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Effective Flow Count Mechanism for Congestion Control Avoidance

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Abstract—

Congestion is a decisive factor, in determining the quality of network. It also determines the sustainability and reliability of a network. Setting up a new network infrastructure to deal with congestion problem is not economically viable decision, hence it is essential to be aware of the reasons behind such network conditions and then design appropriate methods to surmount them. In this paper, network behaviour's has been simulated using NS2.35 to study how node's buffer space gives impact to the in-flight packets in ad hoc environment by taking mobility. The network condition has been simulated with a restricted size of users. Performance has been measured on numerous parameters such as number of dropped packets and varying queue length.

Keywords— Mobile Ad-hoc network (MANET); Adhoc On-demand (AODV), Dynamic Source Routing (DSR) and Adhoc On-demand multipath distance vector (AOMDV)

I. INTRODUCTION

Much of the traditional literature on congestion control and scheduling in communication networks has treated the two problems separately. A considerable amount of work on congestion control has been initiated by Subburam[4], Umut akyol[11] and Aun Haider[16] have indeed found that there may be only low correlation between the delay considered by a flow and packet loss events. When packet loss occurs, and network queue is full, nevertheless high delay is not observed in all flows.

The packets that were dropped might previously have passed through a long way in the network and hence consumed noteworthy resources. In addition, the lost packets often generate retransmissions; hence even more packets are propelled into the network. Thus network congestion can severely depreciate network throughput. This leads to congestion collapse of the network if no appropriate congestion control is performed and hence almost no data is successfully delivered.

This paper does not rely on any wired infrastructure and examined using a wireless network as the communication medium and for controlling congestion which happens due to heavy traffic is surmount by queuing models.

[4] Mobile Adhoc network now days are hot spot in wireless network researching area. The core layer technology in Ad Hoc networks i.e. routing algorithm design has drawn great concern. After the analysis of shortfalls of the existing algorithms, this paper presents a novel flow count mechanism on routing protocols DSR.

Congestion is a decisive factor, in determining the quality of network. It also determines the sustainability and reliability of a network. Setting up a new network infrastructure to deal with congestion problem is not economically viable decision, hence it is essential to be aware of the reasons behind such network conditions and then design appropriate methods to surmount them. In this paper, network behaviour's has been simulated using NS2.35 to study how node's buffer space gives impact to the in-flight packets in ad hoc environment by also taking mobility and power consumption into consideration. The network condition has been simulated with a restricted size of users. Performance has been measured on numerous parameters such as number of dropped packets and varying queue length.

In this paper we revisit the recently voiced concern of the network congestion means the delay that may be fundamentally flawed as a signal for congestion control. Our main objective of this paper is to reveal that the aggregate behaviour of the flows, is responsible for congestion control and to design a novel flow count mechanism on several Reactive Protocols (AOMDV, AODV and DSR).

[3]Packet failure in MANETs is primarily caused due to obstruction. Involving congestion control over a mobility and failure adaptive routing protocol at the network layer can condense the packet loss. The congestion non-adaptive routing protocols, leads to the subsequent technical hitches:

Extensive delay: Most of the congestion control mechanism takes much time for detecting congestion. Sometimes the usage of new routes in some critical situations is advisable. The major issue is the delay stirring associated with route searching in adhoc on-demand routing protocol.

More Overhead: Congestion control mechanism takes effort for processing and communication in new routes for determining it and also takes effort in multipath routing for maintaining the multi-paths.

Heavy packet losses: Once the congestion is detected the packets may be lost. Congestion control issue can be solved either by dropping packets at the transitional nodes or by reducing the rate of sending at the sender, or by dual techniques to diminish the traffic load. [3] Because of high packet loss rate, minimal throughput might occur.

1.1 *Myths about Congestion Control*

[14]Congestion occurs when the demand is greater than the available resources.Hence, as resources become less expensive; the congestion problem will be solved automatically. This has led to the subsequent myths:

1. Congestion is caused due to limited buffer space and will be solved when memory becomes economical enough to allow considerably large memories.
2. Congestion occurs due to slow links. Availability of high-speed links is the solution for this problem.
3. Slow processors will lead to congestion. The problem will be solved by improving the speed of the processors.
4. Either one or conjunction of above mentioned issues will result in congestion problem. Contrary to these beliefs, without proper protocol redesign, the above developments may lead to more congestion and, thus performance degrades.

