



TCP/IP PROTOCOL SUITE

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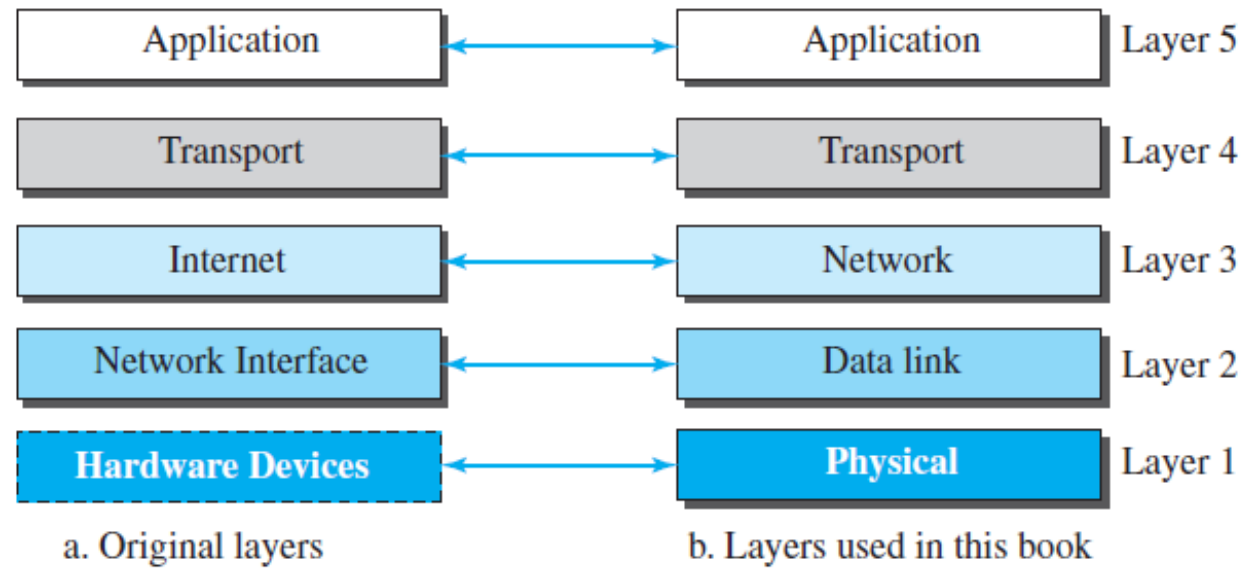
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INTRODUCTION

- TCP/IP (Transmission Control Protocol/Internet Protocol).
- TCP/IP is a protocol suite (a set of protocols organized in different layers) used in the Internet today.
- It is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality.
- The term hierarchical means that each upper level protocol is supported by the services provided by one or more lower level protocols.
- 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.

