# AVAYA

**Avaya Solution & Interoperability Test Lab**

# Application Notes for Avaya Aura® Telephony Infrastructure in a Converged VoIP and Data Network using HP Networking Switches configured with Link Layer Discovery Protocol (LLDP), Quality of Service (QoS), and Power over Ethernet (PoE) - Issue 1.0

## Abstract

These Application Notes describe the configuration of a Voice over IP (VoIP) solution including an Avaya Aura® Telephony Infrastructure running in a converged VoIP and data network built with HP Networking Ethernet switches. The HP Networking switches were compliance-tested with Avaya Aura® Communication Manager, Avaya Aura® Session Manager and Avaya Aura® Communication Manager Messaging. Emphasis was placed on verifying interoperability with LLDP, L2/L3 QoS, and PoE.

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.

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Solution & Interoperability Test Lab Application Notes
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# 1. Introduction

These Application Notes describe the configuration of a Voice over IP (VoIP) solution including an Avaya Aura® Telephony Infrastructure running in a converged VoIP and data network built with HP Networking 5400zl, 3800, 2620, 2915, and 2910 Series Switches. Compliance testing verified multiple methods for configuring Voice VLAN and Quality of Service (QoS), including Aura® Communication Manager forms, settings files, and Link Layer Discovery Protocol for Media Endpoint Devices (LLDP-MED). Power over Ethernet (PoE) was also verified. Quality of Service (QoS) based on Layer 2 Priority (802.1p) and Layer 3 Differentiated Services (Diffserv) was implemented across the network to prioritize voice traffic over data traffic. The Avaya IP Telephones received QoS priority settings from Avaya Aura® Communication Manager and were enforced across the network by the HP Switches. Additionally QoS parameters were verified based on configuration file settings and LLDP auto discovery. To verify proper QoS policies, VoIP traffic was given priority over data traffic, and tests were performed by over subscribing the LAN interfaces with low priority data traffic and verifying that acceptable voice quality was achieved when calls were routed over all of the LAN interfaces. PoE was also verified on the HP Networking switches.

# 2. General Test Approach and Test Results

DevConnect Compliance Testing is conducted jointly by Avaya and DevConnect members. The jointly-defined test plan focuses on exercising APIs and/or standards-based interfaces pertinent to the interoperability of the tested products and their functionalities. DevConnect Compliance Testing is not intended to substitute full product performance or feature testing performed by DevConnect members, nor is it to be construed as an endorsement by Avaya of the suitability or completeness of a DevConnect member's solution.

## 2.1. Interoperability Compliance Testing

The interoperability compliance testing included the following:

All test cases were performed manually.

- LAN connectivity between the Avaya and HP Networking products.
- Registration of Avaya H.323 endpoints with Communication Manager.
- Registration of Avaya SIP endpoints with Session Manager.
- VoIP calls, including, hold, transfer and conferencing.
- QoS for voice signaling and voice media received higher priority based on 802.1p and DSCP settings.
- Configuration of QoS parameters using Avaya Communication Manager
- Auto discovery of QoS parameters using LLDP-MED
- Auto discovery of Voice VLAN using LLDP-MED
- Avaya Communication Manager Messaging voicemail and MWI works properly.

Compliance testing focused on the QoS, VLAN, and PoE implementation in the Avaya/HP Networking configuration. Specifically, compliance testing verified that when the HP Networking switch interfaces were oversubscribed with low priority data traffic, the higher priority VoIP media and signaling traffic still got through and achieved good voice quality. Prioritization of voice traffic was achieved by implementing Layer 3 DiffServ-based QoS and Layer 2 priority (801.p). Voice and data traffic were segmented in the enterprise network using VLANs. Auto discovery of Voice VLAN, and QoS parameters, using LLDP were also verified along with the ability to power Avaya IP telephones via PoE.

## 2.2. Test Results

The test objectives listed in **Section 2.1** were verified. QoS and performance testing was verified by making voice calls while a traffic generator generated low priority data traffic to simulate a congested network. At the end of the performance test, it was verified that the network devices continued to operate successfully. Additionally tests were repeated using the configuration settings discovered via LLDP.

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

All feature functionality, serviceability, and performance test cases passed. The HP Networking implementation prioritized VoIP traffic and yielded good voice quality without dropping any calls.

PoE parameters were verified using HP Networking show commands and fell within acceptable ranges.

All of HP Networking products used in the compliance testing successfully passed.

## 2.3. Support

For technical support on HP Networking products, consult the following support pages by contacting HP Networking customer support at:

- Contact us: http://h17007.www1.hp.com/us/en/contact
- Website Support: http://h17007.www1.hp.com/us/en/support/converter/index.aspx
- Website Product Information: http://h17007.www1.hp.com/us/en/index.aspx

# 3. Reference Configuration

**Figure 1** illustrates the configuration used for compliance testing. The network consisted of Avaya Aura® Communication Manager Server running on an S8300D card that was installed in the G450 Media gateway, Avaya Aura® Session Manager, and IP endpoints including, Avaya IP Telephones, Avaya one-X communicator, and Avaya video endpoints. All Avaya components

were connected to the HP Networking switches and voice and video traffic was carried across this infrastructure. Configuration settings for the endpoints were provided by Avaya Aura® Communication Manager as well as via LLDP. To better manage the different traffic types and endpoint devices, the voice and data traffic were separated onto different VLANs. Additionally Avaya 1000 series Video Endpoints were placed into the Voice VLAN.
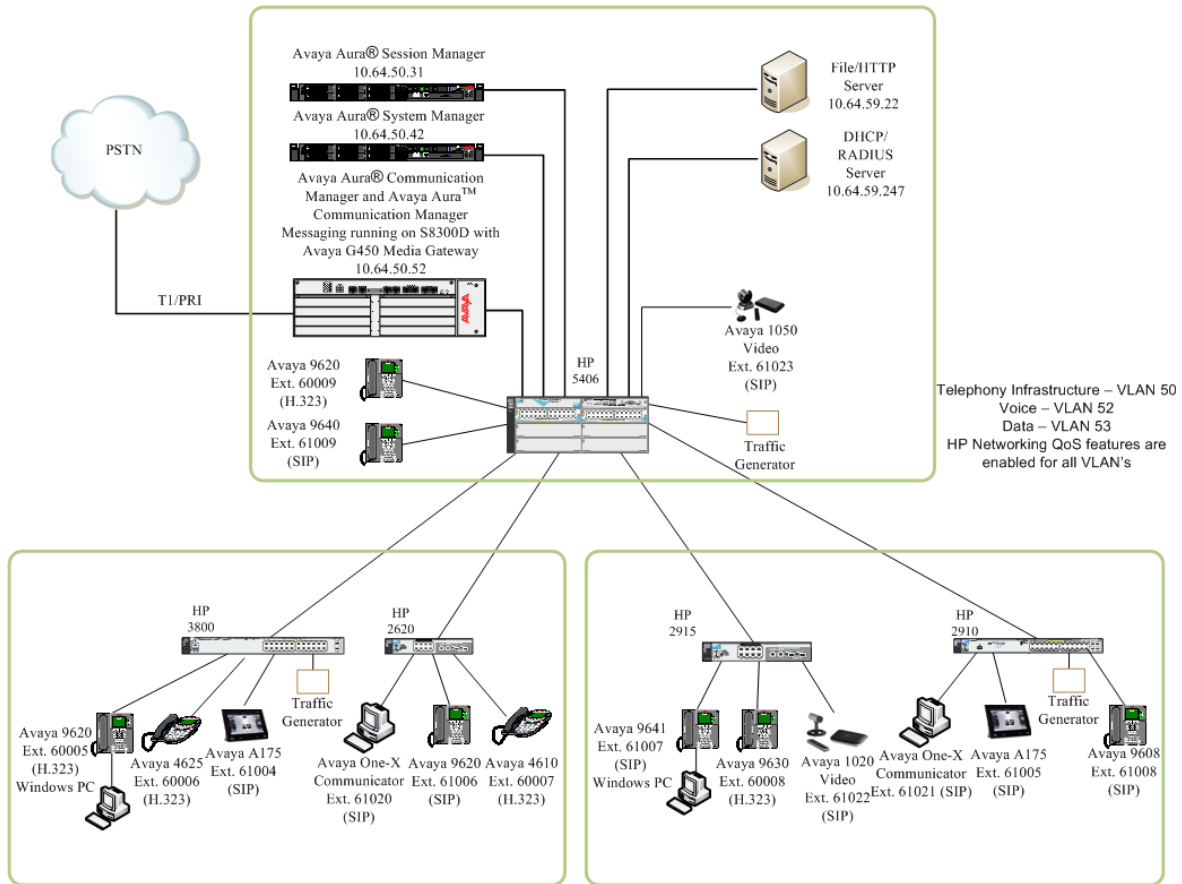


