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Investigation of Prominence of Placements of Relays in Ubicomp Topography with location-aware transmission.

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***Abstract*–The benefits of introducing relays in aubicomp topography are very well accepted: Relays can provide support for communication, for location tracking, and more importantly, efficient reduction in energy consumption by transmitting nodes by reducing coverage areas [4]. However, most benefits are for thr transmitting nodes in the topography. The relay densities and their placements have significant impacts on energy containment [4] and % data transiting through it. Adding new powerful relays at wrong placements may not have significant return on investment. There is need to know the evolution of these impacts to better cater for planning of relay powers and their efficiencies, future upgrades, acceptability of continued use of lower power relays at lesser prominent locations or reshuffling relays of different powers to better suit data flow densities. Results of this study can also be used towards optimisation of relay densities or build new arrangements/architecture of relays over which experimentations can continue.**

This paper is a follow-up of 6 previous papers [1-6] aimed at producing models of behaviours in aubicomp environment and energy savings achievable.The objective of this paper is to present one set of behaviour patterns for amount of data reaching each relay as transit relay over a topography with increasing relay densities, in form of graphs and tabular summaries of data, following which conclusions are drawn.

Key terms: MAUC-Mobile and Ubiquitous Computing, CBR-Constant Bit Rate, DOoP-Descending Order of Prominence, CPN-Corresponding Power Needs, PDT-Percentage Data Transits, PR-Prominence Ratios, Transit Relay-1st relay of transmission reached by sender node, CPoI-Central Point of Intersection.

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1. Introduction

1.1 Brief of Relays.

There is no doubt that relays in a wireless topography has several advantages for communicating nodes. This, however, will **NOT** directly imply the following:

i. Putting a number of equally powerful relays in a uniform positioning will be of significant return. Put differently, all relays will be of same importance.
ii. Investment has to be done massively at one time to put maximum number of relays. There should be a basic "optimal number" of relays placeable and upgradable gradually over the months and years.
iii. Relays getting old over time are completely useless. They could still be useful at lesser prominent places.
iv. Fault tolerance for relays involves directly multiplying the relay density by 2 or more. Fault tolerance strategies can be enforced cost-effectively at high prominence places instead of low prominence places.

1.2What is needed?.

As ubicomp designers, there is a need to know the behaviour of the ubicomp data transiting through each relay in the form of relative prominence ratios which can be used for further development.

More importantly, there is need to formulate a method for observing the behaviour of ubicomp data transiting through each relay, starting from a simulation platform, since the behaviour will be different for different topologies. After thorough observations, upper bounds and lower bounds of tendencies of behaviours could be noted and hence reduce the margin of uncertainties due to random node movements and communications.

1.3Purposes of this Study..

The results of this study may be used for the following:

i. Providing a scientific method for knowing prominence of placements of relays in a real topography.
ii. Following part (i) above, cost-effective investments of relay processing powers can be provided by the designers.

iii. Providing appropriate continued usage of old relays.
iv. More strategic and cost-effective fault tolerance provisioning.
v. Following known bounds of behaviour, appropriate guidelines for formulating communication policies could be put forward.
i. Formulation of omission criteria for relays starting from high relay densities.

The key contribution of this paper is to provide one set of behaviour pattern of prominence of relays in a ubicomp topography of 300 x 300 m^2, using varying number of relays, and after plotting results graphically. Observations and conclusions concerning prominence of placements of relays will be made followed by identification of new areas of research recommended.

The rest of this paper is organised as follows: section 2-Implementation Processing for this Study, section 3-'Results and observations' subdivided in two main sections: 3.1-Trend Analyses of % prominence of relays, 3.2-Specific Observations and Formulations, section 4- Conclusion and References.

2.Implementation Processing for this Study.

The data to be collected for this study had already been identified during studies in preceding paper [4]. For each movement scenario running for each number of relays (1-17 and 25), additional algorithms have been added to track the following:

i. Amount of data transiting through each relay as being the first relay for the data.
ii. For each CBR, how many packets are transiting through each relay as the first relay.

Each of the above is saved in a separate file. For each movement and relay, the amount of data transiting through each relay is taken, and the corresponding percentage of total traffic received by relays directly from sending nodes, is computed and saved in a summary file.

The positioning of the relays are as described in previous paper [2].

3.Results and observations-Prominence of Relays

3.1 Trend Analyses of % Prominence of Relays.

1. Using 1 relay only.

When only 1 relay is used, it is centrally placed in the topography (or it can be placed any other place), All transmissions will however transit through that relay. Percentage transmissions will remain 100%. Using one relay only, is hence not suitable to start a study on prominence of placements of relays.

2. Using 2 relays.

The percentage of data transiting through each relay for the 60 movement scenarios experimented, are as follows (plotted in gnuplot).

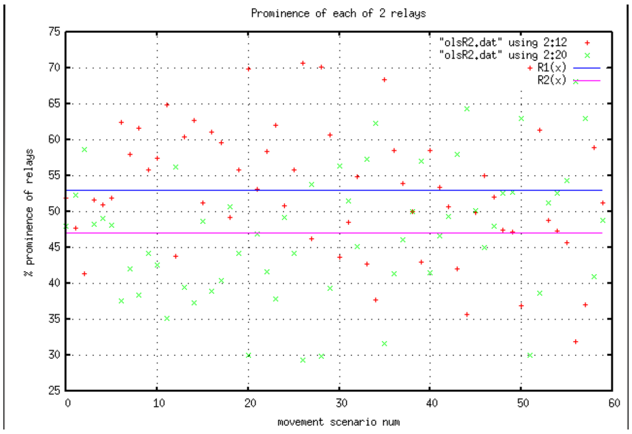

Fig 2: Variation of %Prominence Values across movement scenarios – 2 relays

Although the values show fluctuations, the average values of PDT have been generated using the fit command in gnuplot. This procedure will be repeated in successive observations.

Relays	R1	R2
PDT	53.00	47.00
PR	1.13	1.00-

The Prominence Ratio (PR) is 1.13:1 which mostly depicts equal share of importance. There is some more communication on the left side of the topography (R1). It gives indication that the left side would be more open for future enhancements and Relay R1 may possibly be more powerfully equipped, if this arrangement is decided.

