Introduction to Data Communications (COMP 3721)

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Learning Outcomes of This Lecture

- By the end of this lecture, you will be able to
  - Explain what is protocol layering and its benefits.
  - Describe the layers of TCP/IP protocol suite.

Agenda

- Introduction
- TCP/IP Protocol Suite
- Summary

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- **Introduction**
- TCP/IP Protocol Suite
- Summary

What is a Protocol? Why are Protocols needed?

A protocol defines **what** is communicated, in **what way** and **when**. This provides accurate and timely transfer of information between different devices on a network. In other words, a protocol defines the **format and the order of messages exchanged between two or more communicating entities** as well as **the actions** taken on the transmission and/or receipt of a message or other event.

Protocol Layering

- **Protocol layering** enables us to divide the complex task of communication into multiple smaller and simpler tasks.
- Network designers organize protocols and the network hardware and software that implement the protocols in layers.
- Service model of a layer in protocol layering is the services that a layer offers to the layer above.
- Each layer provides its service by performing certain actions within that layer and by using the services of the layer directly below it.

Protocol Layering – Continued

- **Principles of protocol layering**
  1) For having bidirectional communication, each layer must be able to perform two opposite tasks.
  2) The two objects under each layer at both sites should be identical.

Protocol Layering – Continued

- **Advantages of protocol layering**
  1) **Separating the services from the implementation**
  2) **Simpler and less expensive intermediate systems**
  3) **Modularity** (independent layers) -> black box
     - ✓ **ease of maintenance** and **updating** of the system, **change in a layer's service implementation** is transparent to rest of system

Two Models for Computer Network Operations

- **TCP/IP protocol suite**
- **OSI model**

Protocol Suite (Stack): a set of protocols organized in different layers (designed to work together)

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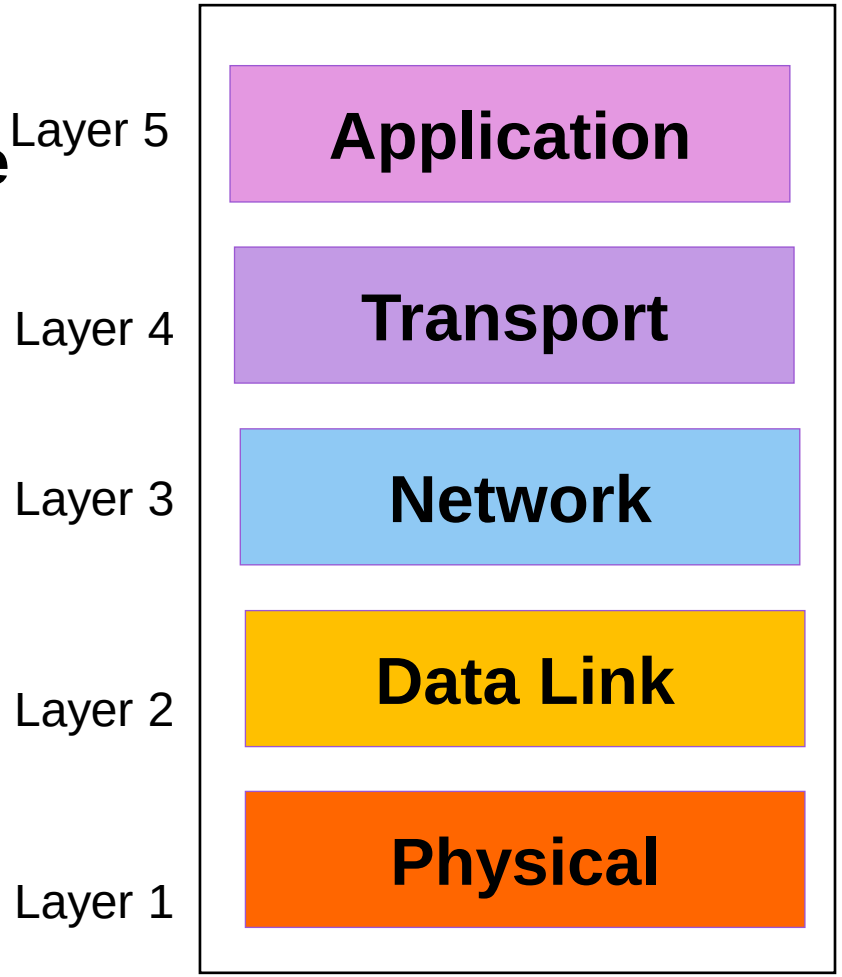
TCP/IP Protocol Suite

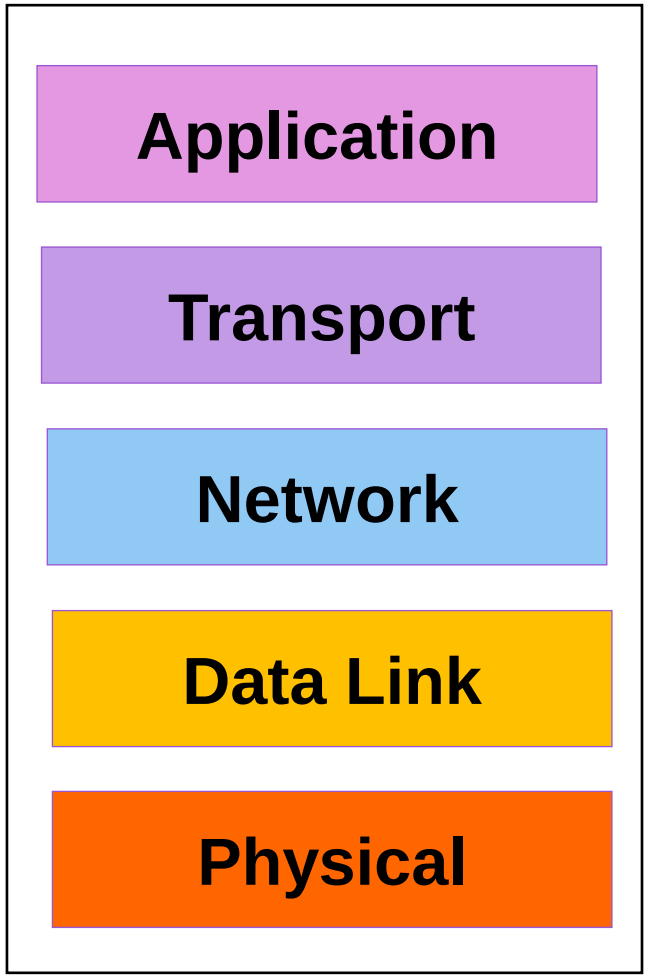
- **TCP/IP** (Transmission Control Protocol/Internet Protocol) **Protocol Suite**
  - used in the Internet today (the Internet protocol stack)
  - a five-layer hierarchical model



