

Wide Area Networks (WAN) and Packet Switching Basics

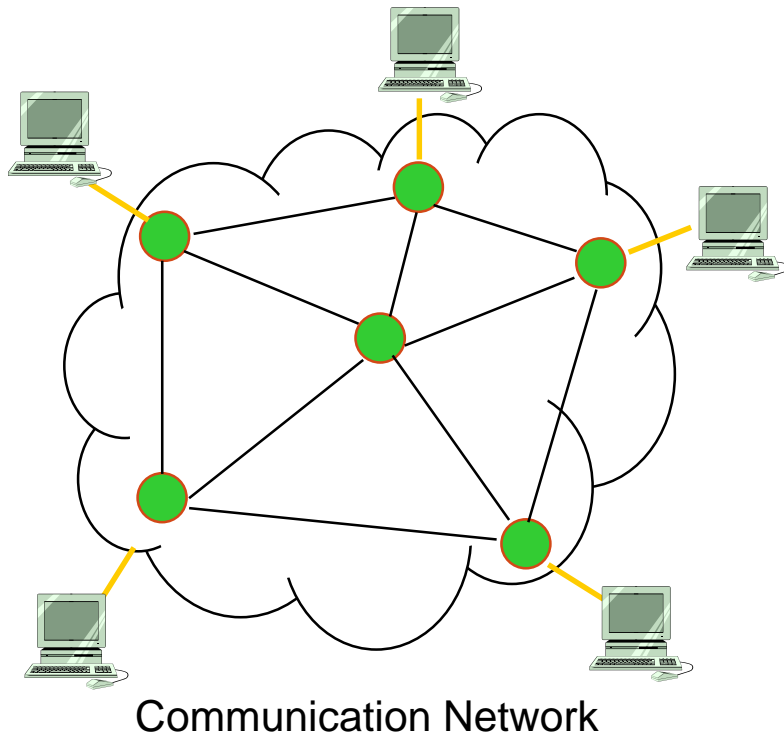
Wide Area Networks (WAN)

- Refers to network spread over a large geographical area, connecting smaller networks
- All machines in a WAN can not be directly connected to each other due to
 - large number
 - geographically far apart
- All machines/nodes are not under the same administrative control
- Transmission done by a network of *switched* nodes —
Switched Network

Switched Networks

- End devices or stations – devices that actually wants to communicate (ex. a PC, phone)
- Communication network – collection of nodes and connections
- Stations communicate using the communication network
- Data is switched from node to node until it reaches destination station
- Intermediate nodes not concerned with content of data

Simple Switched Network



- Communication Network Node
 - provides switching facility (routing)
- Network Station
 - end node (source & destination)

- Used to connect geographically distributed machines and networks into a single cohesive network
- Two key switching techniques
 - Circuit switching (mostly for phone networks)
 - Packet switching (used in data networks)

Circuit Switching

- Dedicated communication path between two stations
- Three phases
 - Establish — signaling to set up path
 - Transfer - transfer data, connection maintained
 - Disconnect — signaling to tear down connection
- Must have switching capacity and channel capacity to establish connection
- Needs to chose a path - routing
- Example — Public Telephone Network

