

# William Stallings

# Data and Computer

# Communications

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## Chapter 1

## Introduction

# A Communications Model

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## ⌘ Source

- ☑ generates data to be transmitted

## ⌘ Transmitter

- ☑ Converts data into transmittable signals

## ⌘ Transmission System

- ☑ Carries data

## ⌘ Receiver

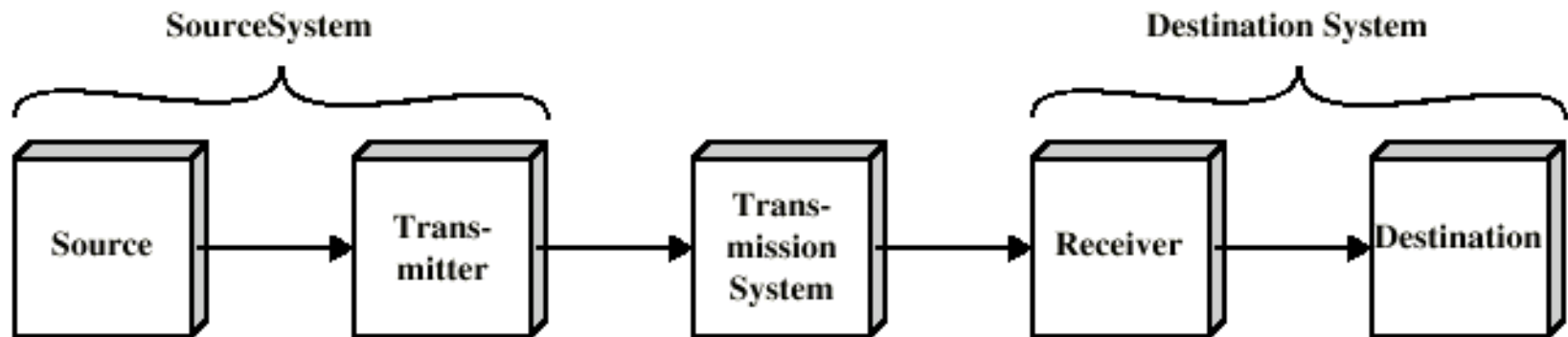
- ☑ Converts received signal into data

## ⌘ Destination

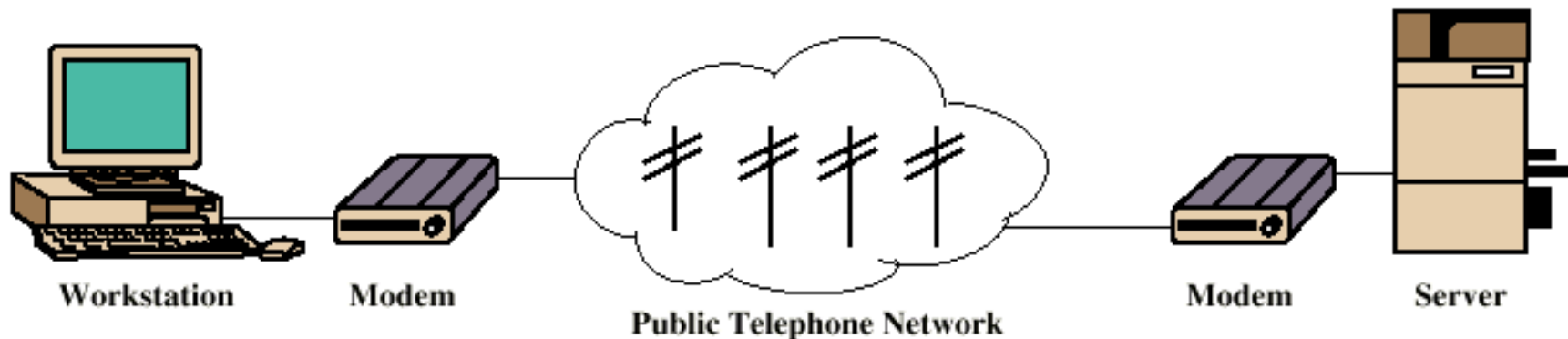
- ☑ Takes incoming data

# Simplified Communications Model - Diagram

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(a) General block diagram



(b) Example

# Key Communications Tasks

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⌘ Transmission System Utilization

