Temasek Junior College

2023 JC2 H2 Computing

Networking 3 – Introduction to the Internet

1 Methods of Communication in a Network – Circuit Switching and Packet Switching

In network communication, the sender sends a message and the receiver receives it. However, both the sender and receiver may lie in different networks with very much far distance. For a message a sender to reach a receiver, it must pass through different devices and networks. As such, the message must be exchanged between different intermediate networks to reach the destination. This mechanism is called switching.

There are generally two kinds of switching: circuit switching and packet switching.

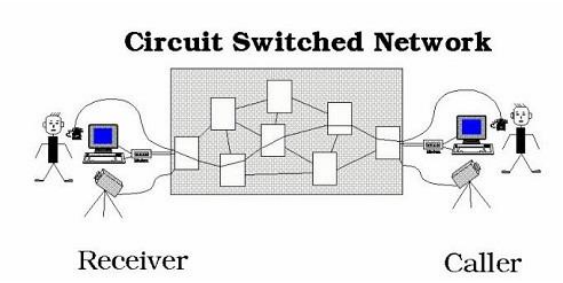
1.1 Circuit Switching

- Circuit switching creates a dedicated communication path is established between source and destination through the network nodes.
- Path is a connected sequence of physical links between nodes.
- On each link, a logical channel is dedicated to the connection.

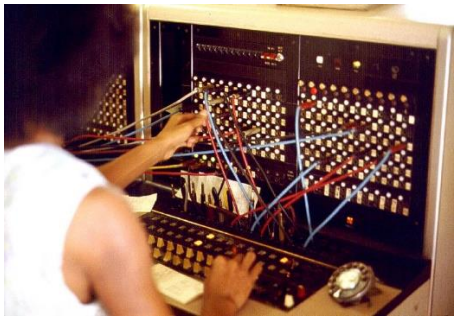
Advantages:
- Data from the source is transmitted through the dedicated link as fast as possible.
- No delay between reception and retransmission of data at each node.
- Since this is an exclusive connection between the two devices for the duration of the communication, data segments (or packets) arrive in the same order that they are sent, simplifying the process of reconstructing the message at the recipient end.

Disadvantages:
- Bandwidth is wasted during the periods when no data is being sent.
- The two devices must also transmit and receive data at the same rate, so circuit switched networks can only connect computers or devices that operate at the same transfer rate.

An example is the telephone network:
- The user dials a number.
- A direct line between the two telephones is opened (though many different cables, exchanges etc.) dedicated to that conversation.
- The telephone users hear each other “as they speak” (subject to speed of light etc.).
- The user doesn’t know or care where the electrical signals go between the two phones (unless there is a problem).



(A clear direct path exists between the caller and the receiver)



(A telephone operator manually connecting calls with cord pairs at a telephone switchboard)
By Joseph A. Carr - http://www.JoeTourist.net/, Attribution, https://commons.wikimedia.org/w/index.php?curid=5169771

1.2 Packet Switching

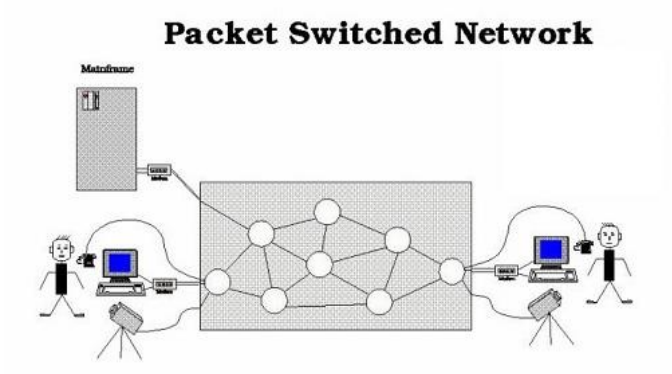
- Packet switching is a method of communicating packets of data across a network on which other similar communications are happening simultaneously.
- Website data that you receive arrives as a series of packets and an email will leave you in a series of packets (a unit of data).
- Packets travel through the network from node to node.

Advantages:
- Dedicated channel does not need to be setup before transmission takes place.
- Different routes are possible for data transfer.

