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PROBABILITY ANALYSIS OF MEAN COMMUNICATION RANGE FOR NAKAGAMI FADING IN WIRELESS ADHOC SENSOR NETWORK

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ABSTRACT-Mean communication range is one of important parameter of wireless Ad-Hoc networks which will judge the performance of wireless communication system. In order to make 100 percent efficient communication system, we must need to analyze the impact of fading medium on mean communication range. In present project work we are analyzing the impact of Nakagami-m fading medium as well as we are investing the effect of superimposed lognormal shadowing. We also present the simulation result with the help of MATLAB simulation tool. Complete numerical and simulated result will help to design more practical wireless Ad-Hoc network.

KEYWORDS: **Ad-Hoc network, mean communication range, Rayleigh fading, Nakagami-m fading, lognormal shadowing.**

1. INTRODUCTION

The growing interest in the field of self-organizing wireless networks, often referred to as *ad hoc*, has led to a considerable amount of literature dealing with the characterization of the limiting performance of such networks, in terms of both connectivity [1–4] and capacity [5–10], two intimately related issues [11]. Further, the results of one-dimensional case may be used to obtain bounds on the connectivity of networks in higher dimensions, although the resulting bounds are known not to be tight [2, 12]. In the literature, results for the connectivity of one dimensional network are presented in [2, 3, 12, 13]. . In this work, we show how we can enhance the model, in order to account for the presence of shadowing and/or fading phenomena on the network connectivity. Note that, in a two-dimensional framework, some results on the impact of channel randomness are known [14–16]. On the other hand, to the best of authors knowledge, no in-depth analysis of connectivity with node placement distributions other than uniform or Poisson has been presented so far. Further, note that, according to the results in [2, 17], we expect our analysis to hold with a good degree of approximation also for the case of *mobile* ad-hoc networks in the presence of a random waypoint mobility model. When we account for random channels, the notion of connectivity fades, due to the different propagation conditions that may be encountered in the forward and backward directions. In this case, we focus on the problem of broadcast percolation, where propagation of one message in the forward direction is studied. In this case, closed-form results may be obtained for the case of nodes distributed accorded to a Poisson point process. We focus on this distribution in order to keep the tractation simple and to gain insight into the impact of channel randomness on the connectivity properties of the resulting network.

By extensive literature survey we can make the conclusion that the reference paper [22] has done the analysis of the mean communication range for Rayleigh fading as well as lognormal superimposed Rayleigh fading but there is a lack of analysis of mean communication range for Nakagami-m fading which is more practical fading scenario than present one. In the present project work effect of Nakagami-m fading and superimposed lognormal shadowing on mean communication range is analyzed and discussed.

The remainder of the paper is organized as follows. In Section 2, the preliminary assumptions and model are provided. Analytical evaluation of mean communication range is presented in Section 3. Section 4 describes the numerical and simulation results. The paper is concluded in Section 5.

2. SYSTEM MODEL

The notion of "communication range", which had an immediate physical interpretation in the case of a deterministic channel model, becomes in this framework only a random variable whose distribution

characterizes the capacity of any node to percolate a broadcast message. In fading channels, the impact of the randomness due the Gaussian noise is usually negligible compared to the variation in SNR due to the fading process. We assume that the fading is constant over the transmission of a frame and subsequent fadings are iid (block-fading channel).
The probability that the message is correctly received at a distance d is given by [22]:

$$p(\gamma \geq \psi) = \int_{\psi}^{\infty} f_{\gamma}(a)da \qquad (1)$$

Transmission range can be given by

$$F_R(a) = p(R \leq a) = 1 - p(R > a) \qquad (2)$$

Mean communication range can be computed as given by,

$$E[R] = \int_{0}^{\infty} [1 - F_R(a)]da \qquad (3)$$

3. ANALYSIS OF MEAN COMMUNICATION RANGE

3.1. Analysis of Mean Communication Range of Nakagami-m Fading Channel

The pdf of SNR equation for *Nakagami fading* is given by [23]

$$P_{s(\bar{\gamma})} = \left(\frac{m}{\bar{\gamma}}\right)^m \frac{\gamma^{m-1}}{\Gamma(m)} \quad e^{-\frac{m\gamma}{\bar{\gamma}}} \qquad (4)$$