TCP/IP Protocol Suite

Carries individual bits in a frame across the link (from one node to the next).
Actually, the bits received in a frame from the data-link layer are transformed to signals and sent through the transmission medium.

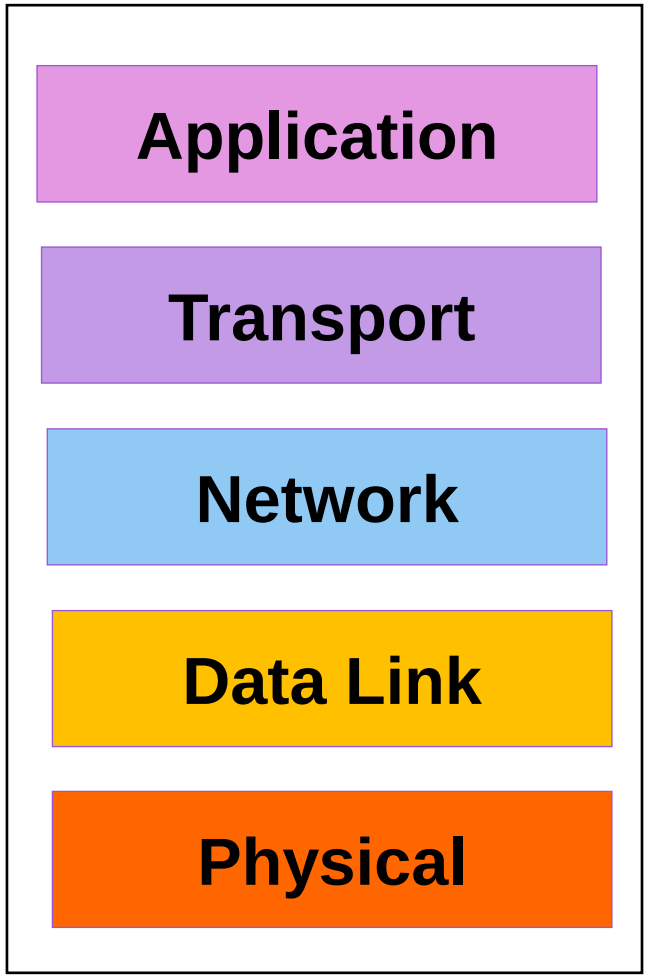
- **physical layer protocols** are link-dependent and they rely on the actual transmission medium of the link.



TCP/IP Protocol Suite

Data transfer between neighboring network elements (without errors)

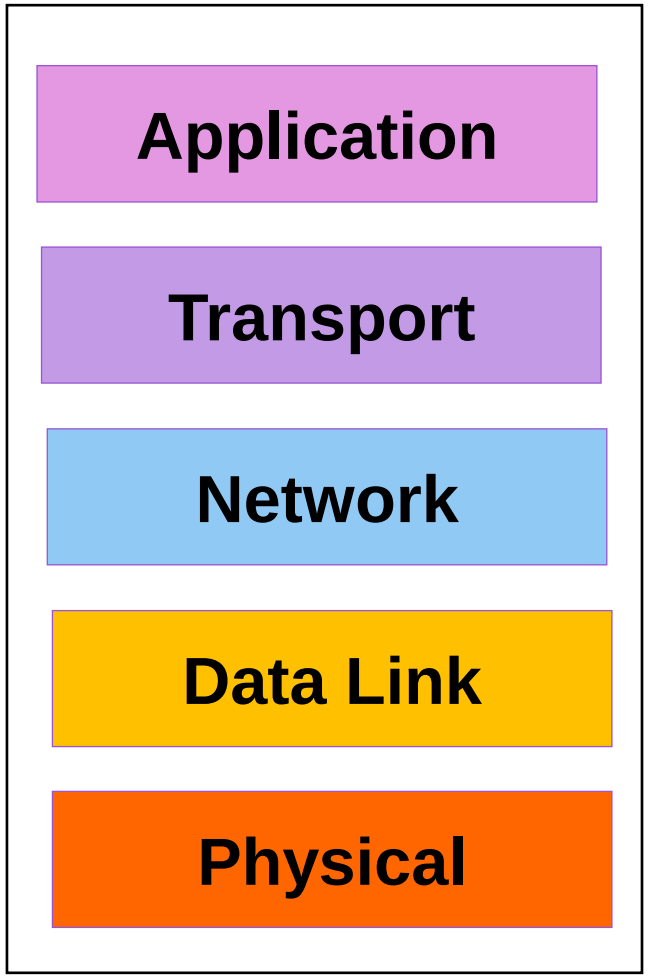
- packet name: frame
- protocols: Ethernet, 802.11 (WiFi), …



