Energy Efficient Routing Protocols for MANETs: A Survey

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ABSTRACT

MANET (Mobile Ad hoc Network) is a type of ad hoc network that can change location and configure itself arbitrarily. MANET is a wireless infrastructure less network environment. The nodes or devices are moves independently. There is a need of routing protocol which is not only focus shortest path but also saving energy. Energy Efficient Routing is a main issue in MANET and Energy based papers proposed in the recent years. This paper is a survey on energy efficient routing protocols for MANET.

Keywords-MANETs, Energy Efficiency Routing, Protocols.

I. INTRODUCTION

Mobile ad-hoc networks (MANETs) that contains wireless mobile nodes that can independently and dynamically self-organize into arbitrary and temporary ad hoc network topologies. Mobile Ad-hoc Network (MANET) is a collection of communication devices or nodes that wish to communicate with infrastructure less networks [1]. In MANET, Routing is main problem to route the data packets from one source node to destination node in networks. MANET aimed to provide communication capabilities to areas where limited or large Multicast routing. MANET does not use a static network infrastructure. The aim of routing protocols is - Find shortest path, minimum routing overhead, congestion and save energy.

II. CLASSIFICATION OF ROUTING PROTOCOLS FOR MANET

Proactive Routing Protocols:

Proactive routing protocol [1] is also called as table-driven routing protocol, which works based on the routing tables in the network. Thus the maintenance of routing tables consists of available destination of reduction in control traffic overhead. Since all the data packets are forwarded to the destination very quickly with routing tables, each node send a message to entire network due to dynamic changes of topology.

Advantages:

- Low route latency.
- State information.

Disadvantages:

- High overhead of periodical updating routing table.
- Bandwidth consumption due to maintenance of links.
- Maintain links in unused situation.

Reactive Routing Protocols:

Reactive routing protocol [1] also called as On-demand routing protocol, which works as creating of routes from source to destination whenever there is a request from sender for initializing the packet transfer process. This request process only based on demand, path will be provided for routing packets. No need to maintain any routing table for storing information about available destination.

Advantages:

- Low bandwidth consumption.
- No table updates.

Disadvantages:

- Very high route latency.

Hybrid Routing Protocols:

It combines both the features of reactive and proactive routing protocols. In intra-domain routing case, these protocols uses the table driven approach, while in inter-domain routing case these protocols uses the on demand approach [1].

Advantages:

- Advantages of both reactive and proactive algorithms.

Disadvantages:

- Advantage depends on amount of nodes activated.

A. Proactive Routing Protocols:

1. Destination Sequenced Distance Vector (DSDV)

DSDV is implemented on the basis of Bellman–Ford routing algorithm with some changes. In DSDV routing protocol, each node in the network maintains a routing table and the routing table maintains all available destinations and the number of hops to each node. Each table entry is marked by the sequence number of destination node. Periodic transmissions mechanism is support maintaining the topology information of the network. If there is any changes in the routing information, the updates are transmitted very quickly. So the information about routing changes might either be periodic or event driven. DSDV protocol needs each node in the network to show its own routing table to its current nearest neighbours. The process is done either by broadcasting or by multicasting. It may help to the neighbouring nodes can know about any change done in the network due to the contiuous movements of nodes [2].

2. Wireless Routing Protocol (WRP)

WRP also known as set of distributed shortest path algorithms that computing the paths using length and second-to-last hop of the shortest path to each destination. WRP minimize the number of temporary routing loop appears. For routing, each node maintains four main tables: 1.A distance table 2. A routing table 3.A link-cost table 4. A message retransmission list (MRL). WRP supports update message transmissions periodically to the neighbours of each node. The nodes in the response state should send acknowledgments. If there is no change in last update, the nodes in the response state should send an idle Hello message to maintain connectivity. A node can decide the better path by update its routing table after receiving an update message from a neighbour [3].

3. Global State Routing (GSR)

In GSR routing protocol [4], each nodes exchange vectors of link states one to another among their neighbours during routing information exchange. Based on the link state vectors, nodes maintain a global network topology and optimize their local routing decisions. Functionally, this protocol is similar to DSDV, but it improves DSDV in the sense of avoids flooding of routing messages.

4. Optimized Link State Routing (OLSR)

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol and its optimized for MANETs, which can also be used on other wireless ad-hoc networks. OLSR is a proactive link-state routing protocol, which uses Hello and Topology Control (TC) messages to discover and then distribute link state information throughout the mobile ad hoc networks. Each individual nodes calculate the next hop destination by using this topology information of all nodes in the network using shortest hop forwarding paths [5].

B. Reactive Routing Protocols:

1. Associativity Based Routing (ABR)

ABR [6] routing protocol defines a new type of routing format, degree of association stability' for mobile ad hoc networks. In this ABR protocol, the degree of association stability of each mobile nodes helps to select a route. Each node generates alert periodically to announce its existence. Upon receiving the beacon message, a neighbour node updates its own associativity table. For each alert received, the associativity tick of the receiving node with the beaconing node is increased. The node is relatively static means a high value of associativity tick for any beaconing node. Associativity tick can possible to reset when any neighbouring node moves out of the neighbourhood of any other node.

