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Technical Survey of Topics and Trends - Internet of Things

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Abstract - Internet of Things is a paradigm in which everyday objects are equipped with sensing, identifying, networking and processing features that can allow them to communicate over the internet, with other devices and services to complete some objective. This article talks about the current state of the Internet of Things, the current trends, describing challenges that threaten IoT diffusion, open research questions, future directions and compiling a comprehensive reference list to assist IoT enthusiasts.

Keywords - *IoT. Objects. Internet of Things [1].*

1. Introduction

Over the last couple of decades, the Internet has been in a constant state of evolution. The early days of the Internet were characterized by the World Wide Web, a network of linked HTML documents that resided on top of the Internet architecture. This network of static HTML pages gradually evolved into what is referred to as Web 2.0, in which two-way communication became common, which enabled user participation, collaboration and interaction. Web 2.0 technologies include social networking services, blogs, and wikis—technologies that have become essential to modern social interaction as well as for global business. While Web 2.0 currently dominates the Internet, scholars have been working towards another goal, commonly referred to as the Semantic Web and sometimes referred to as Web 3.0. The goal of the Semantic Web is to mark up web content in a way that makes it understandable by machines, allowing machines and search engines to behave more intelligent. Marking up web content in standardized formats would allow machines to process and share data on their own, without the need for human mediation. Alongside developments in the Internet technologies, technologies in Sensor Networks and Near Field Communication using RFID tags have also been evolving. Convergence of these two technologies, i.e. the Internet and Sensor Networks, is leading to new possibilities and visions. The possibility of a framework that would allow direct machine-to machine communication over the Internet has led researchers to envision the benefits of bringing more machines online and allowing them to participate in the web as a vast network of autonomous, self-organizing devices. While there is no universal definition for the IoT, this vision has produced a paradigm being referred to as the Internet of Things (IoT), the core concept is that everyday objects [2] can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to achieve some useful objective. For years, technologies such as RFID and sensor networks have been used in industrial and manufacturing contexts for tracking large-ticket items such as cranes and livestock.

2. Major Players in Internet of Things (IoT) Market

Major players contributing to the growth of the global Internet of Things (IoT) market include many leading IT companies. Following are brief details of initiatives by few leading IT giants.

2.1 Intel

Intel is at the forefront of developing new generation low-power chips for connected IoT devices. Moreover Intel is targeting startups and developers. The Intel Galileo developer kit for anyone who wants to create their own thing is being marketed heavily throughout the world. Intel R&D centers (so called Intel Open Labs) and a number of industry co-operations (e.g., Intel and Kuka's PC-based robot-controllers) lay the foundation of Intel's

IoT push. The latest addition to Intel IoT portfolio is a platform for connecting the data from your things to the cloud.[3] Intel is aggressively promoting their new IoT devices in the student community, by frequently organizing "Intel IoT Roadshows".

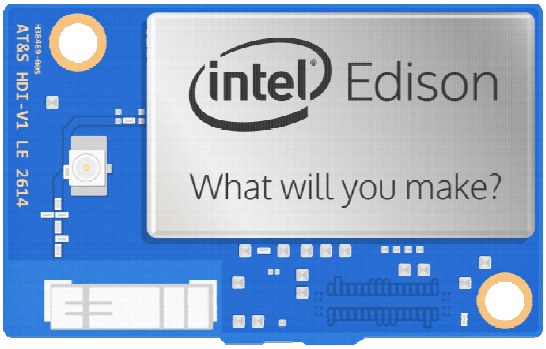

Fig. 1 Intel® Edison Compute Module, Boards, and Kits.

2.2 Microsoft

Microsoft has 3 IoT propositions: Firstly, the Azure platform promises to become the one-stop shop cloud platform for connected devices. Secondly, Microsoft Streaming Analytics aims to benefit from a new kind of processing that will be necessary to extract meaning from sensor data in real-time. Thirdly, Microsoft has entered the wearables and health space with the Microsoft Band. Apart from these product lines, Microsoft is experimenting in the industrial IoT space. In a joint project with robot manufacturer Kuka, Microsoft recently equipped a Jeep Wrangler plant with Microsoft technology to run manufacturing lines. Similar projects have been piloted in the connected health and connected car space.

