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Mathematical Modelling of Need of Exact Number of Relays to Ensure Seamless Mobility in UbiComp.

M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY

Abstract – **One of the requirements of MAUC has been to ensure smooth transition from one relay to another during mobility of a node. This "smoothness" must be unnoticed by a user and hence the term "seamless mobility". Lots of research and development are being carried out to achieve this concept [5-17]. To achieve seamless mobility, neighbouring relays to the closest relay that a node is connected to, must be notified proactively and minimal amount of resources be reserved to initiate communication through it as and when a node comes close to it. Reserving maximum resources at each neighbouring relay can be considerably costly. It is hence desirable to have a probabilistic approach for knowing which relays (usually least number) need to be proactively enabled, the need for activating neighbouring relay, the need by a CBR for 1 relay, 2 relays, 3 relays, etc.., the minimum and maximum relays used in particular relay densities and their probability of occurrences.**

This paper is a follow-up of 4 previous papers [1-4] mainly aimed at modelling of energy savings achievable. The objective of this paper is to present the results of combined data from 17 different sets of experiments carried out in [2-4] for need of exact number of relays, in form of graphs and mathematical conclusions derived.

Key terms: MAUC-Mobile and Ubiquitous Computing, CBR-Constant Bit Rate, DoIPNE-Degree of Importance of Proactive Neighbour Enabling, PoSPIM-Potential of success of policy for insignificant Mobility, Transit Relay-1st relay of transmission reached by sender node.

M. Kaleem GALAMALI,
University of Technology Mauritius (student)
Mauritius

Assoc. Prof Nawaz Mohamudally
University of Technology Mauritius,
Mauritius

1. Introduction

1.1 Brief of Seamless Mobility.

The need to better delimit the minimum and maximum amount of resources that may be required ia a common engineering concept when aiming at high Quality of Service specially when these resources are scarce like bandwidth and RAM memory and lack of optimal methods of using these resources can lead to serious drops in performance and rises in costs of operations. For the case of seamless mobility need, usually the more resources reserved at neighbouring relays until a maximum amount (the requirements limits of the node), the more seamless the mobility will appear to be. An example on how many relays are concerned in such a process is depicted below assuming even distribution of relays in a flat square topography.

R1	R2	R3
R4	R5	R6
R7	R8	R9

If a node (n1) is closest to R5 (Relay number 5, referred to as transit relay throughout the paper), its mobility can bring it close to any neighbouring relays R1, R2, R3, R4, R6, R7, R8 or R9. A relay can have a maximum of 8 neighbour relays. It would be considerable relay to enable all 8 relays with maximum amount of resources to ensure maximal seamlessness. This would have implied:

i. Reserving high bandwidth at each of the 8 neighbour relays. This would increase proportionally with node density.
ii. Need for more communication overhead between relays to communicate information about nodes concerned. This also increases proportionally with node density. This may significantly add to noise intensity over the topography.
iii. The above 2 will force the need for more powerful relays with more powerful communication processors. Cost of implementation may rise significantly.

If concept of central axes is applied, neighbours considerable may include only 4 relays: R2, R4, R6 and R8.

1.2 What is needed?.

Four needs have been identified here:

i. A way of knowing which neighbouring relays need to be proactively enabled. A reduction from 8 to a smaller amount is desirable.
ii. A way of measuring the need for activating the identified neighbouring relays.

iii. A way of estimating probability of a CBR needing only 1 relay, only 2 relays,…..
iv. A track of minimum and maximum numbers of relays used for each experiment set of particular number of relays (this can be derived from (iii) above).

1.3 Use of Information Identified in 1.2 Above.

The information identified can be put to various uses once they have been measured and gathered. Uses identified below are not exhaustive:

1. Getting to know exactly which relays can be considered neighbours and undertake proactive enabling only there. This may imply formulation of policy and manual inputting of data about which relays are neighbours to which other relays.
2. Formulation of policies for dealing with mobility of nodes.
   i. From probabilities of CBR needing only 1 relay, 2 relay,…metrics about degree of mobility can be formulated. This can be used for formulating policies of how much resource reservations need to be carried out at each neighbour relay.
   ii. From number of CBRs needing more than 1 relay, again, how much resource reservations need to be carried out.
   iii. What criteria to apply for speed of updating of data at neighbour relay, if a node has moved away and connected to another relay? Should the records be maintained but resource reservations be reduced gradually as a function of time until a time-out limit is reached?

