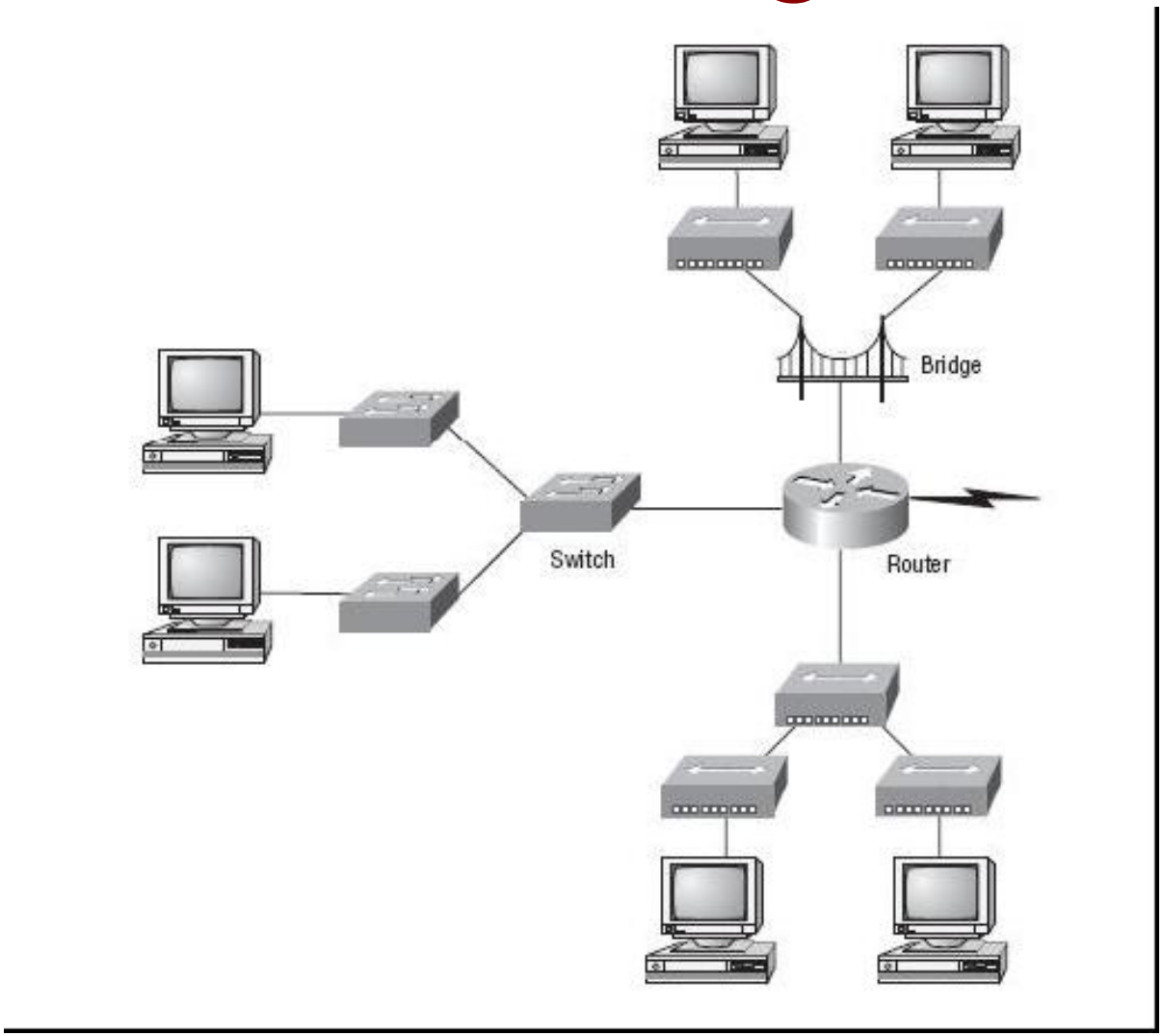
Lecture 2-1

Network Device

Network Hardware

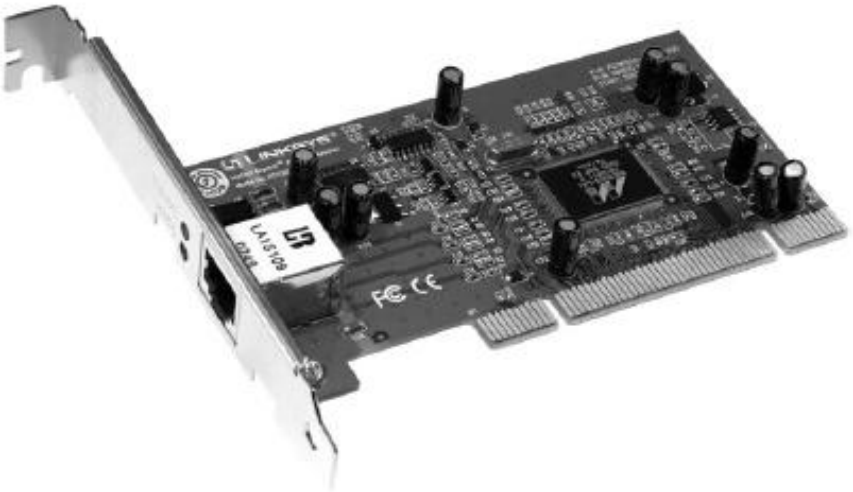
- Network Adapter
- Hub
- Bridge
- Switch
- Router

Internetworking Devices



Network Adapter

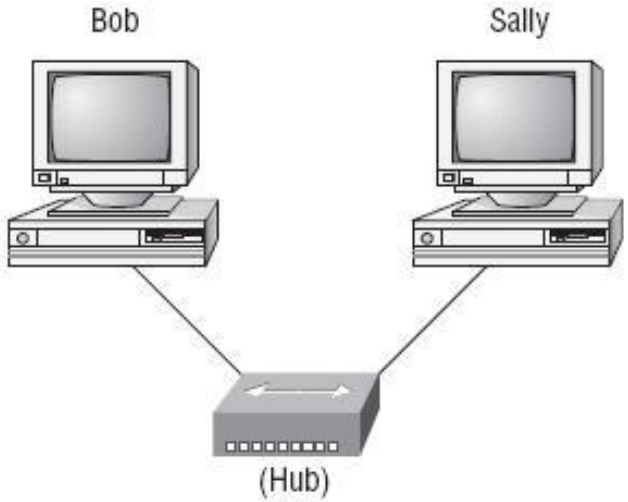
- Wired and wireless
- Network adapter used in a desktop computer is called a Network Interface Card (NIC)



Network Adapter (2)

- Can you see a network adapter on your computer?
  - No? Why not?
- What is network adapter for?

Hub



The basic network allows devices to share information.
The term computer language refers to binary code (0s or 1s).
The two hosts above communicate using hardware or MAC addresses.

