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Determining the High Level of Requirements for the Construction of 5g/Imt-2020 Network Infrastructure, Taking Into Account the Virtualization of Network Elements and Functionality (Sdn/Nfv)

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Annotation: An attempt is presented to theoretically comprehend the 5G/IMT-2020 network infrastructure, taking into account the virtualization of network elements and functionality (SDN/NFV). The groups of factors that explain the reasons for the introduction of new services, the introduction of new network protocols and functionality are determined.

Keywords: network infrastructure, virtual infrastructure, SDN, NFV.

5G networks have great advantages (performance, mobility, signal strength and security) over 4G networks in terms of transmission speed. Existing 4G networks do not meet the new needs of subscribers for innovative mobile services. At the same time, operators are facing insufficient flexibility of communication networks, increasing their complexity and increasing cost of use. 5G / IMT-2020 technologies, which allow to overcome these shortcomings, are a natural stage in the development of mobile networks.

Prospects for the use of SDN / NFV technologies in the networks of telecommunications operators are as follows:

- ✓ high scale of the network, flexible centralized management of the network and network resources;
- ✓ Reduction of capital costs for the purchase of COTS equipment;
- ✓ low operating costs due to the use of virtual network functions;
- ✓ increase energy efficiency through the use of high-efficiency data center servers;
- ✓ reduction of time for launching new network services;
- ✓ ability to use equipment from different vendors;
- ✓ increase the level of security;
- ✓ Use of cloud platforms in data centers on the operator's periphery to improve the quality of service.

The services provided by the 5G/IMT-2020 communication network are divided by ITU-R into 3 groups:

- ➢ The first group: Advanced mobile broadband (eMBB). This group of services includes human-to-human access to multimedia content, services, and data (similar to services currently provided by LTE networks). These services include: Ultra HD and video, 3D video, including real-time mode, online games, virtual reality (possible applications: education, entertainment, health, military industry), advanced social networking services, cloud services (possible field applications: public services, business applications, computing), streaming, including voice, real-time music, MBMS broadcasting.

To support these services, you need to provide multi-gigabit data speeds. In eMBB scenarios, practical user data speed, field unit traffic, maximum data rate, mobility, energy efficiency, and spectrum efficiency are of high importance.

The second group: large-scale machine-to-machine communication (MIoT) systems. This usage mode is characterized by many connected devices that transmit relatively small amounts of data that are not sensitive to delay. In order to provide quality support for these services, it is necessary to ensure a large coverage area and low cost of subscriber devices while maintaining long battery life. Main areas of application: energy, transport, health, trade, public safety, industry, housing and communal services, unmanned vehicles. MIoT scenarios are characterized by the need for high connectivity and the proper operation of a large number of devices in the network. The low cost of the device and its energy efficiency are important for the implementation of this scenario.

Third group: ultra-reliable low-latency data transmission (URLLC). This usage mode places high demands on network performance, such as latency and availability. These services include wireless control of industrial and production processes (robotization), telemedicine, in particular, surgery, automation of electricity distribution in smart grids, public safety, smart homes and cities, the use of smart vehicles and the implementation of smart road infrastructure. takes Based on V2X and others. In some URLLC scenarios, low latency is high to support critical security services, as well as high mobility in traffic security services.

To implement the above three main service groups in the fifth generation mobile network, 5G / IMT-2020 networks must have the following features:

- flexibility in the use of spectrum and bandwidth - the ability to design communication systems for different spectral scenarios and, in particular, the ability to work in different frequency bands;
- reliability - the ability to ensure the operation of a service with a very high availability factor (where the availability factor means the probability that the network will be in an arbitrary state of operation at the same time);
- Stability - the ability to maintain the operational status of the network under and after external influences (emergencies, emergency power outages, etc.);
- security and privacy - the ability to encrypt and protect the integrity of subscriber data, prevent unauthorized access, protect the network from hacking, fraud, etc;
- Energy efficiency - the ability to provide a certain operating time provided by the stored energy. This is especially important for M2M devices that require a long battery life (e.g., more than 10 years) because it is difficult to maintain them permanently for physical or economic reasons.

