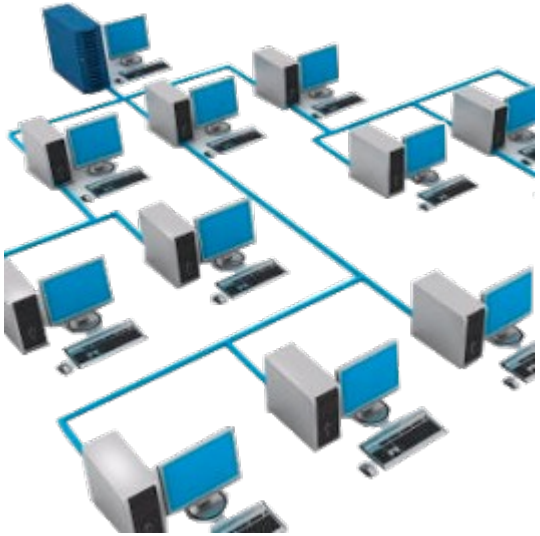
TEL-3214
Computer Communication Networks



Diarmuid Ó Briain
CEng, FIEI, FIET, CISSP

Diarmuid O'Briain

- **Defence Forces**
  - Communications and Information Services Corps
- **US Robotics**
  - Technical Trainer
- **3Com**
  - Network Engineering Manager
- **UTStarcom**
  - Technical Services Manager
- **Ripple Communications Limited**
  - Chief Technical Officer
- **Dublin and Carlow Institutes of Technology**
  - Associate Lecturer
- **Makerere University**
  - College of Engineering, Design, Art, and Technology
  - Associate Lecturer

Diarmuid O'Briain

- **Chartered Engineer (CEng)**
- **Fellow of Engineers Ireland (FIEI)**
- **Fellow of the Institution of Engineering & Technology (FIET)**
- **Member Uganda Institute of Professional Engineers (MUIPE)**

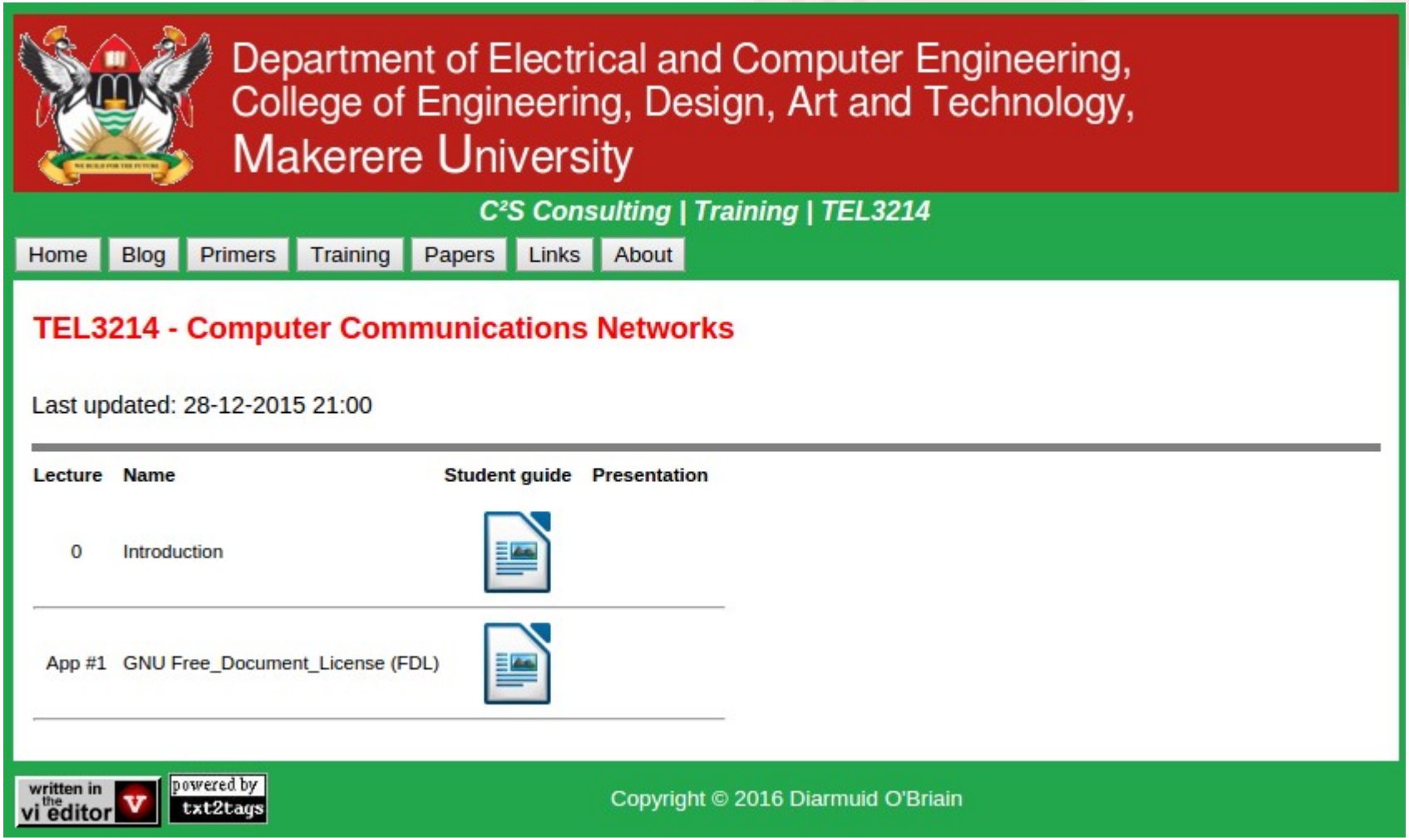
The Institution of Engineering and Technology

