ISSN: 2321-7782 (Online)
Volume 2, Issue 2, February 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Paper / Case Study
Available online at: www.ijarcsms.com

# Internet of Things –A Future of Internet: A Survey

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***Abstract: Internet, the networks of networks avails us the world at one click. This paper is a survey on Internet of Things which is believed to be the next evolution of Internet. The goal of this technology is to make the objects interact in the same way as the computers do. The implementation of Internet of Things requires the use of some special hardware and software, there can be many challenges that Internet of things might face but still this concept can be applied in many diverse areas. All these aspects are discussed in this paper.***

***Keywords: IoT, Sensors Radio Frequency ID, Uniform Resource Locator, URN, Wireless Sensing Network.***

## I. INTRODUCTION

The *Internet of Things (IoT)* is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of variety of things or objects-such as Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile phones etc.-which through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals [1]. IoT represents the next evolution of the Internet, taking a huge ability to gather, analyze and distribute data that we can turn into information known and ultimately, wisdom in this context.

Already IoT projects are under way that promise to close gap between poor and rich , improve distribution of worlds resources to those who need them the most and help us understand our planet so we can be more proactive and less reactive.

The term Internet of Things was first coined by Kevin Ashton in 1999 in the context of supply chain management [2].However in the past decade, the definition has been more inclusive covering wide range of applications like healthcare, utilities, transport, etc[3]. Although the definition of things has changed as technology evolved, the main goal of making computer sense information without the aid of human intervention remains the same. A radical evolution of the current Internet into a network of connected objects that not only harvest information from the environment(sensing) and interacts with the physical world (command /control ), but also uses existing Internet standards to provide services for information transfer, analytics, applications and communications. Fuelled by the prevalence of devices enabled by enabled by open wireless technology such as Bluetooth, radio frequency identification (RFID), Wi-Fi and telephonic data services as well as embedded sensors and actuator nodes, IoT has stepped out of its infancy and is on the verge of transforming the current static Internet into a fully integrated Future Internet[4]. The Internet revolution led to the interconnection between people at an unprecedented scale and pace. The next revolution will be the interconnection between objects to create a smart environment. Only in 2011 the number of interconnected devices on the planet overtook the actual number of people. Currently there are 9 billion interconnected devices and it is expected to reach 24 billion devices by 2020. According to GSMA, these amounts to $1.3 trillion revenue opportunities for mobile network operators alone spanning vertical segments such as health, automotive, utilities and consumer electronics.

