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MICROSERVICES IN CLOUD NATIVE DEVELOPMENT OF APPLICATION

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***Abstract*:** The development of new technologies and architectures has increased the scope of evolving already existing applications for many organizations. Users on multiple platforms are looking for experiences that are rich, dynamic, and participatory. Applications that are highly available, scalable, and simple to use on cloud platforms are able to meet these demands. The majority of businesses desire to routinely, if not daily, update their applications. Prior to the development of microservice architecture, there was an architectural style named monolithic. In a nutshell, in this architecture, the entire application was constructed as a single unit, meaning that all of the components were tightly coupled and interdependent. The monolithic architecture is unstable due to slow development, unsuitability for large and complicated applications, unscalable, blockage of continuous development, unreliability, and inflexibility. In this paper, we describe the microservices architecture, which can help to meet the aforementioned requirements. Applications using this new architecture have a number of services that can be developed and deployed separately. These services concentrate on a small subset of applications. Microservices give applications flexibility and scalability. The fourth industrial revolution (I4.0), which is centred on product development and production scenarios and calls for quick adaptability to consumer needs with little work and little company disruption, includes the concept of plug and produce. Automation solutions that are adaptable and nimble are needed to do this. Industrial automation systems may have the chance to benefit from increased flexibility and agility thanks to the microservices architecture.

***Keywords*: Microservices, Messaging, Cloud, Deployment**

I. INTRODUCTION:

Microservices are a type of architectural style in which the process of developing software is carried out by using autonomous components that isolate fine-grained business activities and connect with one another through standardised interfaces. Microservice architecture is composed of several independent services being developed individually with them being interdependent and deployed independently. These services communicate with each other through a centralized service and each of these services can be deployed independently. Each microservice container focuses on a specific market's characteristics, indicating that they are of higher quality and dependability and have greater reusability, flexibility, and scalability.

Microservice architecture is described as "the smallest independent process that communicates over a messaging and microservice architecture as a shared application wherever all of its modules are microservices". The benefits of this pattern are widely acknowledged to include increased coordination, maintainability, software flexibility, deployment ease, increased developer productivity, scalability, dependability, and concern separation.

A lightweight container system, like Docker, is used to coordinate autonomous components that are separated from one another into a distributed architecture. DevOps, an agile approach that shortens the time between implementing a change in a system and moving it to the production environment, is typically adopted together with this architectural paradigm.

Microservices architecture is recognised as an appropriate design pattern for many applications, such as the first, the deployment of services on cloud computing infrastructures, since it would benefit from the flexibility and on-demand features of the cloud computing paradigm. Many Organizations prefer Microservice Architecture (For eg: Netflix, Uber, Amazon, eBay, Sound cloud, etc.) due to the benefits it provides.

There are a few factors that make the microservice architecture desirable.

1.Continuous Delivery

2.Deployment Velocity

3.Cost Reduction

4.Fault Tolerance

5.Adaptable

A rapidly expanding architectural pattern for the creation of real-time applications in industrial automation is microservice architecture. This architecture is a more reliable, flexible, adaptive, and cost-effective way to create various applications that serve to enhance the functionality and dependability of the customers' business requirements.

Microservice architecture is mostly utilised in applications related to cloud computing, the internet of things, real-time systems, automation, and DevOps. Due to the growth of IoT, monolithic designs have become more intricate, making them less maintainable and scalable.

Despite all these benefits, there are still some problems and difficulties, such as building services across the network, security and safety problems, and problems with data sharing, communication, optimization, and production. Even said, when correctly handled, certain challenges offer practise to reap the majority of the aforementioned advantages. The benefits of this pattern are widely acknowledged to include increased coordination, maintainability, software flexibility, deployment ease, increased developer productivity, scalability, dependability, and concern separation. Despite all these benefits, there are still some problems and difficulties, such as building services across the network, security and safety problems, and problems with data sharing, communication, optimization, and production. Even said, when correctly handled, certain challenges offer practise to reap the majority of the aforementioned advantages.

Also, role of ML and ESPs [13-69] are becoming important in recent applications, data recognition and control.

The below is the representation of Monolithic Architecture: We can see that, it has all the functionalities as one unit thus if one fails the whole application is bound to fail, making it less efficient and giving microservices an advantage over same.

