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.*

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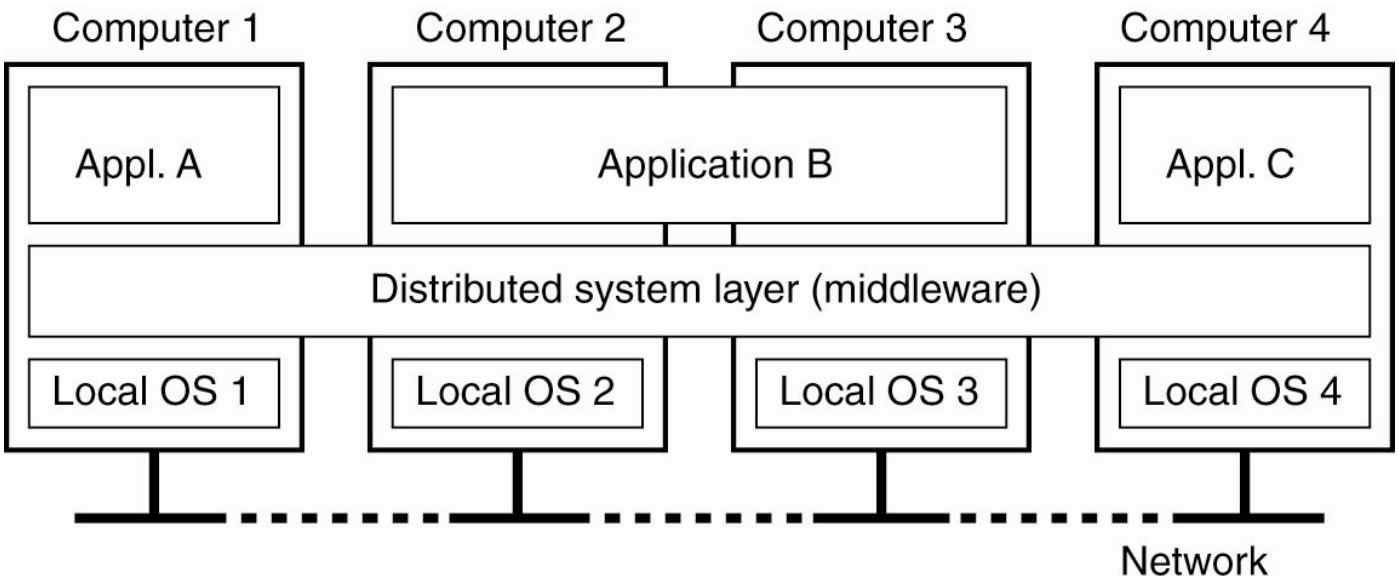

  - It handles resource management, interapplication communication, masking of and recovery from failures, security and accounting services.

Examples (1)

