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Performance of multicast groups moving towards the same direction

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Abstract

MANETs (Mobile Ad-hoc Networks) are self organizing networks without the need for a pre-existing infrastructure. These characteristics make them suitable for situations as rescue procedures, education, and military. When nodes need one-to-many or many-to-many communication then multicasting is employed. Many experiments showed that ODMRP protocol is very efficiency.. In this article we partition the nodes into sub-groups and observe how ODMRP react with respect to antenna range, area, speed and directionality. We partition the nodes to 1 or 2 or 3 or 4 or 5 sub-groups. Then we repeat all the above experiments having the leaders of any sub-group to communicate with each other. The main aim of this paper is to investigate how directionality and group-leaders communication affect the ODMRP, and what is the impact of the antenna range, area and speed. The performance measures to be evaluated are the PDR (Packet Delivery Ratio) and the Latency.

Keywords:

MANET, ad hoc networks, multicasting, ODMRP, directionality, group partitioning.

I. Introduction

MANETs are self organizing mobile ad hoc networks without the need for a pre-existing infrastructure. Every node acts as a sender, as a receiver and as a router at the same time. Devices such as laptops, PDAs (Personal Digital Assistants), mobile phones, pocket PC with wireless connectivity is commonly used. If two nodes are in the transmission range of each other then they can communicate directly. Otherwise, they reach each other via a multi-hop route. MANETs have a wide range of applications such as disaster relief, education, battlefields, and crowd control.

However in MANETs, routing and multicasting are extremely challenging. Nodes in these networks move unpredictably, thus the network topology changes frequently. Furthermore, there is a power consumption limit due to the batteries of the node devices. Finally bandwidth limit is another serious constrain.

Multicast is the transmission of data in a group of nodes which is recognized by one and unique address. Groups exist in most MANETs scenarios and the use of multicast, rather unicast reduces the bandwidth and energy cost, and the end-to-end delay (Mohapatra et al 2004), (Baziakos and Economides, 1998)

Two basic architectures are used in multicast MANET protocols. Tree-based protocols, where MAODV seems to be the most discussed tree-based protocol (Royer and Perkins , 1999), and mesh based protocols, where ODMRP is considered to be the best mesh-based one (Lee and al , 1999). A hybrid architecture is discussed in (Chiang et al 1998). Technologies such as GPS (Global Position System) can be used to predict the node's movement and provide universal timing (Hong and al , 2002)

After many simulation experiments with multicast algorithms ,(Kunz and Cheng 2001), (Vasiliou and Economides, 2005) we have concluded that ODMRP achieves the best performance in most cases. In this paper, we further investigate the ODMRP. In many situations, we must partition the network's nodes in many multicast groups. For example, in a rescue scenario we can have two groups: i) the rescuer's group and ii) the doctor's group. The first goal of our experiments is to investigate how this group partition affects the ODMRP performance, and what is the best number of groups. We also use 3 types of movement: i) RANDOM movement, in which every node moves randomly in the specific area, ii) DIRECTED movement, where every node moves randomly on the x-axis but directionally on the y-axis, and iii) DIRECTED II, where the nodes move in the same way as in the DIRECTED movement, and the group leaders communicate to each other creating a new multicast group. All these experiments are implemented for various values of the speed (1m/sec, 5m/sec, 10m/sec), area (500m*500m, 1000m*1000m, 2000m*2000m) and antenna range (250m, 500m, 1000m).

2. ODMRP (On-demand multicast routing protocol)

ODMRP is an On-Demand protocol, so it discovers the routes only when it has something to send. It is a mesh architecture protocol, so it has multiple paths from the sender to the receivers. When a node has information to send but no route to the destination, a Join Query message is broadcasted. The next node that receives the Join Query updates its routing table with the appropriate node id from which the message was received for the reverse path back to the sender (backward learning). Then the node checks the value of the TTL (time to live) and if this value is greater than zero it rebroadcasts the Join Query. When a multicast group member node receives a Join Query, it broadcasts a Join Reply message. A neighborhood node that receives a Join Reply consults the join reply table to see if its node id is the same with any next hop node id. If it is the same then the node understands that it is on the path to the source and sets the FG_FLAG (Forwarding Group flag). ODMRP is a soft state protocol, so when a node wants to leave the multicast group it is over passing the group maintaining messages (Mohapatra et al 2004) , (Lee and al , 1999), (Kunz and Cheng 2001), (Lundberg, 2004), (Kunz, 2003).