**The general architecture of internet of things**

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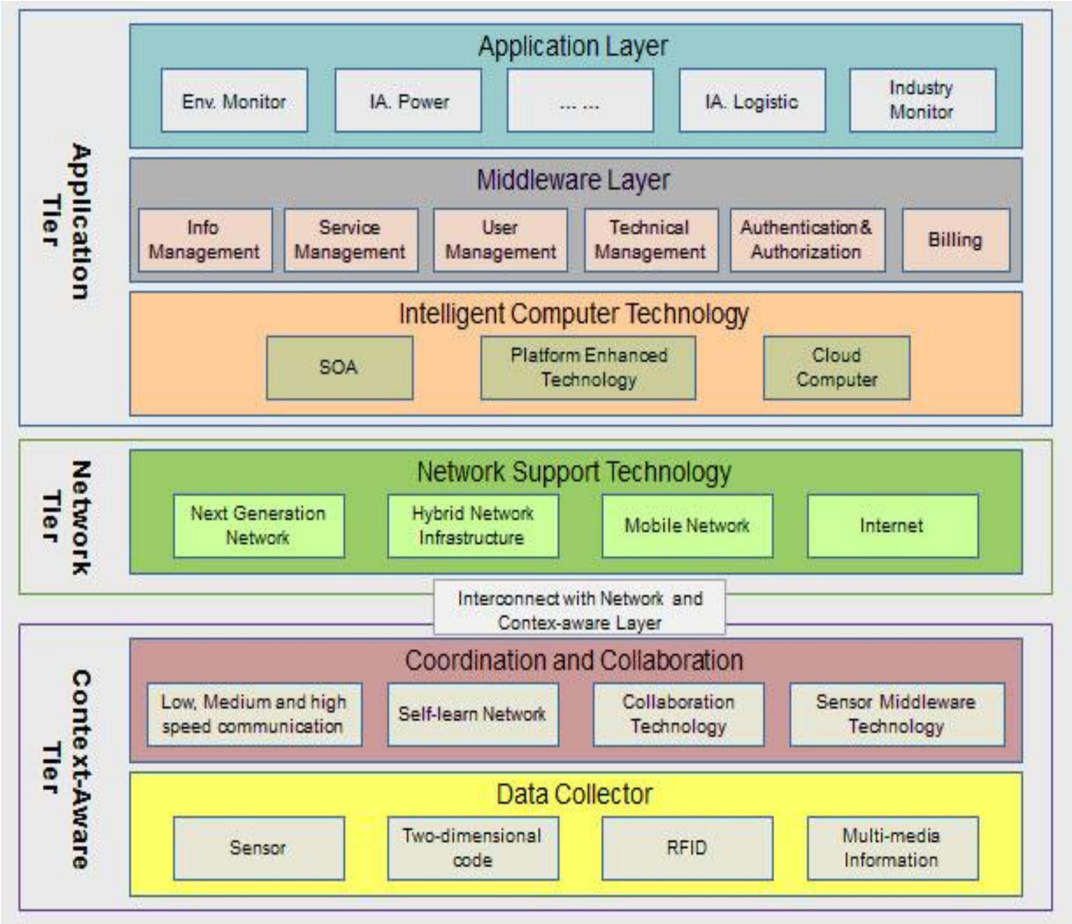
The general architecture used for Internet of things is a three tier architecture. The bottom tier called as context aware tier consist of wide variety of sensor technology .Internet of things is deployed with many type of sensors, each of which is an information source, and different type of sensors capture different content and format of information. Data obtained from the sensor is real time and the sensor collects the environment information at a certain frequency and keeps updating the data. The middle tier called as Network Tier integrates various wireless and wired networks to accurately transfer information of things. Information regularly collected by the sensors on Internet of Things is regularly transferred by the network. The top most tier of IoT architecture is application tier.

The application tier itself consists of three layers technology layer, middleware layer, application layer. The application layer consists of applications that export all the systems functionality to the final user. This layer exploits functionalities of the middleware layer. The middleware is a software layer interposed between the technological and the application levels. Its feature of hiding the details of different technologies is fundamental to exempt the programmer from issues that are not directly pertinent to his focus, which is the development of the specific application enabled by IoT infrastructure.




The middleware is gaining more and more importance in the last few years due to its major role in simplifying the development of new services and the integration of legacy technologies into new ones. This excepts the programmer from the exact knowledge of varied set of technologies adopted by the lower layers.

## II. TECHNOLOGIES USED IN IMPLEMENTATION OF INTERNET OF THINGS

*Radio Frequency Identification (RFID)* The RFID is used in design of microchips for wireless data communication. They help in automatic identification of anything they are attached to acting as an electronic bar code [4][5].

*Wireless Sensor Networks (WSN) Sensors* present in hardware of IoT architecture interact via WSN. The WSN network consists of WSN hardware, WSN communication stack, WSN middleware, secure data aggregation. The WSN hardware consists of sensor interfaces, processing units, transceiver units and power supply. WSN stack enables communication amongst nodes. WSN middleware allows developing sensor application independent of the platform. Secure Data aggregation method is required for extending the lifetime of the network as well as ensuring reliable data collected from sensors.

