IoT (Internet of Things) Concept and Improved Layered Architecture

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***Abstract*: - The internet of things (IoT) is a concept that has a role in facilitating people lives through the use of tablets, smartphones, PCs and other devices connected to the internet. Knowing that the number of people using connected devices on the internet increases every year dramatically. Also, internet of things (IoT) provides a vision of the future internet where connecting physical things; from backnotes to bicycles through a network letting them take an active part in the Internet and exchanging information about themselves and their surroundings, which gives immediate access to information about the physical world, leading to innovative services and increasing efficiency and productivity. This paper proposes an improved architecture to the internet of things (IoT) that takes into consideration the environment surrounding the devices, Basic Concept of IoT and its working**.

Keyword- Internet of Things, Building Blocks of IoT, Layered Architecture

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I. INTRODUCTION

"The "Internet of Things" is the general idea of things, especially everyday objects , that are readable, recognizable, locatable, addressable, and controllable via the Internet - whether via RFID, wireless LAN, wide-area network, or other means." An important thing is that while the most common Internet-connected devices are computers such as laptops, servers, smartphones, and tablets (e.g., iPads, etc.), the IOT concept is much broader. In particular, everyday objects that have not previously seemed electronic at all are starting to be online with embedded sensors and microprocessors, communicating with each other and the Internet. This includes several items such as food, clothing, household appliances, materials, parts, commodities, luxury items, landmarks, buildings, and roads. It is estimated that 5% of human-constructed objects currently have embedded microprocessors [1]. These tiny microprocessor chips and sensors record and transmit data such as sound waves, temperature, movement, and other variables. Cisco estimates that by 2020 there will be 50 billion connected devices, 7 times the world's population [2].

II. BUILDING BLOCKS of IoT (Internet of Things)

Four things form basic building blocks of IoT system –sensors, processors, gateways, applications. Each of these nodes has to have their own characteristics in order to form an useful IoT system.[3]

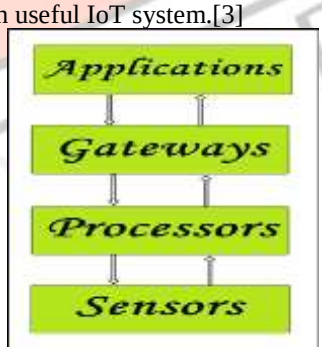

Figure 1: Simplified block diagram of the basic building blocks of the IoT

Sensors - These form the front end of the IoT devices. These are the so called "Things" of the system. Their main purpose is to collect data from its surrounding (sensors) or give out data to its surrounding (actuators).These have to be uniquely identifiable devices with a unique IP address so that they can be easily identifiable over a large network. Examples of sensors are: gas sensor, water quality sensor, moisture sensor etc.

Processors - Processors are the brain of the IoT system. Their main function is to process the data captured by the sensors and process them so as to extract the valuable data from the enormous amount of raw data collected. In a word, we can say that it gives intelligence to the data. Processors mostly work on real-time basis and can be easily controlled by applications. These are also responsible for securing the data – that is performing encryption and decryption of data. Embedded hardware devices, microcontroller etc. are the ones that process the data because they have processors attached to it.

Gateways - Gateways are responsible for routing the processed data and send it to proper locations for its (data) proper utilization. In other words, we can say that gateway helps in to and fro communication of the data. It provides network connectivity to the data. Network connectivity is essential for any IoT system to communicate. LAN, WAN, PAN etc. are examples of network gateways.

Applications - Applications form another end of an IoT system. Applications are essential for proper utilization of all the data collected. These cloud based applications which are responsible for rendering effective meaning to the data collected. Applications ae controlled by users and are delivery point of particular services. Examples of applications are: home automation apps, security systems, industrial control hub etc.

III. Internet of Things (IoT) characteristics

The fundamental characteristics of the IoT as defined by IERC are as follows [6]:

Interconnectivity - With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.

Things- related services - The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, both the technologies in physical world and information world will change.

Heterogeneity - The devices in the IoT are heterogeneous as based on different hardware platforms and networks.

Dynamic changes - The state of devices change dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically.

Enormous scale - The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. The ratio of communication triggered by devices as compared to communication triggered by humans will noticeably shift towards device-triggered communication. Even more critical will be the management of the data generated and their interpretation for application purposes. This relates to semantics of data, as well as efficient data handling.

IV. HOW IoT WORKS

How the IoT works is quite simple.

First, it acquires information with respect to basic resources (names, addresses and so on) and related attributes of objects by means of automatic identification and perception technologies such as RFID, wireless sensor and satellite positioning, in other words the sensors, RFID tags and all other uniquely identifiable objects or "things" acquire real-time information (data) with the virtue of a central hub like smartphones.

Second, by virtue of many kinds of communications technologies, it integrates object-related information into the information network and realizes the intelligent indexing and integration of the information related to masses of objects by resorting to fundamental resource services (similar to the resolution, addressing and discovery of the internet).

