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# Connecting Hosts and Routers

Nicolas Christin  
**University of Virginia**

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## Overview

There are three issues involved in connecting PCs (hosts) and routers. First, setting up a connection from a PC to the serial port of the router. Second, connecting and configuring the network connections between PCs and routers so that PCs and routers can exchange data. Third, connecting and configuring the connections between routers, so that routers can exchange data with each another. This document explains how to address these three issues.

*Remark: By convention, all commands that must be run in privileged EXEC mode on the router side (or as root on the host side) will be preceded by a pound sign (“#”).*

## Disclaimers

If you use the information in this document for your own equipment, you will do so at your own risk. We are not responsible for any damage that may result from following the instructions or suggestions in this document.

This is the first revision of the document. We appreciate any feedback on the usefulness of the document and corrections of typos.

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## Accessing the Router via a Serial Connection

A serial connection from a PC to a router is used for configuring the router via console access.

### Hardware requirements

- A PC with a keyboard and monitor,
- A router (e.g., Cisco 7000),
- a serial cable (RS-232) for connecting the serial ports, and
- possibly some adapters (see below).

### Step 1: Identifying the cable you need

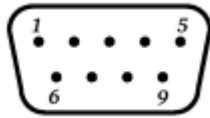
There are two different kinds of serial cables that can be used: **crossover** (also called “null-modem”) or **straight** (also called “straight-through”). In a crossover cable the pin 2 at one end of the cable is connected to pin 6 at the other end, and pin 1 at one end of the cable is connected to pin 3 at the other end. In a straight cable, pins 1 at both ends are connected together, as are pins 2, 3 and 6. Refer to Table 1 to determine which type of cable you need.

If you want to...	You need...
Connect a PC to a Cisco 2500 series router	A crossover cable
Connect a PC to a Cisco 7000 series router	A straight cable

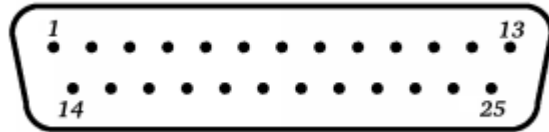
**Table 1.** Type of cable needed.

### Step 2: Identifying the adapters you need

There is unfortunately no standard as far as the connectors on an RS-232 serial cable are concerned. Among the most popular types of connectors, one can identify RJ-45, DB-9, and DB-25. RJ-45 connectors are the connectors used for Ethernet. Female DB-9 and DB-25 connectors are shown on Figures 1 and 2. Use Table 2 to determine which type of connector is used on your systems.



**Figure 1.** DB-9 connector



**Figure 2.** DB-25 connector

Machine	Connector
Recent PC (post 1995)	DB-9 Male
Old PC (pre 1995)	DB-9 Male or DB-25 Male
Cisco 2500 series	RJ-45 Female
Cisco 7000 series	DB-25 Male

**Table 2.** Connectors used on various types of PCs and routers

Once you have determined which cable and possibly which adapter(s) to use, connect the serial port of your PC to the CONSOLE port of the router. There are typically two serial ports on a PC, use the leftmost or topmost one (COM1 under Windows).

*ITLab setup: In our lab, we only use RJ-45 to RJ-45 straight cables. Those are transformed into crossover cables by using RJ-45 to DB-25 adapters that flip pins 2 and 3. When connecting a PC to a 7000 router, we use, on the PC side, a DB-9 to DB-25 adapter daisy chained with a DB-25 to RJ-45 adapter, and, on the router side, a RJ-45 to DB-25 adapter that flips the Transmit/Receive Pins.*

### Step 3: Accessing the router using Kermit

Instructions can be found in the ITLab Manual, Lab 4, part 1.

# Setting up a Network Connection between a PC and a Router

## 1. Setting up an Ethernet Connection

Most PC's on a LAN are Ethernet capable. Thus, if your Cisco 7000 router has Ethernet interface cards, it is easy to send traffic between a PC and a router.

