QOS Optimization for Hierarchical Zones Structure Based Multi Cast Routing: A Two Level Congestion Control Approach

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Abstract:- Here in this paper a MAC layer level overcrowding detection system has been projected. The planned model aims to distribute an energy efficient mechanism to compute the degree of congestion at victim node with maximal accuracy. This congestion detection apparatus is integrated with a Two-Step Cross Layer Congestion Control Routing Protocol. The proposed model involves controlling of congestion in two steps with effective energy capable blocking detection and optimal consumption of resources. Packet loss in network routing is primarily due to link failure and congestion. Most of the existing congestion control solutions do not have the ability to distinguish between packet loss due to link collapse and packet loss due to congestion. As a result these solutions aim towards action against packet drop due to link malfunction which is an unnecessary effort and may product in loss of resources. The other limit in most of the accessible solution is the utilization of energy and resources to detect blockage state, degree of congestion and alert the source node about blocking in routing path. Here in this paper we suggest cross layered model of congestion recognition an control mechanism that include energy efficient congestion detection, Intra level Congestion Evaluation Algorithm [ICEA] and Intra level Egress Regularization Algorithm [IERA], which is a hierarchical cross layer based blocking detection and control model in short we refer this protocol as CDC-CPF(Congestion Detection and organize with Control Plane Functionality). This paper is supported by the investigational and simulation results show that better store utilization, energy efficiency in congestion detection and congestion control is possible by the proposed protocol.

Index Terms— *Ad-hoc networks, MANETS, congestion,cross-layer design, optimization, random access, wireless network*

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1 INTRODUCTION

The regular TCP jamming control mostly adapted for internet is not an apposite for MANETs because MANETs are known to affect protocol and protocol stacks of control mechanisms .also the MANETs are environmentally irreconcilable with standard TCP [17].

The packet rescue delays and losses in MANETs are primarily due to their node mobility combined with intrinsically unexpected medium which is a direct consequence of the common wireless multi hop channel cannot be construe as congestion losses [17].

The primary individuality of a wireless multi hop channel is that within interfering range of one node only a single data is transmitted .In MANETs' networks in an complete area are congested due to shared standard where as internet congestion is single router[17].A note valuable point is that in a MANET the nodes are not overcrowded[17].The main reason for the incompatible of a regular TCP and a MANET is the fact that package losses in MANET may not always be due to network congestion and the transmission times (including the round trip times) vary highly making the package losses quite difficult to observe

It is difficult to find the source of congestion in a multi hop network because a single user has the capability to produce a congestion resulting in comparatively lower bandwidth of mobile ad-hoc networks .The wireless networks are more susceptible to congestion problems when compared with the traditional wire line network.

Therefore a balanced congestion control system is to be employed compulsorily for the stability and superior performance [17] of a wireless network. The non homogeneous nature of the application protocols in the multihop wireless networks, a single and unified solution for the congestion related problems cannot be obtained .Instead a suitable congestion control depending upon the properties and functions of the related network[17] can be designed .As a result ,these proposal majorly form a subset of solutions for the identified problems rather than a complete ,instantly used protocol . They pose as a parent for application-tailored protocol stacks. Exceptionally , few of the protocol properties serve wide range of applications[17].

The recent years have witness a much more focus on the congestion control methods directed on the modeling, analysis, algorithm development of closed loop control schemes (e.g. TCP) making them sympathetic for adaption to the mobile hoc networks .under the provision of constraints of routing path and bandwidth algorithms possessing the ability to unify and stabilize operation have been evolved .Another major constraint to be painstaking in a wireless hoc network is due to the MAC[Media access Control) layer [17].Majority of wireless MACs possess a time constriction permitting a single user to access a physical channel at a given time.

The sections in the paper are organized to provide the following details as regards. The section2 explores the most cited works in the area of text .section3 gives a detail dis-

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cussion of the projected protocol and section 4 relies on the simulation and their results to be consummate by conclusion and references.

