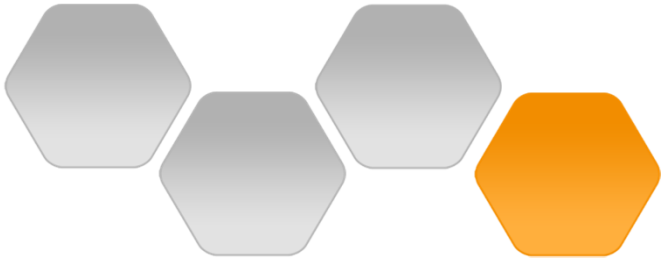

Networks

Bachelor of Science, Electrical Engineering (Communication Engineering)

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Winter Semester 2010 - 2011

Faculty of Mechanical and Electrical Engineering
(Communication Engineering)
Al Baath University

Outline

- Definitions
- History of Telecommunication
- Wireless Business and Markets
- Fundamentals
- Standardizations

Definitions

Communication

- **The process of conveying information**
  - From a sender to a receiver via a medium
  - Communicated informations should be understandable to both the sender and the receiver
- **Common language** between communicated nodes is necessary
- Communication is commonly done via **messages**
  - **Source** (the sender of the message)
  - **Destination** (the receiver of the message)
  - **Content** (data carried with the message)
  - **Protocol** (the protocol responsible for the communicating the message)
  - **Channel** (via which medium the message has been sent)
  - ….

Telecommunication System

- Is a system that enables a communication between nodes
- Consists of three basic elements
  - Transmitter
    - Takes information and converts them into signals
  - Transmission medium
    - Carries the signals
  - Receiver
    - Receives the signals and converts them back into information

Telecommunication Networks

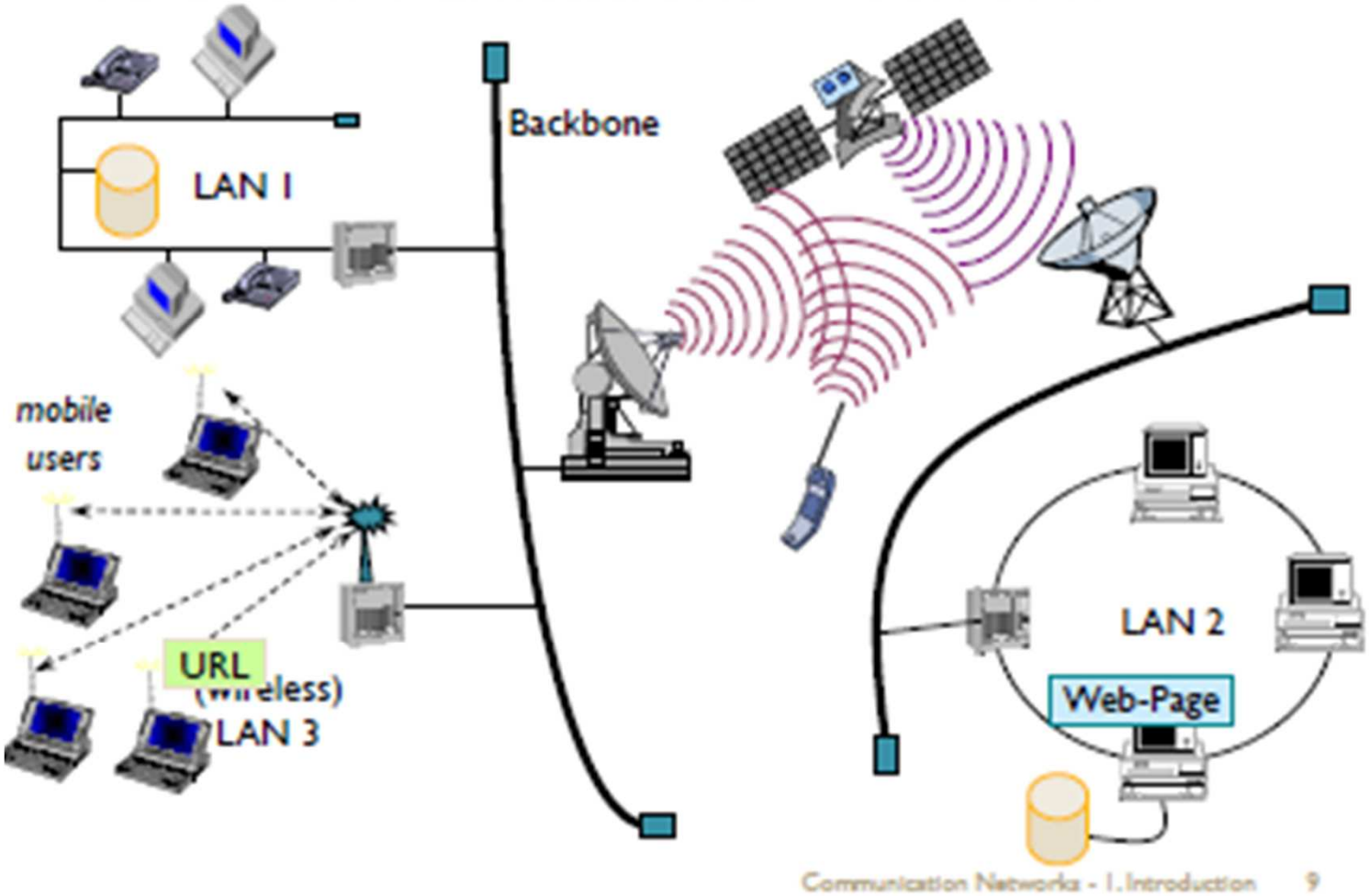
- Telecommunication network
  - A network of telecommunication links and nodes
  - Arranged so that messages can be passed from one part of the network to another over multiple links and through various nodes

- Examples
  - Computer networks
  - The Internet
  - Public switched telephone networks
  - Second and third mobile communication networks
  - ….

Telecommunication Networks - Classifications

- Based on the size
  - Personal Area Network (PAN), (Local Area Network) LAN, (Metropolitan Area Network) MAN, (Wide Area Network) WAN, etc.
- Based on the provider
  - Public vs. privat network
- Based on physical access medium
  - Wired/wireline vs. wireless networks
- Based on the structure/organization/management
  - Ad hoc vs. infrastructure-based networks
- Based on the transported information
  - Analog vs. digital

Telecommunication Networks - Examples



History of Telecommunication

Telegraphy

- Long-distance transmission of written messages without physical transport of letters (developed and patented in the United States in 1837 by **Samuel F. B. Morse**)
- Sent by a telegraph operator (or telegrapher) using **Morse code**
- The first commercially successful transatlantic telegraph cable was successfully completed on 18 July 1866
- In 1870, a telegraph cable was installed between London and Calcutta (length approx. 10.000 km)

Telephony

- **Philip Reis** (1834-1874)
  - Self-taught German scientist and inventor
  - Constructed the first working telephones in 1860/61 (Reis telephone)
  - First publicly demonstration of his telephones on October 26, 1861

- **Alexander Graham Bell** (1847-1922)
  - Eminent scientist, inventor and innovator who is widely credited with the invention of the telephone
  - Patent Number 174,465 was issued to Bell on 7 March 1876 by the U.S. Patent office

Success of Telephony

- Telegraphy was the standard technique for telecommunication
  - Telegraphy companies were against telephony
- Telephony was considered a toy (the first services offered the transport of pieces of music or poems in 1880)
- Speech quality was quite miserable in the beginning
- Communication via telephony was considered impersonal and unreliable

Wireless Telecommunication

- Father of mobile communications: **Guglielmo Marconi** (1874-1937)
- He was only the first scientist, who practically applies the results of other scientists like
  - **Heinrich Hertz** (1857-1894), who demonstrated the presence of electromagnetic waves in a lecture room at the University of Karlsruhe in 1888
  - **Desiré Edouard Branly** (1844-1940), who developed a receiver for radio communications
  - **Augusto Righi** (1850-1920), who built the sender.




Important Dates

- **1896**: Guglielmo Marconi
  - First demonstration of wireless (digital) telegraphy
  - Long wave radio transmission with very high transmitting power (> 200 kW)

- **1907**: commercial wireless transatlantic communication
  - Quite large base stations(30 antenna masts, which were 100 m high)

- **1915**: wireless speech communication between New York and San Francisco
- **1920**: discovery of short wave radio by Marconi
- **1926**: telephony in trains on the track from Hamburg to Berlin
- **1958**: first cellular network (A-Netz) in Germany

Birth of the Internet

- The USSR's launch of Sputnik in 1957 spurred the United States to create the Advanced Research Projects Agency, known as ARPA, in February 1958 to regain a technological lead
- Existed telecommunications networks were unreliable (star topology), proprietary, and slow
- Idea: packet switching (as opposed to circuit switching) to make a network highly robust and survivable
- 30. August 1969: Demonstration of the Internet (Connection between UCLA and Stanford Research Institute (SRI))

