Introduction to Informatics

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Course 07

Computer Network/Network

- a collection of computers and other hardware components interconnected by communication channels that allow sharing of resources and information

- classification
  - the medium used to transport the data
  - communications protocol used
  - scale
  - topology
  - organizational scope

Network

- Communications protocols
  - define the rules and data formats
  - provide the basis for network programming
  - include two Ethernet, a hardware and link layer standard

- Internet protocol suite
  - a set of protocols for internetworking

Networks' properties

- Facilitate communications
- Permit sharing of files, data, and other types of information
- Share network and computing resources
- May be insecure
- May interfere with other technologies
- May be difficult to set up

Communication

- Wired technologies
  - Twisted pair
  - Coaxial cable
  - ITU-T G.hn technology
  - optical fiber
- Exotic technologies
  - IP over Avian Carriers (RFC 1149) – 2001
  - extending the Internet to interplanetary dimensions via radio waves

Communication

- Wireless technologies
  - Terrestrial microwave
  - Communications satellites
  - Cellular and PCS systems
  - Radio and spread spectrum technologies
  - Infrared communication
  - global area network (GAN)

Communications protocols

- Ethernet
  - IEEE 802
  - IEEE 802.11– Wireless LAN (WLAN)
  - IEEE 802.1D – MAC bridging – Spanning Tree Protocol
  - IEEE 802.1Q – VLANs
  - IEEE 802.1X – Network Access Control Protocol

- Internet Protocol Suite – TCP/IP
  - modern internetworking
  - addressing, identification, and routing specification
  - Internet Protocol Version 4 (IPv4) and IPv6

Communications protocols

- Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH)
  - standardized multiplexing protocols
  - transfer multiple digital bit streams over optical fiber using lasers
- Asynchronous Transfer Mode
  - switching technique for telecommunication networks
  - uses asynchronous time-division multiplexing and encodes data into small, fixed-sized cells
  - uses a connection-oriented model
- Network programming
  - involves writing computer programs
  - network sockets – socket programming

Basic requirements of protocols

- Data formats for data exchange
- Address formats for data exchange
- Address mapping
- Routing
- Detection of transmission errors
- Acknowledgements
- Direction of information flow
- Sequence control
- Flow control

Protocols

- Bluetooth protocols
- Fibre Channel network protocols
- Internet Protocol Suite or TCP/IP model or TCP/IP stack
- OSI protocols family of information exchange standards developed jointly by the ISO and the ITU-T
- Routing protocols
- List of IP protocol numbers, protocol numbers used in the Protocol field of the IPv4 header and the Next Header field of IPv6 header
- Yahoo! Messenger Protocol, underlying protocol used by the Yahoo messenger
- RTPS protocol, an interoperability protocol
- SSH Secure Shell
- FTP File Transfer Protocol
- SMTP Simple Mail Transfer Protocol
- Telnet Telephone Network
- HTTP Hyper Text Transfer Protocol
- HTTPS Secure Hyper Text Transfer Protocol
- SFTP Secure File Transfer Protocol
- SSL Secure Socket Layer
- TLS TRANSFER LAYER SECURITY
- POP post office protocol

Types of Networks

- PAN (Personal Area Network)
- LAN (Local Area Network)
- HAN (Home Area Network)
- SAN (Storage Area Network)
- CAN (Campus Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)
- GAN (Global Area Network)
- Internetworks

PAN (Personal Area Network)

- used for communication among computer and different information technological devices
- include wired and wireless devices
- USB and Firewire connections
- Bluetooth and infrared communication

LAN (Local Area Network)

- connects computers and devices in a limited geographical area
- each computer or device on the network is a node
- based on Ethernet technology
- using existing home wires
- tree topology
- LAN Technologies and Protocols
  - LAN Communication
  - Ethernet
- LAN Transmission Media
  - Wired
  - Wireless
- Internetworking Devices

WAN (Wide Area Network)

- computer network that covers a large geographic area
- using a communications channel
- WAN Technologies
  - WAN Communication
- WAN Transmission Media
  - Wired Media
  - Wireless Media
- Internet Browsers
- Cellular Technology
  - Cellular Telephone Standards
- Satellite Technologies
  - Global Positioning System
  - Satellite Phones
  - Satellite Internet
  - Satellite Television
- WAN Devices

Common LAN and WAN Protocols

- Commonly Used Protocols
  - TCP/IP: The Core Protocol
  - File Transport Protocol
  - Simple Mail Transfer Protocol
  - Post Office Protocol version 3
  - Internet Message Access Protocol version 4
  - Hypertext Transfer Protocol
  - Secure Sockets Layer
  - Domain Name System
  - Dynamic Host Configuration Protocol
  - Tenet
  - Simple Network Management Protocol
- Network Time Protocol

