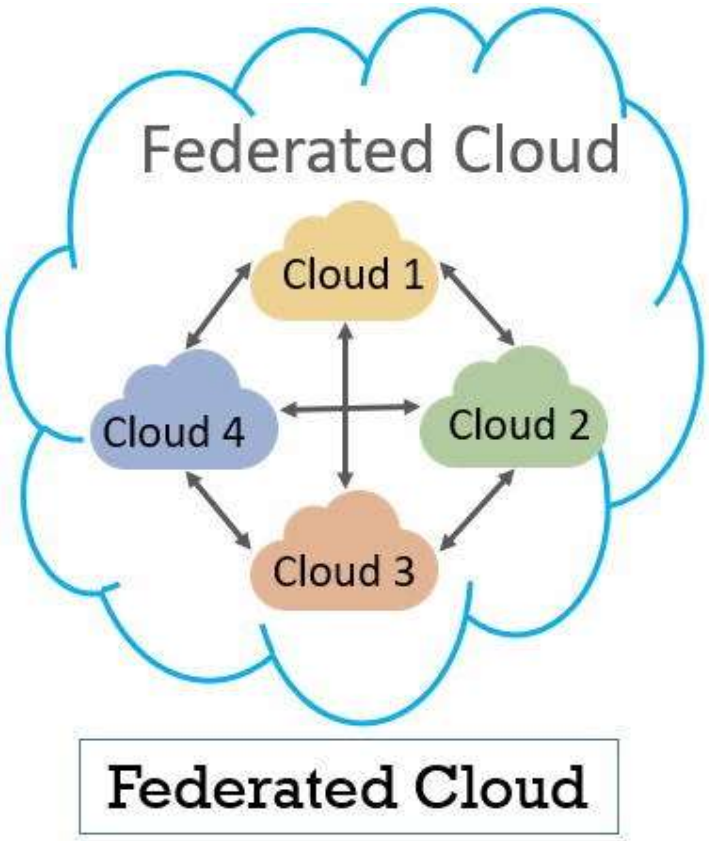
# Federated Cloud

Federated cloud is a seamless environment formed by connecting the cloud environment of two or more cloud service provider using a common standard. Federated cloud integrates heterogeneous cloud environment such as community cloud, public cloud, and private cloud in order to scale up the resources and services for the users.

## What is the Federation in Cloud?

Cloud computing offers computing resources such as servers, databases, storage, networking, runtime environment, virtualization, & software to its customer on their demand over the internet. Customers consume these cloud services with pay as you go pricing model.




Now the term **federation** is associated with the cloud. Federation means associating small divisions to a single group for performing a common task. **Federated cloud** is formed by connecting the cloud environment of several cloud providers using a common standard. This federation in the

cloud helps the provider to easily scale up the resource to match business needs.

## Federated Cloud Architecture

The architecture has three basic components discussed below:

**1. Cloud Exchange**
The Cloud Exchange act as a moderator between cloud coordinator and cloud broker. The cloud exchange maps the demands of the cloud broker to the available services offered by the coordinator. The cloud exchange has the track record of what is the current cost, demand patterns and available cloud providers and this information is periodically updated by the cloud coordinator.

