ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

Emerging Trends of Green IoT for Smart World

Akshay Gapchup, Ankit Wani, Ashish Wadghule, Shashank Jadhav

Student, Department of Electronics & Telecommunication Engineering, Savitribai Phule Pune University, Pune, India.

ABSTRACT: With the rapid development of technology and science the world is becoming smarter. The internet of things (IoT) is an innovative development in the field of communication which enables the number of devices to share the information in collaborative manner. Green IoT (G-IoT) consists of two aspects. The first one refers to designing energy efficient computing devices, communications protocols, and networking architectures for interconnecting the physical world. The second aspect is to leverage IoT technologies to cut carbon emissions and pollutions and enhance the energy efficiency. Enabling green IoT involves various technologies such as RFID, sensor networks, cellular networks, machine-to-machine communications, energy harvesting devices and communications, cognitive radio, cloud computing, and big data analysis. With the advances of these enabling technologies, green IoT poses a great potential to bolster economic and environmental sustainability. This article presents overview of green IoT and summarized the principles of information and communication (ICTs) that enables the G-IoT for smart world.

KEYWORDS: Smart world,internet of things,sensor cloud,wireless sensor network.

I. INTRODUCTION

1. Smart World.

The smart city initiative is global and multidisciplinary effort to create a vibrant and worldwide network of cities and to serve the peoples with smart devices (mobile, watches, computers .Enabling technologies like RFID, sensor networks, biometrics, and nanotechnologies are now becoming very common, bringing the Internet of Things into real implementations addressing varying applications, including smart grid, e-health, intelligent transportation, etc. Green networks in IoT will contribute to reduce emissions and pollutions, exploit environmental conservation and surveillance, and minimize operational costs and power consumption. The Green Internet of Things (G-IoT) is predicted to introduce significant changes in our daily life and would help realizing the vision of “green ambient intelligence”. Living in such a smart world, it’s become esy for a people to share the information worldwide. For example by using the GPS system, one can send its global position to any of the targeting applications. The use of mobile phones, computers and internet connection the peoples worldwide to access and share the information. The recent trends such as cloud technology, Wireless Sensor Networks (WSN), RFID etc. makes the world smarter. The Fig. 1 below shows the concept for smart world where the objectives and services of smart world has been clearly shown. This article focuses on recent trends and development of embedding smart device with hot green technologies to enable the smart world universally become IP enabled with the help of IPV6.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

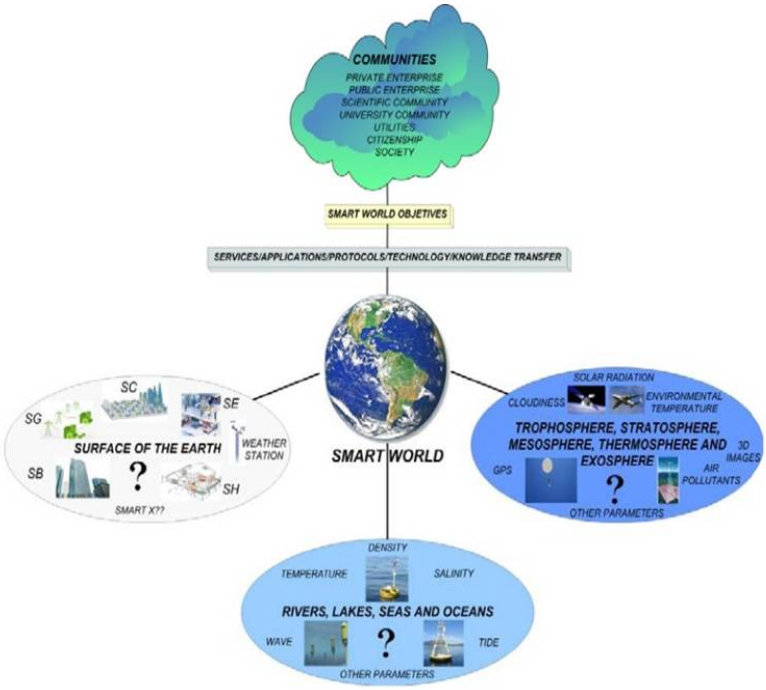

Figure 1. Concept of Smart World

II. OVERVIEW OF IOT AND GREEN IOT

1. Internet of Things

The Internet of Things (IoT) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. Definition of ITU-T: ``In abroad perspective, the IoT can be perceived as a vision with technological and societal implications. From the perspective of technical standardization, IoT can be viewed as a global infrastructure for the information society, enabling advanced services by inter- connecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, while maintaining the required privacy."Definition of IERC: ``A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual ``things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network." In summarized form-“The term "Internet of Things" emanated to describe a number of technologies and research disciplines that enable global connectivity over the world-wide physical objects”. The fig. 2 below shows the system connectivity of Internet of things network how different physical devices get interconnected in IoT network.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