HAN (Home Area Network)

- residential LAN
- used for communication between digital devices
- small number of personal computers and accessories
- sharing of Internet access
- broadband service

SAN (Storage Area Network)

- dedicated network
- provides access to consolidated, block level data storage
- used to make storage devices
  - locally attached devices to the operating system
- own network of storage devices

CAN (Campus Area Network)

- made up of an interconnection of LANs
- the networking equipment: switches, routers
- transmission media: optical fiber, copper plant, Cat5 cabling etc.
- university campus-based campus network
- link a variety of campus buildings

MAN (Metropolitan Area Network)

- computer network that usually spans a city or a large campus
- interconnects a number of local area networks
- using a high-capacity backbone technology
- provides up-link services to wide area networks and the Internet.

GAN (Global Area Network)

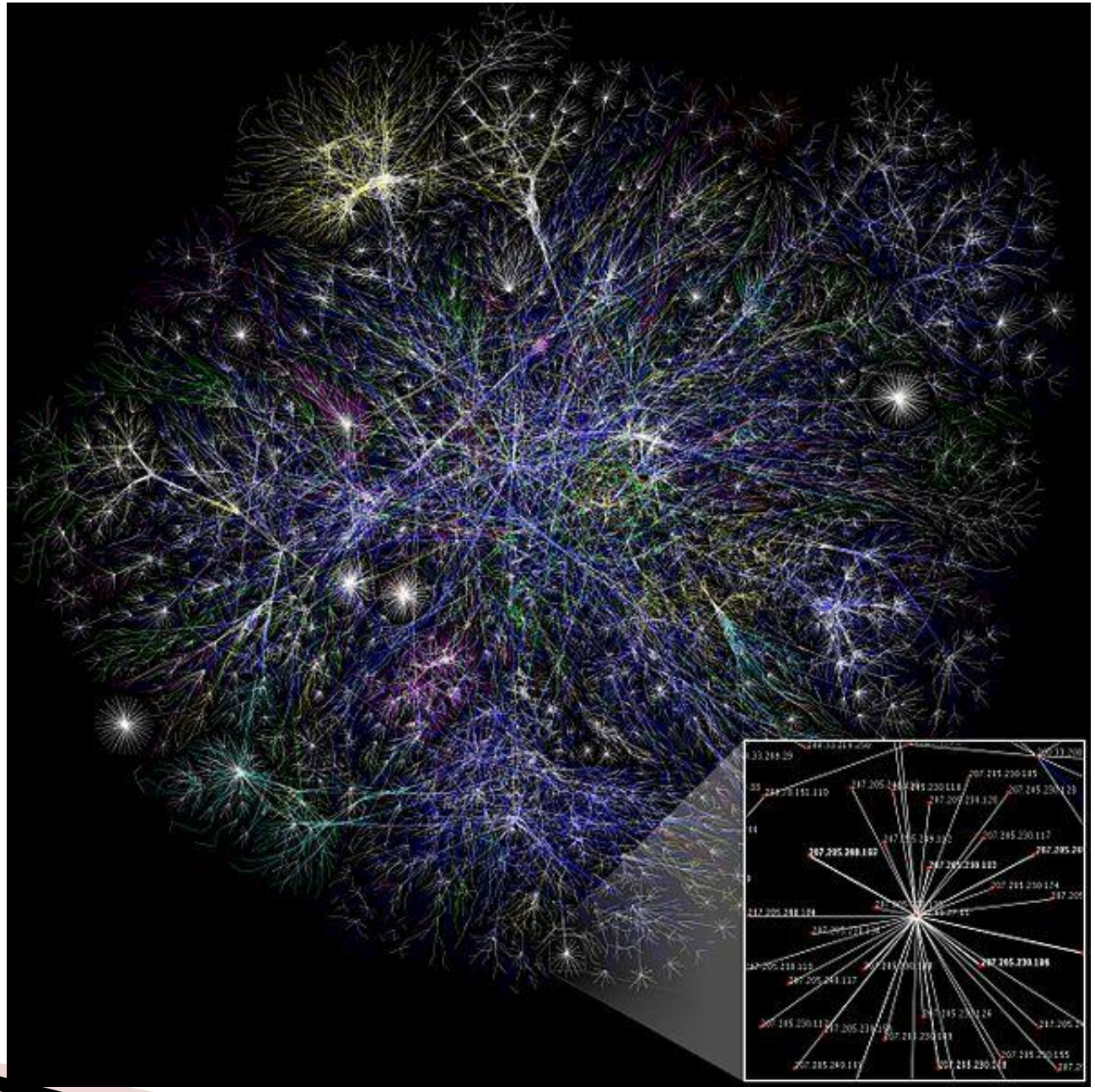
- used for supporting mobile
- number of wireless LANs
- satellite coverage areas