3. Simulation scenarios

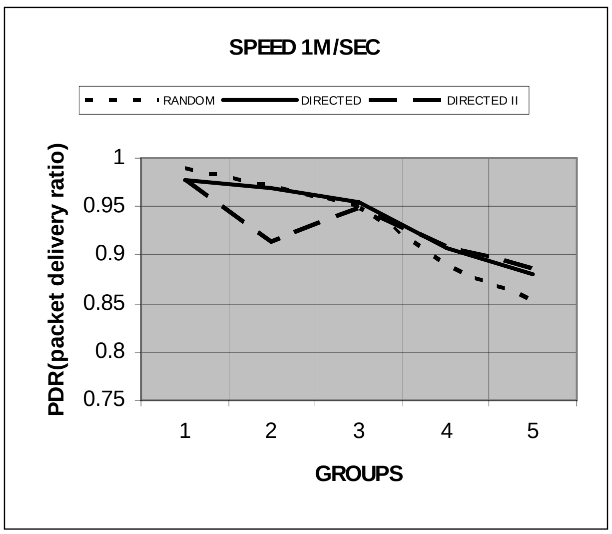
We use the NS-2 simulator with the implementation of the monarch project (Rice University Monarch Project) for simulating the ODMRP protocol. We measure the PDR (Packet Delivery Ratio) and the Latency. PDR is the ratio of the number of packets sent to the number of packets received and shows the reliability of the protocol. Latency is the average end-to-end packet delay.

3.1 Different speed

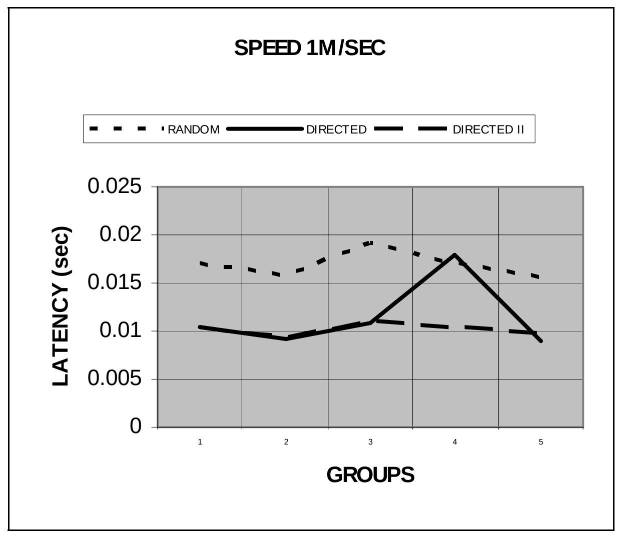
In these experiments we investigate how the ODMRP reacts with respect to various numbers of groups for various node speeds.

Number of nodes	60
Number of groups	1 or 2 or 3 or 4 or 5
Speed	1m/sec or 5m/sec or 10m/sec
Movement	RANDOM, *DIRECTED*, *DIRECTED II*
Antenna range	250m
CBR	512 bytes/sec
Area	1000m * 1000m

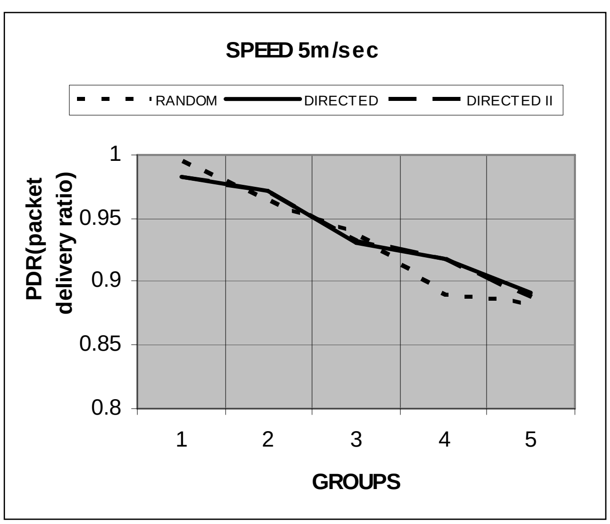
Table1. Simulation parameters for the different speed scenarios.

