Cross Layer TCP Congestion Control Load Balancing Technique in MANET

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Abstract—The multipath protocol AOMDV is removes the limitation of alternative path and balance the load more efficiently. In this research the proposed scheme firstly, introduces a redundant multipath routing strategy, which establishes and maintains multiple backup routes from the source and intermediate node to the destination node and increment the buffer space of nodes with very low routing overhead. The proposed multipath routing protocols promise congestion avoidance, load balancing, improved throughput, fast recovery from link failures hence a more robust network, and a better utilization of the network resources by using the concept of buffer enhancement in AOMDV protocol. The proposed TCP cross layer TCP congestion control AOMDV routing is handled the load by using buffer capacity enhancement of mobile nodes. For congestion control, the route selection is always based on the shortest path during route establishment but after the delivery of data packets the congested path are handled through increment in the buffer space of nodes in network. Proposed Multipath routing algorithms are using the advantage of buffer enhancement removes the possibility of congested paths which is shortest between source and destination. The usage of such buffer enhancement has enabled load balancing and better utilization of the network. Thus, we realize the importance of proposed AOMDV multipath routing protocol as compare to original AOMDV routing protocol.

Keywords—AOMDV, Load balancing, MANET, TCP, Cross Layer

I. INTRODUCTION

It is a group of wireless mobile computers (or nodes); in which nodes collaborate with each other by forwarding packets for communication. Such networks have no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed. The participating nodes act as routers to route the packet to proper destination. These networks are fully distributed, self-configuring and can work at any place without the need of any underlying infrastructure. This property makes the ad-hoc networks extremely robust [1]. Nodes forming a temporary/short-lived network without any fixed infrastructure where all nodes are free to move about arbitrarily. Nodes must behave as routers that take part in discovery and maintenance of routes to other nodes in the network.

If two wireless hosts are not within the transmission range in ad hoc networks, other mobile hosts located between them can forward their messages, which effectively build connected networks among the mobile hosts in the deployed area.

Fig. 1 Mobile Ad hoc Network

Wireless links in MANET are highly error prone and can go down frequently due to mobility of nodes. Stable routing is a very critical task due to highly dynamic environment in Mobile Ad-hoc Network [2]. The Figure1 represents the scenario of MANET. So mobile ad-hoc network (MANET) is a self-configuring network of mobile routers (and associated hosts) connected by wireless links the union of which form a random topology. The routers are free to move randomly and organize themselves at random.

Multipath routing protocols can provide fault tolerance by having redundant information routed to the destination via alternative paths. This reduces the probability that communication is disrupted in case of link failure [3]. Multipath routing protocols can choose to divert traffic through alternate paths to ease the burden of the congested link. The alternative path balance the load in a single link on network i.e. also called the load balancing to reduce the possibility of congestion in network.

II. CONGESTION ISSUE IN MANET

In Mobile Ad hoc Network Wireless links will continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communications after accounting for the effects of multiple access, fading, noise, and interference conditions etc. is often much less than a radio's maximum transmission rate. One effect is congestion [4] is typically the norm rather than the exception, i.e. aggregate application demand will likely approach or exceed network capacity frequently.
As the mobile network is often simply an extension of the field network infrastructure, mobile ad hoc users will demand similar services. The problem of network congestion is considered as the main reason for potential performance degradation.

Congestion occurs when the amount of data exceeds the available capacity. TCP [5] congestion control is performed on an end-to-end basis. The receiver provides an ACK feedback back to the sender. TCP reliability is obtained through the utilization of a positive acknowledgement scheme which specifies TCP receiver to acknowledge data successfully received from the sender. Relying on the information provided by ACKs, the sender can detect which packets are lost during transmission. In MANET, the packet drops are more likely to be caused by failure on wireless interface instead of queue congestion. In addition, the access points do not resemble mobile terminals with limited power and radio capacity.

