



## **Application Notes for Force10 Networks C-Series C300 Switch connected to Avaya Distributed Office in a Converged VoIP and Data Network - Issue 1.0**

### **Abstract**

These Application Notes describe the configuration of a Voice over IP (VoIP) solution using Force10 Networks C-Series C300 Switch connected to Avaya Distributed Office. The Force10 Networks C-Series C300 Switch was compliance-tested with Avaya Distributed Office with emphasis placed on verifying the prioritization of VoIP traffic and voice quality in a 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 Voice over IP (VoIP) solution using Force10 Networks C-Series C300 Switch (Force10 C300 Switch) connected to Avaya Distributed Office. Compliance testing emphasis was placed on verifying the prioritization of VoIP traffic and voice quality in a converged VoIP and data network scenario. 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 the LAN. The Avaya IP telephones get QoS priority settings from Avaya Distributed Office and are enforced in the network by the Force10 C300. To verify VoIP traffic was given priority over data traffic 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. Compliance testing included verifying QoS, throughput, link aggregation, rapid spanning tree, load balancing and Open Shortest Path First (OSPF).

## 2. Hardware Configuration

The configuration in **Figure 1** shows a single site converged VoIP and data network with multiple closets and labs configured with link aggregation, rapid spanning tree, load balancing and OSPF.

For compliance testing, 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. Control Room

The control room consisted of a Force10 C300 Switch, Avaya Distributed Office, one Avaya 9620 IP Telephone, one Avaya 1616 IP Telephone and one Corporate DHCP/File Server. The corporate site provided a DHCP/File Server for assigning IP network parameters and to download settings to the Avaya IP telephones. The Force10 C300 Switch supplied Power over Ethernet PoE r for the Avaya IP Telephones and was configured to support link aggregation, rapid spanning tree, load balancing and OSPF.

### 2.2. Lab-A

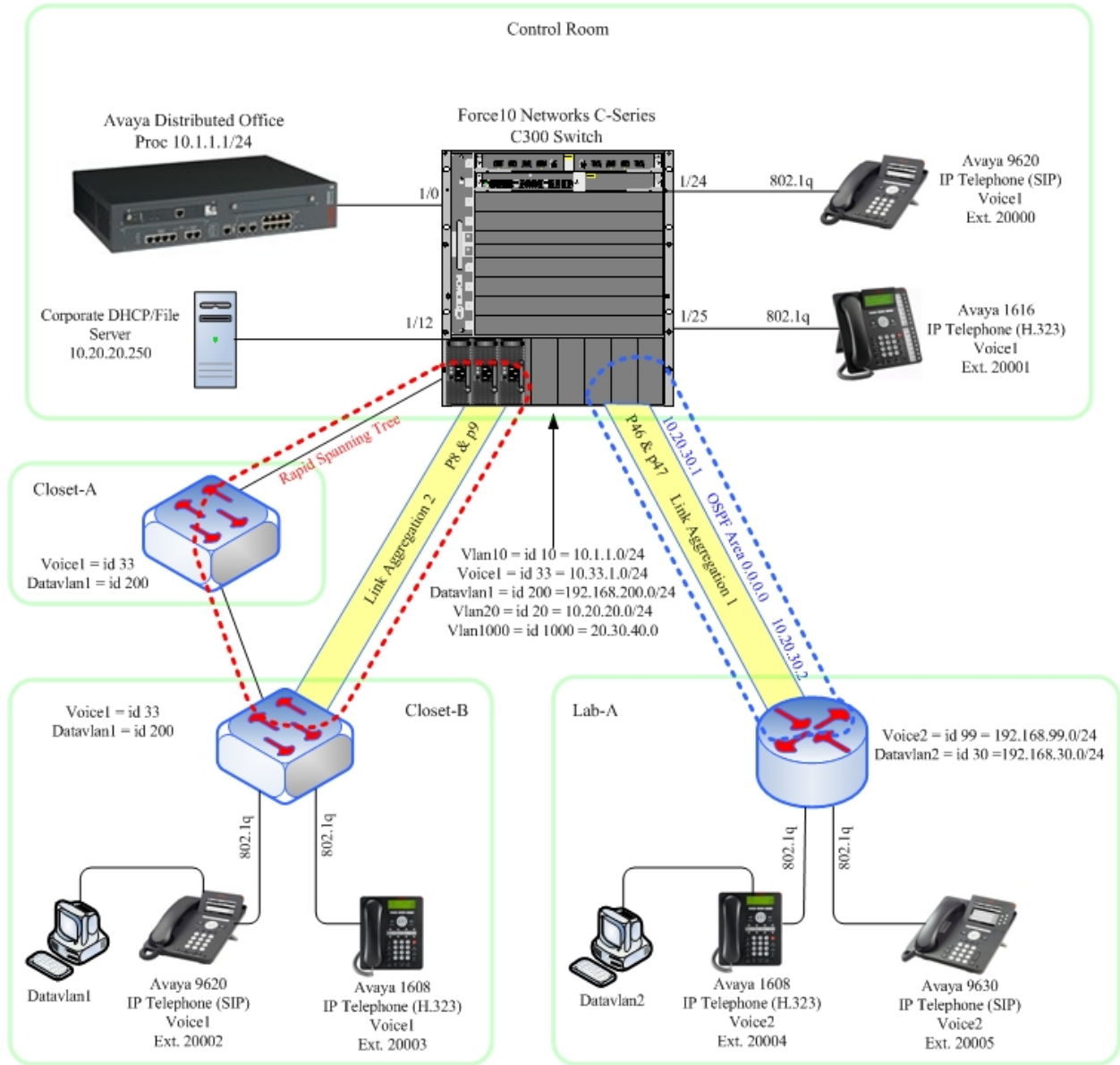
Lab-A consisted of a Layer 3 switch, one Avaya 9630 IP Telephone and one Avaya 1608 IP Telephone on VLAN Voice2 and a PC on Datavlan2. The switch supplied PoE power for the Avaya IP Telephones and was configured to support link aggregation, rapid spanning tree, load balancing and OSPF.

