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CHARACTERISTICS FEATURES OF IOT NETWORKS

Shokir Ruziyev[*1], Djamshid Sultanov[*2], Inomjon Narzullayev[*3]

[*1]Student, Department Of Telecommunication Engineering, Tashkent University Of Information Technologies Named After Muhammad Al-Khwarizmi, Tashkent, Uzbekistan.

[*2]Associate Professor, Department Of Hardware And Software Of Management Systems In Telecommunication, Tashkent University Of Information Technologies Named After Muhammad Al-Khwarizmi, Tashkent, Uzbekistan.

[*3]Researcher, Department Of Artificial Intelligence, Tashkent University Of Information Technologies Named After Muhammad Al-Khwarizmi, Tashkent, Uzbekistan.

ABSTRACT

One of the most pressing issues today is the proper organization of network systems, the creation and management of corporate networks, in-depth study of the capabilities of network operating systems and the training of qualified personnel. IoT (Internet of Things) is a technology of connected smart devices with step-by-step use across networks. With the increasing use in various industries, there is a need to define a common standard for IoT ecosystems. As a design standard, any IoT device has a wide range of features such as connectivity, analytics, endpoint management, and more. One of the main tasks of today is to make effective use of all its technologies and implement them.

Keywords: IoT, network, Bluetooth, Wi-Fi, LPWAN.

I. INTRODUCTION

It is known that the process of penetration of information technology into all spheres of human activity is developing and deepening. The number of users of this diverse computing technology is also growing, with two opposing trends evolving. On the one hand, information technologies are becoming more and more complex, and in order to apply them, a very deep knowledge is required for their further development. On the other hand, users 'communication with computers is simplified. Computers and information systems are becoming more and more "friendly," and even more understandable to people who are not experts in computer science and computing. This is primarily due to the fact that users and their programs communicate with computers through special software - the operating system. Favorable conditions for the development of informatization, the mass introduction and use of modern information technologies, computer equipment and telecommunications in all spheres of economic and social life, to better meet the growing needs of citizens in information, to expand access to global information resources -creation of conditions is the main task of the development of communication and information and communication. The information revolution knows no bounds. New information technologies allow you to instantly deliver images, text and speech around the globe. Internet institutions allow a wide range of databases to be linked to public libraries, schools, and city governments.

II. PROPERTIES OF IOT NETWORKS

IoT (Internet of Things) is a technology of connected smart devices with step-by-step use across networks. With the increasing use in various industries, there is a need to define a common standard for IoT ecosystems. As a design standard, any IoT device has a wide range of features such as connectivity, analytics, endpoint management, and more [1]. An IoT device has the following features:

Connectivity: For IoT, the most important feature that can be considered is connectivity. Without continuous communication between the interconnected components of IoT ecosystems (e.g., sensors, computing engines, data centers, etc.), it is not possible to perform any relevant work on business use. IoT devices can be connected via radio, Bluetooth, Wi-Fi, Li-Fi, and more. In the IoT ecosystem and industry, we can use different protocols of the Internet connection layers to maximize efficiency and establish a common connection. The IoT ecosystem can be built locally or on an intranet.

Perception: We humans naturally easily understand and analyze our own conditions based on our past experiences with different things or situations. To get the best out of IoT, we need to read the analog signal and

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convert it to produce meaningful concepts. We use electrochemistry, gyroscopes, pressure, light sensors, GPS, pressure, RFID, and more to collect data based on a specific problem. For example, when using cars, we use light sensors in combination with pressure, speed and image sensors. To succeed, we must choose the right sensitivity paradigm.

Active Agreements: An IoT device integrates different products, with cross-platform technologies and services working together to establish an active connection between them. In general, we use cloud computing through blockchain software to establish active connections between IoT components. At the industry level, IoT solutions require the purchase, pre-processing and resale of raw analog data depending on the volume of work. According to Google, only 50% of structured and 1% of unstructured data is used to make important business decisions. Thus, in developing IoT ecosystems, carriers need to consider the future needs associated with managing such large amounts of data to meet the growing needs of the business. The need for active communication can be confused, which means that your systems need to have tremendous knowledge of different technologies, platforms, products, and industries.

