



INTERNET OF THINGS (IOT): AN OVERVIEW

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ABSTRACT

Purpose: *Development in the area of Information Technology (IT) including information systems (IS), computing, and intelligent networking comprises an infrastructure, which has millions of physical objects and/or devices. These devices are use for communication and giving advanced collaborations. This infrastructure of various divergent devices is called “Internet of Things” (IoT), which is tightly embedded in Enterprise Information System (EIS).*

Methodology/Sampling: *Our research study is about IoT key technology, applications, ethical issues, merits, demerits & research focus on IoT domain and its future.*

Findings: *Everything will connect to the Internet will have positive impact on individual & society lives across the world due to facilitating & maturing them about health care programs & camps regarding foods, exercise, disease etc. as well on business world.*

Practical Implication: *IoT will provide a communication gateway between Information Systems and the real world as a mentor. IoT will open a new window for business to communicate with real world things using software services & API's. IoT will allow direct operations on information about the physical objects, which will lead to encourage services innovation to increase efficiency and productivity.*

Key Words: Internet of Things (IoT), Security, Wireless networks, Heterogeneity, Information system (IS), Internet of Content (IoC), 3D Internet (3DI)

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1. INTRODUCTION

IoT (Internet of Things) is combination of two words “Internet” and “things”. The Internet refers to vision of networking of IoT, while the Things tend to the integration of heterogeneous physical objects into a common infrastructure. In IoT physical & virtual things are identifies the future Internet with self capabilities based on standard protocols. IoT in the near future are expecting to become a hot participant in global business trade, information communication & social networks. IoT is to produce autonomous process that reacts to the real/physical things without direct human interaction. IoT services will allow users to connect 24/7 hours, anywhere with anything. The actual idea of IoT is the extension of current interaction of human & application via new direction of “Things” communication & integration (Sye Loong Keoh & Tschofenig, 2014) (Erin Anzelmo, 2011).

IoT is a dynamic global infrastructure using standard protocols for communication. IoT framework identifies virtual & physical things by using intelligent interfaces, which is integrated with world of information. IoT is the part of Future Internet which has vision of combining IoT (Internet of Things), IN (Intelligent Networks), IoS (Internet of Services), IoC (Internet of Content) and IoM (Internet of Media) into a common standard platform of Information Technology, which allow human & things to be connected anytime & anywhere, virtually using any network and any service. The common applications of IoT are agriculture & recycling, automotive, aerospace & aviation, Environmental technology, intelligent networking, healthcare services, manufacturing, Oil & Gas, retail & logistics, supply chain management, Safety & security, telecommunications, transportation etc (Luigi Atzuri, 2010) (Schmidt, 2009).

IoT facilitating to integrate various technologies & communications channels like biometric identification, tracking technologies, sensors, intelligent networks, extended communication protocols and smart objects etc. IoT is no more limited to information & communication but also covering the scope of electronics & social sciences. The research on IoT of things is still under process & still researcher community facing major issues. IoT has high impact on working & domestic areas and daily life, behavior & relations of users (Want, 2006) (Xiaopu Shang, 2012).

The future of citizens business, other enterprises and society as whole are hidden behind this new paradigm of IoT. Many terms coming in the mind when we thing to characterize the future design of the IoT like 3D Internet (3DI), Internet of Services (IoS), Internet of Content (IoC), 3rd Generation) (3G), 4th Generation (4G) LTE Internet etc. Considering the various aspects of the Internet future, European Commission (EC) is taking action & funding the research project, which is call “Future Internet Assembly”. IoT in the perspective of business enterprise & economic is the base for the economy based on web services. Future Internet will be the platform of services for business, social societies, and legislation solutions, transportation of goods & things, sensor services. IoT performing the key role minimize the gap between physical world and information world. These smart objects are interconnected by different Services over the Internet, getting their various states and related information, which taking

& privacy issues into account (Andrea Zanella, Castellani, Vangelista, & Zorzi, 2014) (Fei Tao, Xu, Zhang, & Li, 2014) (Sen, 2011).

The development in wireless technologies like wireless networks & mobile devices has high impact on our daily lives because of high availability of digital services. IoT is the great extension of digital information & resources to connect the physical objects of real world like NFC (Near Field Communication) or RFID (Radio Frequency Identification) tags. By IoT, the physical objects can integrate by digital identities with the network. For example mobile devices capturing digital identification of objects by tags (Want, 2006).

The evolution of information is converting the real or physical world to information system (IS) in the form of IoT. The physical things contains of sensors & actuators which are linking via wired or wireless networks by using Internet Protocol (IP) that's connect with network. The revolution of physical objects to become a type of information & some are working without human intervention. Wireless networking technology & standard communication protocols have the capabilities to capture & collect data from these sensors & actuators anywhere (Want, 2006) (Andrea Zanella, Castellani, Vangelista, & Zorzi, 2014).