### 2.3. Closet-A

Closet-A consisted of a Layer 2 switch, as an edge switch, that was configured to support VLANs, enforce QoS policies and support rapid spanning tree.

## 2.4. Closet-B

Closet-B consisted of a Layer 2 switch, one Avaya 1608 IP Telephone on VLAN Voice1, one Avaya 9620 IP Telephone on VLAN Voice1 and a PC on VLAN Datavlan1. The Layer 2 switch supplied PoE power for the Avaya IP telephones and was configured to support link aggregation, rapid spanning tree and load balancing.



**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 Distributed Office i20	i20 sw.27.17.1
Avaya Distributed Office AM110	DO AM110 1.1.1_41.03
Avaya 9600 Series IP Telephones	Avaya one-X™ Deskphone SIP 1.2 (SIP)
Avaya 1600 Series IP Telephones	Avaya one-X Value Edition 1.23 (H.323)
Force10 Networks C-Series C300 with LC-CB-GE-48V Line Card	7.5.1.0

### 4. Avaya Distributed Office Configuration

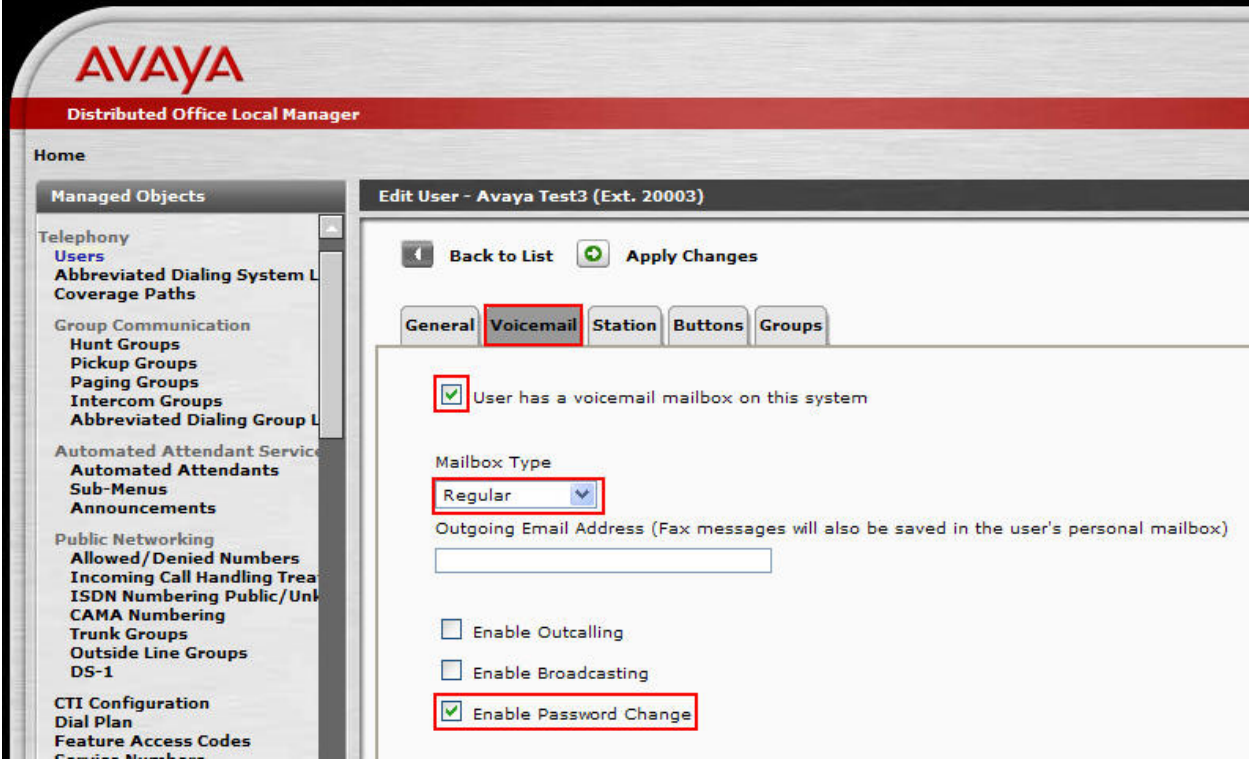
Avaya Distributed Office is administered via a web interface. In the sample network the Avaya Distributed Office was assigned the IP address 10.1.1.1 and the URL <http://10.1.1.1> was used to access the administration interface. For information on how to access and setup a factory default system, refer to **Section 9 [1]**.