**Figure 1: Network Configuration**

# 4. Equipment and Software Validated

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

| Equipment | Software/Firmware |
|---|---|
| *Avaya PBX Products* | |
| Avaya S8300D Server running Avaya Aura® Communication Manager | Avaya Aura® Communication Manager 6.0.1 with SP5.0.1(Patch 19303) |
| Avaya G450 Media Gateway MGP<br>  MM710 T1 Module<br>  MM711 Analog Module<br>  MM712 DCP Media Module<br>  MP80 VoIP-DSP | HW 2 FW 31.20.0<br>HW 5 FW 22<br>HW 23 FW 73<br>HW 7 FW 14<br>HW 6 FW 67 |
| *Avaya Aura® Session Manager* | |
| Avaya Aura® Session Manager HP Proliant DL360 G7 | 6.1 with SP5 |
| Avaya Aura® System Manager HP Proliant DL360 G7 | 6.1 with SP5 |
| *Avaya Messaging (Voice Mail) Products* | |
| Avaya Aura® Communication Manager Messaging (CMM) | 6.0 |
| *Avaya Endpoints* | |
| Avaya 96xx Series IP Telephones | (H.323 3.1SP2), (SIP 2.6.6.0) |
| Avaya 96x1 Series IP Telephones | (H.323 S6.010f), (SIP 6.0.3) |
| Avaya 46xx Series IP Telephones | 2_9_1 |
| Avaya One-X Communicator | 6.1 |
| Avaya A175Video Endpoint | 1.1.0 |
| Avaya 1020 Video Endpoint | 4.8.3 (24) |
| Avaya 1050 Video Endpoint | 4.8.3 (24) |
| *HP Networking Products* | |
| HP 3800 | https://h10145.www1.hp.com/downloads/SoftwareReleases.aspx?ProductNumber=J9573A<br>KA.15.03.3006 |
| HP 2620 | https://h10145.www1.hp.com/downloads/SoftwareReleases.aspx?ProductNumber=J9623A<br>RA.15.06.0009 |
| HP 2915 | https://h10145.www1.hp.com/downloads/SoftwareReleases.aspx?ProductNumber=J9562A<br>A.14.15 |

| Equipment | Software/Firmware |
|---|---|
| HP 2910 | https://h10145.www1.hp.com/downloads/SoftwareReleases.aspx?ProductNumber=J9145A<br>W.14.70 |
| HP 5406 | https://h10145.www1.hp.com/downloads/SoftwareReleases.aspx?ProductNumber=J9532A<br>K.15.07.0008 |

# 5. Configure Avaya Aura® Communication Manager

This section describes the steps required for Communication Manager to support the configuration in **Figure 1**. The following pages provide step-by-step instructions on how to administer parameters specific to the HP Networking solution only. The assumption is that the appropriate license and authentication files have been installed on the servers and that login and password credentials are available and that the reader has a basic understanding of the administration of Communication Manager. It is assumed that all other connections, e.g., to PSTN, to LAN, are configured and will not be covered in this document. The reader will need access to the System Administration Terminal screen (SAT). For detailed information on the installation, maintenance, and configuration of Communication Manager, please refer to [1].

## 5.1. Configure QoS on Communication Manager for H.323 Telephones

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 insure reliable delivery of latency sensitive voice and video traffic, QoS is utilized and should be implemented consistently throughout the entire network.

In order to achieve prioritization of VoIP traffic, the VoIP traffic must be classified. The Avaya IP endpoints support both Layer 2 802.1.p priority and Layer 3 DiffServ.

In the compliance test all network components were in network region 1. The DiffServ and 802.1p values configured here will be downloaded to the Avaya H.323 IP telephones via Communication Manager.

Note: Avaya SIP endpoints can get QoS settings by downloading the 46xxsettings.txt file from the HTTP server. **See Section 6.**

LLDP can also be used for auto discovering the voice VLAN and QoS settings and is covered in **Section 12.**

For more information on QoS settings, please refer to **[1]**.

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. Set the **Call Control PHB Value** to **46** and the **Audio PHB Value** to **46**. Set the **Call Control 802.1p Priority** and **Audio 802.1p Priority** to **6**.

```
change ip-network-region 1                              Page   1 of  20
                            IP NETWORK REGION
  Region: 1
Location: 1      Authoritative Domain: d4f27.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? n
   UDP Port Max: 65535
DIFFSERV/TOS PARAMETERS
 Call Control PHB Value: 46
        Audio PHB Value: 46
        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



 ESC-x=Cancel Esc-e=Submit Esc-p=Prev Pg Esc-n=Next Pg Esc-h=Help Esc-r=Refresh
```

The Differentiated Services Code Point (DSCP) value of 46 is used for both the signaling and audio Per Hob Behavior (PHB) values for voice. DSCP 26 and 802.1p priority 5 is used for video with the Avaya A175. DSCP 46 represents the Traffic Class of Expedited Forwarding (EF) and the Traffic Type Voice.

Note: The 802.1p and DSCP values used above (i.e. 6 and 46) will be used consistently throughout the configuration of the HP Networking switches. The DSCP value used above is in decimal whereas the value used for HP Networking switch configuration later will be in binary (i.e. 101110).

Use the **change ip-network-map** command to change the Voice VLAN setting configured in Avaya Communication Manager. Set the **IP address** range using the **From** and **To** fields. Enter a value for **Subnet Bits**, **Network Region**, and **VLAN.** In this example the Avaya endpoints were located in VLAN 52

```
change ip-network-map                                    Page   1 of  63
                          IP ADDRESS MAPPING

                                      Subnet Network     Emergency
 IP Address                           Bits   Region VLAN Location Ext
 ------------------------------------- ------ ------ ---- -------------
 FROM: 10.64.52.0                      /24    1      52
   TO: 10.64.52.255
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
 FROM:                                 /             n
   TO:
```

# 6. Configure QoS for Avaya 96xx SIP Telephones using 46xxsettings.txt file

Modify the following settings in the 46xxsettings.txt file for configuring the 96xx SIP Telephones for Voice VLAN and desired L2 and L3 QoS parameters.

```
################# 802.1P/Q SETTINGS #################
##
## Voice VLAN Identifier
##   VLAN identifier to be used by IP telephones. This
##   parameter should only be set when IP telephones are to
##   use a VLAN that is separate from the default data VLAN.
##   If the VLAN identifier is to be configured via H.323
##   signaling based on Avaya Communication Manager
##   administration forms, it should not be set here.
##   This parameter may also be changed via LLDP.
##   Note : This setting is applicable for 1603 SIP phones also.
SET L2QVLAN 52
##
## Audio Priority Value
##   Sets the layer 2 priority value for audio packets
##   from the phone. (0-7)
##   For H.323 phones, this parameter may also be
##   changed from Communication Manager. For 96xx SIP
##   phones, this parameter may also be changed via LLDP.
##   Note : This setting is applicable for 1603 SIP phones also.
SET L2QAUD 6
##
## Signaling Priority Value
##   Sets the layer 2 priority value for signaling
##   protocol messages from the phone. (0-7)
##   For H.323 phones, this parameter may also be
##   changed from Communication Manager. For 96xx SIP
##   phones, this parameter may also be changed via LLDP.
##   Note : This setting is applicable for 1603 SIP phones also.
SET L2QSIG 6
##
##  DSCPAUD Sets the DiffServ value for audio streams from the phone.
##  The default is 46 and valid values are 0-63.
##  For 96xx SIP phones, this parameter may also be changed via LLDP.
##  Note: This setting is also applicable for 1603 SIP phones and 364x SIP phones.
SET DSCPAUD 46
##
##  DSCPSIG Sets the DiffServ value for signaling protocol
##  messages from the phone. The default is 34 and valid
##  values are 0-63.  For 96xx SIP phones, this parameter
##  may also be changed via LLDP.
##  Note: This setting is also applicable for 1603 SIP phones and 364x SIP phones.
SET DSCPSIG 46
##
```