The SDN network infrastructure defined by the NFV virtual network infrastructure and software facilitates the accelerated implementation of new services, the introduction of new network protocols and functionality, and integration with innovative third-party applications.

1. NFV virtualization technology allows to separate the software from physical devices and, in particular, to implement the functions of telecommunications equipment on universal

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equipment - IT-servers. Using a virtualization program (hypervisor), multiple virtual servers (or VM virtual machines) on a single high-performance physical server can interact with each other via a virtual switch with their operating systems and software. However, virtual servers share the resources of physical servers.

A distinctive feature of the 5GC network is the use of virtualization technology - the implementation of telecommunication modules (5G Core network functions) using VNF virtual network functions (Figure 1).

The virtual network infrastructure of the NFV data centers of the 5G / IMT-2020 network must comply with the technical specifications of 3GPP and ETSI in terms of creating a MANO management and orchestration system.

The NFV virtual infrastructure allows you to build a flexible, scalable communication network tailored to the needs of communication services and reduce the cost of owning a TCO (Total Cost of Ownership) network using the usual high-efficiency and reliable data.

The disadvantage of the virtual infrastructure is that the processing of user traffic (User plane data packets) is done at the server level, which requires a lot of resources. Overcoming this shortcoming is possible by applying the software-defined network SDN concept.

Another important issue for NFV is the design of standard interfaces not only for a number of virtual devices, but also to promote transparency of NFV objectives as one of the virtualized applications and older equipment, network carriers need to integrate and manage servers, hypervisors and virtuals p tenant NFV in the environment of devices from different vendors. Their continuous integration requires integration interface to facilitate interoperability between them.

Network operators need to support a smooth migration path from private physical devices to open standard-based virtuals, as they may not be able to update all available services and equipment to NFV-based solutions. Developed NFV solutions must be compatible with existing operating and business support systems (OSS / BSS) and Element and Network Management Systems (EMS / NMS) and network functions to operate in a hybrid environment with physical and virtual.

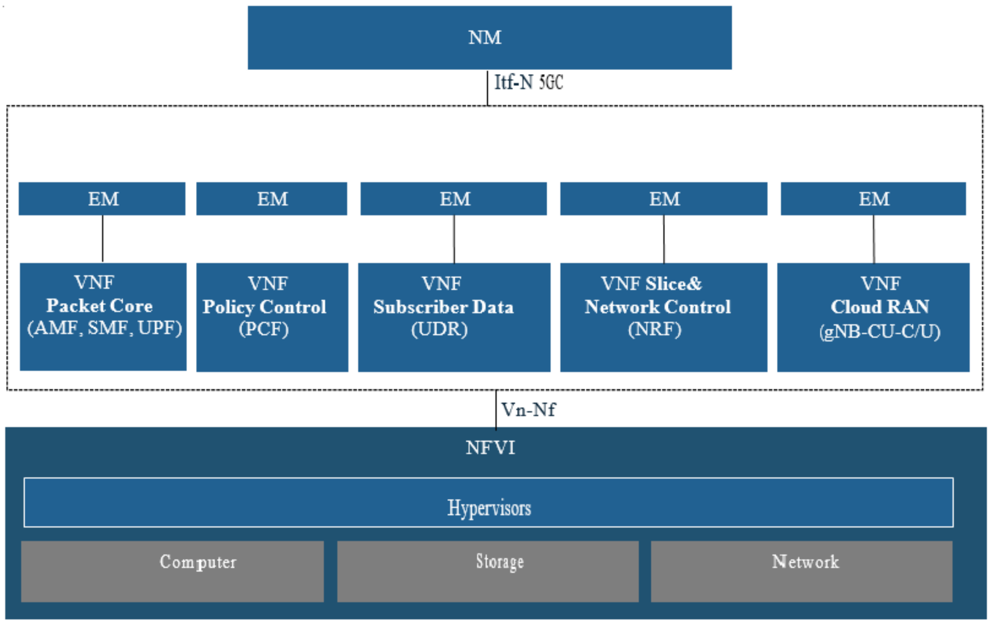

Figure 1. Virtualization of network elements of 5 G/IMT-2020 infrastructures

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2. Software Defined Network (SDN) is a technology that separates the functions of the data layer from the functions of the control plane of the switch and the traffic it carries. This approach involves transferring the intelligent component from the network device to a dedicated server, resulting in maximum simplification of network elements - switches, routers, and cost reduction.

