Internet of Things

Manjit Singh, FIETE
B 54, Sector 14, Noida 201302 UP India

Abstract--**The continuous progress in Microelectronics and networking techniques make it now possible to envisage networks formed by the interconnection of smart network enabled objects and the secure and efficient deployment of services on the top of them. This is the vision of the Internet of Things. We now see the deployment of new generation of networked objects with communication, sensory and action capabilities (Wireless information transport networks, RFID and WSAN, etc.) for numerous applications. But the interconnection of objects having advanced processing and connection possibilities is expected to lead to a revolution in terms of service creation and availability and will profoundly change the way we interact with the environment. In short, the physical world will merge with digital/virtual world.**

Keywords: Internet, Networked objects, IOT, Sensors.

I. INTRODUCTION

PRESENTLY, it is human interacting with computers Human →Machine

In IOT scenario, Machines will directly talk to machines Machine→ Machine

According to Gartner:

Internet of Everything =	Internet of Information (WWW)
(Internet of Things)	Internet of People (social networks)
	Internet of Things
	Internet of Places

The greatest innovation which present generation is fully exploiting is Smart phones (wireless communication) and Internet. Internet has really made world a global village. Many Over the Top (OTT) services are making the social network a place where information flow is instantaneous. Internet is also helping government agencies, banks and all manufacturing sector in ease of doing business. The real time data helps the planners and strategists to make necessary changes in real time getting the best results. Internet of Things(IoT) or Internet of Everything is one innovation which is extension of Internet from Humans to devices. IoT is still in its infancy and all major telecom and IT companies are putting money and manpower to make it happen in most economical way. The emerging technologies like RFID's will help development of IoT in smoother way. For meeting growing requirement of Addressable objects migration from IPV4 to IPV6 will go a long way. GPS, Artificial intelligence is also helping in the development of IoT

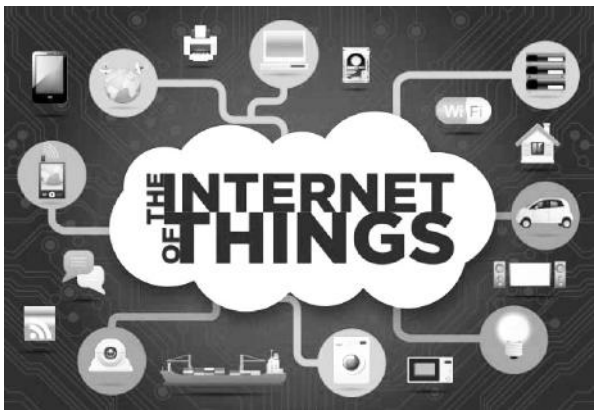


TABLE 1 -- STATE OF INTERNET (GLOBAL)

	2010	2020
Internet users	1.7 bil	4 bil
IP addresses	465 mil	5 bil
Average speed	1.7 Mbps	10 Mbps
%age of connections > 5secs	21%	50%

Internet of Things is referred as "Extending the current Internet and providing connection, Communication and Internetworking between devices and physical objects"

The technologies and Solutions that enable integration of real world data and services with current information networking technologies are often described under the Umbrella term Internet of Things (IoT)

In 1999, 4 Universities including MIT encapsulated the concept of IoT.

These universities started the development of sensors

TABLE 2--INTERNET USAGE AND THE WORLD POPULATION

	2010	2015	2020
World Population	6.8 bil.	7.2 bil	7.6bil
Devices connected*	12.5 bil	25 bil	50 bil
Devices per person	1.84	3.47	6.58

* Doubling every 5 years

In 2010, the number of devices connected on Internet was

more than human population. World Population is about 6.3 bil and the number of devices connected is 12.5 bil that works out to 1.84 per person. There are about 2.5bil Smart phones. It is presumed that all persons have Internet, but if was take only those having Internet this ratio comes to 6.25. In 2020, it is presumed that number of devices will be around 50 billion, which gives a ratio of about 7 per person, which translates to about 20 devices per internet user.

