Developing Industrial IoT

SYLLABUS

Unit I:

Introduction to IoT - Definition - Market Size - IoT v IIoT Scope - History - Vertical and Business Process areas - Leading companies - Importance of building Ecosystems - IIoT Value Chain – who does what? IOT Platform, Interfaces, API, clouds, Data Management Analytics, Mining &Manipulation; Role of IIOT in Manufacturing Processes Use of IIOT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IIOT

UNIT II:

Architectures - Overview of IOT components; Various Architectures of IOT and IIOT, Advantages &disadvantages, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT

UNIT III:

Sensor and Interfacing: Introduction to sensors. Transducers, Classification, Roles of sensors in IOT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet, Current, M2M

UNIT IV:

Protocols and Cloud Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI, I2C, IIOT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIOT cloud platforms: Overview of cots cloud platforms, predix, thing works, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas.

UNIT V:

Privacy, Security and Governance: Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, Analytics and Applications Role of Analytics in IOT, Data visualization Techniques Internet of Things Applications : Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.

TEXTS:

Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications 2. Bernd Scholz-Reiter, Florian

REFERENCE MATERIALS:

1. Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
2. Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN: 978-1-84821-140-7, Willy Publications
3. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications
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Unit-1

Introduction of IoT

What is the Internet of Things (IoT)?

The term IoT, or Internet of Things, refers to the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves. Thanks to the advent of inexpensive computer chips and high bandwidth telecommunication, we now have billions of devices connected to the internet. This means everyday devices like toothbrushes, vacuums, cars, and machines can use sensors to collect data and respond intelligently to users.

The Internet of Things integrates everyday “things” with the internet. Computer Engineers have been adding sensors and processors to everyday objects since the 90s. However, progress was initially slow because the chips were big and bulky. Low power computer chips called RFID tags were first used to track expensive equipment. As computing devices shrank in size, these chips also became smaller, faster, and smarter over time.

INTRODUCTION TO INDUSTRIAL INTERNET

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.

IoT Devices Market Size

IoT Devices Market size was valued at USD 83.76 Billion in 2021 and is projected to reach **USD 508.25 Billion by 2030,** growing at a **CAGR of 22.19% from 2023 to 2030.**

The growth of wireless networking technologies including Wi-Fi, Bluetooth, ZigBee, Z-Wave, Instron, and Digital Enhanced Cordless Telecommunications will increase the number of customers interested in buying IoT devices. This is a critical feature of the IoT Devices Market revenue development. In addition, the growing need for digitalization, increasing penetration of communication and networking technologies, advances in machine learning and AI technologies, increase in the availability of cloud computing platforms, and increase in the use of sensors, are some other factors expected to contribute to growth.

Internet of Things (IoT) vs Industrial Internet of Things (IIoT)

Introduction

Business opportunities created by the Internet of Things (IoT) and the Industrial IoT (IIoT) are among the most debated topics. These are considered important for a broad range of consumer and industrial applications. Leading market research firms already estimate that by 2020 there will be over 20 billion. Installed end-point devices worldwide which are part of IoT and IIoT. Although the forecasted number is growing every year. It is not clear whether these figures correctly refer to deployments which can be and which cannot be considered as an IoT or IIoT.

"Predicated on IoT, Industrial Internet of Things (IIoT) acts as a catalyst for the revolution in Industry 4.0. At a time, when IoT significantly impacts and influences global consumer behavior, the IIoT transforms the way industries function. Although both IoT and IIoT are born of the same mother, they are destined to play disparate roles in this digitized world."

Difference between IoT and IIoT

IoT, Internet of Things is in Everything from cars, home appliances to shoes, and light switches that connect to the internet. Passing and receiving data and connecting the physical world to the digital world are considered a smart object.

Hmm…sounds interesting but did you know there are two categories in IoT

Other than the IoT we mentioned above. There is another similar concept called IIoT, which stands for the Industrial Internet of Things. Both of them have some similarities like the character of availability, intelligent and connected devices. The only difference between those two is their general usages. While IoT is most commonly used for consumer usage. IIoT is used for industrial purposes such as manufacturing, supply chain monitor, and management system. This illustration below will give you a clearer picture of both concepts.

IoT vs IIoT

Applications of IoT and IIoT

The IoT refers to applications such as checking the availability of a product in the store. Here the specific intelligence is provided through a cloud-based service offered by a service provider who manages that ecosystem. Therefore, the IoT ecosystem provides unique value to users of this service. It is useful for small-scale projects or testing a new idea but not for large scale implementations.

The IIoT refers to an industrial operation where a technology sensor is connected to a Programmable Logic Controller. That data will be processed using cloud-based (proprietary) information, and the result is an optimized operation. The IIoT ecosystem (service provider) adds extra intelligence, which a specific user can not access. It has access to multiple systems and sensors and can be controlled simultaneously and since data is cloud-based the data can be organized, stacked easily.

IoT and IIoT comparitive analysis

1.Utility-consuption vs output

IoT helps optimize consumption, personal comfort, easy use, control expenses. While IIoT aims to achieve maximum efficiency and smooth workflow in any processor unit.

2.Applications-Personal use vs productivity

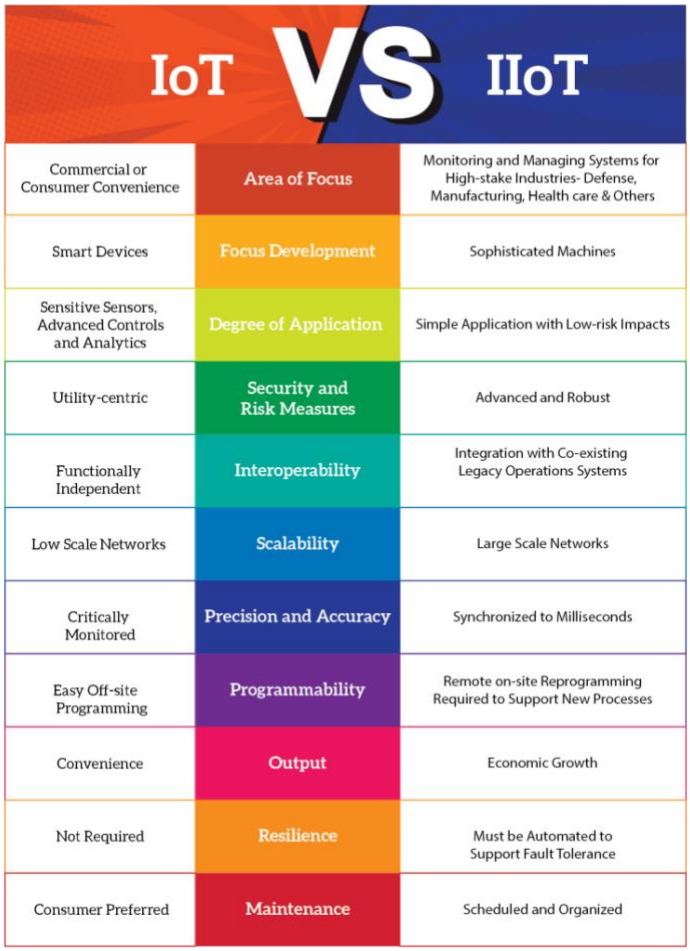
IoT is used to automate day-to-day household processes, try out new things, and experiment. While IIoT is mainly used for monitoring productions and business environmental parameters.

3.Reliability-Flexible vs dormancy

In industries, IoT devices need to be fast, withstand high temperatures, volume pressure, withstand heavy-duty cycles within tolerance, and operate reliably for decades. But IoT on the other hand since IoT is only used in household purposes the flexibility is high.

4.Privacy—Advanced vs. Robust

From encrypted and agile system architectures, specialized chipsets, threat detection to authentication in management processes, IIoT solutions require a number of security measures for system management. It is very costly to maintain these IIoT systems. On the other hand, even though we don't a lot of security in IoT devices it is more cheap and affordable compared to IIoT devices.



comprehensive comparision of IoT and IIoT

Conclusion

A common understanding of the IoT and IIoT speaks of the concept being the same. Having understood the difference mentioned above, we can easily deduce that both these technologies are meant to play disparate roles. The objectives can be the same for IoT and IIoT. But there's a huge difference in their design, engineering, and in the environment in which these technologies are meant to be implemented.

