# UNIT-IV

**Recent trends and Research scope in cloud computing**

# Mobile cloud Computing

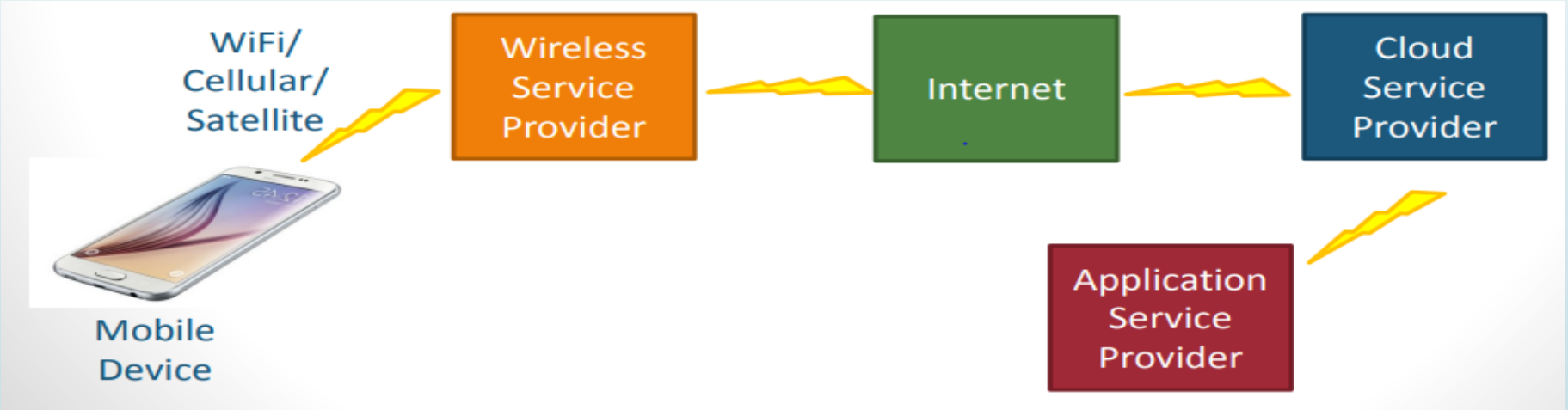
- Mobile cloud computing uses cloud computing to deliver applications to **mobile devices**.
- These mobile apps can be deployed remotely using speed and flexibility and development tools.
- Mobile cloud applications can be built or revised quickly using cloud services.
- They can be delivered to **many different devices** with **different operating systems, computing tasks, and data storage.**
- Thus, users can access applications that could not otherwise be supported.

# Key features

- Facilitates the **quick development, Shared resources** of mobile apps.
- Supports a variety of **development approaches** and devices.
- Improves **reliability** with information backed up and stored in the cloud.
- Applications use fewer device resources because they are cloud-supported.
- Mobile devices are connected to services delivered on an API architecture.

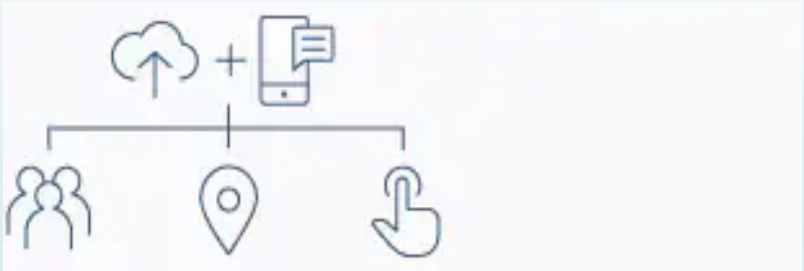
# How it Works?

- Data processing and storage are moved from the mobile device to powerful and centralized computing platforms located in clouds.
- They are accessed by mobile devices over a wireless connection using an app or a web browser.



# Why mobile cloud

- **Speed and flexibility**



- Mobile cloud applications can be built or revised quickly using cloud services. They can be delivered to many different devices with different operating systems.

- **Shared resources**

- Mobile apps that run on the cloud are not constrained by a device's storage and processing resources. Data-intensive processes can run in the cloud.

- **Integrated data**

- Mobile cloud computing enables users to quickly and securely collect and integrate data from various sources, regardless of where it resides.

# Factors Encouraging Adoption Of Mobile Cloud Computing

**Trends and demands:**

- Customers expect convenience in using companies' websites or applications from anywhere and at any time.
- Mobile Cloud computing is meant for this purpose. Users always want to access business applications from anywhere, so that they can increase their productivity, even when they are on the commute.

