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http://ftmk.utem.edu.my

Chapter 1

by

Ts. Dr. Nazrulazhar Bahaman

nazrulazhar@utem.edu.my

INTRODUCTION TO NETWORK-CENTRIC WORLD

BITS 2343 | Computer Network

Objectives

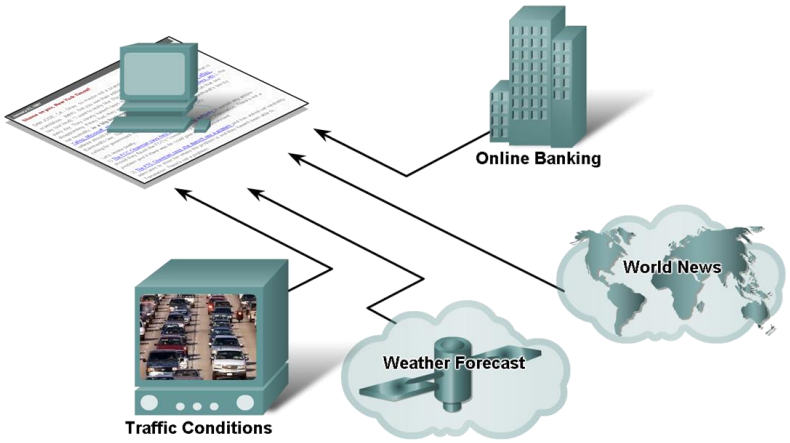
- Describe how networks impact our daily lives.
- Describe the role of data networking in the human network.
- Identify the key components of any data network.
- Identify the opportunities and challenges posed by converged networks.
- Describe the characteristics of network architectures: fault tolerance, scalability, quality of service and security.

Outline

- Communicating in a network centric world
  - Network supporting the way we live
  - Network supporting the way we learn
  - Network supporting the way we work
  - Network supporting the way we play
- Communication
  - What is communication?
  - Quality of communication
- The network as a platform
  - Communicating over networks
  - Elements of a network
  - Converged networks
- The architecture of the Internet
  - The network architecture
  - Fault-tolerant network architecture
  - Scalable network architecture
  - Providing Quality of Service
  - Providing network security

How Networks Impact Daily Life

Benefits of instantaneous communication

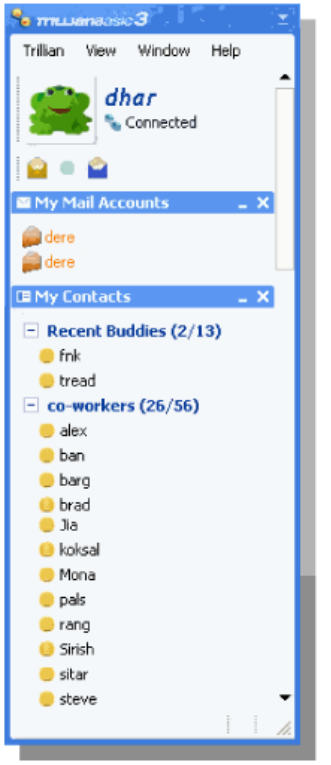


Communicating in a Network Centric World

- People need to interact with each others for daily needs.
- With the existence of the Internet, people can now interact in ways that are not possible before.
- The Internet allows people to share and distribute all types of information.
  - Documents, pictures, sound, video.
  - Can be done regardless of location.

Network Supporting the Way We Live

- Characteristics and purpose of communication media
  - Instant messaging
    - Real time communication between 2 or more people based on typed text
  - Weblogs (Blogs)
    - Web pages created by an individual
  - Podcasting
    - Website that contains audio files available for downloading



Network Supporting the Way We Live

- Early communication relies on face-to-face conversation.
- As our society advances, other means of communication emerged.
  - Mail (written message)
  - Telephone (voice)
  - Television broadcast (one-way video communication).
- With the use of the Internet, all the different types of communication are converging into Web-based communication.

