Note: These course notes are to be used strictly as part of the ECE 462 class at George Mason University.

Lecture 2

ECE 462- Data and Comp. Communications

Protocol Architecture and Layering Concepts

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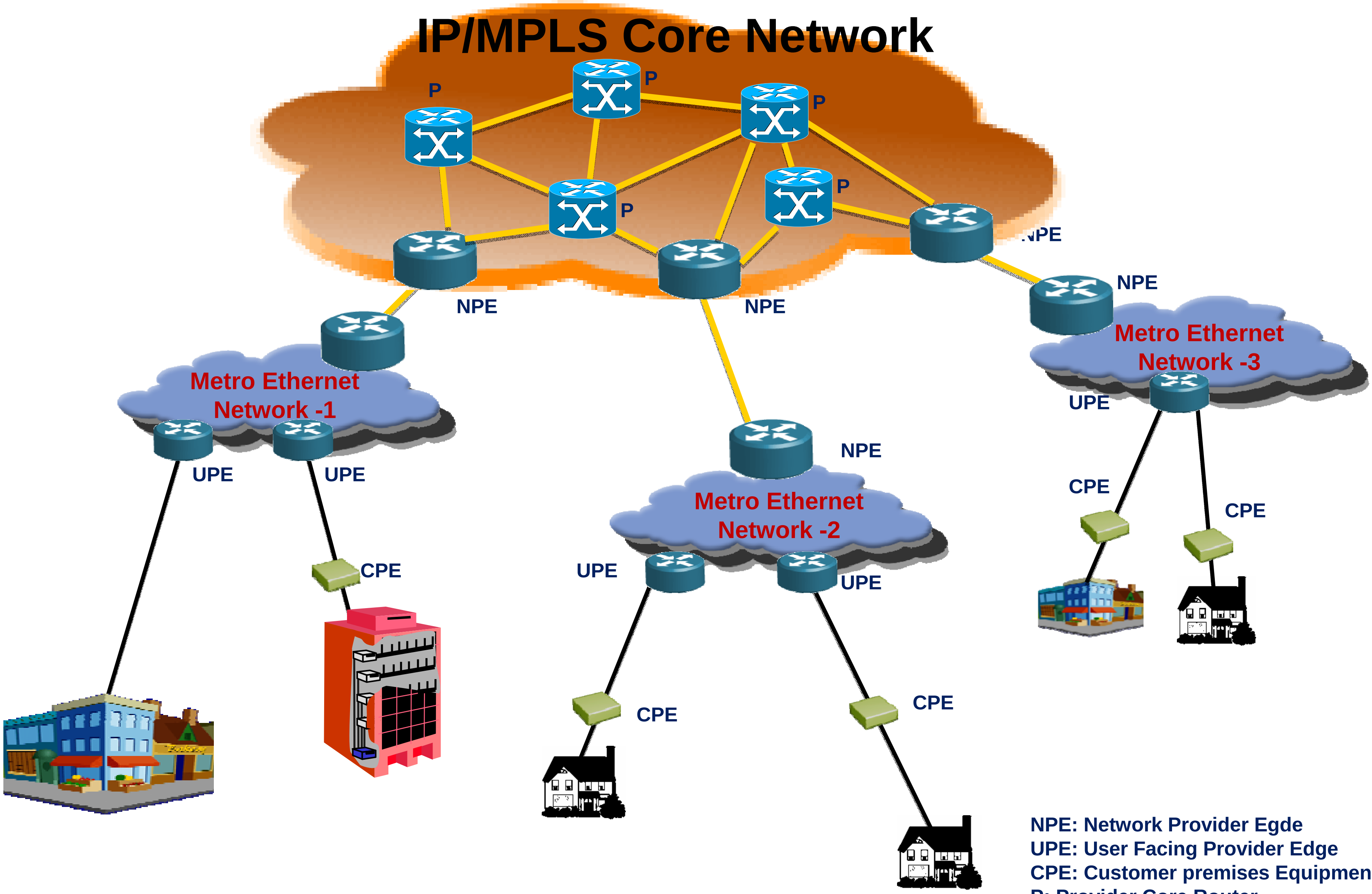
Outline

- Introduction
- OSI Concept
  - Layering
  - Peer-Peer Communications
- Protocol Architecture
- Primitives
- Internet Architecture
- Alignment with Internet

Internet Structure: Network Edge, Core and Access


IP/MPLS Core Network
P
P
P
P
P
NPE
NPE
NPE
NPE
NPE
NPE
Metro Ethernet Network -1
Metro Ethernet Network -2
Metro Ethernet Network -3
UPE
UPE
UPE
UPE
UPE
CPE
CPE
CPE
CPE
CPE

NPE: Network Provider Egde
UPE: User Facing Provider Edge
CPE: Customer premises Equipment
P: Provider Core Router

Need For Protocol Architecture

- E.g. File transfer
  - Source must activate comms. Path or inform network of destination
  - Source must check destination is prepared to receive
  - File transfer application on source must check destination file management system will accept and store file for his user
  - May need file format translation
- Task broken into subtasks
- Implemented separately in layers in stack
- Functions needed in both systems
- Peer layers communicate

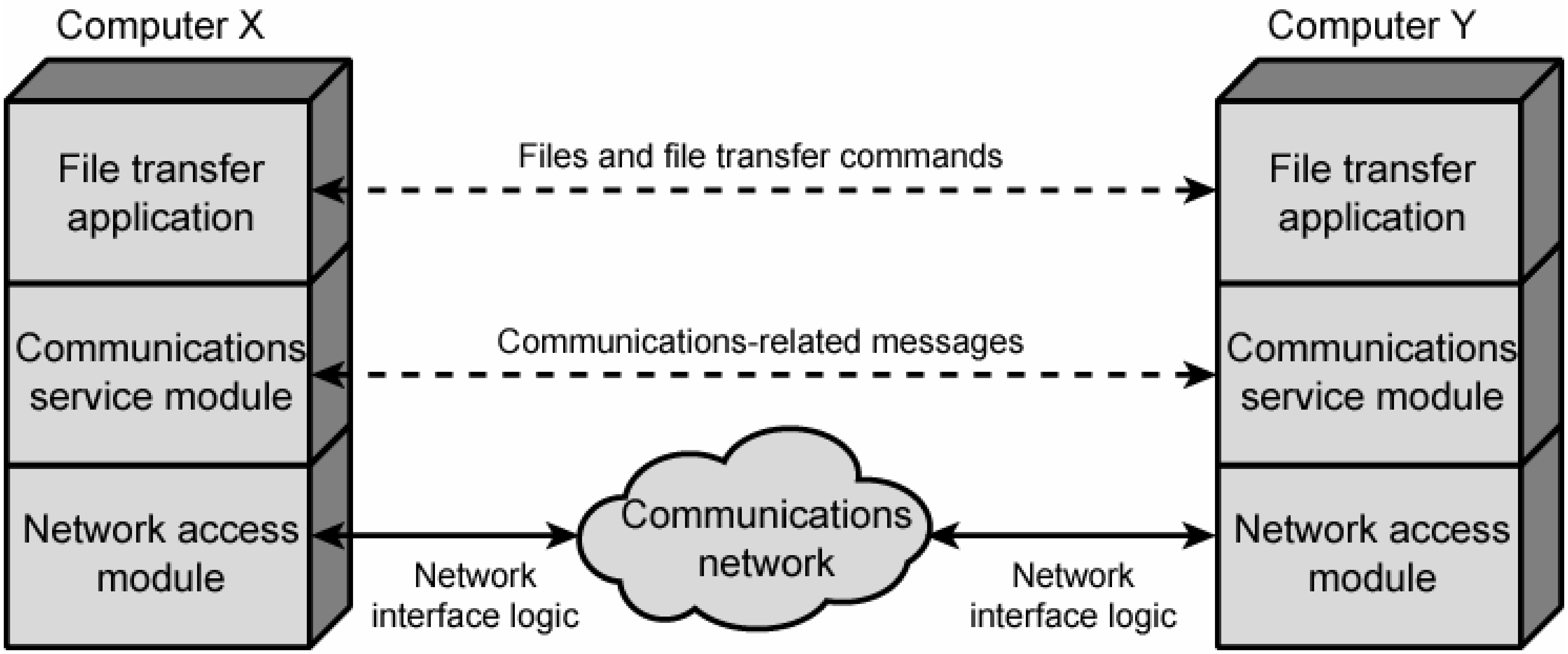
Key Elements of a Protocol

- Syntax
  - Data formats
  - Signal levels
- Semantics
  - Control information
  - Error handling
- Timing
  - Speed matching
  - Sequencing

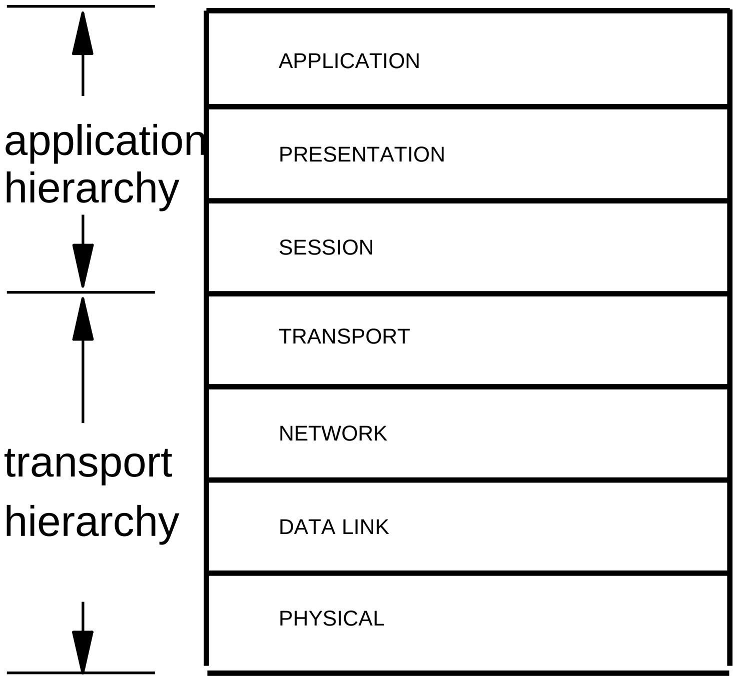
Protocol Architecture

- Task of communication broken up into modules
- For example file transfer could use three modules
    - File transfer application
    - Communication service module
    - Network access module

