Internet of Things and its Big Player

Arpit Kumar Srivastava
Galgotias College of
Engineering and Technology

Sandeep Saxena
G L Bajaj Institute of
Technology & Management

ABSTRACT
The Internet of Things (IoT) is a new set of concepts or technologies that allows devices or machines (such as lights, signs, parking gates, motors or even pacemakers) to transform from simple objects to "smart" through the use of sensors, actuators and data communication technologies. IoT enables the smart devices to be "virtually" tracked, monitored and controlled across a wireless network (or the Internet). As far as Internet of things companies are concerned, they are busy working with organizations around the world to help the incorporate this new technology approach into their business models. This paper reflects about the important aspects of IoT and its features, and various companies using and enhancing it along with companies profile in the area of IoT.

Keywords
Internet of Things (IoT), RFID, Sensing Nodes, Smart Environment, CISCO IOx, Mote-Runner

1. INTRODUCTION
Internet of Things (IoT) is something that connects 100 millions of people as an emerging global Internet-based information architecture facilitating the exchange of data and information at global level. A real entity, with the help of IoT, turns out to be virtual which suggests that everything (whether human, data or objects) are can be traceable, dependable, locatable, addressable and readable counterpart on the internet.

We look at the IoT as millions and billions of smartly connected "things" and "objects" (a type of universal global neural network on cloud) that will encompasses each and every aspect of life.

The term of IoT was first used by Kevin Ashton in 1999 (though the concept has been discussed since 1991) in the context of supply chain management [1]. The idea of IoT first became famous through the Auto-ID Center at MIT and other market publications. Founded in 1999, this group was found working in the field of networked radio frequency identification (RFID) and emerging sensors. The labs consisted of seven-research universities located across four continents. These institutions were chosen by the Auto-ID Center to design the architecture for IoT. The IoT [2-6] has a purpose of providing an IT-infrastructure, providing the exchange of "things" in a safe and reliable manner. Radio Frequency Identification (RFID) and sensor network technologies can be used to meet the new challenge of the next wave in the era of computing, in which information and communication system are invisibly embedded in the environment around us. This result in the generation of enormous amounts of data which need to be stored processed efficiently and presented in a seamless and understandable form.

2. DEFINITION
The Internet of Things (IoT) can be defined in different ways, depending upon what are you dealing with, and how you manage them, it encompasses several aspects of life—from attached to semi-detached homes and its various components (devices such as refrigerator, oven, washing machine etc.) and from cities to connected cars and roads (including traffic information and navigation systems) to devices that track from an individual's behavior to his extent of thinking and collecting data and "apply" services. IoT can also be visualized as the interaction between several packets of data from various devices and their exchange between machines and objects.

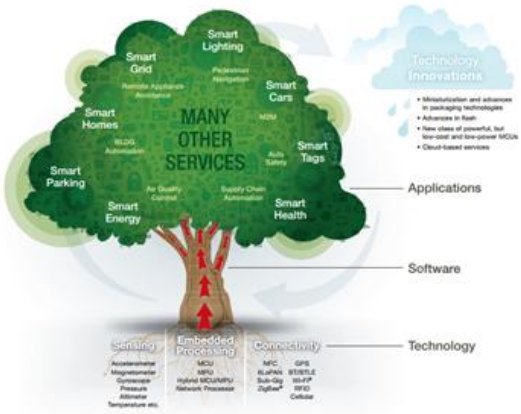

Figure (i)

The IoT: Different Services, Technologies, Meaning for everyone

The RFID group defines Internet of Things as –

- The worldwide network of interconnected objects uniquely addressable based on standard communication protocols.

According to Forrester [7], a smart environment –

- Uses information and communications technologies to create the critical infrastructure components and services of the city administration, education, healthcare, public safety, real estate, transportation and utilities more awarer, interactive and efficient.

3. BUILDING BLOCKS OF IOT
As identified by Atzori *etc. al.* [8], Internet of Things can be realized in three paradigms - things oriented (sensors), internet-oriented (middleware), and semantic-oriented (knowledge). In smooth words, IoT demands: (1) a mutual understanding (clear and concise in nature) of the situation of its users and their appliances, (2) efficient software architectures and smooth communication network to analyze and process the contextual information and convey it to where it is relevant, and (3) the Internet of Things that aims for autonomous and smart behavior.

