Chapter 5: TCP/IP and OSI

Business Data Communications, 5e

What is a Protocol?

- Allows entities (i.e. application programs) from different systems to communicate
- Shared conventions for communicating information are called protocols
- Includes syntax, semantics, and timing

Why Use Protocol Architecture?

- Data communications requires complex procedures
  - Sender identifies data path/receiver
  - Systems negotiate preparedness
  - Applications negotiate preparedness
  - Translation of file formats
- For all tasks to occur, high level of cooperation is required

Modular Approach

- Breaks complex tasks into subtasks
- Each module handles specific subset of tasks
- Communication occurs
  - between different modules on the same system
  - between similar modules on different systems

Advantages of Modularity

- Easier application development
- Network can change without all programs being modified

Three-Layer Model

- Distributed data communications involves three primary components:
  - Networks
  - Computers
  - Applications
- Three corresponding layers
  - Network access layer
  - Transport layer
  - Application layer

Network Access Layer

- Concerned with exchange of data between computer and network
- Includes addressing, routing, prioritizing, etc
- Different networks require different software at this layer
- Example: X.25 standard for network access procedures on packet-switching networks

Transport Layer

- Concerned with reliable transfer of information between applications
- Independent of the nature of the application
- Includes aspects like flow control and error checking

Application Layer

- Logic needed to support various applications
- Each type of application (file transfer, remote access) requires different software on this layer

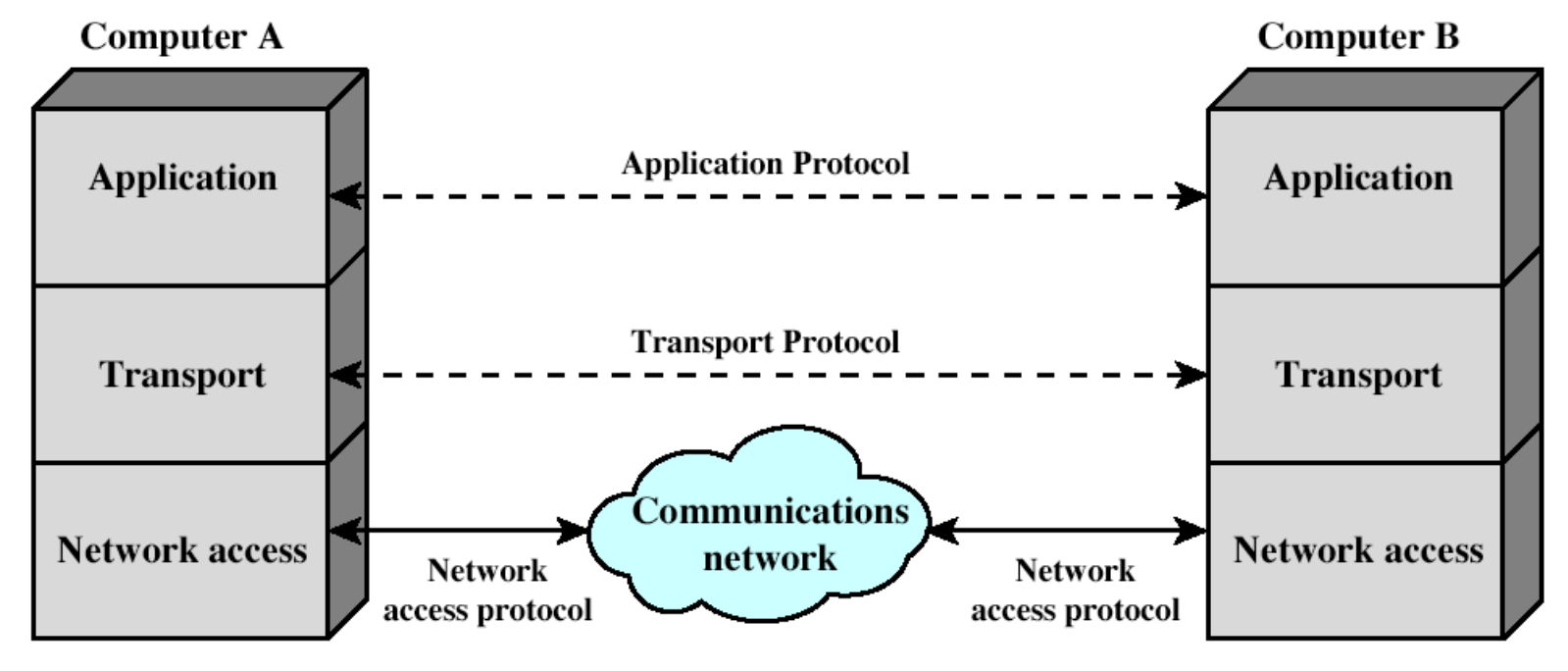
Addressing

- Each computer on a network requires a unique address on that network
- Each application requires a unique address within the computer to allow support for multiple applications (service access points, or SAP)