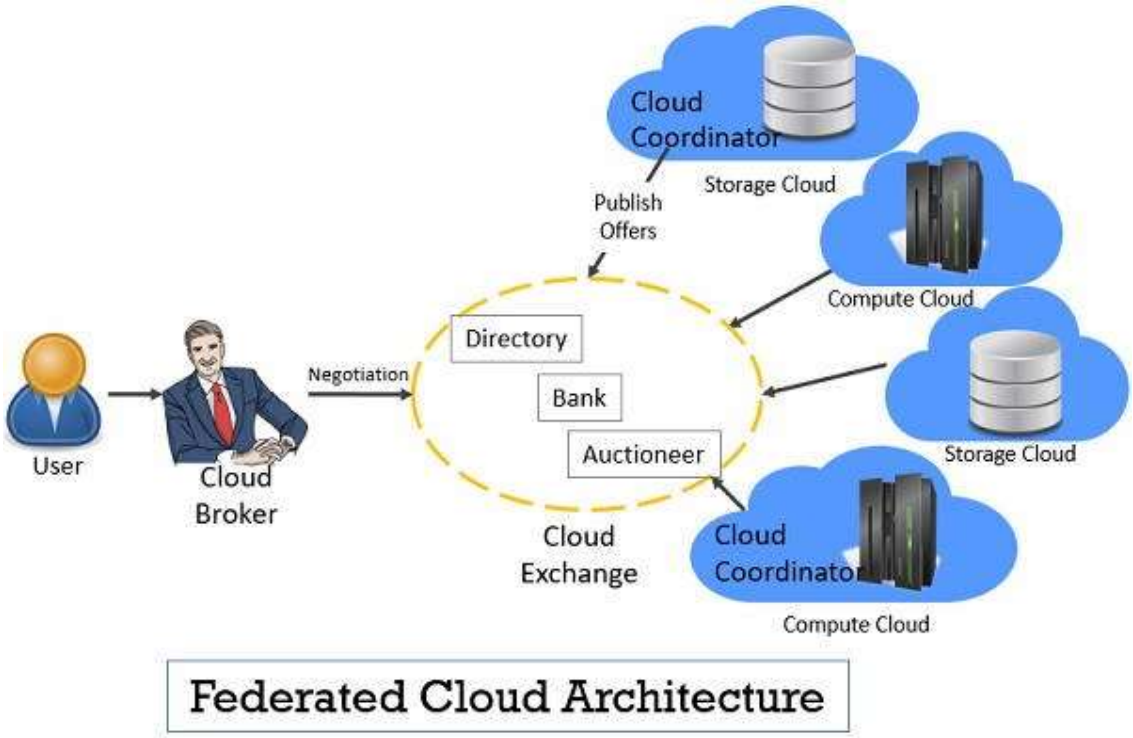
The cloud brokers interact with cloud exchange to gain information about the existing SLA policies, availability of resources offered by the cloud providers.
Following are the services offered by cloud exchange to both cloud broker and cloud coordinator.

- **Database Repository:** Cloud exchange act as a database repository or **directory** where cloud broker announces their resources, service and the price they offer for the services. The customer then analyze this repository to search the most appropriate service and price suiting them and place a request for the service
- **Dealer:** The cloud exchanger always updates policies of its participants, they always act as a third party between broker and coordinator.
- **Bank:** Cloud exchanger facilitates the financial transaction between cloud vendors and its clients thus maintaining the trust.

**2. Cloud Coordinator**
The cloud controller manages the cloud enterprises and their membership. The cloud coordinator allocates the cloud resources to the remote users based on the quality of service they demand and the credits they have in the cloud bank. Based on the policies of SLA the marketing and pricing policies are developed by the cloud coordinator.

**3. Cloud Broker**
On behalf of the customer, it is the cloud broker who interacts with the cloud coordinator, analyzes the SLA agreement, resources offered by

different cloud providers in cloud exchange. Cloud broker finalized the most appropriate deal for their client.




Federated Cloud Architecture

## Cloud Federation Properties

Cloud federation properties can be classified into two categories i.e. **functional cloud federation** properties and **usage cloud federation** properties.

### *Functional Cloud Federation Properties*

**1. Authentication:** Cloud federation has the involvement of several foreign resources that have participated in the federation. To consume these foreign resource customer must be provided with the access credential relevant to the target foreign resource. However, the respective foreign resource must also have authentication information of the customer.

**2. Integrity:** Integrity in the federated cloud offers and demand consistent resources by the providers participated in the federation. If the federated cloud environment lacks in providing the resources its purpose becomes questionable.

To maintain the consistency of the environment management is needed by the providers they can even designate a federation administrative board or the provider can automate the process which will trigger the administrative action when any irregularity is detected.