Where,
$\bar{\gamma}$=Average SNR

γ=Instantaneous SNR

Success probability i.e probability ($\gamma \geq \Psi$) is given by,

$$P_{s(\bar{\gamma})} = \int_{\Psi}^{\infty} \left(\frac{m}{\bar{\gamma}}\right)^m \frac{\gamma^{m-1}}{\Gamma(m)} e^{-\frac{m\gamma}{\bar{\gamma}}} d\gamma$$

$$= \frac{1}{\Gamma(m)} \int_{\frac{m\Psi}{\bar{\gamma}}}^{\infty} t^{m-1} e^{-t} dt \qquad (5)$$

$$P_{s(\bar{\gamma})} = \frac{1}{\Gamma(m)} . \Gamma\left(m, \frac{m\Psi}{\bar{\gamma}}\right) \qquad (6)$$

Where, $\Gamma\left(m, \frac{m\Psi}{\bar{\gamma}}\right) = (m-1)!\, e^{\frac{m\Psi}{\bar{\gamma}}} \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi}{\bar{\gamma}}\right)^l}{l!}$ (7)

Hence,

$$P_{s(\bar{\gamma})} = e^{\frac{m\Psi}{\bar{\gamma}}} \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi}{\bar{\gamma}}\right)^l}{l!} \qquad (8)$$

Where,

$$\bar{\gamma} = \frac{P_r}{P_{noise}} \quad , \; \bar{\gamma} = \frac{P_t d^{-\propto}}{P_{noise}} \qquad (9)$$

From equation (8) and (9) we can get

$$P_s(\bar{\gamma}) = e^{-\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}} \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}\right)^l}{l!} \qquad (10)$$

With the help of the above equation, (3) and (10) we can find E[R],

$$E[R] = \int_0^{\infty} [1 - F_R(a)]\, da \qquad (11)$$

Where,

$$1 - F_R(a) = 1 - [1 - P_s(\bar{\gamma})]$$

$$= \quad P_s(\bar{\gamma})\; [d = a] \qquad (12)$$

From equation (11) and (12) we can get E[R] as ,

$$= \int_0^{\infty} e^{-\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}} \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}\right)^l}{l!} \; da \qquad (13)$$

In order to solve above equation we have from [table]

$$\int_0^{\infty} x^{v-1} \exp(-\mu . x^p) dx = \frac{\mu^{-\frac{v}{p}}}{|P|} \Gamma\left(\frac{v}{P}\right) \; (14)$$

From equation (13) and (14) we can get E[R],

$$E[R] = \left(\frac{m\psi\, p_{noise}}{p_{tx}}\right)^{\frac{-1}{\alpha}} \left(\frac{1}{\alpha}\right) \sum_{l=0}^{m-1} \frac{\Gamma(l + \frac{1}{\alpha})}{l!} \qquad (15)$$

3.2. Analysis of Mean Communication Range of Superimposed Lognormal Nakagami-m Fading Channel

From equation (10) we have

$$P_{s(\bar{\gamma})} = e^{-\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}} \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}\right)^l}{l!}$$

$$\boldsymbol{F_{R(a)} = 1 - Q\left(\frac{\ln \frac{\Psi P_{noise} a^{\propto}}{P_{tx}}}{\sigma}\right)}$$

$$= \quad \varphi\left(\frac{\ln \frac{\Psi P_{noise}\, a^{\propto}}{P_{tx}}}{\sigma}\right) \qquad (16)$$

Hence we can find the mean communication range from [22], as

$$E[R] = \int_{-\infty}^{\infty} P_{s(\bar{\gamma})} \frac{1}{\sqrt{2\pi}\sigma x} e^{-\frac{1}{2}\left(\frac{\ln x - \ln a^{\propto}}{\sigma}\right)^2} dx \quad (18)$$

$$= \sum_{l=0}^{m-1} \frac{\left(\frac{m\Psi\, d^{\alpha} P_{noise}}{P_{tx}}\right)^l}{l!} \cdot \frac{m\Psi\, P_{noise}}{P_{tx}}^{-\left(l+\frac{1}{\propto}\right)} \cdot \frac{1}{|\propto|} \Gamma\left(l +\right.$$

