



## **Avaya Solution & Interoperability Test Lab**

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# **Application Notes for Extreme Networks Summit X450a-24t Switch with Avaya IP Office and Avaya IP Telephones in a Converged VoIP and Data Network - Issue 1.0**

### **Abstract**

These Application Notes describe a sample configuration of a Voice over IP (VoIP) solution using an Extreme Networks Summit X450a-24t Switch with an Avaya IP Office and Avaya IP Telephones in a Converged VoIP and Data Network. The Extreme Networks Summit X450a-24t Switch was compliance-tested with Avaya IP Office and Avaya IP Telephones with emphasis placed on verifying voice quality in a converged VoIP and Data network scenario. Information in these Application Notes has been obtained through compliance testing and additional technical discussions. Testing was conducted via the *DeveloperConnection* Program at the Avaya Solution and Interoperability Test Lab.

# 1. Introduction

These Application Notes describe the configuration of a Voice over IP (VoIP) solution using Extreme Summit X450a-24t Switch connected to an Avaya IP Office and Avaya IP Telephones in a Converged VoIP and Data Network. The Extreme Summit X450a-24t Switch was compliance-tested with Avaya IP Office and Avaya IP Telephones with emphasis placed on verifying voice quality in a converged VoIP and Data network scenario. QoS (Quality of Service) based on 802.1p (Layer 2 Priority) and Layer 3 Differentiated Services (DiffServ) was implemented across the network to prioritize voice traffic over the LAN. The Avaya IP Telephones get QoS priority settings from Avaya IP Office. The QoS settings are enforced in the network by the Extreme Switches. Tests were performed by oversubscribing the LAN interfaces with low priority data and verifying that good voice quality was achieved when calls were routed over all LAN interfaces. Compliance testing included QoS, throughput, Ethernet Automatic Protection Switching (EAPS), rapid spanning tree (RSTP), Open Shortest Path First (OSPF), Direct Media and the G.711 and G.729 codecs.

## 1.1. Extreme X450a Series Switch

The Extreme Summit X450a Series have 24-port or 48-port 10/100/1000BASE-T and 4-port 1000BASE-X SFP. With tri-speed Gigabit Ethernet interfaces as well as optional dual 10-gigabit Ethernet, the Summit X450a Series provide high-performance aggregation for Enterprise network, High Performance Computing Clusters (HPCC) and carrier Ethernet applications. The Summit X450a Series have a non-blocking switching fabric and offer wire-speed Layer 2/Layer 3 switching for all ports with Quality of Service and security features such as hardware based Access Control Lists (ACLs). With rich Layer 2-4 intelligence, the Summit X450a Series meet a variety of requirements at the edge of the converged enterprise network as well as aggregation and small core.

# 2. Hardware Configuration

## 2.1. Avaya IP Office and Extreme Summit X450a-24

The configuration in **Figure 1** shows a converged VoIP and Data network with multiple closets and labs configured with VLANs, rapid spanning tree and OSPF.

For compliance testing, the DHCP server function on Avaya IP Office was disabled and a centralized DHCP server was used. To better manage the different traffic types, the voice and data traffic were separated onto different VLANs.

**Note:** EAPS was compliance tested but is not part of this document.

## **2.2. Control Room**

The control room consists of an Extreme Summit X450a-24t Switch, Avaya IP Office 406V2 with one Avaya 2400 Series Digital Telephone, Avaya IP Office Manager and one DHCP/ File Server. The DHCP server provides IP network parameters to the Avaya IP Telephones. The Extreme Summit X450a-24t Switch will also enforce QoS policies, run rapid spanning tree and OSPF.

## **2.3. Closet A**

Closet A consists of an Extreme Alpine 3804 Switch, two Avaya 4620SW IP Telephones on VLAN Voice3 and two PC's on VLAN Datavlan2. The Extreme Alpine 3804 Switch will supply PoE for the Avaya IP Telephones, enforce QoS policies and run OSPF.

## **2.4. Closet B**

Closet B consists of an Extreme Summit 300-24 Switch, one Avaya 5620SW IP Telephone, one Avaya 5610SW IP Telephone on VLAN Voice1 and two PC's on VLAN Datavlan1. The Extreme Summit 300-24 Switch will supply PoE for the Avaya IP Telephones, enforce QoS policies and run rapid spanning tree.

## **2.5. Lab A**

Lab A consists of an Extreme Summit X450a-24t Switch. It will run Layer 2 infrastructure (VLANs), enforce QoS policies and run rapid spanning tree.

