

QoS Improvement for MANET Using AODV Algorithm by Implementing Q-Learning Approach

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Abstract

Ad-hoc network is a shared wireless network without any infrastructure; mobile nodes are move connected by wireless links. Quality of Service (QoS) is defined as performance agreement between the service provider and user applications based on the connection requirement qualitatively or quantitatively. As an attempt in this direction, the goal of paper is to develop Q-learning scheme, based on QoS parameters. However this approach must take taken into account the QoS parameters in Ad-hoc network: Traffic, Channel Capacity, Energy, Less number of nodes will die out, Cost to achieve Reliability (Confidence factor). AODV protocol is studied in this aspect. Reactive protocol (AODV) is based on On- demand route discoveries that update the routing tables only for the destination that has traffic going through. The work focuses on study and performance evaluation of these categories using Matlab 7.10.

Keywords

Quality of Service, AODV, MANET , Q-Learning , Sparse Matrix

I. Introduction

Tendency to reduce the infrastructure of wireless networks has given rise to mobile ad hoc networks (MANETs). MANETs are system of mobile nodes with routing capabilities, connected via a radio link, forming a network, which can be isolated (no connection to other networks) or extension of traditional wired network [1]. Some applications of MANETs [2] are: tactical military operations, allowing communication among soldiers in a battle field; search and rescue operations, or disaster relief, since in these situations, in general, one cannot rely on a local communication infrastructure; commercial use, promptly allowing the establishment of communication in exhibitions; conferences.

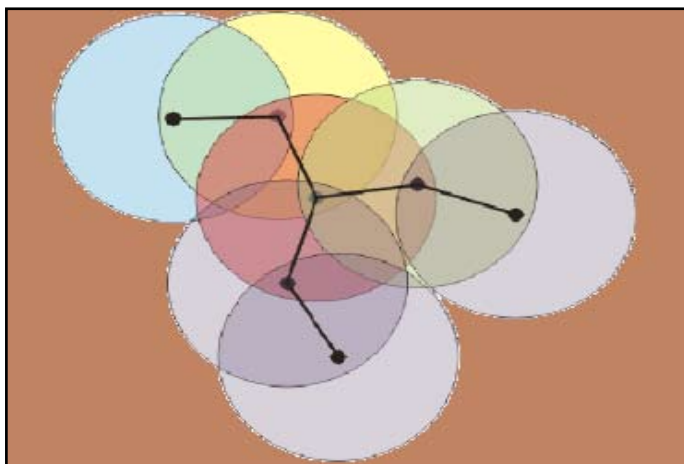


Fig. 1: MANET Structure

Major issue in MANET is energy consumption since nodes are usually mobile and battery-operated. Power failure of a mobile node affects its functionality thus the overall network lifetime. Quality of Service is the performance level of a service offered

by the network to user. Quality of service [1], sometimes refers to the level of quality of service, i.e. guaranteed service quality. Layered QoS approach where each layer's functions are determined to improve quality of service of the network. AODV [4] is On -Demand driven protocol, an efficient, and effective routing protocol for Mobile Ad-hoc Networks which do not have fixed topology. Periodically HELLO messages are used to track neighbors.

II. Review of Literature

This chapter presents a comprehensive review of literature on different aspects of QoS parameters. The detailed information about various functions affecting QoS parameters. To ensure QoS for network it is necessary to quantify the parameters of the given network. Starting from work V.M.Harnal and V.R Badyal [3], there are two different parameters Bandwidth and Packet loss rate evaluated using neuro-fuzzy technique. Coming to a more applied part of this problem, problem of varying Channel Capacity [5] go to zero as the number of nodes in the network increases implying that two close neighbors cannot communicate if node density grows to infinity in MANET.