Simplified File Transfer Architecture


Computer X
Computer Y
File transfer application
Communications service module
Network access module
Files and file transfer commands
Communications-related messages
Communications network
Network interface logic
Network interface logic
File transfer application
Communications service module
Network access module

The OSI Reference Model



Physical transmission media

OSI - The Model

- A layered model
- Each layer performs a subset of the required communication functions
- Each layer relies on the next lower layer to perform more primitive functions
- Each layer provides services to the next higher layer
- Changes in one layer should not require changes in other layers

The OSI Reference Model

- Physical layer: provides transparent transmission of a bit stream over a communication link
- Data link layer: ensures reliable exchange of information by error control, flow control, and other link control activities
- Network layer: performs routing and relaying of data between end users. Includes addressing, routing, logical channel multiplexing and congestion control:
  - Connectionless (datagram services)
  - Connection-oriented (virtual circuit services)

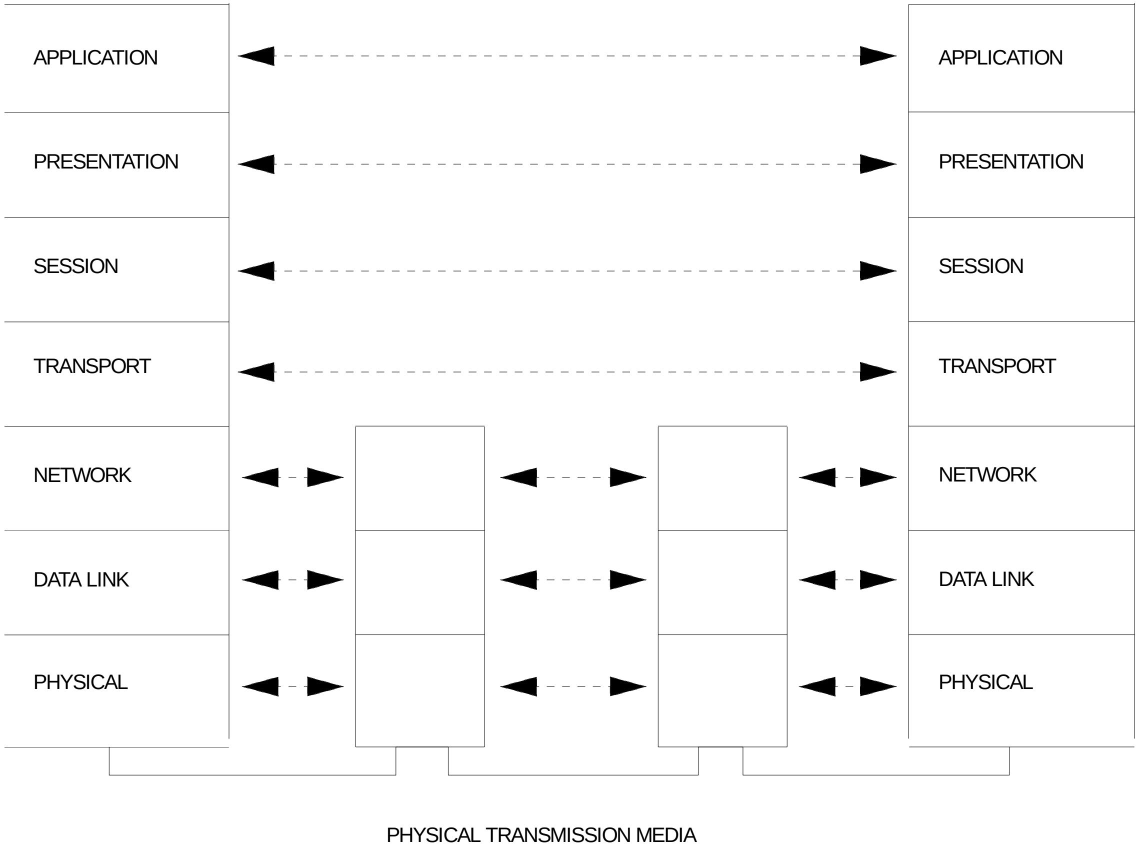
OSI Reference Model (cont'd)

- Transport layer (layer 4)
  - Optimizes the use of resources (I.e. network service) according to the type and character of the communication and relieves the user of any concern for the transfer details
  - Includes functions for end-to-end data flow control independent of the intermediate transport network or links, end-to-end data verification, sequence control, and error control
- Session layer (layer 5)
  - Coordinates the interaction within each association between communicating application processes
  - I.e., it initiates, manages, and terminates sessions, allocates resources and determines whether the mode of data transfer will be full duplex, half duplex dialogue or transaction type.

OSI Reference Model (cont'd)

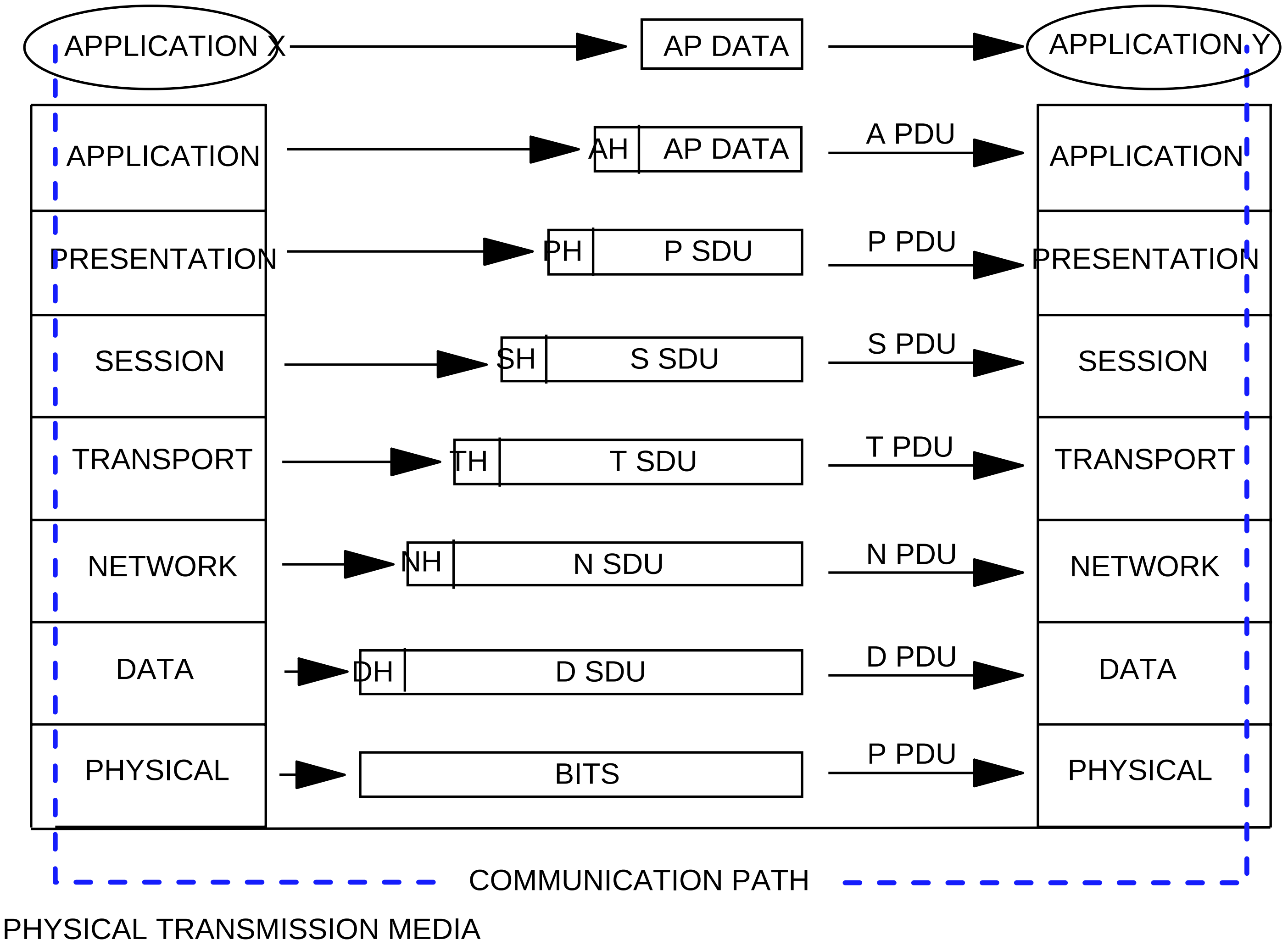
- Presentation layer (layer 6)
  - Transforms the syntax of the data that is to be transferred into a form recognizable by the communicating application processes
  - E.g., converts a data stream from ASCII to EBCDIC, formatting (line/page), storage, and high level encryption/decryption.
- Application layer (layer 7)
  - Specifies the nature of the communication required to satisfy the user's needs
  - The end users are considered to be sitting above this layer

