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TRAFFIC FRACTAL ANALYSIS AND THE DETERMINE THE PROBABILITY CALL BLOCKING IN CELLULAR MOBILE NETWORKS

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The purpose of this article is analysis of fractal properties of traffic and its influence on the characteristics of telecommunication systems for a given quality of service (QoS) as invariant to scale throbbing traffic structure can significantly influence the network performance. Analysis of the causes and consequences of fractal in traffic, and to identify areas handover is an important task in the modeling of radio coverage in the environment base stations Radio Mobile [1]. The numerical analysis model is incomplete two streams available system of mass service (SMS) with expectations calling for the handover and determine the probability of each new call blocking, call handover-and-multiple-call handover in a mobile network cell.

Introduction

Currently, prevalent modes of transmission of voice and multimedia data in packet-switched networks [2], which is characterized by fractal traffic. In modern telecommunication systems (TS) growth trends observed using voice and video sharing services networks with packet switching, also increasing popularity of VoIP [3]. Improving and complexity of broadcasting transmission, the transition to packet data systems and the increasing number of users of voice and multimedia services have made existing design methods unable to satisfy requirements as traditional circuit switched telephony, and in the case of packet switching. So the question fractal aggregate voice traffic streams and their influence on service quality in VoIP systems now need to be studier in more detail.

Systematized research devoted to studying the influence of fractal properties of the total traffic alone voice calls and data calls to customer service quality of service does not exist as an actual task.

Main part

Now it is necessary to revise traditional approaches to the analysis and synthesis of TS using traditional theory teletraffic and mass service theory. Considering packet voice and multimedia it can be noted that there are new features and characteristics of quality of service (QoS), which is devoid of traditional telephony. The development of VoIP has led to the emergence of new low-speech codecs that provide acceptable quality for telephony. An important element of VoIP is the technology VAD (voice activity detection - definition voice activity), which frees the channel in those moments when the user is silent and listening, or when the user pauses between words. Using algorithms to reduce pauses in the voice message together with statistical multiplexing capabilities leads to a significant reduction in the cost of communication. There are new opportunities, such as those associated with the use of resources being freed. With the advent of modern high-speed packet-switched networks having trouble combining new and existing technology transfer and switching of heterogeneous services and applications.

As a result packet traffic has become more difficult. In forecasting of network traffic analysis and network performance are widely used stochastic models of traffic streams as they are acceptable level of accuracy are able to provide the bandwidth networks. Confidence in a model traffic increases as a model, in addition to its statistical characteristics approximating covers visual properties of the traffic.

In TS a number of events in a given time interval depends on the past, distant events. This means that for large-scale traffic it has fractal property, that looks equally well with any sufficiently large scale temporal axis.

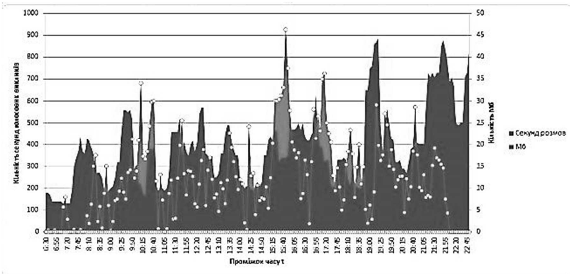
Stochastic process is called fractal when statistical characteristics exhibit scale properties of respective large-scale performance. For example, telecommunications traffic shows fractal properties, where some of its estimated statistical characteristics show a stepwise dependence over a wide time or frequency ranges.

Basic concepts that determine the properties of fractal processes - a self-similarity, long-term dependence of random processes (LDR), slowly decreasing dispersion, endless moments fractal dimension distribution of “heavy tails” dependence of the spectral density. Fractals describe the phenomenon in which some property of the object is stored in the scaling of space and / or time. The object is self-similar or fractal if its part by increasing a similar image. Unlike deterministic fractals, fractal stochastic processes do not have precise similarity components in the smallest details. Nevertheless stochastic self-similarity is a property that can be illustrated graphically and mathematically evaluated.

In terms of fractal traffic methods for calculating network (bandwidth, buffer capacity, etc.). Based on Markov models and formulas Erlang give unjustifiably optimistic decisions and lead to an underestimation of the load [4].

Invariant variability is not compatible with the traditional model of network traffic that exhibit a pulsating character on short time scales, but very smoothed on large time scales because they lack LDR. As the scale invariant structure pulsating traffic can significantly affect network performance, the analysis of the causes and consequences of self-similarity in traffic is a very important task.

