Avaya Solution & Interoperability Test Lab

Application Notes for VoIP over a MLPPP Link between Foundry Networks AccessIron WAN Access Routers with Avaya Communication Manager - Issue 1.0

Abstract

These Application Notes describe a configuration for supporting Voice over IP (VoIP) over a Multilink PPP (MLPPP) link with Quality of Service (QoS) between two Foundry Networks AccessIron WAN Access Routers. The AccessIron AR1202 and AR1204 with T1 interfaces were used during the compliance testing. Avaya Media Servers and Gateways running Avaya Communication Manager delivered voice traffic to the AccessIron routers for transmission over the WAN along with data traffic. QoS, based on Layer 3 Differentiated Services, was implemented across the network to prioritize voice traffic over the WAN. Emphasis was placed on verifying good voice quality in a converged network. Information in these Application Notes has been obtained through compliance testing and additional technical discussions. Testing was conducted via the Developer*Connection* Program at the Avaya Solution and Interoperability Test Lab.

1. Introduction

These Application Notes describe a configuration for supporting Voice over IP (VoIP) over a MLPPP link with Quality of Service (QoS) between Foundry Networks AccessIron AR1202 and AR1204 WAN Access Routers. Avaya Media Servers and Gateways running Avaya Communication Manager delivered voice traffic to the AccessIron routers for transmission over the WAN along with data traffic. The WAN was used to exchange voice and data traffic between a corporate site and a branch office site. To achieve good voice quality across the WAN, QoS based on Layer 3 Differentiated Services (DiffServ) was configured on the WAN interfaces of the AR1202 and AR1204. Before the AccessIron routers can enforce QoS, they must be able to distinguish between low and high priority traffic. This required that the Avaya Media Servers and Gateways, and the Avaya IP Telephones mark voice signaling and media packets with a DSCP value so that the WAN access routers can identify the high priority VoIP packets and prioritize them accordingly.

The configuration shown in **Figure 1** illustrates a corporate site connected to a branch office sites over the WAN using a MLPPP link. Each site consists of an Avaya Media Server and Gateway, Avaya IP telephones, and a Foundry Networks AccessIron router. The networks devices at the corporate site were interconnected via an Avaya P333T Stackable Ethernet Switch and the end-user devices at the branch office site were connected to a Power-over-Ethernet switch (MM314) installed in the G350 Media Gateway. At the corporate site, a FastIron Edge Switch (FES) 4802 was used as a Layer 3 switch for routing within the enterprise. At the branch office site, the internal router in the G350 Media Gateway was used to route packets between the voice and data VLANs, as well as to route packets to the corporate site.

