Carrying Out God's Dominion Through IoT

CALVIN INSTITUTE OF TECHNOLOGY

Computer Networks

(IEE 3112 & IBDA2022 – Jaringan Komputer)

Lecture #05 -- TCP/IP Protocol Suite

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Agenda / Learning Objectives

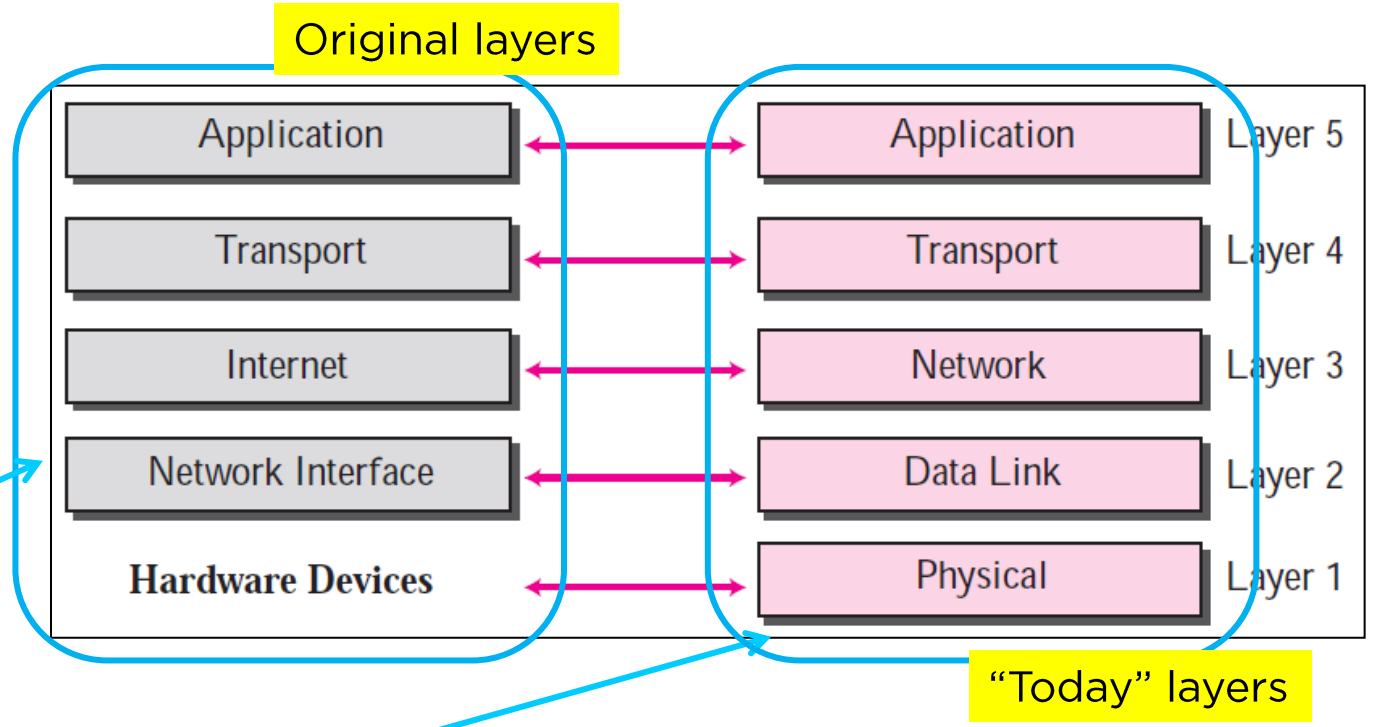
- Understanding five layers of TCP/IP Protocol Suite

PART 1: TCP/IP Protocol Suite

Layers in TCP/IP Protocol Suite

- The **TCP/IP protocol suite** was developed prior to the OSI model, thus these layers do not match exactly with those in the OSI model.

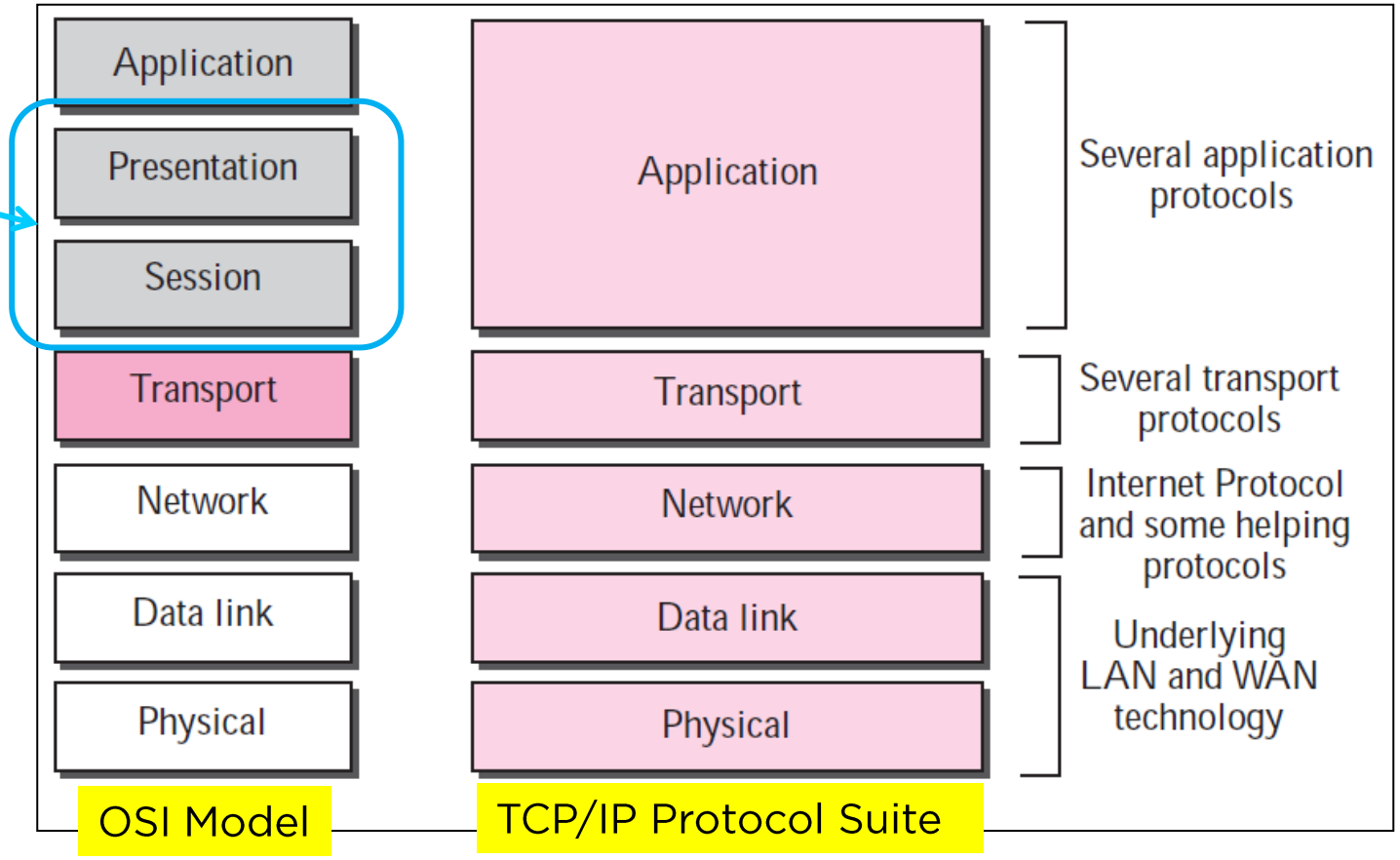
- The original TCP/IP protocol suite was defined as four software layers built upon the hardware.