**Improved and increased broadband coverage:**

- 3G and 4G along with WiFi are providing better connectivity for mobile devices cloud computing.

**Enabling technologies:**

- HTML5, CSS3, a hypervisor for mobile devices, cloudlets and Web 4.0 are enabling technologies that will drive adoption of mobile cloud computing.

# Mobile Cloud Computing Applications

**Mobile Cloud application:**

- It enables to use the smartphone with cloud technology with the following characteristics :

1. A smart-phone has a recognizable Operating System.
2. It provides advanced calling i.e. video calling and conferencing features.
3. Smart-phone must have the capability to run the installable application
4. Messaging features are available.
5. A smart-phone must have a persistent and proper internet connection.

**Mobile Web Services:**

1. Enables in-built external services.
2. Enable the rest protocol.
3. Enables XML-RPC protocols.
4. Enables the capabilities to authenticate user roles.

# Benefits of Mobile Cloud Computing

- Mobile Cloud Computing **saves Business money**.
- Because of the **portability** which makes their work easy and efficient.
- Cloud consumers explore **more features** on their mobile phones.
- Developers reach **greater markets** through mobile cloud web services.
- More network providers can join up in this field.

# Challenges of Mobile Cloud Computing

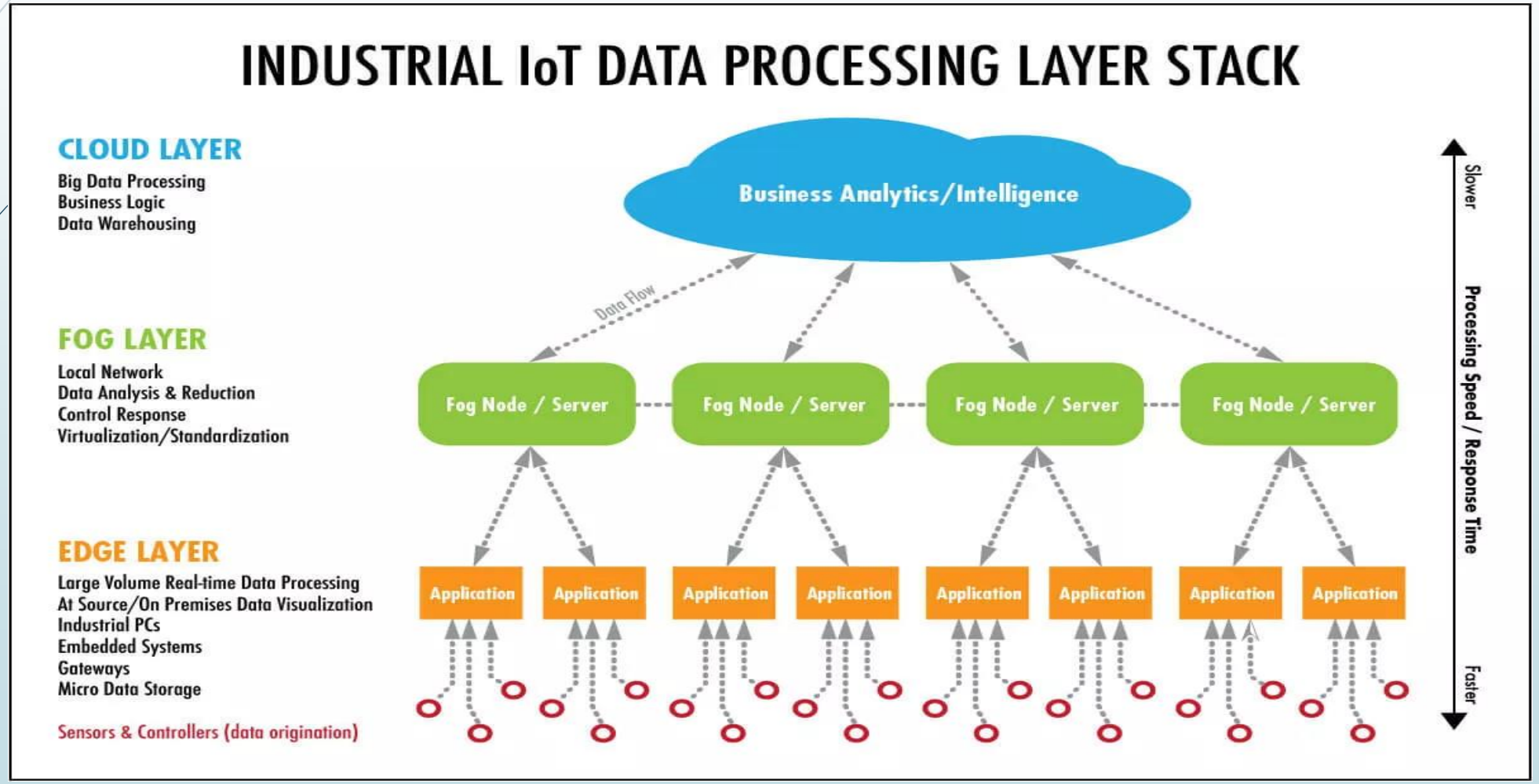
- Low bandwidth
- Security and Privacy
- Service Availability
- Alteration of Networks
- Limited Energy source

