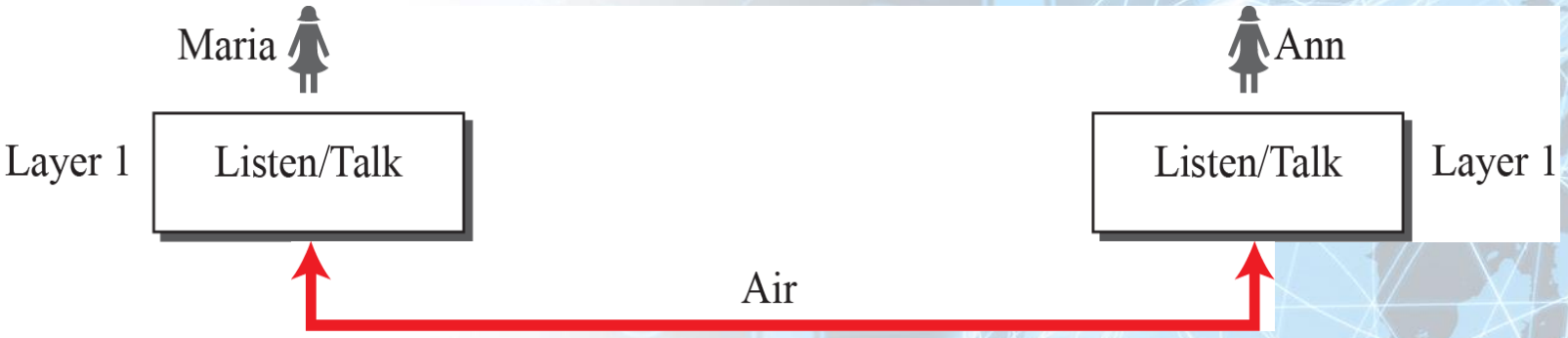
Protocol Layering - Introduction

- **Protocol**
  Rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively

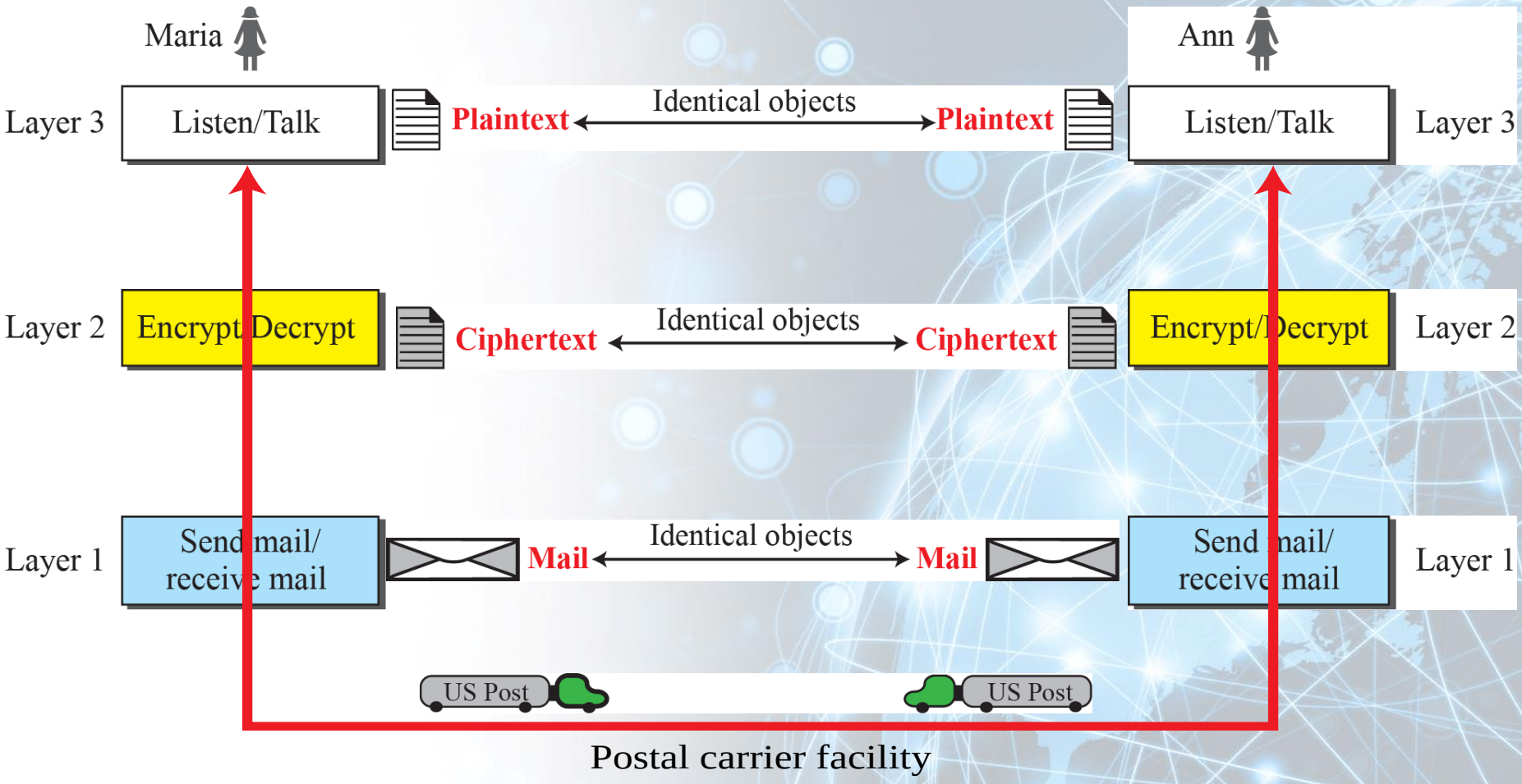
- **Protocol Layering**
  Simple Communication: only one simple protocol

  Complex Communication, we need a protocol at each layer, or Protocol Layering

Protocol Layering - Example Scenario 1



Protocol Layering - Example Scenario 2



Protocol Layering - Advantages and Disadvantages

- **Advantages**
  - ✓ Modularity
  - ✓ Separation of Service & Implementation
  - ✓ Reduced Complexity & Cost

- **Disadvantages**
  - ✓ None Really!