In this paper section 2 will discuss IoT capabilities and its applications; section 3 will explore IoT architecture and its key technologies; section 4 IoT advantages & disadvantages will be discussed; section 5 will highlight IoT ethical issues; section 6 will investigate IoT challenges & open issues and section 7 will conclude with future work.

2. INTERNET OF THINGS CAPABILITIES & APPLICATION

IoT is capable to support complex planning, storage, decision making & long rang communication with computing resources, which are linked with advanced software systems that provide graphical report to analyze data. For example in oil & gas industry using extensive capable sensor networks for exploration & development process to produce more correct readings of site, structure & dimensions. The payoff is lower development costs & improved oil flows & generating revenues by optimized retails. In healthcare providing facilities to monitor patient symptoms like blood pressure, rhythm, heart bit rate & sugar. And allow physicians to diagnose disease easily & better way. IoT contains complex autonomous systems, which involves the rapid, real-time sensors of predictions & quick response like human reactions. In automobile industry, for example system detects collisions and taking actions like auto break system, anti break system, parking sensors, auto lights, auto AC and autopilot are available at the high end. Robots that cleaning up toxic waste & system of auto force in defense, is under research & specially those areas which are dangerous for humans are being under IoT research (Jingzhu Zhaoab*, 2013) (Fei Tao, Xu, Zhang, & Li, 2014) (Joshua Coopera, 2009).

IoT has enormous possibilities to develop applications; some of them are implemented

in different areas. IoT focus on smart system of intelligent applications like home & offices automation, transportation & logistics, healthcare & medicine, aerospace & smart business. The following are some common applications of IoT (Erin Anzelmo, 2011) (Luigi Atzuri, 2010) (Schmidt, 2009) (Sen, 2011).

2.1. Aerospace and Aviation Industry

IoT improve safety and security of products and services by identifying elements by using RFID tags in aviation industries. Apart from this analyses, verifying, authenticity, validity of various parts which can be easily forged.

2.2. Automotive Industry

Advance technology like sensors, actuators are embedded in cars, buses, bicycles, trains to monitor & report various parameters like tyres pressure, airbags, engine faults, fuel gage, ABS, speed monitoring, vehicle tracking, collision detecting, auto parking, auto emergency call etc.

2.3. Telecommunication Industry

IoT has enormous impact on telecommunication industries for example GSM, NFC, Bluetooth, Wireless network, 3G, 4G, intelligent networking, mobile technology revolution, SMS, MMS, voice call and video calling etc.

2.4. Healthcare Industry

IoT provide facilities to healthcare industry also with emergence of advance intelligent machines & healthcare centers for evaluating patient health & disease monitoring observing by patient vital behavior & symptoms. IoT also involved in the research areas of healthcare domain, working on advance technology to proactively handle new diseases & help society with the new emerging technology.

2.5. Retail, Logistics and Supply ChainMmanagement

IoT performing a very good role in the field of procurement, logistics, stock and supply chain management. From production to delivery, tracking the goods shipment, stock monitoring, and check out-of-stock by using RFID technology also can help to track sales, stock, and control the SCM process.

2.6. Manufacturing Industry

By using smart devices in manufacturing processes that optimizing the entire life cycle from production to dispatching are controlled and monitored. More applications of IoT are in Oil and Gas industry, monitoring environments, transport industries, agriculture, entertainment industries, and also in insurance & recycling processes.

3. IoT ARCHITECTURE & ITS KEY TECHNOLOGIES

IoT is based on a multi layer architecture these are technology edge layer, access gateway layer, middleware, application layer and Internet layer. The designing of architecture is like to fulfill the requirements of different enterprises, industries, institutes, societies, government agencies etc. Application & Middleware layers are taking care of utilizing data in applications, Internet layer serving communication between common media. The last two layers are responsible for capturing data as shown in Figure 1 below (Shahid Raza, Hewage, Hummen, & Voigt, 2013) (Mahalle, Anggorojati, Prasad, & Prasad, 2013).