II. BLOCK DIAGRAM:

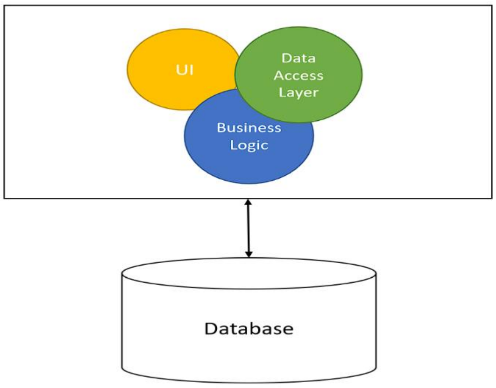

Fig. 1. Typical Monolithic Architecture

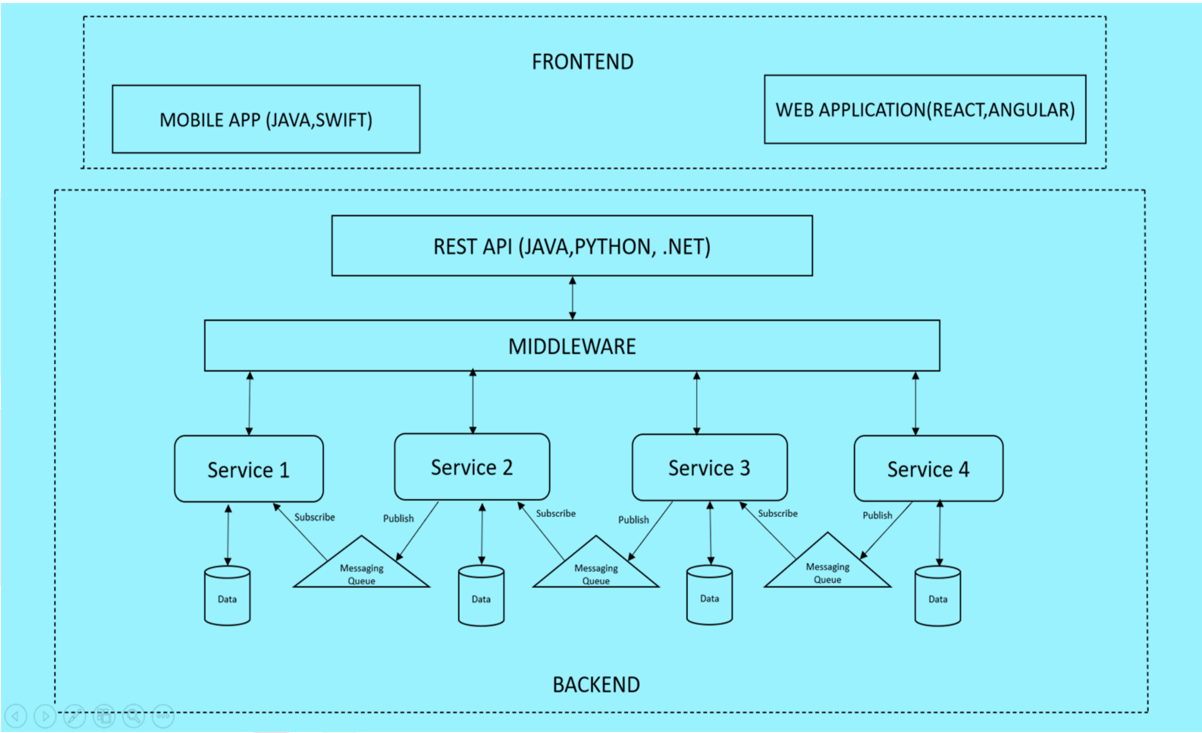

Fig. 2. Microservice Architecture

For any Microservice Architecture there are 3 basic layers for Backend:

1. Controller (Rest API)
2. Service Layer
3. Repository

And a layer or two for Frontend which includes the UI.

UI is the part of the application that is user friendly and helps the user to access the various services provided by the application.

