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UNIT II **(CO2)**

Utility Computing, Elastic Computing, AJAX: Asynchronous 'rich' Interfaces, Mashups: User Interface, Services Virtualization Technology: Virtualization Applications in Enterprises, Pitfalls of Virtualization Multitenant Software: Multi-Entity Support, Multi Schema Approach, Multi-Tenancy using Cloud Data Stores.

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UTILITY COMPUTING

Utility computing basically refers to the utility computing technologies and the business models that are offered by a service provider to the IT customers. The client is charged as per their consumption. Examples of these IT services are storage, computing power, and applications.

The term utility is basically the utility services like water, telephone, electricity, and gas that are provided by any utility company. In a similar manner, the customer when receives utility computing, its computing power on the shared computer network bills is decided on the basis of the consumption which is measured.

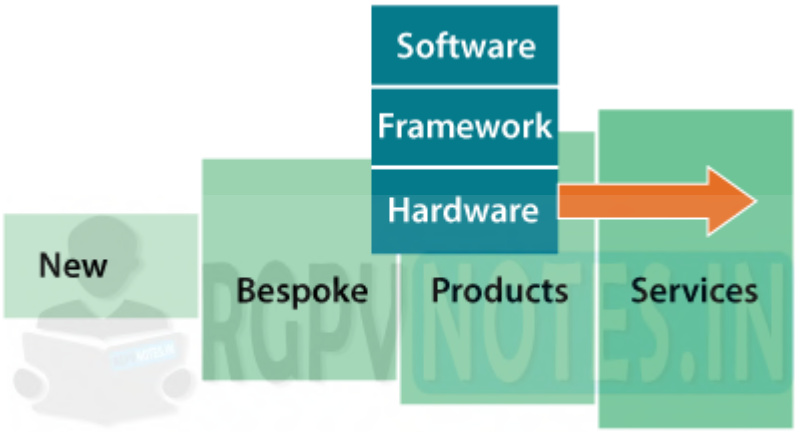

Figure 2.1: Utility Computing

ELASTIC CLOUD COMPUTING

Elastic cloud computing is a process through which a cloud service provider makes available resources for an organization on the basis of their requirements. The cloud service providers have a very meticulous system through which the resources are removed or delivered automatically to the organization according to their requirements. In this way, an appropriate amount of required resources is made available to the enterprise.

Managing cloud services has become very simple and easy with elastic computing at the hands. Enterprises now have incredible flexibility while using resources for infrastructure, storage, computing, etc. For the improvement in digital transformation and competitiveness in the business, organizations seek cost saving, scalability, and agility. And all this possible with elastic cloud storage.

Elasticity in the cloud has brought a turnaround in business storage. It has innumerable benefits to every business that can be summarized as follows:

1. Simple scalability and high performance: Any kind of infrastructure and services required by the business organization are quickly provided with the assistance of computing services. Scalability being the core feature of cloud deployments, the performance is enhanced and excellent speed for computations is ensured.
2. Cost-efficient: With elastic computing in hand, the cost for the organizations are reduced drastically as there is no need for capital infrastructure for IT as well the payment is done only for the usage.
3. Greater redundancy: The opportunity for better flexibility, reliability, affordability, and recovery solutions is assured.
4. More capacity: Unlimited storage capacity is available for business organizations with elastic

cloud computing. Being virtual it can be accessed from anywhere anytime across the network.

5. High availability: The access of files has been simple and available all the time with Cloud services. Also, view and modify options are available, The system breakdown is negligible with alternative backup.
6. Easier management: The era of maintaining, upgrading, and deploying IT infrastructure has become a past and the IT teams are relieved.
7. Environment friendly: Cloud is highly environment friendly as it has lesser consumption of resources.

AJAX

AJAX stands for Asynchronous JavaScript and XML. AJAX is a new technique for creating better, faster, and more interactive web applications with the help of XML, HTML, CSS, and Java Script.

1. Ajax uses XHTML for content, CSS for presentation, along with Document Object Model and JavaScript for dynamic content display.
2. Conventional web applications transmit information to and from the sever using synchronous requests. It means you fill out a form, hit submit, and get directed to a new page with new information from the server.
3. With AJAX, when you hit submit, JavaScript will make a request to the server, interpret the results, and update the current screen. In the purest sense, the user would never know that anything was even transmitted to the server.
4. XML is commonly used as the format for receiving server data, although any format, including plain text, can be used.
5. AJAX is a web browser technology independent of web server software.
6. A user can continue to use the application while the client program requests information from the server in the background.
7. Intuitive and natural user interaction. Clicking is not required, mouse movement is a sufficient event trigger.
8. Data-driven as opposed to page-driven

AJAX is the most viable Rich Internet Application (RIA) technology so far. It is getting tremendous industry momentum and several tool kit and frameworks are emerging. But at the same time, AJAX has browser incompatibility and it is supported by JavaScript, which is hard to maintain and debug.

