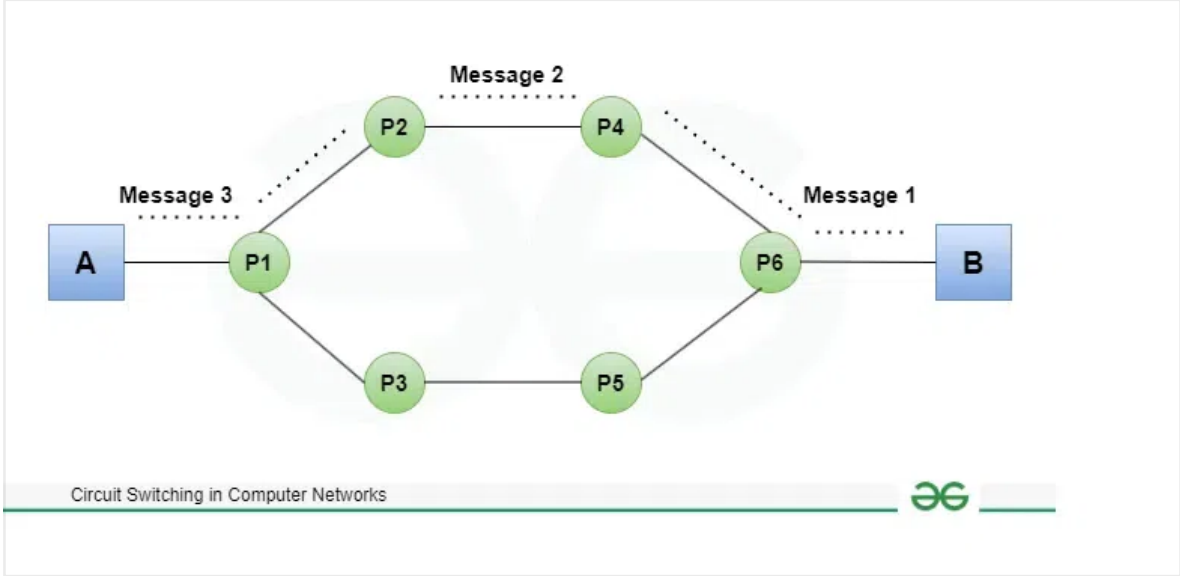
Circuit Switching in Computer Network

Circuit Switching is a type of switching, in which a connection is established between the source and destination beforehand. This connection receives the complete bandwidth of the network until the data is transferred completely. However, circuit switching can be inefficient and costly due to its requirement for dedicated resources, making it less suitable for high-traffic or large-scale networks. In this article, we will discuss every point about Circuit Switching.

What is Circuit Switching?

In circuit switching network resources (bandwidth) are divided into pieces and the bit delay is constant during a connection. The dedicated path/circuit established between the sender and receiver provides a guaranteed data rate. Data can be transmitted without any delays once the circuit is established.



The telephone system network is one of the examples of Circuit switching. **TDM (Time Division Multiplexing) and FDM (Frequency Division Multiplexing)** are two methods of multiplexing multiple signals into a single carrier.

- **Frequency Division Multiplexing:** Frequency Division Multiplexing or FDM is used when multiple data signals are combined for simultaneous transmission via a shared communication medium. It is a technique by which the total bandwidth is divided into a series of non-overlapping frequency sub-bands, where each sub-band carries different signal. Practical use in radio spectrum & optical fiber to share multiple independent signals.
- **Time Division Multiplexing:** Time-division multiplexing (TDM) is a method of transmitting and receiving independent

signals over a common signal path using synchronized switches at each end of the transmission line. TDM is used for long-distance communication links and bears heavy data traffic loads from the end user.
Time-division multiplexing (TDM) is also known as a digital circuit switch.

Phases of Circuit Switching

- **Circuit Establishment:** A dedicated circuit between the source and destination is constructed via a number of intermediary switching center's. Communication signals can be requested and received when the sender and receiver communicate signals over the circuit.
- **Data Transfer:** Data can be transferred between the source and destination once the circuit has been established. The link between the two parties remains as long as they communicate.
- **Circuit Disconnection:** Disconnection in the circuit occurs when one of the users initiates the disconnect. When the disconnection occurs, all intermediary linkages between the sender and receiver are terminated.

