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Maintenance of Link for Stability in MANET

Author: Amit Gupta

Medicaps Institute of Technology and Management, Indore

E-mail: gupta.05.amit@gmail.com

ABSTRACT

In Mobile ad hoc network is a new generation technology which works on the concept of relay communication. Routing algorithms are played key role in network. These routing algorithms are responsible for finding routes are carry data from one node another node. The property of network mobility sometime creates issues such as path break, link failure. These factors affect the performance of network. Therefore a new kind of protocol is required that find the stability of links and most stable links are used for communication.

Present work considers Q-learning concept. That first distinguishes the route stability factor and used most stable routes for data transmission. This is because the less energy nodes can also responsible to path break and link failure. Thus the traditional Q-learning protocol is optimized using the energy factor in the present work.

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Keywords: Mobile ad hoc network, link stability, routing protocol, remaining energy factor.

1. INTRODUCTION

Mobile ad hoc network is one of the most frequently used network technology in research and development. That attracts researchers and engineers for performance improvement and the security aspects. The presented work is focused on improving the performance of links and connectivity issues in network. The chapter includes the detailed overview of the proposed link stability protocol and their involved work.

Mobile ad hoc network is a new technology. That is basically invented for those conditions where the management of huge infrastructure and maintenance is costly, such as battle ground. MANET (Mobile ad hoc network) is defined by its own characteristics. It is self-organizing, mobile communication manner where topologies are dynamically created. Due to the ad hoc nature of the network infrastructure and mobility it is still an area of new research and development. Due to mobility of wireless communication two major issues are found in such kind of network i.e. performance and security.

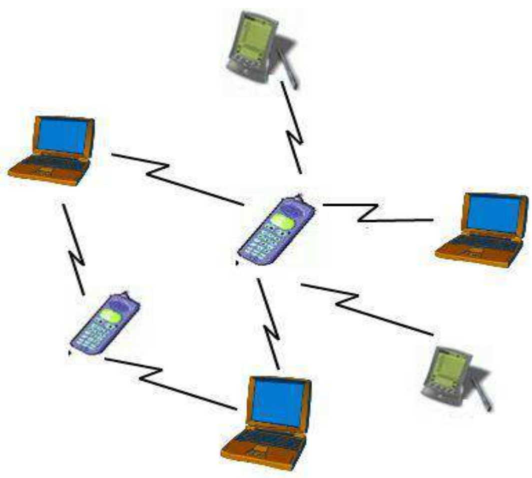

Figure 1.1 Mobile Ad Hoc Networks

There are different criteria for designing and classifying routing protocols for wireless ad hoc networks. This section introduces the two basic kind of routing protocol that is frequently used in ad hoc network.

1.1 Proactive routing protocols

These routing protocols are similar to and come as a natural extension of those for the wired networks. In proactive routing, each node has one or more tables that contain the latest information of the routes to any node in the network. Each row has the next hop for reaching a node/subnet and the cost of this route. Various table-driven protocols different the way the information about a change in topology

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is propagated through all nodes in the network. There exist some differences between the protocols that come under this category depending on the routing information being updated in each routing table. Furthermore, these routing protocols maintain different number of tables.

The proactive protocols are not suitable for larger networks, as they need to maintain node entries for each and every node in the routing table of every node. This causes more overhead in the routing table leading to consumption of more bandwidth. Examples of such schemes are the conventional routing schemes, Destination Sequenced Distance Vector (DSDV) [2].

1.2 Reactive routing protocol

Reactive routing is also known as on-demand routing protocol since they don't maintain routing information or routing activity at the network nodes if there is no communication. These protocols take a lazy approach to routing. They do not maintain or persistently update their route tables with the latest route topology.

If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route discovery usually occurs by flooding the route request packets throughout the network. Examples of reactive routing protocols are the dynamic source Routing (DSR), ad hoc on-demand distance vector routing (AODV) [3].

Table: 1.1 Routing Comparison

	Table-driven	On-demand
Availability of Routing Information	Immediately From route table	After a route discovery
Route Updates	Periodic Advertisement	When requested
Routing Overhead	Proportional to the size of the network traffic regardless of network traffic	Proportional to the number of communicating nodes and increases with increased node mobility

1.3 Strategic Routing Design

In addition of active and proactive routing protocols the MANET routing can be extended with different strategies for satisfying any specific issues in ad hoc networks. This section introduces different other routing protocols that are used to solve issues in routing. Some of them are discussed here in brief [3]:

1.3.1 Flow-oriented routing: This type of protocols finds a route on demand by following present flows. One option is to unicast successively when forwarding data while promoting a new link. The main drawbacks of such algorithms are

Takes long time when exploring new routes without preceding knowledge.

