

INTRODUCTION TO INDUSTRIAL INTERNET

Innovation and IIoT – Intelligent Devices – Industrial Internet – Health care –Oil and Gas Industry – Smart Office – Logistics – IoT Innovations in Retail.

The industrial internet of things (IIoT) is the use of smart sensors and actuators to enhance manufacturing and industrial processes. Also known as the industrial internet or Industry 4.0, IIoT uses the power of smart machines and real-time analytics to take advantage of the data that "dumb machines" have produced in industrial settings for years. The driving philosophy behind IIoT is that smart machines are not only better than humans at capturing and analyzing data in real time, but they're also better at communicating important information that can be used to drive business decisions faster and more accurately.

Connected sensors and actuators enable companies to pick up on inefficiencies and problems sooner and save time and money, while supporting business intelligence efforts. In manufacturing, specifically, IIoT holds great potential for quality control, sustainable and green practices, supply chain traceability, and overall supply chain efficiency. In an industrial setting, IIoT is key to processes such as predictive maintenance (PdM), enhanced field service, energy management and asset tracking.

Working of IIoT

IIoT is a network of intelligent devices connected to form systems that monitor, collect, exchange and analyze data. Each industrial IoT ecosystem consists of:

- connected devices that can sense, communicate and store information about themselves;
- public and/or private data communications infrastructure;
- analytics and applications that generate business information from raw data;
- storage for the data that is generated by the IIoT devices; and
- people.

These edge devices and intelligent assets transmit information directly to the data communications infrastructure, where it's converted into actionable information on how a certain piece of machinery is operating. This information can be used for predictive maintenance, as well as to optimize business processes.

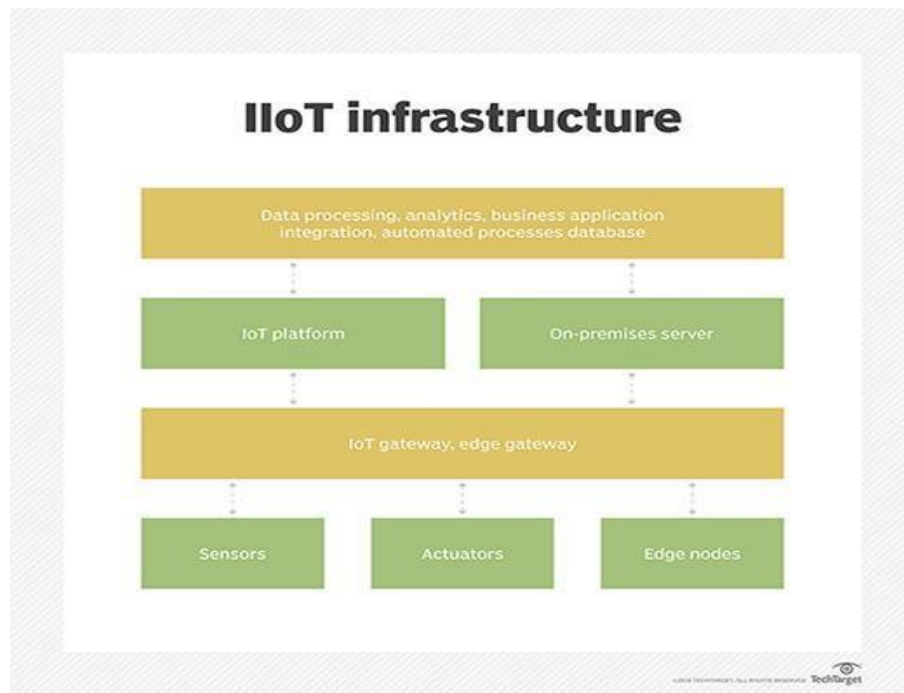


Fig.1.1 : IIoT infrastructure

IIoT utilization in Industry

There are countless industries that make use of IIoT. One example is the automotive industry, which uses IIoT devices in the manufacturing process. The automotive industry extensively uses industrial robots, and IIoT can help proactively maintain these systems and spot potential problems before they can disrupt production.

The agriculture industry makes extensive use of IIoT devices, too. Industrial sensors collect data about soil nutrients, moisture and more, enabling farmers to produce an optimal crop.

The oil and gas industry also uses industrial IoT devices. Some oil companies maintain a fleet of autonomous aircraft that can use visual and thermal imaging to detect potential problems in pipelines. This information is combined with data from other types of sensors to ensure safe operations.

Benefits of IIoT

One of the top touted benefits of IIoT devices used in the manufacturing industry is that they enable predictive maintenance. Organizations can use real-time data generated from IIoT systems to predict when a machine will need to be serviced. That way, the necessary maintenance can be performed before a failure occurs. This can be especially beneficial on a production line, where the failure of a machine might result in a work stoppage and huge costs. By proactively addressing maintenance issues, an organization can achieve better operational efficiency.

Another benefit is more efficient field service. IIoT technologies help field service technicians identify potential issues in customer equipment before they become major issues, enabling techs to fix the problems before they inconvenience customers. These technologies might also provide field service technicians with information about which parts they need to make a repair. That way, the technician has the necessary parts with them when making a service call.

Asset tracking is another IIoT perk. Suppliers, manufacturers and customers can use asset management systems to track the location, status and condition of products throughout the supply chain. The system sends instant alerts to stakeholders if the goods are damaged or at risk of being damaged, giving them the chance to take immediate or preventive action to remedy the situation.

IIoT also allows for enhanced customer satisfaction. When products are connected to the internet of things, the manufacturer can capture and analyze data about how customers use their products, enabling manufacturers and product designers to build more customer-centric product roadmaps.

IIoT also improves facility management. Manufacturing equipment is susceptible to wear and tear, which can be exacerbated by certain conditions in a factory. Sensors can monitor vibrations, temperature and other factors that might lead to suboptimal operating conditions.

IIoT security

Early on, manufacturers created IoT devices with little regard for security, resulting in a perception that IoT devices are inherently insecure. Given the similarities between IoT and IIoT devices, it's worth considering whether it's safe to use IIoT devices.

As with any other connected device, IIoT devices must be evaluated on a device-by-device basis. It's entirely possible that one manufacturer's device is secure while another isn't. Even so, security is a bigger priority among device manufacturers than ever before.

In 2014, several technology companies including AT&T, Cisco, General Electric, IBM and Intel came together to form the Industrial Internet Consortium (IIC). Although this group's primary objective is to accelerate the adoption of IIoT and related technologies, it's making security a priority, even going so far as to form a security working group. The IIC's other working groups include Technology, Liaison, Marketing, Industry and Digital Transformation.

Risks and challenges of IIoT

The biggest risks associated with IIoT use pertain to security. It's relatively common for IIoT devices to continue using default passwords, even after they have been placed into production. Similarly, many IIoT devices transmit data as clear text. These conditions would make it relatively easy for an attacker to intercept the data coming from an IIoT device. Similarly, an attacker could take over an insecure IIoT device and use it as a platform for launching an attack against other network resources. Security is a big challenge for those who are responsible for an organization's IIoT devices, but so, too, is device management. As an organization adopts more and more IIoT devices, it will become increasingly important to adopt an effective device management strategy. More specifically, organizations must be able to positively identify IIoT devices to prevent the use of rogue devices. Establishing a means of identifying each individual device is also crucial for tasks such as replacing a failed device or performing a device refresh.

Patch management presents another big challenge regarding IIoT devices. It's becoming increasingly common for device manufacturers to issue periodic firmware updates. Organizations must have an efficient means of checking devices to see if they have the latest

firmware installed and deploying new firmware if necessary. Additionally, such a tool must adhere to the organization's established maintenance schedule so as to not disrupt operations.

Difference between IoT and IIoT

Although IoT and IIoT have many technologies in common, including cloud platforms, sensors, connectivity, machine-to-machine communications and data analytics, they are used for different purposes.

IoT applications connect devices across multiple verticals, including agriculture, healthcare, enterprise, consumer and utilities, as well as government and cities. IoT devices include smart appliances, fitness bands and other applications that generally don't create emergency situations if something goes amiss.

