Map Outage Factor Optimization for WiMAX

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Abstract---- The emergence of WiMAX has attracted significant interests from all fields of wireless communications. WiMAX has been tipped to bring a revolution in the way where broadband services have been used today; those have been strengthened by the optimization of RF. The systematic investigation to establish facts of necessary modification about the theory for smooth optimization is targeted. This paper has considered the map outage factor of the objective function for the invention of a method to produce suitable values which help to realize better output. Simulation results found to be more precise over conventional RF of WiMAX in finding the modification of the existing theory.

Keywords: **WiMAX, RF, Object Function, Map Outage Factor, SINR.**

I. INTRODUCTION

RF signals are high frequency altering current signals composed of electromagnetic energy. RF signals are generated as electrical energy by the transmitting radio, passed along a copper wire along to the antenna and radiated into the air by the antenna. The antenna converts the wired signal to a wireless signal vice versa.

WiMAX is an IEEE 802.16 standard technology responsible for bringing the broadband wireless access to the world as an alternative to wired broadband. The WiMAX standard 802.16e provides fixed nomadic, portable and mobile wireless broadband connectivity without the need to direct line of signal with the base station. 802.16e adds the feature of mobility to the wireless broadband feature. There is some work on RF optimization in WiMAX [2-8]. Pazhyannur et al [2] have worked on Optimizer Requirements, Propagation Modeling, Mean system SINR, and Mean sector throughput, Propagation Algorithm. They developed a tool to automate the process of "optimizing" system RF attributes. This system is currently in field testing. They also described the nature of the optimizer and the results obtained from laboratory testing. Y. H. Chen et al [3] introduced the architecture of the BFN controller and the steering operation modes of the BFN are also introduced. They analyzed the optimization of the antenna element spacing in considering of the mutual coupling against the grating lobe suppression. They also evaluated the performance in measuring a tested Butler matrix array antenna by BFN. Ildu Kim et al [4] worked with the envelope signal of a Hybrid Envelope Elimination and Restoration (H-EER) technique. They improved linearity and efficiency, resulting in Envelope Tracking (ET) architecture. They also showed that the H-EER transmitter with ET shaping is the most suitable architecture for the highly linear and efficient Base Transceiver Station transmitter. RF optimization in WiMAX system, the problem is in the map outage factor. The value of map outage factor is significant to optimize the RF in WiMAX. So, it is needed to get the desired value. To solve this problem, a new method has been introduced which gives the optimum values. Simulation and result have been tested and verified using Matlab. In this paper, a new formula and an algorithm have been proposed to optimize RF in WiMAX system and it is found to be more precise over conventional RF in finding the modification of the existing theory.

II. BACKGROUNDS

WiMAX systems with a universal frequency reuse plan, doing so can cause severe outage owing to interference, particularly along the intercell and intersector edges. To mitigate this, WiMAX allows for coordination of subchannel allocation to users at the cell edges such that there is minimal overlap. This allows for a more dynamic frequency allocation across sectors, based on loading and interference conditions, as opposed to traditional fixed frequency planning. Those users under good SINR conditions will have access to the full channel bandwidth and operate under a frequency reuse of 1. Those in poor SINR conditions will be allocated nonoverlapping subchannels such that they operate under a frequency reuse of 2, 3, or 4, depending on the number of nonoverlapping subchannel groups that are allocated to be shared among these users. This type of subchannel allocation leads to the effective reuse factor taking fractional values greater than 1. The variety of subchannelization schemes supported by WiMAX makes it possible to do this in a very flexible manner. Obviously, the downside is that cell edge users cannot have access to the full bandwidth of the channel, and hence their peak rates will be reduced. Although there must be many meaningful ways to combine the component measures of the objective function, the most obvious ways are as a weighted sum or "weighted" product wherein the weights are applied as exponents to the individual multiplicands. In either case, the weights serve to emphasize or deemphasize the individual component measures [1-8]. WiROS uses the product form. It is assumed the objective function F is to be minimized. The argument of the function F is an assignment S of physical attributes to the sector antennas of the system, the attributes of each antenna consisting of applied power, azimuth, electrical or mechanical downtilt, and height. For WiROS, the objective function takes the form:

$$F(S) = \left(\frac{1}{\mu_T(S)}\right)^{\alpha} \left(\frac{1}{\mu_S(S)}\right)^{\beta} \left(1+\mu_M(S)\right)^{\gamma} \qquad \text{.....................................} (1)$$

where μT (S) = the mean sector throughput, μS (S) = the mean subscriber SINR, and μM (S) = the system map outage, all resulting from S, and where α, β, $\gamma \geq 0$ are inputs.