IoT devices are more used in household purposes and are not completely automated. They are more on the general usage side whereas IIoT is more on the professional side. It is mostly used for high-end applications and is mostly fully automated and can work in extreme conditions.

We all hope for huge IoT/IIoT deployments in the future, as this is good for users, vendors, and also for innovation. But anyone considering to develop a new IoT/IIoT ecosystem, shall focus on the real needs and values and properly designed cloud-data based architecture.

Cyber protection for any IT and ICS architecture consists of three essential and achievable elements: the use of cyber secured technologies, strict adherence to policies, and careful user behavior achieved through awareness training. Innovative technologies, components, and architectures that will include cyber protection as part of the IoT/IIoT ecosystem at no extra cost will drive success.

History of IOT

The Internet of Things (IoT) has not been around that long. It was only in 1999 that the term 'internet of things' was coined by Kevin Ashton. Ashton used the phrase as the title of his presentation for a new sensor project he was working on and it stuck from there.

While the phrase came about in 1999, the concept of connected devices dates back to 1832. When the first electromagnetic telegraph was designed, allowing direct communication between two machines through the transfer of electrical signals. However, the true Internet of Things history began with the invention of the Internet in the late 1960s.

The world's first IoT device

The world's first IoT device was invented in the early 1980s at the Carnegie Melon University. A group of students from the university created a way to get their campus Coca-Cola vending machine to report on its contents through a network in order to save them the trek if the machine was out of Coke. They installed micro-switches into the machine to report on how many Coke cans were available and if they were cold.

The 1990s

In 1990, John Romkey connected a toaster to the internet for the first time. A year later, a group of students at the University of Cambridge used a web camera to report on coffee. They came up with the idea to use the first web camera prototype to monitor the amount of coffee available in their computer labs coffee pot. They did this by programming the web camera to take photos three times a minute of the coffee pot. The photos were then sent to local computers so everyone could see if there was coffee available.

In 21st Century

The Internet of Things was a common topic used by the media at the beginning of the 21st Century with several major developments paving the way for the future of IoT. LG Electronics introduced the world's first refrigerator connected to the internet in 2000. Allowing consumers to do their food shopping online and make video calls. This invention was followed by a small rabbit-shaped robot in 2005 that could report the latest news, weather forecasts and stock market changes. While the first International Conference on Internet of Things was held in 2008 in Switzerland.

Today there are more than 27 billion devices connected to the Internet of Things, with experts expecting this number to rise to over 100 billion devices by 2030.

OR

History of IoT The businesses have been reaping benefits from the Internet since it emerged four decades ago in 1960s (Howe, 2016). Simultaneously, another technology, which digitally identify and manage things in the physical world started to emerge. That is the use of sensors, actuators, electronic tags, etc. to transfer physical world information via networks. A major difference between the Internet and IoT is that Internet represents a virtual world of services even though the content is physically stored in real servers. Whereas, IoT technology facilitates to interact with things in the physical world through the internet. M2M (Machine-to-Machine) is a technology connecting devices via a network allowing communication among them without human interference (Rouse, 2010). M2M solutions facilitate remote monitoring and managing enterprise assets and the users to obtain information such as inventory levels. Organizations are embracing IoT solutions for their business needs for which they mainly depended on M2M solutions. The factors contributing to this trend are the rising need to obtain information on physical environment and its activities, technological advancements and improved networking capabilities and low cost of components, data collection and processing (Rayes & Samer, 2017).

Vertical process in IoT

What is vertical in IoT?

With the advancement of IoT technologies, two business models have emerged: vertical and horizontal. The vertical market is **closely focused on meeting the needs of one specific industry that is provided and controlled by the same company**.

Business Process in IOT

What is a Business Process?

A business process is defined as a series of tasks or a set of activities performed by a group of stakeholders to achieve an organizational goal. The processes are performed by people or systems in a structured manner to attain a pre-defined objective. Efficient and streamlined execution of business processes directly contributes to the success of business operations and growth.

A business process has also been defined in simple terms as a set of activities and tasks that, once completed, will accomplish an organizational goal.

Each step in a business process denotes a task that is assigned to a participant. It is the fundamental building block for several related ideas such as business process management, process automation, etc.

While there's a deluge of things written and said about business process management, it's essential to understand why they are so important to your business.

Types of Business Processes

1. Core processes

These processes are the critical functions of a business that directly add value to the end customers. These processes are critically aligned with the fundamental values, objectives, and vision of the business. Businesses must continuously monitor and improve these processes as they primarily contribute to the growth and revenue flow of the organization.

2. Support processes

These processes enable and support the core processes to be performed seamlessly. Although they do not contribute to revenue generation, they assist internal departments in creating a collaborative environment where the core processes can be aligned to work better. Human resources, finance management, administration, and operations fall under supporting processes as they help expand a business.

3. Management processes

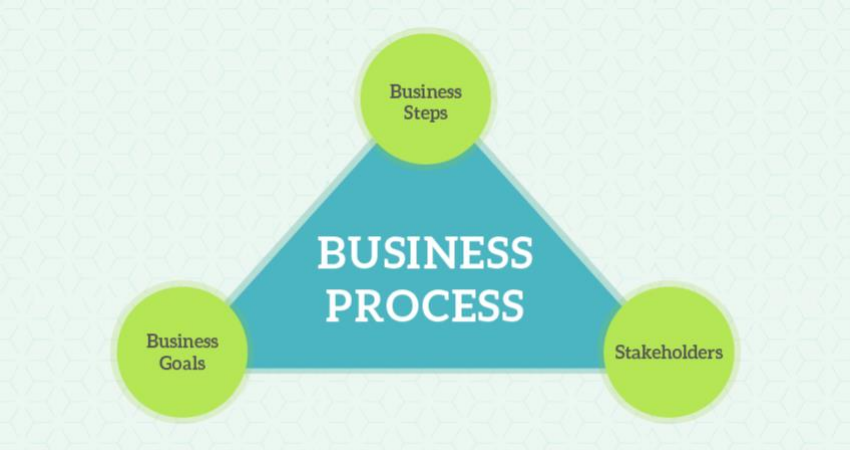
These processes are responsible for planning, monitoring, managing, and controlling the core and supporting processes from start to end. These processes are goal-oriented and ensure that business operations are carried out efficiently and seamlessly. Their focus is to monitor business functionalities internally and externally, analyze opportunities and challenges, and ensure continuous improvement of all processes.

Business Process Technology

Business process technology refers to the use of technology, such as software and systems, to automate, streamline, and optimize business processes. It helps organizations improve efficiency, reduce errors, and save time and resources on manual task completion. It can be customized as per needs and can be used in a variety of industries. Workflow management software, Customer Relationship Management (CRM) systems, and Enterprise Resource Planning (ERP) systems are a few examples of business process technology.

The Importance of Business Processes

The need for and advantages of a business process are quite apparent in large organizations. A process forms the lifeline for any business and helps it streamline individual activities, making sure that resources are put to optimal use.



Key reasons to have well-defined business processes

- Identify what tasks are important to your larger business goals
- Improve process efficiency
- Streamline communication between people/functions/departments
- Set approvals to ensure accountability and optimum use of resources
- Prevent chaos from creeping into your day-to-day operations
- Standardize a set of procedures to complete tasks that really matter to your business

An Example of a Business Process

As an example, let's consider the hiring process of an HR department. Right from posting the job opening to onboarding the employee, there are multiple steps involved in the process. Although this can vary from organization to organization, a simple workflow might look like this:

- The HR executive posts the job update
- Multiple candidates apply in a portal
- The HR executive screens the candidates and filters the best-fits
- The selected candidates are called for the next stages of the recruitment
- The right candidate is chosen at the last stage of the recruitment
- Salary and policy negotiations take place
- The offer letter is sent and the candidate accepts

Leading Companies of IOT Industry

internet of Things (IoT) is a network of physical objects or people called “things” that are embedded with software, electronics, networks, and sensors that allow these objects to collect and exchange data in order to extend the Internet connectivity from standard devices like computer, mobile, tablet to relatively dumb devices like a Toaster or Bulb.

Today several industries use the Internet of things (IoT) in smart homes, smart cities, farming, IoT e-commerce chains, and manufacturing. Companies’ involvement in the Internet of things is on the rise worldwide, with big and small firms are developing IoT devices to offer integrated IoT services.

