Investigation of Methods for Remote Control IoT- Devices Based on Cloud Platforms and Different Interaction Protocols

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***Abstract*— Internet of Things (IoT) is a concept of communications between multiple devices equipped with sensors and actuators for the purpose of convenience and economic benefits. In connection with the rapid development of IoT concept it becomes necessary to use those or other instruments for the control and management of IoT. Considered scenario is based on the interaction between the central element (smart home gateway), which ensures the connection of various sensors and actuators within a smart home. Management is carried out on the basis of specialized application. In this paper as a gateway uses single board computer Raspberry Pi 3 and the sensors and actuators communicate with the gateway using BLE - technology. We consider the operation of applications for remote management of the actuators and sensors using a proper framework AllJoyn. In conducting the study focuses on components of the framework AllJoyn: HTTP protocol, which is the most common in data exchange between smart home gateway and remote applications, MQTT protocol . During the testing of HTTP and MQTT protocols, realized as AllJoyn at the gateway threshold levels of operation have been received. Thus, the paper presents the results of complex testing fragment smart home network, the basic communication protocols and thresholds obtained their operation in conditions of high functional load.**

Keywords— Internet of Things; cloud; protocols; Raspberry Pi 3

I. INTRODUCTION

At the moment, the main direction of development of modern information and communication systems is the modernization and expansion of opportunities of the global public communication network (PCN). Computational capabilities of embedded communication devices increases with decreasing their size. Recent advances in the concept of wireless sensor networks (WSN) [1,2] and the IP integration process, with different types of technology and the physical layer channel change PCN structure [2,3,4,5]. It is assumed that will be connected to the PCN , which will law talk about integration of the Internet of Things (IoT) concept in the global info-communications infrastructure in the near future trillions of computing devices [6]. IoT devices are a IoT of different types of real and virtual items, which include items such as smartphones, tablets, TVs, digital cameras, routers, embedded wireless device, and others. Also, the IoT device can be considered as sensors and actuators which operate under the smart home , through a special device, performing the role of a gateway to the IoT devices.

One of the main advantages of use of the protocols IPv4, IPv6 on the basis of the IoT networks, in case of use of technologies existing in WordWideWeb (WWW) for development of IoT devices is use of classical architecture of providing web services without the need for use of gateways. Such architecture of rendering of services in IoT networks is called Web of Things (WoT) [6,7].

This paper explores the possibility and methods of development of device management platform IoT, located in a certain area that are combined into a single network and connected to the PCN, through IoT gateway, using software AllJoyn platform and the HTTP protocol, which is the most common in data exchange between intelligent gateway home and remote applications, protocols and MQTT. The paper conducted testing methodology protocols HTTP, XMPP and MQTT, realized as AllJoyn gateway.

A lot of the frameworks are proprietary. On the other hand, most of them support at least one open source messaging protocol. IPSO Alliance, AllJoyn, OSGi and IoTivity are based on open-source technologies.

TABLE I: FRAMEWORKS WITH DIFFERENT COMMUNICATION PROTOCOLS

	MQTT	**XMPP**	**CoAP**	**REST**	**Other**	**odular**
IPSO Alliance			+	+		
Xively	+	+	+	+	+	
Cumlocity				+		
Thing-Worx	+	+	+	+	+	
SEP 2.0					+	
OSGI All					+	+
AllSeen All	+	+	+	+	+	+

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Microsoft					+	
IBM					+	
IzoT				+	+	

II. AllJoyn Framework

AllJoyn represents an open-source software system that provides an environment for distributed applications running across different type of devices and operating systems [7]. AllJoyn is ”platform-neutral” framework, meaning it was designed to be as independent as possible of the specifics of the hardware configuration and operating system of the targeted device – framework was developed to run on Windows, Linux, Android, iOS, OS X, and OpenWRT.

AllJoyn is software platform open source, designed to interconnect applications, devices and users through a wireless WiFi network and Bluetooth (and other types of networks), regardless of device type. The main merit of this platform is a special layer of abstraction that allows devices and applications to offer itself as a provider of certain services and to find other devices and applications without any additional equipment and special servers (Figure 1).

Fig. 1 AllJoyn platform structure

III. The Experiment Structural Diagram

As a solution to the problem of a small number of WSN nodes supported by hardware platform was chosen implementation of cloud solutions process data received from the sensor nodes. The advantage of this solution - supported by the increase in the number of sensor nodes, reducing the load on the controller processor (RaspberryPi) and simultaneous use of data from the sensor network multiple remote systems (such as smart home, intelligent office) with a single client XMPP network. For the organization of the interaction between the IoT devices used software platform AllJoyn.

In this paper we tested the two widely logical architecture of construction IoT network:

- architecture using a shared server to forward messages from the client to the host and back
- network with AllJoyn framework.