TCP/IP Protocol Suite

Routing of datagrams from source to destination (host-to-host communication)

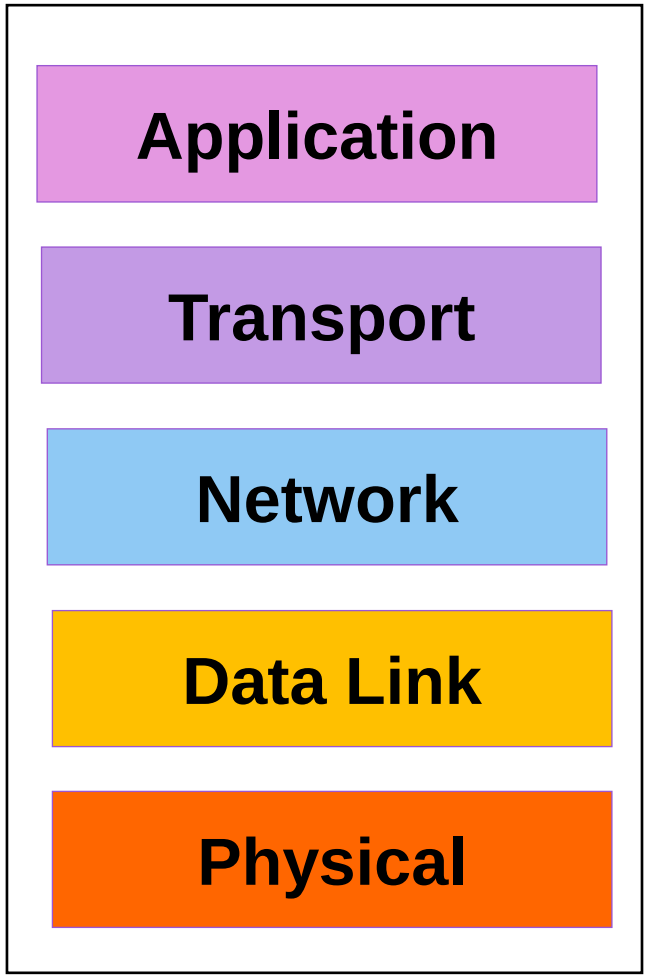
- packet name: datagram
- also called IP layer
- protocols: IP (Internet Protocol), ICMP, DHCP, ARP, routing protocols,…



TCP/IP Protocol Suite

Logical communication between application processes running on different hosts (process-to-process delivery of the entire message)

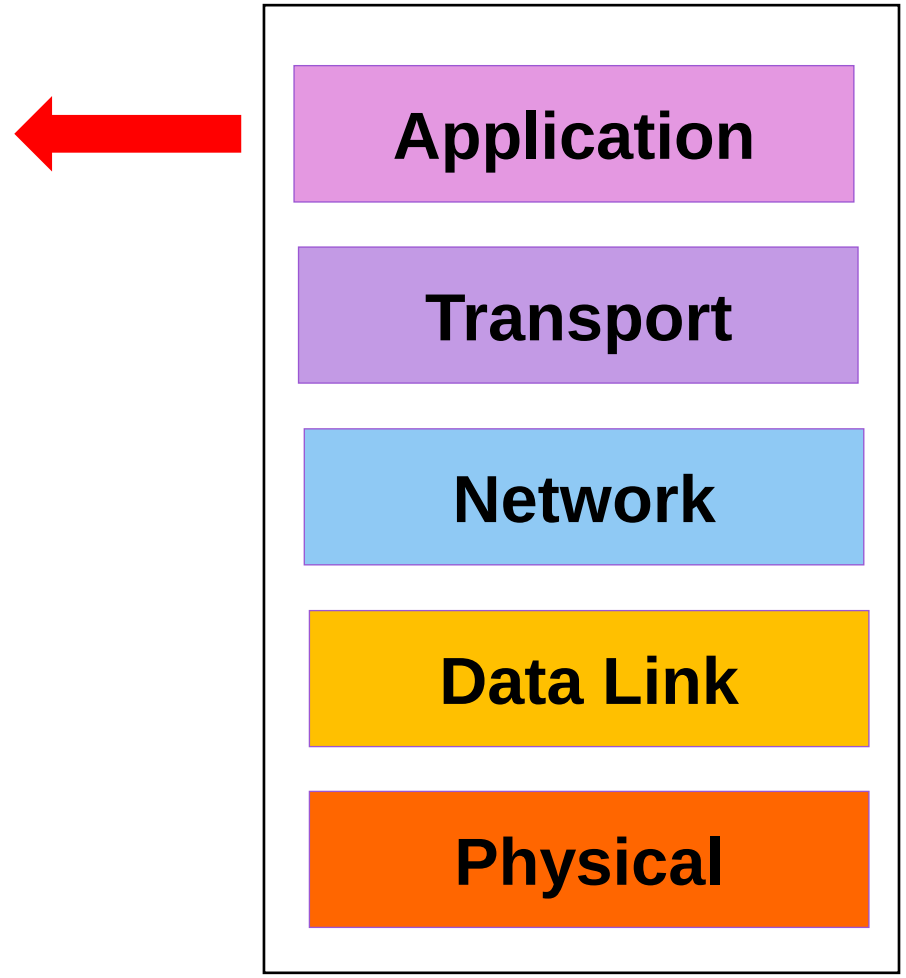
- packet name: segment/user datagram
- protocols: TCP, UDP, SCTP
- transport layer protocols almost always implemented in software in the end system.



