

Configuring Dial Peers

Understanding Dial Peers

This topic describes dial peers and their applications.

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**

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When a call is placed, an edge device generates dialed digits as a way of signaling where the call should terminate. When these digits enter a router voice port, the router must have a way to decide whether the call can be routed, and where the call can be sent. The router does this by looking through a list of dial peers.

A dial peer is an addressable call endpoint. The address is called a *destination pattern* and is configured in every dial peer. Destination patterns can point to one telephone number only or to a range of telephone numbers. Destination patterns use both explicit digits and wildcard variables to define a telephone number or range of numbers.

The router uses dial peers to establish logical connections. These logical connections, known as call legs, are established in either an inbound or outbound direction.

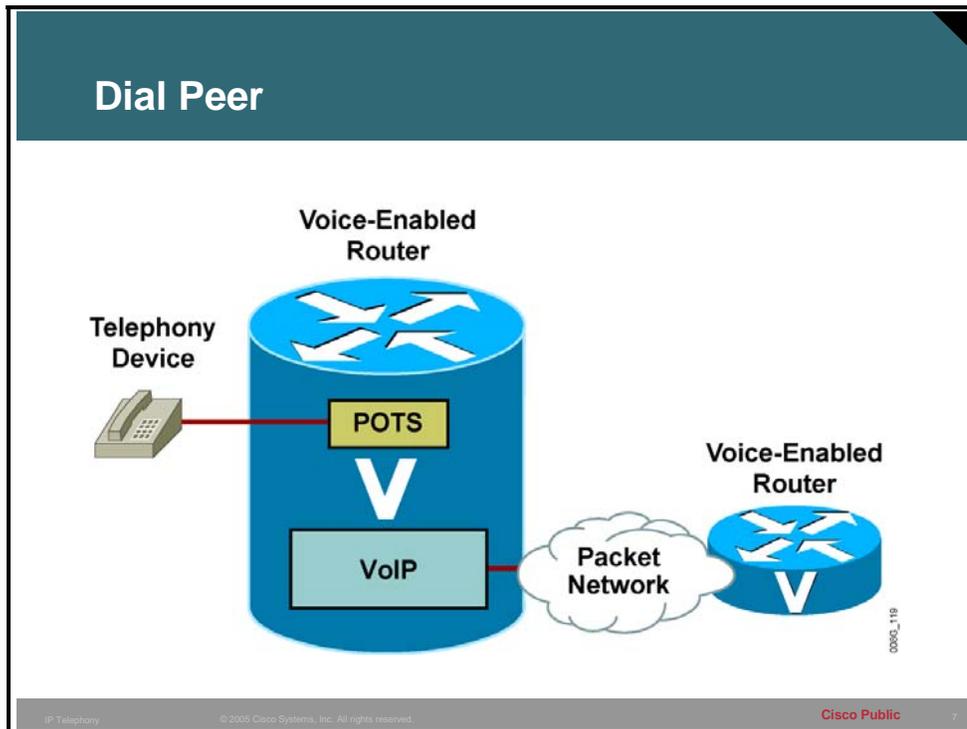
Dial peers define the parameters for the calls that they match; for example, if a call is originating and terminating at the same site, and is not crossing through slow-speed WAN links, then the call can cross the local network uncompressed and without special priority. A call that originates locally and crosses the WAN link to a remote site may require compression with a specific coder-decoder (codec). In addition, this call may require that voice activity detection (VAD) be turned on, and will need to receive preferential treatment by specifying a higher priority level.

Cisco Systems voice-enabled routers support two types of dial peers:

- **POTS dial peers:** Connect to a traditional telephony network, such as the public switched telephone network (PSTN) or a PBX, or to a telephony edge device such as a telephone or fax machine. POTS dial peers perform these functions:
 - Provide an address (telephone number or range of numbers) for the edge network or device
 - Point to the specific voice port that connects the edge network or device
- **VoIP dial peers:** Connect over a packet network. VoIP dial peers perform these functions:
 - Provide a destination address (telephone number or range of numbers) for the edge device that is located across the network
 - Associate the destination address with the next-hop router or destination router, depending on the technology used

Example: Dial-Peer Configuration

This figure shows a dial-peer configuration.



In the figure, the telephony device connects to the Cisco Systems voice-enabled router. The POTS dial-peer configuration includes the telephone number of the telephony device and the voice port to which it is attached. The router knows where to forward incoming calls for that telephone number.

The Cisco voice-enabled router VoIP dial peer is connected to the packet network. The VoIP dial-peer configuration includes the destination telephone number (or range of numbers) and the next-hop or destination voice-enabled router network address.

Follow these steps to place a VoIP call:

How to Place a VoIP Call

Step	Action
1.	Configure the source router with a compatible dial peer that specifies the recipient destination address.
2.	Configure the recipient router with a POTS dial peer that specifies which voice port the router uses to forward the voice call.

Configuring POTS Dial Peers

This topic describes how to configure POTS dial peers.

