



Information Technology Fundamentals

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Web Systems: Architecture

Module 5: Part 1

Module 5. Main Objectives

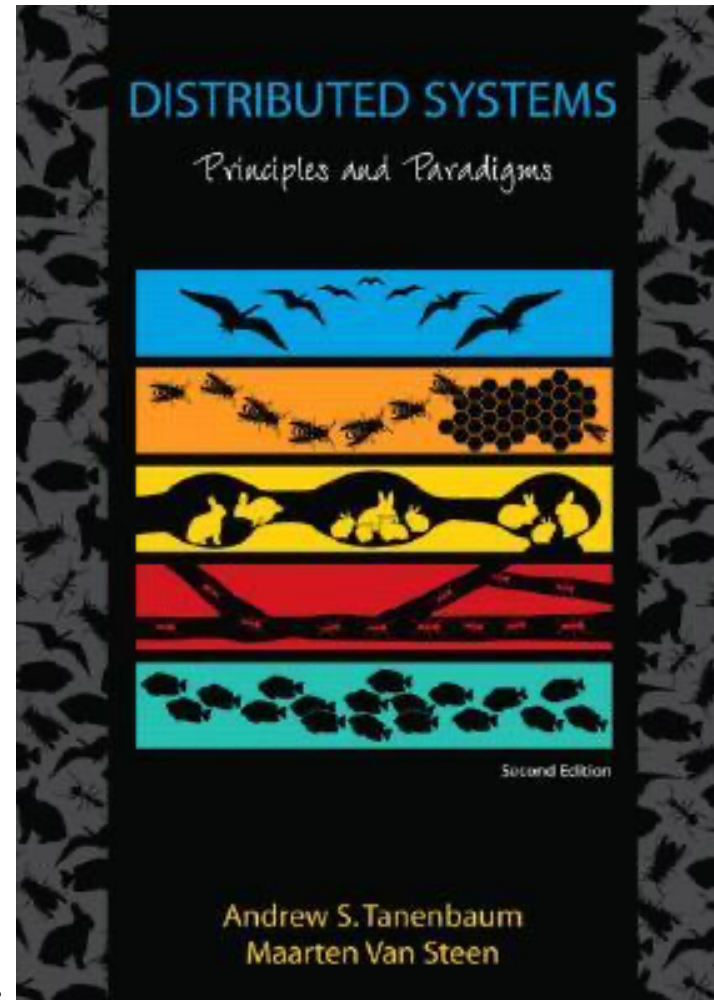
1. Review Web System Architecture
2. Explain E-Commerce Business Models
3. Review Recommender Systems
4. Describe Blockchain Systems, Cryptocurrency, and Smart Contracts

An Introduction to Web Systems

Main Reference

Tanenbaum, Andrew S.,
and Maarten Van Steen.
***Distributed systems:
principles and
paradigms.*** Prentice-
Hall, 2007

Chapter 12: Distributed
Web-Based Systems



Contents

- A Brief History to Web System
- Web System Architecture
- Web Services
- Web System Processes

Web System Definition

Web information **system**, or **web**-based information **system**, is an information **system** that uses Internet **web** technologies to deliver information and services, to users or other information **systems**/applications. It is a software **system** whose main purpose is to publish and maintain data by using **hypertext-based** principles.

World Wide Web (WWW)

- A huge **distributed System** consisting of million clients and servers for accessing linked documents
- Started as a project at **CERN** (the European Particle Physics Laboratory in Geneva) to let its large and geographically dispersed group of researchers access shared documents using a simple **hypertext system**
- Popularity sharply increased when **graphical user interfaces** became available, notably **Mosaic** (Vetter et al., 1994)
- Since 1994, Web developments have been initiated by the **World Wide Web Consortium**, a collaboration between CERN and M.J.T.



