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RESEARCH ARTICLE

CROSS-LAYER APPROACH FOR COMMUNICATION IN MANET

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Abstract- **Routing in mobile ad hoc network is highly dynamic in nature with limited resources. Traditional protocol architecture follows strict layered principles, which ensure interoperability, fast deployment and efficient implementations. However, lack of coordination between layers limits the performance of such architectures due to specific challenges posed by wireless nature of the transmission links. To overcome such problems we consider a cross-layer approach which allows information sharing between different protocol layers. In this work, we modify ad hoc on-demand distance vector routing protocol using cross layer approach which uses three parameters namely Signal to Noise Ratio (SNR), node lifetime and delay to improve the performance of routing protocol in mobile ad-hoc network and to avoid routing through bad quality links.**

Keywords:- Cross-layer approach, SNR, Routing protocol

1. INTRODUCTION

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile nodes connected without wires. In MANET each node moves independently and therefore acts as a router and the nodes which are not in direct contact with each other, contacts the desired node using multiple hops as MANET normally have limited transmission range.

Most of the routing protocol uses minimum hop count when making a route selection. Significant examples include ad hoc on demand distance vector (AODV) [1], dynamic source routing (DSR) [2], destination sequenced distance vector (DSDV) etc. In traditional protocol architecture strict layered principle is followed where only adjacent nodes can communicate with each other as shown in fig.1. To overcome such limitations, cross layer approach has been used where even non-adjacent layers can communicate directly with each other and can derive necessary information to improve overall network performance as shown in fig.2.

In this paper a new ad hoc routing protocol has been proposed which provides a reliable route based on three parameters namely SNR, low delay and longer node lifetime. It helps to find a more reliable connection.

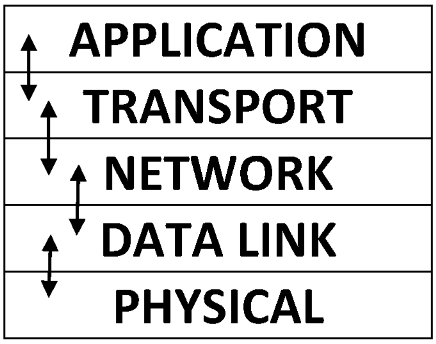

Fig.1: Traditional approach

The remaining section is organized as follows: section 2 describes the related work, section 3 focuses on the background, and section 4 gives the details of proposed work followed by simulation result in section 5. Finally section 6 concludes the paper.

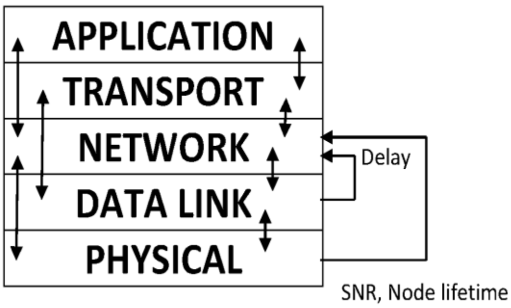

Fig.2: Cross layer approach

2. RELATED WORK

A lot of researches have been carried out in the area of MANET in the past few years to achieve QoS requirements using cross layer approach for communication among mobile nodes of the wireless network.

Fuad Alnajjar and Yahao Chen. proposed a protocol that is an extension to DSR protocol that uses either SNR (Signal to Noise Ratio) or RP (Received Power) to determine route [2]. Accounting only for SNR can't provides bandwidth and delay guarantees required by multimedia applications. Rekha Patil and A.Damodarm [3] proposed a cost based power aware cross layer routing protocol which deals with calculating cost based on battery capacity only. Al-Khwildi et al., proposed Adaptive Link-Weight Routing Protocol using Cross-Layer Communication for MANET which adaptively selects an optimum route on the basis of available bandwidth, low delay and long route lifetime. It provides advantage over AODV only in terms of network load and route discovery time [4]. In [5] author proposed quality of service provisioning in MANET using a cross-layer approach for routing, a novel MANET routing protocol, Type of Service, Power and Bandwidth Aware AODV (TSPBA-AODV), which overcomes resource constraints and simultaneously provides QoS guarantees using a cross-layer approach, is proposed in this paper. In [6], the author presents a solution to only energy conservation by a cross layered approach. In [7] the author proposed a CLD that uses only SNR or RP as parameter over AODV protocol.