# 7. Configure QoS for Avaya A175 SIP Telephone using Axxxsettings.txt file

Modify the following setting in the Axxxsettings.txt file for configuring the A175 SIP Telephones for Voice VLAN and desired L2 and L3 QoS parameters for voice and video.

```
################## 802.1P/Q SETTINGS ##################
##
##    Those settings does not apply to Wi-Fi interfaces.
##
## Telephone Frame Tagging
##    Controls whether layer 2 frames generated by the
##    telephone have IEEE 802.1Q tags.
##    0 for Auto, 1 for On, and 2 for Off
SET L2Q 1
##
## Voice VLAN Identifier
##    VLAN identifier to be used by IP telephones. This
##    parameter should only be set when IP telephones are to
##    use a VLAN that is separate from the default data VLAN.
SET L2QVLAN 52
##
## Audio Priority Value
##    Sets the layer 2 priority value for audio packets
##    from the phone. (0-7). The default value is 6.
SET L2QAUD 6
##
## Signaling Priority Value
##    Sets the layer 2 priority value for signaling
##    protocol messages from the phone. (0-7)
##    The default value is 6.
SET L2QSIG 6
##
## Video Priority Value
##    Sets the layer 2 priority value for video packets
##    from the phone. (0-7). The default value is 5.
SET L2QVID 5
#################### DSCP SETTINGS #######################
##
##  DSCPAUD Sets the DiffServ value for audio streams from
##  the phone. The default is 46 and valid values are 0-63.
SET DSCPAUD 46
##
##  DSCPVID Sets the DiffServ value for video streams from
##  the phone. The default is 26 and valid values are 0-63.
SET DSCPVID 26
##
##  DSCPSIG Sets the DiffServ value for signaling protocol
##  messages from the phone. The default is 34 and valid
##  values are 0-63.
SET DSCPSIG 46
##
```

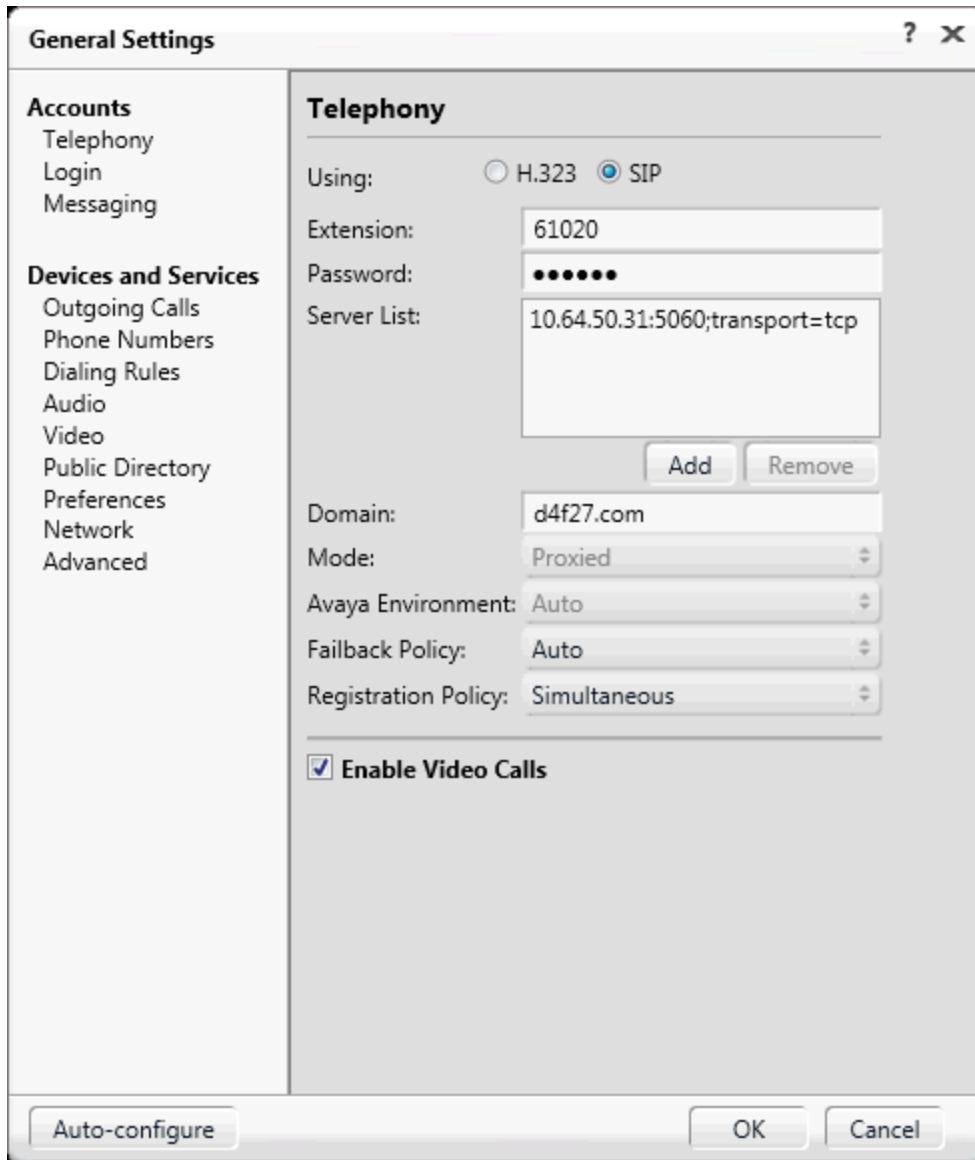# 8. Configure QoS for Avaya one-X Communicator.

Double-click the Avaya one-X Communicator icon to start the application.
Click the drop-down arrow on the Menu button in the top right corner and select **settings** (not shown)
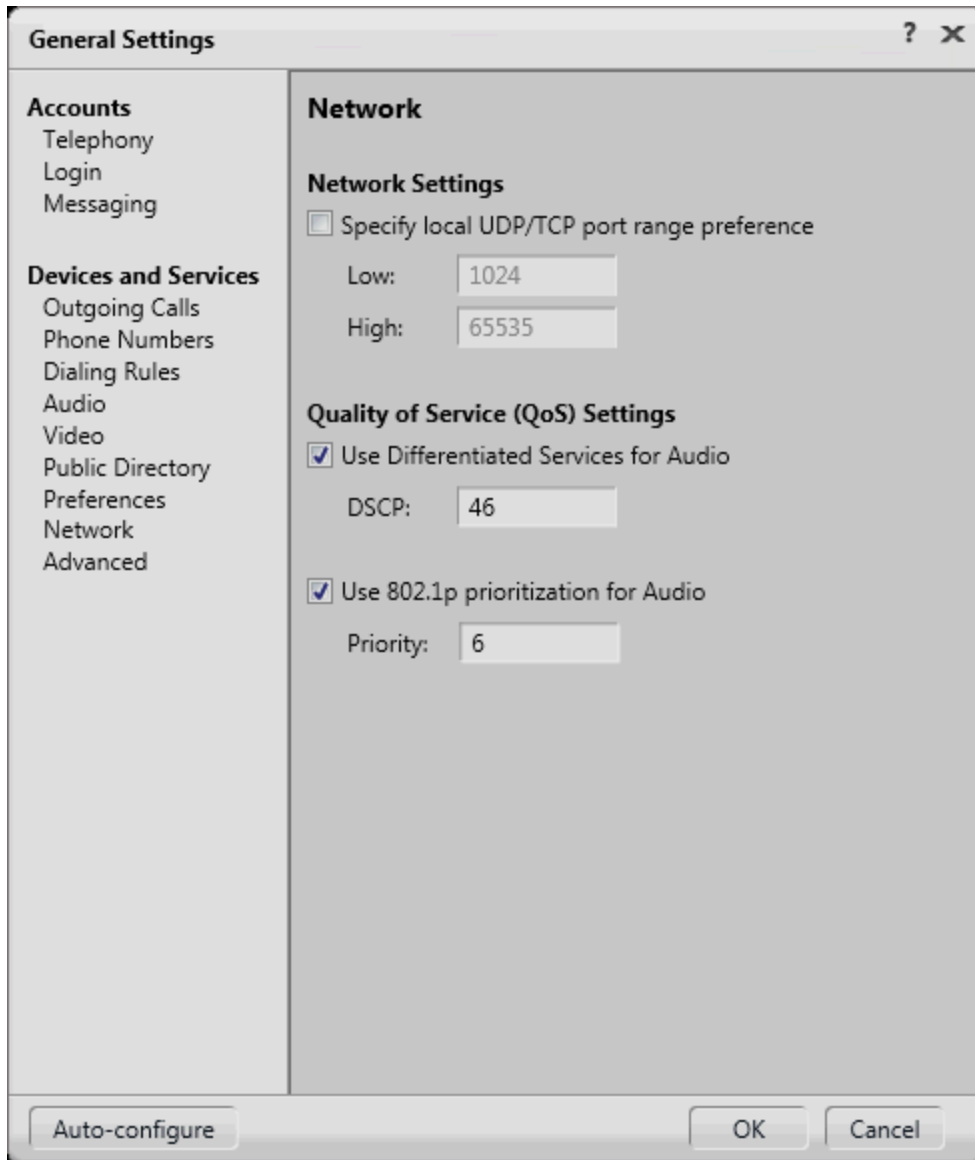
From the left pane of the General Settings screen select **Telephony.** In the right pane **c**lick the radio button for the desired protocol. Continue by entering an **Extension**: and **Password:** in the appropriate fields, configuring **Server List:** by clicking the **Add** button and providing the **IP Address** of the Proxy Server (not shown), and entering the **Domain**: name used for SIP. The compliance test used **SIP**.

