

This article contains an overview of the call flow.

Guide Contents
<a href="#">Troubleshooting Cisco IOS Voice Overview</a>
<a href="#">Debug Command Output on Cisco IOS Voice Gateways</a>
<a href="#">Filtering Troubleshooting Output</a>
<a href="#">Cisco VoIP Internal Error Codes</a>
<a href="#">Troubleshooting Cisco IOS Voice Telephony</a>
<a href="#">Troubleshooting Cisco IOS Voice Protocols</a>
<a href="#">Troubleshooting Cisco IOS Telephony Applications</a>
<a href="#">Monitoring the Cisco IOS Voice Network</a>
<a href="#">Cause Codes and Debug Values</a>

## Contents

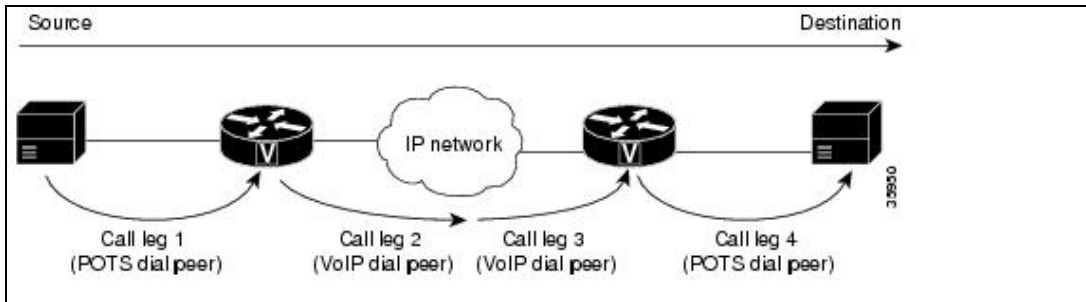
- [1 Call Legs](#)
  - ◆ [1.1 Figure: Dial Peer Call Legs](#)
- [2 Call Setup Elements](#)
  - ◆ [2.1 Source and Destination POTS Dial Peers](#)
  - ◆ [2.2 Voice Network Dial Peers](#)
    - ◇ [2.2.1 Voice and Billing Application Call Leg](#)
      - [2.2.1.1 Figure: Cisco IOS VoiceXML Application Components](#)
  - ◆ [2.3 Inbound and Outbound Call Legs](#)
- [3 Call Setup Process](#)
  - ◆ [3.1 Figure: Call Legs from the Perspective of the Originating Router](#)
  - ◆ [3.2 Figure: Call Legs from the Perspective of the Terminating Router](#)
- [4 Dial Peer Matching](#)
  - ◆ [4.1 Inbound Dial Peer Matching](#)
    - ◇ [4.1.1 Dial Peer 0](#)
    - ◇ [4.1.2 Inbound Dial Peer Configuration Tips](#)
      - [4.1.2.1 Session Target Command](#)
      - [4.1.2.2 ISDN Overlap Configuration](#)
      - [4.1.2.3 Empty Calling Field with Variable-Length Dial Plans](#)
  - ◆ [4.2 Outbound Dial Peer Matching](#)
    - ◇ [4.2.1 DID Configuration](#)
    - ◇ [4.2.2 Two-Stage Dialing Configuration](#)
    - ◇ [4.2.3 Variable-Length Dial Plans](#)
  - ◆ [4.3 Voice Network Dial Peer Matching](#)
  - ◆ [4.4 POTS Dial Peer Matching](#)

## Call Legs

A voice call over a packet network is segmented into discrete call legs. Each call leg is associated with a dial peer. A call leg is a logical connection between two voice gateways or between a gateway and an IP telephony device (for example, Cisco CallManager or a session initiation protocol (SIP) server).

An example of POTS and VoIP call legs is shown in [Figure: Dial Peer Call Legs](#).

Figure: Dial Peer Call Legs



Details for the call setup are described in the following sections:

- [Call Setup Elements](#)
- [Call Setup Process](#)
- [Dial Peer Matching](#)

Troubleshooting and debugging should focus first on each leg independently and then on the VoIP call as a whole.

