

Trend Analyses of Parameters of Equations for Packets Per Distance Achievable in Ubicomp MANETs Using Location-Aware Transmission.

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Abstract – MANET transmission is one solution to provide networking amenities in ubicomp topographies. If protocols pertaining to this strategy are well designed, it can help in controlling energy issues in ubicomp [77]. The enforcement of location-aware transmission strategies is prone to enhance energy management and hence merits all attention needed from researchers. Among the enhancements awaited [1] are: the application of land-based GPS systems, improved location refresh rates and accuracy, development of better protocols optimised for transmission according to distance criteria and refining the precision of the distance criteria to apply the protocol. The knowledge of distance coverages by transmitted packets in ubicomp and corresponding variations over different node densities, is definitely useful for refining transmission protocols in MANETs. Such an empirical study was made in a previous paper [26], whereby the metric PPD was devised and studied.

In this paper, the next study required for metric PPD is forwarded as: “What are the trends of variation observable within each parameter of the equations of curves obtained for metric PPD [26] over varying node densities?” Designers may use the results presented here, towards formulation of better transmission protocols for ubicomp. This piece of research is a follow-up of previous research [1-41].

Key terms: Ubicomp- Ubiquitous Computing, MAUC- Mobile and Ubiquitous Computing, MANET- Mobile Adhoc Network, CBR- Constant Bit Rate, PPD- Packets Per Distance.

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1. Introduction

Ubicomp topographies, especially outdoor ones, may be deficiently equipped with networking devices. Different topographies may demonstrate quite a lot of heterogeneity as concerns accuracy level of distance measurement, location refresh rates and level of performance of existing protocols. MANET transmission may be the undisputed choice for such circumstances. This may be coupled with location-

aware transmission. Several ways of studying the resulting Packet Per Distance coverages in ubicomp for most optimal protocol performances. One such method was explained [26], in which the behaviour of metric PPD was portrayed as split into two:

- Previous to peak values, linear tendency is visible:
$$F(x) = d * x + f$$
- As from the peak value onwards, the exponentially trend is visible:

$$G(x) = a * \exp (b * (x-c))$$

Here, the equations of the model have necessitated 5 parameters: a, b, c, d and f. The next outcome required for metric PPD is to devise the model equations for the parameters of the equations specified above.

The key contributions of this paper is the development of the trend of variation for each parameter of the equations which are constituents of the model for metric PPD presented previously [26] from which tables 1(a) and 1(b) are re-used here. The empirical methods produced here, may be implemented into software simulators, producing a utility welcome by designers for more fruitful investigations of the evolution and predictability of distance considerations in future ubicomp. The rest of this paper is organised as follows: section 2- Parameter Trend Analysis- Metric PPD, section 3- Conclusion and References.

2. Parameter Trend Analysis – Metric PPD.

2.0 General Procedure Adopted.

The initial logical step is to plot the tabulated data for each parameter of the equations for the model for PPD onto gnuplot. The step that must follow is the graphical analyses and relating the general observations feasible. As third step, different equations of fits are experimented. Choice of best fit is made based on least reduced chi-square values and most acceptable extendability at node numbers 80, 100 and 120. Obviously, the conclusive step is to document the corresponding parameter values for each PPD parameter equation.

2.1 Trend Analysis – PPD parameter “a”.

Generally, trend observed is increasing at a decreasing rate. This is characteristics of logarithmic increase.

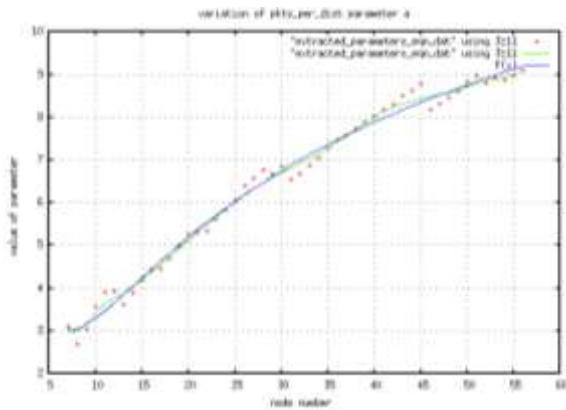


Figure 1: PPD parameter a

The potentially applicable equations of trend are:

1. $F(x) = d * x + f$
 $Ch_sq = 0.144\ 304$ $F(80) = 12.905\ 777$
 $F(100) = 15.518\ 437$ $F(120) = 18.131\ 096$
2. $F(x) = a * \log (b * x) + c$
 $Ch_sq = 0.113\ 519$ $F(80) = 10.181\ 776$
 $F(100) = 10.937\ 411$ $F(120) = 11.554\ 810$
3. $F(x) = a * \log ((b * x) + c) + d$
 $Ch_sq = 0.054\ 542\ 1$ $F(80) = 10.997\ 625$
 $F(100) = 12.113\ 825$ $F(120) = 13.052\ 908$
4. $F(x) = a * x * \log ((b * x) + c) + d$
 $Ch_sq = 0.159\ 503$ $F(80) = 13.181\ 8$
 $F(100) = 16.090\ 719$ $F(120) = 19.068\ 241$
5. $F(x) = a * x^{0.5} * \log ((b * x) + c) + d$
 $Ch_sq = 0.071\ 548\ 9$ $F(80) = 11.443\ 461$
 $F(100) = 12.980\ 736$ $F(120) = 14.397\ 010$
6. $F(x) = a * x^{-0.5} * \log ((b * x) + c) + d$
 $Ch_sq = 0.044\ 679\ 7$ $F(80) = 10.593\ 166$
 $F(100) = 11.425\ 430$ $F(120) = 12.082\ 897$
7. $F(x) = a * x^{-1} * \log ((b * x) + c) + d$
 $Ch_sq = 0.043\ 524\ 7$ $F(80) = 10.463\ 512$
 $F(100) = 11.187\ 897$ $F(120) = 11.733\ 196$
8. $F(x) = a * x^{-2} * \log ((b * x) + c) + d$
 $Ch_sq = 0.102\ 457$ $F(80) = 9.542\ 912$
 $F(100) = 9.885\ 648$ $F(120) = 10.116\ 236\ 771$

Choice of best fit for PPD parameter a

The equation in part 7 above has been selected because of both smallest reduced chi-square value obtained and good extendability. The parameters for best fit are:

$a = -219.302$, $b = 0.094\ 414\ 5$, $c = 0.866\ 839$, $d = 16.304\ 1$

2.2 Trend Analysis – PPD parameter “b”.

Generally a decreasing tendency at a very slowly decreasing rate is observed. With deeper observation, it can clearly be noticed that the trend is not a straight line. A very negligible oscillation is also observed.

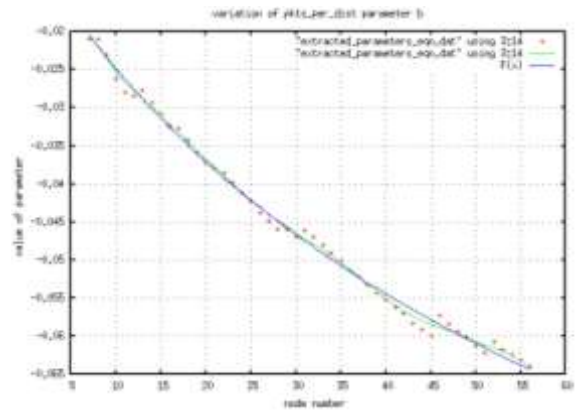


Figure 2: PPD parameter b

The potentially applicable equations of trend are:

1. $F(x) = d * x + f$
 $Ch_sq = 4.118\ 42(e^{-06})$ $F(80) = -0.088\ 337$
 $F(100) = -0.105\ 763$ $F(120) = -0.123\ 189$
2. $F(x) = (a / \log (x + b)) + c$
 $Ch_sq = 9.217\ 84(e^{-07})$ $F(80) = -0.075\ 545\ 120$
 $F(100) = -0.082\ 686$ $F(120) = -0.088\ 531\ 708$
3. $F(x) = ((a * x^{0.5}) / \log (x + b)) + c$
 $Ch_sq = 1.059\ 35(e^{-06})$ $F(80) = -0.078\ 397$
 $F(100) = -0.088\ 119$ $F(120) = -0.096\ 901$

Choice of best fit for PPD parameter b

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

$a = 1.109\ 16$, $b = 41.099$, $c = -0.306\ 784$

2.3 Trend Analysis – PPD parameter “c”.

Generally, an increasing trend at a decreasing rate is observed with a non-uniform oscillation.

