Common Client and Server Network Connectivity Devices

by Sophia

WHAT'S COVERED

In the next two lessons, you will learn about common network connectivity devices. In this lesson, we will review the most commonly used devices that are used in typical networks. You will learn their purpose in the network and be able to explain how they function.

Specifically, this lesson will cover the following:

1. Common Network Connectivity Devices

In previous tutorials, you have learned about various types of network media and connections, so it is time to learn about some of the devices they hook up to that are commonly found on today's networks.

BEFORE YOU START

First, we will define the basic terms, and later in this tutorial, we will discuss how these devices work within a network. We will also discuss detailed descriptions of these devices and the terminology associated with them later in the tutorial.

Because these devices connect network entities, they are known as network devices. Here is a list of the devices that we will cover in this tutorial:

- Network interface card (NIC)
- Hub

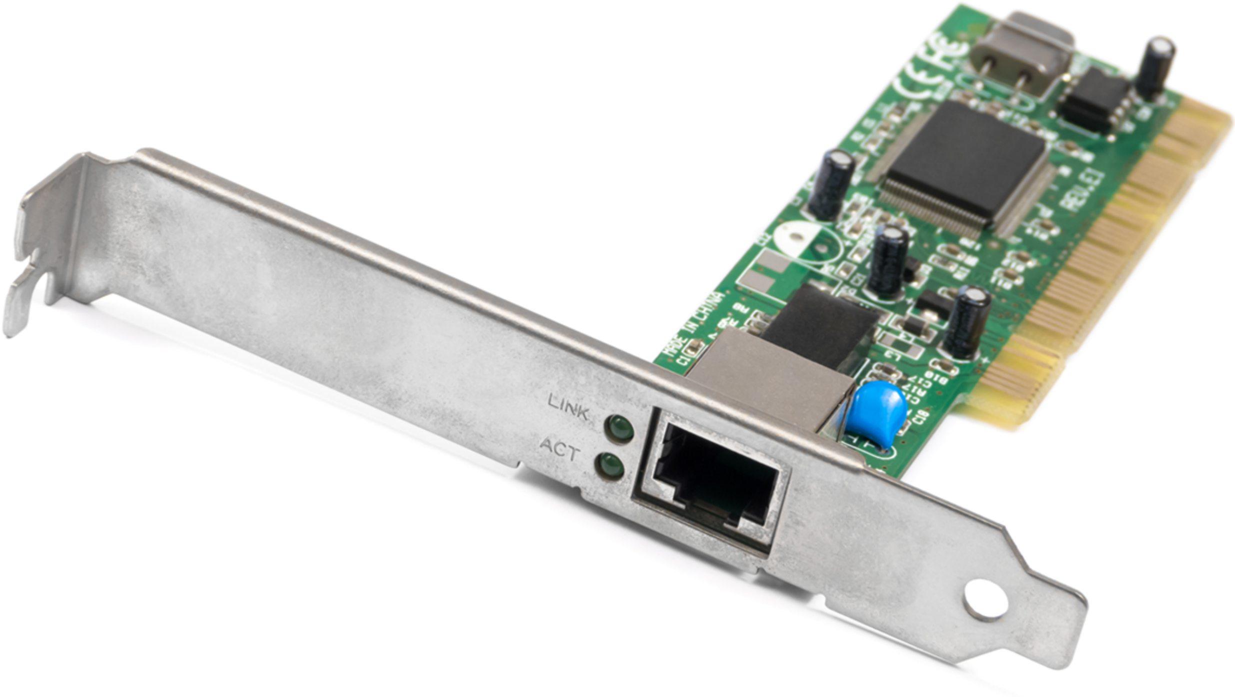
- Bridge
- Switch
- Router

1a. Network Interface Card

A **network interface card (NIC)** is installed on your computer to connect, or interface, your computer to the network. It provides the physical, electrical, and electronic connections to the network media. The NIC resides at the data link layer (Layer 2) of the OSI Model because the information it uses for communication, the MAC address, resides on the data link layer.

An NIC is either an expansion card or built right into the computer’s motherboard. Today, almost all NICs are built into the computer motherboard, but there was a time when all NICs were expansion cards that plugged into motherboard expansion slots. In some notebook computers, NIC adapters can be connected to the USB port or through a mini PCIe or M.2 card slot.

The photograph below shows a PCIe 100 Mbps Ethernet NIC.



DID YOU KNOW

Today, most PCs and laptops of all types come with an Ethernet and wireless connector built into the motherboard, so you usually do not need a separate card. It is rare to find a laptop today without a built-in

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wireless network card, but you can buy external wireless cards for desktops and laptops if you have legacy equipment that needs them.

