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Avaya Solution & Interoperability Test Lab

Application Notes for ProCurve 5400zl and 2600 Series Switches by HP in a Multi-site Avaya IP Office VoIP and Data Network - Issue 1.0

Abstract

These Application Notes describe the configuration of a Voice over IP (VoIP) solution using ProCurve 5400zl and 2600 Series Switches by HP and two Avaya IP Office systems. The ProCurve 5406zl and 2600-PWR Switches were compliance-tested with Avaya IP Office. Emphasis was 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 multi-site Voice over IP (VoIP) solution using ProCurve 5400zl and 2600 Series Switches by HP connected to two Avaya IP Office systems. Compliance testing emphasis was placed on the IP Office site-to-site trunk and verifying voice quality in a converged VoIP and data network scenario. Quality of Service (QoS) 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 IP trunk and small community network features were enabled on Avaya IP Office to allow for direct dialing from Campus A to B. The Avaya IP Telephones get QoS priority settings from Avaya IP Office and are enforced in the network by the ProCurve 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 of the LAN interfaces. Compliance testing included QoS, throughput, and G.711 & G.729 codecs.

1.1. ProCurve Switch 5400zl

The ProCurve 5400zl Series include a 6-slot and a 12-slot chassis. The foundation for all these switches is a purpose built, programmable ProVision ASIC that allows networking features, such as QoS and security, to be implemented in a scalable yet granular fashion. The ProCurve 5400zl Series has a variety of Gigabit interfaces, IEEE 802.3af compliant integrated Power over Ethernet (PoE) l 10/100/1000Base-T ports which provide up to 15.4 Watts per port, 10-GbE capability. A redundant external power supply is also available as an accessory.

1.2. ProCurve Switch 2600 Series

The ProCurve Switch 2600 series is a collection of stackable, multi-layer, managed switches with 48, 24, or 8 auto-sensing 10/100 ports. The 2600 Switch has dual-personality ports for 10/100/1000 or mini-GBIC (gigabit interface converter) connectivity. The ProCurve Switch 2650-PWR, 2626-PWR, and 2600-8-PWR are IEEE 802.3af compliant for Power over Ethernet and provide up to 15.4 Watts per port. A redundant external power supply is also available as an accessory.

2. Hardware Configuration

The configuration in **Figure 1** shows Campus A with a ProCurve 5406zl Switch, and Campus B with a ProCurve 2626-PWR. Each campus has an Avaya IP Office 406V2 on site with an IP trunk between them running small community network.

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

2.1. Campus A

Campus A consists of a ProCurve 5406zl Switch by HP, Avaya IP Office 406V2, two Avaya IP Telephones, one Avaya digital phone, Avaya IP Office Manager, one PC on Datavlan1 running Avaya IP Office Phone Manager Pro and a corporate DHCP/TFTP server. The ProCurve 5406zl Switch provides PoE to the Avaya IP Telephones and is configured for QoS based on Layer 2 Priority and Layer 3 Differentiated Services. Campus A provides a DHCP server for assigning IP network parameters to the Avaya IP Telephones at both sites.

2.2. Campus B

Campus B consists of a ProCurve 2626-PWR Switch by HP, Avaya IP Office 406V2, two Avaya IP Telephones, one Avaya digital phone and one PC on Vlandata2 running Avaya IP Office Phone Manager Pro. The ProCurve 2626-PWR Switch provides PoE for the Avaya IP phones and is configured for QoS based on Layer 2 Priority and Layer 3 Differentiated Services.
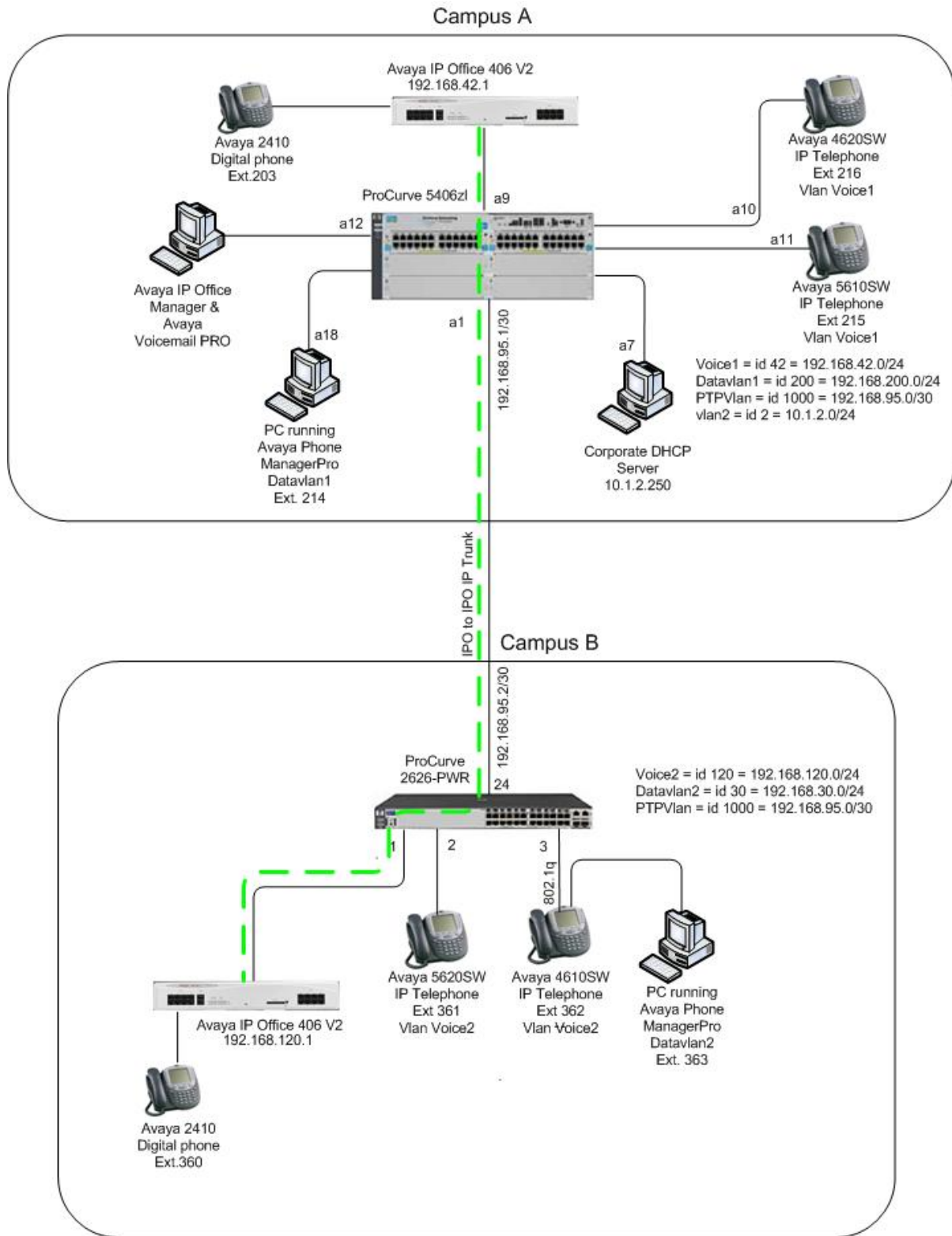
Figure 1: Network Configuration

