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INTERNET OF THINGS: A NEW EVOLUTION IN BUSINESS

Dr. N. Srividya
Post Doctoral Research Fellow, IBM, NCE Bengal, Jadavpur University, Kolkata, West Bengal, India

Abstract:

Through sensors the modern living is made much easier and comfortable in many ways. The perfect blend of sensors and actuators create Internet of Things (IOT) through which the information is shared across the devices in normal day to day life. Combined with RFID (Radio Frequency Identifiers) the IoT has emerged as a Future Internet. Internet of Things means connecting Machine to Machine, Machine to Infrastructure, Machine to Environment and much more Internet of Everything. It can be done using embedded systems and many useful actions that can command and control can be made to make our lives easier and safer. This paper studies various aspects of the Internet of Things in detail.

Keywords: Internet of Things, Ubiquitous sensing, Cloud computing, Wireless sensor networks, RFID, Smart environments

1. Introduction:

The Internet of Things means is to connect all physical objects through internet using RFID as a method of communication. Here objects become far greater than mere physical objects and they can communicate to the surroundings known as "ambient Intelligence". This generates enormous data can be processes, stored and communicated whenever it is required.

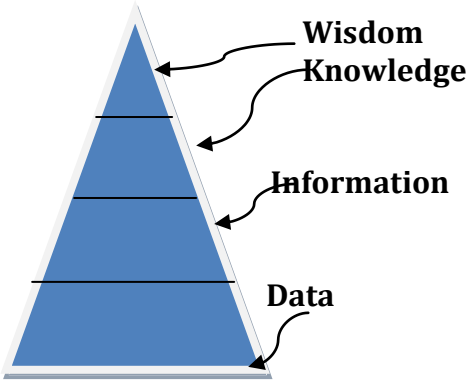
With growing presence of WiFi and 4G-LTE this revolution is possible in day to day life. But for the use of this technology, smart phones and portables with embedded intelligence is a must. By 2025, mobile phones become the eyes and ears of the applications connecting to all those physical objects.

In future all the mobile phones may be connected to the windows, doors, electrical outlets, lights, appliances and heating and AC units we have at our home, thereby creating a greater scope for the market atleast in the western world in the beginning.

These can be examples of usage of IoT in future.

- Machine-to-machine communication
- Machine-to-infrastructure communication
- Telehealth: Remote or real-time pervasive monitoring of patients, diagnosis and drug delivery
- Continuous monitoring of, and firmware upgrades for, vehicles
- 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, to name a few.

2. The Pyramid:



Data is the raw material of the information. The data may or not turn into information. Information is processed Data in a meaningful and purposeful way. The total information a person is having is called Knowledge. When all the kinds of information and data put together for a person it amounts to his or her knowledge. Wisdom is Knowledge + Experience. Acquiring Wisdom is never ending process and timeless. All these layers are interconnected. To acquire more wisdom, one needs more data, information and knowledge. When the base is more, obviously the height would be more. IoT connects once wisdom to the others' for a better purpose. The things once discovered or invented need not be rediscovered or reinvented. They can be communicated to others for their simpler and happy life. Using IoT in Mumbai, the corporation could identify and check the leakages or thefts in the public water transportation system.

3. Evolution of IoT:

The concept of IoT has started in 2008 and by 2015 we are now talking about the driverless cars. In future it would further develop into many folds. The internet evolution has several stages in its development

Stage 1: This is the first stage where the web is used only research purposes and searching over a topic or concept. It is called Advanced Research Projects Agency Network (ARPANET) in those days.

Stage 2: This stage is where all the companies share information about their products and services through web. They all opened their websites like their brochures in the business.

Stage 3: In this stage net is used for transactions through web like e-commerce. Here all the products and services are bought through web. Here the companies like ebay, amazon have emerged to compete with the traditional brick mortar business.

Stage 4: Here people share their social experiences, or opinions, with their friends. They can connect, share, communicate and chat with their friends, through social media websites like Facebook, Twitter etc. Here they can share texts, photos and even videos.

