Slides for Chapter 1
Characterization of Distributed Systems

From Coulouris, Dollimore, Kindberg and Blair
Distributed Systems: Concepts and Design
Edition 5, © Addison-Wesley 2012
Outline

• Introduction
• Examples of Distributed Systems
• Trends in DS
• Resource Sharing
• Case Study: WWW
Introduction

• **Textbook Definition:** A DS is a system in which hardware or software components located at networked computers communicate and coordinate their actions only by passing messages.

• **Consequences**
  - Concurrency
  - No global clock
  - Independent failures
Examples of DS

• Web Search
• Massively Multiplayer Online Games (MMOGs)
• Financial Trading
**Selected application domains and associated networked applications**

<table>
<thead>
<tr>
<th><strong>Finance and commerce</strong></th>
<th>eCommerce e.g. Amazon and eBay, PayPal, online banking and trading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The information society</strong></td>
<td>Web information and search engines, ebooks, Wikipedia; social networking: Facebook and MySpace.</td>
</tr>
<tr>
<td><strong>Creative industries and entertainment</strong></td>
<td>online gaming, music and film in the home, user-generated content, e.g. YouTube, Flickr</td>
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<tr>
<td><strong>Healthcare</strong></td>
<td>health informatics, on online patient records, monitoring patients</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>e-learning, virtual learning environments; distance learning</td>
</tr>
<tr>
<td><strong>Transport and logistics</strong></td>
<td>GPS in route finding systems, map services: Google Maps, Google Earth</td>
</tr>
<tr>
<td><strong>Science</strong></td>
<td>The Grid as an enabling technology for collaboration between scientists</td>
</tr>
<tr>
<td><strong>Environmental management</strong></td>
<td>sensor technology to monitor earthquakes, floods or tsunamis</td>
</tr>
</tbody>
</table>
Figure 1.2
An example financial trading system
Trends in DS

• Pervasive Networking and the modern Internet
• Mobile and Ubiquitous Computing
• Distributed Multimedia Systems
• Distributed Computing as a Utility
Figure 1.3
A typical portion of the Internet
Figure 1.4
Portable and handheld devices in a distributed system
Figure 1.5
Cloud computing
Resource Sharing

• Sharing HWR resources
• Sharing Data
Challenges

• Heterogeneity
• Openness
• Security
• Scalability
• Failure Handling
• Concurrency
• Transparency
• Quality of Service
### Figure 1.6
Growth of the Internet (computers and web servers)

<table>
<thead>
<tr>
<th>Date</th>
<th>Computers</th>
<th>Web servers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993, July</td>
<td>1,776,000</td>
<td>130</td>
<td>0.008</td>
</tr>
<tr>
<td>1995, July</td>
<td>6,642,000</td>
<td>23,500</td>
<td>0.4</td>
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<tr>
<td>1997, July</td>
<td>19,540,000</td>
<td>1,203,096</td>
<td>6</td>
</tr>
<tr>
<td>1999, July</td>
<td>56,218,000</td>
<td>6,598,697</td>
<td>12</td>
</tr>
<tr>
<td>2001, July</td>
<td>125,888,197</td>
<td>31,299,592</td>
<td>25</td>
</tr>
<tr>
<td>2003, July</td>
<td>~200,000,000</td>
<td>42,298,371</td>
<td>21</td>
</tr>
<tr>
<td>2005, July</td>
<td>353,284,187</td>
<td>67,571,581</td>
<td>19</td>
</tr>
</tbody>
</table>
Section 1.5.7
Transparencies

Access transparency: enables local and remote resources to be accessed using identical operations.

Location transparency: enables resources to be accessed without knowledge of their physical or network location (for example, which building or IP address).

Concurrency transparency: enables several processes to operate concurrently using shared resources without interference between them.

Replication transparency: enables multiple instances of resources to be used to increase reliability and performance without knowledge of the replicas by users or application programmers.
**Section 1.5.7**

**Transparencies**

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*Failure transparency*: enables the concealment of faults, allowing users and application programs to complete their tasks despite the failure of hardware or software components.

*Mobility transparency*: allows the movement of resources and clients within a system without affecting the operation of users or programs.

*Performance transparency*: allows the system to be reconfigured to improve performance as loads vary.

*Scaling transparency*: allows the system and applications to expand in scale without change to the system structure or the application algorithms.
Figure 1.7
Web servers and web browsers – Case Study: WWW