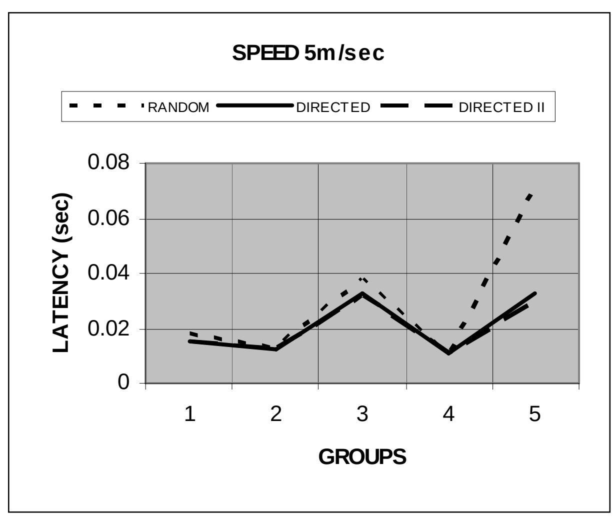


Graph1. PDR versus number of groups with 1m/sec speed



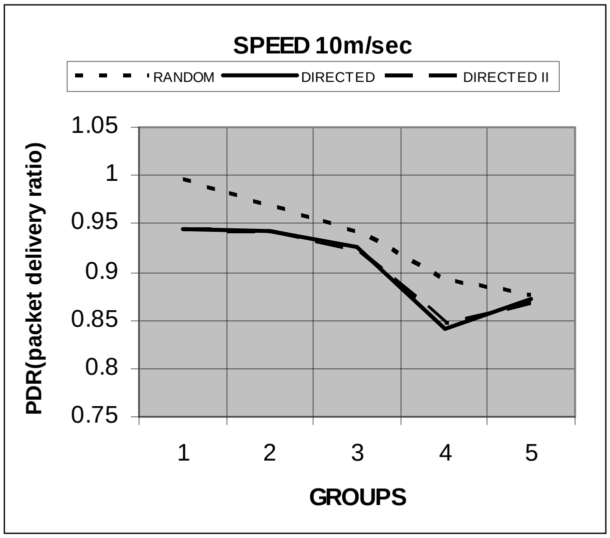
Graph2. Latency versus number of groups with 1m/sec speed