Engineers Ireland

Uganda Institution of Professional Engineers

Course webpage

http://www.obriain.com/training/TEL3214/



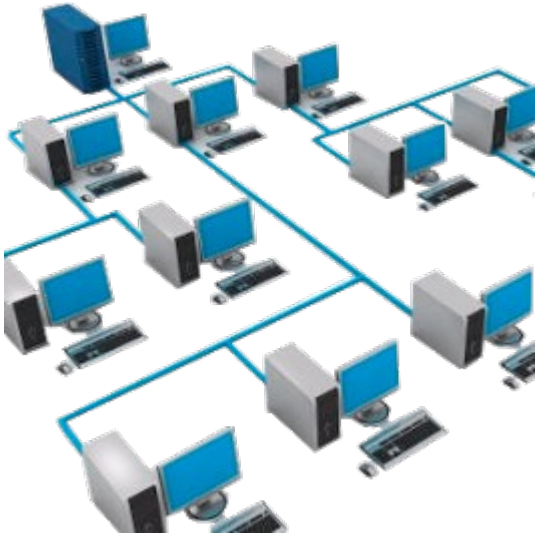
Course sections

- Lecture set 1 – Introduction to Computer Networks
- Lecture set 2 – Internetworking Models
- Lecture set 3 – Transmission Media: Copper and Fibre
- Lecture set 4 - Establishing Network Training Emulation (NTE)
- Lecture set 5 – Switching
- Lecture set 6 – Internet Protocol
- Lecture set 7 – Routing
- Lecture set 8 – Wireless LAN
- Lecture set 9 – Applications
- Lecture set 10 – Network Security
- Lecture set 11 – Firewalls
- Lecture set 12 – Software Defined Networking

TEL3214
Computer Communication Networks

Lecture 01

Introduction to Networking

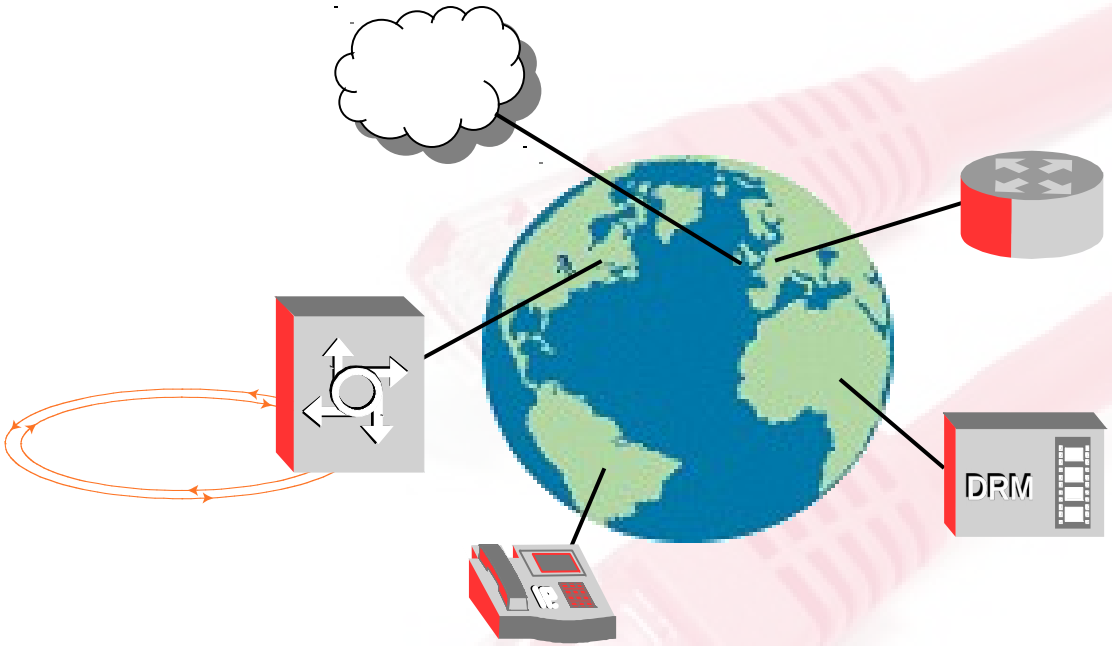


Diarmuid Ó Briain
CEng, FIEI, FIET, CISSP

Internetworking Models - OSI

OSI Layer		
7	Application	File, Print, database & Application services
6	Presentation	Data encryption, compression & translation services
5	Session	Dialogue control
4	Transport	End to End connection
3	Network	Routing
2	Data Link	Framing, Bridging, Switching
1	Physical	Physical network topology

The Functions of Networking



- Demand for high speed Internet access.
- The data and telecommunications industries struggle with the continuous demand for ever increasing speeds.
- Those working in the field also require knowledge of technologies that were traditionally separated.

Basic Concepts

- Communications – activity associated with distributing or exchanging information.
- Telecommunications – technology of communications at a distance that permits information to be created anywhere and used everywhere with little delay.
- Today it, involves
  - Data: digital and analogue.
  - Voice: spoken word.
  - Video: telecommunication imaging.
-

Essentials for Communications

- Must have a message
- Message must have a transmitter
- Message must have a medium
- Message must be understood
- Message must have some level of security

