Voice Dial Plans, Configuring Voice Interfaces and Dial Peers

Cisco Networking Academy Program
Call Establishment Principles
End-to-End Calls

Source
POTS

R1
Originating Gateway

Packet Network

R2
Terminating Gateway

Destination
POTS

Call Leg 1
(POTS Dial Peer)

Call Leg 2
(Voice-Network Dial Peer)

Call Leg 3
(Voice-Network Dial Peer)

Call Leg 4
(POTS Dial Peer)

R1 Inbound

R1 Outbound

R2 Inbound

R2 Outbound
Configuring Dial Peers
Understanding Dial Peers

• A dial peer is an addressable call endpoint.
• Dial peers establish logical connections, called call legs, to complete an end-to-end call.
• Cisco voice-enabled routers support two types of dial peers:
  POTS dial peers: Connect to a traditional telephony network
  VoIP dial peers: Connect over a packet network
Dial Peer

Voice-Enabled Router

Telephony Device

POTS

VoIP

Packet Network

Voice-Enabled Router
POTS Dial Peers

Dial Peer 1

Voice Port 1/0/0

Router 1

Ext. 7777

Configuration for Dial Peer 1 on R1:

```
Router# configure terminal
Router(config)# dial-peer voice 1 pots
Router(config-dialpeer)# destination-pattern 7777
Router(config-dialpeer)# port 1/0/0
Router(config-dialpeer)# end
```
Practice Item 1: POTS Dial-Peer Configuration

R1: 10.1.1.1

1/0/0

2222

1/1/0

R2: 10.1.1.2

1/0/0

3111

1/0/1

3112

2/1/0

1/1/0

3113

PSTN
VoIP Dial Peers

Configuration for Dial Peer 2 on R1:

```
Router# configure terminal
Router(config)# dial-peer voice 2 voip
Router(config-dialpeer)# destination-pattern 8888
Router(config-dialpeer)# session target ipv4:10.18.0.1
Router(config-dialpeer)# end
```
Practice Item 2: VoIP Dial-Peer Configuration

R1: 10.1.1.1
  1/0/0
  2222
  1/1/0

R2: 10.1.1.2
  1/0/0
  1/0/1
  1/1/0
  3111
  3112
  3113
  2/1/0

PSTN
### Command Syntax: destination-pattern [+ ] *string* [T]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>(Optional) Character indicating an E.164 standard number</td>
</tr>
</tbody>
</table>
| string | Series of digits that specify the E.164 or private dial-plan telephone number. Valid entries are the digits 0 through 9, the letters A through D, and the following special characters:  
  - The asterisk (*) and pound sign (#) that appear on standard touch-tone dial pads.  
  - Comma (,) which inserts a pause between digits.  
  - Period (.) which matches any single entered digit (this character is used as a wildcard).  
  - Brackets ([ ]), which indicate a range. A range is a sequence of characters enclosed in the brackets; only numeric characters from 0 to 9 are allowed in the range. |
| T      | (Optional) Control character indicating that the destination-pattern value is a variable-length dial string |
Default Dial Peer 0

Router 1 Configuration

dial-peer voice 1 pots
destination-pattern 7777
port 1/0/0

dial-peer voice 2 voip
destination-pattern 8888
session target ipv4:10.18.0.1

Router 2 Configuration

dial-peer voice 3 pots
destination-pattern 8888
port 1/1/0

When ext.7777 calls ext. 8888, there is no dial peer on router 2 with
destination pattern 7777 to match the incoming call leg.
Router 2 matches default dial peer 0.
Matching Inbound Dial Peers

Configurable parameters used for matching inbound dial peers:

• incoming called-number
  Defines the called number or DNIS string

• answer-address
  Defines the originating calling number or ANI string

• destination-pattern
  Uses the calling number (originating or ANI string) to match the incoming call leg to an inbound dial peer

• port
  Attempts to match the configured dial-peer port to the voice port associated with the incoming call (POTS dial peers only)
Practice Item 3: Matching Inbound Dial Peers

R1: 10.1.1.1

R2: 10.1.1.2
Desktop Support

R3: 10.1.1.3
Printer Support

R4: 10.1.1.4
Laptop Support

555-0111 – Desktop
555-0122 – Printer
555-0133 – Laptop
Matching Outbound Dial Peers

Destination pattern is matched based on longest number match

dial-peer voice 1 voip
destination-pattern .T
session target ipv4:10.1.1.1

dial-peer voice 2 voip
destination-pattern 55501[3-4].
session target ipv4:10.2.2.2

dial-peer voice 3 voip
destination-pattern 555012.
session target ipv4:10.3.3.3

dial-peer voice 4 voip
destination-pattern 5550124
session target ipv4:10.4.4.4

Example 1: dialed number 555-0124 will match dial peer 4
Example 2: dialed number 555-0125 will match dial peer 3
Example 3: dialed number 555-0135 will match dial peer 2
Example 4: dialed number 555-0199 will match dial peer 1
Hunt-Group Commands

- **preference—dial-peer command**
  Specifies which dial peers in a hunt group will be used first
  Options are 0 through 9 with 0 being most preferred

- **huntstop—dial-peer command**
  Stops dial-peer hunting on the dial peer if it is not matched

- **dial-peer hunt—global command**
  Specifies the global hunt-selection order for all hunt groups
Hunt-Group Configuration

dial-peer voice 1 pots
destination-pattern 5550111
port 1/0/0

dial-peer voice 2 voip
destination-pattern 5550188
session target ipv4:10.18.0.1
preference 0

dial-peer voice 3 pots
destination-pattern 5550188
port 1/1/0
preference 1
forward-digits all

VoIP dial peer 2 will be matched first because preference is 0.
POTS dial peer 3 will be matched next if dial peer 2 is busy or not available.
Practice Item 4: Configuring Hunt Groups
Digit Consumption and Forwarding

POTS dial peers - By default the router consumes the left-justified digits that explicitly match the destination pattern and forwards wildcarded digits

POTS dial peers - Use the no digit-strip command to disable the automatic digit-stripping function

VoIP dial peers - By default the router forwards all digits collected

Example 1 - dialed digits 5550124

```
dial-peer voice 1 pots
destination-pattern 555....
port 1/0:1
```

Explicitly matched digits 555 are consumed and 0124 is forwarded.