IIoT applications, on the other hand, connect machines and devices in such industries as oil and gas, utilities and manufacturing. System failures and downtime in IIoT deployments can result in high-risk situations, or even life-threatening ones. IIoT applications are also more concerned with improving efficiency and improving health or safety, versus the user-centric nature of IoT applications.

IIoT applications and examples

In a real-world IIoT deployment of smart robotics, ABB, a power and robotics firm, uses connected sensors to monitor the maintenance needs of its robots to prompt repairs before parts break.

Likewise, commercial jetliner maker Airbus has launched what it calls the *factory of the future*, a digital manufacturing initiative to streamline operations and boost production. Airbus has integrated sensors into machines and tools on the shop floor and outfitted employees with wearable tech -- e.g., industrial smart glasses -- aimed at cutting down on errors and enhancing workplace safety.

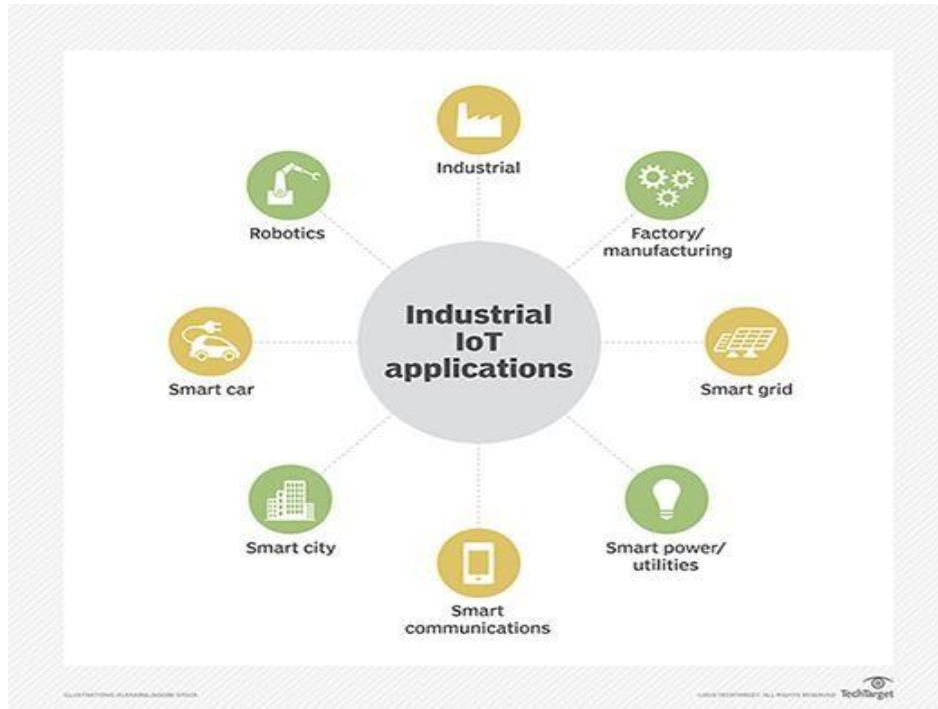


Fig. 1.2 : IIoT Applications

IIoT vendors

There are several vendors with IIoT platforms, including:

- ABB Ability. An IIoT company specializing in connectivity, software and machine intelligence.
- Aveva Wonderware. A company that develops human-machine interface (HMI) and IoT edge platforms for OEMs (original equipment manufacturers) and end users.
- Axzon. An IIoT company focusing on smart automotive manufacturing, predictive maintenance and cold chain.
- Cisco IoT. A networking company offering platforms for network connectivity, connectivity management, data control and exchange, and edge computing.
- Fanuc Field System. A company that has developed a platform for connecting various generations, makes and models of industrial IoT equipment.
- Linx Global Manufacturing. A product development and manufacturing company offering custom IIoT, application and data management platforms.

- MindSphere by Siemens. An industrial IoT solution based around artificial intelligence (AI) and advanced analytics.
- Plataine. An IIoT company specializing in using AI to generate actionable insights in manufacturing.
- Predix by GE. A platform for connecting, optimizing and scaling digital industrial applications.

IIoT and 5G

5G is the emerging standard for mobile networks. It has been specifically designed to deliver fast data throughput speeds with low latency. 5G will support download speeds of up to 20 Gbps (gigabits per second) with sub-millisecond latency.

The emergence of 5G will likely affect the use of IIoT devices in two main ways. First, 5G's high throughput and low latency will make it possible for devices to share data in real time. Previously, this was only possible when the devices were located on private networks with high-speed connectivity. This real-time connectivity will support use cases such as driverless cars and smart cities.

The other way 5G will affect IIoT adoption is that it will likely result in device proliferation. Industrial operations might use thousands of 5G connected devices. 5G's high speed and low latency also means we'll likely see IIoT devices used in remote sites whose lack of high-speed connectivity previously made IIoT use impractical.

Future of IIoT

The future of IIoT is tightly coupled with a trend known as Industry 4.0. Industry 4.0 is, essentially, the fourth Industrial Revolution.

Industry 1.0 was the first Industrial Revolution and occurred in the late 1700s as companies began to use water-powered or steam-powered machines in manufacturing. Industry 2.0 started at the beginning of the 20th century and was brought about by the introduction of electricity and assembly lines. Industry 3.0 occurred in the latter part of the 20th century and was tied to the use of computers in the manufacturing process.

IoT Intelligent Devices

IoT devices are the nonstandard computing devices that connect wirelessly to a network and have the ability to transmit data, such as the many devices on the internet of things. Connected devices are part of an ecosystem in which every device talks to other related devices in an environment to automate home and industry tasks. The devices can be categorized into three main groups: consumer, enterprise and industrial. Consumer connected devices include smart TVs, smart speakers, toys, wearables and smart appliances.

Enterprise IoT devices are edge devices designed to be used by a business. There are a huge variety of enterprise IoT devices available. These devices vary in capability but tend to be geared toward maintaining a facility or improving operational efficiency. Some options include smart locks, smart thermostats, smart lighting and smart security. Consumer versions of these technologies exist as well.

In the enterprise, smart devices can help with meetings. Smart sensors located in a conference room can help an employee locate and schedule an available room for a meeting, ensuring the proper room type, size and features are available. When meeting attendees enter the room, the temperature will adjust according to the occupancy, the lights will dim as the appropriate PowerPoint loads on the screen and the speaker begins his or her presentation.

Industrial IoT (IIoT) devices are designed to be used in factories or other industrial environments. Most IIoT devices are sensors used to monitor an assembly line or other manufacturing process. Data from various types of sensors is transmitted to monitoring applications that ensure key processes are running optimally. These same sensors can also prevent unexpected downtime by predicting when parts will need to be replaced.

If a problem occurs, the system might be able to send a notification to a service technician informing them what is wrong and what parts they will need to fix the problem. This can save the technician from coming on site to diagnose the problem and then having to travel to a warehouse to get the part needed to fix the problem.

Working of IoT devices

IoT devices vary in terms of functionality, but IoT devices have some similarities in how they work. First, IoT devices are physical objects designed to interact with the real world in some way. The device might be a sensor on an assembly line or an intelligent security camera. In either case, the device is sensing what's happening in the physical world.

The device itself includes an integrated CPU, network adapter and firmware, which is usually built on an open source platform. In most cases, IoT devices connect to a Dynamic Host Configuration Protocol server and acquire an IP address that the device can use to function on the network. Some IoT devices are directly accessible over the public internet, but most are designed to operate exclusively on private networks.

Although not an absolute requirement, many IoT devices are configured and managed through a software application. Some devices, however, have integrated web servers, thus eliminating the need for an external application.

Once an IoT device has been configured and begins to operate, most of its traffic is outbound. A security camera, for example, streams video data. Likewise, an industrial sensor streams sensor data. Some IoT devices such as smart lights, however, do accept inputs.

Bitdefender BOX - IoT Security Solution



Security solution which blocks incoming threats and can scan all your devices for vulnerabilities. It protects all your IoT devices, even when you go out! Can act as a wireless router or go alongside your current one.



Google Home- Voice controller

Google Home, the connected voice controller from Google. Besides controlling your home it also comes with Google Assistant, helping with lists, translation, news, music, calendar and many many more.