- Today, however, TCP/IP is thought of as a five-layer model with the layers named similarly to the ones in the OSI model.

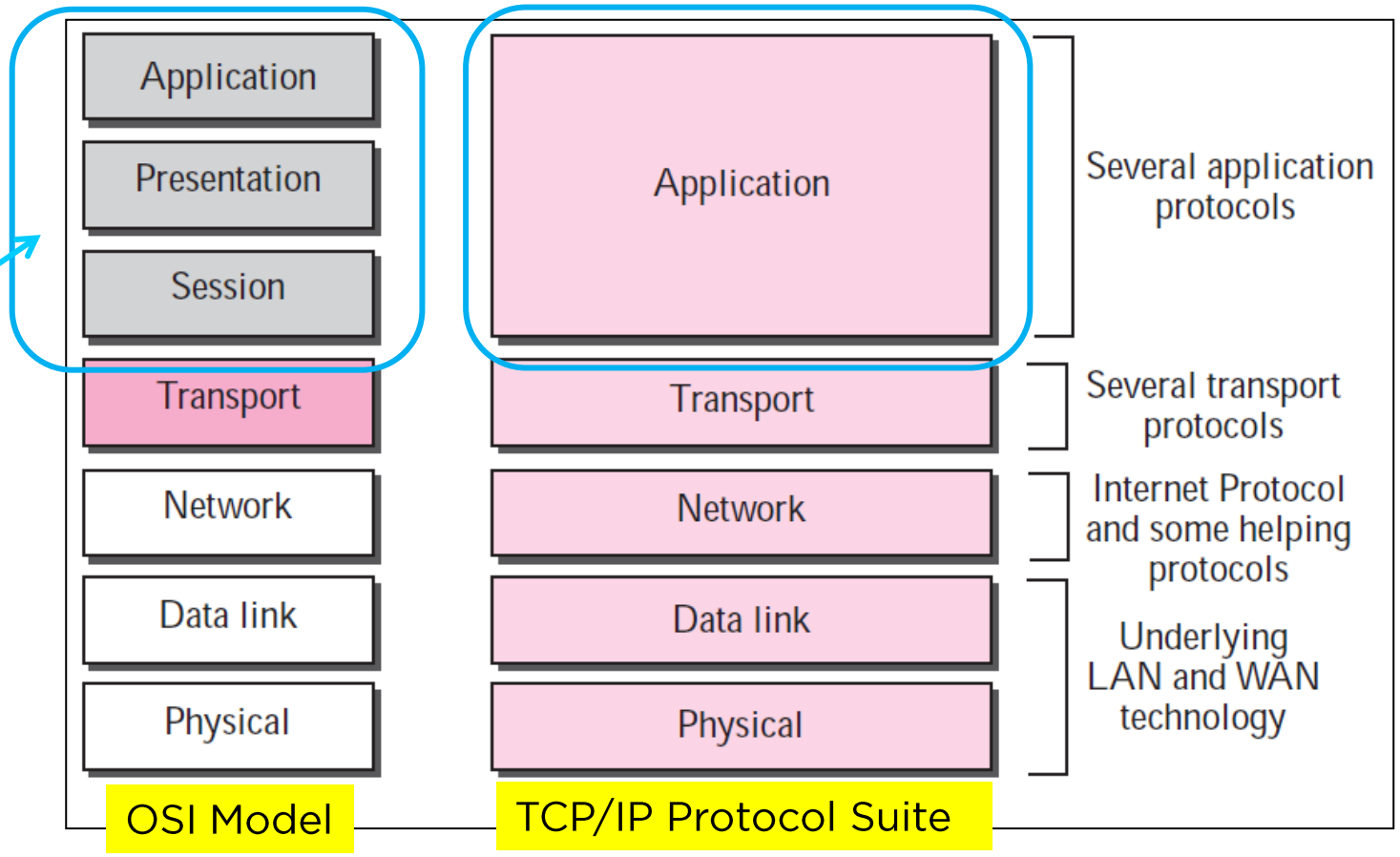
OSI vs. TCP/IP Model (1/5)

- Note that the two layers, Session and Presentation, are missing from the TCP/IP Protocol Suite.
- These two layers were not added to the TCP/IP protocol suite after the publication of the OSI Model.



OSI vs. TCP/IP Model (2/5)

- The application layer in the suite is usually considered to be the combination of three layers in the OSI Model.

