ANNQUEST NOVEMBER 2016
ISSN: 2321-3043
www.stannsannquest.com

A Strategic Literature Research on Technological Confluence for Future Internet of Things

T. Srilatha, Department of Computer ScienceR.B.V.R.R Women's College, Hyd.
toomula.srilatha@gmail.com

Abstract

Internet of Things also referred as Internet of Objects is an innovative uprising of the current Internet. The future Internet of Things is going to extend into the real world, where the physical objects or things are connected to the virtual world. Forthcoming Internet of Things becomes immensely crucial for all the Internet users. The succeeding big leap in the Internet of Things evolution will be the coherence of efforts on all levels towards innovation. Internet of Things helps to create a smart world where the real, digital and virtual are converging to create smart environments that make energy, transport, cities and many other distinguished areas to act more intelligent. The goal of Internet of Things is to make the devices to be connected without any constraints regarding time, location and path/network service. This paper mainly focuses on the enabling technologies required for Internet of Things, such as RFID (Radio Frequency Identification) protocol, Sensor Networks, Mobile Internet, M2M (Mobile to Mobile), IPV6, Data Integration and technological challenges.

Keywords: **:** RFID, Internet Protocol Version 6(IPV6), Sensor Networks, Mobile Internet

Introduction

Maximum all the governments of Europe, Asia and all parts of America, Internet of Things has become an area of Innovation and growth. The future recognition is gained with the Internet of Things. From a technical point of view, the Internet of Things is not the result of a solitary unique technology. The main capabilities [1] include in the figure shown below:

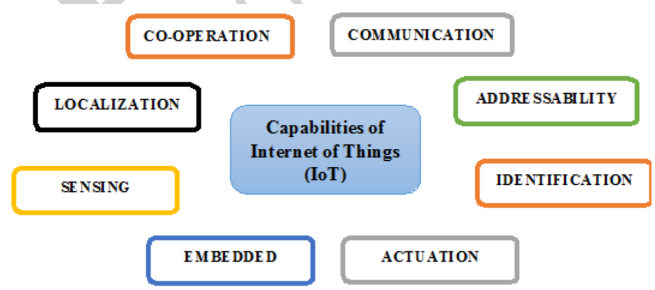

Fig 1: Capabilities of Internet of Things (Internet of Things)

Communication and Cooperation – In this regard, [1] Objects have the ability to link with Internet resources to make use of data and services and update their state.

a) **Addressability** - With Internet of Things, objects can be located and addressed via discovery, look-up or name services.
b) **Identification**- Objects are uniquely identifiable. RFID, NFC (Near Field Communication) and optically readable barcodes are examples of technologies with which even passive objects which do not have built-in energy resources can be identified. Identification enables objects to be linked to information associated with the particular object and that can be retrieved from a

server, provided the mediator is connected to the network.

c) **Sensing**- According to sensing, objects collect information about their surroundings with sensors, record it, forward it or react directly to it.
d) **Actuation**- According to Actuation, objects comprise actuators to operate their environment. Such actuators can be used to remotely control real world processes via the Internet.
e) **Embedded Information Processing**: Smart objects feature a processor or microcontroller plus storage capacity. These resources can be used, for example, to give products a "memory" of how they have been used.
f) **Localization**- Smart things are aware of their physical location, or can be located. GPS or the mobile phone networks are suitable technologies to achieve this.
g) **User Interfaces:** Smart objects can communicate with people in an appropriate manner. Innovative interaction paradigms are relevant here, such as tangible user interfaces, flexible polymer based displays and voice, image or gesture recognition methods.

Literature Research:

"Creativity is thinking up new things. Innovation is doing new things." - Theodore Levitt
Internet of Things is an innovation in the currents trends. Connecting the things all around the world has become a creative idea in the field of research.

Internet of Things as a Network of Networks

Currently, Internet of Things is made up of a collection of disparate and purpose built networks. As Internet of Things evolves, many networks and many others will be [2] connected with added security, analytics and management capabilities. This allows Internet of Things to become even more powerful. The services that Internet of Things can provide include innumerable fields or domains like sensing, computations, analytics, visualization and management capabilities.

