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A Performance Analysis of Multicast Routing Protocols in Manets

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Abstract— A Mobile Ad Hoc Network is a compilation of wireless mobile terminals that are able to dynamically form a temporary network without any centralized administration or rigid infrastructure. MANETs are continuing to attract the attention for their prospective use in several fields like military actions, rescue operations and time critical applications. There are several issues in MANETs such as routing, security. A very important and necessary issue for ad hoc networks is to find and sustain the path for multicasting data. Thus various multicasting routing protocols are designed in ad hoc network such as MAODV, AMRoute, ODMRP, FRRM and ABAM etc. In this paper, the performance of two multicasting protocols for MANETs, notably ODMRP and FRRM is evaluated. These are investigated regarding the different performance aspects such as throughput, packet delivery ratio and energy consumption.

Keywords— Mobile ad hoc network, FRRM, multicasting, ODMRP.

I. INTRODUCTION

Wireless mobile ad hoc network (MANET) is a self-organized network of mobile devices without having any intended Infrastructure to fix those devices to wired networks. Because there is no infrastructure, all important network operations like routing and forwarding must be handled by the mobile nodes, that is each node behaves both as a router and as an end host at the same time. MANETs have many applications in military battlefields, emergency search and rescue operations, firefighting, temporary networks in conferences and etc. MANETs are very flexible and can be established quickly and easily using low cost equipments. Due to limited radio range of wireless nodes, the path between a pair of nodes may consists of many mobile nodes. The goal of a multicast routing protocol is to efficiently disseminate multicast data to a group of multicast members. Generally, there are two models for multicast: "one-to-many" and "many-to-many." In the former case, there is only one sender per group and in the latter there are multiple senders for each group. Several multicast routing protocols has been proposed for wired networks for example DVMRP, PIM etc. There are two essential differences between MANETs and conventional Internet preventing us from using fore mentioned protocols conveniently in MANETs. First, characteristics of wireless communication links are not fixed and predictable due to arbitrary and independent movement of mobile nodes, and signal interference. Second, every mobile node can move arbitrarily causing the network topology changes frequently and unpredictably [1]. In last decade, several efforts have been made to solve multicast routing problems in MANETs. It has several applications such as collaborative participation of participants in a battlefield, a multiplayer game, and a technical conference. Apparently, there are many ways to classified multicast routing protocols. The criteria to classify the multicast routing protocols is routing information gathering method, multicast initiator, multicast topology, reliance on a central node like core, network maintenance and failure management, level of dependency on unicast routing protocol, and stateless multicast routing. Several multicasting protocols have been proposed and designed for ad hoc networks such as MAODV, ODMRP, AMRoute, ABAM, FRRM, CAMP, PUMA etc.

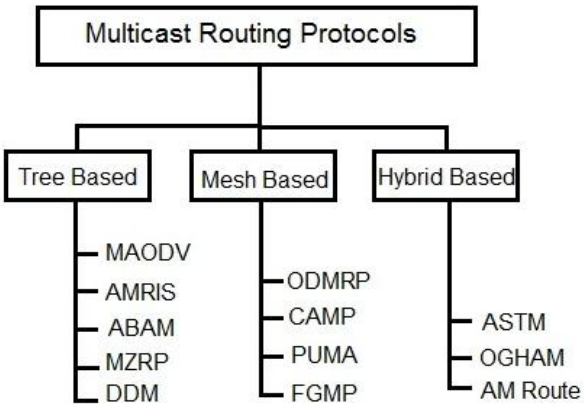

Figure 1. Multicasting protocols [10]

The routing protocols selected for present evaluation study include On Demand Multicast Routing Protocol (ODMRP) and Familiar Route Retrieval for Multicasting (FRRM).

The remaining sections of this paper include related works, protocol descriptions, simulation results and discussion followed by the conclusion.

II. RELATED WORK

Multicast Protocols developed for wired networks, such as Distance Vector Multicast Routing Protocol (DVMRP), Core Based Trees (CBT) [11], Multicast Open Shortest Path First (MOSPF) and Protocol Independent Multicast (PIM) , do not perform very well in ad-hoc network environments because of their continuous dynamic changes. The one major drawback of these multicast protocols is that they possess an inherently volatile tree arrangement. This volatile tree structure obliges this type of networks to constantly update their link status in response to topology changes. Moreover, typical multicast trees generally require a link state or distance vector global routing substructure that can result in large packet loss. Additionally, continuous topology changes caused by the frequent exchange of routing vectors or link state tables can also result in extreme channel and processing overhead, which can notably increase network congestion. As a result, constraints linked to bandwidth resources, power consumption and host mobility makes multicast protocol design typically challenging.

