Study of Fog Computing Structure

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Abstract — **The future Internet structure will be based on cloud computing. With the increase of the mobile traffic, the transmission of an huge amount of data to the cloud was not only a difficult task for the communication channel bandwidth , but also caused delays in transmission and a decline in the quality of services for the end user. With the growth of the role of mobile traffic, the support of mobility and geometric distribution is no less important. For this reason, the emergence of cloud computing as a comprehensive approach for the centralized storage, retrieval and management of information, the successful integration of cloud computing and mobile applications, is an important task. To solve such problems, Cisco introduced a concept of fog computing, designed for local processing of some tasks on fog devices. The fog layer consists of geo-allocated servers that are deployed on the network periphery. Each fog server is a lightweight version of the cloud server, and is equipped with a large data warehouse and the ability to compute and wireless transmission. In this paper, the authors emulated the operation of network nodes under fog computing conditions**

Keywords— Cloud, fog computing, modeling , structure

I. INTRODUCTION

The dynamic development of wireless technology and increasing traffic volumes lead us to create all new communication standards. Currently widely discussed the development of the mobile 5G system [1] , [2]. For its implementation, in addition to high reliability and good communication quality, ultra-low latency and high throughput, as well as better coverage. It is proposed to use such technologies as NFV (network functions virtualization), as well as SDN (software defined networking).

New generations of cellular communication appear every ten years, so the introduction of the standard 5G can be assumed by 2020. The first commercial implementation of 5G will be expected in 2018 [3] . All of them are timed to major sport events. For example, South Korean mobile operator KT Corporation promises to launch fifth-generation networks at the 2018 Winter Olympics in Pyeongchang.

Edge computing is a new technology that is considered one of the key technologies in the mobile 5G system development . The idea of Edge Computing technology is to transfer cloud computing to a cellular network boundary in a radio access network (RAN) in one hop from user equipment [2], [4]. The standardization of edge computing technology is the European Telecommunication Standardization Institute ETSI. By transferring the computing resources to the edge of the radio access network, you can obtain:

- Unloading the core network - all computer operations will be performed at the border of the cellular network;
- Proximity - location in one hop from user equipment;
- Low system delays;
- High bandwidth;

Edge computing based on a virtualized platform and complements NFV: while NVF focuses on network functions, the edge computing platform includes computational applications running on the edge of the network. That is why it will be advantageous to use both these technologies on one platform. It should also be taken into account that, thanks to the edge computing, it may be possible to affect radio networks and data in real time. This means increased flexibility and reliability for the user: different services will be able to respond to information from the user much faster.

In the telecommunications market, new, more adaptive products will emerge. It predicts fast wireless video transmission of ultra-high accuracy, as well as the proliferation of multiplayer games with the VR effect without signal delays. Also, edge computing will contribute to the development and implementation of the Internet of things [11]. Thus, edge computing will positively affect the data transmission technologies and the economy of the telecommunications industry. Currently, the Internet is experiencing a shift towards a structure based on cloud computing. With the increase in mobile traffic, the transfer of an incredibly huge amount of data to the cloud not only a difficult task for the bandwidth of the communication channel, but also caused delays in transmission and a decline in the quality of services for the end user. In addition to this, with the growth of the role of mobile traffic, the support of mobility and geo distribution is no less important.

For this reason, the emergence of cloud computing as a comprehensive approach for the centralized storage, retrieval and management of information, the successful integration of cloud computing and mobile applications, is an important task. To solve such problems, Cisco introduced a concept of fog computing, designed for local processing of some tasks on foggy devices. The fog layer consists of geo-allocated servers that are deployed on the network periphery. Each fog server is

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a lightweight version of the cloud server, and is equipped with a large data warehouse and the ability to compute and transmit wirelessly. The task is to simulate the function of energy consumption and delay each part of the fog cloud system and formalize the task of load sharing. As a result, using numerical examples it is shown that fog computing can significantly improve the cloud computing system by the criterion of reducing transmission delays.

II. System Structure

Edge computing is a new trend established by the cellular network operators to improve the whole network efficiency by offloading its operations to nearby clouds. European Telecommunications Standards Institute (ETSI) is one of the main organizations concerned with the edge computing [5]. ETSI announced an Industry Specification Group (ISG) known as edge computing to research and standardize the new technology. Simply MEC can be defined as the way of moving cloud computing capabilities to the edge of the mobile networks. Moving cloud computing to the edge of the mobile produces a lot of benefits that can be summarized in the following points [6]:

- reduces the round trip latency of communicated data,
- provide an efficient way for offloading data delivered to the core network,
- provides high bandwidth,
- introduces new services and applications by accessing the network context information, and
- introduces new services and applications by accessing the network context information,

