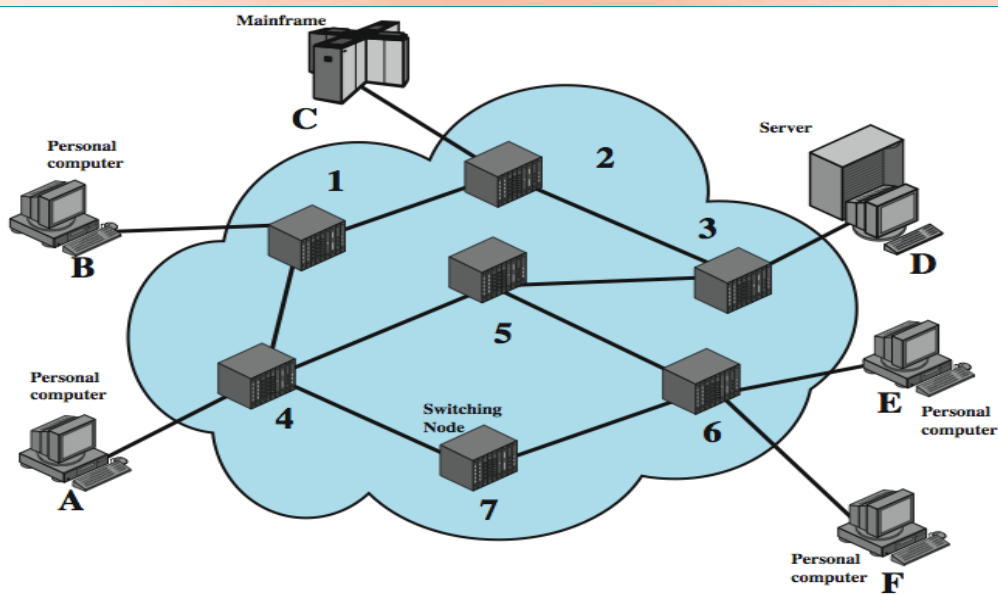


Computer Networks and Communications

Lecture (07):

Switching

Switched Network



- Long distance transmission is typically done over a network of switched nodes.
- Nodes not concerned with content of data.
- Data forwarded by being switched from node to node.

Nodes

- a collection of nodes and connections is a communications network
- nodes may connect to other nodes only, or to stations and other nodes
- network is usually partially connected
 - some redundant connections are desirable
- have two different switching technologies
 - **Circuit switching**
 - **Packet switching**