Following is a handpicked list of Top IoT companies with their website links.

Top IoT Companies | IoT (Internet Of Things) Service Providers

1) Samsara

Samsara is one of the leading service providers in IoT. They help you increase the efficiency, safety, and sustainability of the operations that power up your business. This IoT service provider firm offers data solutions that aim to enhance operational safety and efficiency for an array of industries.

The company’s connected sensors allow businesses to manage various operations easily. It helps you to track and monitor operations.

2) Vates

Vates offers high-end prototyping services which helps you to ensure that your IOT product is market-ready. This IoT service provider assists you with critical decisions that occur during the design and development of an IoT software.

IOT Services: E IoT Software Development, IoT System Integrator, IoT Hardware Knowledge.

3) Oxagile

Oxagile offers robust and secure IoT solutions driven by device-generated data and compliance. This IoT service provider has a team of IoT developers who help you with your IoT hardware/software development process and bring value to your business at any stage.

IOT Services: Software Development, IoT Consulting Services, Hardware Prototyping, and Integration Services.

4) Verizon

Verizon is an IoT platform that enables connectivity management of IoT at a bigger scale. This firm helps you to troubleshoot, locate, and manage your IoT devices' lifecycle.

IoT Services: IoT Security Credentialing**,** IoT Marketplace, IoT for small business, Connected commerce, Connected fleet and field services.

5) HQ Software Industrial IoT Company

HQ Software is a well-known IoT service provider firm. They have completed 450 projects for 300+ clients from the USA, Australia, Norway, Denmark, Germany, and many other countries worldwide.

The firm mainly focus on each aspect of the IoT ecosystem for creating low-level programming for hardware. This IoT service provider firm also offers client's new IOT products and service opportunities.

IoT Services: Automate processes, make better decisions based on enhanced analytics, and unveil a new product or service opportunities., Rapidly build a PoC or prototype to run focus group testing.

6) IBM

IBM is one of the oldest and highly popular IoT firms. It offers the best IoT solutions which suits various industries and business.

IOT Services: Manage and integrate IoT data. Maximize your IoT data. Keep your IoT secure.

7) PTC

PTC is one of the reputed IoT service provider company. The firm provides a market-proven solution that enables companies to drive digital transformation. The full form of PTC is (Parametric Technology Corporation)

IOT Services: Industrial IoT-Build, Develop, & Deploy smart connected solutions.

8) GE Digital

GE Digital is one of the best IoT companies that offer a wide range of test platforms, health modeling and distribution optimization. It provides the best analytical solutions according to your business.

IOT Services: Asset connectivity, edge technologies, analytics and machine learning, big data processing, and asset-centric digital twins.

9) Bosch IoT Sensor Company

Bosch is an open-source-based software platform for IoT solutions. This IoT service provider firm helps connect with more than 10 million sensors, devices, and machines with their users and enterprise systems.

IoT Services: Creating digital representations of physical devices, managing and analyzing IoT data for creating digital representations of physical devices, Visualizing all data from diverse sources within one dashboard.

10) Eastern Peek

Eastern Peak is an IoT service provider that offers custom IoT app development services to startups, medium-sized companies, and enterprises. The company delivers a wide range of Internet of Things solutions and services.

IoT Services: IoT service for connected cars, IoT for sports and healthcare, Industrial IoT service, and IoT consulting services.

11) Digi

Digi is an IoT company that helps you design, deploy, and manage a connected device network. It is built to provide seamless connectivity and reliable performance.

IoT Services: Digi Remote manager, Wireless design services, Trustfency security network, Design and Build Services, Built-in Security, Remote Management.

12) SAP

SAP provides Internet of Things solution which offers capabilities to address industrial IoT. This platform enables users to reimagine business processes and models with embedded IoT services and data.

IOT Services: Cloud service for building IoT applications and integration to business applications. Big Data with built-in and managed event-driven integration framework, Analytical services with live integration to SAP Analytics Cloud.

13) Cisco

Cisco Systems offers various products and services for Networking, IoT, Mobility & Wireless, Collaboration, Datacenter, etc. It helps you to transform your operational network to an IP-based Industrial network.

IOT Services: IoT Networking, IoT Gateways, IoT Operations Management, IoT Data Management, IoT Security. Built-in security, IoT Utilities Services.

14) Telit

Telit offers the industry's best IoT products and solutions. This firm helps you to provide the best IoT expertise and development resources.

Telit offers products and solutions that include cellular communication modules in all technologies, GNSS, short-to-long range wireless modules, and IoT software platforms.

IoT Services: IoT Modules, IoT Connectivity, IoT platforms.

15) Particle

Particle is an IoT platform that combines software, hardware, and connectivity as an integrated solution. This IoT service provider helps you to ensure that your IoT products are reliable, scalable, and secure.

IoT Services: Connectivity, Wi-Fi, Internet of Things, Infrastructure Management, and M2M.

16) Intellias

Intellias is an IoT and digital solutions provider that delivers solutions to Fortune 500 companies and leading technology innovators.

IOT Services: Digital Consulting,

17) Konstant Infosolutions

Konstant Infosolutions is a widely known mobile app development company delivering best-in-class IoT solutions. This firm uses current technologies and tools for IoT solutions to provide a seamlessly connected experience to the customers.

IoT Services: Business Value Across Markets, Strategic Consulting, Seamless IoT Integration.

18) Mobiloitte Inc

Mobiloitte is an IoT service provider that helps you to make your business smart with its world-class, cutting-edge IoT application development solutions and services.

IOT Services: IoT Application Development using IoT platforms, Industry Based IoT Services, Smart Healthcare,

Smart Agriculture, Smart Education, Home Automation, IoT Hospitality, IoT Telecom, etc.

19) Softeq

Softeq is a global full-stack IOT development firm that designs and develop IoT services, custom software, desktop apps, mobile apps, big data, and machine learning-powered solutions.

IOT Services: Industrial IoT, Consumer IoT, Healthcare IoT, Hardware Prototyping and Design, Embedded Software Development, IoT Dashboards, Mobile Apps for Connected Devices.

20) Mobidev

MobiDev is an IoT service provider firm that helps you to create complex business-driven solutions. It focuses on innovation and transparency of actions, guaranteed product delivery, and continuous evolution. The company mainly focuses on Internet of Things, Augmented Reality and Data Science.

IOT Services: IoT software architecture,IoT firmware integration, Smart connectivity, Cloud services for IoT, Predictive analytics, IoT consulting.

21) SoluLab

SoluLab is a leading IoT, web, and mobile apps development company. This IoT startup company provides ideal IoT solutions for your business.

IOT Services: IoT enabled blockchain development, web, mobile apps development, IoT, AI/ML, and Big Data development.

22) DCSL Software Ltd

DCSL Software is one of the UK's leading IoT development companies. This firm helps you design intelligent, cost-effective, and intuitive IoT solutions, web applications, desktop applications, and mobile apps to streamline your business processes.

IoT Services: Offers a completely customizable user interface (UI) dashboard, Quick and simple reporting that can be emailed or printed, Stores large amounts of data indefinitely.

🚀 Which are the Best IOT Companies?