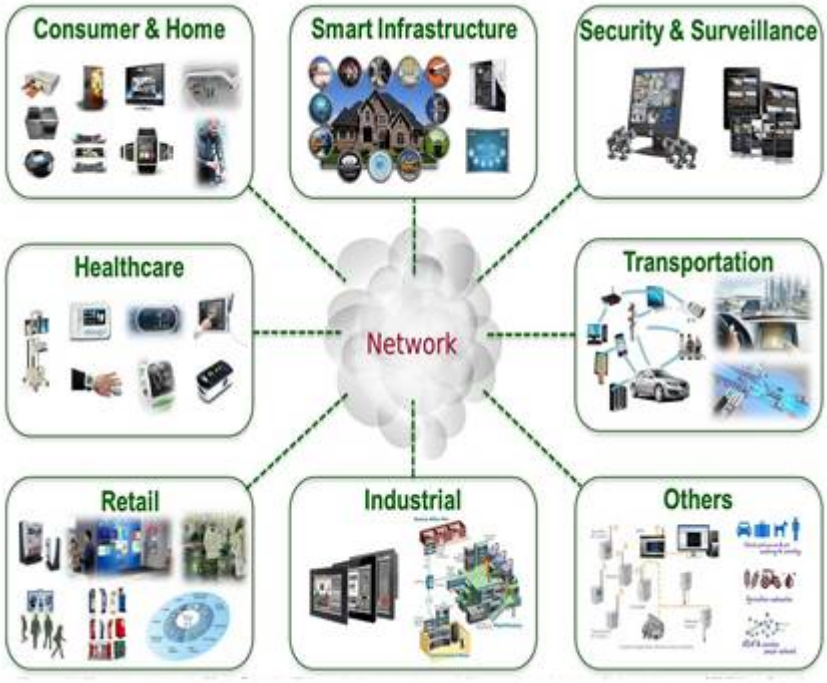

Figure 2.Example of IoT

2. Elements of IoT

The elements of IoT are identification, sensing, communication technologies, computation, services and semantic as described in Fig. 3 below.

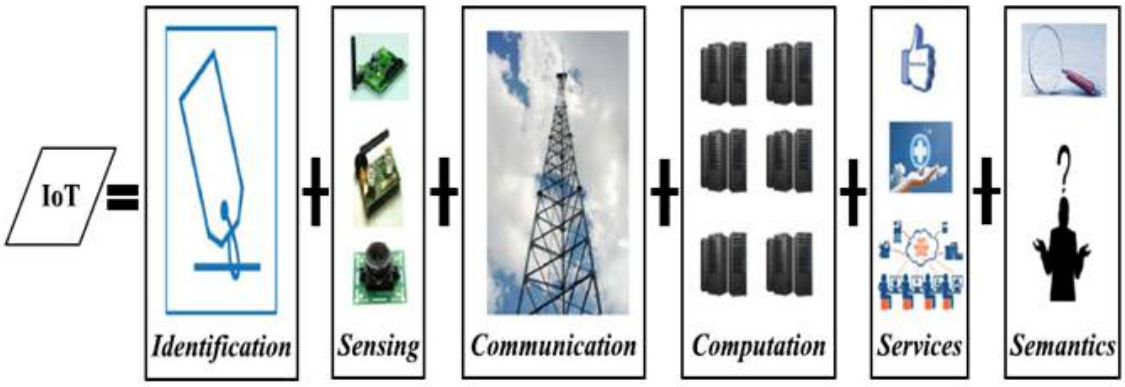

Fig. 3.Elements of IoT

Identification methods such as electronic product code (EPC) plays crucial role in identification of objects and sending its information to database, data warehouses etc. which is then analyzed to perform specific actions based on required

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

services. In computation, the smart embedded devices such as FPGA, microcontrollers as well as cloud data also plays important roles in processing large amount of data over internet of things. The IoT services involved the identity services which enable the identification of smart devices in real world. Aggregation services gather and summarize the raw information which need to be processed and reported. The collaborative related services act on raw data and take action accordingly. Ubiquitous services provide real time action on demand.