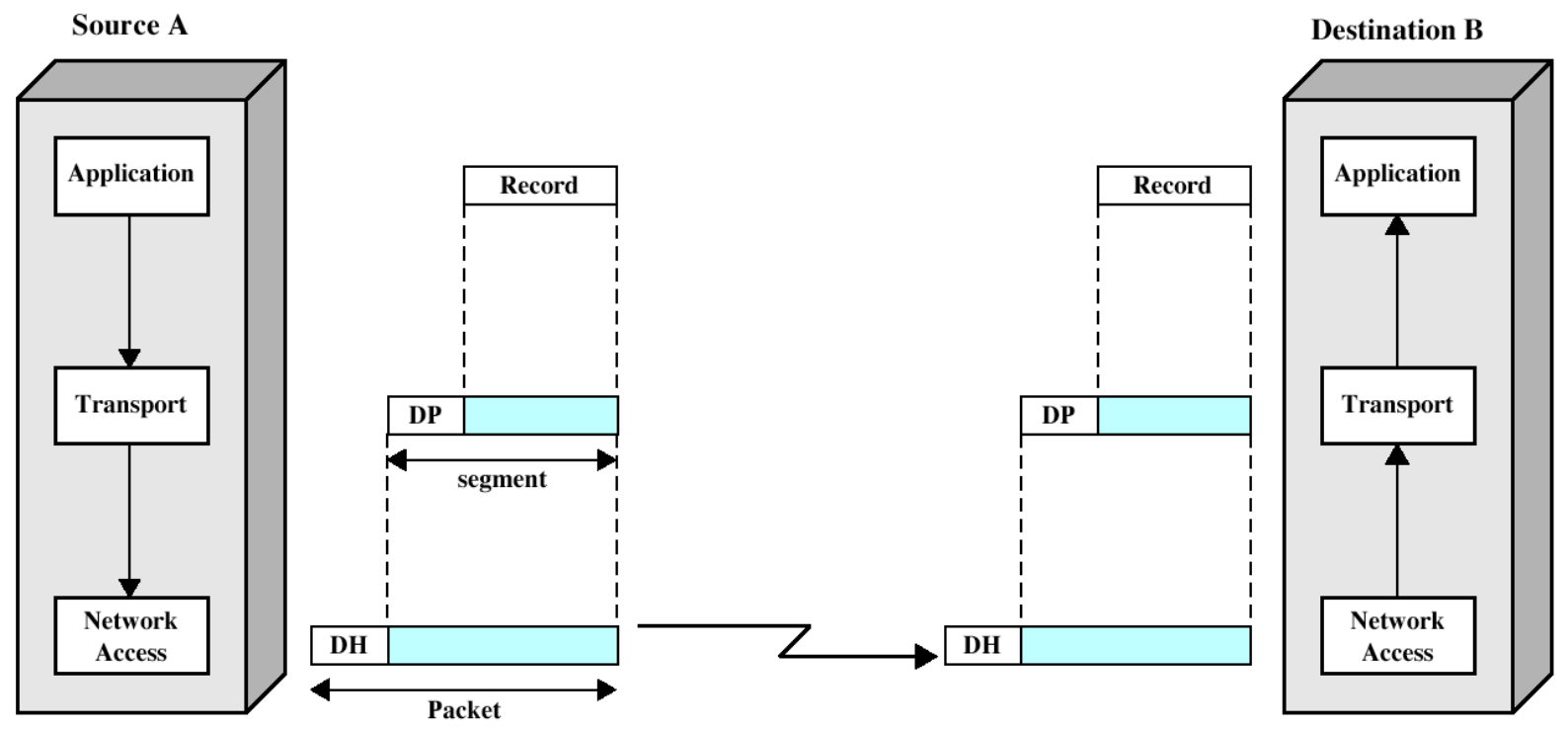
Data Transmission

- Application layer creates data block
- Transport layer appends header to create PDU (protocol data unit)
  - Destination SAP, Sequence #, Error-Detection Code
- Network layer appends another header
  - Destination computer, facilities (e.g. “priority”)
- See figure 4.5 in the book

Simplified Architecture



Protocol Architecture Operation



Standardized Protocol Architectures

- Vendors like standards because they make their products more marketable
- Customers like standards because they enable products from different vendors to interoperate
- Two protocol standards are well-known:
  - TCP/IP: widely implemented
  - OSI: less used, but widely known and still useful for modeling/conceptualizing

TCP/IP

- Transmission Control Protocol/Internet Protocol
- Developed by DARPA
- No official protocol standard

