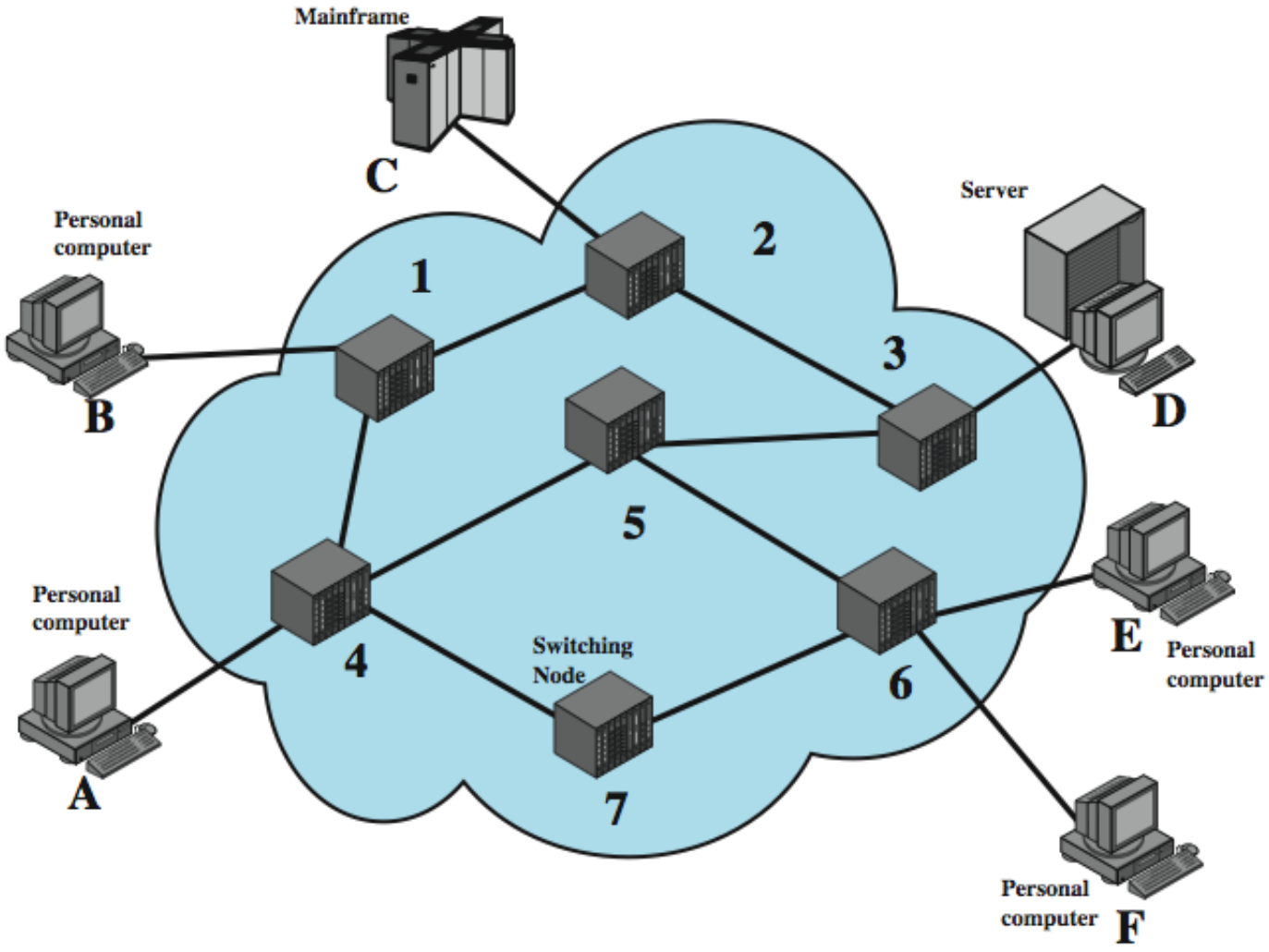
Circuit Switching and Packet Switching

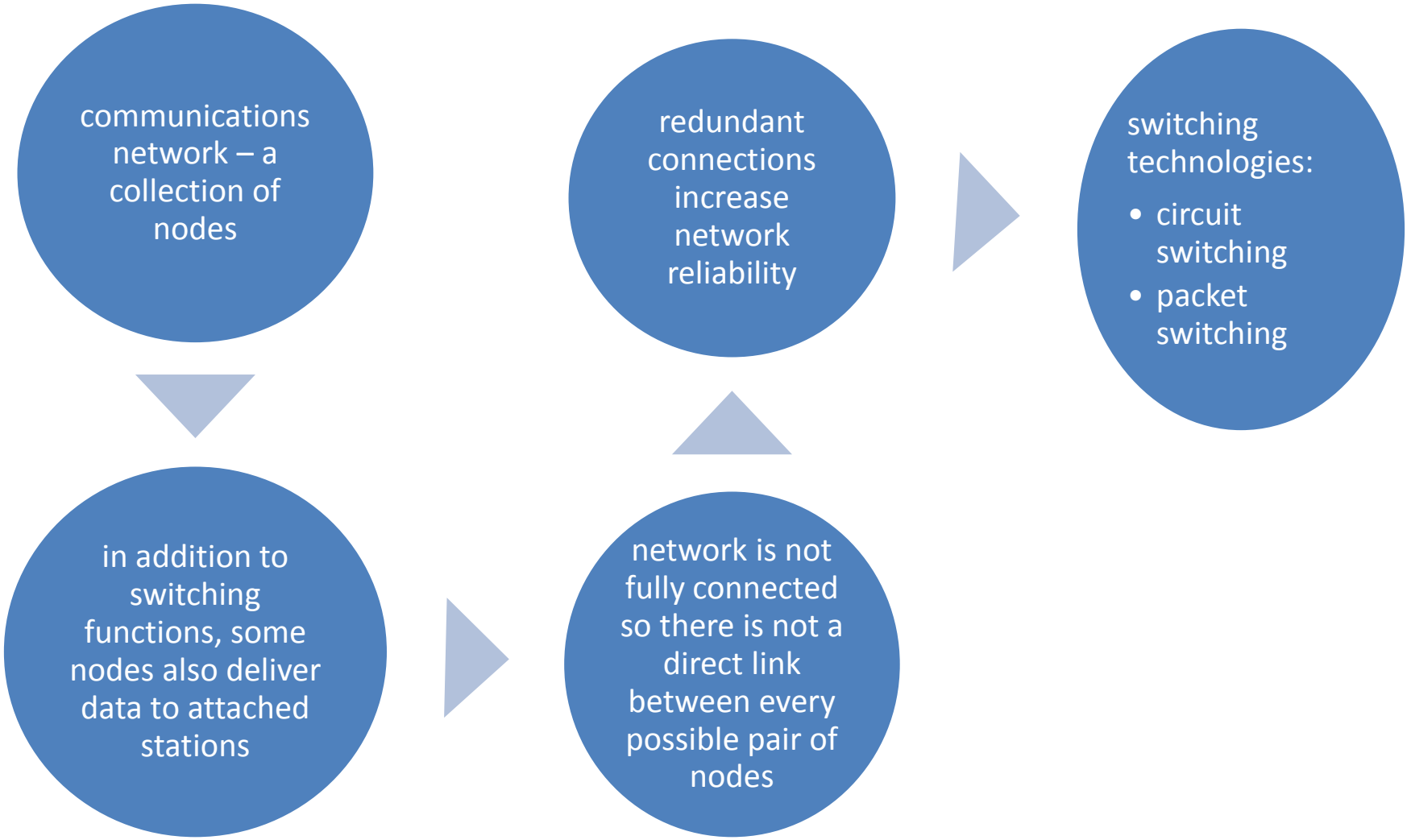
Switched Communications Networks

- switching nodes provide a switching facility that move data between nodes
- **stations** – devices attached to the network
- **nodes** – switching devices that provide communication
  - connected by transmission links
  - dedicated point-to-point
  - usually multiplexed using either FDM or TDM

