk.

```
(M5300-52G-POE+) (Config)#interface 1/0/49
(M5300-52G-POE+) (Interface 1/0/49)#vlan participation exclude 1
(M5300-52G-POE+) (Interface 1/0/49)#vlan participation include 5,10,100,200
(M5300-52G-POE+) (Interface 1/0/49)#vlan tagging 5,10,100,200
(M5300-52G-POE+) (Interface 1/0/49)#exit
```

5. After trunking the VLANs on the uplinks, configure the stack for OSPF routing. Enable OSPF and configure a router ID that is unique to each stack in the LAN. Configure OSPF to redistribute any connected routes.

```
(M5300-52G-POE+) (Config)#router ospf
(M5300-52G-POE+) (Config-router)#enable
(M5300-52G-POE+) (Config-router)#router-id 10.10.10.5
(M5300-52G-POE+) (Config-router)#redistribute connected
(M5300-52G-POE+) (Config-router)#exit
```

6. Configure the correct OSPF area ID for the management VLAN interfae.

```
(M5300-52G-POE+) (Config)#interface vlan 5
(M5300-52G-POE+) (Interface vlan 5)#ip ospf area 0.0.0.0
(M5300-52G-POE+) (Interface vlan 5)#exit
```

7. Raise the VoIP traffic priority and enable the voice VLAN feature as on the XSM7224S stack. Send VoIP traffic with a dot1p priority of 5 and map priority 5 to queue 5.

```
(M5300-52G-POE+) (Config)# classofservice dot1p-mapping 5 5
(M5300-52G-POE+) (Config)#cos-queue strict 5
(M5300-52G-POE+) (Config)#voice vlan
```

8. Enable the LLDP-MED discovery protocol, which works in conjuction with the voice VLAN feature to auto-detect a phone on a port and apply the appropriate QoS and voice VLAN.

```
(M5300-52G-POE+) (Config)#lldp med all
```

9. Create a Diffserv class map policy to provide QoS for voice traffic on on the phone ports. This policy will be copied onto all stacks in the LAN that support VoIP devices.

```
(M5300-52G-POE+) (Config)#diffserv
(M5300-52G-POE+) (Config)#class-map match-all class_voip
(M5300-52G-POE+) (Config-classmap)#match protocol udp
(M5300-52G-POE+) (Config-classmap)#match ip dscp ef
(M5300-52G-POE+) (Config-classmap)#exit
(M5300-52G-POE+) (Config)#policy-map pol_voip in
(M5300-52G-POE+) (Config-policy-map)#class class_voip
(M5300-52G-POE+) (Config-policy-classmap)#assign-queue 5
(M5300-52G-POE+) (Config-policy-classmap)#exit
(M5300-52G-POE+) (Config-policy-map)#exit
```

10. Configure the phone ports to auto-register on voice VLAN 100 and pass data VLAN 200 to the phone's secondary port. If there is no phone detected on the port, the connected device will use the data VLAN. Make sure to place them in the correct OSPF area. Assign the DiffServ voice policy to the phone ports.

```
(M5300-52G-POE+) (Config)#interface 0/1
(M5300-52G-POE+) (Interface 0/1)#voice vlan 100
(M5300-52G-POE+) (Interface 0/1)#vlan participation exclude 200
(M5300-52G-POE+) (Interface 0/1)#vlan participation include 100,200
(M5300-52G-POE+) (Interface 0/1)#vlan pvid 200
(M5300-52G-POE+) (Interface 0/1)#service-policy in pol_voip
(M5300-52G-POE+) (Interface 0/1)#exit
```

Switch - M5300-52G3

1. Declare the VLANs and enable IP routing and the voice VLAN features globally.

```
(M5300-52G3) #vlan database
(M5300-52G3) (Vlan)#vlan 5,10,100,200
(M5300-52G3) (Vlan)#exit
(M5300-52G3) #configure
(M5300-52G3) (Config)#ip routing
(M5300-52G3) (Config)#voice vlan
```

2. Enable routing and configure the management VLAN interface to be able participate in OSPF routing. In this example, the management IP address is 10.10.10.10.

```
(M5300-52G3) #vlan database
(M5300-52G3) (Vlan)#vlan routing 5
(M5300-52G3) (Vlan)#exit
(M5300-52G3) #configure
(M5300-52G3) (Config)#vlan interface 5
(M5300-52G3) (Interface vlan 5)#routing
(M5300-52G3) (Interface vlan 5)#ip address 10.10.10.10 255.255.255.0
(M5300-52G3) (Interface vlan 5)#exit
```

3. Configure the uplink to the XSM7224S stack. Both sides of the uplink must have the same configuration. All transported VLANs must be tagged to create the trunk.

```
(M5300-52G3) (Config)#interface 1/0/49
(M5300-52G3) (Interface 1/0/49)#vlan participation exclude 1
(M5300-52G3) (Interface 1/0/49)#vlan participation include 5,10,100,200
(M5300-52G3) (Interface 1/0/49)#vlan tagging 5,10,100,200
(M5300-52G3) (Interface 1/0/49)#exit
```

4. After trunking the VLANs on the uplinks, configure the stack for OSPF routing. Enable OSPF and configure a router ID that is unique to each stack in our LAN. Configure OSPF to redistribute any connected routes.

```
(M5300-52G3) (Config)#router ospf
(M5300-52G3) (Config-router)#enable
(M5300-52G3) (Config-router)#router-id 10.10.10.10
(M5300-52G3) (Config-router)#redistribute connected
```

5. Configure the management VLAN interface with the correct OSPF area ID.

```
(M5300-52G3) (Config)#interface vlan 5
(M5300-52G3) (Interface vlan 5)#ip ospf area 0.0.0.0
(M5300-52G3) (Interface vlan 5)#exit
```

6. Finish the configuration by configuring any ports with the necessary VLAN (data VLAN 200).

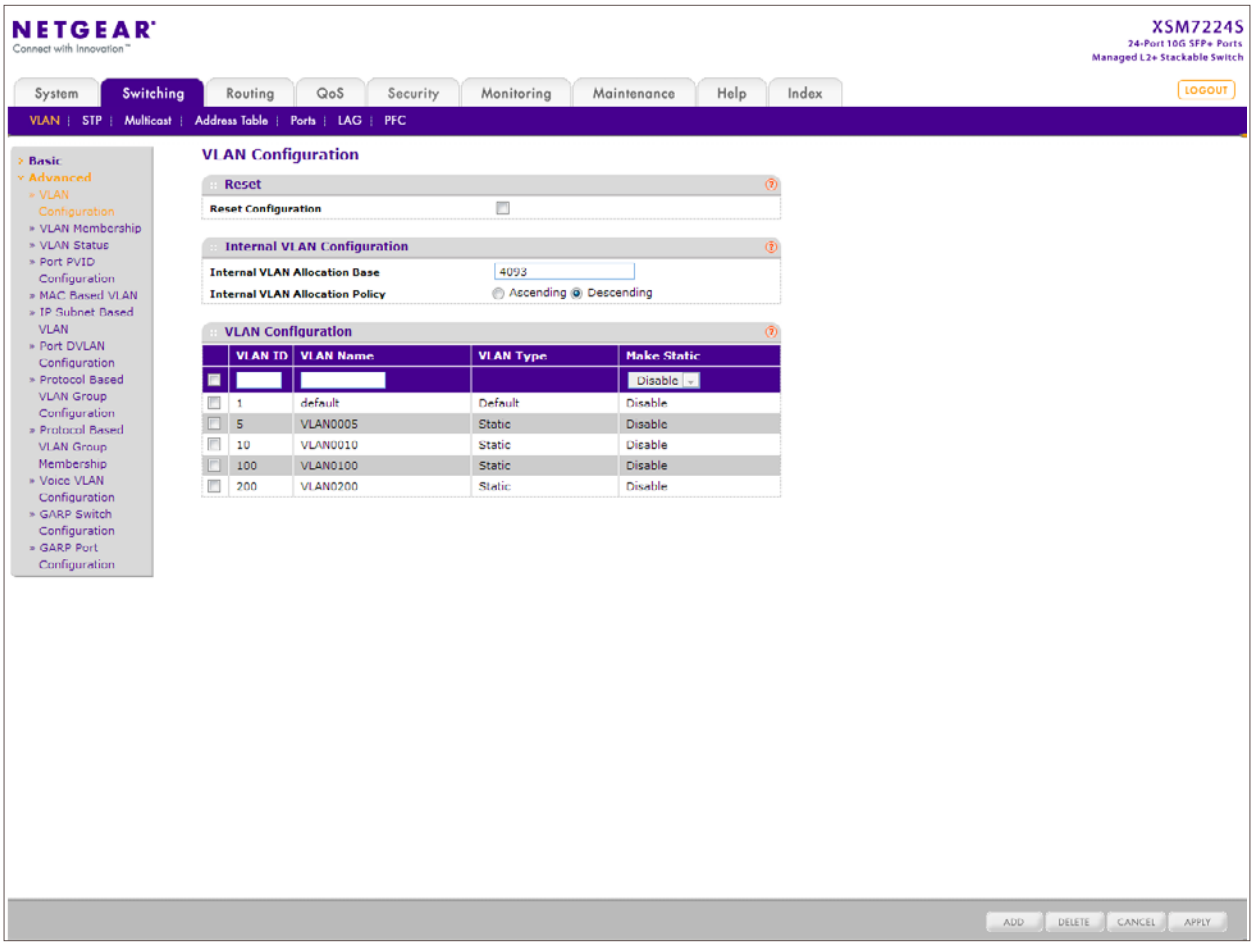
```
(M5300-52G3) (Config)#interface 1/0/1
(M5300-52G3) (Interface 1/0/1)#vlan participation exclude 1
(M5300-52G3) (Interface 1/0/1)#vlan participation include 200
(M5300-52G3) (Interface 1/0/1)#vlan pvid 200
(M5300-52G3) (Interface 1/0/1)#exit
(M5300-52G3) (Config)#exit
```

Web GUI Configuration Steps: 1000-Phone Solution

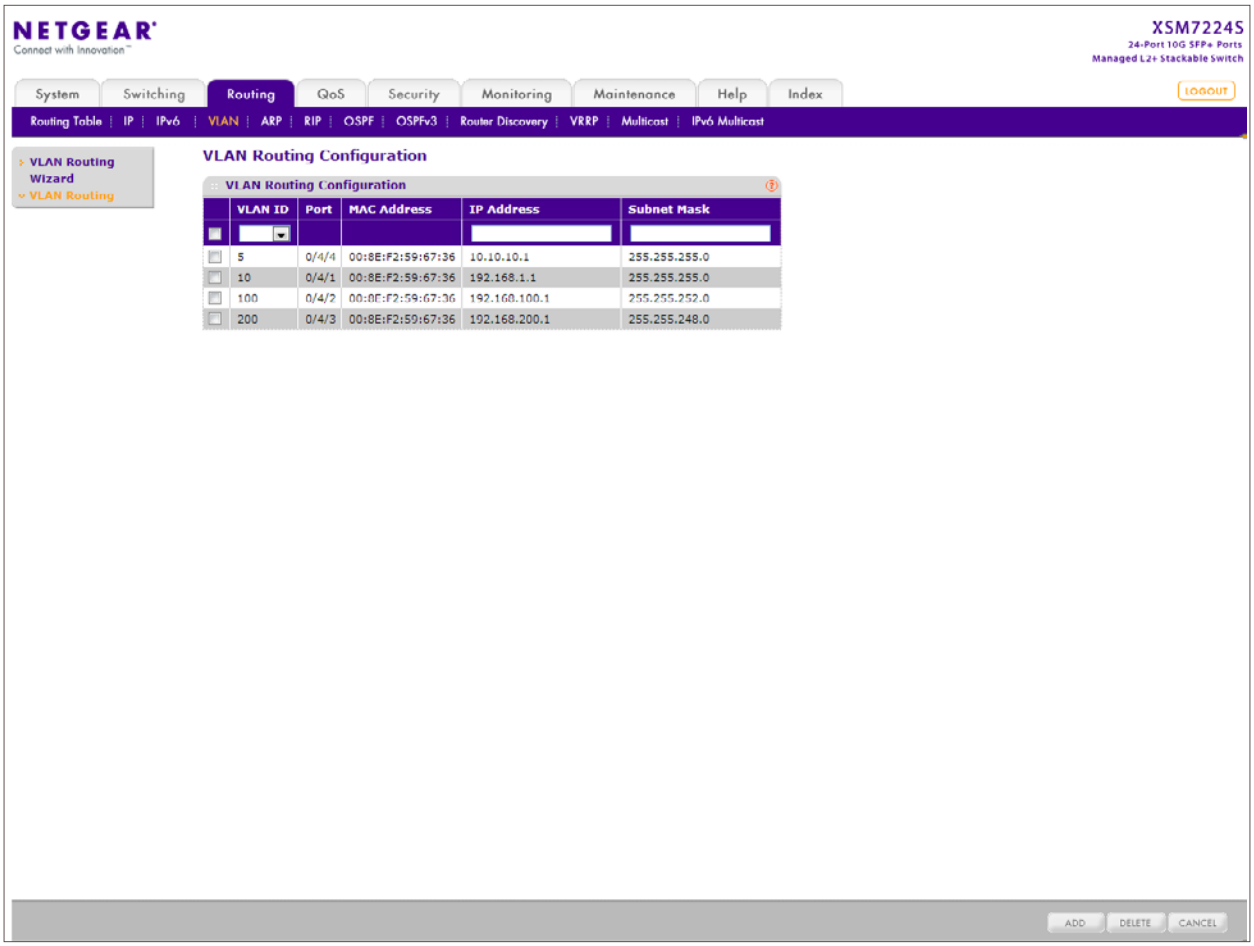
These steps provide an example Web GUI configuration for the 1000-phone solution. For the CLI configuration, see CLI Configuration Steps: 1000-Phone Solution on page 53.

Switch – XSM7224S

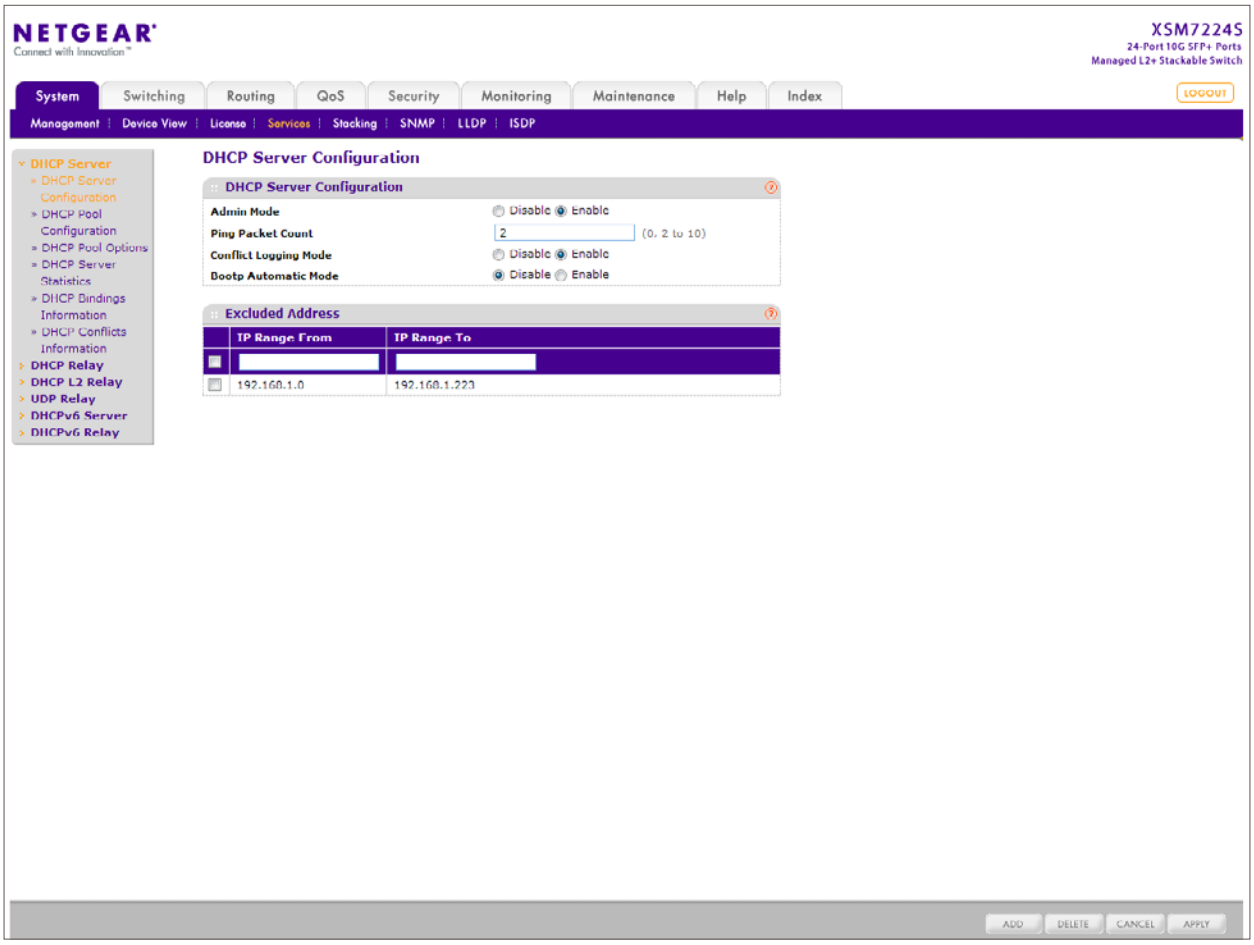
1. Create VLAN interfaces for the subnets: management (VLAN ID 5), infrastructure (VLAN ID 10), voice (VLAN ID 100), and data (VLAN ID 200). Choose S**witching > VLAN > Advanced > VLAN Configuration**. Declare each VLAN ID and click **ADD** after each one.