III. LITERATURE SURVEY

The literature survey has represents the previous work that has done in this field and also gives the idea about, to do different in field of cross layer TCP congestion control.

S. Sheeja, Ramachandra V. Pujeri in this work [6] proposed a Cross Layer based congestion control scheme is developed which attains congestion detection and congestion control among nodes. The first phase of the scheme, cross layer design is approach is proposed. Here the information is shared between the different layers of the protocol stack. In congestion detection phase, the packet loss rate is determined which ensures the detection of congestion in particular link. In congestion control phase, the route is found without congestion. Here the threshold value of path gain, congestion scales value and buffer tenure value. By using the extensive simulation results, the proposed scheme CLCCS achieves the better throughput, packet delivery ratio, low delay and overhead than the existing schemes ECAS.

G. S. Sreedhar & Dr. A. Damodaram in [7] proposed a Medium Access Level Multicast Routing for Congestion Avoidance in Multicast Mobile Ad Hoc Routing Protocol to avoid the congestion in networks. This protocol derives an algorithm that transmits the data in multicast manner at group level unlike other multicast protocols, concentrating of data transmission in a sequence to every targeted node. Being independent, the proposed work was with group of either tree or mesh.

S. A. Jain in [8] provides their deep insight to TCP congestion control mechanism and proposed route failure detection mechanisms.

It is suggested that most of the mechanisms are aiming at increasing the life time of the networks and improving the performance of the parameters like packet delivery ratio, end to end delay etc.

Senthil Kumaran, T. and V. Sankaranarayanan in [9] presents the Congestion Free Routing in Ad hoc networks (CFR), based on dynamically estimated mechanism to monitor network congestion by calculating the average queue length at the node level. While using the average queue length, the nodes congestion status divided into the three zones like safe zone, congested zone and congested zone. The scheme utilizes the non-congested neighbors and initiates route discovery mechanism to discover a congestion free route between source and destination. This path becomes a core path between source and destination. To maintain the congestion free status, the nodes which are helping data packet transmission periodically calculate their congestion status at the node level.

In this paper [10], we study the network utilization in terms of load distribution and path lifetime using the routing optimizations that we previously proposed in this work. The path lifetime is defined as the duration from the moment when the path is established to the moment when the path is considered broken. We already investigated the performance in terms of end-to-end delay, package loss ratio, and the overheads per package introduced by our optimization.

In this paper Chandran [11] proposed TCP-feedback, with this solution, when an intermediate node detects the disruption of a route; it explicitly sends a Route Failure Notification (RFN) to the TCP sender. The source on receiving the RFN, it suspends all packet transmissions and freezes its state. But when a middle node learns of a new route to the destination, it sends a Route Re-establishment Notification (RRN) to the source.

IV. PROPOSED TCP CROSS LAYER TECHNIQUE

The proposed cross layer TCP congestion control mechanism is not able to handle the unique properties of a shared wireless multi-hop channel. In particular the frequent changes of the network topology and the shared nature of the mobile ad hoc network channel pose significant challenges. The sender from source starts forwarding the data packets through the path containing minimum cost, congestion and bandwidth availability. The packets upon reaching every intermediate node updates its list with the node information such as its particular id, information about the neighbor node, cumulative assigned rates for incoming and outgoing flow and requested data rate stored in the available bandwidth field and the intermediate node computes the available bandwidth on the link.
The AODV protocol is established the single route for transmission in between sender and receiver.

The problem of channel availability in single path critical by that it is necessary to used the channel capacity efficiently. If the channel is available then in that case it is necessary to control the data rate of sender in network. For Available bandwidth it is essential data rate is not more than it. So that it is necessary to find data rate is smaller than the channel capacity, then the node forwards the packet to the next node on the path. Else the node replaces rate is controlled and proceeds to forward to the next node. When the data packet reaches the destination, the available field is copied to new packets and feedback to the source. The intermediate node updates its data rate with new value when the data packet is traversing towards the source. The source after receiving the data packet updates its new bandwidth value.

