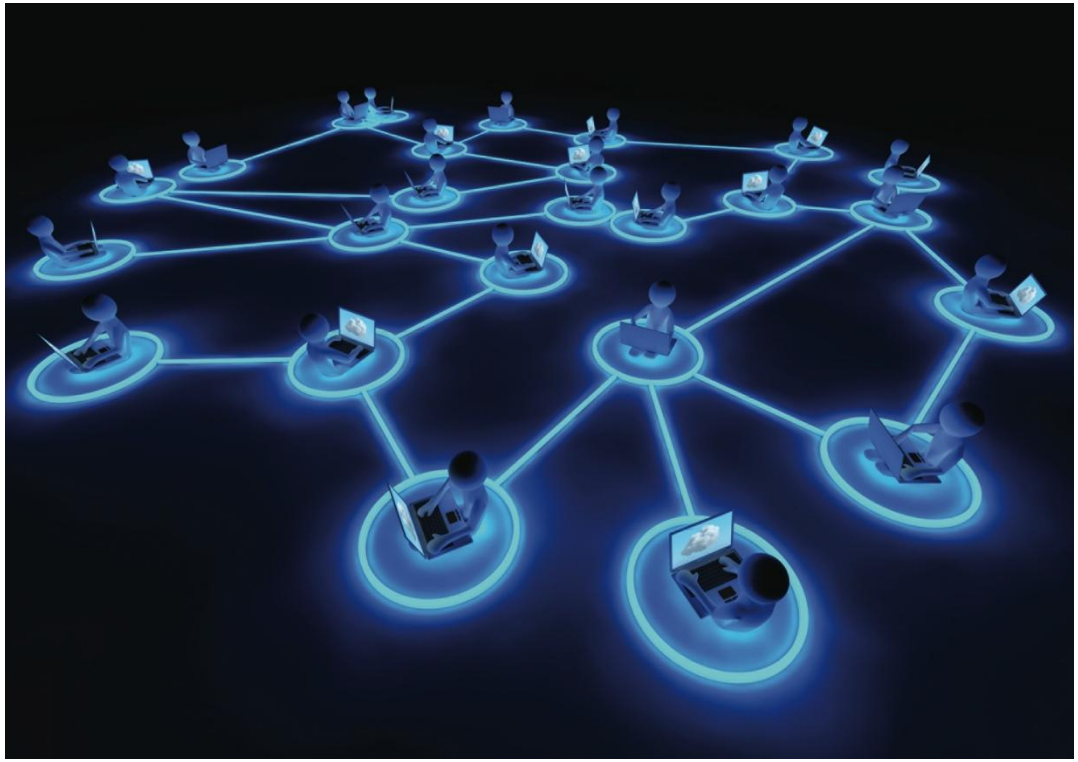
Visible Networks

Chapter 5



Overview

- **In this chapter, you will learn how to**
  - Describe the basic functions of a network, including identifying common devices and connectors
  - Discuss the differences between a LAN and a WAN and the importance of TCP/IP
  - Perform basic resource sharing

What do you do on a network?

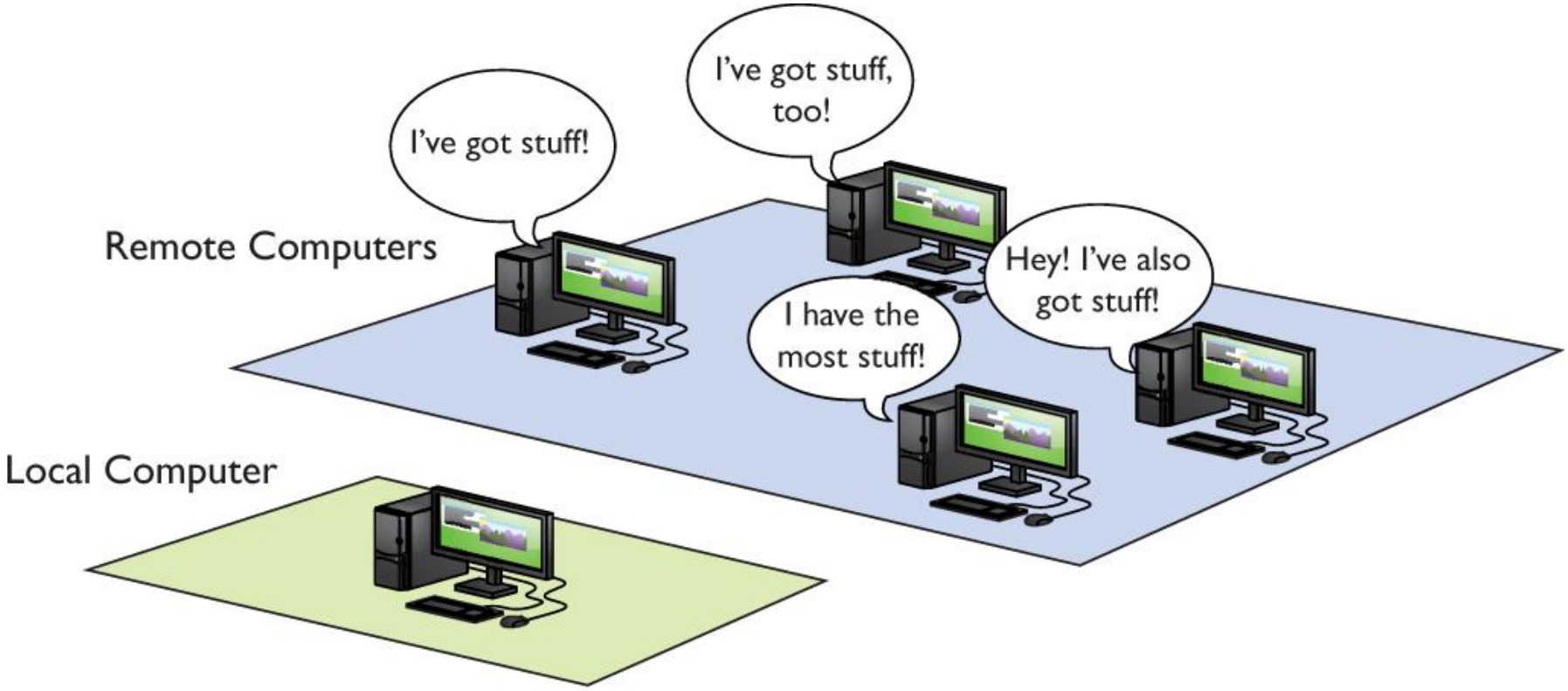


Figure 1: Accessing remote computers

What do you do on a network? (*continued*)

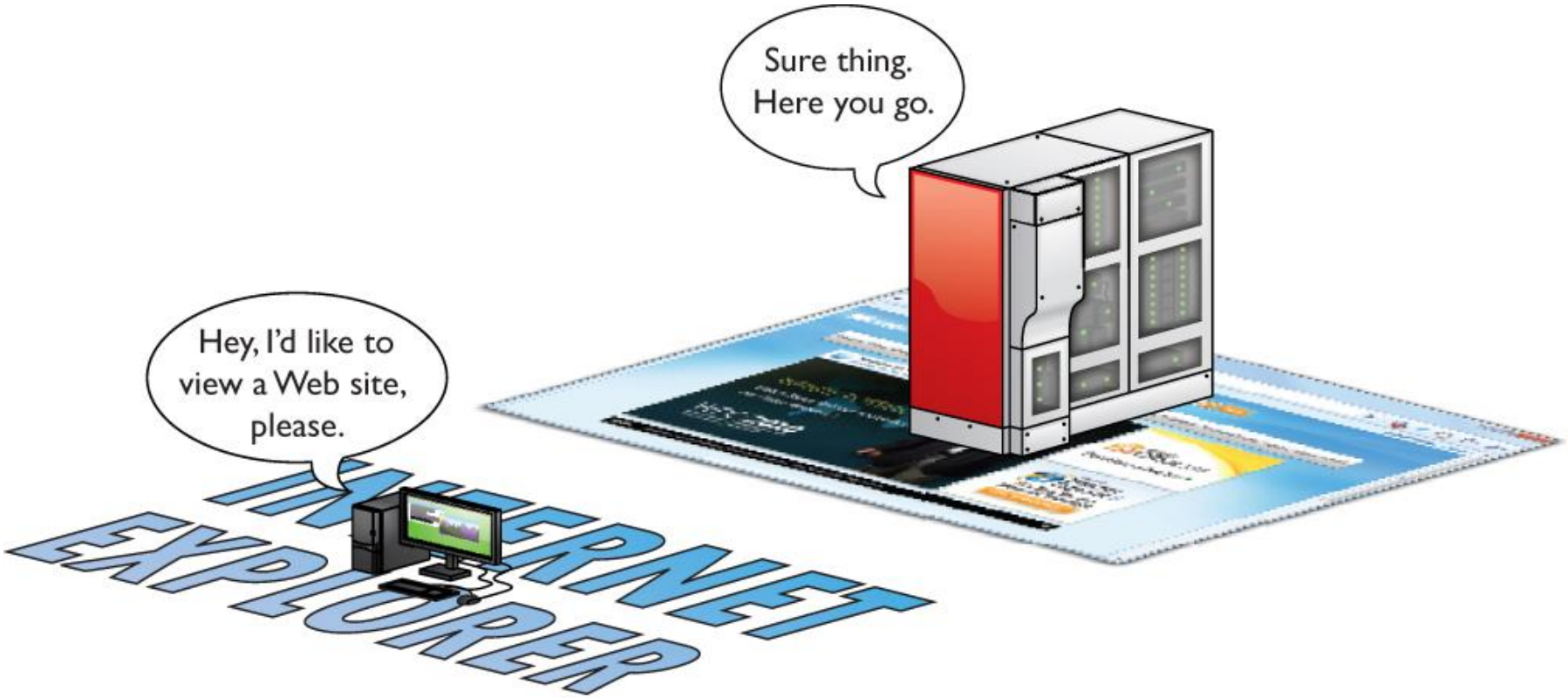


Figure 2: Accessing a Web page

What do you do on a network? (*continued*)