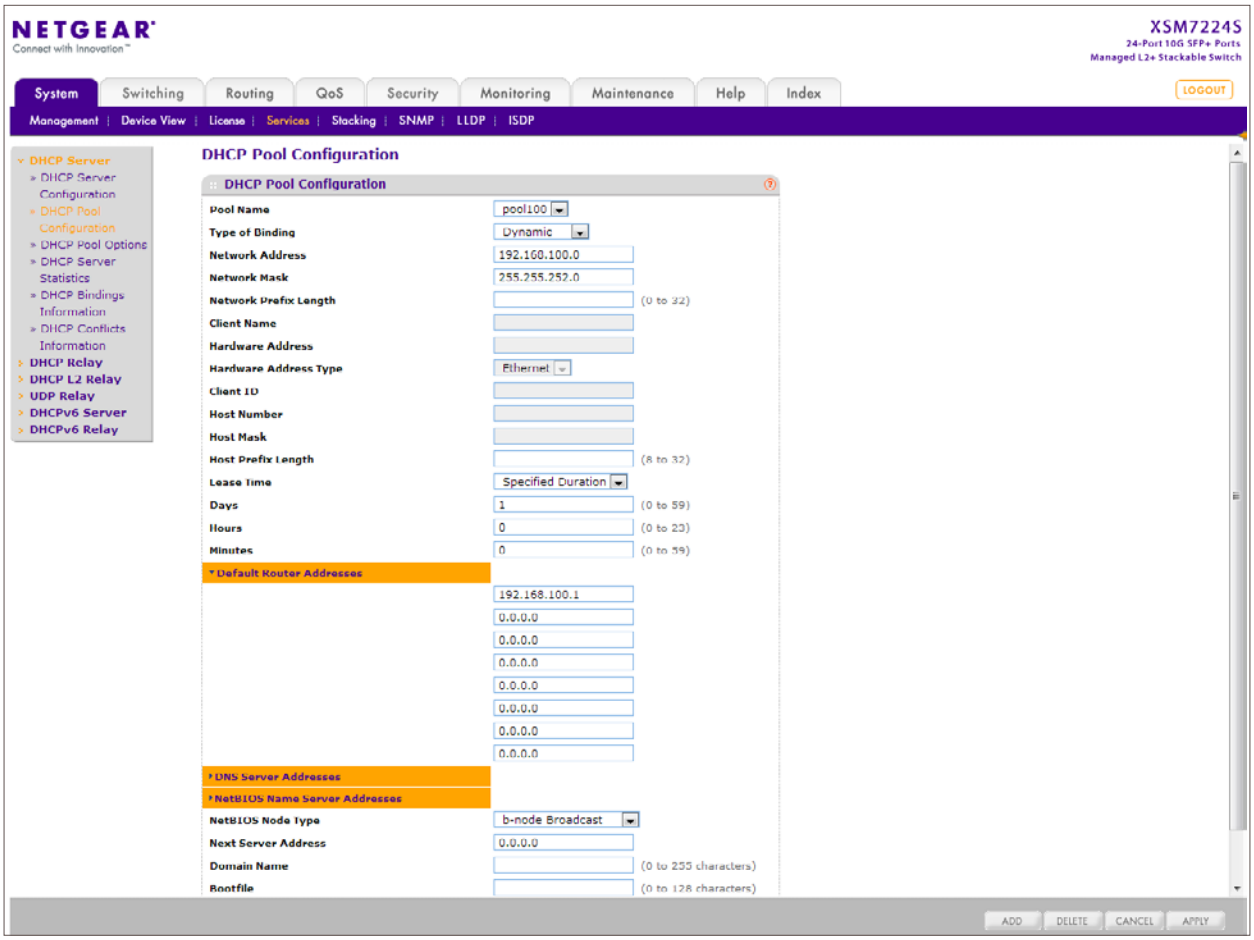
2. Choose **Routing > VLAN > VLAN Routing**. Configure each VLAN interface and enable routing on it. Allocate VLANs and subnets as follows: management VLAN 5 (10.10.10.0/24), infrastructure VLAN 10 (192.168.1.0/24), voice VLAN 100 (192.168.100.0/24), and data VLAN 200 (192.168.200.0/24). Select the VLAN ID and enter the corresponding gateway IP address and subnet mask for each. Click **ADD** after completing each entry.



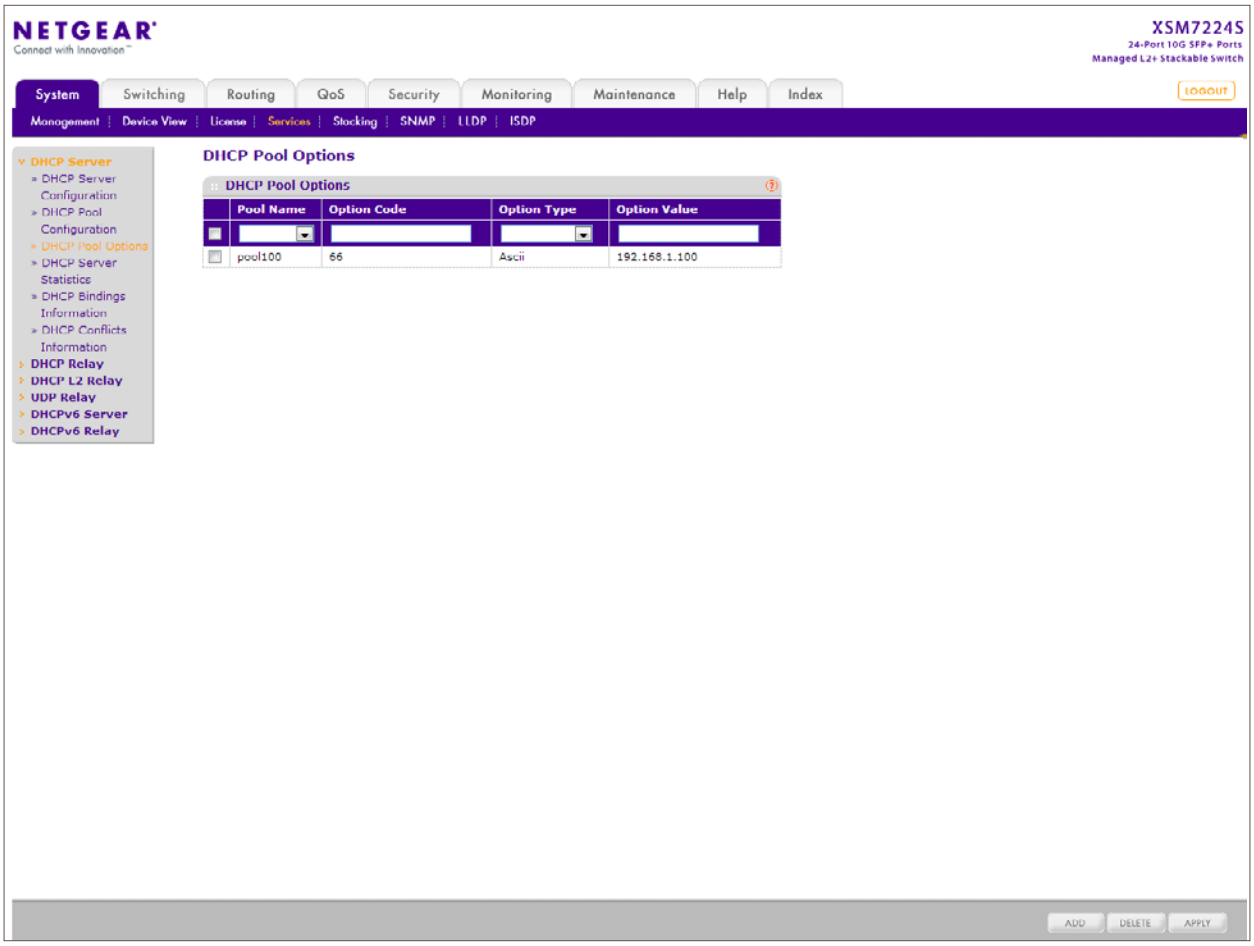
3. Choose **System > Services > DHCP Server > DHCP Server Configuration**. Enable Admin Mode and click **APPLY.** You can also configure any IP address ranges to exclude from the DHCP pools. Click **ADD** after configuring any excluded ranges for static IP addresses.



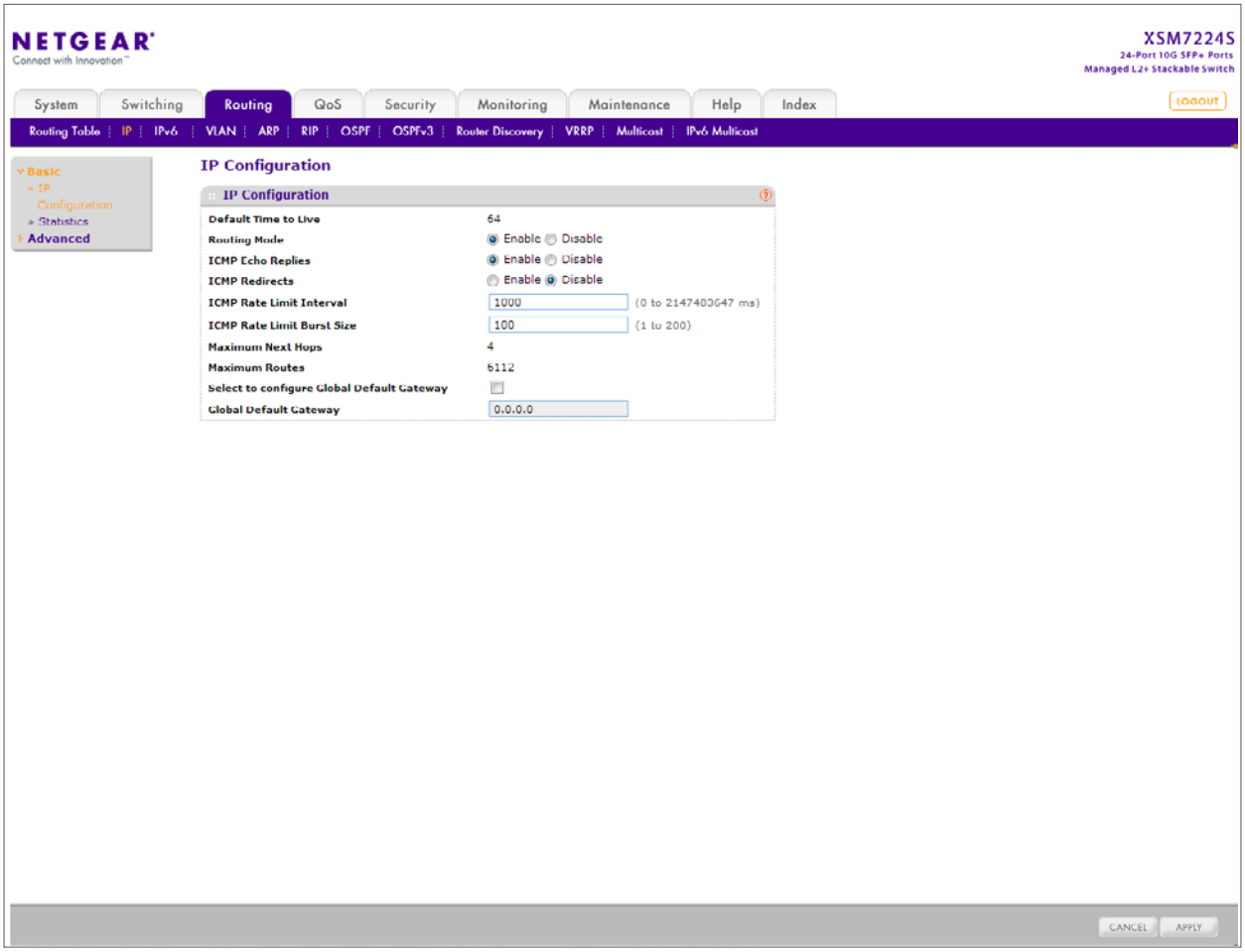
4. Choose S**ystem > Services > DHCP Server > DHCP Pool Configuration**. Create a pool for each subnet associated with the VLANs. Set Type of Binding to Dynamic and enter the address and gateway for each. Set Default Router Address to the IP of the subnet gateway. Optionally change the lease time. Click **ADD**.



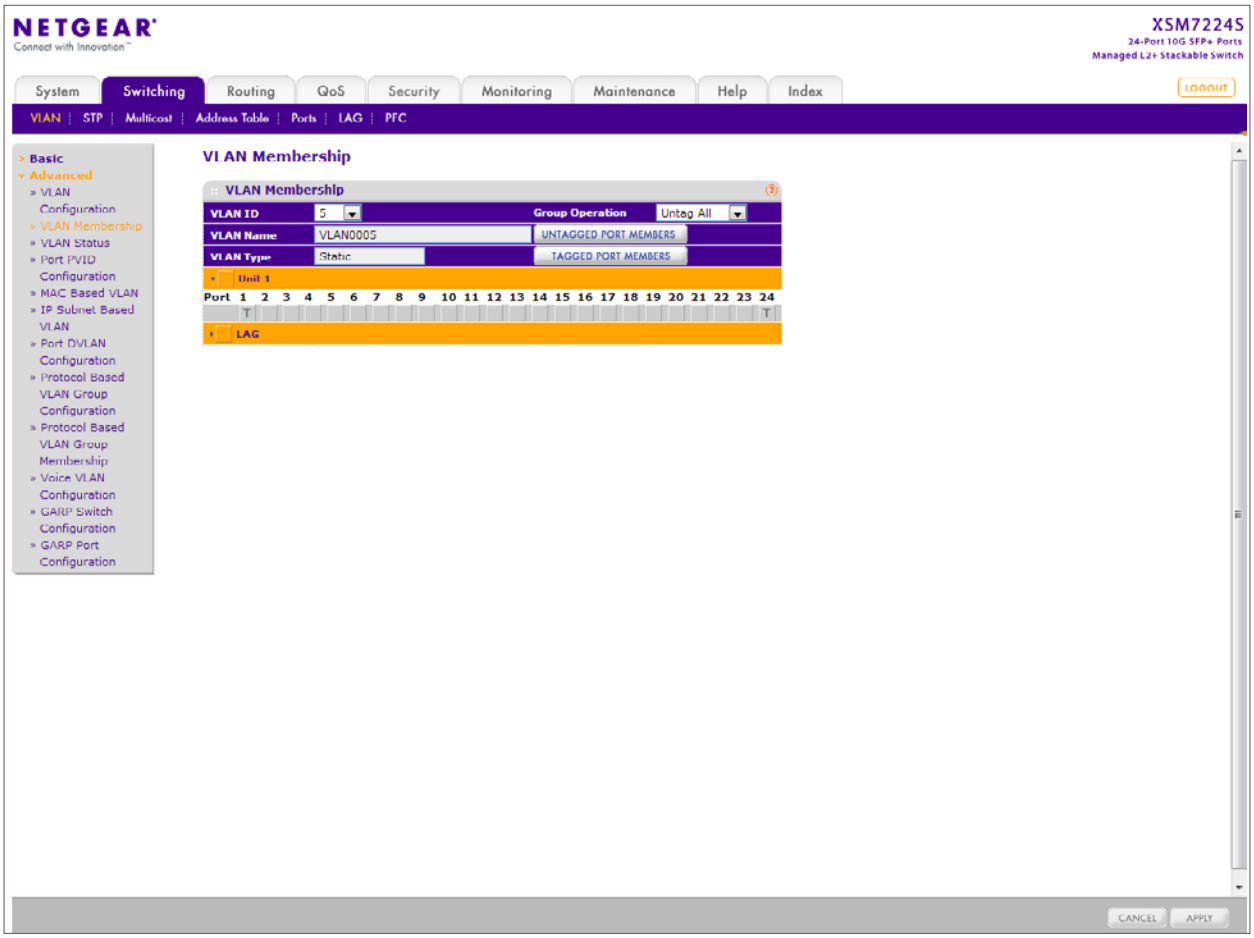
5. Set DHCP option 66 on voice VLAN 100 so that the phones can download firmware and configuration files from a TFTP server. Choose **System > Services > DHCP Server > DHCP Pool Options**. Select the pool name for the VLAN 100 DHCP pool. Enter 66 for Option Code, select Ascii as the Option Type, and enter the TFTP server IP address as Option Value. In this example, the TFTP server's address is 192.168.1.100. Click **ADD** to save changes.



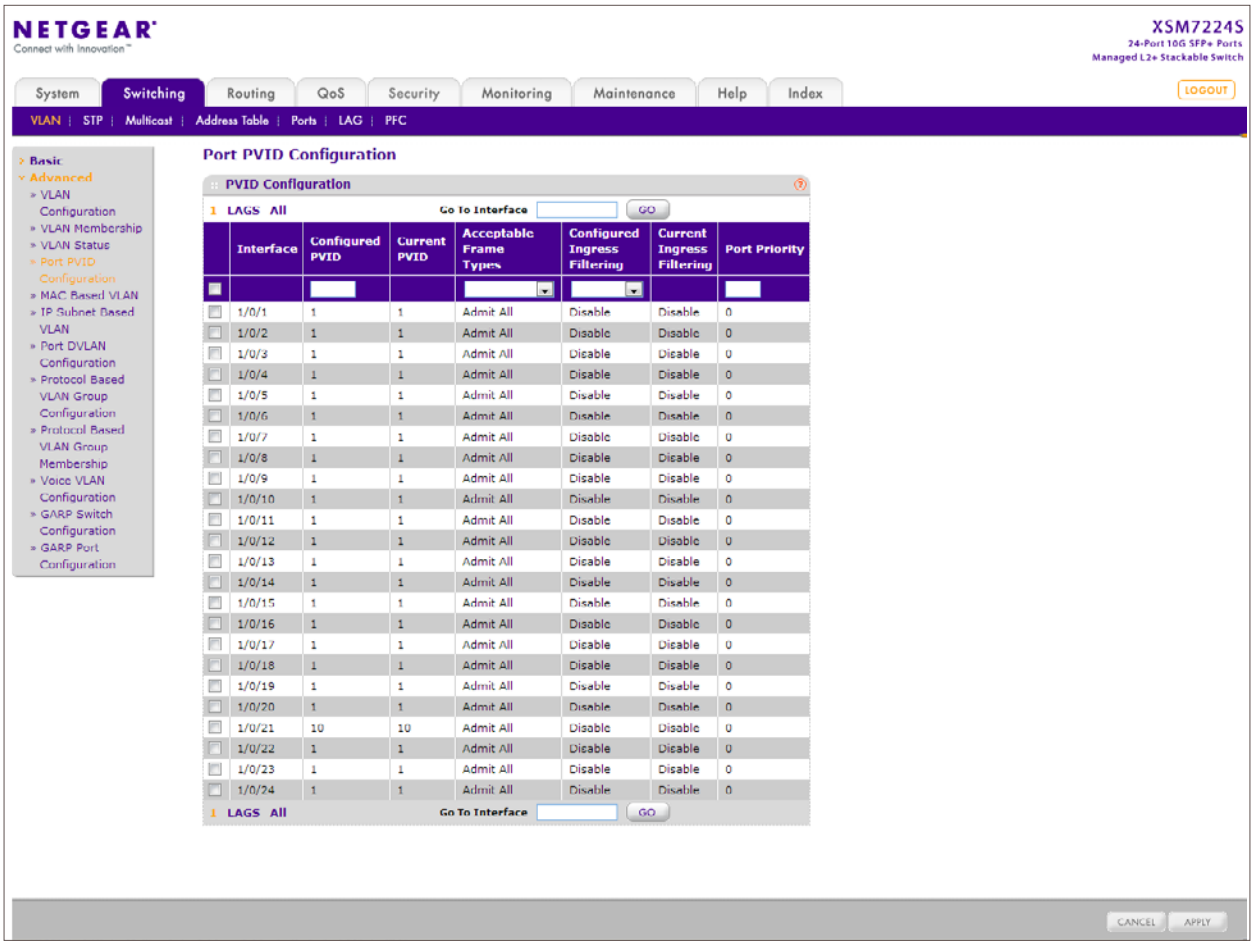
6. Choose **Routing > IP > Basic > IP Configuration** to enable routing globally. Enable Routing Mode and click **APPLY**.