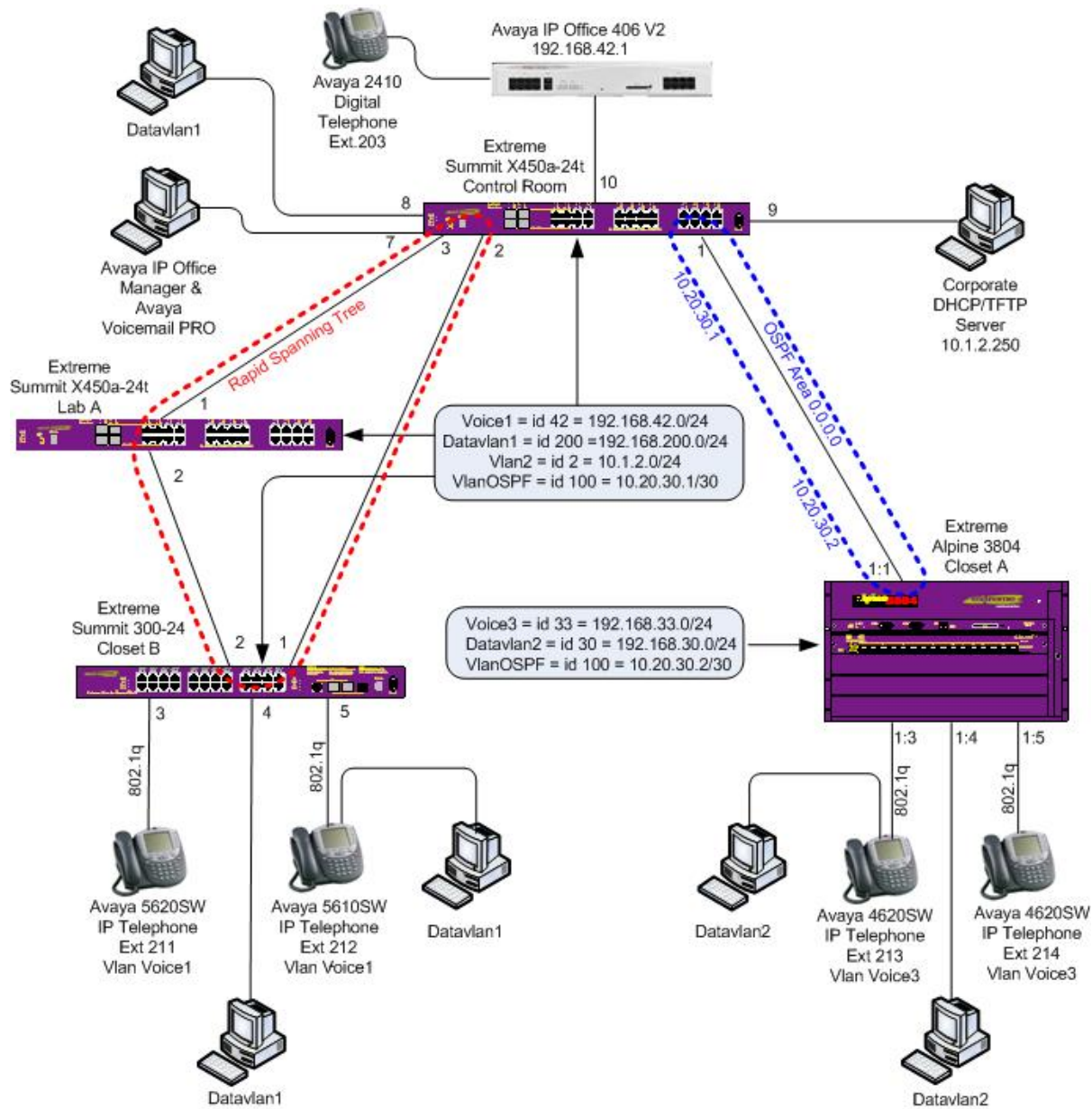


Figure 1: Network Configuration for Avaya IP Office and Extreme Summit X450a-24t

### 3. Equipment and Software Validated

The following equipment and software/firmware were used for the sample configuration provided:

Equipment	Software/Firmware
Avaya IP Office IP406V2	3.2(17)
Avaya 4620SW IP Telephones (H.323)	2.3
Avaya 4610SW IP Telephones (H.323)	2.3
Avaya 5620SW Telephones (H.323)	2.3
Avaya 5610SW Telephones (H.323)	2.3
Avaya 2410 Digital Telephone	N/A
Avaya IP Office Manager	3.2(17)
Extreme Summit X450a-24t	ExtremeXOS 11.5.1.4 (FCS code)
Extreme Summit 300-24	ExtremeWare 7.6
Extreme Alpine 3804	ExtremeWare 7.6

