CHAPTER 3

BUILDING CLOUD NETWORKS

CHAPTER OUTLINE

After studying this chapter, students will be able to understand the:

- Managed Service Provider
- Evolution from Managed Service Providers (Msp) to Cloud Computing
- Single-Purpose Architectures To Multi-Purpose Architectures
- Data Center
- Cloud Data Center
- Data Center Virtualization
- Government Integrated Data Center, Kathmandu
- Service Oriented Architectures (SOA)
- SOA and Cloud
- Cloud Design And Implementation Using SOA

This unit discusses what it takes to build a cloud network, how and why businesses build these high automated private cloud networks that provide resources that can be managed from a single point, t significant reliance of cloud computing architectures on server and storage virtualization as a lay between applications and distributed computing resources, and the fundamentals of how flexible clou computing networks can be built. This contains an overview of how Service Oriented Architecture (SO is utilized as an intermediary step for cloud computing, as well as the fundamental approach to SOA as pertains to data center design, as well as the function and usage of open-source software in data centers.

Nobody could have imagined ten years ago that the cloud (both hardware and software) would becom the next big thing in computing. IT automation arose as a result of customer-expressed busine requirements to infrastructure management and administrators. There has never been a great, coordinate effort to automate the IT business. Responding to the demands of particular clients, each supplier has bee hard at work developing technological solutions to perform repeated operations, respond to events, an generate predictable outcomes under particular situations. Throughout this evolutionary process, it wa assumed that the cost of not doing it would be greater than the cost of doing it.

MANAGED SERVICE PROVIDER (MSP)

A managed service provider (MSP) is a firm that maintains a customer's IT infrastructure and/or end-use systems remotely, often on a proactive and subscription basis. When a provider's service is supported by service level agreement (SLA) and supplied through the internet, the phrases "cloud service provider" an "managed service provider" are frequently used interchangeably.

MSPs emerged in the 1990s with the rise of application service providers (ASPs), which provided remot application hosting services. ASPs paved the path for cloud computing and organizations that offe remote assistance for clients' IT infrastructure. MSPs initially concentrated on remote administration an monitoring (RMM) of servers and networks. MSPs have broadened the scope of their services throughou time to differentiate themselves from other suppliers.

While some MSPs specialize in certain areas of information technology, such as data storage, others focu on vertical sectors such as legal, financial services, healthcare, and manufacturing. Managed Securit Service Providers (MSSPs), for example, provide specialized services such as remote firewall managemen and other security-as-a-service options. Meanwhile, managed print services (MPS) companies take ove the work of maintaining printers and delivering consumables.

The Pricing Model for Managed service providers

The MSP charges the customer a fixed cost for each device under control under per-device pricing Meanwhile, with per-user pricing, the MSP charges a fixed rate for each user, which accommodate consumers who utilize numerous devices. All-inclusive pricing, often known as the all-you-can-eat model involves the MSP charging a fixed rate for all IT infrastructure support and management services that th MSP intends to provide.

In each of these pricing strategies, the consumer pays the flat cost regularly, usually monthly. Such pricing mechanisms enable MSPs to sell services on a subscription basis. In contrast to IT projects, which are often one-time transactions, this technique offers the MSP, a monthly recurring revenue (MRR) stream.

MRR is one feature of managed services that distinguishes it from other revenue models in the IT solution provider and channel partner arena. Break/fix solution providers, for example, often price their services on a time and materials (T&M) basis, invoicing an hourly fee for fixing a customer's IT equipment and charging for components or new equipment.

Companies that do IT project work, such as computer system installation and integration, may charge a set fee for their products and services. In any case, those solution providers get money from each project on a one-time basis. Large projects with several milestones and accompanying payments would be an exception. However, the traditional solutions provider business is primarily transactional. The recurrent income stream of an MSP, on the other hand, may give a more solid and predictable base of business.

Service-level agreements

An MSP frequently delivers its service offering under a service-level agreement, which is a contract between the MSP and its customer that specifies the performance and quality parameters that will govern the relationship.

An SLA can be coupled to the pricing formula of an MSP. For example, an MSP may provide clients with a variety of SLAs, with the client paying a greater charge for greater levels of service under a tiered pricing system.

Challenges of managed service providers

Regardless of price type, a fundamental problem for MSP company management is to set a price that is cheap enough to lure clients to purchase their services while maintaining an appropriate profit margin.

MSPs consider operating costs and the cost of retaining talented staff in addition to the price. Labor is often the most expensive component of an MSP's budget. Most MSPs use remote monitoring and management (RMM) software to monitor their clients' IT processes to save personnel expenses and enhance productivity. RMM software enables MSPs to remotely troubleshoot and resolve server and endpoint device issues. MSPs may use RMM to handle several clients' IT systems at the same time. MSPs may also employ automated scripts to do common system administration tasks, such as monitoring hard drives for defects, without requiring human participation.

Another issue that MSPs confront is the widespread adoption of cloud computing. MSPs have had to create solutions to manage hybrid cloud setups as more of their client's IT infrastructure components migrate to the cloud. MSPs may also strive to provide their cloud computing services or resell the capabilities of other cloud providers, with cloud-based backup and disaster recovery (DR) being a frequent entry point.

Furthermore, even becoming an MSP might be difficult. Many conventional solution providers, such as VARs, have been drawn to the MSP business model by the potential of MRR. However, would-be MSPs have had difficulty breaking into the market. To mention a few issues, the MSP business model necessitates the adoption of various performance measures, technical infrastructure components, and sales reward plans. As a result, many MSPs generate revenue from areas other than managed services, such as IT project work, break/fix business, and on-site assistance. Pure-play MSPs are uncommon in the IT services business.

What MSPs are used for?

MSP customers are often small and medium-sized enterprises (SMBs). Because many smaller businesses have limited in-house IT capabilities, they may see an MSP's service offering as a method to get IT experience. However, larger businesses may also contract with MSPs. Government entities, for example, may contract with an MSP to complement in-house IT workers due to financial constraints and employment limits.

Customers of all sizes benefit from predictable IT support expenses with the MSP subscription model. Furthermore, because MSPs adopt a proactive approach, they may be able to prevent IT problems from arising and, as a result, affecting company operations.

Evolution from Managed Service Providers (MSP) to Cloud Computing

The first incarnation of cloud computing was most likely back in the days of frame relay networks. Frame relay organizations were single clouds that were linked to other frame relay organizations via a carrier/provider to carry data communications between the two entities. Everyone on the frame network who shares a similar Private Virtual Connection (PVC) might share data with everyone else on the same PVC. Users had to rely on routers and switches along the way to connect the dots between clouds if they wanted to leave their cloud and connect to another.The pathway's terminus was a demarcation point between the cloud and the provider's client. Access was regulated by devices such as gateways, proxies, and firewalls on the customer's premises where the dots terminated between the clouds (i.e., the

endpoints). This endpoint was recognized as the principal point of entry from the standpoint of clients and it denoted their permitted gateway into their internal networking infrastructure.By requiring applications to use specific protocols to transport data (e.g., Simple Mail Transfer Protocol for sending an email or File Transfer Protocol for moving files from one location to another), applications behind the 'Minimum Point of Entry' could accept or reject network traffic, allowing email and file transfer to occur with little to no impedance from network infrastructure or telecommunications.Specialized applications (created out of necessity to meet specific business needs) frequently required a client/server implementation using specific portals created through the firewall to allow their traffic protocols to proceed unhindered, and they frequently required special administrative set up before they could function properly. Things have evolved a lot since that model was considered cutting-edge. Regardless of how cutting-edge it was, it was difficult to manage and costly.