LAYERS IN THE TCP/IP PROTOCOL SUITE

Figure 2.4 *Layers in the TCP/IP protocol suite*



COMMUNICATION THROUGH AN INTERNET

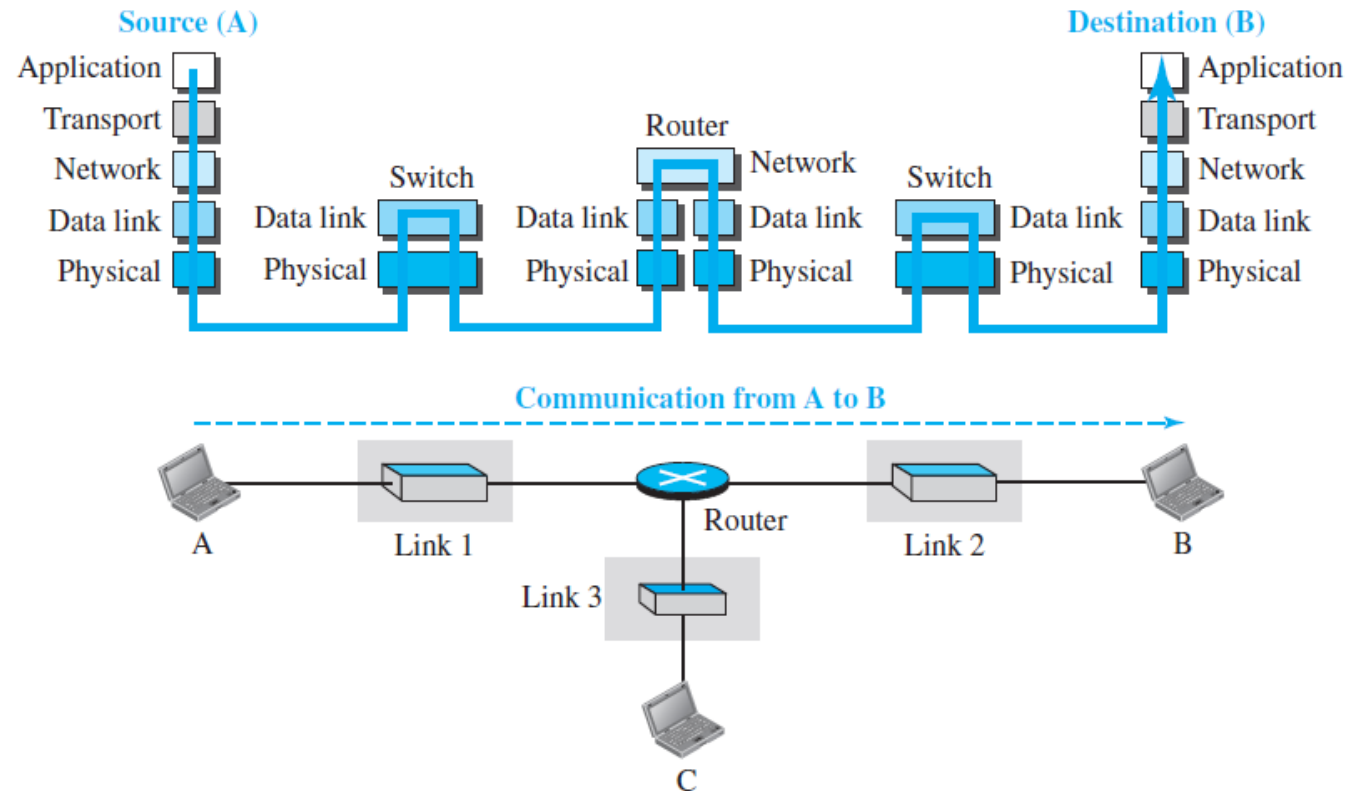
- Let us assume that computer A communicates with computer B.
- Each device is involved with a set of layers depending on the role of the device in the internet.
- The two hosts are involved in all five layers; the source host needs to create a message in the application layer and send it down the layers so that it is physically sent to the destination host. The destination host needs to receive the communication at the physical layer and then deliver it through the other layers to the application layer.
- The router is involved in only three layers; there is no transport or application layer in a router as long as the router is used only for routing. Although a router is always involved in one network layer, it is involved in n combinations of link and physical layers in which n is the number of links the router is connected to.

COMMUNICATION THROUGH AN INTERNET

- Each link may be using different link-layer and physical-layer protocols; the router needs to receive a packet from link 1 based on one pair of protocols and deliver it to link 2 based on another pair of protocols.
- A link-layer switch in a link, however, is involved only in two layers, data-link and physical. Although each switch in the above figure has two different connections, the connections are in the same link, which uses only one set of protocols. This means that, unlike a router, a link-layer switch is involved only in one data-link and one physical layer.