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
```

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Before the configuration of Cisco IOS dial peers can begin, the user must have a good understanding of where the edge devices reside, what type of connections need to be made between these devices, and what telephone numbering scheme is applied to the devices.

Follow these steps to configure POTS dial peers:

How to Configure POTS Dial Peers

Step	Action
1.	Configure a POTS dial peer at each router or gateway where edge telephony devices connect to the network.
2.	Use the destination-pattern command in the dial peer to configure the telephone number.
3.	Use the port command to specify the physical voice port that the POTS telephone is connected to.

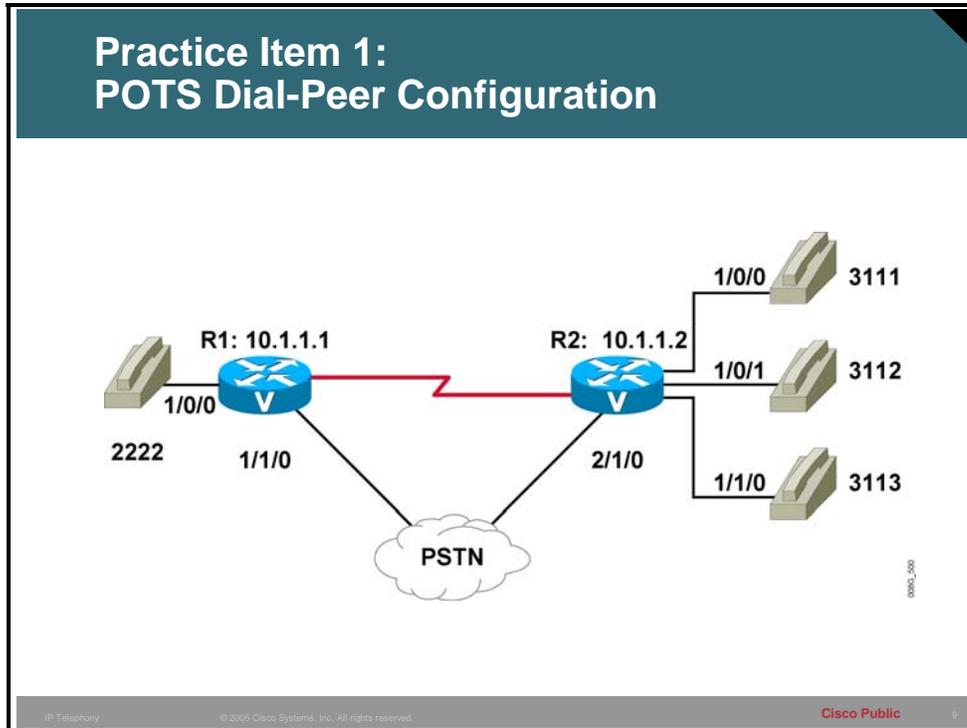
The dial-peer type will be specified as POTS because the edge device is directly connected to a voice port and the signaling must be sent from this port to reach the device. There are two basic parameters that need to be specified for the device: the telephone number and the voice port. When a PBX is connecting to the voice port, a range of telephone numbers can be specified.

Example: POTS Dial-Peer Configuration

The figure illustrates proper POTS dial-peer configuration on a Cisco voice-enabled router. The **dial-peer voice 1 pots** command notifies the router that dial peer 1 is a POTS dial peer with a tag of 1. The **destination-pattern 7777** command notifies the router that the attached telephony device terminates calls destined for telephone number 7777. The **port 1/0/0** command notifies the router that the telephony device is plugged into module 1, voice interface card (VIC) slot 0, voice port 0.

Practice Item 1: POTS Dial-Peer Configuration

Throughout this lesson, you will use practice items to practice what you have learned. In this scenario, assume that there is a data center at the R1 site, and executive offices at the R2 site. Using the diagram, create POTS dial peers for the four telephones shown.

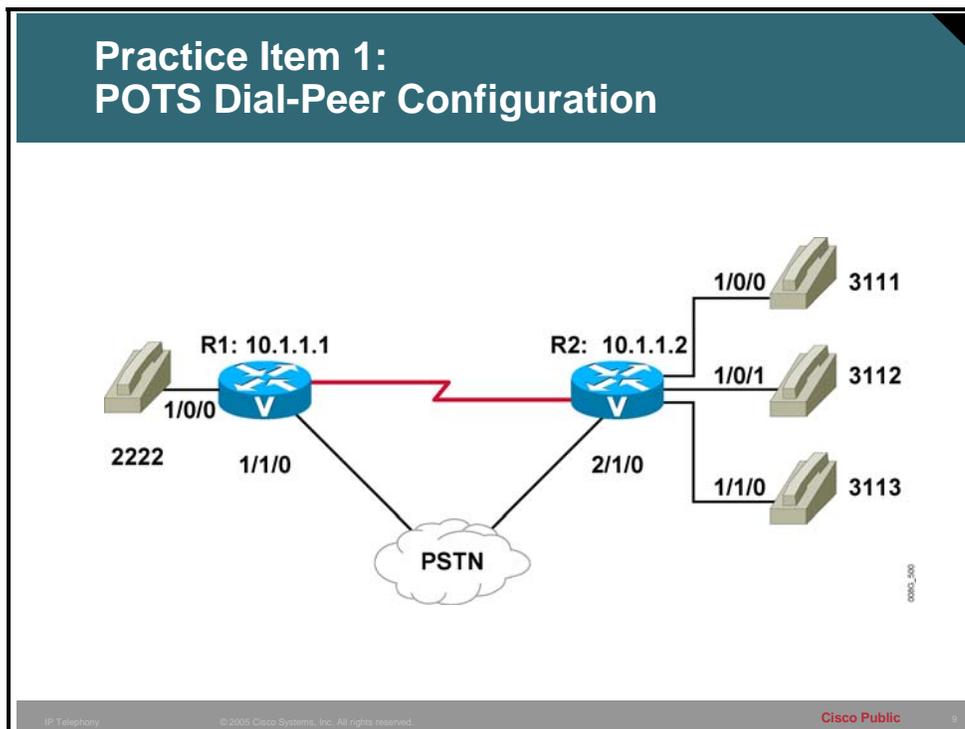


R1

R2

Configuring VoIP Dial Peers

This topic describes how to configure VoIP dial peers.



The administrator must know how to identify the far-end voice-enabled device that will terminate the call. In a small network environment, the device may be the IP address of the remote device. In a large environment, identifying the device may mean pointing to a Cisco CallManager or gatekeeper for address resolution and Call Admission Control (CAC) to complete the call.

You must follow these steps to configure VoIP dial peers:

How to Configure VoIP Dial Peers

Step	Action
1.	Configure the path across the network for voice data.
2.	Specify the dial peer as a VoIP dial peer.
3.	Use the destination-pattern command to configure a range of numbers reachable by the remote router or gateway.
4.	Use the session target command to specify an IP address of the terminating router or gateway.
5.	Use the remote device loopback address as the IP address.

The dial peer is specified as a VoIP dial peer, which alerts the router that it must process a call according to the various parameters that are specified in the dial peer. The dial peer must then package it as an IP packet for transport across the network. Specified parameters may include the codec used for compression (VAD, for example), or marking the packet for priority service.

The **destination-pattern** parameter configured for this dial peer is typically a range of numbers that are reachable via the remote router or gateway.

Because this dial peer points to a device across the network, the router needs a destination IP address to put in the IP packet. The **session target** parameter allows the administrator to specify either an IP address of the terminating router or gateway, or another device; for example, a gatekeeper or Cisco CallManager that can return an IP address of that remote terminating device.

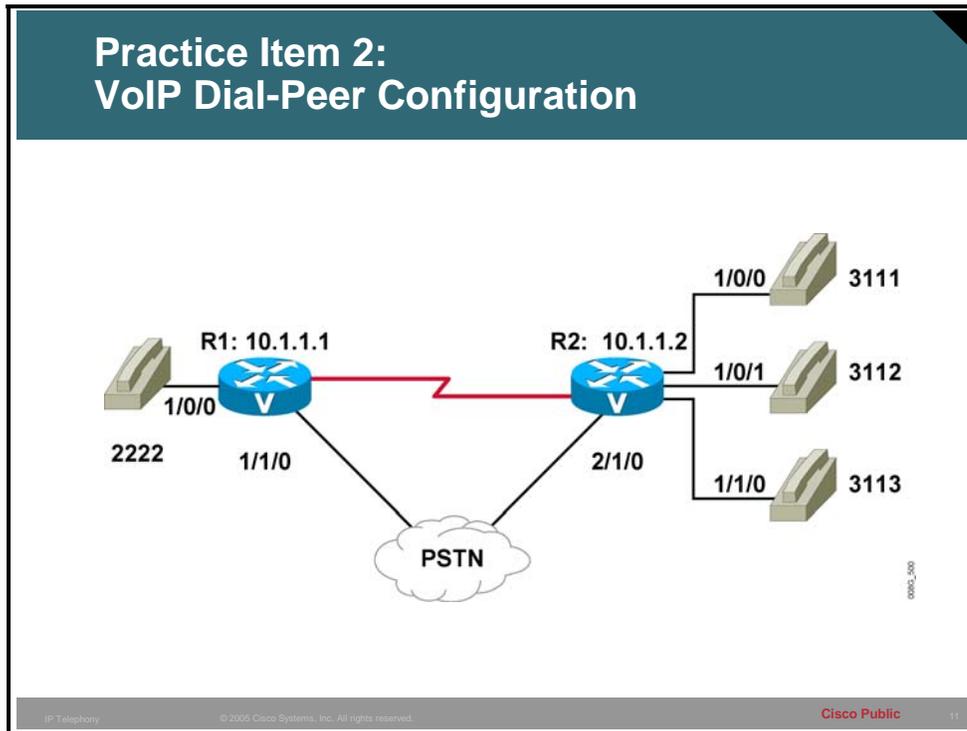
To determine which IP address a dial peer should point to, it is recommended that you use a loopback address. The loopback address is always up on a router, as long as the router is powered on and the interface is not administratively shut down. If an interface IP address is used instead of the loopback, and that interface goes down, the call will fail even if there is an alternate path to the router.

Example: VoIP Dial-Peer Configuration

The figure illustrates the proper VoIP dial-peer configuration on a Cisco voice-enabled router. The **dial-peer voice 2 voip** command notifies the router that dial peer 2 is a VoIP dial peer with a tag of 2. The **destination-pattern 8888** command notifies the router that this dial peer defines an IP voice path across the network for telephone number 8888. The **session target ipv4:10.18.0.1** command defines the IP address of the router that is connected to the remote telephony device.

Practice Item 2: VoIP Dial-Peer Configuration