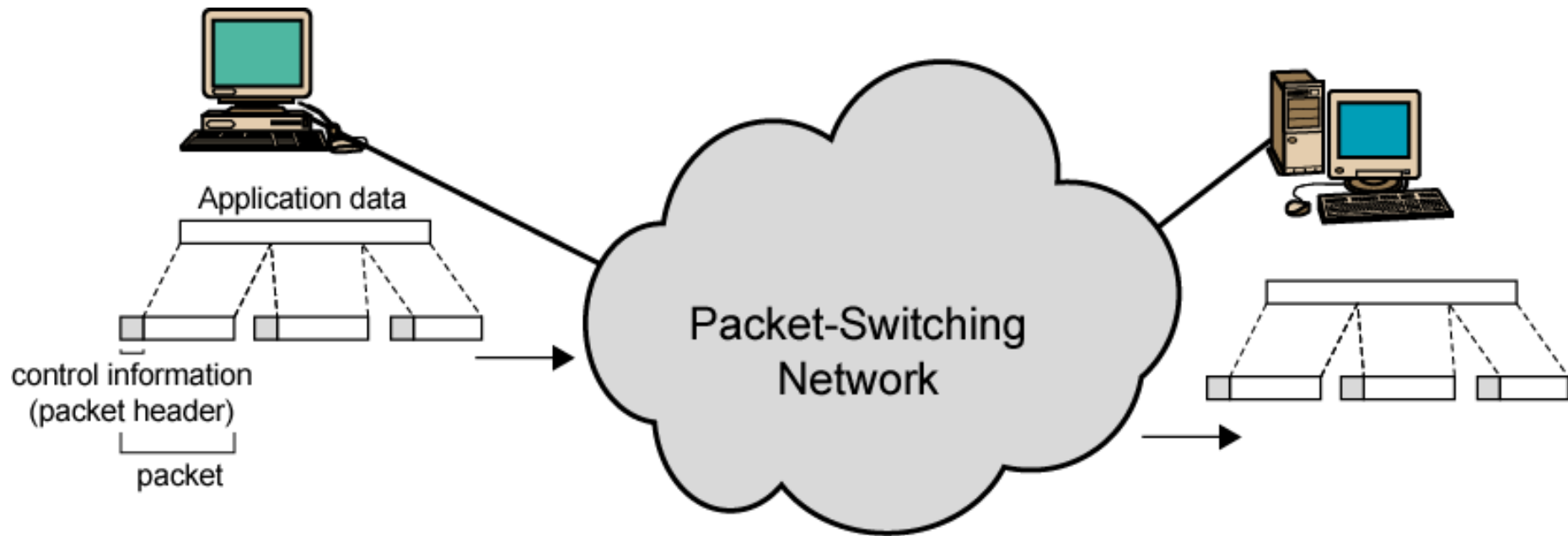
Circuit Switching (contd.)

- Advantages
 - once connected, transfer is fast (no forwarding decision needed after connection)
- Disadvantages
 - Inefficient
 - Channel capacity dedicated for duration of connection
 - If no data to be transmitted, capacity wasted
 - Set up (connection) takes time
- Not done in computer networks

Packet Switching

- Data are transmitted in short messages called *packets* (maximum packet size is defined)
- A dedicated connection between the two end-nodes is not maintained
- Longer messages broken up into smaller packets
- Each packet = data + control info (*header*)
- Intermediate nodes buffer and then forward packets (*store and forward*)
- A node-to-node link can be dynamically shared by many packets