SDN technology aims to solve the following problems:

- ✓ increase the efficiency of network capacity management mechanisms;
- ✓ simplification of network management and increase of its level of automation;
- ✓ scaling up the network;
- ✓ strengthening network security;
- ✓ increase routing efficiency;
- ✓ reduction of capital and operating costs.

The main idea of the SDN approach is:

- ➢ Separate the management of network equipment from the management of data transmission by creating special software that can run on a simple personal computer and are under the control of the network administrator;
- ➢ transition from the management of individual copies of network equipment to the management of the entire network;
- ➢ Creating a software-controlled intelligent interface between the network application and the transport environment of the network.

The main components of SDN networks defined by software based on the OpenFlow protocol (Figure 2):

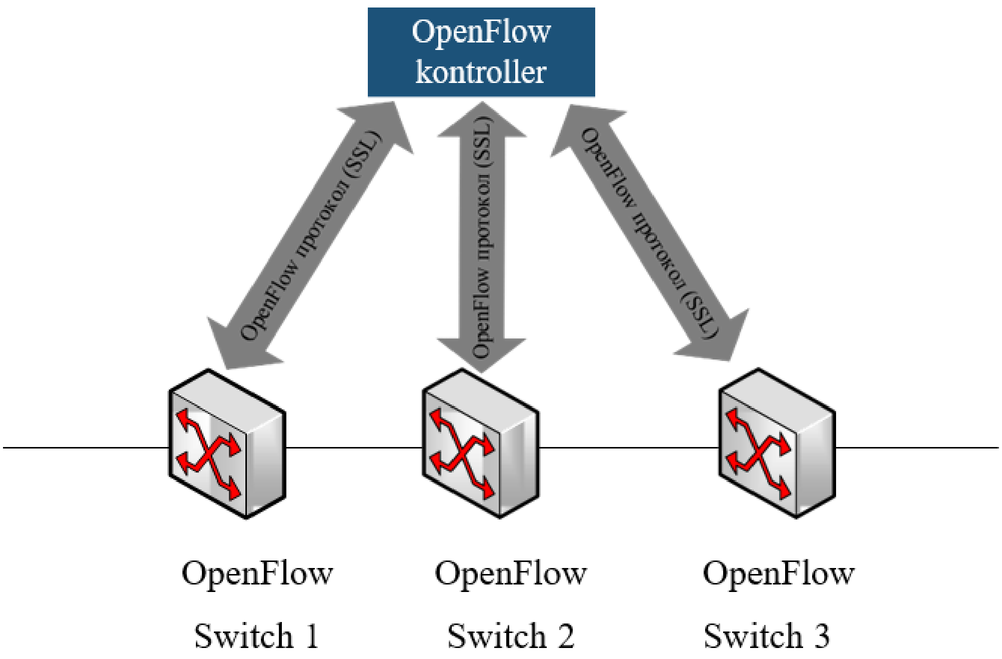

Figure 2. Switching circuit diagram with OpenFlow protocol controllers

- Open Flow switch;
- Open Flow Manager or network operating system;
- A secure channel through which the controller and the key communicate (in most cases TLS (transport layer security) is used to protect the transmitted messages, but transmission can be done without encryption).

The SDN network infrastructure must be built in accordance with the OpenFlow open protocols, be integrated, and provide the ability to implement technical solutions from multiple vendors.

The network infrastructure of the network defined by the SDN software allows the construction of networks with high switching capacity and data transfer speeds.

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