The Internet of Things represents a vision in which the Internet extends into the real world embracing everyday objects. Physical items are no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. The Internet of Things vision is grounded in the belief that the steady advances in communications and information technology we have witnessed in recent years will continue into the foreseeable future.
Due [3] to the diminishing size, constantly falling price and declining energy consumption, today processors, communications modules and other electronic components are being increasingly integrated into everyday objects. "Smart" objects play a key role in the Internet of Things vision, since embedded communication and information technology would have the potential to revolutionize the utility of these objects.
As a whole, Internet of Things can become as link between different distributed networks comprising the entire world in coming future, making the communication very easier and simpler for all the users. The challenge is to converge the various domains like sensor networks, embedded information processing, visualization effects, computational procedures, networking capabilities, analytical processing, satellite signaling, radio frequency and so on.

Refer Fig 2.(Internet of Things Applications)

2.2 Internet of Things Ecosystem:

The Internet of Things Ecosystem [2] mainly have a network between users, enterprises, things and Partners.

To conceptually [2] define Internet of Things, it is a five layer functional model that includes devices, connectivity, applications, platforms, and services as shown in figure 3.

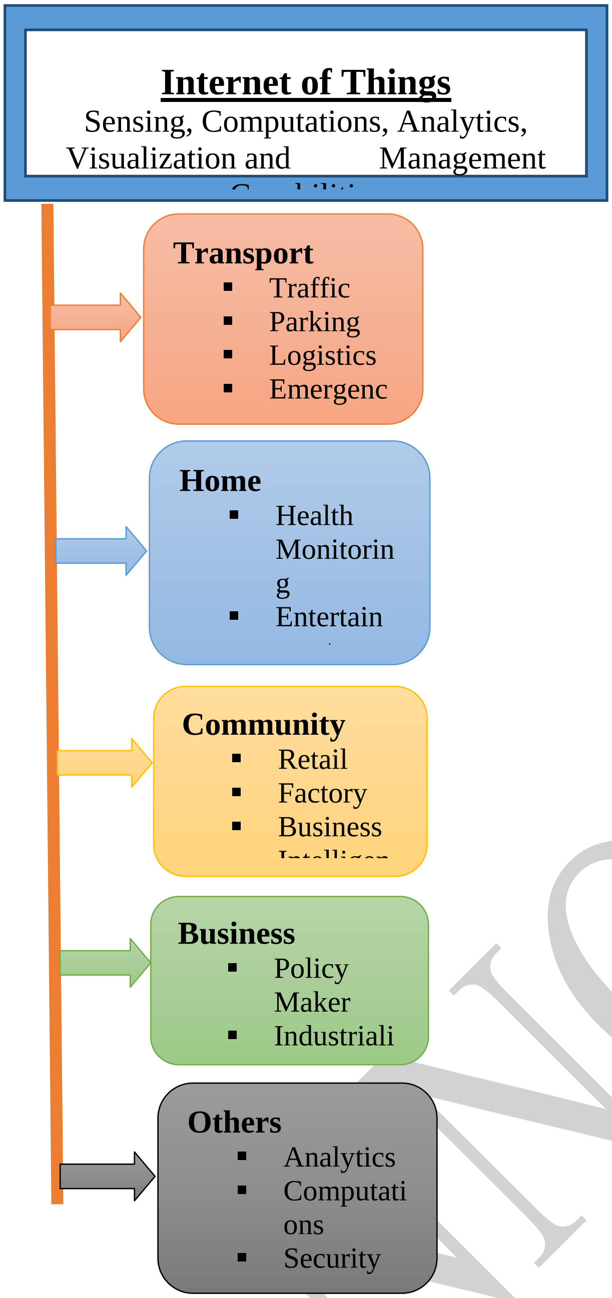

Figure 2: Internet of Things Applications

Devices: Sensors, identifiers and gateways are types of Internet of Things devices used to collect and convey information. A variety of Internet of Things devices have emerged in various verticals, starting in the utility sector to include devices in the health, transportation, home and finance ecosystems.

Connectivity: Devices can be connected directly to the network, or indirectly through another similar device or a gateway that is provisioned to support multiple devices. Connectivity can be through a number of physical media such as fiber optical cable or through a number of wireless technologies.

Applications: Applications define the use of the device and include all the necessary functions required to make use of the device for the intended purpose including the hardware and software architectures.

Platforms: Devices and connectivity requires a platform to provide a service. Platforms are used to provision devices, manage and control them.

