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Model of Minimum Fairness Proportion Achievable in MANET Using Location-Aware Transmission for Ubicomp.

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***Abstract* – Managing energy consumption in ubicomp remains a serious topic of research since MANET transmission may help in energy containment in ubicomp [58], enhance by location-aware transmission strategies. It is assumed that in a MANET for ubicomp, nodes present will transmit in an automated collective fashion, thereby sharing the workload. It can hence be assumed that nodes present in a topography are themselves the infrastructure. If it is also assumed that every node must be providing equitable assistance, then it can also be concluded that this situation will be rarely reached. A research area remains "By how much Fairness reached in a ubicomp deviates from the latter situation reached?" as such questions remain consequent in situations of cooperative functionality.**

A previous study in this direction was made [22] whereby 2 metrics were defined: BFEA and ECFP. ECFP was a first metric for gauging Fairness proportion reached in ubicomp. In this paper, a second metric Min_FP, derived from ECFP is defined and its corresponding trends over varying node densities are presented.

This paper builds further the area of modelling in ubicomp for designers to assess Fairness criteria and subsequently better shape future ubicomp components. This paper is a follow-up of previous research [1-22].

Key terms: Ubicomp- Ubiquitous Computing, MAUC- Mobile and Ubiquitous Computing, MANET- Mobile Adhoc Network, BFEA- Basic Fairness Energy Amount, ECFP- Energy Consumption Fairness Proportion, Min_FP- Minimum Fairness Proportion, CBR- Constant Bit Rate.

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1. Introduction

MANET transmission remains a considerable factor affecting energy consumption in MAUC [21]. In this method, transmission load is distributed among those nodes which have been part of MANET route for a corresponding CBR. The situation being cooperation here, a direction of research crops up with the assumption that the workload of transmission is equitably distributed among all topographic nodes present. Indeed, such a situation will be very rarely reached but still for long duration transmissions over highly dynamic MANET topologies, situations close to the equitable distribution situation may be reached. Hence, devising appropriate metrics and assessing their trends of varying node numbers remain desirable pieces of knowledge for better shaping of ubicomp future.

The work presented here remains empirical and is built over previous work [22]. For this study, the metric BFEA [22] is re-used. BFEA remains the definition of the equitable amount of energy if the overall energy requirement was equally divided among all topography nodes present. ECFP [22] remains a wide scope metric from which other metrics may be extracted for study. Each such extracted metric may have specific features that brings additional value for study of reliability in the field of ubicomp.

The key contributions of this paper is firstly, the development of a second metric Min_FP extracted from a first metric ECFP [22]. The definition and rationale of metric Min_FP is put forward. Secondly, the model of trend is put forward for the metric Min_FP with results for varying node densities from 7 until 56 in a topography of 300 x 300 m^2. The model proposed is the decreasing exponential model. The rest of this paper is organised as follows: section 2- New Derived Metric – Minimum Fairness Proportion, section 3- Min_FP Trend Assessment over Varying Node Numbers, 4- Conclusion and References.

2. New Derived Metric – Minimum Fairness Proportion.

Following definition of ECFP given in previous paper [22], Min_FP will simply be the minimum value of ECFP recorded for a CBR.

If Min_FP value itself is greater than 1, then it can depict certain specific possible situations:

i. The CBR duration may be very short.
ii. The MANET routes may not be changing dynamically enough.
iii. The number of nodes refusing to forward packets in the MANET is high, requiring further actions.

iv. The random movements of nodes generated a temporary sparsely populated sub region where the sender, receiver and MANET route nodes were found. It is suggested here that occurrences of such situation may be subject to further empirical study which is outside the scope of this research.

In general, Min_FP must be positive and the smaller positive value of Min_FP, the healthier the MANET conditions are, i.e. risk of overconsuming the battery resources of topography nodes could be low.

Again, this metric, if appropriately gauged or even predicted, may also serve purposes elaborated in previous paper [21].

3. Min_FP - Trend Assessment over Varying Node Numbers.

3.0 Major Observations.

Here also, the leftmost point in each plot at x-coordinate 0.0 is at an outlying high position and does not correspond to tendency observed by other plots. The x-range is hence taken from 0.1 until a value ensuring coverage of 97 % of CBRs.

The overall tendency is again observed to be decreasing exponential with equation of form:

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G(x) = a * exp (b * (x - 0.1)) + c
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3.1 Tabular Summary of Results.

A tabular summary for results of equations of curves (G(x)) is shown below. Column headings are: A→node number, B→Value of parameter a, C→Value of parameter b, D→ Value of parameter c, E→ reduced chi-square value of plot G(x), F→ Corresponding figure number.

A	B	C	D	E	F
7	3.519 694	-6.103 706	0.077 387	0.027 190 6	1
8	3.175 331	-4.958 864	0.068 833	0.046 193 7	2
9	3.199 009	-5.260 203	0.064 179	0.034 903 8	3
10	6.069 800	-8.408 581	0.108 412	0.008 237 33	4
11	6.484 710	-9.798 954	0.111 688	0.004 406 27	5
12	6.390 306	-10.395 808	0.112 966	0.004 079 33	6
13	6.838 458	-11.213 566	0.130 255	0.020 432 6	7
14	7.147 009	-10.897 153	0.107 034	0.004 231 35	8
15	7.049 066	-10.829 732	0.107 031	0.013 844 5	9
16	7.699 679	-11.563 639	0.102 719	0.009 515 69	10
17	9.213 667	-10.586 292	0.125 671	0.032 779 5	11
18	9.442 423	-11.055 031	0.110 084	0.011 107	12
19	9.681 948	-10.593 552	0.111 622	0.010 282 4	13
20	9.807 329	-11.022 134	0.105 182	0.008 122 92	14
21	11.584 319	-14.091 578	0.129 176	0.027 268 2	15
22	11.836 741	-13.089 681	0.134 579	0.019 362 4	16
23	12.011 652	-13.200 027	0.116 576 77	0.003 126 33	17
24	11.758 422	-13.207 366	0.116 628	0.019 949 5	18
25	11.806 162	-15.234 300	0.145 822	0.042 495	19
26	12.673 915	-14.378 576	0.129 086	0.018 614 1	20
27	12.850 082	-15.083 701	0.131 389	0.017 102 4	21
28	12.537 517	-13.376 120	0.098 156	0.008 727 47	22
29	12.691 689	-14.172 802	0.133 617	0.010 731 8	23
30	12.705 7	-14.673 6	0.136 667	0.042 310 3	24
31	11.941 5	-12.105 8	0.089 418 6	0.014 063 8	25
32	11.915 7	-11.602 4	0.082 318 1	0.004 629 46	26
33	11.813 3	-11.859 8	0.067 380 3	0.003 060 66	27
34	12.569 8	-13.302 3	0.098 544 1	0.006 958 17	28
35	12.636 5	-14.151 6	0.124 397	0.028 057 1	29
36	12.886 4	-15.012 4	0.126 819	0.039 813 7	30
37	14.219 4	-15.612 9	0.159 288	0.061 864 2	31
38	14.026	-14.750 2	0.144 177	0.044 420 2	32
39	14.761 9	-16.113 1	0.142 901	0.056 099 4	33
40	14.124 3	-16.881 7	0.189 772	0.107 852	34
41	14.475 5	-16.985 1	0.146 667	0.061 460 3	35
42	14.493	-16.862 1	0.175 272	0.080 119 9	36
43	14.508 2	-15.522 6	0.134 929	0.072 756 8	37
44	14.912 9	-16.747 6	0.137 645	0.104 207	38
45	15.201 3	-15.719 6	0.139 093	0.088 959 2	39
46	15.344 4	-15.472 3	0.119 961	0.036 936 1	40
47	15.513 8	-15.615 4	0.108 436	0.034 216 9	41
48	15.693 6	-15.925	0.119 886	0.038 963 5	42
49	16.455 9	-16.531 2	0.132 493	0.064 445 9	43
50	16.467 4	-15.413 2	0.175 157	0.041 537 3	44
51	16.653 3	-15.739 1	0.185 173	0.039 426 5	45
52	16.781 6	-15.802 3	0.182 514	0.037 026 5	46
53	16.741 9	-16.175 8	0.186 285	0.059 507 2	47
54	16.738 8	-15.753 7	0.191 406	0.046 541 9	48
55	15.921 6	-14.547 7	0.173 499	0.027 707 5	49
56	16.493 3	-14.873	0.193 355	0.045 775 2	50