4. Making Things Smart:

In future all the physical objects and appliances would become smart that can command and control their functionalities. For example the electric toaster today can become smart toaster as it can be controlled according to the color of the toast. Hence, it can communicate to you and the electric switches and to the mobile phones. It may not be exaggerated if I say that in future we can turn off my house lights and fans using our mobile phones or from our offices.

The smart products contain three components namely

a. Physical components like mechanical and electrical parts
b. Smart components comprise sensors, microprocessors, data storage, controls, software, and embedded operating system.
c. Connectivity components like ports, antennae and protocol enabling wired or wireless connections

The connectivity takes three forms like

a. One to one like an product connected to the user
b. One to many example a central system that is continuously or intermittently connected to many products simultaneously.
c. Many to many here multiple products connect to many other types of products.

Connectivity first allows the information to be exchanged and secondly enables some functions to exist outside the physical device using a cloud.

4.1 The IoT: Different Services, Technologies, Meanings for Everyone:

The first step to achieve the revolution is to make the 'things' smart by using MCU/embedded processor with an associated unique ID. Further the cloud based processing can be used to keep track of these connected things and translate their functionality into useful services.

5. Application Categories:

The IoT related applications can be classified as the following categories.

Category One:

This one to make everybody aware of the connected things that can communicate with unique IDs. They can be automation and machine-to-machine (M2M), machine-to-infrastructure (M2I) and machine-to-nature (M2N) communications.

Category Two:

The second category is to leveraging the data to make the life simpler and safer using data mining. Already credit card companies and membership clubs study our behaviour to promote their sales. In future it can be further augmented to a level to study which aisles you visited, and what type of things you lifted or browsed etc. This can be possible using a mobile phones GPS capability, RFID and smart tags and wireless tags in stores. The result could be to push more products or to suggest an insurance policy suiting to your driving habits. This actually deals with a question of intruding into ones privacy.

6. Prerequisites for this market:

To become successful in this market the product should be

1. Cost effective
2. Reliable and Durable
3. Secure and user friendly
4. Low power consumption

1. Cost Effectiveness:

For any product, the price is the decisive factor for mass adoption in the market. When such a robust technology is involved with many sensors, embedded systems and thermostats if needed, then the cost of the components may be usually high. For daily use, the cost or the price of the product is relevant factor.

2. Quality and Reliability:

The product that we are using daily should be quite reliable and durable. The quality of the product plays an important role. We cannot change the product frequently for every couple of years. That too when we are adopting this technology with automobiles, then it should be more reliable and safe.

3. Secure and user friendly:

In the days of hacking, this issue would be more relevant. When we are using cloud technology, then we must ensure that it is fully secure to operate. In addition to all these the devices should be more user friendly to use even to a lay man.

4. Low power consumption:

When put in everyday life, the things should use power to the lowest extent in the wake of power crisis that is prevailing in India. The gadgets with high power consumption are not viable in India for long run.

5. Wireless connection:

To operate this, the wireless should be more effective covering large areas with high bandwidth. When we are using this technology in day to day life that too in automobiles there should not be any case where the automobile is not reachable or not be connected.

7. Forecast of IoT market:

About 50 to 100 trillion objects can be encoded and human beings in urban environment would be surrounded by 1000 to 5000 objects that can be tracked.

By 2020, there will be nearly 26 bullion devices on the Internet of Things according to Gartner Research. As per ABI Research estimates there will be more than 30 billion devices of this technology by 2020. By 2025, 83 percent of internet users agreed that the combination of Cloud, embedded systems and the wearable computing has vast beneficial effects. UK Government already allocated £40,000,000 towards the research in this technology.

By 2019, the size of IoT will be much more than that of Smart phone, PC, connected car and the wearable market combined.

The IoT will result in $1.7 trillion in value added to the global economy including hardware, software, installation costs, management services, and economic value added from realized IoT efficiencies.

Device shipments will reach 6.7 billion for a five year CAGR of 61% where as revenue from software will be only $50 billion or 8% of the total revenue from IoT.

