

Computer Networking

Network Model

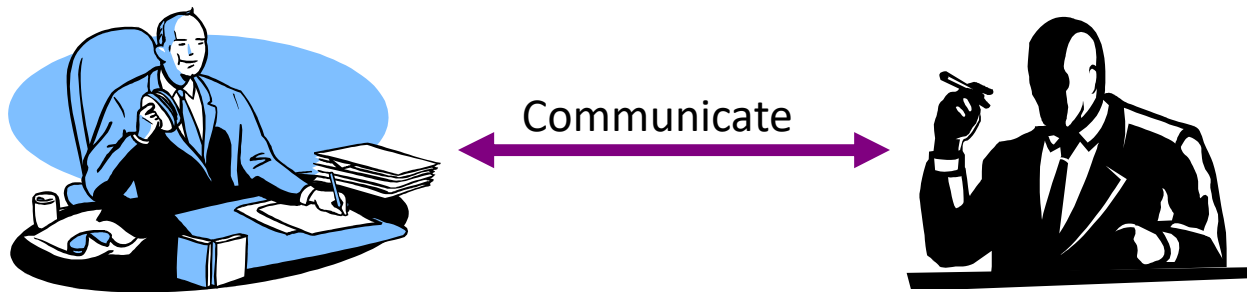
Chapter 2

Protocol Layering

- ▶ Protocol: The rules that the sender, receiver and all intermediate devices follow to communicate effectively
- ▶ Simple communication → Simple protocol
- ▶ Complex communication → Protocol layering
- ▶ Computer networks are complex systems
 - ▶ Tasks involve varieties of hardware and software components, and protocols
- ▶ Networking task is divided into several subtasks, or layers

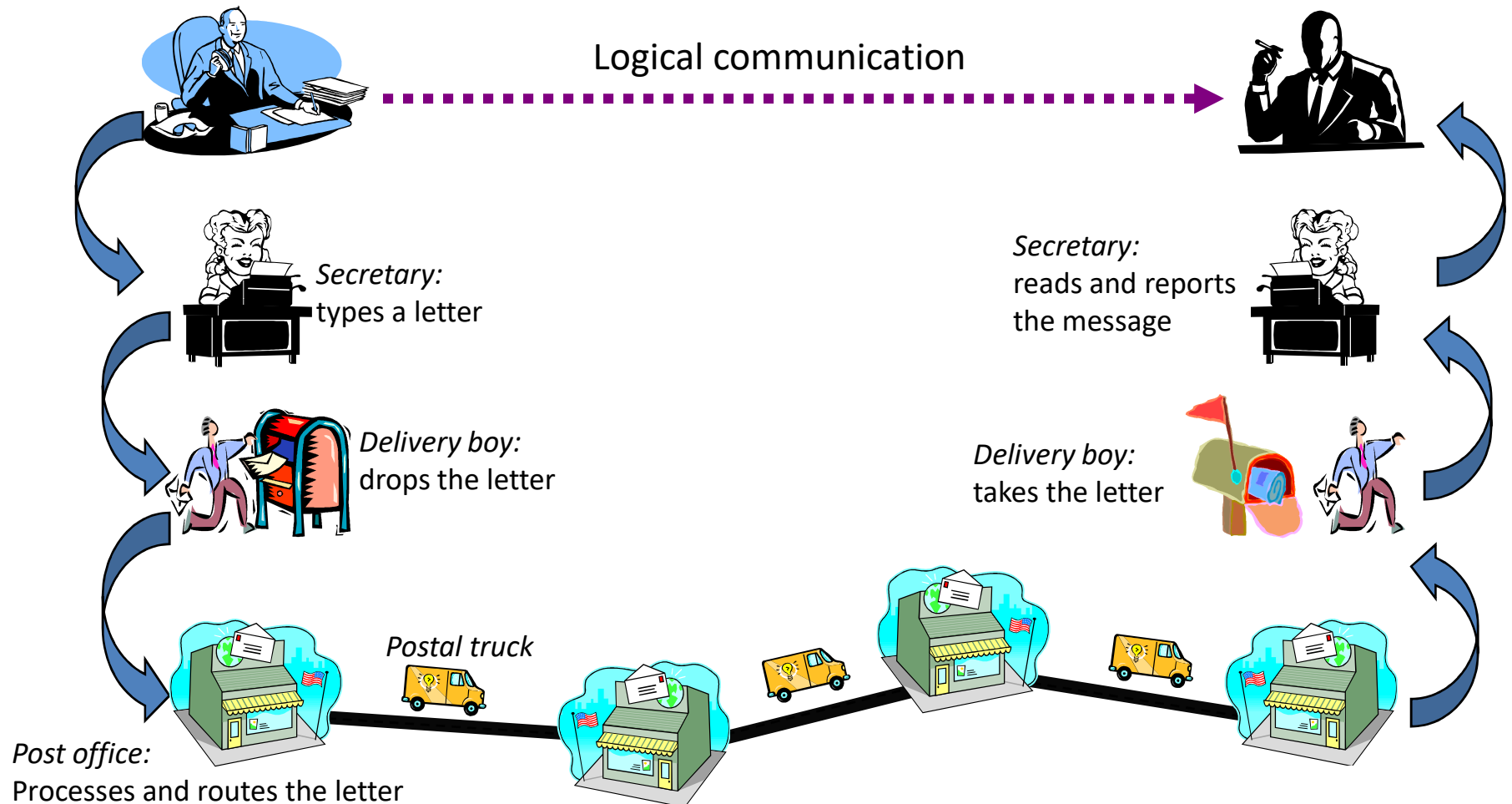
Real World Example

- ▶ Communication between managers of two companies



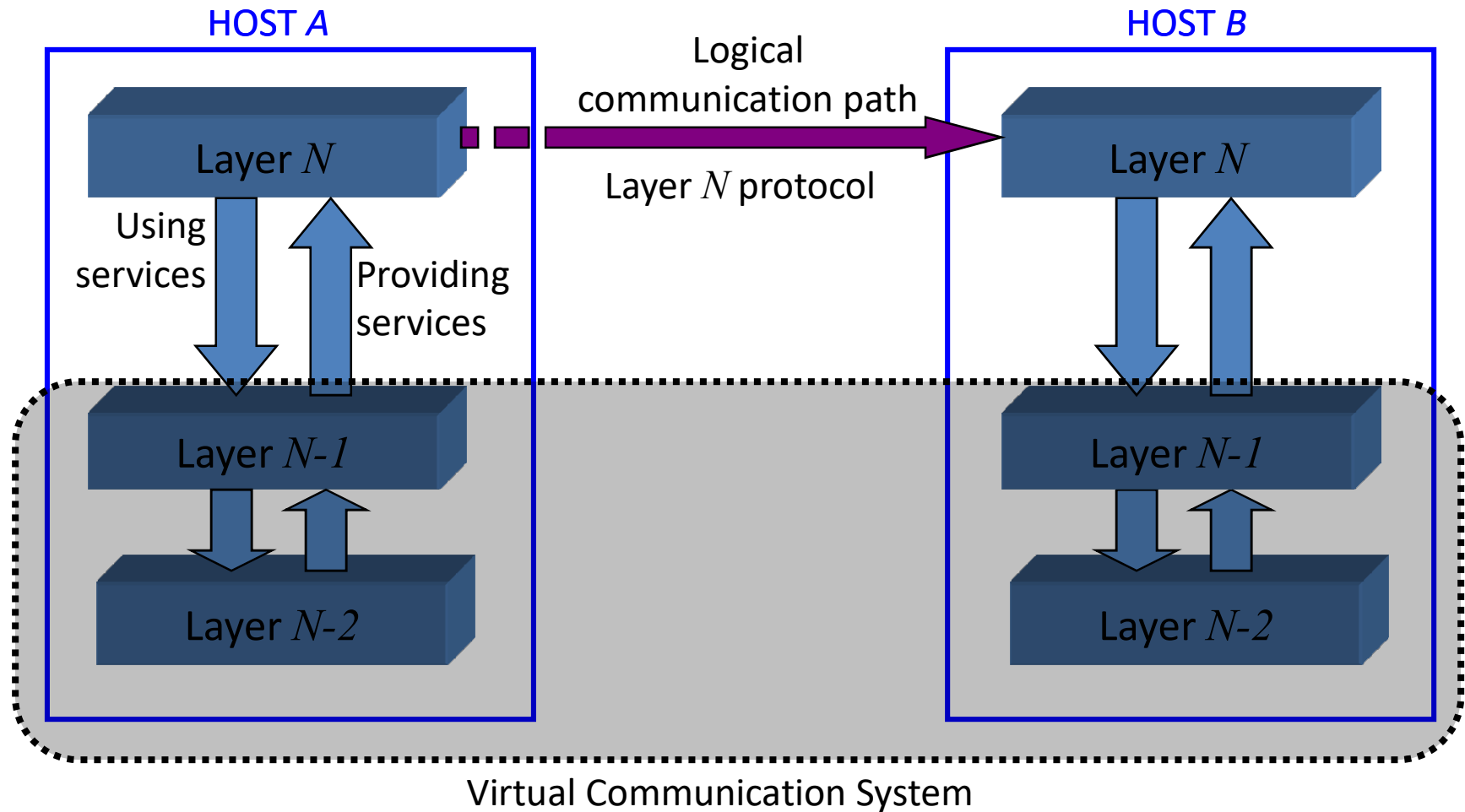
What Actually happens

- Communication takes place thru many layers



Layer Model

- ▶ Layer N uses services provided by Layer $N-1$



Why Layers?