Table 1: summary of results for Min_Fp equations of curves node numbers 7-56

3.2 Graphical Plots for Results Obtained.

This analysis is performed in gnuplot in Linux.

1. Node Number 7

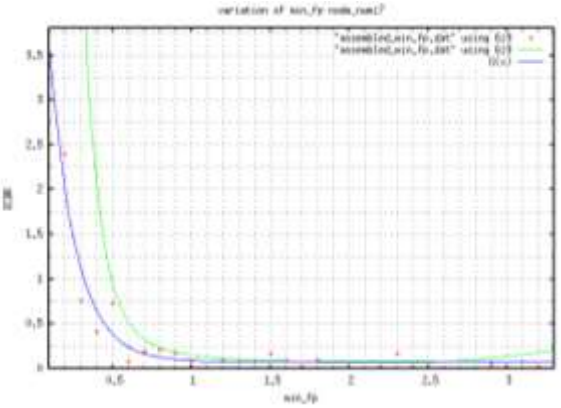

Figure 1: % CBR for Min_FP node_number 7

2. Node Number 8

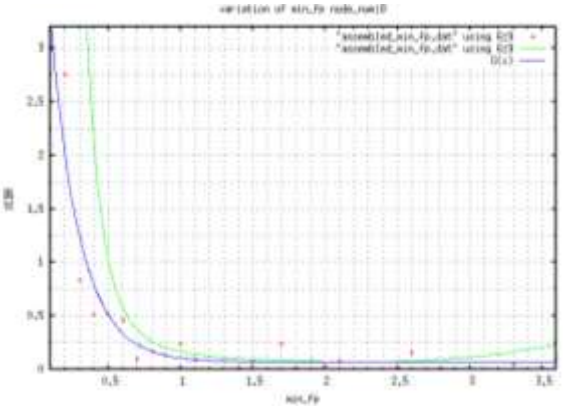

Figure 2: % CBR for Min_FP node_number 8

3. Node Number 9

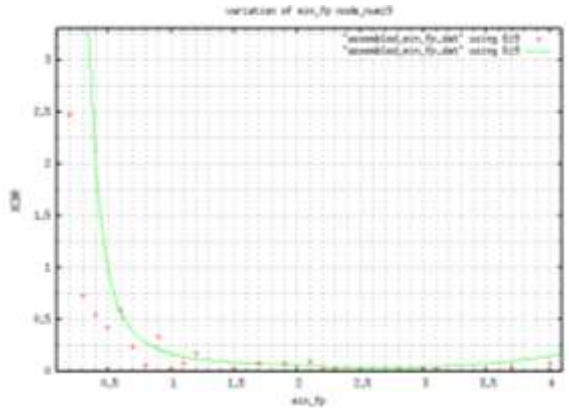

Figure 3: % CBR for Min_FP node_number 9

4. Node Number 10

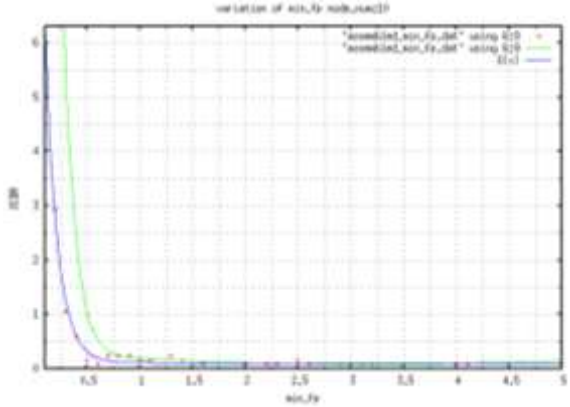

Figure 4: % CBR for Min_FP node_number 10

5. Node Number 11

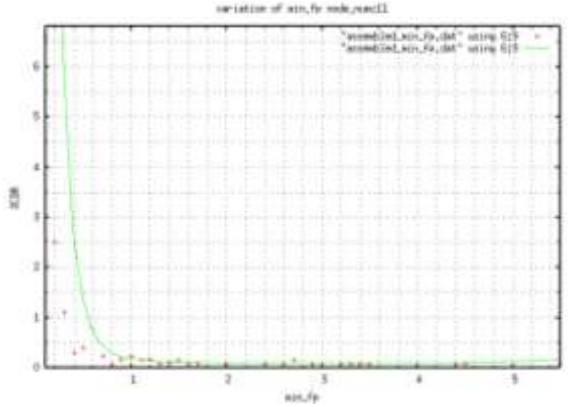

Figure 5: % CBR for Min_FP node_number 11

6. Node Number 12

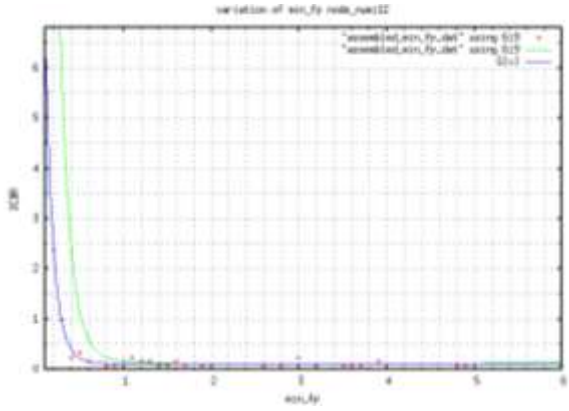

Figure 6: % CBR for Min_FP node_number 12

7. Node Number 13

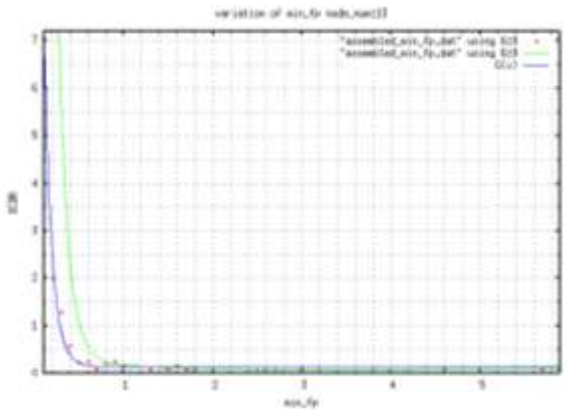

Figure 7: % CBR for Min_FP node_number 13

8. Node Number 14

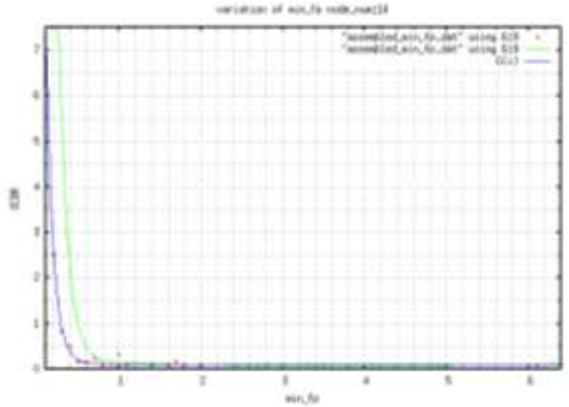