In existing work, $\gamma = 3$ and $\alpha = 1$, $\beta = 0$ or $\alpha = 0$, $\beta = 1$ have been used with SINR [2]. Use of the map outage factor in the definition of F discourages the optimizer from finding solutions which maximize the throughput or SINR of users in good coverage at the expense of putting disadvantaged users in outage. The form of the outage component deserves some discussions. Adding one to the map outage insures that the component is non-zero. This is important, because if any component becomes zero, optimization terminates prematurely. Also, setting $\gamma = 3$ roughly amplifies the effect of outage, as estimated by a Taylor expansion, by a factor of three.

III. PROPOSED METHOD, SIMULATIONS AND RESULTS

To optimize the RF of WiMAX systems, the existing theory [2] has option to improve the performance of factor. An algorithm and some features have been introduced to overcome the problem. In the existing theory, there is an objective function which measures the system performance. It is related with mean sector throughput, mean subscriber Signal Interference to Noise Ratio (SINR), system map outage (the percentage of subscribers whose SINR is too low to read map symbols). The objective function,

$$F(S)=\left(\frac{1}{\mu_T(S)}\right)^{\alpha}\left(\frac{1}{\mu_S(S)}\right)^{\beta}\left(1+\mu_M(S)\right)^{\gamma} \qquad \text{……………………(2)}$$

where μ_T (S) = the sector throughput,

$\mu_S(S)$ = mean subscriber SINR,

$\mu_M(S)$ = the system map outage,

Where $\alpha, \beta, \gamma >= 0$ and α, β = factor attributes and γ = map outage factor

In existing theory, they used $\gamma=3$; $\alpha=1$; $\beta=0$ or $\alpha=0$; $\beta=1$. If $\gamma=3$, then it discourages the optimizer from finding solution. If $\gamma= 0$, then it is optimized perfectly. That's why this paper has proposed a formula with algorithm by which it gets some values ranges $0<=\gamma<1$.

3.1 Formula

Here, the Gama, has been formed with additional parameters in eq.3

Gama =[a/b+a/c]^alpha

$$\gamma=\left(\frac{a}{b}+\frac{a}{c}\right)^{\alpha} \qquad \text{………………..(3)}$$

Where,

a=0-1 (Increasing by 0.1) ⟶ Factor Parameter 1
b=0-1 (Increasing by 0.1) ⟶ Factor Parameter 2
c=0-1 (Increasing by 0.1) ⟶ Factor Parameter 3
alpha = 0 or 1

So the final proposed formula is in the following,

$$F(S)=\left(\frac{1}{\mu_T(S)}\right)^{\alpha}\left(\frac{1}{\mu_S(S)}\right)^{\beta}\left(1+\mu_M(S)\right)^{\left(\frac{a}{b}+\frac{a}{c}\right)^{\alpha}} \qquad \text{…………………(4)}$$

3.2 Algorithm of the program

Step 1: set the value of a,b,c, alpha & gama.
Step 2: Range of the value a,b,c [0 to 1],[where increasing .1], alpha =[0 or 1].
Step 3: gama =[a/b+a/c]^alpha.
Step 4:gama >=0 to ,gama <1.
Step 5:if gama>1, then it goes to step 2,if not, then program ends.
Step 6: Exit.

3.2Data & Graph

Fig. 1 and Table represent graphically and tabular format for introducing the empirical data of α, a, b, c and γ which are extracted from the proposed method.

