Support for Multi-VRF

The Virtual Routing and Forwarding (VRF) feature allows Cisco Unified Border Element (CUBE) to have multiple instances of routing and forwarding table to co-exist on the same device at the same time.

With Multi-VRF feature, each interface or subinterface can be associated with a unique VRF.

Note The information in this chapter is specific to Multi-VRF feature beginning in Cisco IOS Release 15.6(2)T. However, there is some information on Voice-VRF feature for the reference purpose only. For detailed information on the Voice-VRF feature, see http://www.cisco.com/c/en/us/td/docs/ios/12_4t/12_4t15/vrfawvgw.html.

Feature Information for VRF

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com/. An account on Cisco.com is not required.

Table 1: Feature Information for VRF

Feature Name	Releases	Feature Information
Support for Voice-VRF (VRF-Aware)	Cisco IOS 12.4(11)XJ	This feature provides support to configure a VRF specific to voice traffic.
Support for Multi-VRF	Cisco IOS 15.6(2)T	This feature allows CUBE to have multiple instances of VRF to co-exist on the same device at the same time. The following commands are introduced: **media-address voice-vrf** *name* **port-range** *min-max*, **show voice vrf**
Enhancement to support up to 54 VRF instances	Cisco IOS 15.6(3)M Cisco IOS XE Denali 16.3.1	This feature enhancement provides support for up to 54 VRFs. Each of the VRFs supports up to 10 different RTP port ranges.
Support for Inbound Dial-peer Matching using VRF-ID	Cisco IOS 15.6(3)M Cisco IOS XE Denali 16.3.1	This feature supports inbound dial-peer matching using VRF ID.

Feature Name	Releases	Feature Information
Support for media flow-around using Multi-VRF	Cisco IOS XE Gibraltar 16.12.2	This feature adds media flow-around support for the following intra-VRF call flows in standalone and high availability scenarios: • Basic Audio Call • Call Hold and Resume • Re-INVITE based Call Transfer • 302 based Call Forward • Fax Pass Through Calls • T.38 Fax Calls With media flow-around using Multi-VRF, only signalling is routed using VRFs and CUBE passes across the media IP and ports which it receives. For detailed information on media flow-around, see Media Path.
Support up to 100 VRF instances	Cisco IOS XE Amsterdam 17.3.1a	This feature enhancement provides support up to 100 VRFs. Each of the VRFs supports up to 10 different RTP port ranges.

Information About Voice-VRF

Support for Voice-VRF (also known as VRF-Aware) was introduced in Cisco IOS Release 12.4(11)XJ to provide support for configuring a VRF specific to voice traffic. Voice-VRF can be configured using **voice vrf** *vrf-name* command. For more information on voice-VRF, see http://www.cisco.com/c/en/us/td/docs/ios/12_4t/12_4t15/vrfawvgw.html.

Information About Multi-VRF

The Multi-VRF feature allows you to configure and maintain more than one instance of routing and forwarding tables within the same CUBE device and segregate voice traffic based on the VRF.

Multi-VRF uses input interfaces to distinguish calls for different VRFs and forms VRF tables by associating with one or more Layer 3 interfaces. Interface can be physical interface (such as FastEthernet ports, Gigabit Ethernet ports) or sub-interface. CUBE supports bridging calls on both intra-VRF and inter-VRF.

Note One physical interface or sub-interface can be associated with one VRF only. One VRF can be associated with multiple interfaces.

As per the Multi-VRF feature, the dial-peer configuration must include the use of the interface bind functionality. This is mandatory. It allows dial-peers to be mapped to a VRF via the interface bind.

The calls received on a dial-peer are processed based on the interface to which it is associated with. The interface is in turn associated with the VRF. So, the calls are processed based on the VRF table associated with that particular interface.

VRF Preference Order

Voice-VRF and Multi-VRF configurations can coexist. The following is the binding preference order for call processing:

Table 2: VRF Preference Order and Recommendations

Preference Order	Bind	Recommendations
1	Dial-peer Bind	—
2	Tenant Bind	Recommended for SIP trunk, especially when CUBE is collocated with Cisco Unified Survivability Remote Site Telephony. If Tenant bind is not configured, Voice-VRF is preferred for SIP trunk.
3	Global Bind	During device reboot, it is recommended to use global bind configuration to handle the early incoming traffic gracefully.
4	Voice-VRF	Recommended for hosted and cloud services configurations when CUBE is collocated with Cisco Unified Survivability Remote Site Telephony.

Restrictions

- Supports only SIP-SIP calls.
- Cisco Unified Communications Manager Express (Unified CME) and CUBE co-located with VRF is not supported.
- Cisco Unified Survivability Remote Site Telephony (Unified SRST) and CUBE co-location is not supported on releases before Cisco IOS XE Fuji 16.7.1.
- IPv6 on VRF is not supported.

- SDP pass-through is not supported on releases before Cisco IOS Release 15.6(3)M and Cisco IOS XE Denali 16.3.1.
- Calls are not supported when incoming dial-peer matched is default dial-peer (dial-peer 0).
- Media Anti-trombone is not supported with VRF.
- Cisco UC Services API with VRF is not supported.
- Multi-VRF is not supported on TDM-SIP gateway.
- VRF aware matching is applicable only for inbound dial-peer matching and not for outbound dial-peer matching.
- Invoking TCL scripts through a dial-peer is not supported with the Multi-VRF.
- Multi-VRF using global routing table or default routing table (VRF 0) with virtual interfaces is not supported on ISR-G2 (2900 and 3900 series) routers.
- SCCP-based media resources are not supported with VRF.
- Multi-VRF configured in media flow-around mode is supported only for intra-VRF calls. The following are not supported with Multi-VRF configured in media flow-around mode:
  - Supplementary services with REFER Consume, Mid-call (or Early Dialogue) block
  - Session Description Protocol (SDP) Passthrough
  - Media Recording
  - DSP flows (DTMF, transcode)

Recommendations

- For new deployments, we recommend a reboot of the router once all VRFs' are configured under interfaces.
- No VRF Route leaks are required on CUBE to bridge VoIP calls across different VRFs.
- High Availability(HA) with VRF is supported where VRF IDs are check-pointed in the event of fail-over. Ensure that same VRF configuration exists in both the HA boxes.
- Whenever destination server group is used with VRF, ensure that the server group should have the session targets, belonging to the same network as that of sip bind on the dial-peer, where the server-group is configured. This is because, dial-peer bind is mandatory with VRF and only one sip bind can be configured on any given dial-peer.
- If there are no VRF configuration changes at interface level, then reload of the router is not required.

Configuring VRF

Note We recommend you NOT to modify VRF settings on the interfaces in a live network as it requires CUBE reload to resume VRF functionality.

This section provides the generic configuration steps for creating a VRF. For detailed configuration steps specific to your network scenario (Multi-VRF and Multi-VRF with HA), refer to Configuration Examples section.

Note You can also use the latest configuration option, which allows creation of multiprotocol VRFs that support both IPv4 and IPv6. Entering the command **vrf definition** *vrf-name* creates the multiprotocol VRF. Under VRF definition submode, you can use the command **address-family** *{ipv4 | ipv6}* to specify appropriate address family. To associate the VRF with an interface, use the command **vrf forwarding** *vrf-name* under the interface configuration submode.

For more information about the **vrf definition** and **vrf forwarding** commands, refer to the Cisco IOS Easy Virtual Network Command Reference Guide.

Create a VRF

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip vrf** *vrf-name*
4. **rd** *route-distinguisher*
5. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip vrf** *vrf-name* **Example:** `Device(config)# ip vrf VRF1`	Creates a VRF with the specified name. In the example, VRF name is VRF1. **Note** Space is not allowed in VRF name.
Step 4	**rd** *route-distinguisher* **Example:** `Device(config)# rd 1:1`	Creates a VRF table by specifying a route distinguisher. Enter either an AS number and an arbitrary number (xxx:y) or an IP address and arbitrary number (A.B.C.D:y)
Step 5	**exit** **Example:** `Device(config)# exit`	Exits present mode.

Assign Interface to VRF

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es) removed due to
enabling VRF VRF1
```

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface***interface-name*
4. **ip vrf forwarding** *vrf-name*
5. **ip address** *ip address subnet mask*
6. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface***interface-name* **Example:** `Device(config)# interface GigabitEthernet 0/1`	Enters the interface configuration mode.
Step 4	**ip vrf forwarding** *vrf-name* **Example:** `Device(config-if)# ip vrf forwarding VRF1`	Associates VRF with the interface. **Note** If there is an IP address associated with the interface, it will be cleared and you will be prompted to assign the IP address again.
Step 5	**ip address** *ip address subnet mask* **Example:** `Device(config-if)# ip address 10.0.0.1 255.255.255.0`	IP address is assigned to the interface.
Step 6	**exit** **Example:** `Device(config-if)# exit`	Exits present mode.

Create Dial-peers

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **dial-peer voice** *number* **voip**
4. **session protocol** *protocol*
5. Create dial-peer:
   - To create inbound dial-peer:

     incoming called number *number*
   - To create outbound dial-peer:

     destination pattern *number*
6. **codec** *codec-name*
7. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**dial-peer voice** *number* **voip** **Example:** `Device(config)# dial-peer voice 1111 voip`	Creates the dial-peer with the specified number.
Step 4	**session protocol** *protocol* **Example:** `Device(config-dial-peer)# session protocol sipv2`	Specifies the protocol associated with the dial-peer.

Step 5	Create dial-peer:
	• To create inbound dial-peer:
	incoming called number *number*
	• To create outbound dial-peer:
	destination pattern *number*
	Example:
	Inbound dial-peer:
	`Device(config-dial-peer)# incoming called-number 1111`
	Example:
	Outbound dial-peer:
	`Device(config-dial-peer)# destination pattern 3333`
		Creates inbound and outbound dial-peer.

Step 6	**codec** *codec-name* **Example:** `Device(config-dial-peer)# codec g711ulaw`	Specifies the codec associated with this dial-peer.

	Command or Action	Purpose
Step 7	**exit** **Example:** `Device(config-dial-peer)# exit`	Exits present mode.

Bind Dial-peers

You can configure SIP binding at global level as well as at dial-peer level.

- Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error
- Whenever global sip bind interface associated with a VRF is added,modified, or removed, you should restart the sip services under 'voice service voip > sip' mode so that the change in global sip bind comes into effect with associated VRF ID.