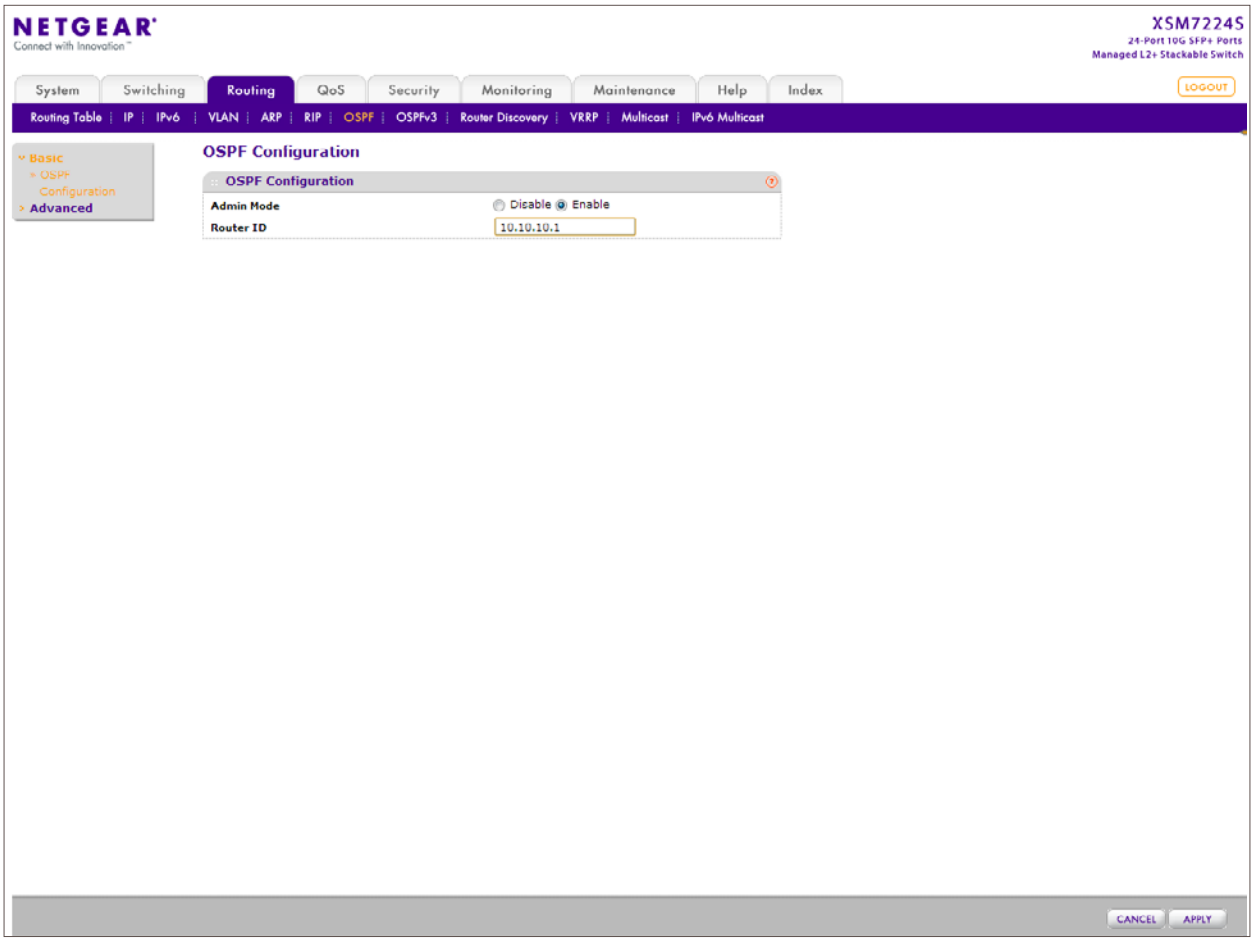
7. Configure the switch ports. Choose **Switching > VLAN > Advanced > VLAN Membership**. For each of the four VLANs, set all uplink ports to neighboring stacks as T for tagged. For the infrastructure ports, set all ports to U for untagged on the infrastructure VLAN. Click **APPLY** after configuring the ports for each VLAN.



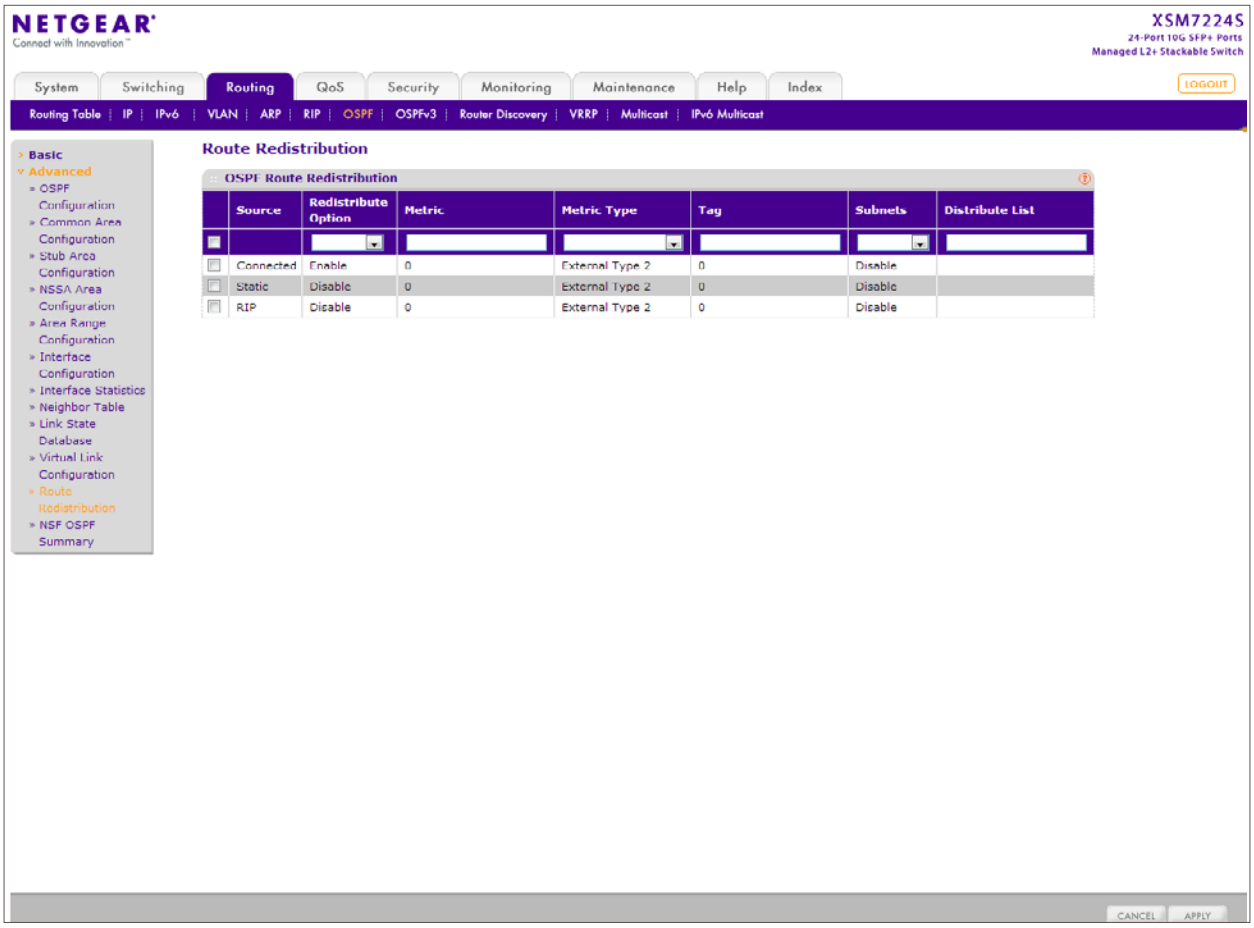
8. For infrastructure ports, configure the port PVID. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. Enter infrastructure VLAN ID 10 as the Configured PVID for all infrastructure ports and click **APPLY**.



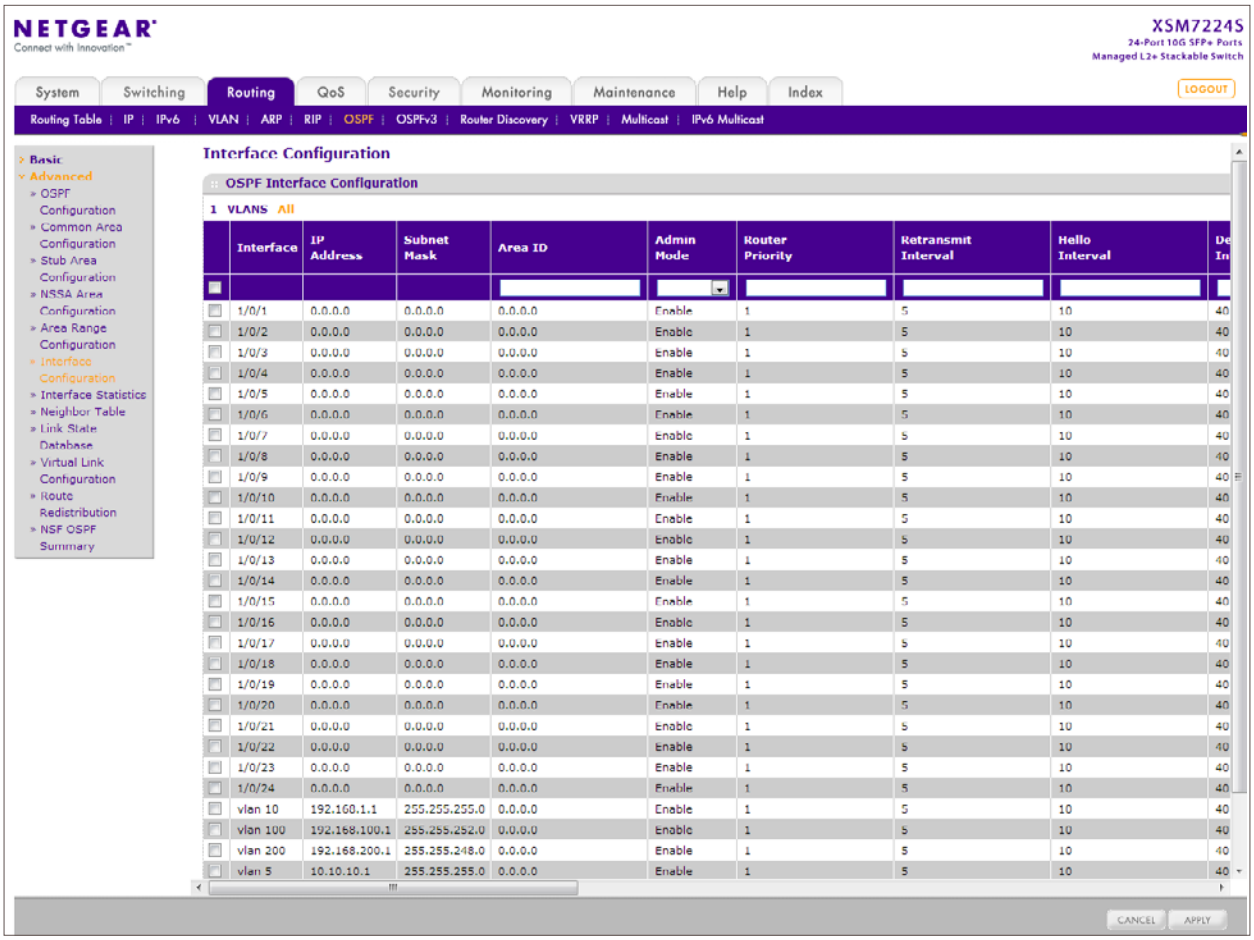
9. Choose **Routing > OSPF > Basic > OSPF Configuration**. Select Enable and set the router ID to 10.10.10.1. Click **APPLY**. The router ID must be unique to each stack in the LAN.



10. Choose R**outing > OSPF > Advanced > Route Redistribution**. Select the box for Connected and set Redistribution Option to Enable. Click **APPLY**.

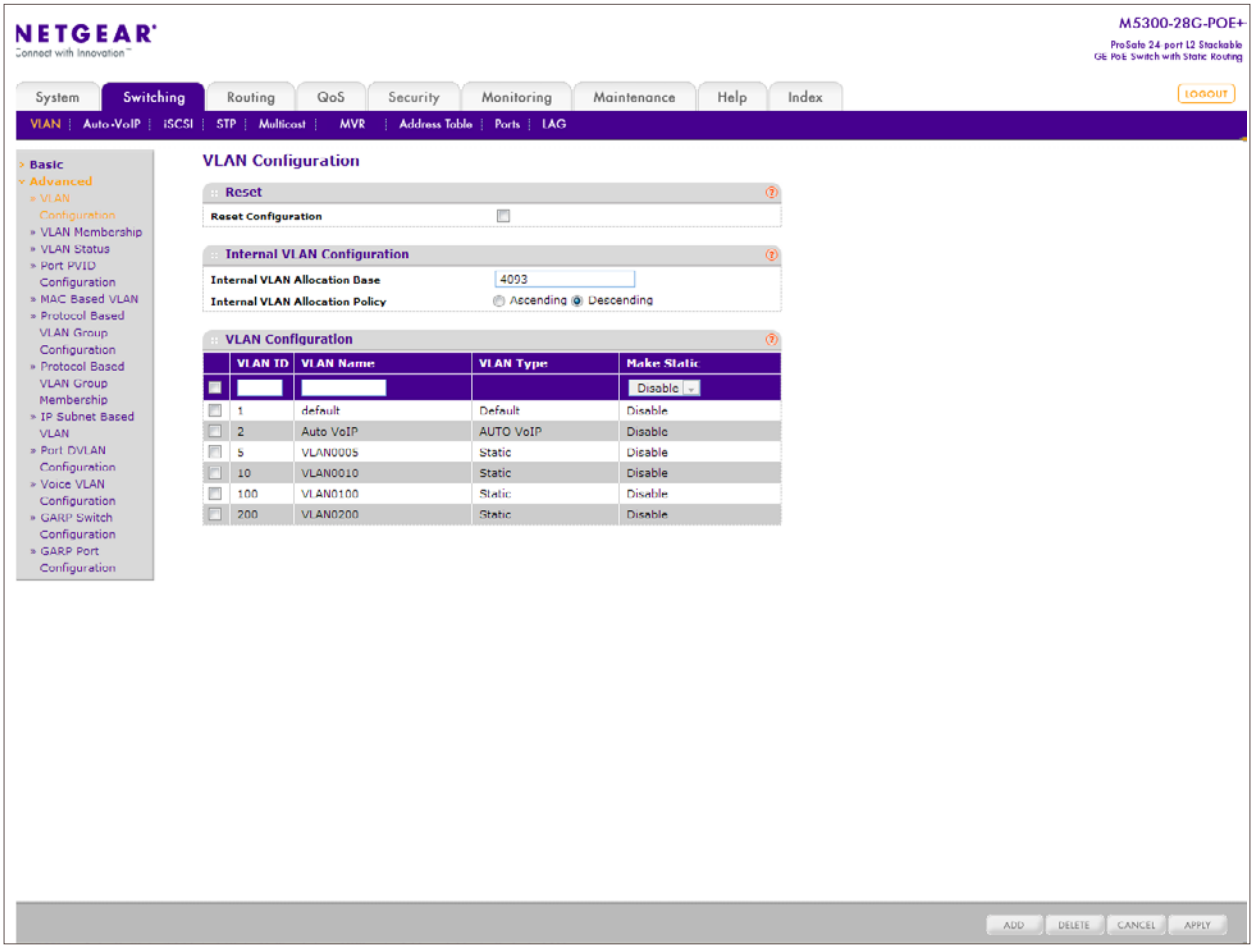


11. Choose **Routing > OSPF > Advanced > Interface Configuration**. Click All above the column headings to list all physical and VLAN interfaces. By default, all interfaces are set to the OSPF area ID 0.0.0.0. Select the box above the first interface's check box to select all interfaces. Enable Admin Mode and click **APPLY**.