The OSI Reference Model

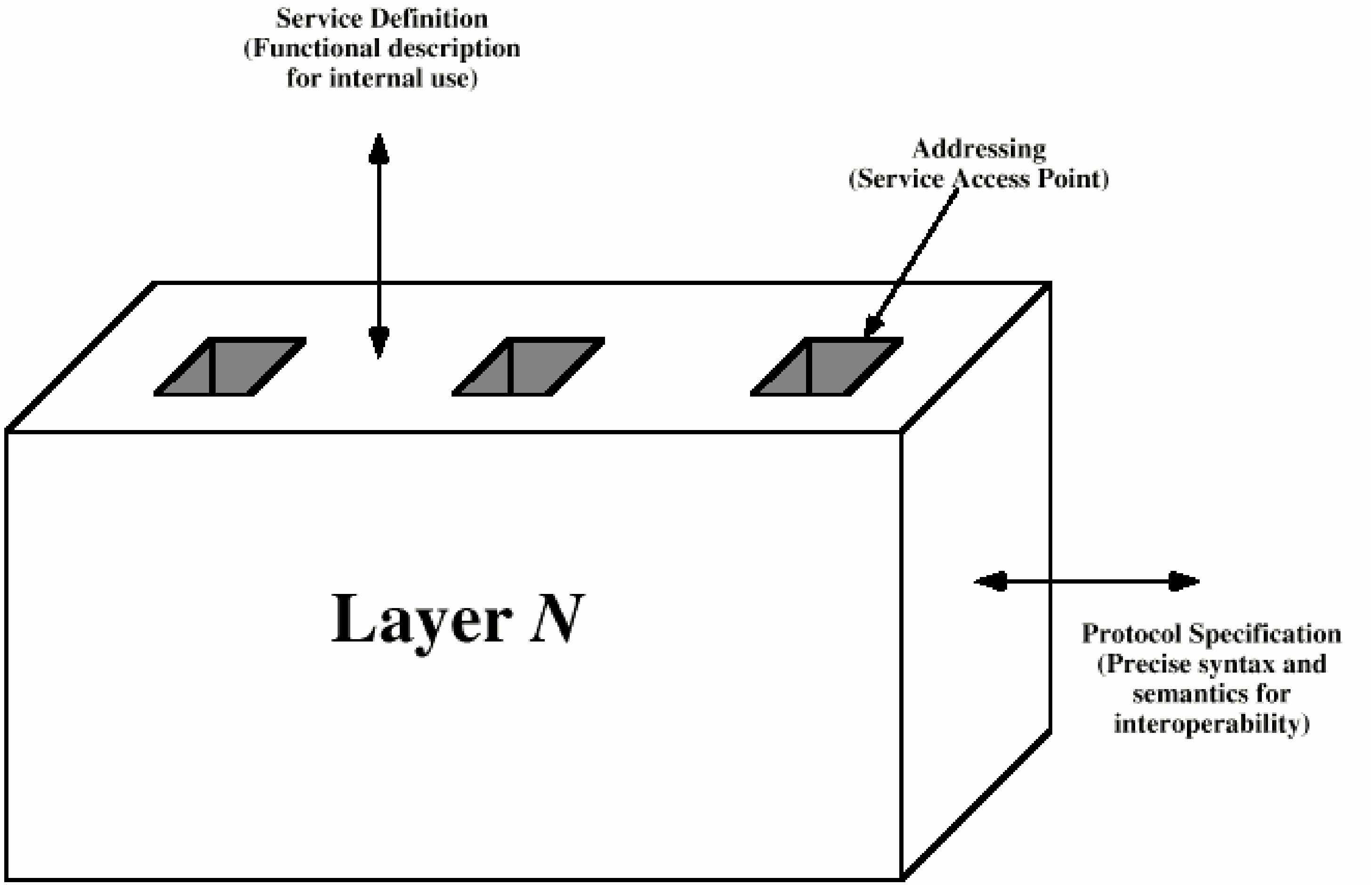


OSICOM

The OSI Reference Model



Layer Specific Standards



Elements of Standardization

- Protocol specification
  - Operates between the same layer on two systems
  - May involve different operating system
  - Protocol specification must be precise
    - Format of data units
    - Semantics of all fields
    - allowable sequence of PCUs
- Service definition
  - Functional description of what is provided
- Addressing
  - Referenced by SAPs

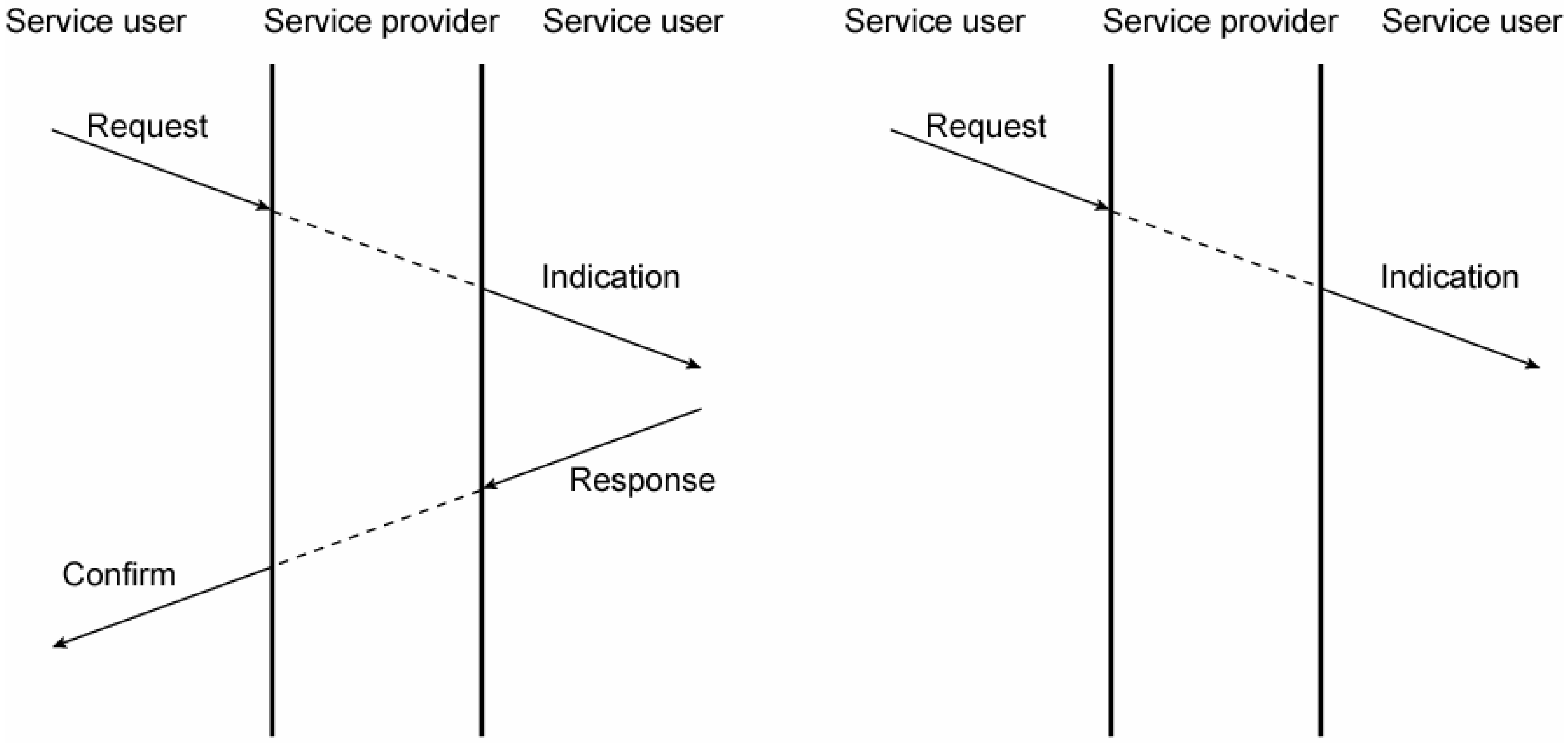
Service Primitives and Parameters

- Services between adjacent layers expressed in terms of primitives and parameters
- Primitives specify function to be performed
- Parameters pass data and control info

Primitive Types

REQUEST	A primitive issued by a service user to invoke some service and to pass the parameters needed to specify fully the requested service
INDICATION	A primitive issued by a service provider either to: indicate that a procedure has been invoked by the peer service user on the connection and to provide the associated parameters, or notify the service user of a provider-initiated action
RESPONSE	A primitive issued by a service user to acknowledge or complete some procedure previously invoked by an indication to that user
CONFIRM	A primitive issued by a service provider to acknowledge or complete some procedure previously invoked by a request by the service user

