

Connecting to IP Gateways/PBXs – example of a CISCO Gateway

This White Paper is based on Brooktrout/customer experience in setting up a Cisco router and connecting it to the Brooktrout TR1034 IP (-1N) board. This White Paper is intended as initial help, but is no substitute for working with Cisco to solve issues with a Cisco router setup.

This white paper describes how to configure a Cisco 2600XM series Modular Access Router to interface with Brooktrout's TR1034/SR140 Modules, using the TR1034's Ethernet port and the Ethernet port from your network card, in a Fax Over IP solution. It also describes how to set up the T1/E1 port side of the router if connecting over the Private Service Telephone Network (PSTN).

Interoperability testing between Brooktrout and Cisco was accomplished for this product. This White Paper can also be used for setting up a Cisco 2691, 3725, 3745 and 2800 series. For further details concerning Cisco routers, see the documentation that was shipped with the router and go to the Cisco website for additional technical information, especially the PDF online manuals. This note attempts to summarize the crucial information from those manuals.

Pre-requisites for Connecting to a Cisco Gateway

To perform these configuration instructions, you should have the following:

- Prior knowledge of Cisco router installation and configurations
- A basic understanding of Cisco networking and router/gateway configurations
- Familiar with basic internet technology
- Certified or experienced in Cisco IOS router/gateway technology
- A thorough understanding of LAN/WANs, bridges, switches, protocols, and network management.

Any Cisco router that you are deploying, should be running Cisco IOS version 12.3 (7) T or higher of the Cisco Internet Operating System (IOS).

If you do not have these pre-requisites, you should seek assistance either internally from your IP network personnel that performs these functions in your own network or an external professional who is certified in Cisco router installation and configurations associated with the following tasks.

Summary of the Configuration Steps

Perform the following steps to configure your Cisco router:

1. Purchase/acquire the correct Cisco components, including possibly an Ethernet hub and (Ethernet and T1/E1 crossover cables), and one or more TR1034 boards / SR140 licenses.
2. Assemble the Cisco router and make cable connections.
3. Access the router with a terminal program.
4. Upgrade the operating system, if required.
5. Perform basic configuration of the router, including Ethernet ports.
6. Perform advanced configuration, including
 - a. IP
 - b. Voice Resources
 - c. T1/E1 controller(s), ISDN
 - d. Voip and pots dial peers

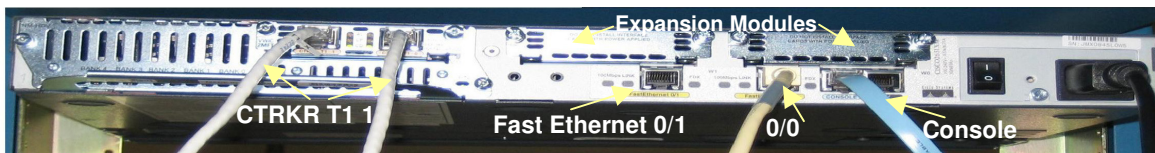
Getting Cisco Technical Support

To get technical support from Cisco, obtain first a username and password for which you will provide your support contract. Then submit a TAC service request using the online web tool. Open separate cases for each question when you have a wide variety of questions.

HARDWARE

The Cisco router comes already assembled. You may rack mount it, or install it at a desk. Being able to see the LEDs on the back of the router will be useful, though the same information can be reported through the terminal textually. Figure 1 illustrates the back of the router with the different parts that will be discussed below.

Figure 1: illustrates the Cisco 2600 Router, back panel



Required for Ethernet Interface

This series router comes with one or two fast Ethernet ports, so there should be nothing extra to purchase in this area.

Required for E1/T1 Interface

You need the following hardware components to install in the Cisco 2600 series router:

- A live T1/E1 line or
- A T1/E1 crossover cable for use with a second TR1034/virtual module in either T1 Robbed-Bit or T1/E1 ISDN (PRI) modes.
- NM-HDV2-T1/E1 module (for T1/E1 capability only) or
- VWIC-1MFT-E1 module (for one E1) or
- VWIC-1MFT-T1 module (for one T1).

In this White Paper, a NM-HDV2-T1/E1 network module was used, which has one RJ-48 port. Note that this is the enhanced successor to the NM-HDV-T1/E1. In the case of the model with two ports, both ports must be configured as either T1 or E1. What protocol you use, for instance T1 Robbed Bit or T1 ISDN Primary Rate, will need to be configured too. The module's ports are labeled CTRLR T1/E1 0 and CTRLR T1/E1 1. After removing the faceplate from the rear of the router, this module can be inserted into the back of the router. Additionally, you can add one or two more T1/E1 ports to this network module by inserting a VWIC (Voice Wan Interface Card) module into the network module's single VWIC slot. So, each network

module can support upto 4 T1/E1 ports. Table 1 lists the total of Cisco network modules for a few Cisco gateways.