To response these difficulties, several multicast routing protocols have been proposed for use in wireless ad-hoc networks such as MAODV, ODMRP, FRRM, ABAM, AMRoute etc. AODV 's multicast operations was examined by Perkins et al. [1].It is on-demand protocol which offers quick adaptation to dynamic link conditions, low processing and memory overhead. It provides loop free routes for both unicast and multicast. The performance of MAODV, ODMRP, ADMR are investigated by Shurdi et al. [2]. The performance of ODMRP degrades as speed increases, whereas the throughput of ADMR is greater than 80%. For both ODMRP and ADMR, the transmission overhead, control overhead and delay vary according to mobility model. A Mesh-based protocol (ODMRP) is described by Begdillo et al.[3].It is on-demand protocol. In which both route request messages and route reply messages are forwarded by broadcasting. Here stable route selection is described in ODMRP to forward the data. In this proposed scheme, node energy in route selection from source to destination is considered. The group size and mobility speed in control overhead and end to end delay is also discussed to improve the PDR. Hybrid Overlay Multicast Routing Protocol (HOMRP) was proposed by Wang et al.[4] for mobile ad hoc networks. Existing mesh multicast routing protocols in ad hoc networks have the main shortcoming of low packet delivery ratio (PDR) and high control overhead. In order to improve these shortcomings, authors integrate unicast and multicasting tunnels for efficient packet delivery. In HOMRP protocol, it creates multiple local multicast trees. Each pair of parent node as well as child node in a local multicast tree is at a distance of one-hop. It uses multicasting to send multicast packets in local multicast trees. This will provide efficient data forwarding. Moustafa et al. [5] examined a performance of ODMRP, ADMR, SRMP. Source Routing-based multicast protocol (SRMP) is on-demand multicast routing protocol which applies a source routing mechanism and establishes a mesh to attach group members. SRMP provides paths in terms of higher battery life, connectivity strength, and links availability. The ODMRP protocol is on- demand and works in two phases such as route request phase and route reply phase. A performance comparison with ODMRP and ADMR shows that SRMP gives better route lifetime and battery lifetime. An Associatively-based multicast routing protocol was proposed by Toh et al. [6], establishes multicast session on-demand. It has three phases such as multicast tree establishment, multicast tree reconfigurations and multicast tree deletion. The performance of ABAM is compared with ODMRP protocol. Familiar route retrieval for multicasting (FRRM) protocol uses the cache to retrieve the familiar routes. This protocol was proposed by Senthil Kumar et al. [9].ANMAS is a novel multicasting algorithm uses the concept of indirect communication method of ants via pheromone to obtain dynamic topology changes information was proposed by Lee et al. [7].The performance of ANMAS is compared with ODMRP protocol in terms of packet delivery ratio.

Authors' Name	Research Area	Tool used	Simulation Area	Performance metrics	Results
Perkins et al.[8]	**AODV**	**PARSEC**	**1100m*1100m**	**Control overhead**	**AODV is able to obtain high goodput ratio for both unicast and multicast communication.**
Shurdi et al.[2]	**MAODV, ODMRP, ADMR**	**QualNet**	**1000m*1000m**	**Control overhead, Throughput, Packet Delay, Transmission overhead**	**Throughput of ADMR is greater than other two protocols. In ADMR and ODMRP, remaining three parameters vary according to mobility model.**
Begdillo et al. [3]	**ODMRP**	**OPNET**	**1000m*1000m**	**Control overhead, End to end delay**	**Stable route selection in ODMRP can improve stability of route due to energy consumption.**
Moustafa et	**ADMR,**	**NS2**	**1100m*1100m**	**End to end delay,**	**SRMP performs better**

al. [5]	**ODMRP, SRMP**			**Packet delivery ratio, control overhead**	**than other two protocols**
Lee et al. [7]	**ANMAS, ODMRP**	**NS2**	**1300m*1300m**	**Packet delivery ratio**	**ANMAS provides better Packet delivery ratio than ODMRP**
Senthil Kumar et al.[9]	**FRRM,DDM**	**NS2**	**1000m*1000m**	**Packet delivery ration, Delay, Packet Loss, Throughput**	**FRRM provides better performance than DDM in terms of PDR, Delay, Throughput and packet loss**
Toh et al.[6]	**ABAM, ODMRP**	**GlomoSim**	**175m*175m**	**Throughput, Control overhead, End to end delay**	**Throughput of ODMRP is more as compared to ABAM even in high mobility scenarios.But control overhead is large in ODMRP.ABAM incurs better end to end delay and smaller communication overhead than ODMRP.**
Wang et al.[4]	**HOMRP, AMRoute, ODMRP**	**GloMoSim**	**1000m*1000m**	**Packet delivery ratio, Control overhead, End to End delay**	**HOMRP have low control overhead, low end to end delay and high packet delivery ratio as compared to other two protocols.**

III. PROTOCOL DESCRIPTIONS

The following section describes about multicasting protocol ODMRP and FRRM.

