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Distributed Systems
Group: C4

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TP2

1. Give four types of hardware resource and five types of data or software resource that can usefully be shared. Give examples of their sharing as it occurs in practice in distributed systems.

2. How might the clocks in two computers that are linked by a local network be synchronized without reference to an external time source? What factors limit the accuracy of the procedure you have described? How could the clocks in a large number of computers connected by the Internet be synchronized? Discuss the accuracy of that procedure.

3. When you arrive at a restaurant, carrying a PDA that is capable of wireless networking. Suggest how you could be provided with information about the local services and amenities at the restaurant, without entering the restaurant's name or attributes. What technical challenges must be overcome?

4. Compare and contrast cloud computing with more traditional client-server computing? What is novel about cloud computing as a concept?

5. Use the World Wide Web as an example to illustrate the concept of resource sharing, client and server. What are the advantages and disadvantages of HTML, URLs and HTTP as core technologies for information browsing? Are any of these technologies suitable as a basis for client-server computing in general?

6. An open distributed system allows new resource sharing services such as the BLOB object to be added and accessed by a variety of client programs. What extent the needs of openness differ from those of heterogeneity.

7. Suppose that the operations of the BLOB object are separated into two categories – public operations that are available to all users and protected operations that are available only to certain named users. State all of the problems involved in ensuring that only the named users can use a protected operation. Supposing that access to a protected operation provides information that should not be revealed to all users, what further problems arise?

8. List the three main software components that may fail when a client process invokes a method in a server object, giving an example of a failure in each case. Suggest how the components can be made to tolerate one another's failures.

9. A service is implemented by several servers. Explain why resources might be transferred between them. Would it be satisfactory for clients to multicast all requests to the group of servers as a way of achieving mobility transparency for clients?

10. Resources in the World Wide Web and other services are named by URLs. What do the initials URL denote? Give examples of three different sorts of web resources that can be named by URLs.

11. Give an example of an HTTP URL. List the main components of an HTTP URL, stating how their boundaries are denoted and illustrating each one from your example. To what extent is an HTTP URL location-transparent

Answer

1. Give four types of hardware resource and five types of data or software resource that can usefully be shared. Give examples of their sharing as it occurs in practice in distributed systems.

- Four types of hardware resource
  - CPU: The central processing unit (CPU) can be shared among multiple processes or tasks running on different machines in a distributed system.
    Example: a cluster of computers can be used to run a parallel computing application, where each machine is responsible for a portion of the computation.
  - Memory: Memory can be shared among multiple processes or tasks running on different machines in a distributed system.
    Example: a distributed database can store its data on a shared memory system, allowing multiple machines to access the data quickly.
  - Disk: Disk space can be shared among multiple machines in a distributed system.
    Example: a network-attached storage (NAS) device can be used to provide shared file storage for multiple machines.
  - Network: The network bandwidth can be shared among multiple machines in a distributed system.
    Example: a group of machines can be used to distribute a large file, with each machine sending a portion of the file to the recipient.
- Five types of data or software resource
  - Database: a database is a structured data collection that may be shared by various processes or users, either locally or remotely. In a distributed database system,
    Example: data stored on multiple workstations can be accessed and updated as if it were on a single database2.
  - Application: a software program that performs a specified function that may be shared by several processes or users, either locally or remotely, is referred to as an application. In a web application system,
    Example: the program operating on a server can be accessed via the web4 by various clients.
  - Service: a service is a type of software component that delivers a specific function that can be shared by numerous processes or users, either locally or remotely. In a service-oriented architecture system,
    Example: services running on multiple machines can be called upon and combined by other services or clients.
  - Files: Files can be shared in distributed systems to allow users to collaborate on documents or other resources.
    Example: a team of engineers working on a software project may share code files on a network drive.
  - Web pages: Web pages can be shared in distributed systems to allow users to access information from anywhere in the world.
    Example: a company's website can be hosted on a distributed web server farm to ensure that it is always available and responsive.

2. Synchronizing clocks in two computers on a local network without an external time source:

One way to synchronize clocks in two computers on a local network without an external time source is to use a peer-to-peer time synchronization protocol such as the Peer-to-Peer Time Synchronization Protocol (PTP).