NICs today usually have one, two, or more LEDs; one, usually green, is called a **link light**, indicating that an Ethernet connection has been established with the device on the other end of the cable, and it flickers when traffic is being passed back or forth. The others usually indicate the speed of the connection: 10, 100, or 1000 Mbps. There is no universal standard for NIC LEDs, so check the manual to familiarize yourself with the ones you are working with. A blinking LED means the NIC is receiving a proper signal from the hub or switch. It can also indicate connectivity to, and detection of, a carrier on a segment. The other LED is aptly named the activity LED, which tends to flicker constantly. The activity indicates the intermittent transmission and reception of frames arriving at the network or leaving it.

TERMS TO KNOW

Network Interface Card (NIC)
A computer hardware component designed to allow computers to communicate over a computer network.

Link Light
An LED light on a network device that indicates network activity.

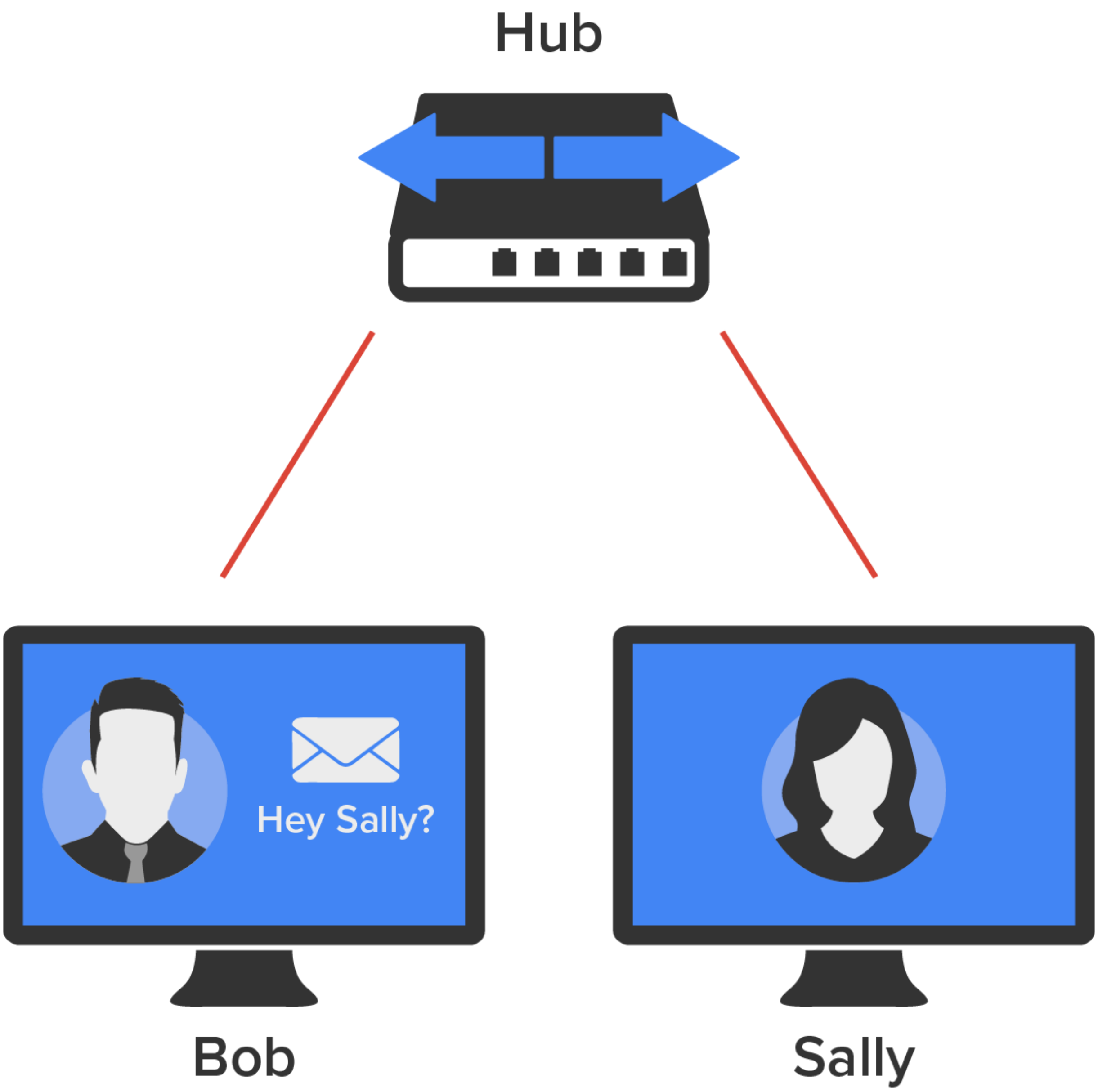
1b. Hub

A **hub** is a device that operates at the Layer 1 (physical) of the OSI model. A hub connects all the segments of the network together in a star topology Ethernet network. A hub has no intelligence, which means it does not interpret that data traffic in any way. Each device in the network connects directly to the hub through a single cable and is used to connect multiple devices without segmenting a network.