Nest Cam- Indoor camera



Nest Cam Outdoor is the monitoring tool you've been waiting for. It brings all the benefits of modern streaming technology and a sleek design so you can watch your home from anywhere.

Mr. Coffee - Smart Coffeemaker



Mr. Coffee 10-Cup Smart Optimal Brew Coffeemaker makes it easy to schedule, monitor, and modify your brew from anywhere.

SmartMat - Intelligent Yoga Mat



The interactive yoga utility that helps you perfect your yoga training through real time pressure sensing technology and smart mobile interfacing.

TrackR bravo - Tracking Device



TrackR bravo is the coin-sized tracking device that locates your belongings in real time & notifies you their location, whether they are lost or misplaced. Great for wallets, keys, phones or pets.

Linquet - Bluetooth tracking sensor



Linquet is the cloud powered tracking device you can attach to anything. Link them to the app and share their location with those interested so nothing gets left behind.

Nest Thermostat - Smart Thermostat



The Nest Thermostat learns what temperature you like and builds a schedule around yours. Also, it will send you an alert when the temperatures are threatening to ruin your belongings and appliances.

Portable Wi-Fi video camera



The smart home security camera that helps you keep home safe and stay connected - all from your smartphone. Comes with AES encryption and free private 24-hour secure cloud storage for your total peace of mind.

Smart Air Quality Monitor



Awair is the first complete device to let you communicate with your air. Awair analyzes your indoor air quality, learns your routines and can communicate with other home devices to help you achieve optimal air quality.

Navdy - Smart navigation system



Navdy combines a high quality projection display with voice and gesture controls to create a safer driving experience. Drivers no longer need to use their phone to navigate, communicate or control their music.

Smart Irrigation Controller



Manage your irrigation controller and save water with predictive schedules from anywhere using your smart device or web browser with Hydrawise web-based software.

Intelligent oven



- modern oven prepared to fit in every kitchen in order to satisfy even the most exquisite tastes. It saves a lot of the time you'd normally spend cooking when connected to your phone.

Blood Pressure Monitor

Wireless Blood Pressure Monitor makes it easy to check your blood pressure & heartrate, anytime and anywhere with an instant feedback and access to all your readings.



Smart baby monitoring



Smart Baby Movement Monitor uses a smart, washable crib sheet to show parents their baby's sleep activity and movement on their smartphone or tablet.

Home Intelligence Sensors



sensors can be thermostats, burglar alarms, leak detectors - or anything else you can think of.

Gas and CO detector



No matter where you are, if Kepler detects danger, it alerts you on your smartphone, while simultaneously flashing its lights and sounding an alarm.

IoT for 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.

Insurers may offer incentives to their customers for using and sharing health data generated by IoT devices. They can reward customers for using IoT devices to keep track of their routine activities and adherence to treatment plans and precautionary health measures. This will help insurers to reduce claims significantly. IoT devices can also enable insurance companies to validate claims through the data captured by these devices.

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.

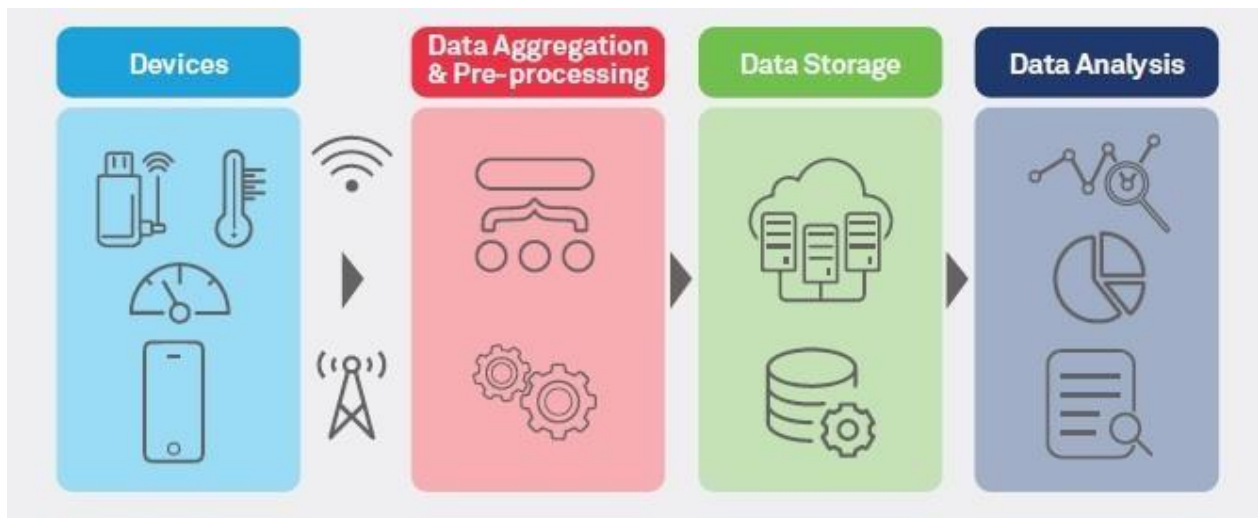


Fig.1.3 : IoT for Healthcare

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.

IoT for OIL and Gas Industry

This high-level overview and architecture focuses what IoT can bring to the oil and gas industry, or most any field, and how to get started.

Deployment of IoT-based smart energy solutions results in better field communication, reduced costs of maintenance, real-time monitoring, digital oil field infrastructure, reduced power consumption, mine automation, greater safety and security of assets, and thus higher productivity.

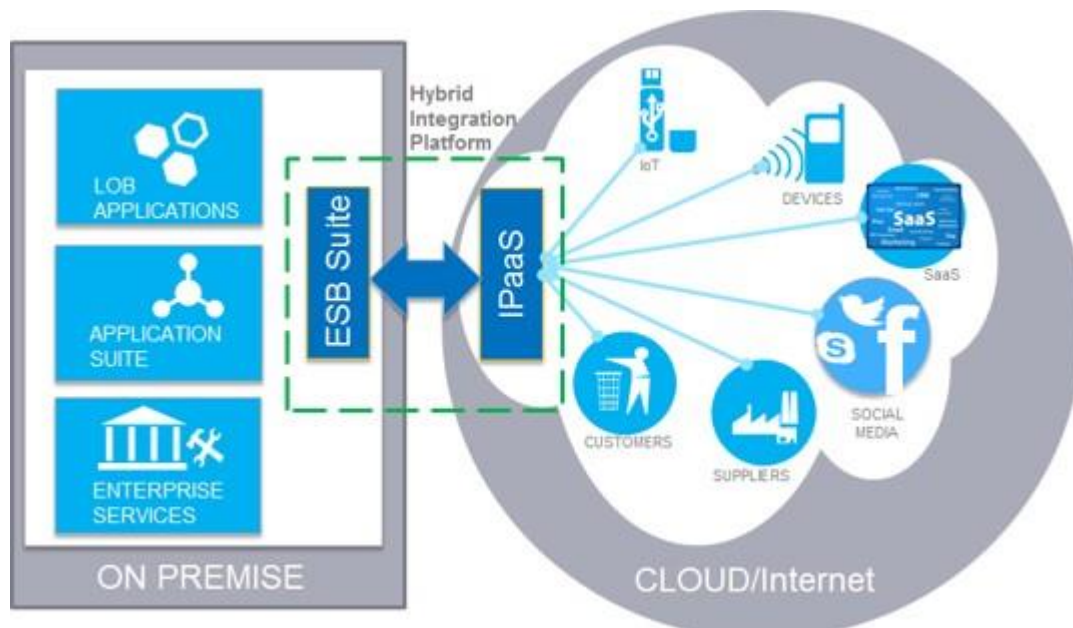


Fig.1.4 : IoT for Oil and Gas Industry

IoT will improve energy efficiency, remote monitoring and control of physical assets, and productivity through applications as diverse as home security to condition monitoring on the factory floor.

Operational Excellence

- Predictive maintenance
- Pipeline and equipment monitoring
- Location Intelligence
- Emissions monitoring and control and release management

Operations

- Real-time machine and sensor integration
- Real-time alerts
- Link to enterprise resource planning data to trigger maintenance workflow
- Plant dashboards and trend analysis
- Asset information network
- Fleet operations

MonitoringGlobal Reach

- IoT is removing the physical barriers so O&G companies helping reach broader target audiences and opening up new global business opportunities.