Figure 2 shows the scheme of hardware and software complex for IoT device management , based on the hardware platform RaspberryPi 3 Model B.

The first architecture consists of a remote broker /server mqtt & XMPP, which forwards the message from the user to the IoT and back.

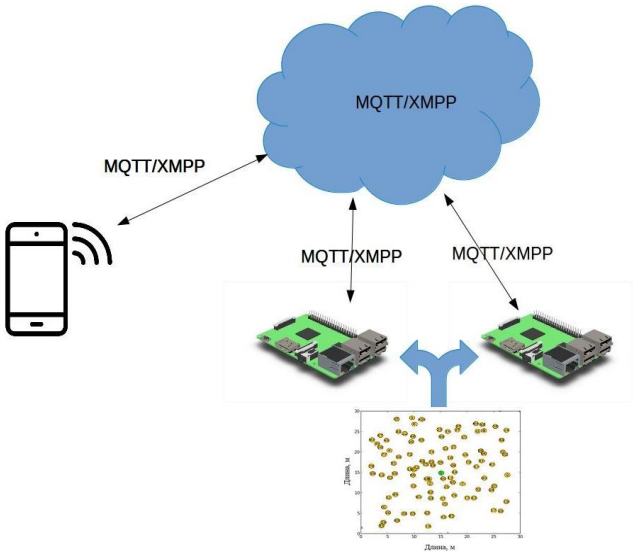

Fig. 1 Traditional architecture for smart home

This hardware-software complex consists of:

- Hardware platform RaspberryPi;
- The mobile terminal that supports XMPP protocol and MQTT;
- Remote data processing server with IoT devices.

The software used to create this software and hardware system:

- JabberXMPP Application;
- MQTT Application
- Cooja simulator version 3- network simulator processes Contiki - simplifies the procedure by providing a user device and network simulation function.

This experiment was conducted based on the united model networks of the Internet of Things laboratory and Laboratory software-configurable communications networks and systems of DWDM-Saint-Petersburg State University of Telecommunications Bonch-Bruevich [8,9,10]. Data network model developed by the ITU-T recommendation Q.3900. Cooja Simulator version 3.0 to generate simulated sensor network traffic and sent through gateways to the user data from the sensors. We measured the time delay from the gateway to the user. For this architecture, we used two protocols mqtt and xmpp.

Experiment was made with the increased load on the gateway, and traffic was generated with 41 simulated sensors on each gateway.

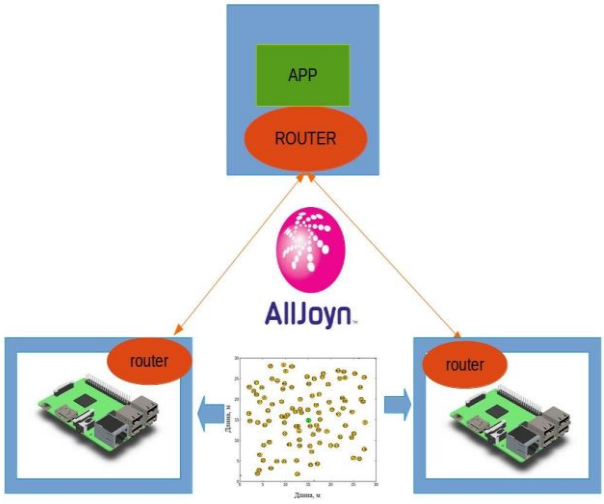

Fig. 2 Smart home architecture with AllJoyn

This hardware-software complex consists of:

- raspberry Pi 3 The hardware platform;
- the mobile terminal supporting AllJoyn platform;

The software used to create this software and hardware system:

- the software platform AllJoyn;
- cooja simulator version 3 network simulator processes Contiki - simplifies the procedure by providing to the user device and network simulation function.

In the second architecture, we are also using 3 cooja generate traffic sensor network and send messages from the sensors to the client phone.

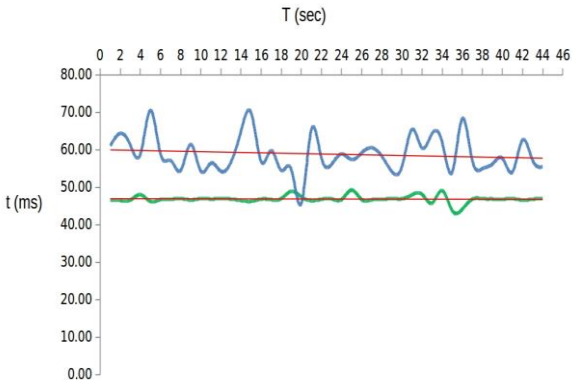

Fig. 4 Delays between the client and gateway

According to the experimental results on the graph clearly that architecture using AllJoyn delay in the transmission of messages about 15 ms less. This proves that architecture using AllJoyn effectively centralized, as this architecture has no common point of failure. Can be seen that by using virtual routers AllJoyn network delay is more stable, while in the first architecture spread between the maximum and minimum values of almost 25 ms.