Source System — Destination System

Source → Transmitter → Transmission → Receiver → Destination

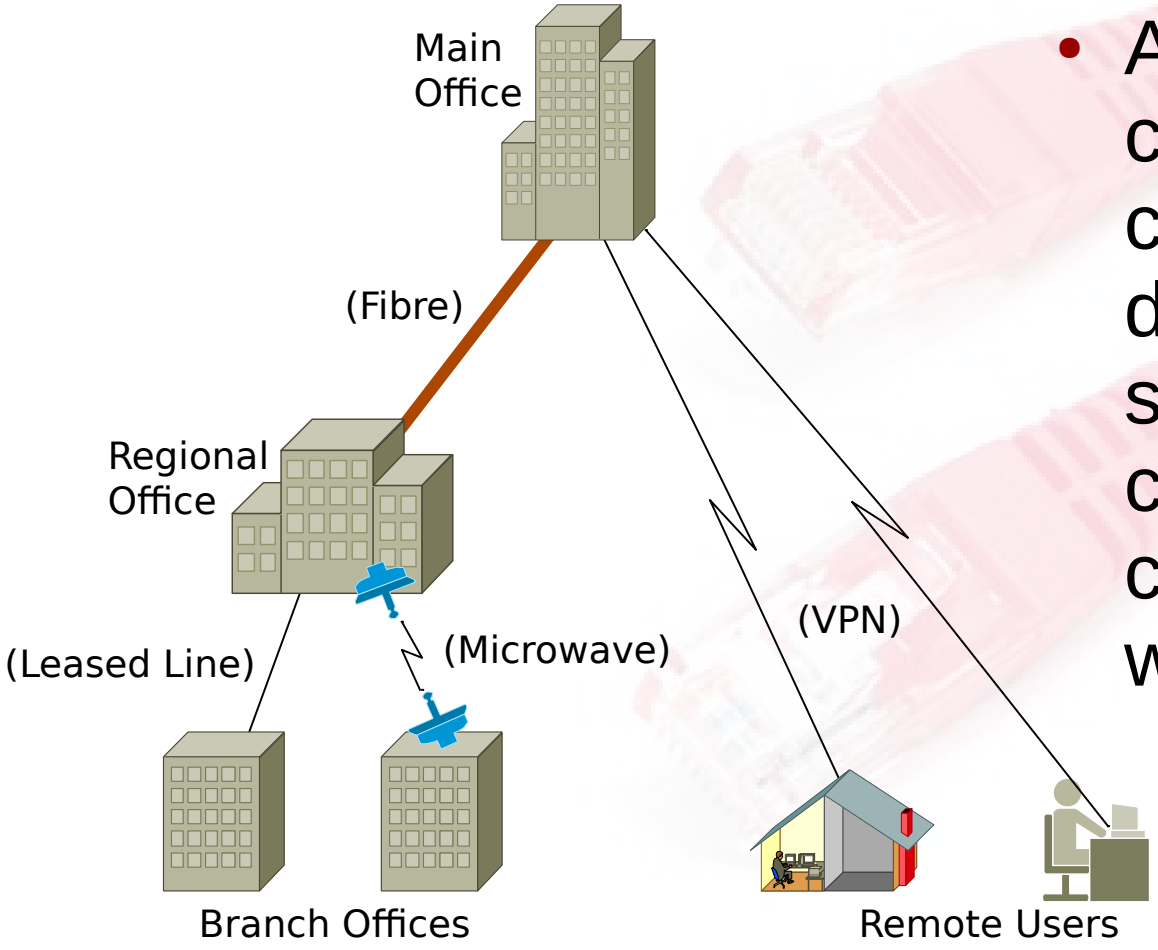
1 2 3 4 5 6

Workstation/PC — Medium — Workstation/PC

Data Communication Tasks

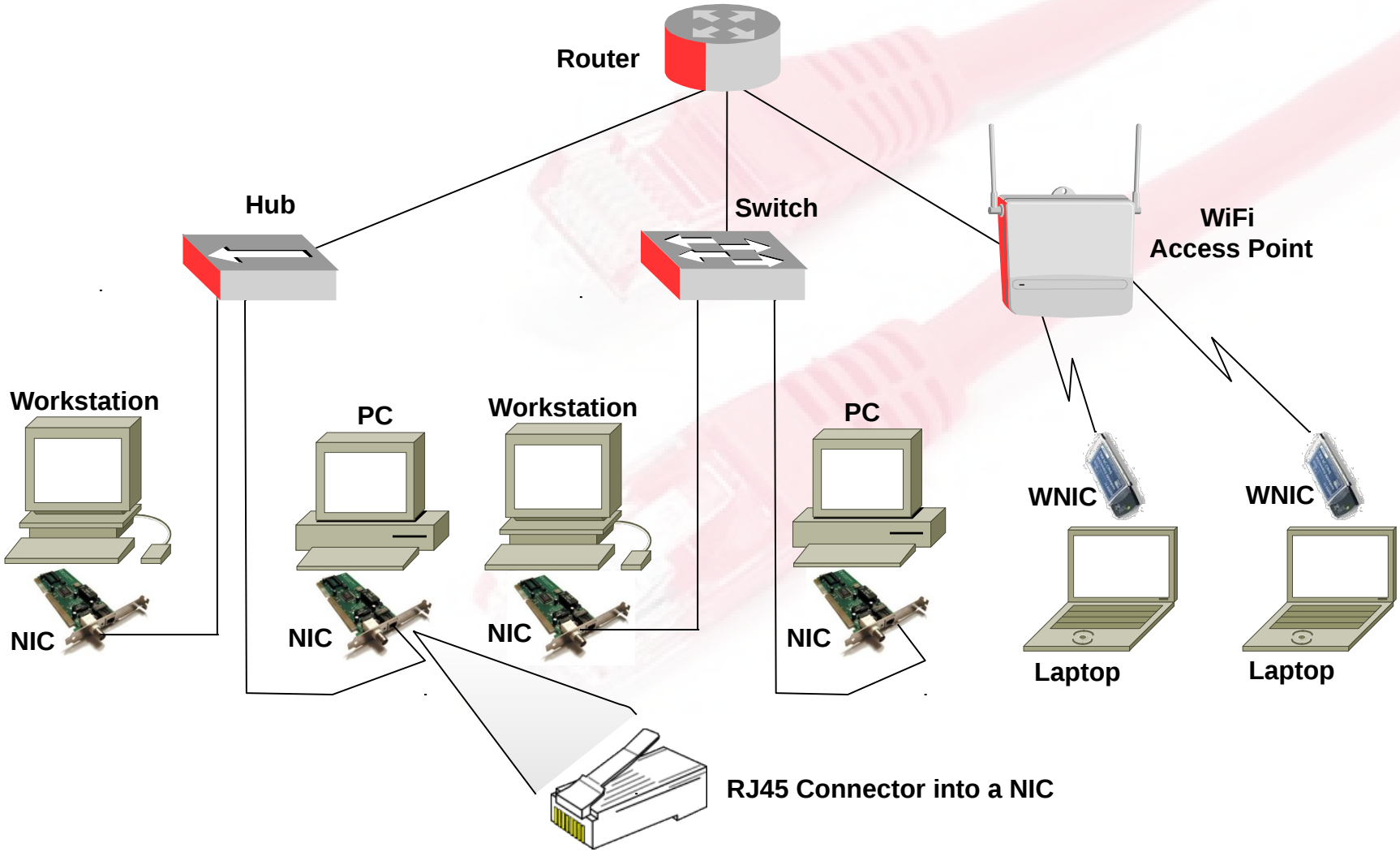
Data System Utilisation	Addressing	Multiplexing Capacity Congestion Control
Interfacing	Routing	Router / Server / Media Control / Protocol
Signal Generation	Recovery	Repeater/Amplifier; Propagation; Interoperable
Synchronisation	Message Formatting	Signal Begins & Ends
Exchange Management	Security	Nature and Timing of Signal
Error Detection & Correction	Network Management	Signal Distortion Bit Error
Flow Control		Routing Delivery Error Feedback