Network Supporting the Way We Live

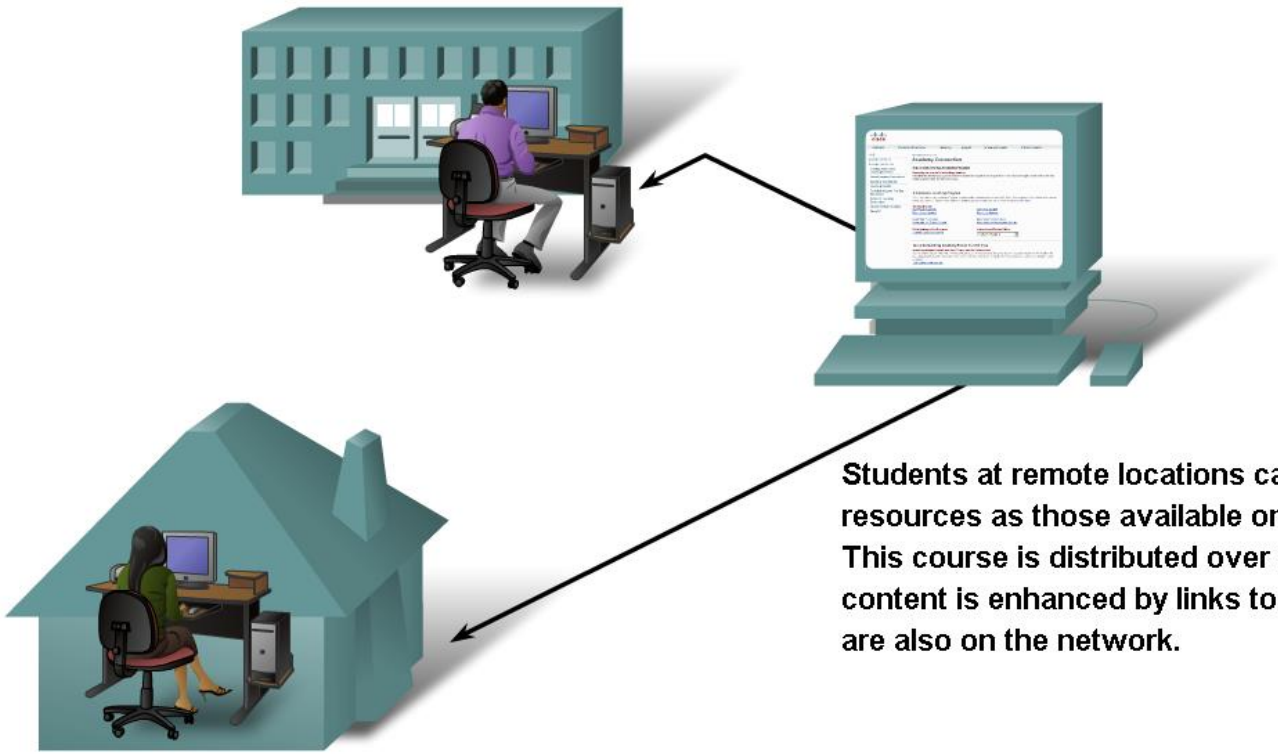
- Early data networks were limited to exchanging character-based information between connected computer systems.
- Current networks have evolved in mainly two ways:
  - They can carry various types of information: text, graphics, voice, video streams.
  - They can support different types of devices: computers, PDAs, mobile phones, webcams, refrigerator, microwave (pretty anything you can think of...).
- National borders, geographic distances and physical limitations become less relevant.

Network Supporting the Way We Live

- The Internet nowadays is used in various ways:
  - Receive and send email
  - Obtain information and advice
  - Online shopping and selling / auction
  - Electronic banking
- Examples of today's popular communication tools:
  - Instant messaging
  - Blogs
  - Podcasting
  - Wikis

Network Supporting the Way We Learn

- Information networks improve teaching and learning



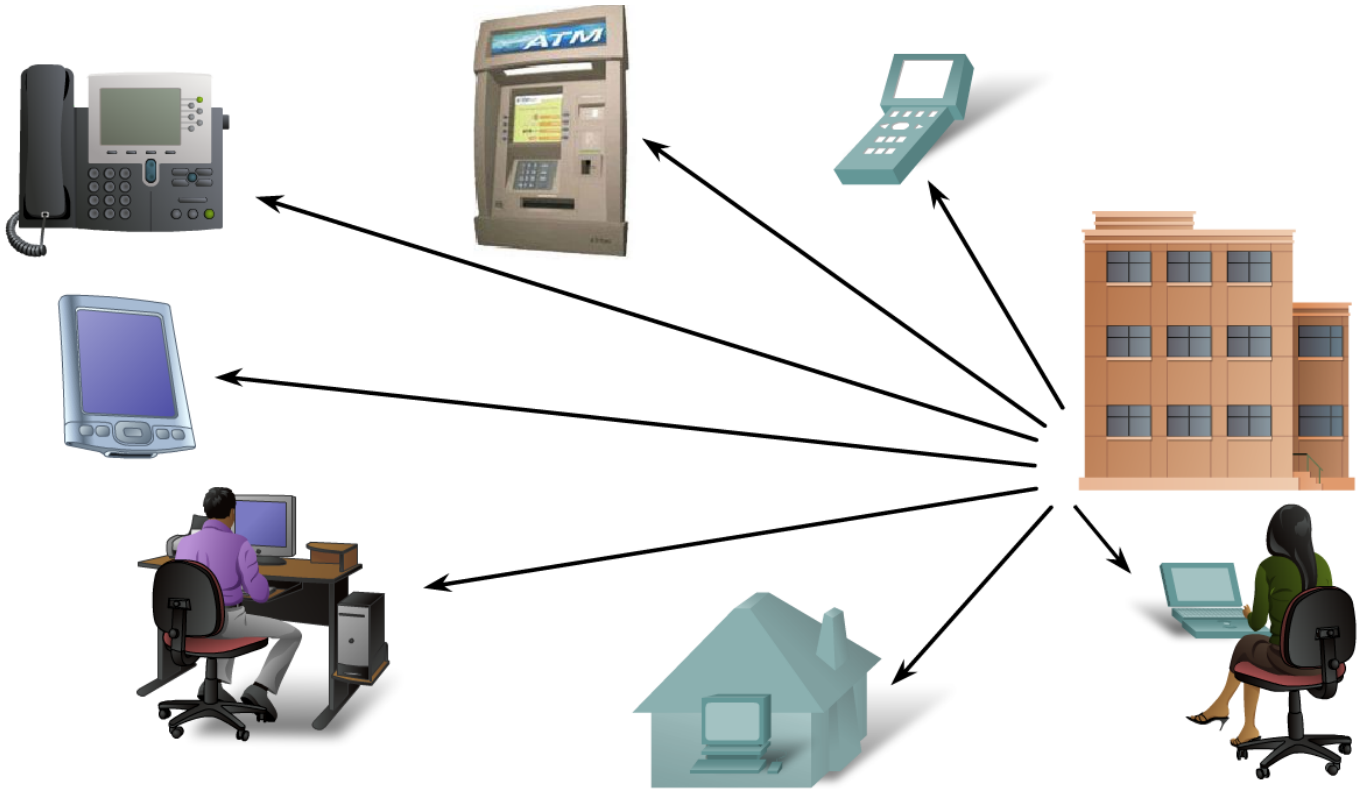
Students at remote locations can access the same resources as those available on campus.
This course is distributed over the network and the content is enhanced by links to other resources, which are also on the network.