Internetworks

- the connection of multiple computer networks via a common routing technology using routers
- the Internet is an aggregation of many connected internetworks spanning the Earth
- **Internet** is a short form of the technical term internetwork

The Internet

- global system of interconnected computer networks that use the standard Internet Protocol suite
- network of networks
- the inter-linked hypertext documents of the World Wide Web (WWW) and the infrastructure to support email
- Internet Protocol (VoIP) and Internet Protocol Television (IPTV)
- origins of the Internet – 1960s
- Internet Protocol address space and the Domain Name System
- Internet Corporation for Assigned Names and Numbers (ICANN).
- Protocols: IPv4 and IPv6

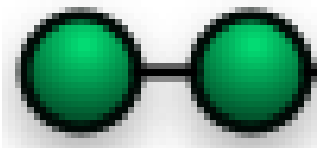


Network Topologies

- Point-to-Point Topology
- Line Topology
- Physical Bus Topology
- Ring Topology
- Mesh Topology
- Star Topology
- Tree Topology
- Hybrid Topology

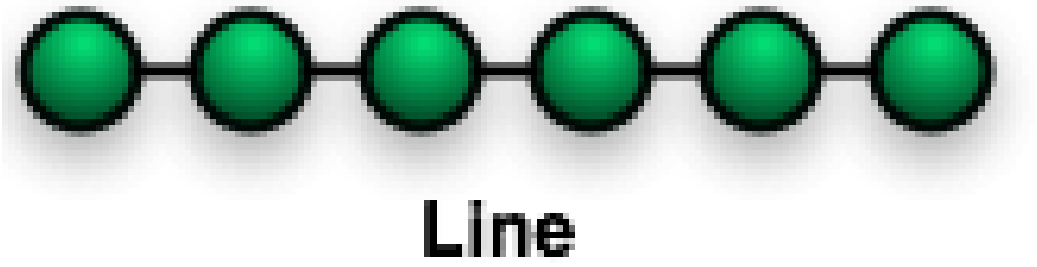
Point-to-Point Topology

- Point-to-point (PTP) topology connects two nodes directly together
- one of the basic building blocks of larger, more complicated topologies
- all major topologies include it
- multipoint topology



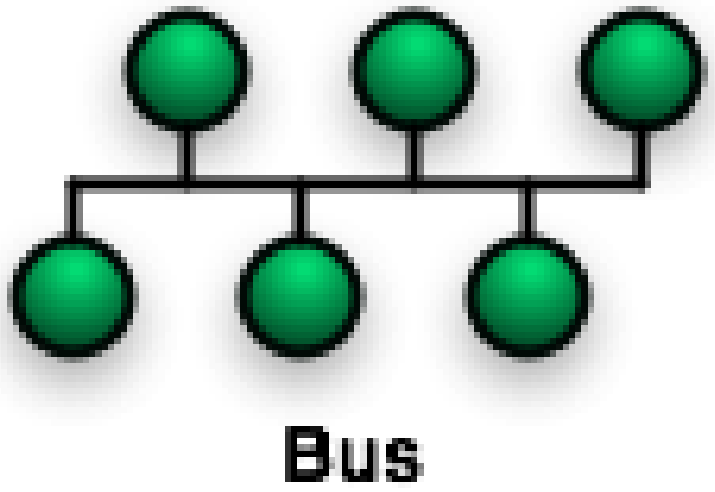
Line Topology

- rare topology
- works by connecting every host to the host located to the right of it



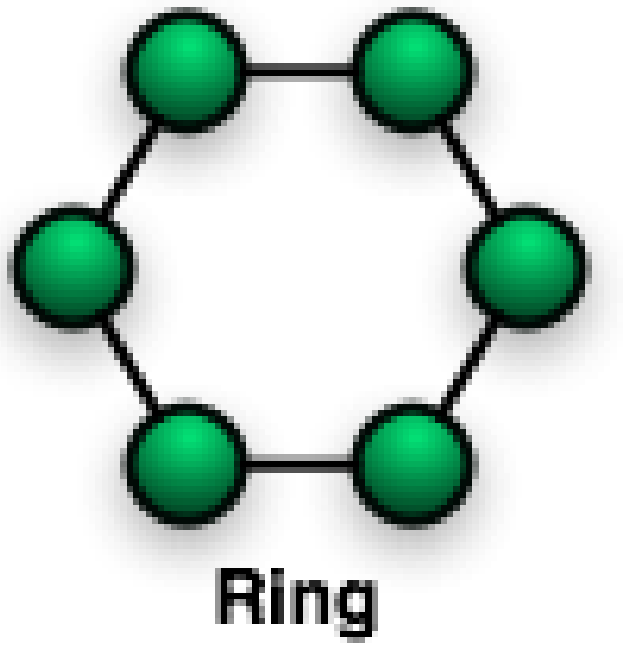
Physical Bus Topology

- creates a network by connecting 2 or more hosts to a length of coaxial backbone cabling
- one of the major network topologies of the networking world



