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Avaya Solution & Interoperability Test Lab

Application Notes for HP ProCurve Networking Switches connected to an Avaya Telephony Infrastructure in a Multi-Site VoIP and Data Network solution using Avaya IP Office - Issue 1.0

Abstract

These Application Notes describe the configuration of a multi-site Voice over IP (VoIP) and data network solution using HP ProCurve Networking 5400zl, 3500yl and 2910al Series Switches with an Avaya Telephony Infrastructure using Avaya IP Office. Emphasis was placed on verifying the prioritization of VoIP traffic and voice quality in a multi-site converged VoIP and Data network scenario.

Information in these Application Notes has been obtained through DevConnect compliance testing and additional technical discussions. Testing was conducted via the DevConnect 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 HP ProCurve 5400zl, (*)3500yl and 2910al Series Switches connected to two Avaya IP Offices. The IP Line and Small Community Network (SCN) features were enabled to allow for direct dialing from Campus A to B. 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 and SNC traffic over the LAN. The Avaya IP Telephones get QoS priority settings from Avaya IP Office and are enforced in the network by the ProCurve Switches.

The VoIP and SCN traffic was given priority over the best effort data traffic. Tests were performed by over subscribing the LAN interfaces with low priority data traffic and verifying that good voice quality was achieved and that the SCN trunk stayed up when routed through the over subscribed LAN interfaces. Compliance testing included QoS, throughput, and G.711 & G.729 codecs.

(*) The ProCurve 3500yl-24G Switch was also compliance tested as the Campus 2 remote switch. Since the syntax for configuring 3500yl and 2910al Series Switches is the same, only the configuration for the ProCurve 2910al Switch is shown.

1.1. Interoperability Compliance Testing

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

QoS testing verified that when the ProCurve Switch interfaces are over subscribed with low priority data traffic, the higher priority VoIP media, signaling and SCN traffic still got through the over subscribed LAN interfaces. Prioritization of voice traffic was achieved by implementing Layer 3 DiffServ-based QoS and Layer 2 priority (802.1.p). Voice and data traffic were segmented in the enterprise network using VLANs. At the end of the performance test, it was verified that the network devices continued to operate successfully.

The telephony features verified to operate correctly included attended/unattended transfer, conference call participation, conference call add/drop, multiple call appearances, caller ID operation, call forwarding unconditional, call forwarding on busy, call Park, call pick-up, bridged call appearances, voicemail, Message Waiting Indicator (MWI), and hold and return from hold.

Serviceability testing was conducted to verify the ability of the Avaya/ProCurve VoIP solution to recover from adverse conditions, such as power cycling network devices and disconnecting cables between the LAN interfaces. In all cases, the ability to recover after the network normalized was verified.

1.2. Support

For technical support on ProCurve products, consult the support pages at:
http://www.procurve.com/customercare/support/manuals/index.htm

2. Reference Configuration

The configuration in **Figure 1** shows a Multi-Site converged VoIP and data network with multiple campuses.

