A SURVEY ON INTERNET OF THINGS

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ABSTRACT*:*

This paper addresses the communication technologies for Internet of Things. Internet platform has been growing day by day, so IoT. IoT consists of smart devices that are able to communicate with each other. In this survey, the general concept of the Internet of Things (IoT) has been introduced. Additionaly, some important wireless communication protocols that is used in IoT systems were described and compared. Moreover, IoT Service Oriented Architecture was discussed, and its layers were described. Also, a case example was given, which is Smart Homes, we have discussed what we have achieved with IoT systems on out new technological homes. We also discussed about further processes and challenges. In the end, I hope that this survey would give you a general understanding of the Internet of Things, its architeure, and protocols and how it works. The interactions between people and machines will be revealed by readers.

I. INTRODUCTION

With over 4 billion internet users on World, and that number equals to 53 percent of whole World population. It is a huge and unbelievable greatness. Internet became so populer over the last couple of decades. It is an evolution in our lives. Due to the improvements in the field of electronics, and computer, popularity of internet is ahead of most of the things. During the past few years, developments on this general fields, helped to achieve some specific progresses. For example, the achievements in the area of wireless communications and networking lead Kevin Ash to introduce Internet of Things in 1998. This concept took a lot of attention on it both academically and industrially. In this concept, the main goal is to connect anything with anything, from anywhere and anytime.

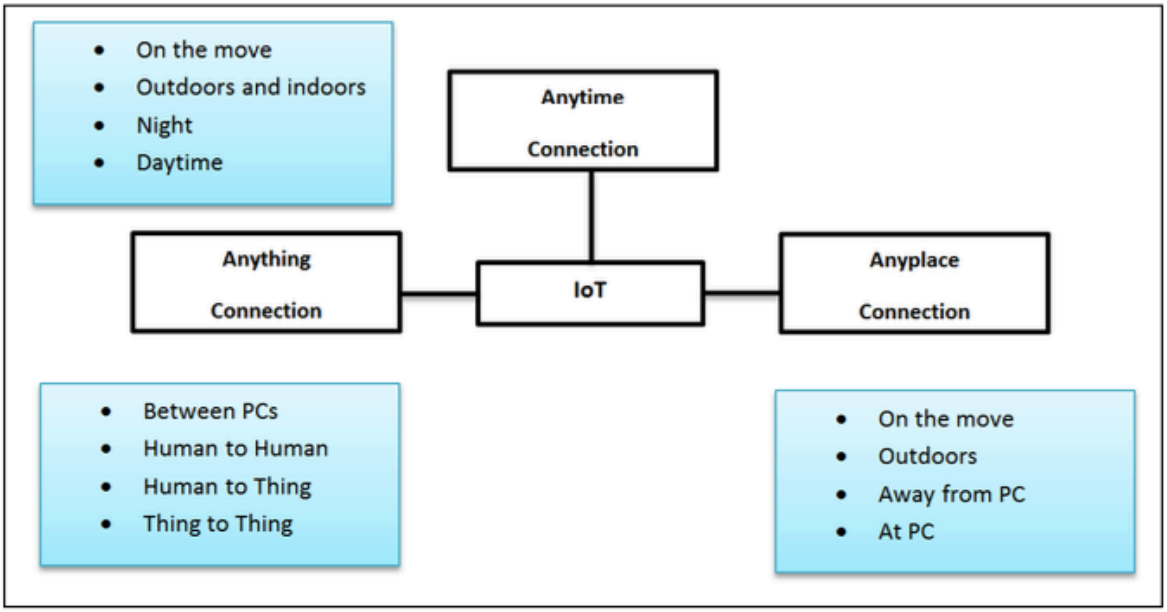

Figure 1: ICT's New Dimension [International Telecominication Union 2005]

II. APPLICATIONS AND EXISTING SYSTEMS

With the development of technology, IoT technologies are implemented to several fields. Smart cities, healt care systems, agricultural system, automative, smart manufacturing, and this list goes on.

IoT at Smart Home

When we examine IoT; most probably first thing that comes to our minds would be Smart Homes. Smart Home concept is new thing, but developing rapidly. New buildings and apartments are built with IoT considered. We communicate with home via mobile devices. Therefore, mobile devices play a big role at smart homes. With the help of mobile devices, we can manage and control IoT devices internally home, and even externally home. The smart white appliances or smart home automation systems are now able to send information of current status of some values according to what we want to know about, so that users who is inside of home or even out of home with mobile Internet can see those datas and act accordingly. In this way, the user can send instructions to home automation system via his mobile devices. Some actions we as users can take Iot adopted smart homes are as follows:

- Controlling home security systems; video camera viewing outside of home.

