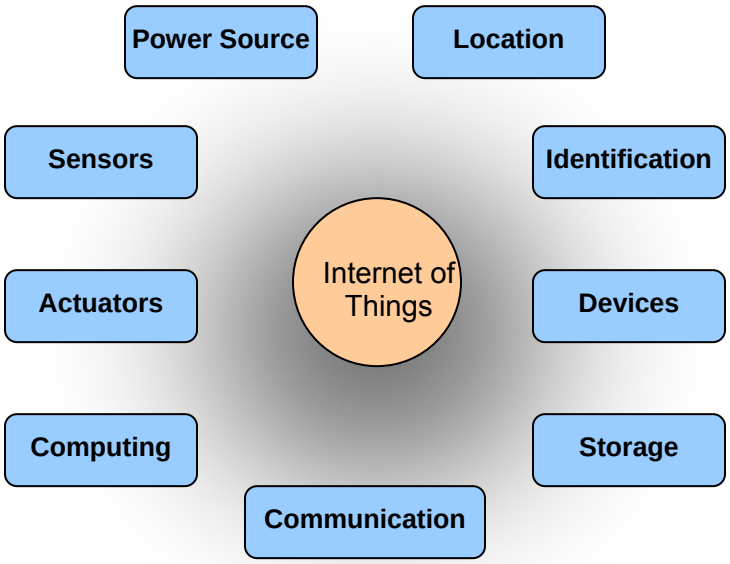
Internet of Things

Over the last decade Internet has made significant impact in our economies and societies by bringing in remarkable communication and networking infrastructure. The world-wide web has been a major driver of global information and media sharing. From Desktop networking Internet is continuing to become more pervasive, with the advent of low cost wireless broadband connectivity, by connecting to new embedded devices and handhelds. In continuation with this trend, it is poised to emerge as an “Internet of Things” where the web will provide a medium for physical world objects to participate in interaction. This way the digital information technology can integrate the physical world to the online world to provide a common interaction platform.

The Internet of Things (IOT) describes a worldwide network of intercommunicating devices. It integrates the ubiquitous communications, pervasive computing, and ambient intelligence. At this point (IOT) must be seen as a vision where "things", especially everyday objects, such as nearly all home appliances but also furniture, clothes, vehicles, roads and smart materials, and more, are readable, recognisable, locatable, addressable and/or controllable via the Internet. This will provide the basis for many new applications, such as energy monitoring, transport safety systems or building security. This vision will surely change with time, especially as synergies between Identification Technologies, Wireless Sensor Networks, Intelligent Devices and Nanotechnology will enable a number of advanced applications. innovative use of technologies such as RFID, NFC, ZigBee and Bluetooth, and are contributing to create a value proposition for Internet of Things stakeholders



Applications

There are several applications of networked Things in Agriculture, Healthcare, Retail, Transport, Environment, Supply chain management, Infrastructure monitoring etc. Some of them are listed below:

Agriculture: Applications in Agriculture include Soil and plant monitoring, Monitoring of food supply chain, Monitoring of animals

Retail Management: Retailing has many applications areas of business interest. It includes monitoring customer behavior and preferences, Shelf stock tracking, context based advertising and product promotions, vending machines, automated checkout, and theft control.

Healthcare: Identification of spurious drugs is a major application in healthcare area. Other application areas are personal healthmonitoring , telemedicine, assisted living.

Security: Detection of counterfeit goods, Access control, Restricted materials, Banknotes, Passports

Government and public sector: Disaster management, Forest monitoring, Tourism support, Homeland security, Pollution monitoring

Home: Home security, Smart - home (lighting, enetertainment, energy management, assistance)

Sports: Sports equipment: user performance monitoring , Safety

Benefits

While there are many interesting applications of networking physical objects, they need a strong value proposition to customers for their wide adoption and acceptance. Their potential benefits are:

- Improved performance, visibility & scalability of business process automation
- Providing better, more cost effective service through real-time high-resolution visibility /capture and analysis of real-time product performance information. This is useful for efficient decision making.
- Better transparency of physical flows and detailed status information. This is also important for regulatory compliance and public dissemination.

