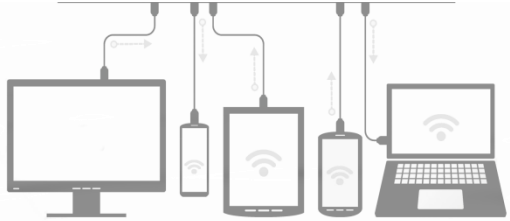
ICT 4010 Data and Communication Networks



Static IP Addresses

Lecture 4

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IP Addresses (Recap)

- An IP address is an address used to uniquely identify a device on an IP network.

- Two versions of IP addresses:
  - IPv4 and IPv6 (Our focus is on IP version 4)

- IPv4 consists of 32 binary bits broken into four octets (1 octet = 8 bits)
  - In dotted decimal format (for example, 192.168.1.100)

Network Address Types

- Four types of network addresses:

1. Physical Addresses (Hardware Addresses)
2. Logical Addresses (IP Addresses)
3. Port Addresses
4. Specific Addresses

Network Address Types

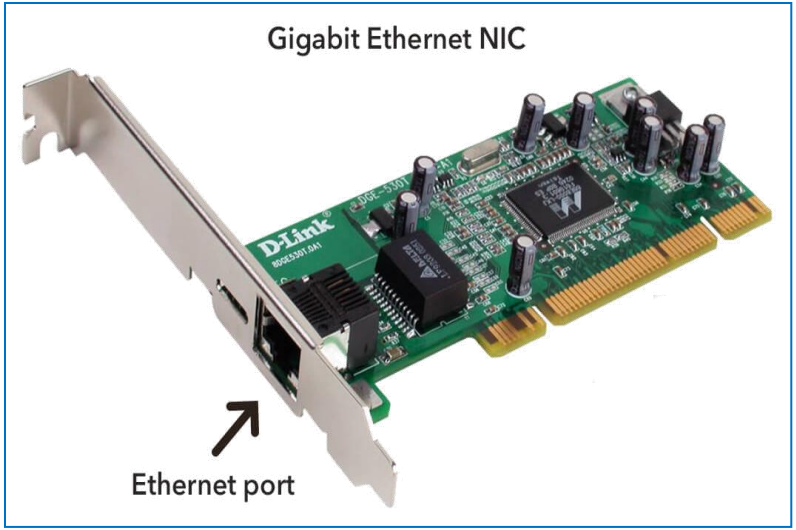
1) Physical Address / Hardware Address

- used to uniquely identify a host(network device) within a local network (using the **data link layer** of the OSI model)

- Ethernet utilizes a 48-bit **MAC address** as its hardware address.

Network Address Types

- **Hardware Address**
  - A media access control address (**MAC address**) is a unique identifier assigned to a network interface controller (NIC) for use as a network address in data communications
  - Each network device (e.g. PC/phone) will have a network interface controller / network interface card (NIC) which will have a MAC address which uniquely identifies the device



Network Address Types

- **Hardware Address**
  - MAC Addresses are used in various networking technologies such as:
    - Ethernet
    - Wi-Fi,
    - Bluetooth.
  - A MAC address is usually represented in a hexadecimal format, with two accepted formats:
    - e.g. 00:43:AB:F2:32:13
      0043.ABF2.3213

Network Address Types

- **Finding a MAC address:**
  - On Windows 10:
    - Press both the Windows Key and the R key simultaneously.
    - Type ncpa.cpl into the search box and press ENTER.
    - Right-click your Local Area Connection (or Wi-Fi Connection) and select Status.
    - Click Details and the Physical Address is your MAC Address.

Network Address Types

- **Finding a MAC address:**
  - On Linux 10.10.X or Newer:
    - Right click on the network arrow's and select Edit Connections.
    - In the Network Connections, click on your Ethernet adapter so it's orange and select "Edit..."
    - The Device MAC address shows the MAC address.