## Call Setup Elements

You can isolate where a problem is occurring by determining which dial peer or call leg is having the problem, as described in the following sections:

- [Source and Destination POTS Dial Peers](#)
- [Voice Network Dial Peers](#)
- [Inbound and Outbound Call Legs](#)

### Source and Destination POTS Dial Peers

POTS dial peers define the characteristics of a traditional telephony network connection. The POTS dial peer maps a dial string to a specific voice port on the local gateway. Normally the voice port connects the gateway to the local public switched telephone network (PSTN), PBX, or analog telephone.

### Voice Network Dial Peers

Voice network dial peers define the attributes of a packet voice network connection. Voice network dial peers map a dial string to a remote network device. Some examples of these remote network devices are as follows:

- Destination gateway
- Cisco CallManager
- SIP server
- Open Settlements Protocol (OSP) server (for VoIP using settlement)
- H.323 gatekeeper
- Mail Transfer Agent (MTA) server (for Multimedia Mail over IP scenarios)

The specific type of voice-network dial peer used depends on the packet network technology. Different technologies supported on voice dial peers are as follows:

## Cisco\_IOS\_Voice\_Troubleshooting\_and\_Monitoring\_--\_Call\_Flow\_Overview

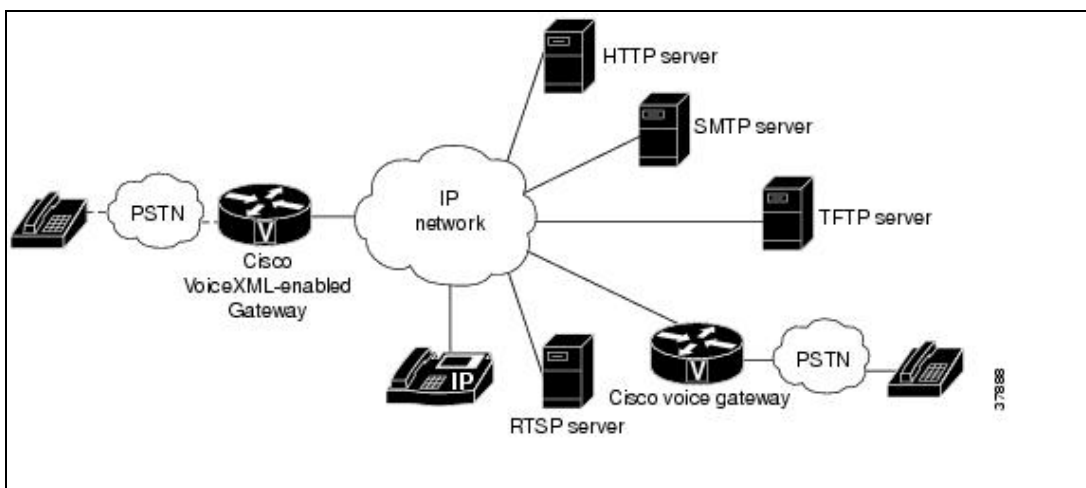
- Voice over IP (VoIP)-The dial peer is mapped to the IP address, Domain Name System (DNS) name, or server-type of the destination VoIP device that terminates the call. This mapping applies to all VoIP protocols such as H.323, SIP, and Media Gateway Control Protocol (MGCP).
- Voice over Frame Relay (VoFR)-The dial peer is mapped to the data-link connection identifier (DLCI) of the interface from which the call exits the router.
- Voice over ATM (VoATM)-The dial peer is mapped to the ATM virtual circuit for the interface from which the call exits the router.
- Multimedia Mail over IP (MMoIP)-The dial peer is mapped to the e-mail address of the Simple Mail Transfer Protocol (SMTP) server. This type of dial peer is used for store-and-forward fax (on-ramp and off-ramp faxing).

The voice-network dial peer also sets the attributes of the network connection, such as which codec to use, the capability to do voice activity detection (VAD), and dual-tone multifrequency (DTMF) relay configuration. A voice network dial peer can point to any device that is compatible with skinny protocol (SCCP), H.323, or SIP. MGCP configuration on a Cisco IOS gateway does not use voice network dial peers.

### Voice and Billing Application Call Leg

An IP call leg can go to an external application server. An example of a Cisco IOS VoiceXML application is shown in [Figure: Cisco IOS VoiceXML Application Components](#). This call leg is used for voice and billing applications, such as interactive voice response (IVR).