World Wide Web (WWW)

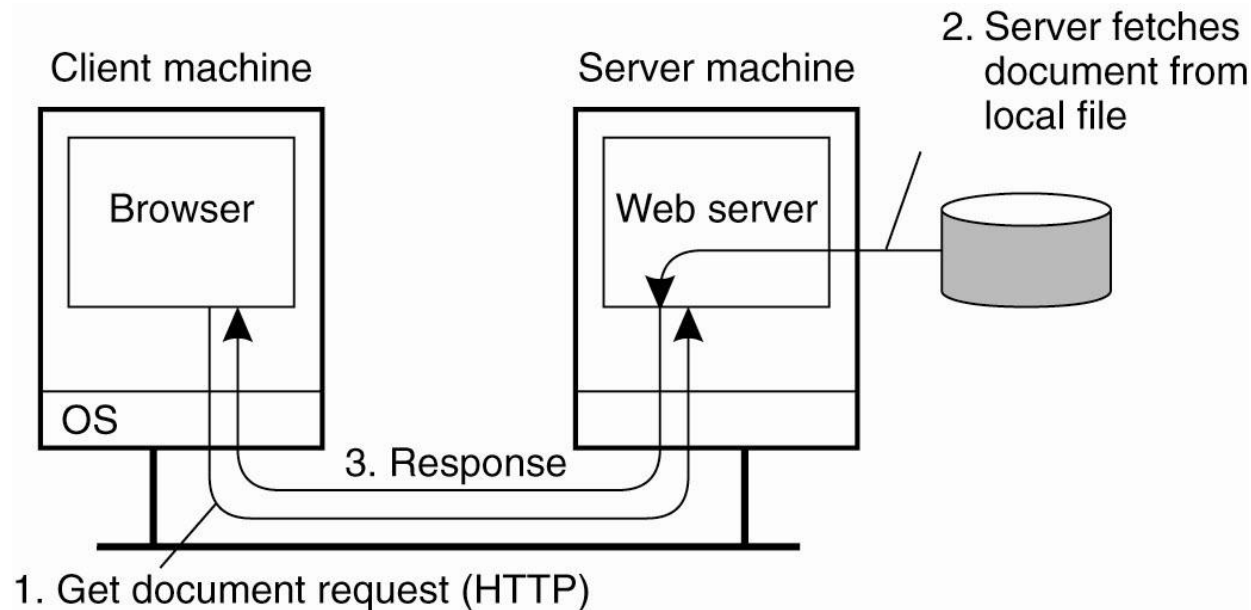
- WWW has become more than just a simple document based system
- It is becoming a system of **distributed services** rather than just a documents
- What can we get?
 - Read news, list music, watch videos
 - Buy or sell goods
 - Make reservation on hotel rooms, rental car, ..
 - Pay bills and transfer money,
- The growth of **ecommerce** is out of this world!
- In 2021, retail eCommerce sales were an estimated \$4.9 trillion U.S. dollars worldwide.
- Over the next four years, it's predicted this number will grow by 56%, reaching just over \$8.1 trillion by 2026.



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Traditional Web-Based Systems



1. Core of a Web Site: A **Process** that has access to a local file system storing documents
2. How to refer to a document: **URL (Uniform Resource Locator)**
3. Clients interacts with Web server through **Browser**
4. Communication protocol is **HTTP**

Introduction to Web Documents

- **HTML (HyperText Markup Language):** Most widely used language in the Web, allows the embedding of links to other documents
- **XML (Extensible Markup Language):** Provides much more flexibility in defining what a document should look like. Includes the definitions of the elements that mark up a document (meta-markup language)
- **MIME (Multipurpose Internet Mail Exchange):** Developed to provide information on the content of a message body that was sent as part of electronic mail. MIME distinguishes various types of message contents.