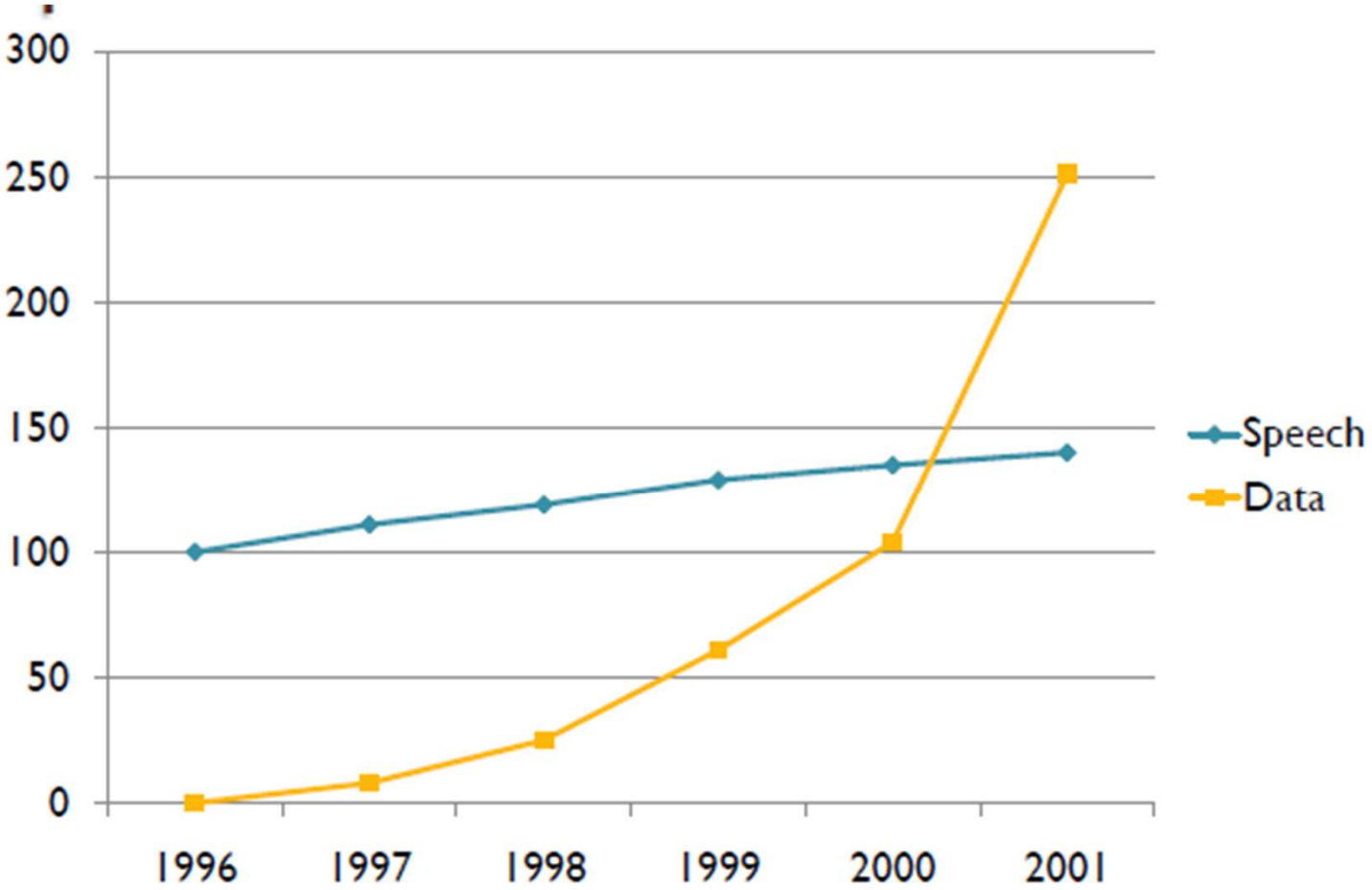
The First Message over the Internet

- It was simply a LOGIN from the UCLA computer to the SRI computer

  - We sent an “L” - did you get the “L”?
    - YEP!
  - We sent an “O” - did you get the “O”?
    - YEP!
  - We sent a “G” - did you get the “G”?
    - CRASH!!

Photo by Louis Bachrach

Speech vs. Data Communication



Source: Alcatel Telecommunication Review, 1998

The Evolution of the Internet

- **1970**: first „Internet“: 4 Hosts
- **1971**: start of the ARPAnet with 15 nodes (the first Internet backbone)
- **1974**: new protocol suite: TCP/IP (Transmission Control Protocol/ Internet Protocol)
- **1988**: Internet access from Germany
  - EUnet-IRB Dortmund
  - Xlink (eXtended Lokales Informatik-Netz Karlsruhe)
- **1991**: EBONE: European backbone
- **1995**: Sun introduces HotJava web browser and promotes the programming language Java (developed five years ago)
- **1996**: University Corporation for Advanced Internet Development (Internet2)
- **2008**: As of March 31, 2008, 1.407 billion people use the Internet according to Internet World Stats

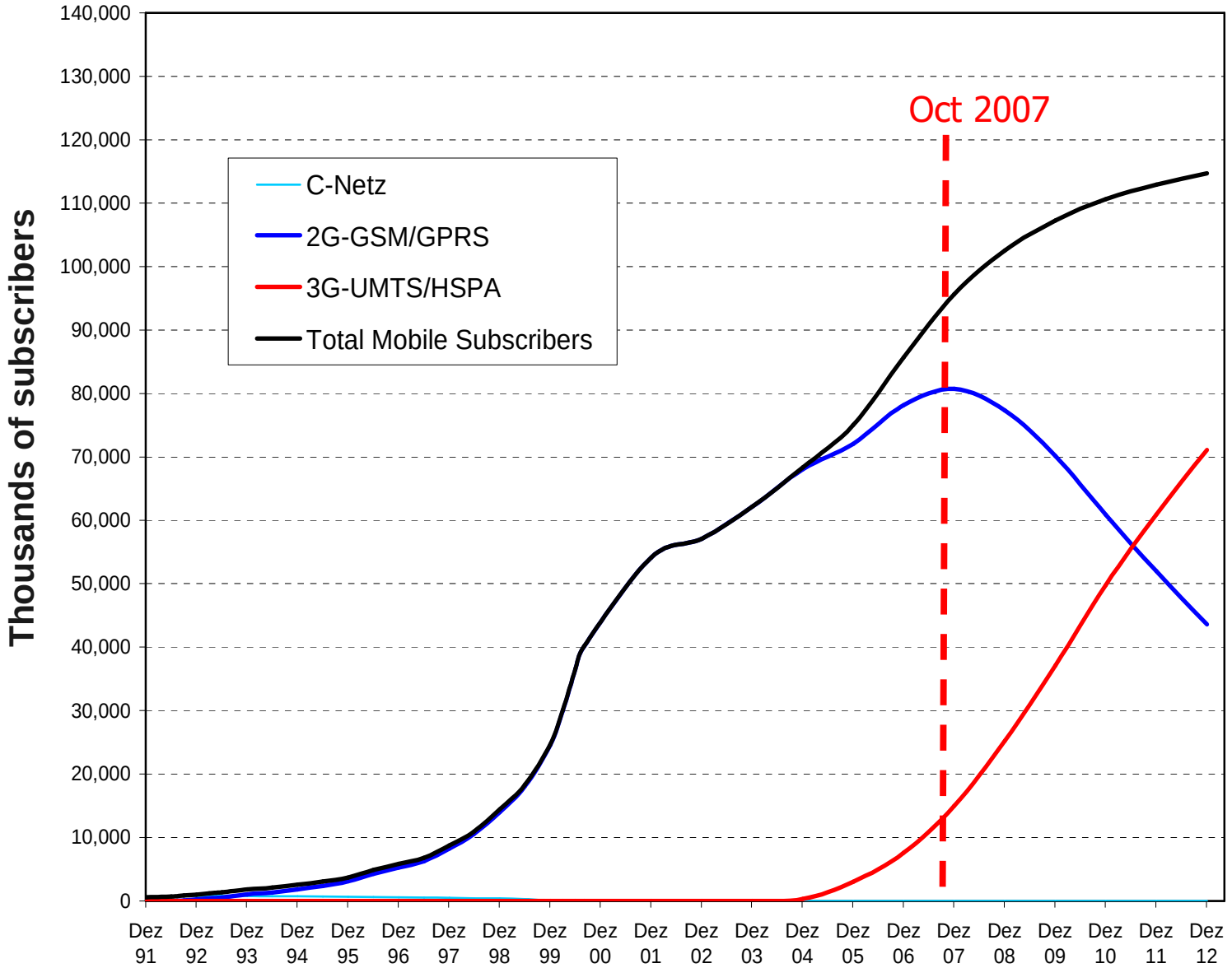
Wireless Business and Markets

State of the Wireless Data Business

- **Telecommunication world**
  - 2G Mobile Communication Systems are in place (GSM, GPRS, EDGE)
  - 3G Mobile Systems (UMTS incl. HSDPA) are available
  - B3G systems (LTE/SAE) are under development
  - Wireless voice market is saturating
  - Data traffic is growing
  - ***Traditional Telecom Operator and infrastructure provider target the Internet market***

- **Internet world**
  - Fixed Internet access is getting common (DSL)
  - WLAN hot spots are installed at airports, campus areas, coffee shops, etc.
  - 802.11a products are standard, 802.11n is establishing
  - 802.16 (WiMAX) products are available
  - 802.20 (MBWA) standards approved
  - ***Internet Service Providers (ISP) and Internet infrastructure provider target the mobile market***