Services: Internet of Things will provide the services like managed and professional interconnecting services to the end-customer.

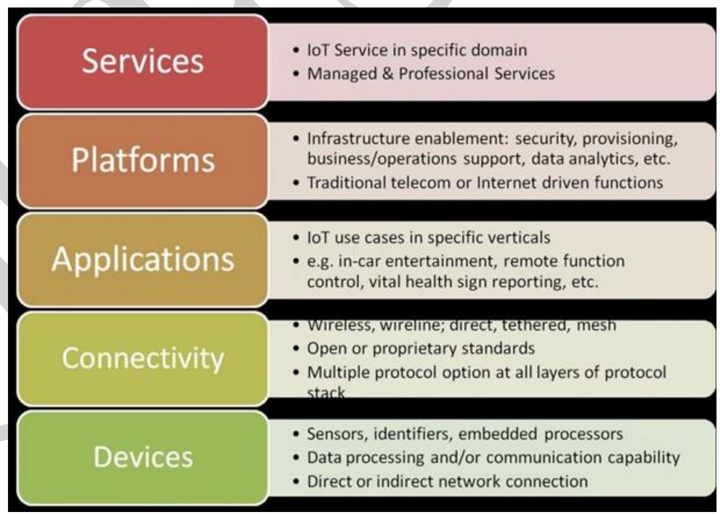

Figure 3: Internet of Things Ecosystem reference model
Source: TMTFinance.com

1.

2. Objectives of Internet of Things

The main objectives of Internet of Things include:

Virtualization: It refers [3] to the act of creating a simulated version of resources, hardware platforms, storage devices etc. Internet of Things's main objective is to support virtualization of all the devices for communication.

Interaction with distributed users: The network communication of Internet of Objects has to support distributed users.

Interconnection of devices: Extensive or massive interconnection of devices is required for Internet of Things.
Creation of Smart Environments: Cook and Das define smart environment as "a small world where different kinds of smart devices are continuously working to make people live more comfortable". Smart environments aim to satisfy the experience of individuals by replacing the risky work, physical labour, and repetitive tasks with automated agents.
Creation of Self Aware objects/things: Examples are Smart transport, products, cities, buildings, rural areas, energy, health etc.
Intelligent data transfer/exchange between devices: One of the key objectives of Internet of Things is quick data transfer between various smart devices.
Data Visualization, processing & storage: Visualization means the process to create images, animations and diagrams. By developing operator interface visualization, processing of images and storage of images.
Data collection: Collection of data from various devices and data sources is a key objective of Internet of Things.
Intensive Information Perception: The process of recognizing or awareness about other objects and processing of Rigorous information is one of the objectives of Internet of Things.
Comprehensive Intelligent service: Dealing with all the aspects of objects and providing intelligent service is crucial objective of Internet of Things.

Technologies

1. RFID:

Radio Frequency Identification technology [6] is a Wireless communication technology [RFID] that enables users to uniquely identify tagged objects or people. RFID is rapidly becoming a cost-effective technology. There are 3 core components of an RFID system.

i) A **tag** (sometimes called a transponder), which is composed of a semiconductor chip, an antenna and a battery.

ii) An **interrogator** (also called a reader or a read/write device), which is composed of an antenna, an RF electronics module, and a control electronics module.

iii) A **Controller** (also called a host), which most often takes the form of a PC or a workstation running database and control software.

RFID (Radio Frequency Identification) [6] is primarily used to identify objects from a distance of a few meters, with a stationary reader typically communicating wirelessly with small battery-free transponders (tags) attached to objects. As well as providing two important basic functions for an Internet of Things – identification and communication – RFID can also be used to determine the approximate location of objects provided the position of the reader is known.