Finally, utilizing intelligent computing technologies such as cloud computing, fuzzy recognition, data mining and semantic analysis, it analyzes and processes the information related to masses of objects so as to eventually realize intelligent decision and control in the physical world.

V. Architecture of IoT

Figure2[4] The internet of things layered architecture is illustrated as supposed by the ITU-T (International Telecommunications Union - Telecommunication Standardization Sector) and is composed of four layers; the top or first layer is the IOT application layer which contains the application user interface, the second layer is the services and application support layer, the third layer is the network layer which contains the networking and transport capabilities, the bottom layer is the device layer, which contains the gateways and the hardware and sensors and RFID tags and others. Along the four layers, the security and management capabilities and functions are distributed.

IoT layered Architecture (Source: ITU-T) The internet of things is a universal concept and needs to be defined in a common way. Taking into consideration the huge background and diverse required technologies, from sensing device, communication subsystems, data aggregation and pre-processing to the object instantiation and finally service provision, generating a clear definition of the "Internet of Things" is not simple.

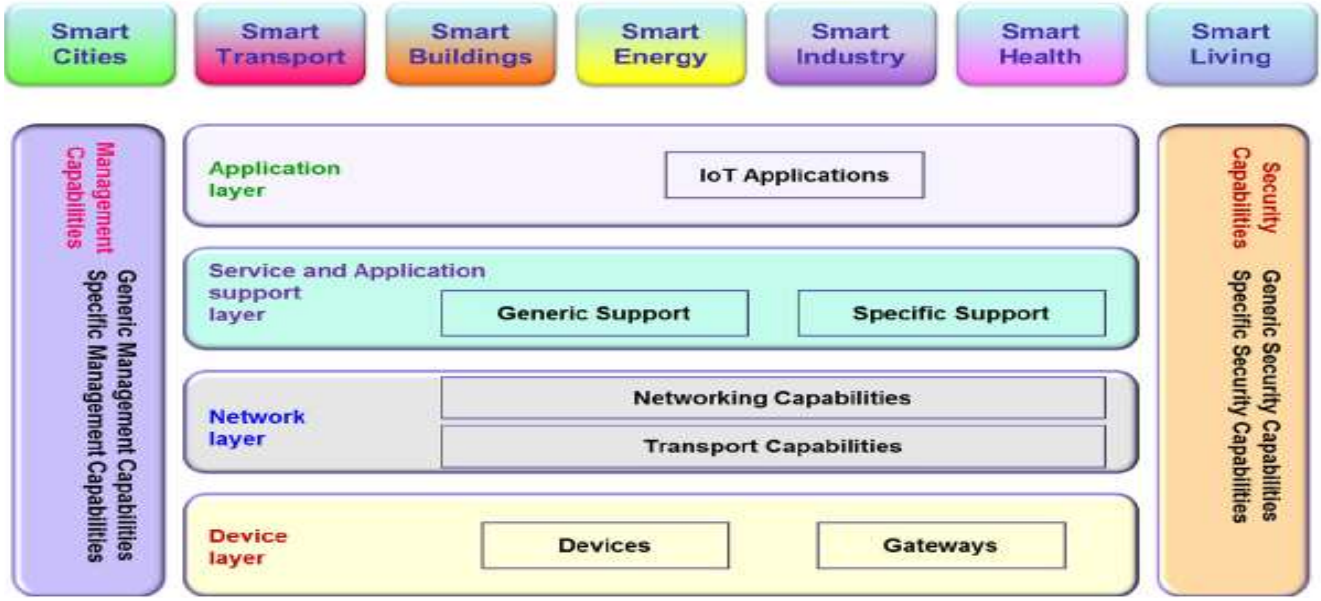

Figure2: Layered Architecture

VI. Proposed Improved Layered Architecture for IoT:

An improved layered architecture for internet of things (IOT) is proposed. [5] This improved layered architecture depends on seven layers, not on four layers as the traditional layered architecture, and takes all the functions of the traditional architecture and distribute them on the seven layers, but in a more reliable way. The proposed improved layered internet of things (IoT) architecture composed of seven layers, is illustrated in Figure3, as follows:

1- Application layer:

Includes the IoT application. This layer is at the top of the architecture and is responsible for delivery of various applications to different users in IoT. The applications can be from different industry segments such as: manufacturing, logistics, retail, environment, public safety, healthcare, food and drug etc. With the increasing maturity of RFID technology, numerous applications are evolving which will be under the umbrella of IoT.

2- Application support & management layer:

Performs the following functions; Qos Manager – Device Manager – Business Process Modeling – Business Process Execution – Authorization – Key Exchange & Management – Trust & Reputation - Identity Management. In this layer, all actions related to the control, security and management of the application are made.

3- Services layer:

Performs the following functions; Service storage & orchestration – Service composition & organization – Virtual Entity resolution – IoT service – VE service – IoT service resolution – VE & IoT service monitoring. All decisions related to the monitoring, storage, organization and visualization of the received information, including resolving virtual entities created, are made.

