Congestion Control using Node Reliability and Rate Control in Mobile Ad-hoc Network

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Abstract

The MANET (Mobile Adhoc Network) wireless system offers a few favorable circumstances, including minimal effort, basic system support, and helpful administration scope. In these systems, congestion can happen anywhere in the route while information getting forwarded from source node to destination node. These nodes can introduce long delays, which affect the overall efficiency of a system. Congestion leads to high data loss, long postponement and time misuse of asset. To avoid it, effective congestion control mechanism should be applied that makes best use the accessible system assets and keeps the load underneath the limit. This paper proposed a mechanism to organize the congestion as well as bestow better performance with respect to network parameters under dynamic behavior. Local route repair methodology for route establishment process mechanism is used to resolve the collision while manifold nodes compete for the channels assignment. The result taken in different scenario conclude that the proposed approach is effective as compared to existing congestion control implemented in on demand routing protocol.

Keywords: *MANET, AODV, PDR, RTT, CTS, RTS, Collision, Congestion*.

1. INTRODUCTION

Adhoc network is a collection of wireless links connecting wireless terminals and it is adaptive in nature, also characterized by self organizing nodes. This is normally a decentralized network. This network is said to be an adhoc because determination of nodes that are willing to forward the data is made dynamically. Due to lack of central controller, if any new terminal is detected, adhoc network automatically inducts it where as if any terminal moves out of network, the rest of the terminals routinely reconfigure themselves. Each wireless terminal in the adhoc network is operational with a transceiver, an antenna and a power source. These wireless nodes are mobile and so this network is termed as Mobile Adhoc NETwork(MANET). Wireless medium is error prone with limited bandwidth and factors like multiple- access, signal fading, noise and interference causes significant throughput loss in MANET. In MANET, there is need of a routing procedure as there is no infrastructure support. Routing is also required to trace the destination node which might be out of range of a source node. In this case to implement routing, each terminal must be able to forward data to other nodes. Mobility of nodes lead to frequent changes in the network topology and also makes existing routing protocols inefficient for the dynamic topologies. Therefore reactive routing algorithm Adhoc On- Demand Distance Vector AODV is specially developed for MANET. AODV works in two phases viz. routing discovery and maintenance which consists of transmission of large number of data packets through relatively small number of nodes and hops. This leads the MANET to congestion that weaken overall network balance and efficiency. supports routing and flow control is supported by TCP. In case of TCP, link broken is mistaken as congestion. So improved congestion mechanisms is required.

2. EXISTING WORK

Reference [1] presented two mechanisms least delay, Interference Aware Multipath Routing protocol (LIMR) and Shortest path, Interference Aware Multipath Routing protocol (SIMR) to reduce the power of interference between the selected node- disjoint multipath schemes.

Authors presented [2] more adaptive, more reliable congestion control protocol for ADHOC network using BYPASS route selection. It is done by distributing traffic on multiple routes by applying traffic splitting function. The work has achieved reduction In packet drop and overhead.

Reference [3] presented node degree theory for congestion control and utilized node with less degree to forward the packets.

Reference [4] introduced the multipath load balancing technique for congestion control in MANET. To efficiently balance the load among the desirable paths, the link cost and the path cost parameters are effectively used.

The literature [5-7] described that reactive protocols lay down the routes on-demand, need raised by source nodes in adhoc manner. Whenever any node wants to open communication with another node, the routing protocol makes efforts to set up a route. This protocol floods the network with Route Request (RREQ) and Route Reply (RERP) messages. With RREQ, the route is discovered from source to target node and when target node sends RERP for the confirmation, the route has been established. It is on-demand means a route is established by AODV from a destination only on demand and it is capable of unicast as well as multicast routing. It keeps these routes as long as they are desired by the sources. To ensure newness of established routes, protocol applies sequence number generated on every RREQ. Every RREQ carries a time to live TTL value. This numeric value stores the count of hops, this message should be forwarded. Every node keeps two separate counters: a node sequence number and broadcast ID which in pair uniquely identifies a RREQ. RERR message is used to notify other nodes of the loss of the link. Each node keeps a precursor list containing IP address for each of its neighbors which are likely to use the link as forwarding hop. If a link crack occurs while the route is active, RERR message is propagated to the source node. After receiving the RERR, if still source node desires the route, it can re initiate route discovery.