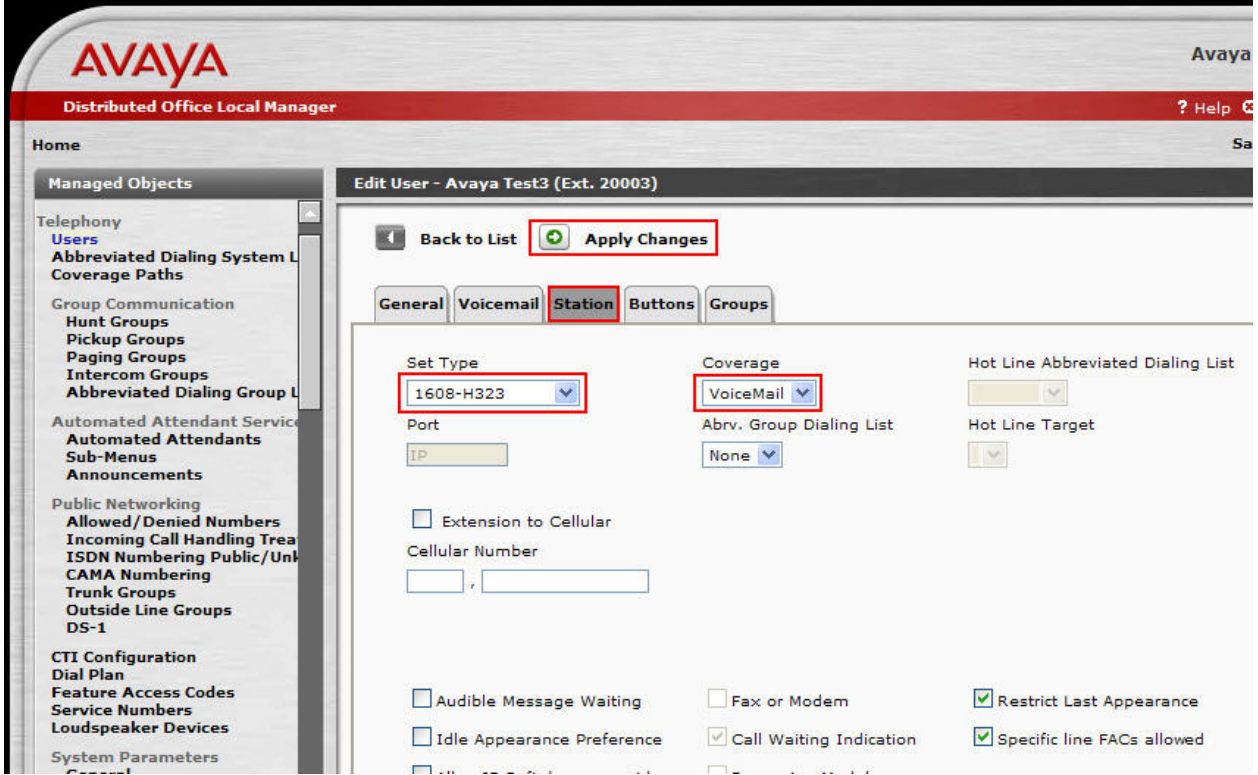
Step	Description
1.	<p>Navigate to the <b>Edit User</b> window by clicking <b>Managed Object</b>→<b>Telephony</b>→<b>Users</b>. Enter the values displayed below and then click <b>Apply Changes</b>. <b>Last Name</b>, <b>First name</b> and <b>Native Name</b> can be any descriptive text that identifies this user. <b>Name (ASCII)</b> may be populated with the same information that is entered in <b>Native Name</b>. <b>Security Code</b> and <b>Confirm Security code</b>. Use the drop-down list for <b>Extension</b> and select any available extension. The remaining parameters were left at the default values.</p>