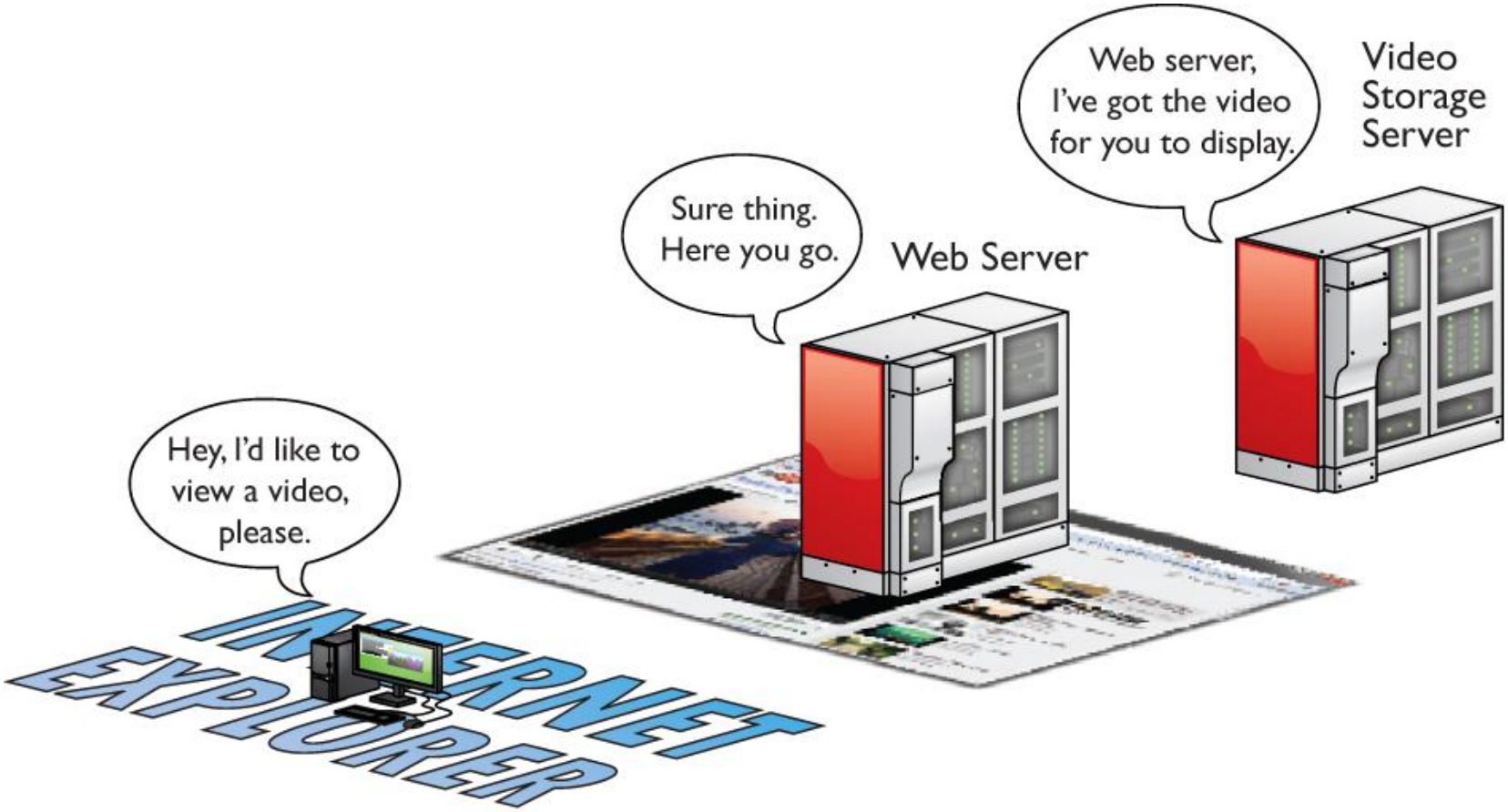


Figure 3: Accessing a YouTube page

What do you do on a network? (*continued*)

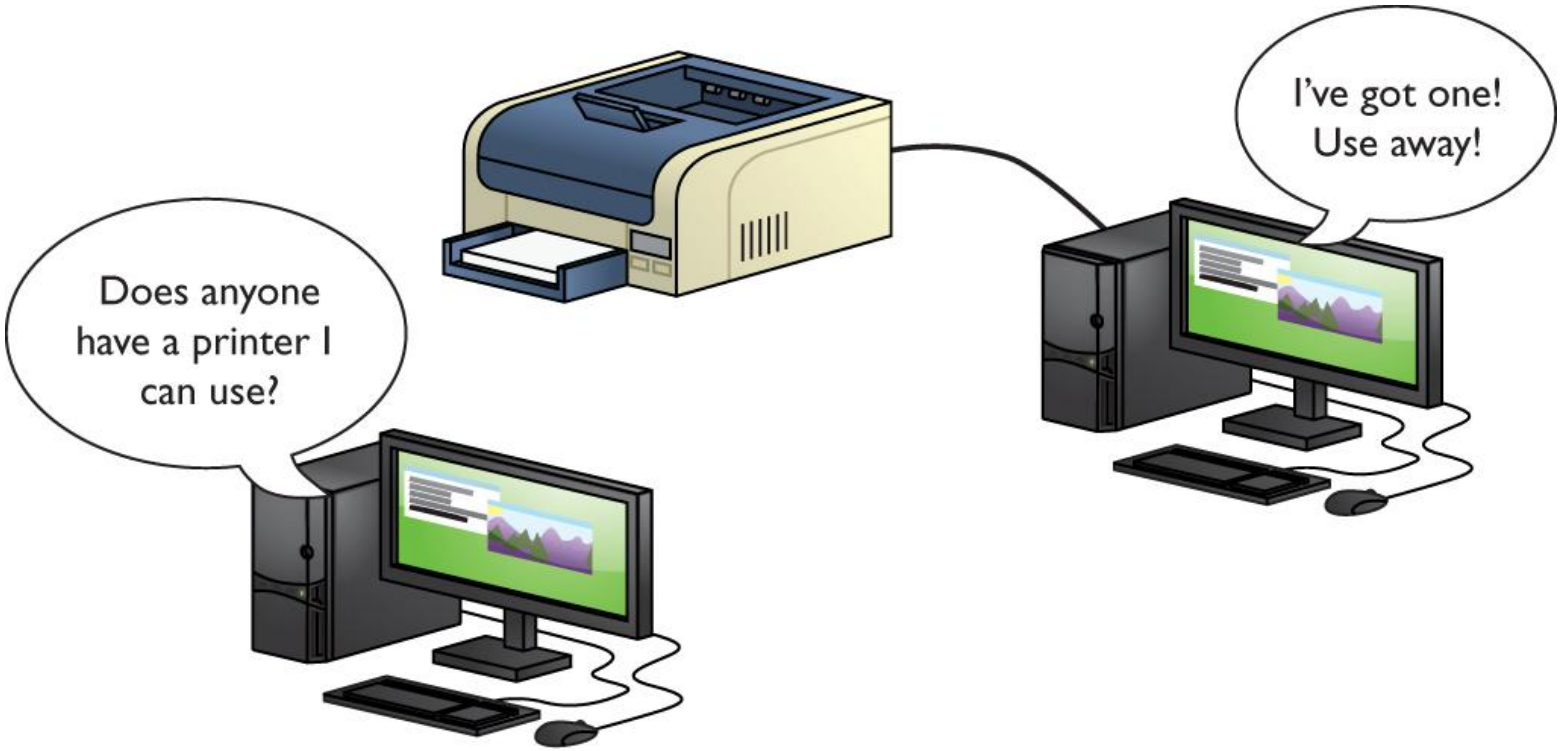


Figure 4: Sharing a printer in Windows 7

Network Technologies

Network Technologies

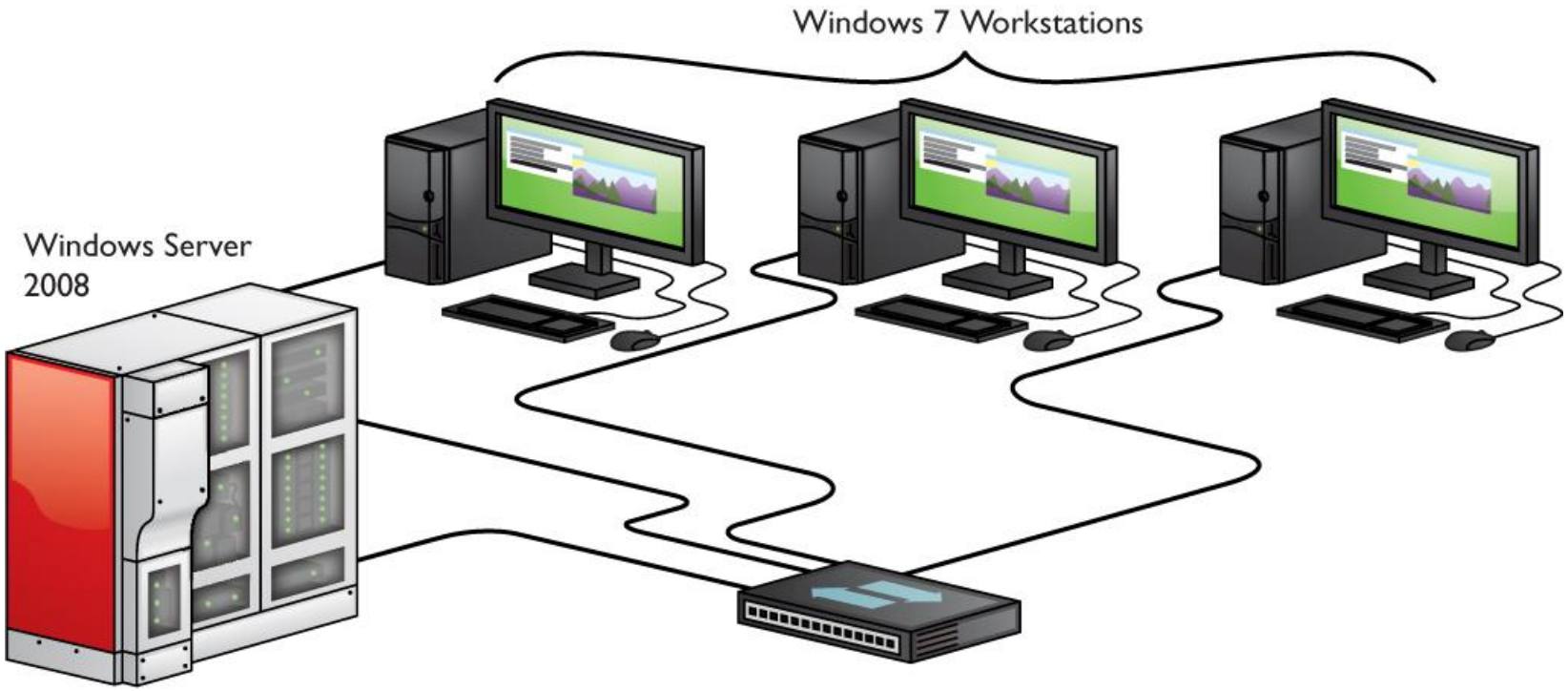


Figure 5: A typical network

Topology

- **Topology is the physical and logical design for the network to connect all of the computers together.**
- **The most common network topologies are called bus, ring, star, and mesh.**
  - In a bus topology, all computers connect to the network via a main line called a bus cable.
  - In a ring topology, all computers on the network attach to a central ring of cable.
  - A star topology has all of the computers on the network connecting to a central wiring point (usually called a switch).

Topology (*continued*)

- **Topologies (continued)**
  - A mesh topology connects each computer to every other computer via a dedicated line.
  - There are also hybrid topologies, such as star bus or star ring, which combine aspects of more than one topology.
- **Make a clear distinction between the logical and physical topology of a network.**
  - The logical topology is how the network is laid out on paper, with nice straight lines and boxes, similar to an electronic schematic.
  - The physical topology describes the actual physical layout of the computer network, with cables running diagonally through the ceiling space or snaking their way through walls.