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)	2.6
Avaya 4610SW IP Telephones (H.323)	2.6
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)
Avaya IP Office Phone Manager Pro	3.2.15
ProCurve 5406zl by HP with Gig-T/SFP zl module J8705A	FW-K.11.41
ProCurve 2626-PWR by HP	FW-H.08.98

4. Avaya IP Office Settings

Log into the PC running Avaya 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 IP Offices in the network. Click on the appropriate Avaya IP Office. Click **OK** to continue.
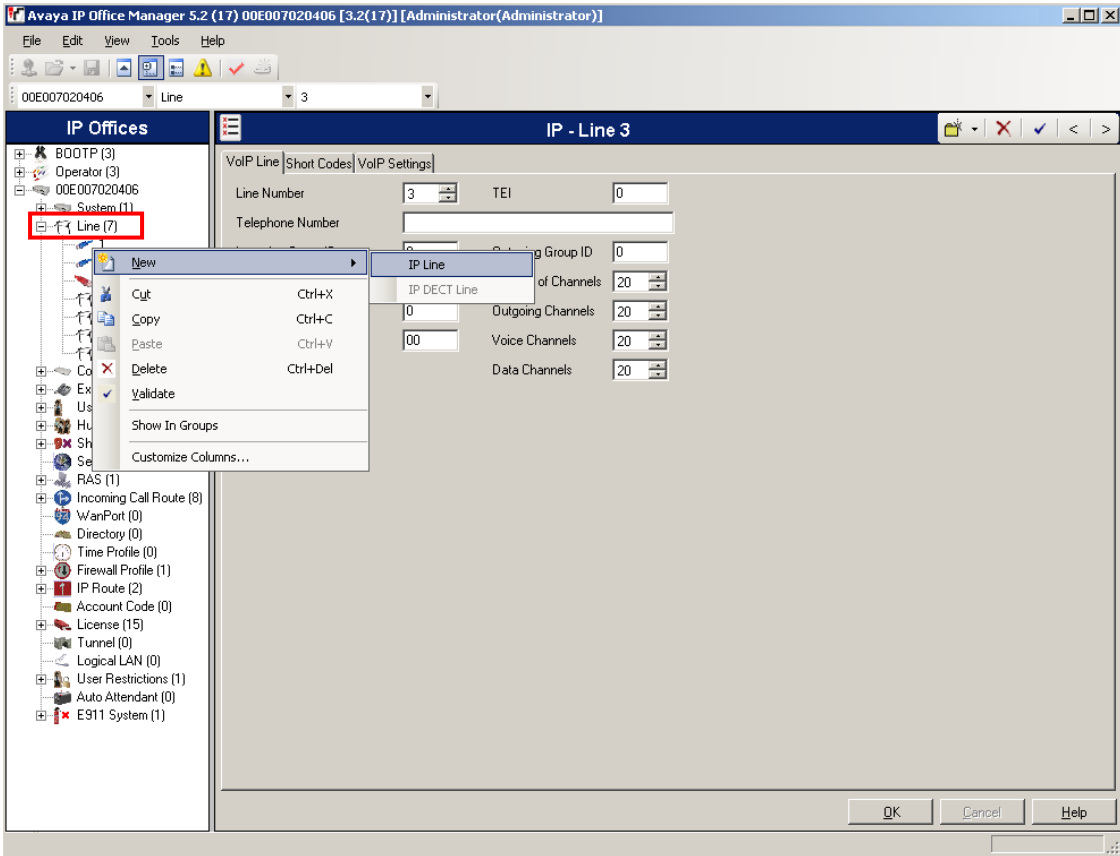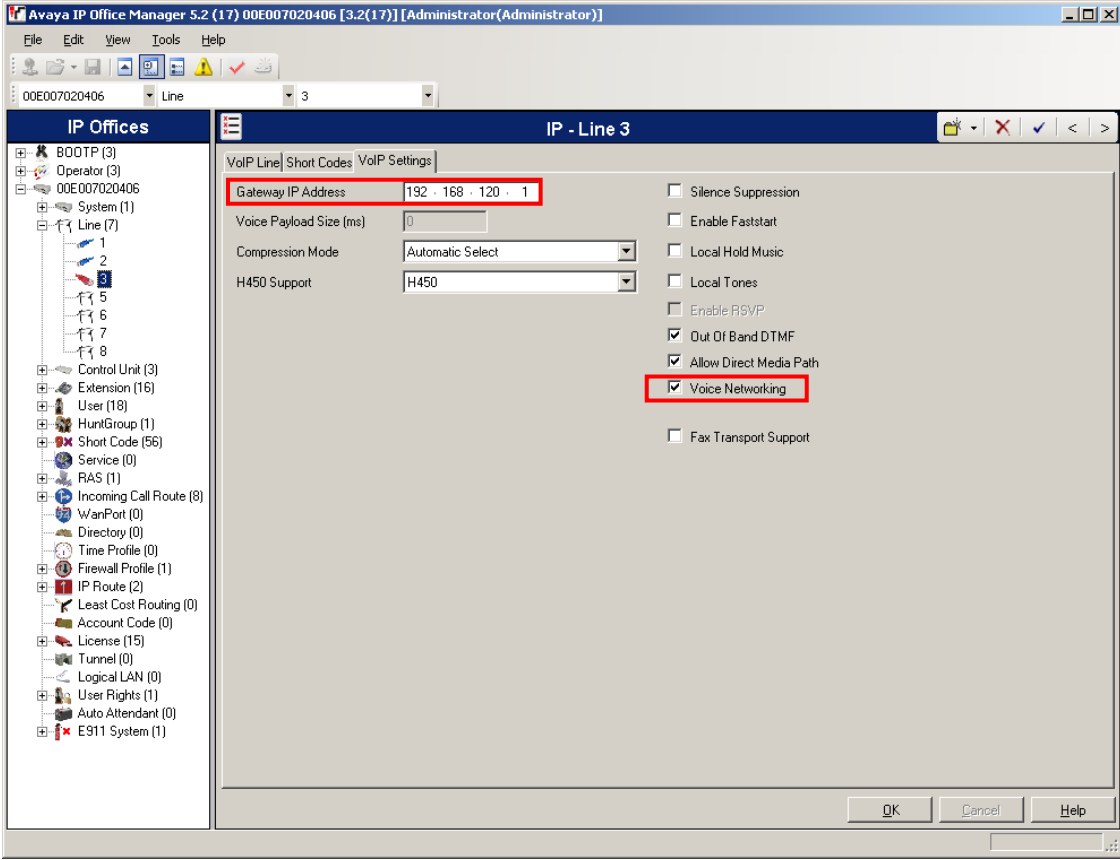
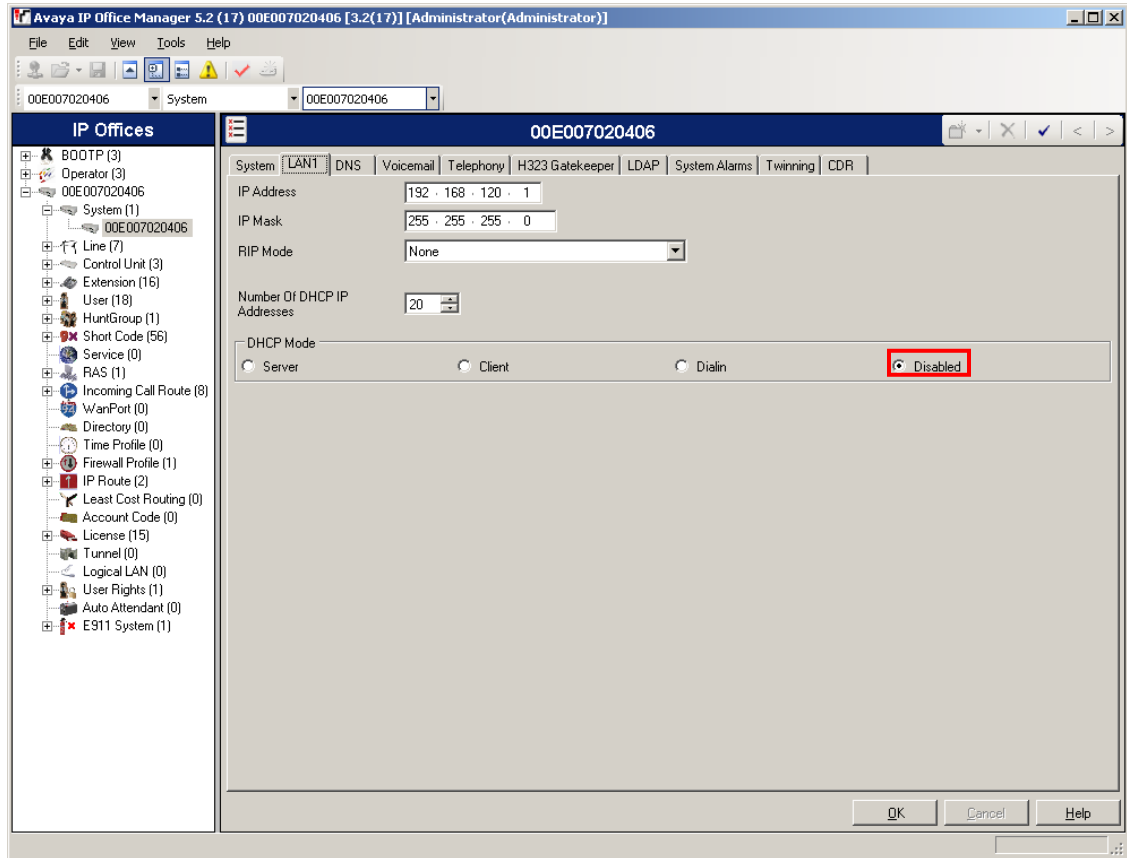| Description |
|---|
| IP Office Manager window. |
| The main IP Office Manager window appears. The following steps refer to the Configuration Tree which is in the left pane of the window and under the heading **IP Offices**. Click **OK** to continue. |
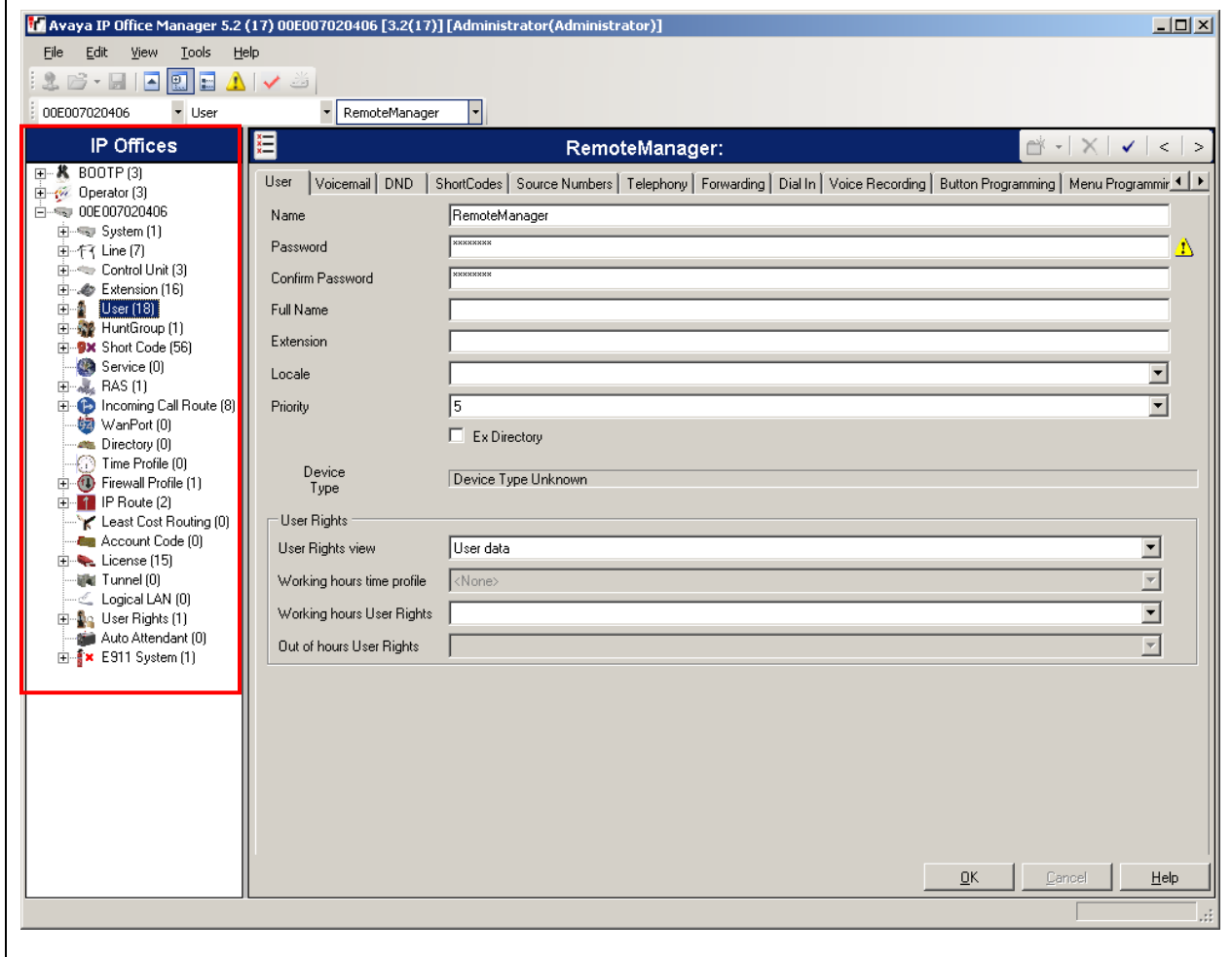
4.1. Avaya IP Office Settings for Campus A

