

Chapter 1: Introduction

What is a Distributed System?

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

Characteristics of a Distributed System (1)

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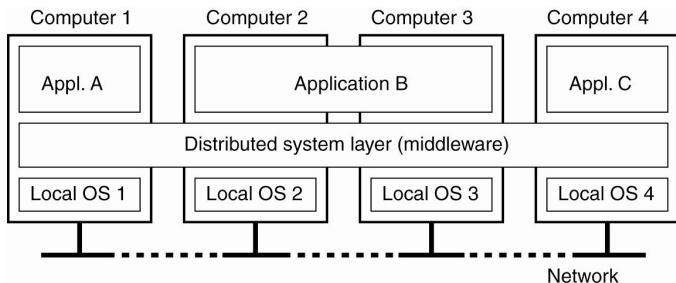
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- ▶ It handles resource management, interapplication communication, masking of and recovery from failures, security and accounting services.

Examples (1)

The image shows the Netflix logo, which consists of the word "NETFLIX" in a bold, white, sans-serif font. The letters have a 3D effect with a black drop shadow. The logo is centered on a solid red rectangular background.

Examples (1)



The Internet is just a world passing around notes in a classroom. –Jon Stewart

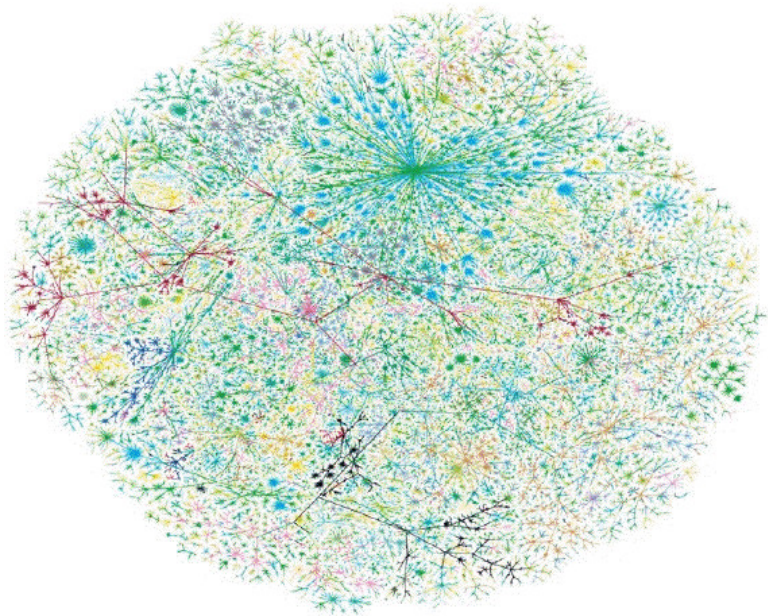
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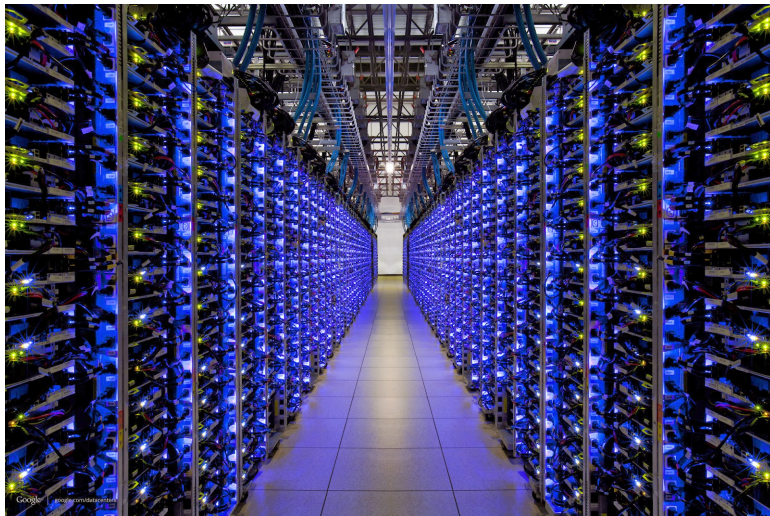
Google Search

I'm Feeling Lucky

Examples (2)



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- ▶ Virtually every substantial website!

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 - ▶ 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 algorithms.

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- ▶ Failure of one machine does not ruin the algorithm.
- ▶ 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

In-class Exercise

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

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 - ▶ Ubiquitous Computing Systems
 - ▶ Mobile Computing Systems
 - ▶ Sensor Networks

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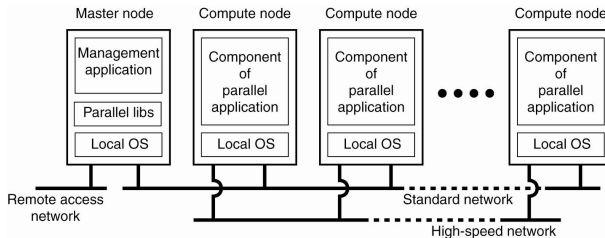
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- ▶ A cluster usually has a dedicated high-speed interconnection network and an optional administrative network.