- Controlling smart home white appliances, or they can inform us for example, refrigerator says “Milk will be expired in two days”.
- Home energy management system, for example air conditioner, light mode, and so on.
- Home entertainment systems, like home theatre

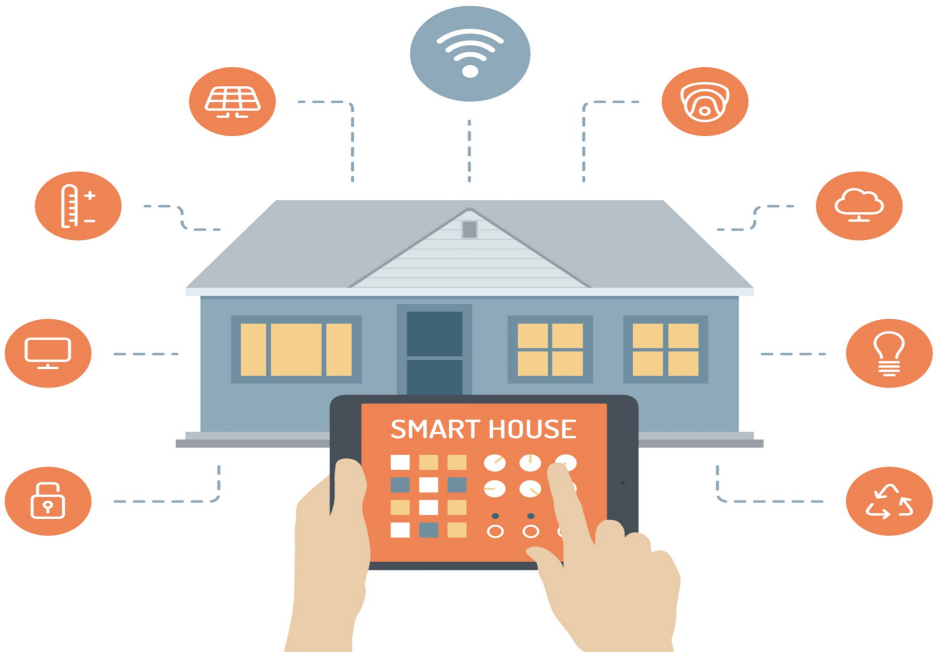

Figure 2: Smart House Properties [A. Tokmakova, 2017]

Sleep Trackers for Little Ones

Sleep is very important for newborns. Therefore, parents should care about their babies to get enough sleep. IoT helps parents in this manner. A new application, which is called “Mimo” offers you to monitorize your baby’s body movements sleeps routines, and breathing level.

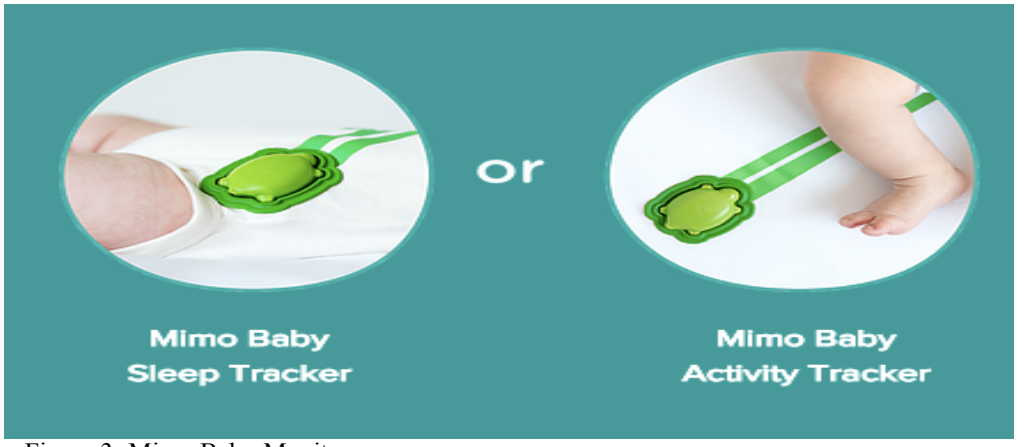

Figure 3: Mimo Baby Monitor

III. TECHNICAL APPROACHES

A. System and Network Architecture

A basic necessity in IoT is that the things in the system must be interconnected. IoT framework designs must ensure that IoT system can make a bridge between physical and virtual universes. There is no certain IoT architecture plan, it changes designer to designer. Therefore design of an IoT system can involve numerous factors such as communication, networking, processes, security and so on. In Service Oriented Architecture, there are four layers which are Sensing Layor, Network Layer, Service Layer, and Interface Layer. Combination of Service and Interface Layers is also known as Application Layer.

