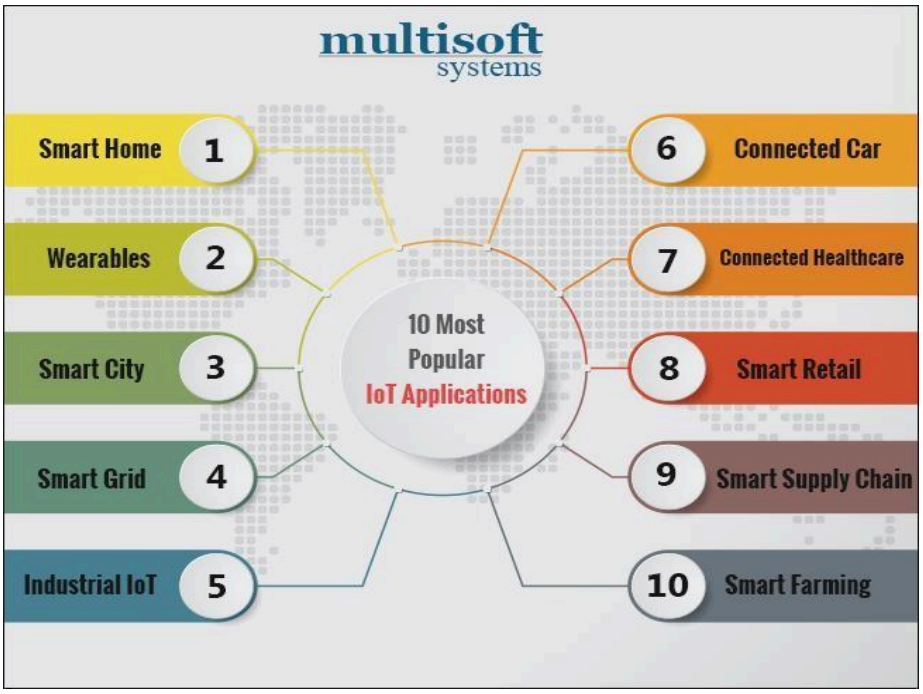
Case Study & IoT

Applications



The three broad categories as following:

- **Industrial use cases**
- **Consumer use cases**
- **Governance use cases**

Under industrial use cases, main focus on two broad use cases:

- **Smart energy**
- **Smart transportation systems**

Under consumer use cases, main focus on the following:

- **Smart homes**
- **Smart buildings**
- **Smart education systems**

Under governance use cases, mainly considered smart cities. Some other Use cases like smart airports and smart healthcare systems are considered.

Case Study:

Definition:

“A case study is a research strategy and an empirical inquiry that investigates a phenomenon within its real-life context. Case studies are based on an in-depth investigation of a single individual, group or event to explore the causes of underlying principles”.

One of the most promising IoT use cases is creating smarter, more efficient cities. Public energy grids can be optimized to balance workloads, predict energy surges, and distribute energy more equitably to customers. Traffic lights could be synced using IoT to adapt to traffic conditions in real-time.

IoT is the next step in the evolution of the internet and is being used in about everything you can think of.

IoT Applications:

IoT applications promise to bring immense value into our lives. With newer wireless networks, superior sensors and revolutionary computing capabilities, the **Internet of Things** could be the next frontier in the race for its share of the wallet. IoT applications are expected to equip billions of everyday objects with connectivity and intelligence. It is already being deployed extensively, few applications of IoT:

- Wearables
- Smart Home Applications
- Smart Buildings
- Smart Infrastructure
- Securities
- Health Care
- Smart Cities
- Agriculture
- Industrial Automation

IoT Applications:Smart Home, Smart Buildings and Infrastructure

IoT home automation is the ability to control domestic appliances by electronically controlled, internet-connected systems. It may include setting complex heating and lighting systems in advance and setting alarms and home security controls, all connected by a central hub and remote-controlled by a mobile app.

