CLOUDS AND FOG COMPUTING IN THE INTERNET OF THINGS

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In the article discusses the problems of cloud computing, an alternative solution in the form of fog computing, helping to expand the range of applications and services, with a minimum latency. Foggy computing is suitable for several critical services and applications of the Internet of Things, the necessary criterion for work is mobility, short latency, scalability, autonomy, mobility, a huge number of nodes, the predominance of the role of wireless access, real-time access. Such services and applications of the Internet of Things can be automobile systems, smart networks, smart cities, homes and in general, networks of wireless sensors and drives.

The development of technologies in the field of software and hardware, the emergence of new communication protocols have led to the expansion of the Internet of Things (IoT). The number of devices is growing day by day, and they generate a huge amount of data. Therefore, a need arises for a convenient system architecture capable of processing, storing and transmitting this data.

Now for these purposes, cloud services are used. However, the ever-growing foggy paradigm is able to complement cloud solutions by scaling and optimizing the IoT infrastructure.

Cloud computing can handle most IoT requests, monitor services, quickly process any amount of data generated by individual devices or entire device systems, as well as visualize them. Fog computing proved to be more effective in solving real-time problems. They provide fast response to requests and the minimum delay in data processing. Fog is an addition to the work of the IoT, expanding the capabilities of the cloud.

Foggy computing is a virtualized platform that provides computing, storage and network services between both devices and data centers of cloud computing, and which usually, but not always, is located on the borders of the network. The IoT architecture shows how the various informational communication technologies that enable the functioning of the IoT are connected to each other using fog computing [1]. The IoT architecture includes four functional layers, shown in Figure 1 and described below.

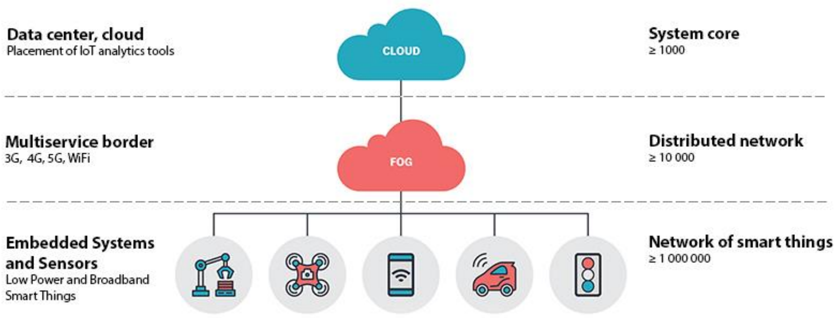

Figure 1 – IoT and fog computing

Computing, storage and network resources are computer capacities realized both in the cloud and fog. The border of the network implies several characteristics that give the fog a number of advantages, being essentially an extension of the cloud.

• Border location, location data and low latency. Fog sources can be tracked to support endpoints with multiple services at the edge of the network, including low latency applications;

• Geographical distribution. Unlike the more centralized cloud, fog-oriented services and applications require widely distributed deployment. Fog can be used for streaming data to moving cars through proxies and access points along all highways and paths;

• Scalability. Large-scale sensor networks for environmental control and smart networks are another example of distributed systems that require distributed computing and storage resources;

• A huge number of nodes, as a result of a wide geographical distribution, as already noted, in sensor networks in general and in smart networks in particular;

• Mobility. For many foggy applications, it is important to communicate directly with mobile devices, and therefore support for mobile technologies, such as the LISP protocol, which separates the identity of the host from the identity of the location and requires a distributed directory system, is very important;

• In real time. Important hazy applications use real-time interaction more often than batch processing;

• Wireless access;

• Heterogeneity. There are many types of fog nodes that can be placed in various environments;

• Compatibility and integration. The holistic support of some services requires the cooperation of various providers, the fog components must be compatible with each other, and the services must be combined across domains;

• Analytics. Support of online analytics and interaction with the cloud in the fog plays a significant role in receiving, entering and processing data close to the source.

The task of fog computing is to ensure the interaction of multiple sensor devices with each other and with the cloud, that is, the data center.

The number of elements in the fog is not constant and, in the general case, can vary from *0* to a certain N_{max}. Fog computing are just wireless sensor networks, characterized by self-organization, in which there is no common infrastructure with the exception of gateways for communication with other networks. Each of the nodes of the sensor network should be able to function as a terminal and as a transit node. In fact, data transmission in sensor networks is carried out by redirecting them to the nearest node step by step.

While fog provides local information and therefore has low latency and awareness of conditions, the cloud provides global centralization. Many applications require both localization of fog and globalization of the cloud, especially for analytics and working with big data.

The IoT World Forum Architecture Committee, made up of industry leaders including IBM, Intel, and Cisco, released an IoT reference model in October 2014. The reference model (figure 2) is intended to foster collaboration and encourage the development of replicable deployment models. This reference model is a useful complement to the ITU-T reference model. The ITU-T documents focus on the device and gateway level with only a broad depiction of the upper layers [2].

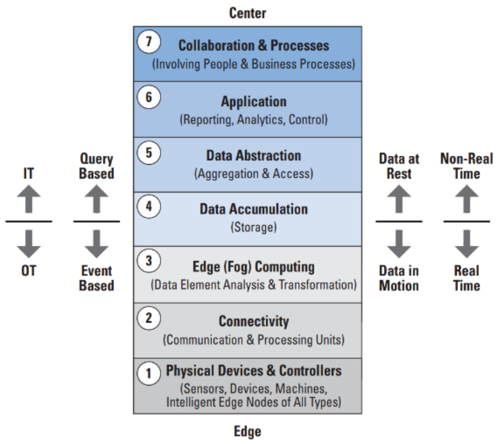

Figure 2 – IoT World Forum reference model [2]

According to the description of the model, Cisco indicates, that the developed model is distinguished by the following characteristics:

• Simplifies: It helps break down complex systems so that each part is more understandable.

• Clarifies: It provides additional information to precisely identify levels of the IoT and to establish common terminology.

• Identifies: It identifies where specific types of processing are optimized across different parts of the system.

• Standardizes: It provides a first step in enabling vendors to create IoT products that work with each other.

• Organizes: It makes the IoT real and approachable, instead of simply conceptual [2].

The article discusses the concept and characteristics of fog computing, a platform that provides a wide range of new services and applications of the Internet of things. Foggy technologies manifest themselves as flexible, hybrid technologies that will eventually become a unifying platform, functional enough to bring a new type of promising services and create the conditions for the development of new applications.

Список использованных источников:

1. Bonomi F. et al. Fog computing and its role in the internet of things //Proceedings of the first edition of the MCC workshop on Mobile cloud computing. – 2012. – С. 13-16.

2. Stallings W. The internet of things: network and security architecture //Internet Protoc. J. – 2015. – Т. 18. – №.