Basic connection using a hub

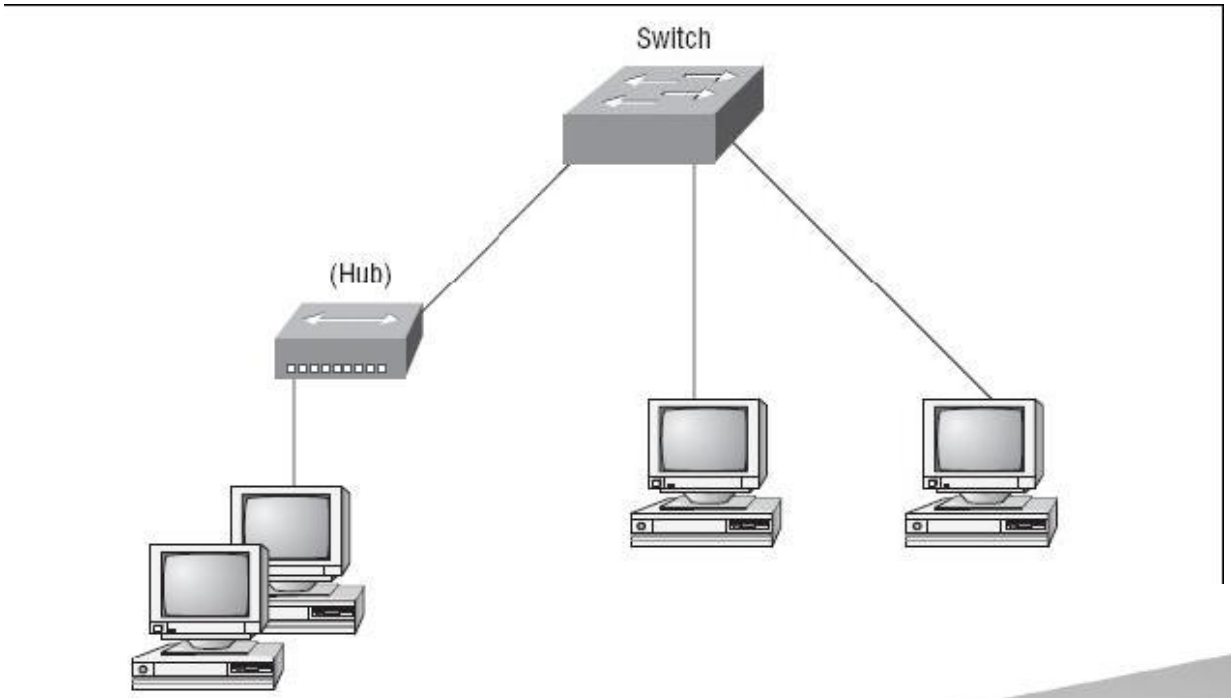
What does a hub do?

- Simply as packet coming in, packet going out .. to all ports
  - Yes, to all ports!
  - We call this “broadcasting”
- Analogous to a message in a mailing list
    - How?
- Layer-1 device
  - Can’t deal with addressing or data filtering
- Problem?

Problem of a Hub Connection

- Collision
- Reduce thoughtput
  - Wasted transmission
- OK for a small network though

Switch Connection



What does a Switch do?

- Contains several ports
- Selects the destination of an incoming packet
  - Forwards only to the corresponding port
- Considers a MAC address
  - Therefore, this is a layer-2 device
- What if a destination MAC address is not in a table?
  - Broadcast to all ports except an incoming port
- What if a destination is the same as an incoming port?
  - Drop the packet

Switch Connection Problems

- A list of some of the things that commonly cause LAN traffic congestion
  - Too many hosts in a broadcast domain
  - Broadcast storms
  - Multicasting
  - Low bandwidth
  - Adding hubs for connectivity to the network
  - A bunch of ARP or IPX traffic (IPX is a Novellrouting protocol that is like IP, but really, really chatty.)

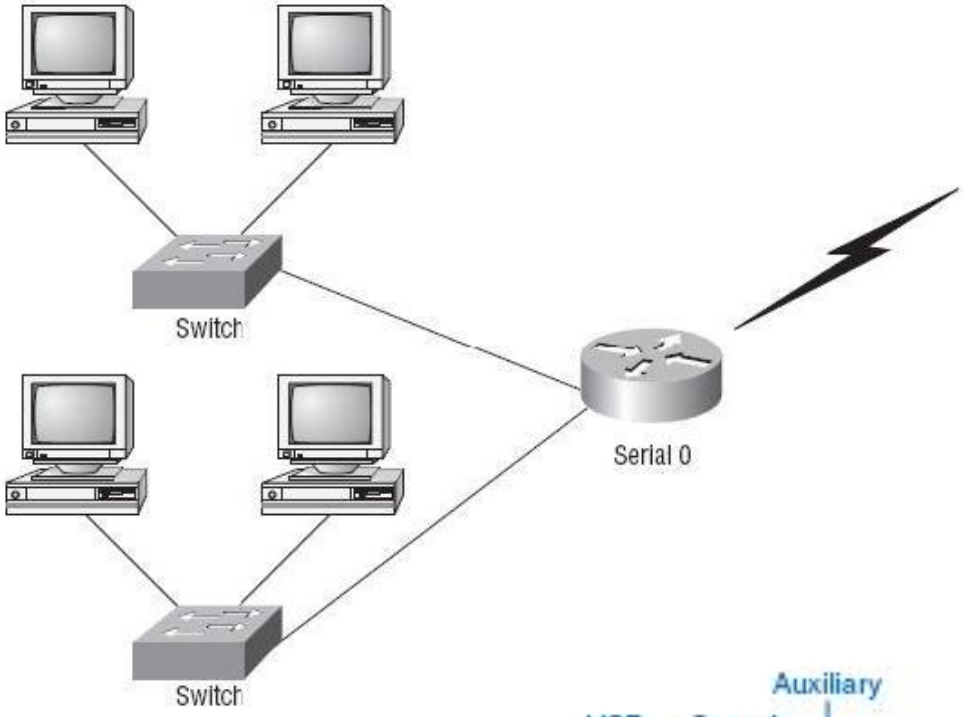
Bridge

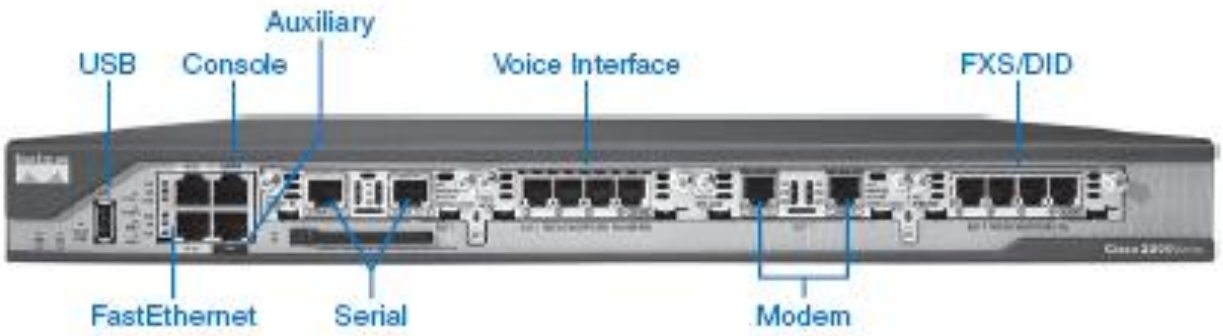
- Allows data to cross a bridge
  - Only data sent to a valid address on the other side of the bridge
- Learns the addresses by listening to traffic
- Used to extend a network
  - Distance-wise
  - Connects 2 or more LANs
- Usually, 1 port in, 1 port out (or just a few ports)
- Keeps network segments free of unnecessary data
- Layer-2 device

Bridge and Switch?