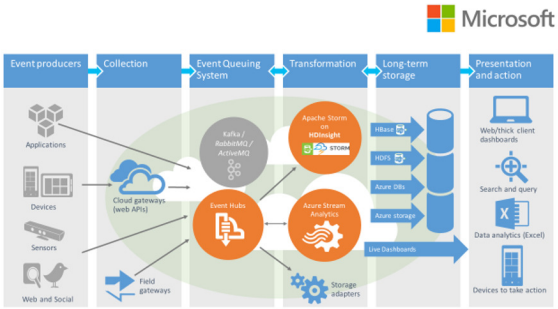

Fig. 2 Microsoft cloud based services for IoT Devices.

2.3 Cisco

Cisco coined the term Internet of Everything. The company is centering its business strategy on the Internet of Things like no other tech heavy-weight. Cisco's move to embrace IoT is a natural one though because it is at the heart of what Cisco has always done: Developing network equipment like routers and switches for enterprise customers. Apart from network equipment, Cisco is also active in security solutions and Cisco is the host of the IoT World Forum.

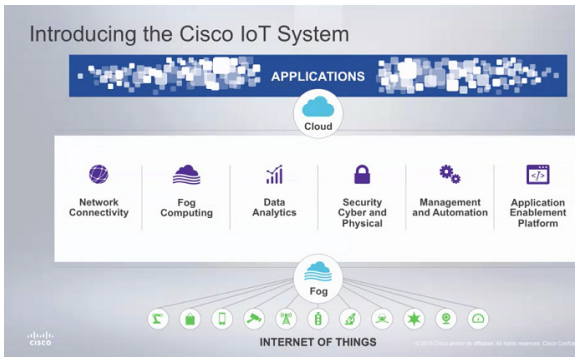

Fig. 3 Cisco IoT system.

2.4 Google

Google accelerated the rise of the Internet of Thing from one day to another. On January 14, 2014 Google announced that it would buy smart home company Nest for $3.2bn. This day marked the beginning of mass market awareness for the Internet of Things. Google's glass and self-driving car project also fall under the category of Internet of Things. In addition, Google recently announced the "Physical web platform". It is not clear yet what the platform will eventually be. But it's IoT. Google has also announced its plans of introducing WEAVE language for IoT based applications.

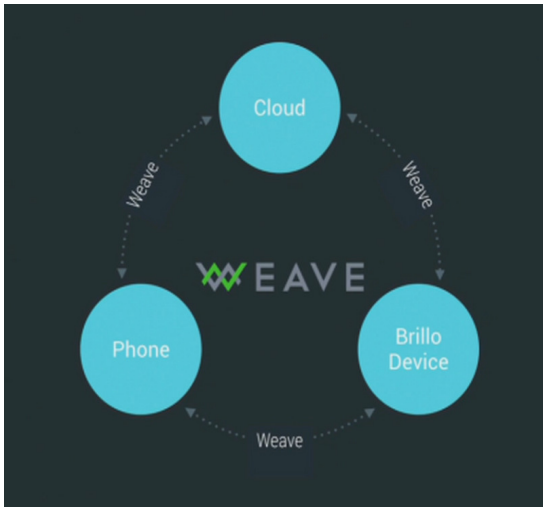

Fig. 4 Google's WEAVE for IoT devices.

2.5 IBM

One of the big five Internet of Things companies is IBM. IBM invests heavily in enterprise application infrastructure and databases for connected devices. Also analytics. IBM, much like Intel or Microsoft, partners with other companies to create IoT showcases in different areas.

IBM has also worked on Big Data Analysis for a long time, its smart computer Watson is quite famous for its versatility.

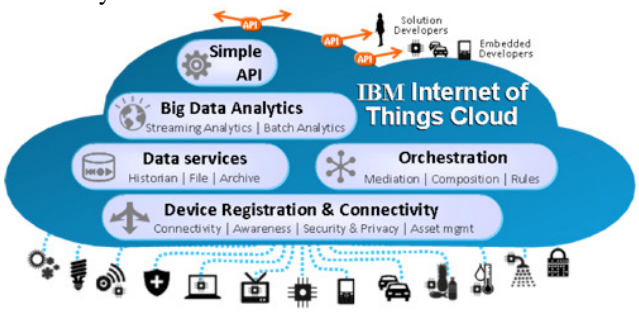

Fig. 5 IBM cloud based services for IoT Devices.