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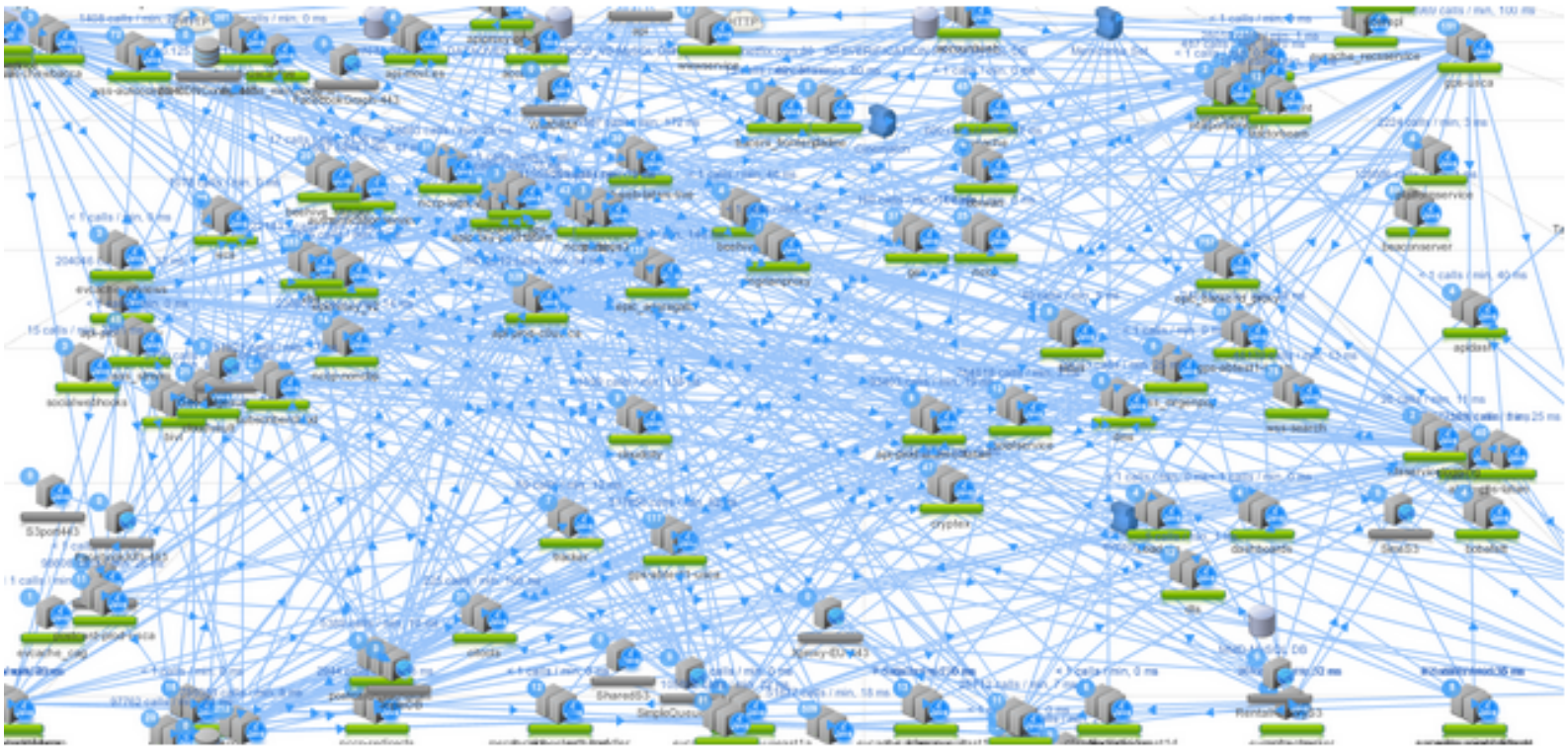

The Internet is just a world passing around notes in a classroom. –Jon Stewart