3.1.Identification, sensing and communication technologies

‘‘Anytime, anywhere, any media” has been for a long time the idea pushing forward the advances in communication technologies. Today, wireless technologies have played a key role in this exponentially growing technical era and the ratio between radios and humans is nearing the 1 to 1 value [8]. Now, essential elements of the IoT will be RFID systems [9], which are composed of more than one reader and several RFID tags, as well as various upcoming high techs. Radio-frequency identification (RFID) is the wireless use of radio-frequency electromagnetic fields to transfer data, automatically identifying and tracking RFID tags attached to objects. Tags are characterized by a unique identifier and are applied to objects (even persons or animals). Readers trigger the tag transmission by generating an appropriate signal; store the information on its non- volatile memory, which represents a query for the possible presence of RFID tags in the environment and their users.

3.2.Middleware

The middleware is basically ―a software layer or a set of sub-layers in between the technological and the applications levels. The middleware Architectures was proposed in the later years for the IoT often follow the Service Oriented Architecture (SOA) approach. The adoption of the SOA principles allows for decomposing traditional and complex systems into applications consisting of an ecosystem of simpler and well-defined components.

4. WIRED AND WIRELESS COMMUNICATION

Our main objective is secure data transmission from different nodes to destinations. The role of the communication nodes is to gather all the related concerned data collected by the sensing nodes and processed by the local embedded processing nodes to the and then send it to the destinations(could be a cloud platform). These collected data (using RFID tags, actuators and embedded sensors), must be available to their respective nodes of operators where these data are remotely processed and commands are generated. Communication nodes bring back those commands to the local embedded processing nodes to execute the tasks. The sensing nodes and the RFID tags or these smart machines along with the processing nodes and smart handling and implementation form a smart environment.

Mark Weiser, the forefather of Ubiquitous Computing (Ubicomp), defined a smart environment [10] as ―the physical world that is richly and invisibly interwoven with sensors, actuators, displays, and computational elements, embedded seamlessly in the everyday objects of our lives, and connected through a continuous network. Smart environments aim to satisfy the requirements of individuals from every environment, by replacing the hazardous work, minimizing the physical labor and repetitive tasks with automated agents.

5. APPLICATIONS

Since smart environment play a vital role in the implication of IoT, few of the applications of IoT as “smart” are as follow [11]:

- Smart cities: smart parking, structural health, noise urban maps, Smartphone detection, electromagnetic field levels, traffic congestion, smart lighting, waste management, smart roads.
- Smart environment: forest fire detection, air pollution, snow level monitoring, landslide and avalanche prevention, earthquake early detection.
- Smart water: portable water monitoring, chemical leakage detection in water, swimming pool remote measurements, pollution level in the sea, water leakage, river flood.
- Smart Metering: smart grid, tank level, photovoltaic installation, water flow, silos stock calculation.
- Logistics: quality of shipment conditions, item locations, storage incompatibility detection, fleet tracking.
- Industrial control: M2M application, indoor air control, temperature monitoring, ozone presence, indoor location, vehicle auto-diagnosis.
- Smart agriculture: wine quality enhancing, greenhouses, golf courses, meteorological station network, and compost.
- Smart animal farming: hydroponics, offspring care, animal tracking, toxic gas levels.
- eHealth: medical fridges, fall detection, sportsman’s care, patient’s surveillance, ultraviolet radiations.

6. SECURITY ISSUES AND CHALLENGES

Some business processes and organizations are now too concerned as far as security matters which require a high degree of reliability. In the literature, the following security and privacy requirements are described:

- **Terminal security issues of IoT**: An attacker can easily access terminal devices to cause damage and modify in formation. Apart from real time data collection and uploading the main concern is related to authentication and integrity of data. Since passive RFID tags cannot exchange too many message with the authentication servers, main problem existed in the perception terminal includes terminal of sensitive information leakage, tampering, copying, terminal virus and other issues.
- **Sensor network security problem of IoT**: the sensor nodes are not only responsible for data transmission but also for data acquisition, integrity and collaborations. Therefore issues such as counterfeit attacks, malicious code attacks and security risks in information transmission and processing may occur.
- **Information transmission security of IoT**: it is mainly related to the network layer security whose security includes two main part: the first is from the security risks of the IoT itself and second comes from the related technologies and protocol vulnerabilities defects of network function.
- **Information processing safety of the IoT**: information processing is mainly reflected in the middleware layer which is mainly responsible for the information and function transfer when network layer and IoT service work together.
- **Data encryption**: it aims to protect the confidentiality and integrity of information transmission and to prevent theft and tampering while transmission. Data encryption is an important mean of protecting data security. Its aim

is to prevent information from being deciphered when it is intercepted by attackers.

