

Protocol Architectures

Layered Protocol Architectures
OSI Reference Model
TCP/IP Protocol Stack

Communication Networks

- The task of exchanging information between devices
 - requires a high degree of cooperation between the involved parties
 - can be quite complex
- Cooperation is achieved by forcing parties to adhere to a set of rules (Protocol) for communication
- The complexity of the communication task is reduced by dividing it into subtasks:
 - Each subtask is implemented independently.
 - Each subtask provides a service to another subtask.

Example: Subtasks of Communications

- **Example:** The purchasing director of the Italian company “Vendetta”, located in Milan, Italy, wants to ask the Sales Director of the US company “Crash”, with headquarters in Mobile, AL, about the price of the Ultimo 6000 Supercomputer which is produced by Crash.
- When we divide the described communication task into subtasks we see that:
 - Separate entities in a company perform certain subtasks
 - Company entities provide services to other entities
 - An entity responsible for a certain subtask performs the task by following a set of rules

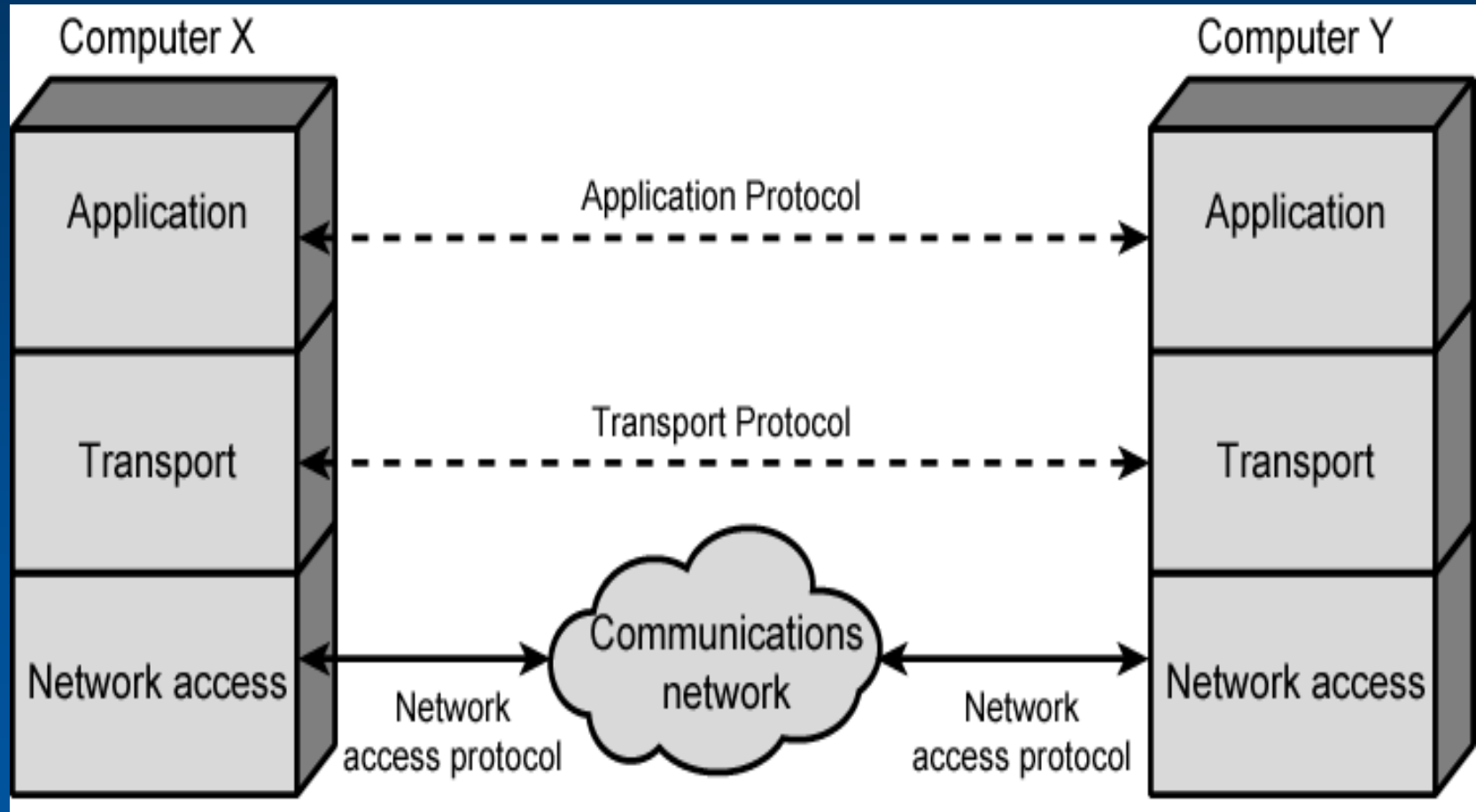
Example: Subtasks of Communications



Network Architecture

- **Protocol:** A set of rules and conventions used for communication of **entities** in different **systems**
 - **System:** Object that contains several entities (e.g., the company).
 - **Entity:** Anything capable of sending or receiving information (e.g, the secretary in a company)
- A **Network Architecture** is a structured set of protocols that implement the exchange of information between computers

A Three Layer Model and Protocols



Network Access Layer

- Exchange of data between the computer and the network
- Sending computer provides address of destination
- May invoke levels of service
- Dependent on type of network used (LAN, packet switched etc.)