1.1 Related Work

QoS centric jamming control solution can be found in [1]. Metrics based solution for blockage aware routing was proposed in[4]. Et al., [2] introduced metrics to evaluate data-rate, MAC transparency and buffer delay, which helps to identify and deal the blocking contention area in network. Hongqiang Zhai, et al., [3] planned a solution by arguing that congestion and severe medium debate is interrelated. Yung Yi et al., [4] proposed a hop level blockage control model. Tom Goff, Nael et al., [5] discussed a set of algorithms that initiates different path usage when the quality of a path in use becomes suspect. Xuyang et al., [6] present a cross-layer hop-by-hop congestion control scheme planned to improve TCP performance in multihop wireless networks. Dzmitry et al [7] presents the impact blocking on transport layer that decreases the performance. Duc et al.[8] proposed that current designs for routing are not adjustable to congestion.

The existing models aim at identify congestion losses in routing path .The packet loss generate a link failure. Making efforts to manage the packet losses that cause link failure are in effective. Another exclusive approach is regularizing the egress at all nodes participating in routing. In majority of cases of control the congestion at hop level [4][15]. Henceforth egress regularization at each node of the network involves operation of expensive wealth.. Here in this paper we argue that it is a important to identify the reason for packet loss. Hence we can avoid the blockage control process via egress regularization under the status of link failure. And also we continue the spat that hop level blocking control alone is not plenty when the hop levels are unable to normalize themselves. The egress load to control the blocking by utilizing the same resources can be done as in spring level egress regularization models. In this situation in our previous work we proposed a Two-Step Cross Layer blocking Control Routing Protocol [18].

Here we propose a new energy efficient cross layer based blocking control routing protocol that contains Congestion detection and congestion control models.

2 CROSS LAYER DESIGN WITH CONTROL PLANE FUNCTIONALITY IN MULTI HOP WIRELESS NETWORKS FOR EFFECTIVE BLOCKING CONTROL

2.1 Energy resourceful Congestion detection mechanism

The aim of the proposed congestion detection device is to capture degree of congestion at relay hop level node with maximal accuracy. In proposed model, the detection mechanism is decoupled from other activities of the MAC layer such as link consistency analysis and buffer size analysis. The recognition model extended to detect the congestion at traffic level, which is based on the degree of congestion quantity at relay hop level node.

2.2 Measuring degree of blockage at Relay hop level node

Unlike conventional networks, nodes in the ad hoc network exhibit a high degree of heterogeneity in terms of both hardware and software configurations. The heterogeneity of the relay hop nodes can reflect as varied radio range, maximum retransmission counts, and barrier capacity. Hence the degree of waterway loading, packet drop rate, and degree of buffer consumption at relay hop level node is minimum combination to find the degree of congestion. The usage of these three purposeful values supports to decouple the congestion measure process from other MAC layer behavior.

The degree of channel load, packet drop rate and degree of buffer operation together provide a scope to envisage the blocking due to inappropriate ratio between collision and retransmission count. When retransmissions compared to collision rate are significantly low then egress delay of relay hop node will increase proportionally, which leads to congestion and reflected as congestion due to buffer overflow.

2.3 Measuring degree of congestion at path level traffic

The degree of congestion at each relay hop together helps to identify the degree of congestion at path level traffic from source to goal node. Each relay hop level node receives the degree of congestion from its doorway architect. Since the destination node, which is last node of the course-plotting path is not egress the emptiness status. Hence the destination node initiates to assess the degree of congestion at path level traffic. The interrupted updates of congestion status at each relay hop level node to it's heir in routing path is significantly energy consuming activity. Hence to conserve the energy, the congestion update strategy considers two conditional activities, which follows:

1. Degree of blocking $d_c(h_i)$ at relay hop level node h_i will be sent to its successor h_{i+1} if the $d_c(h_i)$ is greater than the node level blockage threshold $d_c(\tau)$. Hence the energy conserves due to conditional transmission.
2. If degree of blocking at path level traffic $d_c(rp)$ that received by node h_i from its doorway initiator h_{i-1} is smaller than $d_c(h_i)$ then it update the $d_c(rp)$ else it remains same, hence energy conserve due to prevention of $d_c(rp)$ update.

