One Hop Neighbor based Broadcast Method for Reactive Routing in Mobile Ad-hoc Network

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Abstract. To overcome redundant issues of routing messages for the reactive routing protocol is become research challenge. In general, to discover route or path reactive routing protocols broadcast routing messages which may leads congestions and degrades battery power unnecessarily. Though, to resolve the challenges several efficient broadcast methods have been suggested. Each method has its own procedure and results sort of advantage and disadvantages. The motive of the paper is to presents a method which is proposed to minimize redundant issue of routing messages resulted by broadcasting. Proposed method uses one hop neighbor’s knowledge to broadcast routing messages for the purpose of route discovery. Proposed method experimented through simulation software that named as NS-2. An experimental accomplish certain factors like number of nodes, routing protocol, MAC protocol etc. Proposed method evaluated on the basis of different criteria such as throughput, control overhead, routing efficiency and node remaining battery power.

1. Introduction

According to medium, network is categorized in wired and wireless network. Further, wireless network divides in fixed infrastructure and self-organizing network. Self-organizing network also called infrastructure less that named as wireless ad-hoc network. The complete classification of network depicted in figure 1.

![Network Diagram](image)

Figure 1. Classification of network according to channel.

When devices are free to move anywhere in ad-hoc networks then it is referred as mobile ad-hoc network. In figure 2 the network scenario of mobile ad-hoc network with four nodes labelled A to D presented. Here node A may communicate with node B or C or D and vice versa because they all are in range of node A.
Due to self-organizing nature, devices in the network are enough sufficient to discover route and initiate transmission. If any change occurred then devices are enough confident to manage the changes. On the other hand, the mobility property of mobile ad-hoc network pays heavy penalty in term of routing overhead, link breaks and wastage of resources. For the route discovery, nodes of network employ numerous routing strategies. One among them is reactive routing that enable nodes to broadcast routing information to all its covering nodes. This phenomenon of routing is repeated until routing information reach to the desired destination node. When destination node receives routing information them reply to reverse manner. Though to complete the procedure nodes get route to its destination. The broadcast procedure for reactive routing protocol results duplicity of routing information as well as unnecessary consumption of resource. The broadcast procedure in routing, leads flooding of routing information to the whole network that occurred many issues. Flooding employ transmissions of route information message to the whole network via neighbor’s knowledge which lead congestion, lifetime of network as well as routing overhead issues. Flooding assist routing protocols to discover route through broadcast of route information message to all nodes neighbors and rebroadcast further [1]. A simple analogy of flooding operation illustrated in figure. 3.

Figure 2. Node ‘A’ Coverage in mobile ad-hoc network

Figure 3 presents a portion of network scenario where 7 nodes which labelled from A to G. Here, node A wish to transmits data to G. For this, Node A initiates broadcast of route information message named control packet to all its neighbors which are B and C. Further, neighbor node B and C receive control message from node A and find itself destination or not. If not then broadcast to further neighbor’s and precede same procedure up to node G. When node G found itself is destination then it unicast reply of routing messages to the sender node A. During the route discovery, numerous unwanted retransmissions of routing messages done by intermediate nodes which may lead flooding of routing messages. When intermediate nodes found replica copy of routing messages originated by...
same sender and for the same destination then messages have discarded by these nodes. To do this, effort applied by nodes in term of battery and transmission power. Therefore, the nature of broadcast procedure may be restricting up to some level to minimize flooding. Many approaches came to control broadcast issues. Further, broadcasting based on one hop neighbor knowledge, related work, proposed broadcast method, experiment of proposed method and result evaluation presented in subsequent sections.