2.6 Apple

Apple does IoT the Apple way. Developing behind closed curtains and then coming out with a bang. Right now Apple's Internet of Things activity is centered on the Apple Watch and the Apple HomeKit platform. There is also an Apple HealthKit.

Many companies like Phillips and Marvel Semiconductors have developed hardware, compatible with Apple HomeKit.

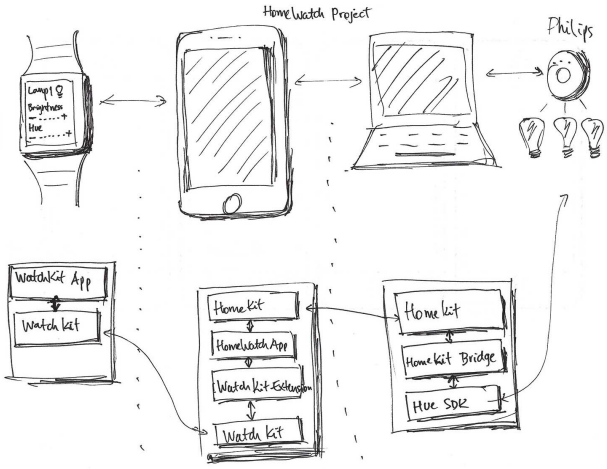

Fig. 6 Apple HomeKit for IoT Devices.

3. Major Hardware Boards for Internet of Things (IoT) Development

Table. 1 Comparisons of Major IoT Hardware Boards. [4]

Product	LinKit One	Edison	Rasberry PI Model B+	Beaglebone Black
Processor	ARM7 EI-S7M,260 MHz MediaTek Aster 2502.	22 nm Intel SoC, that includes a dual-core, Dual-Threaded Intel atom CPU at 500 MHz and a 32 bit Intel Quarck Microcontroller at 100 MHz	Broadom BCM825 ARM 11 700 MHz GPU, Power VRSGX530	TI AM3358 Cortex-A8, 1GHz. GPU, Video Core
RAM	4MB	1 GB LPDDR3 POP Memory	512 MB DDR3	512 MB DDR3 SDRAM
Flash	16 MB	4 GB eMMC	SD Card-External	4 GB 8-Bit eMMC
Ethernet	NO	NO	10/100 M Ethernet (USB to Ethernet chipset)	10/100M Ethernet (Support by SoC)
WiFi	MT5931, 802.11 b/g/n, WiFi antenna	Broadcom*4 3340 802.11 a/b/g/n; Dual Band	No	No
Bluetooth	BR/EDR/BLE(Dual Mode)	Bluetooth 4.0	NO	NO
GSM	850/900/1800/1900	NO	NO	NO
GPRS	Class 12	NO	NO	NO
GPS	MT3332/GPS/GLONASS /BEIDO	NO	NO	NO
USB	UART to USB	1*USB OTG	4*USB 4.0	1*USB 2.0, 2 OTG, 1* USB 2.0 Host
Video	NO	NO	1*HDMI	1*HDMI,1* LCD Interface

Peripherals	1*UART, UART on USB, 1*SD Card, SPI, I2C, 2*External Interrupts, 2*PWM, 4*Analog Input, 16 Digital I/O, Audio.	1*SD Card, 2*UART, SPI, I2C, I2S, GPIO	1*SD Card, 1*UART, SPI, TWI/I2C, PWM I2S, 4*GPIO, Audio Output.	1*SD Card (Compatible with SD and eMMC), 1*UART, ADC, I2CSPI, 1*Jtag, PWM.
Power Consumption	3.7-4.2V Li-Battery, 0.3-3 mA DC Current per I/O.	Input 3.3V-4.5V output100ma@3.3V & 100 mA @ 1.8V	USB 5V 322ma@ idle.Rated at 700mA.	USB 5V DCJack 210 to 460mA @ 5V
Arduino Compatible	Yes	Yes	NO	NO
Dimension	3.3X2.1	3.5X2.5	3.37X2.125	8.6cmX5.3cm
Price (in $)	79	50	35	45

Open hardware platforms, well-known in maker's world are

- Linkit One
- Intel Edison
- Rasberry PI Model B+
- Beaglebone Black

From the above market analysis, it is very clear that almost all the big companies are keen on investing in the IoT (Internet of Things) market. With google also recently announcing its new IoT supported language Project-BRILO which is a tough challenge to the Microsoft Azure and Apple's Homekit. Since BRILO is a smaller/trimmed version of Android OS, which has more than 60% share of the smartphones on the planet.