3 CROSS LAYER CONGESTION CONTROL MODEL

The packet dipping often occurs in Manets. The reasons for this packet plummeting are as below

- Transmission Link failure.
- Inferred Transmission due to weighed down Ingress that leads Ingress getting strength to low. This also can claim as packet dropping due to blocking at routing.

The congestion control can be evaluated in two stages by turning over of the zonal head with the network partitioned into Cells as follows

- The Status of blocking at intra Cell level
- The status of jamming at inter Cell level

This helps in minimization of source level egress regulation cost and balances the power consumption.

TABLE 1

NOTATIONS USED IN PROPOSED MODEL

Cell	A geographical area, which is the part of preferred mobile ad hoc network
ICEA	Intra level jamming Evaluation Algorithm
IERA	Intra level Egress Regularization Algorithm
ERA	Egress Regularization Algorithm
DPG	Distance Power Gradient
EIL	Ingress inferred Loss
LFL	Link Failure Loss
IRS	Ingress receiving strength
IRS_p	Present Ingress receiving strength
IRS_e	Expected Ingress Receiving Strength
RP	Routing Path
dt_n	Delay time at node *n*
N	Number of nodes in entire network
Zn_i	Number of nodes in a Cell *i*
Zh_i	Cell head of the i^{th} Cell
Zh'_i	Reserved Cell head of the i^{th} Cell
Z_c	Current Cell in the hierarchy
Z_p	Preceding Cell to the current Cell Z_c in hierarchy
Z_f	Fallowing Cell to the current Cell Z_c in hierachy
Z_i	i^{th} Cell in the routing path
n_z	Cell of the node *n*
ζ_z	Cell level Transmission Load Threshold
ζ_n	Node level Transmission Load Threshold
ζ_T	Predefined threshold that represents interval between two transmissions at one hop level
ζ_t	Actual interval between last two transmissions
ζ_{et}	Elapsed time since last transmission at one hop level
IRS_{ζ_T}	Average Ingress receiving strength threshold observed for predefined interval ζ_T
∂'	Average slopping threshold of the receiving strength
IRS_{ce}	Expected Ingress receiving strength threshold at current interval
IRS_r	Ingress receiving strength ratio
IRS_{cr}	Current ingress receiving strength ratio
BT_n	Buffering time at node *n*
$Zdil_i$	Cell level degree of ingress load, here i is a Cell id.
$ndil_k$	Node level degree of ingress load, here k is the node id of Cell *i*

3.1 Network and Node activities under projected protocol

The network is to be crack into Cells.

For each Cell i, where $i = 1..|Z|$; $(|Z|$ is entirety number of Cells)

  - Select Cell-head for each Cell i
  - Find spread load threshold ζ_n for each Cell i.

By using ζ_n of each Cell spread load threshold for entire network can be measured.

3.2 Splitting the network into Cells:

We opt to the approach described by Mohammad M. Qabajeh et al[8]. With the knowledge of the presented nodes the region is divided into equal partitions. Hexagon is mostly chased for the zonal shape because it covers a highest surface and also provides the improvement of communicating with more neighbors as they have near circular shape of the transmitter. The availability of small, economical low power GPS receiver makes it possible to apply position-based in MANETs. The communication range of node is denote as R and the side of hexagon as L.As the nodes should be able to correspond with each other the R and L are related as L=R/2.

Each Cell has a Cell characteristics (Zid), Cell Header (Zh) and Cell Leader Backup (Zh'). The Zh node maintains in sequence about all the nodes in a Cell with their positions and IDs. Also, maintain information about the Zh of the neighboring Cells as shown in the figure 1. The CLB node keeps a copy of the data stored at the Zh so that it is not lost when the Zh node is off or touching the Cell. By knowing the coordinates of a node position, nodes can perform our self-mapping algorithm of their physical locations onto the current Cell and calculate its Zid easily. Figure 1.shows the general overview of the network architecture.