Examples (2)

Google Search I'm Feeling Lucky

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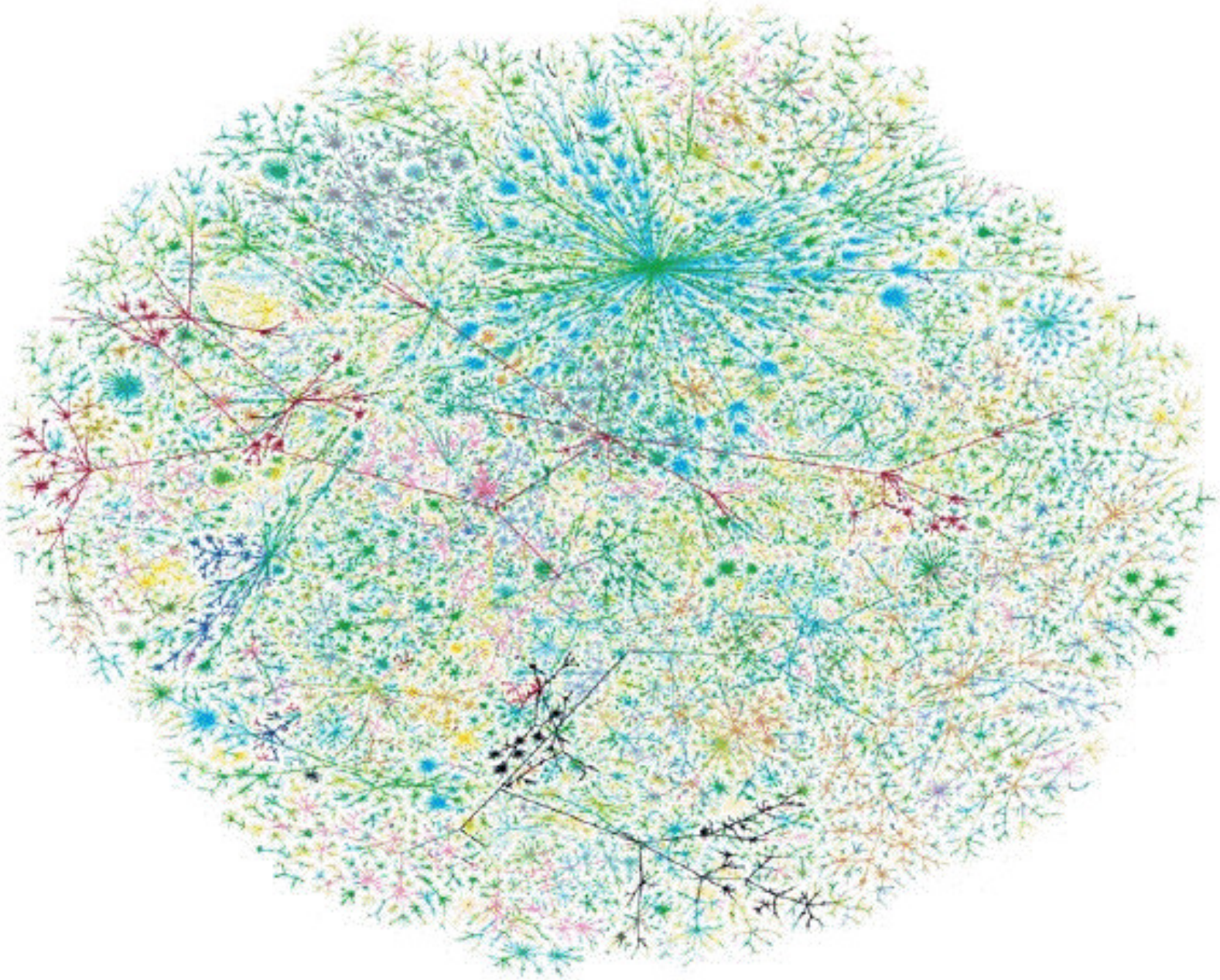

