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Research of reliability parameters of transport level of the next generation networks

Tuygun Nishanbayev[1], Alevtina Muradova[2], Javokhirxon Utkurov[3]
Department of Telecommunication Engineering, Tashkent University of Information Technologies

***Abstract*—This article devoted to the transport level of infocommunication network, examines the parameters of reliability of each equipment. The statistical data MTBF and average recovery time of each component failures. Calculated the parameters of the coefficient of readiness (K_r) to upgrade the network and after the modernization of the network transport level.**
***Keywords*—the transport level of next generation networks, infocommunication network routers of transport level, switches of transport layer, redundant communication channels, uptime, reliability.**

I. INTRODUCTION

In [1,3] introduced the model, that allows from system position to research reliability parameters of infocommunication network (ICN) with distribution structure, the core of that presentation components of the infocommunication network as subsystem, that they presentation as independently levels and accomplishing specific function in packet regime with preassigned quality of service.

The model substantiates the notion that the availability of the K_G, describing the probability of the system in an arbitrarily chosen time performance (i.e, characterizing the degree of reliability ICN), defined as the multiplication of the coefficients of readiness of its component parts (layers), i.e,

$$K_G^{ICN} = \prod_{i=1}^{n} K_G^{n} ,$$

where n– the number of components of info-communication network.

In turn, each level ICN includes a plurality of elements, which also have the final reliability values of parameters, that is, for each i - level fair expression

$$K_G^{i} = \prod_{j=1}^{m_i} K_G^{j} , \qquad (1)$$

m_i– the number of component of i-th level of ICN.

The following are the results of a study of reliability parameters of its equipment level ICN, which directly affect the quality of services ICN as a whole.

II. FORMULATION OF THE PROBLEM

The transport layer is the second from the bottom level of the hierarchy of info-communication network. The main purpose of the transport - transport of packet data for a next-generation network, incoming routers across multiple communication channels from the various gateways and switches the access level.

Transport layer is the frame of modern next generation network (NGN). It is a means for connecting users and applications. NGN brings the following features: the channel model instead of a primary network using a data transmission channel which can be set based on the technology of "virtual channels" and "virtual pipes" in the case of datagram transfer principle. The network connections may be present as a "point to point" that could be interpreted as a channel, and the connection "point-to-multipoint" and even "multipoint" that can no longer be regarded as a channel.

Transport Layer technology, this technology, which allows the network to redistribute the collected traffic access networks. Consumers of transport network resources are the access network. Access Network NGN from the collected traffic and users interact with each other via the transport network. From this model, we get the most important conclusion, which determines the value of technology in the field of transport networks solutions: The main purpose of the transport layer is to serve the NGN traffic data. For traffic service transport layer should provide the following procedures adopted in NGN: traffic distribution, load balancing, routing traffic relations of different topologies ("point-point", "point-to-multipoint communication," and so forth.), Traffic redundancy, multiplexing (combining) and demultiplexing (separation), etc. The more successful the transport network serving the technology packet traffic, the more effective solution.

The transport plane (Transport Plane) is responsible for transporting messages over a communications network. These messages may be signaling messages, message routing information for the organization of the transmission path or just the user voice and data. Located beneath the plane of the physical transport level communications can be based on any technology that meets the bandwidth to carry this type of traffic. The transport plane also provides access to a network of IP-telephony signaling and / or user information received from other networks or terminals. Typically, devices and transport plane functions controlled function service control plane and call signaling.

The transport network is based on IP technology. As IP technology is based on the principle of using datagrams for transmission of information. IP datagram format is crucial, since this structure provides a standardized transmission on the NGN transport network. A datagram comprises header and data field.