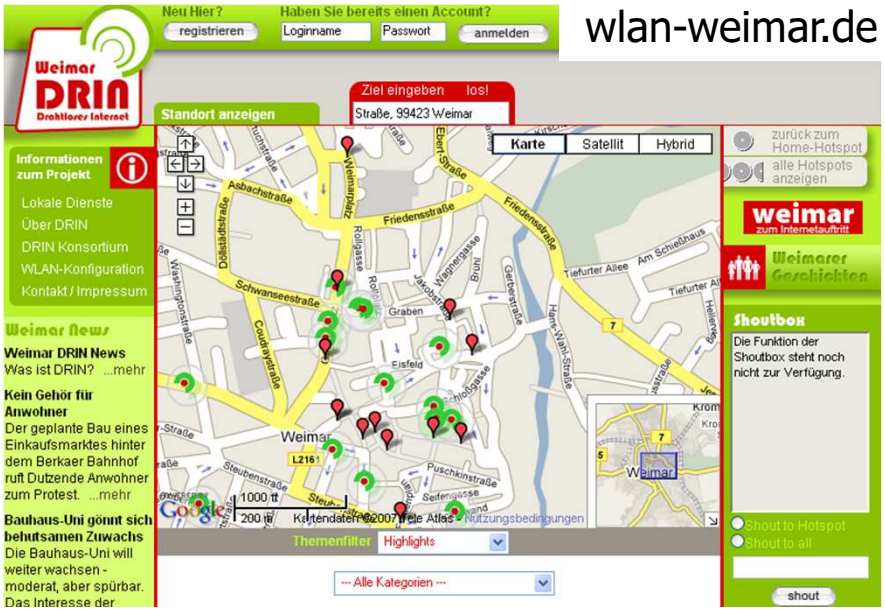
Mobile Networks in Germany

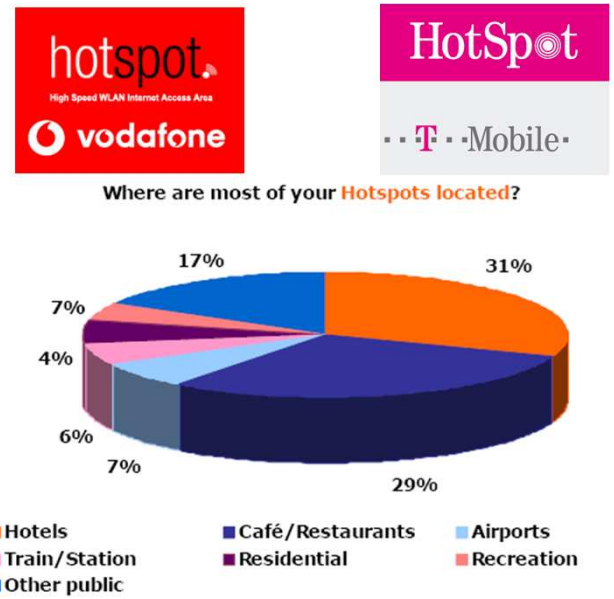


Public and Community WLAN/WiFi/802.11 Systems

www.fon.com

wlan-weimar.de



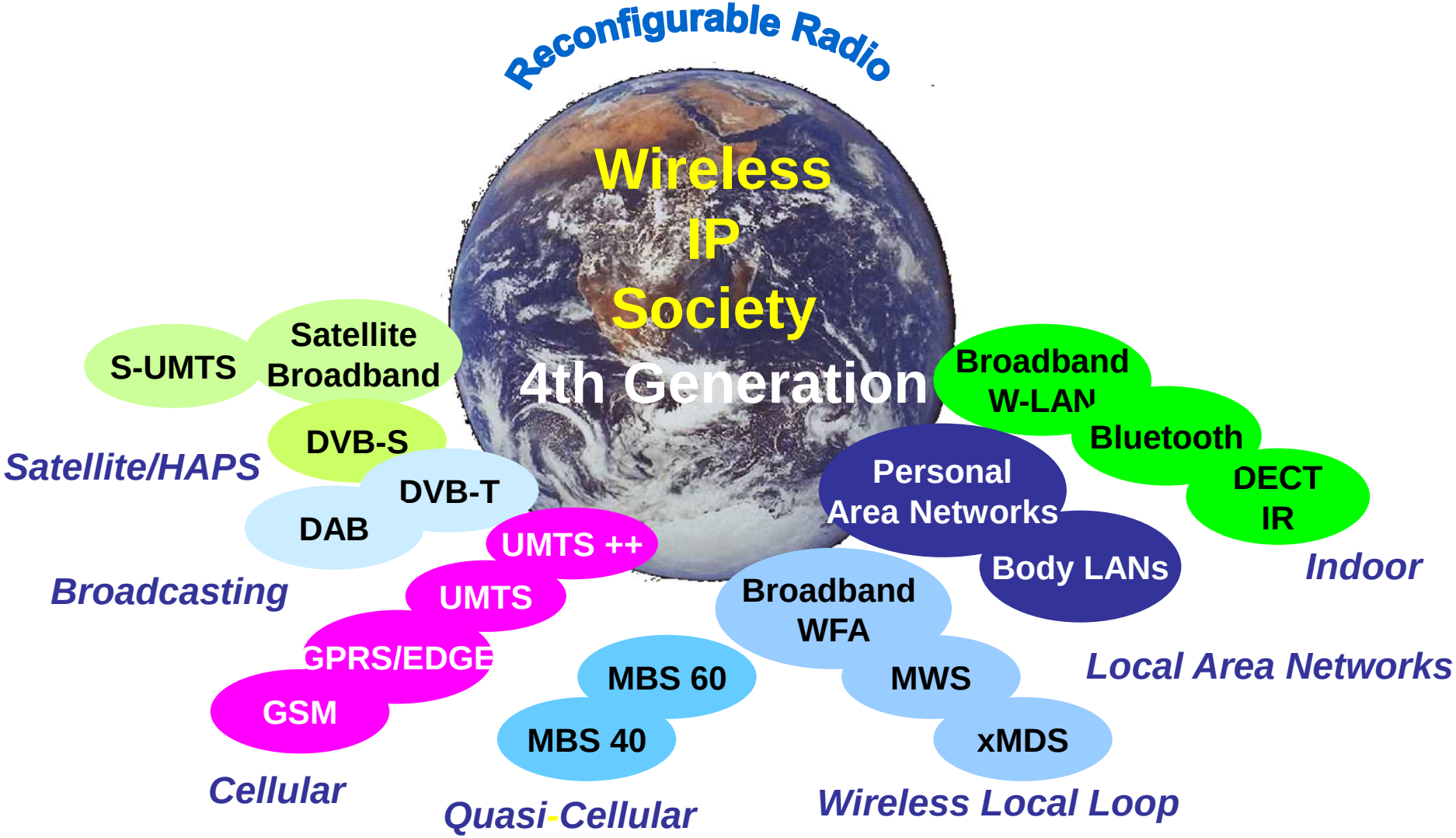


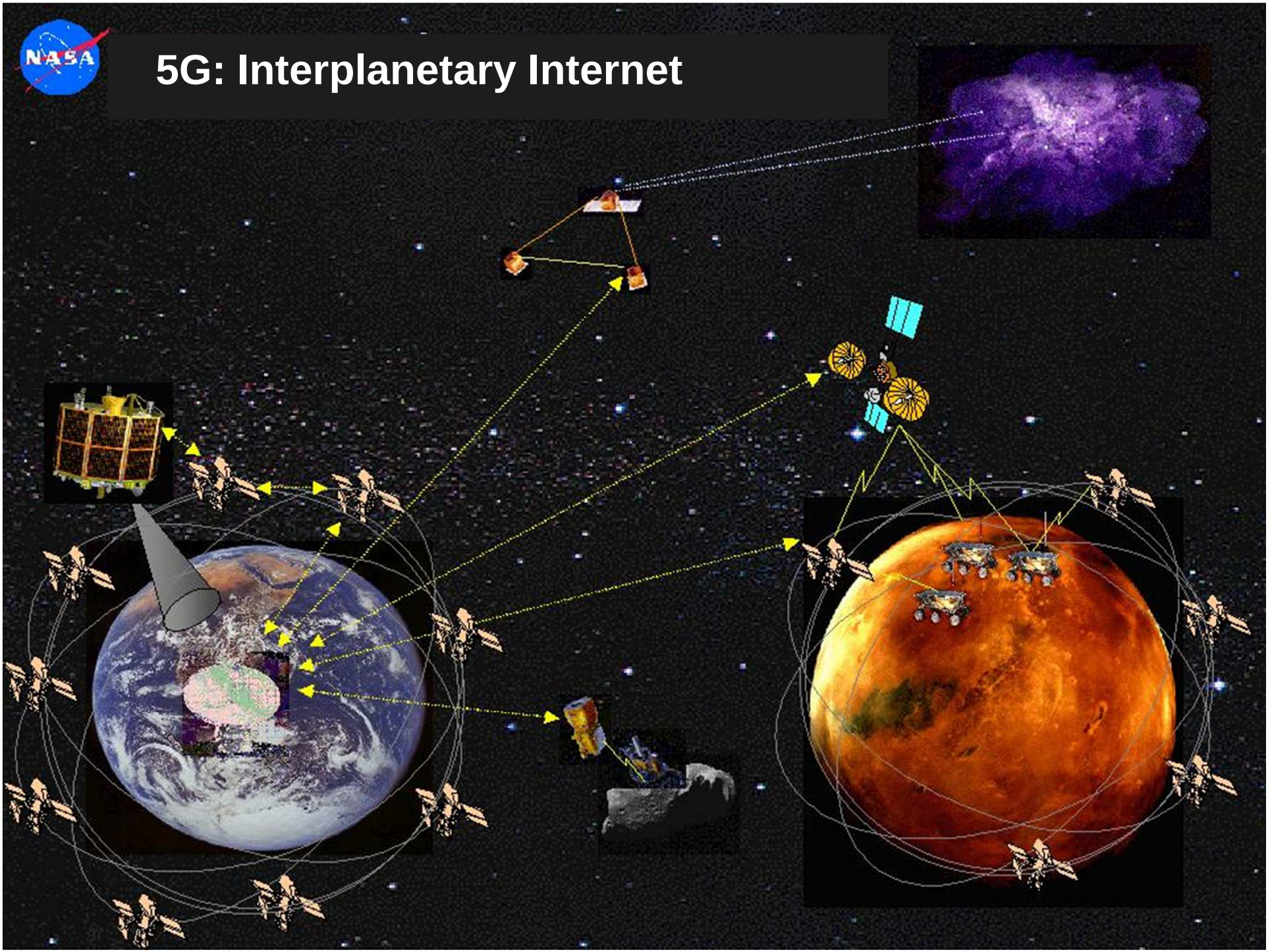
Future Networks/Next Generation Network (NGN)

- Packet-based network
- Provides telecommunication services and more
- Uses multiple broadband, QoS-enabled transport technologies
- Offers unrestricted access by users to different service providers
- Supports generalized mobility
- Allows consistent and ubiquitous provision of services to users

- **Service-related functions are independent from underlying transport-related technologies**

