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Green IOT: Principles, Current Trends, Future Directions

Manas Kumar Yogi[*], *K Ganga Devi Bhavani***

ABSTRACT

The two trending and popular technologies are Cloud Computing (CC) and the Internet of Things (IoT) are current hot discussions in the field of agriculture and healthcare applications. Motivated by achieving a sustainable world, this paper discusses various technologies and issues regarding green cloud computing and green Internet of Things, further improves the discussion with the reduction in energy consumption of the two techniques (CC and IoT) combination in agriculture and healthcare systems. The history and concept of the hot green information and communications technologies (ICT's) which are enabling green IoT will be discussed. Green computing introduction first and later focuses on the recent works done regarding the emerging technologies. Finally, lists out the advantages, challenges, and future research directions related to green application design. Our research aims to make green area broad and contribution to sustainable application world.

Keywords: *Green IoT; Smart Home; ICT; Sensor.*

1.0 Introduction

Security in IoT is a nightmare in spite of its good use on a large-scale. Generally, IoT is a combination of three main technologies.

- Information Technology
- Operations Technology
- Consumer Technology

with electronics, software, sensors, actuators and network connectivity, which enables these objects to connect and exchange data. Each thing is uniquely identified using its built-in address, and is able to inter-operate within the exiting internet infrastructure.

Smart world is beholding as an era in which objects can automatically and intelligently serve people in a collectible manner. Internet of Things (IoT) connectseverything in the smart world. Particularly, an overview regarding IoT and green IoT is performed first.

Then, the hot green information and communications technologies (ICTs) enabling green IoTare studied, and general green ICT principles are epitomized. Furthermore, the latest developments and future vision about sensor cloud, which is a novel paradigm in green IoT, are reviewed and introduced, respectively.

Our work targets to be an enlightening and latest guidance for research with respect to green IoT and smart world. IoT ELEMENTS In this section we have listed and discussed on some key elements for IoT and IoT based applications. If we classify IoT elements/components into few basic categories that aids seamless connectivity then it can be as followed: (i) Hardware (ii) Middleware (iii) User End Visualization actuators, embedded devices and other communication

Hardware constitutes of various sensors, actuators, embedded devices and other communication devices. Middleware constitutes of various tools used for on demand storage of data collected by sensor devices and processed by embedded devices and various computing tools used for data analytics. User End Visualization consists of various data visualization and interpretation tools which can be accessed on various diverse platforms which aids the enduser to keep a track of various events driven by those data collected by various sensory hardware.

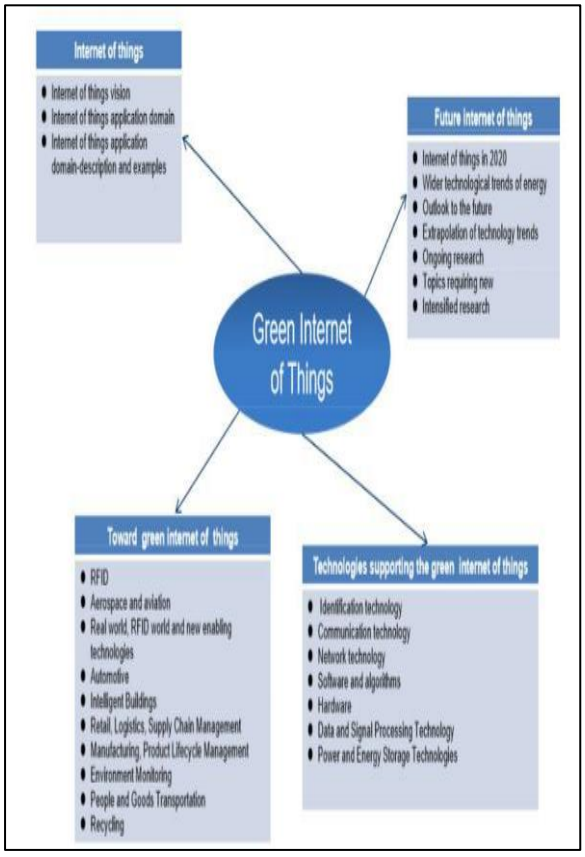
**Corresponding Author: CSE Dept. Pragati Engineering College, Surampalem, Andhra Pradesh, India (E-mail: manas.yogi@gmail.com)*
***CSE Dept. Pragati Engineering College, Surampalem, Andhra Pradesh, India*

We have highlighted few breakthrough and enabling technologies in the above mentioned categories which will provide a clear conscience for the three components listed in figure 1.

2.0 Applications of Green IoT

The Green IoT which makes the smart devices to communicate with real world and which focuses on saving of energy and pollution.

