On the Reliability of ODMRP in Mobile Ad Hoc Networks

Ahmed Sobeih
Department of Computer Science
University of Illinois at Urbana-Champaign
Urbana, IL 61801
sobeih@uiuc.edu

Hoda Baraka, Aly Fahmy
Computer Engineering Department
Cairo University
Giza, Egypt
hbaraka@mcit.gov.eg, afahmy@idsc1.net.eg

Abstract

In response to the important role that multicasting plays in wireless mobile multihop ad hoc networks, we study in this paper the reliability of the On-Demand Multicast Routing Protocol (ODMRP) in terms of the delivery of data packets. Using GloMoSim 2.0, the simulation results have shown that using ODMRP, the average miss ratio does not always increase with increasing the speeds of mobility of the mobile hosts in the ad hoc network. Instead, there is a "sweet spot" of values of the mobility speeds of the mobile hosts. In addition, the average miss ratio decreases with increasing the number of multicast group members, which indicates that ODMRP has more packet delivery capabilities for denser multicast groups.

1. Introduction

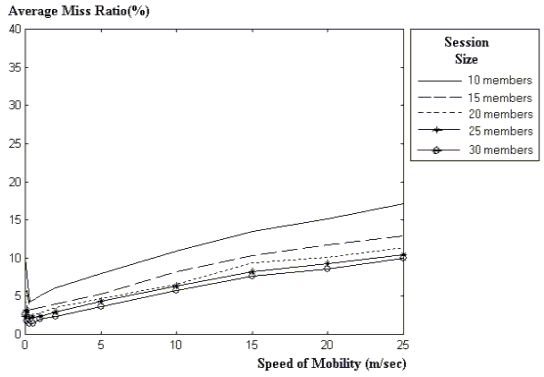
An ad hoc network is a wireless network that comes together when and where needed, as a collection of wireless hosts, without relying on any assistance from an existing network infrastructure such as base stations or routers [1]. Multihop routing is an inherent characteristic of ad hoc networks due to the lack of complete connectivity and the lack of routers. Therefore, the wireless hosts are designed to serve as relays (routers) and assist each other in delivering data packets if necessary. In addition, when the wireless hosts move, the wireless links between them may get broken and other links may get established. Hence, the underlying topology of a wireless mobile multihop ad hoc network (MANET) [2] may change rapidly and unpredictably.

In a typical mobile ad hoc network (e.g., a mobile conference or an emergency and rescue mission), wireless hosts work together in groups to carry out a given task. Therefore, multicasting plays an important role in ad hoc networks [3]. An important question is how the number of multicast group members (e.g., the number of attendees of a mobile conference) and the speed by which they move relative to each other affect the reliability of a multicast routing protocol in terms of the delivery of data packets. In this paper, we provide an answer to that question for the case of the On-Demand Multicast Routing Protocol (ODMRP) [4]. Specifically, we study the effect of mobility, session size (i.e., number of multicast group members), and transmission range on the packet delivery capabilities of ODMRP.

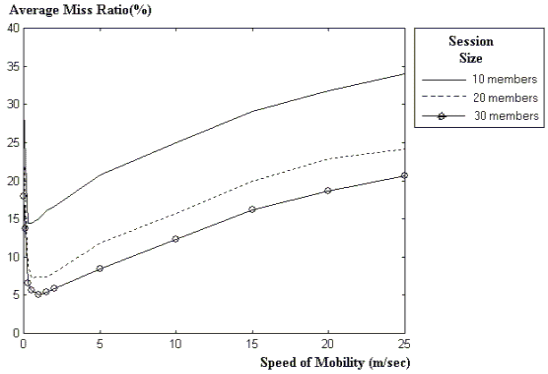
2. Reliability of ODMRP

ODMRP [4] is a *best-effort* mesh-based multicast routing protocol. Hence, a major performance evaluation criterion is the average miss ratio, which is calculated as the number of packets that each receiver did *not* receive divided by the total number of packets sent by the source, and averaged over the total number of receivers in the multicast group. In this section, we study how the average miss ratio of ODMRP is affected by mobility, session size, and the transmission range.

