Site Preparation

Thank you for purchasing the Cisco Systems Installation Service. To help ensure that the system installation goes as planned, use this *Site Preparation Guide* to help prepare your site before the system arrives.

Note For brevity, the term *system* is used throughout this document in reference to Cisco systems products.

About Onsite Installation

The On-Site Services (OSS) team will install any Cisco Systems product. Installations are performed between the hours of 8:00 a.m. and 5:00 p.m. (local time) Monday through Friday, excluding Cisco-observed holidays. Acknowledgment of your Installation Service Order is indicated by your receipt of the *Cisco Site Preparation Guide*.

OSS Will Not Set Up Your Software Configuration

The OSS team will not set up the software configuration for your system. The installation service is limited to hardware installation and setup. You are responsible for setting up the software configuration.

The following software configuration options are available:

Option 1. You will either e-mail or fax the entire configuration to OSS. (The configuration will be downloaded to your system through the console port via a modem line.)

Option 2. You will store the entire configuration on a TFTP server. (The configuration will be downloaded to your system using Cisco's AutoInstall feature.)

Option 3. OSS will configure one port on the router so you can Telnet to the router and download the entire configuration. (Only IGRP and RIP routing are supported for this option.)

Be sure to indicate on the Site Preparation Checklist which software configuration loading option you want to use.

Example of a Software Configuration

The following is an example of how a software configuration might appear on a terminal.

Note Most software configurations are unique. The following configuration might not be valid on your system.

```
! Define line password
line 0 4
 password secret
 login
!
! Define privileged-level password
enable-password Secret Word
!
! Define a system hostname
hostname TIP
! Define host filenames
boot host host1-confg 131.108.1.111
boot host host2-confg 131.108.1.111
! Define system filenames
boot system sys1-system 131.108.13.111
boot system sys2-system 131.108.1.111
!
! Enable SNMP
snmp-server community
snmp-server trap-authentication
snmp-server host 131.108.1.27 public
snmp-server host 131.108.1.111 public
snmp-server host 131.108.2.63 public
!
! Define TACACS server hosts
tacacs-server host 131.108.1.27
tacacs-server host 131.108.13.33
tacacs-server host 131.108.1.33
!
! Define a message-of-the-day banner
banner motd ^C
The Information Place welcomes you

Please call 1-800-555-2222 for a login account, or enter
your password at the prompt.
^C
```

Note If you need assistance developing your configuration, please consult with your sales representative.

Scheduling

You must schedule installations five working days in advance by faxing the completed Site Preparation Checklist form (located at the end of this publication) to Cisco Systems.

Reschedules or Cancellations

Cisco Systems reserves the right to reschedule the installation if any information on the Site Preparation Checklist is not forwarded to Cisco Systems within five working days before the scheduled installation date.

You can reschedule or cancel an installation up to three working days before the scheduled installation date without any penalty; however, installations canceled within 72 hours of the scheduled installation date are subject to a cancellation charge of $100, payable with a credit card to Cisco Systems prior to rescheduling the installation.

On the day of the installation, any cancellation caused by inappropriate site preparation, equipment unavailability, or other circumstances beyond the control of Cisco Systems, is billed as an installation, and another installation must be scheduled.

Note If you need to reschedule your installation or have additional installation-specific questions, contact the On-Site Services (OSS) team at 800 829-2447 or send a fax to Cisco Systems at 408-526-7550.

Delays

Onsite installation delays caused by inappropriate site preparation, equipment unavailability, or other circumstances beyond the control of Cisco Systems will be billed at prevailing Field Engineer time and material rates.

Pricing

Onsite installation pricing is based on the type and number of systems to be installed at a given site. The *Cisco Systems U.S. Price List* contains information on installation pricing.

Customer Responsibilities Before Installation

To ensure a successful installation, complete the following tasks before the arrival of the Cisco Onsite installation personnel:

- Prepare the site according to this guide and complete one Site Preparation Checklist form (located at the end of this guide) for each system to be installed. Send the completed form by fax (within five working days before the scheduled installation date) to Cisco Systems at 408-526-7550.