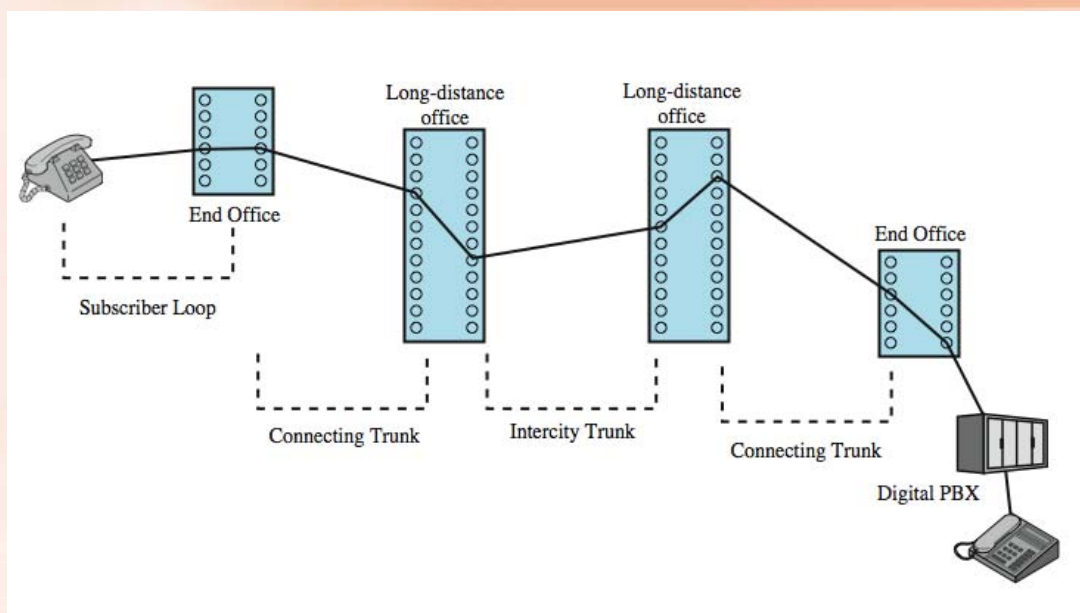
Circuit Switching

- uses a dedicated path between two stations
- has three phases
 - establish
 - transfer
 - disconnect
- inefficient
 - channel capacity dedicated for duration of connection
 - if no data, capacity wasted
- set up (connection) takes time
- once connected, transfer is transparent

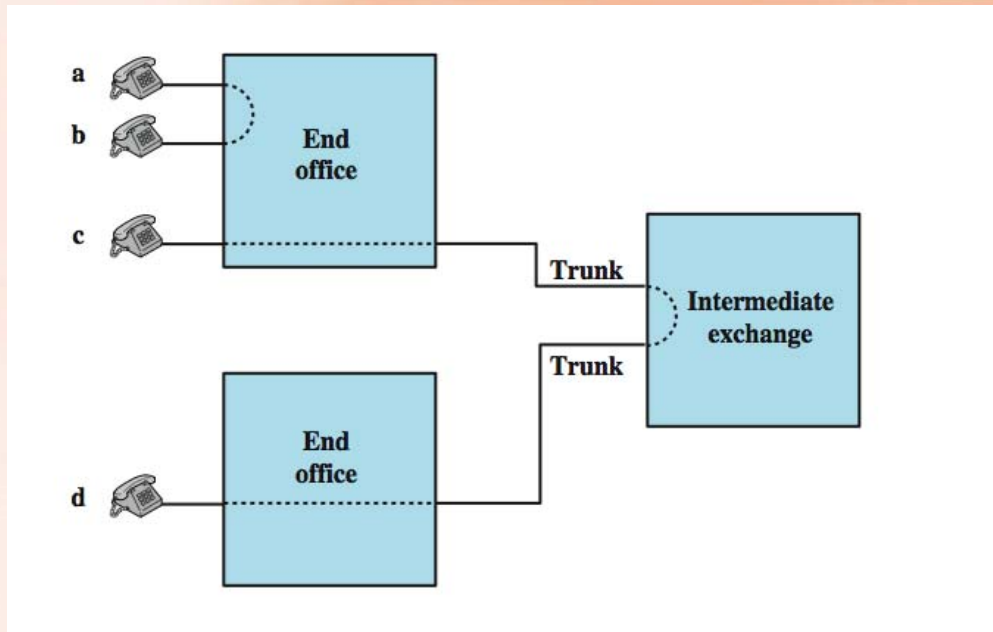
Public Circuit Switched Network

- Four generic architectural components:
 - **Subscribers**
 - Devices that attach to network, eg telephones
 - **Subscriber line**
 - Link between subscriber and network
 - Also called the Local Loop (up to 10kms)
 - Uses UTP cable
 - Electronic switching, no delay through switch once circuit established
 - **Exchanges**
 - Switching centres in the network
 - **Trunks**
 - Links between exchanges
 - Carry multiple voice frequency circuits via FDM or synchronous TDM