Whenever a packet is lost (or more precisely, when the TCP sender believes a packet is lost), the sender should slow down the sending rate. This slowdown is achieved by reducing the congestion window size. The rationale behind this is, TCP assumes only congestion causes packet losses. Here the congestion is essentially buffer overflow occurring at intermediate routers. If the queue sizes of intermediate nodes are full then in that case it necessary to increases the size of queue in network. If the size of queue is increases by that the data is received at higher data rate is stored not drop in network. After the enhancement of queue length the store and forwarding capacity of nodes are increased due to that the packet loss is reduces

The proposed algorithm is mentioned below of above explanation:

A. Proposed Algorithm for TCP Cross Layer base Congestion Control

Initialize Mobile Node: M
Initialize sender: S where S belong M
Initialize sender: R where R belong M
Terrain Size : 800*800 Meter
Initialize Queue DropTail
Initialize Antenna : OmnibAntenna
Initialize MAC : 802.11
Initialize Routing : AODV
Sender ()

{ Broadcast route-pkt (S, R, Range)
  If (Next-hop in Range && Channel == idle)
  { Receives route-pkt;
    Compare (Node-id, R)
    { If (ID not matches)

    Forward route-pkt to next-hop till receiver found or ends of reachable node;
    }
    Else {
      Generate route-table
      Reverse back ACK to Sender;
      Call Data-Tx();
      }
    }
  Else if (next-hop in range && channel == busy)
  { Wait next RTT (Round Trip Time)
  }
  Else {
    Receiver not Found
    } Hello-TCP (Hello_TCP, S,R)
  { Check (next-hop, bandwidth)
    If (bandwidth < Data rate)
    { Data rate = bandwidth;
      } R receives Hello-TCP;
      Send ACK to S;
      }

Data-Tx (Data, S, R)

{ Data Receive by intermediate Node;
  If (incoming-bandwidth > outgoing-bandwidth)
  { Data enqueued;
    Increase queue;
    } Intermediate send data to R node;
    Dqueue
    R sends ACK to S Node;
    Sender rest Data Rate;
    }

V. USING THE TEMPLATE

In order to demonstrate the tradeoff among hop count, load distribution fairness, and path stability, we implement the above three Cross Layer optimizations as well as the interaction architecture in the Network Simulator 2 (ns-2) [12]. We use the AOMDV [13] as the routing protocol. We use the random waypoint mobility model in the ns-2 simulator. In random-based mobility simulation models, the mobile nodes move randomly and freely without any predefined manner.
The destination, speed and direction of each node are all chosen randomly and independently of all other nodes. The traffic pattern and node movement are generated using CMU’s traffic and scenario generating scripts in ns-2. The results are the arithmetic mean of values from different simulations. The simulation uses the following scenario:

- Mobility model: random waypoint [14];
- Number of nodes = 50;
- Area: 500m * 500m;
- Node speed in between 0 to 30 m/s;
- Data sources: 5 FTP on TCP, and 2 CBR on UDP;
- Test duration is of 100 seconds. Compare the result from the original AOMDV and AOMDV with proposed Cross layer load balancing approach.

VI. SIMULATION RESULTS

The simulation results are evaluated on the basis of simulation parameters that are mentioned in section V. The proposed scheme is showing the better results as compare to normal AOMDV routing protocol.

A. PDR Analysis of AOMDV and Proposed AOMDV

The percentage of packets are successful deliver in network are calculated by PDR (Packet Delivery Fraction) in network. The PDF performance is based on the ratio of number of packets send and receives in network. This graph stands for the PDR comparison of original AOMDV and proposed AOMDV. The PDR in case of original AOMDV is about 86% in network and in case of proposed AOMDV is 97% percent in network, it implies the performance of proposed AOMDV are provides the better result as compare to original AOMDV. The proposed AOMDV performance is enhanced because of enhancing the storing capacity of buffer (Queue) in network. The AOMDV has a capability of confiscating the possibility of congestion through providing the alternative path in network and balance the load on a single link and nodes of link. In proposed multipath routing approach the store and forwarding capacity enhancement of nodes are better handle the congestion and balance the load in network.

