# Probability Model of the Mobile System's Channel Capacity


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## ABSTRACT

In this work an attempt is made to simulate functional dependence of the number of channels on the number of mobile elements in the structural hierarchy of mobile telephone system with the help of developed stochastic model, and analyzing any territorial structural unit to find out the best correlation between the numbers of channels and mobile elements.



**Keywords:** capacity, hierarchy, mobile, model, probability.


## 1. INTRODUCTION

Modeling of mobile telephone system structure on early design stages is one of the major problems. First of all for modeling mobile telephone system, it is necessary to observe the basic properties of the investigated object, existing laws and features in them. For creation of such models with the purpose of simplification, we make some assumptions by means of which there is possible a supervision of system's features.

## 2. STOCHASTIC MODEL

As it is known the number of the demand for the channels of the units of arbitrary structural levels is not just any figure but a random value that can be observed with an experiment. For this purpose, groups including cellular units with the given random number must be chosen. Then define the density distribution function $f(m, N_1)$ of the channels in this group. As the experiment can be performed in case of too close values of $N$, the density of the corresponding distribution will form a surface, the equation of which will be $f(m, N)$. The crossing of that surface with $m=m_1$=const surface gives the density distribution function $f(m_1, N)$ of the elements, which have m1 channels (Fig1).

In fact, in this case both the $m$ demand for channels and the $N$ number of structural units of mobile areas are viewed as random value.

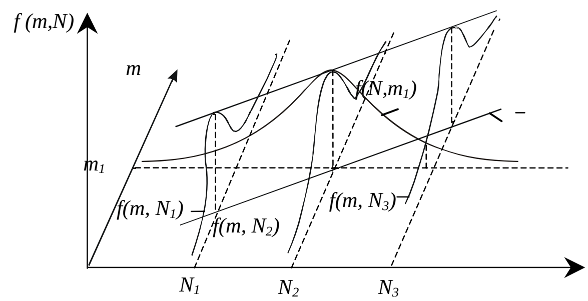
Thus, the capacity of channels of cellular system, depending on the number of structural units of mobile areas is characterized by the $f(m, N)$ surface.

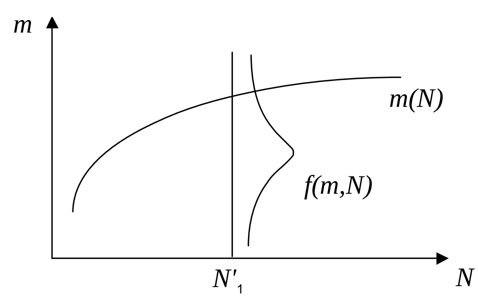
Thus, the distribution curves $f(m, N')$ and $f(N, m')$ should supply the demand for standardization. It means:

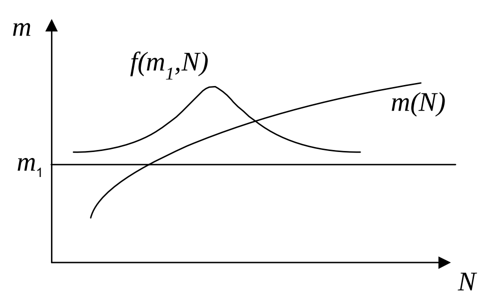
$$\int_0^\infty f(m, N')dm = 1, \quad \int_0^\infty f(N, m')dN = 1 \qquad (1)$$

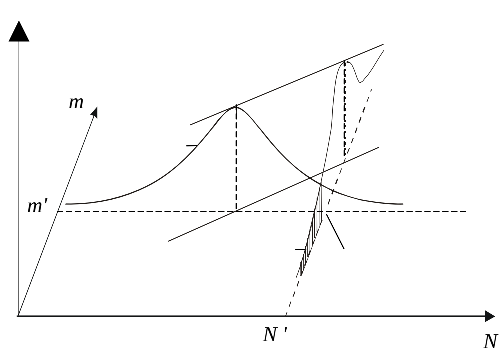
Let's represent the number of mobile users of mobile telephone system with the following equation:

$$N_0 = N_0\int_0^\infty f(m', N)dN = N_0\int_0^{N'} f(N, m')dN + N_0\int_{N'}^\infty f(N, m')dN \qquad (2)$$



So, the first member of equation (2) is the number of the units of those mobile areas, whose channels of mobile areas are fully used, and the second member is the number of the units of those mobile areas in which the channels are not fully used. So, the number of base stations with the territorial structural unit of mobile telephone system depending on $f(m, N)$ surface will be:

The number of base stations, where all the channels are used:

$$Q_{us.} = \frac{N_0}{N'} \cdot \int_{N'}^{\infty} f(N, m')dN \tag{3}$$

The number of those base stations, the channels of which are not fully used will be:

$$Q_{unused} = \frac{N_{unused}}{N_i} \tag{4}$$

where $N_{unused}$ is the number of unused mobile areas,

$N_i$ -is the number of the units of those mobile areas whose channels are fully used.

Thus, the finding of $N_i$ results in the average definition of random value $N$ on $(0 \div N')$ range according to the density distribution of $f(N, m')$:

$$N_i = \frac{\int_0^{N'} N \cdot f(N, m')dN}{\int_0^{N'} f(N, m')dN} \tag{5}$$

Placing the given function in (4), we shall get:

$$Q_{unused} = N_0 \cdot \left[ \frac{\left[ \int_0^{N'} f(N, m')dN \right]^2}{\int_0^{N'} N \cdot f(N, m')dN} \right] \tag{6}$$

The total number of base station in the system will be:

$$Q = Q_{us.} + Q_{unused} \tag{7}$$

$$Q = \frac{N_0}{N'} \int_{N'}^{\infty} f(N, m')dN + N_0 \frac{\left[ \int_0^{N'} f(N, m')dN \right]^2}{\int_0^{N'} N \cdot f(N, m')dN} \tag{8}$$

The coefficient of subscribers' use in the system is:

$$k_{us.} = \frac{N_0}{N' \cdot Q} \tag{9}$$

The number of the units of the unused mobile areas in the system will be:

$$\Delta N = Q_{unused} \cdot (N' - N_i) \tag{10}$$

The average amount of the used channels of the unit of one mobile area will be:

$$m_i = \frac{\int_0^{m'} m \cdot f(m, N')dm}{\int_0^{m'} f(m, N')dm} \tag{11}$$

The total amount of the channels used in the system in mobile areas will be:

$$M_0 = \frac{\frac{N_0}{N'} \int_{N'}^{\infty} f(N,m')dN \cdot \int_0^{m'} m \cdot f(m,N')dm}{\int_0^{m'} f(m,N')dm} + N_0 m' \frac{\left[ \int_0^{N'} f(N,m')dN \right]^2}{\int_0^{N'} N \cdot f(N,m')dN} \tag{12}$$

Thus, the above performed analysis allows estimating the dependence of $m$ capacity of the channels of base and mobile areas on $N$ amount of the units of structural levels in the system.

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