3. Using 3 relays.

The PR is 1.00:1.34:1.35. it shows that if such an arrangement is to be used, Relay R2 and R3 must be more powerfully equipped than R1 by at least 35-40%. R2 and R3 are of roughly same importance. Definitely, addition of a third relay greatly helps in sharing the load of the data transiting through relays.

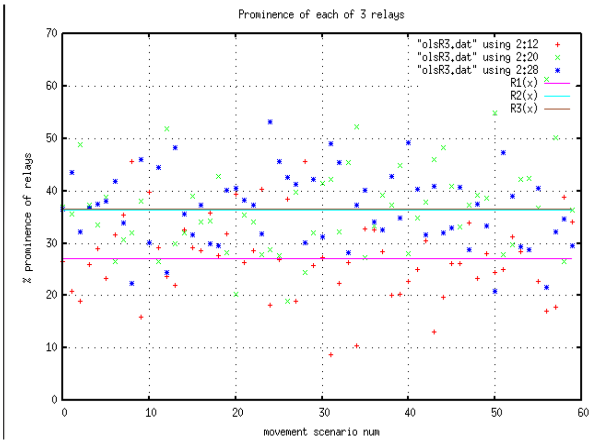

Fig 2: Variation of %Prominence Values across movement scenarios – 3 relays

Relays	1	2	3
PDT	27.1	36.4	36.5
PR	1.00	1.34	1.35

4. Using 4 relays.

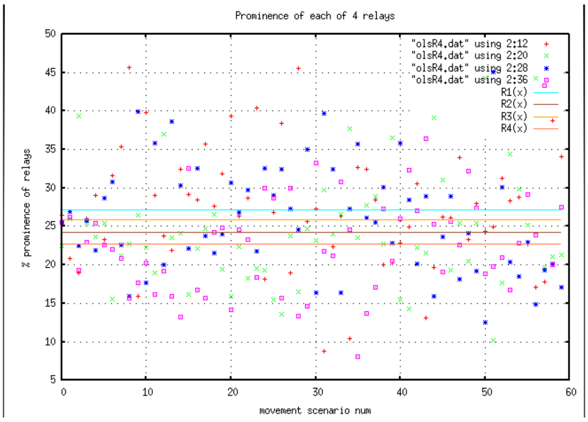

Fig 3: Variation of %Prominence Values across movement scenarios – 4 relays

Relays	1	2	3	4
PDT	27.1	24.25	25.9	22.75
PR	1.19	1.07	1.14	1.00

This result show that there is commendable progress reached in adding the 4th relay. A lot of traffic alleviations happen at R2 and R3.

The difference in ratios do however not indicate if any relays could be removed and remaining relays be rearranged. In this scenario, more traffic occurs at R1.

5. Using 5 relays.

Relays	1	2	3	4	5
PDT	14.16	24.02	15.90	14.43	30.89
PR	1.00	1.70	1.12	1.02	2.18

The results show that situations start changing. Particular relays of much higher importance than others can be depicted, delimiting better the "zones" of prominences. Here R5 is having more traffic because it is covering for a larger span.

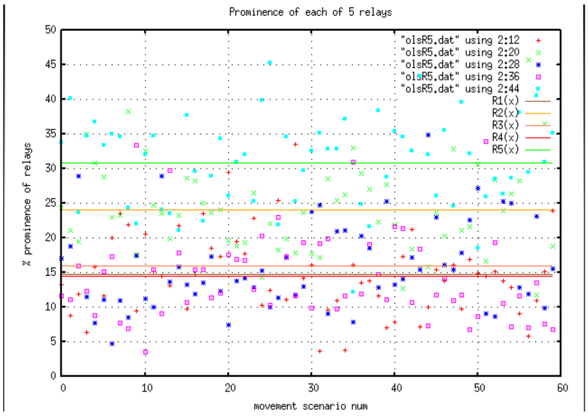

Fig 4: Variation of %Prominence Values across movement scenarios – 5 relays

6. Using 6 relays.

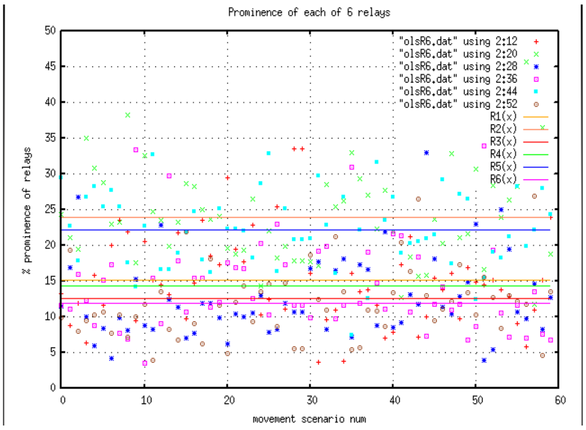

Fig 5: Variation of %Prominence Values across movement scenarios – 6 relays

Relays	R1	R2	R3	R4	R5
PDT	15.08	23.92	12.55	14.30	22.17
PR	1.26	2.00	1.05	1.20	1.85

Relays	R6
PDT	11.96
PR	1.00

Observations from part 5 above continue. Some relays seem to be much more prominent than others. R2 is literally twice more important than R6, in terms of volume of traffic to handle. It can now be put to question: "Can the energy savings performance be achieved using lesser number of relays?". Relays R6 and R3 seem good candidates to be omitted, following which experimentations of its energy savings potentials can be carried out, at a later stage.

