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"Re-Pro-active vs Hybrid Protocols": A Simulation study between different routing approaches using traversing in Wireless Ad-hoc network

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Abstract

Ad-hoc networking is a concept in computer communications, which means that users wanting to communicate with each other form a temporary network, without any form of centralized administration. A node roaming in a particular network is a challenging task for any network management and key aspects is how we can deploy its information through routing protocols to the base station or destination. In this paper, we use to analyze the performance and comparison of good combination of Reactive, Proactive and Hybrid routing protocol[5] for CBR in wireless ad-hoc network. We compare four routing protocols: Zone routing protocol (ZRP)[9], which comprises in Hybrid protocol, Optimized link state routing (OLSR), comes in Proactive routing protocol, and ad hoc on-demand distance vector (AODV) and Dynamic MANET on-demand routing protocol (DYMO), which is in Reactive protocol. We simulate the performance of these routing protocols using QualNet Simulator of Scalable Networks.

Key word : Wireless Ad-hoc network, QualNet, routing protocols.

I. Introduction

In the last couple of years, the use of wireless networks has become more and more popular. There exist three types of mobile wireless networks: *infrastructured networks*, *ad-hoc networks* and *hybrid networks* which combine a infrastructured and ad-hoc aspects. An infrastructured network (Figure 1(a)) consists of wireless mobile nodes and one or more bridges, which connect the wireless network to the wired network. These bridges are called *base stations*. A mobile node within the network searches for the nearest base station (e.g. the one with the best signal strength), connects to it and communicates with it.

The important fact is that all communication is taking place between the wireless node and the base station but not between different wireless nodes. While the mobile node is traveling around and all of a sudden gets out of range of the current base station, a *handover* to a new base station will let the mobile node communicate seamlessly with the new base station. In contrary to infrastructured networks[2], an ad-hoc network lacks any infrastructure. There are no base stations, no fixed routers and no centralized administration. All nodes may move randomly and are connecting dynamically to each other. Therefore all nodes are operating as routers and need to be capable to discover and maintain routes to every other node in the network and to propagate packets accordingly. Mobile ad-hoc networks may be used in areas with little or no communication infrastructure: think of emergency searches, rescue operations, or places where people wish to quickly share information, like meetings etc.

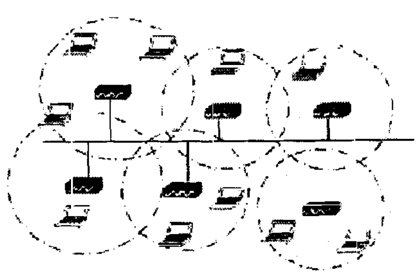
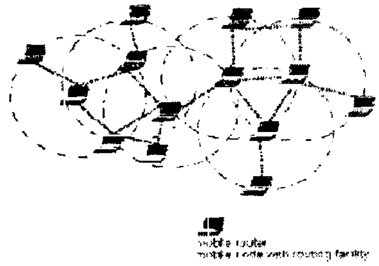


Fig. 1 (a) An infrastructured network with two Base stations.



(b) A mobile Ad-hoc network

A. Manets routing protocols :

MANET research has led to the development of numerous routing algorithms and protocols[2]. Routing protocols perform with differing results, given the various operating conditions of a MANET. Protocol A may be superior to protocol B in a given environment, and protocol B may outperform protocol A in a different environment. Therefore, it is difficult to say one protocol is superior to the other without knowing the network's application. Routing protocols can be classified as either proactive, reactive, or a hybrid of the two.

Each type of network has its strengths and weaknesses, and determination to use one type or the other in a given network depends upon the various conditions and scenarios of that network.

2.1.2.1 *Reactive Routing :*

Reactive routing protocols are on-demand protocols. These protocols do not attempt to maintain correct routing information on all nodes at all times. Routing information is collected only when it is needed, and route determination depends on sending route queries throughout the network. The primary advantage of reactive routing is that the wireless channel is not subject to the routing overhead data for routes that may never be used. While reactive protocols do not have the fixed overhead required by maintaining continuous routing tables, they may have considerable route discovery delay[1,4,5]. Routing information is collected in the route discovery process. The minimum information required by a node to send data is the next hop in the route. If this next hop information is unavailable, broadcasting is performed. In this procedure, the originating node sends a broadcast message requesting the desired route. Nodes that have routing information will respond to the broadcast. The originating node then chooses a route from the responses. In the case the route is not initially known and needs to be determined, there is an initial setup delay.