⌘ Interfacing

⌘ Signal Generation

⌘ Synchronization

⌘ Exchange Management

⌘ Error detection and correction

⌘ Addressing and routing

⌘ Recovery

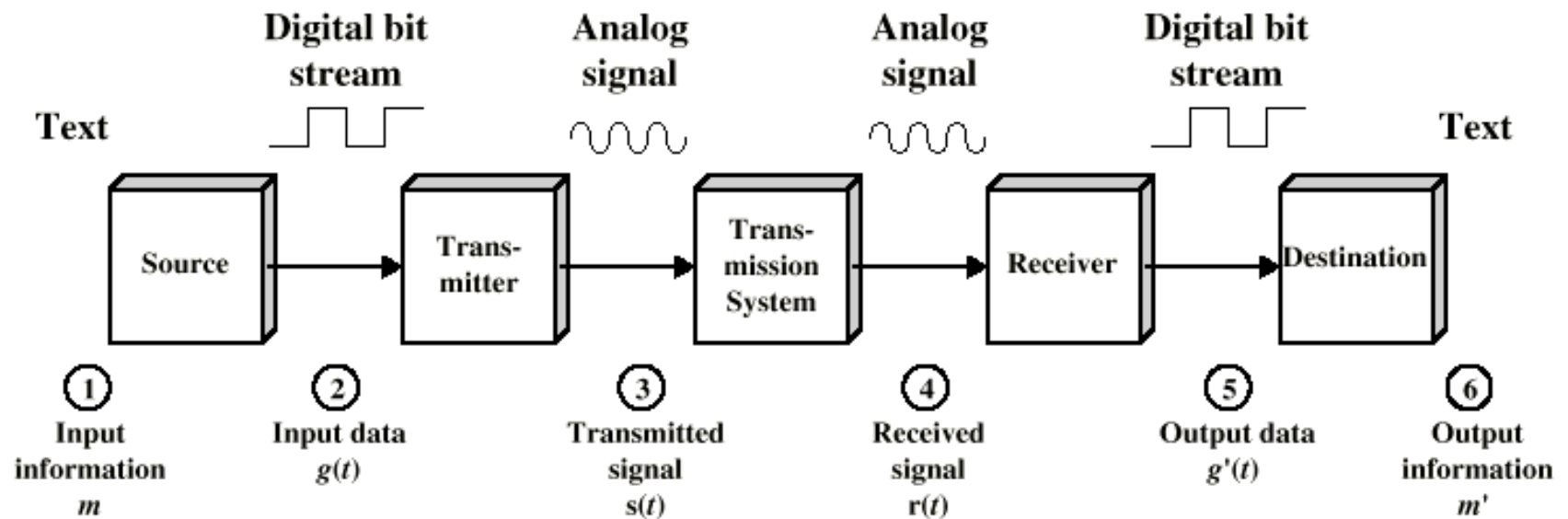
⌘ Message formatting

⌘ Security

⌘ Network Management

# Simplified Data Communications Model

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# Networking

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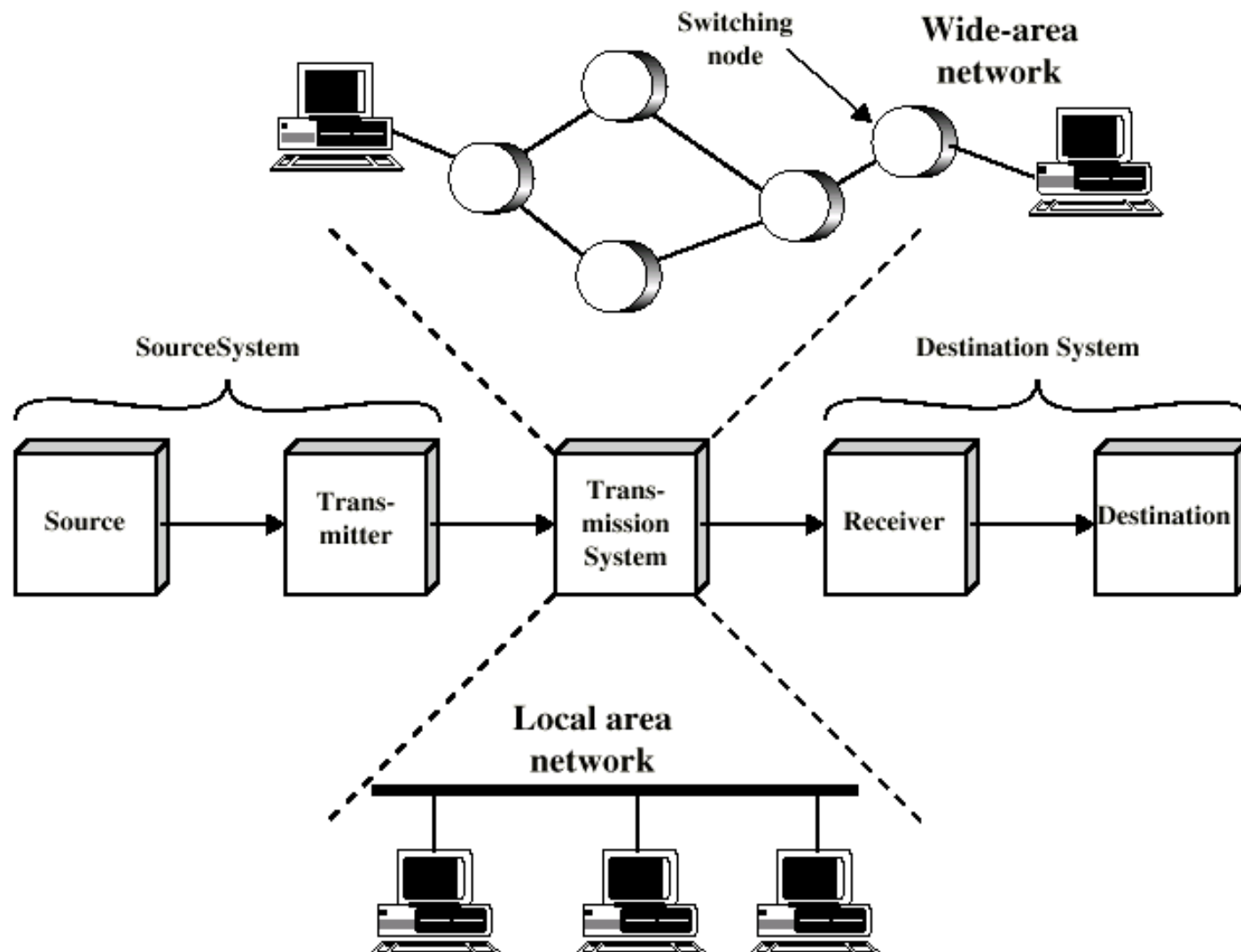
⌘ Point to point communication not usually practical

- ⌘ Devices are too far apart

- ⌘ Large set of devices would need impractical number of connections

⌘ Solution is a communications network

# Simplified Network Model



# Wide Area Networks

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- ⌘ Large geographical area
- ⌘ Crossing public rights of way
- ⌘ Rely in part on common carrier circuits
- ⌘ Alternative technologies
  - ☒ Circuit switching
  - ☒ Packet switching
  - ☒ Frame relay
  - ☒ Asynchronous Transfer Mode (ATM)



# Circuit Switching

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- ⌘ Dedicated communications path established for the duration of the conversation
- ⌘ e.g. telephone network

# Packet Switching

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- ⌘ Data sent out of sequence
- ⌘ Small chunks (packets) of data at a time
- ⌘ Packets passed from node to node between source and destination
- ⌘ Used for terminal to computer and computer to computer communications

# Frame Relay

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- ⌘ Packet switching systems have large overheads to compensate for errors
- ⌘ Modern systems are more reliable
- ⌘ Errors can be caught in end system
- ⌘ Most overhead for error control is stripped out

# Asynchronous Transfer Mode

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- ⌘ ATM
- ⌘ Evolution of frame relay
- ⌘ Little overhead for error control
- ⌘ Fixed packet (called cell) length
- ⌘ Anything from 10Mbps to Gbps
- ⌘ Constant data rate using packet switching technique

# Integrated Services Digital Network

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- ⌘ ISDN

- ⌘ Designed to replace public telecom system

- ⌘ Wide variety of services

- ⌘ Entirely digital domain

# Local Area Networks

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- ⌘ Smaller scope

  - ☒ Building or small campus

- ⌘ Usually owned by same organization as attached devices

- ⌘ Data rates much higher

- ⌘ Usually broadcast systems

- ⌘ Now some switched systems and ATM are being introduced

# Protocols

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- ⌘ Used for communications between entities in a system