Any transmission received on one port will be sent out to all the other ports in the hub, including the receiving pair for the transmitting device, so that the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) on the transmitter can monitor for collisions.

EXAMPLE If one station sends a transmission, all the other stations will receive it; yet, based on the address found in the frame, only the intended recipient will process it. This arrangement simulates the physical bus that the CSMA/CD standard was based on, and it is why we call the use of a hub in an Ethernet environment a physical star/logical bus topology.

The diagram below depicts a typical hub as you might find it employed within a small network. Since there are only two users, there is no problem in using a hub here. However, if there were many users, every station would receive Bob’s request to send information in a packet to Sally. Most of the time, hubs really are not recommended for corporate networks because of their security limitations.



A hub is essentially a multiport repeater that is incapable of recognizing frames and data structures. A transmission sent out by any device on the hub will be repeated to all devices connected to it. And just as in a physical bus topology configuration, any two or more of those connected devices can potentially cause a collision with each other, which means that this hardware device will create a LAN with the most network traffic collisions. Hubs are not recommended for use in today’s corporate network for this reason.

A **repeater** is a simple two-port device used to mitigate the effects of attenuation (that is, signal loss) by retransmitting signals to enable multiple cable segments to be connected together.

☆ BIG IDEA

Repeaters and hubs are Layer 1 devices that extend both the collision domain and the broadcast domain.

TERMS TO KNOW

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Hub

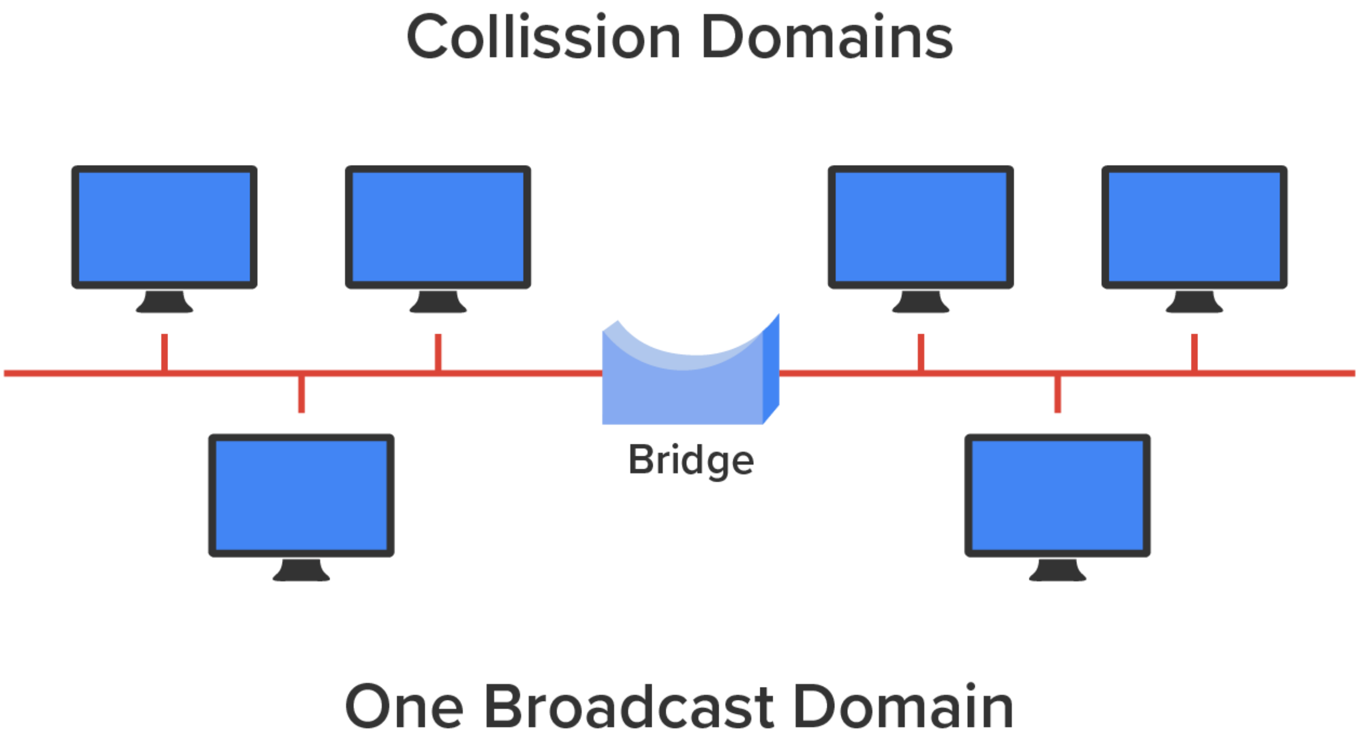
A Layer 1 multiport repeater.