Example 2 - dialed digits 5550124

```
dial-peer voice 1 pots
destination-pattern 555....
no digit-strip
port 1/0:1
```

Digits 5550124 are forwarded.
Digit Collection

The router collects digits, one at a time, until it can match an outbound dial peer.

After a match is made, the router immediately places the call.

No further digits are collected.

Example 1 - dialed string is 5550124

```
dial-peer voice 1 voip
destination-pattern 555
session target ipv4:10.18.0.1

dial-peer voice 2 voip
destination-pattern 5550124
session target ipv4:10.18.0.2
```

Dial peer 1 will match first. Only the collected digits of 555 will be forwarded.

Example 2 - dialed string is 5550124

```
dial-peer voice 1 voip
destination-pattern 555....
session target ipv4:10.18.0.1

dial-peer voice 2 voip
destination-pattern 5550124
session target ipv4:10.18.0.2
```

Dial peer 2 will match first. Collected digits of 5550124 will be forwarded.
Digit Manipulation Commands

- **prefix**
  
  **Dial-peer command**
  
  Adds digits to the front of the dial string before it is forwarded to the telephony interface

- **forward-digits**
  
  **Dial-peer command**
  
  Controls the number of digits forwarded to the telephony interface

- **num-exp**
  
  **Global command**
  
  Expands an extension into a full telephone number or replaces one number with another

- **translation-rule**
  
  **Global and dial-peer command**
  
  Digit translation rules used to manipulate the calling number digits, or ANI, or the called number digits, or DNIS, for a voice call
Practice Item 5:
Digit Manipulation

R1: 10.1.1.1
1/0/0

2222
1/1/0

PSTN

R2: 10.1.1.2
1/0/1
2/1/0

3111
1/0/0

3112
1/1/0

3113
Special-Purpose Connections
Special-Purpose Connection Commands

• connection plar
  Associates a voice port directly with a dial peer

• connection plar-opx
  Extends a PBX connection to a remote location

• connection trunk
  Emulates a permanent trunk connection to a PBX

• connection tie-line
  Emulates a temporary tie-line trunk to a PBX
PLAR Connection

Remote Site

```
voice-port 1/0/0
connection plar 5600

dial-peer voice 5 voip
destination-pattern 5...
session target ipv4:10.18.0.1
```

Central Site

```
dial-peer voice 1 pots
destination-pattern 5...
port 1/0:1
forward-digits 4
```

Ext. 5600
PLAR-OPX Connection

Remote Site

Ext. 5701

dial-peer voice 1 pots
destination-pattern 5701
port 1/1/0

Central Site

IP

10.18.0.1

1/0/0

Ext. 5600

voice-port 1/0/0
connection plar-opx 5701

dial-peer voice 10 voip
destination-pattern 5701
session target ipv4:10.0.0.1
Trunk Connection

E & M Wink Start

IP WAN

E & M Wink Start

10.0.0.1

10.18.0.1

Ext. 5600

voice-port 1/0:1
connection trunk 55

dial-peer voice 55 voip
destination-pattern 55
session target ipv4:10.18.0.1

dial-peer voice 44 pots
destination-pattern 44
port 1/0:1

voice-port 1/0:5
connection trunk 44

dial-peer voice 44 voip
destination-pattern 44
session target ipv4:10.0.0.1

dial-peer voice 55 pots
destination-pattern 55
port 1/0:5
Tie-Line Connection

```
voice-port 1/0:1
connection tie-line 55

dial-peer voice 55 voip
destination-pattern 55...
session target ipv4:10.18.0.1

dial-peer voice 44 pots
destination-pattern 44...
port 1/0:1

voice-port 1/0:5
connection tie-line 44

dial-peer voice 44 voip
destination-pattern 44...
session target ipv4:10.0.0.1

dial-peer voice 55 pots
destination-pattern 55...
port 1/0:5
```
Building a Scalable Numbering Plan
Dial plans contain specific dialing patterns for a user who wants to reach a particular telephone number.
Need for a Scalable Numbering Plan
Attributes of a Scalable Numbering Plan

- Logic distribution
- Hierarchical design
- Simplicity in provisioning
- Reduction in postdial delay
- Availability and fault tolerance
Hierarchical Numbering Plans

Long-Distance Carrier → Local Office

Path to 1 (A '1' Indicates Destination Is Not Local)

Path to 703 (An Area Code Summarizes an Area in VA)

Local Office Alexandria → Local Office Virginia

Path to 555 (A Prefix Summarizes a Smaller Area in VA)

Local Office Virginia → Central Controller

Path to 0123 (Subscriber)

Central Controller → Calling Party

1 703 555 0123

Central Controller → Called Party
Challenges Associated with Integration

- Varying number lengths
- Specialized services
- Voice mail
- Necessity of prefixes or area codes
- International dialing consideration
Integrating Internal and Public Numbering Plans

Calling party dials 703-555-0123
Number Normalization

Site E: 703555...
Site F: 202555...
Site D: 10 Digits

Centrex: 10 Digits
Frame Relay: 10 Digits

Site A: 727555...
Site B: 813555...
Site C: 305555...