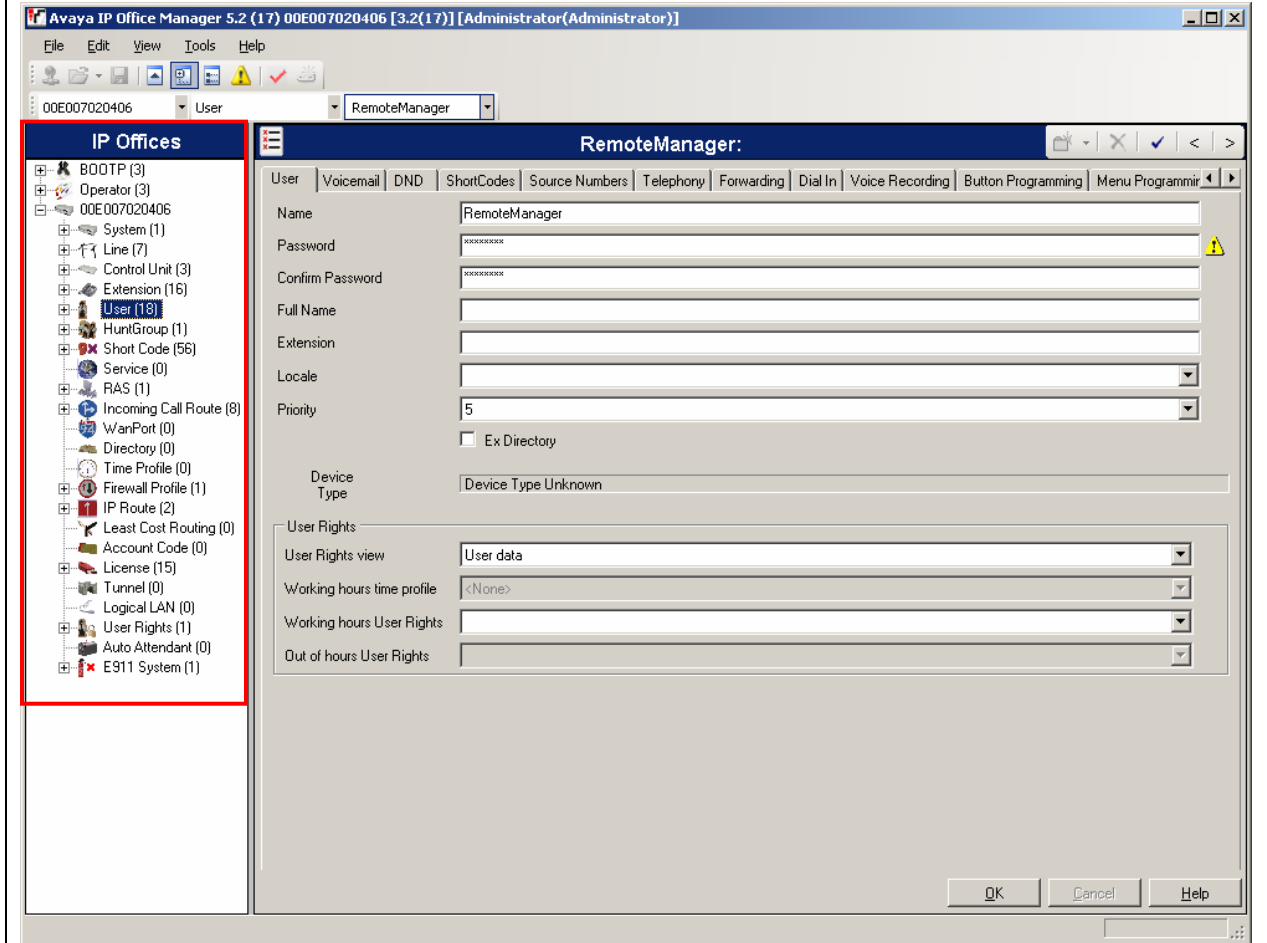
### 4. Avaya IP Office Settings

This section was included to verify that Avaya IP Office was configured correctly. Except where stated, the parameters in all steps are the default settings and are supplied for reference. For all other provisioning information such as provisioning of the trunks, call coverage, and extensions, please refer to the Avaya IP Office product documentation.

Log into the PC running IP Office Manager and go to **Start → Programs → IP Office → Manager** to launch the Manager application. Log into the Manager application using the appropriate credentials. In the Manager window that appears, select **File → Open** to search for an IP Office in the network. Click on the appropriate Avaya IP Office. Click **OK** to continue.

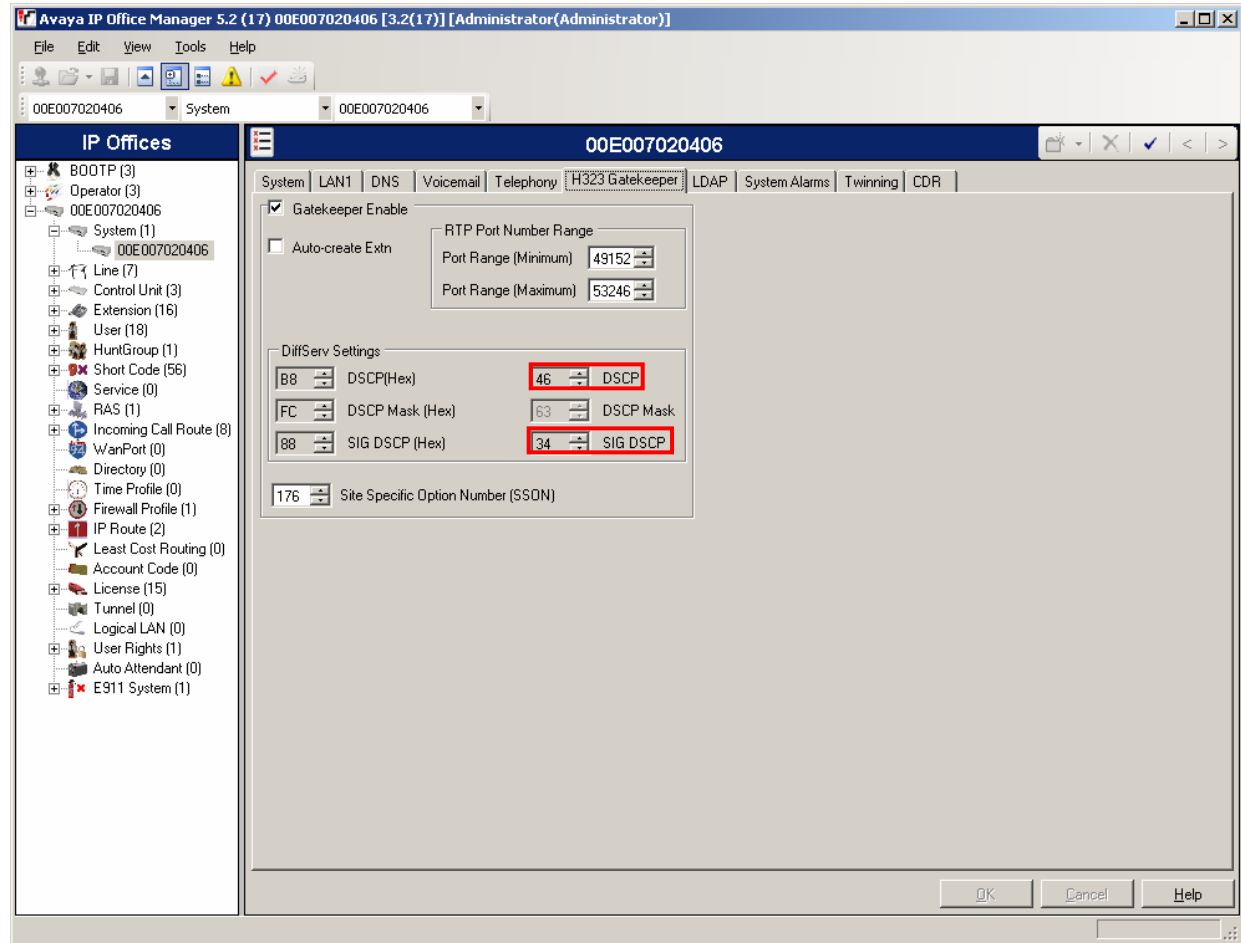
IP Office Manager window.

The main IP Office Manager window appears. The following steps refer to the Configuration Tree, which is in the left pane of the window.

