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ANALIZA ZARZĄDZANIA SIECIĄ SDN ZA POMOCĄ OPROGRAMOWANIA

Streszczenie: Zbadano możliwości interakcji modeli matematycznych z oprogramowaniem do realizacji funkcji fizycznych różnych typów sieci komputerowych 3GPP. Ustalono, że modele scentralizowane mają niższe wskaźniki niezawodności, dlatego konieczne jest zwiększenie niezawodności systemu, konieczne jest również zaplanowanie zadań lub kosztów wdrożenia, rozbudowy, utrzymania infrastruktury, funkcje te zostały przeanalizowane i rozważono rozwiązanie tego problemu.

Słowa kluczowe: oprogramowanie, sieć sterowana oprogramowaniem, wskaźniki niezawodności, infrastruktura sieciowa

ANALYSIS OF SDN NETWORK MANAGEMENT BY SOFTWARE

Summary: The possibilities of mathematical models interaction with software for providing physical functions of different types of 3GPP computer networks are researced. It is established that centralized models have lower reliability indicators, therefore it is necessary to increase the reliability of the system, it is also necessary to be able to plan tasks or costs of deployment, expansion, maintenance of infrastructure, these functions were analyzed and the solution of this problem was considered.

Keywords: software, software-driven network, reliability metrics, network infrastructure.

1. Introduction

3GPP networks have a complex structure. 3GPP networks consist of micro and macro levels, which already complicates the control of traffic, since the principle of operation of these levels is different in hardware and software. In addition, technical

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tools add the complications to the work, these complications turn into errors or delays in the network, which leads to deterioration and affects the quality of services.

Network management tools are automated or management software, so you need process management software to work with high-speed networks with these types of traffic. Namely, the software that will use the process model to analyze the indicators and take into account the negative criteria that need to be developed, to verify through the implementation of software-managed networks in which all the software is installed on the hypervisor.

3GPP standards are evolving towards 5G, where reliability and the ability to easily manage large amounts of traffic are very important. This is why centralized environment management is relevant in the future and is currently positioning itself as a tool for large amounts of information. Such technology has significantly higher performance than 3 and 4G. Therefore, it is important to use software-defined networking (SDN). But no less relevant to the 5G network is its reliability. Therefore, the software will help automate a large number of processes and make the network performance better, will meet the requirements of the above mentioned standard.

2. Literature data analysis and problem statement

Cuses on the network infrastructure management system, which is a multi-tool component of a software-managed network, and does not highlight the low reliability of the SDN network. The source [2] of the article describes the reliability of the SDN system. It offers low reliability by switching from the OpenFlow network to the classic network, which will help maintain the network's performance and increase its reliability. But it should be said that network performance will decrease significantly, because IP-based network is inferior in its characteristics, which can be seen in [3], and in the transition to a more modern network, it is possible to get overload and decrease in quality of service in some areas. It should be emphasized that the reliability of OpenFlow is indeed higher than in the Owerlay network.

Article [4] discusses the method of network congestion, which in turn solves the problem of switching from SDN to NAT, but the low reliability of the Owerlay network remains, which makes it practically impossible to use the network for a mobile operator or large fixed network entities. And for the 4G and 5G standards, the reliability has some characteristics that are more than the SDN controller and other levels of equipment can provide [6, 7].

The purpose of the work is to identify the negative criteria that may arise from the operation of mobile or fixed networks, the ability to control the process and the consequences that will improve the ability to control using software that will analyze the processes and allow to keep phenomena within the limits set by the software application-level security.

3. Outline of the main material

The software-configured network shown in Figure 1 is a data network in which the network management level is separated from the data devices and implemented programmatically - one of the forms of computing resources virtualization.

