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Cross Layer Energy Conservation in Routing Protocol for MANET

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Abstract

Problem statement: The main idea is to design an algorithm for reducing the amount of overhearing problem in MANET using DSR. Applied Approach: a cross layer framework is designed such that the physical, MAC, network layer.RSS value is applied with the physical layer for finding the mobility. Mobility determines the rebroadcast capability and overhearing level. The energy conservation is achieved due to cross layer framework and by integrating 802.11 with DSR. In psm mode initially all the nodes are in sleep state, but disadvantage occurs in case of unconditional overhearing. The conditional overhearing is proposed such that the energy consumption is reduced. In the proposed idea RSS value determines either the selection of the link or not prior to the route discovery process. Keywords: MANET, DSR, overhearing, stale route, RSS.

Keywords

MANET, DSR, RSS, MAC..

1. Introduction

In mobile adhoc network, the nodes can communicate dynamically and arbitrarily. It helps to design a network anywhere and anytime. This facility makes the MANET suitable for many different applications of military and commercial. In MANET the energy conservation is because of the limited lifetime of mobile devices. All the nodes' lifetime depends on DC battery supply. The main goal of this work is to make 802.11psm suitable with Dynamic Source Routing (DSR) for MANET.

Dynamic Source Routing Protocol and Overhearing Problem

DSR is an efficient reactive routing protocol which is capable to manage MANET without using table.

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MANET mobile nodes cooperate for forwarding of packets and allow communicating over multiple hops between nodes.DSR does not use the periodic "Hello" messages. As the network topology is changing so the number or sequence of intermediate nodes needed to reach at the destination may change anytime. DSR always operate in promiscuous listening. So, the node can searches the route for the needed routes in route cache rather than table. If the route to the destination is not found the discovery process of route is initiated by the DSR. DSR stands such: Route discovery is one in which a node S attempts to send the packet to D. In Route maintenance nose S is able to detect a source route to D and does not know a route to D. If the network topology changed, the link breakage occurs so maintenance can no longer use its route to D. When it indicates a source route error occurs, S can attempt to use any other route it happens to know the route to D.DSR does not use periodic 'hello' messages.

DSR is on demand protocol because of the Route Discovery and Route Maintenance is operated on demand. When a data packet node sends the data but does not know the routing path to the destination, it initializes the route discovery process by broadcasting a packet called Route request (RREQ). When the packet reaches the destination, another packet named route reply (RREP) is prepared and replies back to the source with the associated information. After receiving the RREP, the source saves the route information in its memory called the route cache.

The link breakage occurs due to the node mobility and an upstream node propagates RERR packet remove the stale route information from route cache. Each node maintains the route cache. All the route info is stored in that.

The overhearing problem

Overhearing [3] means the node picks up packets that are destined for other nodes. The power will be consumed by wireless nodes unnecessarily due to overhearing transmissions of their nodes. This often happens in case of broadcasting. The mobile nodes receive all the packets that hit their antenna. Such situation results in more power consumption because

only a small number of the received packets are destined to the receiver.

Problem of Stale Route in Source Routing
It occurs as unconditional overhearing problem. This happens because DSR produces more than one RREP packets for a route discovery to find an alternative path in addition to the primary route to the source, while the primary route is checked for its validity during data communication between the source and destination. The routes may remain in the route cache unchecked eve they become stale. Due to unconditional overhearing this is not only for some of the routes, but also for their neighbors.

2. Related Work

The on-demand routing protocols' performance, depends on the implementation of route cache. This process involves cache structure, cache capacity and cache time out policy. Therefore, the cache time out policy is required to predict the route cache lifetime. This plays the important role for ensuring cache freshness. [Shukla, 2007]

Many techniques have been suggested for route cache organization and its effects on the performance of on demand protocols. The cross layer design had been suggested for reducing the amount of overhearing of neighboring nodes. The problem is solved based on the mobility of nodes. The other problem of prevent the stale route from being used, is solved with Received Signal Strength value information. [Lou and Young, 2002]

MANET routing protocol performance mainly depends on the network conditions. The routing protocols are mobility of nodes, idle time and shared medium of RSS. [Lim et. Al. 2009]

Mobility status can be predicted on the factors such as, node degree, number of link breakage and link duration. In ideal case the RSS value determines the link breakages.

