Chapter6: Applications and Case Studies[3hrs]

- High-Potential Use cases
- Edge computing for smart cities.
- Industrial IoT and edge computing.
- Edge computing in Healthcare.

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❖ High-Potential Use cases

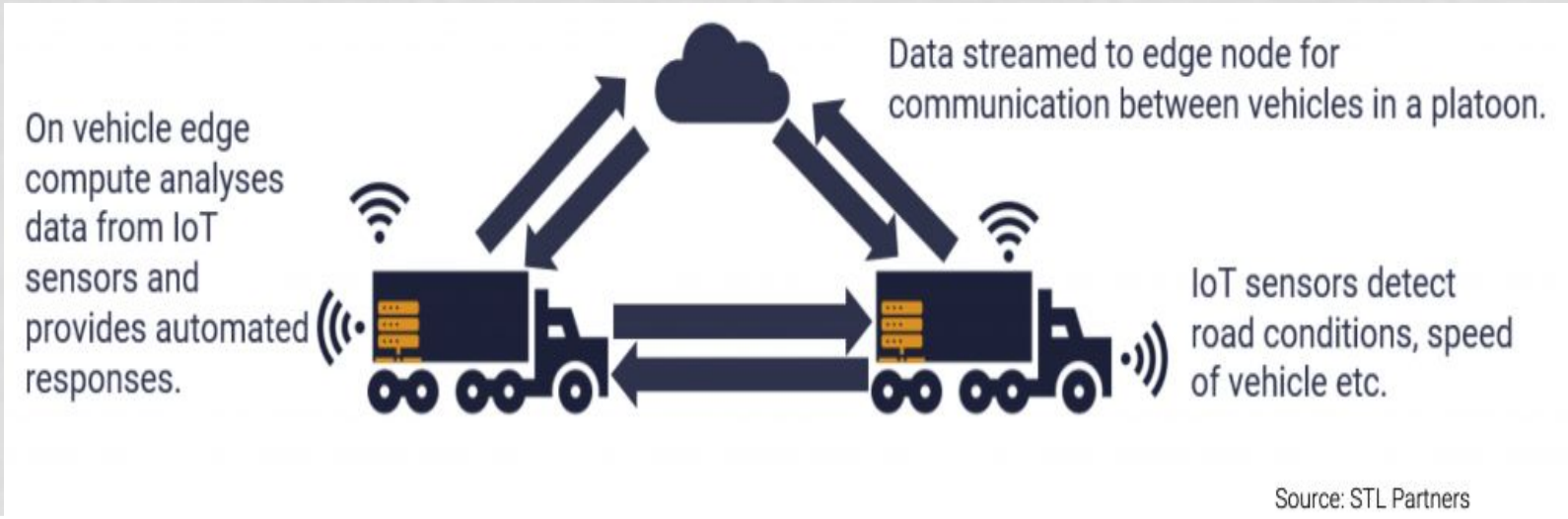
Edge computing is a rapidly evolving technology with many potential use cases across multiple industries. As the technology develops, businesses can increasingly leverage its benefits, such as improved insights, faster response times, enhanced customer engagement, and cost-effectiveness

Edge computing use case examples

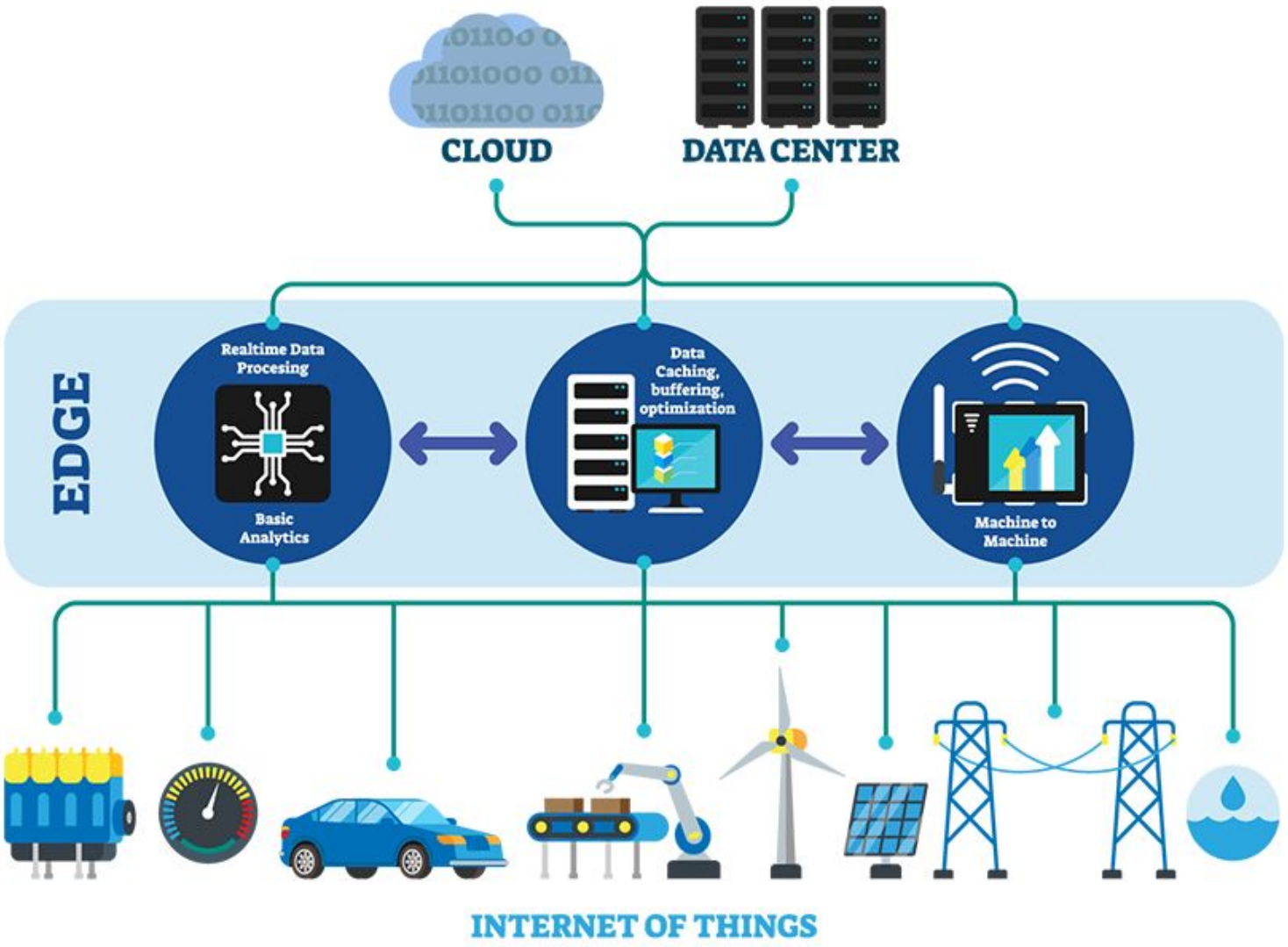
- Autonomous vehicles. ...
- Remote monitoring of assets in the oil and gas industry. ...
- Smart grid. ...
- Predictive maintenance. ...
- In-hospital patient monitoring. ...
- Virtualised radio networks and 5G (vRAN) ...
- Cloud gaming. ...
- Content delivery