Using the diagram, create VoIP dial peers for each of the R1 and R2 sites.



R1

R2

Configuring Destination-Pattern Options

This topic describes destination-pattern options and the applicable shortcuts.

Common Destination-Pattern Options

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

+	(Optional) Character indicating an E.164 standard number
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: <ul style="list-style-type: none">• The <i>asterisk</i> (*) and <i>pound sign</i> (#) that appear on standard touch-tone dial pads.• <i>Comma</i> (,) which inserts a pause between digits.• <i>Period</i> (.) which matches any single entered digit (this character is used as a wildcard).• <i>Brackets</i> ([]), 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

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The destination pattern associates a telephone number with a given dial peer. The destination pattern also determines the dialed digits that the router collects and forwards to the remote telephony interface, such as a PBX, Cisco CallManager, or the PSTN. You must configure a destination pattern for each POTS and VoIP dial peer that you define on the router.

The destination pattern can indicate a complete telephone number, a partial telephone number with wildcard digits, or it can point to a range of numbers defined in a variety of ways.

Destination-pattern options include the following:

- **Plus sign (+):** An optional character that indicates an E.164 standard number. E.164 is the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) recommendation for the international public telecommunication numbering plan. The plus sign in front of a destination-pattern string specifies that the string must conform to E.164.
- **string:** A series of digits specifying the E.164 or private dial-plan telephone number. The examples below show the use of special characters that are often found in destination pattern strings:
 - An asterisk (*) and pound sign (#) appear on standard touch-tone dial pads. These characters may need to be used when passing a call to an automated application that requires these characters to signal the use of a special feature. For example, when calling an interactive voice response (IVR) system that requires a code for access, the number dialed might be “5551212888#”, which would initially dial the telephone number “5551212” and input a code of “888” followed by the pound key to terminate the IVR input query.

- A comma (,) inserts a one-second pause between digits. The comma can be used, for example, where a “9” is dialed to signal a PBX that the call should be processed by the PSTN. The “9” is followed by a comma to give the PBX time to open a call path to the PSTN, after which the remaining digits will be played out. An example of this string is “9,5551212”.
 - A period (.) matches any single entered digit from 0 to 9, and is used as a wildcard. The wildcard can be used to specify a group of numbers that may be accessible via a single destination router, gateway, PBX, or Cisco CallManager. A pattern of “200.” allows for ten uniquely addressed devices, while a pattern of “20..” can point to 100 devices. If one site has the numbers 2000 through 2049, and another site has the numbers 2050 through 2099, then the bracket notation would be more efficient.
 - Brackets ([]) indicate a range. A range is a sequence of characters that are enclosed in the brackets. Only single numeric characters from 0 to 9 are allowed in the range. In the previous example, the bracket notation could be used to specify exactly which range of numbers is accessible through each dial peer. For example, the first site pattern would be “20[0 – 4].”, and the second site pattern would be “20[5-9].”. Note that in both cases, a dot is used in the last digit position to represent any single digit from 0 to 9. The bracket notation offers much more flexibility in how numbers can be assigned.
- **T:** An optional control character indicating that the destination-pattern value is a variable-length dial string. In cases where callers may be dialing local, national, or international numbers, the destination pattern must provide for a variable-length dial plan. If a particular voice gateway has access to the PSTN for local calls and access to a transatlantic connection for international calls, then calls being routed to that gateway will have a varying number of dialed digits. A single dial peer with a destination pattern of “.T” could support the different call types. The interdigit timeout determines when a string of dialed digits is complete. The router continues to collect digits until there is an interdigit pause longer than the configured value, which by default is 10 seconds.

When the calling party finishes entering dialed digits, there is a pause equal to the interdigit timeout value *before* the router processes the call. The calling party can immediately terminate the interdigit timeout by entering the pound character (#), which is the default termination character. Because the default interdigit timer is set to 10 seconds, users may experience a long call setup delay.