- Identifies 5 Layers
  - Application
  - Host-to-Host (transport)
  - Internet
  - Network Access
  - Physical

TCP/IP Physical Layer

- Physical interface between a DTE (e.g. computer or terminal) and a transmission medium
- Specifies:
  - Characteristics of medium
  - Nature of signals
  - Data rate

TCP/IP Network Access

- Exchange of data between systems on a shared network
- Utilizes address of host and destination
- Can also prioritize transmission
- Software at this layer depends on network (e.g. X.25 vs. Ethernet)
- Segregation means that no other software needs to be concerned about net specifics

TCP/IP Internet Layer

- An Internet is an interconnection of two or more networks
- Internet layer handles tasks similar to network access layer, but between networks rather than between nodes on a network
- Uses IP for addressing and routing across networks
- Implemented in workstations *and* routers

TCP/IP Transport Layer

- Also called host-to-host layer
- Reliable exchange of data between applications
- Uses TCP protocols for transmission

TCP/IP Application Layer

- Logic needed to support variety of applications
- Separate module supports each type of application (e.g. file transfer)

TCP & UDP

- Most TCP/IP applications use TCP for transport layer
- TCP provides a connection (logical association) between two entities to regulate flow check errors
- UDP (User Datagram Protocol) does not maintain a connection, and therefore does not guarantee delivery, preserve sequences, or protect against duplication

IP and IPv6

- IP provides for 32-bit source and destination addresses
- IPv6 (1996 standard) provides for 128-bit addresses
- Migraqtion to IPv6 will be a very slow process

TCP/IP Applications

- SMTP (Simple Mail Transfer Protocol)
  - Basic e-mail facility, transferring messages among hosts
- FTP (File Transfer Protocol)
  - Sends files from one system to another on user command
- Telnet
  - Remote login capability, allowing a user to emulate a terminal on the remote system

Internetworking

- Interconnected networks, usually implies TCP/IP
- Can appear to users as a single large network
- The global Internet is the largest example, but intranets and extranets are also examples

Routers

- Equipment used to interconnect independent networks
- Several essential functions
  - Provide a link between networks
  - Provide routing and delivery of data between processes on systems from different networks
  - Provide the above functions without requiring modification of the attached networks

Router Issues

- Addressing schemes
- Maximum packet size
- Interfaces
- Reliability

TCP Segment (TCP PDU)

- Source port (16 bits)
- Destination port (16 bits)
- Sequence number (32 bits)
- Acknowledgment number (32 bits)
- Data Offset (4 bits)
- Reserved (6 bits)
- Flags (6 bits) : URG, ACK, PSH, RST, SYN, FIN
- Window (16 bits)
- Checksum (16 bits)
- Urgent Pointer (16 bits)
- Options (variable)

IPv4 Header

- Version (4 bits)
- Internet header length (4 bits)
- Type of Service (8 bits)
- Total Length (16 bits)
- Identification (16 bits)
- Flags (3 bits
- Fragment Offset (13 bits)
- Time to Live (8 bits)
- Protocol (8 bits
- Header Checksum (16 bits)
- Source Address (32 bits)
- Destination Address (32 bits)
- Options (variable)
- Padding (variable)

Why Study OSI?

- Still an excellent model for conceptualizing and understanding protocol architectures
- Key points:
  - Modular
  - Hierarchical
  - Boundaries between layers=interfaces

OSI

- Open Systems Interconnection
- Developed by ISO
- Contains seven layers (see page 358)
  - Application
  - Presentation
  - Session
  - Transport
  - Network
  - Data Link
  - Physical

OSI Lower Layers

- Physical
- Data Link
- Network

OSI Physical Layer

- Responsible for transmission of bits
- Always implemented through hardware
- Encompasses mechanical, electrical, and functional interfaces
- e.g. RS-232

OSI Data Link Layer

- Responsible for error-free, reliable transmission of data
- Flow control, error correction
- e.g. HDLC

OSI Network Layer

- Responsible for routing of messages through network
- Concerned with type of switching used (circuit v. packet)
- Handles routing between networks, as well as through packet-switching networks

OSI Upper Layers

- Transport
- Session
- Presentation
- Application

OSI Transport Layer

- Isolates messages from lower and upper layers
- Breaks down message size
- Monitors quality of communications channel
- Selects most efficient communication service necessary for a given transmission

OSI Session Layer

- Establishes logical connections between systems
- Manages log-ons, password exchange, log-offs
- Terminates connection at end of session

OSI Presentation Layer

- Provides format and code conversion services
- Examples
  - File conversion from ASCII to EBDIC
  - Invoking character sequences to generate bold, italics, etc on a printer

OSI Application Layer

- Provides access to network for end-user
- User's capabilities are determined by what items are available on this layer

TCP/IP - OSI Comparison