Networking: An Introduction

Lecture 12

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Learning Outcomes

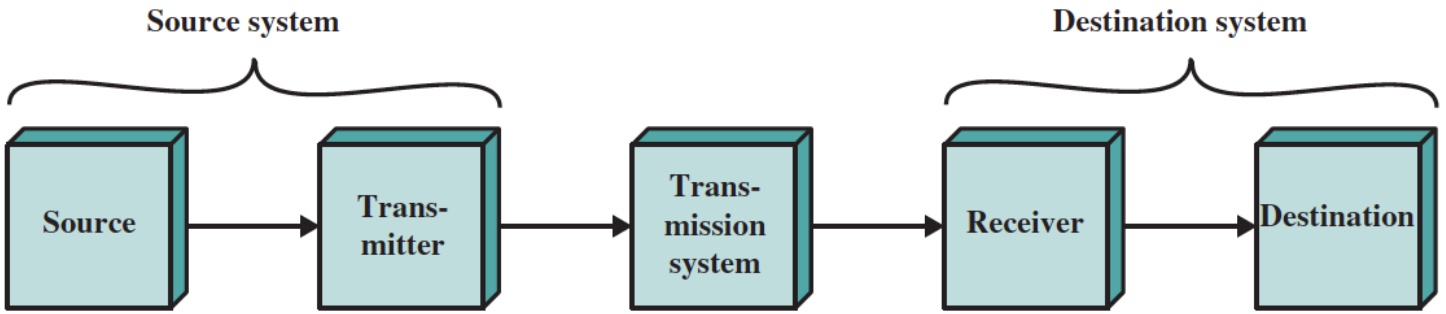
By the end of this lecture you have knowledge of:

- Various network topologies
- The use of TCP/IP in networking
- Network protocols
- The function of common network hardware devices.

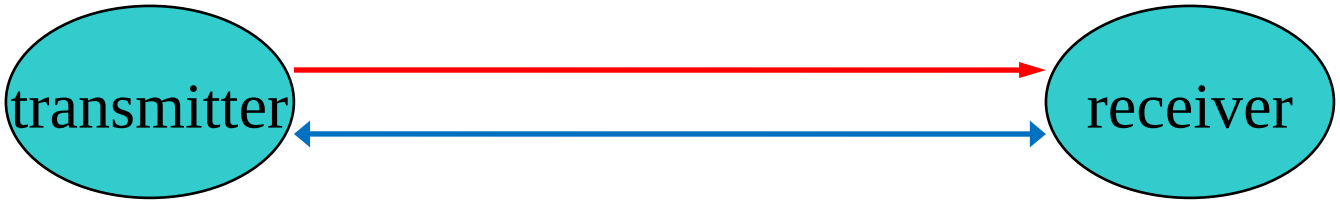
What is Communication?

- General explanation:
  - “**The effective exchange of information**”
  - “for information theory, communication is a process in which the state at a **transmitter**, a source of information, is reproduced with some errors at a **receiver**. The errors are caused by **noise** in the communications channel. “

A basic communication model



Communication Techniques



- Communication that occurs can be –
  - simplex – one direction only
  - half-duplex – only one party can transmit at one time
  - full-duplex – transmit in both directions simultaneously
- The information can be in an **analogue** or **digital** form.

Network Communication

- Modern digital communications tend to use a network system (**local**, **global**)

- This involves Multiple devices sharing information via some type of media
  - Wired
  - Wireless
  - Optical Fibre

Network Topologies

- The way computers in a network are connected together is called the network **topology**
- Examples are:
  - Point to Point (**NOT the Same as Peer-to-Peer**: Peer-to-peer networking is a model of application-level communication)
  - Star
  - Ring
  - Bus
  - Mesh
- Each requires its own protocol to operate

Point to Point

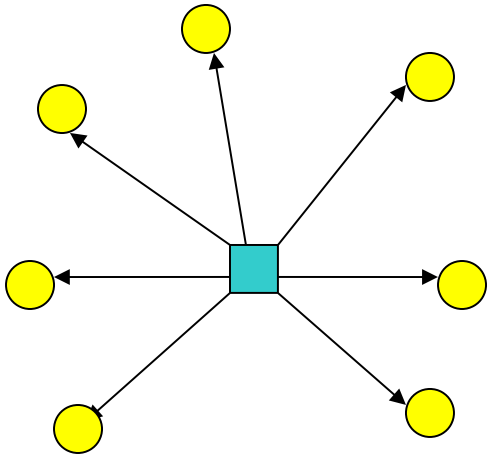
- This is the simplest topology that connects two nodes directly together with a common link