For compliance testing, the DHCP server function on Avaya IP Offices 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 HP ProCurve 5406zl Switch, one Avaya IP Office IP 500, two Avaya IP Telephones, one Avaya digital phone, one PC on Datavlan1 running Avaya IP Office Manager and Avaya IP Office Phone Manager Pro and a corporate DHCP/TFTP server. The ProCurve 5406zl Switch will provide PoE to the Avaya IP Telephones as well as be 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 HP ProCurve 2910al Switch, one Avaya IP Office 406V2, two Avaya IP Telephones, one Avaya digital phone and one PC on Datavlan2. The ProCurve 2910al Switch will provide PoE to the Avaya IP phones as well as be configured for QoS based on Layer 2 Priority and Layer 3 Differentiated Services.
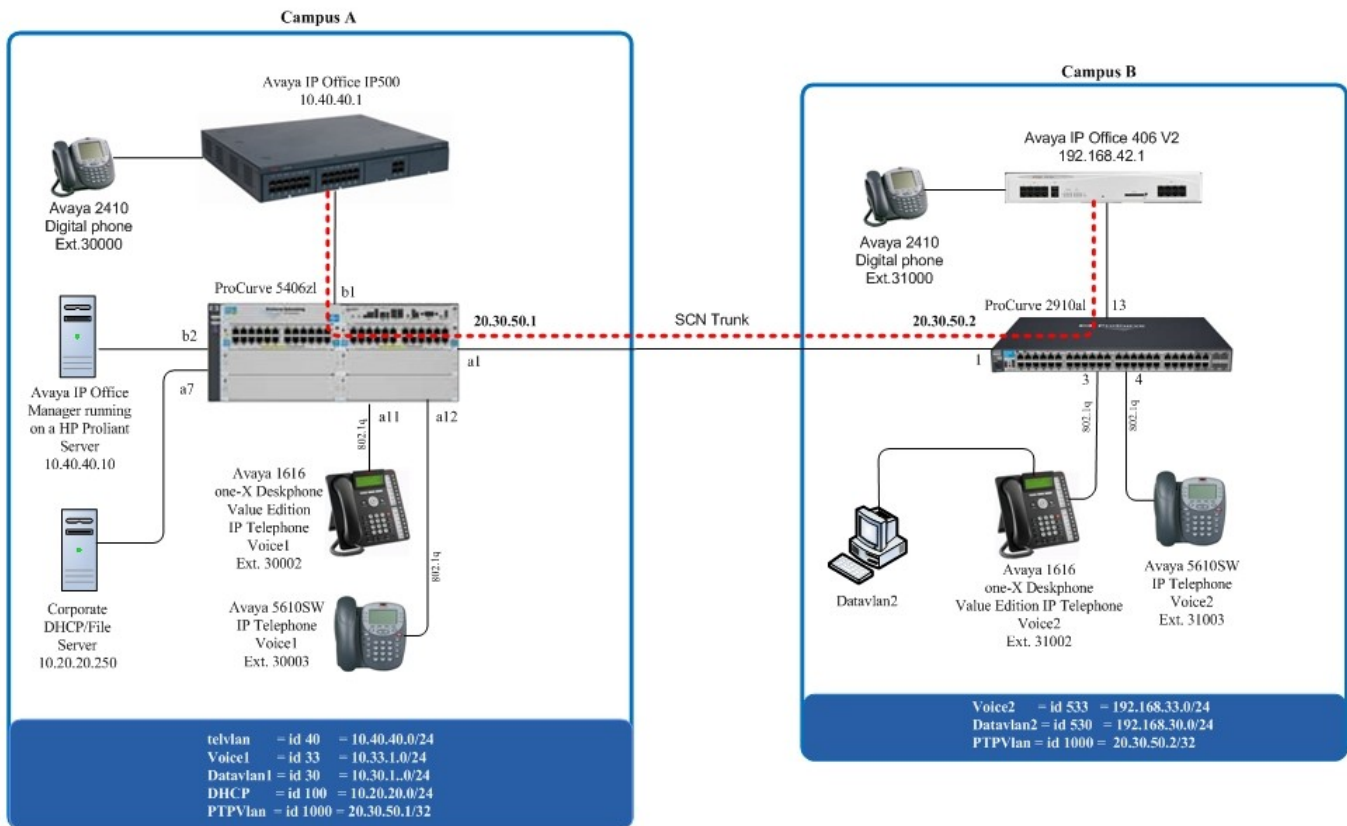
Figure 1: Network Configuration

3. Equipment and Software Validated

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

Equipment	Software/Firmware
Avaya PBX Products	
Avaya IP Office (IP500)	4.2 (14)
Avaya IP Office IP406V2	4.2 (14)
Avaya IP Office Manager	6.2 (17)
Avaya Messaging (Voice Mail) Products	
Avaya VoiceMail Pro	4.2 (30)
Avaya Telephony Sets	
Avaya 1600 Series IP Telephones	Avaya one-X Deskphone Value Edition 1.020
Avaya 5600 Series IP Telephones	8.016
Avaya 2410 Digital Telephone	5.0
ProCurve Products	
HP ProCurve 5406zl Switch	FW-K.14.09
HP ProCurve 3500yl Switch	FW-K.14.09
HP ProCurve 2910al Switch	W.14.28
HP Proliant Products	
HP Proliant Server	Microsoft Windows 2003 Server (Running Avaya IP Office Manager and Avaya IP Office Phone Manager Pro)
MS Products	
PC	Microsoft Windows 2003 Server (File/DHCP Service)