4 Digits
Configuring Voice Ports
Local Calls

Dial: "555-0188"

PBX

Cisco Voice-Enabled Router

Frame Relay, ATM, IP

Cisco Voice-Enabled Router
On-Net Calls

PBX

Cisco Voice-Enabled Router

555-0123

Frame Relay, ATM, IP

Dial: "555-0123"

Analog

Cisco Voice-Enabled Router
Cisco Voice-Enabled Router

PBX

T1 or E1

Frame Relay, ATM, IP

Cisco Voice-Enabled Router

Configured to Dial: "555-0199"

555-0199
PBX-to-PBX Calls

PBX "A"  555-0199
Cisco Voice-Enabled Router

Frame Relay, ATM, IP

Cisco Voice-Enabled Router

PBX "B"
Cisco CallManager-to-Cisco CallManager
On-Net to Off-Net Call

1. Cisco Voice-Enabled Router
2. Frame Relay, ATM, IP
3. PSTN

Cisco Voice-Enabled Router
Cisco Voice-Enabled Router
FXS Voice Port Configuration

- signal
- cptone
- description
- ring frequency
- ring cadence
- disconnect-ack
- busyout
- station id name
- station id number
FXS Voice Port Configuration

Voice-port configuration on voice-enabled router:

Router# configure terminal
Router (config)# voice-port 1/0/0
Router (config-voiceport)# signal ground-start
Router (config-voiceport)# cpton GB
Router (config-voiceport)# ring cadence pattern01

- Enters voice-port configuration mode
- Enables ground-start signaling
- Sets call-progress tones for Great Britain
- Specifies ring cadence pattern 1
FXO Voice Port Configuration

- signal
- ring number
- dial-type
- description
- supervisory disconnect
FXO Voice Port Configuration

Voice-port configuration on voice-enabled router:

```
Router# configure terminal
Router (config)# voice-port 1/0/0
Router (config-voiceport)# signal loop-start
Router (config-voiceport)# ring number 3
Router (config-voiceport)# dial-type dtmf
```

- Enters voice-port configuration mode
- Enables loop-start signaling
- Sets FXO port to answer after three rings
- Specifies dial type to be DTMF
E&M Voice Port Configuration

- signal
- operation
- type
- auto-cut-through
- description
E&M Voice Port Configuration

Voice port configuration on voice-enabled router:

```
Router# configure terminal
Router (config)# voice port 1/1/1
Router (config-voiceport)# signal wink-start
Router (config-voiceport)# operation 2-wire
Router (config-voiceport)# type 1
```

- Enters voice port configuration mode
- Enables Wink-Start signaling
- Sets operation for two-wire cabling scheme
- Configures type 1 E&M port
Timers and Timing Configuration

- timeouts initial
- timeouts interdigit
- timeouts ringing
- timing digit
- timing interdigit
- timing hookflash-in/hookflash-out
Timers and Timing Configuration

Voice-port configuration on voice-enabled router:

```
Router# configure terminal
Router (config)# voice-port 1/0/0
Router (config-voiceport)# timeouts initial 15
Router (config-voiceport)# timeouts interdigit 15
Router (config-voiceport)# timeouts ringing 60
Router (config-voiceport)# timing hookflash-in 500
```

- Enters voice-port configuration mode
- Sets initial timeout to 15 seconds
- Sets interdigit timeout to 15 seconds
- Sets ringing timeout to 60 seconds
- Sets hookflash-in to 500 ms duration
## Basic T1/E1 Controller Configuration

<table>
<thead>
<tr>
<th>Command</th>
<th>T1</th>
<th>E1</th>
</tr>
</thead>
<tbody>
<tr>
<td>framing</td>
<td>SF, ESF</td>
<td>CRC4, no-CRC4, Australia</td>
</tr>
<tr>
<td>linecode</td>
<td>AMI, B8ZS</td>
<td>AMI, HDB3</td>
</tr>
<tr>
<td>clock source</td>
<td>line, internal</td>
<td>line, internal</td>
</tr>
</tbody>
</table>
T1/E1 Digital-Voice Configuration

- Create digital voice ports with the `ds0-group` command
  
  `ds0-group-no`
  
  `timeslot-list`
  
  `signal-type`
Network Module
Slot 1
VWIC Slot 0

T1

Creates DS0 group, or logical voice port, 1/0:1 by grouping 12 timeslots together

Configures T1 Controller 1/0

calendar t1 1/0
framing esf
clock source line
linecode b8zs
ds0-group 1 timeslots 1-12 type e&m-wink-start
ISDN Configuration

• Global configuration
  isdn switch-type

• T1/E1 controller configuration
  pri-group

• D channel configuration
  isdn incoming-voice configuration

• QSIG configuration
  QSIG signaling
**ISDN Configuration**

Voice port configuration on voice-enabled router:

```
Router (config)# isdn switch-type primary-qsig
Router (config)# controller T1 0/0
Router (config-controller)# pri-group timeslots 1-23
Router (config)# interface serial 0/0:23
Router (config-if)# isdn incoming-voice voice
```

- **QSIG signaling support**
- **PRI timeslot allocation**
- **Sends incoming calls to DSPs**
CCS Options

Transparent Common Channel Signaling (Tie-Line emulation between two PBXs)

Router1 Configuration

Router (config)# controller T1 1/0
Router (config-controller)# ds0-group 1 timeslots 24 type ext-sig
Router (config-controller)# exit
Router (config)# dial-peer voice 1 voip
Router (config-dialpeer)# codec clear-channel
Router (config-dialpeer)# destination-pattern 1000
Router(config-dialpeer)# session target ipv4:10.18.0.1
Router (config-dialpeer)# exit
Router (config)# voice-port 1/0:1
Router (config-voiceport)# connection trunk 1000 answer-mode

