Chapter 1: Introduction

What is a Distributed System?

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- *A distributed system collection of independent computers that appears to its users as a single coherent system.*

Examples (1)

The Internet is just a world passing around notes in a classroom. –Jon Stewart
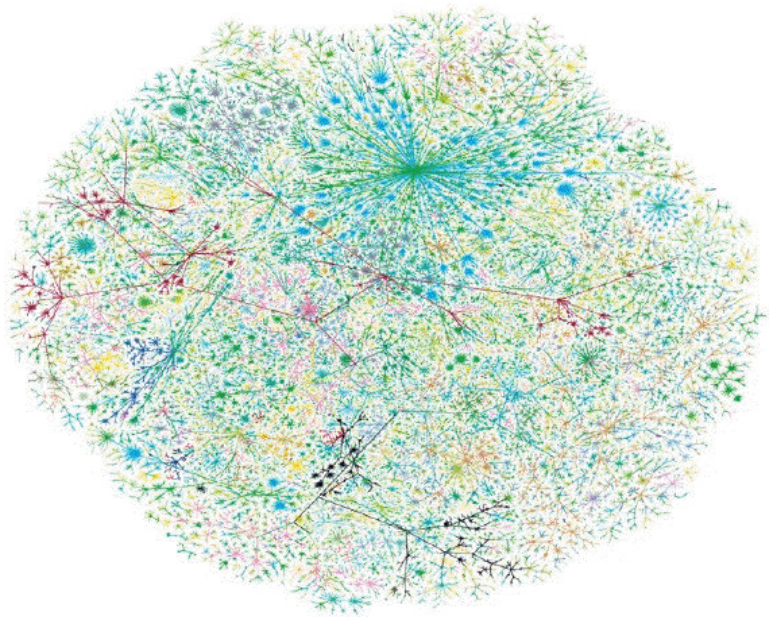
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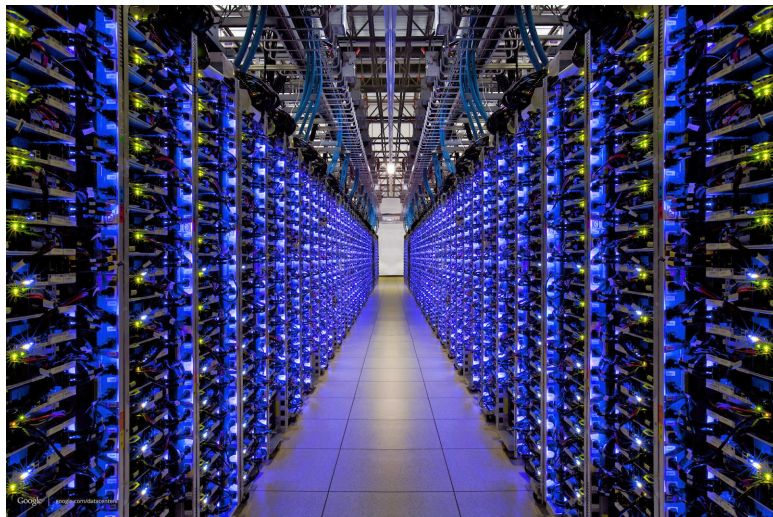
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- ▶ Virtually every substantial website!

In-class Exercise

▶ Walk through architecture of various distributed systems ranging from: single server/client, multiple server/clients to point to point.

How to Implement a Distributed System?

- In order to support a single system view on multiple computers and networks, we need a layer of abstraction implemented in software that is logically placed in the middle of higher layer of users and applications and the lower layer of operating systems and networks. We call this layer the middleware.
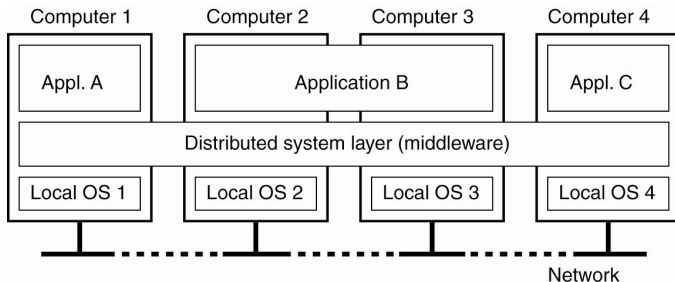
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| Computer 1 | Computer 2 | Computer 3 | Computer 4 |

| Appl. A | Application B | Appl. C |

Distributed system layer (middleware)

| Local OS 1 | Local OS 2 | Local OS 3 | Local OS 4 |

Network

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  - Create virtual organizations where geographically dispersed people can work together using groupware
  - Enables electronic commerce
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- ▶ Problems
  - ▶ Eavesdropping or intrusion on communication
  - ▶ Tracking of communication to build a profile

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Failure	Hide the failure and recovery of a resource

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- ▶ Signal transmission is limited by the speed of light as well as the speed of intermediate switches

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- ▶ Interoperability, Portability, Extensibility.
- ▶ Separating policy from mechanism. For example: *caching* in a web browser.

