Result Research Model of Scheduling Block Allocation in Downlink LTE

Sergiy Garkusha, Aymen Al-Dulaimi, Haider Al-Janabi

Abstract **– Result of the model of time and frequency resource scheduling in downlink LTE development was applied. The given model is directed upon securing the wireless network users being served by the allocation to user equipment required transmission rates. Comparative analysis of the offered model with existing methods from the point of view of securing the common productivity of downlink, level of bandwidth balancing, possibility of allocation to users' equipment required transmission rate are completed.**

Keywords **- LTE, Time-frequency resource, Scheduling block, Required transmission rate.**

I. Introduction

In LTE developed by 3GPP, one of the effective ways of productivity and quality of service (QoS) increasing is network protocols and mechanisms responsible for available net resources improvement. The task solving about radio resources allocation is based upon requirements to QoS and can be placed on radio resources management (RRM) system, upon scheduler inside the system. In LTE as well as in HSDPA or WiMAX, mechanisms of downlink resources are not defined by the standard, leaving the choice behind the evolved NodeB (eNodeB) equipment producers [1 – 4]. The result of the task solution about allocation of frequency and time resources must be allocation scheduling block (SB) to user equipment (UE) in download of a single frame.

In the given research work methods of frequency and time allocation is analyzed, with the algorithm Round Robin Scheduler, algorithm Max C/I Ration, algorithm of Proportional Fair Scheduling. Analysis showed that the most favorable mechanism for giving access to frequency and time resource LTE would be mechanism, including peculiarities of Round Robin Scheduler and Max C/I Ration algorithms. The choice of algorithm depends on category and load intensity. The right choice of algorithm for giving access is particularly important under high intensity.

At the result of analysis it is estimated that using Proportional Fair Scheduling algorithm is directed to apply interactive "best effort" data class to avoid situation when some UE never get access to frequency and time resource. Improvement the service quality under frequency and time resource scheduling of every UE must be directed upon guaranteed transmission rate with access availability to additional (non-guaranteed) after bandwidth line. However none of analyzed mechanisms is able to secure such class of service (CoS).

At the result of conducted analysis we made decision about necessity of frequency and time resource model in downlink LTE scheduling, formulated as allocation SB task for securing guaranteed rate of UE.

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II. Model of SB Allocation in Downlink

The offered model [3], [4] is directed for application in wireless networks LTE, using frequency and time channel division. At the model development we consider the fact that the least structure unit of radio resource to be managed at the scheduling task solving SB [1].

To account subframes, allocated at the data travelling in downlink [1], [2], there was given the idea of matrix of configurations of downlink. Matrix is rectangular with number of lines corresponding to quantity of frame configurations (L) and with number of columns corresponding to quantity of subframes (K) in frame i.e.

$$H = \left\| h_{l,k} \right\|, \; (l = \overline{0, L-1}; \; k = \overline{0, K-1}), \quad (1)$$

where $h_{l,k} = \begin{cases} 1, & \text{for } k\text{-th subframe at } l\text{-th configurations used for data transmission in downlink;} \\ 0, & \text{otherwise.} \end{cases}$

While scheduling blocks allocation task solving within the scope of the offered model it is necessary to secure the calculation of boolean control variable ($x_{k,m}^{n}$) defining the order of allocation scheduling blocks

$$x_{k,m}^{n} = \begin{cases} 1, & \text{if } m\text{-th scheduling block in } k\text{-th subframe allocated } n\text{-th UE;} \\ 0, & \text{otherwise,} \end{cases} \quad (2)$$

where $m = \overline{0, M-1}$; $k = \overline{0, K-1}$; $n = \overline{1, N}$; M – number SB formed during single subframe transmission; N – number UE.

At sought date calculation $x_{k,m}^{n}$ it is necessary to complete a number of conditions/constraints:

1) Condition of allocation m-th SB of downlink during transmission k-th subframe no more that to one UE;

2) Condition of allocation SB only of downlink;

3) Condition of allocation for n-th UE number of SB, securing necessary transmission rate in downlink using MCS;

4) Condition of uniting resource block (RB) and resource block group (RBG) sizes, sutisfacting width of used channel.