Disadvantages:
- Not suitable for applications that require minimal latency.
- Packets will be dropped in transit if there is too much traffic.

- An example is the postal system
  - ✓ The user writes a letter, and puts it in an envelope which is addressed.
  - ✓ The letter is posted, then mixed up with everyone else's letters, until it gets to the destination, where it is sorted out and delivered.
  - ✓ The user does not know or care what route the letter took (unless there is a problem).
  - ✓ This is **PACKET SWITCHING**

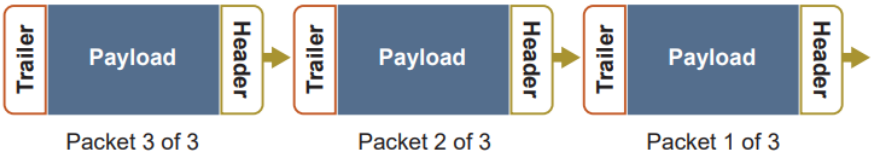
Computer networks have traditionally been PACKET SWITCHED. Modern computer networks incorporate elements of both circuit switching and packet switching.



(Data packets travelling separately through the nodes)

1.2.1 Data Packets

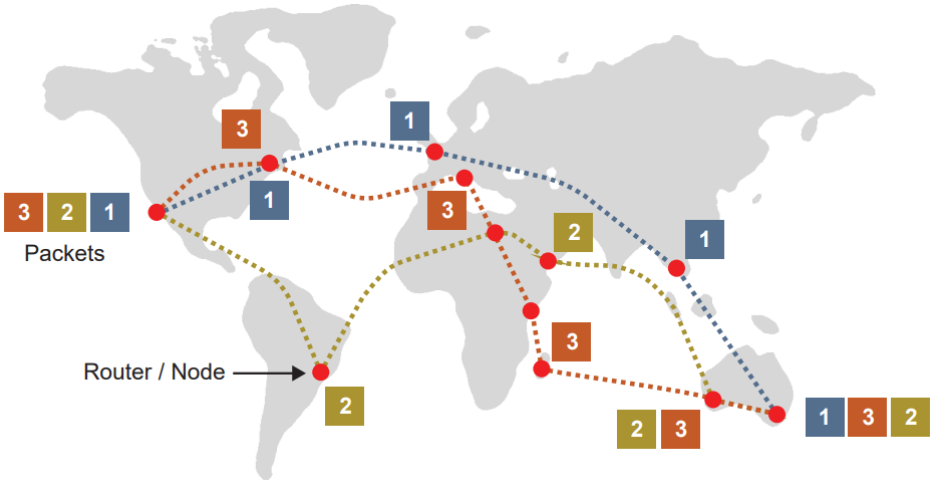
- Data that is to be transmitted across a network is broken down into more manageable chunks called packets. The size of each packet in a transmission can be fixed or variable, but most are between 500 and 1500 bytes.
- Each packet contains a **header** (e.g., source address, destination address and sequence number) and a **payload** containing the body of data being sent.
- Some packets may also use a trailer section with a checksum or Cyclical Redundancy Check (CRC) to detect transmission errors by creating and attaching a hash total calculated from the data contained in the packets. In essence, this hash total commonly involves adding up the total number of 1s in the transmission. The CRC checksum is recalculated for each packet upon receipt and matched to help verify that the payload data has not changed during transmission. If the CRC totals differ, the packet is refused with suspected data corruption and a new copy is requested from the sender.
- The header (much like the box(es) of a consignment you might send or receive through the post) includes the sender's and the recipient's IP addresses, the protocol being used with this type of packet and the number of the packet in the sequence being sent, e.g. packet 1 of 8. They also include the Time To Live (TTL) or hop limit, after which point the data packet expires and is discarded.
- Upon receipt, the packets are reassembled in the correct order and the data is extracted.



Data packets queueing to be sent

1.2.2 Routing packets across the Internet

The success of packet switching relies on the ability of packets to be sent from sender to recipient along entirely separate routes from each other. When a packet leaves the sender's computer, the fastest or least congested route is taken to the recipient's computer. They can be easily reassembled in the correct order at the receiving end and any packets that don't make it can be requested again.



