LIKELIHOOD–TIME CHARACTERISTICS OF A WIRELESS LOCAL NETWORK

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Let's consider the wireless local network (WLN), received for today a wide circulation in system of an exchange of information. The considered network consists the N [1] of users' personal computers, the communication stations, having the buffer B infinite capacity and the wireless radio channels, interaction providing them.

Let on an input of the buffer of each of N stations WLN, arrives Poisson streams of messages with intensity λ, and their service is made in discrete time with interval T. Stochastic model of a considered network it is shown in Fig. 1.

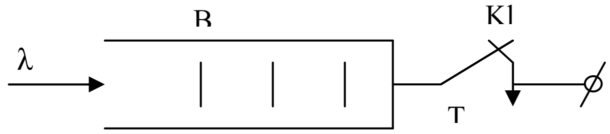

Fig.1 Stochastic model of a wireless local network

The interval of service depending on a condition of the buffer is formed by a stochastic key of Kl. Systems of kind we will name continuously – discret and to designate $M/G^D/1$ with entering puasson a stream in continuous time and general view service in discrete time. For such system more low resulted base analytical model based on transformation by Laplace is received:

$$f_q(s) = f_l(0) s g_\rho(s) / (s - \lambda + \lambda g_\rho(s)), \; f_l(0) = 1 - \rho, \tag{1}$$

where $g_\rho(s)$ is Laplace transformations of density of distribution of intervals of service of the message taken from the occupied buffer of stations WLN, ρ is probability of the occupied condition of the buffer, s is Laplace operator.

Let's define transformations of Laplace of density of distribution t.L.d.d. intervals of service of the message taken from the occupied buffer of station WLN that $g_\rho(s)$.

For this purpose we will consider components of intervals of service $n_{s\rho}$ of the message in considered WLN which is defined so:

$$n_{s\rho} = n_{s\rho_1} + n_{s\rho_2} + \ldots + n_{s\rho_\nu} \quad , \tag{2}$$

where $n_{s\rho_1}$ is a service interval, when the first attempt has ended with deleting of messages, and successful transfer has occurred from the second attempt, $n_{s\rho_1} + n_{s\rho_2}$ is a service interval when first two attempts have ended with deleting, and successful transfer has occurred from the third attempt, $n_{s\rho_1} + n_{s\rho_2} + \ldots + n_{s\rho_\nu}$ is a service interval when all previous attempts have ended with deleting, and successful transfer has occurred in ν attempts (where ν - quantity of intervals of service), which is a random variable.

It is necessary to note, that $n_{s\rho_1}, \ldots, n_{s\rho_\nu}$ are independent and equally distributed random variables.

Expression (1) allows to define z-transformation of some distribution of intervals of service of messages [2,3], taken of the occupied buffer of stations of the considered network, is that:

$$g_\rho(z) = \sum_{\nu=0}^{\infty} g_a(\nu)(g_{s\rho}^{-1}(z))^{-\nu} \quad , \tag{3}$$

where $g_a(v)$ is a number of distribution quantity of attempts.

Having solved expressions (3) method z-transformations we will have

$$g_\rho(z) = g_a(g_{s\rho}^{-1}(z)), \qquad (4)$$

where $g_{s\rho}(z)$ is z- transformation of intervals of service at the first attempt.

Let's find now intervals of service of the message which have ended from the first attempt, that is:

$$n_{s\rho} = n_{sa\rho} + n_n, \qquad (5)$$

where $n_{sa\rho}$ is an interval of access of the message taken from the occupied buffer, n_n is an interval of transfer of the message.

On the basis expression (5) we will define z-transformation of some distribution of intervals of service at the first attempt. Considering that z-transformation of the sum of two random variables equally [2,3] to product of their z-transformation, so expression (5) assume the following kind

$$g_{s\rho}(z) = g_{a\rho}(z) g_n(z), \qquad (6)$$

where $g_{a\rho}(z)$ is z-transformation of some distribution of intervals of access of the message, got to the occupied buffer and taken on service, $g_n(z)$ is z-transformation of some distribution of transfer of the message.

Taking into account that $g_n(z) = z^{-n_n}$ last expression will become

$$g_{s\rho}(z) = g_{a\rho}(z) z^{-n_n}, \qquad (7)$$

then expression for calculation $g_\rho(s)$ taking into account (4) and (7) will be equally

$$g_\rho(s) = g_\rho(z)\big|_{z=l^{sT}}. \qquad (8)$$

At last we will define probability of the occupied buffer of station WLN, a part of expression (1) by means of the interference equation

$$\rho = -\lambda g'_\rho(0), \; g'_\rho(0) = (d/ds) g_\rho(s)\big|_{s\to 0}, \qquad (9)$$

$g_\rho(s)$ is defined by expression (8).