```
CUBE(config)# voice service voip
CUBE(conf-voi-serv)# sip
CUBE(conf-serv-sip)# call service stop
CUBE(conf-serv-sip)# no call service stop
CUBE(conf-serv-sip)# end
```

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Bind control and media to the interface
   - At dial-peer level:

     dial-peer voice *number* **voip**

     voice-class sip bind control source-interface *interface-name*

     voice-class sip bind media source-interface *interface-name*
   - At global configuration level

     voice service voip

     sip

     bind control source-interface *interface-name*

     bind media source-interface *interface-name*
4. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Bind control and media to the interface
	• At dial-peer level:
	dial-peer voice *number* **voip**
	voice-class sip bind control source-interface *interface-name*
	voice-class sip bind media source-interface *interface-name*
	• At global configuration level
	voice service voip
	sip
	bind control source-interface *interface-name*
	bind media source-interface *interface-name*
	Example:
	At dial-peer level:
	`Device(config)#dial-peer voice 1111 voip`
	`Device(config-dial-peer)# voice-class sip bind control`
	`source-interface GigabitEthernet0/1`
	`Device(config-dial-peer)# voice-class sip bind media`
	`source-interface GigabitEthernet0/1`
	Example:
	At global configuration level:
	`Device(config)# voice service voip`
	`Device(conf-voi-serv)# sip`
	`Device(conf-voi-sip)# bind control source-interface GigabitEthernet0/1`
	`Device(conf-voi-sip)# bind media source-interface`
		Interface bind associates VRF to the specified dial-peer.

	Command or Action	Purpose
	`GigabitEthernet0/1`	
Step 4	**exit** **Example:** `Device(config-dial-peer)# exit`	Exits present mode.

Configure VRF-Specific RTP Port Ranges

You can configure each VRF to have its own set of RTP port range for VoIP RTP connections under **voice service voip**. A maximum of ten VRF port ranges are supported. Different VRFs can have overlapping RTP port range. VRF-based RTP port range limits (min, max port numbers) are same as global RTP port range. All three port ranges (global, media-address, VRF based) can coexist on CUBE and the preference order of RTP port allocation is as follows:

- VRF-based port range
- Media-address based port range
- Global RTP port range

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **voice service voip**
4. **media-address voice-vrf** *vrf-name* **port-range** *min max*
5. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**voice service voip** **Example:** `Device(config)# voice service voip`	Enters **voice service voip** mode.

	Command or Action	Purpose

Step 4	**media-address voice-vrf** *vrf-name* **port-range** *min max*
	Example:
	`conf-voi-serv)#media-address voice-vrf VRF1-Dec-15`
	`cfg-media-addr-vrf)#port-range 9112 9118`
	The second line in this example is punt range. Punt range configuration helps to stop relaying media packets to control plane on the specified ports. If you need both punt range and port range, configure the port range inline with VRF and also in the second line.
	Example:
	Example 1
	`Device(conf-voi-serv)#media-address voice-vrf VRF1 port 16000 32000`
	`The output:`
	`Device# show run | section voice`
	`voice-card 0/3`
	`dsp services dspfarm`
	`voice service voip`
	`no ip address trusted authenticate`
	`media-address voice-vrf VRF1 port 16000 32000`
	`*Here, the port-range is configured on the same line as the media address.*`
	Example:
	Example 2
	CUBE supports up to 100 VRFs. Hence, you can configure up to 100 media address instances, that is, one instance per **voice-vrf**. This configuration is subject to the maximum number of VRFs supported by the host platform.
	`Device(conf-voi-serv)#`
	`media-address voice-vrf VRF1 port-range 8000 48000`
	`media-address voice-vrf VRF2 port-range 8000 48000`
	`.....`
	`.....`
	`media-address voice-vrf VRF99 port-range 8000 48000`
	`media-address voice-vrf VRF100 port-range 8000 48000`
		Associates the RTP Port range with the VRF.
		If the RTP port range is not configured per each VRF, the default RTP port range is used across the VRFs used. You can configure up to ten port ranges per media address.
		The default port range is **8000-48198** for ASR and ISR G3 platforms, and **16384-32766** for Cisco ISR G2 platforms.
		Note
		• The port range must be configured on the same line as the media address. The port ranges configured using a second line on outgoing dial peer are not supported.
		• From Cisco IOS XE Amsterdam 17.3.1a onwards, you can configure 100 VRFs for up to 10 different RTP port ranges (that is, 10 different port ranges per each VRF).

Step 5	**exit** **Example:** `Device(conf-voi-serv)# exit`	Exits present mode.

Example: VRF with overlapping and non-overlapping RTP Port Range

Example 1 - Non-overlapping Port Range

The following is example shows two VRFs with non-overlapping RTP port range:

```
Device(conf)# voice service voip
Device(conf-voi-serv)# no ip address trusted authenticate
Device(conf-voi-serv)# media bulk-stats
Device(conf-voi-serv)# media-address voice-vrf vrf1 port-range 25000 28000
Device(conf-voi-serv)# media-address voice-vrf vrf2 port-range 29000 32000
Device(conf-voi-serv)# allow-connections sip to sip
Device(conf-voi-serv)# redundancy-group 1
Device(conf-voi-serv)# sip
```

The output for command **show voip rtp connections** shows as follows:

```
Device# show voip rtp connections

 VoIP RTP Port Usage Information:
Max Ports Available: 23001, Ports Reserved: 101, Ports in Use: 2
                                                        Min   Max   Ports     Ports
Ports
Media-Address Range                     Port  Port  Available Reserved  In-use
-------------------------------------------------------------------------------
Global Media Pool                       8000  48198 19999     101       0
VRF ID Based Media Pool
-------------------------------------------------------------------------------
vrf1                                    25000 28000 1501      0         1
vrf2                                    29000 32000 1501      0         1
-------------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId  LocalRTP    RmtRTP   LocalIP         RemoteIP      MPSS     VRF
1     1001       1002       25000      16400    10.0.0.1       10.0.0.2       NO      vrf1

2     1002       1001       29000      16392    11.0.0.1       11.0.0.2       NO      vrf2

Found 2 active RTP connections
```

In the above output, you can observe that for both the VRF's having non-overlapping rtp port ranges, the local RTP port allocated for vrf1 and vrf2 are different.

Example 2 - Overlapping Port Range

The following is example shows two VRFs with overlapping RTP port range:

```
Device(conf)# voice service voip
Device(conf-voi-serv)# no ip address trusted authenticate
Device(conf-voi-serv)# media bulk-stats
Device(conf-voi-serv)# media-address voice-vrf vrf1 port-range 25000 28000
Device(conf-voi-serv)# media-address voice-vrf vrf2 port-range 25000 28000
Device(conf-voi-serv)# allow-connections sip to sip
Device(conf-voi-serv)# redundancy-group 1
Device(conf-voi-serv)# sip
```

The output for command **show voip rtp connections** shows as follows:

```
Device# show voip rtp connections

 VoIP RTP Port Usage Information:
Max Ports Available: 23001, Ports Reserved: 101, Ports in Use: 2
                                                        Min   Max   Ports     Ports
Ports
Media-Address Range                     Port  Port  Available Reserved  In-use
```

```
-------------------------------------------------------------------------------
Global Media Pool                          8000  48198 19999     101       0
VRF ID Based Media Pool
-------------------------------------------------------------------------------
vrf1                                       25000 28000 1501      0         1
vrf2                                       25000 28000 1501      0         1
-------------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId  LocalRTP    RmtRTP      LocalIP      RemoteIP       MPSS     VRF

1     1001       1002       25000      16400      10.0.0.1     10.0.0.2        NO      vrf1

2     1002       1001       25000      16392      11.0.0.1     11.0.0.2        NO      vrf2

Found 2 active RTP connections
```

In the above output, you can observe that for both the VRF's having overlapping rtp port ranges, the local RTP port allocated for vrf1 and vrf2 is same.

Directory Number (DN) Overlap across Multiple-VRFs

CUBE has the capability to bridge calls across VRFs without the need for route leaks to be configured.

If multiple dial-peers on two different VRFs have the same destination-pattern and preference, CUBE will randomly choose a dial-peer and route the call using the session target of the selected dial-peer. Due to this, the call intended for one VRF may be routed to another VRF.

Dial-peer group feature allows you to route calls within the same VRF and not across VRFs. Configuring dial-peer group, routes the call to a specific VRF even if multiple dial-peers on two different VRFs have the same destination-pattern and preference.

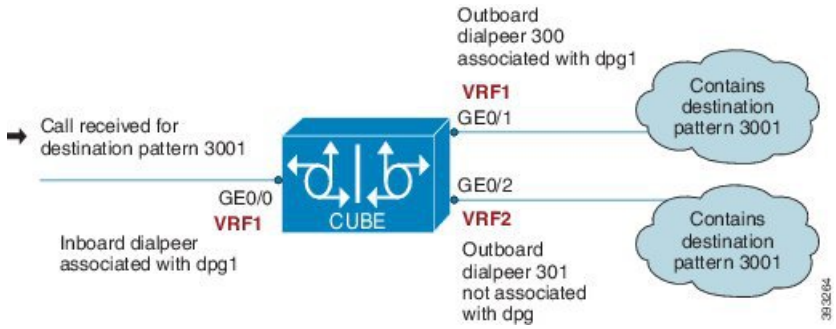
To use dial-peer group feature, configure dial-peers such that there is a unique inbound dial-peer match for calls related to each VRF. Configuring dial-peer group, limits the outbound dial-peer search within the VRF.

Example: Associating Dial-peer Groups to Overcome DN Overlap

If a call is received on VRF1 and there are two dial-peers with same destination-pattern (one dial-peer bind to VRF1 and second dial-peer bind to VRF2), then by default, CUBE picks the VRF in random to route the call.

If you intended to route this call only to VRF1 dial-peer, then dial-peer group can be applied on inbound dial-peer which will restrict the CUBE to route the call only across the dial-peers within the dial-peer group and not pick a dial-peer bind to a different VRF.

Figure 1: Associating Dial-peer Group to overcome DN overlap



The following scenario is considered in the below example:

- VRF1 associated with Gigabitethernt Interface 0/0 and 0/1
- VRF 2 associated with Gigabitethernet Inetrface 0/2
- Dial-peer Group: dpg1
- VRF1 is associated with dial-peer group - dpg 1
- Outbound dial-peer 300 is selected as preference 1
- Inbound dial-peer 3000 associated with VRF 1 and dial-peer group 1 (dpg1)
- Outbound Dial-peer: 300 – destination pattern “3001” associated with VRF1
- Outbound dial-peer: 301 – destination pattern “3001” associated with VRF2

Configure a dial-peer group and set the outbound dial-peer preference.

```
Device# enable
Device# configure terminal
Device(config)# voice class dpg 1
Device(voice-class)# dial-peer 300 preference 1
```

Create inbound dial-peer and associated with dial-peer group 1 (dpg1)

```
Device(config)# dial-peer voice 3000 voip
Device(config-dial-peer)# video codec h264
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session transport udp

Device(config-dial-peer)# destination dpg 1
Device(config-dial-peer)# incoming called-number 3001
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1

Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/1
Device(config-dial-peer)# dtmf-relay sip-kpml
Device(config-dial-peer)# srtp fallback
Device(config-dial-peer)# codec g711ulaw
```

Creating outbound dial-peer with destination pattern ‘3001’ associated with VRF1.

```
Device(config)# dial-peer voice 300 voip
Device(config-dial-peer)# destination-pattern 3001
Device(config-dial-peer)# video codec h264
```

```
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:10.0.0.1
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/1
Device(config-dial-peer)# dtmf-relay sip-kpml
Device(config-dial-peer)# codec g711ulaw
```

Creating outbound dial-peer with destination pattern ‘3001’ associated with VRF2.