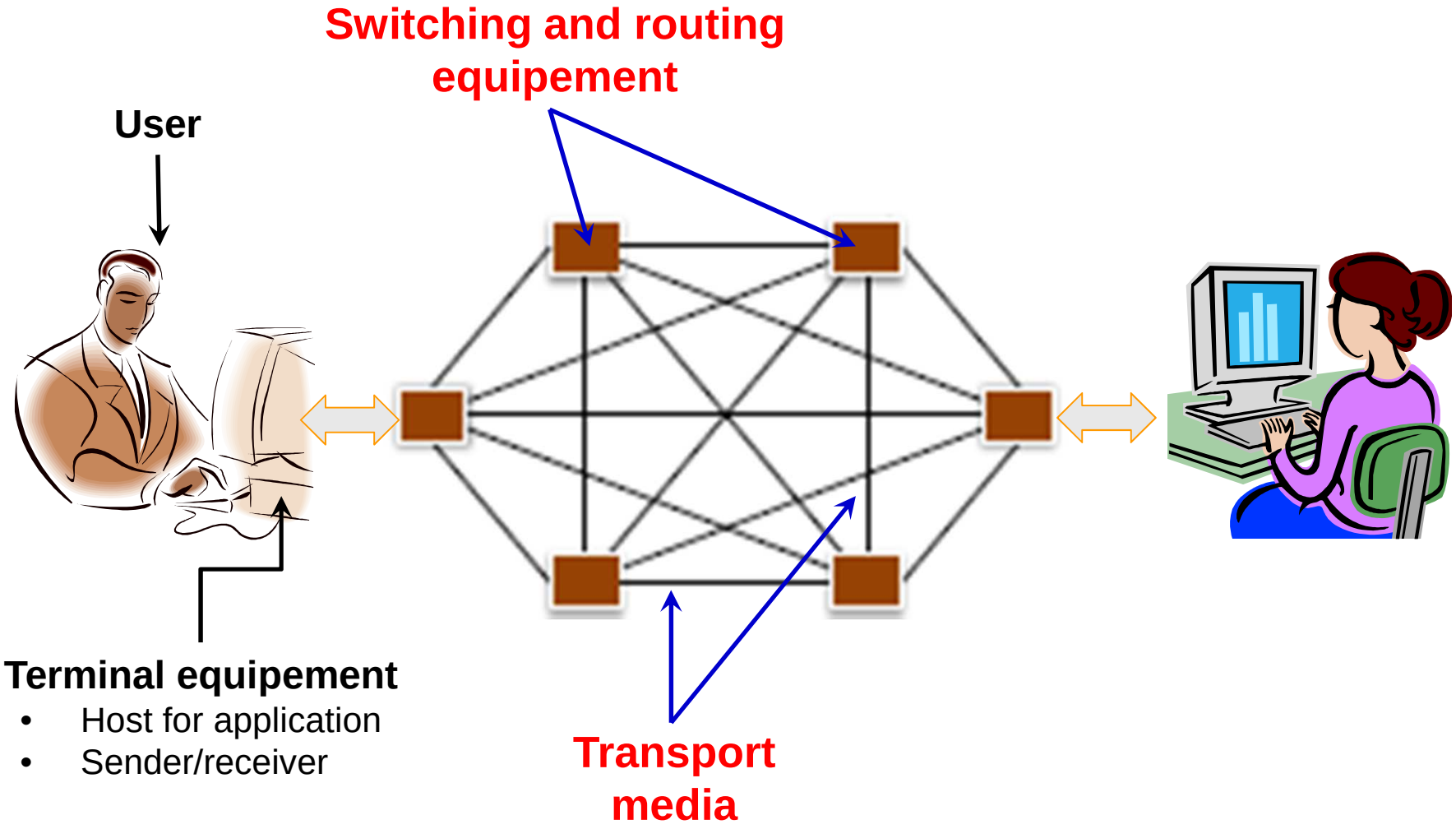
4G Mobile Communication Systems




5G: Interplanetary Internet

Fundamentals

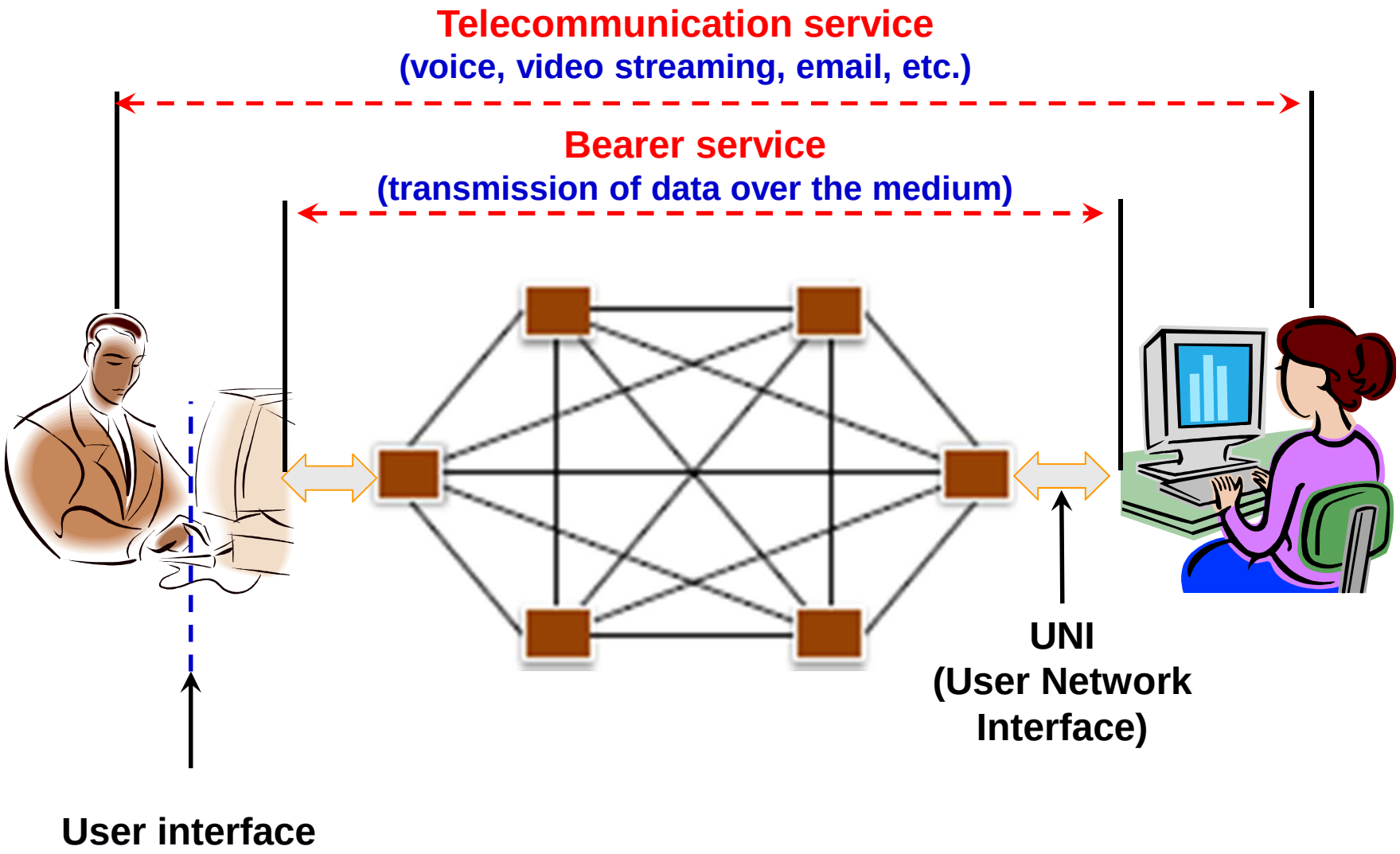
Communication Network – Main Components



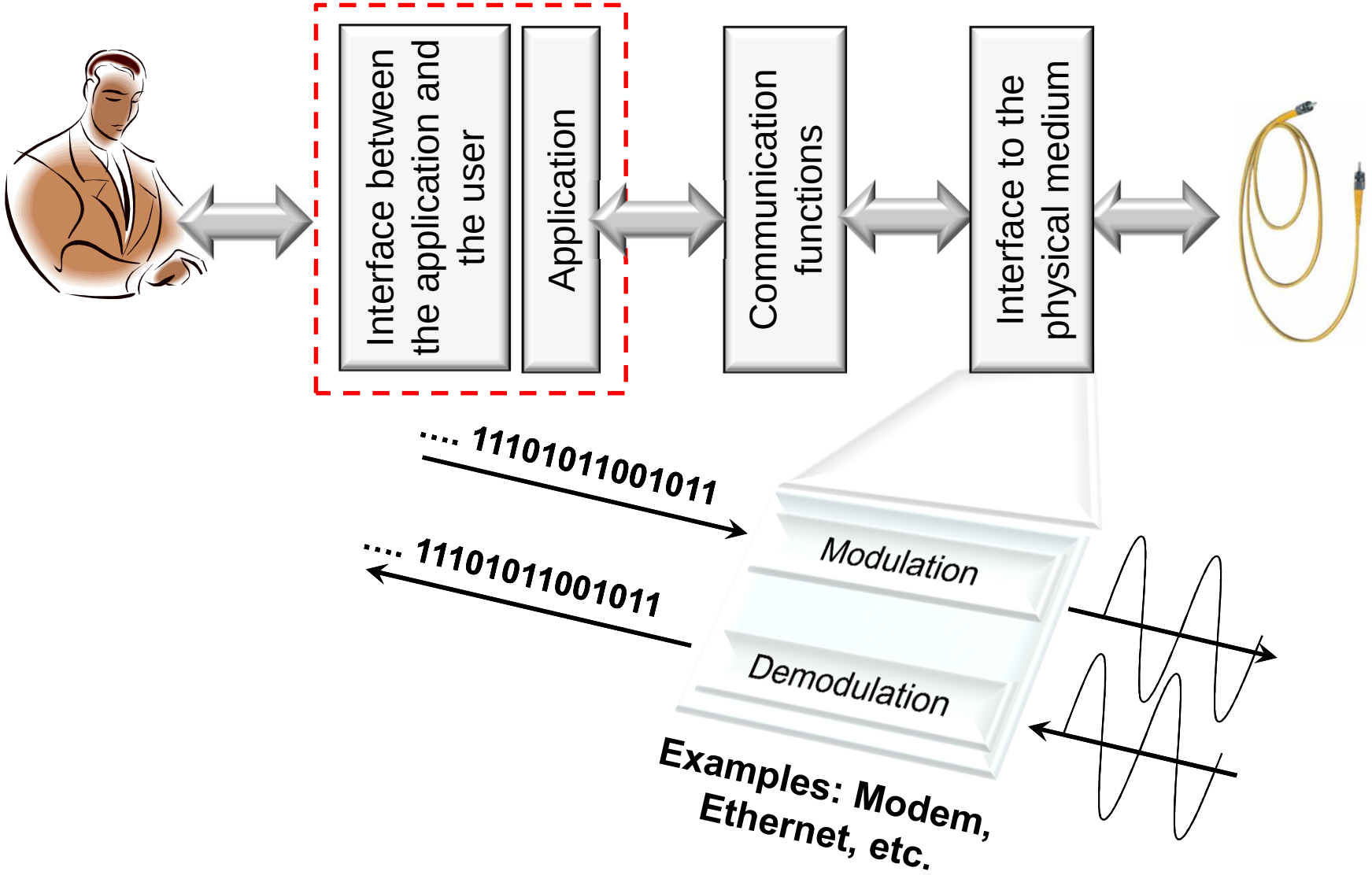
Communication Network – Main Components

- Terminal Equipment
  - Source and/or destination of information flows
  - User interface to communication services
  - Host for applications
- Switching and Routing Equipment
  - Switching, routing of data
- Physical/transport Media
  - Links between
    - terminal equipment and switching/routing equipment and among
    - Switching/routing equipments
- International standards are essential

Communication Network – Communication Service



How Communication Can Be Realized?



