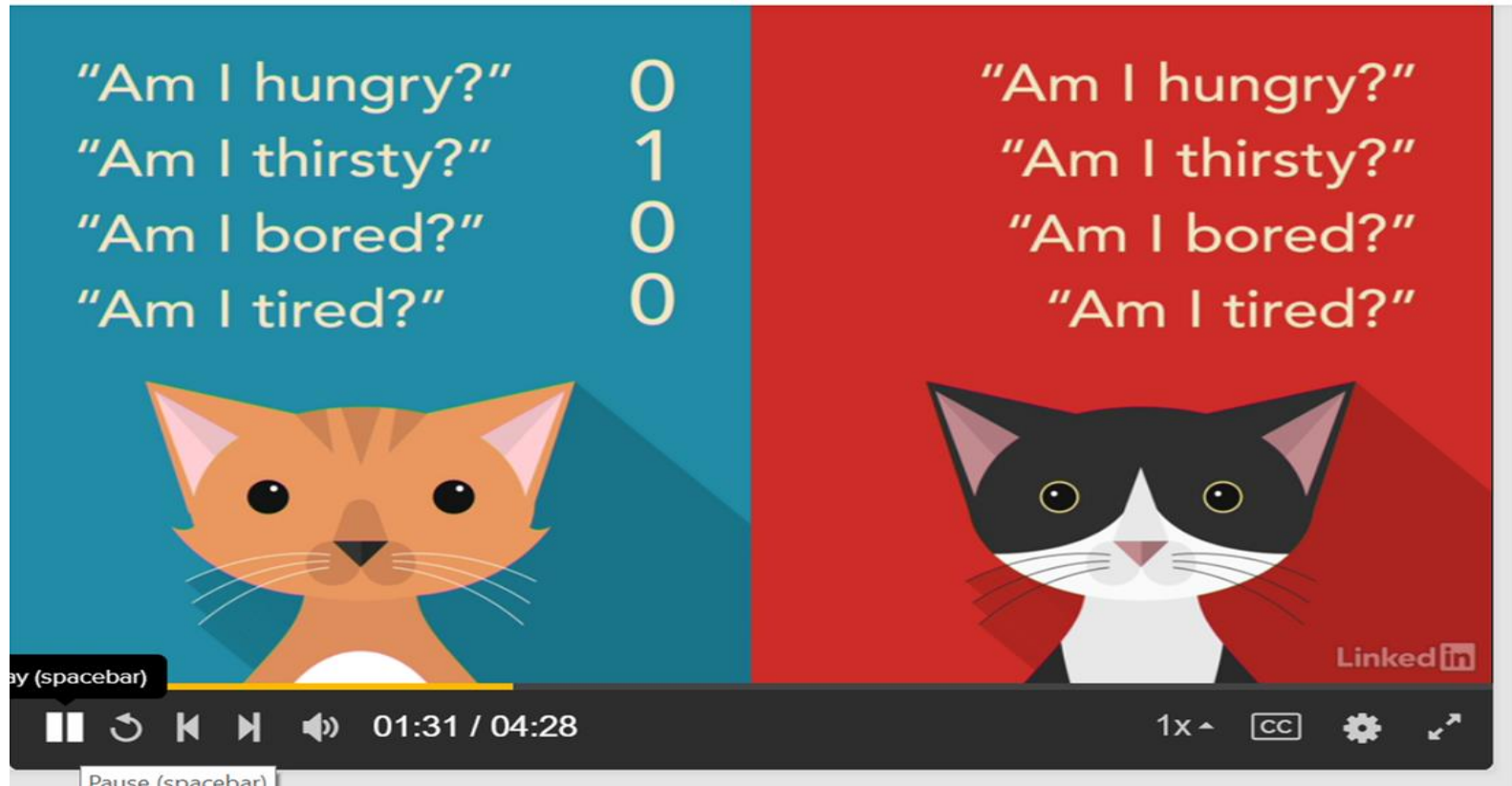


TOPIC 03 Introduction to Computer Networks

Communicate with bits



kbps

In data communications, a Kilobit is one thousand bits.

*It is used to measure the amount of data transferred per second. Kilobits per second is shortened to kb/s, **Kbps** or **kbps** (as opposed to **KBps**, which is Kilobytes per second. Note the capitalization).*

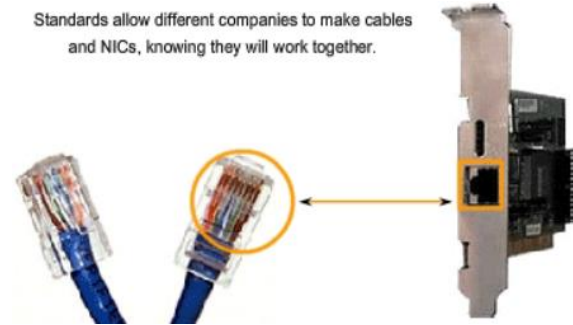
The lowercase b is commonly used to denote bits, while the uppercase B is used for bytes.

1 kb/s = 1000 bits per second

1 KB/s = 1024 bytes per second

Network Components

Standards allow different companies to make cables and NICs, knowing they will work together.



- Hardware components needed
 - *Network interface card*—an add-on card plugged into a motherboard expansion slot that provides a connection between the computer and the network
 - *Network medium*—A cable that plugs into the NIC and makes the connection between a computer and the rest of the network
 - Network media can also be the air waves, as in wireless networks
 - *Interconnecting device*—allow two or more computers to communicate on the network without having to be connected directly to one another