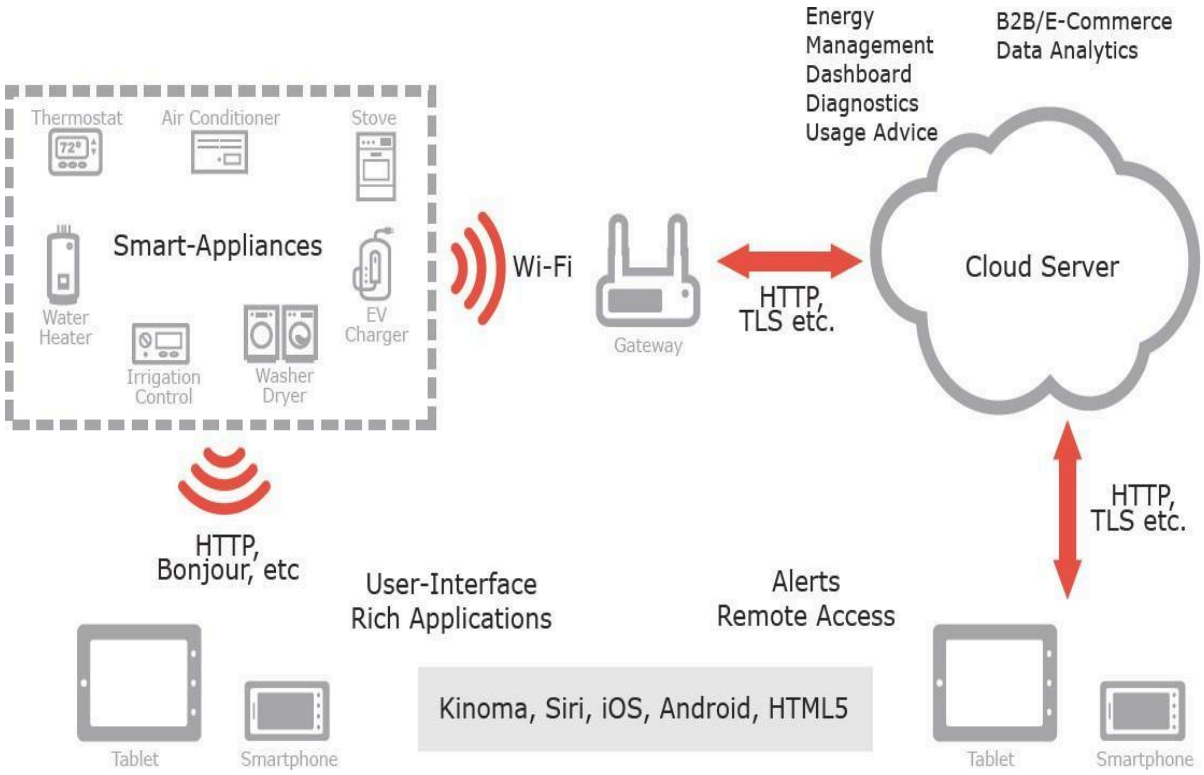


Figure .Smart home platform.

The rise of Wi-Fi's role in home automation has primarily come about due to the networked nature of deployed electronics where electronic devices (TVs and AV receivers, mobile devices, etc.) have started becoming part of the home IP network and due the increasing rate of adoption of mobile computing devices (smartphones, tablets, etc.), see above Figure.

The networking aspects are bringing online streaming services or network playback, while becoming a mean to control of the device functionality over the network. At the same time mobile devices ensure that consumers have access to a portable 'controller' for the electronics connected to the network. Both types of devices can be used as gateways for IoT applications. In this context many companies are considering building platforms that

integrate the building automation with entertainment, healthcare monitoring, energy monitoring and wireless sensor monitoring in the home and building environments.

IoT applications using sensors to collect information about the operating conditions combined with cloud hosted analytics software that analyzes disparate data points will help facility managers become far more proactive about managing buildings at peak efficiency.

Issues of building ownership (i.e., building owner, manager, or occupants)challenge integration with questions such as who pays initial system cost and who collects the benefits over time. A lack of collaboration between the subsectors of the building industry slows new technology adoption and convent new buildings from achieving energy, economic and environmental performance targets.

Integration of cyber physical systems both within the building and with external entities, such as the electrical grid, will require stakeholder cooperation to achieve true interoperability. As in all sectors, maintaining security will be a critical challenge to overcome.

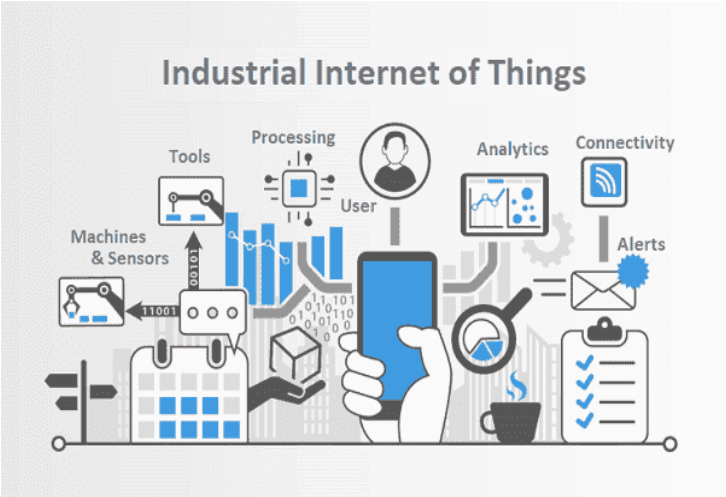
Within this field of research the exploitation of the potential of wireless sensor networks (WSNs) to facilitate intelligent energy management in buildings, which increases occupant comfort while reducing energy demand, is highly relevant.

In addition to the obvious economic and environmental gains from the introduction of such intelligent energy management in buildings other positive effects will be achieved. Not least of which is the simplification of building control; as placing monitoring, information feedback equipment and control capabilities in a single location will make a buildings' energy management system easier to handle for the building owners, building managers, maintenance crews and other users of the building. Using the Internet together with energy management systems also offers an opportunity to access a buildings' energy information and control systems from a laptop or a Smartphone placed anywhere in the world. This has a huge potential for providing the managers,owners and inhabitants of buildings with energy consumption feedback and the ability to act on that information.

In the context of the future Internet of Things, Intelligent Building Management Systems can be considered part of a much larger information system.This system is used by facilities managers in buildings to manage energy use and energy procurement and to maintain buildings systems. It is based on the infrastructure of the existing Intranets and the Internet, and therefore utilizes the same standards as other IT devices. Within this context reductions in the cost and reliability of WSNs are transforming building automation, by making the maintenance of energy efficient healthy, productive work spaces in buildings increasingly cost effective.

IoT Application in industries:

IoT in industry is a rapidly developing area. Numerous IoT research and application projects have been done by universities or in joint industry- university consortia in recent years.



Internet of things (IoT) has become part of your daily life. The “things connected to the internet” idea is continuously evolving in content, areas of applications, visions and technology. New real life and industrial projects have been done and joint future oriented industry and government initiatives such as Industry 4.0 in Germany, have been started [1].Since Industrial production is one of the world’s biggest economic factors one of the major objectives of these initiatives is to bring the paradigms of the IoT to the factories enabling them to cope with the challenges raised by popular megatrends.

