Internet of Things: Emerging trends, Enabling Technologies, levels &Applications

Prof. Pandhare Bharati[1], Prof. Ahire Pritam[2], Prof. Chorade Priti[2]

[1] *D.Y.Patil Institute of Engineering & Technology, Ambi, Pune.*
[2] *D.Y.Patil Institute of Engineering & Technology, Ambi, Pune.*
[3] *SVERI's College of Engineering, Pandharpur*
(E-mail:bharati.pandhare@dyptc.edu.in)

Abstract- 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, often communicate data associated with users and their environments.
The "Things" in loT refers to loT devices which have unique identities and can perform remote sensing, actuating and monitoring capabilities.
Internet of Things (IoT) being a powerful integration of radio-frequency identification (RFID), sensor and wireless devices, has given a challenging yet powerful opportunity to shape the existing systems thereby making them smart. Millions of physical objects are expected to be connected to form a system creating wide distribution network inferencing meaningful deductions from raw data.
This survey paper is an effort to describe IoT along with its vision, possible application domains and key challenges.

Keywords: Internet of Things (IoT), Radio frequency identification (RFID), wireless sensor networks (WSNs), SCADA, Zigbee, KNX, IoT enabling technology, IoT levels

I. INTRODUCTION

Today, more than two billion people are using the Internet to send and receive the e-mails, to access the web content, to use social
With time, a lot of people will be having access to the vast available information, taking Internet to a higher level where gadgets and smart devices will be connecting, communicating, computing and coordinating with each-other.

Designing IoT systems can be a complex and challenging task as these systems involve interactions between various components such as IoT devices and network resources, web services, analytics components, application and database servers.
IoT system designers often tend to design IoT systems keeping specific products/services in mind. So that designs are tied to specific product/service choices made. But it make updating the system design to add new features or replacing a particular product/service choice for a component becomes very complex, and in many cases may require complete re-design of the system.

In this scenario, the concept of Internet will diminish, giving rise to the new concept of connected 'smart' devices as emerging trends in IoT
The IoT will shape the Internet in such a way that it will materialize machine-to-machine (M2M) learning. Compared to the internet protocols where the pay load is heavy along with big headers and footers, in M2M/ IoT protocols the payload is very small(1).

The Internet of Things (IoT) paradigm refers to the network of physical objects or "things" embedded with electronics, software, sensors, and connectivity to enable objects to exchange data with servers, centralized systems, and/or other connected devices based on a variety of communication infrastructures(2).

The concept of Industrial Automation and Control Systems (IACS) is well established. These systems, often referred to as Operational Technology (OT), are employed in diverse industries including manufacturing, transportation and utilities, and are sometimes referred to as cyber-physical systems (CPS)(3).

The IoT refers to a complex network of interactive and technical components clustered around three key elements: sensors, informational processors and actuators. It is this "ability [of] objects to communicate that delivers the power of the IoT".The IoT's networked communication will radically alter the way that we interact with technologies, particularly as our physical relationships to those technologies transform(4).

The concept of elevator supervision lack of effective technical methods, Based on the function of elevator safety monitoring system, we designed a kind of elevator monitoring system based on the Internet of things. It is introduce a schematic diagram of elevator Internet of things (5).

Rapid developments in hardware, software, and communication technologies have facilitated the emergence of Internet-connected sensory devices that provide observations and data measurements from the physical world. By 2020, it is estimated that the total number of Internet-connected devices being used will be between 25 and 50 billion. As these numbers grow and technologies become more mature, the volume of data being published will increase. The technology of Internet-connected devices, referred to as Internet of Things (IoT), continues to extend the current Internet by providing connectivity and interactions between the physical and cyber worlds(6).