What is a network ?



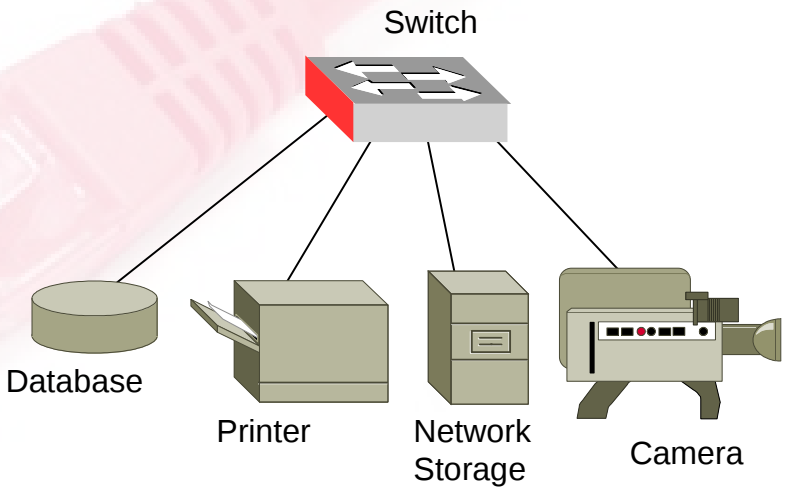
- A network is a connected collection of devices and end systems that can communicate with each other.

Components of a Network



Resource-Sharing

- Data and Applications
- Resources
- Network Storage
- Backup Devices



Network User Applications

- E-Mail
  - Users can communicate information electronically in a timely manor not only to other users on the same network but also to other users outside the network.
- Web Browser
  - This application allows access to the Intranet websites.
- Instant Messaging
  - Such applications allow users to send instant messages to other users, using applications like AOL Yahoo or MSN messenger.
- Collaboration
  - Working together as individuals or groups is accomplished much more easily when those persons collaborating are part of a network. Individuals can create their part of a data file and transmit it to a central resource for compilation.
- Database
  - Databases allow users on a network to store information in central locations (file servers) so that others on the network can easily retrieve selected information in formats that are most useful to them.
  -

Network Characteristics

- While networks can be defined and compared in a number of ways, a commonly used set of characteristics can be used to describe various network types.

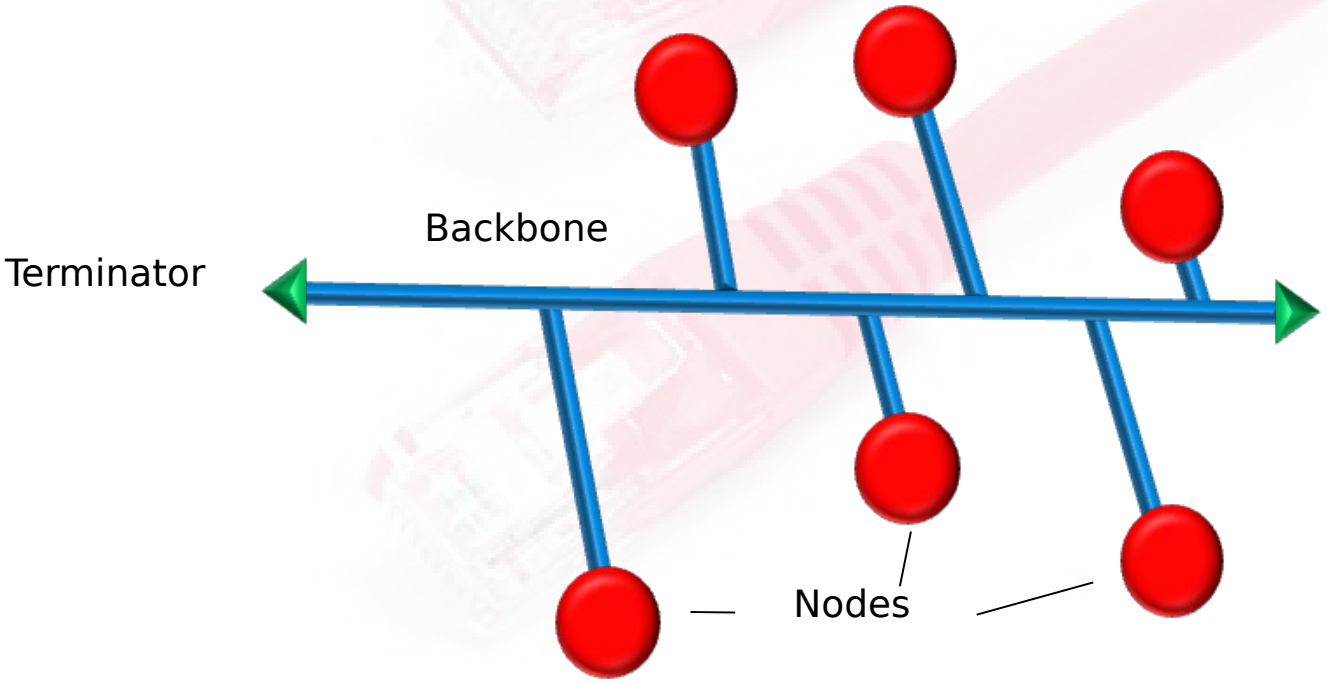
  - Cost
  - Security
  - Availability
  - Scalability
  - Reliability
  - Topology