Modern transport NGN network built based on IP technology, in addition to the already considered routing protocols, uses a lot of different protocols and their modifications. Compared to traditional networks, built on the principles of circuit switching and for this reason it is topologically simple, NGN transport networks are much more diverse in tasks. For example, in the transport network must be provided not only a communication "point to point" and "point-to-multipoint", "point to all users" and "multipoint" with different modes of communication participants select and duplicate payment. Therefore, to ensure the functioning of the different network transport protocols are used in different modes.

All of the protocols can be divided into several classes:

A. Layer 2 Tunneling Protocol, to ensure the creation of "virtual pipe" transport network, or tunnels for traffic.
B. Traffic Routing Layer 3 protocols that provide various routing topologies, including adaptive routing based on principles.
C. The protocols provide a certain level of quality of data in the transport network.
D. Multicast protocols used to implement the traffic transfer schemes "point-to-multipoint", including with the use of adaptive algorithms.
E. Control the protocols that support the various transport network performance management procedures at levels 2-3.
F. The transport layer protocol that provides connectivity control data transmitted.

The transport network is to support, so it meet high requirements for reliability, performance and manageability. The structure of NGN transport network may include:

The transit nodes, performing transport and switching functions.
The end nodes that provide access to the subscriber multiservice network.
Controllers alarm, operating alarm information processing function, call and connection management. 4. gateways, enables the connection of traditional communication networks (PSTN, SPD, SPS).

Router - a device with three levels; it operates at the physical layer, data link, link level (level data link) and a network layer. As the physical layer device, it regenerates the signal it receives. As the device is a data link layer, the router checks the physical addresses (source and destination), contained in the package. As a network-layer device, the router checks the network layer addresses (addresses in the level of IP).

The router can: to connect local area networks; connect with a general-purpose network; connect LANs to general purpose networks. In other words, the router - interworking unit; it brings together independent networks to form the Internet. According to this definition, a network router connectable to become Internet-network, or Internet. The router has the physical and logical (IP) address for each of its interfaces. The router acts only on the packets in which the destination address corresponds to the address of the interface where the packet arrives. This is true for one-way, group or broadcast address. The router changes the physical address of the packet (both the source and destination), when he sends forth a package.

III. THE DECISION OF THE PROBLEM

The integrated scheme of transmission of messaging on the transport layer shown in Fig. 1.

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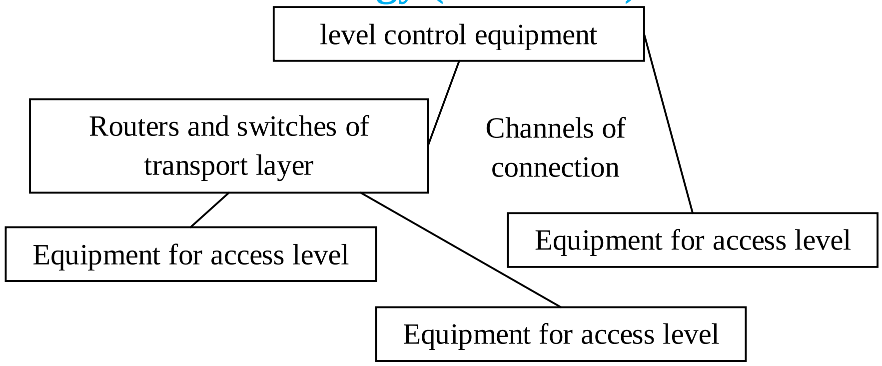

Fig.1. The integrated scheme of transmission line of streams at the transport level ICN network.

According to expression 1, the reliability of the transport layer is characterized by a work readiness coefficients of its components, ie,

$$K_G^{trans} = \prod_{j=1}^{3} K_G^{j} \; .$$

Readiness coefficients usually determined from the statistical data using the following formula:

$K_G = T_0/(T_0+T_в)$,

where T_o- MTBF (for all types of failures), which is calculated by the formula:

$T_o = \sum_{i=1}^{N} t_i / N$,

$T_в$ – mean time to repair of system failures,

$T_в = \sum_{i=1}^{N} t_{ipr} / N$,

t_i – i-period of continuous time of system working;

t_{ipr} – down time of system, caused i-malfunction of considered equipment;

N – amount of malfunction.

