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

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Abstract **– Research and development proper to the control of energy consumption in ubicomp is well ongoing and also concerns MANET transmission [76]. It still is undisputed that this field is underdeveloped. Ubicomp hardware and battery power also are considered constrained. A recent study was conducted [25] to quantify and model the Sender Fairness Proportion (S_FP) achievable for CBRs for node densities of 7 until 56. The corresponding model was described as a combination of linear and exponential trends.**

In this paper, the successive plane of investigation is stated as: "What are the trends of variation observable within each parameter of the equations of curves obtained for metric S_FP [25] over varying node densities?"

It is advisable that the behaviour of each constituent of fitting models for metric S_FP be adequately learnt in form of mathematical notions. This will, in turn, assist studying in further predictability features. This exercise will be quite bulky and will necessitate lots of discord resolution within the research community. The outcome laid forward in this paper will aid ubicomp researchers in more prosperous development of MANET features and algorithmic support for energy management in ubicomp topographies. Such directions may yield significantly different battery designs and surrogate devices needed. This paper is a follow-up of previous work [1-40].

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

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1. Introduction

Ubicomp topographies may be meagrely equipped with networking devices. This degree of equipment may vary from one topography to another. In such circumstances, MANET transmission strategies are welcome as beneficial solutions. In MANETs, following transmission load division, the element of Fairness crops up. Many methods of studying Fairness are possible, including metrics development and analysis. Such a work was produced [25], in which the behaviour of metric S_FP was portrayed in two parts:

- Previous to the maximum point, the linear tendency is visible of form:
  `F(x) = d * x + f`
- As from the peak value onwards, the exponentially decreasing trend is visible of form:
  `G(x) = a * exp (b * (x-c))`

Here, the equations of the model have necessitated 5 parameters: a, b, c, d and f. the next clarification for metric S_FP required is the formulation of model equations for parameters of equations specified above.

The key contributions of this paper is the development of the trend of variation for each parameter of the equations included in the model for metric S_FP presented in a recent paper [25] from which tables 1(a) and 1(b) are re-employed here. The mathematical methods developed here, could be programmed into software simulators, giving a utility means for designers to more constructively investigate the evolution and predictability of ubicomp features, hence enabling the refinement of provisioning for future ubicomp architecture. The rest of this paper is organised as follows: section 2- Parameter Trend Analysis- Metric S_FP, section 3- Conclusion and References.

2. Parameter Trend Analysis – Metric Min_FP.

2.0 General Procedure Adopted.

The initial step is to plot the tabulated data for each parameter of the equations for the model for S_FP onto gnuplot. The following step is to undertake graphical analyses and relating the general observations reachable. The next step is to explore the applicability of selected hypothetical equations of fit. For all parameters, criterion for best fit is value of least reduced chi-square. The additional criterion for parameters b, c and d is most likely extendability at node numbers 80, 100 and 120. The last step is to write down the corresponding parameter values for each S_FP parameter equation.

2.1 Trend Analysis – S_FP parameter "a".

Generally, a straight line with a very small negative gradient is depicted. This is more convincing for plots as from node number 16 onwards. Previous to node number 16, the plots are quite scattered and show the possibility that if the "fit" command in gnuplot is reworked with different starting points, other parameter values are obtained, which may have greater conformance to the line obtained.

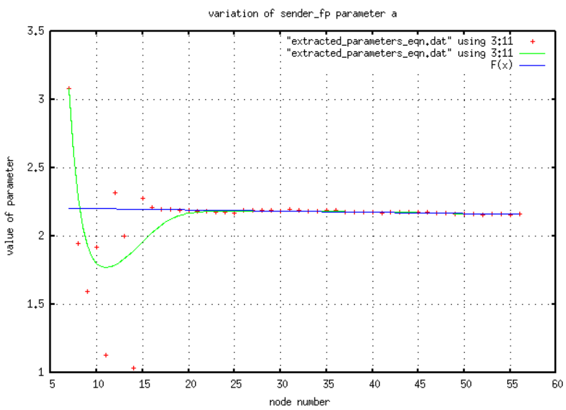

Figure 1: S_FP parameter a

The applicable equation here has been:

```
F(x) = d * x + f
```

Ch_sq = 4.316 08(e^{-06})

The parameters for best fit are: d = -0.000 901 722 , f = 2.211 14

2.2 Trend Analysis – S_FP parameter "b".

Generally the curve depicts a decreasing tendency at a decreasing rate. A slight oscillation is also visible but is not consistent throughout and is hence neglected. The y-axis intervals are also very small.

