Introduction to Informatics

Course 07

Re-take MIDTERM

Operating System

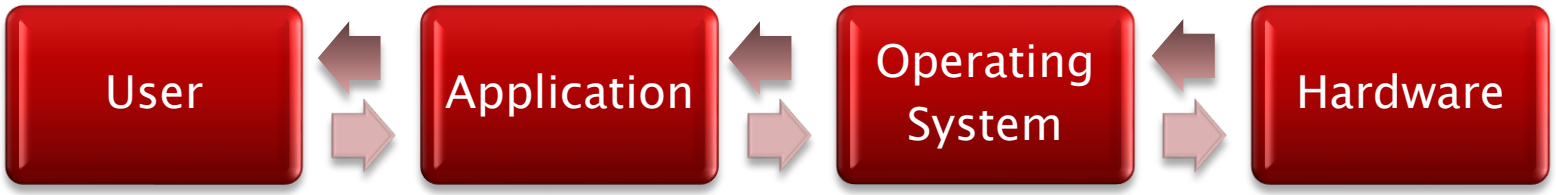
Definition

- the operating system is a system of programs which controls the executions of the programs in the computer system
- it schedules the executions of the programs, distributes the resources and ensures the communication between users and the computer system (hardware)
- ISO (International Standard of Organisation)

Operating System

- time-sharing operating systems
  - include accounting for cost allocation of processor time, mass storage, printing and other resources
- input and output and memory allocation
  - an intermediary between programs and the computer hardware
  - application code is usually executed directly

Operating System



Types of operating system

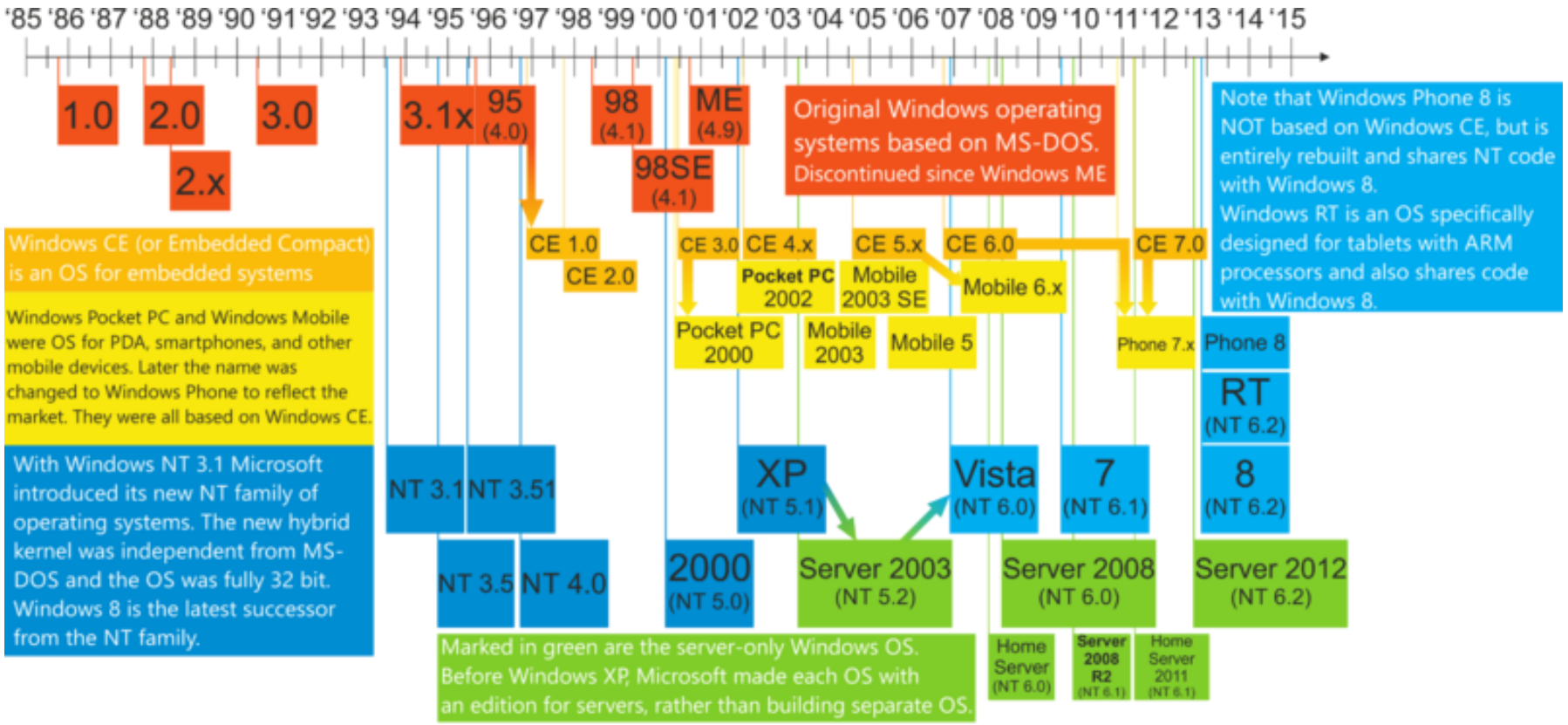
- The most popular:
  - Android
  - BSD
  - iOS
  - Linux
  - Mac OS
  - Microsoft Windows
  - Windows Phone
  - IBM z/OS