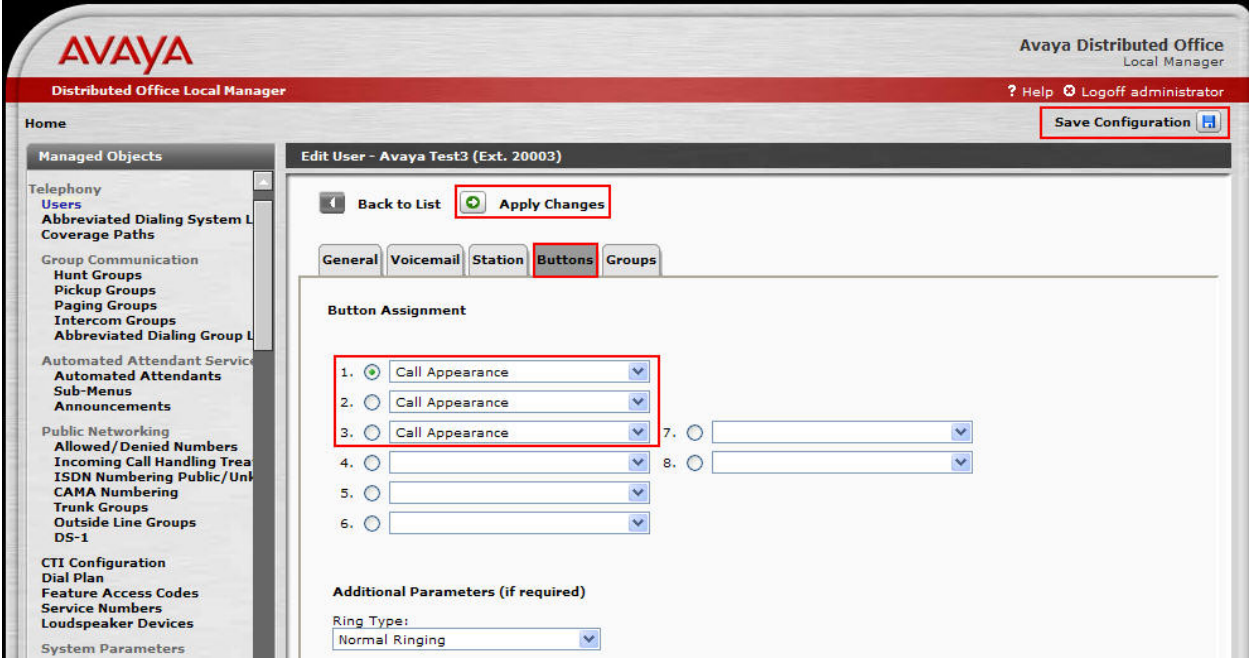
The screenshot shows the Avaya Distributed Office Local Manager interface. The main window is titled "Edit User - (Ext. )". On the left, a sidebar lists "Managed Objects" with "Telephony" and "Users" highlighted. The main content area has tabs for "General", "Voicemail", "Station", "Buttons", and "Groups", with "General" selected. The form contains the following fields:

- Last Name:
- First name:
- Native Name:
- Name (ASCII):
- Extension:  (dropdown menu)
- Security Code:
- Confirm Security Code:
- Preferred Language:  (dropdown menu)
- IM Handle:

Buttons for "Back to List" and "Apply Changes" are visible at the top of the form area.

Step	Description
2.	<p>Navigate to the <b>Voicemail</b> tab by clicking <b>Voicemail</b>. Check the <b>User has a voicemail mailbox on this system</b> and <b>Enable Password Change</b> check boxes. Use the drop-down list for <b>Mailbox Type</b> to select “Regular”.</p> 

Step	Description
3.	<p>Navigate to the <b>Station</b> tab by clicking <b>Station</b>. Use the drop-down list for <b>Set Type</b> to select “1608-H323” and use the drop-down list for <b>Coverage</b> to select “VoiceMail”. The remaining parameters were left at the default values.</p> 

Step	Description
4.	<p>Navigate to the <b>Buttons</b> tab by clicking <b>Buttons</b>. Use the drop list for <b>Button Assignment 1 – 3</b> and select “Call Appearance”. The remaining parameters were left at the default values. Click <b>Apply Changes</b> and then click <b>Save Configuration</b>.</p> <p>Note the user may receive a message indicating the system is busy if <b>Save Configuration</b> is clicked immediately after <b>Apply Changes</b>. If that occurs, simply click <b>Save Configuration</b> after one or two minutes.</p> 
5.	Repeat <b>Steps 1-4</b> for each Avaya IP telephone. Click <b>Apply Changes</b> .

## 5. Configure the Force10 Networks C-Series C300 Switch

This section addresses how to configure the Force10 C300 Switch. The Force10 C300 Switch is used as the core Layer 2/Layer 3 router. The switch enforces QoS policies, link aggregation, OSPF and spanning tree.

To configure the Force10 C300 Switch, connect a PC or laptop to the serial port of the Force10 C300 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 Force10 C300 Switch using the appropriate Login ID and Password.

