Overview on "Internet of Things" Applications based study

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Abstract - The way of connecting the physical world with cyberspace with the help of a smart device led to internet being called as "Internet of Things". The Internet of Things is considered as the third wave of information technology right after Internet and mobile communication network, which is characterized by more comprehensive interoperability and intelligence. By using the Radio Frequency Identification (RFID) technology and wireless sensor networks (WSN), in which information and communication systems are invisibly embedded in environment around us results the generation of data. Internet of things applications are used in domains such as healthcare, supply chain management, defense and agriculture. This paper discusses the growth and evolution of Internet of things, core technologies and useful applications and future applications and at last a brief summary of the paper with its conclusion is given.

Key Words: Internet of Things (IoT), Radio Frequency Identification (RFID), and wireless sensor networks (WSN)

I. INTRODUCTION

The Internet of Things is considered as the third wave of information technology right after Internet and mobile communication network, which is characterized by more comprehensive interoperability and intelligence. It was introduced by Electronic product code (EPC) Technology and research work of International Telecommunication Union (ITU). Initially there was only information online i.e. data content on the internet, then people were connected by means of e-mail, social networking but now the time has come for objects to be connected and that's what Internet of Things achieves. It is new type of internet application and "Thing" in Internet of things refers to the product's information. Hence every object be it a television or a plant, can be connected to the internet. The object's information is shared across the globe using internet and hence the objects can be accessed from a remote place. The product's information is embedded in an electronic tag (RFID tag) using some standard words. The semantic meaning of these words forms ontology and hence Internet of Things forms a part of the semantic web. The difference between an Internet of Things application and a normal internet application is "things-the way information is uploaded and the kind of information that is uploaded". RFID readers are used to read the products information and then upload them onto the internet. The information uploaded has certain attributes that makes it different from other applications. Moreover, the RFID objects generate a lot of dynamic sensor readings which in turn lead to frequent change of information and require more space. In contrast WebPages are static consume lesser space and they are updated weekly or monthly. The properties of Internet of Things are- it's a new type of internet application, thing's information as object, standard expression of information and non-contact uploading by a machine.

II. GROWTH OF INTERNET OF THINGS

Internet has been part and parcel of the social animal's life. It's a huge space of information and people. The internet first evolved as "**internet of computers**" It is a global platform where many services like the World Wide Web could be implemented on top of it. It was an era of information exchange. As the days passed by, people started emerging into the internet- "**Internet of people**". Many social websites came into picture which kept people connected all the time. This has led to internet being filled with people rather than information. On the other hand, technology has been advancing day by day and simultaneously an era of "**MobiComp**" (mobile computing) had

begun. Mobile helped man to be always connected to the internet on the move. Nowadays 3G and 4G and even 5G mobile internet connections have led to faster internet access and deliver better quality in video calls. Wireless technologies and mobile computing have become cheap and have gained more popularity. Hence a new computing had emerged- **Ubiquitous computing**. This computing focuses on smart, intelligent space and minimal user involvement. Advancement in technology led to mobile and other hand-held devices to diminish in size. Smart phones, I pads, tablets and notebooks replaced ordinary mobiles and PCs. Hence there was a change in the device with which people access the internet. This in turn resulted in sophisticated features being configured in devices such as sensors, Global Positioning system (GPS) and actuators. In such a scenario devices were not only connected to the internet but also sense, compute and perform intelligent tasks. Later physical objects were configured with identification tags such as bar code and RFID so that they could be scanned by devices like smart phones and upload their information into the internet. This way of connecting the physical world with cyberspace with the help of a smart device led to internet being called as "**Internet of Things**".

Hence Internet of Things has its roots from Mobile computing, ubiquitous computing and information technology. Internet of Things connects the objects in an intelligent way. The "thing" here refers to the physical object's information read through sensors and RFID reader and uploaded into the internet. The physical object can be anything from smart phones to objects at home. The International telecommunications Union (ITU) has pointed out four dimensions of Internet of Things: object identification "Tagging Things" sensors and wireless sensor networks "feeling things" embedded systems "thinking things" and nanotechnology "shrinking things". Hence from the above , Internet of Things changes the connectivity view from "**any-time , any-place**" for "**any-one**" into "**any-time , any-place**" for "**any-thing**". These things once connected to the internet provide smart services beneficial to the environment and society. They play a major role in supply chain, energy, defense, health care and other useful applications.

