

## Computing systems and communications

- Introduction
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- Communications architecture
- Reference:
  - Data and computer communications, William Stallings, pages 1 – 16  
ISBN 0-02-415441-5

## A universal machine

- At the center of **all** of these computing systems is the computer
- The capacity to compute arithmetic and logical operations has enabled the machine to be used in a vast array of applications
- The user of such computing systems is usually oblivious to the powerful simplicity of the computer that they rely on

## Introduction

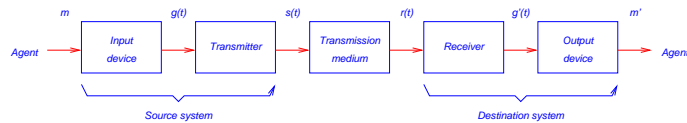
- Need for communications
- What is communications?
  - Communications allows us to transfer and exchange data
  - This allows access to much greater data than that available on one computer
- Where are communications used?
  - Financial systems: ATM networks, stock exchanges
  - Airlines: Reservation systems, aircraft control
  - Manufacture: Assembly line, design systems, stock control
  - Academia: Internet, sharing of ideas
  - University: Sharing computing resources

## Computer-communications revolution

- There is no fundamental difference between data processing (computers) and data communications (transmission and switching equipment)
- There are no fundamental differences among data, voice, graphics and video communications
- The lines between single-processor computer, multi-processor computer, local network, metropolitan network, and long-haul network have blurred

## A communications model

- Exchange of information between two agents
- Data and Information:
  - **Data:** A representation of facts, concepts, or instructions in a formalised manner suitable for communication, interpretation, or processing by human beings or by arithmetic means
  - **Information:** The meaning that a human being assigns to data by means of the conventions being applied to those data [Stallings]



## Example 1 – Electronic mail (1)

- 1 The sender composes a message,  $m$
- 2 Through a keyboard, this is translated into a stream of bits,  $g$
- 3 The bit stream is converted into a signal,  $s(t)$ , appropriate for transmission through the given medium
- 4 The signal  $s(t)$  undergoes some degradation in transmission, the result is a potentially different received signal,  $r(t)$

## Example 1 – Electronic mail (2)

- 5 The receiver converts  $r(t)$  into a bit stream,  $g'(t)$ , reversing the conversion used by the sender to produce  $s(t)$
- 6 At this point, the receiving computer may examine the message for errors
- 7 If errors are detected, the receiving computer may cooperate with the sending computer, re-transmitting as necessary until the errors are resolved
- 8 The receiver eventually will receive a message  $m$ , that is usually identical to the transmitted message

## Example 2 – Telephone conversation

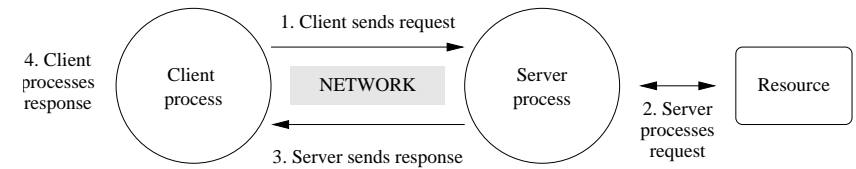
- 1 Message  $m$  is generated as sound waves (by speaker's mouth)
- 2 Telephone converts this to an electric signal,  $s(t)$
- 3 The signal  $s(t)$  may be directly transmitted,  $g(t) = s(t)$
- 4 The transmitted signal will suffer some distortion, so that the received signal,  $r(t)$ , will not be identical to the transmitted signal,  $s(t)$
- 5 The received signal is translated directly to sound waves, with no attempt to recover errors
- 6 The receiver hears a distorted version of the transmitted message  $m'$ , but the message is generally understandable

## Communications tasks

- Reliable communication involves many different tasks
- Some are listed below:
  - Transmission system utilisation
  - Addressing
  - Interfacing
  - Routing
  - Signal generation
  - Recovery
  - Synchronisation
  - Message formatting
  - Exchange management
  - Protection
  - Error detection and correction
  - System management

## Client-Server Programming Model over a Network

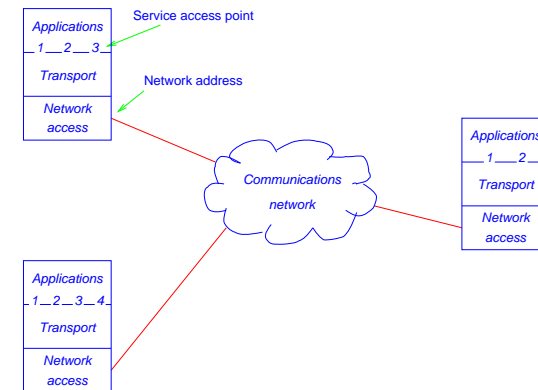
- Every network application is based on a client-server model
- The fundamental operation in this model is the *transaction*



## Data communication networking

- In its simplest form, data communication takes place between two devices connected by some form of point-to-point transmission medium
- This is often impractical
  - The devices are too far apart
  - There is a set of devices, each of which require a link to many of the others at various times
- The solution is to attach each device to a **communication network**

## Computer communications architecture



## Network access layer

- Concerned with the exchange of data between a computer and the network to which it is attached
- The sending computer provides the network with a destination address for every message to be communicated
- The software used at this layer depends on the sort of network used
- There are many different sorts of networks
- The transport and application layers are not concerned with the specifics of the network

## Application layer

- The application layer holds the software associated with the various different network applications, such as file transfer and email
- Different applications transfer information in different ways; e.g. telnet, email, web browser, etc.

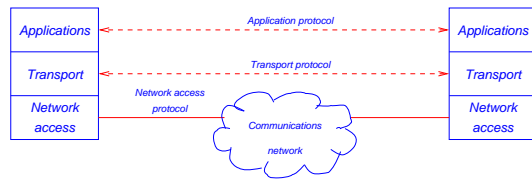
## Transport layer

- Due to the errors that are typically introduced during transmission, software is employed to ensure reliability
- Such error correction can be made independent of the application software and the particular network technology
- The negotiations between sender and receiver to ensure reliable transmission are often complex
- The transport layer ensures reliable transmission, hiding the details from the application layer and insulated from the hardware details by the network access layer

## Addressing and protocols

- A single machine may be host to many applications at a time
- Each application on a machine will access the transport layer through an identifiable point called a **Service Access Point** (SAP)
- Thus, an **address** must specify a machine and a SAP
- **Protocols** are rules of communication that allow orderly, standardised communication between parties
- Protocols are used in human communication
- In machine communication, protocols help to detect errors
- A breach of protocol is viewed as an error

## Protocols in a three layer architecture (1)



- Application layer
  - Data may consist of a message of **any** length
  - The data is given directly to the transport layer

## Protocols in a three layer architecture (3)

- Network access layer
  - A network access layer header is attached to each packet
  - The header typically contains:
    - \* The destination computer address
    - \* Other information including service requirements (priorities, time-stamps, etc.)
    - \* A further error detection code

## Protocols in a three layer architecture (2)

- Transport layer
  - The message is typically broken into small units (**packets**)
  - Associate with each packet will be a **header**
  - The header typically contains:
    - \* An address
    - \* A sequence number
    - \* An error-detection code

## Illustration of the packets at each layer

