An analysis of congestion control in MANETs using Cross-layer TCP protocol

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ABSTRACT: The paper covers the different aspects of cross-layer protocol that provides the congestion control in Ad-hoc mobile networks. Mobile Ad Hoc Networks consists of mobile nodes organized in a random manner that can communicate with each other without any centralized infrastructure. The packet loss is heavily occurred in the particular link due to congestion and to avoid that cross layer based TCP protocol scheme is used. In this paper the introduction to these terminologies has been briefed and the performance analysis of using this protocol in network has also been analyzed in quantative manner. Congestion control and TCP based flow has been discussed while figuring out the problems occurred in networks and solution to such problems.

Keywords: MANETS, TCP protocol, Congestion control, Multihop.

1. INTRODUCTION

1.1 Wireless Networks

Remote systems are more famous among organization and home clients around the world. Clients are looking for novel advancements that gives the support of convey whenever and anyplace utilizing any specialized gadget. Henceforth, remote correspondence assumes an indispensable part in up and coming correspondence frame works. The benefits of remote systems over wired partners are adaptable versatility administration, snappier and less expensive operation, and lastly more straightforward protection and development strategies.

Clients began using the specially appointed method of 802.11 separated from the framework mode, in which numerous remote bounces are utilized to join two far-away hubs. Hubs can impart to one another specifically without a focal facilitator in the specially appointed mode and pass on information to one another in a self-ruling way. This construction modeling is known as multihop remote specially appointed systems or multihop remote systems. The system topology can change rapidly and haphazardly as the versatile hubs change its position or the remote channel's condition shift. Strong and versatile correspondence conventions that can deal with the undertakings of these multihop arranges easily are required.

1.2 Congestion Control using TCP based flow

In MANETs links continue to have significantly lower capacity than their hard wired counterparts and the realized through put of wireless communications is often much less than aradio's maximum transmission rate. To control the congestion one system is based on TCP which is utilized to keep up the information transmission by utilizing sliding window strategies.

TCP congestion control is performed on an end-to-end basis.TCP reliability is obtained through the utilization of a positive acknowledgement scheme which specifies TCP receiver to acknowledged at a successfully received from the sender. The fundamental target of the plan is to guarantee that the sender must level its transmission rate to fulfill their own particular and beneficiary's requirements. The TCP sender has a variable meant window to focus amount packets it can send into the system preceding get an ACK. This variable enthusiastically differs after some time to constrain the association's sending rate.

The stream control and the congestion control are two different concepts to control the flow of packets. Despite the fact that these two instruments are comparable for the situation that both attempt to stay away from the association [8] from sending at an expanded rate, they have one of a kind purpose. To stay away from a TCP sender from flooding the recipient's support, stream control is executed. In each ACK transmitted, the recipient promotes a window point of confinement to the sender. This window is called as recipient publicized window (rwin). It adjusts over the time in view of both the activity conditions and the application speed while perusing the recipient's cushion [1] [3].

Congestion control has the connection with the movement inside the system as opposed to stream control which is a differentiating factor. The fundamental intention is to stay away from disappointment inside the system when the system is slower than the activity source in sending the information.

Notwithstanding that, TCP sender utilizes a constraining window called congestion window abbreviated as cwnd. By accepting that the sender is not restricted by the beneficiary, cwnd means the measure of information that the sender send before an ACK is gotten [8].

By considering both stream control and congestion control, the sender needs to face two restricting elements for its window size abbreviated as rwin and the cwnd. The sender manages its window to the base in the middle of rwin and cwnd to coordinate with both control plans [12].

Putting constraints on variable of a TCP sender analyzes that the beneficiary's support is much of the time sufficiently substantial not to restrict the sender's transmission rate. To identify congestion inside the system and quickly respond by precisely backing off the system of congestion took quite an amount of time to be developed the way it is today.

1.3 Multihop Wireless Networks and TCP

In multihop TCP/IP is the best decision is that a large portion of the late applications like HTTP, FTP, SMTP, and Telnet are suitable for this convention. Moreover, the utilization of TCP/IP' makes interoperation with the web. These days, the selective elements of 802.11 that is tended to underneath, necessities the adjustments in the upper layer conventions utilized as a part of the Internet. The dependable information conveyance gave by the transcendent web transport convention TCP is bargained in such systems. At the point when the system is extensive, the corruption is higher. Conforming TCP to these systems is critical in remote systems as transfer speed is an exceptionally constrained asset.

Because of the disparity in the middle of TCP and the MAC convention, TCP may happen to degrade in Multihops. Regardless of the possibility that the IEEE 802.11 standard can possibly take a shot mode allowing the setup of a system without framework, it is not streamlined for systems with extensive number of jumps.

