Advanced Research in Electrical and Electronic Engineering
Print ISSN: 2349-5804; Online ISSN: 2349-5812 Volume 1, Number 3 (2014) pp. 1-4

http://www.krishisanskriti.org/areee.html

Comparative Study of QoS based routing Protocols in Mobile Ad Hoc Networks

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Abstract: **Due to autonomous and decentralize property, Mobile Ad Hoc Networks are gaining lots of popularity and application. A desirable QoS is required in MANET but it faces many challenging constraints like poor bandwidth, dynamic topology, limited processing and storing capabilities of mobile nodes. So to overcome these challenges several protocol has been proposed showing remarkable improvement in existing protocols. In this paper, we have done a comparative study of three different QoS based routing protocols. Firstly, SQ-AODV is an energy aware routing protocol works on 'make before break' mechanism. It utilizes a cross layer approach, in which residual node energy information is used for route selection and maintenance. Secondly, SMORT is a scalable multipath routing protocol which reduces the routing overhead incurred in recovering from route breaks, by using secondary paths. Lastly, QASR is a QoS aware stable path routing protocol designed using Signal Stability based Adaptive routing. It aims to select stable QoS routes that can survive for longer period of time. We have conducted an exhaustive simulation of the three routing protocols using NS2 simulator. Our results exhibit which protocol will perform better in various conditions and have better packet delivery ratio, end to end delay and control overhead.**

1. INTRODUCTION

Mobile Ad Hoc Network (MANET) is self-created, self-organized and rapidly deployable network architecture. With its growing applications, Quality of Service (QoS) guarantees are required by most multimedia and other real-time applications. The provision of QoS guarantee is much more challenging due to many constraints. These constraints may be poor bandwidth, dynamic topology, node stability, link failures, delays, limited processing and storing capabilities of mobile nodes. Therefore it is important that routing protocols must incorporate QoS metrics to design an efficient and reliable routing strategy.

Routing in MANETs is a challenging task and has received a tremendous amount of attention from researchers around the world. To overcome this problem a number of routing protocols have been developed and the number is still increasing day by day. In recent years, a number of QoS routing protocols with distinguishing features have been proposed. This paper presents a comprehensive and comparative study of three different QoS based routing protocols. This includes a thorough overview of QoS routing metrics, resources and factors affecting their performance. The protocols are SQ-AODV [1], SMORT [2] and QASR [3]. These protocols are classified according to the multi-path, cross layer [4], signal stability, bandwidth reservation and power efficiency based approaches. The relative strengths and weaknesses of these protocols have also been studied. Finally, it allows us to identify the areas for future research.

The remainder of the paper is organized as follows. Background and Survey is discussed in Section 2 in which we will review and discuss all three protocols. Performance evaluation and discussion is done in section 3 and lastly section 4 concludes the paper.

2. BACKGROUND AND SURVEY

This section describes three prominent QoS based routing protocols.

2.1 Stability based, QoS-capable Ad-hoc On Demand Distance Vector (SQ-AODV) protocol

Using the current node energy and without any requirement of virtual overhead, a cross-layered stable routing protocol has been introduced known as Stability based, QoS-capable Ad-hoc On demand Distance Vector (SQ-AODV) protocol [1]. On the basis of nodes current energy, drain-rate and session-duration, it makes a node as an intermediate router. Also a 'make before break' approach is used for finding an alternate path for the session, when the energy drain rate of a node suggests that it will cease forwarding before the session is completed.

The SQ-AODV's operation utilizes the cross-layer design, where energy information from the physical layer is used in admission control decisions at the network layer and to turn-off sessions at the application layer. There are two main features of SQ-AODV as follows:

The first feature checks that SQ-AODV only routes sessions along routes that either have intermediate nodes with sufficient energy to last the length of the session or along routes that maximize the residual life-time of the bottleneck node. Thus it ensures that due to energy depletion, session disruption at an intermediate node does not occur with very high probability.

