CCAG: GOSSIP BASED RELIABLE MULTICAST PROTOCOL

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Abstract

The essential requirement in MANET is now group communication or multicasting since it is used in applications such as network news dissemination, collaborative computing, disaster relief operation, sensor network, military services. In this type of application reliability plays an important role. Designing a reliable multicast protocol in MANET is challenging task due to the dynamic topology, limited bandwidth, constraints of node capability, and frequent disconnections in MANET. In this paper, we propose a scheme called Congestion Control Anonymous Gossip(CCAG) to improve the reliable packet delivery of multicast routing protocols and decrease the variation in the number of packets received by the different nodes. It also consider the issues of reliability, low end to end delay, control overhead and packet delivery in mobile ad-hoc networks. The propose scheme works in two phases. In the first phase any suitable protocol is used to multicast the message to the group, while in second phase, the gossip protocol tries to recover lost messages.

Keywords: *Ad-hoc Wireless network, Anonymous Gossip, MAODV, Packet delivery Reliability, Locality of gossip, Congestion.*

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1. INTRODUCTION

An adhoc network is a dynamically reconfigurable wireless network without any fixed infrastructure. Such type of network have several resource constraints like bandwidth, battery power, and demands like latency and other types of QoS, reliability and security etc. This type of network is specifically useful in situations like military and disaster relief operation etc. In such an application multicast is a natural requirement.

The transmission of packets to a group of zero or more hosts identified by a single destination address is called multicasting [16]. Large number of multicast protocols are available in adhoc network like MAODV [5], ODMRP [14], MCEDAR [9] etc. but this protocol does not provide reliability guarantees due to

1 Mobility and congestion.
2 Transient partition.
3 Maintenance of multicast structure.

In a wired network the basic technique used for recovering the lost messages are

1 Flooding
2 Gossip

In flooding any node that receives the packet retransmits to its entire neighbor hence routing messages are propagated unnecessary and hence congestion in the network increases.

Gossip [15][6] is a control form of flooding in this the messages are slowly propagated without congesting the network. Classical gossip technique used in wired network recovers lost messages but it requires partial or full knowledge of other group members.

Hence these methods are impractical in adhoc network due to several constraints of adhoc network.

Hence we are implementing a protocol which makes use of gossip technique called Congestion Control Anonymous Gossip (CCAG) which provides

1 Reliability guarantees
2 Eliminates the variation in the number of packets received by group member.
3 Less control overhead.
4 High packet delivery.

2. CONGESTION CONTROL ANONYMOUS GOSSIP PROTOCOL

A gossip based reliable multicast protocol[4] involves two phases as depicted in following figure

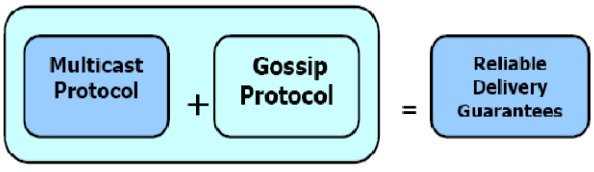

Fig-1: Use of Gossip with Existing Multicast protocol

In the first phase, any suitable unreliable protocol is used to

multicast the message *m*, to be sent to the group. In this experiment we are using the multicast adhoc on demand distance vector routing protocol to disseminate the message unreliably. In the second phase, gossip protocol is used to recover lost messages from other members of the group that might have received it. This phase consists of periodically repeated gossip rounds in the background as more and more messages are multicast. A single gossip round can potentially recover many lost messages. A single round of gossip consists of the following steps:

- Node *A* randomly chooses another member of the group, say *B*.
- A sends B the information about messages it has received or not received.
- B checks to see if it has received any of the messages listed by A.
- Then A and B could exchange messages which are not a part of each other's message history.

To implement the CCAG protocol we include the concept of following:

- Anonymous Gossip.
- Locality of Gossip.
- Cached Gossip.
- Pull mode of message exchange.

2.1 Anonymous Gossip

AG does not require any member to know the other members of the multicast group. A new type of message called gossip message [1][2] is used. This message has the following five fields:

- Group Address: Address of the multicast group
- Source Address: Address of the node sending the gossip message
- Lost Buffer: An array of fixed size, which carries sequence numbers of messages that the source node believes it has lost
- Number Lost: The size of the Lost Array
- Expected Sequence Number: The sequence number of the next message that the source expects

Following Steps are used to implement Anonymous Gossip

- If all the packets are not receive successfully then
- Generate the gossip message.
- Pick a node at random
- Send a digest of local contents to the peer.
- Propagate the message among multicast tree.
- If group member then
  accept and unicast gossip reply
  Else
  propagate gossip message to next node.