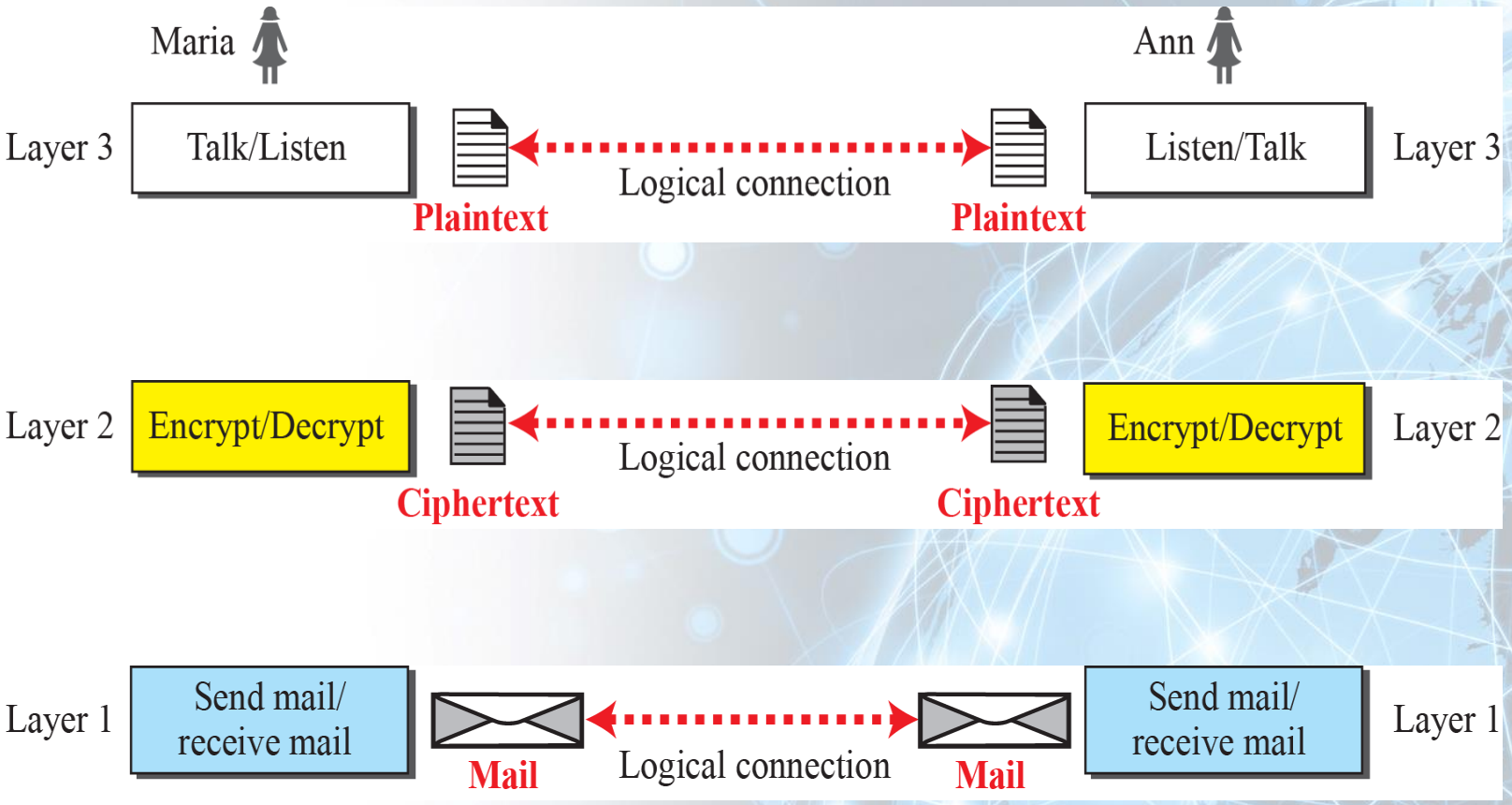
Protocol Layering - Principles

- **Two Principles**
  - ✓ Bidirectional Communication → Each Layer performs two opposite tasks in each direction
  - ✓ Two objects under each layer at both sites should be identical