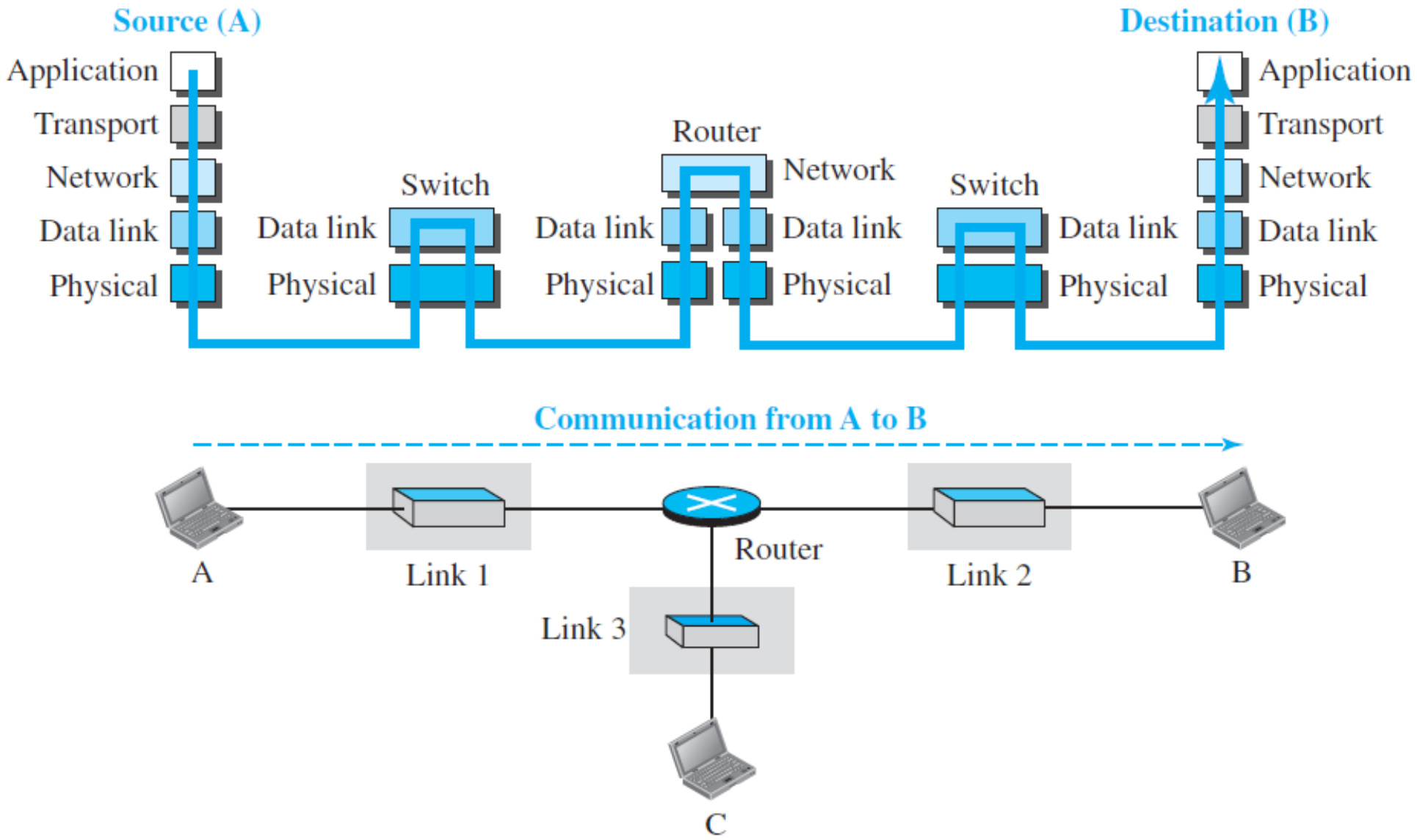
TCP/IP Protocol Suite

Communication for a network application takes place between end systems at the application layer.

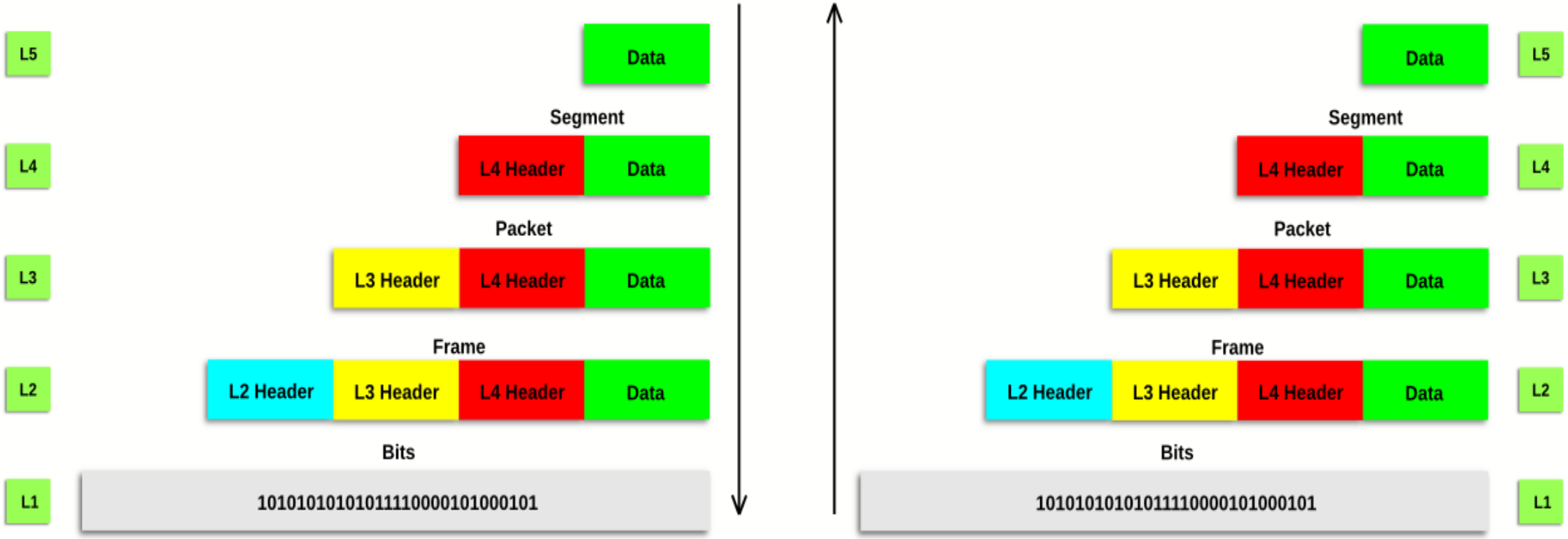
- packet name: message
- protocols: IMAP, SMTP, HTTP, FTP, Telnet, DNS, …
- application layer protocols are implemented in software in the end system.



