Comparative Performance Study of ADMR and ODMRP in the context of Mobile Ad Hoc Networks and Wireless Sensor Networks

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***Abstract*—** Mobile Ad Hoc networks (MANET) and Wireless Sensor Networks (WSNs) are two large groups of wireless networks that have well established application ranges. Despite the fact that they address very distinctive groups of devices and have clearly differentiated wireless interfaces, there are certain similarities which push scientists to look for adopting solutions already designed for existing wireless networks to WSNs. An example of this is the case with routing layer protocols. AODV, a unicast routing protocol, developed for MANETs, has proved to be applicable and was accepted by IEEE as the standard for the routing layer in Low Rate – Wireless Personal Area Networks (LR-WPAN). MANET-originated solutions, like multicast protocols, have also been initially designed in the context of IEEE 802.11 MAC layer protocol but have their applicability for WSNs not been studied so far. This paper investigates the feasibility of two popular MANET multicast protocols, ADMR and ODMRP over the IEEE 802.15.4 standard and provides a comprehensive study of the performance of these two protocols with different underlying physical and media access protocols. The protocols have been analyzed with ns-2 network simulator. It appears that even though both protocols are applicable in the selected scenarios, there are specifics in their performance in the context of WSNs which should not be neglected.

***Keywords*—** Wireless LAN, Mobile Ad Hoc Networks, **wireless s**ensor networks, medium access control mechanisms, multicast routing protocols, performance evaluation .

I. Introduction

Wireless sensor networks (WSNs) enhanced with actuator capabilities materialize the interface between people and the environment and establish a context for assisted living and emergency measures, intelligent production and transport, and environmental monitoring. Existing solutions in different OSI layers, designed initially for MANETS, are tested for their applicability in WSNs. An example is the adoption of AODV as a routing protocol for LR-WPAN. The focus of this paper is further investigating such solutions, like ADMR and ODMRP, which are multicast protocols originally designed for MANETs, in the context of WSN application scenarios and performance requirements. An open question is whether the multicast supporting functions of routing protocols developed for MANETS like ADMR and ODMRP can be used for WSNs. Need for such functions has been seen in many WSN based application scenarios like in the health sector where vital patient information is collected by wireless sensors and transmitted to only interested or responsible personnel (doctors, nurses involved with a certain patient [1]), tracking of fire-fighters in burning buildings, data collection with mobile sensors, disaster rescue etc. These scenarios require more general topologies than the event-to-sink model usually accepted for WSNs. When comparing the two protocols the underlying media access mechanism has been taken into consideration and IEEE 802.11 and IEEE 802.15.4 have been covered.

Performance comparison research has been done before for multicast protocols based on IEEE 802.11 MAC layer [13]. In [14] a comparison is presented for IEEE 802.11 and 802.15.4 using AODV at the routing layer. The effect of using an RTC/CTS mechanism on the packet delivery ratio is investigated and it is proved that even in collision free environments the ratio of RTS/CTS packets to the data packets is quite high because they are also used for transmissions of control packets of the network layer. In this work ADMR and ODMRP were selected representing two different groups of multicasting, with two different underlying MAC layer protocols, respectively IEEE 802.11 and 802.15.4. The relationship between network protocols and MAC layer protocols is investigated in diverse scenarios based on the following parameters: packet delivery ratio (PDR), protocol overhead and effects of mobility.

The paper is structured as follows: the next two sections provide a brief background on the specifics of the protocols that are investigated, first for the medium access control and then for the routing layer. In Section IV the simulation model and the methodology use is discussed. In Section V the simulation results are presented followed by conclusions in Section VI, which summarize the most important contributions of the work.

II. Specifics of the IEEE 802.11 and IEEE 802.15.4 MAC Layer Protocols

Both protocols have been standardized by IEEE for the physical (PHY) and media access control (MAC) layer of wireless networks but aiming at different types of wireless devices and network configurations.

The 802.11 addresses wireless networks consisting of laptops or similar class of devices, in either infrastructure or

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infrastructure-less (Ad Hoc) mode. IEEE 802.11 series standards have been widely used as the MAC layer protocol in wireless networks, which specify the arbitration of channel access under contentions among multiple wireless transmission devices. In particular, the IEEE 802.11a/b/g standards are used to specify the MAC mechanism in wireless local area networks (WLANs).

Whereas IEEE 802.11 are interested in features such as Ethernet matching speed, long range (100m), complexity to handle seamless roaming, message forwarding, and data throughput of 2-11Mbps, WPANs are focused on a space around a person or object that typically extends up to 10m in all directions [4]. The focus of WPANs is low-cost, low power, short range and very small size devices. The IEEE 802.15 WG has currently defined three classes of WPANs – 802.15.1 (Bluetooth), 802.15.4 (ZigBee), 802.15.3 (UWB) - which are distinguished by data rate, battery drain and quality of service (QoS). The low rate WPANs (IEEE 802.15.4/LR-WPAN) are intended to serve a set of industrial, residential and medical applications with very low power consumption, cost requirement and with relaxed needs for data rate and QoS which include wireless sensor nodes as well. The low data rate enables the LR-WPAN to consume very little power.

