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Model of Minimum Energy Consumption Ratio Achievable in MANET Using Location-Aware Transmission in Ubicomp.

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Abstract **– Researchers claim that use of MANET transmission help to save energy in ubicomp [54]. Another strategy would be by applying location-aware transmission in MANET. The resulting method of operation remains a cooperation being required from all nodes present in the topography. A desirable feature in cooperation is to know "what is the proportion of energy being required by the MANET node compared with the sending node itself, together with corresponding trends?" Such a study is provided in another paper [18] whereby a future work identified was "How to gauge Fairness features being reached", as concerns the proportion of nodes spending more or less energy than the sender node. To bring answers to this issue, in this paper, another metric Min_R is put forward together with the corresponding model of trend over varying node densities.**

This paper adds up to the area of modelling in ubicomp and will be used by designers to better bound the resources and architecture needs for ubicomp. This paper is a follow-up of previous research [1-18].

Key terms: Ubicomp- Ubiquitous Computing, MAUC- Mobile and Ubiquitous Computing, ECR- Energy Consumption Ratio, Min_R- Minimum Ratio, MANET- Mobile Adhoc Network, CBR- Constant Bit Rate.

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1. Introduction

Many factors affect energy consumption in MAUC [2]. A very significant factor remains use of MANET transmission and a corresponding subsequent factor is node density. When using MANETs, sender nodes together with nodes forming part of MANET routes, are spending energy. Sender nodes transmit to closest neighbouring node, which in turn, relays data to next closest neighbour [18]. It is a form of cooperative strategy to achieve functionality of networking. It is legitimate for cooperating nodes to know how much assistance (in this case, energy requirements), they are being required to give compared to the sender's own effort. Such a study has been provided in another paper [18], whereby a metric ECR was tackled. A question which builds up over that previous study [18] is "How much fairness is being reached as concerns energy distribution among cooperating nodes".

It is definitely important to devise more methods/metrics for analysing resulting situations evolving in MANETs as concerns fairness among cooperating nodes. One such metric identified is the Min_R derived from ECR [18] which also is heavily affected by same changes in MANET routes as mentioned in the other paper [18].

The key contributions of this paper is firstly, the development of a metric Min_R, which is derived from ECR [18], including its definition and rationale, and secondly, the model of trend put forward for the metric Min_R with results for varying node densities from 7 until 56. The model suggested in this paper is the exponential model. The rest of this paper is organised as follows: section 2- New Derived Metric- Minimum Ratio, section 3- Min_R Trend Assessment over Varying Node Numbers, 4- Conclusion and References.

2. New Derived Metric: Minimum_Ratio.

Min_R is defined as "the smallest ECR value that has been discovered during the whole of a CBR transmission". Min_R values will also be positive values just as ECR values [18]. Min_R values can also be of 3 categories:

i. Min_R values less than 1: it can imply that one or more nodes will spend less energy than the sender node. This can be the result of high rate of MANET topology change resulting in some nodes participating very briefly in a MANET route or even that the sender has its closest neighbours quite far and some support may be needed.
ii. Min_R values equal to 1: it implies that at least one node is spending just as much energy as the sender.
iii. Min_R values greater than 1: it implies that each of the node in the MANET routes, excluding the sender node itself, have spent more energy than the sender, which is a fully unfair situation.

The metric Min_R, if accurately gauged and tracked, can assist in purposes explained in another paper [18]. Additional purposes include QoS policy formulations:

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i. Sender may decide to delay transmission or adopt Ferry Transport Protocols [55].
ii. Sender may decide to transmit in a piecemeal fashion spread over time expecting that by next piece of information, the network topology may improve in its favour.
iii. MANET nodes may use this information to decide to forward or not forward packets, and a delay after which decision will be reviewed.
iv. History tracking of Min_R into a "database" may help for further policy-based decision making, including extent of needs for infrastructure support.

3. Min_R Trend Assessment over Varying Node Numbers.

3.0 Major Observations.

The trends for Min_R achieved for node numbers 7 until 56 have followed the exponential model of form:

```
G(x) = a * exp (b*(x - 0.01)) + c
```

In all the plots for node numbers 7 until 56, the leftmost plot at x-coordinate 0.00 has been very outlying with very high value of y-coordinate, though this decreases with increasing node numbers. This corresponds to same observation as in ECR [18]. Hence, this point has been ignored in trend analyses.

The rightmost plot was at 1.0 since in the experiment, Min_R was considered inclusive of the sender node also. Hence maximum value of Min_R could be 1.0. However, it also appeared as outlying, since the plot tends to be decreasing asymptotically. The x-range taken was therefore 0.01 until a value ensuring that at least 95 % of CBRs have been covered.

3.1 Tabular Summary of Results.

Below is a tabular summary for results of equations of curves. 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, F→ Corresponding figure number.

A	B	C	D	E	F
7	1.646 87	-24.864 6	0.073 553 4	0.009 473 2	1
8	1.646 84	-23.086 5	0.141 432	0.008 242 07	2
9	1.781 37	-24.817 3	0.145 397	0.008 954 01	3
10	6.350 21	-39.901 7	0.152 042	0.023 541 4	4
11	6.468 12	-39.412 8	0.158 373	0.177 031	5
12	6.724 78	-39.461 9	0.164 117	0.018 337 2	6
13	7.148 88	-45.240 9	0.162 89	0.030 332 3	7
14	7.004 7	-41.77	0.172 149	0.036 561 2	8
15	6.876 13	-39.343 7	0.164 934	0.016 824 1	9
16	6.853 53	-39.090 1	0.170 06	0.034 728 2	10
17	7.438 39	-35.788 2	0.190 177	0.027 929 8	11
18	7.583 33	-38.746 9	0.191 434	0.039 328	12
19	7.931 45	-41.085 7	0.212 465	0.053 757 6	13
20	7.722 02	-39.728	0.230 289	0.058 575	14
21	7.580 37	-34.876 5	0.192 683	0.038 721 3	15
22	7.303 81	-33.408 4	0.187 666	0.037 276 8	16
23	6.885 45	-30.863 4	0.201 145	0.035 507	17
24	6.735 16	-28.460 4	0.179 933	0.025 040 2	18
25	6.672 92	-28.714 2	0.189 215	0.037 783 1	19
26	7.056 73	-28.172 8	0.196 115	0.038 750 5	20
27	7.270 39	-29.897 7	0.207 749	0.044 448 4	21
28	7.581 35	-31.330 6	0.197 445	0.052 787 8	22
29	7.325 79	-29.697 1	0.208 124	0.063 060 2	23
30	7.359 3	-29.277 5	0.194 668	0.052 780 3	24
31	7.683 71	-28.827 1	0.184 567	0.062 428 6	25
32	7.394 02	-27.548 9	0.179 418	0.051 951 5	26
33	7.432 98	-28.296 2	0.194 431	0.051 588 9	27
34	7.344 57	-27.842 2	0.199 711	0.034 819 7	28
35	7.266	-26.861 8	0.179 291	0.036 495 1	29
36	7.536 29	-28.06	0.193 665	0.035 156 4	30
37	6.726 68	-26.197 6	0.197 014	0.061 209 8	31
38	6.482 43	-24.344 8	0.189 305	0.042 917 9	32
39	6.456 31	-24.733 2	0.198 88	0.039 691 5	33
40	6.229 4	-22.875 8	0.186 039	0.048 485 6	34
41	6.056 09	-21.722 4	0.199 071	0.048 789 9	35
42	6.567 81	-23.795 9	0.199 613	0.054 831 7	36
43	6.090 87	-22.171 1	0.196 554	0.069 600 5	37
44	5.123 55	-18.278 1	0.164 468	0.034 063 2	38
45	5.731 21	-19.9774	0.178 805	0.052 870 1	39
46	5.947 11	-21.911 2	0.200 792	0.056 867	40
47	5.869 32	-20.940 1	0.187 86	0.042 587 2	41
48	6.036 73	-22.052 3	0.200 332	0.049 270 2	42
49	5.749 47	-20.568 8	0.218 006	0.047 632	43
50	6.654 93	-19.886	0.194 392	0.041 542 6	44
51	5.455 89	-19.055	0.205 536	0.041 171 5	45
52	5.482 5	-18.728 3	0.186 848	0.046 815 8	46
53	5.507 23	-18.274	0.169 024	0.040 215 4	47
54	5.471 94	-18.491 4	0.185 193	0.058 343	48
55	5.314 69	-17.647 8	0.166 317	0.035 974 2	49
56	5.278 27	-17.181 5	0.166 944	0.032 123 9	50

Table 1: results for Min_R equations of curves node num 7-56

3.2 Graphical Plots for Results Obtained.

This analysis is performed in gnuplot in Linux.