DOS (Disk Operation System)

- third generation developed **DOS** about 1965
- control languages were implemented to transmit instructions
- programming languages were implemented to code problems
- terminals
- communication remained textual
- menu controlled connection
- the longer command had to be typed
- the syntax had to be kept in mind
- **GUI** (Graphical User Interface)

Microsoft Windows

- graphical interface operating systems
- 20 November 1985
- Early versions: Windows 1.0, Windows 2.0, and Windows 2.1x
- Windows 3.0 and 3.1
- Windows 95, 98, and Me
- Windows NT family
- 64-bit operating systems
- Windows 7
- Windows CE
- Windows Server 2012
- Windows Phone 7.5
- Windows 8 – 26 October 2012

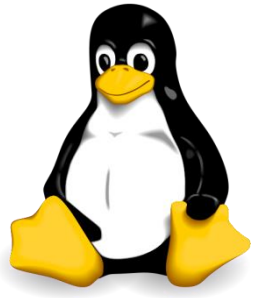


Explanation of arrows: I. Windows CE is based on code from Windows 95. II. Windows Pocket PC 2000 is based on Windows CE 3.0. III. Windows Mobile 6.x is based on Windows CE 5.x, rather than CE 6.0. IV. Windows Phone 7 is based on code from both Windows CE 6.0 and CE 7.0. V. Windows Vista was built on code from Windows Server 2003, rather than Windows XP.

Windows Phone

- mobile operating systems
- developed by Microsoft
- Microsoft created a new user interface
- sets minimum requirements for the hardware