Network Address Types

- **Finding a MAC address:**
  - Apple iOS:
    - Tap on Settings
    - Tap on General
    - Navigate to and tap on "About“
    - Scroll down to "Wi-Fi Address

Network Address Types

- **Finding a MAC address:**
  - Android Phone:
    - On the Home screen, tap the Menu button and go to Settings.
    - Tap About Phone.
    - Tap Status or Hardware Information (depending on your model of phone).
    - Scroll down to see your WiFi MAC address.

Network Address Types

2) Logical Address / IP Address

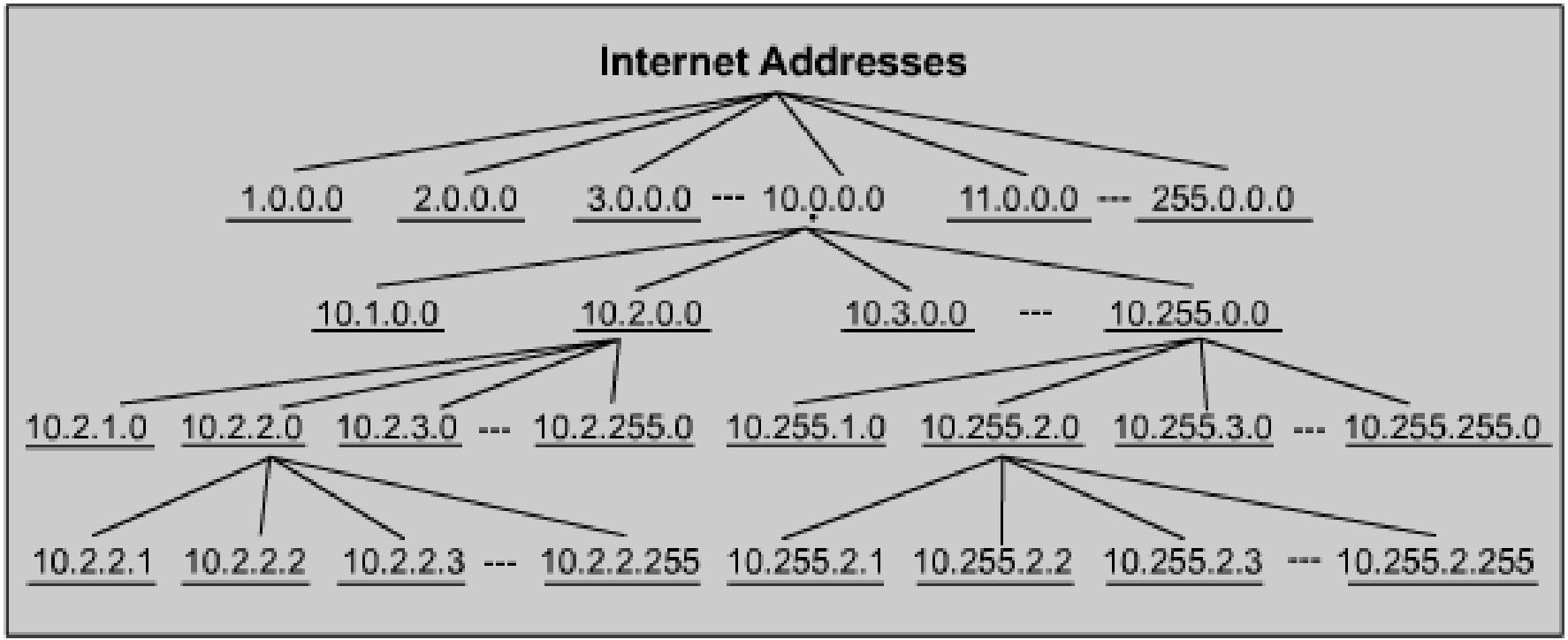
- used to uniquely identify a device on an IP network.

- Logical addressing is a function of the **Network layer** of the OSI Model, which includes a hierarchical structure.