3. Green IoT

Green IoT consists of two aspects. The first one refers to designing energy efficient computing devices, communications protocols, and networking architectures for interconnecting the physical world. The second aspect is to leverage IoT technologies to cut carbon emissions and pollutions and enhance the energy efficiency. Enabling green IoT involves various technologies such as RFID, sensor networks, cellular networks, machine-to-machine communications, energy harvesting devices and communications, cognitive radio, cloud computing, and big data analysis. With the advances of these enabling technologies, green IoT poses a great potential to bolster economic and environmental sustainability. NIC (National Intelligence Council) enabling research and development to enable energy saving when the G-IoT devices to communicates to real world. Considering the energy efficiency the green energy IoT concept can be defined as [7], ``The energy efficient procedures (hardware or software) adopted by IoT either to facilitate reducing the greenhouse effect of existing applications and services or to reduce the impact of greenhouse effect of IoT itself. In the earlier case, the use of IoT will help reduce the greenhouse effect, whereas in the later case further optimization of IoT greenhouse footprint will be taken care. The entire life cycle of green IoT should focus on green design, green production, green utilization and finally green disposal/recycling to have no or very small impact on the environment."

Applications of Green IoT

The green IoT which makes the smart devices to communicate to real world efficiently thus focuses on saving of energy and pollution. The numerous applications of G-IoT are as follows:

Smart Home: A G-IoT enables home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer. It can be equipped with Waste removal, Ultrasonic showers, Beds that make/change sheets themselves, Lighting creates artificial sunrise, Computer suggests clothing based on your taste, weather, Windows and walls will allow adjustable amounts of sunlight, warmth or cold in, Electronic soundproof rooms and windows. Soundproof energy fields that you can walk through, Hidden computers, sensors, microphones and electronics throughout the house. Central computer accepts voice commands, distinguishes between occupants for personalized responses and actions, Television, computer and phone merge into one device etc.

Industrial Automation: Industries have been automated with machines that allow for fully automated tasks without or with little manual intervention. An internet based industry automation system that allows a single industry operator to control industry appliances.

Smart Healthcare: IoT is revolutionizing Healthcare industry by bringing up new and advanced sensors connected with Internet producing essential data on real-time. it helps in achieving three key outcomes of any efficient health care services- improved access to care, increased care quality, reduced care costs.

Smart Grid: Much like the Internet of Things as a whole, a smart grid is about balance. It is about efficiency. It is about dynamically adjusting and re-adjusting to optimally deliver energy at the lowest cost and highest quality possible. A smart grid has the net effect of offering consumers the ability to participate in the solution.

III. ICT ENABLING GREEN IoT

In this section gives overview of Information and communication systems (ICTs) and then described the hot green ICT techniques.

1. Overview of ICT

ICT (information and communications technology - or technologies) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries. Few ho those hot ICT technologies are:

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

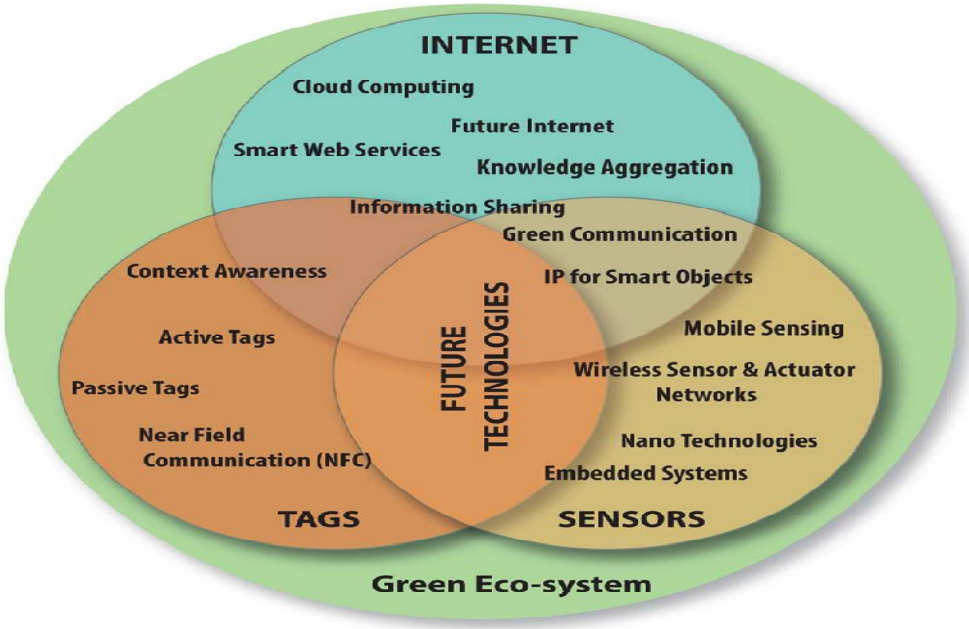

Fig. 4.Green IoT Enablers

RFID: The concept of green RFID researching savings about costs, CO2 emission, RFID is a must for industries, logistics or transportation companies. RFID secure flows, avoid mistakes and wasting of time and fuel. In that way, can save money, energy and preserve the planet.

WSN (wireless sensor network):A mesh network of wireless sensors reports data to a central site for environmental monitoring and risk identification. Data analysis and visual presentation is provided in a geographical and temporal context. This network is considered green due to decreased energy usage by the overall network as well as its actual application, which permits environmental information to be contextually presented and communicated with concerned urban community as well as decision makers. Periodic data reporting from the sensor network, in contrast with the usual timestamp synchronization, reduces the amount of communication required between network nodes, resulting in an overall energy saving, while not compromising the nature of the data gathered. The sensor network applications provide an outstanding representation of green networking as sparse but sufficient environmental monitoring, accompanied by real-time data analysis, and historical pattern identification permits risk identification in support of public safety and protection.

WPAN (wirelesspersonal area network):a low-range wireless network for interconnecting devices centered around an individual person'sworkspace.

WBAN (wireless body area network): a wireless network consisting of wearable or portable computing devices (e.g., sensors, actuators) situated on or in the body.

HAN (home area network): a type of local area networks (LANs), connecting digital devices present inside or within the close vicinity of a home.

NAN (neighborhood area network): an offshoot of Wi-Fi hotspots and wireless local area networks (WLANs), enabling users to connect to the internet quickly and at very little expense.

M2M (machine to machine): a technology that allows both wireless and wired devices to communicate with other devices of the same type.

CC (cloud computing): a novel computing model for enabling convenient, on-demand network access to a shared pool of configurable resources (e.g., networks, servers, storage, applications, services). Integrating CC into a mobile

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

environment, mobile cloud computing (MCC) can further of load much of the data procesing and storage tasks from mobile devices (e.g., smart phones, tablets, etc.) to the cloud.

DC (data center): a repository (physical or virtual) for the storage, management, and dissemination of data and information.

2. The Green RFID

The every rfid application is equipped with a reader that reads the information that is stored on RFID Tag. RFID often plays a part in applications that are helping to deliver a greener world. Systems for recycling or re-use of packaging often use RFID to help identify and route pallets, crates or other packaging. RFID often plays an important part in tracking the health of wildlife and can help to reduce emissions in buildings.

Fig. 5. Green RFID Systems

RFID works at from low frequencies at 124-135 kHz up to ultrahigh frequencies at 860-960 MHz are used to perform transmission. Active tags works with battery power saving while passive uses the on board power for transmission of information. For RFID tag, reducing the tag size considered as use of non-degradable material in its manufacturing which are difficult to recycle. Therefore the use of optimized algorithms should be used to adjust the tag size dynamically and to avoid the tag collision.

3. GREEN WSN

There use of WSNs to monitor and control lighting and heating in buildings, the energy consumption can be significantly reduced. However the use battery powered WSN network limits the widespread deployment of WSNs. Green wireless sensor network mainly focuses on energy efficiency improvement, aiming at the realization of sustainable or battery---less operation of the networks. It involves multidisciplinary research covering topics from hardware architectures to signal processing and networking protocols.

3.1 Green M2M

Machine-to-Machine (M2M) communications constitute a fundamental part of the IoT. The term M2M refers to the exchange of data between two or more entities, objects, or machines that do not necessarily need human interaction.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

From the technical point of view, M2M communications are substantially different from Human-to-Human (H2H) communications. Despite the large number of expected M2M connections, most of them will generate very little and infrequent data traffic. Communication networks shall also provide suitable congestion and overload control solutions in order to handle a huge number of simultaneous connections. Features such as low mobility, time-controlled data delivery, group-based policing and addressing, low connection delays, and a wide variety of Quality of Service requirements are among other challenges that need to be addressed. All of them must have the "green" concept embedded.