The foremost megatrends relevant for factories are globalization, progressing technological evolution, the dynamization of product life cycles, the aging work force and the shortage of resources. Central effects are the acceleration of innovation cycles and the increasing customer demand for individualized mass produces with highest quality expectations. Within the context of industrial production IoT projects and applications are developing in manufacturing, supply chain,

supervision and servicing. A major question in all projects is about the value, the benefit such application can bring to the user, to the owner or to society.

The value question is extremely pertinent in the industry: in the manufacturing industry entire factory related processes, but also in industrial applications where it comes to ensure operation of industrial installations and provide supervision, and improved life service. It is the value which such applications bring which will determine their adoption, acceptance and wide use. However, this value is very difficult to quantify and prove, and it depends on multiple aspects which are strongly application area dependent.

IoT applications form the value creation for industry and brings together expert opinions from academia, research and industry. The industrial application of IoT is multi- facetted and each of the subsections in this paper will highlight an aspect related to industrial application, discuss or show a case or the evolution and potential of a specific technology from industry application point of view. The paper is having a holistic manner to industrial challenges and requirements. Also it will refer to factory concepts and applications supported by IoT, including processes and flows taking a view on related technologies and their evolution.

IoT applications benefit and value creation in an industrial environment may have its origin in different aspects, depending on the application type. There is no value but “values” each contributing to the total benefit such as:

- Value from visibility identification, location tracking
- Value form IoT-supported safety in hard industrial environments
- Value from right information providing or collecting
- Value form improved industrial operation and flows in industry
- Value from reduced production losses
- Value from reduced energy consumption
- Value from new type of processes made possible by IoT applications
- Value form new type of maintenance and lifetime approaches
- Value enabled by smart objects, connected aspects
- Value from sustainability.

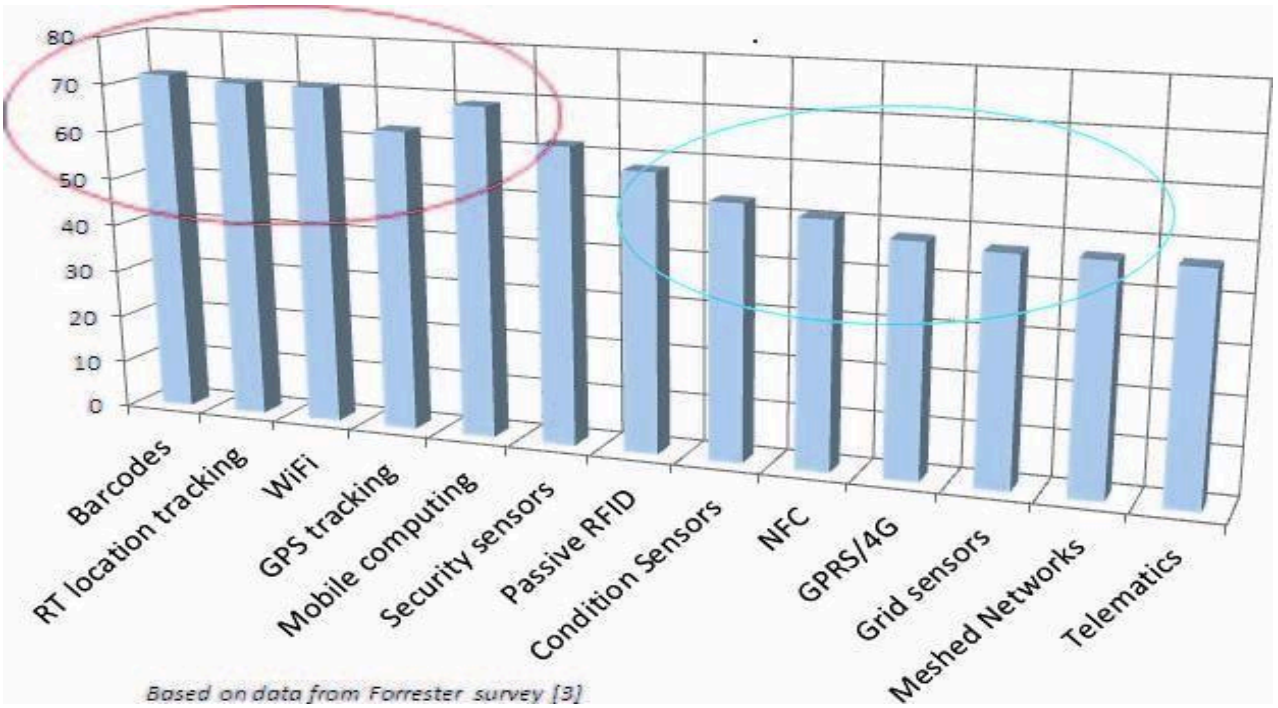


Fig. 5.2 View on very important and important perceived IoT technologies expected to bring value in applications.

The status and estimated potential of IoT applications is presented in Figure 5.3 considering three major areas: supply chain, future industry/future factory and over lifetime applications and activities such as logistics, manufacturing and service/maintenance. A strong potential and additional application is expected in industry operation and industry lifetime applications including lifetime service.

Areas	Supply chain	Industry	Lifetime
Activities	Logistics	Manufacturing	Service
IoT **present** Applications and Value	Many	Some	Few
IoT **additional** Applications **Potential**	Increase	Strong	Strong

Figure. Status and estimated potential of IoT applications.