MANET faces challenge to maintain and allocate shared network resources- bandwidth of the link and queue on the terminal. When excessive packets are pending for transmission in the link or the queue, MANET is said to be congested. Existing congestion control methods are implemented by existing routing method based on Transmission control protocol traffic flow. In other words, performance analysis of traditional TCP congestion control mechanism for MANET is done by application of routing protocol.

2.1 Problem Statement

TCP was designed and implemented to provide end to end reliable communication for wired network. It also ensures ordered delivery of data packets. It also provides flow control and error control mechanism. In case of ad hoc network, packet losses are due to congestion and due to dynamic topologies causing link failure. So TCP traffic flow in routing protocol, misinterprets any type of packet losses as loss due to congestion. TCP modifies the transmission rate further degrading network performance unnecessarily. To overcome these issues, TCP congestion control mechanisms have improved by researchers and literature has reported the various versions of TCP.

This paper proposes new TCP [7] variant that will identify link unavailability due to congestion. Modification in TCP is implemented by modifying routing table entry and HELLO message packet format. Further analysis is done using reactive routing protocol AODV.

3. PROPOSED CONGESTION CONTROL

AODV protocol floods the route link with RREQ and RREP. If congested route is detected by any intermediate node, the RREP response is delayed to sender. After waiting for some time, sender initiates RREQ again in traditional AODV which further increases control messages and network leads to congestion. In proposed protocol, on finding congestion, intermediate node or neighboring node initiates RREQ by itself. Local route repair module finds alternative route. Intermediate node then determines route reliability and node reliability. Proposed congestion control is suggested using collision and congestion resolving using CTS/RTS mechanism.

3.1 Steps for congestion control:

The algorithm is consisting of three modules- route establishment using local route-repair, route reliability and collision resolving.

Periodically transmit modified HELLO packet to check neighboring node status

Read routing table entry of hop count and number of active connections

At neighboring node, buffer count is compared with queue length. If the queue length exceeds threshold count, classify the node into heavy, moderate and slightly congested node

In case of heavy and congested node, choose previous node agent and initiate local_route_repair to find alternative route

In case of slight and moderate congestion, reduce transmission rate using multiplicative decrease factor and achieve congestion control at the cost of delayed transmission.

Route Repair algorithms pseudo code

Initialization:

M: mobile nodes
S: Sender nodes
R: Receiver nodes
I: $\{i_1, i_2, \ldots\ i_j, i_{j+1}, \ldots\ i_{n-1}, i_n\}$ intermediate nodes
L: $\{l_1, l_2, \ldots\ l_k, l_{k+1}, \ldots\ L_{m-1}, l_m\}$ i.e $l_1 = i_1 i_2$
link between nodes
Step time: {1,2,……..100}
λ= 0 step change
While λ <=100
Do
Check route-table(S, i_j, R)
If l_k update && R! exist **then**
Check path l_k to l_m
If i_j to i_{j+1} route break **then** Local-route-repair (l_k, l_{k+2},R)
End if
End if
λ = λ+10
End do
$s(t+1)=s(t) + k$ //if congestion is not detected $s(t+1)=s(t) * l$ //if congestion detected
where s(t) data sending rate at time slot t k -additive increase parameters
$l(0<l<1)$ multiplicative decrease factor

Local-route-repair: This module buffers the packet and spots the route as under repair. The send Request() function sends a RREQ control packet to identify alternate route.

The pseudo code is combined with network configuration files and implemented by varying number of nodes to analyze congestion control.

4. PERFORMANCE ANALYSIS

Proposed Modified TCP Control Flow is implemented and executed by changing number of nodes in simulation environments for number of runs to plot and tabulate results to analyze the work done.

4.1. Simulation Environment

The simulation is done by using widely used powerful network simulator NS-2 version 2.31 for Mobile Ad-hoc Networks [7]. AODV protocol is in built part of NS-2 installation. The paper is implemented by modifying HELLO packet and routing table entry in NS2 with the help of configuration files. An NS2 code is edited to implement congestion control of TCP. TCL script file is written to specify node configurations parameters and other related ns commands. The output of simulation is trace file. Each and every event during the simulation updates this trace file. This file is used for analyzing performance parameters of MANET [7]. The random topologies and varying nodes are generated using set_dest tool in NS2 for the simulations. Simulation configuration file choose the source-destination terminals randomly. Pause time 0 means each node moves constantly throughout the simulation. The queue length is set to 50 packets to analyze congestion situation. Congestion control is observed for a 800m * 800m grid by varying number of nodes as 10,25,50,75 and 100 with random movement.

