Internet of Things: A great wonder

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ABSTRACT

Internet of Things plays a significant role in today's digital world. The "Internet of Things" (IoT) also referred to as the "Web of Things" is the evolving vision of more and more devices connecting to smart networks and interacting with humans and with each other through the Internet. Ubiquitous sensing enabled by Wireless Sensor Network (WSN) technologies cuts across many areas of modern living. This offers the ability to measure, infer and understand environmental indicators, from delicate natural resources to urban environments. We are entering a new era of computing technology that many are calling the Internet of Things (IoT). We see the IoT as number of smart, connected "things" that will covered every aspect of our lives, and its foundation is the intelligence that embedded processing provides. The IoT is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures. As a result, huge volumes of data are being generated, and that data is being processed into useful actions that can "command and control" things to make our lives much easier and safer and to reduce our impact on the environment. The creativity of this new era is boundless, with amazing potential to improve our lives. Internet of Things connects devices such as everyday consumer objects information gathering and management of these devices via software other health, safety, environmental benefits.

Keywords: Internet of Things, RFID, Smart machine, Wireless Sensor Network, Web of Things.

1. Introduction

The Internet of Things (IoT) is emerging as the third wave in the development of the Internet. The 1990s' fixed Internet wave connected 1 billion users while the 2000s' mobile wave connected another 2 billion. The IoT has the potential to connect 30 billion "things" to the Internet by 2025, ranging from ornaments to cars.

The term Internet of Things was first coined by Kevin Ashton in 1999 in the context of supply chain management [1]. However, in the past decade, the definition has been more inclusive covering wide range of applications like healthcare, utilities, transport [2]. 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 interconnected objects that not only harvests information from the environment and interacts with the physical, but also uses existing Internet standards to provide services for information transfer, analytics, applications, and communications. Fuelled by the prevalence of devices enabled by open wireless technology such as Bluetooth, radio frequency identification (RFID), Wi-Fi, and telephonic data services as well as embedded sensor 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 [3]. 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. A schematic of the interconnection of objects is depicted in Figure 1, where the application domains are chosen based on the scale of the impact of the data generated.

We see five key early applications of adoption like users, Cars, Homes, Cities, and Industrials as test cases for what the IoT can achieve. Focus on new products and sources of revenue and new ways to achieve cost efficiencies that can drive sustainable competitive advantages.

Figure:1 Internet of Things showing end users and application areas based on data

A quick Internet search highlighted the following example use applications under consideration:

• Machine-to-machine communication
• Machine-to-infrastructure communication
• Healthcare: Real-time pervasive monitoring of patients, diagnosis and drug delivery
• Asset tracking of goods on the move
• Automatic traffic management
• Remote security and control
• Environmental monitoring and control
• Home and industrial building automation
• “Smart” applications, including cities, water, agriculture, buildings, grid, meters, broadband, cars, appliances, tags, animal farming and the environment.

This paper presents the new trends in Internet of Things research propelled by applications and the need for convergence in several inter disciplinary technologies.

2. Moving to a Smarter Internet

Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analysed and used to initiate action, providing a wealth of intelligence for planning, management and decision making. This is the world of the Internet of Things (IOT).
The IOT concept was coined by a member of the Radio Frequency Identification (RFID) development community in 1999, and it has recently become more relevant to the practical world largely because of the growth of mobile devices, embedded and ubiquitous communication, cloud computing and data analytics.
Since then, many visionaries have seized on the phrase “Internet of Things” to refer to the general idea of things, especially everyday objects, that are readable, recognizable, locatable, addressable, and/or controllable via the Internet, irrespective of the communication means RFID, wireless LAN, wide- area networks, or other. Everyday objects include not only the electronic devices we encounter or the products of higher technological development such as vehicles and equipment but things that we do not ordinarily think of as electronic at all - such as food and clothing. Examples of “things” include:

- People
- Location
- Time Information
- Condition

These “things” of the real world shall seamlessly integrate into the virtual world, enabling anytime, anywhere connectivity. In 2010, the number of everyday physical objects and devices connected to the Internet was around 12.5 billion. Cisco forecasts that this figure is expected to double to 25 billion in 2015 as the number of more smart devices per person increases, and to a further 75 billion by 2025 .(see Figure 1).

