



Computer Networks

Circuit Switching and Packet Switching

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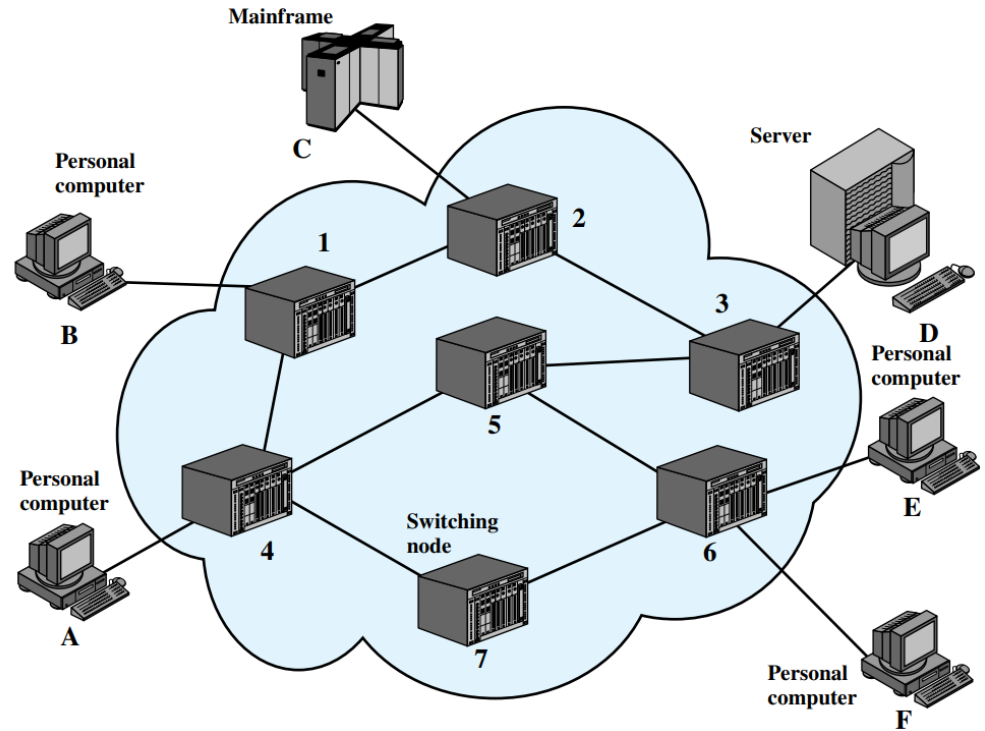
Computer Science and Engineering

IIT Kanpur

Simple Switched Network

□ Two types of switching:

- Circuit switching
- Packet switching



Circuit Switching

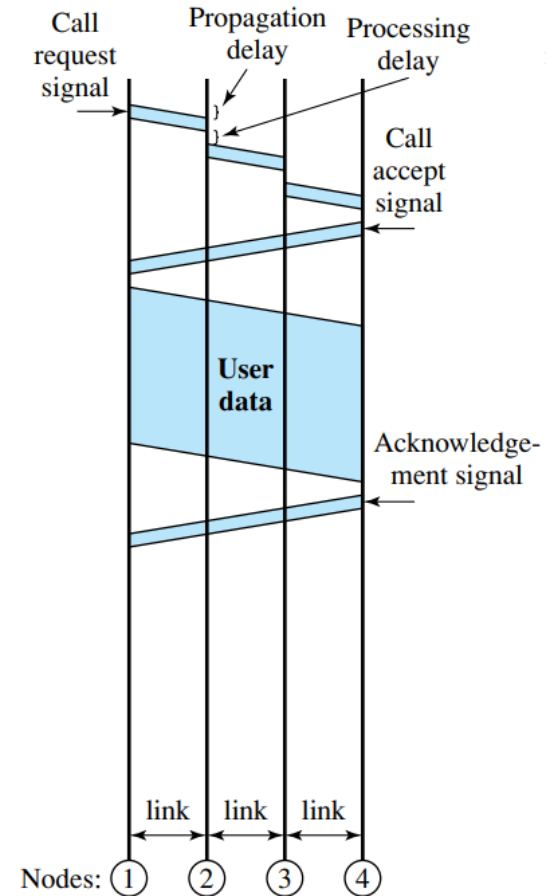
Circuit Switching

❑ Dedicated communication path between two stations

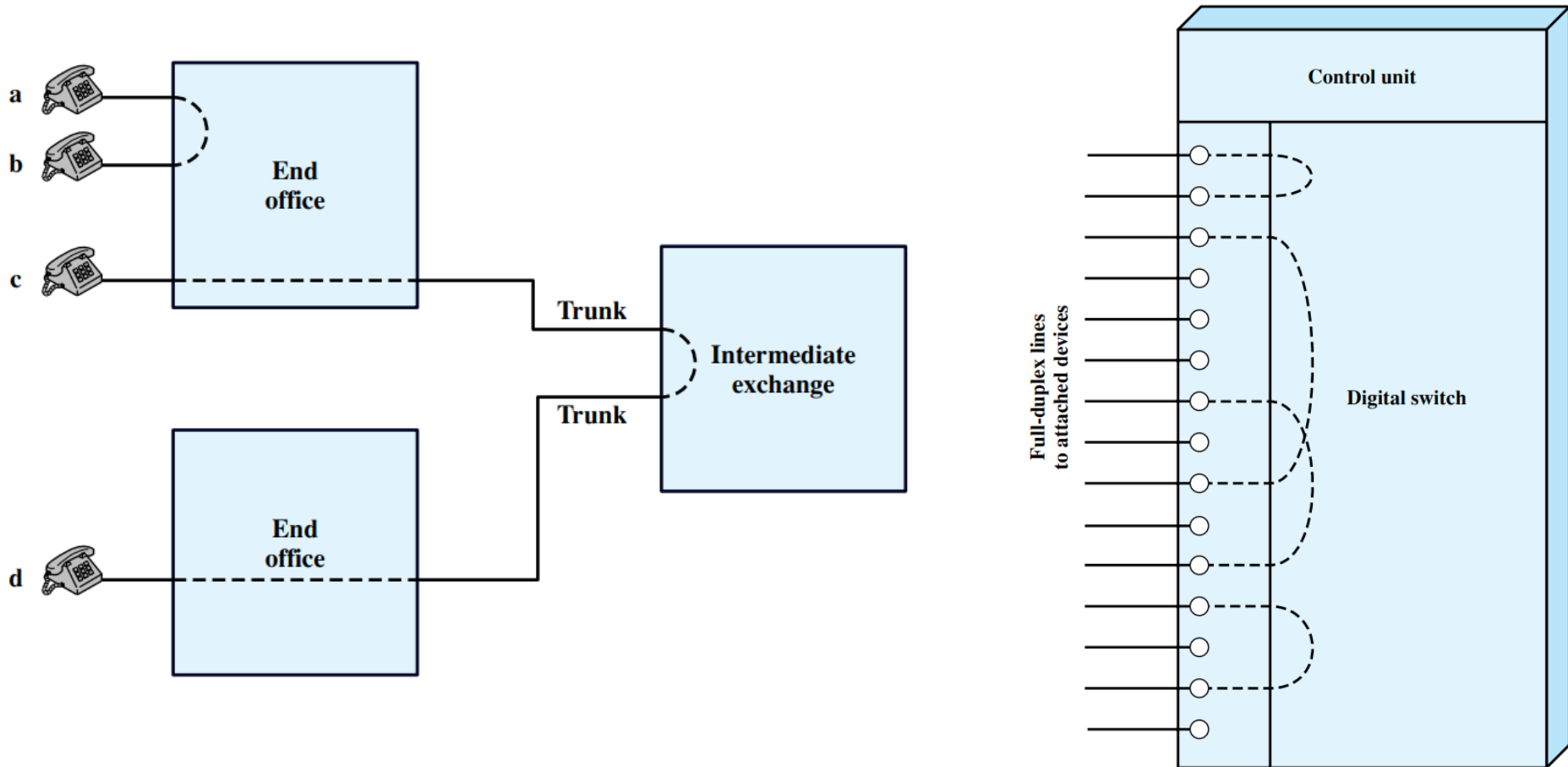
❑ Three phases

- Circuit establish
- Data transfer
- Circuit disconnect

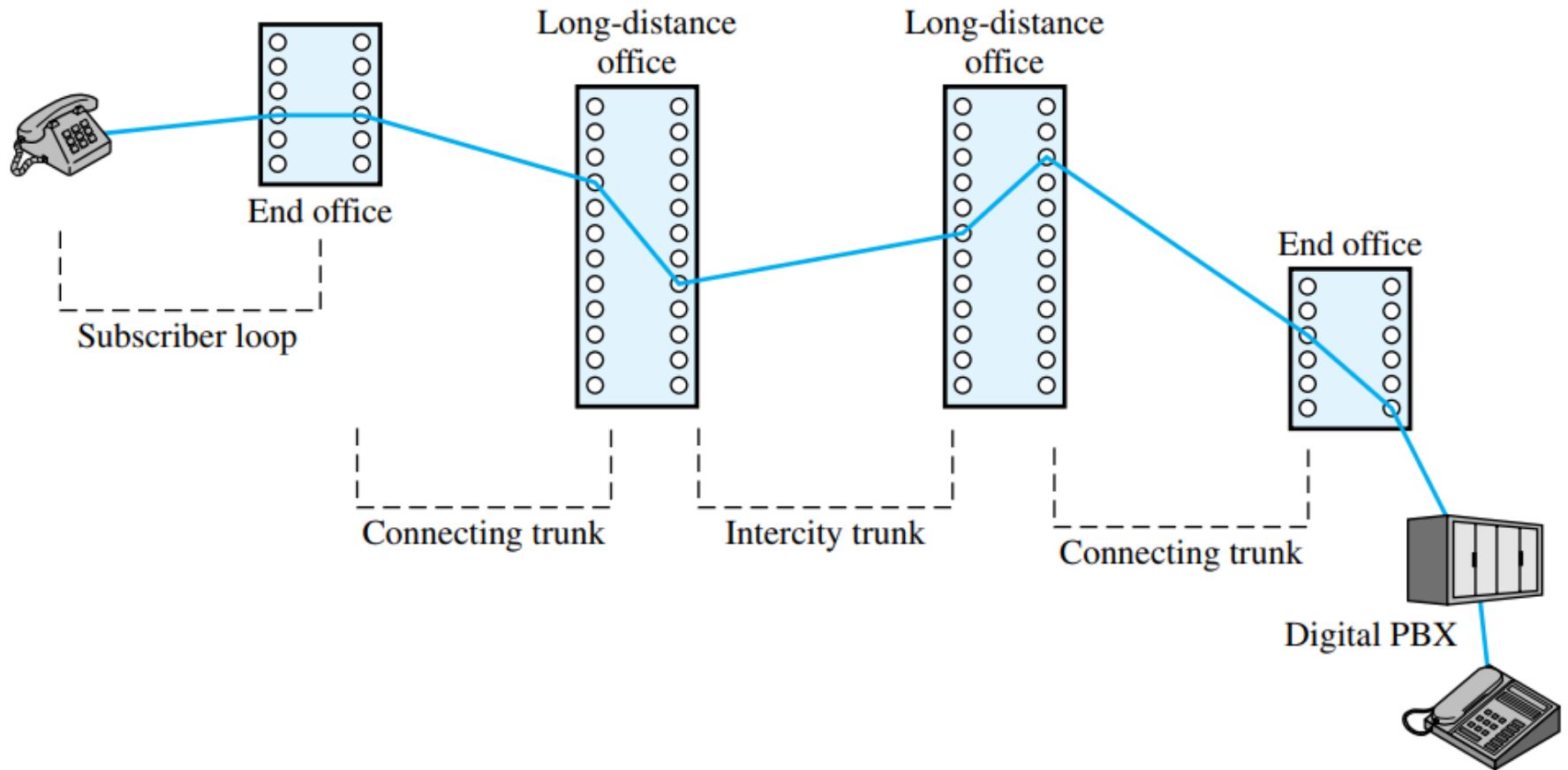
❑ Must have enough channel capacity to establish connection



Circuit Switching



Circuit Switching



Circuit Switching

❑ Inefficiency

- Channel capacity is dedicated for the whole duration of a connection
- If no data, capacity is wasted

❑ Delay

- **Long initial delay**: circuit establishment takes time
- **Low data delay**: after the circuit establishment, information is transmitted at a fixed data rate with no delay other than the propagation delay
- The delay at each node is negligible

❑ Developed for **voice traffic** (public telephone network)

- For voice connections, the resulting circuit will enjoy a high percentage of utilization because most of the time one party or the other is talking
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Switches: Blocking and Non-Blocking

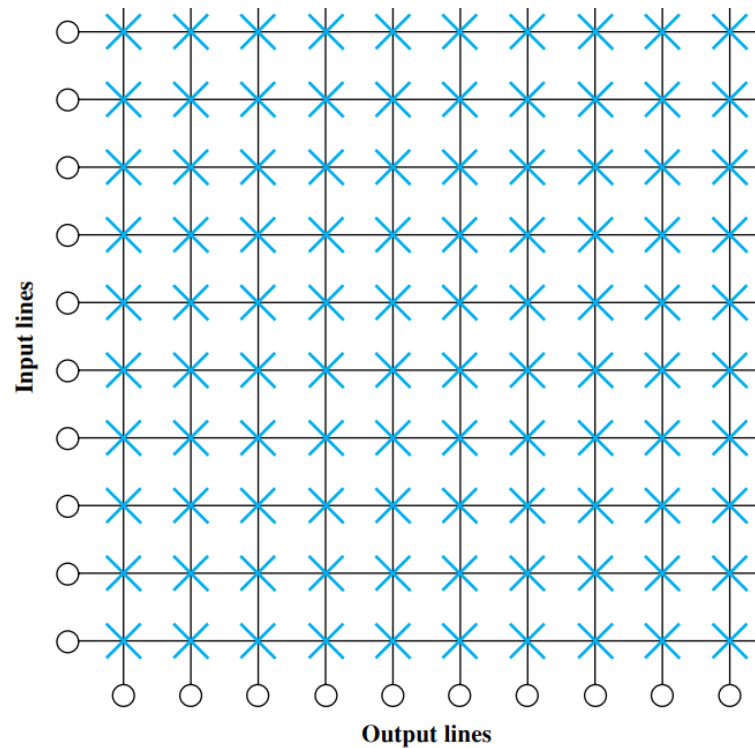
❑ Blocking

- ❑ A network is unable to connect stations because all paths are in use
- ❑ Used on voice systems
 - ❑ Short duration calls

