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Internet of Things in Business

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Abstract: Internet of things is a system where devices interact or communicate through the Internet, to give users a connected experience. It plays an important role in modern society. With billions of smart devices connected to the Internet, businesses can acquire and share real-time information with them. IoT can be utilized in businesses to improve productivity, gather new insights, and assist executives in making better, informed decisions. This paper is an introduction to the use of IoT in business.

Key words: Internet, Internet of things, IoT, business

INTRODUCTION

Technology has always been part of our life, whether we realize it or not. Advancements and developments in technology continue to spread like wildfire and are changing the way we live our daily lives. One such technology that is evolving so well in its usage and benefits is the Internet of things (IoT). In essence, the Internet of Things is a network of physical objects embedded with sensors and other technologies that allow them to connect to each other and exchange data. These IoT devices include smartphone, laptop, fitness band, watch, a microchip, hardware processor, aircraft engines, fridges, thermostats, medical devices, etc. IoT connects these devices so that they communicate or interact with each other. IoT can be defined with simple equation [1]:

Sensors + Actuators + Internet = the Internet of Things.

This equation is not comprehensive, but it captures the essence of the IoT phenomenon. There are many industries like the automotive healthcare, manufacturing, wearables, and others that are making good business sense of the IoT. IoT has been a major game-changer for businesses. Its impact is expected to grow in the future. The number of connected IoT devices was 11.3 billion in 2020. Businesses are expected to be more inter-connected in the digital age. They cannot afford to work in isolation [2].

OVERVIEW ON INTERNET OF THINGS

The term "Internet of things" was introduced by Kevin Ashton from the United Kingdom in 1999. Internet of Things (IoT) is a network of connecting devices embedded with sensors. It is a collection of identifiable things with the ability to communicate over wired or wireless networks. It is the global interconnection of several heterogeneous devices. The devices or things can be connected to the Internet through three main technology components: physical devices and sensors (connected things), connection and infrastructure, and analytics and applications. The Internet of things can be defined using seven characteristics in Figure 1 [3].

The IoT, also known as the Internet of Objects, or the Internet of everything, or the Web of Objects, is a worldwide network that connects devices to the Internet and to each other using wireless technology. It has been gaining popularity rapidly since its inception into the IT community and is being used in healthcare, education, gaming, finance, transportation, and several more. IoT is expanding rapidly and it has been estimated that 50 billion devices will be connected to the Internet by 2020. These include smart phones, tablets, desktop computers, autonomous vehicles, refrigerators, toasters, thermostats, cameras, pet monitors, alarm systems, home appliances, insulin pumps, industrial machines, intelligent wheelchairs, wireless sensors, mobile robots, etc.

There are four main technologies that enable IoT [4]:

(1) Radio-frequency identification (RFID) and near-field communication.

(2) Optical tags and quick response codes.

(3) Bluetooth low energy (BLE).

(4) Wireless sensor network.

Other related technologies are cloud computing, machine learning, and big data.

Figure 2 depicts the application domains of IoT [5]. A typical IoT implementation is depicted in Figure 3 [6].

The concept of IoT has some the following characteristics [7]:

- *Interconnected:* Internet of things facilitates people to devices and devices to other devices.
- *Smart sensing:* The majority of devices and actuators have embedded or connected sensors to detect current conditions.
- *Intelligence*: IoT devices have some calculating units and software used for smart decisions, predictions and automation control.
- *Energetical efficiency*: All IoT devices must be efficient and able to use recyclable energy, boost own energy harvesting, if the application of device requires and allows it.
- *Data sharing*: IoT connected devices have the capability to express and share their current state to all other connected devices.
- *Safety:* Internet of things devices should ensure the safety of individual life. All medical smart devices are a good example of this characteristic.

IoT supports many input-output devices such as camera, microphone, keyboard, speaker, displays, microcontrollers, and transceivers. It is the most promising trend in the healthcare industry. Today, smartphone acts as the main driver of IoT.

The narrowband version of IoT is known as narrowband IoT (NBIoT). This is an attractive technology for many sectors including healthcare because it has been standardized [8]. The main feature of NBIoT is that it can be easily deployed within the current cellular infrastructure with a software upgrade.