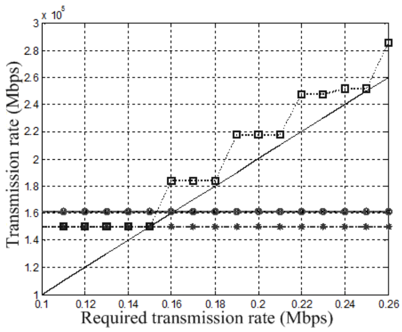
Calculation of the sought variables (2) in correspondence with conditions/constraints is expedient to carry out while solving optimized task, providing minimum or maximum before chosen criterion of allocation task quality SB. The task of SB allocation can be solved using optimality criterion, directed upon maximizing of common productivity of downlink.

III. Analysis of SB Tasks Solving

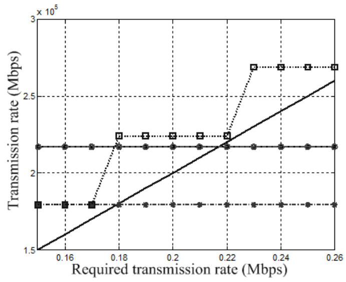
As an example there was received decision of formed during the process optimization task, using system Matlab R2012b. While this there was employed program minlpAssign of optimization packet TOMLAB. For example all the UE had same required rates with meaning $R_{\text{req}}^{n} = 0 \div 0.26$ Mbps.

The modeling results showed that common downlink productivity using known methods during all interval of measuring didn't change and made up for Round Robin method – 0,9622 Mbps, Proportional Fair method – 1,2377 Mbps, Max C/I Ratio method – 1,4192 Mbps. Common productivity of downlink using offered model at the area $R_{\text{req}}^{n} = 0 \div 0{,}15$ Mbps had maximal meaning, corresponding Max C/I Ratio method and made up 1,4192 Mbps. At the interval $R_{\text{req}}^{n} = 0{,}15 \div 0{,}26$ Mbps common productivity lessened for 3 % to meaning 1,3641 Mbps.

Fig. 1 shows how to change the transmission rate distributed to a particular UE in the allocation method used downlink scheduling blocks depending on the required transmission rate.

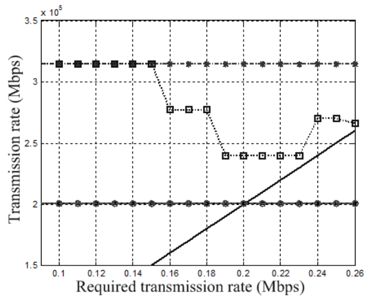


a) transmission rate distributed UE №1

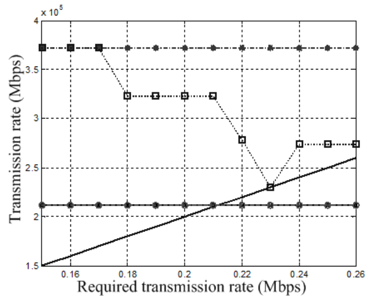


Required transmission rate (Mbps)

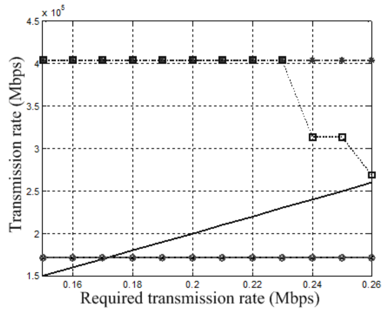
b) transmission rate distributed UE №2



c) transmission rate distributed UE №3



d) transmission rate distributed UE №4



e) transmission rate distributed UE №5

Fig. 1. Dependence allocated transmission rate of the downlink transmission required rate for —✱— corresponds Round Robin method, -·-✱-·- –Max C/I Ratio method, --⊖-- – Proportional Fair method, ···⊡··· – supposed model, where —— - required transmission rate

At the Fig. 2 there are given results of modelling, reflecting dynamics of downlink balancing of bandwidth between UE. Balancing level of bandwidth was defined according to expression:

$$F^{i} = 1 - \left(\max_{n} R_{n}^{i} - \min_{n} R_{n}^{i} \right) / \sum_{n=1}^{N} R_{n}^{i} ,$$

where R_n^i – rate of transmission, distinguished n-th UE at i-th interval of measuring, $n = \overline{1, N}$.