```
Device(config)# dial-peer voice 301 voip
Device(config-dial-peer)# destination-pattern 3001
Device(config-dial-peer)# video codec h264
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:11.0.0.1
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/2
Device(config-dial-peer)# dtmf-relay sip-kpml
Device(config-dial-peer)# codec g711ulaw
```

With above dial-peer group configuration, whenever dial-peer “3000” is matched as inbound dial-peer, CUBE will always route call using dial-peer “300” (VRF1). Without dial-peer group, CUBE would have picked dial-peers “300”(VRF1) and “301”(VRF2) in random to route the call.

```
Device# show vrf brief
  Name                   Default RD              Protocols   Interfaces
  VRF1                      1:1                      ipv4         Gi0/0
                                                                  Gi0/1
  VRF2                      2:2                      ipv4         Gi0/2
```

```
Device# show dial-peer voice summary
dial-peer hunt 0
                    AD                          PRE  PASS                      OUT
TAG    TYPE  MIN  OPER PREFIX DEST-PATTERN  FER  THRU      SESS-TARGET    STAT PORT
KEEPALIVE    VRF
3000   voip   up     up                       0     syst
         VRF1
300    voip   up     up         3001          0     syst   ipv4: 10.0.0.1
         VRF1
301    voip   up                3001          0     syst   ipv4: 11.0.0.1
         VRF2
```

IP Overlap with VRF

Generally, on a router, two interfaces cannot be configured with the same IP address. With the VRF feature, you can configure two or more interfaces with the same IP address because, each interface having the same IP address belongs to a unique VRF and hence belongs to a different routing domain. However, for successful call processing, you must ensure that appropriate call routing protocols are configured on the VRFs.

The following is a sample configuration:

Configure Gigabit Ethernet 0/0 that belongs to VRF1 with IP address 10.0.0.0.

```
Device# enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# exit
```

```
Device> enable
Device# configure terminal
Device(config)# interface GigabitEthernet0/0
Device(config-if)# ip vrf forwarding VRF1
Device(config-if)# ip address 10.0.0.0 255.255.255.0
Device(config-if)# speed auto
Device(config-if)# exit
```

Configure Gigabit Ethernet 0/1 that belongs to VRF2 with IP address 10.0.0.0.

```
Device# enable
Device# configure terminal
Device(config)# ip vrf VRF2
Device(config)# rd 1:1
Device(config)# exit
```

```
Device> enable
Device# configure terminal
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF2
Device(config-if)# ip address 10.0.0.0 255.255.255.0
Device(config-if)# speed auto
Device(config-if)# exit
```

For call routing on VRF1 and VRF2, ensure that appropriate routing entries are configured for both VRF1 and VRF2.

Note The above configurations are specific to VRF support only. For call routing, appropriate routing protocols must be configured in the network.

Even though Gigabit Ethernet 0/0 and Gigabit Ethernet 0/1 have an overlapping IP address, the call processing is not overlapped as they belong to different VRFs.

show ip interface brief command shows that GigabitEthernet 0/0 and GigabitEthernet 0/1 have an overlapping IP address:

```
Device# show ip interface brief
Interface                  IP-Address      OK? Method Status           Protocol
Embedded-Service-Engine0/0 unassigned      YES NVRAM  administratively down down
GigabitEthernet0/0         10.0.0.0        YES NVRAM  up                    up
GigabitEthernet0/1         10.0.0.0        YES NVRAM  up                    up
GigabitEthernet0/1.1       unassigned      YES NVRAM  up                    up
GigabitEthernet0/2         unassigned      YES NVRAM  up                    up
```

show voip rtp connections command shows a video call that is established on CUBE across different interfaces belonging to different VRFs having Overlap IP address:

```
Device# show voip rtp connections
VoIP RTP Port Usage Information:
Max Ports Available: 11700, Ports Reserved: 303, Ports in Use: 4
                                       Min   Max   Ports     Ports     Ports
Media-Address Range                    Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                      20000 22000 900       101       0

VRF ID Based Media Pool
-----------------------------------------------------------------------------
```

```
POD2                                    30002 32000 1000      0         0
POD1                                    20000 30000 4900      101       2
POD3                                    20000 30000 4900      101       2
-------------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId  LocalRTP RmtRTP   LocalIP    RemoteIP   MPSS  VRF
1     37         39         20000    18164  10.0.0.0   11.0.0.3   NO    VRF1
2     38         40         20002    18166  10.0.0.0   11.0.0.3   NO    VRF1
3     39         37         20002    16388  10.0.0.0   11.0.0.3   NO    VRF2
4     40         38         20000    16390  10.0.0.0   11.0.0.3   NO    VRF2
Found 4 active RTP connections
```

Using Server Groups with VRF

Whenever destination server group is used with VRF, ensure that the server group should have the session targets, belonging to the same network as that of sip bind on the dial-peer, where the server-group is configured. This is because the dial-peer bind is mandatory with VRF and only one sip bind can be configured on any given dial-peer.

The following scenario is considered in the below example:

Interfaces and associated IP address

- GigabitEthernet0/0/2 12.0.0.1
- GigabitEthernet0/0/1 11.0.0.1

```
Device# show ip interface brief
Interface              IP-Address  OK?   Method   Status            Protocol
GigabitEthernet0/0/0   10.0.0.1     YES  NVRAM     up                  up
GigabitEthernet0/0/1   11.0.0.1     YES  NVRAM     up                  up
GigabitEthernet0/0/2   12.0.0.1     YES  NVRAM     up                  up
```

- dial-peer 200 is bind to GigabitEthernet0/0/1
- server-group 1 (belonging to VRF1) is applied to dial-peer 200

```
Device(config)# dial-peer voice 200 voip
Device(config-dialpeer)# destination-pattern 4.....
Device(config-dialpeer)# session protocol sipv2
Device(config-dialpeer)# session transport udp
Device(config-dialpeer)# session server-group 1
Device(config-dialpeer)# voice-class sip bind control source-interface GigabitEthernet0/0/1
Device(config-dialpeer)# voice-class sip bind media source-interface GigabitEthernet0/0/1
Device(config-dialpeer)# codec g711ulaw
```

As dial-peer 200 is bind to GigabitEthernet0/0/1 , the session targets configured in the “server-group 1” should belong to the network which is reachable by the bind source interface GigabitEthernet0/0/1 as shown below:

```
Device(config)# voice class server-group 1
 Device(config-class)# ipv4 11.0.0.22
 Device(config-class)# ipv4 11.0.0.8 preference 2
```

Inbound Dial-Peer Matching Based on Multi-VRF

From Cisco IOS Release 15.6(3)M and Cisco IOS XE Denali 16.3.1 onwards, dial-peer matching is done based on the VRF ID associated with a particular interface.

Example: Inbound Dial-Peer Matching based on Multi-VRF

Prior to Cisco IOS 15.6(3)M and Cisco IOS XE Denali 16.3.1 releases, when an incoming out-of-dialog message such as INVITE, REGISTER, OPTIONS, NOTIFY, and so on are received on a particular VRF bound interface, inbound dial-peer matching was done using the complete set of inbound dial-peers regardless of the VRF association. The response would be sent based on this matched dial-peer. Since the inbound dial-peer selected could have a different VRF bound to it, the response was sent to the wrong VRF.

To overcome this issue, the inbound dial-peers are filtered based on the incoming VRF and then followed by the regular inbound dial-peer matching. Now, the response is sent to the same VRF on which the request was received.

Consider the following configuration example output to understand the inbound dial-peer matching criteria used in multi-VRF:

```
interface GigabitEthernet0/0
ip address 8.39.18.37 255.255.0.0
duplex auto
ip vrf forwarding VRF ID1
speed auto

interface GigabitEthernet0/1
ip address 9.39.18.55 255.255.0.0
duplex auto
ip vrf forwarding VRF ID2
speed auto

interface GigabitEthernet0/2
ip address 10.39.18.68 255.255.0.0
duplex auto
ip vrf forwarding VRF ID3
speed auto


dial-peer voice 1000 voip
description "Inbound dial-peer bound to VRF ID2"
session protocol sipv2
session target sip-server
session transport udp
incoming called-number 5678
voice-class sip bind control source-interface GigabitEthernet0/1
voice-class sip bind media source-interface GigabitEthernet0/1
codec g711ulaw


dial-peer voice 2000 voip
description "Inbound dial-peer bound to VRF ID1"
session protocol sipv2
session target sip-server
session transport udp
incoming called-number 5678
voice-class sip bind control source-interface GigabitEthernet0/0
voice-class sip bind media source-interface GigabitEthernet0/0
```

```
codec g711ulaw


dial-peer voice 3000 voip
description "Inbound dial-peer bound to VRF ID3"
session protocol sipv2
session target sip-server
session transport udp
incoming called-number 8000
voice-class sip bind control source-interface GigabitEthernet0/2
voice-class sip bind media source-interface GigabitEthernet0/2
codec g711ulaw


dial-peer voice 4000 voip
description "Inbound dial-peer bound to VRF ID1"
session protocol sipv2
session target sip-server
session transport udp
incoming called-number 2000
voice-class sip bind control source-interface GigabitEthernet0/0
voice-class sip bind media source-interface GigabitEthernet0/0
codec g711ulaw
```

Prior to Cisco IOS 15.6(3)M and Cisco IOS XE Denali 16.3.1 releases, when an incoming call is received for the dialed number 5678 on GigabitEthernet0/0 (VRF ID1), inbound dial-peer matching was done based on the called-number 5678. In this case, dial-peer 1000 which is bound to GigabitEthernet0/1 (VRF ID2) was considered to be the first matched dial-peer for this call. And, the response was sent incorrectly to VRF ID2 instead of VRF ID1.

With the introduction of VRF aware inbound dial-peer matching, the initial filtering is done based on the VRF ID and then based on the called-number. For the above example, a call with called-number of 5678 that is received on GigabitEthernet 0/0 with VRF ID 1 configured, the dial-peers will first be filtered to those that are bound to GigabitEthernet 0/0 before selection of the inbound dial-peer is performed. Now, the response is sent successfully on VRF ID1.

Note Whenever the VRF ID is added, modified, or removed under the interface, it is mandatory to execute the following command before making any calls: **clear interface** <*interface*>. If the **clear interface** <*interface*> command is not executed, the dial-peer is bound to the old VRF ID and not to the new VRF ID.

Note Inbound dial-peer matching based on VRF ID is selected in the following order of preference:

1. Dial-peer based configuration
2. Tenant based configuration
3. Global based configuration

Example: Tenant based Inbound Dial-Peer Matching

```
voice class tenant 1
  bind control source-interface GigabitEthernet0/0
  bind media source-interface GigabitEthernet0/0
  dial-peer voice 2000 voip
```

```
description "Inbound dial-peer bound to VRF-ID 1"
session protocol sipv2
session target sip-server
session transport udp
incoming called-number 5678
voice-class sip tenant 1
codec g711ulaw
```

Example: Global based Inbound Dial-Peer Matching