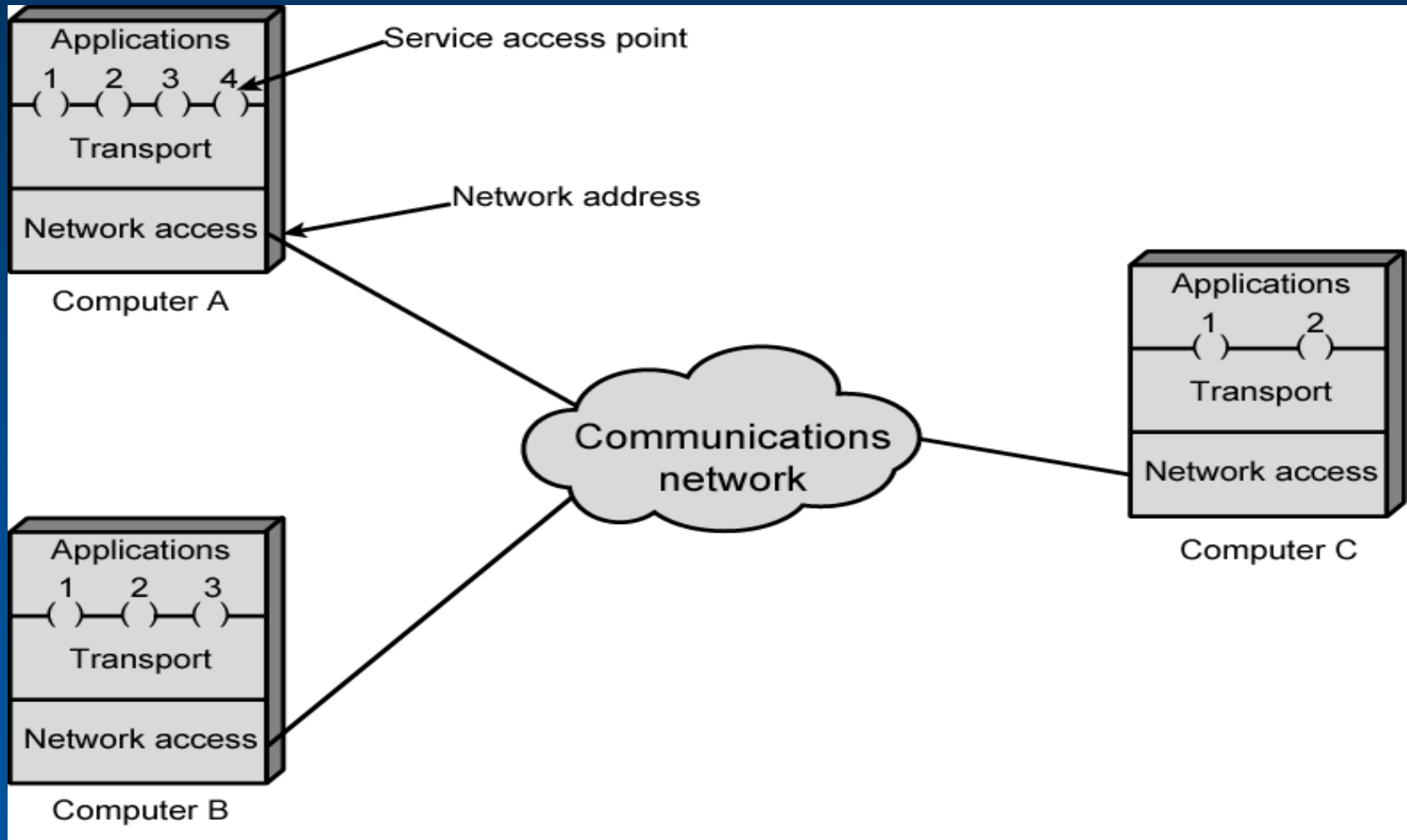
Transport Layer

- Reliable data exchange
- Independent of network being used
- Independent of application

