Improvement of DSR protocol using group broadcasting

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Summary
Wireless Ad hoc network is a network, which does not have any geographical restriction and fixed substructure. This kind of networks are divided into cellular and special networks. Cellular networks are comprised of a fixed spinal column and a radio-base station. When a node exits from the domain of base station and reconnects to another station, it continues to function. In this method, the base station is fixed but the connection of Special Network does not have a predetermined structure. Administration and configuration of these kinds of networks are not dependent on any special user. Such networks back up calculation at any time and in any place and their structures can change automatically. In special networks since all of the nodes are mobile and connect dynamically they are commonly named Ad hoc. There is increasing trend for applications in such fields as mobile vehicular communication, special field tasks and distributed mobile automation systems. In this kind of network, all of the nodes act as routers; they find paths and keep other nodes' information. In this paper, we discussed special networks, improved their routing protocol called DSR (unicast), and introduced new protocol named GBDSR (multicast). GBDSR allows a node located in the network to send data packets for other nodes. In GBDSR, multi distribution of data packets are turned into general distribution of data packets. This leads to have a new protocol with less network traffic, less access time, less packet loss and less energy usage. Of course, these advantages need more use of bandwidths.

Key words:
Mobile Ad Hoc Network, Control systems communication, Routing Protocols, Wireless networks, Broadcasting, Special Networks.DSR

1. Introduction

Mobile special networks are group of wireless computers in the form of network, which do not have predetermined structure [1]. This adhoc type connectivity of the special networks has increasing application fields especially for coordinated and automated field tasks. Non-stationary industrial automation systems, mobile vehicular fleet management and some military applications are some of the popular application areas for adhoc type networking structures. Administration and configuration of these kinds of networks are not dependent on any special user; on the other hand, special networking allows formation of an independent set of nodes. There are abundant scenarios for which a network with fixed structure and configuration cannot be responsible and need a network like special network. For example, military missions, emergency operations, trade and business projects, educational classes, etc [1]. For this purpose, in the recent years, special networks have been considered very seriously. There are many problems in creation of a special network such as routing, wireless media and transportability. Although these networks initially had been formed for small group of cooperative nodes, now larger groups use them in vast geographical regions as well. Therefore, scalability is another problem in creation of these networks. Mobile computing devices are very suitable for growth of special network in terms of transportability and form of the network. One of the main problems for these networks is routing and due to mobility of nodes [4] [5], one cannot use protocols of the networks with fixed structure. Routing protocols are divided into 2 categories: on demand and table driven. Their main difference is in maintained information as well as manner of information submission [12].

2. Background

Wireless networks are divided into cellular and special networks. Cellular networks have been comprised of a fixed spinal column and radio base station so that the last hop, which the user uses it, is wireless but everything is dependent on space and time [1] [2].

2.1 Packet Radio Networks (PRN)

Packet Radio Network (PRN) has been comprised of many mobile repeaters, which transfer information to the mobile terminals. Repeaters of this network are connected with a gate to the external environment. Elements of a PRN network are communication devices and radios, which maintain routing information and update it periodically. For this purpose, a joint radio channel is used. Limitation of this kind of routing is slowness in convergence of route and low operational power. In a RPN, network management is fully distributed, so that each radio packet maintains information relating to network topology and each packet can perform correct routing to the destination independently [6].

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2.2 Fundamentals of special networks

Special wireless network is a network, which does not have any base station and fixed substructure. Such networks back up calculations at any time and in any place and their structures can change automatically. In such networks, each mobile host acts as a router. For this reason, peer to peer communication as well as peer to remote communication is possible in this kind of network [2][4][5]. There are two types of topology for especial networks: heterogeneous mobile devices and mobile host network. The first network has been comprised of different kinds of mobile devices such as PDAs, smart signals and mobile hosts, while, second type of the network has been only comprised of mobile hosts. Traffic in a special network depends on origin and group and can have stable rate or explosion. It is clear that rate of traffic depends on the type of relation whether the relation is peer to peer or peer to remote.
It is necessary to note that this kind of network can use all formal programs such as telnet, ftp, www, ping and etc and one can have client /server programs, colleague calculation and mobile multimedia in this kind of networks. In summary, some important specifications of special networks can be called as follows:

- Topology of network may change at any time.
- Each node can be mobile.
- Capacity of energy of mobile nodes is limited.
- A host acts not only as end system but also as an intermediate system.
- Width of wireless band is limited for communication.
- Quality of channel is variable.
- The present components are not centralized or on the other hand, the network has been distributed.
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One can say that in special network, routing is a complex problem and its reason is mobility of routings.
As a result, links may change frequently and this subject refers to the fact that communication links should be updated continually and its messages should be sent frequently and this control creates traffic and another problem is that routing tables may not be converged; therefore, some rings may be formed in routing. Problems relating to channel access are due to distribution of access to channels and because there is no base station. In a special mobile system, it is very difficult to prevent from collision of packets and quality assurance of service (QOS) [13].

