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Congestion Avoidance in Mobile Ad-Hoc Networks, through Cooperative AODV Routing

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***Abstract*: In MANET, congestion is severe problem and in spite of the lot of works already done in the area, still due to involvement of new techniques and devices it is required to be reconsidered again. Congestion control using congestion window management has also been addressed earlier but there is no algorithm proposed which is controlling congestion window dynamically using packet count and information received from the neighbor nodes about packet count. CARMAN helps in avoiding congestion and provides a network layer solution. It is an extension of CORMAN to provide pipeline transmission of data packets for long distance multihop transmissions. The objectives of CARMAN algorithm are it allows pipeline data transmission for long distance multipath transmission and also provides faster transmission of data packets avoiding congestion. Measure challenges faced in CARMAN are Hop Count Calculation. The CARMAN faces the problems due to application of hop count based calculations for data forwarding and will not be suitable for large networks. This work proposes to eliminate the hop count threshold calculation. It also proposes to use AODV protocol for testing the proposed improved congestion control.**

Keywords: **AODV, Congestion control, Cooperative Routing, Mobile Ad-Hoc network**.

I. INTRODUCTION

Opposed to infrastructure networks, Mobile Ad-Hoc Networks are networks where each user directly communicates with an access point or base station without the need of wired connection, they does not rely on a fixed infrastructure for its operation. The network is an autonomous transitory association of mobile nodes that communicate with each other over wireless links. Nodes that lie within each other's send range can communicate directly and are responsible for dynamically discovering each other. In order to enable communication between nodes that are not directly within each other's send range, intermediate nodes act as routers that relay packets generated by other nodes to their destination. These nodes are often energy constrained— that is, battery-powered devices with a great diversity in their capabilities. Furthermore, devices are free to join or leave the network and they may move randomly, possibly resulting in rapid and unpredictable topology changes. In this energy-constrained, dynamic, distributed multi-hop environment, nodes need to organize themselves dynamically in order to provide the necessary network functionality in the absence of fixed infrastructure or central administration. Such a networking paradigm originated from the needs in battlefield communications, emergence operations, search and rescue, and disaster relief operations. Later, it found civilian applications such as community networks.

These networks faced the traditional problems inherent to wireless communications such as lower reliability than wired media, limited physical security, time varying channels, interference, etc. Despite the many design constraints, mobile ad hoc networks offer numerous advantages. First of all, this type of network is highly suited for use in situations where a fixed infrastructure is not available, not trusted, too expensive or unreliable. Because of their self-creating, self-organizing and self-administering capabilities, ad hoc networks can be rapidly deployed with minimum user intervention. There is no need for detailed planning of base station installation or wiring. Also, ad hoc networks do not need to operate in a stand-alone fashion, but can be attached to the Internet, thereby integrating many different devices and making their services available to other users. Furthermore, capacity, range and energy arguments promote their use in tandem with existing

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cellular infrastructures as they can extend coverage and interconnectivity. As a consequence, mobile ad hoc networks are expected to become an important part of the future 4G architecture, which aims to provide pervasive computer environments that support users in accomplishing their tasks, accessing information and communicating anytime, anywhere and from any device.

Congestion [5] occurs in a network or portion of a network when the total amount of data sent into a network exceeds that capacity available. Congestion manifests itself in excessive packet delay and dropping of packets due to lack of buffer space. There are variety of conditions that can contribute to congestion. These include but are not limited to traffic volume in the network, the network architecture, the specification of the devices in network, packet size and transport protocol being used. Congestion avoidance attempts to predict when congestion is about to occur and reduce the transmission rate at this time.

Within MANET a number of issues further complicate the identification and control congestion including:

- Interference from other nodes
- Route failure
- Variable quality of radio signals
- Congestion
- Transmitter power.

In wireless network ,when a packet is transmitted over a physical channel, it can be detected by all the other nodes within the transmission range on that channel .For the most part of the research history, overhearing a packet not intended for the receiving node had been considered as completely negative i.e. interference .thus, goal of research in wireless networking was to make wireless links as good as wired ones. Unfortunately, this ignores the inherent nature of broadcasting of wireless communication links. For Manet to truly succeed beyond labs and test beds, we must tame and utilize its broadcasting nature rather than fighting it. Cooperative communication [4] is an effective approach to achieving such a goal.

II. RELATED WORK

Congestion represents an overloaded condition in a network. If a network has no congestion control, the consequence may be severe performance degradation, even to the extent that the carried load starts to fall with increasing offered load. The ideal situation is the one with no loss of data, as a result of no congestion. normally, a significant amount of engineering effort is required to design a network with no congestion.

Congestion in MANETs not only causes severe information loss but also leads to excessive energy consumption. Since mobile adhoc networks have wide spread applications and their usage are increasing day by day due to availability of the various wireless devices which are having processing power as a personal computer such as Mobile phones, IPADs, IPhones etc. Such increases of usage of wireless networks impose problems in these network among which Congestion is major problem to be addressed properly.