1. Node Number 7

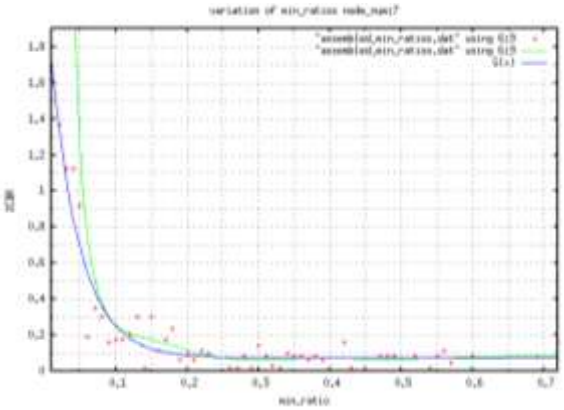

Figure 1: % cbr for Min_R node_number 7

2. Node Number 8

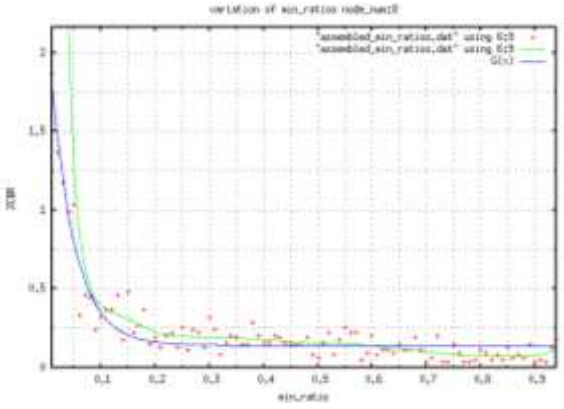

Figure 2: % cbr for Min_R node_number 8

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3. Node Number 9

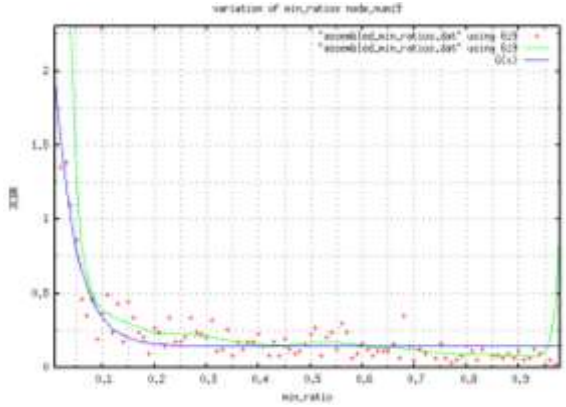

Figure 3: % cbr for Min_R node_number 9

4. Node Number 10

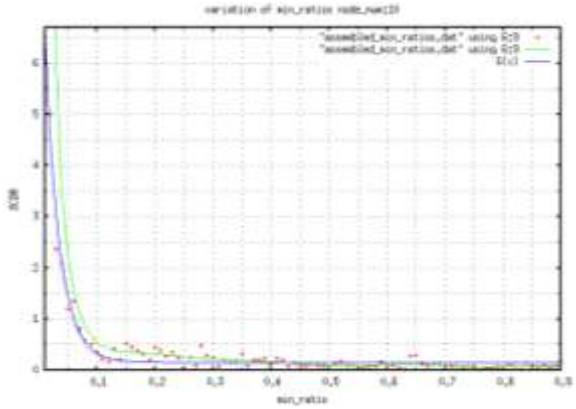

Figure 4: % cbr for Min_R node_number 10

5. Node Number 11

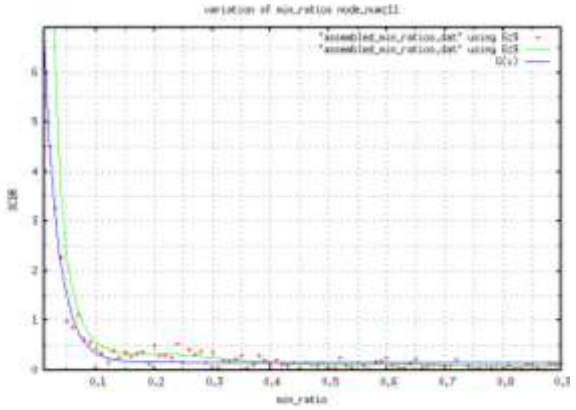

Figure 5: % cbr for Min_R node_number 11

6. Node Number 12

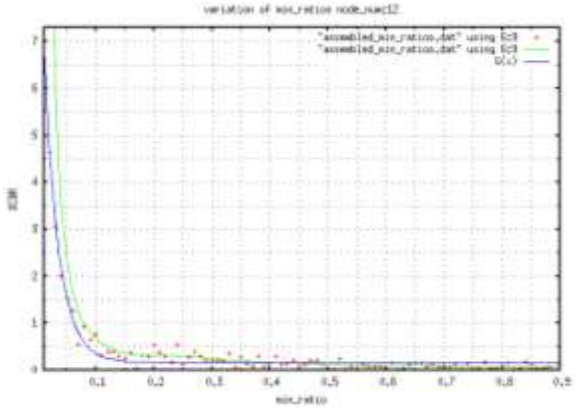

Figure 6: % cbr for Min_R node_number 12

7. Node Number 13

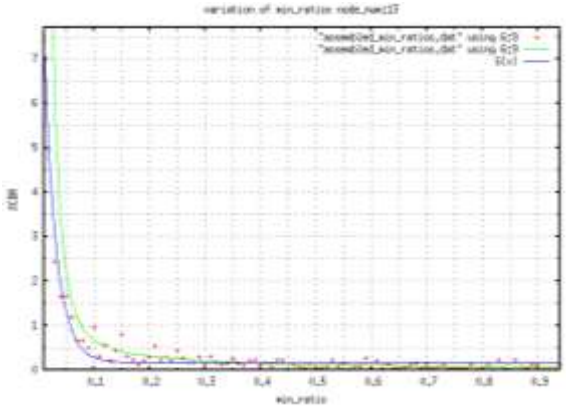

Figure 7: % cbr for Min_R node_number 13

8. Node Number 14

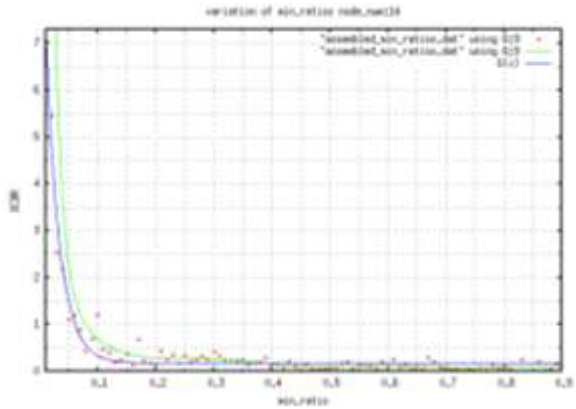

Figure 8: % cbr for Min_R node_number 14

9. Node Number 15

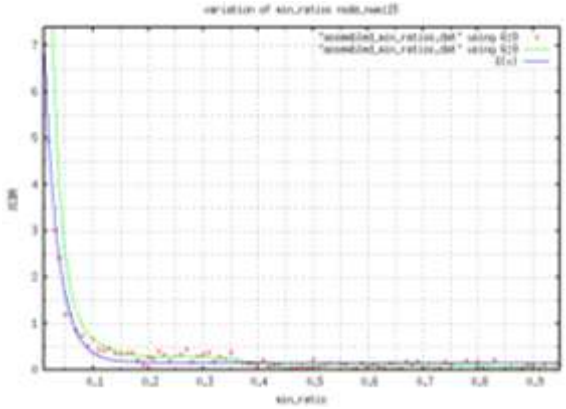

Figure 9: % cbr for Min_R node_number 15

10. Node Number 16

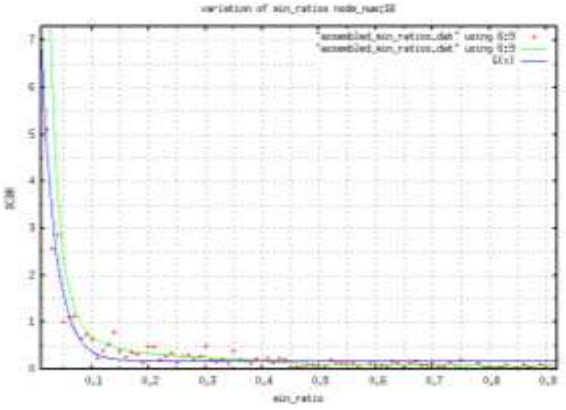

Figure 10: % cbr for Min_R node_number 16

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11. Node Number 17

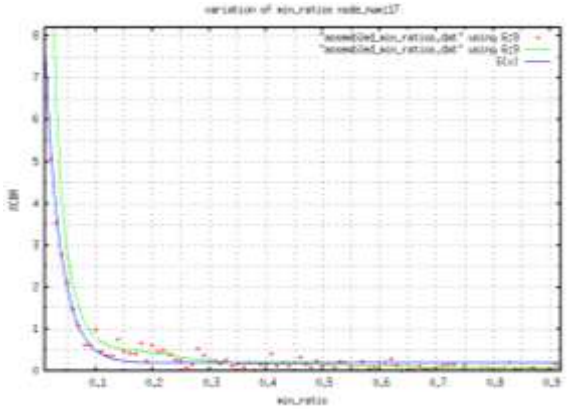

Figure 11: % cbr for Min_R node_number 17

12. Node Number 18

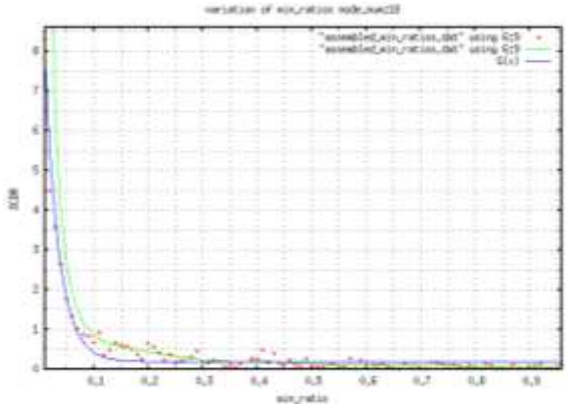

Figure 12: % cbr for Min_R node_number 18

13. Node Number 19

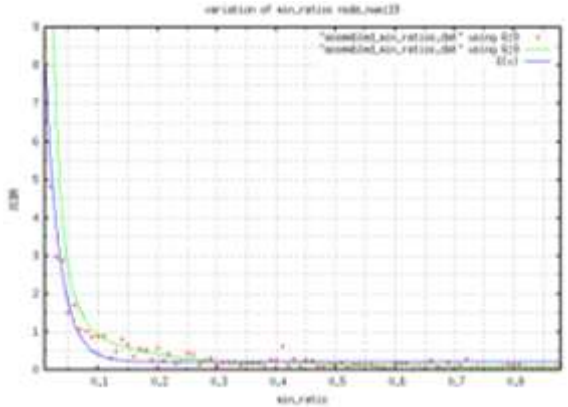

Figure 13: % cbr for Min_R node_number 19

14. Node Number 20

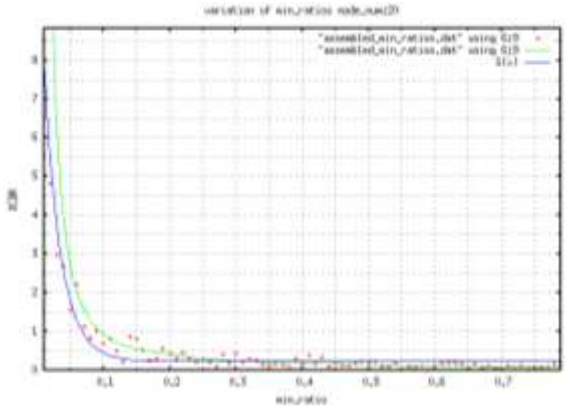

Figure 14: % cbr for Min_R node_number 20

15. Node Number 21

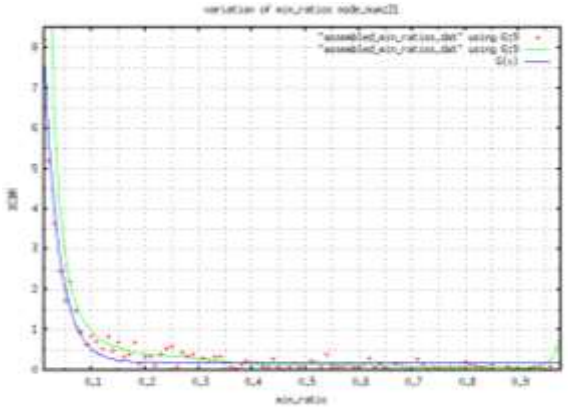

Figure 15: % cbr for Min_R node_number 21