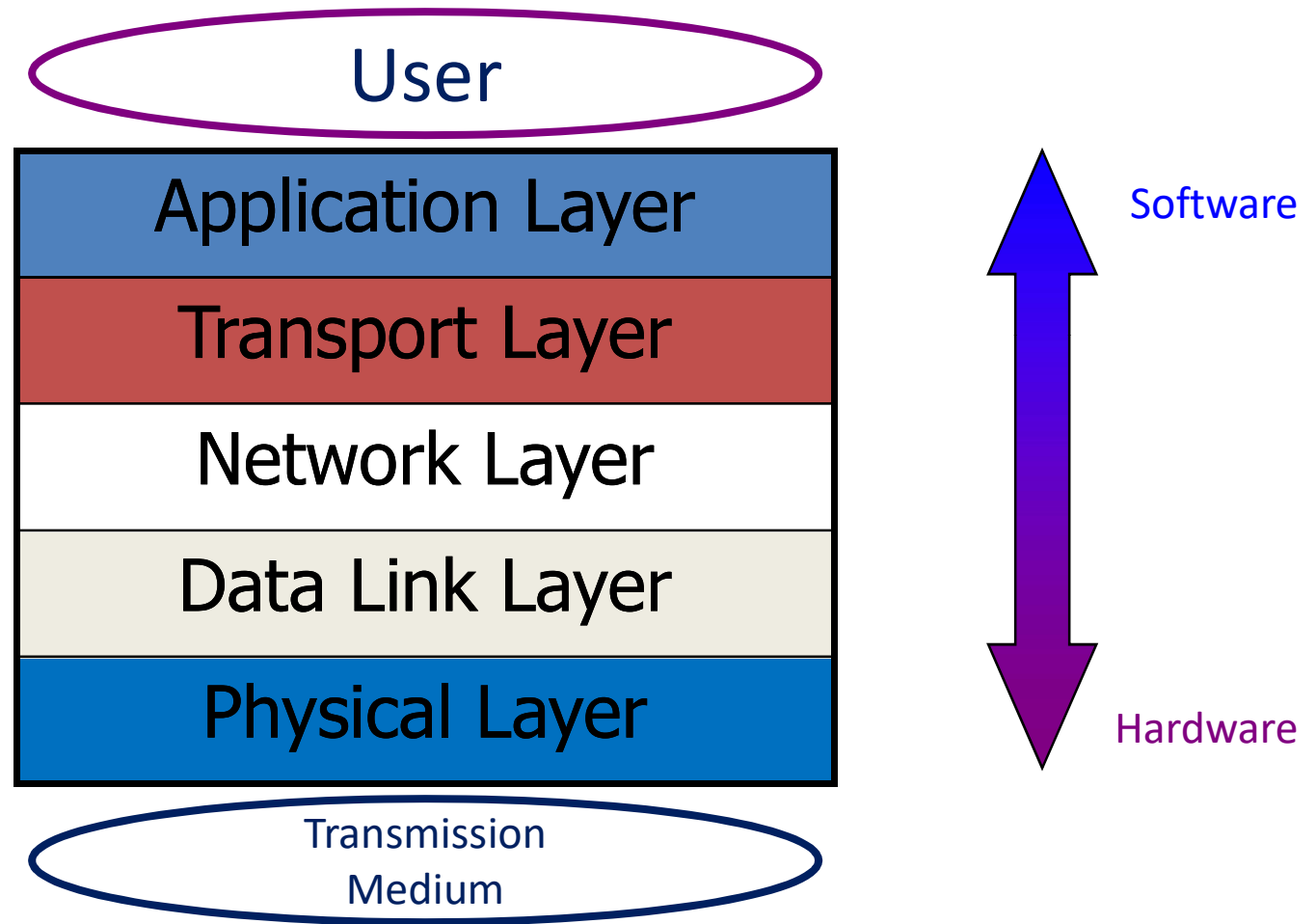
- ▶ Guidelines for protocol developments
 - ▶ Reference model
- ▶ Modularity
 - ▶ Eases maintenance and updating of systems
 - ▶ A change in one layer is transparent to the rest
- ▶ It allows us to separate the services from the implementation.

Two Principles of Protocol Layering

- ▶ Bidirectional communication.
- ▶ The objects under each layer at both sites should be identical.