**Figure: Cisco IOS VoiceXML Application Components**



### Inbound and Outbound Call Legs


Each call leg can be either an *inbound* or *outbound* call leg, depending on the call's direction. For a call from an IP phone to the PSTN, the VoIP call leg is the inbound call leg, and the POTS leg is the outbound call leg. The opposite is true for a call from the PSTN to the IP phone. Every call has an associated inbound and outbound call leg.

### Call Setup Process

A call is segmented into call legs with a dial peer associated with each call leg. See [Figure: Dial Peer Call Legs](#).

The process has eight main steps:

1. The POTS call arrives at the originating gateway, and an inbound POTS dial peer is matched.

 **Note:** At this stage, if configured on the inbound POTS dial-peer, nondefault inbound POTS services or Tool Command Language (Tcl) applications are used. When you use such services or applications, be certain that the correct inbound POTS dial peer is matched. Examples of services or applications include:

- Direct inward dialing (DID)
- Tcl-based applications such as IVR, VoIP SIP transfer, or on-ramp faxing for store-and-forward fax.

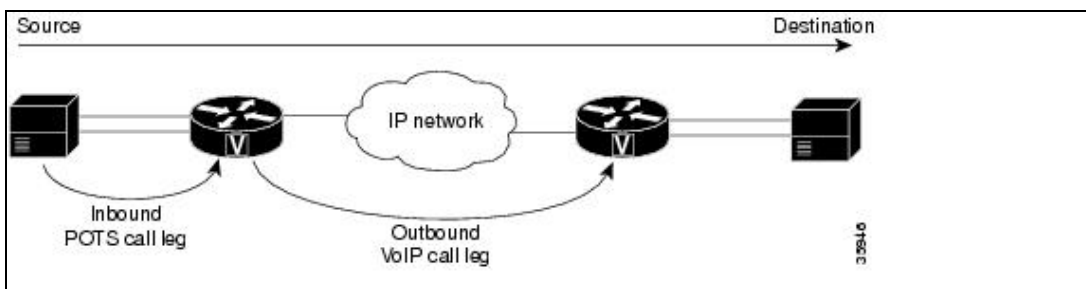
2. After the incoming call is associated with an inbound POTS dial peer, the originating gateway creates an inbound POTS call leg and assigns it a CallEntry ID and global unique identifier (GUID). For more information about these identifiers, see the [Debug Header Format](#).

3. The originating gateway uses the dialed string to match an outbound voice-network dial peer.

4. After the dialed string are associated with an outbound voice network dial peer, the originating gateway creates an outbound voice-network call leg and assigns it a call ID for the second call leg.

The preceding process is illustrated in [Figure: Call Legs from the Perspective of the Originating Router](#).

**Figure: Call Legs from the Perspective of the Originating Router**



5. The voice network call request arrives at the terminating gateway and an inbound voice network dial peer is matched.

6. After the terminating gateway associates the incoming call to an inbound voice-network dial peer, the terminating gateway creates the inbound voice-network call leg and assigns it a call ID for the third call leg.

At this point, both gateways negotiate voice-network capabilities and applications (if required). Default capabilities are not displayed in the gateway Cisco IOS configuration output. Use the **show dial-peer voice** command to display the configured capabilities, services, and applications on POTS and voice-network dial peers:

- ◇ Default capabilities include **codec g729r8**, **vad enable**, **dtmf-relay disable**, **fax-relay disable**, **req-qos best-effort**, **acc-qos best-effort**, and **session protocol cisco** (for H.323).
- ◇ Examples of Tcl applications include remote IP authentication and off-ramp faxing.

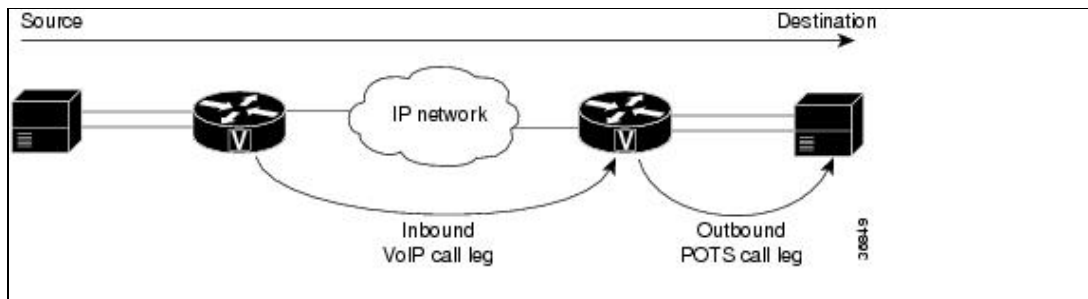
When nondefault capabilities or applications are requested by the originating gateway, the terminating gateways needs to match an inbound voice network dial peer that is configured for these capabilities or applications.