2. Background
As it is known, node of mobile network is not directly reachable to all other nodes. Means, mobile ad-hoc network formed with limited coverage of node depends on its hardware. Each node has specific range; if any other node belongs in its range then it is direct neighbor or one hop neighbor. Though, this formation makes complete mobile ad-hoc network. “Each node collects the information of its 1-hop neighbor through transmitting receiving HELLO packet at the MAC layer using MAC layer protocols [2]”. Here one hop neighbor concepts used for broadcasting routing message to discover route. One hop neighbor concept may opt transmitter as well as receiver for the message forwarding function. Both are discussed below:
- **Transmitter-based**: Here, transmitter take set of neighbors to forward routing messages according some criteria. Methods that comes in [3] [4] [5] are transmitter-based.
- **Receiver-based**: Inverse of earlier, receiver of routing message decides their neighbors to further broadcasting. Method that defines in [6] is receiver-based.

Forwarding nodes choosing strategies shown in figure 4.

![Figure 4. Types of One-Hop Neighbors Knowledge Method](image)

3. Related Work
Several methods that relevant of one hop neighbor and transmitter based have been advised by researchers which discussed here. Flooding with self-pruning (FSP) [7] was the first receiver-based method. A receiving node match its own 1-hop neighbor with node list in the message, if its entire 1-hop neighbor included in list then it was not forward the message otherwise it forward the message as a sender. Another one is transmitter-based method named vertex forwarding [3] that uses one hop neighbor’s knowledge for forwarding routing message. Similarly, another one was an efficient flooding (EF1) method based on 1-hop neighbor’s knowledge and transmitter based [8] evolved. It worked in three phase named as forwarding node selection, forwarding node optimization and mobility handling. Conventional method named selective rebroadcasting extends by Mistral [1] method. The extension ensures balance between control overhead and reliability. Another is, ASTRAL [9] method was advised that ensure efficiency and reliability. It uses forward and backward packet recovery mode. An Efficient Reliable One-Hop Broadcasting (EROB) [10] was also presented that guarantees the completion of one-hop broadcasting, i.e., all nodes in the source’s transmission range will receive the broadcast message. Information broadcasting [11] based a method advised that enable network nodes to take decision about rebroadcast or discard received routing messages. Further, a method named global queue pruning method [12] was come into picture. It restricts transmissions overhead and assures delivery of messages to every node. Recently, selective epidemic broadcast algorithm [13] was proposed that minimize impacts of broadcast storm problem and enhance delivery rate of data. Latest one is a simple flooding scheme [14] based on residual power of nodes. It broadcast RREQ packets to its entire one hop neighbor with respect of node remaining power. It implemented in both static as well as mobile nature of network.
4. Proposed Method

For restricting impacts of flooding and make efficient broadcasting of routing messages, a method is proposed here. A proposed method uses one hop neighbor perimeter of network and apply decision making at the neighbor’s which receive broadcasting messages for further forwarding. Earlier a lot of works have done for efficient flooding. Each one has considered different criteria and procedures. Proposed method is well suitable for mobile nature of network because it considers mobility parameter of nodes for taking decision to forward messages. To accomplish task, initially neighbor discovery performed through HELLO messages at data link layer. In neighbor discovery, HELLO Message broadcast by node to all one hop neighbor. Then each neighbor update neighbor table with entry of Hello message sender id. Similar process done by all the nodes and neighbor to completes network topology. Though proposed method, add two more fields in HELLO message named rem_pw which indicate remaining battery power and vel which indicate velocity of node. Means, when nodes, initiates Hello message then it put its remaining power and velocity in the designated fields to inform about these to all the neighbors. Here the purpose of broadcasting of HELLO Message is only for topology creation or neighbors list preparation not for measure congestion and battery fail. The construction of neighbors table of node is used in routing strategy to select set of neighbors for flooding of routing messages on the basis of mentioned parameters. Though here, each node in the network have neighbor table with remaining power and velocity of each neighbor. These two fields help in broadcasting route messages to selective neighbors according to high remaining power and less velocity. Receiving node of route message decides to further forwarding messages to selective set of neighbors on the basis of these fields. In the similar fashion, broadcasting of route message accomplished in efficient way. After the experiment of proposed method might be results are as expected in terms of routing efficiency, throughput etc.