In contemporary philosophical and social studies, the issues which are related to perceptual experience come to the fore, enhanced by attention to the things of reality in their immediate givens sometimes in everyday experiences. Modern sociology and social philosophy refer to things as to the something that had not previously shown as a relatively independent object without being the representation of the other types of reality and relationships in the world: social, economic (in terms production, distribution and consumption), political, etc. In our opinion, now a thing acquires a special status in philosophical studies, becoming a kind of condensation point of being. Such attention to the things due to several factors, including: the modern understanding of space and time, the expansion of the current "real" crisis idealistic philosophical ideas, the reorientation of phenomenology. In a situation of rapid development of information technologies there is such a phenomenon as the " Internet of things", which captures not only the conjugation of human individuals in the information network, but also systems and hardware devices that can often go without human intervention. Such a phenomenon requires a philosophical rethinking, and represents the focus on perceptual and bodily aspects of life in the modern world (7).

The Internet of Things (IoT) paradigm refers to the network of physical objects or "things" embedded with electronics, software, sensors, and connectivity to enable objects to exchange data with servers, centralized systems, and/or other connected devices based on a variety of communication infrastructures. IoT data collected from different sensors, nodes and collectors are transferred to the cloud over the internet. IoT devices are used by consumers, healthcare, and businesses as well as by the governments. It is being forecast that 31 billion IoT devices will be deployed all over the world by the year 2020(8).

The study and development of Internet of Things (IoT) applications, web and mobile, is on the increase. Applications, working with data obtained from different areas such as transportation, smart homes, health care, public services, industry and many others. Previous studies have focused on managing the obtained data. However, managing the heterogeneous resources that get that data is an area that demands more attention. This work addresses the management of resources in the Internet of Things. This is achieved by proposing a virtual-resource edge layer, which enables access and configuration to constrained physical resources. The architecture presented focuses on the use of virtual resources as a management concept and identifies different approaches in the performance evaluation on edge computing devices. Using the IoT protocol CoAP, virtual resources are exposed in the edge network. An evaluation of a Go CoAP virtual resource is presented (9).

II. BACKGROUND & SCOPE

A.IoT enabling Technology:

- RFID tag is a simplified, low cost, disposable contactless smartcard. It includes a chip to store a static number (ID) and attributes of the tagged object and an antenna. RFID Tags can be active, passive or semi-passive. It tags on an "unintelligent" object like pallet or and animal.
- Cloud Computing: Cloud computing involves provisioning of computing, networking and storage sources on demand and providing these resources as metered services to the users, in a "pay as you go " model. Cloud

computing services are offered to users in different forms Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS),Software-as-a-Service (SaaS)

- Big Data Analytics: Big data is defined as collections of data sets whose volume, velocity (in terms of its temporal variation), or variety, is so large that it is difficult to store, manage, process and analyze the data using traditional databases and data processing tools.
- WSN is more for sensing and information-collecting purposes. Recently with the development of WSN, it led to distributed wireless sensor and actuator networks (WSANs).Extended scope of WSN is the USN (Ubiquitous Sensor Network), a network of intelligent sensors.
- SCADA: The Internet of Controllers, Supervisory Control and Data Acquisition

  It was generally referred as Industrial Control Systems (ICSs): computer systems that monitor and control industrial, infrastructure, or facility-based processes.
- Zigbee: Zigbee is low-cost and low-powered mesh network widely deployed for controlling and monitoring applications where it covers 10-100 meters within the range. This communication system is less expensive and simpler than the other proprietary short-range wireless sensor networks as Bluetooth and Wi-Fi.

  Zigbee supports different network configurations for master to master or master to slave communications. And also, it can be operated in different modes as a result the battery power is conserved. Zigbee networks are extendable with the use of routers and allow many nodes to interconnect with each other for building a wider area network.
- KNX: KNX is designed to be independent of any particular hardware platform.

  A KNX Device Network can be controlled by anything from an 8-bit microcontroller to a PC, according to the needs of a particular implementation. The most common form of installation is over twisted pair medium.