The flow for 1 service goes in a way that:

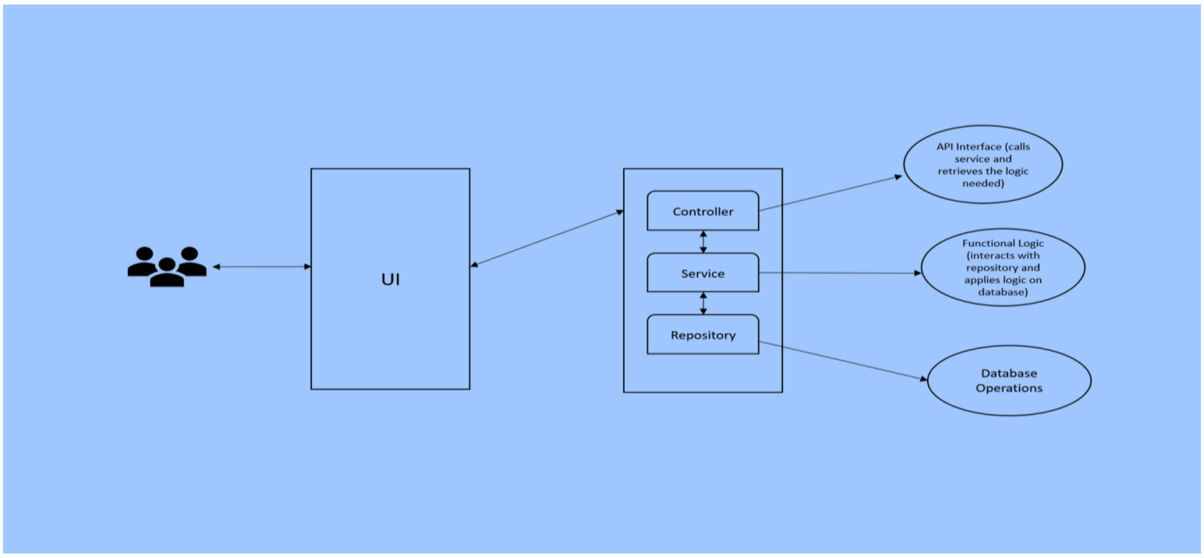

Fig. 3. Flow of a single microservice

The user Interacts with the UI layer, demands for some information or a specific task, followed by which the UI sends information to the controller (i.e., API), the API (Application Programming Interface) calls for the respective service logic associated with the particular API, which in turn interacts with the database layer also known as the repository and performs certain database operation for the same. This explains the basic flow for any app rendered using an UI. For a UI as a mobile application the interactive screen is the mobile device.

III. MESSAGING QUEUE:

Microservices and domain-driven design (DDD) operate together in a symbiotic way. DDD is a design methodology where the business domain is carefully described in software and developed over time, separate from the underlying plumbing that keeps the system running. With the use of Apache Kafka, it is observed that this trend occurring more frequently in the field.

When it comes to event-driven microservice design, Apache Kafka® is by far the most widely used solution, whether it is used with the more robust feature-set offered by Confluent or is self-managed as an open-source tool. Traditional databases, big data architecture, and traditional messaging systems are all combined in Kafka, and Confluent builds on this with an online platform that has superior scalability, limitless storage, and event streaming capabilities including data lineage, schemas, and improved security.

While passing a scalable data from one service to another it is important to acknowledge the data at every step to ensure the successful flow of data, this process is often termed as logging of data. There is a large amount of "log" data generated at any sizable internet company. Log data has long been a component of analytics used to track user engagement (includes the user activity events), system utilization, and other metrics. However recent trends in internet applications have made activity data a part of the production data pipeline used directly in site features (these include relevant search suggestions, recommendations, etc). This production, real-time usage of log data creates new challenges for data systems or services0 because its volume is orders of magnitude larger than the "real" data. For example, search, recommendations, and advertising often require computing the granular click through rates, which generates log records not only for the clicks but for related items on each page that are not even being touched.

IV. KAFKA DETAILS

Kafka is used as an event streaming platform in these projects' microservice designs. The multiple delimited contexts that reflect the various business processes that the application has to execute are defined using domain-driven design. These are connected by events, forming a unidirectional dependency tree that dissociates each bounded context from those that emerge later, resulting in rich event streaming business applications.