  The following information should be included on the Site Preparation Checklist form:

  — Site name and address, installation date and time, sales order number (if the system is new), contact name and telephone number, and if available, a fax number and electronic-mail address.

  - Modem telephone line number for remote access by Cisco Systems personnel during installation.

Note If you purchased the CE-INST-MODEM kit, the modem outlet must be within 6 feet of the system to accommodate the 6-foot modem cable included with the kit.

  - Voice telephone line number (near the new system) for the installer to contact Cisco Systems personnel.
  - System type and chassis-mounting preference (rack mounting, and so forth).
  - Choice of configuration options
- Verify AC or DC power requirements and site environment specifications.
- Verify all distance and interference limitations of interface cables to be used at installation.
- Install and verify the operation of all external communications equipment not provided by Cisco Systems. This external communications equipment includes, but might not be limited to, the following: LAN and WAN connections, channel service unit/digital service unit (CSU/DSU), media attachment unit (MAU), transceivers, modems, and any other external communications equipment related to your site and necessary for the installation.
- Verify operation of all telephone circuits, digital services, and T1 facilities not supplied by Cisco Systems, but required for the installation.

Installer Responsibilities

The onsite installer will complete the following tasks:

- Unpack the system and accessories necessary for installation.
- Mount the system on a desktop, in a rack or wiring closet, or on the wall.
- Connect the system to the network and customer-provided LAN and WAN connections.
- Attach the Cisco-supplied modem for remote diagnostics, validation of network serial link status, and insertion of customer IP address and password.
- Connect console, administrator port, and auxiliary cables (if available and as required).
- Verify the following:
  - System power up.
  - Fan or blower operation.
  - Operation of network interfaces, status reports of these interfaces, and LED status.
  - Primary network serial link testing to the remote end. If the serial link is not available, loopback testing will be used (HDLC encapsulation only).

Site Requirements

This section describes the general ventilation and power requirements your site must meet for your system to operate properly. It also includes information on preventing electrostatic discharge damage (ESD).

System Ventilation

Some systems have an internal blower or fan that pulls air through a card cage and power supply. These systems are designed to operate in a level, dry, clean, well-ventilated, and air-conditioned environment. If either the intake or exhaust vents are blocked in any way, the air-cooling function may be impaired. Ensure that the system's location has adequate air circulation.

Precautions

The proper placement of the chassis and the layout of your equipment rack or wiring closet are essential for successful system operation. Equipment placed too close together or inadequately ventilated can cause system malfunctions and shutdowns. In addition, chassis access panels made inaccessible by poor equipment placement can make system maintenance difficult.

Read and follow these precautions when planning your site layout and equipment locations. This will help avoid future equipment failures and reduce the likelihood of environmentally caused shutdowns.

- Remember that electrical equipment generates heat, and ambient room temperature alone may not be adequate to cool equipment to acceptable operating temperatures.
- Never place chassis side by side because the heated exhaust air from one chassis will be drawn into the intake vent of the adjacent chassis.
- Ensure that the chassis cover and any card access panels are in place and secure. The chassis is designed to direct cooling air through the card cage; an open access panel will redirect the air flow, potentially preventing air from properly flowing through the chassis.

Equipment Racks

The following describes the ventilation considerations that apply to using equipment racks for your system.

- Install the chassis in an enclosed rack only if it has adequate ventilation or an exhaust fan; use an open rack where possible.
- A ventilation system that is too powerful in an enclosed rack may prevent cooling by creating negative air pressure around the chassis and redirecting the air away from the chassis intake vent. If necessary, operate the chassis with the rack door open or in an open rack.
- The correct use of baffles inside the enclosed rack can assist in cooling the chassis.
- Ensure that the rack is not too congested. In an enclosed rack, ideally, separate the units with 12 to 15 inches of vertical clearance. The horizontal clearance is standard for most enclosed racks; avoid obstructing this space. Open racks are recommended, but not required.
- Equipment located near the bottom of the rack may excessively heat the air that is drawn upward and into the intake ports of the equipment above, leading to failures in the chassis at or near the top of the rack. If the enclosed rack you are using does not have a ventilation fan, install one.