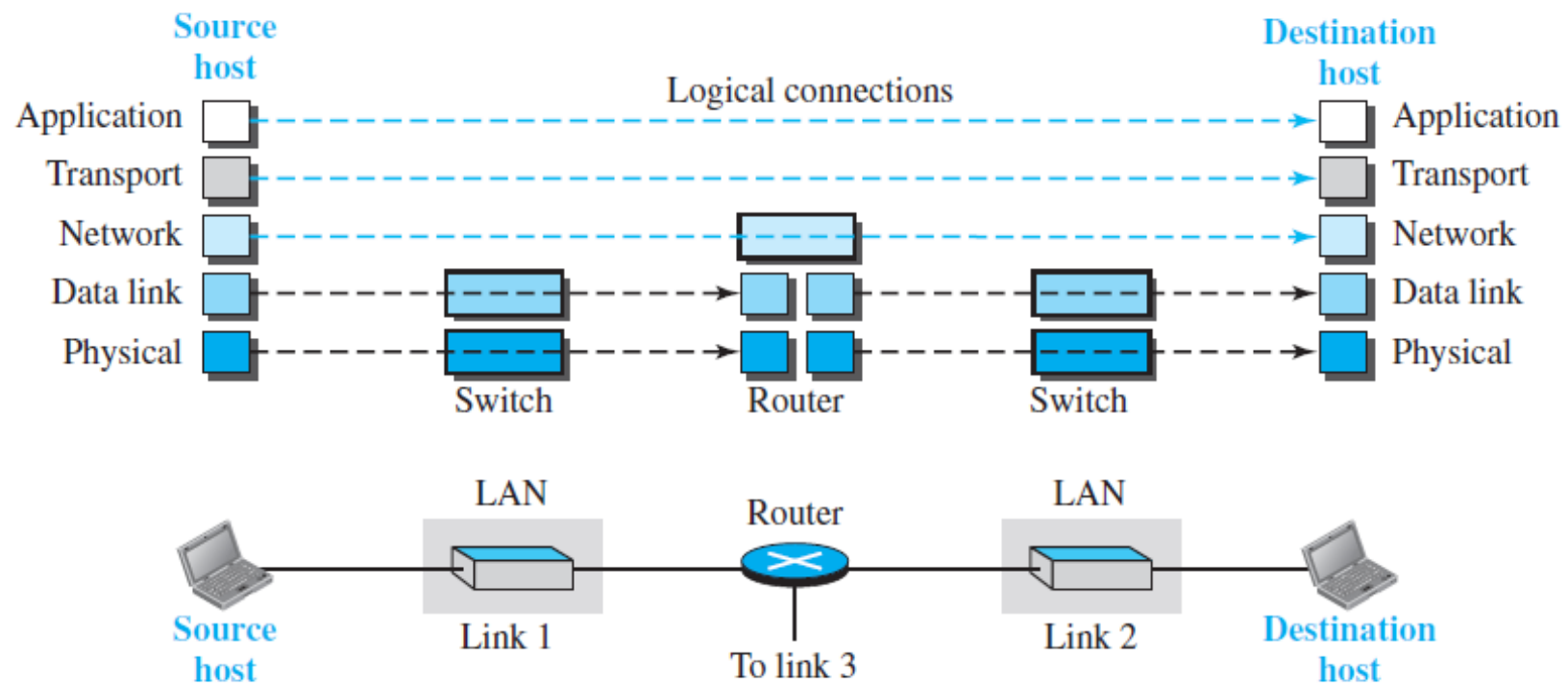
COMMUNICATION THROUGH AN INTERNET

Figure 2.5 *Communication through an internet*



LAYERS IN THE TCP/IP PROTOCOL SUITE

Figure 2.6 *Logical connections between layers of the TCP/IP protocol suite*

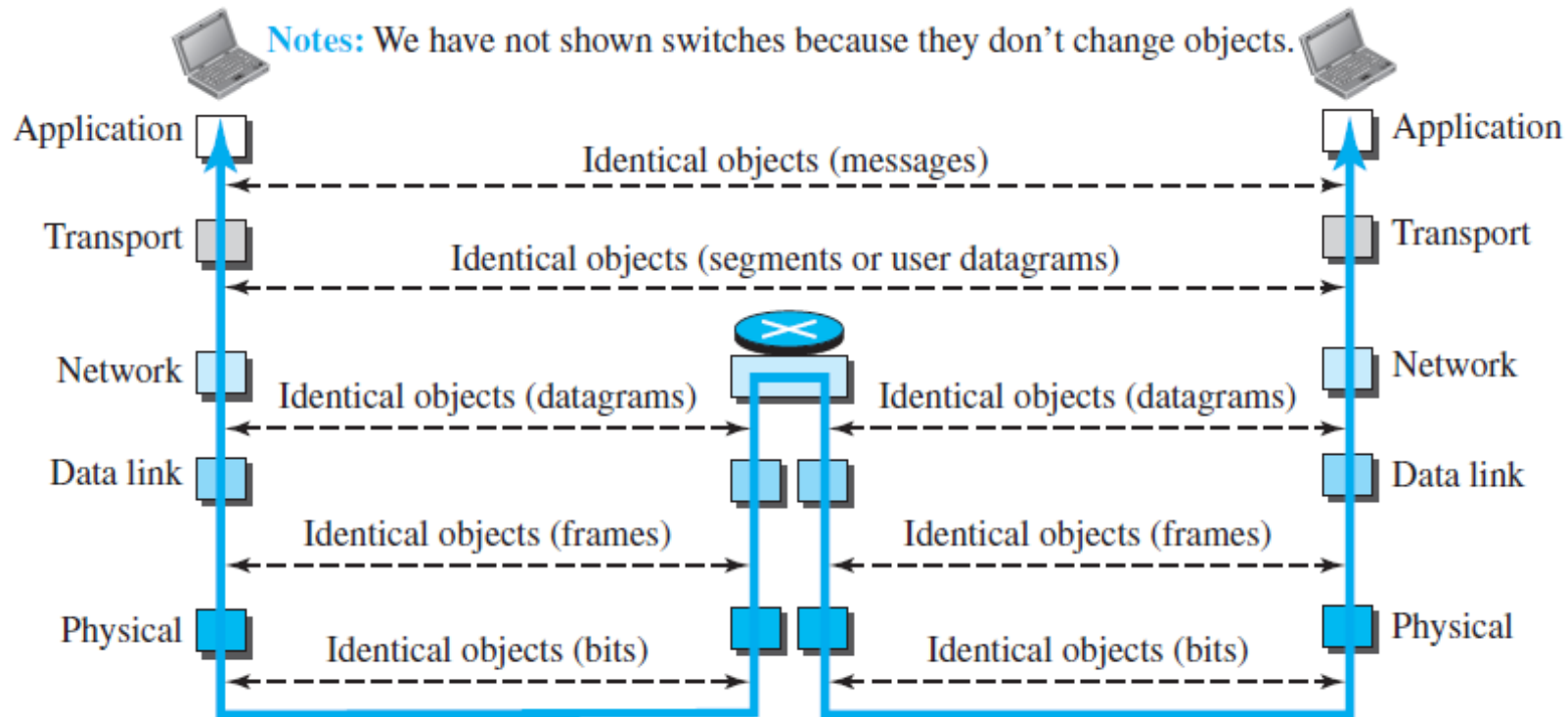


LAYERS IN THE TCP/IP PROTOCOL SUITE

- Using logical connections makes it easier for us to think about the duty of each layer.
- The duty of the application, transport, and network layers is end-to-end. However, the duty of the data-link and physical layers is hop-to-hop, in which a hop is a host or router. In other words, the domain of duty of the top three layers is the internet, and the domain of duty of the two lower layers is the link.
- Another way of thinking of the logical connections is to think about the data unit created from each layer. In the top three layers, the data unit (packets) should not be changed by any router or link-layer switch. In the bottom two layers, the packet created by the host is changed only by the routers, not by the link-layer switches.

LAYERS IN THE TCP/IP PROTOCOL SUITE

Figure 2.7 *Identical objects in the TCP/IP protocol suite*



PHYSICAL LAYER

- The physical layer is responsible for carrying individual bits in a frame across the link. Although the physical layer is the lowest level in the TCP/IP protocol suite, the communication between two devices at the physical layer is still a logical communication because there is another, hidden layer, the transmission media, under the physical layer.
- Two devices are connected by a transmission medium (cable or air). We need to know that the transmission medium does not carry bits; it carries electrical or optical signals. So the bits received in a frame from the data-link layer are transformed and sent through the transmission media, but we can think that the logical unit between two physical layers in two devices is a bit.
- There are several protocols that transform a bit to a signal.