- ⌘ Must speak the same language

- ⌘ Entities

  - ☒ User applications

  - ☒ e-mail facilities

  - ☒ terminals

- ⌘ Systems

  - ☒ Computer

  - ☒ Terminal

  - ☒ Remote sensor

# Key Elements of a Protocol

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## ⌘ Syntax

- ☑ Data formats
- ☑ Signal levels

## ⌘ Semantics

- ☑ Control information
- ☑ Error handling

## ⌘ Timing

- ☑ Speed matching
- ☑ Sequencing



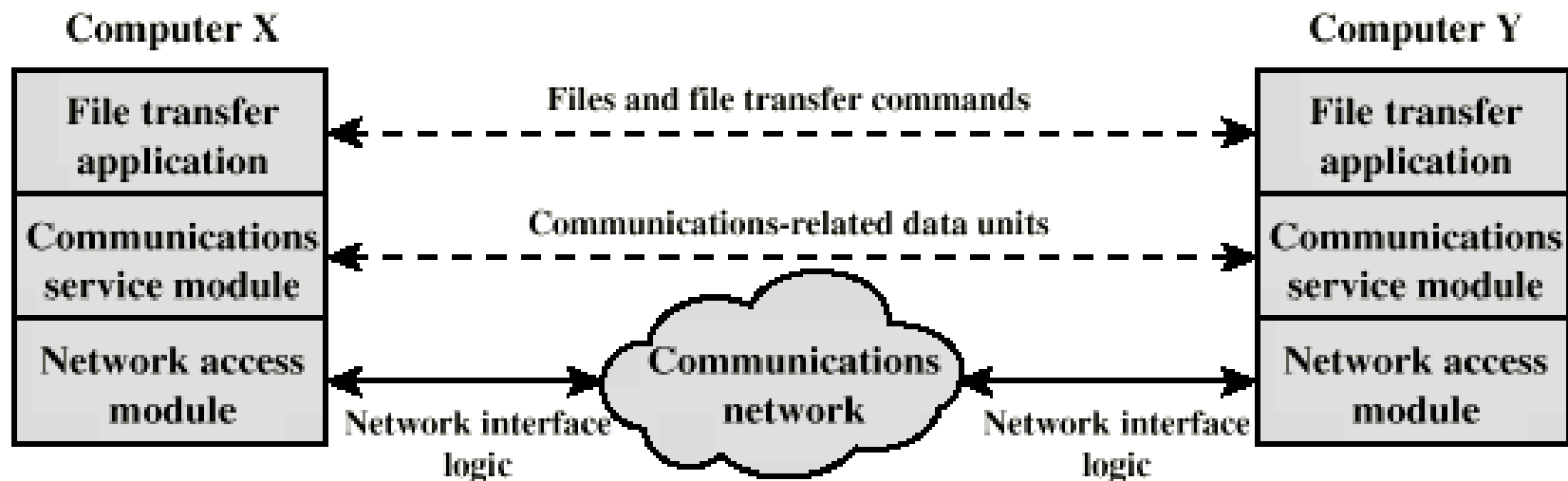
# Protocol Architecture

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- ⌘ 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

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# A Three Layer Model

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⌘ Network Access Layer

⌘ Transport Layer

⌘ Application Layer

# Network Access Layer

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- ⌘ 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

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

# Application Layer

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- ⌘ Support for different user applications

