EOCTC: Energy Efficient Ordered Congestion Tolerant and Control Routing Topology for Mobile Ad hoc Networks

T.SURYAPRAKASH REDDY[1] **Dr P.CHENNA REDDY[2]**
[1]Associate Professor and HOD of CSE
S.K.D. Engineering College
Gooty, Anantapur (dist.), A.P
[2]Associate Professor of CSE
JNTU College of Engineering
Pulivendula, Kadapa (dist.), A.P

ABSTRACT
The impacts of moving directions and speed of the nodes in mobile ad hoc networks leads link failure very often. This route failures causes resource cost due to route rediscovery and multiple transmissions. Often the protocol used in mobile ad hoc routing mislead by assuming link failure as congestion state and then continues retransmissions of the dropped packets, which is severely effects by wasting energy resources. In this context, our earlier work proposed a cross layered routing topology in short OCC to improve the clogging recognition and managing policy. With the motivation gained from OCC, we further proposed an Energy Efficient Ordered Congestion Control routing topology (EOCC) for mobile ad hoc networks. The goal of EOCC is to advance communication performance of OCC with energy efficiency that used for packet transmission. Here in this paper we introduced a novel path restoration strategy to tolerate the congestion state at hop level node that participating in routing. The Proposed protocol is a cross layered and power conserved routing topology for congestion tolerance and control, which is an extension to our earlier cross layered and power conserved routing topology in short EOCC. The proposed protocol can be referred as Energy Efficient Ordered Congestion Tolerant and Control (EOCTC) Routing Topology. The experiment results emerged as an evidence for EOCTC performance and scalability. Better resource utilization, energy efficiency can be observed in data transmission and congestion tolerance achieved due to path restoration strategy and congestion control is effective.

Keywords: **Manet, routing protocol, congestion control, OCC, EOCC, cross layer.**

1. Introduction

While the TCP congestion handling is highly efficient to work over the Internet, mobile ad hoc networks displays some exceptional properties that generally affect the design of the appropriate protocols and protocol stacks in a substantial manner and of a congestion handling mechanism in meticulous. The huge ecological disparities in a mobile ad hoc network pose huge problems for standard TCP.

The node mobility and a shared, wireless multi-hop channel are the principal properties of MANETs. Vary in routes is indicative of node mobility and of the intrinsically unpredictable medium which results in unsteady packet delivery delays and packet losses which are not to be construed as congestion losses.

Using a wireless multi-hop channel permits a single data transmission only within the interference range of one node. Hence, physical close links are dependent on one another thereby influencing the manner in which the network congestion largely manifests itself. A distinctive Internet router is a dedicated host that is connected by high bandwidth links. Whenever there is Internet jams enchanting place, it is usually focused on one single router. On the contrary, MANET congestions affect the entire area due to a shared medium where regions of network and nodes are congested.

Packet losses, which normally depend on the network category, that are not owing to network congestions can be found to happen more often in wireless networks. These results in negative response of TCP congestion control. The watching of packet losses is very hard as the transmission times (as well as the round trip times) show a high difference.

A single sender is accidentally or purposely able of causing a network collapse due to congestion owing to the relatively low bandwidth of mobile ad-hoc networks. Severe inequity can take place among flows due to the severe result of a single traffic flow on the network situation. Traditional wire line networks similar to the Internet are not so prone to congestion-related problems as compared to wireless multi hop networks. We, therefore terminate that a balanced congestion handling is the foundation for network stability and superior performance.

Because of the heterogeneous nature of application scenarios for multi hop wireless networks, suitable congestion handling solutions for a specific network and application will mostly depend on the properties and the function of the relevant network [1]. Hence, there would be customized solutions for dissimilar scenarios in its place of a single, general purpose one as reflected in this paper. A majority of these proposals does not signify complete, ready-to-use protocols, but rather solutions for a subset of the recognized problems. These can serve as the basis for application-tailored protocol stacks. A small number of the protocol possessions are, however, significant for a broader range of applications.

