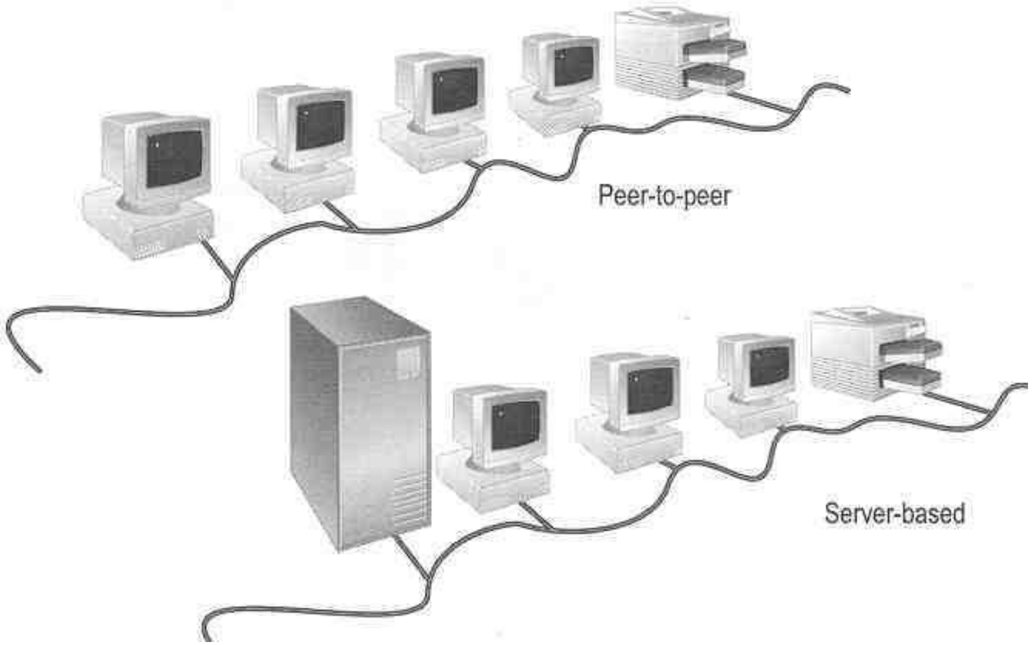


Computer Networking
Lecture 2
Summer

Hassan Alamri

Agenda:

- internet.
- Network Models

- Switched Communications Networks
- Network Devices

- internet.
- Network Models

Internet

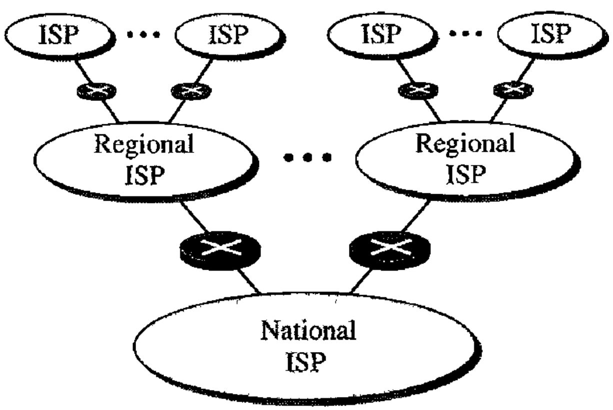
A **network** is a group of connected communicating devices such as computers and printers..

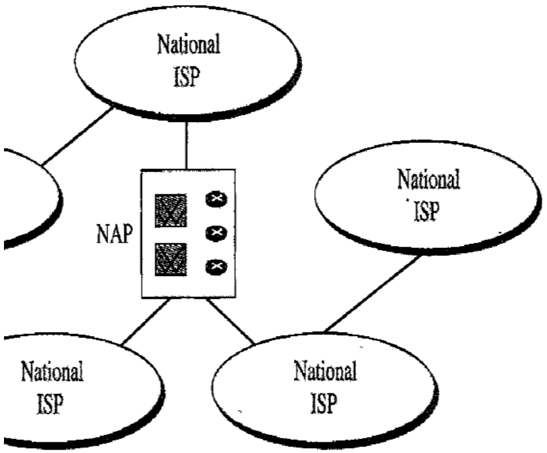
The Internet a collaboration of more than hundreds of thousands of interconnected networks.

The Internet Today

Internet Service Provider (ISP) is an organization that provides services for accessing, using, or participating in the Internet.

Today most end users who want Internet connection use the services of Internet service providers (ISPs). There are international service providers , national service providers, regional service providers and local service providers.





Internet service providers hierarchy

1- International Internet Service Providers

At the top of the hierarchy are the international service providers that connect nations together.

2- National Internet Service Providers

The national Internet service providers are backbone networks created and maintained by specialized companies.

3- Regional Internet Service Providers

Regional internet service providers or regional ISPs are smaller ISPs that are connected to one or more national ISPs. They are at the third level of the hierarchy with a smaller data rate.

4- Local Internet Service Providers

Local Internet service providers provide direct service to the end users. The local ISPs can be connected to regional ISPs or directly to national ISPs. Most end users are connected to the local ISPs.

Standards

Standards provide guidelines to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

Body	Area	Examples
ITU	Telecommunications	G.992, ADSL H.264, MPEG4
IEEE	Communications	802.3, Ethernet 802.11, WiFi
IETF	Internet	RFC 2616, HTTP/1.1 RFC 1034/1035, DNS
W3C	Web	HTML5 standard CSS standard

Network Models

A **network** is a combination of hardware and software that sends data from one location to another.

The **hardware** consists of the physical equipment that carries signals from one point of the network to another.

The **software** consists of instruction sets that make the services that we expect from a network.

The OSI Model

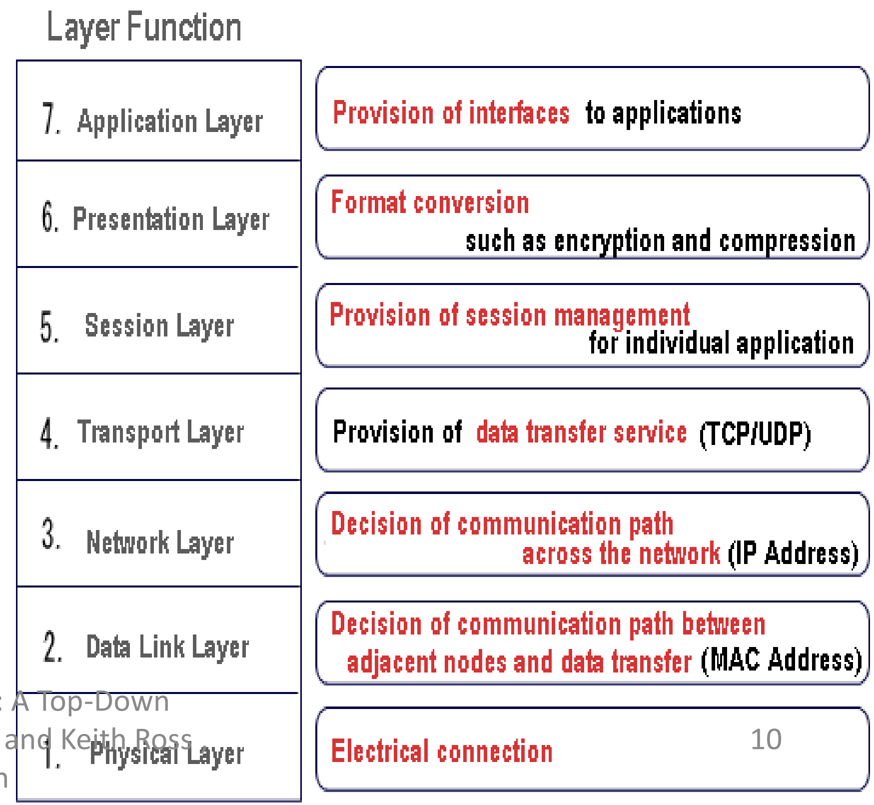
The International Standards Organization (ISO) introduced the Open Systems Interconnection model (OSI) in the late 1970s.