Application Layer

- Support for different user applications
- e.g. e-mail, file transfer

Protocol Architectures and Networks



Addressing Requirements

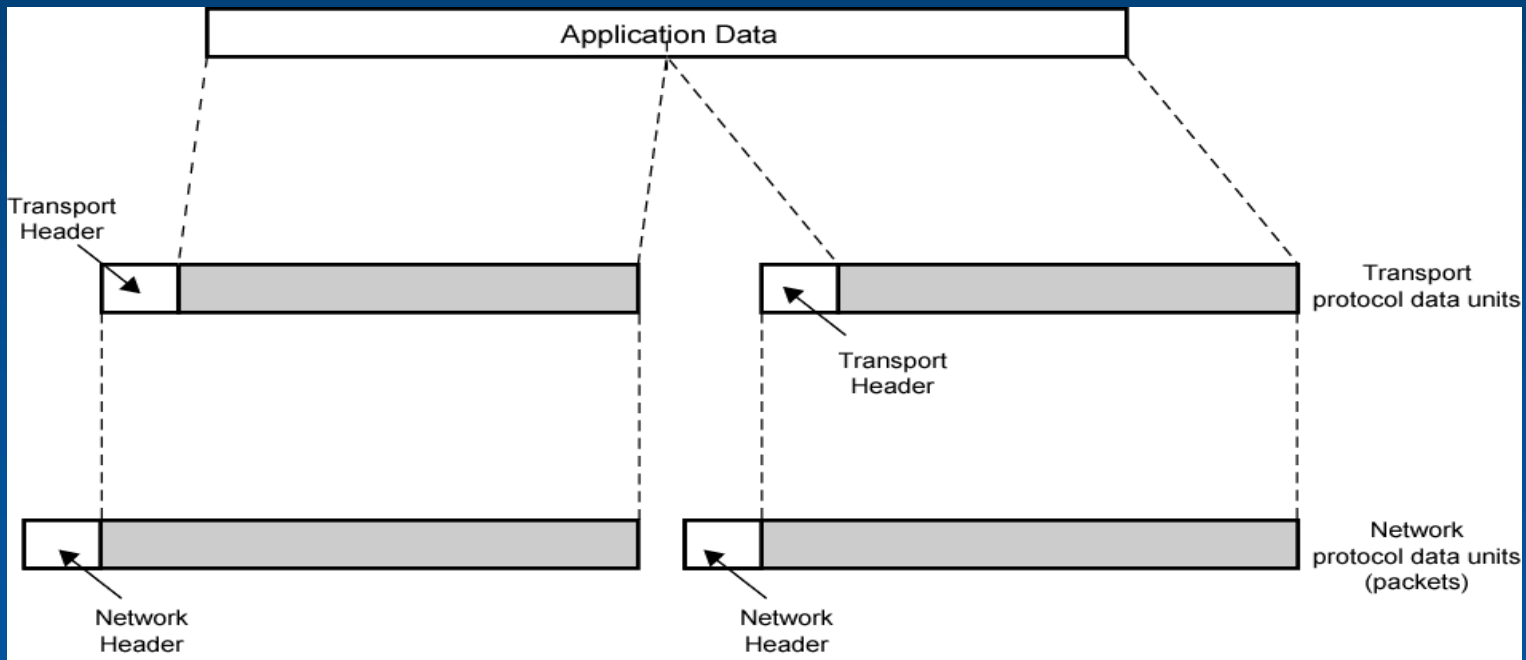
- Two levels of addressing required
- Each computer needs unique network address
- Each application on a (multi-tasking) computer needs a unique address within the computer
 - The service access point or SAP
 - The port on TCP/IP stacks

Protocol Data Units (PDU)

- At each layer, protocols are used to communicate
- Control information is added to user data at each layer
- Transport layer may fragment user data
- Each fragment has a transport header added
 - Destination SAP
 - Sequence number
 - Error detection code
- This gives a transport protocol data unit

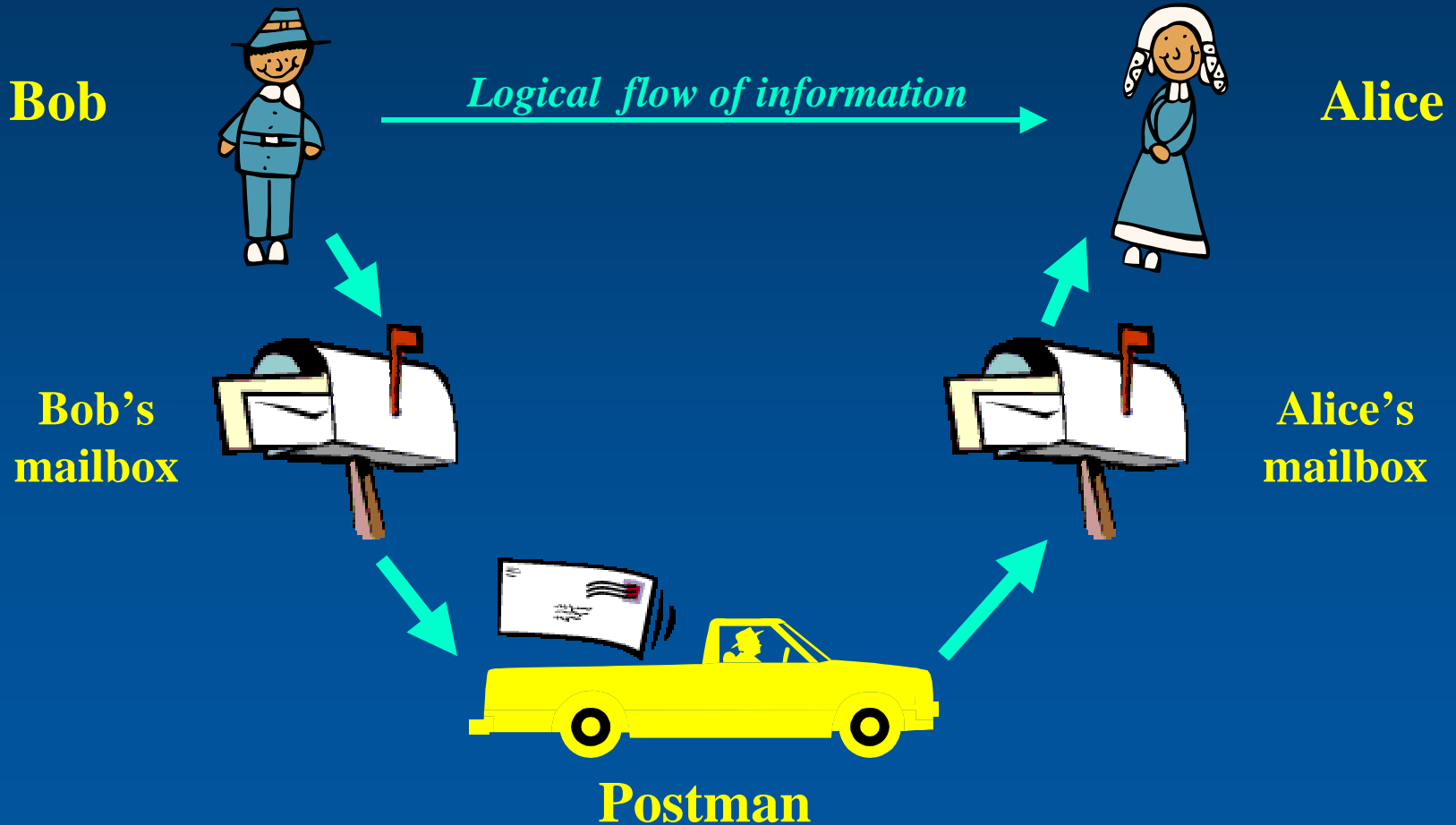
Network PDU

- Adds network header
 - network address for destination computer
 - Facilities requests