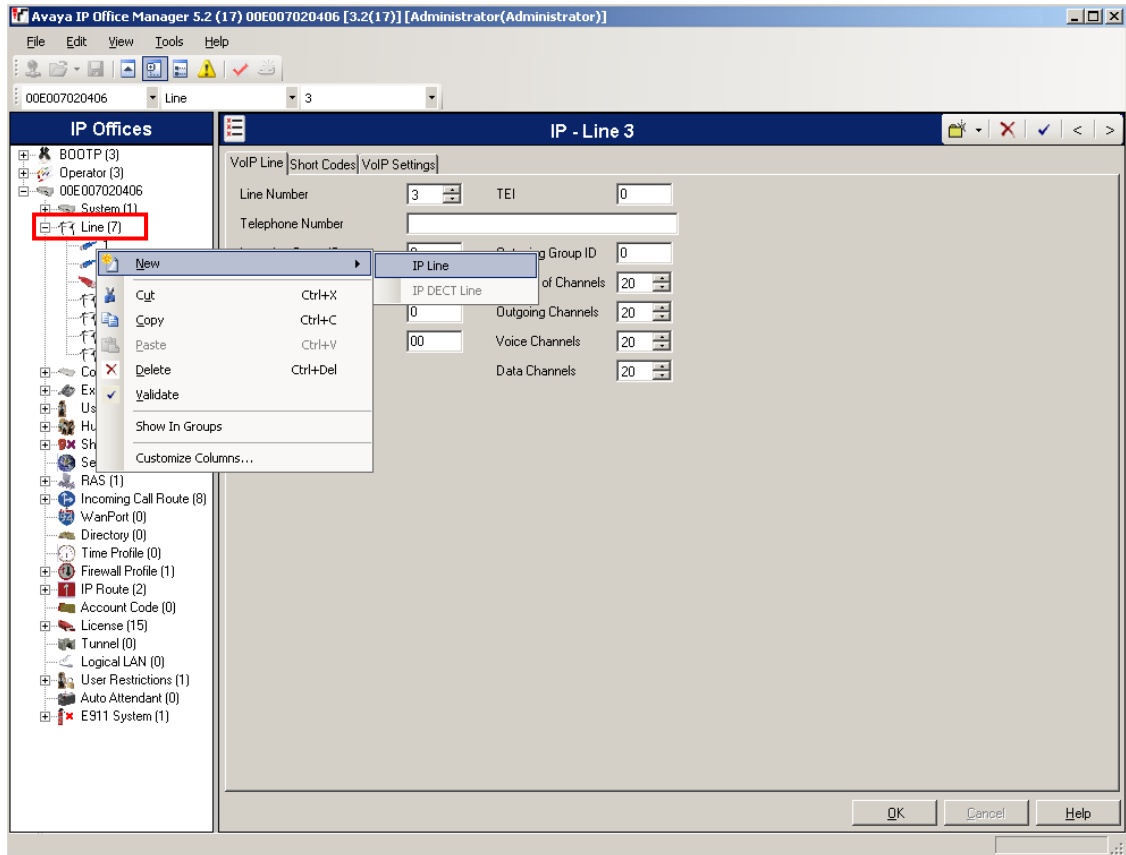| Step	Description
1.	Create IP trunk to Campus B's Avaya IP Office. From the Configuration Tree, Right mouse click **Line → New →IP Line**. Select the **VoIP Settings** tab.