The paper concentrates on the performance comparison of two different multicast routing protocols, originally suggested for Ad Hoc networks, ADMR and ODMRP, using different underlying MAC layer protocols, specifically IEEE 802.11 and IEEE 802.15.4. It is accepted that the protocols designed in accordance with the OSI network model should be independent from the underlying layer. Even though this statement is true in general, it is interesting to investigate if there are any specifics in the performance related to the different mechanisms of accessing the media and formulate the conditions for the applicability of MANET-originated solutions to WSN.

802.11 WLAN technology specifies both the Medium Access Control (MAC) and the Physical Layers (PHY). The 802.11 WLAN PHY layer is responsible for the selection of the correct modulation scheme given the channel conditions and provides the necessary bandwidth. This standard allows the same MAC layer to operate on top of one of several PHY layers. The difference among 802.11/a/b/g/n WLAN standards is mainly on carrier frequencies and on transmission speed.

The MAC layer of IEEE 802.11 decides in a distributed manner on how the offered bandwidth is shared among all stations to provide wireless connectivity. Fairness and maximum bandwidth utilization are a major design goal. Two forms of MAC layer have been defined in IEEE 802.11 specification named, Distributed Coordination Function (DCF) and Point Coordination Function (PCF). The DCF protocol uses Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) and is mandatory, while PCF is defined as an option to support time-bounded delivery of data frames [2]. The DCF protocol combines the carrier sensing with RTS/CTS handshake to reduce interference and cope with the hidden terminal problem.

When a transmitter is ready for transmission of a frame, it checks the status of the channel. If the channel is busy, it waits until the end of the transmission progress. This part makes the DCF a CSMA protocol. When the channel becomes idle, rather than transmitting immediately, the transmitter selects a random backoff interval to reduce the collision probability. This part makes the DCF a collision avoidance protocol. If a data frame is successfully received, the receiver replies with an ACK (Acknowledgement) frame, after a SIFS (Short Inter-Frame Space) time interval. It is only after receiving an ACK frame correctly that the transmitter assumes a successful delivery of the corresponding data frame. On the other hand, if an ACK frame is received in error or no ACK frame is received, this is meaning that a failure of the corresponding data frame transmission occurs. Fig. 1 illustrates frame exchange sequences of the DCF [3].

In multi-hop environments, a frame exchange sequence with an RTS/CTS (Request-to-Send/Clear-to-Send) exchange is used to mitigate the hidden/exposed node problems. Nodes that overhear the duration field of RTS/CTS set their NAV (Network Allocation Vector) in order not to interrupt a data transmission following the RTS/CTS exchange. The SIFS, which is the smallest time interval used between two consecutive frame transmissions, is used within this four-way – RTS-CTS-data-ACK – handshake. Other nodes must wait for an idle medium for at least DIFS (DCF Inter-Frame Space) time interval, and hence are prevented from attempting to use the medium.

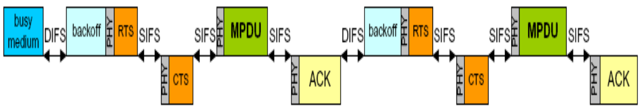

Fig. 1 802.11 DCF.

The IEEE 802.15.4, covering the PHY and MAC layer, is developed for LR-WPANs, providing ad hoc self-organizing functionality among inexpensive fixed, portable and moving devices for applications with relaxed throughput requirements [5].

The PHY layer of the IEEE 802.15.4 provides two services: the PHY data service and PHY management service interfacing to the physical layer management entity (PLME). The PHY data service makes possible the transmission and reception of PHY protocol data units (PPDU) across the physical radio channel. The features of the PHY are activation and deactivation of the radio transceiver, energy detection (ED), link quality indication (LQI), channel selection, clear channel assessment (CCA) and transmitting in addition to receiving packets across the physical medium. The PHY among other functions specifies the receiver sensitivities as -85dBm for 2.4GHz and -92dBm for 868/915MHz. The achievable range is a function of the receiver sensitivity and the transmit power.