To broad cast flood control packets is raised with DSR. To solve this problem conditional overhearing and re broad cast mechanism is proposed with Random Cast in network design. [Lim, 2009]

In MANET state information of energy level plays an important role in route selection. If the latest info is not selected by the node the performance of MANET may degrade. The state information is elected in ideal as well as realistic approach and concluded the frequency of packets improves the performance and increase the traffic over heading. [Sangeetha, 2010]

802.11 PSM
Wireless LANs have become more popular MAC and PHY layer technologies in adhoc network. A power management mode is manually to reduce the energy in ideal state, but it results in poor latency. The power management of DCF is mainly done by ATIM frame which is transmitted in interval directly after beacon. Many methods are introduced to improve the power management in multi hop adhoc network. Monarch version of the network simulator is used for power management in MANET. Nodes in PS mode are expected to synchronize among themselves in a distributed way [2].

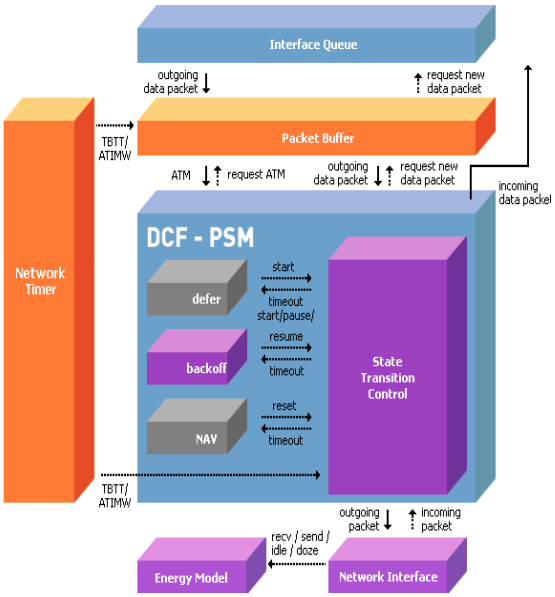

Fig. A: IEEE802.11PSM

Random Cast
Random cast is a new communication mechanism, in which a sender can specify the desired level of overhearing problem for making balance between energy and routing. Random cast is highly energy efficient technique. The ATIM window size and beacon interval is 0.05 and 0.25 sec. All the nodes are operated in power saving mode and the level of overhearing and rebroadcast probability are determined by the number of neighbors. The overhearing probability is inversely proportional to the number of neighbors.

3. Cross Layer Design

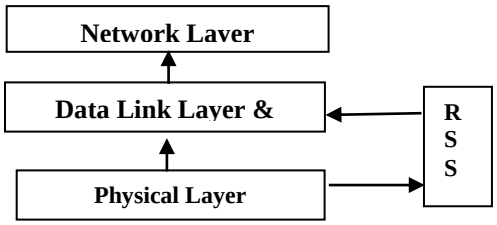

Fig. 1: Cross Layer Design

The cross layer design is designed using three layers: physical, MAC and network layer. The diagram is shown in Fig. 1. The physical layer transmits the RSS value to the other top layers. The RSS value is captured for determining cache expiry of all the links. So to conserve the energy and lifetime of network and battery will be improved. Mobility of node can be measured based on connectivity changes with the neighbors. Connectivity changes using the RSS value of the determined links.

Mobility is defined as the average change in the distance between all the nodes in the given network. The high mobility is defined as high link error rate and that results in high stale route information in the route cache. So the numbers of nodes are kept at the different levels of overhearing based on RSS value. By this the stability of route selection is decided for certain period of time. Thus, the link quality of route is determined by the RSS value. As the high value of RSS results in good quality of link.

A transmitting node can specify the level of overhearing based on mobility that depends on RSS value. The link (i,j) specifies the distance between I and j nodes. The RSS values of these links are calculated based on below given basic formula.

$RSS=Pt(L/4\pi d)XtXr$ (1)

Where,
L=Wavelength,
Pt=Transmitting Power,
Xt=Transmitting Gain,
Xr=Receiving Gain,
d=Distance between transmitter and receiver,

The eq. is modified between as per assumption that the interference is negligible. The Eqn.2 is given below:

$RSS \propto Pt/d^2$ (2)

The probability of rebroadcasting is calculated as follows:

$Por=RSSth/RSS$ (3)

Where,

$RSSth=Pt/4$ (4)

Usually, as the distance increases, the received signal strength value decreases. This result indicates chances of link breakages between two nodes.The random way point mobility model Random Way Point model is selected as mobility model. In this model, a mobile node moves on a finite plane continuously from its position to another position by randomly and the amount of time that it will pause when it finds its destination.