May refer to existing traffic to compensate for missing knowledge on routes.

1.3.2 Hybrid (both pro-active and reactive: This type of protocols combines the advantages of proactive and of reactive routing. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice for one or the other method requires predetermination for typical cases. The main disadvantages of such algorithms are:

Advantage depends on the number of nodes activated.

Reacting to traffic demand depends on the gradient of traffic volume.

1.3.3 Hierarchical routing protocols: With this type of protocols the selection of proactive and of reactive routing depends on the hierarchic level where a node resides. Hierarchical routing significantly increases the scalability routing in ad hoc networks by increasing the robustness of routes. The routing is primarily established with some proactively prospected routes and then provides the demand from additionally activated nodes through the reactive flooding on the lower levels. The choice for one or the other method requires proper attribution for the respective levels. The main disadvantages of such algorithms are:

Advantage depends on the depth of nesting and addressing scheme.

Reacting to traffic demand depends on meshing parameters

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1.3.4 Backpressure Routing: This type of routing does not pre-compute paths. It prefers next-hops dynamically as a packet is in evolution toward its destination. These assessments are based on congestion gradients of neighbour nodes. When this type of routing is used mutually with max-weight link scheduling, the algorithm is throughput-optimal. See further discussion here: Backpressure Routing. Backpressure routing has chiefly been studied in a theoretical context. In practice, ad hoc wireless networks have normally implemented substitute routing methods based on shortest path calculations or network flooding, such as Ad Hoc on-Demand Distance Vector Routing (AODV), Geographic Routing, and Extremely Opportunistic Routing (ExOR).

1.3.5 Host Specific Routing protocols: This type of protocols needs thorough administration to tailor the routing to a certain network layout and a distinct flow strategy, the main disadvantages of such algorithms are:

Benefit depends on the quality of the administration addressing scheme.

The proper reaction to varies in topology demands reconsidering all parameters

2. LITERATURE SURVEY

A mobile ad hoc network (MANET) is an autonomous collection of mobile nodes that communicate over relatively bandwidth constrained wireless links. Frequent link changes and limited bandwidth make communication in MANET particularly challenging. Based on AODV, Celimuge Wu et al [1] propose a MANET routing protocol considering link stability and bandwidth efficiency. The protocol uses distributed Q-Learning to infer network status information and takes in to consideration link stability and bandwidth efficiency while selecting a route. The protocol can efficiently handle network mobility by a way of pre-emptively switching to a better route before current route fails. Author also study the performance of this protocol through simulation and demonstrate its significant improvement compared to AODV. But due to less energy some links are becomes not much effective thus required to improve this protocol using an energy factor.

Frequent changes in network topology, confined battery capacity of nodes and unreliable nature of wireless channels are the main challenges for reliable routing in Mobile Ad hoc Network (MANET). Selecting a long lasting route is a critical task in MANET. In this paper, P. Srinivasan et al [4] propose a new protocol, Route Stability and Energy Aware Ad hoc On-demand Distance Vector (RSEA-AODV) protocol which is an enhancement of Ad hoc On-demand Distance Vector (AODV) protocol. It designs a bi-objective optimization formulation to compute the reliability factor based on stability and residual energy of nodes. The route with the highest reliability factor value is selected for data transmission. This protocol is compared with other similar routing protocols: PERRA and AODV.

Author uses ns-2 for simulation. Given simulation results show that, the proposed protocol increases the node expiration time by 12 -32 % and accomplishes 7 - 13 % higher packet delivery ratio compared to PERRA or AODV. The packet delay and control overhead of the proposed protocol is comparable to that of AODV.

With the increasing popularity of multimedia, there is a growing tendency in mobile ad hoc networks (MANETs) to establish stable routes with long route lifetimes, low control overhead and high packet delivery ratios. According to recent analytical result, the lifetime of a route, which can affect the route stability, depends on the length of the route and the life time of each link in the route. Wenjing Yang et al [5] presents a Greedy-based Backup Routing (GBR) protocol that considers both route length and link lifetime to achieve high route stability. In GBR, the primary path is constructed primarily based on a greedy forwarding mechanism, whereas the local-backup path for each link is established according to the link lifetime. Both analytical and simulation results demonstrate that GBR has excellent performance in terms of route lifetime, packet delivery ratio, and control overhead.