The MAC sublayer provides two services: the MAC data service and the MAC management service interfacing to the MAC sublayer management entity (MLME) service access point (SAP). The MAC data service enables the transmission and reception of MAC protocol data units (MPDU) across the PHY data service. Besides the non-beacon-enabled mode, the MAC sublayer is capable of supporting beacon management in the beacon-enabled mode, as well as channel access, GTS management, frame validation, acknowledged frame delivery, association and disassociation. There are three types of data transfer specified: from a device to a coordinator, from a coordinator to a device and between two peer devices. They differ depending on the use of beacons. Details on the communication with the coordinator in beacon-enabled and non-beacon enabled mode are given in Fig. 2 and Fig.3.

The main functions of the IEEE 802.15.4 MAC layer are grouped based on the use or not of beacons. For the non-beacon mode, which is investigated in this work, they include channel access (CA), frame validation and acknowledged frame delivery. The medium access method used is unslotted CSMA-CA. A device maintains two variables for each transmission attempt: NB and BE. NB, is the number of times the CSMA-CA algorithm was required to backoff while attempting the current transmission. BE shows how many backoff periods a device must wait before attempting to assess the channel. Although the receiver of the device is enabled during CA, during that time frame all frames are discarded. The MAC layer creates delay for a random number of complete backoff periods in the range 0 to 2BE−1 and then requests PHY to perform a CCA.

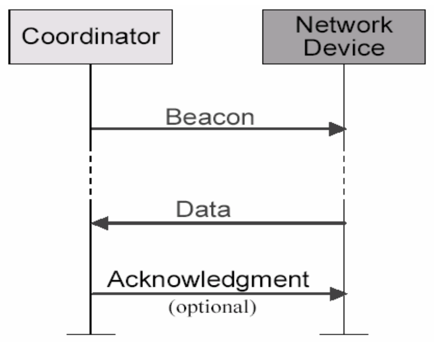

Fig. 2 Communication to a coordinator
In a beacon-enabled network

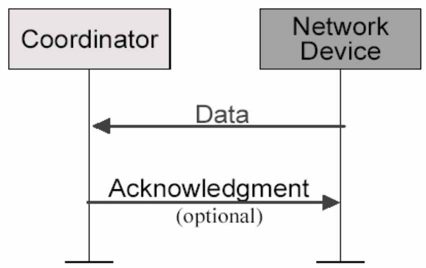

Fig. 3 Communication to a coordinator
In a non beacon-enabled network

III. Ad Hoc Multicast Routing Protocols Functional Overview ath

The current Internet routing system relies primarily on two basic algorithms and their variations. Link-state routing uses the Dijkstra algorithm. Distance-Vector routing (e.g., RIP) and Path-Vector routing (e.g., BGP) use the Bellman-Ford algorithm. The multicast routing was developed to enable one-to-many data delivery in different networks [6]. Multicast is the function of transmitting information to a group of nodes identified by a single destination address. It has been extensively covered for MANETs. Multicast in WSN has come up very recently with the emerging of new application scenarios. Providing multicast can greatly reduce the number of transmitted packets and reduce sensor nodes' energy consumption because radio transmission is the most power-consuming operation.

Unlike the unicast routing protocols, multicast routing protocols set up routing trees, with their leaves being the end users in a specific multicast group. This routing tree can be initiated either by a source or by receiver. For the source initiated routing protocols, flooding is used to find the interested users and routers along the path. Based on that multicast routing tables are established by the following multicast packets. Routers without attached interested users will prune the flooded packets to prevent forwarding of multicast packets. On the other hand, a receiver can also initiate a multicast routing tree by sending a join message to the source and the response from the source will enable the routers on path to establish the multicast routing tables. Multicast routing protocols can be divided into two categories: tree-based and mesh-based according to how packets are routed through the network [7].

Like in "wired" multicast routing, tree-based protocols build a tree over which multicast data is forwarded. Since some of MANETs' key features, like fast deployment, make them attractive for deployment in critical environments, such as military or civilian emergency operations, robustness and reliability are essential. Thus, one of the main challenges faced by multicast routing in MANETs is the need to achieve robustness in the presence of universal mobility and frequent node outages and failures. In a tree-based paradigm data is propagated over a spanning tree connecting all multicast group members while mesh-based ones forward data to all group members over a subset of the nodes. Mesh-based routing builds a mesh over which multicast data is forwarded and thus addresses MANET's robustness requirements through data path redundancy [8].

Our study compares the performance of the On-Demand Multicast Routing Protocol (ODMRP) [9] as the representative of mesh-based protocols against Adaptive Demand Driven Multicast Routing Protocol (ADMR) [10] representing tree-based schemes.