Reliable transport layer is considered as part of the network stability in general and, in general, includes a property a) reliability, b) durability, c) and d maintainability) persistence.

Trouble-free and long-lasting operation of the transport layer is achieved with reliable and smooth operation of the whole complex of the level of equipment.

Here we consider the problem of resource allocation allocated to improve the reliability of the transport layer between its components.

So, let there be given: - initial topological structure of the transport layer, that is: the number of routers, their types and characteristics, the number, types and characteristics of switch equipment; coordinates equipment deployment; the number of channels and their capacities; - Statistical parameters for reliable operation of each equipment for a certain period (eg, one year); overall uptime, total downtime due to a malfunction of each equipment, the degree of congestion of communication channels, the total number of served and unserved orders for each message type and for each area, etc .; - The value of the allocated funds to improve vehicle reliability and so on.

The algorithm for solving the problem can be described as follows:

1. On the basis of statistical data by the expression 1.3 and 1.4 are determined by the average uptime and the average downtime for each type of hardware routers and switches; 2. Based on the calculated value formula 1.2 availability factor for each of the transport-level equipment; 3. According to the formula 1.1 is determined by the current value of the coefficient of readiness K_G^{trans} transport layer as a whole; 4. Checking compliance with the current value K_G^{trans} transport layer required standards. In the case of this condition proceeds to operator 7; 5. Determine the equipment (or more equipments) and the number of communication channels that do not have the condition in terms of reliability, that is, $\{K_G^j\} \le$ required $\{K_G^j\}$, and in relation to them being taken to implement this provision.

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Some detail on this operator.

It should be noted that failure of communication channels connecting the gateway equipment with equipment routers and switches leads to failure of access to the equipment management level, regardless of the status of communication channels connecting equipment routers level control equipment and, conversely, the failure of the link between the router and facilities level control results in failure of the output level control of all equipment connected to this router.

A complete refusal to consider the transport ICN is considered the failure of all the channels of communication between all hardware routers and equipment management level, switches and management level, as well as the transport network equipment. Evaluation of reliability of the software (software) that implements the interaction between the components of the transport on the basis of the relevant protocols, different from the assessment of the reliability of the hardware (AO).

The reliability of the software can be reduced when you make mistakes in their debugging and change. Software to access the network level are based on the approved protocol standards, so they can be considered to satisfy the reliability requirements.

After identifying the vulnerable points of the transport-level measures are taken, increasing the value of K_G. They may include: reservations, "obgreyt" specific hardware areas, within the allocated funds replacement of old with new equipment, the connection gateway equipment to a nearby identical router or to an adjacent equipment management level, etc. As a result of the implementation of specific measures, control is passed to the operator 8.

A. Definition of a loaded sections of the transport layer, as well as areas with the lowest values of K_G and the transfer of control to the operator 6;

B. Determining the value of availability factor after operations 6 operator and check the condition of the operator 5. In case of non fulfillment of the condition the transfer of control to the operator 5, otherwise the fixing of a new transport-layer structure and stop the algorithm.

C.

Work algorithm was tested on a concrete example. Baseline data were taken from the company, which provides services to a modern network. The topological scheme of research transport layer is shown in Figure 2.