- The entire bandwidth is reserved for transmission between those two nodes
- Example – Using your remote control to change you TV channel

Star

- Originally associated with centralised computer systems and mainframes
- Each terminal has its own connection to the computer
- Single point of failure

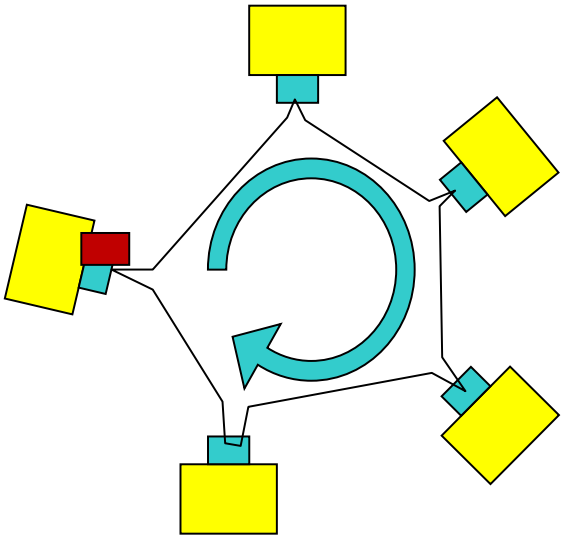
(Similar in operation to a hub – later in lecture)



Ring

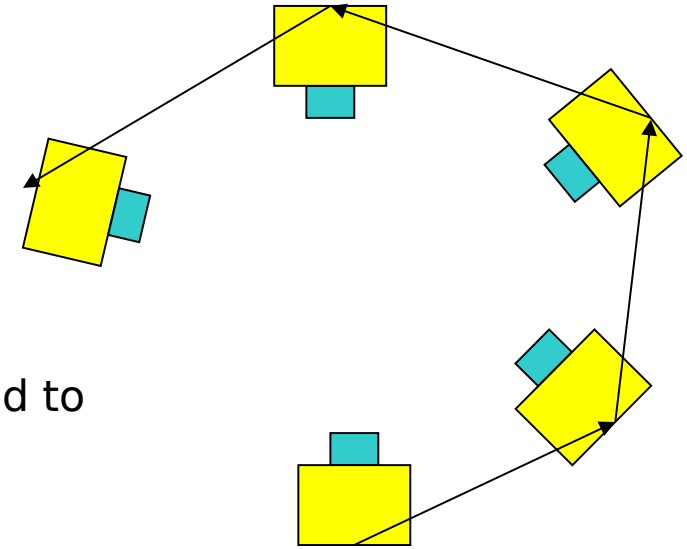
- Each computer is connected to its two neighbours
- A Token passes around ring (pass the parcel game)
- Empty token is filled to send a message
- If the message is for you –
  - Read and keep message
  - Pass empty token on

  or
  - Fill and pass on



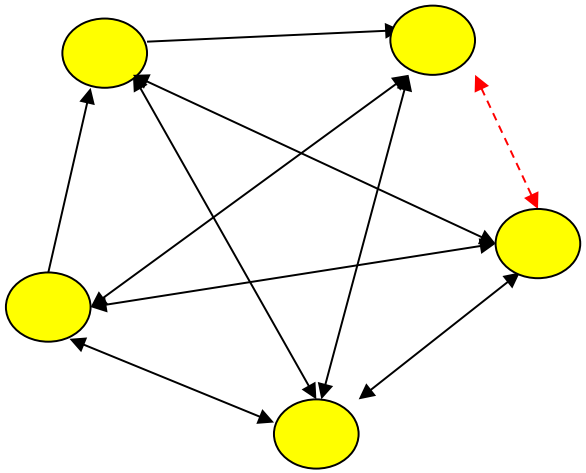
Bus

- Each computer connected to all of its neighbours. (BNC connectors)
- Message is passed to all the computers but the only one it is addressed to reads it
- Lots of collisions
- Slow transfer rate (compared to other topologies)