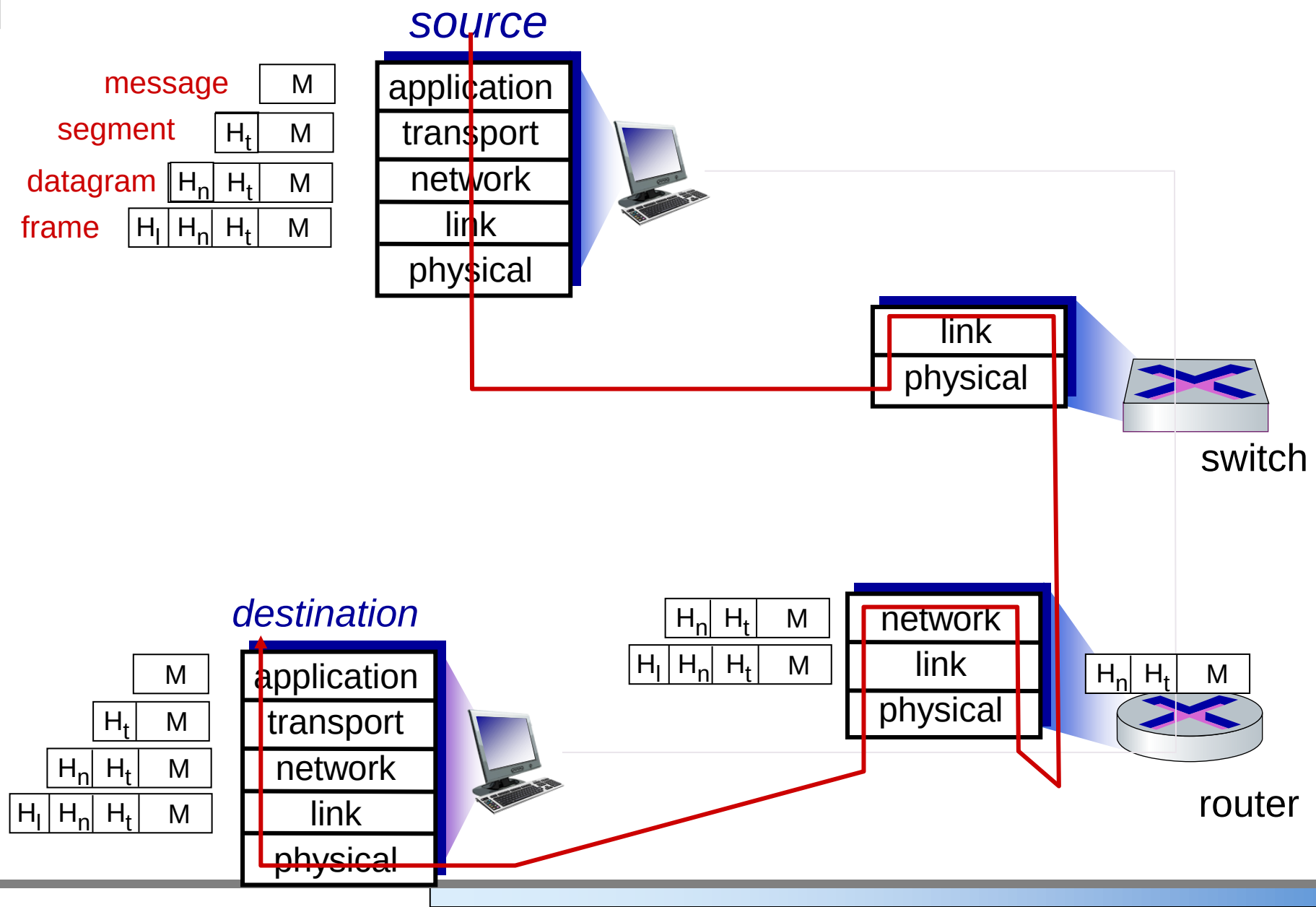
Communication through an internet



Encapsulation and Decapsulation

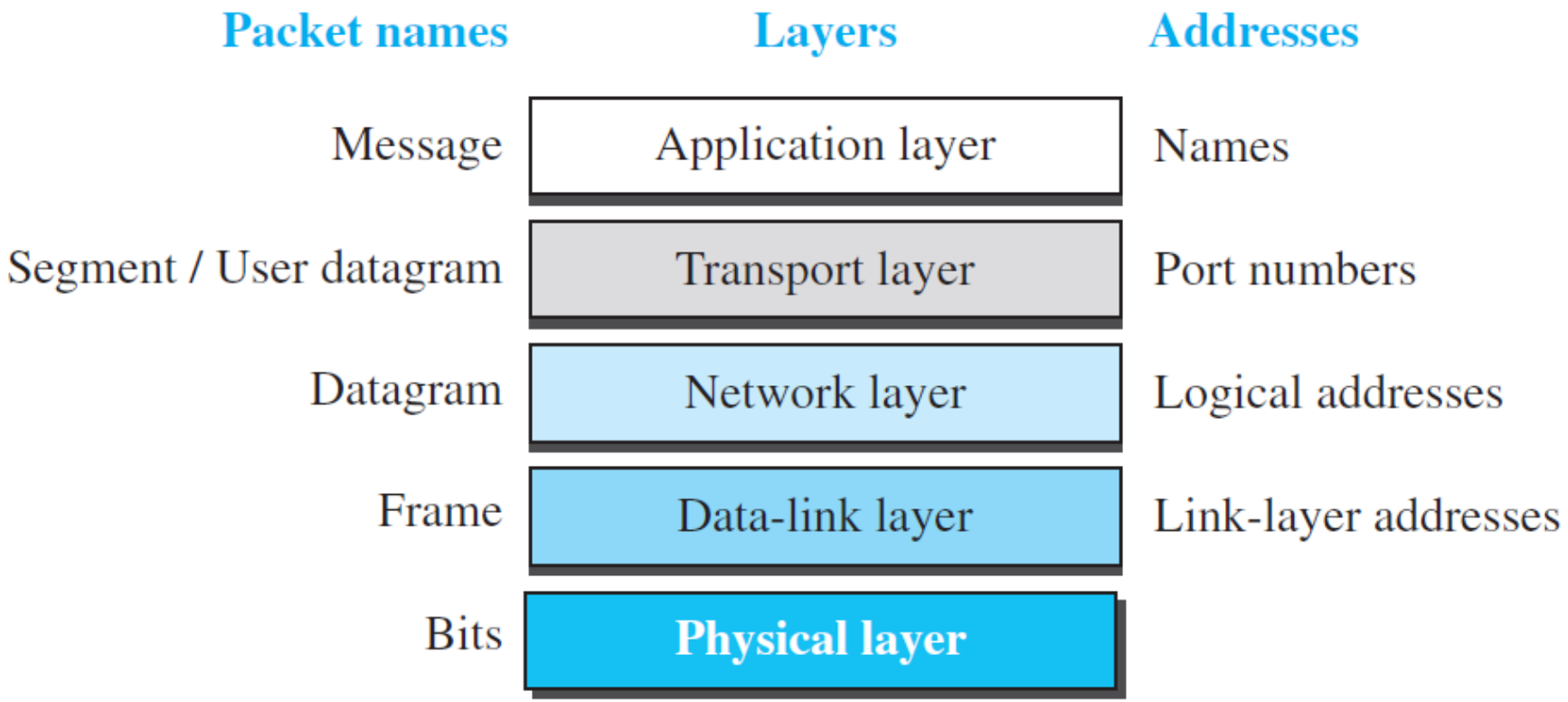


Encapsulation/Decapsulation – Example



