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PROBLEMS OF DATA TRANSFER IN THE NETWORK OF THE ORGANIZATION WITH MINIMIZED CAPABILITIES OF THE USED RESOURCES

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Abstract:

Currently, communication networks are actively developed and evolve, which requires connection of many stations now. Among them are quite a few networks that use LTE technology. It was necessary to create a mathematical model that allows to serve a different type of traffic in LTE networks, as well as implement it. Using this model, it was necessary to evaluate how well applications are served, and then build a system that allows to describe the characteristics of its work, using the results to create a list of recommended actions when managing traffic of various types in real time. The results are given on the assessment of the rate with which the transfer takes place in the part of the LTE-network, in which it is possible to process applications for all types of traffic, with a limited value of losses. Results are shown on estimation of rate value in cell, which will allow processing of requests for all types of traffic, with permissible losses and averaged time for data transmission. The average use of cell resources in data transmission is demonstrated, in the case where resources are maximally available to transmit data traffic.

Keywords:

Computer network, traffic loading, protocol.

ACM Computing Classification System:

Network protocols, network algorithms, network types.

Introduction

The use of 4th generation mobile networks, which are based on technological solutions that allow access from many stations, and have orthogonal OFDMA modulation, using MIMO encoding, allows traffic to be transmitted in greater volume than in previous generation of networks.

These networks are characterized by a very flexible architecture, they can change network topology when connecting, disconnecting users. In addition, they had high data rates that need to be reliably protected from hacking. These networks did not use expensive cabling, which made them cheaper to access.

LTE networks are controlled by base stations. They, together with the main network survey, can determine the routes on which traffic from clients will be directed. But here the main difficulty is to manage it on the interface with compliance with quality requirements (QoS), considering all subscriber services, for example, roaming.

Since mobile applications had recently grown significantly in quantity, that required a high quality of service that could be achieved if the radio interface had a high throughput capacity. Because when using wireless access, load differences are possible due to the fact that users move in stochastic order [1].

As mobile communication becomes cheaper, new types of client-terminals arise, and services that addressably transmit video data develop, then real-time traffic increases accordingly. And its speed indicators must be unchanged.

The purpose of the paper is to develop and describe a model, implement an algorithm for increasing the capacity of the radio interface in LTE networks.

This algorithm is based on the use of a minimum amount of resources per month to analyze different service models, which is achieved by effectively controlling the rate at the time of data transmission.

1 Modeling of Application Distribution in LTE Network

Let's look at the development of algorithmic solutions that will allow you to regulate access to new applications on the network. A simulation model was created that allows to evaluate the traffic of various kinds coming to part of the LTE network. Consider a mathematical model for processing traffic having two real-time rates relative to a portion of the LTE network [2].

To process a single request, you must provide one hundredth of resources c_r bit/second. The real-time application processing time indicator *r is distributed exponentially according to the average indicator* $1/\mu_r$. *In this case,* μ_r is a parameter describing this distribution.

In addition, we indicate that applications for the transfer of files will be received in accordance with the Poisson law, at intensity - λ_d. To process a single request, the cell is given the maximum available amount of resources, with a size of c_d bit/second, which corresponds to an expression $c_1 \le c_d \le c_2$.. The values c_1 , as well as c_2, determine the minimum and maximum speed at which files will be downloaded. Take that $c_1 \le c_2$.

The model in question determines that the file to be transmitted will be exponentially determined having an average of F (bit). It was clear that the value of time to transfer a file, using exclusively c_1 (minimum speed)) and c_2 (maximum speed), would be distributed exponentially, with parameters $\mu_{d,1}$ and $\mu_{d,2}$. . Parameters $\mu_{d,1}$ and $\mu_{d,2}$ are found using an expression $\mu_{d,1} = c_1/F$ and $\mu_{d,2} = c_2/F$.