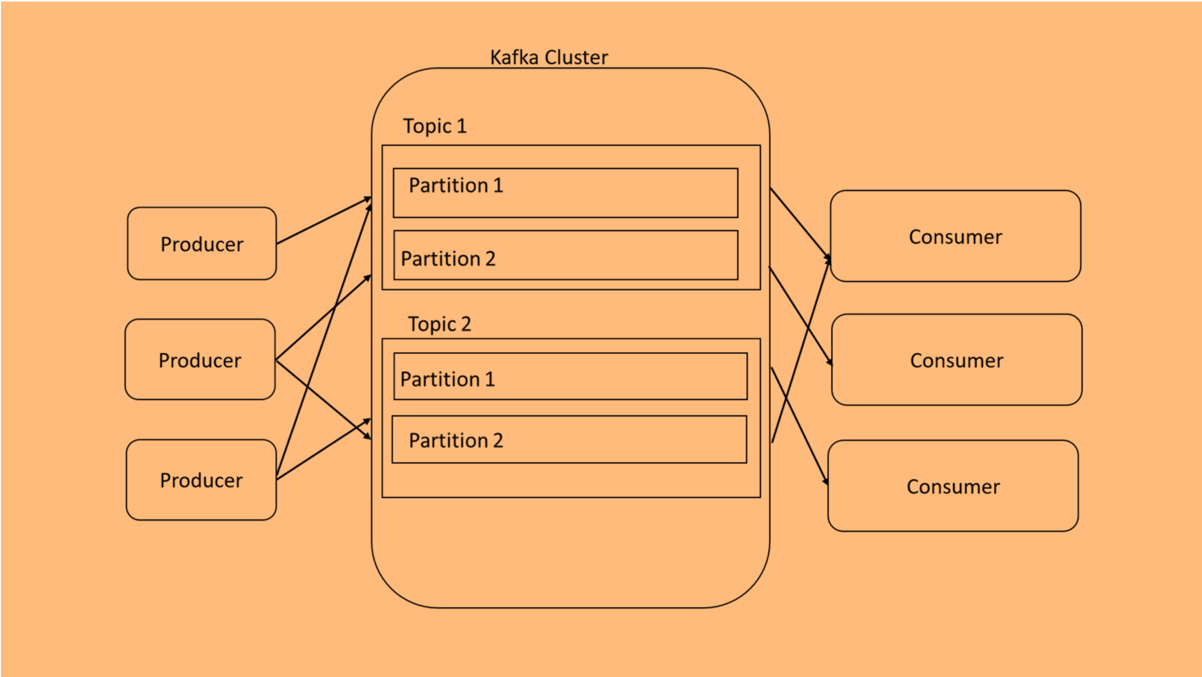

Fig. 4. Kafka Cluster System details

In the above diagram we can see that a producer publishes data to different topics in the Kafka Cluster and the consumer or group of consumers consumes data from the same topic. A producer can publish data to any number of topics and the consumer can read the corresponding topics. Zookeeper assists in the management of all Kafka components.

The different Kafka components are:

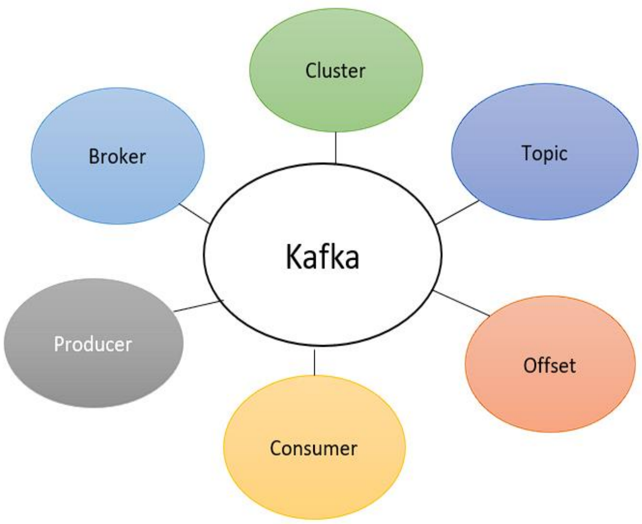

Fig. 5. Kafka Components

A. Producer: The producer acts as a transmitter. It sends the data to Kafka Servers (Brokers). Consumers are not directly targeted by producers. Messages are pushed to the Kafka Server or Broker. The Kafka Broker or Server is where the messages or data are kept. From this broker the messages are being passed to consumer. The same Kafka topic or many Kafka topics may receive messages from multiple producers.

B. Consumers: As the name suggests, this basically consumes the messages available on the Kafka server. Pushing messages to a broker or server is done by the Kafka Producer. A message can be requested from the Kafka broker by the consumer. If the Kafka Consumer has sufficient permissions, the Kafka Broker sends it a message.

C. Broker: The Kafka Broker is essentially a server. A broker is only a middleman who acts as a high-level gateway for communication between a producer and a customer. It acts as both a transmitter and a receiver for Kafka Consumer and Producer. The Kafka cluster may have one or more Kafka brokers.