Addressing

Four levels of addresses are used in an internet following the TCP/IP protocols:



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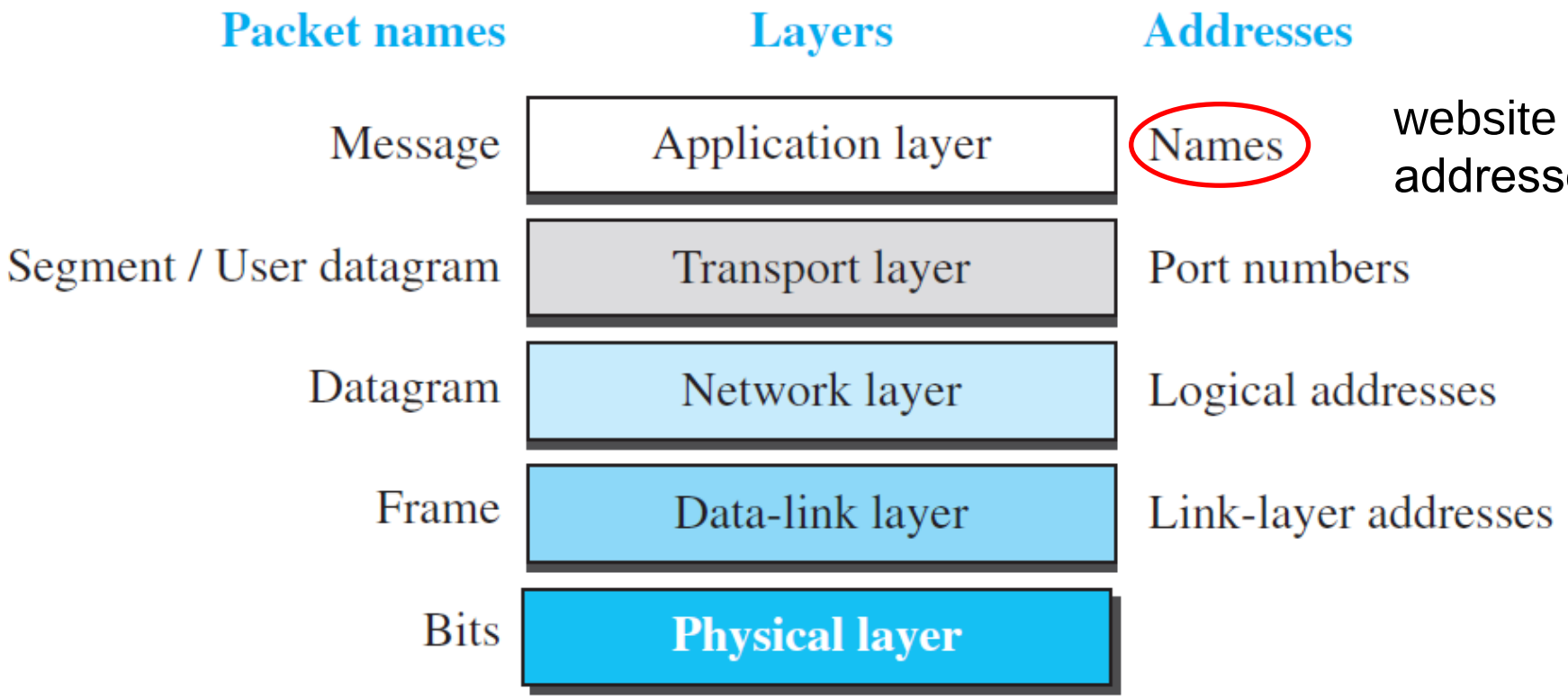