Step	Description
2.	Assign Gateway IP Address.
	Assign an IP address for the **Gateway IP Address** (address of the Campus B IP Office) and enable **Voice Networking**. Click **OK** to continue.

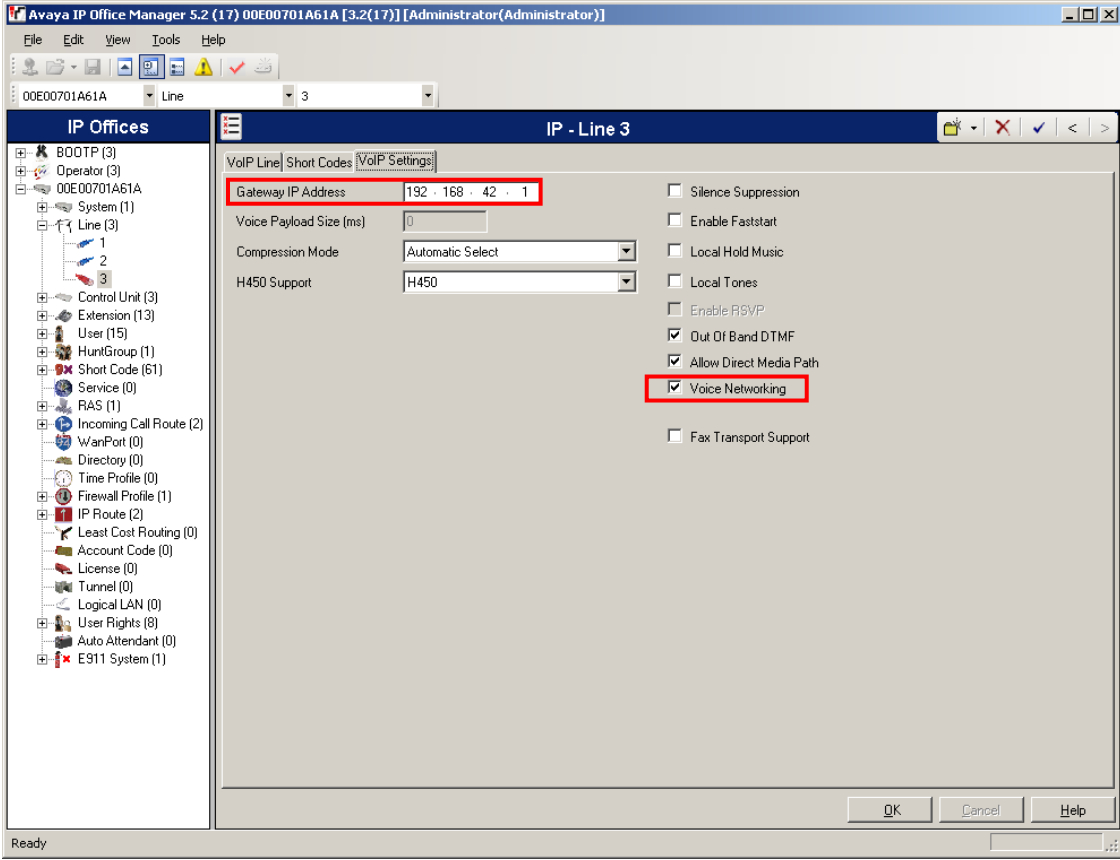|	
3.	Disable DHCP server on Avaya IP Office. From the Configuration Tree, double-click **System**. Select the **LAN1** tab. Set the **DHCP Mode** to **Disabled**. Click **OK** to continue.

4.2. Avaya IP Office Settings for Campus B

1.	Create IP trunk to Campus A's Avaya IP Office. From the Configuration Tree, Right mouse click **Line** → **New** → **IP Line**. Select the **VoIP Settings** tab.

Step	Description
2.	Assign Gateway IP Address. Assign an IP address for the **Gateway IP Address** (address of the Campus A IP Office) and enable **Voice Networking**. Click **OK** to continue.