3. BACKGROUND

AODV is Ad-hoc On Demand Distance Vector Routing protocol. It is purely On-Demand routing protocol where each mobile host operates as a specialized router, and routes are obtained as needed (i.e., on-demand) with little or no reliance on periodic advertisements. The route discovery and route maintenance is done by four messages in AODV. These messages are Route Request (RREQ) and Route Reply (RREP), Route Error (RERR) and HELLO messages. Route Request (RREQ) and Route Reply (RREP) messages are used for route discovery. Route Error (RERR) messages and HELLO messages are used for route maintenance. When a node wishes to send a packet to some destination, it checks its routing table to determine if it has a current route to a destination. If yes, it forwards the packet to the next hop node and if no, then it initiates a route discovery process which begins with the broadcast of Route Request (RREQ) packet. The packet contains– source node's IP address, source node's current sequence number, destination IP address, destination sequence number. The Packet also contains broadcast Id number which is incremented whenever the source issues a new RREQ. Each neighbor either satisfies the RREQ by sending a route reply (RREP) back to the source (reverse path setup), or rebroadcast the RREQ to its own neighbors after increasing the hop count. Since an intermediate node could have many reverse routes, it always picks the route with the smallest hop count. Each node periodically sends HELLO messages to its precursors. If a node has received no messages from some outgoing node for some fixed period of time then that node is presumed to be no longer reachable. Whenever a node determines one of its next-hop to be unreachable, it generates a Route Error (RERR) message. The node sends the RERR to each of its precursors. These precursors update their routing tables and in turn forward the RERR to their precursors and so on.

4. PROPOSED PROTOCOL

SNR, DELAY and POWER

(SDP protocol)

The proposed protocol i.e., SDP uses AODV as the base protocol and makes beneficial changes by using cross layer design and improves the quality of service parameters. Our research applied the ‘lower to upper layers’ approach where information from physical and MAC layer is utilized in network layer as shown in fig.2. The various modifications that are made in the base AODV protocol are as follows:

4.1 Packet format:

SDP protocol tries to find the best route using two control packets: Route Request Packet (RREQ) and Route Reply Packet (RREP). We have modified RREP packet and added an extra fields in the packet format to store the link cost value which is summation of SNR, delay and node lifetime.

The RREP contains the following information:

- Destination IP address
- Source IP address
- Broadcast_id
- Expiration time for reverse path route entry
- Source node’s sequence number
- Link Cost

4.2 Route discovery process

The route discovery process begins when a source node wants to have a route to some destination. When processing the received route request packet from neighboring nodes, the current node first checks whether its node’s battery is above the threshold value because if the node runs out of battery, the source node would have to find an alternative path to destination again. At every node node’s battery should be greater than the threshold value otherwise it discards the packet. When the route request packet arrives at the destination or an intermediate node with a route to the destination, a route reply packet will be generated. This reply packet is then sent back to the source node following the reverse route contained in the route request packet. Each intermediate node will update the link cost (which is the sum of SNR, delay and the node’s battery at the corresponding node) if its link cost value of path traversed by RREP are lower than the existing recorded values in the route table and stores the minimum among them. If link cost value is greater than or equal to the recorded value, the node will not update the value. This process will continue until the route reply packet reaches the source node. Now the source node has multiple available routes with different values of the link parameters. The source node will select the route based on the maximum value of link cost along end to end route. Figure 3 demonstrates the flowchart of how the proposed modified protocol will work.

4.3 Cost Calculation

Link Cost of a node has the following three components:

1) Signal to Noise Ratio cost
2) Delay cost
3) Power cost

Link cost of a node is weighted sum of all three of these costs.