A typical reference architecture is depicted here for Oil and Gas Industry leveraging Microsoft Azure:

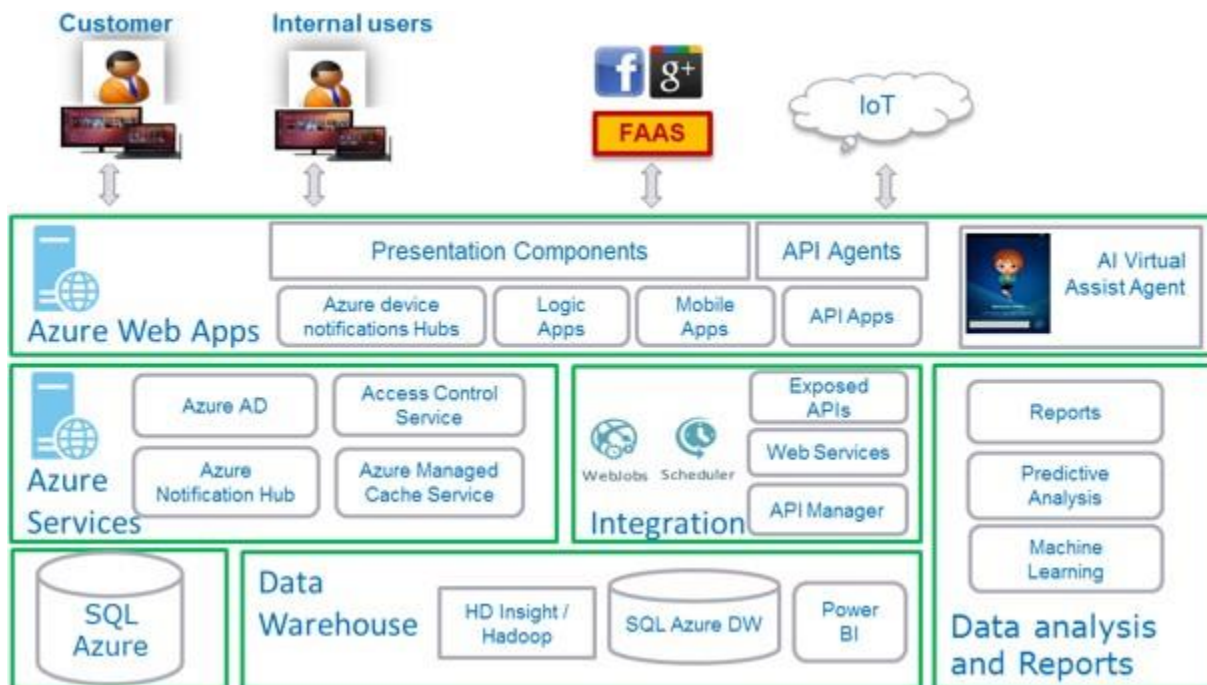


Fig.1.5 : Reference architecture for Oil and Gas Industry

Two important aspects that need to be considered when architecting an IoT solution are scalability and security. The IoT solution should be scalable to support unpredictable traffic surge while security is important at the device level to ensure it is hack-proofed. Azure IoT Hub

provides the reliability to secure the connection between device and cloud and vice-versa, but scalability has to be implemented at the architecture level.

- **Device Management:** After the device registers with the cloud gateway, it can send and receive the data to and from the hubs. It should have the device management feature to add, activate, deactivate, remove the device, and update the attributes of the device.
- **Device Connectivity:** There will be a huge amount of data that needs to be managed, with multiple messages being received in a second from a huge number of devices, which would result in 10s of thousands or possibly millions of messages a day. The platform should provide high-volume message ingestion using a single logical endpoint.
- **Transformation and Storage:** Once the messages arrive, the platform should provide a mechanism to select, transform, and route messages to various storage media for the purpose of archiving and staging for downstream processing.
- **Analytics and Data Visualization:** The value of collecting data in a continuous fashion is to build up a historical record for the purpose of performing analytics to gain business insights.
- **Presentation and Action:** The cloud solution should provide the ability to visualize the status of the messages in real time through tabular or graphical UI components. In addition, some messages may contain information of an alert status so the IoT solution must provide a mechanism for real-time notifications to actionable operation.
- **Microsoft Azure IoT Suite** is an enterprise-grade solution that lets you get started quickly through a set of extensible, preconfigured solutions that address common IoT scenarios, such as remote monitoring and predictive maintenance. These solutions are implementations of the IoT solution architecture described previously.
- The preconfigured solutions are complete, working, end-to-end solutions that include simulated devices to get you started, preconfigured Azure services such as Azure IoT Hub, Azure Event Hubs, Azure Stream Analytics, Azure Machine Learning, and Azure storage, and solution-specific management consoles. The preconfigured solutions contain proven, production-ready code that you can customize and extend to implement your own specific IoT scenarios.

Key Highlights

- HTML5-based UI to support a wider range of devices
- Modernized, highly intuitive, and easy to use UI with internationalization in compliance with customer branding guidelines
- Cloud-based, highly available, and scalable architecture to extend support for additional features in the future
- Cloud-based architecture to eliminate the constraints with increasing users and data growth in the future
- Standard REST-based integration architecture for future extensions and integrations with other on-premise or third-party systems
- Support for event notification and online monitoring
- Real-time/near real-time reporting and move towards self-service business intelligence
- Predictive analytics to improve business process efficiency
- Artificial Intelligence-based agents for learning and knowledge management
- Standards (SAML)-based federated authentication of users to accept the user identities from social networks, like Google, Microsoft, etc.

IoT Revolution in Oil and Gas Industry

- Oil and gas industry is a tech and asset-heavy sector. Malfunctions, incorrect measurements and even tiny mistakes in this field result in billions of dollars in losses and, sometimes, tragic events like Deepwater Horizon.
- Development of IoT for oil and gas industry helps solve different challenges in this field — reduce costly downtime, increase efficiency and safety on the premises and boost performance at every step of production.

Let's find out about these and many other benefits of IoT in this domain.

Challenges in the Oil and Gas Industry

Historically, this sector is associated with high turnover, enormous financial returns and great weight in the economy of a given country and the world in general. This description is valid today, however, things aren't always easy in this industry.

Executives in the oil and gas value chain constantly confront major challenges. For example:

Aging equipment and legacy systems

To make it clear, when we are talking about the equipment in this field, it implies powerful super-machines, huge drills, tankers and complex monitoring systems that perform crucial calculations to both maintain the performance and keep workers safe. They are rugged, work hard and require continuous monitoring and fast response to wear and other maintenance needs. Today, many wells rely on aging equipment and legacy monitoring systems. Upgrading them requires big money and manpower, though the downtime costs even more.

Hazardous environments

Another reason why maintaining wells and other parts of the oil and gas supply chain is challenging is the environment and accessibility. Often, deposits are found in remote offshore areas. Many oil-producing wells are built in the perilous northern seas, gas pipelines go through harsh zones like deserts and tundras. Difficult environment, accessibility and hazardous working conditions make any breakage or leak harder to contain and fix.

This makes the capabilities of Internet of Things in oil and gas industry particularly valuable.



Fig.1.6 : IoT revolution in Oil and Gas Industry

Innovation in Oil and Gas Industry

Today's technology has great potential not only to solve the challenges but also to enhance the performance in this field. Using IoT innovation for oil and gas sector is one of the approaches that receives the most attention and investment.

Sensors

Using the network of IoT sensors for oil and gas extraction and processing helps maintain ongoing control in the supply chain and quickly respond to changes. Sensor-based technology can be leveraged to monitor the pressure in the pipes, oversee the drilling process, machinery conditions and detect leakages. In this industry, the high speed of addressing issues usually translates to billions of dollars in savings.



Fig.1.7 : Sensors in Oil and Gas Industry

Smart algorithms

Smart algorithms cross-reference and analyze data and events registered and detected by diverse sensors. They create unique insights that help management make important decisions, for example, when exactly to start and stop drilling to avoid issues.