Scalability: IoT devices should be designed so that they can be easily enlarged or reduced on demand. In general, IoT is used in everything from smart home automation to the automation of large factories and workstations, so the scale of use varies. The developer needs to design the IoT infrastructure according to their current and future collaborations.

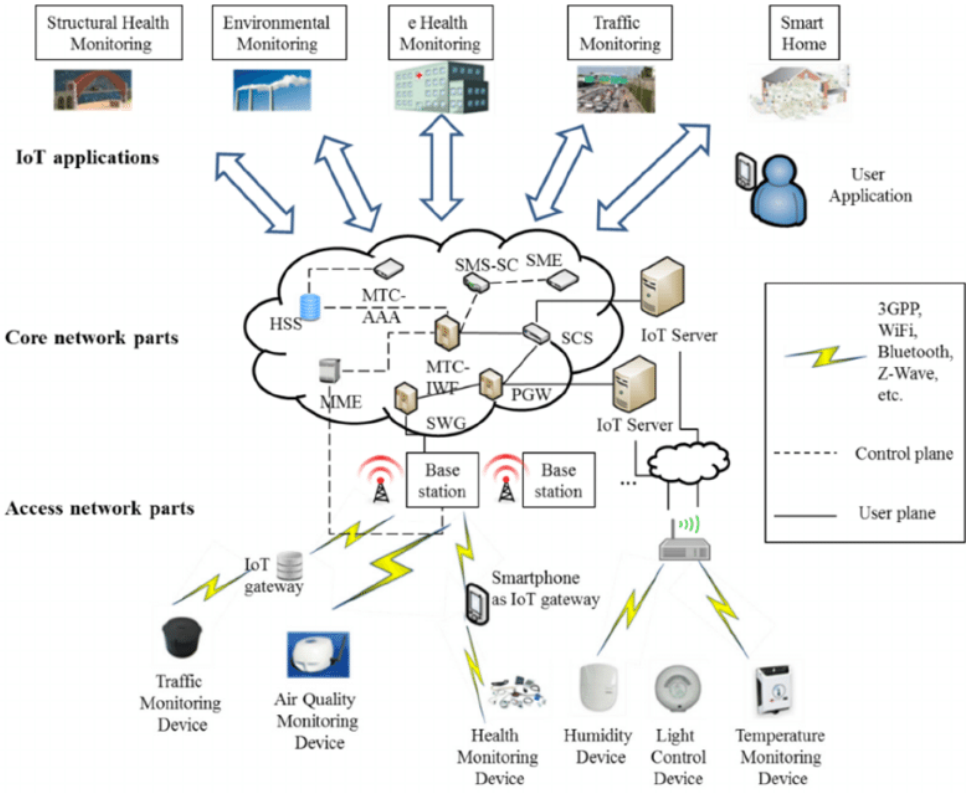

Fig 1: Architecture of IoT

Dynamic nature: To use any IoT, first of all, data collection and conversion, from which business decisions can be made. In this whole process, the various components of IoT must change their state dynamically. For example, the inclusion of a temperature sensor is constantly changing depending on weather conditions, location, and so on. IoT devices should be designed with this in mind.

Intelligence: In almost any IoT use case in the world today, data is used to create important business concepts and make business decisions. We develop machine learning models based on this big data to gain valuable insights. Analog signals are pre-processed and machine models are converted to 10 instructional formats. We need to keep in mind the relevant data infrastructure based on business needs.

Energy: Integrating the final components and the entire ecosystem to the analytical layers requires a lot of energy. When designing an IoT ecosystem, we need to consider a design methodology that minimizes energy

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consumption.

Security: One of the key features of an IoT network is security. Throughout the flow of the IoT network, sensitive data is transmitted from the endpoints to the analytical layer through the connection components. In developing the IoT system, we avoid data misuse and manipulation

III. CHARACTERISTICS OF IOT NETWORKS

We can identify all the features of IoT by describing it, but we need to look at its purpose. Data is a crucial part of this equation, but even if it is the first step, such data is not enough. However, there is no IoT without (big) data. Such information is probably not trivial, but it is certainly meaningless if it is not used for its intended purpose and if it is not translated into meaning, understanding, reason, and action.