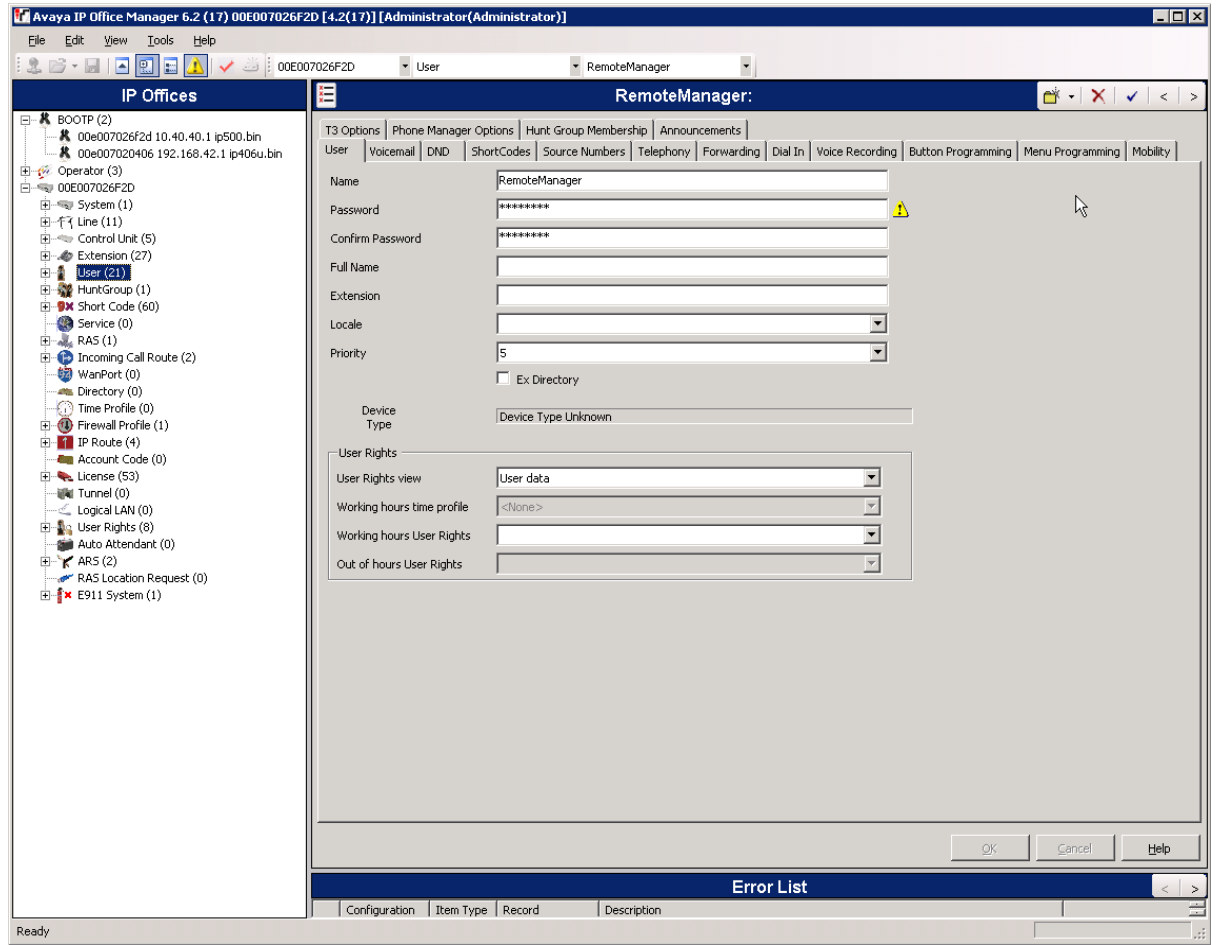## 4. Verify Avaya IP Office Settings for Campus A & B

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, extensions, and voice mail, please refer to the Avaya IP Office product documentation in **Section 10**.

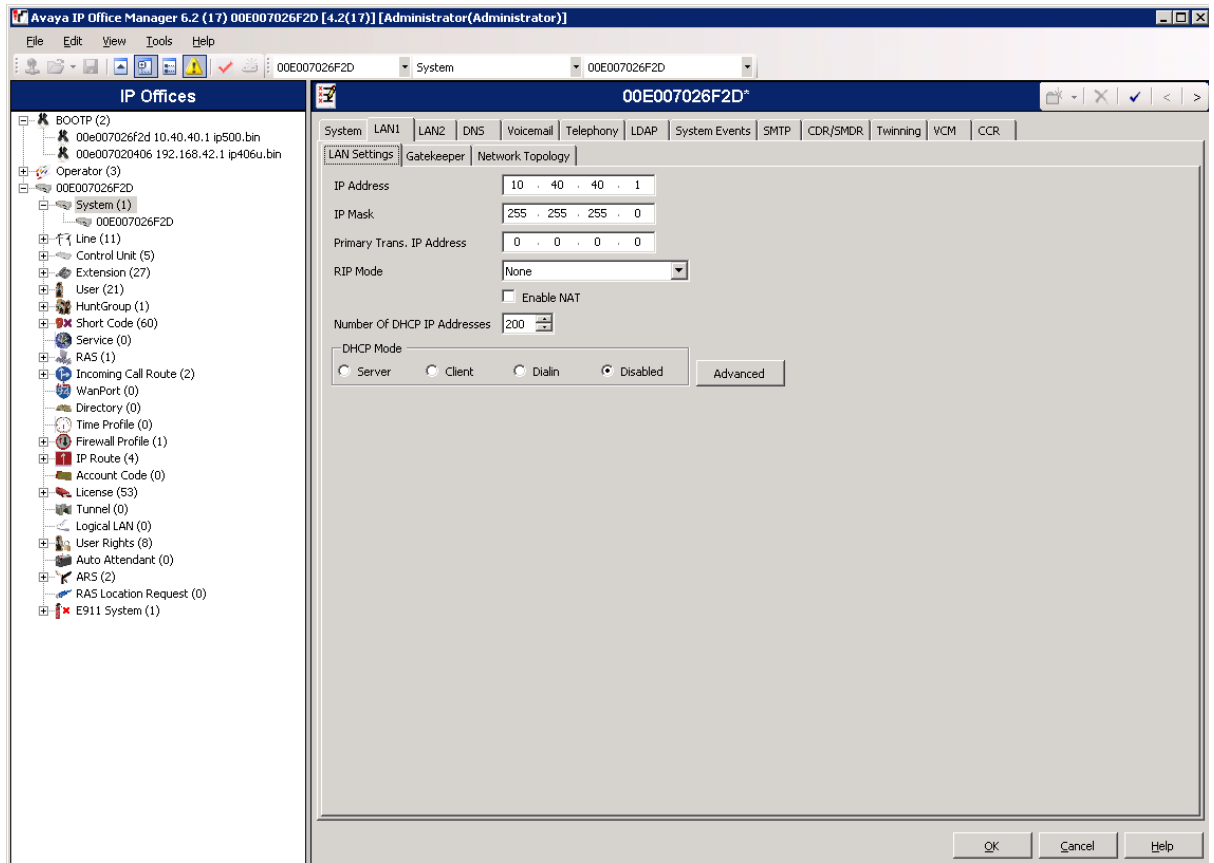| Step	Description
1.	Avaya IP Office is configured via the Avaya IP Office Manager program. Log into the Avaya IP Office Manager PC and select **Start → Programs → IP Office → Manager** to launch the Avaya IP Office Manager application. Select **File → Open** to search for IP Offices in the network. Click on appropriate Avaya IP Office. Click **OK** to continue. Log into the Avaya IP Office Manager application using the appropriate credentials.