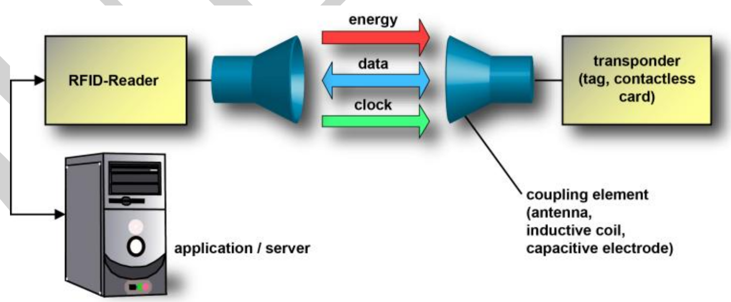

Figure: 4 Radio Frequency Identification

Sensor Networks

A Sensor Network [WSN] is [7] an infrastructure comprised of sensing, computing and communication elements. This network has the ability to instrument, observe and react to events in a specified environment. There are 4 basic components in a sensor network:

i) An assembly of distributed or localized sensors.
ii) An interconnecting network
iii) A central part of information clustering
iv) A set of computing resources at the central point to handle data correlation handling, status querying and data mining.

Algorithmic methods for data management [15] play an important role in sensor networks. Sensors span several orders of magnitude in physical size; they range from nanoscopic-scale devices to mesoscopic-scale devices. Sensors can be simple point elements or can be multipoint detection arrays. Embedded network sensing refers to the synergistic incorporation of micro sensors in structures or environments.

Figure: 5 Wireless Sensor Network Applications

M2M

M2M communication [M2M] M2M Communication [5] is typically composed of a number of networked devices and a gateway is responsible for the connection among the devices and the connection between the M2M communications area and other networks

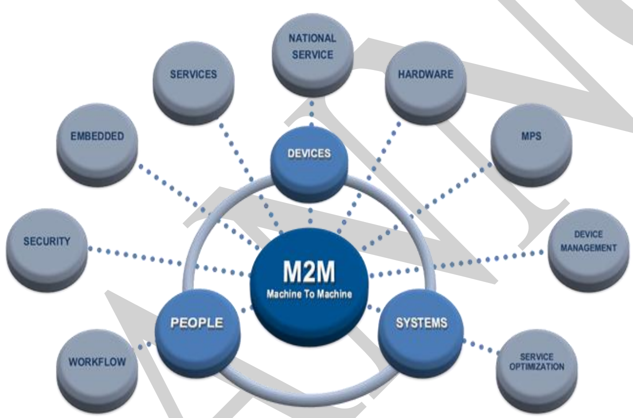

Figure: 6 Machine-to-Machine

Machine to Machine [8][9][10] refers to direct communication between devices using any communications channel, including wired and wireless. In modern times the communication is often via the Internet of Things (Internet of Things). Widespread adoption of Internet Protocol Version 6 (IPv6), with its extremely large address space, is necessary to accommodate all of the sensors and machine-readable identifiers that Internet of Things will require.

Machine to machine [11] communication can include industrial instrumentation, enabling a sensor or meter to communicate the data it records (such as temperature, inventory level, etc.) to the application software that can use it. Such communication was originally accomplished by having a remote network of machines relay information back to a central hub for analysis, which would then be rerouted into a system like a personal computer.

More recent machine to machine communication has changed into a system of networks that transmits data to personal appliances. The expansion of IP networks around the world has made machine to machine communication quicker and easier while using less power. These networks also allow new business opportunities for consumers and suppliers.

Machine to machine (M2M) is a broad label that can be used to describe any technology that enables networked devices to exchange information and perform actions without the manual assistance of humans.M2M communication is often used for remote monitoring. In product restocking, for example, a vending machine can message the distributor when a particular item is running low. M2M communication is an important aspect of warehouse management, remote control, robotics, traffic control, logistic services, supply chain management, fleet management and telemedicine.

It forms the basis for a concept known as the Internet of Things (Internet of Things).

Currently, M2M does not have a standardized connected device platform and many M2M systems are built to be task- or device-specific. It is expected that as M2M becomes more pervasive, vendors will need to agree upon standards for device-to-device communications

IPV6

A unique address called [12] IP address is required to send and receive the information over internet. The DNS system is responsible for providing mappings from IPv6 addresses to domain names. Practically, all widespread [13] services, applications and devices support IPv6. The basic step is to enable IPv6 on different operating systems. The services offered over the internet are designed by any client. The impact of IPv6[14] depends on the different elements like VoIP(Voice over Internet Protocol), Routers, Firewall, Email, DHCP (Dynamic Host Configuration Protocol), operating systems, DNS (Domain Name Server), switches, caching, web services, provisioning, load balancing, network management, security management.