Figure 8: % CBR for Min_FP node_number 14

9. Node Number 15

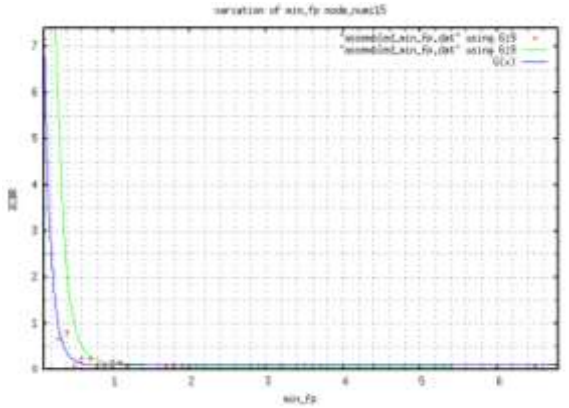

Figure 9: % CBR for Min_FP node_number 15

10. Node Number 16

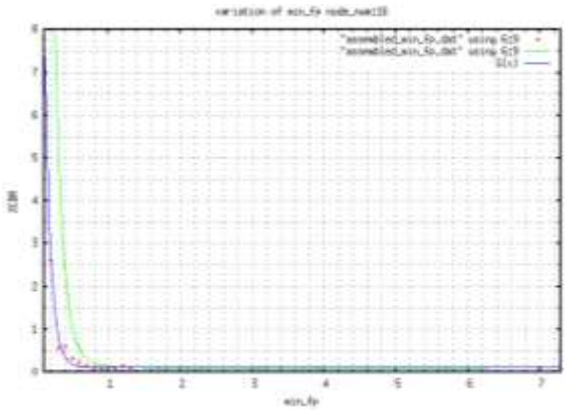

Figure 10: % CBR for Min_FP node_number 16

11. Node Number 17

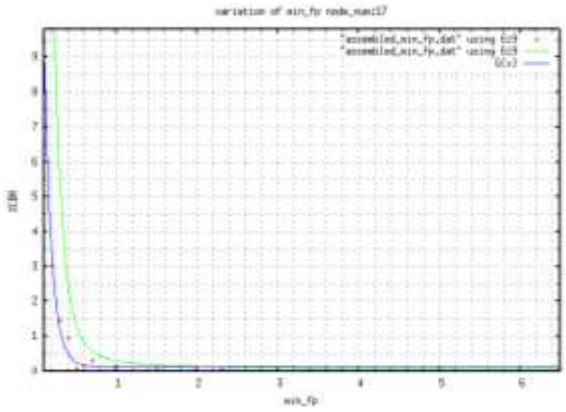

Figure 11: % CBR for Min_FP node_number 17

12. Node Number 18

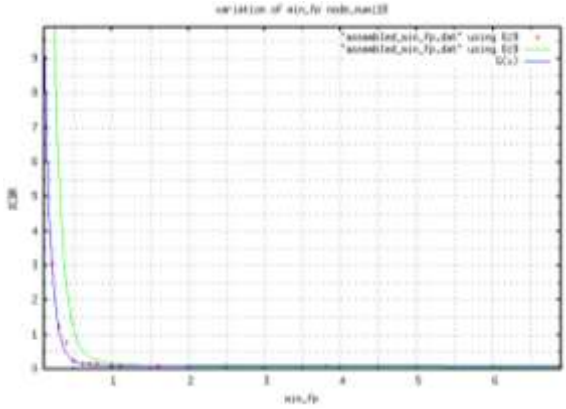

Figure 12: % CBR for Min_FP node_number 18

13. Node Number 19

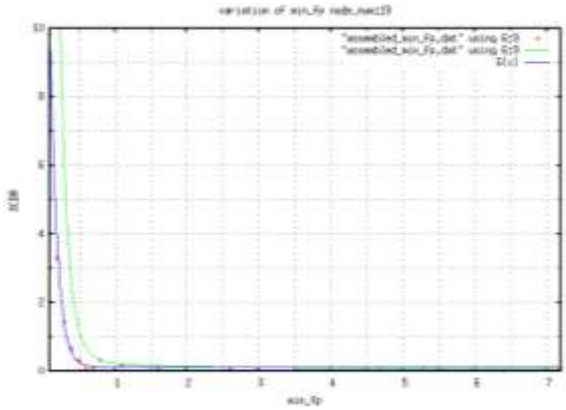

Figure 13: % CBR for Min_FP node_number 19

14. Node Number 20

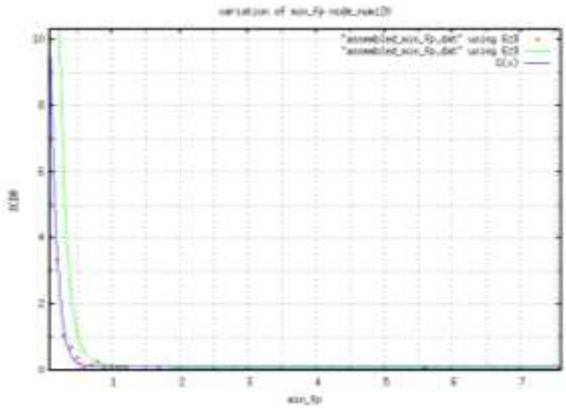

Figure 14: % CBR for Min_FP node_number 20

15. Node Number 21

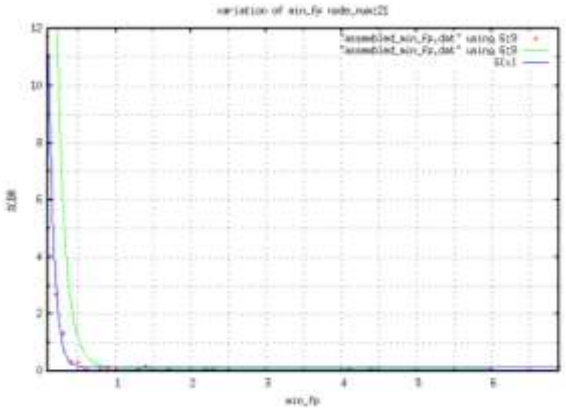

Figure 15: % CBR for Min_FP node_number 21

16. Node Number 22

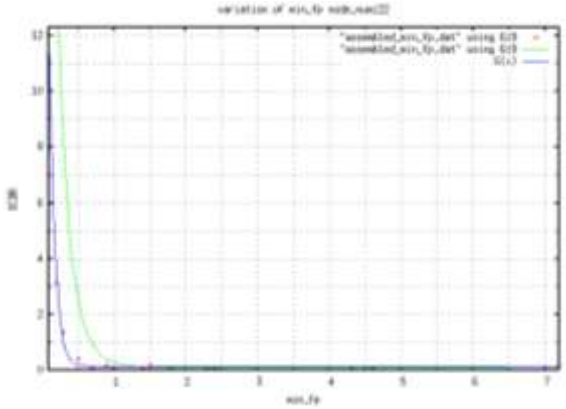

Figure 16: % CBR for Min_FP node_number 22

17. Node Number 23