Configures the signaling channel for external signaling
Creates a VoIP dial peer
Specifies clear-channel codec to pass signaling through the DSP without compression or processing
Specifies a destination pattern
Specifies IP address of remote site router
Creates a trunk on voice-port 1/0:1 and ties it to the VoIP dial peer with destination pattern = 1000
Verifying and Troubleshooting Voice Ports

1. Check for dial tone (FXS only).
2. Check for DTMF tones (FXS only).
3. **Use** `show voice port` **to check configuration**.
4. **Use** `show voice port` **to ensure port is enabled**.
5. Be sure PBX configuration is compatible with voice port.
6. Check physical installation of hardware.
# Commands to Verify Voice Ports

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show voice port</code></td>
<td>Shows all voice port configurations in detail</td>
</tr>
<tr>
<td><code>show voice port x/y/z</code></td>
<td>Shows one voice port configuration in detail</td>
</tr>
<tr>
<td><code>show voice port summary</code></td>
<td>Shows all voice port configurations in brief</td>
</tr>
<tr>
<td><code>show voice busyout</code></td>
<td>Shows all ports configured as busyout</td>
</tr>
<tr>
<td><code>show voice dsp</code></td>
<td>Shows all DSP status</td>
</tr>
<tr>
<td>`show controller T1</td>
<td>E1`</td>
</tr>
</tbody>
</table>
# Test Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Commands</strong></td>
<td>Forces a detector into specific states for testing. For each signaling type (E&amp;M, FXO, FXS), only the applicable keywords display.</td>
</tr>
<tr>
<td>test voice port detector {M lead</td>
<td>battery-reversal</td>
</tr>
<tr>
<td>test voice port inject-tone {local</td>
<td>network} {1000hz</td>
</tr>
<tr>
<td>test voice port loopback {local</td>
<td>network</td>
</tr>
<tr>
<td>test voice port relay {E lead</td>
<td>loop</td>
</tr>
<tr>
<td>test voice port switch {fax</td>
<td>disable}</td>
</tr>
<tr>
<td>csim xxxx</td>
<td></td>
</tr>
</tbody>
</table>
## ISDN Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>show isdn active</td>
<td>Shows ISDN active calls</td>
</tr>
<tr>
<td>show isdn history</td>
<td>Shows ISDN call history</td>
</tr>
<tr>
<td>show isdn status</td>
<td>Shows ISDN line status</td>
</tr>
<tr>
<td>show isdn timers</td>
<td>Shows ISDN timer values</td>
</tr>
<tr>
<td>debug isdn events</td>
<td>Displays ISDN events</td>
</tr>
<tr>
<td>debug isdn q921</td>
<td>Displays ISDN Q.921 packet history</td>
</tr>
<tr>
<td>debug isdn q931</td>
<td>Displays ISDN Q.931 packet history</td>
</tr>
</tbody>
</table>
Adjusting Voice Quality
Factors That Affect Voice Quality

The following factors affect voice quality:

- Transmit and receive power levels
- Input gain
- Output attenuation
## Calculating Decibel Levels

<table>
<thead>
<tr>
<th>Source 1 Out/In</th>
<th>Router 1 Adjustment</th>
<th>Net at Router 1</th>
<th>WAN</th>
<th>Net at M Router 2</th>
<th>Router 2 Adjustment</th>
<th>Destination 1 In/Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dB --&gt;</td>
<td>-3 dB --&gt;</td>
<td>-3 dB</td>
<td>___</td>
<td>-3 dB</td>
<td>± 6 dB --&gt;</td>
<td>--&gt; -9 dB</td>
</tr>
<tr>
<td>-9 dB &lt;--</td>
<td>&lt;-- ±6 dB</td>
<td>-3 dB</td>
<td>___</td>
<td>-3 dB</td>
<td>-3 dB</td>
<td>&lt;-- 0 dB</td>
</tr>
</tbody>
</table>
Configuring Voice Port Voice-Quality Tuning

- input-gain
- output-attenuation
- impedance
Configuration Examples

Router# configure terminal
Router(config)# voice-port 1/0/0
Router(config-voiceport)# input gain 1
Router(config-voiceport)# no echo-cancel enable
Router(config-voiceport)# impedance 900c
Router(config-voiceport)# exit
Router(config)# voice-port 1/1/0
Router(config-voiceport)# echo-cancel coverage 32
Router(config-voiceport)# output attenuation 0
Router(config-voiceport)# exit

Sets input gain to 1
Disables echo cancellation
Sets impedance to 900c
Sets echo cancellation coverage time to 32 milliseconds
Sets output attenuation to 0 decibels
Echo Cancellation

• Echo cancellation is configured at the voice port level.
• Echo cancellation is enabled by default.
• Echo cancellation coverage adjusts the size of the echo canceller.
• Nonlinear echo cancellation shuts off any signal if near-end speech is detected.
Analog and Digital Voice Interfaces
Local-Loop Connections

A loop is the physical pair of wires from the subscriber to the telephone company switch.
Analog Voice Interface: FXS

Foreign exchange station interface

- Connects directly to analog phones or faxes
- Used to provision local service
- Provides power, call progress tones, and dial tone
Foreign exchange office interface

- Connects directly to office equipment
- Used to make and receive calls from the PSTN
- Can be used to connect through the PSTN to another site
- Answer inbound calls arriving
E&M interface