Though there are a few techniques for estimation of Reliability [6] in MANET. The concept of mobile agents roaming in the network and executing tasks at different nodes may not be new. This information thus form the basis of topological information about the MANET. The use of mobile agents for the purpose of reliability estimation for MANET. Many of the work reported on routing protocols have focused only on shortest path, power aware and minimum cost. However much less attention has been paid in making the routing protocol to choose a more reliable route. In critical environment like military operation, data packets are forwarded to destination are forwarded to destination through reliable intermediate nodes [2].

MANET has limited resources like bandwidth and energy. Due to limited battery power nodes die out early and affect the network lifetime. To make network energy efficient, modified position based Location Aided Routing (LAR) for energy conservation in MANET. The proposed protocol is known as Variable Range Energy aware Location Aided Routing (ELAR-VAR). The proposed scheme controls the transmission power of a node according to the distance between the nodes. It also includes energy information on route request packet and selects the energy efficient path to route data packets.

Aim of the proposal by [10] was to find a new scheme that minimizes energy consumption during idle mode of the node. They identified four types of energy consumption by the node in a network as follows:

- Energy consumed during sending a packet
- Energy consumed during receiving a packet
- Energy consumed during idle mode
- Energy consumed during sleep mode which occurs when the wireless interface of the Mobile node is turned off.

Deployment of ad-hoc network leads to many challenges such as limited battery power, limited bandwidth, multi hop routing,

dynamic topology, security [1]. But, the major issue in MANET is energy consumption since nodes are usually mobile and battery-operated. Power failure of a mobile node affects its functionality thus the overall network lifetime. To prolong life time of the network, ad-hoc routing protocol should consider energy consumption. Efficient minimum energy routing schemes can greatly reduce energy consumption and extends the lifetime of the networks. Different routing protocols are designed for MANET such as AODV, DSR, OLSR, DSDV which meets some of challenges explained above.

The varied features of ad-hoc networks lead to many optimization problems with respect to achieving specific performance objectives. The idea of applying reinforcement learning to routing in networks was first introduced by Boyan and Littman [8]. They showed that the Q-learning [7] based routing can compete with the shortest path algorithms, without prior knowledge of the network topology. Q-learning has also been applied to routing in ad-hoc networks [10]. Collaborative Reinforcement Learning (CRL) also introduced and evaluated in [9] as a self-organizing technique for building a MANET routing protocol. Q-learning [11] requires no knowledge about the underlying reward or transition mechanism; thus it is applicable to the problem of learning routing strategy in ad hoc networks.

III. Issues and Challenges While Providing QoS in MANET

QoS provision [3] will lead to an increase in computational and communicational cost. In other words, it requires more time to setup a connection and maintains more state information per connection. The improvement in network utilization various issues are needed to be faced while providing QoS for MANETS. The major problems that are faced are as follows:

A. Unreliable Channel

The bit errors are the main problem which arises because of the unreliable channels. These channels cause high bit error rate and this is due to high interference, thermal noise, multipath fading effects, [10] and so on. The main problem in estimating reliability for MANET is its changing configuration due to node mobility.

B. Mobility of the Node

Since the nodes considered here are mobile nodes, that is they move independently and randomly at any direction and speed, the topology information has to be updated frequently and accordingly so as to provide routing to reach the final destination

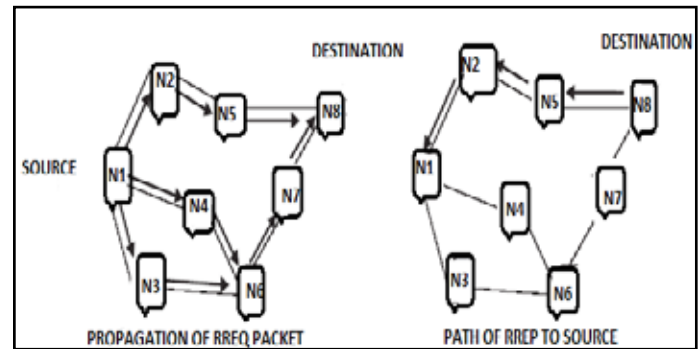
C. Limited Power Supply

The mobile nodes are generally constrained by limited power supply compared to nodes in wired networks. Providing QoS consumes more power due to overhead from the mobile nodes which may drain the node's power quickly.