**Note:** *Default values are ok for the remaining fields.*

## General Settings

**Accounts**
- Telephony
- Login
- Messaging

**Devices and Services**
- Outgoing Calls
- Phone Numbers
- Dialing Rules
- Audio
- Video
- Public Directory
- Preferences
- Network
- Advanced

### Telephony

| | |
|---|---|
| Using: | ○ H.323  ● SIP |
| Extension: | 61020 |
| Password: | ●●●●●● |
| Server List: | 10.64.50.31:5060;transport=tcp |

Add  Remove

| | |
|---|---|
| Domain: | d4f27.com |
| Mode: | Proxied |
| Avaya Environment: | Auto |
| Failback Policy: | Auto |
| Registration Policy: | Simultaneous |

☑ **Enable Video Calls**

Auto-configure          OK   Cancel

From the left pane of the General Settings screen select **Network.** Configure desired QoS parameters in the right pane.

## General Settings

**Accounts**
Telephony
Login
Messaging

**Devices and Services**
Outgoing Calls
Phone Numbers
Dialing Rules
Audio
Video
Public Directory
Preferences
Network
Advanced

### Network

**Network Settings**

☐ Specify local UDP/TCP port range preference

Low: 1024

High: 65535

**Quality of Service (QoS) Settings**

☑ Use Differentiated Services for Audio

DSCP: 46

☑ Use 802.1p prioritization for Audio

Priority: 6

Auto-configure          OK    Cancel

# 9. Configure QoS for Avaya 1000 series Video Conferencing Unit.

From a web browser enter the IP address of the Avaya 1000 series Video Conferencing Unit (VCU) in the URL field to display the login page. Enter the proper login credentials and click the **Submit** button.