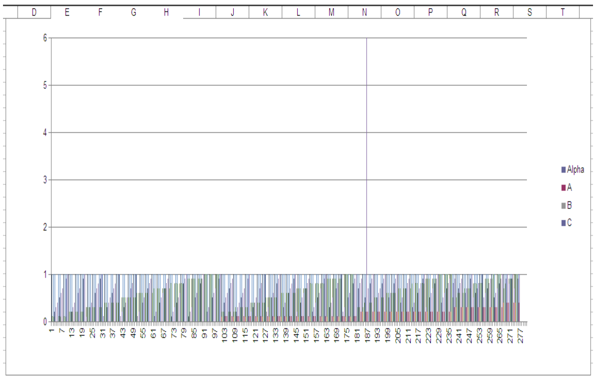

Fig. 1 Data in graphical representation

Table I Data represents in tabular form

Serial	α	a	b	c	γ
1	1	0	0.3	1	0
2	1	0	0.4	0.1	0
3	1	0	0.4	0.2	0
4	1	0	0.4	0.3	0
5	1	0	0.4	0.4	0
6	1	0	0.4	0.5	0
7	1	0	0.4	0.6	0
8	1	0	0.4	0.7	0
9	1	0	0.4	0.8	0
10	1	0	0.4	0.9	0
11	1	0	0.4	1	0
12	1	0	0.5	0.1	0
13	1	0	0.5	0.2	0
14	1	0	0.5	0.3	0
15	1	0	0.5	0.4	0
16	1	0	0.5	0.5	0
17	1	0	0.5	0.6	0
18	1	0	0.5	0.7	0
19	1	0	0.5	0.8	0
20	1	0	0.5	0.9	0
21	1	0	0.5	1	0
22	1	0	0.6	0.1	0
23	1	0	0.6	0.2	0
24	1	0	0.6	0.3	0
25	1	0	0.6	0.4	0
26	1	0	0.6	0.5	0
27	1	0	0.6	0.6	0
28	1	0	0.6	0.7	0
29	1	0	0.6	0.8	0
30	1	0	0.6	0.9	0
31	1	0	0.6	1	0
32	1	0	0.7	0.1	0
33	1	0	0.7	0.2	0
34	1	0	0.7	0.3	0
35	1	0	0.7	0.4	0
36	1	0	0.7	0.5	0
37	1	0	0.7	0.6	0
38	1	0	0.7	0.7	0
39	1	0	0.7	0.8	0
40	1	0	0.7	0.9	0
41	1	0	0.7	1	0
42	1	0	0.8	0.1	0
43	1	0	0.8	0.2	0
44	1	0	0.8	0.3	0
45	1	0	0.8	0.4	0
46	1	0	0.8	0.5	0
47	1	0	0.8	0.6	0
48	1	0	0.8	0.7	0
49	1	0	0.8	0.8	0
50	1	0	0.8	0.9	0
51	1	0	0.8	1	0
52	1	0	0.9	0.1	0
53	1	0	0.9	0.2	0
54	1	0	0.9	0.3	0
55	1	0	0.9	0.4	0
56	1	0	0.9	0.5	0
57	1	0	0.9	0.6	0
58	1	0	0.9	0.7	0
59	1	0	0.9	0.8	0
60	1	0	0.9	0.9	0
61	1	0	0.9	1	0
62	1	0	1	0.1	0
63	1	0	1	0.2	0
64	1	0	1	0.3	0
65	1	0	1	0.4	0
66	1	0	1	0.5	0
67	1	0	1	0.6	0
68	1	0	1	0.7	0
69	1	0	1	0.8	0
70	1	0	1	0.9	0
71	1	0	1	1	0
72	1	0.1	0.2	0.3	0.833333
73	1	0.1	0.2	0.4	0.75
74	1	0.1	0.2	0.5	0.7
75	1	0.1	0.2	0.6	0.666667
76	1	0.1	0.2	0.7	0.642857
77	1	0.1	0.2	0.8	0.625
78	1	0.1	0.2	0.9	0.611111
79	1	0.1	0.2	1	0.6
80					

