Circuit and Packet Switching

ITS323: Introduction to Data Communications

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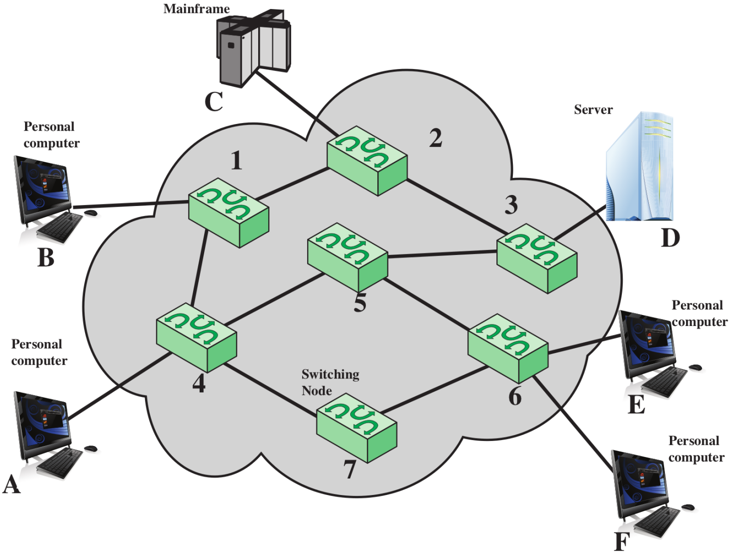
Contents

Switched Communications Networks

- So far focussed on encoding and transmitting information over a link
- Now how networks used to interconnect many devices
- Switched Communication Networks
  - Data transmitted from source to destination through network of switching nodes
  - Switching nodes are not concerned with content of data
  - Collection of nodes referred to as communications network
  - Devices attached to network are called stations
  - Node—station links often dedicated point-to-point links
  - Node—node links often multiplexed
  - Network is often not fully connected; but desirable to have multiple paths for each pair of stations
- Two technologies used in wide area switched networks: circuit switching and packet switching

Simple Switching Network



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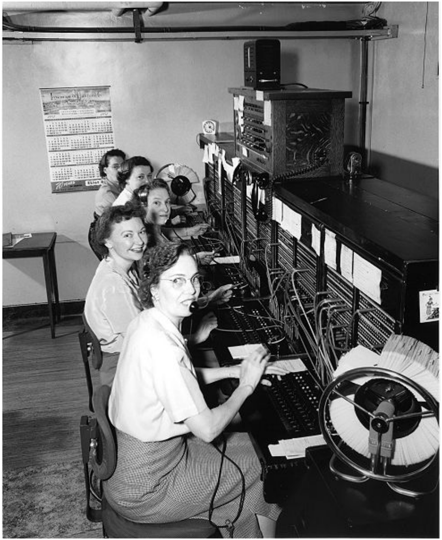
Example of Old-Style Circuit Switch



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Example of Current-Style Circuit Switch

Mudares via Wikimedia Commons; CC BY 2.5

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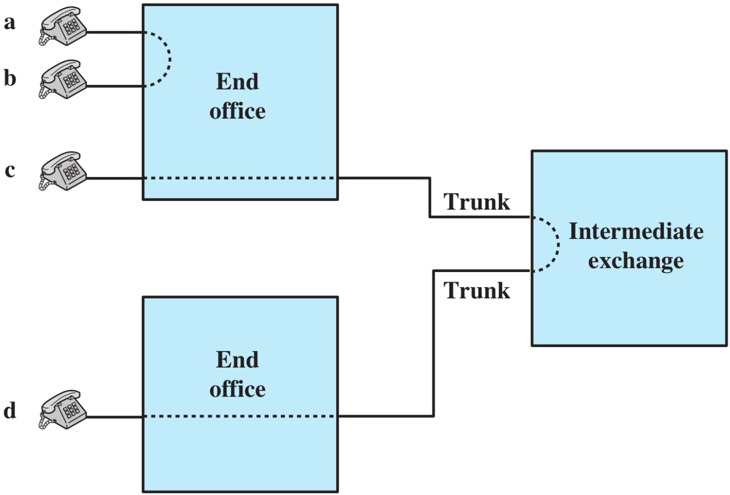
Circuit Switching Networks