Fig. 6. Green M2M system

The following methods might be used to increase energy efficiency:

1) Intelligently adjust the transmission power (e.g., to the minimal necessary level); 2) Design efficient communication protocols (e.g., routing protocols) with the application of algorithmic and distributed computing techniques; 3) Activity scheduling, in which the objective is to switch some nodes to low-power operation (``sleeping'') mode so that only a subset of connected nodes remain active while keeping the functionality (e.g., data gathering) of the original network; 4) Joint energy-saving mechanisms (e.g., with overload protection and resources allocation); 5) Employ energy harvesting and the advantages (e.g., spectrum sensing, spectrum management, interference mitigation, power optimization) of CR.

1. Green CC

Green CC resource such as Infrastructure (IasS) platform (PasS) and software (SaaS) are used as service. The technique involves the adaptation of hardware and software tools that minimizes energy consumption. Power saving virtual machine techniques such VM-consolidation, VM-migration etc. It make use of various energy efficient resource allocation and related task scheduling mechanism. Develops effective and accurate models and evaluation approaches regarding energy saving policies. Green CC mainly based on cloud supporting communication and networking technologies.

2. **Green DC**

The DC involves managing and processing various data created by user. The DC consumes high amount of energy for processing huge amount of data. Therefore the Green DC techniques makes use of renewable and green source of energy e.g. wind, water, solar etc. It makes utilize the dynamic power management techniques such as Turbo boost and Vshpere. By using the recent technologies such as high voltage and frequency scaling it employed the design of energy efficient hardware's.

3. **Green ICT Principles**

Based on the above technological development, green ICT principles can be summarized as:

a) Turn off facilities that are not needed.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

b) Send only data that are needed.
c) Minimize length of data path.
d) Minimize length of wireless data path.
e) Trade off processing for communications.
f) Advanced communication techniques.
g) Renewable green power sources.

IV. THE SENSOR-CLOUD TOWARDS GREEN IOT

This section describes the use sensor cloud technologies which help in developing the green IoT systems.