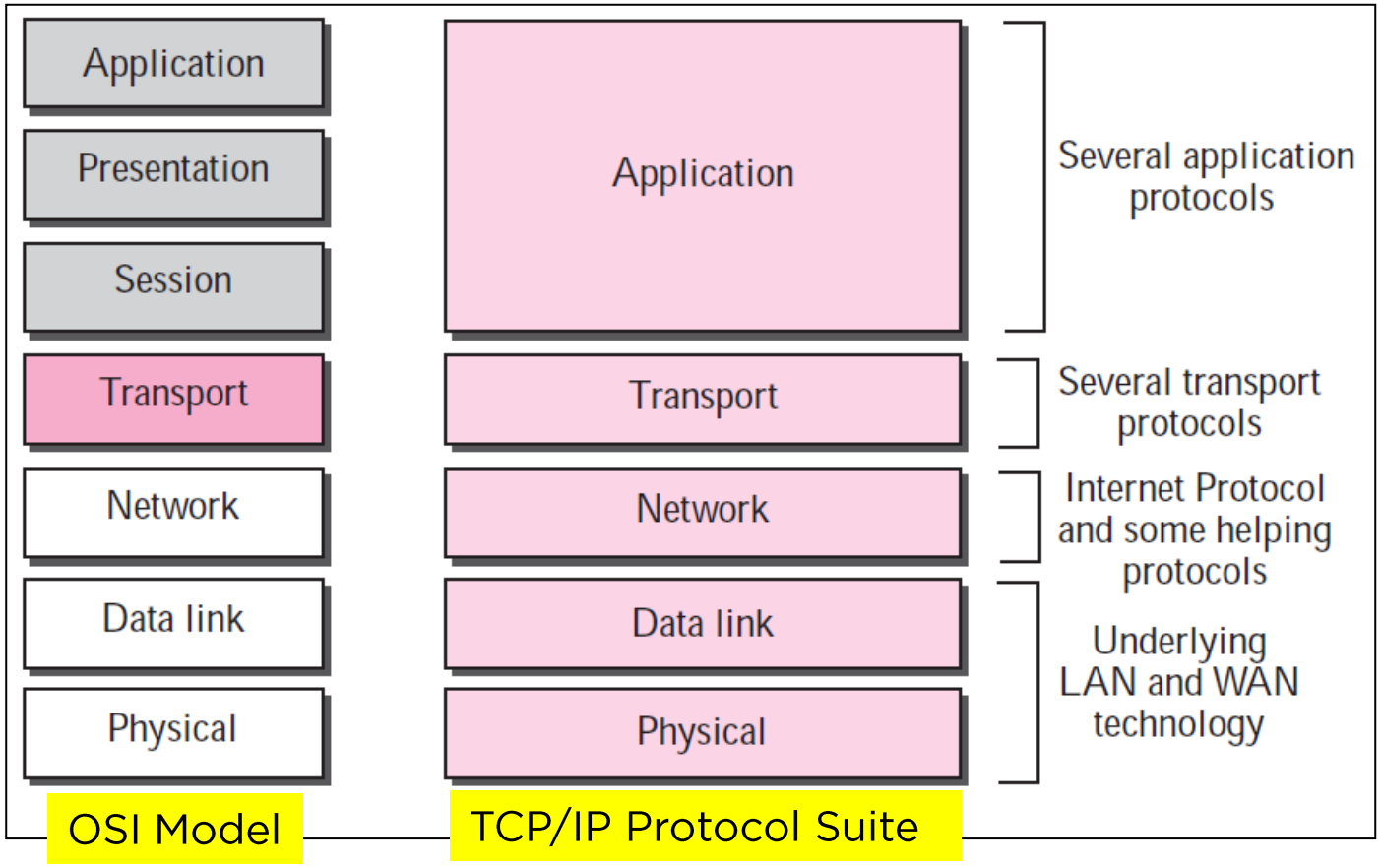


OSI vs. TOCP/IP Model (3/5)

Why?

- First, TCP/IP has more than one transport-layer protocol!
  - Some of the functionalities of the Session Layer are available in some of the Transport Layer protocols.

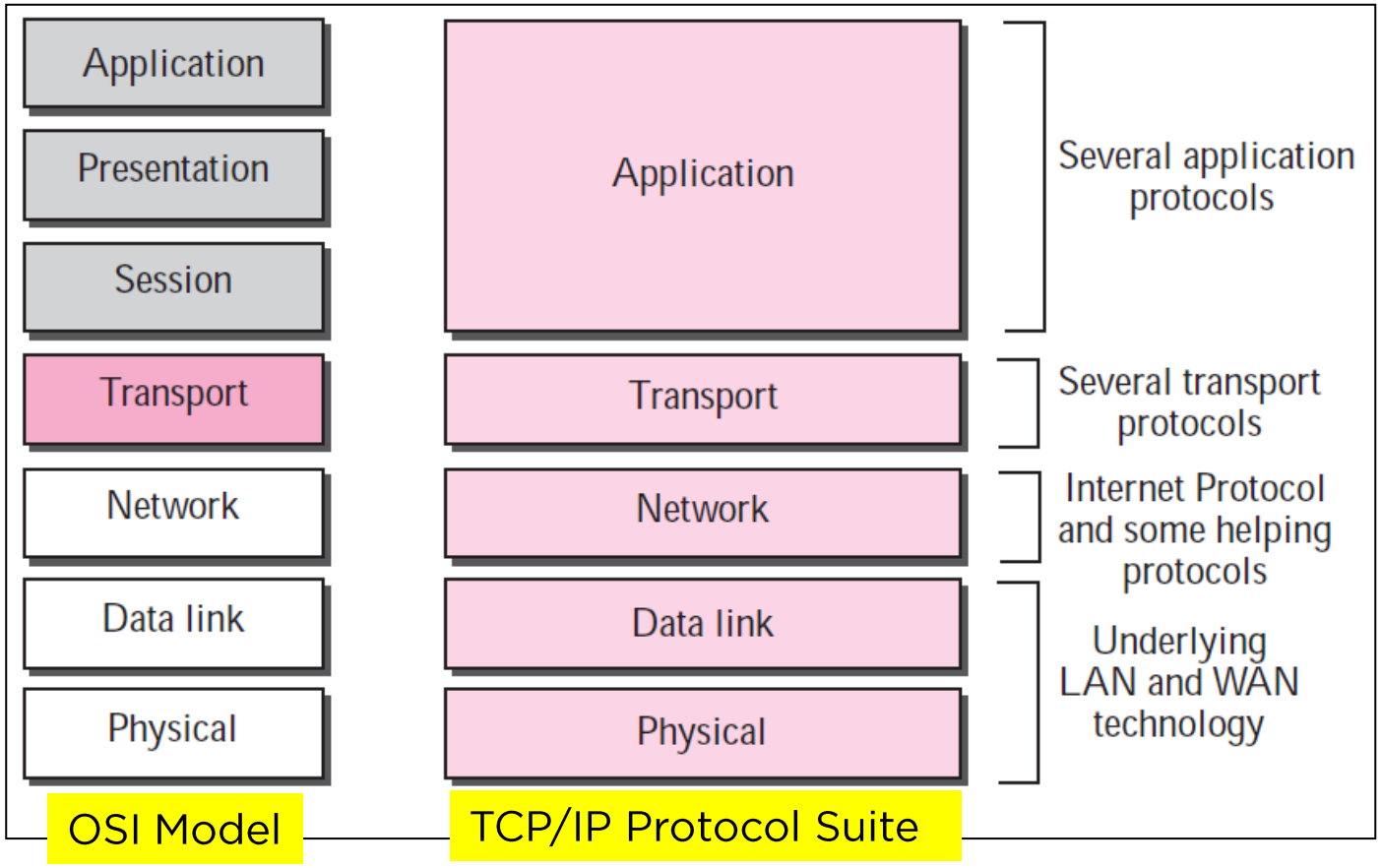
- Second, the Application Layer is not only one piece of software.
  - Many applications can be developed at this layer.
  - If some of the functionalities mentioned in the Session and Presentation Layers are needed for a particular application, it can be included in the development of that piece of software.



OSI vs. TCP/IP Model (4/5)

- TCP/IP is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality, but the modules are not necessarily interdependent.
  - The term *hierarchical* means that each upper level protocol is supported by one or more lower level protocols

- Whereas the OSI model specifies which functions belong to each of its layers, the layers of the TCP/IP protocol suite contain relatively independent protocols that can be mixed and matched, depending on the needs of the system.



OSI vs. TCP/IP Model (5/5)

- As mentioned, the OSI Model appeared after the TCP/IP protocol suite.
- Most experts were at first excited and thought that the TCP/IP protocol would be fully replaced by the OSI model.