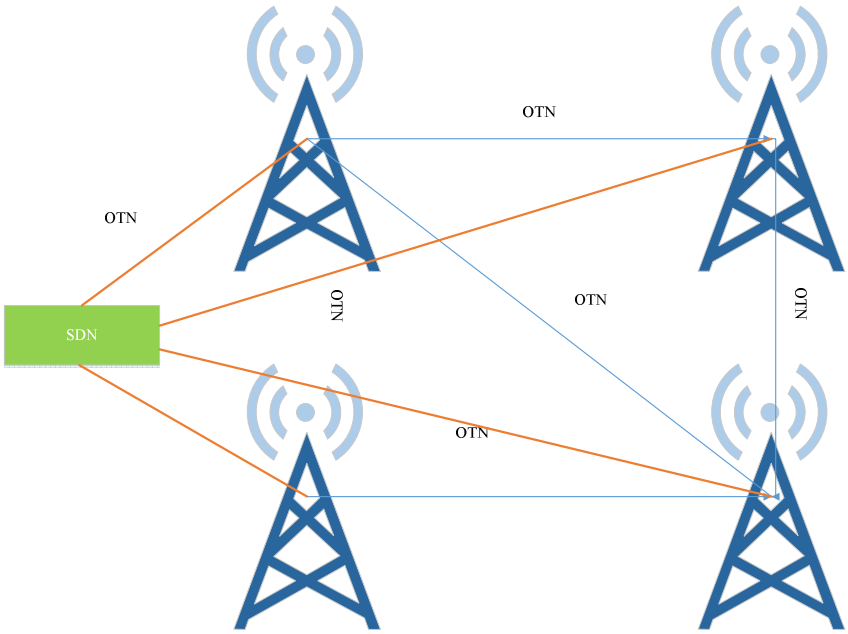

Figure 1. Schematic of a wireless centralized SDN control system

A modern network device consists of three components:

- Management layer - CLI, embedded web server or API and management protocols: the task of this layer is to control the device.
- The level of traffic management is a variety of algorithms and functional tasks of which is an automatic response to traffic changes.
- traffic transfer - functionality provides physical data transfer.

If you centralize traffic management by separating controls from devices and centralizing device management - as a result, the "new" router or switch only serves the data stream (DATAPLANE traffic rate). Of course, the network device will not be able to completely deprive intelligence, but it can be replaced by a simple forwarding table [10].

The centralized management system can be divided into two versions of Overlay and OpenFlow development.

SDN overlay is a software implementation method for an SDN network based on the use of software switches (such as Open Switch) that is installed on virtual machines (VMs). Software switches configure virtual ports to match virtual and physical ports, and physical ports already link the tunnel. OpenFlow is a protocol for controlling the processing of data transmitted over a data network by routers and switches, which implements software-configured network technology.

Decentralized classic IP network IP

Network Address Translation is a mechanism on TCP / IP networks that allows you to convert the IP addresses of transit packets. Also known as IP Masquerading, Network Masquerading and Native Address Translation.

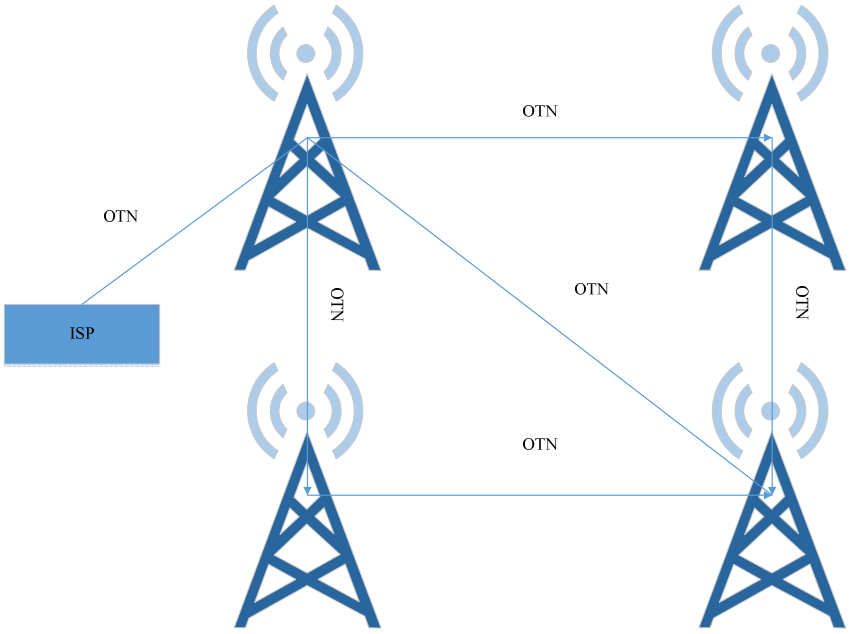

Figure2. Wireless classic IP network scheme

An example of this network is all modern technologies of information transmission, modern network, mobile networks operating on the basis of IP protocol, DNS servers.

Information processes of physical infrastructure of modern 3GPP network

Data transmission processes in centralized networks are different from those of traffic transmission in decentralized networks: the main interaction of centralized processes takes place regardless of the lower levels of the hierarchy.

In a centralized network or, if it is an SDN network, the interaction is managed by the server, ie the interaction of such processes depends on the level above. The most striking example of such a system is the client-server architecture of the network.