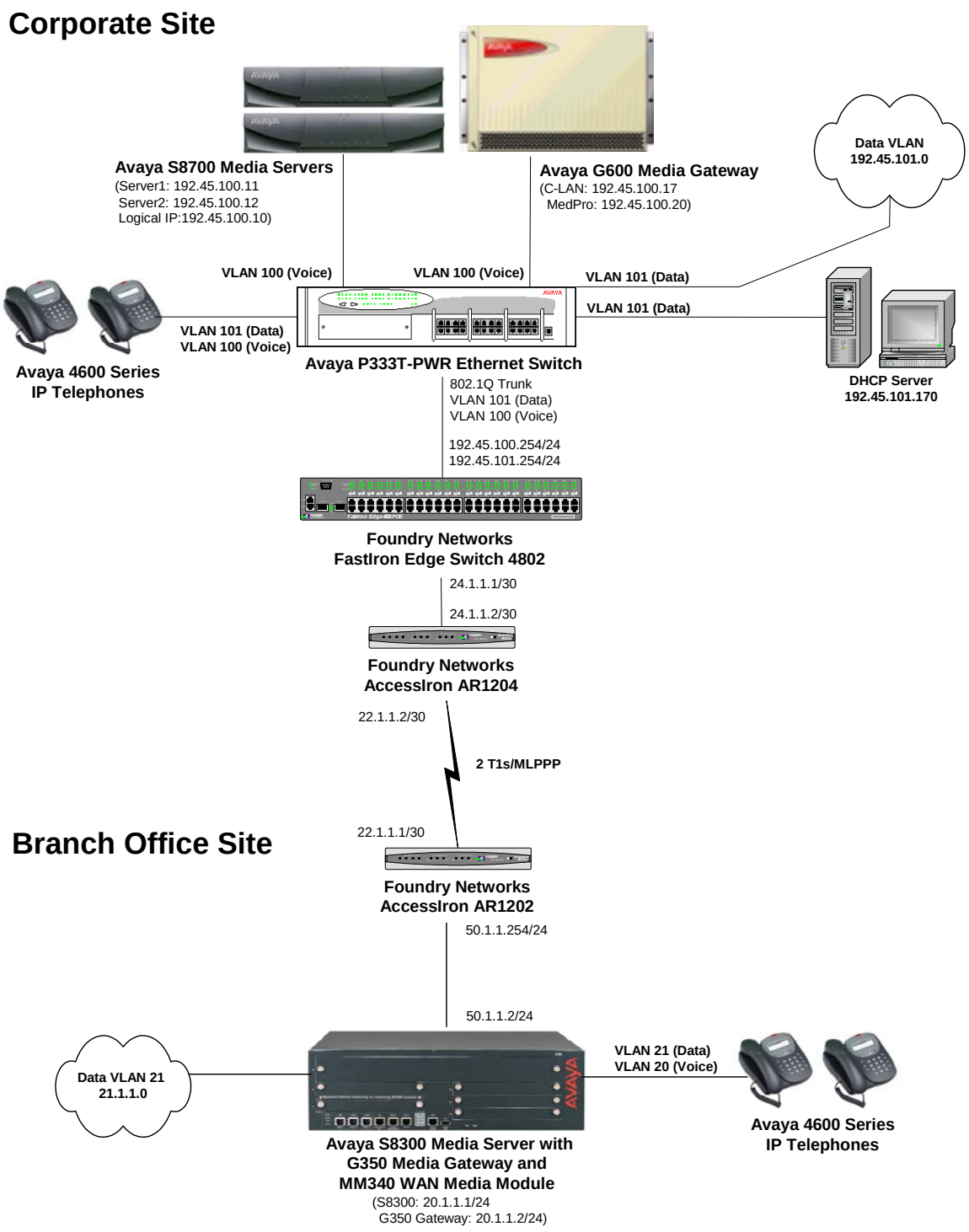

Figure 1: Avaya/Foundry Networks Configuration

2. Equipment and Software Validated

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

Equipment	Software
Avaya S8700 Media Server with Avaya G600 Media Gateway	Communication Manager 2.1 (R012x.01.0.411.7)
Avaya TN799DP C-LAN	HW01 FW012
Avaya TN2302AP IP Media Processor	HW03 FW093
Avaya S8300 Media Server with Avaya G350 Media Gateway	Communication Manager 2.1.1 (R012x.01.1.414.1)
Avaya P333T-PWR Stackable Switch	3.12.1
Avaya 4600 Series IP Telephone	2.1
Avaya 6408D Digital Phones	--
Foundry Networks AccessIron AR1202 WAN Access Router	8.0.1
Foundry Networks AccessIron AR1204 WAN Access Router	8.0.1
Foundry Networks FastIron Edge Switch 4802 in Layer 3 Mode	3.2.0a

3. Configure the Avaya Media Servers

These Application Notes describe a QoS solution based on DSCP markings to classify traffic in the network for QoS handling. This requires that the Avaya Media Servers and Gateways as well as the Avaya IP Telephones mark outgoing VoIP media and signaling packets with DSCP values. For the configuration described herein, VoIP media and signaling packets were tagged with DSCP values 46 and 34, respectively. VoIP media packets are sent by the VoIP resource in the G350 Media Gateway, the IP Media Processor in the G600 Media Gateway, and the Avaya IP Telephones. VoIP signaling packets are sent by the S8300 Media Server, the C-LAN in the G600 Media Gateway, and the Avaya IP Telephones. All of these components derive the DSCP values from the IP network region to which they belong. The C-LAN and IP Media Processor are assigned to the **IP Network Region** specified in the **IP Interface** form, and the G350 Media Gateway is assigned to the IP network region specified in the **Media Gateway** form. The IP network region for the IP telephones is either specified in the **IP Network Map** form or inherited from their C-LAN or S8300 Processor. The IP telephones acquire the appropriate DSCP values during H.323 registration with their respective media server.

IP network region '2' and IP codec set '1' were used on the Avaya Media Servers at the corporate and branch office sites. The **ip-network-region**, **ip-codec-set,** and **ip-network-map** forms are configured the same way for each media server. The configuration shown below is associated with the S8700 Media Server and G600 Media Gateway, but may be applied to the S8300 Media Servers and G350 Media Gateway, except where specified. Note that the H.323 signaling group, IP trunk group, and call routing administration are not covered in these Application Notes.

The Avaya S8700 Media Server is configured using a web interface. Enter the media server's IP address as the URL in a web browser to access the web interface. Follow the prompts and then log in. Select the **configure server** option, to access the server configuration page and set the IP address and default gateway of the S8700 Media Server. The default gateway of the S8700 Media Server is the FES 4802 at the Corporate Site. The **Gateway** field should be set to the IP address of the FES 4802 corresponding to the voice VLAN (i.e., VLAN ID 100 and IP address 192.45.100.254) since the media server belongs to the voice VLAN in this configuration. This ensures that the S8700 Media Server is accessible throughout the network for system management purposes only. VoIP media and H.323 signaling traffic flows to/from the IP Media Processor, C-LAN, and IP telephones at the corporate site, not the S8700 Media Server. Repeat this configuration for the S8300 Media Server using the appropriate IP configuration.