Linux



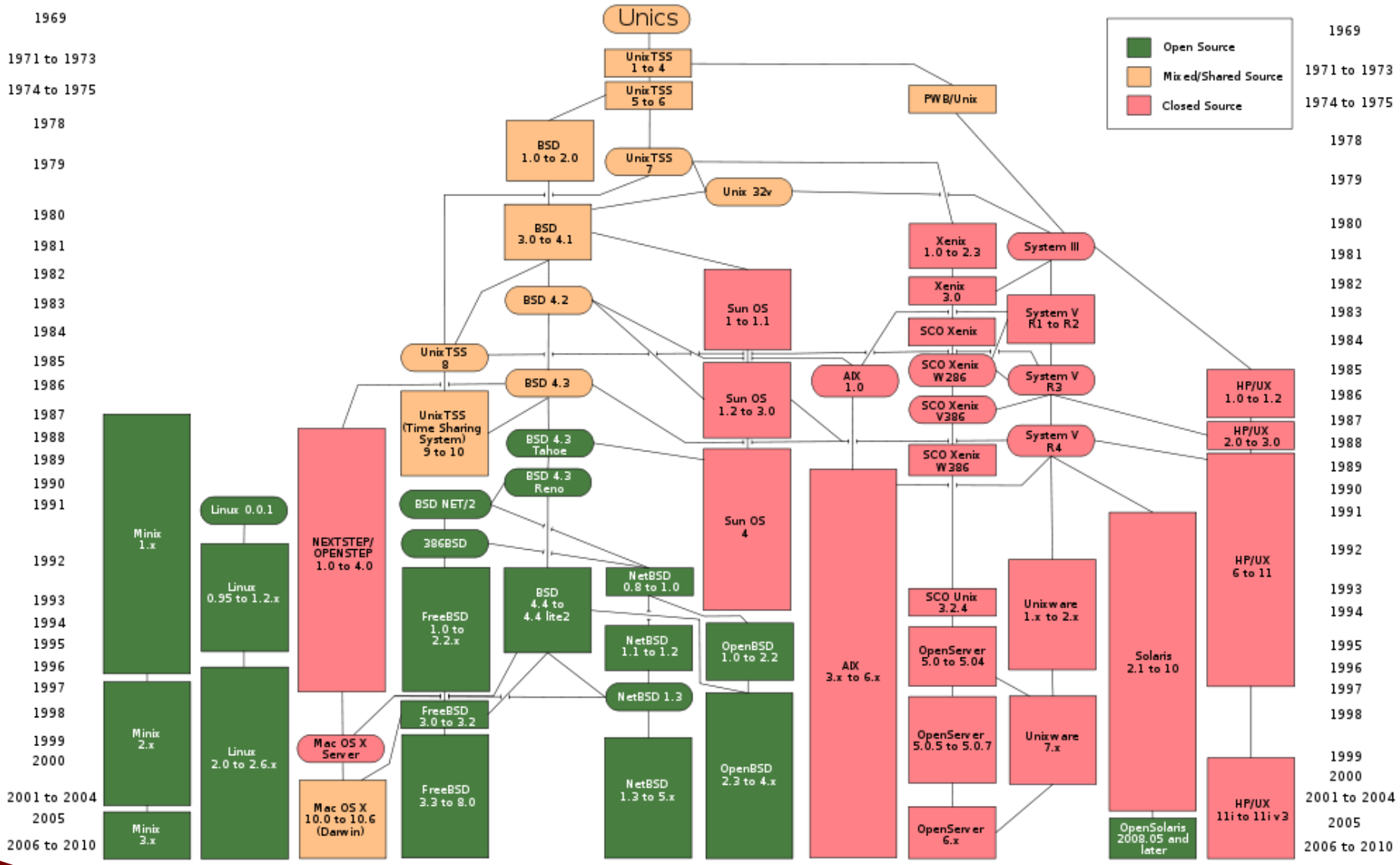
- free and open source software
- 5 October 1991 by Linus Torvalds
- **Unix** – implemented in 1969 at AT&T's Bell Laboratories in the United States by Ken Thompson, Dennis Ritchie, Douglas McIlroy, and Joe Ossanna
- 1971 – assembly language
- 1973 – programming language C by Dennis Ritchie
- 1984 – AT&T divested itself of Bell Labs

Linux

- free and open source software
- GNU – General Public License
- Linux distributions: Debian, Fedora, openSUSE
- C compiler Linux originated in GNU Project
  - GNU Project started in 1983 by Richard Stallman
  - 1985 Stallman started the Free Software Foundation
  - GNU General Public License (GNU GPL) in 1989

LINUX

- BSD
  - 1992 – 386BSD (NetBSD and FreeBSD)
- MINIX
  - Andrew S. Tanenbaum
  - version 3 in 2005
- Linux kernel – Linus Torvalds
- third-party non-GNU components
- distribute
  - the kernel
  - GNU components
  - non-GNU components


