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Internet of Things -Overview

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ABSTRACT

The Internet of Things (IoT), also referred to as the Internet of Objects, will change everything—including ourselves. This may seem like a bold statement, but consider the impact the Internet already had on education, science, communication, business, government, and humanity. Clearly, the Internet is one of the most important and a powerful creation in all of human history. This paper discussesIOT architecture, IOT applications and limitations of IOT.

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I. INTRODUCTION

The use of the word "Internet" in the catchy term "Internet of Things" which stands for the vision outlined above can be seen as either simply a metaphor – in the same way that people use the Web today, things will soon also communicate with each other, use services, provide data and thus generate added value – or it can be interpreted in a stricter technical sense, postulating that an IP protocol stack will be used by smart things (or at least by the "proxies", their representatives on the network). The term "Internet of Things" was popularized by the work of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), which in 1999 started to design and propagate a cross-company RFID infrastructure [2].In 2002, its co-founder and former head Kevin Ashton was quoted in Forbes Magazine as saying, "We need an internet for things, a standardized way for computers to understand the real world"[7]. In recent years, the term "Internet of Things" has spread rapidly – in 2005 it could already be found in book titles [5,6], and in 2008 the first scientific conference was held in this research area. European politicians initially only used the term in the context of RFID technology, but the titles of the RFID conferences "From RFID to the Internet of Things" (2006) and "RFID: Towards the Internet of Things" (2007) held by the EU Commission already allude to a broader interpretation. Finally, in 2 The Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analyzed and used to initiate action, providing a wealth of intelligence for planning, management and decision making. This is the world of the Internet of Things (IOT).

In 2010, the number of everyday physical objects and devices connected to the Internet was around 12.5 billion. Cisco forecasts that this figure is expected to double to 25 billion in 2015 as the number of more smart devices per person increases, and to a further 50 billion by 2020 (see Figure 1)

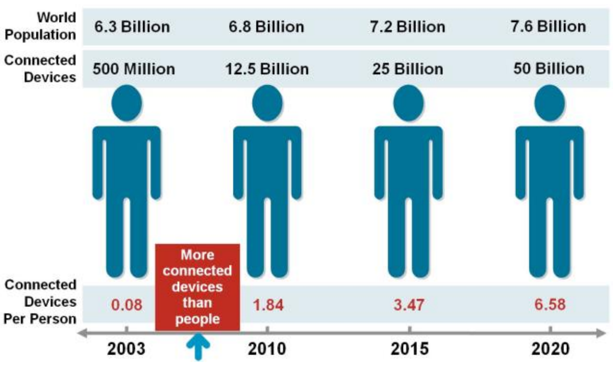

Figure:1 No of connected devices by 2020[1]

With more physical objects and smart devices connected in the IOT landscape, the impact and value that IOT brings to our daily lives become more prevalent. People make better decisions such as taking the best routes to work or choosing their favorite restaurant. New services can emerge to address society challenges such as remote health monitoring for elderly patients and pay-as-you-use services. For government, the convergence of data sources on shared networks improves nationwide planning, promotes better coordination between agencies and facilitates quicker responsiveness to emergencies and disasters. For enterprises, IOT brings about tangible business benefits from improved management and tracking of assets and products, new business models and cost savings achieved through the optimization of equipment and resource usage.

A. *IOT Architecture*

IOT architecture consists of different suite of technologies supporting IOT. It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IOT deployments in different scenarios.

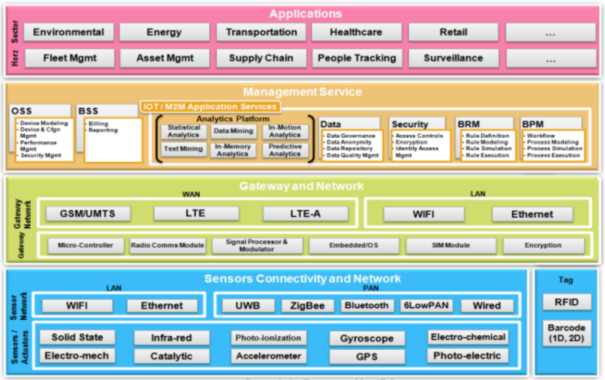

Figure 2: IOT Architecture

B. *Sensor Layer*

The lowest layer is made up of smart objects integrated with sensors. The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. The miniaturization of hardware has enabled powerful sensors to be produced in much smaller forms which are integrated into objects in the physical world.

