A Cross Layer Protocol to Improve Energy Efficiency and QoS in MANET

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Abstract

Limitations of Wireless nodes are the battery power and storage capacity, while plotting a MANET, these are to be considered. By improvising battery life, the energy used by nodes shall be increased such that network is operational. To move data packets efficiently the network, MANET uses smallest Hop Count routing protocol. Most power is used by data transmission process. Key challenges in Ad Hoc networks are the recurring changes in network topology. Network topology changes happen due to motility and finite battery power of the mobile devices. Mostly links are not available in the network as depletion of power source may cause early unavailability of nodes. This paper discusses about the protocol that incorporates link failure prediction at network layer and Power Control Protocol at MAC layer to improve network performance. Performance enhancement in regards to total power transmission, energy regulation and consumption per node along with throughput of our proposed cross layer routing protocol is shown by simulation results when compared to AODV.

Keywords: MANET, MAC Protocol, Cross layer, AODV, RDSR, LBP-AOMSV, LP-PCP

I. Introduction

Mobile Ad hoc Networks (MANETs) should deliver good quality of service which require high turnout, less delay, jitter, reliability, so of throughput, delay, jitter, reliability, etc which is present day needs of multimedia applications Limitations of such systems impose a network like more users at a time and powerful topology. RFC 2386 [V] has a particular feature of providing QoS as series of needs by network to move traffic from source to destination [XX]. It gives power to components in the network (router, node, etc...) to provide security level for transmitting data which is foremost in Ad hoc networks as it gives better conduct and enable flow of data [III]. The routing protocols used here are multi-hops in identity, that is the route selection depends on the minimum number of hops between the source and destination nodes.
This metric of hop count may result in low end-to-end delay at the same time it is not enough for building a route with high dependability [XIII], [II].

The links with high quality along the route will construct a route with high responsibility, while the calibre of link (wireless channel) between the nodes depends on the atmospheric phenomena and time, Doppler Effect, fading and path loss. Generally links with weak calibre have a low signal level strength leading to high frame error rate, low packet delivery fraction and low turnout [XII], [XXV], [XVIII]. During route selection, not considering the factors which have a accepting effect on the standard of links surrounding the nodes is the delicate point of the original routing protocols (e.g. DSR and AODV) and hence the route responsiveness [XXIX], [XXVIII]. While selecting route [VII], [XXIII] it will be better to know about the different links quality among the nodes for a route protocol.

The links quality between the nodes in a row depends on the received signal power of packets interchanged between them [XXII], [XVI]. Signal strength of interchanged packets among the nodes along the path is being used as a metric for route selection [XXI], [XX] which helps to create a route with a relatively high quality of links (i.e. reliable route). Regardless of the change of network nodes movability, network topology changes and immovability of the node in a dynamic environment [XXIV], [XIV] the routing protocol will have the ability to provide coherent attitude by using received signal strength metric. Thus MANET will produce better quality of service.

The factors to make routing layer aware of underlying layers parameters, the cross layer perspective should be combined with routing protocol [IX], [VI], [XXX]. While testing this and aiming to enhance the cross layer design of the original AODV, a novel version of ad hoc on demand distance vector routing protocol called the prediction power control protocol (LPPCP).

Wuetal’s [XXVII] work refers to various ways of choosing route in mobile ad hoc network alike DSR, ZRP, SSA and AODV. The work supposes that MANET has difficult receive mode of wireless devices to find the route. The assessment is concerned with power consumption and decrease in quality of output. The other distress is to enhance energetic routes by adjusting packet overhead and routing tables of protocols.

Anticipated route Maintenance is an algorithm proposed by Park and Voorst [XVII], [XII] which predicts the link failure among the following nodes through the route in limited time, determined on nodes velocities and locations which rely on GPS. This Algorithm consists two phases namely expanding phase, which blocks the route from failure by putting a node as bridge into the weak kink before its collapse and shrinking phase, it removes the nodes which are not needed for the route to decrease the hop count.

Another GPS based implementation given by Park and Voorst, Sjaugi et al [XV] is rooted on the information of location as to enable the network nodes to detect critical links which are at a distance compared to particular threshold. The location of nodes is in packet headers. Finding a unsafe link, the bridge node is activated as it has ability to act as a common node for two unsafe links, this expands the path.
Qin et al. [X] planned an algorithm to predict link failure depending on signal strength changes of two sequential data packets acquired by the mean node on the route. Broken route message is sent by the intermediate node to source node while the signal strength of the present data packet is less compared to the previous packet at some threshold. As and when source node receive message, it finds a different route through route detection process. This does not reduce the cause of route detection process however it aims at decreasing count of data packets lost route failure is about to happen.

Many proposals supporting QoS at route level for mobile AD hoc networks (MANETs) were given by either extending AODV protocol [XVII] using route chosen by multipath protocols which develop an important overhead at the time of discovery and provision phase or using mechanism which predicts link failure depending on residual energy and signal utility received from adjacent node or uses both the methods (prediction & multipath) jointly.

AODV – Reliable Delivery (AODV-RD) advanced in [I] by focusing on predictable mechanism to find and warn a link collapse by Signal Stability-Based Adaptive Routing (SSA) [VIII] which checks a bad or good link depending on how weak or strong the signal is and the requirement to repair prior to breaking of primary path. This improvement in PDR and decreases end to End delay.

To resolve link collapsing complication in Ad hoc network working using AODV protocol, Abdul and Hassan [VI] designed Divert Failure Route Protocol (DFRP). It escapes link collapse in early and directs the link to next hop to anticipate link condition continuously signal strength. These are the important functions of DERP which helps in decreasing delay in sending information about link failure to the sender.