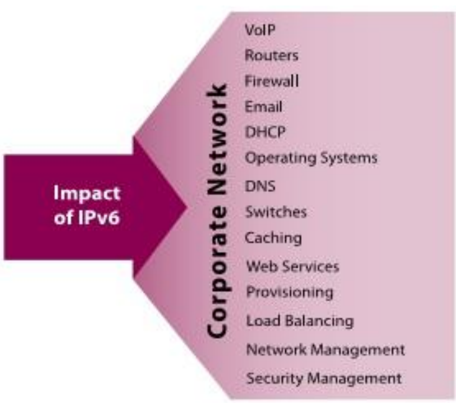

Figure: 7 Impact of IPv6

The characteristics of IPv6 protocol [12][13] enable the future communication very easier. The Large header space-IPv6 has 128 bit (16 byte) IP address, efficient and hierarchical addressing and routing infrastructure, stateless & stateful address configuration, built-in security, extensibility and new protocol for neighbouring mode interaction. The communication enabled by the advent of IPv6 will be particularly useful in the embedded systems arena, as millions of new devices take advantage of internet connectivity. When each device has its own unique global IP address peer to peer communication will become much easier.

3. Data Integration and Challenges

The Internet of Things [6] requires convergence or confluence of many technologies like RFID, Internet of Services, M2M, Cooperating objects, Automatic systems, Cloud computing, Sensor networks etc.., The convergence of various technologies is a challenging task for the researchers for future Internet of Things.

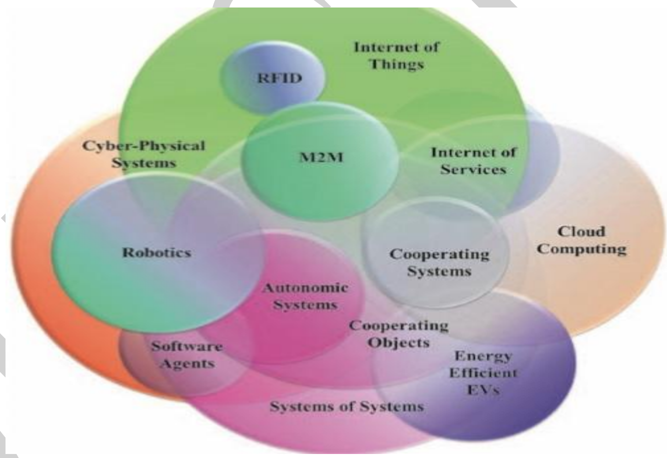

Figure: 8 Convergence of different technologies for Internet of Things

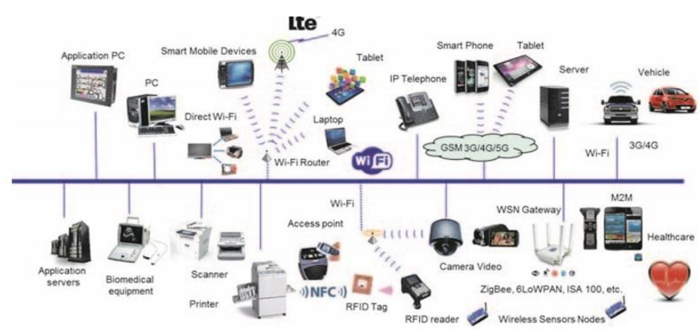

Figure: 9 various devices and technologies confluence

In order to handle the [3][6] challenges of Internet of Things in extensive interconnection, information perception and intelligent service, there are three key scientific problems.

Problem 1: Data exchange among large-scale heterogeneous network elements: Access to large scale heterogeneous network elements and massive data exchange among them are the important novel features associated with the wide application of Internet of Things. On the one hand, Internet of Things realizes the interconnection and network convergence by using Internet, telecommunication networks and other networking platforms, and provides information sharing and collaborative service. On the other hand, Internet of Things has a strong requirement of dynamic autonomy in each local tight-coupled region. In order to execute a specific network task, various network elements in each local region self-organize dynamically, realize the interconnection and interoperability, thus to improve the network service by using the information in the local autonomy region. Therefore, here is a key problem that Internet of Things has to face: how to resolve apparent contradiction between the extra large-scale, heterogeneity and dynamics of Internet of Things system, and the requirement of highly data exchange. For this reason, the challenge of highly efficient interconnection among large scale heterogeneous network elements is raised as the first key scientific problem of Internet of Things, that is, data exchange of large scale heterogeneous network elements in local dynamic autonomy and highly network convergence.