- An IPv4 address consists of 32 binary bits broken into four octets
  - for example, 192.168.1.15

Network Address Types

- Example of IP Addresses Hierarchical structure



Network Address Types

- **IP Address**
  - Addresses in IPv4 are 32-bits long.
    - which allows for a maximum of 4,294,967,296 (2^{32}) unique addresses.
  - Addresses in IPv6 are 128-bits,
    - which allows for 3.4 x 10^{38} (2^{128}) unique addresses.
  - The total usable addresses of both versions is reduced by various reserved addresses and other considerations.
  - IP addresses are binary numbers but are usually expressed in **decimal** form (IPv4) or **hexadecimal** form (IPv6) to make reading and using them easier for humans.

Network Address Types

- **IPv4 Address Space Problem**
  - The original IPv4 specification was designed for the DARPA network that would eventually become the internet.
  - At the time, the 2^{32}addresses (4.3 billion) were considered sufficient. However, over time, it became apparent that the IPv4 address space would not be big enough for a worldwide internet with numerous connected devices per person

Network Address Types

- **IPv4 Address Space Problem**
  - The Internet Assigned Numbers Authority (IANA) manages the remaining supply of IP addresses(IPv4) to ensure that duplication of publicly used addresses does not occur.
  - Duplication would cause instability in the Internet and compromise its ability to deliver packets to networks.

Network Address Types

- **IPv6 - Address Space Solution**
  - the designers of IPv6 created an enormous address space for IPv6. The address size was increased from 32 bits in IPv4 to 128 bits in IPv6.
  - IPv6 has a theoretical limit of 3.4 x 10^{38} (2^{128}) addresses
    - over 340 undecillion addresses (i.e. 340 trillion trillion trillion available addresses to uniquely identify network devices)
    - theoretically enough addresses to assign one to every single atom on the surface of the earth.
  - IPv6 addresses are represented by eight sets of four hexadecimal digits, and each set of numbers is separated by a colon.

    For example
    - 5AB3:FEFE:1102:4FEA:10CB:1EFF:99D3:EE2B

Network Address Types

- **Port Address**
  - a pre-assigned unique number used such that a network device knows how to respond when it is contacted on a specific port.
  - A port address is a 16-bit address
    - 16-bit number
    - ie a port address can be any number from 1 up to 65,535 ($2^{16} - 1$), excluding zero
    - E.g Web Servers use port **80,**
    - SMTP (Simple Mail Transfer Protocol) is delivered to port **25.**

Network Address Types

- **Specific Address**
  - a user-friendly address such as web domains / website names
    - E.g. www.youtube.com, support@gmail.com
  - in both IPv4 and IPv6, remembering the IP address of every device is not possible except on small networks. Name resolution provides a way to lookup an IP address from an easier to use name.
    - On the internet, name resolution is handled by the Domain Name System (DNS). With DNS, a name in the format *host.domain* can be used in place of the destination's IP address.
    - When the connection is started, the source host will request the IP address of the destination host from a DNS server. The DNS server will reply with the destination's IP address. This IP address will then be used for all communications sent to that name.
      - i.e. a user will enter a human-readable website/domain name into a browser, and a DNS server will process the IP addresses of the associated domain, in the background

IP Addresses (continued)

- An IP address – a famous OSI Layer 3 address
- IPv4 – the current (widely used) version of IP addressing.
- IPv6 – the next version of IP addressing
- Each data packet sent along an IP network contains **source** and **destination IP addresses**
- A **router** uses the IP address of the destination to forward the packet to the correct destination

Router overview

- A router is a device that determines the next network point to which a packet should be forwarded toward its destination
  - Allowing different networks to communicate with each other

- A router creates and maintain a table of the available routes and their conditions and uses this information to determine the best route for a given packet.

- A packet will travel through multiple network points with routers before arriving at its destination.

- There can be multiple routes defined. The route with a lower weight will be tried first.

Router Overview – Networking Devices

- Hub
  - Hubs are used to connect multiple users to a single physical device, which connects to the network. Hubs and concentrators act as repeaters by regenerating the signal as it passes through them.

