06-06798 Distributed Systems

Lecture 2: Architectural Models

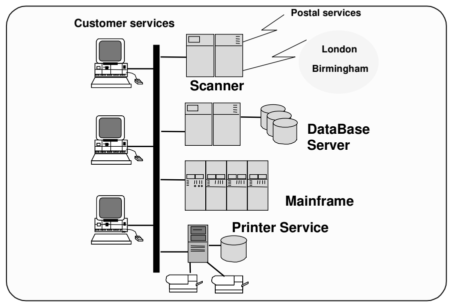
Overview

- System architectures
- Software layers
- Architectural models
  - client-server, peer processes,…
  - mobile code, agents,...
- Design requirements
  - user expectations of the system

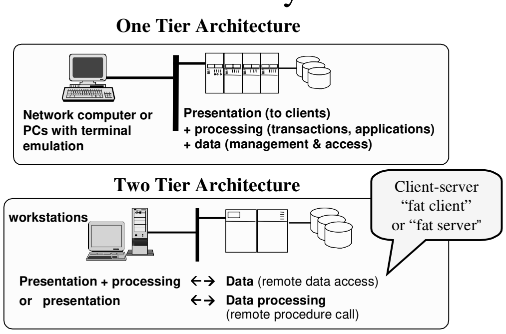
Example: Paperless Office

- Requirements
  - input and storage of scanned documents
  - viewing/printing of documents on demand
  - networking for resource sharing and communications
  - accounting and data analysis
- Required properties
  - no loss/corruption/unauthorised access of data
  - fast response
  - should grow as the business expands

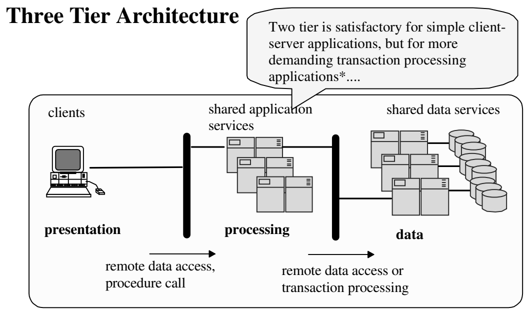
Distributed Design



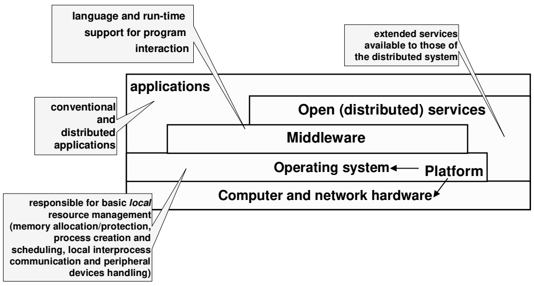
Client Server Systems



Client Server ctd



Software Layers



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Software layers

- Service layers
- Higher-level access services at lower layers
- Services can be located on different computers
- Process types:
  - **server** processes
  - **client** processes
  - **peer** processes

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Important layers

- Platform
  - lowest-level hardware+software
  - common programming interface, yet
  - different implementations of operating system facilities for co-ordination & communication
- Middleware
  - programming support for distributed computing

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Middleware provides...

- support for distributed processes/objects:
  - suitable for applications programming
  - communication via
    - remote method invocation (Java RMI), or
    - remote procedure call (Sun RPC)
- services infrastructure for application programs
  - naming, security, transactions, event notification, ...
  - products: CORBA, DCOM

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The layered view...

- though appropriate for simple types of resource data sharing:
  - e.g. databases of names/addresses/exam grades
- too restrictive for more complex functions?
  - reliability, security, fault-tolerance, etc, need access to application's data
  - see end-to-end argument [Saltzer, Reed & Clarke]

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Architectural models

- Define
  - software components (processes, objects)
  - ways in which components interact
  - mapping of components onto the underlying network
- Why needed?
  - to handle varying environments and usage
  - to guarantee performance

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Main types of models

- Client-server
  - first and most commonly used
- Multiple servers
  - to improve performance and reliability
  - e.g. search engines (1000's of computers)
- Proxy servers
  - to reduce load on network, provide access through firewall
- Peer processes
  - when faster interactive response needed