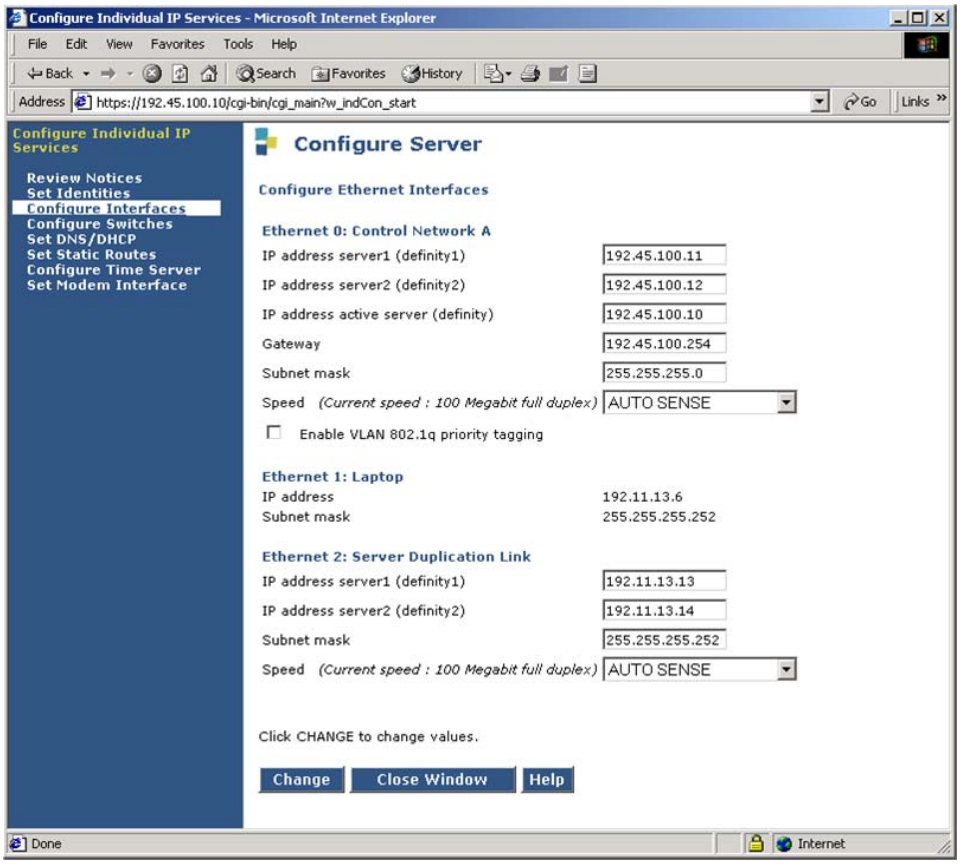

Figure 2: Avaya S8700 Media Server – Configure Server Form

From the System Access Terminal (SAT), enter the **change ip-network-region 2** command to configure the DiffServ values for the C-LAN and IP Media Processor. IP network region '2' is assigned to the C-LAN and IP Media Processor in the **ip-interfaces** forms shown in **Figures 6** and **7**. The IP telephones are programmed with these DiffServ values automatically when they register via the C-LAN. The default settings of the **ip-network-region** form were used. Repeat this configuration on the S8300 Media Server.

```
change ip-network-region 2                                    Page   1 of  19
                              IP NETWORK REGION
  Region: 2
Location:                  Home Domain:
    Name:
                                Intra-region IP-IP Direct Audio: yes
AUDIO PARAMETERS                Inter-region IP-IP Direct Audio: yes
   Codec Set: 1                           IP Audio Hairpinning? y
UDP Port Min: 2048
UDP Port Max: 3028                     RTCP Reporting Enabled? y
                               RTCP MONITOR SERVER PARAMETERS
DIFFSERV/TOS PARAMETERS         Use Default Server Parameters? y
 Call Control PHB Value: 34
        Audio PHB Value: 46
802.1P/Q PARAMETERS
 Call Control 802.1p Priority: 7
        Audio 802.1p Priority: 6      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
```

Figure 3: IP Network Region Form

On the **ip-codec-set** form, select the audio codec type to be used by the media processors and IP telephones in IP network region '2'. Note that IP codec set '1' was specified in IP network region '2' in **Figure 3**. The form is accessed via the **change ip-codec-set 1** command. The default settings of the **ip-codec-set** form are shown below. However, the **Audio Codec** field may be set to G.729 to conserve bandwidth on the WAN interface. Repeat this configuration on the S8300 Media Server.

```
change ip-codec-set 1                                         Page   1 of   1

                          IP Codec Set

    Codec Set: 1

    Audio      Silence      Frames   Packet
    Codec      Suppression  Per Pkt  Size(ms)
 1: G.711MU         n         2        20
 2:
 3:
 4:
 5:
 6:
```

Figure 4: IP Codec Set Form

On the **ip-network-map** form, assign IP network region '2' to the Avaya IP Telephones whose IP addresses are in the specified IP address range. The IP telephones inherit the IP network region of the C-LAN or S8300 Processor if the **ip-network-map** form is not used.

```
change ip-network-map                                          Page   1 of  32
                        IP ADDRESS MAPPING

                                                                  Emergency
                                          Subnet                  Location
 From IP Address  (To IP Address    or Mask)  Region    VLAN     Extension
 192.45 .100.0    192.45 .100.255     24       2        100
    .   .   .        .   .   .                          n
    .   .   .        .   .   .                          n
```

Figure 5: IP Network Map

Assign a default gateway and IP network region to the C-LAN via the **change ip-interface 2a03** form. The default gateway is the FES 4802 (192.45.100.254) at the corporate site. The C-LAN was assigned to IP network region '2'. The C-LAN accepts registration and call setup requests from the IP telephones, and exchanges call setup messages with the Avaya Media Servers at the other sites to establish VoIP calls. There is an H.323 trunk group and signaling group configured between the Avaya Media Servers not described in these Application Notes.

```
change ip-interface 2a03                                       Page   1 of   1

                                 IP INTERFACES

                  Type: C-LAN                            ETHERNET OPTIONS
                  Slot: 02A03                                   Auto? y
           Code/Suffix: TN799  D
             Node Name: clan-02a03
            IP Address: 192.45 .100.17
           Subnet Mask: 255.255.255.0
       Gateway Address: 192.45 .100.254
  Enable Ethernet Port? y
        Network Region: 2
                  VLAN: n

Number of CLAN Sockets Before Warning: 400
```