Login: Password: Force10#
---------------------------------

2. Enable the following features on the Force10 C300 Switch.
  - Enable routing.
  - Enable spanning tree and make the Force10 C300 Switch the root bridge.
  - Create link aggregation trunks Port-Channel 1 and 2. Port-Channel 1 goes to Lab-A and 2 goes to Closet-B.
  - Enable QoS for Differentiated Services.
  - Save the configuration.

```
Force10#configure
Force10(conf)# protocol spanning-tree rstp
Force10(conf-rstp)# no disable
Force10(conf-rstp)# bridge-priority 1
Force10(conf-rstp)# exit
Force10(conf)#
Force10(conf)# interface Port-channel 1
Force10(conf-if-portch) channel-member gi 1/46
Force10(conf-if-portch) channel-member gi 1/47
Force10(conf-if-portch) switchport
Force10(conf-if-portch)exit
Force10(conf)#
Force10(conf)# interface Port-channel 2
Force10(conf-if-portch) channel-member gi 1/8
Force10(conf-if-portch) channel-member gi 1/9
Force10(conf-if-portch) switchport
Force10(conf-if-portch)exit
Force10(conf)#
Force10(conf)# class-map match-any ClassMap05
Force10(conf-class-map)# match ip dscp 46
Force10(conf-class-map)# exit
Force10(conf)#
Force10(conf)# policy-map-input TrustDSCP
Force10(conf-policy-map-in)# service-queue 2 class-map ClassMap05
Force10(conf-policy-map-in)# trust dffserv
Force10(conf-policy-map-in)# exit
Force10(conf)# strict-priority unicast 2
Force10(conf)# exit
Force10#
Force10# write memory
```

3. Create, configure and enable the VLAN for OSPF.

- Assign a VLAN ID for the OSPF VLAN
- Assign ports to the OSPF VLAN
- Assign an IP address for the OSPF VLAN
- Assign OSPF information

```
Forcel0# configure
Forcel0(conf)# interface vlan 1000
Forcel0(conf-if-vl-1000)# ip address 10.20.30.1/24
Forcel0(conf-if-vl-1000)# tagged port-channel 1
Forcel0(conf-if-vl-1000)# exit
Forcel0(conf)# router ospf 1
Forcel0(conf-router_ospf)# network 10.20.30.0/24 area 0.0.0.0
Forcel0(conf-router_ospf)# redistribute connected
Forcel0(conf-router_ospf)# exit
```

4. Create and configure the telephony VLAN that all of the Avaya telephony equipment will run on.

- Assign a VLAN ID for the telephony VLAN
- Assign an IP address for the telephony VLAN
- Assign ports to the telephony VLAN
- Assign a QoS priority to the telephony VLAN

```
Forcel0# configure
Forcel0(conf)# interface vlan 10
Forcel0(conf-if-vl-10)# ip address 10.1.1.254/24
Forcel0(conf-if-vl-10)# exit
Forcel0(conf)# interface gigabitethernet 1/0
Forcel0(conf-if-gi-1/0)# switchport
Forcel0(conf-if-gi-1/0)# spanning-tree rstp edge-port
Forcel0(conf-if-gi-1/0)# service-policy input PolicyMapInput
Forcel0(conf-if-gi-1/0)# no shutdown
Forcel0(conf-if-gi-1/0)# exit
Forcel0(conf)#
Forcel0(conf)# interface vlan 10
Forcel0(conf-if-vl-10)# untagged gigabitethernet 1/0
```

