INTERNET OF THINGS: OBSTACLES AND CHALLENGES

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Abstract

The internet of things is a next generation technology in the making. It is the unrestricted interaction between all physical and logical entities by means of information and communication technologies. IoT requires a tremendous amount of research for successful and motive-oriented development. Like any other technology, IoT faces obstacles and challenges during its development which are not ordinary.

Keywords: Internet of things, Data, Fog Computing, Protocol Suite, Cloud, Challenges, Obstacles.

1. Introduction

The internet of things, IoT is a phenomenal realization of technology in which digital and physical entities interact with each other by means of information and communication technologies. The amount of effort put in research and development by educational institutions, corporate giants, and small scale and medium scale industries across the globe is astounding.

The areas of research include healthcare, supply chain management, smart home systems, manufacturing, public safety, vehicle assistance and others. IoT has stepped out of its infancy. It is now in the making of becoming the next technological revolution. The potential of IoT is unbelievable but it comes with obstacles and challenges that are not ordinary. In this article, we will look at all the major challenges IoTfaces today.

Figure1. IoT devices

2. How does IoT work?

An IoT system is an emerging paradigm which has a combination of sensor capabilities with front-end and back-end systems that convert raw data into useful information for service. The idea is to hand over control from humans to physical or logical entities to do all the computations and services. This independent ecosystem must contain physical systems that are controlled either autonomously (secure systems) or universally.

3. The Analogy

To understand the concept of theinternet of things and the obstacles and challenges it faces, we can comparethe ecosystem of biotic and abiotic with the ecosystem of things. In any ecosystem, there are five important attributes – Structure, Function, Complexity, Interaction and Change [1].

Let us take the example of a forest ecosystem. The structure of a forest ecosystem, when observed,can be described asegment of alandscape dominated by the presence of large trees and plants where trees control the major biological and ecological processes and shape the habitat for animal and microbe survival. In a forest, there are living and dead organisms which rely on natural actions, voluntary or involuntary, performed by other organisms or as a consequence of abiotic environmental activity.

Each organism has its own function bringing change in physical, chemical or biological state of the ecosystem. Functions are interdependent and rely on a stimulus and response system where interaction occurs between organisms and other structural components. For example, survival of plants depends on nutrients from thesoil and hydrological cycle but plants modify local climate and influence soil development.

Figure2. Illustration of Forest Ecosystem by Jeff Grader

In a similar way, the ecosystem or the internet of things can be described as a technological system of interdependent physical and logical entities where changes take place based on stimuli and responses. The changes can occur during a series of consequent or inconsequent events. The structure of this ecosystem includes all the physical and logical entities such as sensors, controllers, and virtual environments which interact with each other as well as with the physical environment.

Figure3. Ecosystem of things by Matt Ceniceros

Organisms in an ecosystem use chemical changes, gestures, or auditory and visual stimuli to communicate with each other. In a similar fashion, all the devices must be able to receive and transmit data between each other to communicate. The exchange must be under a protocol suite that can convert data from one format to the other and allow two physically different end to end protocols to interoperate.

4. Obstacles and challenges

4.1.Data Never Sleeps

An approximate of 3.4 billion people have access to the internet today. The data generated per minute in the entire globe is inconceivable. The poster "Data Never Sleeps 4.0" gives you statistics of a few internet applications. According to a study done by CISCO, we've had 25 billion connected devices in the year of 2015 and by 2020, the number will increase to 50 billion [2]. The problem is not storage of anunprecedented amount of data but retrieving pertinent data and processing it. With theinfluxof tremendous amount of data, the cycle of storing, retrieving and processing dataseems incessant and has to perform every minute of the day.

