Asian Journal of Computer and Information Systems (ISSN: 2321 – 5658)
Volume 02 – Issue 03, June 2014

Development of an Access Point Positioning Algorithm under the Changing in Environment and Users' density Estimation

Twahir Kazema[1], Michael Kisangiri[2], Dina Machuve[3]

Nelson Mandela Institute, School of Mathematica Computatinal and Communication Science and Engineering,
Nambala, Arusha-Tanzania
Twahir Kazema
Email: kazemat {at} nm-aist.ac.tz

ABSTRACT— ***In many wireless networks a single hop is all that is needed or in fact tolerable. The physical region where network is available is known as a coverage area. Generally, a transmitter and a receiver may exchange data by using one or more intermediate relays. In each case a path through the network must be found whereby each hop has a Signal to Interference Noise Ratio greater than ß. There are several ways to describe and compute network connectivity, but at the core, they all need that individual pairs are able to communicate, which is dictated by the SINR. This paper is going to develop an Access Point positioning algorithm by considering the changes of environment and users' density estimation.***

Keywords--- SINR, beta, spatial, coverage

---

1. INTRODUCTION

A stochastic process is noise signal whose amplitude varies in time (or is a random variable / number) drawn from some probability distributions but it is also defined as a time signal where the value at any given time is a random variable. The origins of stochastic geometry can be traced back to two different sources. These are, on one hand, geometric probabilities and integral geometry, with their intuitive problems and imagined experiments, and on the other hand the investigation of real-world materials by stochastic-geometric methods, which in the beginning were often heuristic and required sound mathematical foundations. Any stochastic process may be described by a probability distribution, and may be thought of as the mapping of a sequence of random variable to a new set of states. Examples of systems that may be modeled by a stochastic process are stock markets, images, Brownian motion, landscapes, galaxies, cellular networks and cosmological density _fields. Although the term process first brings to mind a time series it can be generalized to any suitable parameter space. When the space is a spatial volume we refer to it as a spatial random _field.

2. STOCHASTIC GEOMETRY IN WIRELESS COMMUNICATION- RELATED WORK

Stochastic geometry is a powerful tool used to analyze and obtain the performance metrics of wireless networks with random topologies in a statistical manner. Stochastic geometry is a study of random spatial patterns such as:

- ✓ point processes
  (Branch of stochastic geometry which is used to statistically describe the spatial distribution of the network nodes)
- ✓ random tessellations
- ✓ stereology

Applications:

- ➢ astronomy
- ➢ communications
- ➢ material science
- ➢ forestry

A point process is a form of stochastic or random process. It may be thought of as a set of random points in a space, with a certain probability defined over the same space. The application of point process includes femto-cells, hotspots, relays, whitespace harvesters, and meshing approaches, which are often overlaid with traditional cellular networks.
An approach of providing high-capacity network access is characterized by randomly located nodes, irregularly deployed infrastructure, and uncertain spatial configurations due to factors like mobility and unplanned user-installed access points. Because spatial configurations may vary widely over an enormous (often infinite) number of possibilities, one cannot design most systems for each specific configuration but must instead consider a statistical spatial model for the node locations.
Performance of a system can be altered dramatically by altering base station configuration, where by correlation shadowing plays a significant factor on the wide range of performance. This case was investigated on indoor DS-CDMA system [1]. Evaluation of the impact of considering different types of correlation when developing shadow models for system level investigation where by link adaptation and adaptive radio resources management technique have been considered. Most models usually neglect cross-correlation of signals coming from different resources [2].
The PDF of the SINR for the downlink of a cell has been derived in a semi analytical fashion. It models an uncoordinated deployment of BSs which is particularly useful for the analysis in an indoor environment. The results also provide some insights into the performance of the indoor femto cells with universal frequency reuse. First, significant outage can be expected for a scenario where femto BSs are densely deployed in an in-building environment. This highlights that interference avoidance and mitigation techniques are needed. The isolation offered by wall penetration loss is an attractive solution to cope with the interference. Second, the SINR can be worsened by uncoordinated transmission powers of BSs. Thus, a coordination of BSs transmission power is needed to prevent a significant decrease in SINR[3] .
Random spatial models have become increasingly relevant for the dense and complex wireless networks that will emerge over the next decade. The attempt to give a high-level view of the importance of such models and how they can be applied to different types of wireless networks is needed. Much work on the fundamental mathematics, confirmation of the accuracy of the models in the various scenarios, and further application of spatial models to emerging candidate protocols and networks is also required. The most tractable results from stochastic geometry tend to rely on a few assumptions that may not accurately hold in practice[4] .