Network Components

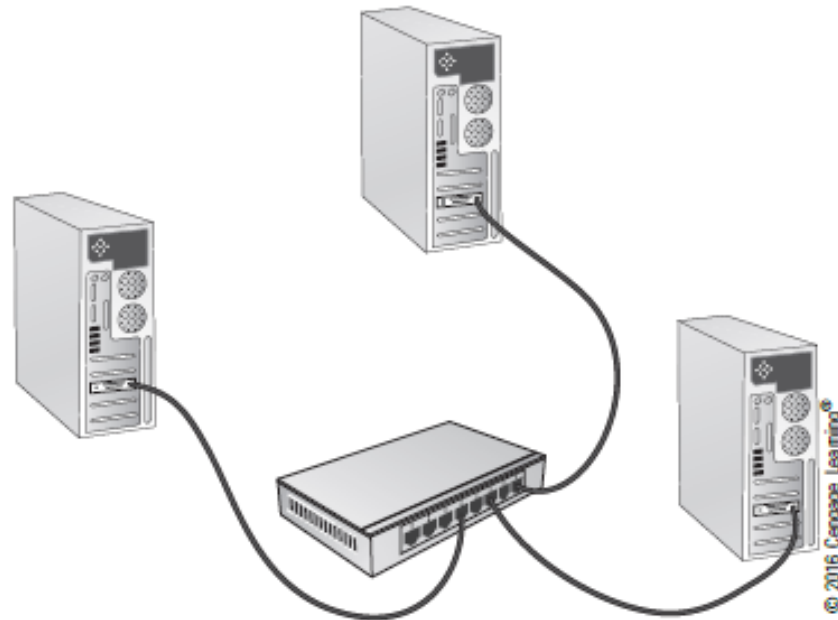


Figure 1-5 A network of computers connected to a switch

Network Components

- Software Components
 - *Network clients and servers*
 - **Network client software** requests information stored on another network computer or device (e.g. Chrome web browser)
 - **Network server software** allows a computer to share its resources (e.g. Apache web server)
 - *Protocols*—define the rules and formats a computer must use when sending information across the network (e.g. TCP/IP protocol stack)
 - *NIC driver*—receives data from protocols and forwards this data to the physical NIC

Steps of Network Communication

- 1. Application tries to access a network resource by sending a message
- 2. Client software formats the message and passes the message on to the network protocol
- 3. Protocol packages the message in a format suitable for the network and sends it to the NIC driver
- 4. NIC driver sends data in the request to the NIC card to be converted into necessary signals to be transmitted on the network

Layers of the Network Communication Process

Step	Description	Layer
1	An application tries to access a network resource.	User application
2	Client software detects the attempt to access the network and passes the message on to the network protocol.	Network software
3	The protocol packages the message in a format suitable for the network and sends it to the NIC driver.	Network protocol
4	The NIC driver sends the data in the request to the NIC card, which converts it into the necessary signals to be transmitted across the network medium.	Network interface

Layers of the Network Communication Process

- Each step required for a client to access network resources is referred to as a “layer”
- Each layer has a task and all layers work together

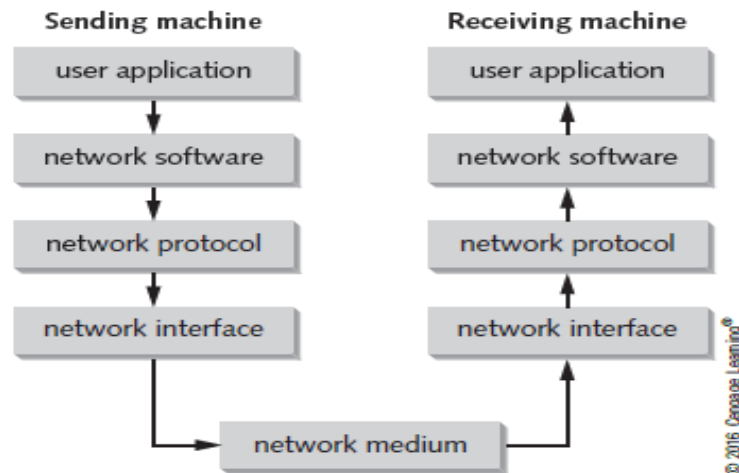


Figure 1-6 Layers of the network communication process

Layers of the Network Communication Process

Table 1-3 Layers of the network communication process

Step	Description	Layer
1	An application tries to access a network resource.	User application
2	Client software detects the attempt to access the network and passes the message on to the network protocol.	Network client or server software
3	The protocol packages the message in a format suitable for the network and sends it to the NIC driver.	Network protocol
4	The NIC driver sends the data in the request to the NIC, which converts it into the necessary signals to be transmitted across the network medium.	Network interface

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How Two Computers Communicate on a LAN: Some Details

- TCP/IP is the most common protocol (language) used on networks
- TCP/IP uses 2 addresses to identify devices
 - Logical address (IP address) **192.168.1.41**
 - Physical address (MAC address) **24-77-03-FA-24-D0**
- Just as a mail person needs an address to deliver mail, TCP/IP needs an address in order to deliver data to the correct device on a network
- Think of the Logical address as *your name* and the Physical address as your *postal address*

CIDR IP address

[Online tools](#)

CIDR Range	192.168.1.0/24
Netmask	255.255.255.0
Wildcard Bits	0.0.0.255
First IP	192.168.1.0
Last IP	192.168.1.255
Total Host	256

RESERVED IP ADDRESS	
192.168.1.0	subnet
192.168.1.255	broadcast
256-2=254	Total usable hosts

broadcast IP address:

192.168.1.255/24

Broadcast addressing was designed to facilitate message broadcasting for all network devices.

The following is a broadcast addressing analogy:

A teacher is preparing to announce the winner of a student competition and can use either of the following approaches: (1) The teacher could stop by each student's desk and discreetly reveal the winner's name, or (2) The teacher could announce the winner's name to the class and then ask the winner to stand for recognition. The second option, which is more efficient, is broadcast addressing in the real world.

How Two Computers Communicate on a LAN: Some Details

1. A user at Comp A types ping 10.1.1.2 at a command prompt
2. Network software creates a ping message
3. The network protocol packages the message by adding IP address of sending and destination computers and acquires the destination computer's MAC address
4. The network interface software adds MAC addresses of sending and destination computers
5. Comp B receives message, verifies that the addresses are correct and then sends a reply to Comp A using Steps 2 – 4

