Volume: 01 Issue: 03 Pages: 170-174 (2009)

A Stable Adaptive Optimization for DSR Protocol in Ad hoc Networks

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ABSTRACT

Ad hoc networks are autonomous systems composed of mobile hosts that are free to move around arbitrarily. Rather than relying on a network infrastructure to perform routing in an Mobile Ad hoc NETwork (MANET) each mobile host serves as a router to forward packets originated from other nodes. Proactive protocols are table driven, find routes between all source-destination pairs regardless of the actual need for such routes. Reactive protocols, on the other hand, are based on the reduction of the routing load by initiating new routing activities only in the presence of data packets in need of a route. Dynamic Source Routing (DSR) is a reactive routing method for ad-hoc wireless networks that floods route requests when the route is needed. DSR is appealing for ad hoc networks as a reactive routing protocol because of the lower routing overhead. However its performance is not ideal for the high dynamic ad hoc networks. As an optimization for the current DSR, a new adaptive routes selection scheme based on the stability of nodes was proposed in this paper, considered joint hop count and node stability. As shown with the simulations results, the enhanced-DSR has higher throughput and less end-to-end packets delay.

Keywords: DSR, stable adaptive, ad hoc network

Date of Submission: September 8, 2009 Revised: November 24, 2009 Accepted: December 20, 2009

I.INTRODUCTION

An ad hoc network [1], which is characterized by a non central administration network in which all nodes function as routers or user and self-organize to form a dynamical network, is very suitable to various requirements and environments in wireless telecommunication. However, there is a challenge to design a suitable routing scheme in such networks because the network topology changes frequently and unpredictably when the nodes are in moving state. And many routing schemes have been proposed for ad hoc networks. All the current routing protocols can be classified into two categories, proactive and reactive.

The Dynamic Source Routing (DSR [2]), a typical reactive routing protocol, is appealing because of its lower routing overhead. But the performance of DSR is not ideal for such quickly mutable and unpredictable networks introduced by the mobility of nodes. Previous research [3] have concluded the performance of ad hoc networks is tight related to the mobility of nodes acting as routers, therefore those nodes with high stability are more suitable for providing higher quality and efficiency of relaying data packets. In this article, a novel stable adaptive optimization to the routing scheme of DSR is proposed to select more stable routes with using only the nodes' history records. It uses joint nodes' packets delivery records and routes' hop count information as route selection criteria and does not bring any extra cost to the system.

The performances of the enhanced-DSR, including packet delivering delay and network throughput, are simulated by GloMoSIM [4]. Comparing with the current DSR protocol presented by Internet Engineering Task Force, it is shown that the enhancement scheme will decrease the average packets delivering delay and improve the whole network throughput. The article is organized as follows. In the next section, the current DSR protocol is briefly reviewed. In the third section, the enhanced-DSR scheme is described. In the fourth section, the simulation results and analysis are given. And the last section gives conclusion.

II DSR PROTOCOL

The Dynamic Source Routing protocol (DSR) is an efficient on-demand routing protocol designed for use in multi-hop wireless ad hoc networks of mobile nodes. It only initiates a *routing discovery process* when the source node originates new data packets but has no route to the estimation node, which will decrease the routing overhead than the proactive protocols. When some source node needs to dynamically find a new route to the destination node, it will send out *route request* (RREQ) packets. When the neighbor node receives the RREQ, if it is just the destination of the route discovery or there is the route information in its Route Cache to the same destination node, it adds the route information in the *routerecord* of the RREQ and returns a *route reply* (RREP) packet to the initiate source node as shown in Fig1.

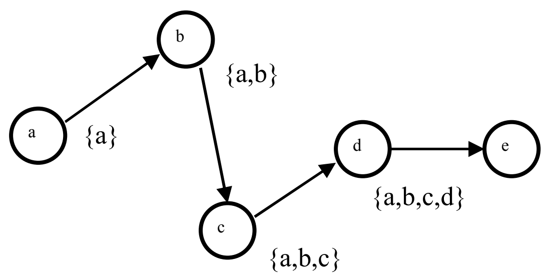

Fig 1: Example of route Discovery with same request ID

When the initiator receives this RREP, it caches this route in its Route Cache for use in sending subsequent packets to this destination. Otherwise, if this node receiving the Route Request has recently seen another RREQ from the same initiator to the same destination, or if this node's own address is already listed in the *route record* in the Route Request, this node discards the Request. Otherwise, this node appends its own address to the *route record* of the RREQ and relay the RREQ as shown in Fig2. And each RREQ contains a "Hop Limit" that may be used to limit the number of intermediate nodes allowed to forward that RREQ. As the Request is forwarded, this limit is decremented, and the RREQ packet is discarded if the limit reaches zero before finding the target.

