Application Note

Sprint SIP Trunking:

Cisco Unified Communications Manager 11.5.1 with Cisco Unified Border Element (CUBE 12.0.0) on ISR 4321 [IOS-XE 16.06.01] using SIP

October 25, 2017

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Introduction

Service Providers today, such as Sprint, are offering alternative methods to connect to the PSTN via their IP networks. Most of these services utilize SIP as the primary signaling method and centralized IP to TDM POP gateways to provide on-net and off-net services.

A demarcation device between these services and customer owned services is recommended. As an intermediary device between Cisco Unified Communications Manager and Sprint network, Cisco Unified Border Element (CUBE) ISR 4321/K9 running IOS 16.5.1b can be used. The Cisco Unified Border Element 16.5.1b provides demarcation, security, interworking and session control services for Cisco Unified Communications Manager 11.5.1 connected to Sprint network.

This document assumes the reader is knowledgeable with the terminology and configuration of Cisco Unified Communications Manager (CUCM). Only configuration settings specifically required for Sprint interoperability are presented. Feature configuration and most importantly the dial plan are customer specific and need individual approach.

- This application note describes how to configure a Cisco Unified Communications Manager (CUCM) 11.5.1 and Cisco Unified Border Element (CUBE) on ISR 4321/K9 [IOS - 16.5.1b] for connectivity to Sprint SIP Trunking service available in the former Sprint Business service area[1] . The deployment model covered in this application note is CPE (CUCM 11.5.1) to PSTN (Sprint).
- Testing was performed in accordance to Sprint generic SIP Trunking test methodology and among features verified were – basic calls, DTMF transport, Music on Hold (MOH), unattended and attended transfers, call forward, conferences and interoperability with Cisco Unity Connection (CUC).
- The CUCM configuration detailed in this document is based on a lab environment with a simple dial-plan used to ensure proper interoperability between Sprint SIP network and Cisco Unified Communications. The configuration described in this document details the important configuration settings to have enabled for interoperability to be successful and care must be taken by the network administrator deploying CUCM to interoperate to Sprint SIP Trunking network.

This application note does not cover the use of Calling Search Spaces (CSS) or partitions on CUCM. To understand and learn how to apply CSS and partitions refer to the cisco.com link below:

http://www.cisco.com/c/en/us/td/docs/voice_ip_comm/cucm/srnd/collab10/collab10/dialplan.html

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Network Topology

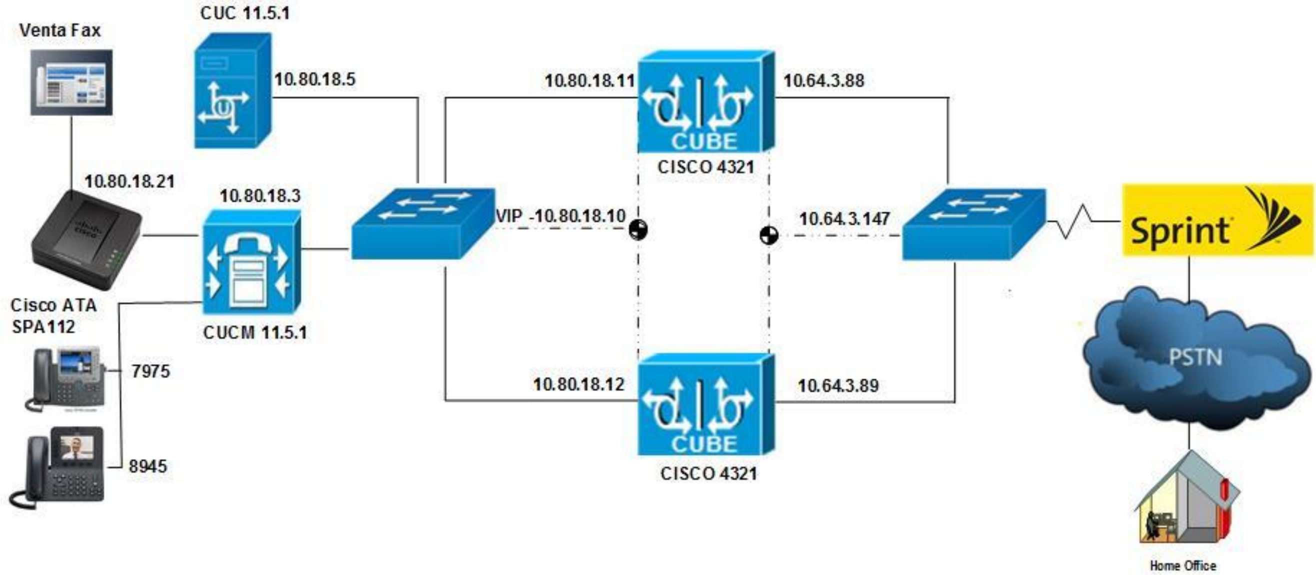


Figure 1: Network Topology

System Components

Hardware Requirements

- Cisco UCSC-C240-M3S VMWare host running ESXi 5.5 Standard
- Cisco ISR4321/K9 router as CUBE
- Cisco ISR4321/K9 (1RU) processor with 1797107K/6147K bytes of memory with 3 Gigabit Ethernet interfaces
- Processor board ID FTX1845AJ9S
- Cisco 2851 Fax Gateway
- IP phones 9971 (SIP), 7960 (SIP) and 8945 (SIP)

Software Requirements

- Cisco Unified Communications Manager 11.5.1
- Cisco Unity Connection 11.5.1
- IOS 16.06.01 for ISR 4321/K9 Cisco Unified Border Element
- Cisco IOS Software, ISR Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 16.06.01, RELEASE SOFTWARE (fc1)
- Cisco IOS XE Software, Version 03.17.01.S
- Cisco SPA112 for FAX

Features

Features Supported

- Incoming and outgoing off-net calls using G729
- Call hold
- Call transfer (unattended and attended)
- Call conference
- Call forward (all, busy and no answer)
- Calling Line (number) Identification Presentation (CLIP)
- Calling Line (number) Identification Restriction (CLIR)
- DTMF relay (both directions) (RFC2833)
- Media flow-through on Cisco UBE
- Fax (G.711 pass-through and T38)

Features Not Supported

- Cisco IP phones used in this test do not support blind transfer
- In HA redundancy mode, the primary cube will not take over the primary/active role after a reboot/network outage

Caveats

- Caller ID is not updated after attended or unattended transfers to off-net phones. This is due to a limitation on CUBE and will be resolved in the next release. The issue does not impact the calls.

Configuration

Configuring Cisco Unified Border Element (CUBE)

Network Interface

The IP address used are for illustration only, the actual IP address can vary. The Active/Standby pair share the same virtual IP address and continually exchange status messages.