Unics
UnixTSS 1 to 4
UnixTSS 5 to 6
PWB/Unix
BSD 1.0 to 2.0
UnixTSS 7
Unix 32v
BSD 3.0 to 4.1
Xenix 1.0 to 2.3
System III
Xenix 3.0
BSD 4.2
Sun OS 1 to 1.1
System V R1 to R2
SCO Xenix
UnixTSS 8
AIX 1.0
SCO Xenix W286
System V R3
BSD 4.3
Sun OS 1.2 to 3.0
HP/UX 1.0 to 1.2
SCO Xenix V386
HP/UX 2.0 to 3.0
UnixTSS (Time Sharing System) 9 to 10
BSD 4.3 Tahoe
System V R4
SCO Xenix W386
BSD 4.3 Reno
BSD NET/2
Sun OS 4
386BSD
NEXTSTEP/ OPENSTEP 1.0 to 4.0
Linux 0.0.1
NetBSD 0.8 to 1.0
SCO Unix 3.2.4
Unixware 1.x to 2.x
HP/UX 6 to 11
Minix 1.x
Linux 0.95 to 1.2.x
FreeBSD 1.0 to 2.2.x
BSD 4.4 to 4.4 lite2
NetBSD 1.1 to 1.2
OpenBSD 1.0 to 2.2
AIX 3.x to 6.x
OpenServer 5.0 to 5.04
Solaris 2.1 to 10
Minix 2.x
Linux 2.0 to 2.6.x
FreeBSD 3.0 to 3.2
NetBSD 1.3
OpenServer 5.0.5 to 5.0.7
Unixware 7.x
Mac OS X Server
FreeBSD 3.3 to 8.0
NetBSD 1.3 to 5.x
OpenBSD 2.3 to 4.x
HP/UX 11i to 11i v3
Minix 3.x
Mac OS X 10.0 to 10.6 (Darwin)
OpenServer 6.x
OpenSolaris 2008.05 and later
Open Source
Mixed/Shared Source
Closed Source
1969
1971 to 1973
1974 to 1975
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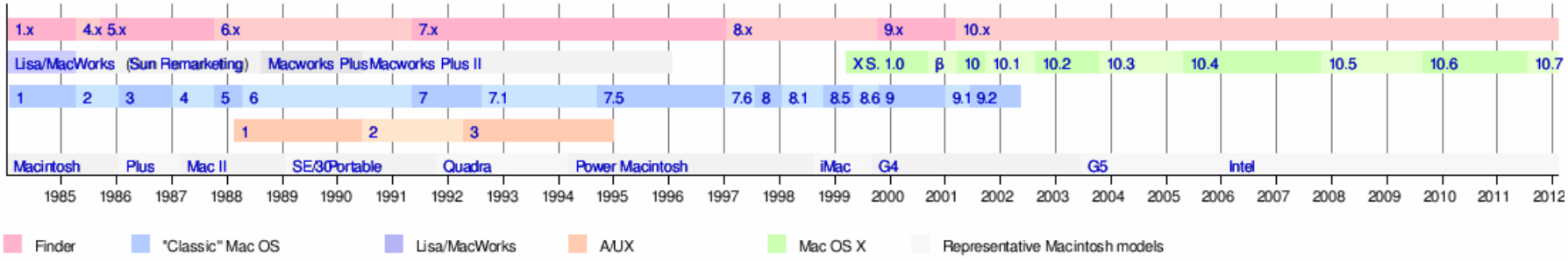
2001 to 2004
2005
2006 to 2010

Mac OS

- graphical user interface – based
- developed by Apple Inc. for their Macintosh line of computer systems
- now calls OS X
- first introduced in 1984 with the original Macintosh

Timeline of Macintosh operating systems



Android

- Linux-based operating system
- for touchscreen mobile devices such as smartphones and tablet computers
- developed by Google in conjunction with the Open Handset Alliance
- initially developed by Android Inc., whom Google financially backed and later purchased in 2005
- in September 2012, there were more than 675,000 apps available for Android
- the estimated number of applications downloaded from Google Play was 25 billion
- first Android-powered phone was sold in October 2008
- by the end of 2010 Android had become the world's leading smartphone platform

iOS (iPhone OS)

- mobile operating system
- developed and distributed by Apple Inc.
- January 9, 2007
- October 17, 2007, Apple announced that a native Software Development Kit (SDK)
- March 6, 2008, Apple released the first beta: iPhone OS
- January 27, 2010, Apple announced the iPad
- In June 2010, Apple rebranded iPhone OS as "iOS"
- September 12, 2012, Apple's App Store contained more than 700,000 iOS applications
- in June 2012, it accounted for 65% of mobile web data consumption

Characteristics of an Operating System

- multi-tasking
- multi-processing
- multi-user
- protected
- built-in support for graphics
- built-in support for networks

Some examples

- **Unix**: multi-tasking, multi-processing, multi-user, protected, with built-in support for networking but not graphics.
- **Windows NT:** multi-tasking, multi-processing, single-user, protected, with built-in support for networking and graphics.
- **Windows 95/98:** multi-tasking, multi-processing, single-user, unprotected, with built-in support for networking and graphics.
- **Windows 3.x**: single-tasking, single-processing, single-user, unprotected, with built-in support for graphics but not networking.
- **DOS:** single-tasking, single-processing, single-user, unprotected with no built-in support for graphics or networking.

