

CCN: End-To-End Communication: **Switching**



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Goals:

❖ Why is Switching is Required

- **Circuit Switching**
 - ✓ **Public Switched Telephone Networks**
- **Message Switching**
- **Packet Switching**
 - ✓ **Virtual Circuit Packet Switching**
 - ✓ **Datagram Packet Switching**

Why is Switching is Required

Why is Switching is required

- ❖ When **two computers are located** close to **each other** that need to communicate,
 - ✓ it is often easiest just to **run a cable** between them.
 - ✓ **LANs** work this way.

Limitations With Directly Connected Networks

- ❖ **Directly connected networks** **limit the geographical area** covered and **number of hosts**
 - ✓ **Enable communication** between hosts **not directly connected**

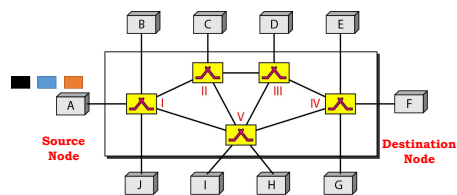
Suitable Mechanism....

- ❖ When the **distances are large** or there are **many computers**
 - ✓ it is necessary to develop **suitable mechanism for communication** between any **two devices**

Switching Mechanism

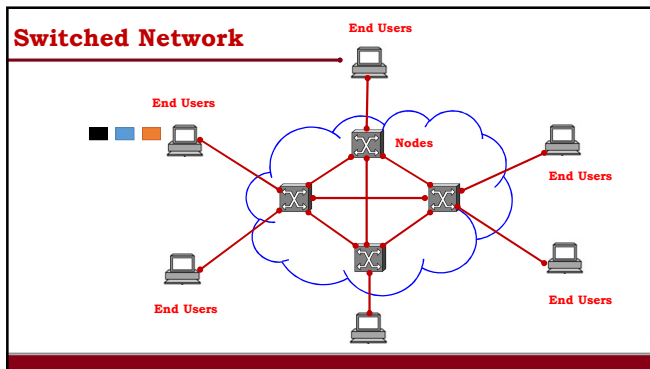
Switching Mechanism

❖ A **Switching techniques** is used to **perform communication** between any **two devices**



Switching Process

- ❖ In the **Switched Network Methodology**,
 - ✓ Network consists of a **set of interconnected nodes**
 - ✓ **Information is transmitted** from source to destination via **different routes**, which is **controlled by the switching mechanism**.



Switched Network: Key Features

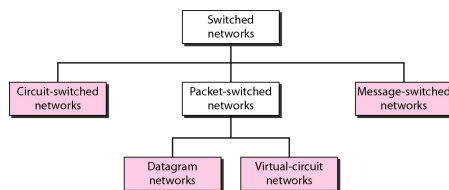
Switched Network: Key Features

- ❖ **Network Topology** is not regular.
- ❖ Uses **FDM or TDM** for node-to-node communication.
- ❖ There **exist multiple paths** between a **source-destination pair** for better **network reliability**.
- ❖ The **switching nodes** are not concerned with the **contents of data**.
- ❖ Their purpose is to provide a **switching facility** that will **move data from node to node** until they **reach the destination**.

Taxonomy of Switched Networks

Taxonomy of Switched networks

❖ The switching performed by different nodes can be categorized into the following three types:



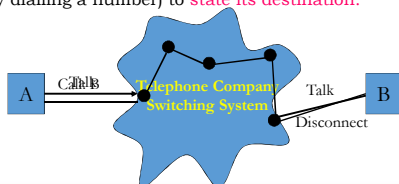
Circuit Switching

Circuit Switching

- ❖ A **Circuit-switched Network** consists of a **set of switches connected** by physical links.
- ✓ A **connection between two stations** is a **dedicated path** made of **one or more links**.
- ✓ Each **connection uses only one dedicated channel** on each link.
- ✓ Each **link is normally divided into n channels** by using **FDM or TDM**.

Circuit Switching

- ❖ **Circuit switching** is commonly used technique in **Telephony**,
- ✓ where the **caller sends a special message** with the **address of the callee** (i.e. by dialling a number) to **state its destination**.