- ⌘ e.g. e-mail, file transfer

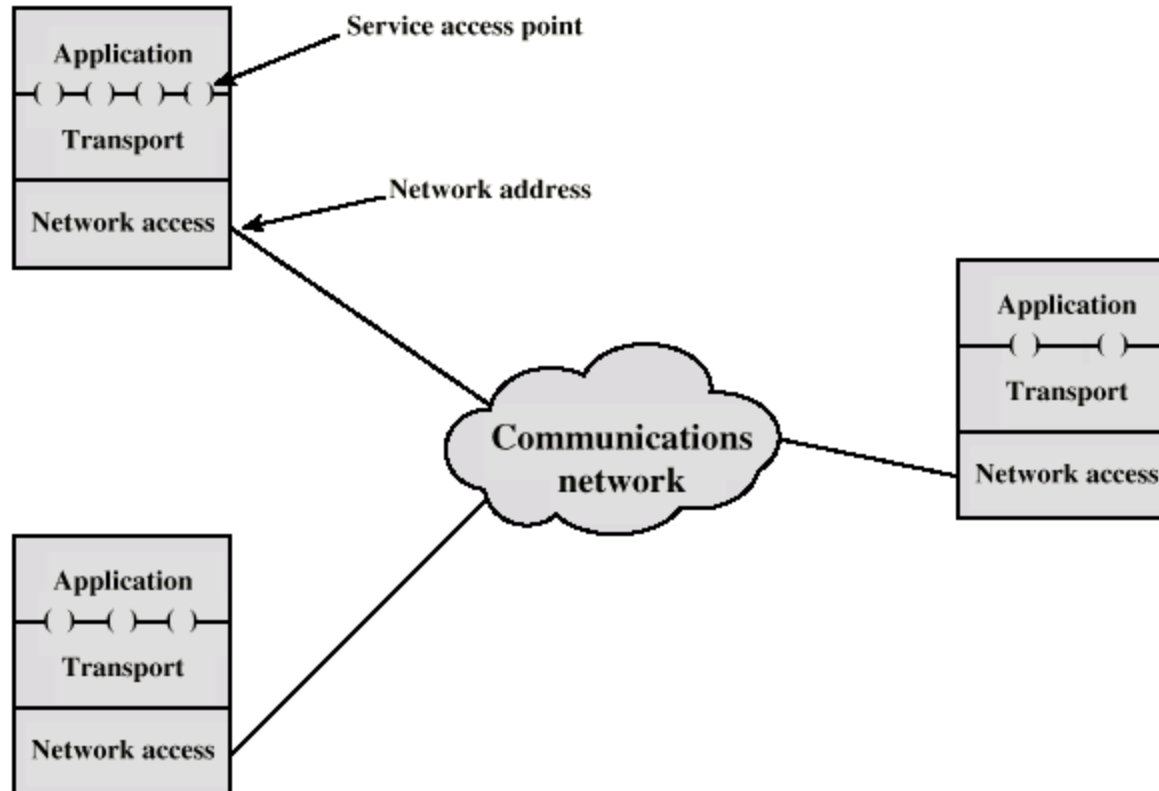
# Addressing Requirements

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- ⌘ 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

# Protocol Architectures and Networks

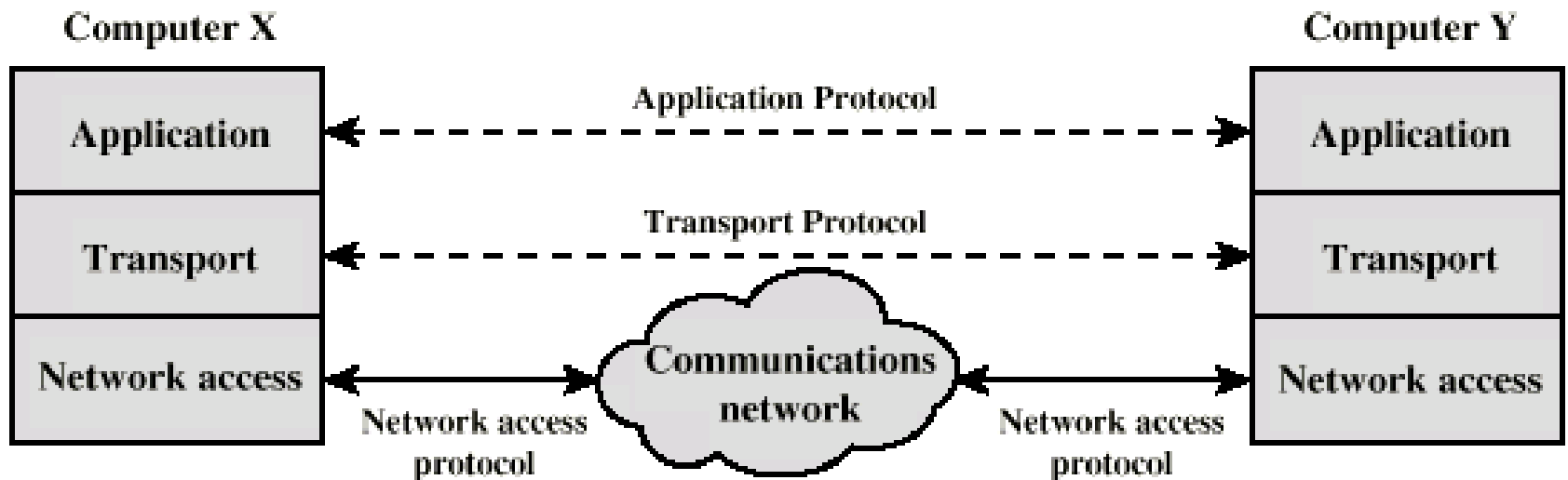
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# Protocols in Simplified Architecture

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# Protocol Data Units (PDU)

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- ⌘ 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

