DATA AND COMPUTER COMMUNICATIONS

Lecture 4 Wide Area Networks - Circuit Switching and Packet Switching

Mei Yang

Based on Lecture slides by William Stallings

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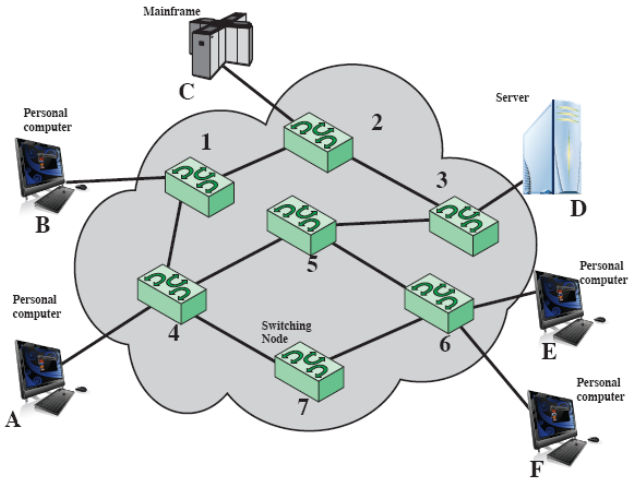
SWITCHED COMMUNICATIONS NETWORKS

- 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

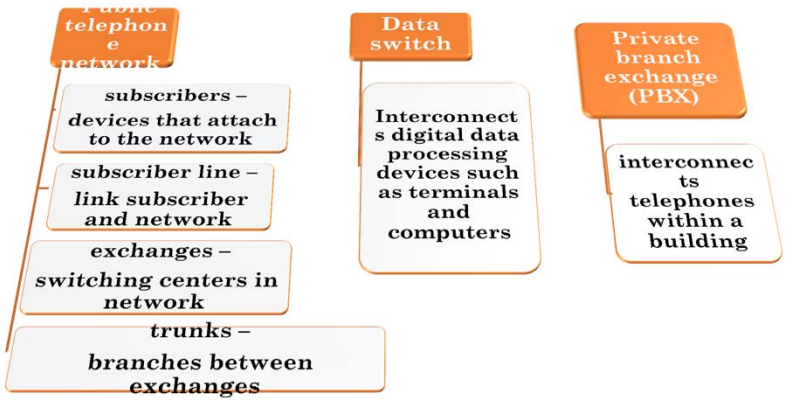
- communications network – a collection of nodes
- redundant connections increase network reliability
- switching technologies:
  - circuit switching
  - packet switching
- network is not fully connected so there is not a direct link between every possible pair of nodes
- in addition to switching functions, some nodes also deliver data to attached stations

Circuit Switching

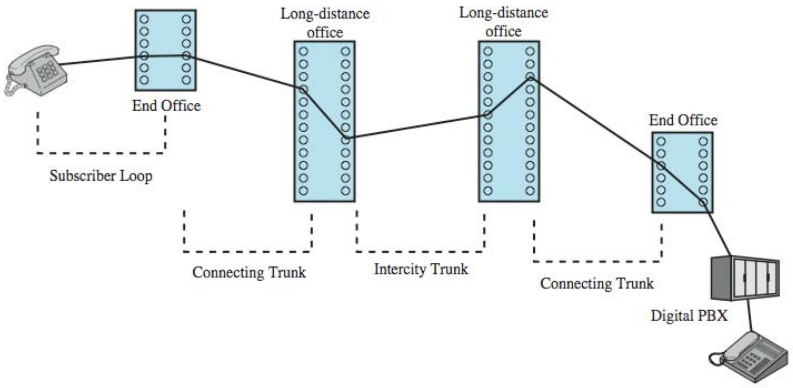
- uses a dedicated path between two stations
- can be inefficient
  - channel capacity dedicated for duration of connection
  - if no data, capacity wasted
- set up (connection) takes time
- once connected, transfer is transparent
- has three phases

Public Telecommunications Network

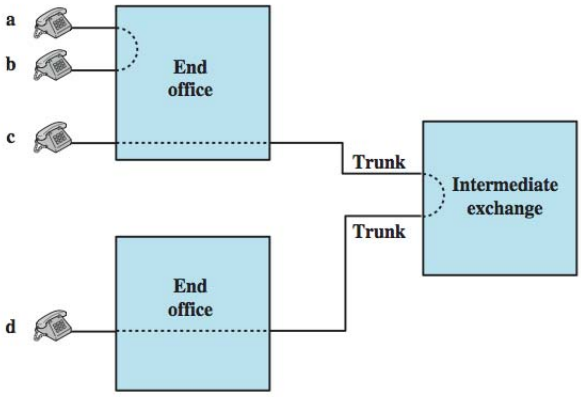
- examples of circuit switching network:



Public Circuit Switched Network



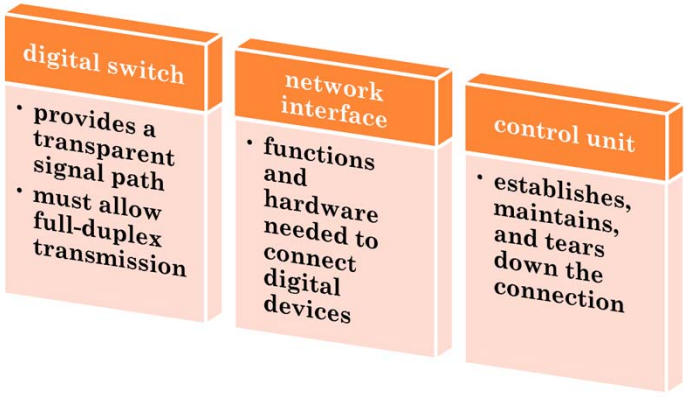
Circuit Establishment



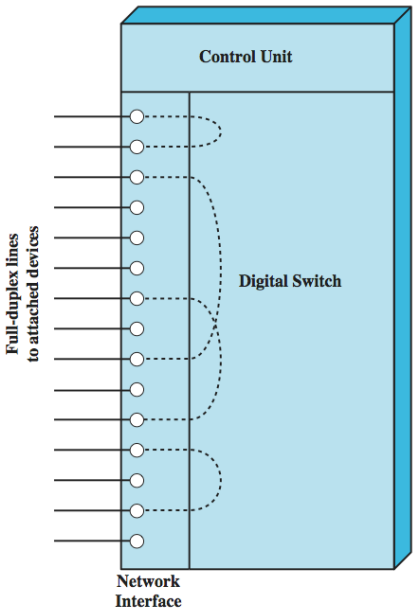
Circuit-Switching Technology

- 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



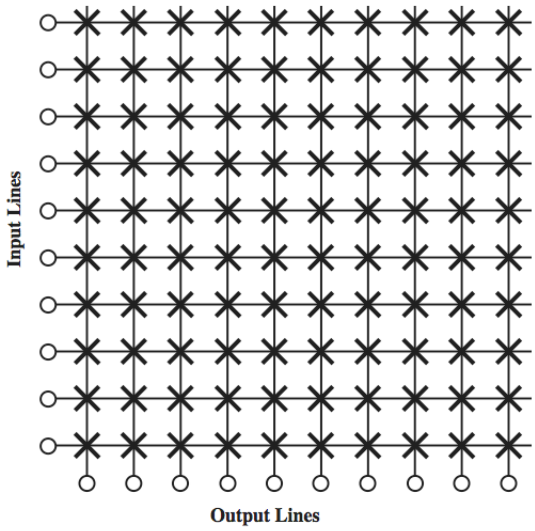
Circuit Switch Elements



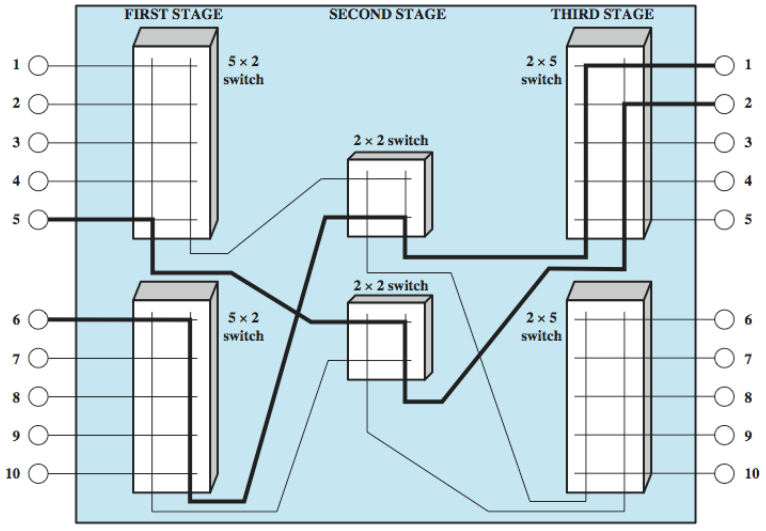
Blocking or Non-blocking

- blocking network
  - may be unable to connect stations because all paths are in use
  - used on voice systems
- non-blocking network
  - permits all stations to connect at once
  - used for some data connections