- Factors that limit the accuracy of PTP:
  - The precision of the clocks in the network
  - The network latency between the clocks
  - The frequency with which the master clock broadcasts its time
- Synchronizing clocks in a large number of computers connected by the Internet:

To synchronize clocks in a large number of computers connected by the Internet, a hierarchical time synchronization protocol such as the Network Time Protocol (NTP) is typically used. NTP uses a hierarchy of time servers to synchronize clocks across the Internet.

- Accuracy of NTP:
  - The accuracy of the root time servers
  - The network latency between the time servers and the clients
  - The frequency with which the clients synchronize their clocks to the time servers

3. Using a location-based service (LBS) on the PDA is one approach to get information about the restaurant's local services and amenities without having to enter the name or other details of the establishment. A software program that offers the user pertinent information or services depending on their device's location is known as a location-based service. For instance, an LBS may locate the PDA using its GPS or Wi-Fi signal, and then show nearby eateries, lodging options, events, and so on a list or map. After choosing a restaurant of interest, the user could read its details, including its name, address, phone number, menu, ratings, and reviews. Some of the technical challenges that must be overcome to implement such a service are:

- Accuracy: In order to deliver accurate and pertinent information, the device's location should be ascertained as precisely as possible. However, the accuracy and dependability of various location determination techniques varies.
  Example: GPS triangulation from cell towers is more accurate than Wi-Fi, but it might not function well indoors or in crowded urban areas with tall buildings. Thus, in order to attain the best accuracy, a variety of techniques could be required.
- Privacy: Both the user's location and the gadget itself should be shielded against abuse or illegal access. When and how their location is disclosed to the service provider or other parties should be at the user's control. In addition, the service provider must abide by all applicable privacy and data protection laws and regulations.
  Example: the user should have the option to remove their location history if they so want, choose what information they want to share or receive, and opt in or out of the service.

- Security: The location data and the information that the service offers must to be protected from tampering or malicious assaults. In order to guarantee that only individuals with permission can access or alter the data, the service provider should employ authentication, authorization, and encryption methods. In addition, the user needs to be informed of the possible dangers and hazards connected to the service, like malware, spoofing, and phishing.

4. Cloud computing and traditional client-server computing are two distinct paradigms for delivering and managing computing resources.
- Client-Server Computing:
    o Client-server computing typically involves a centralized server that provides services or resources to multiple client devices.
    o The server is often a physical machine located on-premises, and clients can be desktop computers or other devices.
    o Resource allocation is typically fixed and not easily adjustable.
    o Costs are often fixed, regardless of actual resource usage.
- Cloud Computing:
    o Cloud computing is based on a distributed model where resources are delivered over the internet.
    o Resources are hosted in data centers operated by cloud service providers, and clients access them remotely.
    o Resource allocation is flexible and can be adjusted in real-time.
    o Costs are based on actual resource usage, making it more cost-effective for many use cases.

What's novel about cloud computing is its transformative approach to delivering, managing, and scaling computing resources.

5. Advantages of HTML, URLs and HTTP as core technologies
    o HTML: Simple and human-readable markup language for structuring web content, Allows the creation of hyperlinks, enabling navigation between web pages and Supports multimedia integration, such as images, audio, and video.
    o URLs: A standardized way to specify the location of web resources, making it easy to access specific web pages, it's Easily shareable and bookmarkable for quick access to web content. URLs Supports multiple protocols, not limited to HTTP, allowing access to various resources.
    o HTTP: Simple and stateless protocol for transferring web resources from servers to clients. Supports a wide range of content types, including HTML, images, documents, and more. Efficient and widely supported, enabling the speedy transfer of web content.
- Disadvantages of HTML, URLs and HTTP as core technologies
    o HTML: html alone is not suited for building complex web applications with rich user interactions. Content and design may not adapt well to different screen sizes and devices without additional styling languages like CSS.