3. MAIN IDEA

As said before, routing protocols in mobile special networks are classified into two classes: table based and need based. Table based or pre active method is used for linkage alternate updating and can use each one of the methods of distance vector and linkage status which are used in fixed networks. In On demand method with reaction, route update is not done alternatively and the routes are found at request of origin. The fact that this method is called a method with reaction means that it reacts clearly for change in linkage which is similar to need based protocols. Therefore, there is possibility of use of caching mechanism. The advantage of this method is that both energy and bandwidth are used effectively. [2]

3.1 On demand protocols

In comparison with routing protocols of driven table, in this group of protocols, all updated routes are not maintained in each node; instead, routes are constructed if necessary. When an origin node wants to send something to destination, it requests route detection mechanisms for finding a route to the destination. Route remains valid until the destination is accessible. This section explains some of need based routing protocols.

3.2 DSR Protocol (Dynamic Source Routing Protocol)

This protocol is an origin routing protocol and is based on demand. A node maintains cache from the routes including routes from origin and it is aware of them [8] [9]. The entered data is updated in cache of the route when new information is obtained about current routes. Two main phases of this protocol are detection of route and maintenance and repair of routes. When origin node wants to send a packet to destination node, it investigates its route cache to see whether it has route to destination or not. If there is a valid route to destination, it will use this route for sending its packet. But if this node doesn't have any route, it will start route detection process through demand packet distribution. Demand packet includes address of origin and destination node and exclusive identification number. Each intermediate node checks whether it has route to destination or not. If not, it will add its own address in this packet and will send it to its neighbors. In order to limit the number of publication of route demands, a node process route demand packet only when it has not seen it before that is its address has not been available in section route record [14].
A route reply is produced when destination node or an intermediate node with current information about destination node receives route demand packet. Route record section of route demand packet which reaches a

node includes sequence of hops passing from origin node to this node. Section (a) shows how route demand packet is distributed in the route and indicates its route record section. If reply of each route is produced by destination node, this node places route record section of route demand packet in route reply. In another state, if an intermediate node wants to produce route reply, it will place its cached route to destination in route record section of route demand packet. Section (b) indicates the state in which destination node itself has sent route reply. For sending route reply packet, the replying node should have a route to origin node. If it has a route to origin in its route cache, it can use it. The reverse route given in route record section can be used when symmetric links are supported. If symmetric links are not supported, node can perform detection of route to the origin and carry route reply in route demand packet.

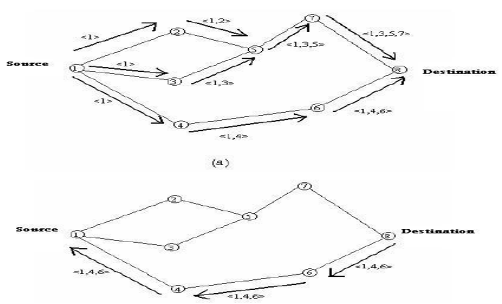

Figure 3-1 example of route detection in DSR

DSR Protocol uses two types of packet i.e. route error and confirmation for route maintenance and repair. When a node confronts with problem of transmission in its linked layer, it produces rote error. When a node receives a route error packet, it omits hop with errors from its route cache. As a result, all the routes including this hop with errors become defective. A confirmation packet is used for research on good function of links of a route.

4. NEW ALGORITHM

4.1 Improvement of DSR protocol using group distribution

GBDSR is development of DSR on the basis of multiple distributions. DSR and GBDSR are both routing protocols for especial network in such a manner that PSR is used in single distribution traffic and GBPSR is used in multiple distribution traffic. NS2 includes standard implementation for DSR protocol on which basis GDPSR protocol has been implemented, but this implementation of GBDSR includes two essential limitations:

1- Only members of the group can send data for multiple distribution groups.
2- Multiple distribution data packets are the same single distribution packets. As result, bandwidth is not used fully effectively

New version of GBDSR allows each node located in the network to send data packets for other nodes and multiple distribution data packets are turned into public distribution data packets during distribution across tree of multiple distribution groups. In total, several acts have been improved in this new protocol and led to improvement of DSR protocol.

