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Traffic Load based Performance Analysis of DSR & STAR Routing Protocol

Rani Astya, and S.C. Sharma

***Abstract*—**The wireless adhoc network is comprised of wireless node which can move freely and are connected among themselves without central infrastructure. Due to the limited transmission range of wireless interfaces, in most cases communication has to be relayed over intermediate nodes. Thus, in such multihop network each node (also called router) is independent, self-reliant and capable to route the messages over the dynamic network topology. Various protocols are reported in this field and it is very difficult to decide the best one. A key issue in deciding which type of routing protocol is best for adhoc networks is the communication overhead incurred by the protocol. In this paper STAR a table driven and DSR on demand protocols based on IEEE 802.11 are analyzed for their performance on different performance measuring metrics versus varying traffic CBR load using QualNet 5.0.2 network simulator.

***Keywords*—**Adhoc networks, wireless networks, CBR, routing protocols, route discovery, simulation, performance evaluation, MAC, IEEE 802.11, STAR, DSR

I. Introduction

THE wireless adhoc network is comprised of wireless node which can move freely and are connected among themselves without any infrastructure. The adhoc networks are very flexible and suitable for several types of applications, as they allow the establishment of temporary communication without any pre installed infrastructure (fig.1). Due to the limited transmission range of wireless interfaces, in most cases communication has to be relayed over intermediate nodes. Thus, in mobile multi-hop ad-hoc networks each node also has to be a router [6]. Beside the disaster and military application domain the deployment of mobile adhoc networks for multimedia applications is another interesting domain.

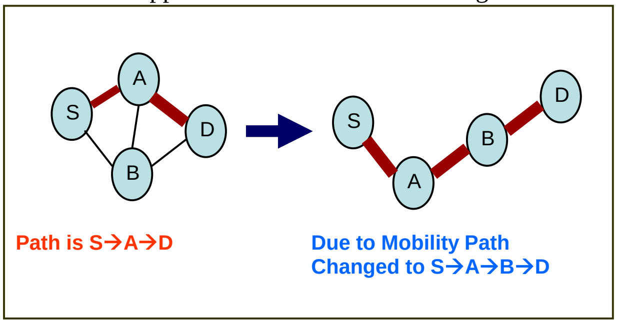

Fig. 1 The Dynamic scenario of network topology with mobility

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To find a route between the end-points is a major problem in mobile multi hop ad-hoc networks. The problem is further aggravated through the node mobility. Many different approaches to handle this problem were proposed in recent years, but so far no routing algorithm has been found suitable for all situations. Other aspects of ad-hoc networks are also subject to current research, especially the dynamic address configuration of nodes.

In this paper the comparison of STAR a table driven and DSR on-demand routing protocol based on IEEE 802.11 [10] is analyzed and presented. This paper explores the impact of MAC overhead on achievable data throughput and packet delivery ratio in environments with varying data traffic CBR (Constant Bit Ratio) load over UDP using Qualnet 5.0.2 simulator [2].

II. Routing Protocols: Classification in Brief

Routing is the process of finding a path using broadcasting [11,12] from a source to some arbitrary destination on the network. The categories of protocols with examples are:

A. *Proactive or Table-driven routing protocol*

Proactive protocols, also called table driven, continuously evaluate the routes within the network, so that when a packet needs to be forwarded the route is already known and can be immediately used. Table driven protocols maintain consistent and up to date routing information about each node in the network. These protocols require each node to store their routing information and whenever there is a change in network topology, the updates has to be made throughout the network. The table driven protocols for example are:

1. Destination sequenced Distance vector routing (DSDV)[5]
2. Source Tree Adaptive Routing (STAR) [8]

B. *Reactive or On-demand routing protocol*

Reactive routing protocols, also called on demand, invoke a route determination procedure only on demand. A node wishing to communicate with another node first seeks for a route in its routing table. If it finds one the communication starts immediately, otherwise the node initiates a *route discovery* phase. Once a Route has been established, it is maintained until either the destination becomes inaccessible (along every path from the source), or until the route is no longer used, or expired. For example