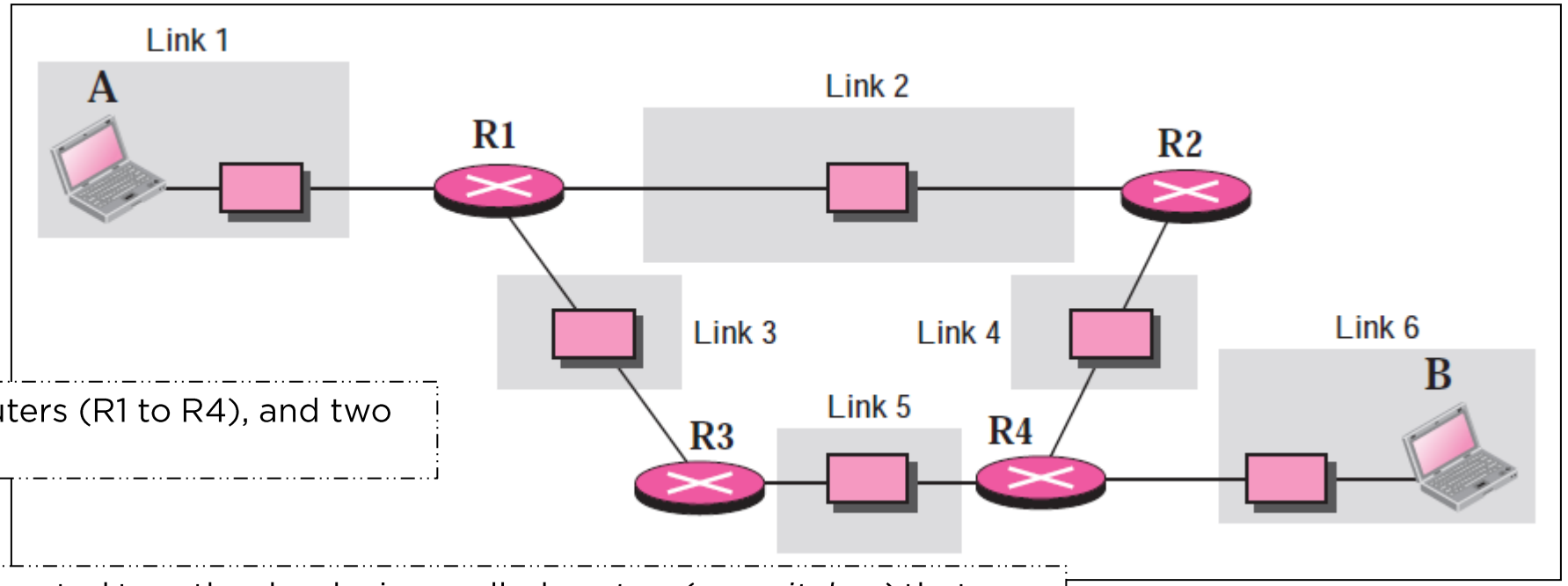
- But this did not happen for several reasons . . .
  - First, OSI was completed when TCP/IP was fully in place; and a lot of time and money had been spent on the suite; changing it would **cost** a lot!
  - Second, some layers in the OSI Model were **never fully defined**.
    - For example, although the services provided by the presentation and the session layers were listed in the document, actual protocols for these two layers were not fully defined, nor were they fully described, and the corresponding software was not fully developed.
  - Third, when OSI was implemented by an organization in a different application, it did not show a high enough **level of performance** to entice the Internet authority to switch from the TCP/IP protocol suite to the OSI model

Part 2: TCP/IP Protocol Suite Layers

Our TCP/IP Link

- Case of private internet of TCP/IP link:

A **link** is a network (LAN or WAN) that allows a set of computers to communicate with each other.



We have six links, four routers (R1 to R4), and two computers, A and B.

Different links can be connected together by devices called *routers* (or *switches)* that route the data to reach their final destinations

PHYSICAL Layer

- TCP/IP does not define any specific protocol for the Physical Layer; it supports all of the standard and proprietary protocols.

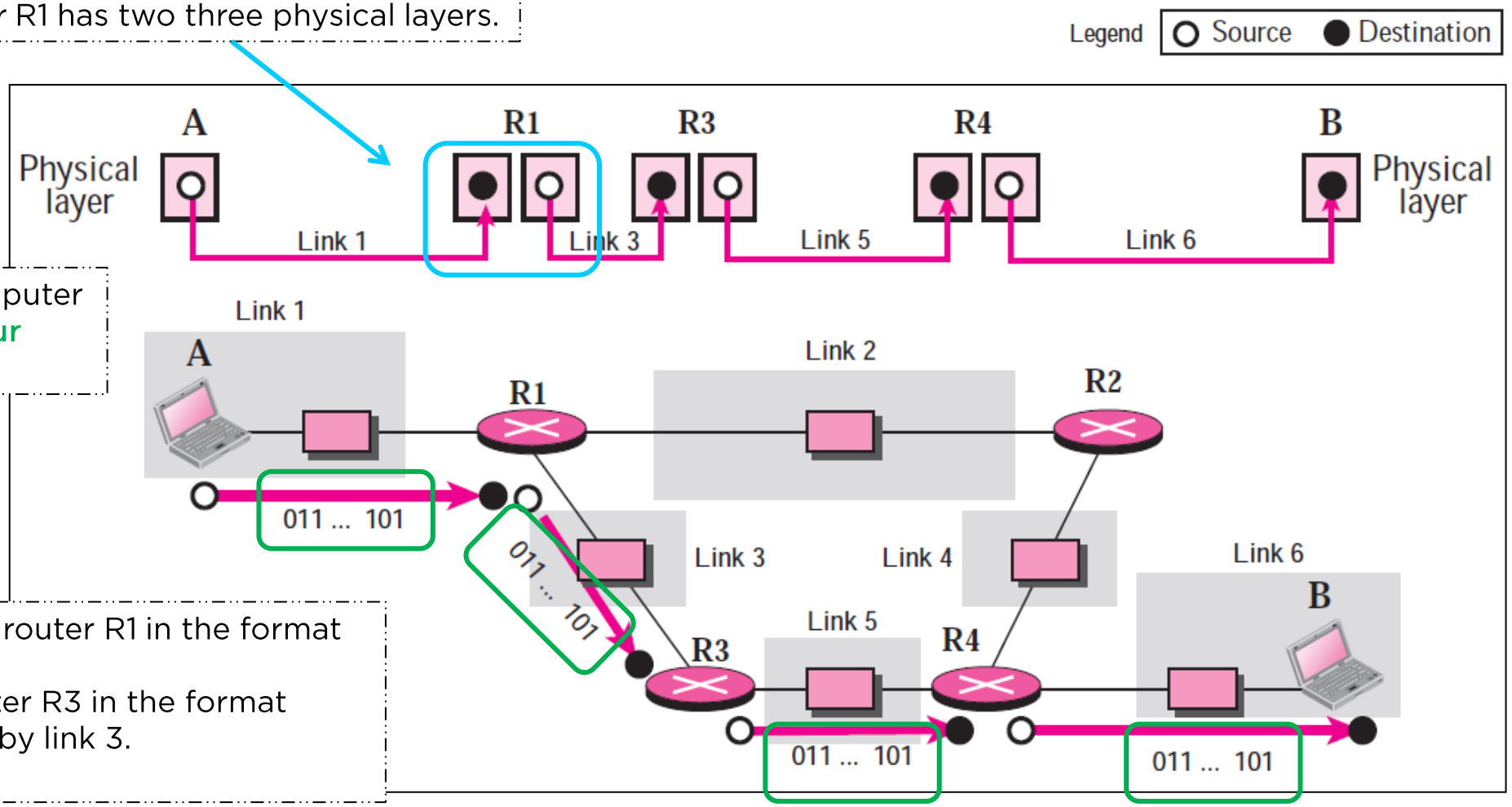
- The communication is between two hops or nodes, either a computer or router.