**3. Monitoring:** Federated cloud can be monitored in two ways global monitoring and monitoring as a service (MaaS). **Global monitoring** aids in maintaining the federated cloud. **MaaS** provides information that helps in tracking contracted services to the customer.

**4. Object:** Marketing object in cloud computing are infrastructure, software, platform that are offered to the customer as a service. These objects have to pass through federation when consumed in the federated cloud.

**5. Contracts:** In cloud computing, the agreement between provider and consumer i.e. service level agreement (SLA) has both technical as well as administrative commitments between provider and consumer. In addition to SLA federated cloud has a **federation level agreement** that encloses commitment to the functional and usage properties.

**6. Provisioning:** Allocating services and resources offered by the cloud provider to the customer through federation. It can be done manually or automatically. In an **automatic** way, the best provider is chosen to allocate the resources and services to the customer. In the **manual** way entity in the federation selects the provider to allocate the resources and services.

**7. Service Management:** Service management discovers and publishes the services offered by the federated cloud.

**8. Interoperability:** Interoperability is a mechanism with which the customer's system is able to interact with the cloud service or cloud service in the federation is able to interact with other cloud services.

**9. Commercialization:** The providers participated in federation publish their offers to a central entity. The customer interacts with this central entity to verify the prices and propose an offer.

*Usage Cloud Federation Properties*

**1. Interaction Architecture:** In the federated cloud, the customers can interact with the architecture either centrally or in a decentralized manner. In centralized interaction, the customer has interacted with a broker to

mediate between them and the organization. Decentralized interaction allows the customer to interact directly with the clouds in the federation.

**2. Expansion:** Expansion of federation depend on how the resources and services in the federation are used.

**3. Centric:** The federated cloud focuses on the implementation and usability of elements in the federated cloud architecture. The four centrics of the federated cloud are customer, business, provider, service. The federated cloud architecture and mechanism are designed prioritizing the customer. Business-centric focuses on the monetization. Provider centric focuses on maximizing the use of resources and services. Service centric focus on the services and their specialities.

**4. Practice Niche:** Federated cloud can be practised with different niches like commercial and non-commercial.

**5. Volunteer:** The providers must voluntarily involve in the federation and must be able to take the decision to leave the federation when they require.

**6. Visibility:** Visibility of a federated cloud helps the customer to interpret the organization of multiple clouds in the federated environment.

## Types of Federation in Cloud

Federation in the cloud is an ability to connect two or more cloud computing environment of distinct cloud service providers. The federation can be classified into four types.

- **Permissive federation**
  Permissive federation allows the interconnection of the cloud environment of two service providers without the verifying identity of peer cloud using DNS lookups. This raises the chances of domain spoofing.

- **Verified Federation**
  Verified federation allows interconnection of the cloud environment, two service providers, only after the peer cloud is identified using the information obtained from DNS. Though the identity verification prevents spoofing the connection is still not encrypted and there are chances of DNS attack.
- **Encrypted Federation**
  Encrypted federation allows interconnection of the cloud

environment of two services provider only if the peer cloud **supports** transport layer security (**TSL**). The peer cloud interested in the federation must provide the **digital certificate** which still provides **mutual authentication**. Thus encrypted federation results in **weak** identity verification.

- **Trusted Federation**
  Trusted federation allows two clouds from different provider to connect only under a **provision** that the peer cloud support **TSL** along with that it provides a **digital certificate** authorized by the **certification authority** (CA) that is trusted by the authenticating cloud.

## Advantages of Federated Cloud

1. Federated cloud allows scaling up of resources.
2. Federated cloud increases reliability.
3. Federated cloud has increased collaboration of cloud resources.
4. Connects multiple cloud service provider globally to let providers buy and sell their services on demand.
5. Dynamic scalability reduces the cost and time of providers.