Table II Data represents in tabular form

Serial	α	a	b	c	γ
81	1	0.1	0.2	1	0.6
82	1	0.1	0.3	0.2	0.833333
83	1	0.1	0.3	0.3	0.666667
84	1	0.1	0.3	0.4	0.583333
85	1	0.1	0.3	0.5	0.533333
86	1	0.1	0.3	0.6	0.5
87	1	0.1	0.3	0.7	0.47619
88	1	0.1	0.3	0.8	0.458333
89	1	0.1	0.3	0.9	0.444444
90	1	0.1	0.3	1	0.433333
91	1	0.1	0.4	0.2	0.75
92	1	0.1	0.4	0.3	0.583333
93	1	0.1	0.4	0.4	0.5
94	1	0.1	0.4	0.5	0.45
95	1	0.1	0.4	0.6	0.416667
96	1	0.1	0.4	0.7	0.392857
97	1	0.1	0.4	0.8	0.375
98	1	0.1	0.4	0.9	0.361111
99	1	0.1	0.4	1	0.35
100	1	0.1	0.5	0.2	0.7
101	1	0.1	0.5	0.3	0.533333
102	1	0.1	0.5	0.4	0.45
103	1	0.1	0.5	0.5	0.4
104	1	0.1	0.5	0.6	0.366667
105	1	0.1	0.5	0.7	0.342857
106	1	0.1	0.5	0.8	0.325
107	1	0.1	0.5	0.9	0.311111
108	1	0.1	0.5	1	0.3
109	1	0.1	0.6	0.2	0.666667
110	1	0.1	0.6	0.3	0.5
111	1	0.1	0.6	0.4	0.416667
112	1	0.1	0.6	0.5	0.366667
113	1	0.1	0.6	0.6	0.333333
114	1	0.1	0.6	0.7	0.309524
115	1	0.1	0.6	0.8	0.291667
116	1	0.1	0.6	0.9	0.277778
117	1	0.1	0.6	1	0.266667
118	1	0.1	0.7	0.2	0.642857
119	1	0.1	0.7	0.3	0.47619
120	1	0.1	0.7	0.4	0.392857
121	1	0.1	0.7	0.5	0.342857
122	1	0.1	0.7	0.6	0.309524
123	1	0.1	0.7	0.7	0.285714
124	1	0.1	0.7	0.8	0.267857
125	1	0.1	0.7	0.9	0.253968
126	1	0.1	0.8	1	0.225
127	1	0.1	0.8	0.2	0.625
128	1	0.1	0.8	0.3	0.458333
129	1	0.1	0.8	0.4	0.375
130	1	0.1	0.8	0.5	0.325
131	1	0.1	0.8	0.6	0.291667
132	1	0.1	0.8	0.7	0.267857
133	1	0.1	0.8	0.8	0.25
134	1	0.1	0.8	0.9	0.236111
135	1	0.1	0.8	1	0.225
136	1	0.1	0.9	0.2	0.611111
137	1	0.1	0.9	0.3	0.444444
138	1	0.1	0.9	0.4	0.361111
139	1	0.1	0.9	0.5	0.311111
140	1	0.1	0.9	0.6	0.277778
141	1	0.1	0.9	0.7	0.253968
142	1	0.1	0.9	0.8	0.236111
143	1	0.1	0.9	0.9	0.222222
144	1	0.1	0.9	1	0.211111
145	1	0.1	1	0.2	0.6
146	1	0.1	1	0.3	0.433333
147	1	0.1	1	0.4	0.35
148	1	0.1	1	0.5	0.3
149	1	0.1	1	0.6	0.266667
150	1	0.1	1	0.7	0.242857
151	1	0.1	1	0.8	0.225
152	1	0.1	1	0.9	0.211111
153	1	0.1	1	1	0.2
154	1	0.2	0.3	0.7	0.952381
155	1	0.2	0.3	0.8	0.916667
156	1	0.2	0.3	0.9	0.888889
157	1	0.2	0.3	1	0.866667
158	1	0.2	0.4	0.5	0.9

Table III Data represents in tabular form

Serial	α	a	b	c	γ
159	1	0.2	0.4	6	0.533333
160	1	0.2	0.4	0.7	0.785714
161	1	0.2	0.4	0.8	0.75
162	1	0.2	0.4	0.9	0.722222
163	1	0.2	0.4	1	0.7
164	1	0.2	0.5	0.4	0.9
165	1	0.2	0.5	0.5	0.8
166	1	0.2	0.5	0.6	0.733333
167	1	0.2	0.5	0.7	0.685714
168	1	0.2	0.5	0.8	0.65
169	1	0.2	0.5	0.9	0.622222
170	1	0.2	0.5	1	0.6
171	1	0.2	0.6	0.4	0.833333
172	1	0.2	0.6	0.5	0.733333
173	1	0.2	0.6	0.6	0.666667
174	1	0.2	0.6	0.7	0.619048
175	1	0.2	0.6	0.8	0.583333
176	1	0.2	0.6	0.9	0.555556
177	1	0.2	0.6	1	0.533333
178	1	0.2	0.7	0.3	0.952381
179	1	0.2	0.7	0.4	0.785714
180	1	0.2	0.7	0.5	0.685714
181	1	0.2	0.7	0.6	0.619048
182	1	0.2	0.7	0.7	0.571429
183	1	0.2	0.7	0.8	0.535714
184	1	0.2	0.7	0.9	0.507937
185	1	0.2	0.7	1	0.485714
186	1	0.2	0.8	0.3	0.916667
187	1	0.2	0.8	0.4	0.75
188	1	0.2	0.8	0.5	0.65
189	1	0.2	0.8	0.6	0.583333
190	1	0.2	0.8	0.7	0.535714
191	1	0.2	0.8	0.8	0.5
192	1	0.2	0.8	0.9	0.472222
193	1	0.2	0.8	1	0.45
194	1	0.2	0.9	0.3	0.888889
195	1	0.2	0.9	0.4	0.722222
196	1	0.2	0.9	0.5	0.622222
197	1	0.2	0.9	0.6	0.555556
198	1	0.2	0.9	0.7	0.507937
199	1	0.2	0.9	0.8	0.472222
200	1	0.2	0.9	0.9	0.444444
201	1	0.2	0.9	1	0.422222
202	1	0.2	1	0.3	0.866667
203	1	0.2	1	0.4	0.7
204	1	0.2	1	0.5	0.6
205	1	0.2	1	0.6	0.533333
206	1	0.2	1	0.7	0.485714
207	1	0.2	1	0.8	0.45
208	1	0.2	1	0.9	0.422222
209	1	0.2	1	1	0.4
210	1	0.3	0.5	0.8	0.975
211	1	0.3	0.5	0.9	0.933333
212	1	0.3	0.5	1	0.9
213	1	0.3	0.6	0.7	0.928571
214	1	0.3	0.6	0.8	0.875
215	1	0.3	0.6	0.9	0.833333
216	1	0.3	0.6	1	0.8
217	1	0.3	0.7	0.6	0.928571
218	1	0.3	0.7	0.7	0.857143
219	1	0.3	0.7	0.8	0.803571
220	1	0.3	0.7	0.9	0.761905
221	1	0.3	0.7	1	0.728571
222	1	0.3	0.8	0.5	0.975
223	1	0.3	0.8	0.6	0.875
224	1	0.3	0.8	0.7	0.803571
225	1	0.3	0.8	0.8	0.75
226	1	0.3	0.8	0.9	0.708333
227	1	0.3	0.8	1	0.675
228	1	0.3	0.9	0.5	0.933333
229	1	0.3	0.9	0.6	0.833333
230	1	0.3	0.9	0.7	0.761905
231	1	0.3	0.9	0.8	0.708333
232	1	0.3	0.9	0.9	0.666667
233	1	0.3	0.9	1	0.633333
234	1	0.3	1	0.5	0.9
235	1	0.3	1	0.6	0.8
236	1	0.3	1	0.7	0.728571
237	1	0.3	1	0.8	0.675
238	1	0.3	1	0.9	0.633333

