Indian Journal of Science and Technology, *Vol 9(3), DOI: 10.17485/ijst/2016/v9i3/81898, January 2016*

ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Improvement in Data Packet Routing on the basis of Stability

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Abstract

Mobile Adhoc Network (MANET) consists of various independent nodes that work on wireless topology; so better Quality of Services (QoS) is required in these networks which can be achieved by selecting the optimal path. The selection of the optimal path between nodes is a fundamental issue that arises in Mobile Ad hoc Network (MANETs). In order to reduce the latency, Packet Delivery Ratio (PDR) and overhead, certain methods are advocated that improves the route efficiency by selection of the most stable path. The proposed work suggests a method where header node in each network is selected and the path with highest average sum of header number is elected as the optimal path. The study was conducted to analyze the performance of technique over existing techniques which revealed that the throughput of the system has been increased by a factor of 2 along with the increase of Packet delivery Ratio by 45.53%.

Keywords: Black Hole Attack, Link Failure, Malicious Node, Packet Delivery Ratio, Throughput

1. Introduction

An increasing interest is achieved in mobile wireless networks as they offer a ubiquitous communication. In particular, Mobile Ad hoc Network facilitate the users to maintain the connectivity to the fixed network or exchange the information in the absence of access point or base station. This can be achieved by multi hop communications, which permits the node to reach the far away destination by means of intermediate nodes as relays. A fundamental problem which is seen in MANET is the selection and preservation of multi hop path. There are certain factors that make intermittent change in the network topology such as node mobility, signal interference and power disruption; as a consequence, the links break down in the path and an alternate path must be found.

MANET requires no access point or base station to accomplish the communication; thereafter leading in an efficient and uncomplicated establishment of the network. The place that experiences exposure to the natural catastrophe inhibits the communication to the farther world MANET[1]. Various methods[2] suggests the way to avoid the packet losses and restrain the latency and overhead due to path reconstruction. The proposed work focuses on the stability of the routing path, which is subjected to link failure caused by the mobility of node. Header numbers are defined in each network on the basis of their mobility. These header numbers are allocated by aid of knowledge based learning algorithm. Knowledge based learning algorithm is a machine learning algorithm that recruits previously learned network and make final decisions on the basis of attained knowledge. This enables us to learn when efficient and adequate prior knowledge is available. The protocol which is taken under consideration to relay the data packets from origin to destination is (Ad hoc on demand distance vector) AODV protocol[3,11,12]. In[4,5] analogy is undertaken between on demand routing protocols which enables us to decide the finest routing algorithm for our work plan. The performance analysis of every protocol is initiated on the basis of certain performance parameters. Protocols correlated in[4] are AODV, DSR, DYMO whereas in[5] the same is performed among AODV, DSR and OLSR.

Stochastic model and electrochemical cell model are incorporated so as to achieve the charge management and recovery. This leads in the minimization of the

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occurrence of latency resulting in prevention of the degradation of network[6,13,14]. Several metrics can be taken in consideration for selection of source destination optimal routing path such that quality of service requirements of mobile users can be met. Some examples can be easily found[7,8]. In[10] a centrally coordinated network topology is designed by means of lead node. The lead node is such elected that the node which retains the highest energy level is tabbed as the lead node. The selected lead node maintains a table with the contents; node id, energy of the node and residual energy. AODV protocol is used for relaying of data packets. In particular, usages of certain formulae are made for computation of residual energy and energy consumption between nodes that are one hop apart. Furthermore, the final selection of most favorable route is made on the basis of per node despite per flow. Node with greatest amount of energy appears to be an actively participating node in the ultimate route. Unlike[9,10] it is not centrally coordinated, instead, the link failure is interrupted by computation of an overall stability factor. Stability factor gauge the stability of each node in the network topology. In initial stages, self-stability and neighbor stability of each node is resolved which enables us the determination of overall stability factor. An inverse relation is provided between the mobility of nodes and stability factor where the critical issue of energy consumption is considered.

