Coding of a Resource Block by a System with Non Equilibrium Weighting Coefficients for Lte-Based Mobile Communication Technologies

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Кодування Ресурсного Блоку Системою з Нерівноважними Ваговими Коефіцієнтами для Технологій Мобільного Зв'язку на Базі LTE

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Abstract—**The structure of the LTE radio frame is considered. The optimal structural unit of LTE - radio frame - resource block is found. The resource block is divided into three bit streams for the purpose of using small bit code words. The process of encoding the resource block is described. The mathematical dependences necessary for mathematical and software simulation of the coding process of the resource block are derived. Statistical parameters of compression and bit intensity of the transformed data stream are calculated using systems with non-uniform weight coefficients.**

Анотація* — *Розглянуто структуру LTE – радіокадру. Знайдено оптимальне структурну одиницю LTE - радіокадрів – ресурсний блок. Ресурсний блок поділений на три бітові потоки з метою використання невеликих за бітовим розміром закодованих слів. Описано процес кодування ресурсного блоку. Виведено математичні залежності, необхідні для математичного та програмного моделювання процесу кодування ресурсного блоку. Статистичні параметри стиснення та інтенсивності бітів трансформованого потоку даних розраховуються за допомогою систем з неоднорідними ваговими коефіцієнтами.

Keywords—system with uneven weight coefficients, weight coefficient, code word, resource element, LTE - radio frame, LTE - 4G-generation technology.

Ключові слова — система з нерівномірними ваговими коефіцієнтами, ваговий коефіцієнт, кодове слово, ресурсний елемент, LTE-радіокадр, LTE-технологія 4G – покоління.

Introduction

The need to increase the speed of data exchange and ensure low bit rate without reducing the quality and the in formativeness of the transmitted data, in the modern world continues to exist and need its solution. [1]

Article task – Analyze the technology of the fourth generation - LTE, for the introduction of systems with uneven weight coefficients. Find the optimal level and optimal structure in the LTE-radio frame for the qualitative use of systems with uneven weight coefficients.

Purpose of the article – Implement a system with uneven weight factors in the technology of the fourth generation - LTE. Develop an optimal structure for converting a radio frame using systems with uneven weight coefficients. Create the necessary mathematical apparatus for describing the encoding process. Calculate and compare the parameters of the bit stream intensity of the source and converted technology.

APPLICATION OF SYSTEMS WITH UNEVEN WEIGHTING FACTORS FOR LTE CODING - RADIO FRAME.

Take the structural part of the radio frame (F_t) – resource block ($B_{\xi,s}$), which is the intersection of the sub frame (U_s) and resource block lines (B_ξ).

A special case of the composition of a resource block ($B_{\xi,s}$) is 12 rows and 14 columns of resource elements ($b(i,j)_{\xi,s}$).

Also, as a special case, the bit size of the resource element ($\left|b(i,j)_{\xi,s}\right|_2$) will be considered equal to 4 bits. (1)

Bit size of the resource element ($\left|b(i,j)_{\xi,s}\right|_2$) taken for settlement in an article:

$$\left|b(i,j)_{\xi,s}\right|_2 = 4bit \quad (1)$$

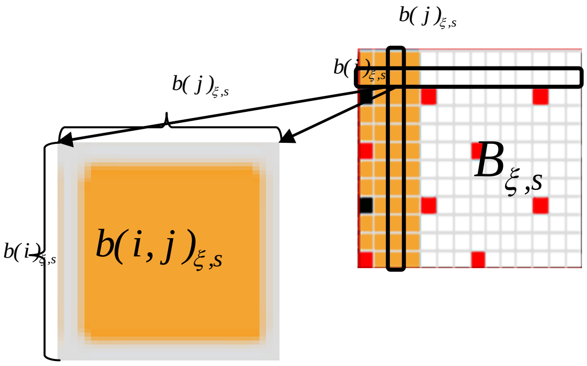

Fig1.Location of the resource element $b(i,j)_{\xi,s}$ in the resource block $B_{\xi,s}$

Thus, we have a bit array ($[B_{\xi,s}]_2$) size 12×14, presented in (Table 1)

TABLE I. BITMAP $[B_{\xi,s}]_2$ TAKEN FROM THE RESOURCE BLOCK

	1	2	m	M
	0001	$\{b(1,2)_{\xi,s}$	$\{b(1,j)_{\xi,s}$	$\{b(1,M)_{\xi,s}$
	0101	$\{b(2,2)_{\xi,s}$	$\{b(2,j)_{\xi,s}$	$\{b(2,M)_{\xi,s}$
	..	…	…	…
	1001	$\{b(i,2)_{\xi,s}$	$\{b(i,j)_{\xi,s}$	$\{b(i,M)_{\xi,s}$
	..	…	…	…
	1011	$\{b(\Omega,2)$	$\{b(\Omega,j)$	$\{b(\Omega,M)$

Where:

i - line number of the bit cell, $\Omega = 12$ - number of rows of bit cells;

j - the number of the column of the bit cell, $M = 14$ - the number of columns of the bit cells.