SINGLE-PURPOSE ARCHITECTURES TO MULTI-PURPOSE ARCHITECTURES

In the early days of MSPs, providers would physically visit customers' homes and execute services on their property. Over time, these MSPs specialized in infrastructure deployment and soon figured out how to build entire data centers and sell those capabilities off in little pieces known as monthly recurring services, in addition to the fundamental rates charged for ping, power, and pipe (PPP). Ping refers to the ability to connect to the Internet, power is self-explanatory, and pipe refers to the quantity of data throughput that a client is prepared to pay for.In most cases, the PPP component of the payment was incorporated into the provider's monthly service price in addition to their service offerings. Remote network, desktop, and security monitoring, incident response, patch management, and remote data backup, as well as technical help, are all common services provided by MSPs.Consumers that use an MSP benefit from the fact that by acquiring a defined set of services, MSPs bill a flat or near-fixed monthly rate, which benefits customers by providing a predictable IT expense to budget for overtime. Today, many MSPs deliver their services remotely through the Internet rather than selling data center space and services or doing on-site customer visits (which is time-consuming and expensive).

DATA CENTER

A data center is a storage facility that holds computer facilities such as servers, routers, switches, and firewalls, as well as supporting components such as backup equipment, fire suppression systems, and air conditioning. A data center can be complicated (dedicated building) or simple (dedicated building) (an area or room that houses only a few servers). A data center can also be private or shared.

Datacenter components are frequently at the heart of an organization's information system (IS). As a result, these important data center facilities often need a substantial investment in supporting technologies such as air conditioning/climate control systems, fire suppression/smoke detection, secure entrance and identification, and elevated floors for easier cabling and water damage avoidance.

When data centers are shared, allowing virtual data center access to numerous organizations and individuals frequently makes more sense than allowing entire physical access to multiple companies and persons. Shared data centers are often owned and managed by a single organization that rents out center partitions (virtual or physical) to other client businesses. Client/leasing organizations are frequently tiny businesses that lack the financial and technical capabilities necessary for dedicated data center upkeep. The leasing option enables smaller enterprises to benefit from professional data center capabilities without incurring large capital expenditures.

A data center is a location where an organization's IT operations and equipment are centralized, as well as where data is stored, managed, and disseminated. Data centers hold a network's most crucial systems and are important to the day-to-day functioning of the network. As a result, corporations prioritize the security and dependability of data centers and associated information.

Although each data center is unique, it may typically be divided into two types: internet-facing data centers and business (or "internal") data centers. Internet-facing data centers often handle a small number of apps, are browser-based, and have a large number of unknown users. Enterprise data centers, on the

other hand, serve fewer users but host more applications ranging from off-the-shelf to bespoke applications.

Datacenter designs and needs can vary greatly. A data center designed for a cloud service provider, such as Amazon® EC2, has facility, infrastructure, and security needs that differ dramatically from a wholly private data center, such as one designed for the Pentagon to secure sensitive data.

CLOUD DATA CENTER

Unlike the MSP or hosting model, the cloud allows clients to select the precise amount of computing power, data, or apps they need to meet their business needs. Because clients do not need to spend funds to obtain these services, we now have a dependable and cost-effective alternative to what was previously offered. Customers may now connect to the cloud without installing software or purchasing specialized hardware. The availability of collaborative services is a major factor in their willingness to adopt the cloud.

Necessary Features of Data Center

- **Infrastructure and location**: Once you have decided how much data storage you would like to outsource to a data center, you can use it as a measure to determine what type of infrastructure you will require. The type of servers utilized, the location of the center, and the configuration of the servers and networks are all factors that might influence your choices.
- **Efficiency and Reliability:** Power backup is critical, and it is also beneficial to understand how this backup is set to your servers. For the efficient running of your organization, the data center's dependability should be at least 99.995%, and this should be backed by easy access to your data for all processes.
- **Data redundancy for unexpected situations**: The data center should guarantee redundancy of your stored data in the event of an emergency or as part of a disaster recovery plan. Discuss with the data center personnel to ensure that all failure situations, such as those outlined in this article, have been considered while designing the data center.
- **Data security in all aspects**: The data center must ensure the physical and virtual security of your data. You must go there in person to evaluate each of these features before making your decision.
- **Access and connectivity for smooth functioning**: Because the data housed in a data center is likely to be more than a static block and will need to be accessible for your company's purposes, the ease of access must also be addressed. The center's network connectivity is also significant in deciding this.
- **Scalability to support growth**: As your company expands, so will its data storage requirements. The methods and speed of obtaining this data would also need to evolve in tandem with this expansion. Check to see whether the data center has plans for future development and can give you these additional resources on short notice.
- **Manageability**: A data center should allow for the simple and seamless management of all of its components. This can be accomplished through automation and a reduction in human interaction in routine chores.
- **Availability**: A data center should guarantee that information is available when needed. It simply implies that there will be no downtime. Unavailability of information might cost businesses a lot of money every hour.
- **Security**: To prevent unauthorized access to information, all rules, processes, and core element integration work together.
- **Scalability**: Business expansion nearly always necessitates the deployment of more servers, new applications, databases, etc. so infrastructure needs to be scalable.
- **Performance**: The goal of performance management is to ensure that all aspects of the DC work optimally to meet the desired service levels.
- **Dataintegrity**: Ascertain that data is saved and retrieved in the same manner in which it was received.
- **Monitoring**: It is a continual process of obtaining information about the numerous parts and services that are active in the data center. The purpose is self-evident: to forecast the unanticipated.
- **Reporting**: Performance, capacity, and utilization gathered together at a point in time.

DATA CENTER VIRTUALIZATION

The rise of the MSP field, along with advancements in Internet and networking technologies over the last decade, has resulted in infrastructure being essentially secondary to the services supplied on such infrastructure. The providers' business model has altered to deliver remotely managed services at cheaper prices by allowing the infrastructure to be virtualized and shared among multiple clients, making it appealing to their clients.The X-as-a-Service (XaaS) models are constantly developing and expanding, as we are at the vanguard of a new age of computing services, driven by a massive spike in demand from both corporations and people. Software-as-a-Service (SaaS) and other [X]aaS products such as IaaS, MaaS, and PaaS can be viewed as a subset or section of the rapidly expanding cloud computing industry.

Traditionally, cloud computing has been considered as a broad array of Internet Protocol (IP) services (usually utilizing a Web browser as the principal interface) that allow customers to get a certain set of functional capabilities on a "pay for use" basis. Previously, accessing such services necessitated significant hardware/software expenditures as well as the professional expertise necessary in hosting settings. The most significant benefits of cloud computing and SaaS over traditional hosting environments for enterprise customers are that cloud computing is a reaction to a business requirement to find an affordable solution for employing expensive outsourced data centers.Furthermore, SaaS is a "pay as you go" approach that arose as an alternative to traditional (expensive) software licensing alternatives. When contrasted to the MSPs from which it emerged, the cloud emerged from the roots of managed service provider settings and data centers and is now a major component of next-generation data centers. Customers no longer care where data is physically kept or where servers are physically situated since they will only use and pay for them when they are required. Lower cost, improved performance and efficiency, and currency of solutions are what drives client decision-making today.

