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BORDERS CALCULATION OF OPTIMIZATION PARAMETERS CHANGES AT SYNTHESIS OF A SATELLITE DISTRIBUTION NETWORK

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Расчет границ изменения параметров оптимизации при синтезе спутниковой распределительной сети

В работе представлены границы изменения параметров оптимизации при синтезе спутниковой сети распределения ТВ-программ в Украине. В качестве параметров оптимизации приняты три основных потребительских параметра: количество программ (каналов) вещания; качество вещания; цена создания радиотехнической части сети.

The paper presents borders of optimization parameters changes at synthesis of satellite distribution network of TV programs in Ukraine. As optimization parameters there are three main consumer parameters: number of programs (channels) of broadcasting; quality of broadcasting; cost of creating a radio part of the network.

I. Introduction. While designing the satellite distribution network of TV programs we are dealing with a large number of conflicting parameters that have both different dimensions and contradictory effects on the target function of system.

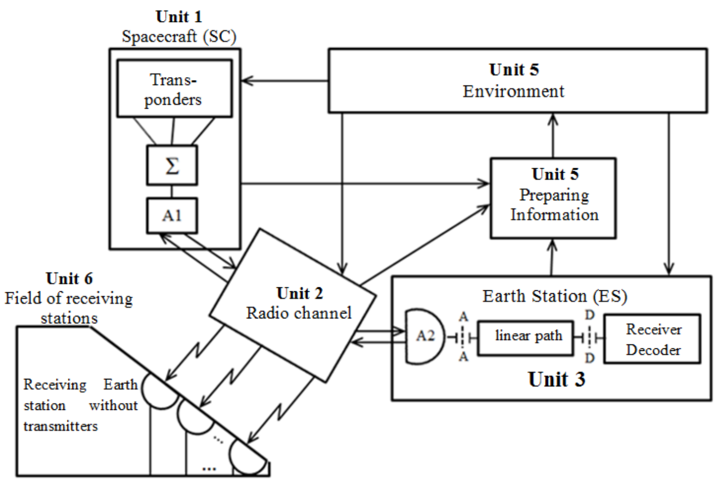

Fig.1. Block diagram of aggregate model of the system of satellite distributed network TV-programs.

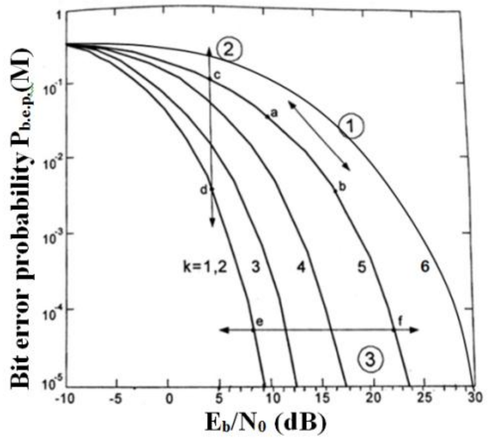

Fig. 2. The dependence of the bit error probability on ratio Ps/Pn at the input of the receiver-decoder of the Earth station satellite signal reception.

Technical requirements for the state network of satellite broadcasting TV-programs on the territory of Ukraine:

1. 400 programs (number of channels).

2. The quality of broadcast must conform to the following requirements: the transmission quality 4:2:2; the reception quality $P_{b.e.p.} \leq 10^{-5}$.

3. The cost of creating the network should be minimal, along with the cost of a transponder must be no more than 50000 $ USA.

The scheme of the research object

Fig. 1 introduces a newly developed structural diagram of aggregate model of the distribution channels.

II. The general formulation of optimization problem. Based on the terms of reference, target optimization parameters are denoted as follows:

y_1^* - the number of channels in the network;

y_2 – the quality of signal reception (estimated probability of bit error receiver - decoder) for the given transmission quality (quality of transmission = 4:2:2);

y_3 – cost of equipment.

For details of all the parameters in one objective function instead y_1^* we will consider the modified parameter $y_1 = 1 / y_1^*$. All parameters will correspond to the basic behavior of the objective function “less is better”.

III. Borders calculation of optimization parameters changes. In Table 1 the relationship A=P_s / P_n for 12 GHz frequency range and for 18 GHz frequency range is shown.

Tables marked border, where the ratio A =P_s / P_n is less acceptable.