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ProCurve-IPOMSS
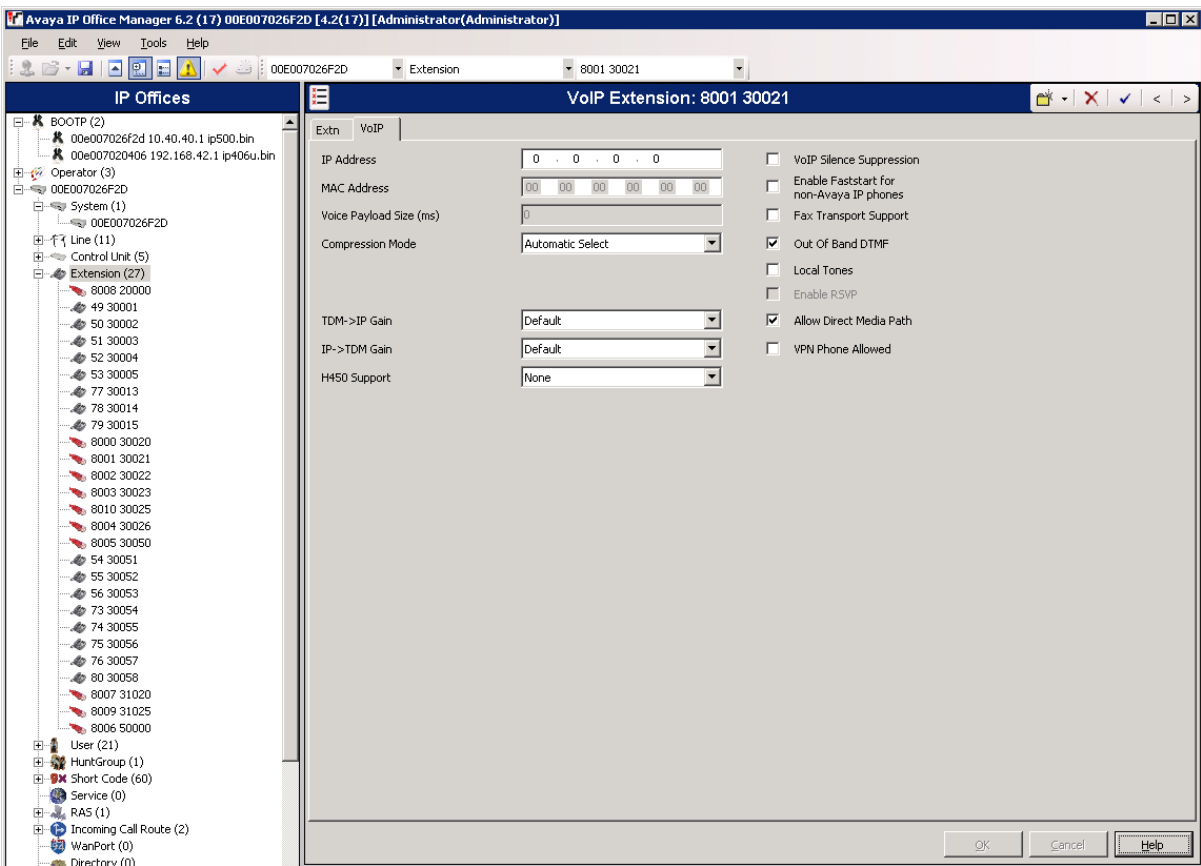
Step	Description
2.	IP Office Manager window. The main IP Office Manager window appears. The following steps refer to the Configuration Tree which is in the left pane of the window and under the heading **IP Offices**.