Table 1. Network Module Types

Model	T1/E1 Ports	Network Modules
2600XM series	4	1
2691	4	1
2800	4	1
3725	8	2
3745	16	4

This network module NM-HDV2 requires the Cisco Internetwork Operating System (IOS) version 12.3 (7) T (the T is important) or later on the Cisco, otherwise the network module will not be recognized. This can be obtained from Cisco. See below on how to determine what version is running (command show version) and on how to upgrade the IOS.

Required for Analog and Basic Rate Interface

For analog and Basic Rate Interface (BRI) support, there are several Voice Interface Card (VIC) models available:

- VIC2-2FXS (a two-port VIC analog for connecting to an analog telephone line from a switch or telephone provider)
- VIC2-2FXO (a two-port VIC analog for connecting directly to an analog device e.g. analog fax machine)
- VIC-4FXS/DID (a four-port VIC analog/analog DID)
- VIC2-2BRI-NT/TE (a two-port VIC Basic Rate, only the T0 interface and not the S0 interface)

Required for voice/fax

Our network module for E1/T1 contains four slots to hold Packet Voice Data Modules (PVDMs), which look like PC SIMMs but contain DSP voice resources. These voice data modules have different densities ranging from 8 to 64 DSP channels (G.711 codec), named as PVDM2-x where x=8, 16, 32, 48, or 64. FOIP/VOIP requires PVDM with enough channels for the timeslots on all the T1/E1 ports on the network module (including optional VWIC).

When you don't have an E1/T1 network module because you have Analog and Basic Rate Interfaces, you though also need PVDMs for FOIP/VOIP. So, you would need for instance at a minimum a network module minus T1/E1 ports to house PVDMs that provide voice resources.

LEDs on the network module faceplate are labeled PVDM1 - PVDM4 and are on green if the PVDM is inserted. Handle and insert the PVDMs into the slots carefully so as not to damage the components.

Viewing Memory Types and Memory Amounts

The router contains 32K of non-volatile RAM (NVRAM), flash RAM (32Mb), and system RAM (132Mb).

NVRAM is used to store the configuration information only, and can be written to permanently using the write command.

Flash RAM can also be written to using FTP and other methods.

To view the contents of any type of memory, use the dir command and specify the memory type, following the dir command, for example:

```
dir nvram:
dir system:
dir flash:
```

```
Directory of flash:/
 1  -rw- 16288488  Dec 17 2004 13:33:15 -08:00
    c5400-is-mz.1238.T5.bin
 2  -rw- 1267290  Dec 17 2004 17:22:55 -08:00
    redirect.out
 3  -rw- 24442    Dec 21 2004 11:25:20 -08:00
    startup-up
31981568 bytes total (14400960 bytes free)
```

Note: The startup-configuration file is located in NVRAM, while the running-configuration file is stored in active system memory.

Upgrading the Cisco IOS

This is required when the Cisco Internetwork Operating System (IOS) is not version 12.3 (7) T (the T is important) or later. The T/E1 high-density module NM-HDV2 would then not be recognized.

The light blue serial cable is used to transfer the binary image of the Operating System. The following steps need to be taken from the HyperTerminal. For details about the commands, see Chapter below.

1. Check that there is enough flash memory to store the OS. Type `show ver` and look for something like "32768K bytes of processor board System flash (Read/Write)"
2. Go into enable mode, and then configure mode (`enable, config t`)
3. Type `config-register 0x2100`. This changes the boot startup mode to Rom monitor.
4. Type 'Control-Z' to finish entering commands.
5. Type `wr mem` to save the configuration to NVRAM.
6. Type `reload` to reload/reboot the O.S. and confirm.
7. On reboot, the rommon prompt will be displayed: `rommon 1 >`
8. Type `confreg 0x3920` to change the serial transfer speed to 115K on the router. The prompt will change to `rommon 2 >`
9. Type `reset` to put this new setting into effect.
10. Stop the HyperTerminal session (menu option 'Call ... Disconnect')
11. Change the HyperTerminal port settings Bits per second to 115200 (File ... Properties ... "Connect To" tab, "Configure ...")
12. Restart the HyperTerminal session (menu option 'Call ... Call')

13. Type `xmodem -y <IOS image file name>`, where `<IOS image file name>` is the Cisco IOS binary you have acquired from Cisco. It is case sensitive. Choose to continue when warned that existing data in bootflash will be lost.
14. Choose menu option "Transfer ... Send File ..."
15. Browse for the Cisco IOS binary and choose Ymodem protocol. Click Send. It will take a while for the file (~20Mb) to be sent.
16. The newly sent OS image will AUTOMATICALLY be rebooted to when the send is finished.
17. Going forward, the T1 module should be recognized as "1 Port NM-HDV2-T1/E1 High Density Voice Port Module".
18. In configuration mode, type `config-register 0x2102` to put the startup mode back to normal, so that the rommon mode won't start on reboot. Also, this switches back to 9600, so revert back to your original 9600 HyperTerminal setting.

COMMUNICATING WITH THE CISCO (COMMANDS)

Communicating with the Cisco router can be done with the Microsoft HyperTerminal utility. This can be accomplished via the supplied, light blue serial interface cable or via an Ethernet connection connected to a laptop or PC.