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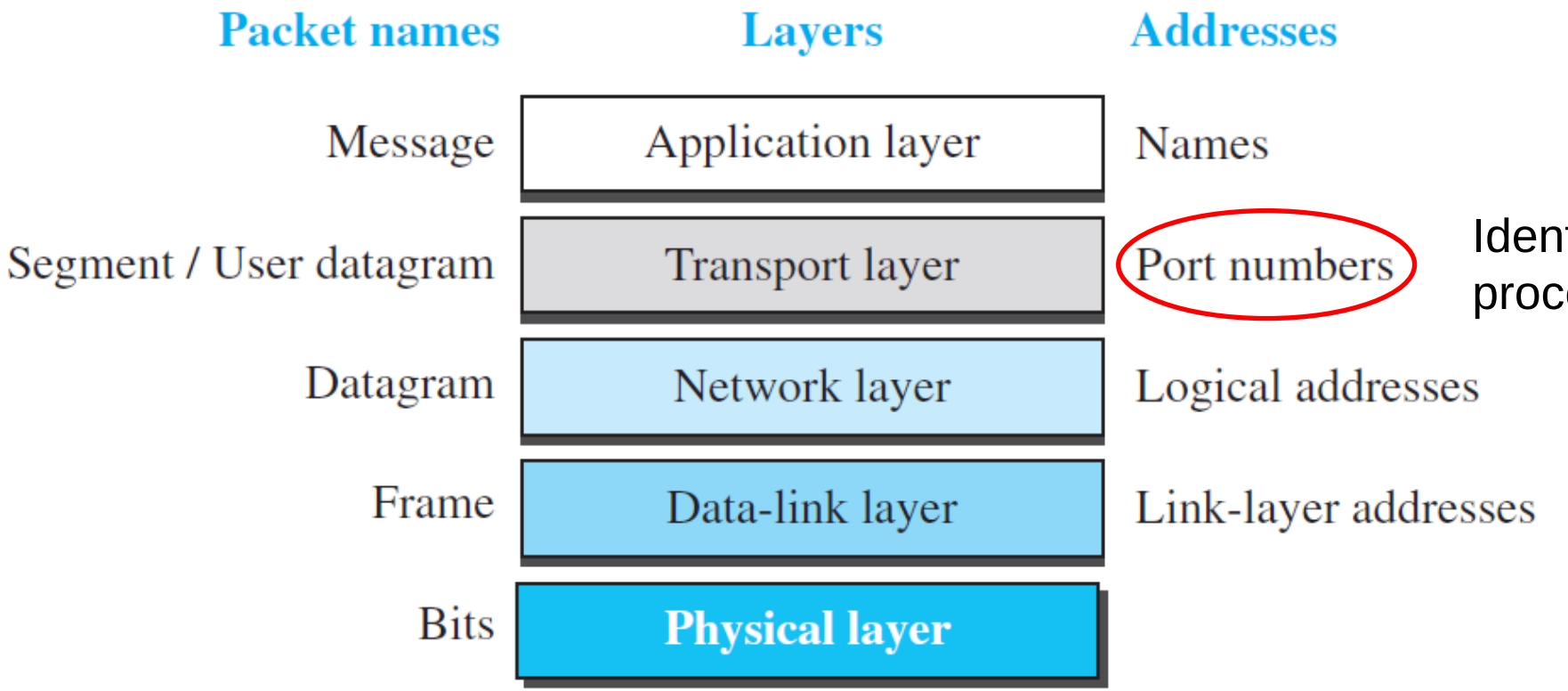