❑ Non-blocking

- ❑ Permits all stations to connect (in pairs) at once
 - ❑ Used for some data connections
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Switches: Crossbar

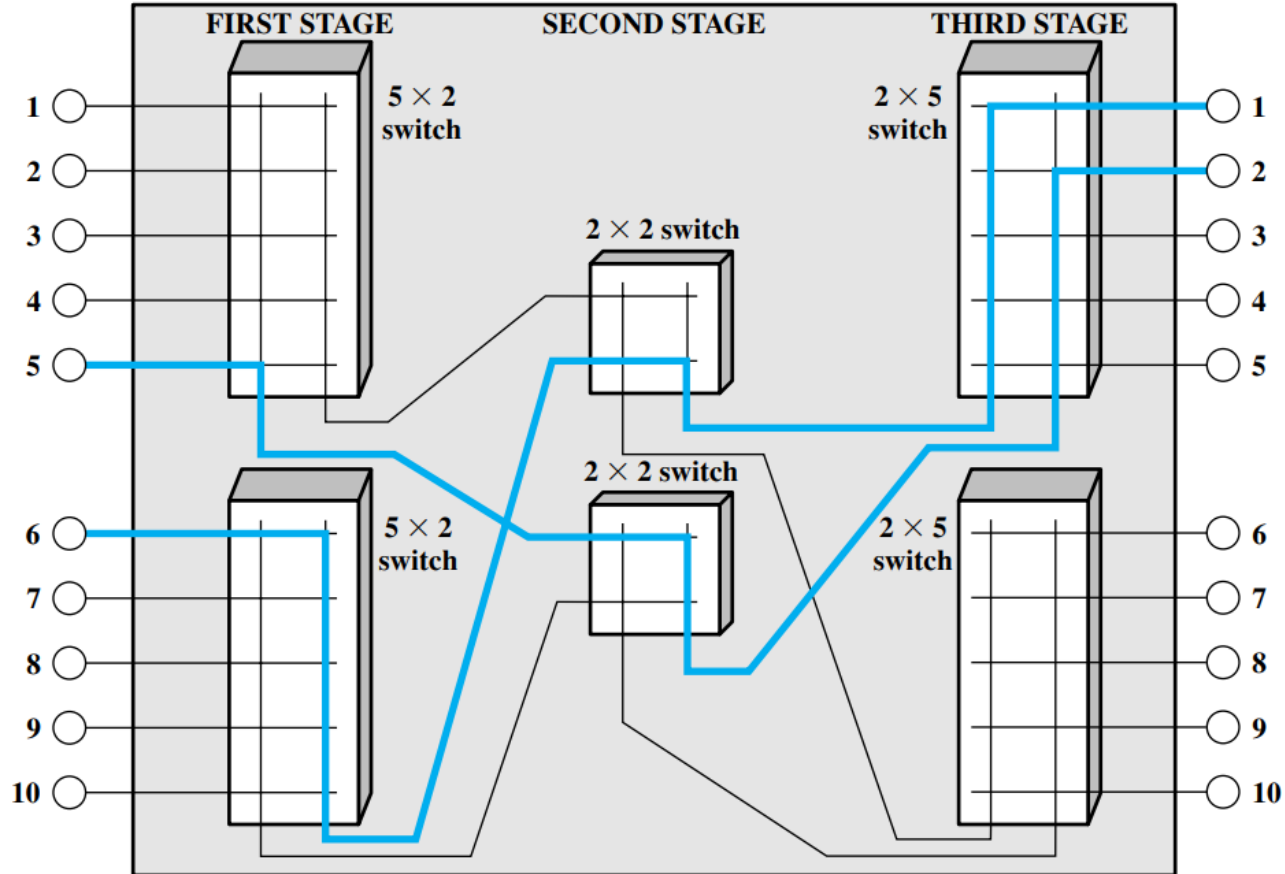


Total number of crosspoints is N^2

Switches: Crossbar

- ❑ Number of crosspoints grows as square of number of stations
 - ❑ Loss of crosspoint prevents connection
 - ❑ Non-blocking
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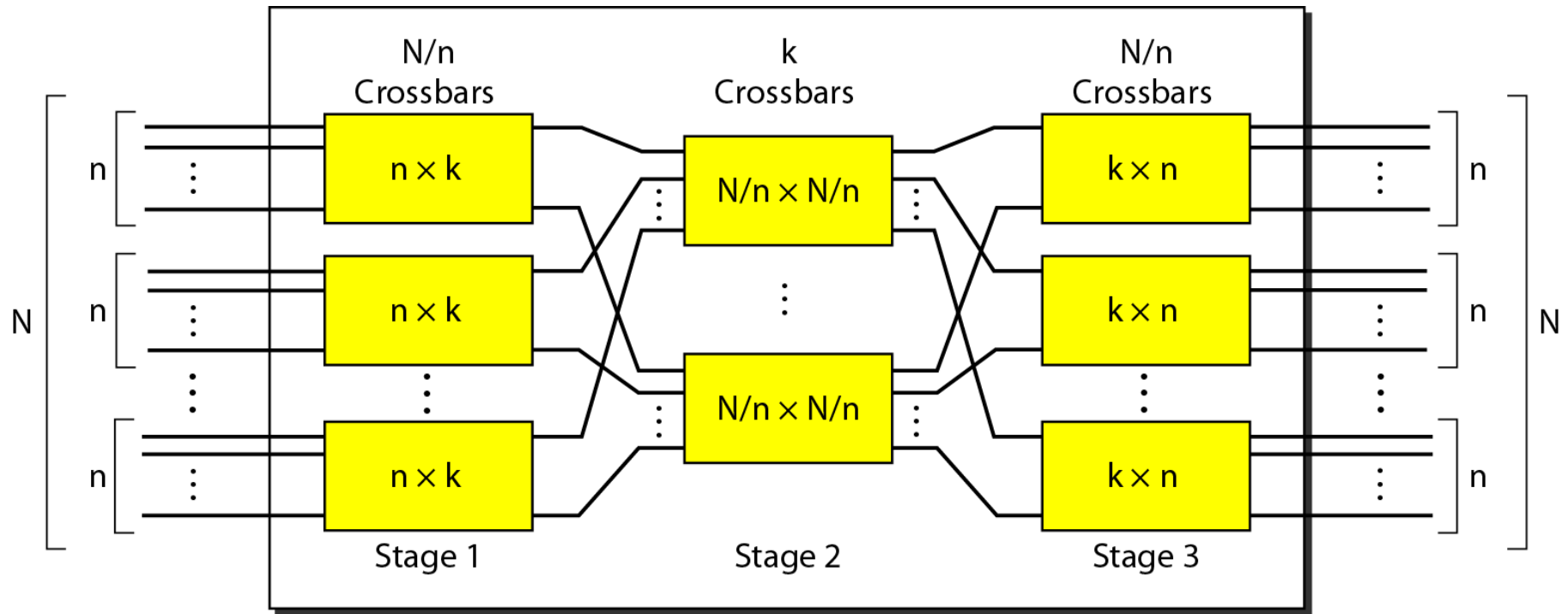
Switches: Multistage Switch