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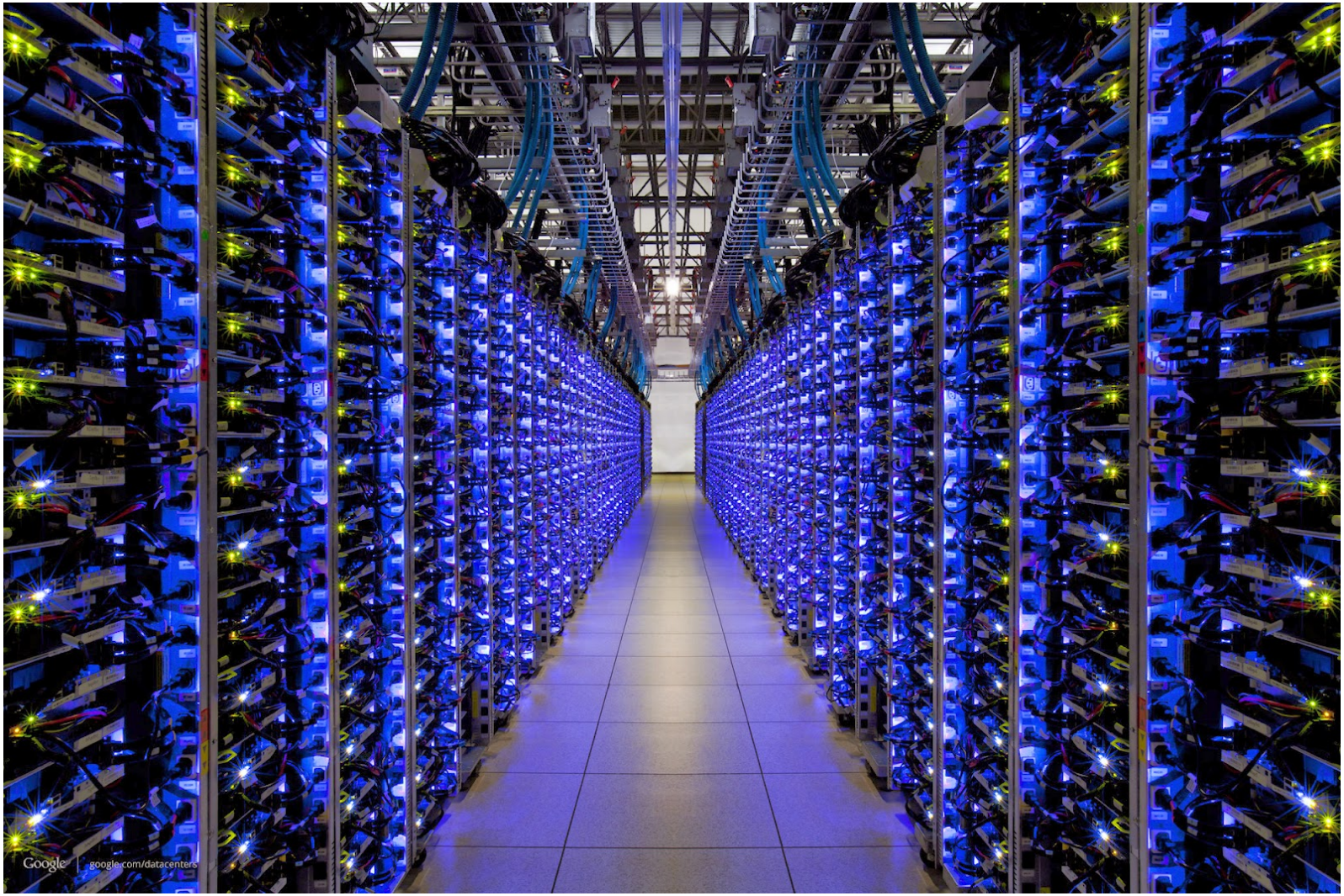