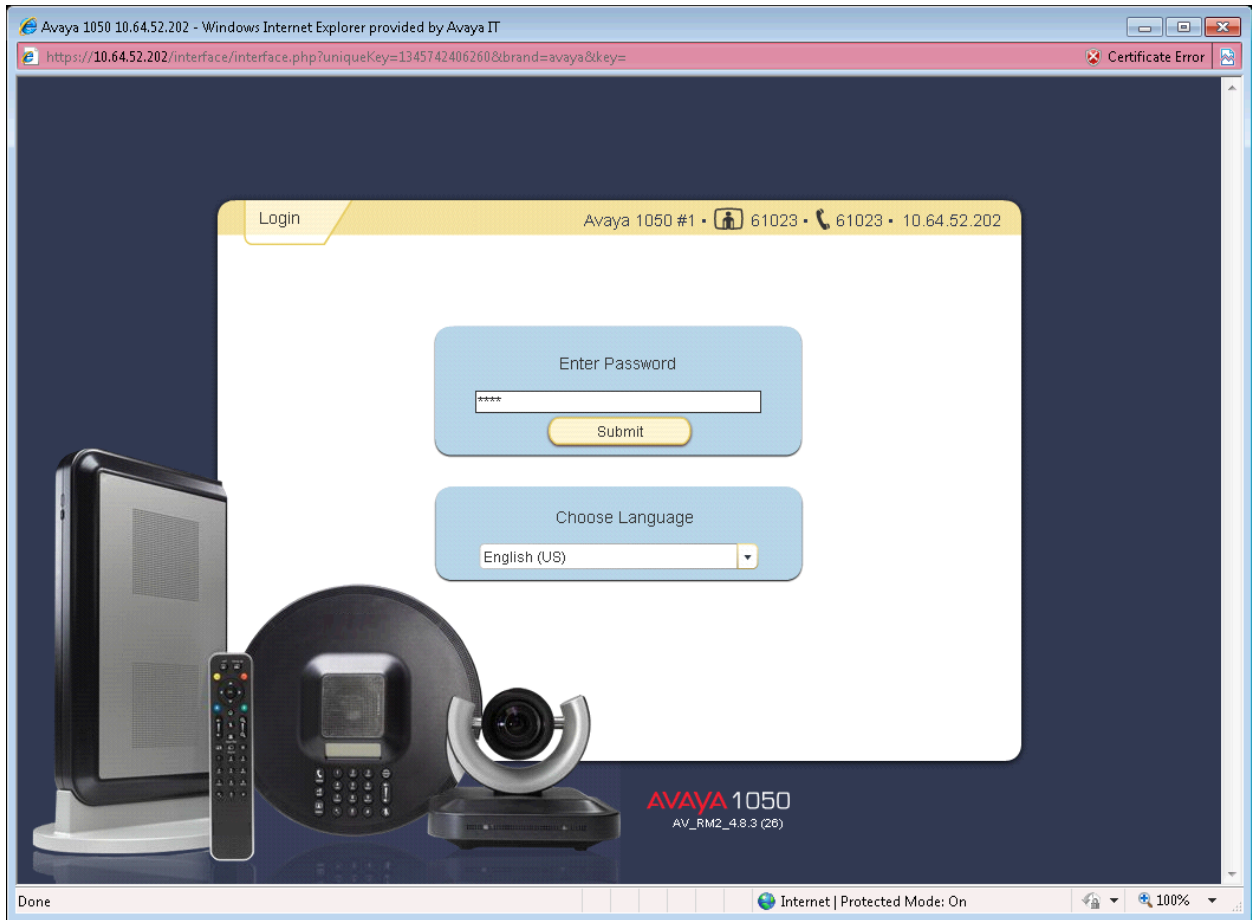
From the left pane of the **Preferences** tab, click **Communications,** and then **SIP** to display the following page. From this page select **Enabled** from the **SIP** dropdown box. Also enter the desired parameters for **SIP Username, Authorization Name,** and **Authorization Password.** For **SIP Registration** select **Through Proxy** and make sure **SIP Proxy** and **SIP Registrar** are both **Enabled.** For compliance testing the Session Manager IP Address was used for **Proxy** and **Registrar Hostname.** The remaining fields can be left at their default settings. Click the **Save Changes** button.
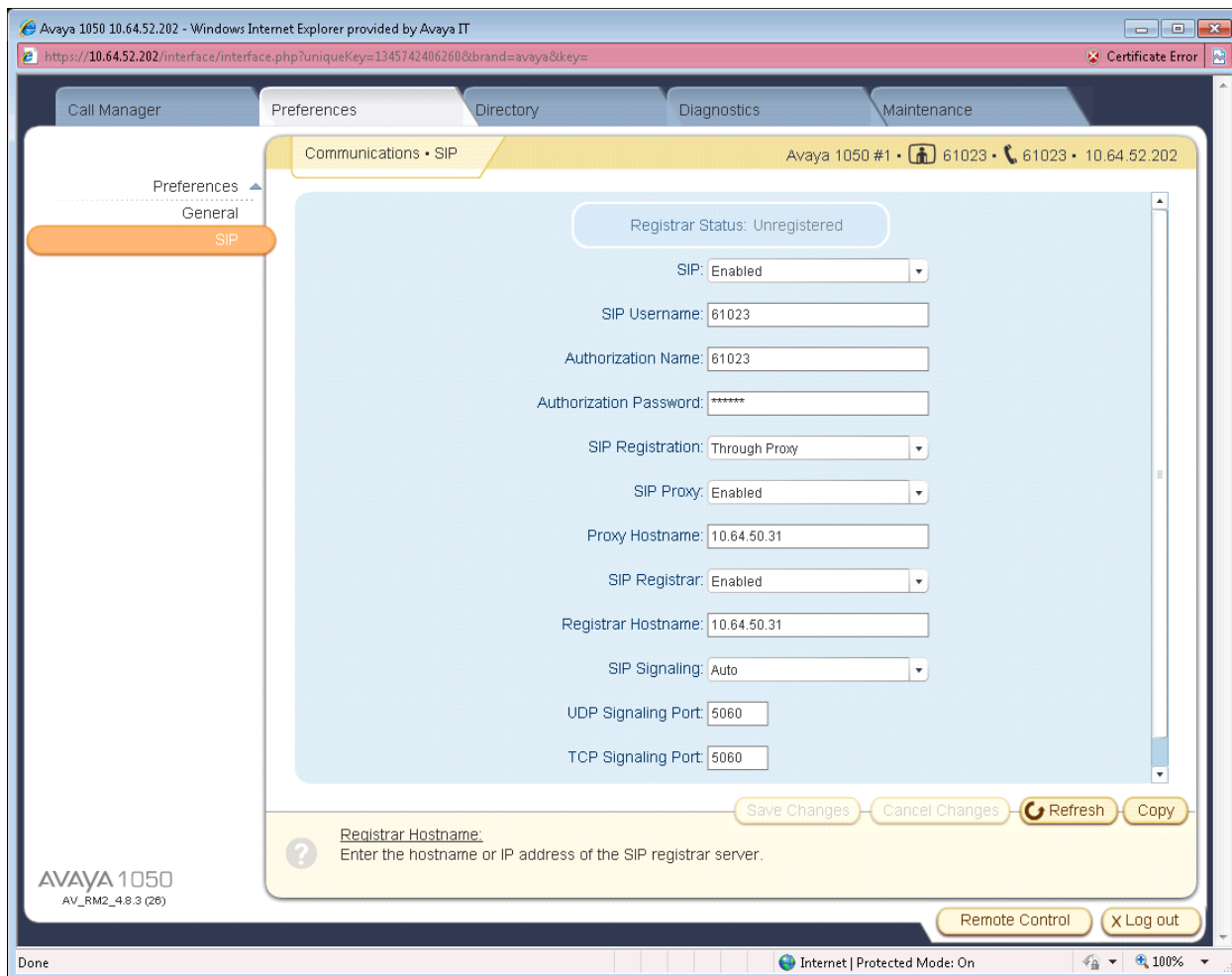
From the left pane of the **Preferences** tab, click **Network,** then **Network QoS** to display the following page. From this page select **DiffServ** from the **Network QoS** dropdown box. Also enter the desired parameters for **DiffServ Audio Priority, DiffServ Video Priority,** and **DiffServ Data Priority** and click the **Save Changes** button.
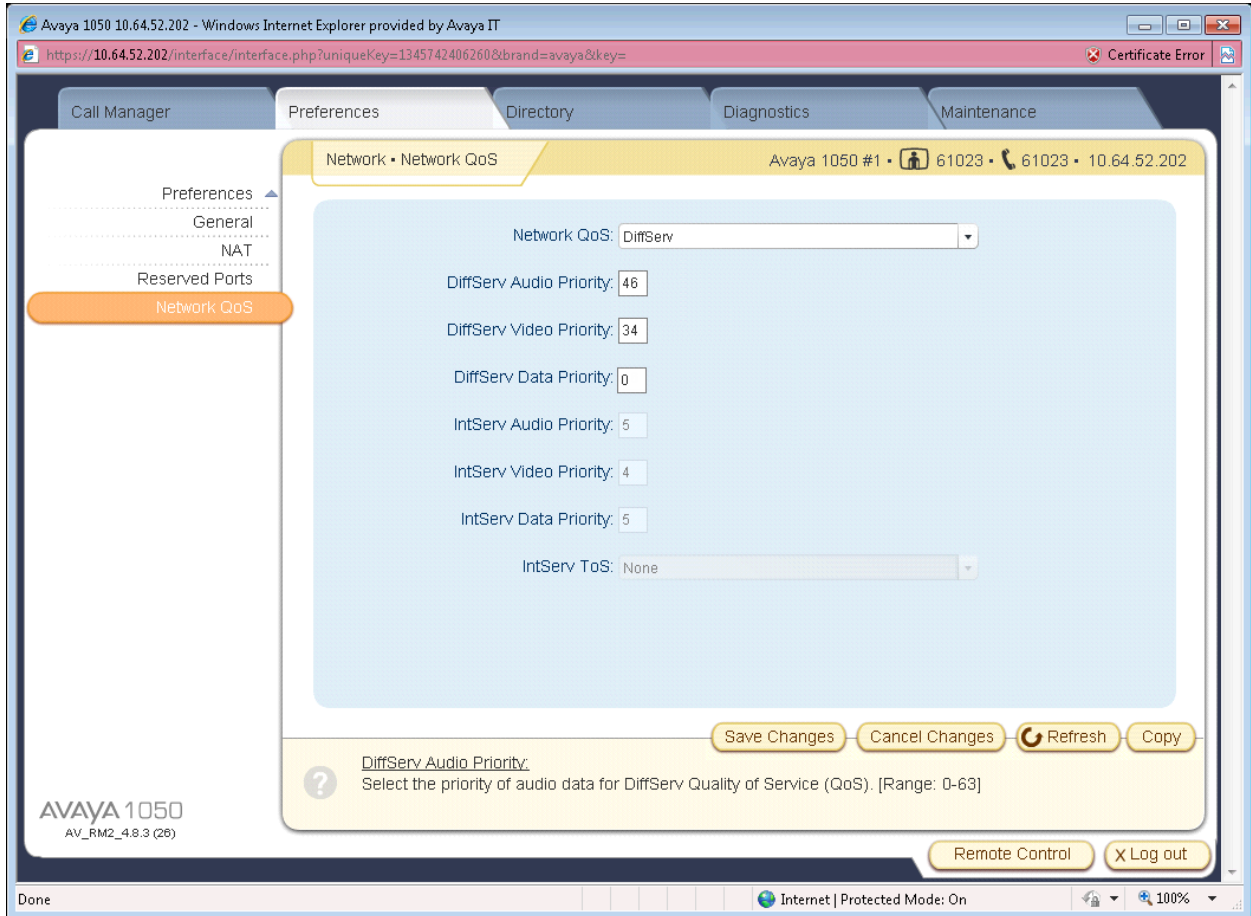
From the left pane click the **General** button to display the following page. From this page select **Enabled** from the **DHCP** dropdown box. Also enter the Voice VLAN ID in the **VLAN Tag** box and click the **Save Changes** button.
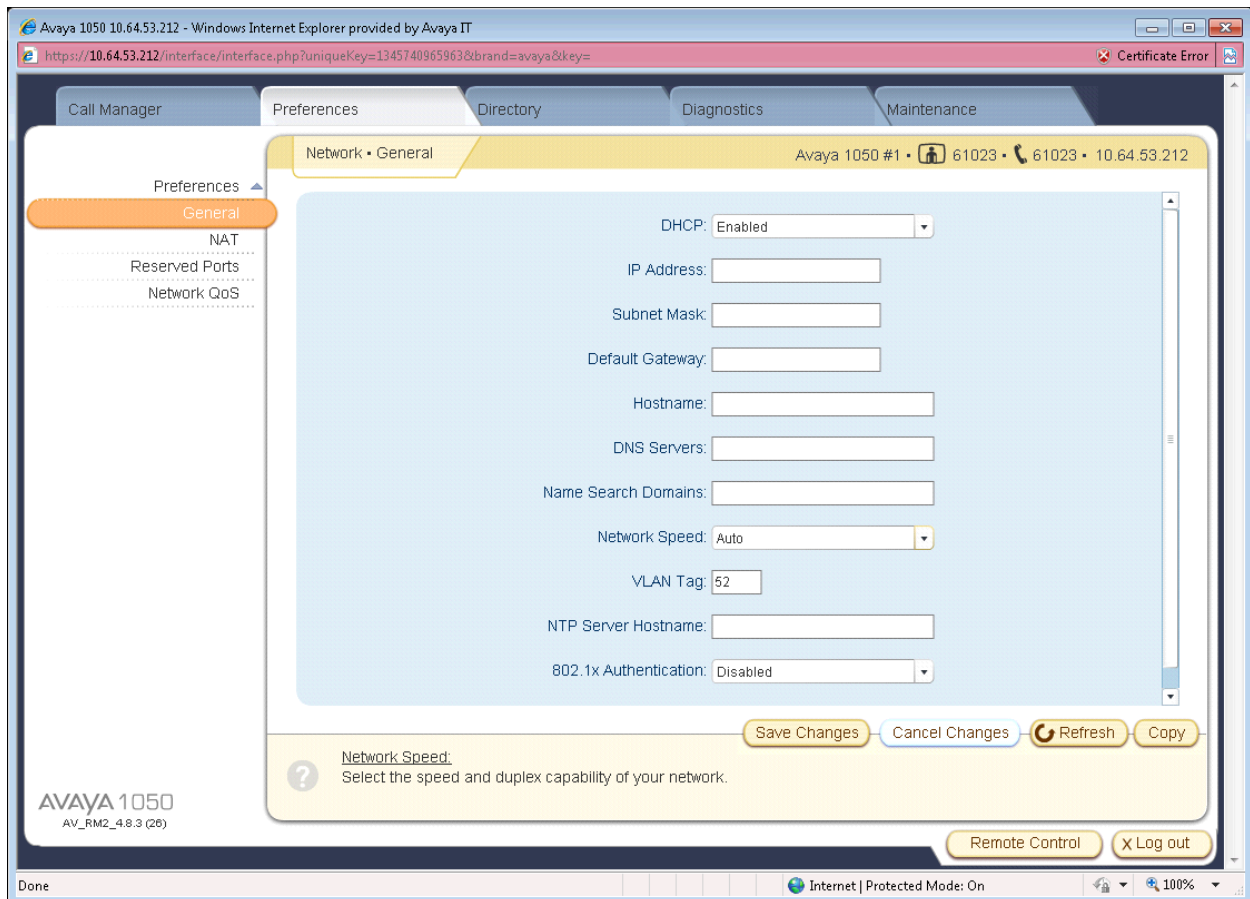