2.2 Locality of Gossip

Locality of gossip[3] refers to the gossip locally i.e. with nearer member with a very high probability and with distant nodes occasionally. Which results in low control overhead?

Following Steps are used to implement Locality of Gossip

- Maintain an additional nearest_member field in MRT table of MAODV protocol.
- If gossip message is received then next hop with smallest nearest member value is hosen with higher probability than with greatest nearest member value.
- Validity of nearest_member is maintain byWhen new member join send MACT message When existing member leaves send Prune message
- Each node send the modify message along the route

2.3 Cached Gossip

Cached Gossip [16][2] uses the unicast routes to gossip with those nodes whose membership is already known. The inclusion of the algorithm adversely affect the delay recorded in locating/delivering packets: whenever a node leaves the group; a new node joins the group; or there is a need for reconfiguration leading to topological changes.

Following Steps are used to implement Cached Gossip

- Every group member maintain member_cache
- Table consists of (node_add, num_hopes, last_gossip).
- If (member_cache table full)then If (member with greatest no. of hopes) delete it Else delete member with most recent last_gossip
- member_cache table is updated with each gossip reply, data packet or maintenance packet.

2.4 Pull Mode of Message Exchange

Because of the importance of the direction of information exchange. The proposed protocol implements a pull mode of message exchange.

Following Steps are used to implement Pull mode of message exchange.

- Each group node maintains Lost_table and History _table.
- Lost_table(sender_add, seq_no) entry is made when
- sequence no greater than expected seq. no is received.
- History_table contains most recent messages received
- If (receive gossip message) then compare Lost_table with History _table If (message found) then unicast gossip reply to initiator Else propagate gossip message to next node

The following figure depicts the complete CCAG protocol

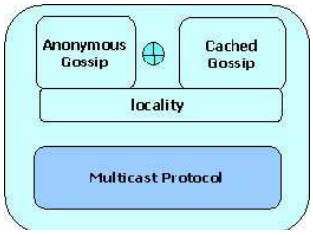

Fig2: The Complete CCAG Protocol

3. SIMULATION

3.1 Implementation Environment

Operating System : Cent O.S.6.0 NS2 version : ns-allinone-2.33 Gnu Plot : GNU4.2.5 Perl Script

3.2 Simulation Environment

The network N consists of |N| nodes with same transmission and communication capabilities, communicating through bidirectional wireless links between each other. A multicast group G is a subset of N with nG nodes.

The following assumptions are made :

- Simulation area : 1800 * 900 meters
- Simulation duration: 100 sec.
- Physical/ MAC layer: IEEE 802.11 at 2 Mbps, 250m transmission range
- Mobility model : Random way point model with no pause time.
- Every node has unique physical ID.
- The transmission radius for each node is fixed.
- Network consist of single multicast group.
- All the nodes join the group at the beginning of the simulation and remains in it throughout the run period.

33 Performance Metrics

After executing the tcl script the trace file is generated this contains a lot of information that may not be required to analyze the performance of a protocol. We are interested in those information that is sufficient to predict the efficiency of a protocol. The following performance metrics are needed to be consider to analyze and compare the performance of MAODV and CCAG protocol.

- **Packet delivery Ratio**: It is the ratio of number of data packets received by the destinations to the number of data packets sent by the source

  $$PDR\% = (TRP / TSP) * 100$$

  Where, PDR: Packet delivery Ratio TRP: Total Received Packets TSP: Total Sent Packets

PDR is used to compare MAODV protocol with CCAG protocol. As it describes the loss rate that is seen by the

protocol this in turn affects the maximum throughput that the network can support. This metric characterizes both completeness and correctness of the protocol.

- **Congestion overhead**: It gives the evaluation of the efficiency of a routing protocol and so if this parameter is low it means that less overhead is introduced in the network and the result is network is less congested and less collision and interference occur.

  It is the ratio of total number of routing signaling packets transmitted during the simulation in terms of total number of packets received.

  $$CO = TRSP/ TXP$$

  Where,
  CO: Congestion overhead
  TRSP: Total of Routing Signaling Packets TXP: Total of transmitted Packets .

- **Data packets received by each node:** It is used to calculate the variation in the number of packets received by each node. In this we calculate the number of data packets received by each node over a time

- **End to end delay:** End-to-end delay is considered as the average time taken by a packet to reach an Node from the time it leaves the sender. When a data packet is first created by the source, it is tagged with a send time. Subsequently, each node that receives the packet calculates the end-to-end delay by subtracting the time the packet was received with the initial send time.