Figure 6: Avaya S8700 Media Server – IP Interfaces Form (C-LAN)

Lastly, assign a default gateway and IP network region to the IP Media Processor via the **change ip-interface 2a04** form. The default gateway is the FES 4802 (192.45.100.254) at the corporate site. The IP Media Processor was assigned to IP network region '2'.

```
change ip-interface 2a04                                      Page   1 of   1

                                IP INTERFACES

                  Type: MEDPRO                          ETHERNET OPTIONS
                  Slot: 02A04                                  Auto? y
          Code/Suffix: TN2302
            Node Name: medpro-02a04
           IP Address: 192.45 .100.20
          Subnet Mask: 255.255.255.0
      Gateway Address: 192.45 .100.254
  Enable Ethernet Port? y
       Network Region: 2
                  VLAN: n
```

Figure 7: Avaya S8700 Media Server – IP Interfaces Form (IP Media Processor)

Figure 8 shows the configuration of the Avaya G350 Media Gateway and applies to the branch office site only. When adding the G350 Media Gateway, set the **Type** field to *g350*, specify the serial number of the media gateway in the **Serial No** field, and assign the appropriate network region. The following screen displays the **media-gateway** form after it was added and the gateway has registered.

```
change media-gateway 1                                        Page   1 of   1
                            MEDIA GATEWAY
         Number: 1                            IP Address: 20 .1  .1  .254
           Type: g350                FW Version/HW Vintage: 22 .16 .0  /1
           Name: G350 Media Gateway           MAC Address: 00:04:0d:29:d2:c5
     Serial No: 03IS69612698                Encrypt Link? y
 Network Region: 2                             Location: 1
    Registered? y                  Controller IP Address: 20 .1  .1  .1
                                                Site Data:
      Slot   Module Type               Name
       V1:   S8300                     ICC MM
       V2:   MM340                     DS1 WAN MM
       V3:   MM712                     DCP MM
       V4:
       V5:   MM710                     DS1 MM
       V6:   MM314                     ETH 24P MM
       V7:   virtual-analog            ANA VMM
       V8:
       V9:
```

Figure 8: Avaya S8300 Media Server – Media Gateway Form

4. Configure the Avaya G350 Media Gateway

This section describes the steps for configuring the G350 Media Gateway.

Step	Description
1	Connect a PC or laptop to the G350 Media Gateway via the console port and use a terminal emulation program to configure the system using the CLI interface. Log in to the G350 Media Gateway using the appropriate credentials. **Note:** The *001* in the command prompt shown below refers to the G350 Media Gateway number configured on the media server via the **add media-gateway** command. It is displayed in the command prompt when the G350 Media Gateway has successfully registered with the S8300 Media Server. Prior to registration, *???* is displayed instead of the media gateway number.

2	Create three VLANs on the G350 Media Gateway, one for voice, one for data, and another one for traffic to be sent across the WAN. Assign the voice and data VLANs to Ethernet ports 6/1 and 6/2, which are connected to IP telephones. VLAN 21 is assigned to Ethernet port 6/7 and 6/8 which are connected to data devices, such as PCs. VLAN 50 is assigned to port 6/24, which is connected to the AR1202 at the branch site.
	
	`G350-001# set vlan 20 name SiteA-Voice`
	`G350-001# set vlan 21 name SiteA-Data`
	`G350-001# set vlan 50 name WAN-Access`
	`G350-001# set port vlan 21 6/1-2`
	`G350-001# set port vlan 21 6/7-8`
	`G350-001# set port static-vlan 6/1-2 20`
	`G350-001# set port static-vlan 6/24 50`

3	Configure the interface associated with voice VLAN 20 on the G350 Media Gateway. Specify the IP address of the G350 Media Gateway, configure the ICC (i.e., S8300 Media Server) on the voice VLAN, designate the voice VLAN interface as the Primary Management Interface (PMI), and specify the IP address of the DHCP server. The PMI interface is the one that is used to register with the S8300 Media Server. In this configuration, the DHCP server resides at the corporate site. Use the **show ip interfaces** command to check the status of the interface.
	
	`G350-001# interface Vlan 20`
	`G350-001(if:Vlan 20)# ip address 20.1.1.254 255.255.255.0`
	`G350-001(if:Vlan 20)# icc-vlan`
	`G350-001(if:Vlan 20)# pmi`
	`G350-001(if:Vlan 20)# ip bootp-dhcp server 192.45.101.170`
	`G350-001(if:Vlan 20)# exit`

Step	Description

4	Configure the interface associated with data VLAN 21 on the G350 Media Gateway. Specify the IP address for the data VLAN interface on the G350 Media Gateway and specify the IP address of the DHCP server. Use the **show ip interfaces** command to check the status of the interface.
	`G350-001# interface Vlan 21`
	`G350-001(if:Vlan 21)# ip address 21.1.1.254 255.255.255.0`
	`G350-001(if:Vlan 21)# ip bootp-dhcp server 192.45.101.170`
	`G350-001(if:Vlan 21)# exit`