- A bridges and a switch basically do the same thing
- You cannot buy a physical bridge these days, only LAN switches
  - But LAN switches use bridging technologies
  - So Cisco still calls them *multiport bridges*

Router


Switch
Serial 0
Switch


Auxiliary
USB
Console
Voice Interface
FXS/DID
FastEthernet
Serial
Modem

What does a Router do?

- Basically, just like a switch
  - What?!
  - Yes, but use an IP address to forward packets
  - So which layer does it belong to?
- Four router functions
  - Packet switching
  - Packet filtering
  - Internetwork communication
  - Path selection
- Doesn’t broadcast by default
  - Need to be setup the lookup table before it can work
  - Unlike a learning bridge

Switch vs. Router

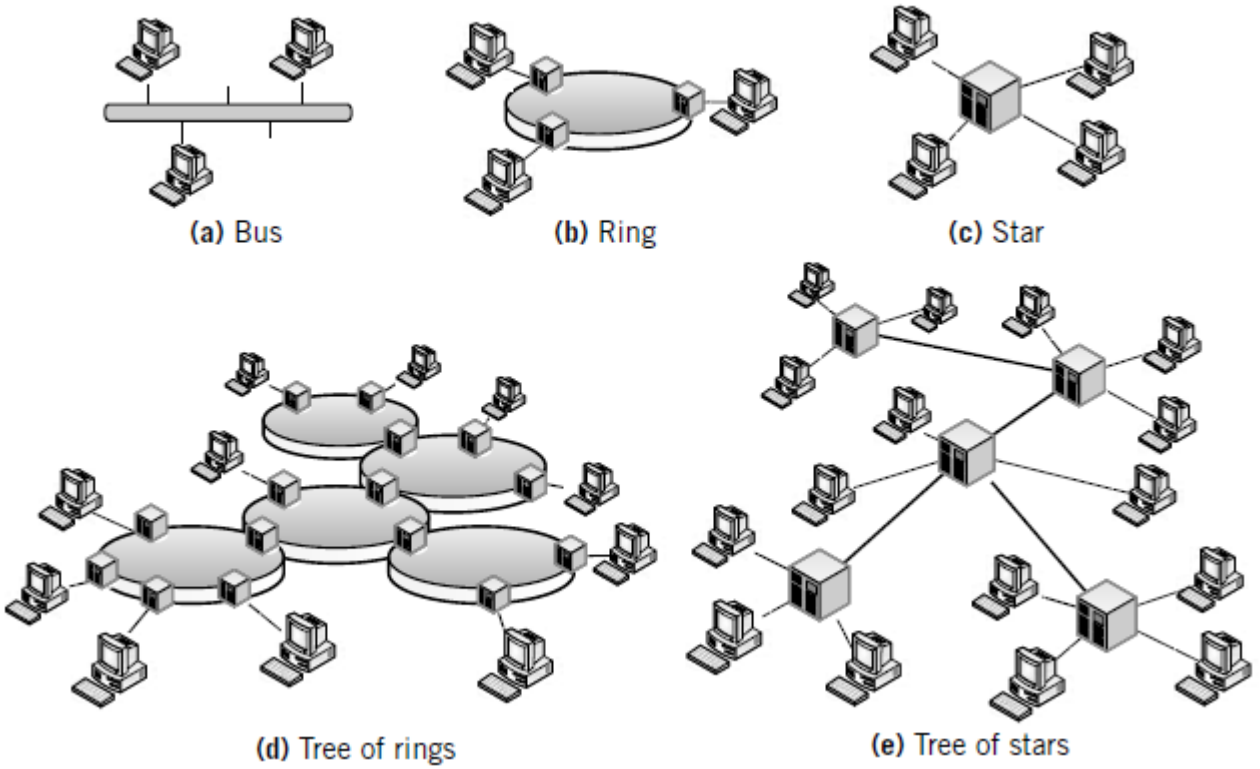
- Routers
  - Connect networks together
  - Route data packets from one network to another
- Switches
  - Aren't used to create internetworks
  - Make a LAN work better—to optimize its performance—providing more bandwidth for a LAN user
  - Break up *collision domains*
    - When one particular device sends a packet on a network segment, forcing every other devices on that same segment to pay attention to it

So, What's Different?

- Hub vs. switch vs. bridge vs. router?
- (article links on the FB group)

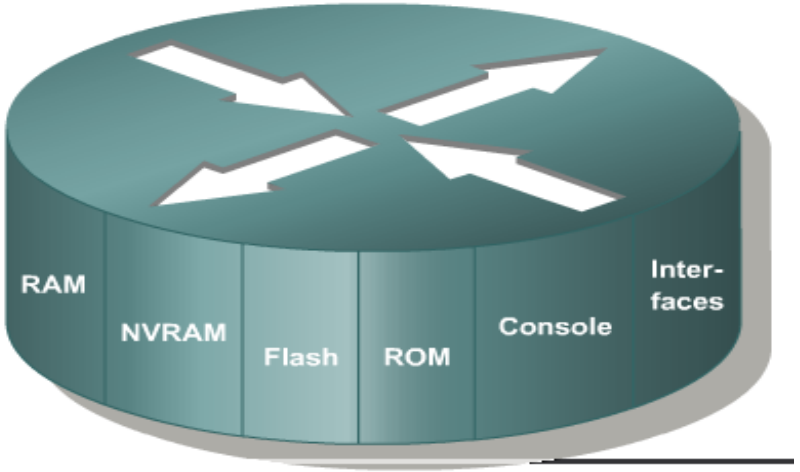
- Note: at present, a router usually comes with hub/bridge/switch technology

Network Topologies Revisited



Introduction to Routers in a WAN

- Routers connect and allow communication between two networks and determine the best path for data to travel through the connected networks.
- Routers need the Internetwork Operating System software (IOS) to run configuration files.



- The main internal components of the router are **random access memory** (RAM), **nonvolatile random-access memory** (NVRAM), **flash memory**, **read-only memory** (ROM), and **interfaces**.