Below are some of the Best IOT Companies:

- Samsara
- Vates
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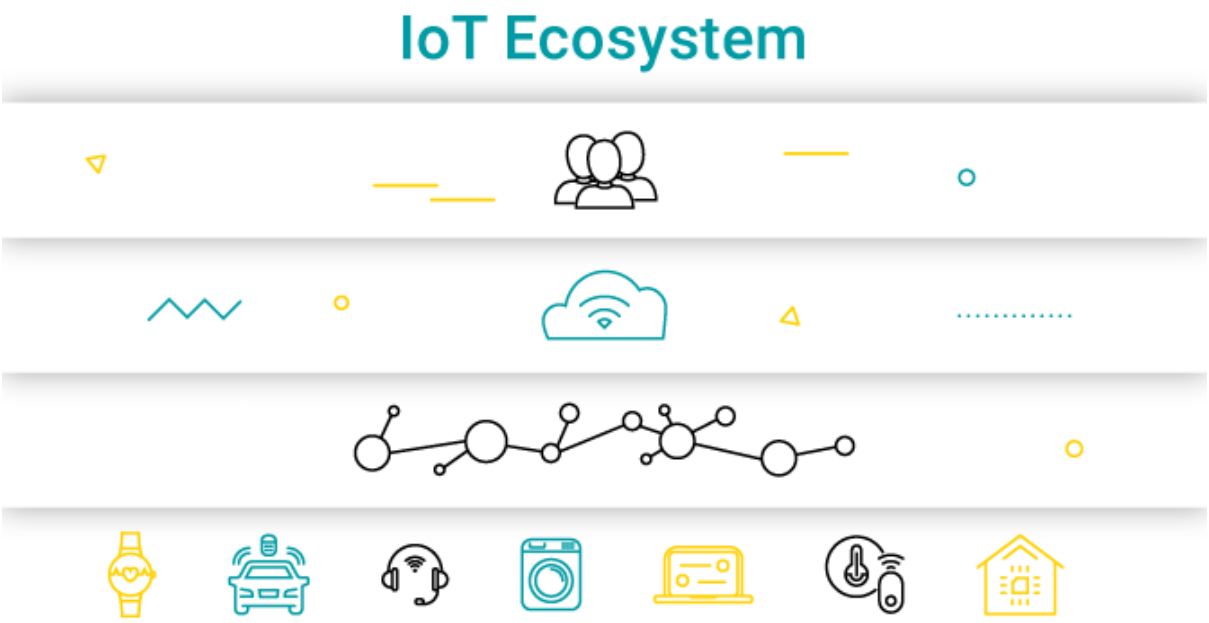
- IBM
- PTC

IOT EcoSystem

IoT ecosystem: 4 key elements

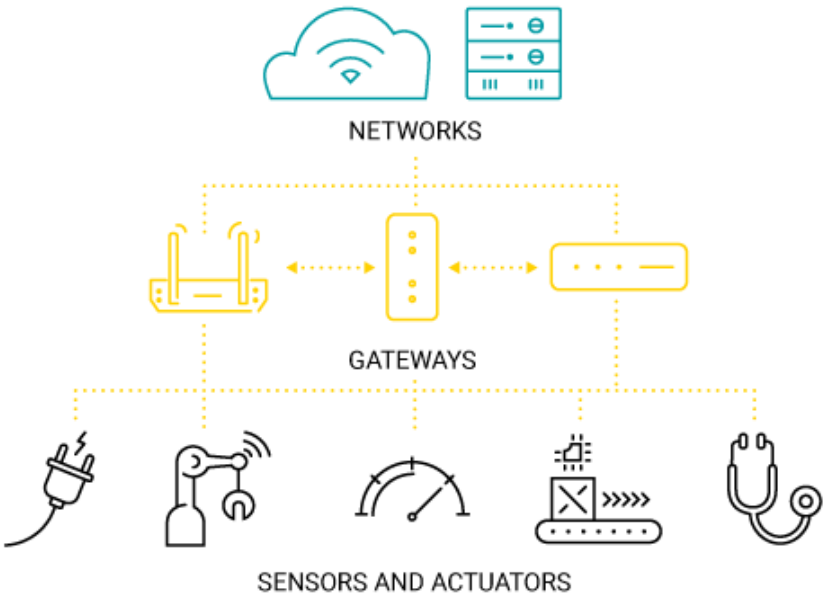


IoT devices don’t exist in a void. A lone sensor isn’t really good for anything, nor is a bunch of them, for that matter, unless they are all connected to one another and to platforms that generate data for further use. This is what we call an **Internet of Things (IoT) ecosystem – a broad network of connected and interdependent devices and technologies that are applied by specialists towards a specific goal**, such as the creation of a smart city.

Obviously, there are limitless applications to the IoT and therefore we can speak of endless coexisting IoT ecosystems. But if you boil what is happening in the ecosystem down to the bare essentials, you will come up with a simple schema: a **device** collects data and sends it across the **network** to a **platform** that aggregates the data for future use by the **agent**. And so we have the key components to an IoT ecosystem: devices, networks, platforms, and agents. Let’s discuss them in more detail.

IoT devices

As we said earlier, there are many scenarios in which IoT can be employed and they all require different devices. Here, at the most basic level, we can speak of **sensors** (i.e. devices that sense things, such as temperature, motion, particles, etc.) and **actuators** (i.e. devices that act on things, such as switches or rotors).
Rarely, though, will a smart solution make do with just one type of an IoT sensor or an actuator. If you think of a smart surgical robot, for example, it will require hundreds, if not thousands, of components that measure different parameters and act accordingly. But even apparently less complicated solutions aren't truly that easy. Consider running a smart farm – for a plant to grow, it's not just a matter of measuring the humidity of the soil, but also its fertility; it's also a matter of providing proper irrigation based on insolation, and much more. So you need not just one, but many sensors and actuators that all have to work together.
When speaking of devices essential for the IoT ecosystem, one cannot forget about IoT gateways. They are a piece of hardware that is capable of "translating" and facilitating the essential connection between devices or between devices and the network and work as a kind of relay for the two. Which brings us to the next element of our puzzle…

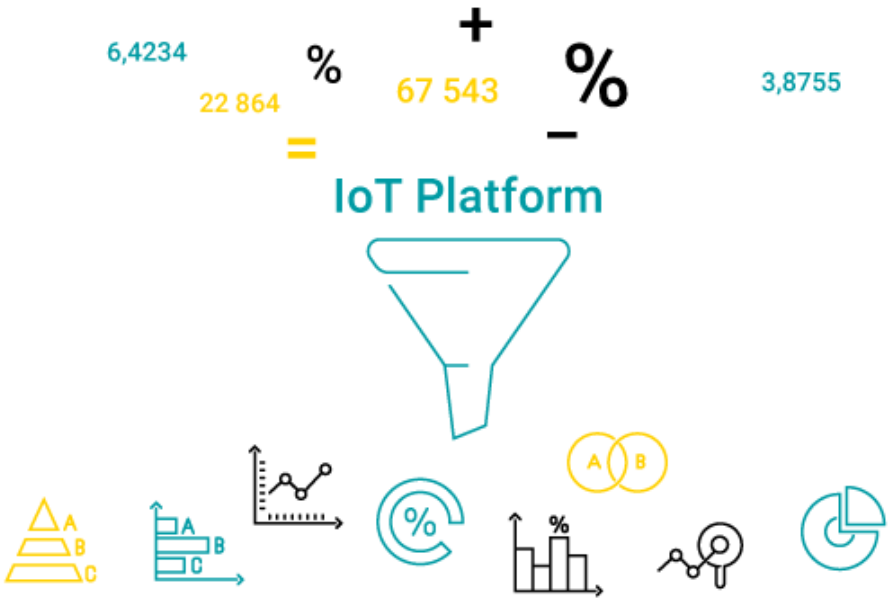


Networks

Based on what you read before, you may think: “Well, if an automatic door senses my presence and opens itself, is that IoT?” Obviously, it is not, because while that door has sensors and actuators, it is not connected to much else. And, as the name suggests,**the Internet of Things requires both things and the Internet (although there are cases of data delivery without the use of the Internet Protocol). Arguably, the real power of this concept lies in the connectivity.**
Again, based on your deployment needs, there are plenty of different IoT connectivity options, starting with the “classics,” such as WiFi or Bluetooth, to more specialized and field-oriented technologies, such as Low-Power Wide Area Networks (LPWAN). **They all differ in range and speed of data transfer, making them more or less appropriate for particular deployments.** Consider, for example, smart cars that require both high data speed and long range and juxtapose them with the smart farms we’ve mentioned that don’t necessarily need either.

IoT platform

Whether they are in the cloud or not, **IoT platforms are always the binder for any IoT ecosystem.** They are the quiet administrators that take care of device lifecycle management, so that you don’t have to worry about them. They are also the hub that collects and aggregates the data, allowing you to make sense of it. With the variety of platforms offered on the market and the breadth of claims their providers make, **the choice of the “ideal” IoT platform for a deployment is arguably the most significant, yet also the most difficult to make.** Sometimes more so for some than for others and for some – such as mobile virtual network operators – it can be the make or break.It shouldn’t be taken lightly, as it determines whether the IoT ecosystem will thrive or wither into oblivion.



The [right IoT device management platform] should be versatile and adaptable, as the IoT world is very fragmented and constantly shifting and you don't want the core element of your ecosystem to become the stumbling block of your deployment. **It should also be scalable,** so that your ecosystem can grow naturally, and **secure**, so it can do so without any threats.