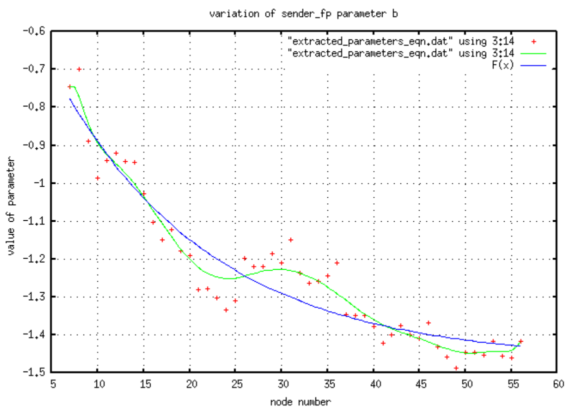

Figure 2: S_FP parameter b

The potentially applicable equations of trend are:

1. `F(x) = a * exp (b*( x - c)) + d`

   Ch_sq =0.004 322 37 F(80) = -1.458 667 2

   F(100) = -1.464 979 1 F(120)=-1.466 906 736

2. `F(x) = a*x * exp (b*(x - c))+d`

   Ch_sq = 0.004 705 4

3. `F(x) = a*x *exp (b*(x-c))+(d/x)`

   Ch_sq = 0.006

4. `F(x) = a * exp (b*(x-c))+(d/x)`

   Ch_sq = 0.003 688 71 F(80) = -1.614

   F(100) = -1.738 F(120) = -1.866

Choice of best fit for S_FP parameter b

The equation in part 1 above has been selected because of best extendability feature even if the reduced chi-square value obtained is not smallest. The parameters for best fit are:

a = 1.039 25 , b = -0.059 307 , c = 0.086 971 1 , d = -1.467 75

2.3 Trend Analysis – S_FP parameter "c".

Here also, an observation similar to that in section 2.1 is made. Mostly as from node number 16 onwards, a straight line is found. Similar observation as in section 2.1 applies here for node number previous to 16.

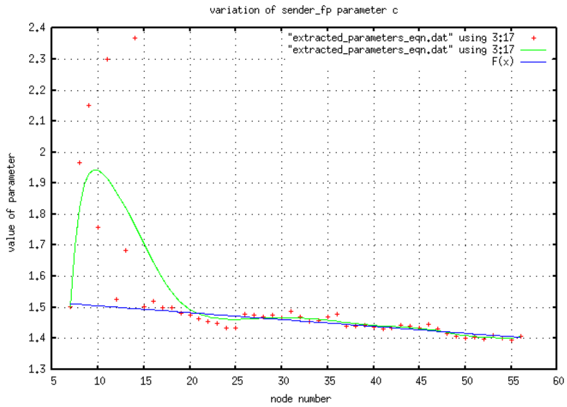

Figure 3: S_FP parameter c

The potentially applicable equations of trend are:

1. `F(x) = a * exp (b * (x-c)) + d`

   Ch_sq= 0.026 057 3 F(80)= 1.400 538 261

   F(100)= 1.400 084 988 F(120)=1.400 017 657

2. `F(x) = d * x + f`

   Ch_sq= 0.000 255 464 F(80) = 1.350 162 528

   F(100)=1.305 815 334 F(120) = 1.261 468 141

Choice of best fit for S_FP parameter c

The equation in part 2 above has been selected because of both smallest reduced chi-square value obtained. The parameters for best fit are:

d = -0.002 217 36 , f = 1.527 55

2.4 Trend Analysis – S_FP parameter "d".

The curve obtained here depicts an oscillation. However, the oscillation is not cleanly uniform nor symmetrical.

