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Application Notes for Force10 Networks C-Series C300 Switch connected to Avaya Communication Manager, Avaya SIP Enablement Services and Avaya Modular Messaging 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 Communication Manager, Avaya SIP Enablement Services and Avaya Modular Messaging. The Force10 Networks C-Series C300 Switch was compliance-tested with Avaya Communication Manager, Avaya SIP Enablement Services and Avaya Modular Messaging. Emphasis was 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.

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Solution & Interoperability Test Lab Application Notes
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Force10-C300-ACM

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 Communication Manager, Avaya SIP Enablement Services (SES) and Avaya Modular Messaging. 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 Communication Manager and are enforced in the network by the Force10 C300 Switch. 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, Open Shortest Path First (OSPF), Direct IP Media connectivity and the G.711 and G.729 codecs.

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 Communication Manager running on an Avaya S8300 Server with an Avaya G700 Media Gateway, one Avaya SIP Enablement Services, one Avaya Modular Messaging, one Avaya 2410 Digital Telephone, one Avaya 9620 IP Telephone, one Avaya 9620 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) 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 9620 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 rapid spanning tree.

2.4. Closet-B

Closet-B consisted of a Layer 2 switch, one Avaya 9620 IP Telephone and one Avaya 9630 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.
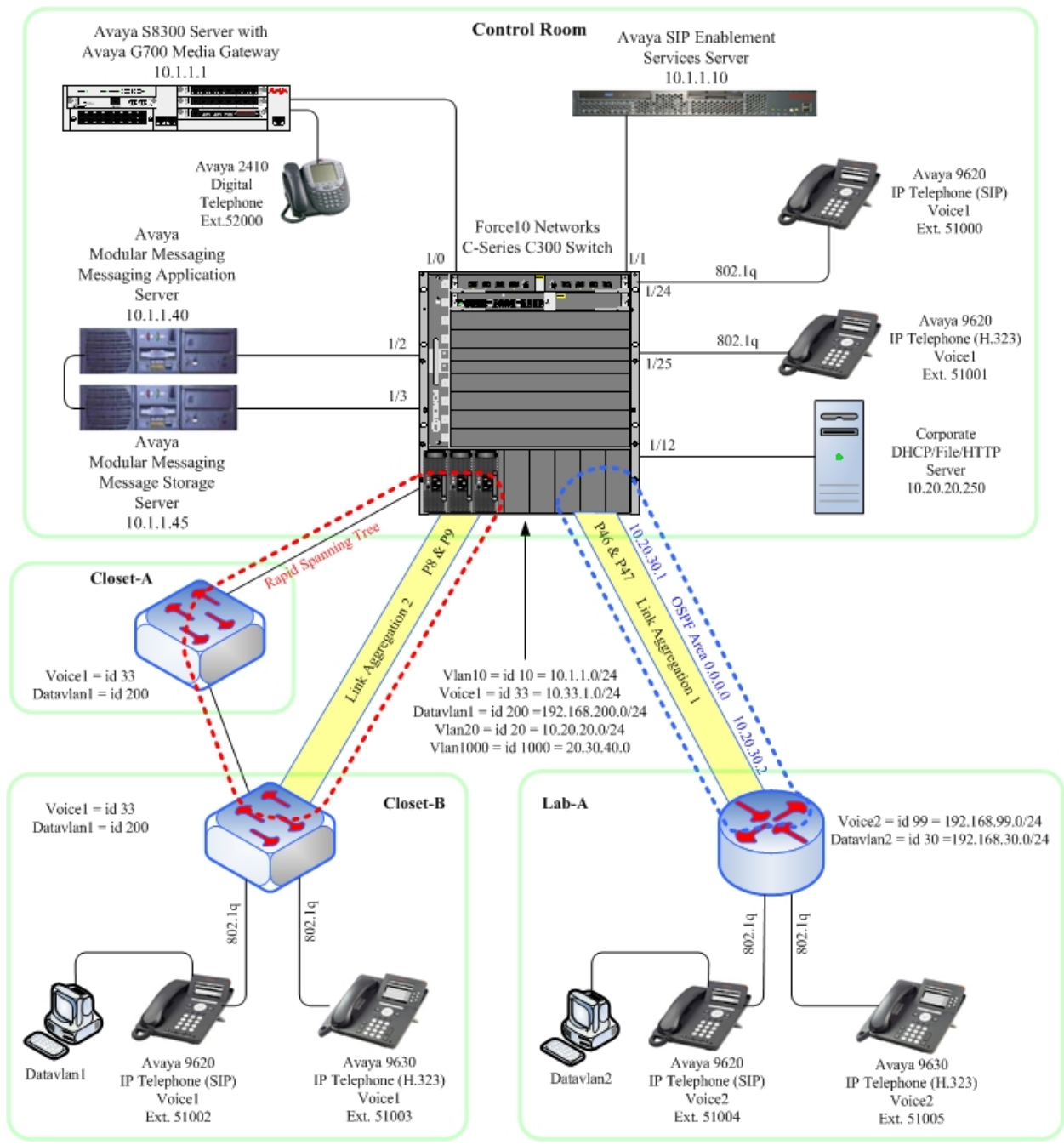
Figure 1: Network Configuration