Switches: Multistage Switch

- ❑ Reduced number of crosspoints
 - ❑ More than one path through network
 - ❑ Increased reliability
 - ❑ More complex control
 - ❑ May be blocking
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Switches: Multistage Switch



Total number of crosspoints is $2kN + k(N/n)^2$

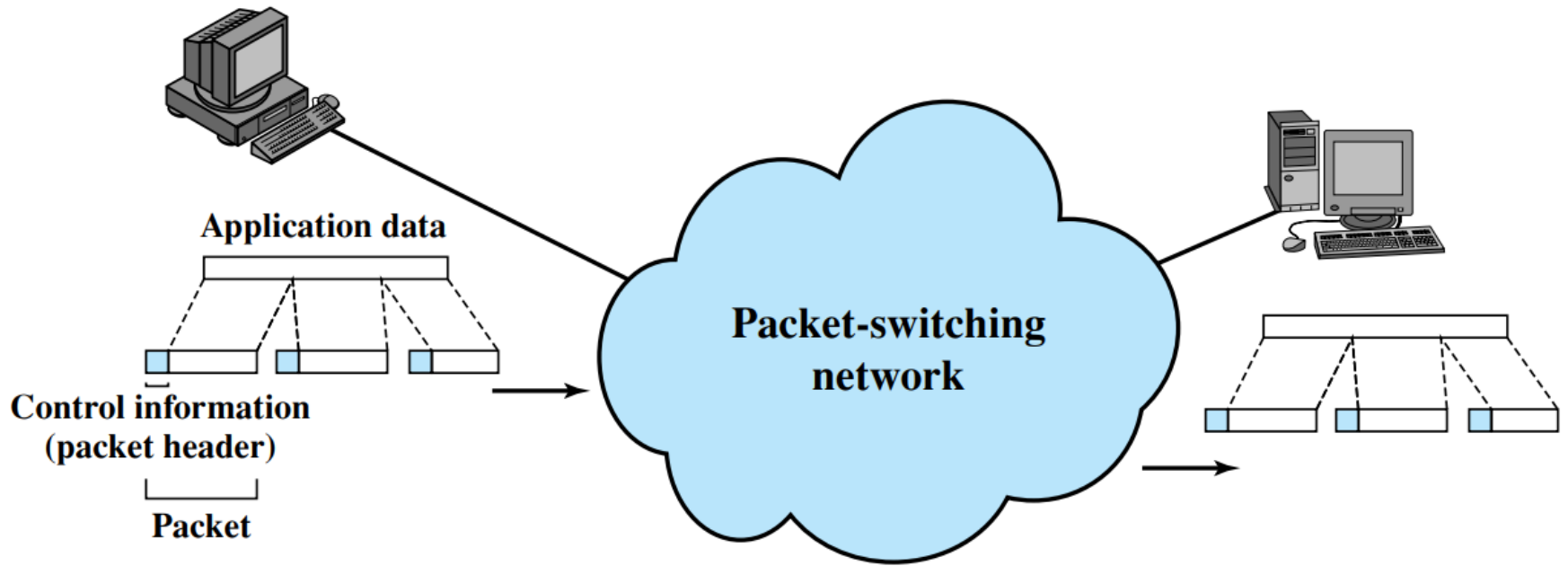
Switches: Example

- Design a three-stage, 200×200 switch ($N = 200$) with $k = 4$ and $n = 20$

Total number of crosspoints is $2kN + k(N/n)^2$

Packet Switching

Packet Switching



Packet Switching

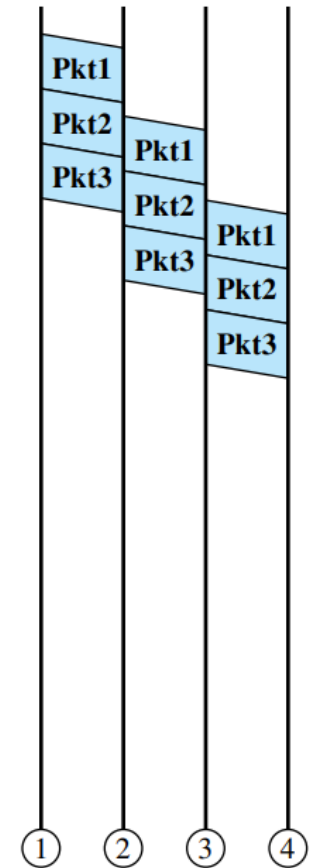
- ❑ Data transmitted in small packets
 - ❑ Longer messages split into series of packets
 - ❑ Each packet contains a portion of user data plus some control info
 - ❑ Control info: Routing (addressing) info
 - ❑ Packets are received, stored briefly (buffered) and past on to the next node
 - ❑ Store and forward
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Packet Switching

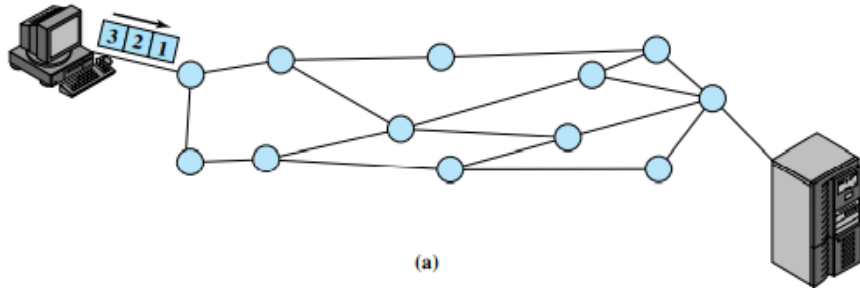
- ❑ Line efficiency
 - ❑ Single node to node link can be shared by many packets over time
 - ❑ Packets queued and transmitted as fast as possible
 - ❑ Packets are accepted even when network is busy
 - ❑ Delivery may slow down
 - ❑ Two types:
 - ❑ Datagram packet switching
 - ❑ Virtual circuit packet switching
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Datagram Packet Switching