# Fog Computing

- The term *fog computing (or fogging)* was coined by Cisco in 2014, so it is new for the general public.
- Fog and cloud computing are **interconnected**.
- In nature, fog is closer to the earth than clouds; in the technological world, it is just the same, fog is closer to end-users, bringing cloud capabilities down to the ground.

- Fog computing is a **decentralized computing infrastructure** or process in which **computing resources are located between the data source and the cloud** or any other data center.
- Fog computing is a paradigm that provides services to user requests at the edge networks.
- The devices at the fog layer usually perform operations related to networking such as **routers, gateways, bridges, and hubs**.
- Researchers envision these devices to be capable of performing both **computational and networking operations, simultaneously**.

- Although these devices are resource-constrained compared to the cloud servers, the geological spread and the decentralized nature help in offering reliable services with coverage over a wide area.
- Fog computing is the **physical location of the devices**, which are **much closer to the users than the cloud servers.**


INDUSTRIAL IoT DATA PROCESSING LAYER STACK
CLOUD LAYER
Big Data Processing
Business Logic
Data Warehousing
FOG LAYER
Local Network
Data Analysis & Reduction
Control Response
Virtualization/Standardization
EDGE LAYER
Large Volume Real-time Data Processing
At Source/On Premises Data Visualization
Industrial PCs
Embedded Systems
Gateways
Micro Data Storage
Sensors & Controllers (data origination)
Business Analytics/Intelligence
Data Flow
Fog Node / Server
Fog Node / Server
Fog Node / Server
Fog Node / Server
Application
Application
Application
Application
Application
Application
Application
Application
Slower
Processing Speed / Response Time
Faster

# Benefits Of Fog computing

**Reduce operating costs:**

- Processing as much data locally as possible and conserving network bandwidth means lower operating costs.

**Enhance security:**

- Whether in transmission or being stored, it is essential to protect IoT data. Users can monitor and protect fog nodes using the same controls, policies, and procedures deployed across the entire IT environment and attack continuum to provide enhanced cybersecurity.

**Improve reliability:**

- Because IoT devices are often deployed under difficult environmental conditions and in times of emergencies, conditions can be harsh. Fog computing can improve reliability under these conditions, reducing the data transmission burden.

# Drawbacks Of Fog computing

**Physical location:**

- Because fog computing is tied to a physical location, it **undermines some of the "anytime/anywhere" benefits associated with cloud computing.**

**Potential security issues:**

- Under the right circumstances, fog computing can be subject to security issues, such as **Internet Protocol (IP) address spoofing or man in the middle (MitM) attacks.**

**Startup costs:**

- Fog computing is a solution that **utilizes both edge and cloud resources**, which means that there are **associated hardware costs**.