IoT application requirements and capabilities:

The expectations toward IoT applications in industry are high. The capabilities they have to offer are depending strongly on the industrial area and the concrete application. For example the environment where IoT application may be used may range from clean room condition and normal ambient temperatures to heavy and dirty environment, locations with high temperatures, areas with explosion risk, areas with metallic surroundings, and corrosive environment on sea or underground.

A list of a set of industry related capabilities and requirements is presented below, without claiming completeness. The list items are related to the IoT hardware, software and to serviceability and management aspects. Comments have been added to all items to make the requirement more specific. The IoT application capabilities for industrial application should meet requirements such as:

- Reliability.
  Reliable IoT devices and systems should allow a continuous operation of industrial processes and perform on-site activities.
- Robustness.
  The IoT application and devices should be robust and adapted to the task and hard working conditions. This should include also the certifications for the specific work environment where they are used.
- Reasonable cost.
  Cost aspects are essential and should be fully justifiable and adapted to the benefit. It is basically about the right balance between cost and benefit rather than low cost. Also the costs are related to a more holistic view and life costs and consider the impact on the whole industrial installation in case of a failed IoT device or application.

- Security and safety.
  Security requirements are related to the cyber security threats and have to be part of the entire security strategy of the company.

  Safety is mainly related to the device construction and the area of use but also to usability such that no safety threats occur due to use of the IoT applications and devices.
- Simple use.
  Simple, intuitive use and (almost) self-explaining are important for the overall IoT application acceptance. The IoT application should ideally be context aware and adapt to the skills of the user and location or environment aspects.
- Optimal and adaptive set of features.
  The IoT application should allow to perform desired task with the sufficient, not-richer-then-necessary, set of features
- Low/No maintenance.
  Maintenance free or reduced maintenance IoT applications and devices over operational life would be ideal. Maintenance over lifetime is an important aspect impacting the life cycle costs of IoT based solutions. It is affected by the sometimes high number of IoT devices in place, the fact that they are typically distributed over large areas, the required skills, tools and time needed for any type of IoT maintenance operation. This is valid for all devices but especially for active IoT devices or active wireless sensing.
- Standardization.
  IoT devices and applications should be using a set of standards to support interoperability of IoT devices, easy exchange and multi-vendor possibilities.
- Integration capabilities.
  Easy integration in the IT and automation and process landscape of the industrial plant are required and may decide if a IoT solution will be used. This is particularly important for brown-field projects but also for green field in the view of future plant extensions.
- Reach sensing and data capabilities.
  IoT applications will relay more and more on complex sensing allowing distributed supervision and data collection and data capabilities. This is a chance in terms of additional data and

real-time information but also a challenge in terms of data and processing.

- Industry grade support and services.
  The IoT applications should be supported over years in operation by a set of rich tools and continuously updated services. Typically industry application requires also a centralized management of devices and systems, managed access rights, this might apply to some of IoT devices too.

Presently there are also numerous challenges to reach all the above.

Challenges faced by IoT industry applications

The challenges for IoT industrial applications can be subject of a more extended treatment, however for the needs of present IoT applications and value creation they have been divided in 4 groups:

- IoT device technical challenges
- Lifetime and energy challenge
- Data and information challenge
- Humans and business

The IoT devices technical challenges are numerous and subject of intense research. Some aspects will be addressed also in the following sections. A set of technical features will be especially needed in industrial applications, depending on application, such as extended capabilities for sensing in terms of sensor types and high sampling rate, communication, wireless data transfer and precise time synchronous collection of data both in single-hop and multi-hop industrial networks. Another aspect is related to the easy deployment, configuration and re-use of non-permanently attached devices, such as the ones used for ad-hoc sensing. One critical and often neglected aspect is the device packaging for the industrial application needs which is essential for reliable operation.

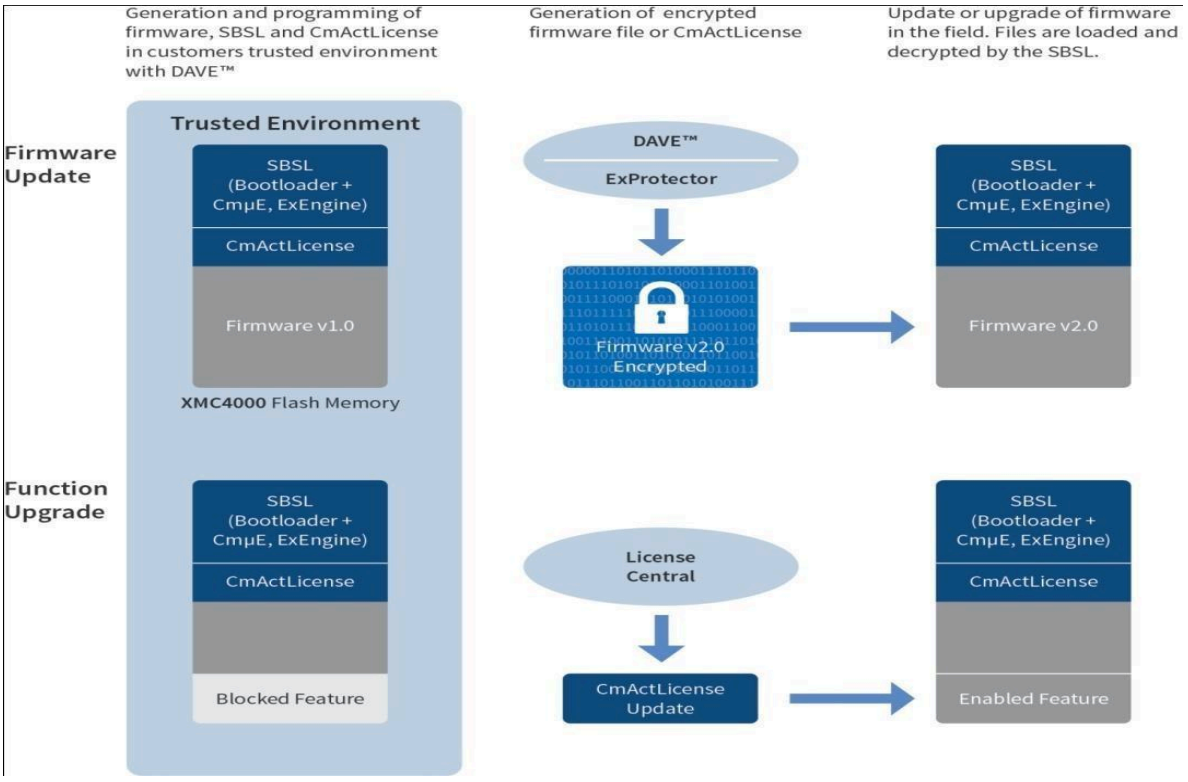
Seurity:

- IoT devices are connected to your desktop or laptop. Lack of security increases the risk of your personal information leaking while the data is collected and transmitted to the IoT device.
- IoT devices are connected with a consumer network. This network is also connected with other systems. So if the IoT device contains any security vulnerabilities, it can be harmful to the consumer's network. This vulnerability can attack other systems and damage them.
- Sometimes unauthorized people might exploit the security vulnerabilities to create risks to physical safety.

Privacy Risks:

- In IoT, devices are interconnected with various hardware and software, so there are obvious chances of sensitive information leaking through unauthorized manipulation.
- All the devices are transmitting the user's personal information such as name, address, date of birth, health card information, credit card detail and much more without encryption.

Though there are security and privacy concerns with IoT, it adds values to our lives by allowing us to manage our daily routine tasks remotely and automatically, and more importantly, it is a game- changer for industries.



IoT Application of home appliances:

Internet of Things is a technology that can connect to the internet without the influence of people and send information collected to users through this internet network to which they are connected. Devices in this dynamic are very common today. Many homes, companies and even public organizations benefit from this technology. Used in smart home IoT home appliances is also one of them.

A house must have smart devices to be smart. These smart devices are the building blocks of today's technology. So why these devices and apps are smart? First, these devices have their own Internet. With this internet tool, users can receive information from the device. With this internet connection, you can get a lot of information from your smart device. This information which receives from smart devices makes safety for your living area.

Smart devices work with technological devices while making you and your home a more secure space. The biggest hero of these technological devices is microprocessors. microprocessors act as the brain for your smart device. There are sensors that allow your smart devices to be classified according to their characteristics and detect the danger or differences in your home. There are many sensors classified by type. ***Motion sensors, light sensors, image detection, and processing sensors are one of them.***

For example, if the position of your belongings changes without your knowledge, there are motion sensors that can detect this position change. The motion sensor detects the position change and sends you information about this.

Home Appliance in Internet of Things:

Smart home systems are integrated and enable you to play an active role in every part of your home by surrounding your home. When you're not at home, but your mind stays at home, it's behind you. With smart home systems, you can intervene in your home as if you are at home and perform the necessary controls.In addition to these protection systems, smart home appliances have been making human life easier since the day it was developed.

Smart Washing Machine:

It is very important to save time in daily life. we live in a period where we have to keep up. that's where technology comes in. **You can access the developed smart washing machine on your smartphone. you can monitor and control the process at the same time. This smart washing machine can also dry your laundry with the control application.**

Smart Refrigerator with Internet of Things:

Internet in this kitchen which makes life easier for you and your family in the kitchen. With this internet connection, you can transmit a lot of information to your shopping list in the weather. You can also view the inside of your refrigerator with its camera technology.

Shortest Way to Dry Hair:

This time it has infrared technology. With this technology, the device is created wirelessly. Wireless shape so you can dry your hair without connecting the machine

Smart Doorbell:

The most important thing in smart home applications is known to be secure and protected home. With this smart doorbell designed for security, you can recognize people who come to your home with high quality. The night also has infrared technology added to the smart bell. This will also send the screen to you when it gets dark.

Smart Camera for Safe Home:

Control of your home is in your hands from every part. This smart camera sends records from every part of your home to your smartphone with the Internet of Things technology. Research on smart camera technology will continue for those who want a safe life.

Industry 4.0 concepts

Industry 4.0 refers to a new phase in the Industrial Revolution that focuses heavily on interconnectivity, automation, machine learning, and real-time data. Industry 4.0, also sometimes referred to as IIoT(Industrial Internet of Things) or smart manufacturing which provides physical production and operations with smart digital technology, machine learning and big data to create a more holistic and better connected ecosystem for companies that focus on manufacturing and supply chain management.

While every company and organization operating today is different, they all face a common challenge—the need for connectedness and access to real-time insights across processes, partners, products, and people. That's where Industry 4.0 comes into play. Industry 4.0 is not just about investing in new technology and tools to improve manufacturing efficiency but it's about revolutionizing the way the entire business operates and grows.