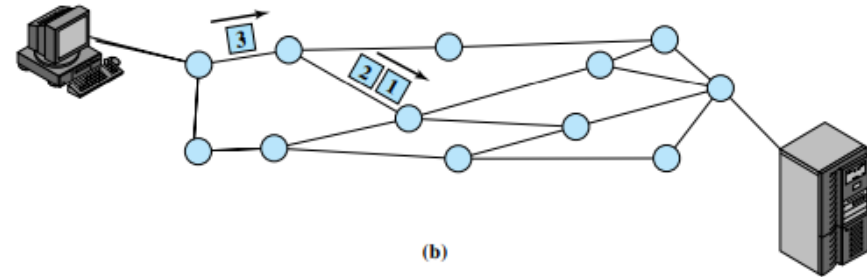
- ❑ Each packet treated independently
- ❑ Packets can take any route
- ❑ Packets may arrive out of order
- ❑ Packets may go missing
- ❑ Up to receiver to re-order packets and recover from missing packets



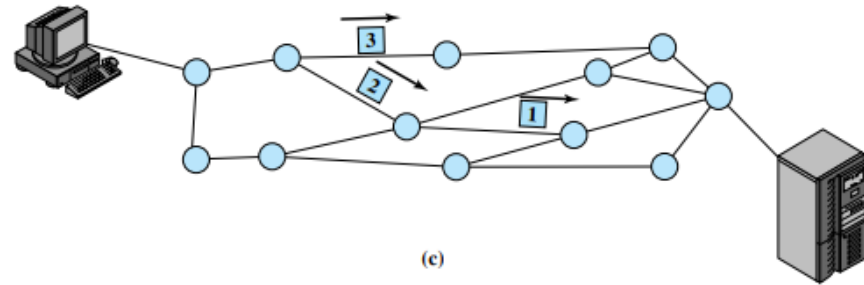
Datagram Packet Switching



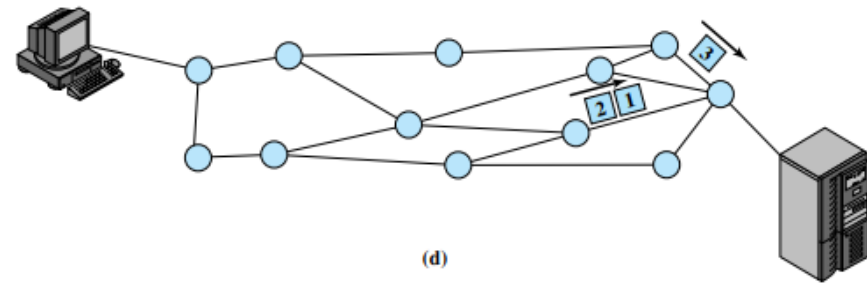
(a)



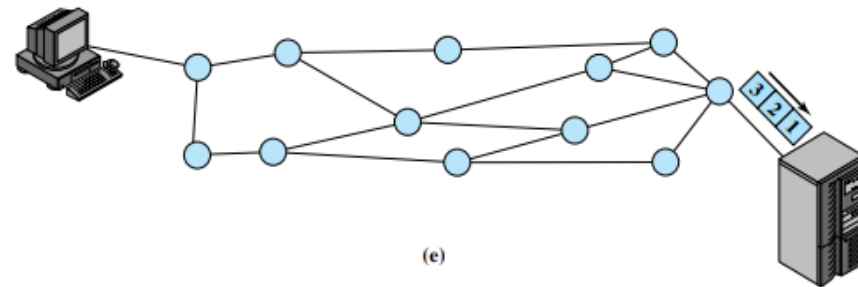
(b)



(c)



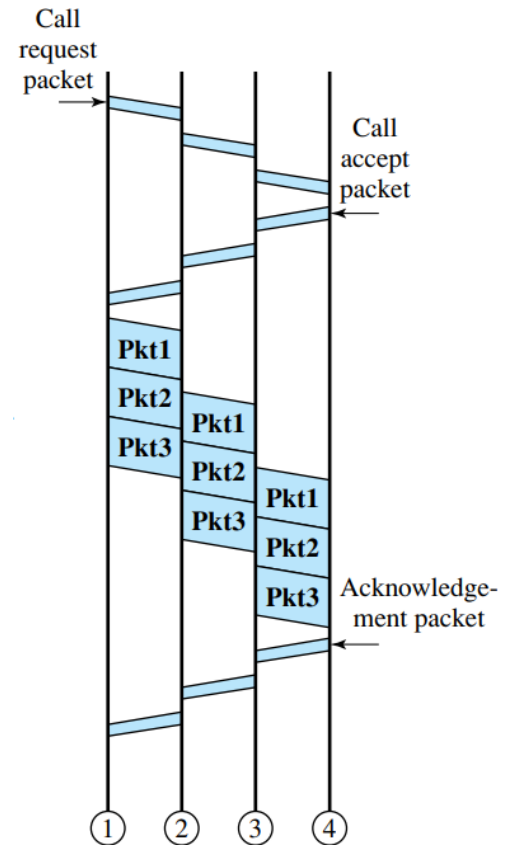
(d)



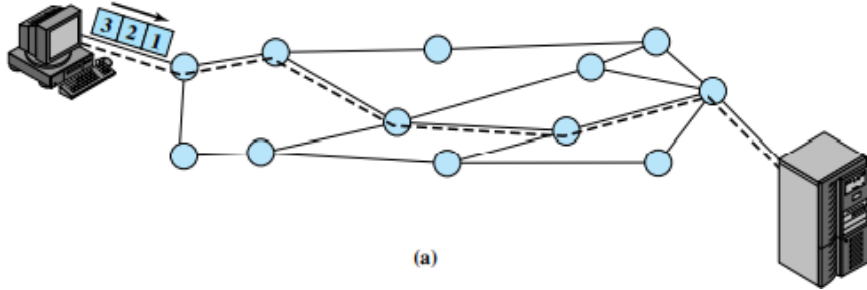
(e)

Virtual Circuit Packet Switching

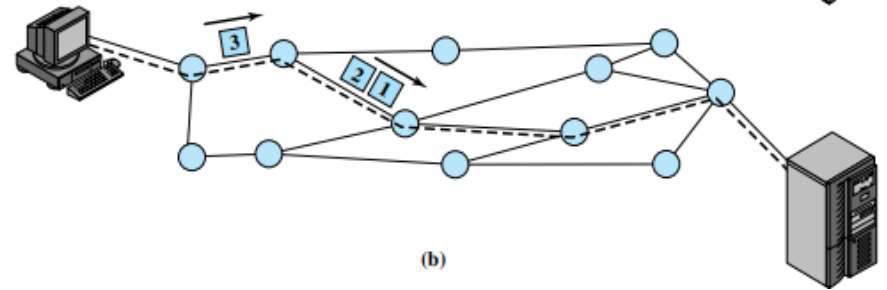
- ❑ Preplanned route established before any packets sent
- ❑ Call request and call accept packets establish connection (handshake)
- ❑ Each packet contains a **virtual circuit identifier** instead of destination address
- ❑ No routing decisions required for each packet
- ❑ Clear request to drop circuit
- ❑ Not a dedicated path