Network Supporting the Way We Learn

- The Internet can enhance learning and makes it easier in several ways:
  - Distribution of learning contents
  - Availability of various resources
  - Enable learning to be done from any location
- Courses delivered using Internet resources are commonly called online learning or e-learning.
- Benefits of e-learning:
  - Easy update of learning materials
  - Availability to a wide audience
  - Consistent quality of instruction
  - Cost reduction

Network Supporting the Way We Work

- Networks change the way we work



Network Supporting the Way We Work

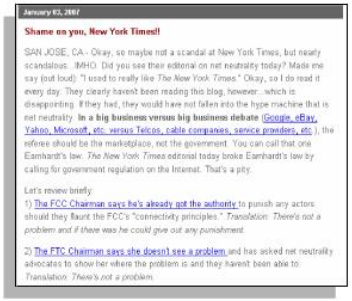
- The use of network can enhance communication between employees in an organization and also with external clients.
- Most companies have an intranet.
  - A private network belonging to the company.
  - Allows communication between employees and also between branches.
- Some companies also have an extranet.
  - A network (or network resources) to provide suppliers, vendors, customers, limited access to corporate data.
  - Example of common data to be shared: order status, inventory, parts lists.

Network Supporting the Way We Work

- The use of technology like VPN (virtual private network) allows employees to access company's intranet remotely.
  - Work can be done even though the employee is outstation or at home.
- In certain countries, there is a rising trend on the concept of "working from home".
  - No longer need to go to the office every day.
  - Communications with other employees or clients can be done online.
  - Can work and take care of family at the same time.

Network Supporting the Way We Play

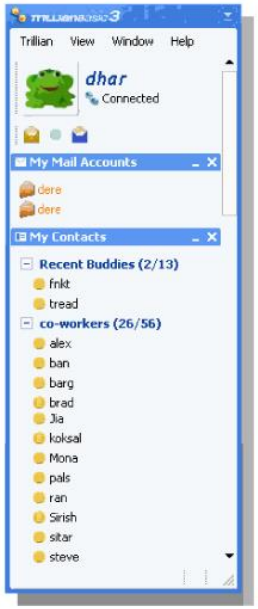
- Networks support the way we play



Online Interest Groups

Online Entertainment

The onboard data network provides a range of services to airline personal seatback video systems.



Instant Messaging

Network Supporting the Way We Play

- Entertainment is getting much more fun these days.
  - Chatting and instant messaging
  - Online interest groups
  - Web blogging
  - Video and audio streaming
  - Online games
- What makes these entertainments really fun is the ability to interact with other people.

Communication: An Essential Part of Our Lives

Role | Components | Challenges

Roles of Communication

- Communication can be in many forms and occurs in different environments.
- Allows two or more entities to send information to each other.
- For communication to be successful, it must be governed by a protocol.
  - An agreement or rules that must be followed in order for the message to be successfully delivered and understood.
  - Used in human communication and also in computer communication.

Roles of Communication

- Among the elements of the protocol that govern successful human conversation are:
  - An identified sender and receiver
  - Agreed upon method of communicating: face-to-face, telephone, letter
  - Common language and grammar
  - Speed and timing of delivery
  - Confirmation and acknowledgement requirements.
- Protocols used in computer communication shares many similar concepts used in the protocol for human communication.

Roles of Communication

- Characteristics of communication
  - Protocol or Rules or agreements are lst established
  - Important information may need to be repeated
  - Modes of communication are important

Quality of Communication

- Communication between individuals is determined to be successful when:
- (Meaning of the message understood by the recipient) == (meaning intended by the sender)
- For data network, the same basic criteria is used to judge the success of communication.
- There are various internal and external factors that may affect the communication.

The Network as a Platform

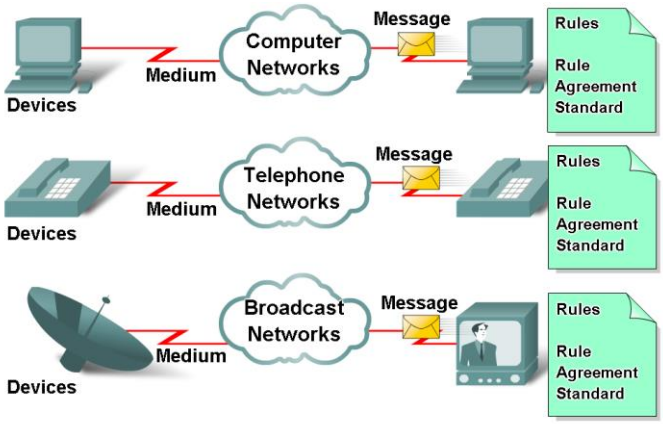
Communication over networks

Different elements that make up a network

Convergence.

