

Internet of Things: an Introduction to Connecting the Unconnected

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Abstract—In these modern days where people have scarcity of time, connecting with physical objects around us is a major requirement. Natural human tendency to automate everything and control everything from remote leads to the evolvement of IoT. What more a person ask for if the tea pot in his kitchen start brewing as soon as he gets up in morning? That’s where magic of IoT lies. It facilitates connectivity anytime, anywhere. It is bringing a huge change in people’s everyday life and at the same time for government and industry. It is creating an omnipresent environment where human being can interact with digital world. It is mobile, virtual and spontaneous connect which is making life smarter than ever before. This paper presents an overview of Internet of Things, brief architecture, its benefit and challenges and different case studies from various fields such as automobile industry, insurance industry, car manufacturing, healthcare and its impact on developing nation like India. This paper also proposes an idea of using IoT for smart city waste management.

Keywords— *Internet of Things, digital world, smart life, Wireless sensor Network*

I. INTRODUCTION

Digital space has witnessed major changes in the last few years, latest entrant being IoT. IoT is a complex interconnected system of engineering and Information Technology. The term IoT was first used by Kevin Ashton in a presentation during 1998.[3]. Since then IoT is spreading its fragrance everywhere in our daily life. Basically IoT is a new dimension added to Information Technology [16].We can think of IoT themes as connected store, connected car, connected home, industry 4.0, connected care etc. Fig.1 gives an overview of this new dimension.

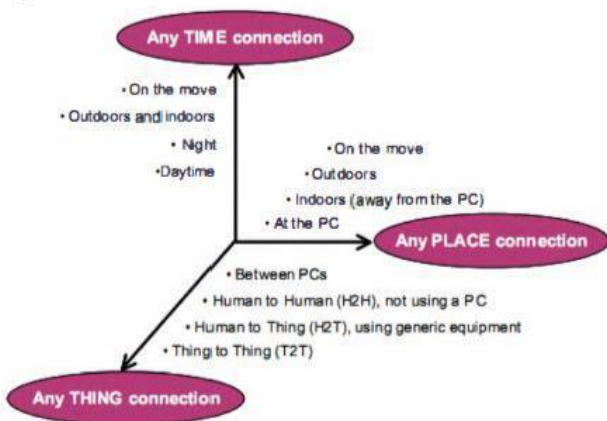


Fig.1 A New Dimension

Internet of Things is actually connection of everything which includes people. Study [1] has shown that number of things connected to internet will exceed no .of people on earth. According to the analysis report by Cisco Internet Business Solution Group [7] total connected things will reach 50 billion in 2020. Main goal of IoT is to connect everything around us and enable seamless communication between them with very minimum human intervention. With the advent of cheaper broadband connectivity and smaller yet more powerful digital devices with a variety of on board sensors, device getting connected to each other is rapidly increasing and it has become a new trend. Main components [15] of IoT are sensors and physical objects. With the help of Wireless sensor Network and RFID, information are exchanged in this era of internet of things every device is uniquely identified and accessed to the network. IoT basically wants things to talk. As an example we can think of an ambulance can collect information about critical patient before reaching hospital thus helping in speeding up the diagnosis process and increasing the survival rate. Fig.2 shows the main components in IoT.

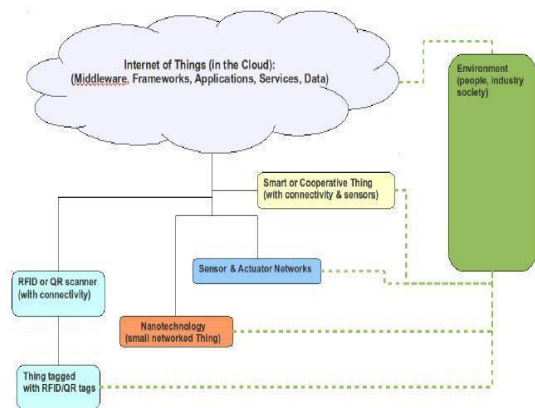


Fig.2 Components in IoT

II. ARCHITECTURE

IoT has four major layers [8]

Application Layer
Management Service Layer
Gateway and Network Layer
Sensors connectivity Layer

A. Sensors Connectivity Layer

This bottom most layer is known as sensor layer. Here at the bottom level of this layer it has Barcode, RFID. At the top of this layer smart devices like sensors or actuators exists. Sensors use low power and low data connectivity. Top most layer provides us network connectivity such as LAN, Ethernet, Wi-Fi, ZigBee etc. Sensors which do not need connectivity to a LAN gateway can be directly connected to internet through a WAN interface. Different types of networks are integrated in single IOT platform with the help of various protocol and technologies. It should be scalable also to handle variety of devices.