On Demand Multicast Routing Protocol (ODMRP): It is a mesh based protocol and uses the concept of forwarding group concept. In other terms only a subset of nodes forwards the multicast packets. In ODMRP, multicast group membership and multicast routes are established and updated by source on demand. When source wants to send packets to multicast group, but there is no route to it. Then it will broadcast JOIN-QUERY control packets to the entire network. These JOIN-QUERY packets periodically broadcast to revive the membership information and update routes. When an immediate node receives the JOIN-QUERY packets, it stores the source-ID and sequence number in its message cache to detect any duplicates. The routing table is updated with upstream node ID (backward learning) from the message which was received for the reverse path back to the source node. If the message is unique and Time-To – Live (TTL) is greater than Zero, it is rebroadcast. When JOIN-QUERY packets reach a multicast receiver, it creates and broadcasts a JOIN-REPLY to its neighbors. When a node receives a JOIN-REPLY, it finds whether the next hop node ID of one the entries matches its own ID or not. If It does, node realizes that it is on the path to the source. The JOIN-REPLY is propagated by each forwarding group member until it reaches the multicast source passing through the shortest path. This process constructs the routes from source to destinations and establishes a mesh of nodes, the forwarding group [3]. The forwarding group is the set of responsible nodes for multicasting data on shortest paths between any member pairs.

Familiar Route Retrieval for Multicasting (FRRM): Route formation and retrieval is based on familiarity factor in the network. Multicast routes are obtained from the routing trees or routing meshes formed. These are formed depending on the node locality, availability of the nodes for communication and routing cost. Familiarity refers to the fact that there is trail of previous memory about a path or any information. Just like how any familiar route can be traced back using partial information. The familiarity of the route or data is retrieved from cache memory if any and then added into the mesh or tree instead of new mesh information process and route establishment process. This means that route discovery message terminate at regions where there already exist routes to the multicasting destinations [9].

IV. SIMULATION RESULTS

We have evaluated the performance of FRRM and ODMRP protocols using simulator NS2.35.The simulation parameters are listed in the table 1.

Parameters	**Value**
Simulation area	**1100m*1100m**
Number of nodes	**50**
Propagation Model	**Two ray ground model**
Antenna Type	**Omni antenna**

Traffic Model	**CBR**
Transmission Range	**250 m**
Basic Routing Protocol	**AODV**
Channel Type	**Wireless phy**

Parameter Evaluation: Performance is evaluated using the throughput, packet delivery ratio, energy consumption metrics.

Throughput: It is the ratio of the number of packets received to the number of packets sent.

Packet Delivery Rate: It is calculated on the basis of number of data packets received per time.

Energy Consumption: It is used to check the energy which is consumed throughout the network.

Figure1 shows the packet delivery ratio of FRRM and ODMRP protocols. Initial PDR of FRRM is less than ODMRP during broadcasting of packets. When FRRM will start multicasting, PDR will start to increase and becomes more than ODMRP.

