Internet of Everything: A Primer

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Abstract The Internet of everything (IoE) is essentially the intelligent connection of people, process, data, and things. It is a concept that extends the Internet of things (IoT). IoE enhances IoT and advances the power of the Internet to improve business and industry outcomes. IoE enables machine-to-machine communication (M2M), people-to-machine (P2M) communication, machine-to-people (M2P) communication, and people-to-people (P2P) communication. This paper provides an introduction to Internet of everything.

Keywords Internet of things, Internet of everything, artificial Intelligence

Introduction

The Internet has changed our society. The Internet is no longer just about people sending emails or sharing pictures, videos, and opinions through social media networks. The number of devices connected to the Internet is growing exponentially mainly due to the proliferation of connectivity enabled smartphones. The modern age is replete with evolutionary Internet-based technologies such as Internet of things, big data, cloud computing, software-defined networking, online education, and smart "everything" or smart systems [1].

The Internet of Things (IoT) consists of networks of sensors and actuators attached to objects and communications devices, providing data that can be analyzed and used to initiate automated actions. As shown in Figure 1, IoT may be regarded as a network of networks [2]. IoT devices include vehicles, wearables, computers, tablets, smartphones, appliances or entity that can be made addressable and has the ability to transmit data without human-to-machine input. Internet of everything (IoE) may be regarded as the next evolutionary step of IoT. IoE adds people, process, and data to loT and thus creates exabyte (billion of billions) of data daily.

In order to fulfill its full potential, the Internet of things (IoT) must evolve into the Internet of everything (IoE). The key to this transition is the maturing fields of AI, cognitive computing, machine learning, and MEMS. These technologies will allow IoT systems to become IoE systems of systems, which will offer paths to improve quality of life. They will allow healthcare systems data be integrated with transportation data, environmental data, etc.

IoE enhances IoT and advances the power of the Internet to improve business and industry outcomes. The Internet of everything (IoE) is bringing together people, process, data, and things to make networked connections more relevant and valuable than ever. While IoT focuses on physical objects only, IoE encompasses four components (things, processes, data and people).
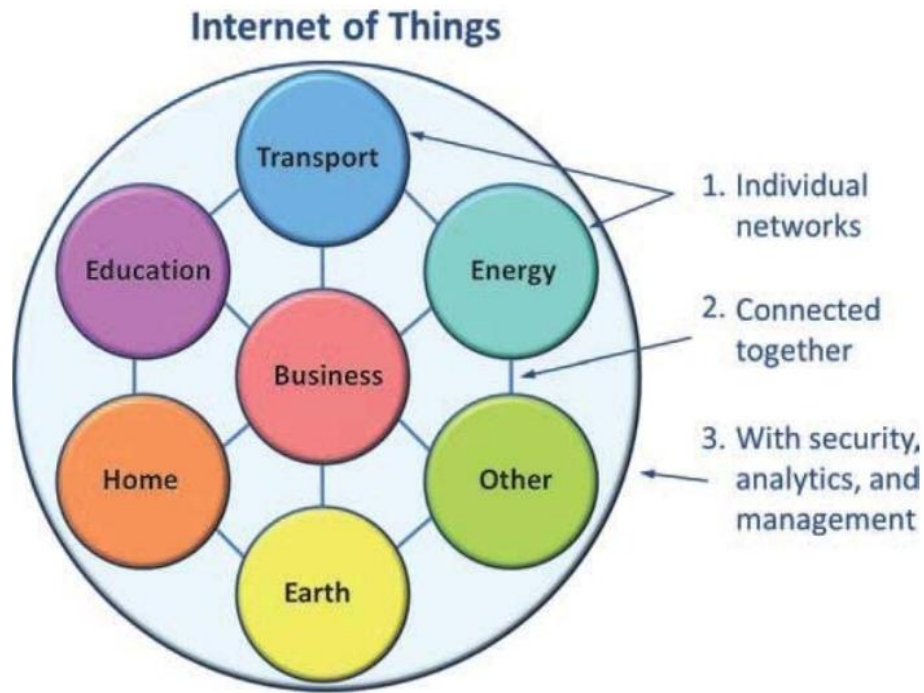
Figure 1: IoT can be regarded as a network of networks [2]