DATA-LINK LAYER

- The Internet is made up of several links (LANs and WANs) connected by routers. There may be several overlapping sets of links that a datagram can travel from the host to the destination. The routers are responsible for choosing the best links.
- However, when the next link to travel is determined by the router, the data-link layer is responsible for taking the datagram and moving it across the link.
- The link can be a wired LAN with a link-layer switch, a wireless LAN, a wired WAN, or a wireless WAN. We can also have different protocols used with any link type. In each case, the data-link layer is responsible for moving the packet through the link.
- TCP/IP does not define any specific protocol for the data-link layer. Any protocol that can take the datagram and carry it through the link suffices for the network layer. The data-link layer takes a datagram and encapsulates it in a packet called a frame.

NETWORK LAYER

- The network layer is responsible for creating a connection between the source computer and the destination computer. The communication at the network layer is host-to-host.
- However, since there can be several routers from the source to the destination, the routers in the path are responsible for choosing the best route for each packet.
- The network layer is responsible for host-to-host communication and routing the packet through possible routes.
- The network layer in the Internet includes the main protocol, Internet Protocol(IP), that defines the format of the packet, called a datagram at the network layer.
- IP also defines the format and the structure of addresses used in this layer. IP is also responsible for routing a packet from its source to its destination, which is achieved by each router forwarding the datagram to the next router in its path.

NETWORK LAYER

- IP is a connectionless protocol that provides no flow control, no error control, and no congestion control services. This means that if any of these services is required for an application, the application should rely only on the transport-layer protocol.
- The network layer also includes unicast (one-to-one) and multicast (one-to-many) routing protocols. The network layer also has some auxiliary protocols that help IP in its delivery and routing tasks.
- The Internet Control Message Protocol (ICMP) helps IP to report some problems when routing a packet. The Internet Group Management Protocol (IGMP) is another protocol that helps IP in multitasking. The Dynamic Host Configuration Protocol (DHCP) helps IP to get the network-layer address for a host. The Address Resolution Protocol (ARP) is a protocol that helps IP to find the link-layer address of a host or a router when its network-layer address is given.

TRANSPORT LAYER

- The logical connection at the transport layer is also end-to-end. The transport layer at the source host gets the message from the application layer, encapsulates it in a transport layer packet (called a segment or a user datagram in different protocols) and sends it, through the logical (imaginary) connection, to the transport layer at the destination host.
- In other words, the transport layer is responsible for giving services to the application layer: to get a message from an application program running on the source host and deliver it to the corresponding application program on the destination host.
- The main protocol, Transmission Control Protocol (TCP), is a connection-oriented protocol that first establishes a logical connection between transport layers at two hosts before transferring data. It creates a logical pipe between two TCPs for transferring a stream of bytes.

TRANSPORT LAYER

- TCP provides flow control (matching the sending data rate of the source host with the receiving data rate of the destination host to prevent overwhelming the destination), error control (to guarantee that the segments arrive at the destination without error and resending the corrupted ones), and congestion control to reduce the loss of segments due to congestion in the network.
- The other common protocol, User Datagram Protocol (UDP), is a connectionless protocol that transmits user datagrams without first creating a logical connection. In UDP, each user datagram is an independent entity without being related to the previous or the next one (the meaning of the term connectionless). UDP is a simple protocol that does not provide flow, error, or congestion control.
- A new protocol, Stream Control Transmission Protocol (SCTP) is designed to respond to new applications that are emerging in the multimedia.

APPLICATION LAYER

- The logical connection between the two application layers is end-to-end. The two application layers exchange messages between each other as though there were a bridge between the two layers.
- Communication at the application layer is between two processes (two programs running at this layer). To communicate, a process sends a request to the other process and receives a response. Process-to-process communication is the duty of the application layer.
- The Hypertext Transfer Protocol (HTTP) is a vehicle for accessing the World Wide Web (WWW). The Simple Mail Transfer Protocol (SMTP) is the main protocol used in electronic mail (e-mail) service. The File Transfer Protocol (FTP) is used for transferring files from one host to another. The Terminal Network (TELNET) and Secure Shell (SSH) are used for accessing a site remotely. The Simple Network Management Protocol (SNMP) is used by an administrator to manage the Internet at global and local levels. The Domain Name System (DNS) is used by other protocols to find the network-layer address of a computer. The Internet Group Management Protocol (IGMP) is used to collect membership in a group.