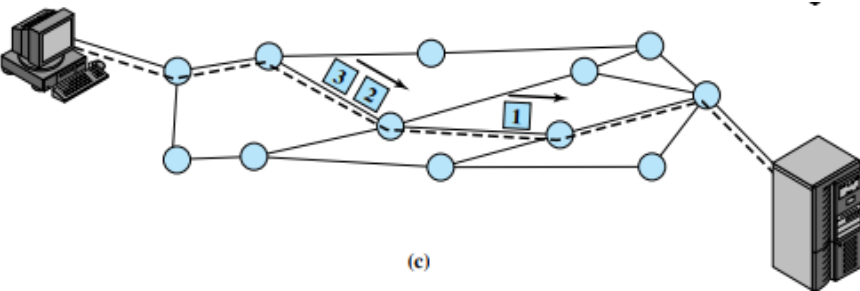
Virtual Circuit Packet Switching



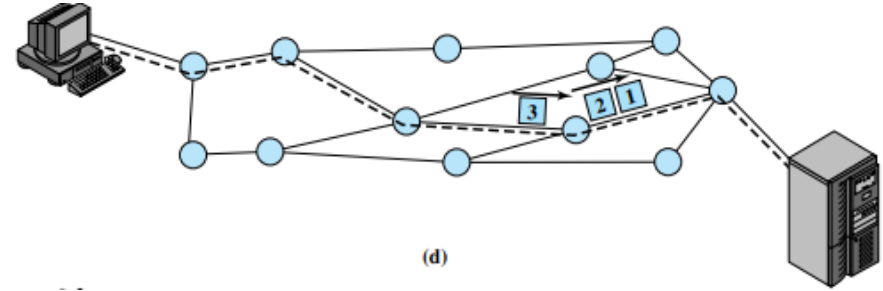
(a)



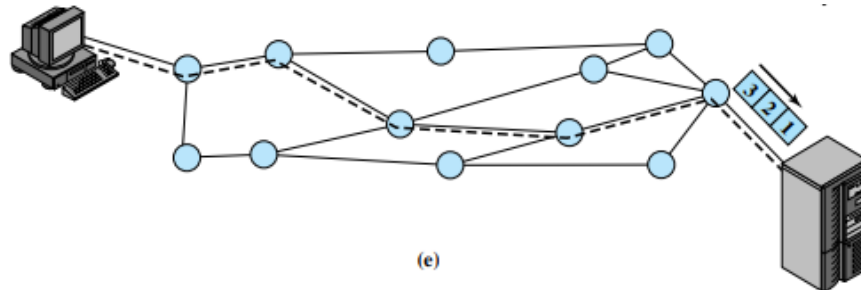
(b)



(c)

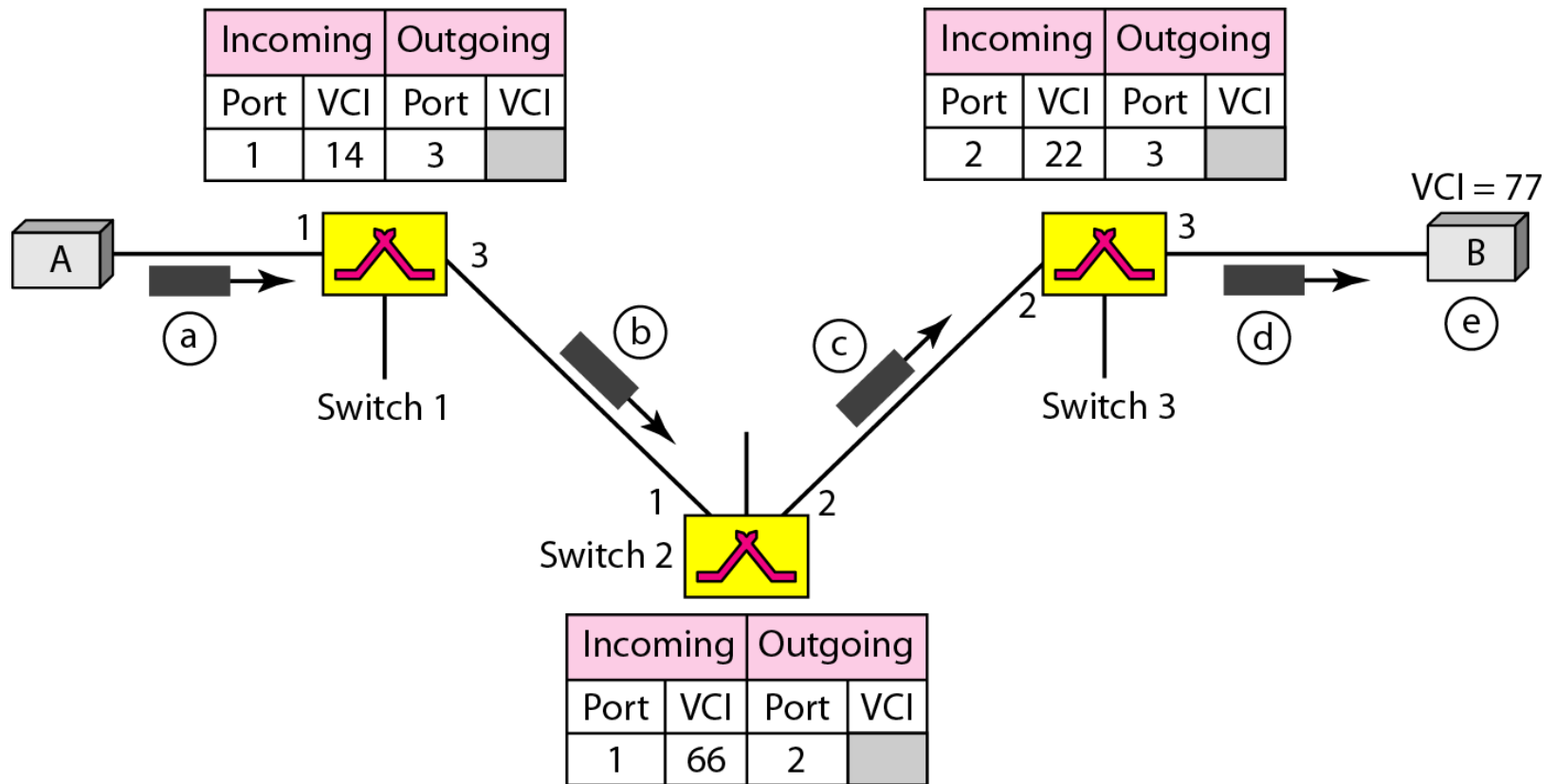


(d)