Switched Network

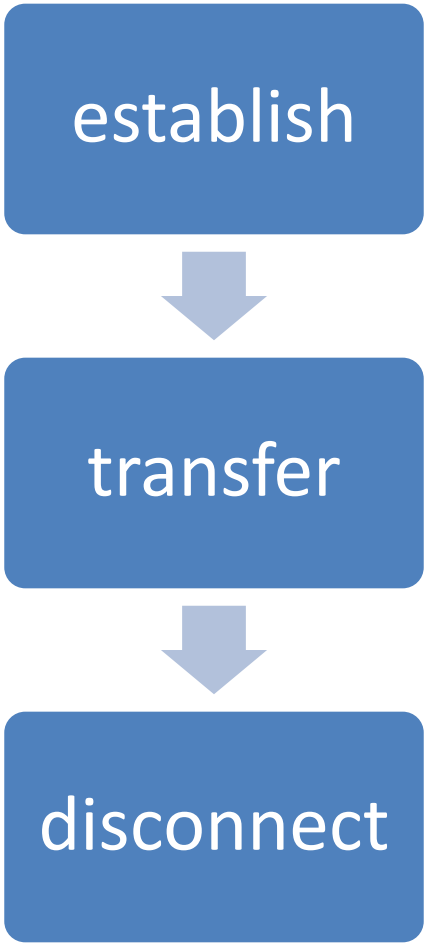


Communication Networks



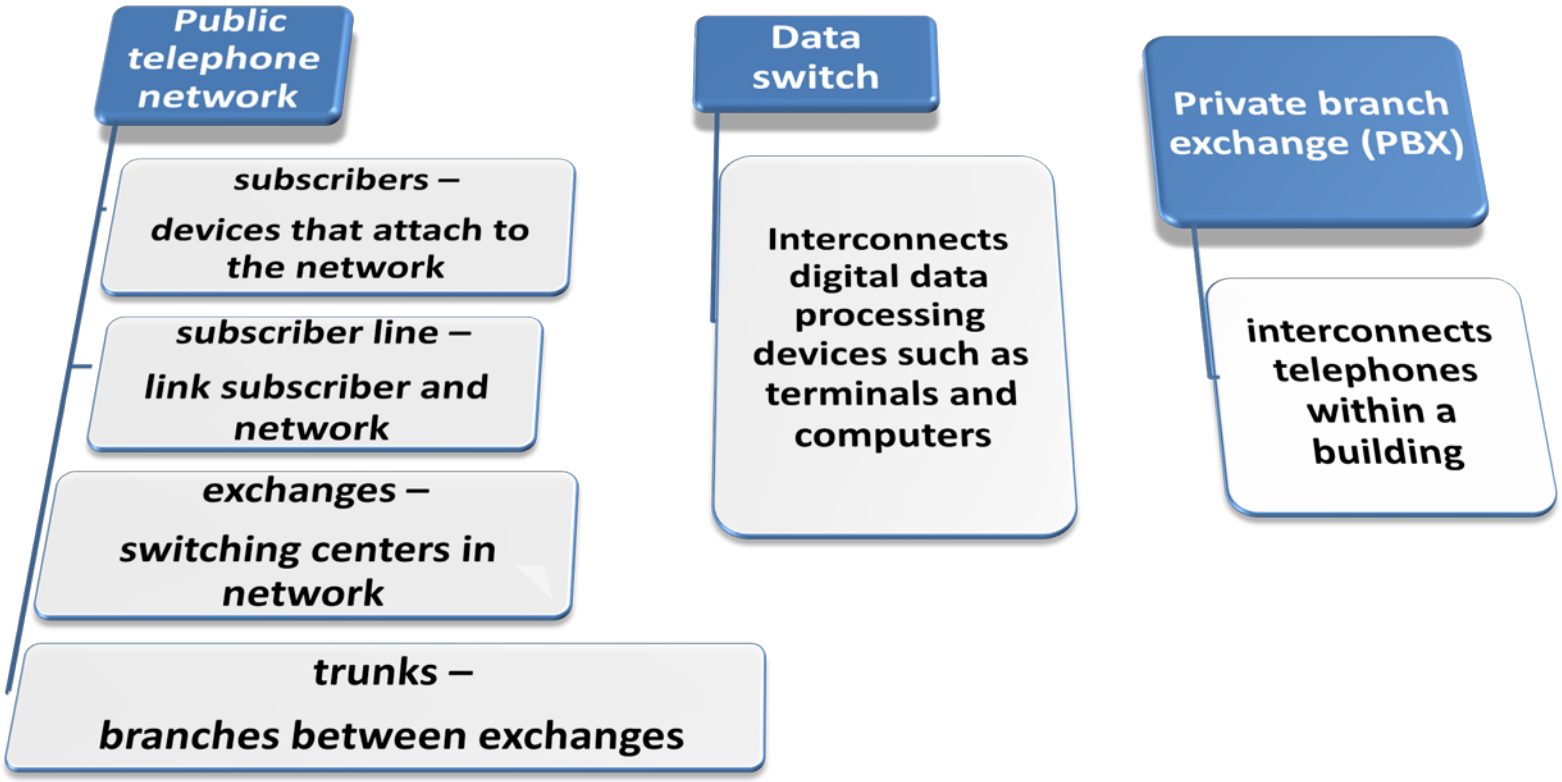
Circuit Switching

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

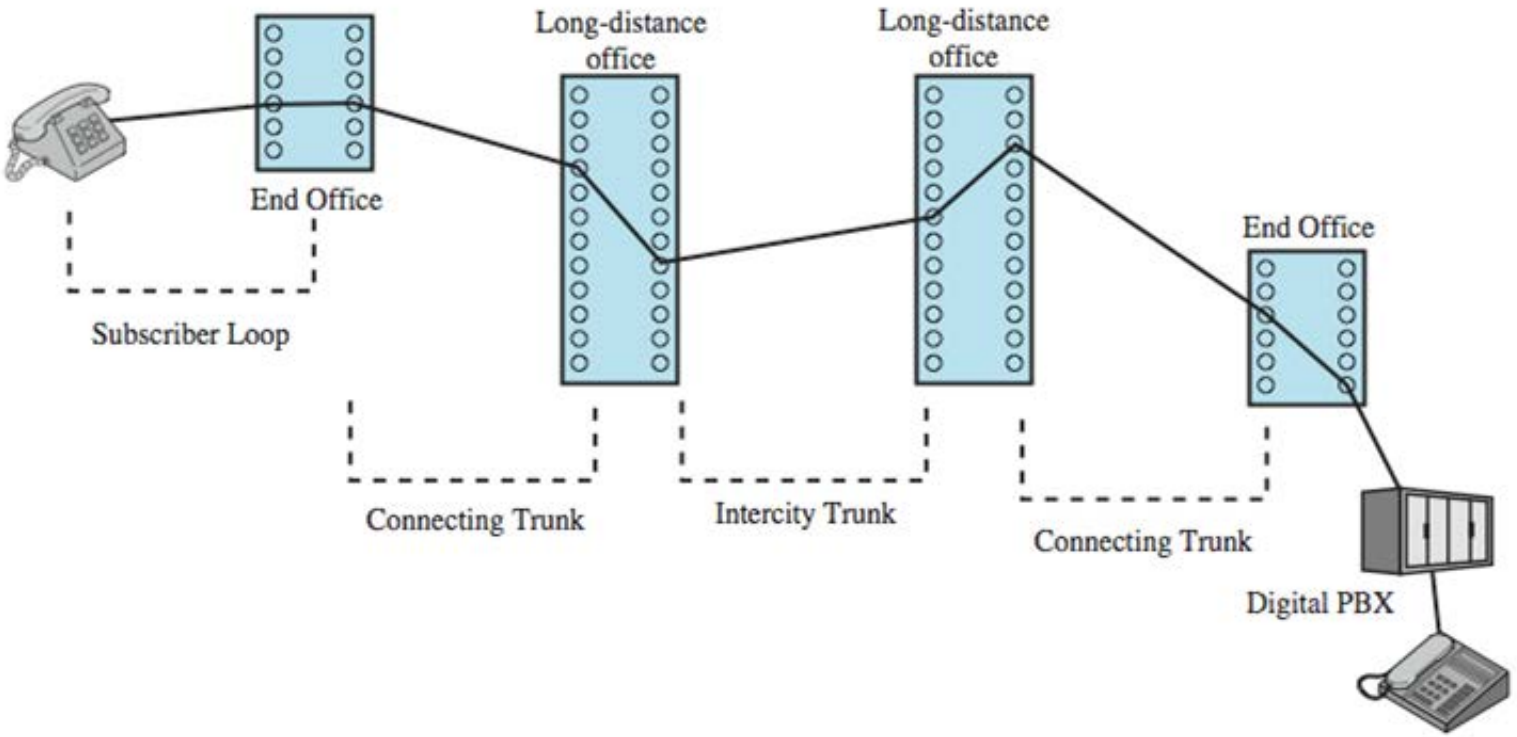


Public Telecommunications Network

- examples of circuit switching network:



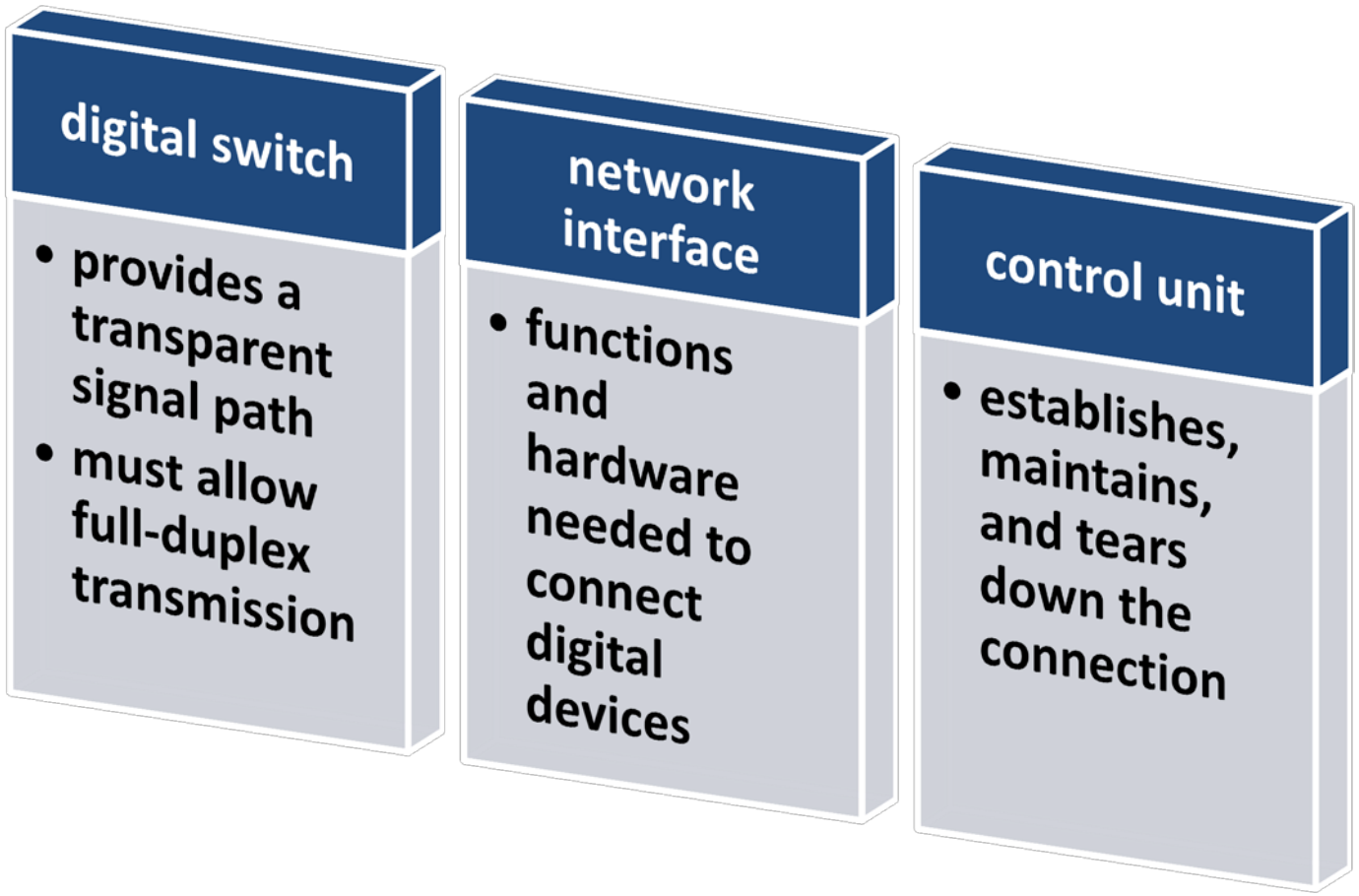
Public Circuit Switched Network



Circuit-Switching Technology

- Driven by applications that handle voice traffic
  - Key requirement is no transmission delay and no variation in delay
- Efficient for analog transmission of voice signals
- Inefficient for digital transmission
- Transparent
  - once a circuit is established it appears as a direct connection; no special logic is needed