16. Node Number 22

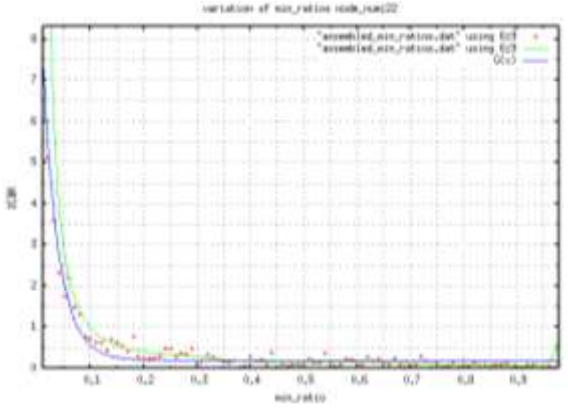

Figure 16: % cbr for Min_R node_number 22

17. Node Number 23

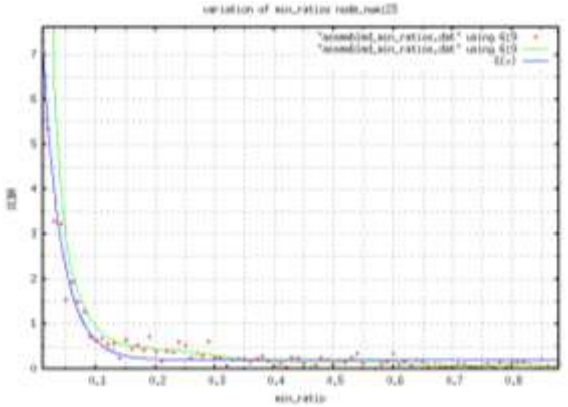

Figure 17: % cbr for Min_R node_number 23

18. Node Number 24

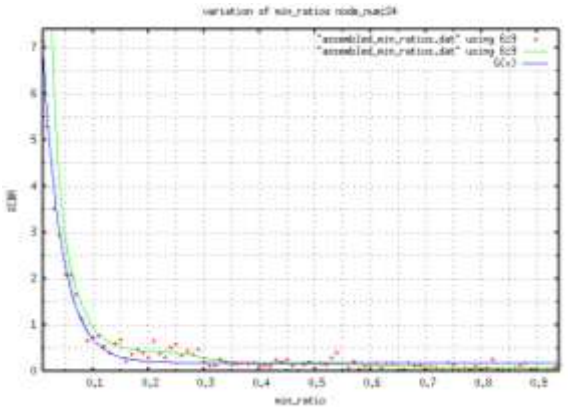

Figure 18: % cbr for Min_R node_number 24

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19. Node Number 25

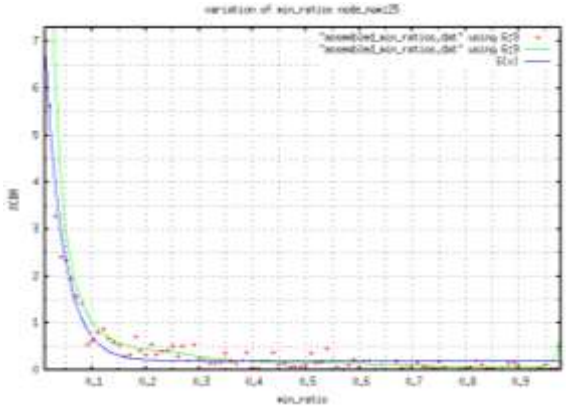

Figure 19: % cbr for Min_R node_number 25

20. Node Number 26

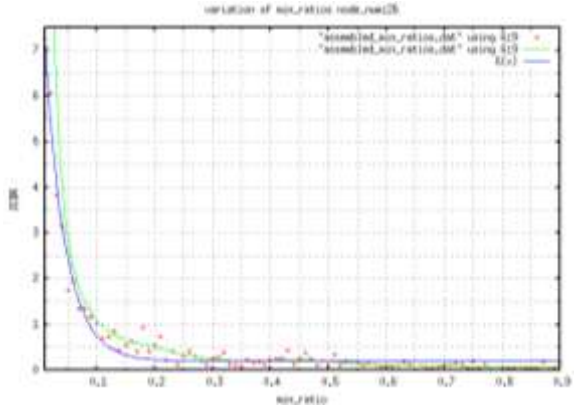

Figure 20: % cbr for Min_R node_number 26

21. Node Number 27

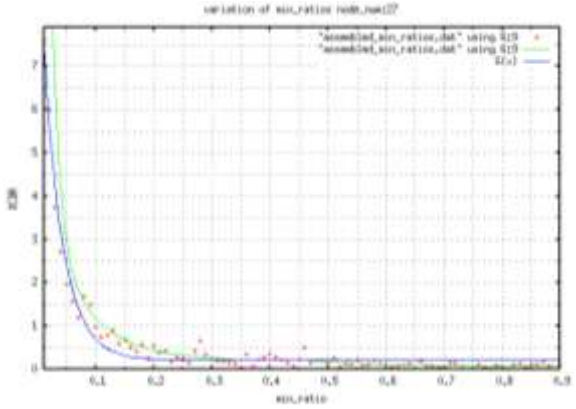

Figure 21: % cbr for Min_R node_number 27

22. Node Number 28

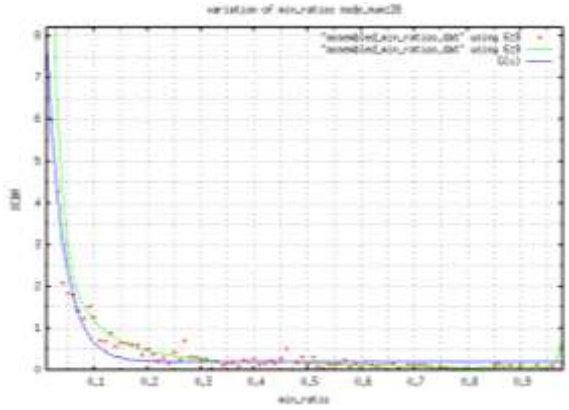

Figure 22: % cbr for Min_R node_number 28

23. Node Number 29

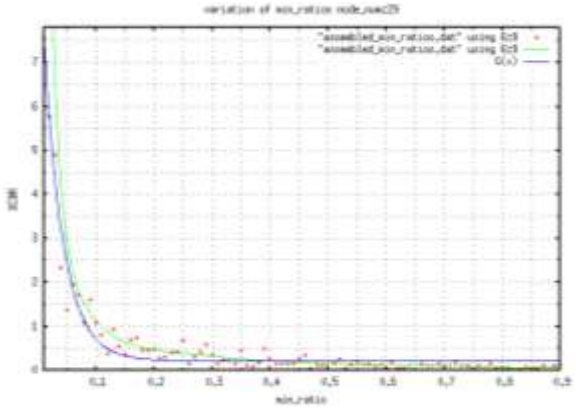

Figure 23: % cbr for Min_R node_number 29

24. Node Number 30

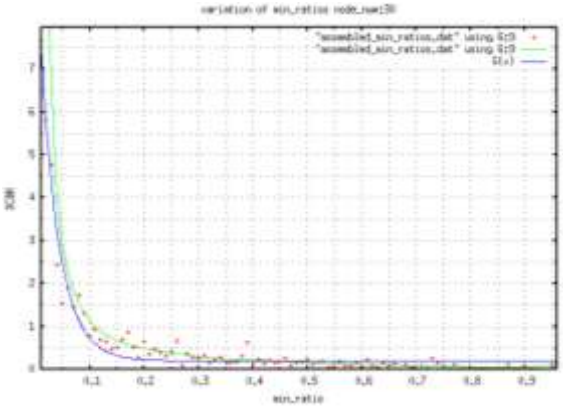

Figure 24: % cbr for Min_R node_number 30

25. Node Number 31

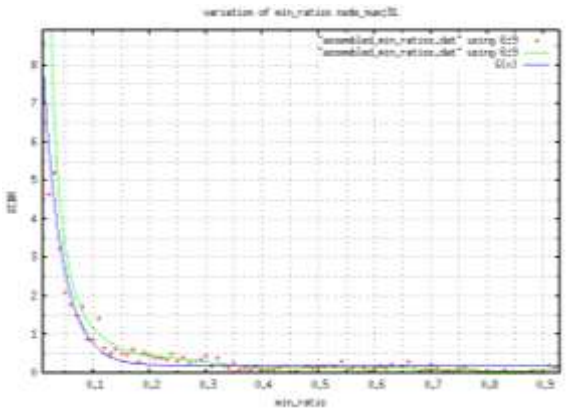

Figure 25: % cbr for Min_R node_number 31

26. Node Number 32

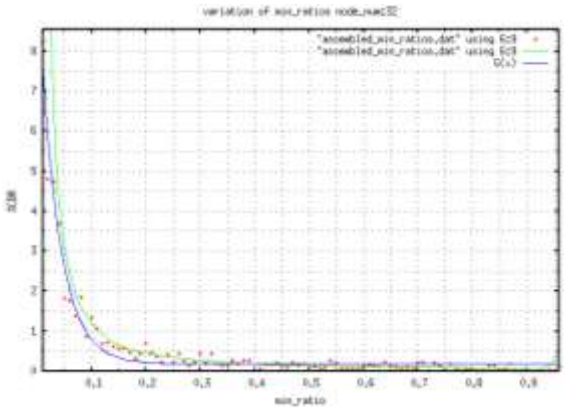

Figure 26: % cbr for Min_R node_number 32

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27. Node Number 33

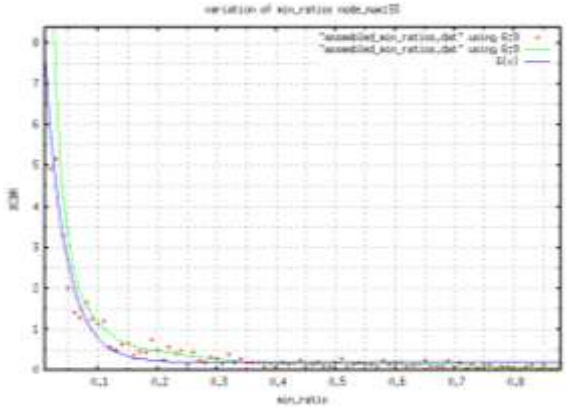

Figure 27: % cbr for Min_R node_number 33

28. Node Number 34

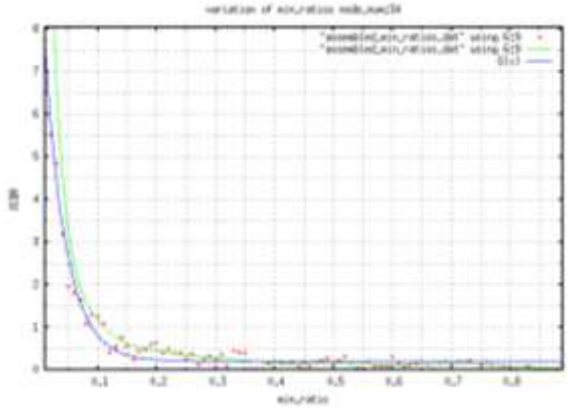

Figure 28: % cbr for Min_R node_number 34

29. Node Number 35

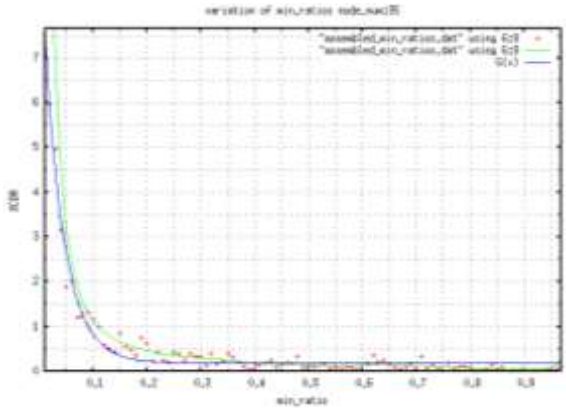

Figure 29: % cbr for Min_R node_number 35

30. Node Number 36

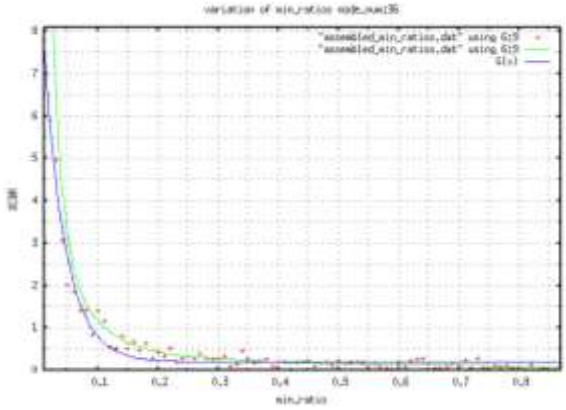

