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A Review on Energy Efficient Approaches for AODV Protocol

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Abstract

Recent years have seen a tremendous growth and application of mobile adhoc networks. MANET has essentially become a part and parcel of modern day lifestyle. One of the challenges faced by MANET is of energy consumption. Therefore a numerous energy efficient routing mechanism have been proposed in the past. With increase in computation power of nodes and use of high end processors in mobile nodes have further increased its importance as battery life is more and less remained same in these years. The following paper reviews energy efficient AODV routing protocol. AODV is a reactive routing protocol and currently an area of much research for network community.

Keywords: AODV, MANET, ERS, EDS

Introduction

Mobile Ad-hoc network is a set of wireless mobile nodes dynamically forming a temporary network. The goal of this architecture is to provide communication facilities between end-users without any centralized infrastructure. In order to provide communication throughout the network, the mobile nodes must cooperate to handle network functions, such as packet routing. The wireless mobile hosts communicate in a multihop fashion. They have the advantage of rapid deployment, robustness, flexibility and inherent support for mobility. This may be done either because it may not be economically practical or physically possible to provide the necessary infrastructure or because the situation does not permit its installation. This flexibility of self configuring and self administration makes it lucrative for various applications in military operations, wireless mesh networks, wireless sensor networks etc.

Routing protocols can be broadly categorized according to two approaches:

1. Traditional approach
2. Power aware approach

Traditional Approach

The traditional approach classifies the routing protocols in three main categories;

1. Proactive protocols
2. Reactive protocols
3. Hybrid protocols

Proactive Protocols

Proactive protocols or table driven protocols attempts to maintain consistent and up-to-date information from each node to every other node in the network. In proactive protocols routes to all destinations are pre-computed and stored in routing tables. They respond to change in network topology by updating their routing table entries periodically by exchanging routing table update packages. Some of the proactive routing protocols are Destination sequence Distance vector (DSDV), Wireless routing Protocol (WRP), Cluster head gateway switch routing(CGSR),Optimized link State Routing(OLSR) etc.

Reactive protocols

In reactive or on demand routing protocols, the route are created as when required. No routing information activity occurs if there is no communication. This protocol searches for route in an on demand fashion and route discovery mechanism to find path to destination is invoked. This process is completed when a destination node is found or all possible routes have been examined. Once a route has been discovered, it is maintained by route maintenance procedure until the destination node become unavailable. Some of protocols are Adhoc On Demand routing protocol (AODV), dynamic Source Routing (DSR), Temporary ordered routing Protocol (TORA), Associatively- Based Routing (ABR) etc.

Hybrid Routing Protocols

It is basically suited for large networks. These protocols are designed to increase the scalability by allowing nodes with close proximity to work together to form some sort of backbone to reduce route discovery overhead. This type of

protocols combines the advantage of proactive and reactive protocols. The proactive protocol scheme's advantage of maintaining routes and reactive protocols scheme's of retaining routes is utilized. Examples are Zone Routing Protocol (ZRP), Zone Based Hierarchical Link State (ZHLS) etc.

Power Aware Approach

This approach can be classified into following basis:

1. Minimizing Active communication Energy
2. Minimizing Inactive Energy

Minimizing Active Communication Energy

This approach minimizes the energy during active node time. This can be achieved by two methods.

1. **Transmission Power Control**
   In this total transmission energy is minimized by controlling the transmission power of radio. Examples include flow augmentation routing(FAR), Online Max-Min Routing(OMM), Power Aware Localized Routing(PLR) etc.
2. **Load Distribution Approach**
   In this approach instead of choosing the shortest route an energy balanced route is used. The goal is to select underutilized nodes to select a path. Protocols based on this approach do not necessarily provide the lowest energy route, but prevent certain nodes from being over utilized, and thus, ensuring longer network lifetime. Some of these protocols are Localized Energy Aware routing (LEAR), Conditional Max-Min Battery Capacity Routing (CMMBR).

Minimizing Inactive Energy

This approach includes powering off the radio of node, when node is not indulged in a communication. The sleep time of radio can be very small but enhances the network lifetime by a big factor.

AODV Routing Protocol

In AODV routes are maintained only between nodes which need to communicate. The routing information is recorded into the routing table of the intermediate router along the path, so the data packet only contains the destination address. it have two phase namely Route discovery and route maintenance. Also sequence numbers are use to keep track of recent routes.. Every time a node sends a new message, it uses a new sequence number which increases monotonically. A greater Sequence number implies new information.

Route Discovery:

When a node wants to send the data to a node other then its neighbouring node a RREQ packet is send. A RREQ contains various field such as type, reserved, hop count, RREQ ID, originators sequence numbers, destination's address, destination sequence number etc. The RREQ packet have the following structure.

type	J/R/G/D/U	reserved	Hop count
RREQ ID			
Destination IP address			
Destination sequence number			
Originator IP address			
Originator sequence number			

Initially the source node broadcast a RREQ message to its neighbours, which further broadcast it to its own neighbours. This process continues till the whole network is covered. To prevent repeated sending of RREQ it is buffered. Each node before sending data checks whether it is already sent or not. When a node receives a route to destination, it generates a RREP message and this is send along the reverse path back towards the source node. In case node receives multiple RREP message, it selects the route with greatest sequence number.