Predictive and preventive maintenance

Smart algorithms can predict when the conditions of expensive equipment change and it requires maintenance, either regular or urgent. It goes without saying that timely on-demand maintenance is more efficient than routine checks and acts as a guarantor of workers' safety.

Robots and drones

Among IoT devices for oil and gas supply chain, drones and robots play an important role. They enable efficient site exploration, ongoing data gathering and 3D mapping of landfills and can withstand hard conditions regular for drill sites.

Wearables

Wearables already boost efficiency and even save lives in this sector. Sensor-based suits, wristbands, smart glasses and helmets allow to continuously monitor the conditions of the workers which perform dangerous operations, seamlessly connect them with the base and even augment worker's capabilities providing timely advice, notification or warnings.



Fig. 1.8 : Smart Helmet in Oil and Gas Industry

Oil and Gas Monitoring Systems

IoT is inherently the first technology to think of when it comes to continuous monitoring and analysis of datum. In this respect, IoT applications in oil and gas industry for system monitoring, management and remote control make a big difference.

First of all, thanks to advancing sensor technology and increasing connectivity options, the management in the oil and gas industry can monitor anything in real-time from the changing seabed topography, the chemical composition of the crude oil to the integrity of a gas pipeline and tanker fleet positioning. The amplified capabilities of IoT-based monitoring systems can be applied all along the oil and gas supply chain upstream, midstream and downstream.

Secondly, the development of IoT technology brings advanced data analytics and visualization tools to the table. Today, management uses convenient dashboards and can track operations and read measurements on PC or mobile from the comfort of one's office, so as to respond to changes remotely using actuators and controls.

Advantages of IoT in Oil and Gas Industry

Remote monitoring which spares workers from going on-site and performing routine manual checks are not the only benefits of using IoT for oil and gas production and distribution.

Let's go through other advantages of IoT in oil and gas industry:

- Enable real-time equipment, fleet and environmental conditions monitoring and provide better transparency and control over processes.
- Allow for timely on-demand equipment maintenance and optimize related cost and effort.
- Ensure better worker safety and transfer risky on-site operations to robots and UAVs.
- Introduce automation, including automated leakage and breakage control.
- Reduce the negative environmental impact associated with oil and gas production and distribution.
- Optimize manpower and cut down on non-productive time and downtime.

IoT Smart Office

Smart office is a place equipped with the latest technology and devices that let people work faster, better and smarter. Such space is not just a new trend, it's a great modern way of thinking that brings a diversity of opportunities. IoT it is possible to do so many things that earlier were considered to be a futuristic tale. Here are just a few examples of what we can do in office if we have IoT solutions:

- Adjust the humidity and heating in office by using a smartphone.
- Use a smart scheduling system to never experience issues with booking a conference room.
- Benefit from smart sensors that will turn lightning and devices off when no one is in the office and make company more energy efficient.
- Improve security system by refusing from the old approach and passcodes and replacing them with smart locks and security cameras.
- Clean space during the lunch break thanks to smart vacuum and window cleaners that can be managed from a device.

And now let's take a look at the statistic that speaks louder than words and proves that smart IoT technologies are at the peak of their glory. Let's take a look at the table provided by Statistics that shows the number of IoT devices used worldwide.

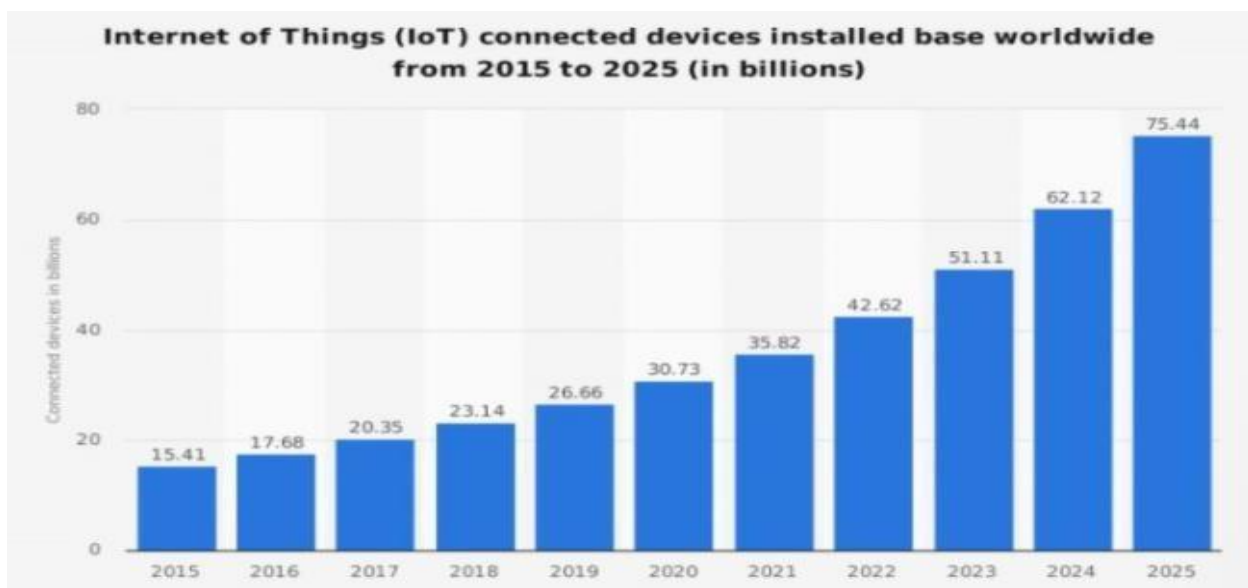


Fig.1.8 : Statistics of IoT Connected Devices

This tendency shows that more and more companies and households are going to adopt IoT technology and invest in smart projects. And this is not just because it is convenient to make everything connected and control it from a distance, the IoT adoption has way more benefits like:

- Decreased operational costs,
- Improved productivity,
- New business opportunities,
- Huge competitive advantage,
- Higher level of employee motivation and involvement.

Top 8 examples of IoT solutions for smart office

Digital transformation is crucial for offices of all sizes. It doesn't really matter whether you have 50 or 500 employees who are going to spend their working hours in office. What really matters is whether their work is efficient and whether company provide them with all necessities to boost their productivity. So to inspire change in office, we have collected several great examples of smart IoT solutions that can be actively used in working space or become the model for own custom development. And before proceed to them, just take a look at the video showing how smart office concept performs in action.



Fig. 1.9 : IoT Smart Office

Smart Business Assistant

We all use Alexa or Siri, but let's be honest, they are great for fun and domestic use but lack many things to become full time business assistant. And to have one these days is a necessity. Technologies used by Alexa for Business include numerous skill APIs (smart home, music, video, education skills), and text-to-speech.

IoT tagging for tracking devices

Although in many offices the heads encourage the usage of own smart devices for work, in others it is still preferable to use office owned devices. But this requires their constant tracking – who took what, and where that device is now. Let's take a real time tracker called Aruba as an example. If there is a smart solution of a kind in company, then we can monitor and pinpoint where this or that device is. It takes a couple of seconds to find what we need within office space.

Smart thermostats

These were the first IoT devices that found their place in our households, but they can be no less useful in office. The ability of smart thermostats to dynamically adjust the temperature in the office can make the working environment more comfortable and let cut costs spent on inefficient and expensive climate control systems. Smart thermostats can be controlled remotely and also with the help of the voice assistance, and there is a huge variety of them available on the market.

Tools for environment monitoring

Twine is a small but extremely intelligent IoT device that is responsible for the advanced diagnostics in household or office space. It can monitor internal and inside temperature, humidity, and even provide advanced reports after analyzing the collected data. We can also use the additional sensors of this device to set a web app to listen to vibrations, noises, etc. and send notifications via email, SMS or even Twitter. So the app can let know when someone knocked on door, when some device stopped working, etc. Here is how the device looks.

Intelligent lightning

The smart bulbs can be connected to the devices of your employees to learn their schedules and turn the light on whenever it is needed. Also the employees will be able to adjust the brightness, color and balance of light during the day to feel comfortable and to minimize eye strain. Among

such smart bulbs you can find the ones produced by Sengled which is the leading company in smart lighting. Here is the scheme of how the lamps work.