Communicating over Networks

- All networks have four basic elements in common:
  - Devices
    - Devices on the network that exchange messages to communicate with one another.
  - Medium
    - The way by which devices are connected together.
    - Can be wired or wireless.
  - Messages
    - The units of information that travels from one device to another over a medium.
  - Rules/ Protocol
    - How messages flow – Rules that govern how the messages are sent, directed, received and interpreted.



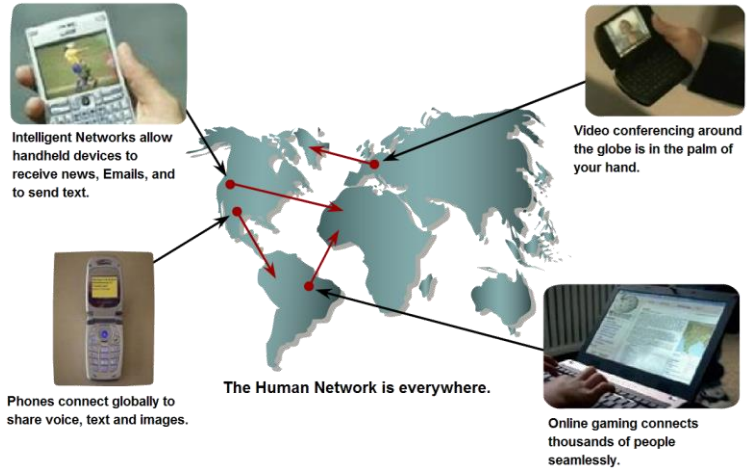
Converged Networks

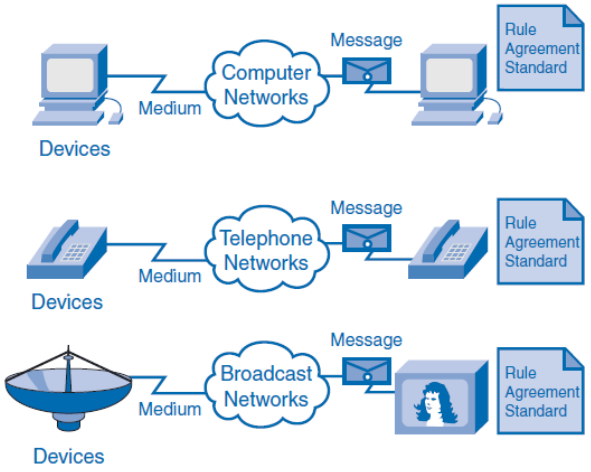
- Traditionally, telephone, radio, television and computer data networks are four separate networks.
  - Each has its own versions of the four basic elements.
- Technology advances has allowed the four networks to be combined together.
  - This combined network is referred to as a converged network.
  - Voice, video and data can be carried over the same network.
  - Eliminate the needs to create and maintain separate networks.

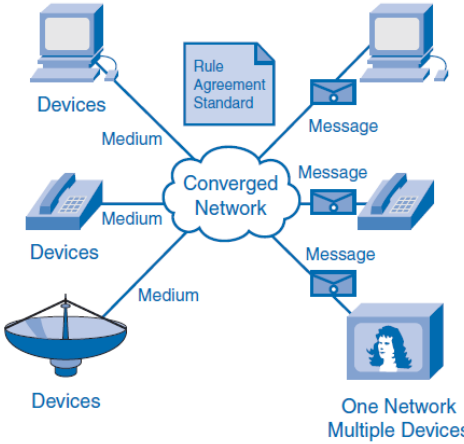
Converged Networks

- Converged network: A network that can carry
  - voice
  - video
  - data

over the same network





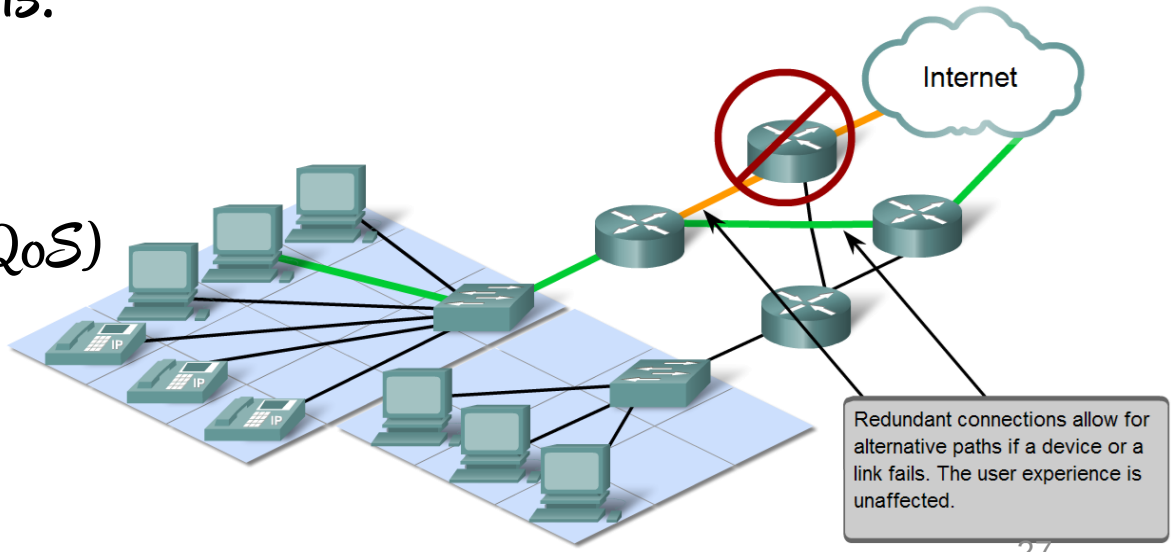


The Architecture of the Internet

Characteristics | Fault-tolerant | Scalable | QoS | Security | Trends

Network Architecture Characteristics

- Network architecture refers to:
  - Technologies that support the network infrastructure.
  - Programmed services and protocols that move messages across that infrastructure.
- Four basic characteristics of network architecture design to meet user expectations:
  - Fault tolerance
  - Scalability
  - Quality of service (QoS)
  - Security