3.3 Selecting Cell-Heads

A Cell-Head selection occur under the pressure of the Following metrics:

a. Node positions: A node with a position *p* that is close to the centre is more likely to act as a Cell head.
b. Optimum energy available: a node with higher energy e more probably acts as a Cell head.
c. Computational ability: the node with high computational ability c is more possible to act as a Cell Head.
d. Low mobility: the mobility *m of* a node is inversly proportional to its selection as a Cell head.

Each node of the Cell broadcasts its (p,e,c,m). The node that identified itself as most optimal in (p,e,c,m) metrics, announces itself as Cell head Zh. The next optimal node in sequence claims itself as reserve Cell head Zh'.

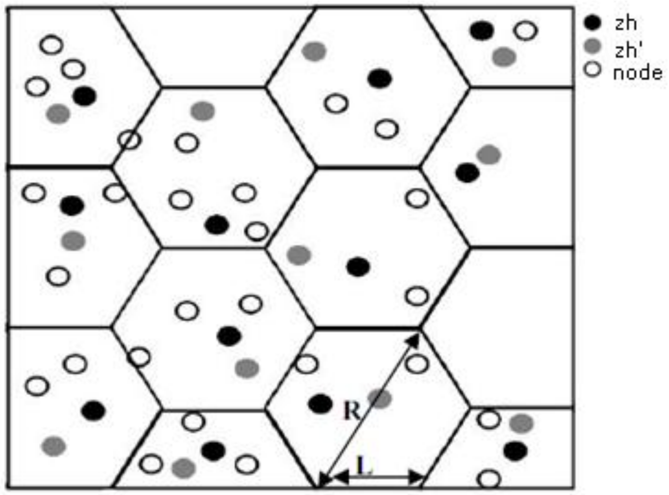

Figure 1[8]: General overview of the Cell partitions in network.

3.4 Information sharing at intra Cell level [between Node and Cell head]

Each node n that is a subset to Cell Z verifies the Ingress load and shares degree of ingress load dil_n with Cell head. Once $ndil_k$ received from each node k of the Cell i, the Cell head zh calculates the degree of ingress load at Cell level $zdil_i$.

$$zdil_{Z_i} = \frac{\sum_{k=1}^{Zn_i} ndil_k}{Zn_i}$$

3.5 Intra level Congestion Evaluation Algorithm (ICEA)

Intra level Congestion Evaluation Algorithm abbreviated as ICEA is presented in this section. ICEA is an optimal algorithm that helps in locating the packet dropping under congestion. This evaluation occurs under Mac layer and then alerts network layer.

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At an event of ingress receiving by node i :

Updating Ingress receiving strength:
    if ($\zeta_t < \zeta_T$) do

    $\delta' := \frac{1}{2}\left[\frac{IRS_{cr} - IRS_{\zeta T}}{\zeta_t}\right] + \frac{1}{2}(\delta')$

    $IRS_{\zeta_T} := IRS_{cr}\left(\frac{\zeta_t}{\zeta_T}\right) + IRS_{\zeta_T}\left(\frac{\zeta_T - \zeta_t}{\zeta_T}\right)$

endif

if ($\zeta_t$ □ $\zeta_T$) do

    $\delta' := \left[\frac{IRS_{cr} - IRS_{\zeta T}}{\zeta_t}\right]$
    $IRS_{\zeta_T} = IRS_{cr}$

 Endif

Detecting packet drop at Mac layer level
    $IRS_{ce} = IRS_{\zeta_T} + \delta' \zeta_{et}$

    if ($IRS_{ce} < IRS_r$) do

MacAlert: link-failure
else
MacAlert: congestion
Endif
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Fig2: ICEA for determining congestion caused packet dropping

3.6 Intra level Egress Regularization Algorithm (IERA)

This event occurs if Mac-layer alert indicates the congestion circumstance. Once the routing protocol [13] gets an alert from the Mac layer a propos the blocking at a node i, it alerts the fellow citizen node which is the source node s for conflict node i. Hence s evaluates it's dil_s by comparing with zdil of Z_c(Cell of the node s). If dil_s is more in magnitude than $zdil_{z_c}$ the variation between dil_s and $zdil_{s_z}$ should be either greater or equal to the egress threshold $\mathcal{E}$ then node s regularizes the egress load by manipulate its buffer time BT_s such that $ndil_s \geq zdil_{s_z} + {}_s$.