D. Kafka Cluster: A cluster is a phrase that is frequently used in distributed computing systems. It is nothing more than a collection of computers operating together to achieve a single goal. Being a distributed system, Kafka also features a cluster with a collection of servers referred to as brokers.

The Kafka cluster may have one or more brokers.

- Single Broker Cluster: A single broker Kafka cluster is referred to as a single broker cluster.
- Multi-Broker Cluster: The term "Multi-Broker Cluster" refers to a Kafka cluster that has more than two brokers.

E. Kafka Topic**:** It is one of Kafka's most significant elements. A data stream or message stream is referred to as a Kafka Topic in a distinctive way. Producer transmits a message stream to the broker, and the broker passes the message stream to the Kafka consumer. On the same Broker, many message streams from various Kafka producers may coexist. Here we introduce the idea of Topic, a special attribute of the message stream. The subject for the message stream is a specific name that the Producer delivers a message to. Furthermore, many producers could send to the same topic. The Kafka Broker topic must be subscribed to by any consumer who wants to consume the message. Now, the customer will get all communications pertaining to that issue.

F. Kafka Partition**:** As of right now, we are aware that the producer provides the broker with data along with a certain identifier known as a topic, and the message with that topic is saved by the broker. Imagine having a significant volume of data and the broker finding it extremely challenging to maintain data on a single system. Kafka, as we are well aware, is a distributed system. In this case, we may divide the Kafka topic and spread the partitions across many machines for storing. When creating a Kafka topic, we may choose the number of partitions for a topic based on the use case and data volume.

G. Offsets**:** Each message in each partition of a Kafka topic is given a sequence number in the software. Offset is the name of this sequence number. Any message that enters a partition is given a number as soon as it does. Different partitions for a particular topic have various offsets. Always local to the subject partition, the offset number. The subject and each partition of the topic do not separately have a global offset. The first message is where the offset pointer first points. The offset pointer moves on to the next message when the consumer has done reading that one, and so forth. Therefore, a message's unique identifier is made up of the combination of the subject name, partition number, and offset number. You can find any message based on below three components.

[Topic Name] + [Partition Number] + [Offset Number]

H. Zookeeper: Zookeeper is a necessity for using Kafka. Kafka uses Zookeeper in the distributed system in order to coordinate and keep track of the wellbeing of its cluster nodes. It also controls offsets, topics, and other elements of Kafka.

Because of its performance traits and features that aid in achieving scalability, dependability, and sustainability, Kafka is widely utilised in the big data arena to swiftly ingest and transport enormous volumes of data. The capabilities, use cases, and applications of Apache Kafka were covered in this post, making it a better tool for streaming data.

V. USE CASES AND ADVANTAGES:

- Messaging: Compared to other conventional messaging systems like ActiveMQ, RabbitMQ, etc., Kafka performs better. Kafka is a superior messaging system for large-scale processing applications because to its higher throughput, integrated partition capability, replication, and fault-tolerance characteristics.

- Website Activity Tracking: User actions (such as page views, searches, or other actions) can be monitored in real-time or analysed using Kafka, or for further analysis or adjustment, these events can be monitored and saved in Hadoop or a data warehouse. Activity tracking creates a significant volume of data that must be moved without data loss to the intended destination.

- Log Aggregation: The act of gathering/merging real log files from several application servers into a single repository (file server or HDFS) for processing is known as log aggregation. Kafka operates well and has a lower end-to-end latency as compared to Flume.

- Cloud Connect: Build reliable messaging platform which deliver messages across systems at cloud scale.

- Build real time event processing system based on ML, AI.

- Build large scale data processing systems like Log monitoring, ETL based

- Build systems with event sourcing where each activity is considered as an event attached to event log.

Due to all of these advantages, Microservice architecture prefers Kafka as a middleware. Some real time examples of Microservices that use Kafka are:

1.Netflix: With its proprietary ingestion framework, Netflix employs Kafka for real-time data ingestion via APIs, dumps input data into AWS S3, uses Hadoop to analyse video streams, and enhances user experience through UI actions and events.

2.Hotstar: For data streaming, monitoring, and target tracking, Hotstar's proprietary Bifrost data management technology uses Kafka. Kafka proved ideal for managing the data that the Hotstar platform generates both routinely and during significant events (LIVE streaming of all sporting events, concerts, etc.) where the amount of data increased drastically.