B. *IoT levels:*

- **IoT Level-1:** It has a single node/device that performs sensing and/or actuation, stores data, performs analysis and hosts the application. Level-I IoT systems are suitable for modeling low-cost and low-complexity solutions.

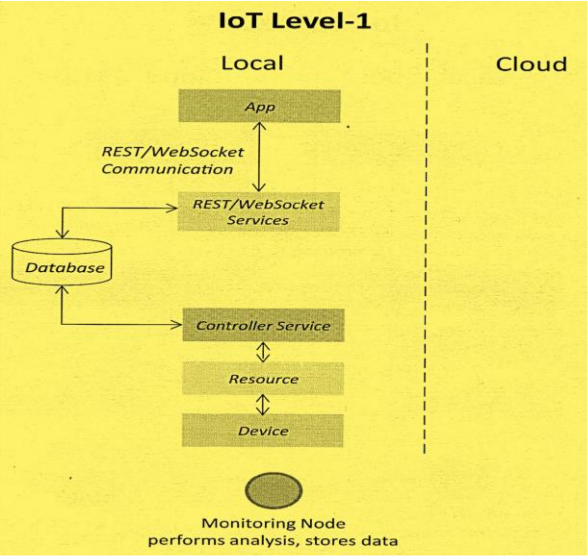

Fig.2.2.1: IoT level 1

- **IoT Level-2:** It has a single node that performs sensing and/or actuation and local analysis. Data is stored in the cloud and application is usually cloud-based.Level-2 IoT systems are suitable for solutions where the data involved is big, however, the primary analysis requirement is not computationally intensive and can be done locally itself.

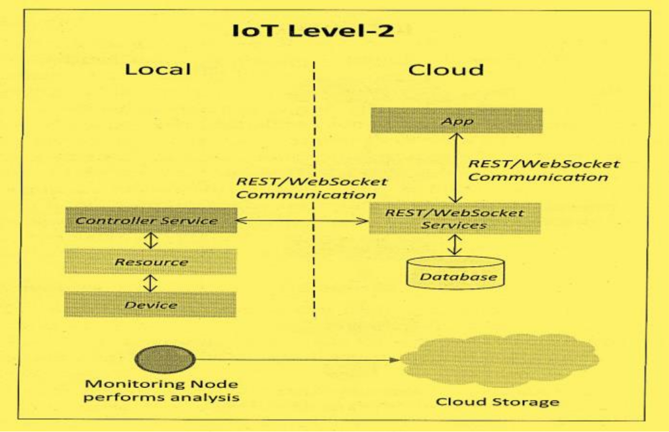

Fig.2.2.2: IoT level 2

- **IoT Level-3:** It has a single node. Data is stored and analyzed in the cloud and application is cloud-based.Level-3 IoT systems are suitable for solutions where the data involved is big and the analysis requirements are computationally intensive.

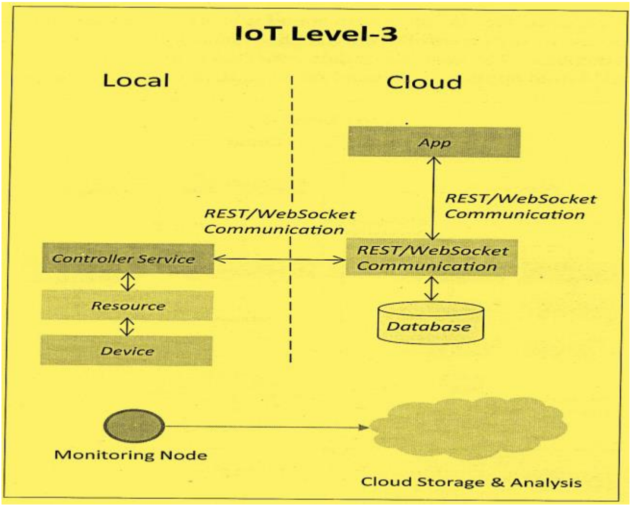

Fig.2.2.3: IoT level 3

- **IoT Level-4:** It has multiple nodes that perform local analysis. Data is stored cloud and application is cloud-based. It contains local and cloud-based observer nodes which can subscribe to and receive information collected in the cloud from IoT devices. Observer nodes can process information and use it for various applications, however, observer nodes do not perform any control functions.Level-4 IoT systems are suitable for solutions where multiple nodes are required, the data involved is big and the analysis requirements are computationally intensive.