Note Cisco IOS software does not check the validity of the E.164 telephone number. It accepts any series of digits as a valid number.

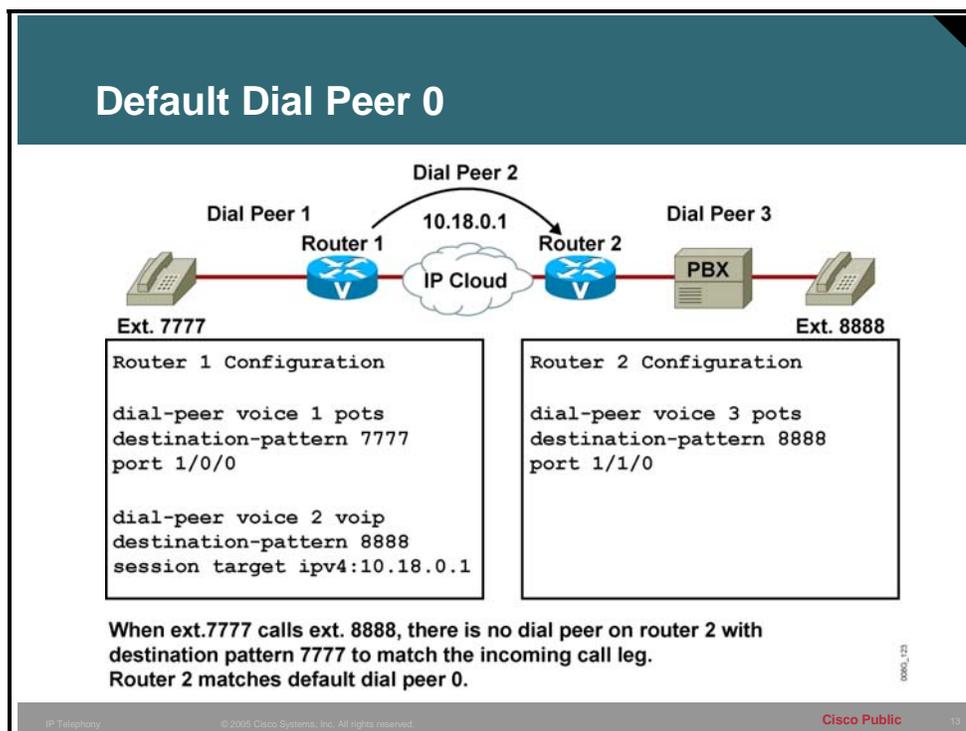
Example: Matching Destination Patterns

Destination-Pattern Options

Destination Pattern	Matching Telephone Numbers
5550124	<p>Matches one telephone number exactly, 5550124.</p> <p>This is typically used when there is a single device, such as a telephone or fax, connected to a voice port.</p>
55501[1-3].	<p>Matches a seven-digit telephone number where the first five digits are 55501, the sixth digit can be a 1, 2, or 3, and the last digit can be any valid digit.</p> <p>This type of destination pattern is used when telephone number ranges are assigned to specific sites. In this example, the destination pattern is used in a small site that does not need more than 30 numbers assigned.</p>
.T	<p>Matches any telephone number that has at least one digit and can vary in length from 1 to 32 digits total.</p> <p>This destination pattern is used for a dial peer that services a variable-length dial plan, such as local, national, and international calls. It can also be used as a default destination pattern so that any calls that do not match a more specific pattern will match this pattern and can be directed to an operator.</p>

Default Dial Peer

This topic describes the default dial peer.



When a matching inbound dial peer is not found, the router resorts to the default dial peer.

Note Default dial peers are used for inbound matches only. They are not used to match outbound calls that do not have a dial peer configured.

The default dial peer is referred to as *dial peer 0*.

Example: Use of Default Dial Peer

In the figure, only one-way dialing is configured. The caller at extension 7777 can call extension 8888 because there is a VoIP dial peer configured on router 1 to route the call across the network. There is no VoIP dial peer configured on router 2 to point calls across the network toward router 1. Therefore, there is no dial peer on router 2 that will match the calling number of extension 7777 on the inbound call leg. If no incoming dial peer matches the calling number, the inbound call leg automatically matches to a default dial peer (POTS or VoIP).

Note There is an exception to the previous statement. Cisco voice and dial platforms, such as the AS53xx and AS5800, require that a configured inbound dial peer be matched for incoming POTS calls to be accepted as voice calls. If there is no inbound dial-peer match, the call is treated and processed as a dialup (modem) call.

Dial peer 0 for inbound VoIP peers has the following configuration:

- **any codec**
- **ip precedence 0**
- **vad enabled**
- **no rsvp support**
- **fax-rate service**

Dial peer 0 for inbound POTS peers has the following configuration:

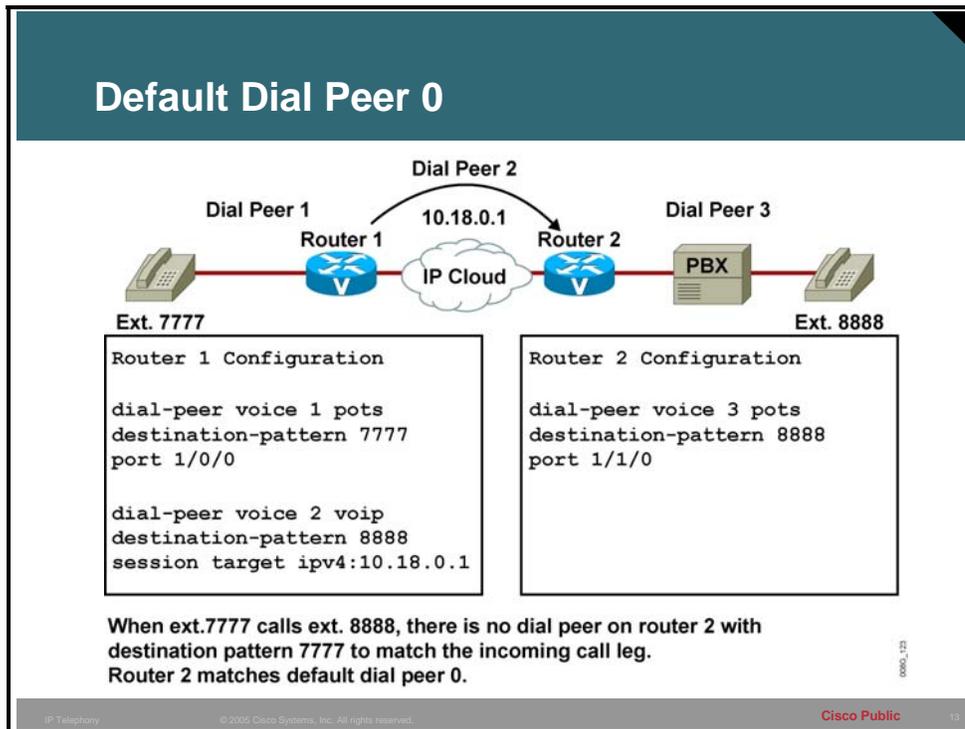
- **no ivr application**

You cannot change the default configuration for dial peer 0. Default dial peer 0 fails to negotiate nondefault capabilities or services. When the default dial peer is matched on a VoIP call, the call leg that is set up in the inbound direction uses any supported codec for voice compression, based on the requested codec capability coming from the source router. When a default dial peer is matched, the voice path in one direction may have different parameters than the voice in the return direction. This may cause one side of the connection to report good-quality voice while the other side reports poor-quality voice; for example, the outbound dial peer has VAD disabled, but the inbound call leg is matched against the default dial peer, which has VAD enabled. In this example, VAD is on in one direction and off in the return direction.

When the default dial peer is matched on an inbound POTS call leg, there is no default IVR application with the port. As a result, the user gets a dial tone and proceeds with dialed digits.

Matching Inbound Dial Peers

This topic describes how the router matches inbound dial peers.



When determining how inbound dial peers are matched on a router, it is important to note whether the inbound call leg is matched to a POTS or VoIP dial peer. Matching occurs in the following manner:

- Inbound POTS dial peers are associated with the incoming POTS call legs of the originating router or gateway.
- Inbound VoIP dial peers are associated with the incoming VoIP call legs of the terminating router or gateway.

Three information elements sent in the call setup message are matched against four configurable dial-peer command attributes.

The table describes the three call setup information elements.

Call Setup Information Elements

Call Setup Element	Description
Called Number Dialed Number Identification Service	This is the call-destination dial string, and it is derived from the ISDN setup message or channel associated signaling Dialed Number Identification Service (DNIS).
