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MULTICASTING IN MANET USING THE BEST EFFECTIVE PROTOCOLS

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Abstract:-

Multicasting is the transmission of datagram's. Maintaining group membership information and building an optimal multicast distribution structure is Challenging even in wired networks. However, nodes are increasingly mobile. One particularly challenging environment for multicast is a mobile ad-hoc network (MANET). Here in this paper we present a study of one-to-many and many-to-many communication in mobile ad-hoc networks. First we compare a range of best-effort protocols: 2 unicast routing protocols, 3 multicast routing protocols, and 2 broadcast protocols. Achieving high packet delivery ratios in these networks can be achieved by adjusting the data volume through flow control to operate in the protocol ", using the best-effort protocol as basic protocol.

Keywords: - [multicast, MANET, Multicast Protocols]

1. INTRODUCTION

Multicasting is intended for group-oriented computing and its use within a network has many benefits. Multicasting reduces the communication costs for applications that send the same data to multiple recipients. Instead of sending via multiple unicasts, multicasting minimizes the link bandwidth consumption, sender and router processing, and delivery delay. There are more and more applications where one-to-many or many-to-many dissemination is an essential task. The multicast service is critical in applications characterized by the close collaboration of teams (e.g. rescue patrol, battalion, scientists, etc) with requirements for audio and video conferencing and sharing of text and images. In the Internet (IPv4), multicasting facilities were introduced via the Multicast Backbone (MBone), a virtual overlay network on top of the Internet. This overlay network consists of multicast-capable islands connected by tunnels. Each island contains one or more special routers called multicast routers, which are logically connected by these tunnels. These routers manage group membership and cooperate to route data to all hosts wishing to participate in a multicast group. IP multicast groups are identified by special IP addresses. Support for multicasting is an integral component of IPv6, so it can be assumed that multicasting applications will become even more popular with the increased popularity and acceptance of IPv6.

2. PROTOCOL DESCRIPTIONS

All protocols discussed in this section have been developed for MANETs.

The first two protocols are on-demand unicast routing protocols, currently considered for standardization by the IETF. The multicast protocols have been proposed by various research groups in recent years for MANETs and follow a design similar to the unicast routing protocol: a packet distribution structure is created and maintained on-demand, the differences are primarily in the nature of the multicast distribution structure. Finally, the two broadcast protocols range from a very trivial one, FLOOD, to a rather complex one, BCAST. The latter minimizes the number of nodes rebroadcasting a data packet while still ensuring that all nodes receive a data packet with high probability.

2.1 Unicast protocols

Unicast routing in a MANET has attracted a lot of attention and consequently a large number of unicast routing protocols have been proposed. These protocols can broadly be classified into pro-active routing protocols, on-demand routing protocols, and hybrid protocols. In pro-active routing protocols, similar to the routing in the Internet, routes to all possible destinations are maintained at all times, typically by having nodes periodically exchange routing protocol control messages. Example protocols in this category are OLSR (Optimized Link State Routing) or DSDV (Destination-Sequenced Distance Vector protocol). On-demand protocols, on the other hand, only worry about routes to destinations that are actually recipients of data. These routes are discovered "on demand" using a request -reply cycle. DSR and AODV, discussed below, fall into this category. Finally, hybrid protocols such as ZRP (Zone Routing Protocol) combine aspects of the first two categories, pro-actively maintaining routes to "close" nodes and discovering routes to "remote" nodes on -demand.