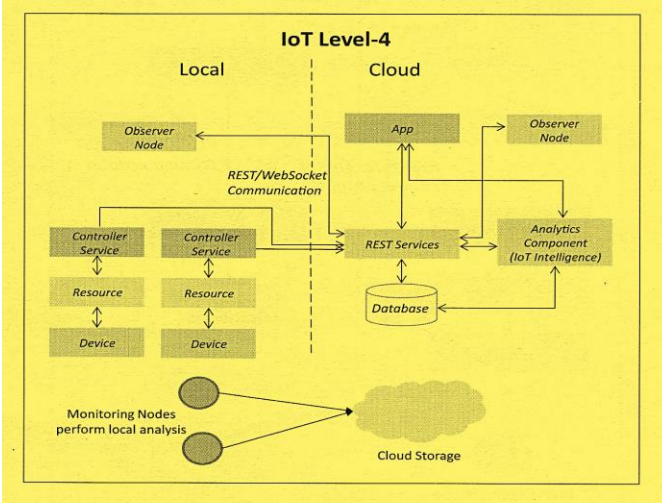

Fig.2.2.4: IoT level 4

- **IoT Level-5:** It has multiple end nodes and one coordinator node. The end nodes that perform sensing and/or actuation. Coordinator node collects data from the end nodes and sends to the cloud. Data is stored and analyzed in the cloud and application is cloud-based.Level-5 IoT systems are suitable for solutions based on wireless sensor networks, in which the data involved is big and the analysis requirements are computationally intensive.

- **IoT Level-6:** It has multiple independent end nodes that perform sensing and/or actuation and send data to the cloud. Data is stored in the cloud and application is cloud-based. The analytics component analyzes the data and stores the results in the cloud database. The results are visualized with the cloud-based application. The centralized controller is aware of the status of all the end nodes and sends control commands to the nodes.

III. APPLICATIONS OF IOT

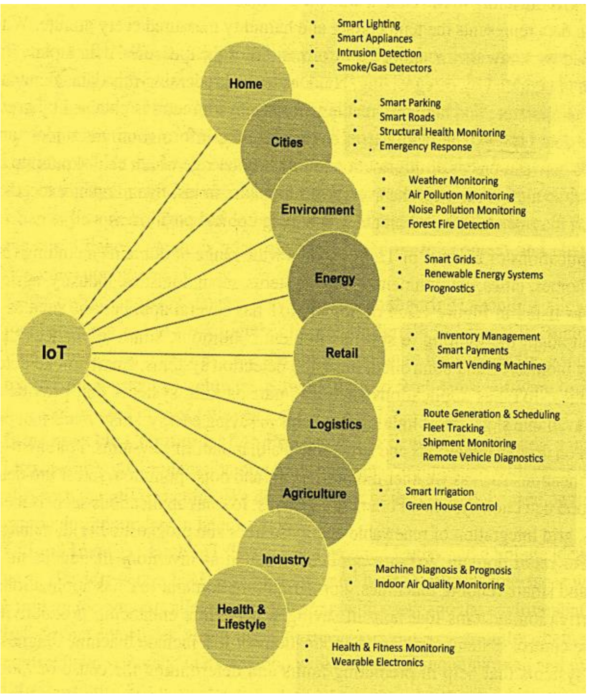

Fig.3.1 Applications of IoT

1) *Smart Homes:* The IoT has the capability of making the homes smart by managing energy consumption, providing interaction among the home appliances, spotting emergencies, ensuring safety etc

2) *Smart Cities*: The IoT also finds its application in designing smart cities e.g., observing and controlling the good air quality, identifying emergency routes etc.