Table 1.

f_c = 12 GHz, FEC = 5/6 $P^{tr.}_{transm}$ = 20 W, $\Delta f^{tr.}$ = 100 MHz		A2 Ø	K_m=1	K_m=2	K_m=4
at output of A2 P_c [W] for one TV-program		1 m	$6.35\cdot10^{-14}$	$3.17\cdot10^{-14}$	$15.5\cdot10^{-15}$
		2.7 m	$3.37\cdot10^{-12}$	$1.6\cdot10^{-12}$	$8.4\cdot10^{-13}$
Δf^n_{OFDM}		AA ES P_n [W]	350 MHz; $1.99\cdot10^{-12}$		11 MHz; $6.25\cdot10^{-14}$
			100 MHz; $5.69\cdot10^{-13}$		4 MHz; $2.27\cdot10^{-14}$
			20 MHz; $1.14\cdot10^{-13}$		
ØA2 1m	350 MHz	$10\lg A$, $A=\frac{P_s}{P_n}$ $[dB]$			
	100 MHz				
	20 MHz				
	11 MHz		0	-3,0	-6,2
	4 MHz		4,47	1,43	-1,67
ØA2 2.7m	350 MHz	$10\lg A$, $A=\frac{P_s}{P_n}$ $[dB]$	-0,76	-3,77	6,23
	100 MHz		7,7	4,7	1,5
	20 MHz		14,6	11,7	8,7
	11 MHz		17,3	14,4	11,3
	4 MHz		21,7	18,7	15,7

The parameters of 5 types of antennas, 4 types of modulation, MPEG2 and MPEG4 were used for calculations.

К=1 (ФМ-1); К=2 (QPSK); К=3 (ФМ-8);

К=4 (QAM-16); К=5 (QAM-32); К=6 (QAM-64) (Fig. 2).

Table 1 (12 GHz) presents the data for calculating the ration $10\cdot\lg(P_s / P_n)\,[dB] = F(\Delta f^n_{OFDM})$ at Δf^n_{OFDM} = 350 MHz, 100 MHz, 20 MHz, 11 MHz and 4 MHz for Earth stations receive signals, which have different antennas at the input of A2.

Promising results showed earth station with antenna a mirror diameter equal to A2 7.5 m and 5.0 m. According to Table 2 with these data it is enough to have 4 transponder, at that in both bands at the operating frequency band of noise is equal not to 20 MHz, but to 100 MHz.

Table 2. Parameters of 24 the most promising earth reception stations of the satellite signal in the distribution network of television programs.

		12 GHz																18 GHz															
		MPEG2								MPEG4								MPEG2								MPEG4							
Km		1		2		3		4		1		2		3		4		1		2		3		4		1		2		3		4	
Design of OFDM-symbol		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
		16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4	16	4
Number of working subcarriers		14	8	28	24	56	54	84	78	28	26	60	54	112	108	168	164	28	14	56	54	112	108	168	174	60	54	124	108	216	232	378	328
ØA2	Δf^{N}_{OFDM} [MHz]																																
1 m	350																																
	100																																
	20																																
	11																																
	4																																
2,7 m	350																																
	100																																
	20	14	8	28	24					28	26																						
	11											60	54					28	14														
	4																			56	54					60	54	124	108				
5 m	350	14	8	28	24					28	26																						
	100											60	54					28	14									124	108				
	20																			56	54							124	108				
	11																											124	108				
	4													112	108													124	108				
7,5 m	350	14	8	28	24					28	26							28	14	56	54												
	100					56	54					60	54															124	108				
	20													112	108													124	108				
	11													112	108													124	108				
	4													112	108													124	108				
12 m	350	14	8	28	24	56	54			28	26	60	54	112	108			28	14	56	54					60	54	124	108				
	100																																
	20																																
	11																																
	4																																

In this scenario, the antenna A2 with a mirror diameter of 12 meters is unnecessary luxury, that will change a little in the final result, in addition, that this station will be considerably more expensive than 260000 $ instead of 90000 $ in the range of 12 GHz and a 500000 $ instead of 150000 $ in the range of 18 GHz [2].

Conclusion

1. Table 1 shows the main parameters of earth stations reception satellite signals, OFDM-symbols and provides the data structure of how many subcarriers may be working in a transponder with a view to ensuring the reception quality with the bit error probability $\leq 10^{-5}$.
2. Since the most expensive antenna ES (A2), selecting them means to provide the most secure network operation success.

References

1. Kalnibolotsky Y.M., Sunduchkov K.S., Solodovnik A.I. Automated design of electronic circuits // Technology, 1987 ill. – Bibliogr.: pp.291-299.
2. A.M.Bonch-Bruevich, V.L.Bykov, L.Y.Kantor and others Satellite communications systems // Radio and Communications, 1992 .; ed. L.Y.Kantor: Textbook for High Schools. – 224 p.: pp.209.