## Key Takeaways

- Federated cloud is interconnected cloud environment of multiple cloud service provider.
- Federation of cloud can be done in permissive, verified, encrypted or trusted way.
- The federated cloud architecture has a cloud broker, cloud exchange and cloud coordinator as three basic components.

The federation in the cloud comes with a challenge as the cloud environment participating in the federation are **heterogeneous.** Along with that building, a federated cloud means building a seamless cloud environment which can interact with people, various devices, different application interfaces and other entities.

# Service level agreements in Cloud computing

A **Service Level Agreement (SLA)** is the bond for performance negotiated between the cloud services provider and the client. Earlier, in cloud computing all Service Level Agreements were negotiated between a client and the service consumer. Nowadays, with the initiation of large utility-like cloud computing providers, most Service Level Agreements are standardized until a client becomes a large consumer of cloud services. Service level agreements are also defined at **different levels** which are mentioned below:

- Customer-based SLA
- Service-based SLA
- Multilevel SLA

Few Service Level Agreements are enforceable as contracts, but mostly are agreements or contracts which are more along the lines of an Operating Level Agreement (OLA) and may not have the restriction of law. It is fine to have an attorney review the documents before making a major agreement to the cloud service provider. Service Level Agreements usually specify **some parameters** which are mentioned below:

1. Availability of the Service (uptime)
2. Latency or the response time
3. Service components reliability
4. Each party accountability
5. Warranties

In any case, if a cloud service provider fails to meet the stated targets of minimums then the provider has to pay the penalty to the cloud service consumer as per the agreement. So, Service Level Agreements are like insurance policies in which the corporation has to pay as per the agreements if any casualty occurs. Microsoft publishes the Service Level

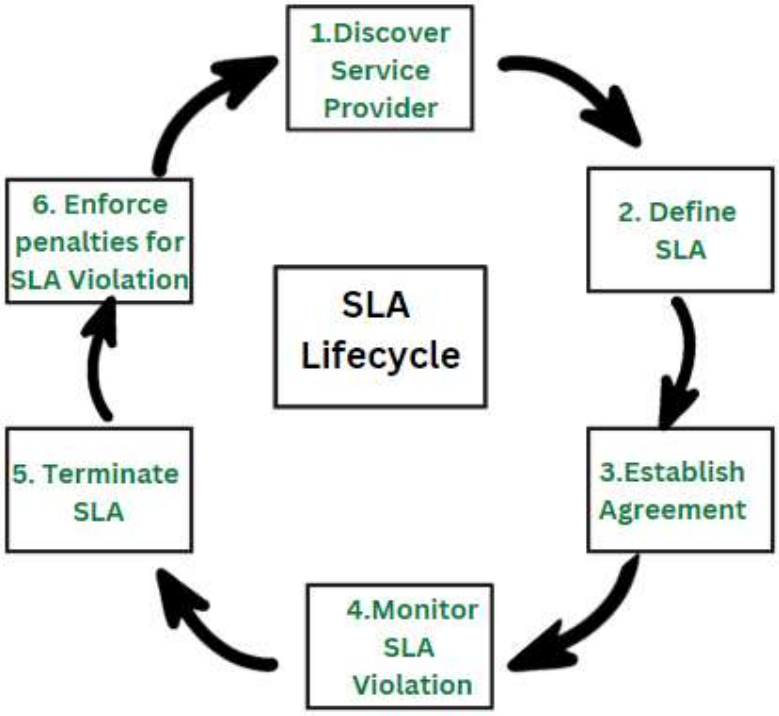
Agreements linked with the Windows Azure Platform components, which is demonstrative of industry practice for cloud service vendors. Each individual component has its own Service Level Agreements. Below are two **major Service Level Agreements (SLA)** described:

1. **Windows Azure SLA –** Window Azure has different SLA's for compute and storage. For compute, there is a guarantee that when a client deploys two or more role instances in separate fault and upgrade domains, client's internet facing roles will have external connectivity minimum 99.95% of the time. Moreover, all of the role instances of the client are monitored and there is guarantee of detection 99.9% of the time when a role instance's process is not runs and initiates properly.