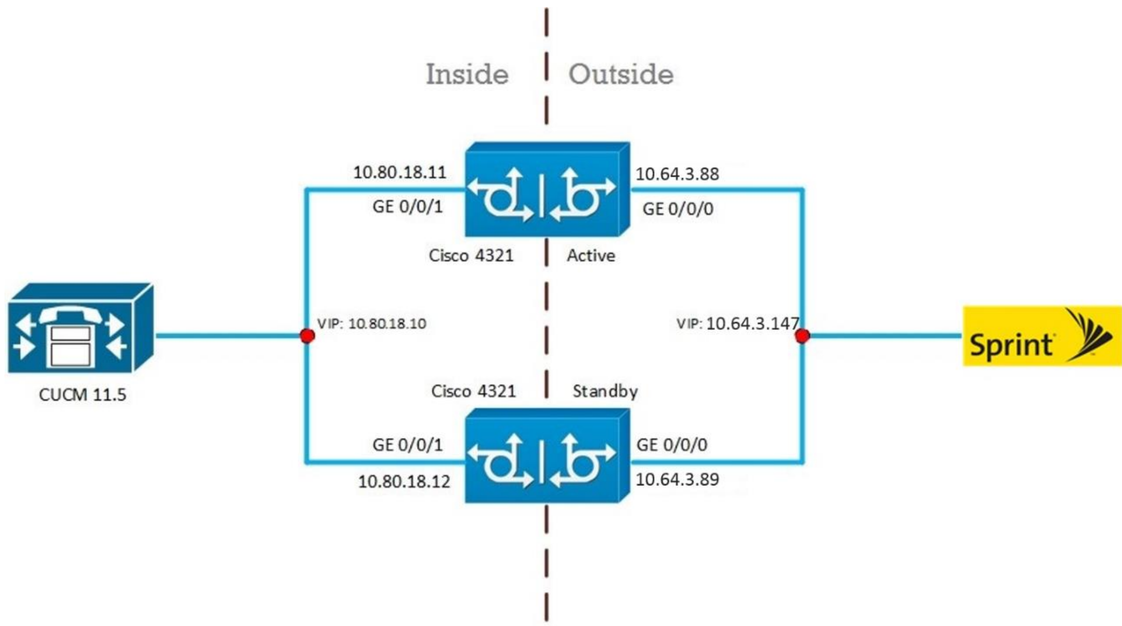


Figure 2: High Availability Topology

CUBE 1:

```
interface GigabitEthernet0/0/0
 description WAN
 ip address 10.64.3.88 255.255.0.0
 negotiation auto
 redundancy rii 1
 redundancy group 1 ip 10.64.3.147 exclusive
!
interface GigabitEthernet0/0/1
 description LAN
 ip address 10.80.18.11 255.255.255.0
 negotiation auto
 redundancy rii 2
 redundancy group 1 ip 10.80.18.10 exclusive
!
interface GigabitEthernet0/1/0
 description CUBE HA
 ip address 10.89.20.10 255.255.255.0
 negotiation auto
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 no ip address
 negotiation auto
!
```

Cisco UBE 2:

```
interface GigabitEthernet0/0/0
 description WAN
 ip address 10.64.3.89 255.255.0.0
 negotiation auto
 redundancy rii 1
 redundancy group 1 ip 10.64.3.147 exclusive
!
interface GigabitEthernet0/0/1
 description LAN
 ip address 10.80.18.12 255.255.255.0
 negotiation auto
 redundancy rii 2
 redundancy group 1 ip 10.80.18.10 exclusive
!
interface GigabitEthernet0/1/0
 description CUBE HA
 ip address 10.89.20.11 255.255.255.0
 negotiation auto
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 no ip address
 shutdown
 negotiation auto
```

Global CUBE Settings

In order to enable CUBE IP2IP SBC functionality, following command has to be entered:

```
voice service voip
 no ip address trusted authenticate
 mode border-element license capacity 20
 allow-connections sip to sip
 redundancy-group 1
 no supplementary-service sip handle-replaces
 redirect ip2ip
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 sip
  midcall-signaling passthru
  pass-thru content unsupp
  pass-thru content sdp
!
```

Explanation

Command	Description
allow-connections sip to sip	Allow IP2IP connections between two SIP call legs
redundancy-group 1	Enable High Availability for the VoIP service
fax protocol	Specifies the fax protocol

Codecs

G729 is used primarily towards Sprint until specified otherwise.

```
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
```

Dial peer

Outbound Dial-peer to Sprint:

```
dial-peer voice 1 voip
 description Incoming call from CUCM
 session protocol sipv2
 incoming called-number .T
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/1
 voice-class sip bind media source-interface GigabitEthernet0/0/1
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
dial-peer voice 2 voip
 description Outgoing to Sprint
 destination-pattern .T
 session protocol sipv2
 session target ipv4:199.11.XXX.XX:5060
 voice-class codec 1
 voice-class sip options-ping 60
 voice-class sip bind control source-interface GigabitEthernet0/0/0
 voice-class sip bind media source-interface GigabitEthernet0/0/0
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
```

Inbound Dial-Peer from Sprint:

```
dial-peer voice 3 voip
 description Incoming call from Sprint
 session protocol sipv2
 incoming called-number 913827....
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/0
 voice-class sip bind media source-interface GigabitEthernet0/0/0
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
dial-peer voice 4 voip
 description Outgoing to CUCM
 destination-pattern 913827....
 session protocol sipv2
 session target ipv4:10.80.18.2:5060
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/1
 voice-class sip bind media source-interface GigabitEthernet0/0/1
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
```

Configuration example

The following configuration snippet contains a sample configuration of Cisco UBE with all parameters mentioned previously.

Active Cisco UBE:

```
Current configuration : 5016 bytes
!
! Last configuration change at 19:32:03 UTC Tue Aug 29 2017
! NVRAM config last updated at 19:32:07 UTC Tue Aug 29 2017
!
version 16.6
service config
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
platform qfp utilization monitor load 80
no platform punt-keepalive disable-kernel-core
!
hostname Sprint_CUBE1
!
boot-start-marker
boot-end-marker
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
```

```
!
enable secret 5
!
no aaa new-model
!
subscriber templating
!
multilink bundle-name authenticated
!
crypto pki trustpoint TP-self-signed-1270583006
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-1270583006
 revocation-check none
 rsakeypair TP-self-signed-1270583006
!
crypto pki certificate chain TP-self-signed-1270583006
!
voice service voip
 no ip address trusted authenticate
 mode border-element license capacity 20
 allow-connections sip to sip
 redundancy-group 1
 no supplementary-service sip handle-replaces
 redirect ip2ip
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 sip
  midcall-signaling passthru
  pass-thru content unsupp
  pass-thru content sdp
```

```
!
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
license udi pid ISR4321/K9 sn FDO19220MQ8
license boot level appxk9
license boot level uck9
diagnostic bootup level minimal
spanning-tree extend system-id
!
redundancy
 mode none
 application redundancy
  group 1
   name voice-HA
   priority 150 failover threshold 75
   timers delay 30 reload 60
   control GigabitEthernet0/1/0 protocol 1
   data GigabitEthernet0/1/0
   track 1 shutdown
   track 2 shutdown
!
track 1 interface GigabitEthernet0/0/0 line-protocol
!
track 2 interface GigabitEthernet0/0/1 line-protocol
!
interface GigabitEthernet0/0/0
 description WAN
```

```
 ip address 10.64.3.88 255.255.0.0
 negotiation auto
 redundancy rii 1
 redundancy group 1 ip 10.64.3.147 exclusive
!
interface GigabitEthernet0/0/1
 description LAN
 ip address 10.80.18.11 255.255.255.0
 negotiation auto
 redundancy rii 2
 redundancy group 1 ip 10.80.18.10 exclusive
!
interface GigabitEthernet0/1/0
 description CUBE HA
 ip address 10.89.20.10 255.255.255.0
 negotiation auto
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 no ip address
 negotiation auto
!
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip http client source-interface GigabitEthernet0/0/0
ip route 0.0.0.0 0.0.0.0 10.64.1.1
ip route 10.64.205.0 255.255.255.0 10.80.18.1
```

```
ip route 10.80.0.0 255.255.0.0 10.80.18.1
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
dial-peer voice 1 voip
 description Incoming call from CUCM
 session protocol sipv2
 incoming called-number .T
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/1
 voice-class sip bind media source-interface GigabitEthernet0/0/1
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
dial-peer voice 2 voip
 description Outgoing to Sprint
 destination-pattern .T
 session protocol sipv2
```

```
 session target ipv4:199.11.104.70:5060
 voice-class codec 1
 voice-class sip options-ping 60
 voice-class sip bind control source-interface GigabitEthernet0/0/0
 voice-class sip bind media source-interface GigabitEthernet0/0/0
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
dial-peer voice 3 voip
 description Incoming call from Sprint
 session protocol sipv2
 incoming called-number 913827....
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/0
 voice-class sip bind media source-interface GigabitEthernet0/0/0
 dtmf-relay rtp-nte
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
dial-peer voice 4 voip
 description Outgoing to CUCM
 destination-pattern 913827....
 session protocol sipv2
 session target ipv4:10.80.18.2:5060
 voice-class codec 1
 voice-class sip bind control source-interface GigabitEthernet0/0/1
 voice-class sip bind media source-interface GigabitEthernet0/0/1
 dtmf-relay rtp-nte
```

```
 fax protocol t38 version 0 ls-redundancy 0 hs-redundancy 0 fallback cisco
 no vad
!
line con 0
 exec-timeout 0 0
 password 7
 login
 transport input none
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 password 7
 login
!
ntp server 34.202.XXX.XXX
ntp server pool.ntp.org
!
End
```