3. Increasing communication throughput and lower latency

IOT relies on a pervasive communication network to allow “everything and everywhere” connectivity to occur. Over the years, network operators have been enhancing their infrastructure to support data capability and improving network throughput for their existing cell sites, transceivers, and interconnection facilities. With the addition of General Packet Radio Service (GPRS) infrastructure, Global System for Mobile (GSM) operators have largely upgraded their data services to Enhanced Data rates for GSM Evolution (EDGE). Today, most operators worldwide are deploying Universal Mobile Telecommunications System (UMTS) with High Speed Packet Access (HSPA) technology for higher throughput and low latency. HSPA, also commonly known as “3G”, has also shown us the power and potential of always-on, everyplace network connectivity that has ignited a massive wave of industry innovation that spans devices and applications.
As the technology trend shifts towards providing faster data rates and lower latency connectivity, the Third Generation Partnership Project (3GPP) standards body has developed a series of enhancements to create the “HSPA Evolution”, also referred to as “HSPA+”. HSPA Evolution represents a logical development of the Wideband Code Division Multiple Access (WCDMA) approach, and is the stepping stone to an entirely new 3GPP radio platform called 3GPP Long Term Evolution (LTE). LTE offers a number of distinct advantages such as increased performance attributes, high peak data rates, low latency and greater efficiencies in using the wireless spectrum.

4. Market Trends

In today’s IT industry, companies are staying competitive by adopting new technologies, streamlining business processes and innovating new services to increase productivity and save costs.
In the logistics and supply chain, the traditional supply of goods is based on established agreements between manufacturers and suppliers. Orders are made in advance and tracking is done by various stakeholders in the supply chain, assembly lines, manufacturers and logistics managers. Warehouses will become completely automatic with goods moving in and out, forwarding of the goods will be made, using intelligent decisions based on information received via readers and positioning systems to optimize transiting routes. Suppliers will have the flexibility to purchase parts from various manufacturers and buy them in a sequence of individual orders. Such automation creates a dynamic production and transportation network and provides better asset management to improve the overall efficiency in the supply chain.

In healthcare, hospitals are shifting from providing healthcare on premise, in hospitals and clinics, to remote self-monitoring for patients. Self-monitoring benefits patients by giving them greater freedom and independence in monitoring their health and frees up hospital equipment for the treatment of emergencies. In the India, electronic health monitoring has been given the go-ahead by the Federal Communications Commission (FCC). FCC allows the use of allotted frequencies for sensors to control devices wirelessly in the monitoring of health at hospitals and homes. Such monitoring allows doctors to inform their patients of critical conditions before they happen and subsequently improves the quality of healthcare by unfettering patients from tubes and wires. Moving into the future, there are newer trends of developing biodegradable materials for sensors and "lab-on-chip" equipment that can be implanted on or in patients. The sensor chips can detect internal organ responses to new medication and guide the application of drugs to infected areas for better treatment.

In automotive transportation, the traffic conditions today are monitored by cameras and motion sensors placed along major road junctions and highways. However, with road traffic growing and land space for road development restricted, these sensing technologies are reaching their limits in providing real-time traffic updates to ease road congestions and help prevent accidents. There are shifting trends in the automotive industry to equip vehicles with dedicated short-range communication (DSRC) to provide vehicle-to-vehicle (V2V) communications to improve vehicle safety and provide better road visibility for traffic management. For instance, when there is a traffic jam, the first car may tell the cars behind if there is an accident, and this will eventually inform the intelligent navigation systems to re-route the path to another less crowded road. These cars can make breakdown calls when appropriate, collecting data about the surrounding infrastructures such as traffic lights and buildings, and about itself. Vehicles gradually become smart "things" which can react, based on real-time situations on the roads, and contribute to a safer traffic system.

In retail, businesses have problems identifying the right customer at the right time to sell them their products. Various techniques of marketing products involve using short messaging system (SMS) broadcast, digital signage's and recently the use of Quick Response (QR) codes to bundle promotions. These methods often fail to deliver the right customer to the right product and vice-versa. Virtual shopping carts can be created and orders placed automatically with warehouses for goods to be delivered to their homes.