Mobile Ad hoc Network (MANET), a flexible and rapidly deployable communication network is widely being used for communication. The mobile nodes often create link changes that demand reconstruction of the already identified routes. The route discovery and the successive route maintenance are performed by the routing algorithm. In order to determine an efficient, robust and scalable routing in MANET, there is a need to develop a routing algorithm that is fully aware of the routes. The route discovery and the successive route maintenance are performed by the routing algorithm. A multi objective unicast MANET route optimization problem that uses network performance measures such as delay, hop distance, load, cost and reliability is addressed[15]. Apart from the routing protocols, node density plays an important role in affecting the QoS parameters of the network. Sparse networks (with few mobile nodes) have difficulty in sending and receiving packets as nodes are not in communication range with one another[16].

The link which is subjected to link failure is stabilized by the acknowledgement of knowledge based learning algorithm. This is followed by the infusion of knowledge based learning algorithm in the network system which allocates the header number to each node on the basis of the available prior knowledge. The above discussed case is with respect to ideal case where no foreign attack is carried. In our proposed work two more cases are considered where one node experiences malicious attack whereas another node experiences black hole attack. This administers us with the three cases; ideal case, malicious case and black hole case. These different scenarios are taken into consideration to show the significance of stability while selecting the route.

2. Application of Knowledge based Learning Algorithm

The prime focus of our proposed work is to downplay the possibilities of link failure in our network system. Knowledge based learning algorithm is used which is particularly a machine learning algorithm.

Knowledge based learning algorithm is recruits previously learned network and make denouement on the basis of attained knowledge. This enables nodes to learn when efficient and adequate prior knowledge is available. The conclusions are drawn on the basis of the prior pattern of node mobility. Header numbers are allocated according to the pattern recognized. Given an unknown function $f\colon X \rightarrow Y$ where f is the ground truth where mapping is done of the input and output occurrence as $x \in X$ and $y \in Y$. These instances are accompanied by the training data that represents the accurate example of required output producing a function g: $X \rightarrow Y$ that provide us the approximate measure of the required output. When a pattern has to be recognized on the basis of probability than the probability estimation of each possible output is made foreach input instance, yielding a function in the form:

$$\mathrm{h}(label|\ x, \text{₳}) = a\ (x, \text{₳}) \qquad (1)$$

Here 'a' is characterized by parameter ₳. The inverse probability of h$(x|label)$ can be calculated by the use of Bayes rule as follows:

$$\mathrm{h(label|\ x, \text{₳}) = ((x|label, \text{₳})h(label|\ \text{₳}))/(\Sigma} L \in alllabels\ h(x|L)h(L|\ \text{₳})) \qquad (2)$$

For the continuous distribution of labels rather than summation; integration is involved in the denominator.

$$h(label|x, ₳) = ((x|label, ₳))h(label|₳))/\int_{L\in label}^{L\in all\ labels} h(x|h)\, h(L|₳)dL) \quad (3)$$

The pattern recognition enables in compilation of the knowledge about mobility of node and on the basis of these patterns allotment of header numbers is performed proportionately.

Whenever the data packets transit from one node to another, then the power required is inversely proportional to the n^{th} power of the distance (d) between these nodes by $1/d^n$. Here n varies between 2 and 4 on the basis of the distance between the contemplated nodes. For successful transit of data packets from node to node, SNR (Signal to Noise Ratio) of second node must exceed the threshold value. If n_i: Transmitting node, n_j: Receiving node Ψ: Threshold value, then following condition must be satisfied:

$$SNR_j = \frac{P_i G_{i,j},}{\sum_{k\neq i} P_k G_{k,j} + \eta_j} \psi_j(BER) \quad (4)$$

where in Eq. (4)

P_i: Transmission power of n_i,$G_{i,j}$: Path gain between $n_i$and n_j,Ψ_j: Threshold value

$$G_{i,j=\frac{1}{d^n_{i,j}}} \quad (5)$$

The mathematical expression for the proposed work is given as follows:

$$A = \{s,d,i,l\} \quad (6)$$

$$P_{s\to i} = \{(x,y)\,|\,P_{s\to i\to(x,y)} < P_{s\to(x,y)}\} \quad (7)$$

Where A: Cluster, s: Source node, d: destination node, i: intermediate node, l: link failure.