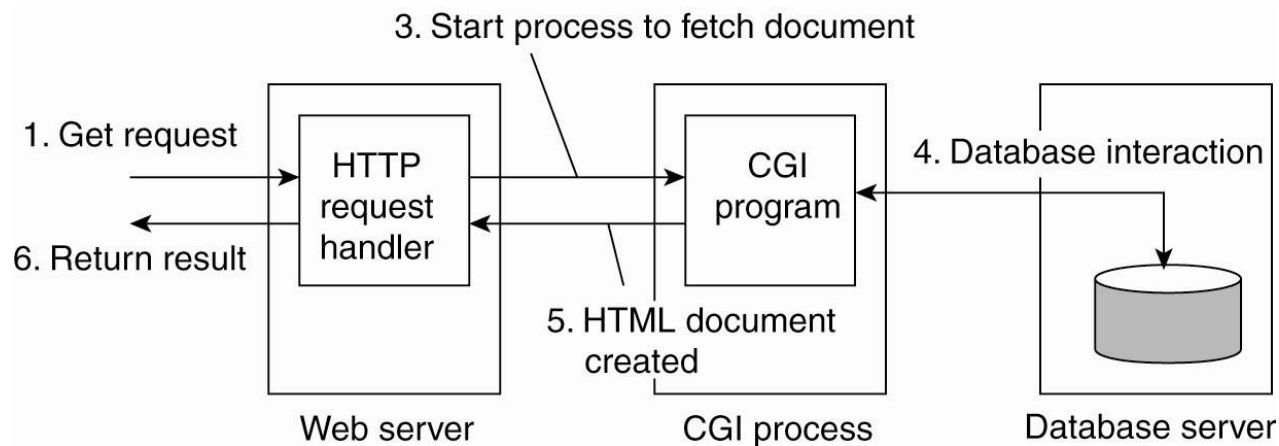
Web Documents

Type	Subtype	Description
Text	Plain	Unformatted text
	HTML	Text including HTML markup commands
	XML	Text including XML markup commands
Image	GIF	Still image in GIF format
	JPEG	Still image in JPEG format
Audio	Basic	Audio, 8-bit PCM sampled at 8000 Hz
	Tone	A specific audible tone
Video	MPEG	Movie in MPEG format
	Pointer	Representation of a pointer device for presentations
Application	Octet-stream	An uninterpreted byte sequence
	Postscript	A printable document in Postscript
	PDF	A printable document in PDF
Multipart	Mixed	Independent parts in the specified order
	Parallel	Parts must be viewed simultaneously

Six top-level **MIME** types and some common subtypes

Multitiered Architectures

One of the first enhancements to the basic architecture was support for simple user interaction by means of the **Common Gateway Interface** or simply **CGI**



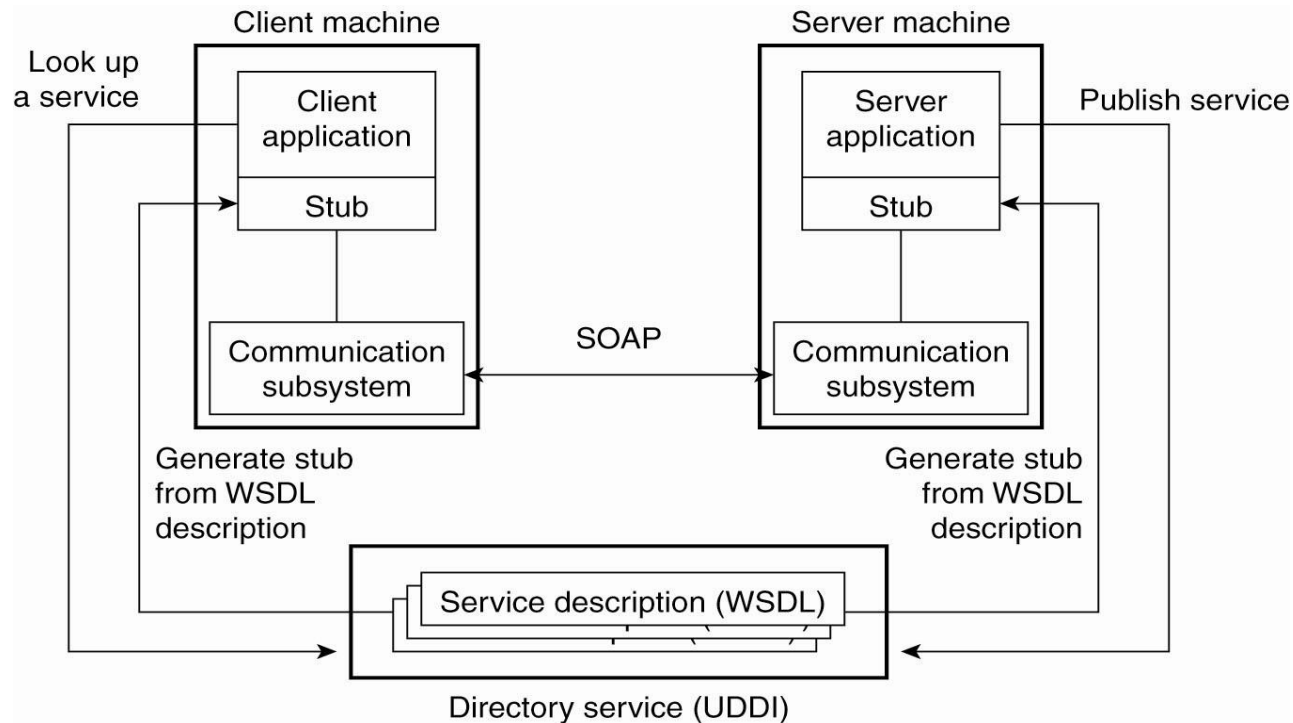
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Web Services