APPLICATIONS OF NANOTECHNOLOGY IN BUSINESS

The ability of IoT to provide sensor information as well as enable device-to-device communication is driving a broad set of applications. The IoT technology can be applied to all areas human beings deal with. The following are some of the most popular applications [9-12]:

- *Automation:* The basic idea of IoT involves direct communication between separate devices without human interference, thus enabling automation. To stay competitive, manufacturers need to relieve their employees of repetitive tasks such as data entry or inventory management. Automation is used in various industries such as education, manufacturing, agriculture, and healthcare. IoT-powered industrial robots work 24/7 and reduce losses caused by human negligence. Temperature sensors are linked to automated heating and cooling systems that require no human intervention. TVs and other devices can be connected to the Internet so that

you can automate their schedules or turn them on and off easily and remotely. IoT technologies can assist educators to either reduce or eliminate entirely the manual processes associated with calculating attendance for students. Internet of things-based systems can store attendance data in one easy-to-access centralized database. In finance, IoT-powered systems can automatically perform certain operations: process requests, open bank accounts, disable credit cards, etc., thus minimizing human intervention and human errors.

- *Smart Homes:* Home management represents one of the most popular applications of IoT. Many aspects inside homes can be enhanced with the Internet of things. One can have Internet-connected devices anywhere in the home. Smart devices in the home create an integrated ecosystem you can control from a single point. Devices can monitor temperature conditions and modify HVAC performance to minimize energy consumption, while security cameras can manage public safety. Smart bulbs that can connect to the home network have really exploded in popularity
- *Automotives:* Cars are becoming increasingly complex with onboard diagnostic and computer systems. IoT applications can allow you to control your car remotely, including doors, windows, and radio. Companies are further investigating IoT networks to create the first generation of genuinely self-driving cars. Automakers are now implementing a wide range of smart connected technologies to create an amazing user experience.
- *Manufacturing:* IoT has many potential applications in manufacturing. With IoT applications in manufacturing, manufacturing units can rightly assess what and where a specific demand arises and collate the resources accordingly, and efficiently manage all the stages in the production activities. Businesses can use IoT in manufacturing to ensure that all devices work together in real-time. Manufacturers can monitor operations, status, and service levels from remote locations. They can gain a competitive advantage by using production-line monitoring to enable proactive maintenance on equipment.
- *Digital factory:* A digital factory is a factory where almost all of the tools are connected via the Internet. Large factories use connected sensors to automate maintenance schedules. Connected sensors can continuously measure equipment performance to detect any changes before a breakdown occurs.
- *Healthcare:* Human life has the highest value. Healthcare is one of the industries most welcome IoT devices. While performing various surgeries and operations, doctors need to be adept at their skills and exercise extreme caution and precision. Any wrong judgment or action can cause harm to the patient. IoT and robotics are effective in the field of healthcare to enable high-risk surgeries. IoT solutions can track critical health data like blood sugar level, heart rate, blood pressure, etc. Healthcare workers use IoT technology to keep an eye on patients in real-time through devices equipped with smart sensors. Common use of IoT devices includes health data trackers. Figure 4 shows a typical use of IoT in healthcare [13].
- *Agriculture:* The agriculture industry benefits greatly from IoT, with many manual processes being automated. Agriculture in the 21st century seriously differs significantly from agriculture in the 20th century. The agricultural sector is expected to continue growing at a rate of 3% annually over the next several years due to the population current growth trends. The adoption of IoT technology in agriculture will be a game-changer in the years to come. Automated agricultural vehicles like drones and autonomous robots along with advanced sensor-based solutions will undoubtedly play significant roles in advancing sustainable agricultural practices. Drones are used to monitor crop growth, analyze soil, and spray plants. Figure 5 shows the use of drones in agriculture [14].
- *Machine-to-Machine Communication:* The Internet of things operates without human intervention. Machine-to-machine communication creates an efficiency of data collection that obviates the need for workers to do the same job. For example, a company that owns a fleet of cars with workers using them for business operations can track the usage and mileage of each car

using IoT devices installed in each car. These devices send real-time data back to a server for monitoring and tracking purposes.