This standard means RTS/CTS control casings to affirm that system transmit with greatest three jumps are not affected by the understood shrouded hub issue. Conflict crashes may happen to corrupt the channel quality for more than three bounces. The overhead of RTS/CTS consolidated with the loss way of the remote channel and portability can bring about a TCP association with a poor execution. The way that TCP is intended for wired systems where this condition does not exist. We audit the key difficulties for TCP over Multihop remote systems.

1.4 Challenges to use TCP

In such systems the loss may occur because of its medium and connection intrusion when the hubs move, not at all like wired situations where a dropped parcel is constantly had a place with congestion [1]. While in TCP, an issue since it minimizes its transmission rate when a drop is seen independent of the misfortune nature. There is a component at the sender which can recognize the first reason for a parcel drop so that the sender has the capacity respond to each of the variables that may cause a loss. Work done in past focusing this problem have serious confinements, for example, high preparing overhead and whole reliance on system unequivocal flagging.

1.4.1 High MAC Contention and Collisions:

The basis of TCP relies on packets from beneficiary to sender for building up a bidirectional stream of information and ACKs to guarantee dependability [1]. It is a costly strategy in multihop remote systems. In light of the critical MAC overhead connected with an ACK transmission notwithstanding the littler ACK size near to an information parcel. This is a result of the arbitrary back off methodology that seeks after any fizzled transmission endeavor and the RTS/CTS control casings traded before any parcel transmission. As such, inside the system, information and ACK streaming in diverse bearings are profoundly defenseless against impact. Under suitable conditions on ideal data transfer capacity use, TCP must abstain from sending excess ACKs.

To settle this issue, prior strategies have proposed to minimize the quantity of ACKs went into the system in an altered way. Under specific conditions, it is impractical in light of the fact that the system condition changes and excess ACKs may be discriminating to the end-to-end execution.

1.4.2 Low Energy Resources:

In Multihop systems as they are comprised up of versatile hubs that are most likely controlled by battery [1]. They include conventions which must have a very much soaked trade off in the middle of execution and vitality use. Automatic transmissions occur in absence of association in the middle of TCP and 802.11 is the essential wellspring of vitality wastage in a TCP usage over multihop systems. Different vitality sparing components for connection and system layers are arriving, which have not been dissected on the transport layer.

1.5 Problem Identification and Solution

Daniel Scofield et al. [5] proposed HxH, and a transport mechanism which uses credit-based congestion control and invert ACKs to work out the emergency with TCP. Congestion control calculations don't utilize rate-based and valuing based criticism. This is the significant restrictions of the proposed approach. The proposed system is not enhanced with quick variety of the congestion window in [6].A set of strategies in TCP utilizing a cross-layer methodology is utilized to address the difficulties are proposed. It likewise gives better association to adequately enhance the end-to-end execution among TCP and 802.11 conventions.

1.6 Cross Layer configuration

In this configuration the infringement of layered correspondence construction modeling in the convention plans as for the first structural planning. This configuration accentuates on the system execution by empowering the distinctive layers of the correspondence stack to share state data or to organize their activities so as to mutually streamline system execution [12].

Calculations can overrun a cross-layer outline to empower every hub to perform fine-grained enhancements locally at whatever point it distinguishes changes in system state. Portability reasons changes for the physical layer (for e.g. impedance levels), the information connection layer (for e.g. connection plans), the directing layer (for e.g. new neighboring hubs), and the vehicle layer (for e.g. association timeouts).

In that capacity, a cross-layer based configuration improves the hub's ability to deal with its assets in the portable situations Antenna clusters can likewise empower the gathering of various parcels all the while on the remote channel and the information bundles relating to a few associations could likewise arrive at the same time at a hub.

The collaboration of different layers, for example, directing, information connection, and physical layer can guarantee the sending of information for every one of the associations inside of time.

1.7 Requirement for Cross layer configuration

It offers execution advantages for a specific framework. Interestingly, the building design offers a model for supported advancement in a framework, so it offers long haul picks up. The transient execution additions of cross-layer outline may be more critical for the system client to make productive utilization of constrained hub assets.

2. RELATED WORKS

S.Sheeja, Ramachandra V.Pujeriinthis work[12] proposed a Cross Layer based congestion control scheme which attains congestion detection and congestion control among nodes. The first phase of the scheme, cross layer design is approach is proposed. Here the in formation 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.