AJAX is based on the following open standards –

1. Browser-based presentation using HTML and Cascading Style Sheets (CSS).
2. Data is stored in XML format and fetched from the server.
3. Behind-the-scenes data fetches using XMLHttpRequest objects in the browser.
4. JavaScript to make everything happen.

MASHUPS

A mashup is a technique by which a website or Web application uses data, presentation or functionality from two or more sources to create a new service. Mashups are made possible via Web services or public APIs that (generally) allow free access. Most mashups are visual and interactive in nature.

To a user, a mashup should provide a richer, more interactive experience. A mashup is also beneficial to developers because it requires less code, allowing for a quicker development cycle.

The main characteristics of the mashup are combination, visualization, and aggregation. It is important to make existing data more useful, moreover for personal and professional use. To be able to permanently access the data of other services, mashups are generally client applications or hosted online.

In the past years, more and more Web applications have published APIs that enable software developers to easily integrate data and functions instead of building them by themselves. Mashups can be considered to have an active role in the evolution of social software and Web 2.0. Mashup composition tools are usually simple enough to be used by end-users. They generally do not require programming skills and rather support visual wiring of GUI widgets, services and components together. Therefore, these tools contribute to a new vision of the Web, where users are able to contribute.

	Portal	Mashup
Classification	Older technology, extension to traditional Web server model using well-defined approach	Using newer, loosely defined "Web 2.0" techniques
Philosophy/approach	Approaches aggregation by splitting role of Web server into two phases: markup generation and aggregation of markup fragments	Uses APIs provided by different content sites to aggregate and reuse the content in another way
Content dependencies	Aggregates presentation-oriented markup fragments (HTML, WML, VoiceXML, etc.)	Can operate on pure XML content and also on presentation-oriented content (e.g., HTML)
Location dependencies	Traditionally, content aggregation takes place on the server	Content aggregation can take place either on the server or on the client
Aggregation style	"Salad bar" style: Aggregated content is presented 'side-by-side' without overlaps	"Melting Pot" style – Individual content may be combined in any manner, resulting in arbitrarily structured hybrid content
Event model	Read and update event models are defined through a specific portlet API	CRUD operations are based on REST architectural principles, but no formal API exists
Relevant standards	Portlet behavior is governed by standards JSR 168, JSR 286 and WSRP, although portal page layout and portal functionality are undefined and vendor-specific	Base standards are XML interchanged as REST or Web Services. RSS and Atom are commonly used. More specific mashup standards such as EMML are emerging.

Table 2.1: Difference between Portal and Mashup

SERVICES VIRTUALIZATION TECHNOLOGY

Virtualization is the process of creating a virtual environment to run multiple applications and operating systems on the same server. The virtual environment can be anything, such as a single instance or a combination of many operating systems, storage devices, network application servers, and other environments.

The concept of Virtualization in cloud computing increases the use of virtual machines. A virtual machine is a software computer or software program that not only works as a physical computer but can also function as a physical machine and perform tasks such as running applications or programs as per the user's demand.

Types of Virtualization:

1. Hardware virtualization
2. Server virtualization
3. Storage virtualization
4. Operating system virtualization
5. Data Virtualization

Service virtualization is associated with service-oriented architecture (SOA). Service-Oriented Architecture (SOA) allows organizations to access on-demand cloud-based computing solutions according to the change of business needs. It can work without or with cloud computing. The advantages of using SOA is that it is easy to maintain, platform independent, and highly scalable.

Service Provider and Service consumer are the two major roles within SOA.

Applications of Service-Oriented Architecture:

There are the following applications of Service-Oriented Architecture -

1. It is used in the healthcare industry.
2. It is used to create many mobile applications and games.
3. In the air force, SOA infrastructure is used to deploy situational awareness systems.