Figure 30: % cbr for Min_R node_number 36

31. Node Number 37

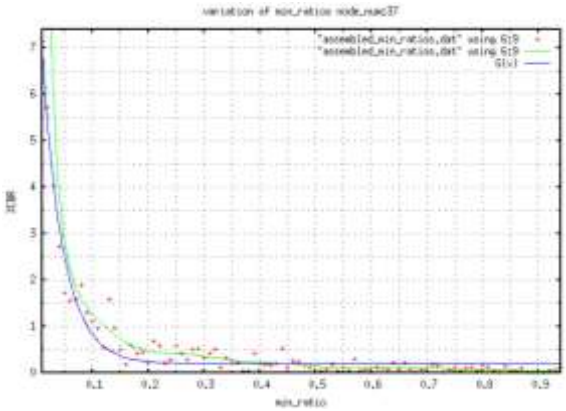

Figure 31: % cbr for Min_R node_number 37

32. Node Number 38

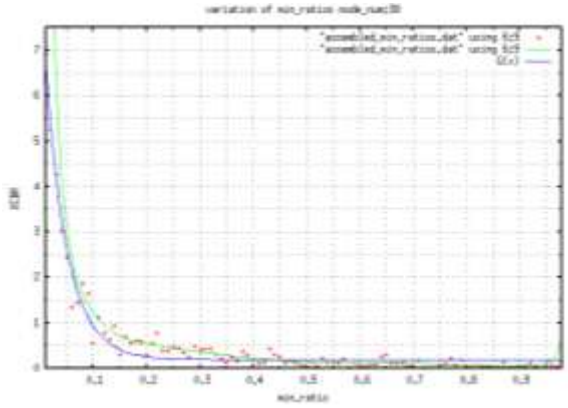

Figure 32: % cbr for Min_R node_number 38

33. Node Number 39

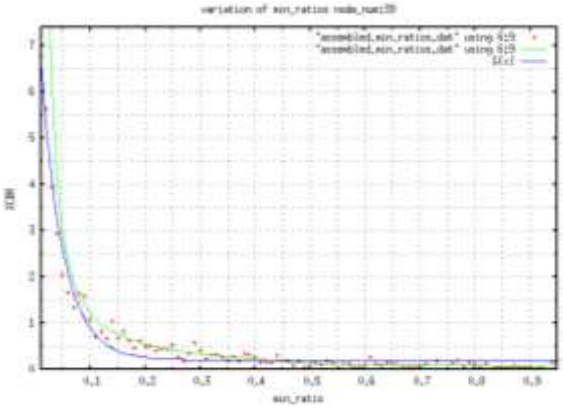

Figure 33: % cbr for Min_R node_number 39

34. Node Number 40

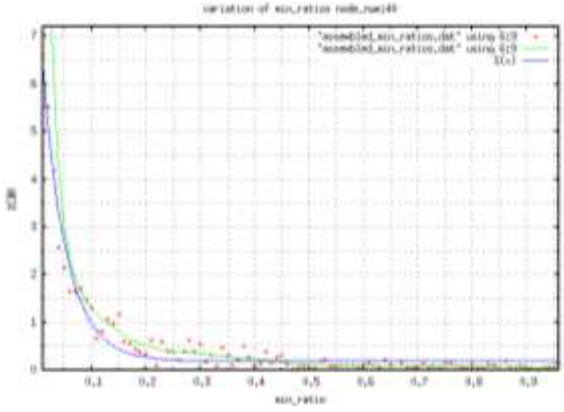

Figure 34: % cbr for Min_R node_number 40

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35. Node Number 41

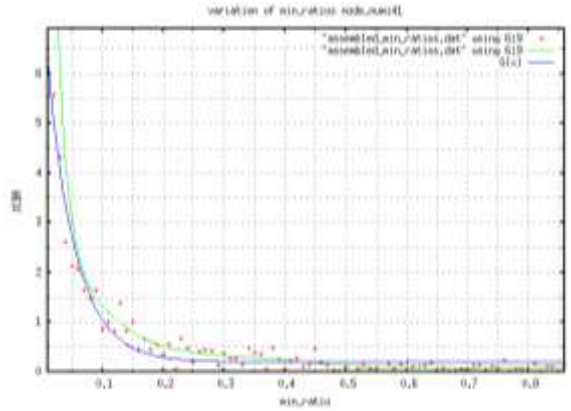

Figure 35: % cbr for Min_R node_number 41

36. Node Number 42

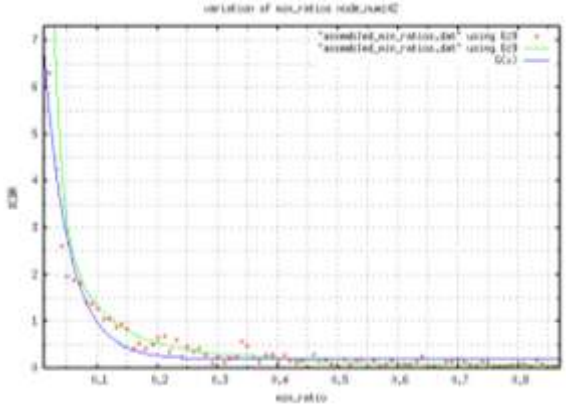

Figure 36: % cbr for Min_R node_number 42

37. Node Number 43

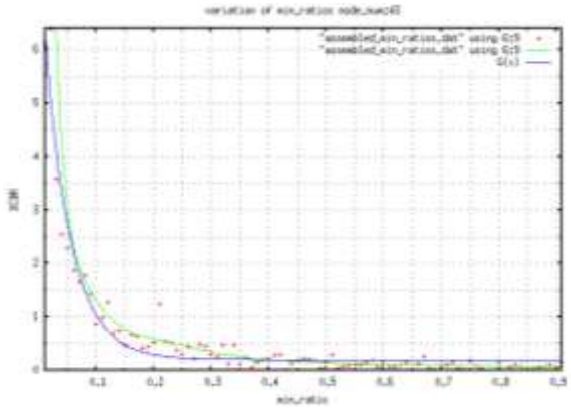

Figure 37: % cbr for Min_R node_number 43

38. Node Number 44

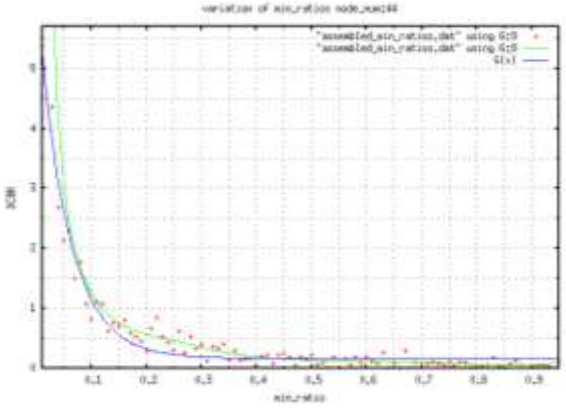

Figure 38: % cbr for Min_R node_number 44

39. Node Number 45

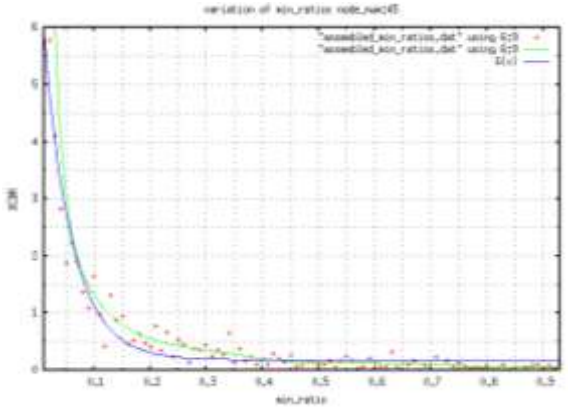

Figure 39: % cbr for Min_R node_number 45

40. Node Number 46

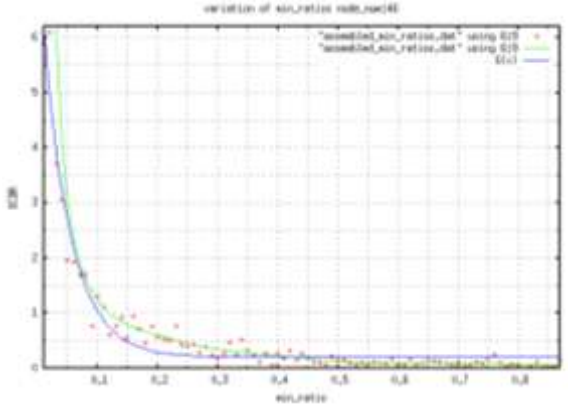

Figure 40: % cbr for Min_R node_number 46

41. Node Number 47

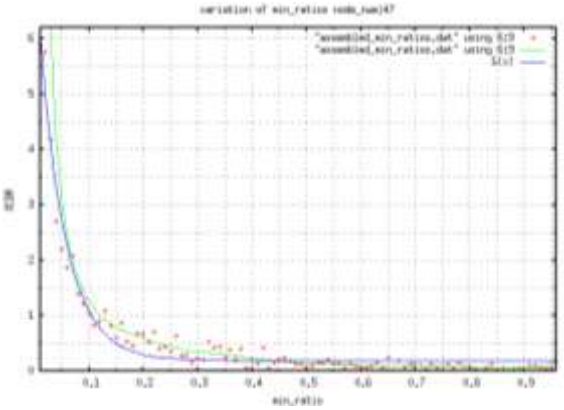

Figure 41: % cbr for Min_R node_number 47

42. Node Number 48

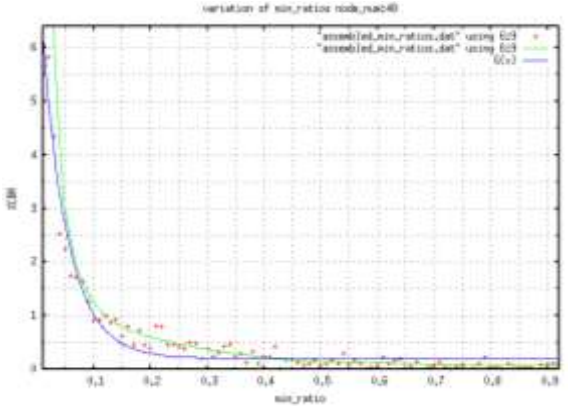

Figure 42: % cbr for Min_R node_number 48

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43. Node Number 49

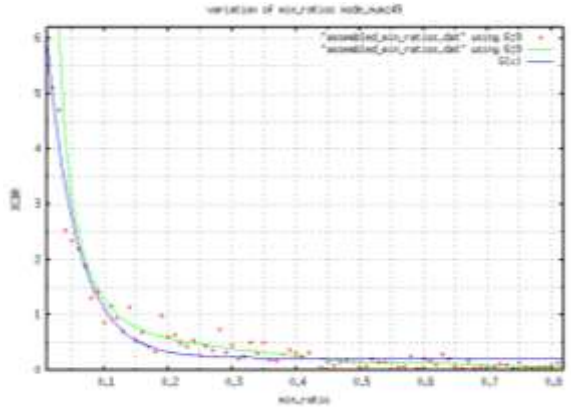

Figure 43: % cbr for Min_R node_number 49

44. Node Number 50

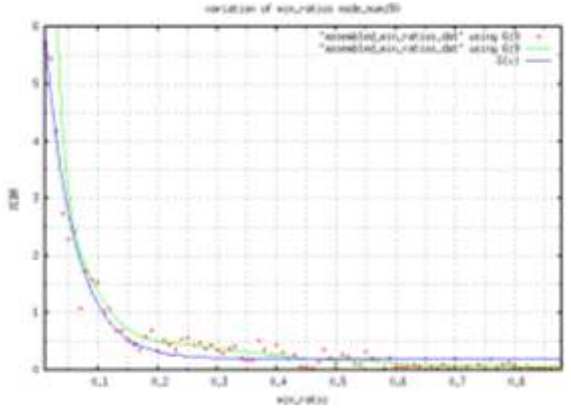

Figure 44: % cbr for Min_R node_number 50

45. Node Number 51