Protocol Layering - Logical Connections

- **Logical Connections**
  - ✓ Imaginary connection between each layer

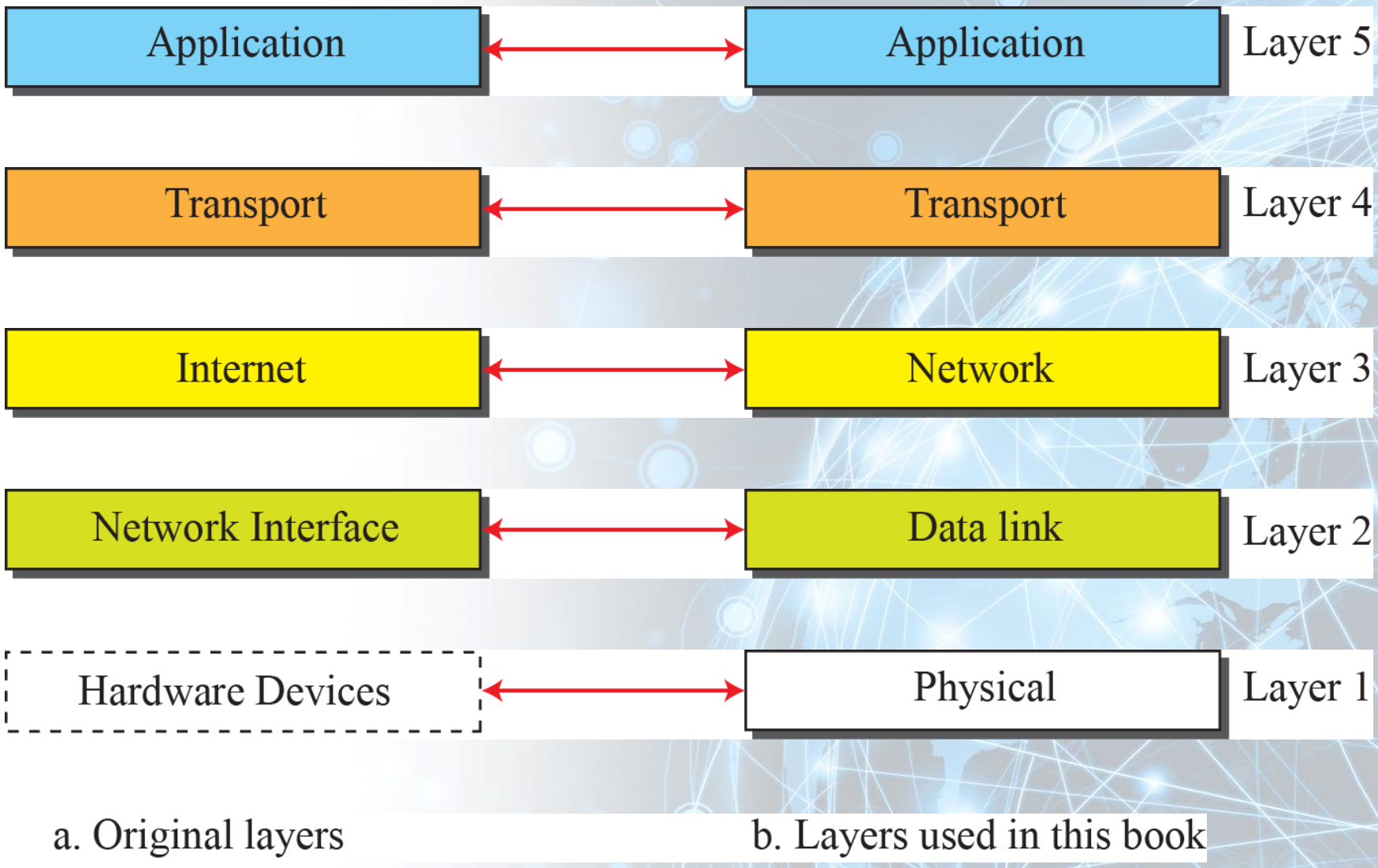
Protocol Layering



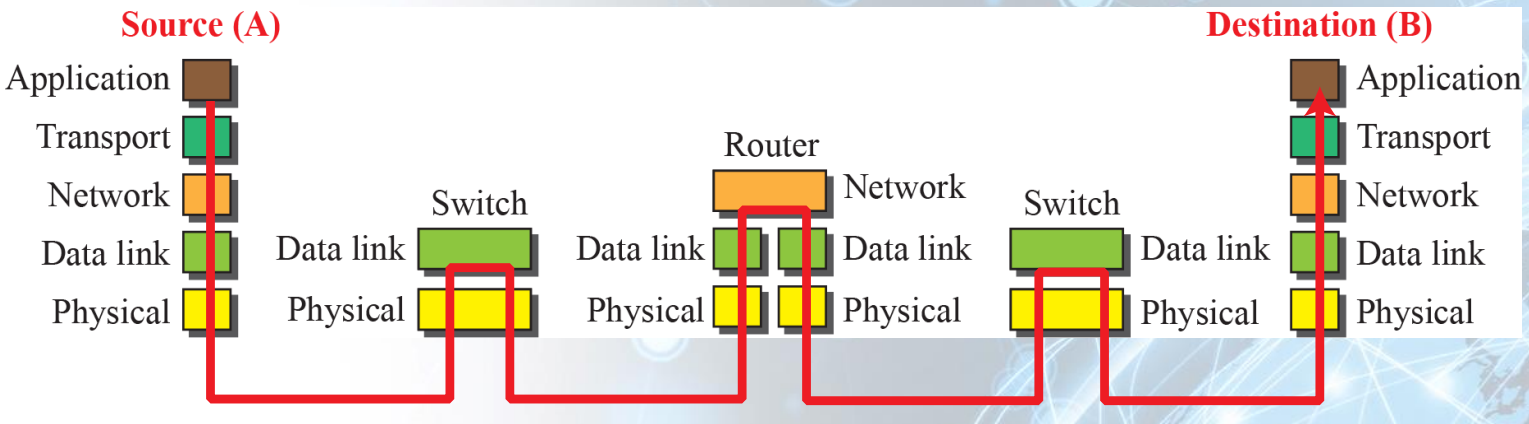
TCP/IP Protocol Suite

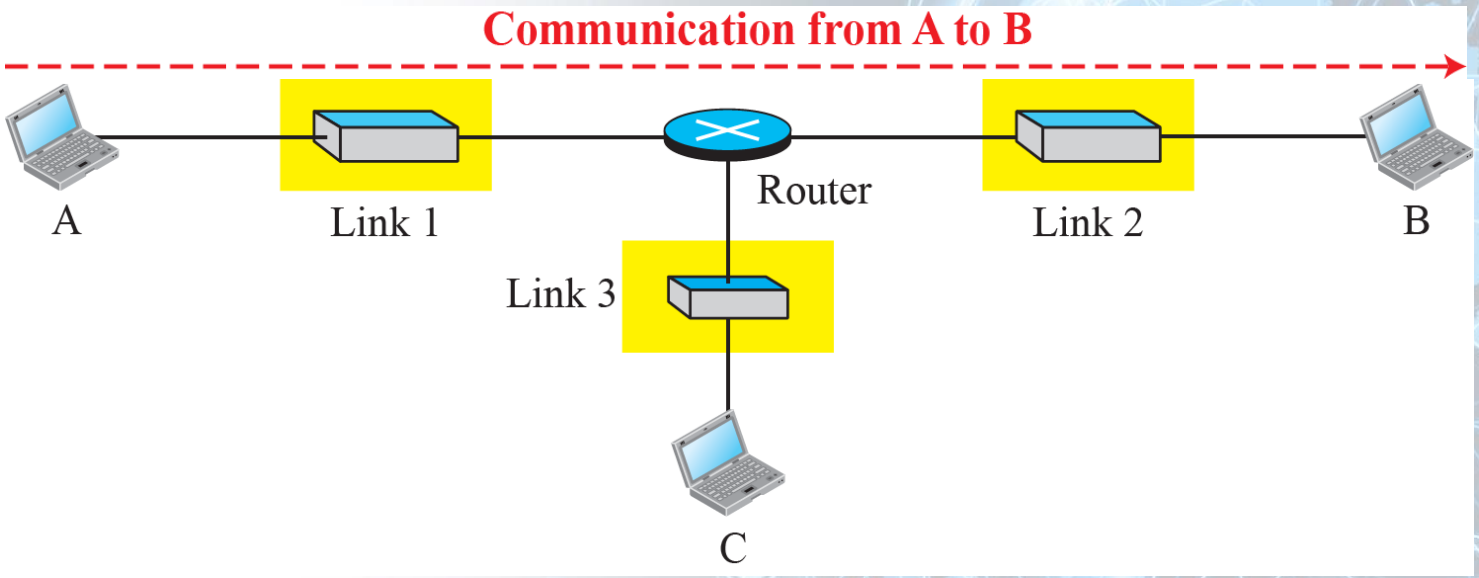
- **TCP/IP Protocol Suite**
  - ✓ Protocol suite used in Internet today
  - ✓ Each Layer provides specific functionality
  - ✓ Hierarchical Protocol
  - ✓ Presented in 1973 and chosen to be the official protocol of Internet in 1983