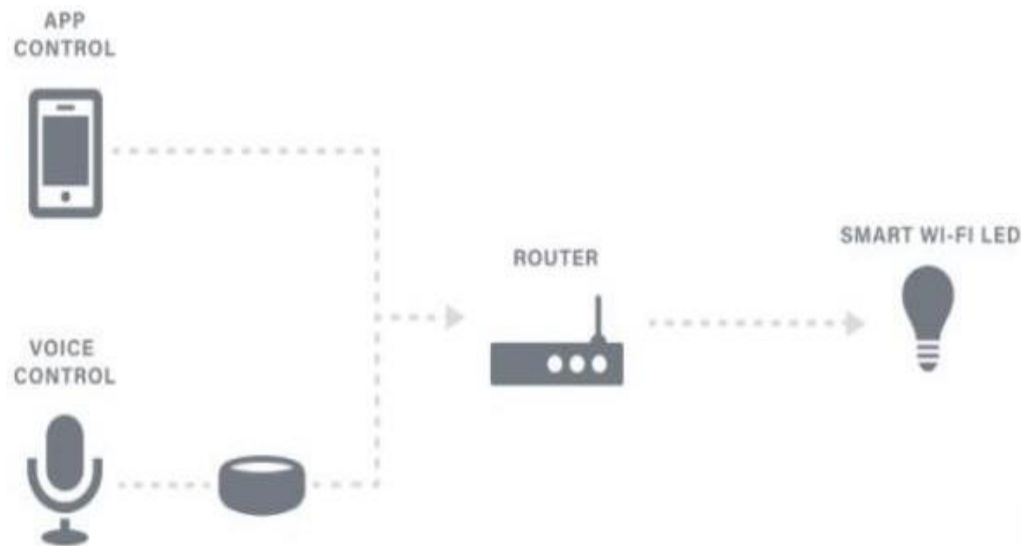


Fig.1.10 : IoT Intelligent Lighting

IoT printers

Nobody will be surprised by the fact that you can manage printers thanks to your device and Internet connection. However, smart printing is not the only advantage of these IoT powered devices. They can monitor the supplies (i.e. the paper, ink) and even perform self-diagnostics to notify the employees that a quick fix or serious repair is needed. And what's more exciting such smart IoT printers can be connected to your inventory system and let you know via notification when you need to fill in your office supplies.

Smart locks

This IoT solution will be appreciated by the owners of big companies, because employees tend to lose the keys and swipe cards that are used to let them into the office. So to keep your office safe and make entrance procedure easier for the employees, you can install smart locks connected to your attendance system. With the right set of options smart locks can even let you know what employee and when entered the office, and how many times he lives it during the day. On top of that, smart locks minimize the risk of break-ins.

Logistic Industry Innovation with IoT

Logistics management requires monitoring multiple activities at once — supply chain, warehousing, and so on. There are dozens of factors that can influence the process itself and cause delays. To streamline processes and increase customer satisfaction, logistics managers should embrace innovations that IoT has to offer.

Challenges within the logistics process

The following illustration shows an example of the process of a logistics network operator. Changing external factors, as well as increasing customer requirements pose the need for further development and expansion of the current process. With the pressure to become more and more efficient, this confronts the logistics industry with several challenges.

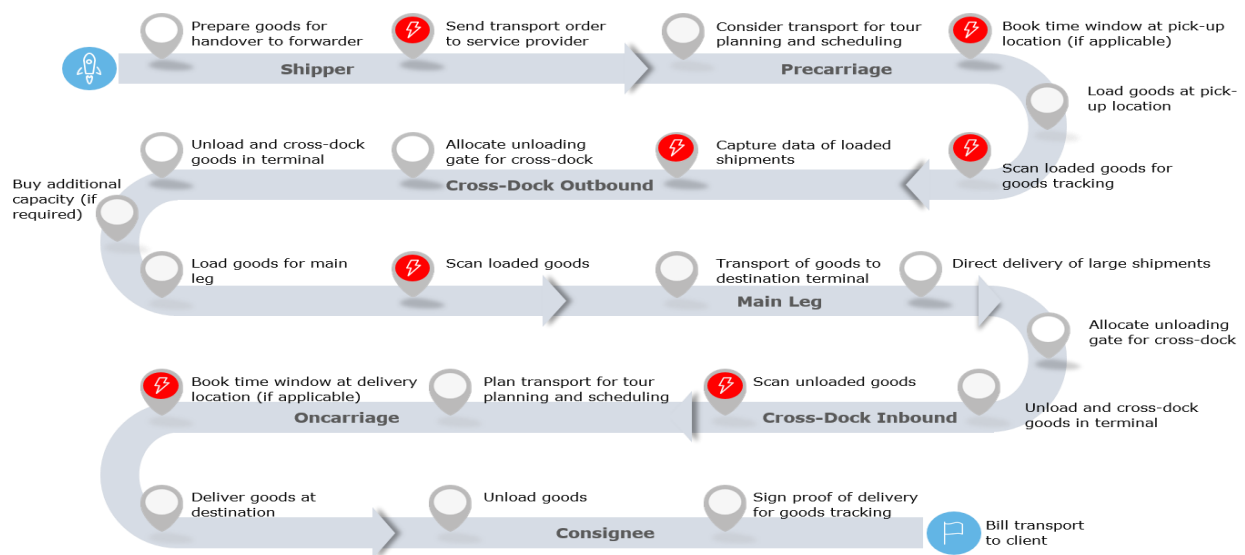


Fig.1.11 : Challenges in logistics process

Receiving transport orders

Digitization in companies is advancing more and more. Even though processes are increasingly being carried out electronically, logistics service providers often receive their orders outside the

transport systems - often still via analog channels. This increases the effort required on the part of logistics service providers to record shipment data.

Booking time windows

In order to optimize the yard planning, staff utilization and operational processes, an increasing number of clients is asking their logistics providers to book dedicated time windows to pick-up and deliver goods. The booking of the time windows usually needs to take place 24h before pick-up/delivery. The booking itself causes additional effort for the logistics providers and reduces efficiency. In addition to that, the flexibility to plan the pick-up/delivery tour is reduced which can negatively affect the utilization of the available loading capacity.

Scanning of goods

Customers are increasingly demanding reliable transparency on the status of shipments from their service providers. This requirement presents logistics companies with an enormous challenge. On the one hand, the recording of the conventional barcode by warehouse personnel is time-consuming and therefore inefficient. On the other hand, additional information, such as temperature or vibrations, must be transmitted to the customer more frequently. Current transport systems are often not suited to provide this type of information.

Capture data of loaded shipments

In the event that companies do not transmit their shipment data electronically, the data must be recorded by the service provider. This entails the risk of incorrect information being recorded, which is even increased by the existing shortage of skilled workers and outsourcing. In addition, shipments cannot be reloaded as long as the shipment data has not been recorded. In reality, this repeatedly leads to delays in operational processes.

Goals of IoT Technology for the Logistics Industry

Companies use IoT to improve logistics processes — both in warehouses and beyond. According to Statistics, by next year worldwide companies will spend over \$40 billion on connected products to increase the productivity of deliveries.

1. Improved security and theft detection

Connected applications increase the control over who enters the warehouse at any given time, help track all items, and alert the business manager in case something goes missing. Examples of IoT-powered security applications are connected CCTVs, apps that allow warehouse managers to block the doors of the facility remotely, asset tracking logistics applications that help monitor deliveries, and more.

2. Higher employee safety

Unreliable machinery puts companies at risk of endangering the lives of its staff. The Internet of Things' effects on logistics include employee protection by detecting equipment issues long before a human interacts with a tool. IoT sensors significantly increase the response time, in case something happened to an employee. A wearable immediately detects a critical change in vitals and transfers the data to a dedicated platform that alerts the manager and even calls an ambulance.

3. End-to-end product tracking

Increasing the transparency of the delivery process is the primary objective business managers want to achieve with IoT implementation. Being able to track the product all the way from the warehouse to the customer's doorstep increases the manager's confidence that all stages of the supply chain are completed smoothly. It also boosts the client's trust in the brand and saves support agents a ton of time as customers no longer bother customer support with delivery status update requests.