7. INTERNET OF THINGS: COMPANY PROFILE

Organizations are on the verge of disputes due to external pressures over technology, government and culture. The extent to which these companies can resolve the disputes depends on how closely and regularly they monitor their resources and utilize their known technologies and develop a positive approach towards their goals. Understanding IoT is elusive and evolving.

The biggest problem that organizations are facing among their employees is the lack of IoT skills and knowledge, and its management is viewed as the biggest obstacle to using the IoT smoothly. In order to reduce these gaps, organizations are organizing different training programs for staff and recruiting IoT talent, thus raising the potential for IoT talent wars. It is assumed that over the next few years the IoT is expected to have the biggest impact on customer service and products.

We will also light up the various company profiles and their related work in the field of IoT:

7.1.CISCO

According to the Cisco Internet Business Solutions Group (IBSG) [12-13], IoT is simply a point in time when more "things or objects" were connected to the Internet than people. According to a survey conducted in 2003, there were approximately 6.3 billion people living on the planet and about 500 devices were connected to the internet [14]. Number of devices per person connected to the internet was found to be even less than one (0.08). Based on Cisco IBSG's definition, IoT did not yet exist in 2003 because the number of connected things (i.e. devices) was relatively small and internet was not omnipresent besides that the ubiquitous devices such as smart phones were just being introduced. So now at the start of new decade, the exponential growth in the number of smart phones and relatively the world population, the ratio of devices used per person is now increased more than one (1.84) which is further expected to increase more than two in upcoming years with more than 14 billion devices on board (see fig below). Analyzing these data and facts, CISCO IBSG estimated that IoT was "born" between 2008 and 2009. Today, IoT is well under way, as initiatives such as Cisco's Planetary Skin, smart grid technology, and intelligent vehicles continue to advance.

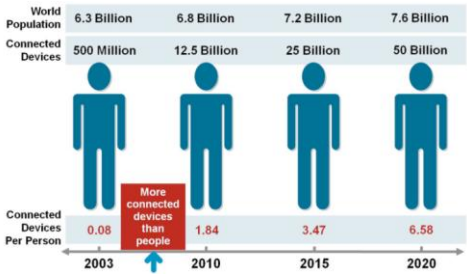

Figure (ii) Population Vs Devices

7.1.1. CISCO, Industrial Networking and IoT

CISCO, an American multinational Corporation, is in the mood to create a whole new world of connectivity. Extending their IP connectivity, remote sites and transportation line is an initiative in the work. Cisco has a broad expertise working, as well as a rugged product portfolio, to help moving the operational job from traditional protocols to IP standard-based system. It helps one to unite one's services with the business size of an enterprise, supply chains, design teams, partners and customers. Now, with CISCO and its networking researches, one can experience the IoT architecture.

7.1.2. CISCO embedded network solution with IoT

Cisco Embedded Networking Solutions [15] provide reliable, efficient and most secure operation in the most harsh environmental conditions and extreme temperatures to meet the most demanding applications. The networks must also provide efficient mobile connectivity on devices invariable to size, weight, and power limitations in anywhere, anytime and anyhow. So this CISCO Embedded Service Solution works in order to bring their business close to get maximum benefit from IoT. Furthermore there are few CISCO embedded devices such as

- The **Cisco ESR 5915 Embedded Services Router** whose main purpose is to extend IP network routing and services to stationary and mobile network nodes across any type of wired and wireless links. It could be helpful in providing a high level mobile connectivity in industrial sector, transportation or public benefits.
- The **Cisco ESR 5921** is a software-based router application which is designed to operate on small, low-powered or mobile devices and to provide very secure, reliable networking capabilities. This help to develop multiple applications and enhance communication facilities.
- The **Cisco ESR 594** is a high-performance based compact PCI router card, which can establish a highly smooth and efficient mobile network in vehicles so that you can securely extend your organization's first-responder vehicles.