Network Monitoring & Management Tools

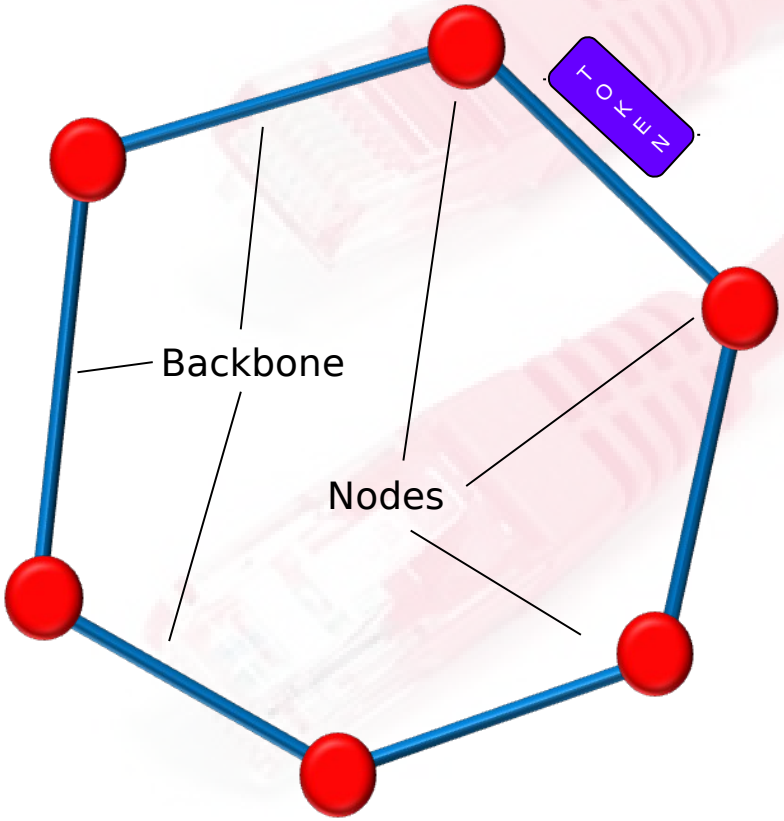
- There are also a number of applications that provide administrators of networks with a means to monitor the network
  - Packet Sniffer or Network Analyzer
    - Computer software application or computer hardware that can intercept and log traffic passing over a digital network or part of a network.
  - Network Management
    - Involves configuring, monitoring and troubleshooting, and also upgrading as networks grow to accommodate more users and communication requirements.
      - HP Openview (HPOV)