Concept of IOE

Internet of everything (IoE), also called ambient intelligence, is a new concept that evolved from advances made in the Internet of things (IoT). The term "Internet of everything" was coined by Cisco, but today all companies are using IoE. IoE is the global network through which people, things, intelligent devices are connected to each other and can share information and services. The four pillars of IoE are illustrated in Figure 2 and described as follows [3].
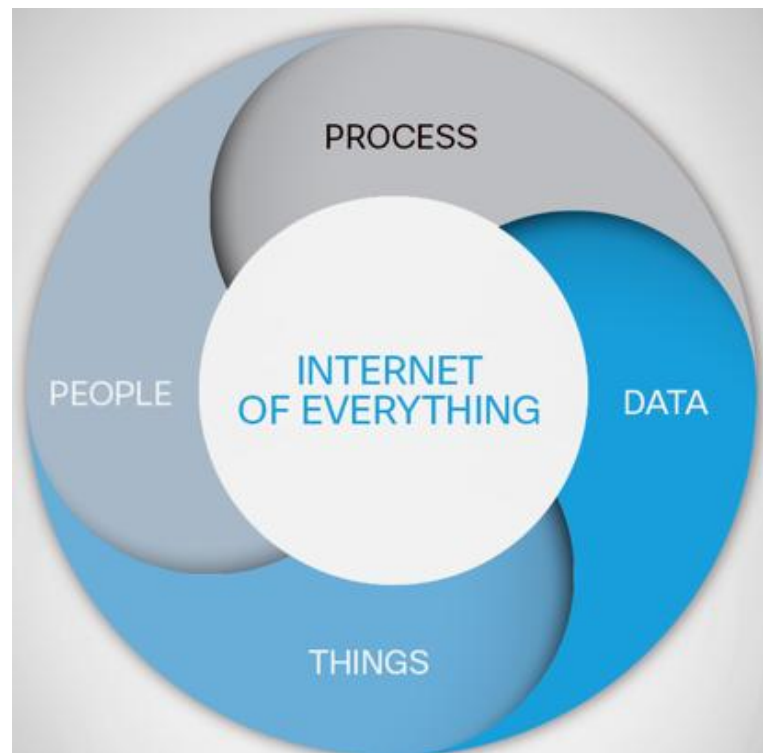

Figure 2: The four pillars of IoE [3]

- *People:* People are connected in more relevant, valuable ways. They provide their personal insights via websites, applications or connected devices they use. No intelligent connection is possible without people.
- *Data:* This is the raw data generated by IoE devices. The world is awash in data. The raw data has no value. It needs to be analyzed and processed into information. Data can be converted into intelligence to make better decisions.
- *Process:* Process refers to the methodology of performing an activity, e.g. manufacturing process, market strategy, etc. Various processes enabled by AI, machine learning, social networks or other technologies ensure that the right information is sent to the right person (or machine) at the right time. The primary objective of the processes is to ensure the best possible usage of big data.
- *Things:* Physical devices and objects (such as smart coffee pots) are connected to the Internet and each other for intelligent decision making. This is where IoT comes in. Things are the building blocks of both IoT and IoE. In IoE, almost every physical object or entity that is equipped with sensors and linked over public or private networks becomes part of IoE. These everyday objects are connected and are becoming smart.

It is in the intersection of all of these elements that the real potential of IoE is realized. IoE includes not only machine-to-machine communication (M2M) but also people-to-machine (P2M), machine-to-people (M2P), and people-to-people (P2P) communication. IoE is related to other technologies as illustrated in Figure 3 [4].
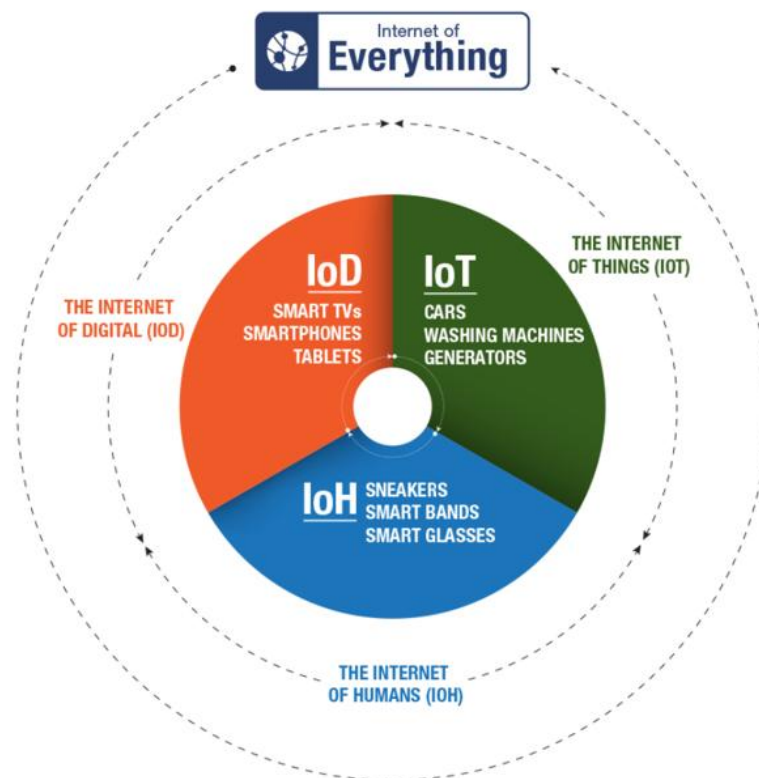

Figure 3: Relationship between IoE and other technologies [4]

Enabling Technologies

Several technologies are enabling IoE. These include AI, cognitive computing, machine learning, global positioning systems (GPS), radio frequency identification (RFID), 5G, MEMS technology, big data, mobile solutions, and wireless sensor networks. Every sensor node or intelligent system is connected to each other using a wireless sensor network. The wireless network is necessary to meet the needs of real-time/bilateral communication among billions of IoE devices. The number of sensors is predicted to reach 50 billion in the next

few years. Each sensor node is used to detect various parameters such as motion, humidity, temperature, pressure and light. Recently, cloud computing has been introduced into the IoE paradigm to provide a multitude of services necessary to compose a smart system that utilizes big data.