- Creation/transformation of new and existing business processes by enhancing efficiency, accuracy, mobility and automation

Emerging Trends

Some of the relevant trends in development and deployment of IOT based applications are:

Miniaturization of devices - While VLSI technologies are moving towards lesser microns, Micro Electric Machines (MEMS) and nano electronics are making the sensors, smaller and power efficient so that they can be used inside smaller devices and even living systems.

IPV6 as an integration layer - Drawing from the OSI layer structure and protocols from Internet, it is natural to extend the IP layer as an integration layer for Internet of things as well. But unlike desktops and laptops the nodes attached to the 'things' are low in resources such as battery and computing power. However there have been successful attempt to develop a standard named 6LoWPAN, which is an acronym of IPv6 over Low power Wireless Personal Area Networks, bringing IPV6 over IEEE 802.15.4.

Cisco, Atmel, the Swedish Institute of Computer Science (SICS) and other leading technology vendors and users formed on 16 September 2008 the IP for Smart Objects (IPSO) Alliance and announced, a few weeks after, the availability of uIPv6, one of the world's smallest open-source, IPv6-ready protocol stack, which could enable every device, no matter how limited by power or memory to have an Internet Protocol address, thus promoting the "launch of the Internet of Things [IPSO]

Mobile phones as data capturing devices - Another development that is taking place and beginning to spread globally is to extend data capture systems on mobile phones. Camera, NFC readers and Bluetooth are used for many diverse data capture applications. The advantage of mobile phone as pervasive device with a support for internet connectivity will enable its wide application and acceptance. For example there are mobile applications which uses camera to read 2-D barcodes and LCD screen to display barcodes such that it can be interfaced to registration/payment systems.

Low power and energy-neutral devices - The energy required to operate the intelligent devices will be dramatically decreased. The search for a zero level of entropy where the device or system will have to harvest its own energy. In addition to relativel established solar cells, there are success stories such as vibration energy harvesting (perpetuum), powering from RF beams (Powercast), energy from shakes (Sandia national Laboratories) and many attempts by exploiting wind, thermal, strain etc. From energy storage perspective thin film batteries (Cymbet) , thin film micro energy cells (Infinite Power Solutions).

Handling High Volume and high bandwidth data - Just to give some numbers, business forecasts indicate that in the year 2015 more than 220 Exabytes of data will be stored. As current network are ill-suited for this exponential traffic growth, there is a need by all the actors to re-think current networking and storage architectures. It will be imperative to find novel ways and mechanisms to find, fetch, and transmit data.

Autonomic management - The ever growing complexity of systems will be unmanageable, and will hamper the creation of new services and applications, unless the systems will show self-* properties, such as self-management, self-healing and self-configuration

Challenges

The development of the Internet of Things would critically depend on progress in machine-to-machine interfaces and protocols of electronic communication, embedded systems, wireless communication, RFID, sensors, actuators, location technology, energy harvesting techniques, and software.

In IOT each of the networked object need to have an Identity. Managing a globally integratable unified ID with mechanisms for naming, addressing and discovery are of paramount importance.

Governance, standardisation and interoperability are absolute necessities for things to be able to communicate with each other. Communication protocols and standards must be scalable, power efficient, secure and fully global. Scale will be such that traditional internet management approach will not work efficiently. This will demand autonomic features such as self organisation and self management built into the devices.

While RFID is one of the sensors, there are innumerous sensors in the market with different technologies, packages, specifications and it is major contributor to the cost of the whole solution. Large scale applications can standardise some of the sensors to reduce the cost.

Robustness is one of the key requirement where the smart devices are able withstand any kind of harsh environment and harvest energy from their surroundings. Efficient implementation of energy neutral platforms with non polluting energy sources is of great social value. Reducing carbon footprint by eliminating or minimizing the use of batteries is an important aspect of this.

Another central issue of the Internet of Things will be related to trust, privacy and security. Here there is also a concern regarding the ownership of data and mechanisms of managing it dynamically. For example the medical data of a patient need to be accessed by the doctor to whom the patient gives consent and

this permission may be revoked once the consultation is over. But what happens to the data which is already downloaded by the doctor. Who is the owner of the data once the patient is dead.