Setting Up HyperTerminal for the Serial Interface

Connect the light blue cable to the serial interface port of the Cisco router and to a COM port of your PC. Choose for HyperTerminal:

- The correct COM port
- 9600 baud
- 8 data bits
- 1 stop bit
- no parity

Note: You must first use a serial interface connection in order to do the initial router setup, because no IP address has been assigned yet to the router.

Setting Up HyperTerminal for the Ethernet Network Connection

Connect the Cisco Ethernet connector to the LAN (for remote access) or directly to a PC or laptop with an Ethernet cable. Set for HyperTerminal:

- TCP/IP (Winsock)
- IP address of the router , e.g. 208.123.111.202
- port number = 23

Note: Once the router's IP address is assigned, you can use the Ethernet method instead of a serial connection when your router is remotely located.

Instead of using the Microsoft HyperTerminal utility, a command line interface can be used to telnet to the IP address of the router. The command would then be for example:

```
telnet 208.123.111.202
```

whereby the IP address in this example is the IP address of the router.

Initial Setup of the router with the Serial Interface

1. Run HyperTerminal in serial interface mode.
2. Turn on the router by pushing the toggle switch to ON.
Output is displayed on the Terminal. It includes the Cisco IOS version.
If a T1 module with one port is recognized, the following displays:
1 Port NM-HDV2-T1/E1 High Density Voice Port Module
To ask you if you want to configure, the following displays:
--- System Configuration Dialog ---
Would you like to enter the initial configuration dialog? [yes/no]:
3. A **yes** answer takes you through a series of questions that will lead to the automatic creation of a configuration file used during boot up. **Note:** You can save this configuration file to NVRAM.

You can choose either basic setup for just the Ethernet connections or extended setup for all the interfaces (e.g. T1/E1).

4. Choose basic.
5. Choose a host name.
6. Create passwords.
7. Choose the Ethernet interface you'll be using: `fastethernet0/0`
8. Answer IP configuration questions, e.g. get the IP address from your system administrator
9. If connecting to a hub, which is half-duplex, choose either half-duplex or auto. Otherwise, the cable will not synchronize when connected (the LEDs closest to the fastEthernet connector remain unlit).
10. Make sure these LEDs next to the fastEthernet connector turn green.
11. Choose '2' to save the selections as displayed to NVRAM and exit.
Your selections are displayed and saved in a configuration file.
12. Press `Enter`.
A prompt labeled with the host name that you provided earlier will be displayed, for example:
`techsupport>`

Rerun the Initial Setup of the router

Re-running the above configuration dialog and starting anew can be done at any time. You need to first enter the rommon (rom monitor) mode. One way to do this is to restart the router (power cycle it with the black I/O on/off switch), and press Ctrl-Break when it starts up. A rommon prompt will be displayed:

```
Rommon 1>_
```

To change the startup mode, type

```
confreg 0x2142
```

Then either power cycle again or type the following to warm reboot the router:

```
reset
```

On startup, the System Configuration Dialog will be displayed. When done configuring, change the startup mode back to 0x2102 (normal startup) using the same procedure just described.

Testing an IP Port

If your IP port is functioning properly, when you connect it to a hub, the LEDs turn green. For test purposes, you can now also connect the port to a PC directly using an Ethernet cross-over cable. The IP address and subnet mask of the PC should be set in order to communicate with the router.

You should try to ping the router from the PC to make sure that the IP address and subnet mask were set. You can also ping from the router, which uses the same format of the command:

```
ping xxx.xxx.xxx.xxx
```

Commands

Entering Commands

On startup, after the output displays on your monitor, a prompt displays with the host name for the router, for example `techsupport>`

At this prompt, or any prompt, you can type a `?` to list all available commands. Commands can be simply one word, or they could be multi-word commands (i.e. commands with parameters), where each word further clarifies the base command. You can even type a `?` after you have partially typed a command and want to see the list of further matches for that command. For example, `c?` simply displays the following commands that start with a letter `c`: `call`, `clear`, `connect`. If your partial command is ambiguous because it could be expanded to two or more valid commands like in this example here with `c`, it will be rejected with a message indicating ambiguity.

Using this feature another level deeper, `ping ?` gives the syntax for the ping command.

You can also abbreviate commands by typing at a minimum the first letters of the command that make the command unique with respect to all the other commands allowed in the mode that you are in: type `?` to see this list as mentioned above. For example, to logout, you would have to type at least `logo`, because there is a similar command `login` that starts with the combination `log`, so, typing `log` is not enough.

As a shortcut, use the Up Arrow key repeatedly to quickly display your history of commands.

Also, you typically will have to enter repeatedly the same command. You can copy and paste them with HyperTerminal, but they must be pasted in the required order, and with the correct values/parameters. To paste in HyperTerminal, you cannot use Ctrl-V but use the menu option `Edit -> Paste To Host`. However, to copy in HyperTerminal, you can use Ctrl-C.

If you want to change an existing configuration value, the new value you add will overwrite the existing one. If you want to completely remove a command, precede the command with:

```
no
```

Commonly Used Commands

The following is a list of commonly used commands.