1.2 CONGESTION CONTROL IN MANETs

A wireless mobile ad hoc network [6] is usually defined as a set of wireless mobile nodes dynamically self-organizing a temporary network without any central administration or existing network infrastructure. Since the nodes in wireless ad hoc networks can serve as routers, the nodes move haphazardly and organize themselves occasionally; thus, the network's topology may change impulsively and swiftly.

They forward packets for other nodes if they are on the route from source to the destination (like intermediate node. Besides other issues, routing is an important problem in need of a solution that not only works well with a small network, but also sustains scalability as the network gets expanded and the application data gets transmitted in larger volume. Since mobile nodes have limited transmission capacity, they mostly intercommunicate by multi hop relay. Multi hop routing is challenged by limited wireless bandwidth, dynamically changing network topology, low device power and high vulnerability to failure. To answer those challenges, many routing algorithms in MANETs [6] were proposed. There are different dimensions to categorize them: proactive routing versus on-demand routing, or single-path routing versus multipath routing.

MANET nodes are typically categorized by their high mobility degree, limited power, memory resources and processing. In such networks, the wireless mobile nodes may occasionally enter and leave the network. Because of limited transmission range of wireless network nodes, multiple hops are usually necessary for a node to exchange information to other node.

[2] Congestion takes place in MANETs with limited resources. In these networks, dynamic topology and shared wireless channel leads to interference and loss during transmission of packets. Packet victims and bandwidth deterioration caused due to congestion, and hence wastage of energy and time occurs at the time of its recovery. Congestion can be controlled using congestion-aware protocol by bypassing the affected links. Severe throughput dilapidation and immense fairness issues are some of the prominent congestion associated problems.

II. CONGESTION CONTROL MECHANISMS

i) ***End-system flow control:*** This is not a congestion control mechanism scheme, but it prevents the sender in network from overflow the receiver's buffer.

ii) ***Network congestion control:*** In this scheme, end systems choke back in order to avoid the network congestion. The method is similar to end-to-end flow control, but the main objective is to decrease congestion in the network, not the number of receivers.

iii) ***Network-based congestion avoidance:*** In this scheme, a router sense that congestion may take place and attempts to decelerate senders before queues become jam-packed.

iv) ***Resource allocation:*** In this technique, the use of physical circuits or other resources are scheduled, for a specific time period. A virtual circuit, constructed across a series switches with a assured bandwidth is a type of resource allocation. This technique is complex, but can eradicate network congestion by blocking the excess of network traffic. [3]

[3]Congestion control is related to resource allocation in a network such that the network can function at an satisfactory performance level when the demand surpasses or is close to the network resource capacity. These resources include bandwidths of links, buffer space (memory), and processing capacity at intermediate nodes.

III. RELATED STUDY

S. Subburam et al, [4] presented predictive congestion control routing protocol for wireless Ad-hoc networks called as PCCAODV.In adhoc networks connection failure between source and destination often occurs, because of transition of nodes.

The connection between source and destination gets disconnected after every failure. The problem is while sending data packets from source to destination, there is a probability of congestion occurrence at any node resulting in long delay and high packet loss, which leads to performance dilapidation of a network.

Unlike traditional AODV, predictive congestion index of a node as the ratio of current queue occupancy over total queue size at node level. PCCAODV utilizes the upstream nodes and downstream nodes of a congested node based on a congestion index and initiates route finding process Bi-directionally to find alternate non congested path between for transmitting data. The protocol is implemented and simulation is done using Ns-2 simulator.

G.Vijaya Lakshmi et al, [5] suggested a queuing model to overcome the congestion problem in mobile adhoc network. The queuing mechanism is developed based on the probability distribution in different range of communication. The queuing mechanism hence improves the network metrics such as overall network throughput, reduces the route delay, overhead and traffic blockage probability. The approach is generated over a routing scheme in adhoc network.

