Improving Efficiency and Fairness in Mobile Ad Hoc Networks

Varun Manchikalapudi and Sk. Khadar Babu

Abstract All mobile ad hoc networks (MANETs) exhibit versatile behaviour in its topology because of node mobility factor. In theory, TCP happens to be a transport layer protocol designed to provide a reliable end-to-end delivery of data over unreliable networks. But in reality, TCP encounters some challenges in multi-hop ad hoc networks especially route failures and so congestion. To address this problem previously, contention detection using congestion window adaptation (CWA-CD) procedures are designed and implemented to handle route failures. Its performance is not up to the mark because of the complexity encountered in detecting the contention variations from the round-trip time delays. So for a robust and better network performance, we propose to use candidate list generation algorithm for packet forwarding with congestion control by contention control (4C) method. The algorithm involves constant updates of location specifics for every small intervals of time and steps to sort out the forwarding list that aids communication. As a result, nearest nodes or routers participate in data transmission and this improves network performance and controls the congestion. A practical implementation of the proposed system validates the claim in terms of efficiency and fairness.

Keywords MANET · TCP · Contention · Congestion · Efficiency · Fairness

1 Introduction

mobile ad hoc networks (MANETs) are a type of unguided ad hoc network that often refers to a function of IEEE 802.11 [1] unguided network, and it has networking environment which is routable. MANETs do not require any external effort

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in order to control its infrastructure. They consist of end-to-end, self-making, self-recoverable network. In contrast to a mesh topological network, MANETs can configure themselves and change locations on the fly. A wireless ad hoc network is a decentralized kind of unguided network. The network is ad hoc because it does not depend on its pre-existing infrastructure, such as guided media network routers or access points in managed (infrastructure) unguided media networks. Instead, each node participates in routing by forwarding data segments for other nodes, so the determination of which node forwards the data is done automatically on the basis of connectivity of the communication network.

The flow rate is not properly given in MANETs due to many problems such as node migration, unguided link failures, channel, or bandwidth capacity variation, so it is required to find the solution for these problems. Moreover, these problems will affect the fairness and efficiency in MANETs. Fairness and efficiency are the two challenges or objectives to achieve when the flow control is come into the scene. Fairness means all the competing flows must have the equal share of the channel capacity or bandwidth and efficiency, or throughput in the form of efficiency is accumulated network traffic at the router must coincide with the available channel capacity of the outgoing links or connections.

In theory, TCP is designed to provide a reliable end-to-end delivery of data over unreliable networks, but in reality, TCP exhibits some challenges in multi-hop ad hoc networks especially route failures. Optimized TCP protocols using contention methods, i.e. contention detection using congestion window adaptation (CWA-CD) procedures, were used to handle route failures. In MANET, every node is functioned solely, and unfairly, information of one node has been accessed by other nodes in the network. Due to this, we face some problems such as network congestion, unfair bandwidth allocation, and decrease in throughput. We use "candidate list generation algorithm" to handle node mobility factor with the combination of congestion control by contention control procedure.

The candidate list will be attached to the packet header and updated hop by hop. Only the nodes specified in the candidate list will act as forwarding candidates. The lower the index of the node in the candidate list, the higher the priority it has. In proposed system, the nodes which are close together participate in the data transmission. So a better ad hoc network that is robust to node mobility is constructed using the above methods.

2 Existing System

In existing system, bandwidth delay product is calculated with congestion window adaptation and contention detection technique. In data communications, bandwidth delay product [2] refers to the product of data link capacity which is calculated in terms of bits per second and its round-trip delay time which is in seconds. Here, contention is detected by dividing or explaining the round-trip time in two ways, one is contention RTT and another one is congestion RTT. We all know that congestion occurs due to the problem obtained by contention between the network nodes. Network performance is gradually decreased due to the overhead of capturing the contention RTT values [2].