The key contribution of this paper is the development of an empirical, simulation-based model of the % of transmissions requiring exact number of relays in various multi-relay scenarios, taking into consideration exact location-aware transmission strategies. The model suggested in this paper is the exponential model of the form

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F(x) = c*exp(-d*(x-2)) + f
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The rest of this paper is organised as follows: section 2-experiment design, section 3-Results and observations, section 4- Conclusion and References.

2. Experiment Design

Here, the same experimental set-up as described in previous paper [4] is made use of. In the same execution as described in this paper [4], specific provisions for measuring number of packets transiting through each relay (as first relay) were made and data was gathered in parallel during experiment executions. Further processing to derive the following have been carried out:

i. The number of CBRs needing 1 relay for transit (as 1st reached relay), same for 2 relays, 3 relays,… until the maximum relays used.
ii. The corresponding fractions/percentages from (i) above can also be calculated.
iii. For each number of relays, a record of minimum relays used (usually 1) and maximum number of relays needed by a CBR can be maintained. This is observable from parts (i)-(iii) above.

3. Results and observations.

3.1 Tabular Results. .

The results will be presented in tabular formats and headings are as follows: A-Total Relays used by CBRs, B-%CBR using total of A relays, C-% CBR using more than A relays and hence does not apply for biggest number of relays.

1. Using 1 relay.

When only 1 relay is used, all data will necessarily be transiting to it only. It has no neighbour and hence its %CBRs needing 1 relay will be at maximum 100%

2. Using 2 relays.

A	1	2
B	24.92	75.08
C	75.08	-

It can be noticed here that even if as few as 2 relays are used, the % of CBRs having needed all 2 relays is as high as 75.08%. It means that 75.08% of CBRs used are having a high enough mobility to be needing all 2 relays.

The DoIPNE can be rated to be 75.08% (or rounded to 75%). This percentage is already very high for just 2 relays. It is expected to increase with greater number of relays. The tendency of this metric will be compiled for greater number of relays and results analysed graphically. This metric can be used to calibrate the amount of resources that need to be reserved in neighbouring relays and also decide speed of updating of location data when significant changes have happened.

It can also be noticed that number of CBRs needing only 1 relay, i.e. communication during immobility or small mobility where a node remains to a single relay as closest relay is also quite high (24.92%). This also can be made use of. In case a different policy of communication is devised for nodes during immobility or insignificant mobility, there is a good proportion of nodes (24.92%), i.e. around a quarter, which will benefit from this more applicable policy. The policy may include higher bandwidth, better QoS applicability, reduced delays and error rates. This policy is being referred to as a communication during insignificant mobility.

3. Using 3 relays.

A	1	2	3
B	21.11	19.51	59.38
C	78.89	59.38	-

Here DoIPNE is 78.89% at start of transmission. PoSPIM is 21.11%. DoIPNE if node, after start of transmission and mobility, has connected to 2nd relay as transit relay drops to 59.38%.

4. Using 4 relays.

A	1	2	3	4
B	18.41	13.10	18.46	50.03
C	81.59	68.49	50.03	-

Here DoIPNE at start of transmission with 1st transit relay is 81.59%. It decreases to 68.49% with first change of transit relay and to 50.03% for second change of transit relay. This interpretation style will follow same trend for remaining number of relays.