3. Equipment and Software Validated

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

Equipment	Software/Firmware
Avaya S8300 Server	Avaya Communication Manager R014x.00.1.731.2

Avaya G700 Media Gateway
    MGP
    MM712 DCP Media Module
	
	26.31.0
	FW 008

Avaya Modular Messaging - Messaging Application Server (MAS)	3.1
Avaya Modular Messaging - Message Storage Server (MSS)	3.1
Avaya SIP Enablement Services	SES-4.0.0.0-033.6
Avaya 9600 Series IP Telephones	Avaya one-X™ Deskphone SIP 1.5(SIP)
Avaya 9600 Series IP Telephones	Avaya one-X Deskphone Edition 1.2 (H.323)
Avaya 2410 Digital Telephone	NA
Force10 Networks C-Series C300 with LC-CB-GE-48V Line Card	7.5.1.0

4. Configure Avaya Communication Manager

This section shows the steps used to configure Avaya Communication Manager. For detailed information on the installation, maintenance, and configuration of Avaya Communication Manager, refer to **[1]**.

4.1. Configure QoS on Avaya Communication Manager

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 prioritize VoIP traffic, QoS is utilized and should be implemented throughout the entire network.

In order to achieve prioritization of VoIP traffic, the VoIP traffic must be classified. The Avaya S8300 Server, Avaya G700 Media Gateway, Avaya SIP Enablement Services and Avaya IP telephones support both Layer 2 802.1.p/Q priority and Layer 3 DiffServ.

All network components are in network region 1 for this sample configuration. The DiffServ and 802.1p/Q values configured here will be downloaded to the Avaya H.323 IP telephones via Avaya Communication Manager. Avaya SIP IP telephones will get QoS settings by downloading the 46xxsettings file from the HTTP Server. 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 **Call Control PHB Value** to **46** and **Audio PHB Value** to **46**. Set **Call Control 802.1p Priority** and **Audio 802.1p Priority** to **6**.

```
change ip-network-region 1                                   Page   1 of  19
                              IP NETWORK REGION
  Region: 1
Location:          Authoritative Domain: devcon.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? y
   UDP Port Max: 3027
DIFFSERV/TOS PARAMETERS                      RTCP Reporting Enabled? y
 Call Control PHB Value: 46        RTCP MONITOR SERVER PARAMETERS
       Audio PHB Value: 46          Use Default Server Parameters? y
       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
```

The Differentiated Services Code Point (DSCP) value of 46 is used for both PHB values. DSCP 46 represents the Traffic Class of Premium and the Traffic Type Voice.

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 diffserv
Force10(conf-policy-map-in)# exit
Force10(conf)# strict-priority unicast 2
Force10(conf)# exit
Force10#
Force10(conf)# 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

```
Force10# configure
Force10(conf)# interface vlan 1000
Force10(conf-if-vl-1000)# ip address 10.20.30.1/24
Force10(conf-if-vl-1000)# tagged port-channel 1
Force10(conf-if-vl-1000)# exit
Force10(conf)# router ospf 1
Force10(conf-router_ospf)# network 10.20.30.0/24 area 0.0.0.0
Force10(conf-router_ospf)# redistribute connected
Force10(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