A Fault-tolerant Network Architecture

- Fault-tolerance refers to the ability of the network to:
  - Limit the impact of hardware and software failures
  - Recover quickly when failure occurs
- Before computer network is invented, the telephone network is already in existence.
- Telephone network is a circuit-switched, connection oriented network.
  - A circuit is established before data transfer. This represents the path to be taken.
  - Resources are dedicated for each circuit – fixed data rate.

A Fault-tolerant Network Architecture

- Any failure in the path may cause the connection to be terminated.
- Has limited number of circuits. During peak periods, some calls may be denied.
- Circuit stays active even if no one is speaking – inefficient use of resources.

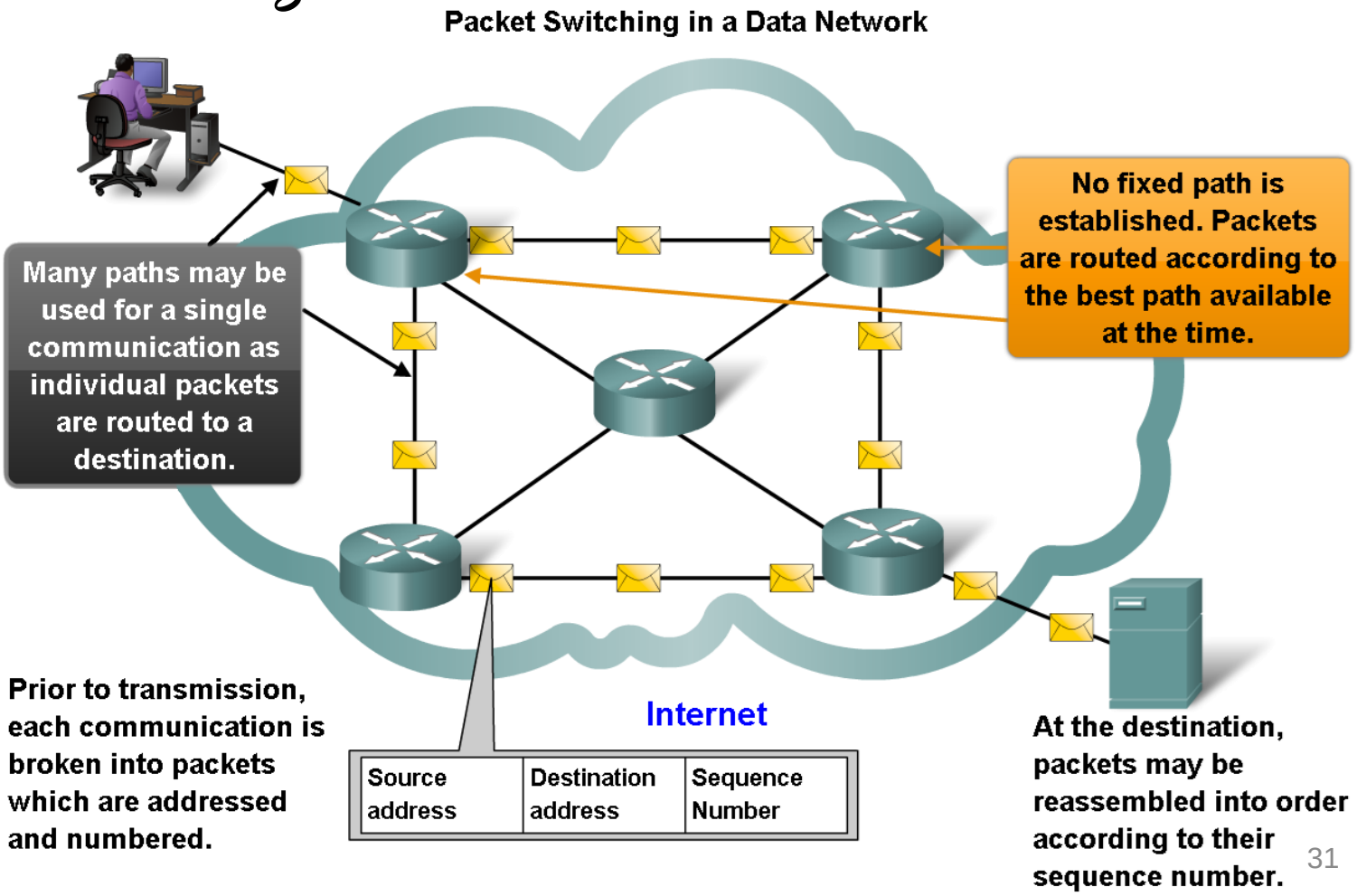
- Circuit-switching network is not very fault tolerant and can be costly (due to inefficient use of network resources).
  - Not very suitable for data networks.