In this work, a formula has been introduced of map outage factor. In this formula, it appears the value of map outage factor which ranges from 0 to 1.There are 237 values of map outage factor. The paper which has been developed [2], there map outage factor is 3, discards the objective function for better optimization. For that reason, RF does not work smoothly in WiMAX system. In this paper, the value of map outage factor, which is less than 3, has been found and it is effective and it works significantly.

IV. CONCLUSIONS

In this paper, RF optimization of WiMAX has been analyzed by a simplified formula of map outage factor which works with immense perfection. Comparing with the existing method, it is found that the proposed simplified formula works more precisely to minimize the objective function. To verify the result, the performance of the proposed system has been examined by MATLAB simulator and it is established that the proposed modified formula is better than the existing technique to optimize RF of WiMAX.

REFERENCES

[1] J. Andrews, A. Ghosh, R. Muhamed, Fundamentals of WiMAX, Prentice Hall, 2007.

[2] R. Pazhyannur, T. Dean, S. Anantha "RF Optimization of WiMAX Systems" Vehicular Techonoogy Conference, 2008, VTC-2008-Fall, IEEE, pp.1-6.

[3] Y. H. Chen, Jun-Horng, Chen, Peng Chia Hsien, Dau- Chyrh Chang, Jung-Hao Huang "Performance Evaluation of Mobile WiMAX Beam Forming Network Implemented by RF Digital Step Attenuators", Wireless Conference 2008, EW 2008, 14th European, pp.1-6.

[4] Ildu Kim, Jungjoon Kim, Junghwan Moon, and Bumman Kim "Optimized Envelope Shaping for Hybrid EER Transmitter of Mobile WiMAX-Optimized ET Operation" Microwave and Wireless Components Letter, IEEE, Vol 19, No. 5.

[5] M. Dillon, A. Diwan, V. Raman, C. Murphy, "Evaluating the Opportunity for Optimization of Various RF Parameters in IEEE 802.16e Multi-Cell Networks", 64th IEEE Vehicular Technology Conference, Fall 2006, pp. 1-5.

[6] J. Koza, M. Keane, M. Streeter, W. Mydlowec, J. Yu, G. Lanza. Genetic Programming IV: Routine Human-Competitive Machine Intelligence. Kluwer Academic Publishers, 2003.

[7] C. Murphy, M. Dillon, A. Diwan, "Performance gains using remote control antennas in CDMA and 1xEV-DO networks," Vehicular Technology Conference, 2005. VTC-2006-Fall. 2005 IEEE 632nd, vol. 1, September 2005, pp. 377-381 [5] S. Sampei, Applications of Digital Wireless Technologies to Global Wireless Communications, Prentice Hall, 1997.

[8] Bruno Pattan, "Robust Modulation Methods & Smart Antennas in Wireless Communication", New Jersey, Prentice Hall, Inc., 2000.