SENSING LAYER

IoT is required to be connected network, in which things are connected wirelessly and can be controlled from far away. In the Sensing Layer, the sensors that are used as components in IoT systems, are able to sense the environment, so that they collect data. Therefore, in Sensing Layer, our main goal is to detect statues of things with available hardware objects.

NETWORK LAYER

The Network Layer in IoT allows all things to connect with each other and also it lets things to know about their environment. Through the network layer, things can report information to the associated things, which is vital for IoT to take an action. Therefore, Network Layer is the basis platform to connect things over wireless or wired connections.

SERVICE LAYER

In Service Layer, our main goal is to create services and control those services required by users or applications.

INTERFACE LAYER

In IoT, there can be many devices connected each other, and those devices can be bought from different vendors, therefore they may not work with same standards. When they make information changes, communication or even processing, there should be an effective interface mechanism to make management and interconnection of things simplier and easier.

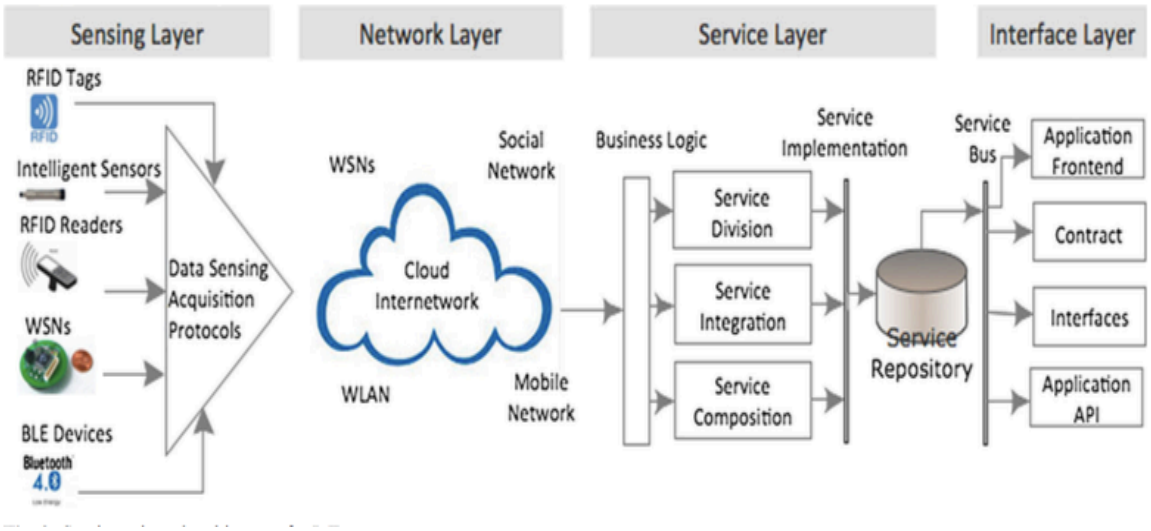

Figure 4: Service Oriented Architecture of IoT, Inf. Sys.(2015) Pp.247

B. Communication Protocols

1 MOBILE

In wireless communication, the electromagnetic waves are used to carry signals. But these waves require line-of-sight. Since Earth is in elliptic shape, it is hard to make long distance communications. To solve this problem, antennas and stations are built in various places of Earth. The signals which comes from mobile devices, are directly sent to space, Communication Satellites take

those signals and sends them back to Earth where those signals should intended to be. Those signals can be telephone calls, internet data, TV brodcasts, radio broadcast, or so on.

2 WIFI

WiFi is also known as WLAN(Wireless Local Area Network), and its standarization is IEEE 802.11. It's wireless so that it allows more than one mobile devices to use internet via wireless connection. The connection is provided by an access point, which allows users to move around within a certain area. Nowadays, WiFi is commenly used technology in our lives. It is easy to have acces and it is also affordable.