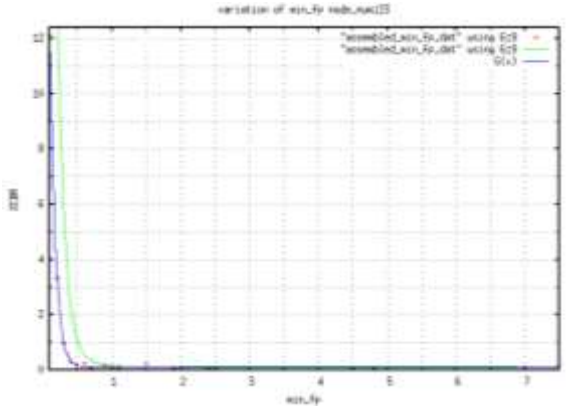

Figure 17: % CBR for Min_FP node_number 23

18. Node Number 24

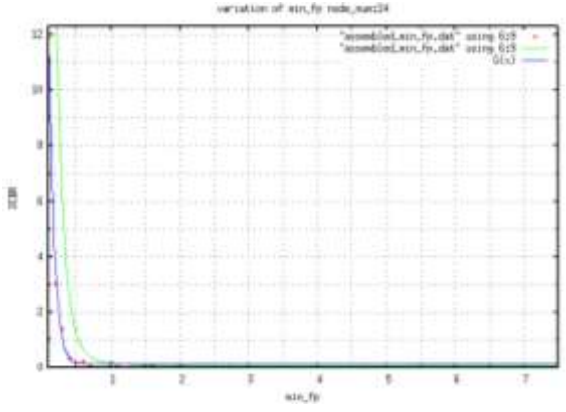

Figure 18: % CBR for Min_FP node_number 24

19. Node Number 25

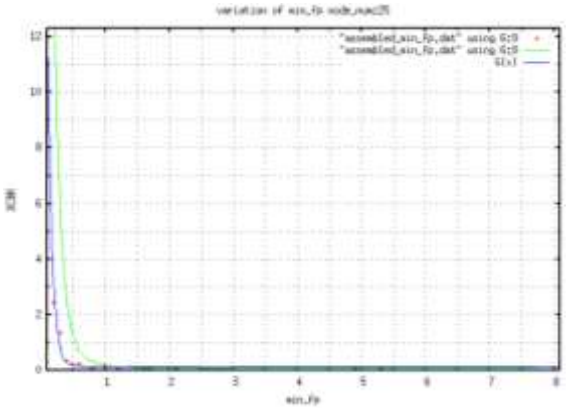

Figure 19: % CBR for Min_FP node_number 25

20. Node Number 26

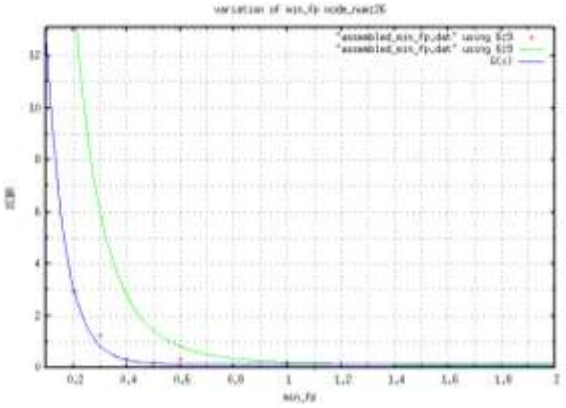

Figure 20: % CBR for Min_FP node_number 26

21. Node Number 27

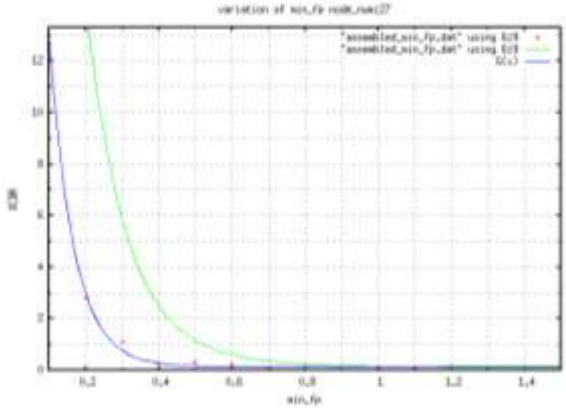

Figure 21: % CBR for Min_FP node_number 27

22. Node Number 28

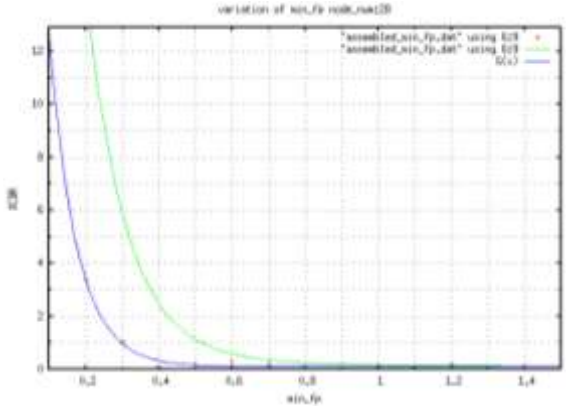

Figure 22: % CBR for Min_FP node_number 28

23. Node Number 29

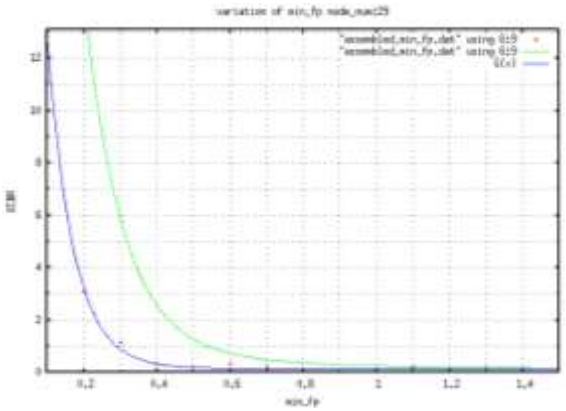

Figure 23: % CBR for Min_FP node_number 29

24. Node Number 30

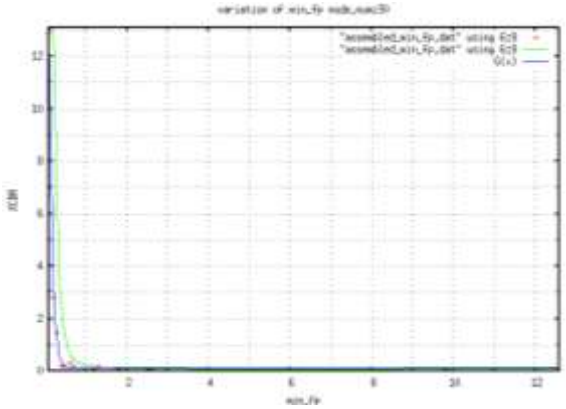

Figure 24: % CBR for Min_FP node_number 30

25. Node Number 31

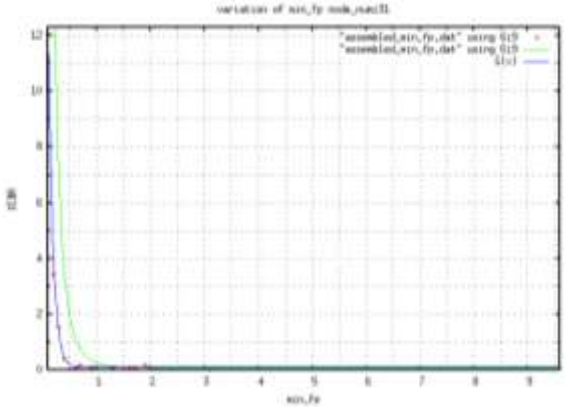

Figure 25: % CBR for Min_FP node_number 31

26. Node Number 32