Topology (*continued*)

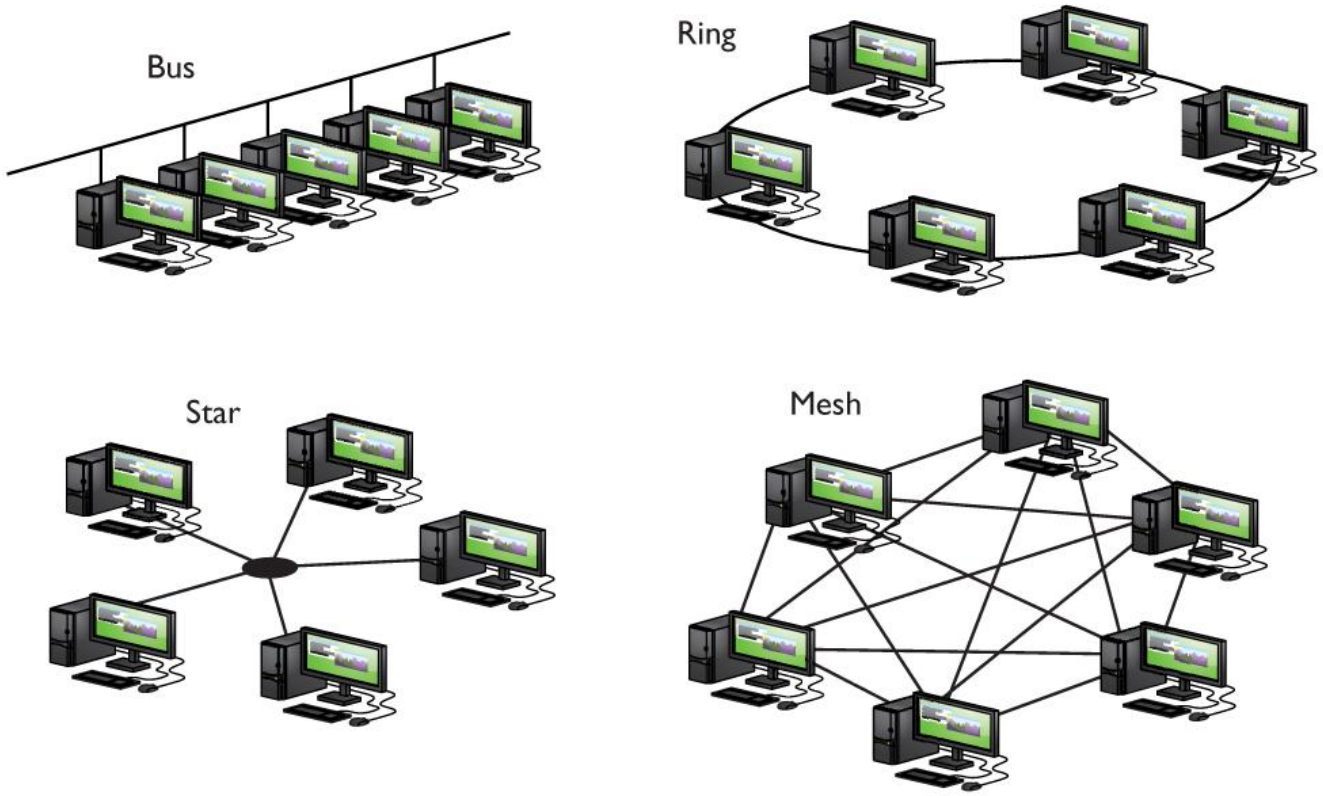


Figure 6: Clockwise from top left: bus, ring, mesh, and star topologies

Topology (*continued*)

- **A network technology:**
  - Is a practical application of a topology and other critical standards to provide a method to get data from one computer to another on a network.
  - Defines many aspects of a network, from the topology to the frame type, cabling, and connectors used—everything necessary to get data from one computer to another.

Frames and NICs

- **Data is moved from one PC to another in discrete chunks called *frames.***
- **All NICs have a built-in identifier:**
  - Binary address unique to that single network card, called a *media access control* (MAC) address
  - The MAC address is 48 bits long, providing more than 281 trillion MAC addresses.
  - MAC addresses are binary, but we represent them by using 12 hexadecimal characters.
  - MAC addresses are burned into every NIC, and some NIC makers print the MAC address on the card.

Frames and NICs (*continued*)

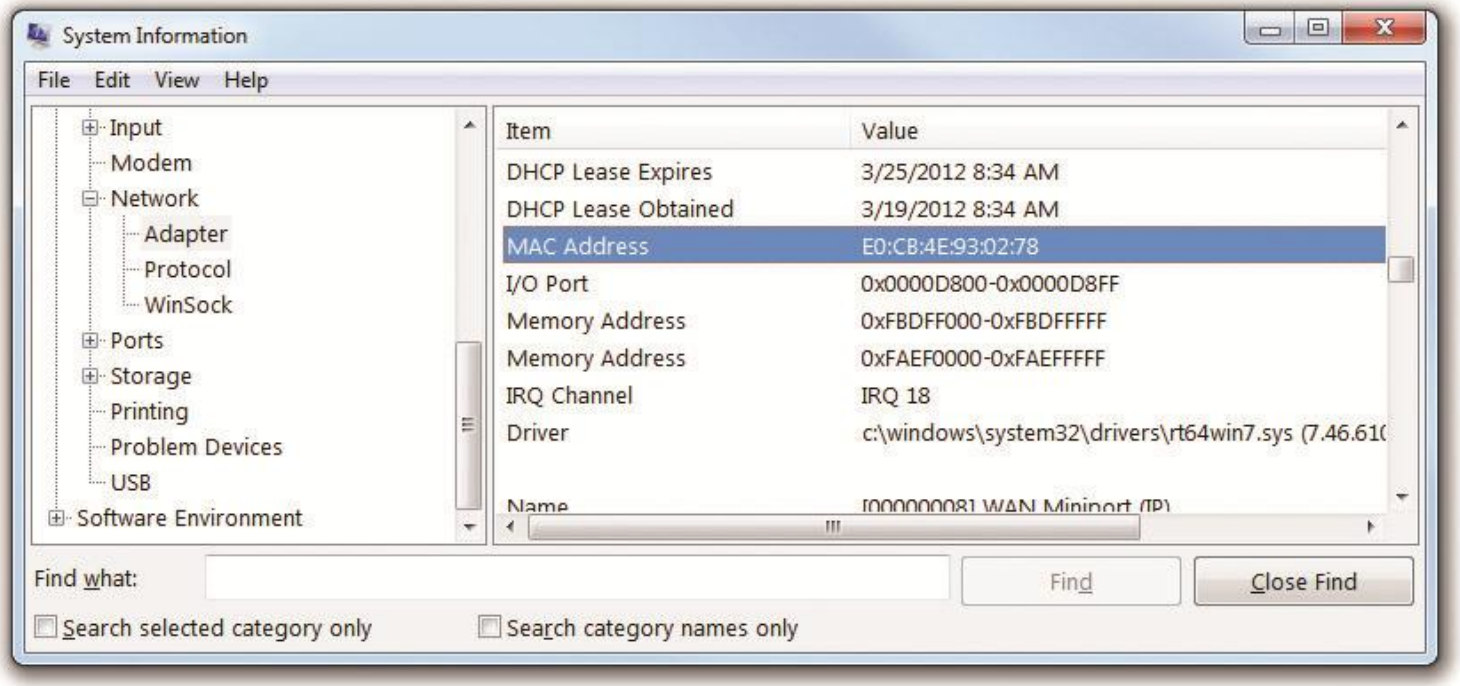


Figure 7: MAC address

Frames and NICs (*continued*)

- **Frames contain:**
  - The MAC address of the network card to which the data is being sent
  - The MAC address of the network card that sent the data
  - The data itself (varies in size depending on the type of frame)
  - A data check to verify that the data was received in good order—called a cyclic redundancy check (CRC)
- **Frames must match the type of cabling, connectors, and devices on the network that carries them.**

Frames and NICs (*continued*)

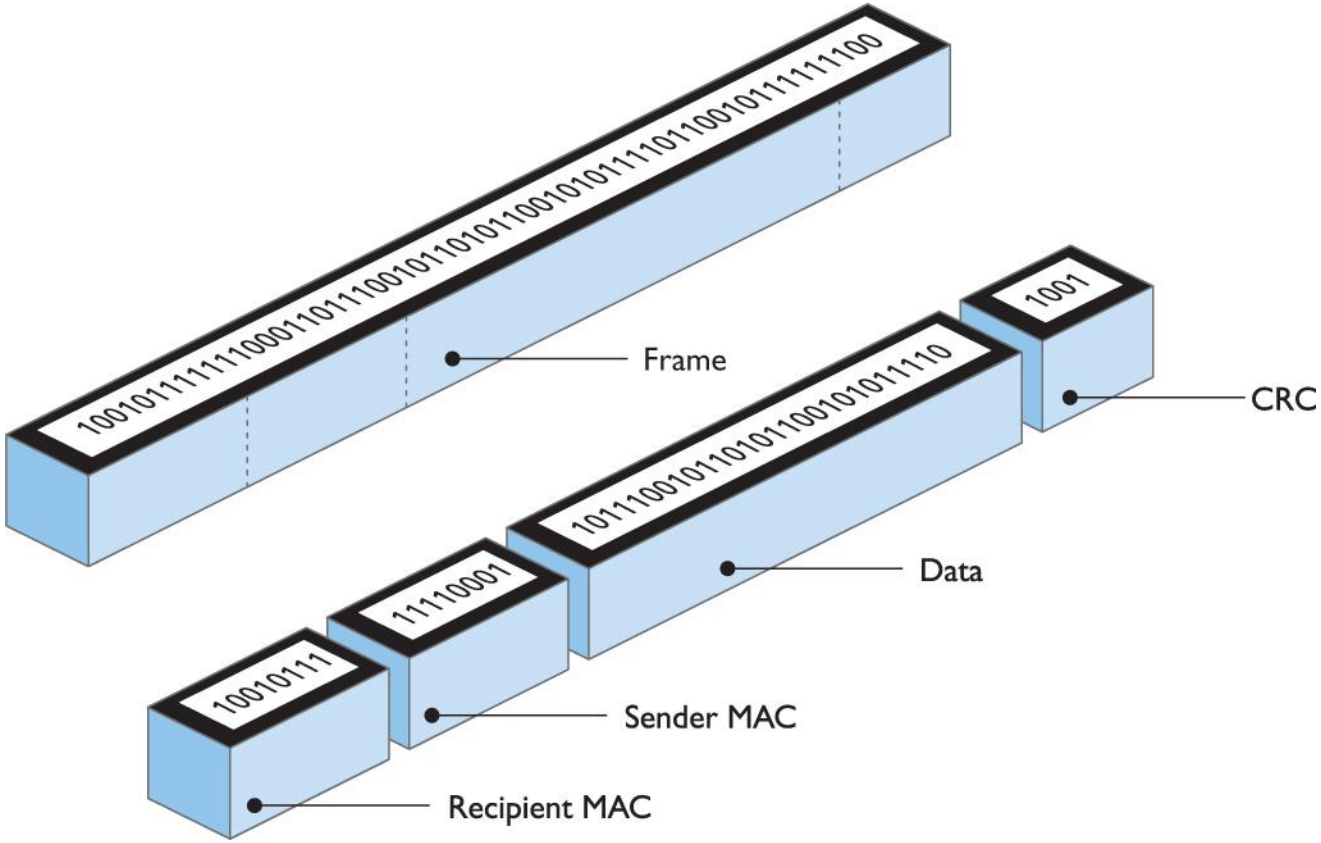


Figure 8: Generic frame

Introducing Ethernet

- **Digital Equipment, Intel, and Xerox**
  - Invented the first network in the mid-1970s and created what eventually became the Ethernet standard
- **Ethernet has gotten faster and used different types of cabling, resulting in sub-flavors of Ethernet—but ALL flavors use the same *frame type.***
  - All three use a star bus topology and usually connect via a type of cable called unshielded twisted pair (UTP).