Jin Ye et al. [4] proposed an enhanced TCP with traverse Wired-remote cross breed systems. Being not quite the same as some current TCP conventions, it takes account into the congestion of direct rivalry in MAC layer. What most essential is that this model is based on the ECN plan, which have been ended up being successful on congestion control and generally bolstered by and large. So this model is of good attainability and versatility.

Senthil Kumaran, T. and V. Sankaranarayananin [6] presents the Congestion Free Routing in Ad hoc networks (CFR), based on dynamic all y estimated mechanism to monitor network congestion by calculating the average equeuelength at the node level. While using the average equeuelength, 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 routed are co very mechanism to discover a congestion free route between source and destination. This path becomes a core path between source and destination.

Jingyuan Wang et al. [7] exhibited the execution of another TCP congestion control calculation in diverse system conditions. The examination demonstrate that the new TCP congestion control calculation, in particular, TCP-FIT, out-performs existing calculations, for example, Bic/Cubic, Reno, Veno, Westwood, Compound TCP, FastTCP and so forth under testing system conditions, while keeping up great bury and intra convention.

Myungjin Lee et al. [6] proposed the recovery process which used a notice (TCP–PRN) instrument to forestall execution debasement amid a handoff. Despite the fact that Freeze-TCP accomplishes an execution increment amid handoff, recognizing precise handoff time and the weakness of high variety in the round trek time (RTT) get to be snags for sending Freeze-TCP in a genuine domain. The proposed convention, TCP– PRN, rapidly recuperates lost parcels by restoring the congestion window, keeping the congestion window to decline, or quickly starting the moderate begin calculation. The proposed system is not upgraded with quick adjustment of the congestion window.

3. **Algorithm usage**

The cross layer congestion control is performed on the basis of existing information from networks and the cross layer outline in which identification of congestion utilizing cross layer methodology and congestion control system are analyzed.

3.1 Cross Layer Design

In MANET every layer of the IP convention stack works autonomously. The data is being shared between the nearby layers just. Because of the conditions in the middle of physical and upper layers, the customary methodology is not suitable for Mobile Ad hoc Networks.

There is have to cross the typical layer limits to enhance the execution of correspondence and consequently superior to the application layer execution. In Cross layer outline, the information is shared between the distinctive convention layers powerfully. The data can be traded between any diverse layers of the TCP/IP convention stack. Figure 1 represents the cross layer outline for data sharing crosswise over diverse layers [9].

In such systems the physical layer, Media Access Control (MAC) layer and routing are system assets. At physical layer, transmission force and information rate is chosen which influences MAC and directing choices. The MAC layer is in charge of booking and assigning the remote channel, it will focus the accessible transmitter transmission capacity and the parcel delay. Steering layer additionally relies on upon data transfer capacity and deferral to choose the connection.

The directing layer picks the course to send the information parcels to the destination. The steering choice will change the dispute level at the MAC layer and likewise the physical layer parameters. On account of adjustment of layers end to-end execution can be improved. Any outline changes in the convention stack when including association between distinctive layers may have impact all in all framework. So cross layer configuration use with alert.

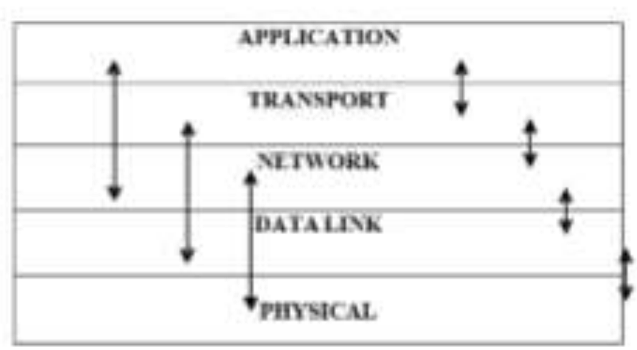

Figure 1 Layers in network model

3.2 Congestion Detection using cross layer approach

Step 1: Source sends packets to destination hub by means of nodes of the road hubs to set up the course revelation process.

Step 2: Set the interim Tn between the two neighboring packets in MAC layer. ts is time for first information arrival. td is the entry time of last information bundle. Tk is the normal preparing time of information parcel in a neighborhood hub.

Step 3: Thete is the transmission time of information packets, and q is a movable parameter, which is set to 0.7. The estimation of Tk is redesigned when an information parcel is conveyed.

Step 4: packet loss rate. It is shown as:

$$P_{LR}(t_1, t_2) = \frac{\int_{t_1}^{t_2} 1_{\{G(t)-D_t\}} dF(t)}{\int_{t_1}^{t_2} dF(t)}$$

where F(t) is the entry process for client parcels. Here, the denominator represents the packets sent in (t1, t2) and the numerator speaks to number of lost packets.