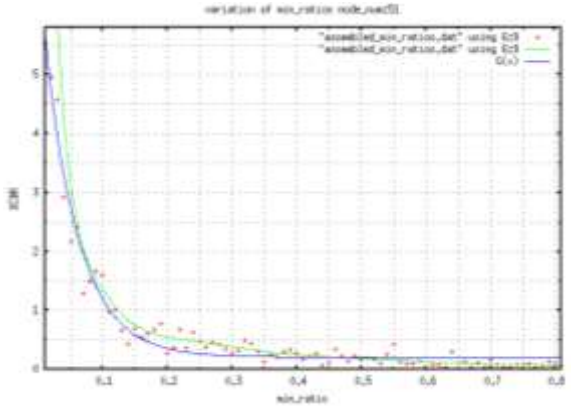

Figure 45: % cbr for Min_R node_number 51

46. Node Number 52

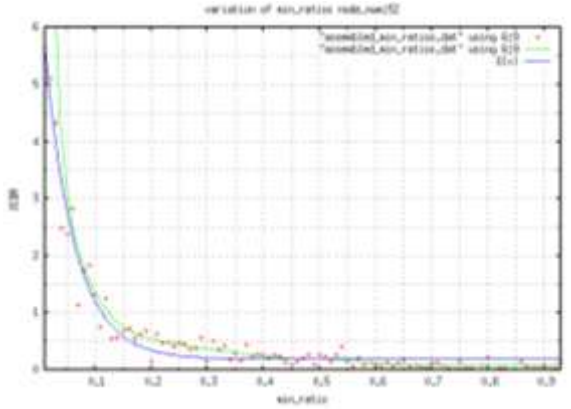

Figure 46: % cbr for Min_R node_number 52

47. Node Number 53

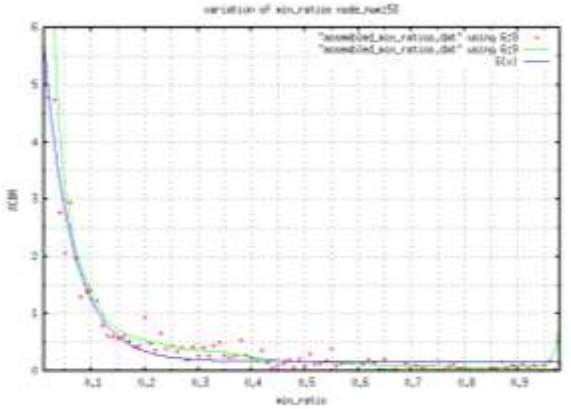

Figure 47: % cbr for Min_R node_number 53

48. Node Number 54

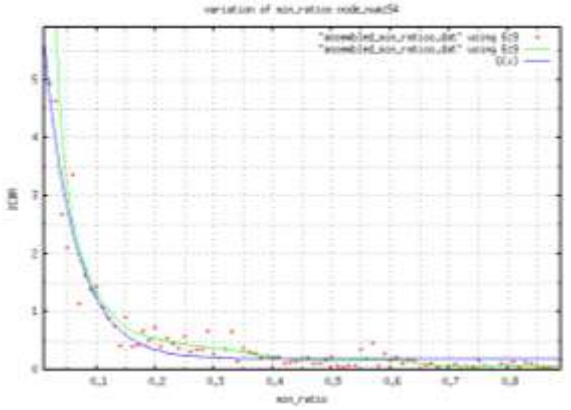

Figure 48: % cbr for Min_R node_number 54

49. Node Number 55

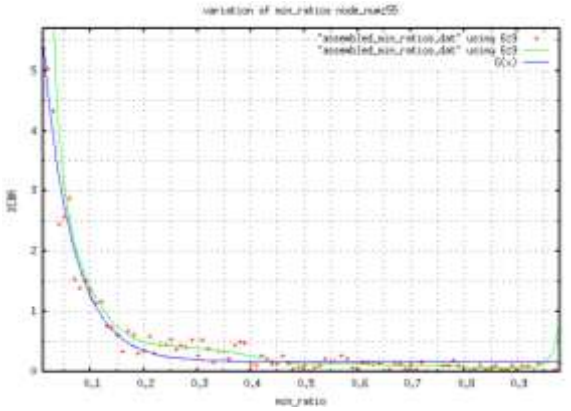

Figure 49: % cbr for Min_R node_number 55

50. Node Number 56

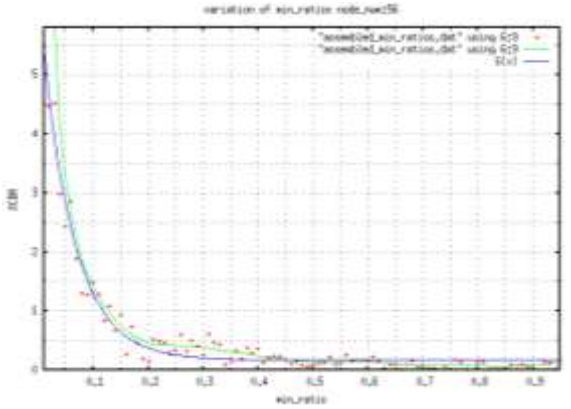

Figure 50: % cbr for Min_R node_number 56

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4. Conclusion.

This piece of research was aimed at developing one method towards studying Fairness reachable in energy consumption by nodes participating in a MANET transmission, in a topography of 300 x 300 m^2. For this purpose, one metric, Min_R, was derived from another previously explained metric, ECR [18]. The trend for metric Min_R has also been put forward. This research remains empirical based and was implemented over same experiment as explained in another paper [15]. The model put forward is the exponential model. Here, again, several components are assumed as available even if they remain subjects of research, e.g. lightweight algorithms for location-aware transmission in mobile environments, lightweight MAUC OS support for efficient and very rapid binding/unbindings of MANET nodes and appropriate multi-threading/parallel communication in modules of MANET nodes.