III. TECHNOLOGIES AND TRENDS

The main motive of Internet Of things is to make the things or objects in the world to be connected through internet, wireless sensor networks (WSN) and smart phones so that they can share information automatically just like people sharing information. To implement this motive, there are many technologies that come into picture. Radio Frequency Identification (RFID) tags mobile phones, sensors, actuators, embedded systems and nanotechnology helps the things to communicate among themselves.

A). Radio Frequency Identification

Radio Frequency identification (RFID) is a wireless technology that is used for identification of objects. Due to its reduced cost and increased abilities like tracking the location, status of objects and remote reading it is more preferred than the usual bar code technology. It is the root cause factor for an object to be identified so that it can be connected to the internet. RFID uses radio waves to identify things and transfer its information to the RFID reader without physical contact. The RFID system has two main components: RFID tags (transponders) and RFID Readers (transceivers). The tags have a microchip, memory to record information using Electronic Product Code (EPC) or Universal Identification (UID) and an embedded antenna. The working of an RFID application is as follows: The RFID tags are attached to the items which have to be monitored and whose information is to be shared. The readers are flashed on the tag and due to the radio signals received by the in-built antenna, the tag responses by transferring their EPC to the reader. The reader then transmits this information from EPC to the computer to be shared across the internet. In cases where smart phones are used, the sensors present in the mobile devices capture the information and are uploaded online using GPRS or Wi-Fi. Tags are of two types: active and passive. Active tags have inbuilt battery, allows reading from distance locations and transmit information frequently to the reader. On the other hand passive tags do not have a battery of their own and transmit EPC only when the transceivers come within their range. The above working refers to an active tag. The Passive tag responds in a different way. When the passive tag is approached by a reader, an electromagnetic signal from the reader energizes the tag. Using inductive coupling the energy from the signal is absorbed by the tag which converts it into electrical energy and stores in a inbuilt capacitors that it can respond to the reader with an EPC. Hence the RFID system uploads the thing's

information through non-contact reading by a machine rather than humans.

B). Wireless Sensor Networks

Wireless Sensor Networks (WSN) plays a vital role in connecting the physical world to the information world. These networks monitor the changes happening in the environment; report them so that corresponding responses can be taken WSN help in short distance communication among the objects by building wireless networks in an ad-hoc way WSN contain many independent nodes that communicate among themselves with the help of wireless radio. The nodes contain a sensor (collecting data), microcontroller (computing data and controlling) memory (storing program and data) radio transceiver (for communication with other nodes) and battery (power supply). These sensors work together to collect data and send it to the sink node. The sink node redirects the data to the destination. Hence many nodes have to coordinate together to send the signal to the sink node.

C) Addressing Scheduled

The ability to uniquely identify 'things' is critical for the success of Internet of Things . This will not only allow us to uniquely identify billions of devices but also to control remote devices through the Internet. The few most critical features of creating a unique address are: uniqueness, reliability, persistence and scalability. Every element that is already connected and those that are going to be connected must be identified by their unique identification, location and functionalities. The current IPv4 may support to an extent where a group of cohabiting sensor devices can be identified geographically, but not individually. The Internet Mobility attributes in the IPV6 may alleviate some of the device identification problems; however, the heterogeneous nature of wireless nodes, variable data types, concurrent operations and confluence of data from devices exacerbates the problem further

D) Data Storage Analytics

One of the most important outcomes of this emerging field is the creation of an unprecedented amount of data. Storage, ownership and expiry of the data become critical issues. The internet consumes up to 5% of the total energy generated today and with these types of demands, it is sure to go up even further. Hence data centers which run on harvested energy and which are centralized will ensure energy efficiency as well as reliability. The data have to be stored and used intelligently for smart monitoring and actuation. It is important to develop artificial intelligence algorithms which could be centralized or distributed based on the need. Novel fusion algorithms need to be developed to make sense of the data collected. State-of-the-art non-linear, temporal machine learning methods based on evolutionary algorithms, genetic algorithms, neural networks, and other artificial intelligence techniques are necessary to achieve automated decision making. These systems show characteristics such as interoperability, integration and adaptive communications. They also have a modular architecture both in terms of hardware system design as well as software development and are usually very well-suited for Internet of Things applications

E) Visualization

Visualization is critical for an Internet of Things application as this allows interaction of the user with the environment. With recent advances in touch screen technologies, use of smart tablets and phones has become very intuitive. For a lay person to fully benefit from the Internet of Things revolution, attractive and easy to understand visualization have to be created. As we move from 2D to 3D screens, more information can be provided to the user in meaningful ways for consumers. This will also enable policy makers to convert data into knowledge which is critical in fast decision making. Extraction of meaningful information from raw data is non-trivial. This encompasses both event detection and visualization of the associated raw and modeled data, with information represented according to the needs of the end-user