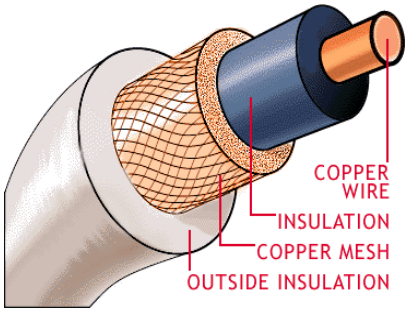
Mesh

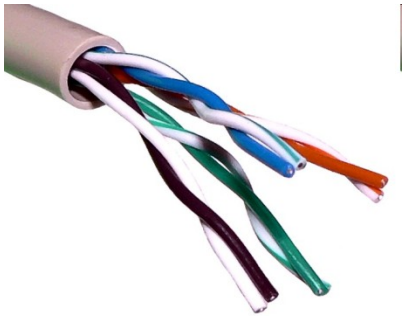
- Each computer is connected to all of its neighbours (or as many as possible)
- The lack of dependency allows nodes to relay information independently
- Enabling dynamic distribution of workloads
- Improved fault-tolerance



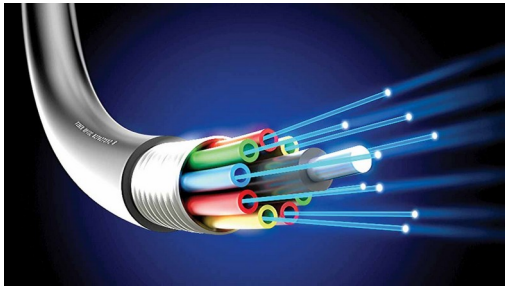
Media

- Networks can be connected via -
  - Wires
    - co-axial
    - twisted pair (shielded or not)





  - Fibre optics (single or multiple strands)



  - Wireless links (different frequency carrier waves)

Network Addressing

- Whichever topology is chosen, each unit (network node) requires a **unique address**
- For Ethernet systems (and similar), this is known as the **MAC address** (Media Access Control address).
- Each physical connection unit has this address '**hardwired**' when made.

MAC Address (examples)

AVTECH Software, Inc.

Room Alert 12E

RA12-123456

MAC ADDRESS

1A-2B-3C-4D-5E-6F

Do Not Remove

Network Scope

- Networks can be:
  - Local (LAN)
  - Metropolitan (MAN)
  - Wide (WAN)

- Differentiated by addressing (The WAN public IP address is assigned by the ISP, such as 52.48.129.156)
- Generally LAN (1G) is much faster than WAN (150M) (depends on network devices, connection speed and bandwidth)
- Be aware of the – "**weakest link in the chain**"

Network Grouping

- On a very small network, it would be possible to address each unit by its **MAC** address.
- However, as these are **fixed numbers**, it is difficult to use them for grouping purposes
- Also MAC addresses are **not** very ‘User friendly’ (easy to associate with a device or user)

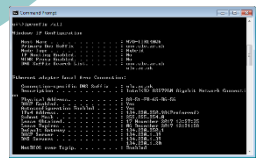
Grouping Techniques

- As the Internet grew from its early beginnings, **IP** (internet protocol) addresses became more widely used
- **IP** allows for hierarchical organisation
- And, using a **DNS** (Domain Name System) allows us to map these numbers onto names or **URL**'s (Universal Resource Locator's)

- Example – www.wlv.ac.uk - 52.48.129.156

TCP/IP Address (Transmission Control Protocol)

- IP address tends to be of the format:
  - **aaa.bbb.ccc.ddd**
  - Numbers can be from 1-254 (with restrictions)
  - The University address is 52.48.129.156