Configuring Cisco UCM 11.5 Cluster

Cisco Unified CM Version

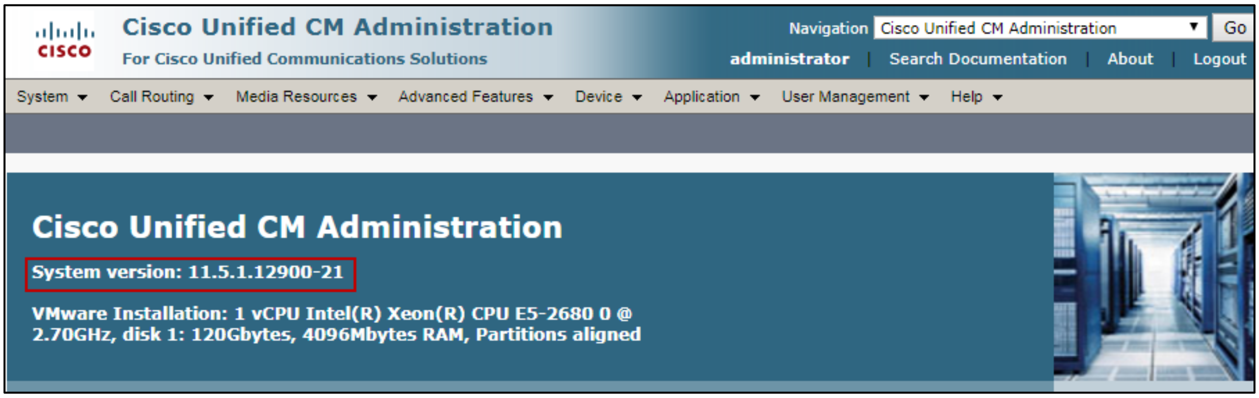


Figure 3: Cisco UCM Version

Cisco Call Manager Service Parameters

Navigation: System → Service Parameters

1. Select **Server***: Clus28Sub1--CUCM Voice/Video (Active)
2. Select **Service***: Cisco CallManager (Active)
3. All other fields are set to default values

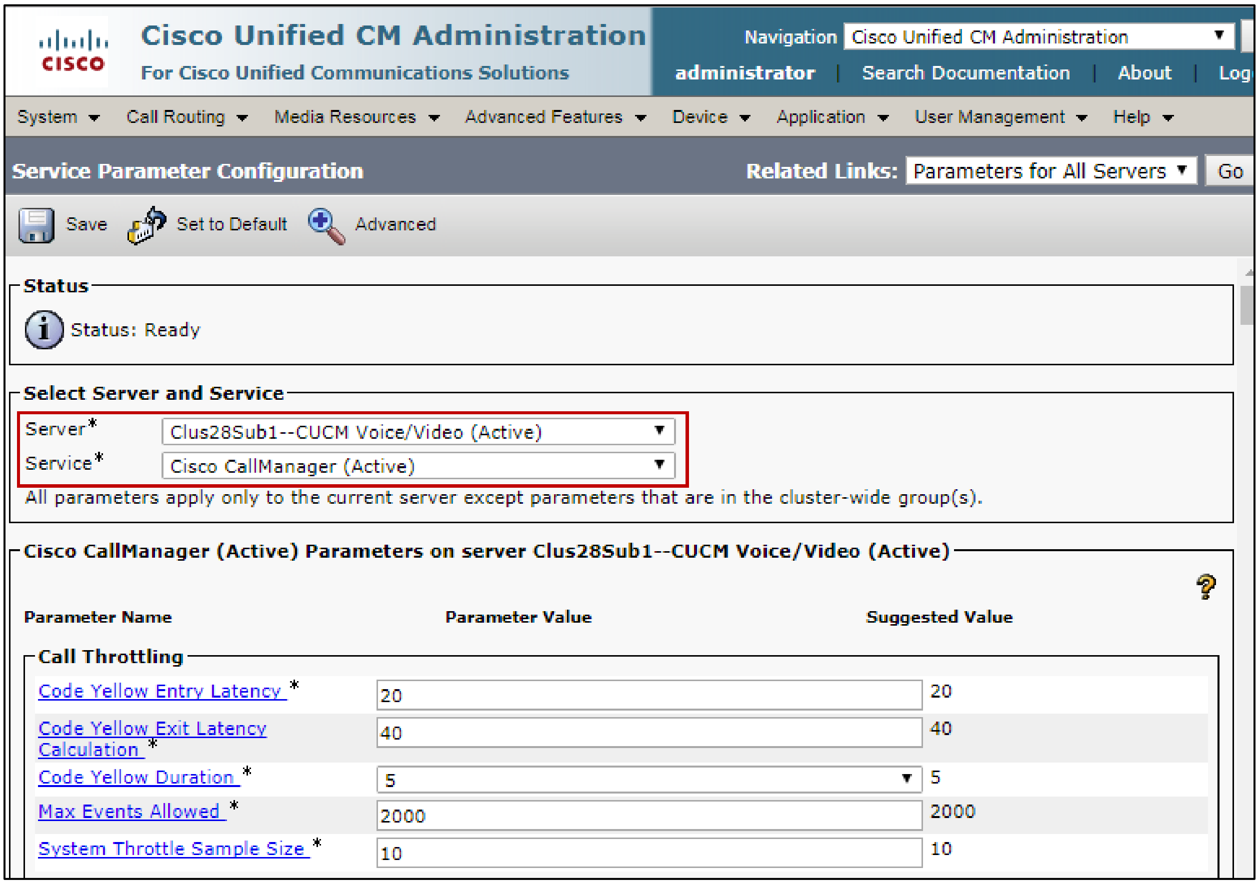


Figure 4: Service Parameters

Clusterwide Parameters (Service)		
Default Network Hold MOH Audio Source ID *	1	1
Default User Hold MOH Audio Source ID *	1	1
Duplex Streaming Enabled *	True	False
Media Exchange Interface Capability Timer *	8	8
Send Multicast MOH in H.245 OLC Message *	True	True
Media Exchange Timer *	12	12
Media Exchange Stop Streaming Timer *	8	8
Open Video Channel Response Timer for SIP Interop *	500	500
Port Received Timer After Call Connection *	500	500
Media Resource Allocation Timer *	12	12
MTP and Transcoder Resource Throttling Percentage *	95	95
Intercluster Capabilities Mismatch Timer *	1000	1000
Silence Suppression *	True	False
Silence Suppression for Gateways *	True	False
Strip G.729 Annex B (Silence Suppression) from Capabilities *	True	False
Enable Source IP Address Verification for Software Media Devices *	True	True

Figure 5: Service Parameters (Cont.)

Off-Net Calls via Sprint SIP Trunk

Off-net calls are served by SIP trunks configured between CUCM and the Sprint network and calls are routed via CUBE

SIP Trunk Security Profile

Navigation: System → Security → SIP Trunk Security Profile

1. **Name***: Non Secure SIP Trunk Profile
2. **Description**: Non Secure SIP Trunk Profile authenticated by null String

