A survey on the most important internet of things technologies

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Abstract

Internet of things (IoT) domain targets human with smart resolutions through the connection of "M2M" in all over the world, effectively. It was difficult to ignore domain importance field of IoT with the new deployment of applications such as smartphone in recent days.

The most important layer in architecture of IoT is network layer, because of various systems (perform of cloud computing, switching, hub, gateway, so on), different technologies of connection (Long-Term Evolution (LTE), WIFI, Bluetooth, etc.) gathered in layer. Network layers should transfer the information from or to various applications/objects, via gateways/interfaces between networks that are heterogeneous, therefore utilizing different connection technologies, protocols. Recent work highlighted IoT technologies state-of-the-art utilized in architectures of IoT, some variations among them in addition to the applications of them in life.

Keywords: Technologies, "IoT", RFID, Wi-Fi, 6LoWPAN, Bluetooth, ZigBee.

Introduction

Connection, computing, progresses of sensing changed the internet to individuals to internet of things. IoT includes sensors and actuators which are placed in daily objects that can outright the connection and decision making. Sensors are power restricted and bandwidth with applications of healthcare, industrial, automatic, smart-home areas and transportation.

While developments restricted battery lost technology to hold with the improvements in computing devices, ask in order to organize power consumption has become essential. Recently, power organization requires some designs for assessing devices power consumption in IoT (1).

As more and more the devices of IoT are communicated, connected, the applications of IoT produce great traffic of "IoT", since the traffic of "IoT" is for connection among things, reliability of transmission is crucial, particularly in the relatively unfixed WSN, compared to the wired network. Technology of IoT is used in a lot of fields, such as transportation, environmental monitoring, industry, automotive vehicles, healthcare, medical technology, smart-home, smart-city (2).

IoT technologies should indicate safe and continuous connection of internet, continuous, connection technologies are the basic systems of IoT, provide a connection that is integrity for the internet allowing devices to change information across the network (3).

Connection in WIFI, small-board, RFID, Bluetooth and ZigBee may be a reasonable answer. Thus, to connection that is large-board such as the industrial automation, Zigbee and cellular technologies (4). WiMAX to a sample mobile phone is able to be the great choice (3&5).

So, the common obstacles in large-board connection technologies are high costs to end-users, the restricted amount of communications, annuity high basic costs. In the other words, hardware devices with small connection have profit, while they are easy to set up cheaper, smaller (6).

Technologies that are essential in architectures of IoT in the healthcare were the connection technologies which are low-board, like Bluetooth (58.3%), WIFI (75%), ZigBee (25%), RFID (37.5%). Thus, 6LoWPAN was major protocol which is utilized in articles (33.33%). The protocol

enables sensor network communications by the internet, which has designed to interoperability guarantee internet and sensor networks (7).

In IoT, there are various technologies to interact, communicate objects with internet/each other, which we described the most recent technologies here and presented for the implementation of it.

Low energy of Bluetooth and Bluetooth

It is provided in 1999, technology of Bluetooth is the technology that is wireless which is called to capability in order to transmit the information through distances that are short in some network private domains. Low energy of Bluetooth "BLTE" is novel add to Bluetooth technology spend over device of Bluetooth Classic half power and the main Bluetooth version. BLTE energy output is imputable for shorter time of comparison required to the devices of BLTE for determining the other devices: 0.6-1.2 MS in comparison to 22.5 MS to the Bluetooth Classic (8).

Thus, data effective transfer with collecting, transferring situations enable BLTE for delivering higher efficiency of energy in comparison to the Bluetooth Classic. Energy Higher efficiency becomes in the lower rates of data cost: BLTE supports 260 Kbps, since Bluetooth Classic supports up to 2.1 Mbps (8).

An existence influence that is paired to devices with low-cost, presents BLTE such as a technology which is provided to IoT applications. However, fixed bottleneck is now interoperability, also BLTE is pleasant to the comparatively recent devices of Bluetooth in the dual-mode (called as the dual mode due to that they support Bluetooth Classic, BLTE), not legacy devices of Bluetooth Classic (9).

Low Power WiFi, WiFi

Although, Ethernet has used in 1970s, Wi-Fi is novel technology that is wireless that is greatly popular as transfer rates of data in privately high-speed and networks of arranged domain.

Commonly, Wi-Fi devices remain the secret, delays in data transmission, also low with keeping the mobile while any information is moved. Sometimes, WIFI communications install with batteries and power specialized line that need to be undertake after the couple of hours usage. Some devices in the lower-power “sleep” and higher-cost Wi-Fi when this moves no information and just need 10 MS to “wake up” while it called up, Low Power Wi-Fi by

the batteries is able to be utilized in order to remotely feel, and control applications, (10).

