



Avaya Solution & Interoperability Test Lab

Application Notes for Extreme Networks Summit X450a-24t Switch with Avaya Communication Manager 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 Summit X450a-24t Switch connected to Avaya Communication Manager with Avaya IP Telephones in a Converged VoIP and Data Network. The Extreme Summit X450a-24t Switch was compliance-tested with Avaya Communication Manager 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 an Extreme Summit X450a-24t Switch connected to Avaya Communication Manager and Avaya IP Telephones in a Converged VoIP and Data Network. The Extreme Networks Summit X450a-24t Switch was compliance-tested with Avaya Communication Manager 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 Communication Manager. These QoS markings 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 a 24-port or 48-port 10/100/1000BASE-T and 4-port 1000BASE-X SFP. With its tri-speed Gigabit Ethernet interface 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 feature such as hardware based Access Control Lists (ACLs). With its rich Layer 2-4 intelligence, the Summit X450a Series meets 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 Communication Manager and Extreme Summit X450a-24t

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, 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 Communication Manager with one Avaya 2410 Digital Telephone, and one DHCP/TFTP 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, one Avaya 9620 one-X Deskphone Edition IP Telephone, one Avaya 4620SW IP Telephone 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 9630 one-X Deskphone Edition IP Telephone with SBM24 24-button Module, one Avaya 9620 one-X Deskphone Edition IP Telephone and two PC's on 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 be configured to run Layer 2 infrastructure (VLANs), enforce QoS policies and run rapid spanning tree.