Introducing Ethernet (*continued*)

- **Modern Ethernet networks all use star bus topology.**
  - Combines characteristics of both star and bus
  - Bus isn't actually a long cable—it's been shrunk down and put in the box
  - PCs connect via network ports on switch or hub
  - Hubs make all computers share a given bandwidth
  - Switches improve bandwidth—each PC on its own separate network
  - Connection between a computer and a switch is a segment—segments are limited to ~100 meters
  - Star bus network doesn't go down if a single cable breaks—but it does if the switch or hub breaks

Introducing Ethernet *(continued)*

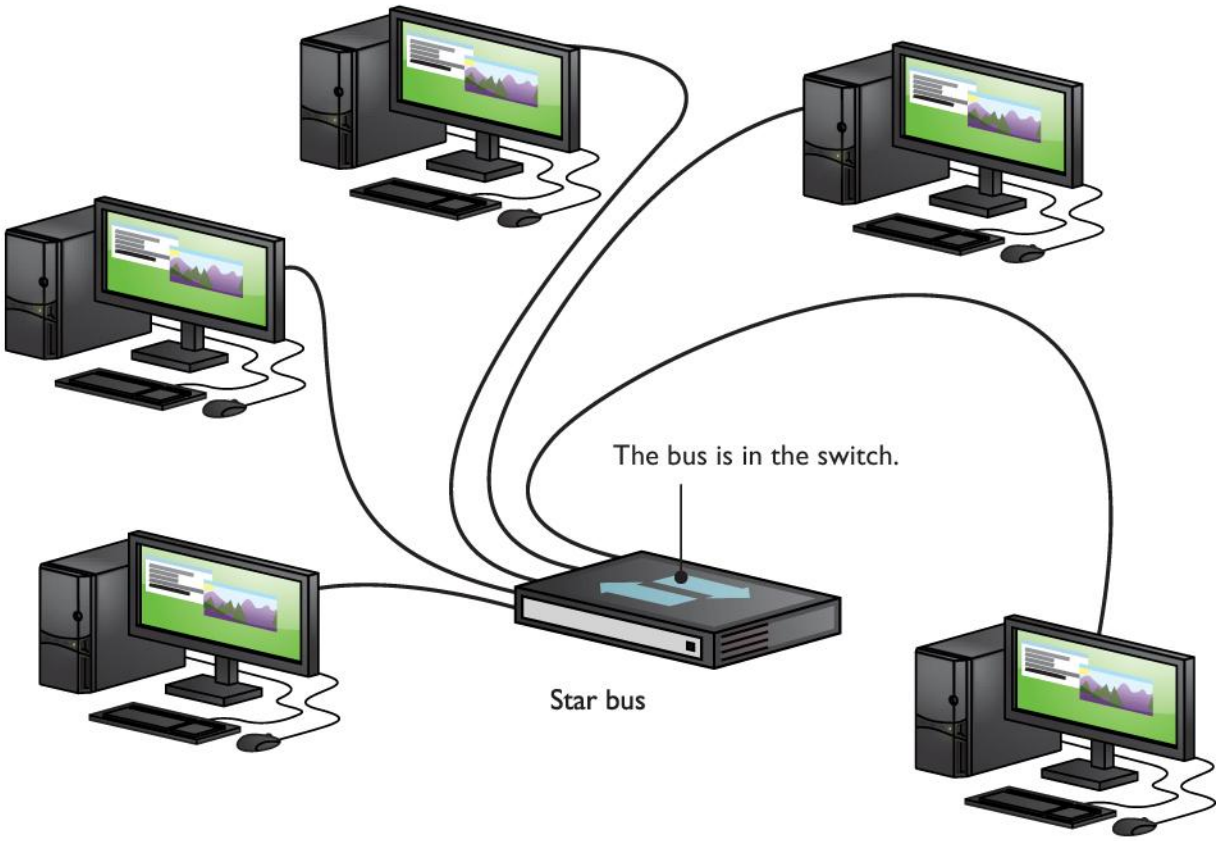


Figure 9: Star bus

Introducing Ethernet *(continued)*

Figure 10: A switch

Introducing Ethernet (*continued*)

- **Unshielded Twisted Pair**
  - Unshielded twisted pair (UTP)—specified cabling for 10/100/1000BaseT and the predominant cabling system used
  - Different types of twisted pair cabling are available for the needs of different networks.
  - Twisted pair is AWG 22–26-gauge wire twisted together into color-coded pairs. Each wire is individually insulated and encased as a group in a common jacket.
  - CAT Levels—UTP cables come in categories that define the maximum speed at which data can be transferred (also called bandwidth). Major categories include CAT 1, 3, 5. 5e, 6, and 6a.

Introducing Ethernet (*continued*)

- **UTP cables come in categories that define the maximum speed at which data can be transferred (bandwidth). The major categories (CATs) are as follows:**

CAT 1	Standard telephone line
CAT 3	Designed for 10-Mbps networks; a variant that used all four pairs of wires supported 100-Mbps speeds
CAT 5	Designed for 100-Mbps networks
CAT 5e	Enhanced to handle 1000-Mbps networks
CAT 6	Supports 1000-Mbps networks at 100-meter segments; 10-Gbps networks up to 55-meter segments
CAT 6a	Supports 10-Gbps networks at 100-meter segments

Introducing Ethernet (*continued*)

- **Unshielded Twisted Pair (continued)**
  - The Telecommunication Industry Association/Electronics Industries Alliance (TIA/EIA) establishes the UTP categories, which fall under the TIA/EIA 568 specification. Currently, most installers use CAT 5e or CAT 6 cable.
- **Shielded Twisted Pair (STP)**
  - Consists of twisted pairs of wires surrounded by shielding to protect them from EMI, or electromagnetic interference
  - Rare to see, used only in locations with excessive electronic noise or areas requiring very high security

Introducing Ethernet (*continued*)

Figure 11: Cable markings for CAT level

Introducing Ethernet (*continued*)

- **Implementing 10/100/1000BaseT**
  - The 10BaseT and 100BaseT standards require two pairs of wires: a pair for sending and a pair for receiving
  - 10BaseT ran on an ancient CAT version called CAT 3, but typically used at least CAT 5 cable
  - 100BaseT requires at least CAT 5 to run
  - 1000BaseT needs all four pairs of wires in a CAT 5e or CAT 6 cable
  - All of these cables use a connector called an RJ-45 connector. The RJ (registered jack) designation was invented by the phone company years ago and is still used today.

Introducing Ethernet (*continued*)

- **Implementing 10/100/1000BaseT (continued)**
  - Currently only two types of RJ connectors are used for networking: RJ-11 and RJ-45.
  - RJ-11, used for telephones, supports up to two pairs of wires; connectors are primarily used for telephone-based Internet connections and are not used in any common LAN installation.
  - RJ-45 is the standard for UTP connectors, has connections for up to four pairs, and is visibly much wider than RJ-11.

Introducing Ethernet (*continued*)

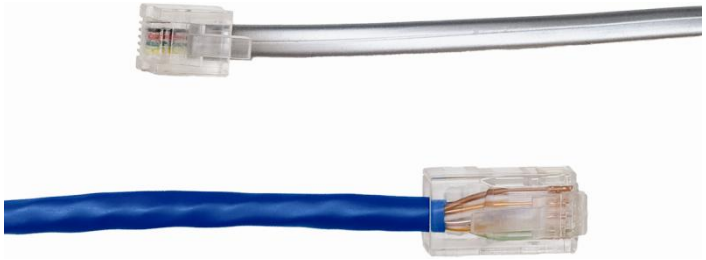


Figure 12: RJ-11 and RJ-45

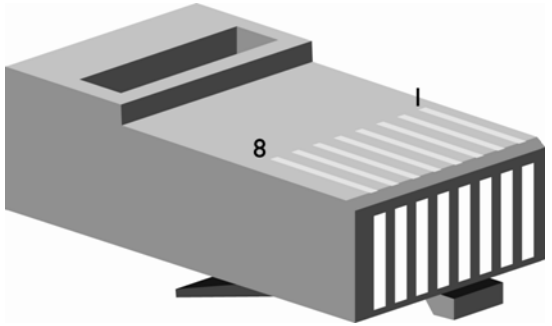


Figure 13: RJ-45 pin numbers

Introducing Ethernet (*continued*)

- **Implementing 10/100/1000BaseT (continued)**
  - The TIA/EIA has two standards for connecting the RJ-45 connector to the UTP cable: the TIA/EIA 568A (T568A) and the TIA/EIA 568B (T568B). Both are acceptable to use.
  - The wires in UTP are color-coded with a standardized color and match to a particular pin (1–8) in the connector. The TIA/EIA standards indicate which color is matched to each pin.

Introducing Ethernet (*continued*)

Pin	T568A	T568B	Pin	T568A	T568B
1	White/Green	White/Orange	5	White/Blue	White/Blue
2	Green	Orange	6	Orange	Green
3	White/Orange	White/Green	7	White/Brown	White/Brown
4	Blue	Blue	8	Brown	Brown

Table 1: UTP Cabling Color Chart

Network Protocols, LANs, and WANs

A Short History of the War of the Network Protocols and Why TCP/IP Won

- **Network Protocols**
  - Network protocols take the incoming data received by the network card, keep it organized, send it to the application that needs it, and then take outgoing data from the application and hand it to the NIC to be sent out over the network.
  - Network protocols take care of addressing, security, and other functions.
  - Protocols are combined into groups, called protocol stacks.

NetBIOS/NetBEUI

- **During the 1980s, IBM developed the NetBIOS Extended User Interface (NetBEUI), the default protocol for early versions of Windows.**
  - NetBEUI offered small size, easy configuration, and a relatively high speed
- **The underlying protocol stack was called NetBIOS/NetBEUI.**
  - NetBIOS protocol handled naming conventions, while NetBEUI chopped up data for delivery via frames.
  - NetBIOS names were very simple—nothing allowed except uppercase letters, numbers, and a few special characters

NetBIOS/NetBEUI (*continued*)

- **NetBIOS/NetBEUI was great for small networks but it relied on individual computers to send out frames addressed to the MAC address FF-FF-FF-FF-FF-FF—which meant everybody**
  - This is called a broadcast—broadcasts eat up bandwidth but are necessary for a node trying to get a MAC address for another node.
  - The larger the network, the more bandwidth broadcasts eat up.
  - By the mid-1980s, it was clear NetBIOS wasn't going to work for really large networks, so a new network protocol was developed.