### Hardware requirements

- A PC with a keyboard and monitor, and with at least one Ethernet network interface,
- A router that can be accessed via serial connection (see above) with at least one Ethernet network interface card,
- 1 Cat5 RJ-45 crossover cable,
- Optional: 2 Cat5 RJ-45 straight cables and an Ethernet hub or switch,

### Step 1: Cabling

As is the case with serial cables, Ethernet cables (Cat5 RJ-45) can be **straight-through** or **crossover**. Simply connect the PC to the router via a Cat5 RJ-45 crossover cable. The PC's and router's network interface cards should display a green light.

*Remark: in a different setup, the PC is connected to a hub (or a switch) and the router is connected to the same hub. This allows for multiple PCs to be connected to the same router. Typically, the first port of the hub (denoted by "1" or "Uplink") is reserved for connecting the router to the hub. Use straight-through cables if connecting the router and the PC via a hub or a switch.*

*Remark: in the ITLab, by convention, crossover Cat5 cables are RED. All other cables are straight-through.*

### Step 2: PC Host Configuration (may be skipped)

Once the PC host and the router are physically connected, they need to be configured so that they can exchange data. On a Unix PC, run the following commands as *root* (recall the pound "#" sign is the shell prompt and is **not** part of the commands). In our lab, you will perform this configuration on **ITL PC 2**.

```
#ifconfig eth1 down
```

➔ brings the network interface down.

```
#ifconfig eth1 192.168.1.12 netmask 255.255.255.0
```

➔ configures the interface "eth0" to have an IP address of 192.168.1.12/24.

```
#ifconfig eth1 up  
→ brings the network interface back up.
```

In all the aforementioned commands, `eth1` is the name of the interface you are configuring. This name refers to a device driver and is typically dependent on the brand of the network interface card. When unsure, run the command `ifconfig -a` (as root or as a regular user) to find out the name of your interface(s).

The interface on the host is now configured. Note that this configuration will be lost when the PC is rebooted. Please refer to the “Installing and Configuring the Linux Environment for ITLab PCs” worksheet to find out how to make such a network interface configuration permanent.

### Step 3: Router Configuration

To change the configuration of the router, you need to be in a system administrator mode, similar to `root` on a Unix system. In Cisco IOS, this mode is called the *privileged EXEC mode*. After connecting to the system, you change to the privileged mode by typing “enable” at the prompt:

```
itlab7000-2>enable
```

```
itlab7000-2#config term
```

→ go to configuration mode

You can then proceed with the configuration of the interface. Here is an example, assuming you want to give the router an IP address of 192.168.1.102/24. Note that 192.168.x.y IP addresses are reserved by the IETF for experimental/private network use (see RFC 1918), which is appropriate for a lab environment.

```
itlab7000-2(config)#interface Ethernet 2/0
```

→ configure the first Ethernet interface located on the Ethernet card inserted in Slot 2

```
itlab7000-2(config-if)#ip address 192.168.1.102 255.255.255.0
```

→ set up an IP address of 192.168.1.102 with a 24 bit prefix.

```
itlab7000-2(config-if)#no shutdown
```

→ enables the interface

```
itlab7000-2(config-if)# exit
```

```
itlab7000-2(config)# (press CTRL and Z at the same time)
```

```
itlab7000-2#
```

→ exit and store the changes

The name of the interface (“Ethernet 1/0”) depends on the type of router you are configuring. Cisco 2500’s have Ethernet interfaces named “Ethernet 0” and “Ethernet 1”, while Cisco 7000’s typically separate the card number from the interface number by a slash. More information can be found in the ITLab Manual, Lab 4. To display the parameters of the Ethernet interface cards on the router, use the command:

```
itlab7000-2#show interfaces
```

Then look for the Ethernet interfaces for which the “line protocol is up”. Those are the interfaces that are physically connected to a network, even though they may not be configured.

## 2. Setting up an FDDI Connection

FDDI is a high-speed LAN technology which runs at 100 Mbps. FDDI networks typically require expensive hardware (FDDI cards for PCs are far more expensive than Ethernet cards). FDDI is still in use nowadays, even if Fast-Ethernet and Gigabit-Ethernet have become predominant.