A Fault-tolerant Network Architecture

- Fault-tolerance can be improved by using a packets witched, connectionless network.
  - A single message is broken into multiple message blocks called packets.
  - Packet contains address information of the sender and receiver.
  - No path needs to be established before data transmission (connectionless).
  - Different packets belonging to the same message can be sent through the network along various paths.
  - The original message will be reassembled once all the packets arrive at the receiver.
- The Internet is a packet-switching network.

A Fault-tolerant Network Architecture

- Packet switching

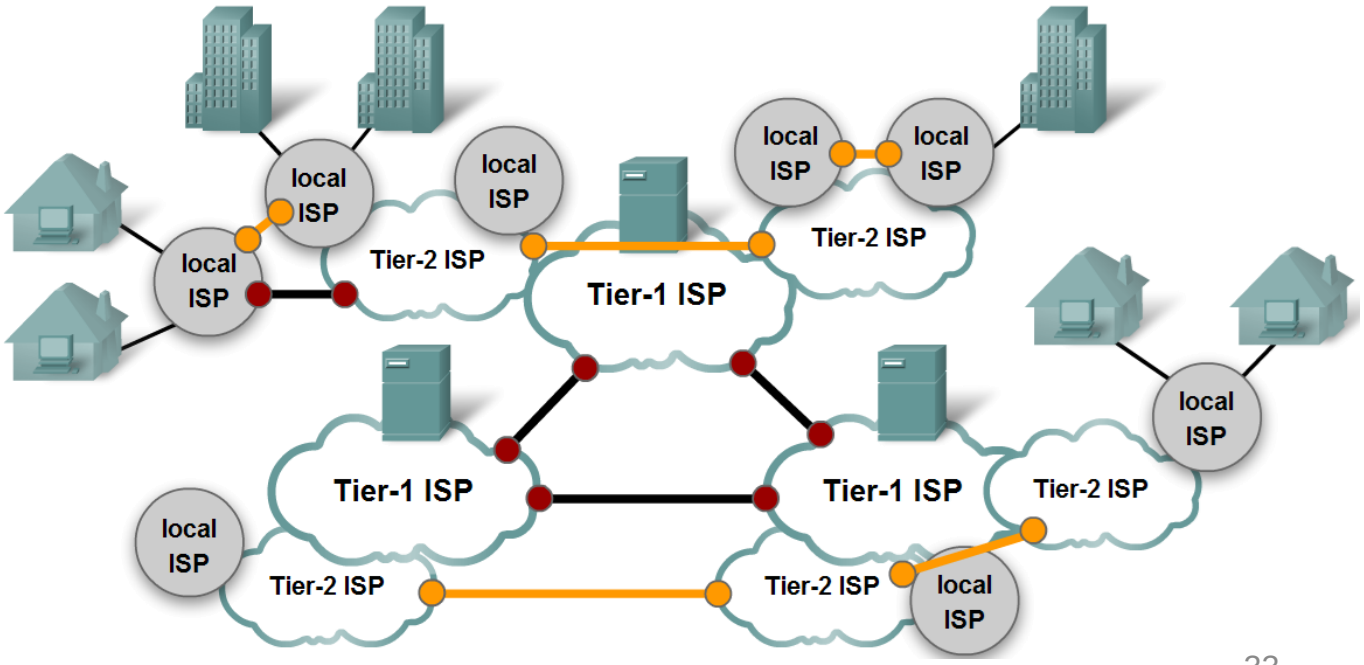


A Scalable Network Architecture

- Scalability refers to the ability of the network to expand quickly to support new users and applications without impacting the performance of the service being delivered to existing users.
- The Internet architecture is scalable due to the following characteristics:
  - It has a hierarchical layered structure for addressing, naming and connectivity service.
  - It uses common standards and protocols.

A Scalable Network Architecture

- Characteristics of the Internet
  - Hierarchical
  - Common standards
  - Common protocols



A Scalable Network Architecture

- There is no single organizations that regulates the Internet.
- Different software and hardware products are able to work with each others by following accepted standards and protocols.
  - This allows many new different products and services to be deployed on the Internet.
  - These new products and services make the Internet more useful and therefore attract more users.