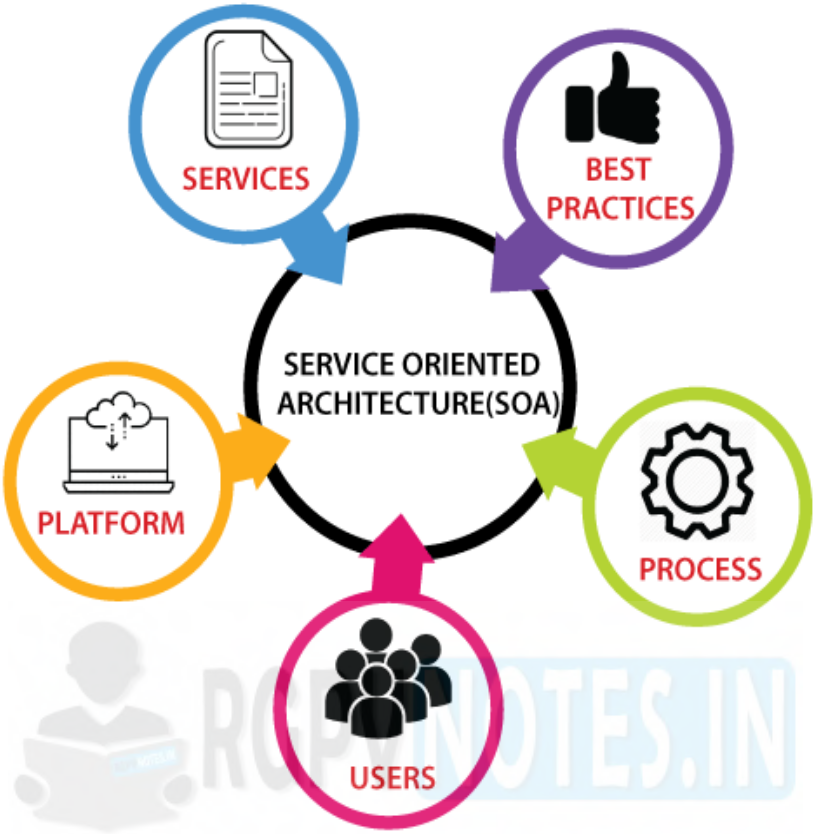

Figure 2.2: Service-Oriented Architecture

PITFALLS OF VIRTUALIZATION

Here are some of the most common issues posed by adopting virtualization that every organization must consider.

1. Detection/Discovery: You can't manage what you can't see! IT departments are often unprepared for the complexity associated with understanding what VMs (virtual machines) exist and which are active or inactive. To overcome these challenges, discovery tools need to extend to the virtual world by identifying Virtual Machine Disk Format (.vmdk) files and how many exist within the environment. This will identify both active and inactive VM's.
2. Correlation: Difficulty in understanding which VMs are on which hosts and identifying which business critical functions are supported by each VM is a common and largely unforeseen problem encountered by IT departments employing virtualization. Mapping guest to host relationships and grouping the VM's by criticality & application is a best practice when implementing virtualization.
3. Configuration management: Ensuring VMs are configured properly is crucial in preventing performance bottlenecks and security vulnerabilities. Complexities in VM provisioning and offline VM patching is a frequent issue for IT departments. A Technical Controls configuration management database (CMDB) is critical to understanding the configurations of VM's especially dormant ones. The CMDB will provide the current state of a VM even if it is dormant, allowing a technician to update the configuration by auditing and making changes to the template.
4. Additional security considerations :If a host is vulnerable, all associated guest VMs and the business applications on those VMs are also at risk. This could lead to far more reaching impact

than the same exploit on a single physical server. Treat a Virtual Machine just like any other system and enforce security policies and compliance. Also, use an application that dynamically maps guest-to-host relationships and tracks guest VM's as they move from host to host.

5. VM identity management issues: Virtualization introduces complexities that often lead to issues surrounding separation of duties. Who manages these machines? Do application owners have visibility into changes being made? Identify roles and criticality and put them through the same processes you leverage for physical devices including change management, release management and hardening guidelines.
6. VM network configuration control: With multiple operating systems sharing a single IP address behind a NAT, network access control becomes much more complex in a virtual network. To address this use AD, DNS and NetBIOS to identify bridged VM's. IP sweeps in most cases will not pick these up.
7. Identifying and controlling VM proliferation: VM's can pop up and move to any location in an instant. To manage this potential issue, you must establish and enforce a process for Virtual Machine deployment.
8. VM host capacity planning: Virtualization can make understanding what applications are running and how many resources are being leveraged much more difficult. To better deal with this issue, organizations must track how many guest to host relationships exist and the configuration of the VM's.
9. ESX host driver and ACL information: How is the ESX System itself configured? Does it meet your PCI requirements? Who has permissions to the system? Does it meet your regulatory compliance needs? Organizations must proactively manage ESX machines by tracking and trending their security configurations over time to make sure they don't "drift" from corporate standards.
10. ESX host configuration management: If a guest is infected with a worm or virus it will attack the other local VMs. If that image is moved to another host, it will continue to do damage across the organization. Do you have visibility into guest to host relationships and their configurations? Guest to host mapping and their configuration history is critical to the success of managing virtual machines.
11. Intellectual property: Virtualization makes it more difficult to know who has what information. How do you know your VMs are not walking out the door with critical information and data? Verifying encrypted data and historical information on your guest VMs can help manage and secure intellectual property.