NetBIOS/NetBEUI (*continued*)

Figure 14: A broadcast in action

LANs, Routing and WANs

- A local area network (LAN): a group of computers that are close to each other—almost always a group of computers that are able to hear each other when one of them sends a broadcast

- A group of computers (a LAN) that are connected by one or more switches is called a *broadcast domain*

LANs, Routing and WANs (*continued*)

Figure 15: Two broadcast domains—two separate LANs

LANs, Routing and WANs (*continued*)

- **A wide area network (WAN) is wide-spread groups of computers (LANs) connected using long-distance technologies. WANs are typically connected via one or more routers.**

- **LANs use broadcasting to send frames to their computers on the network, but the bigger the network, the more bandwidth is taken up by massive broadcasting.**

LANs, Routing and WANs (*continued*)

- **Routers separate LANs (broadcast domains) and do not typically forward broadcasts between two LANs—so a different addressing method was needed.**

- **NetBIOS/NetBEUI was great for a single LAN, but because it is broadcast-based it was not able to function across routers.**

LANs, Routing and WANs (*continued*)

Figure 16: Two broadcast domains connected by a router—a WAN

TCP/IP

- **TCP/IP—a suite of network protocols invented in 1983 that quickly became the de facto protocol suite for any computer connecting to the Internet**

IP Addresses and Subnet Masks

- **In a TCP/IP network, systems have IP addresses**
  - IP address is the unique identification number for your system on the network
  - Part of the address identifies the network, and part identifies the local computer (host) address on the network
  - IP addresses consist of four sets of eight binary numbers (octets) separated by a period
  - The octet numbers range from 0 to 255—this is called dotted-decimal notation

IP Addresses and Subnet Masks (*continued*)

- **IP addresses (*continued*)**
  - Every computer in the same broadcast domain will have a common network ID—computers having the same network IDs are said to be on the same network or LAN.
  - The subnet mask tells the computer what part of its IP address is the network ID.

Default Gateway

- **Default Gateway**
  - To talk to computers that are outside your network, you'll need to go through a router.
  - Routers are devices that have at least two IP addresses: one that connects to your LAN's switch and one that connects to the "next network."
  - The port on your router that connects to your LAN is given an IP address that's part of your network ID.
  - The IP address of the "LAN" side of your router (the port connected to your LAN) is the address your computer needs to send data to anything outside your network ID. This is called the *default gateway.*

Default Gateway (*continued*)

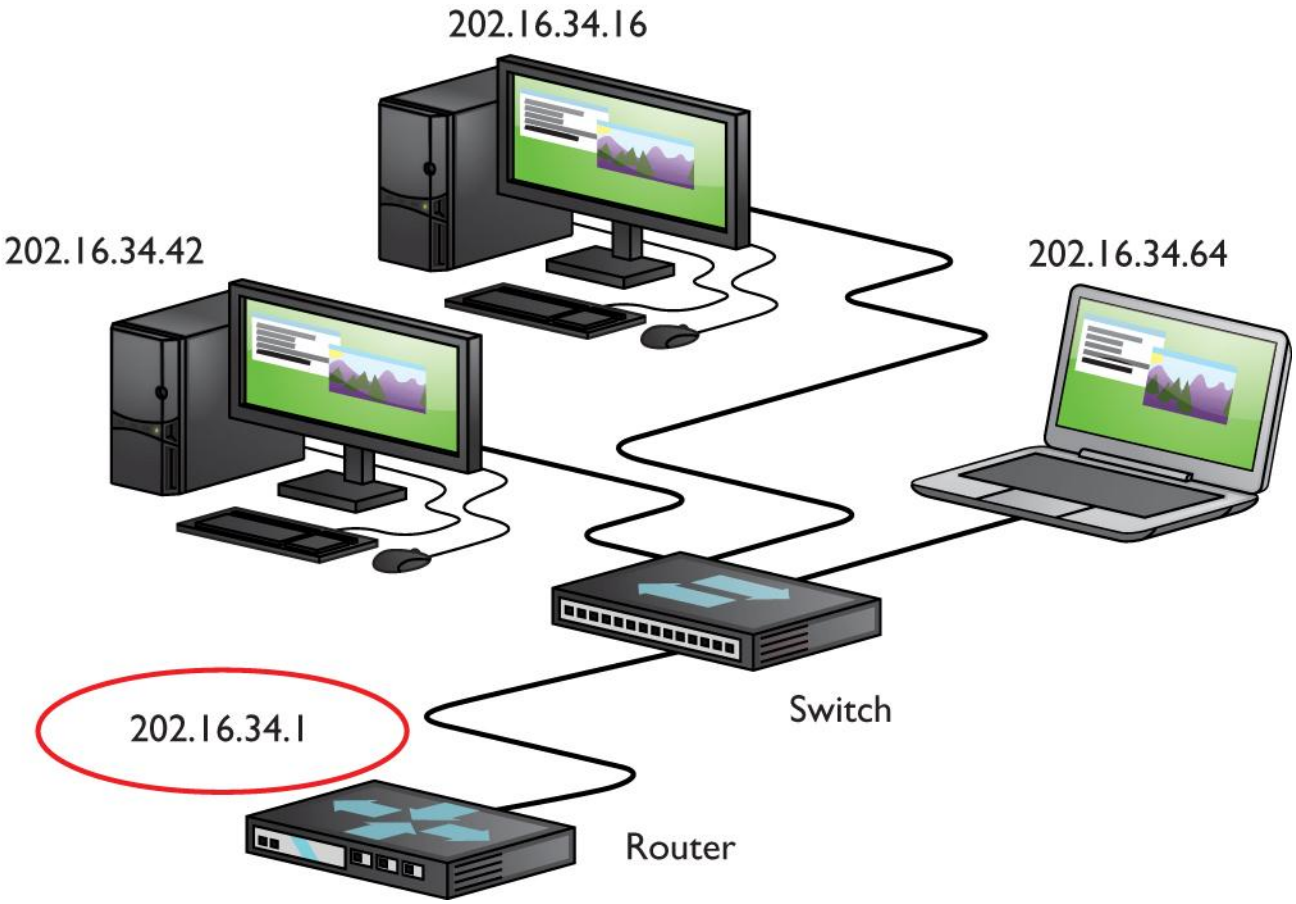


Figure 17: Default gateway

Domain Name Service

- **Domain Name Service (DNS)**
  - Method used to correlate IP addresses with more human-friendly designations
  - Special computers, called domain name service (DNS) servers, keep databases of IP addresses and their corresponding names.
  - When a domain name such as **www.totalsem.com** is used in an Internet browser, the computer queries the DNS server to get **www.totalsem.com**'s IP address and use that to find the right machine.

Domain Name Service (*continued*)

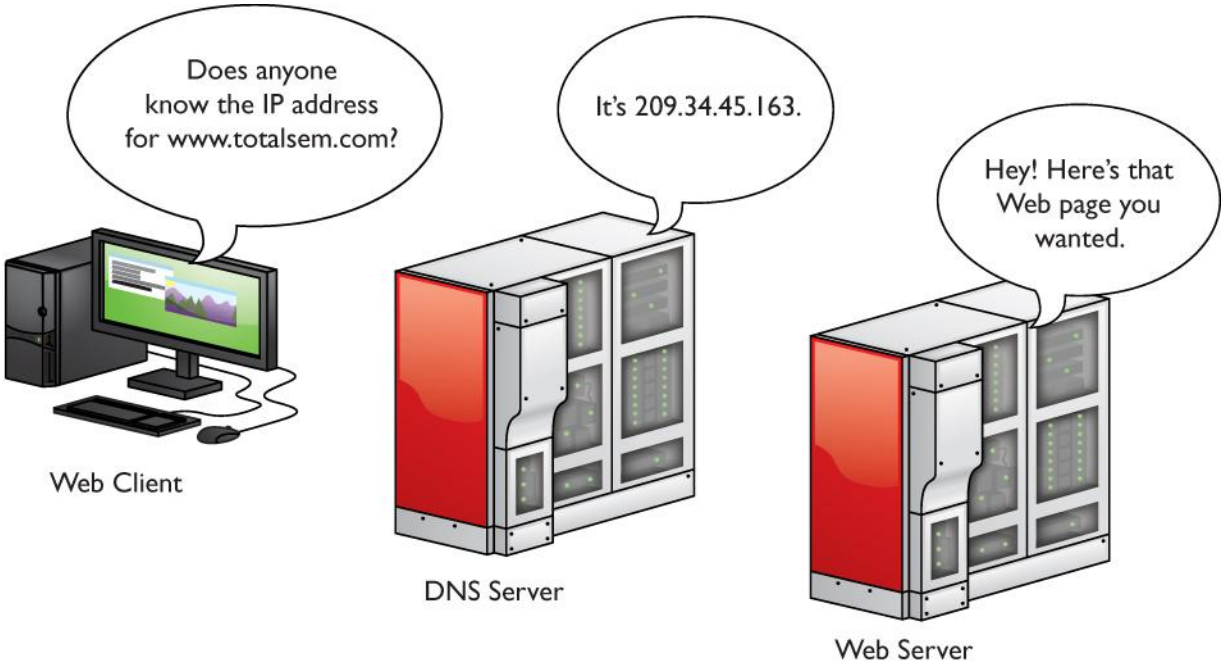


Figure 18: Domain name service

Domain Name Service (*continued*)

- **The Internet has regulated domain names and domain name qualifiers**
  - Called top level domains (TLDs)
  - New TLDs are added occasionally to keep up with the changing Internet
- **The Internet Corporation for Assigned Names and Numbers (ICANN) regulates the TLDs**

Domain Name Service (*continued*)

- **Originally, DNS names all ended with one of the following seven domain name qualifiers, called top level domains (TLDs):**

.com	General business	**.org**	Nonprofit organizations
.edu	Educational organizations	**.gov**	Government organizations
.mil	Military organizations	**.net**	Internet organizations
.int	International		

Entering the IP Information

- **To configure a computer to connect to a network, you must enter:**
  - The IP address, the subnet mask, default gateway, and at least one DNS server
  - IP address: Your computer's unique address on the network
  - Subnet mask: Identifies your network ID
  - Default gateway: IP address or the LAN side of your router
  - DNS server: Tracks easy-to-remember DNS names for IP addresses
  - Each version of Windows configures the IP address differently

Entering the IP Information (*continued*)