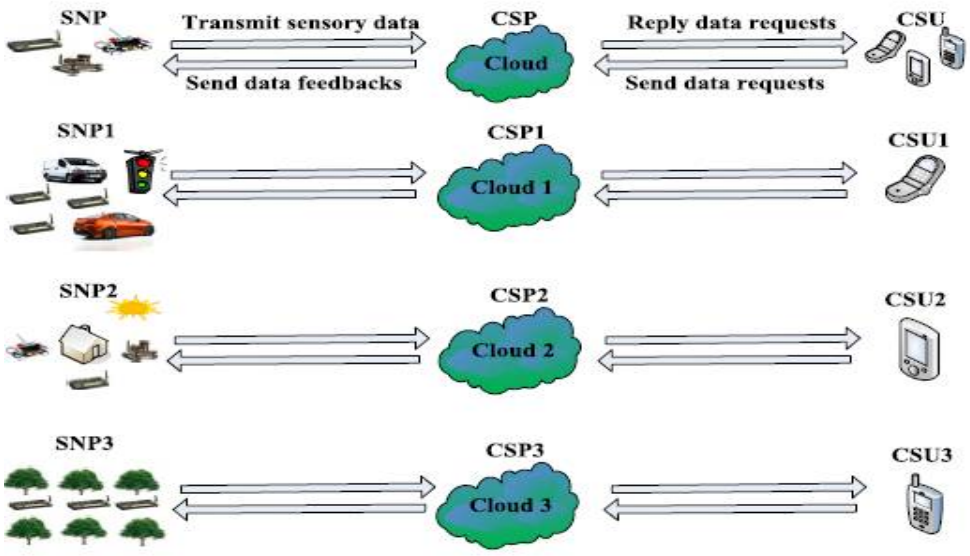

Figure 7. An example of Sensor cloud

1. Overview of Sensor cloud

A cloud computing provides internet services to customers very scalable computing capacities. Wireless Sensor Networks can be used for collecting these data because they present distributed systems which consists of different sensor nodes. Sensor-Cloud is useful for many applications, mainly where data from large sensor networks needs to be collected, monitored and viewed remotely. The various protocols are developed to integrate the Cloud Computing model with WSN. Figure 7. Below gives overview of Sensor Cloud example. This is the basic application model of sensor-cloud is to use the ubiquitous sensors (e.g., static sensors, mobile sensors, video sensors, etc.) offered by the SNP (sensor network provider) to collect various sensory data (e.g., temperature, humidity, traffic, house surveillance, etc.), about the surrounding environment. Then the sensory data is further transmitted to the cloud provided by the CSP (cloud service provider) for storage and further processing. After the cloud stores and processes the sensory data with data centers, the processed sensory data are delivered to the CSU (cloud service user) on demand. In this whole process, SNPs act as the data sources for CSPs. CSUs are the data requesters for CSPs.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

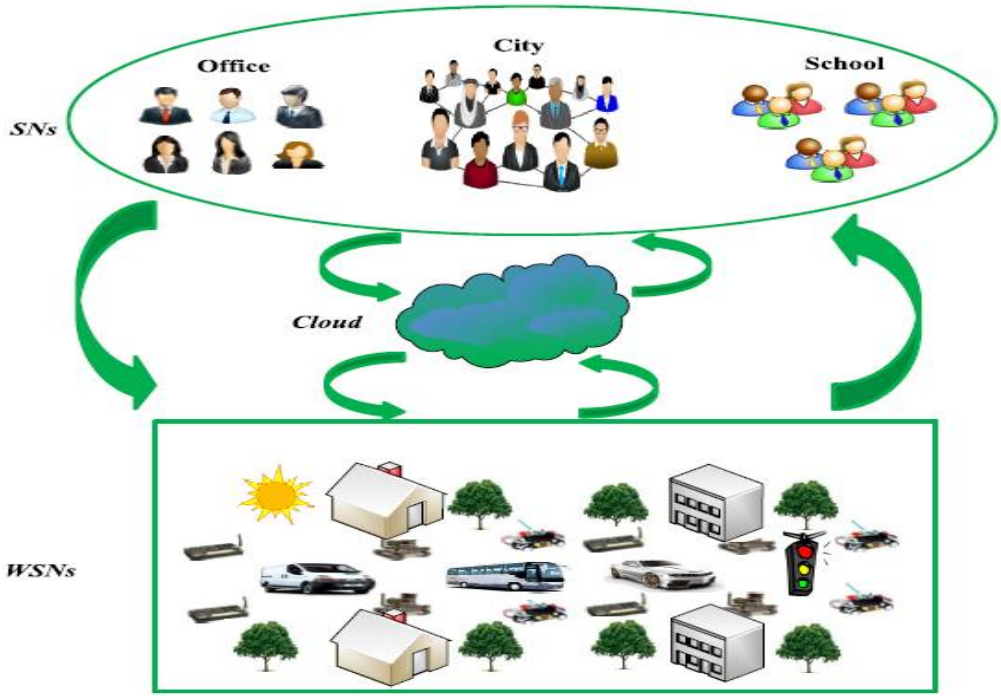

Figure 8.A vision of future sensor-cloud.

2. The Future cloud

The various recent research and developments on sensor cloud such as novel sensory data processing framework (NSDPF) which integrate WSN with mobile cloud has been taken. Collaborative location-based sleep scheduling (CLSS) focuses on energy efficiency. The focus of CLSS is enhancing the WSN lifetime. Sensory data transmission in sensor-cloud (TPSS) aiming at reliably offering more useful data to mobile cloud from WSN. Time and priority-based selective data transmission (TPSDT), deliver more useful sensory data to the cloud. Priority-based sleep scheduling (PSS) saves energy consumption. Authenticated trust and reputation calculation and management (ATRCM) system provide security to sensor data. PTMM (priority-based two phase Min-Min) and PTAM (priority-based two phase Max-Min) focuses on job scheduling in sensor-cloud. Quality of service (QoS) enhance the quality of service of sensor-cloud about achieving sensory data from the cloud by user can be achieve with the help of TASC (trust-assisted sensor-cloud) in contrast to SCWTA(sensor-cloud without trust assistance). The price of sensor carried by SCPM (Sensor Cloud Pricing Model). Based on these researches the vision for future sensor cloud is shown in figure 9 below.