3.	Verify H323 Gatekeeper information.
	The Avaya IP Telephones will get Differentiated Services information from the Avaya IP Office. In the Manager window, go to the Configuration Tree and click **System**, → **LAN1** → **Gatekeeper**. Verify that the **DiffServ Settings** for **DSCP** and **SIG DSCP** are set to **46** and **46,** respectively.

4.	Disable DHCP server on Avaya IP Office. Click **System**, → **LAN Settings**. Set the **DHCP Mode** to **Disabled**. Click **OK** to continue.
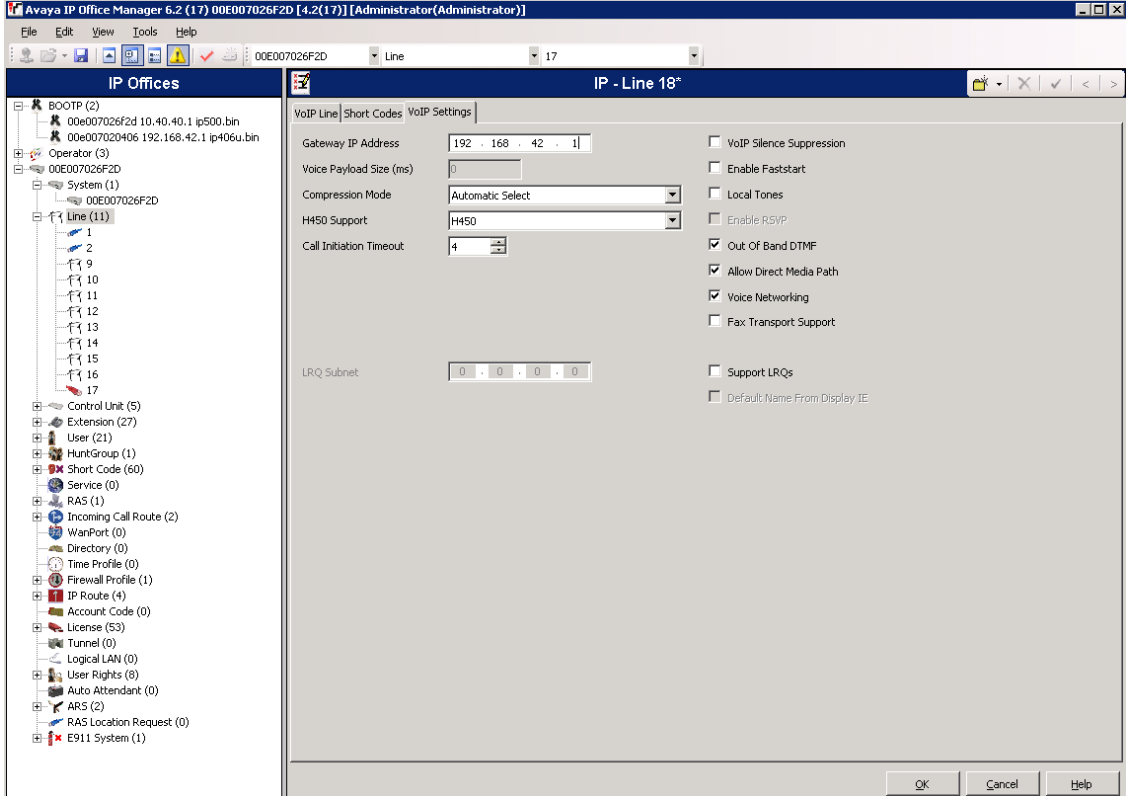
Step	Description
5.	Verify Direct Media Path. From the Configuration Tree, select **Extension**. Click on the IP telephone extension to verify. Select the **VoIP** tab. Verify that **Allow Direct Media Path** is checked. Click **OK** to continue. The changes must be saved before they will take effect, click to the ![save] tab to save the configuration.

| 6. | Repeat **Section 4** steps 1 thru 5 for the remote IP Office. |

Avaya IP Office Settings Campus A

Step	Description
1.	Log into the Avaya IP Office Manager PC and select **Start → Programs → IP Office → Manager**. Select **File → Open** to search for the **Campus A** IP Office. Click **OK** to continue. Log into the Avaya IP Office Manager application using the appropriate credentials.