Components

- Process Management
- File Management
- I/O System Management
- Secondary-Storage Management
- Networking
- Protection System
- Command Interpreter System

Process Management

- process – complete execution context (code, data, PC, registers, OS resources in use, etc.)
- activities
  - creation and deletion of user and system processes
  - suspension and resumption of processes
  - a mechanism for process synchronization
  - a mechanism for process communication
  - a mechanism for deadlock handling

Main-Memory Management

- Primary-Memory or Main-Memory
- activities
  - keep track of which part of memory are currently being used and by whom
  - decide which process are loaded into memory when memory space becomes available.
  - allocate and deallocate memory space as needed

File Management

- computer can store files on the disk (secondary storage), which provide long term storage
  - magnetic tape
  - magnetic disk
  - optical disk
- properties
  - speed
  - capacity
  - data transfer rate
  - access methods
- activities
  - the creation and deletion of files
  - the creation and deletion of directions
  - the support of primitives for manipulating files and directions
  - the mapping of files onto secondary storage
  - the back up of files on stable storage media

I/O Management

- I/O subsystem hides the peculiarities of specific hardware devices from the user
- only the device driver knows the peculiarities of the specific device to whom it is assigned.
- the operating system allows unification and control of access of programmes to material resources via drivers (also known as peripheral administrators or input/output administrators)

Secondary-Storage Management

- secondary storage consists of tapes, disks, and other media designed to hold information

- activities
  - managing the free space available on the secondary-storage device
  - allocation of storage space when new files have to be written
  - scheduling the requests for memory access

Networking

- distributed systems
- communication-network
- routing and connection strategies
- problems of contention and security

Protection System

- multiple users
- multiple processes
- Protection:
  - controlling the access of programs
  - processes
  - users

Command Interpreter System

- interface
- advantages
  - change the way the command interpreter looks, i.e.:
    - I want to change the interface of command interpreter, I am able to do that if the command interpreter is separate from the kernel.
    - I cannot change the code of the kernel so I cannot modify the interface.
  - the command interpreter is a part of the kernel it is possible for a malicious process to gain access to certain part of the kernel that it showed not have to avoid this ugly scenario it is advantageous to have the command interpreter separate from kernel

Operating Systems Services

- Program Execution
- I/O Operations
- File System Manipulation
- Communications
- Error Detection

Program execution

- execute programs
- operating systems provide an environment
- involves the allocating and deallocating memory, CPU scheduling (in case of multiprocess)

I/O Operations

- input and output
- operating systems hide the user the details of underlying hardware for the I/O
- operating systems by providing I/O make it convenient for the users to run programs
- for efficiency and protection users cannot control I/O so this service cannot be provided by user-level programs

File System Manipulation

- the output of a program may need to be written into new files or input taken from some files
- operating systems make it easier for user programs to accomplished their task
- this service involves secondary storage management

Communications

- processes need to communicate with each other to exchange information
- the messages need to be passed to processes on the other computers through a network it can be done by the user programs
- the user program may be customized to the specifics of the hardware through which the message transits and provides the service interface to the operating system

Error Detection

- operating system constantly monitors the system for detecting the errors
- it involves monitoring and in cases altering area of memory or deallocation of memory for a faulty process
- may be relinquishing the CPU of a process that goes into an infinite loop

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)