7. Using 7 relays.

Relays	R1	R2	R3	R4	R5
PDT	8.53	11.88	6.76	12.14	30.43
PR	1.26	1.76	1.00	1.80	4.50

Relays	R6	R7
PDT	17.70	12.56
PR	2.62	1.86

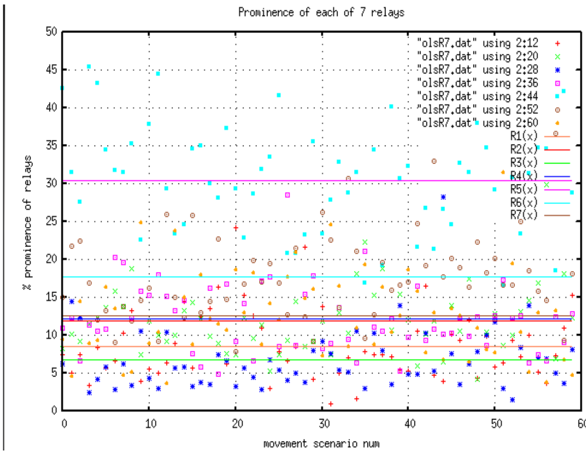

Fig 6: Variation of %Prominence Values across movement scenarios – 7 relays

Here also, some relays are more prominent than others. Here R5 is having more traffic because of the larger span of area it is covering above R5 and on the right of R7. The DOoP is R5, R6, R7, R4, R2, R1, R3. This shows that R3 and R1 are candidates for omission. If a third omission is decided, then it will be R2.

This observation gives rise to the notion of central axes in a topography: R4, R5 and R6 are along the horizontal central axis whereas R2, R5 are along the vertical central axis. The hypothesis is put forward: Prominence of Relays tend to increase as the relays are placed closer to the central axes or their CPoI and the prominence values tend to decrease with increasing distance of placement of the relays and the CPoI. This will be studied in following sections also.

8. Using 8 relays.

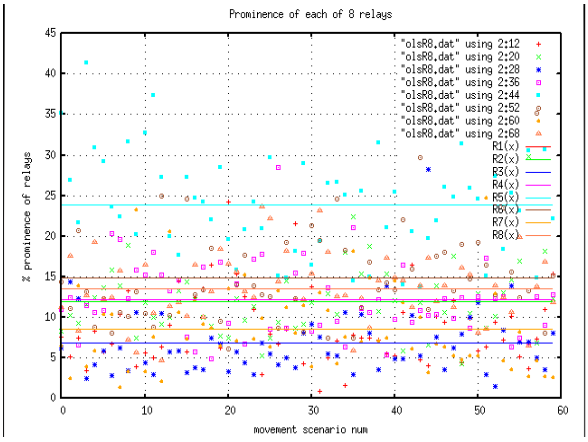

Fig 7: Variation of %Prominence Values across movement scenarios – 8 relays

Relays	1	2	3	4	5
PDT	8.53	11.88	6.76	12.14	23.83
PR	1.26	1.76	1.00	1.80	3.53

Relays	6	7	8
PDT	14.88	8.52	13.45
PR	2.20	1.26	1.99

One observation here is that addition of R8 is reducing quite a lot the load on R5 from previous scenarios. This gives further grounds to the concept of central axes in aubicomp being more prominent positions.

9. Using 9 relays.

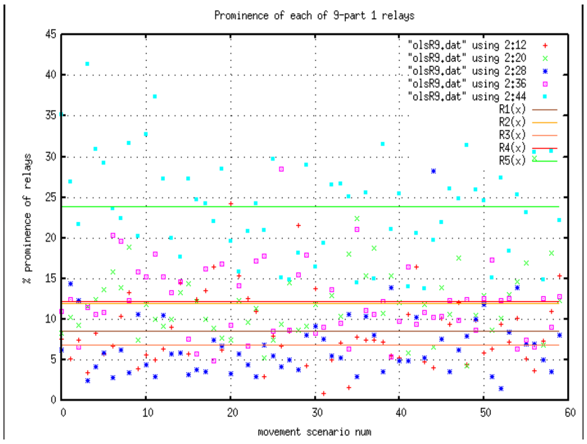

Fig 8a: Variation of %Prominence Values across movement scenarios – 9 relays (R1-R5)

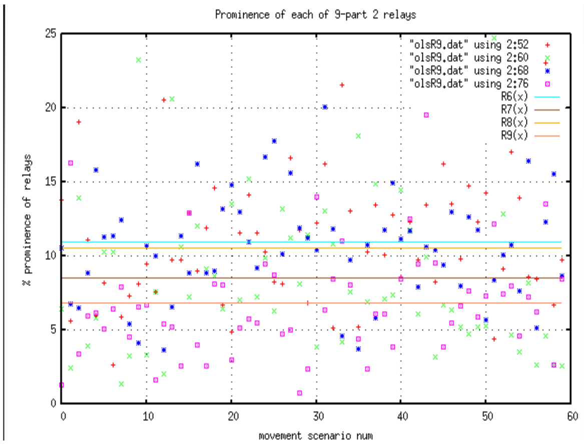

Fig 8b: Variation of %Prominence Values across movement scenarios – 9 relays(R6-R9)

Relays	1	2	3	4	5
PDT	8.53	11.88	6.76	12.14	23.83
PR	1.26	1.76	1.00	1.80	3.53

Relays	6	7	8	9
PDT	10.97	8.52	10.56	6.80
PR	1.62	1.26	1.56	1.01

Here again, some relays seem to be much more important than others. R5, located at the CPoI, is 3.5 times more important than R3, located at a corner furthest from the CPoI.

Hypothetic scenarios of reduced number of relays producing high performance in terms of energy savings are put forward as follows:

i. For 8 relays only, R3 can be omitted and the scenario can be comparable/better than 8 uniform relays.
ii. For 7 relays only, R3 and R9 can be omitted and the scenario can be comparable/better than 7 uniform relays.
iii. For 6 relays only, R3, R9 and R7 can be omitted and the scenario can be comparable/better than 6 uniform relays.
iv. For 5 relays only, R3, R9, R7 and R1 can be removed and the scenario can be comparable/better than depicted in 5 uniform relays. This scenario will depict 5 relays placed along central axes in the topography.

By placing these relays at more strategic locations, it is expected that more energy savings can be reached than with uniform positioning.