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

4.1. Avaya IP Office Settings Campus B

Step	Description
1.	Log into the Avaya IP Office Manager PC and select **Start → Programs → IP Office → Manager**. Select **File → Open** to search for the **Campus B** IP Office. Click **OK** to continue. Log into the Avaya IP Office Manager application using the appropriate credentials.
2.	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.
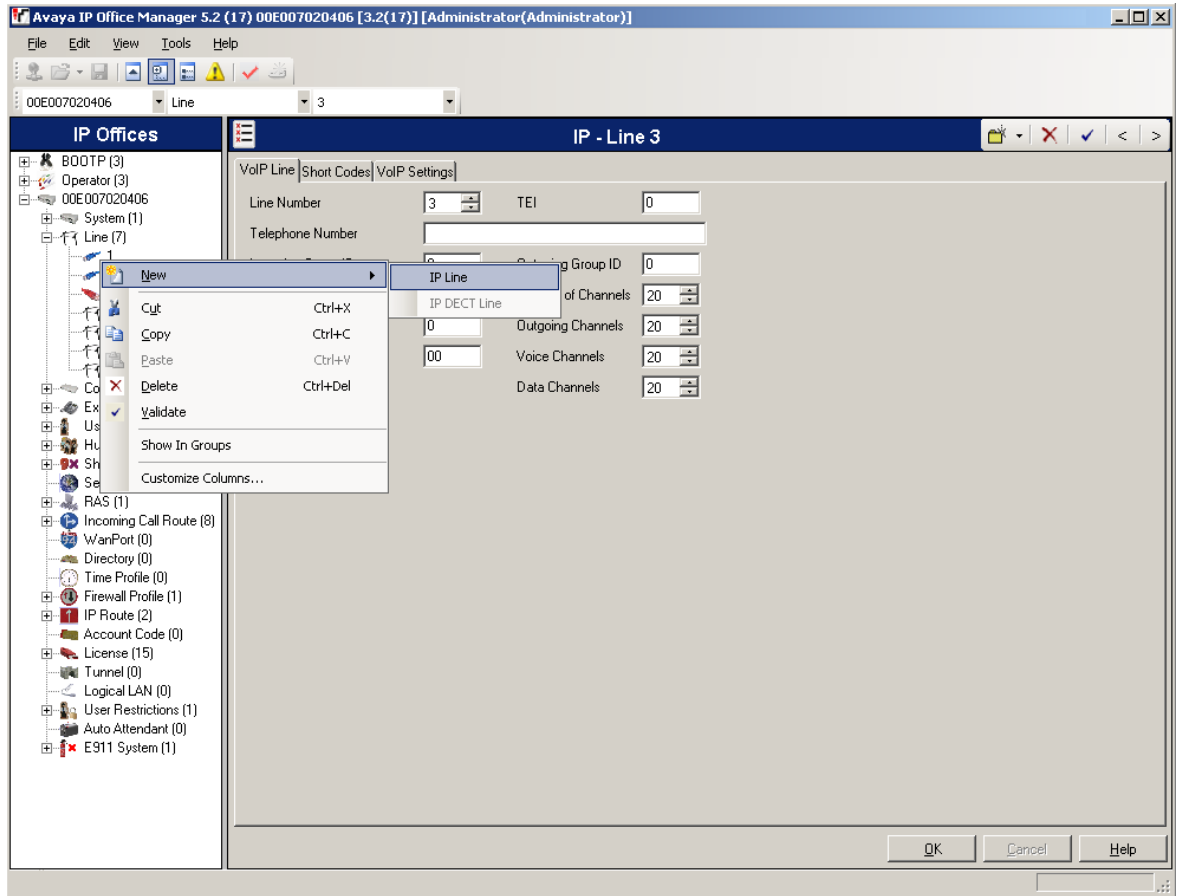
Step	Description
3.	Assign an IP address for the **Gateway IP Address** (address of the Campus A IP Office) and enable **Voice Networking**. Click OK to continue.

5. Configure the ProCurve 5406zl Switch

This section addresses how to configure the ProCurve 5406zl Switch. The ProCurve 5406zl Switch is used as the core Layer 2/Layer 3 router, enforces QoS policies and supports link aggregation, OSPF and spanning tree.

To configure the ProCurve 5406zl Switch, connect a PC or laptop to the serial port of the ProCurve 5406zl Switch. Run a terminal emulation program with the following configuration:

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow Control: None

1. Log into the ProCurve 5406zl Switch using the appropriate Login ID and Password.

```
Login:
Password:
ProCurve Switch 5406zl#
```

2. Enable the following features on the ProCurve 5406zl Switch.
   - Enable routing.
   - Enable spanning tree
   - Make the ProCurve 5406zl Switch the root bridge.
   - Enable QoS type-of-service
   - Assign priority 6 to DSCP CodePoint 101110
   - Assign a QoS value to ARP
   - Assign a QoS value for IP Office
   - Save the running configuration to the startup configuration.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# ip routing
ProCurve Switch 5406zl(config)# spanning-tree
ProCurve Switch 5406zl(config)# spanning-tree priority 1
ProCurve Switch 5406zl(config)# qos type-of-service diff-services
ProCurve Switch 5406zl(config)# qos dscp-map 101110 priority 6
ProCurve Switch 5406zl(config)# qos protocol ARP priority 4
ProCurve Switch 5406zl(config)# qos device-priority 10.40.40.1 dscp 101110
ProCurve Switch 5406zl(config)# write memory
```

3. Create and configure the point to point VLAN on the ProCurve 5406zl Switch.
   - Assign a VLAN ID for the **PTPVlan** VLAN.
   - Assign a name for the **PTPVlan** VLAN.
   - Assign an IP address for the **PTPVlan** VLAN.
   - Assign ports to the **PTPVlan** VLAN.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 1000
ProCurve Switch 5406zl (vlan-1000)# vlan 1000 name PTPVlan
ProCurve Switch 5406zl (vlan-1000)# ip address 20.30.50.1/32
ProCurve Switch 5406zl (vlan-1000)# tagged a1
ProCurve Switch 5406zl (vlan-1000)# exit
```