A. On Demand Multicast Routing Protocol

In ODMRP [9], group membership and multicast routes are established and updated by the source on demand. A request phase and a reply phase comprise the protocol like in on-demand unicast routing protocols. A source node that has packets to send broadcasts an advertising packet, JOIN QUERY to the whole network. This periodic transmission refreshes the membership information and updates the route. ODMRP does not maintain route information permanently. It uses a soft state approach in group maintenance. When an intermediate node receives a non-duplicate JOIN QUERY, it stores the upstream node's ID in its "Message Cache" in order to use this information later for transmission in backward direction and rebroadcasts the packet. The upstream node address is inserted or updated as the next node for the source node in its "Routing Table." If the JOIN QUERY packet is not a duplicate and the Time-To-Live value is greater than zero, appropriate fields are updated and it is rebroadcast.

When a node receives a JOIN REPLY packet, it checks if the next node ID of one of the entries matches its own ID. If it matches, the node realizes that it is a part of the forwarding group of nodes. The nodes which are part of the forwarding group broadcast their own JOIN REPLY packets built upon matched entries. Thus the JOIN REPLY is propagated from the receiver to the source along the shortest path. This process forms a mesh of nodes that constitutes the routes between sources and receivers. Multicast senders refresh the membership information and update the routes by sending JOIN REPLY packets periodically.

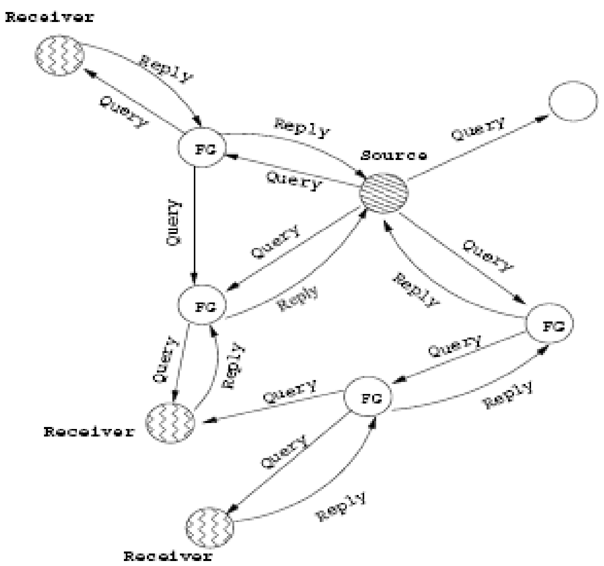

Fig. 4 Mesh formation in ODMRP

After the establishment of the groups and the route construction process, a multicast source can transmit packets to receivers via selected routes and forwarding groups. Periodic control packets are sent only when outgoing data packets are packets are still present.

A node which receives a multicast packet forwards it only if this is a non-duplicate packet. It also sets a flag to show that this multicast group is already in use and not expired. Besides minimizing the traffic overhead, this procedure prohibits sending packets through stale routes.

In ODMRP, no explicit control packets need to be sent to join or leave the group. If a multicast source wants to leave the group, it simply stops sending JOIN REQUEST packets since it does not have any multicast data to send to the group.

There are three types of tables in ODMRP architecture: Member Table, Routing Table and Forwarding Group Table. The Member Table is used for storing the source information. Each entry is designated by "source ID" and "time of last JOIN REQUEST received" pair. If no JOIN REQUEST is received within a refresh period, that entry is removed. The Routing Table is created on demand and is maintained by each node. It is updated when a non-duplicate JOIN REQUEST is received. A cooperating node which performs forwarding, maintains the group information in the Forwarding Group Table.

B. Adaptive Demand Driven Multicasting

ADMR [11] is an on-demand protocol, thus it does not maintain route information regularly. Member nodes that constitute the tree are refreshed as needed and do not send explicit leave messages.

In ADMR, group membership and multicast routes are established and updated by the source on demand. Multicast senders and receivers using ADMR cooperate to establish and maintain forwarding state in the network to allow multicast communication.

The multicast forwarding state for a given multicast group G and sender S in ADMR is conceptually represented as a loosely-structured multicast forwarding tree rooted at S. Each multicast packet is dynamically forwarded from S along the shortest-delay path through the tree to the receiver members of the multicast group.

The forwarding tree consist of receivers, sources and forwarding nodes that they are not receivers for this group but only their duties are packet forwarding along the path. All mentioned nodes constituting the tree are member nodes. Only members of the multicast forwarding tree forward multicast packets, and each node forwards each packet at most once. Duplicate packet suppression is supplied by the protocol by means of created routing tables.

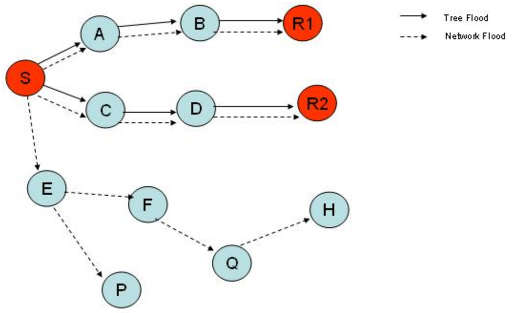

Fig. 5 Network and Tree flood in ADMR

When multicast sources have packets to send, but do not have routing or membership information, they flood an advertisement packet to all nodes in the network, which is known as a network flood. The flood of a packet constrained to the nodes in the multicast forwarding tree is known as a tree flood, and to the more general type of flood of a packet through all nodes as a network flood. (Fig. 5).