2. Dynamic Source Routing (DSR)

DSR [7] routing protocol permit nodes in the MANET to discover a source route across multiple network hops to any destination dynamically. In this protocol, the mobile nodes are need to maintain route caches. If any new route is known for a particular entry in the route cache then only the route cache is updated. Routing of DSR is done in two phases: route discovery and route maintenance. When a source node request to send a packet to a destination, it first check its route cache to determine whether it already known destination or not. If already destination entry is available, the source ready to send the packet to that destination. If not, it initiates a route request broadcast.

3. Ad Hoc On-Demand Distance Vector (AODV)

AODV [8] routing protocol is basically an improvement of DSDVrouting protocol. But, AODV is a reactive routing protocol not in proactive. It reduces the number of hops by creating routes based on demand, which is not the suitable for DSDV. When source node request to send a data packet to a destination, it broadcasts a route request (RREQ) packet first. The neighbouring nodes in broadcast the packet to their neighbours and the process continues until the packet reaches the final destination. During the task of

forwarding the route request, intermediate nodes record the address of the neighbour node after received the packet. This record is in route tables also support to creating a reverse path.

4. Temporally Ordered Routing Algorithm (TORA)

TORA is a routing algorithm and is mainly used in MANETs to improve scalability. TORA is an adaptive routing protocol. It is therefore used in multicasting networks and a destination node and a source node are pairs. TORA forming scaled path between the source and the destination using the Directed Acyclic Graph (DAG) built in the destination node. This algorithm does not use shortest path mechanism, it is considered in secondary part. TORA builds optimized routes using four messages are starts with a query message followed by an update message then clear message and finally optimizations message [9].

C. Hybrid Routing Protocols

1. Zone Routing Protocol (ZRP)

The goal of Zone Routing Protocol (ZRP) [10] is address the problems by combining the best properties of both techniques. ZRP can be classfied as a hybrid reactive/proactive routing protocol. In MANET, it can be assumed that the largest traffic path is directed to nearby nodes. ZRP reduces the proactive scope to a zone based on each node. In a available zone, the maintenance of routing information is simple.

2. Zone Based Hierarchical Link State (ZHLS)

Zone-based Hierarchical Link State routing protocol shortly called as the ZHLS [10], due to different mechanisms of routing protocol, is a hierarchical protocol, where the network is splited into non-overlapping zones. In addition, mobile nodes are assumed to know their physical address with assistance from a locating system like GPS. Each node only knows the node connectivity within its possible zone and the zone connectivity of the entire network.

3. Core Extraction Distributed Ad hoc Routing (CEDAR)

Path creation process uses reactive routing scheme and is performed by core nodes. In core extraction, there are at least on core node every three hops. Every node picks up a node within a distance limitation is not greater than one hop from it. The core consists of two parts are dominators and tunnels. Tunnels consist of at most two intermediate non-core nodes. Core nodes advertise their presence in the three-hop neighbourhood [11].

D. Challenges in MANET

- Routing
- Security and Reliability
- Quality of Service
- Internet-working
- Power Consumption
- Location aided Routing

E. Comparison of Protocols

TABLE I. ADVANTAGES AND DISADVANTAGES OF VARIOUS ROUTING PROTOCOLS

Protocols	Advantages	Disadvantages
DSDV (Proactive)	DSDV was one of the early defined algorithms.	Requir high battry power nad low bandwidth for regular update of routing tableswhen the network is idle. DSDV is not suitable for highly dynamic or large scale networks.
WRP (Proactive)	WRP has the same advantage as that of DSDV. It has faster onvergence and fewer table updates.	The complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the wireless ad hoc network. At high mobility, the control overhead involved in updating table entries is almost the same as that of DSDV and hence is not suitable for a highly dynamic and for a very large ad hoc wireless network as it suffers from limited scalability.
GSR (Proactive)	Betterbandwidth utilization reduces the size of distance	More time is spend in selection of cluster heads and gateways if the mobile node

	vector table because the routing is performed only cluster head.	uses CDMA/TDMA then it can take some time to get permission to send packets changes in the cluster-head, may result inmultiple path breaks.
OLSR (Proactive)	Reduced number of broadcasts.	Overlapping multipoint relaying sets.
ABR (Reactive)	Avoids packet duplicates. No route reconstructions.	Operation complexity. Communication complexity.
DSR (Reactive)	A route is established only when it is required. Reducing load. Loop-free routing.	Route overheads. Higher delay. The route maintenance mechanism is poor.
AODV (Reactive)	Adaptability to dynamic networks. Reduced overhead. Lower setup delay.	Periodic updates. Inconsistent routes.
TORA (Reactive)	Multiple paths created. Communication overhead and bandwidth utilization is minimized.	Routing overheads. Depends on synchronized clocks among nodes.
ZRP (Hybrid)	It reduces the control traffic produced by periodic flooding. It reduces the wastage of bandwidth and overhead.	Memory requirement is greater. Large overlapping of routing zones.
ZHLS (Hybrid)	No overlapping zones. The zone-level topology information is distributed to all nodes. Reduces the traffic and avoids single point of failure.	Additional traffic produced by the creation and maintenance of the zone-level topology.
CEDAR (Hybrid)	Reduces the traffic overhead.	The route establishment and computation is relied on core nodes. Core nodes' movement affects the performance of the protocol.