The format of HELLO message amended as per requirement of proposed method, shown in figure 5.

| Source Node ID | Hello_Int | Ref_Int | VLT | Seq No | Neighbor1 ID | REM_PW | Vel | Options |
|---------------|-----------|---------|-----|--------|--------------|--------|-----|---------|

Figure 5. Modified HELLO Message

The complete flow of proposed method represented in flow chart that depicted in figure 6.
5. Experiment & Evaluation
Proposed method is experimented using simulation software named NS-2. NS-2.35 version was used in simulation that available in ns-2.35-allinone.tar or zip. NS-2.35 have built-in energy model named energy.cc file. Battery power is computed using energy model and used in routing protocol with the help of patch implementation. Here simulation done considering mobile network scenario with number of nodes, routing protocol, simulation time, traffic type etc.

5.1. Simulation Metrics
The Table 1 presents, simulation metrics for proposed method in NS-2 environment.

| Parameters Name          | Value         |
|-------------------------|---------------|
| Number of mobile nodes  | 100           |
| Topography Area         | 1200×1000     |
| Simulation time (seconds)| 90            |
| Transmission area (meters)| 200          |
| Propagation Model       | Two Ray Ground|
| Traffic type            | CBR           |
| Packet size (bytes)     | 512           |
| Routing Protocol        | AODV          |
| Connection Type         | TCP           |

5.2. Simulation Metrics
Simulation of proposed method has done with 100 mobile nodes and simulation time in seconds. In this, a scenario constructed where nodes are scattered in specified topography area with some sender and receivers. CBR traffic is generated using TCP connection. AODV routing protocol modified to accomplish proposed method. Figure7 show scenario of network simulation.

![Figure 7](image_url)

5.3. Evaluation
The results of proposed and experimented method are evaluated with base method by considering few network parameters such as through put, control overhead, routing efficiency, and remaining battery power of nodes.
5.3.1. Throughput
Throughput defines, useful time over the total time multiplied by bandwidth to transmit data packet. In other words, throughput is number or fractions of data packet received per unit time. Figure 8 shows the throughput analysis between proposed method and base method.

![Figure 8. Throughput analysis](image)

5.3.2. Routing Efficiency
It is determining as number of data fractions out of whole number of packets transmitted during the communications. Here routing efficiency was measure via AODV routing protocol with modification of needed things and compare with conventional AODV protocol. Figure 9 shows the routing efficiency analysis.

![Figure 9. Routing efficiency analysis](image)

5.3.3. Control Overhead
Basically, throughput and other parameter affects from control overhead. If control overhead is high then performance is low and if it is less then performance is high. Control overhead defined as number of routing and other control packets used in one communication. It is depicted as number of control packets over the time. Figure 10 shows control overhead analysis.

![Figure 10. Control overhead analysis](image)

5.3.4. Residual Battery Power
Particularly for mobile ad-hoc network the life of network is depends on consumption and residual battery power of nodes. If residual battery power is large then network lifetime is more otherwise it is less. Figure 11 shows residual battery power analysis.

![Figure 11. Residual battery power Analysis](image)

6. Conclusion
Due to self-organizing nature, devices in the network are enough sufficient to discover route and initiate transmission. If any change occurred then devices are enough confident to manage the
changes. On the other hand, the mobility property of mobile ad-hoc network pays heavy penalty in term of routing overhead, link breaks and wastage of resources. For the route discovery, nodes of network employ numerous routing strategies. One among them is reactive routing that enable nodes to broadcast routing information to all its covering nodes. The broadcast procedure for reactive routing protocol results duplicity of routing information as well as unnecessary consumption of resource. Though proposed method has minimized impacts of broadcast procedure of reactive routing strategy. Proposed method evaluated with base method over throughput, routing efficiency and so on. Further proposed method has scope to extend in term of parameter, routing protocols and others.

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