2.1.2.2 *Proactive Routing :*

In networks utilizing a proactive routing protocol, every node maintains one or more tables representing the entire topology of the network. These tables are updated regularly in order to maintain up-to-date routing information from each node to every other node[16].

To maintain the up-to-date routing information, topology information needs to be exchanged between the nodes on a regular basis, leading to relatively high overhead on the network. One the other hand, routes will always be available on request.

Many proactive protocols stem from conventional link state routing, including the Optimized Link State Routing protocol (OLSR).

2.1.2.3 *Hybrid Routing :*

Hybrid routing protocols are a combination of both proactive and reactive routing. They attempt to take advantage of the strengths of purely proactive and reactive routing, while minimizing the weaknesses of both forms of routing. Because of the routing protocol challenges within MANETs mentioned earlier, purely proactive and reactive routing are inefficient[3]. Hybrid routing provides a way to minimize the inefficiencies of MANET routing.

II. Description of the protocols :

A. AODV :

The Ad Hoc On-Demand Distance Vector routing protocol (AODV) is an improvement of the Destination-Sequenced Distance Vector routing protocol (DSDV). DSDV has its efficiency in creating smaller ad-hoc networks. Since it requires periodic advertisement and global dissemination of connectivity information for correct operation, it leads to frequent system-wide broadcasts. Therefore the size of DSDV ad-hoc networks is strongly limited. When using DSDV, every mobile node also needs to maintain a complete list of routes for each destination within the mobile network. The advantage of AODV is that it tries to minimize the number of required broadcasts. It creates the routes on an on-demand basis, as opposed to maintain a complete list of routes for each destination. Therefore, the authors of AODV classify it as a *pure on-demand route acquisition system*[13-15]. When trying to send a message to a destination node without knowing an active route to it, the sending node will initiate a path discovery process. A route request message (RREQ) is broadcasted to all neighbors, which continue to broadcast the message to their neighbors and so on. The forwarding process is continued until the destination node is reached or until an intermediate node knows a route to the destination that is new enough. To ensure loop-free and most recent route information, every node maintains two counters: *sequence number* and *broadcast_id*.

B. DYMO :

DYMO is a recently proposed on-demand routing protocol. The routing protocols being considered, of which DYMO represents the reactive protocol, are expected to combine the best features from the four current experimental MANET protocols: AODV, Dynamic Source Routing (DSR) and Optimized Link State Routing (OLSR). DYMO is a successor

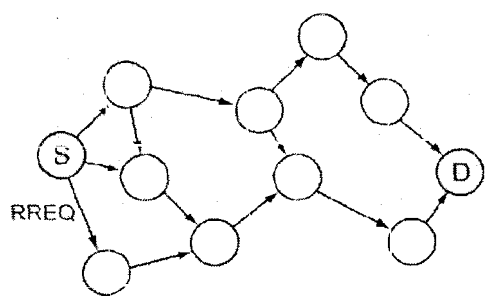
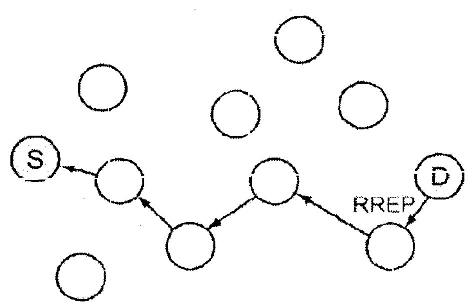


Fig. 2 (a) Source node S initiates the path discovery process.