- Group of Web-based systems that are offering general services to **remote applications** without **immediate interactions** from end users
- It adheres to a collection of standards that will allow it to be discovered and accessed over the Internet by client applications that follow those standards as well

Web Services Fundamentals



Let's Review briefly **WSDL**, **UDDI**, and **SOAP**

Web Service Fundamentals

1. **Universal Description, Discovery and Integration standard (UDDI):** Prescribes the layout of a database containing service descriptions that will allow Web service clients to browse for relevant services
2. **Web Services Definition Language (WSDL):** Contains the precise definitions of the interfaces provided by a service, that is, procedure specification, data types, the (logical) location of services, etc.
3. **Simple Object Access Protocol (SOAP):** A framework in which much of the communication between two processes can be standardized.

Web Service Composition and Coordination

Example (Book Ordering):

1) Selecting a book, 2) paying, 3) and ensuring its delivery.

Actual service should be modeled as a transaction **consisting of multiple steps that need to be carried out** in a specific order.

Complexity increases when considering Web services that are offered by combining Web services from different providers.

Important that a customer sees **a coherent service**.

Web Service Composition and Coordination

There are at least two classes of problems that need to be solved:

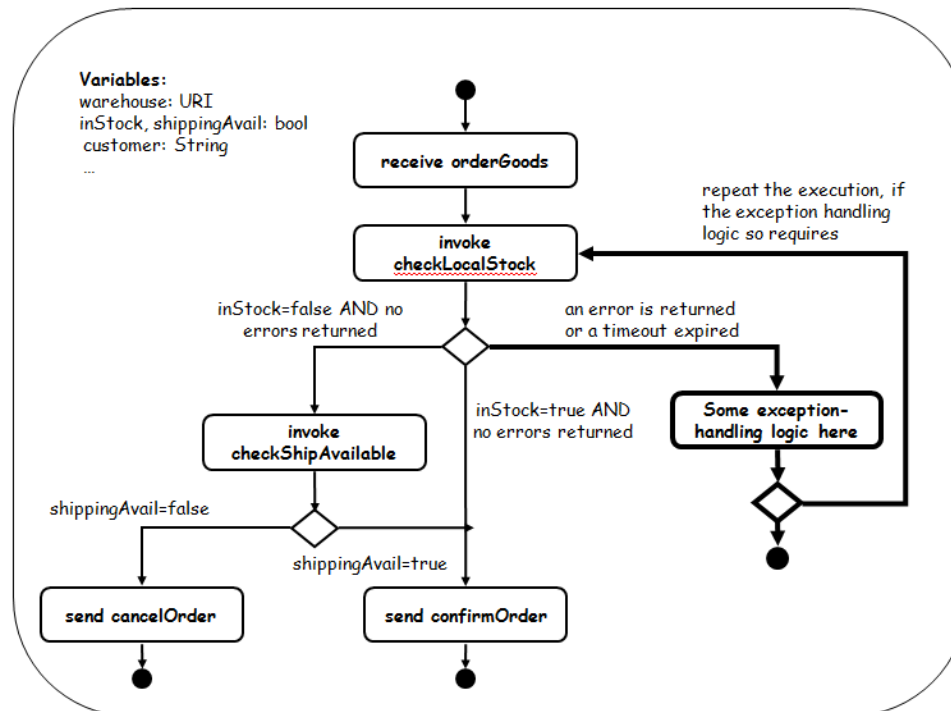
1. How can the **coordination** between Web services, possibly from different organizations, take place?
2. How can services be easily **composed**?