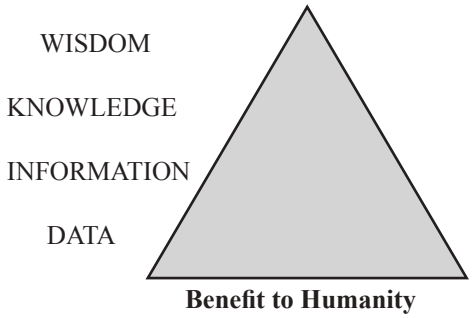
This is the power of Internet which doubles every 5.32 years. The data generated by things connected on Internet may be small in volume but the number of devices being in billions, the volume of data generated will be enormous due to cumulative effect IoT is the term coined by Kevin Ashtom in the year 2000 at MIT.

"The Internet of Things has the potential to change the world, just as the Internet did.
Maybe even more so."
Kevin Ashton, 2009

II. APPLICATION

Internet has already affected our lives. Health, education, businesses, Government doing e-governance are all into exploiting the use of Internet.Internet is the most powerful creation of the Human History. Internet is glue to IoT.
Huge amount of data is being generated on internet and this becomes knowledge.

There is a pyramid, which is:



Applications of IOT in real world:

- Aerospace and aviation (systems status monitoring, green operations)
- Automotive (systems status monitoring, V2V and V2I communication)
- Telecommunications
- Intelligent Buildings (automatic energy metering/ home automation/ wireless monitoring)
- Medical Technology, Healthcare, (personal area networks, monitoring of parameters, positioning, real time location systems)
- Independent Living (wellness, mobility, monitoring of an aging population)
- Pharmaceutical
- Manufacturing, Product Lifecycle Management (from cradle to grave)
- Retail, Logistics, Supply Chain Management
- Processing industries - Oil and Gas
- Safety, Security and Privacy
- Environment Monitoring
- People and Goods Transportation
- Food traceability
- Agriculture and Breeding
- Media, entertainment and Ticketing
- Insurance
- It is estimated that by 2032, each person on earth will be connected to about 2000 devices.

III. TECHNOLOGY

"RFID is kind of the amoeba of the wireless computing world" (Kevin Ashton).

The main technologies in the development of IOT are:

Devices Id – Development of RFID(Radio Frequency Identification)

IP addresses- by changing over to IPV 6 (2↑128)

Network, Wi-Fi enabled connectivity

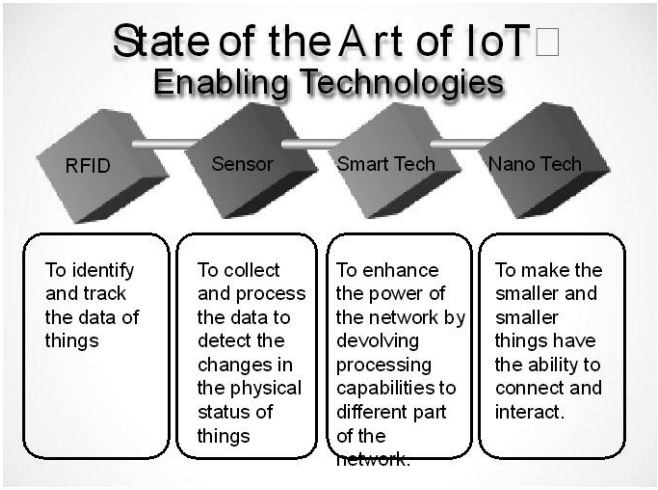
Powering the devices which will need Nano-generators

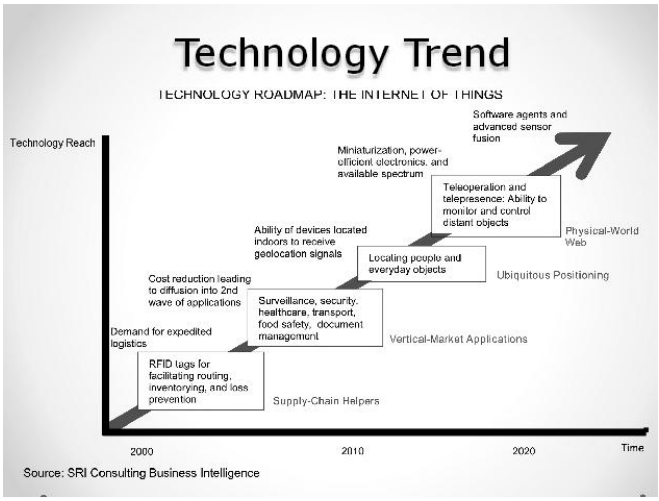
Agreement of all developers for Standardization (open Platform)

TABLE 3 --IoT APPLICATION DOMAINS - DESCRIPTION AND EXAMPLES.