Internet Layer Model: TCP/IP Protocol Suite

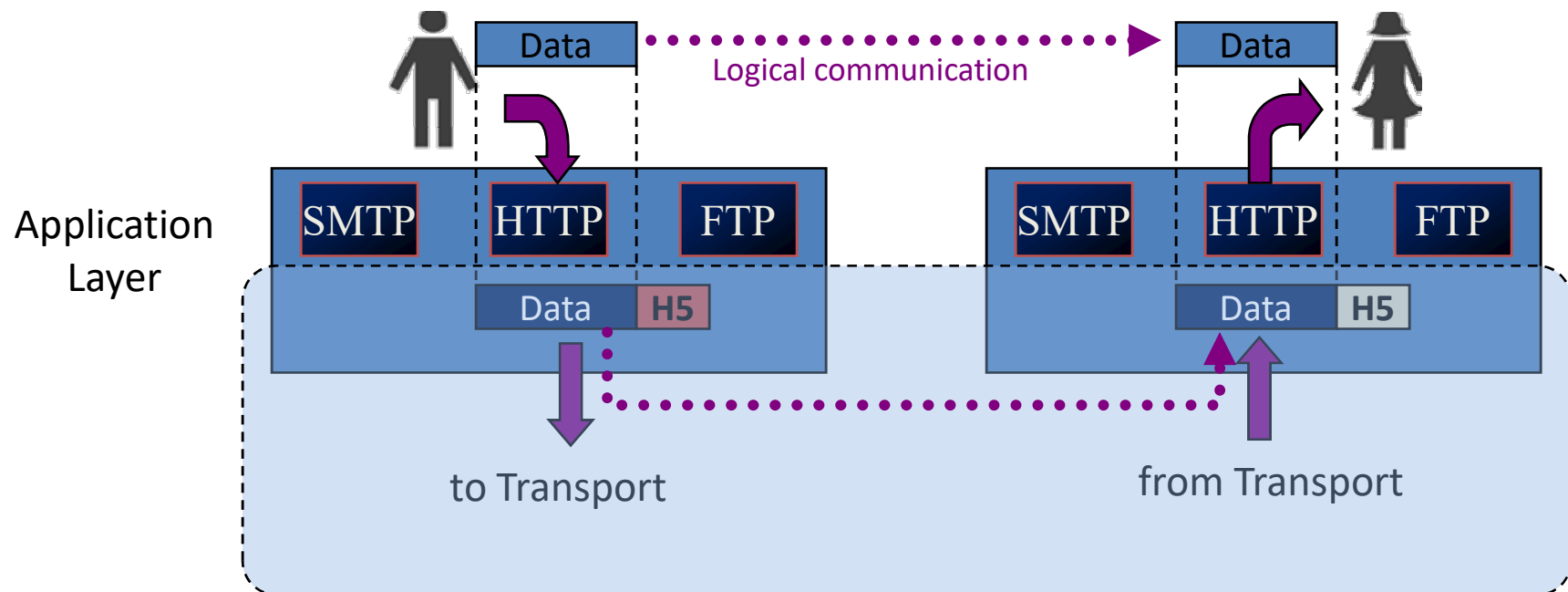
- ▶ The Internet Protocol Stack



Application Layer

Responsible for providing services to the user

- ▶ The only layer to interact with user

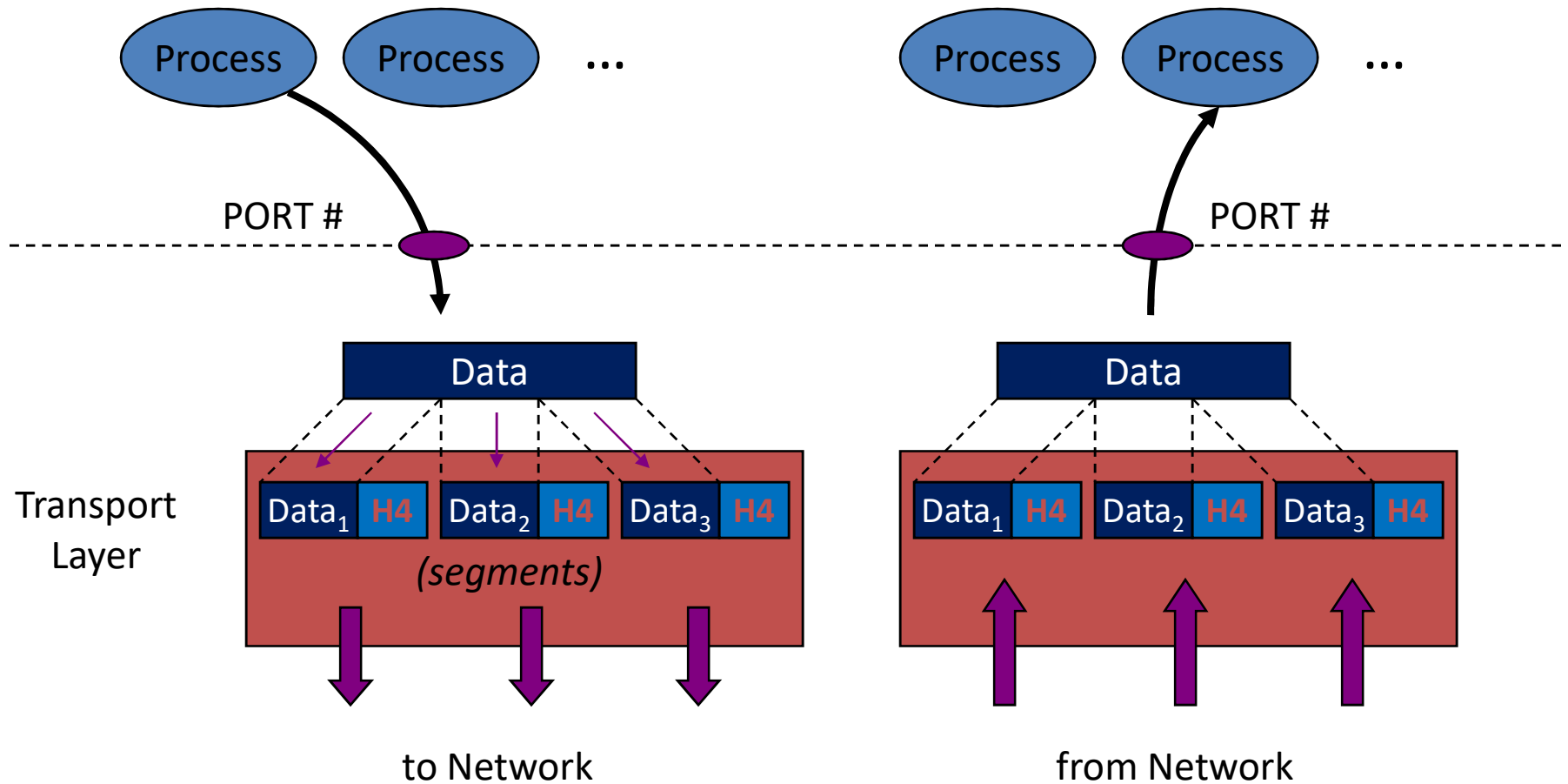


Transport Layer

*Responsible for delivery of a message
from one process to another*

- ▶ Duties/services
 - ▶ Port addressing
 - ▶ Segmentation and reassembly
 - ▶ Connection control
 - ▶ Flow control (end-to-end)
 - ▶ Error control (end-to-end)

Transport Layer

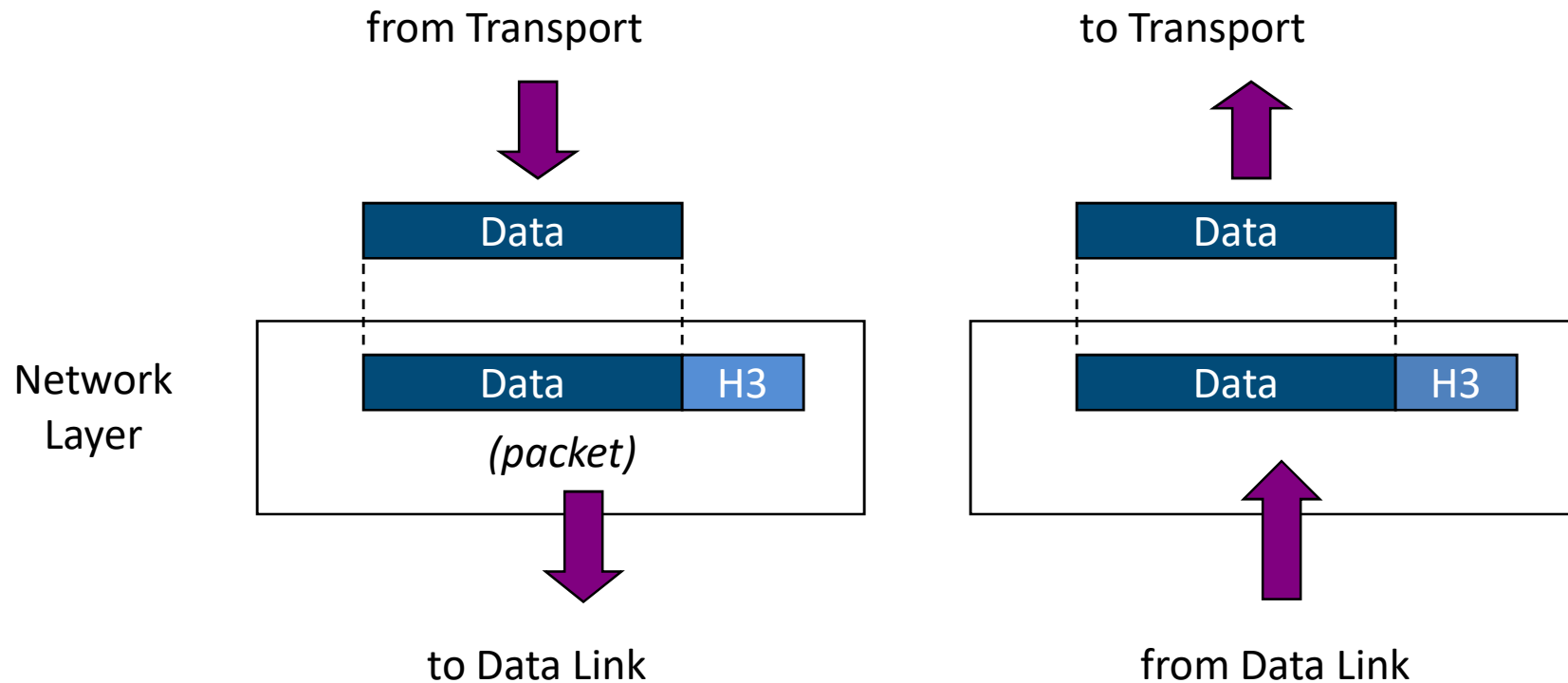


Network Layer

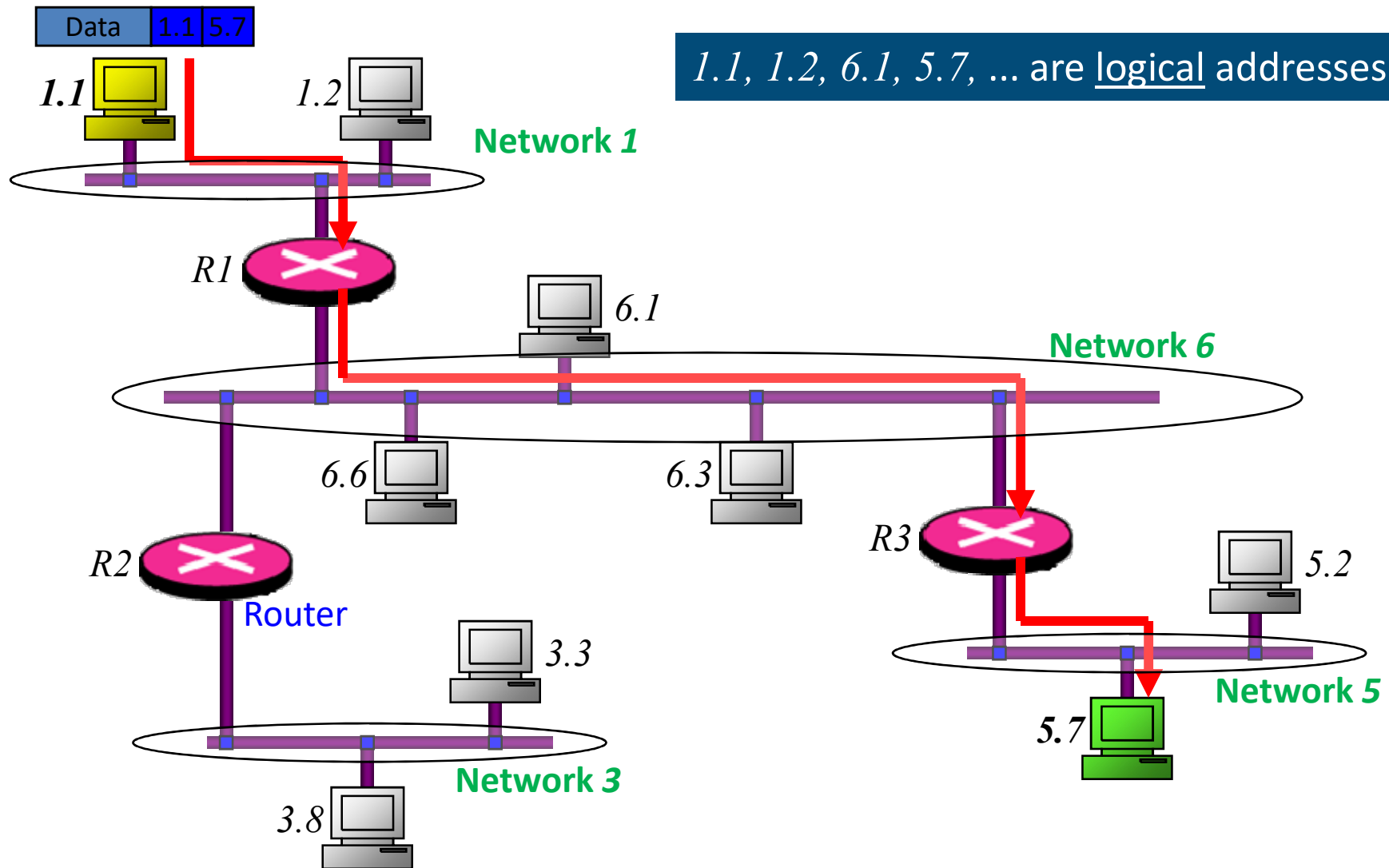
*Responsible for the delivery of packets
from the original source to the destination*