Ad hoc networks are spontaneously forming networks of equal nodes. Every node acts as a router and provides routing information to other nodes. Ad hoc networks can adapt quickly to changes in network topology. The topology changes are often caused by nodes changing physical locations, going to power saving mode, or losing contact with other nodes because of external disturbances.

The Ad-hoc On-demand Distance Vector protocol

The Ad-hoc On-demand Distance Vector (AODV) protocol is a suggested protocol for mobile ad hoc networks (MANETs). It is an on-demand, or reactive, routing protocol in its basic configuration. No effort is made to find new routes before a need arises to transmit packets to a destination for which no route exists. The routes are maintained as long as they are needed by existing connections

AODV multicast operation

The AODV multicast algorithm uses similar RREQ and RREP messages as in unicast operation. The nodes join the multicast group on-demand, and a multicast tree is created in the process. The tree consists of the group members and nodes connected to the group members. This enables a recipient host to join a multicast group even if it is more than one hop away from a multicast group member. The unicast operation of the protocol also benefits from the information that is gathered while discovering routes for multicast traffic. This cuts down the signaling traffic in the network.

Route discovery

When a node wishes to find a route for a multicast group, it sends an RREQ message. The destination address in the RREQ message is set to the address of the multicast group.

If the node wants to join the group in question, i.e., to become a multicast router, the J_flag in the message is set.

Any node may respond to a RREQ merely looking for a route, but only a router in the desired multicast tree may respond to a join RREQ. The corresponding RREP message may travel through nodes that are not members of the multicast group. This means that the eventual route may also include hops through non-member nodes.

The multicast RREP message is slightly different from the unicast RREP. The address of the multicast group leader is stored in a field called Group_Leader_Addr. In addition, there is a field called Mgroup_hop. This field is initialized to zero and it is incremented at each hop along the route. Mgroup_hop contains the distance in hops of the source node to the nearest member of the multicast tree.

Group Hello messages

Because the protocol relies on a group-wide DSN to ensure fresh routes, the group leader broadcasts periodical Group Hello messages. The Group Hello is an usolicited RREP message that has a TTL greater than the diameter of the network. The message contains extensions that indicate the multicast group addresses and the corresponding sequence numbers of all the groups for which the node is the group leader. The sequence number for each group is incremented each time the Group Hello is broadcast. The Hop_Cnt field in the message is initialized as zero and incremented by the intermediate nodes.

The nodes receiving the Group Hello use the information contained therein to update their request tables. If a node does not have an entry for the advertised multicast group, one is inserted. The hop counts are used to determine the current distance from the group leader.

III. OVERVIEW

Congestion Avoidance in Mobile Ad-Hoc Networks, through Cooperative AODV Routing or CAMCAR helps in avoiding congestion and provides a network layer solution. It gets its design from CARMAN (Congestion Avoidance through Cooperative Routing In Manets) which itself is an extension of CORMAN[2] (Cooperative Opportunistic Routing in Mobile Adhoc Networks).The flaw in the CARMAN is its threshold value for 'number of hops. If we limit the number of hops, the size of network remains fixed to particular size. When new nodes arrive or ask to join the network their request will be ignored or neglected completely. Whereas we propose a protocol which removes the threshold limit, and allow the network to expand as and when required.

A. Objective of CAMCAR :

The objectives are:-

1. It provides cooperative communication between the nodes.
2. It allows pipeline data transmission for long distance transmission
3. Provides faster transmission of data packets avoiding congestion

4. Makes use of AODV protocol instead of DSDV[6].

B. Listings of our proposed solutions are:

- The proposed method is based on “Length of the packet”. We set a default value for LP. These values can be changed manually depending on the topography of the network.

- We use AODV protocol .AODV is a reactive protocol which is being used in place of DSDV protocol to avoid the time requirements for processing huge routing tables. As AODV only uses the neighbour database table for searching the paths as and when required therefore it is expected to have easy splitting of the packets for transferring packets over the network topology.

IV. PROPOSED WORK

Congestion Avoidance through Mobile Ad Hoc, Networks, (CARMAN) protocol is designed to overcome problems due to congestion.. CARMAN is based on the assumption that all the nodes in the network are able to calculate the number of hops it needs to travel for that particular transmission. In general when the transmission distance increases, packet loss follows it proportionally. On favor of finding, reducing and retransmitting the lost packet we calculate hop count and this method paves an efficient way for this problem. This same approach is modified in this work to remove the problems faced in CARMAN.

Solution Proposed for above problems:

- From CARMAN we can eliminate Hop Count Threshold processing so that unlimited number of nodes can be there in the network topology.
- AODV reactive protocol is being proposed in place of DSDV protocol to avoid the time requirements for processing huge routing tables. As AODV only uses the neighbour database table for searching the paths as and when required therefore it is expected to have easy splitting of the packets for transferring packets over the network topology.
- Utilizing the broadcasting nature of wireless links to achieve cooperative communication at the links.