Interoperability of Worldwide for the access of Microwave (WiMAX),WiMAX 2

It is presented in 2001, WiMAX extended by ETSI at cooperation with IEEE. Novelist technology in the family of WIMAX is WiMAX 2. WiMAX 2 proposes high-speed data in 1 Gbps in comparison to 100 Mbps by WiMAX (11).

So, for data higher-speed, WiMAX 2 has optimal agreement of backward than WiMAX: network operators of WIMAX2 can provide integrated service by using 3G/2G networks when this is required. In comparing, LTE-A, LTE which is provided bellow, allow agreement of backward (12).

"LTE-advanced", "LTE" (Long-Term Evolution)

LTE is a technology of wireless network in a large domain that was extended by the body 3G Partnership Project members in 2008. The technology presents data of information data speeds up to 300 Mbps.

The advanced LTE is the novel add to LTE technology that proposes rates of data in still-higher in 1 Gbps in comparison to 300 Mbps to LTE. Now, it is a debate between industry occupying in whether LTE is accurately the technology of 4G or not, most people think that LTE is the pre-4G technology, and LTE-Advanced is 4G accurate technology. According to low-secret, high-bandwidth, LTE is attracted clients such as a technology that is more-promising to the applications of IOT; although, underlying the infrastructures of network stays below the deployment, since this is presented in challenges bellow (13).

Weightless

Weightless is a technology that is wireless open-standard WAN that is presented in first of 2014. Weightless utilizes the bandwidth that is unused majorly targets TV broadcast to transfer data; active range assignment technical based on progress, it can change distances that are penetrating and greater through walls.

Also, Weightless is able to present rates of information among 2.5 Kbps-16 Mbps in the wireless range up to 5 kM, with the batteries which are remaining for ten years. Weightless devices keep at replacement state, wake up every 15 minutes, remaining dynamic to 100 MS for the agreement, and work on every texts; this leads to a certain secret. In order to these attributes, Weightless communications dawn to be well-accurate in order to hand short texts in

widespread connections of machine-to-machine (14).

Zigbee

Zigbee is the network technology that is wireless which particularly designed to the sensors in rate that is low, the protocol of it includes one layer that is physical, layer of MAC, layer of network, layer of application. MAC and physical layers depend on the standard IEEE 802.15.4, since these in up specialized in its distinction. In ZigBee, network layer specifies 3 types of device. Router of Zigbee router is FFD by the capabilities of routing. In every network of Zigbee, one Zigbee coordinator exists that is the FFD monitoring in all network. End-device is the last type of device. 3 topologies are supported with networks of Zigbee: start, mesh, and topologies of tree. Performances in layer of Zigbee network unite routing that is hybrid-hop, security, route detection, leaving, joining, and keeping to network which sixteen-bit addresses specialized to the devices which are recently joined (15).

Z-Wave

Z-Wave is the connections protocol which is wireless and previously guide letting transferring that is control one unit reliable to one and the more nodes in a network, this includes 5 layers in the architecture of it: MAC, PHY, routing, transmit, and layers of application. Radio of Z-Wave works necessarily in several bands that are 900 MHz ISM close band. Yet, some areas have various laws. Since, 868 MHz has been utilized in Europe, since 908 MHz has been utilized in United State. FSK frequency is used by encrypting channel of Manchester. Previously, the protocol presented with rate of data in 9,600-bits in every second, yet this is previously developed to 20Kbps. Layer of MAC utilized abstinence of encounter with re-transferring that is a mechanism which is facultative and based on ACKs. This layer is calculated for transferring of data between two nodes. The attributes which are contained include confirmations, checksum and re-transfer. Two device types are allocated with Z-Wave: slaves, controllers. The controllers send commend toward the slaves, the do/respond commends. Also, the slaves might perform like the routers which save the routes which are static (15).

6LOWPAN

LOWPANs are wireless networks which include grate amount of low-price machine which adapt to IEEE 802.15.4 attributes to physical, MAC layers. In comparison to wireless networks, LOWPAN compromise as the low-bandwidth devices in low power, short size, and large amount package,

battery drain unreliability, physical intervention radio connection issues and devices lockups (16). When this is composed to IP, however, restrictions of LOWPAN are pleased. Therefore, 6LoWPAN exists.

6LoWPAN is the protocol which packages of IPv6 are able to be moved through networks of IEEE 802.15.4. 6LoWPAN will have many profits in comparison to utilizing some protocols that are not standard, like Z-Wire/ZigBee (17):

- ✓ At first, the gateways are not essential for translating messages among various protocols that are not standard, while all of WSNs utilized the standard IP.
- ✓ flexibility increased like new applications that won't need correction to specialized protocols in WSN.
- ✓ another profits united quick connection and agreement with some architectures that were exist before, plug-and play installation of WSNs and fast improvement applications in addition to the uniting things possibility by the services of web services existence which utilize the protocol of internet.