There are various types of sensors for different purposes. The sensors have the capacity to take measurements such as temperature, air quality, movement and electricity. A sensor can measure the physical property and convert it into signal that can be understood by an instrument. Sensors are grouped according to their unique purpose such as environmental sensors, body sensors, home appliance sensors and vehicle telematics sensors, etc.Most sensors require connectivity to the sensor aggregators (gateways). This can be in the form of a Local

Area Network (LAN) such as Ethernet and Wi-Fi connections or Personal Area Network (PAN) such as ZigBee, Bluetooth and Ultra- Wideband (UWB).

C. Gateways and Networks

Massive volume of data will be produced by these tiny sensors and this requires a robust and high performance wired or wireless network infrastructure as a transport medium. Current networks, often tied with very different protocols, have been used to support machine-to-machine (M2M) networks and their applications.

With demand needed to serve a wider range of IOT services and applications such as high speed transactional services, context-aware applications, etc., multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security.

D. Management Service Layer

The management service renders the processing of information possible through analytics, security controls, process modeling and management of devices.

One of the important features of the management service layer is the business and process rule engines. IOT brings connection and interaction of objects and systems together providing information in the form of events or contextual data such as temperature of goods, current location and traffic data. Some of these events require filtering or routing to post-processing systems such as capturing of periodic sensory data, while others require response to the immediate situations such as reacting to emergencies on patient's health conditions. The rule engines support the formulation of decision logics and trigger interactive and automated processes to enable a more responsive IOT system.

E. Application Layer

There are various applications from industry sectors that can leverage on IOT. Applications can be verticalised ones that are specific to a particular industry sector, and other applications such as Fleet Management, Asset Tracking, and Surveillance can cut across multiple industry sectors.

F. Technology Outlook

This section covers the various technologies that support IOT. As IOT is architected into layers, the technologies have been categorized into three groups.

- The first group of technologies impacts the devices, microprocessor chips such as low power sensors for power and energy sustainability; miniaturization of chipsets; wireless sensor network for sensor connectivity.
- The second group comprises technologies that support network sharing, address capacity and latency issues like network sharing technologies such as software-defined radios and cognitive networks; network technologies that address capacity and latency issues such as LTE and LTE-A.
- The third group impacts the management services that support the IOT applications like intelligent decision-making technologies such as context-aware computing service, predictive analytics, complex event processing and behavioral analytics; speed of data processing technologies such as in-memory and streaming analytics.

II. IOT Applications

Below are some of the IOT applications that can be developed in the various industry sectors (these applications are not exhaustive).

A. Supply Chains

i. Dynamic Ordering Management Tool

Traditionally, the order picking management in the warehouse picks up multiple types of commodities to satisfy independent customer demands. Using the dynamic ordering tool, the network of smart objects will identify the types of commodities and decompose the order picking process to distributed sub-tasks based on area divisions. The application will plan the delivery routes centrally before activating order pickers for the delivery. Using executable algorithms in active tags, the tags can choose the best paths for the order pickers to take, as well as paths that are within their responsible areas. This results in a more optimized order processing, time savings and lower cost of delivery.

B. Government

i. Crowd Control during Emergencies and Events

The crowd control application will allow relevant government authorities to estimate the number of people gathering at event sites and determine if necessary actions need to be taken during an emergency. The application would be installed on mobile devices and users would need to agree to share their location data for the application to be effective. Using location-based technologies such as cellular, Wi-Fi and GPS, the application will generate virtual "heat maps" of crowds which can be combined with sensor information obtained from street cameras, motion sensors and officers on patrol to evaluate the impact of the crowded areas and help to inform the emergency vehicles about the best possible routes to take.

ii. Intelligent Lampposts

The intelligent streetlamp is a network of streetlamps that are tied together in a WAN that can be controlled and monitored from a central point, by the city or a third party. It captures data such as ambient temperature, visibility, rain, GPS location and traffic density which can be fed into applications to manage road maintenance operations, traffic management and vicinity mapping.

C. Retail

i. Shopping Assistants

In the retail sector, shopping assistant applications can be used to locate appropriate items for shoppers and provide recommendations of products based on consumer preferences.

The application can reside in the shopper's personal mobile devices such as tablets and phones, and provide shopping recommendations based on the profile and current mood of the shopper. Using context-aware computing services, the application captures data feeds such as promotions, locations of products and types of stores, either from the malls' websites or open API if the mall allows it. Next the application attempts to match the user's shopping requirements or prompts the user for any preferences, e.g., "What would you like to buy today?" If the user wants to locate and search for a particular product in the mall, the application guides the user from the current location to the destination, using local-based technology such as Wi-Fi 33 embedded on the user's mobile phone.