Table 2. Commonly Used Commands

<code>show ver, show version</code>	Provides version information: IOS version and binary file name, router model, amount of memory, configure register setting.
-------------------------------------	---

show diag	Provides detailed information on hardware detected in the router.
dir*	Lists files.
enable	Enters privileged mode
disable, logout, exit	Exits privileged mode
config t* configure terminal*	Allows you to change configuration.
?	Lists current available commands.
more (filename)	Prints out file contents one screen at a time.
reload*	Performs a warm reboot on the router (asks to save configuration first if changed but the configuration was not saved during the session).

* Indicates that the user must be in enable mode (privileged). See the following section for further information concerning privileged mode.

Table 3. Commonly Used Commands

Commands	Functions
exit	To change from a specific configuration mode to the global configuration mode.
no	To remove a command, precede the command with .
end or Control-Z	To save configuration changes temporarily .
write memory	To save configuration changes permanently to NVRAM .
copy startup-config running-config	To revert to the previous configuration since your last reboot without rebooting.
copy running-config flash:<filename>	To save configuration changes to flash memory to share configuration files with others on the system, or to maintain multiple configuration files.
Show run	To view the (new) configuration. Be aware : there might have been additional lines automatically added based on your selections.

System Command Error Messages

You must copy and paste many commands in the required order and with the correct values/parameters. Otherwise, the system displays an error message. The system only executes commands that are in the correct order.

If you incorrectly type a command, the system indicates the error location in the command using the caret character (^) as shown in the following example:

```
pv2651xm>config t
                ^
% Invalid input detected at '^' marker.
```

Important Command Modes

To be able to use certain commands, you need to be first in the correct command mode:

1. Privileged mode (needed for many commands)
2. Global configuration mode (needed to make configuration changes)
3. Specific configuration mode (needed for configuration of specific hardware)

1. Privileged Command Mode

Many commands require you to be in privileged mode, especially if you are configuring. To access privileged mode, type

```
enable
```

which prompts you for your password if there is one to access the privileged mode.

The prompt then changes to a # sign instead of a > sign, for example:

```
techsupport#
```

instead of

```
techsupport>
```

Type `logout`, `exit`, or `disable` to leave privileged mode.

2. Global Configuration Mode

This requires being in privileged command mode. In this global configuration mode, the commands you enter will result in updating the configuration at the global level, meaning the commands apply to all hardware as appropriate. You enter configure terminal commands one command per line. To access the global configuration mode:

1. Type `configure terminal` or abbreviated: `config t`
2. Press `Enter`
3. The prompt now changes from

```
techsupport#  
to  
techsupport (config) #
```

When you have finished making changes, type the following to leave the configuration mode with changes temporarily saved:

```
end
```

or hit Control-Z. To permanently save the settings to NVRAM as the file called “startup-config”, type:

```
write memory
```

If you didn’t permanently save the settings yet to the NVRAM and you want to revert back without rebooting to the configuration you started with, use the command:

```
copy startup-config running-config
```

The “startup-config” file is located in NVRAM whereas the “running-config” file is stored in active system memory. You can also make use of the flash memory if you want to share configuration files with others on the system or maintain multiple configuration files: copy your current “running-config” file to flash memory with the following command:

```
copy running-config flash:<filename>
```

3. Specific Configuration Modes

You can also enter commands that apply only to specific hardware, and the prompt symbol changes to reflect what section you are currently configuring. So, it is known where you are in the configuration.

These configuration modes include among others the following:

- Interface Fast Ethernet
- Interface Serial (ISDN)
- Dial-Peer (see *Configuring Dial-Peer*)
- Voice-port (see *Configuring a Voice-Port*)
- Controller (T1/E1)

Your command selections result in listings nested into the proper locations in the generated configuration file. The Cisco IOS also knows what hardware is installed and your existing configuration settings, and doesn’t allow you to enter incomplete commands or commands with conflicting values.

To get out of a specific configuration mode back to the global configuration mode, type:

```
exit
```

Password Access

Passwords can be set or changed. The different levels of password access are described here.

To access the router via the serial interface or via TCP/IP (telnet), there is a password, but they are different:

1. For Serial access, a password is optional. It can be set from the global configuration mode, by typing the following:

```
line con 0 to enter the line configuration mode, and  
password <password>
```

whereby <password> is unencrypted password.

2. For TCP/IP access, a password is required. To set it, first type:
`line vty <first line #> <last line #>`
Where the line # values are a range of potential users who could telnet in. Then enter the password the same way as described for serial access.

To access to privileged mode, you can optionally specify two different passwords, one being called a secret, which is encrypted, and the other just a normal password, which is not encrypted. If you set both, then the secret will take precedence and will be required when you type the `enable` command to access privileged mode.