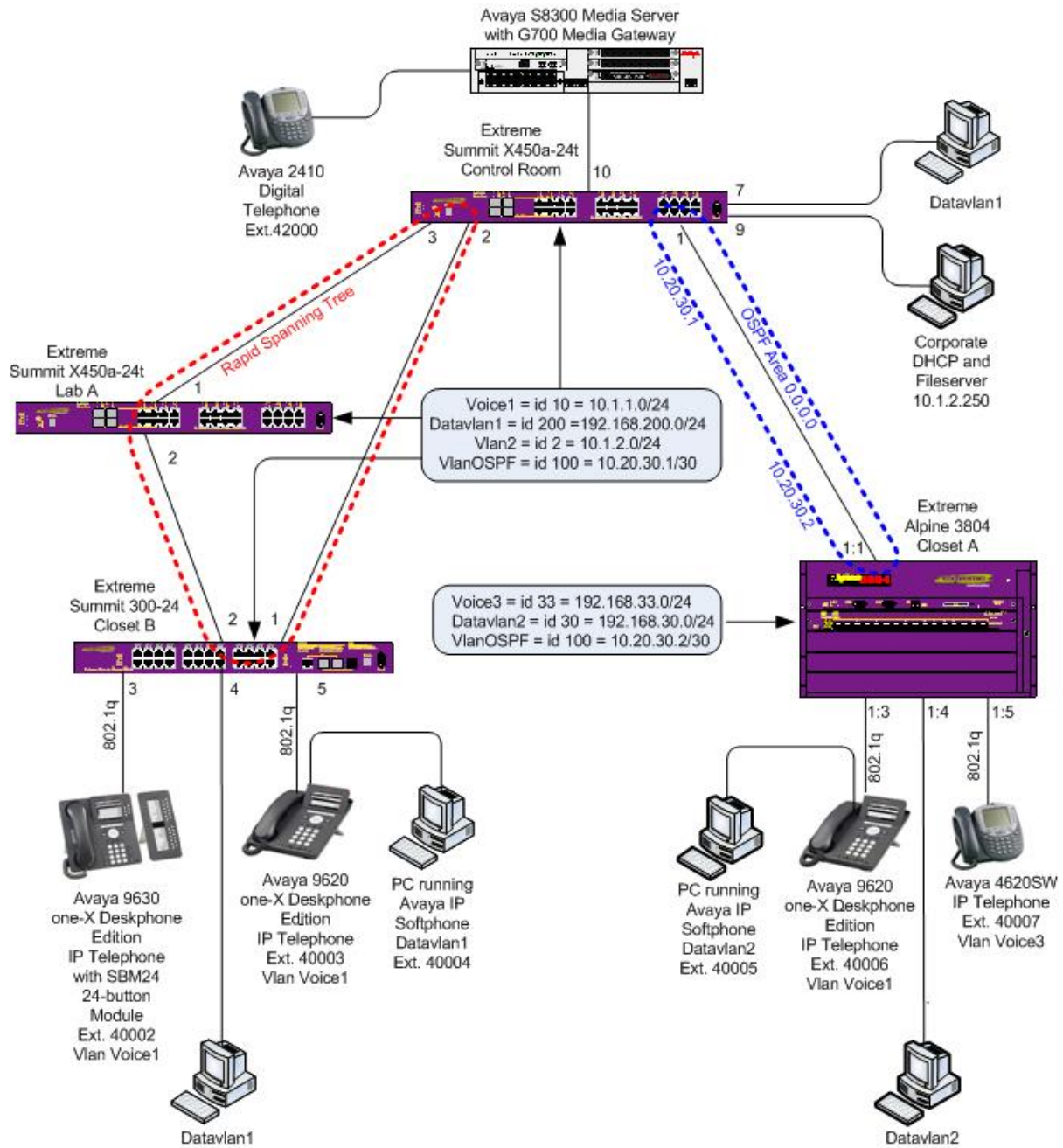


Figure 1: Network Configuration for Avaya Communication Manager and Extreme Summit X450a-24t

3. Equipment and Software Validated

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

Equipment	Software/Firmware
Avaya S8300 Media Server	Avaya Communication Manager 3.1.2
Avaya G700 Media Gateway	25.28.0
Avaya 4620SW IP Telephones (H.323)	2.6
Avaya 9630 one-X Deskphone Edition IP Telephone with SBM24 24-button module (H.323)	1.1
Avaya 9620 one-X Deskphone Edition IP Telephone (H.323)	1.1
Avaya 2410 Digital Telephone	N/A
Extreme Summit X450a-24t	ExtremeXOS 11.5.1.4 (FCS code)
Extreme Alpine 3804	ExtremeWare 7.6
Extreme Summit 300-24	ExtremeWare 7.6

4. Configure Avaya Communication Manager

This section shows the necessary steps in configuring Avaya Communication Manager. For detailed information on the installation, maintenance, and configuration of Avaya Communication Manager, please consult references [1], [2], [3] and [4].

IP networks were originally designed to carry data on a best-effort delivery basis, which meant that all traffic had equal priority and an equal chance of being delivered in a timely manner. As a result, all traffic had an equal chance of being dropped when congestion occurred. To carry voice, Quality of Service (QoS) has to be implemented throughout the entire network.

In order to achieve good voice quality, the VoIP traffic must be classified. The Avaya S8300 Media Server, Avaya G700 Media Gateway and Avaya IP Telephones support both Layer 2 802.1p/Q priority and Layer 3 Differentiated Services (DiffServ). The Extreme Summit X450a-24t can be configured to prioritize VoIP traffic based on these values.

All network components are in network region 1 for this sample configuration. The DiffServ and 802.1p/Q values configured here will be downloaded to the Avaya IP Telephones.

Use the **change ip-network-region 1** command to change the DIFFSERV/TOS PARAMETERS and 802.1P/Q PARAMETERS settings configured in Avaya Communication Manager. The **Call Control PHB Value** should be **46** and the Audio PHB Value should be **46**. The Call Control and Audio 802.1P priority are set to **6**.

```
change ip-network-region 1                                     Page 1 of 19
                                                           IP NETWORK REGION
  Region: 1
  Location:          Authoritative Domain: devcon.com
  Name:
  MEDIA PARAMETERS      Intra-region IP-IP Direct Audio: yes
  Codec Set: 1          Inter-region IP-IP Direct Audio: yes
  UDP Port Min: 2048    IP Audio Hairpinning? y
  UDP Port Max: 3027
  DIFFSERV/TOS PARAMETERS      RTCP Reporting Enabled? y
  Call Control PHB Value: 46    RTCP MONITOR SERVER PARAMETERS
  Audio PHB Value: 46          Use Default Server Parameters? y
  Video PHB Value: 26
  802.1P/Q PARAMETERS
  Call Control 802.1p Priority: 6
  Audio 802.1p Priority: 6
  Video 802.1p Priority: 5      AUDIO RESOURCE RESERVATION PARAMETERS
  H.323 IP ENDPOINTS          RSVP Enabled? n
  H.323 Link Bounce Recovery? y
  Idle Traffic Interval (sec): 20
  Keep-Alive Interval (sec): 5
  Keep-Alive Count: 5
```