5. Using 5 relays.

A	1	2	3	4	5
B	16.52	12.03	14.94	25.24	31.27
C	83.48	71.45	56.51	31.27	-

6. Using 6 relays.

A	1	2	3	4	5
B	15.49	10.14	10.78	17.63	22.86
C	84.51	74.37	63.59	45.96	23.10

A	6
B	23.10
C	-

7. Using 7 relays.

A	1	2	3	4	5
B	15.17	10.54	9.05	15.95	16.67
C	84.83	74.29	65.24	49.29	32.62

A	6	7
B	20.06	12.56
C	12.56	-

8. Using 8 relays.

A	1	2	3	4	5
B	14.54	9.75	7.30	10.08	15.87
C	85.46	75.71	68.41	58.33	42.46

A	6	7	8
B	16.59	15.79	10.08
C	25.87	10.08	-

9. Using 9 relays.

A	1	2	3	4	5
B	14.06	8.87	6.59	8.65	11.51
C	85.94	77.07	70.48	61.83	50.32

A	6	7	8	9
B	16.91	15.70	11.44	6.27
C	33.41	17.71	6.27	-

10. Using 10 relays.

A	1	2	3	4	5
B	14.29	8.10	6.11	8.81	11.43
C	85.71	77.61	71.50	62.69	51.26

A	6	7	8	9	10
B	14.29	13.40	12.94	6.58	4.05
C	36.97	23.57	10.63	4.05	-

11. Using 11 relays.

A	1	2	3	4	5
B	13.57	8.10	5.51	6.95	9.08
C	86.43	78.33	72.82	65.87	56.79

A	6	7	8	9	10
B	12.59	12.62	13.57	8.87	6.21
C	44.21	31.59	18.02	9.14	2.94

A	11
B	2.94
C	-

12. Using 12 relays.

A	1	2	3	4	5
B	13.41	7.86	4.92	6.75	7.86
C	86.59	78.73	73.81	67.06	59.21

A	6	7	8	9	10
B	10.79	12.38	13.33	9.68	7.13
C	48.41	36.03	22.70	13.02	5.89

A	11	12
B	4.22	1.67
C	1.67	-

13. Using 13 relays.

A	1	2	3	4	5
B	12.46	8.02	5.08	5.95	8.56
C	87.54	79.52	74.44	68.49	59.94

A	6	7	8	9	10
B	10.17	11.03	12.30	9.49	9.06
C	49.76	38.73	26.43	16.94	7.87

A	11	12	13
B	5.33	1.75	0.79
C	2.54	0.79	-

14. Using 14 relays.

A	1	2	3	4	5
B	12.30	7.62	4.68	5.08	7.78
C	87.70	80.08	75.40	70.32	62.54

A	6	7	8	9	10
B	8.71	11.13	11.35	10.71	8.60
C	53.83	42.70	31.35	20.63	12.03

A	11	12	13	14
B	6.56	3.57	1.43	0.48
C	5.48	1.90	0.48	-

15. Using 15 relays.

A	1	2	3	4	5
B	12.22	7.22	5.16	4.52	6.59
C	87.78	80.56	75.40	70.87	64.29

A	6	7	8	9	10
B	7.37	10.41	10.87	10.95	9.13
C	56.92	46.51	35.63	24.68	15.56

A	11	12	13	14	15
B	6.38	5.29	2.62	1.11	0.16
C	9.17	3.89	1.27	0.16	-

16. Using 16 relays.

A	1	2	3	4	5
B	12.06	7.38	4.52	4.76	6.19
C	87.94	80.56	76.03	71.27	65.08

A	6	7	8	9	10
B	6.90	9.90	10.73	10.00	9.76
C	58.17	48.27	37.54	27.54	17.78

A	11	12	13	14	15
B	6.57	4.67	4.40	1.67	0.40
C	11.21	6.54	2.14	0.48	0.08

A	16
B	0.08
C	-

17. Using 25 relays.

A	1	2	3	4	5
B	11.51	6.51	3.81	3.65	3.97
C	88.49	81.98	78.17	74.52	70.87

A	6	7	8	9	10
B	3.97	4.21	6.48	7.63	7.27
C	66.90	62.70	56.22	48.59	41.32

A	11	12	13	14	15
B	9.65	6.27	6.67	4.84	4.52
C	31.67	25.40	18.73	13.89	9.37

A	16	17	18	19	20
B	2.79	2.83	1.60	1.03	0.63
C	6.57	3.75	2.14	1.11	0.48

A	21	22	23	24	25
B	0.24	0.24	0.00	0.00	0.00
C	0.24	0.00	0.00	0.00	0.00

3.2 General Observations.

i. For each experiment set, the % of CBRs having needed only 1 relay is highest in its corresponding set of results as from above 10 relays. It is sufficient statistical proof that if a tailor-made policy of communication for insignificant mobility is applied in a ubicomp environment with relays, it will definitely be successful towards increasing QoS.

ii. The number of CBRs having needed all relays as 1^{st} transit relay has been much lesser significant as from above 10 relays (less than 3%) and is actually least in its corresponding set of results as from above 10 relays.

iii. The maximum number of relays as transit relays has been found useful in all experiments to take value at around 21-22. It can be used as a threshold maximum number of usual CBR transmission. It can be used as a figure in probabilistic calculations of amount of resources to reserve in neighbour relays given that node is at its 1^{st}, 2^{nd}, 3^{rd},…n^{th} transit relay. It may be expected that resource reservations may decrease in the 2^{nd} half of this increasing relay number scenario (maybe as from 11^{th} relay).