Why is Circuit Switching Used for?

- **Continuous connections:** Circuit switching is used for connections that must be maintained for long periods, such as long-distance communication. Circuit switching technology is used in traditional telephone systems.
- **Dial-up network connections:** When a computer connects to the internet through a dial-up service, it uses the public switched network. Dial-up transmits Internet Protocol (IP) data packets via a circuit-switched telephone network.
- **Optical circuit switching:** Data centre networks also make use of circuit switching. Optical circuit switching is used to expand traditional data centres and fulfil increasing bandwidth demands.

Advantages of Circuit Switching

- The main advantage of circuit switching is that a committed transmission channel is established between the computers which give a guaranteed data rate.
- In circuit switching, there is no delay in data flow because of the dedicated transmission path.
- **Reliability:** Circuit switching provides a high level of reliability

since the dedicated communication path is reserved for the entire duration of the communication. This ensures that the data will be transmitted without any loss or corruption.

- **Quality of service:** Circuit switching provides a guaranteed quality of service, which means that the network can prioritize certain types of traffic, such as voice and video, over other types of traffic, such as email and web browsing.
- **Security:** Circuit switching provides a higher level of security compared to packet switching since the dedicated communication path is only accessible to the two communicating parties. This can help prevent unauthorized access and data breaches.
- **Ease of management:** Circuit switching is relatively easy to manage since the communication path is pre-established and dedicated to a specific communication. This can help simplify network management and reduce the risk of errors.
- **Compatibility:** Circuit switching is compatible with a wide range of devices and protocols, which means that it can be used with different types of networks and applications. This makes it a versatile technology for various industries and use cases.

Disadvantages of Circuit Switching

- **Limited scalability:** Circuit switching is not well-suited for large-scale networks with many nodes, as it requires a dedicated communication path between each pair of nodes. This can result in a high degree of complexity and difficulty in managing the network.
- **Vulnerability to failures:** Circuit switching relies on a dedicated communication path, which can make the network vulnerable to failures, such as cable cuts or switch failures. In the event of a failure, the communication path must be re-established, which can result in delays or loss of data.
- **Limited Flexibility:** Circuit switching is not flexible as it requires a dedicated circuit between the communicating devices. The circuit cannot be used Waste of Resources for any other purpose until the communication is complete, which limits the flexibility of the network.
- **Waste of Resources:** Circuit switching reserves the bandwidth and network resources for the duration of the communication, even if there is no data being transmitted.

This results in the wastage of resources and inefficient use of the network.

- **Expensive:** Circuit switching is an expensive technology as it requires dedicated communication paths, which can be costly to set up and maintain. This makes it less feasible for small-scale networks and applications.
- **Susceptible to Failure:** Circuit switching is susceptible to failure as it relies on a dedicated communication path. If the path fails, the entire communication is disrupted. This makes it less reliable than other networking technologies, such as packet switching.
- **Not suitable for high traffic:** Circuit switching is not suitable for high traffic, where data is transmitted intermittently at irregular intervals. This is because a dedicated circuit needs to be established for each communication, which can result in delays and inefficient use of resources.
- **Delay and latency:** Circuit switching requires the establishment of a dedicated communication path, which can result in delay and latency in establishing the path and transmitting data. This can impact the real-time performance of applications, such as voice and video.
- **High cost:** Circuit switching requires the reservation of resources, which can result in a high cost, particularly in large-scale networks. This can make circuit switching less practical for some applications.
- **No prioritization:** Circuit switching does not provide any mechanism for prioritizing certain types of traffic over others.

Difference between Circuit Switching and Packet Switching

Circuit Switching	Packet Switching
In-circuit switching, each data unit knows the entire path address which is provided by the source.	In Packet switching, each data unit just knows the final destination address intermediate path is decided by the routers.