B. Gateway and Network Layer

Mainly Micro controller, embedded OS, SIM module are the part of gateway. This layer is used to transfer sensors collected information to its next layer. Network domain of this layer consists of LAN, WAN, LTE, Wi-Fi and Ethernet. It supports massive volumes of IOT data generated by sensors and smart devices.

C. Management Service Layer

This layer forces security. It provides access control, encryption, identify access. Management service can be categorized by three groups. a) OSS (operational support system) b) BSS (billing support system) and c) service analytics platform which includes data mining, text mining, and predictive analysis. Data management is also an important part of this layer. It can be periodic and aperiodic. In periodic IoT sensor data require filtering. Aperiodic might require immediate delivery and response. Example of this can be patient condition emergency sensor data.

D. Application Layer

This top most layer of IoT facilitates users to use various application. Application can be connected home, connected car, people tracking, retail, military, transportation, etc.

III. BENEFITS

Economic impact and benefits of IoT will be huge. The analysts at McKinsey & Company have identified six major benefits [17] that IoT can bring

- Tracking behavior for real-time marketing.
- Enhanced situational awareness.
- Sensor-driven decision analytics.
- Process optimization.
- Optimized resource consumption and Instantaneous control and response in complex autonomous systems.

IV. CHALLENGES

This emerging IoT has tremendous usages as well as dangers also, as it connects with the physical world. Internet threat today steals credit cards. Who can tell that future internet will not ruin home security system and disrupt hospital? Different heterogeneous devices connecting to each other in unsupervised way giving birth of insecurity of internet operation. Two important issue/challenges of IoT can

be low power and security function. For example some crucial services like healthcare, workplace safety which do not require human intervention are automated. Therefore security should be handled with utmost care. Critical risks might include prolonged downtime, physical harm to people, damage to equipment and so on. IoT devices are mostly complex, requires end to end security solution that span cloud and connectivity layers. Symantec has already given four cornerstones of IoT security. They are protecting communication, protecting devices, managing devices and understanding your system. Some of notable challenges of IoT are

Security: As many numbers of sensors are connected, there should be proper authentication and access control mechanism to avoid intruders. Internet protocol security provides a proper secured connection but still there is some outstanding risk exist. Data integrity and at the same time being energy efficient is an important challenge.

Power: Connecting devices requires continuous power for its operation. Power-aware routing, sleep scheduling algorithm helps to improve power management in network. Power routing algorithm determine the routing decisions based on most energy efficient routes. Sleep scheduling algorithm define how devices can sleep and remain energy efficient.

V. CASE STUDIES

In this section different case studies from various industry has been addressed.

1. **Automobile Industry:** Sometimes during a recall situation it is difficult to quickly identify faulty components of a car. Because of this manufacturers end up recalling more than actually affected cars. IoT can provide solution to improve component tractability in an automobile industry. It documents the details of entire manufacturing process of components starting from supplier, billet cutting, blasting etc. using 3D laser etched bar codes. It makes it easier to find faulty parts.
2. **Insurance Industry:** IoT can help to develop driving analysis solution for teen age people using analytics based on driving data. Location based services IP for Geo-fencing and monitoring by parents also possible.
3. **Connected cars-telematics services:** The vehicles leverages new technologies such as Microsoft Kinect v2, windows surface pro tablets, wearable smart watches to provide drivers, passengers and vehicle work in unison to ensure a safer drive.
4. **Elevator Manufacturing Industry:** They need a system to monitor the safety of field engineers who work in hazardous condition maintain and fixing elevators. IoT plays an important role to solve this problem. Body wearable sensors can be used to detect heart rate, ECG, body posture, skin temperature etc. Along with that policy based monitoring of field personnel during emergency situation alerting through SMS, email etc.
5. **HealthCare Industry:** IoT can provide continuous data collection of health parameters of sports person and elderly people and integrate with mobile phone to enable interaction.
6. **Logistic automation for aerospace Industry:** This industry suffers from a problem of limited visibility into

inventory and inventory movement leading to operational inefficiencies. With IoT Item level aerospace parts tagging, Automation of inventory movement tracking using RFID and Real-time integration to SAPR3 via SAPAI and XI is possible.