In Fig. 3 shows a diagram of the distribution of traffic flows in mobile networks. It should be noted that SDN separates service traffic from user traffic, so the computing power is much smaller than for the huge arrays that encapsulate user and service traffic.

It is worth noting that the transmission band for each user on the SDN system per client is equal to the amount that that user requires, which in turn makes the network operation more optimal than the dedicated bandwidth network.

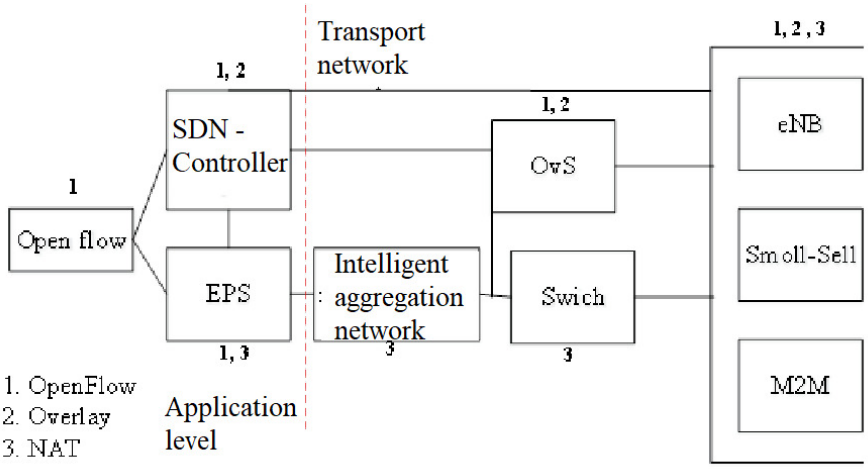

Figure 3. Scheme of traffic flow distribution

The methodology of centralized systems differs significantly from the classical ones in that the classical network does not have a control application layer, centralized systems are controlled at the application level. In an application-level SDN, some physical functions of the equipment are virtualized using Network Functions Virtualization NFV (or Network Function Virtualization) technology. Therefore, we have the ability to install software on the hypervisor and test it through simulation or process emulation. This scheme does not consider the possibilities of heterogeneous networks that need to be analyzed separately, they can be very dynamic and used with a variety of equipment, and program-oriented. Heterogeneous networks have a complex set up, they use WiFi technology, SmollSell. It would be a good idea to virtualize this technology and connect it to an SDN controller that would be able to distribute resources at the micro level.

Model of network reliability calculation, compliance with standard 3 GPP

A mobile network is a complex system that works as long as all its components work, but basic concepts of reliability indicate that the system, no matter how modern it is, has very critical vulnerabilities that can be seen in a typical direct state of system startup. But the reliability of the system can be calculated using the blocks of reliability (Fig. 4) using the formula 1 for independent events.

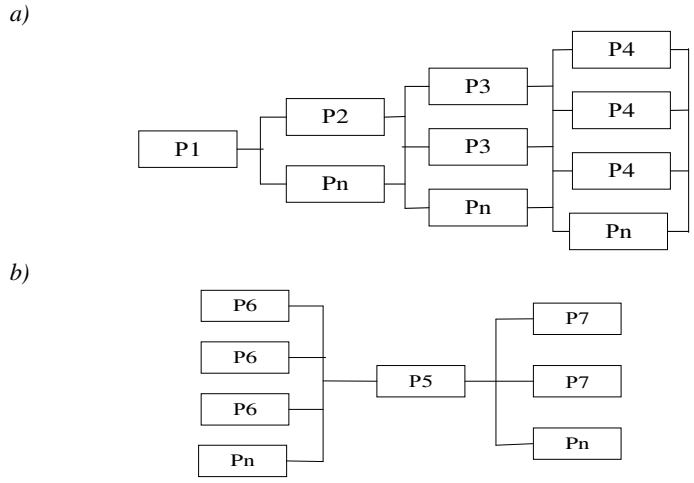

Figure 4. Breakdown into serial / parallel model blocks for calculating mobile network reliability: a –the scheme is a decentralized IP network; b - centralized SDN network

4. Methods for creating software using existing models and processing these metrics and planning for higher levels

Modern manufacturers, such as well-known brands HP, Samsung, Xerox, Cisco, create equipment that connects to the network and records the technical condition of the equipment. This helps to reduce the time spent on servicing the facility and remotely understand its settings, centralizing its maintenance and configuration. The main point of these programs is to make the object more manageable, easier to set up and better to maintain. The program concerns specific hardware, not the system as a whole, ie the hardware has its own microsystems that calculate the technical condition, these are the technical indicators and are analyzed by software solutions. As for the SDN system, there is no industry standard today so those users who have already migrated to this architecture are developing their applications, their software that makes this network. Indicators that can be removed from sensors or from primary models should be used for more detailed analysis, the algorithm of which will work in the application program. Setting up interaction with software that will work with first-model models will allow you to analyze additional states, such as calculating the cost of an extension or the cost of repair, or the cost of maintenance at a specific time. That is, a software-driven network becomes much more intelligent and capable of automated, optimal management, where the allocation of resources will be managed at a lower micro level. This model allows you to monitor network status on the basis of technical data, or on the basis of technical inspection, introduction of additional measures or upgrading.