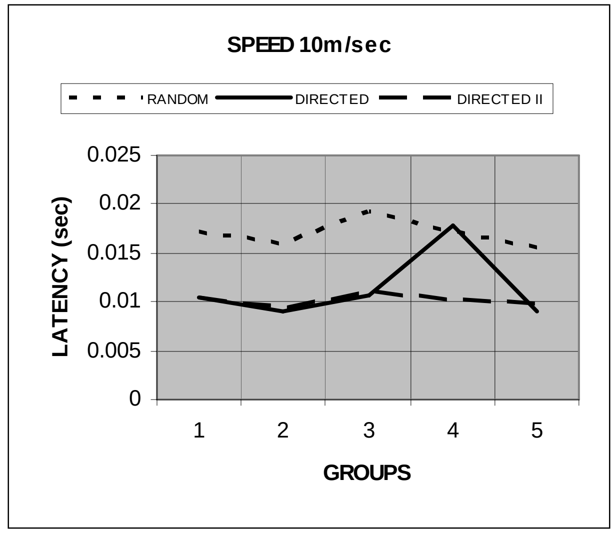


Graph3. PDR versus number of groups with 5m/sec speed

Graph4. Latency versus number of groups with 5m/sec speed



Graph5. PDR versus number of groups with 10m/sec speed



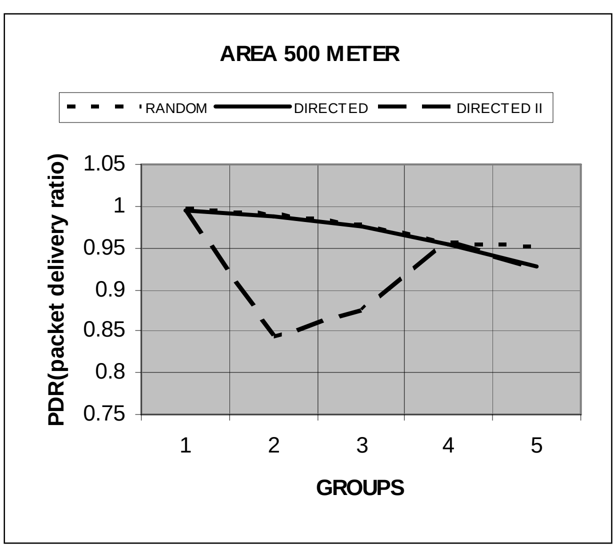
Graph6. Latency versus number of groups with 10m/sec spee

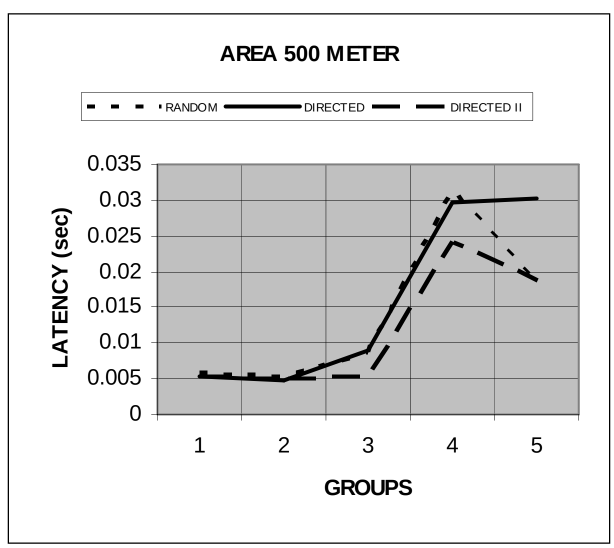
3.2 Different moving area

In these experiments we investigate how the ODMRP reacts with respect to various number of groups for various areas where the nodes move.

Number of nodes	60
Number of groups	1 or 2 or 3 or 4 or 5
Speed	1m/sec
Movement	RANDOM, *DIRECTED*, *DIRECTED II*
Antenna range	250m
CBR	512 bytes/sec
Area	500m*500m, 1000m*1000m, 2000m*2000m

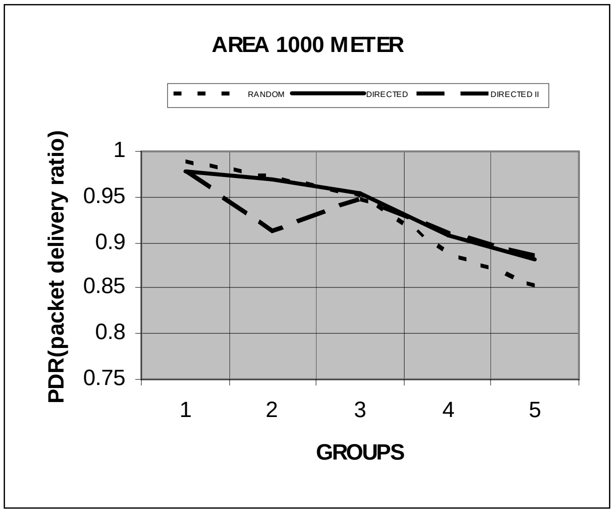
Table2. Simulation parameters for the different moving areas scenarios.