The enterprise sector will account for 46% of device shipment and government will be the leading sector.

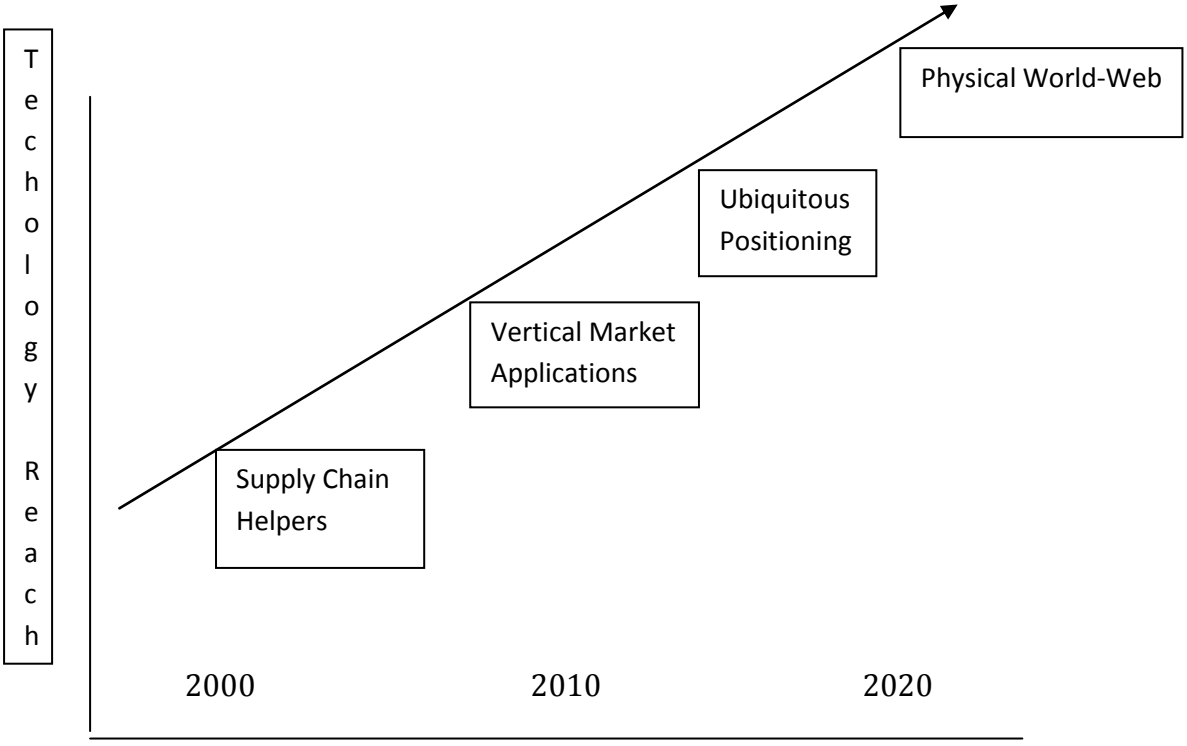
IoT will increase the efficiency and lower costs within the home, city, and workplace giving a solution to the security problems.

IoT may lack the common set of standards and technologies to allow for compatibility and ease-of-use.

The cost of chips will fall to a further low making IoT much affordable.

Smartphone will become wireless hubs controlling and communicating with everything on the earth.

8. Stages in IoT Applications:



Technology Roadmap: The Internet of Things:
Source: SRI Consulting Business Intelligence
The whole timeline for IoT is divided into 4 stages namely