However, in addition to Kafka, we also need to leverage other tools or resources to transform the data stream into meaningful information that can be used to provide insights for data-driven choices. To assist businesses in making better decisions or improving the operation of their services, we may need to develop insights from raw data acquired from IoT devices or data obtained from social media platforms in real-time. After that, we might need to analyse or process those insights.

3.Linkedin: For operational analytics and streaming data, LinkedIn employs Kafka. For its extra services like Newsfeed, LinkedIn utilises Kafka to process messages and analyse the information it receives.

4.Twitter: Twitter is a social networking site that integrates Storm-Kafka into its infrastructure for stream processing. Storm-Kafka is an open-source stream processing application. Tweets are used as the input data and are then aggregated, transformed, and enhanced for use in subsequent processing operations.

VI. CLOUD DEPLOYMENT:

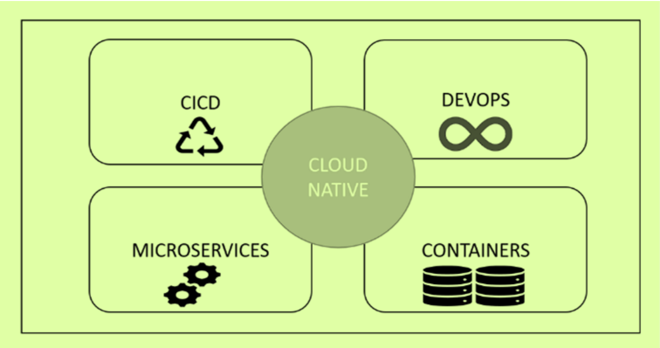

Fig. 6. Typical deployment of cloud

Now when multiple microservices come into picture they bring in a lot of data with them and this data can be accessed through the server as requested. The data flow between various microservices and within the application demands a secure flow of data to avoid the misuse of data. Thus, it demands for cloud architecture where data can be stored and accessed from anywhere and thus securely handled.

Cloud native refers more to how it is built and deployed rather than where an application resides. A cloud native application is made up of discrete, reusable microservices that can be integrated into any cloud environment. These little services frequently come bundled in containers and serve as building bricks. An application is made up of microservices that function together as a whole, but each can be scaled separately, enhanced regularly, and iterated fast thanks to automation and orchestration procedures. Cloud-native apps are more agile and constantly improve due to each microservice's flexibility.

We can see in the above diagram that Cloud native system consists of different components like CICD, DEVOPS, MICROSERVICES, CONTAINERS. These components have a significant role in the Cloud native development of app. Briefly:

1.DEVOPS: The phrase "DevOps" is a combination of the term's "development" and "operations," but it refers to a collection of concepts and methods that go well beyond those two terms individually or jointly, and encompasses many other things as well, such as data analytics, security, and collaborative working methods. DevOps refers to methods for accelerating the procedures by which an idea—such as a new software feature, a request for an improvement, or a bug fix—goes from development to deployment in a production environment where it may be useful to users.

2.CICD: The name "CICD" comes from the abbreviations "CI" and "CD." Continuous Delivery/Continuous Deployment (CD/CD) and Continuous Integration (CI) are two related terms. Building and testing new code changes on a regular basis is known as continuous integration. The technique of often distributing new versions of a programme is known as continuous delivery. Together, CI and CD give enterprises the ability to build and deliver high-quality software in shorter development life cycles and quickly address user demands, increasing customer satisfaction.

3.MICROSERVICES: This method of software development places a high importance on granularity, lightweightness, and the capacity to share common processes across several apps. It is a crucial part of streamlining application development in the direction of a cloud-native approach.

4.CONTAINERS: Containers are a sort of software that logically separates the programme, allowing it to operate independently of physical resources. Microservices are prevented from interfering with one another using containers. They prevent programmes from using up all of the shared resources on the host. They also permit running the same service in numerous instances. Containers are lightweight packages of your application code together with dependencies such as specific versions of programming language runtimes and libraries required to run your software services.

Microservices now a days follow a cloud native approach due to the various advantages it offers.

Cloud computing can be considered as a sub-domain of computer security, network security, and more broadly, information security. Cloud data security is a set of policies, technologies, applications, data, services, and the associated infrastructure of cloud computing. A set of controls can be implemented to provide protection against the misuse of data, the loss of data and information and resources belonging to the customer or the provider. Enhancement of security and privacy is an important aspect in cloud computing development. Cloud storage security covers the data security.