The process of self-similarity is less smooth and more uneven and has a large dispersion. The process of unevenness real traffic is shown in Fig. 1, 2 research [5].



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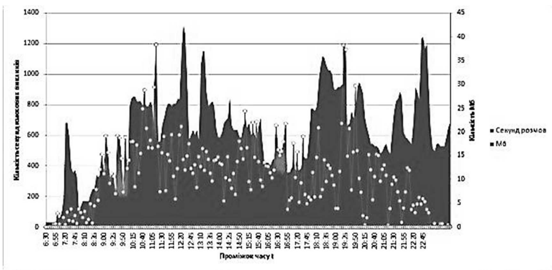

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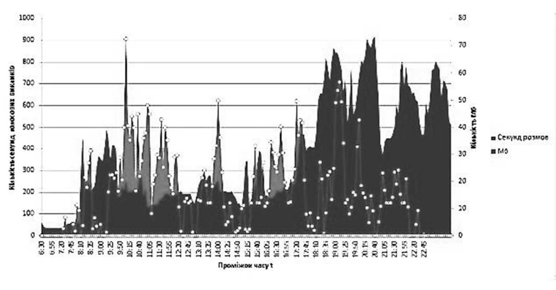
Fig.1. The dynamics of network traffic during the day 01.04.14 (a - base station (BS) Berkovetskaya str., b - BS Podgornaya str., m. Kyiv)



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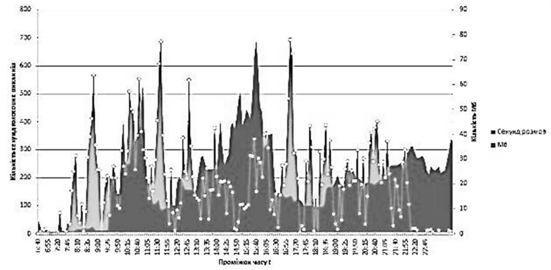

b)

Fig.2. The dynamics of network traffic during the day 06.04.14 (a - BS Berkovetskaya str., b - BS Podgornaya str., m. Kyiv)

Traffic has significant real-time fractal properties and LDR that it is appropriate to consider when assessing the effectiveness of TS. Traffic on large intervals of time describes the periodic structure of daily load and has a pulsing, generally non-Gaussian structure, and on small time scales has fractal enduring and gradually disappears with increasing scale aggregation. Conducted analysis traffic [6] has shown that it has significant fractal properties. Also in [7] that the telecommunications traffic for most service was fractal. In shown [8] research the local and global traffic shows network traffic variability over a wide range of time scales.

Using fractal traffic models will more accurately describe and recreate voice and video traffics that will provide an opportunity to obtain indicators of QoS, which are closer to real indicators.

The main distinguishing property of fractal processes is that they cover a wide range of time scales. The term "pulsating structure" is often used in this context. The overall characteristic of these models is that their spatial and temporal dynamics in some way controlled by a power distribution functions and hyperbolic fading correlation function. Traditional approaches to modeling of fractal phenomena based on a parameterized multi-level hierarchy of traditional models, which are characterized by distributions and correlation functions, faded exponentially.

Successful use of fractal theory teletraffic models will depend also on how they can be used for network analysis and management.

Availability of fractal properties in other types of traffic often negatively affects the quality of service characteristics TS [2, 4], but nevertheless is the ability to predict the behavior of traffic.

There are four methods to check traffic self-similarity. These methods are described completely in [9]. If to speak about the relative accuracy of these methods for determining the self-similarity of traffic, it is presented in [8].

In cellular communication there may be several reasons for the transfer session, the phone comes out of the coverage area of one cell network and enters the coverage area of another cell. Handover allows subscribers to move within the operator's network without breaking the connection.

Usually handover occurs when the signal on another channel or another base station for more efficient operation. The performance is meant for audibility signal from the base station. Now all the standards in the world of mobile communication using handover function but with different technical features implemented [10].

In general, the main reasons for the handover can be:

- A low signal in the forward or reverse channel;
- Poor quality of signal in the forward or reverse channel;
- Availability for better cell service where, for example, you can use a lower level of power and thus save battery life in mobiles;
- Exceeding the distance from the mobile to the BS.

Problem statement

Consider the process stream proceeds to BS calls distinguish two types of calls that create stress on the fixed base station cell (Fig. 3): 1. The new call has arisen within the considered cell and ended here; 2. The new call has arisen within the considered cell and moved to a nearby cell service.