The past couple of years have seen the reception of wide focus on the problem of congestion handling both in the Internet circumstance, in accumulation to an ad-hoc network context. Much of the study focus has been on modeling, analysis, algorithm progress of end-to-end handling schemes (such as TCP), and adaptation of such schemes for ad-hoc networks. Algorithms that unite and steady operations have been industrious, given the routing path and the bandwidth constraints. However, in the context of a wireless network, another main constraint is due to the MAC (Media Access Control) layer [1]. Most wireless MACs utilizes a time-division strategy for accessing channel where at any point in space; the physical channel can be accessed by a single user at each moment of time (a time constraint).

The rest of the paper organized as in section 2 we explored the works most frequently cited in literature. Section 3 elaborates our earlier projected protocol OCC [13] and the proposed EOCTC. Section 4 reveals the simulations and their results, that followed by conclusions and references.

2. Related Work

Congestion awareness and handling in networks is the issue that attains reasonable attention in from researchers. QoS centric congestion handling solution can be established in [39]. Metrics based solution for congestion aware routing was proposed in [5]. Et al., [3] brings in metrics to assess data-rate, MAC overhead and buffer delay, which assist to identify and deal the congestion contention area in the network. Hongqiang Zhai, et al., [4] proposed a solution by arguing that congestion and severe medium contention is consistent. Yung Yi et al., [5] proposed a hop level congestion handling model. Tom Goff, Nael et al., [6] discussed a set of algorithms that initiates alternative path usage when the quality of a path in use becomes thin. Xuyang et al., [7] present a cross-layer hop-by-hop jamming handling scheme designed to develop TCP performance in multi hop wireless networks. Dzmitry et al [8] present the collision congestion on transport layer that mortify the performance. Duc et al., [9] argued that present designs for routing are not congested-adaptive.

Most of the existing models are aimed to identify the congestion through packet loss in routing path. The fair amount of times this packet loss can be an impact of link failure. Hence an attempt to packet outlet regularization to handling the packet loss that occurs against link failure is a useless attempt. The other expensive approach that opted by most of the existing solutions is regularizing the packet outlet at all nodes participating in routing. Most of the times it is possible to handling the congestion at hop node level [5] [15]. Hence packet outlet regularization at each node of the network would be an expensive in resource use. Here in this paper we argue that it is an essential requirement to identify the reason for packet loss. Hence we can avoid the congestion handling process via packet outlet regularization against link failure circumstances. And also we continue the argument that hop level congestion handling is not sufficient, because the when hop level nodes are not able to regularize the packet outlet load to handling the congestion, the resource utilization remains same as in source level packet outlet regularization models.

Here we propose a new cross layer routing topology for congestion handling, which considers

- The heterogeneity in node's packet inlet and outlet capacity
- Cross layered routing topology to distinguish between packet loss due to link failure and arbitrary packet loss.
- Power conservation in packet transmission
- Tolerance of link failures and unsettled congestion state.

3. OCC: Ordered Congestion Control By Cross Layer Support In Manet Routing [13]

We know that in MANETs crashing of the packets happen frequently. The main causes for this to happen are as follows:

- Link collapses during transfer.
- Minimizing the packet entrance power by utilizing conditional Transfer with overwhelming Ingress. This is also named as packet sinking because of congestion near routing strategy.
- Medium usability conflict.
- Malevolent sinking near the recipient.

A concise explanation on introducing OCC is as given: The congestion control methodology that was put forward is attained in stratified way.

In our methodology, at first reduce channel current near the pathway node pn_p antecedent to pathway node pn_c that is affected by congestion. This step is voluntary and probable delay threshold at pn_p and functional part of buffer capability. If there is any situation of error or crash in the functioning of the primary step, then automatically this gives rise to the functioning of the secondary step of the methodology. Coming to the secondary step the MAC layer makes the adjacent nodes pn_p attentive that are also present in that particular region. As a result the outcome of all the other adjacent nodes pn_p will be reduced at a time, so that there will be no delay in the group of the threshold value.

Even if the affected node has not improved after the commencement of the first steps of the methodology then the third step gets instigated. The procedure in this step is that the MAC checks the inward rush of the nodes I near the particular pathway pn_p in a given period of the time span τ, then the nodes that are present in that particular cell c_c of the routing path will be intimated about the affected node pn_v by the MAC. Now all the rest of the nodes have reduced their outward rush in order to make the delay of the threshold group gets decreased. When the MAC checks the inward rush of the nodes I near the particular pathway pn_p in a given period of the time span τ, if $I' \geq I$ and the affected node is not improved then the pathway is re-established by making a link between the nodes pn_p and rpn_c, where rpn_c is the pathway node that is held back, which is a consideration node for pn_c. As a result the routing information avoids the affected node pn_v, that is pn_c.