Calling Number Automatic Number Identification	This is a number string that represents the origin, and it is derived from the ISDN setup message or channel associated signaling (CAS) automatic number identification (ANI). The ANI is also referred to as the calling line ID.
Voice Port	This represents the POTS physical voice port.

When the Cisco IOS router or gateway receives a call setup request, it makes a dial-peer match for the incoming call. This is not digit-by-digit matching; instead, the router uses the full digit string received in the setup request for matching against the configured dial peers.

The router or gateway matches call setup element parameters in the following order:

How the Router or Gateway Matches Inbound Dial Peers

Step	Action
1.	The router or gateway attempts to match the called number of the call setup request with the configured incoming called-number of each dial peer.
2.	If a match is not found, the router or gateway attempts to match the calling number of the call setup request with answer-address of each dial peer.
3.	If a match is not found, the router or gateway attempts to match the calling number of the call setup request to the destination-pattern of each dial peer.
4.	The voice port uses the voice port number associated with the incoming call setup request to match the inbound call leg to the configured dial peer port parameter.
5.	If multiple dial peers have the same port configured, then the router or gateway matches the first dial peer added to the configuration.
6.	If a match is not found in the previous steps, then the default is dial peer 0.

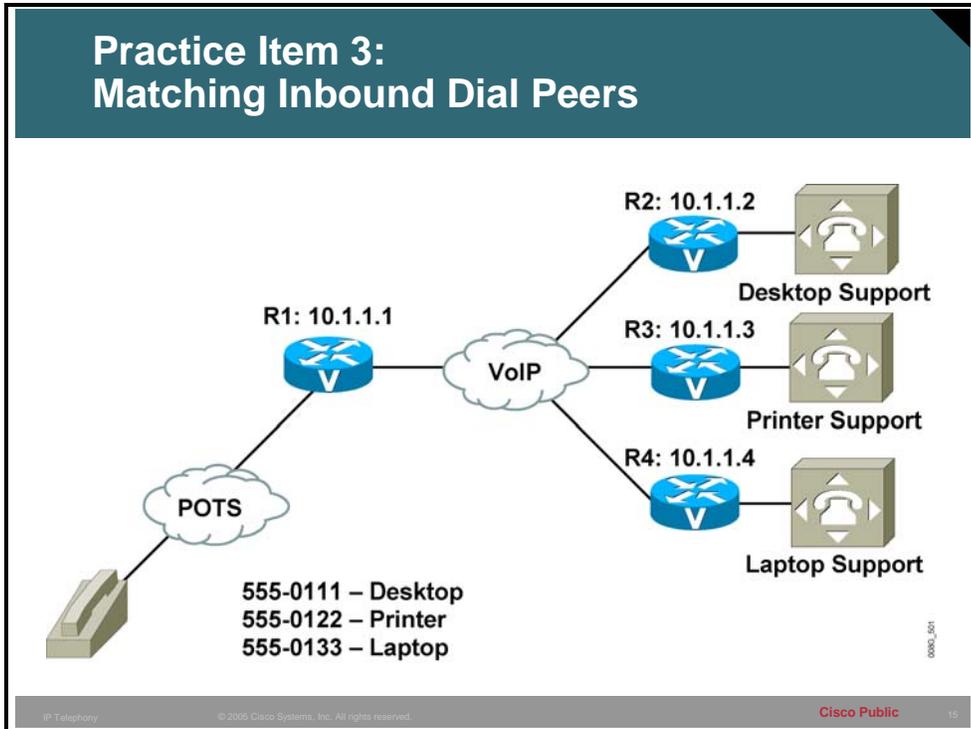
Because call setups always include DNIS information, it is recommended that you use the **incoming called-number** command for inbound dial-peer matching. Configuring **incoming called-number** is useful for a company that has a central call center providing support for a number of different products. Purchasers of each product get a unique 1-800 number to call for support. All support calls are routed to the same trunk group destined for the call center. When a call comes in, the computer telephony system uses the DNIS to flash the appropriate message on the computer screen of the agent to whom the call is routed. The agent will then know how to customize the greeting when answering the call.

The calling number ANI with **answer-address** is useful when you want to match calls based on the originating calling number. For example, when a company has international customers who require foreign-language-speaking agents to answer the call, the call can be routed to the appropriate agent based on the country of call origin.

You must use the calling number ANI with **destination-pattern** when the dial peers are set up for two-way calling. In a corporate environment, the head office and the remote sites must be connected. As long as each site has a VoIP dial peer configured to point to each site, inbound calls from the remote site will match against that dial peer.

Practice Item 3: Matching Inbound Dial Peers

In this practice item, assume that you are setting up a technical support center for desktop PCs, printers, and laptops. Customers who dial specific numbers reach the appropriate technical support staff. Using the diagram, create dial peers on R1 to route incoming calls per the incoming called number to the appropriate site.



R1

Matching Outbound Dial Peers

This topic describes how the router matches outbound dial peers.

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

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Outbound dial-peer matching is completed on a digit-by-digit basis. Therefore, the router or gateway checks for dial-peer matches after receiving each digit and then routes the call when a full match is made.

The router or gateway matches outbound dial peers in the following order:

How the Router or Gateway Matches Outbound Dial Peers

Step	Action
1.	The router or gateway uses the dial peer destination-pattern command to determine how to route the call.
2.	The destination-pattern command routes the call in the following manner: <ul style="list-style-type: none">■ On POTS dial peers, the port command forwards the call.■ On VoIP dial peers, the session target command forwards the call.
3.	Use the show dialplan number string command to determine which dial peer is matched to a specific dialed string. This command displays all matching dial peers in the order that they are used.

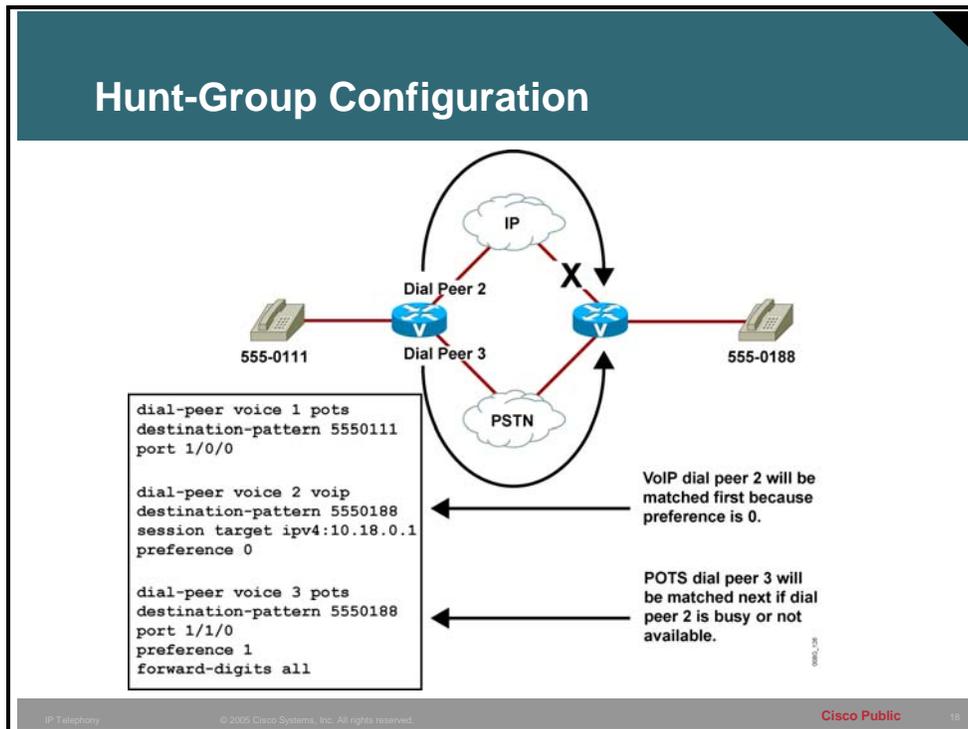
Example: Matching Outbound Dial Peers

In the figure, dial peer 1 matches any digit string that has not matched other dial peers more specifically. Dial peer 2 matches any seven-digit number in the 30 and 40 range of numbers starting with 55501. Dial peer 3 matches any seven-digit number in the 20 range of numbers starting with 55501. Dial peer 4 matches the specific number 5550124 only. When the number