- The unit of communication is a single bit.
  - When the connection is established between the two nodes, a stream of bits is flowing between them.
  - The physical layer, however, treats each bit individually.

Communication at the PHYSICAL Layer

- We are assuming the two computers have discovered the most efficient way to communicate with each other is via routers R1, R3, and R4

Router R1 has two three physical layers.



The journey of bits between computer A and computer B is made of four independent short trips.

- Computer A sends each bit to router R1 in the format of the protocol used by Link 1.
- Router 1 sends each bit to router R3 in the format dictated by the protocol used by link 3.
- And so on

DATA-LINK Layer

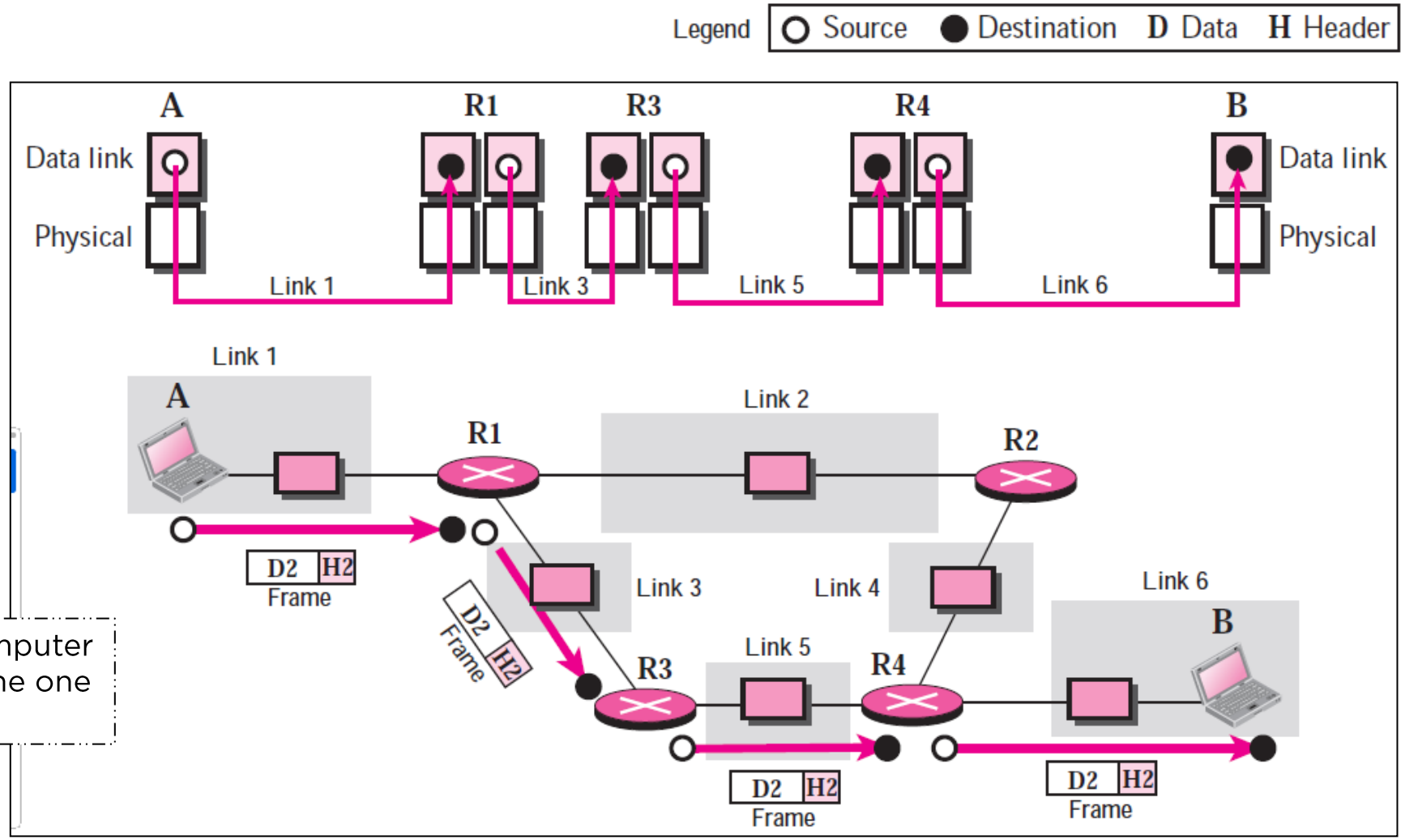
- TCP/IP does not define any specific protocol for the Data-Link Layer; it supports all of the standard and proprietary protocols.

- At this level, the communication is also between two hops or nodes.

- The unit of communication however, is a packet called a frame.
  - A frame is a packet that encapsulates the data received from the network layer with an added header and sometimes a trailer.

- The head, among other communication information, includes the source and destination of frame.
  - The source address is needed for possible response or acknowledgment (ACK), as may be required by some protocols.
  - The destination address is needed to define the right recipient of the frame because many nodes may have been connected to the link.