Web Service Composition and Coordination

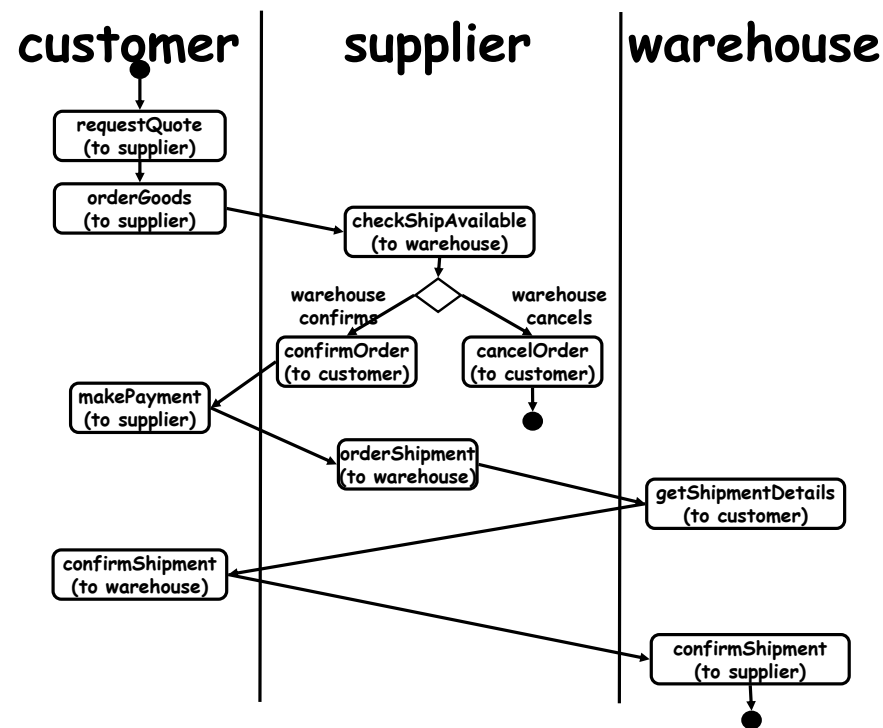
Coordination among Web services is tackled through **coordination protocols**. It is important to standardize the commonalities in coordination protocols.

1. When a party wants to participate in a specific protocol, that it knows with **which other process(es) it should communicate**.
2. A process is involved in multiple coordination protocols at the same time. Therefore, **identifying the instance of a protocol** is important as well.
3. A process should know **which role it is to fulfill**.