Thus, all components a part of the base analytical model, defined by expression (1) are defined.

Let's address to is likelihood-time characteristics LTX of the wireless local network, estimating time expenses for an information exchange. As network characteristics average values of time of a delay which for WLN are defined [2,3], so are used

$$\bar{t}_q = (d/ds) f_q(s)\big|_{s\to 0}, \qquad (10)$$

where $f_q(s)$ is defined by expression (1).

Calculating (10) taking into account (1) we will receive definitive expression for calculation of average time of a delay of the message taken from the occupied buffer of station WLN

$$\bar{t}_q = -g'_\rho(0) + (\lambda g''_\rho(0)/2(1-\rho)), \qquad (11)$$

where ρ is defined by expression (9), and $g'_\rho(0)$ and $g''_\rho(0)$ is accordingly defined by following expression

$$g'_\rho(0) = (d/ds) g_\rho(s)\big|_{s\to 0}, \qquad g''_\rho(0) = (d^2/ds^2) g_\rho(s)\big|_{s\to 0}, \qquad (12)$$

where $g_\rho(s)$ is defined by expression (8) with the account in it (4) and (7).

For an estimation of high-speed properties consiladed network we will enter information speed of transfer in the given network which for WLN the general using and real time is accordingly defined [2,3] by following expressions

$$R_c^{gu} = \lambda kN, \quad R_c^{rt} = R_c^{gu} \overline{\Pi}_q, \tag{13}$$

where k is length of an information field of the message in WLN, $\overline{\Pi}_q$ - probability of timely delivery of the message in WLN.

Information speed for a network of the general using as a whole accordingly we will

$$R_c^{gu} = \sum_{j=0}^{N} R_{cj}^{gu}. \tag{14}$$

For an estimation of reports of levels of a wireless local network when restrictions on a delay of messages are not imposed, we will enter as the characteristic limiting and achievable information speed the transfers received on border of loss stability in a wireless local network which are accordingly defined [2], so

$$R_1 = k / \bar{t}_s, \quad R_2 = k / \bar{t}_q, \tag{15}$$

where $\bar{t}_q$ is average time of a delay of messages in station of the considered network, defined by expression (11), $\bar{t}_s$ is an average holding time of messages which is defined by following expression

$$\bar{t}_s = -(d / ds) g_\rho (s) \big|_{s \to 0}, \tag{16}$$

where $g_\rho(s)$ is defined by expression (8) with the account in it (4) and (7).

For a wireless local network as a whole, limiting of information speed equally

$$R_{1c} = \sum_{j=1}^{N} k / \bar{t}_{sj}, \tag{17}$$

where $\bar{t}_s$ is defined by expression (16).

For the purpose of definition of probability of timely delivery of the message for WLN we will use expression (1), with replacement in it of Laplace operator s on factor of ageing of the information ν , that is

$$\overline{\Pi}_q = ((1-\rho)\nu g_\rho(\nu)) / (\nu - \lambda + \lambda g_\rho(\nu)), \tag{18}$$

where $g_\rho(\nu)$ - it is defined by expression (8) with the account in it (4) and (7) with replacement in them on.

Let's consider now algorithm of calculation of is likelihood-time characteristics of the wireless local network, based on its base model. The algorithm of calculation LTC consists of following steps:

1. To Define sizes of the initial data of a wireless local network, reports of access and a kind of used algorithm for control of errors in WLN
2. Laplace transformations of density of distribution of a holding time $g_\rho(s)$, together with parameters modeled WLN it is entered into base analytical model.
3. To Define average time of a delay $\bar{t}_q$
4. To Define limiting information speed WLN the general using R_c^{gu} .
5. To Define information achievable speed WLN real time R_c^{rt}
6. To Define probability of timely delivery of the message $\overline{\Pi}_q$
7. To Define limiting R_1 and achievable R_2 information speeds of transfer
8. To Increase values of intensity of an entering stream of messages, lengths of its information part and other parameters of a network

9. To Pass in a step 3
10. The end.

The developed algorithm will be used further for calculation likelihood - time characteristics of a wireless local network with concrete reports of collective access.

References

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