1.3 Circuit Switching vs Packet Switching

The following table gives a summary of the differences between circuit switching and packet switching:

Characteristic	Circuit Switching	Packet Switching
Data transmission	Dedicated single route	Different routes in separate data packets
Message	Node delay. Passes by each node immediately	Temporary stored at each node
Node status	Both sender and receiver must be ready	Sufficient for sender to be ready to send the message
Connection	Dedicated	Shared
Utilisation	Poor	Good
Data transmission rate	Fixed	Varies
Prioritisation	Not supported	Supported

2 The Intranet

The **intranet** is a computer network for sharing information, collaboration tools, operational systems, and other computing services within an organization, usually private, i.e. exclude access by outsiders.

- Access to an intranet is usually restricted to people within the organization.
- Security can be ensured by using passwords and secure transmission lines.
- Access controls can be used to ensure that only specific people can access specific facilities and data on the intranet.

- As there is a smaller volume of content on an intranet, the content is more likely to be relevant to the organization.
- The amount of control means that the content on an intranet is more likely to be updated.
- As membership is restricted and users can be easily identified, comments are more likely to be relevant and sensible.

3 The Internet

The Internet is a network of networks set up to allow computers to communicate with each other globally.

3.1 Brief history of the internet

- Began its life in the 1970s as an experimental packet switching network originally developed by the Defence Advanced Research Projects Agency (DARPA) and is called the ARPANET.

- Conceived to be a communications network without any definitive points of administration so that an enemy could not disable the entire network by targeting strategic points.

- Composed of independent computers that communicate using TCP/IP, a collection of platform-independent protocols designed especially for Internet use.

- Designed to function as an open networking medium, largely without centralized administration, and based on public domain standards. No one owns it, and no one is ultimately responsible for it.

- The World Wide Web (WWW) is a collection of web pages that reside on computers connected to the Internet. It uses the Internet as a service to communicate the information contained within these pages.

- The concept of the WWW and using a browser to search the information contained within it was first developed by Sir Tim Berners-Lee, a British scientist working at CERN in Geneva, Switzerland.

- The World Wide Web is not the same as the Internet and even today, the Internet is frequently used without using the WWW.

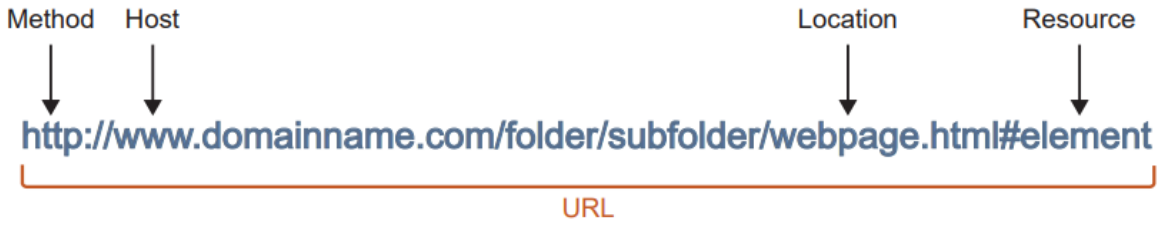
- The Internet provides for the use of:
  - content from the World Wide Web (www)
  - electronic mail
  - file transfer.

3.2 Physical Structure of the Internet

Each continent uses backbone cables connected by trans-continental leased lines fed across the sea beds. National Internet Service Providers (ISPs) connect directly to this backbone and distribute the Internet connection to smaller providers who in turn provide access to individual homes and businesses.

3.3 Uniform Resource Locators (URLs)

A Uniform Resource Locator is the full address of an Internet resource. It specifies the location of a resource on the Internet, including the resource name and usually the file type, so that a browser can request it from the website server.