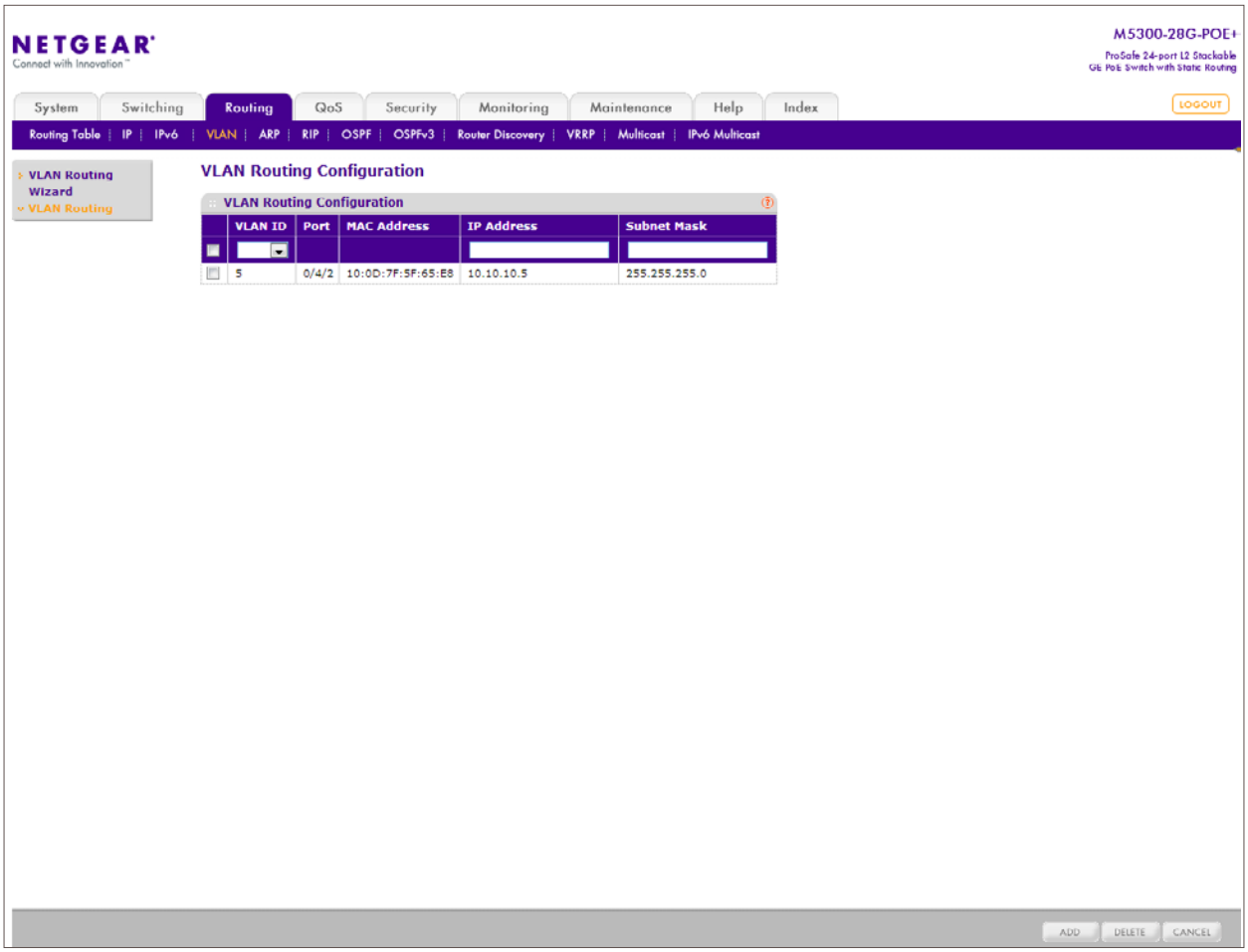


Switch – M5300-52G-POE+

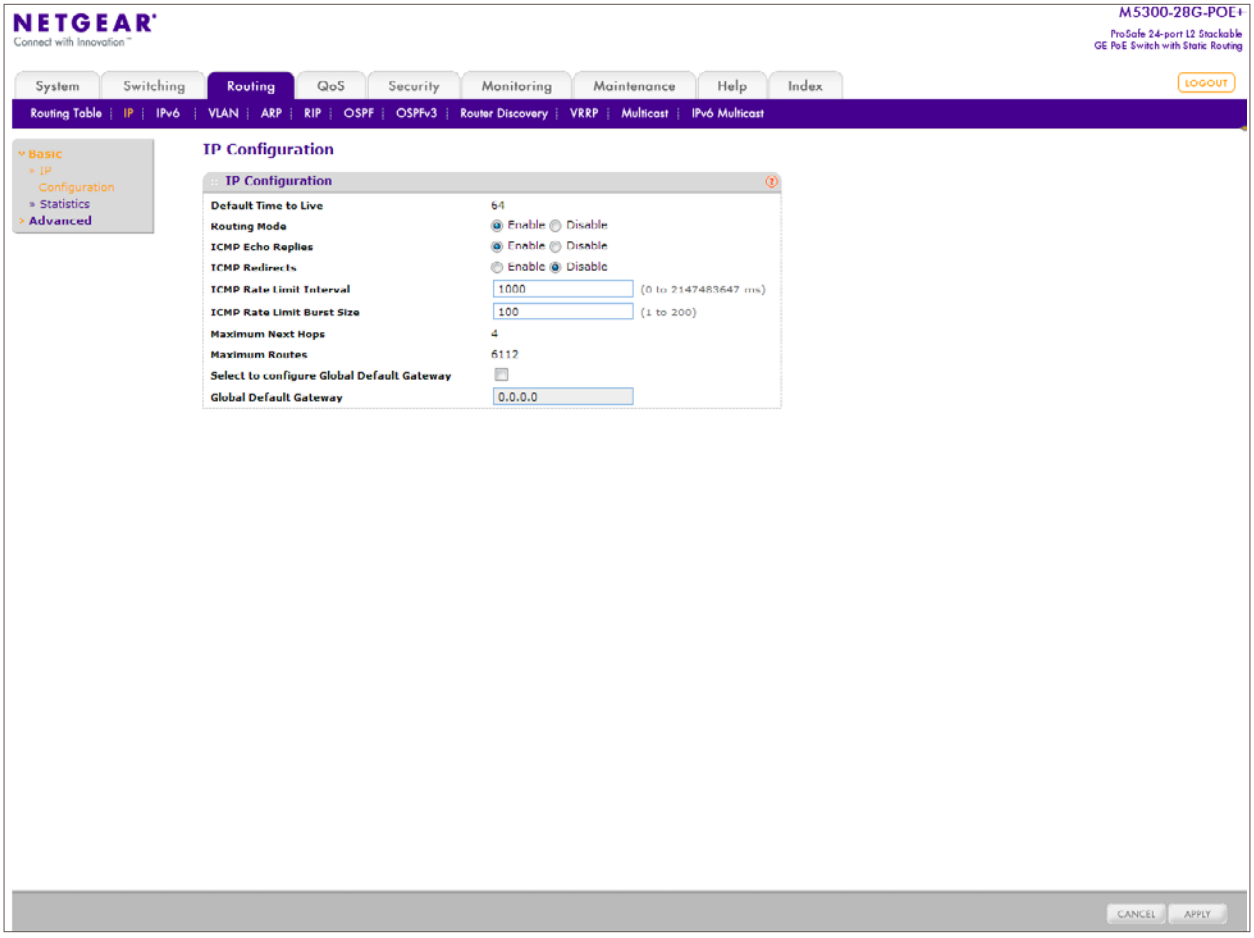
1. Move over to configure the M5300-52G-POE+ switch. Configuration for the M5300-52G-POE+ stacks will be replicated on each one. Create VLAN interfaces for the subnets: management (VLAN ID 5), infrastructure (VLAN ID 10), voice (VLAN ID 100), and data (VLAN ID 200). Choose **Switching > VLAN > Advanced > VLAN Configuration**. Declare each VLAN ID and click **ADD** after each one.



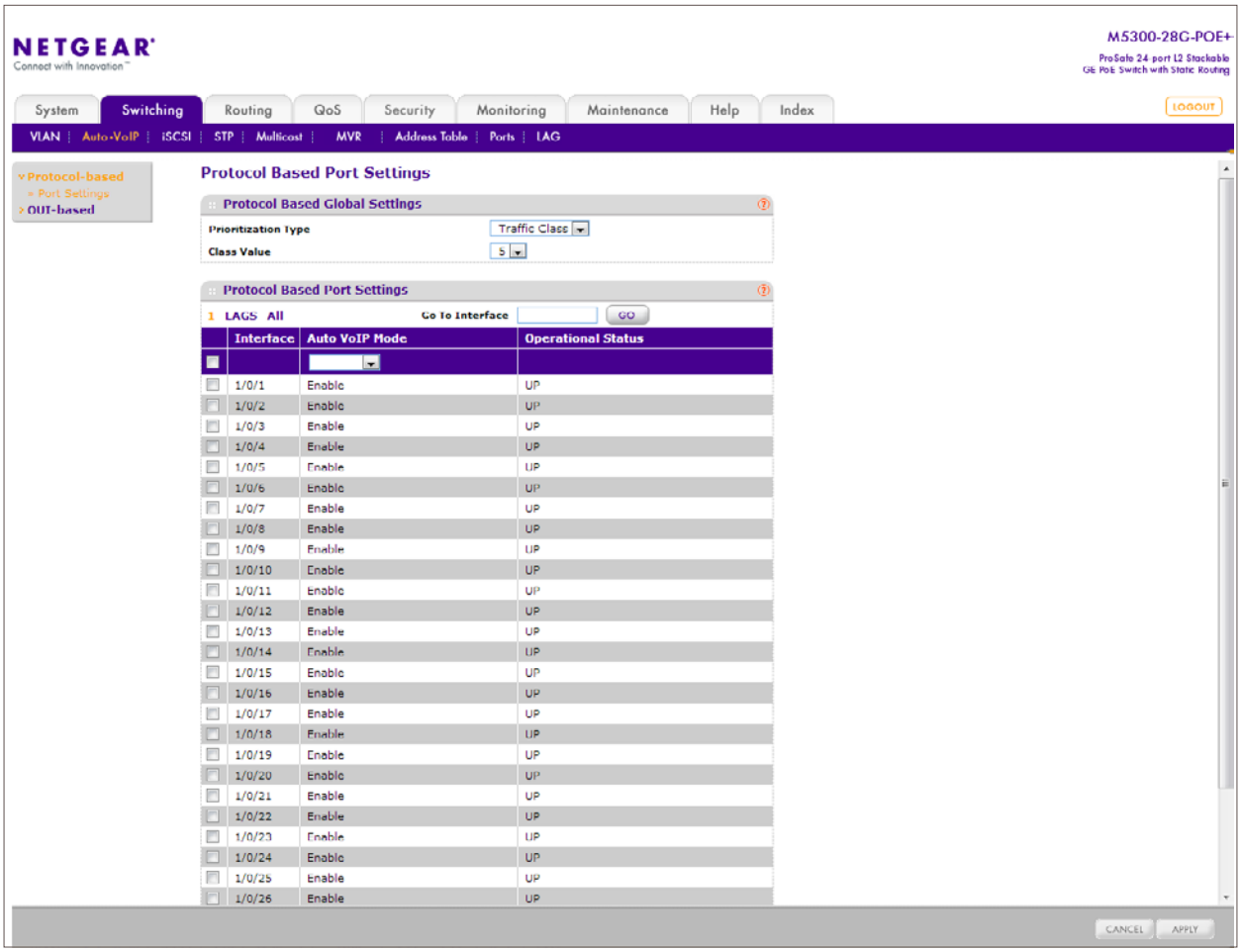
2. Choose **Routing > VLAN > VLAN Routing**. Configure the managment VLAN 5 (10.10.10.0/24). Select the VLAN ID and enter the corresponding gateway IP address and subnet mask. The management gateway address will be unique to each switch stack. In this case, it is 10.10.10.5. Click **ADD**.



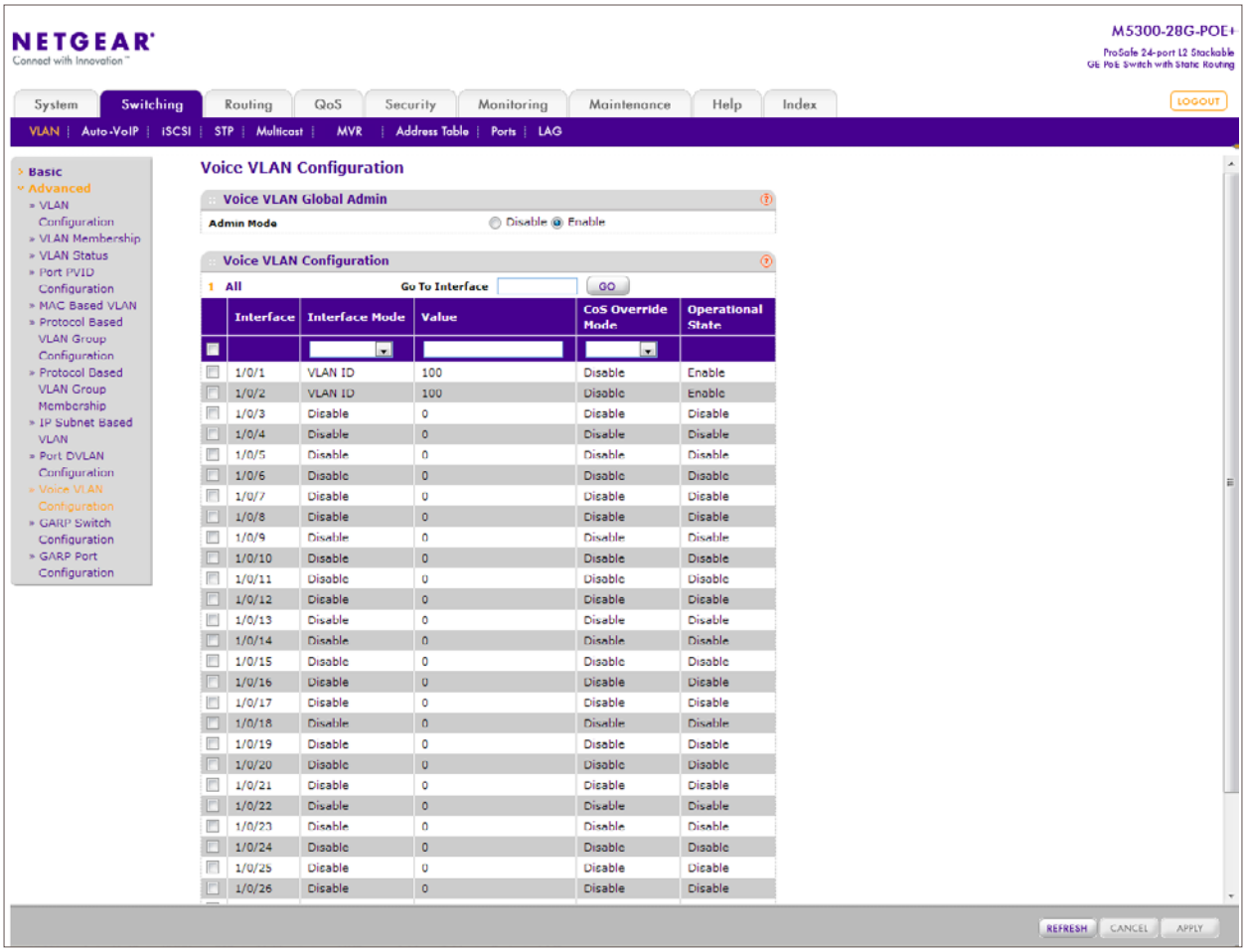
3. Choose **Routing > IP > Basic > IP Configuration** to enable routing globally. Enable Routing Mode and click **APPLY**.



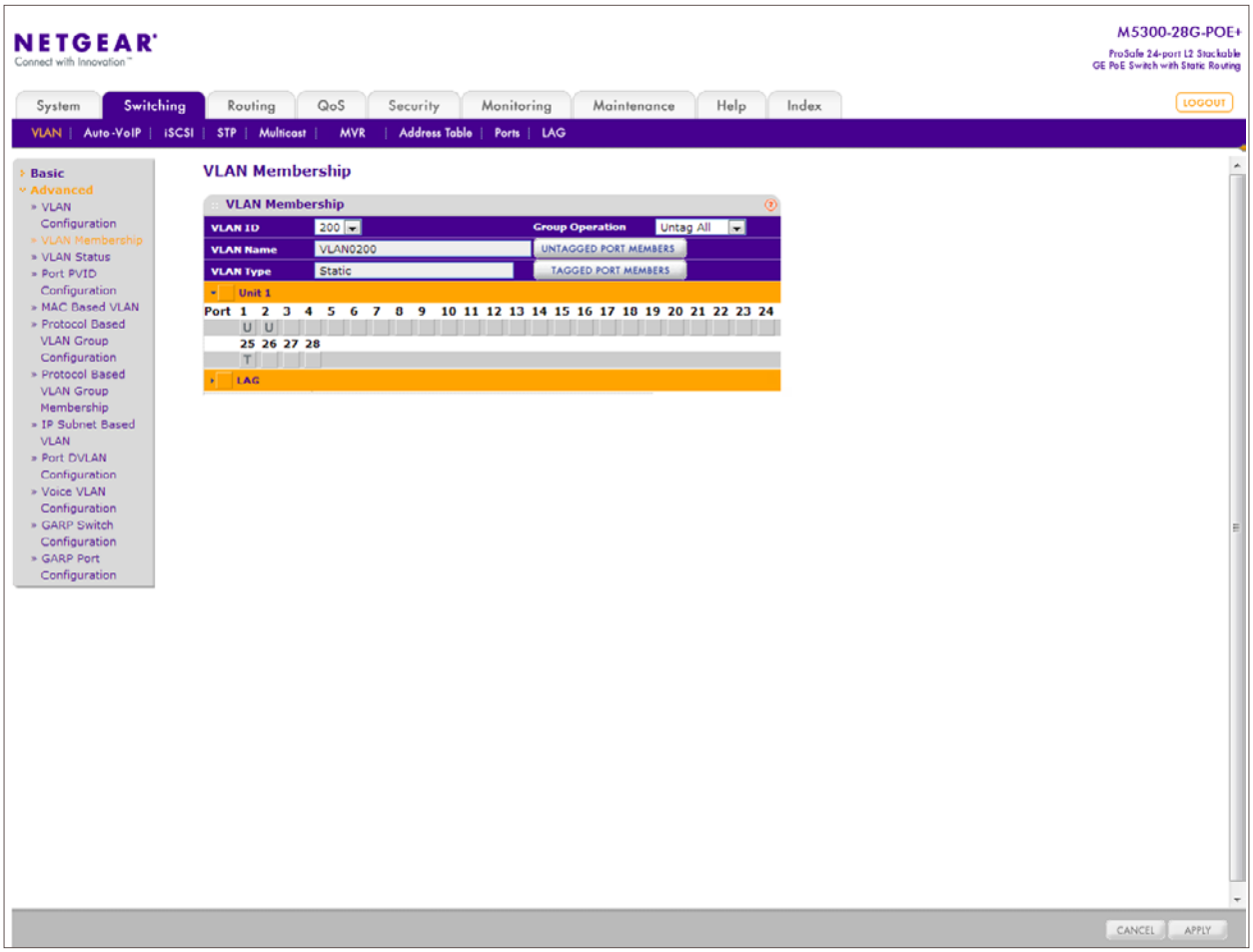
4. Enable auto-VoIP on all interfaces and increase voice traffic priority. Choose **Switching > Auto-VoIP > Protocol based > Port Settings**. Select Traffic Class as the Prioritization Type and set Class Value to 5. Select all interfaces by checking the box above the first interface and change Auto VoIP Mode to Enable. Click **APPLY**.