B. Throughput Analysis of AOMDV and Proposed AOMDV

Throughput is the number of packets completely sends or receives in network in per unit of time. The throughput evaluation is essential to measure the quantity of packets with respect to time unit. This graph represents the throughput analysis in case of original AOMDV and proposed AOMDV in network. The throughput in case of proposed AOMDV is about 950 pks/second at the end of simulation time of 100 seconds and the throughput in case of original AOMDV is about 705 pks/sec. received at destination at the end of simulation time in network. Because of inefficient load balancing and congestion the throughput difference is huge. The proposed nodes buffer enhancement scheme increases the throughput and also improves the routing capability of multipath protocol through extend the storing capability of nodes in network.
C. Hello Packet Analysis in case of AOMDV and Proposed AOMDV

The hello packets are delivering in network because of finding the destination and establishment of connection in between sender and receiver in network. The hello packets are the route request and route reply packets. The hello packets quantity are more than less number of data is deliver in network in a given simulation time. This graph has measured the hello packets interval in case of original AOMDV and proposed AOMDV in network. The routing load in case of proposed AOMDV is less about 410 packets and after time 69 second no routing packets are deliver because of no retransmission are required due to proper load balancing and buffer enhancement in network. However in case of original AOMDV the routing load is very high, about 1100 packets are required to deliver data but at time 95 second no routing packet is also deliver in this multipath routing. The reason of more routing load is due to congestion packets are loss and then provide alternative path it implies the retransmission in network through senders, for that again connection is established then deliver hello packets for destination finding as a result the routing load increases.

<table>
<thead>
<tr>
<th>Drop Reasons</th>
<th>Original AOMDV</th>
<th>Proposed AOMDV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Packets Drop</td>
<td>Drop %</td>
</tr>
<tr>
<td>Drop from ARP</td>
<td>6</td>
<td>0.06%</td>
</tr>
<tr>
<td>Drop from IFQ</td>
<td>733</td>
<td>7.45%</td>
</tr>
<tr>
<td>Drop from CBK</td>
<td>45</td>
<td>0.46%</td>
</tr>
<tr>
<td>Drop from NRT</td>
<td>1</td>
<td>0.01%</td>
</tr>
<tr>
<td>Total Drop</td>
<td>596</td>
<td>6.06%</td>
</tr>
<tr>
<td>Drop Via Congestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Drop</td>
<td>1381</td>
<td>14.03%</td>
</tr>
</tbody>
</table>

VII. CONCLUSION

The source node initiates a route request when all its alternate paths fail. The main drawback of AOMDV routing protocol is that the alternate paths that are computed during route discovery are not maintained during the course of data transfer and there is no ability to handle the load on the existing established path. Thus the paths could become stale and outdated by the time they are actually utilized. The multipath approach in this protocol is therefore not adaptive to the changes in the network topology. The proposed TCP cross layer AOMDV scheme is enhance the storing and forwarding capacity of mobile nodes by that it handles the load beyond the capacity of buffer space. The usage of multiple paths as backup routes and the discussion on the inability of load balancing by multipath routing protocols, forces us to think that multipath routing is unnecessary in mobile ad hoc networks. There are multipath routing protocols that use the available paths simultaneously and, moreover, load balancing can be achieved by those protocols with reasonable considerations. Besides route maintenance, the node also needs to maintain congestion status of the neighbor nodes so that it can forward data packets according to the congestion status of the next hop nodes in routes. The proposed scheme is evaluate the congestion status of a node and updating the storing capacity of other neighbor nodes. The simulation results are shows that the routing enhancement of AOMDV protocol are showing the better result as compare to original routing protocol.
REFERENCES