4.2 GBDSR improved protocol

The first member of the group which has been formed in the group is called group leader for that tree and this member is responsible for preservation of communication of this tree with another tree which does this work with use of group- (GRPH) message public distribution in the entire network and this work is done alternatively. Group leader keeps also serial number of the group and publishes it for the network with GRPH. Each node in network can keep 3 tables. The first of them is unicast route table in which the subsequent hop is recorded for the routes to the destinations for unicast, which is destination of another node of the network. In special cases, destination is a multicast address and this occurs when that node is not member of a tree but multicast data packets are sent for it. The second table is multicast route table including a list of the subsequent hops for tree structure of each group. Each line shows a tree structure group. All nodes which are in a group have equal lines in their table specifying information of group leader, group members and route finders. Each subsequent hop which has been specified determines direction of communication which can be downward and upward in the tree. If the subsequent hop is group leader, the direction will be downward; otherwise, direction will be upward. Group leader cannot keep upward direction but other nodes can keep only upward direction. The third table with is group leader table including address of multicast group with address of its group leader as well as the subsequent hop toward group leader.

4.2.1 Detection and maintenance of route to a special node

Detection and maintenance of the route is main duty of DSR protocol which has been also implemented in NS2. In GBDSR, two important notes about this fact are as follows:

- Only MAC layer is used in recognition of broken links in active route but in GBDSR whether this active route is to a special node or to multicast tree, only one hop named neighbor- hello is used for recognition of link breakage in tree.

- In implementation of DSR in NS2, is broken link local restoration but in GBDSR, this restoration is ignored and in case of breakage of a link, instead of its local restoration origin node finds a new route.

4.2 Detection and maintenance of route to a tree

As said before, in GBDSR, each node can have multicast, therefore, this case should be studied that if origin node is not member of a tree, how data reaches each member of tree. For this purpose, a two- stage method has been selected. First stage, in this stage, there is a route from origin node to a member of tree, therefore, when this member receives closed tree, casts it among all members of tree. For this purpose, route detection and maintenance mechanism is used. This RREQ packet is similar to RREQ of DSR protocol. This node using group leader table identifies a route for reaching group leader. Therefore, with use of this information, it can send RREQ to the group leader. But this work is done when it is the first time that RREQ is sent. During sending RREQ, reverse route is formed to the original node on the basis of DSR protocol. Members of the tree which know address of group leader can create this route by sending RREQ response packet. After this stage, all of the intermediate nodes and origin node update their route from origin node to members of tree using destination address which has been placed in group multicast address.

Thus, this route is placed in unicast route tables. For this stage, final node is a member of tree. The second stage is called multicast tree formation explained in the next section. During sending multicast data packet, each node checks whether it is placed in the tree or no, if node id not member of tree, unicast route table seeks itself for finding the subsequent hop to this address. If information is available in this field, it will send packet for that hop, otherwise, it will send a clear RREP packet for origin node. In this case, origin node starts detecting a new route to multicast address. If a node is not member of a tree, and wants to be its member, it can easily change its identification number in its multicast route table from route finder to the group member. RREQ-J becomes public in the entire cast network, but if node can obtain information about group leader and way of reaching it among group leader table, and this is the first time that it sends RREQ-J packet, sending RREQ-J packet can be sent directly to the group leader itself. During RREQ-J casting, reverse route to the origin node is formed in single route table. When a node receives a non reparative RREQ-J, if it is member of tree, it will response with a RREP-J packet (RREP packet plus linkage identification number) with the same serial number of packet or numbers larger than that. In case that RREP-J is sent only in reverse route to the origin, it means that this route can be cached as a potential branch of tree. One can also enter information about the subsequent upward hop in the tree without addition of new and mistaken hop. If the last node receives another RREP-J which shows a better branch can cache this new route and send a RREP-J toward origin node and origin node will throw other RREP-JS. A new message is MACT multicast route activation message which is used for connecting a branch to tree. When origin node sends RREQ-J, a special time called RREP- wait- time is needed. During this period, it checks whether it has received RREP-J or information- if it receives information, it will send MACT packet with linkage identification number (MACT-J) to its upper node and cache a hop in multicast table. Each node which receives MACT-J packet, adds a hop in its multicast table with the downward direction. Then, if this node is member of tree, branch linkage will be ended, otherwise, it will search in its cache for the subsequent potential upward hop and add this hop in multicast table and send MACT-J for it. If origin node tried for many times to link to a group tree, but it doesn't receive any RREP-J, it means that no group is available in the network or its request packet has not reached any group of different parts of the network. Therefore, origin node forms a group under it, leadership for maintenance of serial number and structure of tree.