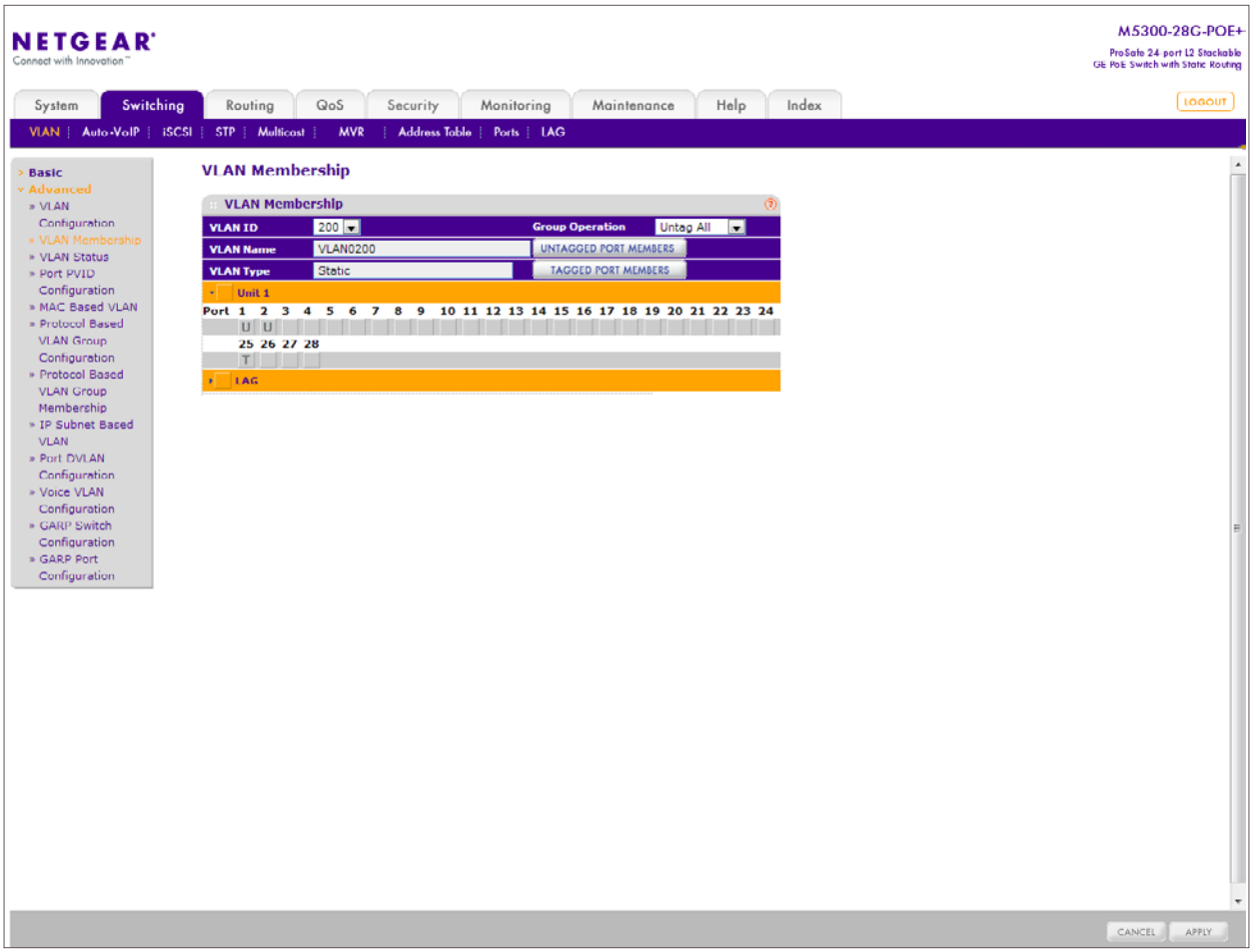
5. Enable the voice VLAN feature globally. Choose **Switching > VLAN > Advanced > Voice VLAN Configuration**. Select the box above the first port to select all ports. Change Interface Mode to VLAN ID and Value to 100. Enable Admin Mode and click **APPLY**.



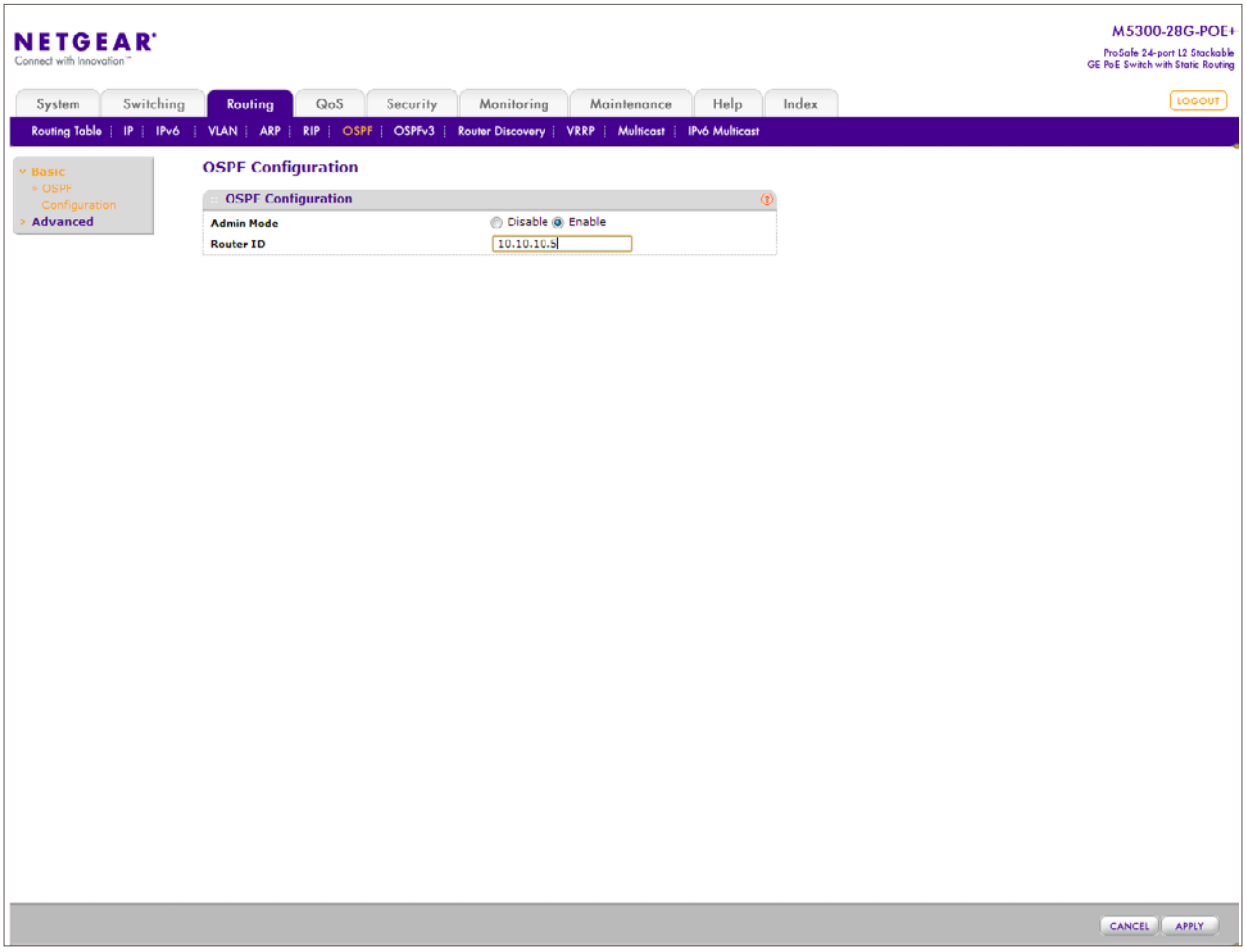
6. Configure the switch ports. Choose **Switching > VLAN > Advanced > VLAN Membership**. For each of the 4 VLANS, set all uplink ports to neighboring stacks as T for tagged. Since our phone ports will also support our data VLAN, set all ports to U for untagged on VLAN 200. Click **APPLY** after configuring each VLAN's ports.



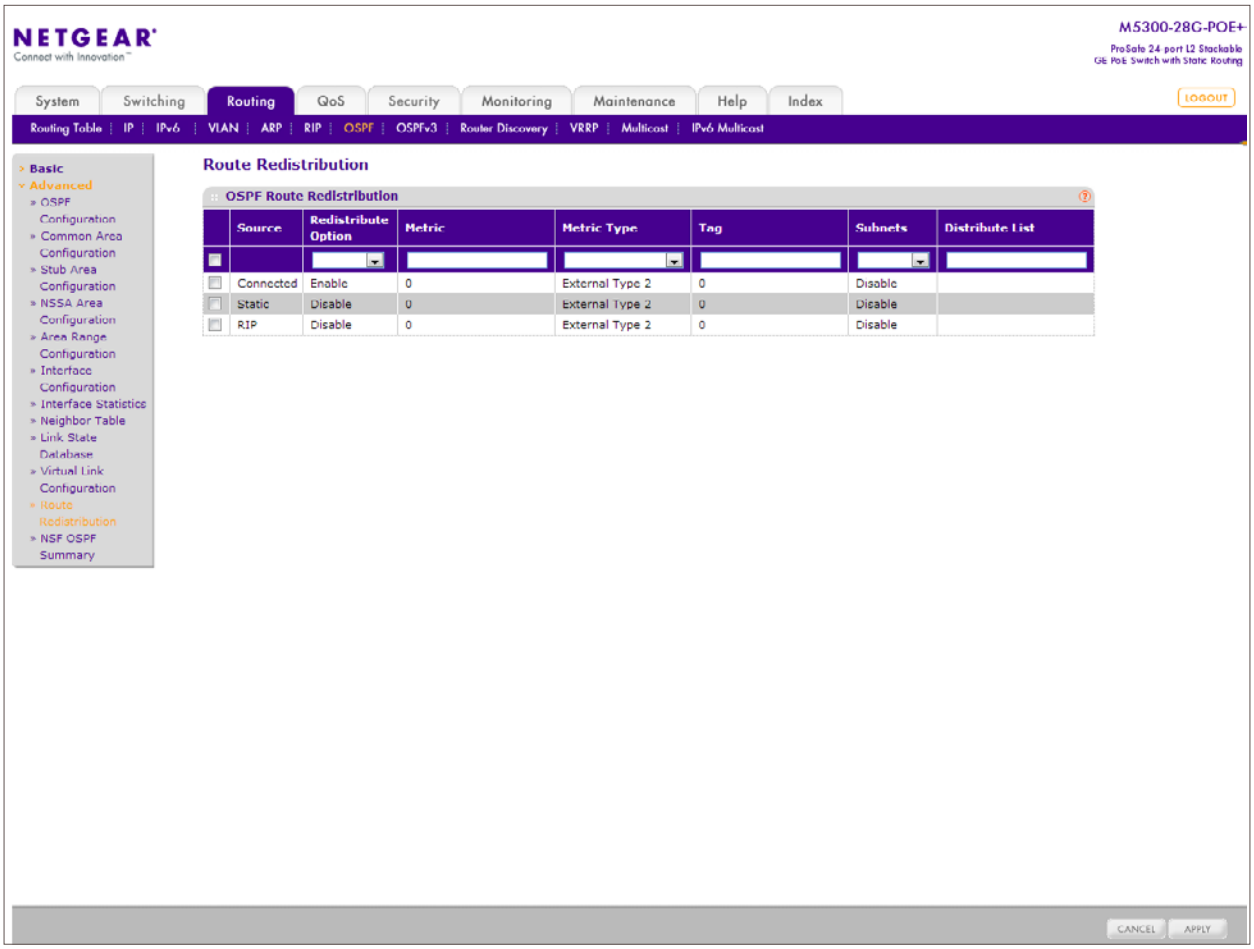
7. For phone ports, the port PVID must be configured to support the data VLAN. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. Enter our data VLAN ID 200 as the Configured PVID for all phone ports and click **APPLY.**



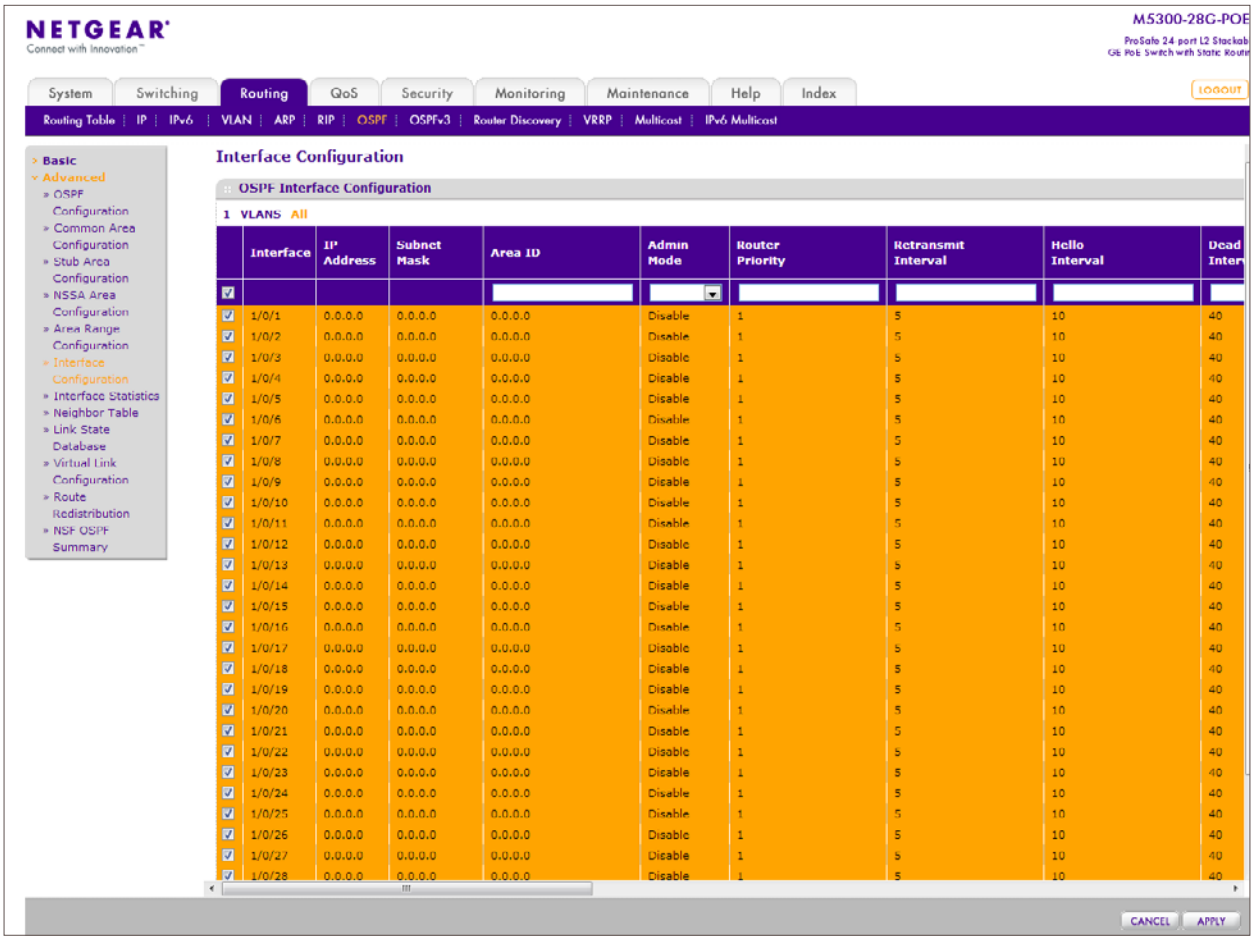
8. Choose **Routing > OSPF > Basic > OSPF Configuration**. Select Enable and set the router ID to 10.10.10.5. Click **APPLY**. Remember that the router ID must be unique to each stack in your LAN network.



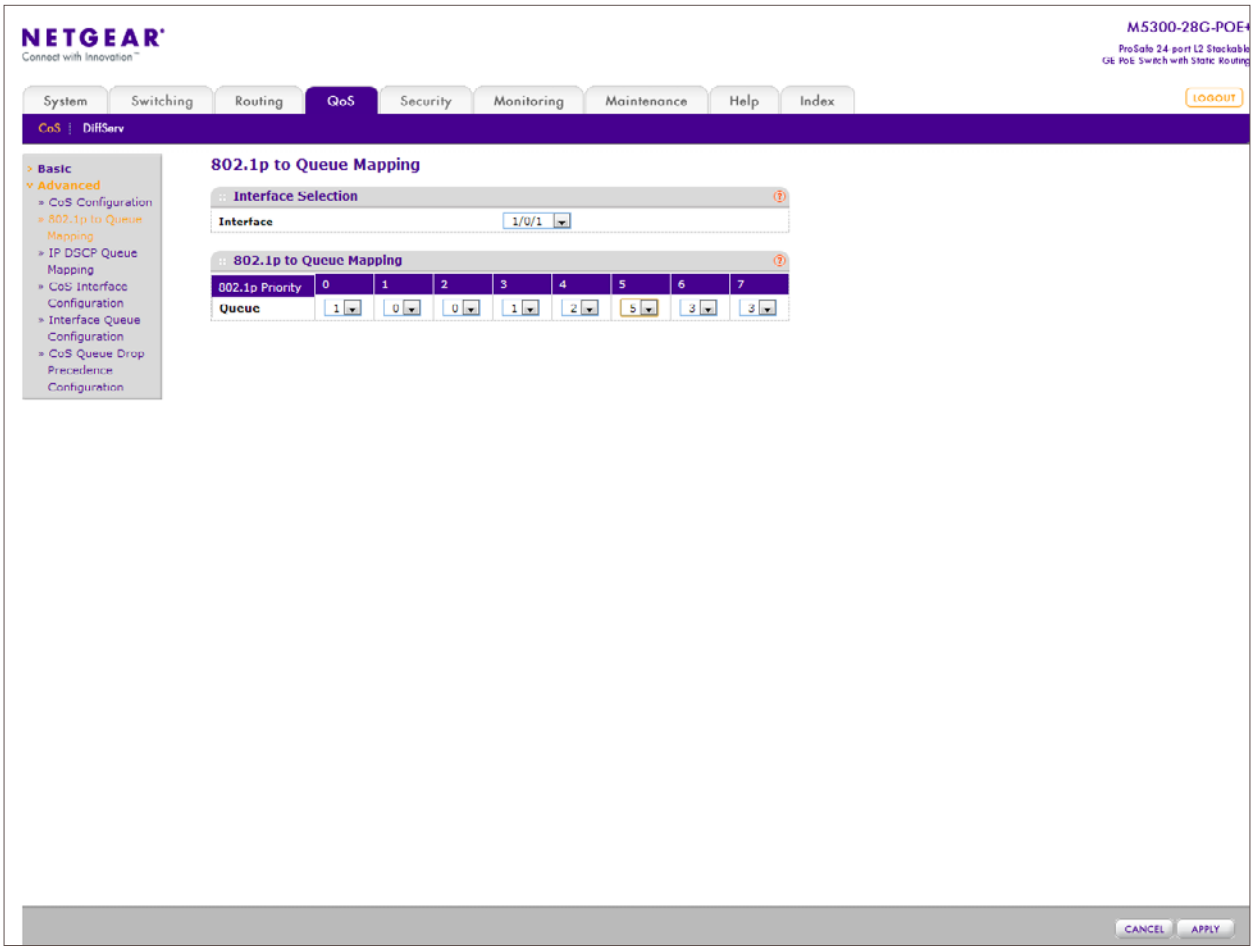
9. Choose **Routing > OSPF > Advanced > Route Redistribution**. Check the box next to the source Connected and set the Redistribution Option to Enable. Click **APPLY**.