The main method of analyzing the performance of an application is to test it. Figure 5 shows the application testing algorithm using information technology

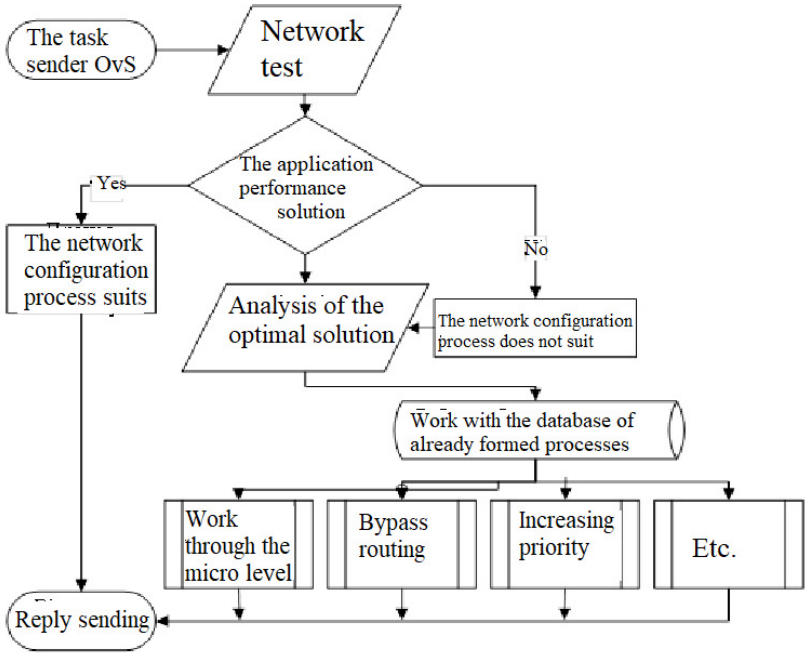

Figure 5. An example of testing an application using information technology

When receiving practical data, the system can monitor the status of the network and keep metrics within the user or standard set. Integrated software will help reduce the hour of network limit state, reduce network reconfiguration times, calculate the cost of equipment repair or maintenance. Using the models: Reliability and Cost of Computer Networks (discussed below), we can deduce additional features that will calculate the cost of repair and the period of service life after repair or maintenance. Figure 6 shows a typical straight line - a model that has been experimented with many equipment launches or systems and is reduced to a general type.

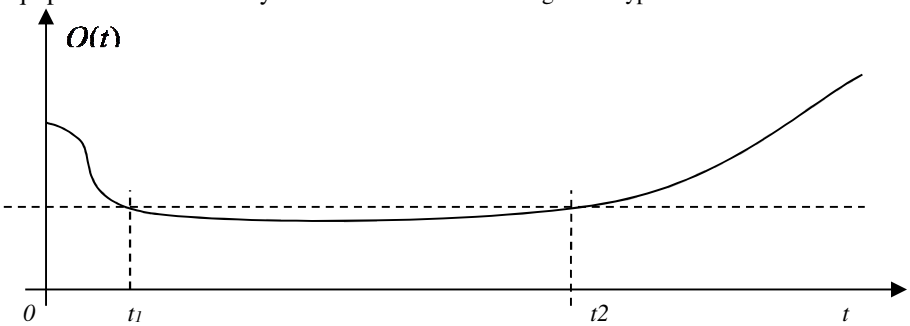

Figure 6. Typical straight line. The state of startup of any equipment or system

In Fig. 6 we see three sections 0- t1 - this is the startup period or "Break-in" of the equipment or system, this period has a very unstable state, 0 - t2 is the withdrawal of the equipment or system from the period of operation, because its failure rate does not allow us to use this equipment . *An example of calculating the cost of maintaining a network over a period of time.*

When considering failures, we are talking only about accidental failures, which are in the period t1 - t2, in the area of "normal" work, where (working and wear areas are discarded). The first assumption is fulfilled. For him, the probability of failure of the system or element is determined by exponential law.