2 Results of Transmission Rate Estimation on LTE Cell Fragment

The characteristics of the model load will be the intensity of traffic in real time λ_r, as well as the intensity of data traffic λ_d.

The main parameter that will determine and allocate resources over the data transfer will be speed. It was clear that if one were to sort, it was possible to estimate each parameter presented if the others were fixed. It was recommended that those applications submitted in real time should be considered a function that would evaluate the quality parameter when processing incoming applications πr that they had not received access.

Clearly, if you browse, it is possible to evaluate each parameter presented if others are fixed AND applications transmitting πd files that also do not have access. By planning data transmission resources, these indicators can change. Further, when conducting the study, we will take this fact into account.

Let us assume that the main value of lost bids will be π, the value of which can be determined using some expression. It was recommended that those applications submitted in real time should be considered a function that would evaluate the quality parameter when processing incoming applications πr that they had not received access.

$$\pi = max(\pi_r, \pi_d).$$

As another equally important parameter that evaluates the quality of file transfer request processing, we will select the average time required to transfer the file T_d. We estimate the transfer resource which has a cell acceptable to handle incoming traffic flows according to the required quality. The quality parameter in the processing of requisitions is determined by the fact that $\pi = 0{,}05.$ if subsequent model parameters are calculated:

$$C = 100\frac{Mbit}{s}, c_r = 3\frac{Mbit}{s}, c_1 = 1\frac{Mbit}{s}, c_2 = 5\frac{Mbit}{s}, F = 16Mbit, \mu_{\hat{e}} = \frac{1}{300}, \lambda_r = 0{,}05, \lambda_d = 5.$$

If there are such values, the loss will be defined as $\pi_r = 0{,}3274, \pi_d = 0{,}1299$. And any parameter value will be greater than π on 0,05.

Next, we will systematically increase the rate at which the data are transmitted until the maximum loss is at least 0.05.

The results of the calculations are shown in (Fig.1).

It presents the results of calculated losses on applications πr, as well as πd, if the data transfer rate increases C. Of course, if the speed C increases, then the loss rate on applications decreases.

From $C = 118\frac{Mbit}{s}$, the amount of losses on requests for data transfer will be less than 0.05,and from $C = 129\frac{Mbit}{s}$, real-time traffic processing requests will also lose less than 0.05. Accordingly, the problem is solved with the value $C = 129\frac{Mbit}{s}$.

Fig.1. Results on estimation of the rate at which the transmission takes place in the part of the LTE network at which requests for all types of traffic can be processed, with the limit loss value.
Horizontal axis: velocity Mbit/sec,
upper blue line: real time loss rate of requests,
lower yellow line: file transfer loss rate of requests.

To find a transfer resource, its volume, often it is required to calculate average time necessary to transfer the file and which will be sufficient to process traffic according to quality parameters.

Suppose the model requires an average transmission time of T_d of not more than five seconds [3].

In this case, the transfer resource is selected until the corresponding condition is fulfilled and the corresponding time parameter is fulfilled with it. The results of this task are shown in (Fig.2).

It shows the average time to transfer file T_d with the condition of increasing the total data rate C.

Naturally, when C is increased, the value of the file T_d will decrease. From the indicator $C = 137\frac{Mbit}{s}$, the value of losses on applications for all types of traffic will be less than 0.05, while the average time to transfer a file will be less than five seconds. And the task was solved with $C = 137\frac{Mbit}{s}$.

Fig.2. Estimates of the rate in the cell, which will allow the processing of requests for all types of traffic, with permissible losses and average transmission time. Horizontal axis: velocity Mbit/sec, vertical axis: average time of data transfer.

Also, the maximum allowed amount of traffic passing through the cell with constant capacity to pass C is selected, as well as with the value of maximum additional losses. As a normative indicator, the average time limit for data transmission is also applied.

To achieve this, if other parameters are constant, the resource load in the cell will decrease until the quality restrictions of the incoming requests are fulfilled [4].