- *Insurance:* IoT devices monitor the state of insured objects and alert the insurers of any abnormalities. An insurer can detect an asset failure and warn a policyholder before it is damaged. This approach helps decrease the number of insurance claims as well as prevent insurance fraud. A combination of IoT and telematics helps insurers collect the data on the vehicle condition and driver behavior to provide personalized insurance plans. For example, Progressive, a US car insurer, launched a telematics-based auto insurance program called Snapshot. Telematics devices transmit personalized driving data to the insurance provider, and safe driving behavior is rewarded by lower insurance rates.
- *Customer Service:* Customers serve as the backbone of any business. IoT is quickly becoming a game-changer in terms of providing top-notch customer support. Customers have access to a range of valuable resources to help them make purchases and engage with companies. Automation is another critical component of IoT when it comes to customer service. The partnership of automation and customers provides customers with comforts that will keep them coming back: convenience, ease, and simplicity. When a business understands which consumers are using their products, they can market those products significantly more efficiently.
- *Traffic Management:* Roadway infrastructure has become more connected in recent years with cameras, sensors, traffic light controls, parking meters and even smartphone. Traffic apps are used to help avert traffic jams, prevent accidents, and ensure smooth travel. Sensors on traffic signals can detect varying levels of light in the sky and adjust the brightness of the signals. Connected devices can be used to detect open parking spaces.
- *Environmental Monitoring:* IoT applications have developed a niche in environmental and agricultural management through sensors to detect air, soil, and water quality. Companies use these technologies to better meet environmental goals by monitoring emissions and planning for weather conditions.

These are just some of the many applications of IoT in business.

BENEFIT

The IoT is changing how businesses optimize processes and engage customers. Optimization, maintenance of equipment, automation of the entire workflow, and remote management are all possible with IoT technology. Security is one of the greatest reasons that made IoT devices gain so much importance. In recent years, IoT adoption has skyrocketed in almost all industries. Top businesses have integrated IoT technology with their existing business models for greater benefits. Companies like Audi, General Motors, Verizon, Siemens, and others are generating revenue with IoT products and services. There are several prime advantages or benefits of IoT in business. Internet of things benefit businesses in the following ways [15]:

- *Connectivity:* Enhanced connections within one network on a worldwide scale provide easy access to various information. Some network protocols for the Internet have made it easy to connect sensors to the cloud and to other "things" for efficient data transfer.
- *Enhance Productivity:* Productivity is maximizing the amount of output from the given set of inputs. At the end of the day, profit or productivity is what makes business sense. Every company craves this vital point of more efficiency in production, and increasing the output produced productivity. Human error can also be minimized to the core. IoT helps boost business's productivity exponentially. AI makes sure that IoT devices work together for higher individual productivity. In a world where communication is key, IoT devices can be incredibly useful.
- *New Business Opportunities:* As time changes, businesses change, and the number of possibilities one can have in business is countless. IoT-influenced technologies have revolutionized the business industry, helping in reaching out better to the customers, and collaborating with an IoT solutions.

- *Cost-effectiveness:* Cost reductions are expected when devices are connected and networked. IoT applications and solutions predict and alarm about the downtime of equipment by monitoring the equipment. Hence, the costs for rectifying failures are reduced greatly. Energy efficiency can be improved and costs involved in energy can be cut down with IoT. IoT devices can save on work that would otherwise be handled manually by humans. For example, IoT-powered smart desks offer the ideal workstation for employees. This improvement will enable businesses to operate more cost-effectively.
- *Workplace Safety:* IoT companies employ tools and devices that can ensure employers and employees with greater safety in their working environment. This is important in high–risk situations like mining, construction, and other heavy industries. To ensure the fullest safety of the workers, embedded wearables and sensors, two of the most common IoT technologies, can be used. Businesses can incorporate IoT to assess equipment malfunction and the condition of the workplace in terms of safety.
- *Predictive maintenance:* IoT sensors check equipment 24/7. IoT devices can collect performance data automatically, which can be used for predictive maintenance to avoid down-time or increase machine availability. Data gathered through IoT helps create periodic maintenance schedules that have minimum impact on the continuity of production lines. IoT sensors predict chances of equipment failure for optimized maintenance schedules. This reduces the effect a breakdown has on active production hours.

CHALLENGES

Businesses should be aware of some challenges and threats like privacy, security, standardization, connectivity, availability of spectrum, standardization, compatibility, interoperability, and other issues that we need to overcome with respect to IoT. Other challenges include [16]:

- *Security Risks:* Security presents one of the most critical obstacles to IoT deployment. Every endpoint that is connected to the Internet is exposed to increased risk and vulnerability. Anything that can be connected, will be connected to the Internet. The number of devices connected through the Internet exceeded the population of the world way back in 2011. The number will only increase in the coming years and the associated security risks will inadvertently multiply. Unauthorized access through these connected devices that can be detrimental to the operations of a business. Hacking is a real threat. It can lead to large breaches in security, violation of privacy, and can cripple large systems.
- *Privacy:* There are concerns regarding data usage and privacy. Privacy defines the rules by which individual data can be accessed and is therefore one of the major challenges. The lack of trust in regards with data, privacy, and security is a major issue.
- *Associated Costs:* Implementation of IoT infrastructure in a business enterprise implies building an extensive network comprising multiple smart devices. Such an initiative requires significant investments to install, maintain, and gradually expand the created network according to future needs. Though IoT solutions provide multiple benefits, it takes a lot of time before they become profitable, and their financial benefits exceed the initial costs of their implementation. The business must first provide the whole range of the required networking equipment: cables, routers, hubs, local data storage means, and so on.
- *Network Dependence:* The core feature of the IoT is the immense amount of interconnections between various devices and access to the global network. Thus, IoT devices require an infrastructure that ensures the uninterrupted communication with high throughput, low latency, and constant access to the Internet.
- *Better Standardization:* Consistency in IoT standards are well needed for better interoperability because some layers of the IoT technology stack have no standards, and others have numerous competing standards. This means IoT requires better standardization, which can enable both horizontal and vertical Interoperability,

- *Compatibility:* Different manufacturers of sensors embedded in smart devices use different data transfer protocols that would cause communication problems.

Regardless of these issues, the benefits of IoT in business far outweigh the challenges we face with its adoption.

CONCLUSION

The Internet of things refers to networks of physical devices that connect to one another and the Internet through a series of integrated software programs and sensors. It is a global infrastructure for the information society, enabling advanced services. IoT technology is becoming a necessity for many businesses. It is emerging as an integral technology in ensuring that devices work together in collaboration. The IoT is projected to have enormous potential to influence and change the society, economy, and environment.

The Internet of things is growing all around us. It is here to stay because it is incredibly useful. Its future is to lead the path to comprehensive business transformation. As the IoT continues to develop, it will have an increasing effect on the way businesses operate. More information about the business potential of IoT can be found in the books in [17-28].

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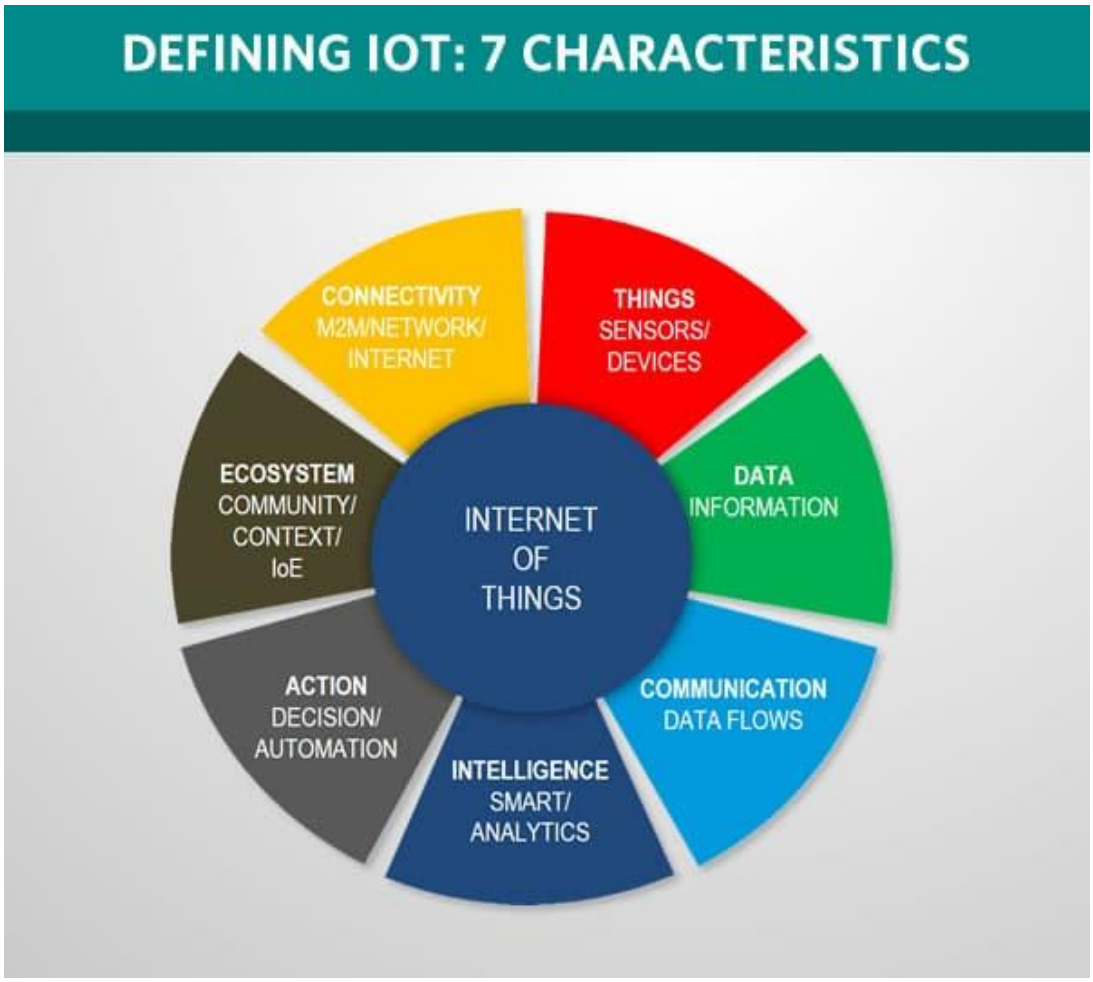