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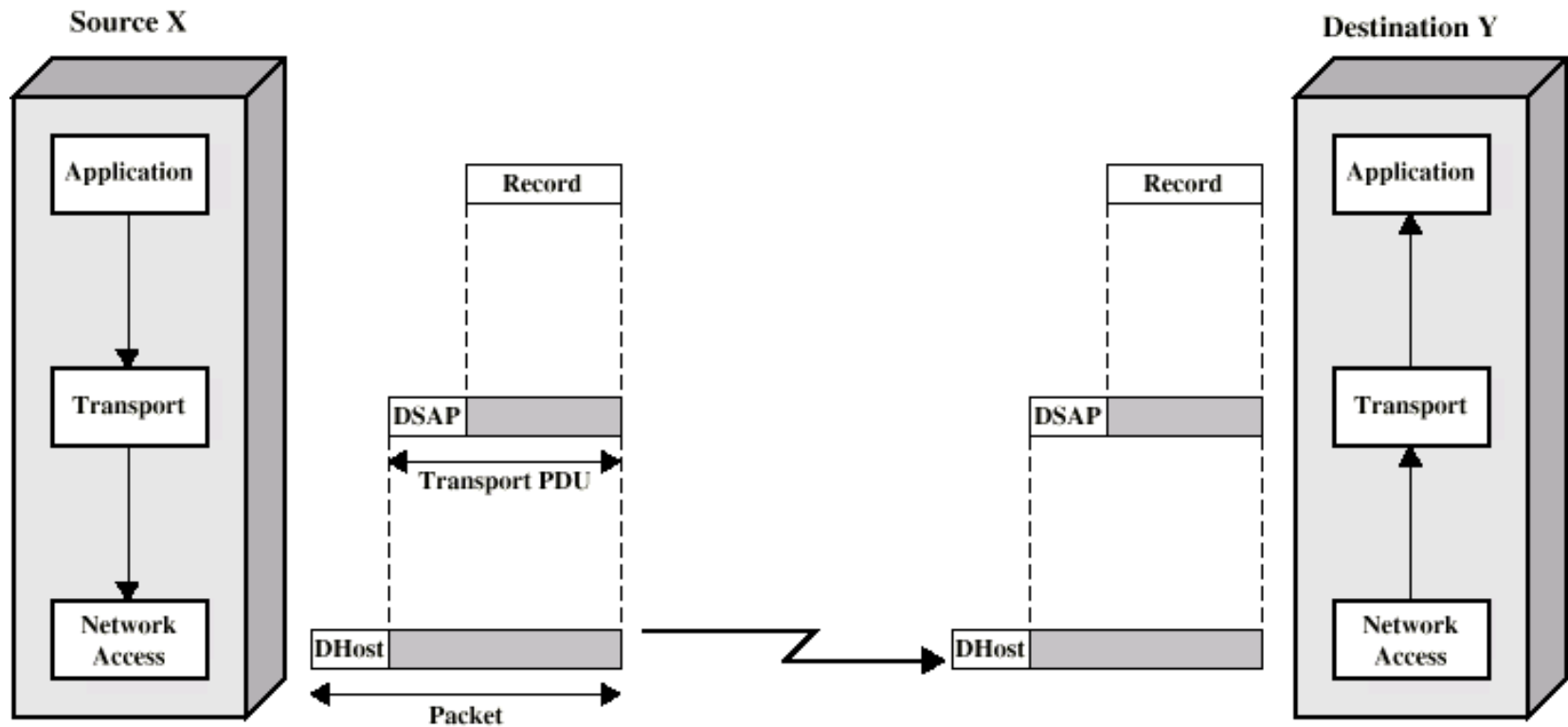
⌘ Adds network header

☑ network address for destination computer

☑ Facilities requests

# Operation of a Protocol Architecture

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# TCP/IP Protocol Architecture

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- ⌘ 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.
  - ☑ Application layer
  - ☑ Host to host or transport layer
  - ☑ Internet layer
  - ☑ Network access layer
  - ☑ Physical layer

# Physical Layer

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

# Network Access Layer

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

# Internet Layer (IP)

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- ⌘ Systems may be attached to different networks
- ⌘ Routing functions across multiple networks
- ⌘ Implemented in end systems and routers



# Transport Layer (TCP)

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- ⌘ Reliable delivery of data
- ⌘ Ordering of delivery