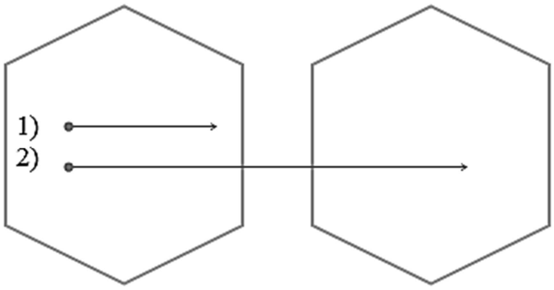

Fig.3. Two types of calls coming in BS cell

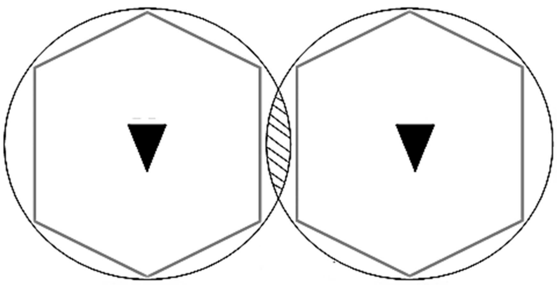

Fig.4. Handover zone for the two cells

In the area of Mobile handover movement towards neighboring cells is accompanied by deterioration of quality. Mobile can spend a handover zone while, depending on system parameters such as the size of the cell, speed and direction of movement of the subscriber. During this stay in the area of Mobile handover searching for free radio base station neighboring cell. Let us assume that, once in the handover zone, mobile cannot change the direction of movement so that the return to the territory of a cell through the base station which supports the current connection. Then there are three options:

- Handoff current connection to one of the free channels BS neighboring cell;
- The successful completion of the current service connection because the conversation subscribers to stay in the area of handover;
- Forced to break the current connection (forced calls termination) in the territory of neighboring cell - blocking handover, which happens at the time of crossing boundaries caller handover zone handoff from the current connection to the neighboring cell BS impossible.

Depending on the radius of radio wave propagation cells are divided into different types. In our case, we can talk about the micro cell (e.g., BS Str. Podgornaya) and macro (e.g. BS on the street. Berkovetskaya and Synoozerniy) Table 1.

Table №1 Characteristics of cell types

Types of cell	Radius	When used
Micro cell	50-300 m	In the city
Macro cell	1-20 km	Along the road

When designing BS calculation is expected radio coverage area to determine not only the radio wave, but also be handover zone. The calculation is made in the program Radio Mobile version 11.4.2. Setting the configuration of two base stations and determining their location, configured properties of stations according to Table 2.

Table 2 Network properties

	Height (m)	Fade in line (dB)	Transmitter power (W)	Receiver sensitivity (mV)	Of the antenna amplification factor (dBi)	Hanging antenna height (m)
BS	17	0,21	40	0,631	16,7	15
Subscriber station	-	1	1	1,7783	2	1,5
Mobile station	-	1	2	1,7783	3	1,5

We note that BS – three sectoral (three differently focused two-way radio antennas) electronic axis angles antennas 6 ° / 4 ° / 4 ° down in sectors with azimuths 60 ° 150 ° 330 °. Each sector of two transmitters is 20 watts. Besides the base station set parameters and subscriber stations and mobile. Their properties are also given in Table 2. The parameters for the network: polarization - vertical, mode - mobile, climate - continental temperate. For the purpose of BS - master, antenna direction - stationary. For the purpose of subscriber stations - slave, system - mobile. The calculation results are combined Cartesian radio coverage areas shown in Figure 5, where there are two BS m. Kyiv on streets Berkovetskaya and Synoozerna as well as a mobile station is selected subscriber station. Display options signal in dBm of (> =): -100 to (<): -30.