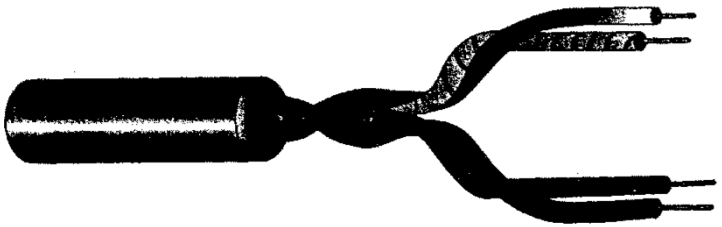
Transmission Media

- Bandwidth
  - How many bits are transmitted per second
- Attenuation
  - Signal strength weakness while distrinution via the medium
- Packet error
  - The ratio of packets received with errors inside
    - Due to attenuation for example

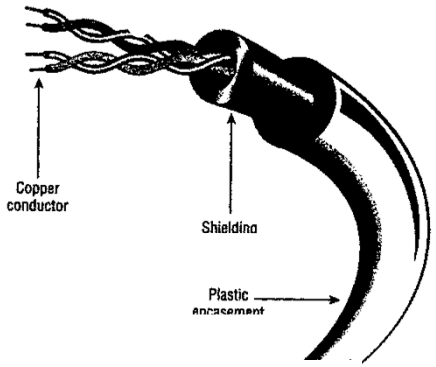
- Distribution function
  - The relationship between the strength of the signal and the length of the medium
- Cost
  - How expensive is the medium

Types of Wired Transmission Media

- Twisted-pair cable
  - Very cheap
  - Consists of two isolated copper cables
  - Two types of twisted-pair cable are known
    - **Shielded Twisted Pair (STP)**
      - Used mostly in Token Ring networks
      - Not that cheap, but reliable
    - **Unshielded Twisted Pair (UTP)**
      - **Cheaper than STP**, but more sensible for attenuation



UTP cable



STP cable

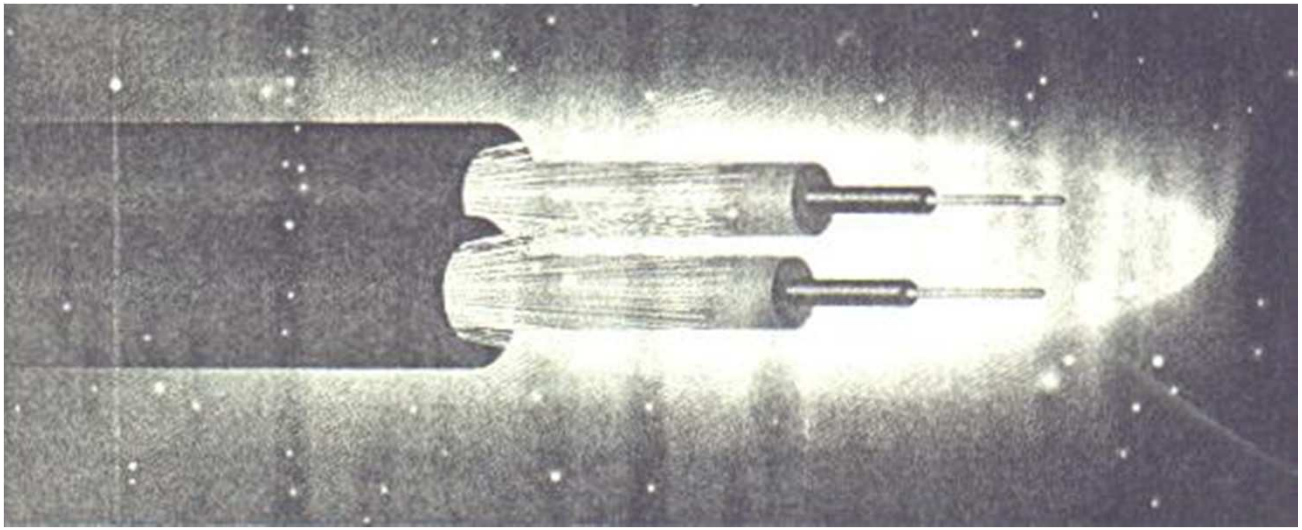
Types of Wired Transmission Media

- Coaxial cable
  - Contains two conductors
  - Consists of
    - Internal conductor
    - External conductor (shield)
    - Isolator
    - Envelop
  - Has two types
    - Thinnet
    - Thicknet

Thin coax (Thinnet)

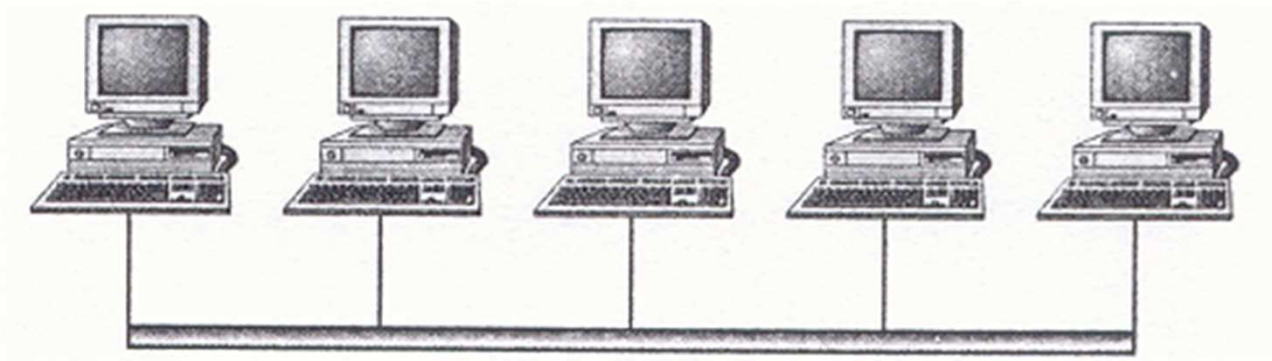
Types of Wired Transmission Media

- Fiber-optic cable
  - The best and the most expensive
  - No attenuation
  - Negligible error rate
  - Sending rate is 100s Mega Bit per second



How Computer Networks are Constructed?

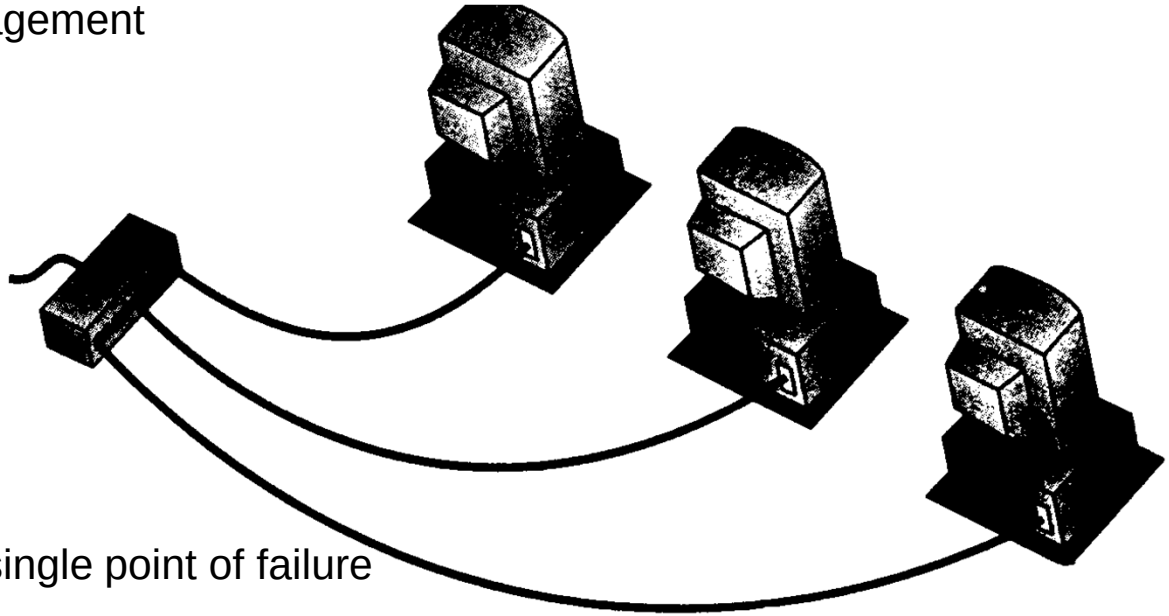
- Bus topology
  - All computers are connected to a single bus
  - Pros
    - Simple
    - Short cable to interconnect computers is adequate → cheap



  - Cons
    - Slow exchange of information
    - The bus is a single point of failure → any defect in the cable destroys the network

How Computer Networks are Constructed?

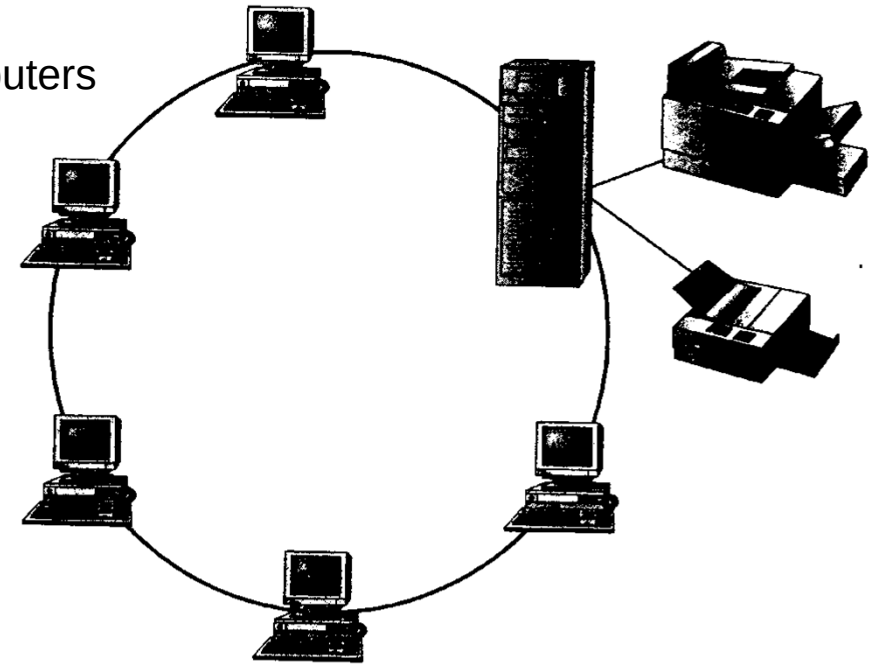
- Star topology
  - All computers are connected to a central point (Hub)
  - Pros
    - Scalable
    - Integration of intelligence in the central point aids in many operations, e.g. network management



  - Cons
    - The hub is a single point of failure
    - Lots of cables are necessary

How Computer Networks are Constructed?