2.2 Multicast protocols

All multicast routing protocols create paths to other hosts on demand. The idea is based on a query-response mechanism similar to reactive unicast routing protocols. In the query phase, a node explores the environment. Once the query reaches the destination, the response phase is entered and establishes the path. The following three multicast protocols are all based on this approach. The difference is in the type of multicast distribution structure (mesh versus tree) and whether there is one shared structure for the multicast group or one per source node. The multicast extensions for the AODV (Ad-hoc On-Demand Distance Vector**)** Routing protocol [Royer 1999] discover multicast routes on demand using a broadcast routediscovery mechanism. The protocol builds a Shared multicast tree based on hard state, repairing Broken links and explicitly dealing with network partitions. A mobile node originates A Route Request (RREQ) message when it wishes to join a multicast group, or when it has data to send to a multicast group but it does not have a route to that group. If an intermediate node receives a RREQ and it does not have a route to that group, it rebroadcasts the RREQ to its neighbors. As the RREQ is broadcast across the network, nodes set up pointers to Establish the reverse route in their route tables. If a Node receives a RREQ for A multicast group, it may reply if Its recorded sequence number for the multicast group is at least as great As that contained in The RREQ. The responding node updates its route and multicast route tables By placing the requesting node's next hop information in the tables, and then unicasts a Request Response (RREP) back to the source node. As nodes along the path to the source node receive the RREP, they add both a route Table and A multicast Route table entry for the node from which they received the RREP, thereby creating the forward path. When a source node broadcasts a RREQ for a multicast group, it often receives More than one reply. The source node keeps the received route with the greatest Sequence number And shortest Hop count to the Nearest member Of the Multicast tree For a Specified period of time, and disregards other routes. At the end of this period, it enables the selected Next hop in its Multicast route table, And unicasts an Activation message (MACT) to this selected next hop. The next hop, On receiving this message, enables the entry for the source node in its multicast Route table. This process continues Until the node that Originated the RREP (member of tree) is reached. The activation message ensures that the multicast tree does Not have multiple paths To any Tree node. Nodes only forward data packets along activated routes In their multicast route tables.

2.3 Broadcast protocols

Broadcasting protocols deliver data to all nodes in a network, independent of whether they are interested in that data or not. Since even unicast and multicast routing protocols often have a broadcast component (for example, the route discovery phase in on-demand unicast routing protocols), efficient broadcast protocols have been investigated heavily. [Williams 2002] gives an overview of the various categories of broadcast protocols and provides simulation results under various mobility scenarios. For the purpose of this study, we selected two broadcast protocols: a very simple protocol (FLOOD) and one of the more complex protocols (BCAST). Based on the results presented in [Williams 2002], we expect BCAST to outperform FLOOD. The first, and simplest protocol is FLOOD. It essentially implements standard flooding: each node, upon receiving a packet for the first time, will re-broadcast it over its wireless interface (i.e., using MAC-layer broadcasting). To reduce the chance of packet collisions, re-broadcasts are randomly jittered by 10 ms.

3. ANALYSIS AND DESIGN OF THE MULTICAST GATEWAY (MGW)

For the mixed network multicasting, the MGW is designed according to different multicast routing protocols used in each subnet. It is built with both the fixed multicast node components and the mobile multicast node components in ns-2, together with our modifications as shown below. In order to understand both wireline and MANET multicast protocols for multicast communication, the MGW node needs to have two types of network interfaces installed, one is the interface to the physical links, the other is the interface to the wireless channel. Figure 3.1 illustrates our detailed design of the MGW node in ns-2. No explicit sending agent exists in MGW for the MANET domain. In the beginning of the simulation, let the MGW join multicast groups on both sides. Although different group addresses are generated for each side according to the definitions in ns-2, the MGW treats them as one group. Only data packets will pass through the MGW from one domain to the other. And the MGW follows the appropriate protocols for each side multicast routing. Detailed processing is provided as follows when data packets arrive at the MGW node. Let the MGW join the multicast group in the fixed domain with a receiver agent inserted to all the replicators. Meanwhile, let the routing agent also be inserted to the replicators so that whenever the MGW receives a data packet from the fixed side multicast group by its attached fixed side receiving agent, its routing agent can also get a copy of this packet. In Figure 3.1, the thick lines with arrows represent the insertions of routing agents to the replicators. After getting a copy of the fixed side multicast data, the routing agent checks that this is not a looped back data (this situation happens when RP based protocol is involved, i.e., some data packet flows from a mobile source -> MGW -> RP => MGW, since the MGW is also a group member in the fixed domain). Then it repacks the packet by changing some packet headers, e.g., resetting the data source to be the MGW node ID, changing the destination to be the multicast group in the MANET, setting the TTL value to be the initial value set in the ad hoc domain. After this, the repacked datagram is ready to be forwarded to the ad hoc domain through the routing or forwarding procedures in MAODV or ODMRP. The design of the MGW for the combination of a source specific tree based fixed/wireline multicast protocol and the MANET protocols is similar to Section 3.1, except when the data packet is forwarded from the MANET to the fixed domain. As shown in the single dashed line targets the routing agent directly to the MGW's node entry (which is assigned as the target3_ in routing agents' implementations). When a data packet arrives at the MGW in its routing agent, the routing agent generates a copy of the packet and forwards the original to the ad hoc domain by using the MANET routing protocol. If this data packet is not a duplicate, the MGW repacks the data copy and forwards it to the fixed side along the source specific multicast tree that is rooted at the MGW.