Circuit Switching

- ❖ **Circuit Switching** involved the following **three distinct steps**
 - **Circuit Establishment**
 - **Data transfer**
 - **Circuit disconnect**

Circuit Switching

❖ Circuit Establishment:

- ✓ To establish an **end-to-end connection** before any transfer of data.
- ✓ Circuit may be a **dedicated link/Shared**.

❖ Data transfer:

- ✓ **Transfer data** is from the source to the destination.
- ✓ The **data may be analog or digital**, depending on the nature of the network.
- ✓ The connection is generally **full-duplex**.

❖ Circuit disconnect:

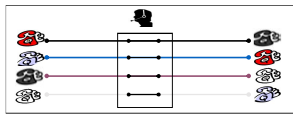
- ✓ **Terminate connection** at the end of data transfer.

Circuit Switching

A Circuit-switched Network is made of a set of switches connected by physical links, in which each link is divided into n channels.



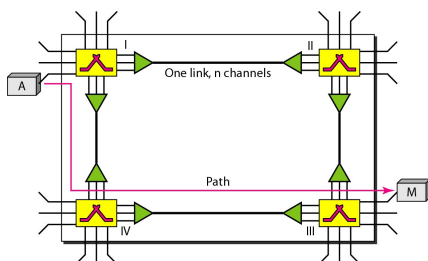
Telephone switch



"Operator, please connect me to 555-1212"



Scenario



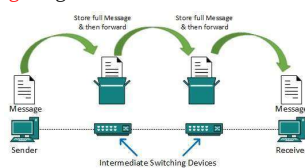
Disadvantages of Circuit-Switched Network

- ❖ A **dedicated connection** that has **no transmission** means **wasted bandwidth**
- ❖ A **connection is time consuming** if short, infrequent, or sporadic communication is to occur

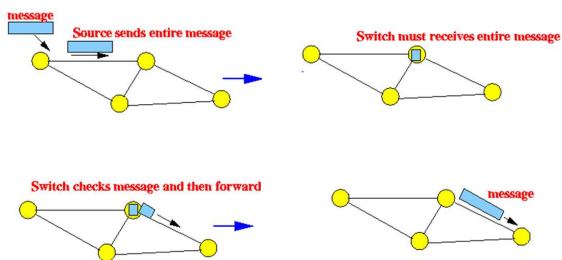
Message Switching

Message Switching

- ❖ Each **network node receives and stores** the message
- ❖ Determines the **next Node of the route**
- ❖ **Queues the message** to go out on that link.



Message Switching



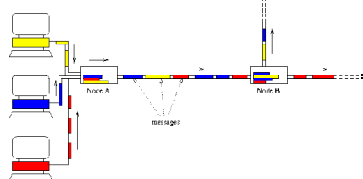
Message Switching

❖ In Message Switching Method,

- ✓ The message is sent to the nearest switching node directly.
- ✓ The nearest node stores the message, checks for errors, selects the best available route and forwards the message to the next intermediate node.

Message Switching

- ❖ The Data Link line becomes free again for other messages, while the process is being continued in some other nodes.
- ❖ Due to the mode of action, this method is also known as **store-and-forward technology**



Message Switching: Disadvantages

- ❖ Message of large size dominates the link and storage

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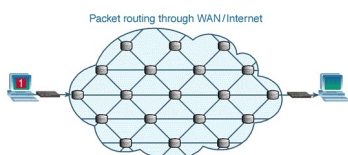
Packet Switching

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Packet Switching

- ❖ Packet Switching approach was developed for long-distance data communication purpose

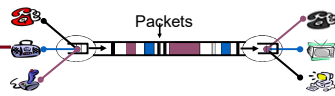
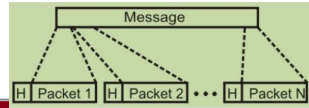
- ✓ To overcome the **limitations of message switching**