Repeater

A Layer 1 device that retransmits all incoming signals out to all ports.

1c. Bridge

A **bridge** is a Layer 2 (data link) network device that connects two similar network segments together. Its primary function is to keep traffic separated on either side of the bridge, separating collision domains, as pictured below.



What we can see here is that traffic is allowed to pass through the bridge only if the transmission is intended for a station on the opposite side. The main reasons you would place a bridge in your network would be to connect two segments or to divide a busy network into two segments. Because bridges use MAC addresses to make forwarding decisions, they are considered Layer 2 devices.

Bridges are software-based legacy devices. Today, given the advances in technology, you would use a switch, which is a hardware-based, multiport bridge. In fact, the terms bridge and switch are often used interchangeably because the two devices use basically the same bridging technologies.

TERM TO KNOW

Bridge

A two-port Layer 2 device that forwards frames based on MAC addresses.

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1d. Switch

Switches connect multiple segments of a network together much like hubs do but with three significant differences. These include the following:

- A switch recognizes frames and pays attention to the source and destination MAC addresses of the incoming frame as well as the port on which it was received.
- A switch makes each of its ports a unique, singular collision domain.
- Switches use MAC addresses to make forwarding decisions. They are considered Layer 2 devices.

If a switch determines that a frame’s final destination happens to be on a segment that is connected via a different port than the one on which the frame was received, the switch will only forward the frame out from the specific port on which its destination is located. If the switch cannot figure out the location of the frame’s destination, it will **flood** the frame out from every port except the one on which the frame port was received. The photograph below shows a typical low-cost Ethernet switch. It looks a lot like a hub. However, switches can come in very large sizes that are expensive. Switches that can perform the basic switching process and do not allow you to configure more advanced features, like adding an IP address for telnetting to the device or adding VLANs, are called **unmanaged switches**. Others, like Cisco switches that do allow an IP address to be configured for management with such applications as SNMP and do allow special ports to be configured (as in VoIP), are called **managed switches**. Managed switches are designed to support **enterprise** IT environments.

That is as far as we are going with switches right now. You will study them in more detail later in the course. For now, you can think of a switch as a faster, smarter bridge that has more ports.

☆ BIG IDEA

Bridges and switches are Layer 2 devices that separate collision domains but extend the broadcast domain.

TERMS TO KNOW

Switch

A multiport Layer 2 device that forwards frames based on MAC addresses.

Flood

A transmission of data out all switch ports when the location of the destination MAC address is unknown.

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Unmanaged Switch

A switch with minimal functionality appropriate for SOHO installations.

Managed Switch

A switch with complex functionality appropriate for large enterprise installations.