Sanjeev Patel *et al.* [7] had shown a comparative analysis of throughput, queue length and delay for the various congestion control algorithms REM, SFQ and RED. He also included the comparative examination of loss rate for these algorithms having diverse bandwidth. Stochastic Fair Queuing (SFQ) guarantees fair access to network resources and prevents a busty flow from consuming more than its fair share. In case of (Random Exponential Marking) REM, the main implication is to decouple congestion measure from performance measure (queue length, delay or loss). Stabilized RED (SRED) is an additional technique of detecting nonresponsive flows.

Dr. Yogesh Chaba1 et al, [1] define congestion as the loss of utility to a network user due to high traffic loads and congestion control mechanisms as those that maximize a user's utility at high traffic loads .He consider the problem of protecting well-behaved users from congestion caused by ill-behaved users by allocating all users a fair share of the network bandwidth. Fairness is said to be done when equal numbers of packets are received from each node and this will be achieved by limiting the queue size and limited bandwidth .This aggregate queue orders packets based on their timestamps rather than arrival order. Through simulation, we show the performance of reactive protocols like AODV, DSR and AOMDV.

K. Natarajan, et al, [10] studied the impact of four IETF (Internet Engineering Task Force) standardized routing protocols on MANETs and hence methodically analyzes their performance under node mobility rates and varying network sizes. The four routing protocols that are taken into consideration during the analysis are Ad-hoc On-demand Distance Vector, Optimized Link State Routing , Temporary Ordered Routing Algorithm and Dynamic Source Routing (DSR). Secondly, the research emphasizes the fact of superiority of proactive protocol, over hybrid and reactive ones while routing the equivalent traffic in the network. However, among the reactive protocols AODV performance has been found to be noteworthy.

Umut Akyol, et al, [11] analyzed the issues related to joint performance scheduling and congestion control in MANETs in order to keep the network queues bounded and the resulting flow rates assure an associated network utility maximization problem. Recently, a number of papers have come up with theoretical solutions regarding this problem that are based on merging utility-based congestion control with differential-backlog scheduling algorithms. Nevertheless, this works characteristically does not address several issues, such as how signalling should be performed and how the new algorithms interact with other wireless protocols.

Wu-chang Feng, *et al.* [8] proposed, put into practice, and evaluated an active queue management algorithm, termed as BLUE. Using experiments done through simulation, it is analysed that BLUE performed notably better than RED, both in terms of buffer size requirements and packet loss rates in the network. He also proposed and examined another queue management algorithm, Stochastic Fair BLUE (SFB), which can recognize and rate-limit nonresponsive flows using a infinitesimal amount of state information.

Yuming Jiang *et al.* [6] proposed S-SFQ which is a single queue design and implementation of the well-known Start-time Fair Queuing (SFQ). This aggregate queue orders packets based on their timestamps rather than order of arrivals. With the help of simulation, we show the performance gains of S-SFQ over other default single-queue schemes such as RED and FIFO in terms of link utilization and flow fairness.

Dr.Ramachandra.V.Pujeri, et al, [2] put forward to develop the Effective Congestion Avoidance Scheme (ECAS), which consists of congestion less based routing, effective routing establishment and congestion monitoring. The overall congestion status is calculated in congestion monitoring. As far as routing establishment is concerned, he proposed the contention metric in the particular channel by considering packet queue length, packet loss rate and drop ratio of packet to monitor the congestion.

Dan Rubenstein *et al.* [12] proposed techniques based on delay or loss observations at end hosts to examine whether two flows experiencing congestion are congested because of the similar network resources. His new result is that this research holds good for unicast flows and the same procedures can also be applied in the case of multicast flows. He also put forward metrics which can be used for measuring the amount of congestion sharing between two flows.

Zhiruo Cao, *et al*, [13] projected an estimated fair sharing mechanism devoid of per-flow state that is different from Core-Stateless Fair Queueing (CSFQ), a scheme to approximate fair bandwidth sharing without per-flow state in the interior routers proposed by Stoica in recent works.

Traditional mechanisms to achieve fair sharing (e.g., Weighted Fair Queueing, Flow Random Early Discard) require per-flow state to determine which packets to drop under congestion, and therefore *are* complex to implement at the interior of a high-speed network.