The past decade has witnessed a phenomenal market penetration of wireless communications and a steady increase in the number of mobile users. Unlike wired networks where communication links are inherently stable, in wireless networks the lifetime of a link is a random variable whose probability distribution depends on mobility, transmission range and various impairments of radio communications. Because of the very dynamic nature of VANET and of the short

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transmission range mandated by the Federal Communications Commission (FCC), individual communication links come into existence and vanish unpredictably, making the task of establishing and maintaining routing paths between fast-moving vehicles a very challenging task. The main contribution of Gongjun Yan et al [6] is to investigate the probability distribution of the lifetime of individual links in VANET under the combined assumptions of a realistic radio transmission model and of a realistic probability distribution model of inter-vehicle headway distance. Our analytical results were validated and confirmed by extensive simulation.

Data communication is severely affected in the mobile ad-hoc cognitive networks (MACNets) due to link instability and channel interference. The availability and stability of each link in MACNets highly depends on not only the relative movement of neighbour nodes but also the adjacent communication among primary nodes and among cognitive nodes. So, in the existing system a cross-layer distributed approach, called mobility-prediction-based joint stable routing and channel assignment (MP-JSRCA), is used to maximize the network throughput by jointly selecting stable routes and assigning channels avoiding inter- and intra-flow interferences based on mobility prediction. Aparna S Menon et al [7] MP-JSRCA, each relay node selects the best link with the smallest DTC as the next hop, within a specified sector region towards the destination. NS2-based simulation results demonstrate that MP-JSRCA algorithm significantly improves network throughput, and the higher degree of interference MACNets experience To quantitatively measure the communication quality of links, a new metric data transmission cost (DTC) is used that captures node mobility, impact to primary nodes, and channel conflict among cognitive nodes. The problem of improving energy efficiency is also an important concern in mobile ad-hoc cognitive networks.

3. PROPOSED WORK:

Traditional Q learning protocol

In QLAODV, when a source node needs to communicate to a destination node, it checks its routing table for a route. If none exists, QLAODV uses original route discovery approach of AODV to create a route to the destination. To avoid frequent route discovery of AODV in highly dynamic networks, it uses dynamic route change mechanism to switch route pre-emptively and therefore reduce the number of route request broadcasting.

The nodes exchange link state information and update Q-Table using hello messages. Every node attaches their MaxQValues, MF and BF to hello message before sending hello. The node which receives hello message extracts the corresponding values from the hello packet and executes Q-Learning algorithm to update its Q-Table.

The MaxQValues which a node obtains from received packet is the Q-Metrics of its previous neighbour and it indicates the neighbour's knowledge about the network. The following algorithm is executed during the link exchange as given in table 3.1.

Table 3.1 Traditional Q-learning algorithm

1. At every node s Initialize Q-table, $Q_s(d,x) = 0, d\,\epsilon D, x\epsilon N_s$ where N_s is a set of neighbors and s and D is a set of destinations
2. **for** every event **do**
3. **if** hello timer expires **then**
4. **for** every d, get the maximum $Q_s(d,x), x\epsilon N_s$ namely MaxQValue, and attach them to hello message.
5. Send hello message.
6. **end if**
7. **if** receives hello from the neighbor x **then**
8. Get MaxQValue from the hello message.
9. Compute γ_x
10. If this hello sender is the destination node, set R to 1, otherwise set R to 0.
11. For destination d, update Q-Table
12. **end if**

end for

Proposed algorithm

The proposed link stability technique is prepared to enhance the routing protocol for improving the performance when some of the node having the less energy in network. Thus the traditional factors are optimized to accept the low energy nodes and their link stability. The key difference among the

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traditional and the proposed approach is that the energy of node is considered in the proposed approach. In order to implement the proposed approach MF, BF and Q-value are computed similar to the traditional technique. The definition of these parameters is given as:

The bandwidth factor BF

$$BF = \frac{avilable\ bandwidth\ of\ node\ x}{maximum\ bandwidth\ to\ node\ x} \ldots\ldots\ldots\ldots(1)$$

Where,

x is a node and Available Bandwidth calculate by

Available Bandwidth= (Maximum Bandwidth - local bandwidth)………………….………….... (2)