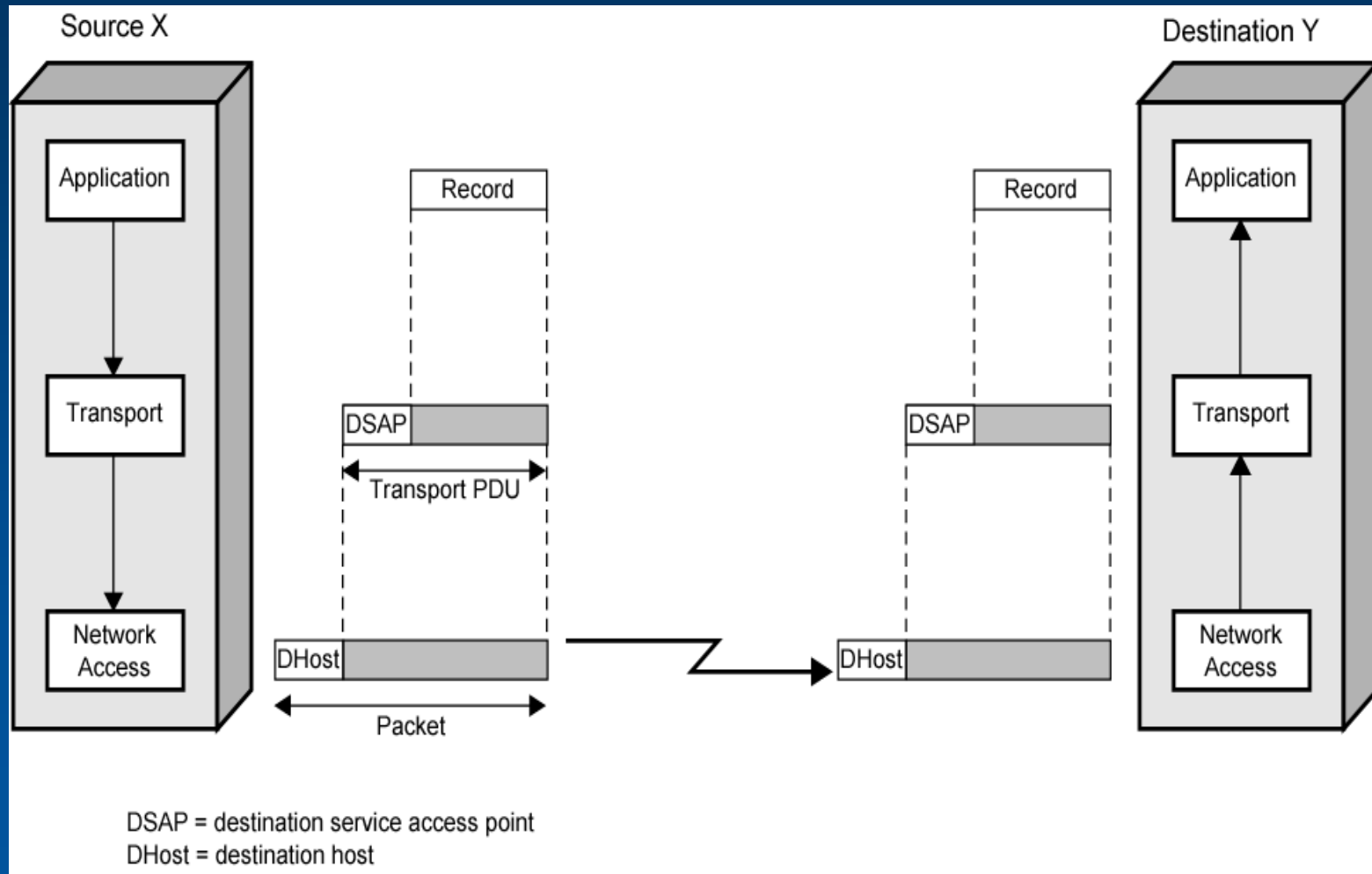


Example: Sending a Letter

- Bob sends a letter to Alice



Operation of a Protocol Architecture



Standardized Protocol Architectures

- Required for devices to communicate
- Vendors have more marketable products
- Customers can insist on standards based equipment
- Two standards:
 - OSI Reference model
 - Never lived up to early promises
 - TCP/IP protocol suite
 - Most widely used
- Also: IBM Systems Network Architecture (SNA)

OSI Reference Model

- In 1977 the International Standardization Organization (ISO) developed a model for a layered network architecture
- Open Systems Interconnection
- The OSI model defines seven layers:

Layer 7: Application Layer

Layer 6: Presentation Layer

Layer 5: Session Layer

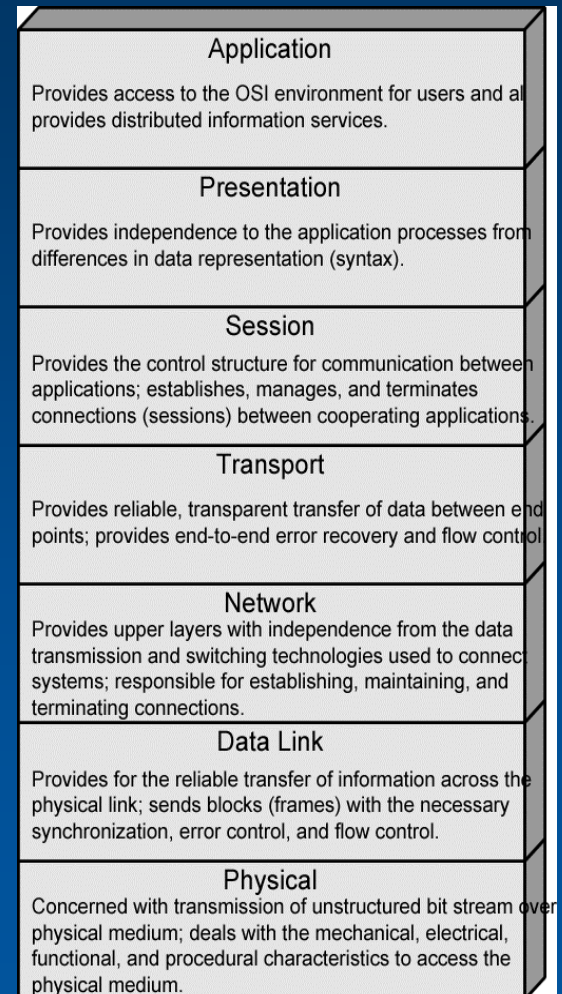
Layer 4: Transport Layer

Layer 3: Network Layer

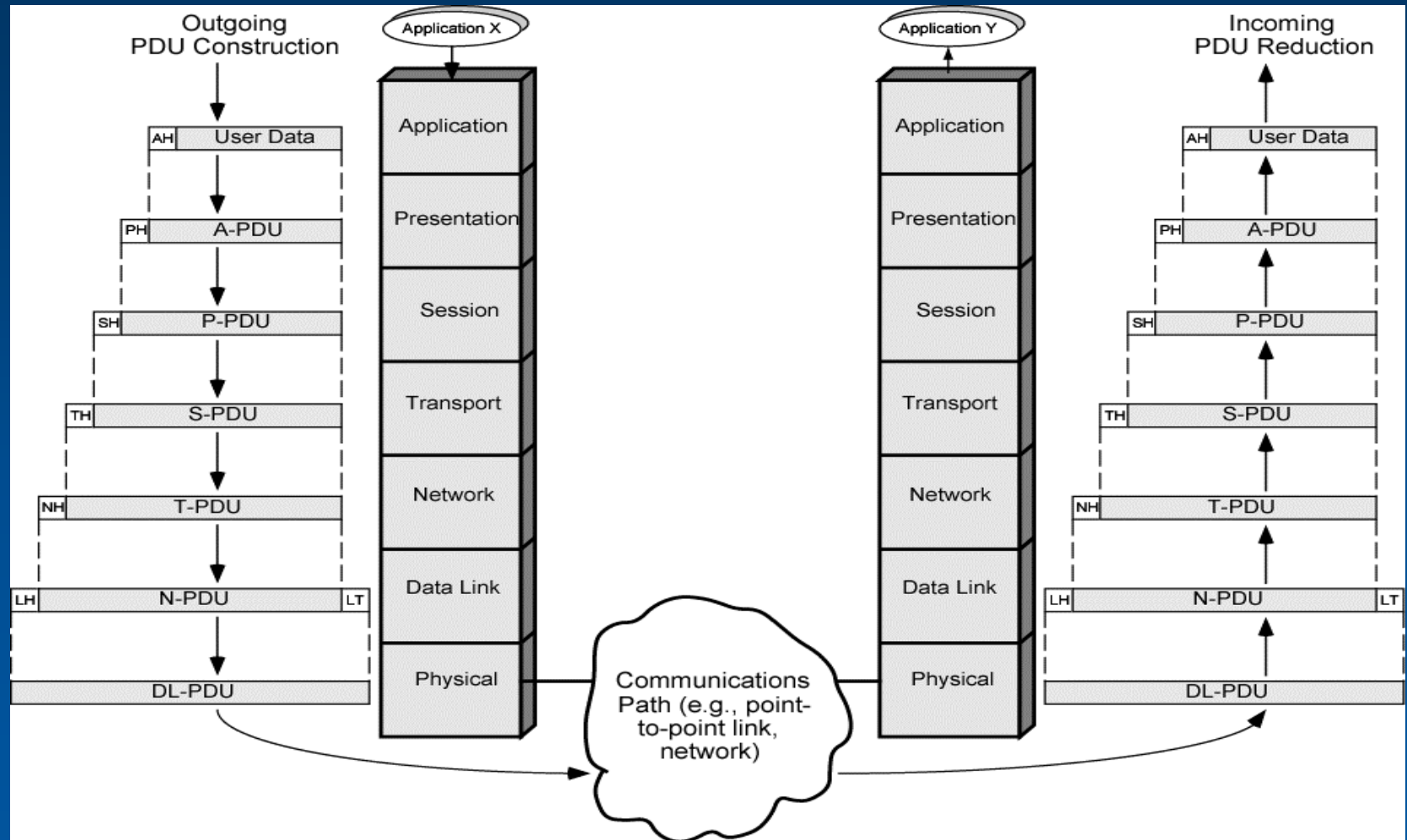
Layer 2: Data Link Layer

Layer 1: Physical Layer

(Layer 0: Interconnection Media)



