Forecasting Energy Requirements of Intermediate Nodes in MANETs

D.V.S.S. Subrahmanyam [1], Dr. T. Ch. Malleswara Rao[2]

[1]*Research scholar, Dept. of CSE, Rayalaseema University, A.P*

[2]*NRSC, ISRO, Govt. Of INDIA (Retd)*

Abstract: Energy management of intermediate nodes in MANETs has been a difficult task. So many protocols have been introduced to handle this critical situation and achieved success towards their goal by using various efficient algorithms and implemented by several simulation procedures. The aim of this paper is to make use of Baye's Theorem as a statistical approach to choose an intermediate node which has sufficient energy in MANETs.

Keywords: MANETs, protocols, intermediate nodes, Bayes theorem, energy level, statistical applications, conditional probability.

I. INTRODUCTION

It is a known fact that the available energy in MANETs is very limited. Nodes need to maintain sufficient energy levels to avoid link failures during transmissions[4][5][6]. To support this fundamental fact, many protocols such as energy efficient AODV, energy conserved AODV protocols are introduced[1][2][3]. They proved their efficiency in conserving energy of the entire network. But in this paper a straight forward statistical application to maintain energy levels among all the possible existing intermediate nodes is discussed by using Bayes Theorem as an alternate to calculate energy levels without using any simulations. A small MANET is considered to prove Bayes theorem's application in its transmissions. In this MANET, the total energy assumed is 75 joules, the number of intermediate nodes in the network is 25, the size of data packet to be transferred is 25 bytes, the frequency of data packets is constant and also assuming a very few link failures in the network. Since the energy is 75 joules and number of nodes is 25, is node is supposed to get 3 joules of energy on an average. MANET can't get even a single extra joule of energy. It has to maintain on its own by making use of the available energy in the network from time to time[6][7][8]. In general nodes lose some amount of energy during their transmission and all nodes can't have the same amount of energy[5]. By taking this point into consideration, all nodes can be categorized into four different groups (an application).

1) Group 1 (G1) contains nodes that have minimum energy just >0 but <=1 joule.
2) Group 2 (G2) contains nodes that have energy levels just >1 joule but < 2 joules.
3) Group 3 (G3) contains nodes that have energy levels around 2 joules.
4) Group 4 (G4) contains nodes that have energy levels > 2 joules.
5) The set of all 25 intermediate nodes can be numbered as n1, n2, n.....n25. Assuming the following sets i.e., each Group has some nodes according to their energy levels and can be described as sets.

G1 = { n1, n2, n3, n4}   (1.1)
G2 = { n5, n6, n7, n8,n9,n10,n11, n12}   (1.2)
G3 = { n13, n14, n15, n16,n17,n18,n19, n20, n21, n22}   (1.3)
G4 = {n23,n24, n25}   (1.4)

II. BAYES THEOREM (FORECASTING by a STASTICAL APPROACH)

It is an excellent tool in probability and statistics that provides a vast number of applications to various fields including in engineering domains[9][10]. It is based on two concepts i) conditional probability and ii) total probability. It predicts an event on the basis of another event which already happened. Is also known as reverse probability. According to Bayes Theorem[9][10], if there are events A, E1, E2, E3,……En and assumed that event A is already happened. Now predicting the probability of any of the events E1, E2, …….En, can be obtained by

$$P(A/E5) = \frac{P(E5/A)\ P(A)}{\sum_{i=1}^{n} P(E5/A)\ P(A)} \qquad (1.5)$$

In the equation (1.5) numerator is conditional probability and denominator is total probability. This concept is different from that of the general probability concept. General probability only predicts output of an event but Bayes Theorem finds probability of en event only when another event is already happened[9]. It involve conditional probability concepts. According to conditional probability, probability of an event A, if B is already happened [10] is $P(A/B) = P(A \cap B)/P(B)$ (1.6)

III.   IMPLEMENTATION OF BAYES APPLICATION

In the hierarchical arrangement of layers, assuming that a node already transmitted a data packet to its higher level node[5][7][8]. Assuming,   the probability of choosing a node from G1 i.e., P(node/G1)=0.15   (1.7)   the probability of choosing a node from G2 i.e., P(node/G2)=0.20   (1.8)   the probability of choosing a node from G3 i.e., P(node/G3)=0.30   (1.9)   the probability of choosing a node from G4 i.e., P(node/G4)=0.35   (2.0) Since   there   are   four   groups,   the   probability   of   choosing   any   group   is   ¼ i.e.,   P(G1) = P(G2) = P(G3) = P(G4) = ¼   (2.1)

Since MANETs are very conducing on their part, they are always greedy[7][6][4]. Thus they wish to utilize very low energy levels to transmit any data packet to the next level node in order to save more energy for their future transmissions[1][2][3]. Even though nodes from G4 are more energetic, but protocols always make them as reserved energies and firstly try to use G1, if not possible then look for G2 and then look for G3. In emergency they will use G4. This kind of calculations is needed for MANETs in order to concentrate on future transmissions [6] [8]. If it is known that how much energy is used by a particular and very recent transmission, then the network will come to know the remaining energy levels available[5][8].