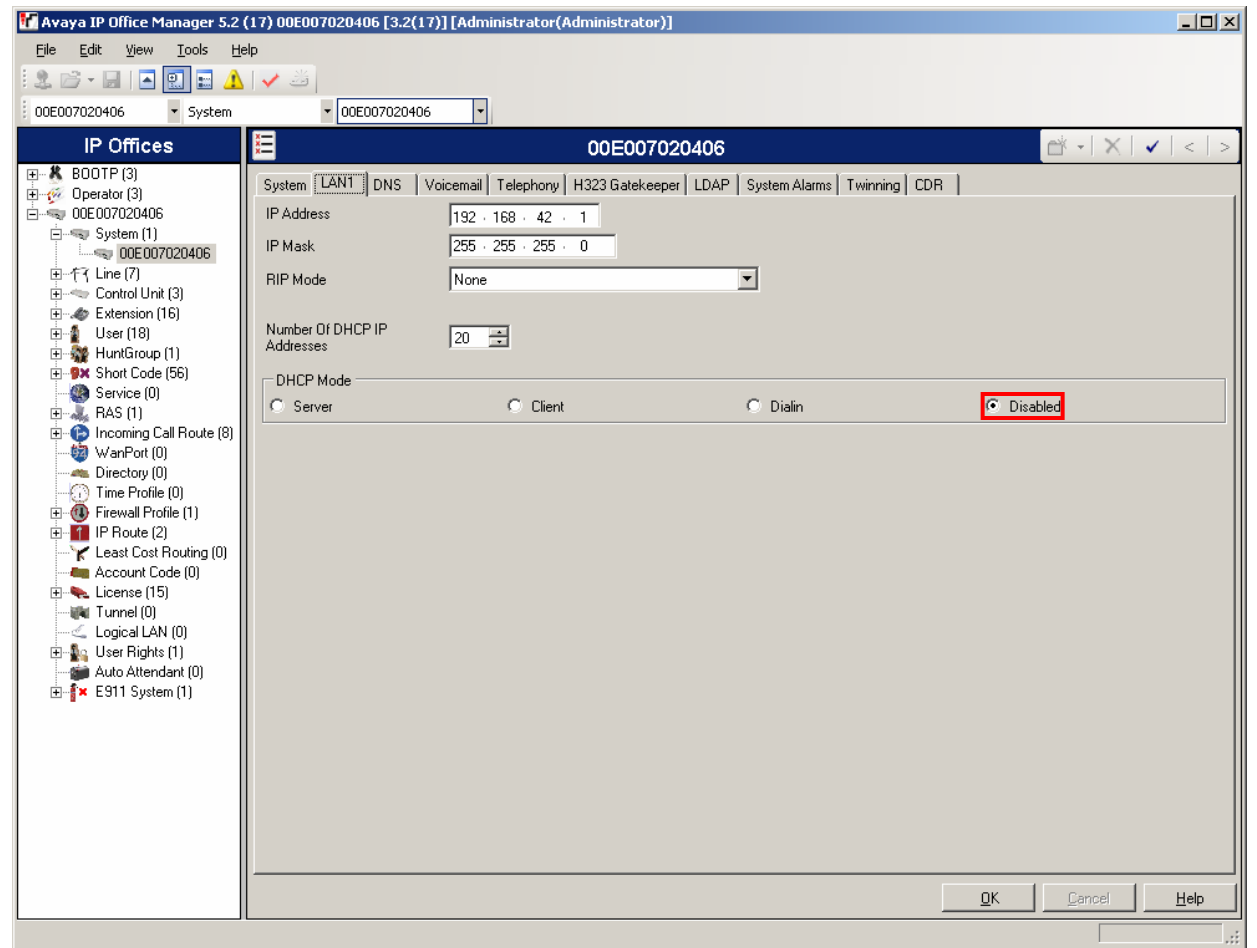


Verify Gatekeeper information.

The Avaya IP Telephones will get Differentiated Services information from Avaya IP Office. This information will be utilized for QoS by the Extreme Switch. In the Manager window, go to the Configuration Tree and double-click **System**. Select the **H323 Gatekeeper** tab. Verify that the **DiffServ Settings** for **DSCP** and **SIG DSCP** are set to **46** and **34**, respectively.



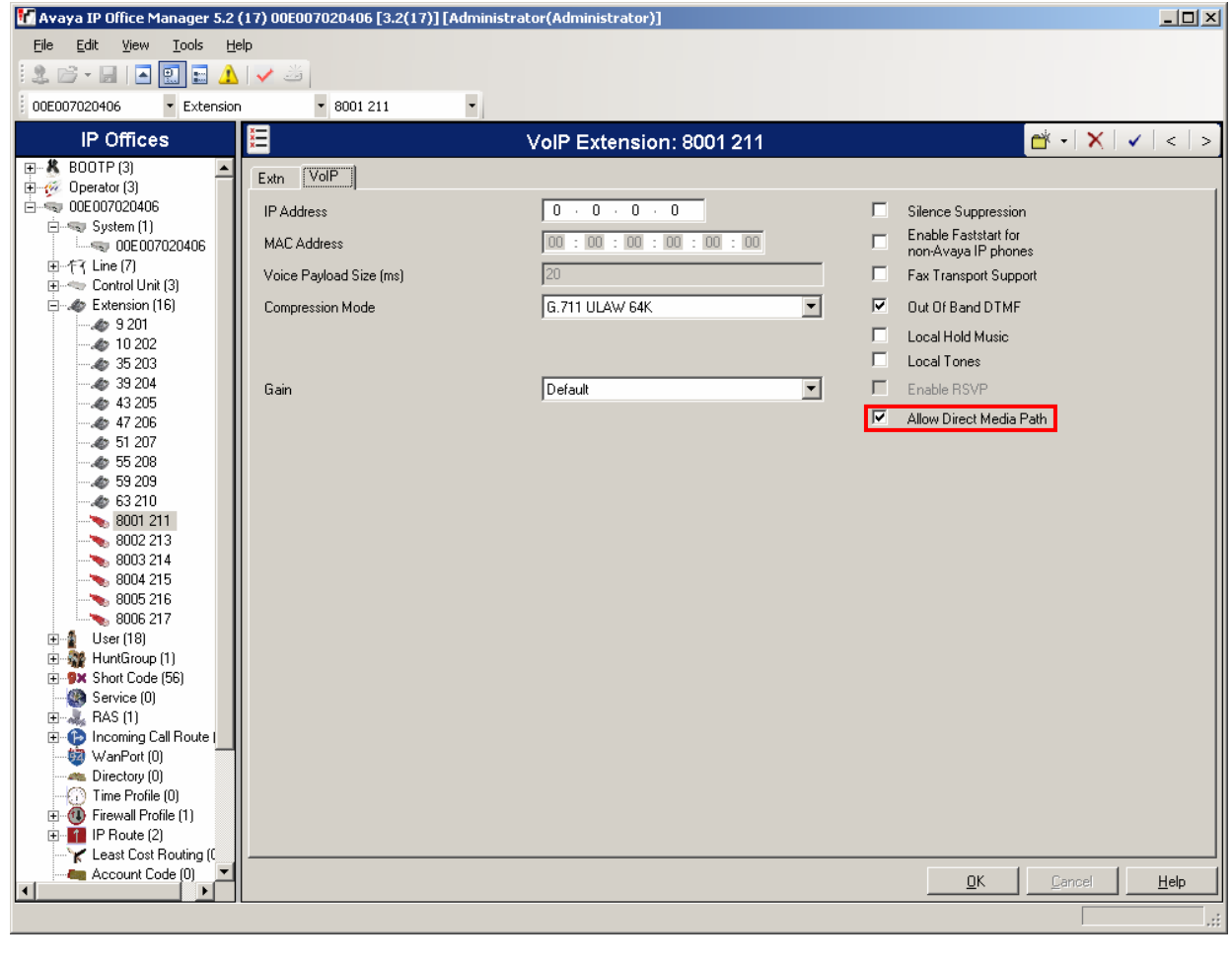
Disable DHCP server on Avaya IP Office.  
From the Configuration Tree, double-click **System**. Select the **LAN1** tab. Set the **DHCP Mode** to **Disabled**. Click **OK** to continue.