Above mentioned equation states; when the data packets are relayed from origin to intermediate node at any arbitrary point (x, y) in the cluster, the power required to transit from the origin to (x, y) via intermediate node is less than the power required when data packets are directly transmitted from source to (x, y) point. The relation of data packets at source and destination is given by:

$$N_s > N_d \quad (8)$$

N_s: Number of data packets at source, N_d: Number of data packets at destination, B: Cluster Knowledge based algorithm; when subjected over the proposed problem then the mathematical expression obtained are:

$$B = s, i_n \quad (9)$$

$$s = \{s_{t1}, s_{t2}, \dots\dots\dots\dots s_{tn}\} \quad (10)$$

$$d = \{d_{t1}, d_{t2}, \dots\dots\dots\dots d_{tn}\} \quad (11)$$

$$i_1 = \{i_{t11}, i_{t12}, \dots\dots\dots\dots i_{t1n}\} \quad (12)$$

$$i_2 = \{i_{t21}, i_{t22}, \dots\dots\dots\dots i_{t2n}\} \quad (13)$$

The Equation (10), (11), (12), (13) describes the mobility sample of each node at different instant of time duration. Through these mobility samples, predictions are made which allows the user to predict the header number and are subsequently balloted to nodes of the scrutinized cluster. In our work plan, h: Header number; and the value of 'h' always lie between 1 and 10.

$$1 < h < 10$$

Ifh_s: Header number at source node, h_i: Header number at intermediate node, h_d: Header number at destination node, then

$$H_1 = \sum (h_s + h_{i1} + h_d) \quad (14)$$

where H_1: Average sum of header number linked in a path having intermediate node i_1 in Equation(14).

$$H_2 = \sum (h_s + h_{i2} + h_d) \quad (15)$$

where H_2: Average sum of header number linked in a path having intermediate node i_2 in Equation (15).

$$\text{If } H_1 > H_2$$
$$\text{then } m_1 > m_2$$

m_1: mobility of intermediate node 1; m_2: mobility of intermediate node 2.

The final selected path 'P' is given as

$$P = \{s, d, i_1\} \quad (16)$$

Along with the ideal case two more cases are considered which are mathematically described as follows

$$C = \{s,,,\} \quad (17)$$

Where C: Cluster; b: Black Hole node

$$s = \{s_{t1}, s_{t2}, \dots\dots\dots\dots s_{tn}\} \quad (18)$$

$$d = \{d_{t1}, d_{t2}, \dots \dots \dots \dots d_{tn}\} \quad (19)$$

$$i_1 = \{i_{t1}, i_{t2}, \dots \dots \dots \dots i_{tn}\} \quad (20)$$

$$R_{s\to i} = \{(x, y) \,|\, P_{s\to i\to(x,y)} < P_{s\to(x,y)}\} \quad (21)$$

If $i \in b$
Then $P \notin d$

$$P \in \{s,d,i\} \quad (22)$$

In Equation (22), P: final selected path.

$$C=\{s,d,i,m\} \quad (23)$$

Where C: cluster node, m: Malicious node.

$$s = \{s_{t1}, s_{t2}, \dots \dots \dots \dots s_{tn}\} \quad (24)$$

$$d = \{d_{t1}, d_{t2}, \dots \dots \dots \dots d_{tn}\} \quad (25)$$

$$i_1 = \{i_{t1}, i_{t2}, \dots \dots \dots \dots i_{tn}\} \quad (26)$$

$$R_{s\to i} = \{(x, y) \,|\, P_{s\to i\to(x,y)} < P_{s\to(x,y)}\} \quad (27)$$

If $i \in m$
Then $P \notin d$

Equation 28 reveals the final selected path.

$$P \in \{s,d,i\} \quad (28)$$

3. Simulation, Results and Analysis

Three cases are implemented in proposed work and performance of each case is evaluated on the basis of two performance parameters: Throughput and packet delivery ratio.