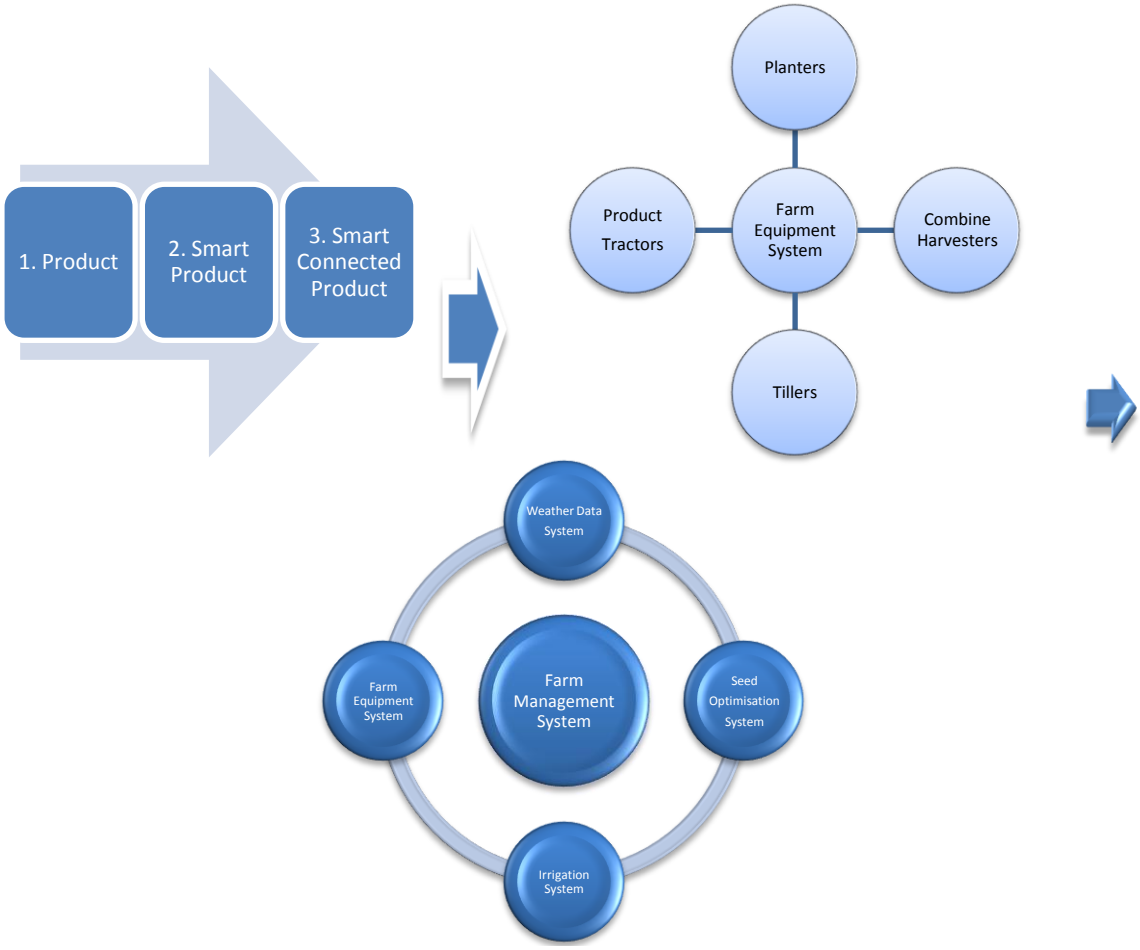
1. Supply chain helpers
2. Vertical Market Applications
3. Ubiquitous Positioning and
4. Physical World Web

Stage 1: Supply Chain Helpers
In this stage this is used for tracking the goods and materials with RFID tags to prevent loss. The RFID tags are used for facilitating routing, inventory and to prevent loss during the transit.
Stage 2: Vertical Market Applications
In this stage IoT is used for surveillance, security, healthcare, transport, food safety and document management. Here cost reduction is the main focus in the businesses.
Stage 3: Ubiquitous Positioning
In this stage it is used for locating people and objects for geo-location signals like GPRS used for cars etc.
Stage 4: Physical World-Web
Here all the devices and objects can be connected through sensors and RFID. Here there is ability to tele-operate the devices using power efficient electronics and spectrum. Further, it can go upto advanced censor fusion and software agents
9. IoT Use Cases:
Smart products can be used for monitoring, controlling, optimisation and autonomy.