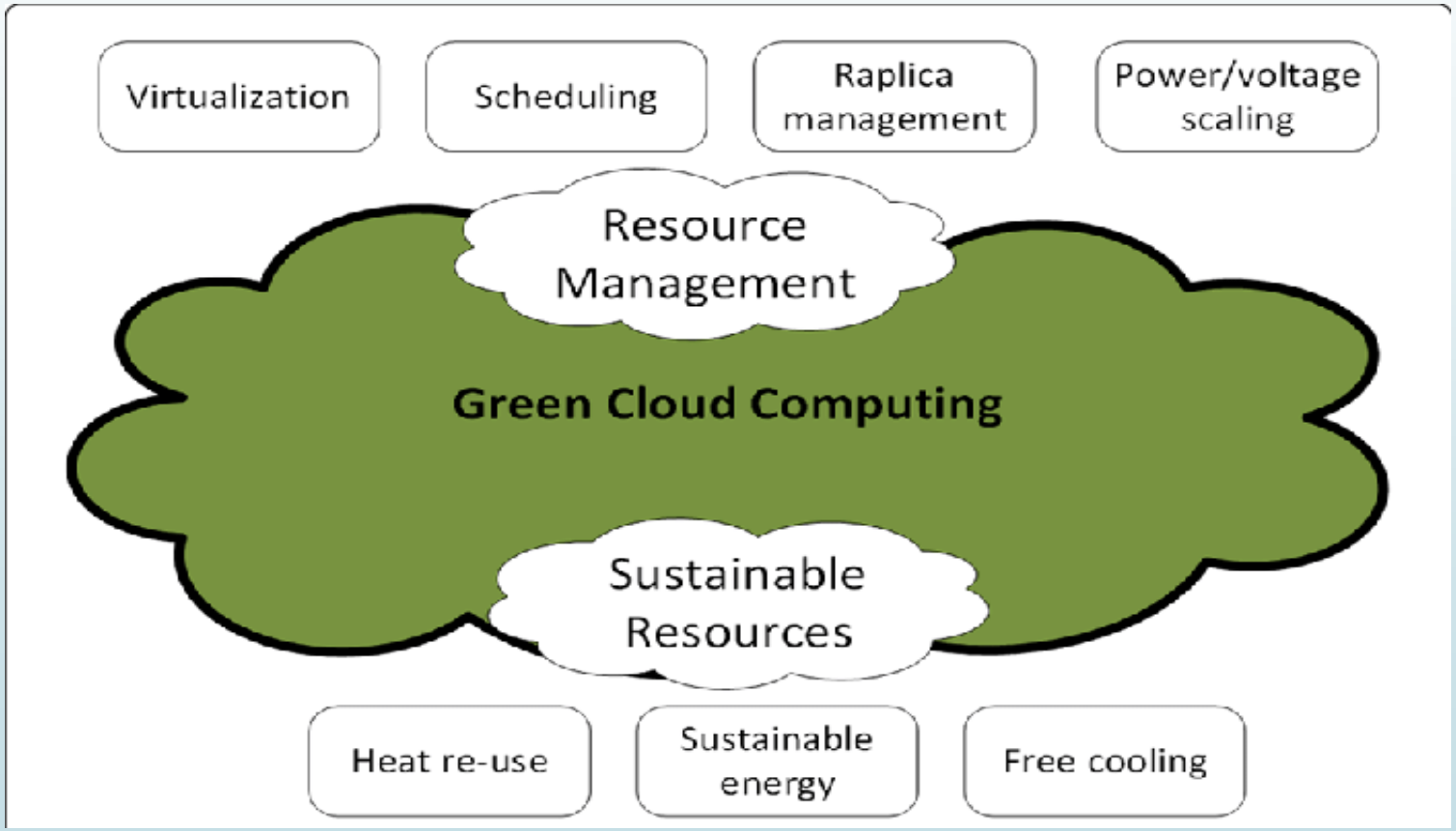
| Feature | Cloud Computing | Fog Computing |
| --- | --- | --- |
| Latency | Cloud computing has high latency compared to fog computing | Fog computing has low latency |
| Capacity | Cloud Computing does not provide any reduction in data while sending or transforming data | Fog Computing reduces the amount of data sent to cloud computing. |
| Responsiveness | Response time of the system is low. | Response time of the system is high. |
| Security | Cloud computing has less security compared to Fog Computing | Fog computing has high Security. |

# Differences between Cloud Computing and Fog Computing

| | | |
|---|---|---|
| Speed | Access speed is high depending on the VM connectivity. | High even more compared to Cloud Computing. |
| Data Integration | Multiple data sources can be integrated. | Multiple Data sources and devices can be integrated. |
| Mobility | In cloud computing mobility is Limited. | Mobility is supported in fog computing. |
| Location Awareness | Partially Supported in Cloud computing. | Supported in fog computing. |
| Number of Server Nodes | Cloud computing has Few number of server nodes. | Fog computing has Large number of server nodes. |
| Geographical Distribution | It is centralized. | It is decentralized and distributed. |

# Green cloud computing

- Green cloud computing involves **designing, producing, and using digital spaces** in a manner to reduce its impact on the environment.
- A green cloud solution can not only save energy but significantly reduce enterprise operational costs.
- Green cloud computing allows users to utilize the benefits of cloud storage while decreasing its adverse effects on the environment, ultimately affecting human well-being.


Virtualization
Scheduling
Raplica management
Power/voltage scaling
Resource Management
Green Cloud Computing
Sustainable Resources
Heat re-use
Sustainable energy
Free cooling

- It includes the following practices:

**Green design:**

- The cloud infrastructure design covers energy-efficient services, computers, software applications, and other devices that **consume reduced energy** than its counterparts.

**Green production:**

- The cloud infrastructure **generates less waste during recycling expeditions** resulting in a more sustainable environment.