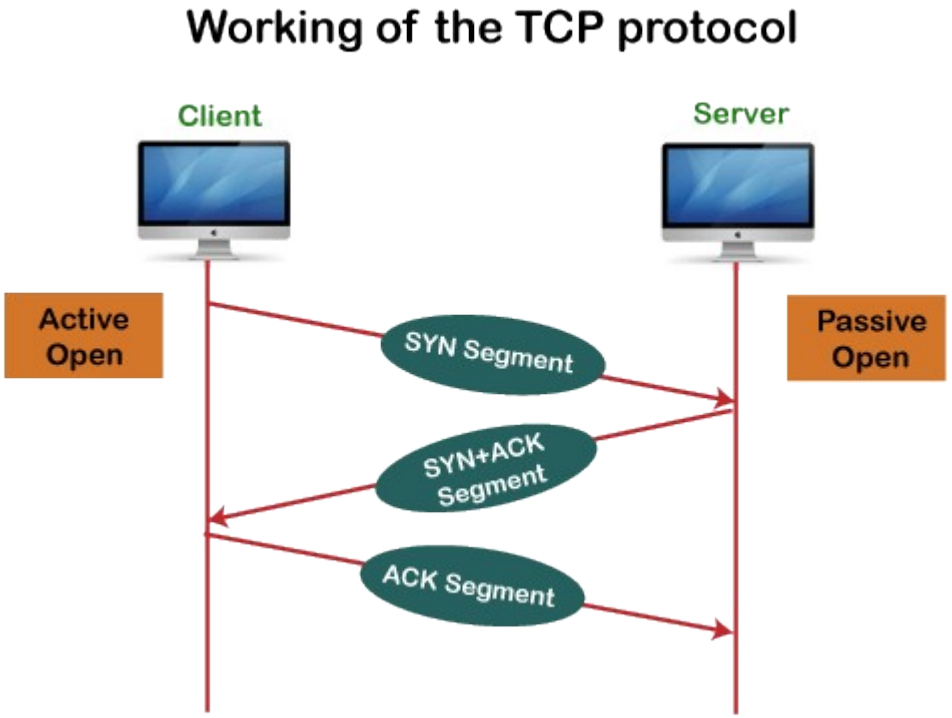
(How did I find this?) *http://www.hcidata.info/host2ip.htm*
(You can also use from the cmd prompt u:\>ipconfig /all)

- The IP address is part of TCP/IP - the **Internet protocol suite**
- Every website on the Internet has an IP address mapped to a URL by the DNS
- IP addresses are also used for **routing**

TCP (Transmission Control Protocol)

- TCP is a connection-oriented, **reliable-delivery protocol**
- It Provides –
  - basic error checking
  - flow control
- Also provides a **port number** mechanism to differentiate between services.

Working of TCP



Port Number Examples

- Server Port 80
  - Hyper text transfer protocol (HTTP) – WEB site
- Server Port 25
  - Simple mail transfer protocol (SMTP) – Email services
- Server port 21
  - File transfer protocol (FTP) – Transferring files
- **One (physical) server can host several services simultaneously**

Network Protocols

- All networking programs and devices speak a variety of different protocols (languages)
- These protocols usually have acronyms such as: HTTP, SMTP, IMAP, POP3, FTP, SSH, TELNET, SMB, ICMP, SNMP and DHCP
- Each one is designed for a particular purpose and will