The results of the calculations are shown in (Fig.3). Real-time bid losses are calculated here $\pi_к$, as well as for file transfer requests $\pi_в$, with reduced load ρ. Of course with a decrease ρ reduced number of losses on applications. If ρ will be less than 0,95, then the amount of losses on applications for all types of traffic will be less than 0.05.

The problem was solved with a value of then the amount of losses on applications for all types of traffic will be less than 0.05.

The problem was solved with a value of $\rho = 0{,}95$. Value size λ_r, and also λ_d The size of the values is determined by the relation that finds about ρ. To solve this problem, you need to know how the intensities for all types of traffic that we analyze relate to each other [5].

Fig.3. Results of estimation by the maximum allowed traffic volume that passes through the cell, with constant data throughput C, as well as with specified marginal losses.
Horizontal axis: load ratio of cell unit, vertical axis: loss rate of requests,
upper blue line: real time loss rate,
lower yellow line: file transfer loss rate.

3 Investigation of the Algorithm for Selecting the Ratio between the Minimum and Maximum File Transfer Rates

Let's go on to consider the problem of choosing the ratios of mines c_1, and also max c_2 data rates. Of course, what if $c_1 = c_2$, then file processing will take place using the Erlang model. If the speed value c_2. increases, then the network operator accelerates the data transmission. To do this, the capacity of the cell itself is used, which is free and does not process traffic in real time.

Let's show this process by example. Imagine a cell with numerical parameters such as:

$$C = 100\frac{Mbit}{s}, c_r = 3\frac{Mbit}{s}, c_1 = 1\frac{Mbit}{s},$$
$$c_2 = 1\frac{Mbit}{s}, F = 16Mbit, \mu_r = \frac{1}{300}, \lambda_r = 0{,}04, \lambda_d = 4call/s.$$

We have already said that if you select these entry parameters, then the processing of applications will be presented using the Erlang model. And with an increase c_2 with constant other parameters, the capacity in the cell will be better since the data will be transmitted at a higher rate.

Let's take this as an example.

The results of the calculations are shown in (Fig.4). It shows real-time loss calculation π_r, and when transmitting information π_d with an increase of the indicator c_2 one to forty Mbps.

Of course, with an increase in the indicator c_2 there is a decrease in losses on applications. This process will be the same for all traffic requests. The occurrence of such dependence occurs since resources are released in an accelerated manner. If the conditions described above were accepted, the greatest efficiency would be achieved if $c_2 = 10 Mbit / s$.

Subsequent promotion c_2 does not have much influence on characteristics [6, 7].

Given this, we can say that the interval for changing the speed value with which files are transmitted is selected from how the parameters relate to each other. And this choice can be made by using a built-in model, together with algorithms that can evaluate its characteristics.

Fig.4. Dependencies of losses by claims, if resource transmitting traffic is as accessible as possible π_f, if speed rises c_2. Naturally, when the speed increases c_2, the load in the cell will also increase. Horizontal axis: upper limit of file transfer velocity, vertical axis: loss rate of requests, upper blue line: real time loss rate, lower yellow line: file transfer loss rate.

(Fig.6) presents the results of calculations of the average number of applications for any of the category m_r as well as m_d, which contains the cell in processing if the index rises $c_{2.}$.

You can see that when zoomed in $c_{2.}$, the average number of file transfer requests that are accepted for processing will decrease. Due to the fact that these applications are processed faster by the system and leave it.

(Fig.7) presents the results of the calculations of the averages for the distribution of cost-effectiveness and s_d directly in part of the network. As well as their total values, which are used for all types of traffic. If increases c_2, the use of resources will change only initially, after these changes will not be significant.

(Fig.8) is a summary of calculations of the average utilization of cell c_d resources in file transfer. When $c_{2.}$ is increased, this parameter will also be increased, but it is the initial operation.