Autonomous vehicles

Autonomous platooning of truck convoys will likely be one of the first use cases for autonomous vehicles. Here, a group of truck travel close behind one another in a convoy, saving fuel costs and decreasing congestion. With edge computing, it will be possible to remove the need for drivers in all trucks except the front one, because the trucks will be able to communicate with each other with ultra-low latency.



Edge Computing



The Internet of Things (IoT) is made up of smart devices connected to a network—sending and receiving large amounts of data to and from other devices—which produces a large amount of data to be processed and analyzed.

Edge computing, a strategy for computing on location where data is collected or used, allows IoT data to be gathered and processed at the edge, rather than sending the data back to a datacenter or cloud.

Together, IoT and edge computing are a powerful way to rapidly **analyze data in real-time**.

What are IoT and edge computing?

The Internet of Things (IoT) re fers to the process of connecting physical objects to the internet. IoT refers to any system of physical devices or hardware that receive and transfer data over networks without any human intervention. A typical IoT system works by continuously sending, receiving, and analyzing data in a feedback loop. Analysis can be conducted either by humans or artificial intelligence and machine learning (AI/ML), in near real-time or over a longer period.

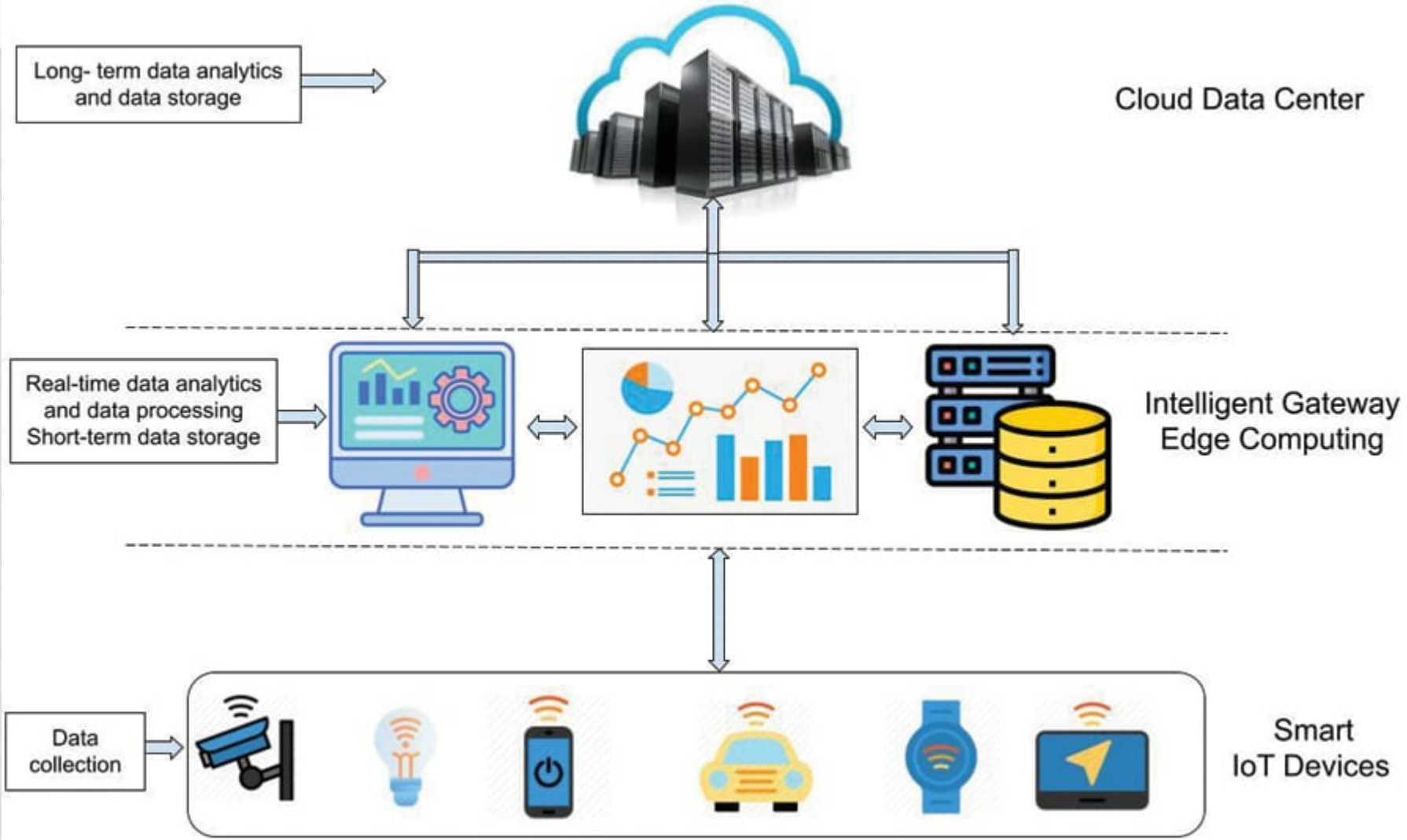
If something is referred to as *smart*, that generally implies IoT. Think of self-driving cars, smart homes, smartwatches, virtual and augmented reality, and industrial IoT

Q)What's the difference between an IoT device and an edge device?

Edge devices are physical hardware located in remote locations at the edge of the network with enough memory, processing power, and computing resources to collect data, process that data, and execute upon it in almost real-time with limited help from other parts of the network.