1. To create a (normal) password, type the following from the configuration mode:
`enable password <password>`
This will add the following line to the configuration:
`enable password <readable password>`
To remove this, type the following from the configuration mode:
`no enable password`
2. To create a secret, type the following from the configuration mode:
`enable secret <password>`
This will add the following line to the configuration:
`enable secret <encrypted password>`
To remove this, type the following from the configuration mode:
`no enable secret`

SPECIFIC CONFIGURATIONS

This chapter covers the following specific configurations:

- Packet Voice Data Module
- T1/E1 Controller
 - for T1 Robbed-Bit
- Additional ISDN settings
- Voice Port
- Dial Peer
- Fax Over IP/T.38

You first need to be in the global configuration mode in order to be able to enter into these specific configuration modes. And global configuration mode requires privileged mode. So, make sure to go first through (with in this example `techsupport` as host name of the router):

```
techsupport>enable
techsupport#_
techsupport#config t
techsupport (config) #_
```

Configuring Packet Voice Data Module (PVDM2)

To configure a packet voice data module, type:

```
voice-card (slot #)
```

to enter the voice card configuration mode, whereby (slot #) is the slot (1-4) that contains the PVDM2 to configure. Note that the range is offset one less than the range (0-3) used for the labeling of the PVDMs on the faceplate of the network module.

The configuration prompt changes to `config-voicecard`.

You can specify additional settings for these packet voice cards like voice codec combinations, but this is beyond the scope of this document.

Configuring ISDN PRI globally

If all your ISDN lines are connected to the same switch type, then you can optionally specify this information in the global configuration mode, thereby avoiding individual port configurations.

To configure, type:

```
isdn switch-type <type>
```

whereby <type> is one of the supported switch types. To figure out what you can specify as <type>, you can display the list of all switch types, by typing:

```
isdn switch-type?
```

For example:

```
pv2651xm(config)#isdn switch-type ?
primary-4ess Lucent 4ESS switch type for the U.S.
primary-5ess Lucent 5ESS switch type for the U.S.
primary-dms100 Northern Telecom DMS-100 switch type for the U.S.
primary-dpnss DPNSS switch type for Europe
primary-net5 NET5 switch type for UK, Europe,
    c Asia and Australia
primary-ni National ISDN Switch type for the U.S.
primary-ntt NTT switch type for Japan
primary-qsig QSIG switch type
primary-ts014 TS014 switch type for Australia (obsolete)
```

Configuring a T1/E1 Controller

First select one network module to configure for T1 or E1, by typing:

```
card type <T1|E1> <slot#> <sub slot#>
```

with:

T1 E1	Set the network module to T1 or to E1. A network module has one or two ports, and if two, the ports will be set both to T1 or both to E1.
-------	---

slot#	Slot Number - Indicates the slot number and ranges from 1 to 4. 1 usually represents the single network module supported by Cisco's 2600 series.
sub slot #	Sub Slot Number - Indicates the subslot number Options are: <ul style="list-style-type: none"> ▪ 1 indicates onboard controller ▪ 0 indicates installed WIC

This command automatically adds entries to the configuration for one or two T1/E1 controller ports, depending on how many there are (see the next set of instructions).

Secondly, configure each of the T1/E1 port(s) of this network module individually by entering the controller config mode for each port. Type:

```
controller <t1 | e1> <slot #>/<port#>
with
```

T1 E1	Select T1 or to E1 - The same choice as above
slot#	Slot Number – Idem as above - Indicates the slot number and ranges from 1 to 4. Usually 1.
port #	Port Number – Refers to the RJ48 connectors. Can be 0 or 1.

The config prompt changes to `config-controller`.

For example:

```
pv2651xm(config)#controller
pv2651xm(config)#controller ?
  T1  T1 controller
pv2651xm(config)#controller T1 (1/0)
pv2651xm(config-controller)#
```

Now the parameters need to be set for this specific port and this needs to be repeated for each port.

1. Set clock source to either line or internal, by typing:

```
clock source <internal | line>
```

- Type

```
clock source internal
```

if the router is providing clock to the line. If in this case the T1/E1 cable from the router is directly connected to a TR1034 T1/E1 high density board, the TR1034 needs to be configured for slave (emulation=CPE).

- Type

```
clock source line
```

if connecting to a PBX/Telephony provider, because the PBX/Telco should always be the clock source. If in this case the T1/E1 cable from the router is directly connected to a TR1034 T1/E1

high density board, the TR1034 needs to be configured for master (emulation=CO and clock_source=internal).

To display the options:

```
pv2651xm(config-controller)#clock source ?
  free-running  Free Running Clock
  internal      Internal Clock
  line          Recovered Clock
```

2. Specify the framing method, by typing

```
framing <sf | esf | crc4 | no-crc4>
```

- T1 uses superframe (sf) or extended superframe (esf).
- E1 uses multiframing with `crc4` or single frames with `no-crc4`.

3. Specify the coding method, by typing

```
linecode <b8zs | ami | hdb3>
```

- T1 uses `b8zs` or `ami`.
- E1 uses `hdb3`.

4. Specify the cable length, by typing

```
cablelength short <133 | 266 | 399 | 533 | 655>
```

- For T1, each value represents the range in feet from the source. For example, 266 = length is within the range of 134 - 266 ft.

