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Layered model architecture for internet of things

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Abstract
Depending on developments in sensor technology, the production of very small and low-cost sensors has been increased. In parallel, thanks to the internet becoming an indispensable part of our lives, accessing from internet to computer, handheld computer, smart phone or other objects become a prerequisites. The networks which used daily life objects communicate each other must be stand robust structure. In this study, we have proposed a layered structure for Internet of things (IOT) and we have compared with other layered model.

Keywords: Internet of things; layered model; layered architecture

1. Introduction

Developments in electronic technology cause rise to shrink in computer systems. Sensors and wireless sensors have been affected from those improvements. Wireless sensors are nodes which transfer one or several physical features of environment directly or by intersecting each other to base station. Wireless sensor nodes consist of central processing unit (CPU), limited storage media, sensing system, data and control bus to communication and operating system. In terms of this, wireless nodes are computer systems. There are other objects in our environment that they have not these qualifications, but we need to communicate with them. Wireless sensor technologies are used to be able to send their own data to other objects by internet.

Internet of things (IOT) is community of network that consists of information shaping devices by interconnecting and communicating with each other thanks to communication protocols. In 1991, about fifteen academics in Cambridge University installed a camera system to be able to see coffee machine. The camera system sent image of coffee machine to computer screen three times per minute. This system is assumed as starting step of IOT. Afterwards, in 1999 this concept was presented by Kevin Ashton which it begins to be widely accepted nowadays [1]. IoT can connect computer to small mechanic devices as in sensor node. Sensors can observe temperature, illuminant, pressure, sounds, or motion. By this way, they can follow habits of people. The things can transfer their preferred temperature, body statistics to adjacent things [2]. Basis of concept of IOT consist of Machine to Machine (M2M) Communication are in communication machines without people intervention. It would seem that data will be able to produce and spend faster than today in future [3].

IOT is able to use in communication between traffic lights and vehicles in traffic, in communication between consumer electronics and kitchenware, smart home system, smart towns and so on. Most of Technology Company starts to invest and make production in this field. The study focuses on the concept of IOT in this section. In second section, sensing and data transfer technologies are handled. In third section, we have given the literature studies. In fourth section, layered model architecture is proposed and in the last section conclusions and future work is mentioned.

2. Sensing and Transfer Technologies

Using of numerous different technology (6LoWPAN, ZigBee, Bluetooth, RFID, NFC, 3G, Wi-Fi, GSM, 4G/LTE etc.) bring along new job models for communication in IOT applications. When traditional communication infrastructure is applied exactly for IOT components, sufficient yield can be not taken.

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As a standardized architecture have not been yet, problems about interoperability of IOT networks can be experienced. In this section, RFID, ZigBee and NFC technologies take part that they are frequently used within IOT.

2.1. Rfid (Radio Frequency Identification)

RFID is sensing technology that contains a microchip, an antenna and protective film (which cover the microchip and antenna) [4]. Microchip provides object recognition by used radio frequency. RFID technology supplies to store and transfer information of things by way of electronic identity. Electronic identity be called as Electronic Product Code (EPC). The technology is able to apply in many areas such as inventory tracking, personnel tracking, access control systems, asset tracking, animal tracking, and automatic toll collection system.
The tag of RFID sends sensed and stored information to reader. The Reader forward received information to system centre directly or by way of a base station on network. Incoming information was used or stored according to intended purpose. RFID technology actualizes sensing process automatically without human interaction [5].

There is a microchip and an antenna that surrounds the microchip in the tag. Electromagnetic waves emitted by the reader providing energy that activate the chip and data transfer is made the reader from tag without contact and wirelessly at defined distance [6].

RFID tags are three types as active, passive and semi-active. Active tags have not their own a power supply. They benefit from power supply of reader. So, their lifetime is long, however distance of readout is short. Passive tags have their own power supply. Passive tags have following specifications: short lived, long reading distance, high cost. Highway toll payment systems used card access control systems contain passive tag and automatic access systems active tag RFID in our country [7].

2.2. ZigBee

ZigBee is a wireless networking standard that is aimed at remote control and sensor applications which is suitable for operation in hard radio environments and in isolated locations. ZigBee technology builds on IEEE standard 802.15.4 which defines the physical and MAC layers. ZigBee defines the application and security layer specifications enabling interoperability between products from different manufacturers. In this way ZigBee is a superset of the 802.15.4 specification.
The distances that can be achieved transmitting from one station to the next extend up to about 70 meters, although very much greater distances may be reached by relaying data from one node to the next in a network. The main applications for 802.15.4 are aimed at control and monitoring applications where relatively low levels of data throughput are needed, and with the possibility of remote, battery powered sensors, low power consumption is a key requirement. Sensors, lighting controls, security and many more applications are all candidates for the new technology [8].