**Note:** *After making these changes the Avaya VCU should reboot in to the Voice VLAN.*

# 10. Configure the HP Networking 5406zl Core Switch

This section addresses how to configure the HP Networking 5406zl Switch for enforcing QoS policies.

To configure the HP Networking switch, connect a PC or laptop to the serial port of the 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. Use Telnet to connect to the HP Networking switch. The following prompt should be displayed.

```
HP-E5406zl#
```

2. Enable the following features on the HP Networking 5406zl Switch.
   - Enable routing.
   - Enable DSCP based QoS.
   - Configure QoS map to be used by device-priority for Differentiated Services.
   - Set priority for the IP address of Communication Manager**.**
   - Set priority for the IP Address of Session Manager.
   - Set priority for the IP Address of Media Gateway.
   - Save the running configuration to the startup configuration.

```
HP-E5406zl#  configure
HP-E5406zl# (config)# ip routing
HP-E5406zl# (config)# qos type-of-service diff-services
HP-E5406zl# (config)# qos dscp-map 101110 priority 6
HP-E5406zl# (config)# qos device-priority 10.64.50.52 dscp 101110
HP-E5406zl# (config)# qos device-priority 10.64.50.31 dscp 101110
HP-E5406zl# (config)# qos device-priority 10.64.50.54 dscp 101110
HP-E5406zl# (config)# write memory
```

3. Create and configure the telephony VLAN where all of the Avaya telephony infrastructure equipment and servers are located.
   - 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.

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 50
HP-E5406zl(vlan-50)# name Telephony_Infrastructure_AA
HP-E5406zl(vlan-50)# ip address 10.64.50.64/24
HP-E5406zl(vlan-50)# untagged A14-A18
HP-E5406zl(vlan-50)# tagged A21
HP-E5406zl(vlan-50)# end
HP-E5406zl#
```

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

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 52
HP-E5406zl(vlan-52)# name Voice
HP-E5406zl(vlan-52)# ip address 10.64.52.1/24
HP-E5406zl(vlan-52)# ip helper-address 10.64.59.247
HP-E5406zl(vlan-52)# tagged A1-A5,A11-A13
HP-E5406zl(vlan-52)# end
HP-E5406zl#
```

5. Create and configure the data VLAN.
   - 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.

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 53
HP-E5406zl(vlan-53)# ip address 10.64.53.1/24
HP-E5406zl(vlan-53)# ip helper-address 10.64.59.247
HP-E5406zl(vlan-53)# tagged A1-A5,A11-A13
HP-E5406zl(vlan-53)# end
HP-E5406zl#
```

6. Save the running configuration to the startup configuration.

```
HP-E5406zl# write memory
HP-E5406zl#
```

# 11.  Configure HP Networking Distribution/Access Switches

This section addresses configuring the HP 3800, 2620, 2915, and 2910 switches to support the configuration shown in **Figure 1**.

**Note:** *The purpose of this compliance test was to validate interoperability with each HP switch. Since each of the distribution/access switches were configured the same way, only the HP 3800 configuration is shown.  To configure the other switches shown in Figure 1, repeat the same configuration commands on each switch.*

To configure the HP Networking switch, connect a PC or laptop to the serial port of the 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

```
HP Stack E3800#
```

1. Enable the following features on the HP 3800 switch.
   - Enable DSCP based QoS.
   - Configure QoS map to be used by device-priority for Differentiated Services.

- Set priority for the IP address of Communication Manager**.**
- Set priority for the IP Address of Session Manager.
- Set priority for the IP Address of Media Gateway.
- Save the running configuration to the startup configuration.

```
HP Stack E3800# configure
HP Stack E3800# (config)# qos type-of-service diff-services
HP Stack E3800# (config)# qos dscp-map 101110 priority 6
HP Stack E3800# (config)# qos device-priority 10.64.50.52 dscp 101110
HP Stack E3800# (config)# qos device-priority 10.64.50.31 dscp 101110
HP Stack E3800# (config)# qos device-priority 10.64.50.54 dscp 101110
HP Stack E3800# (config)# end
HP Stack E3800# write memory
HP Stack E3800#
```

2. Create and configure the voice VLAN.
- 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.

```
HP Stack E3800# configure
HP Stack E3800(config)# vlan 52
HP Stack E3800(vlan-52)# name Voice
HP Stack E3800(vlan-52)# ip address 10.64.52.1/24
HP Stack E3800(vlan-52)# tagged A1-A5,A11-A13
HP Stack E3800(vlan-52)# end
HP Stack E3800#
```

3. Create and configure the data VLAN.
   - 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.

```
HP Stack E3800# configure
HP Stack E3800(config)# vlan 53
HP Stack E3800(vlan-53)# ip address 10.64.53.1/24
HP Stack E3800(vlan-53)# tagged A1-A5,A11-A13
HP Stack E3800(vlan-53)# end
HP Stack E3800#
```

4. Save the running configuration to the startup configuration.