(b) A RREP packet is sent back to the source.

to AODV. It is a simplified combination of the AODV and DSR routing protocols. It operates similarly to AODV and maintains the basic functionality of route discovery and route maintenance, but does so without added features or extensions. DYMO achieves its goal through simplification. DYMO uses AODV as a basis for its operations, combining the concepts of AODV with Path Accumulation (AODV-PA) and AODVjr. The important thing in DYMO is-

1.Route Discovery (Fig.1)
2.Route Maintenance (Fig. 2)

C. OLSR :

The Optimized Link state Protocol (OLSR) is a proactive link state routing protocol. It uses periodic messages for updating the topology information. OLSR is based on the following mechanisms:

- Neighbor sensing based on periodic exchange of HELLO messages
- Efficient flooding of control traffic using the concept of multipoint relays
- Computation of an optimal route using the shortest- path algorithm.

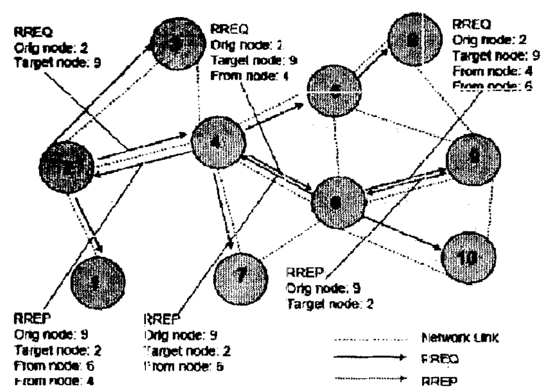


Fig 3. DYMO Route Discovery

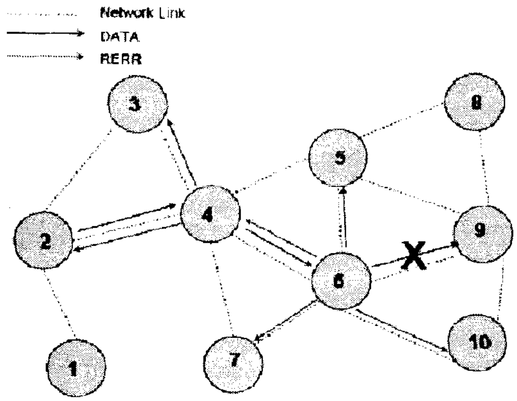


Fig. 4. DUMO RERR Process

C (a) Neighbor sensing :

Neighbor sensing is the detection of changes in the neighborhood of the node. Node **A** is called neighbor of node **B** if the two nodes are directly linked, allowing data transmission in both directions of the link. The node **C** is called a two-hop neighbor of **A**, if node **C** is not neighbor of node and there exists a symmetric link between **A** and **B** and a symmetric link between **B** and **C**. For neighbor sensing the node periodically emits HELLO messages. The HELLO message consists of the emitting node's address, the list of his neighbors, including the link status (e.g. asymmetric or symmetric). A node thereby informs its neighbors of which neighbors it has confirmed communication. By receiving a HELLO message, a node generates information describing its two-hop neighborhood and the quality of the links in its neighborhood. Each node maintains this information set which is valid for a limited time only and has to be refreshed to keep it valid. They also used flooding technique to allow spreading information to each node without unnecessary, duplicate retransmissions.

1. Pure Flooding or Pure Flooding.
2. Multipoint Relays (MPR) Flooding

D. ZRP :

In a mobile ad-hoc network, it can be assumed that most of the communication takes place between nodes close to each other. The Zone Routing Protocol (ZRP) described in[8], takes advantage of this fact and divides the entire network into overlapping zones of variable size. It uses proactive protocols for finding zone neighbors (instantly sending *hello* messages) as well as reactive protocols for routing purposes between different zones (a route is only established if needed). Each node may define its own zone size, whereby the zone size is defined as number of hops to the zone