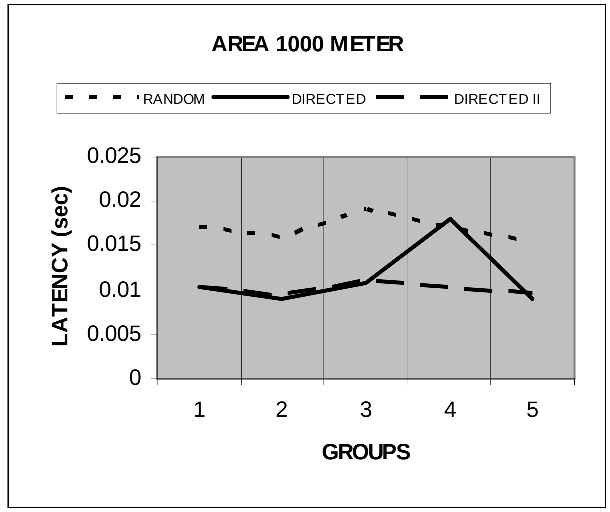


Graph7. PDR versus number of groups with 500m area

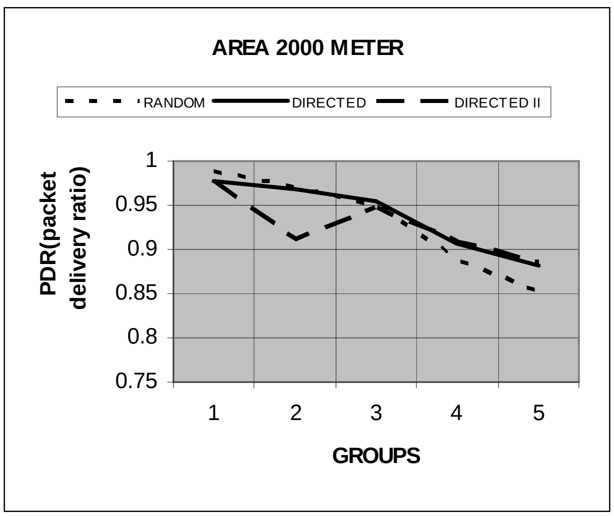
Graph8. Latency versus number of groups with 500m area



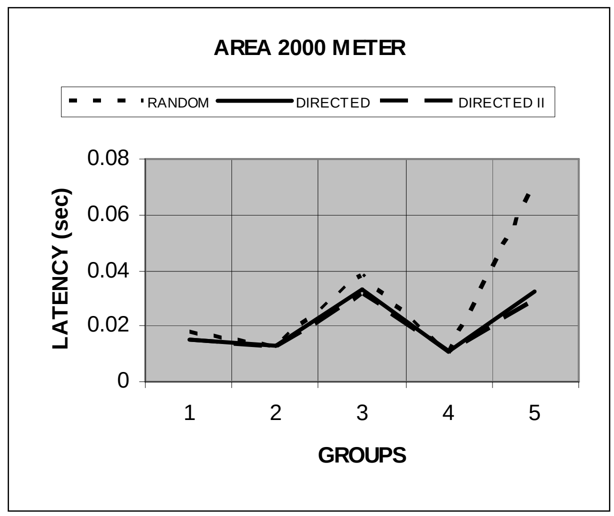
Graph9. PDR versus number of groups with 1000m area



Graph10. Latency versus number of groups with 1000m area



Graph11. PDR versus number of groups with 2000m area



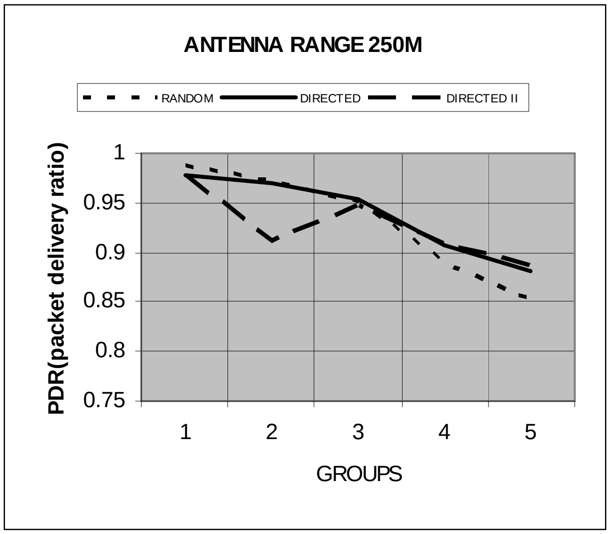
Graph12.Latency versus number of groups with 1000m area