This use of flooding within the multicast forwarding tree is similar to the "forwarding group" concept introduced in the ODMRP, except that the forwarding state of ADMR is specific to each sender rather than being shared for the entire group. When a sender using ADMR sends a multicast packet, it floods it within the multicast distribution tree only towards the group's receivers, whereas with ODMRP, the packet also floods back towards any other senders that are not receivers for this group.

The formation of a forwarding tree starts with the flooding of an advertisement packet called SOURCE INFORMATION packet. A source node sends this packet to produce a Sender Table. A Sender Table consists of a "Source ID – S" and "Group ID – G" touple. Each entry is designated by this touple. When a node receives a SOURCE INFORMATION packet, stores the information in its Node Table and the packet ID to differentiate between trees, and rebroadcasts the packet to its neighbors. They in turn forward the packet to their neighbors, thus packet floods the whole network. When this packet reaches a multicast receiver, it is used in the creation of a Membership Table and the broadcasted to the neighbors. At the same time the receiver node creates a reply packet called MULTICAST SOLICITATION. This packet is also sent in a broadcast manner. The source node propagates a new type of packet called UNICAST KEEPALIVE packet. It is sent in a unicast manner from the source to the receiver to reinforce the shortest path. The receiver node upon receiving this UNICAST KEEPALIVE packet sends a RECEIVER JOIN packet. As the UNICAST KEEPALIVE the RECIEVER JOIN packet is sent unicast. The tree formation is illustrated in Fig 6. and Fig. 7.

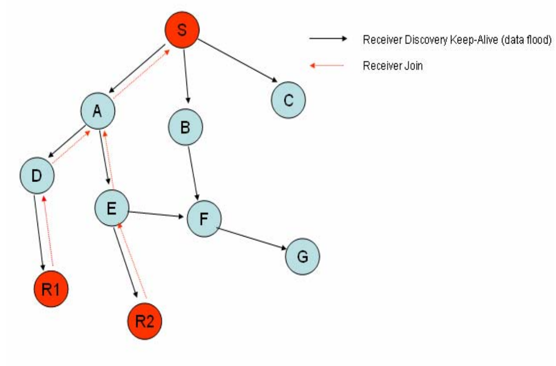

Fig. 6 Multicast State Setup

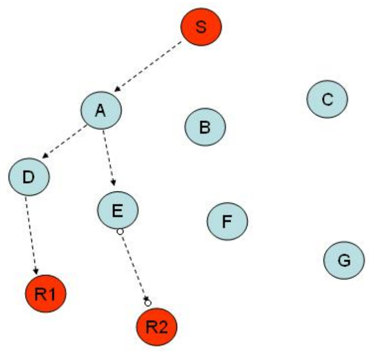

Fig. 7 Concluding tree formation

Each forwarder or receiver for some multicast group detects that it has become disconnected from the multicast forwarding tree when it fails to receive a number of successive expected multicast data (or keepalive) packets (e.g., 3) from S for G. If this situation occurs REPAIR NOTIFICATION, RECONNECT, RECONNECT REPLY packets are used for finding a new route in the network.

IV. Simulation Model and Methodology

Simulation is carried out using ns-2.30 [12]. The simulation model is based on many-to-many communication model. The PDR is studied as a function of the node density, the node mobility and the varying number of senders and receivers in the network. Overhead is evaluated in respect to the network size.

A. Channel and Radio Model

To accurately model the attenuation of radio waves between antennas close to the ground, a model is typically used that attenuates the power of a signal as 1=r2 at short distances (r is the distance between the antennas), and as 1=r4 at longer distances (Fig.8a,b). The crossover point is called the reference distance, and is typically around 100 meters for outdoor low-gain antennas 1.5m above the ground plane operating in the 1–2GHz band [15]. A two ray ground propagation model is used in the experiments. In this model, the shadowing fading factor is not considered. Therefore, for a certain distance, the Pr certain distance, the Pr (power at the receiver side) is a deterministic value:

$$Pr = P_t\, G_t\, G_r\, h_t^2\, h_r^2 \,/\, L\ d^4$$

In the simulations the Pt_ and the thresholds were adjusted to set the transmit range to 25 meters for the IEEE 802.15.4 and 250m for the IEEE 802.11. The CSThresh is set to 1.559e-11W, RXThresh 3.652e-10 for 802.11 and both to 3.07645e-07W for 802.15.4.