LC= SNR+ delay+ node lifetime.

Where,

LC is Link Cost at receiving node,

SNR is Signal to Noise Ratio.

The Link Cost value is updated when the value of Link Cost of the path traversed by Route Reply (rp_lc) is lower than the recorded Link Cost value in the Route Table (rt_lc) as shown below:

if (rp_lc<rt_lc)

then rt_update //update route table entry and store rp_lc.

i.e., min (rp_lc, rt_lc)

else forward RREP //no update required.

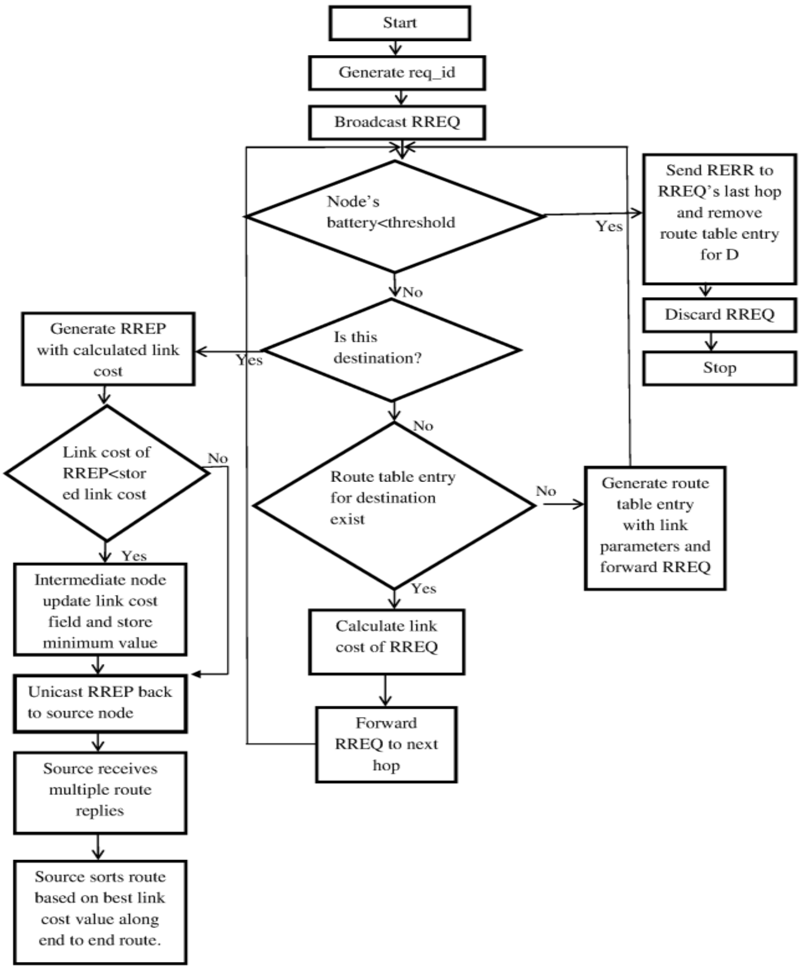

Fig.3: Route discovery process

5. SIMULATIONS AND RESULTS

A. Simulation Environment

In this simulation we have taken 100 nodes in a 2D field of 1000*1000. The simulation runs for 50 sec to 500 sec with pause time of 50 sec over CBR- traffic pattern. The initial lifetime of each node was taken to be 1000 units and node having battery power below threshold will not take part in data transmission or reception.

B. Simulation Results

Performance of AODV protocols in MANET can be realized by quantitative study of values of different metrics used to measure performance of routing protocols which are as follows.

1. Packet delivery ratio: It is the ratio of the data packets delivered to the destinations to those generated by the sources.