In figure 5 graph shows that the number of nodes in the sensor field does not affect to the use of the controller memory by using second architecture. It follows that for smart home complex systems the use of AllJoyn platform is more efficient.

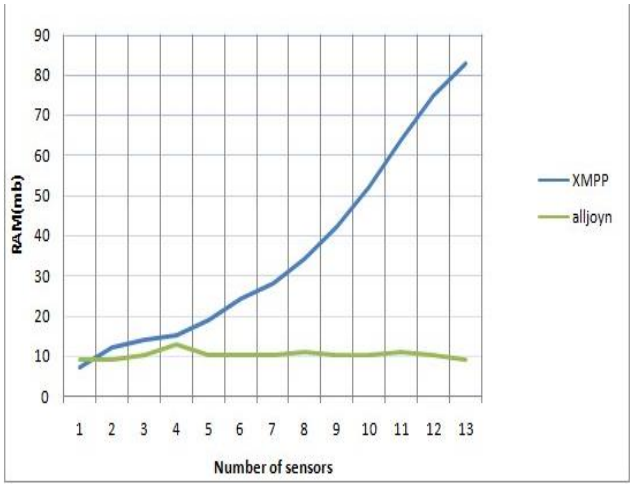

Fig. 5 The dependence of the memory on the number of sensors

IV. Conclusions

In this paper has been studied the possibility of organization IoT gateway-based software platform AllJoyn and client application XMPP/MQTT and the ability to manage nodes WSN connected to this gateway. Had been developed software and hardware complex for management of the WSN nodes on the results of the research obtained in the two experiments (using 2 architectures) has been proven that the use of cloud-based platforms AllJoyn much more effective than the connection to the controller via the remote brokers. Alljoyn platform also has other advantages, such as the simultaneous interaction with a variety of IoT gateways and IoT devices. This solution makes it possible to process large amounts of data, obtained from the WSN nodes. When testing protocols MQTT and the XMPP, realized how AllJoyn at the gateway threshold levels of operation have been received. Thus, the article presents the results of complex testing fragment smart home network, the basic communication protocols and thresholds obtained their operation in conditions of high functional load..

References

[1] Recommendation Y.2060. Overview of Internet of Things. ITU-T, February 2012, Geneva.

[2] A.Muthanna,A.Prokopiev,A.Paramonov,A.Koucheryavy, Comparison of protocols for Ubiquitous wireless sensor network, 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT 2014). pp. 334-337. Oct. 2014.

[3] A.Koucheryavy, A.Muthanna, A.Prokopiev. Ubiquitous Sensor Networks Traffic Models for Image Applications. Internet of Things and its Enablers (INTHITEN). Conference, State University of

Telecommunication, St. Petersburg, Russia, June 3-4, 2013. Proceedings.
[4] Routing Over Low power and Lossy networks IETF WG. http://tools.ietf.org/wg/roll.
[5] Recommendation RFC6550, RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks, IETF, March 2012.
[6] Y.Koucheryavy, D.Moltchanov, J.Harju. A Top-down Approach to VoD Traffic Transmission over Diffserv Domain using AF PHB Class. IEEE International Conference on Communications. ICC'03, Anchorage, Alaska, USA, 2003.
[7] Recommendation Y.2062. Framework of object-to-object communication using ubiquitous networking in NGN. ITU-T, Feb. 2012. Geneva.
[8] A.Koucheryavy, A.Prokopiev. "Ubiquitous Sensor Networks Traffic Models for Telemetry Applications" in The 11th International Conference on Next Generation Wired/Wireless Networking
[9] A. Vladyko; A. Muthanna; R. Kirichek, Comprehensive SDN Testing Based on Model Network. In Internet of Things, Smart Spaces, and Next Generation Networks and Systems. St. Petersburg, Russia, 2016. PP.539-549
[10] Kirichek, R., Vladyko, A., Zakharov, M., Koucheryavy, A. Model networks for internet of things and SDN // 2016 18th International Conference on Advanced Communication Technology (ICACT), 2016. PP. 76–79.
[11] AllSeen Alliance - Working Groups [Online]. Available from: http://bit.ly/1SGYL5M
[12] GitHub: AllJoyn - Gateway-Agent-Connector. Available from: http://bit.ly/1nbCHD4
[13] AllJoyn Framework [Online]. Available from: http://bit.ly/1OA9nNG. 13. AllSeen Alliance [Online]. Available from: https://allseenalliance.org/.