3.1 Congestion Detection With Minimal Energy Utilization

The aim of the extension proposed for our earlier congestion control mechanism OCC [13] is to capture the degree of congestion at relay hop level node with maximal accuracy with low energy usage. The proposed congestion detection model is decoupled from other activities of the MAC layer such as link reliability analysis and buffer size analysis. The detection model extended to detect the congestion at traffic level, which is based on the degree of congestion measurement of relay hop level nodes.

3.2 Measuring degree of congestion at the Relay hop level node

The significant dissimilarity in hardware and software configurations between nodes in ad hoc is common, which is unusual in traditional networks. The results of these dissimilarities can emerge as dissimilar radio ranges, maximum retransmissions and unmanageable buffer sizes. In this context it is clear that the status of congestion can be found with the parameters listed below

- Channel Loading state
- Degree of packet loss
- Using state of the Buffer

Hence the detection congestion state using these three parameters clearly indicating the sign of possibility to suspend the process of congestion state detection from the MAC layer responsibilities. Hereafter these three parameters referred as Congestion detection activity parameter set(C-Daps)

The congestion caused by the inverse ratio of collision due to contention and the count of retransmissions can be observed by the C-daps scope. If the degree of the collision rate appropriately not balanced by the number of retransmissions then the proportional increase in egress delay at the relay hop node is clear evidence that leads to congestion and reflected as congestion due to buffer capacity run over.

3.3 Measuring degree of congestion at path level traffic

The aggregation of congestion state degree csd determined by C-daps at each relay node in the path indicates the 'csd' of the routing path between source and destination nodes. The 'csd' of each relay node n_i can be measured by its ingress initiator n_{i-1}.

A collision detection strategy cds will initiate periodically to find the collision state degree csd at the path $n_{i-1} \rightarrow n_i$, then verifies against the retransmission count rc. The appropriate action listed below will be taken based on the difference between 'csd' and 'rc'.

$condition:(csd - rc) \cong 0$ Action: no action will be initiated

$condition:(csd - rc) > 0$ Action: Congestion found and alerts n_i about the congestion state if it is greater than node level congestion state threshold $dc(\tau)$.

$condition:(csd - rc) < 0$ Action: unnecessary retransmissions found that causes contention, which shall be minimized.

Each node of a selected routing path including destination node receives the degree of congestion dc from its ingress initiator. Since the destination node not having any successor to find the degree of congestion state dc initiates to measure the degree of congestion at routing path level by cumulating the degree of congestion at each relay node. The periodic updates on the congestion status of each relay hop level node to its successor in routing path are significant energy consuming activity. Hence to conserve the energy, the congestion update strategy must be conditional such that

1. Degree of congestion $dc(n_i)$ at relay hop level node h_i will be sent by descendants n_{i-1} iff the '$dc(n_i)$' is greater than the node level congestion threshold $dc(\tau)$. Hence the energy saves due to conditional transmissions.

If the degree of congestion at path level traffic $d_c(rp)$ that measured by destination node will be transmitted to source in the form of response if and only if the path level degree of congestion $dc(p)$ is greater than the path level degree of the congestion threshold $dc(\tau_p)$, hence energy conserves due to avoidance of $dc(p)$ transmission.