```
voice service voip
  sip
  bind control source-interface GigabitEthernet0/0
  bind media source-interface GigabitEthernet0/0
```

VRF Aware DNS for SIP Calls

The VRF Aware DNS for SIP Calls feature enables you to specify the Virtual Routing and Forwarding (VRF) table so that the domain name system (DNS) can forward queries to name servers using the VRF table.

Because the same IP address can be associated with different DNS servers in different VRF domains, a separate list of name caches for each VRF is maintained. The DNS looks up the specific VRF name cache before sending a query to the VRF name server. All IP addresses obtained from a VRF-specific name cache are routed using the VRF table.

While processing a SIP call, if a hostname has to be resolved, only the VRF associated with the SIP call is used during DNS resolutions.

Note Ensure that the name-server is configured using **ip name-server vrf** command. For configuration details, see Name Server Configuration.

High Availability with VRF

CUBE supports VRF in both HSRP and RG Infra high availability mode. VRF is supported on CUBE box-to-box and inbox high availability types.

For box-to-box high availability in Aggregation Services Routers 1000 Series and Integrated Services Routers 4000 Series, RG interface must not be associated with VRF where as the inbound and outbound interfaces (meant for handling VoIP traffic) can be associated with VRF's depending upon the deployment.

For box-to-box high availability in Integrated Services Routers Generation 2, HSRP interface must not be associated with VRF where as the inbound and outbound interfaces (meant for handling VoIP traffic) can be associated with VRFs depending upon the deployment

All the configurations including the VRF based RTP port range has to be identical on active and standby routers. VRF IDs will be check pointed before and after the switchover.

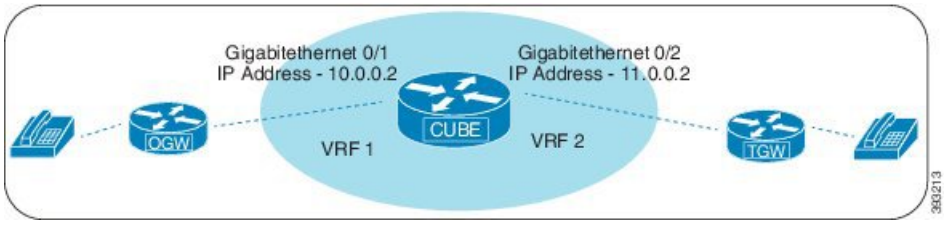
Configuration Examples

Note The steps in the following configuration example is for a new network and hence it is assumed that there is no existing configuration.

Example: Configuring Multi-VRF in Standalone Mode

The configuration in this scenario is as shown below where the Gigabitethernet 0/1 is assigned to VRF1 and GigabitEthernet 0/2 is assigned to VRF2.

Figure 2: Multi-VRF in Standalone Mode



Configuring VRF

```
Device# enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# ip vrf  VRF2
Device(config)# rd 2:2
Device(config)# exit
```

Associating interfaces with VRF

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
```

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es) removed due to
enabling VRF VRF1
```

Configure Interface GigabitEthernet0/1

```
Device> enable
Device# configure terminal
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip address 10.0.0.2 255.255.255.0
Device(config-if)# speed auto
Device(config-if)# exit
```

Configure Interface GigabitEthernet0/2

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip address 11.0.0.2 255.255.255.0
Device(config-if)# speed auto
Device(config-if)# exit
```

Creating Dial-peer

Creating Inbound Dial-peer:

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# incoming called-number 1111
Device(cofig-dial-peer)# codec g711ulaw
```

Creating Outbound Dial-peer:

```
Device(config)# dial-peer voice 2222 voip
Device(config-dial-peer)# destination pattern 1111
Device(config-dial-peer)# session protocol sipv2
```

Execute the following command to verify the dial-peer association with interface:

```
Device# show dial-peer voice summary

                AD                      PRE  PASS                      OUT
TAG   TYPE  MIN OPER PREFIX DEST-PATTERN FER  THRU   SESS-TARGET   STAT PORT KEEPALIVE  VRF
1111  voip  up   up             -         0   syst  ipv4:10.0.0.2
VRF1
2222  voip  up   up             -         0   syst  ipv4:11.0.0.2
VRF2
```

Configure Binding

Note

- Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error.
- Whenever global sip bind interface associated with a VRF is added, modified, or removed, you should restart the sip services under voice service voip sip mode so that the change in global sip bind comes into effect with associated VRF ID.

```
Device(config)# voice service voip
Device(conf-voi-serv)# sip
Device(conf-serv-sip)# call service stop
Device(conf-serv-sip)# no call service stop
Device(conf-serv-sip)# end
```

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/1


Device(config)# dial-peer voice 2222 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/2
```

Execute the following command to verify the interface association with VRF:

```
Device# show ip vrf brief

  Name                              Default    RD             Interfaces
  Mgmt-intf                         <not set>                    Gi0
  VRF1                               1:1                         Gi0/1
  VRF2                               2:2                         Gi0/2
```

Execute the following command to verify a successful and active calls:

For a single call, you should be able to see two RTP connections as shown in the below example.

```
Device# show voip rtp connections

VoIP RTP Port Usage Information:
Max Ports Available: 23001, Ports Reserved: 101, Ports in Use: 2
                                       Min   Max   Ports     Ports     Ports
Media-Address Range                    Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                      8000  48198 19999     101       0

-----------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId  dstCallId  LocalRTP RmtRTP LocalIP   RemoteIP   MPSS  VRF
1     1        2        25000   16390  10.0.0.1  10.0.0.2   NO    VRF1
2     2        1        25002   16398  11.0.0.1  11.0.0.2   NO    VRF2


Device# show call active voice brief  -


Perf-AR1006#show call active voice brief
```

```
<ID>: <CallID> <start>ms.<index> (<start>) +<connect> pid:<peer_id> <dir> <addr> <state>
  dur hh:mm:ss tx:<packets>/<bytes> rx:<packets>/<bytes> dscp:<packets violation>
media:<packets violation> audio tos:<audio tos value> video tos:<video tos value>
 IP <ip>:<udp> rtt:<time>ms pl:<play>/<gap>ms lost:<lost>/<early>/<late>
  delay:<last>/<min>/<max>ms <codec> <textrelay> <transcoded

 media inactive detected:<y/n> media cntrl rcvd:<y/n> timestamp:<time>

 long duration call detected:<y/n> long duration call duration :<sec> timestamp:<time>
 LostPacketRate:<%> OutOfOrderRate:<%>
 VRF:<%>
  MODEMPASS <method> buf:<fills>/<drains> loss <overall%> <multipkt>/<corrected>
   last <buf event time>s dur:<Min>/<Max>s
 FR <protocol> [int dlci cid] vad:<y/n> dtmf:<y/n> seq:<y/n>
  <codec> (payload size)
 ATM <protocol> [int vpi/vci cid] vad:<y/n> dtmf:<y/n> seq:<y/n>
  <codec> (payload size)
 Tele <int> (callID) [channel_id] tx:<tot>/<v>/<fax>ms <codec> noise:<l> acom:<l> i/o:<l>/<l>
 dBm
  MODEMRELAY info:<rcvd>/<sent>/<resent> xid:<rcvd>/<sent> total:<rcvd>/<sent>/<drops>
         speeds(bps): local <rx>/<tx> remote <rx>/<tx>
 Proxy <ip>:<audio udp>,<video udp>,<tcp0>,<tcp1>,<tcp2>,<tcp3> endpt: <type>/<manf>
 bw: <req>/<act> codec: <audio>/<video>
  tx: <audio pkts>/<audio bytes>,<video pkts>/<video bytes>,<t120 pkts>/<t120 bytes>
 rx: <audio pkts>/<audio bytes>,<video pkts>/<video bytes>,<t120 pkts>/<t120 bytes>


Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2
11FF : 8565722 511605450ms.1 (*16:21:53.676 IST Tue Aug 4 2015) +30 pid:400001
Answer 777412373 active
 dur 00:00:22 tx:1110/66600 rx:1111/66660 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 10.0.0.2:30804 SRTP: off rtt:0ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00
 VRF: VRF1
11FF : 8565723 511605470ms.1 (*16:21:53.696 IST Tue Aug 4 2015) +0 pid:400000 Originate
777512373 active
 dur 00:00:22 tx:1111/66660 rx:1110/66600 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 11.0.0.2:30804 SRTP: off rtt:0ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00
 VRF: VRF2

Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2

Device# show sip-ua connections udp brief

Total active connections       : 2
```

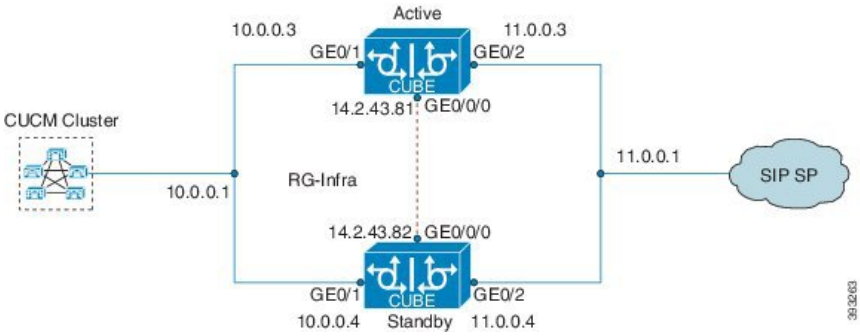
```
No. of send failures            : 0
No. of remote closures          : 0
No. of conn. failures           : 0
No. of inactive conn. ageouts   : 2

-------------- SIP Transport Layer Listen Sockets ---------------
  Conn-Id              Local-Address
 ===========    ============================
   2             [10.0.0.1]:5060:VRF1
   3             [11.0.0.1]:5060:VRF2


Device# show call active voice compact

 <callID>  A/O  FAX T<sec>  Codec       type  Peer Address  IP R<ip>:<udp>   VRF
Total call-legs: 2
   8565722 ANS     T12    g711ulaw     VOIP   P777412373   10.0.0.2:30804   VRF1
   8565723 ORG     T12    g711ulaw     VOIP   P777512373   11.0.0.2:30804   VRF2


Device# show call active video compact
MVRF-CUBE1#show call active video compact
 <callID>  A/O FAX T<sec> Codec type     Peer Address  IP R<ip>:<udp>    VRF
Total call-legs: 2
  10193983 ANS     T30    H264  VOIP-VIDEO  P2005      10.0.0.2:18078    VRF1
  10193985 ORG     T30    H264  VOIP-VIDEO  P3001      11.0.0.2:27042    VRF2
```

Example: Configuring RG Infra High Availability with VRF

Note Below configuration example is applicable for Cisco ASR 1000 Series Aggregated Services Routers (ASR) and Cisco 4000 Series Integrated Services Routers (ISR G3).

Note Do not configure VRF on the interface that is used for RG Infra. Traffic of VRF and RG Infra should be on different interfaces.

Figure 3: Multi-VRF in High Availability Mode (RG Infra)



Configuration on Active Router

Note The configurations of Active Router and Stand By Router should be identical.

Configuring VRF

```
Device> enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# ip vrf  VRF2
Device(config)# rd 2:2

Device(config)# voice service voip
Device(config)# no ip address trusted authenticate
Device(config)# media bulk-stats
Device(config)# allow-connections sip to sip
Device(config)# redundancy-group 1
Device(config)# sip

Device(config)# redundancy
Device(config)# mode none
Device(config)# application redundancy
Device(config)# group 1
Device(config)# name raf-b2b
Device(config)# priority 1
Device(config)# timers delay 30 reload 60
Device(config)# control GigabitEthernet0/0/0 protocol 1
Device(config)# data GigabitEthernet0/0/0
```

Associating interfaces with VRF

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding vrf2
```

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es) removed due to
enabling VRF VRF1
```

GigabitEthernet0/0/0 is used for configuring RG Infra and therefore do not configure any VRF with this interface.

```
Device(config)# interface GigabitEthernet0/0/0
Device(config-if)# ip address 14.2.43.81 255.255.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
```

Inbound interface - GigabitEthernet0/1 is used for voice traffic configured with VRF1.