10. Using 10 relays.

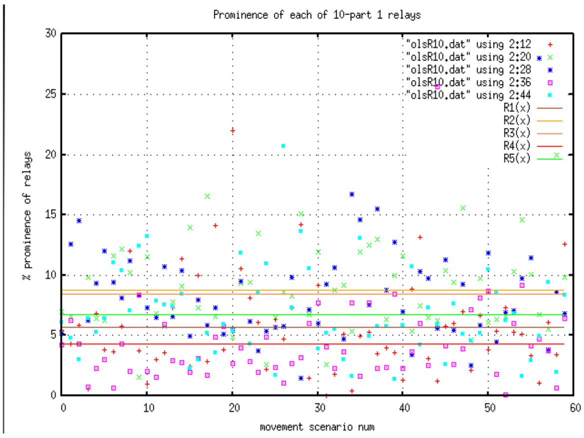

Fig 9a: Variation of %Prominence Values across movement scenarios – 10 relays(R1-R5)

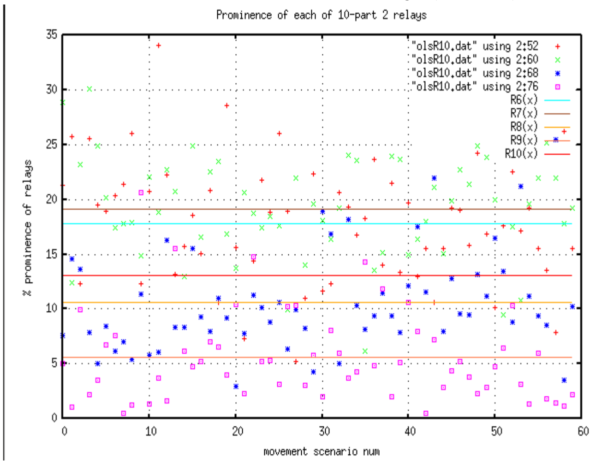

Fig 9b: Variation of %Prominence Values across movement scenarios – 10 relays(R6-R10)

Relays	R1	R2	R3	R4	R5
PDT	5.67	8.78	8.41	4.32	6.71
PR	1.31	2.03	1.95	1.00	1.55

Relays	R6	R7	R8	R9	R10
PDT	17.84	19.11	10.59	5.54	13.03
PR	4.13	4.42	2.45	1.28	3.02

Here R4 and R7 are covering wider area and hence show greater prominence. Studies until 12 uniform relays should be made before re-arrangements of fewer relays are carried out.

11. Using 11 relays.

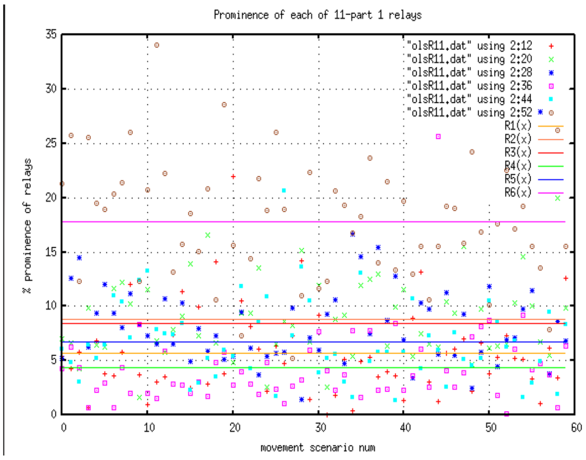

Fig 10a: Variation of %Prominence Values across movement scenarios – 11 relays(R1-R6)

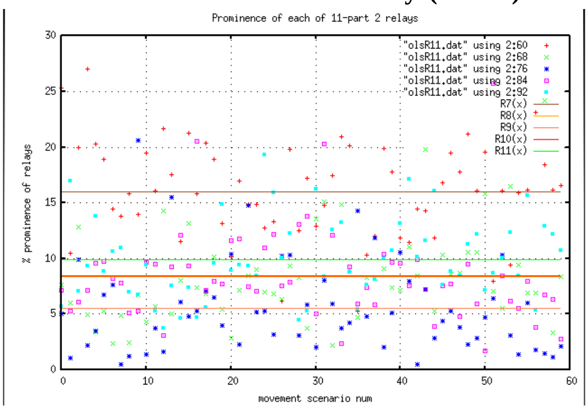

Fig 10b: Variation of %Prominence Values across movement scenarios – 11 relays(R6-R11)

Relays	R1	R2	R3	R4	R5
PDT	5.67	8.78	8.41	4.32	6.71
PR	1.31	2.03	1.95	1.00	1.55

Relays	R6	R7	R8	R9	R10
PDT	17.84	16.00	8.37	5.54	8.47
PR	4.13	3.70	1.94	1.28	1.96

Relays	R11
PDT	9.90
PR	2.29

12. Using 12 relays.

Relays	R1	R2	R3	R4	R5
PDT	5.67	8.78	8.41	4.32	6.71
PR	1.31	2.03	1.95	1.00	1.55

Relays	R6	R7	R8	R9	R10
PDT	17.84	16.00	6.40	5.54	8.47
PR	4.13	3.70	1.48	1.28	1.96

Relays	R11	R12
PDT	7.27	4.60
PR	1.68	1.06

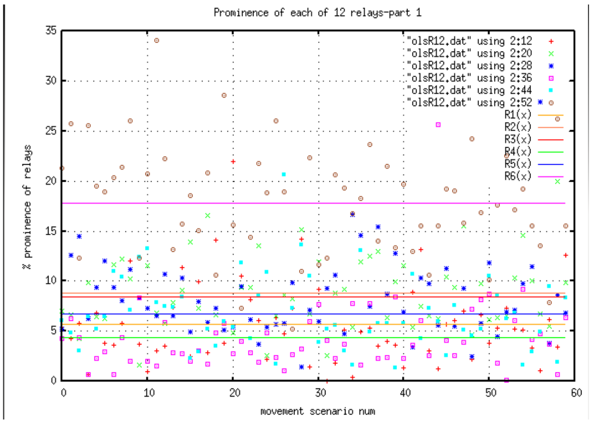

Fig 11a: Variation of %Prominence Values across movement scenarios – 12 relays(R1-R6)

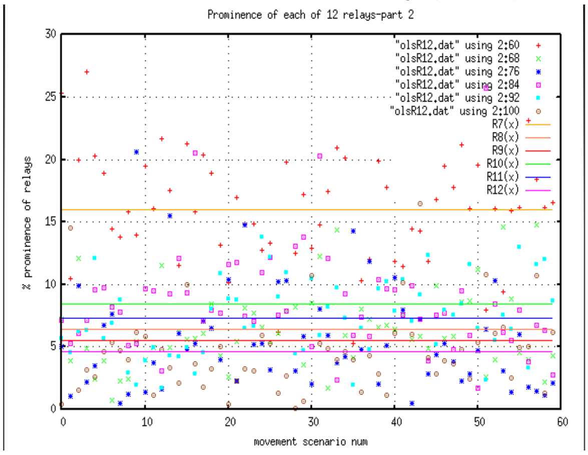

Fig 11b: Variation of %Prominence Values across movement scenarios – 12 relays(R6-R12)

Hypothetic scenarios of reduced numbers of relays producing high performance in terms of energy savings are put forward as follows:

i. For 9 re-arranged relays only, R9, R12 and R4 can be omitted.
ii. An 8 relays arrangement may also be obtained by further removing R1.