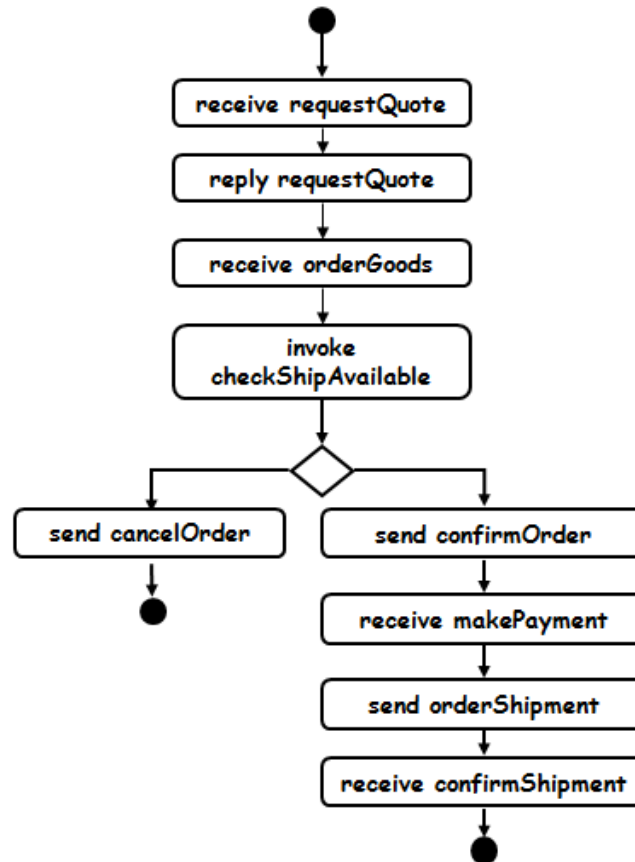
Web Service Composition and Coordination: An Example



Web Service Composition and Coordination: An Example



Web Service Composition and Coordination: An Example



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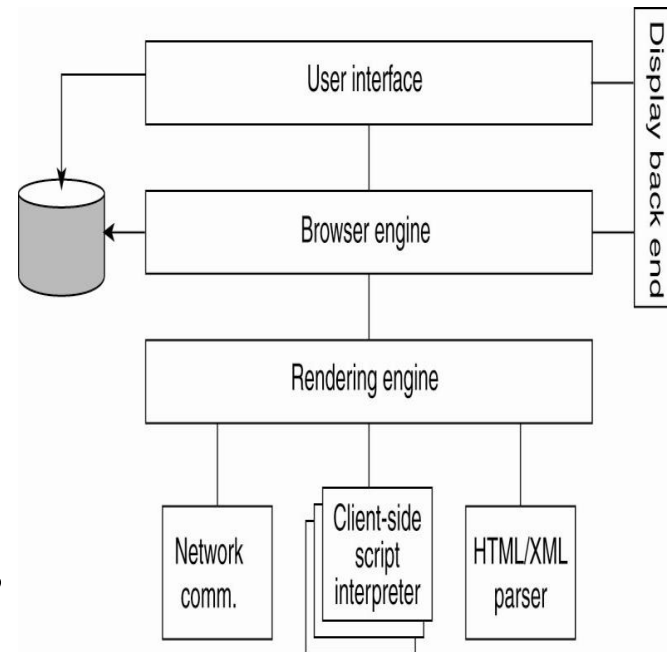
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Processes - Clients

A **Web browser**, which enables a user to navigate through Web pages by fetching those pages from servers and subsequently displaying them on the users' screen.

Important aspect of Web browsers:

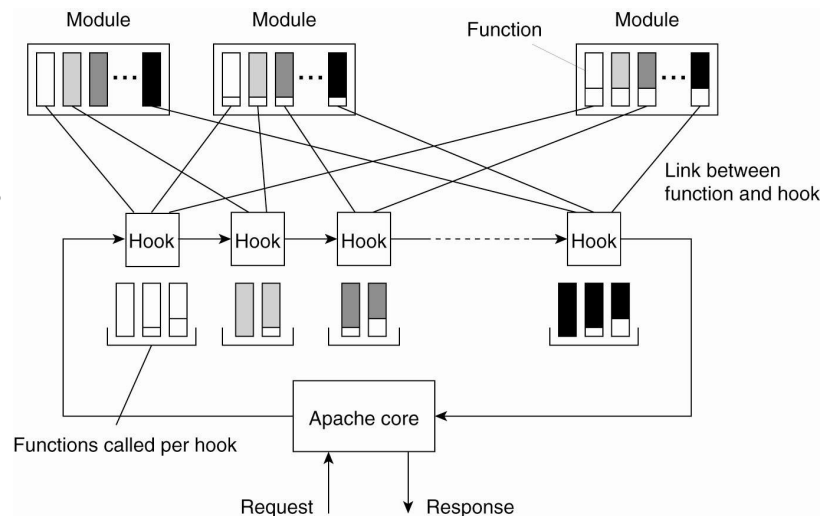
1. Platform independent.
2. Should be easily extensible so that it, can support any type of document that is returned by a server.