When the things are connected and can be communicated, they there can be a case where there can be no human intervention.

Industry interface:

Smart Connected Product Product System System of Systems



Source: Harvard Business Review South Asia, November 2014

With the technology of Pervasive Remote Tracking/Monitoring and (if needed) Command, Control and Routing (TCC&R) all the devices such as lights fans, AC, Washing machine, refrigerator, mixer etc in the house can be functioned remotely through laptop or even further simpler mobile phone with an unique ID. Even doors and windows are also can become smart through wired or wireless connection.

9.1 Uses or Advantages of Internet of Things:

a. Asset Tracking:

In future this will become much simpler with smart tags, near-field communication (NFC) and RFID to globally track all kinds of objects. The user would be able to use Google Earth to track anything with an RFID tag. Similarly, fridge can communicate to you mobile and to the groceries store. The jewellery, cars, hand bags and other precious things can be tracked remotely using mobile phones or laptaps keeping some cameras as sensing nodes with them.

b. Resource Allocation and Optimization:

This is another very important benefit of IoT. When we know we are using our washing machine in peak hours when the cost of electricity is premium, we can adjust our time of usage to non peak hours, thus saving money and energy.

c. Automobiles:

This is highly important as the things will take their decisions. For example, when two aero planes approach each other, they can communicate each other and to the pilot also to avoid the collision.

In the similar way, on road also the smart vehicles can recognize the traffic signals and the space between the other vehicles using GPS. The self driven cars are the best example for this. In future we can find more number of driverless cars on road.

The cars can warn the drivers using the technology about the curve ahead or about a congested route ahead to take a diversion.

d. Medicine:

This is not spared in the medical field also. Using biometrics a message can be sent to the patient or to the doctors or to the near and dear ones when the patient has not taken a medicine in the proper time. Continuous monitoring of the patients with chronic diseases also is possible using a mobile phone or a laptap.

e. Equipment needed:

1) Sensing and data collection capability (sensing nodes)
2) Layers of local embedded processing capability (local embedded processing nodes)
3) Wired and/or wireless communication capability (connectivity nodes)
4) Software to automate tasks and enable new classes of services
5) Remote network/cloud-based embedded processing capability (remote embedded processing nodes)
6) Full security across the signal path

f. Manufacturing Units:

In a factory, using sensors, labels and wired or wireless technology, the whole manufacturing process can be automated with a nil or minimum human interface.

g. Utilities:

Here IoT is used to check any leakages, thefts in the system for optimization in resource management. These can be done using networks to optimize between cost and profit. The networks are prepared through cellular, WiFi and satellites. Further, these networks can be used with the help of cameras for detection of unauthorized properties or left over things etc.

In the water supply, keeping sensors we can detect the contamination of water at any level while distributing. The same network can be used for irrigation, agriculture, drainage system, leakages etc.

h. Transportation

The IoT can be used to find traffic congestions, delays in freight, gas emissions from the vehicles, noise pollution etc. But there are many privacy concerns over this matter.

9.2 Uses of IoT in total:

Fields/Areas	Applications
Healthcare	Triage, patient monitoring, personnel monitoring, disease spread modeling 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, DD heating, Ventilation and Air Conditioning (HVAC)
Environment	Air pollution, noise monitoring, waterways, industry monitoring

Source: Jayavardhana Gubbia, Rajkumar Buyyab, Slaven Marusic, Marimuthu Palaniswami, Internet of Things (IoT): A vision, architectural elements, and future directions, Future Generation Computer Systems 29 (2013) 1645–1660

9.3 Current IoT applications or devices in use

- Philips bulb is already there that can be operated through mobile phones.
- Apple's iBeacon technology is already in use to warm up and cool houses automatically using thermostats.
- Wearable smart watches are in use to track the location speed and even the blood circulation and other body measures etc.
- Self driven cars are already on roads atleast for testing purposes.