**Verify Direct Media Path.**

From the Configuration Tree, select **Extension**. Double-click on the IP telephone extension to verify. Select the **VoIP** tab. Verify that **Allow Direct Media Path** is checked. Click **OK** to continue.



## 5. Configuration of the Extreme Summit X450a-24t Switch for the Control Room

This section addresses how to configure the Extreme Summit X450a-24t Switch. The Extreme X450a-24t will be used as the core router and will run Layer 2 and Layer 3, enforce QoS policies, run OSPF and rapid spanning tree.

1. Log into the Extreme Summit X450a-24t Switch.

Connect to the Extreme X450a-24t Switch. Log in using the appropriate Login ID and Password.

Login:

Password:

X450a-24t.1 #

2. Ensure the ports are not already configured. Use the **show port <port> info detail** command to check the current configuration for the port.

X450a-24t.1 # **show port 1 info detail**

Repeat for ports 2, 3, 7, 8, 9, 10.

3. If any of the ports are configured with VLAN information, use the **configure vlan <VLAN NAME> delete ports <port>** command to delete it.

X450a-24t.1# **configure vlan <VLAN NAME> delete ports <port>**

4. Enable DiffServ examination on port 1.

X450a-24t.1 # **enable diffserv examination ports 1**

5. Create QoS Profile qp7.

X450a-24t.1 # **create qosprofile qp7**

6. Assign DiffServ DSCP replacement value for qp7 to 46.

X450a-24t.1 # **configure diffserv replacement qp7 code-point 46**

7. Assign ports to the native VLAN Default.

X450a-24t.1 # **configure Default add ports 2,3**

8. Enable dot1p replacement for port 10.

```
X450a-24t.1 # enable dot1p replacement ports 10
```

9. Add QoS profile to port 10.

```
X450a-24t.1 # configure port 10 qosprofile qp7
```

10. Create VLAN VlanOSPF.

```
X450a-24t.1 # create vlan VlanOSPF  
X450a-24t.1 # configure VlanOSPF tag 100
```

11. Add an IP address for VLAN VlanOSPF, and enable IP forwarding.

```
X450a-24t.1 # configure VlanOSPF ipaddress 10.20.30.1/30  
X450a-24t.1 # enable ipforwarding VlanOSPF
```

12. Assign ports to VLAN VlanOSPF.

```
X450a-24t.1 # configure VlanOSPF add ports 1
```

13. Enable OSPF.

```
X450a-24t.1 # enable ospf
```

14. Configure OSPF for VlanOSPF.

```
X450a-24t.1 # configure ospf VlanOSPF area 0.0.0.0  
X450a-24t.1 # configure ospf add VlanOSPF area 0.0.0.0
```

15. Enable OSPF to forward information for directly connected interfaces.

```
X450a-24t.1 # enable ospf export direct cost 2 type ase-type-2
```

16. Create VLAN Voice1.

```
X450a-24t.1 # create vlan Voice1  
X450a-24t.1 # configure Voice1 tag 42
```

17. Add an IP address for VLAN Voice1, and enable IP forwarding.

```
X450a-24t.1 # configure Voice1 ipaddress 192.168.42.254/24  
X450a-24t.1 # enable ipforwarding Voice1
```

18. Assign ports to VLAN Voice1 for the interfaces.

```
X450a-24t.1 # configure Voice1 add ports 1, 2, 3 tagged
```

19. Assign a port to VLAN Voice1 for the PC running Avaya Voicemail Pro.

```
X450a-24t.1 # configure Voice1 add ports 7
```

20. Assign a port to VLAN Voice1 for the Avaya IP Office 406v2.

```
X450a-24t.1 # configure Voice1 add ports 10
```

21. Create VLAN Datavlan1.

```
X450a-24t.1 # create vlan Datavlan1  
X450a-24t.1 # configure Datavlan1 tag 200
```

22. Add Datavlan1 to QoS profile qp1 (best effort).

```
X450a-24t.1 # configure Datavlan1 qosprofile qp1
```

23. Add an IP address for VLAN Datavlan1, and enable IP forwarding.

```
X450a-24t.1 # configure Datavlan1 ipaddress 192.168.200.254/24  
X450a-24t.1 # enable ipforwarding Datavlan1
```