Fig 1: Overview of Green IoT



The numerous applications of Green IoT are as follows:

A. Smart Home: A G-IoT enables home equipped withlighting, heating, and electronic devices that can be controlled remotely by using 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.

B. Industrial Automation: Industries have beenautomated 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.

C. Smart Healthcare*:*IoT is to refashion Healthcareindustry by bringing up new and advanced sensors which are 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.

D. Smart Grid: Much like the Internet of Things, asmart 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.

E. Green RFID: by reducing the size of RFID tags to decreasethe amount of non-degradable material used, as the tags are hardly reusable. And also by enery efficient alogorithms for tag estimation.

F. Green IoT*:*Triggered powering up of sensor nodes when itis needed, which will save up energy consumption.Energy depletion by generating power for sensor nodes from environment such as sun, kinetic energy, temperature differentials etc.Radio optimization techniques by minifying the size of data that is transmitted over the communication interface by aggregating,adaptive sampling.

In this section, It gives overview of Information and communication systems (ICTs) and it also describes about the hot green ICT techniques and overview of information and communications technology, it is an umbrella term that includes any communication device or application, like radio, television, cellular phones, computer, network hardware, software, satellite systems and so on, such

that various services and applications associated with them, such as videoconferencing and distance learning.

3.0 Research Contribution

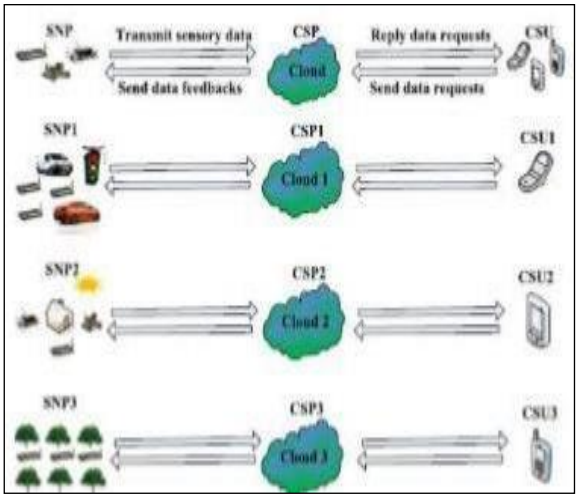
The main contributions of this paper are shown as follows.

1. Enabling green IoT, this paper discusses the hot green ICT (e.g., green RIFD, green WSN, green CC, green M2M and green DC) and further summarizes the general green ICT principles.
2. Towards green IoT, this paper reviews the recent developments about sensor-cloud and envisions the future sensor-cloud. In addition, this paper presents the future research directions and open problems regarding green IoT.

3.1 Design principle of sensor-cloud- green IoT:

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. The various protocols are developed to integrate the Cloud Computing model with WSN. Below gives overview of Sensor Cloud example.

Fig 2: Overview of Sensor Cloud



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.

4.0 Current Trends

Green and Smart Buildings have evolved over the past two decades from being of an environmental glory to a business case with strong industry growth and a long-term business opportunity. Most of the building construction sector stakeholders such as architects, engineers, planners, owners and consultants are now increasingly focusing on green building projects in their portfolio.

This is driven by factors such as client/market demand, lower operating costs, greater environmental consciousness, regulatory requirements or incentives and improved health and productivity benefits.

Construction of green buildings rose to 325 million of new floor space in 2013, representing a $260 billion market, according to a report by Lux Research (Lux Research 2014), Business Case for Going Green According to the latest report by Dodge Data and Analytics the global green building activity continues to double every three years.

The percentage of firms expecting to have more than 60 % of their projects certified green is anticipated to more than double from 18 % currently to 37 % by 2018. It is encouraging to note that the growth of green building activity is also happening in emerging economies such as countries in Asia and Africa.

The top triggers for architects and engineers to focus on green buildings are client demand, environmental regulations, market demand and the notion of ‘right thing to do’.

However, there are several barriers or obstacles for green buildings such as higher perceived first costs, lack of public awareness, lack of political support and incentives, and the perception that green is for the high-end project sector only (Dodge Data and Analytics 2016)

Intelligence: Machine to machine (M2M) communication hashigh priority in IoT because machine automation must be improved to minimise delay, traffic, and immediate action. Smart technologies need to be more intelligent to enable automated systems. Communication Protocol: The heterogeneous nature of IoTenabled services meet an unavoidable problem with communication protocols. Each types of device use separate protocol in terms of data communication. Standard communication protocol needs to be developed for successfully implement IoT services.

Real-Time Solution: It will be really tough to implement the'Anytime' concept of IoT in reality. The real-time systems need to be implemented in grass root level of the IoT things to react prominently at any time. The complexity of the existing real-time systems must be minimised, so that they could be used in nano-scopic devices.