- ▶ Duties/services
 - ▶ Logical addressing
 - ▶ Routing

Network Layer



Network Layer

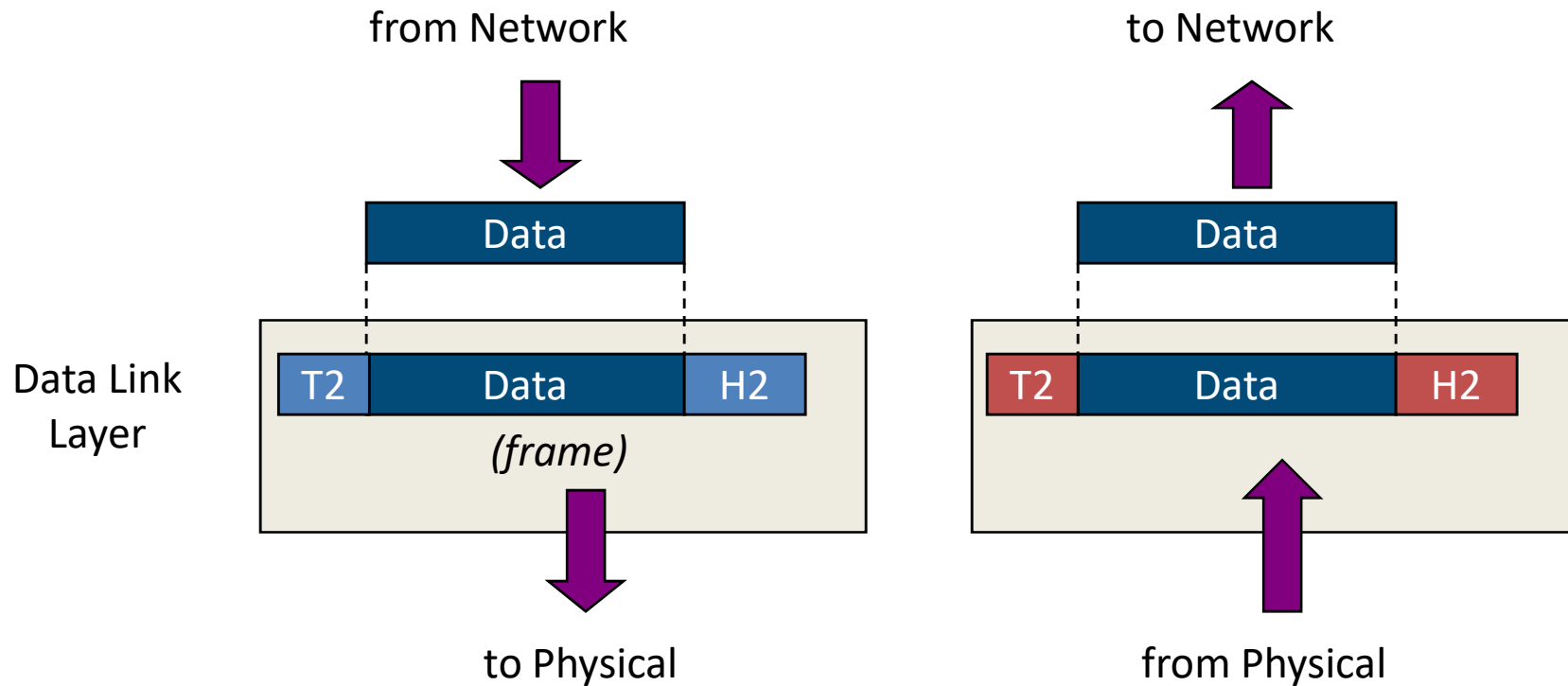


Data Link Layer

*Responsible for transmitting frames
from one node to the next*

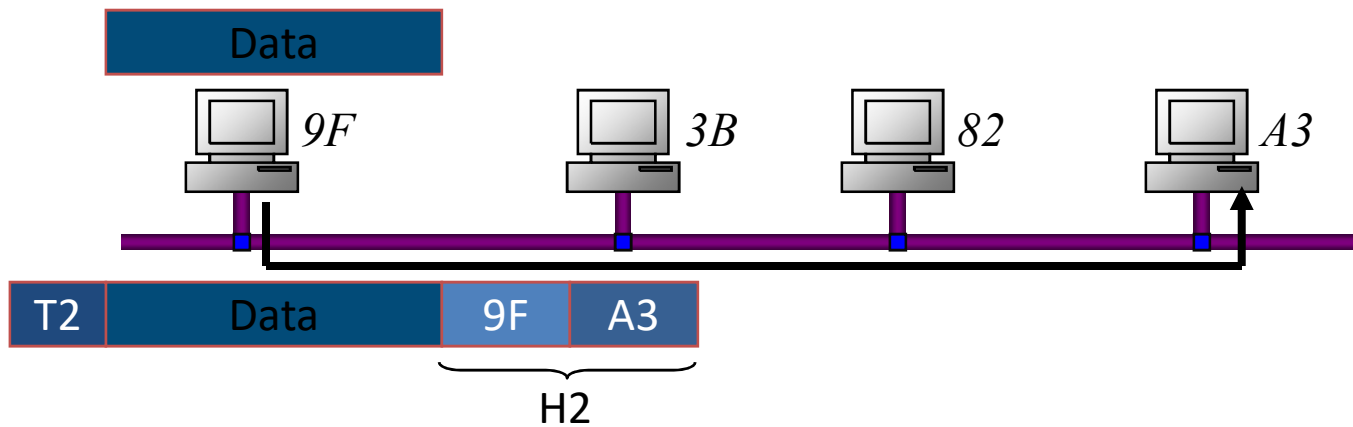
- ▶ Duties/services
 - ▶ Framing
 - ▶ Physical addressing
 - ▶ Flow control (hop-to-hop)
 - ▶ Error control (hop-to-hop)
 - ▶ Access control