Agents

Agents are all the people whose actions affect the IoT ecosystem. These may be the engineers who devise IoT deployments and design the platforms, it can also be the platform operators. But probably, most importantly, it's the stakeholders, who ultimately reap the results. After all, IoT deployments aren't just art for art's sake. **These complex ecosystems are put in place for a reason: to drive efficiency and improve the quality of life. And it is the agents who decide on how to use the devices, networks and platforms to achieve these results.** This is where technology and business converge, because it's business goals that very much shape the IoT ecosystem.

People are an essential part of this equation. Ecosystems are created by us, managed by us and, ultimately, it is our responsibility to realize their full potential. It is the devices that collect the data, but it is the people that make sense of it and put it to use. Similarly with

networks and platforms, which are a necessary component of the ecosystem, but wouldn't be of much value if it weren't for the people who create and perfect them to fit their needs.

Conclusion

As was said, **an IoT ecosystem is a very complex concept that eludes easy classification, as its characteristics vary from deployment to deployment.** Much like our world, the IoT world comprises numerous different ecosystems that evolve and adapt. What they have in common is the idea and the people that make them happen: device manufacturers, service providers, application developers, and enterprises. **Yet in this ever changing landscape there still remains a lot of variety – the technology, represented by the devices, networks and platforms, always gets better.** This is particularly worth remembering, because the one mistake the inhabitants of an IoT ecosystem should never make, is to take it for granted. There is nothing more toxic for that landscape than stagnation and lock-in, so you should always be on the lookout for newer, better technologies that will help you flourish.

IIoT Value Chain

What is the IoT value chain?

An IoT solution is formed of several building blocks or components, and each of these building blocks forms part of the IoT value chain.[1] The IoT value chain illustrates how the different components, in combination with one another or separately, add value to the overall IoT solution and, in turn, for the end user. Furthermore, each component is developed by a range of companies, some of which play several roles in the IoT value chain. The following components form part of the IoT value chain.

- **Devices.** This category includes existing devices such as smart meters or vehicles in which the connectivity component has been integrated into the product design. This could also include new devices that would not have existed without IoT, such as pet trackers. Such a device must have a sensor and an actuator, as well as communications hardware (described in more detail below), but it will also have other elements (for example, a power source such as a battery or mains electricity). In addition, depending on the type of device, it may have a screen and other ways for the user to interact with it directly (such as buttons or a keyboard).
    - **Sensor and actuators** are connected to the device. Sensors are able to capture data from the environment (for example, temperature). Actuators respond to instructions and make changes in the device (for example, adjusting the temperature on a thermostat). The instructions for an actuator can come from sensors on the same device, or from other sources (for example, a thermostat can be activated by mobile phone while the homeowner is on their way home). A device can have sensors, actuators, or both.
    - **Communications hardware** enables the device to connect to the network to send the data from the sensors to the backend systems. This can include hardware for connecting wirelessly via BlueTooth, Wi-Fi, ZigBee, LoRa,

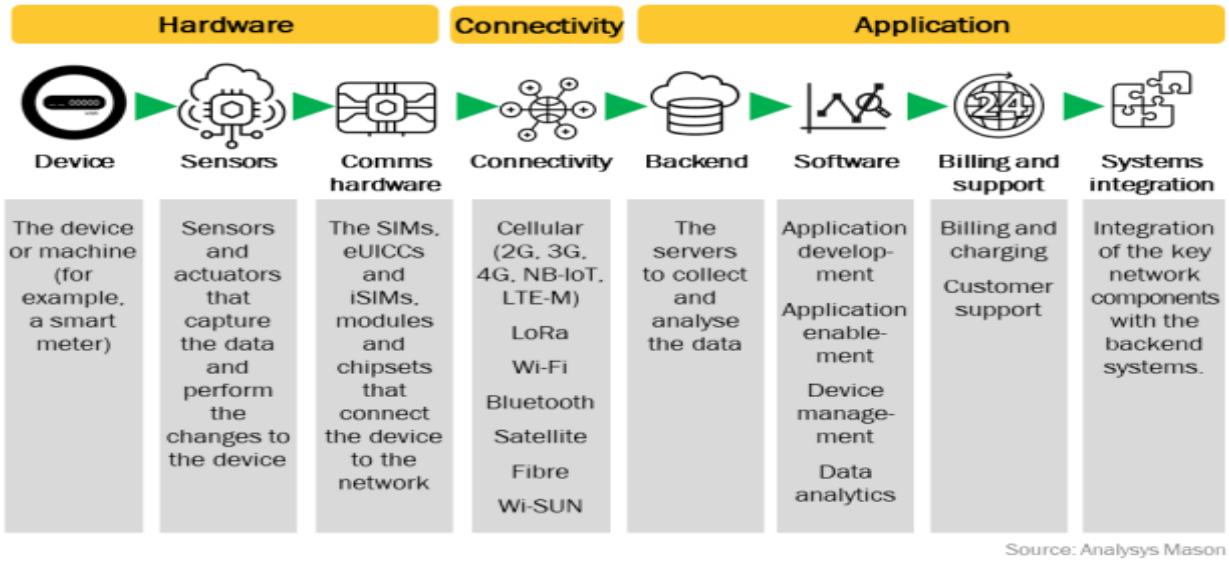
cellular (for example GSM, 5G, NB-IoT, LTE-M) or a number of proprietary technologies, or over a fixed network. Some devices will have hardware to connect to multiple types of network.

- The **connectivity network**, which can be cellular, fixed or satellite, delivers the data from the sensors over the internet or a private network connection to the user's backend systems.

In addition, many different software components, which can be loosely grouped as **applications**, deliver additional value to the end user.

- **Backend systems** include the servers to collect and analyse the data coming from the sensors and from other sources (for example, weather forecast data). These backend systems can be found in the public or private cloud, or on on-premises hardware. For very simple systems, the backend can be a standard PC.
- **Software platforms** such as **device management, security** and **data analytics** ensure that IoT devices are functioning correctly and have not been compromised. Such platforms also include **data analytics** software to make sense of the data and improve business processes, as well as data bases to store the data.
- This area also includes services such as **billing** and **customer support**.

Other parts of the value chain for IoT can include the systems integrators (SIs) or developers that design, build and manage IoT services. The physical IoT device will often need to be installed and maintained. Depending on the service, this installation process can account for a high share of the overall value (for example, in smart metering projects, where the installation process may cost more than the device).



Source: Analysys Mason

IOT platform Interfaces

- **Cloud backend:** programming and designing
- Phone or tablet **Application's interfaces**
- **Voice user interfaces** (VUI), in function of interaction options you choose

- **Access to Application Programming Interfaces**: specifications adapted to your standards, and implementation

When we design an IoT solution, you need a smartphone to turn it on or connect it via Internet, Bluetooth or NFC for example. It is necessary to set up interactions to enter the connected technologies and therefore to **create interface with this product**.

The **backend interface** is all the bricks and the software ecosystem that allow to **interact with the product and to receive data** related to the connected object.