7.1.3. Online and physical security for the IoT

Security products by CISCO keep a close eye on all the area of business i.e. office, data center, retail environment, factory etc. CISCO solutions can increase security, productivity and efficiency by processing information from cameras, phones, recorders and sensors instantly and directly into the network data. This makes it easier to monitor, record, and respond to any unauthorized and unusual activities. CISCO provides a comprehensive range of security solutions. Some of its protected areas include:

- Facility protection for people and their work, technology and devices, in their work areas.
- Network security solutions, including intrusion detection systems, firewall, web-based security, cloud-based Internet intelligence system, and more to maintain strong network security so as to secure the data and its implications.
- Privacy is one of the most sensitive subjects in any discussion of IoT protection. Protocols relating user access to unauthorized data, where they have access to an unprecedented number of personalized services thus reducing the considerable amount of waste generated data.

7.1.4. CISCO IOx

By 2022, the Internet of Things (IoT) is expected to connect more than 50 billion smart objects to the network. A

tremendous amount of data generated by these objects can give a much greater insight to the value of information. Companies can then use these data to develop their research and productivity. Since normally IoT environment need a satellite or cloud-based access, transferring of these sets of data from source to destination may be costly or time consuming. Therefore the solution must be required for faster reaction to derive intelligence from data. So it requires a distributive capability which is well provided by CISCO IOx [16] framework.

7.1.5. Industry Solution

The IoT has potentially transformed nearly every aspect in the industry, internally and externally over a global scale. It has brought up a new era of networking technology to a place where it was once impractical. CISCO offers new ways to manage and store data in the cloud and data center. Few solutions that may increase the productivity and efficiency in mentioned areas are:

- **Manufacturing**- it is one of the fast leading industries which has already began to see the benefits of the IoT. With CISCO, one can move one's manufacturing operations from protocols to IP-standard based systems.
- **Mining**- IoT creates a new ways for mining companies in term of securities for their workers by improving safety standards and visibility into all operations.
- **Oil and Gas**- IoT offers a simpler way for oil and gas corporations to connect all parts of their operations globally. Cisco can help operators' to link various remote fields, rigs, drills, tools and reservoirs to a standards-based network, including their IT systems
- **Transportation**- Cisco Embedded Transportation Solutions support the automotive industry—including commercial fleets, connected cars, emergency-response vehicles and public safety vehicles, ports, railways and roadways— with standards-based, efficient, and highly reliable products.

7.2.INTEL: Rise of Embedded Internet

We are entering into a new phase of the revolution. In comparison to the last decade, the growth rate was noted exponentially. Increasing the number of related devices, increasing the number of connected users, more and more exploitation of objects and data constitutes a smart environment around us. Some call this new era the "Internet of Things", at Intel they call it the 'Compute Continuum' – a world where computing happens on many of our devices or appliances, devices that are always-connected, pervasive and personal [17].

As Intel is known as the heart of computing, it is also leading the way with embedded devices. Thousands of developers are using Intel® Core™ and Intel® Atom™ processor-based platforms in intelligent embedded designs to transform cars, energy management, digital signage, and more. Also, high-performance Intel servers are supporting the data centers of billions of internet-connected devices. They are creating a huge amount of internet traffic and congestion. In 2010, about 245 exabytes of traffic crossed the Internet and that is expected to reach 1,000 exabytes by 2015 [18]. That's 1,000,000,000,000,000,000,000 bytes – or the equivalent of 250,000,000,000,000 digital photos [19].

7.2.1. Rise of M2M communication- IoT

In a matter of fact, the huge number of internet connected devices with respective user generates an enormous amount of data frequently known as "big data" [20]. A large portion of the growth of "Big Data" comes from intelligent systems—devices that are connected to the networks, machines that communicate with each other, communications that take place either directly or through the cloud thus forming the Internet of Things. Collecting and studying both machine-generated and user-created data holds the potential to improve life.