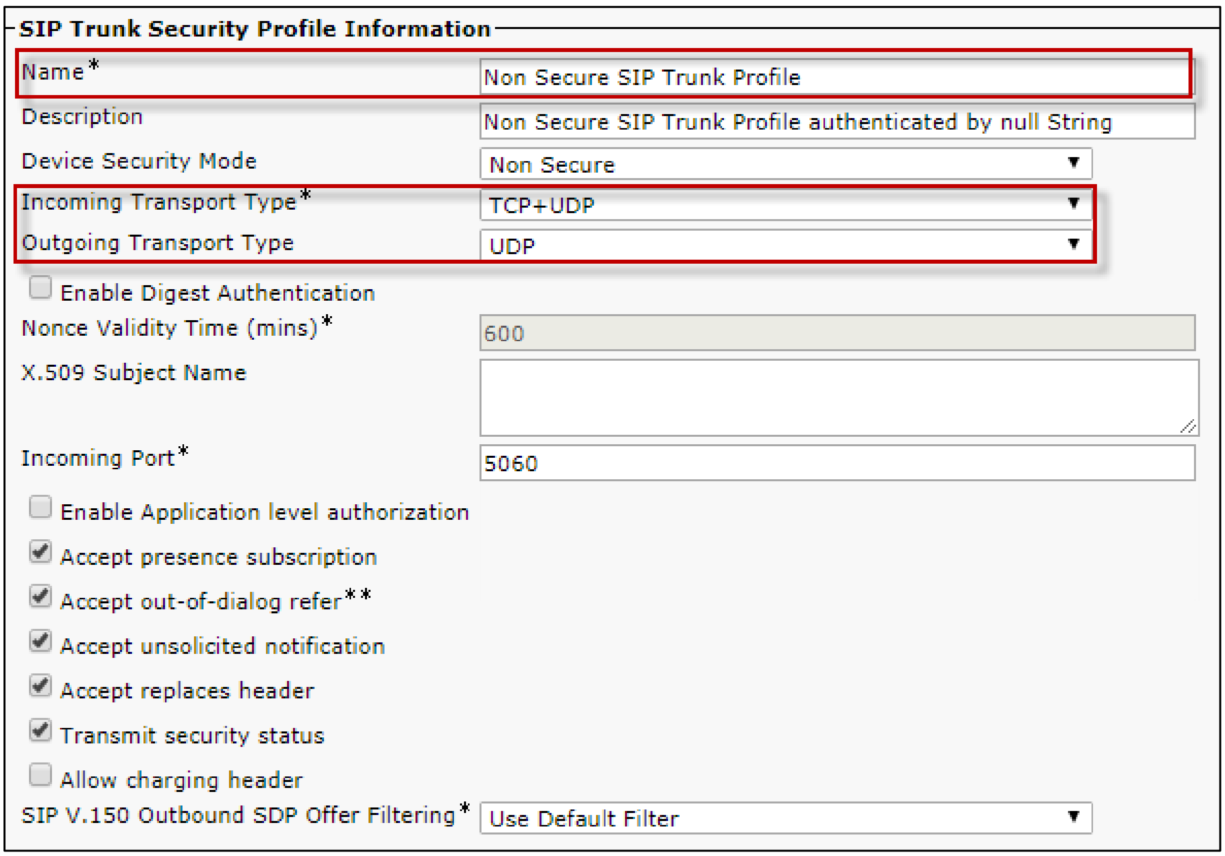


Figure 6: SIP Trunk Security Profile

Explanation

Parameter	Value	Description
Incoming Transport Type	TCP + UDP	
Outgoing Transport Type	UDP	SIP trunks to Sprint SBC should use UDP as a transport protocol for SIP. This is configured using SIP Trunk Security profile, which is later assigned to the SIP trunk itself.