3) *Natural calamities prediction:* The sensors through their interaction, coordination and simulation can predict the natural calamities like earthquake, hurricane, volcanic eruptions etc. so as to initiate feasible actions in time.

4) *Water shortage detection:* The IoT can find out the shortage of water at possible locations. The group of sensors, along with simulation tasks not only monitors water intercession but may also be able to identify the sewage release in the water stream leading to accidental hazards with severe after-effects.

5) *Healthcare:* The IoT can be of great help in medical area for enhancing the lives of many by monitoring metrics associated with health, managing medicines in inventory etc.

6) *Smart farming:* Through a group of sensors different land requirements can be identified and particular actions can be taken as per the need of the land. Various use case scenarios include smart wrapping up of seeds, fertilizers to cater to particular environmental conditions. Smart farming will help in adopting better farming practices by getting acquainted with the various possible land conditions and climate instability. This will drastically enhance the productivity by averting the incorrect farming practices.

7) *Smart Transport:* The intelligent network of sensors will be able to efficiently monitor the traffic and can implement fascinating and much needed feature of ceaseless electronic highway toll, law enforcement, monitoring rules breaching by vehicles, decreasing environmental pollution, alleviating traffic etc.

8) *Smart Security:* The IoT sensors also find their applications in the area of security e.g. inspection of spaces, maintaining infrastructure and equipment's, alarming etc.

The IoT applications will keep on evolving with time but at the same time it has to overcome many challenges pertaining to privacy, complexity, sufficient spectrum for associating large number of smart devices etc. A number of possible key challenges are listed in the section below.

IV. CONCLUSION

Internet of Things (IoT) has the potential of improving our day -to-day life by interconnecting the smart objects, technologies, and applications. IoT would automate nearly all activities around us. This paper presented an outline of this very concept, technologies empowering it, its structure and various possible applications.

This should impart sound knowledge and provide a base for researchers who are keen to have an insight into IoT, key technologies and its architecture. Further, the possible applications have also been discussed.

REFERENCES

[1] International Conference on Computational Intelligence and Data Science (ICCIDS 2018) Internet of Things: Vision, Applications and Challenges Rishika Mehtaa , Jyoti Sahnib, Kavita Khannac *aThe Northcap University, Gurugram b The Northcap*

University, Gurugram cThe Northcap University, Gurugram.

[2]The 9th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN 2018) Towards Security on Internet of Things: Applications and Challenges in Technology Kazi Masum Sadique*, Rahim Rahmani, Paul Johannesson Department of Computer and Systems Sciences, Stockholm University, Stockholm, Sweden

[3] The industrial internet of things (IIoT): An analysis framework, Author links open overlay panel Hugh Boyes Bil Hallaq Joe Cunningham Tim Watson

[4]The Internet of Things: Foundational ethical issues.Author links open overlay panel Fritz Allhoffa Adam Henschkebc

[5]An Elevator Monitoring System Based On The Internet Of Things,Author links open overlay panel You Zhoua Kai Wangb Hongxia Liuab

[6]Machine learning for internet of things data analysis: a survey Author links open overlay panelMohammad maeidMahdavine jadab Mohammadreza Rezvanab Mohammadamin Barekatainc Peyman Adibia Payam Barnaghid Amit P.Shethb

[7] From the Sociology of Things to the “Internet of Things” Yury Shaeva,* a Associate Professor, Pyatigorsk State Linguistic University, ul. Telman str.3, 21, Kislovodsk 35774, Russia Federation

[8]Towards Security on Internet of Things: Applications and Challenges in Technology Kazi Masum Sadique*, Rahim Rahmani, Paul Johannesson

[9]Management and Internet of Things, Author links open overlay panel Mayra Samaniego Ralph Deters.