Distributed Systems

Seminar 1 - Foundations

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Name the essential criteria which motivate the distribution of application functionality.
Cost reduction
- use cheap standard hardware instead of expensive special servers
- automation of processes in enterprises

Independent system components - cooperation
- Separately developed, well defined interfaces
- Cooperation across several computers and different locations
- E.g. business process among different departments

Common use of resources/Sharing of resources
- Sharing devices like printers, plotters
- common data base for customer and product data among departments

Parallelization of processes
- Parts of business process about warehouse management and customer management in parallel
- Partitioning and replication of data

Load balancing
- Distribute work equally or according to available resources
Accessibility, fault tolerance, system stability/reliability in the event of failures

- Separate system components not affected by failures of others
- Replication of mission critical components (order processing), in case of replica failure another replica can take over activities without customer notice

Scalability

- Support increasing load by adding resources (scale out – adding computing nodes instead scale up – adding resources to existing node)
- Limited in centralized systems
- E.g. rapidly increased no. of customers (storage capacity, computation power, communication bandwidth)
- Partitioning and replication as solution in DS
Which of the following systems can be considered as distributed systems?

a) a decentrally organized office environment on a workstation network
b) the central computer of an airline company with 10,000 worldwide, simple booking terminals connected in a star-shaped formation
c) a multiprocessor system with common memory
d) a Grid system
"A Distributed System comprises several single components on different computers, which normally do not operate using shared memory and as a consequence communicate via the exchange of messages. The various components involved cooperate to achieve a common objective such as the performing of a business process." Schill & Springer.

Main Characteristics:
1. Multiple individual components
2. Spatially separated components
3. Components possess own memory
4. Communication via messages
5. Cooperation towards a common objective
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Office environment</th>
<th>Central airline computer</th>
<th>Multiprocessor system</th>
<th>Grid system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple individual components</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Spatially separated components</td>
<td>yes</td>
<td>No, single central system</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Own memory</td>
<td>yes</td>
<td>no</td>
<td>No, shared memory</td>
<td>yes</td>
</tr>
<tr>
<td>Communication via messages</td>
<td>yes</td>
<td>no</td>
<td>No, via shared memory</td>
<td>yes</td>
</tr>
<tr>
<td>Cooperation</td>
<td>yes</td>
<td>Not between distr. comp.</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Note: Dependent on the system design, other answers for some of the criteria are possible. There is not only a single correct answer, rather it is often a matter of argumentation.
What is described by the term “Middleware”? Which fundamental concepts and basic services are provided by a middleware for distributed systems?

ObjectWeb defines middleware as: "The software layer that lies between the operating system and applications on each side of a distributed computing system in a network."

Middleware is a set of general-purpose functionality/services, situated between the operating system and the applications with special support for distributed application components

- Operating system provides general functionality at low level (drivers, APIs for Uis) and local HW access
• **Horizontal Middleware**
  - General functionality usable across application domains
    - Communication
    - Data persistence
    - Security
    - Transactions
    - Naming, Directory, Broker/Trader, Time, Event,

• **Vertical Middleware**
  - Reusable within a particular application domain
    - Health care – management and storage of medical records
    - Mechanical engineering – control of production processes, management of machines in real-time
    - Business Software
Exercise 1.4

- In the given application example, product orders are pre-processed on different servers and balanced with the warehouse management department. Which basic services can be used to fulfill the following requirements?

  a) The pre-processing of product orders will involve both the customer management and warehouse management departments. The dispatch of goods from the warehouse and payment for these goods are performed as part of the pre-processing. It should be ensured that either all of the individual processing steps are executed or none at all.

  b) Particular product orders should only be allowed to be executed by business customers.

  c) Order information should be confidentially handled and especially communicated across a network without the possibility of third party access.

  d) The order service should be findable by any means via the internet.
a) **Transaction service:** Consistent processing of distributed data stores can be achieved with transactions. Transactions ensure, through the property of atomicity, that **either all processing steps involved or none at all are executed.** A transaction service is necessary for the control of distributed transactions. Such a service is often provided in the form of a transaction monitor.

b) **Security service, authentication, access control:** In order to control access to particular system functions, the **identity of the user must be checked** first. The **access rights** of the user can then be controlled. For this purpose, a security service providing functions for authentication and authorisation is necessary.

c) **Encryption:** Product orders must be **encrypted** with the help of cryptographic procedures in order to secure them against unwanted access by third parties during transfer over an insecure channel. Encryption procedures provided by a security service are thereby needed.

d) **Directory services:** are needed to publish resources (e.g. order services) within a distributed system.