The information collected and perceived by IoT devices must be communicated, even to speak of knowledge, understanding, intelligence, or action, in order to begin to transform it into practical information. For example, although in many cases "smart network technology" is needed, connected devices have the ability to move, real intelligence and actions 11 to use this information wisely in analyzing and solving the problem, creating competitive profit, the process automation, network improvement, we need to know in advance what measures our IoT solution will take. Just as there is no IoT without data, without “big” data, it is impossible to create a useful IoT network without understanding meaning, intelligence, (big) data analysis, cognitive and artificial intelligence, and so on [2,3].

Regardless of the scale of the project and the type of IoT program, there is always a degree of automation. In fact, most IoT programs are mostly automated, and this often comes with costs and benefits. Industrial automation, business process automation, or automated software updates: it all depends on the context. We can predict this in the future: the world will be dominated by the IoT network. He also drives Tesla cars and soon autonomous cars, where maintenance, upgrades, etc. are all related to automation and software provided with sensors and connected devices. We focus only on technology and not on purpose and smart action. Obviously, we can talk more about this “IoT” rather than the “Internet of All” or the “IoT” ecosystem or anything else, but it’s important for us not to confuse this IoT with a number of things, e.g. , devices connected to some applications [4].

Although there are these types of applications that most people say, of course, this is the case in most cases in IoT, and they are far from the original meaning of IoT. As it continues to grow, communication or interconnection between these devices has become an important topic. According to Gartner's research, the number of IoT devices will reach 20.4 billion by 2020. There are several IoT communication protocols here that work differently. indicators, data transfer rate, coverage level, power, and memory, and each has its own advantages and more or less disadvantages. Some of these communication protocols are only small. suitable for home appliances, while others can be used in large smart city projects.

IV. NETWORK PROTOCOLS AND FEATURES

IoT stands for Internet of Things. We are very familiar with many communication technologies like WI-FI, Bluetooth, 2G / 3G / 4G and now 5G is coming to market, but there are several new wave network options in the market. Online activity and data transfer is possible only if the IoT system is securely connected to the communication network of the two devices. What allows you to make such a connection?

IoT standards and protocols are invisible languages that allow physical objects to "talk" to each other. Common protocols used for computers, smartphones, or tablets may not meet the specific requirements of IoT-based solutions. Bluetooth technology has come a long way since it was invented by Ericsson in 1994. Bluetooth was developed as an alternative to standard RS cables and was later used to connect external devices to a computer. Bluetooth IoT is used to track equipment in commercial, educational or healthcare applications. Bluetooth applications are very effective for low-power internal surveillance scenarios. However, a Bluetooth connection requires a short-distance connection and does not support underwater transmission or monitoring [5].

Also, Bluetooth connectivity is not recommended for security solutions that require the transmission of visual or audio data over a network. Bluetooth is one of the most widely used short-range wireless technologies. You can quickly get Bluetooth apps that provide you with portable technology to connect smart devices. Yes, we can say that Bluetooth is not designed to transfer large amounts of data, but small amounts of data can be

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transferred easily and perfectly. That is why Bluetooth manages these generation protocols on the Internet. Bluetooth transmits at 2.4 GHz and 1 Mbit / s from 50 to 150 m. Launched in 2009, Low - Energy has enabled Bluetooth IoT to use Bluetooth as a means of communication. BLE is a standard that allows devices to send small amounts of data using minimal power and appeals to small-scale IoT applications such as devices [6].

The role and use of Bluetooth in cars and homes will continue to grow and expand. Daily commute Imagine getting automatic traffic updates or weather information to set the lighting, thermostat, and home theater systems for the perfect mood or relaxation while using Bluetooth while automating or home. Wi-Fi is an acronym for wireless trust. Wireless internet is one of the modern technological developments. It can be locked, protected or unlocked, as well as short or long distances. It is able to connect Wi-Fi phones without the need for flexible cables, and from there we can access the Internet. Wi-Fi on devices is a wireless connection to access the Internet. Wi-Fi uses radio waves to transmit data at certain frequencies instead of using wired connections, typically at 2.4 GHz or 5 GHz, although it is more commonly used in additional current settings.