- E&M interface
- Connects two sites together with a leased connection
- Allows for the use of non PSTN numbers
- Used to create tie-lines
- Commonly used to connect to external Music on Hold sources
Channel Associated Signaling Systems

Extended Superframe

- Audio Address Signaling (DTMF)
- Supervision On/Off Hook
- Address Signaling (Dial Pulse)

Bit Frame
- A: 6th
- B: 12th
- C: 18th
- D: 24th
CAS T1’s have the following characteristics

- Up to 24 Channels for voice
- Each channel is a DS0
- 8000 samples per second
- 1 byte per sample
- Partial T1 may be available
- Signaling travels in-band
Channel Associated Signaling Systems: E1

32 E0 in an E1
2.048 Mbps

E0 no.0
Only contains framing information (time slot no.1)

E0 no.1

E0 no.16
Only contains signaling information (time slot no.17)

E0 no.31
CAS E1’s have the following characteristics

- Up to 30 Channels for voice
- Each channel is a DS0
- 8000 samples per second
- 1 byte per sample
- Partial E1 may be available
- Signaling is carried out of band
Common-Channel Signaling

E1 Time Slot 1

Audio Address Signaling (DTMF)

Supervision On/Off Hook

Address Signaling (Dial Pulse)

Time Slot 17
PRI/BRI

- Allows for a multiple services through one connection
- Well adapted for voice
  - 64kbps channels
  - Q.931 on the D channel
- Supports standards based functions
- Supports proprietary implementations
- International Utilization
Configuring Analog and Digital Voice Interfaces
FXS Voice Port Configuration

- signal
- cptone
- description
- ring frequency
- ring cadence
- disconnect-ack
- busyout
- station id name
- station id number
FXS Voice Port Configuration

CMERouter(config)#voice-port 1/0/0
CMERouter(config-voiceport)#signal loop-start
CMERouter(config-voiceport)#cptone GB
CMERouter(config-voiceport)#ring cadence pattern01
CMERouter(config)#voice-port 1/0/1
CMERouter(config-voiceport)#signal loop-start
CMERouter(config-voiceport)#cptone GB
CMERouter(config-voiceport)#ring cadence pattern02
FXO Voice Port Configuration

- signal
- ring number
- dial-type
- description
- supervisory disconnect
FXO Voice Port Configuration

CMERouter(config)#voice-port 1/1/0
CMERouter(config-voiceport)#signal ground-start
CMERouter(config-voiceport)#ring number 3
CMERouter(config-voiceport)#dial-type dtmf
CMERouter(config-voiceport)#description Connection_to_PSTN
E&M Voice Port Configuration

- signal
- operation
- type
- auto-cut-through
- description
CMERouter(config)#voice-port 1/1/0
CMERouter(config-voiceport)#signal immediate
CMERouter(config-voiceport)#auto-cut-through
CMERouter(config-voiceport)#operation 4-wire
CMERouter(config-voiceport)#type 1
CMERouter(config-voiceport)#description MoH_Device
ISDN Configuration Tasks

• Select the ISDN switch type either globally or on an interface
• The interface setting will override the global setting
• Configure the interface or controller settings
**ISDN BRI Configuration Commands**

CMERouter(config)#

```
isdn switch-type switch-type
```

- Sets the ISDN switch type globally

CMERouter(config)#

```
interface BRI mod/port
```

- Defines a SPID if assigned by the carrier (found in North America)

CMERouter(config-if)#

```
isdn switch-type switch-type
```

- Sets the ISDN switch type on an interface (overrides the global setting if it exists)
ISDN BRI Configuration Commands

```
CMERouter(config-int)#

isdn spid1 spid-number [ldn]
```

- Defines SPID 1 if assigned by the carrier (found in North America)

```
CMERouter(config-int)#

isdn spid2 spid-number [ldn]
```

- Defines SPID 2 if assigned by the carrier (found in North America)
ISDN Configuration Tasks

CMERouter(config)#isdn switch-type basic-5ess
CMERouter(config)#interface bri 0/1
CMERouter(config-int)#isdn spid1 20655512340001
CMERouter(config-int)#isdn spid2 20655512340002
Timers and Timing Configuration

- timeouts initial
- timeouts interdigit
- timeouts ringing
- timing digit
- timing interdigit
- timing hookflash-in/hookflash-out
FXS Voice Port Configuration

FXS Port
1/0/0

CMERouter(config)#voice-port 1/0/0
CMERouter(config-voiceport)#signal loop-start
CMERouter(config-voiceport)#cptone GB
CMERouter(config-voiceport)#ring cadence pattern01
CMERouter(config-voiceport)#timeouts initial 15
CMERouter(config-voiceport)#timeouts interdigit 15
CMERouter(config-voiceport)#timeouts ringing 120
CMERouter(config-voiceport)#timing hookflash-in 500
## Basic T1/E1 Controller Configuration

<table>
<thead>
<tr>
<th>Command</th>
<th>T1</th>
<th>E1</th>
</tr>
</thead>
<tbody>
<tr>
<td>framing</td>
<td>SF, ESF</td>
<td>CRC4, no-CRC4, Australia</td>
</tr>
<tr>
<td>linecode</td>
<td>AMI, B8ZS</td>
<td>AMI, HDB3</td>
</tr>
<tr>
<td>clock source</td>
<td>Line, Internal</td>
<td>Line, internal</td>
</tr>
</tbody>
</table>
Basic T1/E1 Controller Configuration