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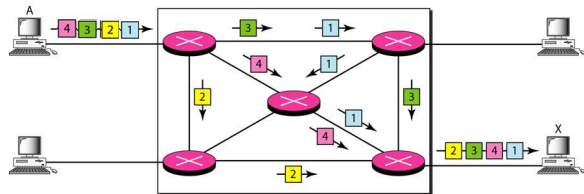
Packet Switching

❖ In **Packet Switching Approach**,

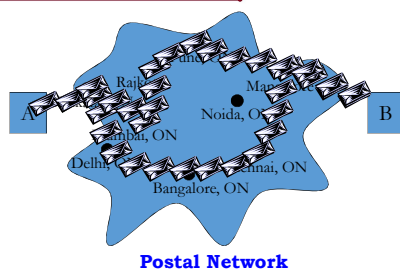
- ✓ Data are **transmitted in short packets** (few Kbytes).
- ✓ A **long message is broken up** into a **series of packets**
- ✓ Every **packet** contains **some control information** in its **header**, which is required for **routing and other purposes**.



Packet Switching



Packet Switching : Example

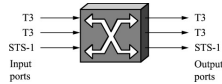


Why Packet Switching

- ❖ The **Directly connected networks** suffer from two limitations
 - ✓ Limits with # of hosts attached.
 - Ex : An **Ethernet** can connect up to only **1024 hosts**.
 - ✓ Limits the geographic area with a single network
 - Ex : An **Ethernet** can span only **2500m**

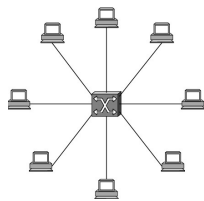
Why Packet Switching

- ❖ To build the **networks that scales well** and **covers the globally**
 - ✓ we need to **enable communication between hosts** that are **not directly connected**.
- ❖ A **Switch** is a **multi-input, multi-output device** that allows us to **interconnect links** to form **larger networks**.
- ❖ A **switch** transfers **packets** from an **input** to **one or more outputs**



Why Packet Switching

- ❖ The **inputs and outputs** of a switch are referred to as **Ports**



Packet Switching Works

- ❖ How does the **Packet Switch** decide which output port to place each packet on?

Packet Switching Works

- ❖ Generally Switch looks at the **header of the packet addresses** to make decisions.
- ❖ There are **two common approaches** to know the details of how it uses the header of the packet addresses,
 1. **Datagram Or Connectionless Packet Switching Approach**
 2. **Virtual Circuit Or Connection-oriented Packet Switching Approach.**

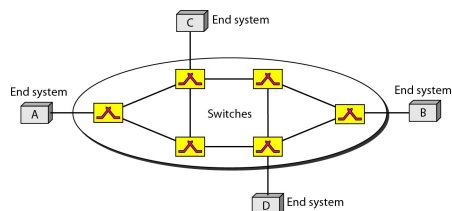
Virtual Circuit Packet Switching

Virtual Circuit Packet Switching

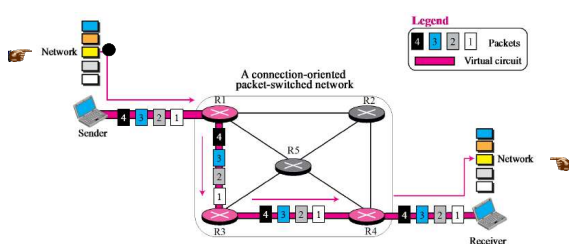
- ❖ Virtual Circuit Packet Switching is a widely used technique that uses the concept of a virtual circuit (VC).
- ❖ This approach, which is also called **connection-oriented model** that requires
 - ✓ **Virtual Connection Setup** between the Source and Destination Host
 - ✓ **Data Transfer**

Virtual Circuit Packet Switching

- ❖ A virtual-circuit network is normally implemented in the **data link layer**

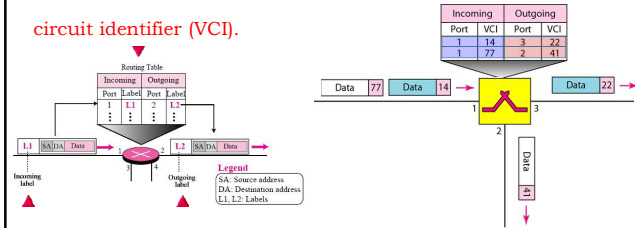


Virtual Circuit Packet Switching



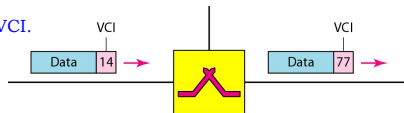
Virtual Circuit Packet Switching

- ❖ Each **Switch** has a **VC table**. Every **VCs** are identified by a **virtual circuit identifier (VCI)**.