Data Link Layer

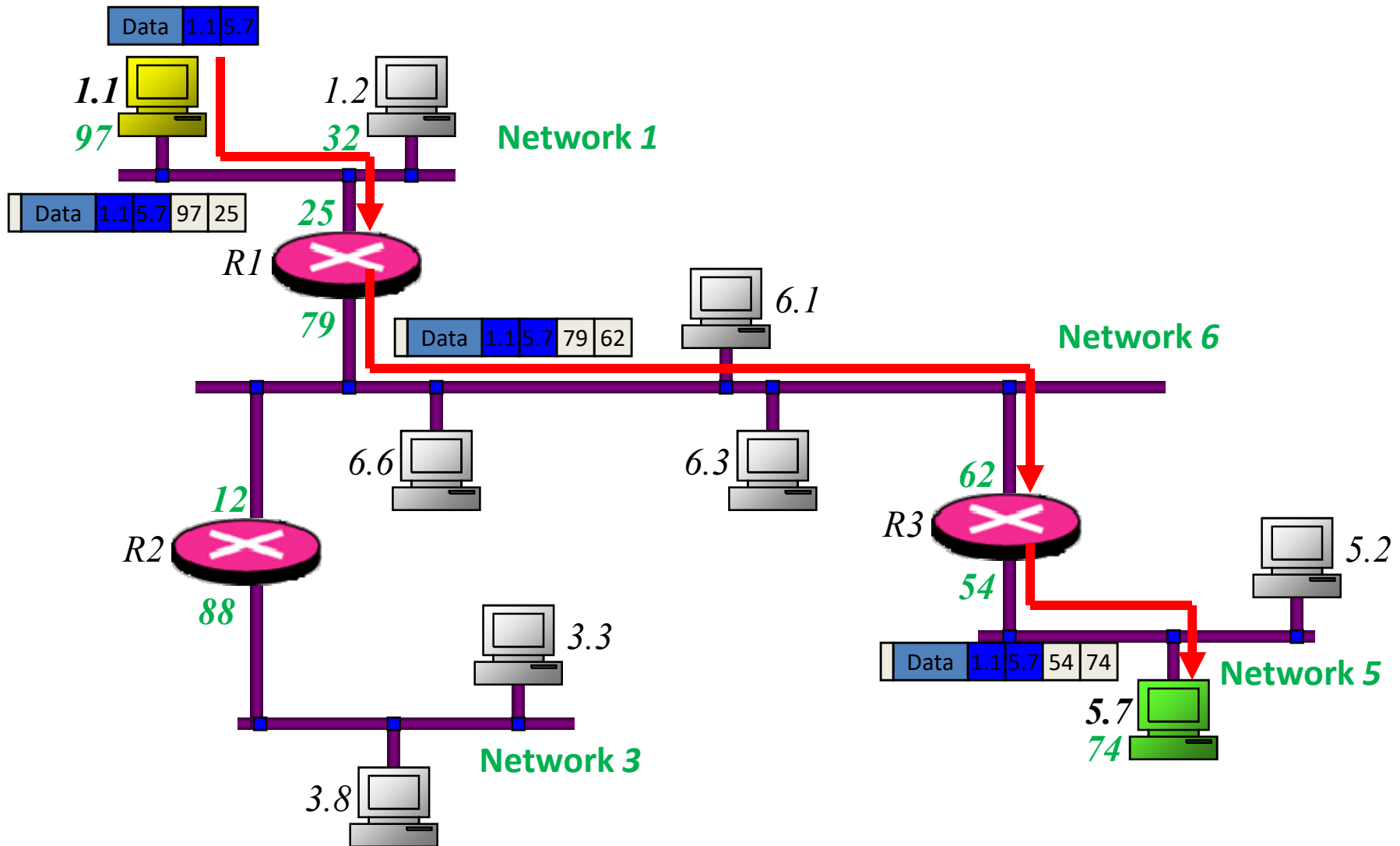


Data Link Layer

A3, 3B, 82, 9F, ... are physical addresses



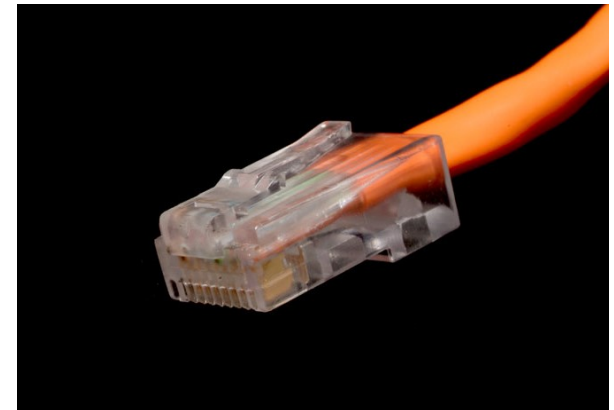
Data Link Layer



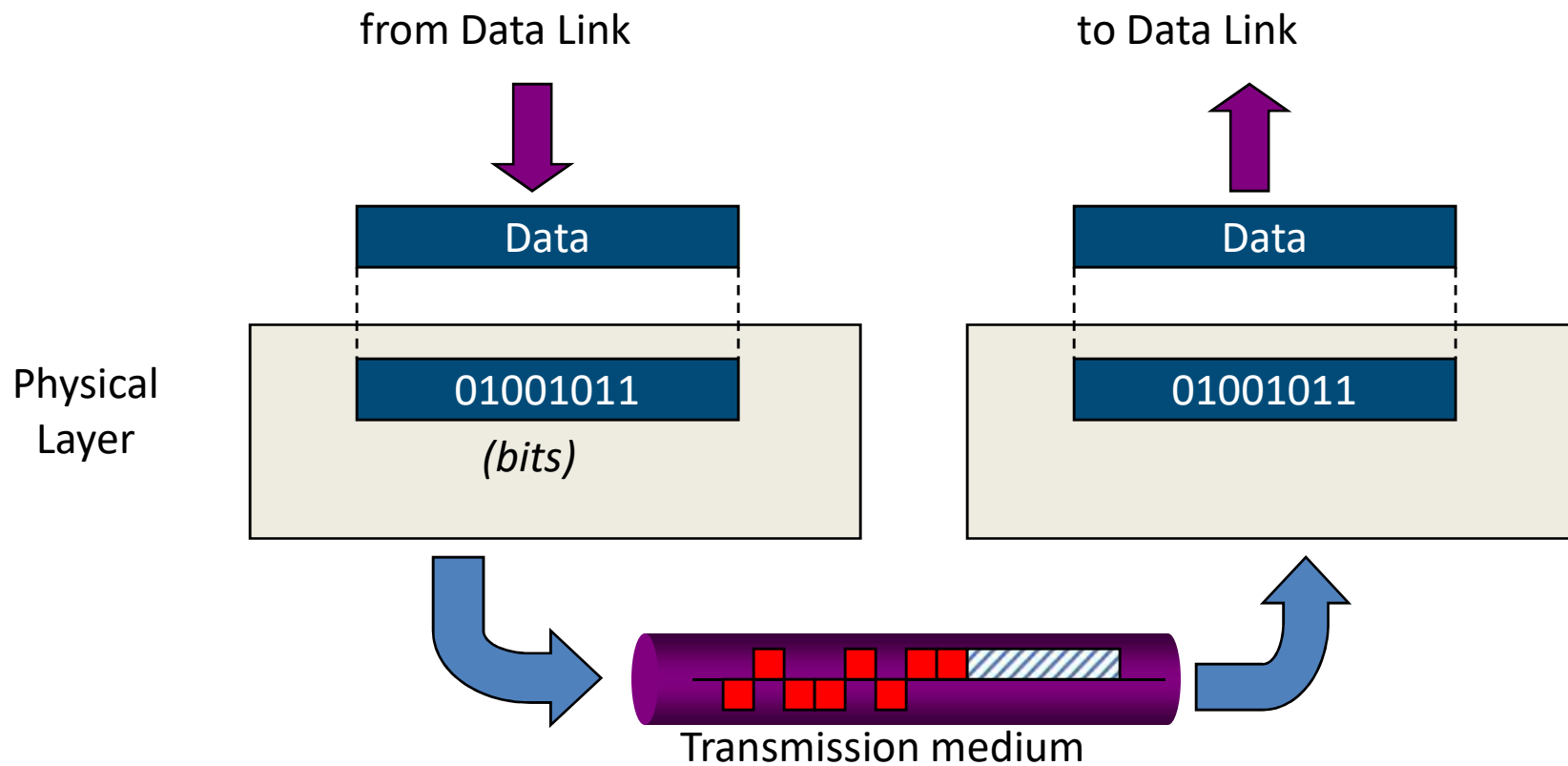
Physical Layer

*Responsible for transmitting individual bits
from one node to the next*

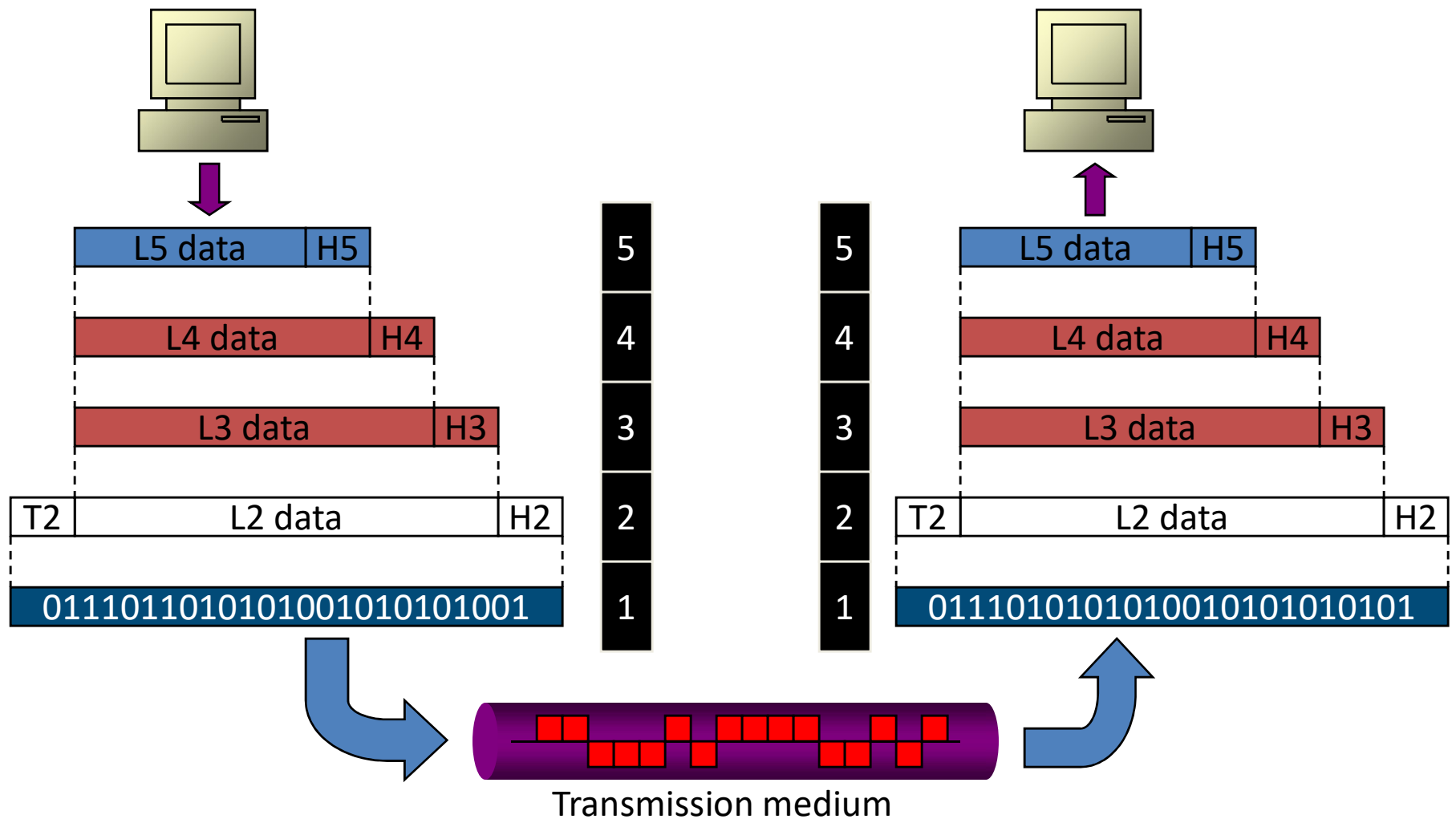
- ▶ Duties/services
 - ▶ Physical characteristics of interfaces and media
 - ▶ Representation of bits
 - ▶ Data rate (transmission rate)
 - ▶ Synchronization of bits



