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Trend Analyses of Parameters of Equations for Maximum Fairness Proportion Achievable in Ubicomp MANETs Using Location-Aware Transmission.

M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY

Abstract **– Research concerning control of energy consumption in ubicomp is deeply ongoing and MANET transmission is also forebode in assisting in this strategy [75]. The fact remains that this field is not yet fully established and hence notions of modelling in ubicomp are still poorly existent. Control on energy expenditure in ubicomp is essential due to present hardware level of constrained battery power. A prior study was undertaken [24] to quantify and model the Maximum Fairness Proportion (Max_FP) achievable for CBRs for node densities of 7 until 56. The corresponding model was described as combining linear and exponential trends.**

In this paper, the successive level of probing is laid as: "What are the trends of variation observable within each parameter of the equations of curves obtained for metric Max_FP [24] over varying node densities?"

It is recommended that the behaviour of each component of suitable models for metric Max_FP be understood in form of mathematical equations before embarking seriously on predictability features. This endeavour will be tough since it will consume lots of effort and involve disagreements between researchers. The outcome generated in this paper will assist ubicomp researchers in more fruitful understanding of MANET features and develop algorithmic support for proper energy management in ubicomp architectures. It may eventuate significantly different battery design and surrogate devices needed. This paper is a follow-up of previous work [1-39].

Key terms: Ubicomp- Ubiquitous Computing, MAUC- Mobile and Ubiquitous Computing, MANET- Mobile Adhoc Network, CBR- Constant Bit Rate, Max_FP- Maximum Fairness Proportion.

M. Kaleem GALAMALI,
University of Technology Mauritius (student)
Mauritius
mkaleemg@gmail.com

Assoc. Prof Nawaz Mohamudally
University of Technology Mauritius,
Mauritius
alimohamudally@umail.utm.ac.mu

1. Introduction

The amount of resources installed in ubicomp environments may be quite sparse and this can vary from one environment to another. In such situations, MANET transmission strategies are venerated as the befitting solutions. In MANETs, due to transmission load division, the criteria of Fairness must be well delimited. Among the different angles of studying Fairness, the study of existing metrics and development of new metrics remain promising. One such endeavour was made [24], whereby the patterns of metric Max_FP were illustrated as split into two:

- Previous to a peak value, the linear tendency is observed of form:
  $F(x) = d * x + f$
- From the peak value onwards, the decreasing exponential trend is observed of form:
  $G(x) = a * \exp(b * (x - k)) + c$

Here, the equations of the model have implicated 6 parameters: a, b, c, d, f and k. The next study called for metric Max_FP is the formulation of model equations for the parameters of the equation mentioned above.

The key contributions of this paper is the development of the trend of variation for each parameter of the equations involved in the model for metric Max_FP presented in a prior study [24], from which Tables 1(a) and 1(b) are re-utilised here.

The mathematical procedures expounded here may be programmed into software simulators, thus entailing a utility for designers to more assiduously study the progression and predictability of ubicomp features and hence more accurately provision for future ubicomp architecture. The rest of this paper is organised as follows: section 2- Parameter Trend Analysis- Metric Max_FP, section 3- Conclusion and References.

2. Parameter Trend Analysis – Metric Min_FP.

2.0 General Procedure Adopted.

The tabulated data for each parameter of the equations for the model for Max_FP is plotted on gnuplot. Then the procedure for undertaking graphical analyses and reporting general observations is undertaken. The successive step is to investigate the applicability of certain hypothetical equations of fit. Criterion for best fit has been value of least reduced chi-square for all parameters. For parameters c and d, additional criterion

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of best extendability at node number 100 is applied. The values of parameters for each max_FP parameter of equation is jotted down.

2.1 Trend Analysis – Max_FP parameter "a".

Generally the curve depicts a decreasing tendency at a decreasing rate. The curve however does not yet show asymptotic flattening.

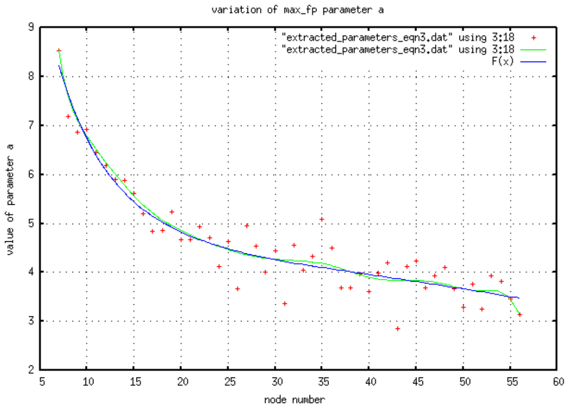

Figure 1: Max_FP parameter a

The potentially applicable equations are:

1. $F(x) = (a * \exp((b * x) + c)) + d$
   Ch_sq = 0.164 722
2. $F(x) = (a*x)/(\exp((b * x)+c)) + d)$
   Ch_sq = 0.152 416
3. $F(x) = ((a*x)+f)/(\exp((b*x)+c))+d)$
   Ch_sq = 0.152 071
4. $F(x)=((a*x^2)+f)/(\exp((b*x)+c))+d)$
   Ch_sq = 0.150 301

Choice of best fit for Max_FP parameter a

The equation in part 4 above has been selected because of both smallest reduced chi-square value obtained. The parameters for best fit are:

a = 0.003 745 2 , b = 0.035 143 9 , c = -0.460 414 , d = -0.530 751 , f = 2.089 1

2.2 Trend Analysis – Max_FP parameter "b".

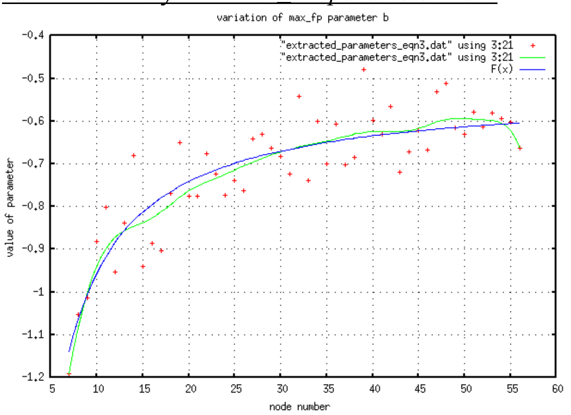

Figure 2: Max_FP parameter b

Generally, the curve depicts an increasing an increasing trend at a decreasing rate. No significant oscillation is found here. The potentially applicable equations of trend are:

1. $F(x) = a * \exp(b * x) + c$
   Ch_sq = 0.005 064 35
2. $F(x) = (a/x) * \exp(b*(x + c))+d$
   Ch_sq = 0.004 930 07

Choice of best fit for Max_P parameter b

The equation in part 2 above has been selected because it has smallest ch_sq value. Parameters for best fit are:

a = -4.286 16 , b = -0.002 206 67 , c = 0.011 805 3 , d = -0.536 591

2.3 Trend Analysis – Max_FP parameter "c".

The plots are very scattered. However the smooth bezier plot depicts a linear trend of very small gradient.

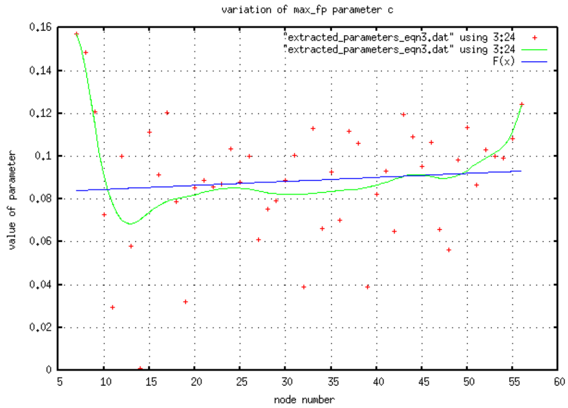

Figure 3: Max_FP parameter c

The potentially applicable equations of trend are:

1. $F(x) = d * x^2 + f * x + g$
   Ch_sq = 0.000
   Projection for F(100) is not good!
2. $F(x) = d * x^2 + f$
   Ch_sq = 0.000 856 657
   Projection for F(100) is better than part 1 above.
3. $F(x) = d * x + f$
   Ch_sq = 0.000
   Projection for F(100) and beyond is much more stable.

Choice of best fit for Max_P parameter c

The equation in part 3 above has been selected because it has best extendability even if its ch_sq value is not least. The parameters for best fit are:

d = 0.000 187 397 , f = 0.082 616 4

2.4 Trend Analysis – Max_FP parameter "d".

Generally the curve depicts a decreasing tendency at a decreasing rate. This is characteristic of inverse logarithmic behaviour. The plot at node number 7 appears as an outlier.

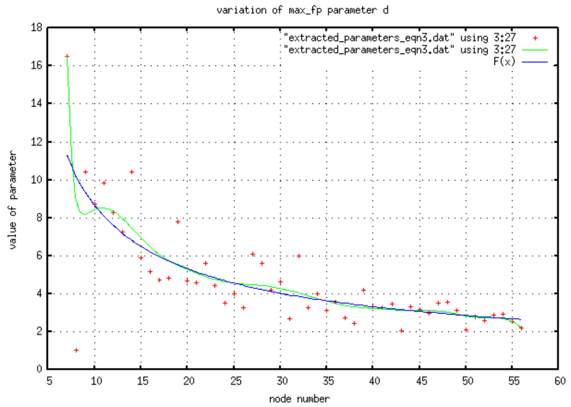

Figure 4: Max_FP parameter d

The potentially applicable equations of trend are:

1. F(x) = a/(log (b * x) + c)

   Ch_sq = 3.503 63

   Expands well to F(100).