D. Maintenance of Route

Dynamic nature of the network topology and changing behavior of the communication medium makes the maintenance of network state information very difficult. Hence the need for maintenance and reconstruction of routing paths. QoS aware routing would require the reservation of resources at the intermediate nodes. The reservation maintenance with the changes in topology becomes cumbersome.

E. Lack of Centralized Control



Members of any ad-hoc networks can join or leave the network dynamically and the network is set up spontaneously. So that there may not be any provision of centralized control on the nodes which leads to increased algorithm's overhead and complexity.

F. Channel Contention

Nodes in a MANET must communicate with each other on a common channel so as to provide the network topology. However, this introduces the problems of interference and channel contention. Primary challenge in building a MANET is equipping each device to continuously maintain the information required for proper data forwarding

IV. Proposed Work

In this work, there is a solution to achieve Reliability factor, by enhancing Channel Capacity, Energy efficiency, Cost Factor, Traffic which will lead to increase of buffer storage of the node. AODV algorithm and Q-Learning algorithm is used for the enhancement of the factors. Various equations and formulas are given below :

Considering a network as an undirected graph $G = (V, E)$ where V is the set of vertices and E is the set

of edges among them. Let the network consist of N nodes, thus $|V|=N$ that may or may not be connected with bidirectional links.

The following assumptions are made

- The network graph has bi-directional links.
- There are no self-loops or edges of the type
- The states of vertices and links are mutually statistically independent and can only take one of the two states: working or failed.

A. Equations to Calculate Each Parameter

- Distance between a pair of nodes (d_{ij}) can be calculated as follows:

$$d_{ij} = ((x_i - x_j)^2 + (y_i - y_j)^2)^{1/2}$$

- Channel Capacity (C) can be given by the Shannon's theorem as follows :

$$C = B \log_2 (1 + \text{SNR})$$

Here B is the bandwidth of the channel. SNR represents signal to noise ratio

- To calculate Node Reliability

$$1/Q \sum_q^Q \lambda_q(t)$$

B. AODV Algorithm

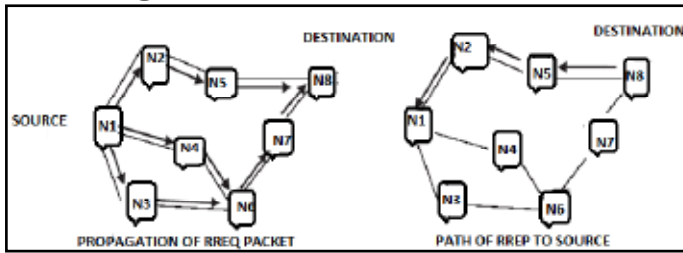


Fig. 2: AODV Working Protocol

AODV is on-demand routing protocol. AODV algorithm gives easy way to get change in the link situation. [7]

1. Originator

If a route to the destination is available, start sending data.
Else generate a RREQ packet. Increment the RREQID by 1. Increment the sequence number by 1. Destination IP address, currently available sequence number included.

2. Intermediate Node

Generate route reply, if a 'fresh enough' route is a valid route entry for the destination whose associated sequence number is at least as great as that contained in the RREQ. Change the sequence number of the destination node if stale, increment the hop count by 1 and forward.

3. Destination

- Increment sequence number of the destination.
- Generate a RREP message and sent back to Originator.

V. Conclusion

MANETs consists of mobile platforms known as nodes, which are free to move at any speed in any direction and organize themselves randomly. Nodes in the network function as routers, clients and servers. Whenever we talk about any service, the quality of the service (QoS) needs to be considered. That is why we only consider QoS MANET. The overall reliability may not always reach the 100% mark. In this paper we propose to enhance the various parameters with Q-Learning, better results will achieve.

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