Domain	Description	Indicative Examples
Industry	Activities involving financial or commercial transactions between companies, organisations and other entities	Manufacturing, logistics, service sector, banking, financial governmental authorities, intermediaries, etc.
Environment	Activities regarding the protection, monitoring and development of all natural resources	Agriculture & breeding, recycling, environmental management services, energy management, etc.
Society	Activities/ initiatives regarding the development and inclusion of societies, cities, and people	Governmental services towards citizens and other society structures (eparticipation), e-inclusion (e.g. aging disabled people etc.

The amount of data will be Huge and we will have to device new technologies to carry this. Already 5G is being developed to carry gigabytes of data. Latency of data will improve with 5G.





The technology for IoT will have to meet the following needs.

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

3 C's of IOT

- Communication
  Necessary for all devices connected whether stationary ormoving,we will need GPS enabled devices

- Control and Animation
  We may need to control devices remotely like AC, lights etc Even today many DTH operators like TATA Sky enamble control of programs on the mobile phoes which can be connected from anywhere in the world. Today many IOT companies are working with elctronis goods manufacturers like Samsung, LG to enable controls from smart phones by putting API's etc

- Cost Savings
  By collecting data of the Plant and machinery, the companies will get performance data of all the machines working in a process thus economizing on their operation costs by analyzing the performance data.

We need to address the following four issues

- Define Sensors-What output we need from these sensors to help industry in the developments. Many RFID companies are developing these sensors

According to SRI Consulting Business Intelligence, the technologies of the Internet of Things are the following:

Enabling Building Blocks
These technologies directly contribute to the development of the IoT

- Machine-to-machine interfaces and protocols of electronic communication
- Microcontrollers
- Wireless communication
- RFID technology
- Energy harvesting technologies
- Sensors
- Actuators
- Location technology
- Software

Synergistic Technologies:
These technologies may add value to the IoT

- Geo-tagging/geo-caching
- Biometrics
- Machine vision
- Robotics
- Augmented reality
- Mirror worlds
- Telepresence and adjustable autonomy
- Life recorders and personal black boxes
- Tangible user interfaces
- Clean technologies

- Build IOT network and security Foundation- We need to work with Open standards as the devices are interconnected there are greater security issues

- Collect as much data as possible- This is very important because if we keep on collecting raw data without any plan, we may end up in big confusion and management of data will become very difficult. There will be then a Tsunami of data.

- Review and Scale of IOT providers- there are going to be 4 categories in this

  a) Sensors and RFID providers
  b) M→M device management Platforms
  c) Solution Delivery Platforms (SDP)
  d) Apps that will enable IOT devices to respond

IV. SMART CITIES

By definition, Smart Cities are those that integrate information communications technology across three or more functional areas. More simply put, a Smart City is one that combines traditional infrastructure (roads, buildings, and so on) with technology to enrich the lives of its citizens. Creative platforms and killer apps have helped reduce traffic, parking congestion, pollution, energy consumption, and crime. They have also generated revenue and reduced costs for residents and visitors.

More than half of the world's population now lives in or near a major urban area, and the move toward ever-greater urbanization shows no signs of slowing. According to the United Nations, the global population is expected to grow from seven billion today to 9.3 billion by 2050, and the world's cities will have to accommodate about 70 percent more residents. The traditional ways of dealing with the influx—simply adding more physical infrastructure—won't work, given limited resources and space. New ways of incorporating technology will be required to provide urban services, whether it's roads, water, electricity, gas, work spaces, schools, or healthcare. In the future, there will be less emphasis on physical connections and more on access to virtual connections.