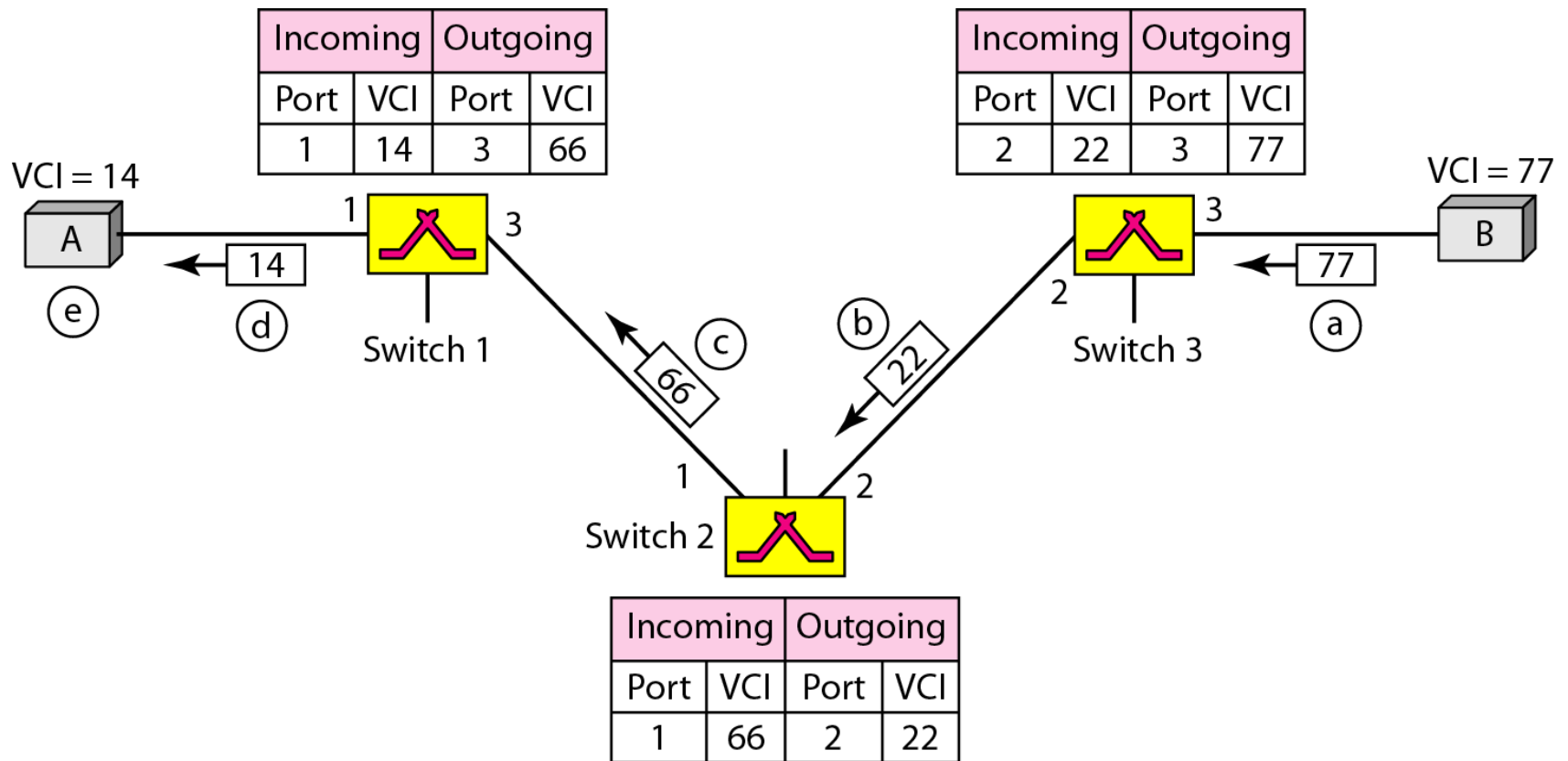


(e)

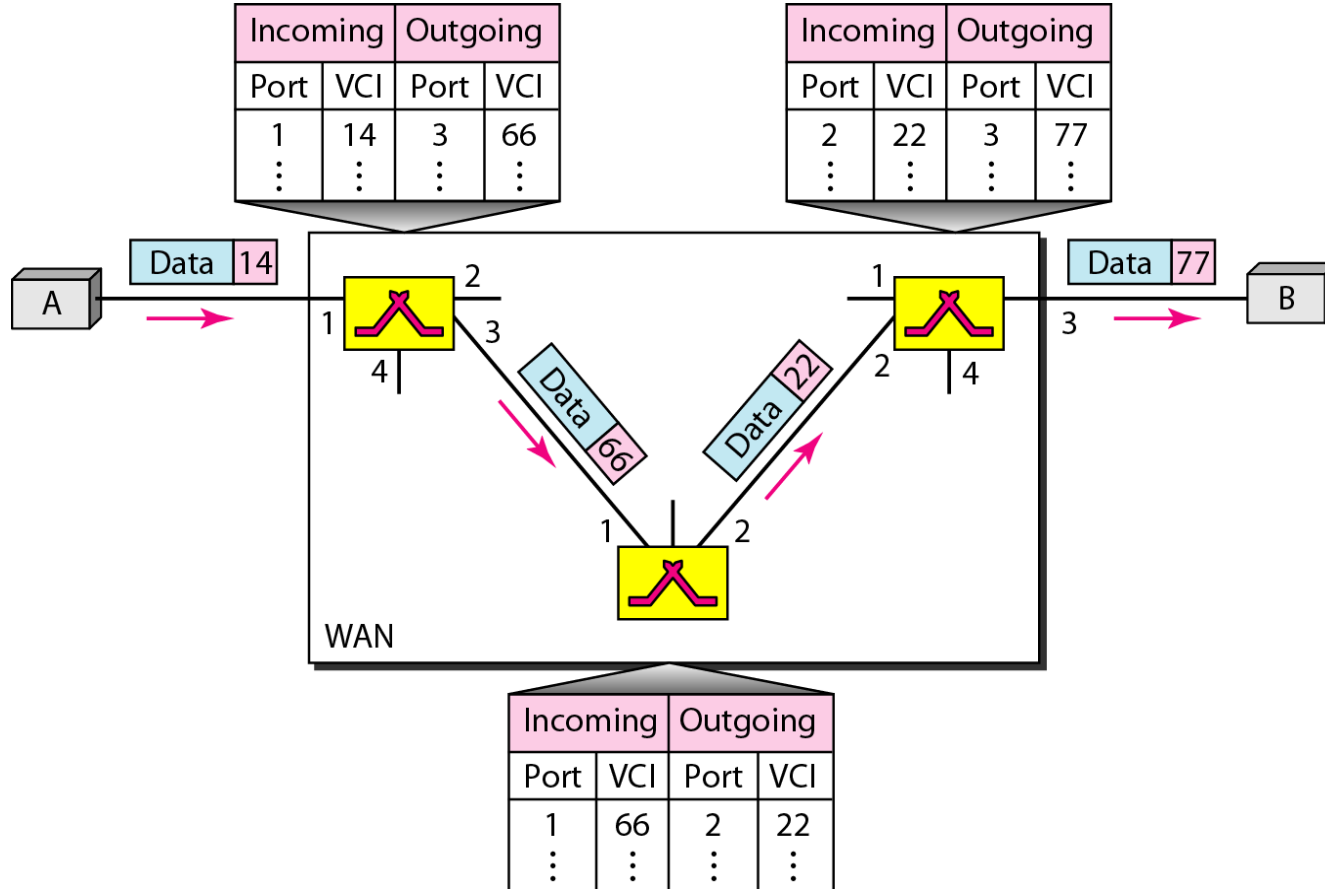
Virtual Circuit Packet Switching: Setup Reqst