An IoT device is a physical object that has been connected to the internet and is the source of the data. An edge device is where the data is collected and processed.Edge devices can be considered part of the IoT when the object has enough storage and compute to make low latency decisions and process data in milliseconds.The terms IoT device and edge device are sometimes used interchangeably.

Q) Why Edge Computing is Important for IoT Applications?



Q)How are IoT and edge related?

IoT benefits from having compute power closer to where a physical device or data source actually exists. In order for the data produced by IoT devices to react faster or mitigate issues, it needs to be analyzed at the edge, rather than traveling back to a central site before that analysis can take place.

Edge computing is a local source of processing and storage for the data and computing needs of IoT devices. Here are some of the benefits of using IoT and edge together:

- Reduced latency of communication between IoT devices and the central IT networks.
- Faster response times and increased operational efficiency.
- Improved network bandwidth.
- Continued systems operation offline when a network connection is lost.
- Local data processing, aggregation, and rapid decision making via analytics algorithms and machine learning.

An IoT gateway can send data from the edge back to the cloud or centralized datacenter, or to the edge systems to be processed locally.

Q) What is Industrial IoT or IIoT?

IoT and edge computing use cases

Industrial IoT, or IIoT, refers to the use of IoT in an industrial context, such as the machines in a factory. Think of the lifecycle of heavy machinery used in a factory. Different people may stress equipment differently over time, and breakdowns are an expected part of operations.

IoT sensors can be added to parts of the machinery that are most prone to breaking or overuse. The data from these sensors can be analyzed and used for predictive maintenance, reducing overall downtime.

Autonomous vehicles are an example of why IoT solutions and edge computing need to work together. An autonomous vehicle driving down the road needs to collect and process real-time data about traffic, pedestrians, street signs and stop lights, as well as monitor the vehicle's systems.

If the vehicle needed to stop or turn quickly to avoid an accident, sending data back and forth from the vehicle to the cloud to be processed would take too long.

Edge computing brings cloud computing services to the vehicle, allowing the IoT sensors in the vehicle to process the data locally in real-time to avoid an accident.

IIoT stands for Industrial Internet of Things, a term for connected devices in manufacturing, energy, and other industrial practices. IIoT is significant for bringing more automation and self-monitoring to industrial machines, helping improve efficiency.

Features	IIoT	IoT
Devices	Industrial machines and equipment.	Smartwatches, home appliances, cars, and other consumer-facing devices.
Purpose	For specific industrial processes such as monitoring and maintenance.	To improve convenience and efficiency in everyday life.
Security	Requires a high level of security and reliability.	Security and reliability levels vary depending on the device.
Power	High power and expensive devices.	Low-power and low-cost devices.

The similarities between IIoT and IoT are:

- Allow for connectivity and communication of devices over the internet.
- They use sensors, devices, and networks to collect data.
- Increase efficiency and automate tasks by allowing devices to communicate and share information.
- They both rely on cloud computing and data analytics. This will help to process large amounts of data generated by connected devices.

How is IIoT related to edge computing?

IIoT devices are often deployed in connection with edge computing.

Edge computing refers to a strategy of shifting computing resources nearer to the physical location of either the user or the source of the data. By placing computing services closer to these locations, users benefit from faster, more reliable services while companies benefit from the flexibility of hybrid cloud computing. Edge computing is one way that a company can use and distribute a common pool of resources across a large number of locations.

It's common for IIoT devices to be used for edge computing. For example, in a factory setting, machines that gather data for the purpose of real-time data analytics on site would represent an IIoT use case that supports an edge computing strategy.

Achieving these benefits requires an underlying platform that can unify disparate data systems—especially because manufacturing systems traditionally have been isolated from each other.

Under a unified system, manufacturing sites can deploy artificial intelligence and machine learning (AI/ML) model training through a scalable service platform.The combination of IIoT and edge computing is helping manufacturers solve problems faster by transforming operations, assisting end users in making business decisions, and making plants even more productive.

Q)What's the difference between IIoT and IoT?

The IoT, or Internet of Things, is a general term for everyday objects which connect to a network, sending and receiving data to and from other devices. The IIoT is a subsection of the IoT. Generally, the IoT is made up of any kind of equipment that takes advantage of Internet connectivity in order to send data and receive data. When that equipment is used for industrial purposes, it is considered IIoT.

Consumers IoT devices include products such as connected home thermostats, lights, and door locks. Industrial IoT devices span a wide range of items—everything from water meters to factory machines to sensors on pipelines.

Q) What does IIoT look like in action?

IIoT solutions have a wide variety of use cases, with manufacturing and energy being two of the primary industries to use IIoT.In manufacturing, providing a view of factory conditions is a common example. Sensor data from machinery, analyzed in real time and fed back to control systems, can lead to improved levels of operational and business efficiency.

In energy, companies can use IIoT to better monitor their field assets. IIoT devices can gather real-time data on electrical grid performance, pipeline flow, or emissions monitoring, even with assets distributed across wide geographic areas.

For example, **a water and sewage utility service in Italy uses connected self-service water kiosks across a region to gather real-time data on water quality.**

Q) How does IIoT automation work?