```
HP Stack E3800# write memory
HP Stack E3800#
```

# 12. Configure the HP Networking 5406zl Core Switch with LLDP

LLDP or 802.1AB is an IEEE standard designed for the discovery of directly attached adjacent network devices such as Ethernet switches and routers. LLDP-MED or ANSI/TIA-1057 is a TIA standard that extends LLDP for the discovery and auto-configuration of directly attached LLDP-MED capable media endpoint devices such as the Avaya 9600 and 4600 Series IP Telephones. LLDP advertisements are encapsulated in LLDP Data Units (LLDPDU) in the format of Type Length Value or TLV for short. The IEEE 802.1AB specification defines different types of TLVs – Standard and Optional. LLDP capable devices must support the advertisement of Standard TLVs such as Chassis ID, Port ID, and Time to Live TLVs. The same LLDP capable device may also include LLDP-MED (Network Policy, Inventory), IEEE 802.3 (MAC/PHY Configuration/Status) and other Vendor specific optional TLVs as part of its LLDP advertisement. The Avaya 9600 and 4600 Series IP Telephones supports the use of the Network Policy TLV as a means to auto discover voice VLAN and QoS assignment in addition to using vendor specific TLVs.

This section addresses how to configure the HP 5406zl Switch for setting VLAN and QoS policies.

To configure the HP 5406zl Switch, connect a PC or laptop to the serial port of the 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. Use Telnet to connect to HP Networking switch. The following prompt should be displayed.

```
HP-E5406zl#
```

2. Enable the following features on the HP Networking 5406zl Switch.
   - Enable routing.
   - Enable DSCP based QoS.
   - Configure QoS map to be used by device-priority for Differentiated Services.
   - Set priority for the IP address of Communication Manager.
   - Set priority for the IP Address of Session Manager.
   - Set priority for the IP Address of Media Gateway.
   - Save the running configuration to the startup configuration.

```
HP-E5406zl#  configure
HP-E5406zl# (config)# ip routing
HP-E5406zl# (config)# qos type-of-service diff-services
HP-E5406zl# (config)# qos dscp-map 101110 priority 6
HP-E5406zl# (config)# qos device-priority 10.64.50.52 dscp 101110
HP-E5406zl# (config)# qos device-priority 10.64.50.31 dscp 101110
HP-E5406zl# (config)# qos device-priority 10.64.50.54 dscp 101110
HP-E5406zl# (config)# write memory
```

3. Create and configure the telephony VLAN where all of the Avaya telephony equipment is located.
   - 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.

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 50
HP-E5406zl(vlan-50)# name Telephony_Infrastructure_AA
HP-E5406zl(vlan-50)# ip address 10.64.50.64/24
HP-E5406zl(vlan-50)# untagged A14-A18
HP-E5406zl(vlan-50)# tagged A21
HP-E5406zl(vlan-50)# end
HP-E5406zl#
```

4. Create and configure the voice VLAN.
   - Assign a VLAN ID for the voice VLAN.
   - Assign a name for the voice VLAN.
   - Assign voice option which enables LLDP-MED and voice VLAN auto configuration.
   - Assign an IP address for the voice VLAN.
   - Set an IP helper address for DHCP.
   - Assign ports to the voice VLAN.
   - Set the DSCP value to be sent to the Avaya Telephones via LLDP.

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 52
HP-E5406zl(vlan-52)# name Voice
HP-E5406zl(vlan-52)# voice
HP-E5406zl(vlan-52)# ip address 10.64.52.1/24
HP-E5406zl(vlan-52)# ip helper-address 10.64.59.247
HP-E5406zl(vlan-52)# tagged A1-A5,A11-A13
HP-E5406zl(vlan-52)# qos dscp 101110
HP-E5406zl(vlan-52)# end
HP-E5406zl#
```

5. Create and configure the data VLAN.
   - 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.

```
HP-E5406zl# configure
HP-E5406zl(config)# vlan 53
HP-E5406zl(vlan-53)# ip address 10.64.53.1/24
HP-E5406zl(vlan-53)# ip helper-address 10.64.59.247
HP-E5406zl(vlan-53)# tagged A1-A5,A11-A13
HP-E5406zl(vlan-53)# end
HP-E5406zl#
```

6. Save the running configuration to the startup configuration.

```
HP-E5406zl# write memory
HP-E5406zl#
```

# 13. Configure HP Networking Distribution/Access Switches with LLDP

This section addresses configuring the HP 3800, 2620, 2915, and 2910 switches to support the configuration shown in **Figure 1**.

**Note:** *The purpose of this compliance test was to validate interoperability with each HP switch. Since each of the distribution/access switches were configured the same way only the HP 3800 configuration is shown.  To configure the other switches shown in Figure 1, repeat the same configuration commands on each switch.*

To configure the switches, connect a PC or laptop to the serial port. Run a terminal emulation program with the following configuration:

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

| HP Stack E3800# |
|---|

1. Enable the following features on the HP 3800 switch.
   - Enable DSCP based QoS.
   - Configure QoS map to be used by device-priority for Differentiated Services.
   - Set priority for the IP address of Communication Manager**.**
   - Set priority for the IP Address of Session Manager.
   - Set priority for the IP Address of Media Gateway.
   - Save the running configuration to the startup configuration.

```
HP Stack E3800# configure
HP Stack E3800# (config)# qos type-of-service diff-services
HP Stack E3800# (config)# qos dscp-map 101110 priority 6
HP Stack E3800# (config)# qos device-priority 10.64.50.52 dscp 101110
HP Stack E3800# (config)# qos device-priority 10.64.50.31 dscp 101110
HP Stack E3800# (config)# qos device-priority 10.64.50.54 dscp 101110
HP Stack E3800# (config)# end
HP Stack E3800# write memory
HP Stack E3800#
```

2. Create and configure the voice VLAN.

- Assign a VLAN ID for the voice VLAN.
- Assign a name for the voice VLAN.
- Assign voice option which enables LLDP-MED and voice VLAN auto configuration.
- Assign an IP address for the voice VLAN.
- Set an IP helper address for DHCP.
- Assign ports to the voice VLAN.
- Set the DSCP value to be sent to the Avaya Telephones via LLDP.

```
HP Stack E3800# configure
HP Stack E3800(config)# vlan 52
HP Stack E3800(vlan-52)# name Voice
HP Stack E3800(vlan-52)# voice
HP Stack E3800(vlan-52)# ip address 10.64.52.1/24
HP Stack E3800(vlan-52)# ip helper-address 10.64.59.247
HP Stack E3800(vlan-52)# tagged A1-A5,A11-A13
HP Stack E3800(vlan-52)# qos dscp 101110
HP Stack E3800(vlan-52)# end
HP Stack E3800#
```

3. Create and configure the data VLAN.
   - 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.

```
HP Stack E3800# configure
HP Stack E3800(config)# vlan 53
HP Stack E3800(vlan-53)# ip address 10.64.53.1/24
HP Stack E3800(vlan-53)# tagged A1-A5,A11-A13
HP Stack E3800(vlan-53)# end
HP Stack E3800#
```

4. Save the running configuration to the startup configuration.

```
HP-E5406zl# write memory
HP-E5406zl#
```

# 14. Configure HP Networking Distribution/Access Switches with PoE

Power over Ethernet (PoE) allows both power and data to be simultaneously carried over standard Ethernet cables. PoE-enabled Ethernet switches can supply power directly to Ethernet devices, thereby simplifying installation and removing the need for separate power supplies for those devices. The IEEE 802.3af-2003 standard defines the mechanisms for Power Sourcing Equipment (PSE), such as PoE-enabled Ethernet switches, to detect, classify, and supply up to 15.4W of power per port to Powered Devices (PDs), such as PoE-enabled IP telephones. In the compliance-tested configuration described in these Application Notes, the HP Networking Switches were configured to supply inline PoE to Avaya PDs. Many HP Networking Switches also support the IEEE 802.3at-2009 standard for Power over Ethernet Plus (PoE+), which can provide up to 30W per port.

The default configuration for the HP Networking switches has PoE/PoE+ enabled. If you need to make modifications or disable PoE or control per-port PoE priority please refer to the HP Networking Switch manuals for more information.

# 15. Verification Steps

## 15.1. Verify QoS

The following steps may be used to verify the configuration:

- From the HP switch CLI, enter the command **show qos device-priority** to verify the QoS configuration for packets being sent to and from the Avaya Telephony Infrastructure devices.

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```
HP-E5406zl# show qos device-priority

  Device priorities

  Device Address                                   Apply rule | DSCP   Priority
  ---------------------------------------------- ---------- + ------ --------
  10.64.50.52                                      DSCP       | 101110 6
  10.64.50.31                                      DSCP       | 101110 6
  10.64.50.54                                      DSCP       | 101110 6
```