Identifying a process on a host

Addressing

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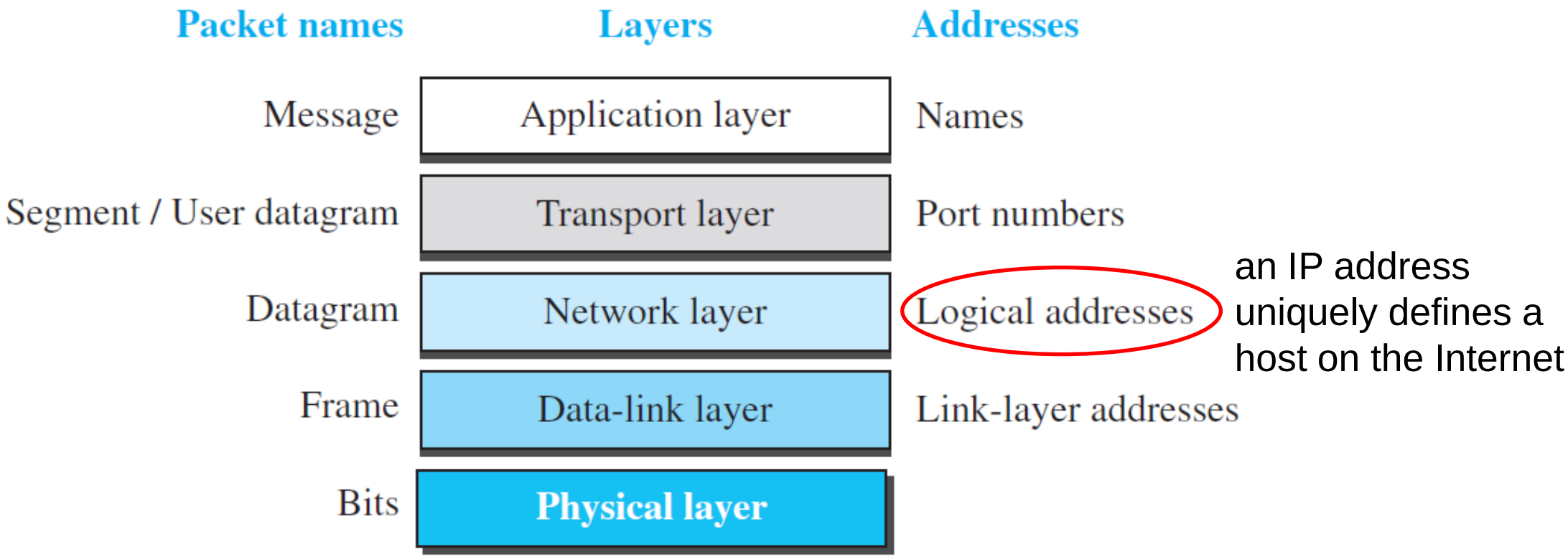

an IP address uniquely defines a host on the Internet

Addressing

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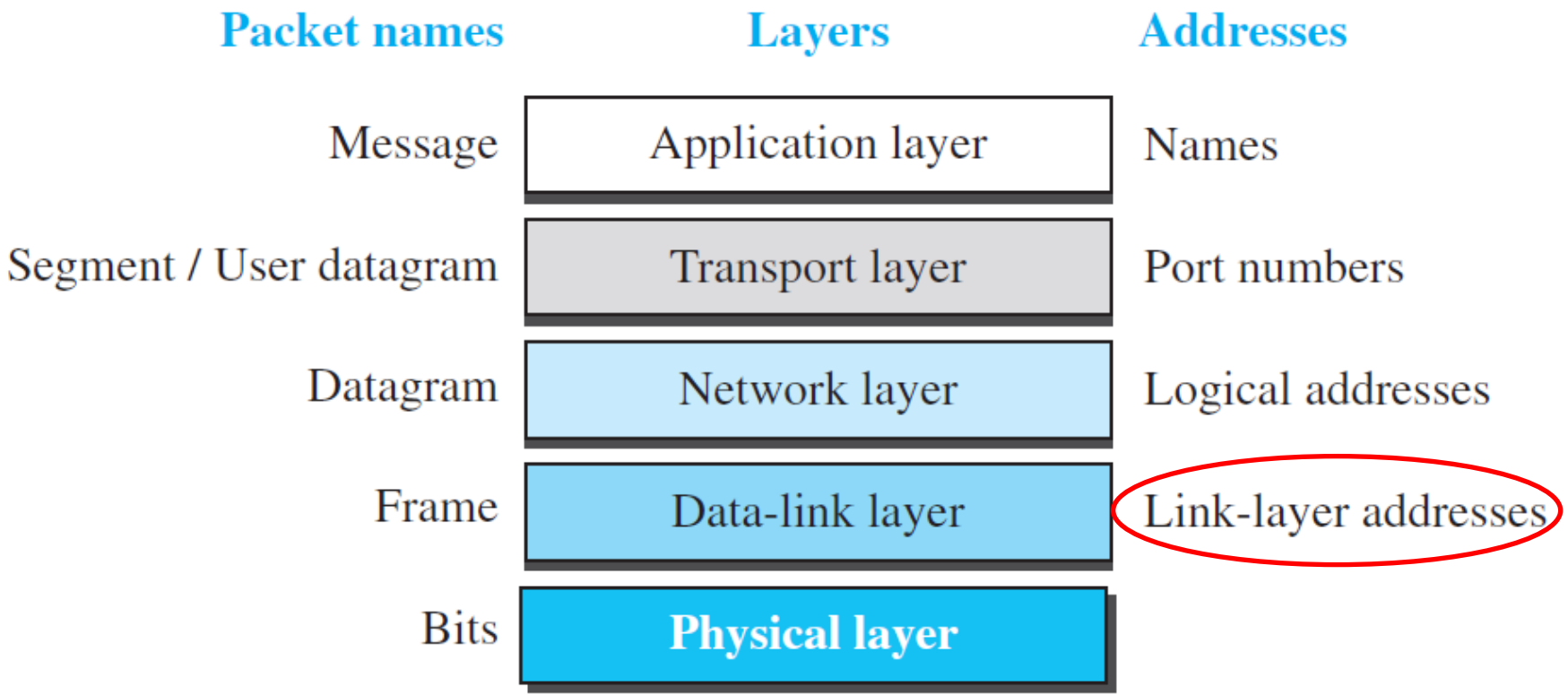

defining a specific host or router in a network (LAN or WAN)

Good to Know

- **Physical layer and data-link layer** typically implemented in a NIC (Network Interface card) and they handle communication over a specific link.
- **Hosts (end systems)** implement all 5 layers of the TCP/IP protocol stack.

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Summary

- Protocol layering provides modularity and network design abstraction.
- TCP/IP protocol suite includes five layers, each of which has certain functionalities.

References

[1] Behrouz A.Forouzan, Data Communications and Networking, 6th Ed, 2022, McGraw-Hill companies.

[2] J.F. Kurose, K.W. Ross, Computer Networking: A Top-Down Approach, 7th Ed, 2017, Pearson Education, Inc.