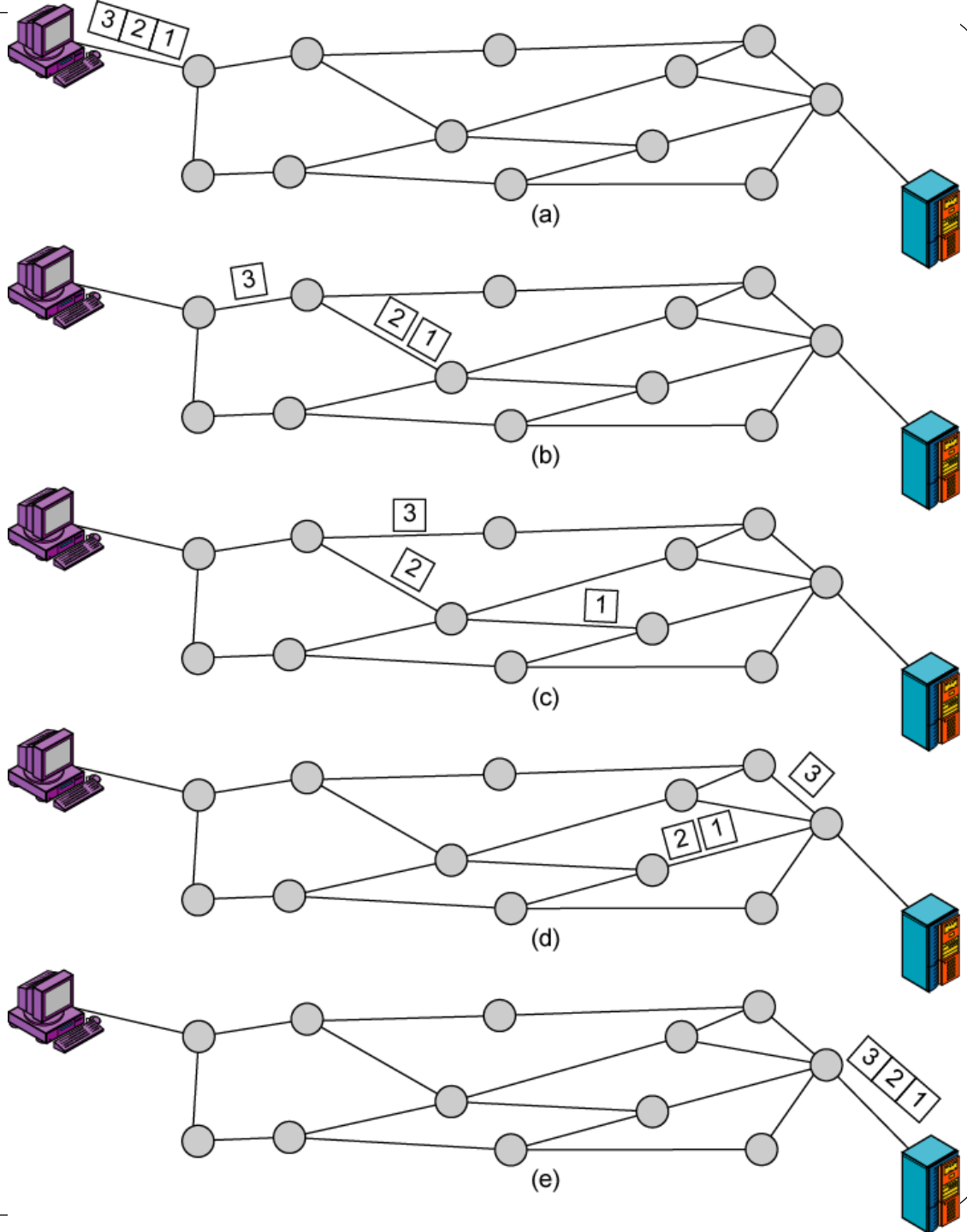
Use of Packets



Packet Switching (contd.)

- Datagram approach
 - Each packet treated independently
 - Packets may follow different paths to the destination
 - May arrive out-of-order or get lost
 - Intermediate nodes need to decide where to forward packets (routing)
 - Up to receiver to re-order packets and recover missing packets