4.2 Performance Factors

This subsection provides the terminology of performance factors that are considered for comparing effective implementation of TCP congestion control with AODV routing presented in this paper. The two main factors analyzed are [18]:

Packet delivery ratio: Packet Delivery Ratio (PDR) is analyzed by counting number of successfully received by the terminal.

Simulation is done by varying number of nodes as 10, 25, 50, 75 and 100 nodes. Packets may queue up at the source and never enter the network in a good disciplines network on getting unstable due to congestion. This affects the network throughput

Normalized Routing Load (NRL) : NRL is counted at destination terminal. Minimum NRL shows less network overhead and maximum channel utilization. Modified AODV with TCP congestion control periodically broadcast HELLO packet for early congestion detection and increases delivery of data packets by alternate route to destination.

4.3 Packet Delivery Ratio

Graph is plotted for percentage PDR against number of nodes, shown in the figure 1. When any intermediate node senses congestion with the help of HELLO message, it requests previous adjacent node to check for alternate route. Availability of alternate route avoids congestion and increase PDR.

4.4 Normalized Routing Load (NRL)

Figure 2 displays the graph of NRL simulated by varying number of nodes and shows significant improvement.

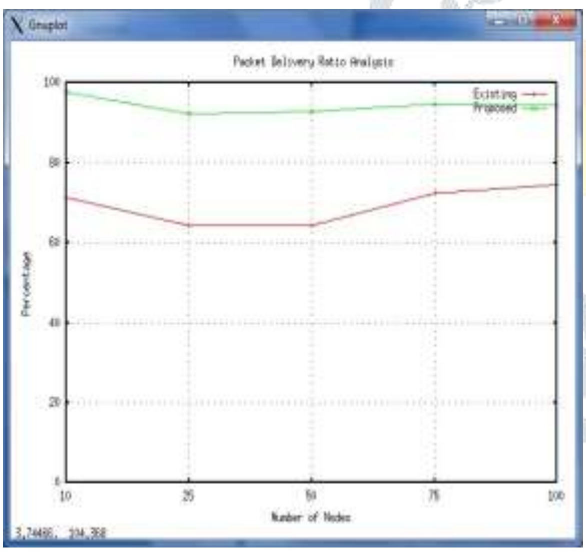

Figure 1 Comparative Analysis of PDR

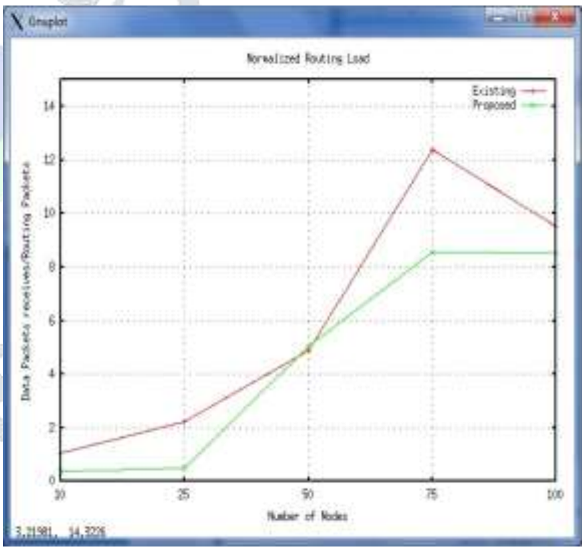

Figure 2 Comparative Analysis of NLR

5. CONCLUSION

The proposed approach gives greater than 90% of PDR, the routing overhead is lowest while number of nodes is minimum and packet drop ratio is also reduced as compared to existing AODV routing. Local route repair methodology for route establishment process mechanism is used to control and resolve collision. This is resulted in improved packet delivery and other network parameters. The work can be extended to study congestion control with other reactive routing protocols.

6. REFERENCES

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