1. Ad-Hoc On-demand Distance Vector(AODV) [1].
2. Dynamic Source Routing (DSR) [3,4]

C. *Hybrid Protocol*

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 features of such algorithms are:

1. Depends on amount of nodes activated.
2. Reaction to traffic demand depends on gradient of traffic volume.

For example

1. Temporally ordered routing algorithm(TORA)[7]
2. Zone Routing Protocol (ZRP)[9]

These classes of routing protocols are reported but choosing best among them is very difficult as one may be performing well in one type of scenario but may not work in another type of scenario [13,14]. It is examined in the paper with the simulation of DSR and STAR-LORA routing protocols and the comparative characteristic summary of proactive, reactive and hybrid routing protocols is presented in Table 1.

TABLE I
CHARACTERISTIC SUMMARY OF PROACTIVE, REACTIVE AND HYBRID ROUTING PROTOCOLS

Metrics	**Proactive**	**Reactive**	**Hybrid**
Network organization	Flat/ Hierarchical	Flat	Hierarchical
Topology dissemination	Periodical	On-demand	Both
Route latency	Always available	Available when needed	Both
Mobility handling	Periodical updates	Route maintenance	Both
Communication overhead	High	Low	Medium

III. DYNAMIC SOURCE ROUTING PROTOCOL

The key feature of DSR [3] is the use of source routing. The source (sender) knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header. It is an on-demand routing protocol and composed of two parts:

A. Route Discovery
B. Route Maintenance

A. Route Discovery

When a node in the ad hoc network attempts to send a data packet to a destination for which route is not known, it uses a route discovery process to find a route. Route discovery uses simple flooding technique in the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it further, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed so far. The RREP routes itself back to the source by traversing this path backward, the route carried back by the RREP packet is cached at the source for future use.

B. Route Maintenance

The periodic routing updates are sent to all the nodes. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. Also, any forwarding node caches the source route in a packet it forwards for possible future use. Some of the techniques that are evolved to improve it are:

(i) Salvaging: an intermediate node can use an alternate route from its own cache, when a data packet meets a failed link on its source route.

(ii) Gratuitous route repair: a source node receiving a RERR packet piggybacks the RERR in the following RREQ.

This helps cleaning up the caches of other nodes in the network that may have the failed link in one of the cached source routes.

IV. SOURCE TREE ADAPTIVE ROUTING (STAR)

Source Tree Adaptive Routing (STAR) Protocol for adhoc network, is a proactive table driven routing protocol. The network topology is presented in the form of a graph G. The G = (V, E) is a directed graph, where E is the set of edges connecting the vertices and V is the set of nodes. These vertices are called nodes (or Routers) and edges are called links between them. The adjacent nodes are called neighbors and all of them have unique address for identity. In a wireless network, a node can have connectivity with multiple nodes over a single physical radio link.

A. Route Discovery & Maintenance

Each node builds a shortest path tree (source tree) and stores preferred path to destination and so each node discovers and maintains information related to network topology. STAR uses two different techniques to neighbor discovery using hello or update messages. It is energy saving protocol in the sense that every node of it updates about only the changes to its source routing tree when they found changes or breakage in the links. If over a given period of time a node doesn't receive any such message, it assumes that either node is out of its range (node may be dead) or link is broken. Within the finite time frame all the changes like link failures, new neighbor notifications etc. are processed and send to neighbors in their order of occurrences and one at time.

B. Different Operating Modes

The STAR operates in two different mechanisms but chooses one at a time. It may work either in the Least Overhead Routing Approach (LORA) mode or Optimum Routing Approach (ORA) mode. With ORA, the routing protocol attempts to update routing tables as quickly as possible to provide paths that are optimum with respect to a defined metric whereas in LORA mode it tries to provide shortest route as per performance and delay metrics.

The characteristic summery of DSR and STAR protocol is given in table II.