3.3 Different antenna range

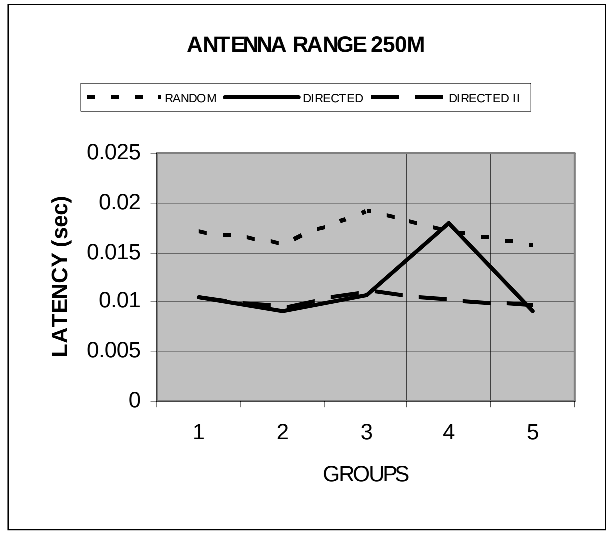
In these experiments we investigate how the ODMRP reacts with respect to various number of groups for various antenna ranges.

Number of nodes	60
Number of groups	1 or 2 or 3 or 4 or 5
Speed	1m/sec
Movement	RANDOM, *DIRECTED*, *DIRECTED II*
Antenna range	250m, 500m, 1000m
CBR	512 bytes/sec
Area	1000m * 1000m

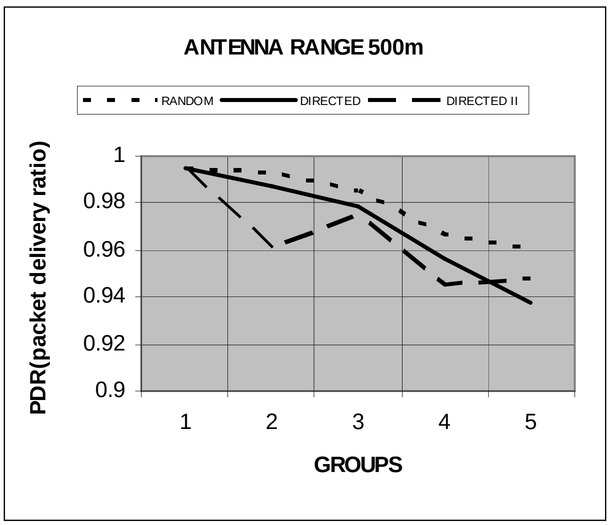
Table3. Simulation parameters for the different antenna range scenarios.



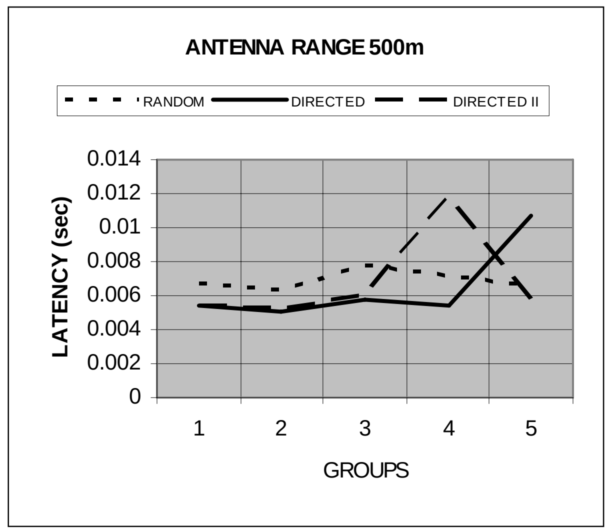
Graph13. PDR versus number of groups with 250m antenna range