The second feature ensures that when a link break due to node energy depletion is imminent, SQ-AODV proactively re-routes sessions, without losing any packets. It guards against link breakages that arise when the energy of a node(s) along a path is depleted, by performing a make-before-break re-routes. This minimizes packet loss and session disruptions and provides near-zero packet loss and better QoS performance.

2.2 Scalable multipath on-demand routing (SMORT) protocol for Mobile Ad Hoc Networks

The principle of reducing the amount of routing overhead generated by a unipath on-demand routing protocol, using multipath routing is main objective of Scalable multipath on-demand routing for Mobile Ad Hoc Networks (SMORT) protocol [2]. The fail-safe multiple paths approach is used in this protocol. The first path received by source node after initiating the route discovery is Primary path. It is usually the shortest path. When path bypasses at least one intermediate node on the primary path then path between source and destination is said to be fail-safe path to the primary path. Alternatively, the fail-safe path can be used to send data packets in case the bypassed node(s) on the primary path move away.

This protocol provides most of the intermediate nodes on the primary path with multiple paths to destination, along with source node. It does not enforce the disjoint-ness constraint on the set of multiple paths that it generates. It uses multiple paths to destination at intermediate nodes of the primary path, so as to avoid overhead of additional route discovery attempts. Reduction in routing overhead helps the protocol in extending to larger networks.

During route break recovery, alternate paths to destination avoid the overhead generated by the additional routing discoveries and route error transmissions. So it reduces the route error transmitted during route break recovery. By having multiple paths at all intermediate nodes on the primary path improves the performance of a multipath routing protocol, than having multiple paths at the source node only.

2.3 QoS Aware Stable path Routing (QASR) Protocol for MANETs

The proposed QoS Aware Stable path Routing (QASR) protocol [3] selects stable QoS routes based on signal stability along with QoS parameters like bandwidth and end to end delay as route selection criterion. Signal stability consists of signal strength and link stability. Strong and weak channels can be easily differentiated by the signal strength criterion. The main objective of using intermediate link stability is that the nodes which have been stationary for a threshold period are less likely to move and therefore, allows the protocol to select a link which has existed for a longer period of time. So the concept of signal strength and link stability plays vital role in selecting the most stable QoS links exhibiting stronger signals for maximum amount of time and leads to stable QoS routes.

The QASR protocol provides an eminent way of instantaneously constructing paths between mobile nodes. The protocol signaling allows on demand route discovery and end-to-end QoS reservation to support QoS in terms of maximum bandwidth and minimum delay. This protocol rectifies the problem of available and used bandwidth as it is projected for shared links. By this it is possible to make an admission control of flows based on the available resources and to easily recover from the QoS violations.

3. SIMULATION MODEL AND PERFORMANCE EVALUATION

3.1 Performance Metrics

We will use the following performance metrics to analyze the performance of QASR.

- Control Overhead: It is defined as the ratio between the total number of control packets transmitted by all the nodes and the total number of data packets delivered to the destinations.
- End-to-End Delay: The delay experienced by packets between their generation time and the arrival time at the destination is termed as end to end delay.
- Packet Delivery Ratio: It is the ratio between the number of data packets received at the destination and the number of data packets sent from the sources.

Table 1 Simulation Model

Parameter	Value
No of Nodes	50
Region	1000X500
Packet Size	512 bytes
Node Mobility	1m/s to 10m/s
Simulation Time	600 sec
Data Traffic CBR	3 pkts/sec
MAC Protocol IEEE	802.11
PCPL Data Rate	1 Mbps
Buffer Length	50 pkts
Radio Coverage Range	300 mts
Propagation Model	Two-Ray Ground

3.2 Result Analysis

The simulation is done in NS-2 simulator using above mentioned simulation model. The comparative result for simulation is shown in Figs.1-3.

The Fig.1 depicts average control overhead against the increasing node mobility speed. With higher node mobility, more route breaks and more intrusions will occur, so the number of control packets also increases. SMORT [2] shows lesser control overhead than QASR [3] and SQ-AODV [1], due to more stable QoS routes.