RAM

- Stores routing tables
- Holds ARP cache and fast-switching cache
- Performs packet buffering (shared RAM)
- Maintains packet-hold queues
- Provides temporary memory for the configuration file of the router while the router is powered on
- Loses content when router is powered down or restarted

NVRAM

- Provides storage for the startup configuration file
- Retains content when router is powered down or restarted

Flash Memory

- Holds the operating system image (IOS)
- Allows software to be updated without removing and replacing chips on the processor
- Retains content when router is powered down or restarted
- Can store multiple versions of IOS software
- Is a type of electronically erasable, programmable ROM (EEPROM)

ROM

- Maintains instruction for power-on self test (POST) diagnostics
- Stores bootstrap program and basic operating system software
- Requires replacing pluggable chips on the motherboard for software upgrades

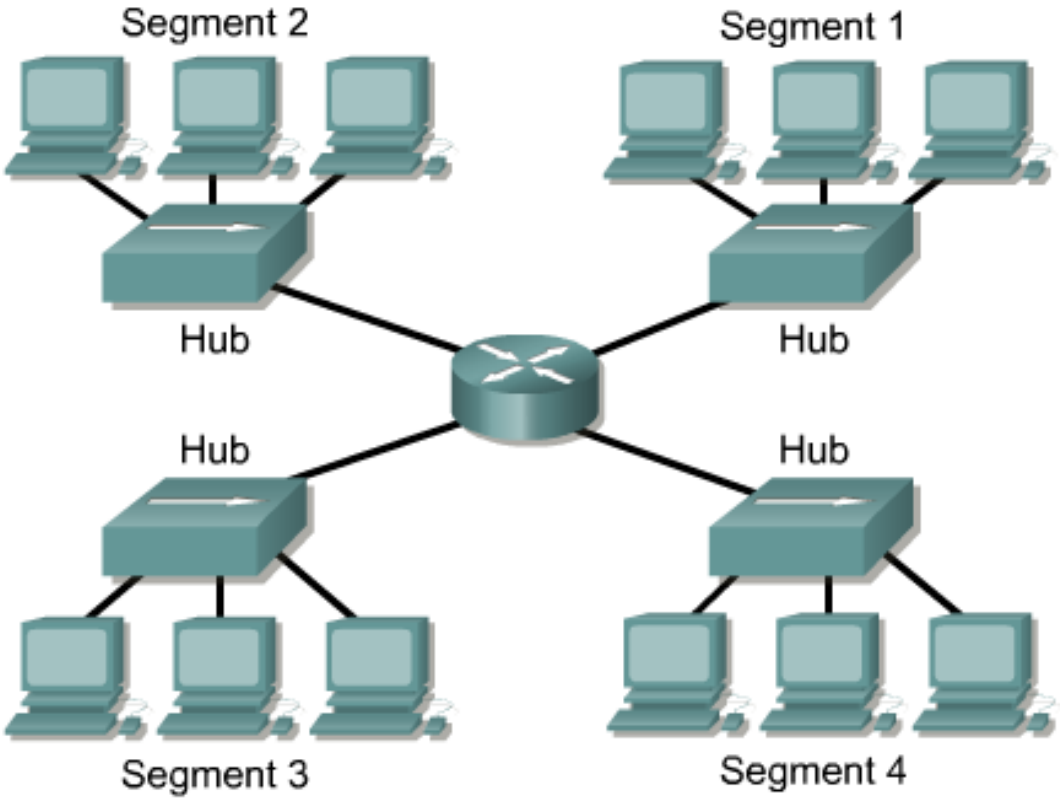
Interfaces

- Connect router to network for frame entry and exit
- Can be on the motherboard or on a separate module

Router LANs and WANs

- While a router can be used to segment LANs, its major use is as a WAN device.
- Routers have both LAN and WAN interfaces
- WAN technologies are frequently used to connect routers and these routers communicate with each other by WAN connections.