4. Providing business managers with advanced analytics

Thanks to a broad range of applications, the Internet of Things provides business managers with the big-picture view of the way all operations are handled. By collecting data from sensors and presenting it in a concise, understandable way, IoT offers a holistic approach to logistics management.

Here's a range of things company owners will be aware of:

- The number of items in the warehouse;
- The temperature in the warehouse;
- The environmental conditions during deliveries;
- Employee efficiency.

Real-time delivery and inventory monitoring improves the quality of planning and budget allocation. The datum, provided by the Internet of Things and logistics, comes in handy during inspections as well so that nothing will catch a manager by surprise.

5. Improving delivery

There are a handful of ways the Internet of Things facilitates delivery management. RFID tags and connected GPS sensors help business managers track shipping all the way to its final stage.

Also, thanks to connected sensors, logistics managers can get real-time location data to ensure the weather or other environmental changes will not jeopardize the delivery.

Internet of Things is Improving the Transportation Industry

Logistics and transportation have always been risky fields due to the lack of control over weather conditions, high odds of scams, and a wide range of assets to manage.

With the Internet of Things, logistics can finally become a fully controlled domain, where all the factors that could negatively impact the delivery process can be either neutralized or avoided.

In a nutshell, these are the benefits of using the Internet of Things in transportation:

- **Reliable vehicle tracking.** The Internet of Things helps businesses track the location of each vehicle and compare the most cost-efficient route with the one a driver has taken. Being highly aware of the ins-and-outs of the delivery process helps company owners evaluate employee performance and incentivize best practices, proactively react to problems on the road, and manage them with the lowest number of losses.

- Reducing shipping costs. Automated order processing and status updating help companies cut the number of employees in charge of shipping, reducing overall operating costs. Using connected bots for last-mile delivery helps cut costs exponentially, as well as increase customer satisfaction. Amazon has been benefitting from autonomous bots and drop-shipping lockers for over 5 years, improving the convenience of delivery and generating profit.
- Improved supply chain planning. The Internet of Things provides businesses with multi-faceted data — how much time it takes to sell a given amount of products in the inventory, what the ways to optimize deliveries are, which employees have better track records, which distribution centers have higher conversions. As a result, business managers can plan operations and predict the outcome of business decisions rather accurately.
- Employee monitoring. IoT devices in logistics allow business managers to monitor the staff's physical safety using wearables and vital sensors. With the Internet of Things, you will be able to protect employees from exposure to toxic substances and alert drivers if they are not adhering to safety practices. There are even devices that can detect an employee's moving speed and the number of bathroom breaks and evaluate staff's efficiency based on the data. To some managers, such in-depth tracking may be over-the-top. However, it does provide you with a better understanding of employee motivation and time-management skills.
- Preventing product theft and monitoring transportation conditions. The range of IoT and logistics anti-theft devices is enormous — connected hardware to detect intrusion, sensors for real-time asset tracking, alarm systems, smart fences, and others. A business manager will be able to find an IoT solution for logistics that provides an increased inventory and supply chain visibility, protects from scams, product theft, or tampering.

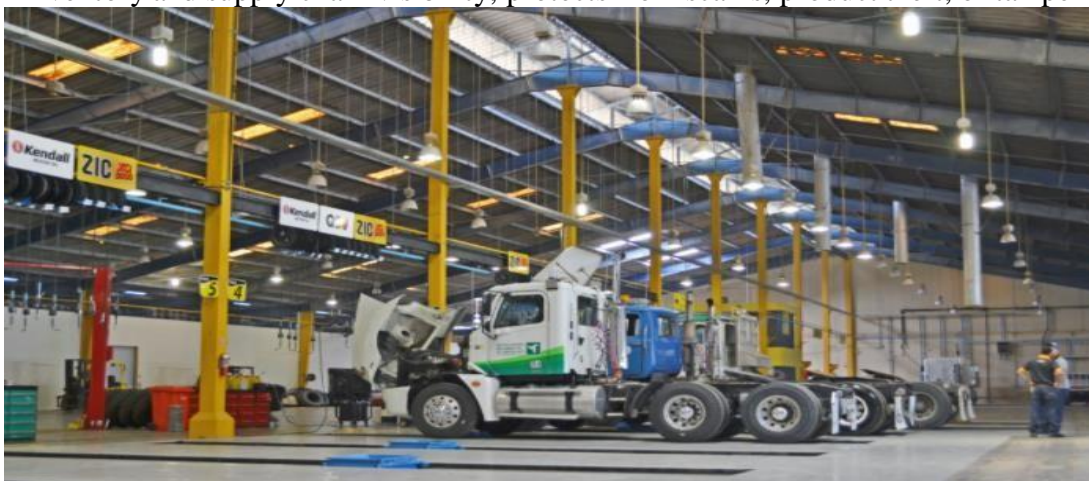


Fig.1.12 : Internet of Things in Transportation

Internet of Things Logistics Use Cases

1. Inventory tracking systems

Inventory tracking systems assist logistics managers in planning re-stocking and distributions.

2. Predictive analytics systems

Predictive analytics solutions help business managers make informed decisions regarding warehouse management and supply chain planning.

3. Location management tools

With IoT in transportation and logistics, company managers can keep track of the real-time location of each vehicle, delivery statuses, and the estimated time needed to complete the process.

4. Drone-based delivery

Drones are an efficient way to speed up and automate deliveries. In logistics, they can be used to improve navigation within the warehouse, provide customers with instant in-store deliveries, and solve last-mile delivery issues.

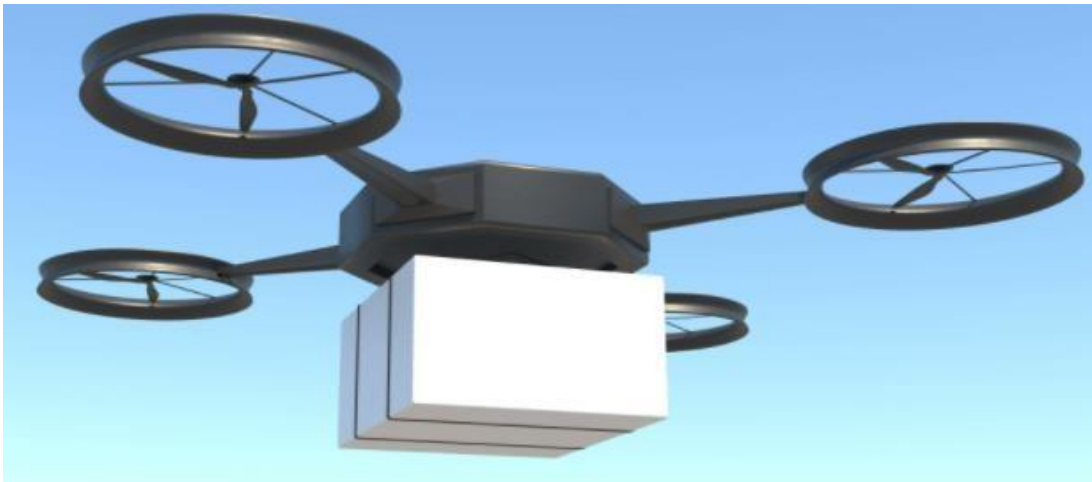


Fig.1.13 : Drone based delivery

5. Automated vehicles

Using AVs helps business managers have more control over the delivery process, reduce the impact of human error, and benefit from machine intelligence.

IoT Innovations in Retail

Amazon.com alone made an incredible leap from an average of 2 billion to 2.5 billion monthly visitors starting from February 2020. The potential of retail in our digital age is staggering i.e the industry is aware of its own issues and drawbacks. Consumer habits, high pressure on delivery services, buyers' mistrust in online purchases or lack of tech fluency are all factors that hold sellers back in an environment they could otherwise be thriving in. However, the pandemic has made many retailers rethink their strategies and speed up towards digitization.

Customer Experience Optimization with IoT

The Internet of Things and retail allows store managers to find new ways to establish a connection with a client, create a short and direct customer journey, improve the process of product maintenance, and build a long-lasting bond with first-time shoppers. Here are several examples of the application of IoT in retail for customer experience improvement.