SIP Profile Configuration

SIP Profile will be later associated with the SIP trunk

Navigation: Device → Device Settings → SIP Profile

1. **Name***: Standard SIP Profile
2. **Description**: Default SIP Profile

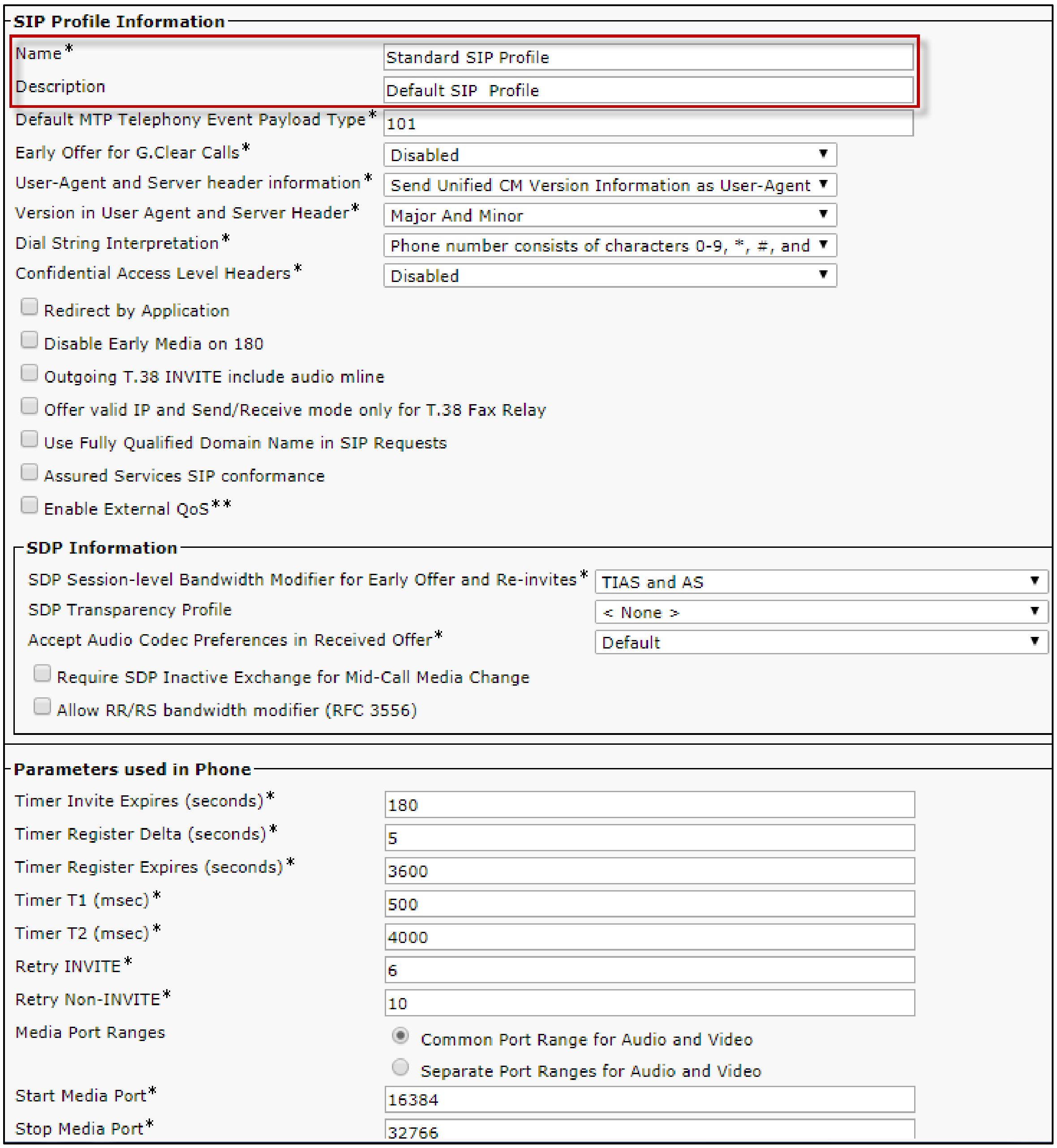


Figure 7: SIP Profile

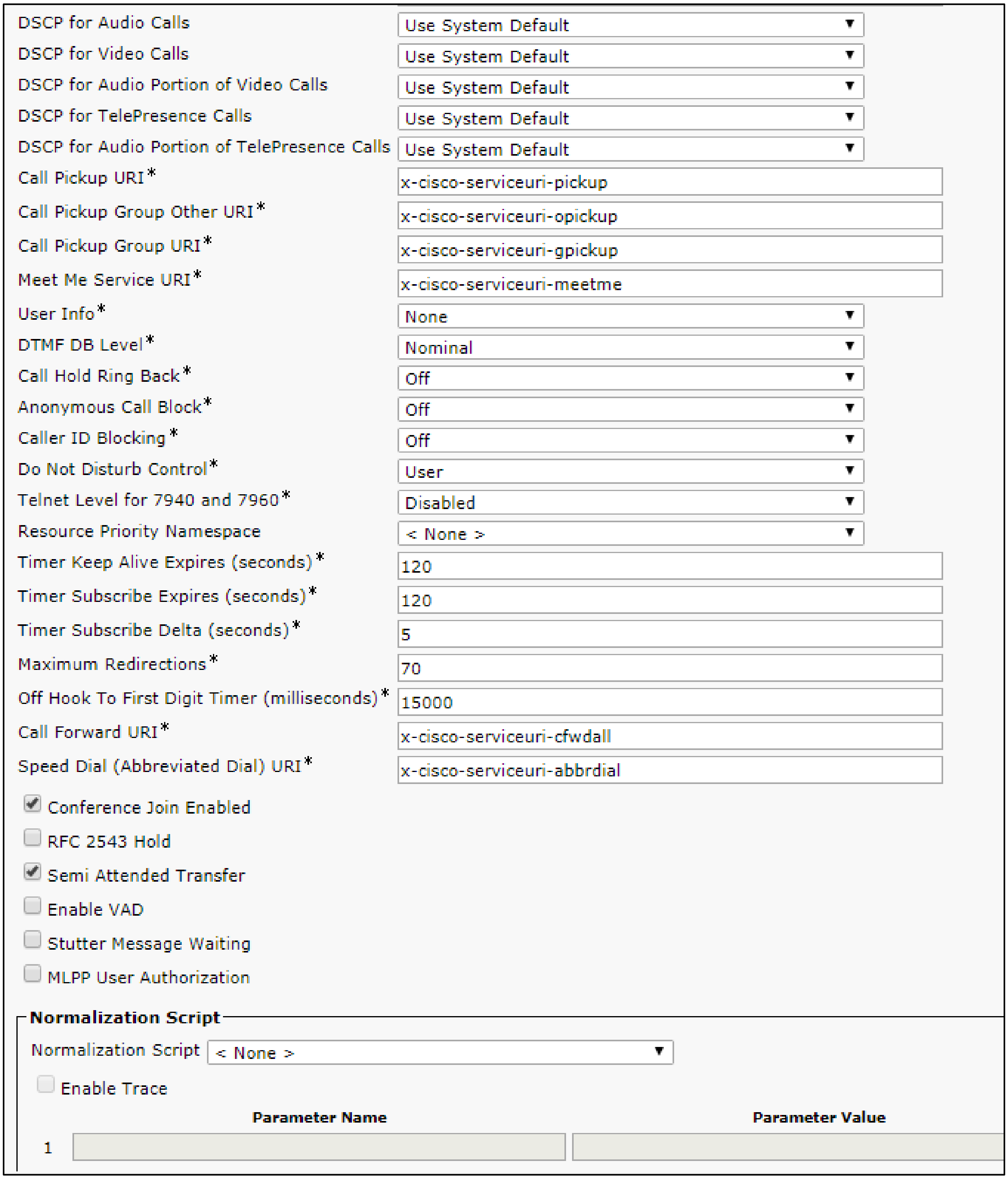


Figure 8: SIP Profile (Cont.)

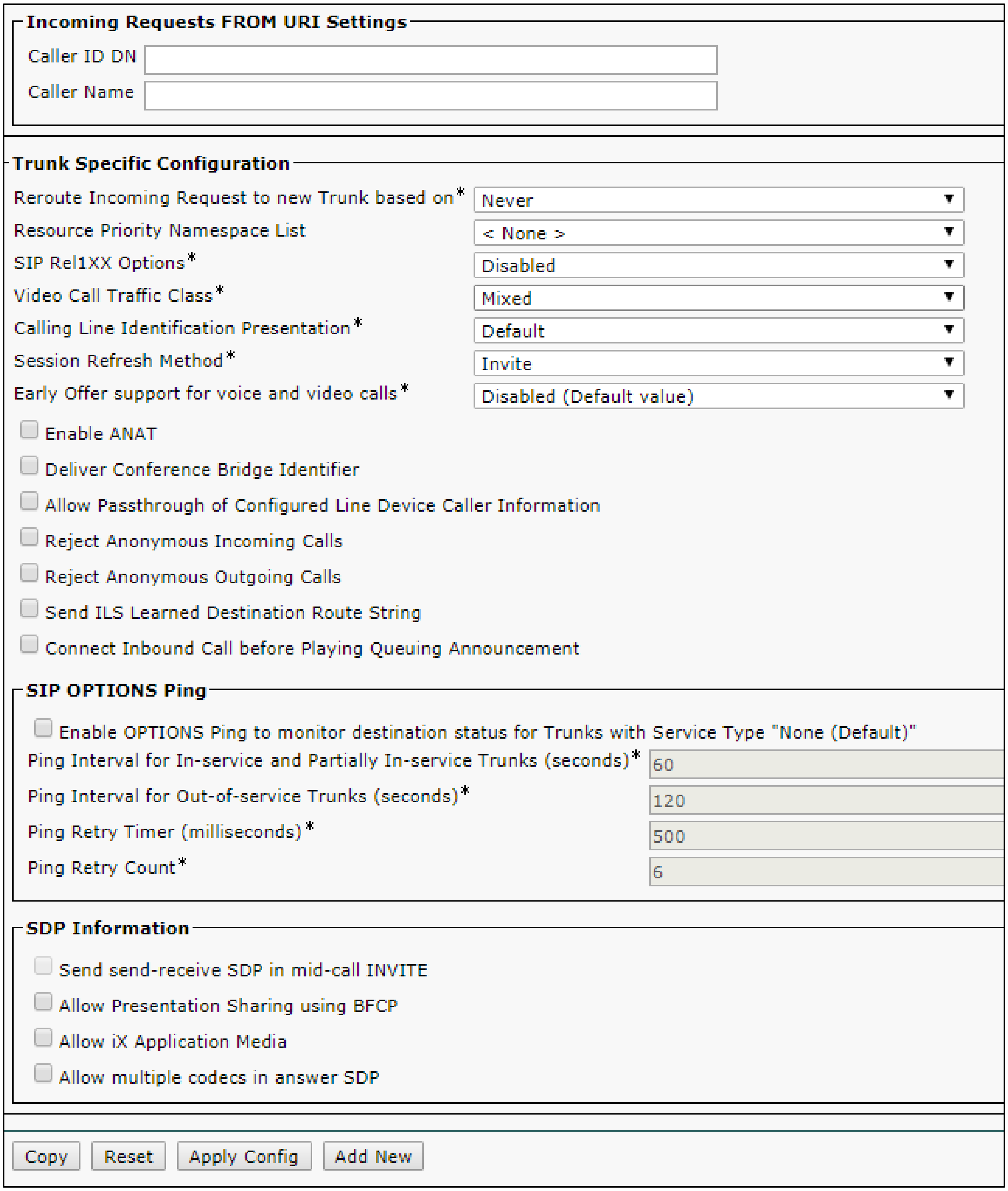
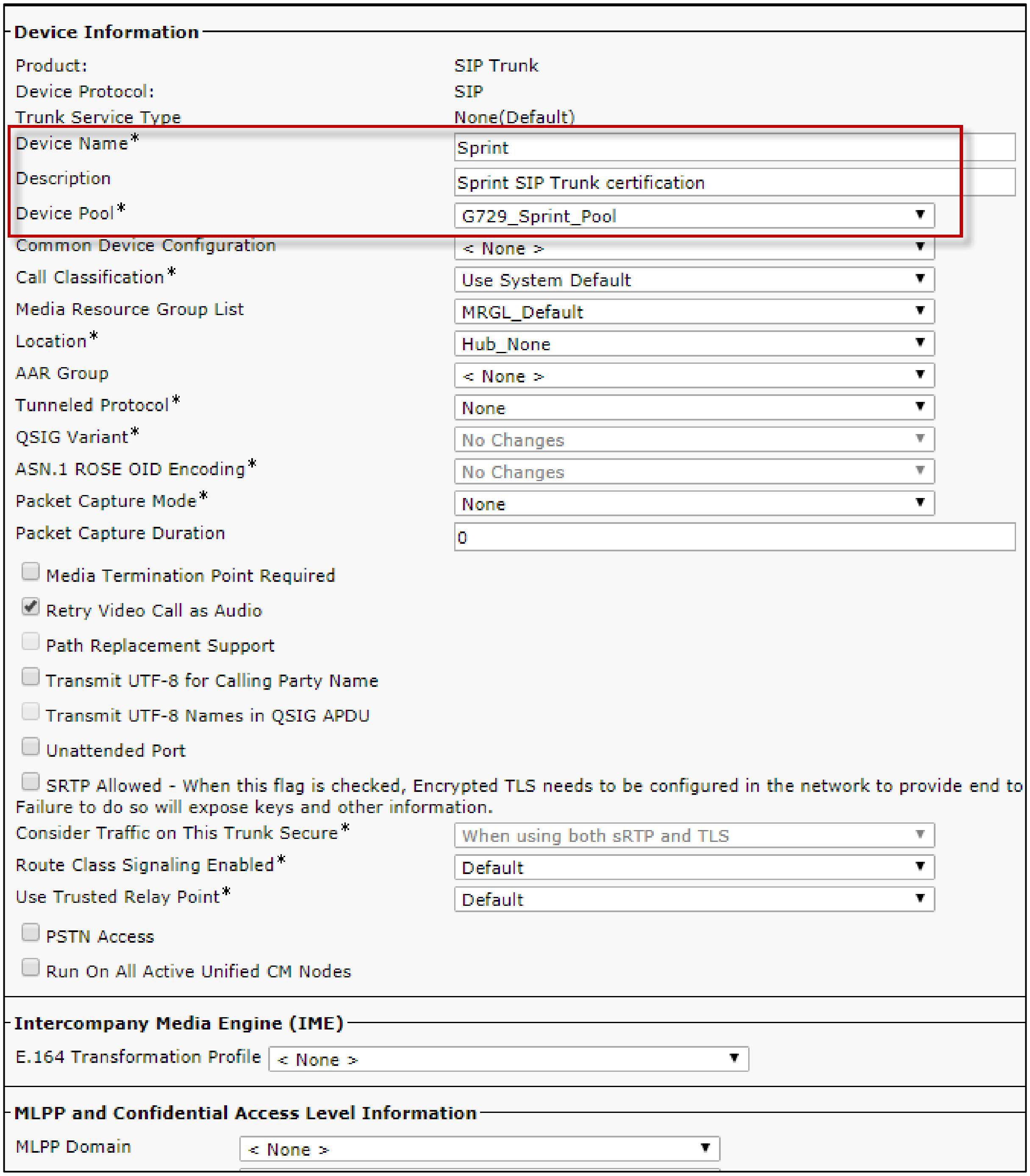