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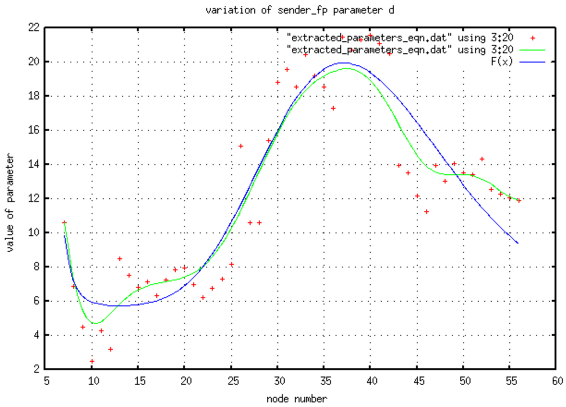

Figure 4: S_FP parameter d

The potentially applicable equations of trend are:

1. F(x) = (((a * x^f) + d)/(exp ((b * x) + c))) + g

   Ch_sq = 5.674 44

2. F(x) = (((a * x^f) + d)/(exp ((b * x^h) + c))) + g

   Ch_sq = 5.394 81 F(80) = 5.779 6

   F(100) = 5.701 685 5 F(120) = 5.700 189

Choice of best fit for S_FP parameter d

The equation in part 2 above has been selected because of both smallest reduced chi-square value obtained. The parameters for best fit are:

a = 5.219 74(e^{-24}) , b = 2.663 42 , c = -9.961 4 , d = 4.593 8 , f = 21.520 8 , g = 5.700 17 , h = 0.683 3

2.5 Trend Analysis – S_FP parameter "f".

The curve obtained here has a minimum point and a maximum point. The curve is not cleanly uniform nor symmetrical.

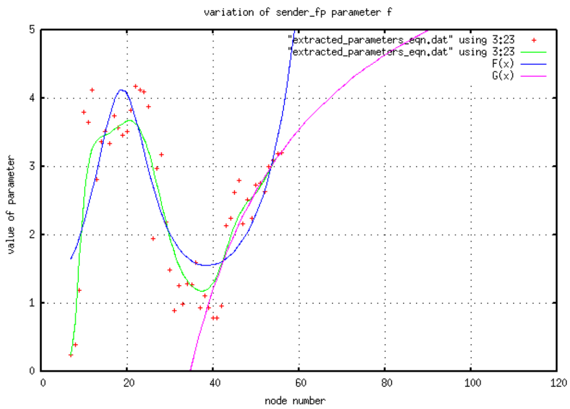

Figure 5: S_FP parameter f

The predictability equation has been broken into two.

i. For node number 7 till 50, the applicable equation is (appears in blue in soft copy)

   F(x) = (1/(a*x^f + d)) * (exp ((b*x^h) +c))

   Ch_sq = 0.548 29

   The parameters of fit are:

   a = 1.688 54 (e^{-10}) , b = 0.024 204 , c = -0.182 282 , d = 0.762 797 , f = 7.356 69, h = 1.459 38.

ii. For node number 50 onwards, the applicable equation is (purple in soft copy)

   G(x) = (i/log (k * x)) + l

   Ch_sq = 0.015 916 G(80) = 4.638 89

   G(100) = 5.291 61 G(120) = 5.735 37

   The parameters of fit are: i = -13.120 2 , k = 0.093 219 , l = 11.168 9

3. Conclusion.

This research endeavour was intended to and has achieved the development of applicable models of trends of the parameters of equations for the metric S_FP in a MANET topography of 300 x 300 m^2. The models detailed here are intrinsically mathematical, and of graded complexity levels. These will assist in more profound studies of MANETs for MAUC. Such development will lead towards the formulation of processing algorithms to be applied in simulators for more specific studies of MANETs. This experiment has been conducted in gnuplot. Criteria for selection of best fit have been mostly value of least reduced chi-square and partly best extendability at higher node numbers.

The fair assumptions put forward in a prior paper [25] are continued in this paper also. Gnuplot is also taken as suitable for the extent of this study.

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

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