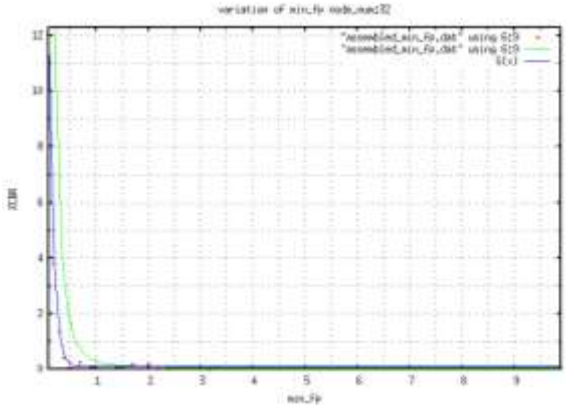

Figure 26: % CBR for Min_FP node_number 32

27. Node Number 33

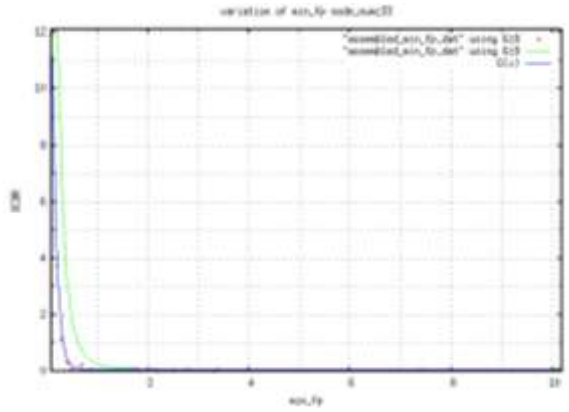

Figure 27: % CBR for Min_FP node_number 33

28. Node Number 34

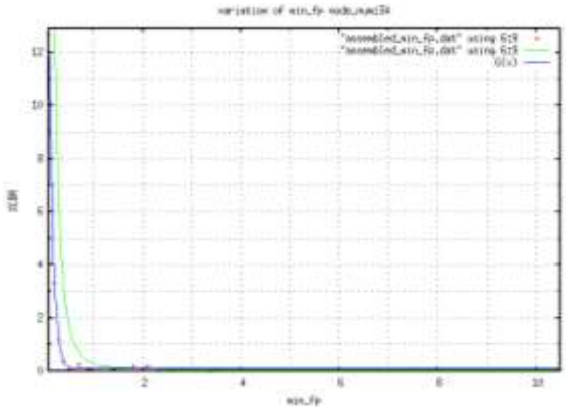

Figure 28: % CBR for Min_FP node_number 34

29. Node Number 35

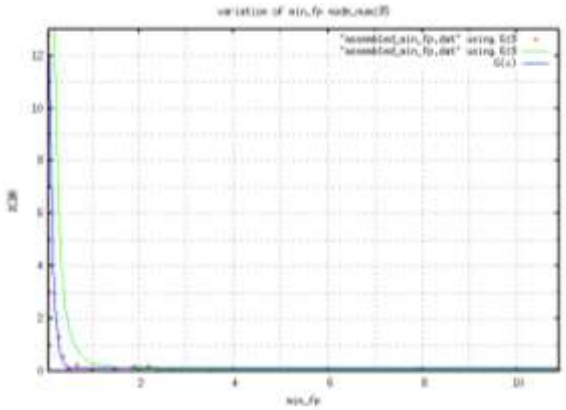

Figure 29: % CBR for Min_FP node_number 35

30. Node Number 36

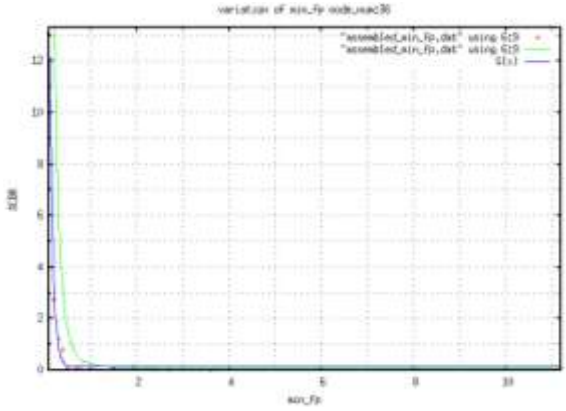

Figure 30: % CBR for Min_FP node_number 36

31. Node Number 37

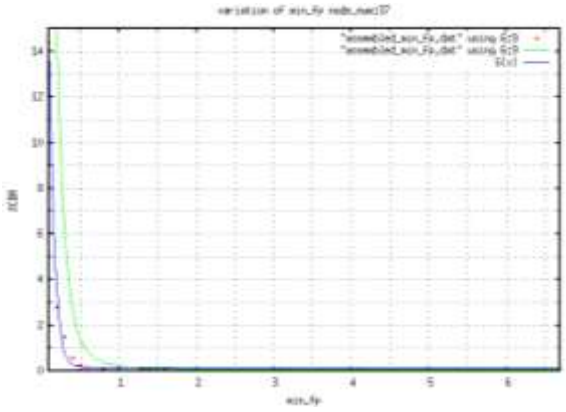

Figure 31: % CBR for Min_FP node_number 37

32. Node Number 38

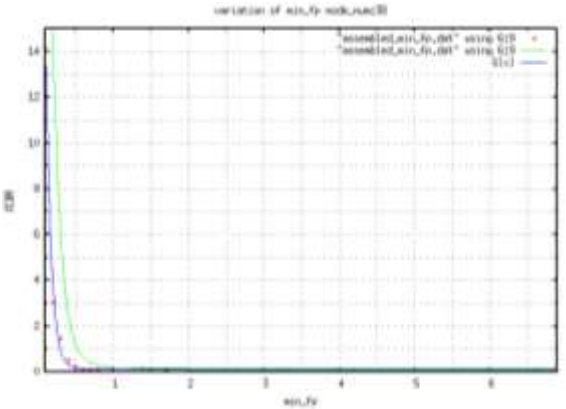

Figure 32: % CBR for Min_FP node_number 38

33. Node Number 39

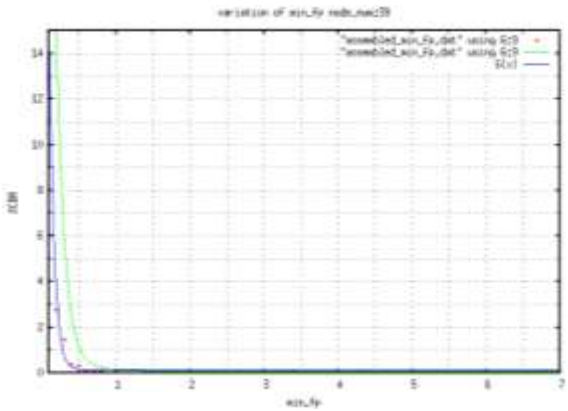

Figure 33: % CBR for Min_FP node_number 39

34. Node Number 40

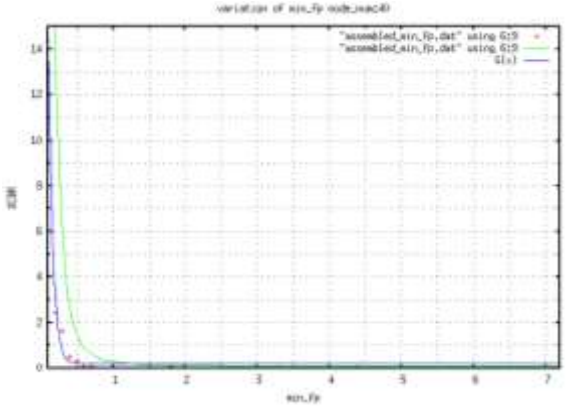

Figure 34: % CBR for Min_FP node_number 40