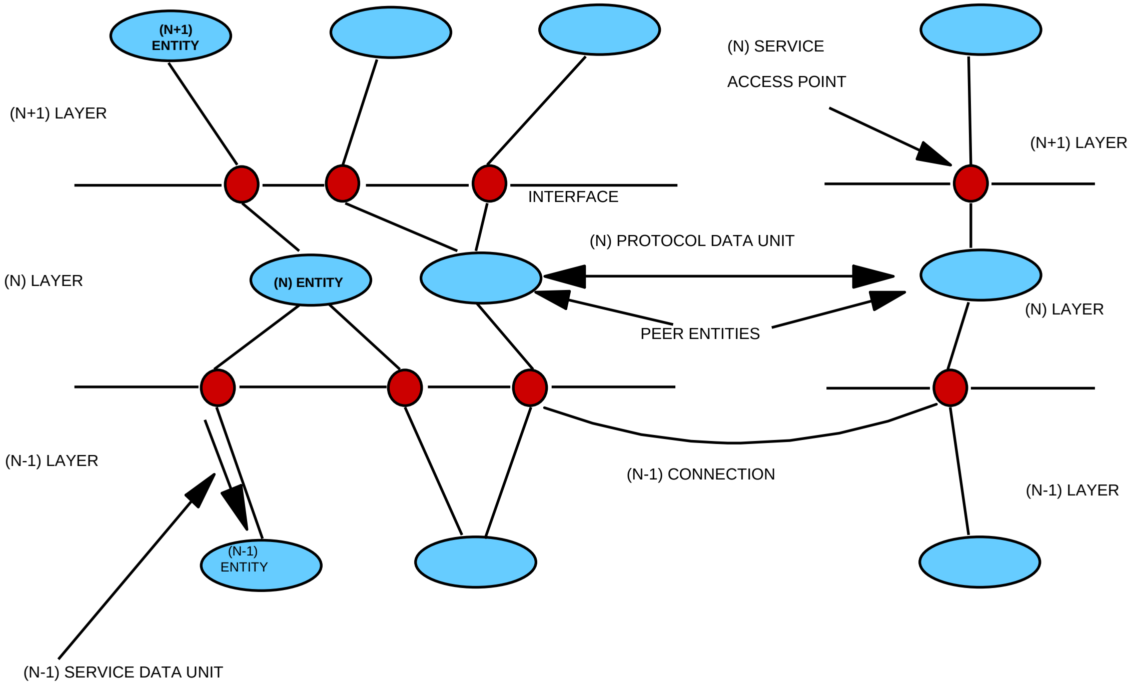
Timing Sequence for Service Primitives

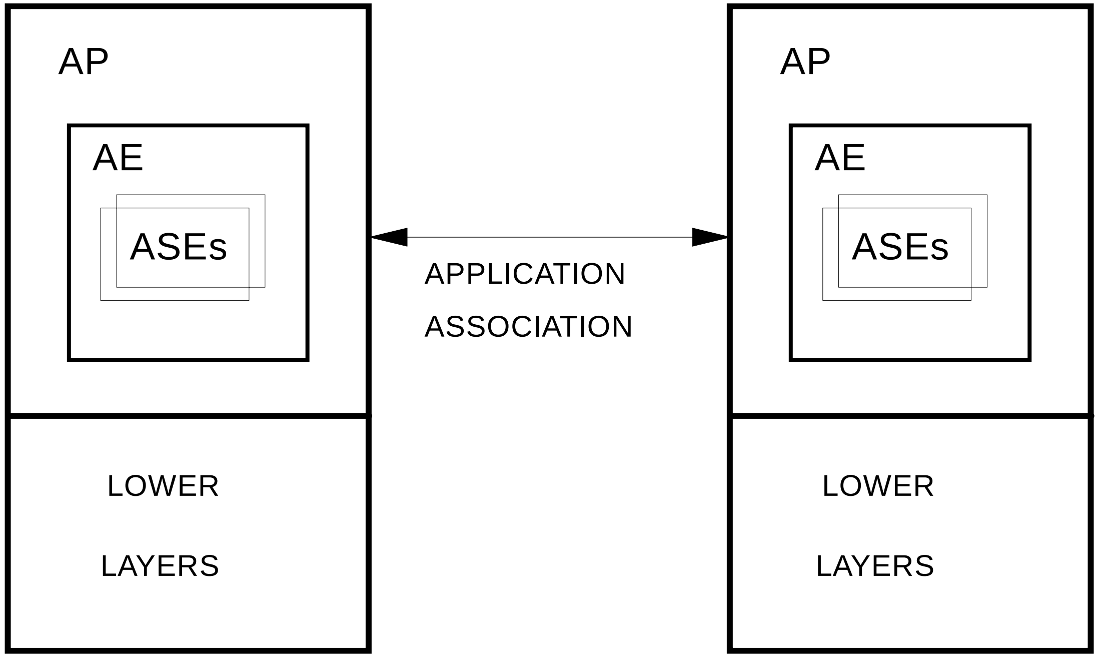


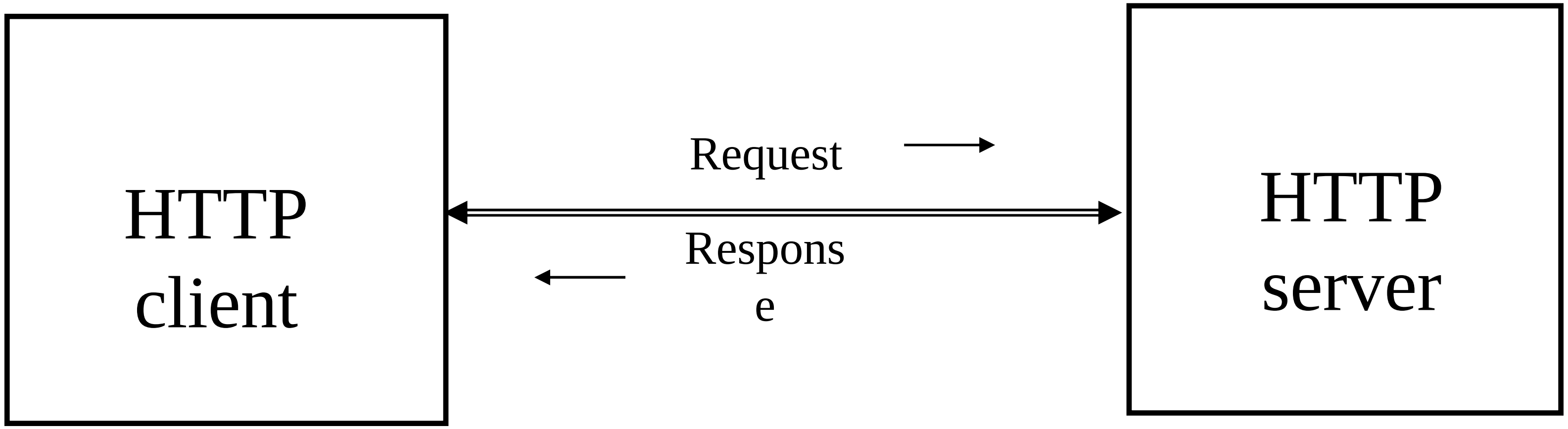
(a) Confirmed Service

(b) Nonconfirmed Service

The OSI Reference Model




AP
AE
ASEs
APPLICATION
ASSOCIATION
LOWER
LAYERS
AP
AE
ASEs
LOWER
LAYERS


HTTP client
Request
Respons e
HTTP server

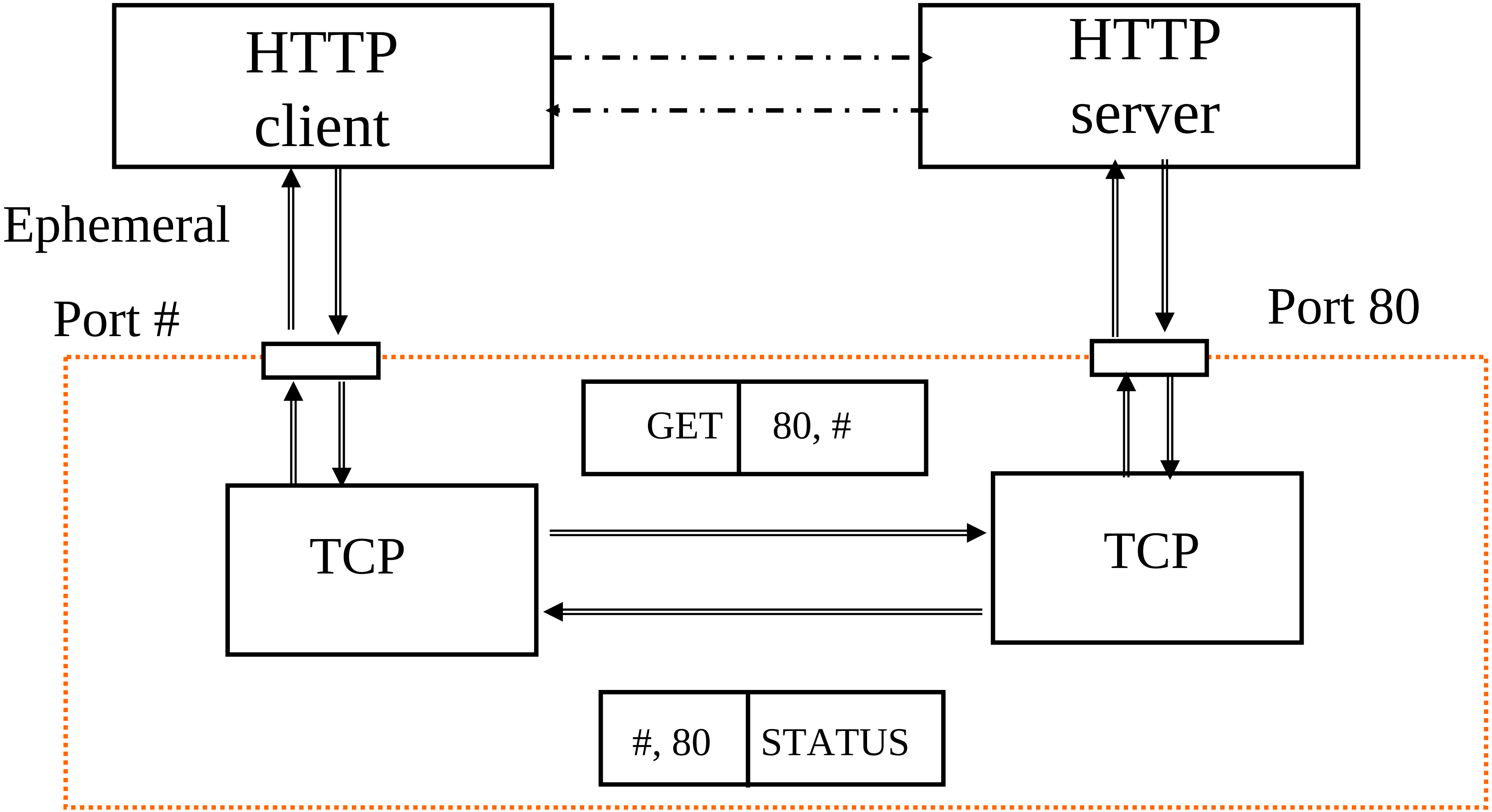

HTTP
client
HTTP
server
Ephemeral
Port #