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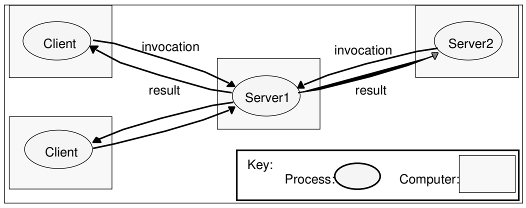
Client server



Server1 acts as **client** for Server2

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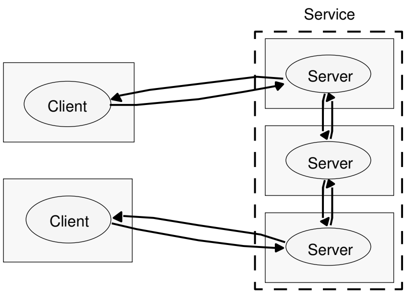
Multiple servers



Servers may **interact**

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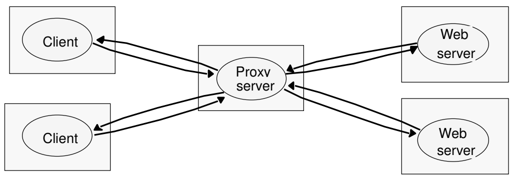
Proxy servers



intranet **firewall** outside world

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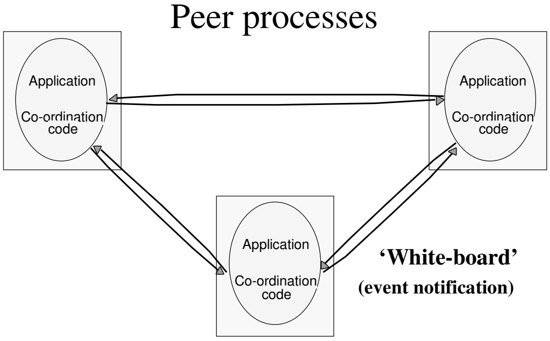
Peer processes



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Client server and mobility

- Mobile code
  - downloaded from server, runs on locally
  - e.g. web applets
- Mobile agent (code + data)
  - travels from computer to another
  - collects information, returning to origin

Beware! Security risks

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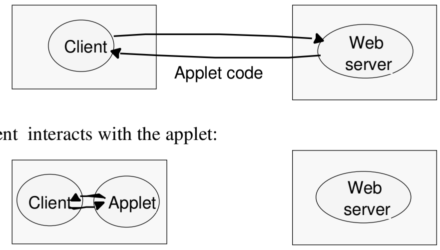
Web applets

Client requests results, applet code is downloaded:

Client interacts with the applet:



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Design Requirements for DSs

Judging how good the architecture is...

- Performance
  - how fast will it respond?
- Quality of Service
  - are video frames and sound synchronised?
- Dependability
  - does it work correctly?

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Performance

- Responsiveness
  - fast interactive response delayed by remote requests
  - use of caching, replication
- Throughput
  - dependent on speed of server and data transfer
- Load balancing
  - use of applets, multiple servers

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Quality of Service (QoS)

Non-functional properties experienced by users:

- Deadline properties
  - hard deadlines (must be met within T time units)
  - soft deadlines (`there is a 90% chance that the video frame will be delivered within T time units)
    - multimedia traffic, video/sound synchronisation
    - depend on availability of sufficient resources
- Adaptability
  - ability to adapt to changing system configuration

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Dependability

- Correctness
  - correct behaviour wrt specification
  - e.g. use of verification
- Fault-tolerance
  - ability to tolerate/recover from faults
  - e.g. use of redundancy
- Security
  - ability to withstand malicious attack
  - e.g. use of encryption, etc

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Summary

- Choose between one tier, two tier, …
  - simple versus complex transaction processing
- Client-server architecture most common
  - used for WWW, email, ftp, Internet services, etc
- but can lead to bottlenecks
  - multiple servers for fast response (e.g. Google search engine based on 6,000 Linux PCs)
  - proxy servers used to limit load (e.g. through firewall)
- Expected to meet requirements of Performance, QoS and Dependability

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