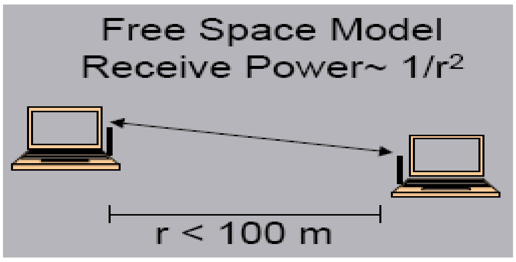

Fig. 8a Propagation models- Free Space Model

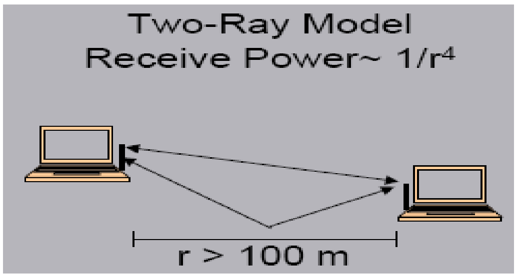

Fig. 8b Propagation models- Two-Ray Model

B. Mobility and Random Way-point Model

The mobility model determines how nodes choose destinations for their movement, the speed at which they move, and the physical paths they take. In the Random Waypoint Mobility (RWP) model, each mobile node begins at a random location and moves independently during the simulation. Each node remains stationary for a specified period that called the pause time and then moves in a straight line to some new randomly chosen location at a randomly chosen speed up to some maximum speed. Once reaching that new location, the node again remains stationary for the pause time, and then chooses a new random location to proceed to at some new randomly chosen speed, and the node continues to repeat this behavior throughout the simulation run. In [16] the authors have proved that this model can produce large amounts of relative node movement and network topology change, and thus provides a good movement model with which to stress ad hoc network routing protocols.

In the current ns-2 distribution, the speed is chosen uniformly randomly from [0,V_max], for every mobile node. In this work two aspects of mobility have been investigated: the effect of node speed on the packet delivery ratio and on the incurred overhead in scenarios with different number of sender S and receiver R nodes.

C. Traffic Pattern

A traffic generator was developed to simulate constant bit rate sources. The packet rate is 1 packet per second in all simulations and the size of data payload is 512 bits. The senders are chosen randomly among nodes in the network. Nodes join the multicast session at the time defined by randomly generated traffic scenario and remain so throughout the simulation.

D. Considered Metrics

The metrics used for the comparison are described in detail below. Some of them were suggested by the IETF MANET WG for routing protocol evaluation.

Packet Delivery Ratio (PDR): Determined as the ratio of the number of data packets actually delivered to the destinations to the number of data packets supposed to be received.

Overhead ratio (OR): Shows the efficiency in terms of channel utilization and is very important especially in sensor networks. It is calculated as:

OR = 1 – (Pdata packets sent / Ptotal packets sent) where P is the number of each type of packets sent by the source node.

V. Simulation Results

A. Node density

In this experiment the effect of node density on the PDR is studied. The number of static nodes varies from 10 to 50 with 1S and 1 or 3R. The results for the different routing protocols with IEEE 802.11 and 802.15.4 are given in Fig.9 and Fig.10 respectively.

It is immediately evident that while the PDR is quite stable for IEEE 802.11 for the whole range of node densities it is not so for the case of IEEE 802.15.4. For densities below 0.005 nodes/m2 the PDR for ODMRP is unacceptably low. ADMR performs much better. This observation comes to support the thesis made in [9] that a large proportion of control packets required by the network layer protocol even when no RTS/CTS packets are used, greatly reduces the throughput. For densities above 0.005 the performance is quite stable and similar to that of IEEE 802.11 for both ADMR and ODMRP.