3.4 Simulation Result and Analysis

Graphs are one of the ways to analyze and compare the result of the trace file. To plot the graph in NS2.33 we are using the software GNUPLOT which gives more appropriate scale. To plot the graph we have to first extract the desired field from the trace file. To do this we had written Perl script. The following are the graphs showing the outputs of the two protocols MAODV Vs CCAG. They show the performance metrics that are discussed in the above section.

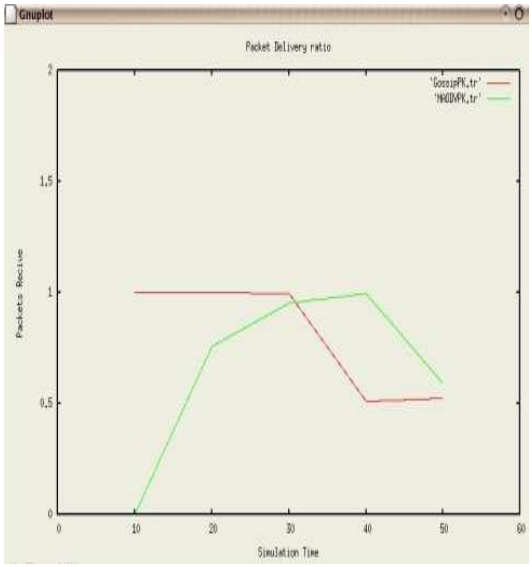

Fig-3: Packet delivery Ratio

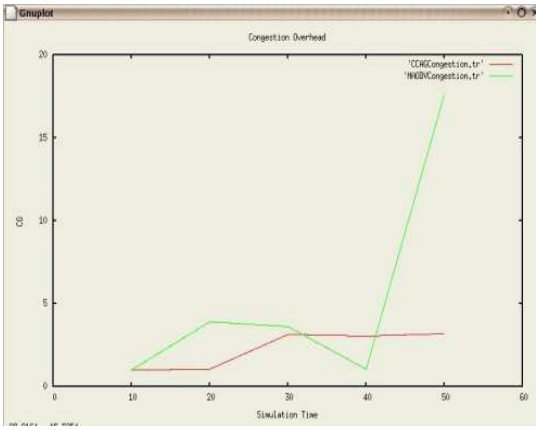

Fig- 4: Congestion overhead

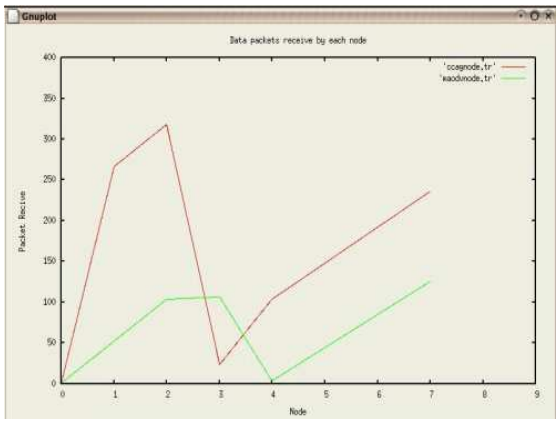

Fig- 5: Data packets received by each node

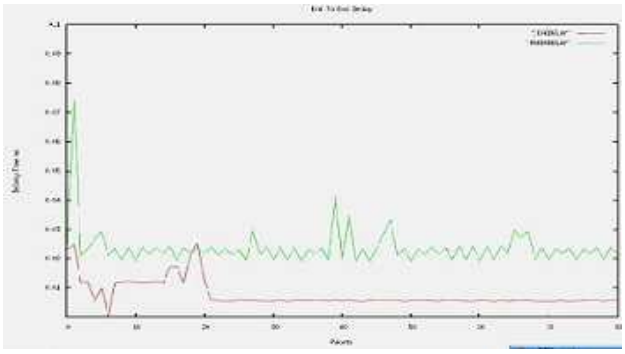

Fig- 6: End to End Delay

CONCLUSIONS

Reliable Multicasting is an important requirement in the MANET. Hence by considering this requirement we design and implemented congestion control anonymous Gossip protocol for Adhoc network which provides the reliability guarantees. It uses MAODV protocol to dissipate the messages unreliably and on top of that CCAG protocol is used. The performance comparison between MAODV and CCAG using graph shows that CCAG gives 22% improvement in the performance as compare to MAODV protocol. The results show that CCAG reduces congestion, increases Packet delivery ratio and also reduces the variation in the number of packets received by different group members.

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