24. Assign ports to VLAN Datavlan1.

```
X450a-24t.1 # configure Datavlan1 add ports 2, 3 tagged  
X450a-24t.1 # configure Datavlan1 add ports 8
```

25. Create VLAN Vlan2.

```
X450a-24t.1 # create vlan Vlan2  
X450a-24t.1 # configure Vlan2 tag 2
```

26. Add an IP address for VLAN Vlan2, and enable IP forwarding.

```
X450a-24t.1 # configure Vlan2 ipaddress 10.1.2.1/24  
X450a-24t.1 # enable ipforwarding Vlan2
```

27. Assign ports to VLAN Vlan2.

```
X450a-24t.1 # configure Vlan2 add ports 9
```

28. Configure Rapid Spanning Tree, make it the root switch and add ports to stpd s0.

```
X450a-24t.1 # configure stpd s0 mode dot1w
X450a-24t.1 # configure stpd s0 priority 0
X450a-24t.1 # configure stpd s0 add Voice1
X450a-24t.1 # configure stpd s0 add Datavlan1
X450a-24t.1 # configure stpd s0 add Voice1 ports 2, 3, 7, 10
X450a-24t.1 # configure stpd s0 add Datavlan1 ports 2, 3, 8
```

29. Enable Rapid Spanning Tree.

```
X450a-24t.1 # enable stpd s0
```

30. Enable DHCP relay.

```
X450a-24t.1 # enable bootprelay
X450a-24t.1 # configure bootprelay add 10.1.2.250
```

31. Save the running configuration to the startup configuration.

```
X450a-24t.1 # save
```

## 6. Configuration of the Extreme Summit X450a-24t Switch for Lab A

This section addresses how to configure the Extreme Summit X450a-24t Switch for lab A. The X450a-24t will run Layer 2 VLANs, enforce QoS policies, and run rapid spanning tree.

1. Log into the Extreme Summit X450a-24t Switch (Lab A)

Connect to the Extreme X450a-24t Switch. Log in using the appropriate Login ID and Password.

Login:

Password:

```
X450a-24t.1 #
```

2. Ensure the ports are not already configured. Use the **show port <port> info detail** command to check the current configuration for the port.

```
X450a-24t.1 # show port 1 info detail
```

Repeat for port 2.

3. If any of the ports are configured with VLAN information, use the **configure vlan <VLAN NAME> delete ports <port>** command to delete it.

```
X450a-24t.1# configure vlan <VLAN NAME> delete ports <port>
```

4. Create QoS Profile qp7.

```
X450a-24t.1 # create qosprofile qp7
```

5. Assign ports to the native VLAN Default.

```
X450a-24t.1 # configure Default add ports 1, 2
```

6. Create VLAN Voice1.

```
X450a-24t.1 # create vlan Voice1  
X450a-24t.1 # configure Voice1 tag 42
```

7. Assign ports to VLAN Voice1 for the interfaces.

```
X450a-24t.1 # configure Voice1 add ports 1, 2 tagged
```

8. Create VLAN Datavlan1.

```
X450a-24t.1 # create vlan Datavlan1  
X450a-24t.1 # configure Datavlan1 tag 200
```

9. Add Datavlan1 to QoS profile qp1 (best effort).

```
X450a-24t.1 # configure Datavlan1 qosprofile qp1
```

10. Assign ports to VLAN Datavlan1.

```
X450a-24t.1 # configure Datavlan1 add ports 1, 2 tagged
```

11. Configure Rapid Spanning Tree and add ports to stpd s0.

```
X450a-24t.1 # configure stpd s0 mode dot1w  
X450a-24t.1 # configure stpd s0 add Voice1  
X450a-24t.1 # configure stpd s0 add Datavlan1  
X450a-24t.1 # configure stpd s0 add Voice1 ports 1, 2  
X450a-24t.1 # configure stpd s0 add Datavlan1 ports 1, 2
```

## 12. Enable Rapid Spanning Tree

```
X450a-24t.1 # enable stpd s0
```

## 13. Save the running configuration to the startup configuration

```
X450a-24t.1 # save
```

# 7. Configuration of the Extreme Alpine 3804 Switch for Closet A

This section addresses configuring the Extreme Alpine 3804 Switch. The Alpine 3804 will run Layer 2 and Layer 3, enforce QoS policies, run OSPF, and supply PoE to the Avaya IP Telephones.

### 1. Log into the Extreme Alpine 3804 Switch.

Connect to the Extreme Alpine 3804 Switch. Log in using the appropriate Login ID and Password.

Login:

Password:

```
Alpine3804:1 #
```

### 2. Enable **DiffServ** examination on ports.

```
Alpine3804:1 # enable diffserv examination ports 1:1, 1:3, 1:5
```

### 3. Ensure the ports are not already configured. Use the **show port <port> info detail** command to check the current configuration for the port.

```
Alpine3804:1 # show port 1:1 info detail
```

Repeat for ports 1:3,1:4,1:5.

### 4. If any of the ports are configured with VLAN information, use the **configure vlan <VLAN NAME> delete ports <port>** command to delete it.

```
Alpine3804:1# configure vlan <VLAN NAME> delete ports <port>
```

### 5. Create VLAN VlanOSPF.

```
Alpine3804:1 # create vlan VlanOSPF
```

```
Alpine3804:1 # configure VlanOSPF tag 100
```

6. Add an IP address for VLAN VlanOSPF, and enable IP forwarding.

```
Alpine3804:1 # configure VlanOSPF ipaddress 10.20.30.2/30  
Alpine3804:1 # enable ipforwarding VlanOSPF
```

7. Assign ports to VLAN VlanOSPF.

```
Alpine3804:1 # configure VlanOSPF add ports 1:1
```

8. Enable OSPF.

```
Alpine3804:1 # enable ospf
```

9. Configure OSPF for VlanOSPF.

```
Alpine3804:1 # configure ospf VlanOSPF area 0.0.0.0  
Alpine3804:1 # configure ospf add VlanOSPF area 0.0.0.0
```