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- Virtually every substantial website!

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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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- Services are described via interfaces, which are often describe via an Interface Definition Language (IDL). Interfaces only specify syntax so semantics is left to the ambiguities of natural language.
- Interoperability, Portability, Extensibility.
- Separating policy from mechanism. For example: *caching* in a web browser.

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- 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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- 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!

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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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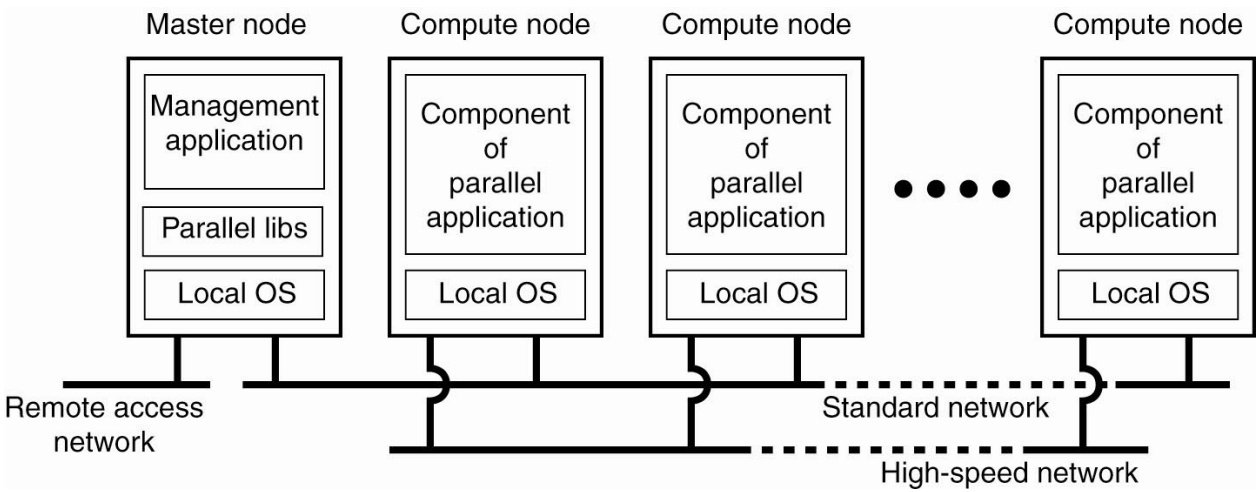
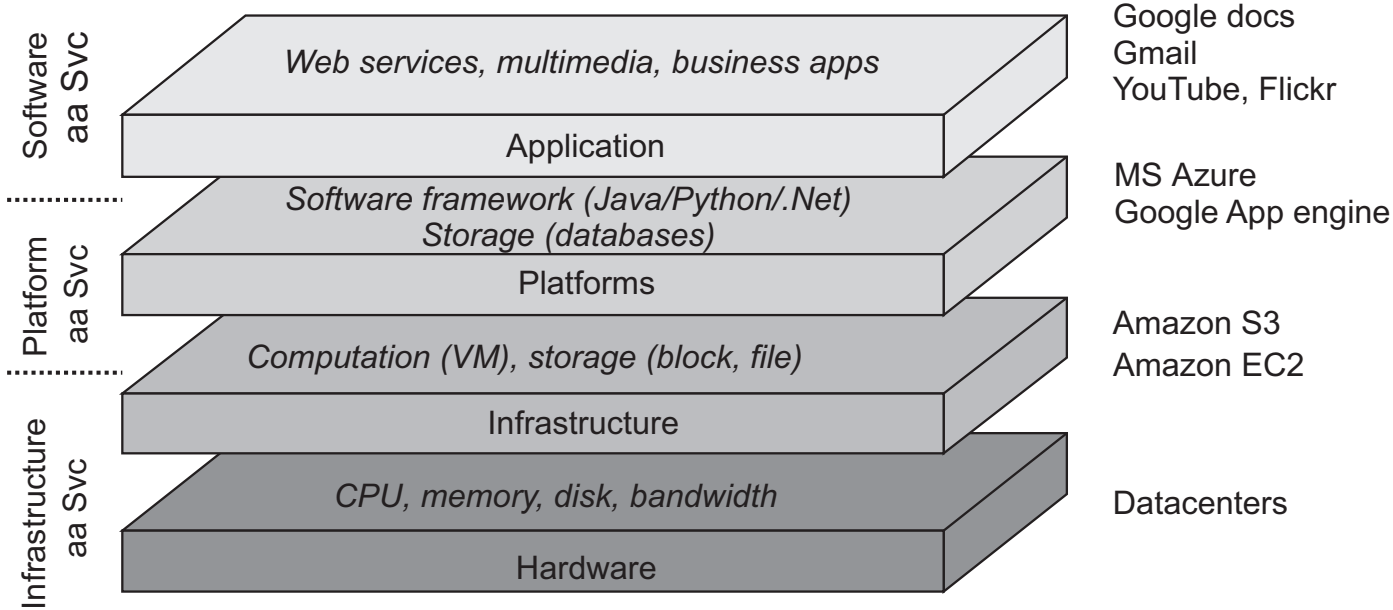