So far for the configuration of the layer 1 of this specific port. You now can configure this specific port for the T1 Robbed Bit protocol or for the ISDN protocol.

For an example screen display, see *Example of Configuration Mode Session*.

Configuring the Controller for T1 Robbed-Bit

5. To configure the T1 Robbed Bit protocol, type

```
ds0-group <group #> timeslots <list of timeslots> type
<e&m-immediate-start | e&m-wink-start> dtmf dnis
```

- Group # is an arbitrary number 0 - 23
- List of timeslots is typically the range of all possible timeslots on the T1/E1, or it can be a combination of individual timeslots, range(s), or a single timeslot.
- `dnis` is required for inbound calls to be answered.

For an example screen display, see *Example of Configuration Mode Session*.

Note: If you attempt to make any changes to the `ds0-group` in this Controller Configuration mode, you will be prevented from doing so and asked to stop voice resources first. To do that, enter the Voice-port Configuration mode and enter the `shutdown` command. Then return to this Controller Configuration mode and enter the `shutdown` command to shutdown the Controller itself. After the changes are made for the Controller, enter the `no shutdown` command for both the Controller in this mode, and then for the Voice-port in Voice-port Configuration mode.

Configuring the Controller for T1/E1 ISDN

5. To configure the T1/E1 ISDN protocol, type

```
pri-group <timeslots range>
```

- Timeslots range is an optional range of timeslots, otherwise all timeslots are assumed.

For an example screen display, see *Example of a T1/E1 Controller Configuration*.

Note: If you attempt to make any changes to the pri-group in this Controller Configuration mode, you will be prevented from doing so and asked to stop voice resources first. To do that, enter the Voice-port Configuration mode and enter the `shutdown` command. Then return to this Controller Configuration mode and enter the `shutdown` command to shutdown the Controller itself. After the changes are made for the Controller, enter the `no shutdown` command for both the Controller in this mode, and then for the Voice-port in Voice-port Configuration mode.

Example of a T1/E1 Controller Configuration Session

The following is an example of a configure mode session where a T1 Robbed-Bit port and a T1 ISDN port were configured:

```
techsupport# config t
techsupport(config)# card type t1 1 1
techsupport(config)# isdn switch-type primary-5ESS
techsupport(config)# controller t1 1/0
techsupport(config-controller)# clock source line
techsupport(config-controller)# framing esf
techsupport(config-controller)# linecode b8zs
techsupport(config-controller)# cablelength short 133
techsupport(config-controller)# ds0-group 0 timeslots 1-24 type e&m-
wink-start dtmf dnis
techsupport(config-controller)# no shutdown
techsupport(config-controller)# exit
techsupport(config)# controller t1 1/1
techsupport(config-controller)# clock source line
techsupport(config-controller)# framing esf
techsupport(config-controller)# linecode b8zs
techsupport(config-controller)# cablelength short 133
techsupport(config-controller)# pri-group timeslots 1-23
techsupport(config-controller)# no shutdown
techsupport(config-controller)# exit
techsupport(config)# end
techsupport#
```

Viewing the Controller Configuration

To see how the controller is configured and to see its state, type in privileged mode:

```
show controller T1 or show controller E1
```

Configuring Additional ISDN Settings

When the T1/E1 controller is configured for ISDN Primary Rate Interface (PRI), the software adds a serial interface section to the configuration file. This section will mention the switch type that was specified when ISDN was configured globally, see Chapter *Configuring ISDN Globally*.

To configure additional settings, you need to enter the serial mode by typing:

```
interface Serial <slot#>/<port#>:<group#>
```

- Slot Number – Idem as above - Indicates the slot number and ranges from 1 to 4. Usually 1.
- Port Number – Idem as above - Refers to the RJ48 connectors. Can be 0 or 1
- The group # was auto set above to 23 for ISDN and cannot be changed.

The configuration prompt changes to `config-if`.

All the ISDN commands begin with `isdn`. Additional ISDN commands include the following:

- calling number
- disconnect-cause
- IE
- incoming-voice
- negotiate-bchan
- outgoing
- reject
- switch-type
- protocol-emulate

To explicitly emulate the network, set `isdn protocol-emulate to network`. This is important if doing back-to-back testing with a TR1034 in PRI mode where the TR1034 is the user side.

Viewing the ISDN Status

To see the status of ISDN layer 1, 2 or 3, type:

```
show isdn status
```

Debugging ISDN

To view the ISDN layer 3 (Q.931) messages live, type:

```
debug isdn q931
```

To view the ISDN layer 2 (Q.921) messages live like RR (receiver ready), type:

```
debug isdn q921
```

This can be very useful for troubleshooting.

When debugging through a telnet session, to view output, you must also enter the command:

```
terminal monitor
```

Configuring a Voice-Port

A voice port configuration setting is added to the configuration automatically when you configure a T1/E1 Controller. To enter the Voice-port Configuration mode, type:

```
voice-port <slot#>/<port#>:<group#>
```

- Slot Number – Idem as above - Indicates the slot number and ranges from 1 to 4. Usually 1.
- Port Number – Idem as above - Refers to the RJ48 connectors. Can be 0 or 1
- For ISDN only, the group# is assigned value 23. For T1 Robbed-Bit, we had set this to 0 in the above Controller example.