TCP/IP Protocol Suite



TCP/IP Protocol Suite - Layered Architecture

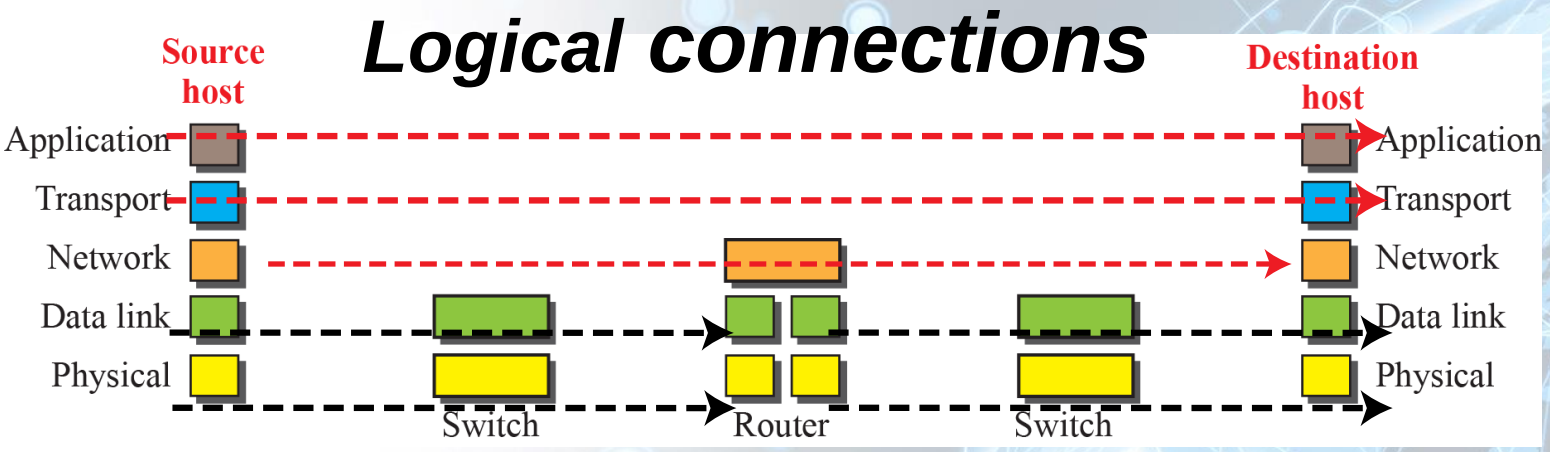


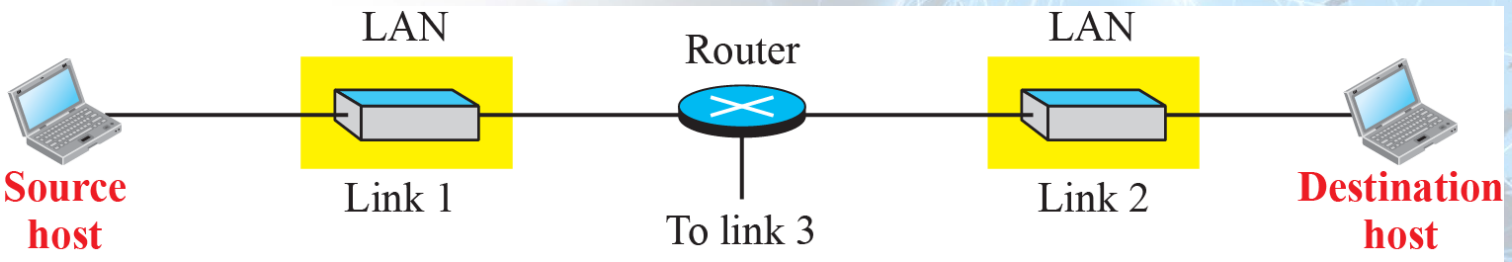


TCP/IP Protocol Suite – Function of Layers

- **Logical Connections between TCP/IP Layers**

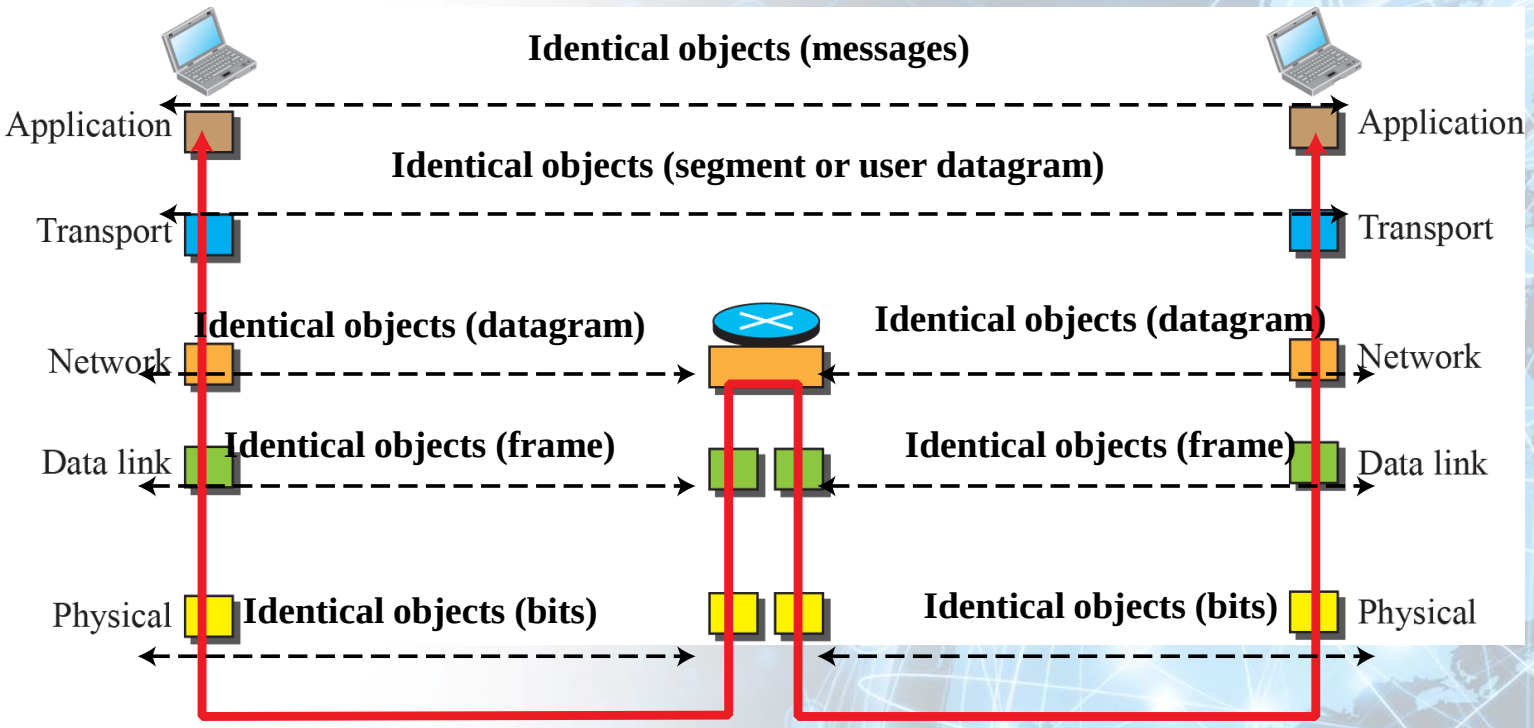
TCP/IP Protocol Suite – Function of Layers