Problem 2. Effective integration and interaction adaptation of uncertain information: Internet of Things intensively senses the physical world through various smart devices, and the sensed information is obviously characterized by a lot of uncertainty.

Problem 3. Service adaptation in the dynamic system environment. Through building the models and the service platforms of the dynamic system environment, methods have to be proposed for automatically acquiring and understanding environment information and adaptive problem solving.

The Key challenges of Internet of Things[6]are:

- Safety and Security
- Addressing Scalability
- Interoperability
- Data Anonymity
- Dealing with Critical Latencies
- System Partitioning
- Mass data processing
- Real time Models & design methods
- Scalability
- Renewable energy sources
- Mobility

The above are few challenges for Internet of Things under convergence of various technologies for smart communication in the future.

Conclusion & Future Work

The Internet of Things or Internet of Objects plays a vital and crucial role and endures to affirm its significant position in the milieu of Information and Communication Technologies (ICT) and the forthcoming communication. Internet of Things may make the world to be small with communication to be faster and extends the imagination of the normal users in the coming future. Machine to Machine interaction will make the things to be easily memorized and give sorted solutions to the intended people making the journey of life to be smarter than the current. Future technologies also include enhanced and extended use of Artificial Intelligence and robotics for making the intelligent objects as part of Internet of Things.

References

[1] Translation of Mattern.F,Floer Keneier,C:vom Internet der Computer Zum Internet deDinge, Informatic Spectrum pub 33(2): pp 107 – 121 in the year 2010.

[2] http://www.tmtfinance.com/content/internet-things-part-1-%E2%80%93-state-union-xona-partners

[3] Ma HD. Internet of things: Objectives and scientific challenges. JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY 26(6): 919–924 Nov. 2011. DOI 10.1007/s11390-011-1189-5

[4] www.tcs.com/sitecollectiondocuments/white%20papers/HighTech-whitepaperTechnology-Review_Trends_M2M-Communication-0212-1.pdf

[5] File://M2M-white-paper-thegrowth-of-the-device-connectivity.pdf

[6] "RFID: A Guide to Radio Frequency Identification ", book by V.Daniel Hunt, Albert Puglia, Mike Puglia, ISSN: 978-0-470-107645-5,2007,WILEY Publishers.

[7] Wireless Sensor Networks, Technology , Protocols an Applications by Kazem Sohraby, Daniel Minoli, Taieb Znati, Wiley-InterScience, A John Wiley & Sons , INC publications, ISBN 978-0-471,74300-2,2007.

[8] Home M2M Networks: Architectures, standards and QoS Improvement by Yanz Lang,Rang Yu, Sheongli xie, Wenging Yao, Yang,Mohesin Guizani ,ISSN: 0163-6804/11, April 2011, IEEE Coomunications Magazin , PP 43-52.

[9] ""Machine-to-Machine (M2M) Communication Challenges Established (U)SIM Card Technology" - GD". *Gi-de.com*. Retrieved 2014-01-21.

[10] "Machine to Machine (M2M) Technology in Demand Responsive Commercial Buildings" (PDF). Archived from *the original* (PDF) on September 30, 2008. *Retrieved 2014-01-21*.

[11] J. Höller, V. Tsiatsis, C. Mulligan, S. Karnouskos, S. Avesand, D. Boyle: From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Elsevier, 2014, ISBN 978-0-12-407684-6.

[12] "IPv6 Tunnelling ove IPv4" by A.Sankara Narayan, M.Syed Khaja Mohideen, M.Chithik Raja, IJCSI, International Journal of Computer Science, Vol9, Issue 2,No2,Mach 2012, ISSN(online): 1694-0814,pp 599-604.

[13] "IPv6 fo all: A Guide for IPv6 usage and application different environments", book by Guillermo Cicileo, Roque Gagliano, Chistian O Flaberty, Mariela Rocha, 2009,ISOC, Internet Society, Agentina chapter.

[14] www.ipv6.com/articles/general/timeline-of-ipv6.htm

[15] " An introduction to Wireless Sensor Networks", by Bhaskar Krishnamachari, tutorial presented at the second International Conference on Intelligent Sensing & Information Processing (ICISIP), Chennai, India, January 2005.