10. Create VLAN Voice3.

```
Alpine3804:1 # create vlan Voice3  
Alpine3804:1 # configure Voice3 tag 33
```

11. Add an IP address for VLAN Voice3, and enable IP forwarding.

```
Alpine3804:1 # configure Voice3 ipaddress 192.168.33.254/24  
Alpine3804:1 # enable ipforwarding Voice3
```

12. Assign ports to VLAN Voice3 for the Avaya IP Telephones.

```
Alpine3804:1 # configure Voice3 add ports 1:3, 1:5 tagged
```

13. Create VLAN Datavlan2.

```
Alpine3804:1 # create vlan Datavlan2  
Alpine3804:1 # configure Datavlan2 tag 30
```

14. Add Datavlan2 to QoS profile qp1 (best effort).

```
Alpine3804:1 # configure Datavlan2 qosprofile qp1
```



15. Add an IP address for VLAN Datavlan2, and enable IP forwarding.

**Note:** subnets/VLANs will not route unless IP forwarding is enabled for that VLAN.

```
Alpine3804:1 # configure Datavlan2 ipaddress 192.168.30.254/24  
Alpine3804:1 # enable ipforwarding Datavlan2
```

16. Assign ports to VLAN Datavlan2.

```
Alpine3804:1 # configure Datavlan2 add ports 1:3 1:4
```

17. Enable DHCP relay.

```
Alpine3804:1 # enable bootprelay  
Alpine3804:1 # configure bootprelay add 10.1.2.250
```

18. Save the running configuration to the startup configuration.

```
Alpine3804:1 # save
```

## 8. Configure the Extreme Summit 300-24 Switch for Closet B

This section addresses configuring the Extreme Summit 300-24 Switch (Closet B). The Extreme Summit 300-24 Switch will run Layer 2 VLANs, enforce QoS policies, run rapid spanning tree and supply PoE to the Avaya IP Telephones.

1. Log into Extreme Summit 300-24 Switch (Closet B).

Connect to the Extreme Summit 300-24 Switch. Log in using the appropriate Login ID and Password.

```
Login:  
Password:  
Summit300-24:1 #
```

2. Ensure the ports are not already configured. Use the **show port <port> info detail** command to check the current configuration for the port.

```
Summit300-24:1 # show port 1 info detail
```

Repeat for ports 2, 3, 4, 5.

3. If any of the ports are configured with VLAN information (including Default), use the **configure vlan <VLAN NAME> delete ports <port>** command to delete it.

```
Summit300-24:1# configure vlan <VLAN NAME> delete ports <port>
```

4. Assign ports to the native VLAN Default.

```
Summit300-24:1 # configure Default add ports 1, 2
```

5. Create VLAN Voice1.

```
Summit300-24:1 # create vlan Voice1  
Summit300-24:1 # configure Voice1 tag 42
```

6. Assign ports to VLAN Voice1 for the interfaces.

```
Summit300-24:1 # configure Voice1 add ports 1, 2, 3, 5 tagged
```

7. Create VLAN Datavlan1.

```
Summit300-24:1 # create vlan Datavlan1  
Summit300-24:1 # configure Datavlan1 tag 200
```

8. Add Datavlan1 to QoS profile qp1 (best effort).

```
Summit300-24:1 # configure Datavlan1 qosprofile qp1
```

9. Assign ports to VLAN Datavlan1.

```
Summit300-24:1 # configure Datavlan1 add ports 1, 2 tagged  
Summit300-24:1 # configure Datavlan1 add ports 4, 5
```

10. Configure Rapid Spanning Tree and add ports to stpd s0.

```
Summit300-24:1 # configure stpd s0 mode dot1w  
Summit300-24:1 # configure stpd s0 add Voice1  
Summit300-24:1 # configure stpd s0 add Datavlan1  
Summit300-24:1 # configure stpd s0 add Voice1 ports 1, 2, 3, 5  
Summit300-24:1 # configure stpd s0 add Datavlan1 ports 1, 2, 4, 5
```

11. Enable Rapid Spanning Tree.

```
Summit300-24:1 # enable stpd s0
```

12. Save the running configuration to the startup configuration.

```
Summit300-24:1 # save
```

## 9. Interoperability Compliance Testing

Interoperability compliance testing covered feature functionality, serviceability, and performance testing.

For feature functionality testing, emphasis was placed on verifying voice quality in a converged VoIP and data network scenario. Specifically, compliance testing verified that when the Extreme switch interfaces are oversubscribed with low priority data traffic, the higher priority VoIP media and signaling traffic still gets through with good voice quality. Prioritization of voice traffic was achieved by implementing Layer 3 DiffServ and Layer 2 priority (802.1p) QoS. Voice and data traffic were segmented in the enterprise network using VLANs.

QoS and performance testing were verified by making voice calls while a traffic generator generated low priority data traffic. At the end of the performance test, it was verified that the network devices continued to operate successfully.

Serviceability testing was conducted to verify the ability of the Avaya/Extreme VoIP solution to recover from adverse conditions, such as power cycling Avaya IP Office, Extreme Networks devices and disconnecting cables between the LAN interfaces. In all cases, the Avaya IP Office and Extreme Networks devices recovered without intervention.

### 9.1. General Test Approach

All feature functionality test cases were performed manually. The general test approach entailed verifying the following:

- LAN connectivity between the Avaya and Extreme products
- Registration of Avaya IP Telephones with Avaya IP Office
- Verification of the DHCP relay configuration
- VoIP calls over Layer 2 and Layer 3 connections
- Inter-office calls using G.711 mu-law & G.729 codecs, direct media, conferencing, and sending low priority data traffic over the LAN
- Verifying that QoS directed the voice signaling and voice media to the higher priority egress queue based on the packets' DSCP value
- Interoperability of 802.1D rapid spanning tree
- Layer-2, Layer-3, port based and VLAN based Quality of Service

**Note:** Ethernet Automatic Protection Switching (EAPS) was compliance tested but is not part of this document.

The performance tests were performed by oversubscribing the network interfaces with low priority data traffic and verifying that good voice quality was achieved when calls were made over the routed and switched interfaces.