5	Configure the interface associated with data VLAN 50 on the G350 Media Gateway.
	`G350-001# interface Vlan 50`
	`G350-001(if:Vlan 50)# ip address 50.1.1.2 255.255.255.0`
	`G350-001(if:Vlan 50)# exit`

6	Enable the DHCP relay agent function on the G350 Media Gateway to allow DHCP broadcast requests from one VLAN to be sent to the DHCP server on a different VLAN or network. `G350-001# ip bootp-dhcp relay`
7	Configure the G350 controller IP address using the **set mgc list** command. The Media Gateway Controller (MGC) is set to the IP address of the S8300 Media Server. `G350-001# set mgc list 20.1.1.1`
8	Define a default gateway for the G350 Media Gateway for connecting to the corporate site. `G350-001# ip default-gateway 50.1.1.254`
9	Use the **copy** command to save changes the configuration of the G350 Media Gateway. `G350-001# copy running-config startup-config`

5. Configure the Foundry Networks FastIron Edge Switch 4802

This section provides the configuration for the FastIron Edge Switch 4802 in the corporate site.

Step	Description

1	The followings commands access the configuration level and set the system name.
	`4802> en`
	`4802# config t`
	`4802(config)# hostname CorpCore`

2	Create two VLANs on the FES 4802. VLAN 100 is associated with the voice VLAN and VLAN 101 is associated with the data VLAN. The following configuration assigns VLANs 100 and 101 to port 1, which connects to the Avaya P333T, and enables 802.1q tagging. In addition, a router interface is added to allow routing between the VLANs.
	Configure port-based VLAN 100, add virtual interface 100 as the routing interface for the VLAN, and enable 802.1q tagging on Ethernet port 1.
	`CorpCore(config)# vlan 100 by port`
	`CorpCore(config-vlan-100)# tagged ethernet 1`
	`CorpCore(config-vlan-100)# router-interface ve 100`
	`CorpCore(config-vlan-100)# exit`
	Configure port-based VLAN 101, add virtual interface 101 as the routing interface for the VLAN, and enable 802.1q tagging on Ethernet port 1.
	`CorpCore(config)# vlan 101 by port`
	`CorpCore(config-vlan-101)# tagged ethernet 1`
	`CorpCore(config-vlan-101)# router-interface ve 101`
	`CorpCore(config-vlan-101)# exit`

3	Create access-list 101 that marks packets from the C-LAN in the G600 Media Gateway (192.45.100.17) with DSCP value 34. The C-LAN in the G600 Media Gateway sends keep-alive messages to the far-end media server to maintain the IP trunk in-service. The following access list is required so that the keep-alive messages are marked with a DSCP value and prioritized downstream by the AR1204. This will allow the keep-alive messages to arrive at the other end in spite of competing low priority traffic in the network. The access list is applied to an interface in Step 4.
	`CorpCore(config)# access-list 101 permit ip host 192.45.100.17 any tos-marking 34`
	`CorpCore(config)# access-list 101 permit ip any any`

4	Configure virtual interface 100 and 101. Assign access list 101 to interface 100 in the incoming direction since that is the interface on the same network as the C-LAN card. Packets received by the C-LAN card will be marked with DSCP 34 and prioritized by the AR1204. Furthermore, assign an IP address to each interface.

Step	Description
	CorpCore(config)# **interface ve 100** CorpCore(config-vif-100)# **ip access-group 101 in** CorpCore(config-vif-100)# **ip address 192.45.100.254 255.255.255.0** CorpCore(config-vif-101)# **ip helper-address 1 192.45.101.170** CorpCore(config-vif-100)# **exit** CorpCore(config)# **interface ve 101** CorpCore(config-vif-101)# **ip address 192.45.101.254 255.255.255.0** CorpCore(config)# **exit**
5	Configure a default static route for routing traffic to the AR1204. CorpCore(config)# **ip route 0.0.0.0 0.0.0.0 24.1.1.2**
6	Configure OSPF routing between the FES 4802 and the AR1204. CorpCore(config)# **router ospf** CorpCore(config-ospf-router)# **area 0** CorpCore(config-ospf-router)# **redistribution connected** CorpCore(config-ospf-router)# **exit**
7	Configure Ethernet port 2, which connects to the AR1204. Assign an IP address and subnet mask to the interface and enable OSPF routing. CorpCore(config)# **interface ethernet 2** CorpCore(config-if-e100-2)# **ip address 24.1.1.1 255.255.255.252** CorpCore(config-if-e100-2)# **ip ospf area 0** CorpCore(config-if-e100-2)# **exit**
8	Use the following command to save the configuration. CorpCore(config)# **write memory**

6. Configure the Foundry Networks AccessIron AR1204

The AccessIron AR1204 provides WAN connectivity for the corporate site using PPP and MLPPP links. The AR1204 supports four T1 interfaces. Two T1 interfaces were bundled together to create a MLPPP link to the branch office site.

Step	Description
1	The following commands access the configuration level and set the system name. `AR1204# config t`

2	Configure the Ethernet interface connected to the FES 4802.
	
	`AR1204/configure# interface ethernet 0`
	`AR1204/configure/interface/ethernet 0# ip address 24.1.1.2 255.255.255.252`
	`AR1204/configure/interface/ethernet 0# exit`

3	Configure the T1 interfaces. By default, the T1 interfaces on the AR1204 are configured with **framing** set to *esf*, **linecode** set to *b8zs*, and **clock source** set to *line*. The default settings are appropriate for the configuration described herein. No additional configuration is required for the physical T1 interfaces.