Step 5: Calculate the congestion scale figure The Value of Csf is given as takes after,

$$C_{sf} = \frac{T_n}{T_k}$$

$$T_n = (1-q) \times T_n + q \times (t_s - t_d) - P_{LR}(t_1, t_2)$$

$$T_k = (1-q) \times (t_s - t_d) + q \times t_e - P_{LR}(t_1, t_2)$$

On the off chance that Csf> 1, the entry rate f the packets is greater than the flight rate of information parcels, which demonstrates congestion might conceivably happen later.

Step 6: Let the edge of cradle occupancy part be Bttf. On the off chance that Btf>Bttf, demonstrating that congestion is happened. In light of the cradle line length in nearby hub, the congestion can be identified. In the event that the quantity of information parcels in cradle line surpasses the limit quality, showing that the information bundles will flood the support line in brief time and congestion will happen in the neighborhood versatile hub.

3.3 Congestion Control Procedure

The process of congestion control follows some steps which need to be carried out in order to measure the variables related to it. The starting point is amount of interference in and noise ratio which is given as:

$$S = \frac{P_k G_d}{\sum_{d \neq k} P_o G_{ko} + n_k},$$

Pk is the transmission power on the connection k, Gd is the way pick up of the connection k, Gko is the way pick up of the hub on connection k to another hub on the connection o. nk is the warm commotion on the connection k. The most extreme limit achievable in the connection k is resolved utilizing Shannon limit hypothesis.

$$C_l = \frac{1}{T} \log(1 + M.S)\ pkts / \sec$$

Where T is the image period and M is consistent in view of tweak plan utilized.

Step 1: Set the starting transmission rate xi.

Step 2: Set force of the connection k is Pk = Pk,min

Step 3: Broadcast the S to the whole connection.

Step 4: Update way pick up of the connection (Gd, Gko) in the wake of getting the TV signals.

Step 5: Calculate the most extreme limit of the connection Cl.

Step 6: Determine the misfortune likelihood

$$\gamma_m(t) = \begin{cases} \frac{\max(0, (x_l(t) - c_l(t)))}{x_l(t)} & x_l > 0 \\ 0 & x_l = 0 \end{cases}$$

Step 7: Calculate the information sent to the connection k,

$$m_k(t) = \frac{\gamma_m(t) * S}{P_k G_{kk}}$$

Step 8: Set the limit estimation of way pick up G, Congestion Scale Factor and Buffer tenure division.

Step 9: If the any parameter underneath its edge esteem, the course is thought to be a congestionless course.

Step 10: Choose the option way while congested.

3.4 Proposed Packet Format

Some of the points which are main focus in the proposed packet format are given below. Wbile the figure below shows the generic format of packet:

Source ID	Dest. ID	Hop Count	MAC	C_{sf}	P_{LR}	B_{tf}

Figure 2 Packet format

The proposed packet is appeared in figure 2. It contains source id, destination id possesses 2 bytes. Source id is utilized to recognize the hub which is prepared to find the course. Destination hub confirms the packet got from course which contains source id.

The Hop tally is increased once the packet is effectively sent. It involves 1 byte field. Jump tally decides number of hubs is joined with the specific hub.

Medium Access Control (MAC) is for getting to the specific channel.

Congestion scale division is utilized to confirm the congestion will happen or not. It involves 4 byte field.

PLR is the packet misfortune rate which possesses 2 bytes field.

4. **Performance Analysis**

In this analysis the performance is main factor which needs to be checked properly in order to diagnose the issues that might come during the process of working. NS 2.34 is used to simulate the proposed algorithm. The simulation tool is C++ based and back end language tool command language (tcl) is front end language. Advantage here is that the tool is more updating. In process, 1500 mobile nodes move in a 1500 meter x 1500 meter square region for 2 minutes simulation time. All nodes have the same transmission rangeof 400 meters.

The simulated traffic is Constant Bit rate. Consider the following table.

# of Nodes in network	1500
Size of Area	1500 x 1500
MAC	802.11
Radio Range	500m
Simulation running time	2 minutes
Traffic Source	CBR
Packet Size	512 bytes
Mobility Model	Random way point
Protocol	AODV
Pause Time	4 msec

4.1 Performance Metrics

It is assessed for the most part the execution as per the accompanying measurements.

Control overhead: The control overhead is characterized as the aggregate number of directing control packets standardized by the aggregate number of got information packets.

End-to-end postpone: The end-to-end-deferral is arrived at the midpoint of overall surviving information packets from the sources to the destinations.