Applications of IOE

IoE is transforming industries and the range of IoE appliances is growing. Virtually any industry can apply the IoE concept into its processes and benefit from it. Specific industries that benefit from IoE include manufacturing, retail, finance, insurance, healthcare, business, aerospace, agrobusiness, automation, smart grid, education, municipality systems including urban transport system. Internet of everything is seen in smart cars, smart watches, connected homes and cities, connected cars and roads, health monitors, fitness trackers, etc. Here are some typical applications of IoE.

- *Smart Homes:* The era of smart home is coming. IoE offers opportunities for smart homes. IoE tries to connect everything that can be connected to the Internet at home, where everything refers to people, cars, televisions, smart cameras, microwaves, sensors, etc. By connecting everything from a thermostat to a cooker, it is possible to fully automate daily life. Connected homes provide comfort living and will manage themselves better, contributing to smarter, more efficient cities.
- *Businesses:* IoE is expected to reinvent the business wheel all-together. By using IoE, we can generate insights form available data to guide critical decision making at every stage of business. For example, Google is an IT company but its concept of smart cars will revolutionize the automobile industry. As another example, Cisco is working with major retailers to use a fusion of sensors, video, and analytics to improve both store productivity and customer experience.
- *Education:* Educations plays a major role in our economy. It has been claimed that the Internet creates a "wall-less" learning community. An educational IoE paradigm consists of four items [5]: (i) people; (ii) processes; (iii) data; and (iv) things. People are students, teachers, administrators. Processes dictate how people and objects must interact to generate data that can be transformed into usable knowledge. IoE provides a suitable environment to generate relevant data about its network and its embedded devices. Things are physical devices that can establish connection with the Internet and utilize sensors to capture information [6].

- *Manufacturing:* Perhaps the most exciting challenge is to develop new manufacturing approaches based on IoE. The variety of smart objects will require highly-flexible manufacturing techniques to address all the emerging IoE applications. The manufacturing industry can implement sensors that monitor industrial machinery to increase utilization in manufacturing. Additive 3D manufacturing methods are currently in use not only for prototyping but also for creating actual products for medical, aerospace, and other applications [7].
- *Healthcare Monitoring*: Healthcare needs an automated system that allows continuous monitoring and reporting of patients' health conditions. Body temperature, blood pressure, and heart pulses can be sensed and sent to the cloud, where physicians can have easy. Mobile phones and specialized wearable sensor networks are being utilized to detect elderly people body posture [8].
- *Supply chain:* This is an area where IoE may help to bring value and improve processes. Logistics and delivery companies can introduce sensors and smart devices on trucks to optimize delivery conditions.

As one can observe from these IoE applications, the future of IoE is bright. However, IoE applications must provide society with a feeling of safety and comfort.

Benefits and Challenges

Internet of everything (IoE) brings data, people, process, and things together to make networked connection. Emerging areas will witness and benefit from the rapid growth of connected things. This will lead to improved safety, security and loss prevention in the insurance industry. The ambition of IoE is to create new talents, richer experiences, and unparalleled financial opportunity for businesses, people, and nations through bringing collectively human beings, processes, data, and the things that surround us [9]. The true measure of IoE success will be the benefits delivered to humanity through converging people, process, data, and things. The IoE is

accompanied by various opportunities in all fields of life, ranging from the energy sector to the healthcare industry. Decentralization is one of the advantages of IoE. IoE is designed to make networked connections more relevant and valuable, turning information into actions, creating unprecedented economic opportunity for businesses, individuals, and nations. IoE showcases a huge potential rise in big data, delivering many useful insights for businesses. IoE can enhance our daily lives by monitoring healthcare to become more of an existing process in our life.

IoE is posing some challenges which will be faced during the following years. IoE devices have different operation principles, weakening the network scalability and data interoperability. Personal security, data privacy, and trust strong are challenges to IoE. The security issue in IoE mainly relies on maintaining the availability, integrity, and confidentiality of the data. Mobility presents some challenges for the efficiency of networks and protocols. Other IoE challenges include extra-low-power chips that harvest their own energy, lack of standards, low cost, cybersecurity, interoperability, and interference caused by radio frequency emitters.

Conclusion

Today, IoE is regarded as a superset of IoT. IoE is a growing phenomenon which will gain more traction with time. It is becoming ubiquitous. It is the Internet of the future, powering billions of integrated devices and processes across industries. It will be soon combining to IIoT, CIoT and WoT for connecting the entire world. We can see its potential for future growth and development. The Internet of everything is posed to re-invent industries at three levels**:** business process**,** business model, and business moment**.** It will eventually enable us to become better stewards of our finite resources by improving how we manage our environment. For more information about Internet of everything, one should consult book in [10-12].

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