An **open system Interconnection** is a *set of protocols that allows any two different systems to communicate regardless of their underlying architecture*.

The **purpose** of the OSI model *is to **show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.***

The OSI Model

The OSI model is a layered framework for the design of network systems that allows communication between all types of computer systems. It consists of seven separate but related layers, each of which defines a part of the process of moving information across a network.



The OSI model is composed of seven ordered layers:
 physical (layer 1),
 data link (layer 2),
 network (layer 3),
 transport (layer 4),
session (layer 5),
presentation (layer 6)
, and application (layer 7).

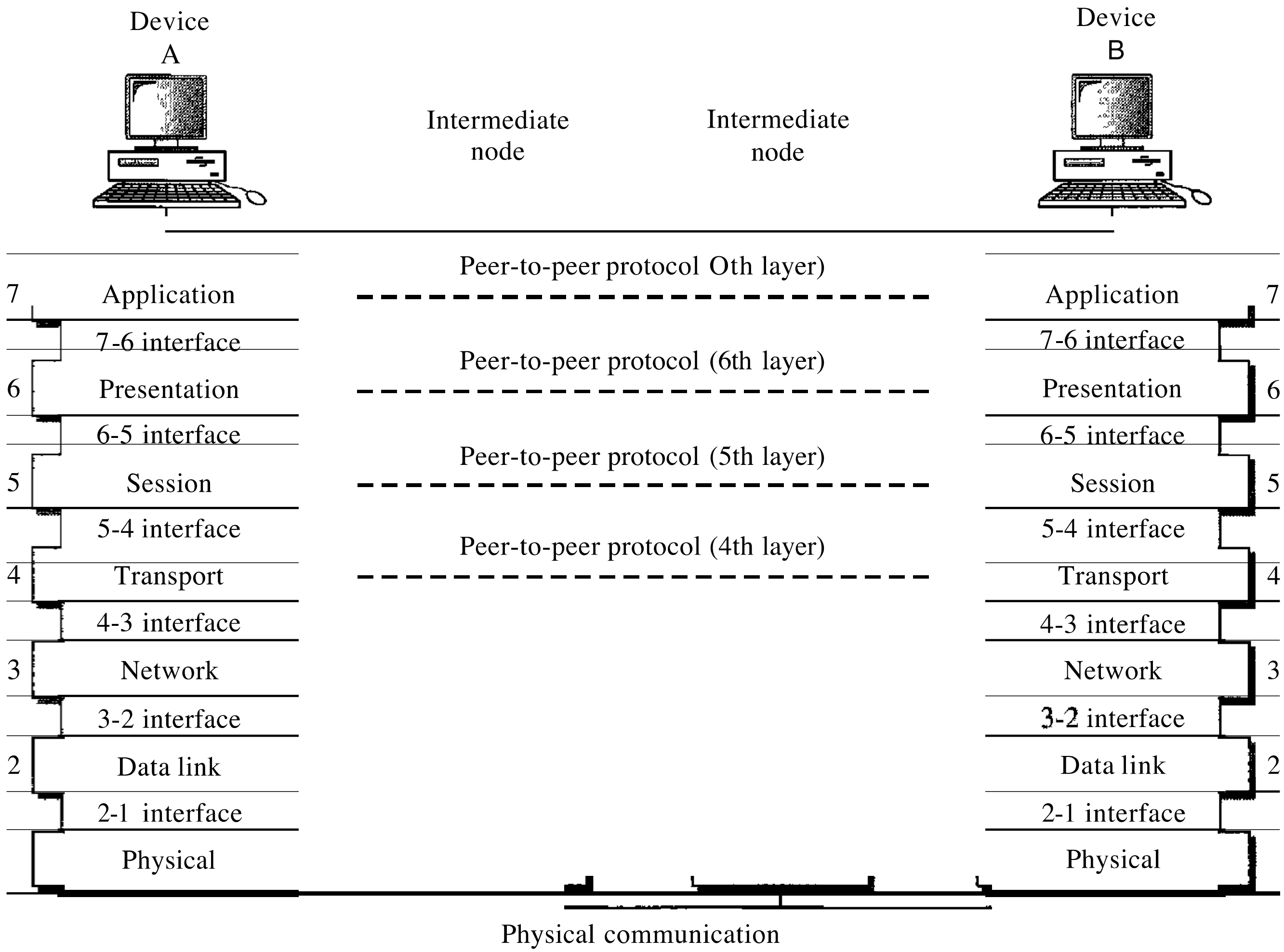
The OSI Model

Within a single machine, each layer calls the services of the layer just below it.

Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4.

Between machines, layer *x* on one machine communicates with layer *x* on another machine. This communication is governed by protocols.
The processes on each machine that communicate at a given layer are called peer-to-peer processes

The interaction between layers in the OSI model



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The interaction between layers in the OSI model

At the physical layer, communication is direct, device A sends a stream of bits to device B (through intermediate nodes). At the higher layers, however, communication must move down through the layers on device A, over to device B, and then back up through the layers. Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it.

The interaction between layers in the OSI model

Organization of the Layers:
The seven layers can be thought of as belonging to three subgroups:

- **Layers I, 2, and 3,**physical, data link, and network are the network support layers; they deal with the physical aspects of moving data from one device to another (such as electrical specifications, physical connections, physical addressing, and transport timing and reliability).
- **Layers 5, 6, and 7**-session, presentation, and application can be thought of as the user support layers; they allow interoperability among unrelated software systems.
- **Layer 4**, the transport layer, links the two subgroups and ensures that what the lower layers have transmitted is in a form that the upper layers can use.