Checks the route cache
If (there exists a fresh enough path for desired destination)
{Use it}
Otherwise
{
Broadcast a route request (RREQ) packet
}
Intermediate or destination node receiving the RREQ checks
If (Itself is a destination)
{
Send a route reply (RREP)}
Otherwise
{
If (there exists a fresh enough path for desired destination)
{Send RREP}
Otherwise
{Broadcast a route request (RREQ) packet) }
}

Fig 2: Procedure for DSR route discovery process

In DSR, the source node may get more than one routes of the same destination because the destination node replies to *all* requests reached in a single request cycle. Then, the source node will set the shortest (in hop counts) route as the *primary* one to prepare for sending data packets. Obviously, the *shortest* route maybe is not the most *stable* route for the different mobility of the middle nodes. And the previous researches [3] have shown that the stability is a key factor to the performance of ad hoc networks. It could improve the system performance to select more stable routes with mostly same hop counts. So the stability should be an important character to be considered in routes selection criterion. There have been some previous routing scheme studies on nodes stability, such as Signal Stability-Based Adaptive Routing protocol (SSA) [5]. In SSA, the nodes will send out a link layer beacon to its neighbors once every time quantum, and every host records the *signal strength* when receiving the beacon. Each node classifies its neighbor as strongly connected if the node has been receiving strong beacons from the neighbor for the past few clicks; otherwise the neighbor is classified as weak connected. In routing table there is an entry to store this information of nodes (strong connected or weak connected) for each route. Then the source node will select stronger connected route to deliver data packets. SSA does consider the stability of the nodes, but it requires node to send link beacons periodically, which brings extra load cost to network.

III ENHANCED-DSR SCHEME

Considering the influence of route stability to the network performance, a self-adaptive routes selection scheme optimizing for DSR is proposed to improve the system performance. In the optimized scheme, the nodes will choose *more stable* route when they send data packets. The *packets successfully delivering numbers* is used to measure the nodes' stability and a parameter V is introduced as the routes selection criteria.

The detail scheme is shown as below.

- Every node has a *delivering counter* to takes number of how many data packets have been successfully delivered to its neighbor nodes.
- The route-establishing scheme is based on conventional DSR scheme. The source nodes will broadcast a RREQ packet containing *route record*, when data packets need be sent but with no route to the destination. The middle nodes will relay the request and the destination node will reply the request to establish a route. The difference is that when the middle node relays the routing request, the node appends both its own address and delivering counter value to the route record in the Route Request and then propagates it.
- When nodes receive more then one routes replies (of the same destination), the nodes will calculate the V value of the route, defined as below

$$\mathbf{V}_{k\text{-}ij} = \mathbf{N} - \mathbf{W} \sum_{r=1}^{N-1} \mathbf{D}_r / (\mathbf{N-1})$$

Where $\mathbf{V}_{k\text{-}ij}$ **:** The k^{th} route from node i to node j ;
N: the hop count of k^{th} route;
W: weight value;
$\mathbf{D}_r$: the delivering counter value of the r^{th} middle node;

The route with smallest V value will be selected when sending data packets, and the routes have same V values will be selected randomly.

Dr is used to describe the stability of a node; Vk-ij value is smaller means that this route is shorter and more stable. So the packets success delivering ratio and delivering delay performances of the optimized scheme will be improved for tending to choose these more stable routes. The routes selection criteria parameter V uses jointed routes' hop count and nodes' stability history information, which brings less extra cost to network.

In enhanced-DSR, the routing scheme is adaptive to the stability of networks. If the nodes in a sub-area all are in high mobility, the routes will be selected mainly according to the hop counts, just similar as the current DSR, and the data traffic will spread in this sub-area of the network. If some nodes are more stable than their neighbor nodes, the data stream will partly concentrate into these nodes through higher quality routes.

IV SIMULATIONS & RESULTS

In order to evaluate the benefits of the new scheme, we compared the performance of enhanced-DSR and the conventional DSR protocols with GloMoSim, which is developed by USLA.

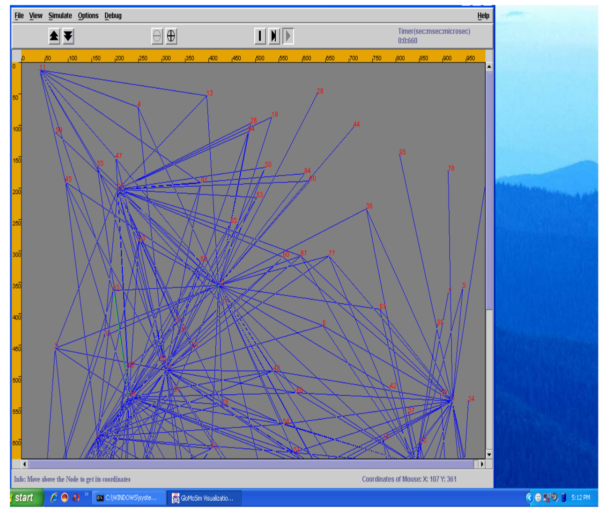

Fig3 : Snapshot of Simulation in GLOMOSIM

In this study, it assumes that nodes are placed uniform within the physical terrain area divided into a number of cells (based on the number of nodes in the simulation), and a node is placed randomly within each cell. And the simulating parameters in GloMoSim are set as below [6].