Represent resource elements of the cell in the decimal system (2) (figure 3.):

$$\{b(1,2)_{\xi,s}\}_2 = 1001 \Rightarrow \{b(1,2)_{\xi,s}\}_{10} = 9 \quad (2)$$

	m	1	2	…
ω				
1		0001	$\{b(1,2)_{\xi,s}\}$	…
2		0101	$\{b(2,2)_{\xi,s}\}$	…
…		…	…	
ω		1001	$\{b(\ ,2)_{\xi,s}\}$	…
…		…	…	

Fig. 2 Representation of resource elements in decimal form.

As a result, we get a decimal array (Table 2). We divide the resulting array in such a way that a stream of rows with a height of 4 elements is obtained.

The domain of a decimal array belonging to one stream is transformed, using a system with uneven weighting factors (SNWC), into a sequence of code words and information components.

The flow is divided into columns, 4 elements each ($\{b(i,j)_{\xi,s}\}$) where $i = i \ldots i+4$, for these four elements, we find the base values by the formula (3):

$$\varphi(i,j)_{\xi,s} = \left|b(i,j)_{\xi,s}\right|_{10} + 1 \quad (3)$$

$$V(i+1,j)_{\xi,s} = \begin{cases} \varphi(i,j)_{\xi,s} \cdot V(i,j)_{\xi,s} & i \in 1\ldots4 \\ \varphi(i,j)_{\xi,s} \cdot V(i,j)_{\xi,s} & i \in 5\ldots8 \\ \varphi(i,j)_{\xi,s} \cdot V(i,j)_{\xi,s} & i \in 9\ldots12 \end{cases} \quad (4)$$

provided that $V(1,j)_{\xi,s} = V(5,j)_{\xi,s} = V(9,j)_{\xi,s} = 1$

Code components are found using expression (5):

$$E(p,j)_{\xi,s} = \begin{cases} \sum_{i=1}^{4} \left|b(i,j)_{\xi,s}\right|_{10} \cdot V(i,j)_{\xi,s} & p \in 1 \\ \sum_{i=5}^{8} \left|b(i,j)_{\xi,s}\right|_{10} \cdot V(i,j)_{\xi,s} & p \in 2 \\ \sum_{i=9}^{12} \left|b(i,j)_{\xi,s}\right|_{10} \cdot V(i,j)_{\xi,s} & p \in 3 \end{cases} \quad (5)$$