GOVERNMENT INTEGRATED DATA CENTER, KATHMANDU

A data center is a centralized location for the storage, management, processing, and exchange of data that exists within a specific enterprise or a specialized facility. In general, data centers can be broken down into three types - Internet Datacenter (IDC), Storage area network (SAN), and Enterprise data center (EDC).

An **Internet data center (IDC)** is a facility that provides data and Internet services for other companies. *GIDC* falls in this phase.

A **Storage Area Network (SAN)** is a network of interconnected storage devices and data servers usually located within an enterprise data center or as an off-site facility offering leased storage space.

An **Enterprise data center (EDC)** is the central processing facility for an enterprise's computer network

Features of GIDC	Facilities of GIDC
• High-End Computing Infrastructure • Storage Area Network (SAN) • High-Speed Local Area Network • Multi-Tier Security • High-Speed Internet Connectivity • 24*7*365 Help Desk • Multi-level redundant power back-up • Air Conditioning Management • Fire Detection & Control System	• Information Technology System • Routers, Backbone Switches, etc. • Integrated Network Management System • Integrated Server Management System • Integrated Storage – 158 TB • IPS, Web Application Firewall

Infrastructure System

- Air-Circulation System: HVAC (Heating, Ventilating, and Air Conditioning)
- Security: Biometric Access Control System, Card Reader Access Control System, CCTV
- Main Monitoring Room: Integrated Console
- Facility Management System: Water Leakage Sensing
- Disaster Prevention System: Firefighting

Electrical System

- 200 KVA transformers (3 nos.)
- Main Power Switchboard (Separate for servers and general lighting)
- Emergency Generator: 400 KW
- U.P.S.- Redundant 100 KVA, 120 KVA; Batteries: 620.

SERVICE ORIENTED ARCHITECTURES (SOA)

An SOA consists of policies, concepts, and a framework that demonstrates how corporate applications may use network services to accomplish desired business goals. These results include the ability to deliver and consume business capabilities as a collection of services. SOA is therefore an architectural style that promotes the development of interconnected business services. SOA's "services" are business services. Changing a customer's service-level agreement, for example, is a business service, but updating a record in a database is not.A service is a unit of labor performed by a service provider to accomplish the intended results for a service consumer. An SOA solution is made up of a networked set of business services that implement an end-to-end business process. SOA architecture consists of various layers such as the consumer interface layer, business process layer, services layer, service component layer, and operational systems layer. The consumer interface layer consists of GUI-based apps for end-users to access applications, the business process layer consists of business-use cases in terms of application, the services layer is a repository of services, the service component layer is used to build services, such as functional and technical libraries, and the operational systems layer contains the data model.

Figure 3.1: SOA

Service-Oriented Architecture (SOA) is an architectural approach that allows diverse applications to communicate independently of platform, implementation language, or location by leveraging generic and dependable services that may be utilized as application building blocks. SOA encompasses approaches and strategies for developing complex applications and information systems. SOA differs from traditional architectures in that it has its own set of architectural traits and rules. SOA combines a group of loosely coupled black-box components to offer a well-defined degree of service.

Each service in SOA has the code and data necessary to perform a full, discrete business operation (for example, checking a customer's credit, calculating a monthly loan payment, or processing a mortgage application). The service interfaces allow loose coupling, which means that they may be called with little or no knowledge of how the service is implemented below, minimizing application dependencies. Applications behind the service interface can be built in Java, Microsoft.Net, Cobol, or any other

programming language, provided by a vendor (e.g., SAP), SaaS applications (e.g., Salesforce CRM), or any open-source applications. Service interfaces are commonly defined using Web Service Definition Language (WSDL) which is a standard tag structure based on XML (eXtensible Markup Language).

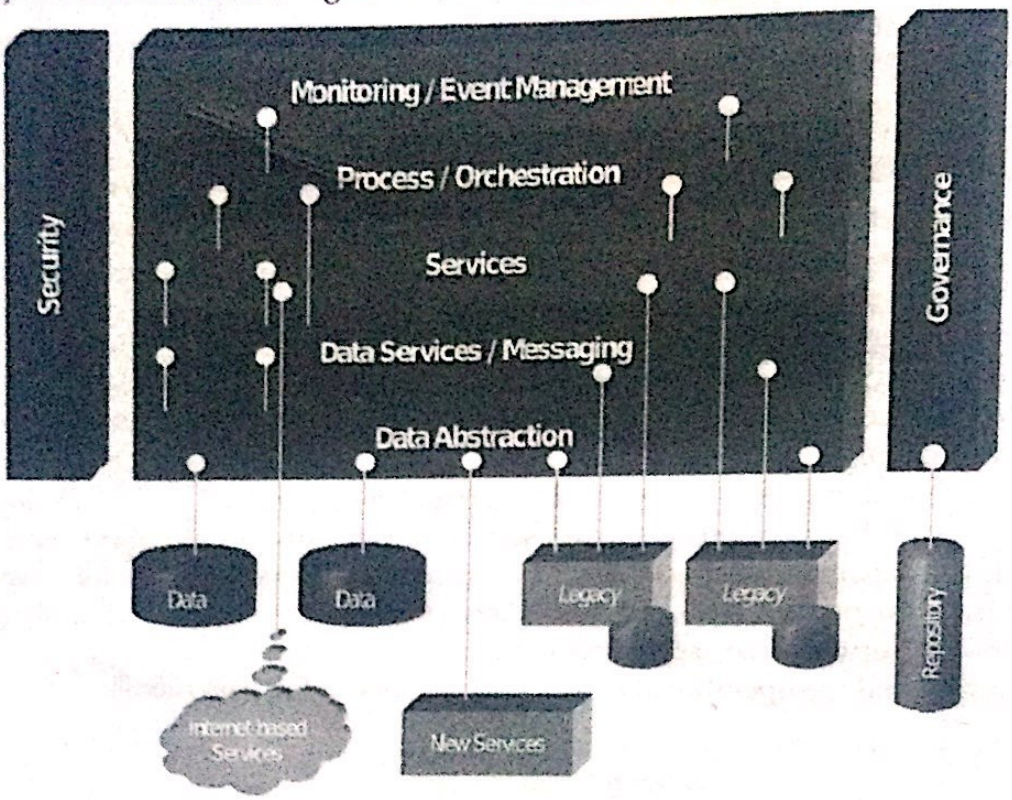

Figure 3.2 SOA meta-model (The Linthicum Group, 2007)

To submit requests to read or modify data, the services are offered using conventional network protocols such as SOAP (Simple Object Access Protocol)/HTTP or Restful HTTP (eg. JSON/HTTP). Service governance governs the development lifecycle, and at the right moment, the services are published in a registry, allowing developers to rapidly identify and reuse them to build new applications or business processes.