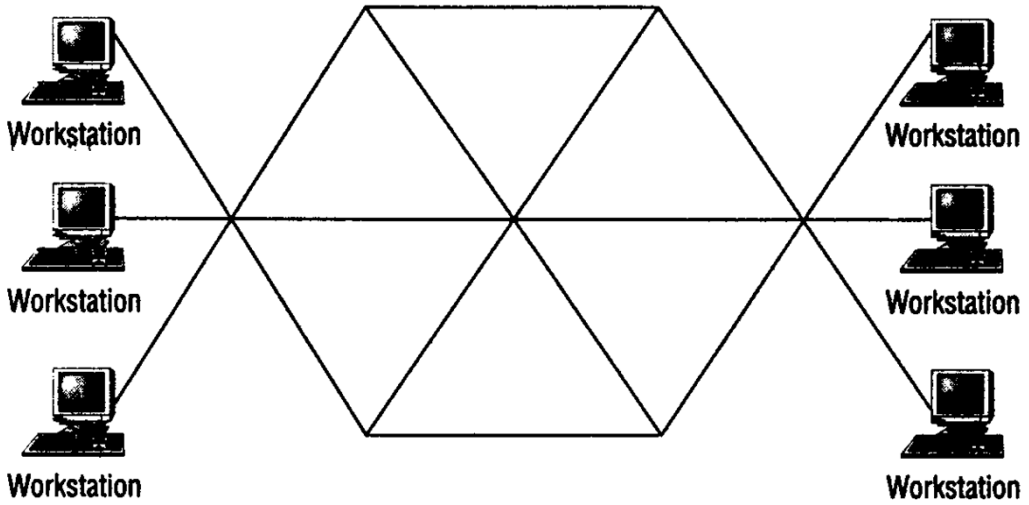
- Ring topology
  - Computers are interconnected via a ring
  - Pros
    - Fairness among computers



  - Cons
    - Each computer is a single point of failure
    - Hard management

How Computer Networks are Constructed?

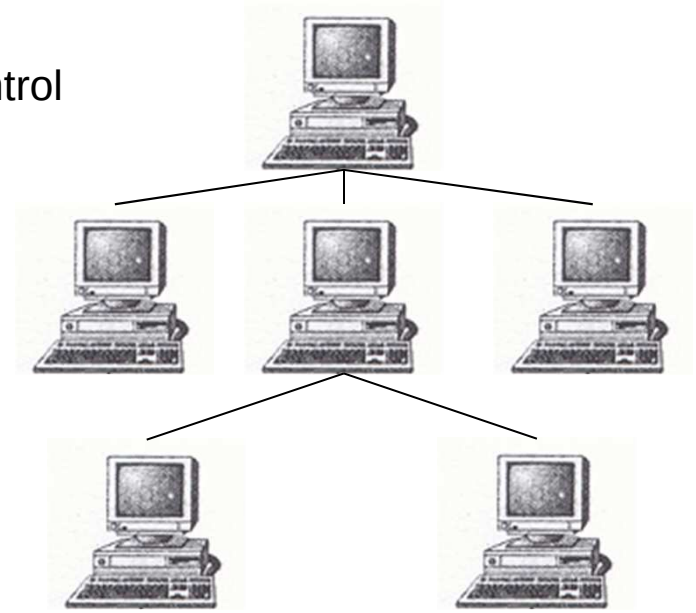
- Mesh topology
  - Each computer is interconnected with anyone else in the network
  - Pros
    - Robust (inspite of defects, the network remains working)



  - Cons
    - Hard management
    - Lots of cables

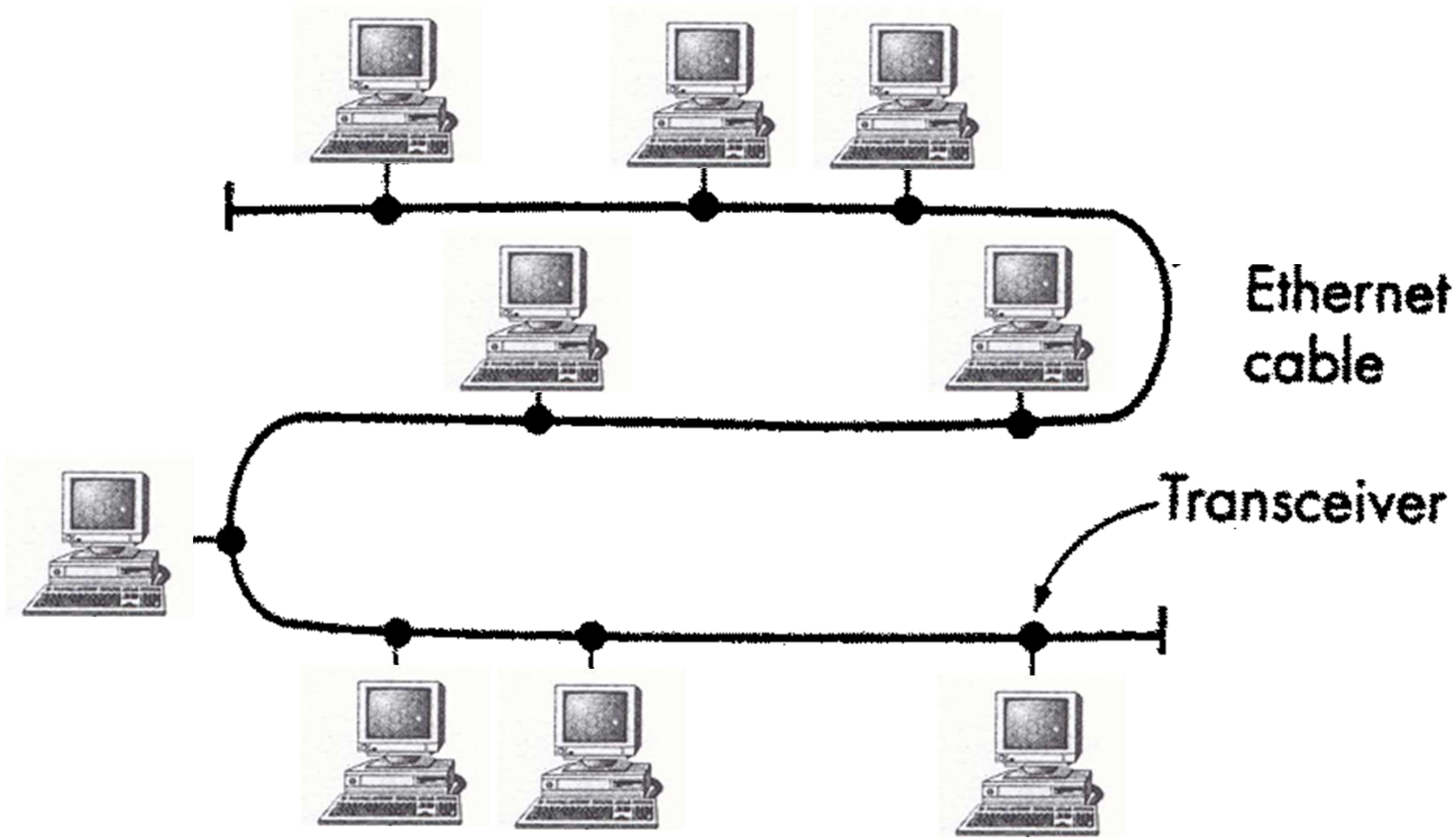
How Computer Networks are Constructed?

- Hirarchical topology
  - Computers are interconnected in a hierarchical manner
  - Pros
    - Simple management and control



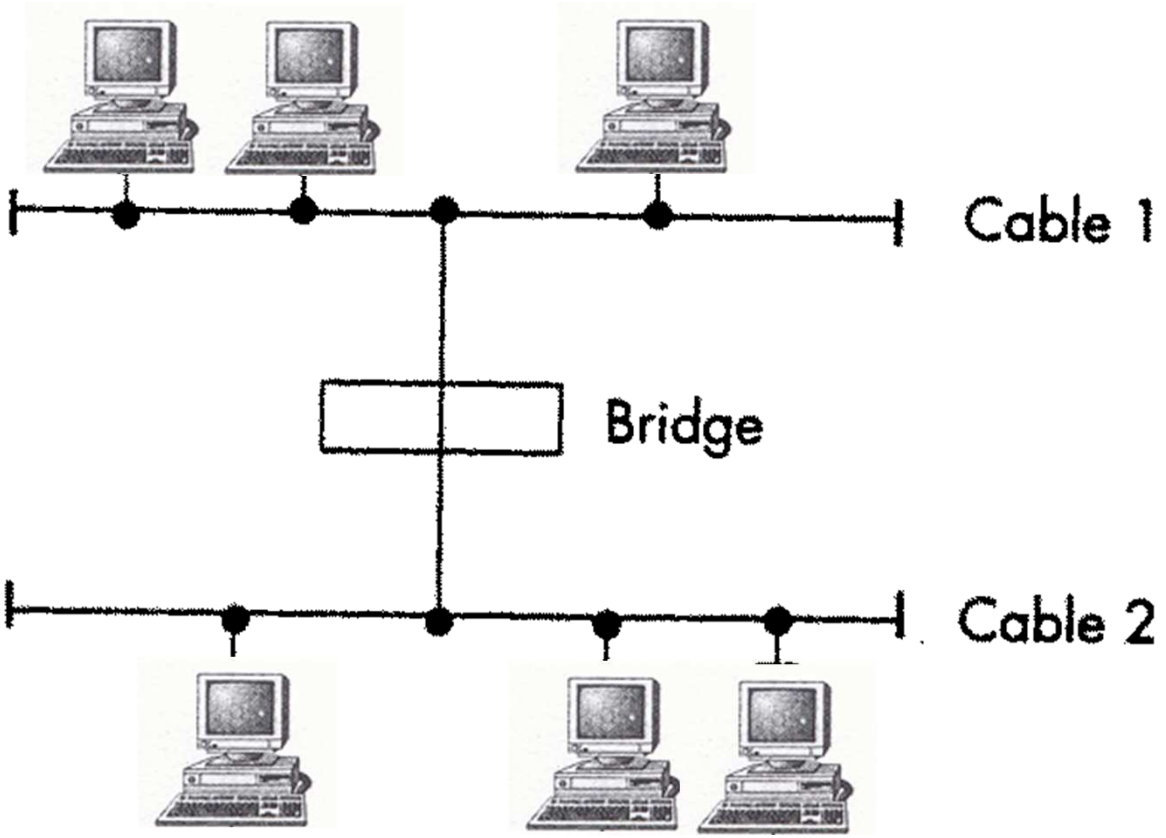
  - Cons
    - Many single point of failures