On the other hand, this mechanism is different from CSFQ, particularly, that divides each flow into multiple layers, based on rate. The packets in a flow are marked at an edge router with a layer label (or "color"). A core router maintains a color threshold and drop layers whose color exceeds the threshold. Using simulations, he showed that the performance of his Rainbow Fair Queueing (RFQ) scheme is comparable to CSFQ when the application data does not contain any preferential structure. RFQ outperforms CSFQ in goodput when the application takes advantage of the coloring to encode preferences.

Ehssan Sakhaee *et al.* [9] present a scheme for reducing overall traffic and end-to-end delay in highly MANET networks. In this a new routing algorithm is introduced to reduce the frequency of flood requests by increasing the link duration of the selected paths. In order to lengthen the extent of path, non unlink paths are taken into consideration. This concept is a new approach in route discovery as previous reactive routing protocols seek only disjoint paths. The basic concept behind this scheme is to broadcast only specific and well-defined packets, referred to as "best packets" in the paper. The new protocol is simulated with respect to traffic overhead. Although his main aim in this paper is to reduce the net control traffic in a MANET network, there are other advantages arising from the proposed schemes, namely the increase in duration of link, reduction in the end-to-end delay, less disturbance in flow of data, and less path setups.

K.Kathiravan,et al, [15] described an NS2- based simulation analysis of TCP using omni antennas over mobile ad-hoc network. In particular, he compared the performance of end to end protocols such as TCP-Newreno and TCP-SACK with the routing provided by AODV, DSR and DSDV protocols using omni directional antenna. He investigated the effects of varying node density, mobility of nodes and pause time of nodes has on TCP performance. With the help of simulation, he demonstarted that TCP throughput drops considerably when nodes travel, due to TCP's lack of ability to recognize the dissimilarity between congestion and link failure. He compared the throughput performance between the TCP versions.

Aun Haider,et al [16] presents a brief and breadth wise survey of major CCAs designed to operate at the gateway routers of multimedia telecommunication networks. Multiple algorithms put forward in recent times try to provide an proficient solution to the issue. In one of these, Explicit Congestion Notification (ECN) with Active Queue Management (AQM), packets originated by several data sources are marked at the gateways of network. In other algorithms, packets are dropped to avoid and control congestion at gateways. Hence, different data senders can be needed to decrease their traffic volume. Communication with authentic senders of data is preserved by returning distinct acknowledgement packets.

IV. PROPOSED WORK

In this paper, a flow control mechanism is proposed in MANET.The evaluation will be done through simulation (NS2 2.35) on various network parameters such as increased usage, speed mismatch and number of sender increased and varying queue length. The main work in this paper is

1. To study the performance of existing flow control mechanism.
2. To develop an enhanced flow count mechanism on Reactive Protocol DSR.
3. Review the Issues of Congestion control in network.

4.1 RESEARCH METHODOLOGY

If the number of flows a router would have to handle is predetermined, routers could be shipped with parameters set to attain a reasonable tradeoff between loss rate and queuing delay. The problem divides into three parts. Firstly, a mechanism to count active flows. Secondly, a choice of specific queue length and drop rate in the basis of the flow count. Thirdly, a technique to enforce the targets on a FIFO queue.

The queuing scheme will

- Provide 100 packets of buffering per active flow,
- Maintain the FIFO queue simplicity
- No manual tuning is needed

A counter can count flows with just one bit of state per flow as follows.A vector of vmax bits called v is created and the index for v is the hash of a packet identifier. Preserve the count of bits sets a variable c. After the arrival of packet, set the bit in v for its identifier and increment the variable c. Clear bits out of the table, so that that every bit is cleared, and if the bit was set then after the passage of tclear seconds, c is decremented.