Industry 4.0 refers to the use of automation and data exchange in manufacturing. According to the Boston Consulting Group there are nine principal technologies that make up Industry 4.0: Autonomous Robots, Simulation, Horizontal and Vertical System Integration, the Industrial Internet of Things, Cybersecurity, The Cloud, Additive Manufacturing, Data and Analytics, and Augmented Reality. These technologies are used to create a "smart factory" where machines, systems, and humans communicate with each other in order to coordinate and monitor progress along the assembly line. Networked devices provide sensor data and are digitally controlled. The net effect is the ability to rapidly design, modify, create, and customize things in the real world, while lowering costs and reacting to changes in consumer preferences, demand, the supply chain and technology.

The goal is to enable autonomous decision-making processes, monitor assets and processes in real-time, and enable equally real-time connected value creation networks through early involvement of stakeholders, and vertical and horizontal integration.

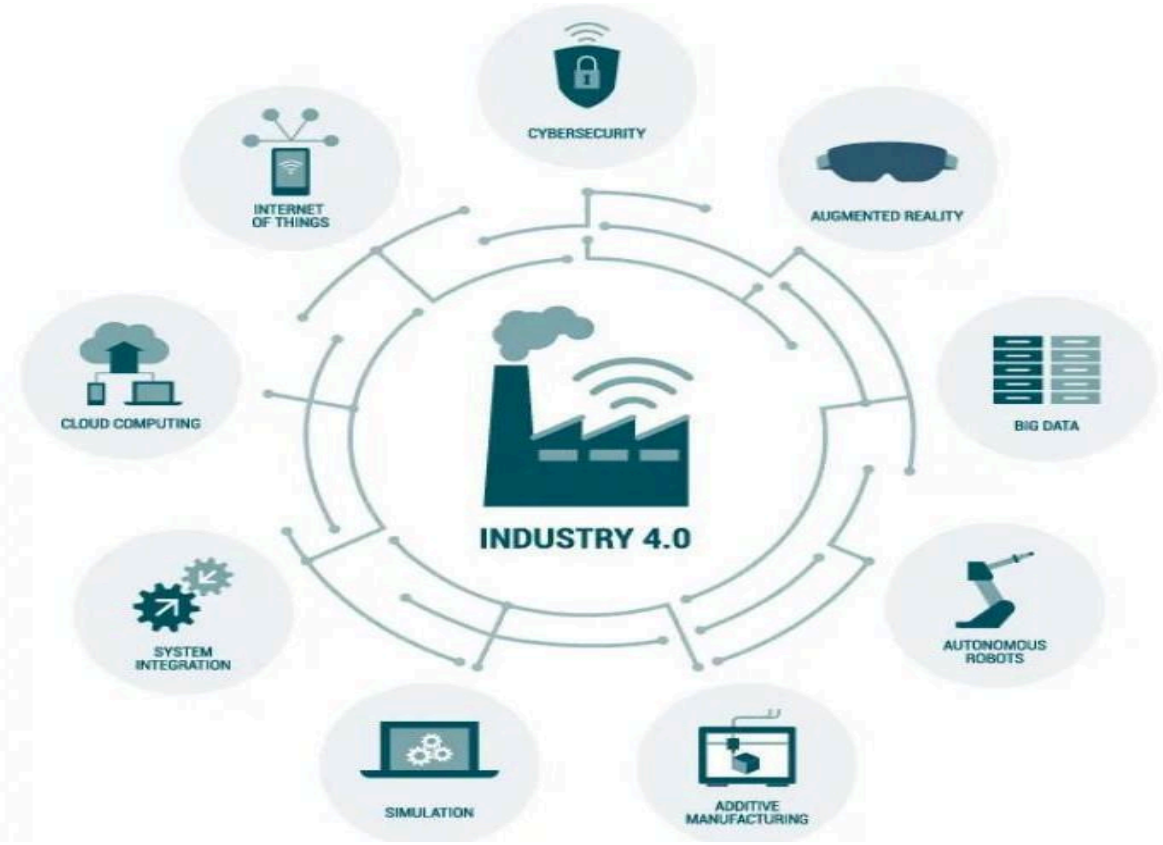
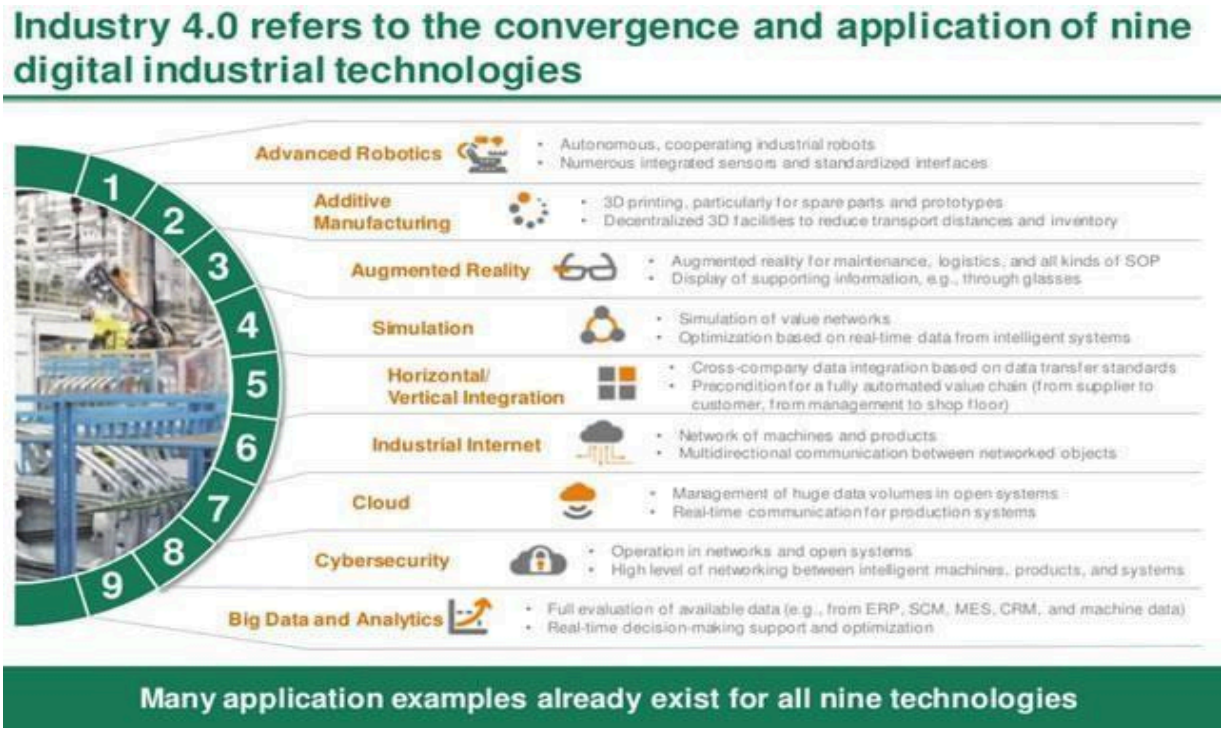