2. F(x) = (a/x) * (log (b * x) + c)

   Ch_sq = 4.262 56

3. F(x) = $(a*x^{-0.5})$/(log (b * x) + c)

   Ch_sq = 3.412 29

   Expands well to F(100) = 1.812 741 194 673.

Choice of best fit for Max_P parameter d

The equation in part 3 above has been selected because of least ch_sq and good extendability. The parameters for best fit are: a = 3.412 29 , b = 8.239 13 , c = 0.045 317 9

2.5 Trend Analysis – Max_FP parameter "f".

Generally the curve depicts a small increasing tendency at a slowly decreasing rate. The plot at node number 7 appears as an outlier.

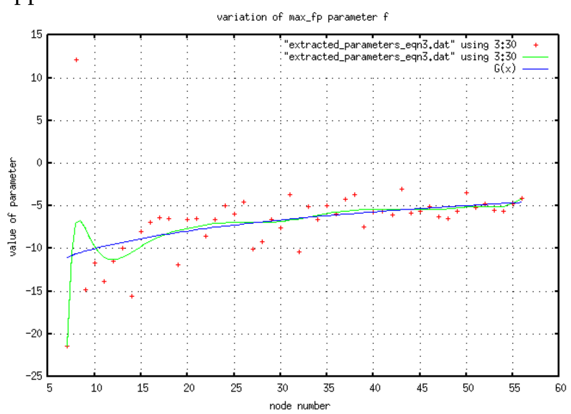

Figure 5: Max_FP parameter f

The applicable equation of trend is logarithmic:

F(x) = a * log ((b * x)+c) + d

Ch_sq = 18.002 1

The curve depicts good extendability feature.

The parameters for best fit are: a = 3.504 44 , b = 2.828 64 , c = 6.714 68 , d = -22.484 1

2.6 Trend Analysis – Max_FP parameter "k".

Generally, a linear increasing tendency is depicted here. The plots, however, remain quite scattered.

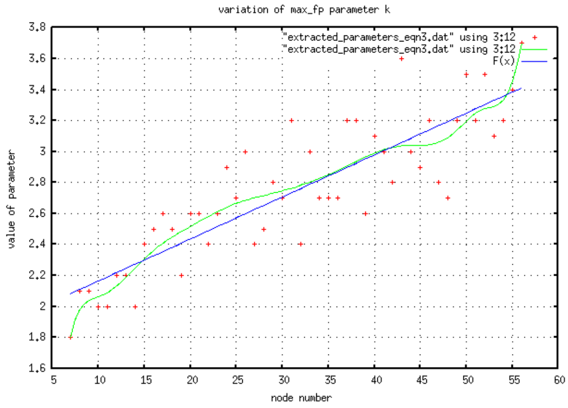

Figure 3: Max_FP parameter k

The applicable equation of trend has been linear:

F(x) = a * x + b

Ch_sq = 0.055

The parameters for best fit are: a = 0.027 082 8 , b = 1.894 89

3. Conclusion.

This research activity was intended to and has accomplished the establishment of applicable models of trends of the parameters of equations for the metric Max_FP in a MANET topography of 300 x 300 m^2. These models, put forward as equations of mathematical nature of varying complexity, will permit deeper study of MANETs for MAUC environments. Such development will entail the formulation of computational algorithms to be incorporated into simulators for more profound studies of MANETs. The experiment, whose output is reported in this paper, has been carried out in NS-2 over linux. The plottings and "fit" trials were conducted in gnuplot. Criteria for choosing best fit have been mostly value of least reduced chi-square and partly extendability offered at higher node number.

The reasonable assumptions put forward in a prior paper [24] are upheld in this paper also. Gnuplot is also assumed as convenient for this study.

Further work identified remain: formulating methods of predictability for metric Max_FP and its trend and reporting observations of certain critical values found.

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About Author (s):

Associate Professor Nawaz Mohamudally works at University of Technology, Mauritius (UTM) and has undertaken supervision of MPhil/PhD Students for many years.

M. Kaleem Galamali is a part-time student (achieved M Phil Transfer on 28.10.2014, currently PhD student) at UTM under supervision of A.P. Nawaz Mohamudally.

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