Moreover, in MANET, every node functions independently and all the nodes try to access the links bandwidth so the packets send by one station may also be available to other stations [3], because of this, network performance is degraded and fairness is not achieved. Figure 2 represents a MANET in which all the nodes have huge number of links to other nodes in the same network, the packets send by one node are made available to the other nodes, and every node will access those packets.

As shown in Fig. 1, the MANET completely filled with congestion or unfair accessing of information in the network among the nodes. This leads to heavy traffic load and unfair data transmission and slow data transmission rate, i.e. reduction in throughput. Due to all these drawbacks in existing system, enhancements had been done and are presented in this paper.

In Fig. 2, there are 10 nodes taken for sample and these nodes are being connected to other nodes in an unfair manner, and due to this, fairness is not achieved and efficiency of network in the form of throughput will be degraded. Assume every

Fig. 1 Illustration of MANET and packet transmission with unfair data transmission

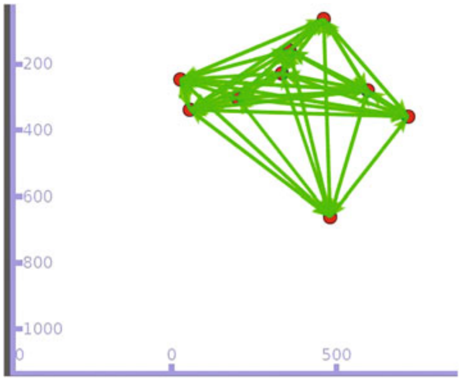
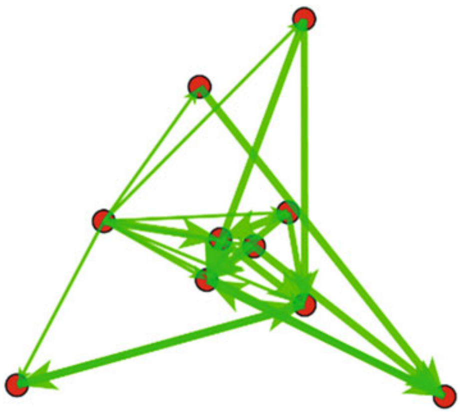


Fig. 2 Illustration of MANET and Packet transmission with better performance to some extent



individual node acts as a sender or receive. So we need to go for the further extensions to this model in order to get the efficiency and fairness among the nodes in the MANET.

3 Proposed Method

Existing mechanisms [2, 4] focused on link contentions and congestion control process. Even though, for calculating contention variation for every RTT is difficult because in the network, we keep sending so many packets from source to destination. So this process becomes very complex in order to observe the contention variation for every time interval, and bandwidth allocation is done unfairly. Link failures due to mobility are part of the main sources of link unreliability in MANETs. Among the proposed solutions to improve throughput of a network in MANET, we find a mechanism that focuses on MANET routing environment that exhibits high data transmission rates and less latency and reduces network congestion and fairness. In this paper, we propose to develop candidate list generation for packet forward algorithm along with congestion control by contention control (4C) method to handle route failures efficiently.