Figure 9: SIP Profile (Cont.)

SIP Trunk Configuration

Create SIP trunks to CUBE

Navigation: Device → Trunk



Device Information

Product:	SIP Trunk
Device Protocol:	SIP
Trunk Service Type	None(Default)
Device Name*	Sprint
Description	Sprint SIP Trunk certification
Device Pool*	G729_Sprint_Pool
Common Device Configuration	< None >
Call Classification*	Use System Default
Media Resource Group List	MRGL_Default
Location*	Hub_None
AAR Group	< None >
Tunneled Protocol*	None
QSIG Variant*	No Changes
ASN.1 ROSE OID Encoding*	No Changes
Packet Capture Mode*	None
Packet Capture Duration	0

- [ ] Media Termination Point Required
- [x] Retry Video Call as Audio
- [ ] Path Replacement Support
- [ ] Transmit UTF-8 for Calling Party Name
- [ ] Transmit UTF-8 Names in QSIG APDU
- [ ] Unattended Port
- [ ] SRTP Allowed - When this flag is checked, Encrypted TLS needs to be configured in the network to provide end to
Failure to do so will expose keys and other information.

Consider Traffic on This Trunk Secure*	When using both sRTP and TLS
Route Class Signaling Enabled*	Default
Use Trusted Relay Point*	Default

- [ ] PSTN Access
- [ ] Run On All Active Unified CM Nodes

Intercompany Media Engine (IME)

E.164 Transformation Profile	< None >

MLPP and Confidential Access Level Information

MLPP Domain	< None >

Figure 10: SIP Trunk to CUBE

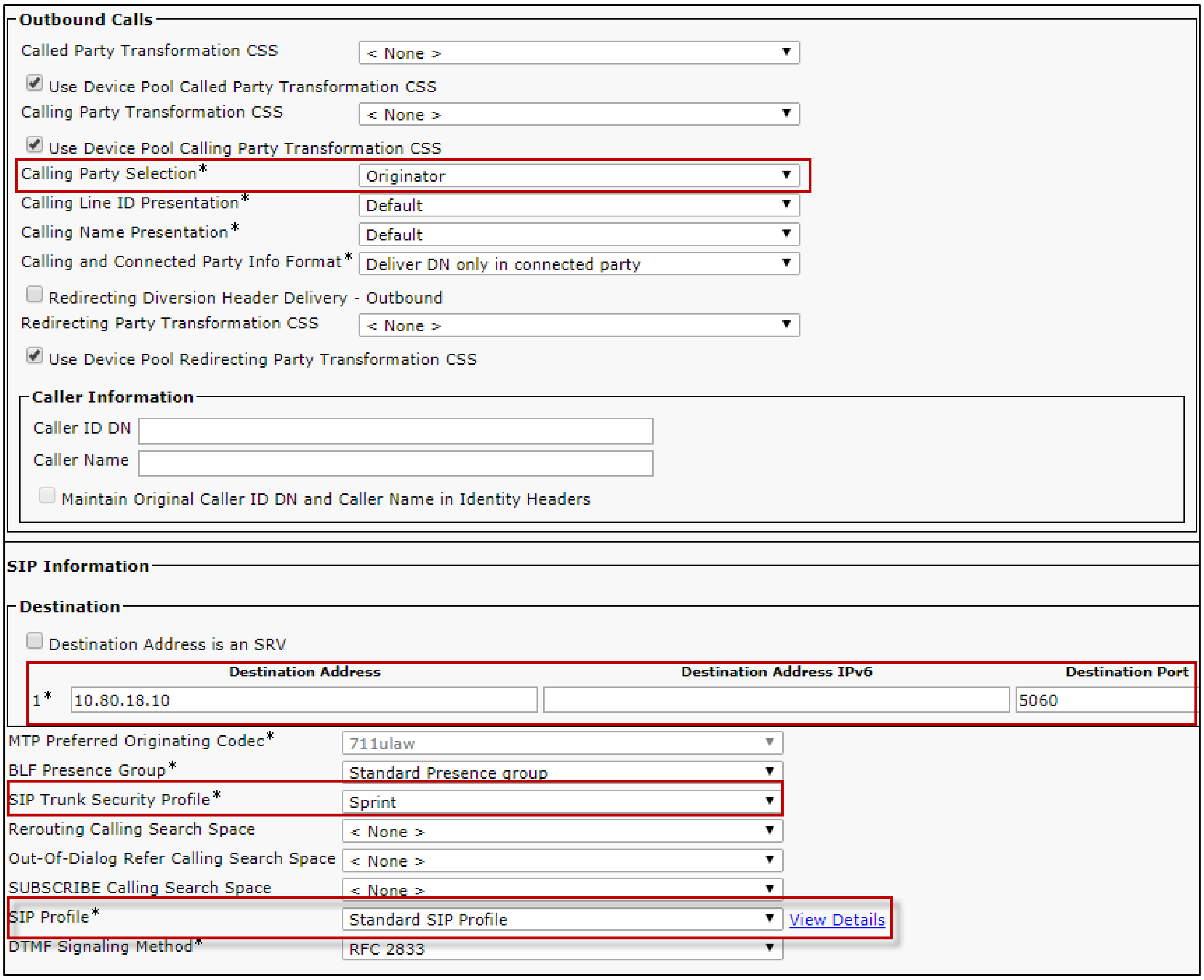


Figure 11: SIP Trunk to CUBE (Cont.)

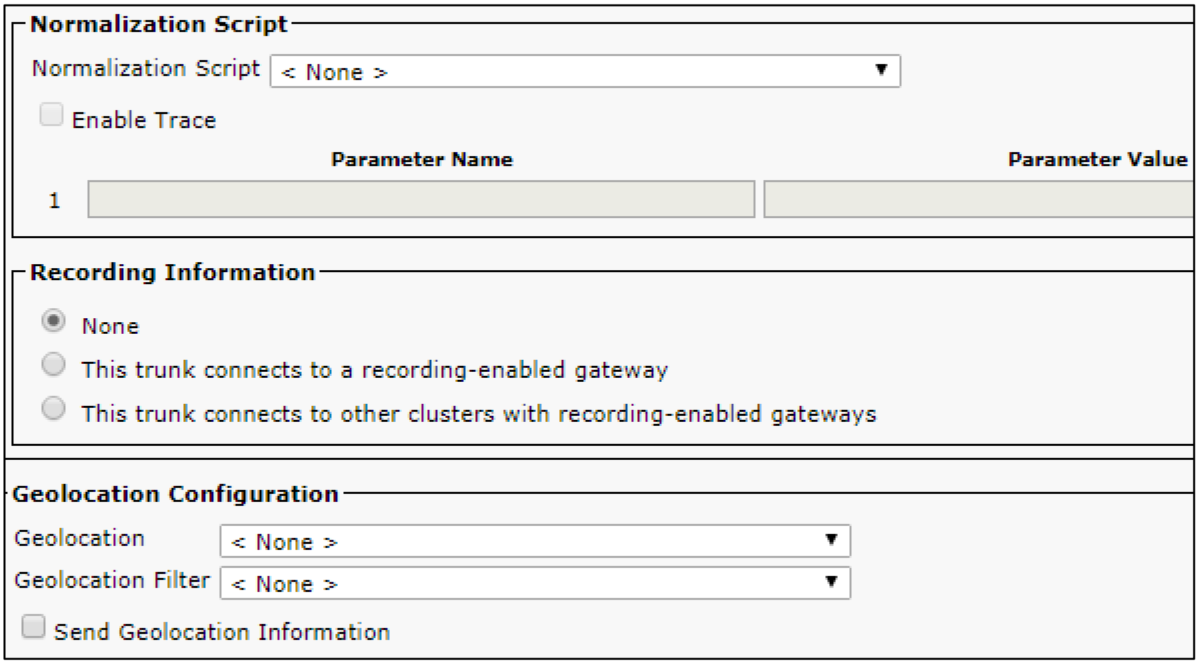


Figure 12: SIP Trunk to CUBE (Cont.)