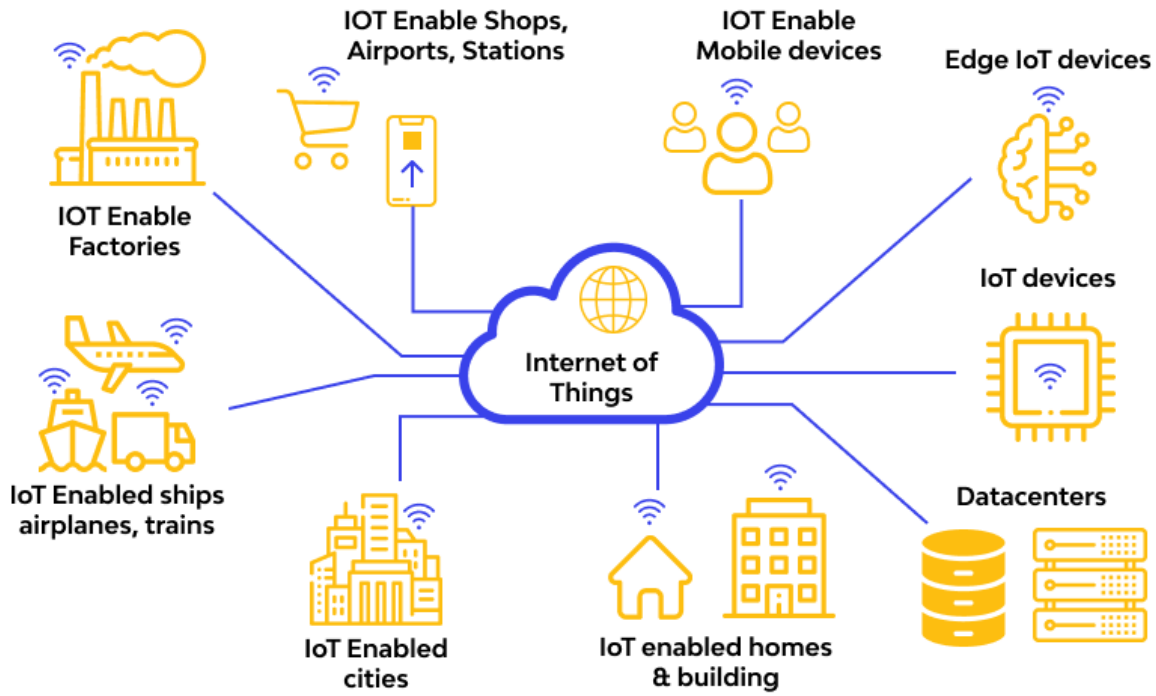
IoT API

What is an IoT API?

In general, API is the term referring to standard framework collection, protocols, and resources dictating the generic web and mobile application. It defines the communication rules that every application component must follow while exchanging information with each other.

APIs that are used in the creation of IoT solutions are known as IoT APIs. They are the web services application programming interfaces. They work in a similar fashion and make seamless data flow, with HTTPbeing the medium. Using the IoT API lets developers design advanced applications that are easy to integrate with other web services.

IoT APIs make the end-user experience exceptional in multiple manners. For instance, they can log in to the websites easily and bring a good number of applications on board.



API Types in IoT

APIs in IoT are highly diverse to support IoT development by all means. The key API types

are as mentioned next.

1. **SOAP**

SOAP APIs are crucial for IoT devices development as they make building a communication bridge between the servers and the clients. The API supports only XML-based data transfer.

2. **REST**

IoT REST APIs useful for HTTP data transmission and for empowering IoT devices to stay associated with the rest of the world. These APIs are driven by architectural principles and boast features like interfaces simplicity, instant resources identification during the request, and manipulation of particular interfaces.

3. **JSON and XML**

A bit older than SOAP APIs, JSON and XML IoT APIs are based on a simple approach and consume limited bandwidth.

The important role of APIs in the IoT

What makes API crucial for IoT and any other device/software is the fact that they support effective utilization of pre-existing functions to ensure smooth software processing while keeping developers free from the need of reprogramming again and again.

The world of IoT is too complex demanding continual contact between multiple agents involved. API usage makes the task achievable as integrating assorted IoT components with each other is 100% possible.

API usage empowers the IoT world and makes innumerable as fresh development and integration opportunities are rendered.

IoT APIs serve as amazing technical development resources as unmatched flexibility is granted.

Speaking of cybersecurity, APIs are essential as developers can use them to gain control over access requests. This limited and controlled access keeps the DDoS attack possibilities less than expected.

Considering all this, it's easy to conclude that the world of IoT will be on the brink of fall, with less productivity, and higher security risks if APIs are not involved.

IoT Cloud Platforms

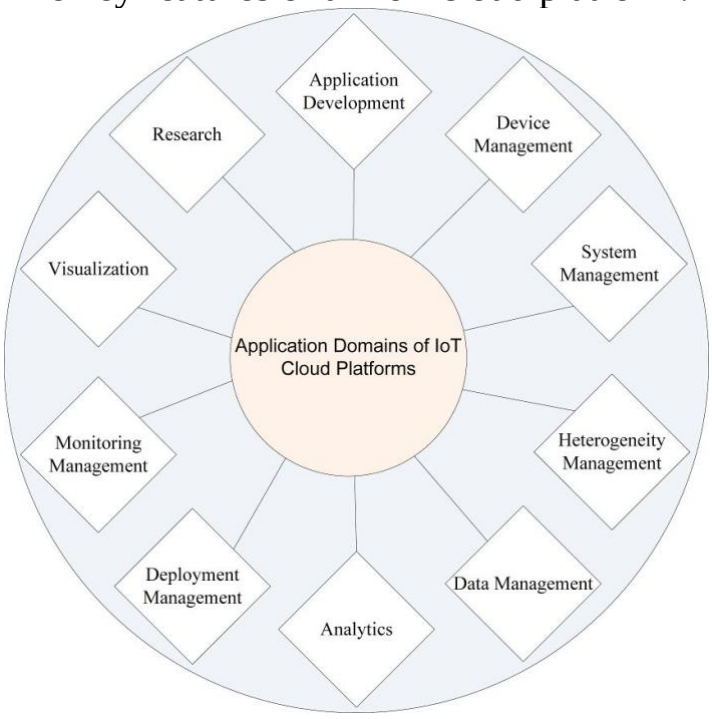
A sample of IoT cloud platform providers.

IoT cloud platforms bring together capabilities of IoT devices and cloud computing delivered as a end-to-end service. They are also referred by other terms such as *Cloud Service IoT Platform*. In this age, where billions

of devices are connected to the Internet, we see increasing potential of tapping big data acquired from these devices and processing them efficiently through various applications.

IoT devices are devices with multiple sensors connected to the cloud, typically via gateways. There are several IoT Cloud Platforms in the market today provided by different service providers that host wide ranging applications. These can also be extended to services that use advanced machine learning algorithms for predictive analysis, especially in disaster prevention and recovering planning using data from the edge devices.

The key features of an IoT cloud platform?



Application domains of IoT cloud platforms.

An IoT cloud platform may be built on top of generic clouds such as those from Microsoft, Amazon, Google or IBM. Network operators such as AT&T, Vodafone and Verizon may offer their own IoT platforms with stronger focus on network connectivity. Platforms could be vertically integrated for specific industries such as oil and gas, logistics and transportation, etc. Device

manufacturers such as Samsung (ARTIK Cloud) are also offering their own IoT cloud platforms.

In most cases, typical features include connectivity and network management, device management, data acquisition, processing analysis and visualization, application enablement, integration and storage.

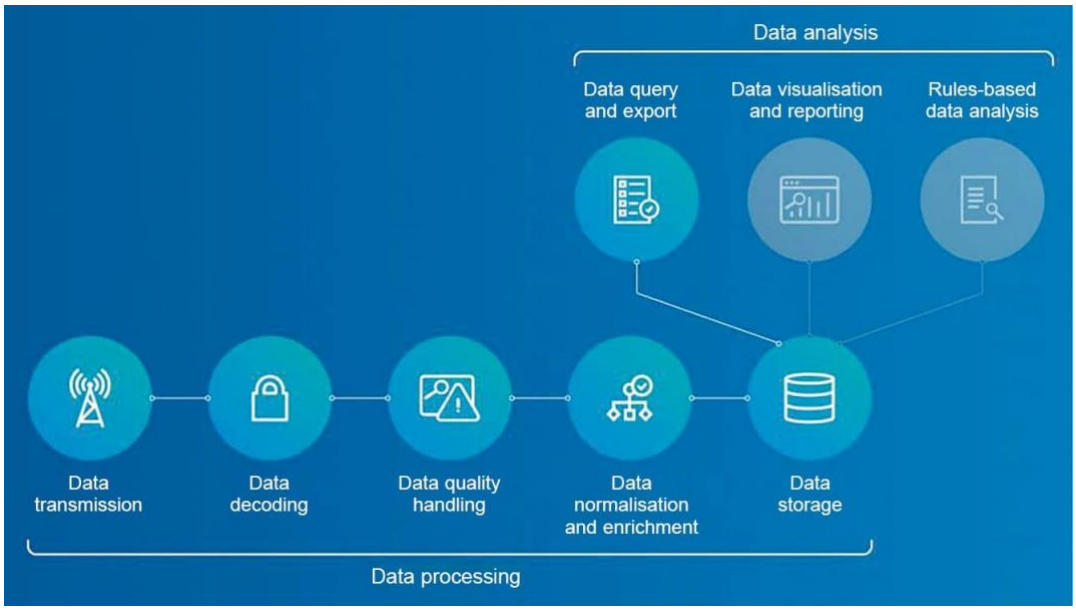
Cloud for IoT can be employed in three ways: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) or Software-as-a-Service (SaaS). Examples of PaaS include GE's Predix, Honeywell's Sentience, Siemens's MindSphere, Cumulocity, Bosch IoT, and Carriots. Developers can deploy, configure and control their apps on PaaS. Prefix is built on top of Microsoft Azure (PaaS). Likewise, MindSphere is built on top of SAP Cloud (PaaS). Siemens's Industrial Machinery Catalyst on the Cloud is an example of SaaS which is a ready-to-use app within minimal maintenance.