Processing experimentations to investigate whether the above two re-arrangements give good performance is also recommended to be undertaken.

13. Using 13 relays.

Relays	R1	R2	R3	R4	R5
PDT	4.14	4.97	4.67	3.05	5.04
PR	1.36	1.63	1.63	1.00	1.65

Relays	R6	R7	R8	R9	R10
PDT	12.96	11.69	4.85	4.77	15.41
PR	4.25	3.83	1.59	1.56	5.05

Relays	R11	R12	R13
PDT	15.31	7.42	5.73
PR	5.02	2.43	1.88

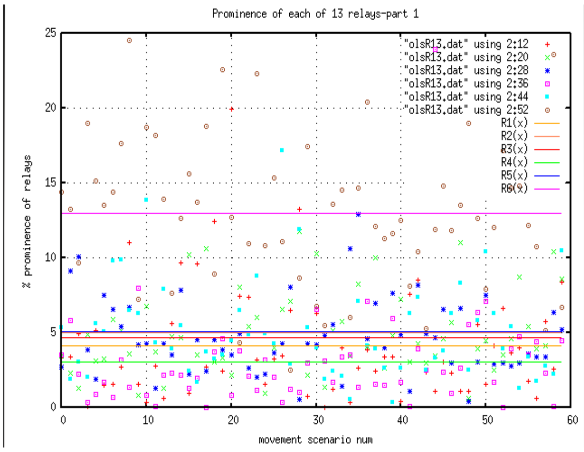

Fig 12a: Variation of %Prominence Values across movement scenarios – 13 relays(R1-R6)

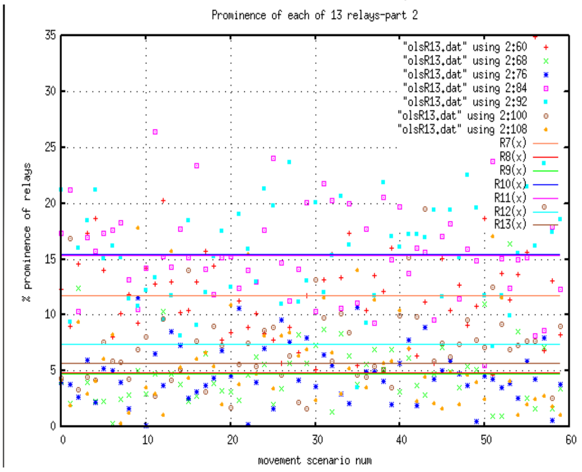

Fig 12b: Variation of %Prominence Values across movement scenarios – 13 relays(R7-R13)

Studies until 16 relays is felt desirable before finding re-arrangements of fewer relays giving better performance.

14. Using 14 relays.

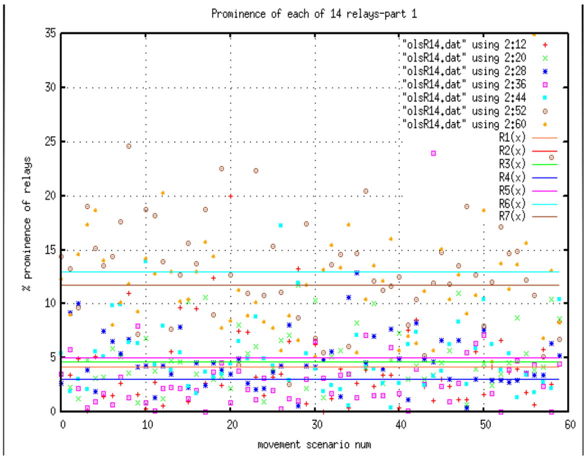

Fig 13a: Variation of %Prominence Values across movement scenarios – 14 relays(R1-R7)

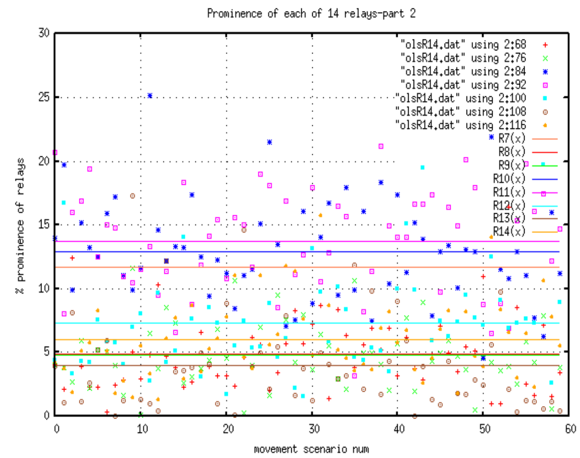

Fig 13b: Variation of %Prominence Values across movement scenarios – 14 relays(R7-R14)

Relays	R1	R2	R3	R4	R5
PDT	4.14	4.97	4.67	3.05	5.04
PR	1.36	1.63	1.53	1.00	1.65

Relays	R6	R7	R8	R9	R10
PDT	12.96	11.69	4.85	4.77	12.90
PR	4.25	3.83	1.59	1.56	4.23