The OSI Environment



OSI Layers

- Physical
 - Physical interface between devices
 - Mechanical
 - Electrical
 - Functional
 - Procedural
- Data Link
 - Means of activating, maintaining and deactivating a reliable link
 - Error detection and control
 - Higher layers may assume error free transmission

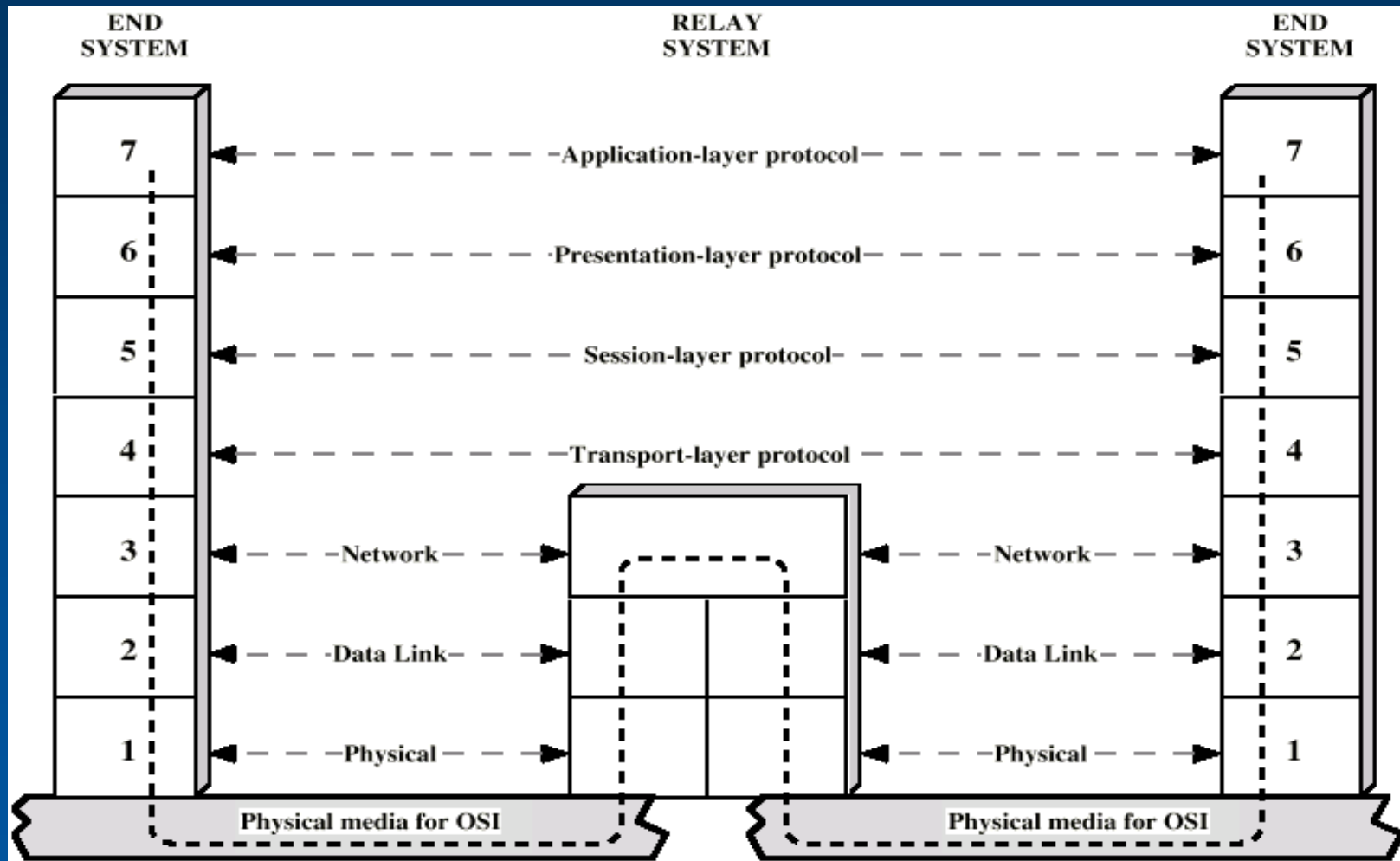
OSI Layers

- Network
 - Transport of information
 - Higher layers do not need to know about underlying technology
 - Not needed on direct links
- Transport
 - Exchange of data between end systems
 - Error free
 - In sequence
 - No losses
 - No duplicates
 - Quality of service

OSI Layers

- Session
 - Control of dialogues between applications
 - Dialogue discipline
 - Grouping
 - Recovery
- Presentation
 - Data formats and coding
 - Data compression
 - Encryption
- Application
 - Means for applications to access OSI environment

Use of a Relay



TCP/IP Protocol Suite

- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet
- No official model but a working one.
- Five layers:
 - Application layer
 - Host to host or transport layer
 - Internet layer
 - Network access layer
 - Physical layer

OSI vs TCP/IP

OSI	TCP/IP
Application	Application
Presentation	
Session	
Transport	Transport (host-to-host)
Network	Internet
Data Link	Network Access
Physical	Physical

TCP/IP Layers

■ Physical Layer

- Physical interface between data transmission device (e.g. computer) and transmission medium or network
- Characteristics of transmission medium
- Signal levels
- Data rates