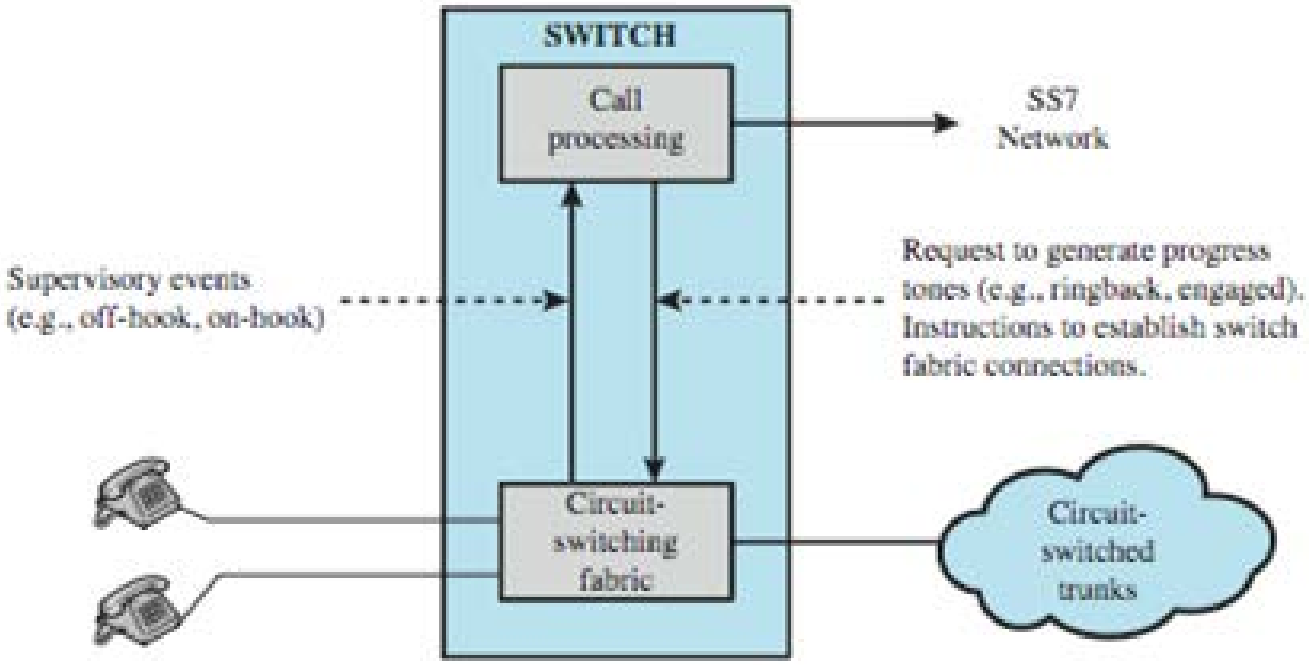
Circuit-Switching Concepts



Softswitch Architecture

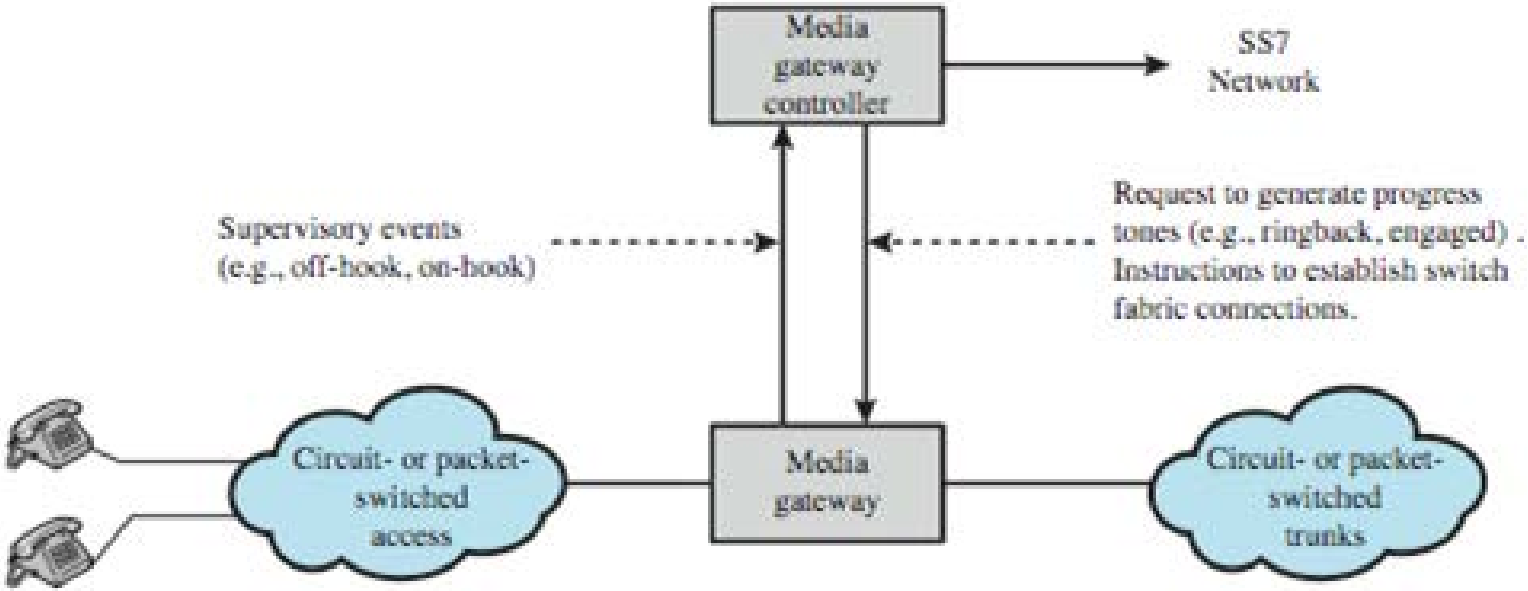
- latest trend in circuit-switching technology
- computer running specialized software that turns it into a smart phone switch
- costs less and provides more functionality
- Media gateway (MG) – physical switching
- Media gateway controller (MGC) – call processing logic

Traditional Circuit Switching



(a) Traditional circuit switching

Softswitch

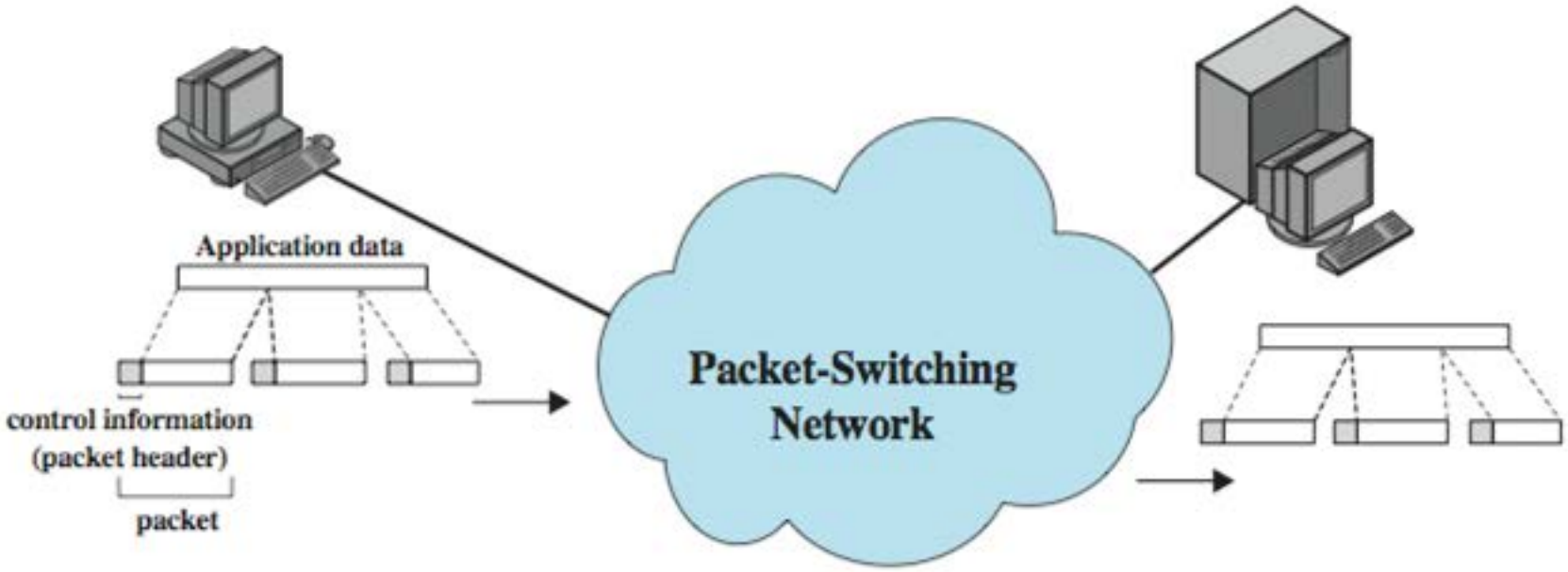


(b) Softswitch architecture

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 information includes routing (addressing)
- packets are received, stored briefly (buffered) and passed on to the next node

Packet Switching



Advantages

- line efficiency
  - single link shared by many packets over time
  - packets queued and transmitted as fast as possible
- data rate conversion
  - stations connects to local node at own speed
  - nodes buffer data if required to equalize rates
- packets accepted even when network is busy
- 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
    - each packet is treated independently with no reference to previous packets
  - virtual circuit
    - a preplanned route is established before any packets are sent