3.4 Administering Congestion

When the packet is crashed and that is determined that it crashed at the node pn_i then MAC layer checks the conflict position near pn_i, if that point is found then it makes the antecedent node pn_{i-1} of main node pn_i aware regarding the need of the transferring again in the given span τ as conflict alert con_+. If the span id maximizing the delay near pn_{i-1} so that the packet is crashing at the node pn_{i-1} and its values is higher than the tolerable threshold value, then the node depends on the substitute path among the nodes pn_{i-1} and pn_{i+1} which is present in the routing collection. This substitute path will be on use until the MAC layer sends the acknowledgement $con\_$ of conflict removed at the main path node pn_i by the node pn_{n-1}. When the node pn_{i-1} receives the acknowledgement $mac\_$ sent from the MAC layer then it returns the path back to the pn_{i+1}. The MAC layer again validates and if it derives that the congestion is not because of the conflict then MAC checks the buffer during the inward rush at the main node and if it is full then delivers bof_+ regarding the crowd in the buffer. When the node pn_{i-1} takes delivery of bof_+, then it tries to reduce the inward rush so that the delay that is incrementing may not make the packet collided at the main node pn_{i-1}. If this process fails to reduce the inward rush at the node pn_{i-1}, then the network layer makes the all the remaining nodes of the cell c_c in which the node pn_{i-1} is presently aware, so that the rest will reduce their inward rush because of which the increment in the delay may not make the packet colloid at those nodes. Even if this case fails then the network layer makes the successor cell of the present cell c_c aware of this circumstance. This procedure will be continued frequently until the congestion that is caused due to the rush in the buffer gets prohibited or it is delivered to the cell c_s in which origin node n_s is present. If the result is failed to come then in order to continue the information transfer among the nodes pn_{i-1} and pn_{i+1}, that was troubled because of the congestion bear the main node pn_i, the node pn_{i-1} depends on the substitute path that is accessible in the route compilation. If the MAC concludes that the congestion is occurring due to the link crumple between the node n_i and its descendant n_{i+1} then the main node pn_i chooses the substitute path in order bond up with the pn_{i+2} that is stored in the routing collection of the main node pn_i.

4. Congestion Tolerance Strategy

4.1 A Cross layered Route Discovery:

This practical methodology is termed as a DSR policy for Path discovery. A disseminated technique is used in order to decide the path to the end node n_d by the source node n_s. The appealed packet $rreq$ that is being transmitted will take the node related data like the involvement in the routing path and its id value cid of that node that is conversing. While the packets are transporting the transport layer ensures the cell stage nodes of every node that is corresponding and holds the data with the packet $rreq$ .After the final end node gets this packet $rreq$ from the source then it gets ready to send the reply packet $rrep$ which incorporates the record of all the pathway nodes and their corresponding nodes in the region of the cell. At the time when the reply packet is approved then all the communicating nodes made the essential changes in their routing table and amend it with the ancestor and successor node data. It also corrects with the other corresponding nodes of that scrupulous node and its successor node in the pathway.

When the reply packet $rrep$ finally reaches the origin node n_s, then the most preferred path will be chosen. Then the origin node n_s delivers an acknowledgement $ack(pn)_i$ for every path node for the routing desired path. After the acknowledgement packet $ack(pn)_i$ is delivered then ahead the pathway node pn_i determines the desirable paths among the node pn_i and the both hop stage descendant node pn_{i+2}. In this step the main path node pn_i delivers an appeal $rreq$ to pn_{i+2}. This appeal $rreq$ communicates by using only the communicating nodes of the main node pn_i and the node pn_{i+1}. When this appeal is delivered to pn_i, then pn_{i+2} acknowledges it by using the packet $rrep$ and transfers it to the pn_i on the same path that used by the $rreq$. When the acknowledgement $rrep$ is delivered then pn_i chooses the desired path among the nodes pn_i and pn_{i+2}, lastly is accumulating it into the routing tables. The preferred path that was selected is used for the re-establishment among the nodes pn_i *and* pn_{i+2}, on the basis of a condition that the congestion is obvious at the adjacent descendant node pn_{i+1} of the main node pn_i.

4.2 Path detection algorithm

1 The node n_s that needs to transmit data to target node n_d initiates route discovery, in this regard broadcasts $rreq$ to neighbor nodes.
2. The neighbor node n_i receives route request packet $rreq_i$, if $rreq_i$ is not a clone of earlier broadcasted route request packets then broadcasts to it's neighbor nodes by adding following to $rreq_i$
   a. its identity
   b. and list of overhearing nodes of $n_{i-1} \to n_i$
3. The step2 is continues till $rreq$ reaches target node n_d
4. Then target n_d prepares a route response $rrep_i$ with details of the nodes, which relayed $rreq_i$ between n_s and n_d and over hearing nodes of each relay node. And then $rrep_i$ sends back to n_s through the same relay nodes.
5. Upon receiving the $rrep_i$ every relay node updates routing table with following
   a. Identity of the predecessor relay node pn_{i-1},
   b. Identity of successor node pn_{i+1}
   c. and eavesdropping nodes of pn_i and pn_{i+1}
6. The step 5 is similar for all relay nodes between n_s and n_d
7. n_s determines a path p with dense cells as optimal.
8. For each relay node of the selected path n_s sends $ack(pn)_i$ to each relay node n_i.
9. Each relay node pn_i of route p determines alternate routes to pn_{i+2} such that these alternative routes build only by using overhearing nodes of the pn_i and pn_{i+1} and updates routing table with these alternate routes.