802.11 Protocol	Release date	Frequency (GHz)	Data rate per stream (Average)	Data rate per stream (Maximum)	Approximate indoor Range (m)	Approximate outdoor range (m)
Legacy	1997	2.4	1Mbit/s	2 Mbit/s	20	100
802.11a	1999	5	25 Mbit/s	54 Mbit/s	35	120
802.11b	1999	2.4	6.5 Mbit/s	11 Mbit/s	35	140
802.11g	2003	2.4	25 Mbit/s	54 Mbit/s	38	140
802.11n	2009	2.4 or 5	300Mbit/s (20MHz* 4MIMO)	600Mbit/s (40MHz* 4MIMO)	70	250

Table 1: 802.11 Standards, W. Mengdi, 2017

Above table shows the basic information about Wifi versions. It is obvious that which one is the best so far, clearly 802.11n . Therefore, IEEE802.11n is the one which is most commonly used in our day. To get high quality performance, we need to give higher power. Therefore, WiFi is not recommended for low-powered devices.

3 BLUETOOTH

Bluetooth is another wireless communication protocol, we commonly use in our life. It is used for short range data exchange among devices. Bluetooth products have a chip, a radio and software that

allows them to be connected. To be able to communicate for two bluetooth devices, firstly they should be paired. The communication of devices is provided by short range networks, also known as piconet. Piconet lets two to eight devices to communicate with each other. When this short range network is created, one device acts like master device, and the others act like slave devices.

4 ZIGBEE

ZigBee is one of the universal standards which are used as a wireless communicitation protocols. Zigbee is also known as IEEE802.15.4 standard. It's name comes from the bees' dances. In May 2003, it was created, and June 2005 it was started to be used. Unlike Wifi, it doesn't require high level power consumption. Another advantage of it is that its cost is less than Bluetooth or Wifi. As a weak side of it is its data range is very low compared to WiFi and Bluetooth.

5 RFID

RFID stands for Radio Frequency Identification which is a wireless communication protocol used in IoT systems. It is the transformation of information in the working environment where the control of the data is carried by Radio Waves. It allows radio signals to specify targets, so that they make information change between spesific target and the system without establishing any mechanical or optical bridge. There is two main devices in RFID, Tag and Reader.

6 NFC

NFC stands for Near Field Comminucation and it is another type of wireless communication technology just like WiFi or Bluetooth. But unlike them, its range is very short, around less than 10 cm. NFC technology's aim is that enabling devices with this technology to standardize and exchange data.

C. Existing Hardware

In IoT systems, there are some hardware components used for interacting. These components could be sensor, some bridge devices, or wearable electronics. These tools are used for controlling devices as a remote dashbord, or a routing, managing key tasks such as communication, system activation, detection of values.

IoT Sensors

There are sensors used in IoT systems. These devices are used as energy modules, sensing modules, power management modules, or radio frequency modules. Radio frequency modules manage communication systems with their signal processing, WiFi, Bluetooth, ZigBee, and NFC or some other protocols. Sensing modules manage detection of measurements. The following list consists of some detection devices used as sensing module.

Devices	
accelerometers	temperature sensors
magnetometers	proximity sensors
gyroscopes	image sensors
acoustic sensors	light sensors
pressure sensors	gas RFID sensors
humidity sensors	micro flow sensors

Table 2: Sensors can be used in IoT systems

Wearable Electronics

There are some wearable small electronic devices worn on the arm, head, and feet. In this devices, IoT systems can be used. For example, smart watches. They allow to acces when needed, so that we stay connected. Another example is smart glasses. They help us enjoy more.

IV. COMPARISON OF EXISTING SOLUTIONS:

Protocol	Standard	Frequency	Range	Data Rates
Mobile	GSM/GPRS/EDGE (2G), UMTS/HSPA (3G), LTE (4G)	900/1800/ 1900/2100MHz	35km max for GSM; 200km max for HSPA	35-170kps (GPRS), 120-384kbps (EDGE), 384Kbps-2Mbps (UMTS), 600kbps-10Mbps (HSPA), 3-10Mbps (LTE)
WiFi	802.11n	2.4GHz and 5GHz bands	50m	600 Mbps(max) 50-200Mbps
Bluetooth	Bluetooth 4.2 core specification	2.4GHz	50-150m	1Mbps
ZigBee	IEEE802.15.4	2.4GHz	10-100m	250kbps
RFID	ISO 18000	120–150 kHz (10cm), 3.56 MHz (10cm-1m), 433 MHz (1-100m), 865-868 MHz (Europe), 902-928 MHz (North America) (1-12m)	10cm(short)	LF - 125-134 kHz HF - 13.56 MHz UHF - 850-960 MHz
NFC	ISO/IEC 18000-3	13.56MHz (ISM)	10cm	100–420kbps