### Hardware Requirements

- A PC with a keyboard and monitor, and with at least one FDDI network interface,
- A router that can be accessed via serial connection (see above), with
- 1 multi-mode fiber optic cable with MIC connectors,
- Optional: 1 extra multi-mode fiber optic cable and an FDDI concentrator

### Step 1: Cabling

Simply connect the PC FDDI interface (the port on this interface is called a MIC port) to the router via a multi-mode fiber optic cable. The PC’s and router’s FDDI interface cards should display a green light. If this is not the case, either the fiber-optic cable has been plugged “backwards” (flip the MIC connector on the PC side) or the fiber-optic cable is damaged and needs to be replaced. Fiber-optic cables are extremely fragile and expensive.

*Remark (Star topology): for larger networks, the PC is connected to an FDDI concentrator and the router is connected to the same FDDI concentrator. A concentrator is a “hub” for FDDI networks. We will get back to star topologies in a later section.*

## Step 2: PC Host Configuration

The configuration process is similar to the one described for an Ethernet (see above). Only the interface name changes. In our lab, the FDDI interfaces are named "fddi0". The IP address to be allocated is 192.168.1.11/24 (on **ITL PC 1**).

## Step 3: Router Configuration

The configuration process is the same as with Ethernet interface cards. Only the name of the interface changes, thus you type (in privileged EXEC mode):

```
itlab7000-1#configure term
itlab7000-1(config)#interface FDDI 0/0
```

The remaining configuration process (IP address and netmask) is as discussed for Ethernet. The IP address to be allocated is 192.168.1.101 (on **itlab-7000-1**).

## Setting up a Network Connection between two Routers

Once a PC is connected to a router, the next step is to connect routers together. We will describe how to setup four types of connections between routers: Ethernet, FDDI, Fast-Serial (“T1”) and High-Speed Serial (“T3”).

### 1. Setting up an Ethernet/Fast-Ethernet Connection

#### Hardware requirements

- two routers, each of them having at least one Ethernet interface card,
- one Cat5 RJ-45 crossover Ethernet cable,
- possibly one or two AUI/RJ-45 transceivers.



**Figure 3.** Two AUI/RJ-45 transceivers – the top one shows the RJ-45 end, the bottom one shows the AUI end.

#### Step 1: Cabling

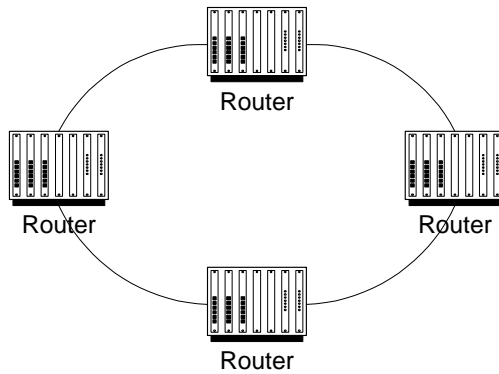
There are essentially two types of Ethernet connectors that are in use on modern routers: RJ-45 and AUI. BNC connectors (coax cable) are obsolete. Determine if you need an AUI/RJ-45 transceiver (see Figure 3) by referring to the table below. The only remaining step is to connect the two routers with a **crossover** Cat5 Ethernet cable.

Machine	Ethernet connector
Cisco 2500 series	AUI (DB-15)
Cisco 7000 series	RJ-45

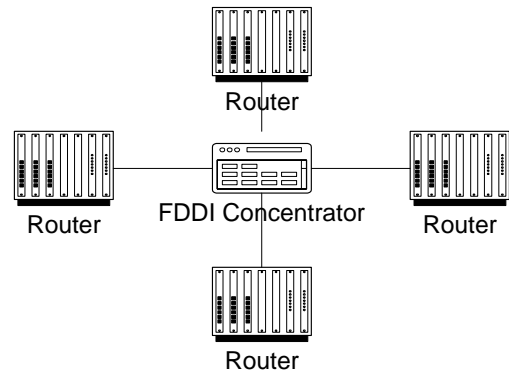
**Table 3.** Ethernet connectors in use on Cisco 2500 and 7000 series