4. Create and configure the telephony VLAN where all of the Avaya telephony equipment will run.
   - Assign a VLAN ID for the telephony VLAN.
   - Assign a name for the telephony VLAN.
   - Assign an IP address for the telephony VLAN.
   - Assign ports to the telephony VLAN.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 40
ProCurve Switch 5406zl (vlan-40)#vlan 40 name telvlan
ProCurve Switch 5406zl (vlan-40)#ip address 10.40.40.254/24
ProCurve Switch 5406zl (vlan-40)# untagged b1-b2
ProCurve Switch 5406zl (vlan-40)# exit
```

5. Create and configure the voice VLAN for Campus A.
   - Assign a VLAN ID for the voice VLAN.
   - Assign a name for the voice VLAN.
   - Assign an IP address for the voice VLAN.
   - Set an IP helper address for DHCP.
   - Assign ports to the voice VLAN.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 33
ProCurve Switch 5406zl (vlan-33)#vlan 33 name Voice1
ProCurve Switch 5406zl (vlan-33)#ip address 10.33.1.254/24
ProCurve Switch 5406zl (vlan-33)# ip helper-address 10.20.20.250
ProCurve Switch 5406zl (vlan-33)# tagged a1,a10-a12
ProCurve Switch 5406zl (vlan-33)# exit
```

6. Create and configure the data VLAN for Campus A.
   - Assign a VLAN ID for the data VLAN.
   - Assign a name for the data VLAN.
   - Assign an IP address for the data VLAN.
   - Set an IP helper address for DHCP.
   - Assign ports to the data VLAN.

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 30
ProCurve Switch 5406zl (vlan-30)# vlan 30 name Datavlan1
ProCurve Switch 5406zl (vlan-30)# ip address 10.30.1.254/24
ProCurve Switch 5406zl (vlan-30)# ip helper-address 10.20.20.250
ProCurve Switch 5406zl (vlan-30)# tagged a1
ProCurve Switch 5406zl (vlan-30)# untagged a11-a12
ProCurve Switch 5406zl (vlan-30)# exit
```

7. Create and configure the VLAN that where the DHCP/File server runs.
   - Assign a VLAN ID for the DHCP/File VLAN
   - Assign a name for the DHCP/File VLAN
   - Assign an IP address for the DHCP/File VLAN
   - Assign ports to the DHCP/File VLAN

```
ProCurve Switch 5406zl# configure
ProCurve Switch 5406zl(config)# vlan 100
ProCurve Switch 5406zl (vlan-2)#vlan 100 name DHCP
ProCurve Switch 5406zl (vlan-2)#ip address 10.20.20.254/24
ProCurve Switch 5406zl (vlan-2)# untagged a7
ProCurve Switch 5406zl (vlan-2)# exit
```

8. Save the running configuration to the startup configuration.

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

6. Configure Closet-A ProCurve 2910al Switch

This section addresses configuring the ProCurve 2910al Switch. The ProCurve 2910al 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 power to the Avaya IP telephones.

To configure the ProCurve 2910al Switch, connect a PC or laptop to the serial port of the 2910al. Run a terminal emulation program with the following configuration:

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow Control: None

1. Log into ProCurve 2910al Switch using the appropriate Login ID and Password.

```
Login:
Password:
ProCurve 2910al-48G-PoE Switch#
```

2. Enable the following features on the ProCurve 2910al Switch.
   - Enable routing.
   - Enable spanning tree
   - Enable QoS type-of-service
   - Assign priority 6 to DSCP CodePoint 101110
   - Assign a QoS value to ARP
   - Assign a QoS value for IP Office

```
ProCurve 2910al-48G-PoE Switch# configure
ProCurve 2910al-48G-PoE Switch(config)# ip routing
ProCurve 2910al-48G-PoE Switch(config)# spanning-tree
ProCurve 2910al-48G-PoE Switch(config)# qos type-of-service diff-services
ProCurve 2910al-48G-PoE Switch(config)# qos dscp-map 101110 priority 6
ProCurve 2910al-48G-PoE Switch(config)# qos protocol ARP priority 4
ProCurve 2910al-48G-PoE Switch(config)# qos device-priority 192.168.42.1 dscp 101110
```

9. Create and configure the point to point VLAN on the ProCurve 2910 Switch.
   - Assign a VLAN ID for the PTPVlan VLAN.
   - Assign a name for the PTPVlan VLAN.
   - Assign an IP address for the PTPVlan VLAN.
   - Assign ports to the PTPVlan VLAN.