(Fig.9) is a summary of the average time calculations for file transfer T_d if increases c_2. is raised from one to forty one Mbps. By increasing c_2., the average data transmission time will decrease from a value of sixteen seconds and will decrease to a value of 6.2 seconds, depending on how the cell is loaded.

Fig.5. Results of calculations of part of time at whole load of cell resources, in case, when resource availability increases when transferring file traffic. Horizontal axis: upper limit of data transfer velocity, vertical axis: time rate.

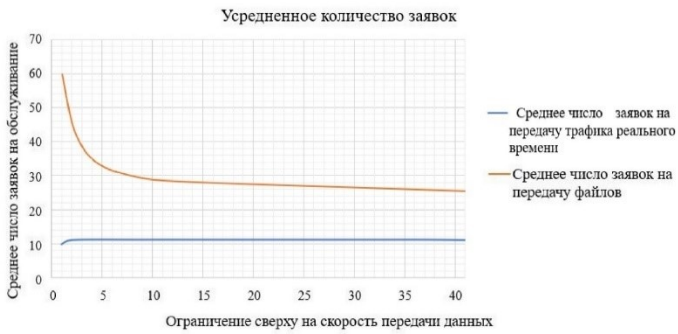

Fig.6. The average number of requests that a cell contains in processing, in the case where resources are maximally available when transmitting information traffic. Horizontal axis: upper limit of data transfer velocity, vertical axis: average number of requests.

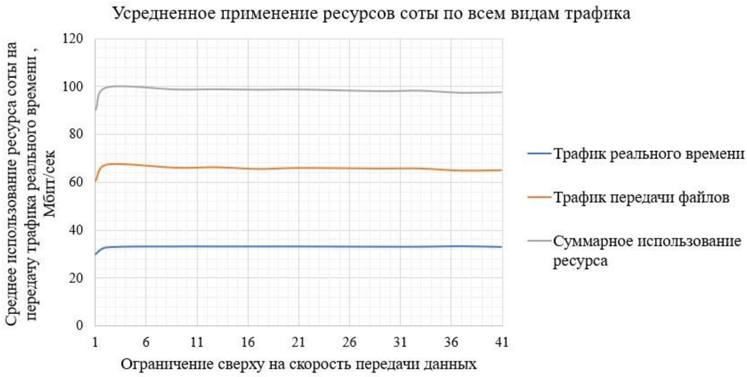

Fig.7. Average utilization of cell resources across all types of traffic,
in the case where resources are maximally available to transmit data traffic.
Horizontal axis: upper limit of data transfer velocity, vertical axis: average utilisation Mbit/sec.

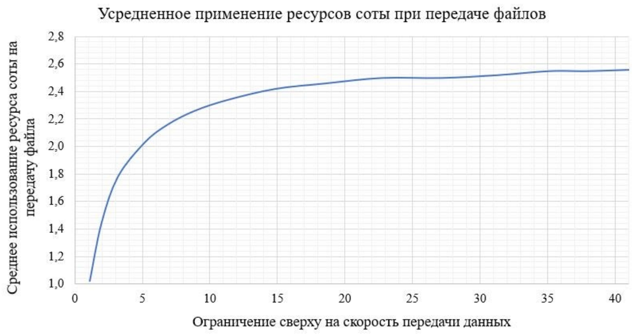

Fig.8. Average use of cell resources in file transfers
when resources are as available as possible to transmit data traffic.
Horizontal axis: upper limit of data transfer velocity.

Fig.9. Average use of cell resources in data transmission, in case when maximum resources are available for data traffic.
Horizontal axis: upper limit of data transfer velocity, vertical axis: average time of data transfer.

Conclusion

There was introduced an algorithm to solve the problems of planning the way to skip the data of a part of the network. In addition, the maximum amount of traffic allowed was determined, with its transmission in accordance with the established quality requirements. It is determined how restrictions are related to the rate at which files are transferred in order to increase the efficiency of using the resources of a part of the network.

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