4	The MLPPP link between on the AR1204 is configured under *interface bundle wan1*. In this example, the WAN interface is configured as MLPPP with a bandwidth of 3.072Mbps using two T1 interfaces. An IP address is also assigned to the interface.
	
	`AR1204/configure# interface bundle wan1`
	`AR1204/configure/interface/bundle wan1# link t1 1`
	`AR1204/configure/interface/bundle wan1# link t1 2`
	`AR1204/configure/interface/bundle wan1# encapsulation ppp`
	`AR1204/configure/interface/bundle wan1# ip address 22.1.1.2 255.255.255.252`
	
	Configure the QoS policy for the WAN interface. Three traffic classes are defined, *control* which prioritizes call signaling packets, *voice* which prioritizes audio or RTP packets, and *default* which is used to categorize all other traffic classes. The *default* traffic class is assigned the lowest priority (8) by default. Each traffic class is given a committed rate (cr), a burst rate (br), and a priority. If a traffic class is not transmitting at its committed rate, the other traffic classes may use the remaining bandwidth with the higher priority traffic given precedence. Precedence is defined by the priority assigned to the traffic classes with priority 1 having the highest priority and priority 8 having the lowest priority.
	
	`AR1204/configure/interface/bundle wan1# qos`
	`AR1204/configure/interface/bundle wan1/qos# add_class control root-out cr 50 br 3072 priority 2`

Step	Description
	AR1204/configure/interface/bundle wan1/qos# **add_class voice root-out cr 3000 br 3072 priority 1** AR1204/configure/interface/bundle wan1/qos# **add_class default root-out cr 1 br 3072** Packets with DSCP marking of 34 are classified as *control* traffic. Note that DSCP 34 is displayed as *af41* in the AR1204 configuration. AR1204/configure/interface/bundle wan1/qos# **class control** AR1204/configure/interface/bundle wan1/qos/class control# **add_dscp af41** AR1204/configure/interface/bundle wan1/qos/class control# **exit** Packets with DSCP marking of 46 are classified as *voice* traffic. Note that DSCP 46 is displayed as *ef* in the AR1204 configuration. AR1204/configure/interface/bundle wan1/qos# **class voice** AR1204/configure/interface/bundle wan1/qos/class voice# **add_dscp ef** AR1204/configure/interface/bundle wan1/qos/class voice# **exit** All other DSCP values are classified as *default* (non-prioritized) traffic and given the lowest priority as configured above. AR1204/configure/interface/bundle wan1/qos# **class default** AR1204/configure/interface/bundle wan1/qos/class default# **add_dscp default** AR1204/configure/interface/bundle wan1/qos/class default# **exit** Enable the QoS policy in the outgoing direction. AR1204/configure/interface/bundle wan1/qos# **enable cbq outbound** AR1204/configure/interface/bundle wan1/qos# **exit** AR1204/configure/interface/bundle wan1# **exit**
5	Configure IP static routes for routing traffic over the WAN links. AR1204/configure# **ip** AR1204/configure/ip# **route 20.1.1.0 255.255.255.0 22.1.1.1 1** AR1204/configure/ip# **route 21.1.1.0 255.255.255.0 22.1.1.1 1** AR1204/configure/ip# **route 50.1.1.0 255.255.255.0 22.1.1.1 1** AR1204/configure/ip# **exit**
6	Configure OSPF routing on the Ethernet interface to the FES 4802. AR1204/configure# **router routerid 24.1.1.2** AR1204/configure# router **ospf** AR1204/configure/router/ospf# **area 0** AR1204/configure/router/ospf/area 0# **exit** AR1204/configure/router/ospf# **interface ethernet0 area_id 0**

Step	Description
	AR1204/configure/router/ospf/interface ethernet0# **exit** AR1204/configure/router/ospf# **redistribute connected** AR1204/configure/router/ospf# **redistribute static** AR1204/configure/router/ospf# **exit**

7. Configure the Foundry Networks AccessIron AR1202

This section covers the configuration of the AR1202 at the branch office site.

Step	Description
1	The following commands access the configuration level and set the system name. AR1202# **config t**
2	Configure the Ethernet interface connected to the G350 Media Gateway. AR1202/configure# **interface ethernet 0** AR1202/configure/interface/ethernet 0# **ip address 50.1.1.254 255.255.255.0** AR1202/configure/interface/ethernet 0# **exit**
3	Configure the T1 interfaces. By default, the T1 interfaces on the AR1202 are configured with **framing** set to *esf*, **linecode** set to *b8zs*, and **clock source** set to *internal*. The default settings are appropriate for the configuration described herein. No additional configuration is required for the physical T1 interfaces.
4	The MLPPP link between on the AR1202 is configured under *interface bundle wan1*. In this example, the WAN interface is configured as MLPPP with a bandwidth of 3.072Mbps using two T1 interfaces. An IP address is also assigned to the interface. AR1202/configure# **interface bundle wan1** AR1202/configure/interface/bundle wan1# **link t1 1** AR1202/configure/interface/bundle wan1# **link t1 2** AR1202/configure/interface/bundle wan1# **encapsulation ppp** AR1202/configure/interface/bundle wan1# **ip address 22.1.1.1 255.255.255.252** Configure the QoS policy for the WAN interface. Three traffic classes are defined, *control* which prioritizes call signaling packets, *voice* which prioritizes audio or RTP packets, and *default* which is used to categorize all other traffic classes. The *default* traffic class is assigned the lowest priority (8) by default. Each traffic class is given a committed rate, a burst rate and a priority. If a traffic class is not transmitting at its committed rate, the other traffic classes may use the remaining bandwidth with the higher priority traffic given precedence. Precedence is defined by the priority assigned to the traffic classes with priority 1 having the highest priority and priority 8 having the lowest priority.