Cloud Computing is all about connecting different environments and providing infrastructure whenever needed (for the client). Cloud computing is the centre of attention now a days as it helps the user to store and access large amount of data via the internet instead of the physical hard-drives on the computer. Cloud Computing is a service model which is based on virtualization and distributed computing technologies. Google Drive can be taken as a computing service where we can store all our data online. Different companies have started providing their own cloud services, for example apple provides Apple cloud where u can store and access all data online, Mi provides MI cloud, one plus provides their cloud services for mobile purposes. These services are mainly used for online storage, backup and synchronization of many things together.

According to the definition of NIST, the cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Networks, servers, storage, applications, and services are some examples of computing resources. They are of three types:

1. Software as a service (SaaS)
2. Infrastructure as a service (IaaS),
3. Platform as a service (PaaS).

And also, there are three types of cloud computing: Private, Public, Hybrid. Private cloud is solely for an organization operated within the firewall. Public cloud is a service for many numbers of users provided by the provider. Hybrid cloud is a combination of two or more private and public clouds.

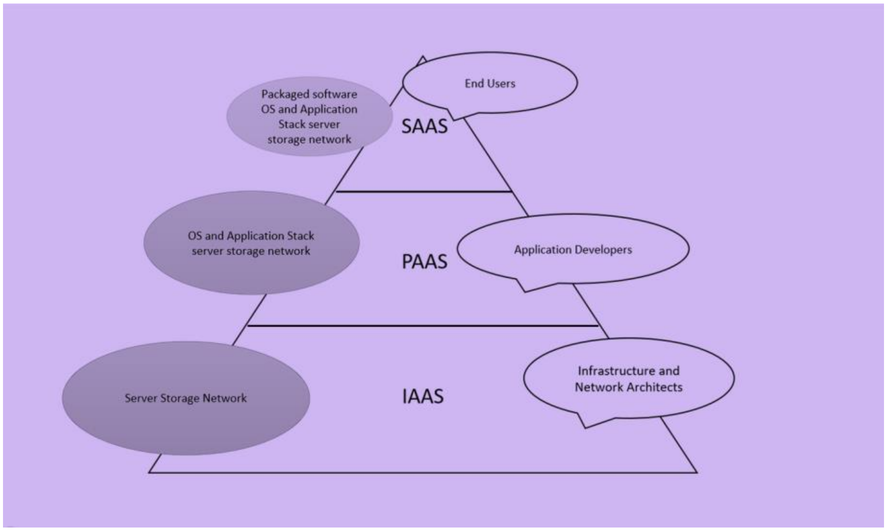

Fig. 7. Typical deployment of cloud

Securing the data is a key concern while handling a large amount of data. In recent years due to many advances in the technology there are many architecture models proposed by specialist in this field. To govern the integrity of data there should be a high level of security when the user stores their data in multi-cloud storages. Followed by which the legal actions on the user can be addressed.

Advantages of cloud native application:

1.Faster release space

2.Superior customer experiences

3.Ease of Management

4.Reduced cost through containerization and cloud standards

5.Build reliable systems.

Thus, building any application over cloud would increase the efficiency of the application and would give it a proper structure making it more reliable, reusable, efficient, fast and secure. Thus, building a cloud native application (i.e., a microservice which can be developed and deployed on cloud) is a need of todays era. It would increase the production levels and thus make the delivery speed boost following the agile approach.

Most of the companies now a days are shifting their products and process to being cloud native, which explains that, it would take over the application development process in no time.

VII. CONCLUSION:

Microservices are independent services which are interdependent and make the application more reliable and efficient.

A large amount of data is handled while services interact with each other thus the middleware comes into picture. Kafka is used for data handling at different service points which includes logging, streaming, etc. It can handle high velocity and high quantity of data and is a fault tolerant system.

Cloud native is a technique that solely uses cloud-based technology when designing applications. In contrast to cloud-based and cloud-enabled applications, cloud native apps are created and hosted on a cloud service from the very beginning. On the other hand, programmes that are cloud-based and cloud-enabled are created using traditional architecture and then modified for cloud execution.

This new architecture, when combined with cloud native security, continues to be a crucial part of digital transformation due to its great scalability, flexibility, and portability. Additionally, speed and agility are key components of cloud native technology. In our fast-paced world, when end customers desire quickly responsive programmes with plenty of functionality but minimal downtime, these two are among the most important needs.

VIII.ACKNOWLEDGEMENT

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