Power Requirements

To connect the chassis to AC power, you need the proper AC receptacle at your site. The chassis power supply is either autoranging or is factory-configured for either 110 volts alternating current (VAC) or 240 VAC operation (230 VAC in the United Kingdom). All chassis include a 6-foot electrical power cord.

Warning If the voltage indicated on the chassis label is different from the power outlet voltage, *do not connect the chassis to that receptacle*. A voltage mismatch can cause equipment damage, create a shock hazard, and may pose a fire hazard.

Note We recommend attaching dual power supplies to independent power sources for full redundancy. We also recommend an uninterruptable power source (UPS) to protect against power failures at your site.

Preventing Electrostatic Discharge Damage

ESD damage, which occurs when electronic components are improperly handled, can result in complete or intermittent failures. ESD can impair electronic circuitry and equipment. Typically, the successful installation of the chassis should not require handling any system components; however, always follow ESD prevention procedures.

Cabling Distance Limitations

The size of your networks and the distance between connections on your networks will depend on the type of signal, the signal speed, and the transmission media (the type of cable used to transmit the signals). For example, standard coaxial cable has a greater channel capacity than twisted-pair cabling.

The distance and rate limits in these descriptions are the IEEE-recommended maximum speeds and distances for signaling. For instance, the recommended maximum rate for V.35 is 2 megabits per second (Mbps), but it is commonly used at 4 Mbps without any problems.

Caution Even though you can usually get good results at speeds and distances far greater than those listed in this section, exceeding the maximum distances is not recommended or supported. If you understand the electrical problems that might arise and can compensate for them, you can get good results with rates and distances greater than those shown here; however, do so at your own risk.

Channel Attachment Connections

If your system has a Channel Interface Processor (CIP), be aware that the maximum transmission distance for ESCON (with LED) is 1.9 miles (3.1 km) point-to-point or 5.7 miles (9.2 km) with two ESCON directors. The maximum transmission distance for bus and tag is 400 feet (122 m). The IBM 3044 C/D (host side/remote side) copper-to-fiber repeater can be used to extend the bus and tag distance up to 1.2 miles (2 km).

Fast Ethernet Connections

Table 1 lists the cabling specifications and the connection limitations for 100-Mbps Fast Ethernet transmission over UTP, STP, and fiber-optic cables.

Table 1 Cabling Specifications and Connection Limits for 100-Mbps Transmission

Parameter	RJ-45	MII	SC-Type
Cable specification	Category 5[1] UTP[2], 22 to 24 AWG[3]	Category 3, 4, or 5, 150-ohm UTP or STP, or multimode optical fiber	62.5/125 multimode optical fiber
Maximum cable length	–	1.64 ft. (0.5 m) (MII-to-MII cable[4])	–
Maximum segment length	328 ft. (100 m) for 100BaseTX	3.28 ft. (1 m)[5] or 1,312 ft. (400 m) for 100BaseFX	328 ft. (100 m)
Maximum network length	656 ft. (200 m)[5] (with 1 repeater)	–	656 ft. (200 m)[5] (with 1 repeater)

1. EIA/TIA-568 or EIA-TIA-568 TSB-36 compliant.
2. Cisco Systems does not supply Category 5 UTP RJ-45 or 150-ohm STP MII cables. Both are available commercially.
3. AWG = American Wire Gauge. This gauge is specified by the EIA/TIA-568 standard.
4. This is the cable between the MII port on the FE port adapter and the appropriate transceiver.
5. This length is specifically between any two stations on a repeated segment.

Table 2 summarizes characteristics of 100BaseTX and 100BaseFX with respect to IEEE 802.3u physical characteristics.