**Green usage:**

- It reduces the amount of energy produced when using a cloud-based product by a 27% margin.

- With green cloud computing, users have capability of managing **e-waste** of cloud-based infrastructure and policy designs for ensuring better e-waste deployment and **recycling** methods.
- By appointing, a more efficient and lower-emitting resources, with the Green cloud computing customers get reduced **carbon emissions** and best regulatory standards.
- Green cloud computing's improved resiliency, system consolidation and improved operation handles environmental spaces quite well, by handling the **cooling capacity** across the system and also by managing the public as well as private cloud features among customers.

# Goals Of Green Cloud Computing

- Reduce the use of hazardous material , it causes harm to environment .
- “Green” Data Centers.
- Using recycle materials.
- Supply Chain Energy Usage.
- Green Cloud Computing Architecture

# The Internet of Things and the Cloud

- Because activities like **storage and data processing** take place in the cloud rather than on the device itself, this has had significant implications for IoT.
- Many IoT systems make use of large numbers of **sensors** to collect data and then make intelligent decisions.
- **Using the cloud is important for aggregating data and drawing insights from that data.**
- For instance, a smart agriculture company would be able to compare soil moisture sensors from other soil after planting the same seeds.
- **Without the cloud, comparing data across wider areas is much more difficult.**


INTERNET
of THINGS
Wireless
Network
Network
Cloud
Computing

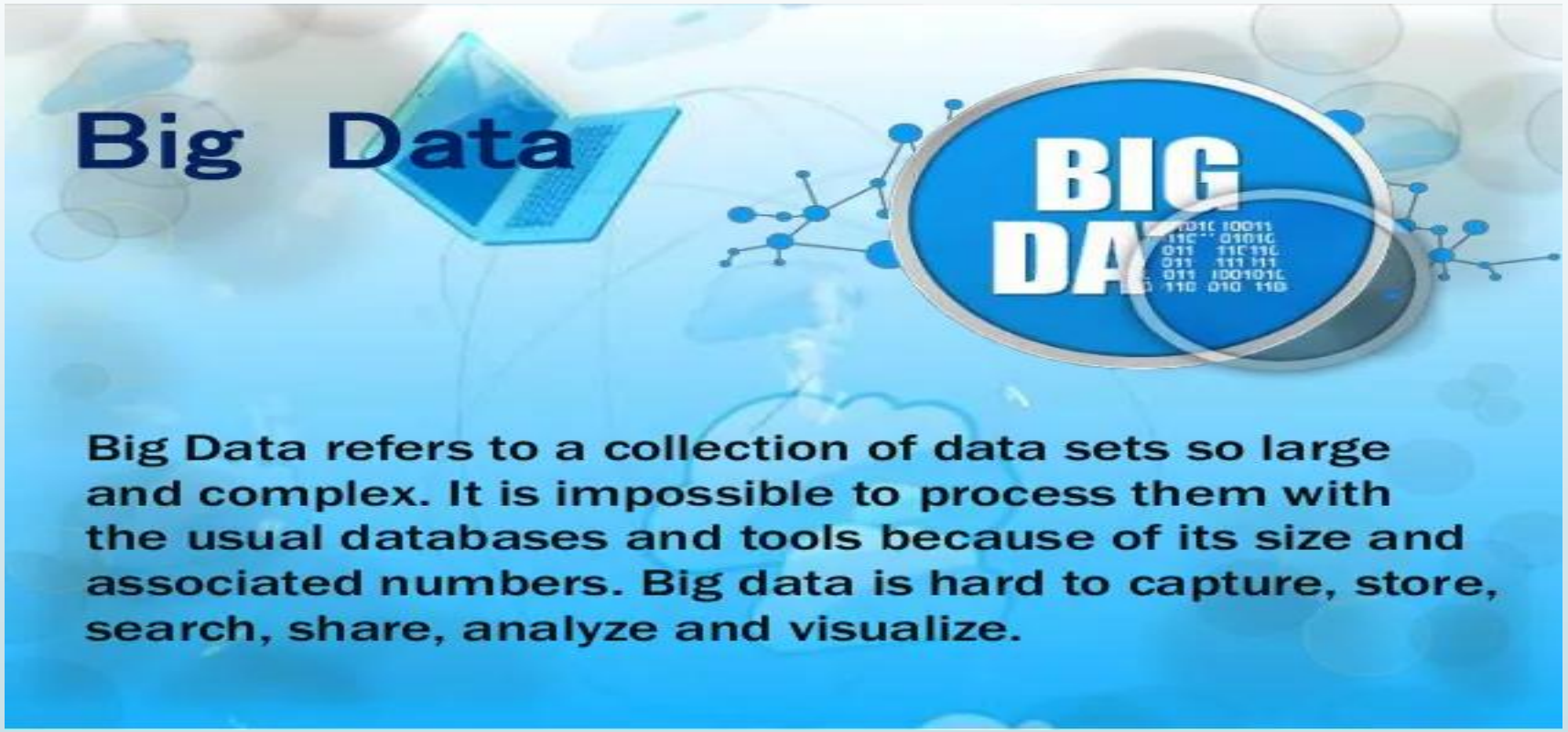
- Using the cloud also allows for **high scalability**. When you have hundreds, thousands, or even millions of sensors, putting large amounts of computational power on each sensor would be **extremely expensive** and **energy-intensive**.
- Instead, data can be passed to the cloud from all these sensors and processed there in aggregate.
- For much of IoT, **the head** (or rather, the **brain**) of the system is **in the cloud**. Sensors and devices collect data and perform actions, but the **processing/commanding/analytics** (aka the "smart" stuff), typically happens in the cloud.