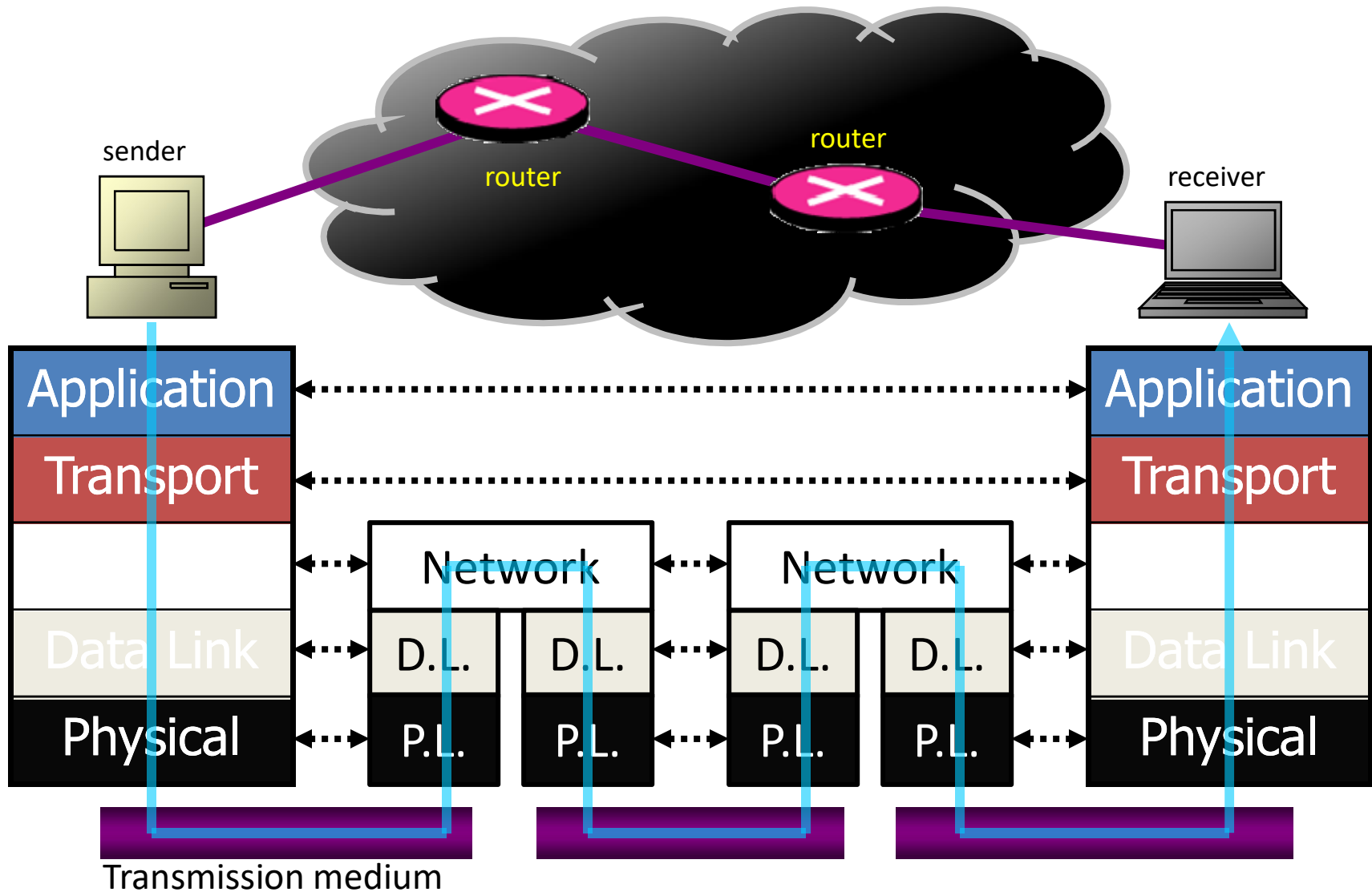
Physical Layer



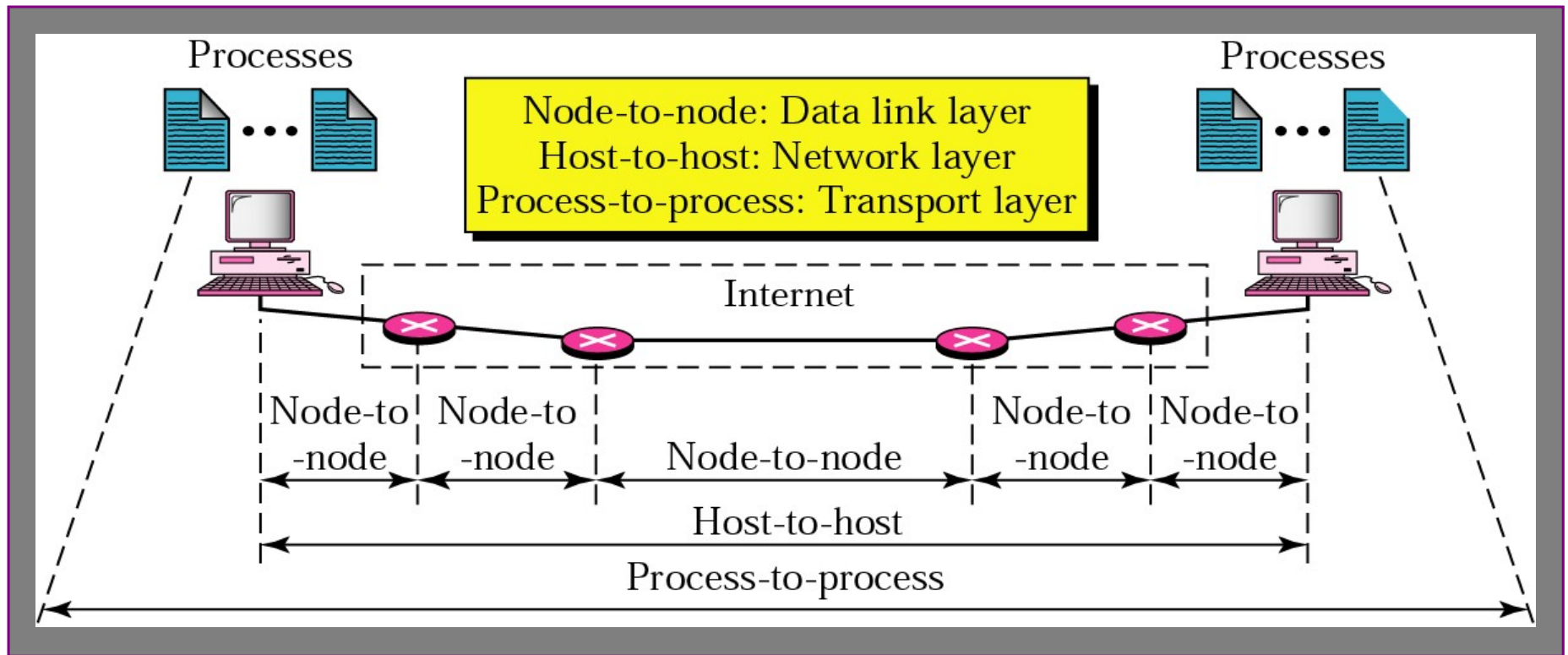
The Big Picture



Internet Model



Internet Model



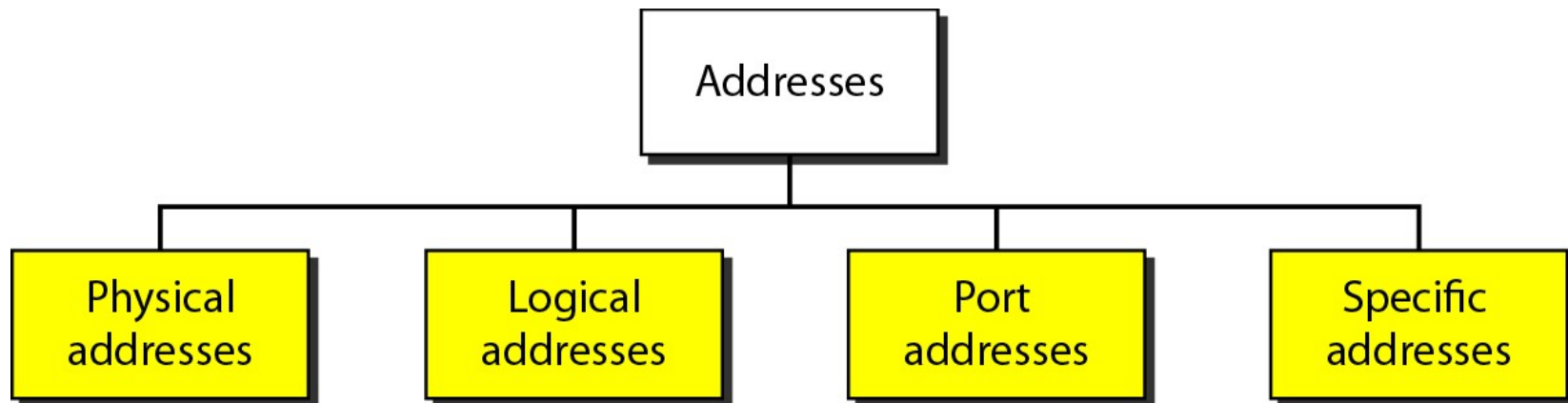
Protocol Suites

- A set of protocols must be constructed
 - to ensure that the resulting communication system is **complete** and **efficient**
- Each protocol should handle a part of communication not handled by other protocols
- How can we guarantee that protocols work well together?
 - Instead of creating each protocol in isolation, protocols are designed in complete, cooperative sets called **suites** or **families**