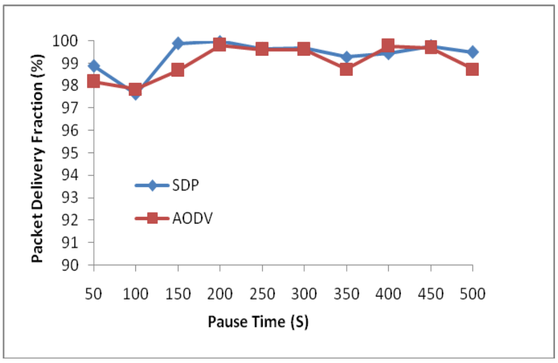

Fig. 4. Packet Delivery Ratio

SDP has better PDR than the reference protocol.

2. Average end to end delay: The average end-to-end delay of data packets is the interval between the data packet generation time and the time when the last bit arrives at the destination.

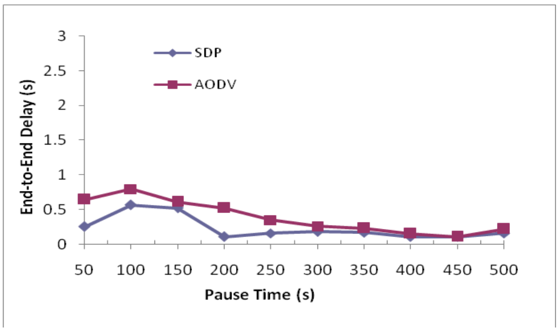

Fig. 5. End-to- End Delay

The graph shows improvement in end to end delay over small pause time but with large pause time the graph get overlapped with the traditional protocol.

3. Throughput: The throughput metric measures how well the network can constantly provide data to the sink. Throughput is the number of packet arriving at the sink in unit time.

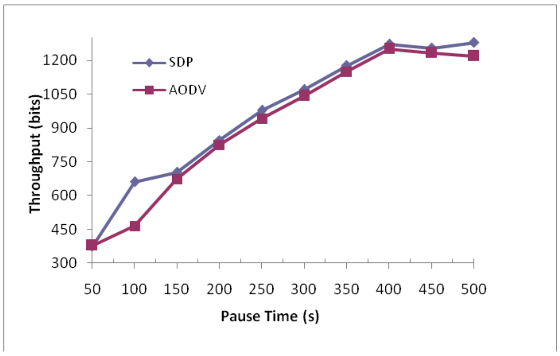

Fig. 6. Throughput

The graph shows improvement in the number of packets arriving at the destination in unit time with respect to traditional protocol.

4. Normalized routing load: It is defined as the total number of routing packet transmitted per data packet.

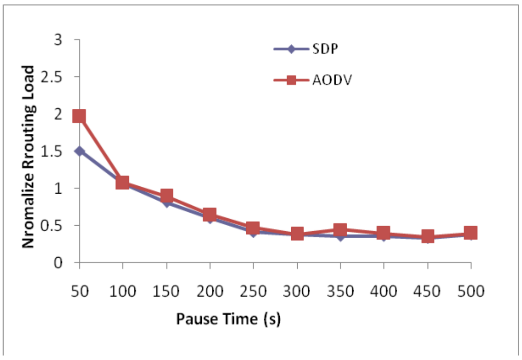

Fig. 7. Normalized Routing Load

6. CONCLUSION

In this paper we proposed SDP-AODV,a cross-layer routing protocol for MANET capable of achieving QoS in MANET. The results show that SDP-AODV perform better than traditional AODV [1].The performance is improved in terms of average end to end delay, throughput, packet delivery ratio and normalized routing load for CBR traffic pattern.

	SDP	AODV
E2E Delay	Low	High
PDF	High	Low
NRL	Low	High
THPUT	High	Low

The concept of cross-layer provides a wide field of information exchange between layers. We focused on SNR which is useful information to exchange because a low SNR level impacts throughput on the path. A low SNR level leads to a high bit error rate and consequently to a low link throughput. This protocol uses SNR, delay and node life time information in the calculation of the network metric to choose the link with the best available quality (low bit error rate and high throughput).

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