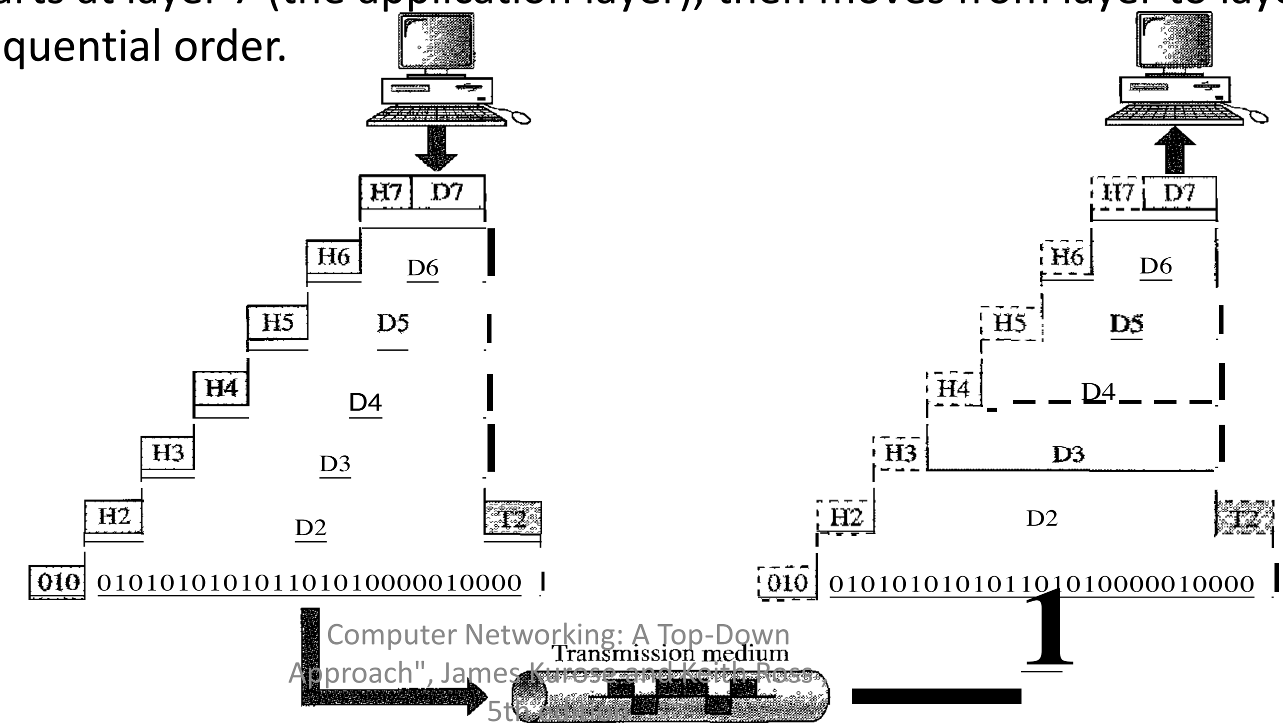
The upper OSI layers are almost always implemented in software.
The lower layers are a combination of hardware and software.

Adding headers and Encapsulation

At Sender Side:

*At each layer, a **header** can be added to the data unit.*

When the formatted data unit passes through the physical layer it is changed into an electromagnetic signal and transported along a physical link.
The process starts at layer 7 (the application layer), then moves from layer to layer in descending, sequential order.



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Adding headers and Encapsulation

At Receiver Side:

1. Upon reaching its destination, the signal passes into layer 1 and is transformed back into digital form.
2. The data units then move back up through the OSI layers.
3. As each block of data reaches the next higher layer, the headers attached to it at the corresponding sending layer are removed.
4. By the time it reaches layer 7, the message is again in a form appropriate to the application and is made available to the recipient.

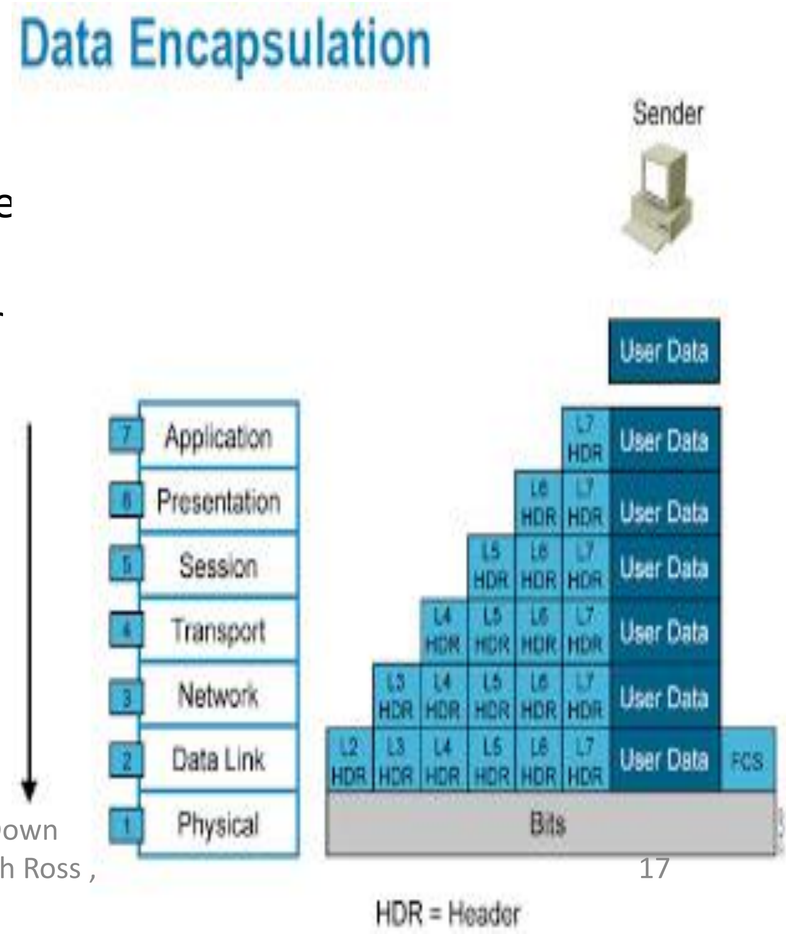
The process starts at layer 1 (the Physical layer), then moves from layer to layer in ascending, sequential order.

Encapsulation

Encapsulation **adds** data with the necessary protocol information before each OSI Model layer transits. As the data moves down through the layers of the OSI model, each OSI layer adds a header, if applicable) to the data before passing it down to a lower layer.

The following steps occur to encapsulate data:

Step 1 The user data is sent from an application to the application layer.
Step 2 The application layer adds the application layer header (Layer 7 header) to the user data.
The Layer 7 header and the original user data become the data that is passed down to the presentation layer.
Step 3 The presentation layer adds the presentation layer header (Layer 6 header) to the data.
This then becomes the data that is passed down to the session layer.



Encapsulation (2)

Step 4 The session layer adds the session layer header (Layer 5 header) to the data. This then becomes the data that is passed down to the transport layer.

Step 5 The transport layer adds the transport layer header (Layer 4 header) to the data. This then becomes the data that is passed down to the network layer.