7. The terminating gateway uses the dialed string to match an outbound POTS dial peer.

8. After associating the incoming call setup to an outbound POTS dial peer, the terminating gateway creates an outbound POTS call leg, assigns it a call ID, and terminates the call.

The preceding steps are illustrated in Figure: Call Legs from the Perspective of the Terminating Router.

**Figure: Call Legs from the Perspective of the Terminating Router**



In scenarios where Cisco CallManager is present with a Cisco IOS gateway, the following assumptions apply:

- For inbound calls to Cisco CallManager through a Cisco IOS gateway, the gateway behaves as an originating device. (See Steps 1 to 4.)
- For outbound calls from Cisco CallManager through a Cisco IOS gateway, the gateway behaves as a terminating device. (See Steps 5 to 8.)

## Dial Peer Matching

In order for a call to be routed, the attributes set in the dial peers must be matched. Each dial peer can contain a variety of parameters. Some parameters are valid only for voice network or POTS dial peers, and others apply to all dial peers. This section covers the following topics:

- Inbound Dial Peer Matching
- Outbound Dial Peer Matching
- Voice Network Dial Peer Matching
- POTS Dial Peer Matching

The **destination-pattern** parameter on the **dial peer** command controls call routing. For inbound dial peers, the **destination-pattern parameter** is matched against the calling number, or automatic number identifier (ANI) string. For outbound dial peers, the **destination-pattern** parameter is matched against the called number, or dialed number identification service (DNIS) string. A dial peer with the **destination-pattern** parameter works for both outbound and inbound matching.

Multiple dial peers can match a specific digit string. The gateway usually attempts to perform longest-match routing. For example, if you have two patterns, 555.... and 55501..., and the called party number is 5550123, the gateway matches the peer with 55501...; however, if the call to that peer fails, the gateway attempts to use the other matching peer. If more than one peer has the same destination pattern configured, the **preference** parameter on the dial peer can resolve the priority. The peer with the lowest preference number has the highest priority.

The operational status for a dial peer must be administratively up and valid for it to be matched. To be considered operational, dial peers must meet one of the following conditions:

- **destination-pattern** is configured and a **voice-port** or **session target** is also configured.
- **incoming called-number** is configured.
- **answer-address** is configured.

Matching the called party number with the **destination-pattern** parameter is always used to match an outbound dial peer. The inbound dial peer does not affect where the call is routed, but it does determine all of the call properties for the voice network side of the call, regardless of where the outbound peer terminates. The **incoming called-number** and **answer-address** commands are used only to match inbound dial peers. They are not used for call routing or choosing an outbound dial peer. The **incoming called-number** command matches based on the called party number but does not play a role in where the call is routed. It is used only to select the inbound dial peer. If this match is unsuccessful, the **answer-address** command tries for a match using the calling party number information rather than the called party number. If both of these matches fail, the calling party information is matched against the **destination-pattern** command configured on the dial peers. On POTS ports, the inbound dial peer can be matched based on port configuration. If no match can be made, the dial peer 0 attribute is used. See the [Dial Peer 0](#) for more information about dial peer 0.

For more information about the operational status of dial peers, refer to [Understanding the Operational Status of Dial Peers on Cisco IOS Platforms, document ID 12426](#).

For more detailed information on dial peer matching, configuration steps, and information about parameters, refer to "[Dial Peer Features and Configuration](#)" in the [Dial Peer Configuration on Voice Gateway Routers](#) document.

For additional information about dial peer matching, refer to [Understanding Inbound and Outbound Dial Peers Matching on IOS Platforms, document ID 14074](#).

## Inbound Dial Peer Matching

The inbound dial peer determines all of the call properties for the voice network side of the call. Inbound POTS dial peers are associated to incoming POTS call legs on the originating gateways. Inbound voice-network dial peers are associated to incoming voice-network call legs of the terminating gateway.