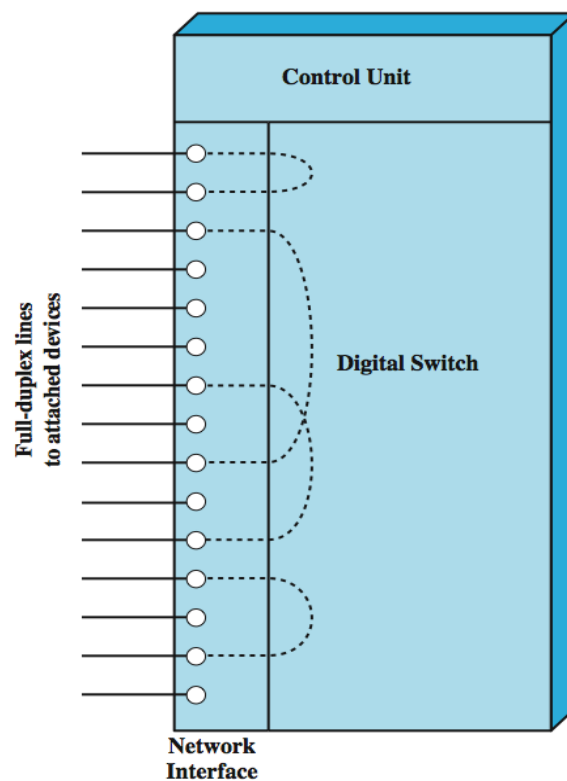
Public Circuit Switched Network



Circuit Establishment



Circuit Switch Elements



Circuit Switching Concepts

- Digital Switch:
 - Provides a signal path between any pair of attached devices
 - The path is **transparent** in that it appears to the attached devices that there is a **direct** connection between them
- Network Interface:
 - Represents functions and hardware needed to connect devices.
- Control Unit:
 - Establish connections:
 - Generally on demand.
 - Handle and acknowledge requests.
 - Determine if destination is free.
 - Construct path.
 - Maintain connection.
 - Disconnect.

Circuit Switching Concepts

- **Control signals** are the means by which the network is managed and by which calls are established, maintained and terminated.
- Control Signaling Functions:
 - Call establishment & Termination.
 - Billing information.
 - Control of specialist equipment.
 - Two types of signaling: Common channel signaling & Inchannel signaling.
 - Common channel signaling is more flexible and powerful.
 - Most widely used scheme is Signaling System Number 7 (SS7).

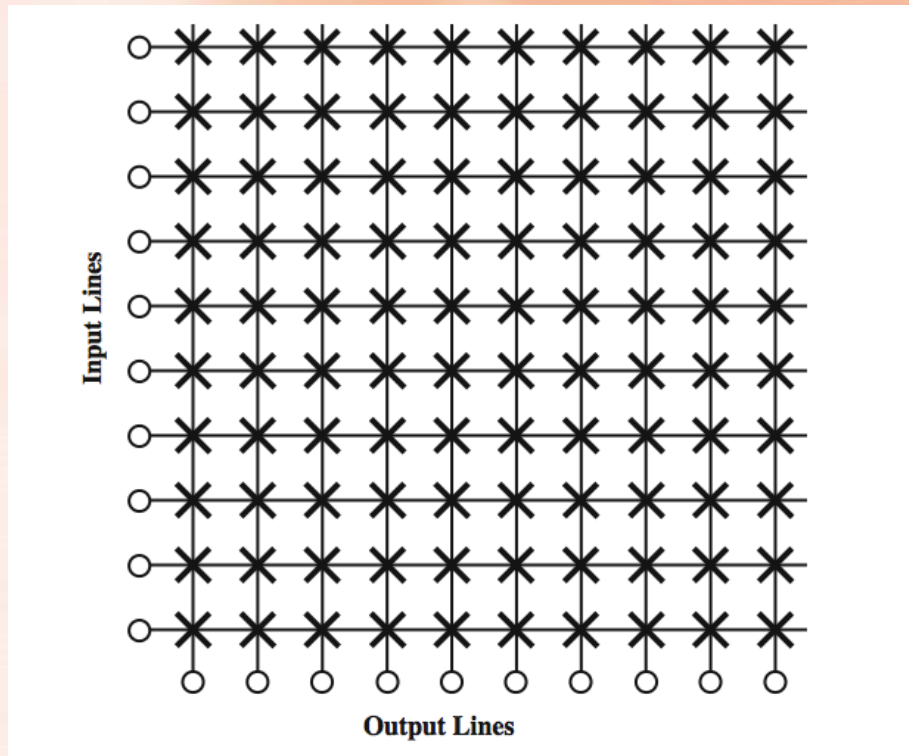
Circuit Switching

- Channel capacity dedicated for duration of connection.
- If no data, capacity wasted.
- Set up (connection) takes time.
- Once connected, transfer is transparent.
- Developed for voice traffic (phone).