Now assuming that a node transmitted a data packet in the MANET. Calculations in predicting energy levels of nodes in MANETs: case i) to know if the transmitted data packet is forwarded by any node of group G1, for example by any node n1 or n2 or n3 or n4, then the chances of transmission to receive the packet either from G1 or G2 or G3 is :

$$P(G1/node) = \frac{P(n2/G1)\ P(G1)}{\sum_{i=1}^{3} P(any\ node\ from\ the\ group\ /G\ i)\ P(G\ i)} \qquad (2.2)$$

Now from equations (1.7), (1.8), (1.9) , (2.0) and (2.1) and substituting these values in the equation (2.2), then

$$P(G1/node) = \frac{0.15 * (¼)}{0.15 * (¼) + 0.20 * (1/4) + 0.30\ (1/4)} \qquad (2.3)$$

P (G1 / node) = 0.0375 / 0.1625 = 0.231 ~ 23 % i.e., there are 23 % chances that the data packet is from the group G1. case ii) the same data packet if it comes from the group G2, then its chances from G2 can be :

$$P(G2/node) = \frac{0.20 * (¼)}{0.15 * (¼) + 0.20 * (1/4) + 0.30\ (1/4)} \qquad (2.4)$$

P (G2 / node) = 0.05 / 0.1625 = 0.308 ~ 30.8 % = ~ 31 % i.e., there are 31 % chances that the data packet is from the group G2. case iii) the same data packet if it comes from the group G3, then its chances from G3 can be :

$$P(G3/node) = \frac{0.30 * (¼)}{0.15 * (¼) + 0.20 * (1/4) + 0.30\ (1/4)} \qquad (2.5)$$

P (G3 / node) = 0.075 / 0.1625 = 0.4615 ~ 46.15 % = ~ 46 % i.e., there are 46 % chances that the data packet is from the group G3. Similarly energy levels can be estimated and predicted from transmission to transmission in any MANET. This approach helps a lot to know the remaining energy levels of the network after every

transmission. This will lead the network to make efficient and effective decisions in terms of energy issues with respect to their intermediate nodes.

In this way, any MANET can estimate and predict its available energy levels of nodes in it and it is very useful for its future course of transmissions. This concept can be extended to any number of nodes or data sets accordingly. Bayes Theorem has much strength in expanding its wings of efficiency on any domain. Bayes Theorem provides much technical views to various kinds of applications[9][10].

IV. ACKNOLEDGEMENT

REFERENCES

[1] P Ng, S Liew. Throughput Analysis of IEEE 802.11 Multi-hop MANETs Networks. IEEE / ACM Transaction-on-Networking,June-2007.

[2] Safa, H.; Mirza, O. "A load balancing energy efficient clustering algorithm for MANETs", International Journal of Communication Systems, Vol. 23, Issue 4, pp.463-483, April 2010.

[3] Hongmei Deng, Wei Li, and Dharma P. Agrawal, "Routing Security in Wireless Ad Hoc Network," IEEE Communications Magzine, vol. 40, no. 10, October 2002.

[4] Dekar, L., & Kheddouci, H., (2008). A Cluster Based Mobility Prediction Scheme for Ad Hoc Networks", Ad-Hoc Networks Journal. Vol. 6(2), April 2008, Elsevier.

[5] Dimitrios Liarokapis, and Ali Shahrabi "An Adaptive Broadcasting Scheme in Mobile Ad Hoc Networks" 2009 IEEE Communication Networks and Services Research Conference, 2009. CNSR '09. Seventh-Annual.

[6] B. Johnson and D. A. Maltz, "Dynamic source routing in ad hoc wireless networks," in Mobile Computing, T. Imielinski and H. Korth, Eds. Boston, MA: Kluwer Academic, 1996, ch. 5, pp. 153-181.

[7] S. M. Jiang, Y. D. Liu, Y. M. Jiang, and Q. H. Yin, "Provisioning of adaptability to variable topologies for routing schemes in MANETs," IEEE J. Sel. Areas Commun., vol. 22, no. 7, pp. 1347-1356, Sep. 2004.

[8] F.F. Zou, X.M. Zhang, X.M. Gao, D. Shi, E.B. Wang, "Load balance routing using packet success rate for mobile ad hoc networks", Proc. Of the 3rd IEEE International Conference on Wireless Communications, Networking and Mobile Computing (WICOM'07), September. 2007

[9] Bayes Theorem, Wikipedia

[10] Conditional Probability, Wikipedia

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