Data Management Analytics

The Internet of Things (IoT) device management enables users to track, monitor and manage the devices to ensure these work properly and securely after deployment.

Billions of sensors interact with people, homes, cities, farms, factories, workplaces, vehicles, wearables and medical devices, and beyond. The Internet of Things (IoT) is changing our lives from managing home appliances to vehicles. Devices can now advise us about what to do, when to do and where to go. Industrial applications of the

IoT assist us in managing processes, and predicting faults and disasters. The IoT platforms help set and maintain parameters to refine and store data accordingly.



Data management is the process of taking the overall available data and refining it down to important information. Different devices from different applications send large volumes and varieties of information. Managing all this IoT data means developing and executing architectures, policies, practices and procedures that can meet the full data lifecycle needs.

Things are controlled by smart devices to automate tasks, so we can save our time. Intelligent things can collect, transmit and understand information, but a tool will be required to aggregate data and draw out inferences, trends and patterns.

Developers and manufacturers of embedded systems and devices need to build systems that answer the demands of data management. They need to design a data management framework compatible with all the software and hardware that play a role in collecting, managing and distributing data. The design needs to be efficient to accelerate time-to-market of the end-product.

Data from IoT devices is used for analytical purposes. Information that businesses collect and store but remains relatively stagnant, because it is not used for analytical purposes, is called dark data. It includes customer demographic information, purchase histories and satisfaction levels, or general product data. To better understand customers, dark data is invaluable to businesses, as it allows them to uncover additional insights more efficiently.

Before the release of a product, IoT data management requires field tests. Data from the field tests helps improve the design and create a higher-quality product. Collecting field data post-launch helps in continuous product improvement with software updates and by identifying anomalies. This also provides important insights to support the development process of new products.

The IoT data management

In edge computing, data is processed near the data source or at the edge of the network. While in a typical cloud environment, data processing happens in a centralised data storage location. By processing and using some data locally, the IoT saves storage space for data, processes information faster and meets security challenges.

Edge computing, data governance policies and metadata management help firms deal with issues of scalability and agility, security and usability. This further assist them decide whether to manage data on the edge or only after sending it to the cloud.

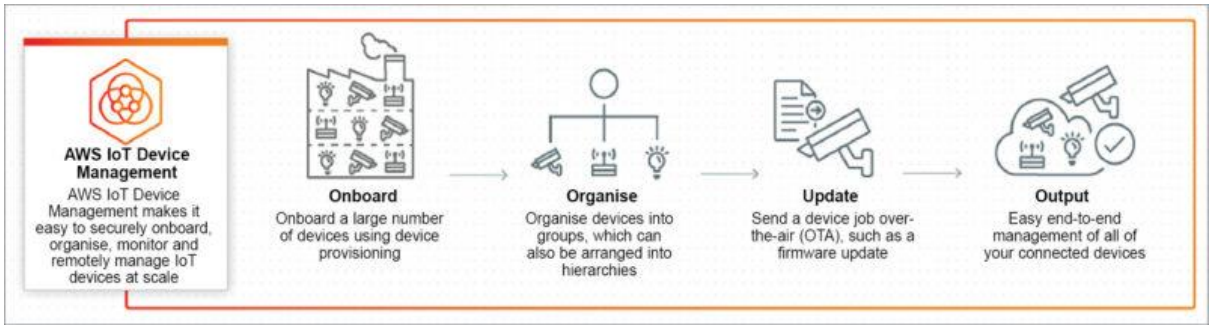
Sensors produce a large amount of data for edge gateway devices so that these can make decisions by analysing the data. These high-performance systems not only need to collect data in real time but also to organise and provide data to other systems.

Sensors and devices can connect indirectly through the cloud, where data is centrally-managed, or send data directly to other devices to locally collect, store and analyse the data, and then share selected findings or information with the cloud. Edge devices for data management help secure the most valuable data and reduce bandwidth cost. These also provide great performance, ownership over data and lower maintenance cost.

Edge devices run a Web-based dashboard that end-users can access to monitor the flow of data, so they can decide how various systems in demonstration and devices are running, and get notified by alarms. A large amount of data can be represented in the form of a graph for any desired range of time, and each point on the graph represents a record that can be found by searching the database, which stores a large quantity of data.

AWS IoT device management

This is critical across industrial, consumer and commercial applications such as an industrial and connected home. It enables customers to manage large and diverse device fleets such as operational technology systems, cameras, machines, vehicles, appliances and more.



It enables monitoring of usage and performance metrics for devices across industrial sectors such as manufacturing, oil and gas, and mining. It allows monitoring metadata and policy changes with service alerts to inform about any adjustments to the devices'

configuration. It also allows detection of any unusual behaviour across a device and to take mitigating actions.

It provides secure onboarding, organising, monitoring, troubleshooting and sending of firmware updates over-the-air (OTA). It enables adding device attributes like device name, type and manufacturing year, certificates and access policies to the IoT Registry. Then, it assigns them to devices, and makes connected devices ready for service quickly. This helps to quickly search and find any IoT device across the entire device fleet in near real time.

It is easy to find devices based on a combination of attributes like device ID, device state and type, so that action can be taken, in addition to troubleshooting. Actions such as reboots, factory resets and security patches can also be remotely executed.

Data management challenges

With time, the number of IoT devices will increase, thus increasing the challenges for real-time processing and analysis to reduce time for storage. Space has to be optimised for metadata like user IDs and passwords to ensure enough space for new information.

Functions such as adaptive maintenance, predictive repair, security monitoring and process optimisation rely on real-time data. Selecting the right tools is a challenge because integration between different sensors should be proven and compatibilities confirmed. When there is no connection, devices must still gain insights, make decisions and prepare for data distribution.

There are important factors behind an IoT device data management platform, including interoperability, scalability, security and standards offered by software technologies to build IoT products. It is important to protect data from unauthorised

access and tampering. Organisations need to be compliant with national rules and regulations on securing data.

IoT device data also need to be checked for quality. Having many different devices connected directly to cloud services presents a huge attack surface, which can be mitigated by channelling data through a secure gateway device.

Potential of IoT device management

IoT device management software enable users to track, monitor and manage physical IoT devices to ensure they work properly and securely after deployment. These tools often allow them to push software and firmware updates to devices and troubleshoot problems remotely.

They also provide permissions and security capabilities to ensure each device is protected from vulnerabilities. These solutions are mainly used by IT administrators to track performance, security and the overall state of each connected device.

Exploring IoT data from the field will give a better idea of how the product functions in a user's day-to-day life. IoT data management lets the user optimise smart algorithms by looking at sensory data and the points in time when a user made a change. Then, the user can redesign or retrain the product to offer a better user experience.

Data Mining in IoT

Smart IoT connected environments generate huge amounts of raw data. To become more data-driven, it is not enough for business owners to just collect and store large amounts of data. Namely, there is a need to select and synthesize the most appropriate algorithm using data mining for IoT. You should extract the maximum value and based on the insights take strategic business decisions. It will also produce valuable analytics and accurately predict future events.

This article will discuss the main data mining techniques, big data mining issues in IoT, and models. It will cover issues of how the application of data mining in IoT enables the useful accumulation of tremendous amounts of data generated from heterogeneous environments and transformed into valuable insights that can be used to the great benefit of the organization. It allows more data-driven decision-making, boosts performance, enables efficient management of resources and services.

The Role of Data mining and processing in IoT technology

According to the research, IoT technology plays a pivotal role in covering traditional equipment to general household objects. The IoT systems generate huge amounts of data. Raw data is flawed and also contains lots of mistakes, various types of data; data mining is something that allows structuring the data, extracting the needed knowledge that can be further used for effective decision-making.