3. 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.
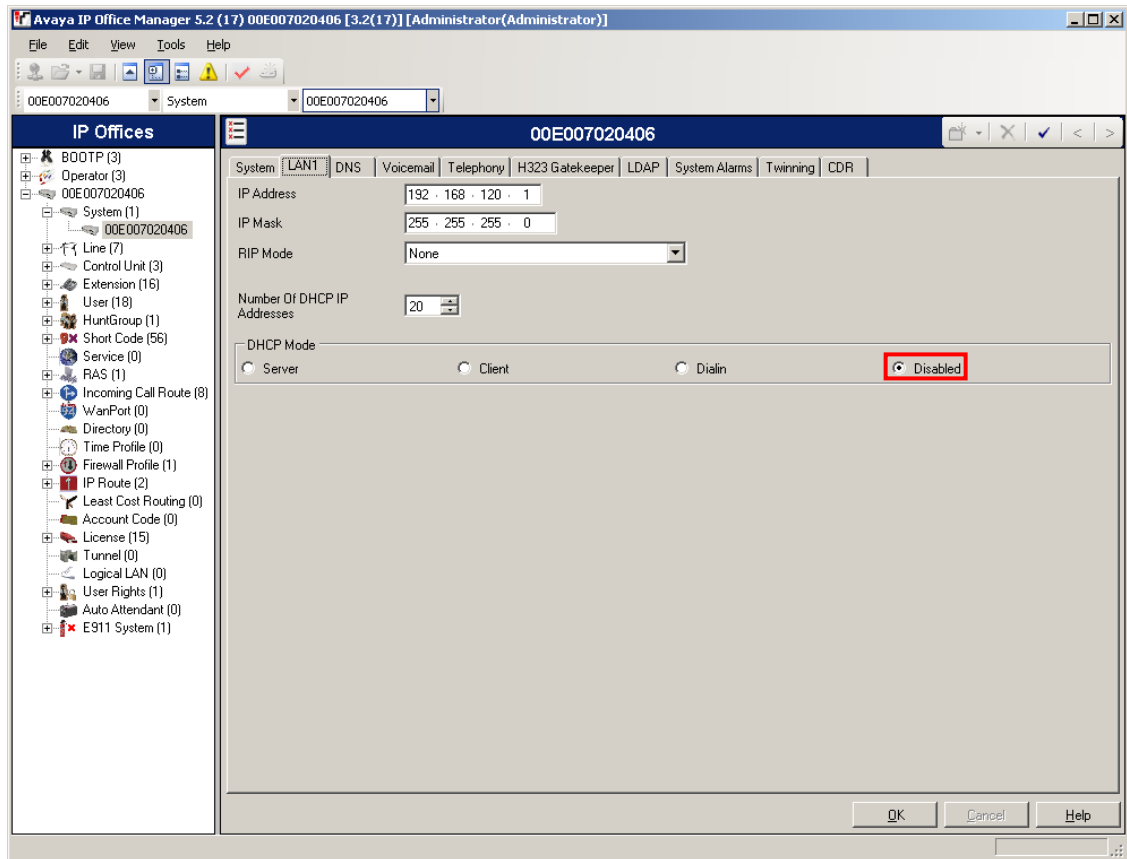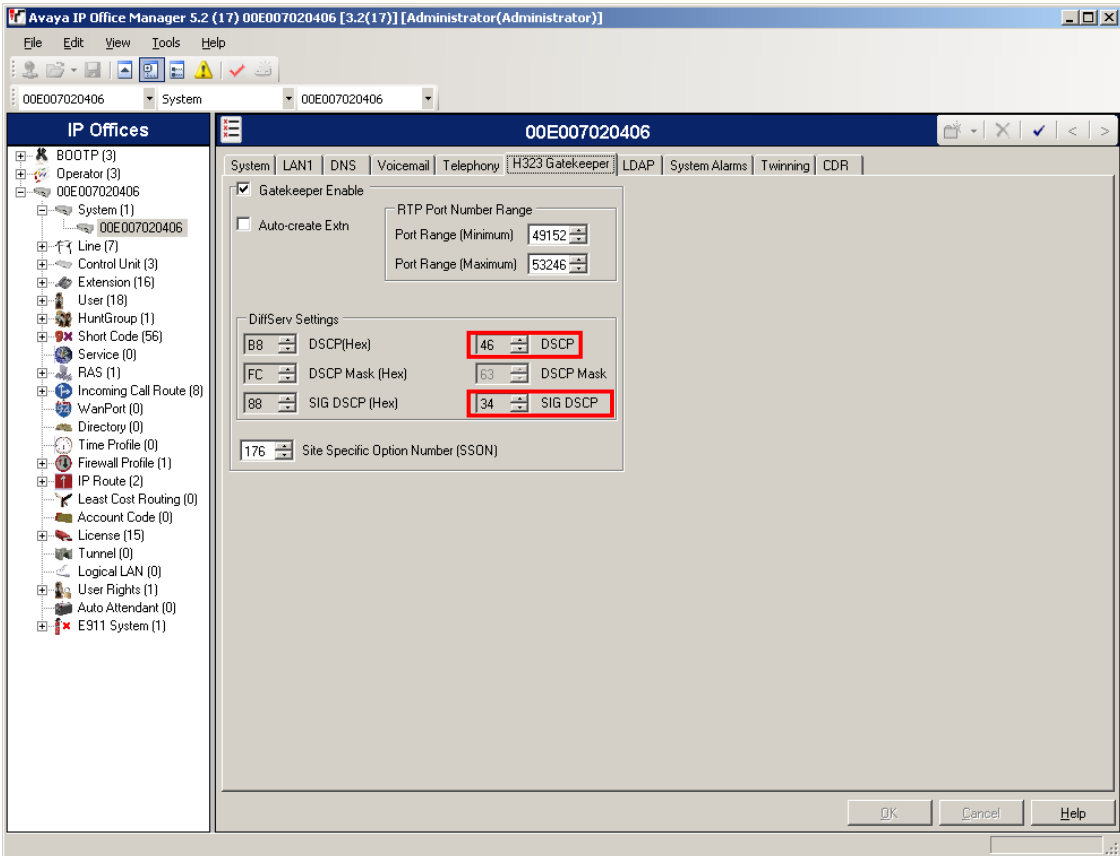
5. Verify Avaya IP Office Settings For Campus A & B

This section is included to verify Campus A & B Avaya IP Office systems were 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.

Step	Description
1.	Verify Gatekeeper information. The Avaya IP Telephones will get Differentiated Services information from the Avaya IP Office. This information will be utilized for QoS by the ProCurve Switch. In the Avaya IP Office 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.