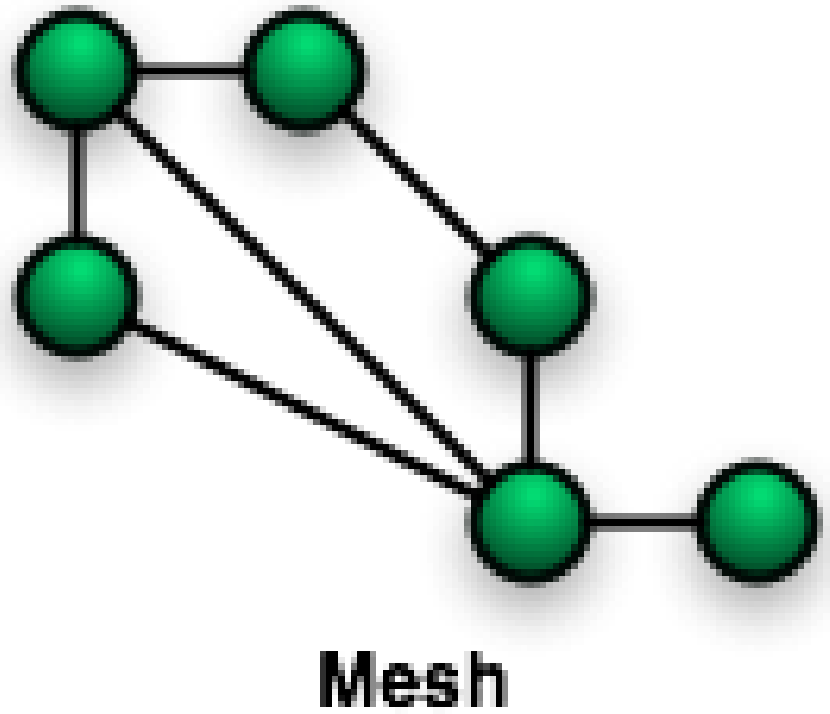
Ring Topology

- token ring topology
- creates a network by arranging 2 or more hosts in a circle
- data is passed between hosts through a 'token.'



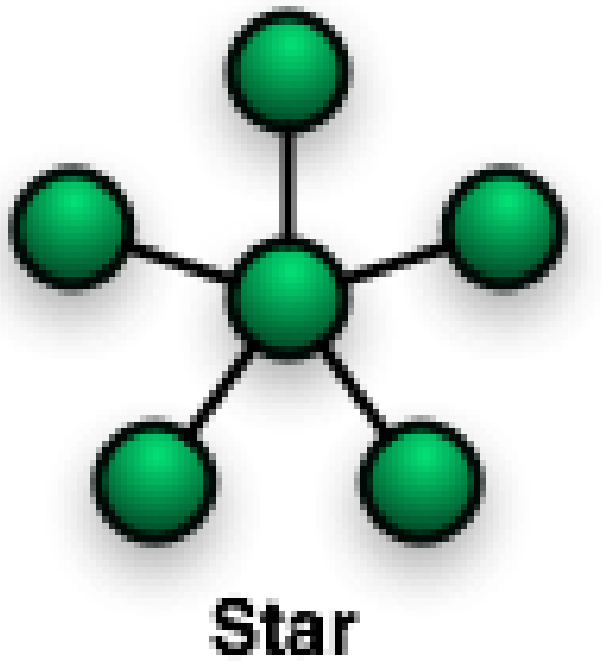
Mesh Topology

- creates a network by ensuring that every host machine is connected to more than one other host machine on the local area network