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1
Device(config-if)# ip address 10.0.0.3 255.0.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
Device(config-if)# redundancy rii 1
Device(config-if)# redundancy group 1 ip 10.0.0.1 exclusive
```

Outbound interface - GigabitEthernet0/2 is used for voice traffic configured with VRF2.

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
Device(config-if)# ip address 11.0.0.3 255.0.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
Device(config-if)# redundancy rii 2
Device(config-if)# redundancy group 1 ip 11.0.0.1 exclusive
```

Creating Dial-peer

Creating Inbound Dial-peer:

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# destination pattern 1111
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:10.0.0.2
Device(config-dial-peer)# incoming called-number 1111
```

Creating Outbound Dial-peer:

```
Device(config)# dial-peer voice 3333 voip
Device(config)# destination-pattern 2222
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:11.0.0.2
```

Configuring Binding

Note Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error.

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/1

Device(config)# dial-peer voice 3333 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/2
```

Configuration on Standby Router

Note The configurations of Active and Stand By should be identical.

Configuring VRF

```
Device> enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# ip vrf  VRF2
Device(config)# rd 2:2

Device(config)# voice service voip
Device(config)# no ip address trusted authenticate
Device(config)# media bulk-stats
Device(config)# allow-connections sip to sip
Device(config)# redundancy-group 1
Device(config)# sip

Device(config)# redundancy
Device(config)# mode none
Device(config)# application redundancy
Device(config)# group 1
Device(config)# name raf-b2b
Device(config)# priority 1
Device(config)# timers delay 30 reload 60
Device(config)# control GigabitEthernet0/0/0 protocol 1
Device(config)# data GigabitEthernet0/0/0
```

Associating interfaces with VRF

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
```

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es)removed due to enabling
 VRF VRF1
```

GigabitEthernet0/0/0 is used for configuring RG Infra and therefore do not configure any VRF with this interface.

```
Device(config)# interface GigabitEthernet0/0/0
Device(config-if)# ip address 14.2.43.81 255.255.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
```

Inbound interface - GigabitEthernet0/1 is used for voice traffic configured with VRF1.

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1
Device(config-if)# ip address 10.0.0.4 255.0.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
Device(config-if)# redundancy rii 1
Device(config-if)# redundancy group 1 ip 10.0.0.1 exclusive
```

Outbound interface - GigabitEthernet0/2 is used for voice traffic configured with VRF2.

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
Device(config-if)# ip address 11.0.0.4 255.0.0.0
Device(config-if)# negotiation auto
Device(config-if)# cdp enable
Device(config-if)# redundancy rii 2
Device(config-if)# redundancy group 1 ip 11.0.0.1 exclusive
```

Creating Dial-peer

Creating Inbound Dial-peer:

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# destination pattern 1111
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:10.0.0.2
Device(config-dial-peer)# incoming called-number 1111
```

Creating Outbound Dial-peer:

```
Device(config)# dial-peer voice 3333 voip
Device(config)# destination-pattern 2222
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:11.0.0.2
```

Configuring Binding

Note Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error.

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# voice-class sip bind control source-interface
GigabitEthernet0/1
Device(config)# voice-class sip bind media source-interface
GigabitEthernet0/1

Device(config)# dial-peer voice 3333 voip
Device(config)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config)# voice-class sip bind media source-interface GigabitEthernet0/2
```

Verification of Calls Before and After Switchover

RTP Connections on Active router:

```
Device# show voip rtp connections

VoIP RTP Port Usage Information:
Max Ports Available: 19999, Ports Reserved: 101, Ports in Use: 2
                                        Min   Max   Ports     Ports     Ports
Media-Address Range                     Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                       8000  48198 19999     101       2
-----------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId   LocalRTP  RmtRTP   LocalIP     RemoteIP    MPSS   VRF
1     5              6       8008     16388   10.0.0.1    10.0.0.2    NO     VRF1

2     6              5       8010     16388   11.0.0.1    11.0.0.2    NO     VRF2
Found 2 active RTP connections
```

RTP Connections on Standby Router after switchover

```
Device# show voip rtp connections

VoIP RTP Port Usage Information:
Max Ports Available: 19999, Ports Reserved: 101, Ports in Use: 2
                                        Min   Max   Ports     Ports     Ports
Media-Address Range                     Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                       8000  48198 19999     101       2
-----------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId   LocalRTP   RmtRTP    LocalIP     RemoteIP      MPSS    VRF
1     7              8      8012       16390    10.0.0.1    10.0.0.2       NO     VRF1

2     8              7      8014       16390    11.0.0.1    11.0.0.2       NO     VRF2

Found 2 active RTP connections
```

Active calls on Active Router

```
Device# show call active voice brief


11F3 : 5 243854170ms.1 (*11:48:43.972 UTC Mon May 25 2015) +6770 pid:0 Answer  active
 dur 00:00:14 tx:843/50551 rx:1028/61680 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 10.0.0.2:16388 SRTP: off rtt:1ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00

11F3 : 6 243854170ms.2 (*11:48:43.972 UTC Mon May 25 2015) +6770 pid:3333 Originate 2222
active
 dur 00:00:14 tx:1028/61680 rx:843/50551 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 11.0.0.2:16388 SRTP: off rtt:65522ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00
```

```
Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2
```

```
Device#show sip-ua connections udp brief

Total active connections       : 2
No. of send failures            : 0
No. of remote closures         : 0
No. of conn. failures           : 0
No. of inactive conn. ageouts  : 2

-------------- SIP Transport Layer Listen Sockets ---------------
  Conn-Id               Local-Address
 ===========    ============================
   2             [10.0.0.1]:5060:VRF1
   3             [11.0.0.1]:5060:VRF2
```

Active calls on Standby router after switchover:

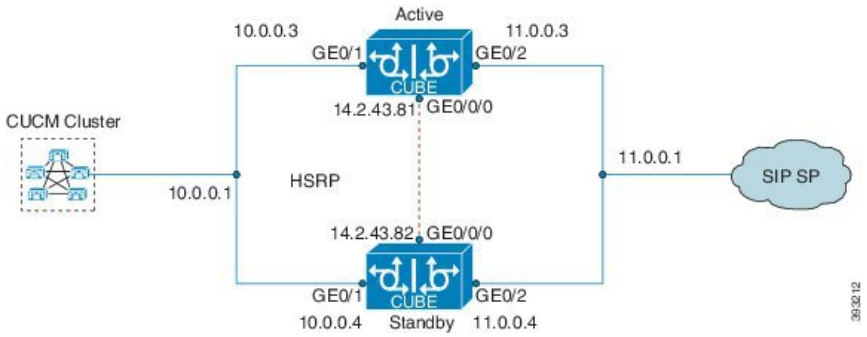
```
Device# show call active voice brief

11F9 : 8 245073830ms.1 (*12:16:18.094 UTC Mon May 25 2015) +26860 pid:3333 Originate 2222
connected
 dur 00:03:37 tx:6757/405420 rx:6757/405420 dscp:0 media:0 audio tos:0x0 video tos:0x0
 IP 11.0.0.2:16390 SRTP: off rtt:65531ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00

11F9 : 7 245073850ms.1 (*12:16:18.114 UTC Mon May 25 2015) +26840 pid:0 Answer  connected
 dur 00:03:37 tx:6757/405420 rx:6757/405420 dscp:0 media:0 audio tos:0x0 video tos:0x0
 IP 10.0.0.2:16390 SRTP: off rtt:65523ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00


Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2
```

Example: Configuring HSRP High Availability with VRF

Note Below configuration example is applicable for Cisco Integrated Services Routers Generation 2 (ISR G2) Platforms. [Cisco 2900 Series Integrated Services Routers and Cisco 3900 Series Integrated Services Routers]

Note Do not configure VRF on the interface that is used for HSRP. Traffic of VRF and HSRP should be on different interfaces.

Figure 4: Multi-VRF in High Availability Mode (HSRP)



Configuration on Active Router

Note The configurations of Active Router and Stand By Router should be identical.

Configuring VRF

```
Device> enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# ip vrf  VRF2
Device(config)# rd 2:2
```

Associating interfaces with VRF

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1

Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
```

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es) removed due to
enabling VRF VRF1
```

The interface used for HSRP should not be configured with any VRF. In this example, GigabitEthernet0/0/0 is used for configuring HSRP and therefore no VRF is associated with this interface.

```
Device(config)# interface GigabitEthernet0/0/0
Device(config-if)# ip address 14.2.43.81 255.255.0.0
Device(config-if)# standby version 2
Device(config-if)# standby 93 ip 14.2.43.82
Device(config-if)# standby 93 priority 50
Device(config-if)# standby 93 preempt
Device(config-if)# standby 93 name cubeha
Device(config-if)# standby 93 track 1 decrement 5
Device(config-if)# standby 93 track 2 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
```

Inbound interface - GigabitEthernet0/1 is used for voice traffic configured with VRF1.

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1
Device(config-if)# ip address 10.0.0.3 255.0.0.0
Device(config-if)# standby version 2
Device(config-if)# standby 63 ip 10.0.0.4
Device(config-if)# standby 63 priority 50
Device(config-if)# standby 63 preempt
Device(config-if)# standby 63 track 1 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
Device(config-if)#media-type rj45
```

Outbound interface - GigabitEthernet0/2 is used for voice traffic configured with VRF2.

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
Device(config-if)# ip address 11.0.0.3 255.0.0.0
Device(config-if)# standby version 2
Device(config-if)# standby 36 ip 11.0.0.4
Device(config-if)# standby 36 priority 50
Device(config-if)# standby 36 preempt
Device(config-if)# standby 36 track 1 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
Device(config-if)#media-type rj45


Device(config)# ipc zone default
Device(config-ipczone)# association 1
```

```
Device(config-ipczone-assoc)# no shutdown
Device(config-ipczone-assoc)# protocol sctp
Device(config-ipc-protocol-sctp)# local port 5000
Device(config-ipc-local-sctp)# local-ip 14.2.43.81
Device(config-ipc-local-sctp)# exit
Device(config-ipc-protocol-sctp)# remote port 5000
Device(config-ipc-remote-sctp)# remote-ip 14.2.43.82
```

Creating Dial-peer

Creating Inbound Dial-peer:

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# destination pattern 1111
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:10.0.0.2
Device(config-dial-peer)# incoming called-number 1111
```

Creating Outbound Dial-peer:

```
Device(config)# dial-peer voice 3333 voip
Device(config)# destination-pattern 2222
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:11.0.0.2
```

Configuring Binding

Note Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error.

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/1

Device(config)# dial-peer voice 3333 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config-dial-peer)# voice-class sip bind media source-interface GigabitEthernet0/2
```

Configuration on Standby Router

Note The configurations of Active and Stand By should be identical.

