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A New Broadcast Algorithm to Optimize Routing Protocol in Mobile *Ad hoc* Networks

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Abstract: An efficient broadcasting algorithm in *ad hoc* network has received more attention because of its important role in topology information, route finding and diffusing data. This study attempted to propose a new broadcast algorithm based on combination of nodes signal strength and short path protocol in *ad hoc* network. The effect of network topology and traffic parameters were taken into account for the broadcast storm problem. The neighbor nodes signal was classified into two groups: good and poor signal strength. The selected short path depends on degree of signal strength and information tables to optimize route in case of any congestion. The simulation results show the effectiveness of the proposed algorithm to improve the network performance in term of reception rates and lower message travel time.

Key words: Broadcasting algorithm, short path, signal strength

INTRODUCTION

Mobile *ad hoc* network (MANET) generally is a very special kind of wireless network environment use omnidirectional antenna and consists of heterogeneous mobile node or devices such as Personal Digital Assistant (PDA), cell phone, Notebook etc. According to a MANET, the broadcast storm problem is the reason of the major building block for discovery, routing and localization functions to transmit information from one transmission to all the nodes in the network, (Saad and Zukarnain, 2009).

Many route discovery protocols, found in the literature, Hafeez *et al*. (2010), Harutyunyan and Wang (2010), Punnagai *et al*. (2011), Gandhi *et al*. (2012), Khabbazian *et al*. (2012) proposed efficient protocols to optimize the route discovery MANETs., Li *et al*. (2004) proposed optimal range from a pre-calculated scenario for a specific network. Torrent-Moreno *et al*. (2006). Proposed average hop distance without including the effect of the hidden terminal problem. There are also many proposed solutions to handle the broadcast storm problem which can be classified as either probability, priority or timer based solutions. Tseng *et al*. (2002) present five different schemes to alleviate the impact of the roadcast storm problem by prohibiting some nodes from re-broadcasting and favoring others depending on their location and their knowledge of how many times the message has been broadcasted. Torrent-Moreno *et al*. (2005), introduced a power control algorithm to reduce the contention between nodes in a single hop by limiting the maximum power assignment for each node. Nourazar and Sabaei (2009) optimized the flooding process named 'Geoflood' method by refraining from retransmitting and receiving the message from some other node. Xiong and Bodanese (2011) focus on a Signal-Strength based Medium Access Protocol to orchestrate the channel access in Orthogonal Frequency-Division Multiple Access (OFDMA) based MANETs. Wu *et al*. (2010), a broadcast algorithm can significantly bring lower dissemination redundancy so as to improve broadcasts efficiency. Jang and Hung (2010), a direction based routing strategy proposed to select more stable relay nodes and to largely reduce change frequency for the network, prevent broadcast storm, increase successful packet delivery ratio and reduce packet delay. Shakkeera (2010) improve the greedy algorithm from a different angle; the algorithm decreases the number of Multipoint Relays (MPRs) significantly. Varaprasad (2011) power aware with signal strength based routing algorithm for mobile *ad hoc* networks; it's used a residual battery capacity with signal strength to forward the data packets from the source node to the destination node. Obaidat *et al*. (2011), a multipath routing protocol for Mobile *Ad hoc* Networks based *Ad hoc* On-Demand Distance Vector (AODV) routing protocol to lowest the delays based on the interaction of many factors from different layers.

Finally for more information Khalaf *et al*. (2010) present many methods such as Counter Based Scheme, Probabilistic Scheme, Location Based Scheme, Distance Based Scheme and Cluster Based Scheme to solve the Broadcast Storm Problem.

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This study presented a new route broadcasting algorithm based on minimum distance and signal strength to achieve an optimum solution. First, it briefly describes the exciting broadcasting protocols through its mathematical models to evaluate the short path. Then, the proposed algorithm selected the route based on the status of each node signal itself with other nodes to decide whether the message would forward or not. Finally, the performance analysis shows that the proposed scheme reduces broadcast time and increases the consistency of information in all nodes in the network.