Step	Description
	AR1202/configure/interface/bundle wan1# **qos** AR1202/configure/interface/bundle wan1/qos# **add_class control root-out cr 50 br 3072 priority 2** AR1202/configure/interface/bundle wan1/qos# **add_class voice root-out cr 3000 br 3072 priority 1** AR1202/configure/interface/bundle wan1/qos# **add_class default root-out cr 1 br 3072** Packets with DSCP marking of 34 are classified as *control* traffic. Note that DSCP 34 is displayed as *af41* in the AR1202 configuration. AR1202/configure/interface/bundle wan1/qos# **class control** AR1202/configure/interface/bundle wan1/qos/class control# **add_dscp af41** AR1202/configure/interface/bundle wan1/qos/class control# **exit** Packets with DSCP marking of 46 are classified as *voice* traffic. Note that DSCP 46 is displayed as *ef* in the AR1202 configuration. AR1202/configure/interface/bundle wan1/qos# **class voice** AR1202/configure/interface/bundle wan1/qos/class voice# **add_dscp ef** AR1202/configure/interface/bundle wan1/qos/class voice# **exit** All other DSCP values are classified as *default* (non-prioritized) traffic and given the lowest priority as configured above. AR1202/configure/interface/bundle wan1/qos# **class default** AR1202/configure/interface/bundle wan1/qos/class default# **add_dscp default** AR1202/configure/interface/bundle wan1/qos/class default# **exit** Enable the QoS policy in the outgoing direction. AR1202/configure/interface/bundle wan1/qos# **enable cbq outbound** AR1202/configure/interface/bundle wan1/qos# **exit** AR1202/configure/interface/bundle wan1# **exit**
5	Configure a default static route for routing traffic over the WAN link. AR1202/configure# **ip** AR1202/configure/ip# **route 0.0.0.0 0.0.0.0 22.1.1.2 1** AR1202/configure/ip# **exit**

8. Configure the Avaya P333T-PWR Ethernet Switch

This section provides the VLAN configuration for the Avaya P333T-PWR Ethernet Switches at the corporate site. The native and static VLANs of the Ethernet ports of the Avaya IP Telephones were bound to the data VLAN and voice VLAN, respectively. The Ethernet ports that connected to the data devices, including the DHCP server, were bound to the data VLAN only.

The IP telephones at the corporate site were connected to ports 1 and 2, the data devices and DHCP server were connected to ports 5-8, and the FES 4802 was connected to port 24. 802.1Q trunking was configured on port 24 to the FES 4802. At the corporate site, the voice VLAN was assigned VLAN 100 and the data VLAN was assigned VLAN 101. The configuration below illustrates the VLAN configuration of the P333T at the corporate site. The configuration was performed with a terminal emulator program connected to the console port of the Avaya P333T-PWR Ethernet Switch.

```
P330-1# set port vlan 101 1/1-2,5-8,24
P330-1# set port static-vlan 1/1-2,24 100
P330-1# set trunk 1/24 dot1q
P330-1# set port vlan-binding-mode static-vlan 1/24
```

9. Interoperability Compliance Testing

Interoperability compliance testing covered feature functionality, serviceability, and performance testing. Feature functionality testing focused on the QoS implementation in the Avaya/Foundry Networks configuration. Specifically, compliance testing verified that VoIP media and signaling traffic could be carried together with low priority data traffic on a WAN link while still achieving good voice quality. Prioritization of voice traffic was achieved by implementing DiffServ-based QoS on a MLPPP link. Voice and data traffic were segmented in the enterprise network using VLANs.

The serviceability testing verified that the Foundry Networks and Avaya products recovered from basic adverse conditions, such as rebooting a router and disconnecting cables.

Performance testing was conducted by generating voice calls with a bulk call generator and data traffic with a data traffic generator to simulate a converged network for a prolonged period of time. The bulk call generator was also used to quantify the speech quality of the VoIP calls. At the end of the performance test, it was verified that the network devices continued to operate successfully.

9.1. General Test Approach

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

- LAN/WAN connectivity between the Avaya and Foundry Networks products
- Registration of Avaya IP Telephones with the Avaya Media Servers
- VoIP calls between the corporate site and the branch office site using H.323 signaling groups and IP trunks between the sites
- Inter-office calls using G.711mu-law and G.729, shuffling (i.e. direct IP-IP audio between the IP telephones), and conferencing
- Oversubscribing the WAN links with low priority data traffic and verifying that QoS directed the voice signaling and voice media to the higher priority egress queues based on the packets' DSCP value,

The performance tests were performed with a bulk call generator and data traffic generator running simultaneously. The most important verification step was checking voice quality while transmitting low priority data traffic at the full access rate of the WAN links.

9.2. Test Results

All feature functionality, serviceability, and performance test cases passed. The AccessIron QoS implementation over a MLPPP link yielded good voice quality. The stability of the Avaya/Foundry Networks solution was successfully verified through serviceability and performance tests.