5.0 Zero Energy Buildings

The next frontier in Green and Smart Buildings is the move towards Zero energy buildings. Energy efficiency solutions have already become mainstream in many regions around the world. Some building developers are now pushing the limits and trying to differentiate themselves by going towards net zero energy buildings. In this respect we use the solar photovoltaic (Solar PV) technology on buildings for local renewable energy source generation. With the cost of solar PV components dropping exponentially over the last decade and availability of third party financing schemes, the adoption rate of solar PV in buildings has been increasing rapidly. Other technologies for on-site renewable energy generation include solar hot water collectors, small-scale wind power turbines and geothermal energy.

6.0 Future Directions

Buildings Enabled by IoT the advent of Internet of Things (IoT) is also affecting the way green and smart buildings are getting connected with various stakeholders throughout the world. IoT, for buildings can be imagined as a network for buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data. And Urban residents growing + 60 M Year 60% world's population will be living in cities by 2050+ 100 cities of 1 M pops will be built in the next 10 years.

6.1 Startup companies

(1) ENERTIV- It is analytics company aimed atindividual buildings. On their platform you can apprehension actual usage of everything on a building-level, floor-level, room-level or even at the equipment-level. That lets landlords monitor and then encourage tenants to make smarter energy choices.

(2) BRIGHTFARMS-It has the most idyllic, country-laneinvoking name of any company on 46th Street. The company finances, designs, builds and operates urban farms located near grocery stores. They are making commercial-scale in agriculture in a reality manner. All it need is your grocer needs to do is throw it down from the roof, but it also cuts a lot of distance, and thus waste, from the time your food is plucked until it's in your mouth.

(3) CALMENERGY-It is for Computational LearningSystems which uses machine learning to make buildings and utility grids more efficient. Their onsite building management system, Watchdog, connects to the internet, and enables building managers to make money from their flexibility in electricity use. If the grid is experiencing high demand, Watchdog can automatically control IoT sensors on things like temperature sensors. The result, according to CALM Energy, is around a 30 percent savings on energy bills.

(4) RADIATOR LABS-Radiator Labs is a system thatturns old fashioned radiators into smart-heating devices. Using their device, which are conveniently recycle for already existing systems, building owners can save about 35 percent on fuel costs. There are two things pre-war apartment dwellers loathe: overheating and the inability to control heat at a room-level.

(5) BANDWAGON-Bandwagon makes it easy to share ataxi at an event or an airport. Think about how wasteful it is for everyone at the airport to take an individual taxi back to their houses. Chances are, many people are heading in the same direction, if not to the same neighbourhood. Bandwagon lets people instantly match with others heading the same way and share a ride in a licensed taxi.

There is a new concept called Blue IoT which is also a part of Green IoT.

6.2 Blue Iot

Blue IoT is an innovative boutique energy and infrastructure services , who can deliver projects and refurbishments as a service fully spaced. We educe energy, maintenance and operating costs while improving safety,efficiency,productivity,health and energy security averaging the cloud and the IoT.

It provides concepts of

1. Data analytics and IoT
2. Secure and heathy & Buildings
3. Mission Critical facilities

7.0 Conclusions

This paper sincerely attempts to present the novel approaches towards design, implementation of green IoT. this paper discusses the design principles involved towards a environment friendly IoT architecture. we observe according to current trends that most of the major players in IoT industry are accepting the need for incorporating green IoT principles in their operating architecture. we also look into the popular organizations which have already started using green IoT devices in their business services. green IoT is an inspiration towards a green digital smart world. we conclude this paper by advocating quality guidelines which developing a green IoT framework towards technological advancements for the greater needs of the society.

IoT has been continuously bringing a progression of mechanical changes in our day by day lives, which thus makes our life less difficult and more agreeable through different innovations and applications.

There is incalculable value of IoT applications in different areas including medicinal, fabricating, mechanical, transportation, training, administration, mining, living space and so on. Notwithstanding plenteous advantages IoT is confronting a few imperfections in administration and execution level. Key perceptions in the writing are as per the following.

Firstly, there is no standard definition worldwide till date. Second, widespread institutionalizations are required in structural level as well. Third, as advances shift from seller to-merchant, interoperability issues are to be tended to all the more genuinely. Ultimately, for better world-wide-administration, we have to manufacture consistently acknowledged worldwide standard conventions with legitimate wellbeing and security issues.

The expansion of gadgets with imparting impelling abilities is bringing nearer the vision of an Internet of Things, where the detecting and incitation works consistently mix away from plain sight and new capacities are made conceivable through access of rich new data sources. The development of the cutting edge portable framework will rely on upon the inventiveness of the clients in outlining new applications. IoT is a perfect developing innovation to impact this space by giving new advancing information and the required computational assets for making progressive applications.

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