Type	R/A	reserved	Prefixed Size	Hop Count
Destination IP address				
Destination Sequence number				
Originator IP address				
Life Time				

Route maintenance

Each node maintains a precursor list and an outgoing list.Each node periodically sends a HELLO message to its precursors. A node decides to send a HELLO messsage to given precursor only if no message has been sent to that precursor recently. In the mean time if a node doesnot receive a message from outgoing node for definite prolonged time, it is considered to be dead. When a node discovers that one of its next hop is unreachable, it removes all affected route entries, and generates a Route error message. This RERR message is send to its precursors which update their own routing table. To avoid RERR message loops, a node only forwards a RERR message if atleast one route has been removed.

Proposed Improvements:

A. Hop by Hop Power Control

Gao and Jantti[7] proposed an energy efficient routing mechanism which can be applied to AODV by analysing topology of adhoc network. The proposed protocol rely on hop by hop power control. In this method, each node is able to decide the Transmitt Power level by P_{tx} and put in a transmitt power field in the transmitted packet. Also radio receiver should be able to measure the received signal strength. From this the distance between transmitter node and node that have received packet is determined. Also upon receiving signal power, the node can adjust its transmisssion power to remote level by

$P_{tx}= P_{tx}-P_{rx}+S_r+M$

Here

P_{tx}= Transmitt Power Level

P_{rx}=Received Signal Strength

M= Power safety margin

S_r= minimum signal power required to correctly receive packet.

RTS/CTS handshake mechanism is used, that uses maximum power to avoid any collision. When a route is to be established, a RREQ is broadcasted with maximum power. A intermediate node backs off RREQ packet. The Back off Interval is proportional to the difference between received signal power and a optimal value. Upon receiving a duplicate RREQ packet, the node compares it with previous one and if found better it will update its routing table. Finally a node drops all the RREQs that are received after the back off interval.The simulated result showed a improvement of 30% to 35% in power consumption but delay increased to twice of original as it implementes a back off mechanism.

B. ERS Approach

In this method an ERS scheme[6] is applied to AODV to reduce overhead of route discovery process and make it efficient.

To use this scheme ERSS TTL value is increased gradually. It have some start value TTL_START and a maximum value TTL_TRESHOLD. Initially Route discovery is made by setting TTL value as TTl_start. If no reply is received within the discovery period, the source increases the RREQs broadcast id and increases TTL value by TTL_increment. This continues until TTL_THRESHOLD is reached.The RREQ is broadcasted across the entire network till RREQ retires. The basic idea behind the E^2AODV is to extract neighbour information from duplicate RREQ packets, which are dropped. For this a Predecessor Address field(P-Addr) is added in RREQ packet which shows the address of node from which the sender node has got the request. The simulation shows a reduction in enegy consumption by 75% to 80% and reduction in routing overhead 60% to 65%.

C. Expanding Disk Search(Eds Approach)

Abdullah,Imran,Mahmood[8] proposed a expanding Disk Search(EDS) that make AODV energy efficient. Nodes are considered to be uniformly distributed over an area and each node has a limited coverage area and transmission power. The protocol controls various parameters such as disk area, no of attempts to form disk before network wide broadcast etc. The path is established with help of intermediate node. Whole area is divided into different circular ring band(CRB) and named as CRB1, CRB2, etc. The CRB1 is formed for TTL value=1 and similarly for next TTL value CRB2 receives packets from source alongside CRB1. Then Block-expanding disk search mechanism is used to further improve energy efficiency. Simulated result showed an improved energy efficiency.

D. SPAN

Chen, Balkrishnan, Morris[3] have proposed SPAN that operates under the routing layer and above the MAC and Physical layer. AODV then can be implemented over SPAN. SPAN utilises the feature that energy consumption of idle nodes is much higher as compared to when nodes are in sleep mode. So in SPAN nodes are put to sleep for short interval of time. Also the on/off period of radio is of few milliseconds. SPAN protocol employs a master eligibility route. Each node checks whether it can become master/coordinator or not. Coordinator eligibility route is very simple. If two node neighbours of a non coordinator node cannot reach each other directly or via one or two coordinator, the node should become a coordinator. In this way SPAN ensures entire network is covered with coordinators. The contention for coordinator can be handled by introducing a random backoff delay. Also each node periodically checks wether it should withdraw itself as a coordinator or not. It withdraws ony when every pair of neighbor node can reach each other via some other neighbors, even if those neighbors are not currently coordinator.

To mainatain connectivity during coordinator withdrawl and new coordinator announcement, the node continue to serve as coordinator even after its withdrawl for some time. This is called the grace period and in this period old as well as new coordinator may be used for routing. Simulation in ns2 showed a considerable amount of energy saving as compared to normal AODV.

E. Local Repair (ES AODV)

ESAODV[10] make use of route information which is cached during the stage of route optimization to repair broken link. It computes excess energy of nodes and calculates the cost of link. It focus on local repair and thus minimizes the probability of choosing source node for route rebuild.

Conclusion

The paper discusses the various power saving approaches that can be included in AODV to improve its energy efficiency. We saw various criteria of improving energy efficiency in AODV such as controlling transmission power, ERS method, power on/off method(SPAN). Moreover high mobility increases the challenge of energy efficiency. Further some proposed mechanism though, resulted in energy efficiency but other parameters such as delay was increased. Hence choice of one protocol for all scenarios seems unlikely. These protocols may be implemented as per need of situation and scenario.

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