D. Healthcare

i. Elderly Family Member Monitoring

This application creates the freedom for the elderly to move around outdoors with family members being able to monitor their presence. The elderly sometimes lose their way or are unable to identify familiar surroundings to recall their way back home. The application can be a tiny piece of wearable device such as a coil-on-chip tag attached to the elderly. This tag will be equipped with location-based sensors to report the paths that the wearer has travelled. It can emit signals to inform family members if the wearer ventures away from predetermined paths. It can also detect deviations in their daily routines. Family members can also track the location of their elderly online via the user interface (UI) application.

ii. Continuous Patient Monitoring

Continuous patient monitoring is an extension to the "Elderly Family Member Monitoring" application; this application, however, requires the medical services companies to support it. Continuous patient monitoring requires the use of medical body sensors to monitor vital body conditions such as heartbeat, temperature and sugar levels. The application examines the current state of the patient's health for any abnormalities and can predict if the patient is going to encounter any health problems. Analytics such as predictive analytics and CEP can be used to extrapolate information to compare against existing patterns and statistics to make a judgment.

E. Transportation

i. Special Needs and Elderly Transportation Assistant

The transportation assistant application serves to address the group of commuters with special needs and who require assistance as they commute using public transportatione.g., using the public train service, the transport assistant will inform the nearest transport staff so they can provide special assistance such as audio and visual services and physical assistance for the passengers.

ii. Distributed Urban Traffic Control systems

Distributed Urban Traffic Control systems enable the tracking of car locations in real time and provide an appropriate traffic management response to handle road conditions. It can be used in times of emergency such as setting up of fast lane corridors for emergency services, i.e., ambulances, police cars and fire brigades, to pass through during heavy traffic conditions.

F. Energy Management

i. Facilities Energy Management

Facilities energy management involves the use of a combination of advanced metering and IT and operational technology (OT) that is capable of tracking, reporting and alerting operational staff in real time or near real time. They provide dashboard views of energy consumption levels, with varying degrees of granulation, and allow data feeds from a wide range of building equipment and subsystems.

ii. **Home Energy Management/Consumer Energy Management**

Home energy management (HEM) optimizes residential energy consumption and production. Solutions include software tools that analyses energy usage, and home-area network (HAN) energy management sensors that respond to variable power prices. A combination of these solutions contributes towards reducing overall carbon emissions for homes.

iii. **Cloud Computing**

IOT connects billions of devices and sensors to create new and innovative applications. In order to support these applications, a reliable, elastic and agile platform is essential. Cloud computing is one of the enabling platforms to support IOT.

Cloud computing is an architecture that orchestrates various technology capabilities such as multi-tenancy, automated provisioning and usage accounting while relying on the Internet and other connectivity technologies like richer Web browsers to realize the vision of computing delivered as a utility. Cloud computing is seen as a growing adoption with three commonly deployed cloud service models namely Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). For example, in IaaS, the use of hardware such as sensors and actuators can be made available to consumers as cloud resources. PaaS can provide a platform from which to access IOT data and on which custom IOT applications (or host-acquired IOT applications) can be developed. SaaS can be provided on top of the PaaS solutions to offer the provider's own SaaS platform for specific IOT domains.

III. Limitations

Three of the main concerns that accompany the Internet of Things are the breach of privacy, over-reliance on technology, and the loss of jobs. When anything is put on the internet it will always be there. Of course there are security measures that are taken to protect information, but there is always the possibility of hackers breaking into the system and stealing the data. For example, Anonymous is a group of individuals that hacked into federal sites and released confidential information to the public. Meanwhile the government is supposed to have the highest level of security, yet their system was easily breached. Therefore, if all of our information is stored on the internet, people could hack into it, finding out everything about individuals lives. Also, companies could misuse the information that they are given access to. This is a common mishap that occurs within companies all the time. Just recently Google got caught using information that was supposed to be private. These all privacy issues leads to the question of who will control the Internet of Things?

Another argument against IOT is the over-reliance on technology. As time has progressed, our current generation has grown up with the readily availability of the internet and technology in general. However, relying on technology on a day to day basis, making decisions by the information that it gives up could lead to devastation. No system is robust and fault-free. We see glitches that occur constantly in technology, specifically involving the internet. Depending on the amount that an individual relies on the information supplied could be detrimental if the system collapses. The more we entrust and the more dependent we are on the Internet could lead to a potentially catastrophic event if it crashes.

Finally the connecting of more and more devices to the Internet will result in the loss of jobs. The automation of IOT "will have a devastating impact on the employment prospects of less-educated workers" (Schumpeter, 2010). For example, people who evaluate inventory will lose their jobs because devices can not only ommunicate between each other, but transmit that information to the owner. We already are witnessing jobs being lost to automated machines, such as the checkout line in supermarkets and even ATM's. These disadvantages can be largely devastating to society as a whole, as well as individuals and consumers.

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