# Is the Cloud Necessary for IoT?

- Technically, the answer is no.
- The data processing and commanding *could* take place locally rather than in the cloud via an internet connection. Known as "**fog computing**" or "**edge computing**", this actually makes a lot of sense for some IoT applications.
- However, there are substantial benefits to be had using the cloud for many IoT applications.
- Choosing *not* to use the cloud would significantly **slow the industry** due to the increased costs.

# Benefits of using the cloud for IoT

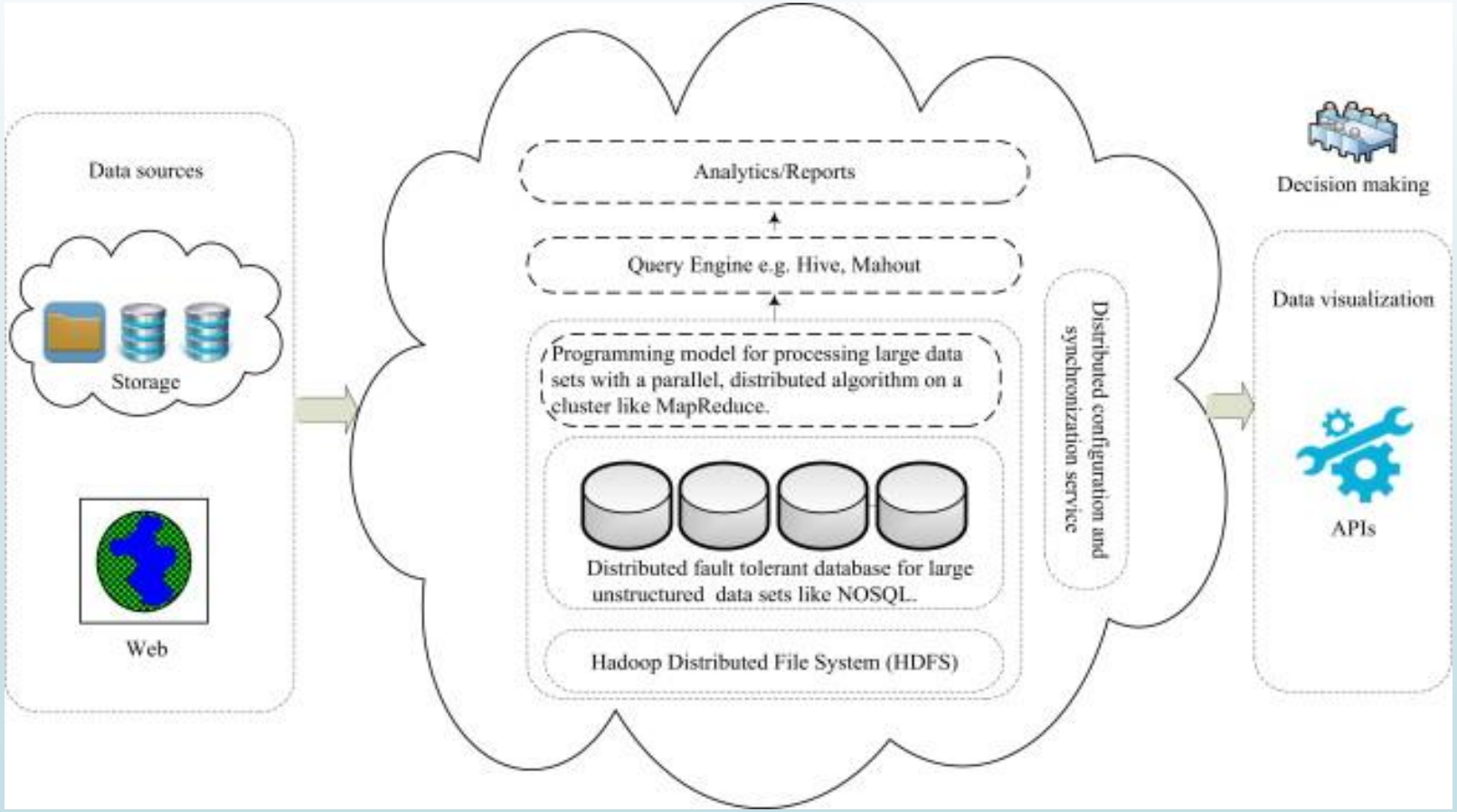
- Decreased costs, both upfront and infrastructure
- Pay-as-needed for storage/computing
- High system scalability and availability
- Increased lifespan of battery-powered sensors/devices
- Ability to aggregate large amounts of data
- Anything with an internet connection can become “smart”


