

# Trend Analyses of Parameters of Equations for Overall Fairness Ratio Achievable in UbiComp MANETs Using Location-Aware Transmission.

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**Abstract** – The fields of location-tracking, ubiComp functionalities and MANET transmission strategies are prone to quite a lot of productive research [37-73]. It still remains unrefutable that the engineering portion of modelling in ubiComp to scrutinise predictability properties is at its inception phases. The sub-portion of energy management is distinctively important since in present technology, battery power is still considered constrained. Formerly, an investigation was conducted to quantify and model the Overall Fairness Ratio (OFR) of energy consumption recordable for CBRs for node densities of 7 until 56. The corresponding model was observed to be a combination of exponentially and linearly increasing tendencies.

In this paper, the next milestone of investigation is expressed as: “What are the trends of variation observable within each parameter of the equations of curves obtained for metric OFR [21] over varying node densities?”

Studying the demeanor of constituents of applicable models for metric OFR and successively model the observed behaviour of each constituent mathematically is very consequent as it necessitates huge efforts and disagreement resolution among researchers. The results put forward will aid designers towards more profitable understanding of ubiComp and prepare hardware and algorithmic support for ubiComp architecture. This paper is a follow-up of previous research [1-36].

**Key terms:** UbiComp- Ubiquitous Computing, MAUC- Mobile and Ubiquitous Computing, MANET- Mobile Adhoc Network, CBR- Constant Bit Rate, OFR- Overall Fairness Ratio.

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## 1. Introduction

MANETs remain a fulfilling solution to scant resource availability in ubiComp, whereby energy consumption load is distributed among nodes present in the topography. In situations of such cooperation, the criteria of Fairness crops up. One feature for fairness is

how many contributing nodes are spending more energy than the sender and those spending less energy than the sender in the topography. An anterior study [21] was undertaken with the aim of finding the trends observable for metric OFR for node densities ranging from 7 until 56. The trend followed in that paper [21] was noted to be increasing and the model equation put forward combined the exponential and linear models.

$$F(x) = a * \exp(b * x) + (c * x) + d$$

Here, the equations of the model has involved 4 parameters: a, b, c and d. The next quest required for metric OFR is the derivation of model equations for the parameters of the equation mentioned above.

The key contributions of this paper is the establishment of the trend of variation for each parameter of the equations involved in the model for metric OFR presented in former paper [21] whose table 1 is re-adopted here. The mathematical procedures put up in this paper may feasibly be inserted into software simulators, thereby, providing an additional utility for designers to better understand the evolution and predictability of ubiComp characteristics to promote in better equipping future ubiComp architecture. The rest of this paper is organised as follows: section 2- Parameter Trend Analysis- Metric OFR, section 3- Conclusion and References.

## 2. Parameter Trend Analysis – Metric OFR.

### 2.0 General Procedure Adopted.

Firstly, the tabulated data for each parameter of equations for the model for OFR is plotted on gnuplot. Secondly, graphical analyses are carried out and general observations are detailed. Thirdly, various equations of fit are tried. Choice of best fit was made depending on value of reduced chi-square and a combination of projected parameter values at higher node numbers. Fourthly, the values of parameters for each OFR parameter of equation is noted.

### 2.1 Trend Analysis – OFR parameter “a”.

The curve obtained depicts a clean oscillation along a straight line with positive gradient as axis of oscillation.

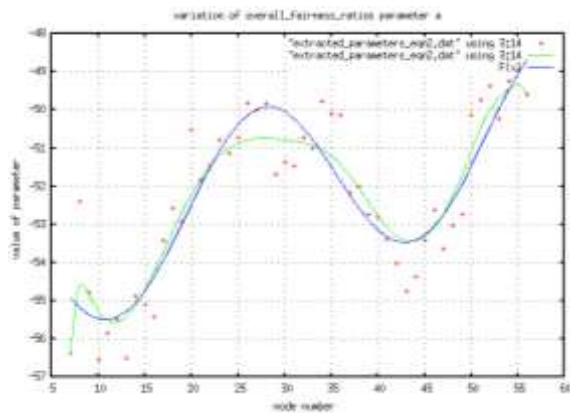


Figure 1: OFR parameter a

The potentially applicable equations are:

1.  $F(x) = 3 \cos(2 * x) + 2 * x + 1$   
Initial iteration bringing only partial progress
2.  $F(x) = a * \cos(b * (x + f)) + c * x - d$   
Ch\_sq = 0.977 308 F(80) = -50.360  
F(100) = -47.801 86

**Choice of best fit for OFR parameter a**

Of course, the equation in part 2 above has been selected because of good enough ch\_sq and good extendability. The parameters for best fit are:

$a = 2.261 78$  ,  $b = 0.196 123$  ,  $c = 0.063 059 5$  ,  $d = 53.938$  ,  $f = 4.503 24$  .

2.2 Trend Analysis – OFR parameter “b”.

At the start of the curve, there is a decreasing tendency until a minimum point is reached, following which the curve increases at a decreasing rate.

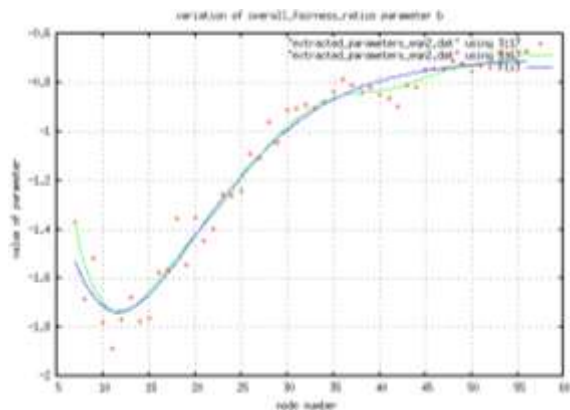


Figure 2: OFR parameter b

The potentially applicable equations are:

1.  $F(x) = a * x * \exp(b * x) + c$   
Ch\_sq = 0.007 942 29 F(80) = -0.618 009  
F(100) = -0.612 510 29 F(120) = -0.611 62
2.  $F(x) = a * x * \exp(b * (x - c)) + d$   
Ch\_sq = 0.008 114 94
3.  $F(x) = a * x * \exp(b * x) + (c * x) + d$

Ch\_sq = 0.014 125 3 F(80) = -2.95

F(100) = -12.114 9

4.  $F(x) = a * x^2 * \exp(b * (x - c)) + d$   
Ch\_sq = 0.004 953 52 F(80) = -0.701 009 178  
F(100) = -0.700 646 8 F(120) = -0.700 628 6

**Choice of best fit for OFR parameter b**

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

$a = -0.055 73$  ,  $b = -0.172 07$  ,  $c = 0.100 375$  ,  $d = -0.700 628$

2.3 Trend Analysis – OFR parameter “c”.

Generally the curve depicts a smoothly decreasing tendency with decreasing rate of decrease.

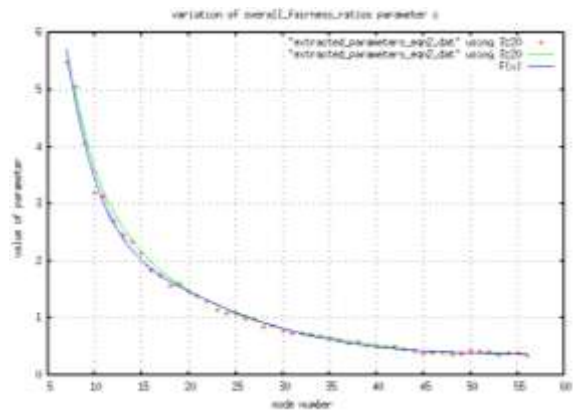


Figure 3: OFR parameter c

The potentially applicable equations are:

1.  $F(x) = ((a * x + f) / \exp(b * (x - c))) + d$   
Ch\_sq = 0.021 561 9
2.  $F(x) = ((a * x^2 + f) / \exp(b * (x - c))) + d$   
Ch\_sq = 0.017 352 3
3.  $F(x) = ((a * x^3 + f) / \exp(b * (x - c))) + d$   
Ch\_sq = 0.009 035 95
4.  $F(x) = ((a * x^4 + f) / \exp(b * (x - c))) + d$   
Ch\_sq = 0.007 111 31 F(80) = 0.351 710 56  
F(100) = 0.351 474 F(120) = 0.351 468
5.  $F(x) = ((a * x^5 + f) / \exp(b * (x - c))) + d$   
Ch\_sq = 0.020 359 4

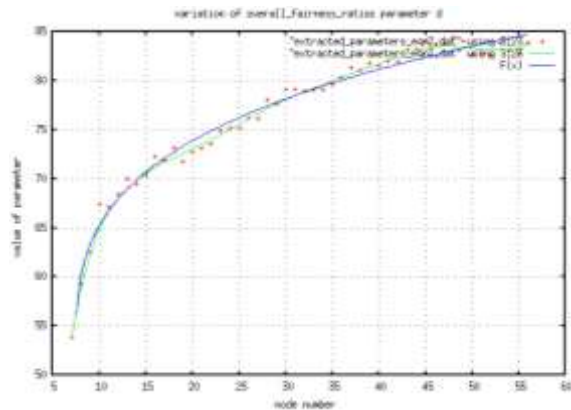
**Choice of best fit for OFR parameter c**

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

$a = 0.000 302 874$  ,  $b = 0.228 457$  ,  $c = 2.298 92$  ,  $d = 0.351 468$  ,  $f = 14.972 8$

### 2.4 Trend Analysis – OFR parameter “d”.

The curve obtained depicts an increasing curve at a decreasing rate of increase, with increasing node numbers. This is typical of logarithmic curves.



**Figure 4: OFR parameter d**

The potentially applicable equations are:

1.  $F(x) = a * \log(b * (x - c)) + d * x + f$   
 $Ch\_sq = 0.992\ 908$        $F(80) = 89.317\ 657\ 314$   
 $F(100) = 92.513\ 065\ 155$        $F(120) = 95.429\ 391\ 556$
2.  $F(x) = a * \log(b * (x - c)) + d * x^{0.5} + f$   
 $Ch\_sq = 0.965\ 712$        $F(80) = 88.930\ 58$   
 $F(100) = 91.685\ 026\ 4$        $F(120) = 94.056\ 896$
3.  $F(x) = a * \log(b * (x - c)) + d * x^{0.3} + f$   
 $Ch\_sq = 0.959\ 342$        $F(80) = 88.692\ 715$   
 $F(100) = 91.247\ 724\ 6$        $F(120) = 93.399\ 691\ 38$
4.  $F(x) = a * \log(b * (x - c)) + d * x^{0.25} + f$   
 $Ch\_sq = 0.931\ 535$        $F(80) = 88.700$   
 $F(100) = 91.256\ 8$        $F(120) = 93.406\ 119$
5.  $F(x) = a * x^{0.5} * \log(b * (x - c)) + d * x^{0.25} + f$   
 $Ch\_sq = 1.749\ 87$        $F(80) = 84.989\ 061\ 5$   
 $F(100) = 84.610\ 635$        $F(120) = 83.581\ 118\ 1$

### Choice of best fit for OFR parameter d

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

$$a = 3.550\ 29, b = 19.634\ 6, c = 7.180\ 17, d = 9.876\ 62, f = 33.368\ 8$$

## 3. Conclusion.

This piece of investigation was meant to and has achieved the setting up of applicable models of trends of the parameters of equations for the metric OFR in a MANET topography of 300 x 300 m<sup>2</sup>. These models which have been formulated using quite complex

mathematical equations, will undoubtedly facilitate further study of MANETs for MAUC environment using software engineering concepts, successively formulating computational algorithms to be executed into simulators for conducive studies of MANET. This experiment was conducted in NS-2 over linux. The plottings and “fit” attempts were carried out in gnuplot, following which criteria adopted for selecting best fit have been reduced chi-square values and valid extendability of equations obtained.

Assumptions stated in former paper [21] are upheld in this paper also. Gnuplot and validity of its constructs are also assumed as appreciable.

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

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