In order to create 6LoWPAN as a real hard, it will require to have each node to agree the same protocol. Previous great amounts of WSN protocols limited the support to be able to work via interfaces that are standard (15). So, difficulties increase in order to shape various protocols of WSN which join to a wider internet. Hardware and software significant assets might be essential to transfer protocol data of WSN to the relevant standards like TCP/IP. Answers might add overhead to data transmission and the reduction efficiency. As WSN protocols must be created to protect IPv6, currently, software layers bridging various 6LoWPAN efficiencies that must let inter-device connection. Although, the last aim of IoT is to have a fully practical performance.

Smart tag technology "RFID"

Smart tag technology/"RFID", refers to the systems which utilize the waves of radio in order to transmit information on a thing identity. The tags are more advanced barcodes types, due to that they have both capability of writing and reading, data which is stored on the tags of RFID is able to be locked, changed and updated. The technology has succeeded in order to prove the efficiency and capability of it as the affordable tool to improve performance, as well as reducing manpower and resources

cost and time in a lot of cases. From a total view, while parts of manufacture arrive in the step of processing with a reader of, the happening like reading number of RFID as well as storage provide important information for us. Robot or Machine will be informed with happening also it will consists a pat of production (18).

Near Field Communication

This is taken into consideration as the most effective subsets of RFID. Near Field Communication (NFC) is the novel capability of communication which is able to be utilized in order to connect securely among 2 devices which are at the short distance from each other. Besides the two gadgets adjacently, this is essential for both to utilize the specific hardware. Indeed, Near Field Communication is RFID latest version which the communication range of it restricted to 4 inches. It makes Near Field Communication very effective for the usages that are sensitive like utilizing the credit card (such as electronic payment wit utilizing Google Wallet)/entering the locations which are security. Some devices which protect the technology of NFC are easily able to let users to exchange/send the information with approximating/touching the devices to the other device (19).

Networks of Mobile (5G)

Development of fifth generation, mobile telecommunication networks 5G is occurring with high speed. Indeed, yet several countries have not upgraded the communications network to forth generation however 5G in under the development, scientists are talking on this with excitement. By utilizing the high rates of data, high bandwidth as well as facilitating the communications based on the internet, like video calls is just the capabilities corner which will be accessible for users via 5G networks implementation (20). One thing which enhances high bandwidth need is IoT concept. In order to deal with network connected devices increasing amount which are an IoT part, we require the wireless connectivity novel level to internet. According to 2020, we hope that projects implementation like smart home, smart city, smart things, smart transportations will just be feasible by 5G networks usage. The other 5G main attribute is network stability. Investigators highlight 5G networks stability so high which such networks are able to be taken into consideration better than the optical fiber in stability. In order to information which presented by Ericsson, delay in 5G network is 1MS. The attribute is a major using this technology pillars in regions where the stability has a significant

importance. Between the regions, this is feasible to utilize fifth generation networks related to the smart cars with no driver, and also to perform surgical ways variety in a remote form, the technologies are compared with each other in table1, Figure1 indicates IoT applications fields.

Table1. Technologies comparison utilized in architecture of IoT.

Cost	Low	High	High	High	High	Low	Low	Low	Low	Low to High	Low
Energy consumption	Bluetooth : Medium BLE: Very Low	High	Medium	High	Low	Low	Low	Low	Low	Very Low	Low
Transmission range	8–10 m	20–100 m	<50Km	15 km	5 km (urban)	10-100m	~30 m	25 - 50 m	3m	~ 5cm	
Data rate	1–24 Mb/s	1 Mb/s–6.75 Gb/s	1 Mb/s–1 Gb/s (Fixed) 50–100 Mb/s (mobile)	up to 100 Mbps downstream and 30 Mbps upstream	2.5 Kbps to 16 Mbps	20 kbit/s to 250 kbit/s	9.6/40 kbit/s	200 kbps	40 Kbps to 640 Kbps for FM0, 20-320Kbps(For Miller , M=2) , 10-160Kbps(For Miller, M=4), 5-80Kbps (For Miller, M=8)	106, 212, 424 Kbps	Avg 100 Mb/s Peak 20 Gb/s
Frequency band	2.4-2.5 GHz	5–60 GHz	2–66 GHz	Licensed LTE 200 MHz	470-790 MHz	969/915 MHz; 2.4 GHz	908.42 MHz	2.4 GHz	<135KHz, 13.56MHz, 2.45GHz, 5.8GHz, 860 to 960 MHz, 433 MHz	13.56 MHz	27.5 – 28.35 GHz and 37 – 40 GHz pre-commercial deployments in 2018
Standard	IEEE 802.15.1	IEEE 802.11 a/c/b/d/g/n	IEEE 802.16	3GPP	Weightless SIG	IEEE 802.15.4	ITU-T	IEEE 802.15.4	1)ISO 18000-7 2)IEEE 802.15.3 3)IEEE 802.11 4)IEEE 802.15.4	ISO/IEC 14443 A&B, JIS X-6319-4	Single unified standard
Parameters	Bluetooth	Wi-Fi	WiMAX	LTE	Weightless	Zigbee	Z-Wave	6LOWPAN	RFID	NFC	5G