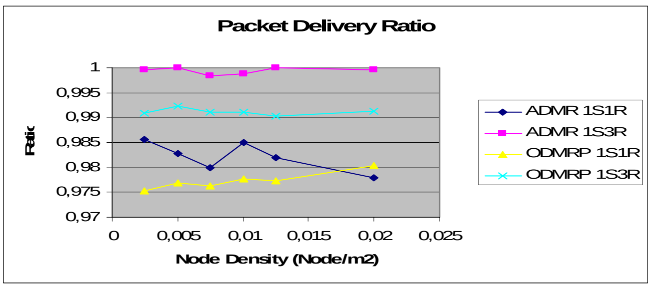

Fig. 9 PDR comparison with varying network density - 802.11

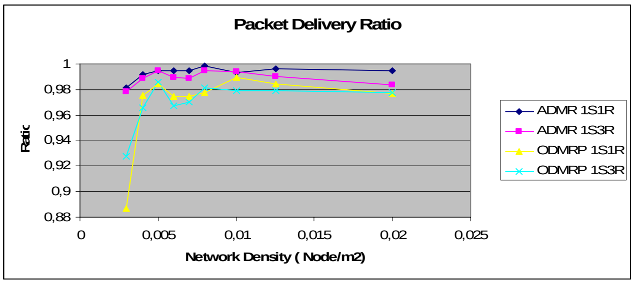

Fig. 10 PDR comparison with varying network density -802.15.4

B. *Varying Number of Senders and Receivers*

The number of nodes in the network is set to 30 and the nodes are static. The number of S is taken from the set {1, 3, 5, 10, 15}. For MANET this is a model of “a class lecture scenario”, while for WSNs (IEEE 802.15.4), a 1S represents “a single node reading scenario”; 15S represent “a video conference scenario” or “a single sink scenario” where readings from 15 nodes are sent to a single sink node. Respectively the case with several receivers represents “a multi-sink scenario”.

It is observed that the performance is much more stable for both network protocols under IEEE 802.11. For wireless sensor networks ODMRP has a varying behavior. It is claimed in [5] that ODMRP performs well in MANETs for greater number of receivers and this is in line with our observations. Unfortunately the same cannot be claimed for WSN. The PDR in the latter is reduced by nearly 10% compared to that in MANETs. ADMR shows a much more consistent performance for both MAC layer protocols. (Fig.11 and Fig.12).

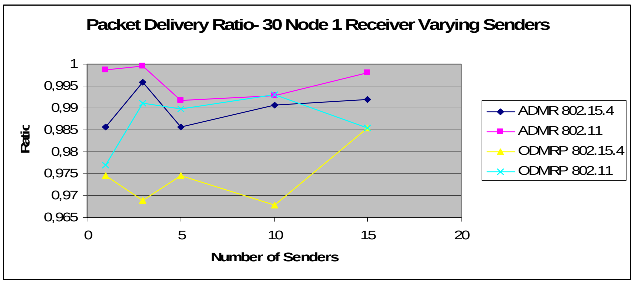

Fig. 11 PDR for a varying number of senders

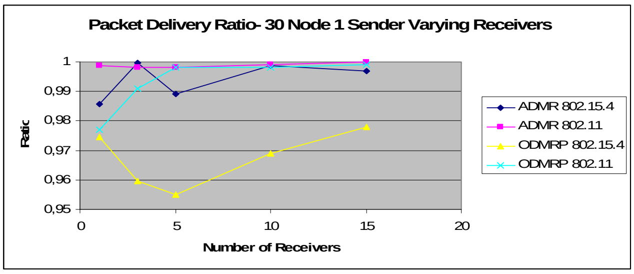

Fig. 12 PDR for a varying number of receivers

C. *Overhead*

The overhead observed is the total overhead incurred at the MAC layer and the routing layer. For the routing layer this includes the overhead of ADMR and ODMRP for setting up and maintaining the multicast tree or forwarding group. As explained above all the control packets used by a specific protocol are considered.

As the simulation results prove ODMRP has an order higher overhead mainly due to periodic flooding of join queries to maintain redundant paths from source to destination. ADMR creates much lower overhead, independent of the network size or the underlying MAC protocol. Another important observation is that while for IEEE 802.11 networks ODMRP’s overhead is varying from 33% to 37% it is much higher for IEEE 802.15.4, reaching 53% (Fig.13, 14).

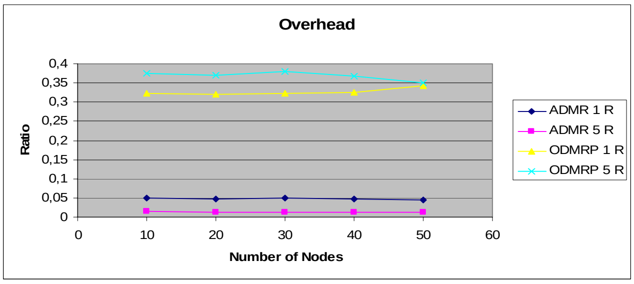

Fig. 13 Overhead as a function of network size–802.15.4

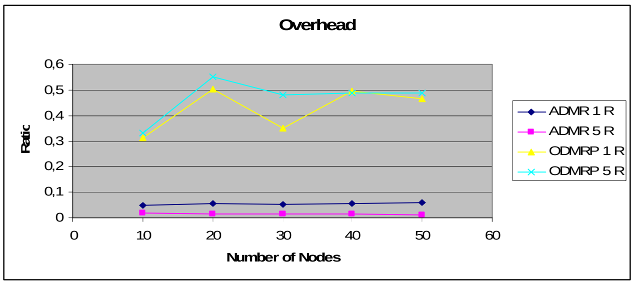

Fig. 14 Overhead as a function of network size–802.11

D. *Impact of Mobility*

For studying the impact of mobility the network size is constant at 30 nodes, the node mobility speed is varied 2, 10, and 15 m/s, and pause time is 0. The impact of mobility is evaluated by means of PDR and OR metrics. To create a suitable model of a sensor network, 1 receiver and a varying number of senders (1, 5 and 15) is selected.