To match inbound call legs to dial peers, the router uses three information elements in the call setup message and five configurable dial peer attributes. The three call setup elements are:

- Called number or DNIS-A set of numbers representing the destination, which is derived from the ISDN setup message or channel associated-signaling (CAS) DNIS.
- Calling number or ANI-A set of numbers representing the origin, which is derived from the ISDN setup message or CAS ANI.
- Voice port-The voice port carrying the call.

The five configurable dial peer attributes are:

- Incoming called number-A string representing the called number or DNIS. It is configured by using the **incoming called-number** dial-peer voice configuration command in POTS or MMoIP dial peers.
- Answer address-A string representing the calling number or ANI. It is configured by using the **answer-address** dial-peer voice configuration command in POTS or VoIP dial peers and is used only for inbound calls from the IP network.
- Destination pattern-A string representing the calling number or ANI. It is configured by using the **destination-pattern** dial-peer voice configuration command in POTS or voice-network dial peers.
- Application-A string representing the predefined application that you enable on the dial peer. It is configured by using the **application** dial-peer voice configuration command on inbound POTS dial

peers.

- Port-The voice port through which calls to this dial peer are placed.

When the gateway receives a call setup request, a dial-peer match is made for the incoming call to facilitate routing the call to different session applications. The gateway does not perform digit-by-digit matching. Instead, the full digit string received in the setup request is used for matching against configured dial peers.

The gateway selects an inbound dial peer by matching the information elements in the setup message with the dial peer attributes. The gateway matches these items in the following order:

### 1. Called number or DNIS with **incoming called-number**

First, the gateway attempts to match the called number of the call setup request with the configured **incoming called-number** parameter of each dial peer. Because call setups always include DNIS information, Cisco recommends using the **incoming called-number** command for inbound dial peer matching. This attribute has matching priority over the **answer-address** and **destination-pattern** parameter.

### 2. Calling number or ANI with **answer-address**

If no match is found in Step 1, the gateway attempts to match the calling number of the call setup request with the **answer-address** of each dial peer. This attribute may be useful in situations where you want to match calls based on the calling number (originating).


### 3. Calling number (ANI) with **destination-pattern**

If no match is found in step 2, the gateway attempts to match the calling number of the call setup request to the **destination-pattern** of each dial peer.

### 4. Voice port (associated with the incoming call setup request) with the configured dial peer **port parameter** (applicable for inbound POTS call legs).

If no match is found in Step 3, the gateway attempts to match the configured dial-peer **port** parameter to the voice port associated with the incoming call. If multiple dial peers have the same port configured, the dial peer first added in the configuration is matched.

If no match is found using these steps, then dial peer 0 is used. See the [Dial Peer 0](#) for more information about dial peer 0.

 **Note:** Step 4 is not applicable to voice or dial platforms such as the Cisco AS5300 access server, Cisco AS5350 universal gateway, Cisco AS5400 universal gateway, Cisco AS5800 universal gateway, and Cisco AS5850 universal gateway. If any one of first three steps are not used, then dial-peer 0 is matched and the call is treated as a dial modem call. This call treatment can result in getting modem tones as opposed to dial tone for inbound calls.


Only one condition must be met for the gateway to select a dial peer. The gateway stops searching as soon as one dial peer is matched. It is not necessary for all the attributes to be configured in the dial peer or that every attribute match the call setup information.

The longest prefix matching criteria applies while each step is performed. At each step, if multiple matches are found, the one with the longest explicit match is chosen.

For more information on dial-peer matching, configuration steps, and information about parameters, refer to "[Dial Peer Features and Configuration](#)" in the [Dial Peer Configuration on Voice Gateway Routers](#) document.

### Dial Peer 0

If no inbound peer can be matched by the defined criteria, the inbound peer is set to dial peer 0, which sometimes appears as *pid:0*. The characteristics of dial peer 0 cannot be changed.

 **Note:** Cisco universal gateways, such as the Cisco AS5350, Cisco AS5400, Cisco AS5800, and Cisco AS5850, require configured inbound dial peers to match incoming POTS calls in order to be accepted as a voice call. If there is no inbound dial peer match, the call is treated and processed as a dialup (modem) call.


