System Models and Networking Chapter 2,3

Bina Ramamurthy

Fundamental Issues

- There is no global time.
- All communications are by means of messages.
- Message communication may be affected by network delays and can suffer from a variety of failures and security attacks.
- How does one express a solution/process for handling an issue? One of the ways is to establish a model.

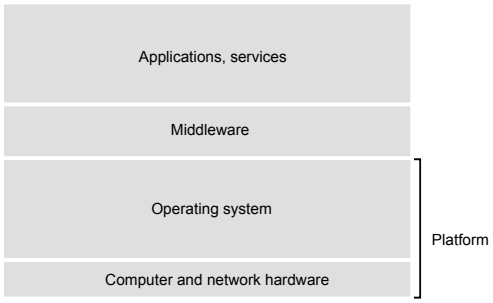
System Models

- **Interaction model** deals with performance and setting time limits in a distributed system, say, for message delivery.
- **Failure model** gives specification of faults and defines reliable communication and correct processes.
- **Security model** specifies possible threats and defines the concept of secure channels.
- **Architectural model** defines the way in which the components of the system interact with one another and the way in which they are mapped onto the underlying network of computers.

Architectural Model

- Abstracts the functions of the individual components.
- Defines patterns for distribution of data and workload.
- Defines patterns of communication among the components.
- Example: Definition of server process, client process and peer process and protocols for communication among processes; definition client/server model and its variations.

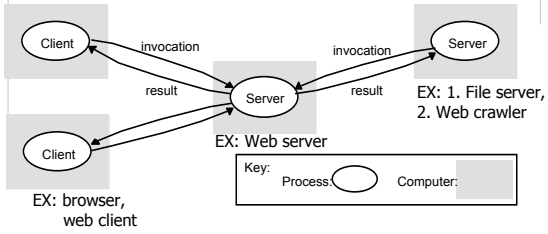
Software and hardware service layers in distributed systems



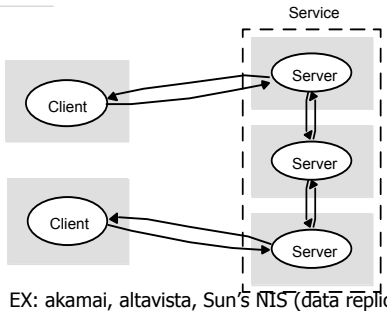
Middleware

- Layer of software whose purpose is to mask the heterogeneity and to provide a convenient programming model for application programmers.
- Middleware supports such abstractions as remote method invocation, group communications, event notification, replication of shared data, real-time data streaming.
- Examples: CORBA spec by OMG, Java RMI, MS's DCOM.

Clients invoke individual servers

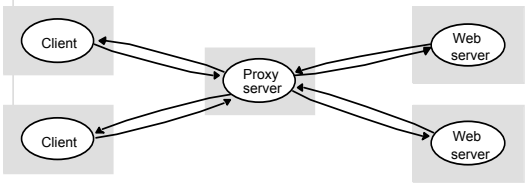


A service provided by multiple servers



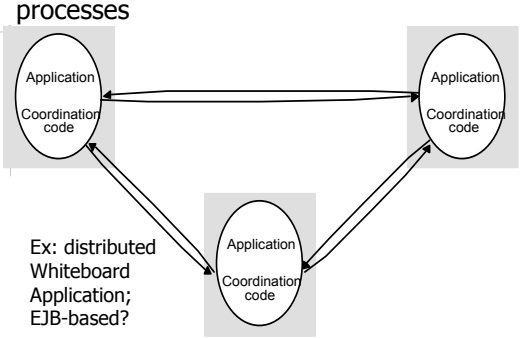
EX: akamai, altavista, Sun's NIS (data replication)

Web proxy server and caches



Proxy servers + cache are used to provide increased Availability and performance. They also play a major role Firewall based security. http://www.interhack.net/pubs/fwfaq/

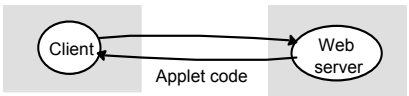
A distributed application based on peer processes



Ex: distributed Whiteboard Application; EJB-based?

Web applets

a) client request results in the downloading of applet code



b) client interacts with the applet

EX: Look at Object by value in CORBA

Networking (Chapter 3)

- Distributed systems use local area networks, wide area networks and internet for communication.
- Performance, reliability, scalability, mobility, and quality of service (qos) impact the design.
- Changes in user requirements have resulted in emergence of wireless and qos guarantees.
- Principles: protocol layering, packet switching, routing, data and behavior streaming.
- Coverage: Ethernet, Asynchronous Transfer Mode (ATM), IEEE 802.11 wireless network standard.