Relays	R11	R12	R13	R14
PDT	13.70	7.34	3.96	5.97
PR	4.49	2.41	1.30	1.96

15. Using 15 relays.

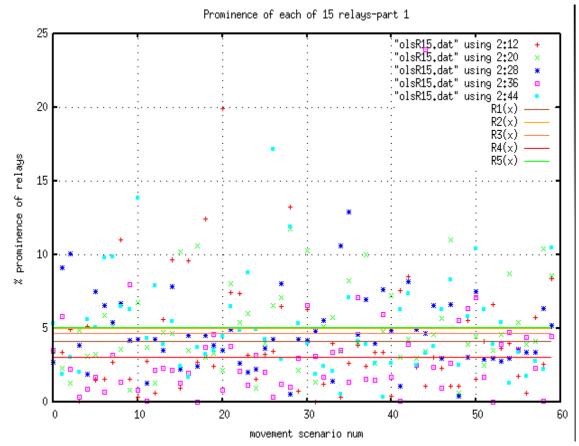

Fig 14a: Variation of %Prominence Values across movement scenarios – 15 relays(R1-R5)

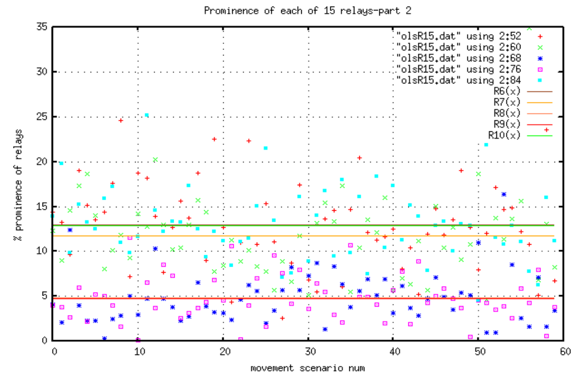

Fig 14b: Variation of %Prominence Values across movement scenarios – 15 relays(R6-R10)

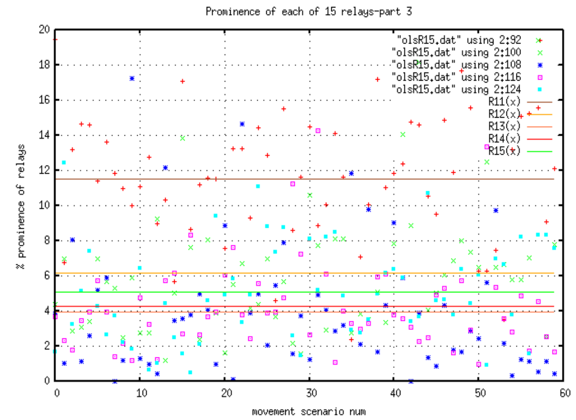

Fig 14c: Variation of %Prominence Values across movement scenarios – 15 relays(R11-R15)

Relays	R1	R2	R3	R4	R5
PDT	4.14	4.97	4.67	3.05	5.04
PR	1.36	1.63	1.53	1.00	1.65

Relays	R6	R7	R8	R9	R10
PDT	12.96	11.69	4.85	4.77	12.90
PR	4.25	3.83	1.59	1.56	4.23

Relays	R11	R12	R13	R14	R15
PDT	11.52	6.15	3.96	4.26	5.08
PR	3.78	2.02	1.30	1.40	1.67

16. Using 16 relays.

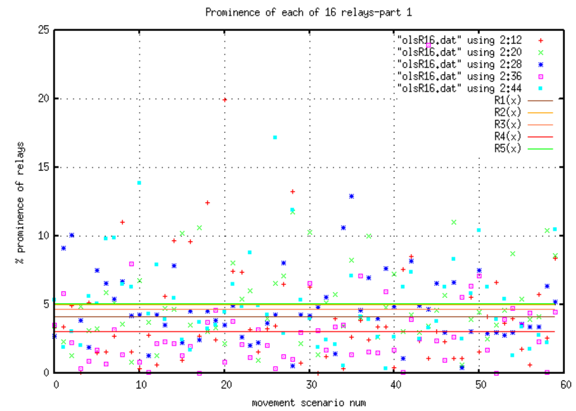

Fig 15a: Variation of %Prominence Values across movement scenarios – 16 relays(R1-R5)

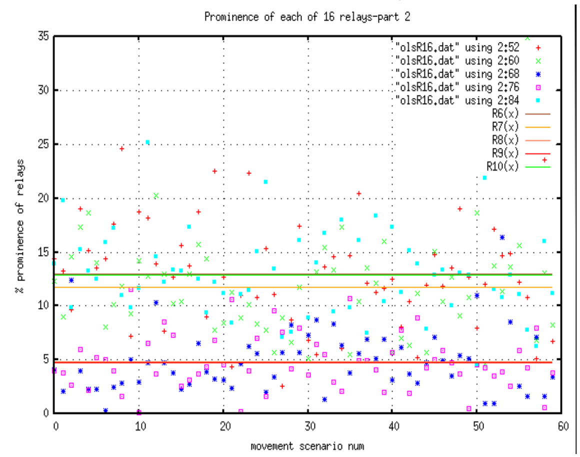

Fig 15b: Variation of %Prominence Values across movement scenarios – 16 relays(R6-R10)

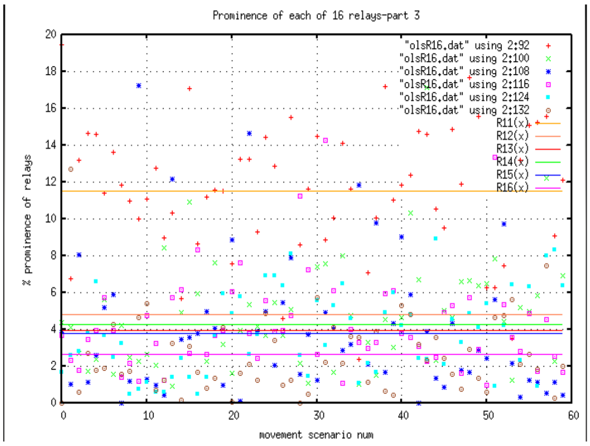

Fig 15c: Variation of %Prominence Values across movement scenarios – 16 relays(R11-R16)

Relays	R1	R2	R3	R4	R5
PDT	4.14	4.97	4.67	3.05	5.04
PR	1.57	1.89	1.76	1.16	1.92

Relays	R6	R7	R8	R9	R10
PDT	12.96	11.69	4.85	4.77	12.90
PR	4.93	4.44	1.84	1.81	4.90

Relays	R11	R12	R13	R14	R15
PDT	11.52	4.79	3.96	4.26	3.81
PR	4.38	1.82	1.51	1.62	1.45

Relays	R16
PDT	2.63
PR	1.00

Here again, some relays seem much more important than others. Hypothetic scenarios of reduced numbers of relays producing high performance in terms of energy savings are as follows:

i. 12 relays by omitting R16, R4, R15 and R13.
ii. 11 relays by further omitting R1.
iii. 10 relays by further omitting R14.
iv. 9 relays by further omitting R3.