Local Area Network (LAN)



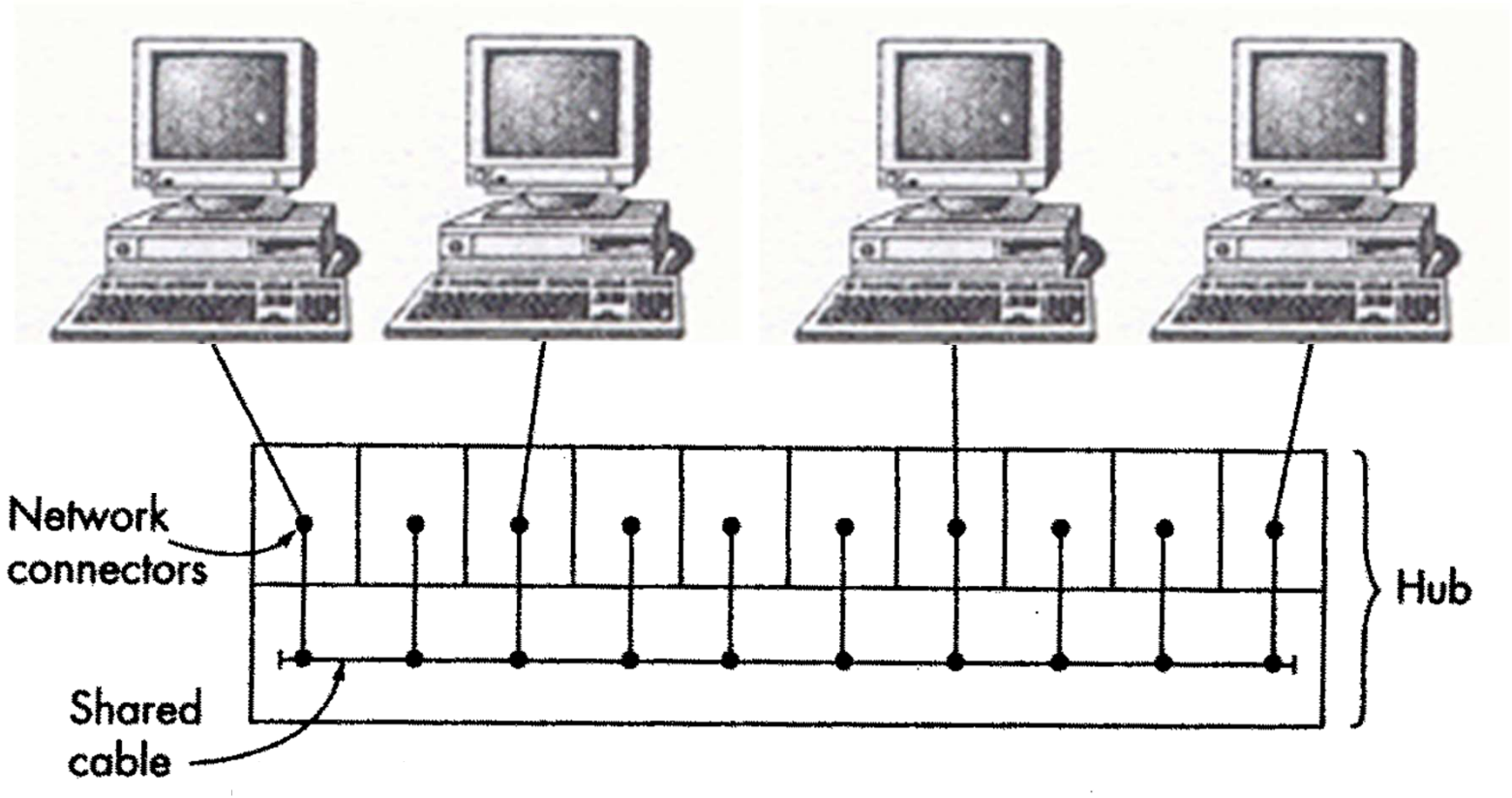
A Single Shared Cable Configuration

Local Area Network (LAN)

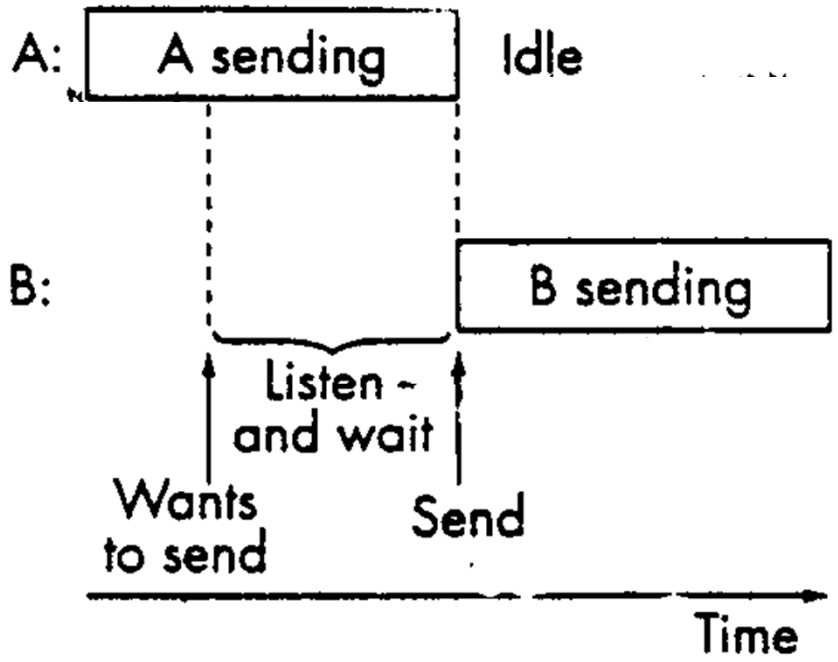


A Multiple Cable Configuration

Local Area Network (LAN)