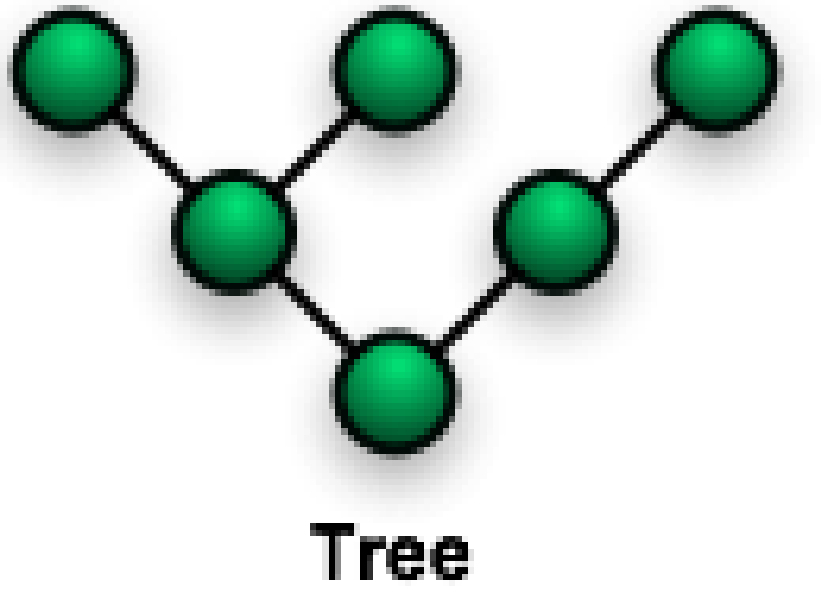
Star Topology

- creates a network by arranging 2 or more host machines around a central hub
- 'star ring' topology
- used in a broadcast or SIMO network



Tree Topology

- "root" node
- smaller nodes
- DNS system
- connect with individual networks and computers



Hybrid Topology

- most networks implement today
- uses a combination of multiple basic network topologies
- the most common hybrid topologies include Star Bus, and Star Ring

Network Architecture

- the design of a communications network
- a framework
- expressed by its use of the Internet Protocol Suite
- The Simple Network: Peer-to-Peer
- The Modern Network: Client/Server

The OSI Networking Model
OSI – Open Systems Interconnection

1. Application Layer
2. Presentation Layer
3. Session Layer
4. Transport Layer
5. Network Layer
6. Data Link Layer
7. Physical Layer

THE 7 LAYERS OF OSI

Application Layer

- contains all protocols and methods of process-to-process communications across an Internet Protocol (IP) network
- methods use the underlying transport layer protocols to establish host-to-host connections
- comprise
  - Internet protocol suite (TCP/IP)
  - Open Systems Interconnection model
- strict modular separation of functionality

Presentation Layer

- serves as the data translator for the network
- syntax layer
- responsible for the delivery and formatting of information
- the conversion of an EBCDIC-coded text computer file to an ASCII-coded file
- the lowest layer
- deals with issues of string representation
- encryption
- decryption
- n many widely used applications and protocols, no distinction is made between the presentation and application layers (Hyper Text Transfer Protocol - HTTP)

Session Layer

- layer provides the mechanism for opening, closing and managing a session between end-user application processes
- consist of requests and responses
- the session-layer protocol may close connection and re-open it
- responds to service requests from the presentation layer and issues service requests to the transport layer

Transport Layer

- provides end-to-end communication services for applications
- provides convenient services such as connection-oriented data stream support, reliability, flow control, and multiplexing
- contains
  - TCP/IP model
  - Open Systems Interconnection (OSI) model
- Transmission Control Protocol (TCP)
  - connection-oriented transmissions
  - connectionless User Datagram Protocol (UDP)
- Datagram Congestion Control Protocol (DCCP)
- Stream Control Transmission Protocol (SCTP)

Network Layer

- responsible for packet forwarding including routing through intermediate routers
- provides the functional and procedural means of transferring variable length data sequences
- Functions of the network layer include:
  - Connection model: connectionless communication
  - Host addressing
    - Fred Murphy, 1 Main Street, Dublin, Ireland
    - Internet Protocol (IP) address
  - Message forwarding

Data Link Layer

- in TCP/IP reference model, it corresponds to, or is part of the link layer
- the protocol layer that transfers data between adjacent network nodes in a wide area network or between nodes on the same local area network segment
- Ethernet
- Point-to-Point Protocol (PPP)
- HDLC and ADCCP

Data Link Layer

- provides data transfer across the physical link
- transfer can be reliable or unreliable
- higher-level protocols must provide flow control, error checking, and acknowledgments and retransmission in case of transmission errors
- IEEE 802 LAN, data link sublayers
  - media access control (MAC)
  - logical link control (LLC)

Physical Layer

- the implementation of this layer is often termed PHY
- consists of the basic networking hardware transmission technologies of a network
- the most complex layer
- defines the means of transmitting raw bits rather than logical data packets over a physical link connecting network nodes
- provides an electrical, mechanical, and procedural interface to the transmission medium