4. EXPERIMENTAL SETUP

To compare the performance of the various "multicast" solutions, we studied the above protocols in NS2. Except where noted, we set up a rather challenging simulation environment, using the Following parameters (similar to other setups reported in the literature):

•Area: 1800 x 400 meters
•Number of nodes: 100
•Simulation length: 910 seconds
•Number of repetitions: 10
•Physical/Mac layer: IEEE 802.11 at 2 Mbps, 250 meter transmission range

Mobility model: random waypoint model with no pause time, maximum speed 20 m/s (high mobility scenarios) or 1 m/s (low mobility scenarios). Some additional experiments with maximum speeds of 15 m/s, 10 m/s, 5 m/s were also done. The results are not reported here. All nodes are in constant movement in our experiments. The only traffic is the multicast traffic. We study a range of multicast senders (1, 2, 5, or 10), sending to a number of multicast receivers (10, 20, 30, 40, or 50). We keep the sender and receiver sets disjoint. For example, in a scenario with 10 senders and 30 receivers, nodes 0 through 9 are the senders and nodes 20 through 49 are the receivers. Only in scenarios with 50 multicast receivers will some nodes act as both sender and receiver. In these scenarios, we expect the packet delivery ratio to be slightly better, since packet delivery within a single node is not subject to network problems. Each sender sends data at a specified rate and size. To explore different traffic loads,
the Following three different traffic sources per sender were evaluated:

•2 packets per second, each packet 256 bytes long (light traffic)
• 4 packets per second, each packet 512 bytes long (medium traffic)
• 8 packets per second, each packet 1024 bytes long (heavy traffic)

However, under the latter two loads, the MANET is almost always heavily congested, resulting in very poor protocol performance. We therefore present the results for the light traffic load only. Some work on increasing the overall network capacity to support higher offered loads is currently under way. An ideal protocol will achieve high packet delivery ratio and low packet latency. It will also do this with little overhead. Traditionally, counting the number of control messages and relating them to the number of received packets measures protocol overhead. However, FLOOD does not generate any dedicated control messages. And the overheads in any broadcast protocol are not only related to any control messages, but also to the waste of delivering packets to nodes not interested in this data. So we generalize the protocol overhead, defining metrics that capture the "network efficiency of the protocol":

• Packet send ratio (PSR): the number of packet transmissions (at the MAC layer) per data Packet received by a multicast receiver

• Bytes send ratio (BSR): the number of bytes transmitted (at the MAC layer) per data packet received by a multicast receiver.

UNICAST Routing protocols

Table 1: PDR and latency for DSR, 1 m/s maximum speed

	1 Sender		2 Senders		5 Senders		10 Senders	
	PDR	Latency	PDR	Latency	PDR	Latency	PDR	Latency
10 Receivers	0.973	0.040	0.970	0.025	0.754	1.054	0.331	2.536
20 Receivers	0.983	0.202	0.888	0.520	0.303	2.601	0.149	3.411
30 Receivers	0.642	1.653	0.436	1.502	0.168	2.904	0.082	3.441
40 Receivers	0.363	2.376	0.213	2.231	0.083	3.555	0.039	3.202
50 Receivers	0.254	2.410	0.152	2.142	0.073	2.561	0.048	1.655

Table 2: PDR and latency for DSR, 20 m/s maximum speed

	1 Sender		2 Senders		5 Senders		10 Senders	
	PDR	Latency	PDR	Latency	PDR	Latency	PDR	Latency
10 Receivers	0.712	0.805	0.326	1.946	0.140	2.753	0.085	2.911
20 Receivers	0.205	2.964	0.124	3.199	0.069	2.835	0.040	2.779
30 Receivers	0.146	3.011	0.074	3.166	0.037	3.271	0.023	2.903
40 Receivers	0.097	3.306	0.049	3.458	0.025	3.243	0.015	2.844
50 Receivers	0.093	2.495	0.063	2.276	0.039	1.630	0.032	1.012