$$P\{t\} = e^{-\lambda t} \tag{1}$$

where λ – the failure rate

$\lambda(t) = const$

t – the operating time of the system or its element

$$\int_{t_1}^{t_2} e^{-\lambda t} dx = Pt_1 - Pt_2 + C \tag{2}$$

Calculation of failure rate for period t1 - t2,

$$\int (P\sum N + ms)dx = Q\{t_1\} - Q\{t_2\} + C$$

$$\int (P\sum N + ms) - (V + R)dx = Q\{t_1\} - Q\{t_2\} + C$$

$$\int (R\sum N + ms)dx = Q\{t_1\} - Q\{t_2\} + C \tag{3}$$

This model will help us determine the status of the network and take some steps before the network becomes unusable. Also, these models will help you calculate the cost of network maintenance over a period of time. With these models we will be able to build an algorithm for calculating technical measures and calculating the cost of conducting, maintaining, repairing or upgrading equipment. Considering exactly when to do it, for what specific time and the consequences of performing or not completing the necessary work as a whole.

Modern manufacturers, such as well-known brands HP, Samsung, Xerox, Cisco, create equipment that connects to the network and records the technical condition of the equipment. This helps to reduce the time spent on servicing the property and remotely understand its settings, centralizing its maintenance and customization capabilities.

The main purpose of these programs is to make the object more manageable, easier to set up and better to maintain. The program concerns specific hardware, not the system as a whole, ie the hardware has its own microsystems that calculate the technical condition, these are the technical indicators and are analyzed by software solutions.

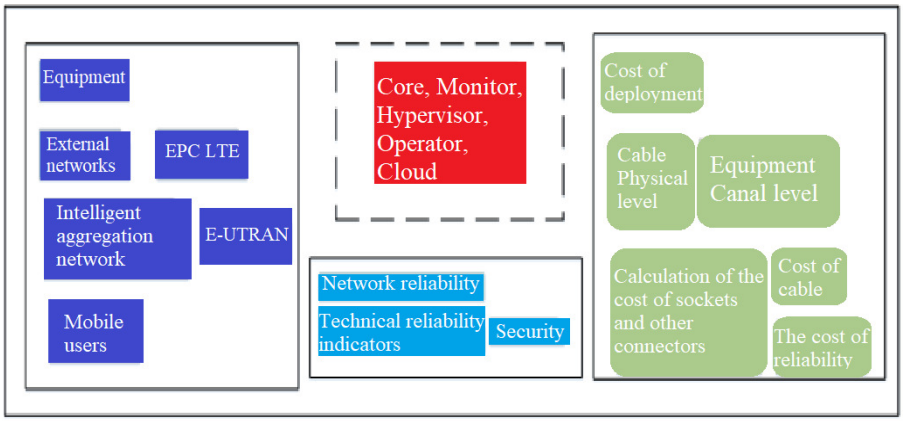

Figure 7. Semantic model (network) blocks of software

Indicators that can be removed from sensors or from primary models can be used for more detailed analysis, the algorithm of which will work in the application-level program. Setting up interaction with software that will work with first-rate models will allow you to analyze additional states, such as calculating the cost of an extension or the cost of repair, or the cost of maintenance at a specific time. That is, a software-controlled network becomes much more intelligent and capable of automated, optimal management, where the allocation of resources will be managed at a lower micro level.

This model may monitor the network status on the basis of technical data, or if the operator has assumed the responsibility to extend the life of the technical inspection or to introduce additional measures or upgrades.

When receiving practical data, the system can monitor the status of the network and keep metrics within the limits set by the user or standard. Integrated software will help reduce the hour of network limit state, reduce network reconfiguration times, calculate the cost of repairing or servicing equipment.

5. Conclusions

Computer network analysis has been completed. Centralized SDNs and decentralized IP management systems for computer networks, which are most popular today are analyzed. It is determined that in modern industrial implementation the most acceptable are the centralized openflow and overlay control systems, which have better performance than the decentralized IP networks.

Centralized systems have been found to have lower reliability than decentralized systems and, over time, these indicators decrease. Therefore, additional monitoring and control tools need to be developed. Based on the analysis, the model is expanded. Methods for developing, implementing, and using SDN software are offered. Which can be used at the software level using the hypervisor available on these networks.

It is determined that mathematical models can be used and software can be used to interact with them. This will help improve the way you manage and maintain

your facility. The method of software development is offered and the possibility of interaction between models is shown. A model for analyzing the technical state of the network has also been developed.

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