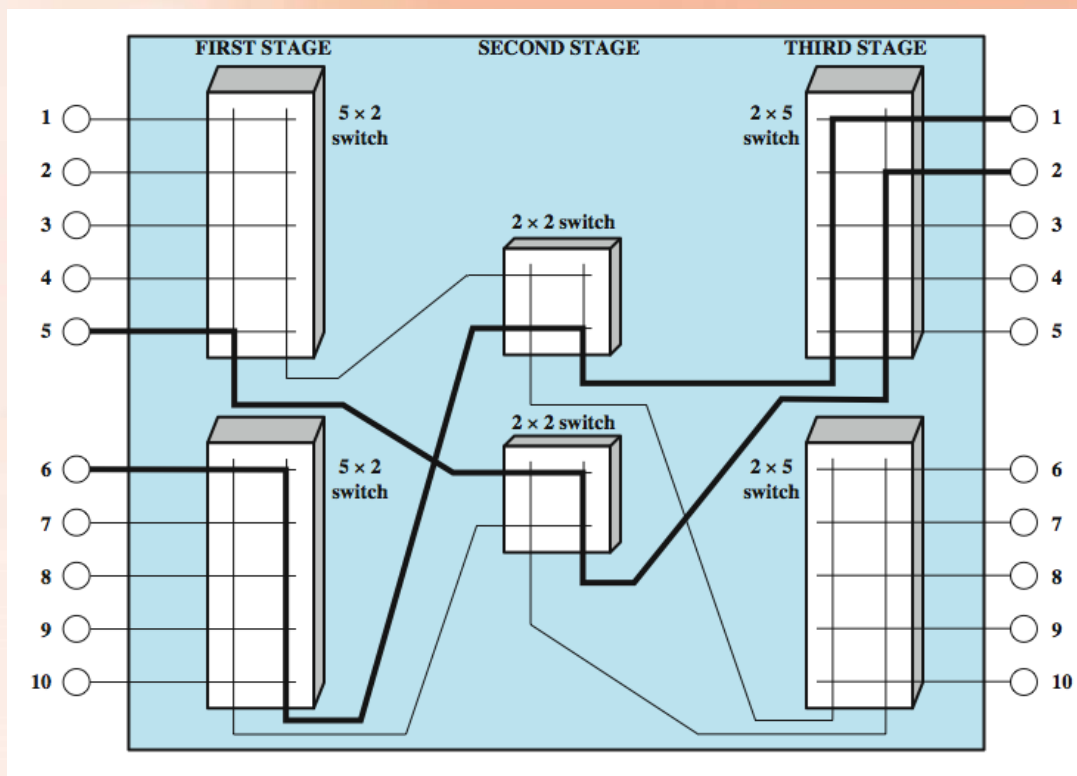
Blocking or Non-blocking

- blocking network
 - If the network is unable to connect stations because all paths are in use, the call is blocked
 - Engaged tone on voice call
- non-blocking network
 - permits all stations to connect at once
 - used for some data connections