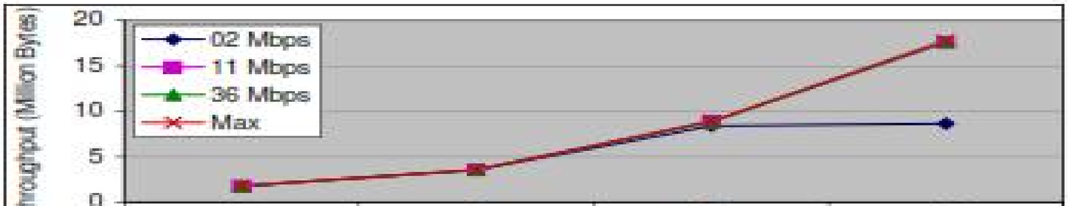
Table 3: PDR and latency for AODV, 1 m/s maximum speed

	1 Sender		2 Senders		5 Senders		10 Senders	
	PDR	Latency	PDR	Latency	PDR	Latency	PDR	Latency
10 Receivers	0.995	0.022	0.996	0.024	0.756	1.430	0.277	4.543
20 Receivers	0.996	0.033	0.966	0.208	0.328	2.957	0.128	3.676
30 Receivers	0.988	0.091	0.730	0.942	0.209	2.839	0.078	3.081
40 Receivers	0.915	0.321	0.537	1.159	0.147	2.725	0.055	2.650
50 Receivers	0.855	0.420	0.452	1.118	0.135	2.217	0.061	1.734

Table 4: PDR and latency for AODV, 20 m/s maximum speed

	1 Sender		2 Senders		5 Senders		10 Senders	
	PDR	Latency	PDR	Latency	PDR	Latency	PDR	Latency
10 Receivers	0.974	0.038	0.972	0.040	0.499	1.430	0.199	2.092
20 Receivers	0.974	0.049	0.784	0.558	0.219	1.920	0.095	1.915
30 Receivers	0.939	0.167	0.492	1.213	0.135	1.932	0.060	1.781
40 Receivers	0.826	0.434	0.342	1.361	0.092	1.926	0.041	1.688
50 Receivers	0.688	0.734	0.279	1.298	0.089	1.516	0.050	1.071

7.3.1. BCAST under medium load



	1	2	5	10
02 Mbps	1769601.27	3523629.957	8398183.219	8652084.019
11 Mbps	1775153.234	3548610.232	8823916.954	17552901.73
36 Mbps	1776040.55	3551047.68	8846580.941	17662515.61
Max	1781760	3563520	8908800	17817600

Number of Senders

Figure 1: BCAST throughput, 01 m/s maximum speed, medium load

	1	2	5	10
02 Mbps	1766511.698	3518990.254	8421666.816	8566523.904
11 Mbps	1769344.696	3537499.177	8812299.878	17536901.53
36 Mbps	1769501.491	3538553.979	8833698.816	17625989.53
Max	1781760	3563520	8908800	17817600

Number of Senders

Figure 2: BCAST throughput, 20 m/s maximum speed, medium load

• Mobility is not a problem. Both protocols achieve fairly similar performance under both low and high mobility. High-mobility scenarios seem to result in slightly higher packet delivery ratios and lower packet latencies, in particular for medium traffic loads. Also, the reliable protocol seems to improve more on the unreliable protocol for comparable scenarios under high mobility and for relatively few multicast senders.

• The best-effort BCAST protocol achieves pretty good performance if collisions can be avoided. So additional ways to reduced collisions even for low-bandwidth MACs could be beneficial for the protocol. One idea would be to increase the random packet jitter in heavy network load scenarios, i.e., make the random jitter a function of observed network load (which we observe to throttle NACKs already). Alternatively, MAC protocols that provide medium access among neighboring nodes in a more coordinated fashion could improve the protocol performance

CONCLUSION

Our results show that broadcast protocols, in particular BCAST, performs well and that this performance does not come with a high overhead. We then enhance BCAST with a NACK-based retransmission scheme to further increase the packet delivery ratio, resulting in reliable BCAST. We also explore the impact of the MAC layer on the performance of both best-effort BCAST and reliable BCAST. Varying the user traffic load and the MAC layer, the results provide a number of insights into the relationship between MAC and ROUTING layer. Overall, BCAST is a protocol that achieves high packet delivery, at the cost of an increase in packet latency. We show that the protocol performs well in a wide range of scenarios and over a number of MAC layers increasing packet delivery through a retransmission scheme is, however, only of limited value. As MAC rates increase for current and future networks, MANETs will be able to support a non-trivial amount of traffic per multicast sender.

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