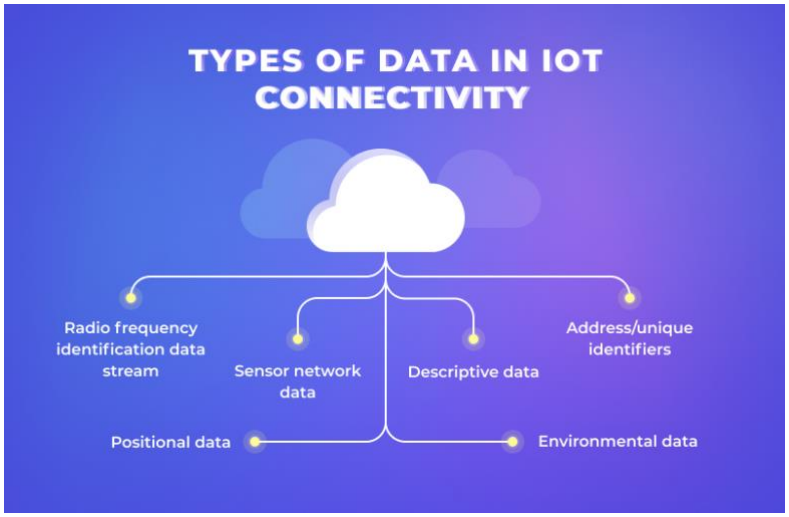
The centralized middleware (i.e. data mining algorithms) helps simplify the process of software development for IoT, extract useful analytical insights, enhance security as well as support the interoperability of connected devices.

Interesting insights about data mining:

- It is applied to various forms of data;
- Data mining acts as a base for ML and AI;
- Application of Data mining in IoT offers comprehensive information about the connected assets and their data interchange – the baseline (normal communication between the devices);
- Data mining is used when you need to customize your baseline and use the data insights for your specific business needs.

The main challenges and key issues in data mining

IoT-connected devices generate complex data types, including sensor data, radio frequency identification data, two-dimensional code, video data, and image data. This diverse nature presents a number of challenges for data mining in IoT. According to the research, apart from the choice of the suitable algorithms, environment, and providing privacy and data security, and interoperability, there are some more pain points to deal with.



Here is the list of challenges associated with the application of data mining in IoT:

- **Security** – the presence of multiple devices in IoT connections offers multiple decentralized points of entry for malware. Such connection models create more security and complexity issues. Usually, security measures are designed for a specific set of data with certain characteristics.
- **Standardization efforts** and the emergence of standard protocols such as Message Queue Telemetry Transport (MQTT) and Advanced Message Queuing Protocol (AMQP), Lack of standards that guarantee interoperability of devices. It requires more data transformations.
- **Scalability.** Data mining algorithms should be efficient and scalable enough to dig the insights from voluminous sets of data in datasets.
- **Unique identification** of each device.
- **Privacy** is also a serious concern when it comes to connected networks containing a great deal of personal information.
- **Algorithms and models**. The choice of the right data mining algorithms the best suitable IoT data mining model plays an important role in IoT data review and extraction.

However, realistically, big data mining issues in IoT are possible to overcome with some help from a reliable tech partner. GBKSOFT experts guarantee the security and privacy of your IoT-connected devices and their data. They provide centralized monitoring and offer security management through all stages of development and after deployment.

The emergence of 5G networks will enable the swift and speedy transmission and exchange of massive amounts of data. Cloud infrastructure is, in turn, scalable enough to accommodate this plentiful supply of data. An advanced team of experts offers scalable and multi-featured solutions that will purposefully be built to be a perfect fit for your business needs. Transparency, security, reliability, advanced expertise, and full dedication are the reasons why our clients time and again choose GBKSOFT as a tech partner!

Role of IIoT in manufacturing process

How is IIoT used in manufacturing?

Industrial Internet of Things (IIoT) solutions empower manufacturers to operate smarter using connected assets, real-time data analytics and monitoring to keep agile, informed and in control. Whether you're looking to launch smart connected products, improve quality or gain insights into your supply chain, do it quickly and easily with the #1 self-service **IoT platform**.

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Imagine what you can do with IIoT in manufacturing

Smart, connected products

Deliver new features faster with connected products. With the ability to remotely monitor, manage and analyze product data, you'll know how and when customers use your products. You'll see how to sell more services, create new product bundles, design contracts based on use and offer higher-value services with stronger SLAs.

Predictive product services

Use predictive analytics with your IIoT solution to reduce downtime by anticipating maintenance needs. With an enterprise IIoT platform, you can access and analyze usage and status data from sensors embedded in your connected products and use predictive models to forecast the need for repairs. Increase customer lifetime value and first-call repair rates on a platform for usage- or outcome-based services.

Condition-based & predictive maintenance

With an IIoT solution, you can access real-time usage and status data from sensors and actuators embedded in your manufacturing equipment. Continuously stream this data to your IIoT solutions in the cloud, or analyze that data at the edge for real-time fault detection and alerting. Condition monitoring improves asset use and availability, IIoT increases product quality and reduces maintenance costs.

Manufacturing process optimization

Monitor manufacturing processes and machinery in real time and identify what's causing production bottlenecks. Analytics-driven visualizations of operational KPIs help you see, decide and act faster. By creating a "digital twin"—a digital representation of a physical asset—you can remotely monitor a machine's status at any time.

Smart logistics

Build a digital supply network by connecting your systems and those of your suppliers, distributors and customers. Asset tracking, from supply to delivery, informs you on asset use. Gain real-time insights into location, vibration, temperature and other environmental factors with IIoT connected assets. Receive alerts when something's not going according to plan.

The Benefits of Industrial IoT

First off, it's useful to explain just what IIoT is and how it can revitalize modern operations. IIoT is the application of connected smart devices to monitor, automate, and predict all kinds of industrial processes and outcomes. These technologies offer everything from enhanced worker protections through factory floor monitoring systems to the predictive maintenance possibilities currently revolutionizing the fleet management industry.

Widespread implementation of such systems changes the ways manufacturers, supply chains, and warehouse managers function more effectively. With IIoT, data-driven insights power greater results. For many businesses, this can mean:

- Greater energy efficiency
- Reduced costs
- Better quality products
- Improved decision-making potential
- Less equipment downtime

In short, the automation and data-gathering capabilities of IIoT devices make for a more efficient workplace. As less energy is used, product efficiency is enhanced, and metrics are

assessed, industrial businesses have the potential to streamline practices like never before. Since every downtime incident causes an average loss of $17,000, the application of IIoT in predictive maintenance alone can mean substantial savings.

These benefits of IIoT are the reason widespread adoption of this technology is so desirable. As of now, many companies across industries are already using it to great effect.

How IIoT Is Being Used

The innovative potential of IIoT is virtually limitless. However, there are three primary categories in which this technology is applied within industries to promising results. These categories are remote monitoring, predictive maintenance, and automation.

Here are examples of IIoT uses in each of these three categories to give you a better idea of what properly implemented smart devices can achieve:

Remote Monitoring

Radar-level sensors provide local displays so that operators can easily manage levels through a singular dashboard. These systems make for easy measuring points on moving and rotating machinery, so operators are constantly fed real-time data regarding the equipment's functionality. This, in turn, gives insights into overall equipment life-cycles and repair needs, allowing for predictive maintenance.

Predictive Maintenance

In the power industry, drones with equipment monitors and sensors are being used to monitor powerline networks and evaluate risks. These drones can anticipate scenarios such as estimating when a tree is likely to fall on a line, resulting in costly maintenance and repair.

That way, companies will be informed before the damage is done. In this fashion, predictive maintenance enables cost-effective repairs and intervention before the damage is even done.

Automation

One vital use of automation via IIoT is smart irrigation in industrial farming. Water is a precious resource, but farmers typically have to keep a consistent watering schedule to ensure proper plant care. Smart irrigation systems, however, are automating this process while conserving water. The IIoT device reads moisture levels in the soil and reports to the sprinkler system when water is needed. This way, water, money, and time are all saved.

These three categories of IIoT implementation give industries unprecedented precision and efficiency with the right application. Unfortunately, however, businesses must first overcome the challenges.