7.2.2. Intelligent devices

To match up the pace of IoT, Intel is focused on accelerating the development and implementation of intelligent devices, creating software and systems and connecting them to the cloud and enabling end to end analytics of transform business. Intel® Quark™ SoC The low-power, small-core **Intel® Quark™ SoC X1000 series** will enable Intel to extend into new and rapidly growing IoT markets. The **Intel® AtomTM processor E3800 product families'** features help to reduce time-to-market, accelerate data-handling applications and using it and reduce its energy consumption [21].

7.2.3. Application

Intel few connected embedded application are: **(i) military**- Intel Xenon processor based applications helps in accurately locating the moving target and also used for radar applications, **(ii) medical**- fire department and medical crew use compact based mobile diagnostic equipments embedded with the latest technology on Intel Core 2 duo processor, **(iii) industrial**- Intel core 2 duo improves manufacturing process efficiently by creating intelligent multi-axis robotic arms, **(iv) retail**- handheld point of sale (POS) terminals based on Intel Atom processor helps in bringing low-cost banking services to remote villages etc.

7.3.IBM: a new dimension of IoT

Internet of Thing is the internet of the future, powering billions of integrated devices and processors across industrial and global locations connecting people and defining their need. Even IBM considers it as a useful step of the new generation of technology where everything and anything will be interconnected and interdependent.

The Internet of Things is based on three dimensions [22] as shown in figure below: Blocks that determine the architecture and product technologies that emerge from the integrating traditional technology component. Also system of system describes the unique methods of implying these building blocks, integrated and deployed across the industries.

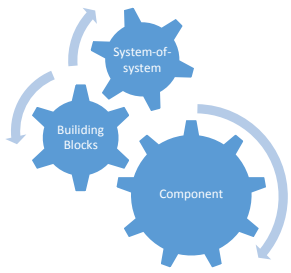

Figure 3 IBM: three dimensions of IoT

Components are specific to applications. Building blocks are standard solutions that could be analyzing system, data monitoring unit, remote compute nodes etc. They are normally the backbone of the many solutions mostly securities. Building blocks are used to create systems that are then combined to form system-of-system. Some examples of system of systems include. They may also include

pharmaceutical, medicals, retails, supply chain, processing and manufacturing, media and entertainment, agriculture, grocery and food traceability, and operational scenarios and business cases.

7.3.1. IoT via IBM & Semtech

On 11 Oct 2013, IBM and Semtech Corp. (SMTC), a leading supplier of analogue and mixed semiconductors, announced a significant advancement in wireless technology, combining an IBM software and Semtech hardware so as to create a system capable enough of transmitting data up to a distance of 15km (9 miles), depending on environment with significantly improved ease-of-use.

IBM has developed a software development kit so as to make wireless sensor networks (WSN) easier to program and to use — called Mote Runner — that provides an open and programmer-friendly platform to connect a sensor. This development kit is now available on the Semtech SX 1272 RFIC so as to create a system very well capable of covering a wide range up to 15 km (9 miles) in the rural environment and up to 5km in dense urban environment. At present, the maximum distance smart-meter transceiver in Europe, utilizing FSK modulation, is capable of covering only one to two kilometers [23].

Working: the IBM and Semtech platform utilizes Semtech's new LoRa (long range) modulation technology to enable wide range improvements over FSK and other traditional transmission methods. This LoRa additional range facilitating device will not only able to reduce the total cost of deployment but also simplifies the system architecture. The Semtech SX127xIC for the end nodes and the Semtech SX130x for the gateway are low power thus making the system ideal for the battery operated devices.

IBM Mote Runner is easy to use, working platform for WSN. This highly-optimized virtual machine based software allows the applications to be loaded and updated even on a cloud after deployment, in a similar way as the smart phones are updated over-the-air. IBM Mote Runner has been widely used in a vast range of Internet-of-Things applications and variety of its features has been implemented on various scales including measuring of air quality standard in cities and the monitoring of snow accumulation.