3.3 Trend Analysis of % CBRs needing only x relays (V(n=x)).

Obviously, to make this study, we have to start from a number greater than *x*. *V(n=x)* should be read as % CBR needing exactly *x* transit relays

1. For *x*=1.

Relays	2	3	4	5	6
V(n=1)	24.92	21.11	18.41	16.52	15.49

Relays	7	8	9	10	11
V(n=1)	15.17	14.54	14.06	14.29	13.57

Relays	12	13	14	15	16
V(n=1)	13.41	12.46	12.30	12.22	12.06

Relays	25
V(n=1)	11.51

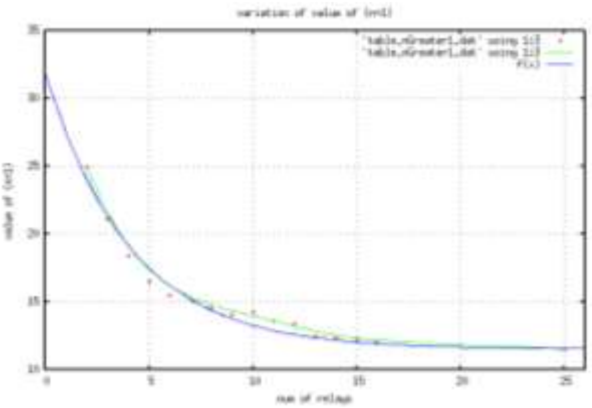

Fig 1: Trend Analysis of V(n=1).

The curve obtained through smooth Bezier is very convincing as an inverse exponential distribution. The equation of curve obtained here through the fit command is

$$F(x)=12.5024 * \exp(-0.244916*(x-2)) + 11.5$$

As number of relays increases, the proportion of CBRs having needed only 1 relay decreases exponentially but throughout it has remained above 11.5%. The maximum value reached is 24.92%. The range remains 13.4.

If a policy for communication with only 1 relay is enabled, assuming the information of projected number of transit relays is 1 and this information is available, with corresponding optimised QoS, it might be useful for at least 11.5% of CBRs. Designers of MAUC networks must make further studies to decide whether 11.5% success rate may be considered useful if implemented. This will surely involve considerations of initial distance of transmitting node to the first relay and degree of mobility.

2. For *x*=2.

Relays	3	4	5	6	7
V(n=2)	19.51	13.10	12.03	10.14	10.54

Relays	8	9	10	11	12
V(n=2)	9.75	8.87	8.10	8.10	7.86

Relays	13	14	15	16	25
V(n=2)	8.02	7.62	7.22	7.38	6.51

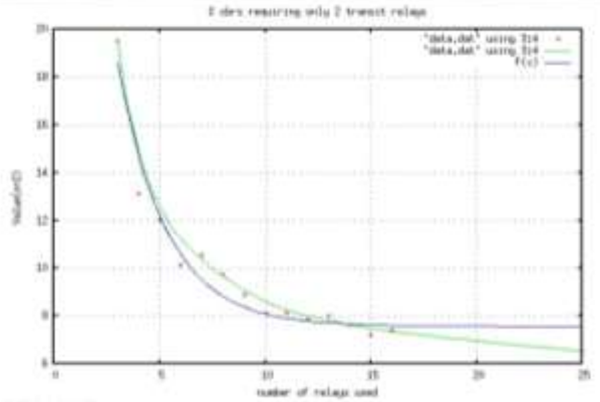

Fig 2: Trend Analysis of V(n=2).

The curse obtained through smooth Bezier is very convincing. The equation of curve obtained here through the fit command is

F(x)=17.0546 * exp (-0.434572*(x-2)) + 7.56584

As number of relays increases, the proportion of CBRs having needed only 2 transit relays decreases exponentially but throughout it has remained above 6.5%. The maximum value reached is 19.51%. The range remains 13.

Assuming a transmitting node has ability to project that it will need only 2 relays, a corresponding tailor-made policy of communication will be useful for at least 7% of CBRs. This figure has dropped significantly from corresponding value where *x* equals 1. Designers of MAUC networks must again make more studies to assert if 7% success rate is enough for formulating a corresponding optimal transmission medium, though it appears of lower need.

3. For *x*=3.

Relays	4	5	6	7	8
V(n=3)	18.46	14.94	10.78	9.05	7.30

Relays	9	10	11	12	13
V(n=3)	6.59	6.11	5.51	4.92	5.08

Relays	14	15	16	25
V(n=3)	4.68	5.16	4.52	3.81

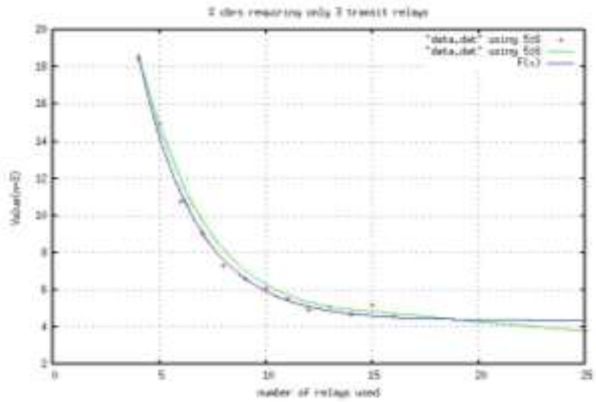

Fig 3: Trend Analysis of V(n=3).

