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Performance Analysis of Power Aware Routing Protocols in Mobile Ad-Hoc Network (MANET)

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ABSTRACT

Infrastructure-less and self-configure mobile networks are identified as Mobile Ad Hoc Networks (MANET). A routing protocol will establish routes between mobile nodes to enable communication within the network. Routing protocols for MANETs could be classified depending on the application and network architecture. This paper presents different energy efficient routing protocols for Mobile Ad-Hoc networks and discusses about the conventional protocols.

Keywords: Self-Configure, infrastructure-less, MANET, Energy Efficient Routing.

1. INTRODUCTION

A Mobile Ad Hoc Network is a collection of Self-Configure and Self –Organized mobile nodes that dynamically form the network without any existing fixed infrastructure. One of the typical features of MANET is each node must be able to act as a router as well as node, to find out the optimal path to forward a packet. As nodes may be mobile, entering and leaving the network frequently, the topology of the network will change continuously. MANETs provide an emerging technology for civilian and military purpose. One of the important research areas in MANET is establishing and maintaining the ad hoc network through the use of routing protocols [1].

Objectives of MANET Routing Protocols

- To maximize network throughput.
- To maximize network lifetime.
- To minimize delay.

The network throughput is commonly measured by packet delivery ratio while the most important contribution to energy consumption is measured by routing overhead which is the number or size of routing control packets. The one of the most important goals of MANET routing protocol is to maximize energy efficiency, since nodes in MANET rest on limited energy resources. Devices used in the ad hoc wireless networks in most cases require portability and therefore they also have size and weight as constraints along with the restrictions on the power source. Increasing the battery power may make the nodes as big size and less portable. The energy efficiency remains an important design thought for these networks [2].

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2. TYPES OF ROUTING PROTOCOL

MANET routing protocols classified into three major categories- Table Driven (Proactive), on demand (Reactive) and Hybrid (both Proactive and Reactive).

A. Table Driven (Proactive) Routing Protocols

In this type, protocol maintains fresh lists of destinations and their routes by periodically broadcasting routing tables throughout the entire network. Proactive protocols continuously learn the topology of the network by swapping topological information among the network nodes. It maintains the unicast routes between all pair of nodes without seeing of whether all optimal routes are actually used or not.

Samples of Proactive algorithms are:

- OLSR (Optimized Link State Routing Protocol) Optimized Link State Routing Protocol RFC 3626.
- DSDV(Destination Sequence Distance Vector)

B On Demand (Reactive) Routing Protocols

Reactive (On Demand) protocols, finds a route on request by flooding query in the network with Route Request packets (RREQ). The reactive routing protocols are based on some sort of query-reply dialog. The main idea is to find a route between a source and destination whenever that route is needed. Discovery Mechanism discovering the route on demand avoids the cost of maintaining routes that all are not being used and also controls the traffic of the network since it doesn't send unnecessary control messages which significantly generate a large difference between proactive (Table Driven) and reactive (On Demand) protocols. Time delay in reactive protocols is greater comparative to proactive types routes are calculated when it is required.

Samples of on-demand algorithms are:

- Ad hoc On-demand Distance Vector(AODV) (RFC 3561)
- Dynamic Source Routing (DSR) (RFC 4728)
- Power-Aware DSR-based

C. Hybrid Routing Protocols

Hybrid routing protocol incorporates the advantages of proactive and reactive routing. Initially established with some proactively searched routes and then works the demand from additionally triggered nodes through reactive flooding. The selection of one or the other method requires predetermination for typical cases.

Samples of hybrid algorithms are:

- ZRP (Zone Routing Protocol) ZRP uses IARP as proactive and IERP as reactive component.

Power Model

A wireless network interface can be in one of the following four positions: Transmit, Receive, Idle or Sleep. Each level represents a different level of energy consumption.

Transmit

A node is transmitting a frame with some transmission power.

Receive

A node is receiving a frame with reception power. That energy is consumed even if the frame is discarded by the node because it was intended for another destination, or it was not correctly decoded.

Idle (listening)

Even when no messages are being transmitted over the medium, the nodes stay idle and keep listening the medium.

Sleep

When the radio is turned off and the node is not capable of detecting signals, no communication is possible. The station uses the power that is largely smaller than any other power.

3. POWER AWARE METRICS

The majority of energy efficient routing protocols for MANET try to decrease energy consumption by means of energy efficient routing metric, used in routing table calculation instead of the minimum-hop count metric there are four possibilities to save power from the devices:

1. Minimal Energy Consumption per Packet
2. Maximize Network Connectivity
3. Minimum Variance in Node Power Levels
4. Minimize Maximum Node Cost

Power Aware Routing

The aim of power (energy)-aware routing protocols is to reduce energy consumption in transmission of packets between source and a destination, to avoid routing of packets through nodes with low residual energy, to optimize flooding of routing information over the network and to avoid interference and medium collisions. A single node failure in sensor networks is usually unimportant because it does not lead to a loss of sensing and communication coverage whereas ad-hoc networks are oriented towards private communication and the loss of connectivity to any node is significant.[3]

4. RELATED WORK

4.1 Power Aware Routing

The major goal of power (energy)-aware routing protocols is to reduce energy utilization in communication of packets between sender and a receiver, to avoid routing of packets over nodes with low residual energy, to improve flooding of routing information over the network and to escape interference and medium collisions. A single node failure in sensor networks is commonly unimportant because it does not lead to a loss of identifying and communication coverage whereas Mobile ad-hoc networks are concerned with personal communication and the loss of connectivity to any node is significant.