■ Network Access Layer

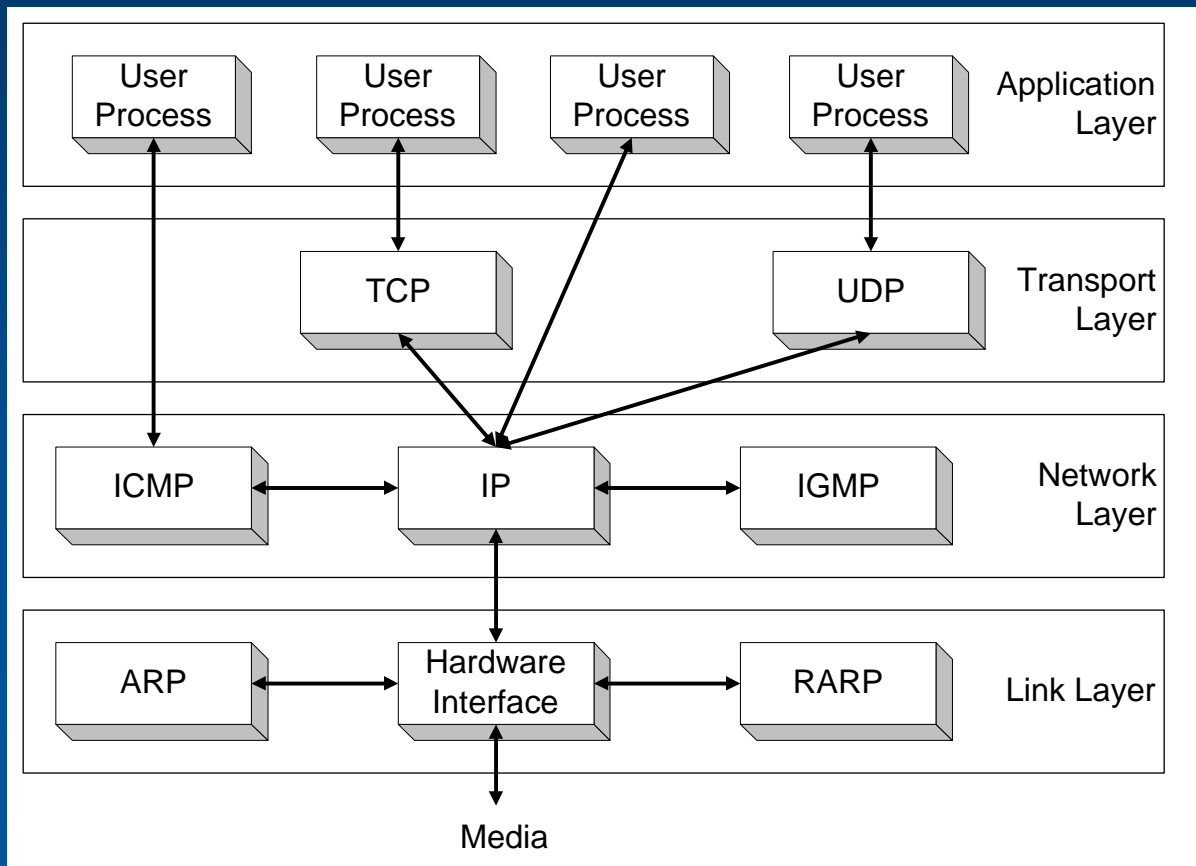
- Exchange of data between end system and network
- Destination address provision
- Invoking services like priority

TCP/IP Layers

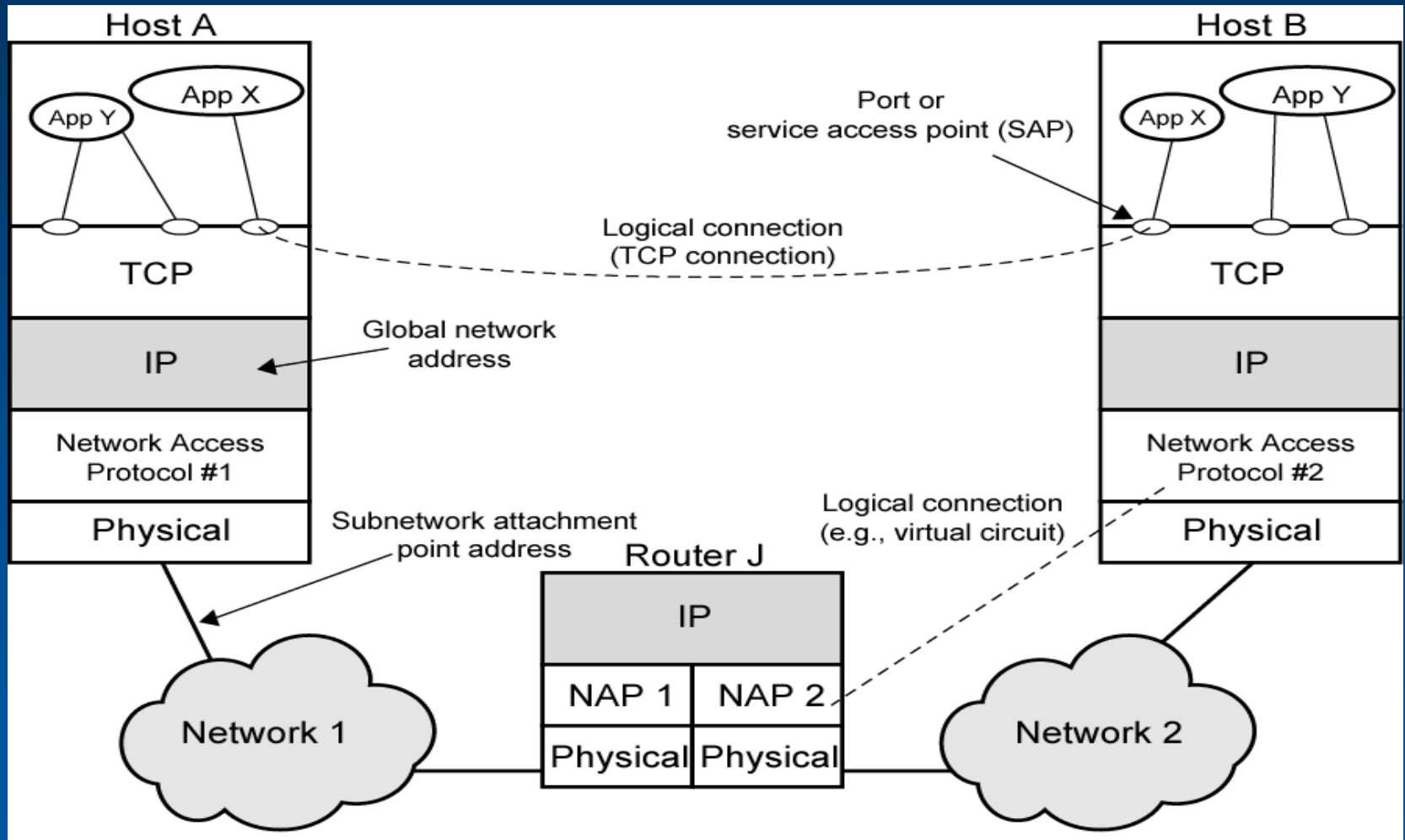
- Internet Layer (IP)
 - Systems may be attached to different networks
 - Routing functions across multiple networks
 - Implemented in end systems and routers
- Transport Layer (TCP)
 - Reliable delivery of data
 - Ordering of delivery
- Application Layer
 - Support for user applications
 - e.g. http, SMTP