Configuring VRF

```
Device> enable
Device# configure terminal
Device(config)# ip vrf VRF1
Device(config)# rd 1:1
Device(config)# ip vrf  VRF2
```

```
Device(config)# rd 2:2
```

Associating interfaces with VRF

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1

Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
```

Note If an IP address is already assigned to an interface, then associating a VRF with interface will disable the interface and remove the existing IP address. An error message (sample error message shown below) is displayed on the console. Assign the IP address to proceed further.

```
% Interface GigabitEthernet0/1 IPv4 disabled and address(es) removed due to
enabling VRF VRF1
```

The interface used for HSRP should not be configured with any VRF. In this example, GigabitEthernet0/0/0 is used for configuring HSRP and therefore no VRF is associated with this interface.

```
Device(config)# interface GigabitEthernet0/0/0
Device(config-if)# ip address 14.2.43.82 255.255.0.0
Device(config-if)# standby version 2
Device(config-if)# standby 93 ip 14.2.43.81
Device(config-if)# standby 93 priority 50
Device(config-if)# standby 93 preempt
Device(config-if)# standby 93 name cubeha
Device(config-if)# standby 93 track 1 decrement 5
Device(config-if)# standby 93 track 2 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
```

Inbound interface - GigabitEthernet0/1 is used for voice traffic configured with VRF1.

```
Device(config)# interface GigabitEthernet0/1
Device(config-if)# ip vrf forwarding VRF1
Device(config-if)# ip address 10.0.0.4 255.0.0.0
Device(config-if)# standby version 2
Device(config-if)# standby 63 ip 10.0.0.3
Device(config-if)# standby 63 priority 50
Device(config-if)# standby 63 preempt
Device(config-if)# standby 63 track 1 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
Device(config-if)#media-type rj45
```

Outbound interface - GigabitEthernet0/2 is used for voice traffic configured with VRF2.

```
Device(config)# interface GigabitEthernet0/2
Device(config-if)# ip vrf forwarding VRF2
Device(config-if)# ip address 11.0.0.4 255.0.0.0
Device(config-if)# standby version 2
```

```
Device(config-if)# standby 36 ip 11.0.0.3
Device(config-if)# standby 36 priority 50
Device(config-if)# standby 36 preempt
Device(config-if)# standby 36 track 1 decrement 5
Device(config-if)# duplex auto
Device(config-if)# speed auto
Device(config-if)#media-type rj45
```

```
Device(config)# ipc zone default
Device(config-ipczone)# association 1
Device(config-ipczone-assoc)# no shutdown
Device(config-ipczone-assoc)# protocol sctp
Device(config-ipc-protocol-sctp)# local port 5000
Device(config-ipc-local-sctp)# local-ip 14.2.43.82
Device(config-ipc-local-sctp)# exit
Device(config-ipc-protocol-sctp)# remote port 5000
Device(config-ipc-remote-sctp)# remote-ip 14.2.43.81
```

Creating Dial-peer

Creating Inbound Dial-peer:

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# destination pattern 1111
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:10.0.0.2
Device(config-dial-peer)# incoming called-number 1111
```

Creating Outbound Dial-peer:

```
Device(config)# dial-peer voice 3333 voip
Device(config)# destination-pattern 2222
Device(config-dial-peer)# session protocol sipv2
Device(config-dial-peer)# session target ipv4:11.0.0.2
```

Configuring Binding

Note Control and Media on a dial-peer have to bind with same VRF. Else, while configuring, the CLI parser will display an error.

```
Device(config)# dial-peer voice 1111 voip
Device(config-dial-peer)# voice-class sip bind control source-interface GigabitEthernet0/1
Device(config)# voice-class sip bind media source-interface GigabitEthernet0/1

Device(config)# dial-peer voice 3333 voip
Device(config)# voice-class sip bind control source-interface GigabitEthernet0/2
Device(config)# voice-class sip bind media source-interface GigabitEthernet0/2
```

Verification of redundancy States

On Active Router

```
Device(config)# show redundancy status

my state = 13 -ACTIVE
peer state = 8  -STANDBY HOT
Mode = Duplex
Unit ID = 0

Maintenance Mode = Disabled
Manual Swact = enabled
Communications = Up

client count = 17
client_notification_TMR = 120000 milliseconds
RF debug mask = 0x0
```

On Standby Router

```
Device(config)# show redundancy status

my state = 8 -STANDBY HOT
peer state = 13 ACTIVE
Mode = Duplex
Unit ID = 0

Maintenance Mode = Disabled
Manual Swact = enabled
Communications = Up

client count = 17
client_notification_TMR = 120000 milliseconds
RF debug mask = 0x0
```

Verification of Calls Before and After Switchover

RTP Connections on Active router:

```
Device# show voip rtp connections

VoIP RTP Port Usage Information:
Max Ports Available: 19999, Ports Reserved: 101, Ports in Use: 2
                                       Min   Max   Ports     Ports     Ports
Media-Address Range                    Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                      8000  48198 19999     101       2
-----------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId   LocalRTP  RmtRTP   LocalIP     RemoteIP    MPSS  VRF
1     5              6       8008     16388   10.0.0.1    10.0.0.2    NO    VRF1

2     6              5       8010     16388   11.0.0.1    11.0.0.2    NO    VRF2
Found 2 active RTP connections
```

RTP Connections on Standby Router after switchover

```
Device# show voip rtp connections

VoIP RTP Port Usage Information:
Max Ports Available: 19999, Ports Reserved: 101, Ports in Use: 2
                                       Min   Max   Ports     Ports     Ports
```

```
Media-Address Range                     Port  Port  Available Reserved  In-use
-------------------------------------------------------------------------------
Global Media Pool                       8000  48198 19999     101       2
-------------------------------------------------------------------------------
VoIP RTP active connections :
No. CallId     dstCallId            LocalRTP        RmtRTP      LocalIP         RemoteIP
      MPSS   VRF
1     7              8                8012         16390      10.0.0.1         10.0.0.2
       NO    VRF1
2     8              7                8014         16390      11.0.0.1         11.0.0.2
       NO    VRF2
Found 2 active RTP connections
```

Active calls on Active Router

```
Device# show call active voice brief


11F3 : 5 243854170ms.1 (*11:48:43.972 UTC Mon May 25 2015) +6770 pid:0 Answer  active
 dur 00:00:14 tx:843/50551 rx:1028/61680 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 10.0.0.2:16388 SRTP: off rtt:1ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00

11F3 : 6 243854170ms.2 (*11:48:43.972 UTC Mon May 25 2015) +6770 pid:3333 Originate 2222
active
 dur 00:00:14 tx:1028/61680 rx:843/50551 dscp:0 media:0 audio tos:0xB8 video tos:0x0
 IP 11.0.0.2:16388 SRTP: off rtt:65522ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00


Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2



Device#show sip-ua connections udp brief

Total active connections       : 2
No. of send failures            : 0
No. of remote closures         : 0
No. of conn. failures           : 0
No. of inactive conn. ageouts  : 2

-------------- SIP Transport Layer Listen Sockets ---------------
  Conn-Id               Local-Address
 ===========    ============================
   2             [10.0.0.1]:5060:VRF1
   3             [11.0.0.1]:5060:VRF2
```

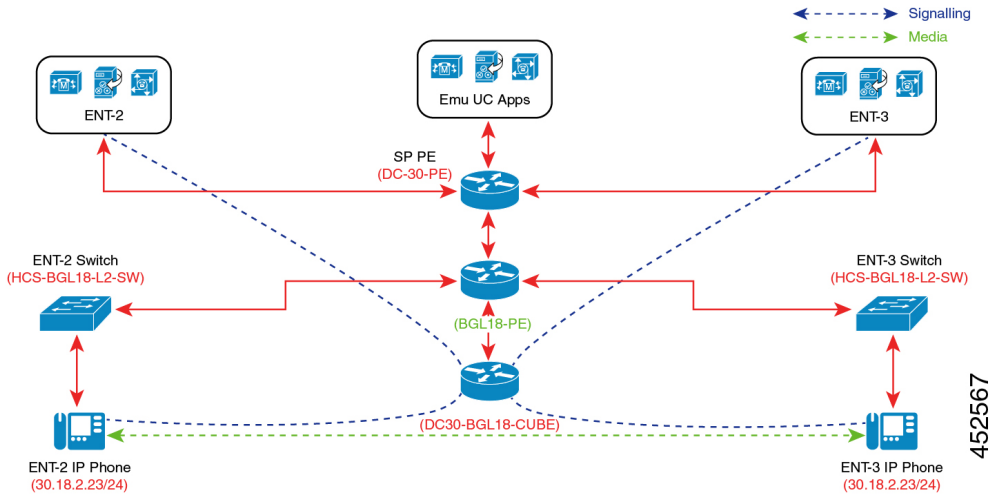
Active calls on Standby router after switchover:

```
Device# show call active voice brief

11F9 : 8 245073830ms.1 (*12:16:18.094 UTC Mon May 25 2015) +26860 pid:3333 Originate 2222
connected
 dur 00:03:37 tx:6757/405420 rx:6757/405420 dscp:0 media:0 audio tos:0x0 video tos:0x0
 IP 11.0.0.2:16390 SRTP: off rtt:65531ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00

11F9 : 7 245073850ms.1 (*12:16:18.114 UTC Mon May 25 2015) +26840 pid:0 Answer  connected
 dur 00:03:37 tx:6757/405420 rx:6757/405420 dscp:0 media:0 audio tos:0x0 video tos:0x0
 IP 10.0.0.2:16390 SRTP: off rtt:65523ms pl:0/0ms lost:0/0/0 delay:0/0/0ms g729r8 TextRelay:
 off Transcoded: No ICE: Off
 media inactive detected:n media contrl rcvd:n/a timestamp:n/a
 long duration call detected:n long duration call duration:n/a timestamp:n/a
 LostPacketRate:0.00 OutOfOrderRate:0.00


Telephony call-legs: 0
SIP call-legs: 2
H323 call-legs: 0
Call agent controlled call-legs: 0
SCCP call-legs: 0
Multicast call-legs: 0
Total call-legs: 2
```

Example: Configuring Multi VRF where Media Flows Around the CUBE

The configuration in this scenario is as shown below where there is overlapping endpoint IP address across two customers and use CUBE for inter-enterprise calls. Here the media flows around the CUBE for the enterprises with Multi-VRF feature and both the enterprises have the same endpoint IP address.

Figure 5: Multi-VRF with Media Flow Around CUBE



Set-up Information

- Two enterprises ENT2 and ENT3 have the same endpoint IP address.
- Provider Edge (PE) router acts as DHCP for both enterprises.
- PSTN call flow is simulated with the Emulation Call Manager.
- When a call is initiated from ENT2 to ENT3, the call is a flow around call and both the endpoints are connected directly.

Configuration Information

The table below details the configuration information required to configure Multi-VRF, where the media (call) flows around the CUBE.