2.3. Nfc (Near Field Communication)

Near field communication (NFC) is a set of ideas and technology that enables smart phones and other devices to establish radio communication with each other by touching them together or bringing them into proximity, typically a distance of 10 cm or less. Each full NFC device can work in 3 modes: NFC target (acting like a credential), NFC initiator (as a reader) and NFC peer to peer. Most of the first business models like advertisement tags or other industrial applications have not been successful, always overtaken by another technology. The main advantage of NFC is that NFC devices are often cloud connected. "Connected" credentials can be provisioned over the air unlike a standard card. All connected NFC enabled smart phones can be provisioned with dedicated applications, which give any application a huge potential, like dedicated readers, access control or payment readers. All NFC peers can connect a third party NFC device with a server for any action or reconfiguration [9].
As with proximity card technology, near-field communication uses electromagnetic induction between two loop antennas located within each other's near field, effectively forming an air-core transformer. It operates within the globally available and unlicensed radio frequency ISM band of 13.56 MHz on ISO/IEC 18000-3 air interface and at rates ranging from 106 kbit/s to 424 kbit/s. NFC involves an initiator and a target; the initiator actively generates an RF field that can power a passive target called tag. This enables NFC targets to take very simple form factors such as tags, stickers, key fobs, or battery-less cards. NFC peer-to-peer communication is possible, provided both devices are powered. NFC tags contain data and are typically read-only, but may be rewritable. The tags can securely store personal data such as debit and credit card information, loyalty program data, PINs and networking contacts, among other information. They

can be custom-encoded by their manufacturers or use the specifications provided by the NFC Forum. The NFC Forum defines four types of tags that provide different communication speeds and capabilities in terms of flexibility, memory, security, data retention and write endurance. The Forum also promotes NFC and certifies device compliance and if it fits the criteria for being considered a personal area network [9].

3. Layered Architecture Studies

Some layer proposal studies are involved in literature, even though a widely accepted layered architecture is not for IOT. The studies are explained in this part.

In [10], three layered structure is suggested for IOT. These are sensing layer, network layer and application layer. Two dimensional RFID tags and readers, cameras, GPS, all sensors, sensor network and machine device run in sensing layer. Fundamental function of sensing layer is to collect information, to define sensing object and to sense physical features. Network layer provide a combination environment for all communication types. IOT management system and information system are components of network layer. Network layer runs as a universal service. Smart application technologies are carried out in application layer. It is the last point that industrial applications integrate with each other in this place.

Similarly, three layered architecture is proposed by Yan Bo [11]. This architecture consists of sensing layer, network layer and application layer. In this study, devices and applications which run in each of layer are detailed.

In [12], a five layered architecture is proposed by Anthony Furness. Edge technology layer, access gateway layer, internet layer, middleware layer and application layer are found in this structure. RFID readers and tags are in edge technology layer. Inter technology communication devices are situated in access gateway layer. IP-based communication is provided in network layered. Middleware layer incorporates services which run in background of application layer software.

Layered architecture is introduced by ITU (International Telecommunication Union) which consists of five layers. These are network element layer, element management layer, network management layer, service management layer and business management layer [13]. Sensors take part in network element layer. Element management layer focuses on managing running elements at the bottom independently of their technology. Network management layer is responsible for widespread physical element's functional addressing. Service management layer's function is to take and conclude service requests. Business management layer is the top of layer which is responsible for action of all applications.

According to architecture proposal which predicates ITU's architecture on involves five layers. These are RFID tags, RFID readers, sensors and signaling between these are defined in sensing layer. Transfer layer is responsible for data transfer which produces in sensing layer. Processing layer is responsible for storing data, analysis of data and significant information extraction. Different industrial applications are realizable in application layer. Business layer supplies management of applications [14].

In [15], three layered model is suggested. This model has sensing extension layer, network layer and application layer. Sensors and physical devices take part in sensing extension layer. Network layer and application layer fulfills similar task to other models.

The other layered architecture proposal gives in [16]. EPC compose of three layers: EPC coding system, radio frequency definition system and information network system.

Most of the models are based on architecture that it is proposed by Jammes et al in [10].

4. A New Iot Layered Architecture

TCP/IP model is first model of computer networks area. The model in Figure-1 consists of four layers and based on TCP/IP protocol stack. This model's point of motivation is interactions of protocols. Then OSI model has been developed in order to reveal a standard language in the network world. The architectural with TCP/IP and OSI model contains of seven layers in Figure-1.