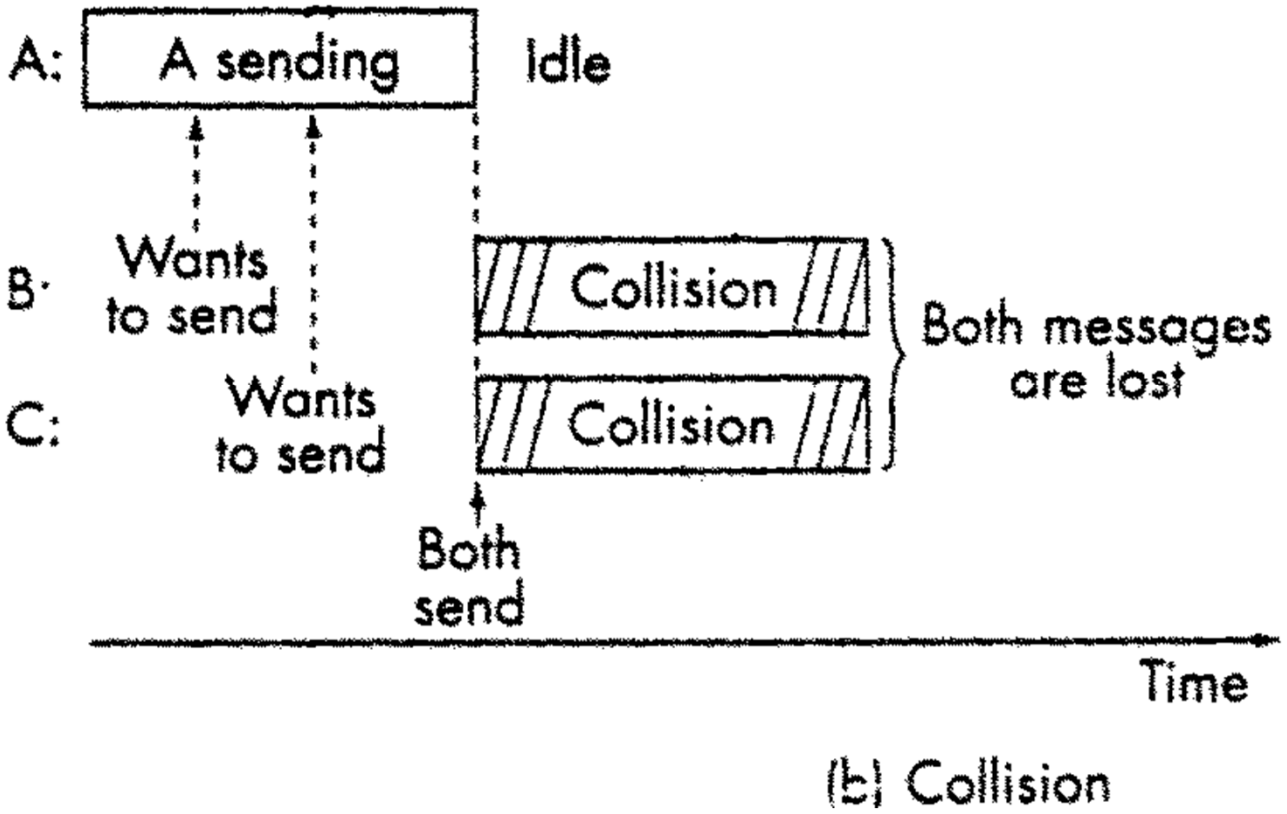


Transmission of Data



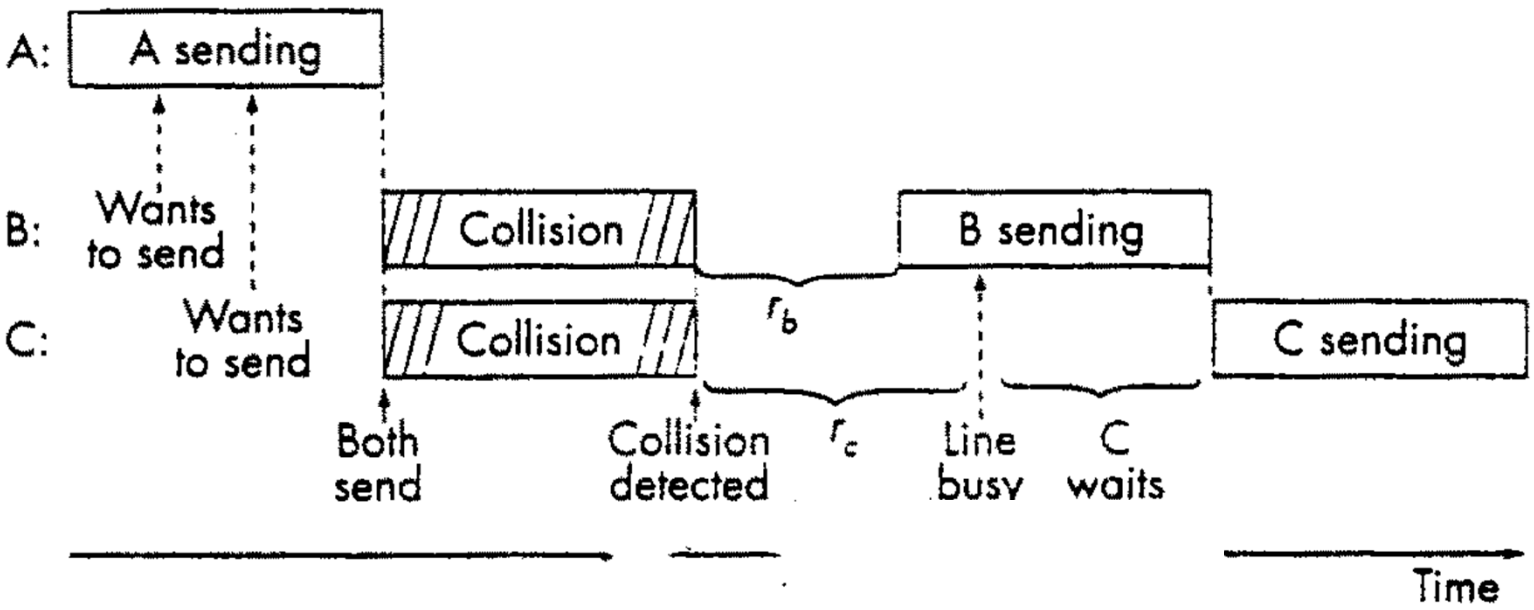
(a) No Collision

Transmission of Data



(b) Collision

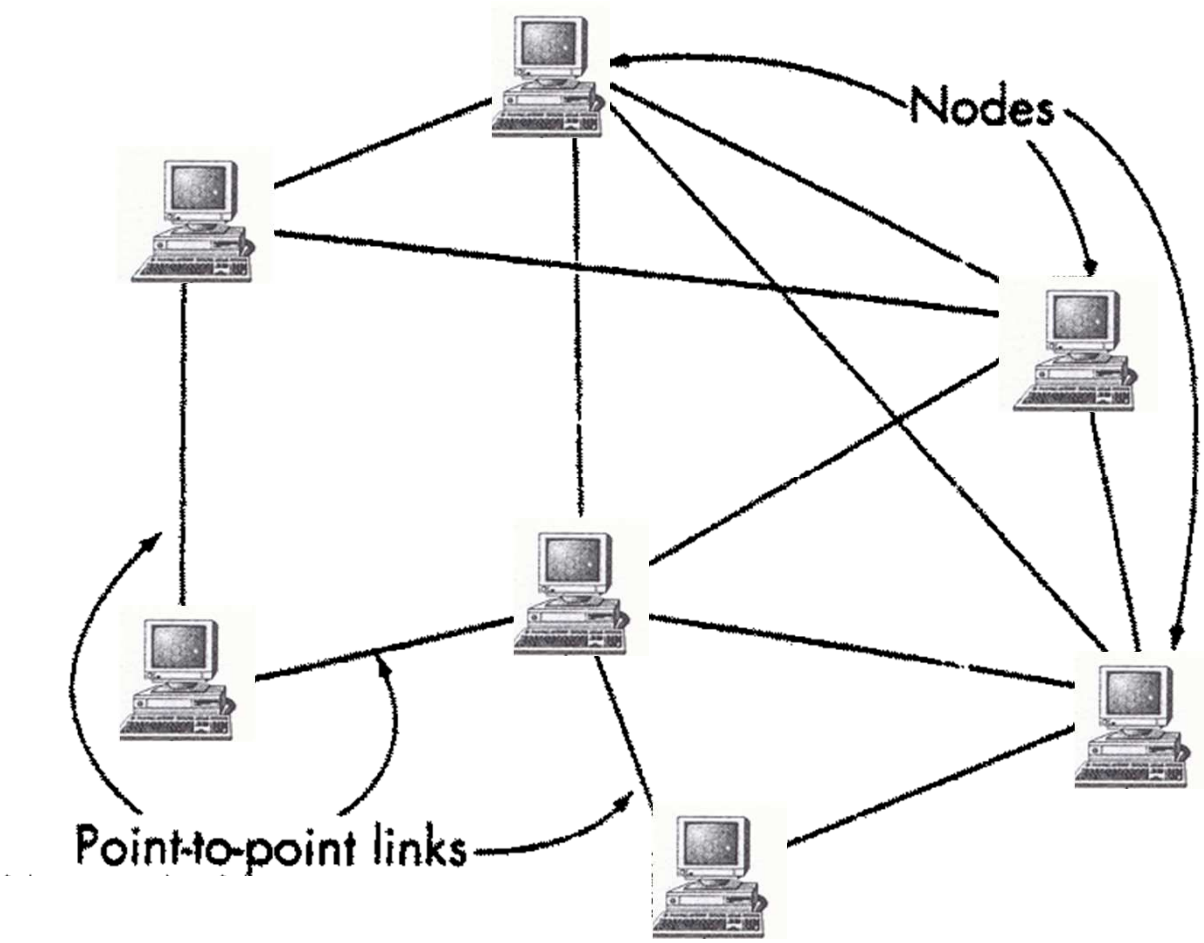
Transmission of Data



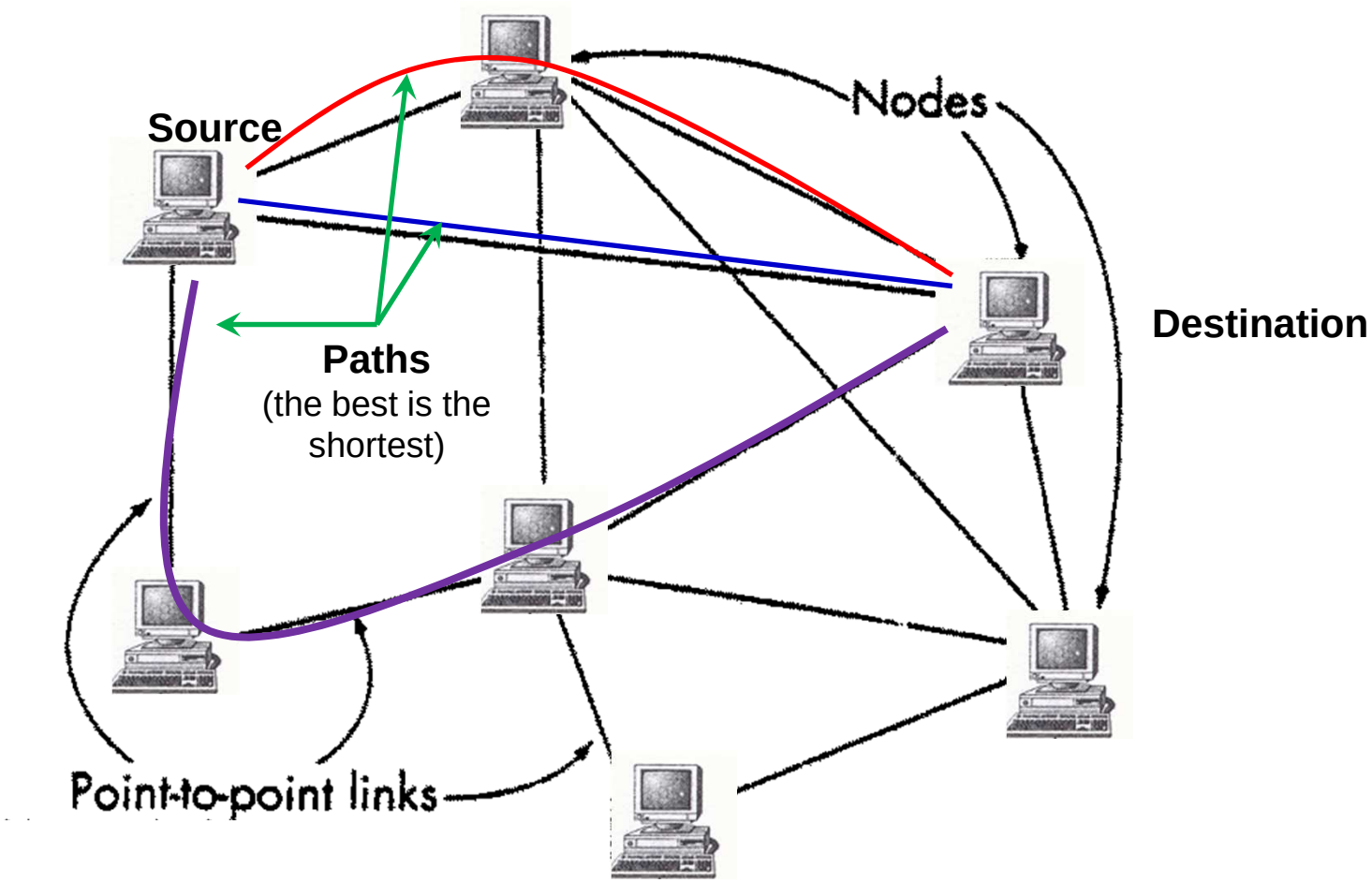
r_b = random waiting time of node B
r_c = random waiting time of node C

(c) Collision and Retransmission

Wide Area Networks (WAN)



Wide Area Networks (WAN)



Standarization

Standardization Organizations

- International Standardization Organizations
  - International Organization for Standardization (ISO)
    - ISO Reference Model for Open Systems Interconnection (OSI)
  - International Telecommunication Union (ITU)
    - Telecommunication Standardization Sector, ITU-T
    - Radio communication Sector, ITU-R
    - Telecommunication Development Sector, ITU-D
  - Institute of Electrical and Electronics Engineers (IEEE)

- Regional/National Standardization Organizations
  - European Telecommunication Standards Institute (ETSI)
  - American National Standards Institute (ANSI)
  - Deutsches Institut für Normung (DIN)

Standardization Organizations

- Standardization of the Internet
  - Internet Engineering Task Force (IETF)
    - Large number of working groups and informal discussion groups
    - Working groups organized into areas, each for a subject
    - Area directors, together with the IETF Chair, form the Internet Engineering Steering Group (IESG)

- Special Interest Groups (SIGs)
  - Bluetooth-SIG
  - EcmaInternational (former European Computer Manufacturers Association)
  - The Open Group (former OSF and X/Open)
  - ZigBeeAlliance