- Dedicated communications path between two stations; path is sequence of links between nodes
- On each physical link, logical channel allocated to connection
- Three phases:
  1. Circuit establishment: Create station-to-station circuit, allocating resources as needed
  2. Data transfer: Analog or digital data transmitted from station to station
  3. Circuit disconnect: Circuit is terminated, de-allocation of resources

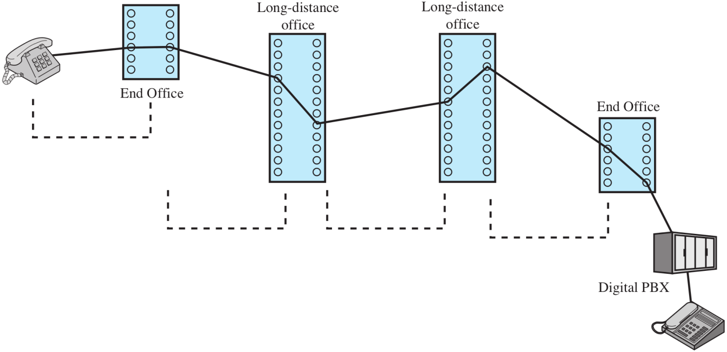
Circuit Switching Networks

- Path established before data transfer begins; channel capacity must be reserved between each pair of nodes in path, and switching capacity allocated at each switching node
- Developed to handle voice traffic, but also used for data traffic
- Examples: public telephone network, private telephone networks, prviate data networks

Circuit Establishment



Example Connection Over a Public Circuit-Switching Network



Issues in Circuit-Switching

Efficiency

- Resources reserved for duration of connection (capacity in all links, circuit in all switches)
- Inefficient if applications do not use the capacity

Quality

- Data rate, delay guaranteed for duration of connection

Link Speeds

- End devices must be the same speed

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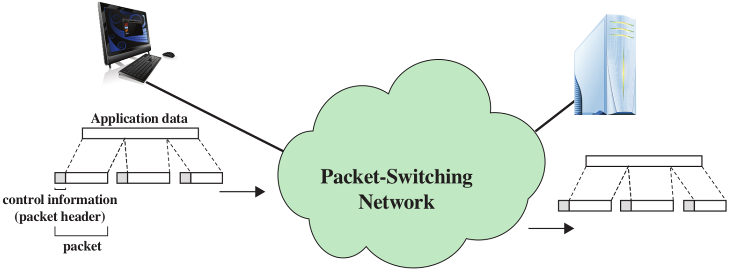
Packet Switching

- For data connections, much of the time the line is idle; circuit-switching inefficient
- Packet switching: break data into packets, sending one at a time from source to destination



Types of Packet Switching

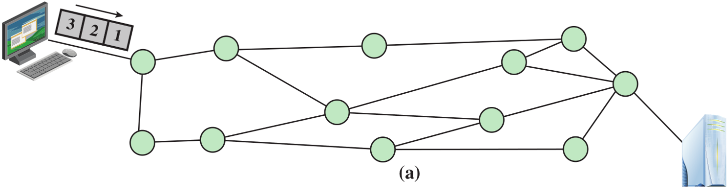
Datagram Packet Switching

- Each packet is treated independently of all others
- Packets belonging to the same message may:
  - Take different paths across the network
  - Arrive at destination out of order and may be lost
- Packets need headers so switches know where to send them

Virtual Circuit Packet Switching

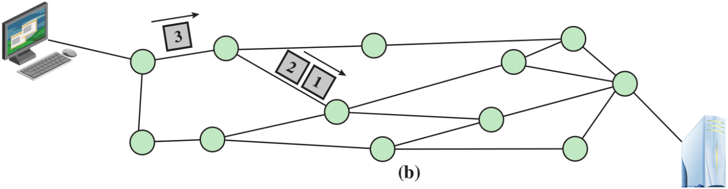
- Virtual circuit setup and teardown
- Once setup, data is transferred as individual packets
  - Take the same path across the network
  - Arrive in-order at the destination, but may be lost
- Packets need headers so switches know what is the next switch it must be sent to

Packet Switching: Datagram Approach: (a)