4.2 PROPOSED ALGORITHM

```
void
QueueMonitorCompat::flowstats(int flowid)
{
        Tcl& tcl = Tcl::instance();
```

Step1 : Initialization

```
V(i) =( 0..vmax-1 ) = 0;
c = 0;   //
f = 0;
tlast = now;
```

Step2: After Packet arrival

```
c=hash (Packet *p);
t=now;
nclear = vmax *  ((t-tlast)/tclear);
if (nclear >0)
tlast = t;
for (i=0;i< nclear-1;i++)
{
r=random v(i)
if (v(r) == 1 )
v( r ) = 0;
c = c - 1;
}
f = ln (1-c/vmax) / ln (( vmax-1 ) / vmax);
}
```

```
QueueMonitorCompat::hash (Packet *q)
{
if (*q==0)
{
*q=1;
c=c+1;
}
Return (c);
}
```

Variables:
v(i) = vector of vmax bits.
It indicates if a packet from a flow with hash i have arrived in the last tlcear seconds.
c = Count of bits in v.
f = Current estimated flow count.
tlast = Time at which bits in v were last cleared.
r = randomly selected index of a bit to clear in v.
Constants:
vmax = Size of v in bits should be larger than the number of expected flows.
tclear = Interval in seconds over which to clear all of v.
h(p) = Hashes a packet's flow identifying fields to a value between 0 and vmax.

V. TOOL USED

NS-2.35 simulator is used for performance evaluation. The network is a collection of 10-14 nodes deployed on square area of 1200mx1200m. Transmission range of each node is 250 m. The medium access control (MAC) protocol based on IEEE 802.11 with 2 Mbps raw capacity. In radio propagation model, a two-ray ground reflection model is applied. In all simulations, we will use the RWP (Random waypoint) mobility model.

TABLE 1: SIMULATION PARAMETERS

Simulator	NS-2.35
Total number of nodes	10,14
Simulation Time	15
Simulation Area	1200mx1200m
Propagation Model	Two-ray ground reflection model
Mobility Model	RWP (Random waypoint)
Radio Range	250m
MAC Protocol	IEEE 802.11
Data Packet Size	512 bytes
Antenna	Omni directional
IFQ Length	100
Routing Protocol	DSR
No. of Packets per second	5
Traffic	CBR

VI. RESULTS AND DISCUSSION

Performance of existing flow control mechanism and an enhanced flow count mechanism on various Reactive Protocols (AODV, DSR). For investigating the performance of these protocols, the following performance metrics were taken into consideration:
Packet Delivery Ratio (PDR): It represents the ratio between the packets generated by the sources and the packets arriving at the destination.
Average End-to-End delay: It refers to the delay acknowledged by the successfully delivered packets in arriving to their destinations. This is an appreciable metric to compare protocols. This signifies how capable the particular routing algorithm is, because delay mainly depends on the path chosen.

TABLE 2: TOTAL NUMBER OF PACKETS RECEIVED IN DIFFERENT NETWORK SCENARIOS

Simulation Time	**Packets Received at 10 nodes**	**Packets Received at 14 nodes**	**Packets Received at 50 nodes**
0	0	0	0
1	33	20	0
2	102	68	70

4	103	69	129
6	103	69	129
8	103	69	129
10	103	69	129
12	103	69	129
14	103	69	129

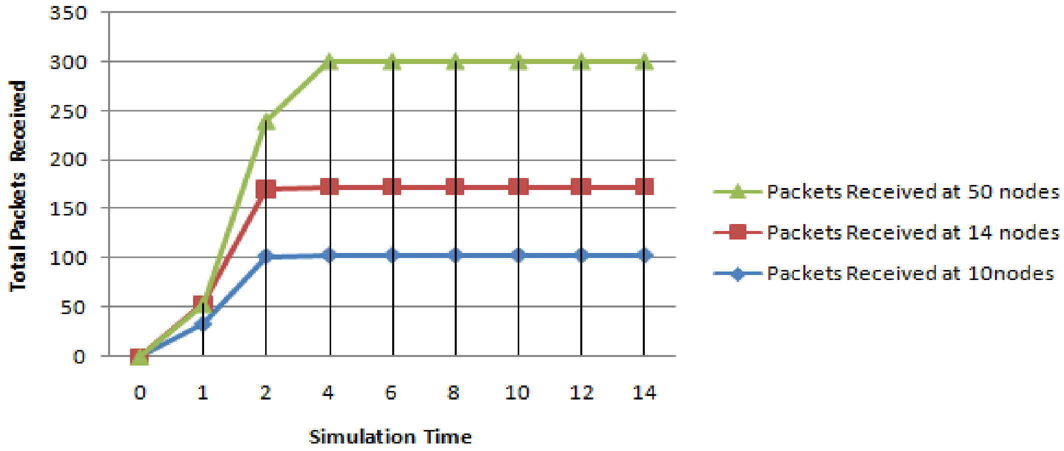

FIG.1: GRAPH SHOWING TOTAL NUMBER OF PACKETS RECEIVED

Here graph depicts the Total number of Packets arriving. The horizontal axis shows the simulation time and the vertical axis shows the number of packets. In this three different network scenarios are compared where the Blue line depicts the number of packets arriving at 10 nodes scenario.The Red line shows the number of packets arriving at 14 nodes scenario and the Green line depicts the number of packets arriving at 50 nodes scenario.