4.3 Energy-Efficient Ordered Congestion tolerance and control: OCTC

1. Let us presume a case of packet colliding at pn_i
2. MAC ensures the level of the conflict:
3. If congestion rouses for the reason that of conflict near pn_i
   a. Then MAC distinguishes the conflict near pn_i and make pn_{i-1} conscious by conveying information in con_+,
   b. Then pn_{i-1} acts on the congestion caused by the conflict: move to step 6.
4. else if congestion is reasoned because of the rush in buffer near pn_i

a. Then MAC recognizes the rush in buffer near pn_i and make pn_{i-1} aware of it by transferring information in bof_+
b. then pn_{i-1} acts on the congestion due to the rush in buffer: move to step 7
c. If victim node 'i' not recovered from the congestion state then

The relay node s relies on alternative path available at its routing table.
End of If

5. else if congestion is caused because of the link collapse among pn_i *and* pn_{i+1} near pn_i
   a. Then MAC recognizes the link collapse among pn_i *and* pn_{i+1}, and make aware by sending link collapse information in LF_+.
   b. then path node pn_i acts on the congestion caused by the link collapse: move to step 8

Step 6: Managing Congestion caused by conflict:

i. When con_+ is taken the delivery from MAC, path node pn_{i-1} acts
   a. Evaluate the con_+, that includes a particulars regarding whether retransmission is needed and span τ for retransmission.
   b. Checks the weight of the τ on inward rush delay time Δ
      i. If $\Delta \geq \delta$ (inward rush delay threshold) [consequences are packet termination because of surpassing delay] For span τ, choosing to alternate path among path node pn_{i-1} and pn_{i+1} to avoid the affected node pn_i, which was caused by congestion by conflict.
ii. Past the span τ path node pn_{i-1} is taken the delivery of either con_+ or con_- from MAC. MAC delivers mac_+ if the conflict is still present in the affected node pn_i else intimates to pn_{i-1} regarding the situation of no conflict at affected node pn_i through con_-.
iii. If con_+ is delivered from MAC then pn_{i-1} executes steps 1 and 2.
iv. else if con_- is taken delivery by pn_{i-1} then it re-establishes the original path among pn_{i-1} *and* $pn_{i+!}$

Step 7: Managing Congestion caused by the rush in the Buffer

v. When bof_+ is taken the delivery from MAC, path node pn_{i-1} acts
   Evaluate the bof_+, that includes a particulars regarding congestion because of rush in the buffer near pn_i.
vi. Executes the procedure of inward rush reducing so that delay Δ does not cross delay threshold δ limit.
vii. If inward rush not reasonable as needed to manage the congestion near pn_i then
   a. Network layer makes every path node that is located in the similar cell c_c to which pn_{i-1} is part of, aware regarding congestion position near pn_i.
   b. As a result every path node of cell c_c tries to reduce their inward rush so that that delay Δ does not cross delay threshold δ limit of individual path nodes.
viii. If inward rush near individual nodes not reasonable as needed to manage the congestion near pn_i then
   a. Network layer makes path nodes in the cell c_p aware, that is antecedent to the c_c.
   b. As a result every path node of cell c_c tries to reduce their inward rush so that that delay Δ does not cross delay threshold δ limit of individual path nodes.
   c. If $n_s \notin c_p$ then $c_p \rightarrow c_c$: move to step viii.
   d. Else if inward rush at individual not reasonable as needed to manage the congestion near pn_i then pn_{i-1} chooses the substitute path that bonds pn_{n-1} *and* pn_{n+1} to make the information transport, which avoids the congestion affected node pn_i.

Step 8: Managing congestion caused by link collapse

ix. When LF_+ is taken the delivery from MAC then path node pn_i chooses the substitute path alp that bonds n_i *and* n_{i+2} to make the information transport.

