On Improving DSR routing protocol

Eun-Yong Ha and Dong-Huan Piao
Dept. of Computer Engineering, Anyang University

Abstract

Ad hoc network is a kind of new wireless network paradigm for mobile hosts. Ad Hoc wireless networks consist of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. Mobile hosts rely on each other to keep the network connected. Each host is not only mobile hosts but also router. So how to design a routing protocol is the most important problem. Dynamic source routing is a kind of routing protocol. In this paper we suggest a new automatic route shortening method and an energy-aware routing mechanism based on DSR.

1.Introduction[1]

Mobile hosts and wireless networking hardware are becoming widely available, and extensive works have been done recently in integrating these elements into traditional networks such as the Internet.

Ad hoc networks are a new paradigm of wirelesscommunication for mobile hosts. In an ad hoc network, there is no fixed infrastructure such as base stationsor mobile switching centers[1].

As we describe the design of a routing protocol for ad hoc networks is the key of ad hoc networks. On-demand routing protocol and table-drive routing protocol have their pros and cons[2]. So we can't perspicuously tell which one is better. But in this paper, we will investigate about dynamic source routing. It is a kind of on-demand routing protocol. On-demand routing protocol needs not always send route information like table-drive protocol. So it is very fit for temporary networks such as ad hoc networks.

Dynamic source routing is an on-demand routing protocol for small-size ad hoc networks: dynamic source routing isn't fit for big-size ad hoc networks. It is a simple and efficient routing protocol. The protocol is composed of the two mechanisms of route discovery and route maintenance. In order to improve route discovery efficient, the protocol uses cache mechanisms. We will suggest an automatic route shortening mechanism to improve route discovery. Because mobile hosts use battery of limited capacity as their energy power, a kind of energy-aware routing protocol is necessary. In this paper, we suggest an energy–aware routing protocol. We explain about DSR protocol in section 2, our new automatic route shortening mechanism in section 3 and we evaluate performance of our method in section 4. And then we conclude.

2. Overview of Dynamic Source Routing protocol

At first we assume that all nodes want to communicate with other nodes within the ad hoc network and all nodes wishing to participate fully in the network protocols. Every node can move at any time to any place arbitrarily, but the speed with which nodes move is moderate. Every node can enable a promiscuous receive mode. Because any pairs of nodes have different radiation range, so any pairs of nodes may be only unidirectional.

2.1 Route Discovery

If a node want to send packets to another node, at first it will search its cache. If it can find a route to destination, it will use this route. If it can't find, it will discovery a route to the destination.

At first every node can directly reach any other nodes within wireless transmission range. So if a node wants to communicate with other node, it can broadcast a Route Request to any node within its transmission range. If a node receives the Request and it is the target of the routing, it will return a Reply. If it isn't the target, it may examine its Reply. If it isn't the target, it may examine its cache. If the route to target can be found, it will return a Reply. If route couldn't be found, it will forward the Request and write itself into the route record as routing information. From this mechanism, Route Request will arrive to the target. When the target receives a Request, it will search its cache. If the target can find a route to sender, it uses this route to send Reply. If it can't find a route in its cache, it will reverse the route information and use the reversing routing information to send a Reply. But if the route is unidirectional, the target has to use Route Discovery to find a route to sender and then replies.

2.2 Route Maintenance

For example, if node A is the initiator and node E is the target. There are nodes B, C, and D from node A to node E. We want to build a route from node A to node E, pass by node B, node C and node D. Node A sends a Request. Node B receives it and forwards it, Node C also receives it from node B and forwards it; how can node B confirm receipt at node C? Node B can confirm receipt at node C by overhearing node C transmit the Request to forward it on to node D. Each node can store a route in its

[1] This work was supported by grant No. R05-2003-000-12092-0 from the Basic Research Program of the Korea Science & Engineering Foundation

cache, when it forwards a packet or by overhearing the other routing. But the route must is bi-directional, otherwise it will not store the route in its cache. Route Discovery often uses cache to find a route.

2.3 Optimizations

When a sender sends a Request, any node within its transmission range can receive the Request. If any nodes within its radius are not the target but a lot of them have the route to the target in their cache, they can reply to the initiator. It will make a problem that many replies simultaneously send to the initiator. In order to preventing Route Reply storms, a kind of delay mechanisms is introduced.