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 AccessIron WAN Access Routers. In general, the verification steps include:

1. Check the status of the WAN link on the AR1204 by entering the **show interface bundle** command. Repeat this step for the AR1202 at the branch office site.

```
AR1204/configure# show interface bundle wan1

bundle wan1
-----------
status                              up
number of links                     2
total bandwidth                     3072 kbps
link restoral type                  automatic
link restoral time                  10

link                speed  bw     inverted  status     diffdelay(msec)
----                -----  --     --------  ------     ---------------
t1 1                64     1536   no        up          0
t1 2                64     1536   no        up          0

encapsulation                       ppp
    mtu                             64-1500-4500
    mru                             64-1500-4500
    mrru                            1500-1524-8192
    sequence                        long
    seg_threshold                   512
    differential delay              128
    discriminator                   22.1.1.2
    minimum_links                   1
    magic_check                     enable

Negotiated ppp bundle values
    negotiated mru                  1500
    negotiated mrru                 1524
    negotiated mtu                  1524

ip info
    ipaddr                          22.1.1.2
    netmask                         255.255.255.252

counters since last boot/clear
    Bytes Rx             1644325391    Bytes Tx             1631110287
    Packets Rx             13605123    Packets Tx             27174016
    Err Packets Rx                0
    Up/Down States                1

counters for the last five minutes
    Bytes Rx              105474061    Bytes Tx              105099131
    Packets Rx               156853    Packets Tx               310123
    Err Packets Rx                0
    Up/Down States                0

RED Configuration
-----------------
Status: Enabled
```

```
Minimum Threshold: 14
Maximum Threshold: 42
Wq Bias Factor  : 5

Current Queue Size = 1, Maximum Queue Size = 31
Current Average Queue Size = 0, Maximum Average Queue Size = 0

RED Statistics
--------------
   Threshold      Below Min   Betn Min-Max      Above Max    Q Overflows
     Allowed              0              0              0              -
     Dropped              0              0              0              0
```

2. Verify IP communication from the WAN router to the following network devices and interfaces by using the **ping** command.

   - Ping the Avaya Media Servers.
   - Ping the Avaya IP telephones registered with the Avaya Media Servers.
   - Ping the C-LAN and IP Media Processor in the Avaya Media Gateways.

3. Verify that the AR1204 is prioritizing voice traffic and dropping data packets when the WAN link becomes saturated. Use the **show qos bundle** command to verify that data packets are dropped, and not voice packets, when the link is congested. Repeat this step for the WAN link on the AR1202 at the branch office site.

```
AR1204/configure# show qos bundle wan1

Interface: Bundle wan1 (Bandwidth = 3072Kbps)

Interface Outbound Configuration & Statistics
---------------------------------------------
CBQ: on  Policing: off  MON: off
+------------------+------+------+------+-------+-------+----------+----------
Traffic Class       CBQ-CR CBQ-BR Police Avg Out  Avg In    Packets    Packets
                    (kbps) (kbps) (kbps)  (kbps)  (kbps)      Fwded    Dropped
+------------------+------+------+------+-------+-------+----------+----------
default                1   3072      -  2991.7  2989.5    8752982   11281421
audio               3000   3072      -       0       0    4614578          0
control               50   3072      -       0       0      32083          0

Interface Inbound Configuration & Statistics
--------------------------------------------
Policing: off  MON: off
```

4. If a WAN router is unable to communicate with any of the aforementioned IP devices and interfaces, check the routing table and status of the Ethernet and WAN interfaces using the **show ip routes** and **show interface** commands.

5. Check that the Avaya IP Telephones have successfully registered using the **list registered-station** command on the SAT of the Avaya Media Servers.

6. Place inter-calls between the IP telephones. If the call cannot be established, check the status of the signaling groups and IP trunks on the media servers.

11. Support

For technical support on Foundry Networks products, contact the Technical Support Center using any of the following options:

- Toll-free: 1-877-TURBOCALL (1-877-887-2622)
- Direct: 408-586-1881
- Email: support@foundrynet.com

12. Conclusion

These Application Notes describe the configuration steps required for integrating the Foundry Networks FastIron Edge Switch 4802 and the AccessIron AR1202/AR1204 into an Avaya IP Telephony infrastructure. The AccessIron WAN Access Routers were responsible for enforcing QoS using DiffServ and achieving good voice quality over the WAN.

13. References

This section references the Avaya and Foundry Networks product documentation that are relevant to these Application Notes. The following Avaya product documentation can be found at http://support.avaya.com.

[1] Administration for Network Connectivity for Avaya Communication Manager, Issue 8, June 2004; Document Number 555-233-504.
[2] Administrator's Guide for Avaya Communication Manager, Issue 8, June 2004; Document Number 555-233-506.
[3] Administration of the Avaya G350 Media Gateway, Issue 2, June 2004; Document Number 555-245-501.

The following Foundry Networks product documentation can be found at http://www.foundrynet.com

[4] Foundry AR-Series Router Configurations Guide, June 2004.
[5] Foundry AR-Series Router Command Reference Guide, June 2004.
[6] Foundry Enterprise Configuration and Management Guide, July 2004.

Please e-mail any questions or comments pertaining to these Application Notes along with the full title name and filename, located in the lower right corner, directly to the Avaya Developer*Connection* Program at devconnect@avaya.com.