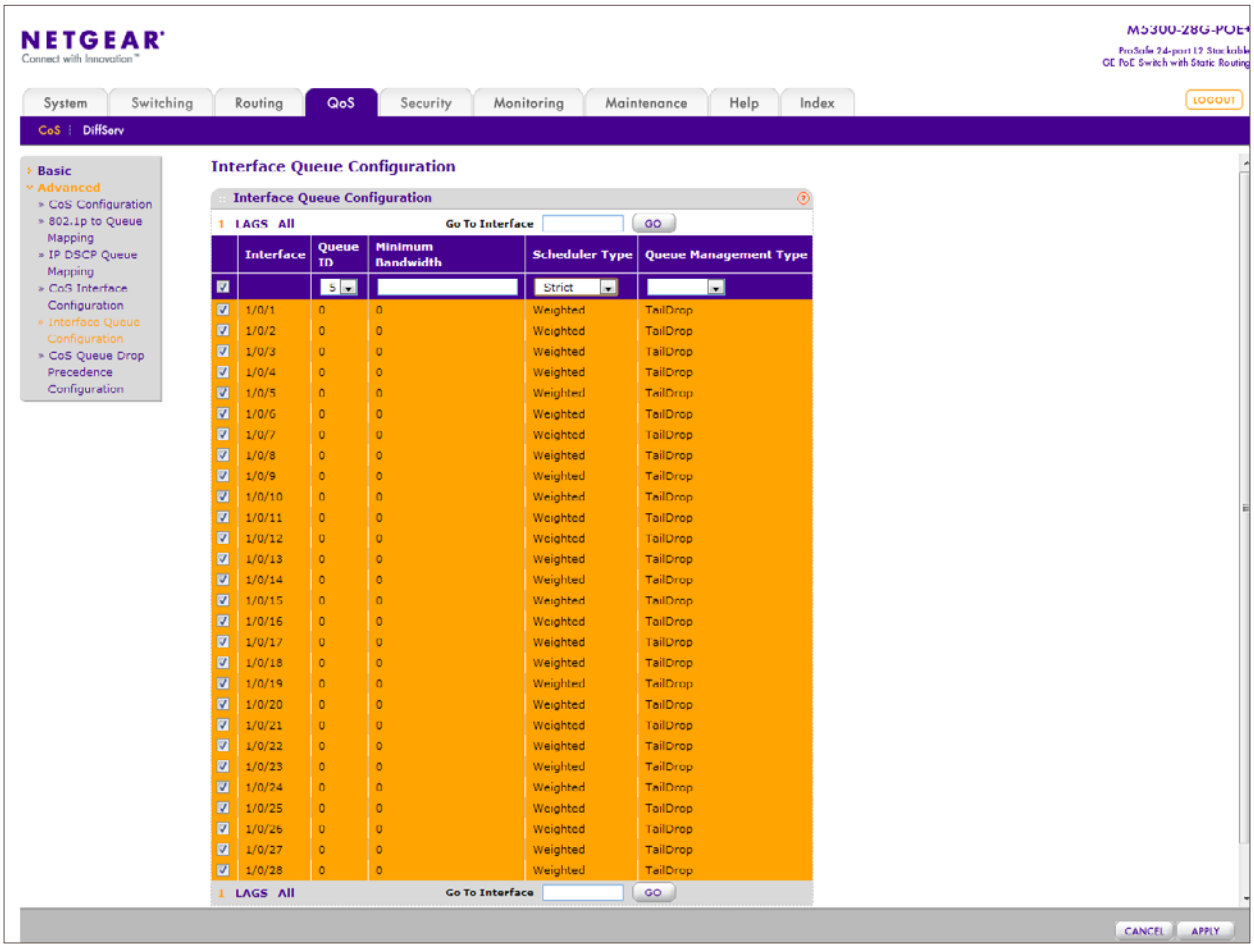
10. Choose **Routing > OSPF > Advanced > Interface Configuration**. Click All above the column headings to list all physical and VLAN interfaces. By default, all interfaces are set to the OSPF area ID 0.0.0.0. Select the box above the first interface's check box to select all interfaces. Enable Admin Mode and click **APPLY.**



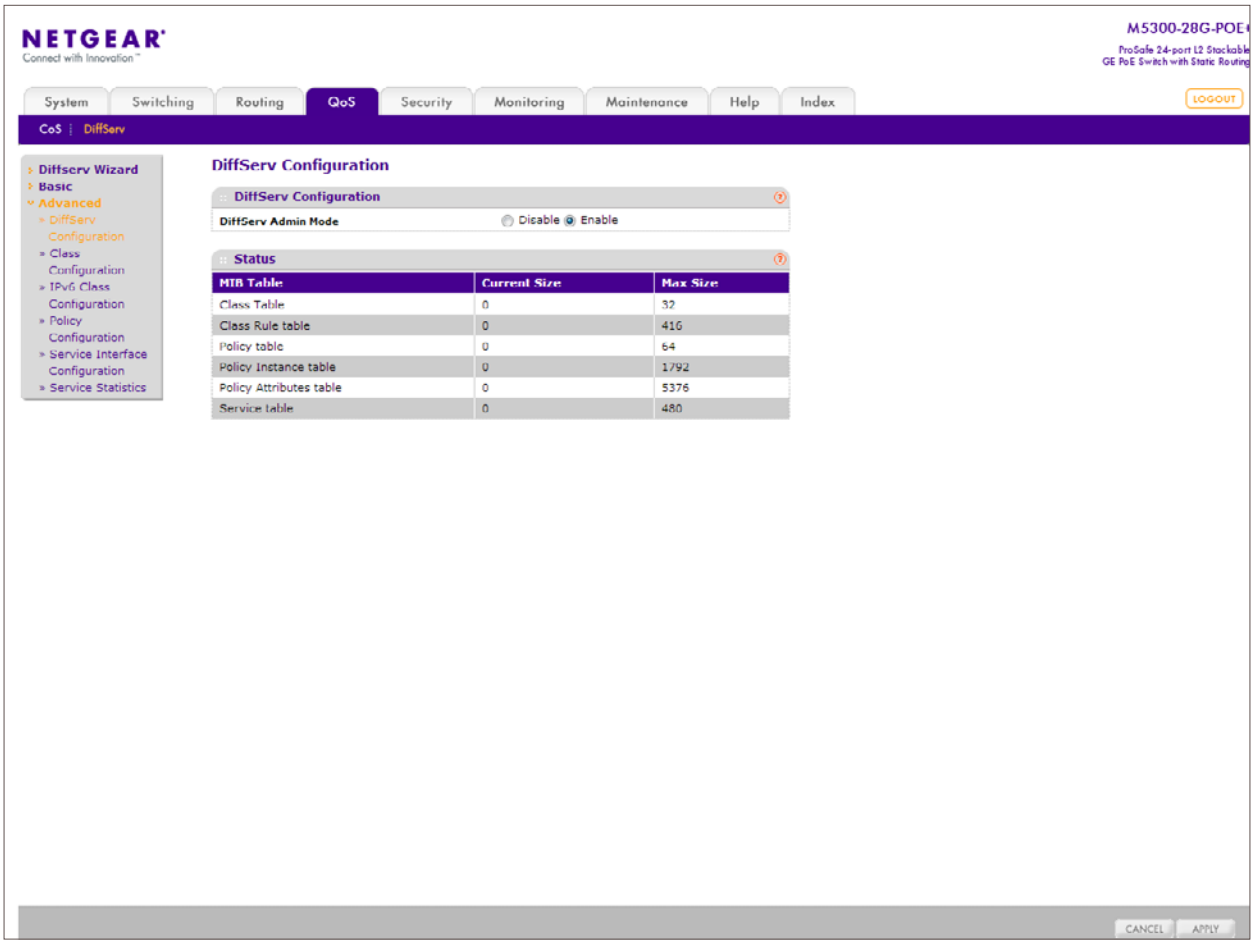
11. To queue and prioritize VoIP traffic properly, change the 802.1p queue mapping. Choose **QoS > CoS > Advanced > 802.1p to Queue Mapping**. Select All from the Interface Selection drop-down menu and change the Queue value to 5 for 802.1p Priority 5. Click **APPLY**.



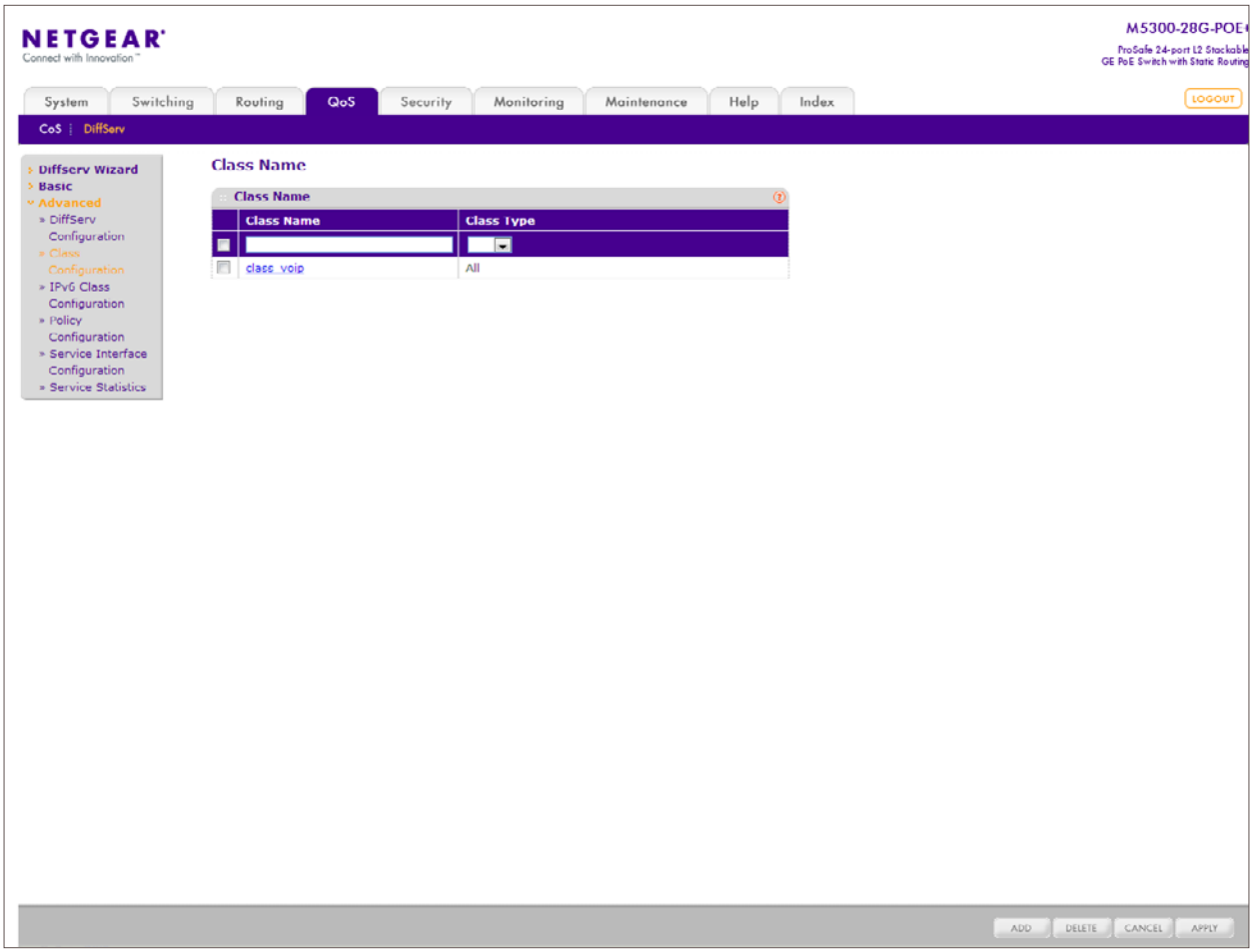
12. Assign queue priority to our phone ports. Choose **QoS > CoS > Advanced > Interface Queue Configuration**. Select all phone ports, change the Queue ID to 5, and change the Scheduler Type to Strict. Click **APPLY**.



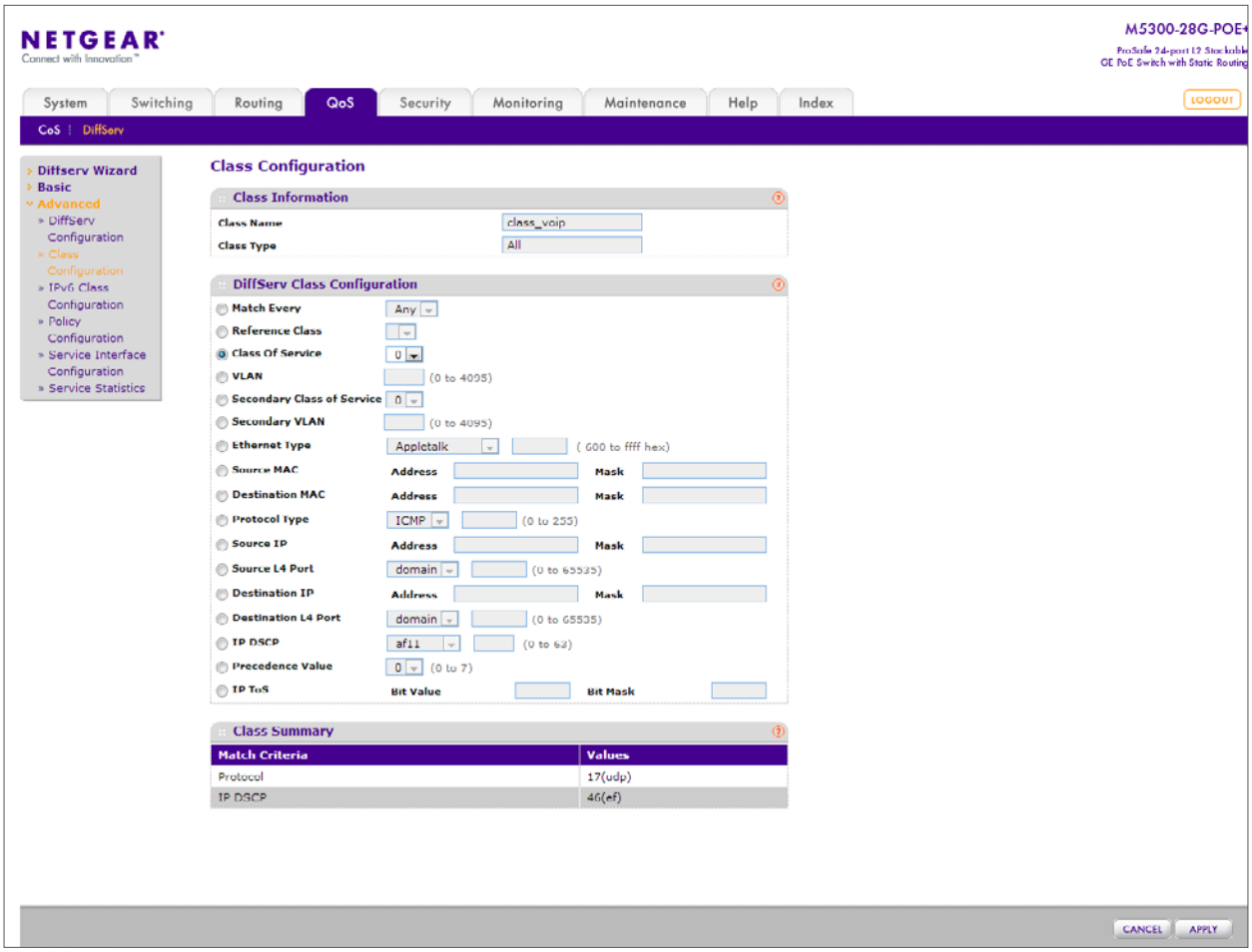
13. Enable the DiffServ feature. Choose **QoS > DiffServ > Advanced > DiffServ Configuration**. Enable DiffServ Admin Mode and click **APPLY**.



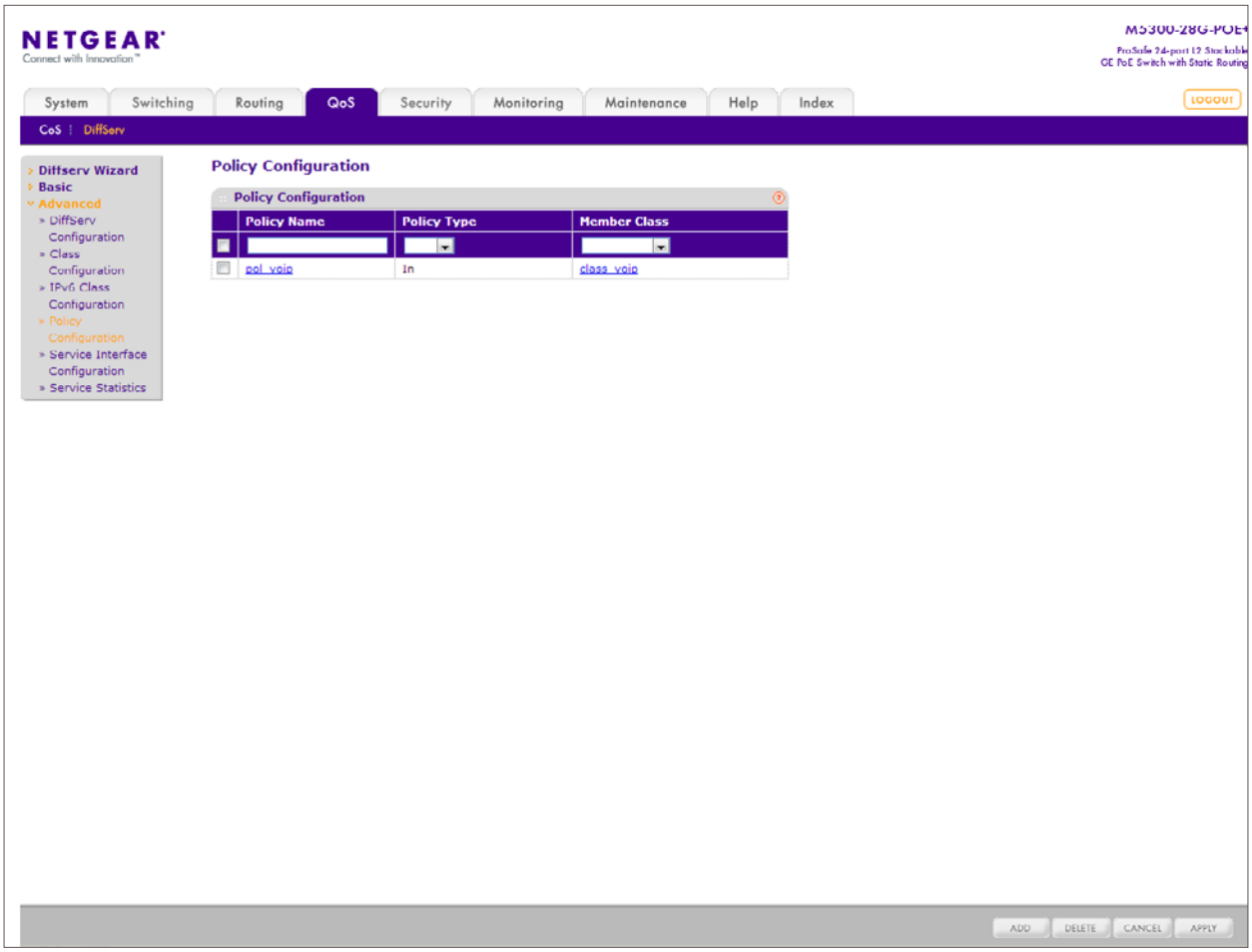
14. Create a DiffServ class for our DiffServ policy. In this class, we will specifically queue VoIP traffic on the protocol level. Go to **QoS > DiffServ > Advanced > Class Configuration**. Enter the VoIP class name, change the Class Type to All, and Click **ADD**. Once the class is created, click on the class to open the VoIP class' configuration page.