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

6. Configuration of the ProCurve 5406zl Switch

This section addresses configuring the ProCurve 5406zl Switch. The 5406zl will be used as the core router for Campus A and will run Layer 2 and Layer 3 and enforce QoS policies as well as supply PoE to the Avaya IP telephones.

1. Log into the ProCurve 5406zl Switch.

Connect to the ProCurve 5406zl Switch. Log in using the appropriate Login ID and Password.

Login:
Password:
ProCurve Switch 5406zl#

2. Enable Routing on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **ip routing**

3. Create and configure VLAN PTPVlan on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **vlan 1000 name PTPVlan**

4. Assign an IP address to VLAN PTPVlan on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **vlan 1000**
ProCurve Switch 5406zl (vlan-1000)#**ip address 192.168.95.1/30**

5. Assign ports to VLAN PTPVlan on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **vlan 1000**
ProCurve Switch 5406zl (vlan-1000)# **tagged a1**

6. Enable QoS for Differentiated Services on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **qos type-of-service diff-services**

7. Create and configure VLAN Voice1 on the ProCurve 5406zl Switch.

ProCurve Switch 5406zl# **configure**
ProCurve Switch 5406zl(config)# **vlan 42 name Voice1**

8. Assign an IP address and DHCP helper-address to VLAN Voice1 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 42
ProCurve Switch 5406zl (vlan-42)#ip address 192.168.42.254/24
ProCurve Switch 5406zl (vlan-42)# ip helper-address 10.1.2.250
```

9. Assign ports to VLAN Voice1 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 42
ProCurve Switch 5406zl (vlan-42)# untagged a9,a12
ProCurve Switch 5406zl (vlan-42)# tagged a10,a11
```

10. Create and configure VLAN Datavlan1 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 200 name Datavlan1
```

11. Assign an IP address and DHCP helper-address to VLAN Datavlan1 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 200
ProCurve Switch 5406zl (vlan-200)#ip address 192.168.200.254/24
ProCurve Switch 5406zl (vlan-200)# ip helper-address 10.1.2.250
```

12. Assign ports to VLAN Datavlan1 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 200
ProCurve Switch 5406zl (vlan-200)# untagged a18
```

13. Create and configure VLAN vlan2 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 2 name vlan2
```

14. Assign an IP address and DHCP helper-address to VLAN vlan2 on the ProCurve 5406zl
Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 2
ProCurve Switch 5406zl (vlan-2)#ip address 10.1.2.254/24
ProCurve Switch 5406zl (vlan-2)# ip helper-address 10.1.2.250
```

15. Assign ports to VLAN vlan2 on the ProCurve 5406zl Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 2
ProCurve Switch 5406zl (vlan-2)# untagged a7
```

16. Set priority to the IP Office IP address.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# qos device-priority 192.168.42.1 dscp 100010
```

17. Set the port of the IP Office IP to priority of 6.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# int a9
ProCurve Switch 5406zl(eth-A10)# qos priority 6
```

18. Create static routes on the ProCurve 5406zl Switch for the networks at Campus 2.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# ip route 192.168.30.0 255.255.255.0 192.168.95.2
ProCurve Switch 5406zl(config)# ip route 192.168.120.0 255.255.255.0 192.168.95.2
```

19. Save the configuration by writing the running configuration to the startup configuration.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# write memory
```

7. Configuration of the ProCurve 2626-PWR Switch

This section addresses configuring the ProCurve 2626-PWR Switch. The ProCurve 2626-PWR Switch will be used as the core router for Campus B and will run Layer 2 and Layer 3, enforce QoS policies and supply PoE to the Avaya IP Telephones.

1. Log into ProCurve 2626-PWR Switch.

Connect to the ProCurve 2626-PWR Switch. Log in using the appropriate Login ID and Password.

Login:
Password:
ProCurve Switch 2626-PWR#

2. Enable DSCP map to priority 6 on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **qos dscp-map 100010 priority 6**

3. Enable QoS for Differentiated Services on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **qos type-of-service diff-services**

4. Enable Routing on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **ip routing**

5. Create and configure VLAN PTPVlan on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **vlan 1000 name PTPVlan**

6. Assign an IP address to VLAN PTPVlan on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **vlan 1000**
ProCurve Switch 2626-PWR(vlan-1000)#**ip address 192.168.95.2/30**

7. Assign ports to VLAN PTPVlan on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **vlan 1000**
ProCurve Switch 2626-PWR(vlan-1000)# **tagged 24**

8. Create and configure VLAN Voice2 on the ProCurve 2626-PWR Switch.

ProCurve Switch 2626-PWR# **configure**
ProCurve Switch 2626-PWR(config)# **vlan 120 name Voice2**

9. Assign an IP address and DHCP helper-address to VLAN Voice2 on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# vlan 120
ProCurve Switch 2626-PWR (vlan-42)#ip address 192.168.120.254/24
ProCurve Switch 2626-PWR (vlan-42)# ip helper-address 10.1.2.250
```

10. Assign ports to VLAN Voice2 on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# vlan 120
ProCurve Switch 2626-PWR (vlan-120)# untagged 1
ProCurve Switch 2626-PWR (vlan-120)# tagged 2-3
```

11. Create and configure VLAN DataVlan2 on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# vlan 30 name Datavlan2
```

12. Assign an IP address and DHCP helper-address to VLAN Datavlan2 on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# vlan 30
ProCurve Switch 2626-PWR (vlan-30)#ip address 192.168.30.254/24
ProCurve Switch 2626-PWR (vlan-30)# ip helper-address 10.1.2.250
```

13. Assign ports to VLAN Datavlan2 on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# vlan 30
ProCurve Switch 2626-PWR (vlan-30)# untagged 3
```

14. Create default route on the ProCurve 2626-PWR Switch.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 2626-PWR(config)# ip route 0.0.0.0/0 192.168.95.1
```

15. Save the configuration by writing the running configuration to the startup configuration.

```
ProCurve Switch 2626-PWR# configure
ProCurve Switch 2626-PWR(config)# write memory
```

8. Interoperability Compliance Testing

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

For feature functionality testing, emphasis was placed on the IP Office site-to-site trunk and verifying voice quality in a converged VoIP and data network scenario. Specifically, compliance testing verified that when the ProCurve 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/ProCurve VoIP solution to recover from adverse conditions, such as power cycling Avaya IP Office systems, ProCurve network devices and disconnecting cables between the LAN interfaces. In all cases, the Avaya IP Office systems/trunks and ProCurve network devices recovered without intervention.