THEORETICAL BACKGROUND

Route discovery: If node S originates a new route destined to another node D, it places in a sequence of giving hops that the packet should follow form S ways to D. Normally, S will obtain a suitable source route by searching its Route Cache of routes previously learned but if no route is found in its cache, it will initiate the Route Discovery protocol to dynamically find a new route to Johnson *et al*. (2003) and Unnikrishnan (2004).

Figure 1 shows initiate the Route Discovery in which a node A transmits a Route Request message attempting to discover a route to node G. Then, all nodes will receive within wireless transmission range of A. Each Route Request message identifies the source and destination of the Route Discovery and also contains a unique request ID which contains a record listing the address of each intermediate node through which this particular Route Request message has been forwarded. This route record is initialized to an empty list by the source of the Route Discovery.

When another node receives a Route Request as a destination of the Route Discovery, it returns a Route Reply message to the source, giving a copy of the accumulated route record from the Route Request; then the source will caches this Route Reply and use it to send subsequent packets to this destination. Otherwise, if this node receiving the Route Request has recently seen from another Route Request message this source bearing this same request id, or if it finds that its own address is already listed in the route record then, it discards the request. Otherwise, this node will add its own address to the route record and propagates it by transmitting it as a local broadcast packet.

Route maintenance: When a packet with a source route is forwarded, then each node will make sure that the packet has been received by the next hop in the source route. The confirmation of receipt will be received only by re-transmitting the packet for a number of Unnikrishnan (2004); Matos and Miranda (2011).

Figure 2 shows Route Maintenance, in which node A is source of sending the packet to the desired destination G and the packet has a source route through intermediate nodes B, C, D and E. Node A is responsible for receipt of the packet at B, node B at C and so on until and node F at G. Node C confirms receipt of the packet at D by overhearing D transmit the packet to forward it to E. The confirmation of acknowledgment is done by passive acknowledgments or as a link-layer mechanisms such as opting in Medium Access Control (MAC) protocol.

The node receiving the packet can return a Dynamic Source routing (DSR) specific software acknowledgement if neither acknowledgments are available and this will set up a bit in the packet's header which requesting a DSR specific software acknowledgement by the node transmitting the packet. When a node is unable to deliver a packet to the next node then it will send a Route Error message to the original sender of the packet. Then the broken link will remove from the cache by the packet sender and retransmissions it to the same destination by upper layer protocols like Transmission Control Protocol (TCP).

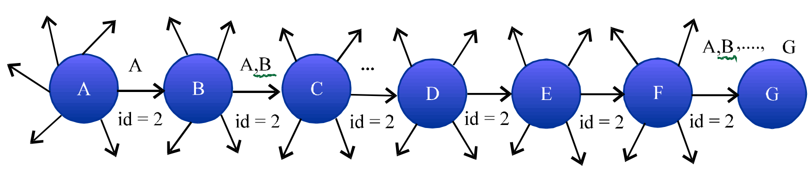

Fig. 1: An example of route discovery: Node A is the source and node G is the destination

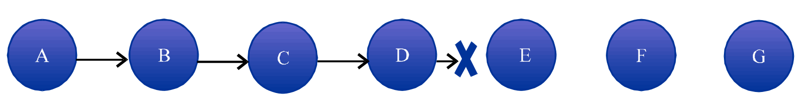

Fig. 2: Example of route maintenance

Mobility models in *ad hoc* networks: The movement pattern of nodes (users) plays an important role in performance analysis of mobile and wireless networks. Mobility modeling specifies the dynamic characteristics of nodes' movement in *ad hoc* network, Liang and Midkiff (2005).

In a wireless *ad hoc* network, the mobility models focus on the individual motion behavior between mobility epochs (the smallest time periods in the simulation) in which a mobile host (node) usually moves in a constant direction at a constant speed. The simplest and often used mobility model is: Random mobility model which assumes that the speed and direction of motion in a new time interval has no relations to the values in the previous intervals and can be chosen between uniformly distributed values, Gavrilovska and Prasad (2006).