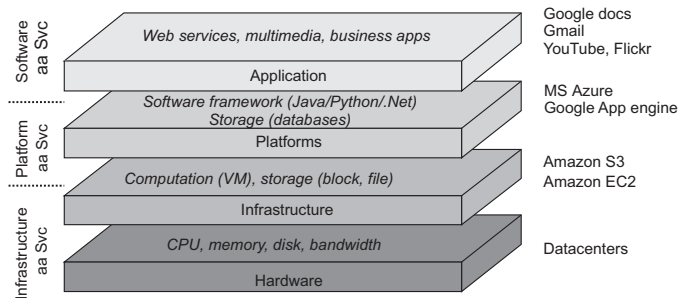
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- ▶ **Application:** Actual applications, whether distributed or not. Includes apps such as office suites (text processors, spreadsheet applications, presentation applications). Comparable to the suite of apps shipped with traditional OSes.

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- ▶ **Next step:** Allow direct application-to-application communication, leading to **Enterprise Application Integration (EAI)**.

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- ▶ BEGIN_TRANSACTION
- ▶ END_TRANSACTION
- ▶ ABORT_TRANSACTION
- ▶ READ, WRITE

ACID characteristic properties of transactions:

- ▶ **Atomic**: To the outside world, the transaction happens indivisibly
- ▶ **Consistent**: The transaction does not violate system invariants
- ▶ **Isolated**: Concurrent transactions do not interfere with each other
- ▶ **Durable**: Once a transaction commits, the changes are permanent

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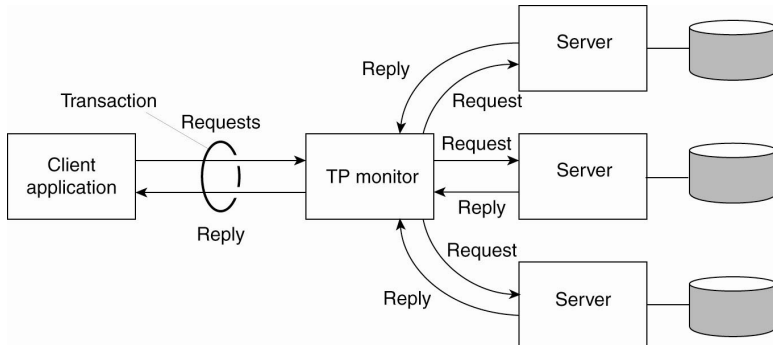
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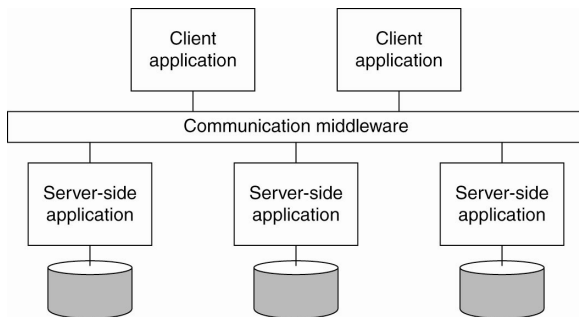
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Transactions can be **nested**. Durability applies to top-level transactions only. For example: an airline and a hotel database. This led to the design of Transaction Processing Monitors (TP Monitors) to coordinate the commitment of multiple subtransactions.

Example EAI: Transaction Processing Systems (2)



Enterprise Application Integration



Middleware as a communication facilitator for enterprise application integration. This can be done in multiple ways. For example:

- ▶ **Remote Procedure Call (RPC)**: Requests are sent through local procedure call, packaged as message, processed, responded through message, and result returned as return from call.
- ▶ **Message Oriented Middleware (MOM)**: Messages are sent to logical contact point (published), and forwarded to subscribed

Distributed Pervasive Systems

Characteristics of pervasive systems (aka Internet Of Things):

- ▶ Blends into the environment
- ▶ Encourage ad hoc composition
- ▶ Naturally distributed
- ▶ Nodes are often small and battery powered
- ▶ Wireless/mobile communication is the norm

Examples: Ubiquitous Computing Systems, Mobile Computing Systems, Sensor (and actuator) networks

In-class Exercise: Classify the distributed system examples we have seen so far into the three categories: Distributed Computing Systems, Distributed Information Systems, Distributed Pervasive Systems.

Chapter 1: Recommended Exercises

- ▶ **Problem 1.** What is the role of middleware in a distributed system?
- ▶ **Problem 2.** Explain what is meant by transparency, and give examples of different types of transparency.
- ▶ **Problem 3.** Scalability can be achieved by applying different techniques. What are these techniques?
- ▶ **Problem 4.** Give further examples of distributed pervasive systems.