Space Division Switch



3 Stage Space Division Switch



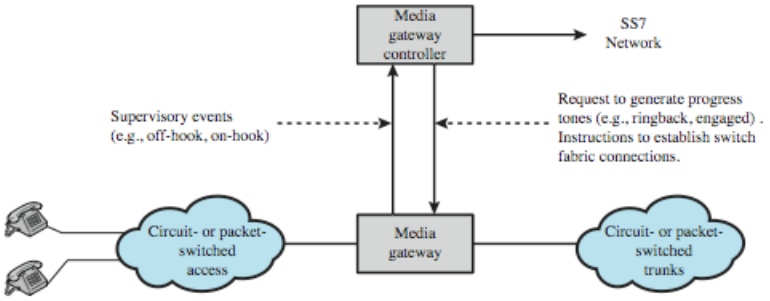
Time Division Switching

- 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 Architecture

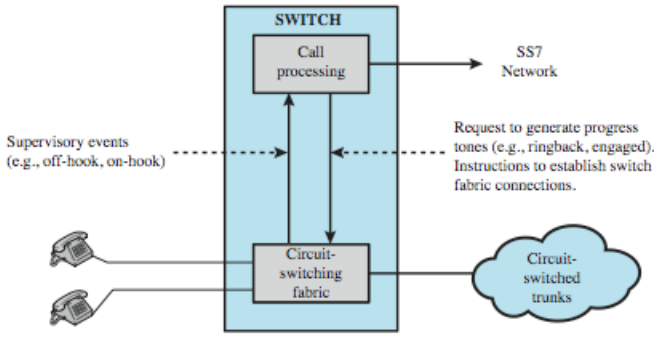
- latest trend in circuit-switching technology
- computer running specialized software that turns it into a smart phone switch
- costs less and provides more functionality
- Media gateway (MG) – physical switching
- Media gateway controller (MGC) – call processing logic