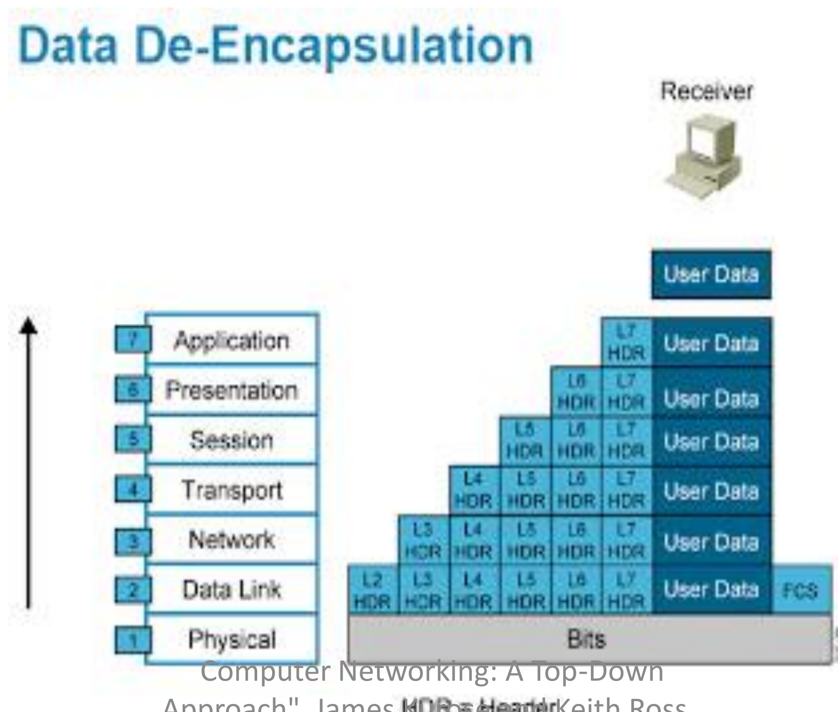
Step 6 The network layer adds the network layer header (Layer 3 header) to the data. This then becomes the data that is passed down to the data link layer.

Step 7 The data link layer adds the data link layer header and trailer (Layer 2 header and trailer) to the data. A Layer 2 trailer is usually the frame check sequence (FCS), which is used by the receiver to detect whether the data is in error. This then becomes the data that is passed down to the physical layer.

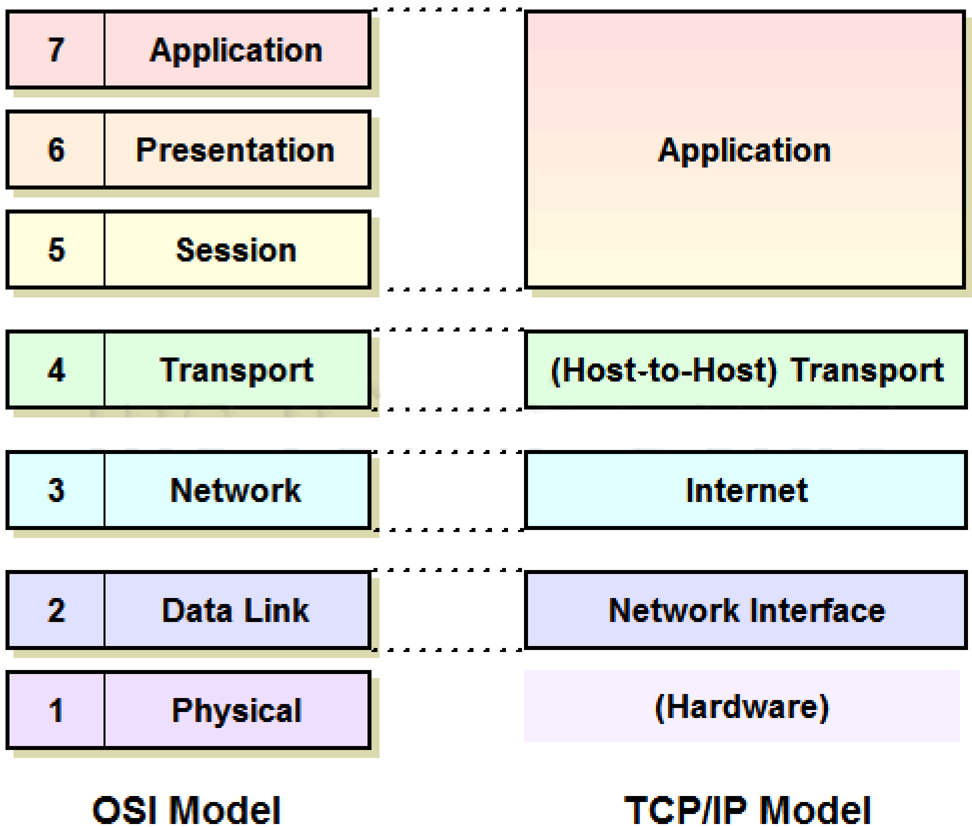
De-encapsulation

When the Receiver receives the date, each layer **removes** the header, and then passes the remaining data up to the network layer

This process is referred to as de-encapsulation. Each subsequent layer performs a similar de-ecapsulation process.



