**Module 2 Technologies & Tools**

**2.0 Networking Basics**

**What is a “Network”?**

* Network is way to get “stuff” between 2/more “things”
* Goal: Basic understanding of common modern networking technology & terminology
* Examples:

1. Analog – ‘Snail’ Mail, phone system, conversations, railroad system, highways & roads
2. Digital – routers & switches, clients & servers
3. Applications – Email/Messaging, Database, Web

**Protocol Concepts**

* Protocols are set of rules
* What do you want to do? (Application)
* Where are you going? (Addressing)
* How do you get there? (Media Types)
* Did you get there? (Acknowledgements, Error checking)

**Computer Networking Models**

* Models, AKA protocol stacks, represented in layers, help to understand where things go right/wrong
* OSI 7-layer model

1. Physical – transmission of raw bit stream. Electrical signalling & hardware interface
2. Data Link – frames exist here. Layer handles flow control. Specifies topology & provides hardware addressing (MAC)
3. Network – how systems on different network segments find each other. Source-destination address. Subnets, path determination exists in this layer. IP & IPX protocols used
4. Transport – breaks data into frames & assigns sequence numbers. Also checks for errors in received data. UDP & SPX are protocols that work here
5. Session – establishing & maintaining connections. Responsible for ports & ensures queries for services
6. Presentation – ensures data received in useable format. Data encryption done here
7. Application – responsible for determining when access to network required

**Physical Layer (Layer 1)**

* Cat 5 (or Cat 5e/Cat 6) twisted pair copper wire
* Fibre (multi-mode/single-mode) coaxial copper (thick & thin net)
* Cable modem, plain phone (DSL), microwaves (wireless Ethernet), etc.
* Wi-Fi, IEEE 802.11

**Data Link (Layer 2)**

* Media Access Control (MAC) address (sometimes Ethernet Address/physical address/adaptor address/hardware address etc.)
* 12-digit (48 bit) hexadecimal address that is unique to Ethernet adaptor
* 1st 6 digits are vendor code (Eg. 003065 belongs to Apple), last 6 digits are individual interface’s own

**Network Layer (Layer 3)**

* Network packets can be routed
* Network layer packets have to be stuffed inside data layer packets (AKA Encapsulation, this why layered model handy)
* When linking computers, via layer 1 (Physical) & Layer 2 (Data) you get a network

1. When linking networks, you get internetwork
2. Need Layer 3 (Network) to get data between all little networks (Often called subnets) of your internetwork

* Network Layer protocols – Internet Protocol (IP) & some others that aren’t used anymore (AppleTalk, Netware etc.)

1. Internet Protocol (IP) is Network Layer protocol used on internet
2. ARP (Address Resolution Protocol) – maps IP address to MAC address

**IP Addressing**

* IPv4 addresses consists of 4 octets Eg. 171.64.20.23

1. Each octet consists of numbers between 0 & 255 (or OO & FF in hex) (Don’t ask why Ethernet in hex but IP isn’t, they just are)
2. Subnet masking (Eg. 255.255.255.0 Subnet Mask of 171.64.20.23. 1st 3 octets refer to network, last octet refer to user connected to the network)

* IPv6 uses 128-bit address, theoretically allowing 2^138/3.4 x 10^38 address

1. Eg. FD1A:C35:241:0:AC05:9A33:B74:3B15

**IP: Domain Name Resolution (DNS)**

* Since easier to remember names than numbers, IP associated with names
* Computer however needs number, so Domain Name System (DNS) exists
* Name, such as networking.bellevue.edu tells you 1st (/top) level domain (.edu for educational institutions), 2nd level domain (Bellevue) & actual host’s name (networking)

1. DNS server will provide IP associated with bellevue.edu
2. If servers don’t know IP associated with domain name requested, it will ask other server(s) (Maybe global DNS server Eg. 8.8.8.8)

**Transport Layer (Layer 4)**

* Protocols of layer provide host-to-host communication services for apps
* Uses in-coming & out-going ports to/from server

1. Eg. HTTP – port 80, HTTPS – port 443

* Major types

1. Transmission Control Protocol (TCP) is connection-oriented & provides error checking
2. User Datagram Protocol (UDP) is connectionless. Used for streaming

**TCP Connections**

* 3 Way Handshake: TCP Connection Establishment (Forming TCP socket)

1. SYN request from Dynamic Source Port=5480 to Static Destination Port=80 setting SEQ=100
2. SYN ACK at Static Source Port=80 to Dynamic Destination Port=5480 setting SEQ=200, & ACK your SEQ=100+1=101
3. ACK at Dynamic Source Port=5480 to Static Source Port=80 setting SEQ=101 & ACK your SEQ=200+1=201
4. Socket TCP establishment must complete before data transfer begin (SEQ is Sequence Number)

**Application Layer (Layer 7)**

* Interfaces with OS & apps & communicates data between files, messages & other network activities
* Eg. Email (SMTP), Web (HTTP), File Transfer (FTP), Time (NTP)