The curve obtained through smooth Bezier is very convincing as inverse exponential fit. The equation of curve obtained here through the fit command is

F(x)=29.9909 * exp (-0.369081*(x-2)) + 4.3456

As number of relays increases, the proportion of CBRs having needed only 3 transit relays decreases exponentially but throughout it has remained above 3.8%. The maximum value reached is 18.46%. The range remains 14.65.

A tailor-made policy of communication for this situation would be beneficial for around 4% of transmissions. It is suggested that this figure is too small and designers may not want to experiment further or to increase this proportion. This will apply in following observations also.

4. For *x*=4.

Relays	5	6	7	8	9
V(n=4)	25.24	17.63	15.95	10.08	8.65

Relays	10	11	12	13	14
V(n=4)	8.81	6.95	6.75	5.95	5.08

Relays	15	16	25
V(n=4)	4.52	4.76	3.65

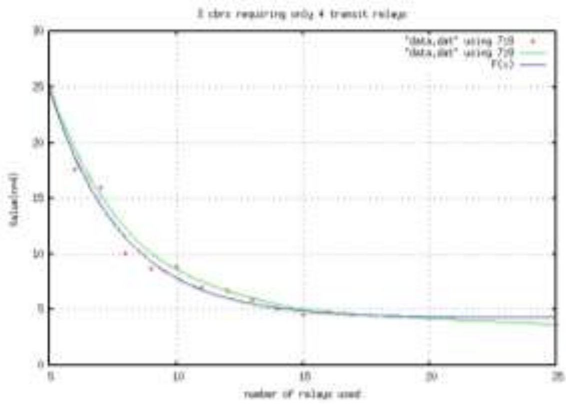

Fig 4: Trend Analysis of V(n=4).

The curve obtained through smooth Bezier is, again, very convincing as inverse exponential with equation

F(x)=58.4604 * exp (-0.348737*(x-2)) + 4.25499

As number of relays increases, the proportion of CBRs needing only 4 transit relays decreases exponentially but throughout it has remained above 3.6%. The maximum value reached is 25.24. The range is 21.59.

A tailor-made communication policy here will be of even lower success rate at minimum 3.6%.

5. For *x*=5.

Relays	6	7	8	9	10
V(n=5)	22.86	16.67	15.87	11.51	11.43

Relays	11	12	13	14	15
V(n=5)	9.08	7.86	8.56	7.78	6.59

Relays	16	25
V(n=5)	6.19	3.65

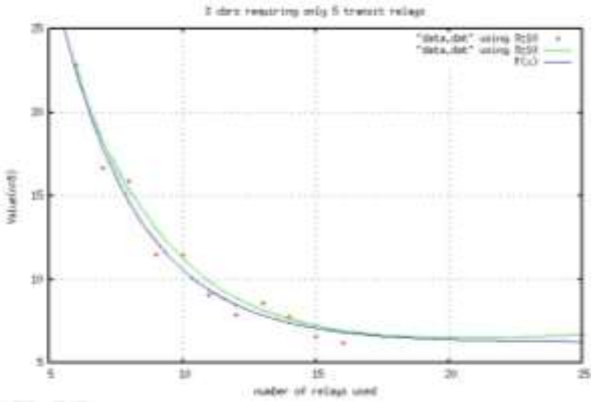

Fig 5: Trend Analysis of V(n=5).

The curve obtained through smooth Bezier is very convincing as inverse exponential with equation

F(x)=60.9271 * exp (-0.330443*(x-2)) + 6.2338

As number of relays increases, the proportion of CBRs needing only 5 transit relays decreases exponentially but has remained above 3.6% throughout. The maximum value reached is 22.86%. The range is 19.21.

A tailor-made communication policy here will benefit a minimum of 3.6% of CBRs.

6. For *x*=6.

Relays	7	8	9	10	11
V(n=6)	20.06	16.59	16.91	14.29	12.59

Relays	12	13	14	15	16
V(n=6)	10.79	10.17	8.71	7.37	6.90

Relays	25
V(n=6)	3.97

The curve obtained through smooth Bezier is very convincing as inverse exponential with equation.