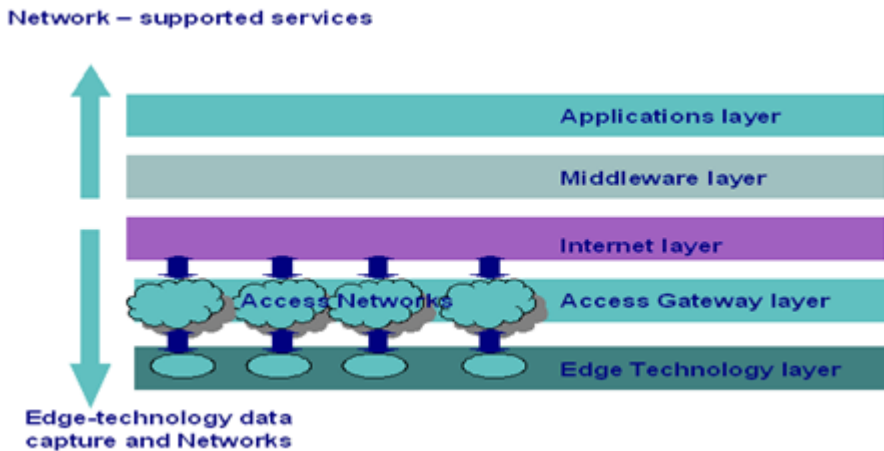


Figure 1: IoT architecture

IoT is a collection of multiple smart technologies like software, hardware and smart applications in industrial & operation domains. The following are some key technology areas, which enabling the IoT to future research and current challenges. (a) architecture technology (b) communication technology (c) data and signal processing technology (d) discovery and search engine (e) hardware technology (f) Identification technology (g) network technology (h) power and energy storage (i) relationship network management technology (j) software’s and algorithms (k) security and privacy technologies and (l) standardization (Shahid Raza, Hewage, Hummen, & Voigt, 2013).

4. IoT ADVANTAGES & DISADVANTAGES

IoT has enormous advantages helping us in our day to day life as individuals, businesses, and society, for example in the forms of health, safety, financially, management, and planning. By implementing of IoT in Healthcare field could prove to be highly beneficial for both individuals as well for society. IoT can provide facilities to help physician in the judgment of disease with respect to symptoms & behavior. It will also guide to decide whether serious assessment is required or not. The IoT can also help in the society for adopting self care activities. For example ADT which is security system which help people to monitor their home via handsets. Another example of IoT

GM-On-Start system which is installed in GM cars that can help to detect if a crash has occurred & will help in accident related services. IoT are using for communication, collection, sharing & transferring of data and translating for efficient use. IoT also facilitating business areas on more high level like inventory control, shipping, supply chain management, manufacturing, tracking etc (Mahalle, Anggorojati, Prasad, & Prasad, 2013) (Yinghui Huang, 2010) (Sye Loong Keoh & Tschofenig, 2014). IoT allowing communication between machine-to-machine (M2M) with this being possible, individuals are able to know about the status & location. By reducing the cost inefficiencies IoT have enormous impact on revenue of organization within the business. Coffee Machine operations with the features like setting the temperature, pressure & vibrating is a good example of excellent IoT to produce high quality throughputs, which will results of client satisfaction & retention. It's looking very simple and beneficial for an organization to ensure quality services to clients by using IoT. IoT is also embedded smart devices, which could make decisions and adapt without human interaction to save energy. IoT has big impact on the revenue of organization by automating the system with advance technology & smart device embed. The IoT has many advantages to businesses, individuals, users, environment, and society, but it has some demerits also. In today era of IT security is the main concerns. It is right that there are security mechanisms to secure the assets on Internet but still we have some concepts that Internet is an unsecure place. There are always possibilities of hacking, leaking and stealing of information & data. Hackers, a group of people that chopped some government Websites, leaked & steal secret information. Governments are implementing top security practices, but hacking specialists have the expertise to easily breach the system. Because the Internet is a publically accessible & open world, which people could chop into it, and stealing the information for misusing it? Getting leak information or data are useful for competitors & enemies to easily catch up business secretes (Fei Tao, Xu, Zhang, & Li, 2014).

In IoT the privacy issues also have a red signal that who would be the controller of accessing data & information from the Internet. For example if there is only one company, that could lead to a monopoly hurting customers. On the other hand if there are more companies that are given access to the information & data acquired, raising the question of privacy on consumer's assets? Also, where is the information going to be stored? Because of high cost some phone service providers (PSP) like AT&T & Verizon are not offering unlimited mobile data, yet by 2020 it is expected that 50 billion devices will be connected, collecting and storing data (Shahid Raza, Hewage, Hummen, & Voigt, 2013).

Another argument against IoT is the full trust over IoT and its technology. As our new generation are getting Internet & modern technology by birth and grown up with availability of IoT in general. However, over reliance on technology by daily basis, would be approached to disaster by taking decisions on base of available information. Every system has faults & glitches and it's difficult to have free of fault system. As per observation we can see bugs in technologies are constantly occurring, especially Internet based. Dependency level over the information could be causing harm or damage in case of systematic error. The high level of reliance over the Internet, the high

potentially catastrophic event could anticipate if the information system crashes (Sye Loong Keoh & Tschofenig, 2014) (Harald Sundmaecker, 2010).

Finally by the more dependency could lead to unemployment or losing individual jobs. By the implementation of IoT in business operational environment “will have a devastating impact on the employment prospects of less-educated workers”, such as those individuals who are evaluating various operational processes, will lead to unemployment in their jobs sites. Researchers observed that many jobs being lost due to application of automation in business processes & operational work such as banking or super markets etc. Technology aftermaths could impact on individual’s consumer as well on whole society (Joshua Cooper, 2009).