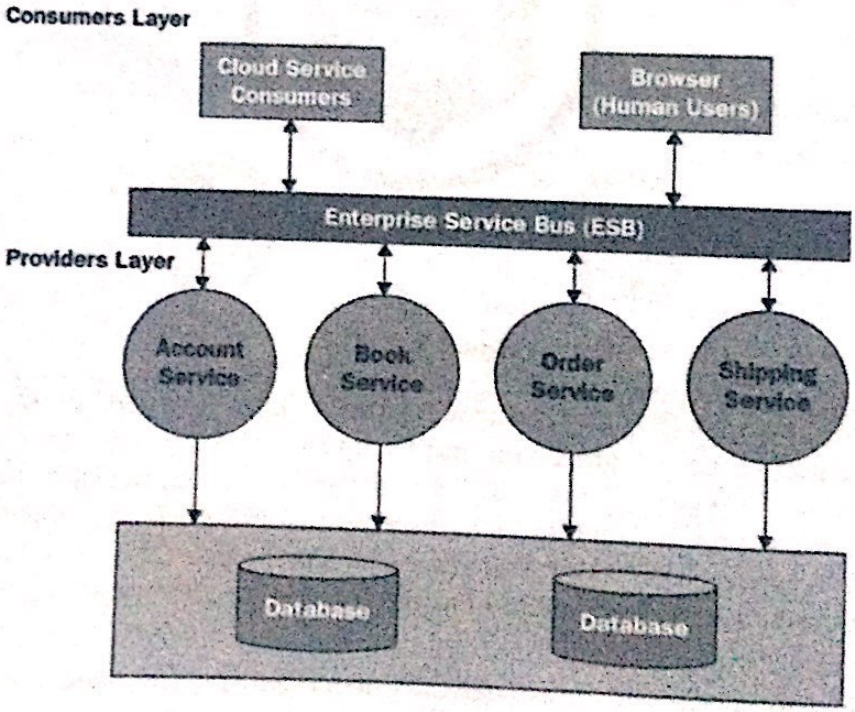

Figure 3.3: SOA in Action

Cloud service providers such as Amazon and Force.com (SalseForce.com) have moved from the traditionally poorly designed SOA service models and done an admirable job of architecting and

providing their services. Another evolutionary step away from the SOA paradigm that cloud computing has made is to construct and build services into the cloud so that they may be expanded and used as required. Extending services in SOA is often a time-consuming and costly procedure.

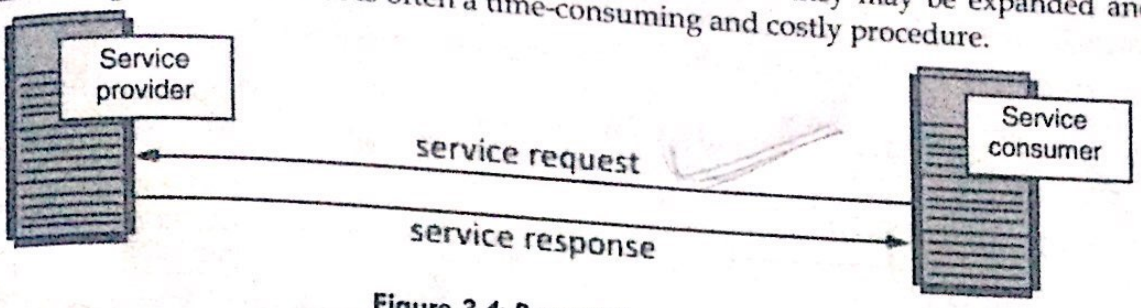

Figure 3.4: Request-Response Cycle

SOA has grown into an important component of cloud computing as a method of enabling the sharing of IT infrastructures in which vast pools of computer systems are linked together to deliver IT services. The cloud provides access to virtual resources and computational assets, including not just externally hosted services but also those offered internationally by businesses. This lays the groundwork for the next generation of business data centers, which, like the Internet, will offer high scalability and rapid access to networked users.This is why cloud computing may be utilized for a wide variety of tasks, which is a significant benefit over grid computing, which distributes IT exclusively for a certain job. It is ineffective to move information, services, and processes outside of the organization without a clear plan.

An SOA-based process, architecture, and technique are utilized to use cloud computing. SOA, as part of corporate architecture, provides a framework for utilizing cloud computing resources. In this context, SOA serves as an evolutionary step toward cloud computing by establishing the required interfaces between the organization's IT infrastructure and the cloud outside the organization. Cloud computing is effectively an extension of SOA. Services and procedures can be operated inside or outside the company, depending on the needs of the organization.By connecting the corporation to a web platform or cloud, firms may benefit from Internet-delivered resources that enable access to prebuilt processes, services, and platforms supplied as a service, when and when required, to decrease overhead expenses. SOA serves as a gateway to cloud computing. SOA as enterprise architecture is a stepping stone to cloud computing.

The defining Concepts of SOA

- The **business value** is more important than the technical strategy.
- **Strategic goals** are more important than benefits related to specific projects.
- **Intrinsic interoperability** is more important than a custom integration.
- **Shared services** are more important than implementations with a specific purpose.
- **Flexibility** is given more importance than optimization.
- **Evolutionary** refinement is given more importance than the pursuit of initial perfection.

Roles in each of the Service-Oriented Architecture building blocks

The services are specified as logical entities which are accessed by the consumers via one or more public interfaces. It is a distinct unit of functionality that can be accessed remotely, acted on, and updated separately, such as receiving a credit card statement online.A service has four properties:

- It logically represents a business activity with a specified outcome.
- It is self-contained.
- It is a black box for its consumers.
- It may consist of other underlying services.

The building blocks of service-oriented architecture are made up of 3 roles.

- Service provider.
- Service broker.
- Service requester/consumer.

The **service provider** collaborates with the service registry to discuss the 'whys' and 'hows' of the services being supplied, such as security, availability, pricing. This position also defines the service category and whether or not any trading agreements are required.