Datagram Diagram

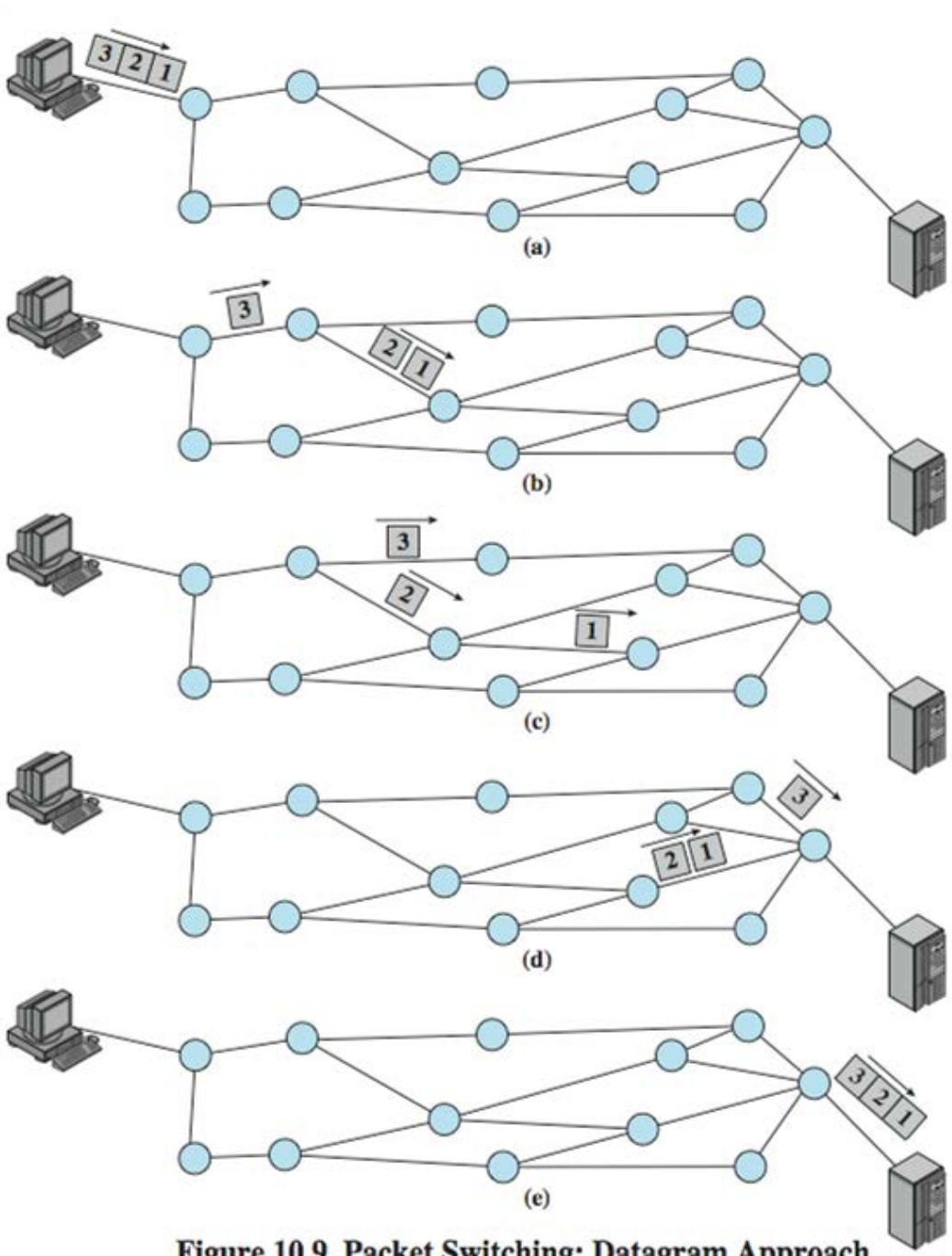


Figure 10.9 Packet Switching: Datagram Approach

Virtual Circuit Diagram

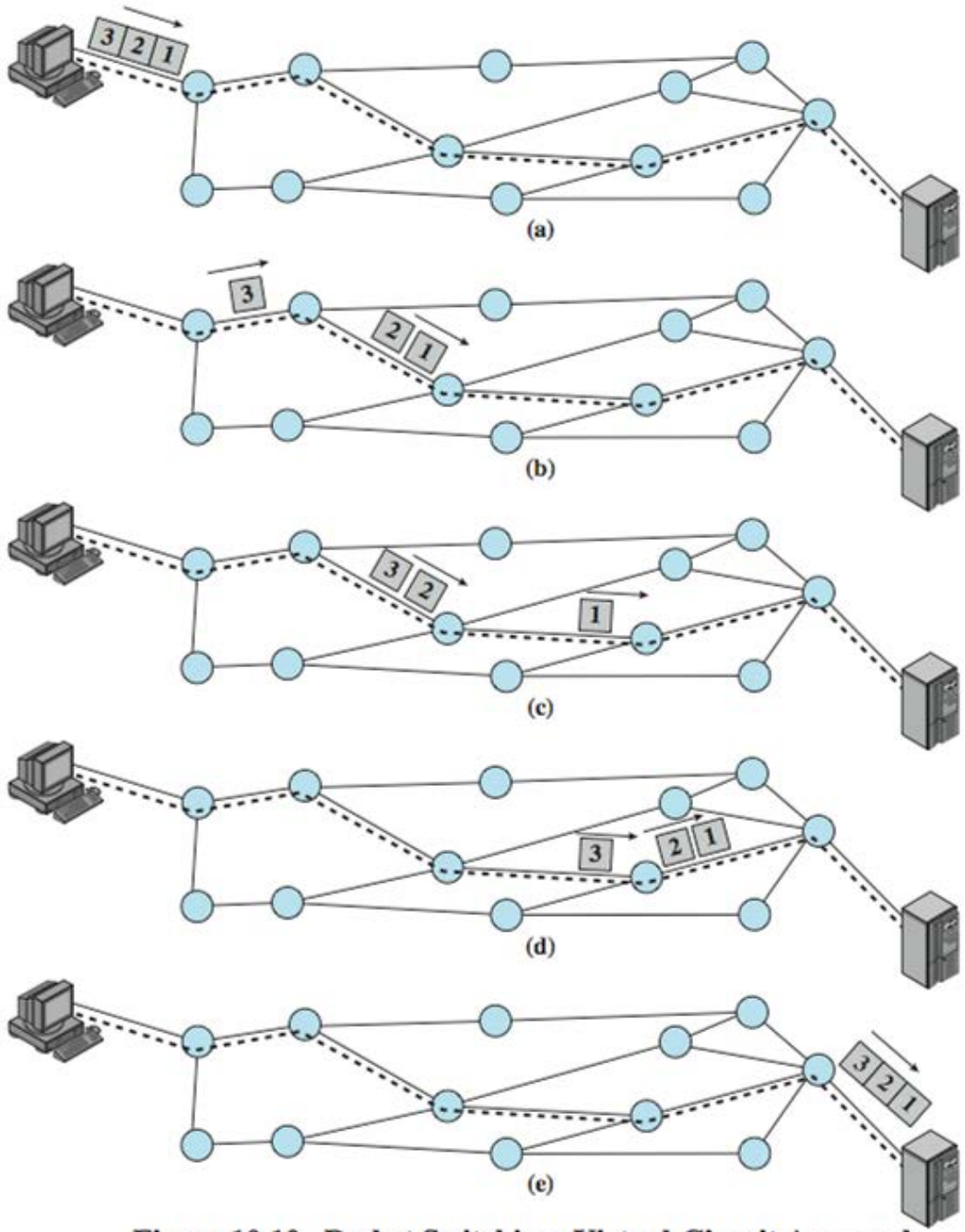


Figure 10.10 Packet Switching: Virtual-Circuit Approach