Here ε can be calculated with following equation

$$\varepsilon_j = \frac{\sum_{k=1}^{zn_j} zdil_j - dil_k}{zn_j}$$

In case that the node s not able to normalize its egress so that disagreement node i terminates blocking then it alerts the zh_{s_z}(Cell-head of theZ_c,$S \varepsilon Z_c$). subsequent that event Zh_{z_c}alerts all the nodes in the network building the all nodes in the upstream of source node to way out load using the above stated slant. Then all nodes update their ndil and send to Cell-head Zh_{z_c}, then Cell-head Zh_{z_c}calculate Zdil and confirms integrity of the Zdil by evaluation with dil. $zdil_{Z_c} \geq dil + \bar{\varepsilon}$ concludes that congestion at contention node maintained by egress regularization at current Cell level. If $zdil_{z_c} < dil + \bar{\varepsilon}$ then CEA will be started at Z_p, which is adjacent upstream Cell to Z_c in transmissible . In this process Cell head of the Z_c firstly alerts the Cell head of the counterpart Z_p then Zh_{z_p}alerts all nodes that belongs to Z_p, of the route path. The above procedure of egress regularization at Cell level can be referred as IERA (Intra level Egress Regularization Algorithm). Hence the nodes belong to Z_p regularize their egress load by utilize

IERA and alert Cell-head about their efficient degree of ingress load ndil. Then Zh_{z_p} measures $Zdil_{z_p}$ and verifies the result of $zdil_{Z_p} \geq dil + \overline{\varepsilon}$ .True indicates the elimination or minimization of congestion at the Cell due to the egress regularization at Cell Z_p, if false then Cell head of the Z_p performs the action of alerting all other Cell heads using a broadcasting[12] instrument about the congestion at adjacent Cell in downstream of the heridetary. Hence all Cells in the upstream side of the Z_p apply IERA and the Cells in downstream side of the Z_p fill in theirZdil. Then all Cells broadcast Zdil to resource Cell. Hence the source Cell revaluates the dil .Based on the *dil* , source node regularize its egress load.

Notations used in Algorithm:

i: Node that effected by congestion
s: source node of the i.
Z_c: current zone where i,s ϵ Z_c
Z_p: Immediate zone to Z_c in upstream side of the hierarchy.
$\{nu1, nu2,..., nuk\}_{Z_C}$: All upstream nodes to s
$\{nd1, nd2,..., ndk\}_{Z_C}$: All downstream nodes to *s*.
$\{Z_s, Z_{u1}, Z_{u2}, \ldots, Z_{uk}\}$: Set of upstream zones to Z_p in routing path, here Z_s is a zone that contains source node of the routing path
$\{Z_{d1}, Z_{d2}, \ldots, Z_{dm}, \ldots, Z_t\}$: Set of downstream zones to Z_p in routing path, here Z_t is a zone that contains target node of the routing path

ε: Cell level egress threshold
$\overline{\varepsilon}$: Network level Egress threshold

Algorithm:

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Mac layer alerts about the blocking at node of Cell $Z_c$ to routing protocol, hence the following steps perform in sequence
$\varepsilon_{z_c} = \frac{\sum_{k=1}^{zn_{z_c}} zdil_{z_c} - dil_k}{zn_{z_c}}$
complete following at node S
If $ndil_s > zdil_{z_c}$ and $ndil_s - zdil_{z_c} \geq {}_{z_c}$ begin
 $BT_s = BT_s + bt$
Note: Value of buffer threshold bt should be certain such that $dil_S \geq zdil_{z_c} + {}_{z_c}$
Return.
Endif
S sends alert to $zh_{z_c}$ about contention node i.
$zh_{z_c}$ alerts all nodes that belongs to zone $z_c$
  1) $\{n_{u1}, n_{u2}, \ldots, n_{uk}\}$ updates their ndil by apply IERA recursively and alerts $zh_{z_c}$
$\{nd1, nd2,..., ndk\}_{Z_c}$ measures their ndil and alerts $zh_{z_c}$
$zh_{z_c}$ Measures zdil as fallows
$zdil_{Zc} = \frac{\sum_{k=1}^{zn_{z_c}} ndil_k}{zn_{z_c}}$
If $zdil_{Z_c} > dil$ and $(zdil_{Z_c} - dil) \geq \overline{\varepsilon}$ begin
Alert: blocking at contention node handle at current Cell $Z_c$ level.
Return.
Endif
$Zh_{z_c}$ Alerts $Zh_{z_p}$
$Zh_{z_p}$ Alerts all nodes that belong to Cell $Z_p$
For each node n ϵ $Z_p$ begin
If $ndil_n > Zdil_{z_p}$ and $ndil_n - Zdil_{z_p} > \varepsilon_{z_p}$ begin
$BT_n = BT_n + bt$
Note: Value of barrier threshold bt should be decided such that $dil_n \geq zdil_{z_c} + {}_{z_c}$
Endif
Find $dil_n$ and send $dil_n$ to $Zh_{z_p}$
End-of-for each
$Zh_{z_p}$ measures $Zdil_{z_p}$
if $Zdil_{z_p} > dil$ and $(zdil_{Z_p} - dil) \geq \overline{\varepsilon}$ begin
Alert: Egress regularization at $Z_p$ leads to overcome congestion situation at contention Cell.
        Return;
Endif
$Zh_{z_p}$ Alerts all Cell heads in network regarding congestion contention Cell.
 For each Cell z in $\{Z_S, Z_{u1}, Z_{u2}, \ldots, Z_{uk}\}$ begin
$Zh_z$ Alerts all nodes that belongs to Cell z
For each node n ε z begin
If $ndil_n > zdil_z$ and $(ndil_n - zdil_z) \geq \epsilon_z$ begin
$BT_n = BT_n + bt$
Note: Value of barrier threshold bt should be understood such that $dil_n \geq zdil_Z + \varepsilon_Z$
Endif
Find $dil_n$ and send $dil_n$ to $Zh_z$
End-of-foreach
$Zh_z$ measures $Zdil_z$ and broadcast towards source Cell.
End-of-foreach
For each Cell z in $\{Z_{d1}, Z_{d2}, \ldots, Z_{dm}, \ldots, Z_T\}$ begin
For each node n belongs to Cell z begin
determine $ndil_n$ and sends to $Zh_z$
        End-of-foreach
$Zh_z$ measures $Zdil_z$ as
$zdil_Z = \frac{\sum_{k=1}^{zn_Z} ndil_k}{zn_Z}$
$Zh_z$ Sends $Zdil_z$ to source Cell via propagation [12]
End-of-foreach
$Z_S$ Measures dil as
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$$dil=\frac{\sum_{i=1}^{|Z|} zdil_i}{|Z|}$$

Hence source node S of Cell ZS, which is source node of the routing path regularize it's egress load to direction-finding path. Hence source node S of t's egress laod to direction finding path.

Fig 3: Intra level Egress Regularization Algorithm

4 SIMULATIONS AND RESULTS DISCUSSION

In this section we discuss the outcome acquired from simulation conducted using 'Madhoc simulator' [16] in this section. We evaluated concert using madhoc with the following considerations:

TABLE 2

PARAMETERS USED IN MADHOC [16] FOR PERFORMANCE ANALSIS

No of Hops	225
Approximate Hop distance	300 meters
Approximate total network	1000X1000 meters
fairly accurate Cell Rdious	100X100 meters
Physical channel bandwidth	2mbps
Mac Layer:	802.11 DCF with option of handshaking prier to data transferring
Physical layer illustration	802:11B
presentation Index	Egress regularization cost and end-to-end throughput
be very successful simulation time	150 sec

The simulations are conducted on three routes differing by the no of hops and length.

a. Short length path: A route with 15 hops
b. middling length : A route with 40 hops
c. Max Length: A route with 81 hops

The same load is given to all the paths with a regular interval of 10 sec. Load given in kilo bytes are shown in fig 4. The fig 5 concludes the improvement of CDC-CPF over congestion control protocol[15] in blockage control cost. A. The congestion detection cost evaluation between CDC-CPF and congestion control protocol[15] is explore in fig 6 that elevates the energy good organization achieved under CDC-CPF.