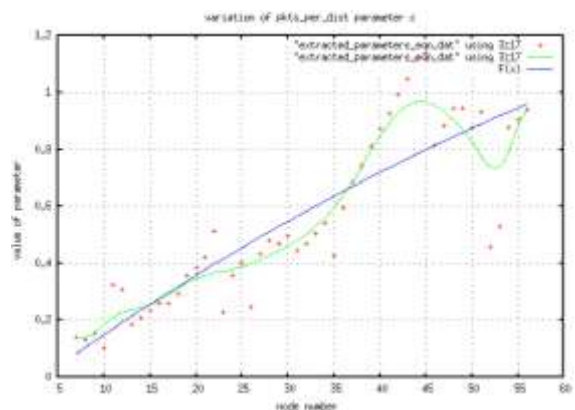


Figure 3: PPD parameter c

The potentially applicable equations are given below:

- $F(x) = a * \exp((b * x) + c) + d$
 $Ch_sq = 0.024\ 072$ $F(80) = 1.465\ 150$
 $F(100) = 1.872\ 295$ $F(120) = 2.298\ 488$
- $F(x) = a * x * \exp((b * x) + c) + d$
 $Ch_sq = 0.023\ 517$ $F(80) = 1.249\ 998$
 $F(100) = 1.435\ 847$ $F(120) = 1.578\ 478$
- $F(x) = a * x^2 * \exp((b * x) + c) + d$
 $Ch_sq = 0.022\ 283$ $F(80) = 1.029\ 582$
 $F(100) = 0.968\ 668$ $F(120) = 0.844\ 939$
- $F(x) = a * x * \exp((b * x) + c) + d * x^{-0.5}$
 $Ch_sq = 0.023\ 647\ 1$ $F(80) = 1.288\ 117$
 $F(100) = 1.516\ 645$ $F(120) = 1.712\ 207$

Choice of best fit for PPD parameter c

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

$a = 0.022\ 088\ 5$, $b = -0.004\ 623\ 72$, $c = 0.086\ 786\ 9$, $d = -0.081\ 385\ 6$

2.4 Trend Analysis – PPD parameter “d”.

Generally, the trend is increasing mostly linearly with a slight oscillation. Linear fit has been better than exponential or logarithmic fits.

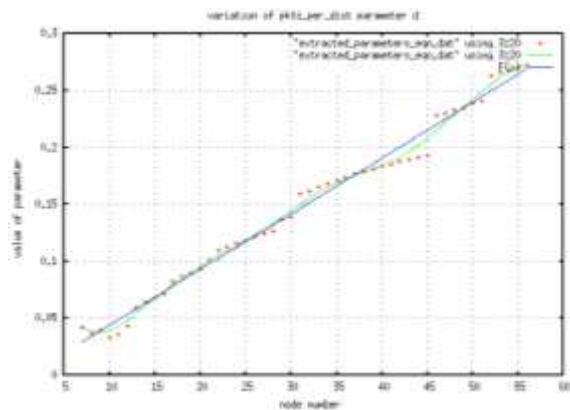


Figure 4: PPD parameter d

The potentially applicable equations of trend are:

- $F(x) = a * x + b$
 $Ch_sq = 6.717\ 86(e^{-05})$ $F(80) = 0.387\ 222$
 $F(100) = 0.485\ 369\ 993$ $F(120) = 0.583\ 516\ 278$
- $F(x) = a * \exp((b * x) + c) + d$
 $Ch_sq = 7.186\ 25(e^{-05})$ $F(80) = 0.378\ 129\ 477$
 $F(100) = 0.466\ 659\ 281$ $F(120) = 0.552\ 141$
- $F(x) = (a / \exp((b * x) + c)) + d$
 $Ch_sq = 7.448\ 75(e^{-05})$ $F(80) = 0.371\ 644\ 984$
 $F(100) = 0.454\ 022$ $F(120) = 0.531\ 660\ 468$
- $F(x) = a * \log((b * x) + c) + d$

- $Ch_sq = 6.999\ 12(e^{-05})$ $F(80) = 0.408\ 079$
 $F(100) = 0.531\ 949$ $F(120) = 0.668\ 276$
- $F(x) = (a / \log((b * x) + c)) + d$
 $Ch_sq = 7.715\ 5(e^{-05})$ $F(80) = 0.366\ 605$
 $F(100) = 0.444\ 234$ $F(120) = 0.516\ 388$

Choice of best fit for PPD parameter d

The equation in part 1 above has been selected because of both smallest reduced chi-square value obtained and good extendability. The parameters for best fit are:

$a = 0.004\ 907\ 31$, $b = -0.005\ 361\ 43$

2.5 Trend Analysis – PPD parameter “f”.

Generally, the trend is an oscillation along an axis which is itself increasing at a decreasing rate.

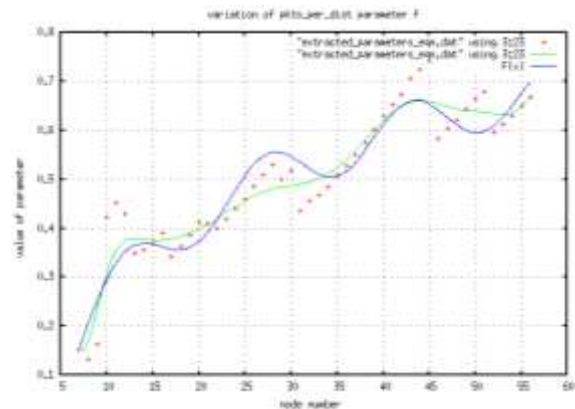


Figure 5: PPD parameter f

The potentially applicable equations of trend are:

- $F(x) = a * \sin((b * x) + c) + d * x + f$
 $Ch_sq = 0.003\ 232\ 9$ $F(80) = 0.902\ 465\ 943$
 $F(100) = 1.109\ 852$ $F(120) = 1.359\ 131\ 576$
- $F(x) = a * x + b$
 $Ch_sq = 0.004\ 331\ 45$ $F(80) = 0.925\ 287$
 $F(100) = 1.100\ 079$ $F(120) = 1.274\ 871$
- $F(x) = a * \sin((b * x) + c) + d * \log(x) + f$
 $Ch_sq = 0.002\ 678\ 33$ $F(80) = 0.721\ 350$
 $F(100) = 0.784\ 592$ $F(120) = 0.905\ 128$

Choice of best fit for PPD parameter f

The equation in part 3 above has been selected because of both smallest reduced chi-square value obtained and good extendability. The parameters for best fit are:

$a = 0.051\ 979\ 8$, $b = 0.402\ 748$, $c = 3.138\ 85$, $d = 0.241\ 553$, $f = -0.299\ 812$

3. Conclusion.

This investigation attempt was aimed at and has developed applicable models of trends of the

parameters of equations for the metric PPD in a MANET topography of 300 x 300 m². The models illustrated in this paper consist of mathematical equations of differing complexity. Such knowledge may lead researchers and designers towards producing processing algorithms to be applied in simulator packages for more refined studies of MANETs. This experiment was carried out in gnuplot. Criteria for designating best fit has remained value of least reduced chi-square and most admissible extendability experienced at higher node numbers.

The candid assumptions mentioned in previous paper [26] are re-exercised here. Gnuplot is also believed as sufficiently powerful for the purpose of this study.

Further work recognised here are: formulating an appropriate method of predictability for metric PPD and its trend and reporting specific observations of selected critical values.

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