CMERouter(config-control)#
linecode {ami | b8zs}

• Configures the linecode for a T1 line

CMERouter(config-control)#
linecode {ami | hdb3}

• Configures the linecode for an E1 line
Basic T1/E1 Controller Configuration

CMERouter(config-control)#

framing {sf | esf}

- Configures the framing for a T1 line

CMERouter(config-control)#

framing {crc4 | no-crc4 | australia}

- Configures the framing for a E1 line
Basic T1/E1 Controller Configuration

CMERouter(config-control)#

```plaintext
ds0-group ds0-group-no timeslots timeslot-list type
{e&m-delay-dial | e&m-fgd | e&m-immediate-start | e&m-wink-start | ext-sig | fgd-eana | fxo-ground-start | fxo-loop-start | fxs-ground-start | fxs-loop-start}
```

• Creates the voice ports of the T1 or E1 and the signaling that is used

CMERouter(config-control)#

```plaintext
clock source {line | internal}
```

• Sets the source of the clocking
Basic T1/E1 Controller Configuration

CMERouter(config)#controller T1 1/0
CMERouter(config-controller)#linecode b8zs
CMERouter(config-controller)#framing esf
CMERouter(config-controller)#ds0-group 1 timeslots 1-24 type fxo-groundstart
CMERouter(config-controller)#clock source line

CMERouter(config)#controller E1 1/0
CMERouter(config-controller)#linecode hdb3
CMERouter(config-controller)#framing crc4
CMERouter(config-controller)#ds0-group 1 timeslots 1-15 type e&m-wink-start
CMERouter(config-controller)#clock source line
PRI Reference Points

- ITU-T I.430
- ITU-T I.431
- ANSI T1.601
ISDN PRI Configuration Commands

CMERouter(config)#

isdn switch-type switch-type

• Sets the ISDN switch type globally

CMERouter(config)#

ccontroller {t1 | e1} {slot/port | unit-number}

• Defines a SPID if assigned by the carrier (found in North America)

CMERouter(config-controller)#

isdn switch-type switch-type

• Sets the ISDN switch type on an interface (overrides the global setting if it exists)
ISDN PRI Configuration Commands

CMERouter(config-controller)#

pri-group timeslots range

• Sets the PRI group with a range of timeslots

CMERouter(config-int)#

interface serial slot/port:timeslot

• Sets the PRI D channel
ISDN Configuration Tasks

CMERouter(config)#isdn switch-type primary-ni
CMERouter(config)#controller t1 0/1
CMERouter(config-controller)#pri-group timeslots 1-24
CMERouter(config-controller)#framing esf
CMERouter(config-controller)#linecode b8zs
CMERouter(config-controller)#clock source line
CMERouter(config)#interface serial:23
Dial Peers
What is a Dial Peer?

• A dial peer is an addressable call endpoint.

• Dial peers establish logical connections, called call legs, to complete an end-to-end call.

• Cisco voice-enabled routers support two types of dial peers:
  
  POTS dial peers: Connect to a traditional telephony network

  VoIP dial peers: Connect over a packet network
Dial Peer
POTS Dial Peers

Configuration for Dial Peer 1 on R1:

Router# configure terminal
Router(config)# dial-peer voice 1 pots
Router(config-dialpeer)# destination-pattern 7777
Router(config-dialpeer)# port 1/0/0
Router(config-dialpeer)# end
VoIP Dial Peers

Configuration for Dial Peer 2 on R1:

```
Router# configure terminal
Router(config)# dial-peer voice 2 voip
Router(config-dialpeer)# destination-pattern 8888
Router(config-dialpeer)# session target ipv4:10.18.0.1
Router(config-dialpeer)# end
```
# Destination-Pattern Options

## Command Syntax: destination-pattern [+] string [T]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>(Optional) Character indicating an E.164 standard number</td>
</tr>
<tr>
<td>string</td>
<td>Series of digits that specify the E.164 or private dialing-plan telephone number. Valid entries are the digits 0 through 9, the letters A through D, and the following special characters:</td>
</tr>
<tr>
<td></td>
<td>• The asterisk (*) and pound sign (#) that appear on standard touch-tone dial pads</td>
</tr>
<tr>
<td></td>
<td>• Comma (,) which inserts a pause between digits</td>
</tr>
<tr>
<td></td>
<td>• Period (.) which matches any single entered digit (this character is used as a wildcard)</td>
</tr>
<tr>
<td></td>
<td>• Brackets ([ ]), which indicate a range. A range is a sequence of characters enclosed in the brackets; only numeric characters from 0 to 9 are allowed in the range</td>
</tr>
<tr>
<td>T</td>
<td>(Optional) Control character indicating that the destination-pattern value is a variable-length dial string</td>
</tr>
</tbody>
</table>
Default Dial Peer 0

Router 1 Configuration

dial-peer voice 1 pots
destination-pattern 7777
port 1/0/0

dial-peer voice 2 voip
destination-pattern 8888
session target ipv4:10.18.0.1

Router 2 Configuration

dial-peer voice 3 pots
destination-pattern 8888
port 1/1/0

When ext. 7777 calls ext. 8888, there is no dial peer on router 2 with
destination pattern 7777 to match the incoming call leg.
Router 2 matches default dial peer 0.
Call Setup and Digit Manipulation
End-to-End Calls

Source
POTS

R1
Originating Gateway

Packet Network

R2
Terminating Gateway

Destination
POTS

Call Leg 1
(POTS Dial-Peer)

Call Leg 2
(Voice-Network Dial-Peer)

Call Leg 3
(Voice-Network Dial-Peer)

Call Leg 4
(POTS Dial-Peer)

R1 Inbound
R1 Outbound
R2 Inbound
R2 Outbound
Matching Inbound Dial Peers

Configurable parameters used for matching inbound dial peers:

- **incoming called-number**
  Defines the called number or dialed number identification service (DNIS) string