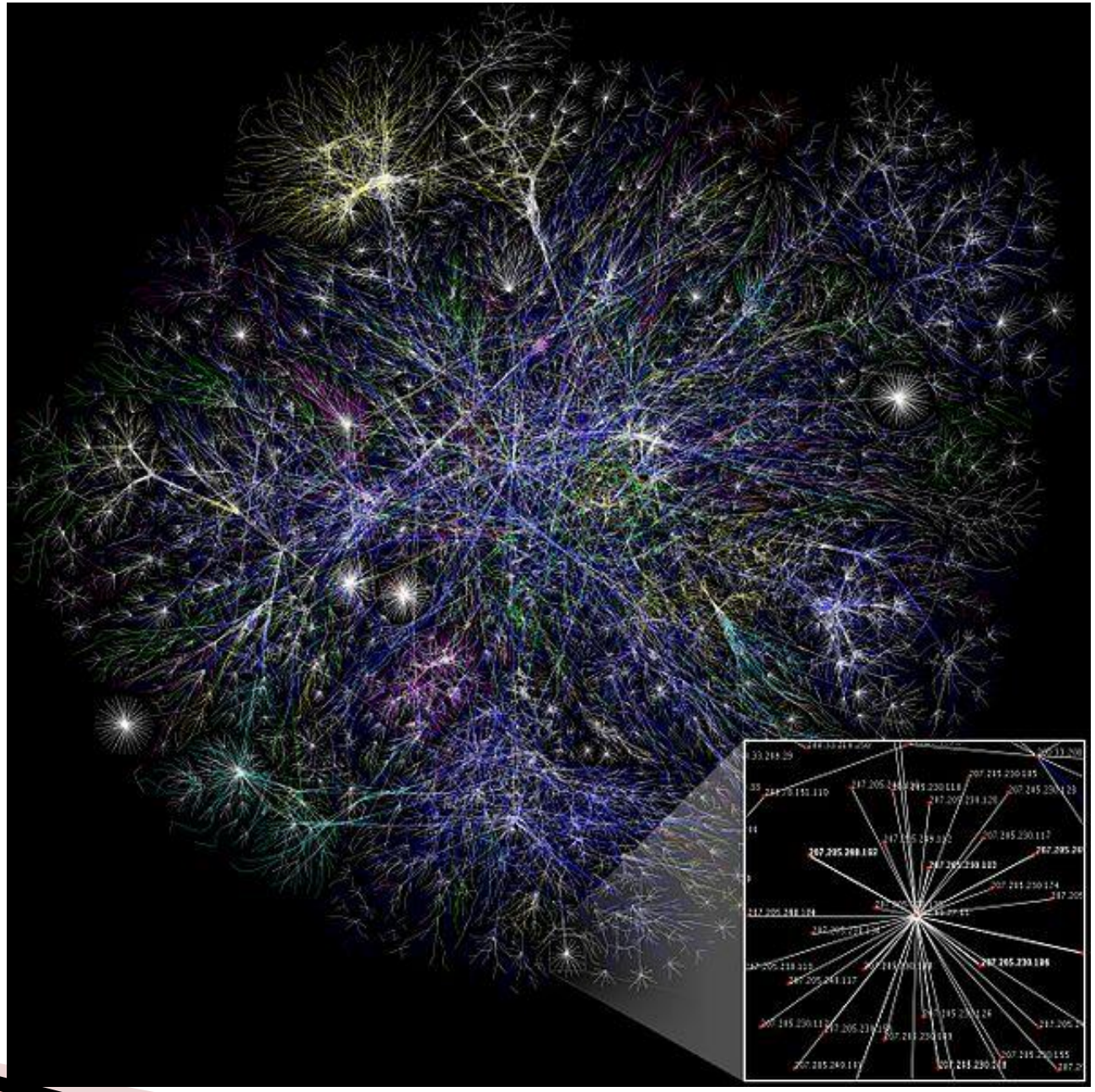
- used for supporting mobile
- number of wireless LANs
- satellite coverage areas