Moving from the great, massive and expensive data centers into small distributed cloud units based on a small hardware platform will open the way for achieving the required latency constraint for tactile realization. The suggested architecture of the 5G system is based on reducing round trip latency by moving cloud to the edge of the mobile network. Only one or two communication hops away from the mobile will be efficient to achieve the 1 ms latency. Generally, the 5G cellular system can be viewed as a mobile user, cloud unit, core mobile network, current Internet and remote cloud. Searching for the best place for the introduced cloud unit, researchers go different ways. Based on the ETSI report of edge computing, there are multiple scenarios for the place of employment of the cloud computing units. There are multiple locations for the edge computing servers such as [5]:

- Cloud servers are connected to the LTE macro base station (eNB).
- Cloud unit may be placed in the 3G/4G radio network controller (RNC).
- Cloud unit may be connected to multiple sites (multiple eNB).
- Cloud unit may be at the edge of the core network.

There are a lot of researches for introducing small cloud units that can be employed in the mobile networks. Some uses the term cloudlet to refer to any secondary and small cloud units. Small cloud units are such as Nebula [7] and Wang et al.'s micro clouds [8].

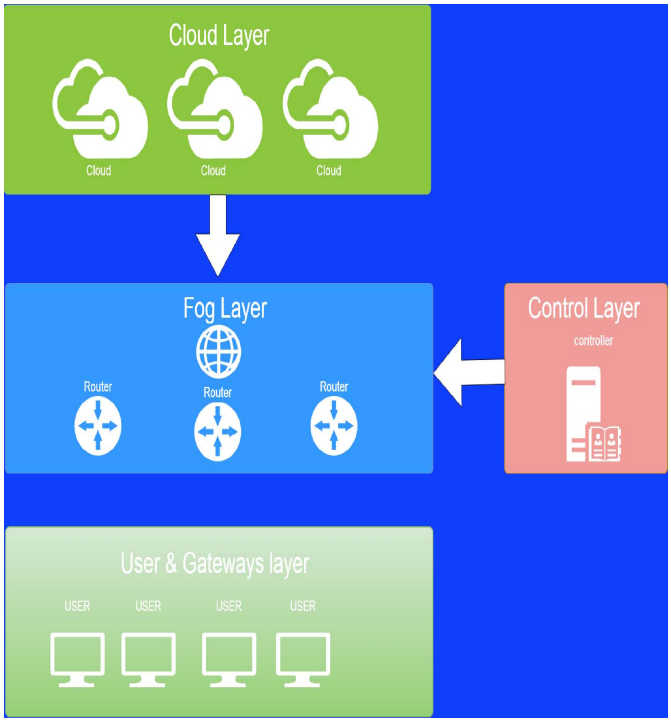

Fig. 1. Cloud computing layers

The fog computing paradigm announced by Cisco has been extended to the edge of the wireless networks and can be employed in the cellular networks [9]. Clearly, cloud computing is the main base to build the 5G and Tactile Internet system [10] . Figure 1 provides a system structure based on fog computing .

III. Model Network

During the work we simulate the work of the network nodes in terms of fog computing.

For work we needed:

- OF switch
- SDN controller (B4N)
- traffic generator (50 * Raspberry pi 3)
- zabix server network monitor
- KVM
- Remote clouds