Each Request message contains a 'hop limit'. It is used to limit the number of hops over which the packet may be propagated. DSR uses a kind of mechanism named expanding ring search to limit Route Request hop.

In order to shorten the route, some unnecessary hops are discarded. If node C overhears a message sent from node A to node B for later forwarding to node C, node C will return a *gratuitous* reply message to the original sender and gives the shorter route. This mechanism can shorten the route.

When each node overheard a Route Error, it will update its cache. If a Route Error as a part of Route maintenance is sent to the initiator, the initiator will attempt to salvage the packet.

3. Improvements on DSR protocol

3.1 A New Automatic Route Shortening

As you can see in figure 1, we assume that source is node S, destination is node D and the current source route is (S, B, C, W, D).

Node C can overhear the message sent from node S to node B for later forwarding to node C. And then node C forwards the message to the next node W and notifies node S that a shorter route (S, C, W, D) is found. When a source node sends a route request, many nodes in promiscuous mode overhear the route request packet. If they are not the target and also have not a route to the target, they can not reply to the source. But when a reply returns to the source, the neighboring nodes around the decided backward route can overhear the route information. Though neighbor nodes can not connect directly to the target, they may connect to neighbors of other nodes on this route. In this case, they can return a route reply packet to tell the source that a shorter route exists. When the source receives a route reply from its neighbor, it learns that this path maybe is a better way. So it may use this way.

From figure 1, we can see node E can tell node S the best way to the target. The way is Path (S, E,W, D). Our method is different in that non-member nodes of the source route can notify to the source that there is a shorter route form the source node to the target node.

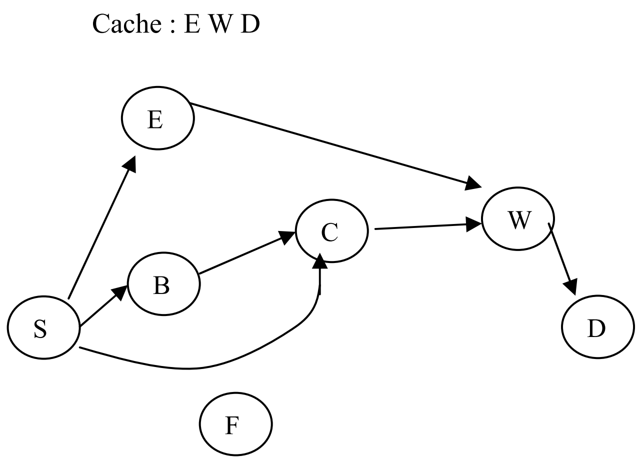

Fig.1 Route Shortening

2. DSR-based Energy-Aware Routing Protocol

We consider two routing protocols in this section. The one is named request-delay routing protocol[3], and the other one is named max-min routing protocol[4]. First, we describe request-delay routing protocol. In figure 2, you see the energy level of each node is shown. We assume that node S is the source and node D is destination. When node S sends a route request, node A or node E maybe receives the request. But node E's energy is too low, so it will delay forwarding the packet more than node A very long time. According to this method the source will find the route to the target. The decided route may be the path (S, A, B, C, D).

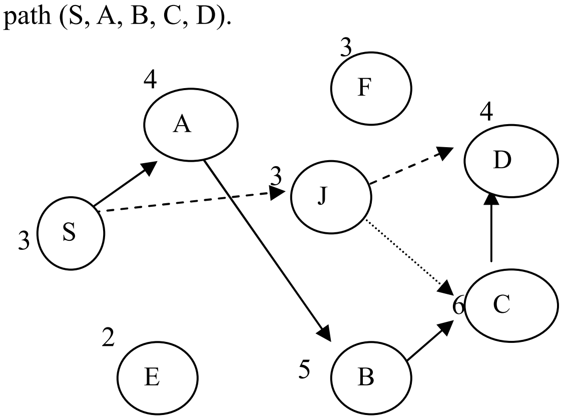

Fig.2 Request Delay Energy-Aware Routing

In this example, because node A, node B and node C have highly energy, and the other low energy node always forward packet after delay very long time. So the route always passes by node A, node B and node C. It is not possible that another route be found from node S to node D. This method will deplete the energy of the central nodes quickly and cause the network partitioned.