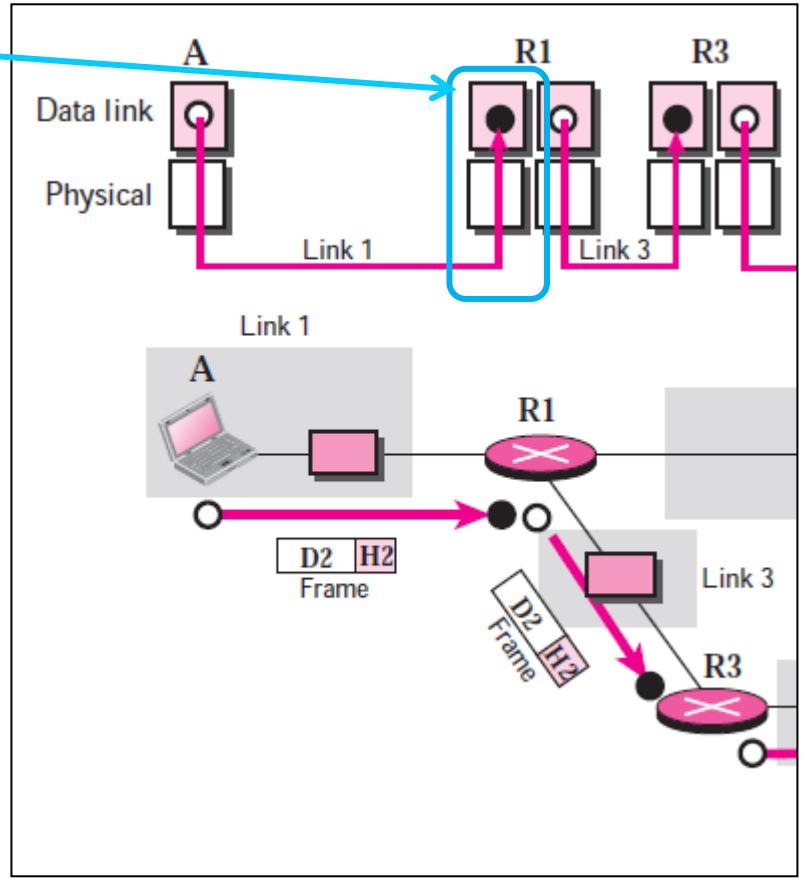
Communication at the DATA-LINK Layer



The frame that is travelling between computer A and router R1 may be different from the one travelling between router R1 and R3.

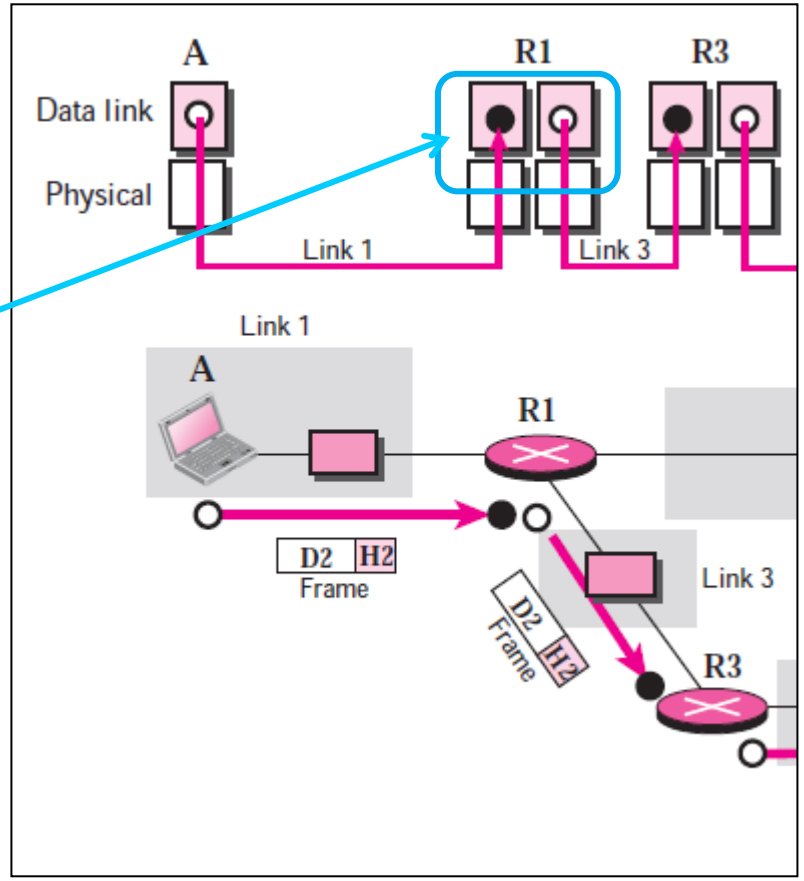
(1/3)

- When the frame is received by Router R1, it passes the frame to the Data-Link Layer protocol at the left.



(2/3)

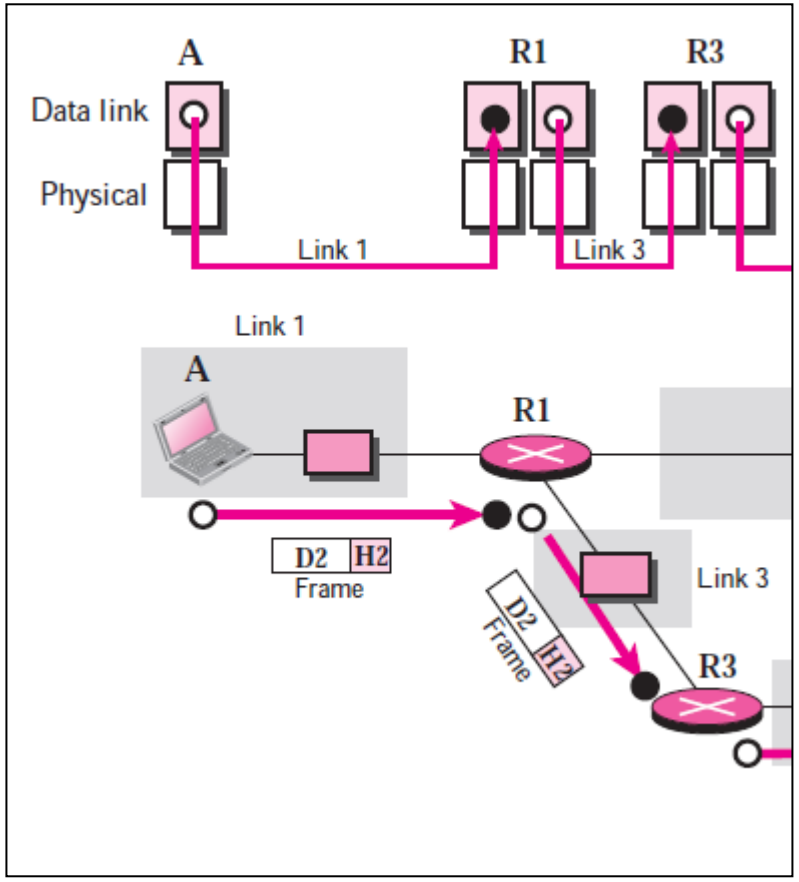
- The frame is opened, the data are removed.
- The data are then passed to the Data-Link Layer protocol at the right, to create a new frame to be sent to the router R3.
- The reason is that the two links, *link-1* and *link-3*, may be using different protocols and require frames of different formats.



(3/3)

- The two nodes communicate logically at the data link layer, not physically.

- In other words, the Data-Link layer at router R1 only *thinks* that a frame has been sent directly from the Data-Link layer at computer A.
  - What is sent from A to R1 is a stream of bits from one physical layer to another.
  - Since a frame at A is transformed to a stream of bits, and the bits at R1 are transformed to a frame, it gives this impression to the two Data-Link layer that a frame has been exchanged.



NETWORK Layer

- At the network layer (or, more accurately, the internetwork layer), TCP/IP supports the **Internet Protocol (IP)**.