For implementation, Network Simulator 2 (NS2) is used in Linux (Ubuntu12.04). Analysis can be easily made on the basis of performance parameters mentioned in Table 1, hence enables us to become aware of the performance characteristics. It shows that the PDR and throughput decreases in malicious case as well as in Black hole attack. Figure 1 and Figure 2 shows the considered performance parameters; throughput and packet delivery ratio. It can be clearly concluded that in the absence of any foreign attack the parameters attain a high and efficient value whereas declination in the value is seen when black hole and malicious node are introduced in the network system.

The comparison of values made us understand that the performance of network system degrades by introduction of foreign attack.

Table 1. Average throughput and PDR

Parameters	Ideal case	Malicious case	Black hole attack
Average Throughput(*Kbps*)	314.32	241.05	147.04
PDR (Packet DeliveryRatio)	0.91190	0.725279	0.456591

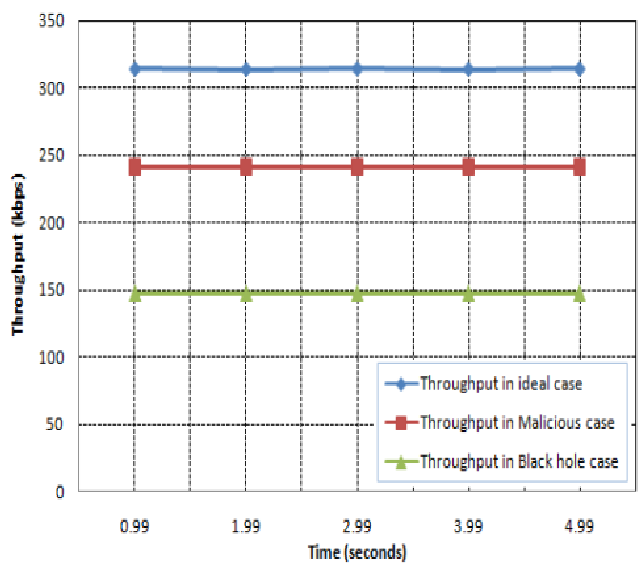

Figure 1. Throughput.

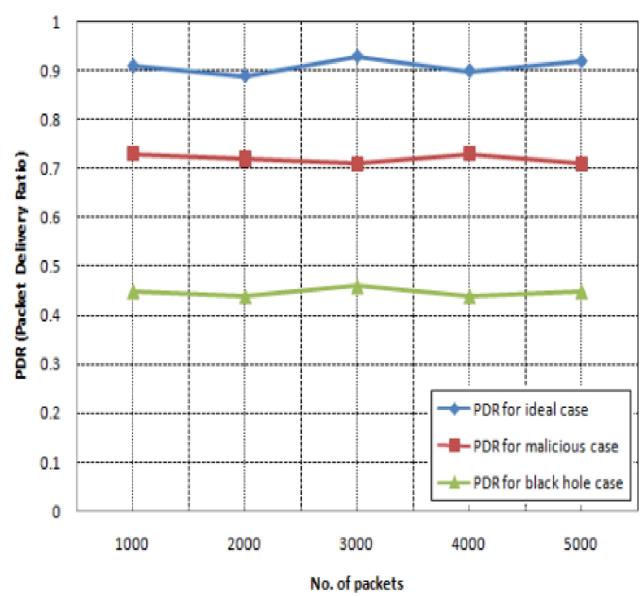

Figure 2. Packet Delivery Ratio (PDR).

4. Conclusions

It is found that knowledge based learning algorithm can provide reliable and short routes from n possible routes in MANETs. We focused on per node analysis rather than per flow analysis. The focal point of proposed work is to diminish the prospect of network degradation provoked by the energy exhaust of node. Use of machine learning algorithm enabled us to determine the optimal path in terms of header number. This proposed work presented some properties some properties for obtaining the optical path through header number even in case of mobility.

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