The achieved results (Fig.15 and Fig.16) support the ones in [5] that ODMRP is more efficient in more dynamic environments. This is more evident in WSNs. The PDR achieved using ODMRP is around 93% for 5s at 15m/s while that with ADMR is only around 83%. On the other hand, greatly increasing the number of senders (15) together with their speed reduces the PDR noticeably for both protocols.

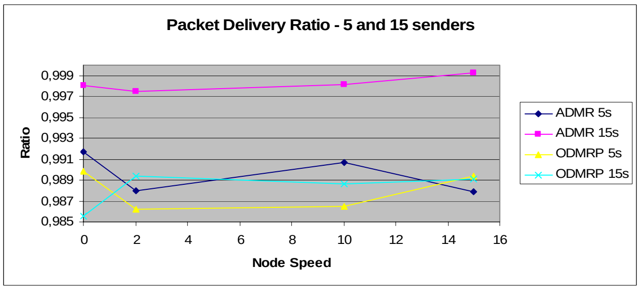

Fig. 15 PDR for a varying number of senders at different speeds – 802.11

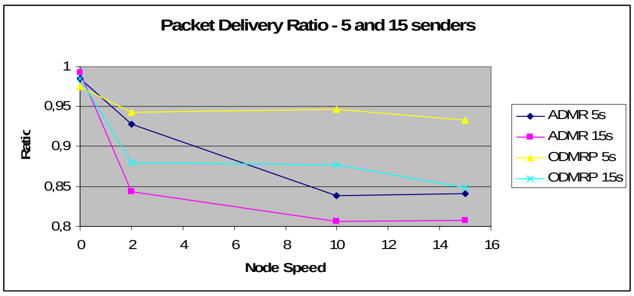

Fig. 16 PDR for a varying number of senders at different speeds – 802.15.4

The total incurred overhead (Fig.17,18) for both IEEE 802.11 and 802.15.4 is little influenced by increasing the node speed. But for ODMRP there is 35% to 40% overhead in Ad Hoc networks while in WSN it is as high as 70%. There is also difference whether we have a large number of senders or a large number of receivers. For 15s-1r at 15 m/s the overhead in ODMRP is round 70% compared to only 45% for 1s-15r at 15m/s.

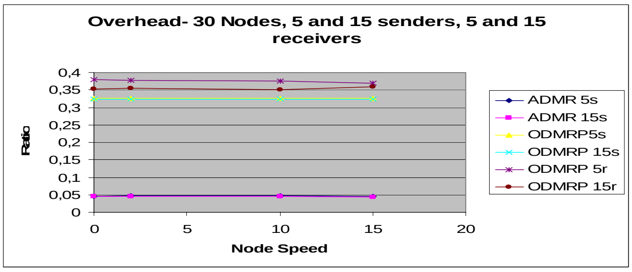

Fig. 17 Overhead for a varying number of senders and receivers at different speeds – 802.11

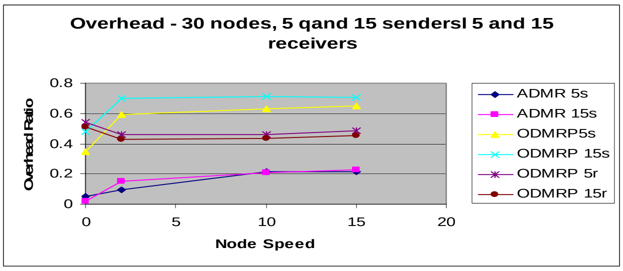

Fig. 18 Overhead for a varying number of senders and receivers at different speeds – 802.15.4

VI. Conclusion

In this paper we have provided a comparative performance study of two multicast protocols, ADMR and ODMRP, over two different underlying MAC layer protocols – the IEEE 802.11 and the IEEE 802.15.4. The impact of node density, changing number of senders and receivers and mobility speed on the PDR has been studied. One of the important conclusions is that while these two routing protocols show quite a stable performance for different scenarios based on IEEE 802.11 the same is not true for the case of IEEE 602.15.4. Even though their operation is independent of the underlying MAC layer, it is observed that both the PDR and the overhead values are quite sensitive to the media access control. This study points out to some specifics when utilizing higher level protocols designed for Ad Hoc networks in WSN. It also supports the thesis that there is a strong relation between the contention mechanism used for media access and the performance of the routing protocol both in terms of packet delivery ratio and overhead, with either static or mobile sensor nodes.

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