TCP/IP Protocol Suite

- The complete TCP/IP protocol suite contains many protocols. The following graph is far from complete



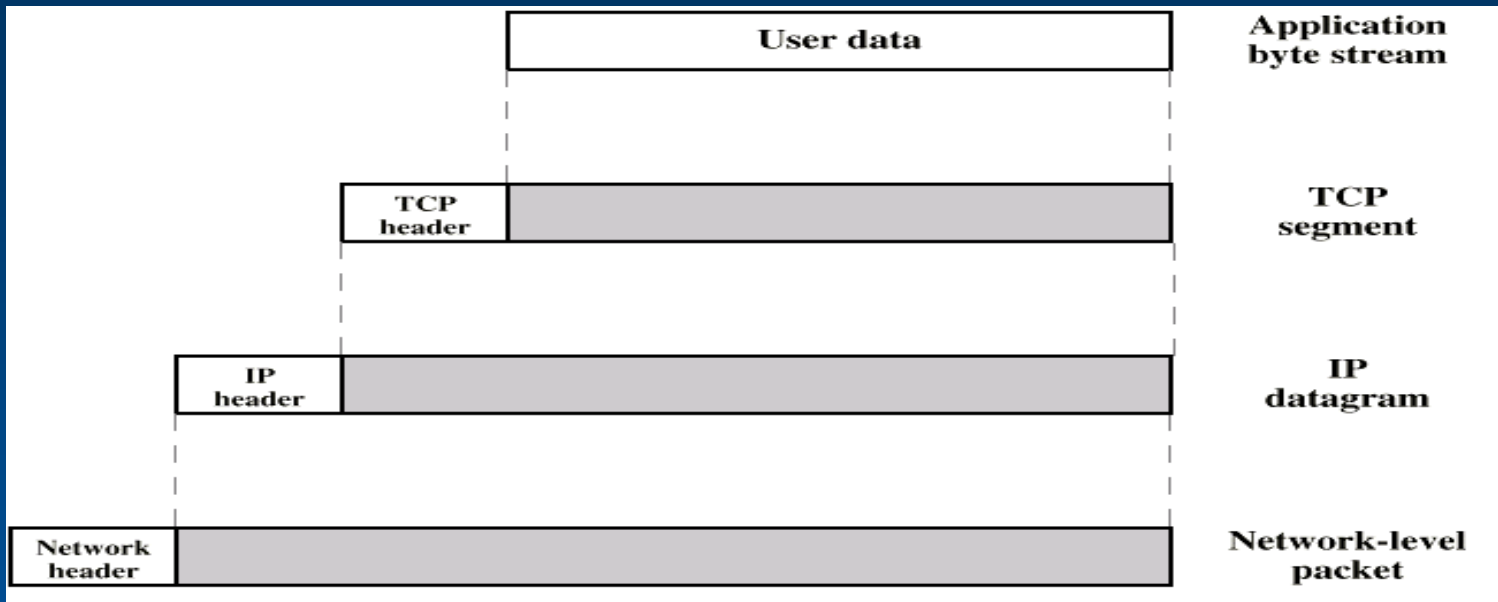
TCP/IP Concepts



Addressing level

- Level in architecture at which entity is named
- Unique address for each end system (computer) and router
- Network level address
 - IP or internet address (TCP/IP)
 - Network service access point or NSAP (OSI)
- Process within the system
 - Port number (TCP/IP)
 - Service access point or SAP (OSI)

PDU in TCP/IP



- Example Header Information
 - Destination port
 - Sequence number
 - Checksum