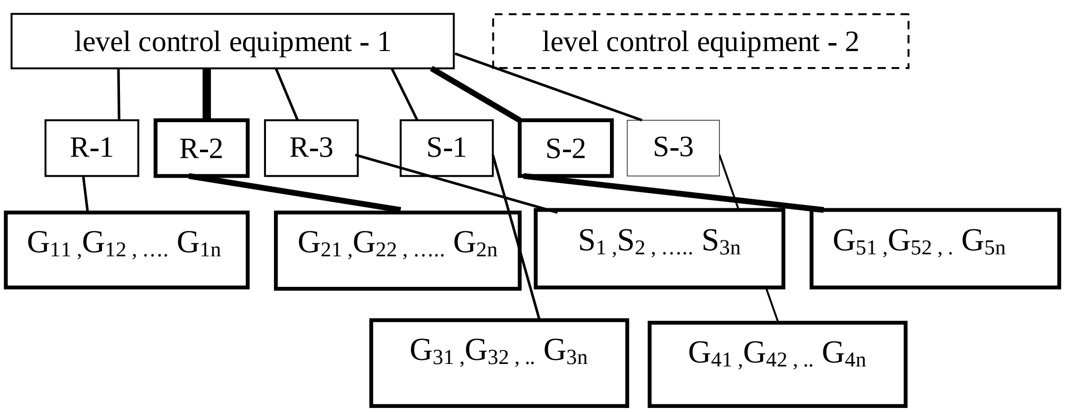

Fig.2. The topology of research transport layer

Referring to Figure 2 this topological scheme of the transport layer contains equipment routers, switches, which are connected to the appropriate gateway equipment. Routers and switches are connected to the appropriate equipment management level (Softswitch) info-communication network having a distributed structure. The transport equipment are interconnected via communication channels with different bandwidths. The table summarizes the average values of the smooth operation of communication channels plots gateway router, switch, router, and the main channels between the routers (and switches) and equipment management level.

The statistical parameters characterizing the reliability of the parameters listed in the table. As a safety parameter used uptime K_G. Value K_G was determined on the basis of the above mentioned formulas. For example, router K_G will be:

$K_G^M = T_0^M/(T_0^M + T_в^M) = 8756/(8756+5) = 0{,}999429.$

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TABLE I

THE STATISTICAL PARAMETERS OF THE RELIABILITY OF THE EQUIPMENT PARAMETERS OF TRANSPORT LAYER

№	Name of equipment of transport layer	T_0	$T_в$	K_G	T_0^M	$T_в^M$	K_G^M
1.	Router - 1	8756	5	0,999429	8757	4	0,99954
2.	Router - 2	8545	9	0,9989	8546	8	0,99906
3.	Router - 3	9018	4,5	0,9995	9019	3,5	0,99961
4.	Switch - 1	8755	5	0,999429	8757	3	0,99966
5.	Switch - 2	8932	5	0,99944	8933	4	0,99955
6.	Switch - 3	8456	4	0,99953	8458	2	0,99976
7.	Channels of connection: Gateway Router (Switch)	8755	13	0,9985	8760	8	0,99909
8.	Channels of connection: router (switch) - Equipment management level (of Softswitch)	9025	9,5	0,9989	9030,3	4,2	0,99954

The degree of reliability of the transport layer is defined as the product of the readiness factors of all its components, ie,

$$K_G^{trans} = \prod_{j=1}^{8} K_G^{j} = 0{,}9936$$

As you can see, the current value K_G^{trans} transport layer is in the "two nines" area. This is an average result. To identify vulnerable "points" transport layer ICN and the adoption of certain measures to enhance the availability factor values program was that by entering the initial data determined which areas it is necessary to "strengthen" in terms of increasing the value K_G. These areas were mostly trunk and terminal links as well as some routers. The program data were introduced, what steps must be taken to improve K_G each section of the transport layer. For the considered case such areas are outlined in bold lines.

Thus, at the expense of the allocated funds (defined in relative units) "and the existing capacity (in terms of "obgreyt" technical equipment) K_G transport layer can be raised to a value as shown below:

$$K_G^{trans} = \prod_{j=1}^{8} K_G^{j} = 0{,}9958$$

IV. CONCLUSIONS

In conclusion we note that the program is designed with the input of initial data allows to determine the vulnerable points of the transport layer and what modernization needs to be done to raise the value of the coefficient of readiness of the site and the transport layer as a whole.

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