Router Overview – Networking Devices

- Bridge
  - a device that divides a network into segments. Each segment represent a separate collision domain, so the number of collisions on the network is reduced. They operate at the OSI data link layer (Layer 2) and are independent of higher-layer protocols

Router Overview – Networking Devices

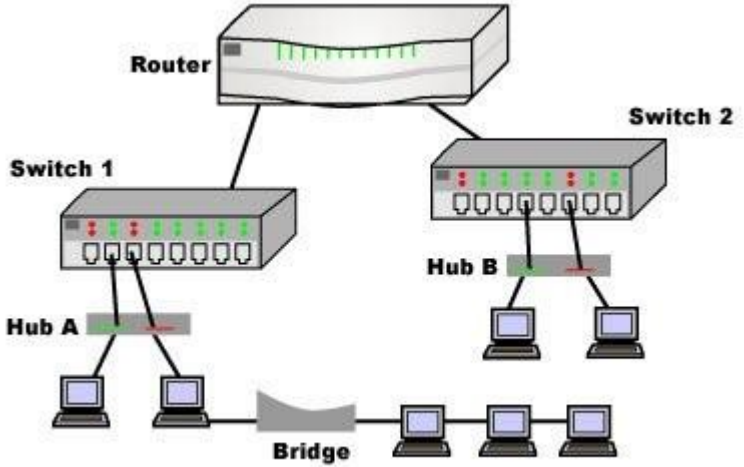
- Switch
  - Switches are similar to bridges but usually have more ports.
  - Switches provide a unique network segment on each port, thereby separating collision domains. Today, network designers are replacing hubs with switches to increase their network performance and bandwidth while protecting their existing wiring investments.

Router Overview – Networking Devices

- Switch and Bridge Similarity
  - both operate at the Data Link layer (Layer 2) and both can filter data so that only the appropriate segment or host receives a transmission.
  - Both filter packets based on the physical address (AKA MAC – Media Access Control – address) of the sender/receiver although newer switches sometimes include the capabilities of a router and can forward data based on IP address (operating at the Network Layer) and are referred to as IP Switches

Router Overview – Networking Devices

- Router
  - Routers direct network traffic based on the destination network layer address (Layer 3) rather than the data link layer (Layer 2) or MAC address.



IP Address Assignment

- An IP address should be assigned to every network device for the devices to exchange data on an Local Area Network and on the Internet.
- There are two ways of assigning IP addresses to network devices:
  - **Static assignment**
  - **Dynamic assignment**

Static IP Address Assignment

- **Static IP Address assignment** is whereby IP addresses are manually assigned for each computer, printer, or server on the network.
- Static assignment works best on small, non-frequently changing networks.
- Servers should be assigned a static IP address so workstations and other devices will always know how to access needed services.

Dynamic IP Assignment via DHCP

- **DHCP** Stands for Dynamic Host Configuration Protocol.
- A range of IP addresses which can be assigned to hosts are defined on a DHCP server.
- As a network device/host connects to a network, they contact the DHCP server and request for an IP address.
  - (This is done by the system, in the background, not by the user manually)
- The DHCP server chooses an address and *leases* it to that host.
- An IP address can be leased to a host for **a week, a month** etc.

Assigning a Static IP Address

- On Windows 10 (using the Control Panel):
  - From the Start Menu, Open **Settings**
  - Click on **Network & Internet.**
  - Click on **Change Adapter options**
  - Right-click the wanted network adapter (e.g. Local Area Network) and select the **Properties** option.
  - Select the **Internet Protocol Version 4 (TCP/IPv4)** option.
  - Click the **Properties** button.
  - Select **Use the following IP address**
  - Assign the static **IP address** , a **Subnet mask** and **Default gateway** (which is usually the router's IP address)