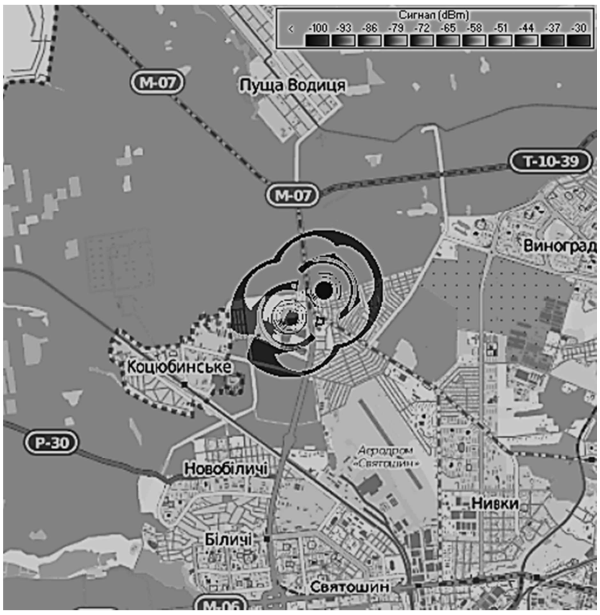

Fig.5. Radio coverage for two BS (m. Kyiv on the streets Berkovetskaya and Synoozerna)

In this article we do not consider cases where there handover call that came in from a neighboring cell examined cell and ended in the considered cell or handover call that came in from a neighboring cell examined and moved to cell service in the next cell.

Unlike the two models available full stream SMS [11] lossy handover zone where unpredictable and reservation service channels for handover calls, it is not a fully accessible model of a finite queue impatient and allows requests to provide handover zone. Let the physical model to the mathematical, therefore, assume that the streams of new and handover calls are Poisson-streams intensity λ_o (original calls) and λ_h (handover calls) respectively. Thus, the total stream of calls that create load on BS cell is Poisson stream of intensity $\lambda = \lambda_o + \lambda_h$. Any call served by BS with intensity μ_1 completes service within a cell and intensity μ_2 goes in the next cell. Thus, the length of service BS call that complete service within under considered cell has an exponential distribution with parameter μ_1, and the duration of service calls, which owns handover - exponential distribution with parameter μ_2. Thus, the channel length employment are exponential distributed random variables with a parameter $\mu = \mu_1 + \mu_2$. The number of channels in the cell is C. Used redundant access strategy: BS in cell g channels designed to serve new and handover calls, and the remaining $C-g$ channels are reserved only for service handover calls. Provides for a handover zone in which the MP can be no more than a random time has an exponential distribution with parameter λ. If at the time when the call comes in for service, the number of channels $C-g$ and $0 \le g \le C$, while the channel is engaged, otherwise the call is lost. The next call if no free channel is exemption channel. Maintenance is the type FIFO. A call is waiting in the queue can leave SMS with intensity μ_1 that corresponds to the conversation in the handover area, as well as the intensity γ corresponding to the handover blocking calls when trying to handoff from a neighboring cell to cell examined. Length of service calls are independent random variables with exponential distribution with parameter μ. The probability of B_o a new call blocking probability corresponds π_1 to the loss of 1 call. According to [11] can determine the probability of loss, length of queues blocking probability B_h.

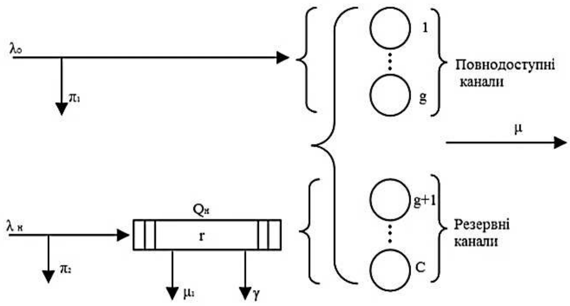

Fig. 6 Two streams available SMS with incomplete a finite queue and impatient requests

We perform numerical analysis of two-stream model available is incomplete SMS with expectations for handover of calls provided $r_1 = 0$, $r_2 = r$. List of symbols: r - queue length, π_1- possibility of losing the first request, π_2 - possibility of losing a second request, C - number of radio channels in a cell, λ - intensity of incoming calls to cell, λ_h - intensity receipt of handover calls in cell, λ_o - intensity for new calls in cell, μ - exemption channel intensity in the cell, B_o - blocking probability of new calls in the cell, B_h - handover call blocking probability in a cell, P_h - blocking probability multiple handover call. Necessary to determine B_o, B_h and P_h.

Initial data for calculation are listed in Table 3.