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- ► Size: be able to easily add more users and resources to a system
- ► Geographical: be able to handle users and resources that are far apart
- ► Administrative: be able to manage even if it spans independent administrative organizations

Centralized versus distributed implementations.

Centralized Solutions with Scalability Problems

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- Centralized services.

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- Centralized services.
- Centralized data.

Centralized Solutions with Scalability Problems

- ▶ Centralized services.
- ▶ Centralized data.
- ▶ Centralized algorithms.

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Distributed Approach

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- ▶ There is no implicit assumption that a global clock exists.

In-class exercise. Simulate a centralized and a distributed algorithm for the same problem in class!

Scaling Techniques

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- **Distribution**: Taking a component, splitting into smaller parts, and subsequently spreading them across the system. (E.g. Domain Name System)

- **Replication**: Replicating components increases availability, helps balance the load leading to better performance, helps hide latencies for geographically distributed systems. Caching is a special form of replication.

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"A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable."
–Leslie Lamport

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In-class Exercise: Classify the examples we have seen so far into the three categories above.

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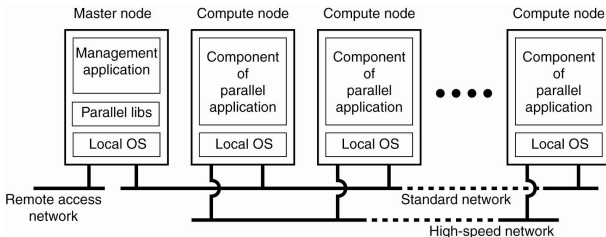
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Transactions can be nested. Durability applies to top-level transactions only. For example: an airline and a hotel database.
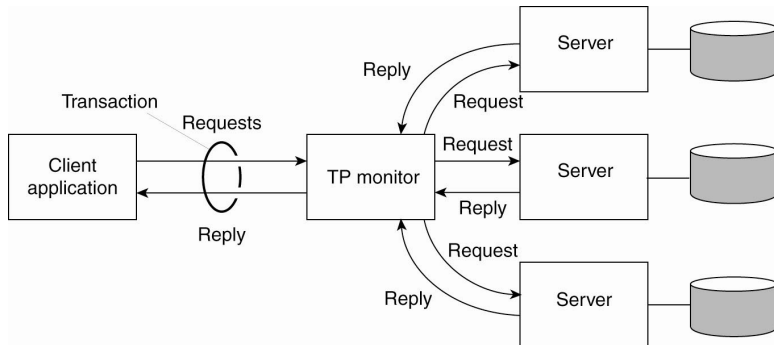
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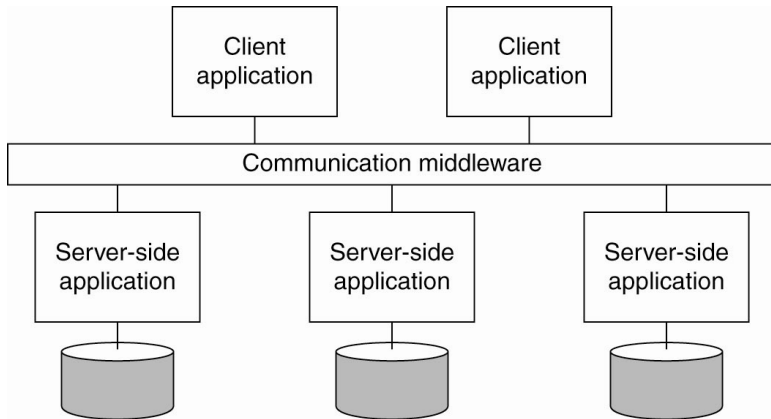
Middleware as a communication facilitator for enterprise application integration.

Distributed Pervasive Systems

Requirements for pervasive systems:

- ▶ Embrace contextual changes.
- ▶ Encourage ad hoc composition.
- ▶ Recognize sharing as the default.

Examples: Home systems, Body Area Networks, Sensor Networks.

Chapter 1: Recommended Exercises

- ▶ **Problem 2**. What is the role of middleware in a distributed system?
- ▶ **Problem 4**. Explain what is meant by transparency, and give examples of different types of transparency.
- ▶ **Problem 9**. Scalability can be achieved by applying different techniques. What are these techniques?
- ▶ **Problem 14**. Give further examples of distributed pervasive systems.