Figure: Nine Technologies of Industry 4.0



Today some companies have invested in a few of these technologies; predominantly the traditional pillars of the third platform such as cloud and Big Data / Analytics and increasingly in the Industrial Internet of Things from an integrated perspective and thus

overlapping with several of these “technologies” or maybe better: sets of technologies and connected benefits.

Evolution of Industry 4.0

There are four distinct industrial revolutions that the world either has experienced or continues to experience today.

1. The First Industrial Revolution

The first industrial revolution happened between the late 1700s and early 1800s. During this period of time, manufacturing evolved from focusing on manual labor performed by people and aided by work animals to a more optimized form of labor performed by people through the use of water and steam-powered engines and other types of machine tools.

2. The Second Industrial Revolution

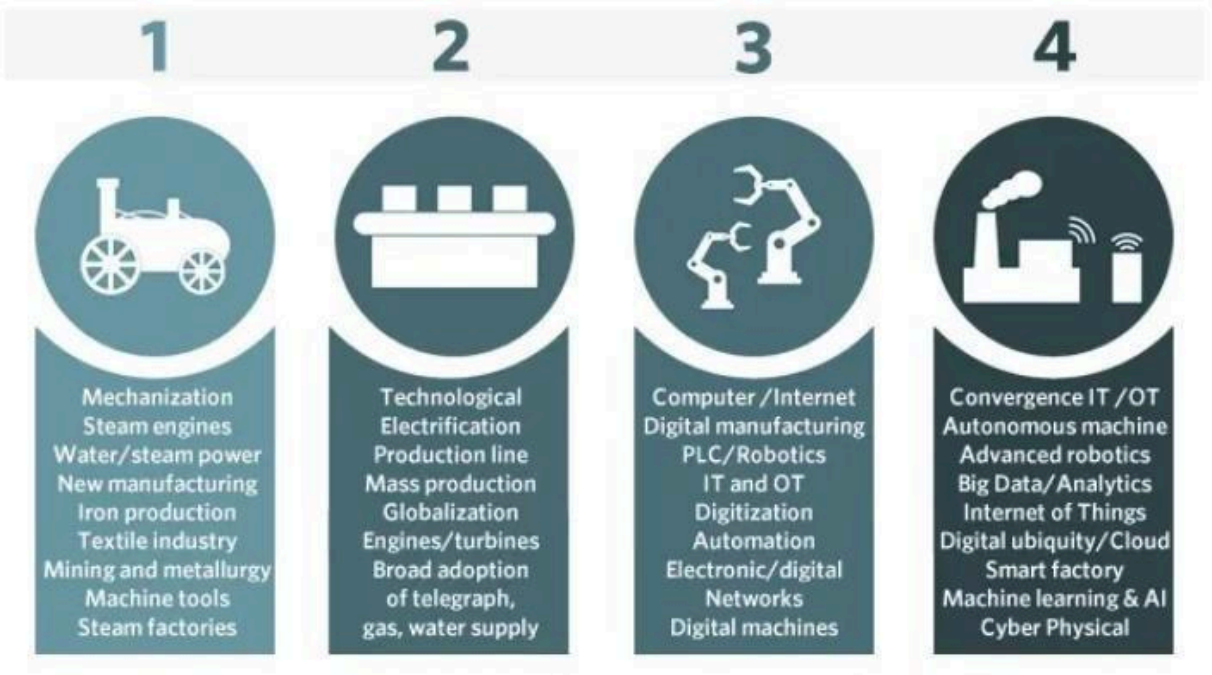
In the early part of the 20th century, the world entered a second industrial revolution with the introduction of steel and use of electricity in factories. The introduction of electricity enabled manufacturers to increase efficiency and helped make factory machinery more mobile. It was during this phase that mass production concepts like the assembly line were introduced as a way to boost productivity.

3. Third Industrial Revolution

Starting in the late 1950s, a third industrial revolution slowly began to emerge, as manufacturers began incorporating more electronic and eventually computer technology into their factories. During this period, manufacturers began experiencing a shift that put less emphasis on analog and mechanical technology and more on digital technology and automation software.