$1\propto *\ \ -\infty\infty 12\pi\sigma xe - 12\ln x - \ln a\propto\sigma 2dx$

(19)

After solving the above equation we will get E[R]

$$E[R] = \left(\frac{m\psi\, p_{noise}}{p_{tx}}\right)^{\frac{-1}{\alpha}} \left(\frac{1}{\alpha}\right) \sum_{l=0}^{m-1} \frac{\Gamma(l+\frac{1}{\alpha})}{l!} e^{\frac{\sigma^2}{2\alpha^2}} \quad (20)$$

4. NUMERICAL AND SIMULATION RESULT

The numerical and simulation results are obtained from the analytical model using MATLAB. The system parameters are selected as follows: K=10dB, P_{tx}=1mWatt, W=0.01mWatt, ψ=10dB. The parameters such as m, λ, α, and σ are selected suitably. We choose a random number of nodes according to Poisson process and the nodes are placed over the simulation area according to a random uniform distribution.

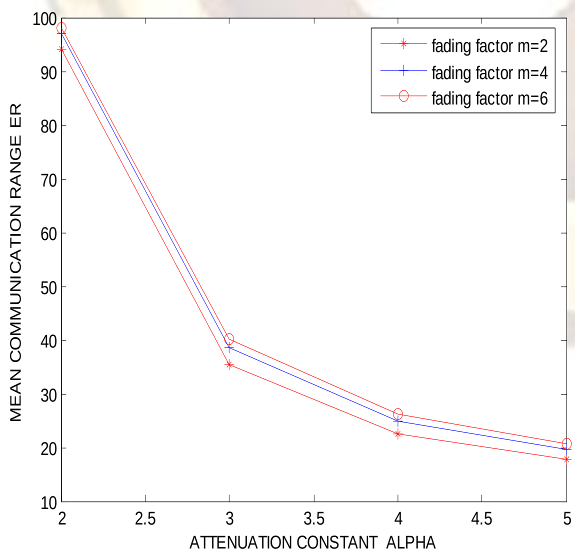

Fig1: attenuation constant versus mean communication range at m=2, 4 and 6

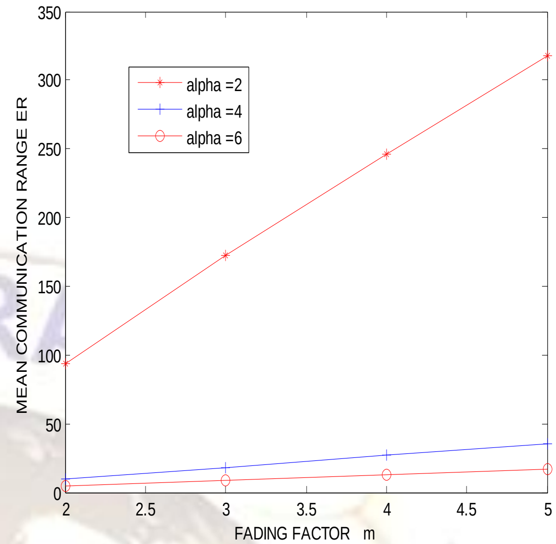

Fig2: fading factor m versus mean communication range at alpha =2, 4 and 6

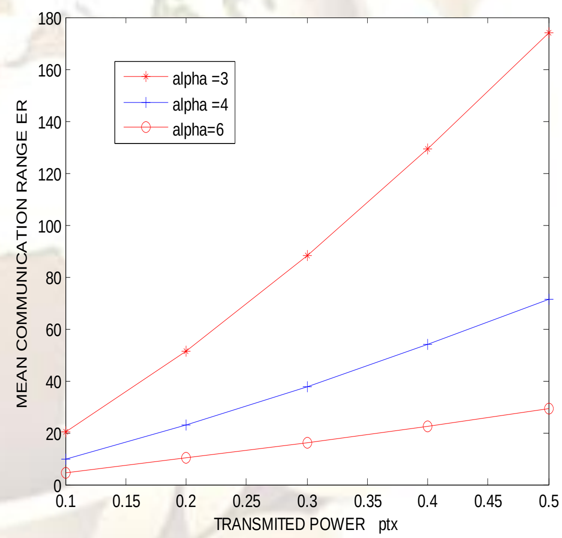

Fig3: mean communication range v/s transmitted power at attenuation constant

α= 2, 4 and 6.