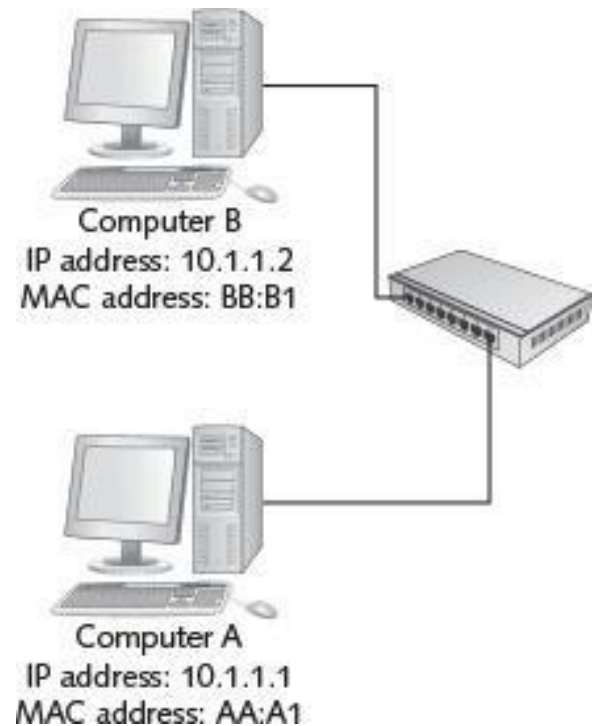


Figure 1-7 Communication between two computers

How Two Computers Communicate on a LAN: Some Details

Table 1-4 Saving a file with the network communication process

Step	Description	Layer
1	The user on ClientA clicks Save in the word-processing program and chooses a shared folder on ServerX to save the file.	User application
2	Client for Microsoft Networks detects the attempt to access the network, formats the message, and passes the message to the network protocol.	Network software
3	The network protocol (in this case, TCP/IPv4) packages the message in a format suitable for the network interface and sends it to the NIC driver.	Network protocol
4	The NIC driver sends the data in the request to the NIC (in this case, Ethernet0), which converts it into signals to be transmitted across the network medium.	Network interface
5	ServerX's NIC receives the message from the network medium, processes it, and sends the data to TCP/IPv4.	Network interface
6	TCP/IPv4 on ServerX receives the message from the NIC, processes it, and sends the data to the network software (in this case, File and Printer Sharing for Microsoft Networks).	Network protocol
7	File and Printer Sharing for Microsoft Networks formats the message and requests that the OS save the file to the disk.	Network software

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Network Terms Explained

- Every profession has its own language and acronyms
- It is essential to know the language of networks to be able to study them

LANs, Internetworks, WANs, and MANs

- Local area network (LAN) – small network, limited to a single collection of machines and connected by one or more interconnecting devices in a small geographic area

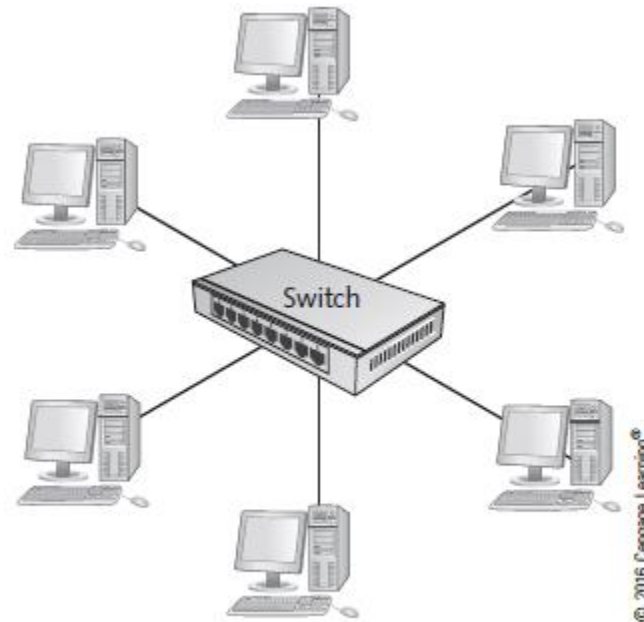


Figure 1-13 A LAN with computers interconnected by a switch

LANs, Internetworks, WANs, and MANs

- Wireless LAN



Figure 1-14 A wireless LAN

LANs, Internetworks, WANs, and MANs

- An **internetwork** is a networked collection of LANs tied together by devices such as routers
- Reasons for creation:
 - Two or more groups of users and their computers need to be logically separated but still need to communicate
 - Number of computers in a single LAN has grown and is no longer efficient
 - The distance between two groups of computers exceeds the capabilities of most LAN devices

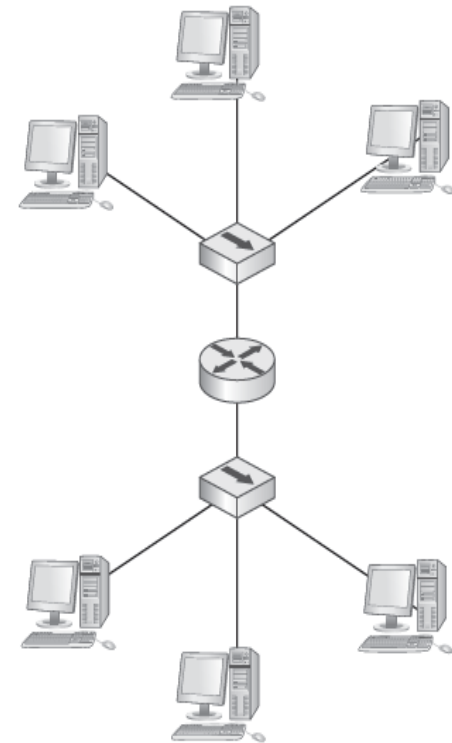


Figure 1-16 An internetwork with two LANs connected by a router

LANs, Internetworks, WANs, and MANs

- **Wide area networks (WANs)** use the services of third-party communication providers to carry network traffic from one location to another (**covers world-wide**)
- **Metropolitan area networks (MANs)** use WAN technologies to interconnect LANs in a specific geographic region, such as a county or city (**or a campus**)