4. Fourth Industrial Revolution[Industry 4.0]

Fourth industrial revolution has emerged known as Industry 4.0. Industry 4.0 takes the emphasis on digital technology from recent decades to a whole new level with the help of interconnectivity through the Internet of Things (IoT), access to real-time data, and the introduction of cyber-physical systems. Industry 4.0 offers a more comprehensive, interlinked and holistic approach to manufacturing. It connects physical with digital, and allows for better collaboration and access across departments, partners, vendors, product, and people. An industry 4.0 empowers business owners to control and understand every aspect of their operation, and allows them to leverage instant data to boost productivity, improve processes, and drive growth.



Industry 4.0 is often used interchangeably with the notion of the fourth industrial revolution. It is characterized among others by

1) even more automation than in the third industrial revolution

2) the bridging of the physical and digital world through cyber-physical systems, enabled by Industrial IoT

3) a shift from a central industrial control system to one where smart products define the production steps

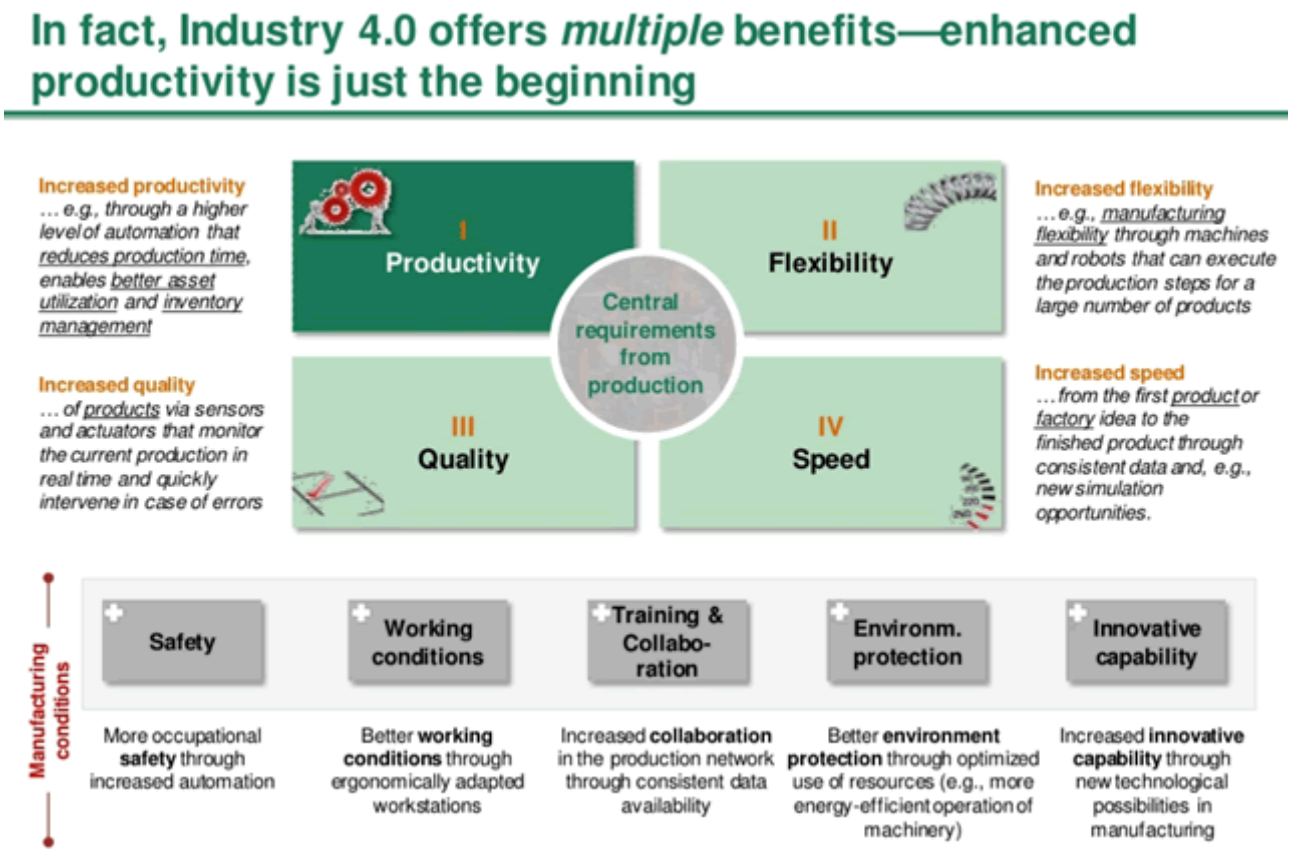
4) closed-loop data models and control systems and

5) personalization/customization of products.

Benefits of Industry 4.0

Industry 4.0 spans the entire product life cycle and supply chain, design, sales, inventory, scheduling, quality, engineering, and customer and field service. Everyone shares informed, up-to-date, relevant views of production and business processes and much richer and more timely analytics.

The essential goal of Industry 4.0 is to make manufacturing and related industries such as logistics faster, more efficient and more customer-centric, while at the same time going beyond automation and optimization and detect new business opportunities and models.



Most of the benefits of Industry 4.0 are obviously similar to the benefits of the digital transformation of manufacturing, the usage of the IoT in manufacturing, operational and business process optimization, information-powered ecosystems of value, digital transformation overall, the Industrial Internet and many other topics on our website. Few of the key benefits of Industry 4.0 are.

1. Enhanced productivity through optimization and automation
2. Real-time data for a real-time supply chain in a real-time economy
3. Higher business continuity through advanced maintenance and monitoring possibilities
4. Better quality products: real-time monitoring, IoT-enabled quality improvement and cobots
5. Better working conditions and sustainability
6. Personalization and customization for the ‘new’ consumer
7. Improved agility
8. The development of innovative capabilities and new revenue models