Space Division Switch



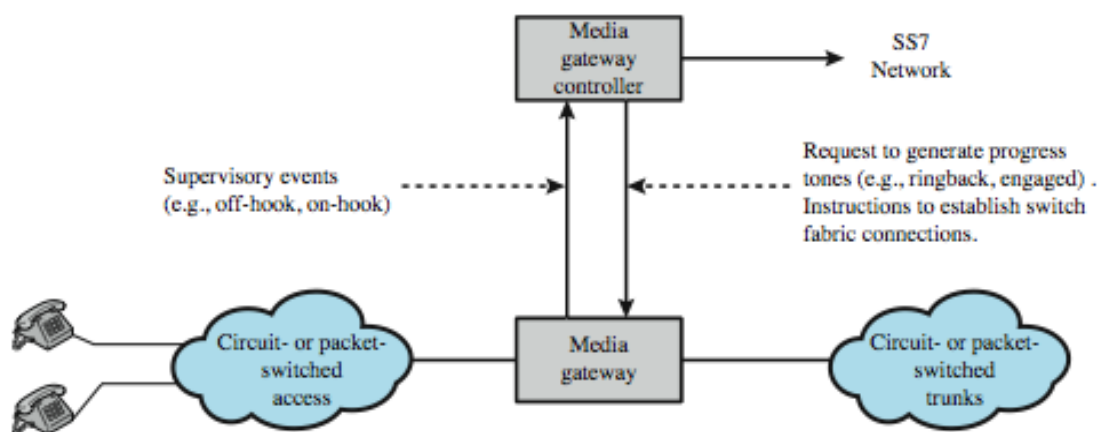
3 Stage Space Division Switch



Time Division Switching

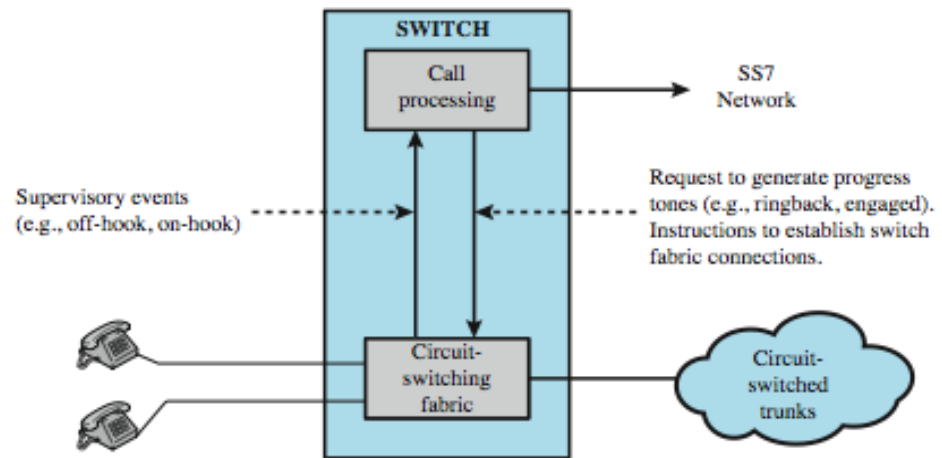
- modern digital systems use intelligent control of space & time division elements
- use digital time division techniques to set up and maintain virtual circuits
- partition low speed bit stream into pieces that share higher speed stream
- individual pieces manipulated by control logic to flow from input to output

Softswitch



(b) Softswitch architecture

Traditional Circuit Switching

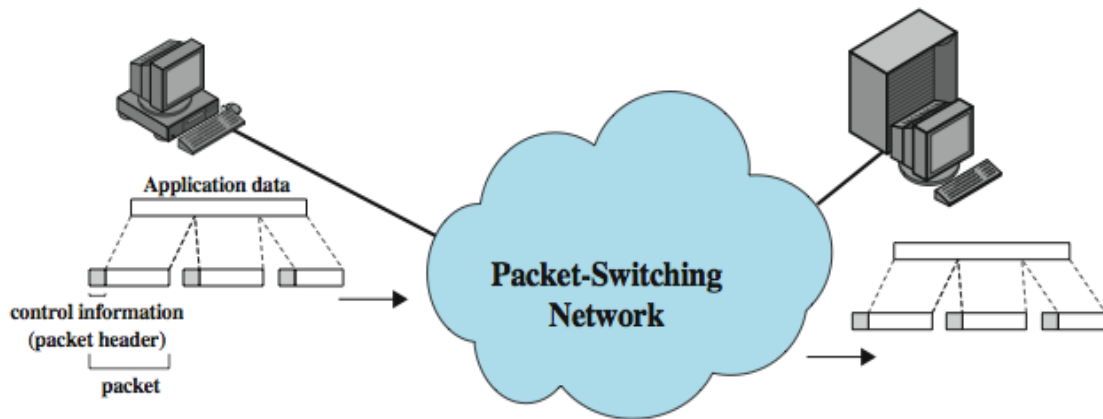


(a) Traditional circuit switching

Packet Switching

- circuit switching was designed for voice
- packet switching was designed for data
- transmitted in small packets
- packets contains user data and control info
 - user data may be part of a larger message
 - control info includes routing (addressing) info
- packets are received, stored briefly (buffered) and past on to the next node
- Transmission time depends on the packet size.
 - Optimum packet size to reduce delay & overhead.