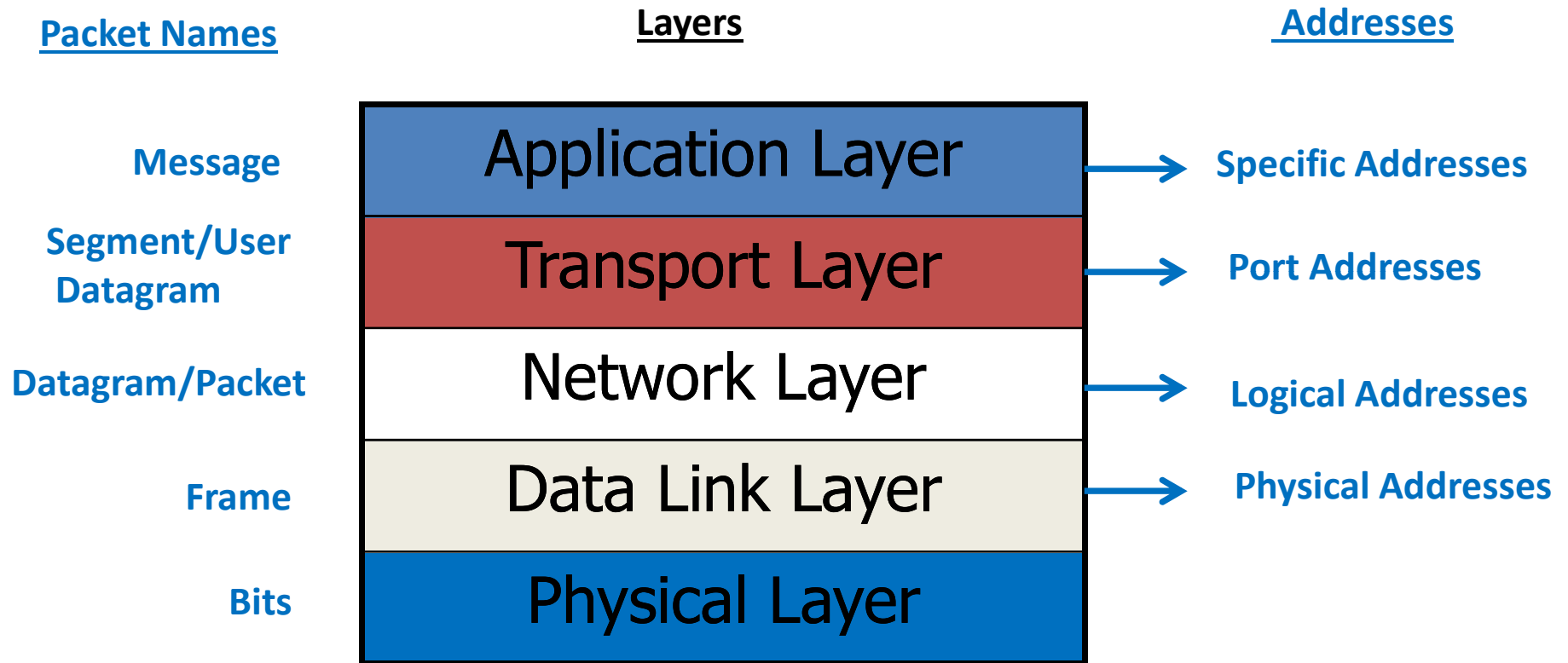
Internet Protocol Suite

Layer	Protocols
Application	HTTP, FTP, Telnet, SSH, SMTP, DNS, SNMP, IGMP, ...
Transport	TCP, UDP, SCTP, ...
Network	IP (IPv4), IPv6, ICMP, IGMP, ARP, RARP, ...
Data Link	Ethernet, Wi-Fi, PPP, ...
Physical	RS-232, DSL, 10Base-T, ...