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

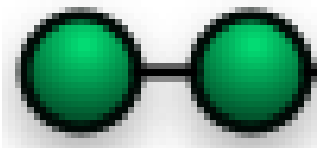


Network Topologies

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

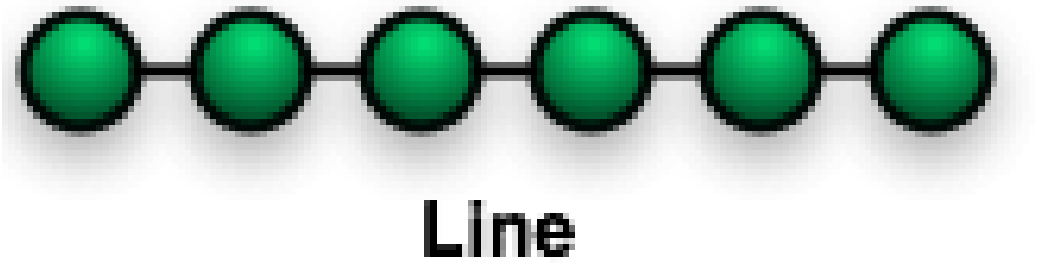
Point-to-Point Topology

- 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



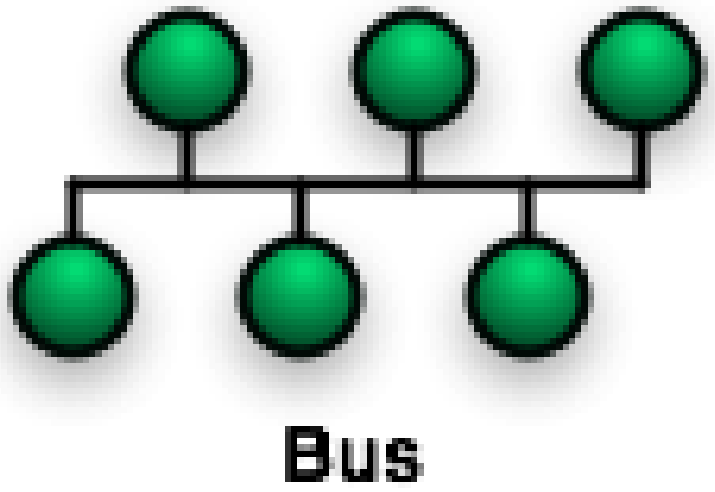
Line Topology

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



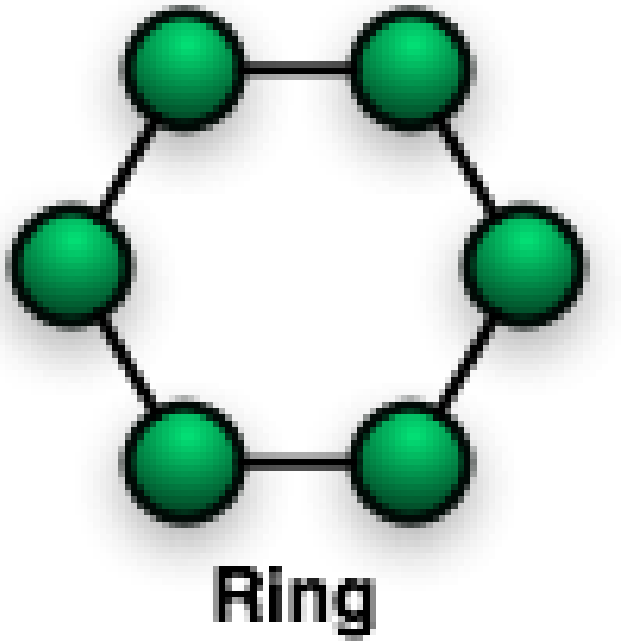