Again, processing experimentations to investigate the above stated hypothesis is recommended.

17. Using 25 relays.

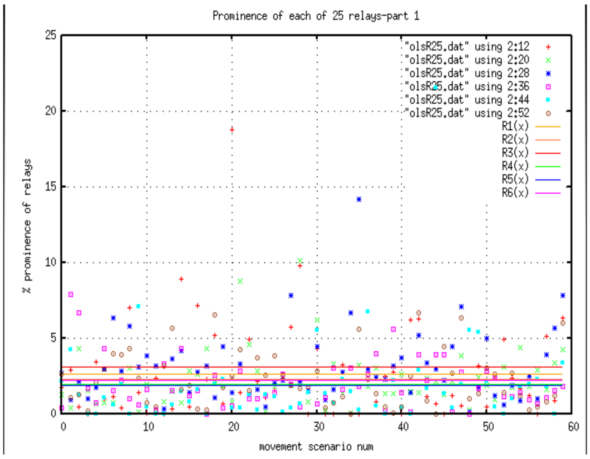

Fig 16a: Variation of %Prominence Values across movement scenarios – 25 relays(R1-R6)

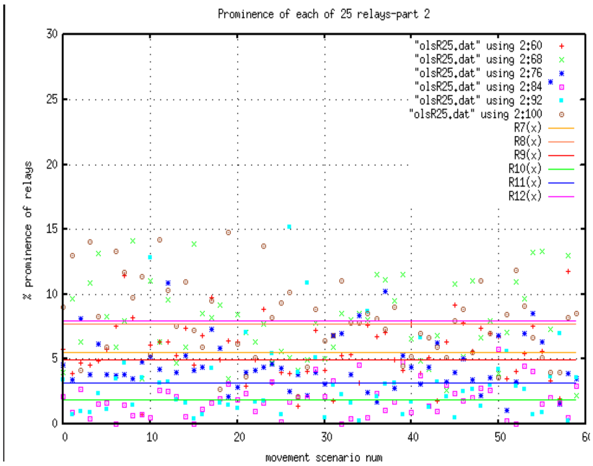

Fig 16b: Variation of %Prominence Values across movement scenarios – 25 relays(R6-R12)

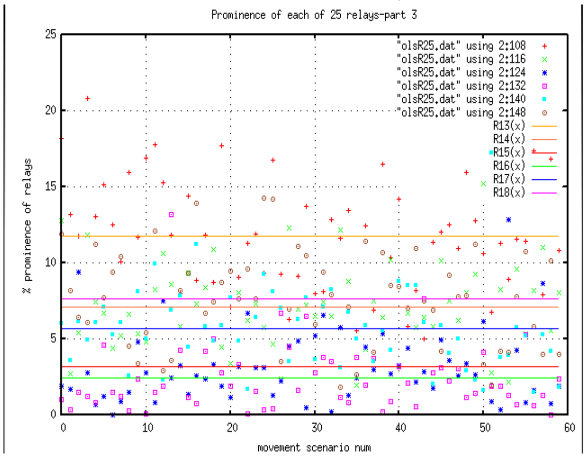

Fig 16c: Variation of %Prominence Values across movement scenarios – 25 relays(R13-R18)

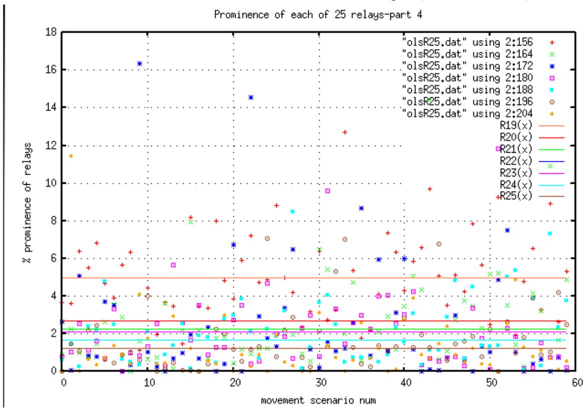

Fig 16d: Variation of %Prominence Values across movement scenarios – 25 relays(R19-R25)

Relays	R1	R2	R3	R4	R5
PDT	2.60	2.29	3.11	1.96	1.88
PR	2.15	1.89	2.57	1.62	1.55

Relays	R6	R7	R8	R9	R10
PDT	2.25	5.56	7.72	4.92	1.89
PR	1.86	4.60	6.38	4.07	1.56

Relays	R11	R12	R13	R14	R15
PDT	3.14	7.96	11.77	7.13	3.17
PR	2.60	6.58	9.73	5.89	2.62

Relays	R16	R17	R18	R19	R20
PDT	2.43	5.67	7.65	4.96	2.66
PR	2.01	4.69	6.32	4.10	2.20

Relays	R21	R22	R23	R24	R25
PDT	2.25	2.07	2.08	1.67	1.21
PR	1.86	1.71	1.72	1.38	1.00

Here again, and even more clearly, certain relays are much more important than others. The first 10 relays in DOoP are bringing big contributions. Hypothetic scenarios of reduced numbers of relays producing high performance in terms of energy savings are as follows:

i. 16 relays, omitting the last 9 relays in DOoP.
ii. 15 relays, omitting the last 10 relays in DOoP.
iii. 14 relays,omitting the last 11 relays in DOoP.
iv. 13 relays,omitting the last 12 relays in DOoP.

Again,Processing experimentations to investigate the above stated hypothesis is recommended.