7.3.2. Other applications

Before looking into new IBM tech for retail, [24] let us review a survey done by 30,554 peoples over 16 countries to know them closely about shopping and we found that-

- Mobile traffic and sales increases by 40% in last decades
- Retailers face growing expectation from consumers that want to use the technology fully
- Shoppers place the highest value on receiving consistent price regardless of the channel they use to buy

Another solution provided by IBM is guardian. In five year digital guardian will protect us online. We all will be protected from internet related identity frauds by this guardian. From powerful cloud-based analytic, this guardian will know us inside and out and have your back 24*7. For instance he will know that when we go for a workout at a particular time along with the equipment or we have a regular habit to visit the church every Sunday. This guardian will remind us of all our routines, so when an imposter try to copy out the same routine, guardian informs us and take relevant action.

8. COMPARATIVE STUDY

Till now we discussed about few major companies such as INTEL, CISCO and IBM (including features of Semtech), studied their approaches towards technologies, their mode of work and their behaviors toward changing internet era and we find out that the market of Internet of Thing is exponential. Increase in use of internet and smart devices is growing and by the end of this decade, it is expected to get doubled.

According to CISCO, IoT was born between 2008 and 2009. IoT is technology when number of devices connected is more than the number of people. CISCO is playing a significant role in IoT industry with its embedded network solutions and ESR devices. Cisco Embedded Networking Solutions provide reliable and secure operation in the harsh environments with fluctuating temperatures to meet the applications. Few embedded devices such as **Cisco ESR 5915 Embedded Services Router** for IP network routing, **CISCO ESR 594** a high profile compact PCI networking card for establishing internet connectivity etc. These solutions provided by CISCO not only helping them widen their market but also provides a smarter environment.

Similarly, as per INTEL, increasing number of connected devices, increasing the number of connected users, more and more exploitation of objects and data constituting a smart environment around us. Thousands of INTEL processor based platforms in various embedded systems are supporting data centers for billions of interconnected devices and a large amount of data thus generated. CISCO, on one hand develops hard stiff hardware for better performance under stiff conditions, INTEL, on the other hand helps with the internal processor system. Intel focused on accelerating the development of intelligent devices and connecting them to the cloud. **Intel® Quark™ SoC X1000 series** will enable Intel to extend into new and rapidly growing IoT markets. The **Intel® Atom™ processor E3800 product family** features help reduce time-to-market.

IBM has a set a different new dimension for the IoT into components, blocks and system-to-system architecture. IBM and Semtech in collaboration creating a system capable of transmitting data up to 15 km range. IBM software development kit **Mote Runner** and **Semtech SX 1272 RFIC** working together to create a system capable of covering a wide range up to 15 km (9 miles) in the rural environment and up to 5km in dense urban environment. Various other features like a digital guardian are also being implemented in the new world technology.

9. FUTURE WORK

We have very well discussed every aspect of the Internet of Things and also throw light on works by few companies over IoT. Latest news tells that CISCO has announced to invest $150 million into its early stage companies so as to benefit from emerging and disruptive technology trends. Even INTEL and IBM are working in the same field continuously for more and more benefits. This technology is capable of changing the future. Imagine one wakes up in the morning and finds his schedule prepared, or while shopping one can easily able to locate one's choice of material. Imagine how carefree world would be with real implementation of this feature.

It is for the same reason that by far most of the companies in the world is working in this particular field. With coming time, miracles will only be found in books and reality with super technology will exist.

10. COMPARISON TABLE

IOT Features	CISCO	INTEL	IBM
Key Features	Generally based on CISCO IOx framework which provides opportunities to developers	Based on machine-to-machine communication between devices	Implicates the feature of three-building blocks-system-to-system, building blocks and communications
They do believe in	extending their IP connectivity and transportation line for better IOT services	using their integrated silicon-based chips for smooth and effective communication and "Big Data"	long distance data transmission over a wide range
Purpose	CISCO is working for such devices which can even work in harsh conditions and variable temperature	using M2M communication, INTEL is trying to connect each device with each other and also with the internet so that the pool of data that is being collected can be analyzed and utilized efficiently	IBM software development kit along with Semtech SX 1272 RFIC hardware is working on the system capable of transmitting data over 15 km range in rural areas and up to 5km in urban
Real life applications	CISCO ESR 5915 embedded service routers, CISCO ESR 5921 and ESR 594 routers	INTEL Quark S0C X1000 series processor, INTEL ATOM processor E3800 product families	Mote Runner- a software development kit
Additional features Privacy Security transmission	High High moderate	High High Moderate	Moderate Moderate High

Above mentioned features are not their only features. There are much more these companies cover in the field of IOT. This comparison table is only reflecting the foundations of these companies.