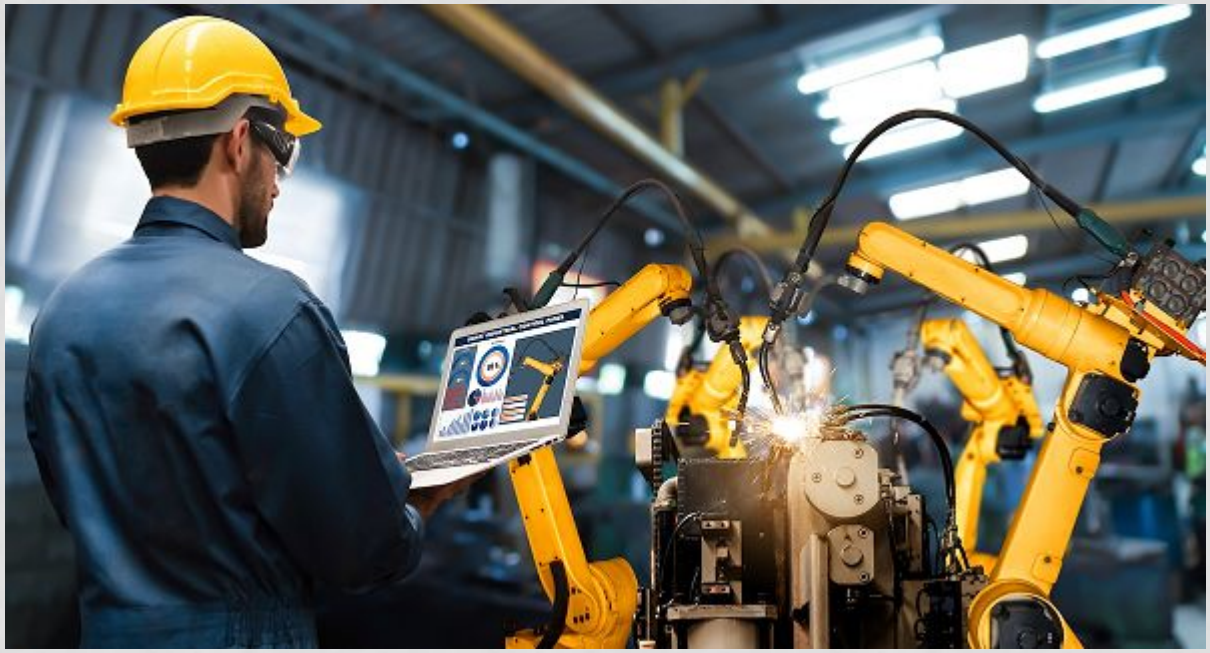
IIoT and automation are tightly linked. Data gathered by IIoT devices can prompt automated tasks that improve efficiency, such as predictive maintenance. Additionally, automation tools can be used to more effectively manage large numbers of IIoT devices.

Using the example of factory machinery, a machine can be programmed to respond to data from onboard sensors—such as noting an increase in vibrations—and automatically take an action—such as alerting an operator that maintenance is required. In ways such as this, IIoT-driven automation can minimize downtime and reduce overall maintenance costs.

Automation can also help with the challenge of managing a large number of IIoT devices, especially ones scattered across large geographic areas—at the edge. Just as automation software can manage servers and network devices, it can also be used to keep IIoT devices updated and validated.

1. Different Industries Manufacturing

IIoT enables connected devices to gather and analyze data for manufacturing processes. The sensor data can track machine performance. It can also detect potential issues before they cause problems.Production is more efficient and flexible when devices and machines communicate with robots.



Agriculture

One specific industrial internet of things example application in agriculture is Precision Agriculture. Precision Agriculture uses devices like drones to gather data from the farming process.

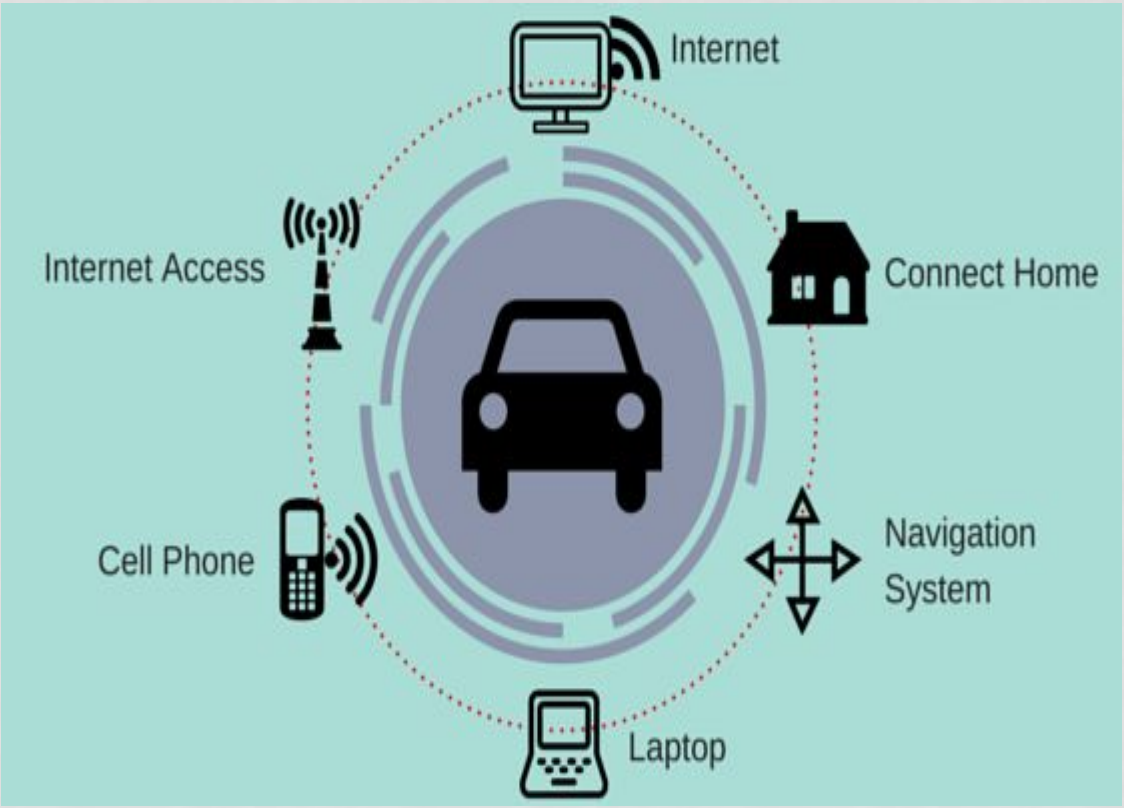
This data can help to optimize crop production, reducing waste and improving efficiency. For example, sensor data can track soil moisture and nutrient levels.

Another critical industrial internet of things example in agriculture applications is automation and robotics in farming. Autonomous tractors help plant and harvest, reduce waste, and increase crop yields.

Automotive

An industrial internet of things example applicable in the automotive industry is the presence of "Connected Cars." Connected cars use various devices, such as sensors, cameras, and GPS, to scan data from the vehicle.

This data is to improve safety, reduce emissions, and optimize performance. For example, sensor data can track tire pressure. It can also predict traffic patterns to optimize routing. The data is then used for predictive analytics to improve fuel efficiency and reduce emissions.



2. Industrial IoT Examples in Action

The internet of things transforms industries. They allow machines and devices to communicate in sync. By integrating IoT with industrial processes, companies can improve efficiency, productivity, and safety. Some examples of industrial IoT use cases in action include:

In the Manufacturing Industry:

GE has implemented IIoT technology to optimize production processes. This has led to a reduction in downtime and the number of defects. It also increases productivity.