*Addressing schemes* The uniform resource network (URN) system is considered fundamental for the development of IoT. URN creates replicas of resources that can be accessed through URL.IPv6 also gives a very good option to access the resources uniquely and remotely. Wireless sensor networks which run on a different stack compared to the Internet, cannot posses IPv6 stack to address individually and hence a subnet with a gateway having URN will be required. At the subnet level, the URN for the sensor devices could be the unique IDs rather than human friendly names as in www, and a lookup table at the gateway to address this device. At the node level each sensor will have a URN (as number) for sensors to be addressed by the gateway. The entire network now forms a web of connectivity from users (high level) to sensors (low level) that is addressable (through URN), accessible (through URL).

*Data storage and analytics:* The IoT typically create huge amount of data. The data have to be stored and used intelligently for smart monitoring and actuation. 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. As of 2012, Cloud based storage solutions are becoming increasingly popular and in the years ahead, Cloud based analytics and visualization platforms are soon expected to be developed.

*Visualization:* Visualization is critical for an IoT application as this allows interaction of the user with the environment. For a lay person to fully benefit from IoT revolution, attractive and easy to understand visualization has to be created.

## III. Application Areas

Internet of things has wide application areas today some of them can be Health and wellness, Transport, Energy, Security, Communication, Infotainment[9].


Other Application areas include:

*Smart Parking: Monitoring* of Parking spaces availability in the city.

*Structural health*: Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

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*Noise urban maps:* Sound monitoring in bar areas and centric zones in real time.

*Traffic Congestion:* Monitoring of vehicles and pedestrian levels to optimize driving and walking routes.

*Waste Management:* Detection of rubbish levels in containers to optimize the trash collection routes. In the field of retail its application includes *Supply Chain Control*: Monitoring of storage conditions along the supply chain and product tracking for traceability purpose. *Intelligent Shopping Application*: Getting advice at the point of sale according to customers habits , preferences , presence of allergic components for them.

*Smart Product Management*: Control of rotation of products in shelves and warehouses to automate the restocking process. Domestic and Home Application includes *Energy and Water Use: Energy* and water supply consumption monitoring to obtain advice on how to save cost and resources. *Remote Control Appliances:* Switching on and off remotely appliances to avoid accidents and save energy. Apart from this Internet of Things also can be applied in the field of Agriculture, Industrial control, Animal farming etc.

## IV. Technological Challenges

*Scalability:* An Internet of Things potentially has a larger overall scope than the conventional Internet of computers. But then again, things cooperate mainly within a local environment. Basic functionality such as communication and service discovery therefore need to function equally efficiently in both small-scale and large-scale environments.

*"Arrive and operate":* Smart everyday objects should not be perceived as computers that require their users to configure and adapt them to particular situations. Mobile things, which are often only sporadically used, need to establish connections spontaneously, and organize and configure themselves to suit their particular environment.

*Interoperability:* Since the world of physical things is extremely diverse, in an Internet of Things each type of smart object is likely to have different information, processing and communication capabilities. Different smart objects would also be subjected to very different conditions such as the energy available and the communications bandwidth required. However, to facilitate communication and cooperation, common practices and standards are required. This is particularly important with regard to object addresses. These should comply with a Standardized schema if at all possible, along the lines of the IP standard used in the conventional Internet domain.

*Discovery:* In dynamic environments, suitable services for things must be automatically identified, which requires appropriate semantic means of describing their functionality. Users will want to receive product-related information, and will want to use search engines that can find things or provide information about an object's state.

*Software complexity:* Although the software systems in smart objects will have to function with minimal resources, as in conventional embedded systems, a more extensive software infrastructure will be needed on the network and on background servers in order to manage the smart objects and provide services to support them.

*Data volumes:* While some application scenarios will involve brief, infrequent communication, others, such as sensor networks, logistics and large-scale "real-world awareness" scenarios, will entail huge volumes of data on central network nodes or servers.

*Data interpretation:* To support the users of smart things, we would want to interpret the local context determined by sensors as accurately as possible. For service providers to profit from the disparate data that will be generated, we would need to be able to draw some generalizable conclusions from the interpreted sensor data. However, generating useful information from raw sensor data that can trigger further action is by no means a trivial undertaking.