4.2 Proactive Energy Efficient Routing

A. Destination-Sequenced Distance Vector (DSDV)

Destination-Sequenced-Distance-Vector Routing (DSDV) is a table-driven or proactive routing scheme for mobile ad hoc mobile networks based on the Bellman–Ford algorithm. It avoided the shortcomings

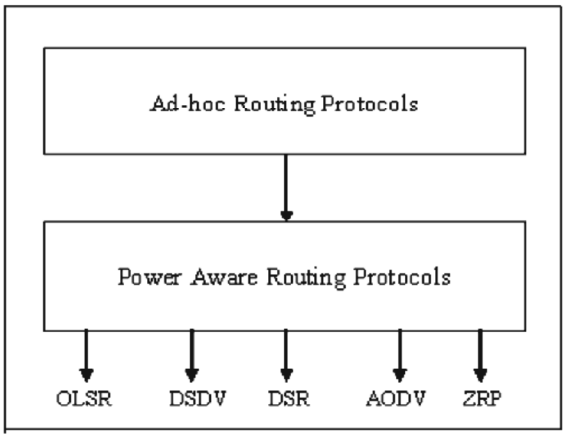

Figure 1: Energy Efficient Routing Protocol.

(loops, count to infinity problem) of contemporary distance vector protocol. In DSDV every node retains a routing table. This routing table holds all available receivers, the next intermediate node to reach to destination, and the number of hops between it. Whenever the network has changes, it communicates the routing updates to the other nodes. Sequence number is used to eliminate loop problems. [4] Keeping the simplicity of distance vector protocol it guarantees loop freeness it reacts directly on topology changes. Since the route for destination is always available at the routing table of each node so there is no delay caused by route discovery. But broadcasting of routing updates may reason for high traffic load between the nodes if the densities of the nodes are high. So this protocol is best suited if the density of the ad-hoc network is less. However if the mobility of the node is too high broadcasting updates may cause time delay.

B. OLSR (Optimized Link State Routing Protocol)

Optimized Link State Routing OLSR includes two optimizations above the conventional link state routing in mobile ad hoc networks. Each node picks a set of neighbor nodes called multi-point relays (MPRs). routing table of each and every node so there is no latency caused its Multipoint Relay Selector set .Further, the link state updates are diffused all over the network only using these MPRs thus considerably sinking the number of retransmissions. The protocol chooses bi-directional links for routing.[4]

EE-OLSR (Energy Efficient OLSR Routing Protocol) With EE-OLS (Energy-Efficient OLSR) is a routing protocol obtained by modifying OLSR in order to expand its energy behavior, without loss of performance. We have two mechanisms for this protocol.

(i) *EA-Willingness Setting Mechanism:* The Energy Aware Willingness Setting is a Technique to encompass energetic thoughts in MPR selection. The OLSR specification has a flexible, the “willingness” of a node, representing the availability of node to act as a MPR for its neighbors. Normally, each node declares a default willingness value. In EE-OLSR, each node, computing its own energetic status, and can state an suitable willingness. The decision to base the willingness selection is on both metrics the battery capacity and the predicted lifetime of a node. The experiential used to associate a willingness (“low” ,”default” or “high”) to a pair (lifetime ,battery)[4].

(ii) *Overhearing Exclusion:* Another mechanism that permits energy saving in OLSR protocol is the Overhearing Exclusion. Turning off the device when a unicast message exchange occurs in our neighborhood, can save a large amount of energy. This can be achieved using the signaling techniques of the lower layers and do not affect the protocol performance. In fact, OLSR does not yield any advantage from unicast network information directed to other nodes. After the MPR selection it is important to select the next hop for data packet forwarding (between the MPR neighbors set).