5. Markets Covered

This segment the Internet of Things market and M2M communications market by Application ,Technology and platform, connection and module, component, and region. These segments are further sub segmented into the following sections:

- Applications: Consumer electronics, healthcare, energy and utilities, automotive and transportation, industrial and commercial buildings, consumer and residential, government, manufacturing and supply-chain, and others
- Technologies and platforms: Radio Frequency Identification (RFID), sensor nodes, gateways, cloud management, ZigBee, and Information and Discovery Services (IDS), platforms, and system integrators
- Connections and modules: Network connections, sim-cards, and module types
- Components: Sensing and identification: RFID, network communications, data processing, and safety, security, and support technology
- Regions: North India, south India, Middle East and west India

6. Technology Trends

Several technology trends will help shape IOT. Here are some identified macro trends: the miniaturisation of devices, RFID technologies, cloud computing technologies and security.

6.1 Miniaturization of devices

IOT uses technologies to connect physical objects to the Internet. The size and cost of electronic components that are needed to support capabilities such as sensing, tracking and control mechanisms, play a critical role in the widespread adoption of IOT for various industry applications.

Several measures of digital technology are improving at exponential rates related to Moore's law, including the size, cost, density, and speed of components. Moore wrote only about the density of components, "a component being a transistor, resistor, diode or capacitor," at minimum cost. The most popular formulation is of the doubling of the number of transistors on integrated circuits every two years. At the end of the 1970s, Moore's law became known as the limit for the number of transistors on the most complex chips. The graph at the top shows this trend holds true today.

6.2 Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) technology is of particular importance to IOT as one of the first industrial realizations of IOT is in the use of RFID technology to track and monitor goods in the logistics and supply chain sector. **RFID** is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic induction from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder. Other types have a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within

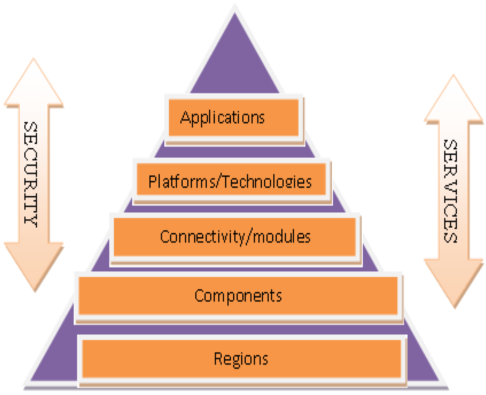

Figure :2 Internet of Things and market covered

line of sight of the reader, and may be embedded in the tracked object. Radio frequency identification (RFID) is one method for Automatic Identification and Data Capture (AIDC).

RFID can be used variety of applications, such as:

- Access management
- Tracking of goods
- Tracking of persons and animals
- Toll collection and contactless payment
- Machine readable travel documents
- Smart dust (for massively distributed sensor networks)
- Tracking sports memorabilia to verify authenticity
- Airport baggage tracking logistics[20]
- Timing sporting events

6.3. Cloud Computing

IOT connects number of devices and sensors to create new and innovative applications. In order to support these applications, a reliable, elastic and lively platform is essential. Cloud computing is one of the enabling platforms to support IOT.

Cloud computing is an architecture that orchestrates various technology capabilities such as multi-tenancy, automated provisioning and usage accounting while relying on the Internet and other connectivity technologies like richer Web browsers to realise the vision of computing delivered as a utility. Cloud computing is seeing service model (Figure 3) and there are three commonly deployed cloud service models namely Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS) and Cloud Infrastructure as a Service (IaaS). For example, in IaaS, the use of hardware such as sensors and actuators can be made available to consumers as cloud resources. Consumers can set up arbitrary services and manage the hardware via cloud resource access control. PaaS can provide a platform from which to access IOT data and on which custom IOT applications can be developed. SaaS can be provided on top of the PaaS solutions to offer the provider's own SaaS platform for specific IOT domains.