Port 80
GET
80, #
TCP
TCP
#, 80
STATUS

Figure 2.2

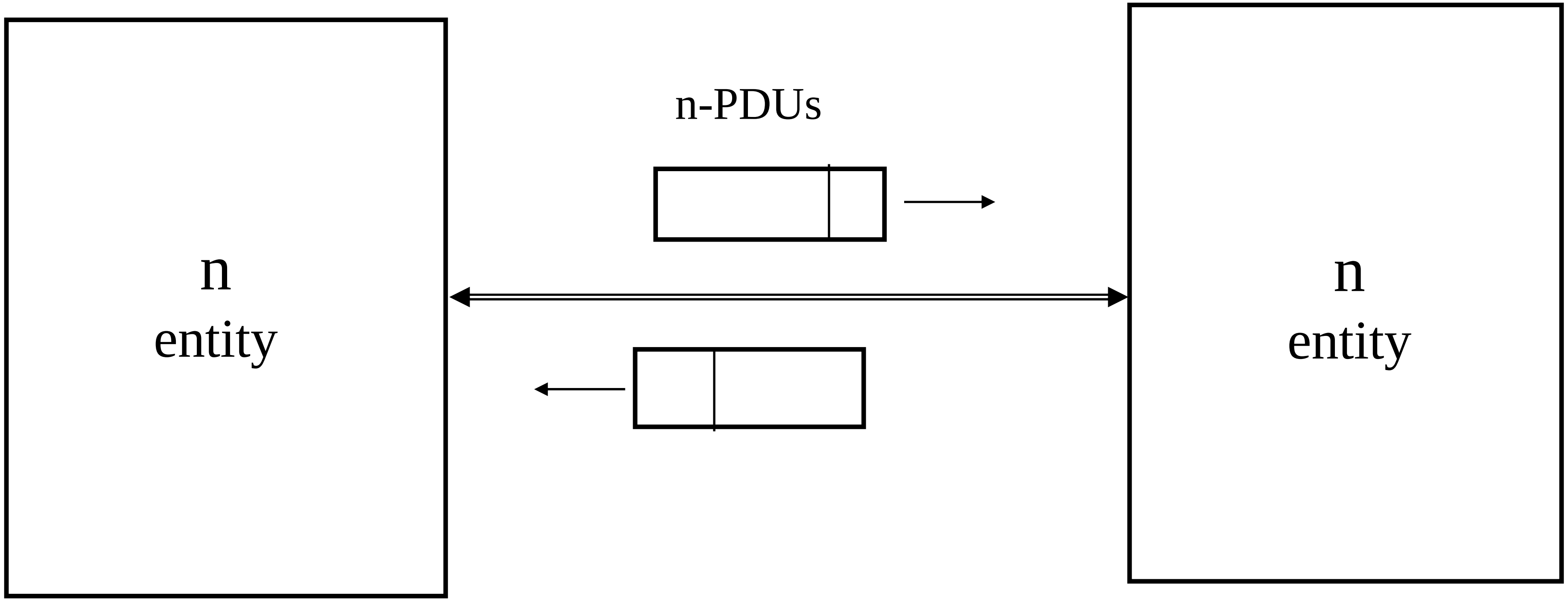


Figure 2.3

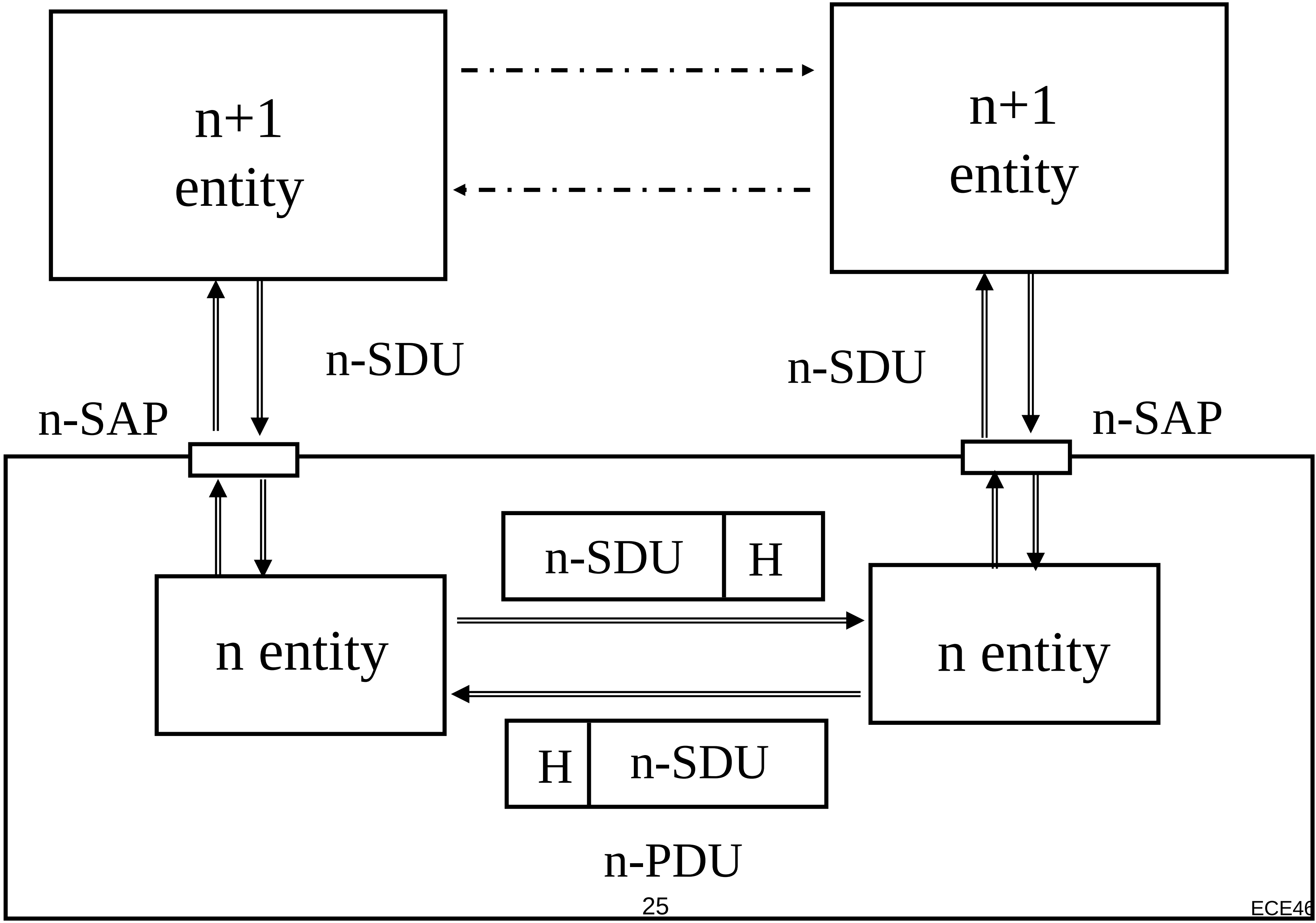

n+1
entity
n+1
entity
n-SDU
n-SDU
n-SAP
n-SAP
n-SDU
H
n entity
n entity
H
n-SDU
n-PDU

Figure 2.4

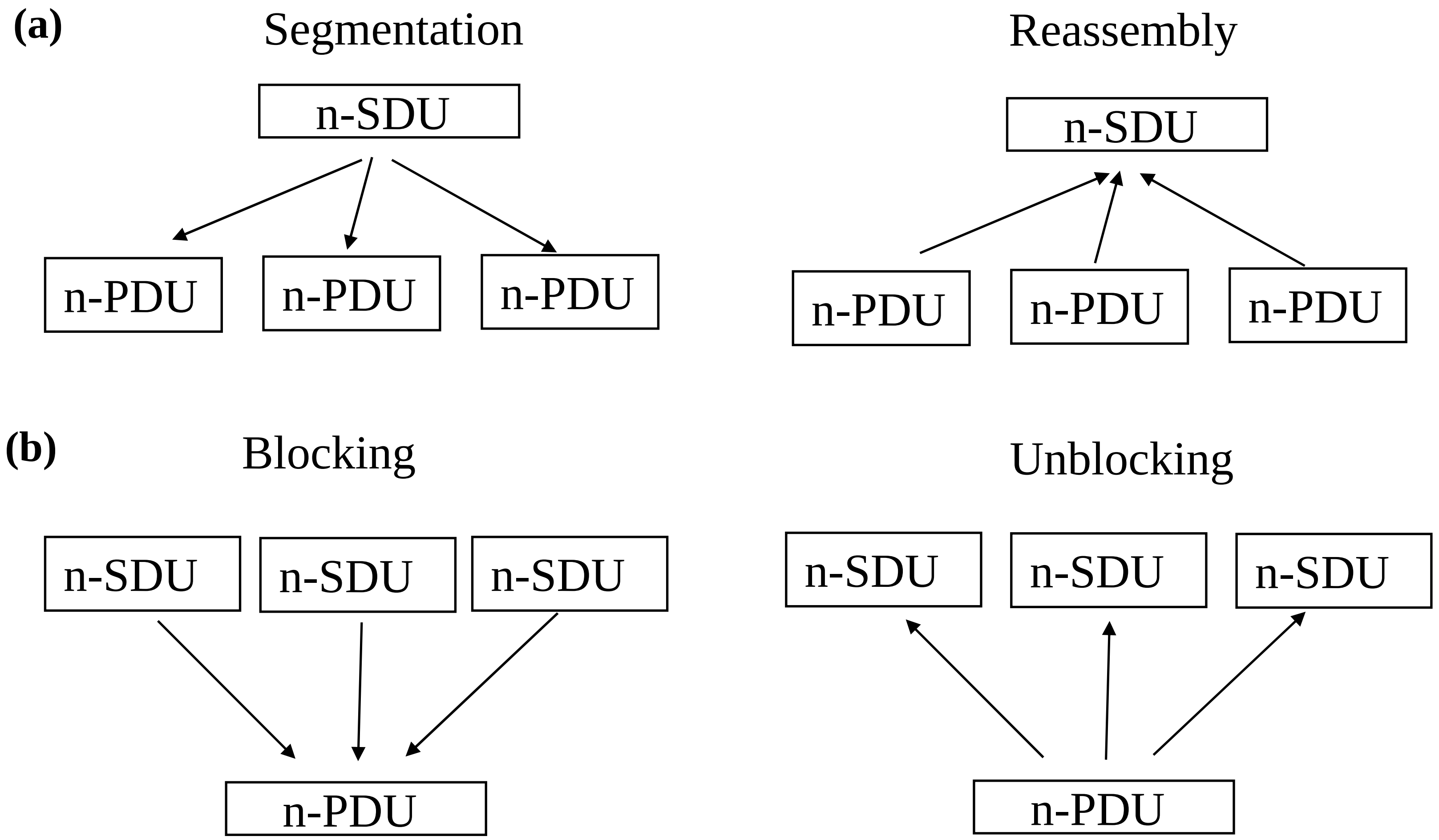

(a)
Segmentation
n-SDU
n-PDU
n-PDU
n-PDU
Reassembly
n-SDU
n-PDU
n-PDU
n-PDU
(b)
Blocking
n-SDU
n-SDU
n-SDU
n-PDU
Unblocking
n-SDU
n-SDU
n-SDU
n-PDU