## 9.2. Test Results

All feature functionality, serviceability, and performance test cases passed. The Extreme implementation yielded voice quality and no calls were lost. The stability of the Avaya/Extreme solution was successfully verified through performance and serviceability testing.

## 10. Verification Steps

This section provides the steps for verifying end-to-end network connectivity and QoS in the field from the perspective of the Extreme Summit X450a-24t Switch. In general, the verification steps include:

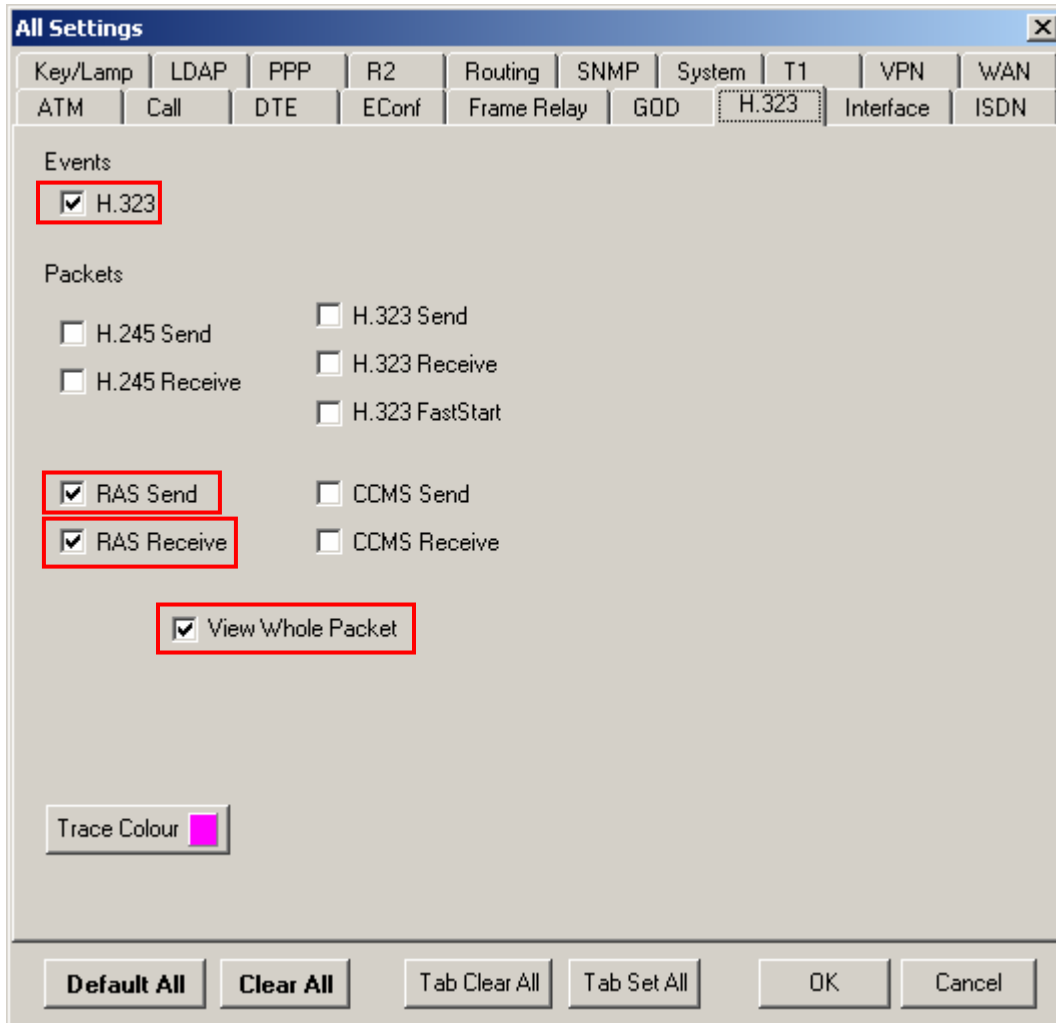
- Verify that the DHCP relay on the Extreme switches is functioning by confirming that the Avaya IP Telephones receive their IP addresses from the DHCP server connected to The Extreme Summit X450a-24t Switch.
- Check that the Avaya IP Telephones have successfully registered using the Avaya IP Office System Monitor. See Section 10.1.
- Place calls between the Avaya 2410 Digital Telephone and the Avaya IP Telephones.

## 11. Troubleshooting

### 11.1. Avaya IP Office Troubleshooting

Troubleshooting can be done on Avaya IP Office via the Avaya IP Office System Monitor application. Log into the IP Office Monitor PC and select **Start** → **Programs** → **IP Office** → **Monitor** to launch the IP Office System Monitor application. Log into the application using the appropriate credentials.

To see the registration messages going to and from Avaya IP Office, select **Trace Options** under the **Filters** Menu. Select the **H.323** tab and configure as illustrated below. Click the **OK** button.



## 11.2. Extreme Networks Troubleshooting

- If the voice quality is poor, check sections 5, 6, 7 and 8 for QoS options.
- If any of the Extreme switches are unable to communicate with any of the aforementioned IP devices and interfaces, check the VLAN configuration, routing and status of the Ethernet and LAN interfaces.

## 12. Conclusion

These Application Notes describe the configuration steps required for integrating Extreme Switches into an Avaya IP Office infrastructure. For the configuration described in these Application Notes, the Extreme switches were responsible for enforcing QoS using Layer 3 Differentiated Services and Layer 2 (802.1p), rapid spanning tree (802.1D) and OSPF. Good

voice quality was successfully achieved in the Avaya/Extreme Networks configuration described herein.

### **13. Additional References**

This section references the Avaya and Extreme product documentation that are relevant to these Application Notes.

The Avaya IP Office product documentation can be found at:

<http://marketingtools.avaya.com/knowledgebase/>

The Extreme product documentation can be found at:

<http://www.extremenetworks.com/products/summit-x450a.aspx>

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