You can connect to a standard Wi-Fi network up to 100 meters outdoors. For many developers, Wi-Fi connectivity is often the clear choice, especially given the prevalence of Wi-Fi in the LAN home environment. This is a local area network that uses the IEEE 802.11 standard in the 5 GHz frequency range. Wi-Fi is a short-distance technology that provides a distance of about 60 m from the entrance. Wi-Fi is a wireless protocol designed to replace Ethernet with wireless devices. Its purpose was to provide interoperability with an easy-to-implement, short-range wireless connection outside of the vendor. Standard Wi-Fi is often not the best IoT technology, but some IoT applications have standard Wi-Fi, especially for use in a building or business environment.

Obviously construction and home automation also includes internal energy management that can be used as a Wi-Fi communication channel and plugged into electrical outlets. On the other hand, Wi-Fi 802.11ah called HaLow is specially designed for IoT and requires unique clients and infrastructure. Wi-Fi technology vendors continue to improve and strive to provide better technology every day. LoRa is one of the modern LPWANs. LoRa is one of the first technologies in modern LPWAN networks to service IoT devices. LoRa's mission is to support LoRaWAN networks globally. According to experts of LoRaWAN communication services, such popularity of the network is due to its advantages: high autonomy and low cost of sensors, wide coverage area of the network and others. LoRaWAN (Long Range wide-area networks) is the most popular LoRa network protocol for managing communication between LPWAN gateways and end devices. LoRaWAN is based on a star topology [7].

Many devices wirelessly transmit data to more than one gateway at a time. The connection between the devices and the gateways is made on a two-way basis. The gateways that receive the data then forward the received packets from the last node to a cloud network server connected via a mobile or satellite connection, wired or wireless broadband connection. From there, the data is sent to the application servers. The convenience of using multiple gateways is that the last nodes are not connected. This allows you to guarantee data and control devices in your movement. For example, a wireless network connected to long-distance shipping containers will be able to exchange data without any problems because they are not connected to a single gateway.

The data transfer rate between the final devices and the gateways varies from 0.3 to 50 kbps and can be adjusted by the gateways themselves, depending on the conditions of use. LoRaWAN networks have many advantages. One base station is capable of servicing tens of thousands of devices, which is due to the large signal coverage and high noise tolerance. In addition, the battery lasts up to ten years. When using solar panels, the device operates autonomously until it runs out of power. LPWAN the gateway must have a very high bandwidth or the ability to receive messages from a large number of devices to ensure the normal operation of the network [8].

The high capacity of the LoRaWAN network can be achieved through the flexible speed of data and the reception of a multi-channel receiver in the gateway, which guarantees the reception of messages on several channels simultaneously. LoRaWAN networks can be deployed with minimal infrastructure. If necessary, depending on the number of devices in the network, you can change the data transfer rate or increase the number of gateways. LoRaWAN usage options. The following options are available for LoRaWAN [9]:

- Automatic reading from meters of consumption of various resources (water, gas, electricity, etc.);

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- Monitoring of smart grids;
- Traffic monitoring and cargo control;
- Monitoring the condition of containers containing harmful substances in production;
- Monitoring of industrial equipment;
- Parking monitoring;
- Smart street lighting systems;
- Weather monitoring;
- Fire and safety alarm;
- Building automation;
- Automatic collection of data from agricultural lands, etc.

The main advantages of LoRaWAN are not only low maintenance, but also minimal costs for the purchase and repair of sensors. For LoRaWAN networks, the sensors will probably cover the maximum number of uses possible. 6LoWPAN is an IP-based communication protocol. 6LoWPAN stands for IPv6 over a low-power wireless personal network. IPv6 (Internet Protocol Version 6) is a 128-bit Internet protocol designed to overcome 32-bit IPv4 limitations when accessing. Therefore, a number of devices can be connected to each other. The 6LoWPAN system is used for a variety of purposes, including wireless networking of sensors [7].

This wireless sensor network format transmits data as a packet and uses IPv6 as the basis for the IPv6 name for low-power WLAN networks. As the world moves to IPv6 packet data, such a 6LoWPAN scheme offers many advantages for low-power wireless sensor networks and other low-power wireless networks. IPv6 (Internet Protocol Version 6) is designed to overcome 32-bit IPv4 limitations in access. Therefore, a number of devices can be connected to each other. Sigfox: Created a worldwide network to listen to the data transmission of billions of machines. Sigfox is able to collect very small signals from IoT devices around the world to achieve the efficiency of natural energy collection systems.