Repeating pause and motion intervals are introduced in the random waypoint mobility model where the entire movement of a mobile node is broken into a sequence of pause and motion periods. During the pause periods, the nodes stay in a certain location for a specific time period then it travels towards the newly chosen destination with a selected speed. The speed is uniformly chosen between [0, Vmax].

Figure 3 depicts the motion pattern of a node in an area of 500 m^2 which used the random waypoint mobility model (Gavrilovska and Prasad, 2006; Ning *et al*., 2011).

The correlation between the speed/direction values in previous and current intervals are introduced in incremental models. The relationships and cooperation between the nodes, which move with a common objective (such as disaster recovery, military deployment), give new flavor to mobility modeling. A new movement patterns, related to new application scenarios and different enhancements are continually appearing. Some of them consider the obstacles that restrict movement and signal propagation, (Gavrilovska and Prasad, 2006; Romsaiyud and Premchaiswadi, 2012).

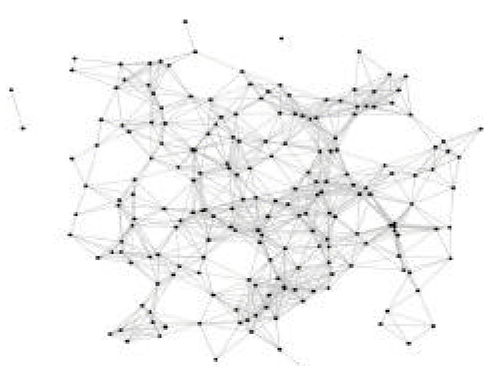

Fig. 3: Random waypoint mobility model, Dutot and Pigne (2010)

PROPOSED METHOD

Many of the existing re-active routing protocols process performed flooding of control packets because of one node sends a packet to all other nodes to find a short path. The Route Discovery Process usually implements a query dissemination mechanism such the source and destination nodes in the same transmission range of each other or out of transmission range.

Table 1 lists all information data to select the optimum transmitting route. It is assumed that each node knows the received signal strength of all nodes on the ways to the destination node.

The sequential steps of each node that wants to initiate the Route must map as follows:

- Initiate table 1 for all possible transmission route from source node to destination nodes.
- This decision rule

First, calculate the route signal index with without considering shortest path:

$$\text{Route index} = \frac{\sum_{i=n}^{n} SS}{N*3}$$

Where:
N = No. of node per path
SS = Signal strength for each node

Route index: Maximum index is one for a good route path.
Second, find the shortest path route and address [S,… …, D]:
Then, If yes, then
Call for Send Data
If not then,
Re-initiate Table 1.

Finally, to reduce all unnecessary receiving messages using doop or forward the route request based on both signal strength and short path.

RESULT AND DISCUSSION

In the proposed cross-layer routing protocol the search space in route discovery phase is optimized by selecting partial neighbor nodes of the transmitting node

Table 1: Tabilate all routes information

Route list	Register all possible route path
ID	From IP layer, recored all nodes address from source and destination node
Signal strength	From Physical layer, record the signal strength for all nodes
Sending type	Indicate if is it route request or route replay

The signal strength from physical layer will be measured as; excellent, good and low depending on the distance between the node and its neighbor instead of selecting all neighbor nodes for broadcastingRoute request messages, (Dewberry and Beeler, 2012; El-Bazzal *et al*., 2012; Unnikrishnan, 2004; Matos and Miranda, 2011). Figure 4 and 5, the following properties are used to evaluate the effectiveness of the proposed routing protocol.