- **answer-address**
  Defines the originating calling number or automatic number identification (ANI) string

- **destination-pattern**
  Uses the calling number (originating or ANI string) to match the incoming call leg to an inbound dial peer

- **port**
  Attempts to match the configured dial-peer port to the voice-port associated with the incoming call (POTS dial peers only)
Matching Outbound Dial Peers

Destination pattern is matched based on longest number match

```
Dial-peer voice 1 voip
Destination-pattern .T
Session target ipv4:10.1.1.1

Dial-peer voice 2 voip
Destination-pattern 555[2-3]...
Session target ipv4:10.2.2.2

Dial-peer voice 3 voip
Destination-pattern 5551...
Session target ipv4:10.3.3.3

Dial-peer voice 4 voip
Destination-pattern 5551234
Session target ipv4:10.4.4.4
```

Example 1: dialed number 555-1234 will match dial peer 4
Example 2: dialed number 555-1235 will match dial peer 3
Example 3: dialed number 555-2000 will match dial peer 2
Example 4: dialed number 551-1234 will match dial peer 1
Digit Consumption and Forwarding

POTS dial peers - by default the router consumes the left-justified digits that explicitly match the destination pattern and forwards wildcarded digits.

POTS dial peers - use the no digit-strip command to disable the automatic digit-stripping function.

VoIP dial peers - by default the router forwards all digits collected.

Example 1 - dialed digits 5551234

```
dial-peer voice 1 pots
destination-pattern 555...
port 1/0:1
```

Explicitly matched digits 555 are consumed and 1234 is forwarded.

Example 2 - dialed digits 5551234

```
dial-peer voice 1 pots
destination-pattern 555...
no digit-strip
port 1/0:1
```

Digits 5551234 are forwarded.
Digit Collection

The router collects digits, one at a time, until it can match an outbound dial peer.

After a match is made, the router immediately places the call.

No further digits are collected.

Example 1 - dialed string is 5551234

dial-peer voice 1 voip
destination-pattern 555
session target ipv4:10.18.0.1

Dial peer 1 will match first.
Only the collected digits of 555 will be forwarded.

dial-peer voice 2 voip
destination-pattern 5551234
session target ipv4:10.18.0.2

Example 2 - dialed string is 5551234

dial-peer voice 1 voip
destination-pattern 555....
session target ipv4:10.18.0.1

dial-peer voice 2 voip
destination-pattern 5551234
session target ipv4:10.18.0.2

Dial peer 2 will match first.
Collected digits of 5551234 will be forwarded.
Digit Manipulation Commands

- **prefix**
  - Dial-peer command
  - Adds digits to the front of the dial string before it is forwarded to the telephony interface

- **forward-digits**
  - Dial-peer command
  - Controls the number of digits forwarded to the telephony interface

- **number expansion table**
  - Global command (num-exp)
  - Expands an extension into a full telephone number or replaces one number with another

- **digit translation**
  - Global and dial-peer command
  - Digit translation rules are used to manipulate the calling number, or ANI, or the called number, or DNIS, digits for a voice call
PLAR Connection

Remote Site

voice-port 1/0/0
connection plar 5600

dial-peer voice 5 voip
destination-pattern 5...
session target ipv4:10.18.0.1

Central Site

10.18.0.1

dial-peer voice 1 pots
destination-pattern 5...
port 1/0:1
forward-digits 4

Ext. 5600
Class of Restriction (COR)

• Provides a way to deny certain calls based upon the incoming and outgoing settings on dial-peers or ephone-dns

• Each dial-peer or ephone-dn can have one incoming COR and one outgoing COR

• Can be used to control access to dialable destinations that are internal to the enterprise or external to the enterprise

• Incoming COR list indicates the capacity of the dial peer to initiate certain classes of calls.

• Outgoing COR list indicates the capacity required for an incoming dial peer to deliver a call via this outgoing dial peer.
Class of Restriction

Incoming COR

- The incoming COR is like having one or more keys
- The lack of an incoming COR is like having a master key that can unlock all locks

Outgoing COR

- The outgoing COR is like a lock or locks
- The lack of an outgoing COR is like having no lock
# Class of Restriction

<table>
<thead>
<tr>
<th>COR List on Incoming dial-peer or ephone-dn</th>
<th>COR List on Outgoing dial-peer or ephone-dn</th>
<th>Result</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>No COR</td>
<td>No COR</td>
<td>Call Succeeds</td>
<td>COR not applied</td>
</tr>
<tr>
<td>No COR</td>
<td>Outgoing COR applied</td>
<td>Call Succeeds</td>
<td>The no (null) incoming COR condition has the highest COR priority</td>
</tr>
<tr>
<td>Incoming COR applied</td>
<td>No COR</td>
<td>Call Succeeds</td>
<td>The incoming COR list is a superset of the no (null) outgoing COR list</td>
</tr>
<tr>
<td>Incoming COR applied is a superset of outgoing COR</td>
<td>Outgoing COR applied</td>
<td>Call Succeeds</td>
<td>The incoming COR list is a superset of the outgoing COR list</td>
</tr>
<tr>
<td>Incoming COR applied not a superset of outgoing COR</td>
<td>Outgoing COR applied</td>
<td>Call cannot be completed</td>
<td>The incoming COR list is NOT a superset of the outgoing COR list</td>
</tr>
</tbody>
</table>
Steps to Configure Class of Restriction

• Step 1 – Configure the Class of Restriction names
• Step 2 – Configure the Class of Restriction lists and members
• Step 3 – Assign the COR list to the dial peers
• Step 4 - Assign the COR to the ephone-dns
Steps to Configure Class of Restriction