The End to End Delay of these protocols is compared in Fig.2. With increasing node mobility, end to end delay also increases. In QASR and SQ-AODV protocols, end to end delay remains fairly

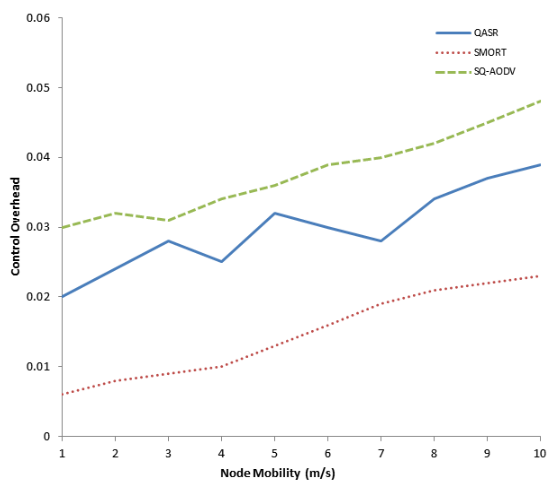

Fig.1 Control Overhead

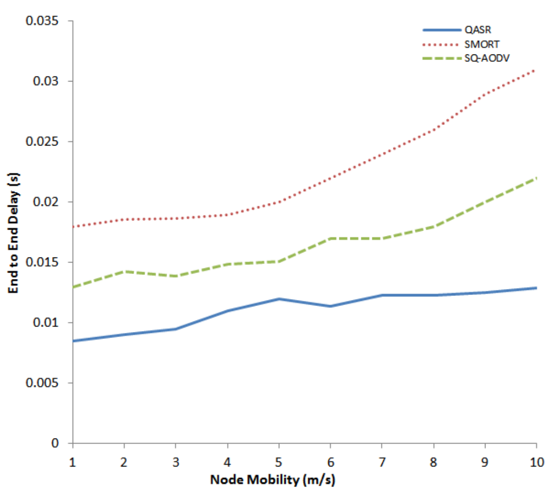

Fig.2 End to End Delay

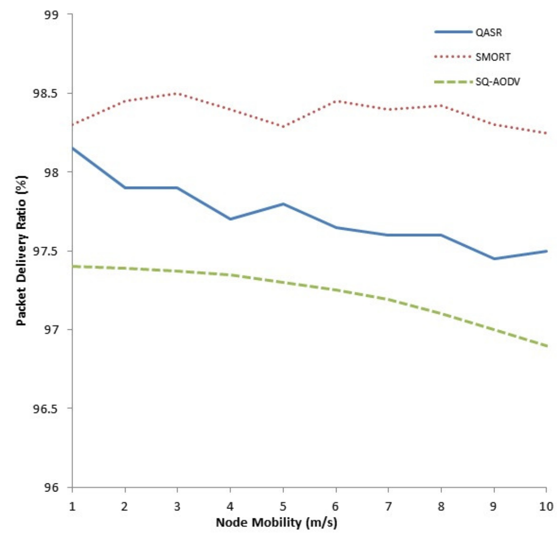

Fig.3 Packet Delivery Ratio

constant while it is very less in QASR protocol and quite significant in SMORT protocol.

Lastly, Fig.3 shows packet delivery ratio against node mobility. As node mobility increases, more route breaks and hence the packet delivery ratio is reduced. SMORT protocol shows fairly stable packet delivery ratio, while it is decreasing in QASR and SQ-AODV with increasing node mobility.

4. CONCLUSION

After reviewing these QoS based protocols and observing their simulation result, it can concluded that by considering different QoS metrics these protocols outperforms in some condition with limited performance in others. Like SMORT performs well in denser network, SQ-AODV provides fast re-routing capability and QASR enables quick recovery from channel deterioration and route breaks.

For future work several directions are possible from here. Like by combining more reliable QoS based constraints to these protocols explicitly give more efficient results.

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