# Application Layer

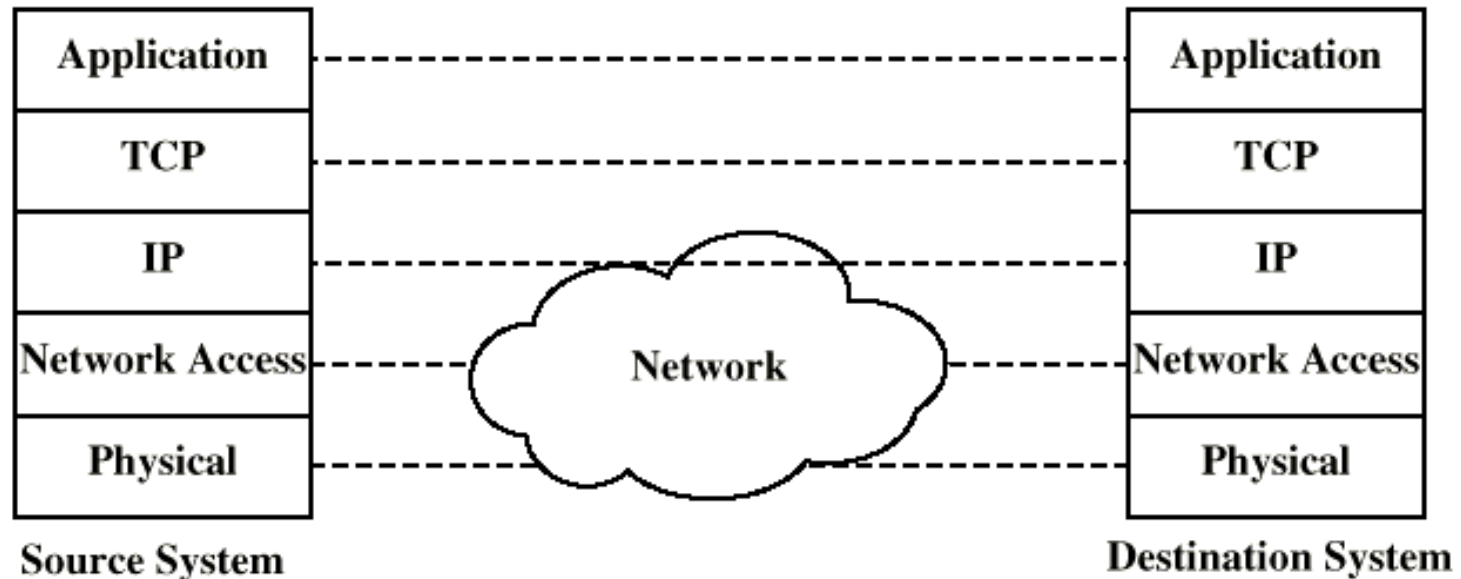
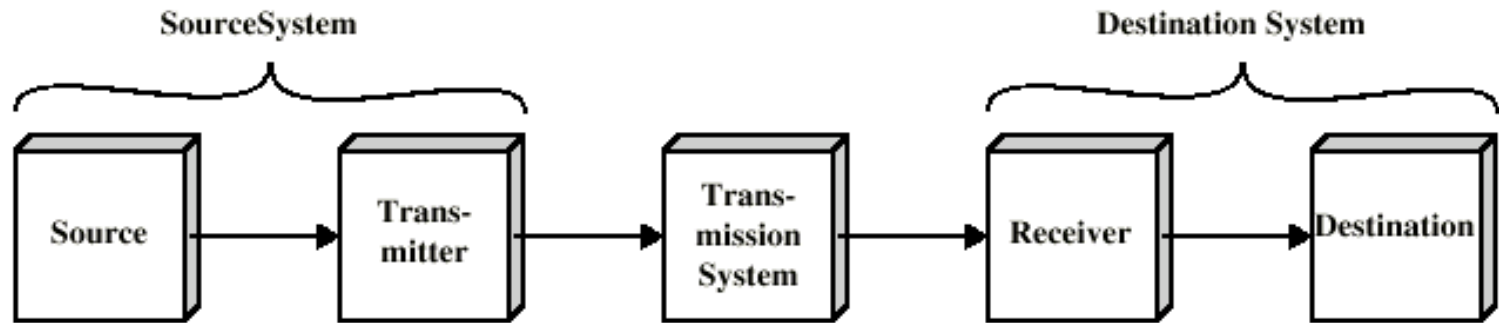
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- ⌘ Support for user applications

- ⌘ e.g. http, SMTP

# TCP/IP Protocol Architecture Model

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# OSI Model

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- ⌘ Open Systems Interconnection
- ⌘ Developed by the International Organization for Standardization (ISO)
- ⌘ Seven layers
- ⌘ A theoretical system delivered too late!
- ⌘ TCP/IP is the de facto standard