Figure 2.5

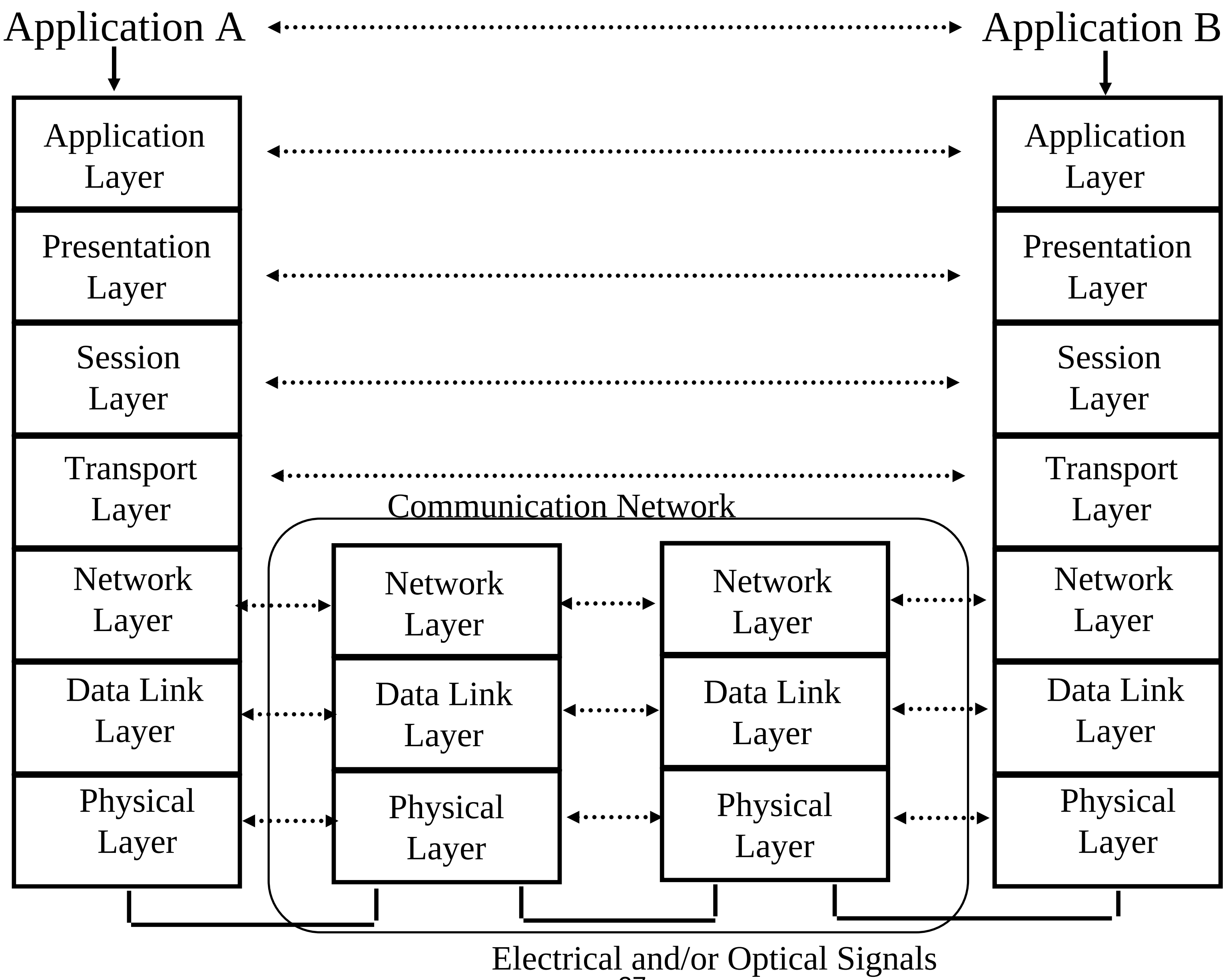
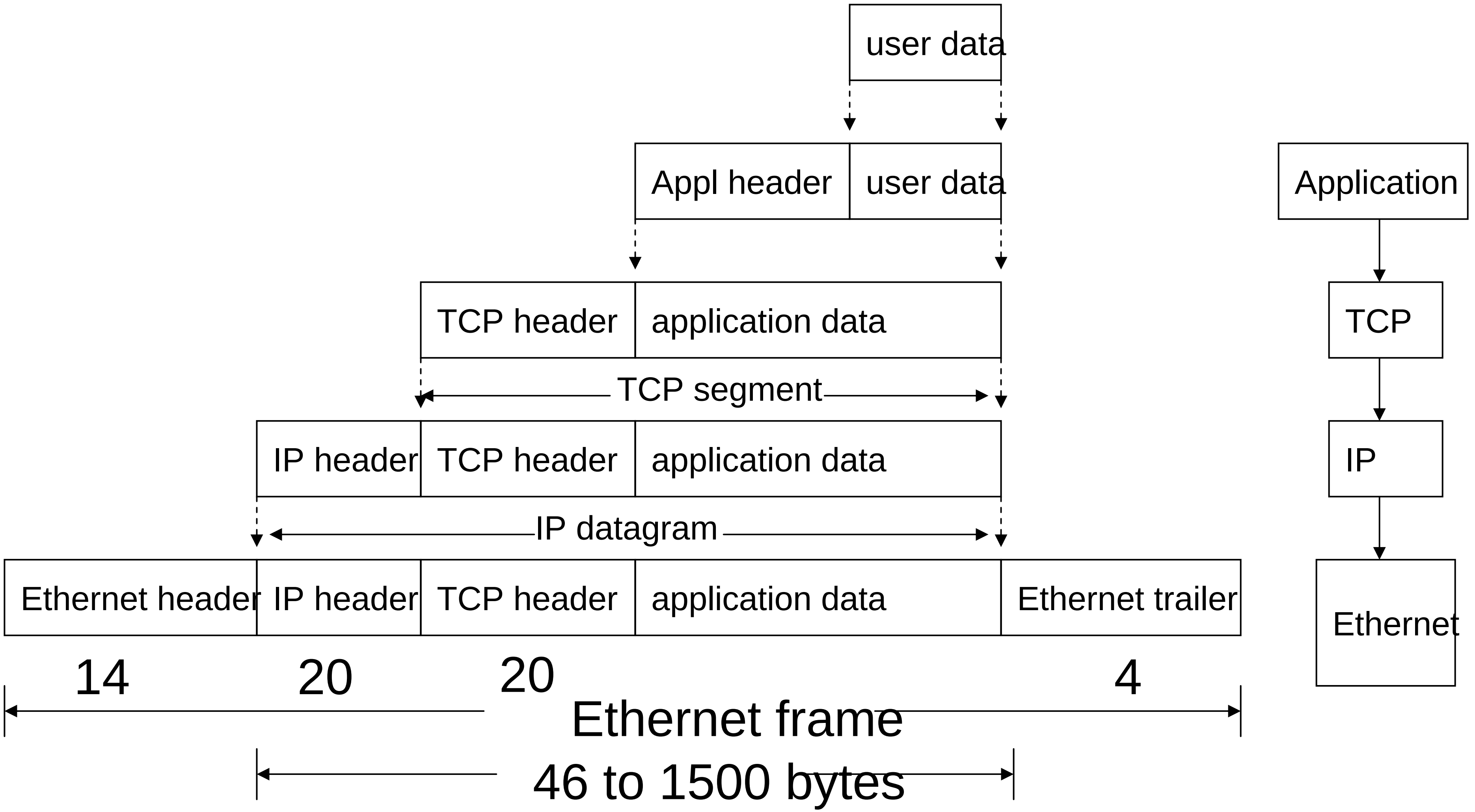
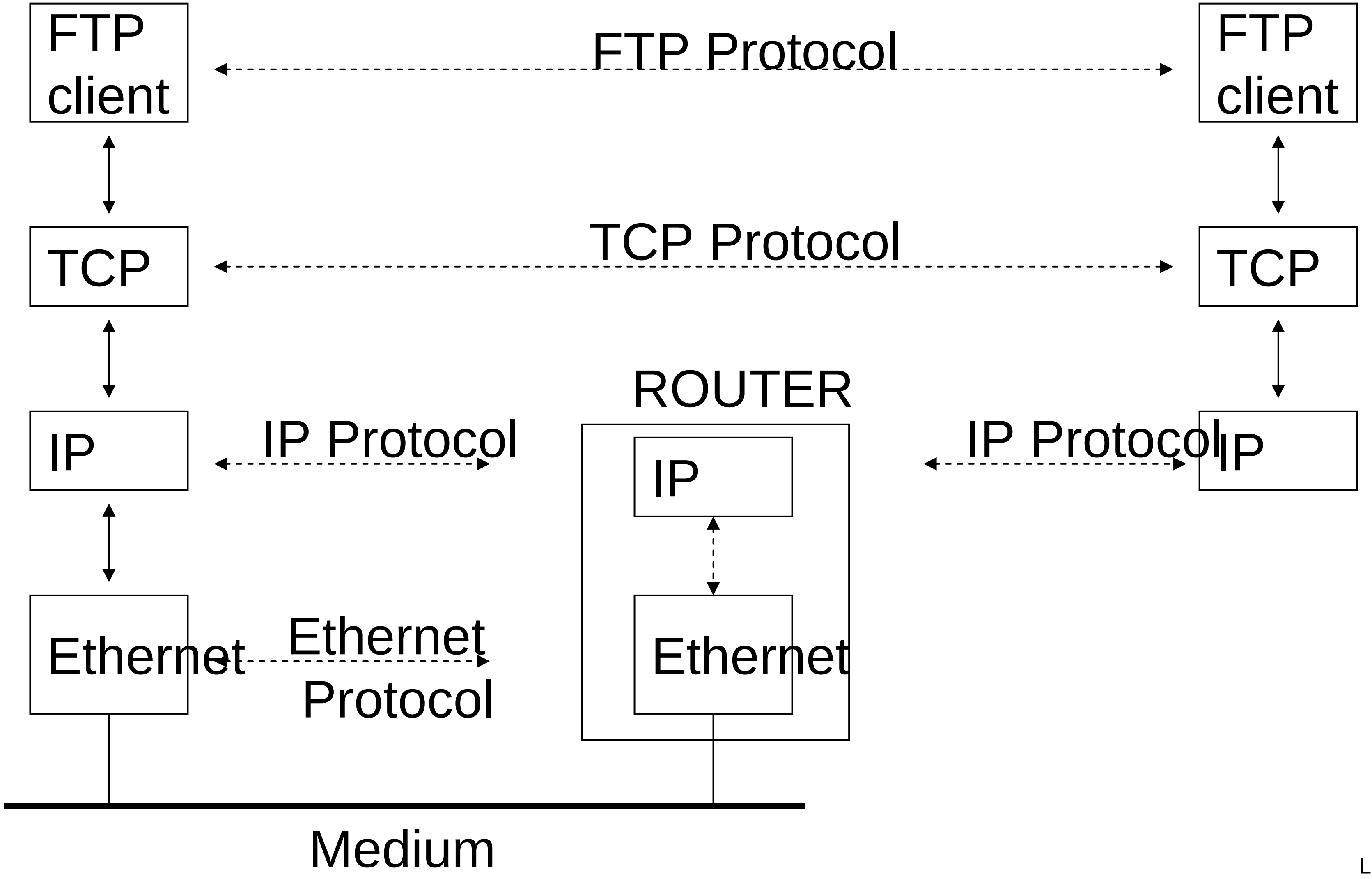