9.4 Ten practical examples of IoT applications

1. UPS:

This largest shipping company uses this technology to save money, improve efficiency and lessen environmental impact by checking monitor speed, miles per gallon, mileage, number of stops, and engine health. This helps the company to reduce idling time, fuel consumption, and harmful emissions.

2. Barcelona, Spain:

This city offers smart parking meters using citywide WiFi. Using this they can guide the people about the nearest parking lot and bus stops. The passengers can pay through their mobiles. The city even can display the information about temperature, air quality, noise level, and pedestrian traffic.

3. Virgin Atlantic:

Virgin Atlantic connects all their air crafts and cargo devices to improve flight and fuel efficiency.

4. John Deere:

This equipment manufacturer sends information to the farmers about moisture levels, air and soil temperature, wind speed, humidity, solar radiation, rainfall and leaf wetness etc. This data helps farmers to take right timely decisions about the irrigation techniques. Further using trend analysis this data can be used to know how much the change in seasons affects moisture retention.

5. Tempu Tech:

This company offers data about grain storage and potential hazards in the system like grain elevators, broken belts or bearings. The system even shows the moisture and

temperature level in grain bins to allow aeration and fan settings to compensate. The same data about the moisture and temperature can also be sent to farmers for better decisions.

6. Disney World Magic Band:

This company prepared a magic band that is wearable and sensor laden to do everything like checking the hotel room, buy their lunch, go through the turnstiles at the amusement parks, and even to reserve a spot for specific attractions. They need to tap the wristband against the receiver to track them via RFID. Using this Disney can able to better manage their visitors, accommodate more guests, properly staff rides and attractions, and better regulate inventory at highly-trafficked shops and restaurants.

7. Alex and Ani:

This is a jewellery store which uses this technology to track customer movements and to guide them about attractive, specialized and customized offers to their customers through their phones to drive their sales.

8. Clermont-Ferrand University Hospital:

This hospital uses this technology for treating their patients in a better way using sensors and RFID.

9. King's Hawaiian:

The food company King's Hawaiian uses this technology to monitor the factory performance about their bread production to reduce potential downtime of machines and lower maintenance costs.

10. BC Hydro:

This company started preparing smart electricity meters for the users to track their own electricity consumption. Thereby the theft is considerably reduced and the company can detect if there is any power out in the covered area. With all these, the cost of electricity came down considerably.

10. Disadvantages of this system:

Getting accessed from anywhere is a good thing to a certain extent. But it may intrude the privacy of the person by tracking his movements. At the same time sending the information about an intruder into a house to the police station the next day is a waste. It should be considered and filtered what things or persons should be tracked and when, how frequently etc.

This can be happen if

1. Information needs to be available when needed
2. Information needs to be confidential
3. The data should be accurate, authentic, timely and complete
4. The information should be secured from any hacking agencies or agents.

10.1 Security of the system:

Hacking is a threat to the information on internet like credit cards, banking sites. They same continues to be threat to the IoT also. More than that, embedded system is the integral part of the IoT. The different types of integrated MCUs are highly vulnerable to hacking which is a great threat to the IoT.

To work IoT needs a common and secured platform to connect all the things work together. IoT can be network of networks to connect all the things meaningfully.

10.2 Concern for Privacy:

As the usage of IoT is increasing drastically, the concern for privacy also increases proportionately. The potential problems are

1. **User content -** the user have to give his consent to track and procure the data about him and his belongings.

2. **Freedom of Choice** – They should have the choice of choosing the vendors and looking at the privacy options that they would offer.
3. **Anonymity –** When using the data for what may be purpose, anonymity of the user should be protected.

10.3 Environmental Impact:

The recycling of electronic devices is a great headache and needs great attention towards it making it environmentally non-harmful.

11. Summary and conclusions:

IoT is the next generation of the Internet and it can be used for better purposes for the benefit of human beings. Using sensors and actuation functions all the objects and devices can be connected. It can change the face of internet through many mobile apps. Privacy may be a concern factor for human beings while using this technology. Internet of Things would change the whole environment altogether in future.

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