Explanation

Parameter	Value	Description
Device Name	Sprint	Name for the trunk
Device Pool	G729_Sprint_pool	Default Device Pool is used for this trunk
Significant Digits	4	4 digits Extension for all CPE phones
Destination Address	10.80.11.10	IP address of the CUBE Virtual LAN
SIP Trunk Security Profile	Non Secure SIP Trunk Profile	SIP Trunk Security Profile configured earlier
SIP Profile	Standard SIP Profile	SIP Profile configured earlier

Dial Plan

Route Pattern Configuration

Navigation: Call Routing → Route/Hunt → Route Pattern

Route patterns are configured as below:

- Cisco IP phone dial "71" 10 digits number to access PSTN via CUBE
    - "71" is removed before sending to CUBE
    - "+1" is added to the calling number for outbound calls
    - The rest of the number is sent to CUBE to Sprint network
- Incoming fax call to 1491 will be sent to Cisco Fax ATA

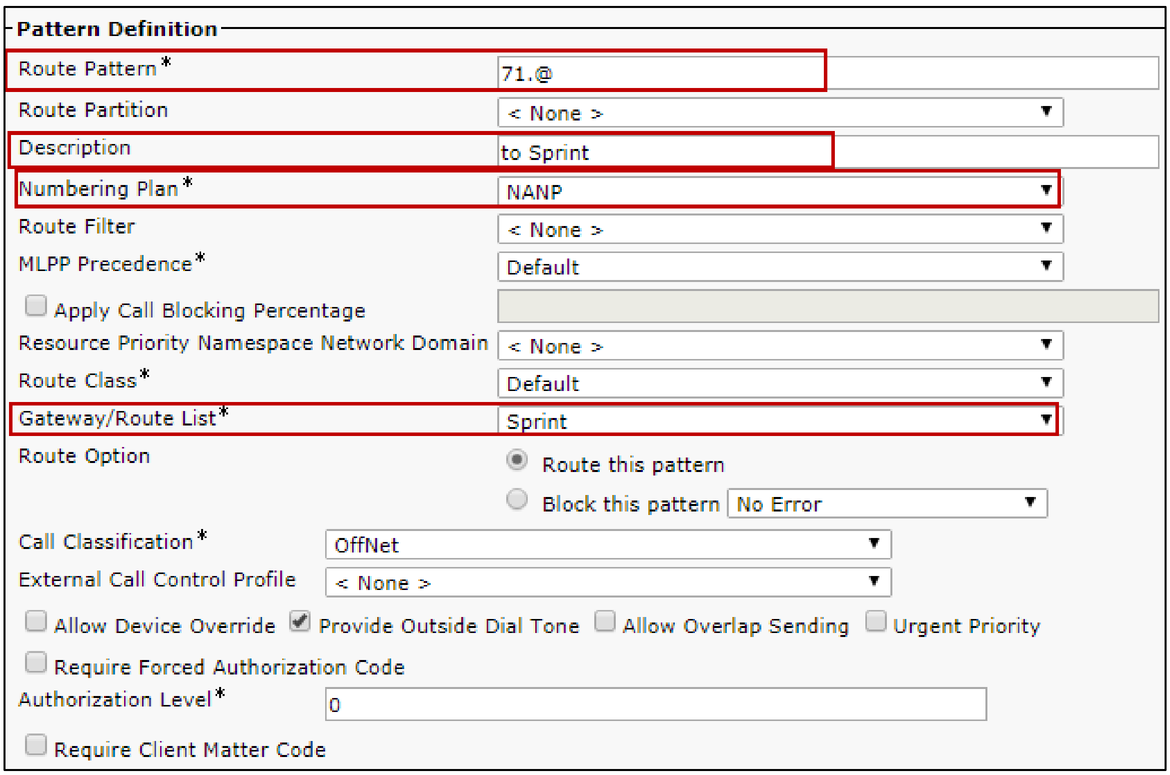


Figure 13: Route Pattern for Voice

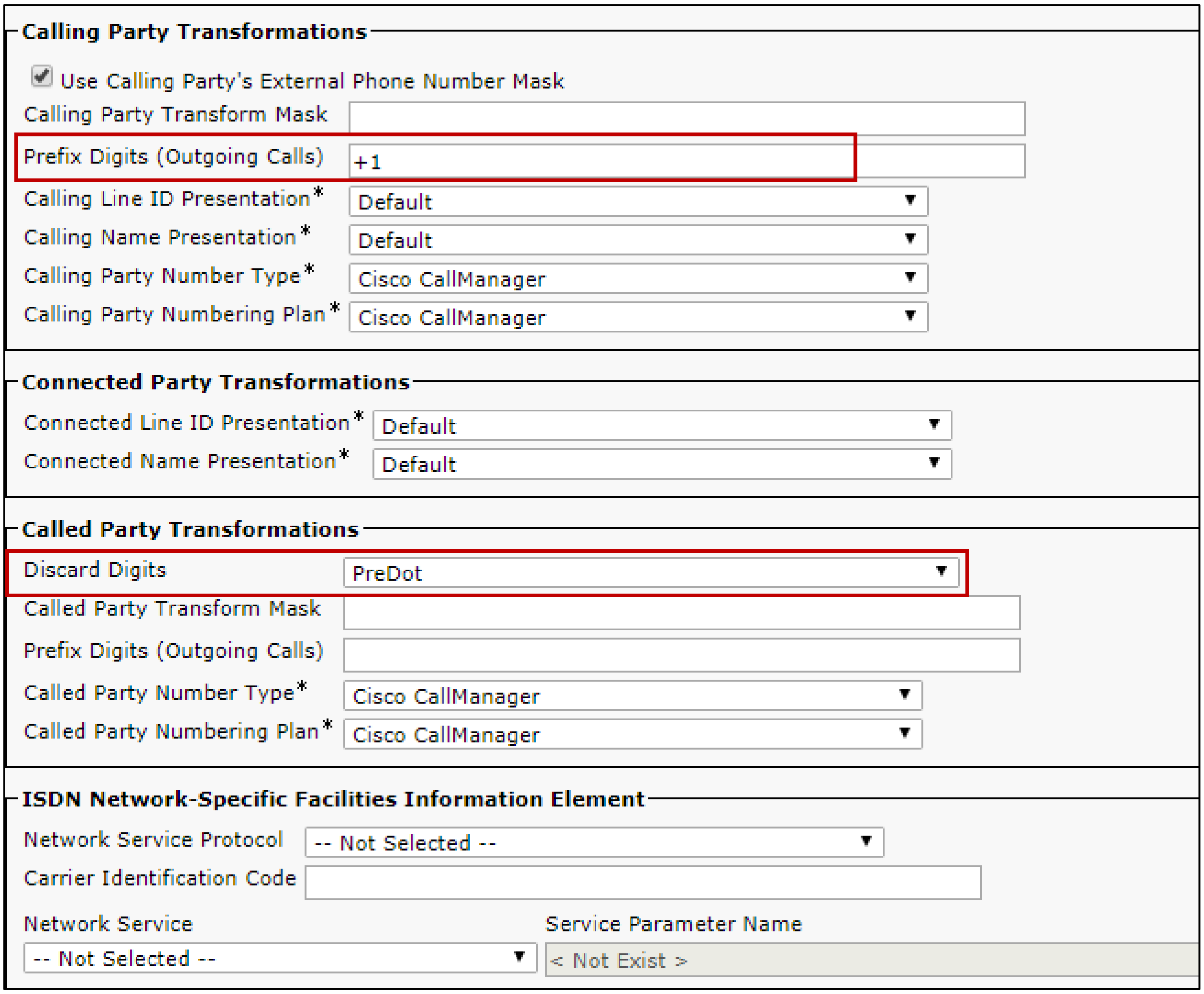


Figure 14: Route Pattern for Voice (Cont.)