OSI vs. TCP/IP Model



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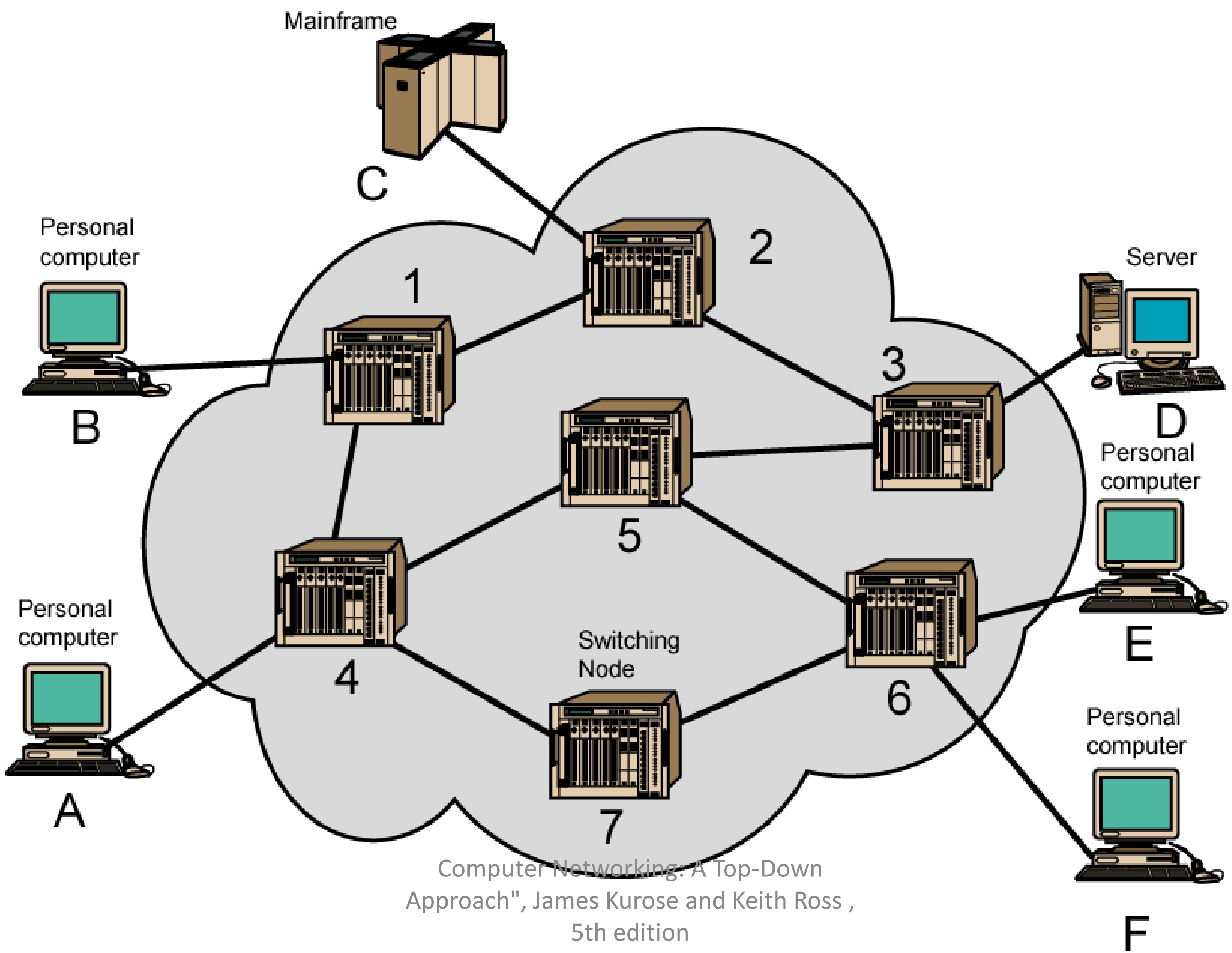
- Switched Communications Networks
- Network Devices

Simple Switching Network



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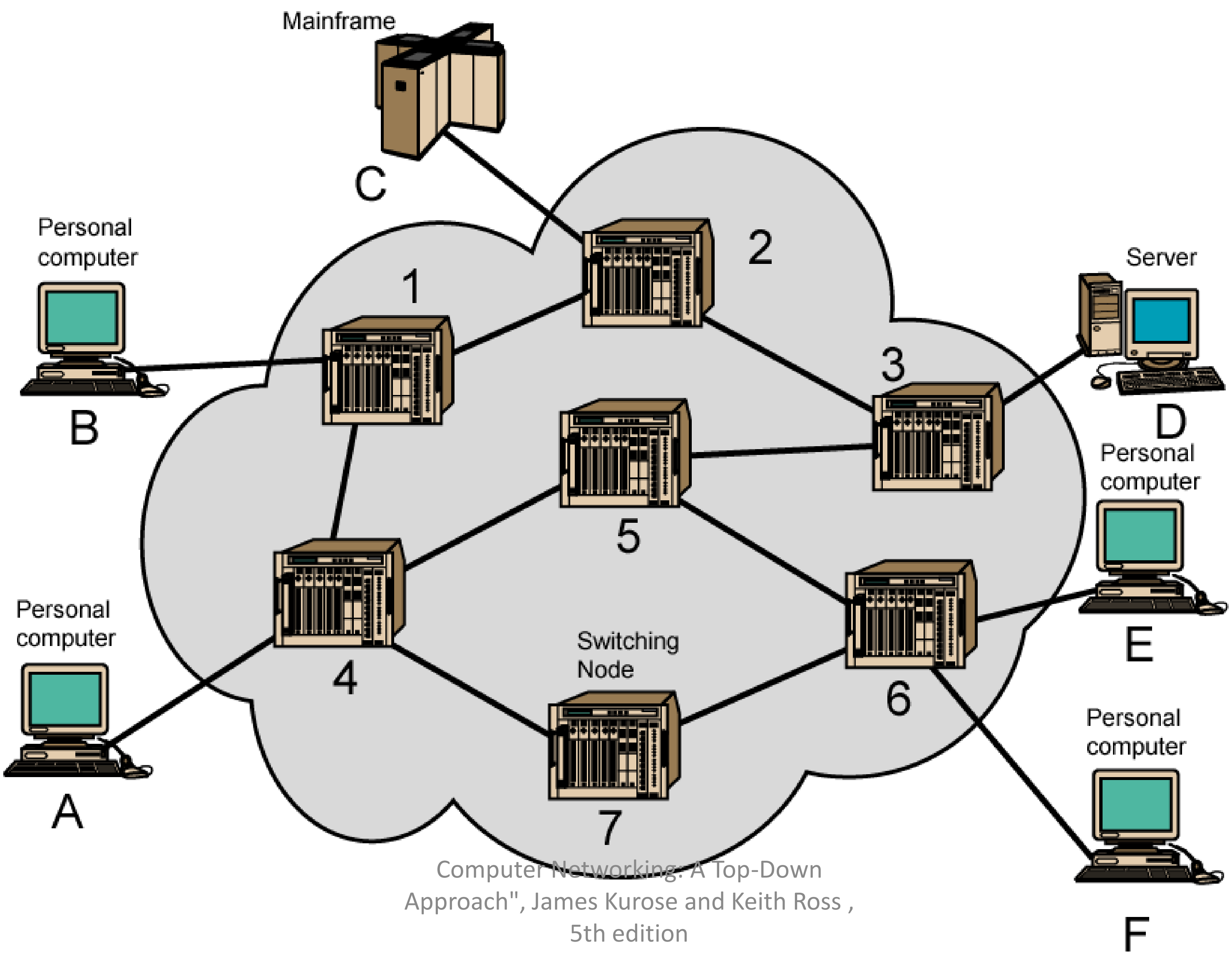
Switching Nodes

- Nodes may connect to other nodes, or to some stations.
- Two different switching technologies
  - Circuit switching
  - Packet switching

Circuit Switching

- Circuit switching:
  - There is a dedicated communication path between two stations (end-to-end)
  - The path is a connected sequence of links between network nodes. On each physical link, a logical channel is dedicated to the connection.
- Communication via circuit switching has three phases:
  - Circuit establishment (link by link)
  - Data transfer
  - Circuit disconnect

Simple Switching Network



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Circuit Switching Properties

- 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) but can also applied to data traffic.
  - 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.
  - But how about data connections?