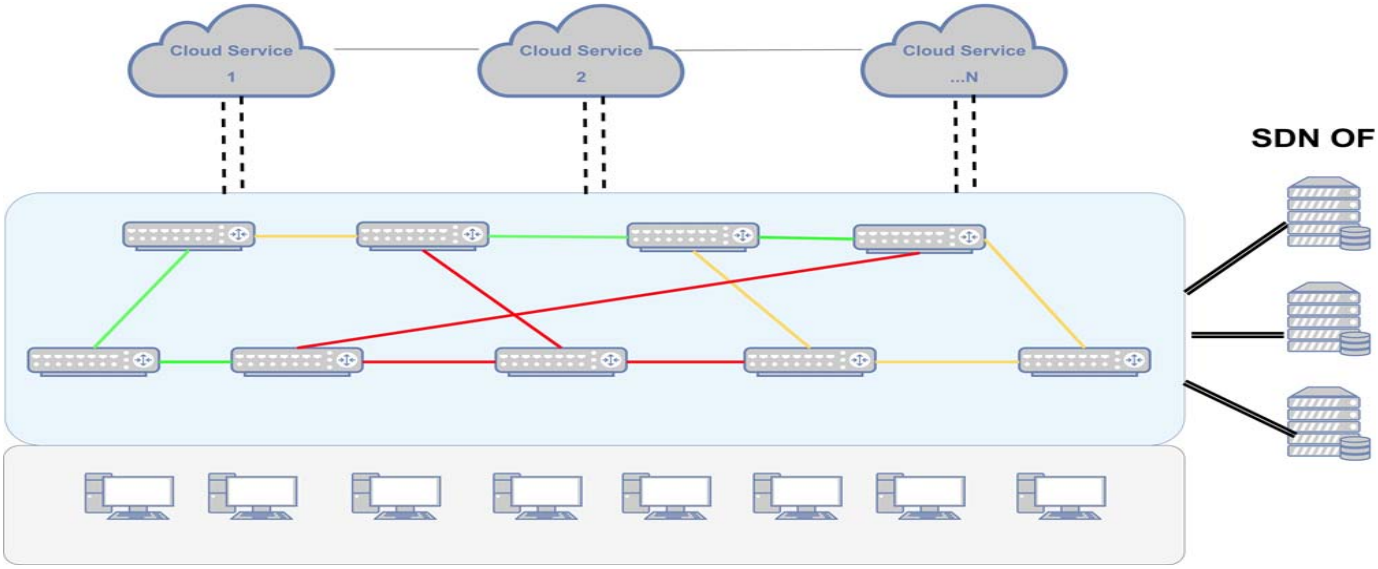

Fig. 2. Model Network structure

The essence of the application of fog computing to distribute the tasks of remote cloud services among network nodes information communications network.

This allows:

a) reduce latency in the network,

b) make better use of network equipment

c) allocation of computing power of cloud servers for other tasks.

Algorithm for the operation of fog computing. Suppose in the cloud system, calculation is performed for the client client task A.. And every time δt sends the status and the current result of the task to the client. The cloud redirects the task to the nearest looser network node or to several more free nodes. This enables distributed computation execution.

The model of the operation of fog computing to the ratio of one communication node.

Suppose we have a network node that serves the transit segment of the network. Since at different times of the day the CPU load of the node is different, you can use this in solving other problems. Accordingly, for the computing power of the equipment does not stand idle, a certain distributed computer system is loaded into it. Optimum CPU utilization, we chose 90%, thats mean when the CPU load is less than 90%, additional tasks are loaded for calculation. To be precise, the problem is obtained from external cloud systems. This allows us to localize the solution of computational problems on a particular section of the network. The advantages of such use effectively affect the delay of certain tasks of this part.

Such solutions are well suited for SDN networks based on NFV nodes [12]. NFV allows you to use the hardware part of the equipment for different tasks. And SDN will allow you to properly allocate and monitor additional tasks. The concept of 5G technology is based on the use of such systems up to the access networks (last mile): Base stations, Software-defined radio (SDR) and even subscriber equipment. Within the framework of this concept, the fulfillment of fog computing tasks is easily performed in all sections of 5G communication networks.

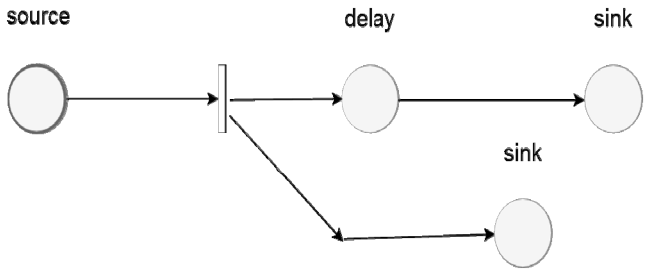

Fig.3 Queue system for fog computing

In figure 3 illustrated that the probability of the absence of fog computing on the device is equal to 0.16 (from monitoring operator during the busy hour.)

IV. RESULTS

The figure displays the simulation results, where the CPU displays blue OF one load switch. And orange shows a fog computing.

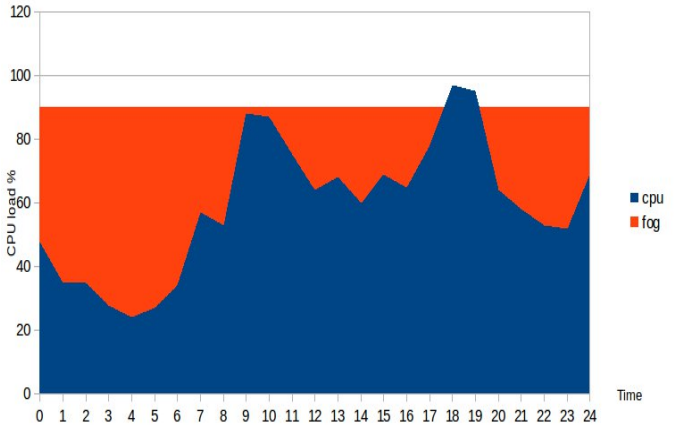

Fig. 4. Simulation results

V. CONCLUSIONS

Fog computing is a key solution to overcome the challenge of ultra low latency associated with the realization of 5G cellular system and its applications. Also, edge computing provides a way for offloading computation from the core of the cellular network. Moving from centralized huge data centers to distributed micro-cloud units will no doubt be the main feature of the future 5G.

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