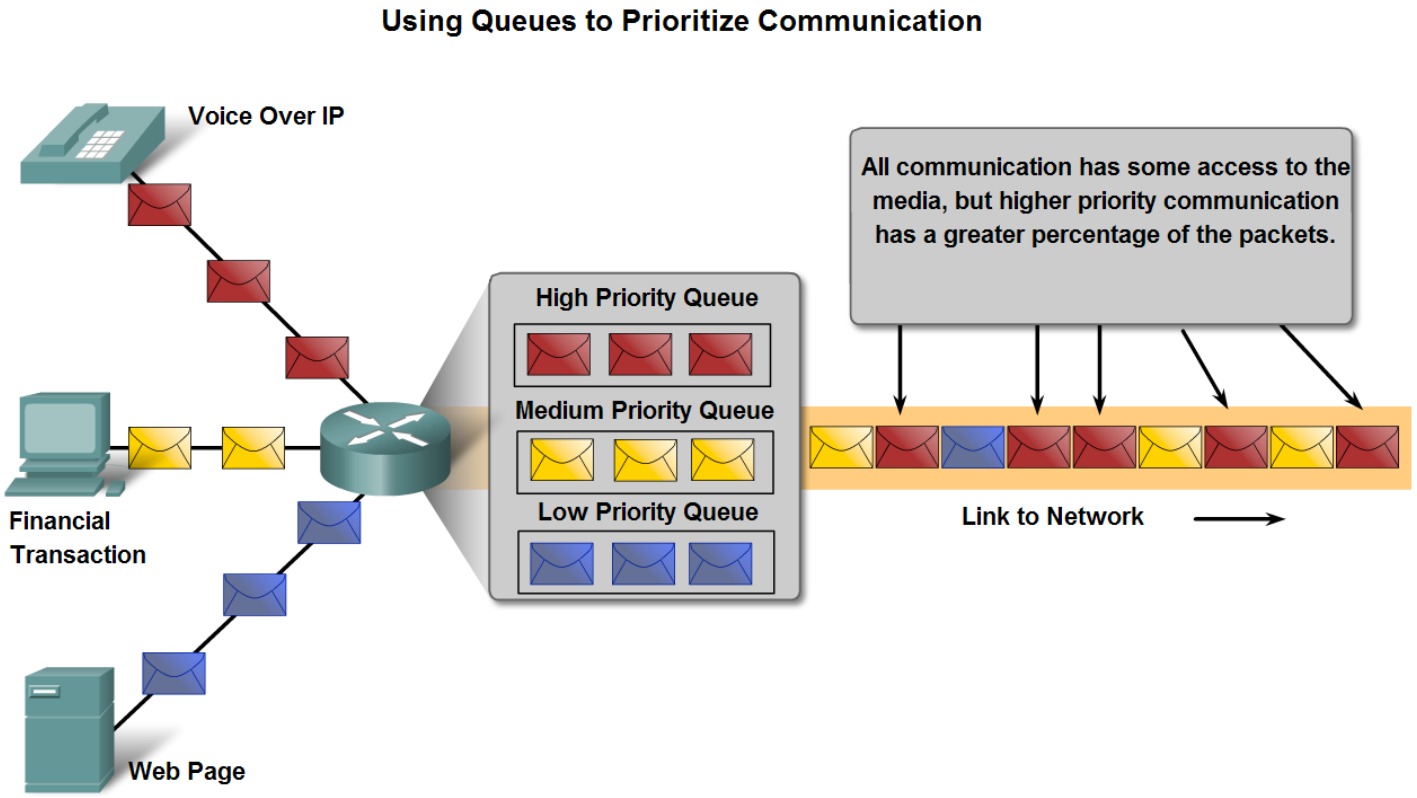
Providing Quality of Service (QoS)

- QoS indicates the performance level of the services offered through the network.
- Traditional computer applications do not have much requirement in terms of QoS.
- However, multimedia applications such as audio and video streaming requires consistent quality and uninterrupted delivery.
- The problem is that the Internet architecture does not have any mechanism to provide QoS.
  - Packets may or may not arrive.
  - If arrive it may not be on time or may not be in order.

Providing Quality of Service (QoS)

- The key concept behind providing QoS is to manage the utilization of network resources.
- Applications that have certain quality requirements should be given more priority to use network resources.
  - In the situation where network resources are not sufficient, low-priority packets can be delayed or dropped.
- There are various techniques to implement QoS in the Internet. One way is to use priority queue at the network routers.

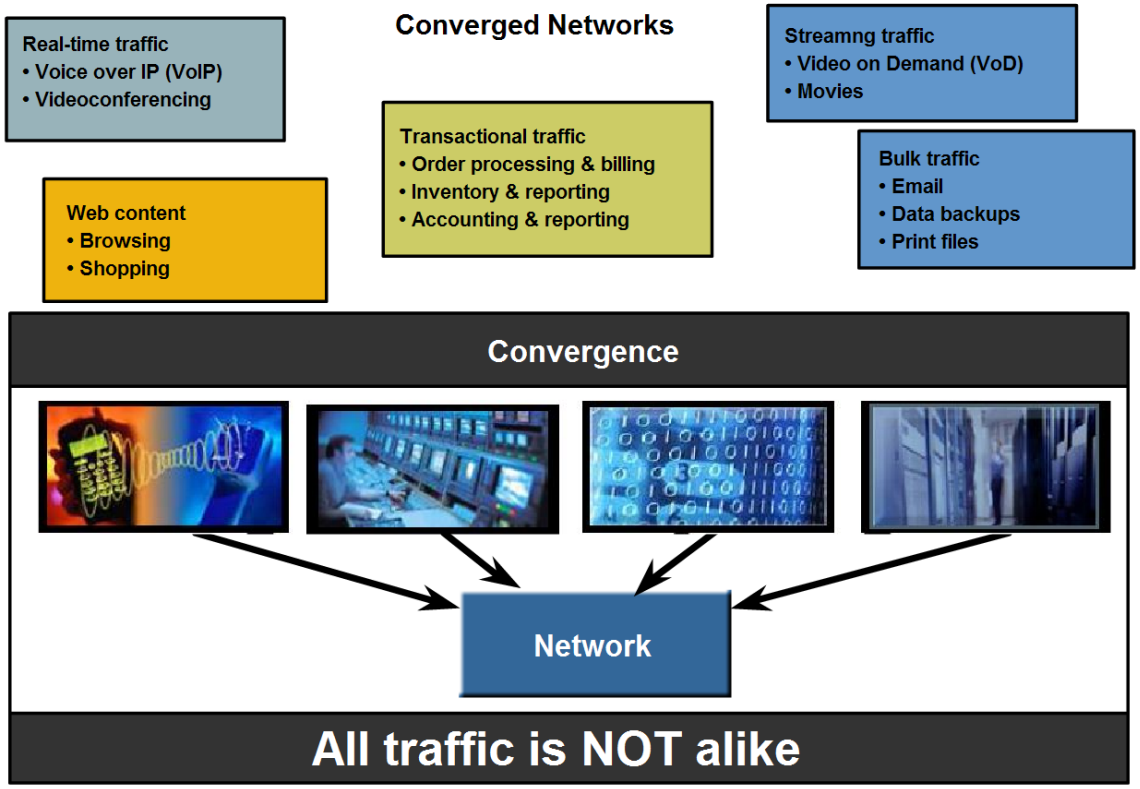
Providing Quality of Service (QoS)



Queuing according to data type enables voice data to have priority over transaction data, which has priority over web data.