Figure 1 The Internet of things is defined using 7 characteristics [3].

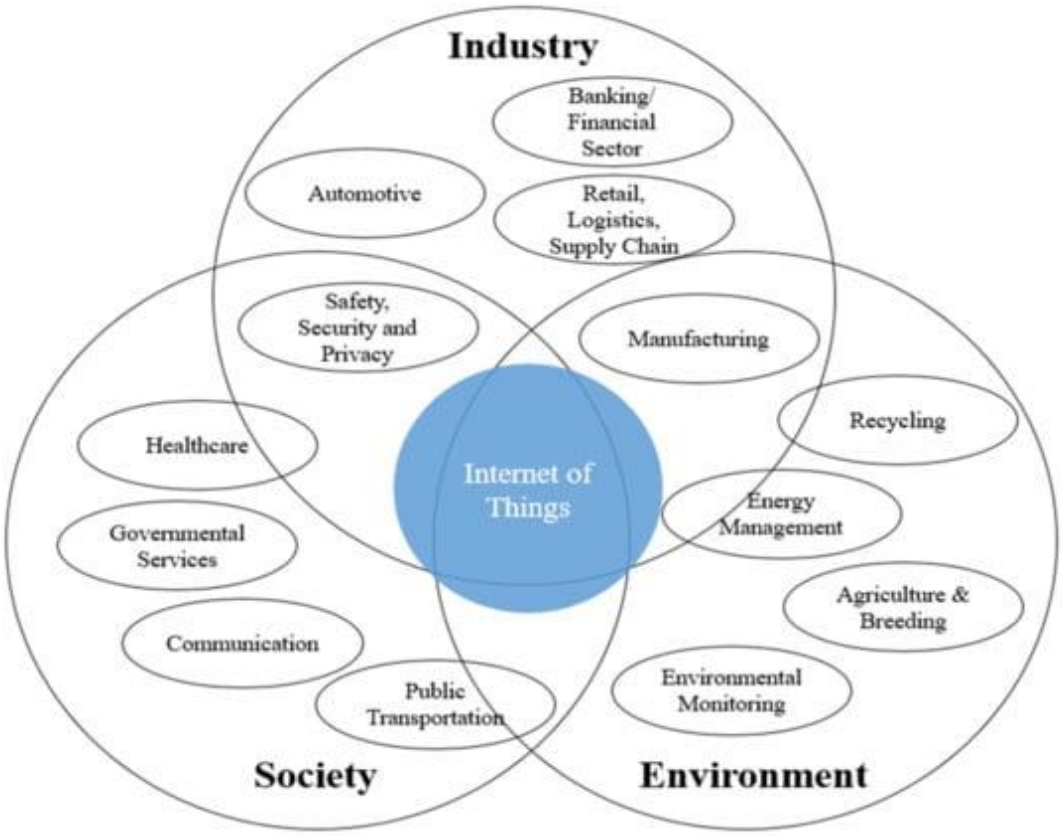

Figure 2 Application domains of IoT [5].

Figure 3 A typical IoT implementation [6].

Figure 4 A typical use of IoT in healthcare [13].

Figure 5 The use of drones in agriculture [14].