11. CONCLUSION

With this paper I have just tried to through a light on the one of the most exciting and emerging technology "The Internet of Things" (IoT) and also tried to mention related work in this field by few of the world largest technical gropus. At last a small comparative study is done to show in which field these organizations are differ from each other when it comes to most successful and efficient use of this technology. It also shows different applications and features implemented by these organizations into various products beneficial to mankind.

12. REFERENCES

[1] Ashton, Kevin (22 June 2009). "That 'Internet of Things' Thing, in the real world things matter more than ideas". RFID Journal.

[2] The Internet of Things. International Telecommunication Union (ITU). ITU Internet Report, 2005

[3] Gonzalez G. Organero M, Kloos C. "Early in infrastructure of all Internet of Things in space for learning". 8th IEEE International Conference on Advance Learning Technologies, 2008:381-383

[4] Amardeo C, Sarma J. Identities in the future Internet of Things. Wireless Pers Commun, 2009, 49:353-363

[5] Security model and key technologies for the Internet of things, The Journal of China Universities of Posts and Telecommunications, December 2011

[6] J. Belissent, Getting Clever About Smart Cities: New Opportunities Require New Business Models, Forrester Research, 2010.

[7] L. Srivastava, Pervasive, ambient, ubiquitous: the magic of radio, in: European Commission Conference ''From RFID to the Internet of Things", Bruxelles, Belgium, March 2006.

[8] K. Finkenzeller, RFID Handbook, Wiley, 2003.

[9] M. Weiser, R. Gold, The origins of ubiquitous computing research at PARC in the late 1980s, IBM Systems Journal. (1999).

[10] Source:https://community.freescale.com/servlet/JiveServlet/showImage/38-1561-3788/Image+4+-+Today's+Wireless+Landscape.JPG

[11] Source:http://www.libelium.com/top_50_iot_sensor_applications_ranking/

[12] The Internet of Things- How the Next Evolution of the Internet Is Changing Everything, Cisco white paper

[13] Sources: U.S. Census Bureau, 2010; Forrester Research, 2003.

[14] Source:http://www.cisco.com/web/solutions/trends/iot/overview.html

[15] Source:http://www.cisco.com/web/solutions/trends/iot/application-enablement.html

[16] Source: the internet of things backgrounder.pdf, intel

[17] Otellini, Q4 2010 call with press and analysts http://www.eweekeurope.co.uk/news/intel-sees-benefits-challenges-in-tablets-smartphones-18123

[18] Rough guide based on 10 mega pixel camera

[19] Source:http://download.intel.com/newsroom/kits/embedded/pdfs/Intel-Intelligent-Systems-Framework_Overview.pdf

[20] Source:http://www.intel.com/content/www/us/en/intelligent-systems/iot/internet-of-things-starts-with-intelligence-inside.html

[21] The interconnecting of everything- an IBM redbook, point of view publication by the IBM academy of technology

[22] Internet of Things Gets Major Distance Boost From IBM and Semtech: http://www-03.ibm.com/press/us/en/pressrelease/42180.wss

[23] Source:http://ibminternetofthings.tumblr.com/

[24] Source:http://www.freescale.com/files/32bit/doc/white_paper/INTOTHNGSWP.pdf

[25] The Internet of Things business index: A quiet revolution gathers pace- http://www.arm.com/files/pdf/eiu_internet_business_index_web.pdf

[26] Source:http://www.theinformationdaily.com/2014/03/24/how-organisations-can-get-the-most-from-the-internet-of-things

[27] Source: http://slickercity.net/

[28] Source:www.springer.com/law/book/978-3-642-11709-1

[29] Source: http:// wikipedia.org/wiki/Smart_environment.

[30] Source:http://www.businesswire.com/news/home/20131008005558/en/Intel-Delivers-Intelligence-Device-Cloud-Drive-Internet

[31] Source:http://www.digitimes.com/supply_chain_window/story.asp?datepublish=2013/12/04&pages=PR&seq=202

[32] Source:http://www.cisco.com/web/solutions/trends/iot/industry_solutions.html