TABLE II
CHARACTERISTIC SUMMARIES OF DSR, STAR ROUTING PROTOCOLS

Protocol	Dynamic Source Routing **(DSR) [3,4]**	SOURCE TREE ADAPTIVE ROUTING **(STAR) [8]**
Category	Reactive	Proactive
Metrics	Shortest path, next available	Shortest path works in two mode • Least Overhead Routing Approach (LORA) mode **or** • Optimum Routing Approach (ORA) mode
Route Recovery	New route, notify source	Reverse link
Route repository	Route cache	Routing table
Broadcasting	Simple	Simple
Multiple paths	Yes	No
Loop freedom maintenance	Source route	Updated messages
Communication Overhead	High	High
Feature	Completely on demand	Control packets localized to area of topology change

V. SIMULATION SETUP

The Qualnet 5.0.2 simulator is used for the analysis. The animated simulation is shown in fig. 2. The IEEE 802.11[10] for wireless LANs is used as the MAC layer protocol. In the scenario UDP (User Datagram Protocol) connection is used and over it data traffic of Constant bit rate (CBR) is applied between source and destination. The 100 nodes are placed uniformly over the region of 1500mx1500m. The mobility model uses the random waypoint model in a rectangular field. The multiple CBR application are applied over 13 different source nodes – 4,53,57,98,100,7,5,49,10,93,1,92,9 and destinations nodes - 51,91,94,59,60,96,58,97,100,54,45,44,38 respectively. The data traffic load is varied as 1, 2, 4, 5, 10 packets per sec to analyze the performance of DSR and STAR-LORA (STAR with LORA method) routing protocols.

TABLE III
SIMULATION PARAMETERS

Parameter	Value
Area	1500mX1500m
Simulation Time	90,120, 200 sec
Channel Frequency	2.4 Ghz
Data rate	2.Mbps
Path Loss Model	Two Ray Model
Mobility Model	Random-Way Point
Packet size	512 bytes
Physical Layer Radio type	IEEE 802.11b
MAC Protocol	IEEE 802.11
Antenna Model	Omni-directional

A. Performance Metrics

The performance analysis of these protocols is done on the following important performance metrics.

1) *Packet Deliver Ratio:* The (PDR) is defined as the ratio between the amount of packets sent by the source and received by the destination.
2) Throughput*:* Throughput is the average rate of successful data packets received at destination. It is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second.
3) *End-to-End Delay:* It is the accumulation of processing and queuing delays in routers, propagation delays, and end-system processing delays. The packets that are delayed by more than the threshold value are effectively lost.
4) Jitter: Jitter is the variation of the packet arrival time. In jitter calculation the variation in the packet arrival time is expected to be low. The delays between the different packets need to be less than threshold value for better performance.

VI. RESULTS & DISCUSSION

The analysis is done using Qualnet 5.0.2 network simulator and it is shown from 3 to 6. It displays the parametric analysis of DSR and STAR-LORA routing protocol over the varying traffic load. In this analysis thirteen different CBR traffic is applied on separate source to destination nodes. The following important performance metrics are analyzed in fig. 3 to 6.

Packet Deliver Ratio: Performance is analyzed on this parameter and it is observed that DSR routing protocol performance better than STAR-LORA initially but as the traffic load is increased to more than 2 packets per sec the STAR-LORA protocol outperforms the DSR protocol as shown in figure 3.

Throughput: With the varying CBR data traffic the throughput is analyzed. The successful packet delivery in an adhoc network is observed with increasing MAC based CBR load. It is observed that at low traffic load of 1 packet per sec the DSR protocol perform better but as the traffic is loaded heavily the STAR-LORA performs much better as shown in figure 4.

End-to-End Delay: When a packet is transmitted from source to destination it takes time that include different delay as described in its definition above. In this analysis it is found as expected the delays are increasing as the traffic load is increasing. The average end-to-end delay is very high in DSR than STAR-LORA protocol as shown in figure 5.

*Jitter***:** Jitter, the variation of the packet arrival time, is an important metrics for any routing protocol. In this analysis it is found to vary with the traffic load in case of DSR and is largest when traffic load is 4 packets per sec. But in SATR-LORA case it is uniformly increasing. It is also noted that the jitter is always more with DSR protocol as shown in figure 6.