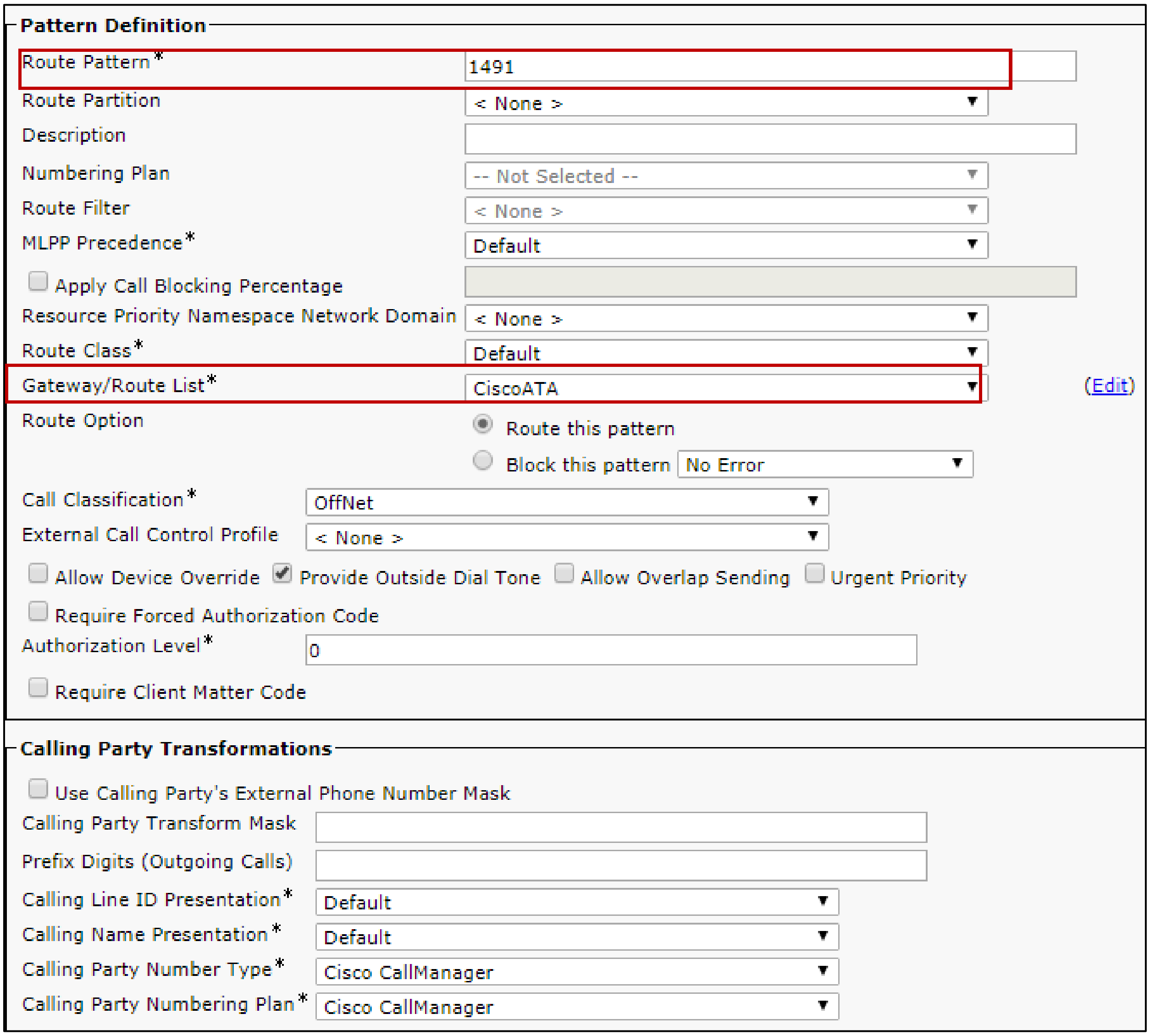


Figure 15: Route Pattern for Voice (Cont.)

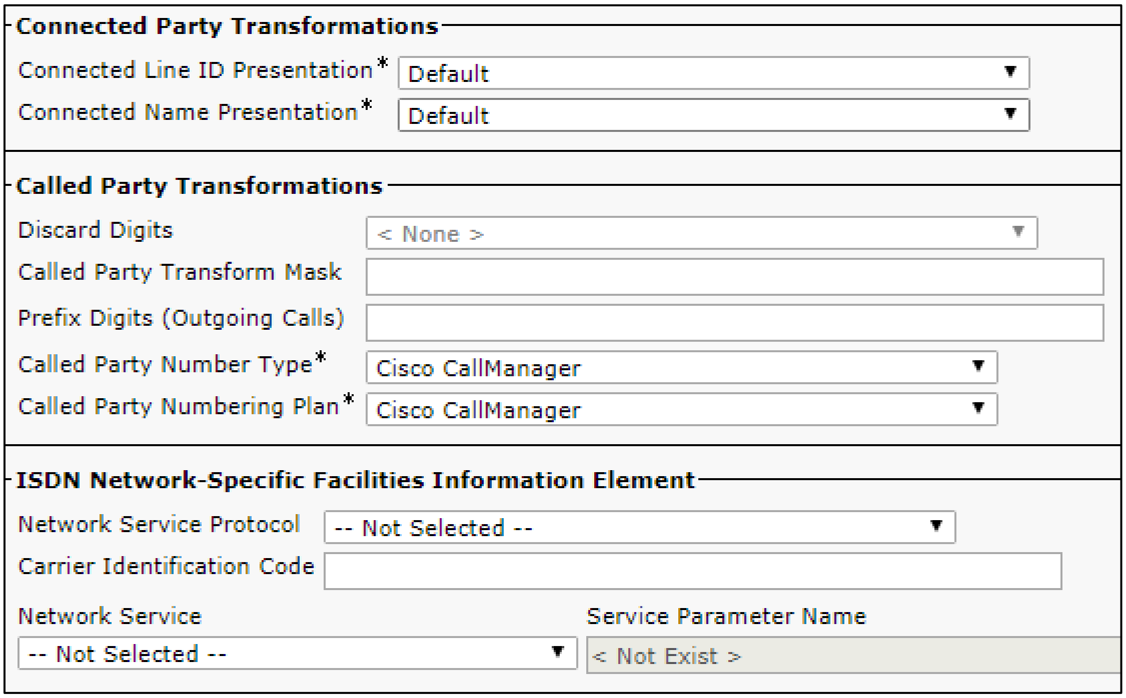


Figure 16: Route Pattern for Voice (Cont.)

Explanation

Setting	Value	Description
Route Pattern	71.@ for Voice & International Calls and 1491 for Fax Call	Specify appropriate Route Pattern
Gateway/Route List	Sprint for Route Pattern 71.@ and 8021 for SIP Trunk To Fax ATA	SIP Trunk name configured earlier
Numbering Plan	NANP for Route Pattern 71.@	North American Numbering Plan
Call Classification	OffNet for Route Pattern 71.@ and 1491	Restrict the transferring of an external call to an external device
Discard Digits	PreDot for Route Pattern 71.@	Specifies how to modify digit before they are sent to Sprint network
Prefix Digits (Outgoing Call)	"+1" is added as prefix from calling party number to convert to E.164 format.	

Acronyms

Acronym	Definition
CPE	Customer Premise Equipment
Cisco UBE	Cisco Unified Border Element
Cisco UCM	Cisco Unified Communications Manager
MTP	Media Termination Point
POP	Point of Presence
PSTN	Public Switched Telephone Network
ESBC	Enterprise Session Border Controller
SCCP	Skinny Client Control Protocol
SIP	Session Initiation Protocol

Important Information

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