The configuration prompt changes to `config-voiceport`.

For example:

```
pv2651xm(config)#voice-port 1/0:?  
    <0-23> Controller ds0-group number  
pv2651xm(config)#voice-port 1/0:0  
pv2651xm(config-voiceport)#
```

No additional settings should be required for basic setup, but there are many other commands. Type ? for a list of commands while in this mode:

```
pv2651xm(config-voiceport)#?
```

Voice-port configuration commands:

<code>auto-cut-through</code>	E & M auto cut-through without answer signal
<code>bearer-cap</code>	Specify the bear capability
<code>busyout</code>	Configure busyout trigger event & procedure
<code>comfort-noise</code>	Use fill-silence option
<code>compand-type</code>	The companding type for this voice port
<code>condition</code>	Condition Signaling bit patterns
<code>connection</code>	Specify Trunking Parameters
<code>cptone</code>	Configure voice call progress tone locale
<code>default</code>	Set a command to its defaults
<code>define</code>	Define Signaling bits
<code>description</code>	Description of what this port is connected to
<code>dial-type</code>	Configure type of dialer for voice
<code>disc_pi_off</code>	close voice path when disconnect with PI received
<code>echo-cancel</code>	Echo-cancellation option
<code>exit</code>	Exit from voice-port configuration mode

fake-answer-disable	Disable E&M fake answer for trunks hung in EM_PARK state
idle-detection	Idle code detection for digital voice
ignore	Ignore RCV Signaling bits
input	Configure input gain for voice
music-threshold	Threshold for Music on Hold
no	Negate a command or set its defaults
non-linear	Use non-linear processing during echo cancellation
outgoing-cas	Set delay on outgoing CAS connection
output	Configure output attenuation for voice
playout-delay	Configure voice playout delay buffer
shutdown	Take voice-port offline
snmp	Modify SNMP voice port parameters
station-id	Configure station ID
threshold	Threshold [noise] for voice port
timeouts	Configure voice timeout parameters
timing	Configure voice timing parameters
translate	Translation rule
translation-profile	Translation profile
trunk-group	Configure interface to be in a trunk group
voice-class	Set voiceport voice class control parameters

pv2651xm(config-voiceport)#

Viewing the Voice-port Configuration

To see an extensive list of configuration information on a specified port, type in privileged mode:

```
show voice port
```

Configuring Dial-Peer

One or more dial-peers map the translations between PSTN numbers and IP addresses.

For example, if making an IP call from the TR1034/SR140 virtual module to the PSTN, a dial-peer allows the PSTN call to be made by the router, depending on the number dialed. You can configure the T1/E1 port to send a call out of one of its channels when it receives a call from another one of its channel.

In the other direction, you can set up the router to make a corresponding IP call when an incoming call is received by the T1/E1, depending on the number dialed.

Therefore, at least two dial peers are required when configuring for traffic moving in both directions between the PSTN and IP networks.

To enter the Dial-Peer configuration mode, type

```
dial-peer voice <dial-peer tag><pots | voip>
```

- The dial-peer tag/label is an arbitrary number between 1-2147493647.
- Choose POTS (Plain Old Telephony Service) to configure any PSTN line type (T1, E1, BRI, analog).
- Choose voip to configure an Ethernet port for voice/fax over IP.

The configuration prompt changes to `config-dial-peer`.

For detailed explanations concerning setting up dial peers, refer to the “Dial Peer Configuration for Cisco Voice Gateway Routers” manual from Cisco.

Patterns

The pattern can include individual digit wildcards as the period (.) character, which represents any digit. For example, if the pattern is 781911.... then any number of the form 781911 followed by four or more digits would match (less than four would fail). Zero or more digits in succession can be handled with the percentage character (%), where % follows the digit that can be repeated zero or more times, including the “.” to signify any digit. For example, if the pattern is .%50.. then any number that ended with 50 followed by any two digits would match, for example 789115048. A pattern of .% would match any number combination. A straight range or list of digits for a specific location in the dial string can be handled with the square brackets, for example 50[0-2,9]. handles 5000-5029 and 5090-5099.

Dial-Peer for POTS / from IP to PSTN

Dial-peer works in the following manner on a POTS line: You have to specify a pattern of digits and a ds0-group for T1 Robbed Bit or a pri-group for ISDN PRI. A pattern is unique and so appears in only one dial-peer. If a call comes through the router and the dialed number matches a pattern in a dial peer, then an outbound call is made through the group associated with that dial peer.

Table 4 lists and defines the dial-peer commands and their functions.