```
Force10# configure
Force10(conf)# interface vlan 10
Force10(conf-if-vl-10)# ip address 10.1.1.254/24
Force10(conf-if-vl-10)# exit
Force10(conf)# interface gigabitethernet 1/0
Force10(conf-if-gi-1/0)# switchport
Force10(conf-if-gi-1/0)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/0)# service-policy input TrustDSCP
Force10(conf-if-gi-1/0)# no shutdown
Force10(conf-if-gi-1/0)# exit
Force10(conf)#
Force10(conf)# interface gigabitethernet 1/1
Force10(conf-if-gi-1/1)# switchport
Force10(conf-if-gi-1/1)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/1)# service-policy input TrustDSCP
Force10(conf-if-gi-1/1)# no shutdown
Force10(conf-if-gi-1/1)# exit
Force10(conf)#
Force10(conf)# interface gigabitethernet 1/2
Force10(conf-if-gi-1/2)# switchport
Force10(conf-if-gi-1/2)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/2)# service-policy input TrustDSCP
Force10(conf-if-gi-1/2)# no shutdown
Force10(conf-if-gi-1/2)# exit
Force10(conf)#
Force10(conf)# interface gigabitethernet 1/3
Force10(conf-if-gi-1/3)# switchport
Force10(conf-if-gi-1/3)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/3)# service-policy input TrustDSCP
Force10(conf-if-gi-1/3)# no shutdown
Force10(conf-if-gi-1/3)# exit
Force10(conf)#
Force10(conf)# interface vlan 10
Force10(conf-if-vl-10)# untagged gigabitethernet 1/0-3
```

5. Create and configure the 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

```
Force10# configure
Force10(conf)# interface vlan 33
Force10(conf-if-vl-33)# name Voice1
Force10(conf-if-vl-33)# ip address 10.33.1.254/24
Force10(conf-if-vl-33)# ip helper-address 10.20.20.250
Force10(conf-if-vl-33)# exit
Force10(conf)#
Force10(conf)# interface gigabitethernet 1/24
Force10(conf-if-gi-1/24)# portmode hybrid
Force10(conf-if-gi-1/24)# switchport
Force10(conf-if-gi-1/24)# power inline auto 15400
Force10(conf-if-gi-1/24)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/24)# service-policy input TrustDSCP
Force10(conf-if-gi-1/24)# no shutdown
Force10(conf-if-gi-1/24)# exit
Force10(conf)#
Force10(conf)# interface gigabitethernet 1/25
Force10(conf-if-gi-1/25)# portmode hybrid
Force10(conf-if-gi-1/25)# switchport
Force10(conf-if-gi-1/25)# power inline auto 15400
Force10(conf-if-gi-1/25)# spanning-tree rstp edge-port
Force10(conf-if-gi-1/25)# service-policy input TrustDSCP
Force10(conf-if-gi-1/25)# no shutdown
Force10(conf-if-gi-1/25)# exit
Force10(conf)#
Force10(conf)# interface vlan 33
Force10(conf-if-vl-33)# tagged gig 1/24-25
Force10(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

```
Force10# configure
Force10(conf)# interface vlan 200
Force10(conf-if-vl-200)# name Datavlan1
Force10(conf-if-vl-200)# ip address 192.168.200.254/24
Force10(conf-if-vl-200)# ip helper-address 10.20.20.250
Force10(conf-if-vl-200)# untagged gig 1/24-25
Force10(conf-if-vl-200)# tagged gig port-channel 2
Force10(conf-if-vl-200)# exit
```

7. Create and configure the VLAN that the DHCP/File/HTTP 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

```
Force10# configure
Force10(conf)# interface vlan 20
Force10(conf-if-vl-20)# ip address 10.20.20.1/24
Force10(conf-if-vl-20)# untagged gigabitethernet 1/12
Force10(conf-if-vl-20)# exit
Force10(conf)# interface gigabitethernet 1/12
Force10(conf-if-gi-1/12)# switchport
Force10(conf-if-gi-1/12)# no shutdown
Force10(conf-if-gi-1/12)# exit
```

8. Save configuration.

```
Force10# 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 Communication Manager.
- Registration of Avaya SIP IP telephones with Avaya SIP Enablement Services.
- Verification of the DHCP relay configuration.
- VoIP calls over Layer 2 and Layer 3 connections.
- Inter-switch calls using G.711 mu-law & G.729 codecs, conferencing, and sending low priority data traffic over the LAN.
- Verifying that QoS directed the voice signaling and voice media to the higher priority egress queue based on the packet's DSCP value.
- Verifying that Avaya Modular Messaging 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/Force10 solution 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:

1. 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.

2. Check that the Avaya IP telephones have successfully registered with Avaya Communication Manager by using the **list registered-ip-stations** command.

3. Place calls between Labs and Closets for each Avaya IP telephone.

8. Conclusion

These Application Notes describe the configuration steps required for integrating Force10 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 Communication Manager 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] *Administrator Guide for Avaya Communication Manager*, February 2007, Issue 3.1, Document Number 03-300509
[2] *Installing and Administering SIP Enablement Services*, March 2007, Issue 2.1, Document Number 03-600768
[3] *Avaya one-X Deskphone Edition for 9600 Series IP Telephones Administrator Guide*
[4] *Messaging Application Server (MAS) Administration Guide* Release 3.1, February 2007
[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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