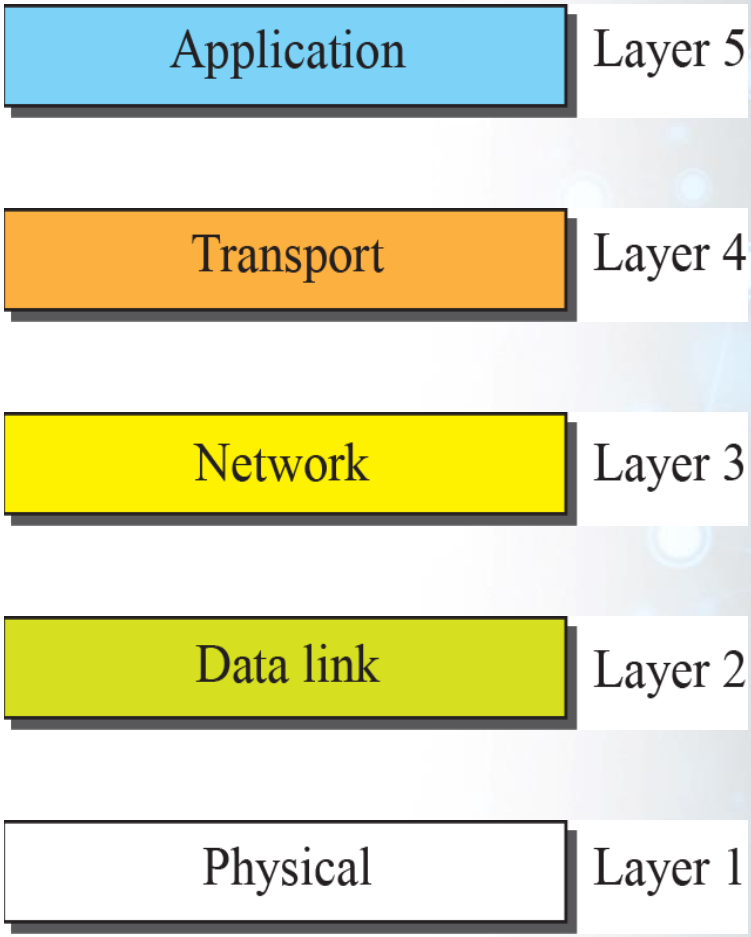


TCP/IP Protocol Suite – Function of Layers

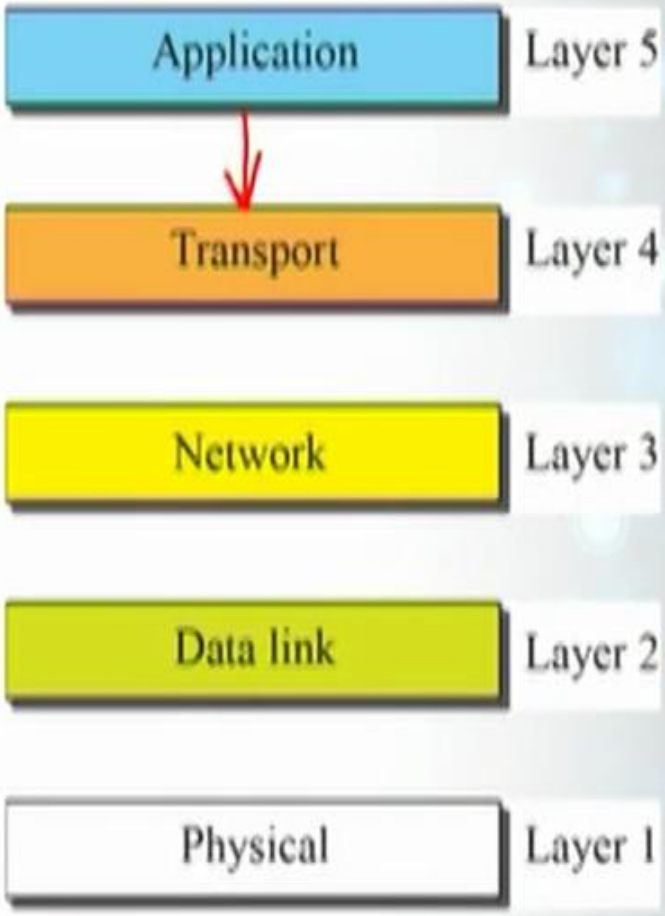
Notes: We have not shown switches because they don't change objects.



TCP/IP Protocol Suite – Layer Description



TCP/IP Protocol Suite – Layer Description

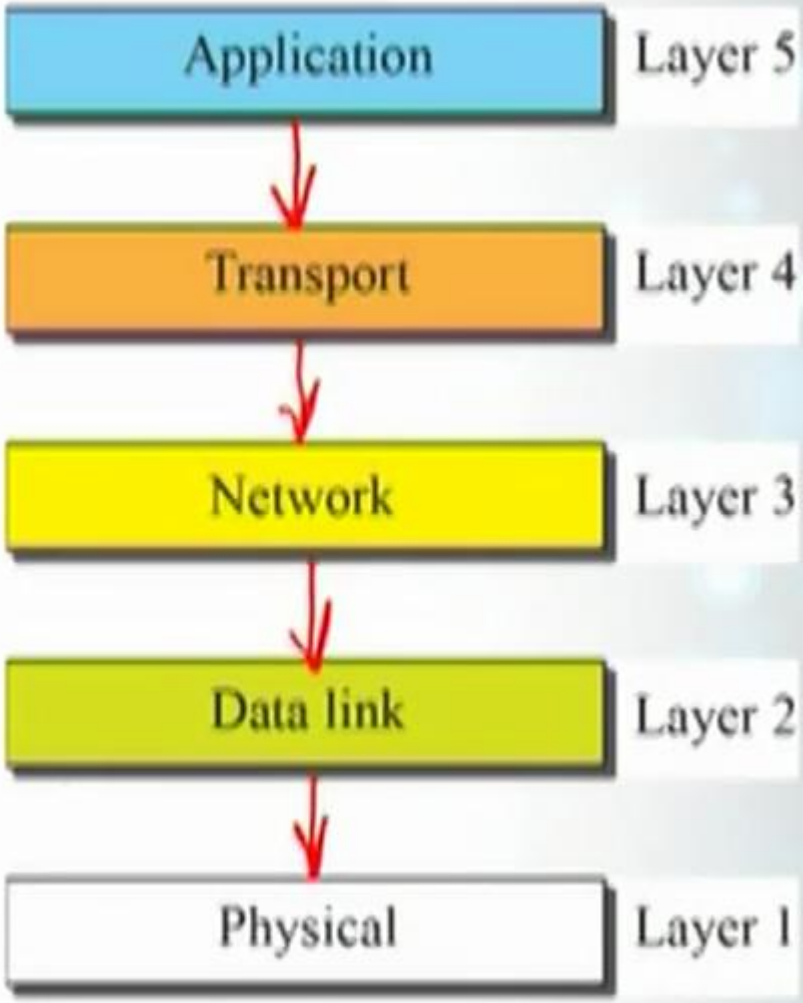


Message (object) HTTP, SMTP, FTP, ...

