Script **generated by TTT**

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Software layers

applications , services
middleware
operating system
computer and network devices

Middleware

is defined as a layer of software whose purpose is to mask heterogeneity and to provide a convenient programming model to application programmers.

hides the complexity of the communication between two or more systems or services.

major categories of middleware: distributed objects, distributed components, publish-subscribe, web service, peer-to-peer.

Examples are Corba, Java RMI, DCOM (Microsoft's Distributed Component Object Model).

Middleware services are e.g.: communication facilities, naming of remote entities (objects), persistence (distributed file system), distributed transactions, facilities for security.

System Models

A distributed system can be described in form of descriptive models.

Architectural model

defines the interaction between components and the mapping onto the underlying network.

Software layers

System architectures

Interaction model

Failure model

Security model

The following sections of the course will discuss in more detail various aspects of these system models.

Failure model

The failure model defines the ways in which failures may occur and how they are handled.

distinction between failures of processes and communication channels.

different types of failures:

crash faults: the process simply stops due to Hardware failures or Software errors.

message loss: messages may be lost due to buffer overflow of routers or network congestion.

fail stop failures: the process fails by crashing; system notifies relevant partners.

timing failures: a local clock exceeds the bounds on its rate of drift from real time or transmission takes longer than the specified bound.

arbitrary failures (non-malicious Byzantine failure): a process arbitrarily omits intended processing steps, takes unintended processing steps or sends corrupted messages.

malicious Byzantine failure: an attacker who has studied the system attempts to break it. Examples are the corruption or replay of messages, or the modification of the program (install hacked version).

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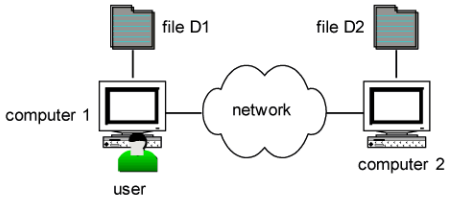
Access transparency

Problem : How to access objects in a distributed system.

⇒ Access transparency provides access to local and remote objects in exactly the same way.

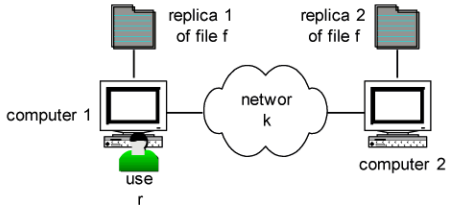


Replication transparency

For reasons of availability or fast access, resources, e.g. objects may be replicated.

Problem : Management of several copies of an object in a distributed system.

⇒ Replication transparency means that the user is unaware of whether an object is replicated or not. The user accesses replicated objects as if they exist only once.



A variety of protocols have been proposed that deal with the problem of consistency among replicated files (Update of replicated files) .

Migration transparency

Problem : Object relocation in distributed systems.

⇒ Objects may migrate from one computer to another without influencing the correct behavior of running applications.

Host migration transparency

Problem : Computer migrates from one subnetwork to another subnetwork, e.g. if a user connects his laptop computer to different subnetworks. This requires a dynamic assignment of the IP address (e.g. DHCP), a name server, etc.

⇒ The computer supports the same environment, the same applications, and the same look-and-feel, no matter where the mobile workers are currently connected to the network.

Types of migration

off-line migration.

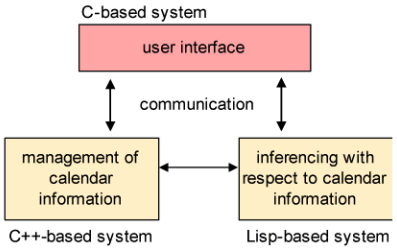
on-line migration.

Language transparency

Problem : An application's components are realized by different programming languages.

⇒ Interactions between individual components is independent from the programming language used for implementing the respective components.

Example: calendar system



Other transparencies

There are a number of other transparencies relevant for distributed systems.

Failure transparency

Problem : Partial failure in distributed systems, for example computer crashes or network failures.

⇒ Up to a certain degree, failures are masked by the system.

Concurrency transparency

concurrent access to shared resources by distributed users or application components.

Problem : shared access to objects in distributed systems.

⇒ Several users or application programs can access objects simultaneously (for example shared data) without mutual influence.

Execution transparency

Execution transparency implies that processes may be processed on different runtime systems.

Performance transparency

allows for dynamic reconfiguration of the system to improve the overall system performance when changes in load characteristics are detected.

Scalability transparency

supports extensions and enhancements of the system or the applications without the need of modifications to the system structure or changes to the application algorithms.

Transparency

key concept for better exploitation of resources within a distributed, heterogeneous system.

Transparency

key concept for better exploitation of resources within a distributed, heterogeneous system.

Location transparency

Access transparency

Replication transparency

Migration transparency

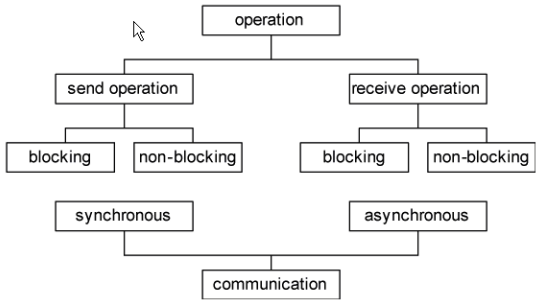
Language transparency

Other transparencies

Goal for distributed applications

Message exchange

Interprocess communication (IPC): message exchange between sender and receiver.



Background

Categories of Message Exchange