Virtual Circuit Packet Switching: Setup Ack



Virtual Circuit Packet Switching: Data Trans



Datagram vs Virtual Packet Switching

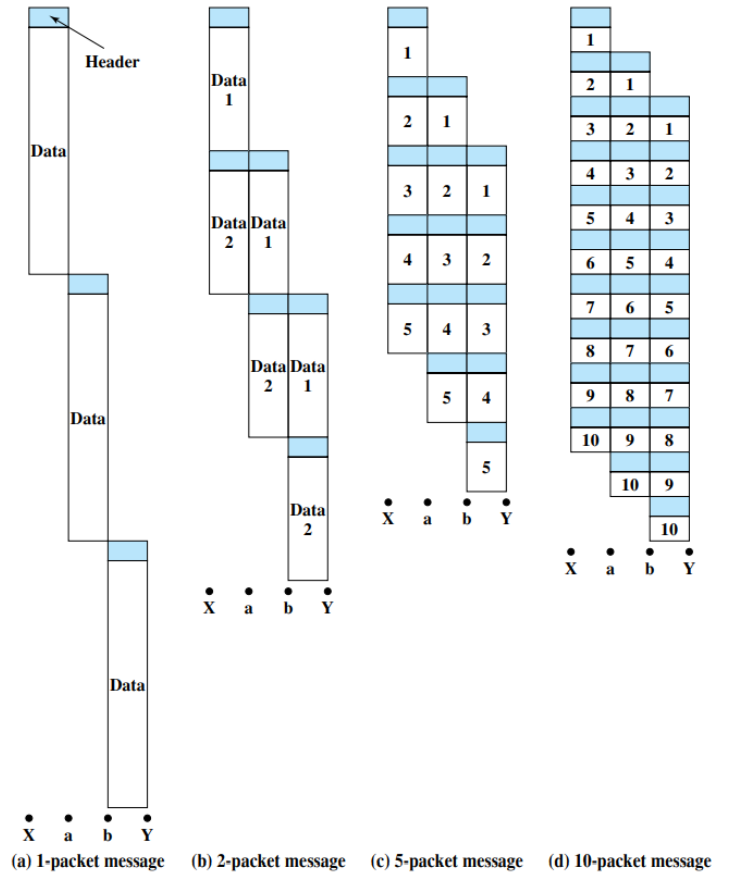
❑ Virtual circuits

- ❑ Packets are forwarded more quickly
 - ❑ No routing decisions to make
- ❑ Less reliable
 - ❑ Loss of a node loses all circuits through that node

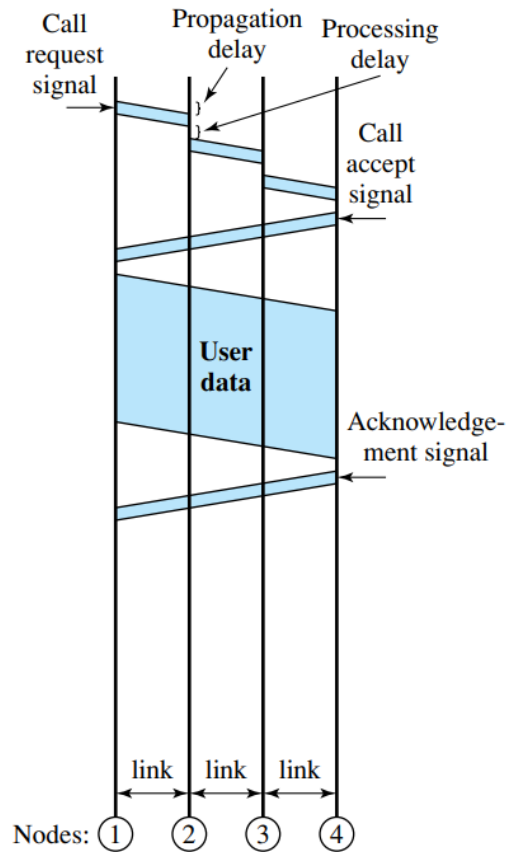
❑ Datagram

- ❑ No call setup phase
 - ❑ Better if few packets
 - ❑ More flexible
 - ❑ Routing can be used to avoid congested nodes/links
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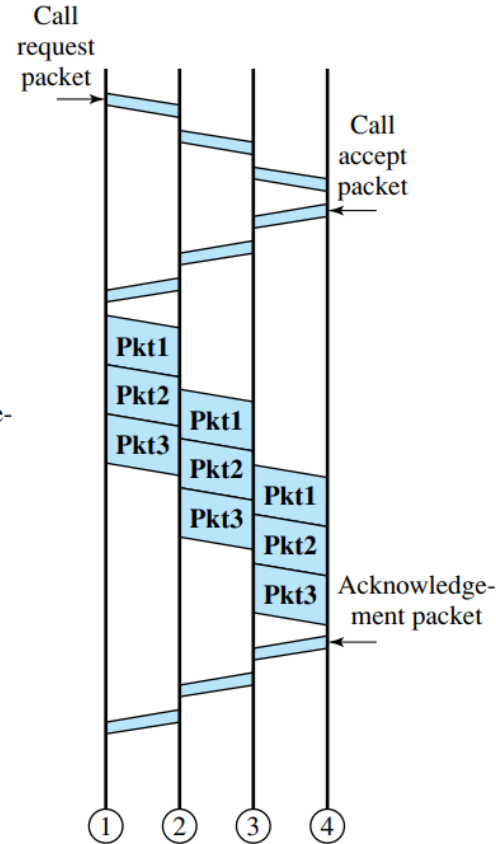
Packet Size



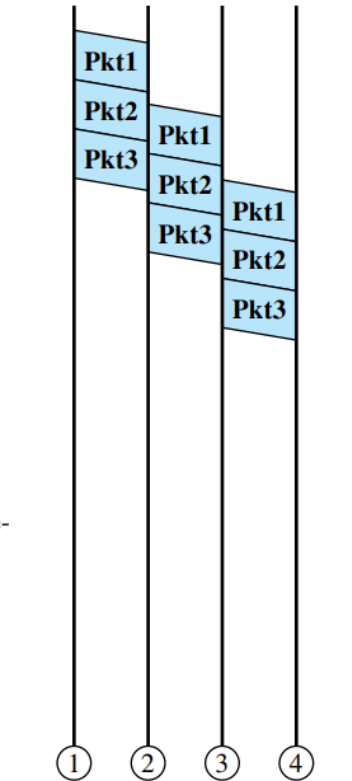
Event Timing



(a) Circuit switching



(b) Virtual circuit packet switching



(c) Datagram packet switching

Circuit switching vs Packet switching

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
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
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

Summary

- Circuit switching
 - Packet switching
 - Datagram packet switching
 - Virtual circuit packet switching
 - Comparison of circuit switching and packet switching
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