*Security and personal privacy:* In addition to the security and protection aspects of the Internet with which we are all familiar (such as communications confidentiality, the authenticity and trustworthiness of communication partners, and message integrity), other requirements would also be important in an Internet of Things. We might want to give things only selective access to certain services, or prevent them from communicating with other things at certain times or in an uncontrolled manner; and business transactions involving smart objects would need to be protected from competitors' preying eyes.

*Fault tolerance:* The world of things is much more dynamic and mobile than the world of computers, with contexts changing rapidly and in unexpected ways. But we would still want to rely on things functioning properly. Structuring an Internet of

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Things in a robust and trustworthy manner would require redundancy on several levels and an ability to automatically adapt to changed conditions.

## V. INTERNET OF THINGS AND CLOUD

As stated in The future of cloud computing , opportunities for European Cloud Computing beyond 2010,A cloud can be defined as an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granulites for a specified level of quality.

Internet of Things will certainly have to deal with issues related to elasticity, reliability and data management etc. there is an implicit assumption that resources in cloud computing are of type that can host and process data-in particular storage and processors that can form a computational unit(a virtual processing platform). However specialized clouds may eg integrate dedicated sensors to provide enhanced capabilities and the issues related to reliability of data streams etc are principally independent of the type of data source. Though sensors as yet do not pose essential scalability issues mastering of resources will already require some degree of sensor information integration into the cloud. Clouds may offer vital support to the Internet of Things in order to deal with flexible amount of data originating from diversity of sensors and smart things. Similarly cloud concepts of scalability and elasticity may be of interest for the Internet of Things in order to better cope with dynamically scaling data streams. Cloud computing is the building block of Internet and it is expected that Internet of Things will be the biggest consumer of cloud. Services managing Internet of Things involve rapidly varying data rates and volume. Clouds provide an elastic facility to manage this variability.

**Internet of things in year 2013-2014**

As per news in Computer World India,

- In the year 2013 many companies like ARM, Intel, IBM, SAP, CSC, Free scale, Oracle, and Cisco - have been most vocal in expressing their interest towards the Internet of Things, which encompasses hardware (the things themselves), embedded software, communications services and information services associated with the things. These companies are exhibiting a commitment that is likely to touch more lives than some of the most popular consumer gadgets.
- ARM acquired Sensinode Oy, a provider of software technology for the Internet of things, in a bid to enable a standards-based Internet of Things where billions of devices of all types and capabilities are connected through interoperable Internet Protocols and Web Services.
- In support of the IoT effort to enable intelligent devices, end-to-end analytics and connecting legacy devices to the cloud to drive business transformation, Intel unveiled several products including the Intel Atom processor E3800 product family (formerly codenamed "Bay Trail-I"), a new family of Intel-based intelligent gateway solutions featuring integrated software from McAfee and Wind River, and new features for the low-power, small-core Intel Quark SoC X1000 to help combat the increased fragmentation, interoperability and security challenges as more devices become connected every day.
- IBM and Libelium, a wireless sensor network hardware provider, released an Internet of Things Starter Kit to ease application development, testing, and scalability of wireless sensor networks (WSN). The new kit integrates Libelium's Wasp mote wireless sensor platform with IBM's Mote Runner software and 6LoWPAN, which allows every single sensor and device to connect directly to the Internet using the new IPv6 protocol.
- "At the core of M2M are three key elements: Mobility, Big Data and the Cloud. These are precisely the focus areas that we've designated as innovation factors at SAP," said Adaire Fox-Martin, senior vice president, Industry, Value and Solutions, SAP Asia Pacific Japan in an earlier interview with Computerworld India. Reaffirming SAP's commitment in the field of IoT she added, "We have our MDM product, SAP Afaria, running on HANA (our Big Data In-Memory

Database), all in the Cloud. Supplementing this Mobility management, SAP HANA provides a big data infrastructure to handle large volumes of data that are streamed from "things" so as to make intelligent choice through the use of analytics."