Providing Quality of Service (QoS)

- QoS mechanisms



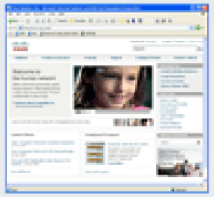
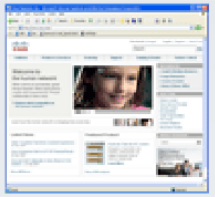
Providing Quality of Service (QoS)

- QoS strategies

Quality of Service Matters

Communication Type	Without QoS	With QoS
Streaming video or audio	 Choppy picture starts and stops.	 Clear, continuous service.

Vital Transactions	`Time : Price`
	`02:14:05 $1.54`
	Just one second earlier...
		`Time : Price`
		`02:14:04 $1.52`
		The price may be better.

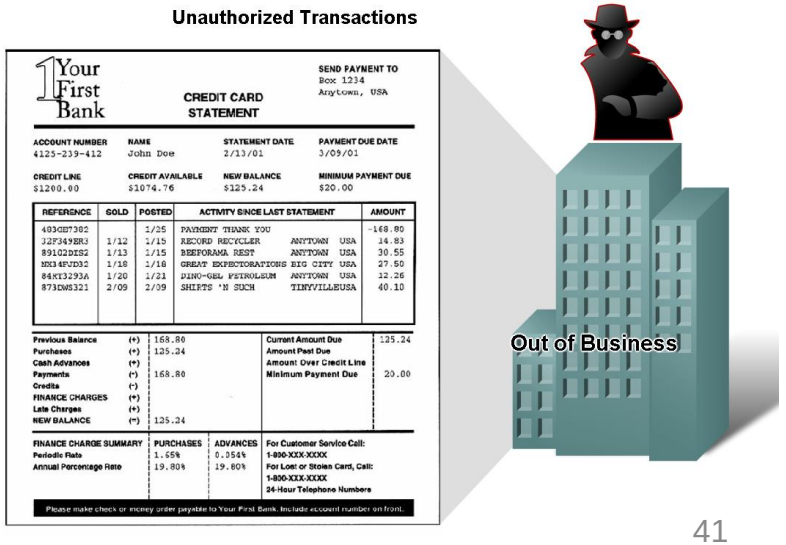
Downloading web pages (often lower priority)	 Web pages arrive a bit later...	 But the end result is identical.

Providing Network Security

- The Internet nowadays are used for exchanging confidential and business critical information.
  - Unauthorized use of communication data might have serious consequences.
- Two types of network security concerns that must be addressed.
  - Network infrastructure security – physically securing the network devices and preventing unauthorized access.
  - Content security – protecting the information contained in the packets while being transmitted over the network and while being stored on network-attached devices.

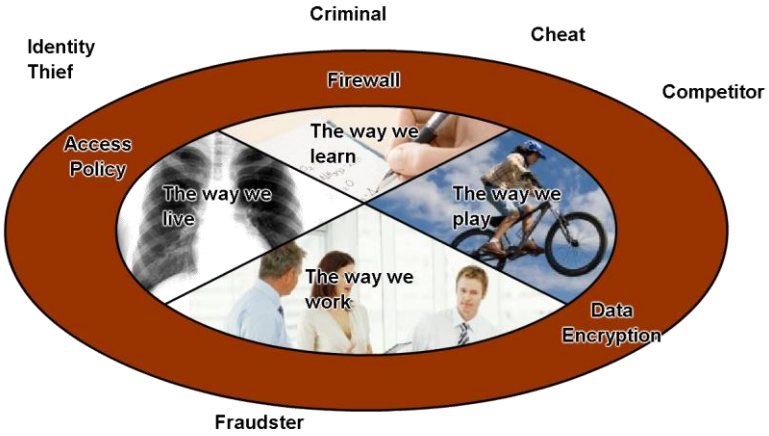
Providing Network Security

- Security measures taken in a network should:
  - Prevent unauthorized disclosure or theft of information – ensuring confidentiality
  - Prevent unauthorized modification of information – ensuring integrity
  - Prevent denial-of-service (DoS) – ensuring availability.
- Networks must be secure



Providing Network Security

- Measures to secure data networks
  - Ensure confidentiality through
    - User authentication
    - Data encryption
  - Maintain communication integrity through use of
    - Digital signatures
  - Ensure availability through use of
    - Firewalls
    - Redundant network architecture
    - Hardware without a single point of failure



Trends in Networking

- Three major trends that are contributing to the future shape of complex information networks:
  - Increasing number of mobile users
  - Proliferation of network capable devices
  - Expanding range of services
- As network increase in sophistication, the demand for people with networking skills will continue to grow.

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