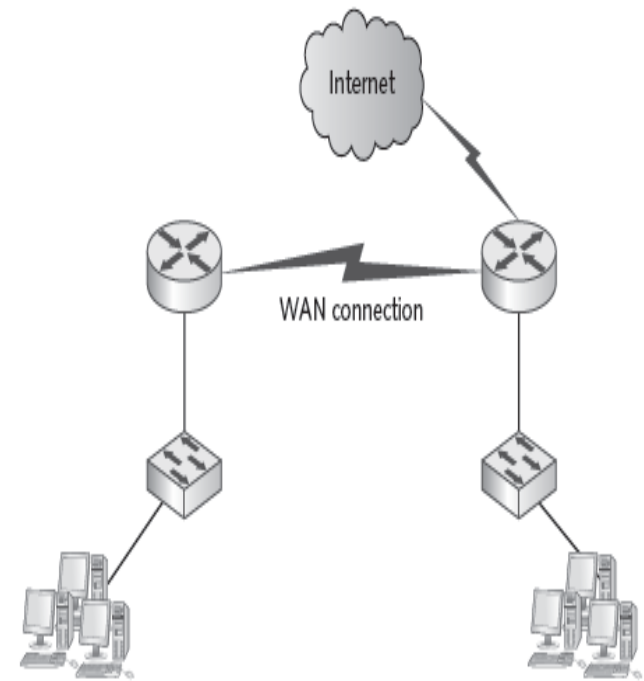


Figure 1-17 A WAN with a connection to the Internet

Internet, Intranet, and Extranet

- **Internet:** a worldwide public internetwork
 - Uses protocols such as TCP/IP and HTTP to transfer and view information
- **Intranet:** a private internetwork in which devices and servers are only available to those users connected to the internal network (like an internal Internet)
- **Extranet:** allows limited and controlled access to internal resources by outside users

Internet, Intranet, and Extranet

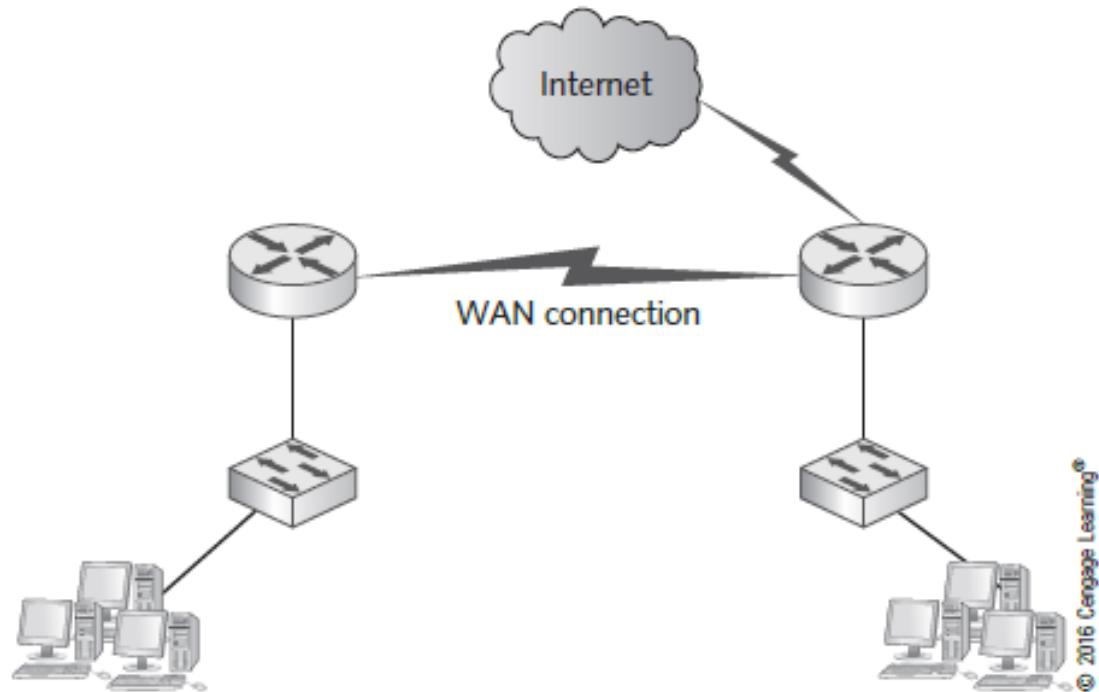
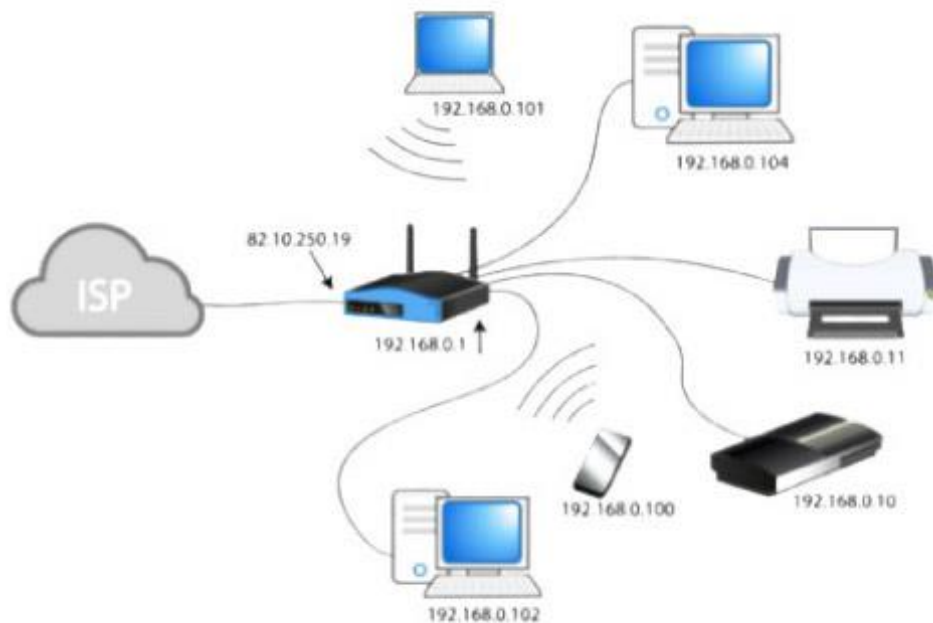


Figure 1-18 A WAN with a connection to the Internet

LAN

Privated IP address



Reserved for private networks.

The organizations that distribute IP addresses to the world reserves a range of IP addresses for *private networks*.