<u>*3.2 Specific Observations and Formulations.*</u>

1. *Procedure for finding Optimal numbers of most prominent relays.*

   Study from part 1 until part 17 under section 3.1 has led to the formulation of a way of finding more prominent placements of relays. This procedure, initially introduced in previous paper [4], can be adopted in any circumstance of communication scenarios that are more adapted to real environment scenarios. The procedure may give different relays as being more prominent for different scenarios and topographies but overall, it should deliver more optimal placements for each topography and communication scenarios concerned. The procedure is as follows:

   i. Start from a maximum uniform distribution scenario like 6 relays, 12 relays, 20 relays or 25 relays. The number of relays will mostly be in the form n^2 or n(n-1).
   ii. Perform processing for energy savings achieved in the scenario as in previous paper [4] and retrieve amount of data transiting through each relay.
   iii. Following step (ii) above, % prominence of each relay in the scenario is calculated.
   iv. Then the DOoP of relays is arranged.
   v. From step (iv) above, reduction of lesser important relays can be made. The reduced number of relays should most probably be equal or above the previous number of maximum uniform distribution, e.g. if in step (iv) above, 25 relays were arranged, reduction until 20 relays can be achieved quite safely. Further reduction can be attempted on a trial basis and energy savings observed.
   It is felt important here that plausible omission criterion be put forward rather than doing hap hazard omission.
   vi. Simulation experiments for finding energy savings possible from the reduced number of relays can be run and performance evaluated.
   vii. Decisions of relays placements and future enhancement plans can follow from results from above steps.

   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 aubicomp environment with relays, it will definitely be successful towards increasing QoS.

2. *Suitability of Prominence along Central Axes.*

   It is observed here that relays along central axes in the topography have higher prominence. The relay found at the intersection of the two axes has highest prominence. The prominence values tend to decrease as a relay is found away from the central axes. Hence the central axes must be given more due consideration.

3. *All arrangements available for future upgrades.*

   All arrangements of reduced/optimised relays, may also serve as starting points or intermediate states considering expected future enhancement. This reinforces the need for understanding ubicomp node behaviour in a non-uniformly reduced relay density.

4. Conclusion.

This piece of work is a follow-up from 6 previous papers [1-6]. The nature of this investigation has been to study the average prominence ratios of relays following varying relay densities in aubicomp topography of 300 x 300 m^2. For each relay density scenario, the study was made over 60 different movement scenarios and hence graphical plot is used to display the results obtained.

This piece of study has provided one set of observations about prominence of uniform placements of varying number of relays. A workable idea of lower and upper bounds of % data transiting through each relay is obtained from the tabular displays. This may help designers better plan for relay capacities needed in a ubicomp topography. The differences in prominence ratios are also clear in each tabular result displays and possibilities of optimisations are also expressed wherever such possibilities have been identified. More such studies should be designed for better bounding of tendencies observable. A basic procedure for finding optimal number of relays has also been suggested followed by preliminary identification of prominence suitability along central axes.

Overall, this study has opened more avenues for research and analysis over optimised number of relays. Two avenues are suggested here: Trends of energy savings achievable and resulting prominence of relays used, both over optimised numbers of relays. Finally, these sets of studies will contribute towards formulating reliability models and accompanying metrics set for enhancements of ubicomp reliability features and architecture support needed in the near future.

References

[1] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Towards Dependable Pervasive Systems-A Position and Vision Paper, CEET 2014

[2] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Node-to-Node Transmission in UbiComp , CEET 2014

[3] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Node-to-Node Transmission in UbiComp Using Location Refresh Intervals, CEET 2014

[4] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Model of Energy Savings achievable with Location-aware Transmission in UbiComp Using Relays, CEET 2014

[5] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Mathematical modeling of need of exact number of relays to ensure seamless mobility in mobile computing, CEET 2014

[6] M. Kaleem GALAMALI, Assoc. Prof Nawaz MOHAMUDALLY, Modelling of need for multiple relays for ensuring seamless mobility, CEET 2014

[7] Markus Bylund and ZarySegall, Towards seamless mobility with personal servers, 2004.

[8] Masugi Inoue, Mikio Hasegawa, Nobuo Ryoki and Hiroyuki Morikawa, Context-Based Seamless Network and Application Control, 2004

[9] Xiang Song, UmakishoreRamachandran, MobiGo: A Middleware for Seamless Mobility, College of Computing Georgia Institute of Technology, Atlanta, GA, USA, August 2007

[10] Budzisz, Ferrús, R., Brunstrom A., Grinnemo, K, Fracchia, R., Galante, G., and Casadevall, F. Towards transport-layer mobility: Evolution of SCTP multihoming, March 2008

[11] Paul Dourish& Genevieve Bell, Divining a digital future, 2011.

[12] Xiang Song, Seamless Mobility In Ubiquitous Computing Environments, PhD Thesis, Georgia Institute of Technology, August 2008

[13] Kevin O Mahony, Jian Liang, Kieran Delaney, User-Centric Personalization and Autonomous Reconfiguration Across Ubiquitous Computing Environments, NIMBUS Centre Cork Institute of Technology, Cork, Ireland, UBICOMM 2012

[14] Pablo Vidales, Seamless mobility in 4G systems, *Technical Report, University of Cambridge*, Computer Laboratory, Number 656, November 2005

[15] João Pedro Sousa and David Garlan, Aura: An Architectural Framework for User Mobility in Ubiquitous Computing Environments, School of Computer Science, Carnegie Mellon University, USA, *August 2002*

[16] Dennis Lupiana, Ciaran O'Driscoll, Fredrick Mtenzi, Defining Smart Space in the Context of Ubiquitous Computing, Dublin Institute of Technology, Ireland, Special Issue on ICIT 2009 Conference - Web and Agent Systems, 2009

[17] N.S.V.Shet1, Prof.K.Chandrasekaran2 and Prof. K.C.Shet3, *WAP Based Seamless Roaming In Urban Environment with Wise Handoff Technique,* International Journal of UbiComp (IJU), Vol.1, No.4, October 2010

[18] Yipeng Yu Dan He WeidongHuaShijian Li Yu Qi Yueming Wang Gang Pan,FlyingBuddy2: A Brain-controlledAssistant for the Handicapped, Zhejiang University, *UbiComp'12,* September 5-8, 2012.

[19] Jing Su, James Scott, Pan Hui, Jon Crowcroft, Eyal de Lara Christophe Diot, AshvinGoel, Meng How Lim, and Eben Upton, Haggle: Seamless Networking for Mobile Applications, 2007

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