Apache Web Server

The most popular Web server
(estimated to be used to host
approximately **70% of all Web sites**)

Apache's runtime environment, known as the **Apache Portable Runtime (APR)**, is a library that provides a platform-independent interface for file handling, networking, locking, threads, and so on.



Apache Web Server

Fundamental to this organization is the concept of a **hook**, which is nothing but a placeholder for a specific group of functions.

Exampels:

1. There is a hook to **translate a URL to a local file name**.
2. Likewise, there is a hook for **writing information to a log**
3. A hook for checking a **client's identification**
4. A hook for **checking access rights**
5. A hook for **checking which MIME type the request** is related to (e.g., to make sure that the request can be properly handled).

The hooks are processed in a predetermined order.

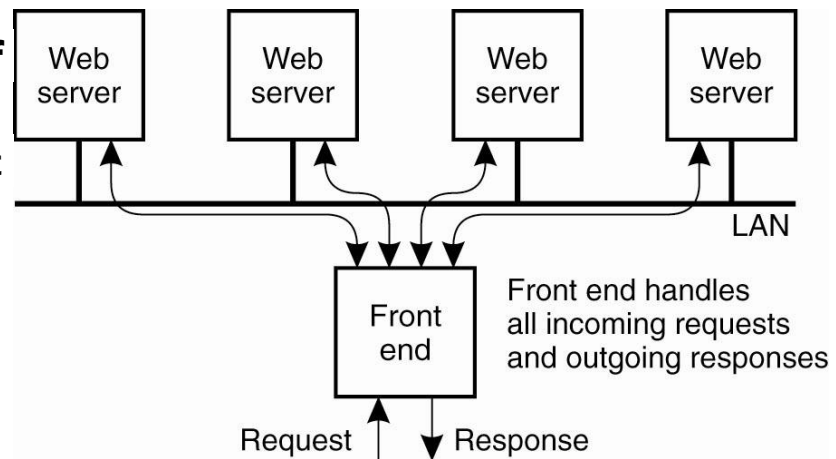
Web Server Cluster

To avoid Web server overload, we can **replicate a server** on a **cluster of servers** and use a separate mechanism, such as a front end, to redirect client requests to one of the replicas.

A crucial aspect of this organization is the **design of the front end as it can become a serious performance bottleneck**, what will all the traffic passing through it.

A transport-layer switch simply **passes the data sent along the TCP connection to one of the servers**, depending on some measurement of the server's load. The response from that server is returned to the switch, which will then forward it to the requesting client.

But the switch **cannot** take into account the **content of the HTTP request** that is sent along the TCP connection. At best, it can only base its redirection decisions on server loads.



Web Server Cluster

Deploy content-aware request distribution, by which the front end first **inspects an incoming HTTP request**, and then decides.

Several advantages:

1. If the front end always forwards requests for the **same document** to the **same server**, that server may be able to effectively **cache** the document resulting in higher response times.
2. **Distribute the collection of documents among the servers** instead of having to replicate each document for each server. This approach makes more efficient use of the available storage capacity and allows using dedicated servers to handle special documents such as audio or video.

A problem: The front end needs to do a lot of work

Web Server Cluster

Distribute the work of the front end, and combine that with a transport-layer switch: The front end has **Two Tasks**:

1. When a request initially comes in, it must decide **which server will handle** the rest of the communication with the client.
2. The **front end should forward** the client's TCP messages associated with the handed-off TCP connection.

The **dispatcher** is responsible for deciding to which server a TCP connection should be handed off.

A **distributor** monitors incoming TCP traffic for a handed-off connection.

The **switch** is used to forward TCP messages to a distributor.