#### Step 2: Configuration

First, use the command `show interfaces` to determine which Ethernet interface is connected (that is the Ethernet interface for which the “line protocol is up”). Repeat the router configuration process described in the section “Connecting a PC to a router” on both routers. Concerning the IP addresses, one can for instance choose 192.168.2.101 as the IP address on the first router and 192.168.2.102 on the second router.



**Figure 4.** Ring topology (single-attached)



**Figure 5.** Star topology

## 2. Setting up an FDDI Connection

FDDI connections are setup as ring topology or a star topology (see Figures 4 and 5). In a ring topology, each router is directly connected to another router (point-to-point connection) via a single-link (single-attached station) or a double link (dual-attached station) for fault-tolerance – if one link fails, the ring uses the second link and is therefore not broken. In a star topology all routers are connected to an FDDI concentrator. Star topologies present the same fault-tolerant properties as dual-attached stations FDDI rings.

### Hardware requirements

- two routers, each with at least one FDDI interface card.
- one multi-mode fiber optic cable.
- (for dual-attached stations or star topology) a second multi-mode fiber optic cable.
- (for star topology) an FDDI concentrator.

### Step 1: Cabling

Connecting a router to another router via an FDDI connection is only a matter of connecting one FDDI interface of the first router to one FDDI interface of the second router by a multi-mode fiber-optic cable. Each FDDI card contains two FDDI MIC ports, labeled PHY A and PHY B. Connect PHY A on the first router to PHY B on the second router.

*Remark 1: The above setup refers to single-attached stations. For dual-attached stations, use a second multi-mode fiber optic cable to connect PHY A on the*

*second router to PHY B on the first router. You need an extra FDDI card to be able to connect to the rest of the network.*

*Remark 2: For a Star topology, connect both routers to the FDDI concentrator, using a multi-mode fiber optic cable.*

## Step 2: Router Configuration

Repeat the configuration process described for setting up an FDDI connection between a PC and a router (Step 3) on both routers.

### 3. High-Speed Serial ("T3") Connection

#### Hardware requirements

- two routers, each of them with a High-Speed Serial Interface (HSSI) card,
- one high-speed serial null-modem cable.

#### Step 1: Cabling

Connecting two routers with HSSI interfaces can be done with a high-speed serial cable (null-modem cable). You need to purchase the high-speed serial cable (null-modem cable) separately. This type of cable uses a 50-pin connector, and is not standardized. It only works with Cisco routers.

#### Step 2: Configuration

The configuration process is similar to configuring an Ethernet interface. First, use the command `show interfaces` to determine which HSSI is connected (that is the HSSI interface for which the "line protocol is up"). Then, to set or change the IP address of an interface, you must enter the interface configuration mode for this interface. For example, to configure an HSSI interface on the 7000 routers, in this case, the interface which is at slot 4 and port 2.

```
Enable → configure term → interface hssi 4/2
```

Then you can set the IP address using the following syntax:

```
itlab7000-1(config-if)# ip address 192.168.3.1 255.255.255.0
```

(the IP address should be 192.168.3.2 on itlab7000-2.) Finally, the clocks need to be synchronized. That is, you need to type

```
itlab7000-1(config)# hssi internal-clock
```

on the first router and

```
itlab7000-2(config-if)# no hssi internal-clock
```

on the second router. The first router acts then as a “master” clock, which is used by the second router, ensuring both routers are synchronized.