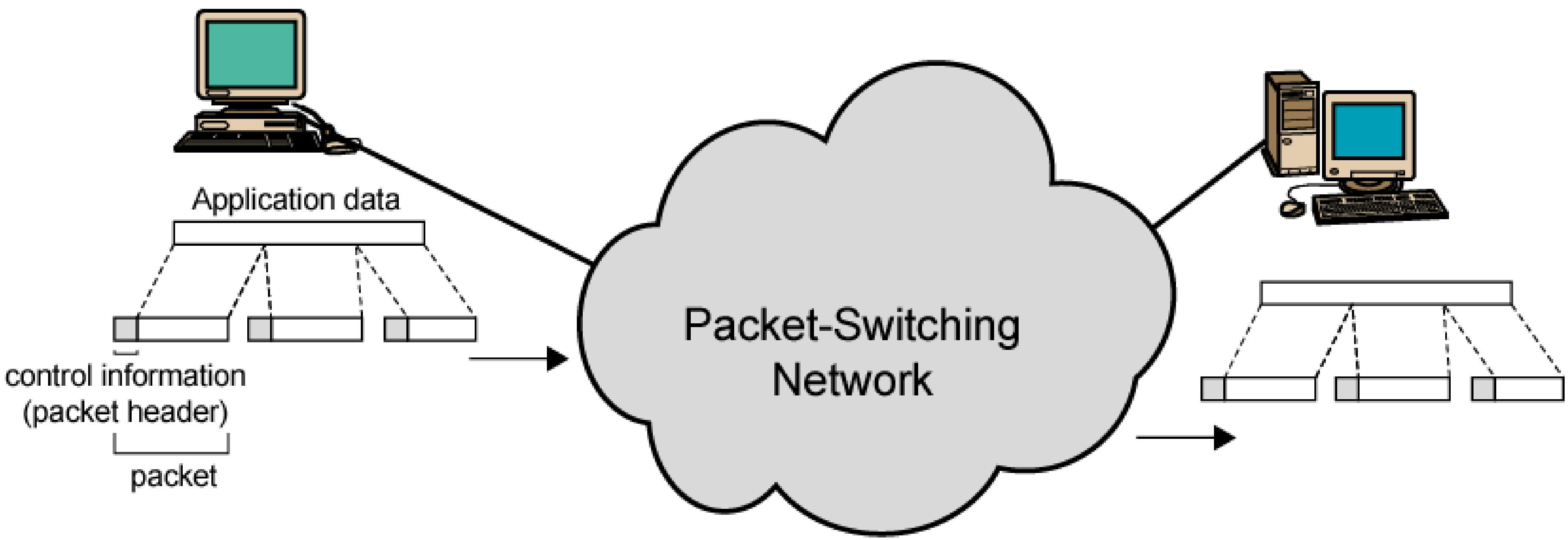
Packet Switching

- Problem of circuit switching
  - designed for voice service
  - Resources dedicated to a particular call
  - For data transmission, much of the time the connection is idle (say, web browsing)
  - Data rate is fixed
- Packet switching is designed to address these problems.

Basic Operation

- Data are transmitted in short packets
  - Typically at the order of 1000 bytes
  - Longer messages are split into series of packets
  - Each packet contains a portion of user data plus some control info
- Control info contains at least
  - Routing (addressing) info, so as to be routed to the intended destination
  - Recall the content of an IP header!
- **store and forward**
  - On each switching node, packets are received, stored briefly (buffered) and passed on to the next node.

Use of Packets



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Advantages of Packet Switching

- Line efficiency
  - Single node-to-node link can be dynamically shared by many packets over time
  - Packets are queued up and transmitted as fast as possible
- Data rate conversion
  - Each station connects to the local node at its own speed
- In circuit-switching, a connection could be blocked if there lacks free resources. On a packet-switching network, even with heavy traffic, packets are still accepted, by delivery delay increases.
- Priorities can be used
  - On each node, packets with higher priority can be forwarded first. They will experience less delay than lower-priority packets.

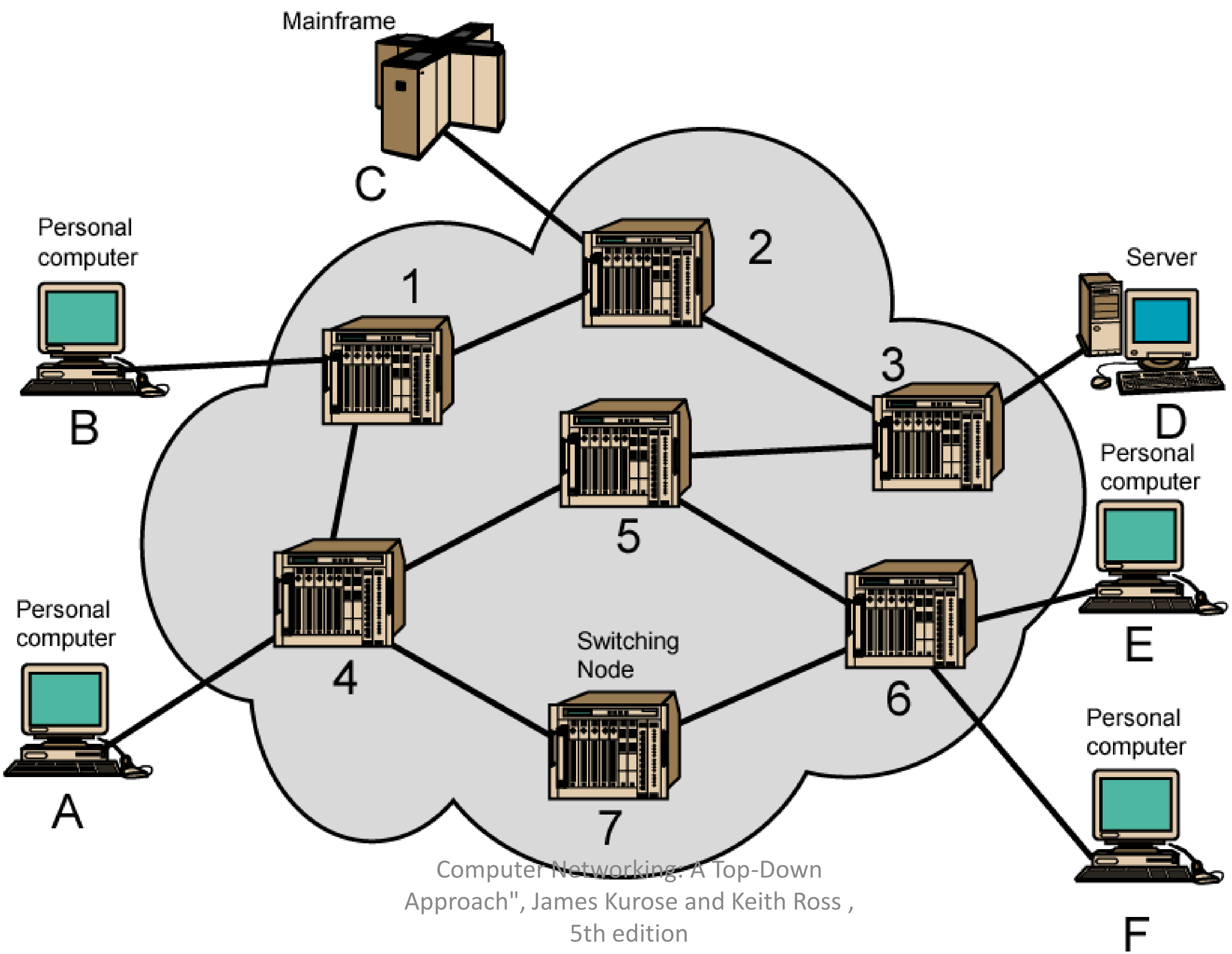
Packet Switching Technique

- A station breaks long message into packets
- Packets are sent out to the network sequentially, one at a time
- How will the network handle this stream of packets as it attempts to route them through the network and deliver them to the intended destination?
  - Two approaches
    - **Datagram** approach
    - **Virtual circuit** approach