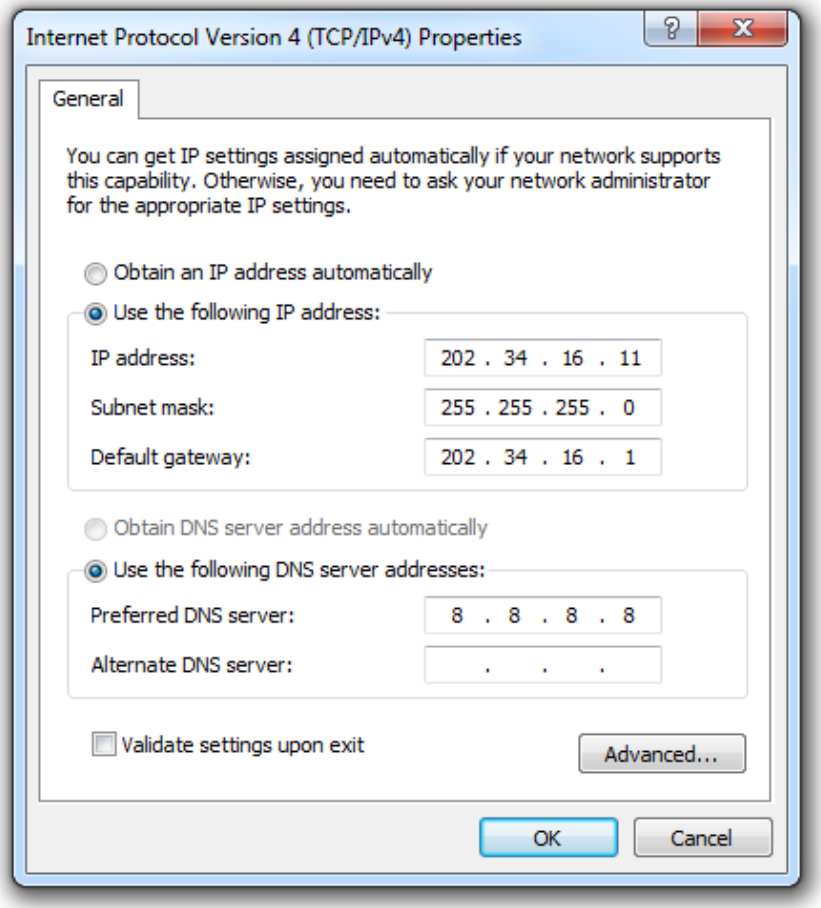


Figure 19: IP settings on a Windows 7 system

Dynamic Host Configuration Protocol (DHCP)

- **If DHCP is running on your network:**
  - Your computer must be configured to obtain an IP address automatically.
  - Your computer boots up and will broadcast a DHCP request.
  - The DHCP server provides your computer with all the IP information it needs to get on the network.
  - Manual IP address configuration is unnecessary.

Dynamic Host Configuration Protocol (DHCP)(*continued*)

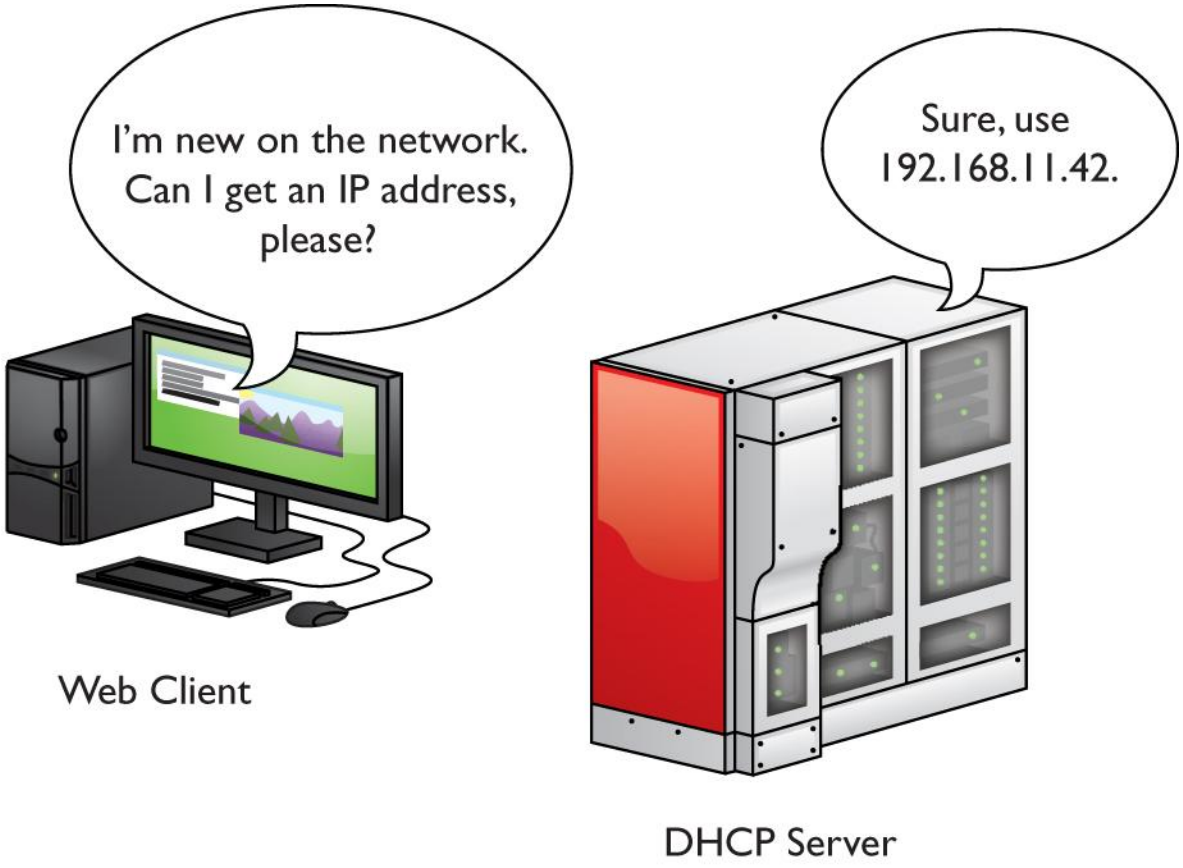


Figure 20: Dynamic Host Control Protocol

Network Organization

Workgroups

- Workgroups are the most basic and simplistic of the three network organizations.
- Default for almost every fresh installation of Windows (with default name of WORKGROUP)
- Every computer on the network needs the same workgroup name to be able to share resources—use default of WORKGROUP or easily change it.

Workgroups (*continued*)

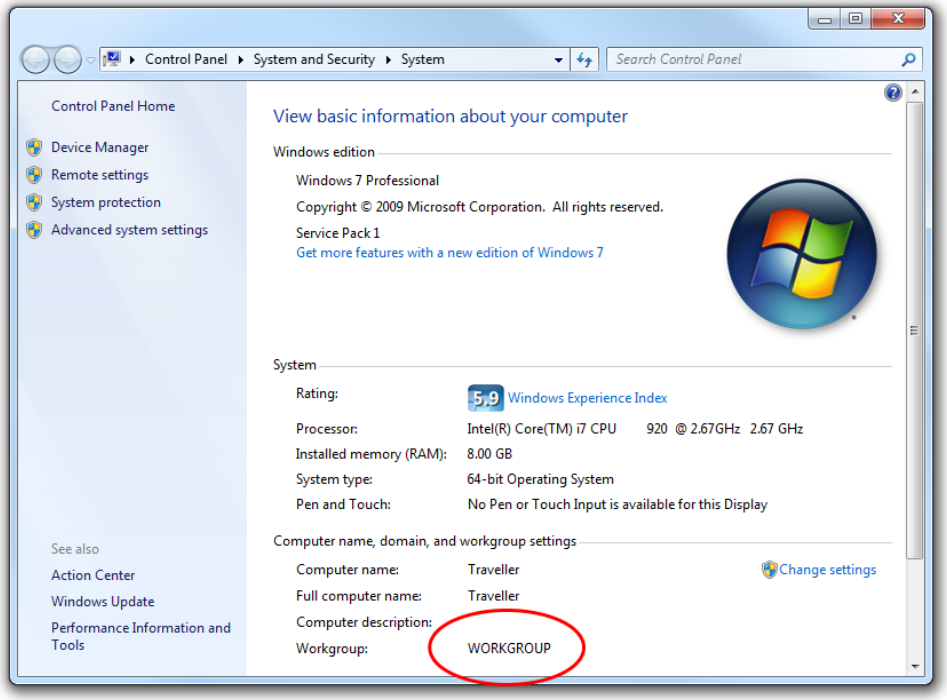


Figure 21: Default Workgroup

Workgroups (*continued*)

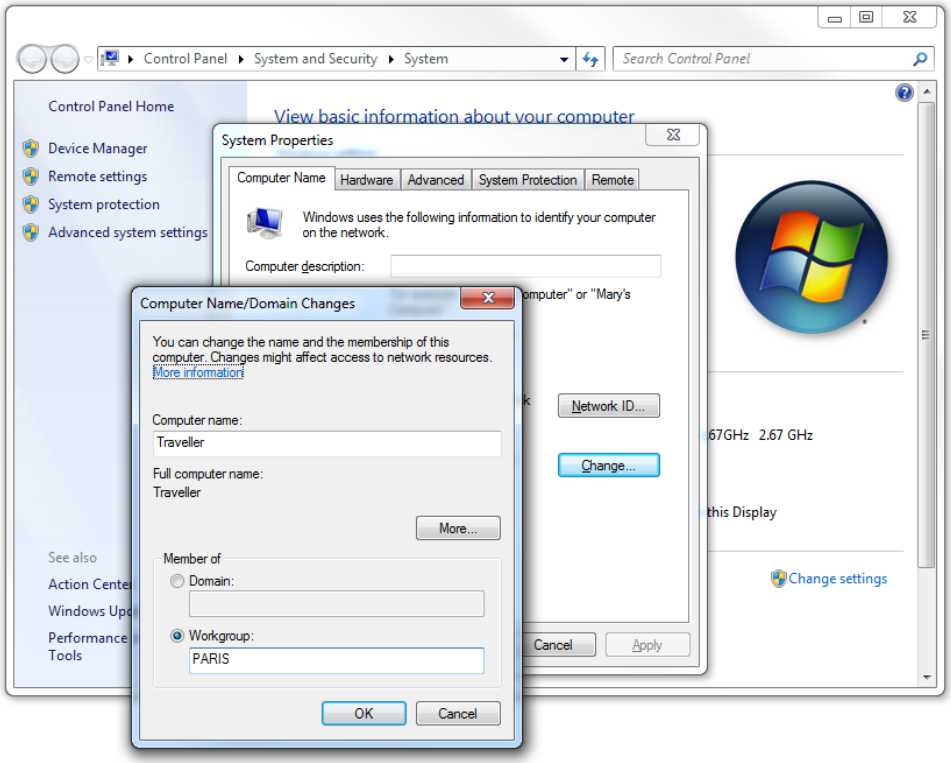


Figure 22: Changing the workgroup in advanced settings

Workgroups (*continued*)

- **Workgroups lack centralized control over the network—all systems connected to the network are equals**
- **Works well for smaller networks because there are fewer users, connections, and security concerns**

Workgroups (*continued*)

- **Usernames and passwords are stored on computer**
  - Unique to that computer—won't work on others
  - Useful to use and understand this nomenclature: COMPUTER\USERNAME (Example: MYPC1\Bobby)
- **Shared folders and files grant access based on the local computer's user accounts only in a workgroup**
  - People logging on from another computer in the workgroup across the network need a username and password—but it has to be an account on the other computer

Workgroups (*continued*)