- **192.168.0.0 - 192.168.255.255** (65,536 IP addresses)
- **172.16.0.0 - 172.31.255.255** (1,048,576 IP addresses)
- **10.0.0.0 - 10.255.255.255** (16,777,216 IP addresses)

Public IP address

Private IP address

<https://whatismyipaddress.com/>

The screenshot shows the homepage of the 'WhatIsMyIP' website. The navigation bar includes links for 'MY IP', 'IP LOOKUP', 'HIDE MY IP', 'VPN SERVICE', 'SPEED TEST', and 'BLACKLIST'. The main content area features several sections: 'IP Lookup' with a description, 'Trace Email', 'Hide My IP', and a large red banner for 'Explore the best of Melbourne and Tasmania with Qantas'. The central focus is the 'My IP Address Is:' section, which displays the IPv4 address '203.211.155.32' in blue and 'IPv6: Not detected' below it. At the bottom, there is a 'My IP Information' section with a close button, showing hotel recommendations like 'KSL Hotel & Resort' for \$83, 'Pan Pacific Singapore' for \$576, and 'The Ritz-Carlton, Mille.' for \$439.

Type command:
ipconfig

```
Select C:\WINDOWS\system32\cmd.exe

Wireless LAN adapter Wi-Fi:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::e844:ff81:8bcf:17b3%13
    IPv4 Address. . . . . : 10.197.28.200
    Subnet Mask . . . . . : 255.255.252.0
    Default Gateway . . . . . : 10.197.28.1

Ethernet adapter Bluetooth Network Connection:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

C:\Users\Humb1>
```


ipconfig utility

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FROM LINKEDIN

LIBRARY ▾

Search for the software or skills you want to learn

Q

Hi Singapore

IT > IT Help Desk

ipconfig command

From: IT Help Desk for Beginners

Layout

Add to Playlist

Share

Contents

Notebook

Search This Course

Q

3m 34s

▼ 4. Workgroup vs. Domain

What is a workgroup?
1m 26s

What is a Windows domain?
1m 33s

Join a computer to a domain
5m 56s

Remove a computer from the domain
6m 57s

▼ 5. Troubleshooting

Troubleshooting tips
3m 29s

IT HELP DESK FOR BEGINNERS

By: Jason Ruediger

THE IPCONFIG UTILITY

Play (spacebar)