In the Transportation Industry:

Routes and supply chain operations are better using IIoT sensors and tracking devices. For example, **industrial IoT use cases** can be observed in companies like Daimler and Volvo. IIoT helps to improve the efficiency of their vehicles. Daimler uses IIoT sensors to check the health of truck engines. It also helps to predict when they will need maintenance.

In the Agriculture Industry:

John Deere is using IIoT technology to improve the efficiency of its farming equipment. *(An American corporation that manufactures agricultural machinery, heavy equipment, forestry machinery, diesel engines, drivetrains used in heavy equipment, and lawn care equipment).* For example, the development of tractors that a farmer can control in a remote setting. Based on data from sensors, their speed and direction can adjust to suit the farmer.

In the Healthcare Industry:

IoT equipment can check patients' condition from a far. It also improves outcomes in a remote setting.

Medtronic is one of the best industrial IoT use cases in the medical field. They use IIoT technology to track patients' vital signs. It then sends an alert to healthcare professionals if any changes need attention.

Q) What are the features of IIoT?

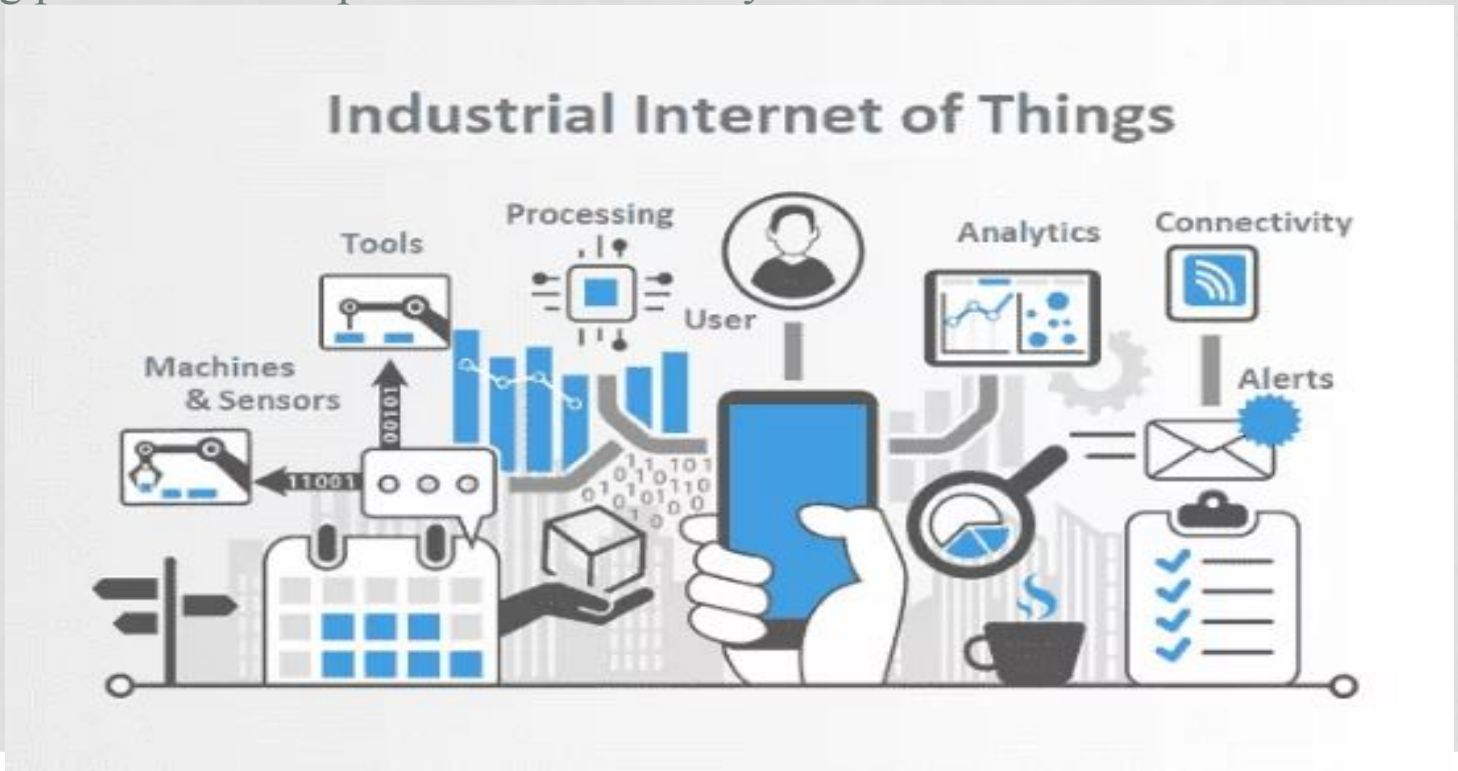
3. The main features of Industrial Internet of Things (IIoT) solutions

Businesses depend on the internet of things to increase efficiency and productivity. The main features of IIoT are:

Smart Alerts and Notifications

Smart alerts and notifications are critical features of IoT. In manufacturing, it allows for real-time monitoring and control of manufacturing assets. Preset conditions trigger equipment failure alerts. It also helps with production process deviations or safety hazards.

These are then sent to the relevant personnel via various communication channels (e.g., SMS, email, push notifications). IIoT allows for quick response and resolution of issues by manufacturing personnel. It improves total efficiency and reduces downtime in manufacturing operations.



Condition Monitoring & Remote Maintenance

It allows for real-time monitoring and control of equipment and other manufacturing assets. This technology allows the collecting of data and analyzing it to detect potential issues.

Remote maintenance enables technicians to access and diagnose equipment. This leads to a reduction of costs associated with on-site repairs. It allows for proactive maintenance and improved equipment uptime. It also increases efficiency in manufacturing operations.

Location Tracking & Geofencing

Enterprise's asset includes equipment, tools, and personnel. This technology can be used to track the location of these assets, as well as set up virtual boundaries that trigger alerts when crossed.

This enables manufacturers to improve operational efficiency and increase productivity in manufacturing.

Data Processing and Analyzing

IIoT allow for analyzing large amounts of data from various manufacturing equipment and personnel. This data can be used to optimize production processes and reduce downtime. It can help to recognize patterns. It can also help to determine trends in the data. This will improve quality control and increase efficiency in manufacturing operations.