For an inbound voice network call, dial peer 0 has the following characteristics:

- Supports any codec
- No DTMF relay
- IP precedence 0
- VAD-enabled
- No RSVP support
- Fax-rate voice

Dial peer 0 fails to negotiate nondefault capabilities, services, and applications, such as DTMF relay or disabled VAD.

For an incoming POTS call, dial peer 0 has the following characteristics:

- No applications
- No DID

 **Note:** Avoid using dial peer 0. Having the **incoming called-number** parameter configured correctly ensures that the dial peer is always matched with the parameters you want when placing outbound calls through a gateway. Many problems with calling out through a Cisco IOS gateway are due to codec, VAD, and DTMF-relay misconfigurations when dial peer 0 is being matched. To display which dial peers are being matched for an active call, use the **show call active voice brief** command.

### Inbound Dial Peer Configuration Tips

For inbound dial peers, the following configuration tips apply to certain configurations:

#### Session Target Command

For inbound dial peers, the **session target** command is ignored.

#### ISDN Overlap Configuration

When the timer (**T**) character is included at the end of the destination pattern, the router collects dialed digits until the interdigit timer expires (10 seconds, by default) or until you dial the termination character (the default is #). The timer character must be an uppercase **T**. In most cases, you must configure the **T** indicator only when the router uses two-stage dialing. If DID is configured in the inbound POTS dial peer, the router uses one-stage dialing, which means that the full dialed string is used to match outbound dial peers. The only exception is when the **isdn overlap-receiving** command is configured; the ISDN overlap-receiving feature requires the **T** indicator.

When the **isdn overlap-receiving** command is configured on ISDN interfaces, dial peers are checked for matches after every digit is received at the ISDN layer. If a full match is made, the call is routed immediately without waiting for additional digits. The **T** indicator can be used to suspend this digit-by-digit matching and



force the gateway to wait until all digits are received. The **T** refers to the T302 interdigit timer at the ISDN level, configurable under the serial interface associated with the ISDN interface. ISDN also provides other mechanisms to indicate the end of digits, such as setting the Sending Complete Information Element (IE) in a Q.931 information message.

### Empty Calling Field with Variable-Length Dial Plans

In some voice network configurations, variable-length dial plans are required, especially if the network connects two or more countries where telephone number strings could be different lengths. However, this configuration can result in the calling number field being replaced with an empty number.

If you enter the **T** character in the **destination-pattern** parameter for your dial peer, the router can be configured to accept a fixed-length dial string, and then wait for additional dialed digits. For example, the following dial peer configuration shows how the T character can be set to allow variable-length dial strings:

```
dial-peer voice 1 pots
  destination-pattern 9T
  port 1/0:1
```

If an incoming call arrives with no calling number information and is matched with the POTS dial peer shown based on the **destination-pattern** 9T, the gateway uses the "9" digit as the calling number and forwards the call to the corresponding device. To eliminate this behavior of replacing the empty calling number field, create a dummy POTS dial peer with just the **incoming called-number** command configured. Because the **incoming called-number** statement has higher priority than the **destination-pattern** parameter for inbound POTS matching, dial-peer voice 2 is the POTS dial peer that is used:

```
dial-peer voice 1 pots
  destination-pattern 9T
  port 1/0:1
!
dial-peer voice 2 pots
  incoming called-number .
```

### Outbound Dial Peer Matching

The method a router uses to select an outbound dial peer depends on whether DID is configured in the inbound POTS dial peer. If DID is not configured in the inbound POTS dial peer, the router collects the incoming dialed string digit by digit. When one dial peer is matched, the router immediately places the call using the configured attributes in the matching dial peer.

If DID is configured in the inbound POTS dial peer, the router uses the full incoming dial string to match the destination pattern in the outbound dial peer. With DID, the setup message contains all the digits necessary to route the call; no additional digit collection is required. If more than one dial peer matches the dial string, all of the matching dial peers are used to form a rotary group. The router attempts to place the outbound call leg using all of the dial peers in the rotary group until one is successful.

For matching outbound dial peers, the gateway uses the **destination-pattern** dial peer command.

- On POTS dial peers, the **port** command is used to forward the call.
- On voice network dial peers, the **session target** command is used to forward the call.