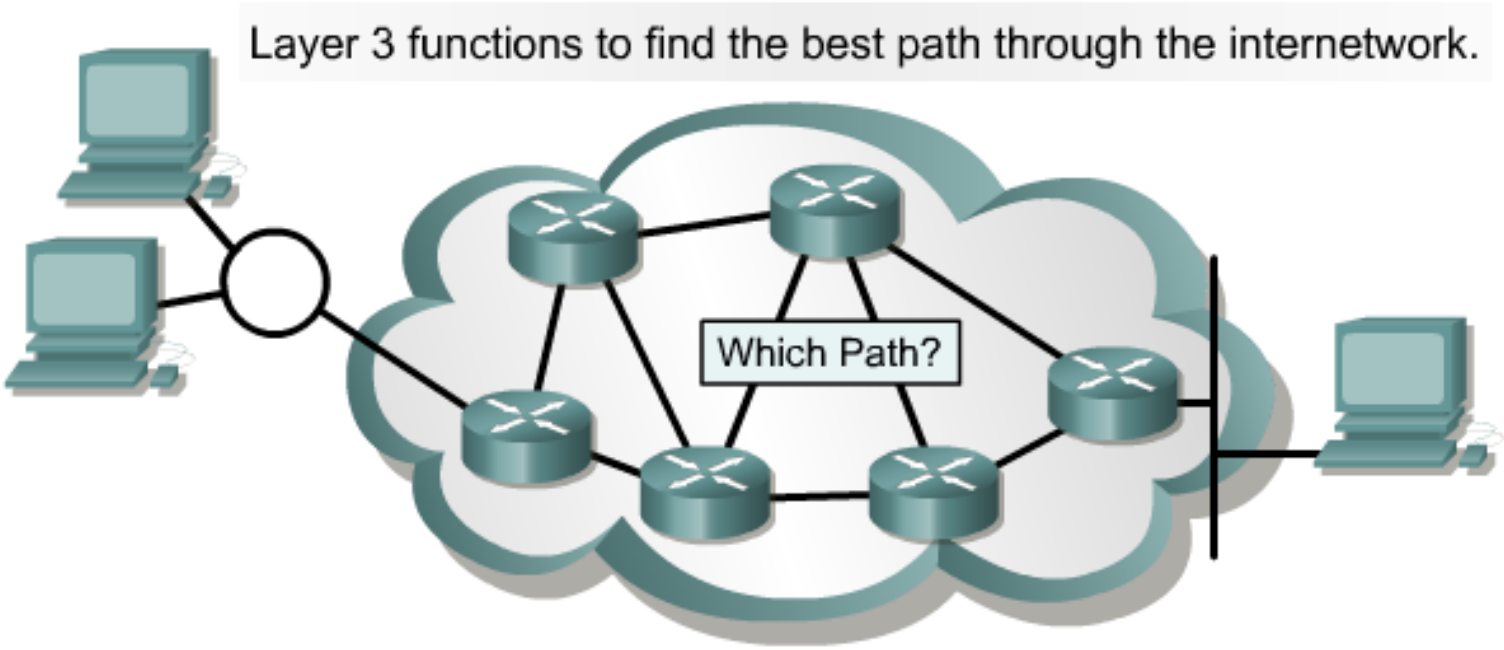
Router LANs and WANs



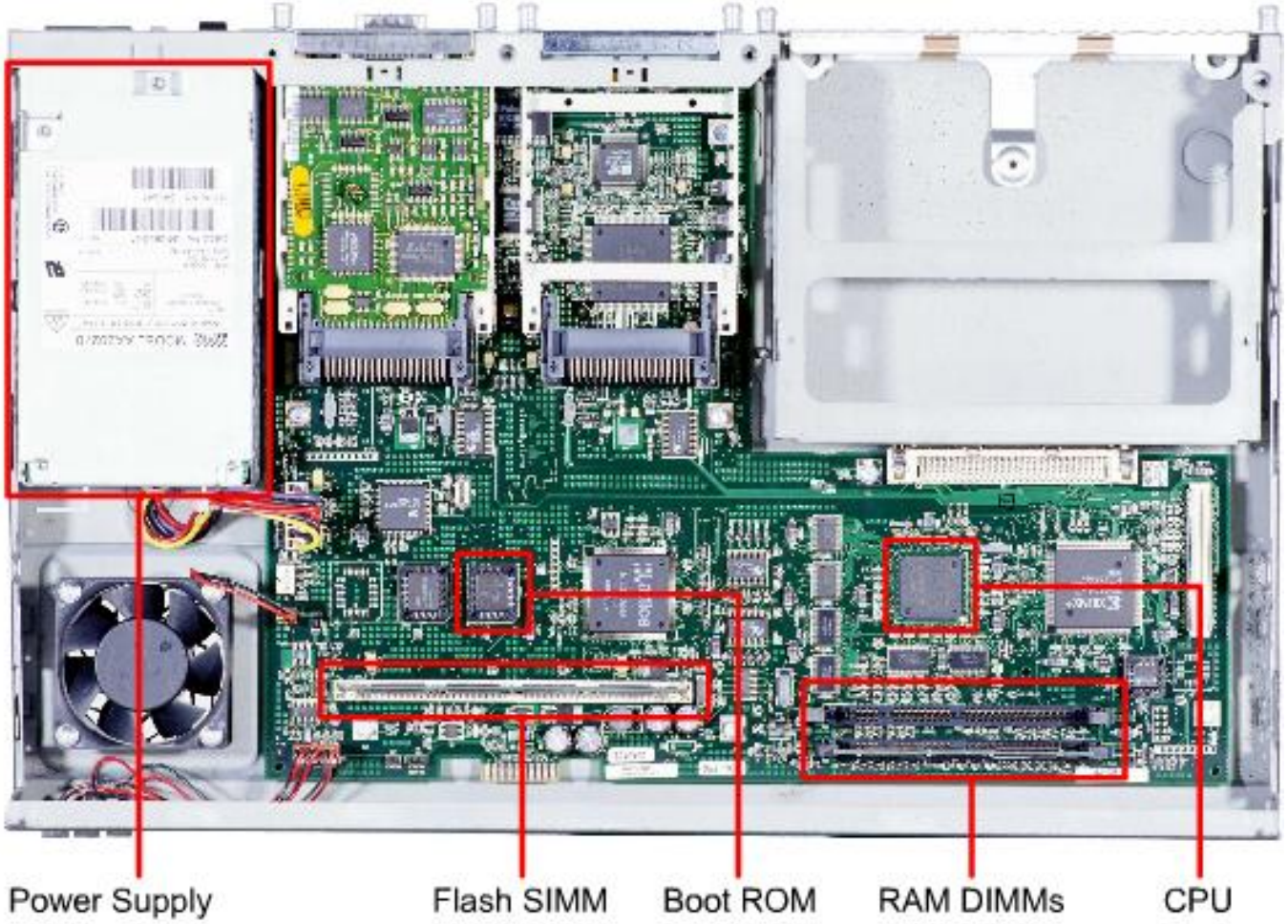
- More manageable, greater functionality, multiple activite paths
- Smaller broadcast domains
- Operates at Layer 3

Router LANs and WANs

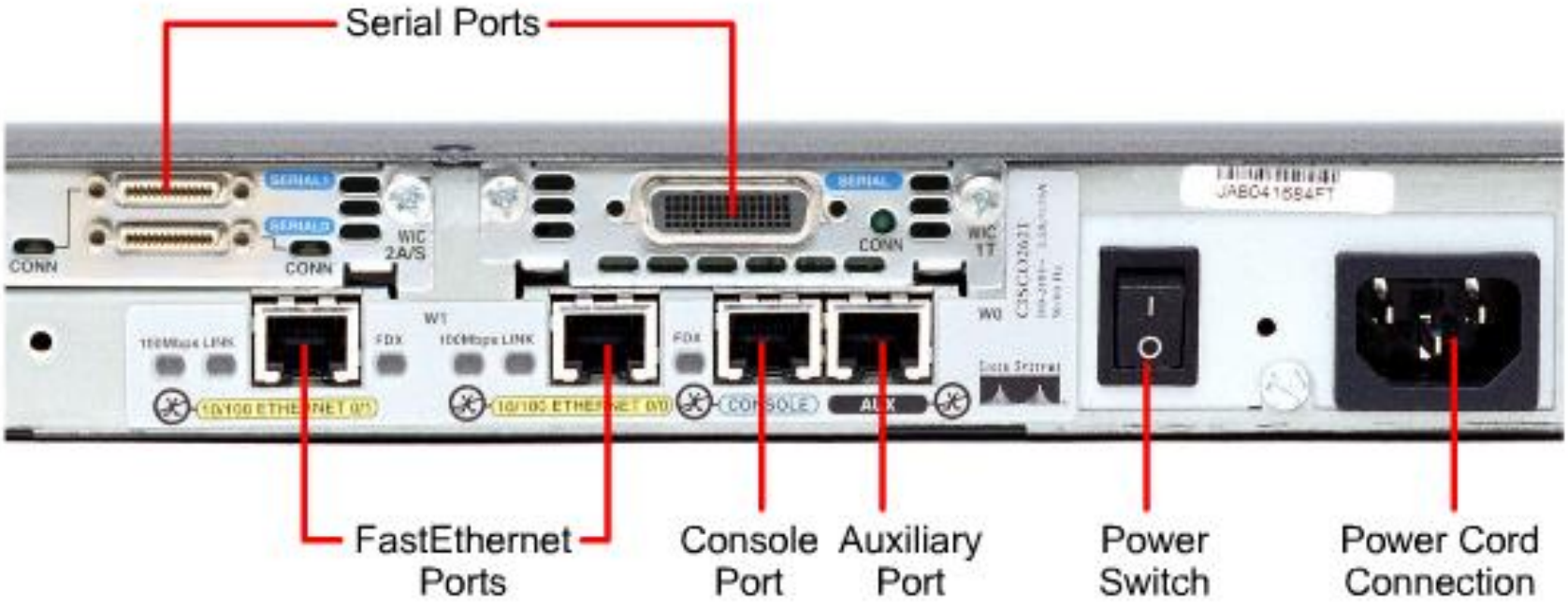
- Two main functions of a router are the ***selection of best path*** and the ***switching of frames*** *to the proper interface*.
- Routers accomplish this by building routing tables and exchanging network information with other routers.