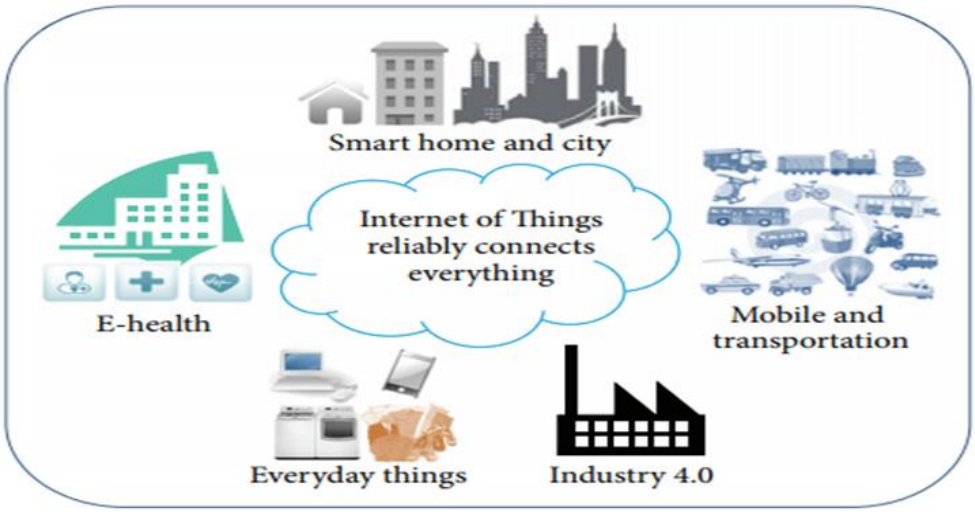

Figure1. IoT areas application (2).

Comments and Conclusion

E-health devices which utilized in IoT systems limit substantially in progressing and healthcare information storage case. In e-health area, technologies of short-board like RFID, Bluetooth, ZigBee are more prevailing than the technologies of large-board systems like cellular connection. Thus, there is requirement for using service of gateway which interprets texts between large-board, low-board connection technologies (21). Furthermore, technologies of IoT like smartphones, sensors have the identifier that enables them to interact together with environment by straight connection concept with an extra component such as gateway (22).

Further, analyzing, collecting data in applications based on sensor were organized locally with agents of software agents. Currently, sensors remotely controlled via web. In order to controlling remotely like HTTP protocol and resources are utilized; however, this is not a proper answer because of different bosses which participates more CPU power than sensors. Furthermore, in order to defeat the challenges, the other standards have been provided (22, 23&24).

Nowadays, other protocols such as web services descriptive language (WSDL), Representational State Transfer (RESTful), Simple Object Access Protocol (SOAP) and 6LowPAN have been provided for making transactions of HTTP for upgrading, reading information of sensor (25 and 26).

The mentioned protocols ascertain the forms that used to change different information, information progress of encryption, IP devolution boss to address network devices. Other operations standards include resource packages routing to target, data transmission, controlling data, organizing the rate between two nodes, as well as the packets send again which have been missed (27).

In present work, the technologies utilized architectures of IoT were studied. The basic IoT architecture technologies were Zigbee, Bluetooth, RFID and Wi-Fi. In other words, 6LoWPAN was major protocol which has utilized at papers which were selected, like improved felling devices, triggering application IPv6, let to outright health managing. With respect to that, data that were collected in progress will be transferred in protocols that are standard terms, created accessible for the provider of healthcare in order to control the state of health. Thus, cheaper, shorter, and good executing smart sensors and controllers can obtain efficiently the physical environment information to aim to optimize the work, and enhancing the usefulness.

At certain applications in great-scale, technology large IoT development might not be feasible due to the costs of restriction. Since this is illustrated with some papers, price might be the expensive agency control of IOT. The novel technology will be attractive for a user who is potential if investment on the service reveals the conclusion which is reasonable.

Furthermore, architectures must be designed in way which not only creates simple mental features cost reduction, but also encourages governments makers, the policy to make race to good management of services that are affordable. Since low-cost technology usage is able to extend IoT adaptation level, a lot of papers are needed. In addition, the other important agencies that should be placed in order to attract the user to accept the technologies are accurate and usage ease of infrastructures establishment.

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