Table 3: Communication Protocols Comparison, W. Mengdi, 2017

V. OPEN RESEARCH ISSUES:

Although, there is a lot improvement in IoT, there are still some challenges we have to face. For example, there are some problems on technical challenges, standardization, security and private protection, innovation in IoT environment, and development strategies.

- Designing of Service oriented Architecture for IoT is still a bigproblem, because of cost.
- IoT is very complex network, because it may have connections among various communication technologies. It may be very hard to coordinate all of them. (Managing heterogeneity is hard.)
- Because of the our current internet architecture, we have some limitations from the point of mobility, scability, availability, and manageability. These are the major problems of IoT.
- Security, Privacy and Trust issues.

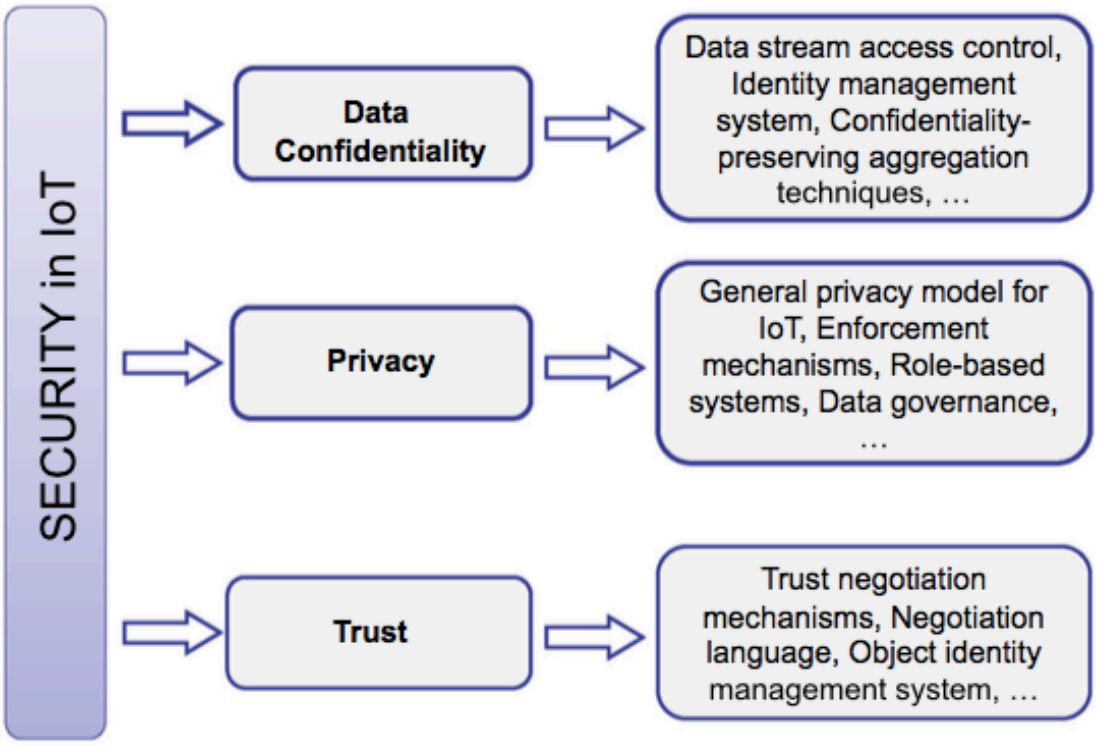

Figure 5: Graphical representation of security challenges in Internet-of-Things.[Ad Hoc Networks pp.1505, 2012]

VI. CONCUSİON:

In this survey, Internet of Things, and its architecture, IoT protocols and comparison of them, and challenges of IoT were introduced. In order to understand how IoT work, we examined its architecutes and its protocols. We also compared protocols, so that we had an understanding about which one works best for a specific purpose. We also gave a real example, how IoT system is embedded to our lives, smart homes were introduced. How capable they are, and what features they have were described. Therefore, we understood that, how far we got over this process. Last but not least, we also examined the challenges that we face with IoT and its future progress.

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