Name	ENT2 Configuration	ENT3 Configuration
PE VRF Configurtion	ENT2 PE VRF Configuration	ENT3 PE VRF Configuation
DHCP Configurtion	ip dhcp pool DC30-ENT302 vrf Ent302 network 30.18.2.0 255.255.255.0 domain-name hcsent2.ciscolabs.com option 150 ip 200.1.1.10 default-router 30.18.2.1 dns-server 200.1.1.59	ip dhcp pool DC30-ENT303 vrf Ent303 network 30.18.2.0 255.255.255.0 domain-name hcsent3.ciscolabs.com option 150 ip 200.1.1.10 default-router 30.18.2.1 dns-server 200.1.1.59
CUBE VRF Configurtion	ENT2 - CUBE VRF Configuration	ENT3 - CUBE VRF Configuration
CUBE Voice Class URI Configurtion	! voice class uri 2112 sip pattern 200.1.1.10:8012 ! voice class uri 2114 sip pattern 172.16.30.62:8012 !	! voice class uri 3112 sip pattern 200.1.1.10:8013 ! voice class uri 3114 sip pattern 172.16.30.62:8013 !

Name	ENT2 Configuration	ENT3 Configuration
CUBE DPG Configurtion	voice class dpg 2012 dial-peer 2012 ! voice class dpg 2014 dial-peer 2014 !	voice class dpg 3012 dial-peer 3012 ! voice class dpg 3014 dial-peer 3014 !
CUBE COR Member Configurtion	dial-peer cor custom name Ent3102 name PGW-Ent3102	dial-peer cor custom name Ent3103 name PGW-Ent3103
CUBE COR List Configurtion	dial-peer cor list From-Ent3102 member Ent3102 member PGW-Ent3102 ! dial-peer cor list To-Ent3102 member Ent3102 ! dial-peer cor list From-PGW-Ent3102 member Ent3102 ! dial-peer cor list To-PGW-Ent3102 member PGW-Ent3102 !	dial-peer cor list From-Ent3103 member Ent3103 member PGW-Ent3103 ! dial-peer cor list To-Ent3103 member Ent3103 ! dial-peer cor list From-PGW-Ent3103 member Ent3103 ! dial-peer cor list To-PGW-Ent3103 member PGW-Ent3103 !
Dial Peer Configurtion	ENT2 - Dial Peer Configuration	ENT3 - Dial Peer Configuration

PE VRF Configuration - ENT2

```
BLR-PE-BGL18-NEW#sh run vrf Ent302
Building configuration...
Current configuration : 1072 bytes
ip vrf Ent302
 description Enterprise 3102 VRF
 rd 3102:1
 route-target export 3102:1
 route-target import 3102:1
 route-target import 110:1
!
interface GigabitEthernet0/0/0
 description Link to HCS-BGL18-CUBE(CUBE-ENT)
 ip address 192.168.18.9 255.255.255.252
 ip ospf network point-to-point
```

```
 logging event link-status
 load-interval 30
 negotiation auto
 mpls bgp forwarding
 cdp enable
!
interface Port-channel1
 no ip address
 no negotiation auto
!
interface Port-channel1.302
 encapsulation dot1Q 302
 ip vrf forwarding Ent302
 ip address 30.18.2.1 255.255.255.0
!
router bgp 65535
 !
 address-family ipv4 vrf Ent302
 redistribute connected
 exit-address-family
!
end
```

PE VRF Configuration - ENT3

```
BLR-PE-BGL18-NEW#sh run vrf Ent303
Building configuration...
Current configuration : 850 bytes
ip vrf Ent303
 description Enterprise 3103 VRF
 rd 3103:1
 route-target export 3103:1
 route-target import 3103:1
 route-target import 110:1
!
interface GigabitEthernet0/0/0
 description Link to HCS-BGL18-CUBE(CUBE-ENT)
 ip address 192.168.18.9 255.255.255.252
 ip ospf network point-to-point
 logging event link-status
 load-interval 30
 negotiation auto
 mpls bgp forwarding
 cdp enable
!
interface Port-channel1
 no ip address
 no negotiation auto
!
interface Port-channel1.303
 encapsulation dot1Q 303
 ip vrf forwarding Ent303
 ip address 30.18.2.1 255.255.255.0
!
router bgp 65535
 !
 address-family ipv4 vrf Ent303
 redistribute connected
 exit-address-family
!
end
```

CUBE VRF Configuation - ENT2

```
DC30-BGL18-CUBE#sh run vrf Ent302
Building configuration...
Current configuration : 616 bytes
ip vrf Ent302
 description Enterprise 3102 VRF
 rd 3102:1
 route-target export 3102:1
 route-target import 3102:1
!
interface GigabitEthernet0/0/0
 description Link to HCS-BGL18-PE1 from CUBE-VRF
 ip address 192.168.18.10 255.255.255.252
 ip ospf network point-to-point
 load-interval 30
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/0/0.302
 encapsulation dot1Q 302
 ip vrf forwarding Ent302
 ip address 172.131.2.21 255.255.255.252
 ip ospf network point-to-point
!
router ospf 302 vrf Ent302
 network 172.131.2.20 0.0.0.3 area 0.0.0.0
!
ip route vrf Ent302 0.0.0.0 0.0.0.0 172.131.2.22
end
```

CUBE VRF Configuration - ENT3

```
DC30-BGL18-CUBE#sh run vrf Ent303
Building configuration...
Current configuration : 616 bytes
ip vrf Ent303
 description Enterprise 3103 VRF
 rd 3103:1
 route-target export 3103:1
 route-target import 3103:1
!
interface GigabitEthernet0/0/0
 description Link to HCS-BGL18-PE1 from CUBE-VRF
 ip address 192.168.18.10 255.255.255.252
 ip ospf network point-to-point
 load-interval 30
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/0/0.303
 encapsulation dot1Q 303
 ip vrf forwarding Ent303
 ip address 172.131.3.21 255.255.255.252
 ip ospf network point-to-point
!
router ospf 303 vrf Ent303
 network 172.131.3.20 0.0.0.3 area 0.0.0.0
!
ip route vrf Ent303 0.0.0.0 0.0.0.0 172.131.3.22
end
```

Dial Peer Configuation - ENT2

```
dial-peer voice 2011 voip
corlist incoming From-Ent3102
description Inbound Trunk from BT-Ent302 CUCM
```

```
session protocol sipv2
destination dpg 2014
incoming uri via 2112
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.302
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.302
!
dial-peer voice 2012
 voipcorlist outgoing To-Ent3102
description *** Outbound Trunk to BT-Ent302 DN Routing ****
destination-pattern 8115
session protocol sipv2
session target ipv4:200.1.1.10:8012
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.302
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.302
!
dial-peer voice 2013 voip
corlist incoming From-PGW-Ent3102
description Inbound Trunk from PGW-Ent3102
session protocol sipv2
session transport tcp
destination dpg 2012
incoming uri via 2114
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.3030
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.3030
!
dial-peer voice 2014 voip
corlist outgoing To-PGW-Ent3102
description Outbound Trunk to PGW-BT-Ent302
destination-pattern 8115
session protocol sipv2
session target ipv4:172.16.30.62:8012
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.3030
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.3030
!
```

Dial Peer Configuration - ENT3

```
dial-peer voice 3011 voip
corlist incoming From-Ent3103
```

```
description Inbound Trunk from BT-Ent303 CUCM
session protocol sipv2
destination dpg 3014
incoming uri via 3112
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
GigabitEthernet0/0/0.303
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.303
!
dial-peer voice 3012
 voipcorlist outgoing To-Ent3103
description *** Outbound Trunk to BT-Ent303 DN Reouting ****
destination-pattern 8115
session protocol sipv2
session target ipv4:200.1.1.10:8013
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.303
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.303
!
dial-peer voice 3013 voip
corlist incoming From-PGW-Ent3103
description Inbound Trunk from PGW-Ent3103
session protocol sipv2
session transport tcp
destination dpg 3012
incoming uri via 3114
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.3030
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.3030
!
dial-peer voice 3014 voip
corlist outgoing To-PGW-Ent3103
description Outbound Trunk to PGW-BT-Ent303
destination-pattern 8115
session protocol sipv2
session target ipv4:172.16.30.62:8013
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.3030
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.3030
!
```

Debug Information

Note Execute **sh sip-ua calls called-number +14089135001**, to check the call behaviour.

Figure 6: Debug Information

```
Call 2
SIP Call ID                : 23D487BE-ED4111EA-90AE9E69-F6447A3E@172.131.2.21
   State of the call       : STATE_ACTIVE (7)
   Substate of the call    : SUBSTATE_NONE (0)
   Calling Number          : +14089245001
   Called Number           : +14089135001
   Called URI              : sip:+14089135001@200.1.1.10:8012
   Bit Flags               : 0xC04018 0x90000100 0x80080
   CC Call ID              : 1199827
   Local UUID              : 000020c200105000a00000505686a91d
   Remote UUID             : 00002de600105000a000005056864727
   Source IP Address (Sig ): 172.131.2.21
   Destn SIP Req Addr:Port : [200.1.1.10]:8012
   Destn SIP Resp Addr:Port: [200.1.1.10]:8012
   Destination Name        : 200.1.1.10
   Number of Media Streams : 3
   Number of Active Streams: 0
   RTP Fork Object         : 0x0
   Media Mode              : flow-around
     Media Stream 1
     State of the stream      : STREAM_DEAD
     Stream Call ID           : 1199827
     Stream Type              : voice+dtmf (1)
     Stream Media Addr Type   : 1
     Negotiated Codec         : Passthrough (0 bytes)
     Codec Payload Type       : 255 (None)
     Negotiated Dtmf-relay    : inband-voice
     Dtmf-relay Payload Type  : 0
     QoS ID                   : -1
     Local QoS Strength       : BestEffort
     Negotiated QoS Strength  : BestEffort
     Negotiated QoS Direction : None
     Local QoS Status         : None
     Media Source IP Addr:Port: [172.131.2.21]:0
     Media Dest IP Addr:Port  : [30.18.2.23]:0
     Media Stream 2
     State of the stream      : STREAM_DEAD
     Stream Call ID           : 1199848
     Stream Type              : video (7)
     Stream Media Addr Type   : 1
     Negotiated Codec         : Passthrough (0 bytes)
     Codec Payload Type       : 255 (None)
     Negotiated Dtmf-relay    : inband-voice
     Dtmf-relay Payload Type  : 0
     QoS ID                   : -1
     Local QoS Strength       : BestEffort
     Negotiated QoS Strength  : BestEffort
     Negotiated QoS Direction : None
     Local QoS Status         : None
     Media Source IP Addr:Port: [172.131.2.21]:0
     Media Dest IP Addr:Port  : [30.18.2.23]:0
     Media Stream 3
     State of the stream      : STREAM_DEAD
     Stream Call ID           : 1199849
     Stream Type              : application (10)
     Stream Media Addr Type   : 1
     Negotiated Codec         : Passthrough (0 bytes)
     Codec Payload Type       : 255 (None)
     Negotiated Dtmf-relay    : inband-voice
     Dtmf-relay Payload Type  : 0
     QoS ID                   : -1
     Local QoS Strength       : BestEffort
     Negotiated QoS Strength  : BestEffort
     Negotiated QoS Direction : None
```

Which indicates call is media flow around

Both Enterprises having same IP address

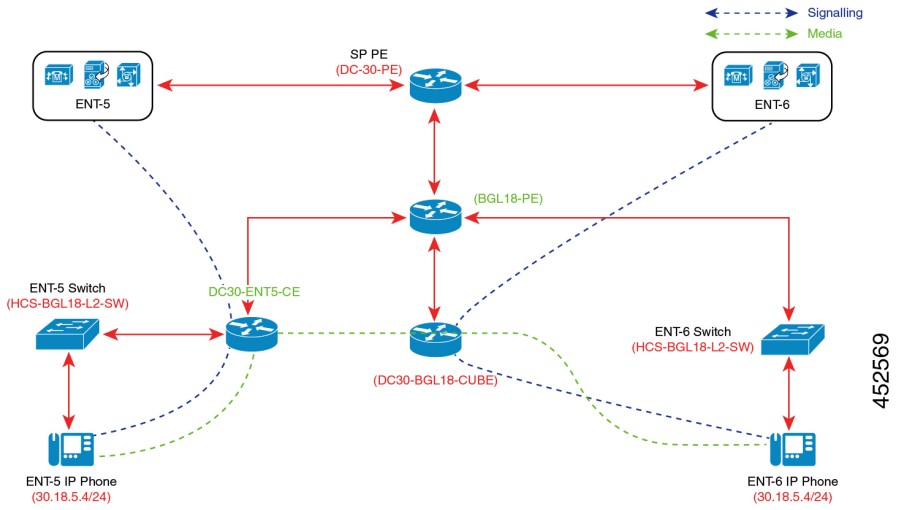
Both Enterprises having same IP address

452568

Example: Configuring Multi VRF where Media Flows Through the CUBE

The configuration in this scenario is as shown below where there is overlapping endpoint IP address across two customers and use CUBE for inter-enterprise calls. Here the media is flowing through the CUBE for the enterprises with Multi VRF feature and both the enterprises having same end-point IP address.