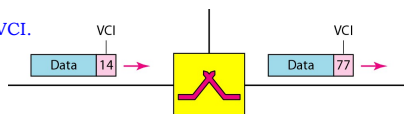
Virtual Circuit Packet Switching

- ❖ The **identifier** that is actually used for **data transfer** is called the **virtual-circuit identifier (VCI)**.
- ❖ A **VCI** is used by a **frame between two switches**.
 - ✓ When a **frame arrives at a switch**, it has a VCI; when it leaves, **it has a different VCI**.



Virtual Circuit Packet Switching

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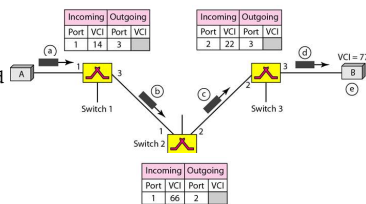


Phases...

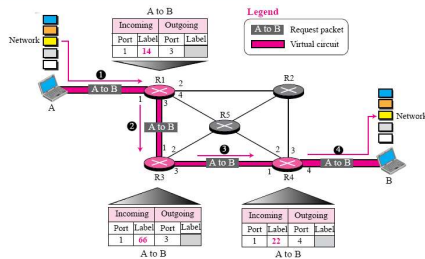
- ❖ Virtual-circuit Network will go through **three phases** between source and destination
- ❖ **Setup,**
- ❖ **Data Transfer,**
- ❖ **Disconnect**

Setup Phase: Request

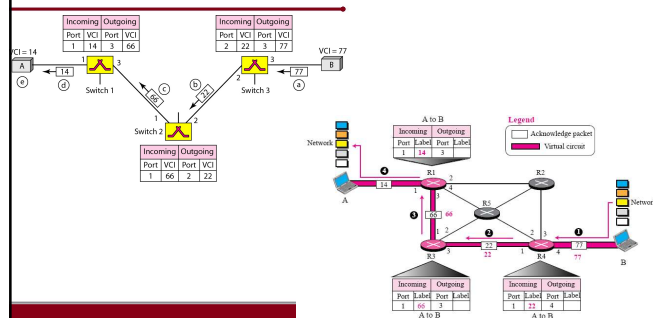
- ❖ In the setup phase,
 - ✓ A switch creates an entry for a virtual circuit.
 - ✓ Two steps are required:
 - The **setup request** and
 - The **acknowledgment**.



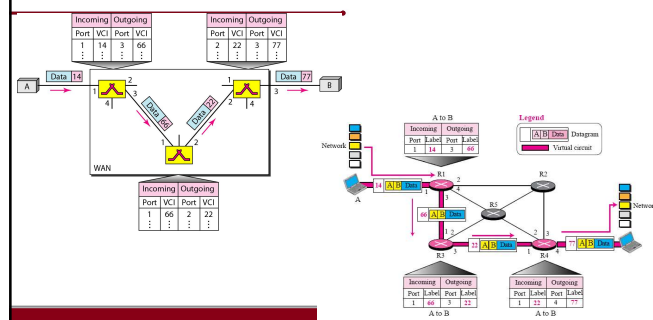
Setup Phase: Request



Setup Phase: Acknowledgment



Data Transfer Phase



Popular VC Networks

- ❖ Two popular networks are **X.25** and **Frame Relay**, which are commonly used for **public data networks (PDN)**.

Advantages.....

- ❖ Routing is faster
 - ✓ A route must only be determined once, for the first message
 - ✓ Once the route has been determined, the path used by the router is reused for all messages
 - ✓ As a result, routing tables are much smaller (and can be searched more quickly)

Advantages.....

