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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 meseurement, 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.

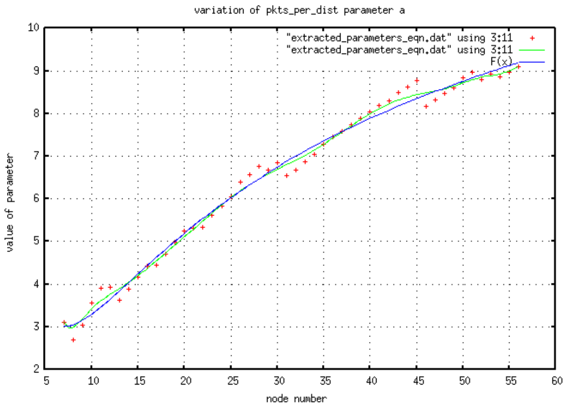

Figure 1: PPD parameter a

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.

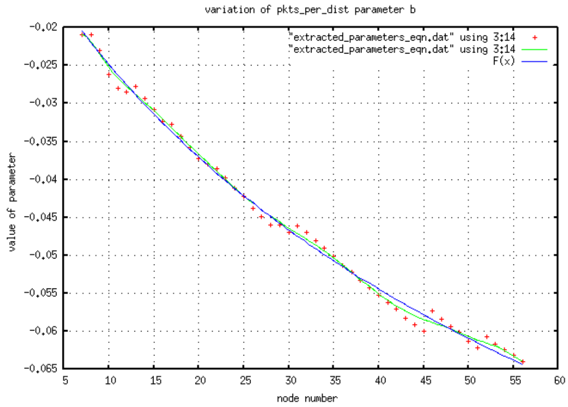

Figure 2: PPD parameter b

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.

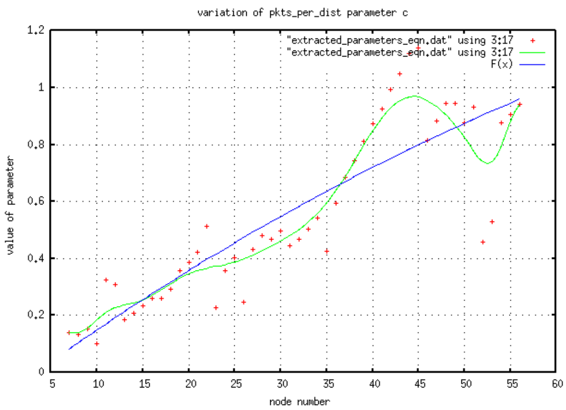

Figure 3: PPD parameter c

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The potentially applicable equations are given below:

1. 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
2. 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
3. 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
4. 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.

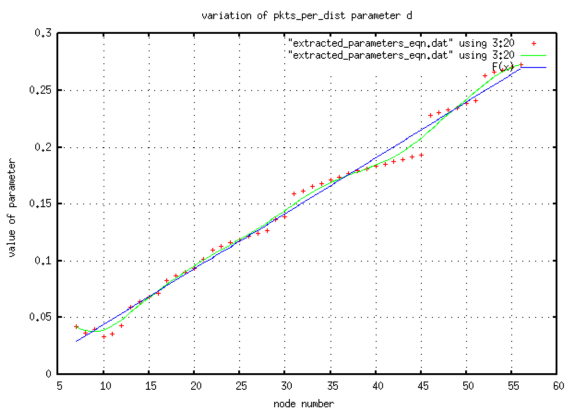

Figure 4: PPD parameter d

The potentially applicable equations of trend are:

1. 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
2. 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
3. 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
4. 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
5. 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.

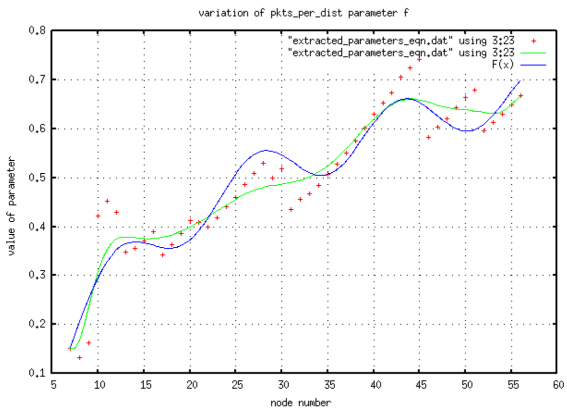

Figure 5: PPD parameter f

The potentially applicable equations of trend are:

1. 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
2. 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
3. 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 m^2. 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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