Figure 23: Windows 7 logon screen

Workgroups (*continued*)

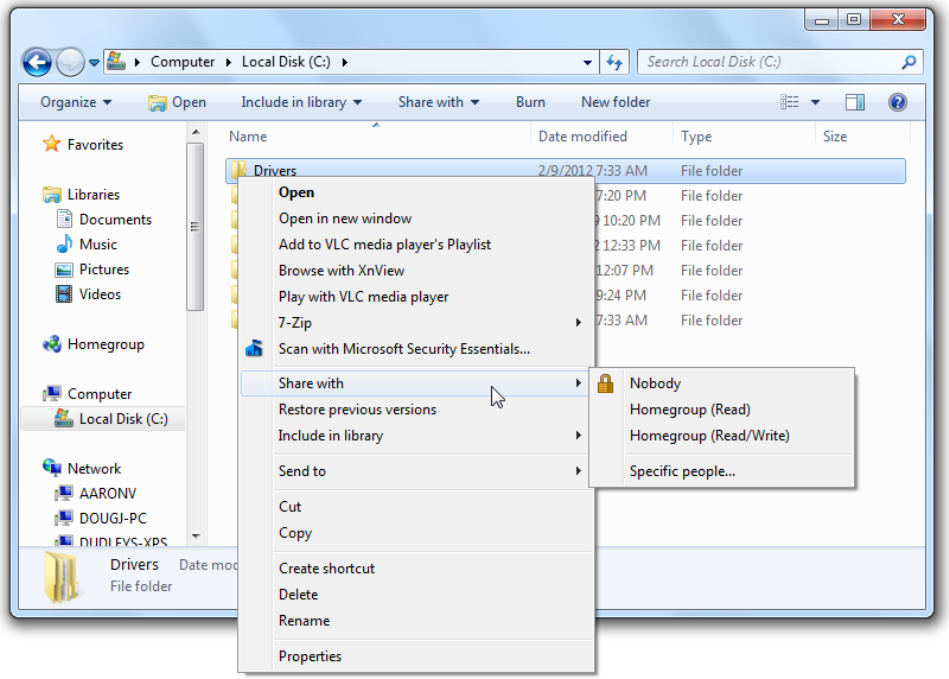


Figure 24: Folder sharing box

Workgroups (*continued*)

- **Three options to enable resource access in a workgroup:**
  - You can make people log on using another user account on the computer that has the shares
  - You can create the same accounts (same user name and same password) on all the computers and give sharing permissions to all the users for all the shares
  - You can use one account on all computers. Everyone logs on with the same account and then all shares are by default assigned to the same account

Workgroups (*continued*)

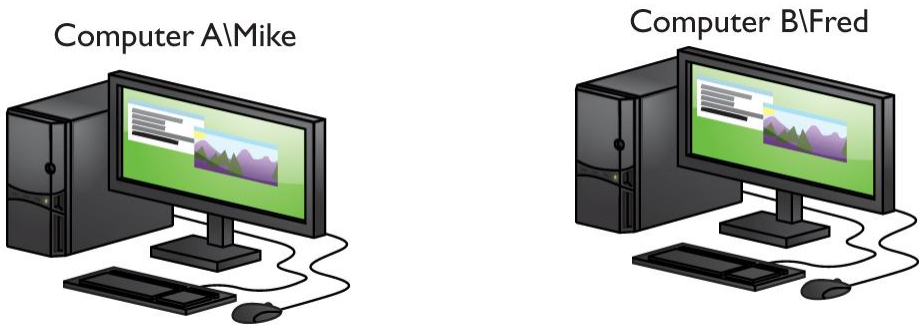


Figure 25: Computers A and B

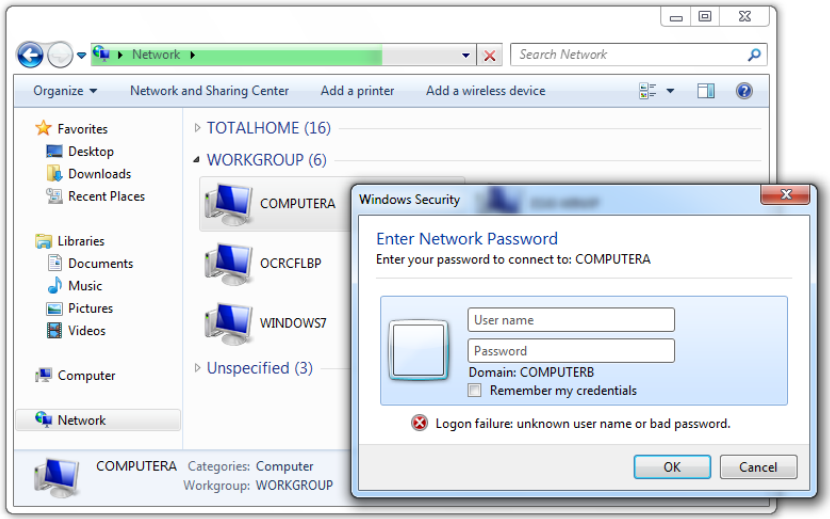


Figure 26: Enter Logon Name

Domains

- Larger networks that need more control use *domains*
- Domains offer centralized security and control, unlike workgroups
- Domains require a specific server to control access to the network's resources
- Domains make it possible to track each user, each resource, and what each user can do to each resource

Domains (*continued*)

- **Domains require a computer running a version of Windows Server**
  - Current versions include Windows Server 2008 and Windows Server 2008 R2
  - Windows Server 2003 can also implement domains
- **Systems running the Windows Server products are called domain controllers (DC)**
  - User accounts are called domain accounts and reside on the domain controllers instead of local PCs
  - Computers on the network must join a domain to access domain resources

Domains (*continued*)

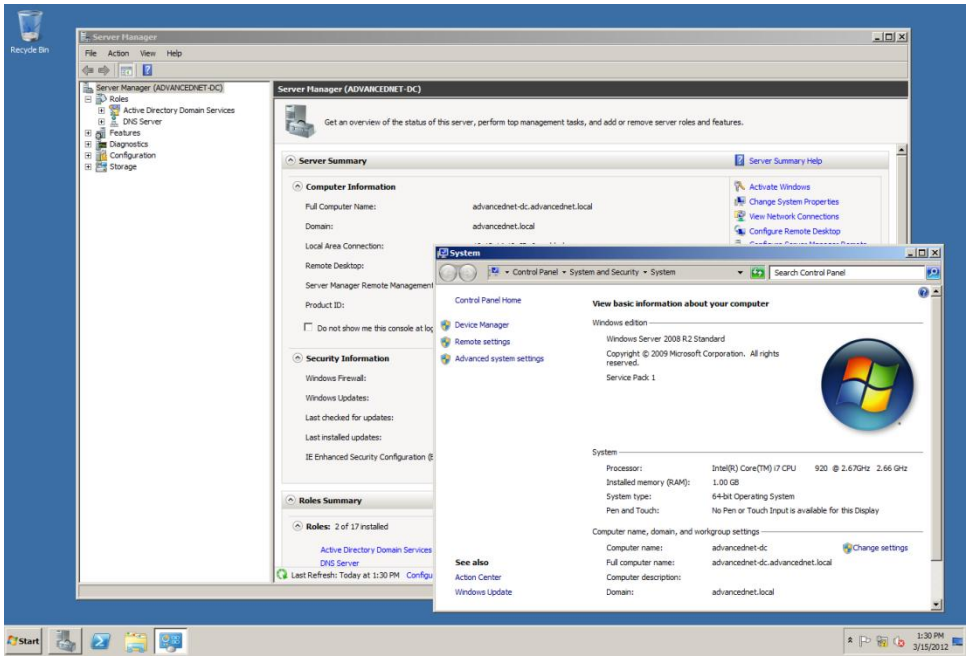


Figure 27: Windows Server

Domains (*continued*)

- **When logging on to a domain, Windows prompts for a username instead of showing all of the domain users on the network**
  - Can use the <domain>\<domain user name> format to logon if needed
  - One of the key features of domains the ability to log on to any computer on the domain using the same domain account (called single sign-on); no local computer accounts are needed

Domains (*continued*)

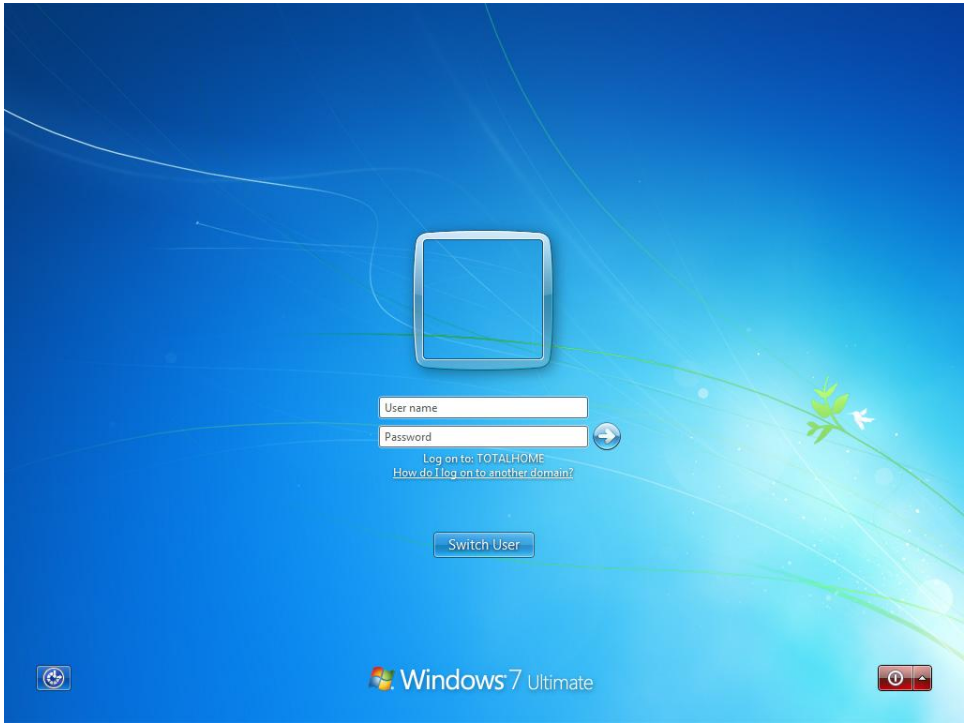


Figure 28: Domain logon screen

Domains (*continued*)