Assigning a Static IP Address

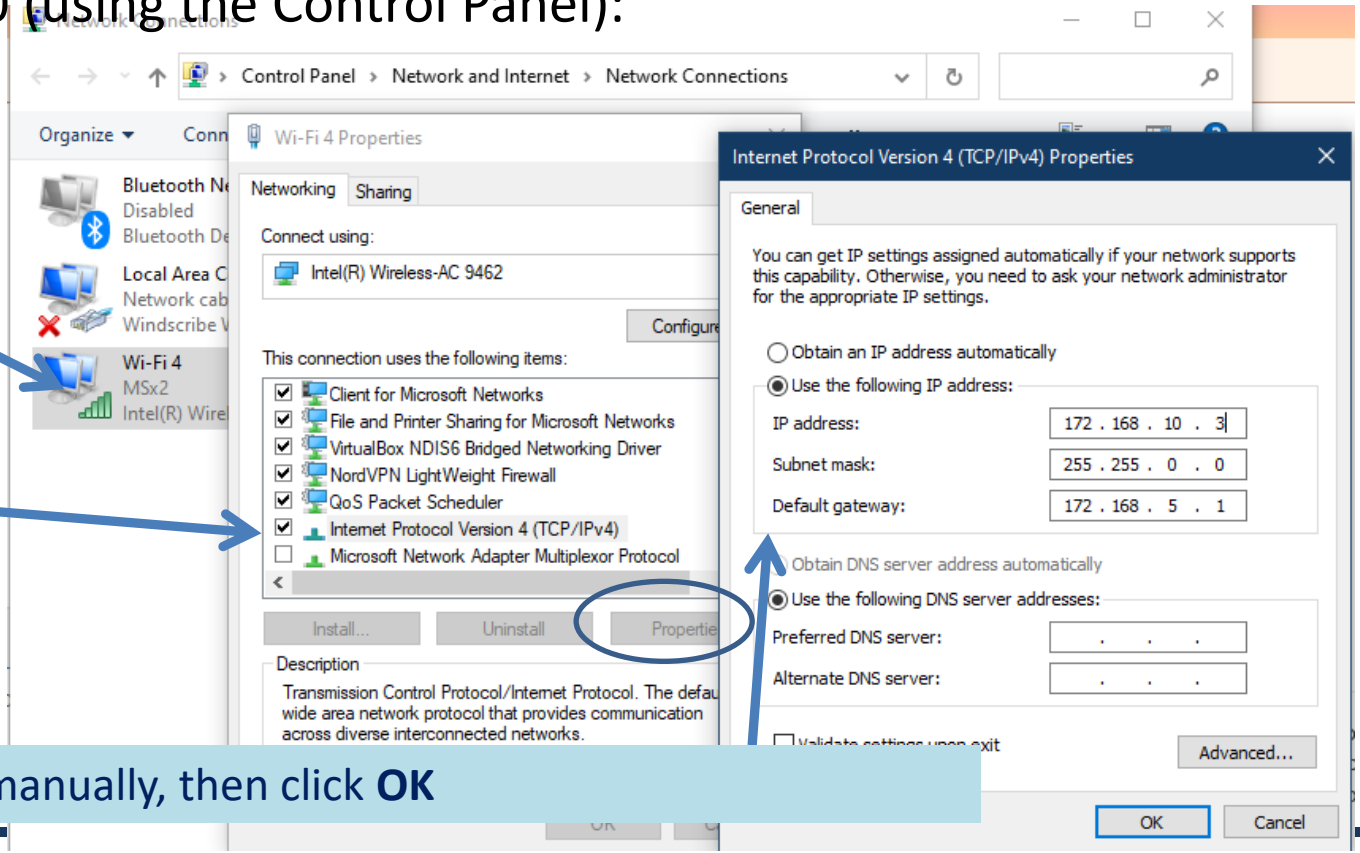
- On Windows 10 (using the Control Panel):

1. Right click > **Properties**

2. Select **Internet Protocol Version 4 (TCP/IP)**

3. Click **Properties**

4. Enter IP Address details manually, then click **OK**



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  - Click the **Properties** button.
  - Select **Obtain An IP Address Automatically**

Assigning a Dynamic IP Address

- On Windows 10 (using the Control Panel):
  - Select **Obtain An IP Address Automatically**
    - Note that this option will usually be the default option (already selected