The result of modeling showed (Fig. 2) that balancing level of downlink bandwidth using known methods during all the interval of measuring did not change and made up for Round Robin method – 0,9421, Proportional Fair method – 0,9163, Max C/I Ratio method – 0,8214. Balancing level of downlink bandwidth using offered model at the area $R_{\text{req}}^n = 0 \div 0{,}15$ Mbps had minimal meaning corresponding to Max C/I Ratio method and made up 0,8214. At interval $R_{\text{req}}^n = 0{,}15 \div 0{,}26$ Mbps balancing level of bandwidth is increased to 0,9859.

At fig. 3 there are results of requirement fulfillment probability calculation of transmission rate allocated to all UE. Requirement fulfillment probability of transmission rate at i-th interval of measurement was defined according to expression

$$P^i = \sum_{n=1}^{N} Q_n^i / N ,$$

where $\sum_{n=1}^{N} Q_n^i$ – UE quantity, which distinguished required transmission rate at i-th measurement interval, i.e. $Q_n^i = \begin{cases} 0, \text{ if } R_n^i < R_{\text{req}}^i; \\ 1, \text{ if } R_n^i \geq R_{\text{req}}^i. \end{cases}$

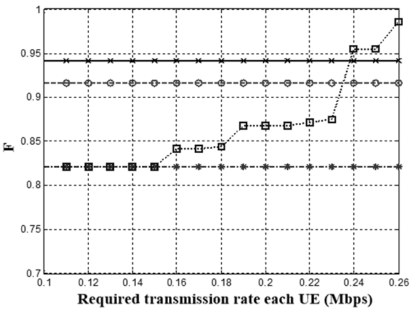


Fig. 2. Balancing level of downlink bandwidth distinguishing UE required transmission rate probability, where —✕— corresponds Round Robin method, -·✱·- –Max C/I Ratio method, --⊖-- – Proportional Fair method, ···⊡··· – supposed model

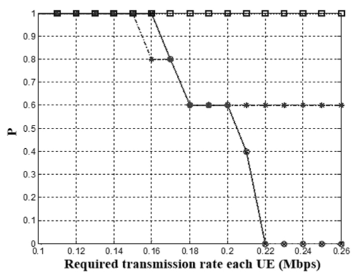


Fig. 3. Distinguishing UE required transmission rate probability, where —✕— corresponds Round Robin method, -·✱·- –Max C/I Ratio method, --⊖-- – Proportional Fair method, ···⊡··· – supposed model

As the modelling results showed at measuring the required transmission rate from 0,15 Mbps and higher all the considered and known methods don't secure required transmission rate meaning for all UE. Fulfillment of the transmission rate requirement by known models is secured only at high meanings R_{req}^n when $R_{\text{req}}^n = 0 \div 0{,}15$ Mbps. Using the offered model secures allocation required transmission rate UE at whole measurement interval $R_{\text{req}}^n = 0 \div 0{,}26$ Mbps.

IV. Conclusion

On the basis of detected drawbacks of known decisions is suggested that the model which is represented by a range of linear and non-linear conditions/constraints. Novelty of model is in formulating the task of SB allocation as task of redistribution available bandwidth of downlink LTE for data transmission to UE taking into account their territorial remoteness (type of modulation and coding system). Comparative analysis showed that under conditions of high requirements to UE transmission rate, using model in comparison with known methods lets increase balancing level of downlink bandwidth to 5-20 %, to increase probability of allocation to UE required transmission rate to 40-100 %. While this the productivity of downlink under conditions of high requirements to transmission rate 3 % less of productivity received from Max C/I Ratio method and 10-42 % more of productivity using Round Robin and Proportional Fair methods. The usage of the offered model is directed upon securing each UE guaranteed transmission rate in downlink with access possibility to additional (non-guaranteed) bandwidth.

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