3. INVESTIGATION OF THE EFFECTS OF THE CHANGING IN ENVIRONMENT

The W-LAN environment is very complex, while there have been a great progress made in the speed and relieve in the implementation of Wi-Fi networks, the basic nature of radio frequency (RF) is generally unchanged. Still, increasing the number of users that can access the AP per unit area in a small physical space remains a challenge.
The changing of environment to an existing W-LAN like addition of partitions, change of building materials and population increase in an office and academic buildings (the indoor case). The growing of trees, construction of building structures and population increase (the outdoor case). These all affects much the W-LANs RF propagation and QoS in the sense that, the reflections of signals (EMW) back to its source and increasing of fading (absorption) of EMW. The channel access of W-LANs relies on direct sequence spread spectrum or frequency hop spread spectrum (DSSS/FHSS) which is a CDMA system. The CDMA system is affected with the near far effect (distance dependant) which raises the level of the noise floor of the system and its quality of service is highly affected when the number of users increases due to the codes generated by each user. The phenomenon above is supported with my simulations which show that, the SINR decreases as a function of distance in a small fraction but it affects much the probability of connectivity due to the changing in fading (channel characteristics).There are several methods which can solve this problem, this includes;

Table 1: Changing of Environment Technique

	Technique	**Effects**
1	Pre-planning the W-LAN	Its costly and time consuming
2	Increasing of an AP power (outdoor)	Causes co and adjacent channel interference
3	Installing another AP	Causes co and adjacent channel interference

However, using the spatial concepts; this paper will concentrate on solving the part 3 of the Table 1 with the aim of finding an optimal placement of an AP in a hotspot environment so as to eliminate co and adjacent channel interference.

4. ADJUSTMENT OF THE MODEL

As it is explained above, this part will concentrate on the placement of an AP under the hotspot environment. Based on the current situation, the changing in environment will almost need an addition of another AP. Its detrimental effect is co and adjacent channel interference. At this part, the focus is the interference caused by frequencies and interference caused by power. The below equation was developed under the stochastic (spatial) geometry; From the book "Stochastic Geometry and Wireless Networks" Volume I (theory) and Volume II (application) of F.Baccelli in 2009, [5] the equation was stated and derived. However the equation is applied in multi-hop networks (Cellular & Manet network).

$$2r^2\lambda_{\max}(r) = r^2{}_{\max}(\lambda).\lambda \qquad [1]$$

Where;

$r^2{}_{\max}(\lambda)$ = maximum radius for a given density

λ = expected density

$\lambda_{\max}(r)$ = maximum density of the maximum radius

r = expected AP location

5. SIMULATION ASSUMPTIONS

Based on the data obtained from the simulations before (*SINR and probability of connectivity simulations*)

$r^2{}_{\max}(\lambda)$ = The maximum radius is taken to be 15m, this is the point at which the EMW will propagate (cover) from a given AP in indoor environment.

$\lambda_{\max}(r)$ = The maximum density is taken as the ratio between maximum number of users (which is assumed to be n=20) and area of coverage, where by its radius is $r^2{}_{\max}(\lambda)$ =225m.