Algorithm

```
Algorithm    : Candidate node selection for packet forwarding
ListN        : Neighbor list
ListC        :  Candidate list, initialized as an empty list
Nr           : Receiver node
Base         : Distance between current node and Nr
               If (find (ListN, Nr) then
                      Next, hop← Nr
                  Return
                 End if
                For i←0 to length (ListN[i], Nr)
               End for
               ListN.sort ()
               Next.hop←ListN [0]
  For i,←1 to length(ListN) do
    If dist (ListN[i], Nr)>= base or length (ListN)=N
   Then
       Break
   Else if dist (ListN[i], ListN [0]<R/2 then
       ListC.add (ListN[i])
   End if
  End for
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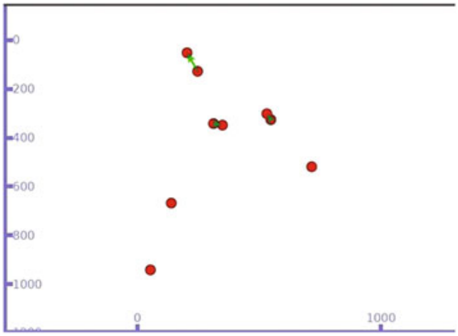
In the algorithm, ListN represents the neighbour list and ListC represents the candidate list, and the logic of algorithm verifies all the neighbours and selects candidate nodes through which data packets can be transferred to other nodes.

3.1 Congestion Control by Contention Control (4C) Procedure

Congestion and contention together degrade the network performance certainly, and one of the main reasons for congestion is simultaneous attempts to access the single network channel. So if we can control the contention problem, then obviously we can also control the congestion problem in MANET by using congestion control by contention control procedure. Every packet in the network contains a special header in which source and destination address is stored. As per the algorithm for the entire network, candidate node selection is done for packet forwarding. We all know that MANET migrates frequently from one place to another in all the way. Every nearest router checks the packet header and transfers that packet to nearest router in such a way that it reaches the target place or node.

The neighbour node verifies the special packet, and if it is not the target node, just forward to the next node and vice versa. If the target node is found with the help of acknowledgement, then it starts transferring the packets as long as the route is available. Due to mobility, if the target node goes faraway, then the link failure is occurred. Nodes in MANET continuously check the status of