F(x)=36.2029 * exp (-0.141527*(x-2)) + 2.23584

As number of relays increases, the proportion of CBRs needing only 6 transit relays decrease exponentially but remained above 3.9% throughout.

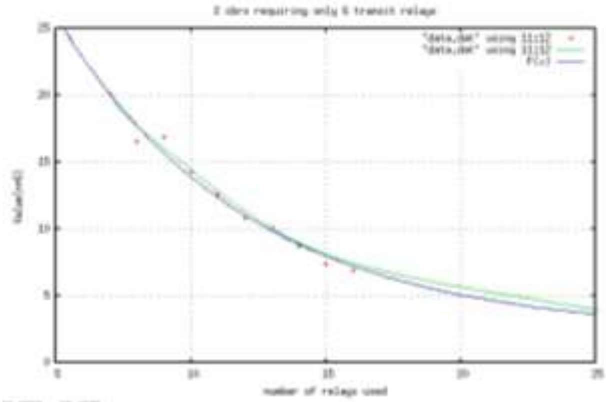

Fig 5: Trend Analysis of V(n=5).

A tailor-made communication policy here will benefit at least 3.9% of CBRs.

7. For *x*=7.

Relays	8	9	10	11	12
V(n=7)	15.79	15.70	13.41	12.62	12.38

Relays	13	14	15	16	25
V(n=7)	11.03	11.13	10.41	9.90	4.21

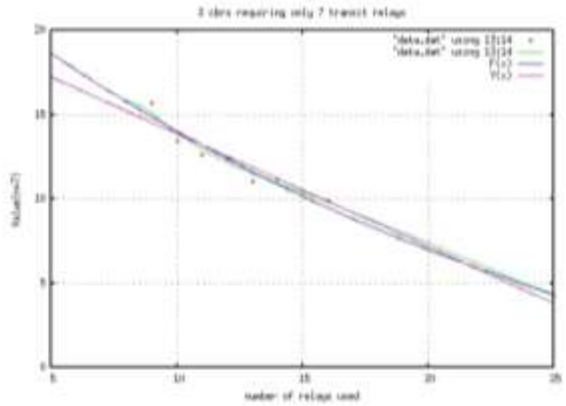

Fig 7: Trend Analysis of V(n=7).

The curve obtained through smooth Bezier is very convincing with equation

F(x)=30.2934 * exp (-0.0376356*(x-2)) – 8.41811

As number of relays increases, the proportion of CBRs needing only 7 transit relays decreases exponentially but remained above 4.2%. The maximum value reached is 15.79. The range is 11.58

The curve has however flattened resembling a straight line. The best straight line fit obtained is

Y(x)=-0.6714(x) + 20.5876

However the curve is preferred rather than the straight line since it has a smaller Chi-Square value (0.289625) than the straight line (0.388909).

A tailor-made communication policy here will benefit a minimum of 4.5% of CBRs.

8. For x=8.

Relays	9	10	11	12	13
V(n=8)	11.44	12.94	13.57	13.33	12.30

Relays	14	15	16	25
V(n=8)	11.35	10.87	10.73	6.48

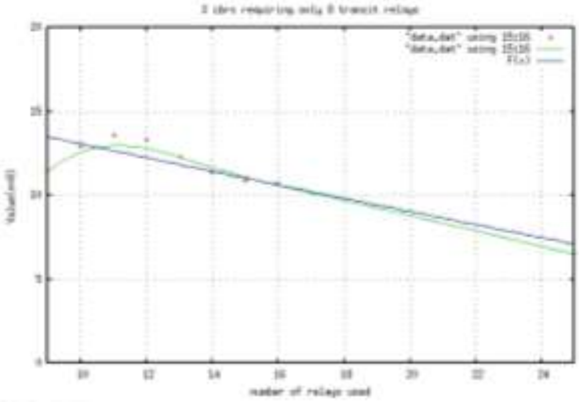

Fig 8: Trend Analysis of V(n=8).

The curve obtained through smooth Bezier is very different from what has been observed previously. Initially, from 10 to 12 relays, an increasing tendency is observed, then a slowly decreasing tendency is observed. An exponential curve has fitted though less convincingly. The equation is

$$F(x)=74.6989 * \exp(-0.00583591*(x-2)) - 58.2215$$

The maximum value reached is 13.57 and minimum reached is 6.48. The range is 7.09

This may be the start of change of category of model as will be shown in next section.

A tailor-made communication policy here will have optimal importance only for around 12 relays arranged in a 4x3 fashion. For other relay numbers, success rate for the policy is above 6.4%.