- From the HP switch CLI, enter the command **show qos vlan-priority** to verify the QoS configuration for the Voice VLAN.

```
HP-E5406zl# show qos vlan-priority

  VLAN priorities

  VLAN ID Apply rule  | DSCP   Priority
  ------- ----------- + ------ -----------
  1       No-override |        No-override
  50      No-override |        No-override
  51      No-override |        No-override
  52      Priority    |        6
  53      No-override |        No-override
  54      No-override |        No-override
```

- From the HP switch CLI, enter the command **show qos dscp-map** to verify the DSCP QoS policy mapping.

```
HP-E5406zl# show qos dscp-map

  DSCP -> 802.p priority mappings

  NOTE: 'qos type-of-service diff-services' must be configured
        before DSCP is honored on inbound traffic.

  DSCP CodePoint DSCP Value 802.1p tag  DSCP Policy name
  -------------- ---------- ----------- -------------------------------
  000000         0          0           cs0
  000001         1          No-override
  000010         2          No-override
  000011         3          No-override
  000100         4          No-override
  000101         5          No-override
  000110         6          No-override
  000111         7          No-override
  001000         8          1           cs1
  001001         9          No-override
  001010         10         1           af11
  001011         11         No-override
  001100         12         1           af12
  001101         13         No-override
  001110         14         2           af13
  001111         15         No-override
  010000         16         2           cs2
  010001         17         No-override
  010010         18         0           af21
  010011         19         No-override
  010100         20         0           af22
  010101         21         No-override
  010110         22         3           af23
  010111         23         No-override
  011000         24         3           cs3
  011001         25         No-override
  011010         26         4           af31
  011011         27         No-override
  011100         28         4           af32
  011101         29         No-override
  011110         30         5           af33
  011111         31         No-override
  100000         32         4           cs4
  100001         33         No-override
  100010         34         6           af41
  100011         35         No-override
  100100         36         6           af42
  100101         37         No-override
  100110         38         7           af43
  100111         39         No-override
  101000         40         5           cs5
  101001         41         No-override
  101010         42         No-override
  101011         43         No-override
  101100         44         No-override
  101101         45         No-override
  101110         46         7           ef
  101111         47         No-override
  110000         48         6           cs6
  110001         49         No-override
  110010         50         No-override
  110011         51         No-override
  110100         52         No-override
  110101         53         No-override
  110110         54         No-override
```

- During the compliance testing wireshark was used to capture packets and verify the proper setting for L2/L3 QoS parameters.

## 15.2. Verify LLDP

Use the **show lldp info remote-device** command to display the list of devices that are discovered by the HP Networking switches via LLDP.

```
HP-E5406zl# show lldp info remote-device

 LLDP Remote Devices Information

  LocalPort | ChassisId                PortId PortDescr SysName
  --------- + ------------------------ ------ --------- -------------------
    ---
  A1        | b4 99 ba 54 76 8b        48     1/48      HP Stack E3800
  A2        | 00 16 35 b6 30 c0        24     24        HP-E3500yl-24G
  A3        | 00 23 47 51 bb 40        48     48        HP Networking
  A4        | f0 62 81 d1 85 10        10     10        HP Networking
  A5        | 10 1f 74 a7 92 e0        26     26        HP-E2620-24-PoEP
  A11       | 10.64.52.129             00 ...           AVAEBCE4A
  A12       | 10.64.52.143             00 ...           AVTC4F4BE
  A14       | cc f9 54 26 f0 60        115...
  A21       | 00 1b 4f d9 14 00        00 ...
```

Use the **show lldp info remote-device <port>** command to display more specific details about an individual device.

Hint: This command is also useful for debugging voice vlan and QoS issues, since it shows the actual vlan and QoS settings as advertised by the IP phone.

```
HP-E5406zl# show lldp info remote-device A12

 LLDP Remote Device Information Detail

  Local Port   : A12
  ChassisType  : network-address
  ChassisId    : 10.64.52.143
  PortType     : mac-...
  PortId       : 00 07 3b c4 f4 be
  SysName      : AVTC4F4BE
  System Descr :
  PortDescr    :
  Pvid         :

  System Capabilities Supported  : bridge, telephone
  System Capabilities Enabled    : bridge

  Remote Management Address
     Type    : ipv4
     Address : 10.64.52.143

  MED Information Detail
    EndpointClass        :Class3
    Media Policy Vlan id  :52
    Media Policy Priority :6
    Media Policy Dscp     :46
    Media Policy Tagged   :True
    Poe Device Type       :PD
    Power Requested       :5.3 W
    Power Source          :From PSE
    Power Priority        :High
```

## 15.3. Verify PoE

Use the **show power-over-ethernet** command to display general PoE information.

```
HP-E5406zl# show power-over-ethernet

 Status and Counters - System Power Status

  Pre-standard Detect    : Off
  System Power Status    : No redundancy
  PoE Power Status       : No redundancy

 Chassis power-over-ethernet:

  Total Available Power  :  273 W
  Total Failover Power   :    0 W
  Total Redundancy Power :    0 W
  Total used Power       :    9 W +/- 6W
  Total Remaining Power  :  264 W

 Internal Power
        1   273W/POE  /Connected.
        2   Not Connected.
 External Power
        EPS1   /Not Connected.
        EPS2   /Not Connected.
```

Use the **show power-over-ethernet brief <port>** command to display brief info about the power on a specific port. The example below displays power information for a port connected to an Avaya 96xx Telephone.

```
HP-E5406zl# show power-over-ethernet brief a12

 Status and Counters - Port Power Status

  PoE   | Power  Power     Alloc Alloc Actual Configured  Detection   Power
  Port  | Enable Priority  By    Power Power  Type        Status      Class
  ------ + ------ --------  ----- ----- ------ ----------- ----------- -----
  A12   | Yes    low       usage 17 W  4.3 W              Delivering  2
```

Use the **show power-over-ethernet <port>** command to display detailed info about the power on a specific port.

```
HP-E5406zl# show power-over-ethernet a12

 Status and Counters - Port Power Status for port A12

  Power Enable      : Yes
                                        LLDP Detect        : enabled
  Priority          : low               Configured Type    :
  AllocateBy        : usage             Value              : 17 W
  Detection  Status : Delivering        Power Class        : 2

  Over Current Cnt  : 0                 MPS Absent Cnt     : 0
  Power Denied Cnt  : 1                 Short Cnt          : 0

  Voltage           : 50.7 V            Current            : 87 mA
  Power             : 4.3 W
```

# 16. Conclusion

These Application Notes describe a compliance-tested configuration comprised of Avaya Aura®
Telephony Infrastructure connected to HP Networking Switches. The HP Networking Switches
enforced L2/L3 QoS parameters that were configured via settings files and LLDP. Additionally
HP Networking Switches provided Power over Ethernet for the Avaya Telephones. Prioritization
of VoIP traffic and good voice quality was successfully achieved in the Avaya/HP Networking
configuration described in **Figure 1**. HP Networking successfully passed the compliance test.
Refer to **Section 2.2** for more details and listed observations.

# 17. Additional References

The documents referenced below were used for additional support and configuration
information.

The following Avaya product documentation can be found at http://support.avaya.com.

[1] *Administering Avaya* Aura® *Communication Manager*, June 2010, Release 6.0, Issue 6.0,
   Document Number 03-300509, available at http://support.avaya.com.
[2] *Administering Avaya* Aura® *Session Manager*, October 2010, Issue 1.1, Release 6.1,
   Document Number 03-603324, available at http://support.avaya.com.
[3] *Avaya one-X Deskphone Edition for 9600 Series IP Telephones Administrator Guide
   Release 3.1,* November 2009, Document Number 16-300698.
[4] *Administering Avaya one-X® Communicator*, October 2011
[5] *Avaya 1010 and1020 User and Administrator Guide*, May 2011
[6] *Avaya 1030, 1040, and 1050 Video Conferencing Systems User and Administrator Guide*,
   February, 2011
[7] *Implementing and Administering the Avaya A175 Desktop Video Device with the Avaya
   Flare® Experience Release 1.1,* Document Number 16-603739Issue 2March, 2012

Product information for the HP Networking Switches may be found at
http://h17007.www1.hp.com/us/en/products/switches/index.aspx