Big Data
BIG
Big Data refers to a collection of data sets so large and complex. It is impossible to process them with the usual databases and tools because of its size and associated numbers. Big data is hard to capture, store, search, share, analyze and visualize.

# Big Data and Cloud Computing

- One of the vital issues that organizations face with the storage and management of Big Data is the **huge amount of investment** to get the required **hardware setup and software packages**.
- Some of these resources may be **overutilised** or **underutilised** with varying requirements overtime.
- We can overcome these challenges by providing a set of computing resources that can be **shared through cloud computing**.

- The cloud computing environment saves costs related to infrastructure in an organization by providing a framework that can be **optimized** and **expanded horizontally**.


Data sources
Storage
Web
Analytics/Reports
Query Engine e.g. Hive, Mahout
Programming model for processing large data sets with a parallel, distributed algorithm on a cluster like MapReduce.
Distributed fault tolerant database for large unstructured data sets like NOSQL.
Hadoop Distributed File System (HDFS)
Distributed configuration and synchronization service
Decision making
Data visualization
APIs

# Benefits of Big data analysis in Cloud.

**Improved analysis**

- With the advancement of Cloud technology, big data analysis has become more improved causing better results.
- Hence, companies prefer to perform big data analysis in the Cloud. Moreover, Cloud helps to integrate data from numerous sources.

**Simplified Infrastructure**

- Big Data analysis is a tremendous strenuous job on infrastructure as the data comes in large volumes with varying speeds, and types which traditional infrastructures usually cannot keep up with.
- As the Cloud computing provides **flexible infrastructure**, which we can **scale** according to the needs at the time, it is easy to manage workloads.

**Lowering the cost**

- Both Big data and Cloud technology delivers value to organizations by **reducing the ownership**. The Pay-per-user model of Cloud turns **CAPEX into OPEX.**
- On the other hand, Apache cut down the licensing cost of Big data which is supposed to be cost millions to build and buy.
- Cloud enables customers for big data processing without large-scale big data resources.
- Hence, both Big Data and Cloud technology are driving the cost down for enterprise purposes and bringing value to the enterprise.