Table 2 IEEE 802.3u Physical Characteristics

Parameter	100Base-FX	100BaseTX
Data rate (Mbps)	100 Mbps	100 Mbps
Signaling method	Baseband	Baseband
Maximum segment length	328 ft. (100m) between repeaters	328 ft. (100m) between DTE[1] and repeaters
Media	SC-type: dual simplex or single duplex for Rx and Tx	RJ-45MII
Topology	Star/Hub	Star/Hub

1. DTE = data terminal equipment.

E1-G.703/G.704 Connections

If your system has a Fast Serial Interface Processor (FSIP), be aware that unbalanced G.703/G.704 interfaces allow for a longer maximum cable length than those specified for balanced circuits. Table 3 lists the maximum cable lengths for each FSIP E1-G.703/G.704 cable type by the connector used at the network (non-FSIP) end.

Table 3 E1-G.703/G.704 Maximum Cable Lengths

Connection Type	BNC	Twinax
Balanced	–	984 ft. (300 m)
Unbalanced	1968 ft. (600 m)	–

Ethernet Connections

The maximum distances for Ethernet network segments and connections depend on the type of transmission cable used: 0.4-inch diameter coaxial (10Base5), 0.25-inch diameter coaxial (10Base2), or unshielded twisted-pair (10BaseT). Network connections to the coaxial-type cables are tapped into a network segment and must be spaced at specific intervals. The maximum number of connections (taps) per segment and the intervals at which they must be placed are listed in Table 4. A maximum of four repeaters and seven bridges can be used to link segments in a single network.

Table 4 Ethernet Coaxial-Type Connection Limits for 10-Mbps Transmission

Description	10Base5	10Base2
Cable diameter	0.4 in. (1.01 cm)	0.25 in. (0.635 cm)
Maximum segment length	1,640 ft. (500 m)	656 ft. (200 m)
Maximum network length (with 4 repeaters)	8,200 ft. (2,500 m)	3,280 ft. (1,000 m)
Maximum connections (taps) per segment	100	30
Minimum connection (tap) spacing	8.2 ft. (2.5 m)	1.64 ft. (0.5 m)

The unshielded twisted-pair (UTP) cabling used with 10BaseT is suitable for voice transmission, but may incur problems at 10-Mbps transmission rates. UTP wiring does not require the fixed spacing between connections that is necessary with the coaxial-type connections. Table 5 lists the IEEE recommendations for the UTP maximum distances between station (connection) and hub.

Table 5 Ethernet UTP Maximum Transmission Distances

Transmission Speed	Maximum Station-to-Hub Distance
10 Mbps (10BaseT)	328 ft. (100 m)

In general, the Workgroup Catalyst switch implementation of 10BaseT requires a minimum of Category 3 UTP cable as specified by the EIA/TIA 568B wiring standard.

Table 6 summarizes the characteristics of IEEE 802.3 Ethernet and Ethernet version 2 for 10BaseT.

Table 6 IEEE 802.3 and 10BaseT Ethernet Version 2 Physical Characteristics

Parameter	IEEE 802.3 Ethernet	10BaseT Ethernet Version 2
Data Rate	10 Mbps	10 Mbps
Signaling method	Baseband	Baseband
Maximum segment length	1640 ft. (500 m)	328 ft. (100m)
Media	50-ohm coax (thick)	Unshielded twisted-pair (UTP)
Topology	Bus	Star

Table 7 lists the cabling specifications for 10-Mbps transmission over UTP and STP cables.

Table 7 Cable Specifications for 10-Mbps 10BaseT

Parameter	RJ-45
Cable specification	Category 5 UTP[1], 22 to 24 AWG[2]
Maximum segment length	328 ft. (100 m) for 10BaseT
Maximum network length	656 ft (200 m) with 1 repeater

1. Cisco Systems does not supply Category 5 UTP RJ-45 cables; these cables are available commercially.
2. AWG = American Wire Gauge. This gauge is specified by the EIA/TIA-568 standard.