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 Summit 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, 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. Create VLAN VlanOSPF.

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

9. 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
```

10. Assign ports to VLAN VlanOSPF.

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

11. Enable OSPF.

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

12. 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
```

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

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

14. Create VLAN Voice1.

```
X450a-24t.1 # create vlan Voice1  
X450a-24t.1 # configure Voice1 tag 10
```

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

```
X450a-24t.1 # configure Voice1 ipaddress 10.1.1.254/24  
X450a-24t.1 # enable ipforwarding Voice1
```

16. Assign ports to VLAN Voice1 for the interfaces.

```
X450a-24t.1 # configure Voice1 add ports 1, 2, 3, 10 tagged
```

17. Create VLAN Datavlan1.

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

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

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

19. 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
```

20. Assign ports to VLAN Datavlan1.

```
X450a-24t.1 # configure Datavlan1 add ports 2, 3 tagged  
X450a-24t.1 # configure Datavlan1 add ports 7
```

21. Create VLAN Vlan2.

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


22. 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
```

23. Assign ports to VLAN Vlan2.

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

24. 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, 10  
X450a-24t.1 # configure stpd s0 add Datavlan1 ports 2, 3, 7
```

25. Enable DHCP relay.

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

26. Enable Rapid Spanning Tree.

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

27. 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 Extreme Summit X450a-24t will run Layer 2 VLANs, enforce QoS policies, and run rapid spanning tree.

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 #

1. 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

2. 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>
```

3. Assign ports to the native VLAN Default.

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

4. Create VLAN Voice1.

```
X450a-24t.1 # create vlan Voice1
```

```
X450a-24t.1 # configure Voice1 tag 10
```

5. Assign ports to VLAN Voice1 for the interfaces.

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

6. Create VLAN Datavlan1.

```
X450a-24t.1 # create vlan Datavlan1
```

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

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

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

8. Assign ports to VLAN Datavlan1.

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

9. 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
```

10. Enable Rapid Spanning Tree.

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

11. 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 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.

```
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 10
```

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 get 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 Communication Manager, Extreme Networks devices and disconnecting cables between the LAN interfaces. In all cases, the Avaya 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 Communication Manager

- 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: 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 with Avaya Communication Manager.
- Place calls between the Avaya 2410 Digital Telephone and Avaya IP Telephones.

11. Troubleshooting

11.1. 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:
 1. Check the VLAN configuration with the command **show vlan**
 2. Check routing with the command **show iproute**
 3. Check the status of the Ethernet and LAN interfaces with the command **show port <port> information detail**

4. Check spanning tree with the command **show stpd s0**

12. Conclusion

These Application Notes describe the configuration steps required for integrating Extreme Networks Switches into an Avaya Communication Manager 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. Voice quality was successfully achieved in the Avaya/Extreme configuration described herein.

13. Additional References

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

Product documentation for Avaya products may be found at <http://support.avaya.com>

- [1] *Administrator Guide for Avaya Communication Manager*, Doc # 03-300509, Issue 2.1, May 2006
- [2] *Avaya Communication Manager Advanced Administration Quick Reference*, Doc # 03-300364, Issue 2, June 2005
- [3] *Administration for Network Connectivity for Avaya Communication Manager*, Doc # 555-233-504, Issue 11, February 2006
- [4] *Avaya IP Telephony Implementation Guide*, May 1, 2006

The Extreme product documentation can be found at:

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

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