00:09 / 03:18

1x

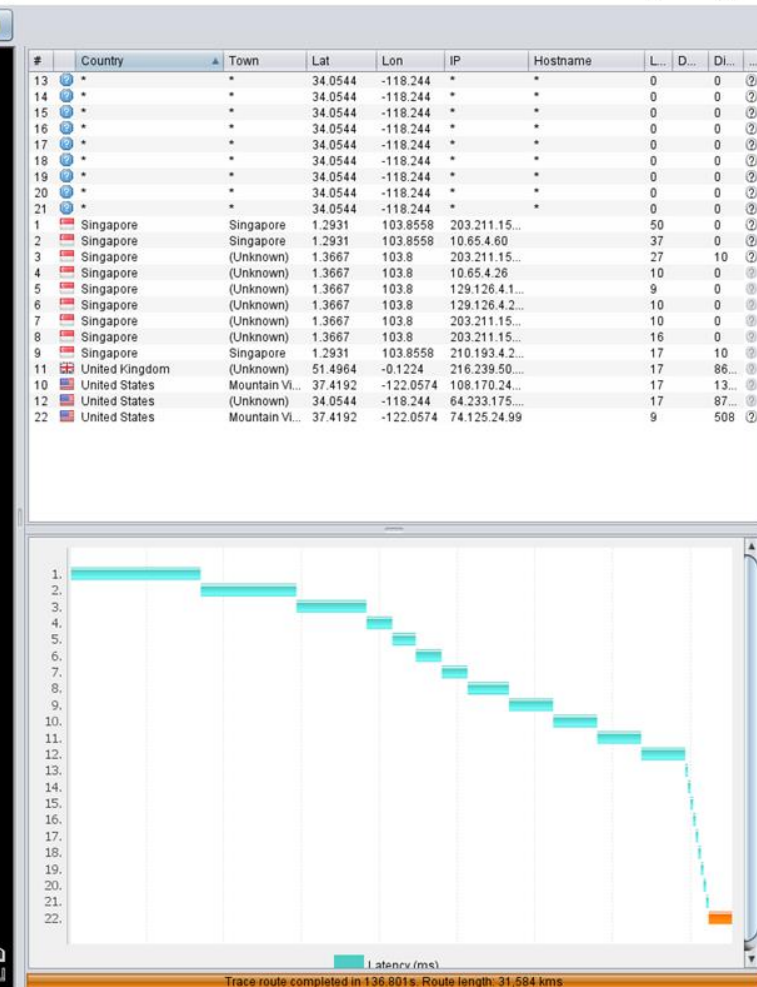
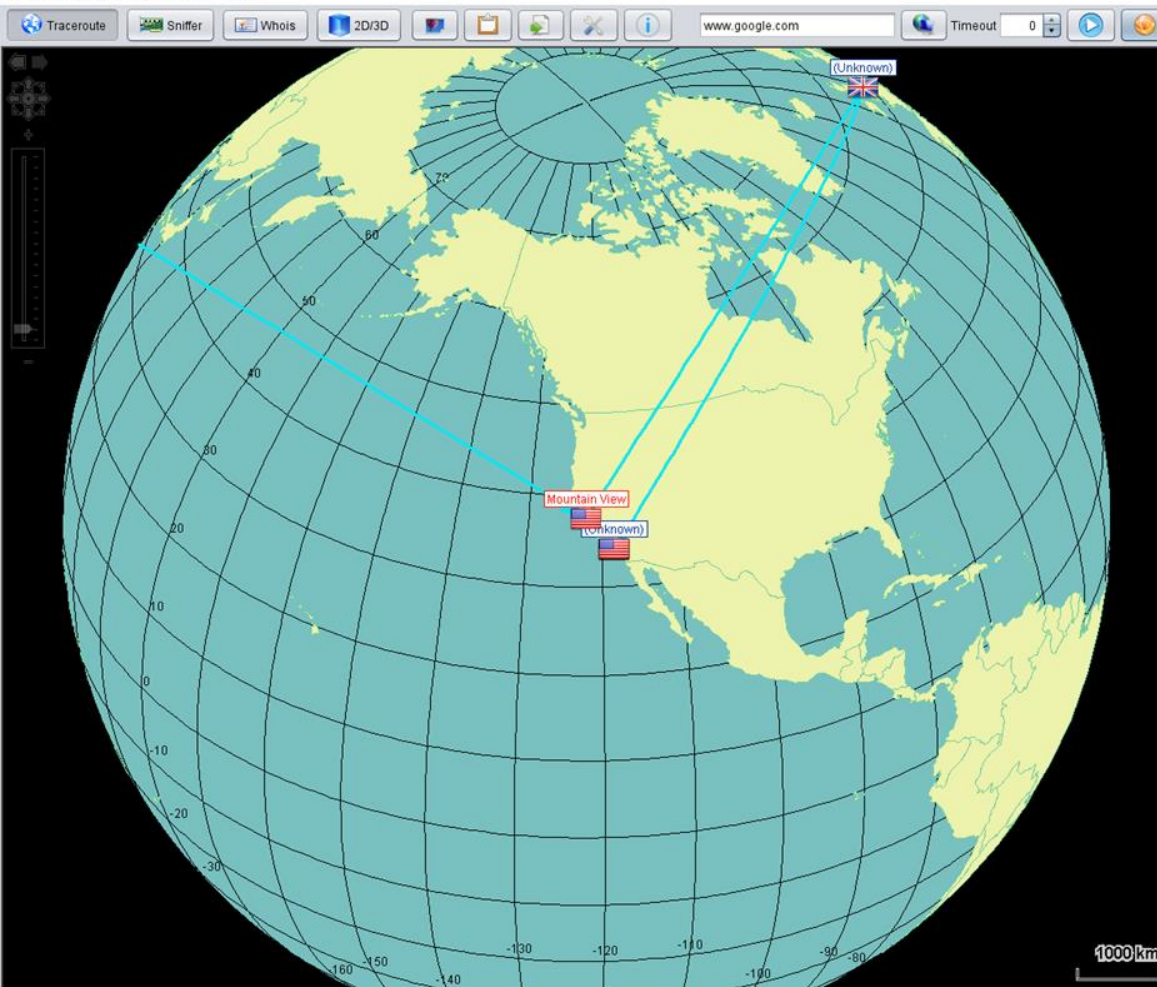
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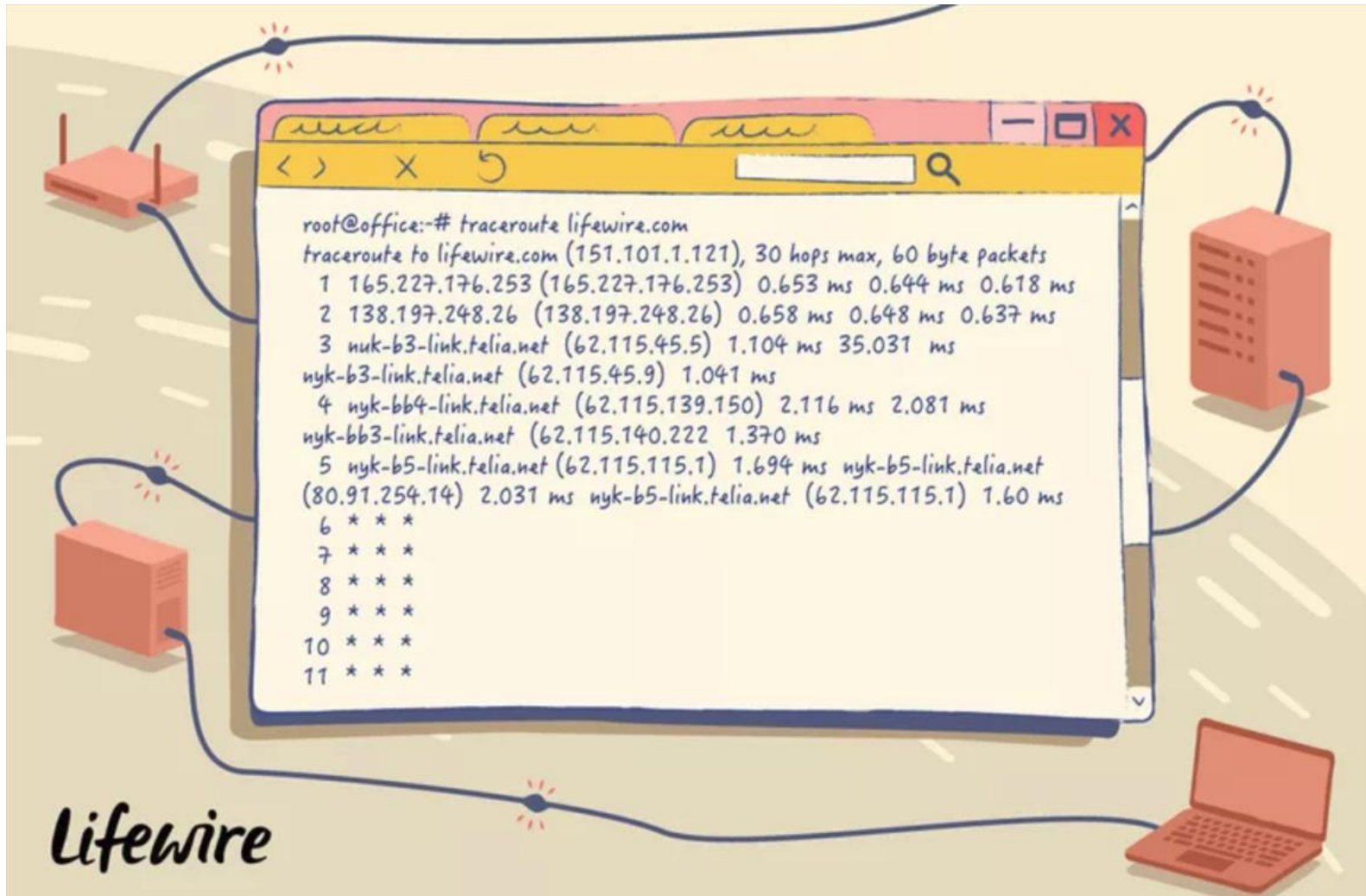
Download Open Visual Trace Route:

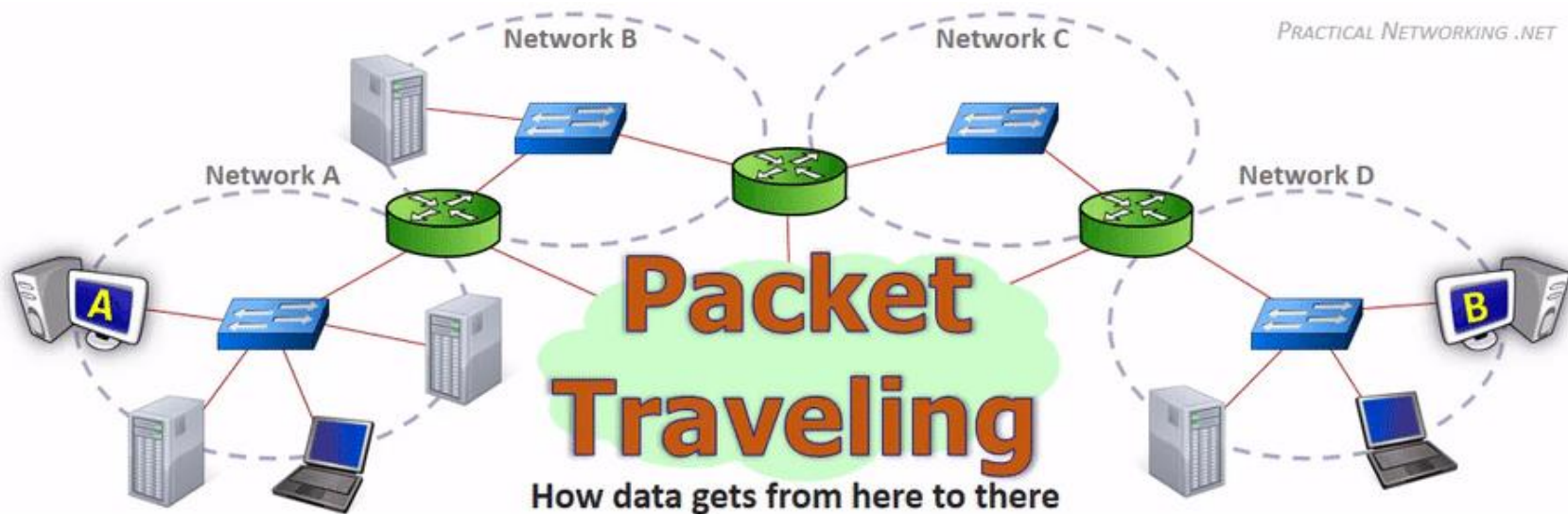
<https://sourceforge.net/projects/openvisualtrace/>

Open Visual Trace Route 1.7.1



traceroute www.google.com



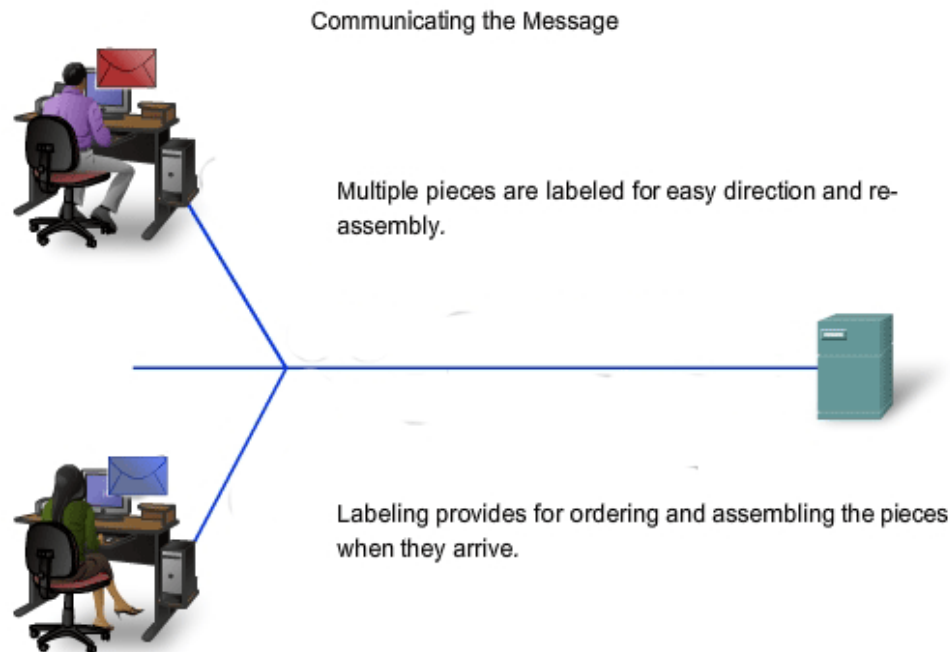


When data leaves your computer, it is grouped into small chunks called **Packets**. These packets are essentially **little envelopes that carry data across the Internet** (Network of networks connected through Routes)

<https://www.practicalnetworking.net/series/packet-traveling/packet-traveling/>

Packets and Frames

- Computers transfer information across networks in short bursts of about 1500 bytes of data (**bursty – unlike video streaming**)



Packets and Frames

- Reasons data is transferred this way:
 - Pause between bursts allows other computers to transfer data during pauses
 - Allows the receiving computer to process received data
 - Allows the receiving computer receive data from other computers at the same time
 - Gives the sending computer an opportunity to receive data from other computers and perform other processing tasks
 - If an error occurs during transmission of a large file, only the chunks of data involved in the error have to be sent again