Datagram

- Each packet is treated independently, with no reference to packets that have gone before.
  – Each node chooses the next node on a packet's path.
- Packets can take any possible route.
- Packets may arrive at the receiver out of order.
- Packets may go missing.
- It is up to the receiver to re-order packets and recover from missing packets.
- Example: Internet

Simple Switching Network



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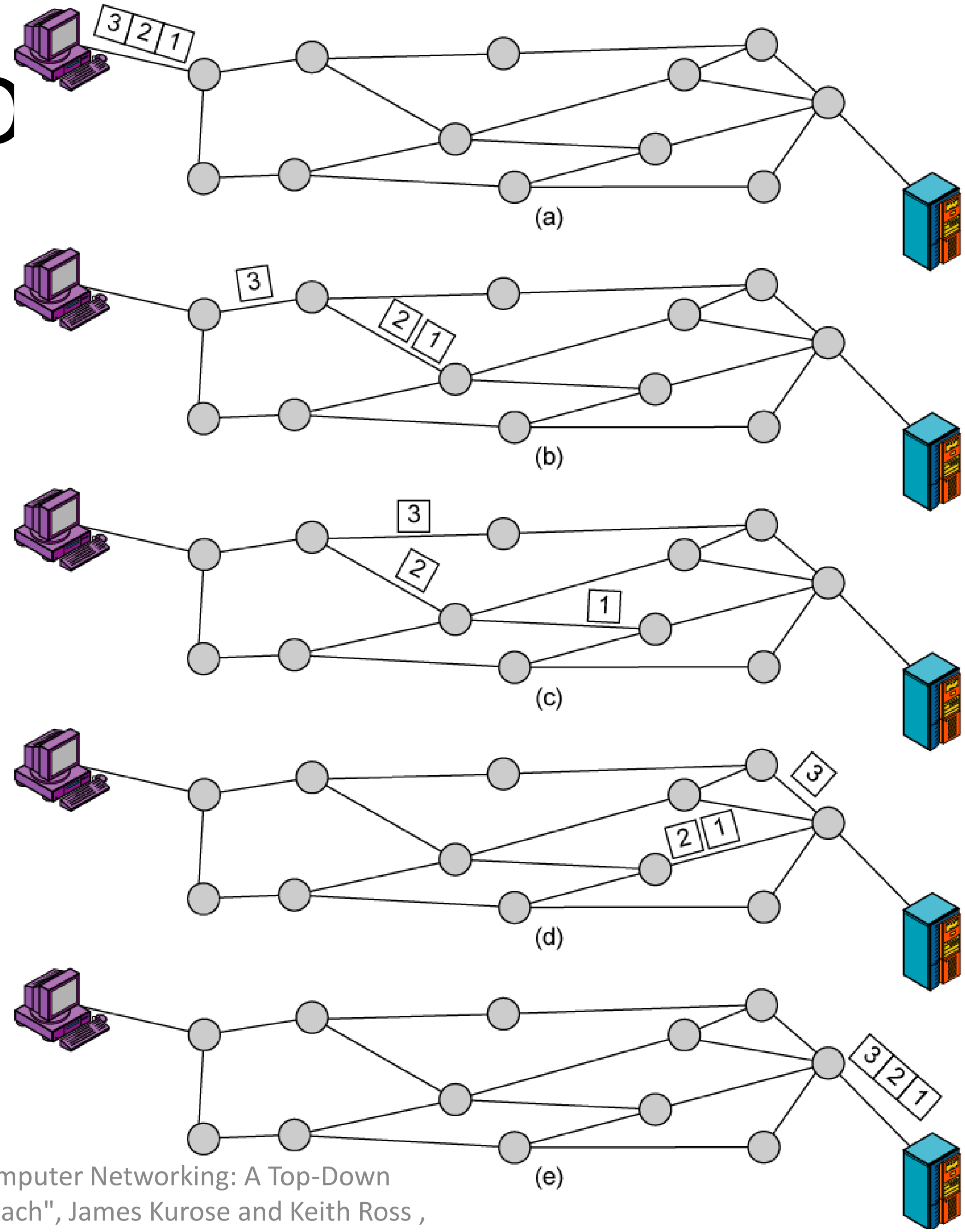