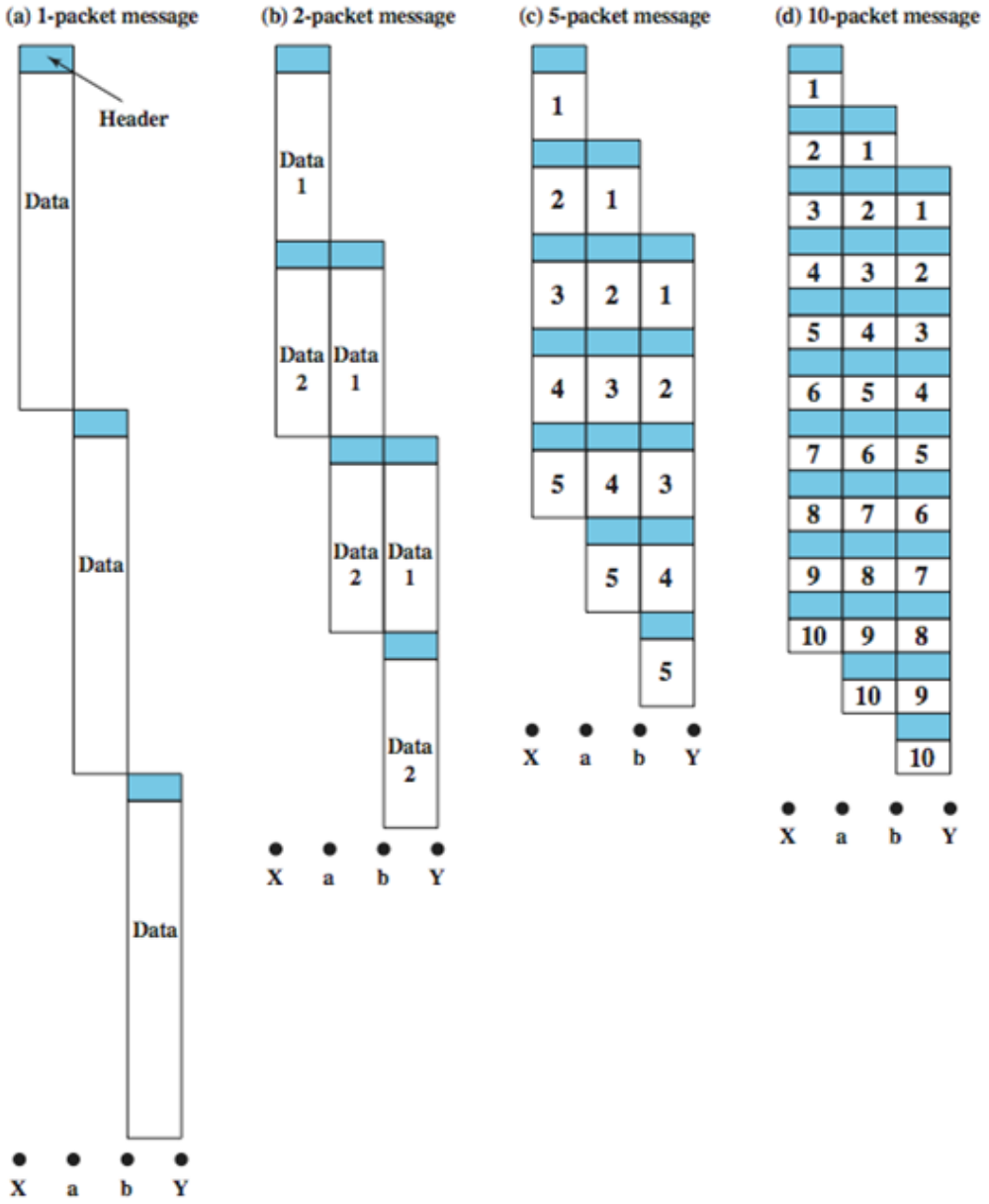
Virtual Circuits vs. Datagram

- 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

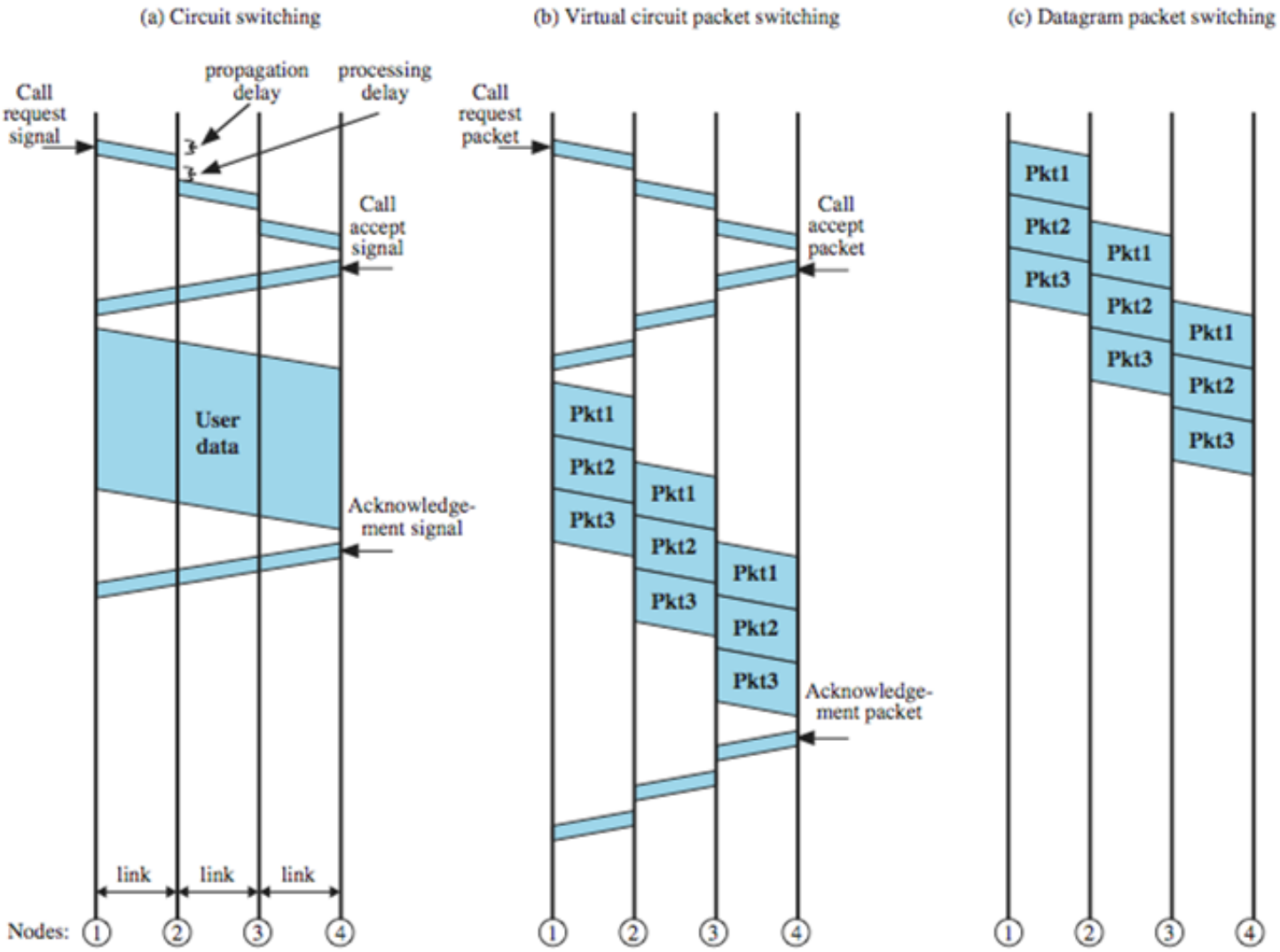
There is a significant relationship between