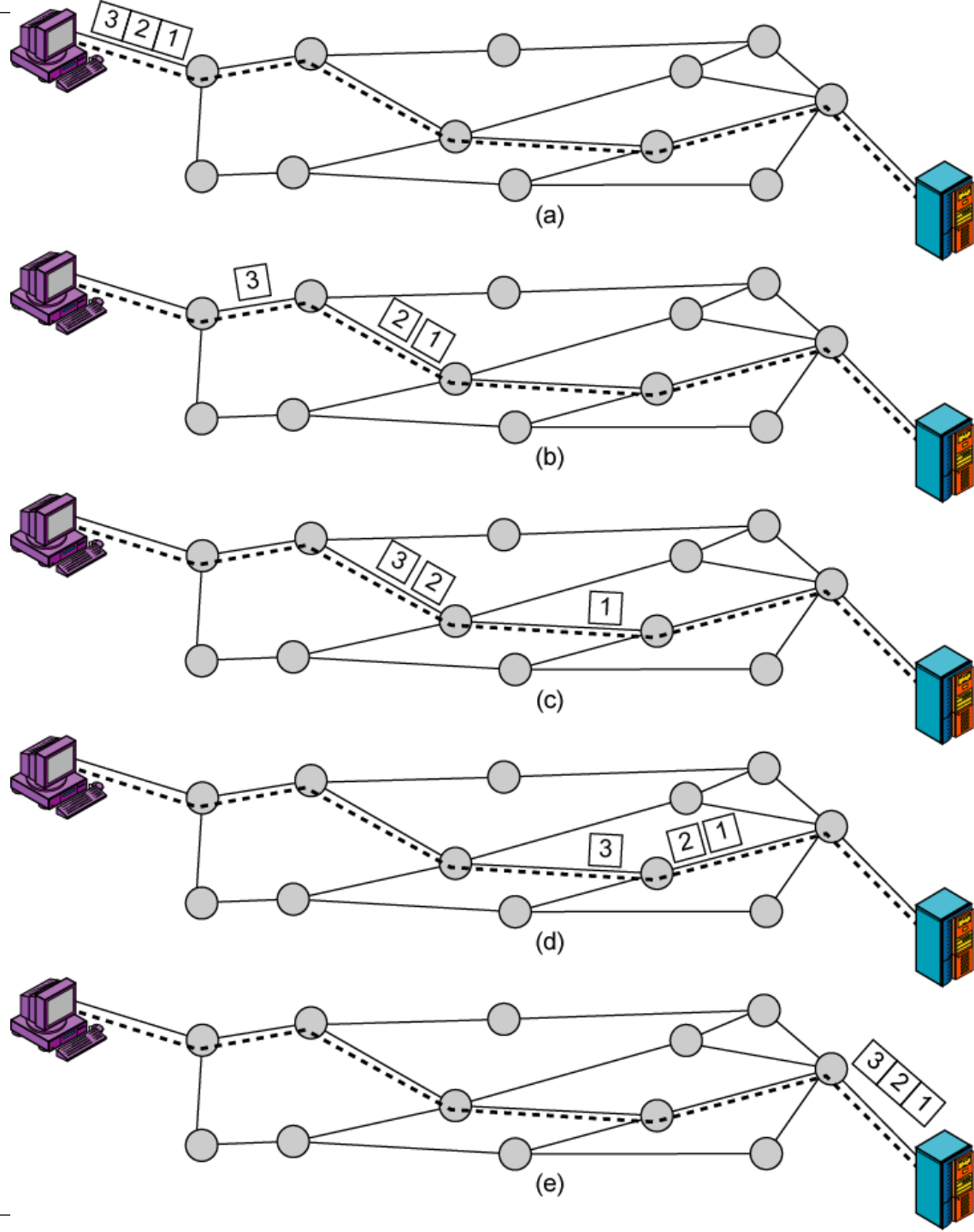
Datagram Example



Packet Switching (contd.)

- Virtual Circuit approach
 - Preplanned route established before any packets sent
 - Call request and call accept packets establish connection (handshaking) [Similar to circuit switching]
 - Each packet contains a virtual circuit identifier instead of destination address
 - No routing decisions required for individual packets
 - Clear request packet is used to drop circuit
 - *Not a dedicated path (unlike circuit switching, the links in a path may be shared between different virtual circuits)*

Virtual Circuit Example



Virtual Circuits vs. Datagrams

- Virtual circuits
 - Network can provide sequencing and error control
 - Packets are forwarded more quickly
 - No forwarding 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 and reliable
 - Routing can be used to avoid congested parts of the network, loss of a single node does not drop all packets

Advantages of 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
 - But delivery may slow down
- Priorities can be used

Effect of Packet Size

What is the relation between the packet size, header size, number of hops, and the time to transmit all packets?

What would be a good packet size?