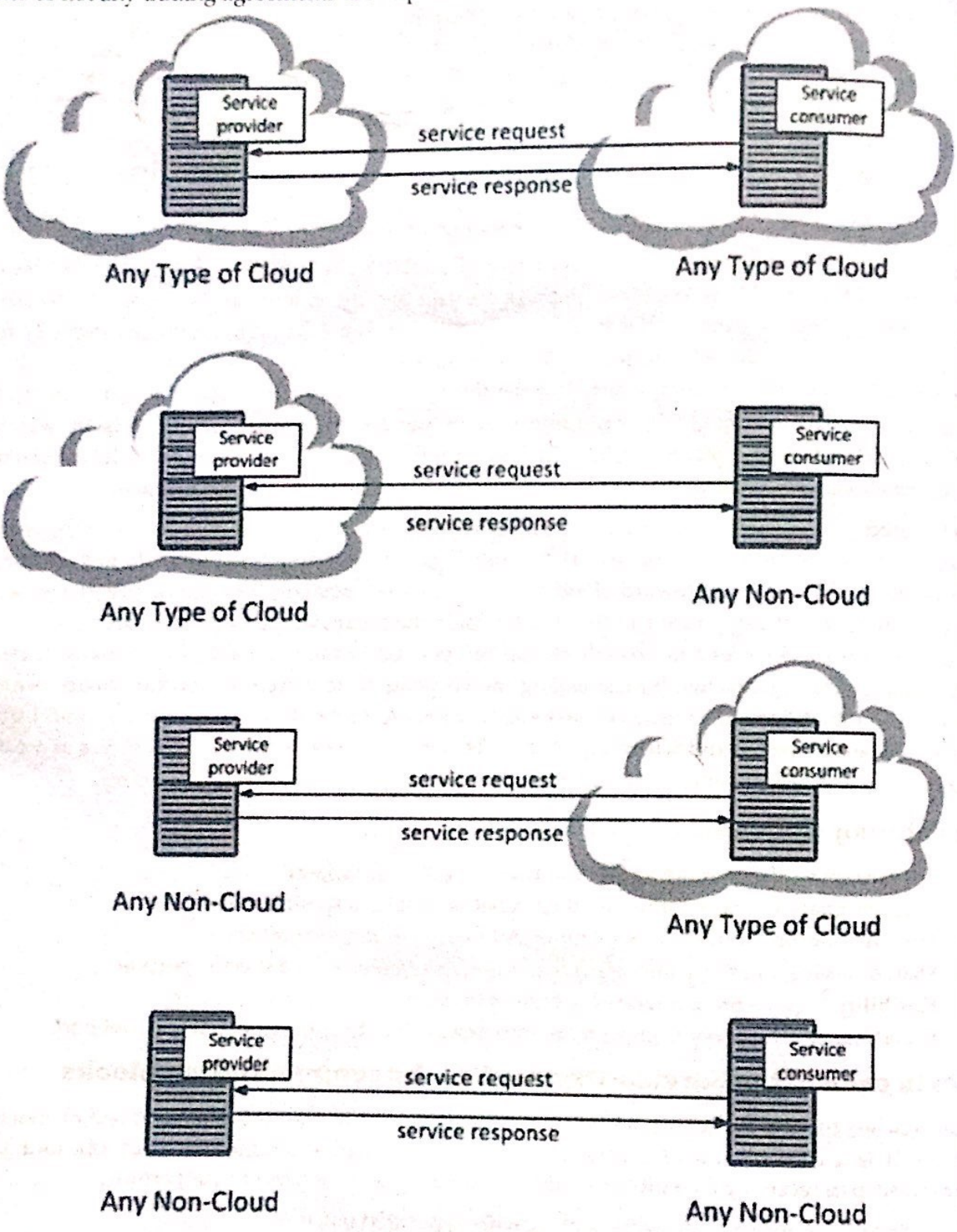

Figure 3.5: A service provider can be in the Cloud or not, and SAO can include any mix of Clouds and Non-Clouds

A **service broker** (*or service registry*) is responsible for providing information about the service to a requester. The broker's scope is determined by whoever implements it.It may be public or private.

The **service requester** searches the broker registry for entries and then ties them to the service provider. They may or may not be able to access numerous services, depending on the service requester's capabilities.

Components of SOA

We will discuss the components of SOA with functional aspects and quality of service aspects.

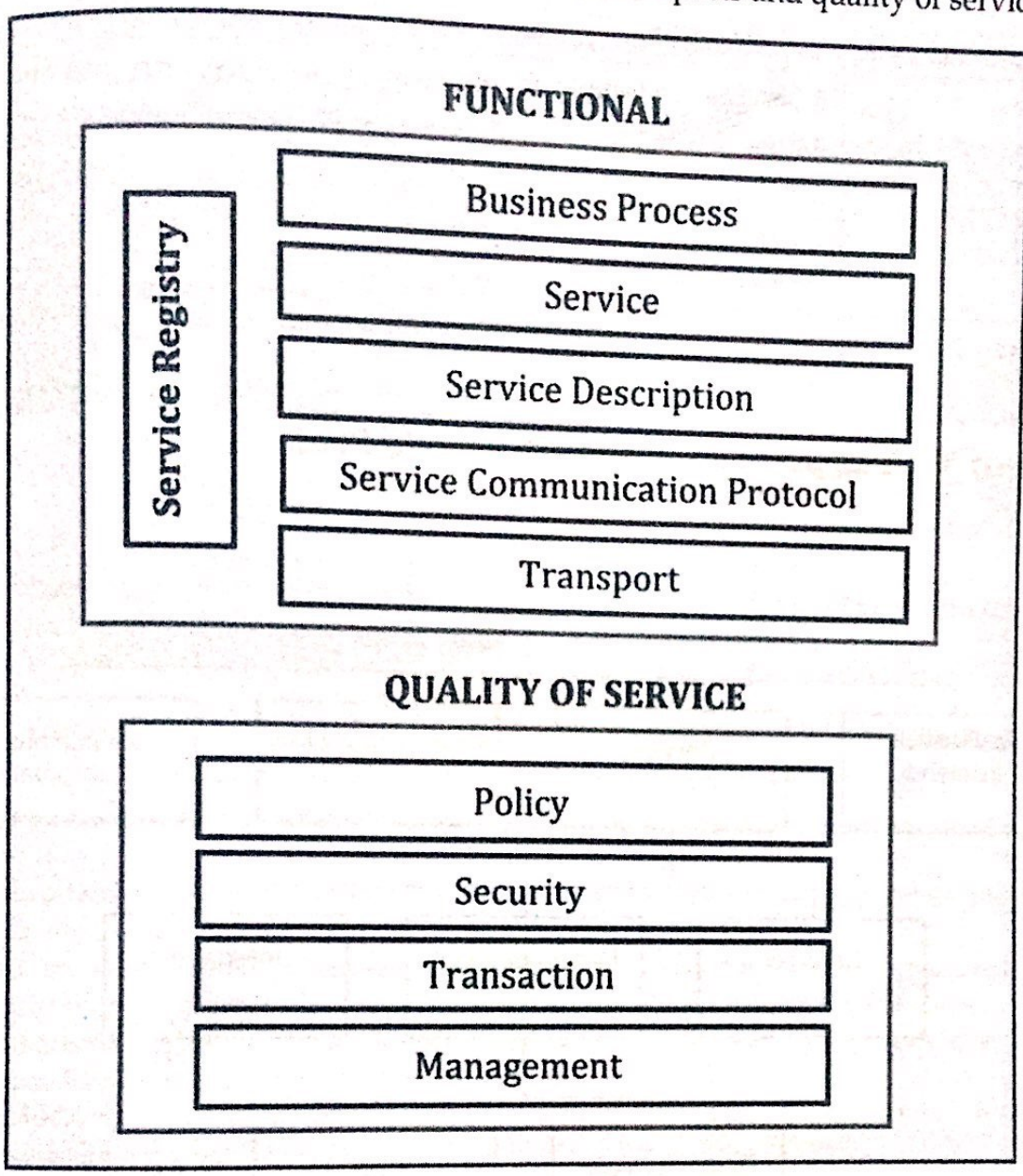

Figure 3.6: Components of SOA

Functional Aspects

Transport	It delivers service requests from service consumers to service providers and service responses from service providers to service consumers.
Service Communication Protocol	It enables the communication between the service provider and the service customer.
Service Description	It defines the service and the data needed to use it.
Service	It is a real service.
Business Process	It represents a set of services called in a certain order and connected with specific rules to satisfy the business needs.
Service Registry	It provides information on the data that service providers use to publish their services.

Quality of Service (QoS) aspects

Policy	It is the collection of protocols that a service provider uses to create and provide services to customers.
Security	It is the collection of procedures necessary for identification and permission.
Transaction	It ensures that the results are consistent. This indicates that if we utilize the set of services to fulfill a business function, we must finish all of them or none of them.
Management	It specifies the collection of attributes that will be used to administer the services.