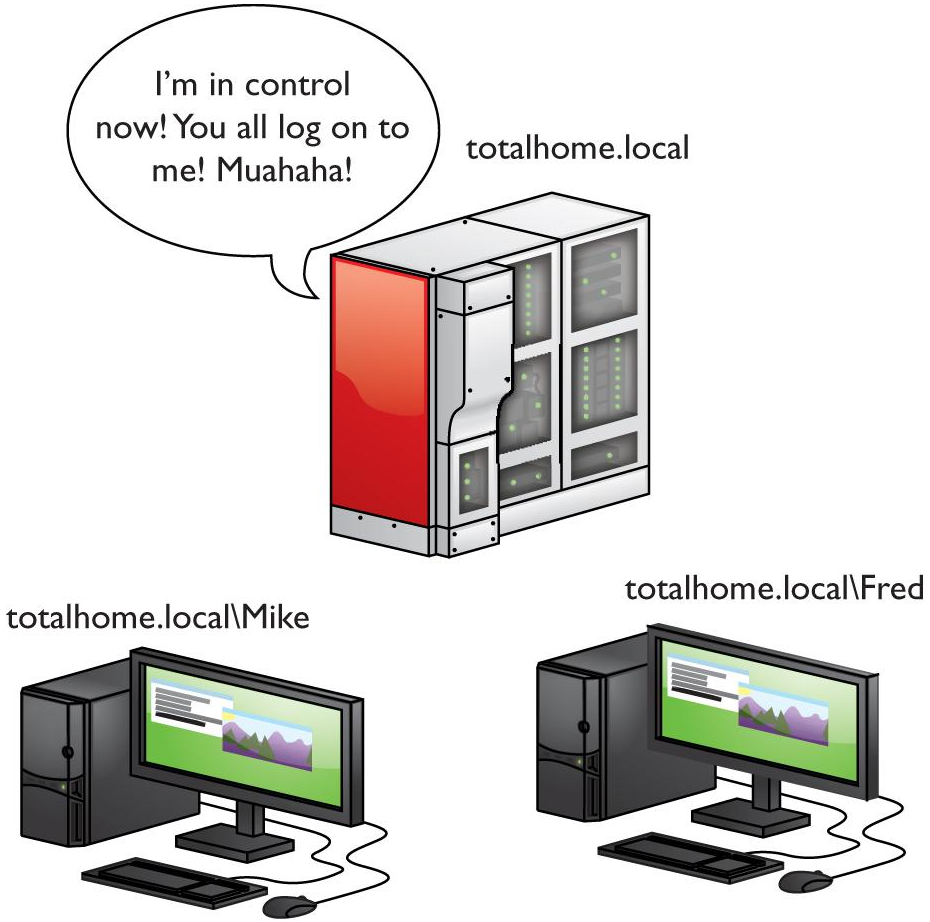


Figure 29: Domain network

Homegroups

- HomeGroup uses the idea that people want to connect data, not folders.
- Microsoft introduced a new feature in Windows 7 called HomeGroup.
- Homegroups skip folders and share your Windows 7 libraries by default.

Homegroups (*continued*)

Figure 30: Default HomeGroup dialog box

Homegroups (*continued*)

- **A homegroup connects a group of computers using a common password—no special user names required**
- **Each computer can be a member of only one homegroup at a time**
- **To make a homegroup, open the HomeGroup Control Panel applet**
  - Five default options: Pictures, Music, Videos, Documents, and Printers
  - All homegroup data is encrypted between systems

Homegroups (*continued*)

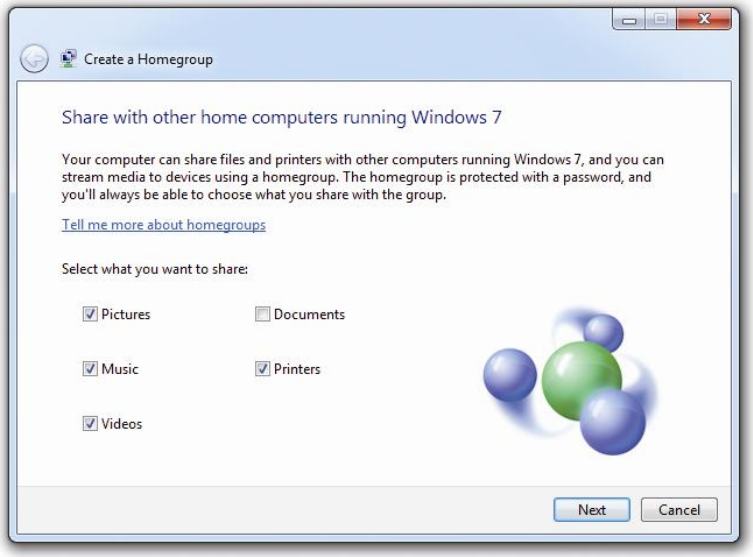


Figure 31: Create a Homegroup dialog box

Homegroups (*continued*)

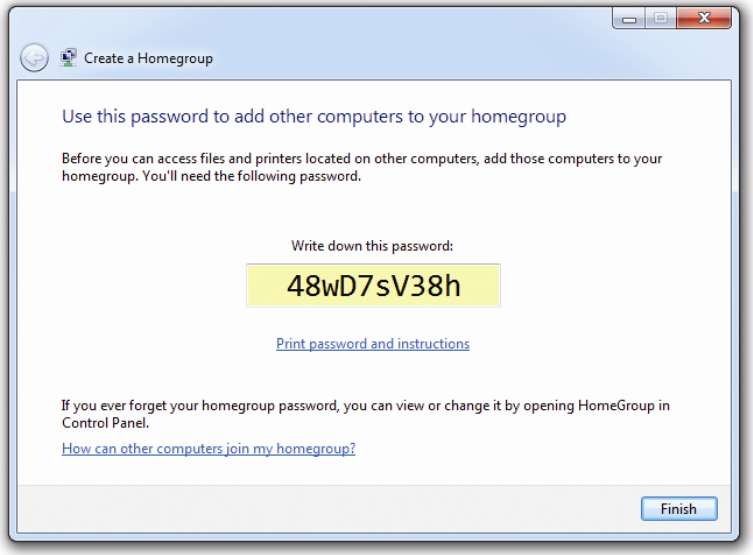


Figure 32: The homegroup's password

Homegroups (*continued*)

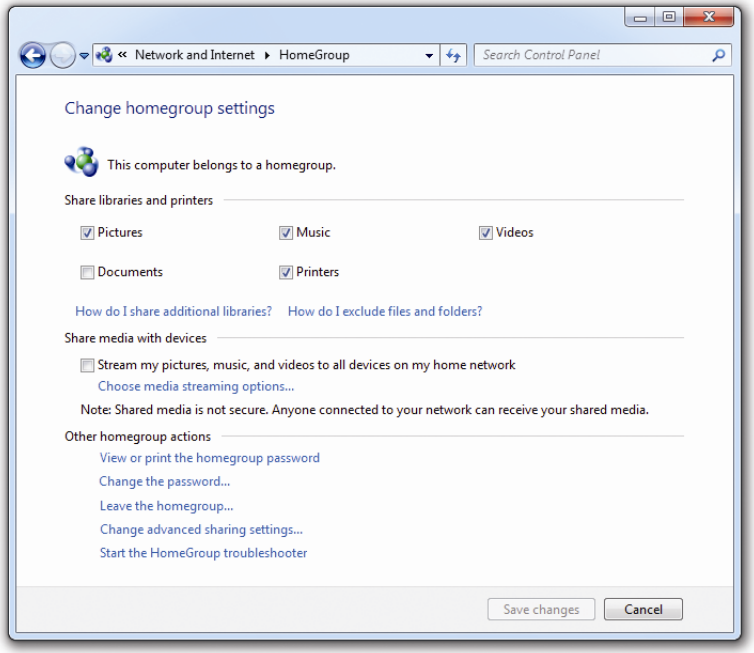


Figure 33: Homegroup configured

Homegroups (*continued*)

Figure 34: HomeGroup showing an existing homegroup

Homegroups (*continued*)

- **Sharing additional libraries or even folders is done by right-clicking on an item after homegroup is set up**
  - Four options to share with: Nobody (the item is not shared), Homegroup (Read), Homegroup (Read/Write), and Specific people

Homegroups (*continued*)

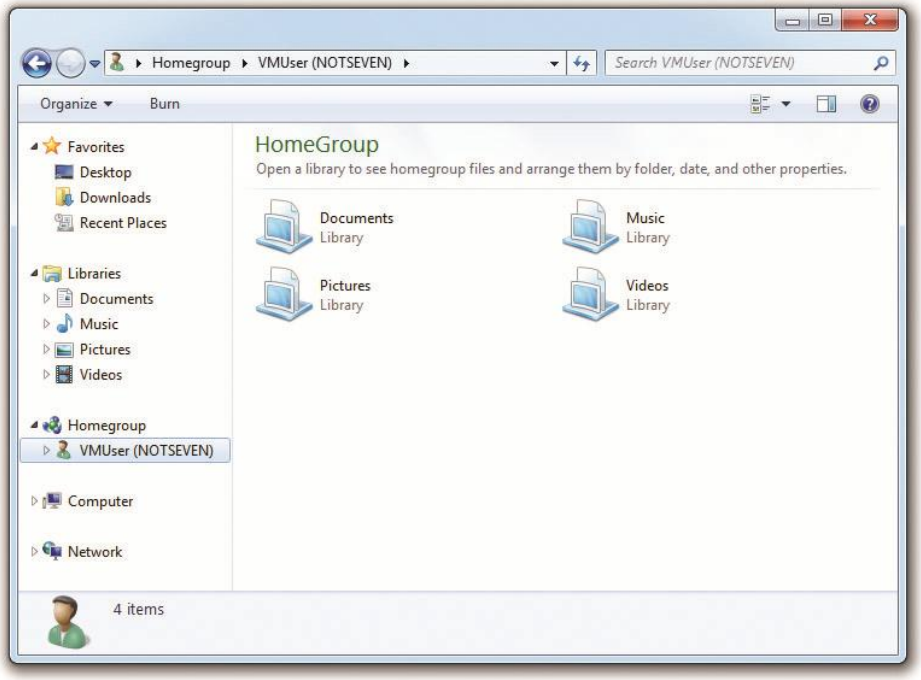


Figure 35: Using homegroups

Homegroups (*continued*)

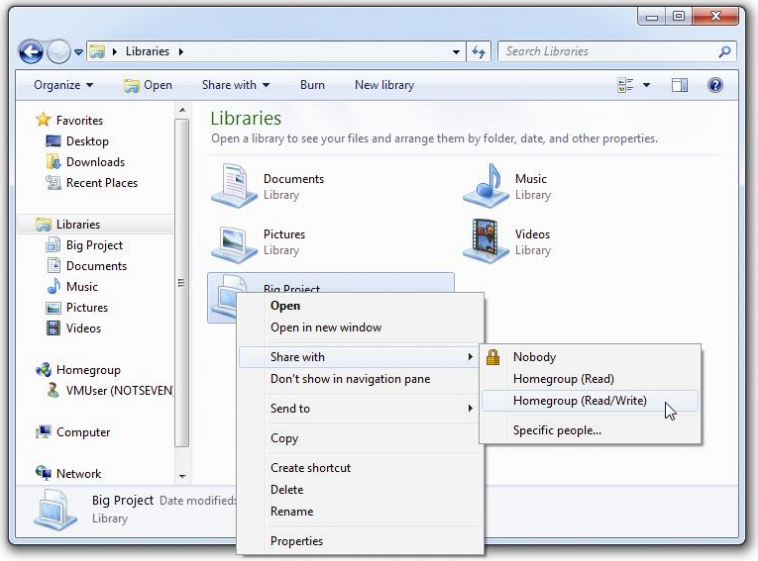


Figure 36: The Share with menu