The local bandwidth of the node can be computed using the equation 3.

$$BW = \frac{n * S_B * 8}{T} \ldots\ldots\ldots\ldots(3)$$

Now for calculating the mobility factor for the stable nodes the equation 4 is utilized

$$MF = \begin{cases} \frac{|N_x \cap N_x^p|}{|N_x \cup N_x^p|} & if\ |N_x \cup N_x^p| \neq \emptyset \\ 0 & otherwise \end{cases} \ldots\ldots\ldots(4)$$

Where,

N_x= current neighbor of node x

N_x^p =neighbour of node x when previous hello message was send

Now the additional included factor for computing the energy of nodes in the routes is computed

using the equation 5.

$$REF = T_E^x \ldots\ldots\ldots\ldots(5)$$

Where,

T_E^x = Initial energy of node x

Tr_E^x = transmission energy of node x

R_E^x = receiving energy of node x

I_E^x = ideal energy of node x

All the considered parameters are having the different scales of the measurement therefore a normalization factor is required to combine these considered factors. In order to design the normalization factors three factors namely $w_1, w_2\ and\ w_3$ are used in the following manner.

$$w_1 + w_2 + w_3 = 1$$

Therefore the normalization factors are considered between 0-1 and the distribution of the weights are given in such manner the sum of these factors are equal to 1.During the implementation the w_1= 0.5, w_2= 0.25 and for w_3= 0.25 is considered, thus link stability between two communicating node i and j is given using equation 6.

$$L_{ij} = Q\ value + \{REF * w_1 + BF * w_2 + MF * w_3\} \ldots\ldots\ldots(6)$$

Where L_{ij} is value between node i and j.

Proposed Algorithm steps:

1. At every node s
2. Initialize Q-table, $Q_s(d,x) = 0, d \epsilon D, x \epsilon N_s$ where N_s is a set of neighbors and s and D is a set of destinations
3. **for** every event **do**
4. **if** hello timer expires **then**
5. **for** every d, get the maximum $Q_s(d,x), x \epsilon N_s$ namely MaxQValue, and attach them to hello message.
6. Send hello message.
7. **end if**
8. **if** neighbor L_{ij} receives hello from the x **then**
9. Get MaxQValue from the hello message.
10. Compute
11. If this hello sender is the destination node, set R to 1, otherwise set R to 0.
12. For destination d, update Q-Table
13. **end if**

end for

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4. RESULTS ANLYSIS

Performance Metrics:

3.1 Packet delivery: The total number of packets sent by source device and successfully received packets ratio is responsible for PDR packet delivery ratio. That may include RREP and RREQ packets too. The packet delivery ratio is estimated using the below given formula.

$$Packet\ delivery\ ratio = \frac{total\ recived\ packets}{Total\ transmitted\ packets} X100$$

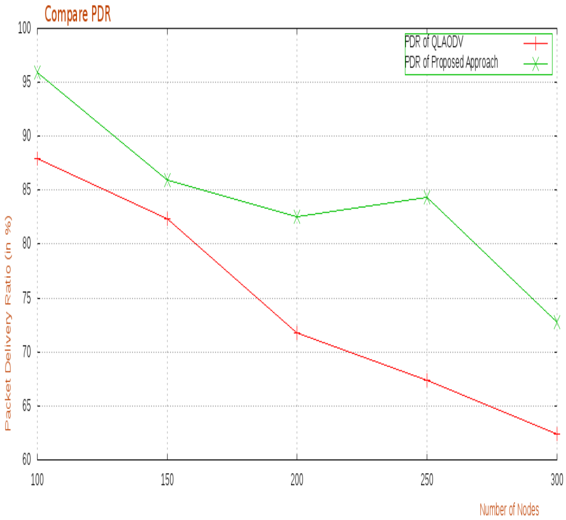

Figure 4.1 Packet Delivery Ratio

Figure 4.1 shows the comparative packet delivery ratio of the proposed and traditional technique of learning. This diagram contains number of nodes in X axis and in Y axis the packet delivery ratio. According to the demonstrated results the proposed technique having higher packet delivery ratio as compared to the traditional technique.