3.4 Internet registries and registrars

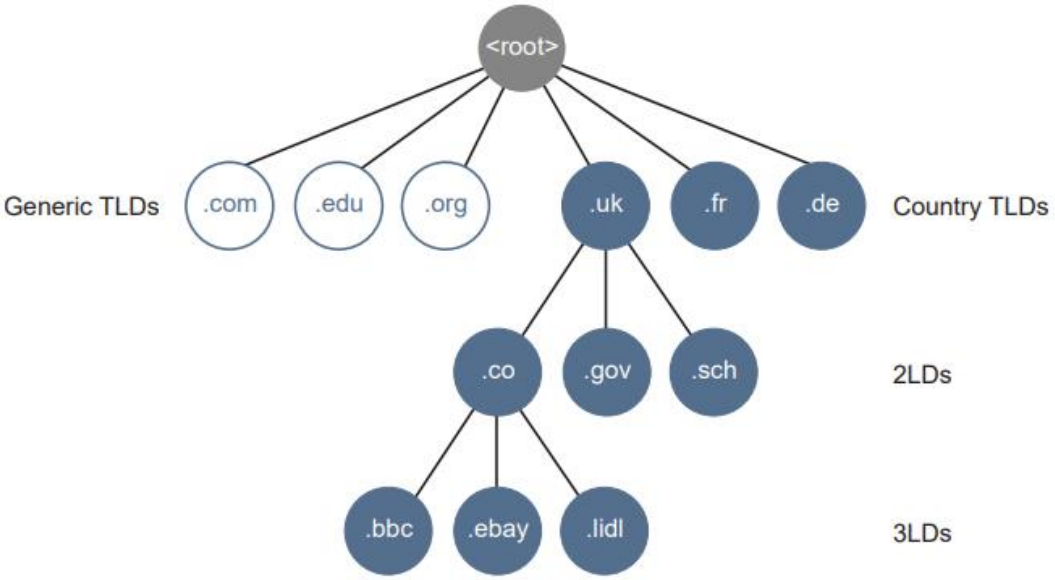
- **Internet registrars** hold records of all existing website names and the details of those domains that are currently available to purchase. These are companies that act as resellers for domain names and allow people and companies to purchase them. All registrars must be accredited by their governing registry.

- **Internet registries** are five global organisations governed by the Internet Corporation for Assigned Names and Numbers (ICANN) with worldwide databases that hold records of all the domain names currently issued to individuals and companies, and their details. These details include the registrant's name, type (company or individual), registered

mailing address, the registrar that sold the domain name and the date of registry. The registries also **allocate IP addresses** and keep track of which address(es) a domain name is associated with as part of the **Domain Name System (DNS).**

3.5 Domain names and the Domain Name System (DNS)

- A domain name identifies the area or domain that an Internet resource resides in. These are structured into a hierarchy of smaller domains and written as a string separated by full stops as dictated by the rules of the Domain Name System (DNS)



A hierarchical domain system from Top Level Domains (TLDs) to 3rd Level Domains (3LDs)

- The domain name system (DNS) maps human-readable domain names to IP addresses and provides a system for finding the IP address for a given individual domain name.
- Each domain name has one or more equivalent IP addresses. The DNS catalogues all domain names and IP addresses in a series of global directories that domain name servers can access in order to find the correct IP address location for a resource.
- When a webpage is requested using the URL a user enters, the browser requests the corresponding IP address from a local DNS. If that DNS does not have the correct IP address, the search is extended up the hierarchy to another larger DNS database.
- The IP address is located and a data request is sent by the user's computer to that location to find the web page data. A webpage can be accessed within a browser by entering the IP address if it is known.

3.6 IP addresses

- An IP or Internet Protocol address is a unique address that is assigned to a network device. An IP address performs a similar function to a home mailing address. For example:

216.239.38.120

- The IP address indicates where a packet of data is to be sent or has been sent from. Routers can use this address to direct the data packet accordingly. If a domain name is associated with a specific IP address, the IP address is the address of the server that the website resides on.

- We will discuss more about IP addressing on the next unit when we learn about TCP/IP.

3.7 Media Access Control (MAC) addresses

- Every computer device, whether it's a PC, smartphone, laptop, printer or other device which is capable of being part of a network, must have a wired or wireless Network Interface Card (NIC).

- Each NIC has a unique Media Access Control address (MAC address), which is assigned and hard-coded into the card by the manufacturer and which uniquely identifies the device.

- The address is 48 bits long, and is written as 12 hex digits, for example:

00-09-5D-E3-F7-62

- You can find out the MAC address of your PC by selecting Command Prompt from the Start menu in Windows, and then typing `ipconfig /all`. This will display the physical address, i.e. MAC address.