35. Node Number 41

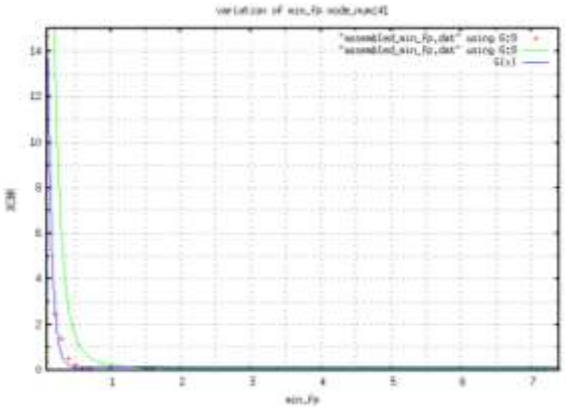

Figure 35: % CBR for Min_FP node_number 41

36. Node Number 42

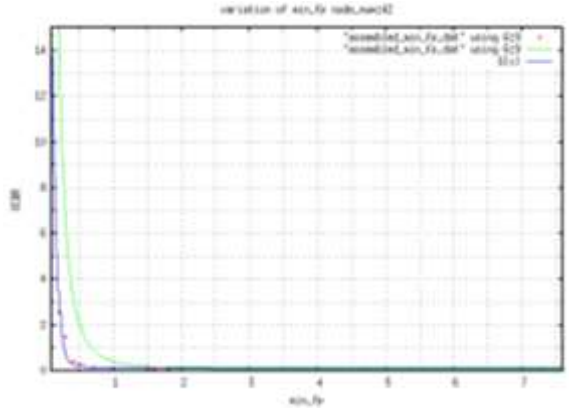

Figure 36: % CBR for Min_FP node_number 42

37. Node Number 43

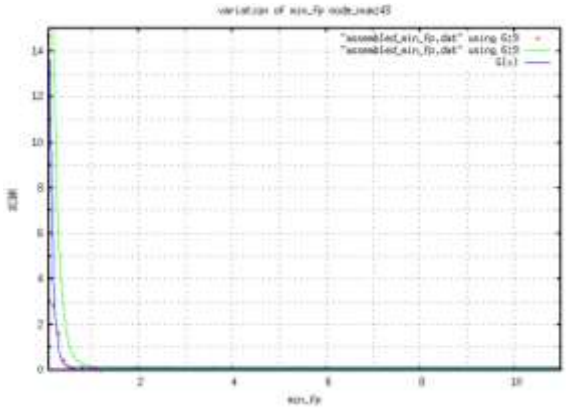

Figure 37: % CBR for Min_FP node_number 43

38. Node Number 44

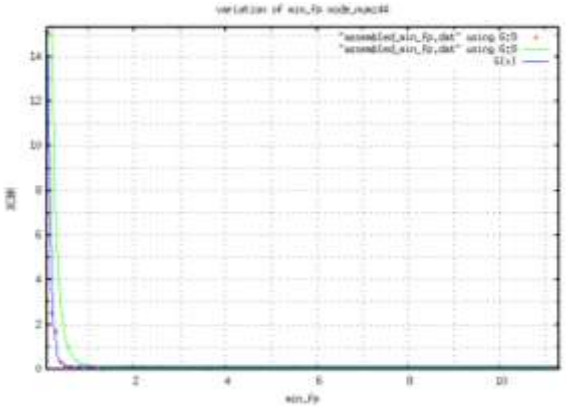

Figure 38: % CBR for Min_FP node_number 44

39. Node Number 45

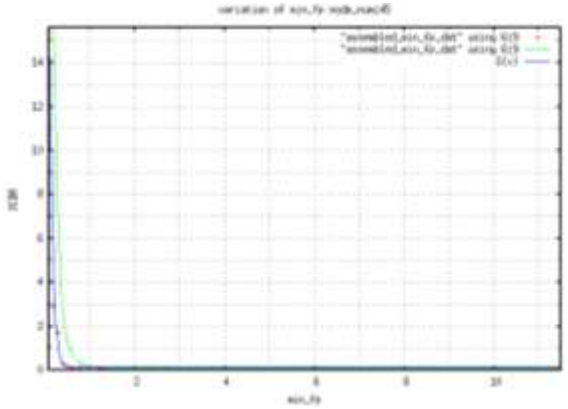

Figure 39: % CBR for Min_FP node_number 45

40. Node Number 46

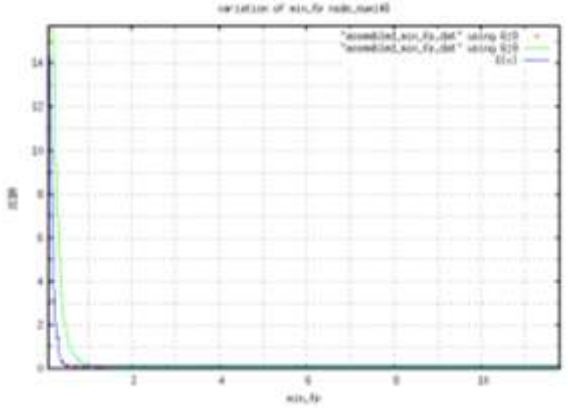

Figure 40: % CBR for Min_FP node_number 46

41. Node Number 47

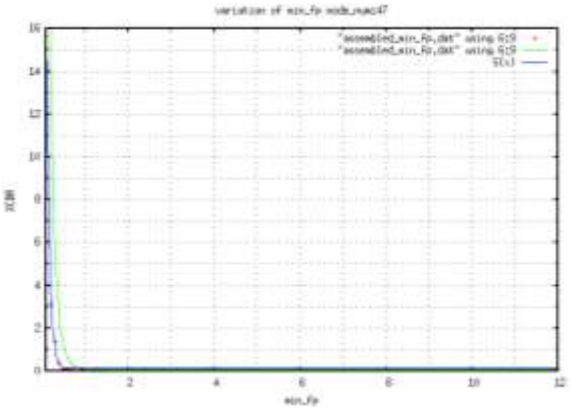

Figure 41: % CBR for Min_FP node_number 47

42. Node Number 48

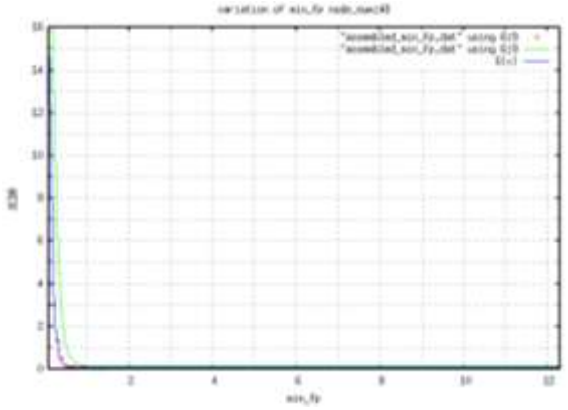

Figure 42: % CBR for Min_FP node_number 48

43. Node Number 49

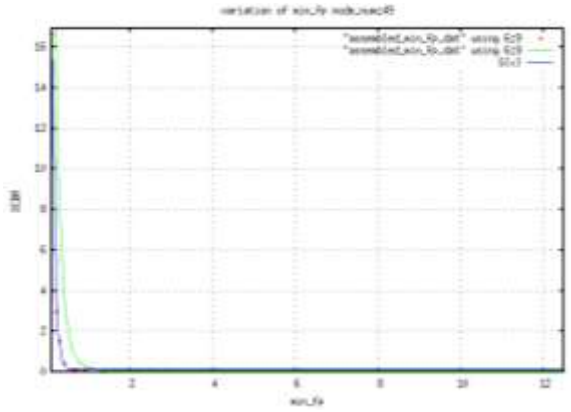

Figure 43: % CBR for Min_FP node_number 49