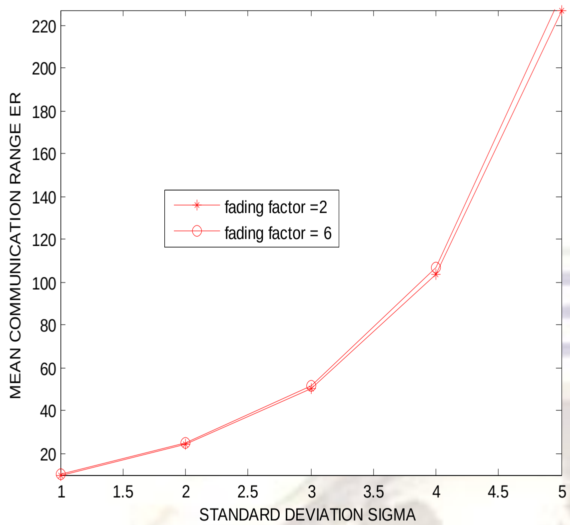

Fig4: mean communication range v/s SD at fading factor m =2 and 6

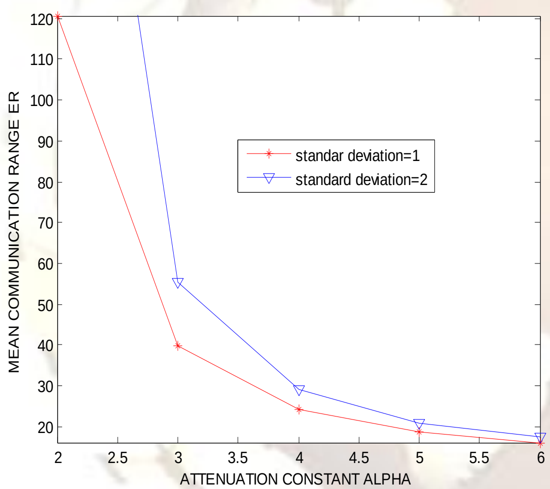

Fig5: mean communication range v/s attenuation constant at SD =1 and 2

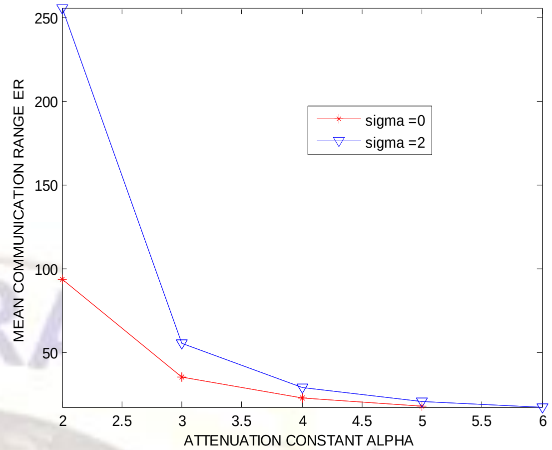

Fig.6: mean communication range v/s attenuation constant at sigma =0 and 2

5. CONCLUSION

The concern paper work is doing an extensive investigation of mean communication range for Nakagami-m fading as well as superimposed Nakagami lognormal shadowing channel which is more practical result than present one. we have presented the analytical as well as simulation results which will give clear insight for a practical design wireless sensor network.

The present paper can be extended to diversity scheme, to overcome the fading effect and we can analyze the improvement over mean communication range with respect to several diversity scenario. The concern project work can be extended to MIMO scheme as well as co-operative MIMI schemes.

REFERENCES

[1] P. Gupta and P. R. Kumar, "Critical power for asymptotic connectivity," in *Proc. of IEEE CDC*, Tampa, USA, 1998.

[2] P. Santi and D. M. Blough, "The critical transmitting range for connectivity in sparse wireless ad hoc networks," *IEEE Trans. on Mob.Comp.*, vol. 2, no. 1, pp. 25–39, Jan–Mar 2003.