- The Internet Protocol (IP) is the transmission mechanism used by the TCP/IP protocols. IP transports data in packets called **datagrams**, each of which is transported separately.

- Datagrams can travel along different routes and can arrive out of sequence or be duplicated.
  - IP **does not** keep track of the routes, and has **no** facility for reordering datagrams once they arrive at their destination.

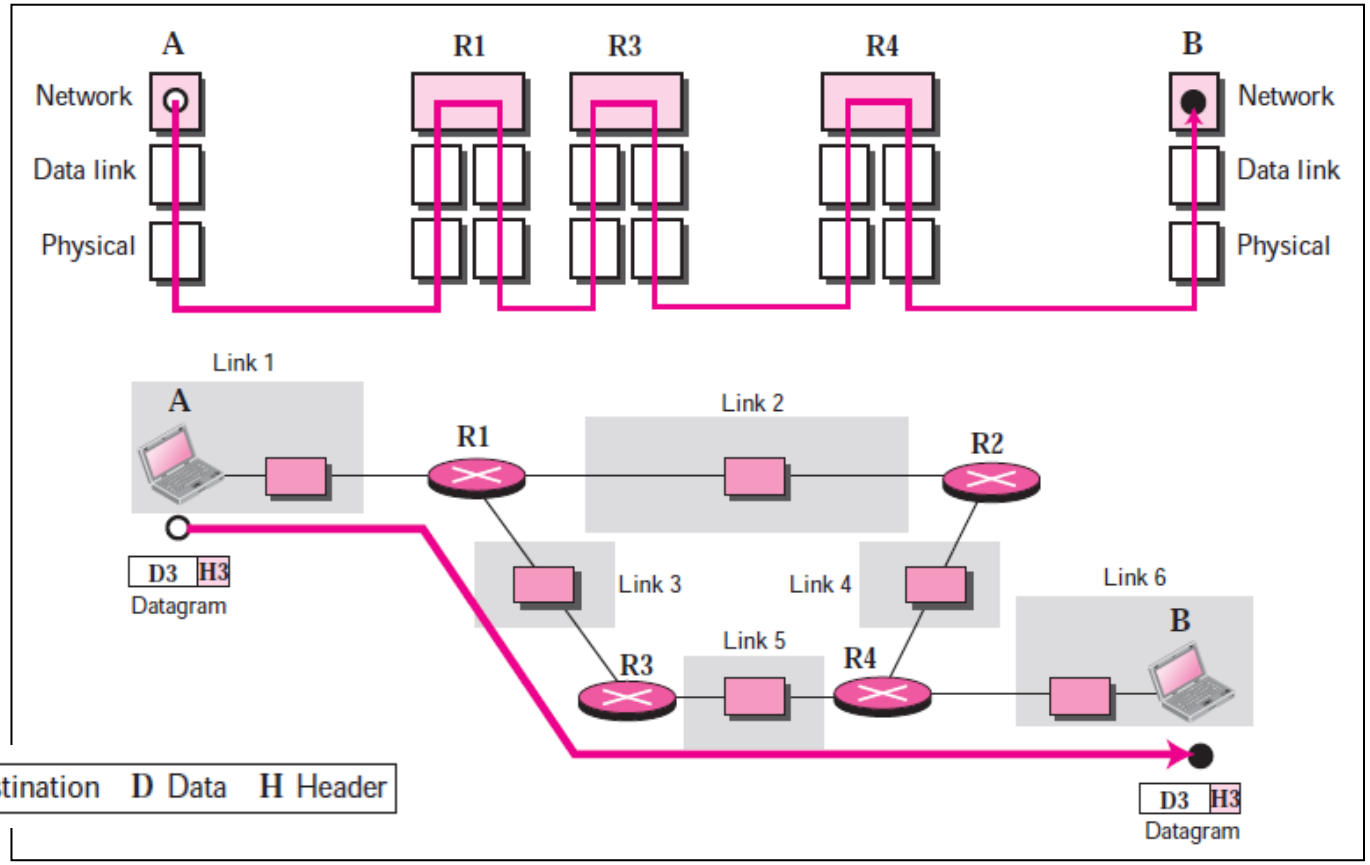
- Note that there is a main difference between the communication at the Network Layer and Data-Link/Physical Layers!
  - Communication at the Network Layer is end-to-end; while the communication at the other two layers are node-to-node.

Communication at the NETWORK Layer

- The datagram started at computer A is the one that reaches computer B.

- The Network Layers of the routers can inspect the source and destination of the packet for finding the best route, **but** they are not allowed to change the contents of the packet.

- Again, the communication is logical, not physical.
  - Network Layer of computer A and B *think* that they are sending and receiving datagrams, but the actual communication again is done at the physical level.



TRANSPORT Layer

- There is a main difference between the Transport layer and the Network layer.
  - Although all nodes in a network need to have the Network Layer, only the two end computers need to have the Transport Layer.

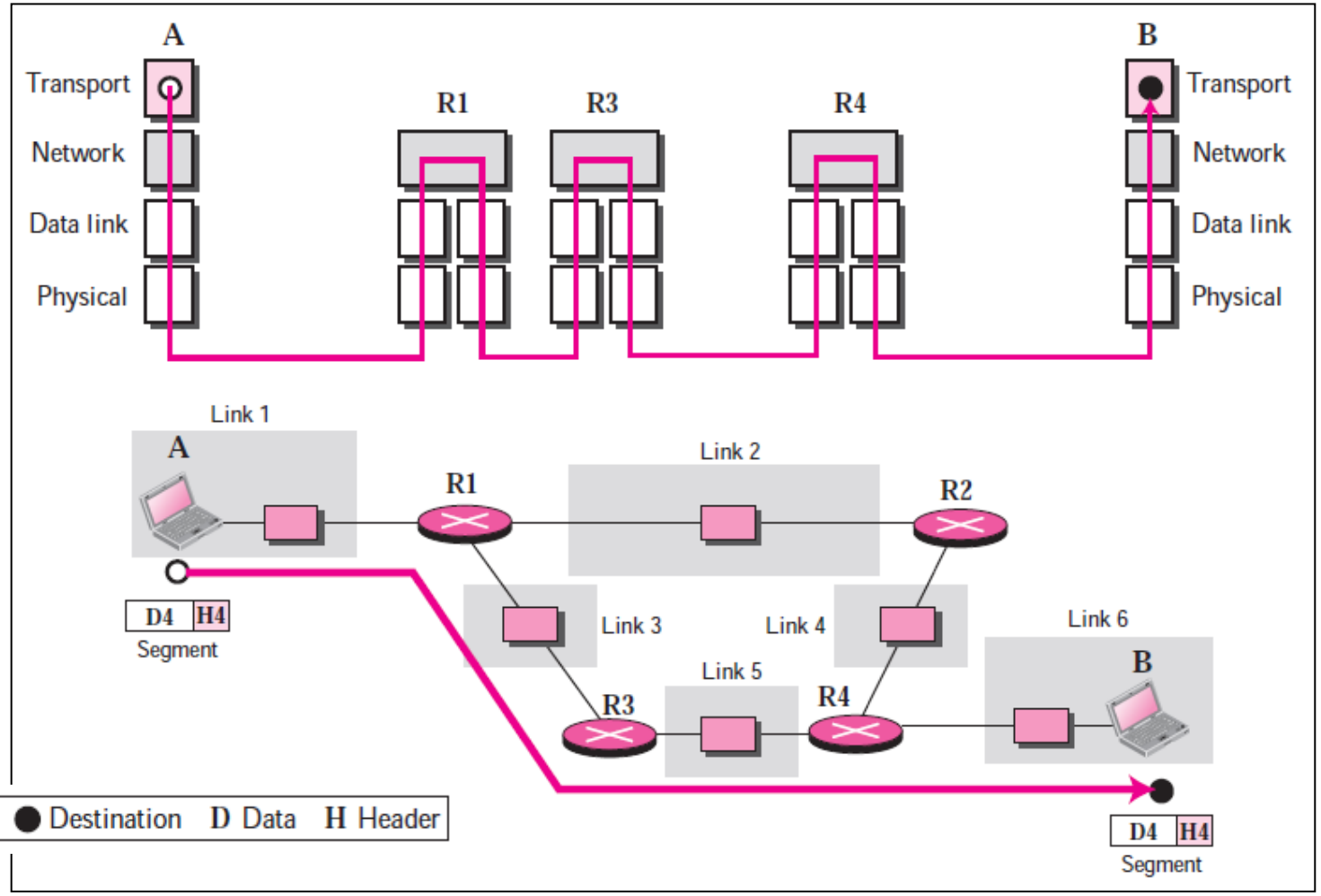
- The Network Layer is responsible for sending individual datagrams from computer A to computer B; while the Transport Layer is responsible for delivering the whole message, which is called a segment, from A to B.
  - A segment may consist of a few or tens of datagrams.
  - The segments need to be broken into datagrams and each datagram has to be delivered to the network layer for transmission.