Packet Switching



- Station breaks long messages into packets.
- Packets sent one at a time to the network.
- Packets handled in two ways.
 - Datagram.
 - Virtual circuit.

Advantages

- Line efficiency:
 - Single node to node link can be shared by many packets over time.
 - Packets queued and transmitted as fast as possible.
- Data rate conversion:
 - Each station connects to the local node at its own speed.
 - Nodes buffer data if required to equalize rates.
- Packets are accepted even when network is busy.
 - Delivery may slow down.
- Priorities can be used.

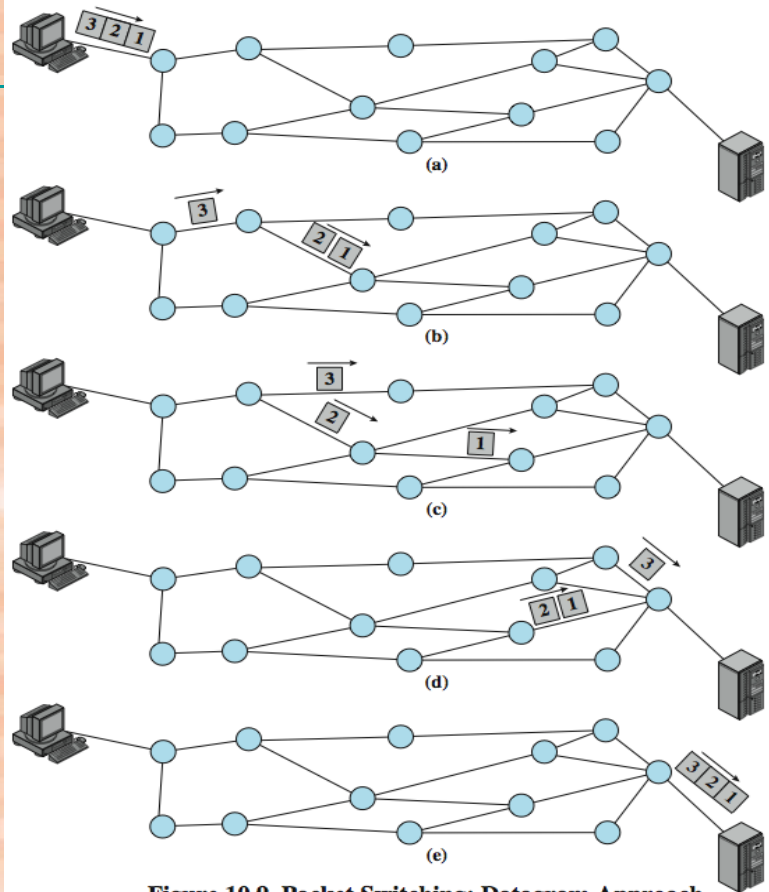
Switching Techniques

- station breaks long message into packets
- packets sent one at a time to the network
- packets can be handled in two ways
 - datagram
 - virtual circuit

Packet Switching: Datagram

- Each packet treated independently.
- Packets can take any practical route.
- Packets may arrive out of order.
- Packets may go missing.
- Receiver to re-order packets and recover from missing packets.
- No call setup phase: Better if few packets.
- More flexible: Routing can be used to avoid congested paths of the network.

Datagram Diagram



Packet Switching: Virtual Circuit

- Preplanned route established before any packets sent.
- Call request and call accept packets establish connection (handshake).
- Each packet contains a virtual circuit identifier instead of destination address.
- No routing decisions required for each packet
- Network can provide sequencing and error control.
- Clear request to drop circuit.
- Loss of a node losses all circuits through that node