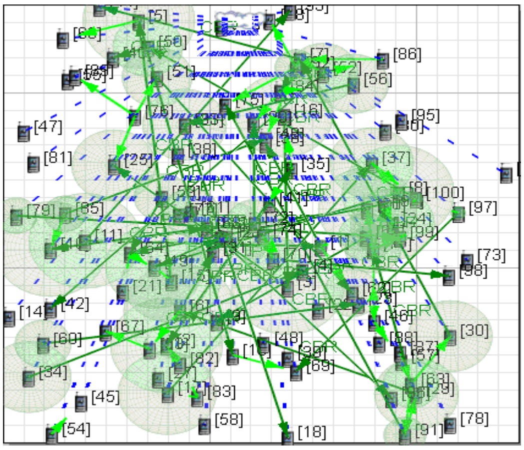

Fig. 2 Animation view of simulation

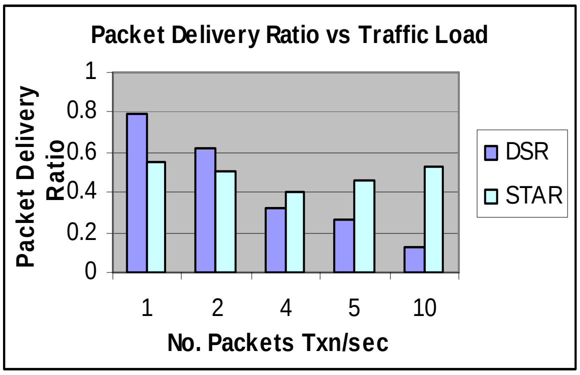

Fig. 3 Packet Delivery Ratio vs Traffic Load

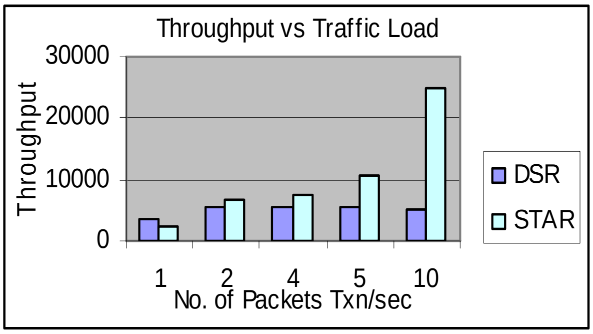

Fig. 4 Throughput Vs Traffic Load

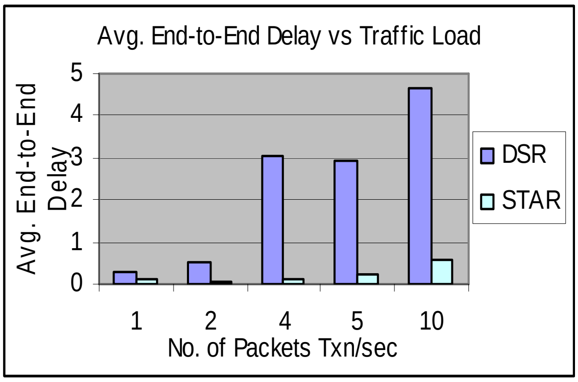

Fig. 5 Average End-to-End Delay vs Traffic Load

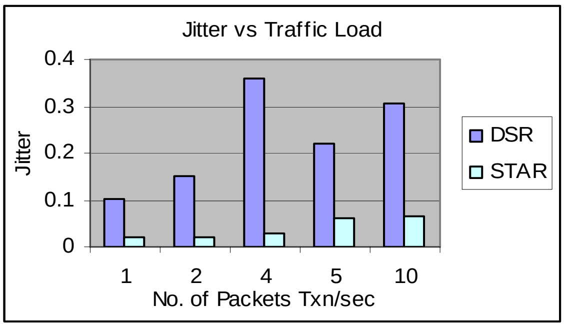

Fig. 6 Average Jitter vs Traffic Load

VII. Conclusion

It is observed with the simulation analysis that at low traffic load DSR performs better than the STAR-LORA protocol but as the traffic load increases STAR-LORA outperforms DSR protocol as shown in figures from 3 to 6. The performance of STAR-LORA is better because of its LORA technique that enables it to find route faster and safe. The packet delivery and throughput are better in case of STAR-LORA. The end-to-end delay and jitter are also very high for DSR.

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