Cloud Computing

- Cloud Computing provides the facilities to dynamically construct an infrastructure and compose what is needed from available services.



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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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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.

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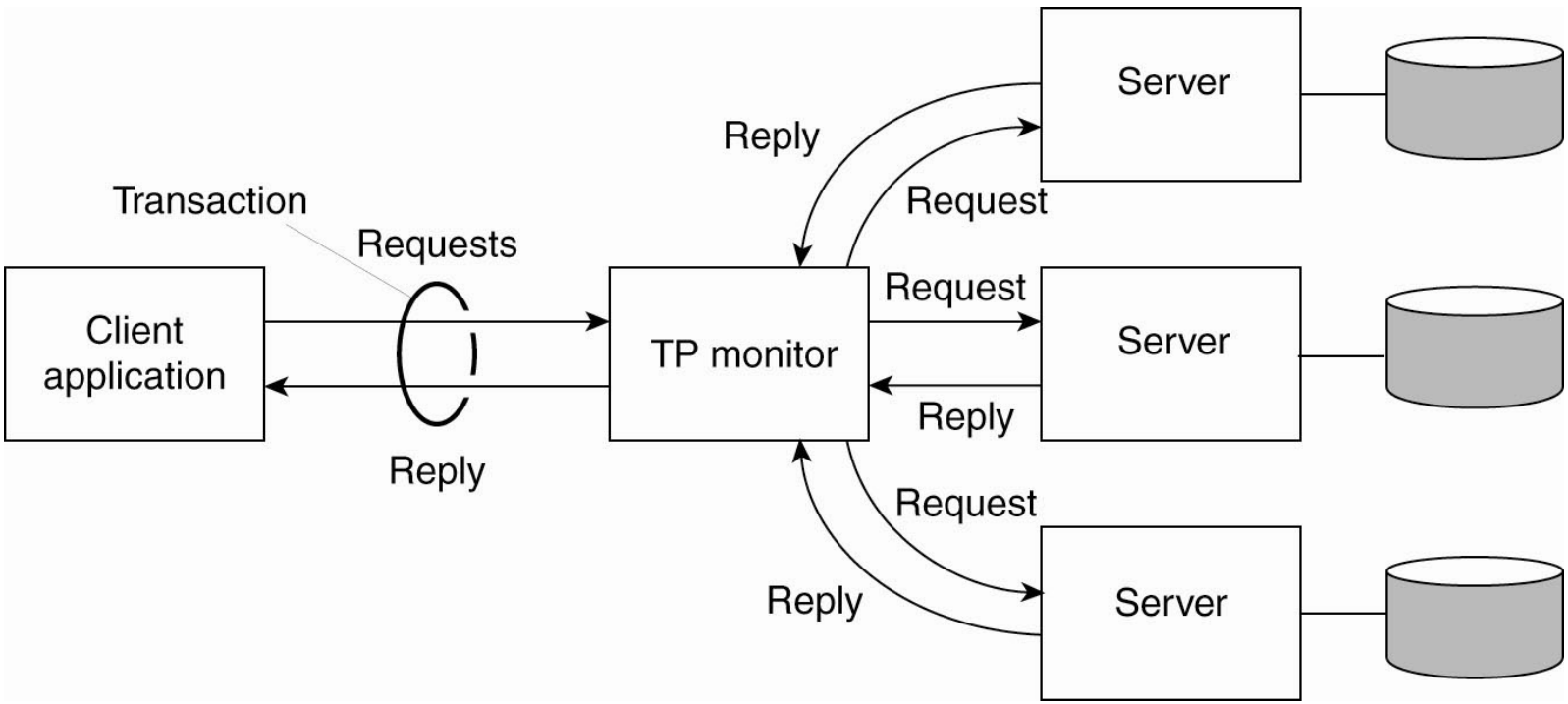
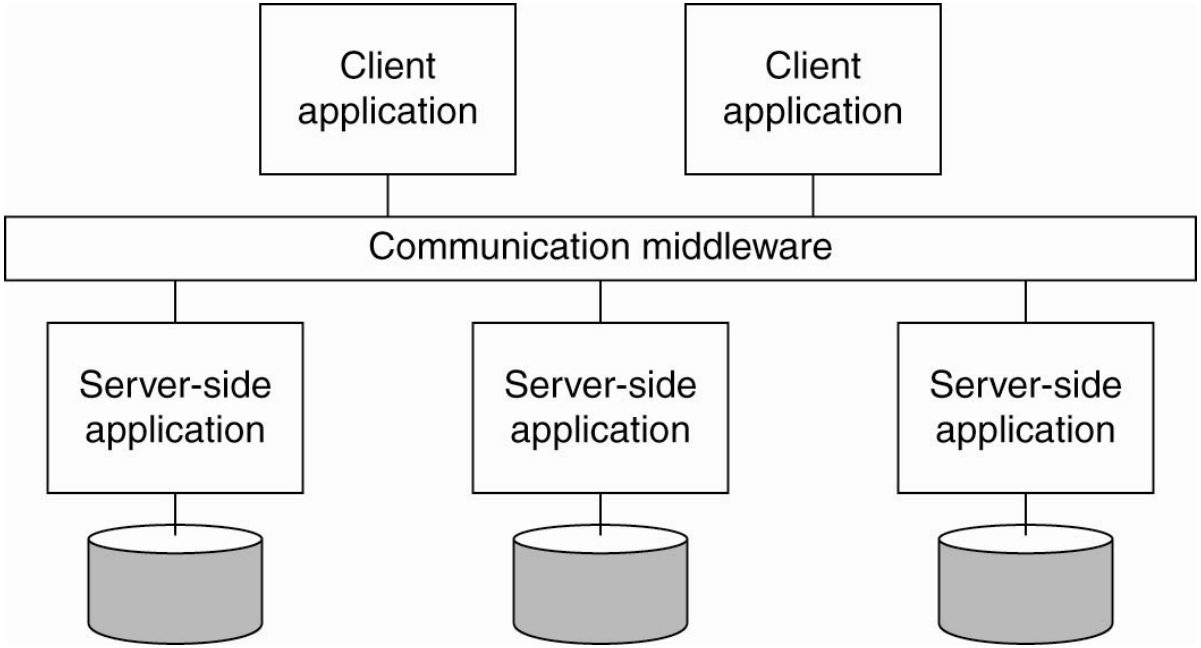


Enterprise Application Integration



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 applications.

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

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.