In view of the fact that the alp is being utilized the path node pn_i tries to derive a desired path among pn_i and pn_{i+2} and this substitute path gets constructed by considering corresponding nodes of pn_i *and* pn_{i+1}.

5. Simulations and Results Discussion

In this section we look at the simulations conducted using Ns-2 simulator [11]. We carried out performance assessment using ns-2 with considerations described in table 3.

No of Hops:	225
Approximate Hop distance	300 meters
Approximate total network	1000X1000 meters
Approximate Cell Rdious	100X100 meters
Physical channel bandwidth	2mbps
Mac Layer:	802.11 DCF with the option of handshaking prier to data transferring
Physical layer representation	802:11B
Performance Index	Outlet directive cost and end-to-end throughput
Max simulation time	150 sec

Table 2: Parameters used in NS-2 [11] for performance analysis

We carried out simulations on three dissimilar routes, which are diverse in length as the number of hops. Paths and their lengths are

1. A path that contains 15 nodes
2. A path contains 40 nodes
3. A path that contains 81 nodes

The same load given to all three paths with a standard interval of 10 Sec load given in bytes can be originate in Fig 1. The Fig 2 finish the throughput observed for the proposed OCC. The congestion control cost observed for OCC is in Fig 3.

The procedure of measuring jamming control fallows:

Based on the obtainable resources, bandwidth and liveliness, for each individual transaction a threshold value between 0 and 1 assigned. In the process of congestion evaluate and control the total cost was measured by summing the cost threshold of each event involved. In Fig 5 we can find the comparison between congestion cost observed for OCC and congestion and contention control model [15].

$$ccc = \sum_{e=1}^{E} ct_e$$

Here ccc is the cost of a congestion control, E is the total number of events involved. ct_e is cost threshold of an event e. The example events are" cost of communication between Mac, physical and application layers ", "alert from Mac to source node of victim node", "outlet directive cost of the participating groups", "packet inlet estimation and packet outlet directive".

The packet delivery fraction (PDF) can be expressed as:

$$P' = \sum_{f=1}^{e} \frac{R_f}{N_f}$$

$$P = \frac{1}{c} * P'$$

- P is the division of efficiently delivered packets,
- c is the total quantity of flow or associations,
- f is the unique flow id allocated as index,
- R_f is the quantity of packets recognized from flow f
- N_f is the quantity of packets transmitted to flow f

The figures 12 indicates the advantage of EOCTC over our earlier proposed model EOCC[14], which is because of path restoration strategy introduced under congestion tolerance activity. Figure 13 to 15 reveals the advantage of the EOCTC over any other cross layer congestion models such as [15], which is identical to the performance of

EOCC [14]. The Figure 6 indicates the advantage of EOCTC over EOCC in packet delivery fraction that achieved due to root discovery strategy introduced under concept of path restoration for congestion and link failure tolerance

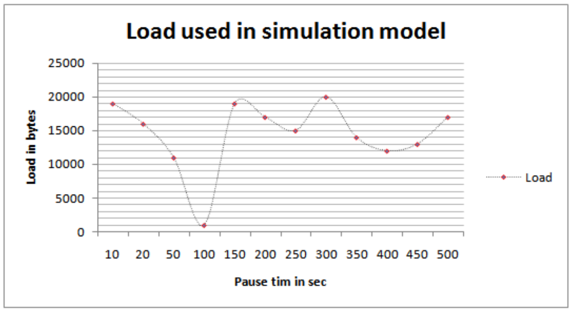

Fig 1: Data size in bytes is sent to destination node from the source node

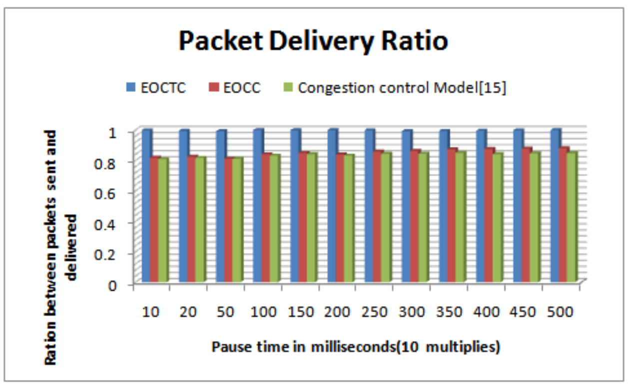

Fig 2: PDR advantage of EOCTC over EOCC and cross layer congestion control model [15]