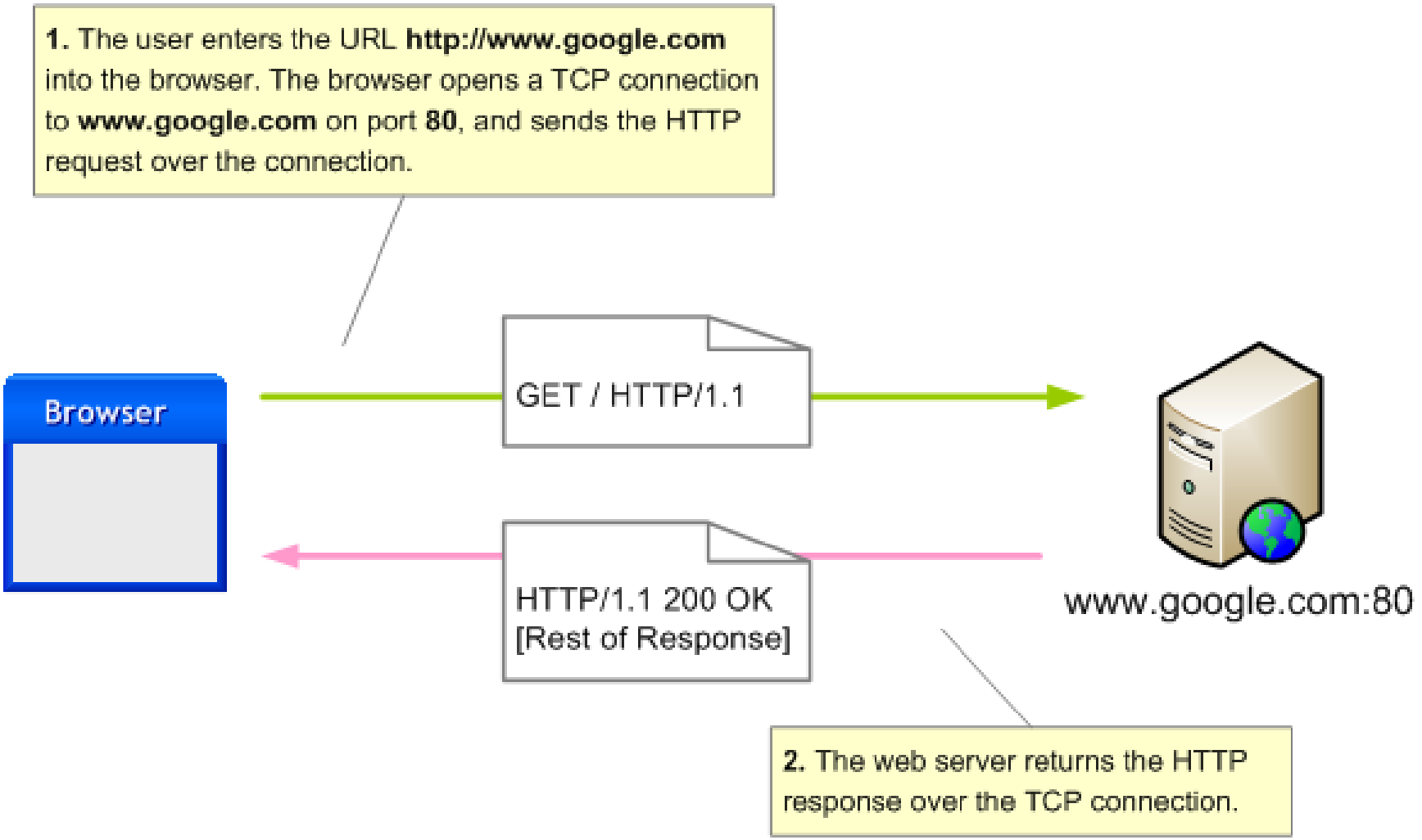
  not work with any other.

HTTP (hyper text transfer protocol)

- This is the language of the Web
- This is how Web Browsers speak to Web Servers
- To get the first page of a website, the web browser connects to the web server sends a HTTP "GET" message like:

```
GET /index.html  HTTP/1.0
```