Cities also face budgetary challenges, battling rising costs and shrinking resources. The world's cities account for 70 percent of greenhouse gas emissions, and according to UNHABITAT, energy related costs are one of the biggest municipal budget items.

The Internet of Things is going to be the main backbone for the formation of Smart cities
Some examples are

- Traffic flow
- Street Lighting
- Water and waste management
- Policing
- Education
- Agriculture.

There are a number of iconic examples of cities that have put the Internet of Everything into use. They range from the ancient—Barcelona, Spain—to the new—Songdo, South Korea. Barcelona, which, with a population of about 1.6 million people, is Spain's second largest city, has embraced the Internet of Everything and is reaping the rewards. The city has deployed free WiFi and created a rich assortment of citizen and government apps. Barcelona is also using the Internet of Everything to improve the city's water and waste management, public transport system, install smart street lighting and embed sensors in parking spaces to let drivers know where open spaces exist.

On the other side of the globe, Songdo, South Korea, is the world's first truly green field city developed from the ground up with sustainability metrics-economic, social, and environmental-in mind. Through the city's network, citizens can access a host of urban services—healthcare, government, transportation, utilities, safety and security, healthcare, and education—from the convenience of their living rooms or within a 12minute walk. Real-time traffic information helps them plan their commutes. Remote healthcare services and information reduce expenses and travel time. Remotely automated building security improves safety and lowers costs.

Other Agencies will use the IOT data for their efficient management.

Examples are:

- Insurance companies will fix premiums for vehicle insurance based on the driving habit of insures like how fast or slow you drive, what was the tyre pressure etc.

- Home lighting, temperature control, Fridge management like buying stuff for the fridge, fire safety alarms etc.

- Health Sensors to monitor ECG and other health parameters directly go to the Physician who will check the health of his patients

- Shopping- The optical bar codes on the products will give information about its location, brand name price etc. The shopper, as he enters the shop, his id will be registered and he will get all the deals on his mobile. Check out will become easier as all items in the cart have their id's and the amount so calculated is debited from the shopper's account automatically.

- Travel will be easier as the cars will have RFID's and this

is linked to the owner's credit/debit card. So the driver just passes the tollgate automatically. In fact, this is being widely used in many countries even today.

- Power Companies can monitor the theft and other losses and thereby reduce their losses, this will enable power companies to reduce rates and pass on benefit to Consumers.

- In Mumbai, this is evident in Dharavi area where the rates for power and water are more than the nearby regular colonies.

Figure IOT will check POWER THEFTS

V. ITU AND INTERNET OF THINGS

The concept of "Internet of Things" came into limelight in 2005 when the International Telecommunications Union published the first report on the subject.

The ITU report adopts a comprehensive and holistic approach by suggesting that the Internet of Things will connect the world's objects in both a sensory and intelligent manner through combining technological developments in item identification ("tagging things"), sensors and wireless sensor networks ("feeling things"), embedded systems ("thinking things") and nanotechnology ("shrinking things"). By addressing ICT and nanotechnology together, this report touches on the concept of "convergent technologies" for achieving "a tremendous improvement in human abilities, societal outcomes, the nation's productivity, and the quality of life"

At that time, Lara Srivastava, ITU's Strategy and Policy Unit, said: "It's safe to say that technology today is more pervasive than we would ever have imagined possible 10 years ago. Similarly, 10 years from now things will continue in this general direction. That's what these new technologies

"By 2025 Internet nodes may reside in everyday things – food packages, furniture, paper documents, and more. Today's developments point to future opportunities and risks that will arise when people can remotely control, locate, and monitor even the most mundane devices and articles. Popular demand combined with technology advances could drive widespread diffusion of an Internet of Things (IoT) that could, like the present Internet, contribute invaluably to economic development and military capability"

The initiatives of IBM (Smarter Planet: "instrument the world's systems, interconnect them, make them intelligent") and Cisco (Intelligent Urbanization: "using the network as a utility for integrated city management"), and also General Electric (Ecomagination: "solve today's environmental challenges and benefit customers and society at large") and other multinational companies, are typical examples of the contribution of the Internet of Things to the development of Smart Cities.