Packet Size

and transmission time.



Event Timing



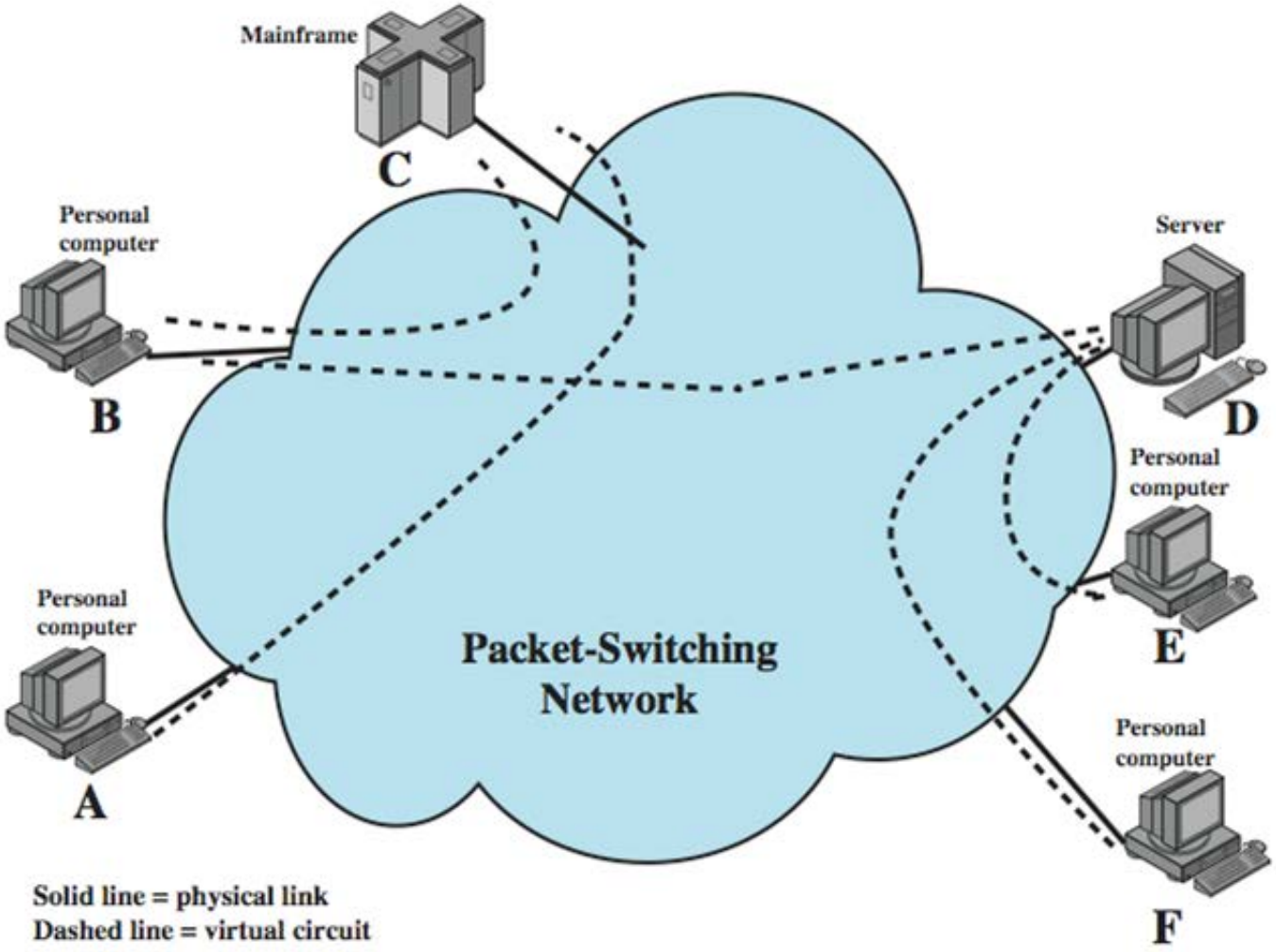
Comparison of Communication Switching Techniques

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

External Network Interface

- ITU-T standard for interface between host and packet switched network
- almost universal on packet switched networks and packet switching in ISDN
- defines three layers
  - Physical
  - Link
  - Packet

X.25 Use of Virtual Circuits



Circuit vs. Packet Switching

- performance depends on various delays
  - propagation delay
    - time it takes a signal to propagate between nodes
  - transmission time
    - time it takes for a transmitter to send a block of data
  - node delay
    - time it takes for a node to perform processing as it switches data
- range of other characteristics, including:
  - transparency
  - amount of overhead

Summary

- switched communications networks
  - stations / nodes
- circuit switching networks
- circuit switching concepts
  - digital switch, network interfacing, control unit
- softswitch architecture
- packet switching principles