Example: HTTP GET



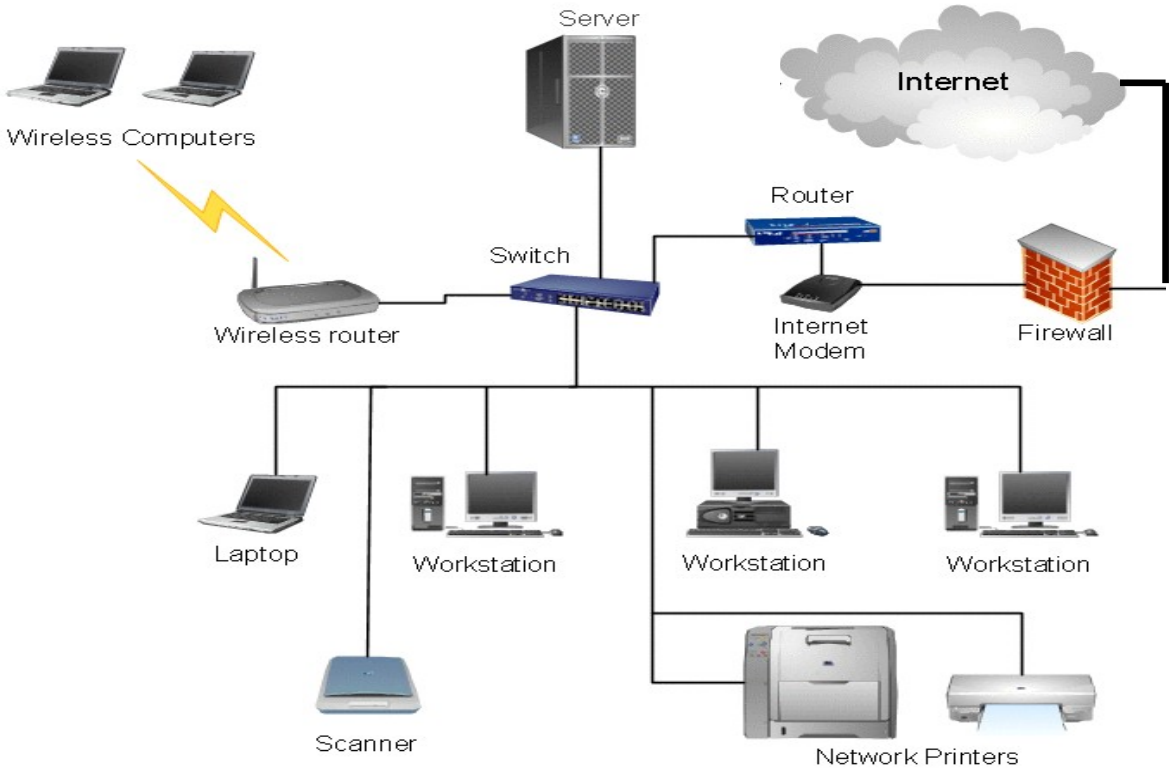
Ref: Introduction to Networking, Jeffrey Ting, 2018

Other HTTP commands

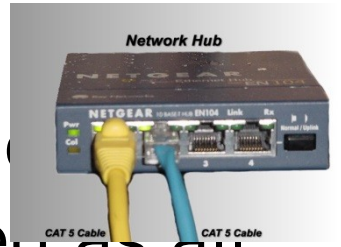
- **POST** – send data to Web Server. This how most web browser Forms are handled
- **PUT** – send a file to Web Server
- **DELETE** – delete a file on Web Server
- There are several other HTTP commands but all the main web browsers *only support GET and POST*

Network Hardware Devices

- There are a number of network hardware devices that are readily available for purchase (see diagram – more detail on next slide(s))

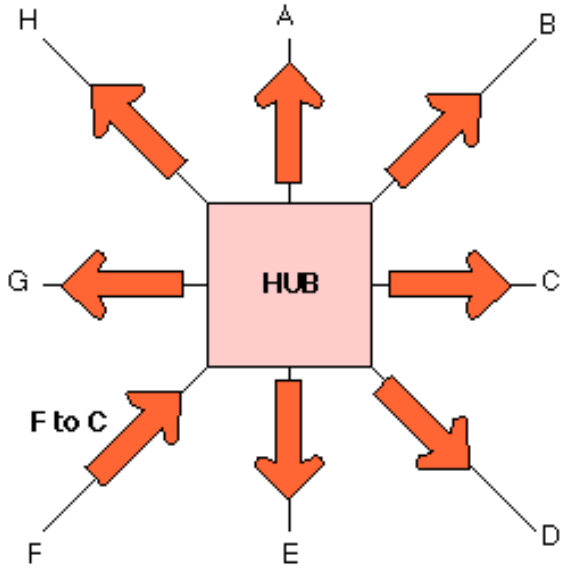


Hubs & Switches… (Look the same!)