Virtual Circuit Diagram

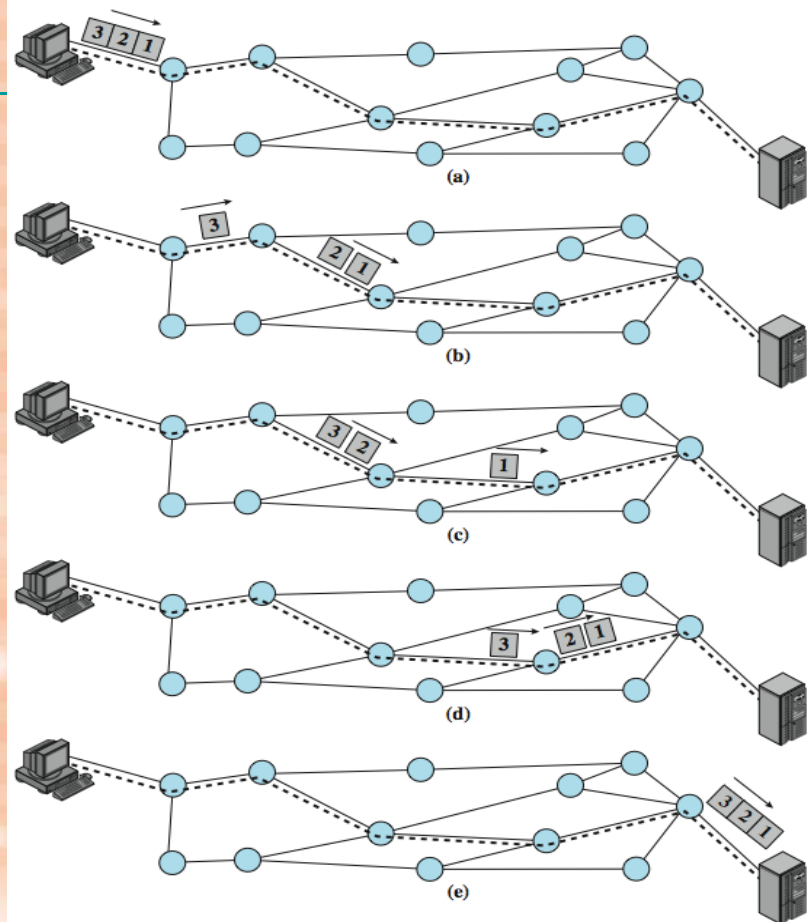
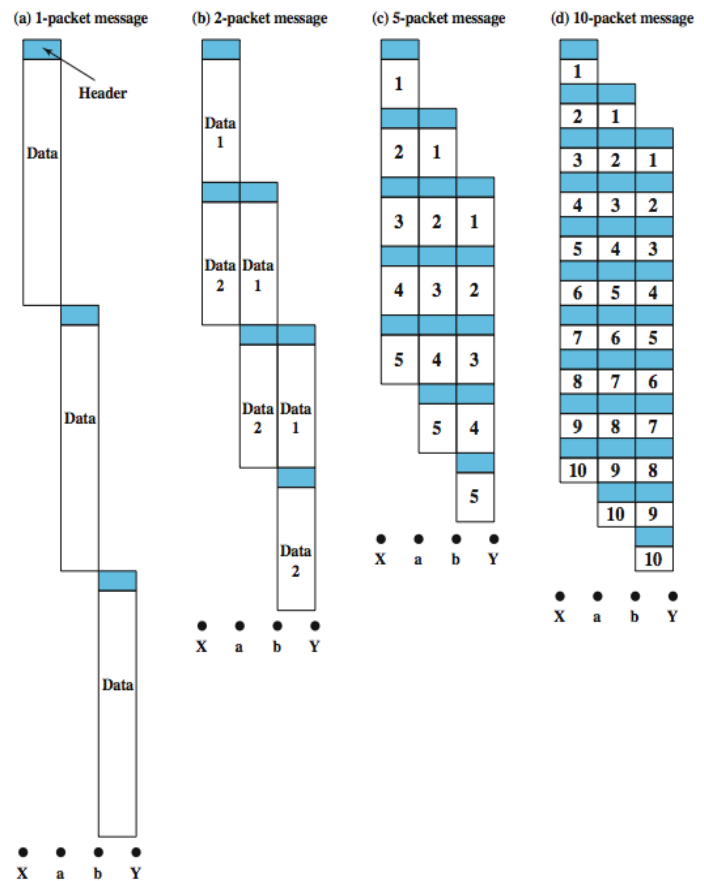


Figure 10.10 Packet Switching: Virtual-Circuit Approach

Virtual Circuits v Datagram

- virtual circuits
 - network can provide sequencing and error control
 - packets are forwarded more quickly
 - less reliable
- datagram
 - no call setup phase
 - more flexible
 - more reliable