In base paper, authors have considered DSDV for testing CARMAN[1] which uses Hop Count Threshold. This is a draw back in high density network as the threshold is going to restrict the network with huge packet loss when the number of nodes is very high. Another problem found is use of DSDV protocol, as the DSDV is proactive table driven protocol therefore calculations to be done on each node for CARMAN will require lot of time.

From CARMAN we can eliminate Hop Count Threshold processing so that unlimited number of nodes can be there in the network topology. AODV reactive protocol is being proposed in place of DSDV protocol to avoid the time requirements for processing huge routing tables. As AODV only uses the neighbour database table for searching the paths as and when required therefore it is expected to have easy splitting of the packets for transferring packets over the network topology.

CARMAN transmits data packets similar to CORMAN. All the nodes before transmitting the data packets, calculates the number of hops of that transmission and the number of packets it carries in that process. The node compares these calculated values with the default values in it. If it finds both the values less than the default values, it proceeds the transmission in a normal fashion. Else, even if any one of the value seems greater it triggers the CARMAN algorithm programmed in it. This could be easily explained through algorithm. Terms used in the algorithm are: Default hop count (DH), Default number of packets(DP), Actual hop count- calculated (AH), Actual number of packets-calculated (AP).

The proposed work shall be implemented using following steps:

Initially the network topology shall be created using different –different node count.

Proposed Algorithm:

1. Source node requests for data transmission
2. After getting ACK from destination node, source node sends the packet to destination
3. Destination checks in rate and out rate on the node
4. if the in rate is higher than the out rate and queue status is also full than the packet is forwarded to next neighbor without storing it in the queue

5 else

6. if the next node(s) are not available than the sender is sent with a message to slow down the out rate.

Each node will be created with AODV routing enabled over it and Constant Bit Rate (CBR) traffic will be used over it to simulate the implementation. CARMAN uses hop count threshold to check if the congestion is occurring on a node. This work will eliminate the constraint of hop count. Each node is added with a updated send API to check if the node is having high number of packets in queue. If node is having high in rate than out rate then the packets will be forwarded from the other routes. If the other routes are not available then it will send a message to the sender to slow down the in rate by adjusting the congestion window size.

V. SIMULATION MODEL AND PERFORMANCE MATRIX

Even though the performance evaluation/analysis of ad hoc routing protocols is usually measured in homogeneous network, this evaluation is not much effective in the real applications where nodes have different capabilities. To study the efficiency and the effectiveness of routing protocols in heterogeneous ad hoc networks, NS-2 simulator is used to construct the simulation. The details of the simulation scenarios and performance metrics are illustrated in the following sections.

Simulation Model

In heterogeneous ad hoc networks, each node normally has different capabilities since some nodes are portable devices with limited capacity and battery life, while the others may be stationary or equipped with vehicle. These nodes are not power-constrained and usually have higher capacity than the former one. In this research work, there are two types of nodes which are High-capacity nodes (H-nodes) and General capacity nodes (G-nodes). These two types of nodes have different capacity which are bandwidth and transmission range.

Simulation scenarios are constructed by varying number of nodes. In each scenario, a few nodes approximately 5-20% are included as malicious nodes. For example, if there are totally 50 nodes in the heterogeneous networks, 5 nodes of them are the malicious nodes while other nodes are correct nodes performing good communication practices.

TABLE 1: SIMULATION PARAMETERS

channel type	Channel / WirelessChannel
radio-propagation model	Propagation / TwoRayGround
network interface type	Phy/WirelessPhy
MAC type	Mac/802_11
interface queue type	Queue / DropTail / PriQueue
link layer type	LL
antenna model	Antenna / OmniAntenna
routing protocol	AODV
X dimension of the topography	1080
Y dimension of the topography	1080
max packet in ifq	500
seed for random number gen.	0
simulation time	25
number of mobile nodes	500

Performance Evaluation Metrics

The performance metrics which are used to analyze the performances of routing protocols in heterogeneous ad hoc networks are discussed in the following:

- Packet delivery ratio (PDR): the ratio of total number of packets received by destinations to total number of packets sent by sources

$$\sum \text{Number of packet receive} / \sum \text{Number of packet send}$$

The greater value of packet delivery ratio means the better performance of the protocol.

- Average end-to-end delay: the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

$$\sum (\text{ arrive time} - \text{send time }) / \sum \text{Number of connections}$$

The lower value of end to end delay means the better performance of the protocol.

VI. CONCLUSION

The proposed work in this research is focusing on the congestion control of the wireless networks in AODV based routing protocol. The congestion is severe problem increasing day by day with invent of new wireless devices. The proposed work is expected to provide better end to end delay, packet delivery ratio and energy consumption value and therefore it is expected to provide better performance. Since most of the processing shall be done locally on the nodes therefore network overhead shall be minimized by the proposed algorithm.

The proposed work can be tested in future for other routing protocols for the MANET such as DSDV, DSR, and OLSR etc.

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