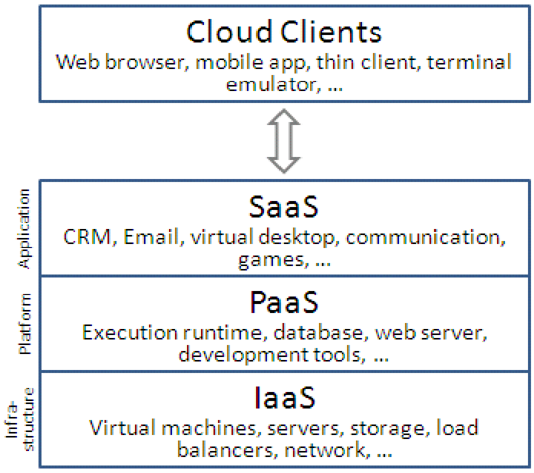

Figure:3 Cloud computing service model.

6.4 Security and Privacy

Today, various encryption and authentication technologies such as Message Authentication Code (MAC) protect the confidentiality and authenticity of transaction data as it "transits" between networks. Encryptions such as full disk encryption (FDE) is also performed for user data "at rest" to prevent unauthorised access and data interfered.

In future, new standards and technologies should address security and privacy features for users, network, data and applications. In areas of network protocol security, Internet Protocol Version 6 is the next generation protocol for the Internet, it contains addressing and security control information, i.e., IPSec to route packets through the Internet. The security services are access control, connectionless integrity, data origin authentication, protection against replays, encryption and limited traffic flow confidentiality.

7. Technology Outlook

This is covers the various technologies that support IOT. While IOT is architected into layers, the technologies have been categorized into three groups.

The first group of technologies impacts the devices:

- Low power sensors for power and energy sustainability;
- Intelligence of sensors in the field;
- Wireless sensor network for sensor connectivity.

The second group comprises technologies that support network sharing and address capacity and latency issues:

- Network sharing technologies such as software-defined radios and cognitive networks;

- Network technologies that address capacity and latency issues

The third group impacts the management services that support the IOT applications:

- Intelligent decision-making technologies such as predictive analytics, complex event processing and behavioral analytics.
- Speed of data processing technologies such as in-memory and streaming analytics

8. Technological challenges

While the possible applications and scenarios outlined above may be very interesting, the demands placed on the underlying technology are considerable. Progressing from the Internet of computers to the remote and somewhat fuzzy goal of an Internet of Things is something that must therefore be done one step at a time. In addition to the expectation that the technology must be available at low cost if a large number of objects are actually to be equipped, we are also faced with many other challenges, such as:

Data Control: From the user perspective, this is one of the more significant barriers to large-scale adoption of the technology. Data control is commonly mistaken for data ownership. However, as recent developments have shown, sharing personal data can be a two-way street.

Data Sharing: In the Internet of Things pattern, data is gold. However, data provisioning builds off a social contract between large corporations and customers. Corporations provide a free or nominally-priced service in exchange for a consumer's personal data. This data is either sold to advertisers or used to develop further products or services useful to consumers. Third-party applications, which build off the core service, customers data from such applications. For established networks and large corporations, this can be critical practice because such applications eventually simmer their customers. In such a scenario, large corporations need to balance their approach to open source with commercial considerations.

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.

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.

Wireless communications*:* From an energy point of view, established wireless technologies such as GSM, UMTS, Wi-Fi and Bluetooth are far less suitable. Three well-known organizations that manage certification programs today to assure interoperability between wirelessly connected devices are the Wi-Fi Alliance, the Bluetooth Special Interest Group (SIG) and the ZigBee Alliance. All three organizations provide member companies the option to take products through an interoperability test plan, which grants rights to wear the Wi-Fi, Bluetooth or ZigBee logo.

9. Market Opportunities

IOT presents many opportunities for industry verticals and brings about new innovations to businesses. With real-time data and potentially cross-domain data sharing, new business models can be created. Opportunities such as IOT as a service, new markets and value chains can be formed to enhance competitive edge. This section, though not comprehensive in coverage, considers the business drivers for IOT and potential applications that can be developed to support various industry sectors and cross-domain businesses.

10. IOT Applications

Below are some of the IOT applications that can be developed in the various industry sectors .

10.1 Supply Chains

Traditionally, the order picking management in the warehouse picks up multiple types of commodities to satisfy independent customer demands. The order picker tries to minimise the travelling distance for time and energy savings via route optimisation and order consolidation. Using the dynamic ordering tool, the network of smart objects will identify the types of commodities and decompose the order picking process to distributed sub-tasks based on area divisions. The application will plan the delivery routes centrally before activating order pickers for the delivery. Using executable algorithms in active tags, the tags can choose the best paths for the order pickers to take, as well as paths that are within their responsible areas. This results in a more optimised order processing, time savings and lower cost of delivery.