FDDI Connections

The distance limitations for single-mode and multimode Fiber Distributed Data Interface (FDDI) stations are listed in Table 8.

Table 8 FDDI Maximum Transmission Distances

Transceiver Type	Maximum Distance Between Stations
Single-mode	6.2 mi (10 km)[1] Up to 9.3 miles (up to 15 km)[2]
Multimode	Up to 1.2 mi (2 km)[2]

1. For AGS+ and Cisco 4000 series applications of FDDI.
2. For the VIP single-mode FDDI port adapter using SC-type optical fiber.

Table 9 summarizes the characteristics of IEEE 802.3 Ethernet and Ethernet 10BaseFL.

Table 9 IEEE 802.3 Ethernet and Ethernet 10BaseFL Physical Characteristics

Parameter	IEEE 802.3 Ethernet	10BaseFL Ethernet
Data Rate	10 Mbps	10 Mbps
Signaling method	Baseband	Baseband
Media	50-ohm coax (thick)	Multimode optical fiber
Topology	Bus	Star

Table 10 lists the distance limitations for 10-Mbps transmission over multimode optical-fiber cables.

Table 10 Cable Distance Limitations for 10-Mbps 10BaseFL Transmission

Parameter	ST Connections
Cable specification	Multimode fiber-optic cable[1]
Maximum segment lengths	1,312 ft (400 m) for any repeater-to-DTE fiber segment 1,640 ft (500 m) with four repeaters and five segments 3,280 ft (1000 m) for any inter-repeater fiber segment 6,561 ft (2000 m) without a repeater

1. Cisco Systems does not supply fiber-optic cables; these cables are available commercially.

Table 11 lists multimode optical-fiber parameters required for 10BaseFL.

Table 11 Multimode Optical-Fiber Parameters for 10BaseFL

Parameter	Multimode
Size	62.5/125 micrometer (nominal diameter) optical fiber[1]
Attenuation	3.75 dB/km, at 850 nanometers (nm)
Insertion loss	< 12.5 dB, at 850 nm
Bandwidth	> 160 MHzkm, at 850 nm
Propagation delay	5 microseconds/km

1. Specified in IEC Publication 793-2[14].

The single-mode multimode optical-fiber connections conform to the following optical power parameters:

- Output power: –19 to –14 dBm
- Input power: –31 to –14 dBm
- Input sensitivity: –31 dBm @ $2.5x10^{-10}$ BER @ 125 Mbps

HSSI Connections

The High-Speed Serial Interface (HSSI) standard (EIA/TIA 612/613) specifies a maximum cable length of 50 feet (15 meters) for 52-Mbps HSSI connections. The typical (nominal) cable length between the HSSI Interface Processor (HIP) and the DSU is 6 feet (2 meters). The HSSI interface cable has 25 twisted pairs and a 50-pin plug at each end. Both DTE and DCE ports on the HIP and the DSU are 50-pin receptacles. The HSSI interface cable is similar to a small computer systems interface(SCSI)-II-type cable; however, the HSSI cable specification is more stringent than that for a SCSI-II.

Caution Do not substitute a SCSI-II-type cable for a HSSI cable when connecting the HSSI interface. Trying to use a SCSI-II-type cable might prevent proper operation of the interface.

MultiChannel Connections

Following are the MIP E1 specifications:

- Transmission bit rate: 2.048 kilobits per second (kbps) 50 parts per million (ppm)
- Output port specifications: see G.703/Section 6.2 (ITU-T specification)
- Input port specifications: see G.703/Section 6.3 (ITU-T specification)
- Jitter attenuation starting at 6 Hz, which meets or exceeds G.823 for E1

Following are the MIP T1 specifications:

- Transmission bit rate: 1.544 kbps 50 ppm
- Output pulse amplitude: 3.0 volts (V) 0.6V measured at DSX
- Output pulse width: 324 nanoseconds (ns) 54 ns

The MIP T1 specifications comply with all AT&T Accunet TR 62411 specifications.