5. Simulation/Evaluation

5.1 Results of GBDSR implementation and its-comparison with DSR

For implementation of GBDSR, many different simulations have been performed and we have conditions of simulation environment and results obtained there from as follows:

1- Area of simulation: 1500×300 sq meters
2- Number of nodes: 50
3- Time of simulation: 900s
4- Number of simulation frequency: 7 times
5- Physical layer of IEEE 802, 11: MAC/ in 2 Mbps and 250 meter transmission interval.
6- Movement model: random model without stop time and speed of nodes movement, 0m/s, 1m/s, 5m/s, 15m/s and 25m/s.
7- Each sender sends two data packets, each 256 bytes long, in second
8- Each receiver is a multicast group member but each sender is not group member unless all 50 nodes are receivers and members of group.
9- Each receiver belongs to a group at the beginning of simulation and senders starts sending data after 30 seconds all senders stop sending data after 900s.
10- Traffic used in this simulation is only multicast.

Two criteria measured for assessment of GBDSR are PPR and latency as follows:

- PDR is packet receiving rate which is obtained through total number of sent packets × the number of receivers
- Latency of is reaction period of average delay for transmission of data from the sender to the receiver.

Figure (5-1),(5-2),(5-3) illustrates difference between traditional DSR and GBDSR.

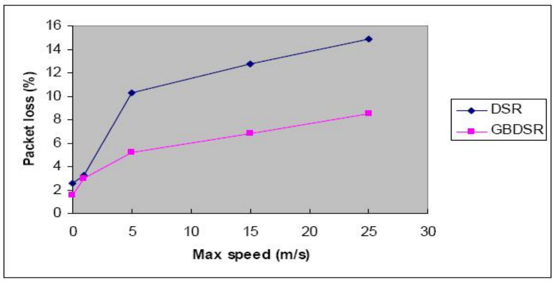

Figure 5-1 Packet loss trend between DSR and GBDSR

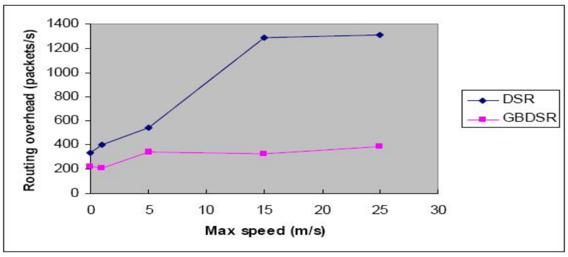

Figure 5-2 Routing overhead trend between DSR and GBDSR

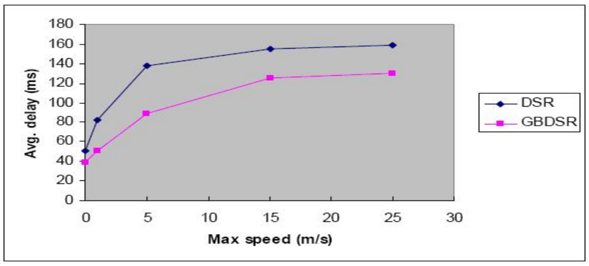

Figure 5-3 Avg. Delay trend between DSR and GBDSR

6. Conclusion

Spatial speed of communication nodes is one of the key factors for design and performance of mobile Ad hoc networks. In this study, simulation has been performed with traffic load of 20 origins and maximum speed of 20 m/s. All protocols deliver high percentage of the produced packets when movement of nodes is low (for example in case of high stop time) and this value reaches 100% when movement of nodes reaches zero, especially DSR which delivers more than 95% of the packets in each rate of movement.

DSR that is on demand protocol has the lowest parasite and its parasite changes with changes of movement rate and completely depends on it. Nevertheless, table–driven protocols are not highly dependent on rate of movement and show constant behavior. DSR protocol, which is the most important protocol for routing special network, has been improved with use of multicast property. Regarding to simulation results which have been obtained for DSR protocol and its improved protocol i.e. GBDSR, it is observed that new algorithm has improved characteristic values in all aspects rather than base DSR.

New version of GBDSR allows each node located in the network to send data packets for other nodes and multiple distribution data packets are turned into public distribution data packets. Overall, several actions have been improved in new protocol. This led to improvement in DSR protocol.

Access time has importance for mobile control & automation systems where physical response time is critical. Energy efficiency is one of the design objectives for the mobile applications where main energy source is not generative as in the case of Ad hoc sensor nodes. Finally, we will have a new protocol with less network traffic, less access time, less packet loss and less energy usage. On the other hand, these advantages require more use of bandwidth.

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