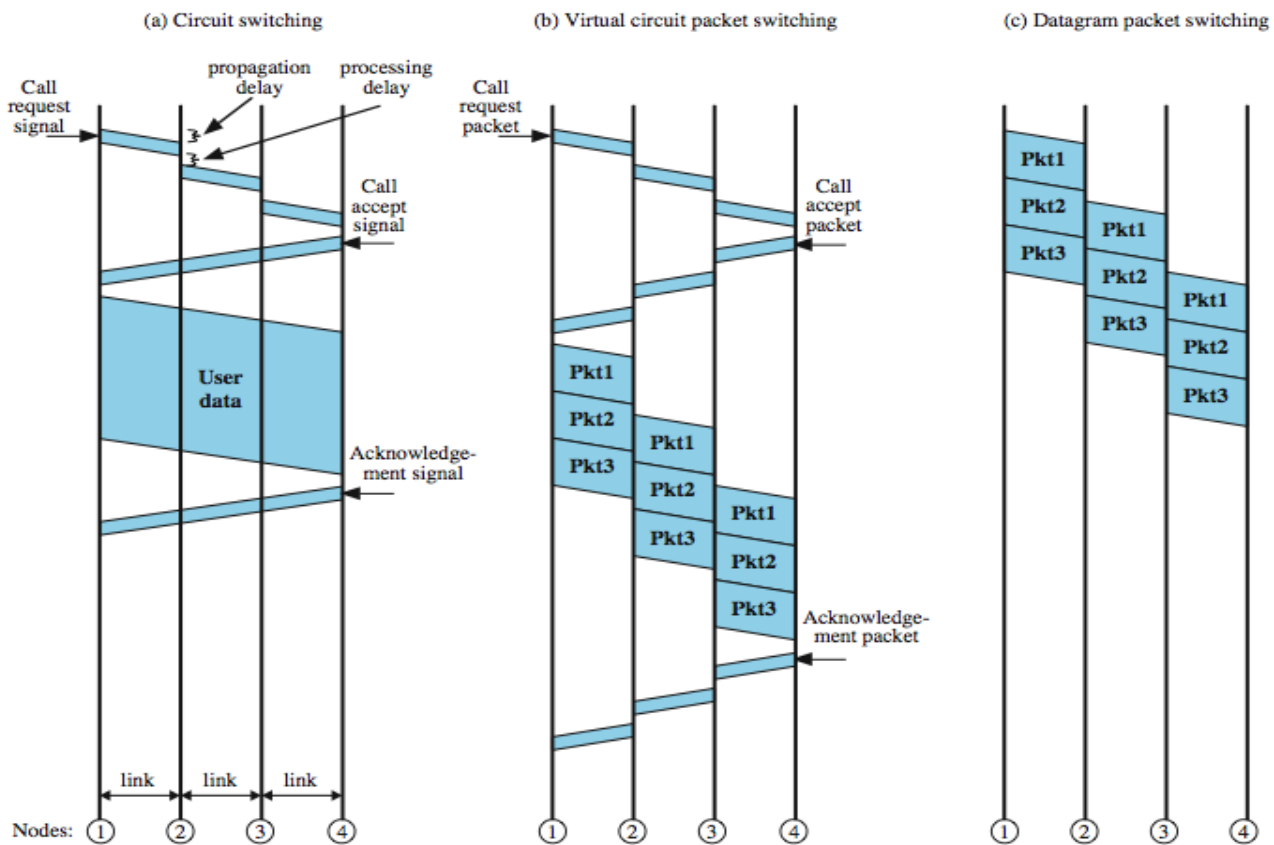
Packet Size



Circuit v Packet Switching

- performance depends on various delays
 - propagation delay
 - transmission time
 - node delay
- range of other characteristics, including:
 - transparency
 - amount of overhead

Event Timing



Required Reading

**Data and Computer Communications,
10th Edition by William Stallings,
(c) Pearson Education - Prentice Hall, 2013**

>> Chapter 09 <<

WAN TECHNOLOGY AND PROTOCOLS