7. Oil Industry: Real time monitoring of production from oil field is possible with IoT. It can help to design real time data acquisition system used for monitoring and calculating life of well and yield from reservoir over a period of time.
8. Mining Industry: IoT helps to mobilize help to the miners in life threatening conditions (fatal fall injury, moved out of safe working zone, hit by moving equipment, poisonous gas area etc.). It can keep track miners and high risk worker in real time on supervisor's iPad App using 2D/3D map visualizations. It can be used to alert supervisor immediately via a SOS call.
9. Retail Store: Some client from this industry wants smart energy solutions to reduce overall energy consumption in its stores without compromising on quality of products or customer experience. IoT can provide several solutions including Plug Load Manager + Ambient Intelligence Monitoring, Timer and Occupancy based lighting UPS energy saver and Smart Air Load Balancing.
10. Smart city waste management: Statistics says that by 2030 almost two-third of world population will be living in cities. This Internet of Things provides new opportunities to make city smarter. One of the important aspect of smart city is Waste management.

VI. PROPOSED IDEA FOR SMART WASTE MANAGEMENT

The proposed approach is based on intelligent waste container which uses sensor technology. It has Ultrasonic sensor, GSM, GPS and Microcontroller. Here Ultrasonic technology is combined with GSM communication technology. GPS will help to find out location of the waste bin. This application can be used by waste management people (registered employee). The trash bin will be embedded with ultrasonic sensor and force sensor. Ultrasonic Sensor will check fill level of trash and Force sensor will detect weight of thrash. If it exceeds some threshold level it will send SMS alert to all those registered employee indicating that thrash need to be emptied. Fig.3 shows the proposed architecture.

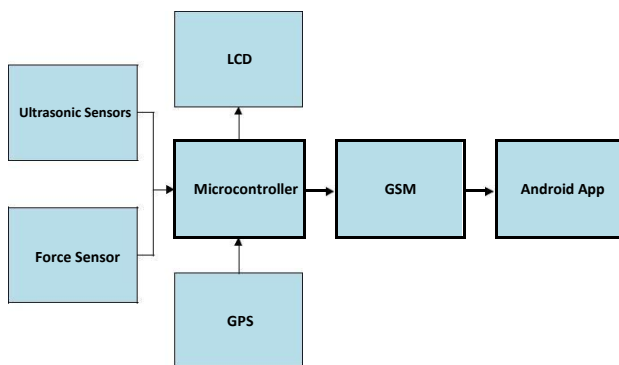


Fig.3 Proposed Architecture

VII. IMPACT ON INDIA

IoT has gained a prominent position in the "Digital India" program launched by current Prime Minister of India [18]. With a vision to create an IoT industry of \$15 billion by 2020, the government has drafted a strategic roadmap to build domain competency, encourage budding entrepreneurs, buffer product failure, energize research acumen, and thereby place India on the global IoT map.

A. Agriculture

India is a country where farmers are committing suicide because of low crop production or unpredictable market conditions, IOT can play an important role. For crops, smart farming means preparing the soil, planting, nurturing and harvesting at precisely the best time via access to market data. TCS has launched a program named mKRISHI which provides advisory services to farmers. IOT can provide some solution where we get a mechanism that provides farmers with on-demand information on the basis of their context that can be sensed through a network of IoT sensors. This can be used to optimize efficiency, maximize productivity and ensure quality of produce. Crop specific information and alerts regarding current/future weather conditions, soil type, fertilizer, pest control, etc. from industry experts should be made accessible via mobile device

B. Disaster Prediction and Management

As India is prone to a number of disasters such floods, drought, cyclones, landslides, with IoT it is possible to provide strategic solution to manage those disaster. We cannot say that disaster will be completely avoided but its impact can be minimized by using a combination of GIS, remote sensing and satellite communication. For instance, a combination of sensors can provide information on the condition of railway tracks that can be used to avoid derailment incidents.

C. Health & Wellness

As the cost of treatment is increasing day by day, IOT can ensure affordable, accessible and quality healthcare with its P2M (Person to Machine) relationship. Fitness Chronic Disease Management is possible via wearable devices which can monitor a patient's blood pressure, blood glucose levels, breathing, pulse and many more aspects. Hospitals can use the facility provided by IoT for remote monitoring of their patients, disease management, inpatient care, patient specific record databases and more.

VIII. CONCLUSION

In this survey paper I tried to analyze the concepts of IoT considering its architecture, application and case studies from several crucial field of our daily life. IoT's contribution to the society could be huge. IoT can boost the economy while improving citizen's life in multiple ways unthinkable now.

ACKNOWLEDGMENT

I would like to express my gratitude to Dr Rana Pratap Reddy N, Principal, Global Academy of Technology, Bengaluru for sharing his pearls of wisdom and encouraging us to take up new challenges in research and exploring new ideas in my field of study.

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