To find multiple broken routes with high lifetime, Hwang and Varshney [XXVI] introduced an Adaptive Dispersity QoS Routing (ADQR) method which uses signal strength value collected from lower layers to anticipate route collapses and initiate and act quickly route maintenance and network changes as to improve route execution and end to end QoS.

II. Proposed framework

Key challenges in Ad Hoc networks is the recurring change in network topography, due to motility and finite battery capacity of mobile devices. Mostly, links are not available in the network as depletion of power source may cause early unavailability of nodes. The performance of applications is affected by repeated route breaks which are caused due to mobility of nodes. It is main to foresee the availability of link which is presently available as it factors to availability of route.

Packets cannot be forwarded as nodes die due to limited energy source at each node thus hampering the connectivity of network which has led to research in developing power aware protocols for Ad hoc networks. Protocols which change the transmission power level are called as power aware protocols divided based on parameter used by protocol to minimize the consumption of energy.
A cross layer representation for power control and prediction of link failure has been proposed as to make ad hoc networks checks the issues of link availability due to mobility and to improve battery life of nodes, this method needs non adjoining layers interaction e.g. For prediction of links break and achieve maximum efficiency of power at MAC layer interaction of physical and network layers it shown in figure 1.

This work benefits in increasing the capacity of network by increasing the network lifetime in order to ensure data packets are transmitted successfully with reduced contention and less power Introducing a cross layer design for power control and availability of link to ensure performance of mobile ad hoc network is improved here by adding link failure prediction at network layer and power control protocol at MAC layer.

**Pseudo code / algorithm**

N = total number of nodes  
RSS = received signal strength; MSS = Max. RSS  
RE = node residual energy; ME = Max RE  
SN = selected node  
FN = final node  
For I = 1: N  
Calculate RSS of every node  
MSS = RSS
End
For I = 1: N
Calculate RE of every node
ME = RE
End
For J = 1: N
If (RSS > MSS)
SN = Node (J)
Else J++
If (RE( SN )  > ME)
FN = Node (J)
EndIf
EndIf
Endfor
End

III. Results

Comparing simulation parameters such as Energy consumption (EC), Average End to End Delay (E-to-E Delay), and Throughput are used to check performance assessment of proposed scheme, LP-PCP, against original RDSR and LBP-AOMSV have been done using network simulator NS2.

| Simulation Parameters     | Values                  |
|---------------------------|-------------------------|
| Simulation Tool           | NS-2.35                 |
| No. of nodes              | 23                      |
| Simulation time           | 20 second               |
| Simulation area           | 1000*1000 m             |
| Pause time                | 2-20 S                  |
| Mobility model            | Random waypoint model   |
| Routing protocol          | AODV-LPPCP-AODV         |
| Packet rate               | 2 packet/millisecond    |
| Mobility speed            | 2m/ms                   |
| Channel type              | Wireless                |
| Mac layer                 | 802.11                  |
| Traffic type              | CBR                     |
| Antenna type              | Antenna/Omni antenna    |
| Initial energy            | 100 j                   |

Table:
To study and examine proposed idea Network Simulator NS2 version 2.35 is considered. This simulator consists of 23 nodes in 1000 x 1000m² region. For ideal unstructured the transmission scope is set to 250 m and Random Way Point (RWP) mobility is used. The average speed of nodes is 2m/ms. Simulator uses two Scripts for producing traffic randomly for constant bit rate (CBR) of 1024 bytes according to UDP protocol and to generate mobility scenarios the second code (Setdest) is used. For all the tests the simulation time is set to 20s. Pause time varies between 2 and 20s seconds. 2s indicates high node mobility and 20 s means a static node. Pause time is affected by node level movement which has strong effect on signal strength measured for data/reply packet received at any node.

![Energy Vs Simulation time](image1)

**Figure2: Energy Vs Simulation time**

Above figure2 gives Energy Vs Simulation time for RDSR, LBP-AOMSV and LP-PCP, from which we find LP-PCP consumes low energy when compared to RDSR, LBP-AOMSV. LP-PCP depends on maximum-minimum signal strength and link failure mechanism for early prediction of link failure prior to energy loss at individual nodes thus has efficient energy consumption.

![End to End Delay vs simulation time](image2)

**Figure3: End to End Delay vs simulation time**
From above graph figure 3, it is clear that LP-PCP has minimum end to end delay when compared to RDSR and LBP-AOMSV, it is due to extended route stability in combination with link failure detection which lowers the reiteration of route discovery process.

The above figure 4 tells us about the throughput of LP-PCP is 30Kb/s as average which is higher than RDSR and LBP-AOMSV which averages to 19.6 Kb/s and is constant. The increase in throughput of LP-PCP is high due to route selection which in turn depends on maximum-minimum signal strength which not only gives extended route lifetime but also mechanism to detect dropping of packets in early time due to link failure.

IV. Conclusion

This paper gives a polished version of AODV called LP-PCP AODV aiming to get secure route through extended route lifetime. Through route discovery phase, route selection depends on signal strength of RREP packet. By using cross layer mechanism which estimates link failure in advance prior to packet drops. To enhance network performance we add link failure prediction at network layer and power control protocol at MAC layer. Using Network Simulator NS2, performance of LP-PCP is rated by comparing with RDSR and LBP-AOMSV. The simulation results make clear that LP-PCP has high performance compared to RDSR and LBP-AOMSV in terms of consuming energy, End to end delay and output rate.
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