Gains for India:
This development of IOT growth is good for India.

a) India will grow faster in its dream of Digital India and Smart Cities.
b) It will revive manufacturing hub and "Make in India" slogan.
c) Enhance ease of doing business.
d) India can be an innovation hub with the success of many startups.
e) There will be boost to Infra Projects and concept of Next Generation Infra will mature.

VI. INTERNET OF THINGS VISION

The vision of Future Internet based on standard communication protocols considers the merging of computer networks, Internet of Media (IoM), Internet of Services (IoS), and Internet of Things (IoT) into a common global IT platform of seamless networks and Networked "things".

IoS is denoting a software-based component that will be delivered via different networks and Internet. Research on SOA, Web/Enterprise 3.0/X.0, Enterprise Interoperability, Service Web, Grid Services and Semantic Web will address important bits of the IoS puzzle, while improving cooperation between service providers and consumers.

IoM will address the challenges in scalable video coding and 3D video processing, dynamicallyadapted to the network conditionsthat will give rise to innovative applicationssuch as massive multiplayer mobile games,digital cinema and in virtual worlds placingnew types of traffic demands on mobile networkarchitectures.

This future network of networks will be laid out as public/ private infrastructures and dynamically extended and improved by edge points created by the "things" connecting to one another. In fact, in the IoT communications will take place

not only between people but also between people and their environment. Communication will be seen more among terminals and data centres (e.g. home data centres, Cloud computing, etc.) than among nodes as in current networks. Growth of storage capacity at lower and lower costs will result in the local availability of most information required by people or objects. This, coupled with the enhanced processing capabilities and always-on connectivity, will make terminals gain a main role in communications. Terminals will be able to create a local communication network and may serve as a bridge between communication networks thus extending, particularly in urban environments, the overall infrastructure capacity.

This will likely determine a different view of network architectures. The Future Internet will exhibit high levels of heterogeneity ("things" – physical/real, cyber physical, web enabled, digital and virtual, devices and device models, communication protocols, cognitive capabilities, etc.), as totally different things, in terms of functionality, technology and application fields are expected to belong to the same communication environment. The Internet of Things will create a dynamic network of billions or trillions of wireless identifiable "things" communicating with one another and integrating the developments from concepts like Pervasive Computing, Ubiquitous Computing and Ambient Intelligence.

Internet of Things hosts the vision of ubiquitous computing and ambient intelligence enhancing them by requiring a full communication and a complete computing capability among things and integrating the elements of continuous communication, identification and interaction. The Internet of Things fuses the digital world and the physical world by bringing different concepts and technical components together: pervasive networks, miniaturization of devices, mobile communication, and new models for business processes.

Applications, services, middleware components, networks, and endpoints will be structurallyconnected in entirely new ways. Recognising that initially there will be commercialand physical challenges to establishingglobal ubiquitous network connectivity andthat initially the many connected things anddevices may have limited ability to engage in2-way network connectivity, it is importantthat the architectural design for the Internetof Things supports effective two-way caching and data synchronisation techniques, as well as network-connected endpoints for virtual representations of the connected things and devices, which can be used for monitoring their location, condition and state, as well as sending requests and instructions to them.

The Internet of Things will bring tangible business benefits, such as the high-resolution management of assets and products, improved life-cycle management, and better collaboration between enterprises; many of these benefits are achieved through the use of unique identification for individual things together with search and discovery services, enabling each thing to interact individually, building up an individual life history of its activities and interactions over time. Improved sensor and device capabilities will also allow business logic to be executed on the edges of a network – enabling some existing business processes to be decentralized for the benefit of performance, scalability, and local decision-making. For example, algorithms could be used for intelligent decision making based on real-time readings from sensors that are used to monitor the health of patients or the condition of vehicles, in order to detect the early signs of problems or deterioration of condition .