4.3 Reactive Energy Efficient Routing

C. DSR (Dynamic Source Routing Protocol)

DSR is a loop-free, source based, on demand routing protocol. It is source-initiated rather than hop-by-hop. This is particularly planned for use in multi hop wireless ad hoc networks of mobile nodes. Fundamentally, DSR protocol does not want any existing network infrastructure or administration and this allows the network to be entirely self-organizing and self-configuring. This protocol has two essential parts of route discovery and route maintenance. Every node keeps a cache to store recently discovered paths.[4],[10]

Energy Dependent DSR

EDDSR is Energy Dependent DSR algorithm which supports node from sharp and sudden drop of battery power. EDDSR gives better power utilization compare to LEAR (least energy aware routing) then MDR (minimum drain rate). EDDSR escapes use of node with less power supply and remaining energy information of node is suitable in discovery of route. Residual battery power of each node is calculated by itself and if it is above the exact threshold value then node can contribute in routing activities otherwise node delays the broadcasting again of route request message by a time period which is inversely proportional to its defined lifetime. EDDSR has additional advantage over MDR because it can use route cache used by DSR.[6]

D. AODV (Ad hoc on Demand Distance Vector Protocol)

Ad hoc On Demand Distance Vector AODV is a difference of Destination-Sequenced Distance-Vector (DSDV) routing protocol which is jointly based on DSDV and DSR. It aims to decrease the necessity of system-wide broadcasts to the better extent. It does not maintain routes from every node to each and every other node in the network rather they are discovered as and when needed and are maintained only as long as they are required. The key steps used by AODV for formation of unicast routes are used Route discovery and Route maintenance.

Energy-Aware Algorithm for AODV in Ad Hoc Networks

This is a new energy optimized algorithm that can be applied to current ad hoc routing protocols such as AODV. A cost function has been deduced based on both the propagation power loss and node battery capacity information and routes are optimized based on the cost functions of links and nodes. In particular, a low-battery alert mechanism is introduced to improve the routing update behavior, preventing overuse of critical nodes. Network throughput is not affected much, which is a trade-off issue with the low-battery alert level. The energy consumption is balanced among the network plus the limited battery powers are utilized efficiently.

Power Aware AODV (PA-AODV) Protocol

PAAODV protocol is an enhancement of AODV [13] routing protocol, which implements power control information during route discovery.

PAAODV incorporates two mechanisms.

(i) Multiple Power Level Route Discovery

(ii) Link-By-Link Power Control.

During route discovery, route request (RREQ) packets are used to discovery a route that is power effective and route reply packets are used for link-by-link power transmit control. PAAODV employs

numerous power levels when its establish route discovery. The nodes attempt to find a route to the destination initially with low power levels. If it does not succeed, then the power level is increased. It continues until route discovery succeeds. Two power levels are used, i.e. one low and one high, are used [6].

Hybrid Routing Energy Efficient Routing Protocol

E. Zone Routing Protocol (ZRP)

ZRP is a hybrid protocol taking advantage of a proactive routing strategy inside a node's local neighborhood and a reactive routing protocol for communication between the neighborhoods. Each node defines a zone about itself and the zone radius is the number of hops to the perimeter of the zone. The reactive overall search is done proficiently by querying only a selected set of nodes in the network. The number of nodes queried by the calculation of [r_zone / r_network]*2 of the number of nodes queried using a network wide flooding process. Unless the zone radius is wisely chosen, a node can be in multiple zones and zones overlap. As a result, the efficiency in route discovery reduces. Also, in the presence of node mobility, the zone radius may fluctuate rapidly and also affect the functionality of nodes inside and at the periphery of the zone. The two techniques of intra zone routings.

Multiple Power Level Route Discovery ng protocol (IARP) used within a zone is rather a family of limited-depth table-driven proactive routing protocols. Similarly, the Inter zone routing protocol (IERP) is a family of reactive routing protocols which could provide enhanced route discovery and maintenance services using the native connectivity information delivered by IARP. Thus, we do not classify ZRP into neither of the two categories and view it as a outline for the proactive and reactive routing protocols.

Optimizing Power-Aware Routing using Zone Routing Protocol in MANET

The lifetime of routing path differ with the power control method. A routing model Improving Power-Aware Routing using Zone Routing Protocol by PARO (Power-Aware Routing Optimization) and ZRP (Zone Routing Protocol) has been developed for effective power control and transmission. This routing algorithm tries to minimize the power consumed in communicating a packet from the lifetime of the network by escaping nodes that have a shorter lifetime remaining [13].

Table 1
Comparison Between Different Routing Protocols

Protocol Property	*DSDV*	*DSR*	*AODV*	*ZRP*
Loop Free	Yes	Yes	Yes	Yes
Multicast Routes	No	Yes	No	No
Distributed	Yes	Yes	Yes	Yes
Unidirectional Link Support	No	Yes	No	No
Multicast	No	No	Yes	Yes
Periodic Broadcast	Yes	No	Yes	Yes
QoS Support	No	No	No	No
Routes Maintained in	Route Table	Route Table	Route Table	Route Table
Route Cache/Table Timer	Yes	No	Yes	Yes
Reactive	No	Yes	Yes	Yes

5. CONCLUSION

In this Paper we have discussed about various protocols and their alteration which includes energy efficiency with the importance of energy efficient routing protocols. According to this paper there is not a single protocol which can give the best performance in Mobile ad-hoc network. Performance of the routing protocol varies according to the variation in the network parameters. DSR best in throughput, AODV better in high mobility area, FSR provide low end to end delay, and ZRP provides less jitter. Mobility of the node greatly affects the performance of different protocols but energy of the node is our prime concern.

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