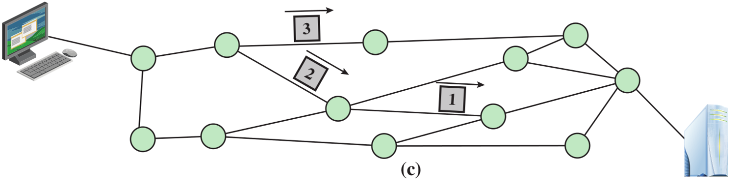
(a)

Packet Switching: Datagram Approach: (b)



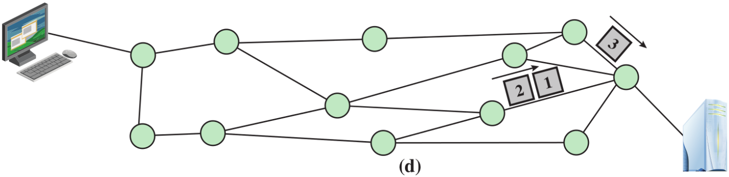
(b)

Packet Switching: Datagram Approach: (c)



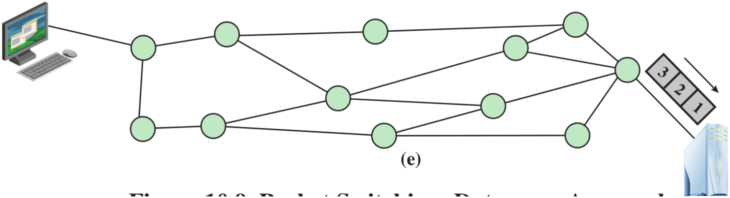
(c)

Packet Switching: Datagram Approach: (d)



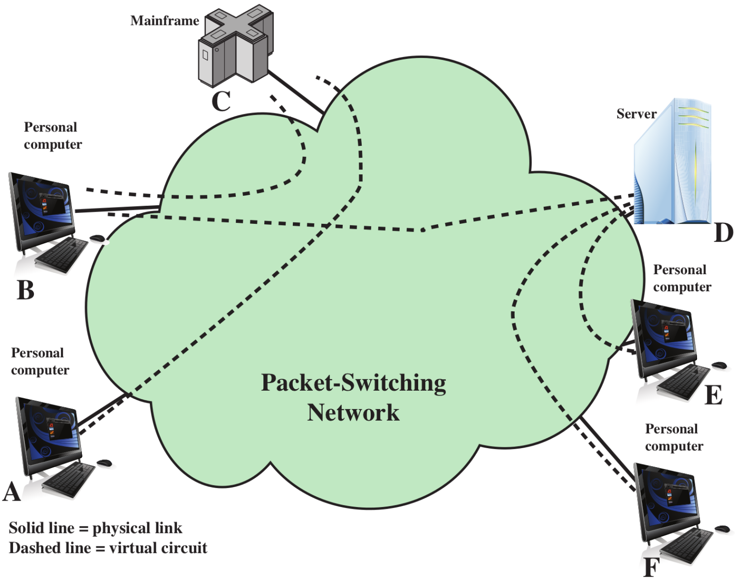
(d)

Packet Switching: Datagram Approach: (e)

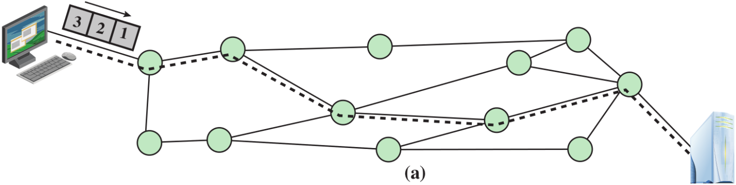


(e)

The Use of Virtual Circuits

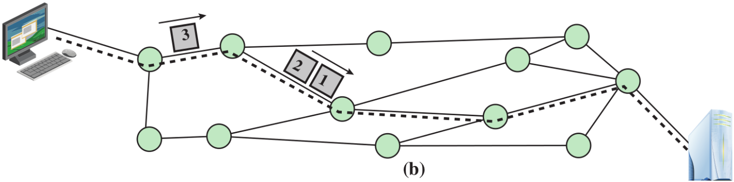


Packet Switching: Virtual-Circuit Approach: (a)