4.2 Routing overhead

During the routing activity the additional packets are injected in network, the additional packets which are injected are known as the routing overhead. The Figure 4.2 shows the amount of routing overhead for both the implemented routing techniques, for representing the proposed methodology the performance is given using green line and the performance of traditional technique is given using red line. In order to demonstrate the performance of the routing protocols the X axis shows the number of nodes in network and the Y axis shows the routing overhead. According to the obtained results the traditional algorithm having higher routing overhead as compared to the proposed learning technique thus the proposed method is much optimum then the traditional Q learning technique.

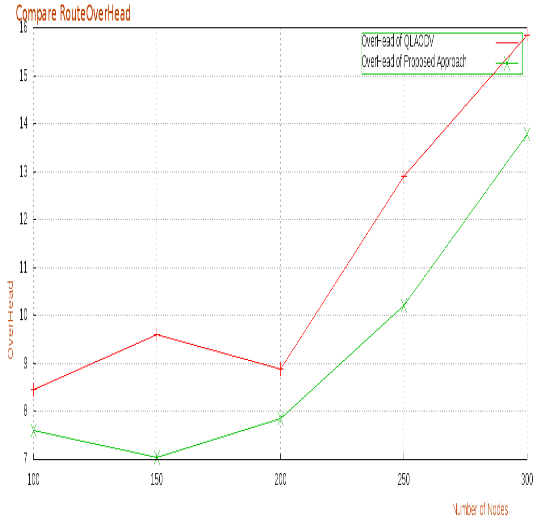

Figure 4.2 Routing Overhead

4.3 Throughput

Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

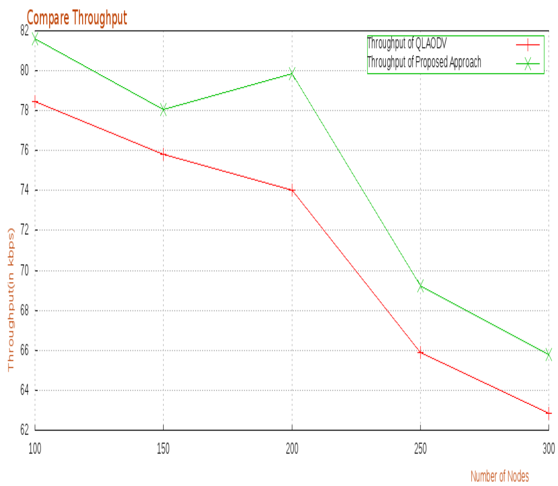

Figure 4.3 Throughput

Figure 4.3 shows the performance of the proposed and traditional learning technique in this diagram the throughput of the learning is simulated using Y axis and the X axis contains number of nodes in network.

5. CONCLUSIONS AND FUTURE WORK:

Mobile ad hoc networks are a collection of mobile network devices where to support the mobility the topology of network is defined on the basis of wireless connections. In this network not a centralized control available all the nodes are having the similar functionality and similar capability of resources. Thus topology development and data transmission is responsibility of routing protocols. Routing protocols first find the optimum route between source and destination nodes are then source node can send data to destination node but due to mobility the path can be broken or link can be damaged. Thus for stable routes a new kind of routing protocol is required to design which first find the optimum route on the basis of their stability.

For designing such kind of routing protocol an essential effort noticed during literature collection as listed in [2]. In this article a routing protocol is reported which finds the link stability by estimating the MF (mobility factor) and BF (bandwidth factor). But the proposed work addressed the problem of low energy nodes for path break issues thus an addition factor named energy factor is recommended for include in the previous work. After including the energy factor the traditional protocol is modified and implemented using the NS2 network simulator.

The results shows the source node able to find the optimum stable route during the route discovery process even when the intermediate nodes having the less energy. The comparative performance analysis of the proposed algorithm is also performed using the throughput, packet delivery ratio and routing overhead. The performance of the algorithm is summarized using table 5.1.

Table 5.1 Performance Summary

S No.	Parameters	Proposed technique	Traditional technique
1	Packet Delivery Ratio	high	low
2	Throughput	high	low
3	Routing Overhead	low	high

According to the obtained results as given in table 5.1 the proposed algorithm out performed as compared to the traditional algorithm. Thus proposed algorithm is much adoptable as compared to the traditional approach.

The proposed work is intended to find a routing algorithm which discovers the routes based on their stability. That primary goal is achieved by modifying the Q-learning concept with energy parameter and the performance improvement is noticed. In near future the proposed algorithm is extended with some additional performance parameters which affect the network during mobility or causes the path breaks.

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