Once the pause time expires the node selects the new destination, speed and pause time.The mobility parameter of link is found using following formula:

$M=RSS/Pt$ (5)

In the proposed architecture, for the conditional overhearing level Por is kept lower as compared to MP in case of unicast packets. RREP is a unicast packet so it is necessary the nodes which are involved in RREP should have high RSS value. It improves the lifetime of route and network. The condition of MP greater than or equal to Por reduces the overhearing and it improves the network performance. The route discovery initiated will be reduced.

In case of conditional overhearing broad cast the packet i.e. RREQ Por is higher than MP distance. The RSS value is kept nominal. So, the nodes are not allowed to overhear, but RREQ made to rebroadcast it for conditional overhearing.

FC	DI	DA	SA	IBSS	SC	Frame Body
(2)	(2)	(6)	(6)	(2)	(2)	(4)

FC- Frame Control DI- Destination ID
DA- Destination Addr SA- Source Addr
IBSS-Address SC- Sequence Counter

Fig. 2: ATIM Frame Format (in Bytes)

PV	T	ST	DS To	DS Fm	MF	R	PM	W	O	MD
(2)	(2)	(4)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

PV- Protocol Version MF- Flags
T- Type R- Retry
ST- Sub Type MF- Flags
R- Retry O- Order
PM- Power Management W- WEP
Sub Type Values:
1110- No Overhearing
1001- Unconditional Overhearing
1101- Conditional Overhearing

Fig. 3: Frame Control Field of ATIM Frame Format (in bits)

The broadcast and unicast packets are considered here. In PS mode, the packet advertisement period is waked up periodically, called Adhoc Traffic Indication Message, to see the window if it has any data to receive. ATIM frame format is shown in Fig. 2. ATIM is modified for the level of overhearing for the nodes. It the transmitted packet is of broadcast type all the neighbor will get the packet through sending the ATIM frame and rebroadcast it. The levels of overhearing are of three types: No Overhearing, Unconditional Overhearing, and Conditional Overhearing due to distance. The control field of ATIM frame is presented diagrammatically in Fig. 3. As per the IEEE 802.11, ATIM frame is a management of type 002 and its sub type is 10012, which indicates the unconditional overhearing. The proposed distance and MP based conditional overhearing takes two unused subtypes such as: 10012 and 11102 for conditional overhearing and no overhearing respectively. The function for specified frame type is specified by the frame control header in sub type subfield of that. For example, if the frame type management it indicates the type of management and that is used for defining the overhearing levels.
A node in adhoc network the routing information is given by forwarding of packets of other nodes and the routes are maintained in route cache.

When a node receives the unicast ATIM frame, it wakes up from sleep state at the beaconing interval beginning. It follows the following conditions for that:

1. The receiving node is anticipated destination.
2. The source node likes unconditional overhearing and receiving node is not destination.
3. Conditional overhearing mechanism is applied for the receiving node is not destination.

For route discovery and maintenance DSR utilizes the RERR, RREP, and RREQ as the control packets. For data transfer the conditional mechanism is proposed using DSR.

1. As the distance varies due to mobility conditional overhearing is applied for RREP packets. It is not desired that RREP should have unconditional overhearing by all nodes in the network. RREP is created by DSR from all the nodes.
2. In case of conditional overhearing all the nodes cannot overhear because the route information is kept by the data packets.
3. Unconditional Overhearing for RERR packets error RERR is used to intimate the link breakage, so it can be overhear by all the nodes. In case of unconditional broadcasting of RERR packets, the performance of network can be improved by removing the stale route in cache is removed and the breakage links are eliminated from cache.
4. Conditional overhearing for RREQ packets are controlled by specifying the mobility level.

The algorithm steps for transmitting an ATIM frame in case of conditional overhearing are given below:

1. RREQ packet will be broadcasted in the network.
2. Frame field of the ATIM frame sends the overhearing level for unicast packets of DATA and RREP.
3. RREP is overheard by the network nodes and its information is stored on the basis of subtype.
4. RERR link error is detected and link can be deleted from route cache.
5. Route cache is updated based on receiving signal strength.

The algorithm based on RSS value when ATIM frame is received.

```
If (RSS>RSSth) then
{
If (DA==unicast)
{
If (DA==AD)/*anticipated destination*/
Receive the node;
Else if (OID==1001)
                Unconditional Overhearing;
Else if ((OID==1101) && (M>=Por)
                Send an ATIM frame;
Else
                Nodes go in sleep state;
}
Else
{
If (OID==1001)
        Send an ATIM frame
Else if (OID==1101) && (M>=Por)
        Send an ATIM frame;
Else
        Nodes go in sleep state;
}
}
Else
Remove the links from route cache;
```

4. Results

For the performance evaluation of proposed methodology, Network Simulator under Linux platform is chosen as the simulation tool.