SIMULATION GRAPH

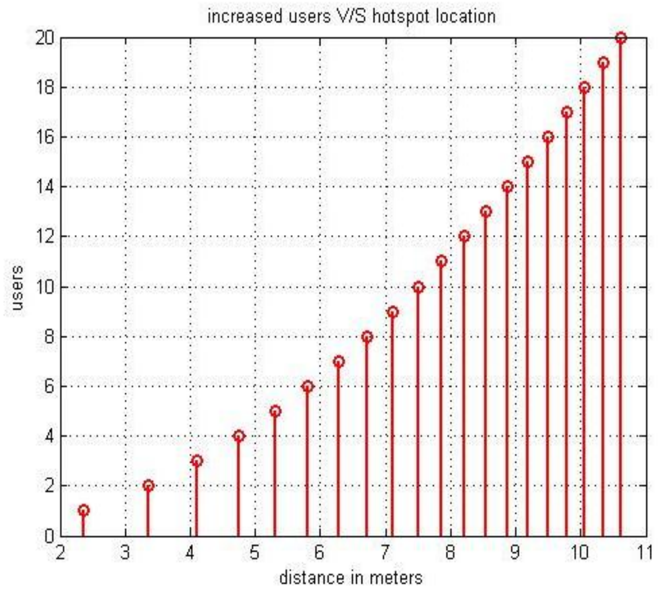


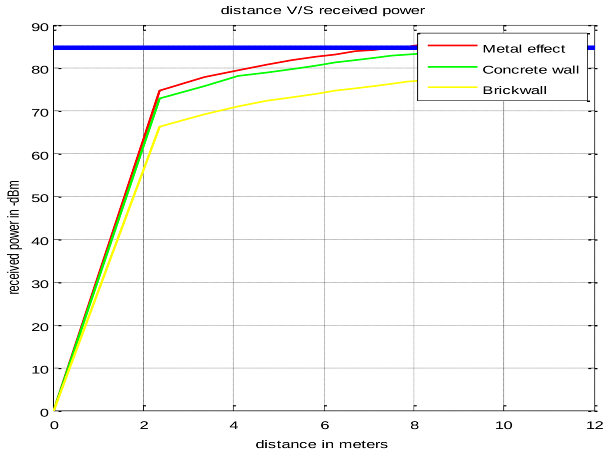
Figure 1: Preliminary Simulation

6. INTERPRETATION OF RESULTS

The equation is simulated under the assumptions given above. Under the assumptions of exceeding the maximum number of user that can access the given AP, the Y-axis represent the number of users that will appear above the maximum limit and the X-axis represents its respective distance of placing an AP. However, more concentration is between n=10 to n=20. At those points, the result shows that; an AP can be placed at a distance of 7.5 meters up to 10.6 meters. It is kept in mind that, we are trying to place an AP at a distance which will not cause interference to the existing Access Points (APs). The next part is for testing the validity of the simulated results.

7. TESTING THE RESULTS

The results were tested by considering the APs which are a major concern for this phenomenon. Three different environments were created as the testing scenarios. We state that, between the existing APs, the attenuation existing in the medium is a metal object, a brick wall and a concrete wall whereby free-space loss is applied to all scenarios. These are just assumption which may vary depending on the environment. On average most indoor APs have got a transmitted power of -18dBm and an average receiver sensitivity of -85dBm. The above values were used for the simulating the environment. The objective of creating this environment (testing) is to find an optimal (average) distance at which the power of AP (To be placed to the existing APs) will be below the receiver sensitivity of either the co-channel or Adjacent channel APs of the an already existing system. It should be known that, frequency and radiated power (from other W-LANs APs or Non W-LANs APs) contribute to a lot to interference.



8. INTERPRETATION (OF TESTING) OF THE RESULTS

The developed model seems to prove failure in W-LAN environment especially for smaller values of n (i.e. number of users less than ten). It is known that, in a hotspot environment it is very difficult to avoid intersections of EMWs of other W-LAN.

The testing results shows that, a distance of 7.86 meters and 9.77 meters for concrete and metal is where the receiver sensitivity is below the Co & Adjacent channels APs. For the brick wall, the assumptions were made only for one wall which isn't true for many circumstances. The effect of wall in many hotspot environments is always more than what I have assumed; this is due to random reflections that will occur along the wall itself which causes absorption and obstruction of EMW. However the maximum distance in that kind of environment is on average of (12 – 13) meters [6, 7]. From the above explanations, it is clear that; there is a need to create a condition on the existing model so that it will become applicable in W-LANs hotspot environment.