IoT will create the possibility of merging of different telecommunication technologies and create new services. One example is the use of GSM, NFC (Near Field Communication), low power Bluetooth, WLAN, multi hop networks, GPS and sensor networks together with SIM-card technology. In these types of applications the Reader/tag is part of the mobile phone, and different applications share the SIM-card. NFC enables communications among objects in a simple and secure way just by having them close to each other. The mobile phone can therefore be used as a NFC-reader and transmit the read data to a central server. When used in a mobile phone, the SIM-card plays an important role as storage for the NFC data and authentication credentials (like ticket numbers, credit card accounts, ID information etc).

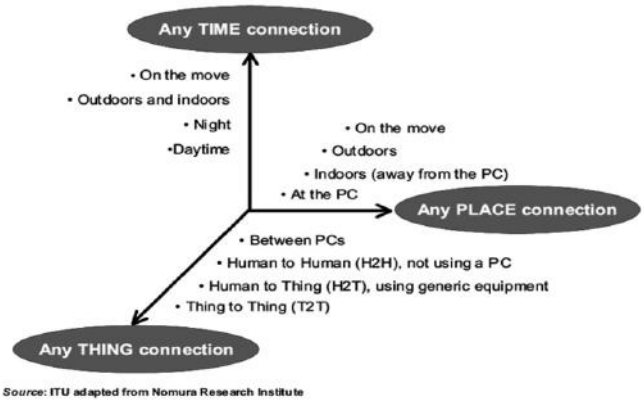


Figure 1. A New dimension.

"With a trillion sensors embedded in the environment—all connected by computing systems, software, and services—it will be possible to hear the heartbeat of the Earth, impacting human interaction with the globe as profoundly as the Internet has revolutionized communication."

- Peter Hartwell
- HP Labs

VII. CONCLUSION

The Internet of Things is a vision that encompasses and surmounts several technologies at the confluence of Nanotechnology, Biotechnology, Information Technology and

Cognitive Sciences. Over the next 10 to 15 years, the Internet of Things is likely to develop fast and shape a newer "information society" and "knowledge economy", but the direction and pace with which developments will occur are difficult to forecast.

It will become Technocracy from democracy and anarchy because, technology will control everything.World will become Panopticom. (A small number of devices controlling large numbers.Panopticon buildings were designed in 18thcentury, which enabled monitoring of inmates without their knowing about it. Similar is going to be case where somany devices will monitor nobody will know who is is monitoring what?

Eric Schmidt of Google once said that there will be so many sensors, devices around you that you will forget.(Internet will pervasive that it will disappear.) This means there will be so many devices connected around you that u will forget about Internet.

World will become an open book, nothing to hide. Security of Internet will be totally insecure leading to complexities for wrong elements to cause havoc.

However on positive note, it is expected that a highly personalized, highly interactive very interesting world will emerge. The Internet of Everything will change how we work—more information, better decisions, more agile supply chains, more responsive manufacturing, and increased economic value. The foundation of the city of the future will be the Internet of Everything, and those embracing this technology are leading the way. In fact, when considering the spectrum of possibilities for the Internet of Things in the 2020-2025 timeframe, little can be said at this stage since the technology is still being refined, the industry is in a process of reconfiguration, and the market is embryonic.

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Manjit Singh was President of Himachal Futuristic Communications Ltd. (HFCL), heading HFCL's technical operations and business development. He directed the successful implementation of CDMA, GSM and WLL equipment including PDSN, billing, customer care, and SMS/VMS systems.
Prior to joining HFCL, he worked for Crompton Greaves Limited as Vice President Telecom Services.
He served Government of India for over 27 years. During this period, he served in several key positions of national policy, Director responsible for maintenance and switching in the Ministry of Telecommunications, New Delhi, and, General Manager in charge of two large telecom circles in North India. He was responsible for the planning, installation, commissioning, and monitoring of several large telecom networks in this period.
Mr. Singh served on the technical groups of two world telecom forums: the ITU (International Telecommunications Union) and the APT (Asia Pacific Telecom). As Chair of the India DECT Forum from 1997-1998, he played a pivotal role in promoting Wireless Local Loop technology in India and abroad.
Mr. Singh is a Fellow of the IETE and holds a B.Sc. (gold medallist) degree in Electrical Engineering from the University of Punjab.