The further works identified may include: trend analyses of parameters of equation for the model, formulating method of predictability for metric Min_R and its trend and reporting observations of certain critical values identified. Other research avenues remain development of other metrics for assessing fairness in energy expenditure of participating nodes in MANET transmission, together with the trend analyses.

References

[1] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Towards Dependable Pervasive Systems-A Position and Vision Paper, CEET 2014

[2] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Node-to-Node Transmission in UbiComp , CEET 2014

[3] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Node-to-Node Transmission in UbiComp Using Location Refresh Intervals, CEET 2014

[4] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Transmission in UbiComp Using Relays, CEET 2014

[5] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Mathematical modeling of need of exact number of relays to ensure seamless mobility in mobile computing, CEET 2014

[6] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Modelling of need for multiple relays for ensuring seamless mobility, CEET 2014

[7] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Investigation of prominence of placements of relays in a ubicomp topography,

[8] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of energy savings achievable with location-aware transmission in ubicomp using optimised number of relays.

[9] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Investigation of Prominence of Placements of Optimised Number of Relays in a Ubicomp Topography using Location-Aware Transmission, CEET 2015.

[10] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Extending Node Battery Availability in Ubicomp with Location-Aware Transmission, CEET 2015.

[11] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Extending Node Battery Availability in Ubicomp with Location-Aware Transmission using Location Refresh Intervals, CEET 2015.

[12] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Extending Node Battery Availability in Ubicomp with Location-Aware Transmission using Uniformly Placed Relays, CEET 2015.

[13] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Extending Node Battery Availability in Ubicomp with Location-Aware Transmission Using Optimally Placed Relays, CEET 2015.

[14] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Sender Node Energy Savings Achievable with Location-Aware MANET Transmission in Ubicomp, ACCN 2016

[15] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Overall Node Energy Savings Achievable with Location-Aware MANET Transmission in Ubicomp, ACCN 2016

[16] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Sender Node Extra Energy Savings Achievable in MANET Against Direct Node-to-Node Transmission Using Location-Aware Transmission in Ubicomp, ACCN 2016

[17] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Overall Node Extra Energy Savings Achievable in MANET against Direct Node-to-Node Transmission Using Location-Aware Transmission in Ubicomp, ACCN 2016

[18] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Consumption Ratio Achievable in MANET Using Location-Aware Transmission in Ubicomp, ACCN 2016

[19] Markus Bylund and Zary Segall, Towards seamless mobility with personal servers, 2004.

