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Trend Analyses of Parameters of Equations for Overall Node Energy Savings Achievable in ubicomp MANETs using Location-Aware Transmission.

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Abstract – **Location-Tracking and corresponding applications based on it together with modern functionalities are being developed in the field of ubicomp [31-67]. MANET transmission strategies also remain subject to research. The field of ubicomp, however, suffers from an underdeveloped area of metric development, analysis and modelling for predictability purposes compared to the current level of development in the field of software engineering. Such information in ubicomp will serve towards better gearing of future investments. An area of concern here is energy considerations in ubicomp since devices still suffer from constrained battery availability. A previous research [15] was carried out to assess how much energy savings can be achieved by overall nodes in location-aware MANET transmission and the corresponding trend was put forward as following a normal distribution model.**

In this paper, the next set of question to be investigated is legitimately put forward as: “What are the trends of variation observable within each parameter of the equation of normal curve obtained for metric OES [15] over varying node densities?”

The need for studying the behaviour of components of an applicable model for OES and successively model the behaviour of each component mathematically is felt required since it involves a lot of work. Results obtained may be used by designers to better predict ubicomp behaviour and formulate correspondingly better architectures. This paper is a follow-up of previous papers [1-30].

Key terms: Ubicomp- Ubiquitous Computing, MAUC-Mobile and Ubiquitous Computing, ES- Energy Savings, OES- Overall ES, MANET- Mobile Adhoc Network, CBR- Constant Bit Rate.

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1. Introduction

Many factors affect energy consumption in MAUC [2]. Still another factor is type of transmission whereby MANET transmission and successively node density become very significant. In a previous research [15], an attempt has been made through simulation experiments, to find a particular trend/model which depicts energy savings that can be reached by overall nodes in MAUC (OES) to rate the effectiveness of location-aware MANET transmission strategies compared to the theoretical/empirical models derived in simulations. The model put forward for metric OES was the normal distribution model of form:

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F(x)=b*(1/(a*sqrt(2*pi)))*exp(-(x-c)^2/2*a*a)
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Here also, the equation of the model comprises of three parameters: a, b and c. the next level of research is to study the mathematical modelling of the parameters of the equation obtained above and successively deriving the model of variation for each parameter.

The key contributions of this paper is the establishment of the trend of variation for each parameter of the equation of the normal distribution model for metric OES presented in previous paper [15] by using the same tabular data presented in that same paper, covering node numbers 7 until 56. Availability of such mathematical methods will certainly help designers to better understand the evolution and predictability of ubicomp behaviour in a manner that these methods may easily be implemented into a software program for future adaptability requirements of ubicomp following different situations observed. The rest of this paper is organised as follows: section 2- Parameter Trend Analysis- Metric OES, section 3- Conclusion and References.

2. Parameter Trend Analysis – Metric OES.

2.0 General Procedure Adopted.

The tabulated data for each parameter of equation of model for OES is plotted onto gnuplot over Linux. Graphical analyses using smooth bezier support and “fit” command is performed. General observations, for each such graph obtained is reported. Several equations of fit have been tried and a summary is reported for each OES parameter of equation. Ultimately, choice is made taking into consideration firstly the value of least reduced chi-square and secondly most plausible extendability produced at node numbers 80 and 100.

Finally, the values of parameters for each OES parameter of equation is also noted.

2.1 Trend Analysis – OES parameter "a".

Generally the curve depicts a decreasing tendency at a decreasing rate until about node number 36 after which the curve increases slowly. A slight oscillation or even damped oscillation is perceived but has been difficult to accommodate in an equation since high ch_sq value was being obtained.