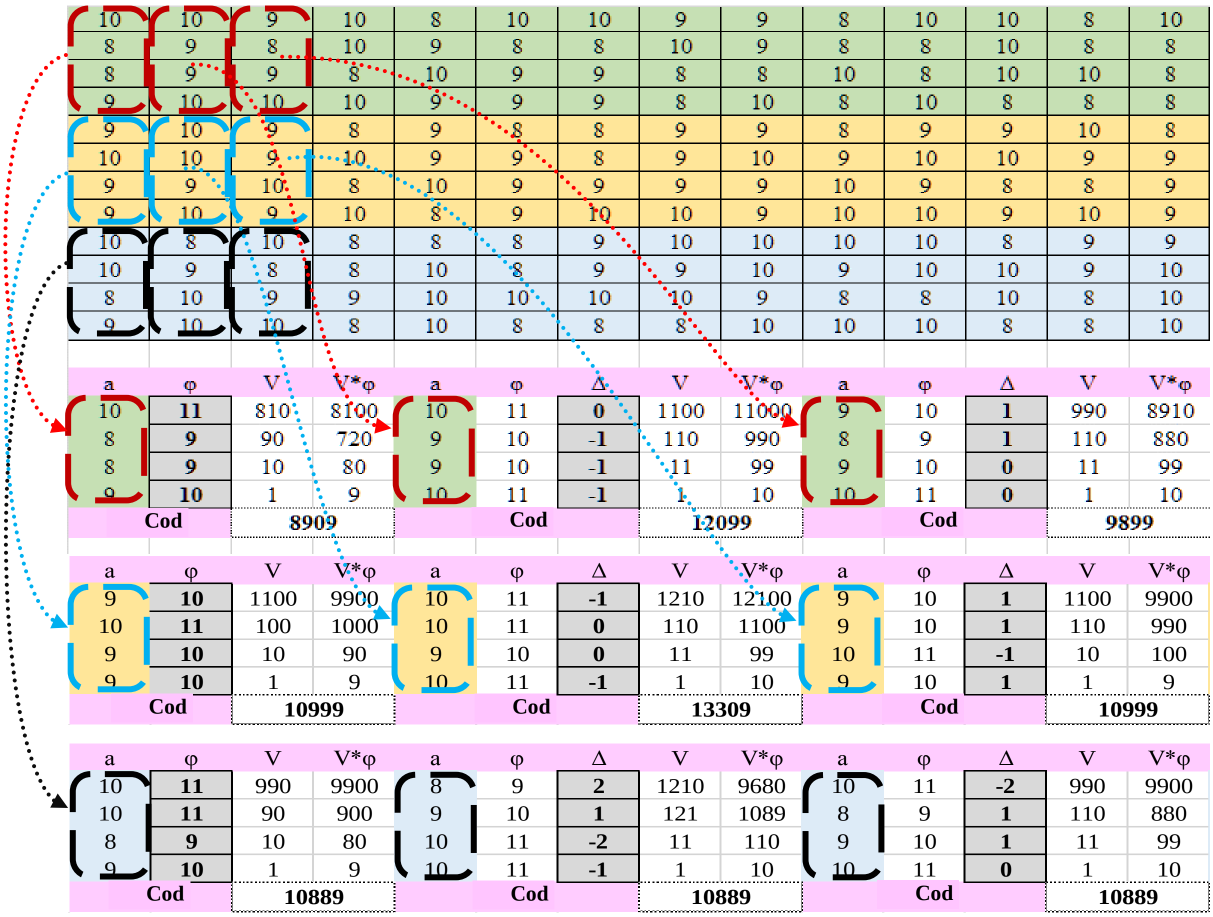

Fig3 The process of encoding a part of a resource block using a system with an uneven weighting factor

A visual graphical display of the encoding process The parts of the resource block are shown in Fig. 3, the values $\varphi, V, "Code"$ are calculated according to formulas (3, 4, 5) according to the order.

Therefore, we will transmit once per frame changes for the bases ($\Delta(i,0)_{\xi,s}$).

The values of the array in the resource block have the nature of the video stream; therefore, the difference in the values of the array elements in adjacent cells is negligible. As a consequence, the difference module of the bases $\Delta(i,j)_{\xi,s}$ any two adjacent columns of resource elements ($b(i,j)_{\xi,s}$) will be much less than the value of the base itself ($(i,j)_{\xi,s}$) (6):

$$(i,j)_{\xi,s} - (i+1,j)_{\xi,s} = \Delta(i,j)_{\xi,s} \ll (i,j)_{\xi,s} \vee (i+1,j)_{\xi,s} \quad (6)$$

Proceeding from the conclusion (6) it is expedient to transfer the difference in the bases $\Delta(i,j)_{\xi,s}$ in order to save traffic.

The transmission of this radio frame above the proposed method was simulated and calculated As a result, the following statistical data were obtained (Table 3)

TABLE II. ESTIMATED STATISTICAL DATA ON THE CHANGE IN THE BIT CAPACITY OF THE ENCODED RADIO FRAME

№	**Parameter name**	**Parameter value**	**Percentage to original quantity**
1.	The bit size of the original radio frame	672 bit	100%
2.	Number of bits of the service component	234 bit	35%
3.	Number of bits of the information component	518 bit	77%
4.	Total number of bits in the encoded radio frame	752 bit	112%

The information component practically by ¼ decreased in volume, but the service component occupies 35% of all information. This code structure allows you to transfer the service component much less frequently without losing information.

Therefore, we will transmit once per frame changes for the bases ($\Delta(i,0)_{\xi,s}$).

Since in the resource block Ω – The number of bits of the service component will be, reduced by $\Omega = 14$ – times. (7)

$$\left|\{\Delta(i,0)_{\xi,s}\}\right| = \frac{\left|\{\Delta(i,j)_{\xi,s}\}\right|}{\Omega} = \frac{234}{14} = 17 \qquad (7)$$

After that, we will compile an updated table of statistical analysis of the coded resource block (Table 4)

TABLE III. ESTIMATED STATISTICAL DATA ON THE CHANGE IN THE BIT CAPACITY OF THE ENCODED RADIO FRAME IN THE TRANSMISSION OF SERVICE INFORMATION ONCE PER FRAME.

	Parameter name	**Paramet er value**	**Percentage to original quantity**
5.	The bit size of the original radio frame	672 bit	100%
6.	Number of bits of the service component	17 bit	3%
7.	Number of bits of the information component	518 bit	77%
8.	Total number of bits in the encoded radio frame	535 bit	80%

From the analysis of the new statistical table it is clear that in the encoded resource block using systems with uneven weight coefficients, bit-rate traffic is saved by 20%

CONCLUSION

The structure of the radio frame of LTE technology is considered and mathematically described. The groups of RE resource elements performing a single function and entering one logical channel are analyzed, as well as their interaction with other RE groups that are in a definite relationship. [1, 2]

An optimal structure has been developed for converting a radio frame using systems with uneven weight coefficients. A necessary mathematical apparatus for describing the coding process has been created. (3, 4, 5)

Calculations showed that when using the encoding of a resource block using systems with uneven weight coefficients it is necessary to transfer the service component one to the entire resource block. In this case, the saving of bit traffic is 20%

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