44. Node Number 50

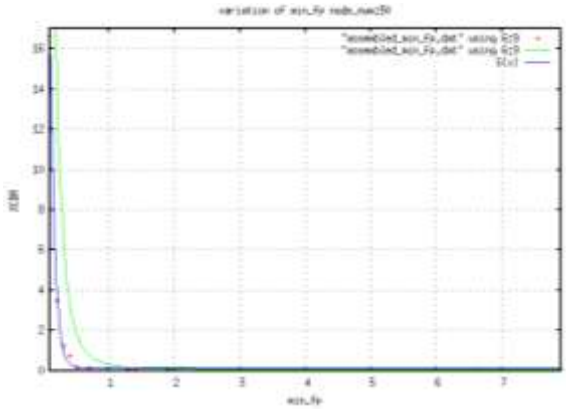

Figure 44: % CBR for Min_FP node_number 50

45. Node Number 51

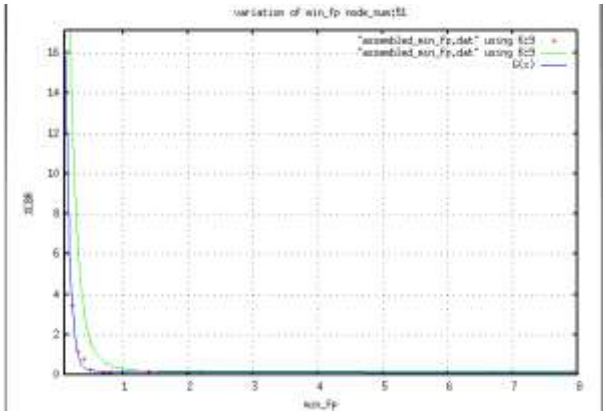

Figure 45: % CBR for Min_FP node_number 51

46. Node Number 52

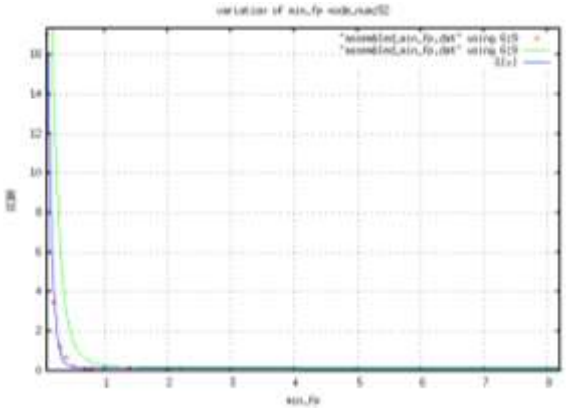

Figure 46: % CBR for Min_FP node_number 52

47. Node Number 53

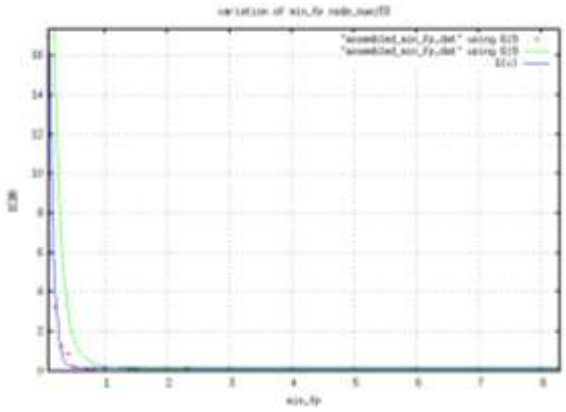

Figure 47: % CBR for Min_FP node_number 53

48. Node Number 54

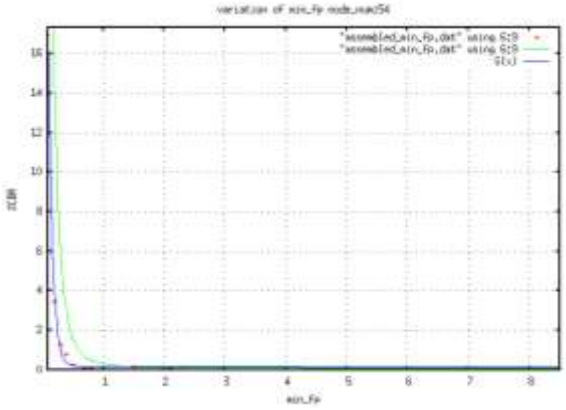

Figure 48: % CBR for Min_FP node_number 54

49. Node Number 55

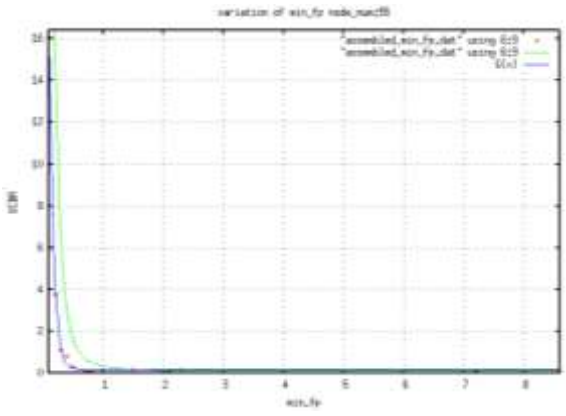

Figure 49: % CBR for Min_FP node_number 55

50. Node Number 56

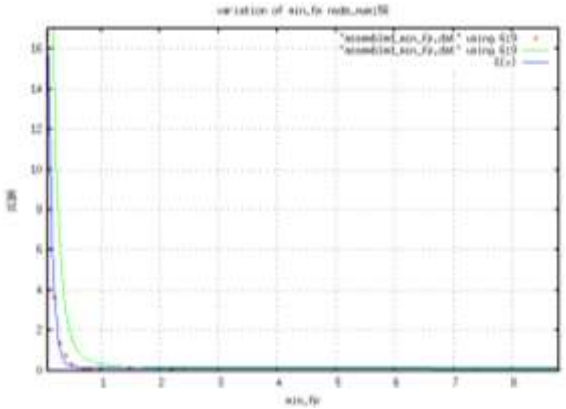

Figure 50: % CBR for Min_FP node_number 56

4. Conclusion.

This piece of research was aimed at studying trends of fairness reached in ubicomp as concerns energy load distribution. This research extends from previous work [22], in the sense that here, a sub component of previous metric defined, ECFP [22], is studied. This new metric Min_FP, is also built over the BFEA and the research results presented here remain empirical based. The model put forward is the decreasing exponential model. Again, previously stated assumptions [21] hold, e.g. availability of lightweight algorithms for location-aware transmission in mobile environments, lightweight MAUC OS supports for efficient binding/unbinding of MANET nodes and appropriate multi-threading/parallel communication in modules of MANET nodes.

The further work identified may include: trend analyses of parameters of equations for the model, formulating methods of predictability for metric Min_FP and its trend and reporting observations of certain critical values identified. Development of further metrics for studying Fairness in ubicomp remain desirable.

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