1. Personalized communications based on the IoT-collected data

The Internet of Things makes a good case for improving communication between a customer and a brand. IoT sensors can track down a customer's habits and share insights with the marketing team. Content teams will be able to create segment-specific personalized content that would help a shopper to find the product he or she is looking for, get tips and advice, or introduce a friend to the store.

2. Optimizing product usage

All the data collected by IoT allows brands to improve product maintenance, features, even design. A company can tweak the settings and make necessary updates on a product as a client uses it at home. Moreover, all insights during the run of the product will be collected and transferred back to the company's server. When it's time to design a new lineup, all the gathered data will prove useful.

3. Monitor and predict in-store wait times

This is an important benefit of IoT technology in retail in the time of the pandemic. Long lines at cash decks increase the risks associated with COVID-19 and lower customer retention rates. It's

not just the wait that leaves the customer frustrated so much as not being able to predict the amount of time they will spend waiting. The Internet of Things is helpful as it allows brands to manage in-store wait times. The technology can provide a store's employees with data on how long a user has been waiting, suggest distractions, or offer a quieter place or useful activities to make the time in line more tolerable.

4. Using wearables for loyalty programs

Wearable technology has been a known success for fitness and healthcare. However, the wearable IoT application in retail is not limited to tracking health data. In fact, retail companies can benefit from wearables to identify loyal clients. Hotels use wristbands to identify premium guests and offer additional bonuses and discount programs for their stay. Wristbands are a non-invasive way to offer a loyalty program and say 'thank you' to those who have supported the brand since its first days.

5. Keep the customer updated on the product delivery status

The demand for delivery has surged during the pandemic and so has the pressure on the delivery services. However, insecurities regarding product delivery time and safety remain. Brands can use the Internet of Things to make sure customers are clear on expectations. The technology allows a retailer to create updates regarding the delivery status so a user can see the location of their order in real time.

Ideas for IoT use cases in retail

There is a ton of applications of IoT in retail industry for improving customer experience and just about as many in retail management. Here are the main opportunities of the Internet of Things in retail.

Customer experience personalization

Using the Internet of Things is a good way for a brand to foster a personal connection between the brand and its customers. For instance, you can attract passersby to visit your store by sending an IoT-enabled notification to their smartphones. Retailers can use the technology to find out more about a customer in order to lay the groundwork for microtargeting. This way, marketing

managers will be able to make more conscious choices and use more focused and cost-efficient advertising.

Supply chain optimization

GPS and RFID technology will allow brands to track each individual item through the entire delivery process. You will be able to have a tight grip on your vendors as you will be able to monitor the delivery conditions and the location as well as predict a precise delivery time. The range of applications of IoT in supply chain management is impressive. For instance, you can test different vendors, vehicles, and delivery routes; collect the data on the process; and find the cheapest framework that also transports the product with no damage.

Innovating in-store experiences

Implementing the Internet of Things can help retailers to redesign their stores completely. You'll be able to provide a new experience for fitting rooms, create a system of intelligent suggestions, and go as far as to replace human workers with connected technology. Amazon Go is, without a doubt, the most famous and successful example of large-scale IoT implementation for revolutionizing the in-store experience.

Increased store management efficiency

The Internet of Things and cloud-based technologies empower a range of solutions that improve the efficiency of business operations in retail. These include:

- Automated packaging services;
- SKU accounting;
- IoT drones for inventory monitoring

Implementing IoT for retail management and as a part of warehouse technology results in reducing shrinkage, managing each storage unit, and navigating the inventory easier.

Decrease the amount of workforce needed for running a store

One of the most effective ways of reducing the amount of workforce involved in store management is automating tasks using robot tech and network solutions. What seemed like something straight out of sci-fi just a few years ago is now commonplace.

IoT Applications in Retail

Location tracking

The Internet of Things solves one of the biggest issues in retail — lack of delivery reliability. The technology is capable of increasing operational efficiencies and improving logistic transparency.

Predictive equipment maintenance

Malfunctioning electric appliances (refrigerator units, for example) can lead to tremendous reputational and monetary losses, and it can send dozens of product units to waste. In order to be updated on store maintenance and take a proactive approach in equipment managers, store managers often use IoT in retail. The technology is capable of providing real-time equipment monitoring and notifying the user in case of likely malfunctioning. predictive equipment maintenance has already been implemented in transportation (Volvo and IBM), manufacturing (Chevron and Microsoft), and utilities (Florida Power Light)

Inventory management

IoT allows store managers to automate product orders, is capable of notifying when a certain product needs to be re-ordered, gathers and analyses data regarding the popularity of a certain item, and prevents theft.

There is no lack of inventory-centered IoT solutions, including:

MIT Drone Inventory System — an IoT-based drone that monitors inventory in real time and sends alerts in case there are no available units left.

Intel Retail Sensor Platform — the RFID antenna scans the number of units on the sales floor and alerts a store manager in case it's low. The platform has a plug-and-play interface and easy to adopt and use.

Lululemon uses RFID-based technology for customer-facing inventory managers. A buyer can conduct a real-time check to ensure the desired product is available at the nearest store.

Shopper mapping and analyzing mall traffic

By placing IoT sensors around the store, managers will be able to get a better understanding of the most popular zones and products. User activity heat maps help understand where it's better to put items for sale, how to optimize store space to use spaces with low activity in a more efficient way, and record and trace shopping trends over time.

Smart shelves

Smart shelf technology was widely introduced to the retail market when Kroger, the supermarket chain with the highest revenue in the US, tested over 2,000 smart shelves in 2016. As a stocker walks around the shop with a digital shopping list on their smartphone, the cell phone will vibrate in case a needed product is on the shelf nearby. Smart shelves have three common elements — an RFID tag, an RFID reader, and an antenna. All the data collected by smart shelves during the day will be later shared with a store manager to provide customer-related insights.

Personalized alerts

IoT-based hyper-personalization is widely used in retail. Geofencing and IoT beacons are both tried-and-true ways to catch a customer's attention. Here are a few IoT examples in retail that have to do with these technologies:

- Starbucks IoT beacons. Passing by a Starbucks, people would get notifications about new coffee brews or promotions and were invited to visit. According to RT Insights, the campaign has proven to be highly efficient.
- Starbucks IoT beacons. Passing by a Starbucks, people would get notifications about new coffee brews or promotions and were invited to visit. According to RT Insights, the campaign has proven to be highly efficient.

Benefits of IoT in the Retail Industry

Reducing shrinkage and fraud

As the Internet of Things adds an additional layer of traceability and visibility of the inventory and delivery process.

Optimizing product placement.

IoT allows store managers to identify premium store areas, test the placement of different items in those spots, and find the most efficient layout thanks to detailed reports based on the data gathered by sensors.

Efficient use of in-store staff.

IoT can use cameras, sensors, and facial recognition algorithms in order to identify an impatient or confused shopper. Staff will be able to make proactive decisions and successfully engineer the atmosphere within the store

Improved retail management and tracking.

IoT helps store managers be aware of the number of products on the shelves and in the inventory

Connecting online and in-store experiences

The Internet of Things in the retail industry allows users to benefit from brand-related digital solutions while using physical stores. This way, retail companies can achieve synergy between ecommerce and in-store experiences.

Text/Reference Books

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.2020
3. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014
4. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015

Question Bank

PART-A

1. List the major benefits of IIOT.
2. Compare IOT and IIOT in terms of functionality, connectivity and usage.
3. Illustrate the infrastructure of Industrial Internet of Things.
4. Identify the challenges in IIOT in Oil and gas industry.
5. Examine how IOT in smart office helps better productivity.
6. List down any 3 major use cases of IOT.
7. Examine how predictive maintenance is done using IIOT.

PART-B

1. Explain in detail the architecture of Industrial Internet of Things.
2. Describe in detail the working and communication of any four IOT intelligent devices.
3. Design and explain an architecture to implement IOT for health care in an hospital where Covid situation must be controlled via IOT.
4. How IOT in OIL and GAS industry works, Explain in detail.
5. Discuss in detail about the communication methods employed in IIOT.
6. Examine the challenges and working of Logistic Industry in IOT.