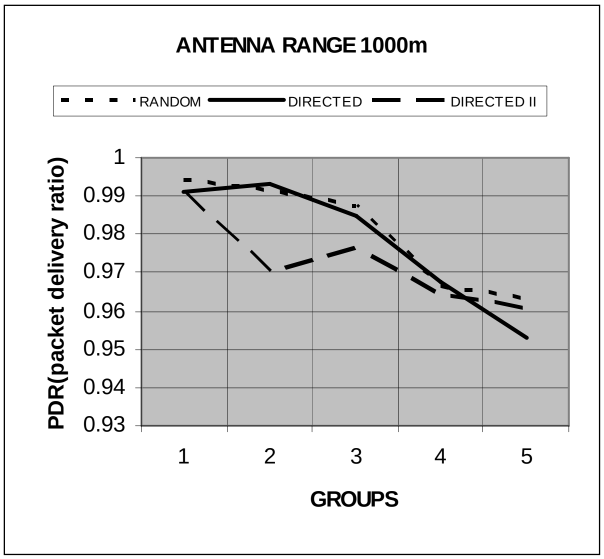
Graph14. Latency versus number of groups with 250m antenna range

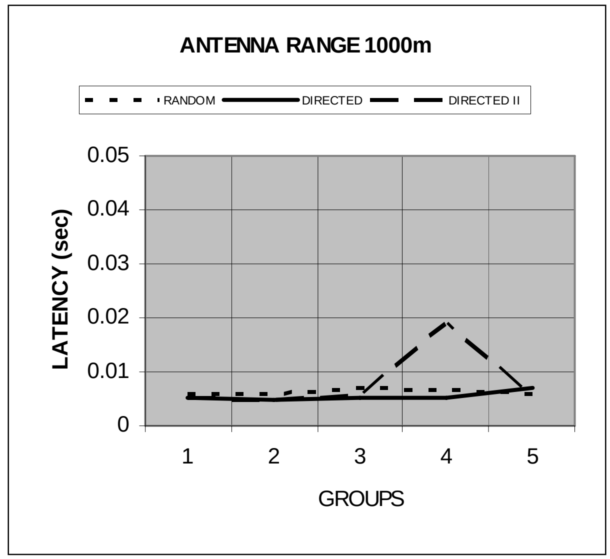


Graph15. PDR versus number of groups with500m antenna range



Graph16. Latency versus number of groups with 500m antenna range





Graph17. PDR versus number of groups with1000m antenna range

Graph18. Latency versus number of groups with 1000m antenna range

4. Simulation results

4.1 different speed experiments

Graphs 1, 3, and 5 show the PDR values versus the number of groups with node speed= 1, 5, and 10 m/sec respectively. The best PDR values are achieved when a single group is employed. The PDR values are very high (84%-99%) for all the experiments. RANDOM movement and DIRECTED movement have similar values when the node speed is 1 and 5 m/sec. RANDOM movement outperforms when the node speed is 10m/sec. DIRECTED II movement shows (as it was expected) the lowest PDR values, but in most experiments these values are very close to the DIRECTED values. Thus, the ODMRP protocol shows great tolerance to the speed, and the different moving scenarios do not affect strongly the protocol.

Graphs 2, 4, and 6 show the Latency values versus the number of groups with node speed=1, 5, and 10 m/sec respectively. The best Latency values are achieved when two groups are employed. DIRECTED II movement achieves the best Latency values which are close enough to the DIRECTED movement values in most cases. RANDOM movement shows the worst Latency values.

When the node speed= 1 m/s, for 1, 3 and 5 groups, the DIRECTED and DIRECTED II movement achieve similar performance. For 2 groups, the DIRECTED movement is the best. For 4 groups, the DIRECTED II movement is the best. When the node speed= 5 m/s the three movements have similar results except for two cases. For 4 groups, the PDR value of the RANDOM is lower than that of the others. For 5 groups, the Latency value of the RANDOM is higher than that of the others. When the node speed= 10 m/sec, the DIRECTED movement has the worst values (PDR and Latency) when we use four groups.

4.2 different moving area experiments

Graphs 7, 9, and 11 show the PDR values versus the number of groups with moving area= 500m*500m, 1000m*1000m, and 2000m*2000m respectively. The best PDR values are achieved when a single group is employed. For moving area= 500*500m and 1000m*1000m, the PDR values are very high (85% -99.8%). For moving area= 2000m*2000m, the PDR values are extremely low (11%-22%). Thus, the ODMRP does not operate reliably in these conditions. One solution would be to increase the antenna range. RANDOM and DIRECTED movements show very similar PDR values. DIRECTED II movement gets the strongest negative influence from the number of groups, especially when using two groups.