- Freescale Semiconductor and Oracle are working together to rapidly evolve the IoT with a new, secured service platform that will help standardize and consolidate the delivery and management of IoT services for the home automation, industrial and manufacturing automation markets.
- ThingWorx, a provider of M2M business products and applications announced a strategic alliance with CSC, a global provider of technology enabled business solutions and services, which allows the ThingWorx software platform for building M2M and Internet of Things solutions to be embedded into CSC's Omni Location Machine Edge enterprise M2M solutions offering; enables cross licensing of CSC's Omni Location technology to ThingWorx; and provides CSC with the necessary M2M application platform infrastructure to develop and deploy M2M solutions for its customers worldwide.
- The Linux Foundation, a nonprofit organization dedicated to accelerating the growth of Linux and collaborative development, on the formation of the All Seen Alliance - a broad cross-industry consortium to advance adoption and innovation in the 'Internet of Everything' in homes and industry. Founding members of the All Seen Alliance include some of the world's leading companies such as Cisco, Haier, LG Electronics, Panasonic, Qualcomm, Sharp, Silicon Image and TP-LINK.
- Cisco had earlier affirmed its commitment to the field with the formation of an Internet of Things group within the organization to help focus its initial efforts in the fields of security, sensors, real-time analytics and applications, with the company specifically developing the connectivity infrastructure between sensors and applications. Cisco also made known that it hopes its IoT initiative will develop vertical business solutions to connect previously unconnected sensors, devices and other "things" into an Internet of Things.
- With so much enthusiasm and activity from the vendors in 2013, the analysts too have been keeping close watch on this segment and included pointers on the IoT in their predictions for 2014. IDC expects to see new industry partnerships to emerge in 2014 as traditional IT vendors accelerate their partnerships with global telecom service providers and semiconductor vendors to create integrated offerings in the consumer electronics and connected device spaces.
- Forrester expects sensors and devices to draw ecosystems together. The research firm said that the Internet-of-Things will move from hype to reality with the ubiquity of connectivity and proliferation of devices, and wearable computing will go from nice to broader use while adding that the IoT will generate billions of data points in 2014 and aggregating this data and acting on its findings will best be achieved by capturing, analyzing and responding from the cloud.. This will turn the traditional "spray-and-pray promotional campaigns" into marketing to ecosystems that emerge as a result of these changes, says Forrester.
- IoT is set to be a key area of interest for IT buyers and sellers in 2014, according to Frost & Sullivan. "Numerous opportunities will emerge as more and more data is generated by machines ('things') than human beings. These include the ability to analyze and use vast amounts of data, to store data and source application functionality in/from the cloud, to create, manage and support apps that enable the operation and management of IoT implementations and to provide high speed connectivity between objects and the people, who work with them and use them," said Andrew Milroy, Vice President, ICT Practice, Frost & Sullivan Asia Pacific.
- While Gartner too admitted in its 2014 predictions that the Internet is expanding beyond PCs and mobile devices into enterprise assets such as field equipment, and consumer items such as cars and televisions, the research firm also pointed

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out that most enterprises and technology vendors have yet to explore the possibilities of an expanded Internet and are not operationally or organizationally ready.

- Ovum, however, gives the IoT a longer gestation period. Nicole McCormick, Ovum analyst, said that while he expected companies like Telstra to launch its LTE M2M service offer in 2014, he doesn't see 2014 as being the 'year of LTE M2M'. "As while there is initial interest in high bandwidth M2M services over LTE, actual deployment of these services will be limited in 2014. LTE M2M will expand faster in 2015," he said.

## VI. CONCLUSION

This paper discusses the Internet of Things which is one of the upcoming concepts in the field of Internet. We analyzed the general architecture that can be used to implement internet of things and the actual technologies that can be used. We also found relationship between Cloud Computing and Internet of things and how these fields can work together. Finally the events related to this field that took place in 2013 are stated and we are hopeful of a bright future of this field in the years to come.

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