F). Embedded Systems and Nanotechnology

Embedded systems are intelligent and things with embedded intelligence become smart things. These make things perform certain actions automatically. For e.g. A smart watching machine can wash and dry clothes automatically without human intervention. Nano-technology can imbibe intelligence in things which are called

smart devices. They are able to process information, self-configure and take independent decisions. These smart devices are connected with the help of LAN, GPRS, WSN, Wi-Fi, 3G, etc.

D) Ubiquitous computing

The human-to-human interface through technology in the late 1980s resulted in the creation of the ubiquitous computing discipline, whose objective is to embed technology into the background of everyday life. The post-PC era where smart phones and other hand held devices are changing our environment by making it more interactive as well as informative. Mark Weiser, the forefather of Ubiquitous Computing (ubicomp), defined a smart environment 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. The creation of the Internet has marked a foremost milestone towards achieving ubicomp‘s vision which enables individual devices to communicate with any other device in the world. The inter-networking reveals the potential of a seemingly endless amount of distributed computing resources and storage owned by various owners

E) Cloud Computing

More importantly, they identify two critical technologies for growing the ubicomp infrastructure - Cloud Computing and the Internet of Things. Cloud computing is the most recent paradigm to emerge which promises reliable services delivered through next generation data centers that are based on virtualised storage technologies. This platform acts as a receiver of data from the ubiquitous sensors as a computer to analyze and interpret the data as well as providing the user with easy to understand web based visualization. The ubiquitous sensing and processing works in the background of hidden from the user. This novel integrated Sensor-Actuator-Internet framework shall form the core technology around which a smart environment will be shaped information generated will be shared across diverse platforms and applications, to develop a common operating picture (COP) of an environment where control of certain unrestricted ‘things‘ is made possible. Cloud computing promises high reliability, scalability and autonomy to provide ubiquitous access, dynamic resource discovery and composability required for the next generation Internet of Things applications.

IV. APPLICATIONS

Internet of Things applications are used widely in many domains. Healthcare, agriculture, smart buildings (school, hospital, home), supply chain management, Transportation and defense.

A) Personal and Home

Control of home equipment such as air conditioners, refrigerators, washing machines etc., will allow better home and energy management. This will see consumers become involved in Internet of Things revolution in the same manner as the Internet revolution itself Social networking is set to undergo another transformation with billions of interconnected objects. An interesting development will be using a Twitter like concept where individual ’things‘ in the house can periodically tweet the readings which can be easily followed from anywhere creating a Tweet O T. Although this provides a common framework using cloud for information access, a new security paradigm will be required for this to be fully realized. An extension of the personal body area network is creating a home monitoring system for aged-care, which allows the doctor to monitor patients and elderly in their homes thereby reducing hospitalization costs through early intervention and treatment.

B) Enterprise

We refer to the Network of Things within a work environment as an enterprise based application. Information collected from such networks are used only by the owners and the data may be released selectively. Environmental monitoring is the first common application which is implemented to keep a track of the number of occupants and manage the utilities within the building (e.g., HVAC, lighting Sensors have always been an integral part of factory setup for security, automation, climate control, etc. This will eventually be replaced by wireless system giving the

flexibility to make changes to the setup whenever required. This is nothing but an Internet of Things subnet dedicated to factory maintenance.

C) Mobile

Smart transportation and smart logistics are placed in a separate domain due to the nature of data sharing and backbone implementation required. Urban traffic is the main contributor to traffic noise pollution and a major contributor to urban air quality degradation and greenhouse gas emissions. Traffic congestion directly imposes significant costs on economic and social activities in most cities. Supply chain efficiencies and productivity, including just-in-time operations, are severely impacted by this for online monitoring of travel times, origin-destination (O-D) route choice behavior, queue lengths and air pollutant and noise emissions. The Internet of Things is likely to replace the traffic information provided by the existing sensor networks of inductive loop vehicle detectors employed at the intersections of existing traffic control systems. They will also underpin the development of scenario-based models for planning and design of mitigation and alleviation plans, as well as improved algorithms for urban traffic control, including multi-objective control systems. Combined with information gathered from the urban traffic control system, valid and relevant information on traffic conditions can be presented to travelers.