TABLE 3: TOTAL NUMBER OF PACKETS LOST IN DIFFERENT NETWORK SCENARIOS

Simulation Time	No. of Packets Lost at 10 nodes	No. of Packets Lost at 14 nodes	No. of Packets Lost at 50 nodes
0	0	0	0
1	3	3	0
2	3	3	30
4	3	3	51
6	3	3	63
8	3	3	63
10	3	3	63
12	3	3	63
14	3	3	63

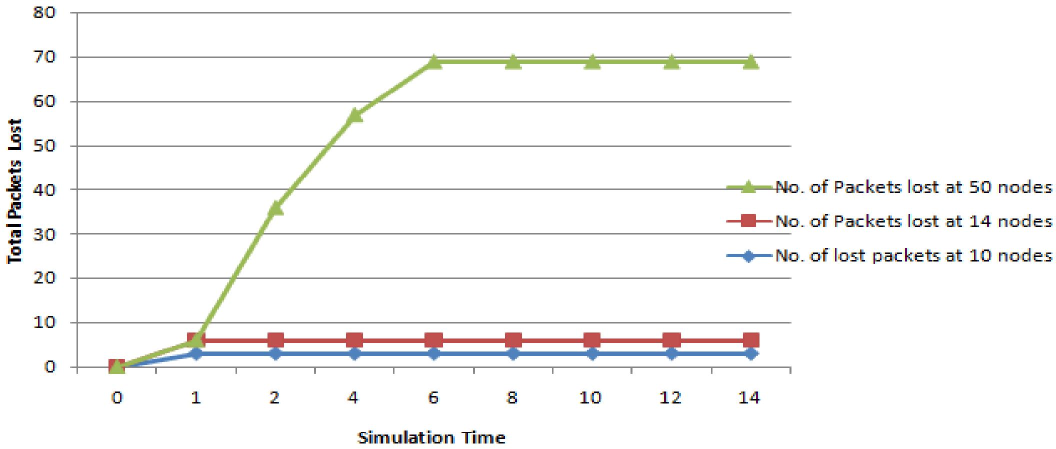

FIG.2: GRAPH SHOWING TOTAL NUMBER OF PACKETS LOST

Here no. of packets per sender can accept is 100 packets. Graph shows the total number of packets lost during the simulation.In this we can see that the Packet drop in case of large network i.e. 50 nodes is very large as compared to the Packet drop in other networks i.e. 10 or 14 nodes scenario. It is also seen that Packet drop is close to zero after applying the flow count mechanism.

VII. CONCLUSION

In this paper DSR reactive protocol is studied. The performance evaluation parameters are Packet Delivery Ratio, Average end to end delay. We have surveyed the impact of varying queue length and Flow Count on network performance. In this paper we address the problems with existing congestion control algorithms and we tried to show packet loss in bust networks depends on the number of active flows and the total storage in the network. Total storage included both router buffer memory and packets in flight on long links. In this thesis a simple flow counting mechanism is presented. The algorithm provides congestion feedback by varying the number of packets per sender in proportion to the queue length. This approach has the enviable cause of reduced queuing delay, fewer packet drop however it produces high loss rate as the number of flows increases, causing long and unfair timeout delays in case of large networks. We showed that our scheme can provide a coarse control over bandwidth allocation to routing protocol. Bandwidth is properly utilized by DSR protocol in case of small as well as larger queue lengths. This protocol provides superior results as it allows the network to completely self configuring and self organizing devoid of necessitate of existing network. The current works has been limited with constant pause time and fix simulation area with CBR traffic.