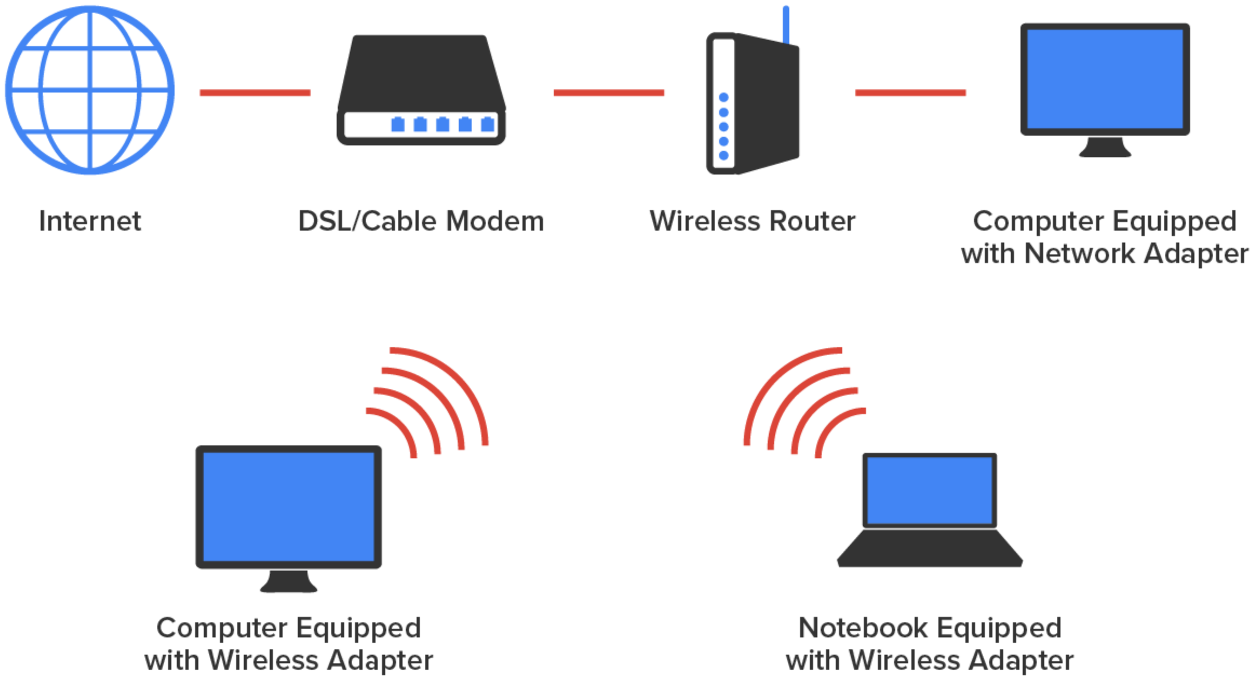
Enterprise

A company, business, or organization.

1e. Router

A **router** is a Layer 3 (network) device used to connect different networks together, combining them into what we call an **internetwork**. Routers separate broadcast domains. A well-configured router can make intelligent decisions about the best way to get network data to its destination. It gathers the information it needs to make these decisions based on a network's particular performance data. As routers use IP addresses to make forwarding decisions, they are considered Layer 3 devices.

The diagram below shows a **small office, home office (SOHO)** router that provides wired and wireless access for hosts and connects them to the Internet without any necessary configuration.


Internet
DSL/Cable Modem
Wireless Router
Computer Equipped with Network Adapter
Computer Equipped with Wireless Adapter
Notebook Equipped with Wireless Adapter

Routers can be multifaceted devices that behave like computers unto themselves with their own complex operating systems—for example, Cisco's **Internetworking Operating System (IOS)**. You can even think of them as CPUs that are totally dedicated to the process of routing packets. And due to their complexity and flexibility, you can configure them to perform the functions of other types of network devices (like firewalls, for example) by simply implementing a specific feature within the router's software.

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KEY CONCEPT

Routers can have many different names: Router, **Layer 3 switch**, and multilayer switch are the most common. Remember, if you hear just the word *switch*, that means a Layer 2 device. Routers, Layer 3 switches, and multilayer switches are all Layer 3 devices. If you see the term *Layer 3 switch*, that means you are talking about a router, not a Layer 2 switch. The terms *router* and *Layer 3* switch are interchangeable.

BIG IDEA

Routers are Layer 3 devices that separate broadcast domains.

In the next tutorial, we will discuss additional common network connectivity devices.

TERMS TO KNOW

Router
A Layer 3 (network) device used to connect different networks together.

Internetwork
A network linking separate networks together.

SOHO
An acronym for small office, home office.

Internetworking Operating System (IOS)
A Cisco proprietary operating system for switches and routers.

Layer 3 Switch
A router.

SUMMARY

In this lesson, you learned basic information about **common network connection devices** that operate at Layers 1, 2, and 3 of the OSI Model.

Source: This content and supplemental material has been adapted from CompTIA Network+ Study Guide: Exam N10-007, 4th Edition. Source **Lammle: CompTIA Network+ Study Guide: Exam N10-007, 4th Edition - Instructor Companion Site (wiley.com)**

TERMS TO KNOW

Bridge
A two-port Layer 2 device that forwards frames based on MAC addresses.

Enterprise

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A company, business, or organization.

Flood

A transmission of data out all switch ports when the location of the destination MAC address is unknown.

Hub

A Layer 1 multiport repeater.

Internetwork

A network linking separate networks together.

Internetworking Operating System (IOS)

A Cisco proprietary operating system for switches and routers.

Layer 3 Switch

A router.

Link Light

An LED light on a network device that indicates network activity.

Managed Switch

A switch with complex functionality appropriate for large enterprise installations.

Network Interface Card (NIC)

A computer hardware component designed to allow computers to communicate over a computer network.

Repeater

A Layer 1 device that retransmits all incoming signals out to all ports.

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SOHO

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A switch with minimal functionality appropriate for SOHO installations.

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