Packets

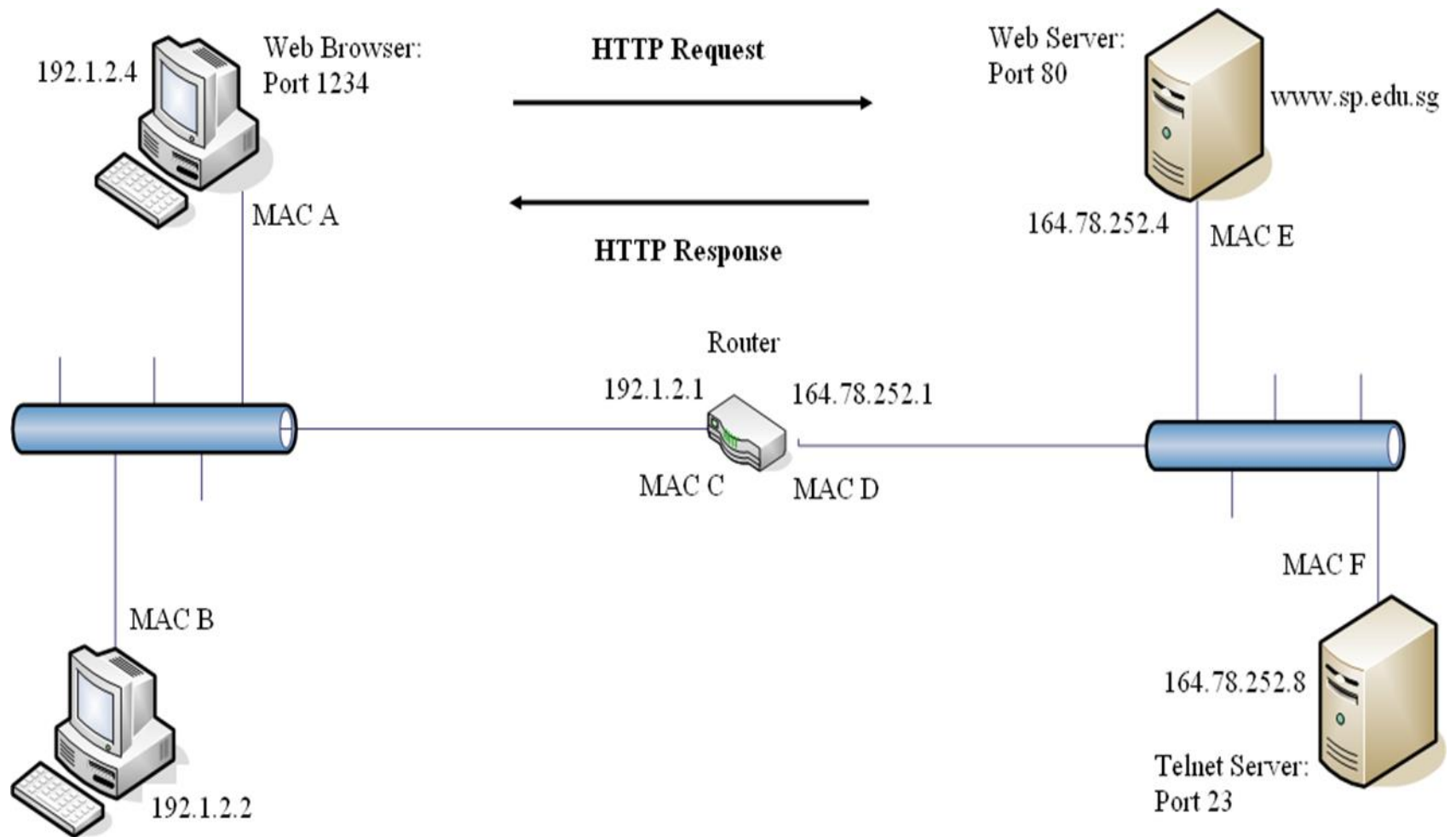
- Chunks of data sent across the network are usually called packets or frames, with packets being the more well-known term
- **Packet:** a chunk of data with a source and destination IP address added to it (routers route packets between networks)
- Using the U.S. mail analogy, you can look at a packet as an envelope that has had the zip code added to the address but not the street address

Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request
-------------------------	----------------------	------------------	--------------	-------------------	--------------

Frames

- **Frame:** a packet with the source and destination MAC addresses added to it
 - The packet is “framed” by the MAC addresses on one end and an error-checking code on the other (NIC sends and receives frames)
- The process of adding IP addresses and MAC addresses to chunks of data is called encapsulation
- Information added to the front of the data is called a header and information added to the end is called a trailer

Dst MAC: MAC C	Src MAC: MAC A	Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	Frame Trailer
-------------------	-------------------	-------------------------	----------------------	------------------	--------------	-------------------	--------------	------------------



Source: 192.1.2.4 (Sends a HTTP Request)									
Application: HTTP								HTTP Request	
Transport: TCP						Dst Port: 80	Src Port: 1234	HTTP Request	
Network: IP			Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	
Physical Network: Ethernet	Dst MAC: MAC C	Src MAC: MAC A	Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	Frame Trailer
1st Hop:									
Physical Network: Ethernet	Dst MAC: MAC C	Src MAC: MAC A	Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	Frame Trailer
Network: IP			Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	
Physical Network: Ethernet	Dst MAC: MAC E	Src MAC: MAC D	Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	Frame Trailer
Destination: 164.78.252.4									
Physical Network: Ethernet	Dst MAC: MAC E	Src MAC: MAC D	Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	Frame Trailer
Network: IP			Dst IP: 164.78.252.4	Src IP: 192.1.2.4	Protocol: TCP	Dst Port: 80	Src Port: 1234	HTTP Request	
Transport: TCP						Dst Port: 80	Src Port: 1234	HTTP Request	
Application: HTTP								HTTP Request	

Clients and Servers

- A **client** can be a workstation running a client OS or it can refer to the network software on a computer that requests network resources from a server
- The word “client” is usually used in these three contexts:
 - *Client operating system* – the OS installed on a computer
 - *Client computer* – primary role is to run user applications and access network resources
 - *Client software* – software that requests network resources from server software on another computer

Clients and Servers

- A computer becomes a server when software is installed on it that provides a network service to client computers
- The term “server” is also used in three contexts:
 - *Server operating system* – OS installed on a computer designed to share network resources and provide other network services
 - *Server computer* – a computer’s primary role in the network is to give client computers access to network resources and services
 - *Server software* – responds to requests for network resources from client software

Summary

- Components needed to make a stand-alone computer a networked computer include a NIC, a network medium, and usually an interconnecting device
 - Also client/server software, protocols, and NIC driver

Summary

- The layers of the network communication process can be summarized as user application, network software, network protocol, and network interface
- The four terms used to describe networks of different scope are LAN, Internetwork, WAN, and MAN
- Packets and frames are the units of data handled by different network components
 - Packets have the source and destination IP address added and are processed by the network protocol

Summary

- Frames have the MAC addresses and an error code added and are processed by the network interface
- A client is the computer or network software that requests network data and a server is the computer or network software that makes the network data available to requesting clients