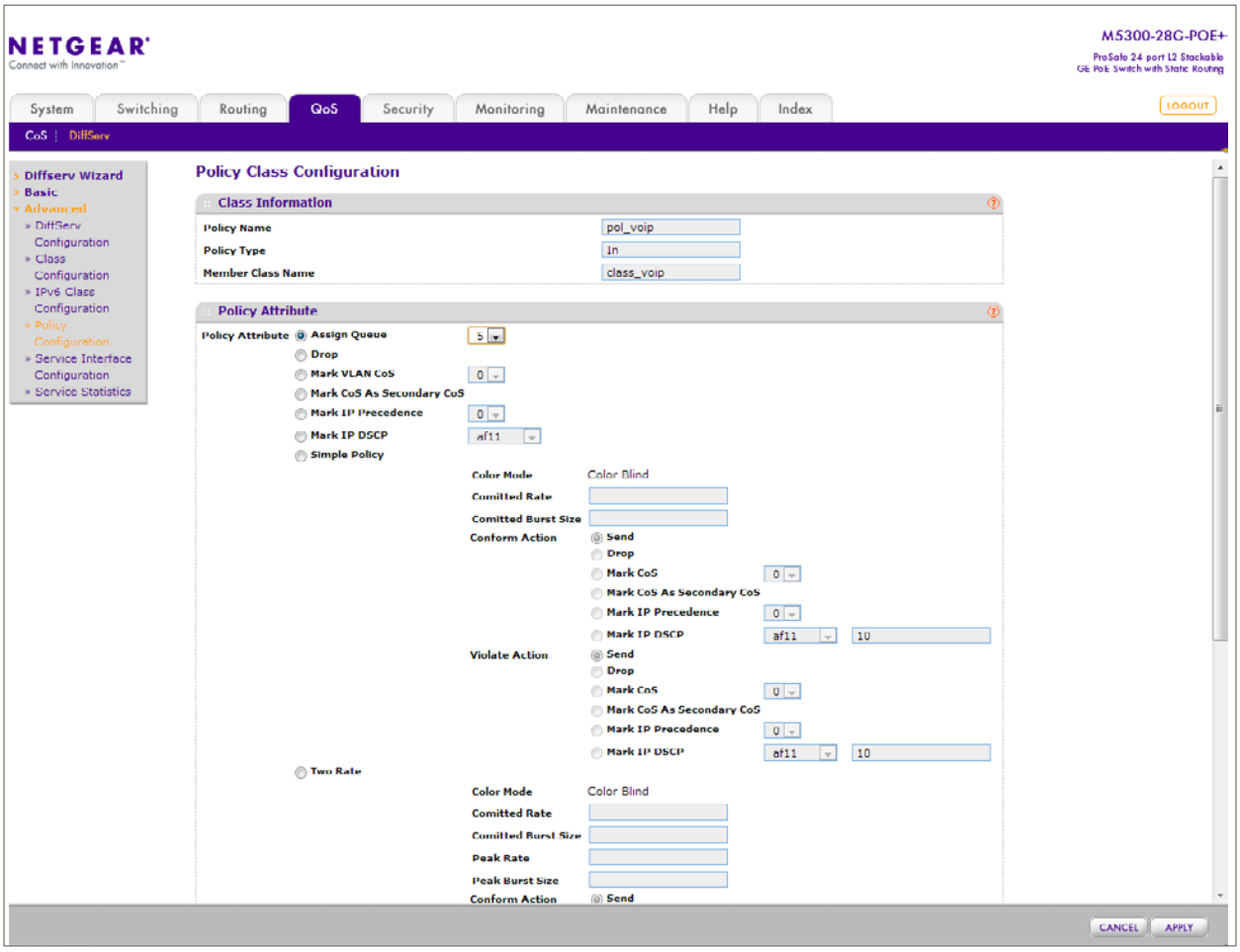
15. On the VoIP class' configuration page, notice the settings that can be applied to the class. Click Protocol Type and select UDP from the drop-down menu. Click **APPLY**. Then click IP DSCP and select EF from the drop-down menu. Click **APPLY.** Next, click Class of Service and select 5 from the drop-down menu. Click **APPLY**.



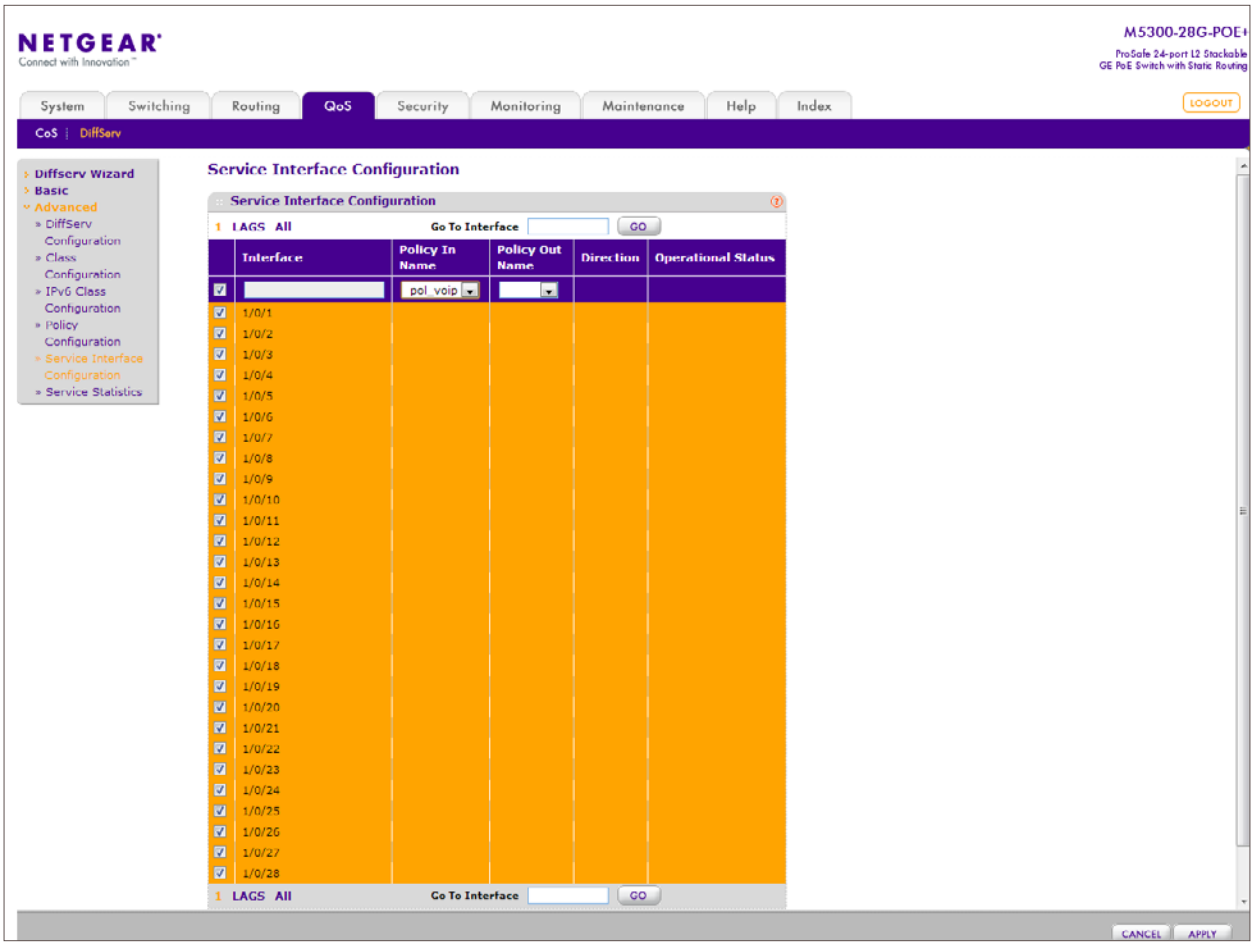
16. Apply the class to a policy map. To create the policy map, choose **QoS > DiffServ > Advanced > Policy Configuration**. Enter the VoIP policy name, change the Policy Type to In, and change the Member Class to the VoIP class you created. Click **ADD**. When the policy is created, click the VoIP policy to enter its configuration page.



17. On the VoIP policy configuration page, change the Assign Queue value to 5 and click **APPLY**.

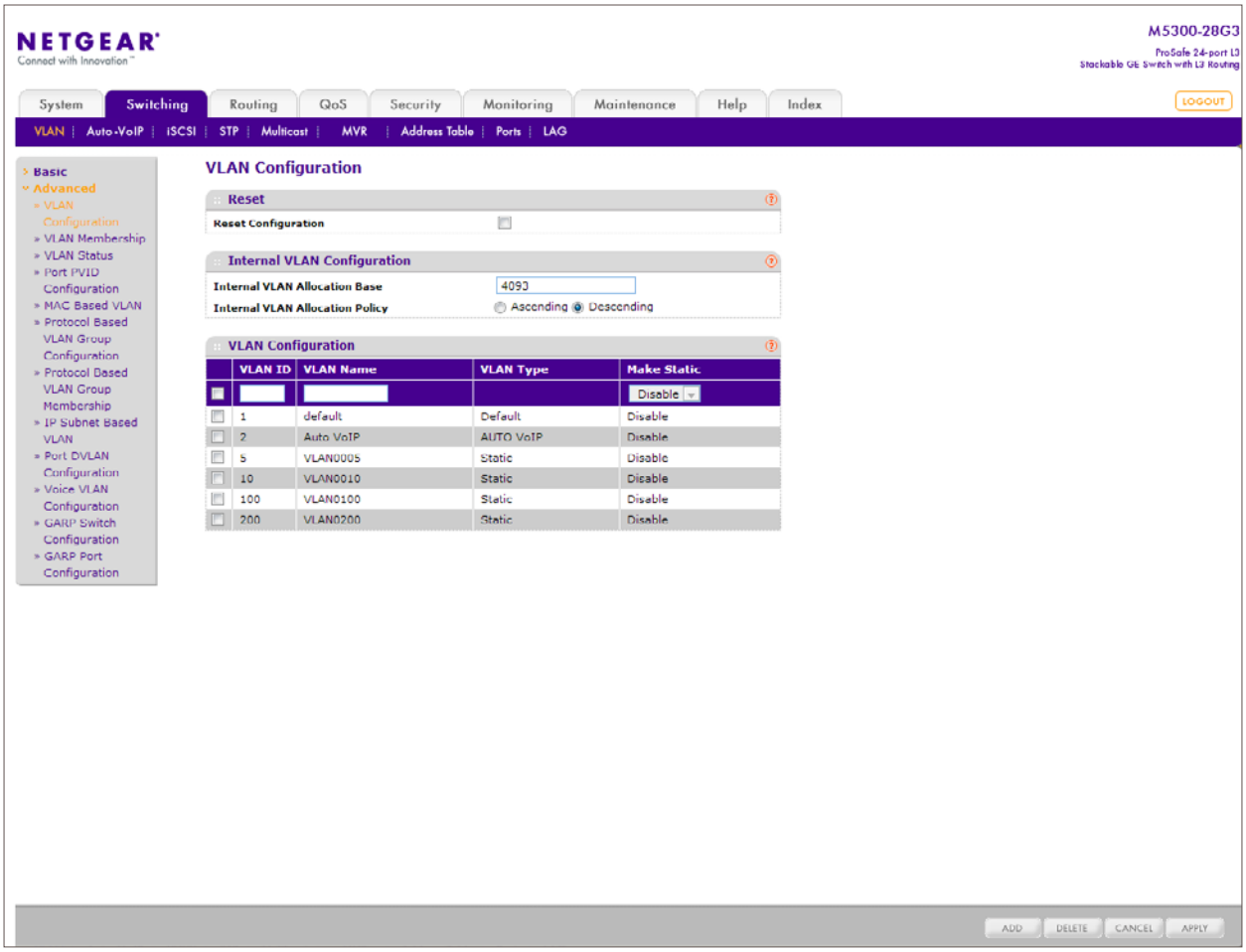


18. Apply the policy to all the phone ports. Choose **QoS > DiffServ > Advanced > Service Interface Configuration**. Select all phone ports and change the Policy In Name to the VoIP policy created. Click **APPLY**.

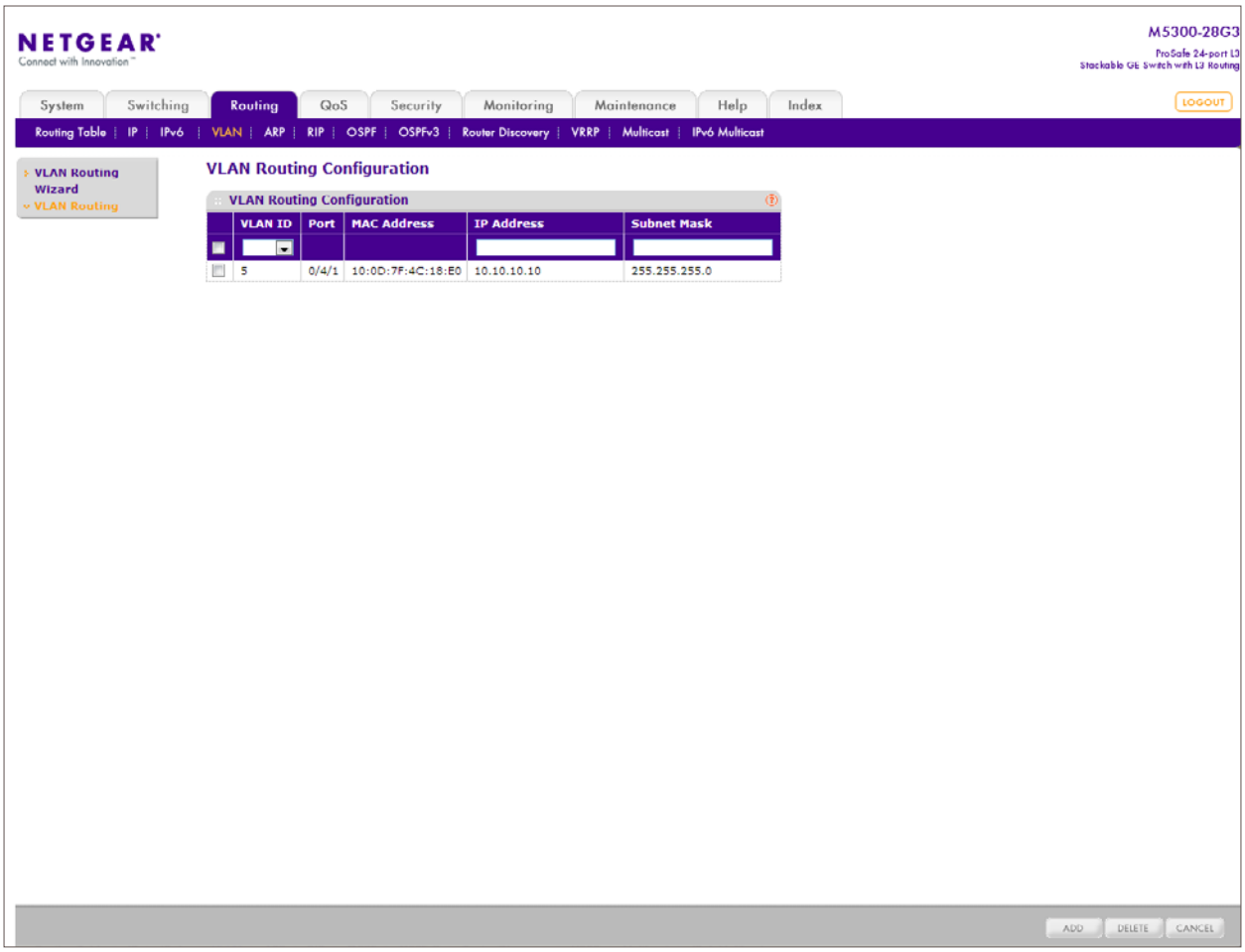


Switch – M5300-52G3

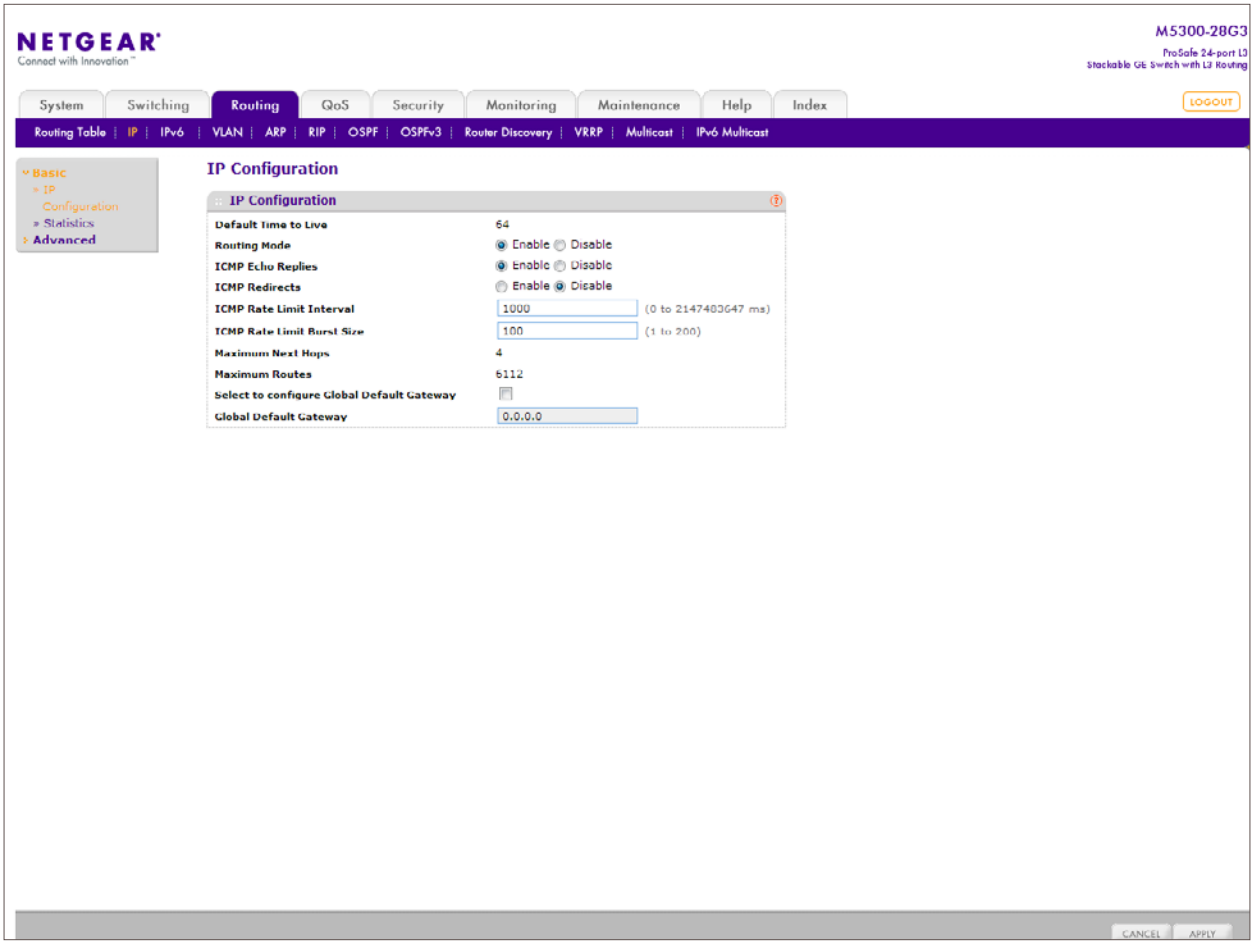
1. We now move over to the M5300-52G3 stacks. The configuration will be replicated on each one. Create VLAN interfaces for the subnets: management (VLAN ID 5), infrastructure (VLAN ID 10), voice (VLAN ID 100), and data (VLAN ID 200). Choose **Switching > VLAN > Advanced > VLAN Configuration**. Declare each VLAN ID and click **ADD** after each one.