### DID Configuration

An example of incoming dial-peer configured with DID follows:

```
dial-peer voice 1 pots
  incoming called-number 81690
  voice-port 0:D
  direct-inward-dial
```

On DID calls, also referred to as one-stage dialing, the setup message contains all digits necessary to route the call, and the gateway should not do subsequent digit collection. When the gateway searches for an outbound dial peer, it uses the entire incoming dial string. This matching is by default variable-length. It is not done digit by digit because by DID definition all digits have been received. The following example helps clarify this concept:

If the DID dial-string is "81690," the router matches dial peer 4 and forwards the complete dial-string "81690."

```
dial-peer voice 3 voip
  destination-pattern 816
  session target ipv4:172.22.10.1
!
dial-peer voice 4 voip
  destination-pattern 81690
  session target ipv4:172.22.10.1
```

### Two-Stage Dialing Configuration

If DID is not configured on the matched incoming dial peer, the gateway enters digit collection mode, called two-stage dialing. Digits are collected inband. Outbound dial peer matching is done on a digit-by-digit basis. The gateway checks for dial peer matches after receiving each digit and then routes the call when a full match is made.

In this example, the dial string is "81690." Immediately after the router receives the digit "6," it matches dial peer 3 and routes the call, forwarding only the digits "816."

```
dial-peer voice 3 voip
  destination-pattern 816
  session target ipv4:172.22.10.1
!
dial-peer voice 4 voip
  destination-pattern 81690
  session target ipv4:172.22.10.1
```

In this example, dial-peer 3 is configured for wild card matching:

```
dial-peer voice 3 voip
  destination-pattern 816..
  session target ipv4:172.22.10.1
!
dial-peer voice 4 voip
  destination-pattern 81690
  session target ipv4:172.22.10.1
```

In this case, the longest-prefix rule applies and dial peer 4 is matched for the outbound call leg.

## Variable-Length Dial Plans

There are situations where expected dial strings do not have a set number of digits. In such cases, it is usually best to use variable-length dial peers by configuring the **T** terminator on the dial-peer **destination-pattern** command.

The **T** terminator forces the gateway to wait until the full dial string is received by doing the following:

- Waiting for a specified interdigit timeout before routing the call.
- Routing the call once it receives the **#** termination character in the dial string. For example, if you dialed **5550112#**, the **#** would indicate to the router that you dialed all the digits and that all digits before the **#** should be used to match a dial peer.


In the following example, the router receives a call setup from the network with dial string "95550112." Dial peer 2 then forwards the digits "5550112" to the PSTN.

```
dial-peer voice 2 pots
 destination-pattern 9T
 port 2/0:23
```

In the following example, the dial string from an inbound POTS interface is "81690":

```
dial-peer voice 3 voip
 destination-pattern 8T
 session target ipv4:172.22.10.1
!
dial-peer voice 4 voip
 destination-pattern 81690T
 session target ipv4:172.22.10.1
```

In this case, the longest-prefix rule applies, and dial peer 4 is matched for the outbound call leg.

 **Note:** The default interdigit timeout is set for 10 seconds. To modify this value, use the **timeouts interdigit** voice-port command.

Anytime the **T** is used with **destination-pattern** parameter, it must be preceded by a **.** or digits (**.T** or **555T**, for example). Using **T** on its own causes the dial peers to act improperly and affects how calls are handled by the router.

## Voice Network Dial Peer Matching

When a call comes in through VoIP, the voice gateway searches for an inbound peer by looking through all the configured voice network dial peers. Using regular digit matching rules, it tries to match the peer in the following order:

1. Match the called number with the incoming called number.
2. Match the calling number with the **answer-address** parameter.
3. Match the calling number with the destination pattern.
4. Otherwise, use dial peer 0. See the [Dial Peer 0](#) for more information.

## POTS Dial Peer Matching

When a call comes in through POTS, the voice gateway searches for an inbound peer by looking through all the configured POTS dial peers. Using regular digit-matching rules, it tries to match the peer in the following order:

1. Match the called number with the incoming called number.
2. Match the calling number with the **answer-address** parameter.
3. Match the calling number with the destination pattern.

If the inbound interface is not PRI or BRI, or if a PRI or BRI interface does not match a dial peer using the preceding three rules, the voice gateway matches a POTS dial peer that has the inbound port configured if any of the following parameters are configured:

- **destination-pattern**
- **answer-address**
- **incoming called-number**

The **answer-address** parameter overwrites the call's calling-party number or ANI.