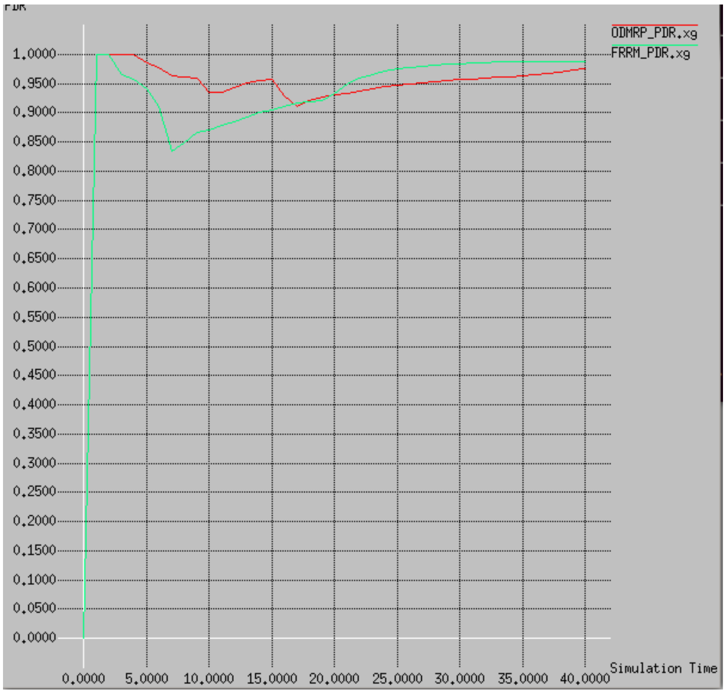

Figure 1. Packet Delivery Ratio

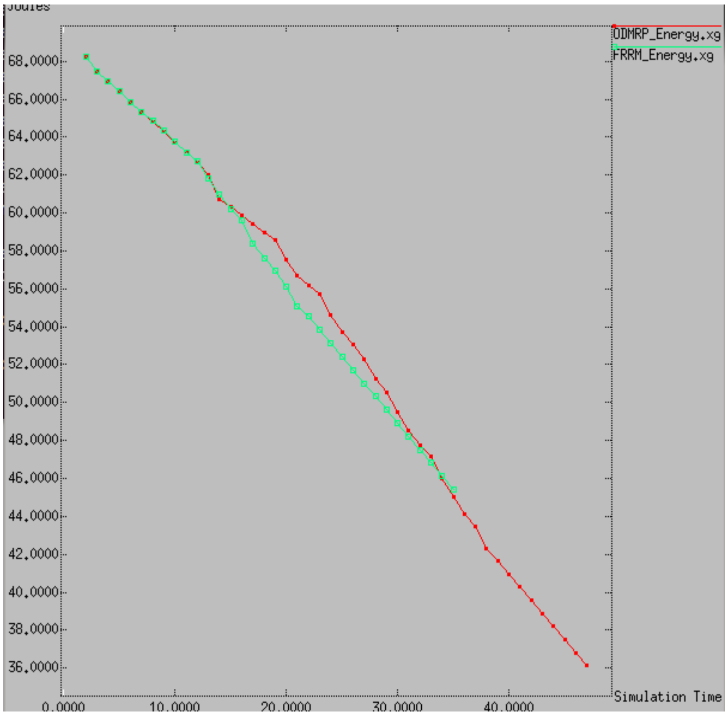

Figure 2. Energy Consumption

Figure 2 shows the energy consumption in FRRM and ODMRP protocols. Initial energy of Network is 70 joules. ODMRP consumes more energy as compared to FRRM. Because in ODMRP, both route request packets and route reply messages are forwarded through broadcasting. But in case of FRRM, Broadcasting is required in initial phase to send route request packets to find the routes to destination. Route reply messages will be unicast. The remaining energy of FRRM is 44 joules and ODMRP's remaining energy is only 36 joules.

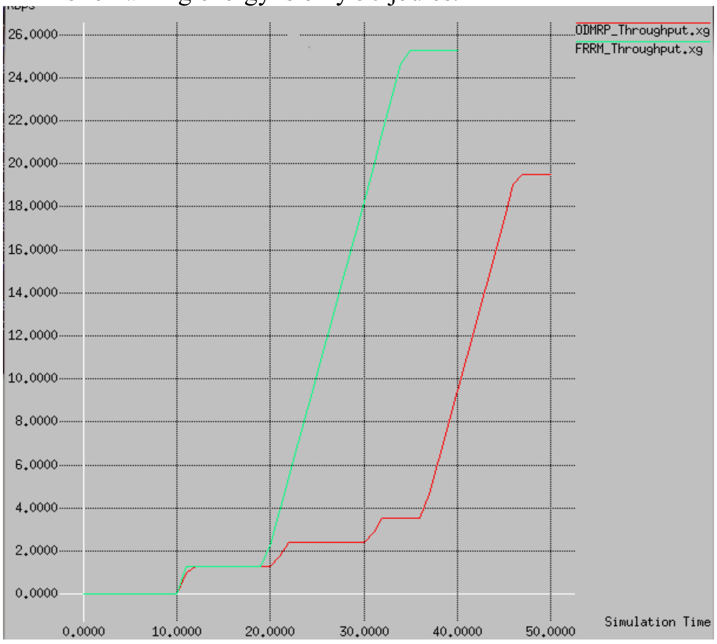

Figure 3. Throughput

Figure 3 shows the comparison of throughput of ODMRP with FRRM. In initial phase of route request, the throughput of both protocols is similar. But in FRRM, after multicasting of packets, throughput starts to increase and become 25 kb/s. But in case of ODMRP, throughput increases to 19.5kb/s.

V. CONCLUSION

The performance of FRRM and ODMRP is evaluated on the basis of throughput, energy consumption and packet delivery ratio. The simulation results show that ODMRP (decrease by 48%) consumes more energy as compared to FRRM (decrease by 37%) technique because in ODMRP, route request and route reply is done through broadcasting. The throughput of FRRM is 25 kb/s, whereas ODMRP has only 19.5kb/s. The Packet delivery ratio of ODMRP is less than PDR of FRRM. By comparing these protocols on the basis of various performance metrics, we have reached to a conclusion that FRRM is better than ODMRP protocol.

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