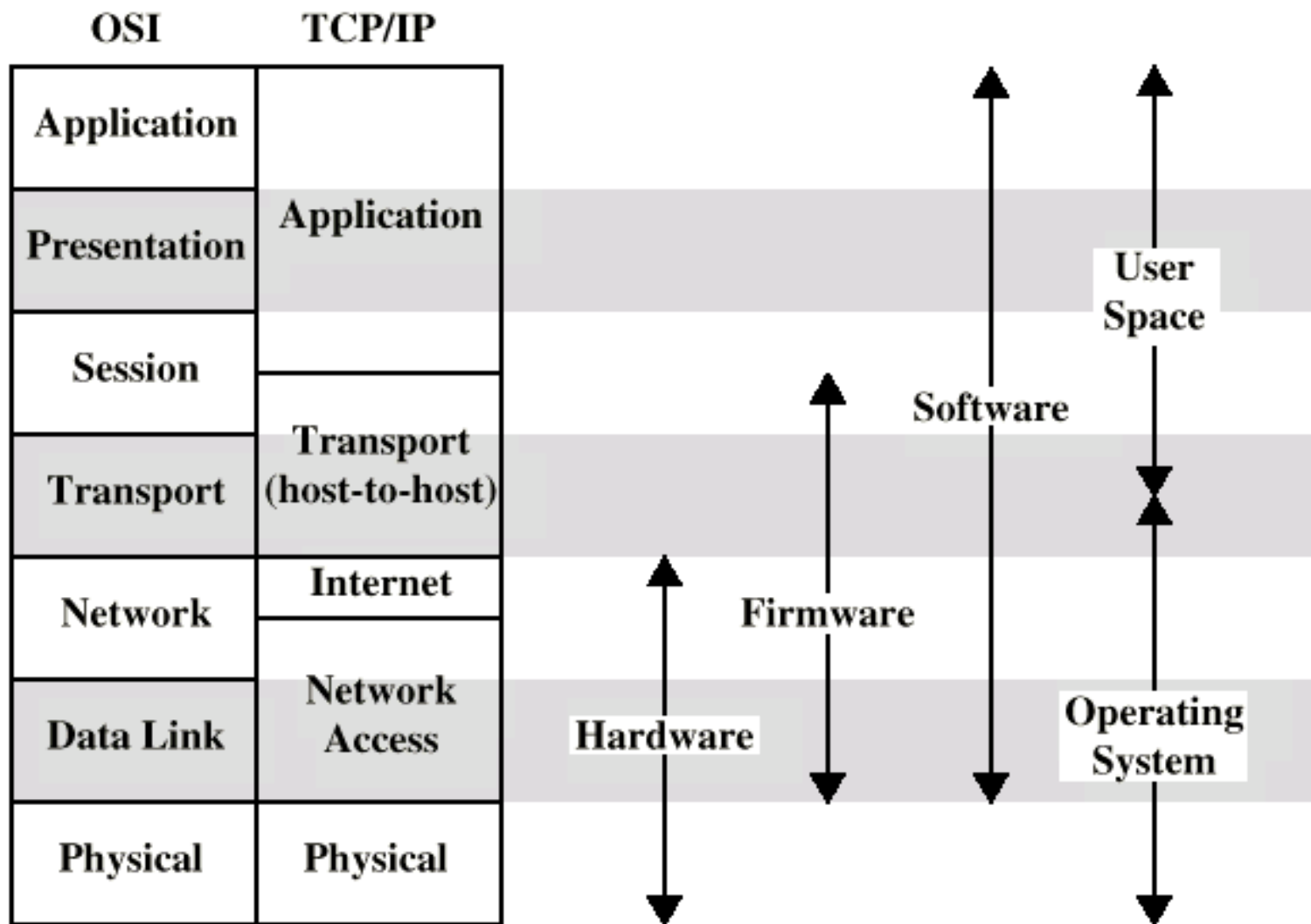
# OSI Layers

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- ⌘ Application
- ⌘ Presentation
- ⌘ Session
- ⌘ Transport
- ⌘ Network
- ⌘ Data Link
- ⌘ Physical

# OSI v TCP/IP

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# Standards

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- ⌘ Required to allow for interoperability between equipment

- ⌘ Advantages

- ☑ Ensures a large market for equipment and software
  - ☑ Allows products from different vendors to communicate

- ⌘ Disadvantages

- ☑ Freeze technology
  - ☑ May be multiple standards for the same thing

# Standards Organizations

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- ⌘ Internet Society
- ⌘ ISO
- ⌘ ITU-T (formally CCITT)
- ⌘ ATM forum



# Further Reading

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⌘ Stallings, W. Data and Computer Communications (6th edition), Prentice Hall 1999 chapter 1

⌘ Web site for Stallings book

[⌘ www.shore.net/~ws/DCC6e.html](http://www.shore.net/~ws/DCC6e.html)

⌘ Web sites for IETF, IEEE, ITU-T, ISO

⌘ Internet Requests for Comment (RFCs)

⌘ Usenet News groups

[⌘ comp.dcom.\\*](http://comp.dcom.*)

[⌘ comp.protocols.tcp-ip](http://comp.protocols.tcp-ip)