```
ProCurve 2910al-48G-PoE Switch# configure
ProCurve 2910al-48G-PoE Switch(config)# vlan 1000
ProCurve 2910al-48G-PoE Switch(vlan-1000)# vlan 1000 name PTPVlan
ProCurve 2910al-48G-PoE Switch(vlan-1000)# ip address 20.30.50.2/32
ProCurve 2910al-48G-PoE Switch(vlan-1000)# tagged 1
ProCurve 2910al-48G-PoE Switch(vlan-1000)# exit
```

3. Create and configure the voice VLAN for Campus B.
   - Assign a VLAN ID for the voice VLAN.
   - Assign a name for the voice VLAN.
   - Assign an IP address for the voice VLAN.
   - Assign ports to the voice VLAN.

```
ProCurve 2910al-48G-PoE Switch(config)# vlan 533
ProCurve 2910al-48G-PoE Switch(vlan-533)# vlan 533 name Voice2
ProCurve 2910al-48G-PoE Switch(vlan-533)# ip address 192.168.133.254/24
ProCurve 2910al-48G-PoE Switch(vlan-533)# tagged 1,3-4
ProCurve 2910al-48G-PoE Switch(vlan-533)# exit
```

4. Create and configure the data VLAN for Campus B.
   - Assign a VLAN ID for the data VLAN.
   - Assign a name for the data VLAN.
   - Assign an IP address for the data VLAN.
   - Assign ports to the data VLAN.

```
ProCurve 2910al-48G-PoE Switch(# configure
ProCurve 2910al-48G-PoE Switch(config)#  vlan 530
ProCurve 2910al-48G-PoE Switch(vlan-530)# vlan 530 name Datavlan2
ProCurve 2910al-48G-PoE Switch(vlan-530)# ip address 192.168.130.254/24
ProCurve 2910al-48G-PoE Switch(vlan-530)# untagged 3-4
ProCurve 2910al-48G-PoE Switch(vlan-530)# tagged 1
ProCurve 2910al-48G-PoE Switch(vlan-350)# exit
```

5. Save the running configuration to the startup configuration.

```
ProCurve 2910al-48G-PoE Switch# write memory
```

7. General Test Approach and Test Results

7.1. 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 Small Community Networking trunk between the two Avaya IP Offices.
- Verification of the DHCP relay configuration
- VoIP calls over Layer 2 and Layer 3 connections
- Inter & Intra office calls using G.711 mu-law & G.729 codecs, conferencing, and sending low priority data traffic over the LAN
- Verifying that QoS directed the voice signaling, voice media and SCN to the higher priority egress queue based on the packets' DSCP value

The performance tests were performed by oversubscribing the lines with low priority data and verifying that good voice quality was achieved when calls are routed over all of the LAN interfaces.

7.2. Test Results

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

8. 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:

- Verify the DHCP relay is functioning by confirming that the all IP telephones from all locations receive their IP addresses from the DHCP server connected to the ProCurve 5406zl Switch.

- Place calls between Campuses for each Avaya IP Telephone.

9. Conclusion

These Application Notes describe the configuration steps required for integrating HP ProCurve Networking Switches into a Multi-Site solution with an Avaya Telephony Infrastructure using mutable Avaya IP Office in a Converged VoIP and Data Network. 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. Prioritization of VoIP traffic and good voice quality was successfully achieved in the Avaya/ProCurve configuration described herein.

10. Additional References

This section references the Avaya documentation relevant to these Application Notes. The following Avaya product documentation is available at http://support.avaya.com

[1] *Avaya IP Office 4.2 Installation Manual,* Document Number 15-601042
[2] *Avaya IP Office 4.2 Embedded Voicemail User Guide,* Document Number 15-601067
[3] *Avaya IP Office 4.2 Phone Manager User Guide,* Document Number 15-600988
[4] *Avaya IP Office 4.2 Manager 6.2,* Document # 16-601443
[5] *Deskphone Value Edition 1600 Series IP Telephones Installation and Maintenance Guide,* Document # 16-601443

The HP product documentation can be found at:
http://www.procurve.com/customercare/support/manuals/index.htm

[6] *Command Line Interface Reference Guide for the ProCurve Series 3500yl, 6200yl, 5400zl, and 8212zl Switches*
[7] *Management and Configuration Guide for the ProCurve Series 3500yl, 6200yl, 5400zl, and 8200zl Switches*
[8] *Management and Configuration Guide for the ProCurve Series 2910 Switches*

11. Change History

Issue	Date	Reason
1.0	7/20/2009	Initial issue