Element of SOA as presented by *Dirk Krafzig Et al.*

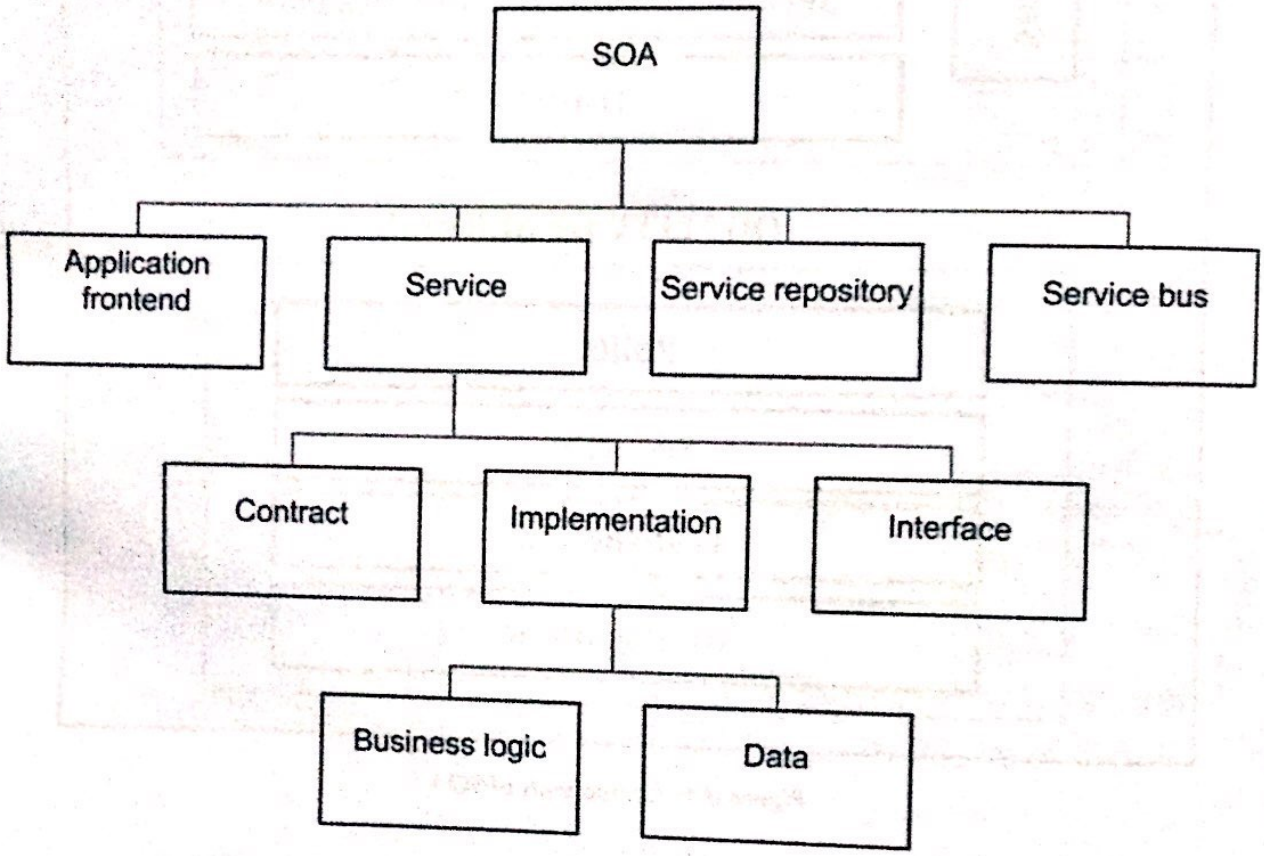

Figure 3.7: Elements of SOA

Implementing SOA

Depending on the ultimate aim, a variety of technologies can be utilized to achieve SOA. SOA is accomplished through the use of web services, which establish functional building pieces that are accessible via Internet protocols. SOAP, which stands for Simple Object Access Protocol, is a popular online service standard. SOAP is a communications protocol standard used in the deployment of web services in computer networks for transferring structured information. Jini, COBRA, and REST are some more choices for building Service-Oriented Architecture.

Details of web services are explained in Unit VIII.

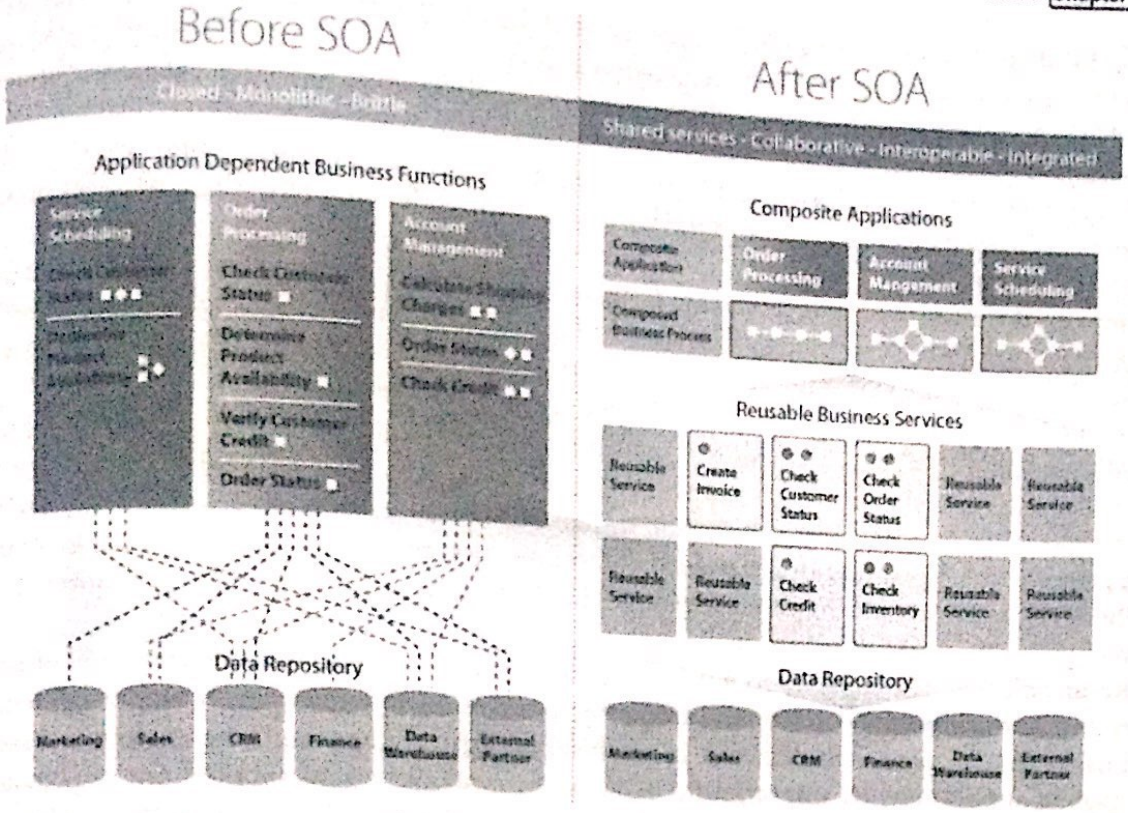

Figure 3.8: Communication of components of application before and after implementing SOA

Service-Oriented Architecture (SOA) has several core ideas that should be addressed:

- **A set of services** that a business wants to provide to its customers, partners, or other areas of an organization
- **An architectural style** that requires a service provider, mediation, and service requestor with a service description
- **A set of architectural principles, patterns, and criteria** that address characteristics such as modularity, encapsulation, loose coupling, separation of concerns, reuse, and composability
- **A programming model** complete with standards, tools, and technologies that support web services, REST services, or other kinds of services
- **A middleware solution** optimized for service assembly, orchestration, monitoring, and management

Benefits of SOA

- **Reusable code:** The opportunity to reuse code for multiple applications is the key reason for businesses to transition to SOA. Enterprises may greatly cut the time spent on development by reusing code that already exists within a service. Not only does the ability to reuse services reduce time limitations, but it also reduces expenditures that are frequently spent during application development. Because SOA allows different languages to interact through a centralized interface, application engineers do not need to be worried about the environment in which these services will be operated.
- **Increased business agility and a shorter time to market**: The efficiency of building programs from reusable modules rather than rewriting and reintegrating with each new development project allows developers to respond to new business possibilities considerably more rapidly. The service-oriented architectural approach allows for situations including application integration, data integration, and service orchestration-style automation of business processes or workflows. This accelerates software design and development by allowing developers to spend far less time integrating and far more time focused on delivering and enhancing their products.
- **Promotes interaction:** The amount of interoperability that may be obtained when SOA is correctly implemented is a significant advantage. With SOA, communication across platforms will no longer be hampered by the languages on which they are constructed. Once a common communication

protocol is in place, the platform systems and languages may stay independent of one another while still transmitting data between clients and services. The fact that SOA can negotiate firewalls adds to this degree of interoperability, guaranteeing that enterprises may exchange services that are critical to operations.