Another important application in mobile Internet of Things domain is efficient logistics management. This includes monitoring the items being transported as well as efficient transportation planning. The monitoring of items is carried out more locally, say, within a truck replicating enterprise domain but transport planning is carried out using a large scale Internet of Things network.

D) Agriculture

Internet of Things can be of great use in the field of agriculture. It can be helpful in monitoring growth of medicinal plants. These plants are fitted with RFID tags and sensors. When there is a drastic or unexpected change in the growth of plant due to temperature, humidity, the sensors sense this and the RFID tags send the EPC (information) to the reader and are shared across the internet. The farmer or scientist can access this information from a remote place and take necessary actions.

E) Smart Buildings – School

A school has many buildings in its campus like Administration block, library, Refreshment building, teaching block, etc. All these buildings have their own ventilation mechanism, AC supply and elevator systems. These facilities have to be individually managed and maintained which becomes a tedious process. This scenario can be easily handled using Internet of Things for better management of the facilities. Each of the above blocks is fixed with RFID tag that keeps monitoring the ventilation, AC supply behavior. The RFID system keeps sensing the change in environment and collects the data and sends it to the Information Gathering manager present in the respective block. Since the school campus will be equipped with Wi-Fi, the data from here is sent to the Central Control system. The control system on receiving the data will take necessary actions such as reducing the AC supply or stopping the elevator service. A communication mediator is required to mediate between the physical world and information world. Hence using IOT, steps are taken without human intervention.

F) Healthcare-Telemedicine

Internet of Things plays a crucial role in healthcare. It can be used in many ways such as tracking the number of patients in a hospital, identifying the right patient for the right medicine and monitoring a patient's health conditions from a remote place which is known as Telemedicine. This includes providing treatment, diagnosis and treatment. Ambient assisted living provides technical systems for elderly people who are alone at home and need to be monitored. The patient's health status is periodically sensed using RFID and sensors. The doctor from a remote location provides medical assistance based on the information received.

Potential Internet of Things Applications Identified by Different Focus Groups

Citizens	
Healthcare	triage, patient monitoring, personnel monitoring, disease spread modelling and containment - real-time health status and predictive information to assist practitioners in the field, or policy decisions in pandemic scenarios
Emergency services, defense	remote personnel monitoring (health, location); resource management and distribution, response planning; sensors built into building infrastructure to guide first responders in emergencies or disaster scenarios
Crowd monitoring	crowd flow monitoring for emergency management; efficient use of public and retail spaces; workflow in commercial environments
Transport	
Traffic management	Intelligent transportation through real-time traffic information and path optimization
Infrastructure monitoring	sensors built into infrastructure to monitor structural fatigue and other maintenance; accident monitoring for incident management and emergency response coordination
Services	
Water	water quality, leakage, usage, distribution, waste management
Building management	temperature, humidity control, activity monitoring for energy usage management Ð Heating, Ventilation and Air Conditioning (HVAC)
Environment	Air pollution, noise monitoring, waterways, industry monitoring

V. ISSUES IN INTERNET OF THINGS

Though Internet of Things has been a boon in many ways, it also poses certain challenges. The main challenges are privacy, reliability, data confidentiality and security. A vehicle attached with RFID tag leads to lack of privacy for the passenger in the vehicle. Internet of Things in healthcare can also lead to dangerous consequences such as the data present in the health status can be changed by an intruder , hence giving the doctor wrong information. Wireless sensors in war fields, if found by the enemies can be mishandled to generate false information. An individual's right to privacy should be protected. Strong security and sound privacy solutions will lead to better acceptance by public. There should be laws and policies to curb the misuse of Internet of Things technology. Global Standards need to be developed for the spread of this new technology.

One of the conundrums facing the smart home space is the lack of one universal protocol. Different devices use different protocols. Chosen on the basis of what suits its function best. While this lead to headaches for the user

VI. CONCLUSION

Internet of Things is a new internet application which leads to an era of smart technology where there

exists thing to thing communication rather than human to human communication. Through Internet of Things, each and every object in this world can be identified, connected and take decisions independently. It has taken its birth from mobile computing and ubiquitous computing. Technologies such as RFID, wireless sensor networks and embedded systems play a vital role in forming an Internet of Things application. It is used in many applications in healthcare, agriculture, smart buildings, transportations etc. Though Internet of Things is used in many domains, its path to success is not smooth. There are many privacy and security issues that need to be addressed. If these issues are addressed, then Internet of Things will definitely be the global buzz word.

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