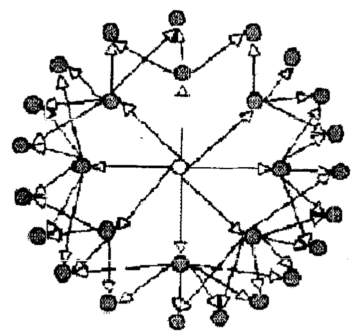
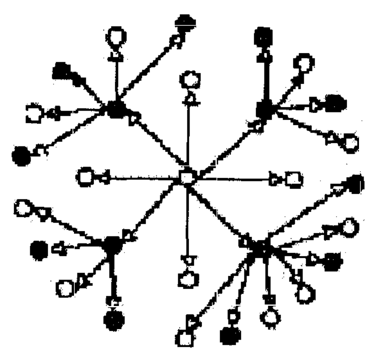


Fig. 5 (a) Pure flooding



(b) MPR Flooding

perimeter. For instance, the zone size may depend on signal strength, available power, reliability of different nodes etc. While ZRP is not a very distinct protocol, it provides a framework for other protocols[9].

The routing processes inside a zone are performed by the *Intrazone Routing Protocol* (IARP). This protocol is responsible for determine the routes to the peripheral nodes of a zone. It is generally a proactive protocol. Other type of protocol is used for the communication between different zones. It is called *Interzone Routing Protocol* (IERP) and is only responsible for routing between peripheral zones. A third protocol, the *Bordercast Resolution Protocol* (BRP) is used to optimize the routing process between perimeter nodes. Thus, it is not necessary to flood all peripheral nodes, what makes queries become more efficient.

III. *Simulation model*[10-12] :

To compare the routing protocols, a discrete event simulator developed by Scalable

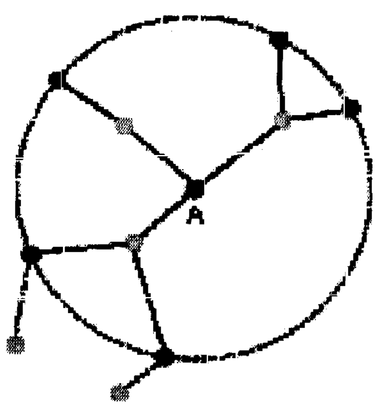


Fig. 6. ZRP - Routing Zone of Node A, $p = 2$

Networks- QualNet was used. It is extremely scalable, accommodating high fidelity models of networks of 10's of thousands of nodes. QualNet makes good use of computational resources and models large-scale networks with heavy traffic and mobility, in reasonable simulation times. We focused on four performance measurements to compare the four routing protocols: mean end-to-end delay, packet delivery ratio, and throughput and energy consumption as measured by the number of control packets generated for routing. Performance metrics used for this works are as follows.

(i) Throughput is the measure of the number of packets successfully transmitted to their final destination per unit time. It is the ratio between the numbers of sent packets vs. received packets.

(ii) Average End-to-End delay is the average time from the beginning of a packet transmission (including route acquisition delay) at a source node until packet delivery to a destination.

(iii) Energy Consumption, is used to rate the energy used by the routing protocol, how much energy have consumed by the routing.

(iv) Packet delivery ratio, the packet delivery ratio in this simulation is defined as the ratio between the number of packets sent by constant bit rate sources (CBR, "application layer") and the number of received packets by the CBR sink at destination.

The control parameters we used in our simulation experiments were *number of sensing nodes and transmission interval of sensing nodes* with respect of four routing protocols.

In the first simulation[17-19], the total numbers of sensing nodes have varied from 10 nodes to 50 nodes with a step size of 10 nodes. Other parameters such as transmission interval of sensing nodes (1 Sec) and outgoing transmission of every node remain constant. In second simulation, the transmission interval of sensing nodes varied from 5Sec to 25Sec with a step size of 5Sec, and the no of sensing nodes have constant for 20 nodes. In the overall simulation any aware node have detect the roaming object and transmit its information to its neighbors sensing nodes to reach upto base station. The network terrain size was fixed for 1,500 *1,500 meters. The simulation time was 120 seconds for all the experiments.

IV. Simulation result and Observation

Topics to Refer	No. of sensing Nodes	Routing Protocols	Transmi-ssion Interval
IV.1	Will Change	Constant	Constant
IV.2	Constant	Constant	Will Change

In this section, we present our simulation efforts to evaluate and observations that compare the performance of the protocols that we described previously in Section 2.