These models are suitable for wired and wireless networks. All network manufacturers and users refer to this model. Similarly, the use of layered model in IOT provides between manufacturers and users association. Although there are studies in about IOT technology, there are not accepted standard studies.

Our proposal IOT architecture consists of four layers.

When we creating architecture, both has been considered computer network's conventional model and has been included new technological aspects. Accordingly, the layered model shown in Figure-2 consists of perception layer, network layer, transport layer and application layer.
Perception layer consists of two sub layers. The first is device sub layer, second is the access sub layer. All devices makes measurement of physical quantities (Sensors, RFID tags, RFID readers, NFC readers etc.) works in device layer. Access sub layer supplies devices which same type or using same media access method. Perception layer provides transmission of data if homogeny technology used in network.

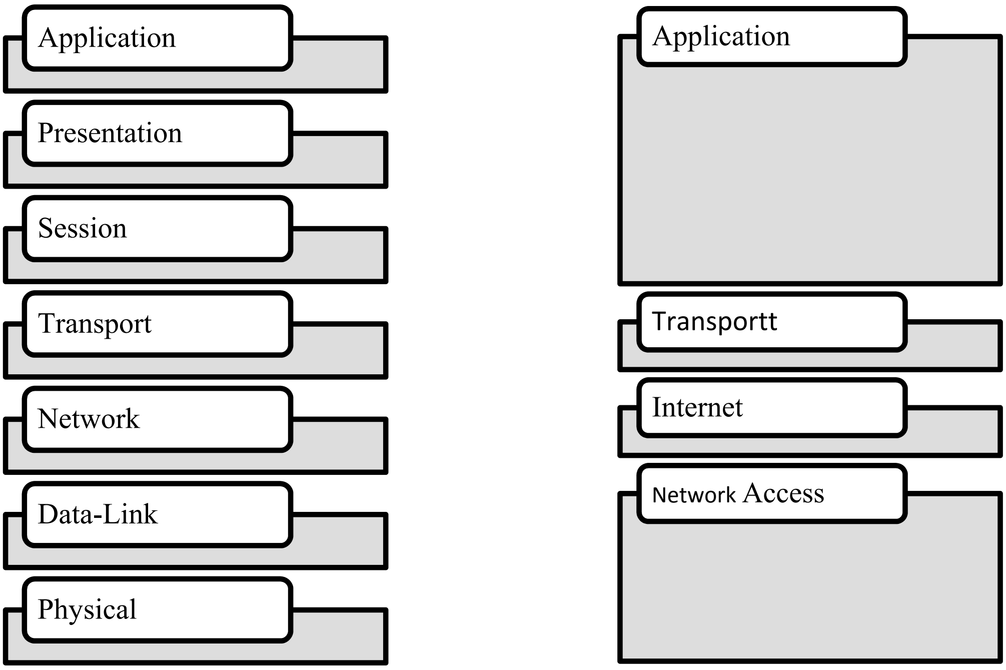

Figure 1. OSI and TCP / IP layer models.

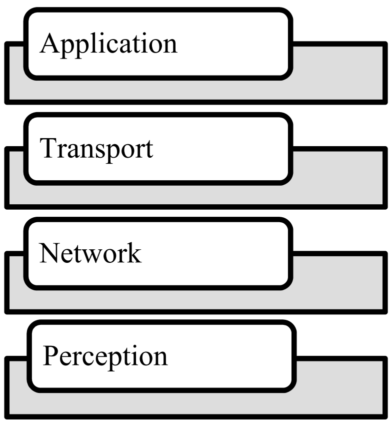

Figure 2. New IOT Layered Architecture.

The network layer provides the communication nodes have the different technologies. Network layer must use one of IP protocols. IPv6 protocol proposed as default protocol by us. IPv6 protocol has some technical specification such as application of security policy, high addressing number.
Transport layer provides implementation of Quality of Service (QoS), reliability and security rules. Quality of service must be applied for communication which between devices communication to be given priority on IOT. Reliability rules to guarantee that the transmission frame received by the receiver can be operated in the transport layer. Application layer provides end-user

operations and forms communications software. Application software and services work on application layer.
The proposed layered model is different from the other models in literature in terms of perception sub layers and transport layer functions. Our layered model is similar OSI and TCP/IP model in terms of performed roles.

5. Conclusions

Depending on development of communication and sensing technologies cheaper and simpler nowadays, it has been need to communication with all of the objects in our lives. Internet of Things has become a new focusing issue for the researchers. In this study, a new layered model proposed for IOT architecture. The proposed model compared with IOT models in the literature and conventional OSI and TCP/IP models that using wired and wireless computer networks.

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