9. MODEL DEVELOPMENT ON CONDITIONING BASIS

It is known that, power is the main contributor of interference either on power basis or in frequency basis. Here to overcome this problem, a power condition has to be made. The effect of interference will be felt at an APs level when the power of an AP of either the one managed by our administrators or others W-LANs falls above the receiver sensitivity of another co or adjacent channel interferers. Hence, the model is conditioned on the basis of power being below the receiver sensitivity of co or adjacent channel interferers. The model is shown below with its condition function.

Abbreviations;

$r^2_{max}(\lambda)$ = maximum radius for the maximum density

λ = expected density

$\lambda_{max}(r)$ = maximum density for the maximum radius

r = expected AP location

$P_{t\text{-}AP}$ = transmitted power of an AP

R_{sens} = Receiver sensitivity of co & adjacent channels interference

f (r) = distance function of AP placement in an already existing W-LAN networks

FLS = free space path loss

P_{EAA}= Available environmental attenuation (walls, doors, shadowing effect etc)

$$f(r)=\left\{\sqrt{\frac{r^2{}_{\max}(\lambda).\lambda}{2\lambda_{\max}(r)}}\_\_if\_\_(P_{t-AP}-P_{total-pathloss}\prec R_{sens})\right\}\ f(r)=\left\{Invalid\_\_if\_P_{t-AP}-P_{total-pathloss}\geq R_{sens}\right\}$$

Elaboration of the functions

$$P_{total-pathloss}=P_{EAA}+FLS$$
$$FLS=20*\log_{10}(51.28f(r))$$

10. CONCLUSION

This paper has developed a model for placing an Access Point in highly low density areas. This is model can specifically solve the interference problems between AP cell in an indoor environment where, there is a higher percentage of concentration of users and Access Points but also it's a region which is highly susceptible to environment changes.
However, depending on the environment the model's application in concentrated areas might result to the occurrence of large intersection of cell, at this point a problem might be created in a MAC Layer (data link layer) especially for the co-channel APs.

11. REFERENCES

[1] Andrews, J. G., Ganti, R. K., Haenggi, M., Jindal, N., & Weber, S. (2010). A primer on spatial modeling and analysis in wireless networks. *Communications Magazine, IEEE, 48*(11), 156-163.

[2] Baccelli, F., & Blaszczyszyn, B. (2009). *Stochastic Geometry and Wireless Networks, Part I: Theory* (Vol. 1): Now Publishers Inc.

[3] Butterworth, K., Sowerby, K., Williamson, A., & Neve, M. (1998). *Influence of correlated shadowing and base station configuration on in-building system capacity.* Paper presented at the Vehicular Technology Conference, 1998. VTC 98. 48th IEEE.

[4] Kouhbor, S., Ugon, J., Kruger, A., & Rubinov, A. (2005). *Optimal placement of access point in WLAN based on a new algorithm.* Paper presented at the Mobile Business, 2005. ICMB 2005. International Conference on.

[5] Kouhbor, S., Ugon, J., Rubinov, A., Kruger, A., & Mammadov, M. (2006). *Coverage in WLAN with minimum number of access points.* Paper presented at the Vehicular Technology Conference, 2006. VTC 2006-Spring. IEEE 63rd.

[6] Monserrat, J., Fraile, R., Cardona, N., & Gozalvez, J. (2005). *Effect of shadowing correlation modeling on the system level performance of adaptive radio resource management techniques.* Paper presented at the Wireless Communication Systems, 2005. 2nd International Symposium on.

[7] Sung, K. W., Haas, H., & McLaughlin, S. (2010). A semianalytical PDF of downlink SINR for femtocell networks. *EURASIP Journal on Wireless Communications and Networking, 2010*, 5.