Benefits of Industrial Internet of Things (IIoT)

- **It reduces manual processes:** Allows for device automation when connected to the internet. This leads to a reduction in manual intervention and increases efficiency.
- **Reduce errors:** IIoT collects and analyzes data in real-time. This makes it easy to identify and correct errors quickly, reducing the risk of costly mistakes.
- **Optimize operational processes:** IIoT helps to optimize and analyze data. This leads to an increase in the efficiency of operational processes and reduces costs.
- **Reduce costs:** IIoT reduces costs by automating manual processes. It also reduces errors and optimizes operational processes.
- **Worker Safety and Productivity:** IIoT helps to automate dangerous and repetitive tasks. This improves worker safety and increases productivity.
- **Sustainability:** IIoT can help companies reduce their environmental impact. This can be done by optimizing operational processes and automating manual tasks.

Challenges of IIoT

The Industrial Internet of Things (IIoT) has the potential to revolutionize various industries. They also introduce several security challenges. For example:

- **Network security:** IoT devices are connected to the internet. This becomes a potential entry point for hackers to gain access to a company's network.
- **Data security:** IoT devices collect large amounts of data. This increases the risk of data breaches and unauthorized access to sensitive information.
- **Privacy:** IoT devices contain large amounts of personal data. This can be used for malicious purposes if it falls into the wrong hands.

Market Segments of IIoT

The Industrial Internet of Things (IIoT) market is a rapidly growing and diverse field that can be segmented in various ways. This allows companies better to understand the specific needs of their target customers. They can also develop products and services that meet those needs.

The IIoT market segments are based on:

- **Device and Technology:** They include sensors and industrial robots.
- **Connectivity Technology:** They include Wi-Fi, Bluetooth, Zigbee, Z-Wave, and cellular networks.
- **Software:** They include platform software, analytics software, security software, and others.
- **Vertical:** It is present in manufacturing, transportation, healthcare, agriculture, and others.

Why is IoT Growing So Rapidly?

The Internet of Things (IoT) is increasing due to a combination of factors. These factors include: Advancements in technology.

- The increasing availability of data.
- The growing demand for connected devices.
- Declining costs of IoT devices.
- Connectivity options.
- Increase in IoT application.
- Government support.
- Growing demand for automation.
- Development of new technologies like 5G.

All these are making it easier and more cost-effective to connect devices to the internet. Additionally, it is possible to extract valuable insights from IoT data. This can be done using the growing availability of data. The increasing capabilities of analytics software make IoT popular.

Edge computing in Healthcare

Before Internet of Things, patients' interactions with doctors were limited to visits, and tele and text communications. There was no way doctors or hospitals could monitor patients' health continuously and make recommendations accordingly.

Internet of Things (IoT)-enabled devices have made remote monitoring in the healthcare sector possible, unleashing the potential to keep patients safe and healthy, and empowering physicians to deliver superlative care. It has also increased patient engagement and satisfaction as interactions with doctors have become easier and more efficient. Furthermore, remote monitoring of patient's health helps in reducing the length of hospital stay and prevents re-admissions. IoT also has a major impact on reducing healthcare costs significantly and improving treatment outcomes.

IoT is undoubtedly transforming the healthcare industry by redefining the space of devices and people interaction in delivering healthcare solutions. IoT has applications in healthcare that benefit patients, families, physicians, hospitals and insurance companies.

IoT for Patients - Devices in the form of wearables like fitness bands and other wirelessly connected devices like blood pressure and heart rate monitoring cuffs, glucometer etc. give patients access to personalized attention. These devices can be tuned to remind calorie count, exercise check, appointments, blood pressure variations and much more.

IoT has changed people's lives, especially elderly patients, by enabling constant tracking of health conditions. This has a major impact on people living alone and their families. On any disturbance or changes in the routine activities of a person, alert mechanism sends signals to family members and concerned health providers.

IoT for Physicians - By using wearables and other home monitoring equipment embedded with IoT, physicians can keep track of patients' health more effectively. They can track patients' adherence to treatment plans or any need for immediate medical attention. IoT enables healthcare professionals to be more watchful and connect with the patients proactively. Data collected from IoT devices can help physicians identify the best treatment process for patients and reach the expected outcomes.

IoT for Hospitals - Apart from monitoring patients' health, there are many other areas where IoT devices are very useful in hospitals. IoT devices tagged with sensors are used for tracking real time location of medical equipment like wheelchairs, defibrillators, nebulizers, oxygen pumps and other monitoring equipment. Deployment of medical staff at different locations can also be analyzed real time.

The spread of infections is a major concern for patients in hospitals. IoT-enabled hygiene monitoring devices help in preventing patients from getting infected. IoT devices also help in asset management like pharmacy inventory control, and environmental monitoring, for instance, checking refrigerator temperature, and humidity and temperature control.

IoT for Health Insurance Companies – There are numerous opportunities for health insurers with IoT-connected intelligent devices. Insurance companies can leverage data captured through health monitoring devices for their underwriting and claims operations. This data will enable them to detect fraud claims and identify prospects for underwriting. IoT devices bring transparency between insurers and customers in the underwriting, pricing, claims handling, and risk assessment processes. In the light of IoT-captured data-driven decisions in all operation processes, customers will have adequate visibility into underlying thought behind every decision made and process outcomes.

Redefining Healthcare

The proliferation of healthcare-specific IoT products opens up immense opportunities. And the huge amount of data generated by these connected devices hold the potential to transform healthcare.

IoT has a four-step architecture that are basically stages in a process (See Figure 1). All four stages are connected in a manner that data is captured or processed at one stage and yields the value to the next stage. Integrated values in the process brings intuitions and deliver dynamic business prospects.