Future Research Directions and Open Problems

The future research should consider the fallowing objective to make attendance of sensor network (SN) will be of great help to sensor cloud to fulfill green IoT, These includes:

a) The design of green IoT,
b) Characteristics of different IoT applications and service requirements
c) Realistic energy consumption models
d) Sharing the sensor-cloud resources and services
e) The massive user behavior information in SNs,

V. CONCLUSION

The recent development in Internet of things technology has been discussed in this article. We have also focused on various scope of IoT adopted to make Green Internet of Things. Also the overview of various G-IoT principles

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

summarized. The sensor cloud approach is the crucial development in smart world era. We have also summarized the recent research trends in the field of sensor cloud and describe the future sensor cloud in brief. In order to make the world smart the ongoing challenges in G-IoT and sensor cloud technology are need to be focused and minimized.

REFERENCES

[1] Q. Han, S. Liang, and H. Zhang, ``Mobile cloud sensing, big data, and 5G networks make an intelligent and smart world," IEEE Netw., vol. 29, no. 2, pp. 4045, Mar./Apr. 2015.
[2] L. Atzori, A. Iera, and G. Morabito, ``The Internet of Things: A survey," Comput. Netw., vol. 54, no. 15, pp. 27872805, Oct. 2010.
[3] C. Perera, C. H. Liu, S. Jayawardena, and M. Chen, ``A survey on Internet of Things from industrial market perspective," IEEE Access, vol. 2, pp. 16601679, Jan. 2014.
[4] L. Da Xu, W. He, and S. Li, ``Internet of Things in industries: A survey," IEEE Trans. Ind. Informat., vol. 10, no. 4, pp. 22332243, Nov. 2014.
[5] C. Perera, C. H. Liu, and S. Jayawardena, ``The emerging Internet of Things marketplace from an industrial perspective: A survey," IEEE Trans. Emerg. Topics Comput., to be published.
[6] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, ``Internet of Things: A survey on enabling technologies, protocols and applications," IEEE Commun. Surveys Tuts., to be published.
[7] F. K. Shaikh, S. Zeadally, and E. Exposito, ``Enabling technologies for green Internet of Things," IEEE Syst. J., to be published.
[8] V. Namboodiri and L. Gao, ``Energy-aware tag anticollision protocols for RFID systems," IEEE Trans. Mobile Comput., vol. 9, no. 1, pp. 44-59, Jan. 2010.
[9] Y.-H. Lin, Z.-T. Chou, C.-W. Yu, and R.-H. Jan, ``Optimal and maximized confgurable power saving protocols for corona-based wireless sensor networks," IEEE Trans. Mobile Comput., to be published.
[10] F. Farahnakian et al., ``Using ant colony system to consolidate VMs for green cloud computing," IEEE Trans. Services Comput., vol. 8, no. 2, pp. 187198, Mar./Apr. 2015.
[11] C.-H. Chang, R. Y. Chang, and H.-Y. Hsieh, ``High-delity energy-effcient machine-to-machine communication," in Proc. IEEE 25th Annu. Int. Symp. Pers., Indoor, Mobile Radio Commun., Sep. 2014, pp. 91-96.
[12] J. Shuja et al., ``Survey of techniques and architectures for designing energy-effcient data centers," IEEE Syst. J., to be published.
[13] A. Alamri, W. S. Ansari, M. M. Hassan, M. S. Hossain, A. Alelaiwi, and M. A. Hossain, ``A survey on sensor-cloud: Architecture, applications, and approaches,' Int. J. Distrib. Sensor Netw., vol. 2013, Nov. 2013, Art. ID 917923.
[14] S. Misra, S. Chatterjee, and M. S. Obaidat, ``On theoretical modeling of sensor cloud: A paradigm shift from wireless sensor network," IEEE Syst. J., to be published.
[15] P. Sathyamoorthy, E. C.-H. Ngai, X. Hu, and V. C. M. Leung, ``Energy effciency as an orchestration service for mobile Internet of Things," in Proc. 7th IEEE Int. Conf. Cloud Comput. Technol. Sci., Nov./Dec. 2015, pp. 1-8.
[16] H. Lee, M. Wicke, B. Kusy, O. Gnawali, and L. Guibas, ``Predictive data delivery to mobile users through mobility learning in wireless sensor networks," IEEE Trans. Veh. Technol., to be published.
[17] S. Rahman, ``Green power: What is it and where can we nd it?" IEEE Power Energy Mag., vol. 1, no. 1, pp. 3037, Jan./Feb. 2003.