8.1. 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 ProCurve 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

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 from Campus A to Campus B.

8.2. Test Results

All feature functionality, serviceability, and performance test cases passed. The ProCurve implementation yielded good voice quality. The stability of the Avaya/ProCurve solution was successfully verified through performance and serviceability testing.

9. Verification Steps

This section provides the steps for verifying end-to-end network connectivity and QoS in the field from the perspective of the ProCurve 5406zl switch. In general, the verification steps include:

1. Verify that the DHCP relay on the ProCurve switches is functioning by confirming that the Avaya IP Telephones receive their IP addresses from the DHCP server connected to the ProCurve 5406zl.

2. Check that the Avaya IP Telephones have successfully registered using the Avaya IP Office **System Monitor**. See Section 10.1.

3. Place internal and external calls between the Avaya 2410 Digital Telephone and Avaya IP Telephones at each site.

10. Troubleshooting

10.1. Avaya IP Office Troubleshooting

Troubleshooting can be done on the 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 IP Office, select **Trace Options** under the **Filters** Menu. Select the **H.323** tab and configure as illustrated below. Click the **OK** button.
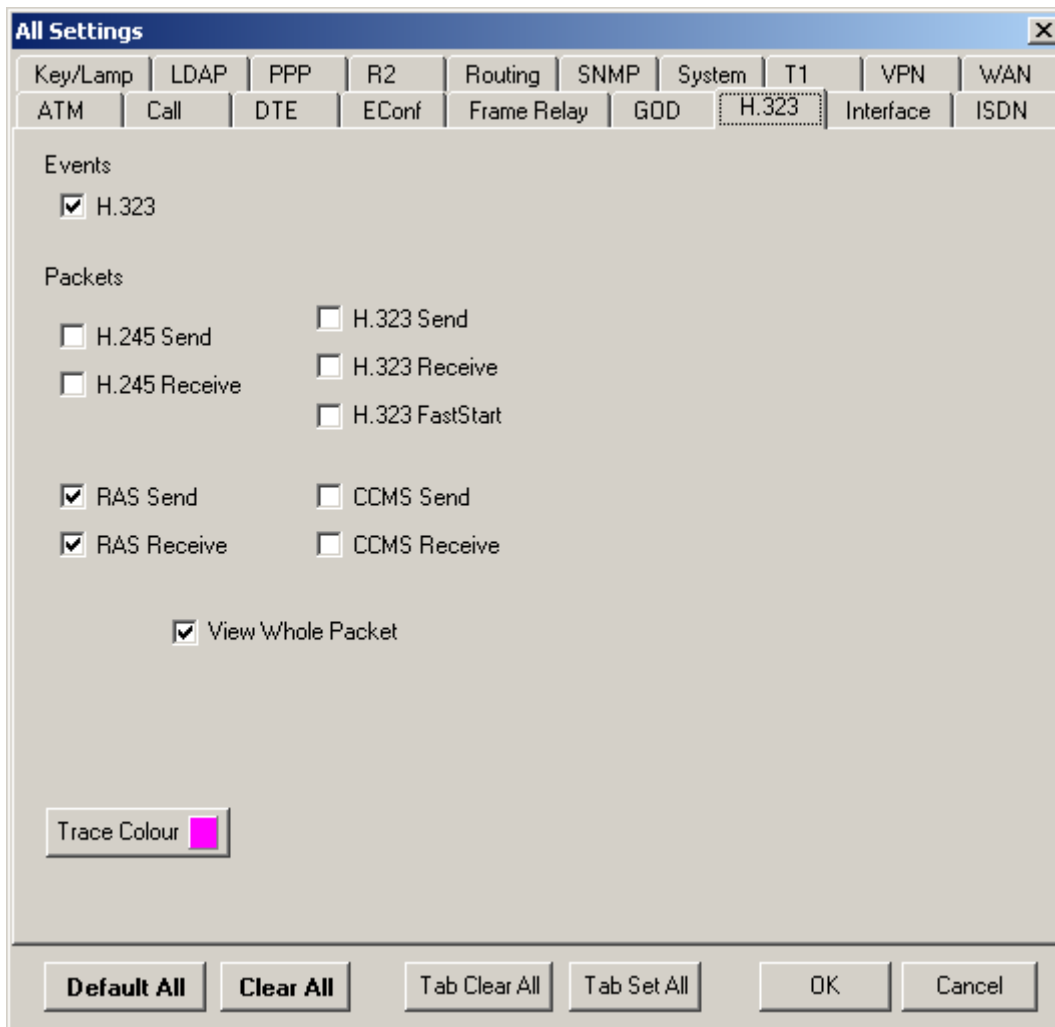
10.2. ProCurve Troubleshooting

1. If the voice quality is poor, check Sections 6 & 7 for QoS options.

2. If any of the ProCurve 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.

11. Conclusion

These Application Notes describe the configuration steps required for integrating ProCurve Switches by HP into a multi-site Avaya IP Office infrastructure. For the configuration described in these Application Notes, the ProCurve switches were responsible for enforcing QoS using Layer 3 Differentiated Services and Layer 2 (802.1p). The Avaya IP Office delivered the voice traffic to the routers for transmission over the LAN together with low

priority data traffic. Good voice quality was successfully achieved in the Avaya/ProCurve configuration described herein.

12. Additional References

This section references the Avaya and HP 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 HP product documentation can be found at:
http://www.hp.com/rnd/support/manuals

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