10.2 Crowd Control

The crowd control application will allow relevant government authorities to estimate the number of people gathering at event sites and determine if necessary actions need to be taken during an emergency. The application would be installed on mobile devices and users would need to agree to share their location data for the application to be effective. Using location-based technologies such as cellular, WiFi and GPS, the application will generate virtual "heat maps" of crowds. These maps can be combined with sensor information obtained from street cameras, motion sensors and officers on patrol to evaluate the impact of the crowded areas. Emergency vehicles can also be informed of the best possible routes to take, using information from real-time traffic sensor data, to avoid being stuck among the crowds.

10.3 Shopping Assistants

In the retail sector, shopping assistant applications can be used to locate appropriate items for shoppers and provide recommendations of products based on consumer preferences. Currently, most of shopping malls provide loyalty cards and bonus points for purchases made in their stores but the nature of these programmes are more passive, they do not interact with, and often do not make any recommendations for, the buyers. The application can reside in the shopper's personal mobile devices such as tablets and phones, and provide shopping recommendations based on the profile and current mood of the shopper.

10.4 Health care

This application, however, requires the medical services companies to support it. Continuous patient monitoring requires the use of medical body sensors to monitor vital body conditions such as heartbeat, temperature and sugar levels. The application examines the current state of the patient's health for any abnormalities and can predict if the patient is going to encounter any health problems. Analytics such as predictive analytics and CEP can be used to extrapolate information to compare against existing patterns and statistics to make a judgment. Energy harvesting sensors can be used to convert physical energy to electrical energy to help power these sensors to prevent the patient from having to carry bulky batteries or to perform frequent re-charging.

10.5 Transportation

The transportation application serves to address the group of commuters with special needs and who require assistance as they commute using public transportation. When these commuters travel, e.g., using the public train service, the transport assistant will inform the nearest transport staff so they can provide special assistance such as audio and visual services, and physical assistance for the passengers. When commuters are outdoors, the transport assistant will alert oncoming public vehicles to slow down as the passengers require special assistance to board the vehicle. The transportation assistant application can embedded into watches, bracelets and panic button devices with built-in intelligent capabilities such as context-aware computing services and predictive analytics. Depending on the user's profile, the application recommends the most suitable assistance required by the user, gathering inputs from the current surroundings to make the decision. Using sensors on these wearable devices, the application communicates with other sensors or receivers, e.g., staff badges using radio frequency to establish connectivity and make the request.

10.6 Energy Management

Energy management involves the use of a combination of advanced metering and IT and operational technology (OT) that is capable of tracking, reporting and alerting operational staff in real time or near real time. Systems are capable of allowing highly dynamic visibility and operator influence over building and facility performance. They also provide dashboard views of energy consumption levels, with varying degrees of granulation, and allow data feeds from a wide range of building equipment and subsystems.

10.7 Logistics Industry

Logistics companies are tapping on traffic patterns, road congestions information from road cameras and sensors and early knowledge of weather conditions to make constant routing adjustments for their delivery trips. These cross-domain information help them increase their delivery efficiencies and reduce overall congestion costs. the transport assistant will alert oncoming public vehicles to slow down as the passengers require special assistance to board the vehicle. The transportation assistant application can embedded into watches, bracelets and panic button devices with built-in intelligent capabilities such as context-aware computing services and predictive analytics. Depending on the user's profile, the application recommends the most suitable assistance required by the wearer, gathering inputs from the current surroundings to make the decision. Using sensors on these wearable devices, the application communicates with other sensors or receivers, e.g., staff badges using radio frequency or Zigbee, to establish connectivity and make the request.

11. Conclusions

Internet of Things is the next evolution of the internet. The concept of connecting "things" together through a data network is not new and has been implemented for some time but to a limited coverage. However, technology has developed to allow realization on a much larger, more complex and rapidly expanding scale which has implications that are difficult to predict. An increasing number of large industry players are investing significant resources in IoT infrastructure and applications which will make increased innovation and commercialization. By using IoT concept all areas of life to health, business, national, transport, energy consumption, etc,. can be promoted.

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