Table 4. Dial-Peer Commands and their explanation

Command	Explanation
<code>description <your description></code>	This is a description of the dial peer. The optional description line allows entering a description of the dial peer as a comment.
<code>destination-pattern <pattern></code>	This command represents the phone number pattern.
<code>port <slot>/<port>:<group></code>	<ul style="list-style-type: none"> ▪ Slot Number – Idem as above - Indicates the slot number and ranges from 1 to 4. Usually 1. ▪ Port Number – Idem as above - Refers to the RJ48 connectors. Can be 0 or 1

	<ul style="list-style-type: none"> ▪ For ISDN only, the group# is assigned value 23. For T1 Robbed-Bit, we had set this to 0 in the above Controller example.
no digit-strip	This command is important, otherwise, all digits that explicitly match the destination pattern are stripped before the call is made. If the destination-pattern has no digits (i.e. %), then this command is not applicable because there are no explicit digit matches.
direct-inward-dial	This command must be specified. Though it is put into the POTS dial peer, it is actually important for the VOIP dial peer to work. This feature enables the router to use the called number (DNIS) to directly match an outbound (VOIP) dial peer when receiving an inbound call from a POTS interface, known as one-stage dialing. Otherwise, the router presents a dial tone to the caller and collects digits until it can identify an outbound dial peer, which is known as two-stage dialing.

The following is a configuration that matches a pattern with the T1 Robbed-bit ds0 group established above:

```
dial-peer voice 9110 pots
destination-pattern 7819110...
no digit-strip
direct-inward-dial
port 1/0:0
```

Dial-Peer for IP / from PSTN to IP

IP works similarly to dial-peer, except that instead of specifying a ds0 group (for T1 Robbed Bit) or a pri group (for PRI ISDN), you specify an IP address to send the call. You also specify the call control protocol and the IP protocol for the fax data. Type the following commands:

- session protocol <call control protocol>
 - Choose sipv2, therefore, type session protocol sipv2
- session target ipv4:<IP address of destination>
 - This is the IP address used for the SIP call control, which is the IP address of the network card in the Brooktrout fax server (the fax server has besides the network card a virtual SR140 or a TR1034 IP board installed, but it's not the IP address of the TR1034 IP board that should be specified here)
- session transport <transport>
 - Choose udp, therefore, type session transport udp
- voice-class codec <codec group tag #>
 - The tag # for the voice-class codec will be specified in the next Chapter *Configuring Fax Over IP/T.38*. Whatever you choose here, must match with what you set as codec when you configure the FOIP.

If your PBX/Telco is only passing some of the digits of the destination phone number (DNIS/Called party number), then the pattern for those digits is what you must specify for the destination-pattern for the dial-peer. For example, if the range of numbers assigned to the line is 7819721400 - 7819721499, and 4 digits are passed, then 14.. is the pattern that should be set.

The following is an example for configuring the IP side:

```
dial-peer voice 9119 voip
destination-pattern 7819119...
voice-class codec 1
session protocol sipv2
session target ipv4:10.128.30.64
session transport udp
```

Debugging Dial-Peers

To determine which dial peer was matched when a call arrives, type:

```
debug voip dialpeer all
```

The command used to be called `debug dialpeer`.

When debugging through a Telnet session, to view the output on your monitor, you must also enter `terminal monitor`.

Debugging SIP

To debug SIP, type :

- `debug ccsip messages`
- `debug ccsip calls`
- `debug ccsip error`

When debugging through a Telnet session, to view the output on your monitor, you must also enter `terminal monitor`.

Configuring Fax Over IP/T.38

Configure VOIP/FOIP

To configure Fax over IP/T.38 you need to configure Voice over IP since FOIP and VOIP rely on similar settings. Type:

```
voice service voip
```

The configuration prompt changes to `conf-voi-serv`

Two things need to be configured in this mode:

1. The fax protocol settings by typing:

```
Fax protocol t38 ls-redundancy 0 hs-redundancy 0 fallback none
```

- Set T38

- Low redundancy and high redundancy set to 0
- Fax transport to use if far end doesn't support T.38 set to none

Example:

```

pv2651xm(conf-voi-serv)#fax ?
  protocol          The system-wide fax protocol type
pv2651xm(conf-voi-serv)#fax protocol ?
  cisco            Use Cisco proprietary protocol
  none            Disable fax transport
  pass-through     Use an audio codec for fax transport
  t38             Use T.38 protocol
pv2651xm(conf-voi-serv)#fax protocol t38 ?
  fallback        fax transport to use if T.38 unsupported on far end
  ls-redundancy   t38 low speed redundancy
  hs-redundancy   t38 high speed redundancy
  nse            Use Cisco NSEs to signal T.38 mode switch

```

2. The call control. For SIP (supported by the TR1034 IP and the SR140) type:

```

sip

```

and for H.323 (supported by the TR1034 IP from Brooktrout SDK 4.0 on and by the SR140) type:

```

h323

```

Configure Voice Codec

To specify a voice codec, type

```

voice class codec <tag #>

```

- The tag # must match the voice-class codec from the previous dial-peer chapter.

The configuration prompt changes to `config-class`

One value needs to be set in this mode. Type:

```

codec preference <priority> <codec>

```

- Choose `priority = 1`, which is the highest priority
- Set `codec` to `g711 ulaw`