WIRESHARK

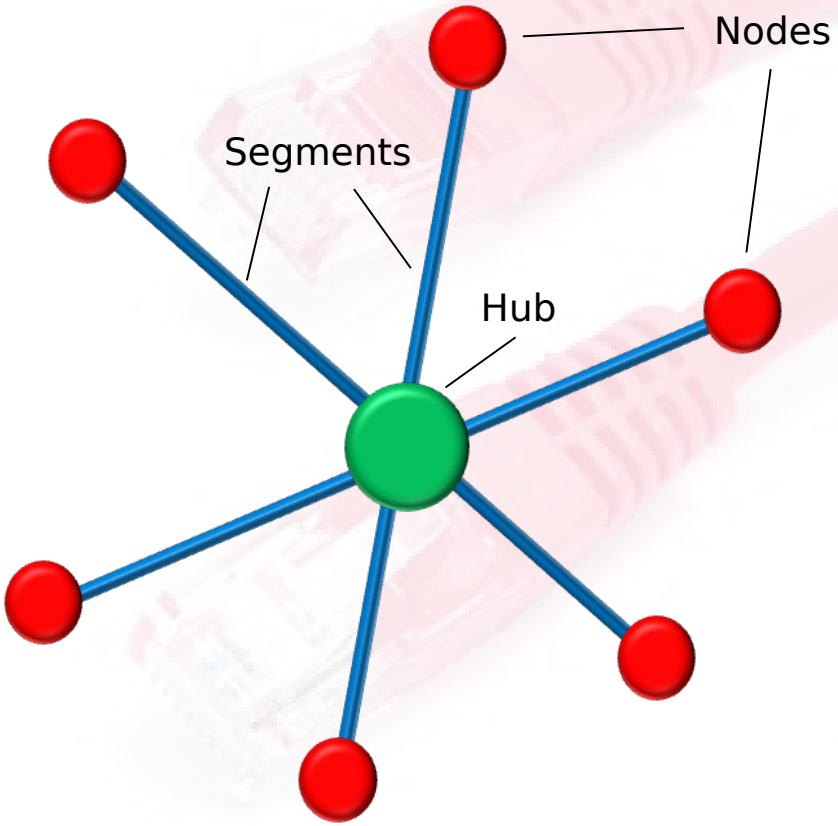
Common Topologies - Bus



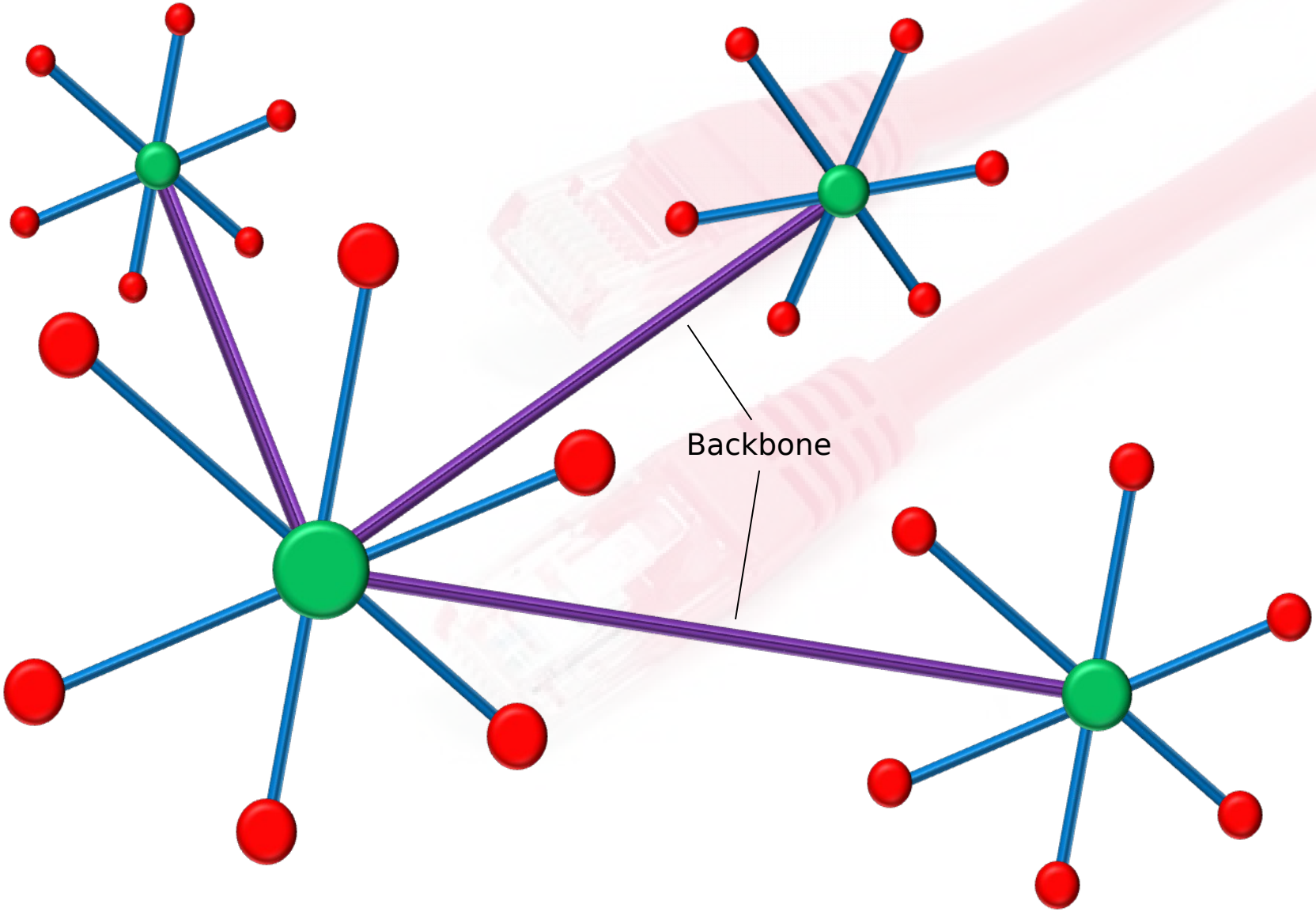
Common Topologies - Ring



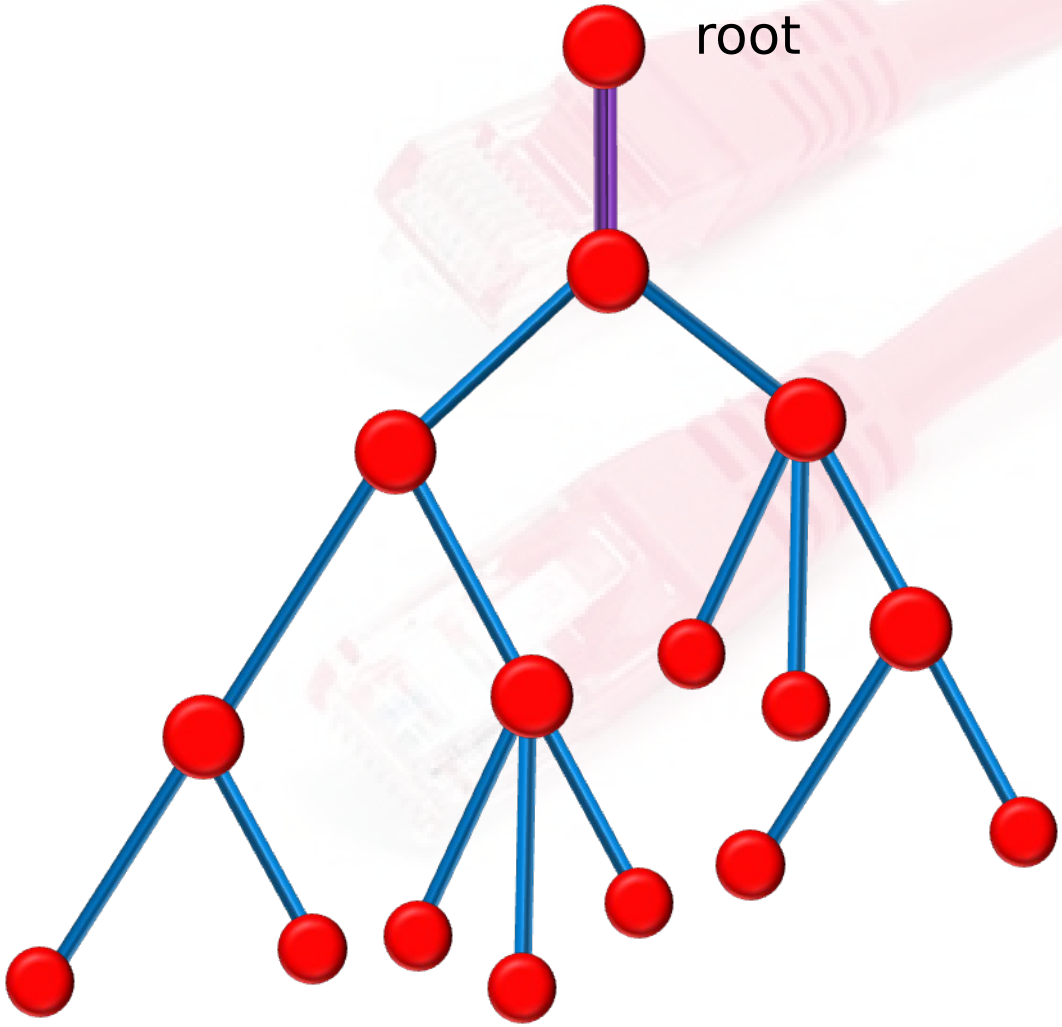
Common Topologies - Star



Common Topologies – Star Bus

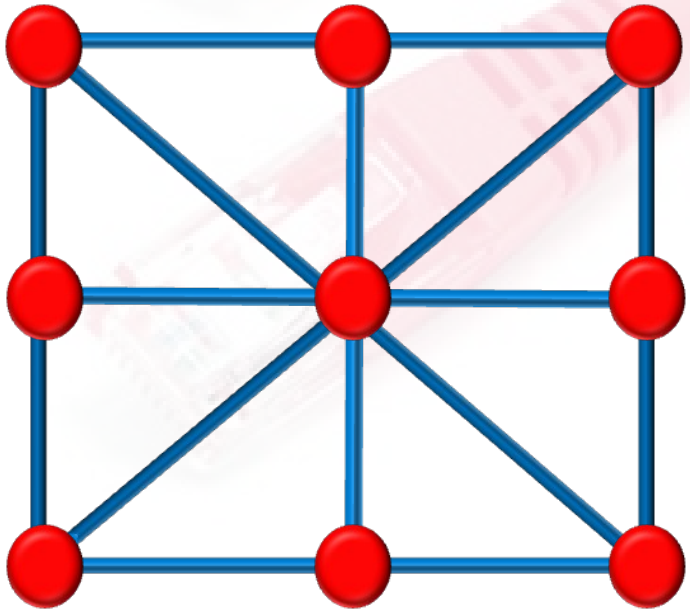


Common Topologies – Tree



Common Topologies - Mesh

- Partially Connected
- Fully Connected



Key Network Terminology