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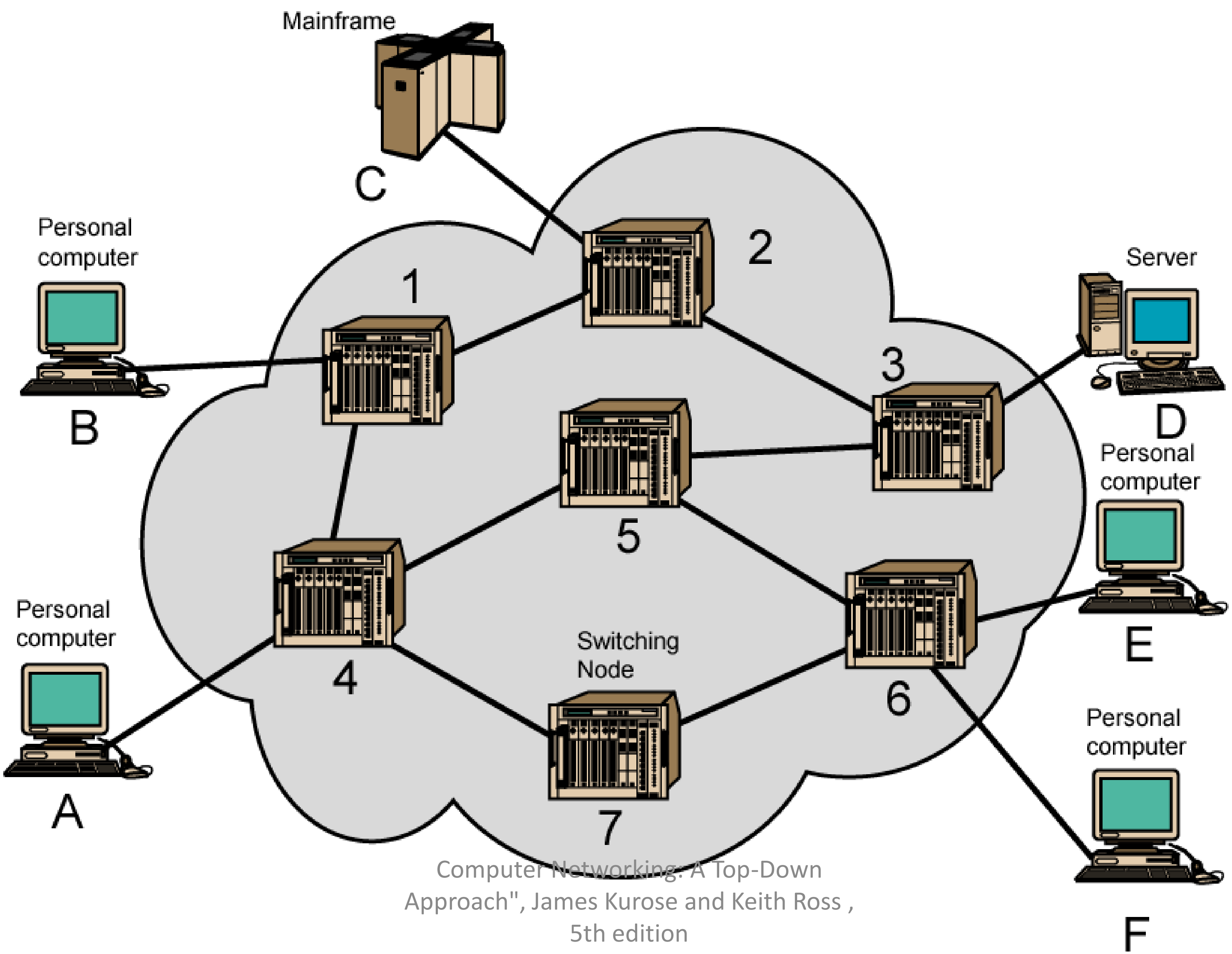
Virtual Circuit

- In virtual circuit, a preplanned route is established before any packets are sent, then all packets follow the same route.
- Each packet contains a **virtual circuit identifier** instead of destination address, and each node on the preestablished route knows where to forward such packets.
  - The node need not make a routing decision for each packet.
- Example: X.25, Frame Relay, ATM

Simple Switching Network



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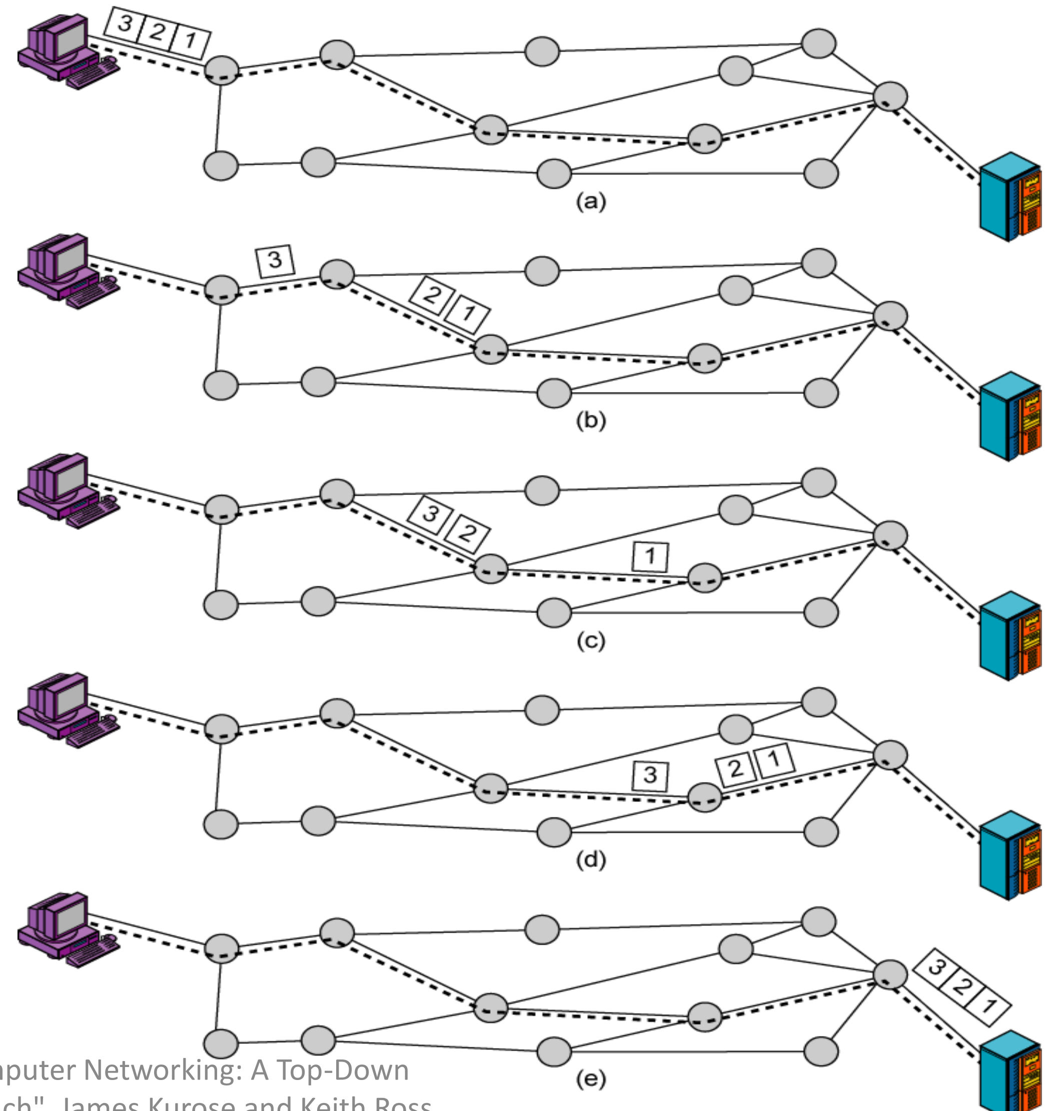
Virtual Circuit

A route between stations is set up prior to data transfer.

All the data packets then follow the same route.

But there is no dedicated resources reserved for the virtual circuit! Packets need to be stored-and-forwarded.



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Virtual Circuits v Datagram

- Virtual circuits
  - Network can provide sequencing (packets arrive at the same order) and error control (retransmission between two nodes).
  - Packets are forwarded more quickly
    - Based on the virtual circuit identifier
    - No routing decisions to make
  - Less reliable
    - If a node fails, all virtual circuits that pass through that node fail.
- Datagram
  - No call setup phase
    - Good for bursty data, such as Web applications
  - More flexible
    - If a node fails, packets may find an alternate route
    - Routing can be used to avoid congested parts of the network