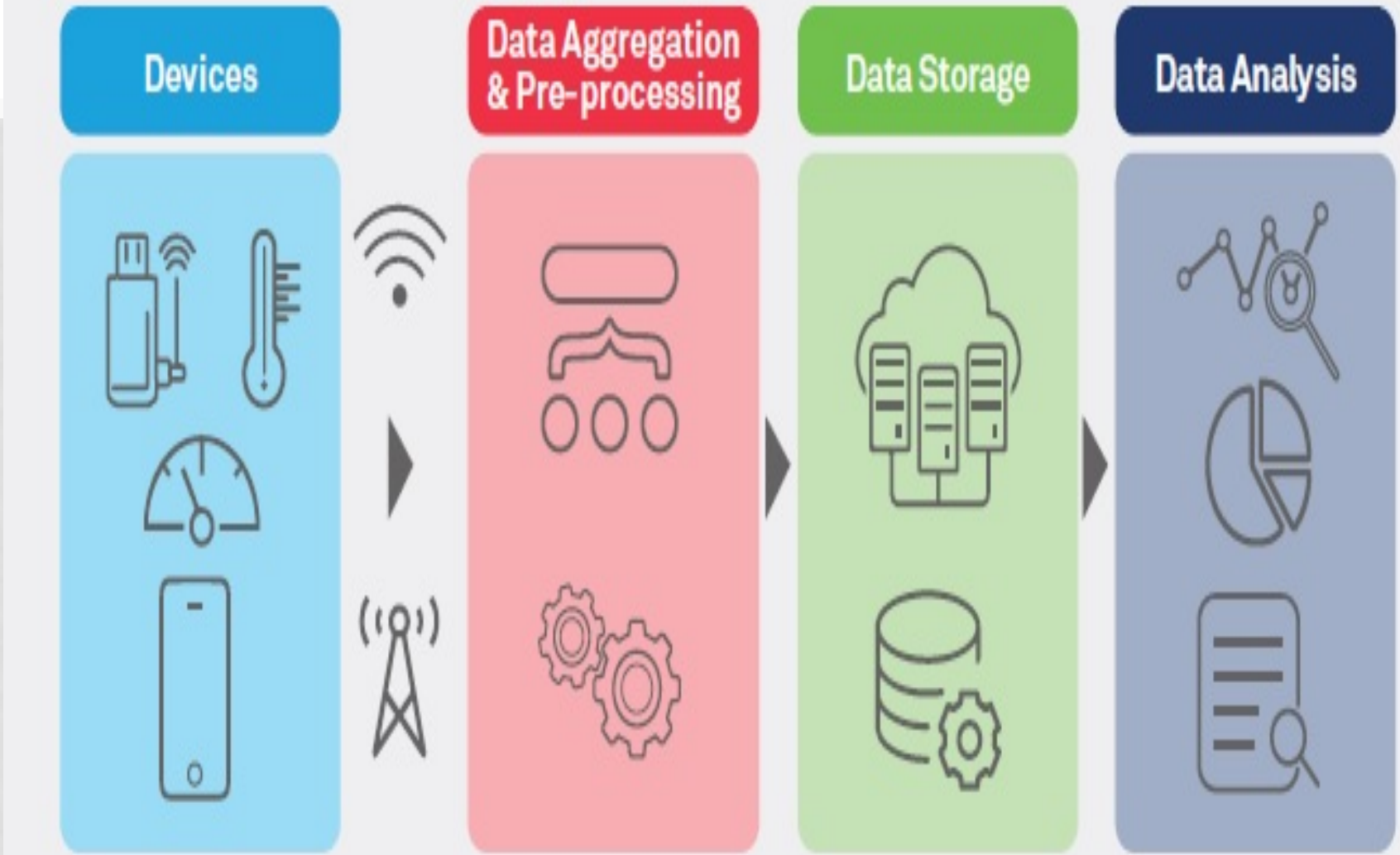
Step 1: First step consists of deployment of interconnected devices that includes sensors, actuators, monitors, detectors, camera systems etc. These devices collect the data.

Step 2: Usually, data received from sensors and other devices are in analog form, which need to be aggregated and converted to the digital form for further data processing.

Step 3: Once the data is digitized and aggregated, this is pre-processed, standardized and moved to the data center or Cloud.

Step 4: Final data is managed and analyzed at the required level. Advanced Analytics, applied to this data, brings actionable business insights for effective decision-making.

IoT is redefining healthcare by ensuring better care, improved treatment outcomes and reduced costs for patients, and better processes and workflows, improved performance and patient experience for healthcare providers.


Devices
Data Aggregation & Pre-processing
Data Storage
Data Analysis

The major advantages of IoT in healthcare include:

Cost Reduction: IoT enables patient monitoring in real time, thus significantly cutting down unnecessary visits to doctors, hospital stays and re-admissions

Improved Treatment: It enables physicians to make evidence-based informed decisions and brings absolute transparency

Faster Disease Diagnosis: Continuous patient monitoring and real time data helps in diagnosing diseases at an early stage or even before the disease develops based on symptoms

Proactive Treatment: Continuous health monitoring opens the doors for providing proactive medical treatment