Creation of awareness among public regarding these technologies is very important for its success in the market. This can be more convincing with some real-life implementations and help in building customer confidence.

Opportunities for Standardisations

Interoperability is a particularly crucial dimension of standardisation that it contributes to the provisioning of affordable end-to-end solutions while reducing the costs of application integration.

At a high level following are the major aspects for new standards developments:

- Ubiquitous identification of Things
- Service Oriented Architecture
    - Directory and Protocols for discovery of services
    - Service description and capability declaration
    - Publication and subscription of devices and resources
- Unified Data exchange formats and protocols
- End-to-End Security
- Middleware with specifications for Application Programming Interfaces
- Convergence layer
- Self-Organisation and Management
- Synchronisation and Coordination for lowpower operations
- Regulatory framework for RF spectrum and network services

Internet of things - Indian Perspective

As one of the fastest growth market for cellular technologies, India has demonstrated its appetite for technologies to revolutionalise the life across all its diversity. The value, impact on daily life, and competition has helped the cell phone to reach the masses across all strata of the society.

Urbanisation of India is happening at a rapid pace. Migration from rural places to cities is ever increasing. One way to address this is to enhance the opportunities at villages to reduce the overburdening of the cities. Experience shows that this is not that easy. We need scalable architectures and funding models for building our city infrastructures to handle large populations.

There is a requirement for efficient systems for transportation, utilities, healthcare, safety & security, education, environment, governance and entertainment. Deployment of advanced ICT technologies would be affordable and cost effective considering the improved quality of life of citizens and enhanced GDP growth from the resultant productivity improvements.

A large percentage of Indian population is in rural areas and there is a constant drive for addressing those sections of the society. Majority of the manpower is spent on agriculture and farming. Many cases they are resource constrained in terms of water, energy, fertilisers, and market opportunities. Systems for monitoring and improving the efficiency of resource utilisation will be highly beneficial. Health care is another area of attention here where remote monitoring can enable the skilled doctors in cities to extend their services to villages.

Challenges

There are many challenges for successful adoption of IOT in India.

- Scalability : As the size of the systems tends to be large in size, the solutions should be scalable. Also many times the deployments happen in stages and the architecture should be able to scaleup incrementally without taking too much overhead.
- Affordability of products and services: Affordability is one of the major aspect for success. It may not be low cost always , but the right cost for a specified target group with a clear business case or cost benefit. Standardised platforms, tools and manufacturing processes can bring the cost down with increased volumes.
- Integration with Legacy systems: Since there are no widely deployed IOT applications, there may not be any major challenge with legacy technologies in that space. However there may be legacy devices and systems which are not amenable for new standardisation and need to coexist.
- Robustness: While there is a pressure for low cost, there is a strong demand for robustness and reliability of products and services. One of the approaches for addressing this is to build upgradable/disposable systems which take care of current requirements and strip of the low priority features to reduce cost. A Robust solution will get a buy-in even if it is less sophisticated.
- Social and Cultural Sensitivity: Social response to an IOT application has many aspects. It can have cultural, linguistic, geographic, political

dependencies for the acceptance. Help of awareness and regulations are to be explored for the success of large scale social applications.

Conclusions

The development of the Internet of Things, based on the synergistic combination of several scientific disciplines and technologies, creates tremendous opportunities for improving economic competitiveness and citizens' quality of life.

IOT also raises complex non-technical issues, especially with respect to ethics, privacy, security, governance, spectrum, interoperability, and more, which deserve to catch the highest attention from public authorities, preferably within the context of a sustained and well focused international bodies.

To achieve the vision of communicating things, there are several technical and non-technical challenges to be solved. We have also discussed the impact of IOT for developing countries like India with specific challenges and priorities. Open areas for standardization have been identified where organizations like GISFI could work in conjunction with other global standardization bodies. It is also necessary to bring together the eco-system partners such as government, Industry and academics to conduct research and developments to create IPRs and business models to proliferate the IOT technology for mass benefit.