IMPROVING TRANSMISSION RATE IN WiMAX TECHNOLOGY DOWNLINK

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Abstract

In this article presents mathematical model of sub-channels distribution in networks with standard IEEE 802.16, which provides a guaranteed rate of user stations in downlink. Using various kinds of objective functions in offered model is directed to allocation of minimum data rate transmission of every user station. A comparative analysis of obtained solutions by using different objective functions was conducted.

The given work presents mathematical model of sub-channels distribution in networks with standard IEEE 802.16, which provides a guaranteed rate of user stations in downlink. Using various kinds of objective functions in offered model is directed to allocation of minimum data rate transmission of every user station. A comparative analysis of obtained solutions by using different objective functions was conducted.

The principles of structural and functional self-organization have to be used. A high level of self-organization can be achieved through perfected existence of network protocols and mechanisms responsible for allocation of network access resources.Subcarrier frequency is primary building block of OFDM method that using to distribute sub-channel for users, logical union of which forms an element of frequency resources, called the sub-channel[1]. Most of famous solutions for frequency resource allocation are directed to solving subcarriers allocation problem. Number of subcarriers forming a single frequency channel may be different and is determined by scaling factor. As a result task of frequency resources allocation should be reduced to the problem of sub-channels allocation between user network stations [2].

In developing of mathematical model it must be taken into account the fact that in the case of a allocated arrangement of sub-carriers in the specification of WMAN-OFDMA, there are two sub-modes determine formation of "frequency structure" of sub-channels [2]:

- submode OFDMA FUSC Full Usage of Subcarriers;
- submode OFDMA PUSC Partial Usage of Subcarriers.

In addition to calculation of required variables it is necessary to meet a number of important conditions, restrictions [4]:

1) Condition of fixing of k sub-channel only for one user station:

$$\sum_{n=1}^{N} x_n^l \le 1 \quad (l=\overline{1,L}); \tag{1}$$

2) Condition selection of n- user desired rate :

$$r_k^n \sum_{k=1}^{K} x_n^k \ge R_{req}^n \ (n=\overline{1,N}). \tag{2}$$

The formulation of task should not be too complicated, and its solution must be known or developed an effective method. As a result of mentioned above optimality criterion can be represented in the form of [3]:

$$\mathbf{min}\, f^T x, \tag{3}$$

where f – objective function.

Using optimality criterion (3) is aimed at minimizing the frequency resource allocated to all user stations. Selecting minimum number of frequency resources improves signal-noise conditions in used frequency band, and also provides availability of frequency resources for transmission of information if it is necessary for new subscriber stations. Quality of frequency resource allocation solution is also dependent on type of f objective function used in optimization criteria (3).

Minimizing used frequency resource can be achieved by providing the least amount of user stations subchannels, taking into account the conditions of constraints (1) and (2). In this case objective function takes the form of

$$f_1 = [1,1,1,1,..,1], \quad (4)$$

with the proviso that number of elements in the vector f_1 corresponds to the number of elements in the vector x all of them are equal to one.

Besides, problem of minimizing number of used frequency resource can be solved by using an objective function that enables minimization of transmission rate allocated to each of user stations. Such an objective function may be represented as

$$f_2 = \left[r_1^1, r_2^1, ..., r_k^n, ..., r_K^N\right]. \quad (5)$$

In solving problem of frequency resource-saving can be used objective function also, which includes characteristics of objective function (4) and (5), which takes form

$$f = f_1 + f_2. \quad (6)$$

The use of objective function (6) is aimed at minimizing the number of used joint subchannel and transmission rate of user allocated to stations in downlink.

The problem formulated from a mathematical point of view, the use of the objective function (4) is the problem of integer linear programming (Linear Integer Programming, LIP), and the use of objective functions (5) and (6) a linear programming (Linear Programming, LP).

Fig. 3 shows results of sub-channels allocation objective function using (6). Analysis of obtained solution showed by objective function using (6), as in the case of objective function using (4), that all users are given nine stations allocated sub-channels of the sixteen available. Thus all user stations are allocated to three sub-channels. In addition seven sub-channels are available to connect new user stations.

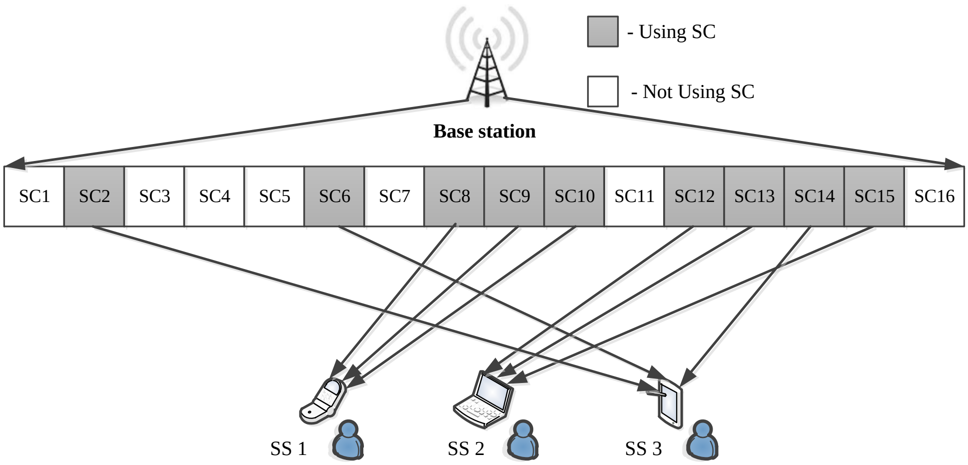

Fig.1. Objective function using example (6)

The analyzed solutions of optimization problem of sub-channels allocation in this articles by using couple of objective functions:

- frequency resources allocation in order to distinguish the minimum number of sub-channels (objective function (4));
- frequency resources allocation in order to distinguish the minimum transfer rate of each of user stations (the objective function (5));
- frequency resources allocation in order to minimize the amount of joint used sub-channels and transmission rate distinguished to user-made stations in downlink (objective function (6)).

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