Networking Issues

- Performance:
  - Latency: delays at the switches and routers.
  - Data transfer rate (bits/sec) : raw data
  - Bandwidth: total volume of traffic that can be transferred across the network in a given time.
- Scalability:
  - How does a system handle increase in the number of users? Increase in the size of the system? Increase in load and traffic?

Networking Issues (contd.)

- Security: requirements and techniques for achieving security. Firewall, Virtual Private Network (VPN).
- Mobility: Support for moving devices. Not necessarily wireless.
- QoS: Bandwidth and latency bounds.

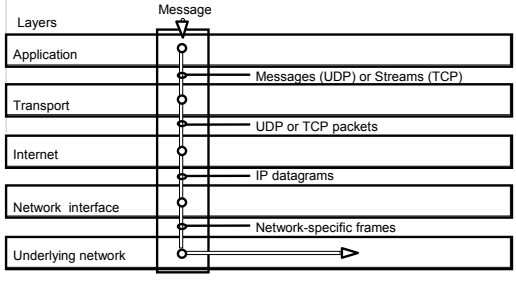
Types of Networks

- Characterized by speed, communication medium, size, geographical distances, bandwidth, latency, technology.
- LAN :
  - Single medium such as twisted pair of copper wires, coaxial cables, or optical fibers.
  - Technology: Ethernet, token rings, slotted rings.
- WAN:
  - Set of comm circuits (coax, satellite) linked by dedicated computers called routers.
  - Technology: Switching.

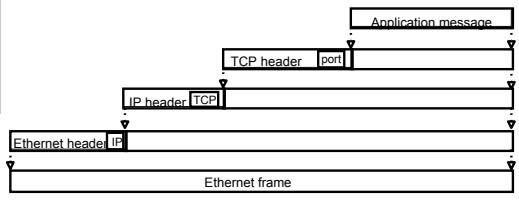
Types of Networks

- MAN:
  - High bandwidth copper or fiber optic cables. (phone lines, DSL, cable modem)
  - Technology: Ethernet, IEEE802.6, ATM
- Wireless:
  - Radio frequency, infrared,
  - Technology: IEEE 802.11 (wavelan), CDPD, GSM, bluetooth (proximity)

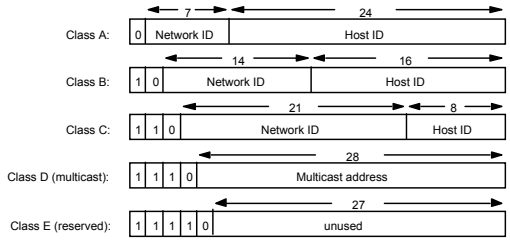
TCP/IP layers



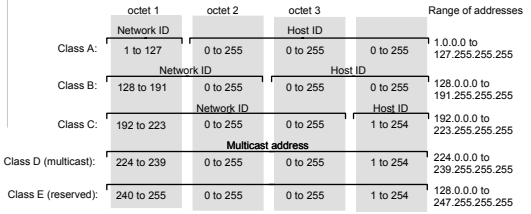
Encapsulation in a message transmitted via TCP over an Ethernet



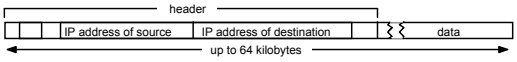
Internet address structure, showing field sizes in bits



Decimal representation of Internet addresses



IP packet layout and IPV4 Issues



- Address limitations
- Scarcity of Class B addresses
- Managing entries in routing tables
- Ad hoc measures such as allocation Class C to Class B address ranges (CIDR – classless interdomain routing).

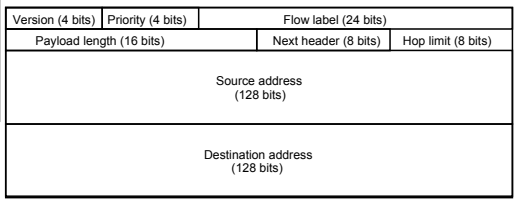
Issues in IPV4

- Address limitations
- Scarcity of Class B addresses
- Managing entries in routing tables
- Ad hoc measures such as allocation Class C to Class B address ranges (CIDR – classless interdomain routing).

IPV6 Features

- Addresses are 128 bits (double that of IPV4)
- Address space is partitioned
- Routing speed improved by removing some operations such as checksum.
- Accommodates real-time and special services. (streams and devices)
- Future evolution possible (next header field).
- IPV6 support "anycast" (message delivered to at least one of the hosts).
- Built-in security.

IPv6 header layout



Tunnelling for IPv6 migration