Packet Delivery Ratio: It is the number's proportion .of packets got effectively and the aggregate number of packets transmitted.

Throughput: It is characterized as the quantity of packet got at a specific purpose of time.

The recreation results are exhibited in the coming part. The CLCCS is contrasted and ECAS and CoDio ABCD convention in vicinity of congestion environment.

Figure 3 delineates the topology of the proposed plan. In existing work, it is utilized that the entire system to execute the congestion less course. Here, it is picked just on the single course to accomplish the congestion less steering productivity with the assistance of cross layer outline. The course R1 comprises of 30 portable hubs. The portability of these versatile hubs is generally high. Because of versatility vicinity, the congestion happens uncertainly.

To conquer this issue, the proposed methodology in view of cross layer outline proposes the congestion less course [10]. Source hub picks the destination hub taking into account the hub's proficiency, limit of the connection and most brief way course. Figure 4 demonstrates that activity creation among the hubs. To recognize the packet misfortune, the steady piece rate activity is executed. The deferral is created in packet from source hub to destination hub by means of neighbor hubs. Source may pick the diverse ways to accomplish the high packet conveyance division [11].

Figure 3 Network in given area

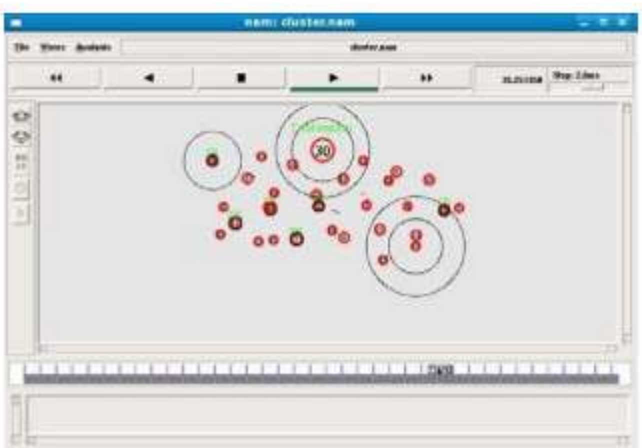

Figure 4 Traffic on Nodes

Time vs. Congestion in figure 5 has also been analyzed using the statistics from traffic on network which is shown below:

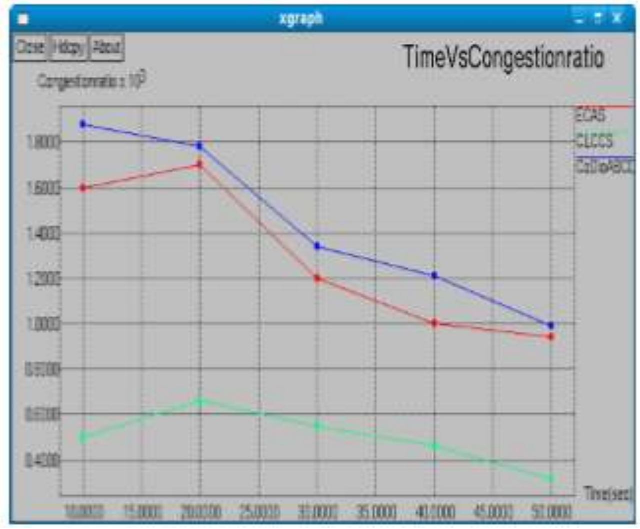

Figure 5 Time vs. Congestion

Analysis of proposed packet format is shown in table below:

Metrics	CLCCS	ECAS	COIOABCD
Congestion Ratio	500-354	1600-987	1830-1000
Packet Delivery	1494-4845	1000-4127	490-1945
Throughput	348-674	246-412	145-362
Delay (msec)	0.212-0.543	0.356-0.789	0.908-1.967
Overhead	0.189-0.623	0.204-0.623	0.967-1.874

5. **Conclusion**

The process of congestion control and its detection has been elaborated from certain viewpoints. The first portion of the paper discussed the factors which play an important role in the working of wireless ad-hoc mobile networks. In the working of network the information is shared between the different layers of the protocol stack which in subsequent layers becomes packets which are to be transmitted. In process of congestion detection, the packet loss rate is determined which ensures the detection of congestion in particular. After the detection is determined and factors related to it are analyzed, it needs to be controlled in a way that it should perform efficiently.

The route is found without congestion, the threshold value of path gain, congestion scales value and buffer tenancy value. By making user of simulation the extensive results are derived and the proposed scheme achieves the better throughput, packet delivery ratio, low delay and overhead than the existing schemes ECAS, CoDio ABCD protocol while varying the mobility, speed, throughput and time, with the number of nodes in network.

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