Segment (User Datagram) TCP, UDP

Datagram → Routing → IP

TCP/IP Protocol Suite – Layer Description



Message (object) HTTP, SMT

Segment (User Datagram) TC

Datagram → Routing →

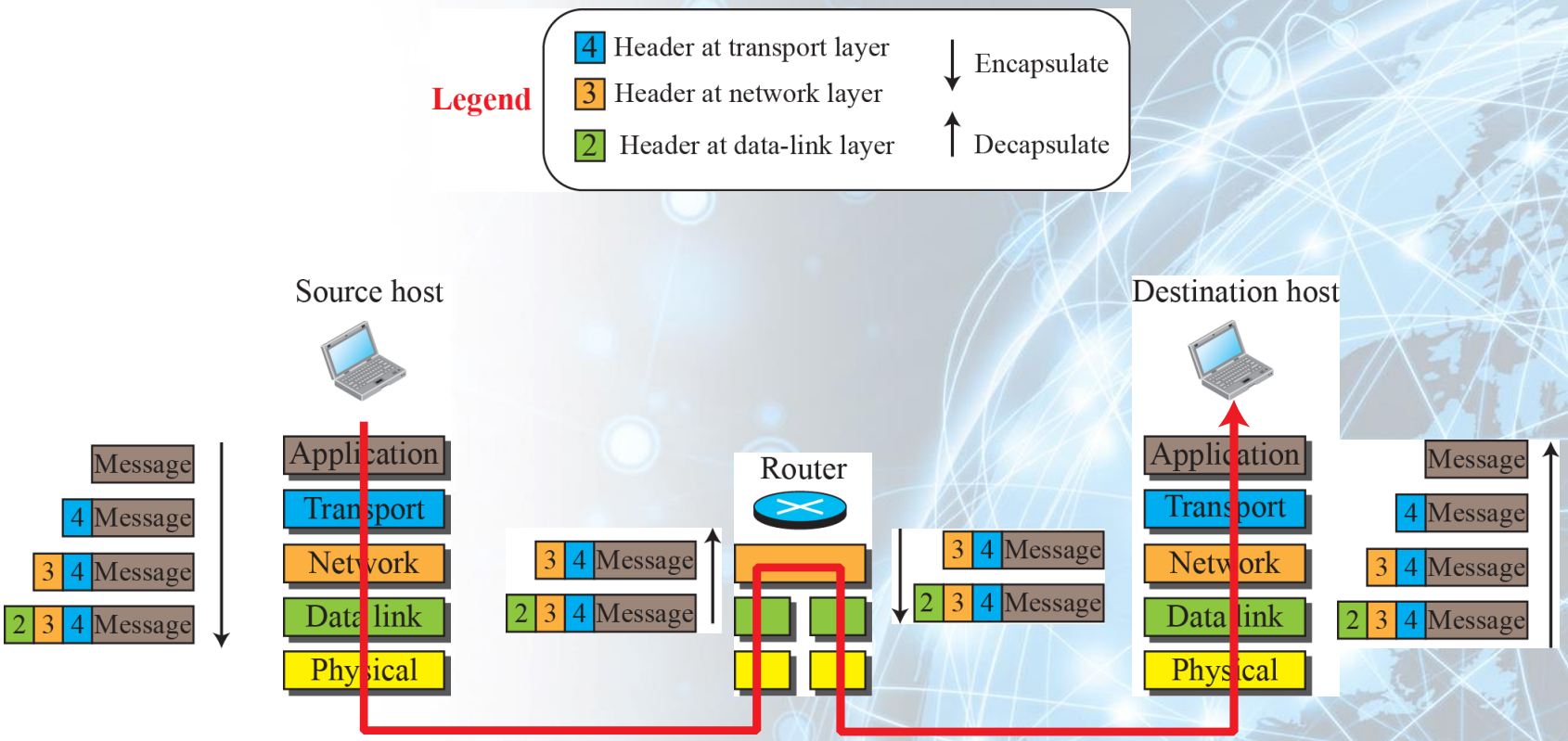
Frame (object) Standard,

Bits (object)

Encapsulation & Decapsulation

- Important Concept in Internet Protocol Layering
- Layer Header

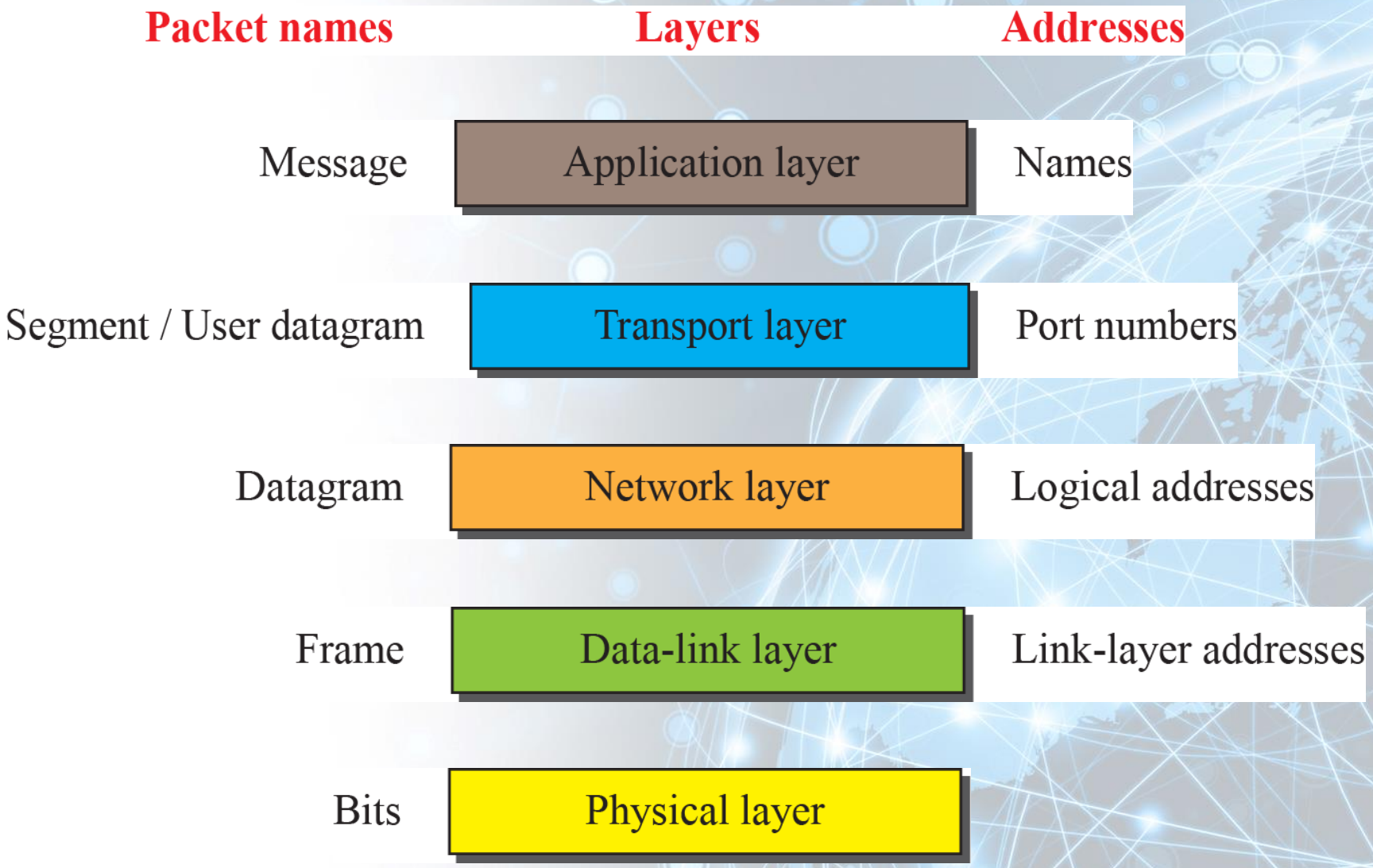
Encapsulation & Decapsulation



Addressing in TCP/IP Protocol Suite

- Every communication needs at least two addresses:
  - ✓ Source Address &
  - ✓ Destination Address
- Addressing by Layer
- Physical Layer is an exception