their neighbours by sending hello packets for every interval of time and update the routing table, and the router always stores the details according to the nearest router first. So it can easily allocate the next reliable route when link failure is identified, and due to this, continuous path will be maintained with less latency, and it also controls the packet loss and maintains high data transmission rate which causes throughput. When network haves multiple hops [5], then only the problem occurred usually is congestion, and due to this, packet loss or throughput reduction is happened. So handing route failure in multipath network is a challenge really and causes poor performance [6] of network (Fig. 3).

Fig. 3 MANET having fair bandwidth allocation and data transmission between nearest routers



4 Results and Observations

This result additionally demonstrates more change than the case in the past static situation [7], and accordingly, it outlines that the easing of blockage window overshooting still viably works in the element situation (Figs. 4, 5 and 6).

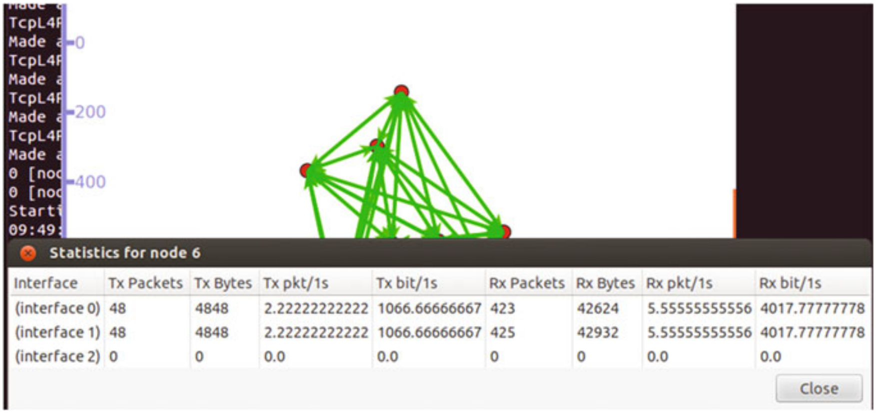


Fig. 4 Statistics for data transmission in the network

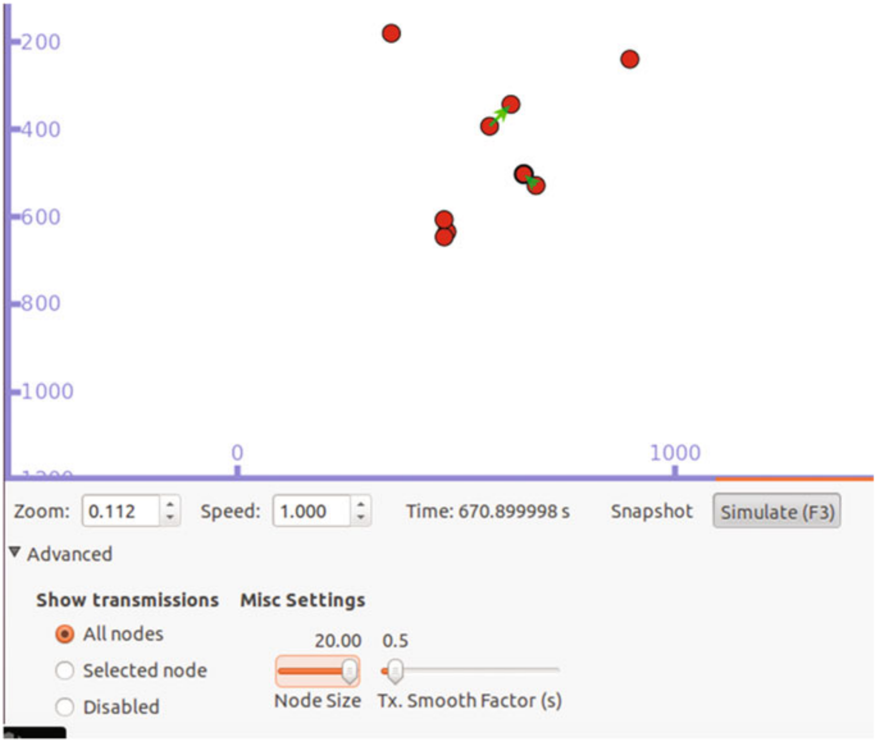


Fig. 5 Data transmission among the nearest nodes

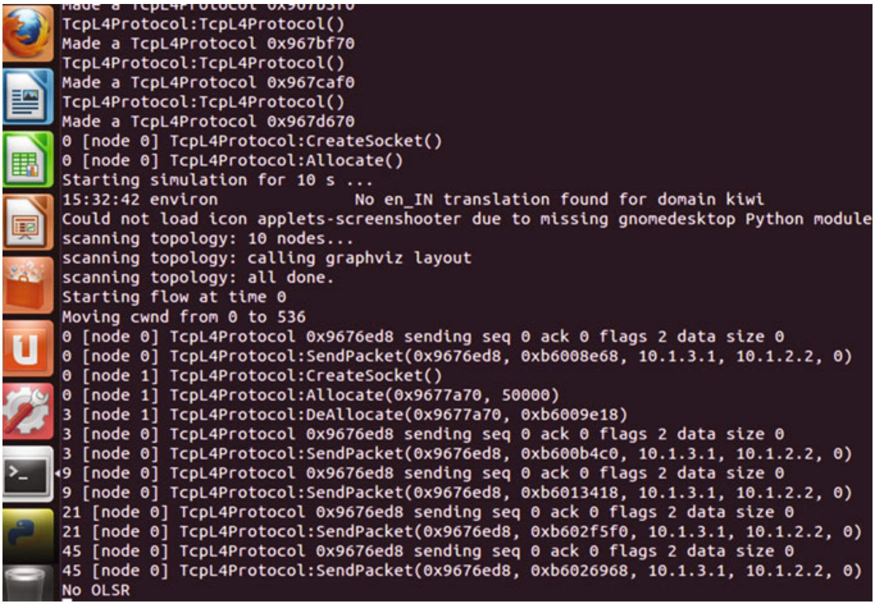


Fig. 6 Details of protocols displayed in the terminal

5 Conclusion

In this paper, we prefer to explain all data transmitting operations in order to improve the efficiency and fairness of the MANET. We present a new method called congestion control by contention control (4C) method in which contention is controlled in such a way that nearby nodes will participate in data transmission and we are using candidate node selection for packet forwarding algorithm. This algorithm keeps track of updated routing table which consists of list of nodes selected for packet forwarding and checks the status of the node in the network. Data packets are transferred as every node consists of packet header which holds source and destination address. This process reduces the contention and congestion, improves the throughput without packet loss, and maintains the fairness by allocating available bandwidth properly among several nodes.

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