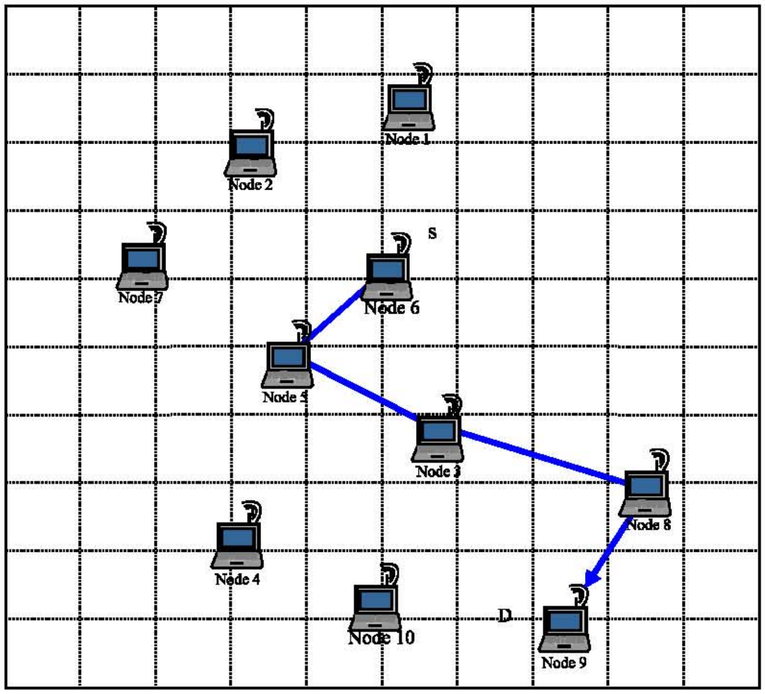

Fig. 4: Randam distributed 10 nodes within 5 km

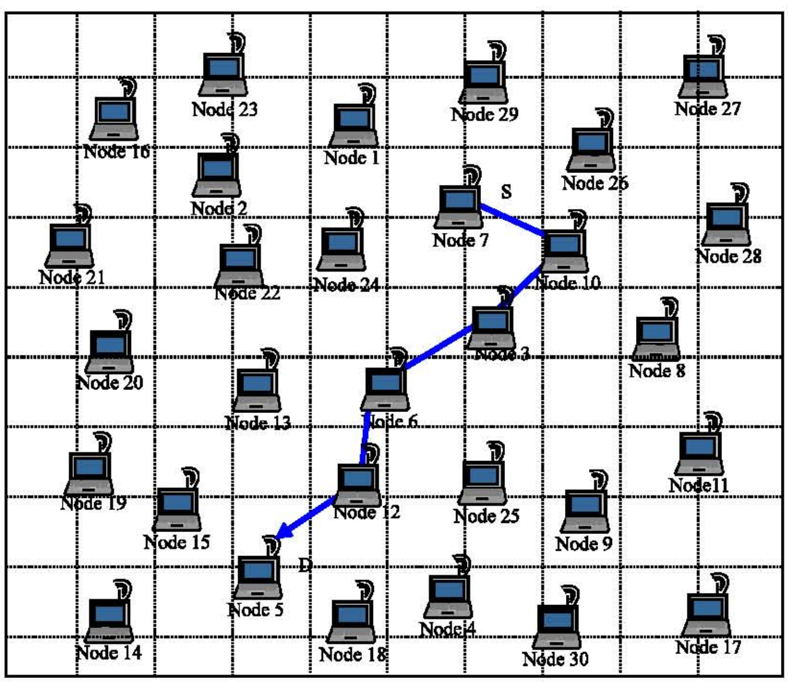

Fig. 5: Randam distributed 30 nodes within 5 km

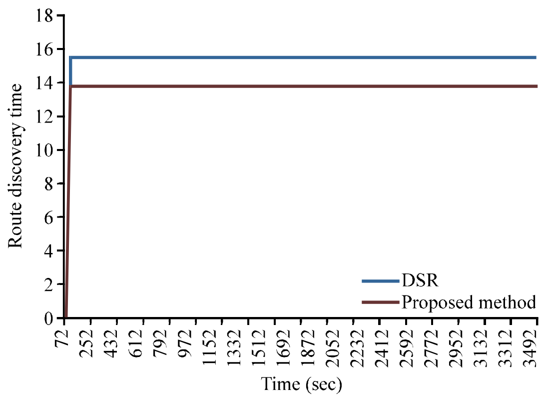

Fig. 6: Route discovery time for 10 nodes

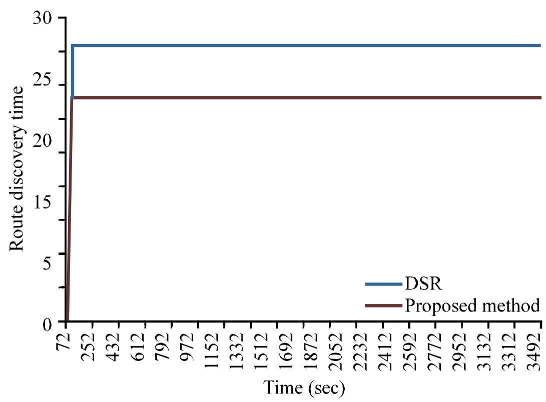

Fig. 7: Route discovery time for 10 nodes

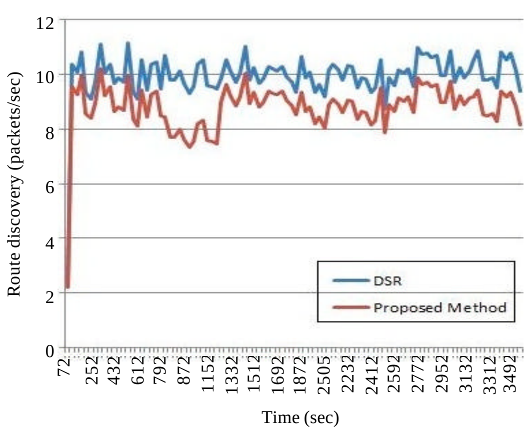

Fig. 8: Routing overhead for 10 nodes

Figure 6 and 7 show the optimized flooding percentage is reduced to 11, 18% for 10 and 30 nodes, respectively compared to DSR routing protocol. In addition, it can observe that the reduction will depend on both of the total number and topology of the nodes which have different arrangement across the network with

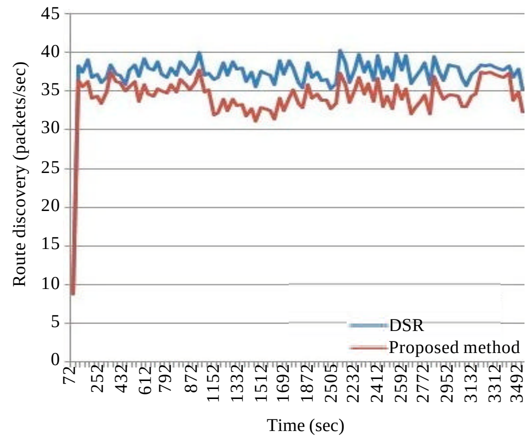

Fig. 9: Routing overhead for 30 nodes

different signal strength compared to the transmitting node, Matos and Miranda (2011) and Varaprasad (2011).

Figure 8 and 9, the effectiveness of the proposed algorithm has clearly reduced routing overhead due to using less number of Route Request messages in route discovery phase such as total number of routing packets transmitted counts as one transmission (Khalaf *et al*., 2010).

CONCLUSION

Many researchers propose various algorithms to solve the Broadcast Storm Problem, in which each node will be required to rebroadcast the packet whenever it receives the packet. However, most of the algorithms are blind flooding and only work for the static environment. The proposed cross layer routing protocol improves the Route Discovery Phase by minimizing the number of transmissions needed for broadcasting by selective forwarding, where only a few selected nodes in the network do the broadcasting. The simulation result shows that control packets significantly reduced the traffic load and shorter the time to find the optimum route nodes through easy mathematical computation.

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