- **Encourages interoperability:** Platforms may simply communicate data between clients and services by using a common communication protocol, independent of the languages on which they are constructed.
- **Improved business-IT collaboration:** In SOA, services may be described in business terms such as 'generate insurance quotation'. This allows business analysts to collaborate more effectively with developers on critical insights such as the scope of a business process specified using services or the business consequences of altering a process to get a better outcome.
- **Allows scalability:** One challenge to consider while designing applications for web services is the capacity to scale the service to suit the demands of the customer. The dependencies necessary for apps to interface with other services limit their scalability. However, this is not the case with SOA. By implementing SOA with a standard communication protocol, enterprises can drastically reduce the level of interaction required between clients and services, allowing applications to be scaled without putting additional strain.
- **Reduced costs:** The capacity to minimize costs while maintaining a desirable level of productivity is critical to corporate success, and this principle applies to personalized service solutions as well. Businesses can reduce the amount of analysis necessary when building customized solutions for specific applications by migrating to SOA-based systems. As all services are self-contained, they can be readily adjusted and upgraded without interfering with other services. This reduces an organization's operational costs. These cost savings are made possible by the fact that loosely connected systems are simple to maintain and do not require costly development and analysis. Furthermore, the growing popularity of SOA means that reusable business functions are becoming increasingly frequent for web services, which drives down costs.

Drawbacks of SOA

- Implementation of SOA requires a large initial investment.
- Service management is complicated since the services exchange millions of messages that are hard to track.
- The input parameters of services are validated every time services interact, thus decreasing performance and increasing load and response times.

SOA AND CLOUD

To begin, it is crucial to highlight that Service-Oriented Architecture may be used with or without cloud computing. As more firms move file storage to the cloud, it makes sense to employ cloud computing and Service-Oriented Architecture together. Cloud computing enables users to quickly and easily develop services suited to their clients without needing to consult an IT staff. One disadvantage of combining SOA and Cloud is that some factors, such as security and availability, are not assessed. The integration of current data and systems into the cloud solution is a significant problem for enterprises when combining cloud computing and Service-Oriented Architecture. For the transition to be seamless, there must be continuity from beginning to end. It is also crucial to remember that not every IT function can be outsourced to the cloud.

CLOUD DESIGN AND IMPLEMENTATION USING SOA

Elasticity, self-service provisioning, standards-based interfaces, and pay-as-you-go are some of the major characteristics of the cloud. These kinds of capabilities must be built into the software. To achieve this level of engineering, the cloud's basis must be properly conceived and properly architected. Cloud services aid businesses by bringing SOA's best practices and business process emphasis to the next level. It gives advantages to both cloud service providers and cloud service customers.

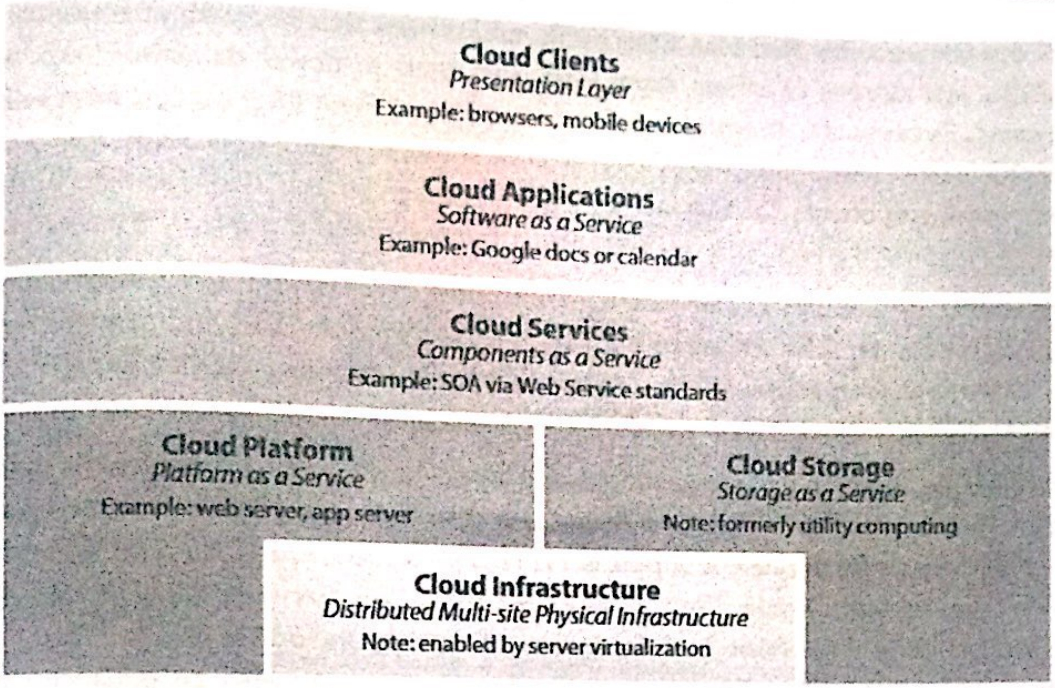

Figure 3.9: Stack of service categories

To offer services with the desired levels of flexibility and scalability, cloud service providers must develop solutions using a service-oriented approach. Businesses that build and regulate business processes using reusable service-oriented components can more quickly determine which components can be effectively migrated to public and private clouds.

Cloud computing has many services that can be viewed as a stack of service categories. These service categories include Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Storage-as-a-Service, Components-as-a-Service, Software-as-a-Service (SaaS), and Cloud Clients.

SOA is a cloud service that is an essential component of the *'Component as a service'* of the cloud service stack. SOA's structure enables business processes to be emphasized to provide interoperability and quick delivery of functionality. It facilitates system-to-system integration by generating loosely connected services that may be utilized for a variety of applications. SOA is related to Object-Oriented Programming in that objects are standardized to allow them to be reused for numerous purposes.

The cloud's services and structure should be built using a modular architecture approach. Component-based, modular architecture allows for flexibility and reuse. This flexibility is supported by SOA. SOA is more than just a technology strategy and technique for developing IT systems. It is also a corporate strategy and technique. Companies have embraced SOA concepts to improve understanding between business and IT and to assist businesses in adapting to change.

This method enables businesses to utilize current assets to build new business services that are consistent, controllable, changeable, and manageable. SOA is a commercial approach to developing efficient IT systems that encourage reuse and allow firms to respond rapidly to opportunities and challenges.