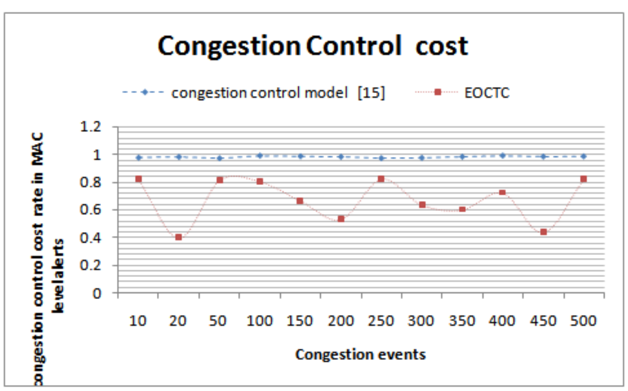

Fig 3: The advantage of EOCTC to minimize the cost to control congestion over cross-layered congestion control model [15]

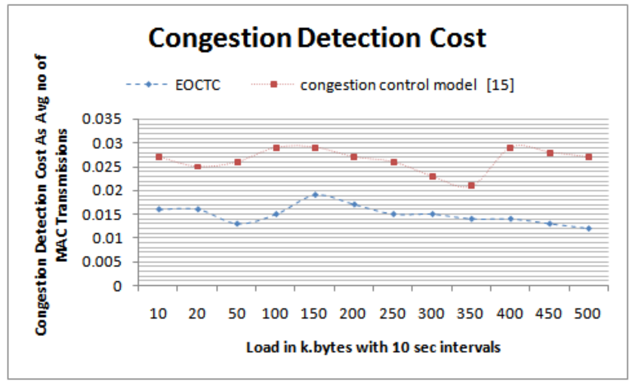

Fig 4: The advantage of EOCTC to minimize the cost to detect congestion over cross-layered congestion control model [15]

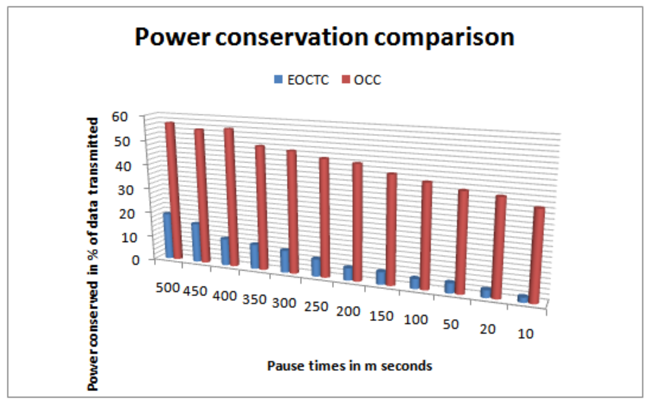

Fig 5: The Advantage of EOCTC over OCC in energy efficiency for data transmission

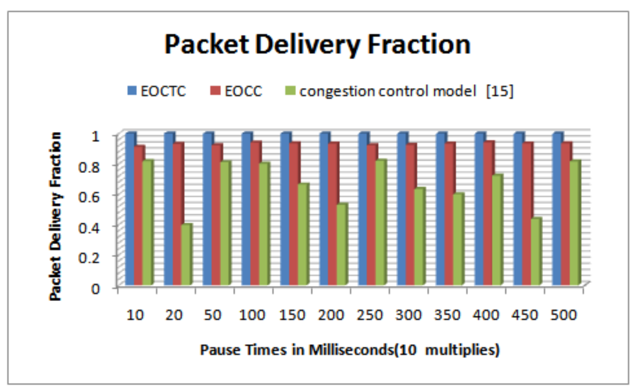

Figure 6: Packet Delivery Fraction advantage of EOCTC with congestion tolerance strategy over EOCC.