5550124 is dialed, dial peers 1, 3, and 4 all match that number, but dial peer 4 places that call because it has the most specific destination pattern.

Configuring Hunt Groups

This topic describes how to configure hunt groups.



In some business environments, such as call centers or sales departments, there may be a group of agents available to answer calls coming in to a single number. Scenario 1 may randomly distribute the calls between all agents. Scenario 2 may send calls to the senior agents first, and send calls to the junior agents only when all senior agents are busy. Both of these scenarios can be serviced by configuring a hunt group with specific commands to control the hunt actions.

Follow these steps to configure hunt groups:

How to Configure Hunt Groups

Step	Action
1.	Configure the same destination pattern across multiple dial peers.
2.	The destination pattern matches the greatest number of dialed digits.
3.	Use the preference command if the destination pattern of the dial peer is the same for several dial peers.
4.	If the preference does not act as the tiebreaker, then the router picks the matching dial peer randomly.

You must use the **dial-peer hunt** global configuration command to change the default selection order of the procedure or to choose different methods for hunting through dial peers. To view the current setting for **dial-peer hunt**, use the **show dial-peer voice summary** command.

If the desired action is not hunting through a range of dial peers, the **huntstop** command disables dial-peer hunting on the dial peer. After you enter this command, no further hunting is allowed if a call fails on the selected dial peer. This is useful in situations where it is undesirable to hunt to a less-specific dial peer if the more specific call fails; for example, if a call is destined for a particular staff member and the person is on the phone, the router searches for any other dial peer that may match the dialed number. If there is a more generic destination pattern in another dial peer that also matches, the call is routed to the generic destination pattern. If this is not the desired action, then configuring the **huntstop** command in the more specific dial peer will send the caller a busy signal.

You can mix POTS and VoIP dial peers when creating hunt groups. This is useful if you want incoming calls sent over the packet network; however, if that network connectivity fails, you want to reroute the calls back through the PBX, or through the router, to the PSTN.

By default, the router selects dial peers in a hunt group according to the following criteria, in the order listed:

How the Router Selects Dial Peers in a Hunt Group

Step	Action
1.	The router matches the most specific telephone number.
2.	The router matches according to the preference setting.
3.	The router matches randomly.

The destination pattern that matches the greatest number of dialed digits is the first dial peer selected by the router. For example, if one dial peer is configured with a dial string of “345....” and a second dial peer is configured with “3456789”, the router selects “3456789” first because it has the longest explicit match of the two dial peers. Without a PBX, if the line is currently in use, the desired action is to send a call to a voice-mail system or a secretary, instead of giving the caller a busy signal.

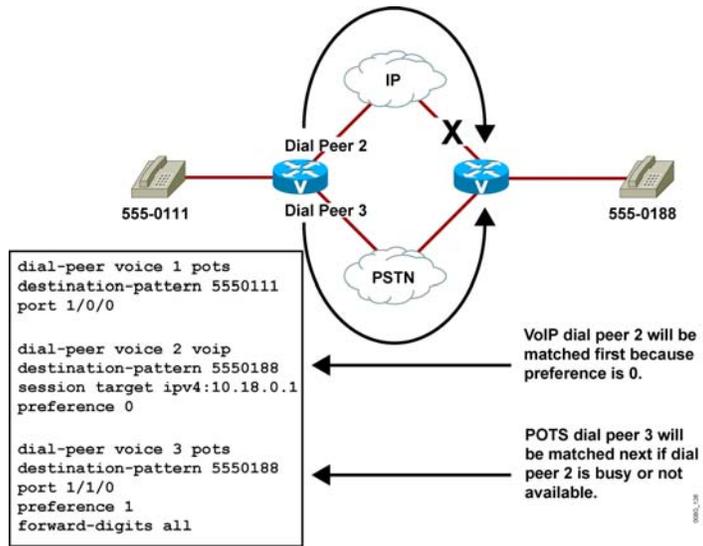
If the destination pattern is the same for several dial peers, you can configure the priority by using the **preference** dial-peer command. You would use the **preference** command to configure service for scenario 2, where the dial peers connecting to the senior agents would have the preference 0 and the dial peers connecting to the junior agents would have the preference 1. The lower the preference setting, the higher the priority for that dial peer to handle the call.

If all destination patterns are equal, by default, the preference is set to 0 on all dial peers. If the preference does not act as the tiebreaker, then a dial peer matching the called number will be picked randomly. This configuration would service scenario 1.

Example: Hunt-Group Application

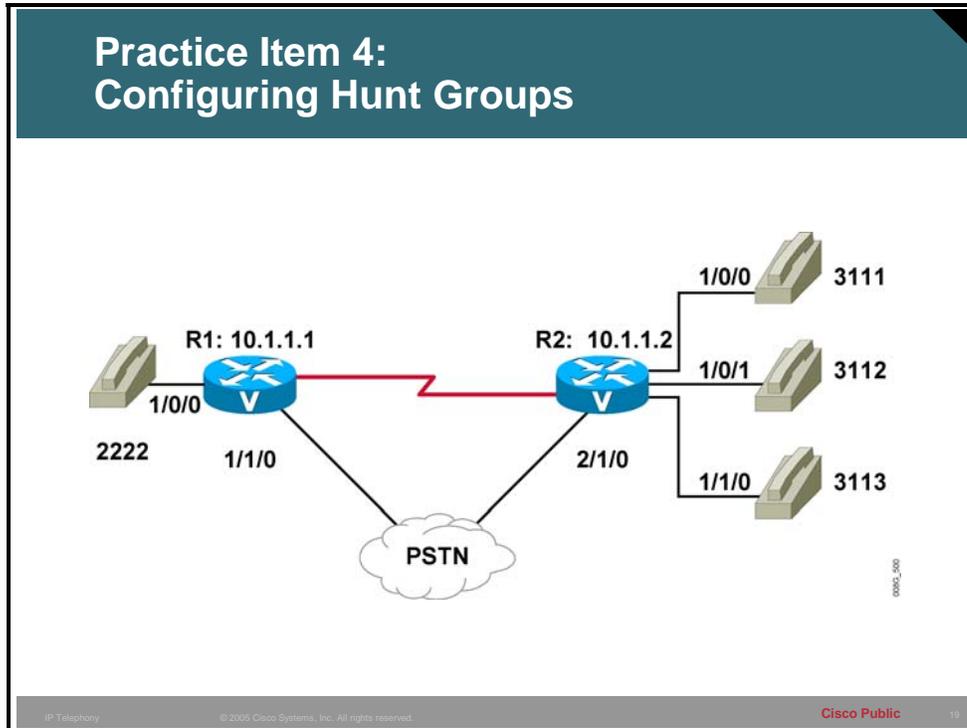
The figure shows an example of configuring a hunt group to send calls to the PSTN if the IP network fails. For all calls going to 555-0188, VoIP dial peer 2 is matched first because the preference is set to zero. If the path through the IP network fails, POTS dial peer 3 is matched and the call is forwarded through the PSTN. The **forward-digits** command forwards all digits to the PSTN to automatically complete the call without a secondary dial tone.

Hunt-Group Configuration



Practice Item 4: Configuring Hunt Groups

Using the diagram, configure a hunt group using the preference command on R2 such that if extension 3111 is busy, the call rings extension 3112. Assume that you have POTS dial peers for all three extensions already configured.



R2: Already configured