In-Circuit switching, data is processed at the source system only	In Packet switching, data is processed at all intermediate nodes including the source system.
The delay between data units in circuit switching is uniform.	The delay between data units in packet switching is not uniform.
Circuit switching is more reliable.	Packet switching is less reliable.
Wastage of resources is more in Circuit Switching	Less wastage of resources as compared to Circuit Switching
Circuit switching is not convenient for handling bilateral traffic.	Packet switching is suitable for handling bilateral traffic.
In-Circuit Switching there is a physical path between the source and the destination	In Packet Switching there is no physical path between the source and the destination

The Takeaway

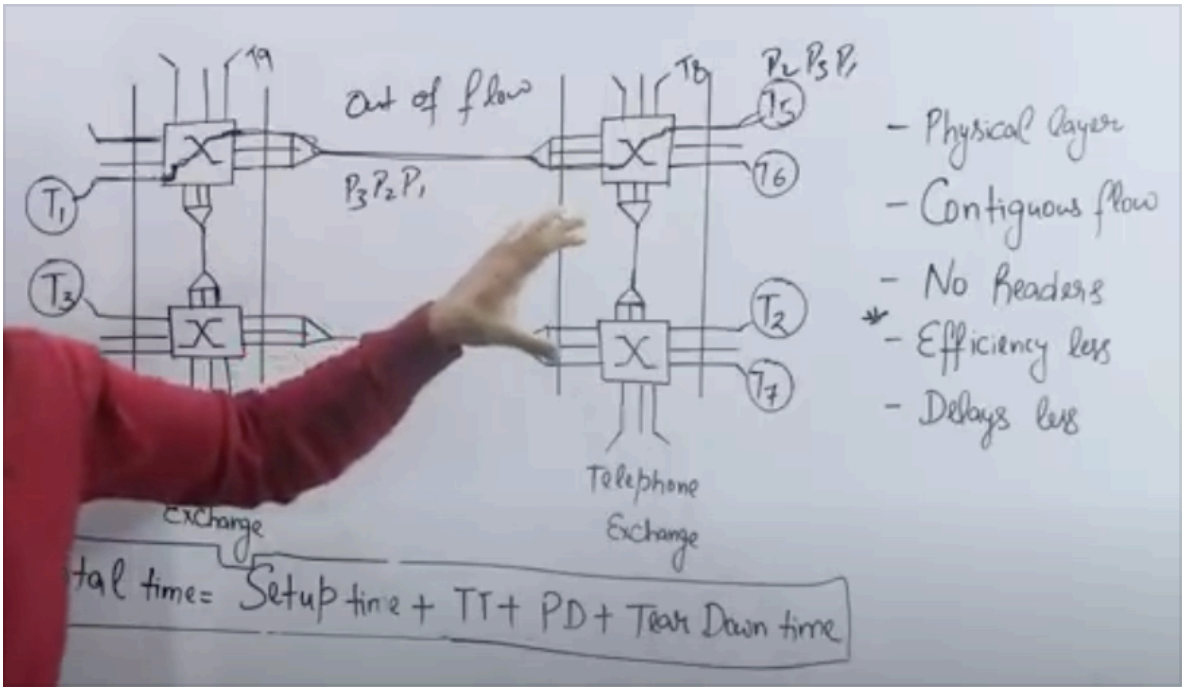
Traditional telecommunications systems and landlines rely on circuit switching for their functioning. Packet switching is the foundation of the modern Internet. Each has both advantages and disadvantages. Sometimes they overlap, like when a packet-switching network emulates circuit-switching technology and establishes a connection-oriented manner of data transport. The internet and most phone services now rely on packet switching. However, most legacy networks were intended to handle circuit-switched traffic. A new optical routing architecture could help overcome this gap.

Formulas used in Circuit Switching

Transmission rate = Link Rate or Bit rate /
no. of slots = R/h bps

Transmission time = size of file /
transmission rate
= x / (R/h) = (x*h)/R second

Total time to send packet to destination =
Transmission time + circuit setup time


T1
T3
T5
T6
T2
T7
P3 P2 P1
Out of flow
P2 P3 P1
Telephone Exchange
Exchange
- Physical layer
- Contiguous flow
- No Readers
- Efficiency less
- Delays less
tal time= Setup time + TT + PD + Tear Down time