In spite of the tough competition among different companies, there is no company which is operational throughout the world, as Microsoft and Amazon web services are the only options available in 5 or more countries. Intel ships its developer kit that includes basic sensors and other prerequisites to support Amazon web services and make our own home automation possible but the min price for such readymade kits is not less than 300 € (~Rs 20,000/-). Apple also has its customized version called Apple-Homekit, which basically requires an I-Phone i.e., IOS supported device to control the whole setup. This makes it next to impossible for a common man to use Homekit services.

Thus there is no affordable alternative for both hardware platforms and the cloud services, which charge nearly $8 per million messages (Asia Specific), by Amazon AWS and hardware platform boards which cost a minimum of $45 per board.

4. Major Technologies, Involved in Internet of Things (IoT)

There are several technologies that can be used to implement the concept of Internet of Things. In this paper, we discuss few important technologies that have made IoT.

4.1 Radio Frequency Identification (RFID)

RFID system is composed of one or more readers and several RFID tags. Tags are characterized by a specific address and are applied to objects. Tags uses radio-frequency electromagnetic fields to transfer data attached to an object. RFID allows to monitor objects in real-time, without the need of objects being in line-of-sight. [6] The RFID tags are used in many applications like Monitoring the life cycle of a product, manage the inventory in the warehouse, tracking of goods, tracking of animals, airport baggage tracking logistics, mobile payment, etc. We can combine the RFID technology with the other technologies like sensing technology to open a new horizon for new applications.

4.2 Near Field Communication (NFC)

NFC is quite similar to RFID, or it can be looked as an integration of RFID reader into a mobile phone, which makes NFC customer-oriented as mobile phone is the most popular personal device worldwide NFC can also be seen as a type of radio communication between NFC enabled mobile devices by touching them together or bring close in the proximity of the other phone. [6] NFC is a short range, low power wireless link evolved from RFID that can transfer small amounts of data between two devices held in proximity. Mobile NFC also has the potential to transform the mobile headsets into different types of smart objects like when we need to pay the bills and then our mobile can be used as our credit card. The NFC technology will significantly contribute to the future development of IoT.

4.3 Machine-to-Machine Communication (M2M)

The use of M2M communication is increasing in the scenario at a fast pace. For instance, researchers predicted

that, by 2014, there will be 1.5 billion wirelessly connected devices excluding mobile phones. [6] M2M has several applications in various fields like healthcare, smart robots, cyber transportation systems (CTS), manufacturing systems, smart home technologies, and smart grids. [5]

4.4 Vehicle-to-Vehicle Communication (V2V)

In this V2V Communication, vehicles act as a node in a network and communicate with each other with the use of sensors connected in an ad-hoc network [6]. The infrastructure of V2V network is a bit complicated as there is no fixed topology to be followed as vehicles are moving from one place to another all the time.

5. Major Issues in Implementation of Internet of Things (IoT)

There are several issues to be addressed before the worldwide implementation of IoT. Some important issues are

- Addressing and networking issue.
- Routing protocol issue inV2V communication.
- Privacy and security issue.
- Standardization issue.
- Congestion and overload issue.

IoT should be considered as a part of future internet as everything is going to be connected in a network so that objects can interact with each other, but still there are lots of issues which are to be solved to make this a reality.

6. Conclusions

After a proper understanding of the current IoT market, worldwide and in Asia Specific, India. It is very clear that there are many big companies like Google, Microsoft, Cisco, Qualcomm, Apple, Amazon and others who are investing a lot on the IoT market. This IoT (Internet of Things) is a very promising field for the automation.

1. Almost all the IT companies in the world are trying to make money from the IoT which is still in its starting stage. This shows that connecting everything to the internet is about to happen, with lots of perfection and reliability.

2. For IoT both hardware companies like Intel and software companies like Amazon (AWS) are teaming up, to share the data/communicate through the cloud. This kind of collaborations make applications more cost effective.

3. But all these companies and services have just began and there is no company which provides these services all over the globe. This makes it affordable to only some rich economies like USA and UK.

4. There are many startups in the home automation industry, which are trying to make huge profits by creating customized automation devices, due to which the home automation in India is still a rich man's thought.

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