- Since the Internet defines a different route for each datagram, the datagrams may arrive out of order and may be lost.
  - The Transport Layer at computer B needs to wait until all of these datagrams to arrive, assemble, then make a segment out of them.

Communication at the TRANSPORT Layer

- Again, we should know that the two transport layers only think that they are communicating with each other using a segment; the communication is done through the physical layer and the exchange of bits.

- Traditionally, the transport layer was represented in the TCP/IP suite by two protocols: User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).
  - A new protocol called Stream Control Transmission Protocol (SCTP) has been introduced in the last few years.

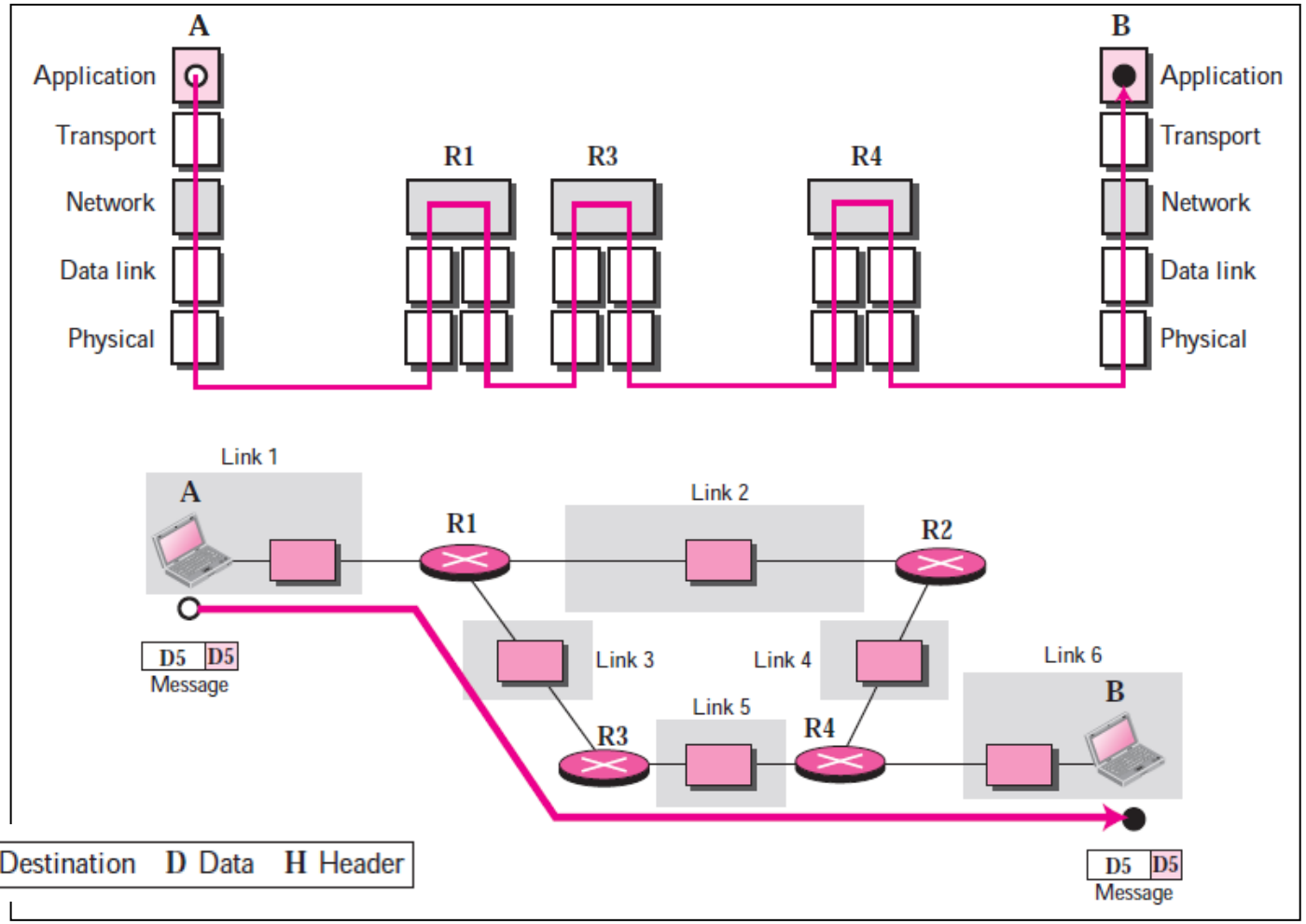


APPLICATION Layer

- The application layer in TCP/IP is equivalent to the combined session, presentation, and application layers in the OSI model.
- The application layer allows a user to access the services of our private internet or the global Internet.
- Many protocols are defined at this layer to provide services such as electronic mail, file transfer, accessing the World Wide Web, and so on.

Communication at the APPLICATION Layer

- Note that the communication at the Application Layer, like the one at the Transport Layer, is end to end.
- A message generated at computer A is sent to computer B without being changed during the transmission.
- The unit of communication at the application layer is a message.



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