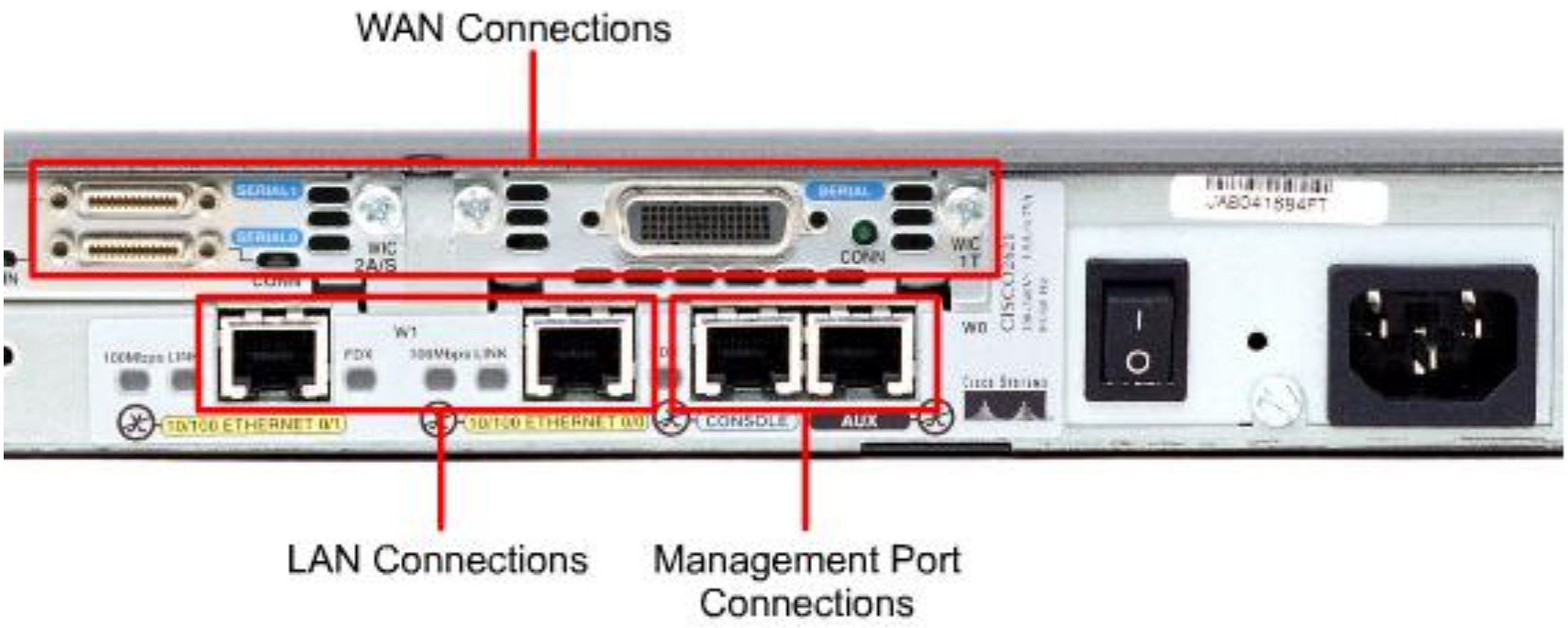
Internal Components of a 2600 Router



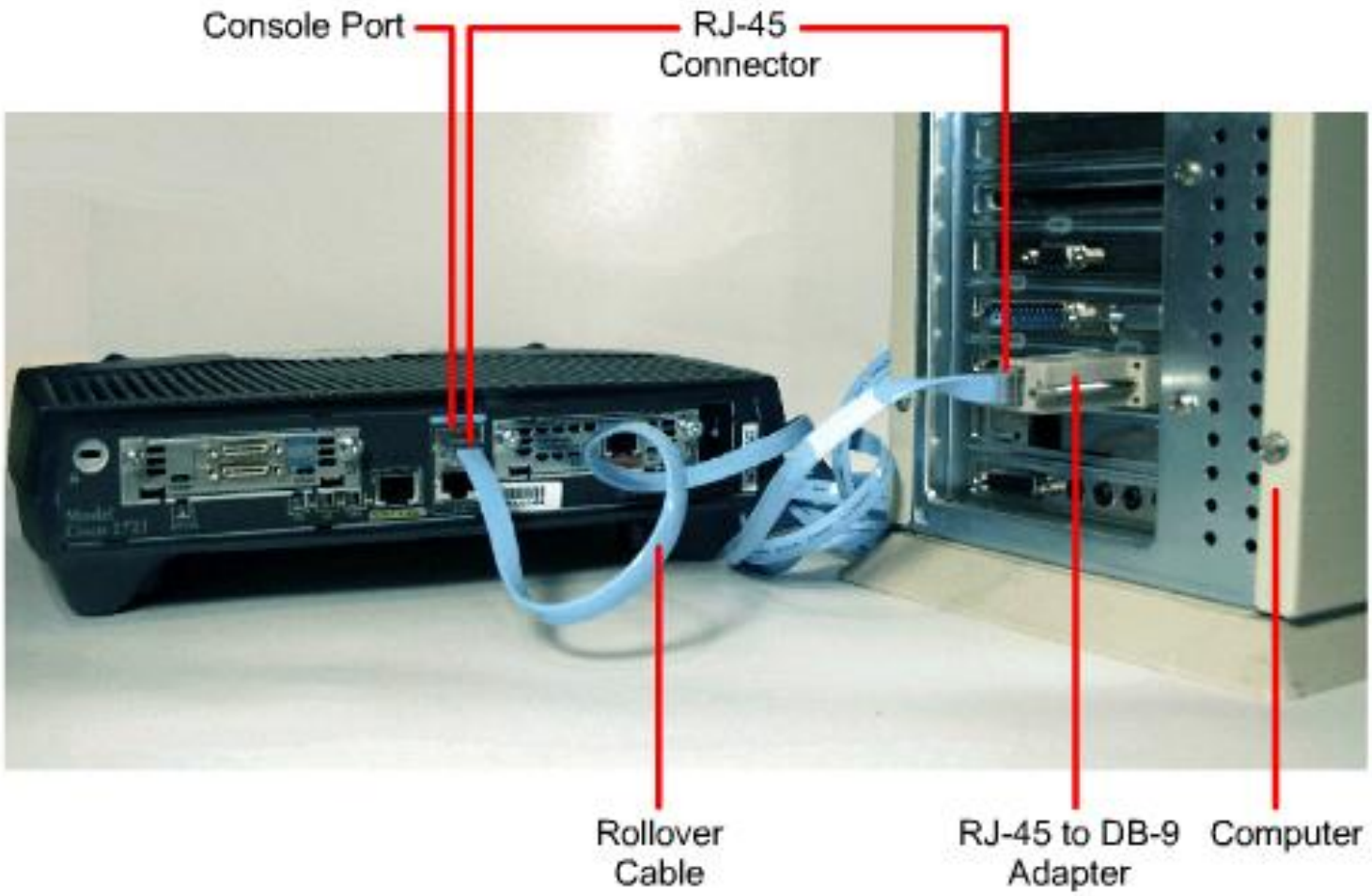
External Connections on a 2600 Router



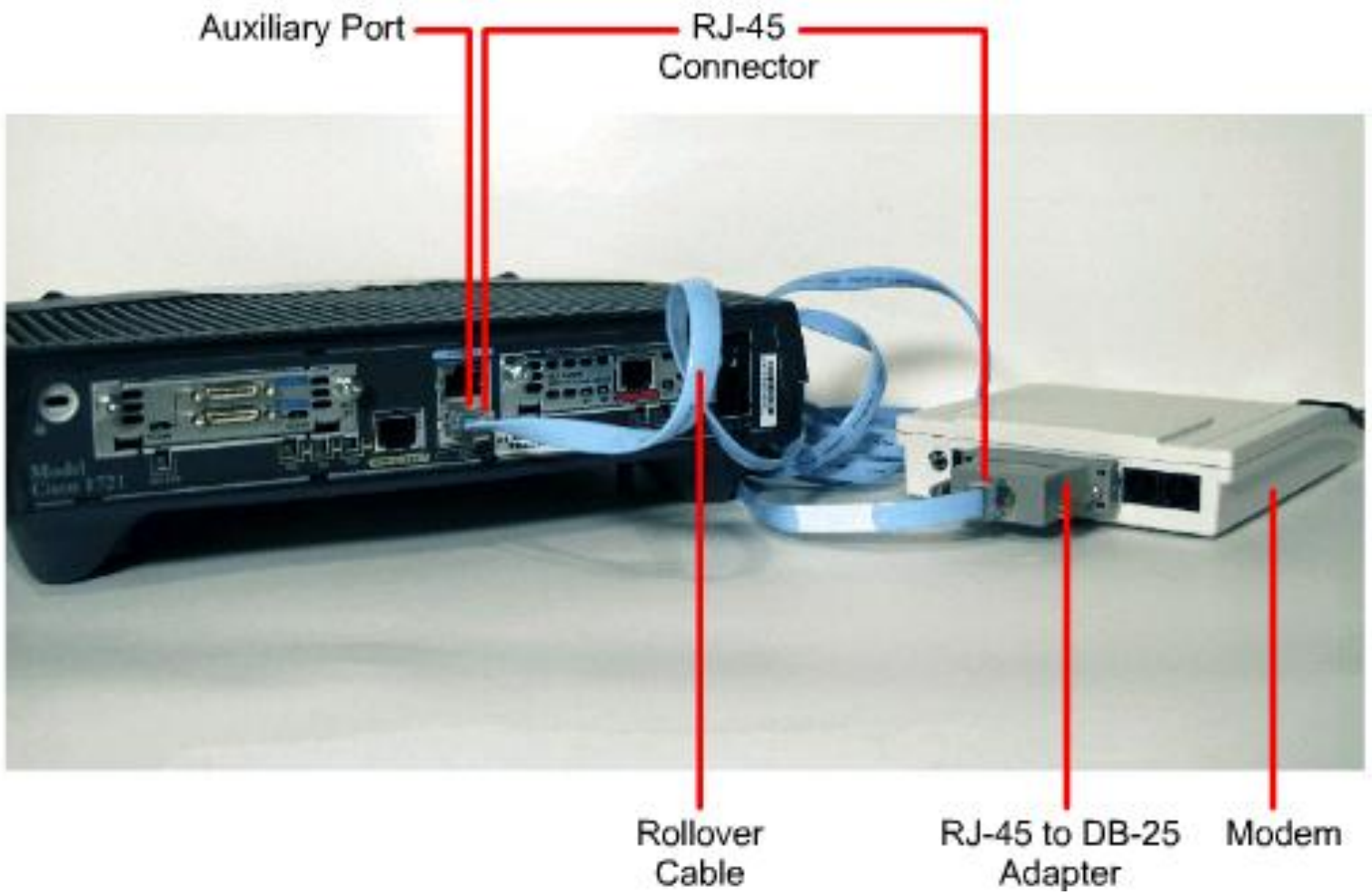
Router External Connections



Computer or Terminal Console Connection



Modem Connection to Console or Auxiliary Port

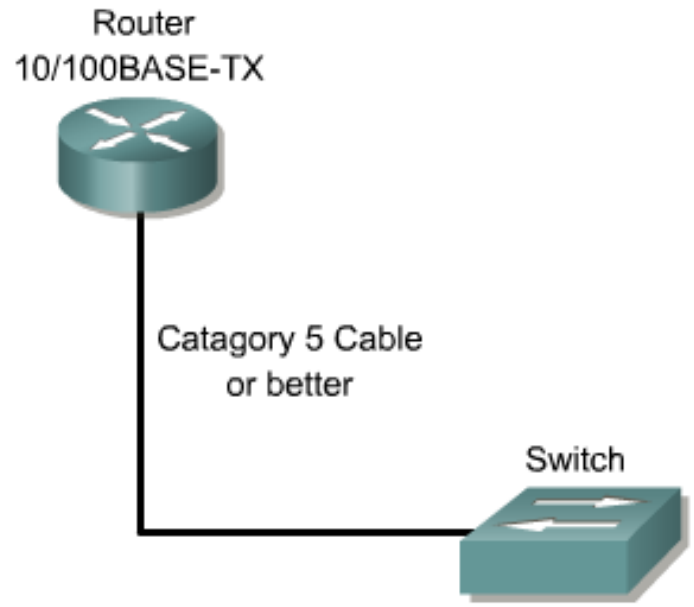


Connecting Console Interfaces

1. Configure terminal emulation software on the PC for the following:
   - The appropriate com port
   - 9600 baud
   - 8 data bits
   - 1 stop bit
   - No parity
   - No flow control
2. Connect a rollover cable to the router console port (RJ-45 connector).
3. Connect the other end of the rollover cable to the RJ-45 to DB-9 adapter
4. Attach the female DB-9 adapter to a PC.