- o URLs: Can be long and complex, making them less user-friendly for certain purposes. URLs may change over time, leading to broken links if not properly maintained.
- o HTTP: it does not provide encryption for data transfer, which can lead to data interception and Lack of built-in features for authentication and session management, necessitating additional technologies for secure web applications.

Suitability as a basis for client-server computing, HTML, URLs, and HTTP are core technologies for information browsing and serve their respective purpose well in the context.

6. An open distributed system allows new resource sharing services such as the BLOB object to be added and accessed by a variety of client programs. The needs of openness differ from those of heterogeneity, while openness and heterogeneity share common goals of enhancing the adaptability and usability of distributed systems, they differ in their primary focus. Openness emphasizes the ease of adding new services and resources, while heterogeneity focuses on the ability of the system to interact with and support diverse platforms and technologies. Both principles are critical for building robust and extensible distributed systems.

7. Ensuring that only designated users can access protected operations presents a number of difficulties when dividing a BLOB object's activities into public and protected categories:

- Access Control: To confirm user identities and provide or refuse access based on permissions, authentication and authorization systems are required.
- Data confidentiality: It is essential to protect sensitive data accessed by protected operations; this calls for audit trails, data masking, and encryption.
- User Management: Significant issues include user revocation, managing security, and administering the list of permitted users.
- Security Concerns: It is crucial to take precautions against numerous security concerns, data integrity, and user impersonation.

8. Three primary software components can malfunction in a distributed system when a client process invokes a method on a server object:

- Client Software: There could be a client process crash or unresponsiveness. Implement timeouts, retries, error handling, and server switching to accommodate this.
- Server Software: It's possible for the server process to malfunction or crash. Use data replication, load balancing, redundancy, and crash recovery to tolerate this.
- Communication Middleware: Messages may be lost or delayed due to middleware problems or network outages. Use failover, redundancy, monitoring, and strong communication protocols to withstand this.

9. If one server updates a resource that another needs or others need, the one that changes it could use reliable broadcast to send the change to the other servers. Multicasting all requests to the group of servers as a way of achieving mobility transparency for clients might not be satisfactory. This is because multicasting all requests to the group of servers can result in increased network load. Instead, clients can use a load balancer to distribute requests across multiple servers. Load balancers can help improve application availability and responsiveness, and also help prevent server overload

10. URL stands for Uniform Resource Locator. It is a reference to a resource that specifies its location on a computer network and a mechanism for retrieving it. URLs are used to locate web pages, images, videos, and other resources on the internet. Here are three different sorts of web resources that can be named by URLs:

- Web Pages: A URL can be used to locate a web page on the internet. For example, the URL https://www.bing.com/ can be used to locate the Bing search engine's homepage.
- Images: A URL can also be used to locate an image on the internet. For instance, the URL https://i.imgur.com/9Jf5ZvL.jpg can be used to locate an image of a cat.
- Videos: A URL can also be used to locate a video on the internet. For example, the URL https://www.youtube.com/watch?v=dQw4w9WgXcQ can be used to locate the music video for Rick Astley's "Never Gonna Give You Up".

11. An example of an HTTP URL is http://www.example.com:80/path/to/myfile.html?key1=value1&key2=value2#SomewhereInTheDocument.

- Scheme: The scheme specifies the protocol used to access the resource. In this example, the scheme is http.
- Host: The host specifies the domain name or IP address of the server hosting the resource. In this example, the host is www.example.com.
- Port: The port specifies the network port number to use when connecting to the server. In this example, the port is 80.
- Path: The path specifies the location of the resource on the server's file system. In this example, the path is /path/to/myfile.html.
- Query: The query specifies additional parameters to be passed to the server along with the request. In this example, the query is key1=value1&key2=value2.
- Fragment: The fragment specifies a specific part of the resource to be displayed after it has been retrieved from the server. In this example, the fragment is SomewhereInTheDocument.

The boundaries of each component are denoted by special characters in an HTTP URL 2. Here's how each component is illustrated in our example:

An HTTP URL is location-transparent to a certain extent because it can be used to access resources on any server connected to the internet. However, if a resource is moved to a

different server or location, its URL will no longer be valid. Therefore, HTTP URLs are not completely location-transparent.