[3] O. Dousse, P. Thiran, and M. Hasler, "Connectivity in ad–hoc and hybrid networks," in *Proc. of IEEE INFOCOM*, New York, USA, 2002.

[4] O. Dousse, F. Baccelli, and P. Thiran, "Impact of interferences on connectivity in ad–hoc networks," in *Proc. of IEEE INFOCOM*, San Francisco, USA, 2003.

[5] P. Gupta and P. R. Kumar, "The capacity of wireless networks," *IEEE Trans. on Inf. Th.*, vol. 46, no. 2, pp. 388–404, Mar. 2000.

[6] A. E. Gamal, J. Mammen, B. Prabhakar, and D. Shah, "Throughput-delay trade-off in wireless networks," in *Proc. of IEEE INFOCOM*, Hong Kong, 2004.

[7] S. R. Kulkarni and P. Viswanath, "A deterministic approach to throughput scaling in wireless networks." *IEEE Trans. on Inf. Th.*, vol. 50, no. 6, pp. 1041–1049, Jun. 2004.

[8] A. Rajeswaran and R. Negi, "Capacity of power constrained ad-hoc networks," in *Proc. of IEEE INFOCOM*, Hong Kong, 2004.

[9] A. Jovicic, P. Viswanath, and S. R. Kulkarni, "Upper bounds to transport capacity of wireless networks," *IEEE Trans. on Inf. Th.*, vol. 50, no. 11, pp. 2555–2565, Nov. 2004.

[10] M. Franceschetti, O. Dousse, D. Tse, and P. Thiran, "On the throughput capacity of random wireless networks," 2004, subm. for publ.

[11] O. Dousse and P. Thiran, "Connectivity vs capacity in dense ad hoc networks," in *Proc. of IEEE INFOCOM*, Hong Kong, 2004.

[12] M. Desai and D. Manjunath, "On the connectivity in finite ad hoc networks," *IEEE Comm. Lett.*, vol. 6, no. 10, pp. 437–439, Oct 2002.

[13] P. Panchapakesan and D. Manjunath, "On the transmission range in dense ad hoc radio networks," in *Proc. of SPCOM*, Bangalore, India, 2001.

[14] R. Hekmat and P. Van Mieghem, "Study of connectivity in wireless ad–hoc networks with an improved radio model," in *Proc. of WiOpt*, Cambridge, UK, 2004.

[15] M. Franceschetti, L. Booth, J. Bruck, M.Cook, and R. Meester, "Continuum percolation with unreliable and spread out connections," *Journal of Statistical Physics*, vol. 118, no. 3/4, pp. 721–734, Feb. 2005.

[16] D. Miorandi and E. Altman, "Coverage and connectivity of ad-hoc networks in presence of channel randomness," INRIA, Tech. Rep. RR5377, 2004. [Online]. Available: http://www.inria.fr/rrrt/rr-5377.html

[17] P. Santi, "The critical transmitting range for connectivity in mobile ad hoc networks," *IEEE Trans. on Mob. Comp.*, vol. 4, no. 2, pp. 310–317, Mar. 2005.

[18] L. Hanzo, C. H. Wong, and M. S. Yee, *Adaptive Wireless Transceivers*. New York: John Wiley and Sons, 2002.

[19] I. S. Gradshteyn and I. M. Ryzhik, *Table of integrals, series, and products*. Orlando: Academic Press, 1983.

[20] T. S. Rappaport, *Wireless Communications*. Upper Saddle River, New Jersey: Prentice Hall, 1999.

[21] C. Bettstetter and C. Hartmann, "Connectivity of wireless multihop networks in a shadow fading environment," in *Proc. of ACM MSWiM*, San Diego, CA, 2003.

[22] **Daniele Miorandi · Eitan Altman**," *Connectivity in one-dimensional ad hoc networks: A queueing theoretical approach",*Published online: 8 May 2006 C _Springer Science+Business Media, LLC 2006

[23] A.V**.** Babu and Mukesh Kumar Singh, *"node isolation probability of wireless adhoc networks in Nakagami fading channel,"* International journal of Computer Networks & Communications (IJCNC), Vol.2, March 2010.

[24] I. S. Gradshteyn and I. M. Ryzhik, *Table of integrals, series, and products*. Orlando: Academic Press, 1983.