REFERENCES

[1] Dr. Yogesh Chaba1 et al. "*Performance Evaluation of Flow Count Mechanism for Congestion Control"* proc. International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 5, May 2013.

[2] Dr. Ramachandra.V.Pujeri, et al, "*Effective Congestion Avoidance Scheme for Mobile Ad Hoc Networks"* proc. I. J. Computer Network and Information Security, 2013, 1, 33-40.

[3] Abhishek Bande, et al, "*An Improvement In Congestion Control Using Multipath Routing In Manet" proc.* International Journal of Engineering Research and Applications (IJERA) , Vol. 2, Issue 3, May-Jun 2012, pp. 509-514.

[4] S. Subburam, et al, *"Predictive congestion control mechanism for MANET" proc.* Indian Journal of Computer Science and Engineering (IJCSE) , Vol. 3 No.5 Oct-Nov 2012.

[5] G.Vijaya Lakshmi et al, "*CONGESTION CONTROL AVOIDANCE IN ADHOC NETWORK USING QUEUING MODEL" proc.* Int. J. Comp. Tech. Appl., Vol2 (4), 750-760

[6] Yuming Jiang et al, *"On the Flow Fairness of Aggregate Queues"* proc. 2011 Baltic Congress on Future Internet and Communications.

[7] Sanjeev Patel et al, "*Comparative Analysis of Congestion Control Algorithms Using ns-2*" proc. IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011.

[8] Wu-chang Feng, et al, "*The BLUE Active Queue Management Algorithms*" proc. IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 10, NO. 4, AUGUST 2002.

[9] Ehssan Sakhaee, et al, "*A Novel Scheme to Reduce Control Overhead and Increase Link Duration in Highly Mobile Ad Hoc Networks*" proc. reviewed at the direction of IEEE Communications Society subject matter experts for publication in the WCNC 2007 proceedings**.**

[10] K. Natarajan,et al, "*A Comparative Analysis and Performance Evaluation of TCP over MANET Routing Protocols"* proc. Int Jr of Advanced Computer Engineering and Architecture Vol. 1, No. 1, June 2011.

[11] Umut Akyol, et al, "*Joint Scheduling and Congestion Control in Mobile Ad-Hoc Networks",* proc. reviewed at the direction of IEEE Communications Society subject matter experts for publication in the IEEE INFOCOM 2008 proceedings.

[12] Dan Rubenstein, et al, "*Detecting Shared Congestion of Flows via End-to-End Measurement*" proc. IEEE/ACM TRANSACTIONS ON NETWORKING, VOL.10, NO. 3, JUNE 2002.

[13] Zhiruo Cao,et al, "*Rainbow Fair Queueing: Fair Bandwidth Sharing Without Per-Flow State",* proc. IEEE INFOCOM 2000.

[14] Raj Jain,et al, "*CONGESTION CONTROL IN COMPUTER NETWORKS:ISSUES AND TRENDS"*, proc. Published in IEEE Network Magazine, May 1990, pp. 24-30.

[15] K.Kathiravan,et al, "*TCP PERFORMANCE ANALYSIS FOR MOBILE AD HOC NETWORK USING ON-DEMAND ROUTING PROTOCOLS*", proc. Ubiquitous Computing and Communication Journal, VOL.2, NO.2.

[16] Aun Haider, et al, "*Congestion Control Algorithms in High Speed Telecommunication Networks*",proc. Department of Computer Science, University of Canterbury, Christchurch New Zealand.

[17] M.Jehan,et al, "*Scalable TCP: Better Throughput in TCP Congestion Control Algorithms on MANETs",* proc. (IJACSA) International Journal of Advanced Computer Science and Applications,Special Issue on Wireless & Mobile Networks.

[18] Jang-Won Lee,et al, "*Joint Opportunistic Power Scheduling and End-to-End Rate Control for Wireless Ad Hoc Networks",* proc. IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 56, NO. 2, MARCH 2007.

[19] Sally Floyd, et al, "*Controlling High-Bandwidth Flows at the Congested Router",*proc. 2001 IEEE.

[20] Jang-Won Lee, et al, "*Joint Opportunistic Power Scheduling and End-to-End Rate Control for Wireless Ad Hoc Networks",* proc. IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 56, NO. 2, MARCH 2007.