- **Hubs** connect units in star topology
- Not intelligent – can lead to network c
- Through-traffic can be easily monitored as all connections carry the same information
- **Switches** connect in a point-to-point topology
- They redirect traffic to the appropriate connection line
- Thus allowing multiple channels of communication at the same time (swithes a higher frequency so they can cope with the bandwidth for every channel)

Hubs & switches



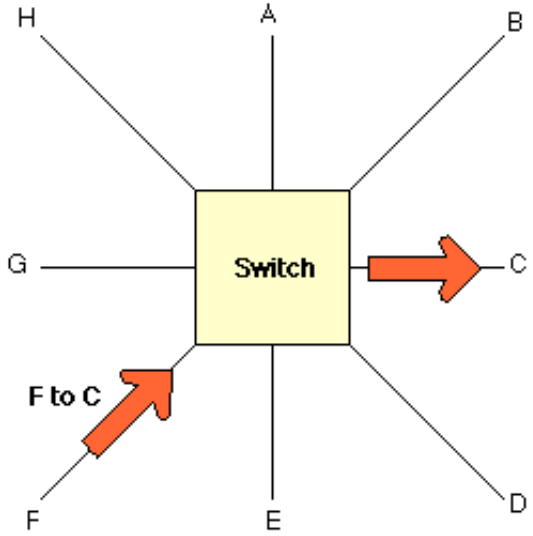


Image ref: http://www.erg.abdn.ac.uk/users/gorry/course/lan-pages/bridge.html

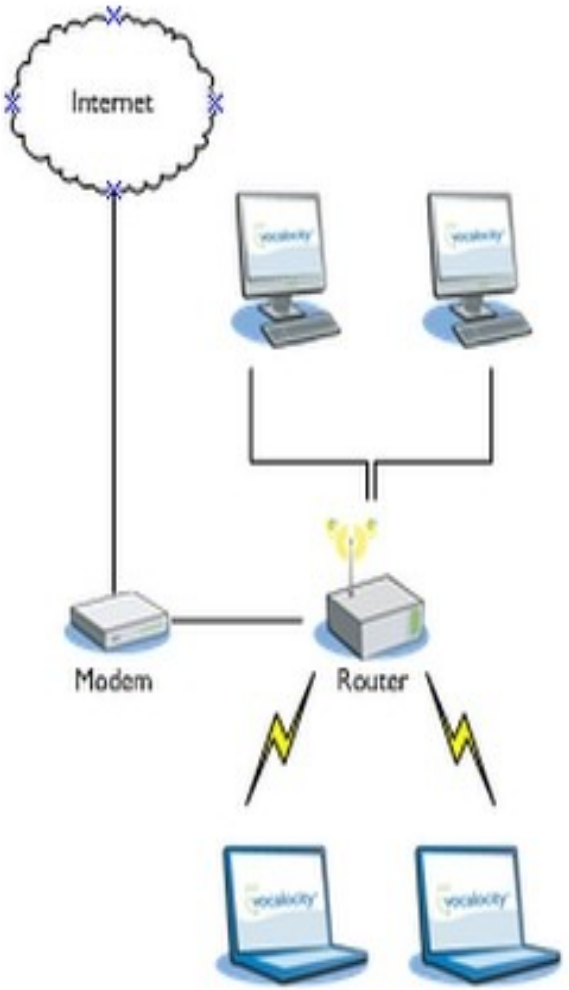
Repeaters and Bridge

- **Repeater** is used to repeat a signal received
  - It can **amplify** (clean-up) a signal (wired network) or
  - used to **expand** a devices range (wireless)

- **Bridge** is used to connect segmental networks together (or different local systems together)

Routers

- The **router** connects the modem to the computer or network
- The **modem** decodes / encodes signals for internet connection
- ***Most modern routers have built-in modems***
- The **router** will permit multiple computers to communicate with an external network at once
- Modern **router's** also provide -
  - **IP filter system**
  - basic **firewall**



Basic Network Design

- **Questions** to be asked for the development of a network -
  - Location of workstations/PCs/laptops
  - Number of units
  - Number of servers (if any)
  - Access to network (internal – external)
  - Use of hubs, switches, bridges, routers, etc.
  - Current infrastructure employed (develop or replace)
  - Others….(case dependent)

Summary

- Networking requires knowledge of:
  - Addressing (local & global)
  - Topology (best fit for purpose)
  - Protocols (various based on role)
  - Hardware devices (dedicated gear)
  - Setting up a Network
  - **OVERALL GOAL = Maximum secure connection bandwidth and functionality**

Workshop

- Complete *batchfile* program (**assessed**) - submission date is the end of module. See canvas for details
- The last workshop was Database material and SQL usage on canvas for when you have completed batchfile program
- Any problems speak to your workshop tutor.