Physical Bus Topology

- 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



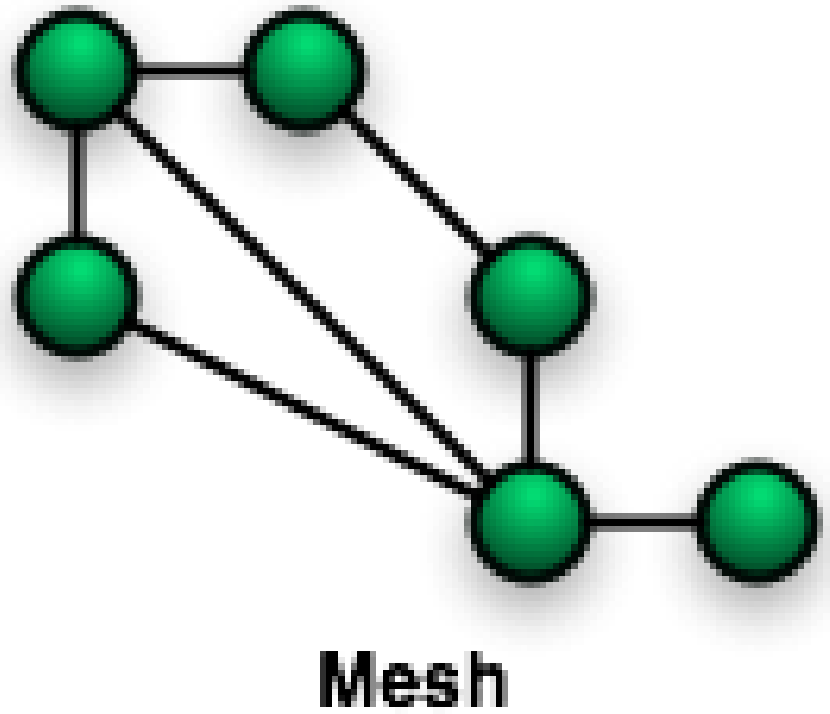
Ring Topology

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



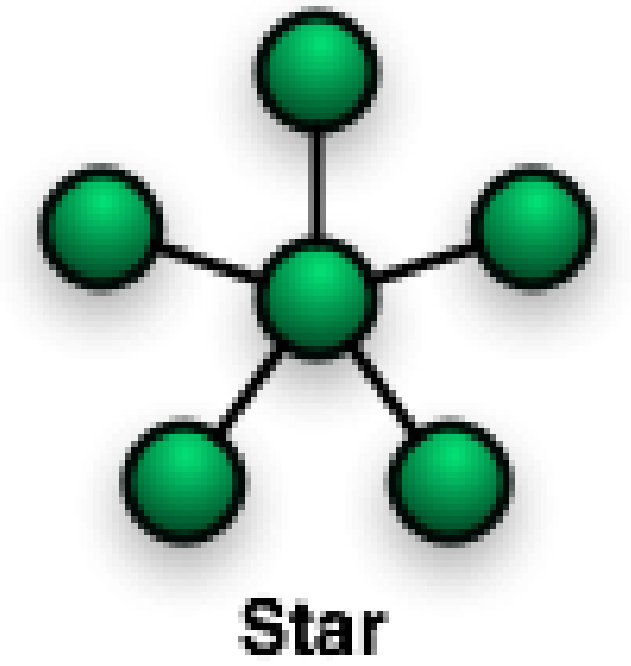
Mesh Topology

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



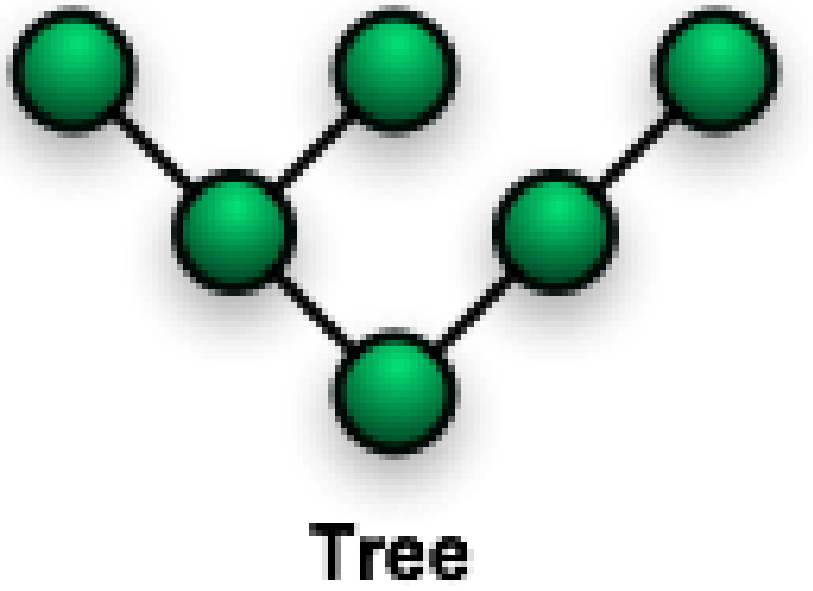
Star Topology

- 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