Application A
Application B
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
Communication Network
Network Layer
Data Link Layer
Physical Layer
Network Layer
Data Link Layer
Physical Layer
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
Electrical and/or Optical Signals

Figure 2.6

Encapsulation



IP Protocol Stack



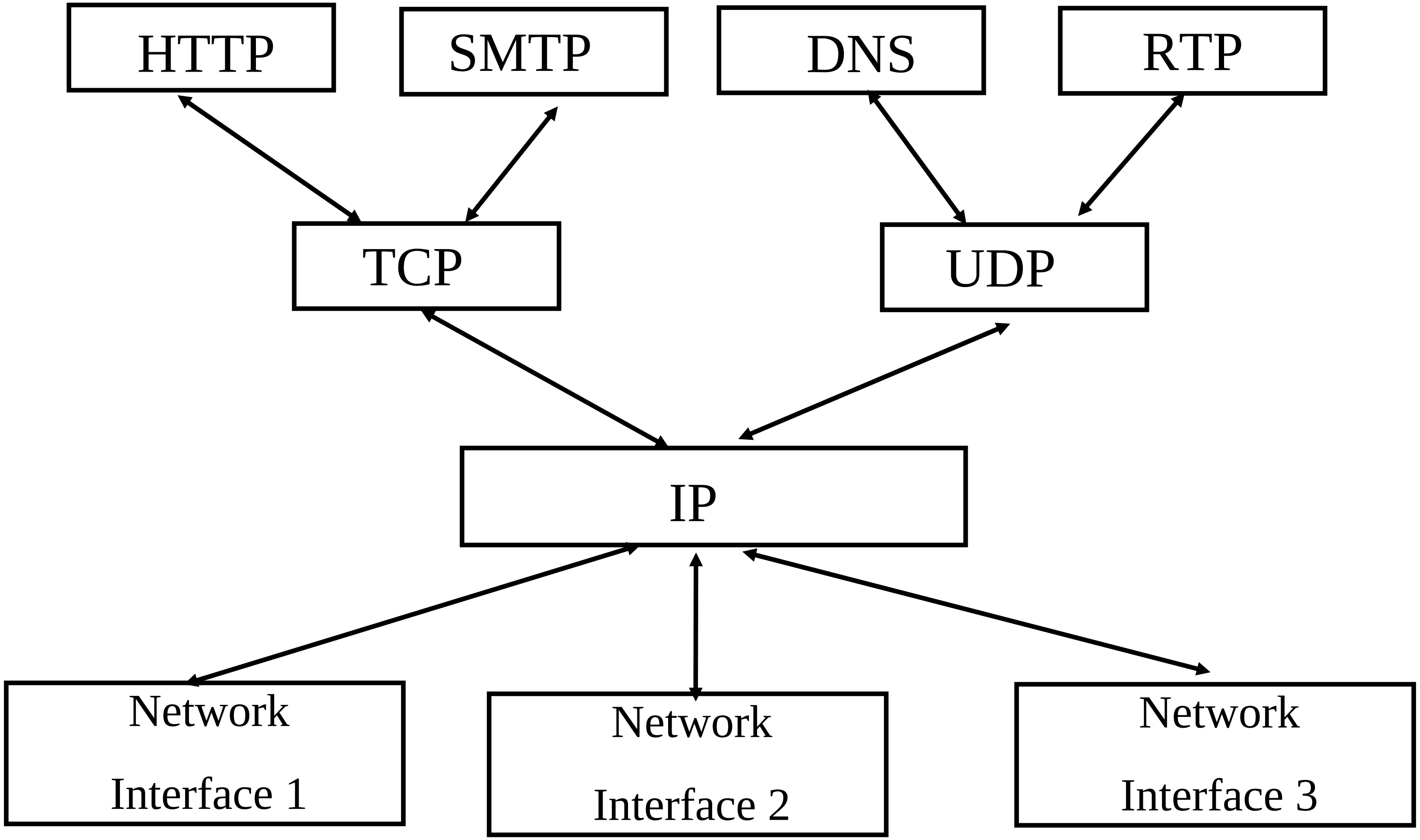
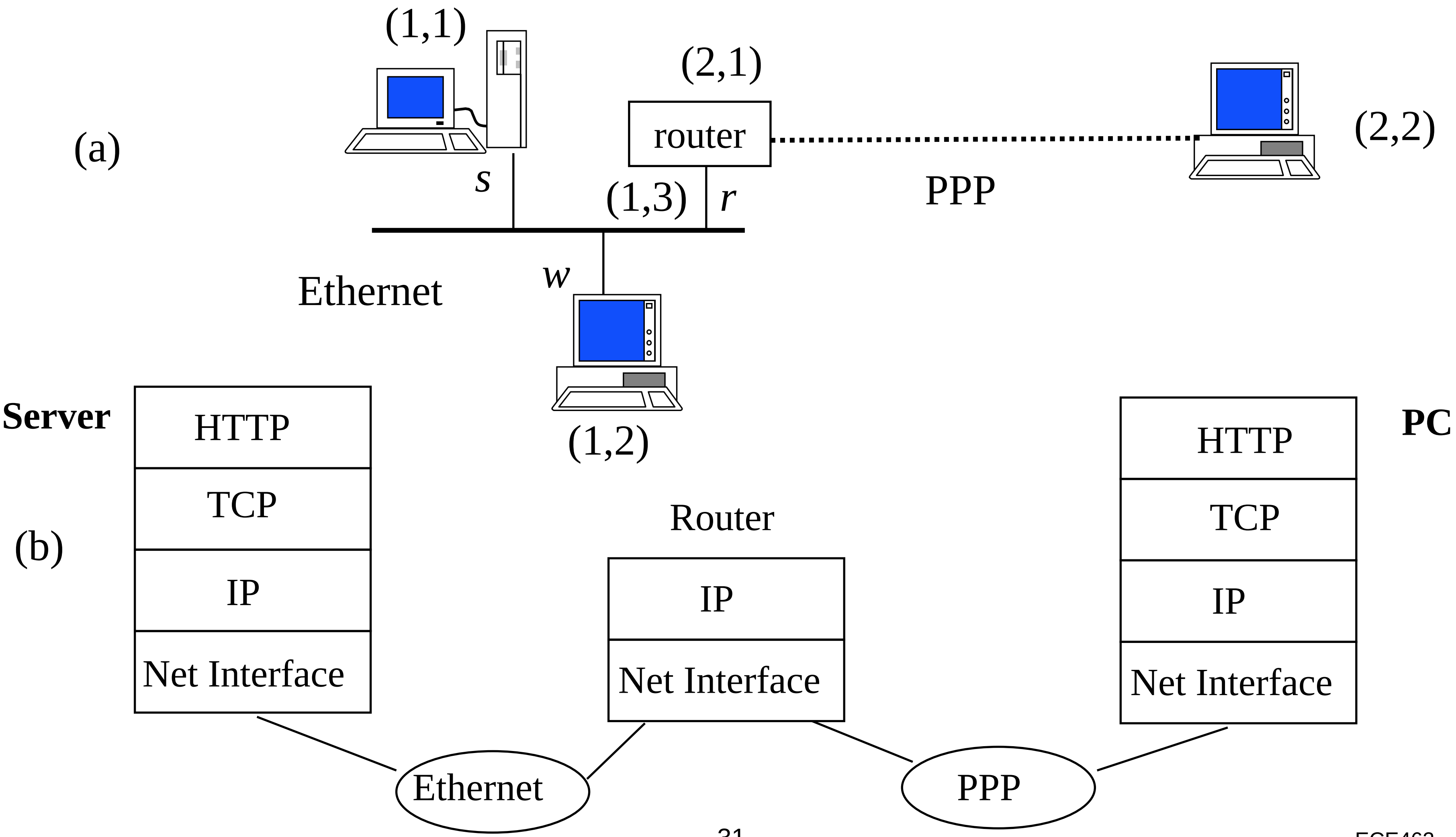
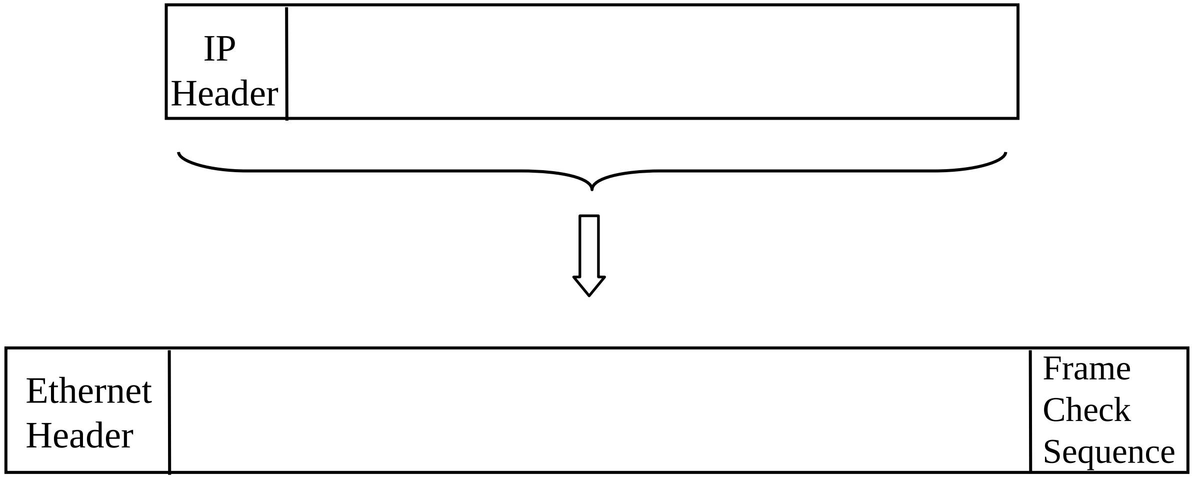
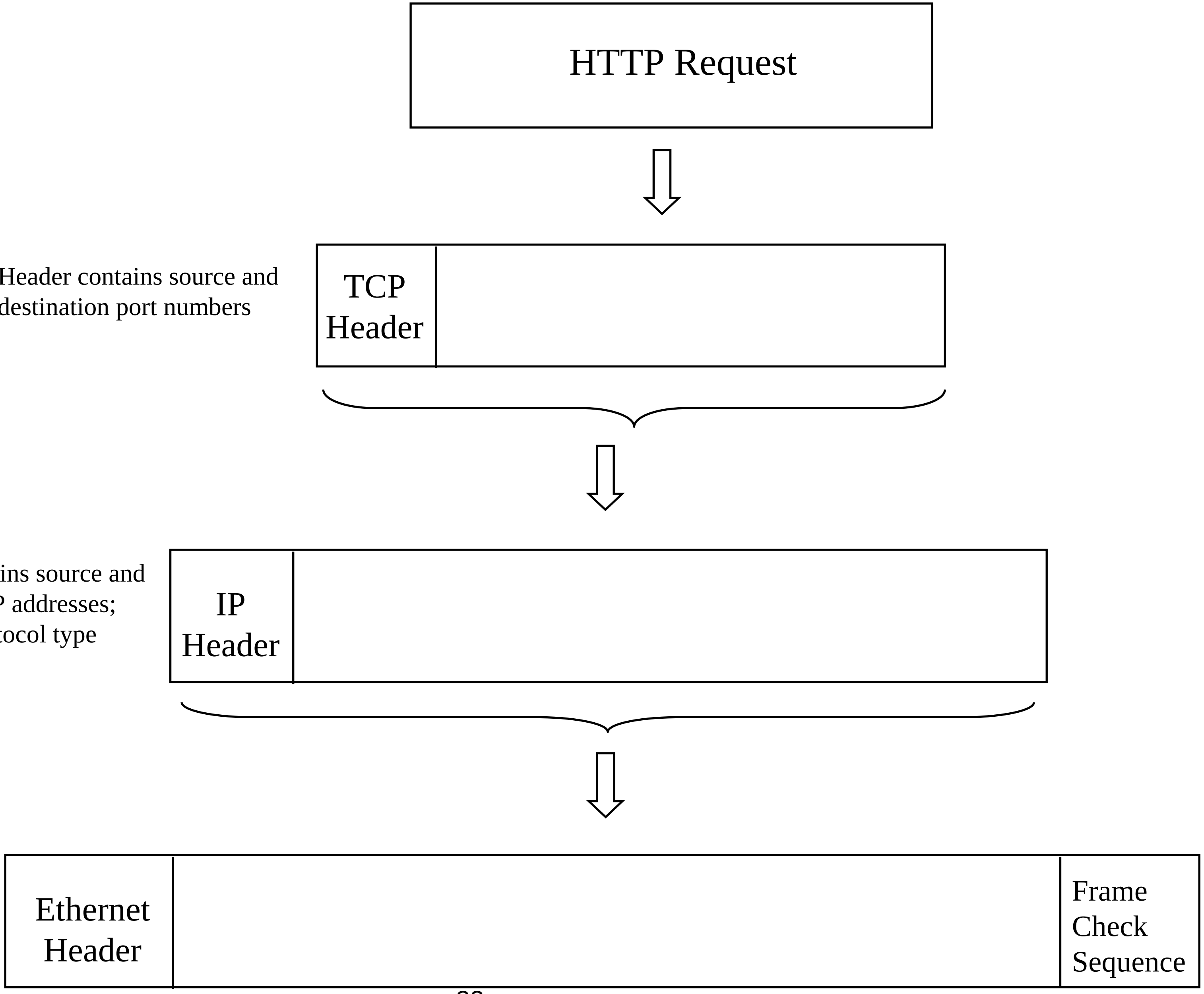