```
dial-peer voice 1 pots
destination-pattern 3111
port 1/0/0
```

```
dial-peer voice 2 pots
destination-pattern 3112
port 1/0/1
```

```
dial-peer voice 3 pots
destination-pattern 3113
port 1/1/0
```

R2: Hunt group dial peer

Digit Collection and Consumption

This topic describes how the router collects and consumes digits and applies them to the dial-peer statements.

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.

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Use the **no digit-strip** command to disable the automatic digit-stripping function. This allows the router to match digits and pass them to the telephony interface.

By default, when the terminating router matches a dial string to an outbound POTS dial peer, the router strips off the left-justified digits that explicitly match the destination pattern. The remaining digits, or *wildcard digits*, are forwarded to the telephony interface, which connects devices such as a PBX or the PSTN.

Digit stripping is the desired action in some situations. There is no need to forward digits out of a POTS dial peer if it is pointing to a Foreign Exchange Station (FXS) port that connects a telephone or fax machine. If digit stripping is turned off on this type of port, the user may hear tones after answering the call because any unconsumed and unmatched digits are passed through the voice path after the call is answered.

In other situations, where a PBX or the PSTN is connected through the POTS dial peer, digit stripping is not desired because these devices need additional digits to further direct the call. In these situations, the administrator must assess the number of digits that need to be forwarded for the remote device to correctly process the call. With a VoIP dial peer, all digits are passed across the network to the terminating voice-enabled router.

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.

0000_139

When a voice call enters the network, the router collects digits as follows:

How the Router Collects Digits

Step	Action
1.	The originating router collects dialed digits until it matches an outbound dial peer.
2.	The router immediately places the call and forwards the associated dial string.
3.	The router collects no additional dialed digits.

Example: Digit Collection

The figure demonstrates the impact that overlapping destination patterns have on the call-routing decision. In example 1, the destination pattern in dial peer 1 is a subset of the destination pattern in dial peer 2. Because the router matches one digit at a time against available dial peers, an exact match will always occur on dial peer 1, and dial peer 2 will never be matched.

In example 2, the length of the destination patterns in both dial peers is the same. Dial peer 2 has a more specific value than dial peer 1, so it will be matched first. If the path to IP address 10.18.0.2 is unavailable, dial peer 1 will be used.

Destination patterns are matched based on the longest explicit number match. Digits collected are dependant on the configured destination pattern. The table describes how different number combinations are matched and collected.

Matching Destination Patterns

Dialed Digits	Destination Pattern	Dialed Digits Collected
5550124	5.....	5550124
5550124	555....	5550124
5550124	555	555
5550124	555T	5550124

In the first row of the table, the destination pattern specifies a seven-digit string. The first digit must be a five, and the remaining six digits can be any valid digits. All seven digits must be entered before the destination pattern is matched.

In the second row, the destination pattern specifies a seven-digit string. The first three digits must be 555, and the remaining four digits can be any valid digits. All seven digits must be entered before the destination pattern is matched.

In the third row, the destination pattern specifies a three-digit string. The dialed digits must be exactly 555. When the user begins to dial the seven-digit number, the destination pattern matches after the first three digits are entered. The router then stops collecting digits and places the call. If the call is set up quickly, the answering party at the other end may hear the remaining four digits as the user finishes dialing the string. After a call is set up, any dual tone multifrequency (DTMF) tones are sent through the voice path and played out at the other end.

In the last row, the destination pattern specifies a variable-length digit string that is at least three digits long. The first three digits must be exactly 555, and the remaining digits can be any valid digits. The “T” tells the router to continue collecting digits until the interdigit timer expires. The router stops collecting digits when the timer expires, or when the user presses the pound (#) key.

Understanding Digit Manipulation

This topic describes digit manipulation and the commands that are used to connect to a specified destination.

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

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Digit manipulation is the task of adding or subtracting digits from the original dialed number to accommodate user dialing habits or gateway needs. The digits can be manipulated before matching an inbound or outbound dial peer. The following is a list of digit manipulation commands and their uses:

- **prefix:** This dial-peer command adds digits to the front of the dial string before it is forwarded to the telephony interface. This occurs after the outbound dial peer is matched, but before digits get sent out of the telephony interface. Use the **prefix** command when the dialed digits leaving the router must be changed from the dialed digits that had originally matched the dial peer; for example, a call is dialed using a four-digit extension such as 0123, but the call needs to be routed to the PSTN, which requires ten-digit dialing. If the four-digit extension matches the last four digits of the actual PSTN telephone number, then you can use the **prefix 902555** command to prepend the six additional digits needed for the PSTN to route the call to 902-555-0123. After the POTS dial peer is matched with the destination pattern of 0123, the **prefix** command prepends the additional digits, and the string “9025550123” is sent out of the voice port to the PSTN.
- **forward-digits:** This dial-peer command specifies the number of digits that must be forwarded to the telephony interface, regardless of whether they are explicitly matched or wildcard matched. This command occurs after the outbound dial peer is matched, but before the digits are sent out of the telephony interface. When a specific number of digits are configured for forwarding, the count is right justified. For example, if the POTS dial peer has a destination pattern configured to match all extensions in the 1000 range (**destination-pattern 1...**), by default, only the last three digits are forwarded to the PBX that is connected to the specified voice port. If the PBX needs all four digits to route the

call, you must use the command **forward-digits 4**, or **forward-digits all**, so that the appropriate number of digits are forwarded. To restore the **forward-digits** command to its default setting, use the **default forward-digits** command. Using the **no forward-digits** command specifies that no digits are to be forwarded.

- **num-exp:** The **num-exp** global command expands an extension into a full telephone number or replaces one number with another. The number expansion table manipulates the called number. This command occurs before the outbound dial peer is matched; therefore, you must configure a dial peer with the expanded number in the destination pattern for the call to go through. The number expansion table is useful, for example, where the PSTN changes the dialing requirements from seven-digit dialing to ten-digit dialing. In this scenario, you can do one of the following:
 - Make all the users dial all ten digits to match the new POTS dial peer that is pointing to the PSTN.
 - Allow the users to continue dialing the seven-digit number as they have before, but expand the number to include the area code before the ten-digit outbound dial peer is matched.

Note You must use the **show num-exp** command to view the configured number-expansion table. You must use the **show dialplan number** *number* command to confirm the presence of a valid dial peer to match the newly expanded number.

- **translation-rule:** Digit translation is a two-step configuration process. First, the translation rule is defined at the global level. Then, the rule is applied at the dial-peer level either as inbound or outbound translation on either the called or calling number. Translation rules manipulate the ANI or DNIS digits for a voice call. Translation rules convert a telephone number into a different number before the call is matched to an inbound dial peer, or before the outbound dial peer forwards the call; for example, an employee may dial a five-digit extension to reach another employee of the same company at another site. If the call is routed through the PSTN to reach the other site, the originating gateway may use translation rules to convert the five-digit extension into the ten-digit format that is recognized by the central office (CO) switch.

You can also use translation rules to change the numbering type for a call. For example, some gateways may tag a number with more than 11 digits as an international number, even when the user must dial “9” to reach an outside line. In this case, the number that is tagged as an international number needs to be translated into a national number—without the 9—before it is sent to the PSTN.

As illustrated in this topic, there are numerous ways to manipulate digits at various stages of call completion. The administrator needs to determine which command will be most suitable and the requirements that are necessary for manipulation.

Note To test configured translation rules, you must use the **test translation** command.

Example: Using Digit Manipulation Tools

The following is a sample configuration using the **prefix** command:

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

In the sample configuration using the **prefix** command, the device attached to port 1/0/0 needs all seven digits to process the call. On a POTS dial peer, only wildcard-matched digits are forwarded by default. Use the **prefix** command to send the prefix numbers 555 before forwarding the four wildcard-matched digits.

The following is a sample configuration using the **forward-digits** command:

```
dial-peer voice 1 pots
destination-pattern 555....
forward-digits 7
port 1/0/0
```

In the sample configuration using the **forward-digits** command, the device attached to port 1/0/0 needs all seven digits to process the call. On a POTS dial peer, only wildcard-matched digits are forwarded by default. The **forward-digits** command allows the user to specify the total number of digits to forward.

The following is a sample configuration using the number expansion table (**num-exp**) command:

```
num-exp 2... 5552...
dial-peer voice 1 pots
destination-pattern 5552...
port 1/1/0
```

In the sample configuration using the **num-exp** command, the extension number 2... is expanded to 5552... before an outbound dial peer is matched; for example, the user dials 2401, but the outbound dial peer 1 is configured to match 5552401.

The following is a sample configuration using the digit translation (**translation-rule**) command:

```
translation-rule 5
rule 1 2401 5552401
dial-peer voice 1 pots
translate-outgoing called-number 5
```

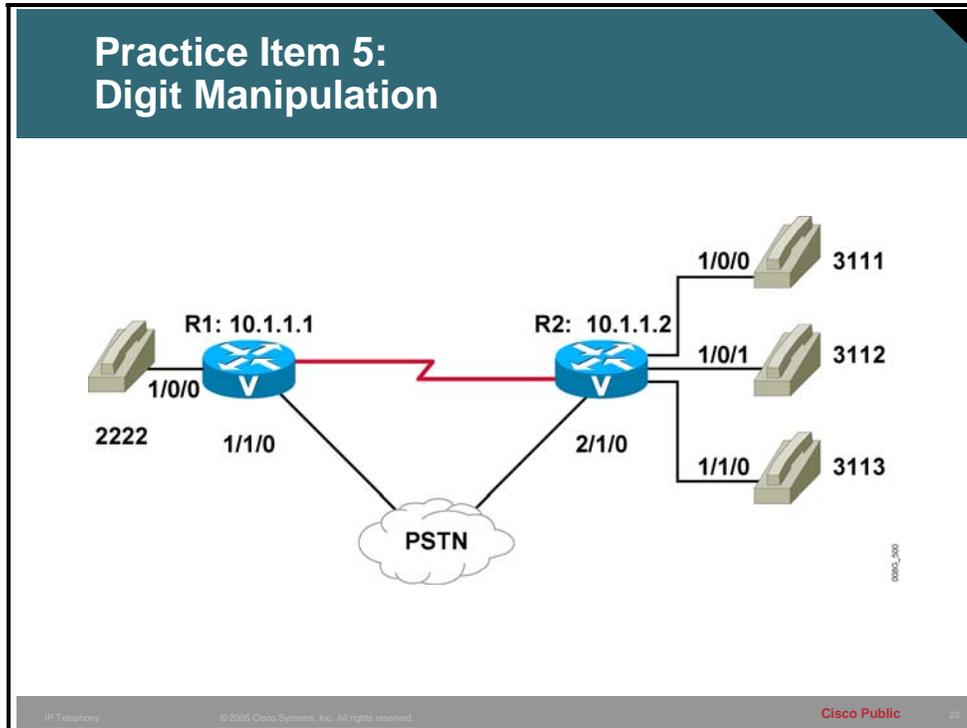
In the sample configuration using the **translation-rule** command, the rule is defined to translate 2401 into 5552401. The dial peer **translate-outgoing called-number 5** command notifies the router to use the globally defined translation rule 5 to translate the number before sending the string out the port. It is applied as an outbound translation from the POTS dial peer.

The following example shows a translation rule that converts any called number that starts with 91 and is tagged as an international number into a national number without the 9 before sending it to the PSTN.

```
translation-rule 20
rule 1 91 1 international national
!
!
dial-peer voice 10 pots
destination-pattern 91.....
translate-outgoing called 20
port 1/1:5
forward-digits all
```

Practice Item 5: Digit Manipulation

Assuming that all POTS and VoIP dial peers are configured, create a dial peer to divert calls from R1 to R2 across the PSTN in the event of failure of the VoIP network. Assume that digits must be forwarded to the PSTN, and a prefix of 555 is necessary.



R1

Practice Item Answer Key

Practice Item 1: POTS Dial Peers

R1:

```
dial-peer voice 1 pots
destination-pattern 2222
port 1/0/0
```

R2:

```
dial-peer voice 1 pots
destination-pattern 3111
port 1/0/0
```

```
dial-peer voice 2 pots
destination-pattern 3112
port 1/0/1
```

```
dial-peer voice 3 pots
destination-pattern 3113
port 1/1/0
```

Practice Item 2: VoIP Dial-Peer Configuration

R1:

```
dial-peer voice 101 voip
destination-pattern 3...
session target ipv4:10.1.1.2
```

R2:

```
dial-peer voice 101 voip
destination-pattern 2...
session target ipv4:10.1.1.1
```

Practice Item 3: Matching Inbound Dial Peers

R1:

```
dial-peer voice 202 voip
incoming called-number 5550111
session target ipv4:10.1.1.2
```

```
dial-peer voice 203 voip
incoming called-number 5550122
session target ipv4:10.1.1.3
```

```
dial-peer voice 204 voip
incoming called-number 5550133
session target ipv4:10.1.1.4
```

Practice Item 4: Configuring Hunt Groups

R2:

```
dial-peer voice 4 pots
destination-pattern 3111
port 1/0/1
preference 2
```

Practice Item 5: Digit Manipulation

R1:

```
dial-peer voice 300 pots
destination-pattern 3...
port 1/1/0
forward-digits all
prefix 555
preference 2
```