Serial Connections

As with all signaling systems, serial signals can travel a limited distance at any given rate. Generally, the lower the baud rate, the greater the distance. Table 12 lists the relationship between transmission rate and distance for the HSSI.

Table 12 IEEE Standard EIA/TIA-232 Transmission Speed Versus Distance

Baud Rate	Distance
2400	200 ft. (60 m)
4800	100 ft. (30 m)
9600	50 ft. (15 m)
19200	25 ft. (7.6 m)
38400	12 ft. (3.7 m)
56000	8.6 ft. (2.6 m)

Note EIA/TIA-232 and EIA/TIA-449 were known as recommended standards RS-232 and RS-449 before their acceptance as standards by the Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA).

Balanced drivers allow EIA/TIA-449 signals to travel greater distances than EIA/TIA-232. Table 13 lists the standard relationship between baud rate and distance for EIA/TIA-449 signals.

Table 13 IEEE Standard EIA/TIA-449 Transmission Speed Versus Distance

Baud Rate	Distance
2400	4,100 ft. (1250 m)
4800	2,050 ft. (625 m)
9600	1,025 ft. (312 m)

Baud Rate	Distance
19200	513 ft. (156 m)
38400	256 ft. (78 m)
56000	102 ft. (31 m)
T1	50 ft. (15 m)

Caution The distance limits for EIA/TIA-449 (listed in Table 13), which are also valid for V.35 and X.21, are recommended maximum distances; exceeding these maximum distances is not recommended or supported. In common practice, EIA/TIA-449 supports 2-Mbps rates, and V.35 supports 4-Mbps rates without any problems.

Synchronous Optical NETwork (SONET) Connections

The SONET specification for fiber-optic transmission defines two types of fiber: single mode and multimode. Modes can be thought of as bundles of light rays entering the fiber at a particular angle. Single-mode fiber allows only one mode of light to propagate through the fiber, while multimode fiber allows multiple modes of light to propagate through the fiber. Because multiple modes of light propagating through the fiber travel different distances depending on the entry angles, causing them to arrive at the destination at different times (a phenomenon called modal dispersion), single-mode fiber is capable of higher bandwidth and greater cable-run distances than multimode fiber. The maximum distances for single-mode and multimode transmissions, as defined by SONET, are listed in Table 14. If the distance between two connected stations is greater than these maximum distances, significant signal loss can result, making transmission unreliable.

Table 14 SONET Maximum Fiber-Optic Transmission Distances

Transceiver Type	Maximum Distance Between Stations[1]
Single-mode	Up to 9 miles (14.8 kilometers)
Multimode	Up to 1.5 miles (2.4 kilometers)

1. This table lists typical results.

Token Ring Connections

There is currently no maximum transmission distance defined for IEEE 802.5 (Token Ring) networks. Shielded twisted-pair cabling is most commonly used for rates of 16 Mbps, and either shielded or UTP cabling is used for rates of 1 and 4 Mbps. When planning your connections, remember that twisted-pair cabling is more susceptible to interference than other types of cabling, so plan the total network length and repeater spacing accordingly.

Interference Considerations

When wires are run for any significant distance in an electromagnetic field, interference can occur between the field and the signals on the wires. This fact has two implications for the construction of terminal plant wiring:

- Bad practices can result in radio interference emanating from the plant wiring.
- Strong electromagnetic interference, especially as caused by lightning or radio transmitters, can destroy EIA/TIA-232 drivers and receivers.

Note To predict and remedy strong electromagnetic interference, you may need to consult experts in radio frequency interference (RFI).

If you use UTP Ethernet cables in your plant wiring with a good distribution of grounding conductors, the plant wiring is unlikely to emit radio interference. When exceeding the distance listed in Table 5, use a high-quality twisted-pair cable with one ground conductor for each data signal.