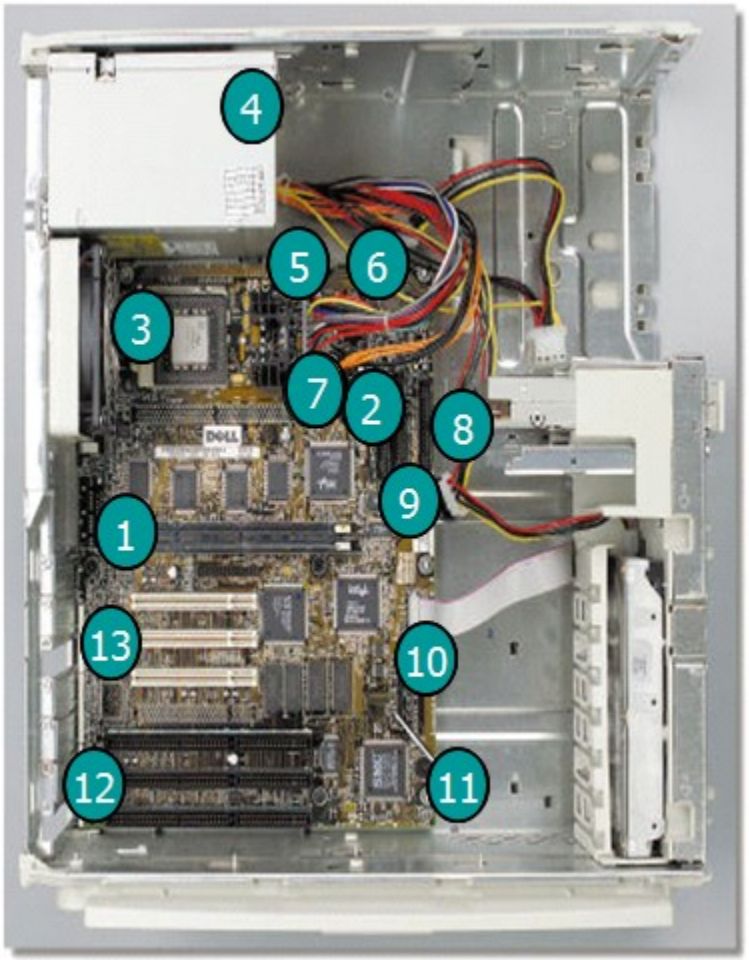
- Simplex
  - Information flows in only one direction.
- Half-duplex
  - Information flows in two directions, but only in one direction at a time.
- Full-duplex
  - Information flows in two directions at the same time.

Data Transmission

- Successful transmission of data depends on:
  - The quality of the signal being transmitted.
  - Characteristics of the transmission medium.