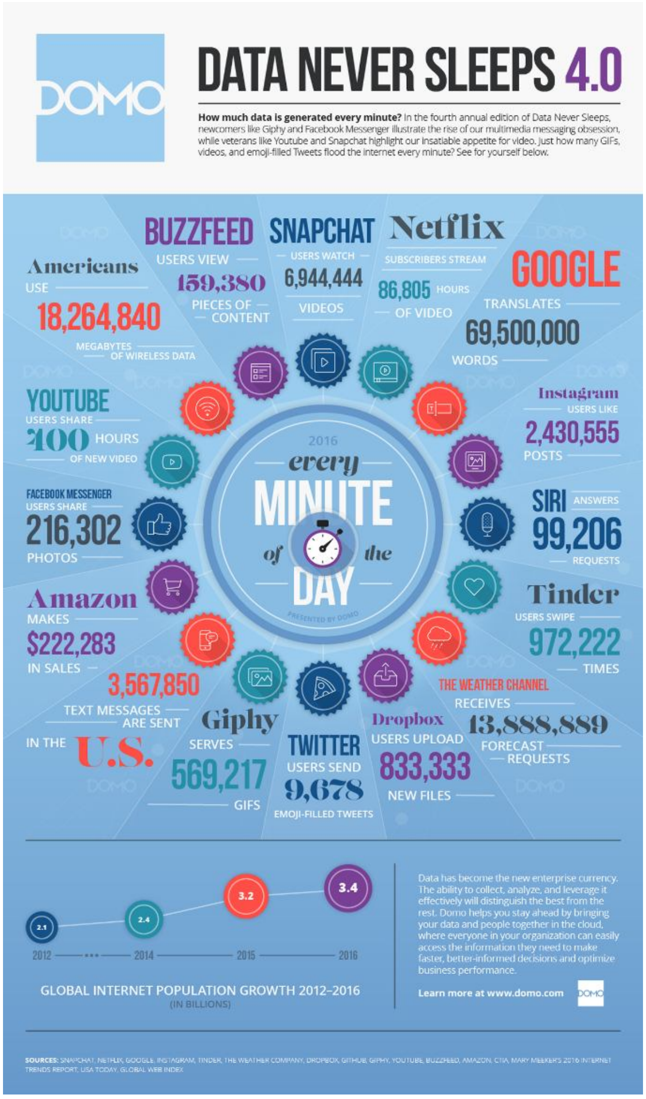

Figure4. Data never sleeps poster [3]

4.2.Data Storage, Retrieval, and Analytics

The greatest challenge IoT applications, especially mission critical applications face is to convert raw data into meaningful information that can be fed to devices in real time. In real time systems, latency must be given utmost importance for accurate and appropriate stimuli and responses.There are several techniques for storing, retrieving and processing data.

The ongoing research for handling data includes Big Data, Edge Computing, and Fog Computing. In the current scenario, the combination of Big Data with either Edge Computing or Fog Computing (by CISCO) is being used by developers and researchers to implement IoT. The server technology must also evolve to withstand the amount of data that will be generated in the coming years. Obstacles such as temperature control, latency issues, and maintenance of server farms have to be tackled soon before they topple over and the dispensable capital runs out.

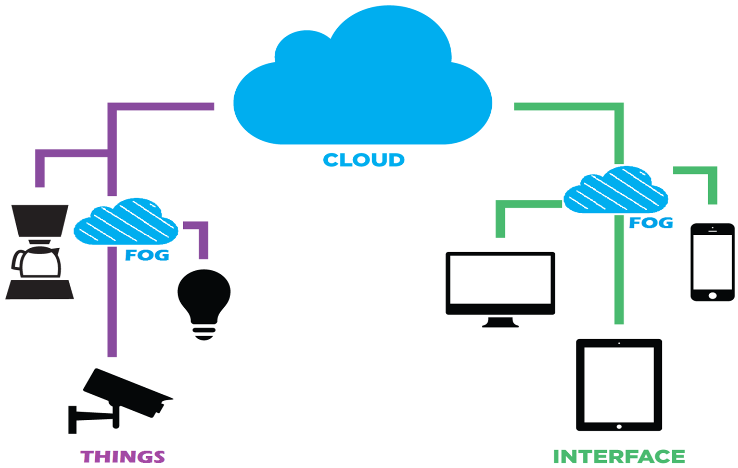

Figure5. Fog computing depiction [4]

4.3.Universality

The first question that comes to mind when we say "IoT" is – is it scalable? When implemented as an autonomous ecosystem, the IoT loses its very definition. An autonomous system may restrict access to other devices due to theusage of different platform, method of transferring data, or communication technique. This poses a huge problem to the development of a universal ecosystem where every entity should be able to communicate with each other through theexchange of data, and stimuli and response.

There are various research groups around the world developing their ownIoT. The obstacle of restrictiveness and proprietary rights come into picture when these groups are unwilling to cooperate and collaborate, making it a lost cause. With theincrease in the number of physical and logical entities, the problem of naming arises.

Today, we make use of various protocols such as Bluetooth, IP, IEEE 802.11 and WLAN to connect 25 billion devices to each other and every device must have a static address to communicate with. Researchers have proffered the idea of using IPv6 protocol that can accommodate 340 trillion trilliontrillion unique addresses to name devices. But, the downside to the idea is alack of interoperability.

4.4.Protocol Trouble

The idea of IoT is to connect all entities across the globe so that each entity can give a response to a stimulus and exchange data unrestrictedly. Devices today are manufactured on various platforms using different hardware technologies. Interoperability is the need of the hour. Let us take the example of fitness bands.