9. For x=9.

Relays	10	11	12	13	14
V(n=9)	6.59	8.87	9.68	9.49	10.71

Relays	15	16	25
V(n=9)	10.95	10.00	7.63

The curve obtained through smooth Bezier shows similar behaviour as in x=8 above but of bigger observable magnitudes. The initial tendency from 10-15 relays where the model fits, is increasing exponential with equation:

$$F(x)=-120 * \exp(-0.40*(x-2)) + 11.5$$

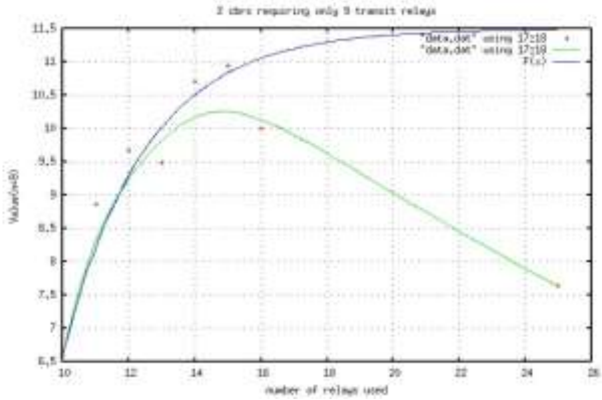

Fig 9: Trend Analysis of V(n=9).

Beyond 15 relays, the curve shows decreasing tendency. This marks a significant change in category of model being followed. The major reason for it is that as relay density increases, even those nodes which were having insignificant mobility now have very significant impacts on number of transit relays. More refined studies could suggest different models being followed and hence remains an avenue for further research.

The minimum value observable is 6.59 and maximum value reached is 10.95, giving a range of 4.36.A tailor-made communication policy here may prove important for large relay densities. It may prove optimal for relay numbers 14, 15 and 16.

10. For x=10

Relays	11	12	13	14	15
V(n=10)	6.21	7.13	9.06	8.60	9.13

Relays	16	25
V(n=10)	9.76	7.27

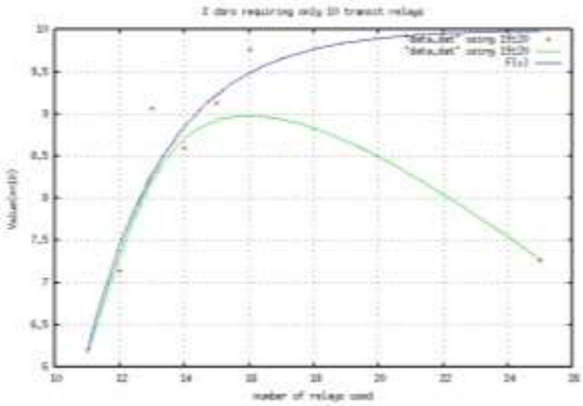

Fig 10: Trend Analysis of V(n=10).

The curve obtained through smooth Bezier is similar to above where x=9. The initial tendency from 11-16 relays, where the model fits, is increasing exponential with equation

$$F(x)=-140 * \exp(-0.40*(x-2)) + 10$$

Beyond 16 relays, the curve shows decreasing tendency. The minimum value observable is 6.21% and the maximum is 9.76% giving a range of 3.55 (very small range). Again a tailor-made communication policy here may prove optimal for high node densities (around 15 to 16)

11. For *x*=11

Relays	12	13	14	15	16
V(n=11)	4.22	5.33	6.56	6.38	6.57

Relays	25
V(n=11)	9.65

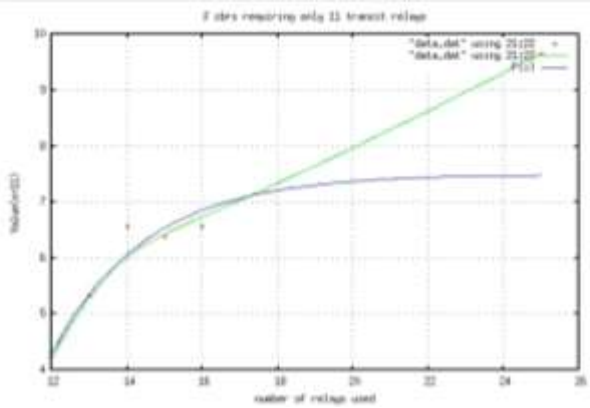

Fig 11: Trend Analysis of V(n=11).