Table 3. Initial data

C	g	r	μ1	μ2	γ
100	70	30	1/110	1/150	1/100

To calculate this:

$$B_o = \sum_{n=g}^{C+r} p_n,$$

$$B_h = \frac{\gamma \sum_{n=C+1}^{C+r} (n-C) p_n}{\gamma_h \sum_{n=C}^{C+r-1} p_n},$$

$$P_h = \sum_{k=0}^{\infty} P(k) = \sum_{k=0}^{\infty} p^{k+1} (1-B_h)^k B_h = \frac{pB_h}{1-p(1-B_h)},$$

To calculate the definition P_n, P_o used the principle of local balance [12]:

$$\begin{cases} (\gamma_o + \gamma_h) P_{n-1} = n\mu P_n, & 1 \le n \le g; \\ \gamma_h P_{n-1} = n\mu P_n, & g+1 \le n \le C. \end{cases} \quad (1)$$

From (1) it follows that

$$P_n = \begin{cases} \frac{(\gamma_o+\gamma_h)^n}{n!\mu^n} P_o, & 1 \le n \le g; \\ \frac{(\gamma_o+\gamma_h)^g \gamma_h^{n-g}}{n!\mu^n} P_o, & g+1 \le n \le C. \end{cases}$$

Where P_o determined from the normalization condition:

$$\sum_{n=0}^{C} P_n = 1,$$

$$P_o = \left[\sum_{n=0}^{g} \frac{P^n}{n!} + \sum_{n=g+1}^{C} \frac{P^g P_h^{n-g}}{n!} \right]^{-1}.$$

The range of the load $\rho_o \in [0,\ 400]$ Earl, Fig. 7. With increasing load blocking probability of new of calls decreases, which means that in this range of load of calls for sufficient resources, and by increasing the number of channels povnodo foot blocking probability decreases.

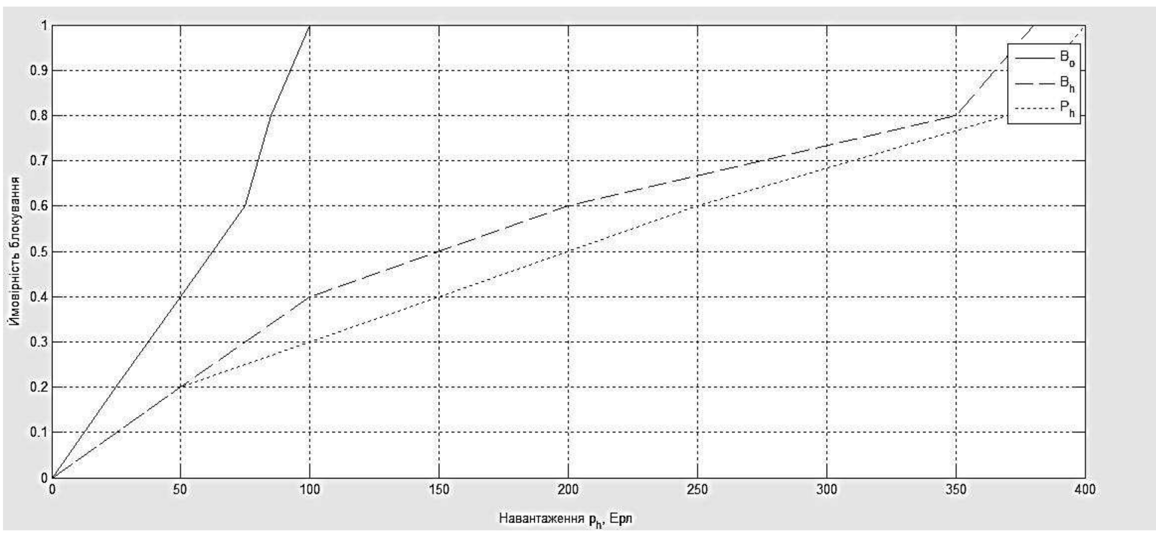

Fig.7. The dependence of the probability B_o, B_h, P_h the load ρ_h

Conclusion

Analysis of fractal traffic characteristics showed that the characteristics of telecommunication systems vary depending on the scale invariant pulsating traffic patterns and fractal traffic affects the specified quality of service QoS. Taking into account the fractal properties of traffic can greatly improve network performance. Numerical analysis of two-stream model available is incomplete SMS with expectations calling for the handover and the determining the probability of blocking a new call-call handover and multiple-call handover in the cell showed that this model is needed to determining the probability blocking a new call-call handover and multiple handover-call in the cell, the result of which can be used to improve effective method of dynamic channel assignment between voice calls and data [6]. Calculation of the quality of service available for the model is incomplete SMS with expectations calling for the handover and the determining the probability of blocking a new call-call handover and multiple-call handover in the cell [11].

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