#### 4. Fast Serial (“T1”) Connection

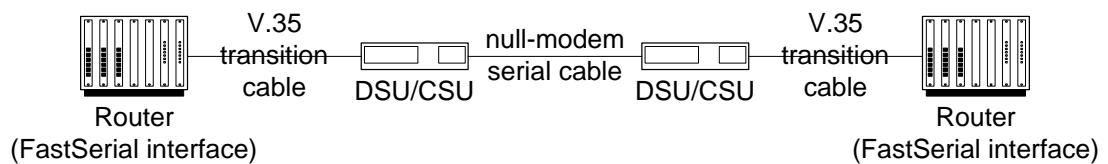
##### Hardware requirements

- two routers, each of them having at least one Fast-Serial interface card (T1 interface).
- one fast serial null-modem cable (DB-60 to DB-60) **or**
- two T-1 DSU/CSU (“T1 modems”),
- one crossover (“null-modem”) serial cable (RJ-45 on both ends),
- two V.35 serial transition cables (DB-60 to V. 35).

##### Step 1: Cabling

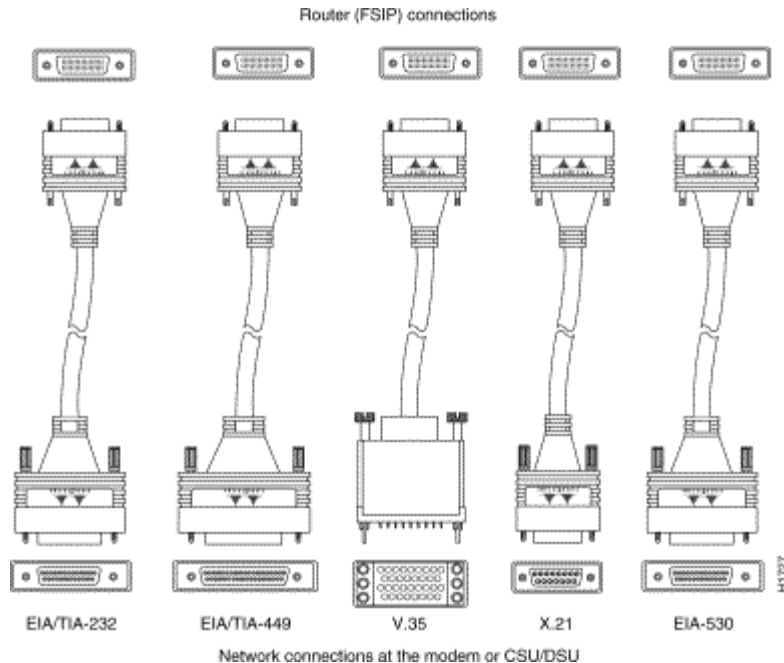
There are two options for establishing a T1 connection: using a Fast-Serial null-modem cable, or using two DSUs/CSUs.

The procedure for establishing a T1 connection using two DSU/CSUs is as follows. On each router, the T1-interface needs to be connected to the T1 DSU/CSU using a V.35 Serial Transition cable (34 pins on the network end). To connect two DSU/CSUs we need a crossover serial cable. So, to connect two serial interfaces one uses the connections represented in Figure 6.



**Figure 6.** A T1 connection using DSU/CSUs

*Remark: Not all DSU/CSUs use a V.35 port. Please refer to Figure 7 to determine which serial transition cable you need.*



**Figure 7.** Various serial cables that can be used with Cisco routers.

### Step 2: DSU/CSU configuration

Make sure the clocks of the two DSU/CSUs are synchronized. Most DSU/CSUs can be configured by navigating through the menus using the keypad. To synchronize the clocks, set the clock to “Internal” on one of the two DSU/CSUs, and to “Network” on the other DSU/CSU. All other parameters ought to be identical on both DSU/CSUs.

In our lab, this can be done by selecting the CONFIG menu (by using the arrows and pressing the ENTER key) and then the NETWORK submenu, and finally, changing the value of CLOCK SOURCE.

### Step 3: Router configuration

The configuration process is similar to previous sections.

```
ielab1#configure
ielab1#interface Serial 1/0
```

In this example, the Fast Serial interface you have connected is labeled Serial 1/0 – do a `show interfaces` to determine which Fast Serial interface is connected. Repeat then the configuration process (IP address and netmask) discussed in previous sections.