For solving this problem, we suggest a delay mechanism to make each node have "different speed". It does not really make each node have different speed. Because the transmission speed is regular from a node to its neighbor nodes, we can not change it. Now that every low energy node will delay longer time, we make a rule about delay time. In figure 2, we assume that a node's energy is beyond 4, it can forward a packet when it receives a packet. If a node's energy is below 4, it has to delay a little time, we assume this delay time unit is 1/4 second. So if a node's energy is 3, it waits 2/4 second before forwards. Energy 2 nodes wait 3/4 second and energy 1 node wait 4/4 second. Using this method, we also can find path (S, J, D) or path (S, J, C, D). It avoids to find alike route.

The second energy-aware routing protocol is max-min routing protocol. For example, assume that in figure 3, node S sends route request and then finds the target—node D, node D will receive many routes. At first node D will discard duplicate request packets with the same request id (in this example the path (S, A, E, B, D)). Because the path (S, C, E, B, D)'s minimum energy is 4 and the path (S, A, F, D)'s minimum energy is 3, so node D will choose the path (S, C, E, B, D), although this way is longer than the others.

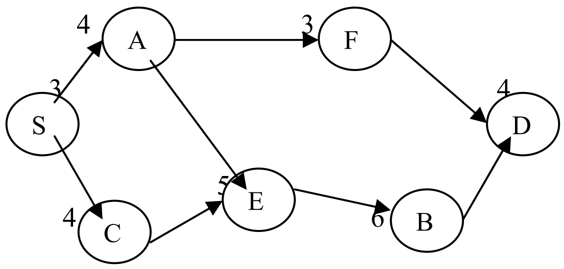

Fig. 3 max-min routing

If only one route is selected and used for sending data, those nodes on the route will waste their energy quickly. So we suggest that, we use many routes as many as possible to send data packets. For example, if there is three route from the source to the destination, the source sends every first packet via first route, every second packets via second route and every third packet via third route. It will have the effect to spread the traffic over network wide nodes and in result it will prolong the life time of the ad hoc networks.

4.Simulation and experiments

At first we assume that simulation zone is 200 x 200 units. There are 10 mobile nodes in the zone. We define movement of some nodes arbitrarily. We assume that node 0 and node 2 are the source of routing and node 1 and node 5 are the destination of routing. We assume pause times are 100,200,300,400 and 500.

The elementary simulation parameters were chosen to represent an ad hoc network consisting of a group of mobile hosts moving around in a medium-sized zone.

We assume that each node moves not very fast. And every node's broadcast range is certain. Every host is initially located at an arbitrary location inside in the simulation zone. As the simulation progresses, every hosts pause at their current position for a period, which we describe the pause time, and then arbitrarily chooses a new position to move. Every host continues this action, alternately pausing and moving to a new position, for the duration of the simulation.

Using this depiction, hosts emerge to wander through the area with their restlessness determined by the pause time continuously.

In this estimate process, we implement our anticipated protocols using ns-2. It is kind of discrete event-driven network simulator with support for different mobile ad hoc network routing algorithms.

Whenever a host transmits a packet, some manner must be used to conclude which of the surrounding hosts will obtain a duplicate of the packet. But our simulation's transmission representation is very simple, it still allows us to estimate the fundamental action of the protocol.

From the figure 4 we can see very clearly the topology of mobile nodes, and we also can see the source and the destination. Figure 5 and 6 shows some simulation results we got by now.

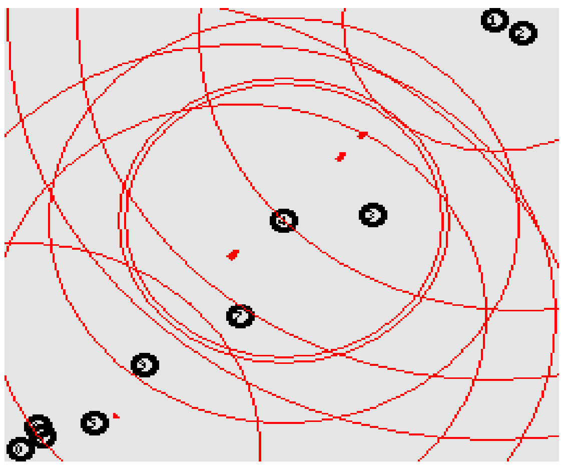

Fig. 4 topology of ad-hoc network

5.Conclusion

In this paper, we propose two routing protocols for dynamic source routing. The one is about automatic route shortening, and the other one is about energy-aware routing protocol.