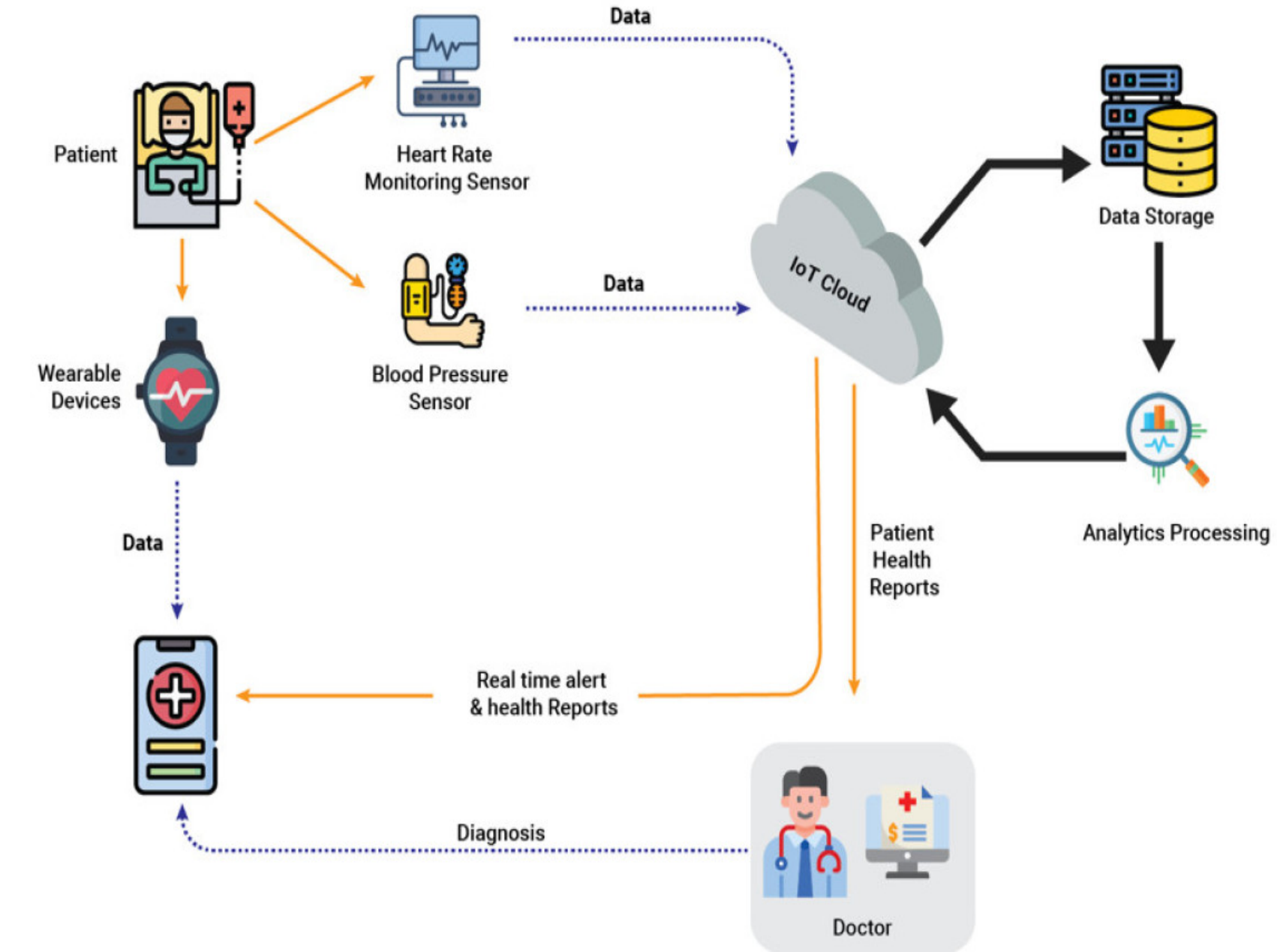
Drugs and Equipment Management: Management of drugs and medical equipment is a major challenge in a healthcare industry. Through connected devices, these are managed and utilized efficiently with reduced costs

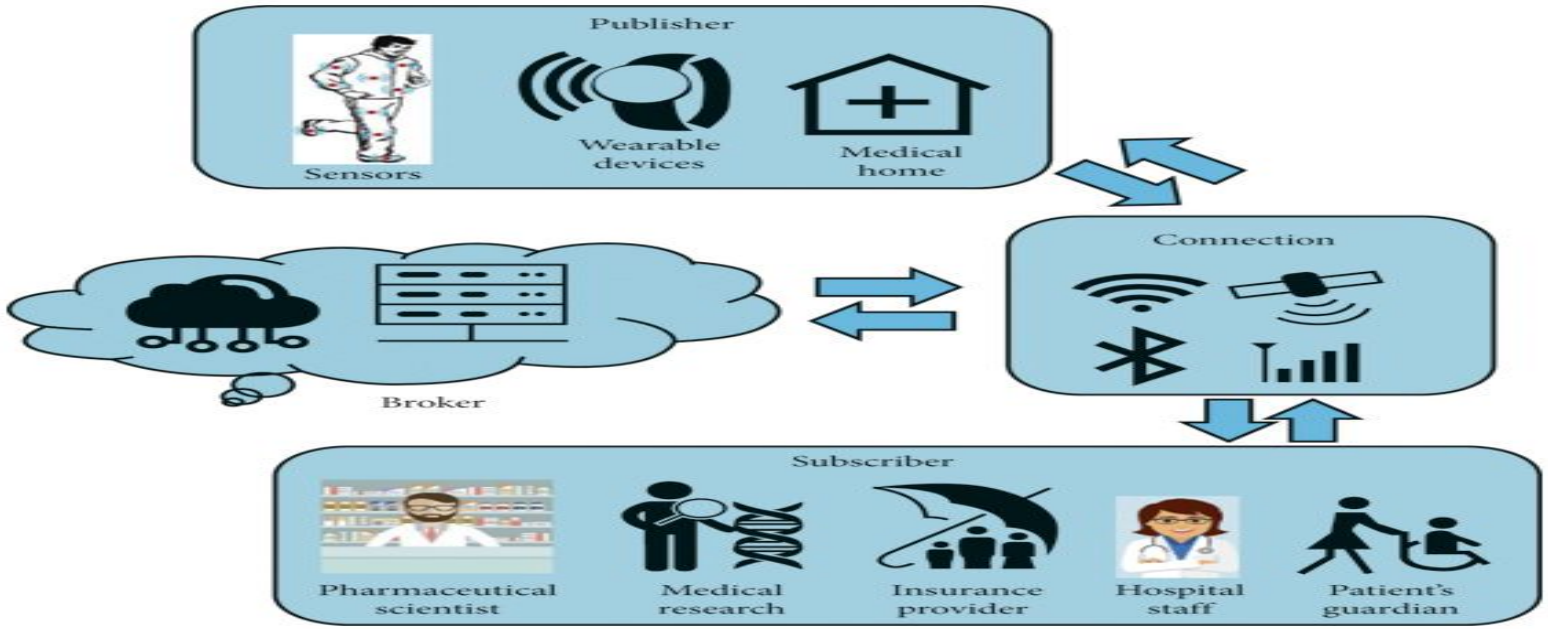
Error Reduction: Data generated through IoT devices not only help in effective decision making but also ensure smooth healthcare operations with reduced errors, waste and system costs

Healthcare IoT is not without challenges.

IoT-enabled connected devices capture huge amounts of data, including sensitive information, giving rise to concerns about data security.

Implementing apt security measures is crucial. IoT explores new dimensions of patient care through real-time health monitoring and access to patients' health data. This data is a goldmine for healthcare stakeholders to improve patient's health and experiences while making revenue opportunities and improving healthcare operations. Being prepared to harness this digital power would prove to be the differentiator in the increasingly connected world.


Patient
Heart Rate
Monitoring Sensor
Data
Data Storage
IoT Cloud
Wearable
Devices
Blood Pressure
Sensor
Data
Analytics Processing
Data
Patient
Health
Reports
Real time alert
& health Reports
Diagnosis
Doctor



IoT Applications in Healthcare

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All the best

God Bless You

Prof.Yasmeen