Many fitness bands make use of a mobile phone to store and update information onto to a cloud.First, the information is sent to the mobile phone's application. The application connects to a cloud where it performs storage, modification, retrieval,or computations and sends information back to the band. This is synonymous with fog computing which is a close-to-ideal solution for the IoT data problem.

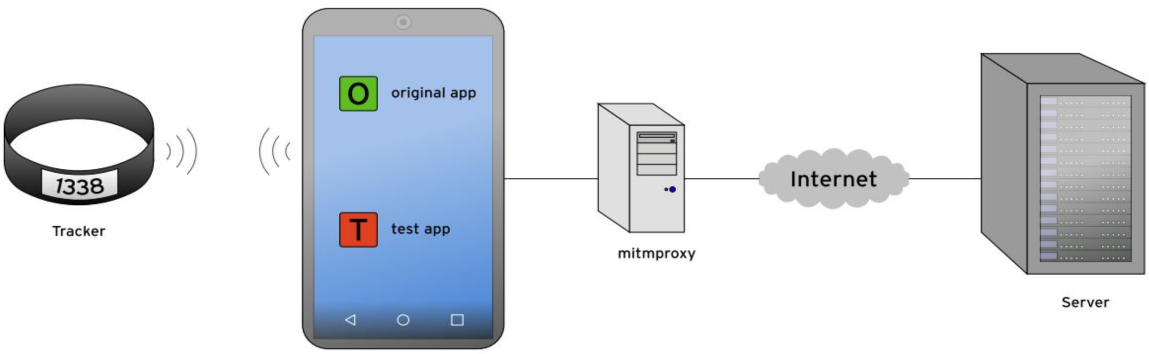

Figure6. Fitness band communication [5]

If such a system is implemented, a protocol suite needs to be developed to accommodate thetransfer of information through theprotocol to protocol transformations and transfer of data to ensure interoperability, leaving no device behind. Every device must be able to have access to a server at thelocal gateway for storage, retrieval, and computations. Only the useful information (a cache) must get stored in thecloud to avoid stocking of raw and dispensable data and latency issues.

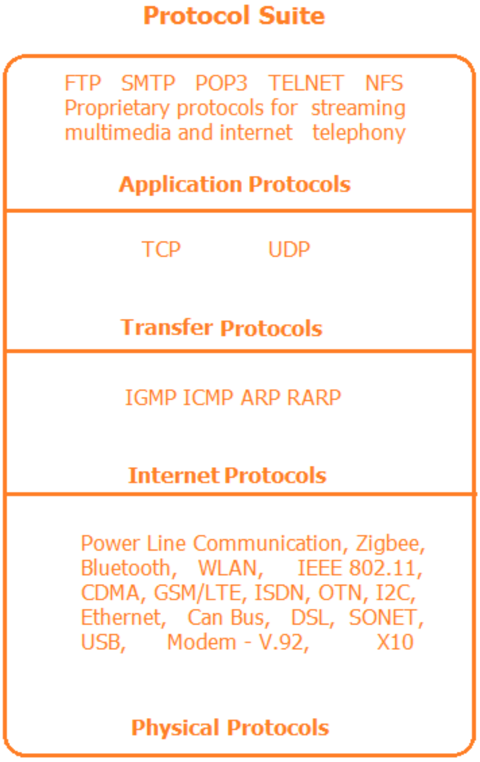

Figure7. Illustration of Protocol Suite by M V Siva Abhishek

4.5.Privacy and security

An IoT system should protect consumer information as well as safeguard all the entities involved in the ecosystem [6]. Each physical or logical entity must expose information necessary to create stimulus or response. This exposure must be restrictive enough to safeguard consumer privacy and perform required functionality. Security breaches can occur at different levels in an ecosystem such as entity, local gateway, and cloud level. Corporations across the globe are competing to improve IoT-based on security metrics as this would be a pivotal factor in determining their success in developing IoT.

5. Conclusion

The Internet of things could potentially transformour business and lifestyle. If security and privacy are kept as a pivot, the technological revolution can change the approach towards “things” and shape commerce and culture.IoT will add value to augmented reality, 3D printing, nanotechnology, next gen mobiles, bionics, and other promising technologies. CISCO anticipates IoT to add $19 trillion in economic value by 2020 while GE estimates a $10-15 trillion addition to the global GDP by 2035[7]. The expectations are high and so is the number of hurdles. The obstacles and challenges IoT faces today are not ordinary but definitely surmountable.

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