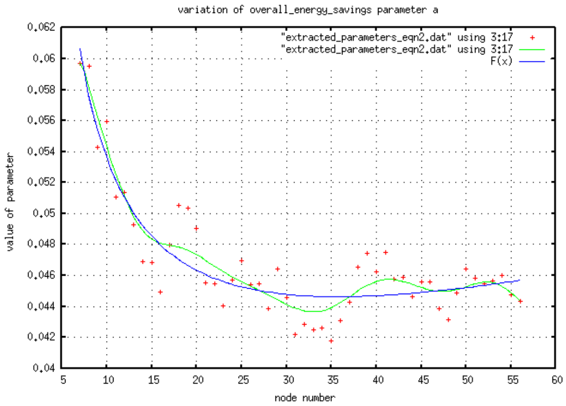

Figure 1: OES parameter a

The equation of best fit is

$F(x) = (a*\exp((b*x^{0.5})+c)+d)/(x^{0.5})+(f/x^{1.5})$

Ch_sq = 3.026 22(e^{-06}) F(80) = 0.048 245

F(100) = 0.050 803 58

The parameters of fit are:

a=0.145 884 , b=0.130 511 , c=0.104 894 , d=-0.091 087 6, f=0.158 455

2.2 Trend Analysis – OES parameter "b".

A similar curve for trend as for OES parameter "a" is observable here.

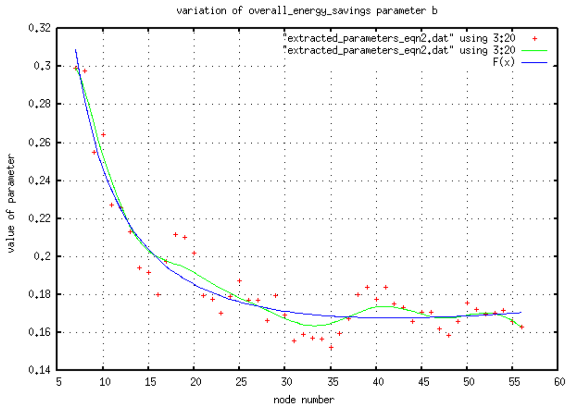

Figure 2: OES parameter b

The equation of best fit is

$F(x) = (a*\exp((b*x^{0.5})+c)+d)/(x^{0.5})+(f/x^{1.5})$

Ch_sq = 0.000 114 899 F(80) = 0.181 741 7

F(100) = 0.194 367

The parameters of best fit are:

a = 0.329 893 , b = 0.170 636 , c = 0.076 165 4 , d = -0.038 196 3 , f = 2.070 51.

2.3 Trend Analysis – OES parameter "c".

The curve obtained depicts a steady decrease at a decreasing rate. Again, a slight oscillation is noticed but it is difficult to work with.

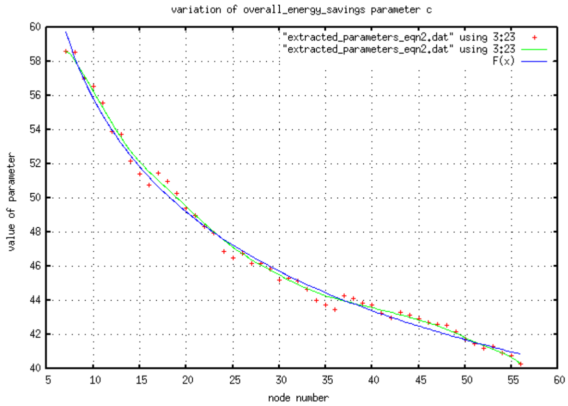

Figure 3: OES parameter c

The potentially applicable equations are:

1. $F(x) = d*x + f$

   Ch_sq = 2.676 46

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

   Ch_sq = 0.219 049 F(80) = 38.324 95

   F(100) = 36.824 916

Choice of best fit for OES parameter c

The equation in part 2 above has been selected because of smallest ch_sq and good extendability over larger node numbers. The parameters obtained for best fit are:

a = 840.388 , b= 802.688 , c= -37.590 9

3. Conclusion.

This piece of research was aimed at and has developed the models of trends of the parameters of equations for the metric OES in a MANET topography of 300 x 300 m^2. The models put forward have involved quite complicated mathematical equations and will assist in studying MANETs for MAUC environment from a software engineering perspective. The mathematical models can be mapped onto programming algorithms. The experiment was carried out in NS-2 over linux. The plottings and "fit" attempts were done in gnuplot. Best fit was evaluated from reduced chi-square values and best extendability of equations obtained.

Assumptions stated in previous paper [15] hold here also. Gnuplot is also assumed as appropriate. The intrinsic constructs of gnuplot is not criticised here.

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

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