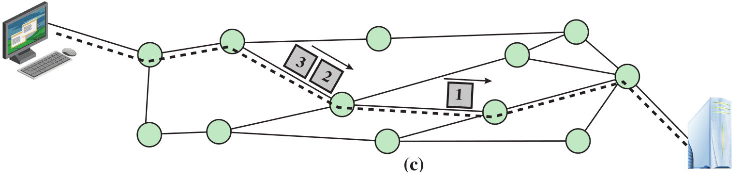
(a)

Packet Switching: Virtual-Circuit Approach: (b)



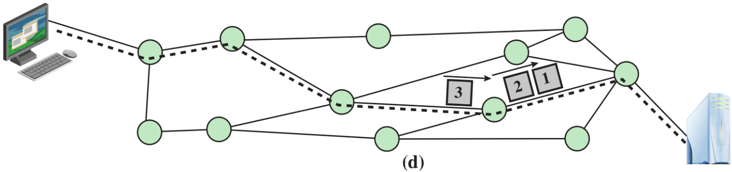
(b)

Packet Switching: Virtual-Circuit Approach: (c)



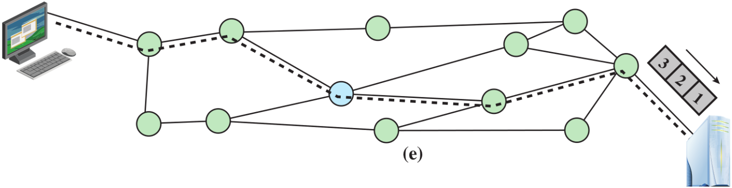
(c)

Packet Switching: Virtual-Circuit Approach: (d)



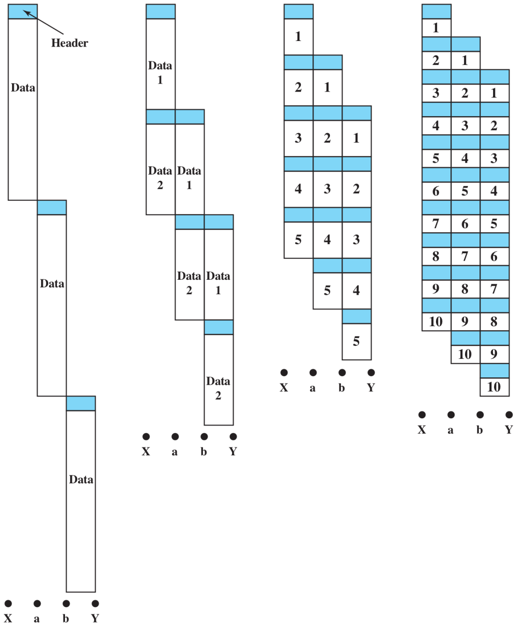
(d)

Packet Switching: Virtual-Circuit Approach: (e)



(e)

Effect of Packet Size on Transmission Time



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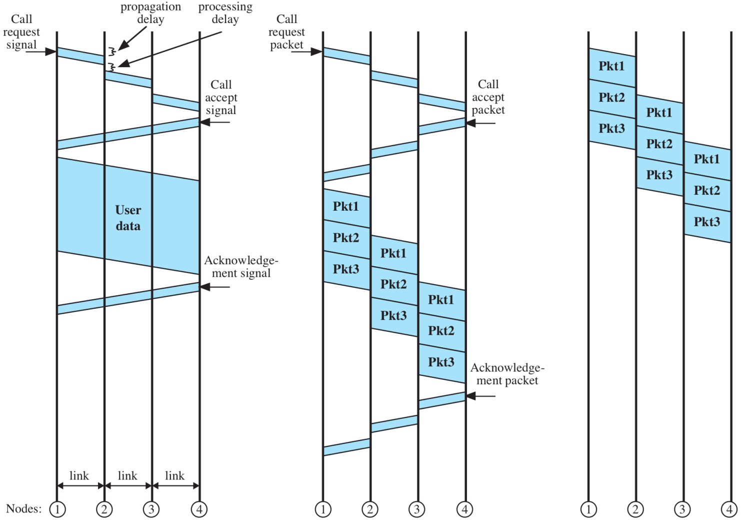
Event Timing for Circuit Switching and Packet Switching



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