Graphs 8, 10, and 12 show the Latency values versus the number of groups with moving area= 500m*500m, 1000m*1000m, and 2000m*2000m respectively. Most of the best Latency values are achieved when two groups are employed. DIRECTED II movement achieves the best Latency values, in most cases close enough to the DIRECTED values. RANDOM movement achieves the worst Latency values.

4.3 different antenna range scenarios

Graphs 13, 15, and 17 show the PDR values versus the number of groups with antenna range= 250m, 500m, and 1000m respectively. The best PDR values are achieved when a single group is employed. In all the experiments we achieved very good PDR values (85%-99.5%). As we expected, when the antenna range increases the PDR value increases too. When we use one group the increase of the PDR value, as the antenna range increases, is between 0.5-1.5 percent. However, by increasing the antenna range we consume more energy. Depending on the conditions, we must choose if we want better PDR values or better battery consumption.

Graphs 14, 16, and 18 show the Latency values versus the number of groups with antenna range= 250m, 500m, and 1000m respectively. The best PDR values are achieved when two groups are employed.

In general, PDR gets worst as the number of groups increases. What is remarkable is that with DIRECTED II movement we see a drop-fall of the PDR value with two groups.

5. Conclusions

When we use one group, we achieve the best PDR values and close to the best Latency values in all the experiments. When we use two groups, we achieve the best Latency values in most of the experiments. Thus, if we have to choose the number of groups, we would prefer a single group. Regarding the different speed, the ODMRP protocol shows great tolerance with respect to the speed. Regarding the moving area, double sizing the area from 1000m*1000m to 2000m*2000m and keeping the same number of nodes the ODMRP become unreliable (average PDR= 16.5%). Regarding the different antenna range, increasing the antenna range we achieve better PDR values. However, the gain is not so remarkable, since with the lowest antenna range (250m) we also achieve very good PDR values.

References

1. Vasiliou A.& Economides A.A., "Evaluation of Multicasting algorithms in MANETs", *Proceedings 3rd World Enformatika Conference (WEC'05)- International Conference on Telecommunications and Electronic Commerce (TEC 2005),* 2005.
2. Baziakos A.A., Economides A.A., "Multicast routing algorithms: a survey", *Proceedings ICT '98, International Conference on Telecommunications*, pp. 476-480, 1998.
3. Chiang, C. Gerla M., and Zhang L. " Adaptive shared tree multicast in mobile wireless networks" *Proceedings of IEEE Globecom '98, pp. 1817-1822.*
4. Lundberg D. " Ad Hoc Protocol Evaluation and Experiences of real world Ad Hoc networking" *Uppsala University Department of Information Technology , technical report 2004-026, June 2004*
5. . Royer Elizabeth M , Perkins Charles E., "Multicast Operation of the Ad-hoc On-demand Distance Vector Routing Protocol", *Proceedings of MobiCom '99, Seattle, WA, August 1999, pp. 207-218.*
6. The Rice University Monarch Project "Wireless Multicast Extensions for ns-2.1b8"
7. Mohapatra, P. , Li J., Gui C. " Multicasting in Ad Hoc Networks", *book chapter, Kluwer Press, 2004,*
8. S.-J. Lee, M. Gerla, and C.-C. Chiang, "On-demand multicast routing protocol" *Proceedings of IEEE WCNC, 1999, pp. 1298- 1302.*
9. Kunz Thomas and Cheng Ed "Multicasting in Ad-Hoc Networks: Comparing MAODV and ODMRP", *Proceedings of the Workshop on Ad hoc Communications, Bonn, Germany, September 2001.*
10. Kunz Thomas, "Reliable Multicasting in MANETs", *Contractor Report, Communications Research Centre, Ottawa, Canada, July 2003.*
11. Hong X.,. Xu K, and Gerla M., "Scalable Routing Protocols for Mobile Ad Hoc Networks" *IEEE Network, July-Aug, 2002, pp. 11-21.*

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