**Security and Privacy**

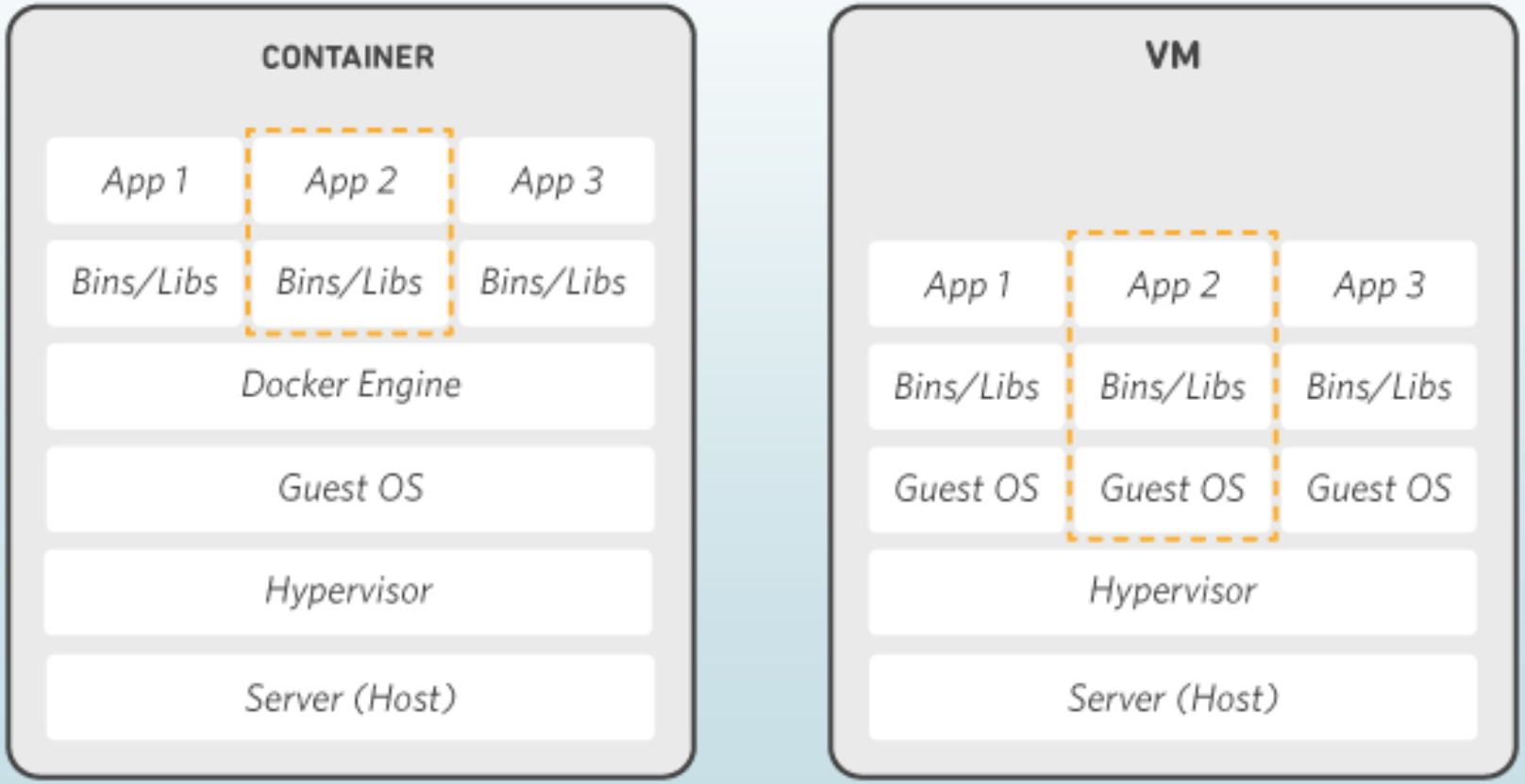
- Data security and privacy are two major concerns when dealing with enterprise data. Moreover, when your application is hosted on a Cloud platform due to its open environment and limited user control security becomes a primary concern.
- On the other hand, being an open source application, Big data solution **like Hadoop uses a lot of third-party services and infrastructure**.
- Hence, nowadays system integrators bring in Private Cloud Solution that is **Elastic and Scalable**. Furthermore, it also leverages Scalable Distributed Processing.

# What is Docker and Docker Container?

- Docker is a **software platform** that allows you to **build, test, and deploy applications quickly.**
- Docker packages software into standardized units called **containers** that have everything the software needs to run **including libraries, system tools, code, and runtime**.
- Using Docker, you can **quickly deploy and scale applications** into any environment and know your code will run.

# How Docker works

- Docker works by providing a **standard way** to run your code.
- Docker is an **operating system** for containers.
- Similar to how a virtual machine virtualizes server hardware, containers **virtualize the operating system of a server**.
- Docker is installed on each server and provides simple commands you can use to **build, start, or stop containers**.


CONTAINER
App 1
App 2
App 3
Bins/Libs
Bins/Libs
Bins/Libs
Docker Engine
Guest OS
Hypervisor
Server (Host)
VM
App 1
App 2
App 3
Bins/Libs
Bins/Libs
Bins/Libs
Guest OS
Guest OS
Guest OS
Hypervisor
Server (Host)

# Why use Docker?

- Using Docker lets you ship code **faster, standardize application operations, seamlessly move code, and save money** by improving resource utilization.
- With Docker, you get a single object that can reliably run anywhere. Docker's simple and straightforward syntax gives you full control.
- Wide adoption means there's a robust ecosystem of **tools** and off-the-shelf applications that are ready to use with Docker.

# When to use Docker?

- You can use Docker containers as a **core building block creating modern applications and platforms**.
- Docker makes it easy to build and run **distributed micro services architectures, deploy your code with standardized continuous integration and delivery pipelines, build highly-scalable data processing systems, and create fully-managed platforms for your developers**.