Effects of Varying Number of Nodes :

In the first simulation IV.1, the total numbers of sensing nodes have varied from 10 nodes to 50 nodes with a step size of 10 nodes. Other parameters such as transmission interval of sensing nodes (1 Sec) and outgoing transmission of every node remain constant.

Effects of Varying Transmission interval :

In IV.2, the transmission interval of sensing nodes varied from 5Sec to 25Sec with a step size of 5Sec, and the no of sensing nodes have constant for 20 nodes. Simulation time for all three experiment remain constant with value equal to ~180 seconds. In the overall simulation any aware node have detect the roaming object and broadcast its information to its neighbors sensing nodes.

Figure 7. Various Performance Parameter V/s No. of Nodes

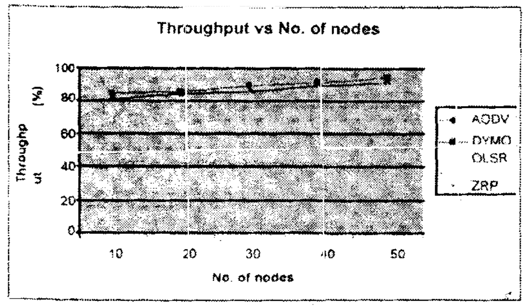


Fig. 7 (a) Throughput vs. No. of nodes

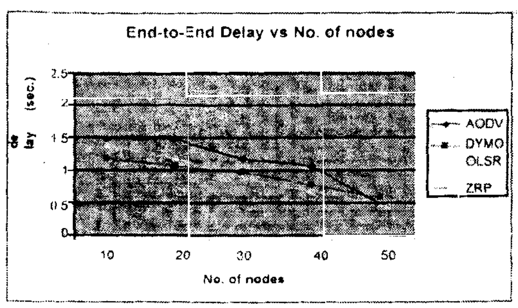


Fig. 7 (b) Effects of End-to-End delay (sec.) on nodes variation.

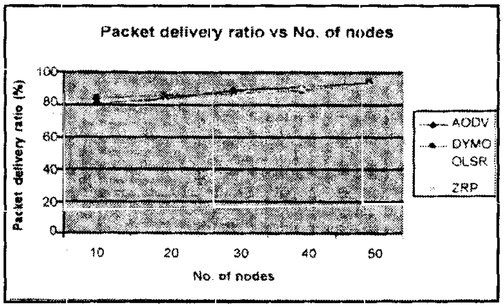


Fig. 7 (c) Effects of Packet delivery ratio as compared to node variation.

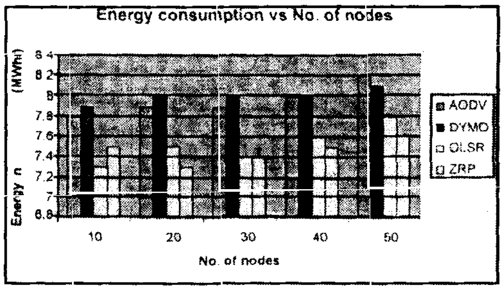


Fig. 7 (d) Effects of Energy consumption as compared to variable number of nodes

Figure 8. Various Performance parameters versus Transmission interval (sec.)