[20] Masugi Inoue, Mikio Hasegawa, Nobuo Ryoki and Hiroyuki Morikawa, Context-Based Seamless Network and Application Control, 2004

[21] Xiang Song, Umakishore Ramachandran, MobiGo: A Middleware for Seamless Mobility, College of Computing Georgia Institute of Technology, Atlanta, GA, USA, August 2007

[22] Budzisz, Ferrús, R., Brunstrom A., Grinnemo, K, Fracchia, R., Galante, G., and Casadevall, F. Towards transport-layer mobility: Evolution of SCTP multihoming, March 2008

[23] Paul Dourish & Genevieve Bell, Divining a digital future, 2011.

[24] Xiang Song, Seamless Mobility In Ubiquitous Computing Environments, PhD Thesis, Georgia Institute of Technology, August 2008

[25] Kevin O Mahony, Jian Liang, Kieran Delaney, User-Centric Personalization and Autonomous Reconfiguration Across Ubiquitous Computing Environments, NIMBUS Centre Cork Institute of Technology, Cork, Ireland, UBICOMM 2012

[26] Pablo Vidales, Seamless mobility in 4G systems, *Technical Report, University of Cambridge*, Computer Laboratory, Number 656, November 2005

[27] João Pedro Sousa and David Garlan, Aura: An Architectural Framework for User Mobility in Ubiquitous Computing Environments, School of Computer Science, Carnegie Mellon University, USA, *August 2002*

[28] Dennis Lupiana, Ciaran O'Driscoll, Fredrick Mtenzi, Defining Smart Space in the Context of Ubiquitous Computing, Dublin Institute of Technology, Ireland, Special Issue on ICIT 2009 Conference - Web and Agent Systems, 2009

[29] N.S.V.Shet1, Prof.K.Chandrasekaran2 and Prof. K.C.Shet3, *WAP Based Seamless Roaming In Urban Environment with*

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Wise Handoff Technique, International Journal of UbiComp (IJU), Vol.1, No.4, October 2010

[30] Yipeng Yu Dan He Weidong Hua Shijian Li Yu Qi Yueming Wang Gang Pan, FlyingBuddy2: A Brain-controlledAssistant for the Handicapped, Zhejiang University, *UbiComp'12,* September 5-8, 2012.

[31] Jing Su, James Scott, Pan Hui, Jon Crowcroft, Eyal de Lara Christophe Diot, Ashvin Goel, Meng How Lim, and Eben Upton, Haggle: Seamless Networking for Mobile Applications, 2007

[32] Rui Han, Moustafa M. Ghanem, Li Guo, Yike Guo∗, Michelle Osmond, Enabling cost-aware and adaptive elasticity of multi-tier cloud applications, Future Generation Computer Systems, 2012

[33] Byrav Ramamurthy, K. K. Ramakrishnan , Rakesh K. Sinha, Cost and Reliability Considerations in Designing the Next-Generation IP over WDM Backbone Networks, 2012.

[34] Bhavish Aggarwal, Aditya Akella, Ashok Anand, Athula Balachandran, Pushkar Chitnis, Chitra Muthukrishnan, Ram Ramjee and George Varghese, EndRE: An End-System Redundancy Elimination Service for Enterprises, NSDI 2010, San Jose, CA

[35] Ashok Anand, Vyas Sekar and Aditya Akella, SmartRE: An Architecture for Coordinated Network-wide Redundancy Elimination, SIGCOMM 2009, Barcelona, Spain

[36] John Breeden II, "Smart-phone battery life could double – without better batteries", Nov 14, 2012

[37] Andy Boxall, "When will your phone battery last as long as your kindle", December 5, 2012.

[38] Imielinski, T. and Navas, J.C. (1999). GPS-based geographic addressing, routing, and resource discovery. *Comms. ACM*, Vol. 42, No. 4, pp. 86-92.

[39] Hightower, J. and Borriello, G. (2001). Location Systems for Ubiquitous Computing. *IEEE Computer*, Vol. 34, No. 8, August, pp. 57-66.

[40] Harter, A., Hopper, A., Steggles, P., Ward, A. and Webster, P. (2002). The Anatomy of a Context-Aware Application. Wireless Networks, Vol. 8, No. 2-3, Mar-May, pp. 187-197.

[41] Hightower, J., Brumitt, B. and Borriello, G. (2002). The Location Stack: A Layered Model for Location in Ubiquitous Computing. *Proceedings of the 4th IEEE Workshop on Mobile Computing Systems & Applications (WMCSA 2002)*, Callicoon, NY, USA, June, pp. 22-28.

[42] Graumann, D., Lara, W., Hightower, J. and Borriello, G. (2003). Real-world implementation of the Location Stack: The Universal Location Framework. *Proceedings of the 5th IEEE Workshop on Mobile Computing Systems & Applications (WMCSA 2003)*, Monterey, CA, USA, October, pp. 122-128.

[43] Ko, Y., & Vaidya, N. H. (2000). Location-aided routing (LAR) in mobile ad hoc networks. *Wireless Networks*, *6*(4), 307-321.

[44] Liao, W.-H., Tseng, Y.-C., & Sheu, J.-P. (2001). GRID: a fully location-aware routing protocol for mobile ad hoc networks. *Telecommunication Systems*, *18*(1), 37-60.

[45] Kuhn, F., Wattenhofer, R., Zhang, Y., & Zollinger, A. (2003). Geometric ad-hoc routing: of theory and practice. In *Proceedings of the ACM (PODC'03)* (pp. 63-72).

[46] Jiang, X., & Camp, T. (2002). Review of geocasting protocols for a mobile ad hoc network. In Proceedings of the *Grace Hopper Celebration (GHC)*.

[47] Ko, Y. & Vaidya, N. H. (1999). Geocasting in mobile ad hoc networks: location-based multicast algorithms. In *Proceedings of the IEEE (WMCSA'99)* (pp. 101).

[48] Mauve, M., Fuler, H., Widmer, J., & Lang, T. (2003). *Position-based multicast routing for mobile ad-hoc networks* (Technical Report TR-03-004). Department of Computer Science, University of Mannheim.

[49] Xu, Y., Heidemann, J., & Estrin, D. (2001). Geography-informed energy conservation for adhoc routing. In *Proceedings of the ACM/IEEE (MOBICOM'01)* (pp. 70-84).

[50] Hu, Y.-C., Perrig, A., & Johnson, D. (2003). Packet leashes: a defense against wormhole attacks in wireless ad hoc networks. In *Proceedings of the INFOCOM' 03* (pp. 1976-1986).

[51] Patwari, N., Hero III, A. O., Perkins, M., Correal, N. S., & O'Dea, R. J. (2003). Relative location estimation in wireless sensor networks. *IEEE Transactions on Signal Processing*, *51*(8), 2137-2148.

[52] Baldauf, M., Dustdar, S., & Rosenberg, F. (2007). A Survey on Context Aware Systems. *International Journal of Ad Hoc and Ubiquitous Computing*, Inderscience Publishers. forthcoming. Pre-print from: http://www.vitalab.tuwien.ac.at/~florian/ papers/ijahuc2007.pdf

[53] Hong, D., Chiu, D.K.W., & Shen, V.Y. (2005). Requirements elicitation for the design of context-aware applications in a ubiquitous environment. In *Proceedings of ICEC'05* (pp. 590-596).

[54] Neeraj Tantubay, Dinesh Ratan Gautam and Mukesh Kumar Dhariwal, A Review of Power Conservation in Wireless Mobile Ad hoc Network (MANET)", International Journal of computer Science Issues, Vol 8, Issue 4, No 1, July 2011.

[55] Wenrui Zhao, Mostafa Ammar and Ellen Zegura, "A Message Ferrying Approach for Data Delivery in Sparse Mobile Ad Hoc Networks", *MobiHoc'04,* May 24–26, 2004, Roppongi, Japan.

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