SOFTSWITCH



(b) Softswitch architecture

TRADITIONAL CIRCUIT SWITCHING

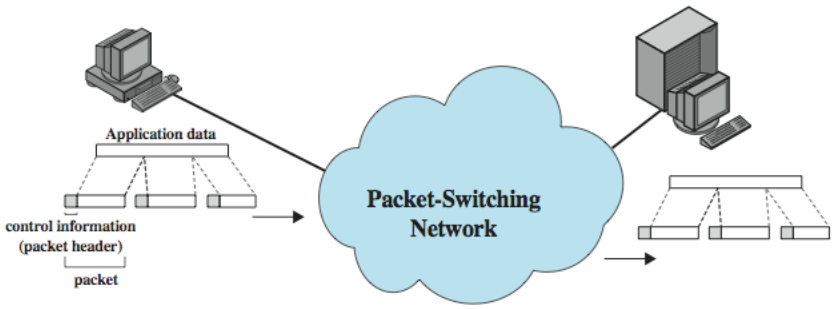


(a) Traditional circuit switching

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

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

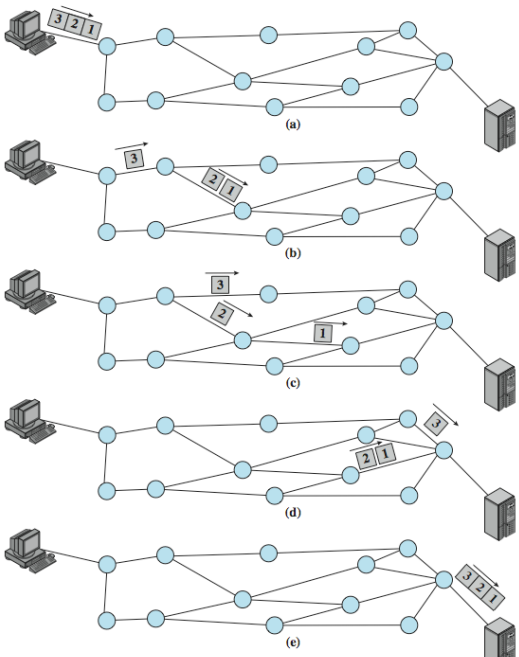


Figure 10.9 Packet Switching: Datagram Approach

VIRTUAL CIRCUIT DIAGRAM

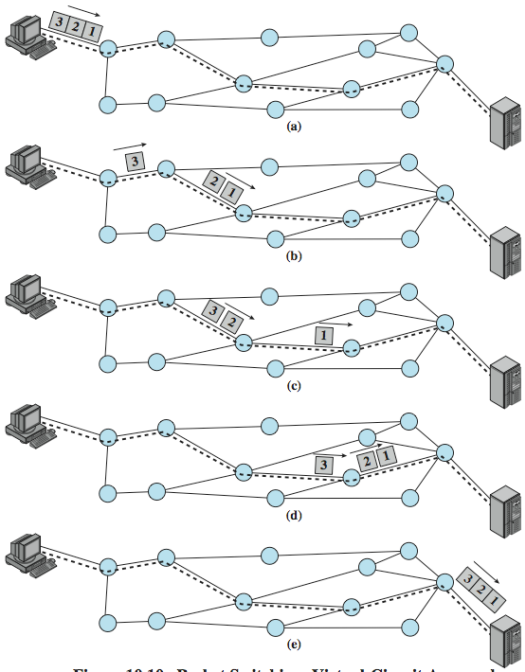
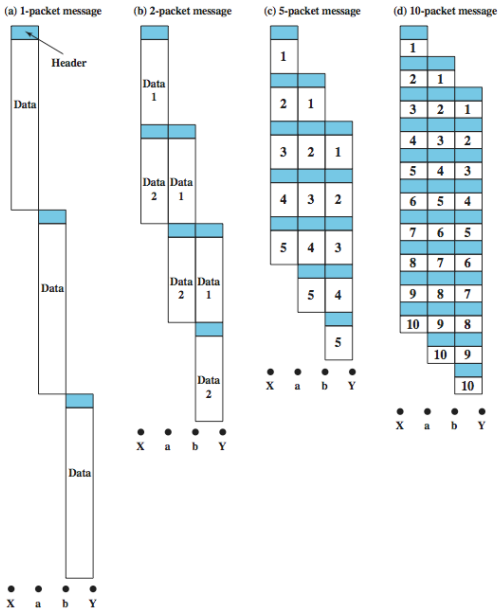


Figure 10.10 Packet Switching: Virtual-Circuit Approach

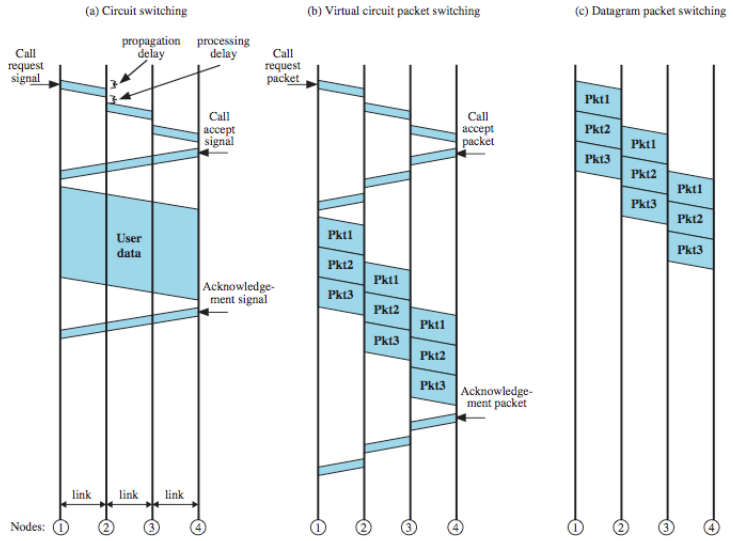
VIRTUAL CIRCUITS VS. DATAGRAM

- 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

PACKET SIZE



EVENT TIMING



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

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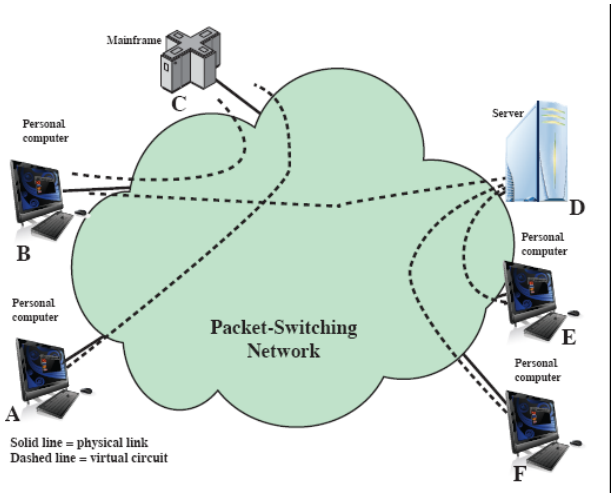
X.25 Use of Virtual Circuits



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