OPEN-SOURCE SOFTWARE IN DATA CENTERS

The Open-Source Definition is used by the Open-Source Initiative to verify if a software license is a genuinely open source. The phrase "open source" refers to a form of software licensing that makes source code available to the public without imposing significant copyright limitations. The defined standards make no mention of trademark or patent usage, and no collaboration is required to guarantee that any shared audit or release system applies to any derivative products. It is regarded as an explicit "feature" of open source that has no limits on usage or distribution by any organization or person. It restricts this in principle to ensure continuous access to derivative works, even for the significant original creators. Over the last decade, there has always been a desire for software that is free, dependable, and adaptable to individual demands.

Open-source distributions like Red Hat, OpenSuSE, and others, together with open-source software like Apache, MySQL, and dozens of others, have long been used to power databases, web, email, and file servers. However, because the programs utilized in a data center have such a large influence, many implementers have been hesitant to deploy open-source software—until now. More than a few users have recently been vocal proponents for the fact that open source can and does function in the data center environment.

An Enterprise Service Bus (ESB) is a software architecture that is often implemented using middleware infrastructure technologies. ESBs are often built on well-known standards and provide core services for complicated systems via an event-driven, standards-based messaging engine (called the bus since it transforms and transports the messages across the architecture).

Apache Synapse, a lightweight and easy-to-use open-source ESB, provides a wide variety of administration, routing, and transformation features. It is considered quite versatile and can be used in a wide range of environments because it supports HTTP, SOAP, SMTP, FTP, and file system transports. It supports Web Services Addressing, Web Services Security, Web Services Reliable Messaging, efficient binary attachments, and important transformation standards including XSLT, XPath, and XQuery. Synapse has a lot of useful functions out of the box, but it may also be enhanced with common programming languages such as Java, JavaScript, and Ruby.

Another example is the Open ESB project, which offers an enterprise service bus runtime along with sample service engines and binding components. With Open ESB, corporate applications and web services may be easily integrated as loosely connected composite applications. This enables a company to construct and recompose composite applications in real-time, reaping the benefits of a genuine service-oriented design. Today, most open-source users feel that these products have attained a degree of maturity comparable to, and in some cases superior to, their commercial equivalents. Open-source goods have pushed commercial suppliers to compete on pricing and service quality. Because open-source code is accessible and visible, developers may troubleshoot difficulties and learn how other developers have dealt with challenges. Users can utilize these solutions throughout their businesses and around the globe without having to track client licensing.

OPEN-SOURCE SOFTWARE IN DATA CENTERS

- **Web**
  - Apache, Jetty, Laminas Project (formerly Zend Framework), etc.
- **Database**
  - MySQL, PostgreSQL, MariaDB, MongoDB, SQLite, CouchDB etc.
- **Application**
  - Zope, Plone, Apache Struts, etc.
- **Systems and Network Management**
  - OpenQRM, Zenoss, Linux Virtual Server Load Balancer, DNS-based role management clusters, Dispatcher-Based Load Balancing Clusters, etc.
- **Virtualization**
  - Xen Server, VirtualBox, PROXMOX, LINUX-KVM, oVirt, Client Hyper-V, etc.

Objective Questions

1. **Which of the following describes a message-passing taxonomy for a component-based architecture that provides services to clients upon demand?**

a. SOA b. EBS c. GEC d. All of the mentioned

2. **Point out the correct statement.**

a. Service-Oriented Architecture (SOA) describes a standard method for requesting services from distributed components and managing the results
b. SOA provides the translation and management layer in an architecture that removes the barrier for a client obtaining desired services
c. With SOA, clients and components can be written in different languages and can use multiple messaging protocols
d. All of the mentioned

3. **Which of the following is a repeatable task within a business process?**

a. service b. bus c. methods d. all of the mentioned

4. **Point out the correct statement.**

a. Some mature SOA implementations favor orchestration over choreography
b. Most mature SOA implementations favor choreography over orchestration
c. With orchestration, multiple services manage the various processes
d. None of the mentioned

5. **Point out the wrong statement.**

a. SOA provides the standards that transport the messages and makes the infrastructure to support them possible
b. SOA provides access to reusable Web services over an SMTP network
c. SOA offers access to ready-made, modular, highly optimized, and widely shareable components that can minimize developer and infrastructure costs
d. None of the mentioned

6. **Which of the following is used to define the service component that performs the service?**

a. WSDL b. SCDL c. XML d. None of the mentioned

7. **Which of the following is commonly used to describe the service interface, how to bind information, and the nature of the component's service or endpoint?**

a. WSDL b. SCDL c. XML d. None of the mentioned

8. **Which of the following provides commands for defining logic using conditional statements?**

a. XML b. WS-BPEL c. JSON d. None of the mentioned

9. **Which of the following element is used by an orchestrated business process commonly referred to as?**

a. conductor b. coordinator c. orchestrator d. all of the mentioned

10. **A repository for the storage, management, and dissemination of data in which the mechanical, lighting, electrical, and computer systems are designed for maximum energy efficiency and minimum environmental impact.**

a. Storage lab b. Data Center c. Data warehouse d. Fabric

11. **The process of assigning storage, usually in the form of server disk drive space, to optimize the performance of a storage area network.**

a. Storage Provisioning b. Data mining
c. Storage assignment d. Data Warehousing

12. **Simply stated, these are large boxes that hold lots of hard disks.**

a. Host b. Tape library c. Switch d. Disk Array

13. **This consists of the precautions taken so that the effects of a disaster will be minimized.**
    a. Data retrieval b. Disaster recovery c. Archive d. Replication

14. **The practice of collecting computer files that have been packaged together for backup, to transport to so other location, for saving away from the computer so that more hard disks can be made available, or some other purpose.**
    a. Backup b. Archive c. Migration d. Compression

15. **Method of reducing storage needs by eliminating redundant data**
    a. Data snapshot b. Data De-duplication c. Data compression d. Data encryption

16. **This is the pooling of physical storage from multiple network storage devices into what appears to be single storage device that is managed from a central console.**
    a. Server Provisioning b. Data mining
    c. Disk/Tape virtualization d. None of the mentioned

17. **Assignment of different categories of data to different types of storage media to reduce total storage cos Categories may be based on levels of protection needed, performance requirements, frequency of use, an other considerations.**
    a. Data mining b. Tiered storage
    c. Data protection d. Meta-Data management

18. **Activity of copying files or databases so that they will be preserved in case of equipment failure or othe catastrophes.**
    a. Snapshot b. Replication c. Archival d. Backup

19. **A firm that maintains a customer's IT infrastructure and/or end-user systems remotely, often on a proactive and subscription basis**
    a. SLA b. MSP c. SOA d. GIDC

20. **With an all-inclusive pricing model, the MSP:**
    a. Charges a fixed rate for all IT infrastructure b. Charges a fixed rate for each user
    c. Charges as per the use d. None of the above

21. **Which of the following is the component of data center infrastructure**
    a. HVAC b. Biometric Access Control and CCTV
    c. Water Leakage and Fire Sensing d. All of the above

QUESTION

1. What is the relationship between SOA and cloud architecture?
2. What is a data center? Describe data center virtualization. Explain the difference between cloud and traditional data centers.
3. What are Managed Service Providers? How do they manage single-purpose architectures and multipurpose architectures? Explain.
4. Explain and differentiate single-purpose architectures and multi-purpose architectures.
5. What are MSPs? Explain the challenges of MSPs.
6. What is Service-Oriented Architecture (SOA)? Explain data center and its features along with Open-Source Software in data centers.
7. What is a data center? List and explain the features of GIDC, Nepal.
8. List and describe open-source software used in the data center.
9. Explain the components of SOA from various aspects.

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