Parameters	Operating Frequency	Maximum Range	Throughput	Latency	Bandwidth	Battery life
802.15.4-Based (Zigbee, WirelessHART, ISA 100.11a)	900 MHz, 2.4 GHz	~200m	250 kbps	10-100 ms	2-5MHz	several years
LoRa	915 MHz (US), 868 MHz (Eur), 433 MHz (Asia)	5-20km	0.3-50 kbps	-	7.8-500 kHz	10+ years
NB-IoT (LTE Cat NB2)	Cellular bands	1- 10 km	159 kbps	1.6-10s (NB1)	180 kHz	10+ years
LTE-M2 (LTE Cat M2)	Cellular bands	>11 km (M1)	4 Mbps (DL), 7 Mbps (UL)	10-15ms (M1)	5 MHz	-
Sigfox	868 MHz, 902 MHz	>50km	100-600 bps	-	100-600 Hz	10+ years
Bluetooth 5 Low Energy	2.4 GHz	<200 m (PtP), <1.5km (mesh)	1 to 3 Mbps	<3ms	~ 2 MHz	-
WiFi	2.4, 3.6, 4.9, 5, 5.9 GHz	< 300 ft	>54 Mbps	1-3ms	~22 MHz	-

802.15.4 - Based
LPWAN
Popular Protocols

Fig 2: Comparative table of IoT protocols [7]

This SigFox is based on three pillars: - Low power consumption; - Low prices; - Additional technology. SigFox offers a standard way to collect data from 17 sensors and devices with a single standard API package. Sigfox is compatible with Bluetooth, GPS, 2G / 3G / 4G and Wifi. Radio Frequency Identification (RFID) is a communication method used for wireless tracking and object detection. It is one of the simplest communication methods and is used in most IoT ecosystems. It is used not only to track consumer products around the world, but also to track paid collection devices.

These are used by hospitals to monitor patients and farmers to monitor their animals. RFID tags are an evolution of traditional barcodes that can read and write data. The tags contain two parts of the RFID

component: a microchip that stores and processes the data, and an antenna that transmits the signal. There are usually two types of RFID, the first is passive and the second is battery operated. A passive RFID tag is used to transmit stored data to the interrogator via radio. The battery-operated RFID tag is installed in the data transmission system using a small battery. A label contains a serial number for a specific item.

Zigbee is a short-range wireless protocol. It is based on the IEEE 802.15.4 protocol. It is mainly used in home automation and industry. Power is preferred in applications where the level is low. The main features of the Zigbee are low power consumption, high expansion, safety and durability. Zigbee spacing is 10 meters, but this distance can be extended up to 100 meters. Zigbee has a maximum data rate of 250 kbit / s. Satellite communication allows cell phones to communicate with the nearest antenna at a distance of about 10-15 miles (24.14 km).

These are called GSM, GPRS / GSM, 3G, 4G / LTE, 5G and others depending on the connection speed. Satellite communication is also known in IoT as Machine to Machine communication because it allows communication between mobile devices. A specially designed satellite connection seems to be the only possible solution to limit communication, which is the wide 18-scale interconnection of IoT devices. Satellite technology can help develop the IoT sector and easily solve this comprehensive connectivity problem. Data transfer speeds can be a concern for such large amounts of data. However, it will take time for innovative solutions to emerge. Satellite providers are already collaborating to provide services and equipment that are capable of unlocking all the capabilities of IoT. A solution is being developed to connect satellite and wireless networks. The global nature of satellite systems and their ability to transmit to multiple points simultaneously make it the most efficient signal transmission on earth [7,8,9].

V. CONCLUSION

IoT is a technology where a lot of work is done and organizations try to automate people's actions, with the probability of error being minimal or zero. IoT makes it easier for people and organizations to interact and connect with their machines. In the new digital age, IoT plays an important role as always, and it offers ways to make our world smarter and more interconnected than ever before. An Internet connection is easy for an IoT network, but an IoT connection must be secure and secure. There are different types of IoT connection protocols that can be used to connect a device, and the choice of the correct connection depends entirely on the state of use. The IoT network allows for easy collection of information from the environment, increasing efficiency and providing new services to improve community life. To accomplish this process, sufficient software models and programming abstractions are needed to overcome the complexities of the physical world and help developers create applications faster and more efficiently.

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