- ❖ Messages do not arrive out of order
 - ✓ As a result, receivers do not need to reorder the cells

Disadvantages.....

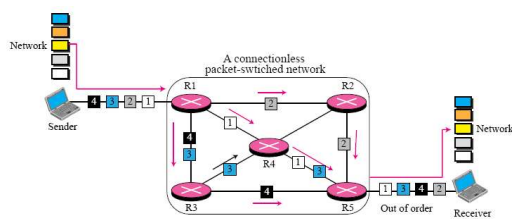
- ❖ Connections take some time to create
- ❖ The connection may be lost after a timeout, and will have to be recreated again and again
- ❖ Routing tables will be dynamic, and routing algorithms are more complex

Datagram Packet Switching

Datagram Packet Switching

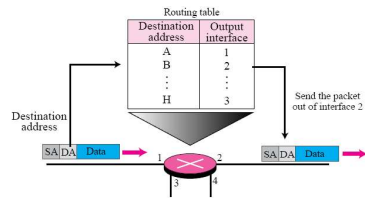
- ❖ A switch in a datagram network uses a routing table that is based on the destination address.
- ❖ The destination address in the header of a packet in a datagram network remains the same during the entire journey of the packet.
 - ✓ Each packet is routed individually

Datagram Packet Switching

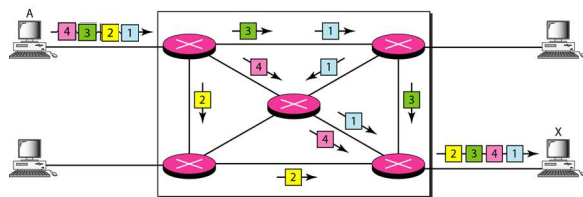


Datagram Packet Switching

- ❖ A switch in this network consults a routing table which is stored inside the switch to decide how to forward a packet.



Datagram Packet Switching



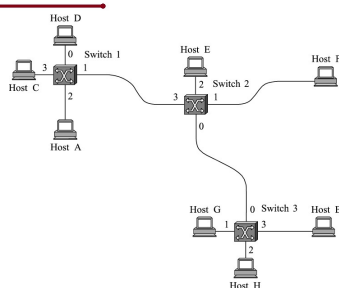
Datagram Packet Switching

- ❖ No dedicated connection between communicating hosts
- ❖ Packets are sent to the switch at any time
- ❖ Source is not aware of the state of the destination
- ❖ Packets may follow independent paths to the destination (out-of-order delivery, larger delays, etc.)
- ❖ Less prone to switch failures if alternative paths exist

Datagram Packet Switching

Destination	Port
A	3
B	0
C	3
D	3
E	2
F	1
G	0
H	0

Routing table of Switch 2



Advantages.....

- ❖ Connections need not be created
- ❖ Infrequent messaging is perfect for **connectionless messaging**
- ❖ Routing each message separately allows for **load balancing**

Disadvantages.....

- ❖ Each message takes a certain amount of time to transmit (including transmission, routing, reception, etc.)
- ❖ Messages may arrive out of order

Comparison of Virtual-Circuit and Datagram Approaches

Comparison of Virtual-Circuit and Datagram Approaches

Issue	Datagram subnet	Virtual-circuit subnet
Circuit setup	Not needed	Required
Addressing	Each packet contains the full source and destination address	Each packet contains a short VC number
State information	Routers do not hold state information about connections	Each VC requires router table space per connection
Routing	Each packet is routed independently	Route chosen when VC is set up; all packets follow it
Effect of router failures	None, except for packets lost during the crash	All VCs that passed through the failed router are terminated
Quality of service	Difficult	Easy if enough resources can be allocated in advance for each VC
Congestion control	Difficult	Easy if enough resources can be allocated in advance for each VC

Goals:

- ❖ Why is Switching is Required
 - Circuit Switching
 - ✓ Public Switched Telephone Networks
 - Message Switching
 - Packet Switching
 - ✓ Virtual Circuit Packet Switching
 - ✓ Datagram Packet Switching

Thank You