Table 1: Simulation Settings

No of Nodes	50
Area Size	1000X1000 m^2
Radio Range	250m
Simulation Time	60 sec.
Traffic Source	CBR
Packet Size	256 bytes
Channel Data Rate	2 Mbps
Packet Rate	1-5 packets/sec
Mobility Model	Random Way Point

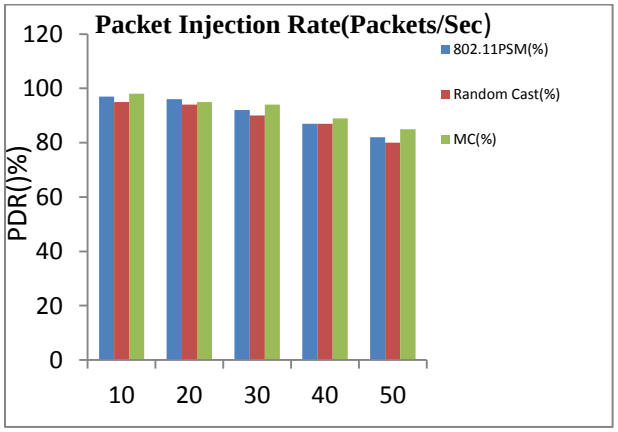

Fig. 4: Packet Delivery Ratio Comparison

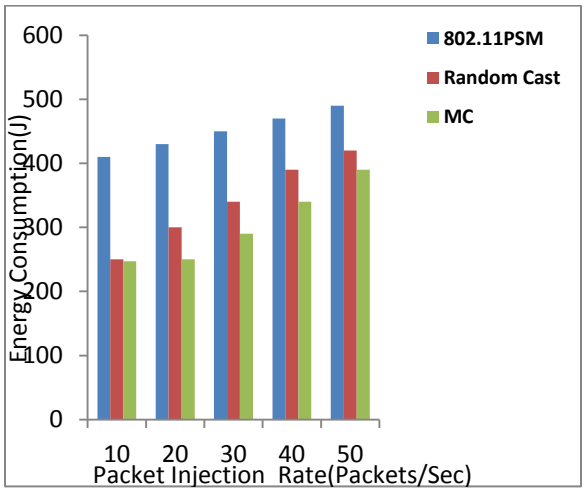

Fig. 5: Energy Consumption Vs PIR

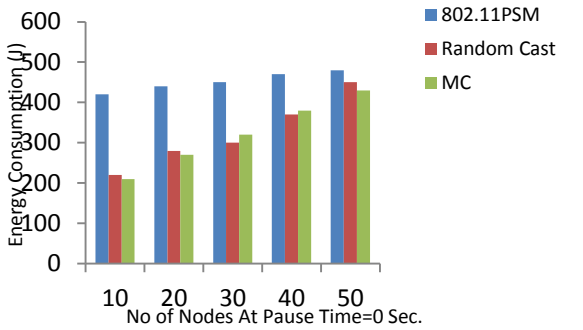

Fig. 6: Energy Consumption Vs No of Nodes

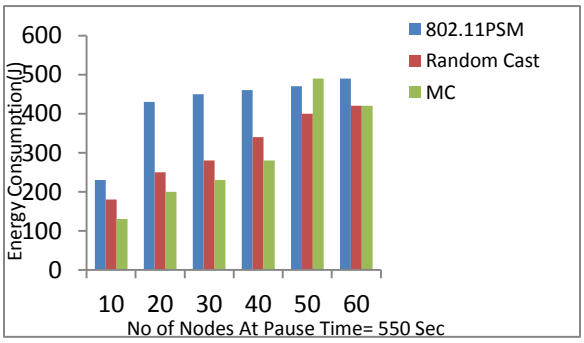

Fig. 7: Energy Consumption Vs No of Nodes

5. Conclusion

It is seen from the analytical results of simulation analysis that energy is utilized efficiently in MANET under the cross layer framework. The user can specify the specified overhearing level based on RSS value. Based on RSS value the physical layer prevents the stale route problem and decides the route selection. The link or path selection before transmission of data results as less frequency failures so energy will be conserved. Route discoveries based on RSS in turns as less overhearing. PDR of MC based design improves the 3.1% improvement and 22% energy conservation as compared to the existing systems. Significant power saving is achieved by this system. Under high mobility condition, it performs better than Random Cast. The End to End delay is the drawback of this system. As the packet is announced before actual delivery and only one hop at a time results as more delay in this system. This system conserves 50 Joules energy as compared to Random Cast under mobility condition based. The future work

should be done to improve the path maintenance mechanism.

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