2. **SQL Azure SLA** – SQL Azure clients will have connectivity between the database and internet gateway of SQL Azure. SQL Azure will handle a "Monthly Availability" of 99.9% within a month. Monthly Availability Proportion for a particular tenant database is the ratio of the time the database was available to customers to the total time in a month. Time is measured in some intervals of minutes in a 30-day monthly cycle. Availability is always remunerated for a complete month. A portion of time is marked as unavailable if the customer's attempts to connect to a database are denied by the SQL Azure gateway.

Service Level Agreements are based on the usage model. Frequently, cloud providers charge their pay-as-per-use resources at a premium and deploy standards Service Level Agreements only for that purpose. Clients can also subscribe at different levels that guarantees access to a particular amount of purchased resources. The Service Level Agreements (SLAs) attached to a subscription many times offer various terms and conditions. If client requires access to a particular level of resources, then the client need to subscribe to a service. A usage model may not deliver that level of access under peak load condition.

## SLA LIFE CYCLE




## Steps in SLA Lifecycle

1. **Discover service provider:** This step involves identifying a service provider that can meet the needs of the organization and has the capability to provide the required service. This can be done through research, requesting proposals, or reaching out to vendors.
2. **Define SLA:** In this step, the service level requirements are defined and agreed upon between the service provider and the organization. This includes defining the service level objectives, metrics, and targets that will be used to measure the performance of the service provider.
3. **Establish Agreement:** After the service level requirements have been defined, an agreement is established between the organization and the service provider outlining the terms and conditions of the service. This agreement should include the SLA, any penalties for non-compliance, and the process for monitoring and reporting on the service level objectives.

4. **Monitor SLA violation:** This step involves regularly monitoring the service level objectives to ensure that the service provider is meeting their commitments. If any violations are identified, they should be reported and addressed in a timely manner.
5. **Terminate SLA:** If the service provider is unable to meet the service level objectives, or if the organization is not satisfied with the service provided, the SLA can be terminated. This can be done through mutual agreement or through the enforcement of penalties for non-compliance.
6. **Enforce penalties for SLA Violation:** If the service provider is found to be in violation of the SLA, penalties can be imposed as outlined in the agreement. These penalties can include financial penalties, reduced service level objectives, or termination of the agreement.

## Advantages of SLA

1. **Improved communication:** A better framework for communication between the service provider and the client is established through SLAs, which explicitly outline the degree of service that a customer may anticipate. This can make sure that everyone is talking about the same things when it comes to service expectations.
2. **Increased accountability:** SLAs give customers a way to hold service providers accountable if their services fall short of the agreed-upon standard. They also hold service providers responsible for delivering a specific level of service.
3. **Better alignment with business goals:** SLAs make sure that the service being given is in line with the goals of the client by laying down the performance goals and service level requirements that the service provider must satisfy.
4. **Reduced downtime:** SLAs can help to limit the effects of service disruptions by creating explicit protocols for issue management and resolution.

5. **Better cost management:** By specifying the level of service that the customer can anticipate and providing a way to track and evaluate performance, SLAs can help to limit costs. Making sure the consumer is getting the best value for their money can be made easier by doing this.

## Disadvantages of SLA

1. **Complexity:** SLAs can be complex to create and maintain, and may require significant resources to implement and enforce.
2. **Rigidity:** SLAs can be rigid and may not be flexible enough to accommodate changing business needs or service requirements.
3. **Limited service options:** SLAs can limit the service options available to the customer, as the service provider may only be able to offer the specific services outlined in the agreement.
4. **Misaligned incentives:** SLAs may misalign incentives between the service provider and the customer, as the provider may focus on meeting the agreed-upon service levels rather than on providing the best service possible.
5. **Limited liability:** SLAs are not legal binding contracts and often limited the liability of the service provider in case of service failure.