Connecting Router LAN Interfaces

- **A router is usually connected to a LAN through an Ethernet or Fast Ethernet interface.**
- **The router is a host that communicates with the LAN through a hub or a switch.**

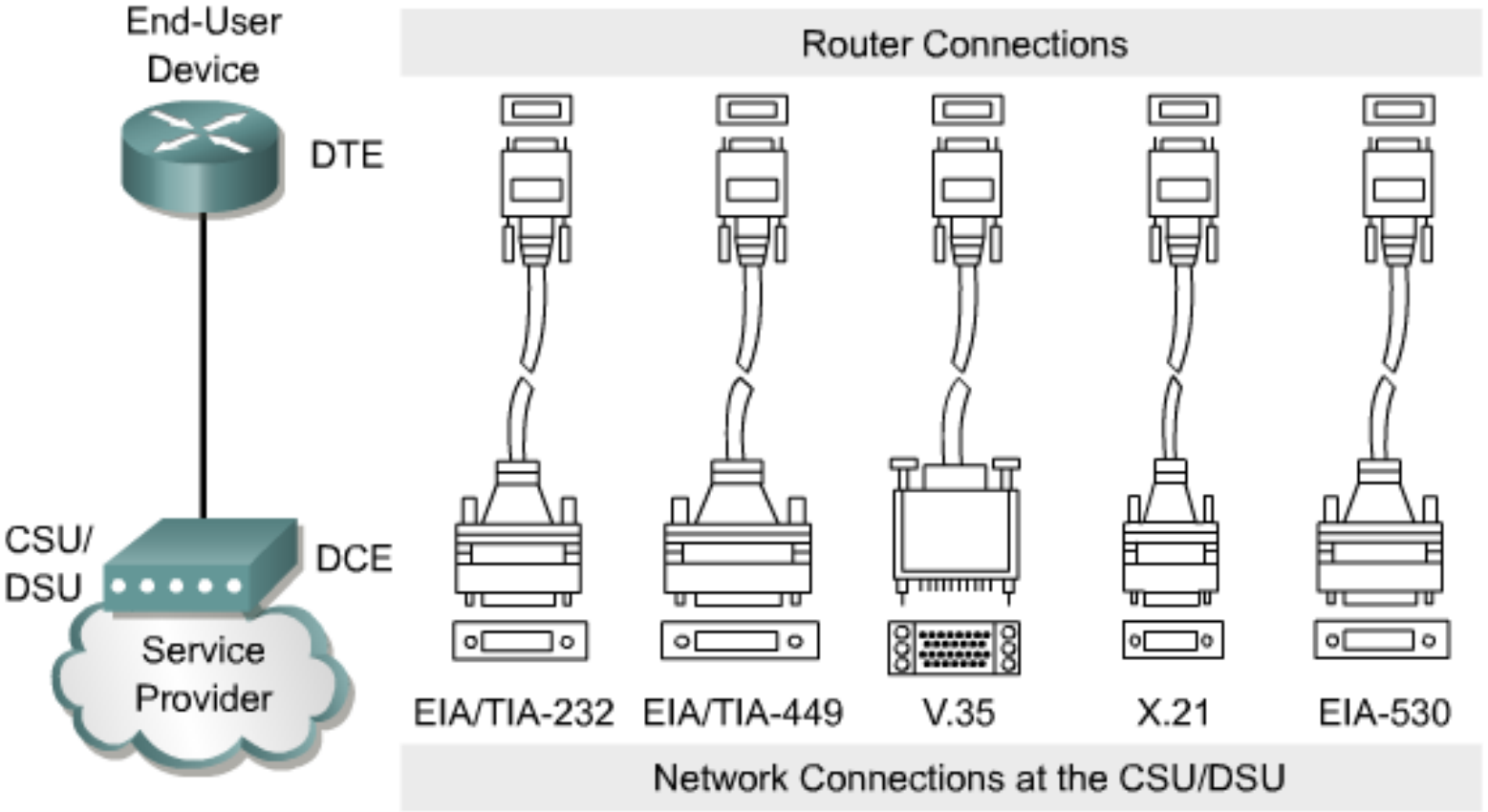


- **A straight-through cable is used to make this connection. A 10BASE-TX or 100BASE-TX router interface requires**
- **Category 5, or better, unshielded twisted-pair (UTP) cable, regardless of the router type**

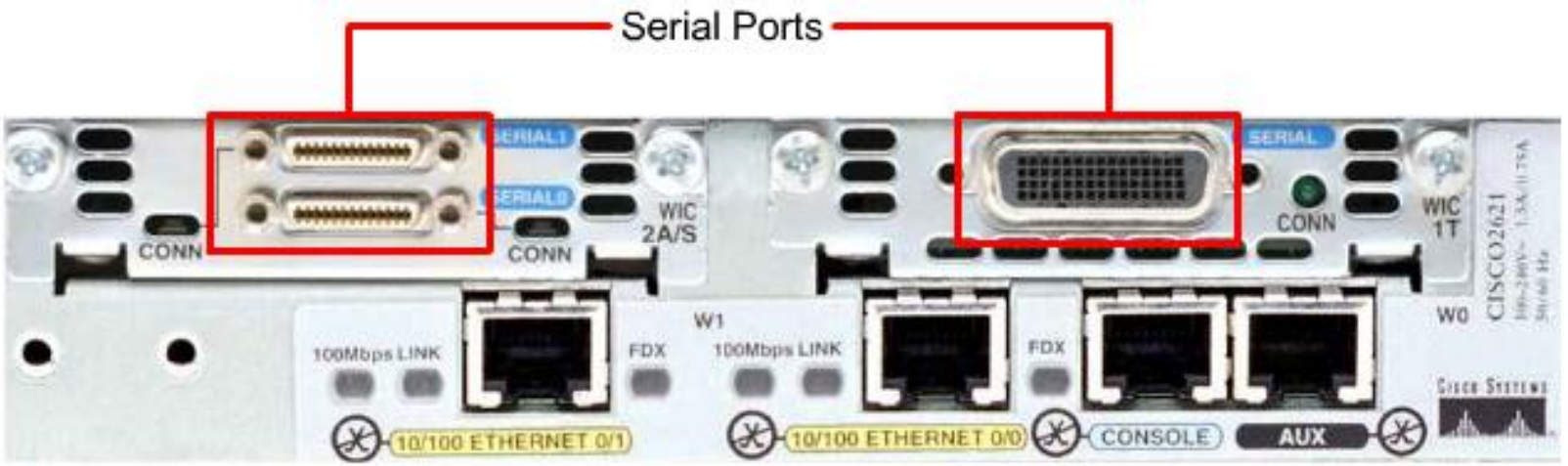
Connecting Router Interfaces

Port or Connection	Port Type	Color	Connected To	Cable
Ethernet	RJ-45	yellow	Ethernet hub or Ethernet switch	Straight-through
T1/E1 WAN	RJ-48C/ CA81A	light green	T1 or E1 network	RJ-48 T1
Console	8 pin	light blue	Computer com port	Roll over
AUX	8 pin	black	Modem	Roll over
BRI S/T	RJ-48C/ CA81A	orange	NT1 device or private integrated network exchange (PINX)	RJ-48
BRI U WAN	RJ-49C/ CA11A	orange	ISDN network	RJ-49
Token	UTP, STP	purple	Token Ring device	RJ-45 Token Ring cable

Router Serial WAN Connectors



Router Serial WAN Connectors



Cisco IOS Software

- **A router or switch cannot function without an operating system.**
- **Cisco calls its operating system the Cisco Internetwork Operating System or Cisco IOS.**
- **It is the embedded software architecture in all of the Cisco routers and is also the operating system of the Catalyst switches.**
- **The Cisco IOS provides the following network services:**
  - **Basic routing and switching functions**
  - **Reliable and secure access to networked resources**
  - **Network scalability**

Steps in Router Initialization