Step 1 – Configure the Class of Restriction names

CMERouter(config)#

dial-peer cor custom

• Enters COR config mode where classes of restrictions are specified

CMERouter(config-dp-cor)#

name class-name

• Used to specify a class of restriction
Steps to Configure Class of Restriction

Step 2 – Configure the Class of Restriction lists and members

CMERouter(config)#

dial-peer cor list list-name

• Provides a name for a list of restrictions

CMERouter(config-dp-corlist)#

member class-name

• Adds a COR class to this list of restrictions
Steps to Configure Class of Restriction

Step 3 – Assign the COR list to the dial peers

CMERouter(config)#

```bash
dial-peer voice number {pots | voip}
```

- Defines a dial-peer and enters dial-peer config mode

CMERouter(config-dial-peer)#

```bash
corlist {incoming | outgoing} list-name
```

- Specifies a COR list to be used when the dial-peer is either the incoming or outgoing dial-peer
Steps to Configure Class of Restriction

Step 4 – Assign the COR list to the ephone-dns

CMERouter(config)#
ephone-dn  tag

- Defines an ephone-dn and enters ephone-dn mode

CMERouter(config-ephone-dn)#
cor {incoming | outgoing} list-name

- Specifies a COR list to be used when the ephone-dn is used as either the incoming or outgoing part of a call
Class of Restriction (COR)

dial-peer cor custom
  name 1xxx
  name 2xxx
dial-peer cor list Executive
  member 1xxx
  member 2xxx
dial-peer cor list Employee
  member 1xxx
ephone-dn 1
  number 1000
cor incoming Employee
ephone-dn 2
  number 2000
cor outgoing Executives

- The executive can call the employee but the employee cannot call the executive
- The incoming COR Employee is not a superset of the Executive, so the call will not succeed
Class of Restriction – Case Study

Class of Restriction Case Study – XYZ company

- The XYZ company wishes to prevent toll fraud by restricting the destinations on the PSTN that IP phones and analog phones attached to FXS port can call.
- There should be no restrictions internally; everyone internal should be able to call anyone else internal
- All phones MUST be able to call 911
- Within the XYZ company there are Lobby phones, Employee phones, Sales, and Executive phones
- The Lobby phone should be able to call only 911 on the PSTN
- The Employee phones should be able to call 911 and local calls on the PSTN
- The Sales phones should be able to call 911, local calls, and domestic long distance on the PSTN
- The executives should be able to call 911, local call, domestic long distance, and international on the PSTN
- No one should be able to call 900 numbers
Class of Restriction – Case Study

- • Step 1 - Define the classes of restriction

```plaintext
dial-peer cor custom
  name 911
  name local
  name long_distance
  name international
  name 900
```

911
local
long_distance
international
900
### Class of Restriction – Case Study

**Step 2 – Define the COR lists and members**

<table>
<thead>
<tr>
<th>COR List</th>
<th>Call Extension</th>
<th>Corresponding Members</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>call911</code></td>
<td></td>
<td>911</td>
</tr>
<tr>
<td><code>callLocal</code></td>
<td></td>
<td><code>local</code></td>
</tr>
<tr>
<td><code>callLD</code></td>
<td></td>
<td><code>long_distance</code></td>
</tr>
<tr>
<td><code>callInt</code></td>
<td></td>
<td><code>international</code></td>
</tr>
<tr>
<td><code>call900</code></td>
<td></td>
<td>900</td>
</tr>
<tr>
<td><code>Lobby</code></td>
<td></td>
<td>911</td>
</tr>
<tr>
<td><code>Employee</code></td>
<td></td>
<td>911, <code>local</code></td>
</tr>
<tr>
<td><code>Sales</code></td>
<td></td>
<td>911, <code>long_distance</code></td>
</tr>
<tr>
<td><code>Executive</code></td>
<td></td>
<td>911, <code>local</code>, <code>long_distance</code>, <code>international</code></td>
</tr>
</tbody>
</table>

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Step 3 – Assign the COR to the PSTN dial-peers

- Dial-peer 1 – COR out call911
  - `dial-peer voice 1 pots`
  - `destination-pattern 911`
  - `port 1/0/0`
  - `corlist outgoing call911`

- Dial-peer 2 – COR out callLD
  - `dial-peer voice 2 pots`
  - `destination-pattern 1[2-9]..[2-9]......`
  - `port 1/0/0`
  - `corlist outgoing callLD`

- Dial-peer 3 – COR out callLocal
  - `dial-peer voice 3 pots`
  - `destination-pattern [2-9]......`
  - `port 1/0/0`
  - `corlist outgoing callLocal`

- Dial-peer 4 – COR out callInt
  - `dial-peer voice 5 pots`
  - `destination-pattern 1011T`
  - `port 1/0/0`
  - `corlist outgoing callInt`

- Dial-peer 5 – COR out call900
  - `dial-peer voice 6 pots`
  - `destination-pattern 1900......`
  - `port 1/0/0`
  - `corlist outgoing call900`
Class of Restriction – Case Study

• Step 4 – Assign the COR to the ephone-dns

- ephone-dn 1
  number 1001
  cor incoming Lobby

- ephone-dn 2
  number 1002
  cor incoming Employee

- ephone-dn 3
  number 1003
  cor incoming Sales

- ephone-dn 4
  number 1004
  cor incoming Executive
Results:

- The Lobby ephone-dn can only call 911 on the PSTN
- The Employee ephone-dn can call 911 and local calls on the PSTN
- The Sales ephone-dn can call 911, local calls, and long distance on the PSTN
- The Executive ephone-dn can call 911, local calls, long distance, and international on the PSTN
- No one can call 900 numbers