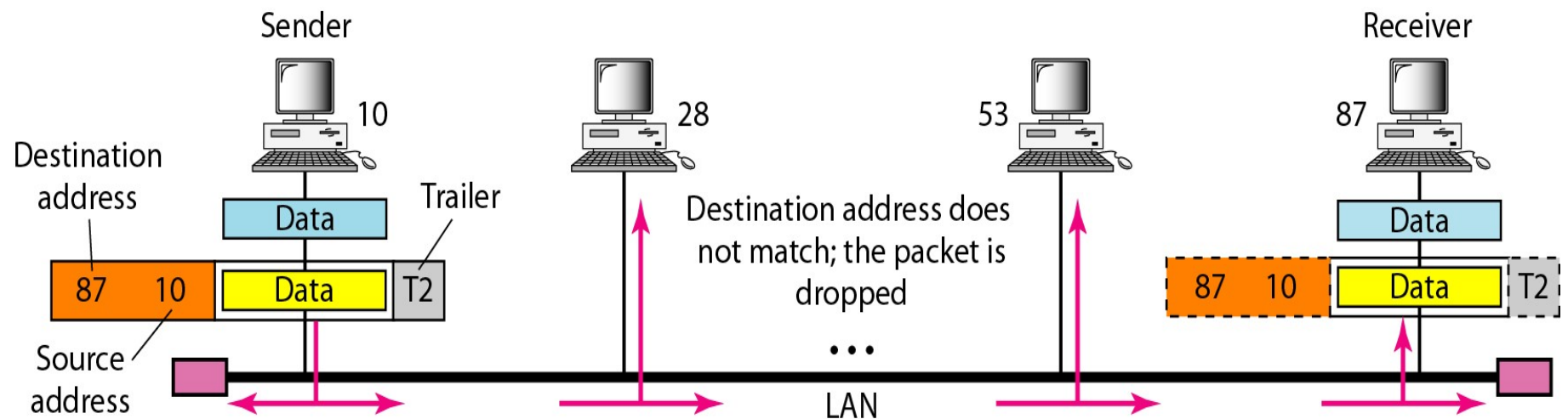
Addresses in TCP/IP



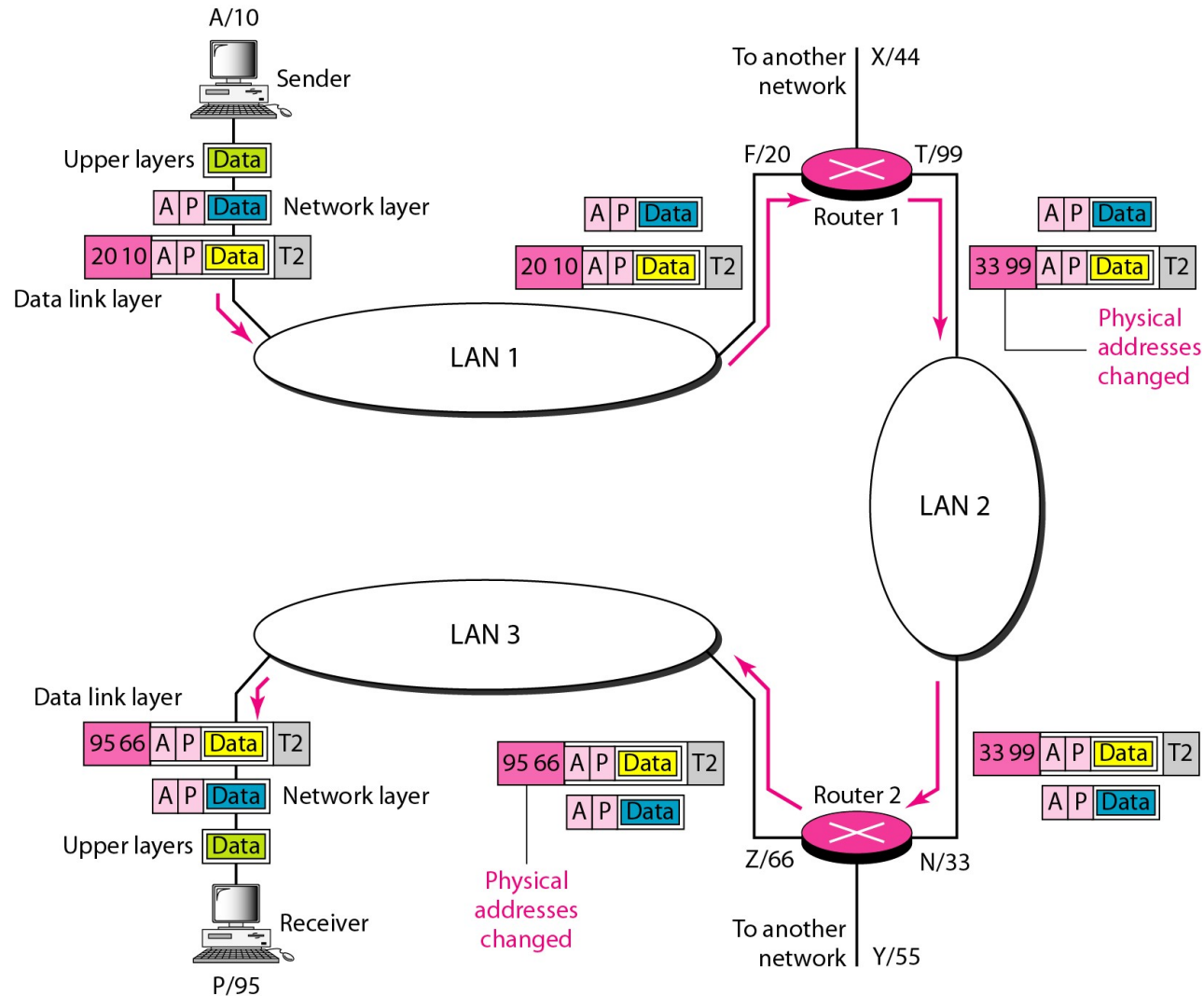
Addressing in TCP/IP



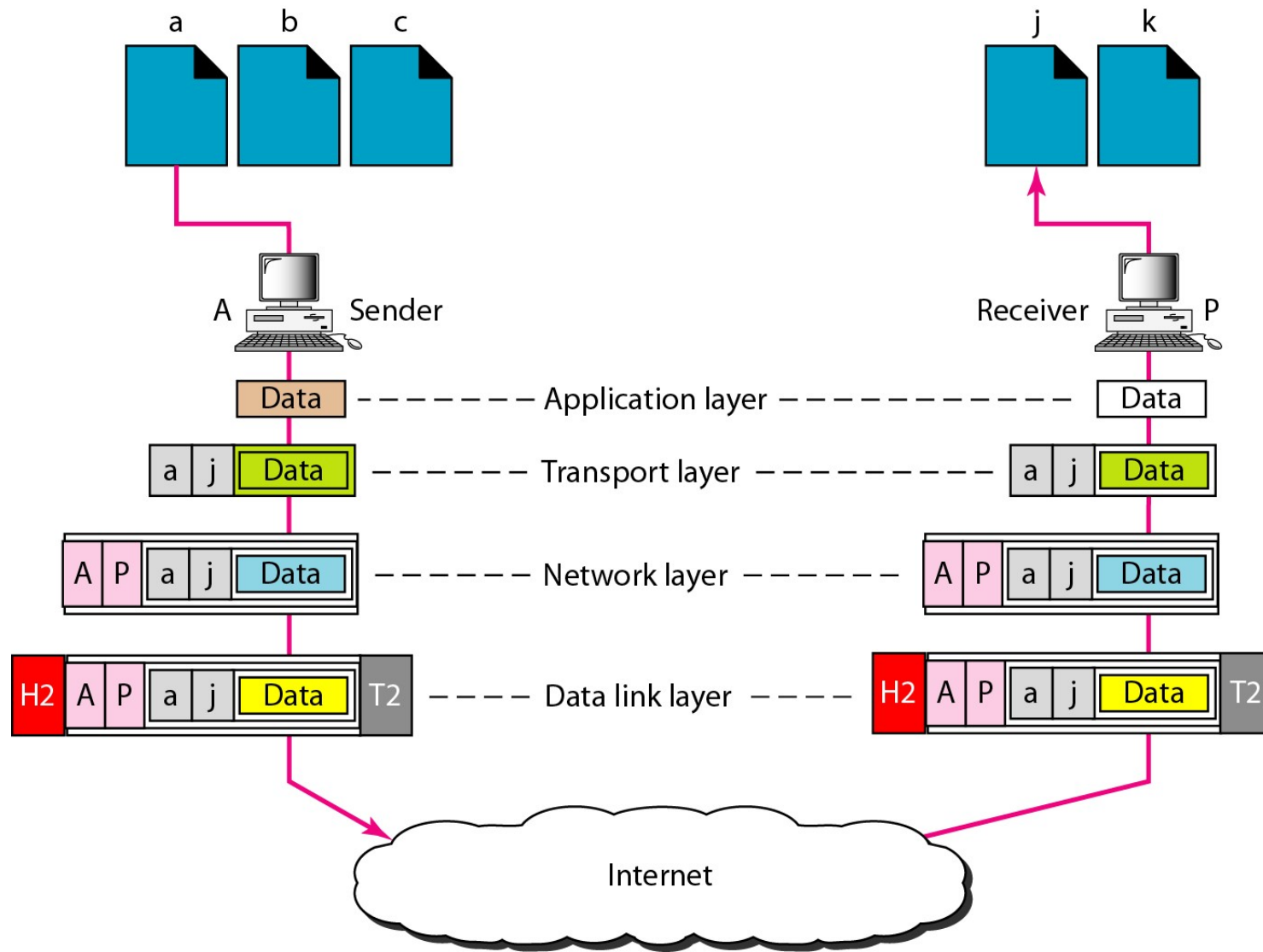
Physical Addresses



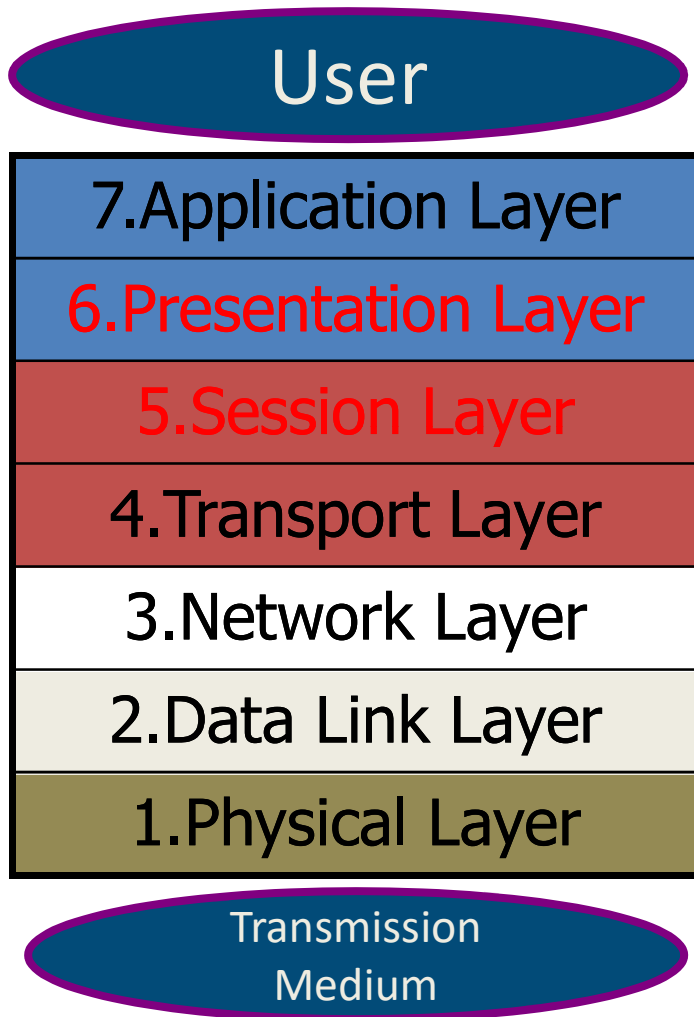
Logical/IP Addresses



Port Addresses



OSI Model



- OSI – Open Systems Interconnection
- Developed by the International Standards Organizations (ISO)
- Two additional layers
 - Presentation layer
 - Session layer

Session Layer

Responsible for establishing, managing and terminating connections between applications

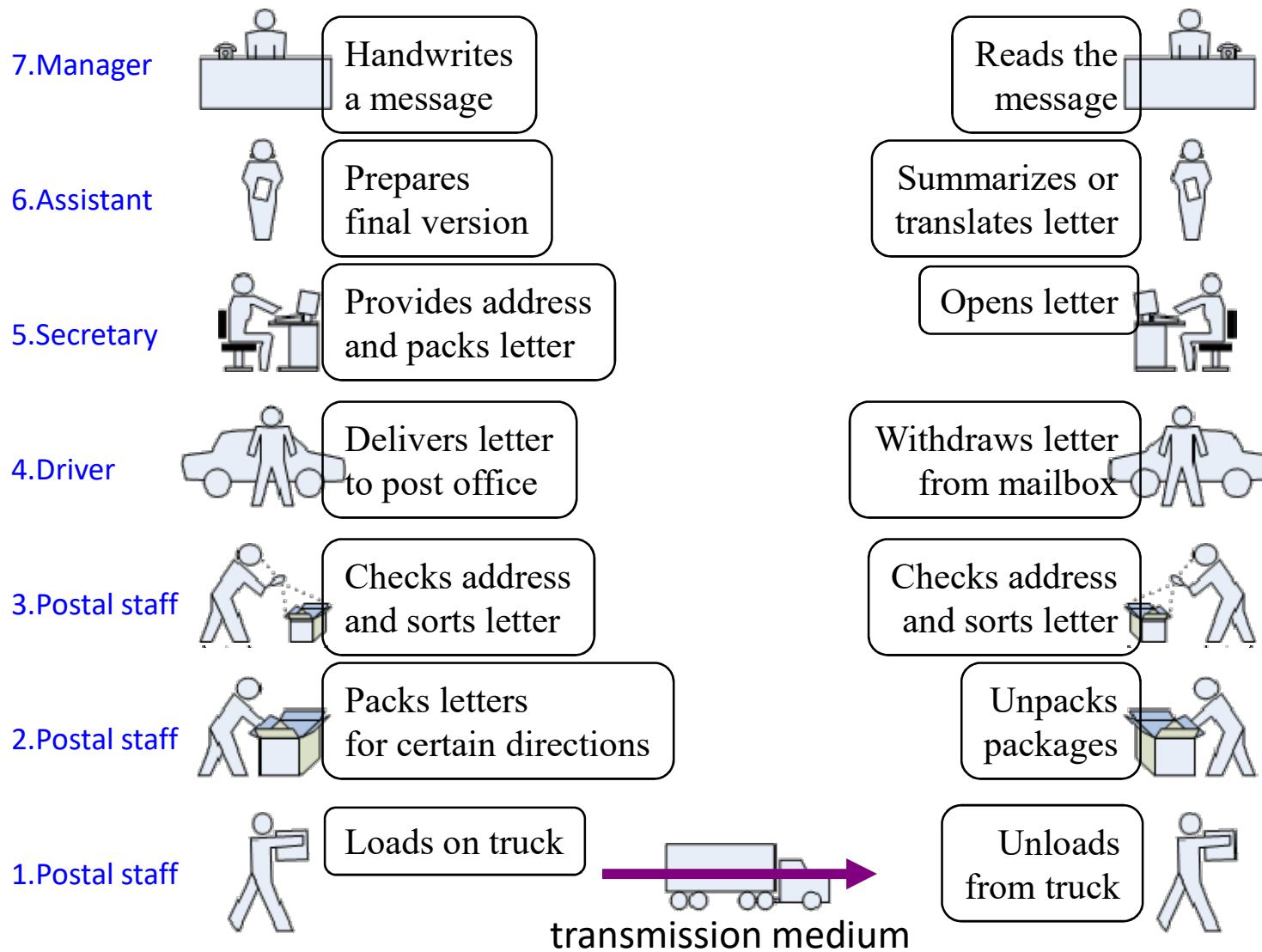
- Duties/services
 - Interaction management
 - ⇒ Simplex, half-duplex, full-duplex
 - Session recovery

Presentation Layer

Responsible for handling differences in data representation to applications

- Duties/services
 - Data translation
 - Encryption
 - Decryption
 - Compression

OSI Layers in Real World



Pictures from Wikipedia

Lack of OSI Model's Success

- ▶ Costly
- ▶ Some of layers were never fully defined
- ▶ Performance