For this study, lesser data was available but plot is quite interesting. The curve obtained through smooth Bezier depicts increasing tendency. A fitting curve equation is

$$F(x)=-175 * \exp(-0.40*(x-2)) + 7.5$$

The last pair of data (25,9.65) is quite exceptionally high. Its effect could have reduced if more data was available for number of relays between 16 and 25. It has thus been considered with a dampened importance.

It can also be put forward that a tailor-made communication policy here is having increasing success rate at higher node densities which tends towards stabilisation to around 7.5% to 8%.

12. For *x*=12

Relays	13	14	15	16	25
V(n=12)	1.75	3.57	5.29	4.67	6.27

Here also, less data is available but plot is successful. Curve obtained through smooth Bezier depicts increasing tendency throughout, with equation

$$F(x)=-175 * \exp(-0.33*(x-2)) + 6.5$$

Here also, tailor-made communication policy will have increasing success rate at higher node densities stabilising to 6.5%-7%

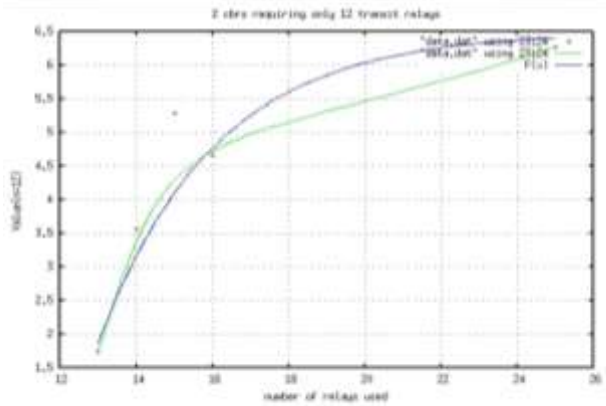

Fig 12: Trend Analysis of V(n=12).

Note: It will not be appropriate to study for values of *x* greater than 12, since there will be fewer sets of data and reliability of graphical plotting will be reduced.

These sets of observations will serve towards producing policies of how much resource reservations need to be carried out at each neighbour relay when the transmitting node is at its n^{th} transit relay.

3.4 Specific Observations of Results.

i. All trends observed have fitted exponential model of the form

$$F(x) = c * \exp(-d*(x-2)) + f$$

The parameters c, d and f do however not vary in any observable trends as value of *x* varies.

ii. However, two categories of the exponential model have been found. For values of *x* ranging from 1 until 7, a clear-cut decreasing exponential curve is obtained. For values of *x* ranging from 9 until 12, a clear-cut increasing exponential model is observed. For value of *x* 8, a combination of increasing model in the beginning, followed by a decreasing model is observed.

This suggests that, as relay density increases above 8 over topography of 300x300 m^2, more CBRs require more relays as first transit Relay during their respective nodes' mobility.

This may also be a ground for further experimentation open to discover better models applicable as from 8 relays and above.

iii. As evolution of success rate for tailor-made communication policies, 3 ranges of behaviour have been identified as relay density increases.

a. For values of *x* between 2 and 8, the projected success rate for tailor-made communication policy starts at a high value 11.5% and mostly decreases till 3.6%.

b. For values of *x* between 9 and 10, the optimal success rate is at relay number around 16.

c. For values of *x* between 11 and 12, the tailor-made communication policy is projected to have higher success rates at higher node densities.

4. Conclusion.

This piece of study is a follow-up from a previous paper titled "Model of energy savings achieved with Location-aware Node-to-Node Transmission in Ubicomp". This conclusion, hence, adds to the conclusion of the previous paper. The nature of the study of this research has been to study 24 experiments sets and hence explains the vast number of graphs obtained.

This piece of study is a follow-up of 4 previous papers [1-4]. The nature of this study has been to study several sets of experiments, compile data from each experiment, formulate graphs and equations of curves, hence the presence of the number of graphs in this paper.

This piece of research has investigated the need for exact number of transit relays for transmission and produces a support model which can help to formulate policies of resource reservations in neighbour relays. The model which has very convincingly been applicable is an exponential model of the form

$$F(x) = c * \exp(-d*(x-2)) + f$$

This model will assist in prediction in a MAUC environment and preparing more refined groundwork for more advanced experiments. It can also serve in formulating base models to build appropriate communication policies against a known projected model of success rate or as a reference against which some reliability features of MAUC can be rated. It can ultimately help in formulation of appropriate metrics and new architecture support in a MAUC.

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About Author (s):

Associate Professor Nawaz Mohamudally works at University of Technology, Mauritius and has undertaken supervision of MPhil/PhD Students for many years.

M. Kaleem Galamali is a part-time student at University of Technology, Mauritius under the supervision of A.P. Nawaz Mohamudally.