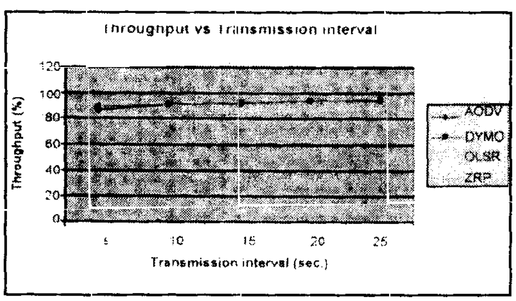


Fig. 8 (a) Effects of Throughput as variation in transmission time of nodes

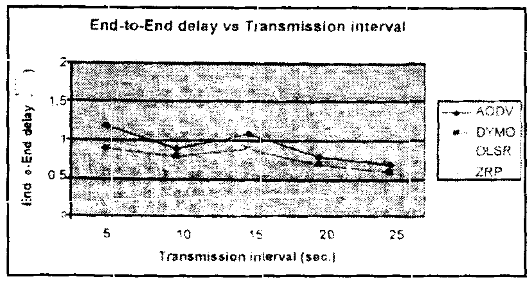


Fig. 8 (b) Average End-to-End delay as compared to Transmission time

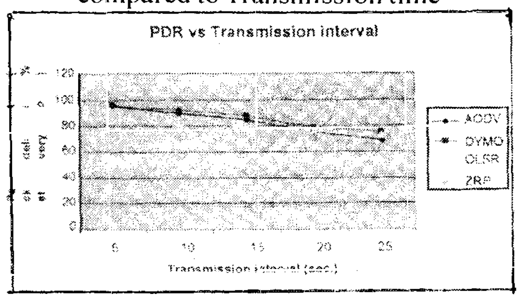


Fig. 8 (c) Effects of Packet delivery ratio as variation in Transmission interval of sensing nodes

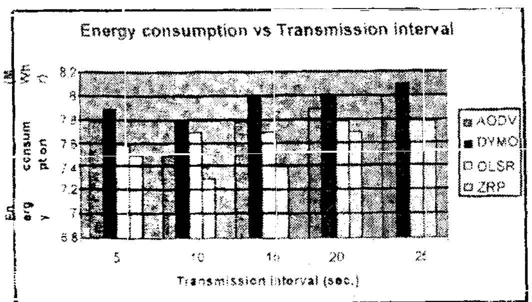


Fig. 8 (d) Effects of Energy consumption as variation in Transmission interval of time

V. Conclusion

In this paper, a performance comparison of four different mobile ad-hoc routing protocols (AODV, DYMO, OLSR and ZRP) was presented as a function of network area size and transmission interval between nodes. Different kinds of protocols are included in this comparison, as we have on-demand (AODV, DYMO vs. hybrid routing (ZRP), vs. Proactive routing (OLSR). In the last few years, there were several performance examinations of such routing protocols, although the performance was almost always evaluated as a function of mobility rate and speed without considering the network size. Scalability is a very important factor for mobile ad-hoc network protocols, as it determines if a protocol will function or fail when the number of mobile users increases. However, there are still very few papers published in this subject area. We assume this might be due to the huge amount of system resources and processing power such a large scale simulation requires. We used Qual-Net simulator, which is commercial and said to be faster than *ns-2* for instance.

However, the simulation speed was still slow and we were only able to perform a single run per scenario in the context of this project.

Therefore, those results should be validated through multiple, additional simulation runs in a future work. Also, different initial node position patterns, more sources, additional metrics (such as path length difference from shortest) could be used.

As a result of our studies, it can be said that ZRP performs very poor in larger networks, as it shows extreme high delays and delivers less than 30% of all packets in a network of 50 nodes. The performance of AODV and DYMO was very good in all network sizes, even though the routing overhead is higher than in OLSR. OLSR is even better than ZRP up to 40 nodes in terms of delivery ratio and routing overhead, but the delivery ratio then decreases to 70 percent. It must be added that the comparison between OLSR and the other protocols is not so fair, as OLSR additionally uses geographic information. A comparison of OLSR with those protocols would be more convenient. Unfortunately, we cannot take a conclusion for ZRP due to the missing IERP packets. Those results will need to be validated in a future experiment.

Future scope :

The results of the assessment of the four protocols indicate that there is scope for improvement in reactive protocols, proactive protocols and hybrid protocols, particularly DYMO and OLSR Inria. The observations from simulation results have revealed that DYMO performs well in large dense networks, but requires increased overhead during changes of transmission interval. We can also work on verification of the mobility model and the propagation model. We work on source node traversing and then come on routing protocol, after choose particular node and broadcast its information throughout the network. So, we can also provide overcome sudden break down of any routing protocol and checks its visibility and scalability. Also, the protocols discussed do not address security issues; it would be interesting to observe the effects of security additions to the performance of these protocols. The simulation study can be extended to any future MANET routing protocols to facilitate comparison of the new protocol to the existing ones investigated in this study.

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