## 5. Create and configure VLAN Voice1

- 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
- Configure voice ports
- Assign spanning tree to voice ports
- Assign a QoS priority to the voice ports
- Assign ports to the voice VLAN

```
Forcel0# configure
Forcel0(conf)# interface vlan 33
Forcel0(conf-if-vl-33)# name Voice1
Forcel0(conf-if-vl-33)# ip address 10.33.1.254/24
Forcel0(conf-if-vl-33)# ip helper-address 10.20.20.250
Forcel0(conf-if-vl-33)# exit
Forcel0(conf)#
Forcel0(conf)# interface gigabitethernet 1/24
Forcel0(conf-if-gi-1/24)# portmode hybrid
Forcel0(conf-if-gi-1/24)# switchport
Forcel0(conf-if-gi-1/24)# power inline auto 15400
Forcel0(conf-if-gi-1/24)# spanning-tree rstp edge-port
Forcel0(conf-if-gi-1/24)# service-policy input TrustDSCP
Forcel0(conf-if-gi-1/24)# no shutdown
Forcel0(conf-if-gi-1/24)# exit
Forcel0(conf)#
Forcel0(conf)# interface gigabitethernet 1/25
Forcel0(conf-if-gi-1/25)# portmode hybrid
Forcel0(conf-if-gi-1/25)# switchport
Forcel0(conf-if-gi-1/25)# power inline auto 15400
Forcel0(conf-if-gi-1/25)# spanning-tree rstp edge-port
Forcel0(conf-if-gi-1/25)# service-policy input TrustDSCP
Forcel0(conf-if-gi-1/25)# no shutdown
Forcel0(conf-if-gi-1/25)# exit
Forcel0(conf)#
Forcel0(conf)# interface vlan 33
Forcel0(conf-if-vl-33)# tagged gig 1/24-25
Forcel0(conf-if-vl-33)# tagged gig port-channel 2
```

6. Create and configure the data VLAN that will run between the control room and closets.
  - 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

```
Forcel10# configure
Forcel10(conf)# interface vlan 200
Forcel10(conf-if-vl-200)# name Datavlan1
Forcel10(conf-if-vl-200)# ip address 192.168.200.254/24
Forcel10(conf-if-vl-200)# ip helper-address 10.20.20.250
Forcel10(conf-if-vl-200)# untagged gig 1/24-25
Forcel10(conf-if-vl-200)# tagged gig port-channel 2
Forcel10(conf-if-vl-200)# exit
```

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

```
Forcel10# configure
Forcel10(conf)# interface vlan 20
Forcel10(conf-if-vl-20)# ip address 10.20.20.1/24
Forcel10(conf-if-vl-20)# exit
Forcel10(conf)# interface gigabitethernet 1/12
Forcel10(conf-if-gi-1/12)# switchport
Forcel10(conf-if-gi-1/12)# no shutdown
Forcel10(conf-if-gi-1/12)# exit
Forcel10(conf)#
Forcel10(conf)# untagged gigabitethernet 1/12
```

8. Save the configuration

```
Forcel10# write memory
```

## 6. Interoperability Compliance Testing

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

Feature functionality testing focused on the QoS and VLAN implementation in the Avaya/Force10 configuration. Specifically, compliance testing verified that when the Force10 Switch interfaces are over subscribed 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.

QoS and performance testing was verified by making voice calls while a traffic generator generated low priority data traffic to simulate a converged network. At the end of the performance test, it was verified that the network devices continued to operate successfully.

Serviceability testing was conducted to verify the ability of the Avaya/Force10 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.

### 6.1. General Test Approach

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

- LAN connectivity between the Avaya and Force10 equipment.
- Registration of Avaya H.323 IP Telephones with Avaya Distributed Office.
- Registration of Avaya SIP IP Telephones with Avaya Distributed Office.
- Verification of the DHCP relay configuration.
- VoIP calls over Layer 2 and Layer 3 connections.
- Calls using conferencing, and sending low priority data traffic over the LAN.
- Verifying that QoS directed the voice signaling and voice media to the higher priority egress queue based on the packet's DSCP value.
- Verifying that voicemail and MWI work properly.