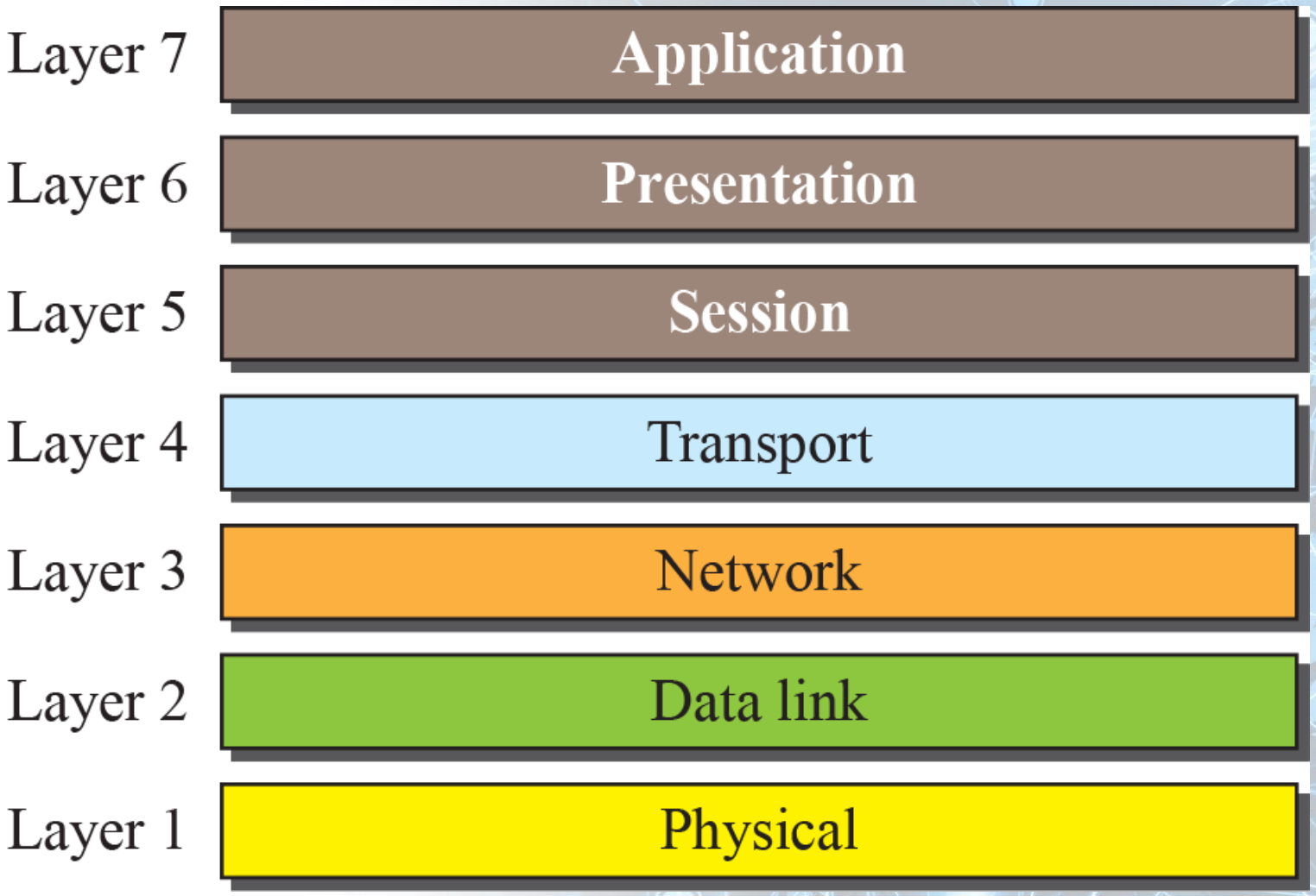
Addressing in TCP/IP Protocol Suite



The Open System Interconnection (OSI) Model

- International Organization for Standardization (ISO)
- ISO established in 1947
- Close to three-fourths of countries represented
- Introduced OSI Model in late 1970s
- OSI: a 7-Layer Model