Automatic route shortening wants to improve about routing maintenance and find a better way from source to destination.

Energy aware routing protocol takes into account of mobile's energy and avoids use the same way in routing discovery.

We should point out that our new ideas are efficient, so we are researching on how to extend and improve our protocol.

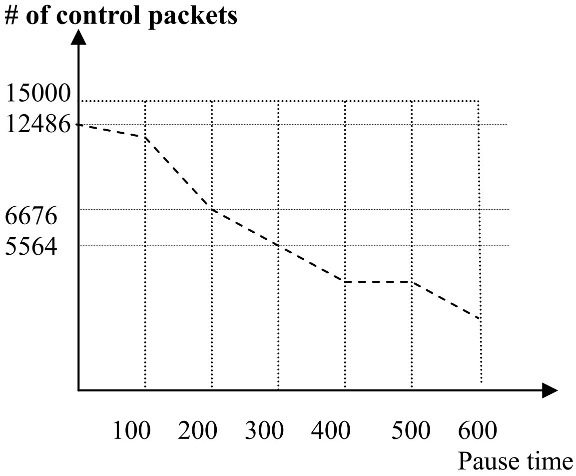

Fig.5 routing overhead

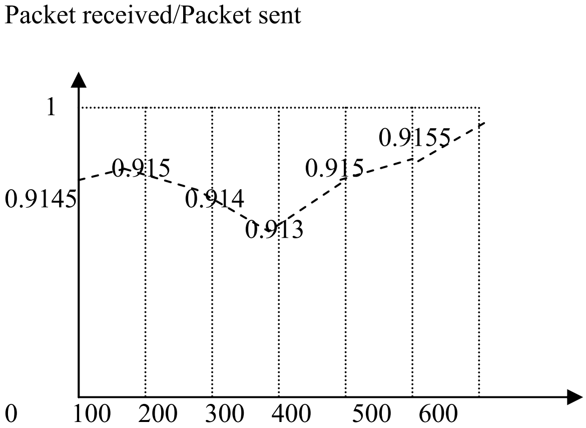

Fig. 6 packet delivery ratio

REFERENCES

1. David B.Johnson, David A.Maltz and Josh Broch, The Dynamic Source Routing Protocol for Multihop wireless Ad Hoc Networks

2. Josh Broth, David A. Maltz, David B. Johnson, Yih-Chun Hu and Jorjeta Jetcheva, ``A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols", *Proc. of the Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking(MobjCom'98)*, Oct. 1998.

3. Wei Yu and Jangwon Lee, "DSR-based Energy-aware Routing Protocols in Ad Hoc network".

4. J. C, Cano. P. Manzoni, "A performance Comparision of Energy Consumption for Mobile Ad-hoc Network Routing Protocol", Proc. IEEE Modeling, Analysis and Simulation of Computer and Telecommunication Systems, 2000

5. R. Dube et al., ``Signal Stability based Adaptive Routing (SSA) for Ad-Hoc Mobile Networks", *IEEE Pers. Commun*, Feb. 1997, pp. 36-45.

6. C-K Toh, ``Associativity-Based Routing for Ad-Hoc Mobile Networks", *Wireless Pers. Commun*, vol. 4, no. 2, pp. 1-36, Mar. 1997

7. M.R Pearlman, "The zone routing protocol for ad hoc networks", *Internet Draft http://www.ietf.org/internet-drafts/draft-ietf-manet-zone-zrp-01.txt*, Aug. 1998.

8. Elizabeth M. Royer, Santa Barbara and Chai-Keong Toh, "A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks", *IEEE personal Communications*, pp. 46-55, Apr. 1999