5. ISSUES OF ETHICS

In the era of IoT many ethical issues are raised. According to the IEEE Code of Ethics its describes that it will strive to treat apparently with every body regardless of race, age, physical fitness, gender, nationality, religion. In the code of ethics of ACM also states that it will account action fairly that should not discriminate. IoT supporter claims to deal with poor & rich on traits, but it could lead to have some backlashes impacts. IoT can differentiate between various groups of people who don’t have the Internet access by some reasons such as living in remote regions; poor life style can’t afford access to the Internet, so they would deprive to elicit the IoT benefits. In other words, some of the families do not have sufficient amount of money to purchase these devices, which are not able to reap the advantages offered by IoT. In conclusion the IoT charging cost same for both the lower socio economical families and high economic classes which will decrease the efficiencies (Sye Loong Keoh & Tschofenig, 2014) (Mahalle, Anggorajati, Prasad, & Prasad, 2013).

The IoT also compromise on individual’s privacy issue, according to the ACM code of ethics, which is teaching that it will “respect the privacy of others” & “honor confidentiality”. Gathering information on individuals personal life & antiquates and their habits, the firms will have hold on tools to access to customers data. For instance, according to the recent law suit of Google, to share confidential data & information with other firms in order to open new business opportunities & increase to generate revenue. Another example some companies selling our email ids & phone numbers, which are more likely to infringe on our rights. The Internet base tracking system could identify for like or dislike of everyone and which sites they usually visits etc. Some organization will pass us their commercial & advertisements that are specially generated to agree us, on this for more purchases. Actually ACM is supposed to help the society, but it not controlling to prevent firms & business hubs from misusing of IoT. One way to control this ethical misuse of individual confidential information by ACM is to give the rights to individuals keep the information that is generated as private assets and the shared in different repositories. In this case individual could be able to sign a formal written statement that to shared the information with other of their interests (Payam Barnaghi, 2012) (Xiaopu Shang, 2012).

6. CHALLENGES AND OPEN ISSUES

The focus of IoT in future on highly dynamic & ad-hoc relationships across organization operations within the enterprise system environment, home and office automation and other smart areas. In current information & communication technology (ICT) a limited support is available, which leads to some of the following key challenges in future (Joshua Cooper, 2009) (Erin Anzelmo, 2011) (Harald Sundmaeker, 2010).

6.1. Network Foundation – the current limitations in different areas like mobility, availability, performance, capacity, scalability & robustness, manageability, problem & incident handling, pro activity are some huge barriers to IoT.

6.2. Trust, privacy and Security – In today technology security & privacy is the big concerns, which leads to the following challenges (a) IoT architecture security during designing, development & execution stages (b) Defending various attacks like active & passive attacks from cyber enemies and handling proactively and protecting of IOT. (c) Proactive handling of IOT from malicious software & SQL injection & hacking challenges. In IoT user privacy is also facing the following challenges, (a) Data privacy, it means controlling over personals information leaking like individual's physical location & private information (b) required advance technology to enhance privacy. (c) According to Code's standards and tools using for users and physical objects identification.

In trust case, some of the specific challenges are: (a) required easy transfer of sensitive and private data or information. (b) Trust should be to embed in IoT design

6.3. Managing heterogeneity – another major challenge is the management of different domains environments, devices and applications all together under the umbrella of IoT.

CONCLUSION AND FUTURE WORK

IoT is sentiment that will impact on high level on the world. Some people perceptions are raising the question that what will be its impact on society? And whether it will influence as positively or negatively. Everything will connect to Internet in some way that what we are using in everyday life. This will have positive impact on individual & society lives across the world due to facilitating & maturing them about health care programmes & camps regarding foods, exercise, disease etc. It will have enormous impact on businesses all over the world by making strategic planning and increasing productivity in more effective & robust way. Obviously IoT has more merits versus demerits and for sure will have positive influence on the individuals as well as whole society lives. We should look forward for excitement about this new idea to improve our everyday lives. In IoT several areas in which more research is required to make a robust and efficient, global schemes for identification and management of ID using authentication/ authorization, encryption/ decryption and encoding/ decoding users groups, addressing schemes and identity. Multi layer, heterogeneous systems, neutral accesses are designed for distributed architecture with end-to-end characteristics. IoT is responsible to design and efficient communication by using communication spectrum, multi frequency protocol, and frequency allocation. Software Defined Radios (SDR) as hardware independent for new protocol and performing efficiently with scalable algorithms. Chip technology for virtual connections by using dynamic configurations and dynamic routing scheme (Harald Sundmaeker, 2010) (Sen, 2011).

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