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

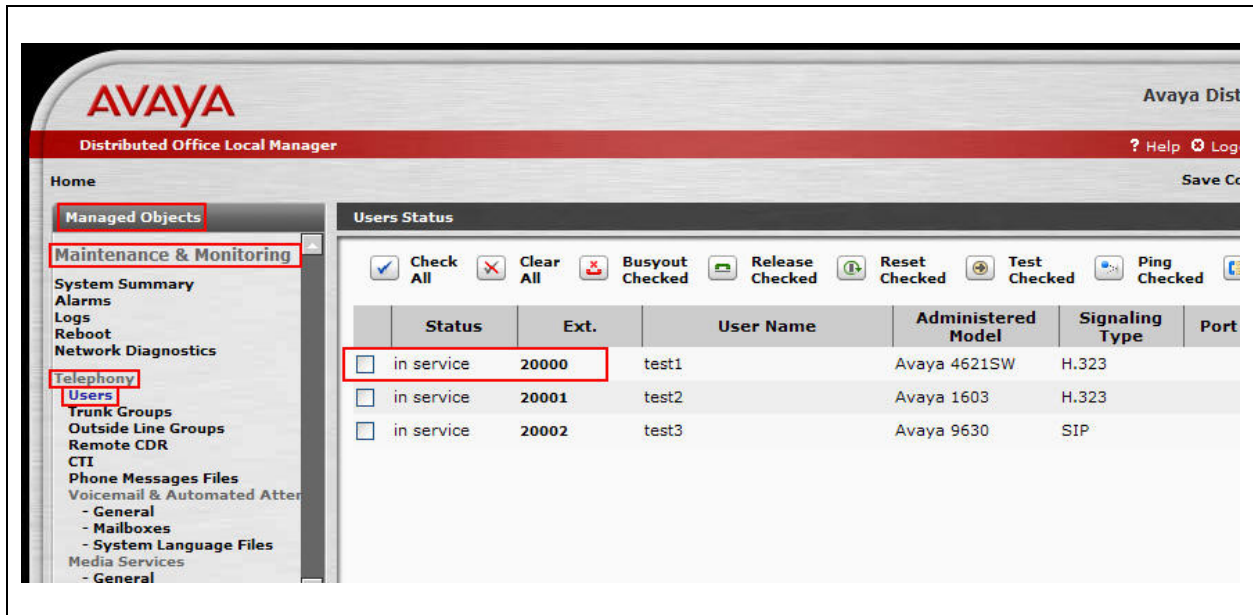
### 6.2. Test Results

All feature functionality, serviceability, and performance test cases passed. The Force10 Networks C-Series C300 Switch implementation did prioritize VoIP traffic and yielded good voice quality with no calls being lost. The stability of the Avaya telephony infrastructure running over the Force10 C300 switch was successfully verified through performance and serviceability testing.

## 7. Verification Steps

This section provides the steps for verifying end-to-end network connectivity and QoS in the field from the perspective of the Force10 C300 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 Force10 C300 switch.
- Place calls between Labs and Closets using each Avaya IP telephone.
- Check that the Avaya IP telephones have successfully registered with Avaya Distributed Office. Log into Avaya Distributed Office using the appropriate credentials, select **Managed Objects** → **Maintenance & Monitoring** → **Telephony** → **Users**, look for **in service**.



## 8. Conclusion

These Application Notes describe the configuration steps required for integrating the Force10 Networks C-Series C300 Switch with an Avaya telephony infrastructure. For the configuration described in these Application Notes, the Force10 C300 Switch was responsible for enforcing QoS using Diffserv and 802.1p as well as link aggregation, rapid spanning tree, load balancing and OSPF. Avaya Distributed Office delivered the voice traffic to the routers for transmission over the LAN together with data traffic. Prioritization of VoIP traffic and good voice quality was successfully achieved in the Avaya/Force10 configuration described herein.

## 9. 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] *Avaya Distributed Office i20 Installation Quick Start*, May 2007 Issue 1, Document Number 03-602289
- [2] *Command Reference Release*, Document Number: 882-10034 Rev 1
- [3] *Configuration Guide*, Document Number: 882-20034 Rev 2
- [4] *Avaya one-X Deskphone Value Edition 1600 Series IP Telephones Installation and Maintenance Guide Release 1*, Doc # 16-601438
- [5] *Avaya one-X Deskphone SIP for 9600 Series IP Telephones Installation and Maintenance Guide Release 1.0*

The following Force10 Networks product documentation can be found at:  
<https://www.force10networks.com/>

- [6] *Force10 Networks C-Series C300 Switch Configuration Guide - 7.5.1.0*
- [7] *Force10 Networks C-Series C300 Switch Command Reference - 7.5.1.0*

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