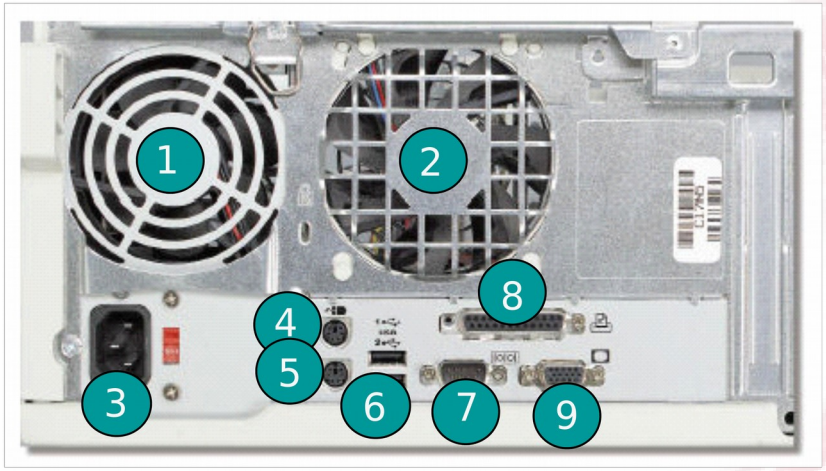
  - Data rate
  - Bandwidth
  - Noise
  - Error rate

Major Computer Components



1. DIMM memory sockets
2. Secondary EIDE channel connector
3. Microprocessor
4. Power supply
5. Power input connector
6. Battery socket
7. 3.3-V power input connector
8. Diskette drive interface connector
9. Primary EIDE channel connector
10. Control panel connector
11. System board jumpers
12. ISA expansion card connectors
13. PCI expansion card connectors

Major Computer Components



1. Power supply cooling fan
2. Cooling fan
3. Power input
4. PS/2 mouse connector
5. Keyboard connector
6. USB ports
7. Serial port
8. Parallel port
9. Monitor port

Bits and Bytes

- The following are commonly used computer measurement terms:
  - Binary digit (bit)
    - The smallest unit of data in a computer. A bit equals 1 or 0 in the binary format in which data is processed by computers.
  - Byte (B)
    - A byte is a unit of measure used to describe the size of a data file, the amount of space on a disk or other storage medium, or the amount of data being sent over a network. 1 B = 8 bits of data.

Bits

- Kilobit (kb) 10^3
- Megabit (Mb) 10^6
- Gigabit (Gb) 10^9
- Terabit (Tb) 10^{12}
- Petabit (Pb) 10^{15}

Bytes

Name	SI Meaning	Binary meaning	Size difference
Kilobyte (kB)	$10^3 = 1000^1$	$2^{10} = 1024^1$	2.40%
Megabyte (MB)	$10^6 = 1000^2$	$2^{20} = 1024^2$	4.86%
Gigabyte (GB)	$10^9 = 1000^3$	$2^{30} = 1024^3$	7.37%
Terabyte (TB)	$10^{12} = 1000^4$	$2^{40} = 1024^4$	9.95%
Petabyte (PB)	$10^{15} = 1000^5$	$2^{50} = 1024^5$	12.59%

Speed (Hertz)

- Kilohertz (kHz) 10^3
- Megahertz (MHz) 10^6
- Gigahertz (GHz) 10^9

- Computer processors are getting faster all the time.
  - 1980's typically ran under 10 MHz (the original IBM Pc was 4.77 MHz).
  - Today Gigahertz (GHz).

Other memory associated with networking devices

- NVRAM
  - Non-volatile random access memory (NVRAM) is the general name used to describe any type of random access memory which does not lose its information when power is turned off.
- Flash memory
  - Flash memory is non-volatile computer memory that can be electrically erased and reprogrammed. Flash memory costs far less than byte-programmable EEPROM and therefore has become the dominant technology wherever a significant amount of non-volatile, solid-state storage is needed.

- Switches and routers tend to use flash instead of a hard drive, the cost is higher and the capacity is less, but this is more than offset by the gain in reliability.

Operating Systems

- An operating system (OS)
  - set of computer programs that manage the hardware and software.
  - processes raw system and user input
  - allocates resources and managing tasks
  - controlling and allocating memory
  - prioritising system requests
  - controlling input and output devices
  - facilitating networking and managing file systems
  - platform for application software.

Operating System Services

- Process management
  - Every program running on a computer, be it background services or applications, is a process. Modern operating systems enable concurrent execution of many processes at once via multitasking even with one CPU.
- Memory management
  - Current computer architectures arrange the computer's memory in a hierarchical manner, starting from the fastest registers, CPU cache, random access memory and disk storage.
- Disk and file systems
  - Modern file systems comprise a hierarchy of directories. While the idea is conceptually similar across all general-purpose file systems, some differences in implementation exist. Two noticeable examples of this are the character used to separate directories, and case sensitivity.

Operating System Services

- Networking
- Security
- Graphical user interfaces
  - X Server
- Device drivers

Operating Systems

- UNIX®
  - UNIX is a computer operating system originally developed in the 1960s and 1970s by a group of AT&T employees at Bell Labs including Ken Thompson, Dennis Ritchie and Douglas McIlroy
  - Today's UNIX systems are split into various branches, developed over time by AT&T as well as various commercial vendors and non-profit organisations.
  - Examples include: Sun Solaris, HP UX, SCO UNIX, BSD UNIX.
- Linux

  - Linux is a UNIX-like computer operating system family, as well as one of the most prominent examples of free software and open source development; its underlying source code can be modified, used, and redistributed by anyone, freely.
  - Examples include: Ubuntu, Debian, Redhat

Operating Systems

- Mac OS X
  - Mac OS X is a line of proprietary, graphical operating systems developed, marketed, and sold by Apple Inc., the latest of which is pre-loaded on all currently shipping Macintosh computers.
  - Mac OS X is the successor to the original Mac OS, which had been Apple's primary operating system since 1984.
  - Unlike its predecessor, Mac OS X is a UNIX-like operating system.

- BSD
  - Berkeley Software Distribution (BSD, sometimes called Berkeley UNIX) is the UNIX derivative distributed by the University of California, Berkeley, starting in the 1970s.
  - BSD should not be used to refer to the different BSD like operating system around today.
  - Instead they should be called BSD like or BSD descendants.

Operating Systems

- Microsoft Windows
  - Microsoft Windows is the name of several families of proprietary software operating systems by Microsoft.
  - Microsoft first introduced an operating environment named Windows in November 1985 as an add-on to MS-DOS in response to the growing interest in graphical user interfaces (GUI).
  - Microsoft Windows eventually came to dominate the world's personal computer market, overtaking OS/2 and Mac OS which had been introduced earlier.

Thank you

Diarmuid Ó Briain
CEng, FIEI, FIET, CISSP