Figure 7: Multi-VRF with Media Flow Through CUBE



Set-up Information

- ENT5 and ENT6 have same endpoint IP addressing, and ENT5 act as PSTN customer.
- DC30-ENT5-CE and BGL-18-PE act as DHCP servers for ENT5 and ENT6 endpoints respectively.
- When a call is inititated from ENT5 to ENT6, the call is connected between two endpoints, and signalling and media flows through the CUBE.
- Customer Edge (CE) router will directly communicate with CUBE-Enterprises' Public IP address.

Configuration Information

The table below details the configuration information required to configure Multi-VRF, where the media (call) flows through the CUBE.

Table 3: Configuration Information

Name	CE CUBE Configuration	SP CUBE Configuration
DHCP Configuation	ip dhcp pool DC30-ENT305 network 30.18.5.0 255.255.255.0 domain-name hcsent5.ciscolabs.com option 150 ip 200.1.1.10 default-router 30.18.5.1 dns-server 200.1.1.59 !	ip dhcp pool DC30-ENT306 vrf Ent306 network 30.18.5.0 255.255.255.0 domain-name hcsent6.ciscolabs.com option 150 ip 200.1.1.10 default-router 30.18.5.1 dns-server 200.1.1.59 !
Voice Class URI Configuration	! voice class uri 5112 sip pattern 200.1.1.10:8015 ! voice class uri 5114 sip pattern 10.225.104.192 !	! voice class uri 102252 sip pattern 10.225.104.195:5060 ! voice class uri 102254 sip pattern 200.1.1.10:7016 !
DPG Configuration	! voice class dpg 5012 dial-peer 5012 ! voice class dpg 5014 dial-peer 5014 !	! voice class dpg 9992 dial-peer 1022502 ! voice class dpg 9994 dial-peer 1022504 !
COR Member Configuration	dial-peer cor custom name Ent3105 name PGW-Ent3105 !	dial-peer cor custom name BGL-Ent3105 name RCDN-Ent3106 !

Name	CE CUBE Configuration	SP CUBE Configuration
COR List Configuration	! dial-peer cor list From-Ent3105 member Ent3105 member PGW-Ent3105 ! dial-peer cor list To-Ent3105 member Ent3105 ! dial-peer cor list From-PGW-Ent3105 member Ent3105 ! dial-peer cor list To-PGW-Ent3105 member PGW-Ent3105 !	! dial-peer cor list From-BGL-Ent3105 member BGL-Ent3105 member RCDN-Ent3106 ! dial-peer cor list To-BGL-Ent3105 member BGL-Ent3105 ! dial-peer cor list From-RCDN-Ent3106 member BGL-Ent3105 ! dial-peer cor list To-RCDN-Ent3106 member RCDN-Ent3106 !
Dial-Peer Configuration	CE - Dial Peer Configuration	SP - Dial Peer Configuration
Interface Configuration	! interface GigabitEthernet0/0/0 ip address 10.225.104.195 255.255.255.0 negotiation auto !	! interface GigabitEthernet0/0/1 ip address 10.225.104.192 255.255.255.0 negotiation auto !

Dial Peer Configuration - CE

```
!
dial-peer voice 5011 voip
corlist incoming From-Ent3105
description Inbound Trunk from Ent3105 CUCM
session protocol sipv2
destination dpg 5014
incoming uri via 5112
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/2
voice-class sip bind media source-interface
 GigabitEthernet0/0/2
!
dial-peer voice 5012 voip
corlist outgoing To-Ent3105
```

```
description *** Outbound Trunk to BT-Ent304 DN
 Reouting ****
destination-pattern 8115
session protocol sipv2
session target ipv4:200.1.1.10:8015
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/2
voice-class sip bind media source-interface
 GigabitEthernet0/0/2
!
dial-peer voice 5013 voip
corlist incoming From-PGW-Ent3105
description Inbound Trunk from PGW-Ent3105
session protocol sipv2
session transport tcp
destination dpg 5012
incoming uri via 5114
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0
voice-class sip bind media source-interface
 GigabitEthernet0/0/0
!
dial-peer voice 5014 voip
corlist outgoing To-PGW-Ent3105
description Outbound Trunk to PGW-Ent3105
destination-pattern 8115
session protocol sipv2
session target ipv4:10.225.104.192
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0
voice-class sip bind media source-interface
 GigabitEthernet0/0/0
!
```

Dial Peer Configuration - SP

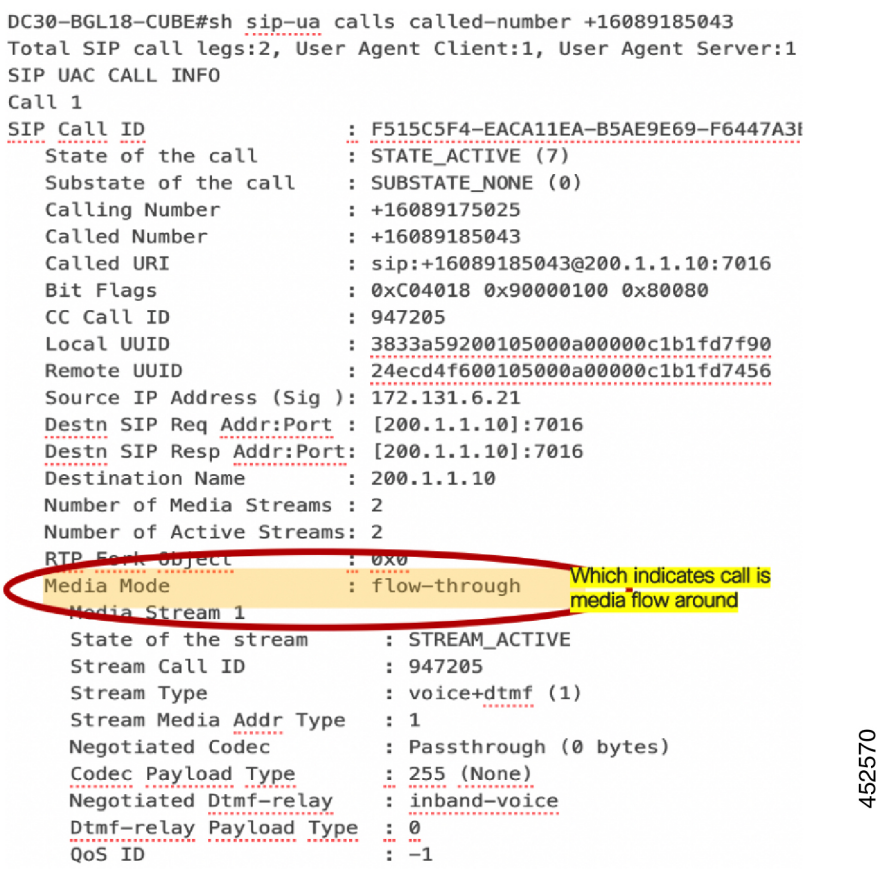
```
!
dial-peer voice 1022501 voip
corlist incoming From-BGL-Ent3105
description Inbound Trunk from Ent3105 CUCM
session protocol sipv2
destination dpg 9994
incoming uri via 102252
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/1
voice-class sip bind media source-interface
 GigabitEthernet0/0/1
```

```
!
dial-peer voice 1022502 voip
corlist outgoing To-BGL-Ent3105
description *** Outbound Trunk to BT-Ent304 DN
 Reouting ****
destination-pattern 8115
session protocol sipv2
session target ipv4:10.225.104.195
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/1
voice-class sip bind media source-interface
 GigabitEthernet0/0/1
!
dial-peer voice 1022503 voip
corlist incoming From-RCDN-Ent3106
description Inbound Trunk from PGW-Ent3105
session protocol sipv2
session transport tcp
destination dpg 9992
incoming uri via 102254
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.306
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.306
!
dial-peer voice 1022504 voip
corlist outgoing To-RCDN-Ent3106
description Outbound Trunk to PGW-Ent3105
destination-pattern 8115
session protocol sipv2
session target ipv4:200.1.1.10:7016
session transport tcp
voice-class codec 1
voice-class sip profiles 1
voice-class sip options-keepalive
voice-class sip pass-thru content sdp
voice-class sip bind control source-interface
 GigabitEthernet0/0/0.306
voice-class sip bind media source-interface
 GigabitEthernet0/0/0.306
!
```

Debug Information

Note Execute **sh sip-ua calls called-number +16089185043**, to check the call behaviour.

Figure 8: Debug Information



Troubleshooting Tips

The following commands are helpful for troubleshooting:

- **show voip rtp connections**

  The following is an example where media flow-around is configured. The output shows 0 connections since media does not flow through CUBE.

```
Device#show voip rtp connnections
VoIP RTP Port Usage Information:
Max Ports Available: 19999, Ports Reserved: 101, Ports in Use: 0
Port range not configured
                                        Min   Max   Ports     Ports     Ports
Media-Address Range                     Port  Port  Available Reserved  In-use
-----------------------------------------------------------------------------
Global Media Pool                       8000  48198 19999     101       0
-----------------------------------------------------------------------------

No active connections found
```

- **show call active voice compact**

```
Device#show call active voice compact
<callID> A/O FAX T<sec> Codec type Peer Address IP R<ip>:<udp> VRF
4021 ORG T45 g711ulaw VOIP P7474 8.41.17.71:27754 VRF1
4020 ANS T45 g711ulaw VOIP Psipp 8.41.17.71:17001 VRF1
```

- **debug ccsip verbose**

  The output of **debug ccsip verbose** command is wordy and may cause issues when enabled on a busy network environment.