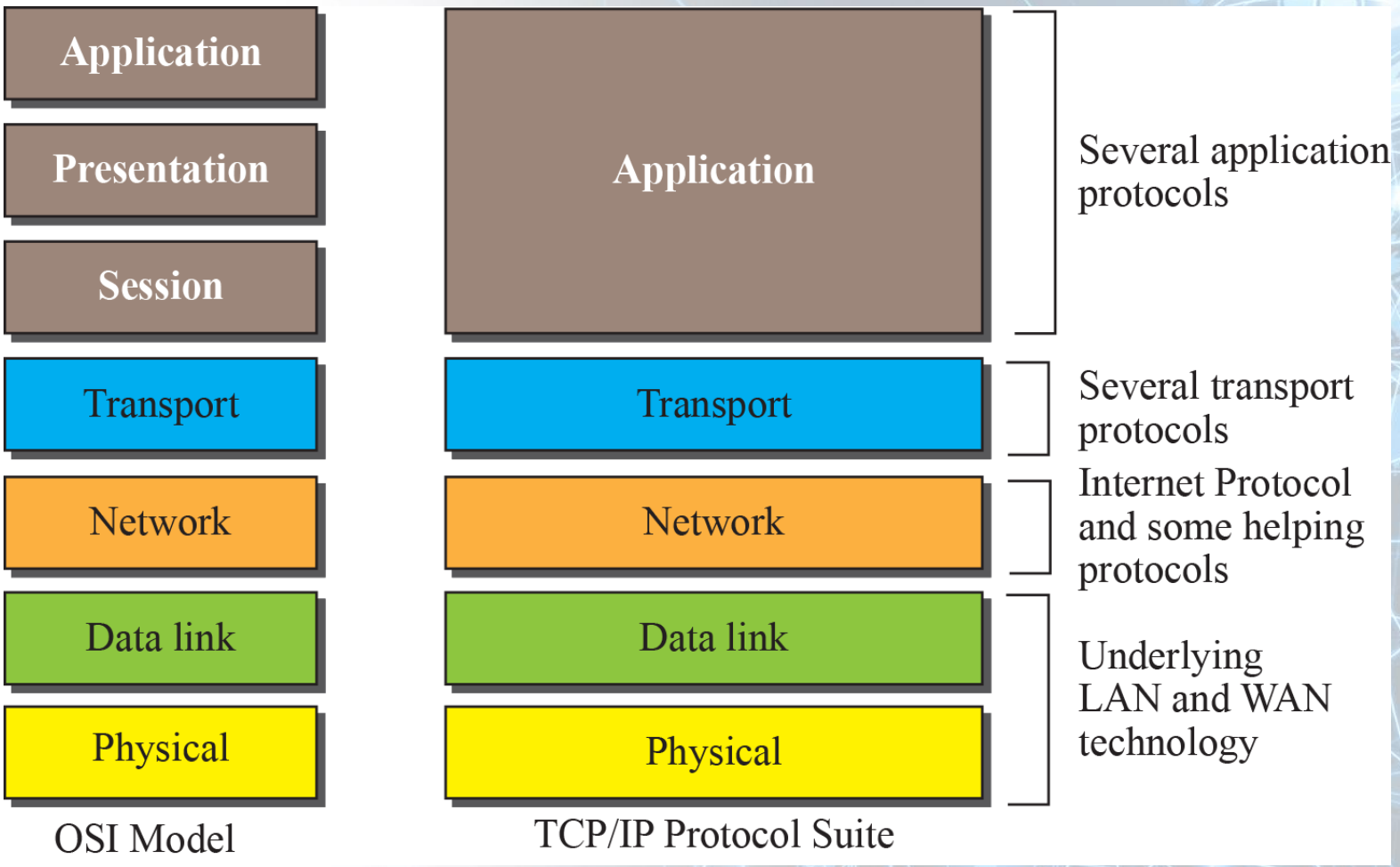
The Open System Interconnection (OSI) Model



OSI Model vs TCP/IP Protocol suite

- Two Layers of OSI missing from TCP/IP
- Application (TCP/IP) = Application + Presentation + Session (OSI)

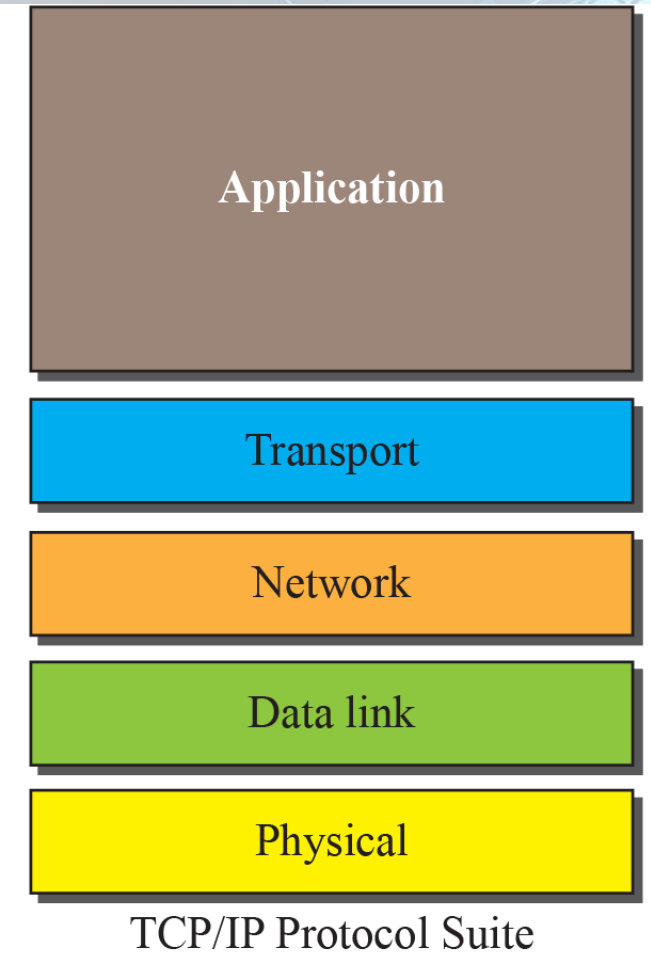
OSI Model vs TCP/IP Protocol suite



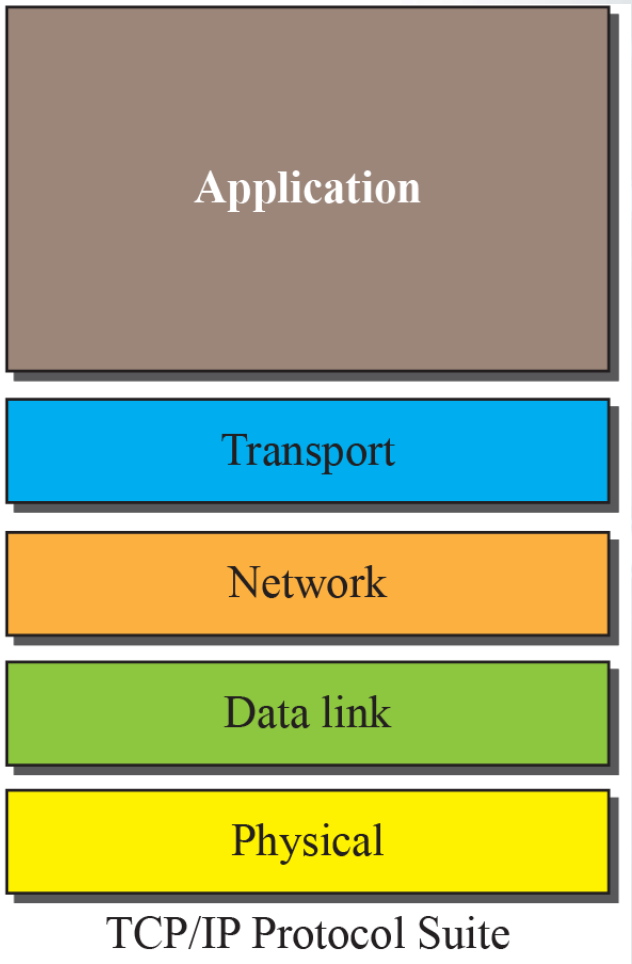
Lack of OSI Model's Success

- Three reasons OSI did not replace TCP/IP:
  - ✓ OSI was completed when TCP/IP was fully in place
  - ✓ Some layers in OSI not fully defined
  - ✓ Performance of TCP/IP better than that of OSI

Data Communication versus Computer Networks



Data Communication versus Computer Networks



TCP/IP Protocol Suite

- Analog & Digital Transmission
- Transmission Media
- Switching
- Error Detection and Correction
- Media Access and Data Link Control
- Wired and Wireless LANs