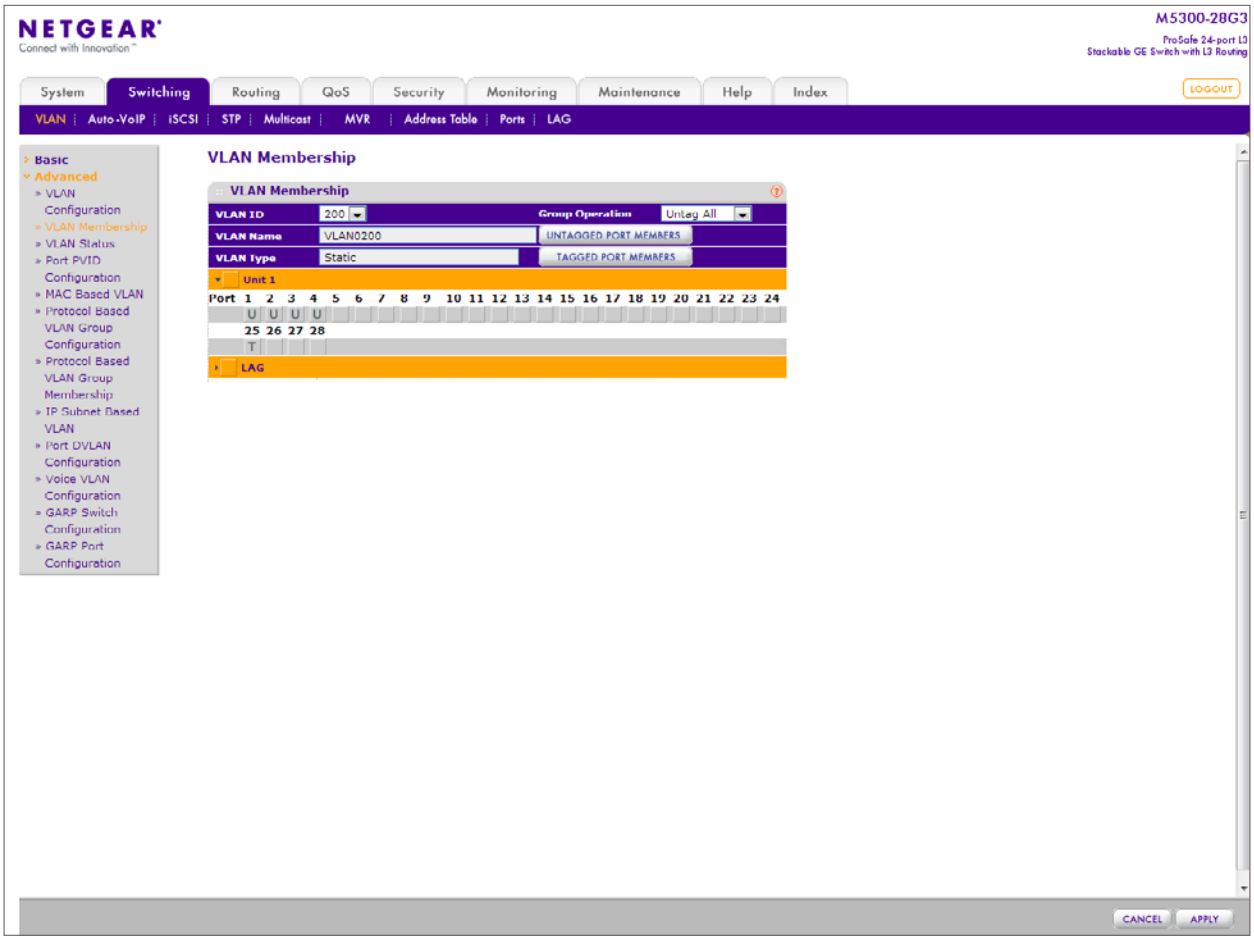
2. Choose **Routing > VLAN > VLAN Routing**. Configure management VLAN 5 (10.10.10.0/24). Select the VLAN ID and enter the corresponding gateway IP address and subnet mask. The management gateway address will be unique to each switch stack. In this case, it is 10.10.10.10. Click **ADD.**



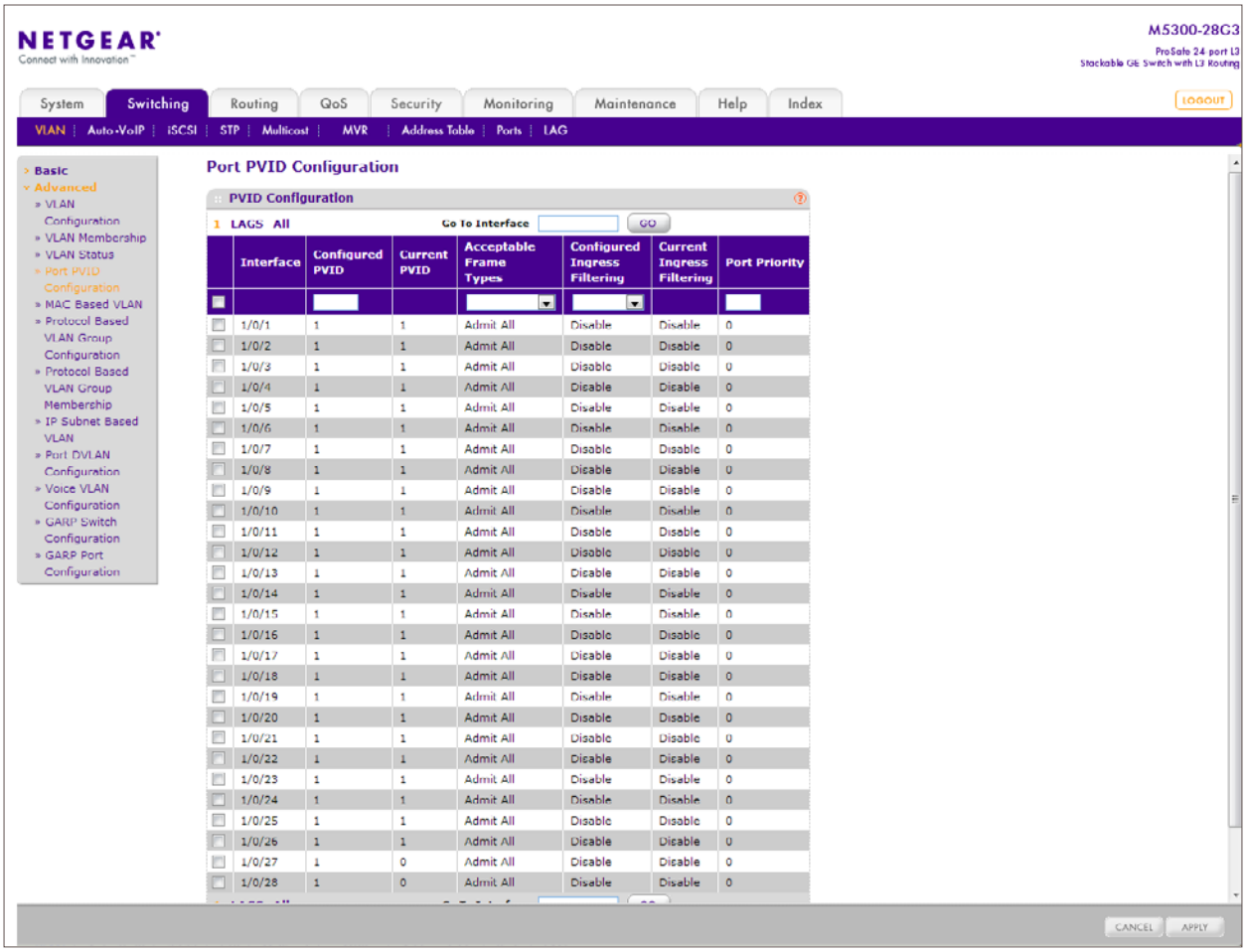
3. Choose **Routing > IP > Basic > IP Configuration**. Enable Routing Mode and click **APPLY**.



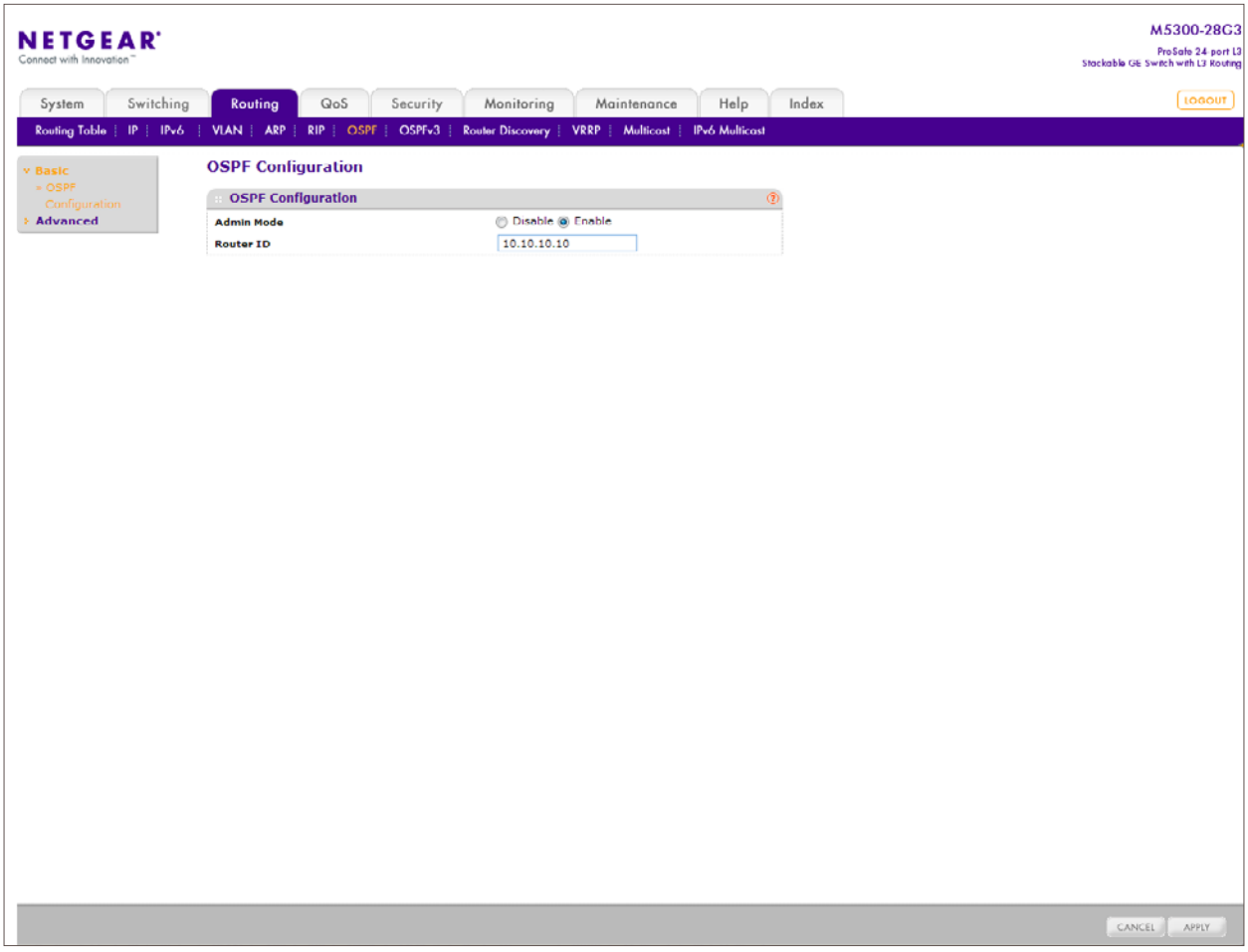
4. Configure the switch ports. Select **Switching > VLAN > Advanced > VLAN Membership**. For each of the four VLANs, set all uplink ports to neighboring stacks as T for tagged. For all other ports, set ports to U for untagged on the necessary VLAN. Click **APPLY** after configuring the ports for each VLAN.



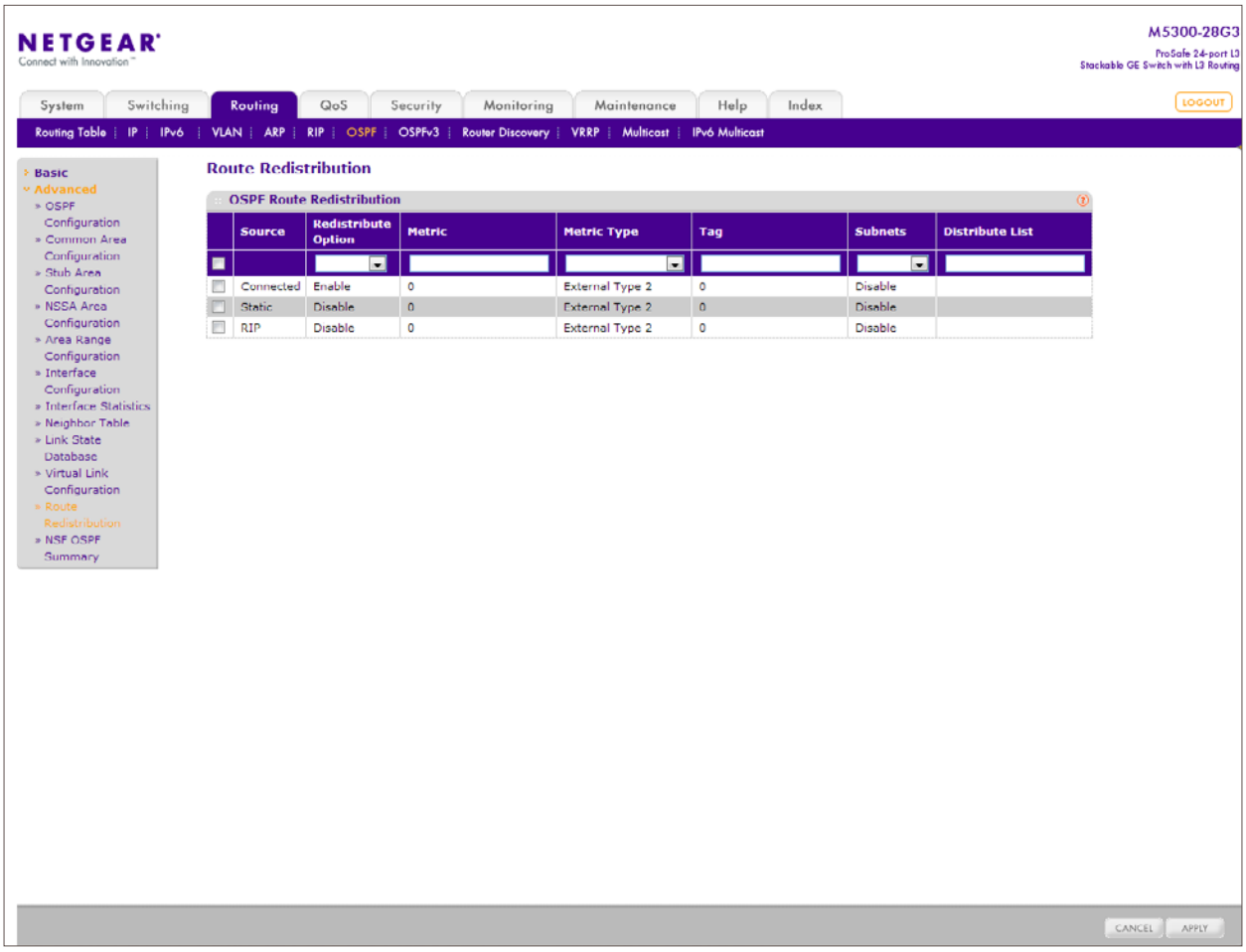
5. For untagged ports, configure the port PVID to support the data VLAN. Choose **Switching > VLAN > Advanced > Port PVID Configuration**. Enter the corresponding VLAN ID as the Configured PVID for all non-trunk ports in that VLAN and click **APPLY**.



6. Choose **Routing > OSPF > Basic > OSPF Configuration**. Select Enable and set the router ID to 10.10.10.10. Click **APPLY**. The router ID must be unique to each stack in the LAN network.



7. Choose **Routing > OSPF > Advanced > Route Redistribution**. Check the box next to the source Connected and set the Redistribution Option to Enable. Click **APPLY**.



8. Choose **Routing > OSPF > Advanced > Interface Configuration**. Click All above the column headings to list all physical and VLAN interfaces. By default, all interfaces are set to the OSPF area ID 10.10.10.10. Check the box above the first interface's check box to select all interfaces. Enable Admin Mode and click **APPLY**.