MULTI-TENANT SOFTWARE

In multi-tenant software architecture—also called software multitenancy—a single instance of a software application (and its underlying database and hardware) serves multiple tenants (or user accounts). A tenant can be an individual user, but more frequently, it's a group of users—such as a customer organization—that shares common access to and privileges within the application instance. Each tenant's data is isolated from, and invisible to, the other tenants sharing the application instance, ensuring data security and privacy for all tenants.

Software multitenancy is the architecture on which Software-as-a-Service (SaaS) is delivered. If your organization uses salesforce.com, HubSpot, or another cloud-based SaaS offering, you're a tenant in a multi-tenant offering.

Multitenancy is a type of software architecture where a single software instance can serve multiple distinct user groups.It means that multiple customer's of cloud vendor are using same computing resources . As they are sharing same computing resources but the data of each Cloud customer is kept totally separate and secure. It is very important concept of Cloud Computing.

In cloud computing Multitenancy also refer as shared host where same resources are divided among different customer's.

The example of multitenancy is same as working of Bank. Multiple people can store money in the one same bank. But every customer asset is totally different like one customer cannot have access to the other customer's money and account and different customer's are not aware about each other's account balance and details etc.

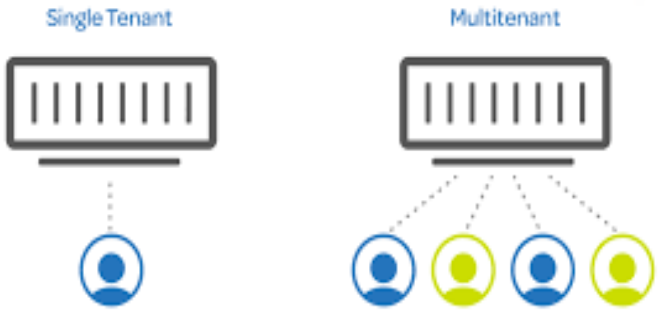

Figure 2.3: Single Tenant V/S Multitenant

Advantages of Multitenancy:

1. Use of Available resources is maximized by sharing resources.
2. Customer's Cost of Physical Hardware System is reduces.
3. It reduce usage of physical devices and thus power consumption and cooling cost save.
4. Save Vendor's cost as it become difficult for cloud vendor to provide separate Physical Services to each individual.

Disadvantages of Multitenancy :

1. As data is stored in third party services , this reduces security of our data and put it into vulnerable condition .
2. Unauthorized access will cause damage of data.

Multi-Tenant Databases:

In a multi-tenant environment, multiple customers share the same application, in the same operating environment, on the same hardware, with the same storage mechanism and database. This is how Sales force and every other SaaS operator runs. Every tenant is a customer/user who has common access and specific privileges in the software instance.
The database, however, is another matter. There are three ways to architect your database in a multi-tenant system.

A Single, Shared Database Schema:

A schema is a layout for database tables that relate to each other. In the first approach, one database is used with tenant tables all linked to the database. The tables handle relations and version control or updates, such as handling two people attempting to manipulate the same table or data entry. This is the fastest way to operate, since only one database is being used, assuming it scales.
Single Database, Multiple Schemas
Multiple schemas inside a single database is a popular method to have sub-databases, so you can divide up your data without having to set up multiple databases. Each schema is isolated from the others and operates differently, which can be useful in situations where different data has different regulations, like international data.

Multiple Databases:

This takes the multi-schema approach one step further because now you have the data in multiple databases. Sales or customers can be divided up by region, for example. So the upside is you get the best isolation of data. Of course, that also adds to the complexity of management, maintenance and scalability that would come with deploying multiple databases.

MULTI-TENANCY USING CLOUD DATA STORES

The concept of delivering cloud services by sharing virtualized hardware infrastructure and application servers has existed for years. Within these hosted services, multi-tenancy functionality has been a critical factor in separating software services for tenant customers while keeping costs at a

level acceptable for software providers. However, at the same time, the sharing of resources to service many tenant customers can result in the co-location of data by many potentially competing organizations using the service within the same storage solution. This situation introduces some risks and data protection concerns that must be addressed to ensure a secure and acceptable solution.

Multi-tenancy and its importance in shared Cloud Services:

A multi-tenant cloud storage architecture consists of a single and centralized infrastructure system purpose-built to provide service-oriented storage for multiple customers or "tenants." All customer data is stored in hosted yet shared servers, storage, and databases. The separation of various customer data is mandatory to ensure any data stored is not accessible or viewable by another tenant user.

For Service Providers in an "as-a-service" evolving world, this means managing multiple and potentially competing client organizations and the company's data from within a single yet shared storage solution. A service provider can share the hardware resources across all customer tenant instances and then spread the infrastructure cost across all of the serviced customers, instead of having to secure each one of the individual instances and significantly reducing the total cost of ownership of managing the solution.

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