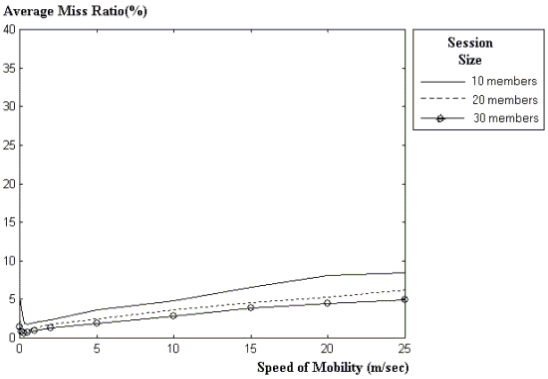
In order to study the reliability of ODMRP, we built a simulation environment in GloMoSim 2.0 [5]. The simulation environment consists of 30 hosts in a 700 m * 700 m area. Three values of the transmission range of each host are considered: 200 m., 250 m. and 300 m. A single source multicasts 2000 512-byte DATA packets to a multicast group. The packet transmission rate has a Poisson distribution with a mean of 500 msec. between each two successive packets. Network bandwidth is 2 Mbit/sec. MAC protocol is 802.11. The underlying multicast routing protocol is ODMRP [4]. The random waypoint [5] mobility pattern is used with equal minimum and maximum speeds of mobility (i.e., mobile hosts move with a constant speed). Several values of constant mobility speeds between 0 m/sec. (i.e., stationary hosts) and 25 m/sec. are considered. Figure 1 shows the session sizes that we considered.



(a) Transmission range is 250 m.



(b) Transmission range is 200 m.



(c) Transmission range is 300 m.

Figure 1, Average miss ratio versus speed of mobility for different session sizes and transmission ranges

At zero speed of mobility, the hosts are stationary and thus, the topology of the ODMRP multicast mesh is fixed. Hence, when a source multicasts a data packet, only the receivers that are in the mesh may receive it but other receivers that are far away from the mesh will not. As mobility increases, distant receivers may, while moving, reach the multicast mesh and hence start receiving some data packets causing the average miss ratio to decrease (as shown in Figure 1a). However, as mobility increases further, there are more frequent disconnections in the multicast mesh and hence packet loss increases.

As for the session size, we observed that as the session size increases, the probability that a receiver is within the transmission range of the source increases, causing a reduction in the average miss ratio (as shown in Figure 1a). Moreover, for larger session sizes, there are more forwarding nodes [4] in the multicast mesh, and therefore more redundancy in the mesh, leading to falling back on alternate multicast links when a multicast link fails and thus, reducing the average miss ratio.

The average miss ratio in Figure 1b (Figure 1c) is higher (lower) than its counterpart in Figure 1a due to the reduction (increase) in the transmission range. However, it is interesting to see that the pattern of the graph is the same.

3. Conclusions

In this paper, we study the reliability of ODMRP in terms of the delivery of data packets to the receivers in a multicast group. Simulation results have shown that the average miss ratio decreases with increasing the number of multicast group members, which indicates that ODMRP has more packet delivery capabilities for denser multicast groups. In addition, our simulations have also shown that using ODMRP, the average miss ratio does not always increase with increasing the speeds of mobility of the mobile hosts. Instead, there is a range of mobility speeds in which the average miss ratio decreases with increasing speeds of mobility and after that range, the average miss ratio increases with increasing speeds of mobility. Hence, there is a "sweet spot" of values of the mobility speeds of the mobile hosts.

References

[1] C.E. Perkins, *Ad Hoc Networking*, Addison Wesley, 2001.

[2] IETF MANET Working Group Charter http://www.ietf.org/html.charters/manet-charter.html

[3] S.-J. Lee, *Routing and Multicasting Strategies in Wireless Mobile Ad Hoc Networks*, Ph.D. dissertation, CS Department, UCLA, 2000.

[4] S. Ho Bae, S.-J. Lee, W. Su, and M. Gerla, "The Design, Implementation, and Performance Evaluation of the On-demand Multicast Routing Protocol in Multihop Wireless Networks," *IEEE Network Magazine*, vol. 14, no. 1, Jan./Feb. 2000, pp. 70-77.

[5] X. Zeng, R. Bagrodia, and M. Gerla, "GloMoSim: A Library for Parallel Simulation of Large-scale Wireless Networks," *Proc. of the 12th Workshop on Parallel and Distributed Simulation*, Banff, Alberta, Canada, July 1998, pp. 154-161.