Parameter	Value
Propagation-Path-loss	two-ray model
Radio bandwidth	20Mbps
RADIO-RX-SNR-THRESHOLD	21.0dB
Traffic sources	CBR, Every Source node sends 50 kbs
Pkt. Size	512bits
Inter-departure time	1e-5s
Model 1 (High Node density)	90 nodes in 300X200m Speed 0-2 m/s
Model 2 (Low node density)	90 nodes in 1500X1000m Speed 8-15 m/s

TABLE1: GLOMOSIM PARAMETERS

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Two performance metrics are evaluated, average end-to-end delay [7] and system throughput. In simulations, the pause time after each node moves to its new location is changed form 1 second to 1500 second. The nodes are in high mobility when the pause time is 1s. But when the pause time is as same as simulation time, the nodes can be considered as fixed.

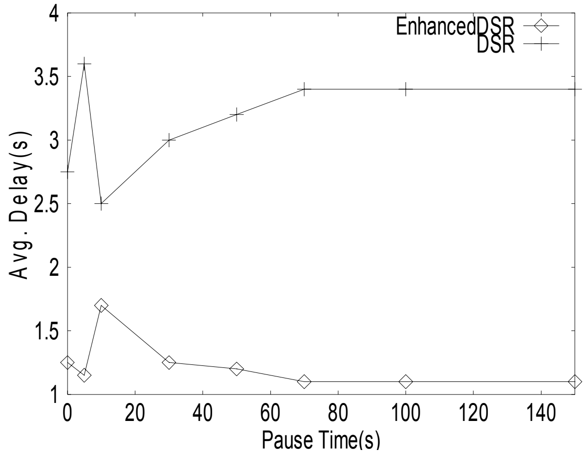

Fig.4: Delay Vs Mobility for Model1

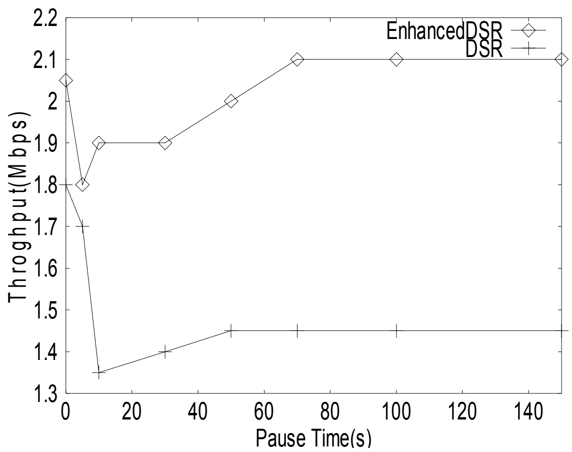

Fig.5: Throughput Vs Mobility for Model1

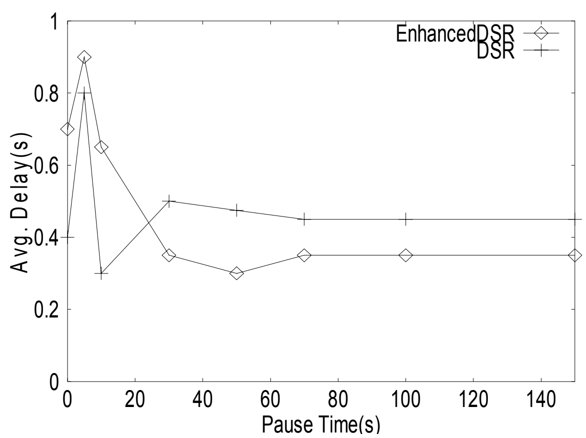

Fig.6: Delay Vs Mobility for Model2

(1500X1000)

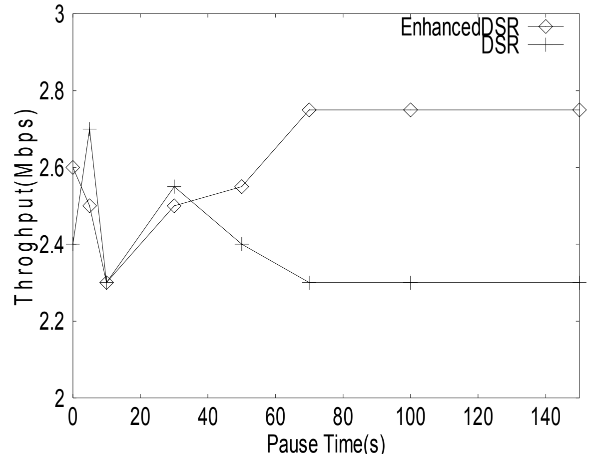

Fig.7:Throughput Vs Mobility for Model2

As shown in the above Figures, in the simulation of both the models, enhanced- DSR presents much higher throughput and lower packets delay than conventional DSR protocol. In the model1(High node density network), the throughput is increased 51% and the average packets delivering delay is decreased 67%. In the model2(Low Node density network), it is increased 10% in system throughput and decreased 17% in packets delay.

(300X200)

V CONCLUSION

A new stable adaptive enhanced-DSR protocol is proposed in this article, jointly considered the hop-count and routes stable as the routes selection criteria. The optimization brings less extra routing overhead to the network with using the nodes history transmission information to measure the nodes stability. The simulation results show the enhanced DSR has much less average packets delivering delay and better throughput performance than conventional DSR protocols.

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