Generally, if wires exceed recommended distances or pass between buildings, give special consideration to the effect of lightning strikes in your vicinity. The electromagnetic pulse (EMP) caused by lightning or other high-energy phenomena can easily couple enough energy into unshielded conductors to destroy electronic devices. If you have had problems of this sort in the past, you may want to consult experts in electrical surge suppression and shielding. Most data centers cannot resolve the infrequent but potentially catastrophic problems just described without pulse meters and other special equipment. Identifying and resolving interference problems can consume an excessive amount of time. To avoid these problems, provide a properly grounded and shielded environment for your system, with special attention to issues of electrical surge suppression.

External Connection Considerations

You may need some of the following data communications equipment to complete your installation. Your needs depend on many factors, including the interfaces you plan to use.

- After the system is installed and remotely configured by way of the modem connection, you might need a console terminal with an EIA/TIA-232 data terminal equipment (DTE) connector for future configuration requirements. You can detach the terminal (and cable) after you complete these configuration procedures.

  For routers and communication servers, the chassis console port is a data communications equipment (DCE) device (using a DB-25 female connector), and the auxiliary port is a data terminal equipment (DTE) device (using a DB-25 male connector). You must adjust the baud rate of your console terminal to match the chassis console port default baud rate of 9600, 8 data bits, no parity, and 2 stop bits. Consult the documentation for your terminal for this wiring specification.

  For the workgroup concentrators and catalyst switches, the administration interface port (admin port) is an EIA/TIA-232 DCE connection (requiring an RJ-45 female connector). The admin port is configured at the factory with the following communications parameters: 9600 baud, 8 data bits, no parity, one stop bit. Consult the documentation for your terminal for this wiring specification.

- To use an IEEE 802.3 or Ethernet interface at your installation, you need an 802.3 media attachment unit (MAU) and an attachment unit interface (AUI) cable, or an Ethernet transceiver and transceiver cable. These devices can be purchased as additional equipment. (Contact a customer service representative.) This additional equipment is not required for an Ethernet 10BaseT connection using the 10BaseT applique with routers or communications servers. These appliques have built-in transceivers.
- To use a low-speed synchronous serial interface at your installation, you need a synchronous modem or a channel service unit/digital service unit (CSU/DSU) to connect to the network. EIA/TIA-232, EIA/TIA-449, or V.35 connections (or attachments) are typically provided as the electrical interfaces on the CSU/DSU.
- To attach a chassis to a T1 network, you need a T1 CSU/DSU that converts the High-Level Data Link Control (HDLC) synchronous serial data stream into a T1 data stream with the correct framing and ones density. (The term *ones density* refers to the telephone system requirement of a minimum number of 1 bit per time unit in a data stream.) Several T1 CSU/DSU devices are on the market. A T1 CSU/DSU is available as additional equipment. Note also that most T1 CSU/DSUs provide either a V.35 or EIA/TIA-449 electrical interface to the system.

  T1 is the term for a digital carrier facility used for transmitting data over a telephone network at 1.554 Mbps. E1 is the European equivalent of T1, with a data transmission rate of 2.048 Mbps.
- To connect a HSSI port, you need a DSU capable of the type of service to which you will connect the following: T3 (45 Mbps), E3 (34 Mbps), or Synchronous Optical Network (SONET) STS-1 (51.84 Mbps), and a HSSI interface cable to connect the DSU with the High-Speed Serial Interface Processor (HIP).

  T3, also known as *digital signal level 3 (DS-3),* is the U.S. standard for a digital carrier facility used for transmitting data over a telephone network at 44.736 Mbps. T3 is equivalent to 28 T1 (1.544 Mbps) interfaces. E3 is the European equivalent of T3.
- SONET is an international standard (ANSI/CCITT) for optical communications systems. STS-1 (Synchronous Transport Signal level 1) is the basic building block signal of SONET; level 1 is 51.84 Mbps. Faster SONET rates are defined as STS-*n*, where *n* is a multiple of 51.84 Mbps. For example, the rate for SONET STS-3 is 155.52 Mbps, three times 51.84 Mbps.