

Example 2 – Telephone Conversation

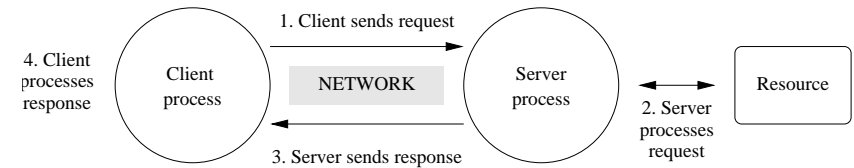
- 1 message m is generated as sound waves (by speaker's mouth)
- 2 telephone converts this to an electric signal, $s(t)$
- 3 the signal $s(t)$ may be directly transmitted, $g(t) = s(t)$
- 4 the transmitted signal will suffer some distortion, so that the received signal, $r(t)$, will not be identical 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

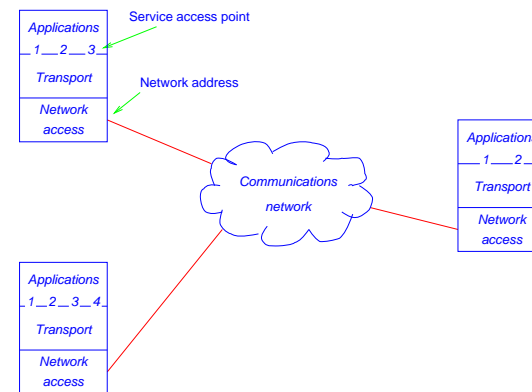
- reliable communication involves many different tasks
- some are listed below:
 - transmission system utilisation
 - addressing
 - interfacing
 - routing
 - signal generation
 - recovery
 - synchronisation
 - message formatting
 - exchange management
 - protection
 - error detection and correction
 - system management

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 large number 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
- example: 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

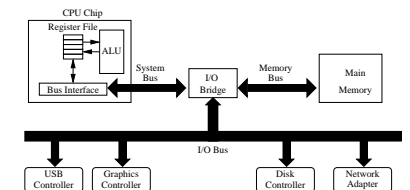


Computer Communications Architecture



on each node (computer), recall the network adapter is just another another I/O device:

- data copied from adapter to memory using DMA



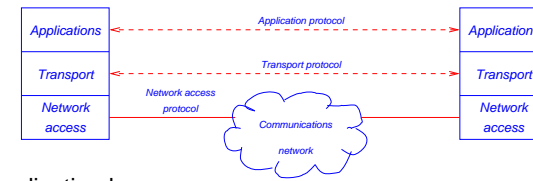
Abstraction Layers in the Computer Communications Architecture

- network access layer: deals with the physical network hardware
 - handles exchange of data between a computer and its attached network
 - the sending computer provides the network with a destination address for every message to be communicated
 - its software must deal with the specifics of the many kinds of network
- transport layer: ensures reliable transmission
 - 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
 - may involve complex negotiations between sender and receiver
 - hides the details from the application layer and insulated from the hardware details by the network access layer
- application layer: holds the software for the various different network applications
 - different applications transfer information in different ways; e.g. telnet, ftp, email, web browser, etc.

Addressing and Protocols

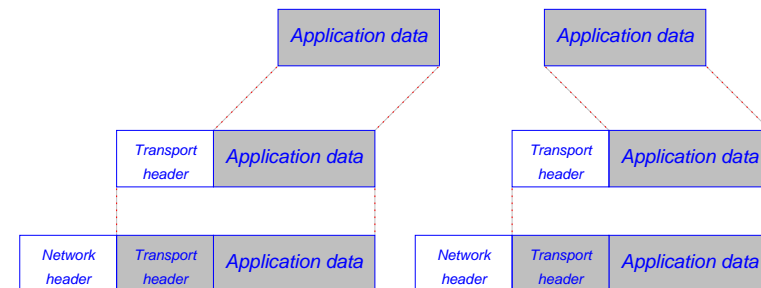
- a single machine may be host to many applications at a time
- each application on a machine will access the transport layer through an identifiable point called a Service Access Point (SAP, e.g. TCP/IP port)
- thus, an address must specify a computer and a SAP
- protocols are rules of communication 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



- application layer:
 - data may consist of a message of *any* length
 - the data is given directly to the transport layer
- transport layer:
 - the message is typically broken into small units (packets) (issue: choosing size)
 - associated with each packet will be a header typically containing:
 - ◆ an address, a sequence number, and an error-detection code
- network access layer:
 - attaches its own header to each packet, typically containing:
 - ◆ the destination computer address, information on service requirements (priorities, time-stamps, etc.), and a further error detection code

Illustration of the Packets at Each Network Layer



(c.f. the communications model)