TABLE II. THE COMPARISON OF THE DIFFERENT TYPES OF ROUTING PROTOCOL BY DIFFERENT PARAMETERS

Parmeters	**Proactive Protocol**	**Reactive Protocol**	**Hybrid Protocol**
Routing Scheme	Table driven	On demand	Combination of both
Traffic Overhead	High	Low	Medium
Mobility	Periodical updates	Route maintenance	Combination of both
Routing Overhead	High	Low	Medium
Power Capacity	High	Medium	Medium
Unicast	Yes	No	Yes
Multicast	No	Yes	Yes
QOS	Yes	Yes	Yes

III. ENERGY EFFICIENT ROUTING PROTOCOLS: TWO APPROACHES

A. To minimize activity Communication Energy

1. Transmission Power Control

Transmission Power Control is each node defines an appropriate transmission power consumtion level to ensure that the transmitted packet is received correctly. A higher network capacity can be achieved by transmitting packets to the nearest neighbor node in the forward process. Transmission Power Control improves network throughput and increase the lifetime of mobile nodes, but also increases the number of hops to the destination and also impact the connectivity of the network, and, potentially, partitioning the network. Transmission power control is an active link of study in mobile ad hoc networks (MANETs). Several MAC

protocols using this technique have been proposed. PCMA (Power Controlled Multiple Access) is a MAC protocol which provides communication with minimum propagation ranges, allowing reuse.

Agawam et al. proposed a distributed power control algorithm for MANETs. Medium access control (MAC) protocols, for example, modify transceiver parameters and the topology of the network in order to reduce energy consumption. One of the transceiver's parameters is the transmission power. Transmission Power Control (TPC) techniques improve the performance of the network in several aspects. First, power control techniques improve the reliability of a link, transmission power, probability of successful data transmissions. Second, only nodes which really must share the same space will access the medium, decreasing the collisions in the network .This enhances network utilization, lowers latency times and reduces the probability of hidden and exposed terminals. Finally, by using a higher transmission power, the physical layer can use modulation and coding schemes with a higher bit/baud ratio, increasing the bandwidth in the presence of heavy workloads, or decreasing it to maximize energy savings [13].

2. Load Distribution

In [13], a vital part of the optimal network is the load distributing. Job completion becomes complex, if it have high load is given to the nodes with less processing capabilities and share the load is meaningless. There is a possibility of load imbalance due to that the computing/processing power of the systems are non-uniform as few nodes maybe idle and few will be overloaded. A node which has high processing power finishes its own work quickly and is estimated to have less load at all most of the time. Multi-path routing can balance the load better than the single path routing in ad hoc networks, where the first selective shortest paths are used for routing. This is possible only for the networks having a huge number of nodes between any source-destination pair of nodes. It is infeasible to build such a system it is economical for discovering and maintaining a large number of paths.

Load balance improved not only based on the usage of multiple shortest path routes instead of a single path. So, for a better load balanced network distributed multi-path load splitting strategies is carefully designed .Load balancing is a methodology to distribute workload across multiple paths, to achieve optimal resource utilization, maximize throughput, minimize response time, increase network life time, and avoid overload. Using multiple paths with load balancing, instead of a single path, may increase reliability through redundancy. Load balancing techniques may have a various of special features as:

• Asymmetric Load: A ratio can be manually assigned to cause some paths to get a greater share of the workload than others.

• Priority Activation: The workload is distributed according to paths priority as the size of free bandwidth and number of hops.

B. Minimize inactivity Energy

1. Sleep/Power down mode

This adaptive techniques is used to block the powered consumes during the periods of low network load. Such techniques are particularly supported for the low utilization. The combination of large contribution to the entire network power consumption and low power utilization involves high potential for exploiting load adaptive techniques. This approach is only optimal to a certain level and it opposite to another aim of increased energy efficiency which is increased integration. Integration can decrease the maximum power consumption of network elements by increasing the utilization of subunits within the network element. The finite wake-up time of systems and components reduces the energy savings of cyclic low power modes [13].

CONCLUSION

In this paper, there are many routing protocols recently presented for energy efficient routing in networks. We also discussed about Comparison of reactive, proactive and hybrid protocols and its advantages and disadvantages. There are still various scopes for researchers to optimize algorithm. The single protocol cannot give any optimal solution and it selected based on energy efficiency, congestion control, different mobility models and changing more than one parameter at a time.

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