4- Communication layer:

Performs the following functions; Flow control & Reliability – Qos – Energy Optimization. Also, it performs cross platform communication, if required. The IoT web portal is in this layer. All decisions related to communications and measurements of the flow and its quality and energy consumed are made in this layer.

5- Network layer:

Performs the following functions; Gateway – Routing & Addressing – Network Capabilities – Transport Capabilities – Error detection & Correction. Also, it takes care of message routing, publishing and subscribing. With demand needed to serve a wider range of IOT services and applications such as high speed transactional services, context-aware applications, etc, multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security.

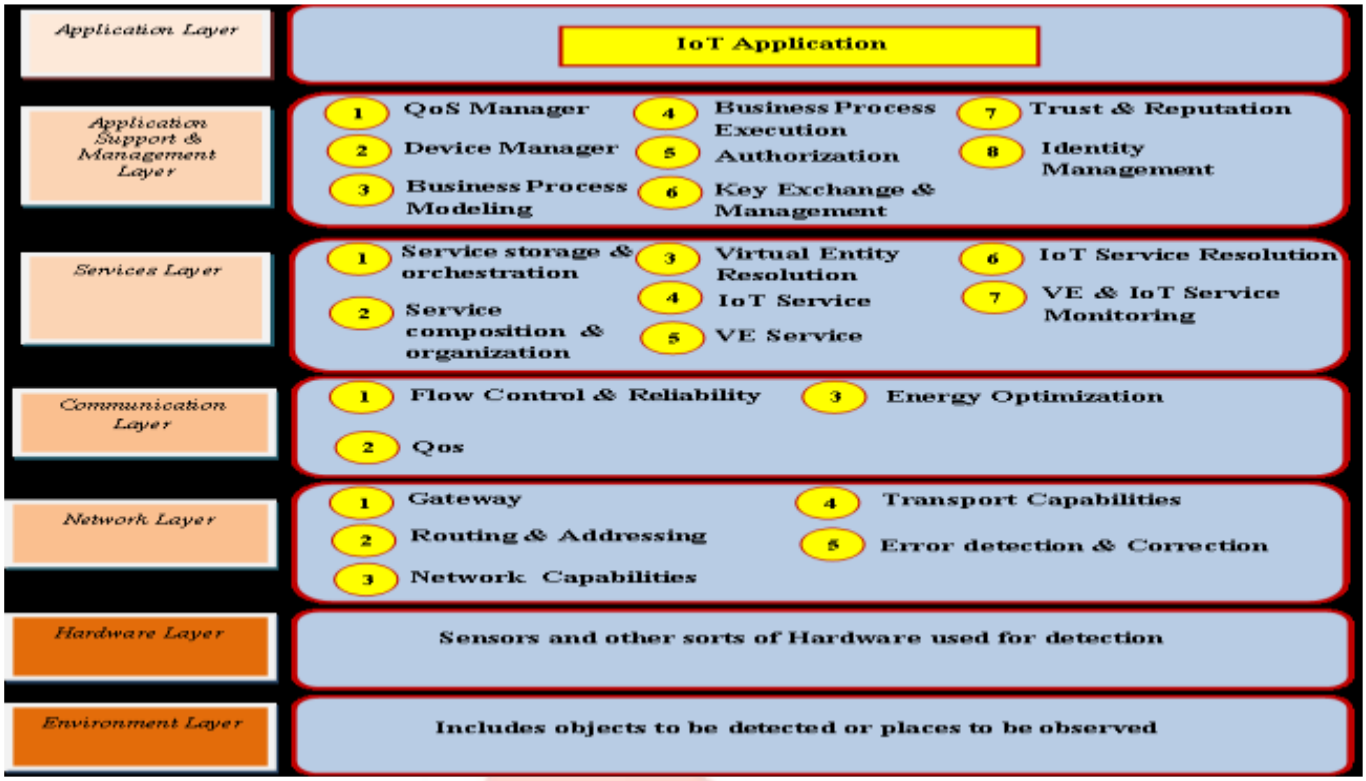

Figure3: Proposed Improved Seven Layered Architecture

6- Hardware layer:

Includes sensors, other hardware such as; embedded systems, RFID tags and readers and others. The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. The miniaturization of hardware has enabled powerful sensors to be produced in much smaller forms which are integrated into objects in the physical world. There are various types of sensors for different purposes. The sensors have the capacity to take measurements such as temperature, air quality, movement and electricity. In some cases, they may also have a degree of memory, enabling them to record a certain number of measurements. A sensor can measure the physical property and convert it into signal that can be understood by an instrument. Sensors are grouped according to their unique purpose such as environmental sensors, body sensors, home appliance sensors and vehicle telemetric sensors, etc. Many of these hardware elements provide identification and information storage (e.g. RFID tags), information collection (e.g. sensors), and information processing (e.g. embedded edge processors).

7- Environment layer

Includes objects to be detected or places to be observed. The objects to be detected vary from physical moving objects, such as humans, cars, to environmental factors such as, temperature, or humidity. The places to observed are ranging from buildings, universities, streets and so on.

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