HTTP
SMTP
DNS
RTP
TCP
UDP
IP
Network Interface 1
Network Interface 2
Network Interface 3

Figure 2.12


(a)
(1,1)
s
(2,1)
router
(1,3)
r
PPP
(2,2)
Ethernet
w
(1,2)
(b)
Server
HTTP
TCP
IP
Net Interface
Router
IP
Net Interface
PC
HTTP
TCP
IP
Net Interface
Ethernet
PPP



Header contains source and destination physical addresses; network protocol type



Header contains source and destination port numbers

Header contains source and destination IP addresses; transport protocol type

Header contains source and destination physical addresses; network protocol type

Figure 2.15

Measurements for Traffic delays across Networks - PING

- **Ping to GMU from the desktop**

```
C:\>ping osf1.gmu.edu

Pinging osf1.gmu.edu [129.174.1.13] with 32 bytes of data:

Reply from 129.174.1.13: bytes=32 time<10ms TTL=62

Reply from 129.174.1.13: bytes=32 time<10ms TTL=62

Reply from 129.174.1.13: bytes=32 time<10ms TTL=62
```

- **Ping to a Network Address from a Router**

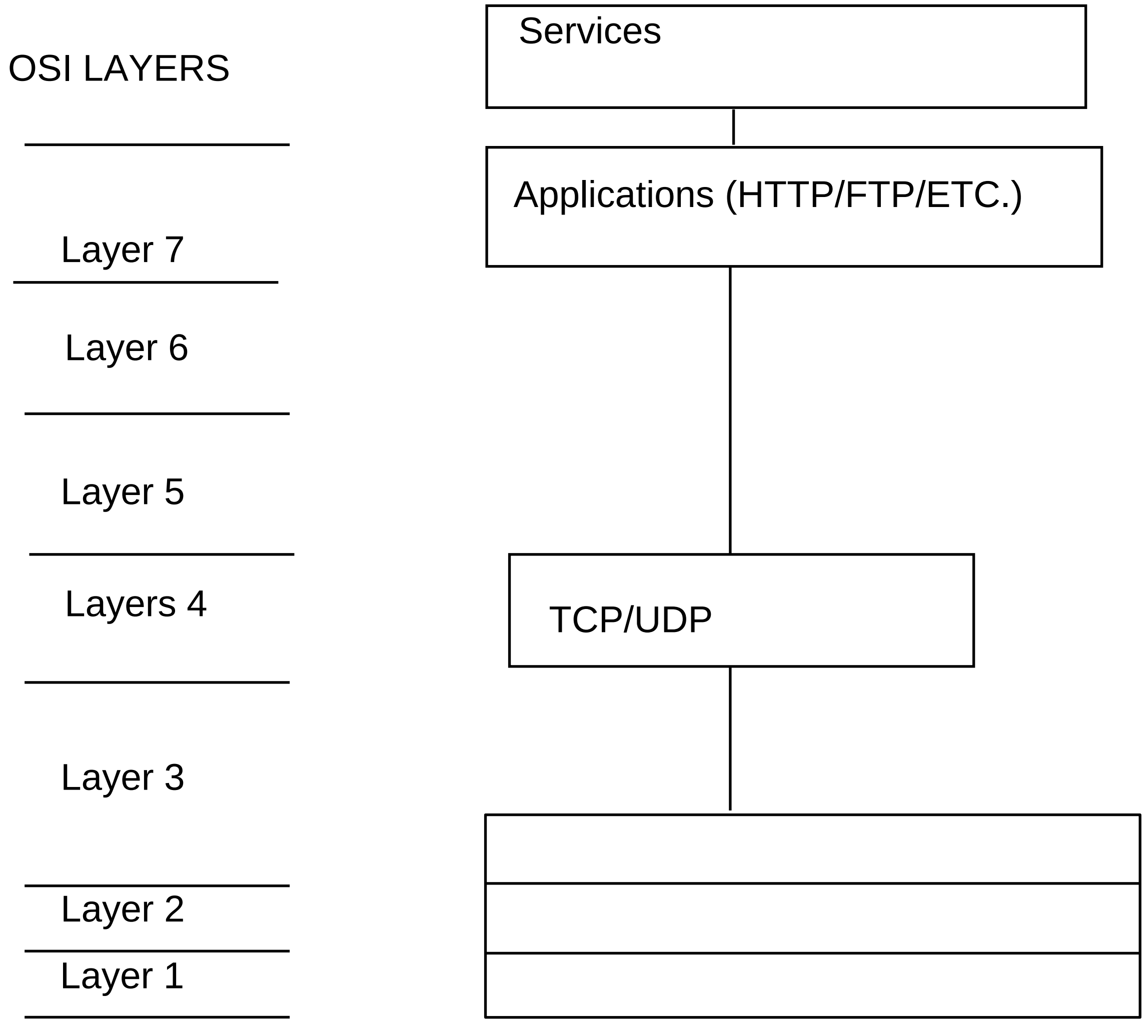
```
Router@cnl#ping 10.1.7.2

Sending 5, 100-byte ICMP Echos to 10.1.7.2, timeout is 2
seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max =
1/1/4 ms
```

OSI Alignment and Internet



OSI LAYERS

Layer 7

Layer 6

Layer 5

Layers 4

Layer 3

Layer 2

Layer 1

Services

Applications (HTTP/FTP/ETC.)

TCP/UDP