6. Conclusion

A cross layered and power conserved routing topology for congestion tolerance and control in mobile ad hoc networks introduced in this paper. Since this is an extension to our earlier proposed model called EOCC [15], we can refer this proposed protocol in short as EOCTC. As an extension to EOCC [15] the EOCTC helps to distinguish between packet loss due to link failure and arbitrary packet loss. Once the congestion contention node found then attempts to resolve it at the source node to node identified as victim of congestion, if congestion not resolved at node level, attempts to handle at current group level, and the same continues at predecessor groups if failed to control congestion at current group level. Since the packet outlet directive is carried out at node level, current group level and all predecessor group levels in a succession, the cost of jamming control is minimal and required level, also capable to identify the required minimal state of the signal to transmit a data packet during the route request and the same will be normalized during RTS/CTS. Along with all these abilities that are inherent from EOCC, the EOCTC capable to tolerate the link failure and congestion if it unable to resolve. Here in this proposed model we introduced a new route discovery strategy that manages to store the overhearing nodes of the next hop level relay node in current relay node routing table. This overhearing node list helps to establish the alternative path if link failed to next hop level relay node or congestion unable resolve at next hop level relay node. The simulation results that we observed are very impressive and promising. In particular, the proposed EOCTC is identical to EOCC in all aspects but shown its advantage over EOCC in congestion and link failure tolerance (see figure 2 and 6). In future we can extend this work to conserve the power at Mac at congestion detection strategy.

References

[1]. Xuyang Wang and Dmitri Perkins, "Cross-layer Hop-byhop Congestion Control in Mobile Ad Hoc Networks", IEEE, 2008.

[2]. Dzmitry Kliazovich, Fabrizio Granelli, "Cross-layer Congestion Control in Ad hoc Wireless Networks," Elsevier, 2005.

[3]. Duc A. Tran and Harish Raghavendra, "Congestion Adaptive Routing in Mobile Ad Hoc Networks", 2006.

[4]. Nishant Gupta, Samir R. Das. Energy-Aware On-Demand Routing for Mobile Ad Hoc Networks, OPNET Technologies, Inc. 7255 Woodmont Avenue Bethesda, MD 20814 U.S.A., Computer Science Department SUNY at Stony Brook Stony Brook, NY 11794-4400 U.S.A.

[5]. Laura, Energy Consumption Model for performance analysis of routing protocols in MANET,Journal of mobile networks and application 2000.

[6]. LIXin MIAO Jian –song, A new traffic allocation algorithm in AD hoc networks, "The Journal of ChinaUniversity of Post and Telecommunication", Volume 13. Issue3. September 2006.

[7]. Chun-Yuan Chiu; Wu, E.H.-K.; Gen-Huey Chen; "A Reliable and Efficient MAC Layer Broadcast Protocol for Mobile Ad Hoc Networks," Vehicular Technology, IEEE Transactions on , vol.56, no.4, pp.2296-2305, July 2007

[8]. Giovanidis, A. Stanczak, S., Fraunhofer Inst. for Telecommun., Heinrich Hertz Inst., Berlin, Germany This chapter appears in: 7th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks, 2009. WiOPT 2009

[9]. Outay, F.; Vèque, V.; Bouallègue, R.; Inst. of Fundamental Electron., Univ. Paris-Sud 11, Orsay, France This chapter appears in: 2010 IEEE 29th International Performance Computing and Communications Conference (IPCCC)

[10]. Yingqun Yu; Giannakis, G.B.; , "Cross-layer congestion and contention control for wireless ad hoc networks," Wireless Communications, IEEE Transactions on , vol.7, no.1, pp.37-42, Jan. 2008

[11]. http://www.isi.edu/nsnam/ns/

[12]. Prof.K.Srinivas and Prof.A.A.Chari. Article: Cross Layer Congestion Control in MANETs and Current State of Art. International Journal of Computer Applications 29(6):28-35, September 2011. Published by Foundation of Computer Science, New York, USA

[13]. T.Suryaprakash Reddy,Dr.P.Chenna Reddy; "OCC: Ordered congestion control with cross layer support in Manet routing"; (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 3, No. 3, 2012

[14]. T.Suryaprakash Reddy, Dr. P. Chenna Reddy; "EOCC: Energy-Efficient Ordered congestion control using cross layer support in Mobile Ad Hoc Network routing"; International Journal of Scientific & Engineering Research, Volume 3, Issue 10, October-2012, ISSN 2229-5518

[15]. Jacquet P, Mu¨ hlethaler P, Clausen T, Laouiti A, Qayyum A, Viennot L (2001) Optimized Link State Routing Protocol for Ad Hoc Networks. IEEE INMIC 2001:62–68