The process of capacity of congestion control and congestion detection cost is as follows:

Based on the resource ease of use, bandwidth and energy, for individual operation a threshold value between 0 and 1 assigned. In the mechanism of congestion detection and control the total cost is calculated by summing the cost threshold of every involved event. In fig 5 the judgment between congestion costs observed for CDC-CPF and jamming and contention control model [15] are shown.

$$\cos t_{ch} = \sum_{e=1}^{E} ct_e$$

Here cost_{ch} is the price of a blockage controlling activity ch,E is total amount of events included. $ct_e$is the threshold cost of an event e. The example events are:

1." alert to source node from Mac layer"
2. "Alert from node to Cell head", "propagation by Cell head to other Cell heads"
3. "Ingress judgment and egress regularization".
4. Alert about $d_c(h_i)$
5. bring up to date $d_c(rp)$

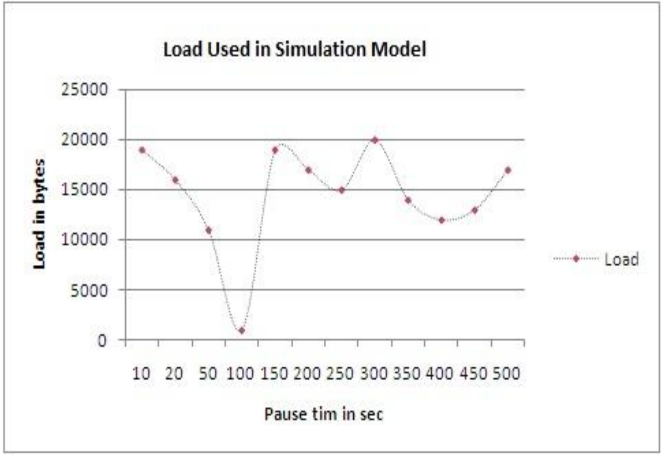

Fig 4: Load in bytes drive by source node of the routing path [in regular interval of 10 sec]

5 CONCLUSION

This manuscript discussed about proposed "Energy Efficient Cross layered blocking Detection and Control Routing Protocol" in short referred as CDC-CPF(Congestion Detection and have power over with Control seaplane Functionality). CDC-CPF derived a cross layered congestion detection mechanism with energy effectiveness as primary criteria that included as congestion detection mechanism to our earlier work "Two step cross layer congestion routing"[18] .

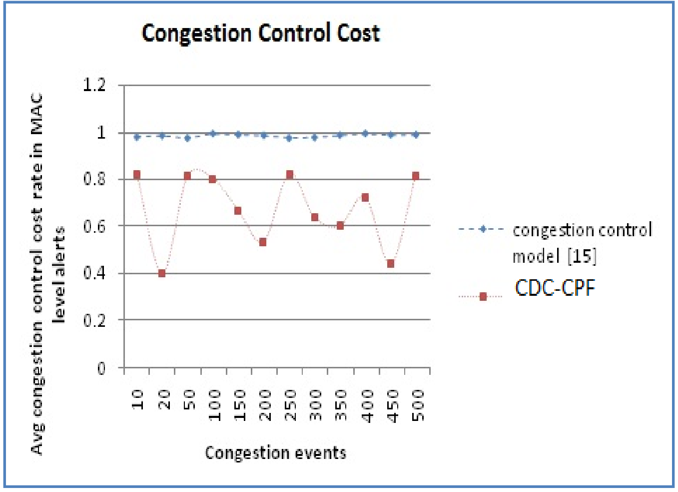

Fig 5: Congestion Control cost comparison chart

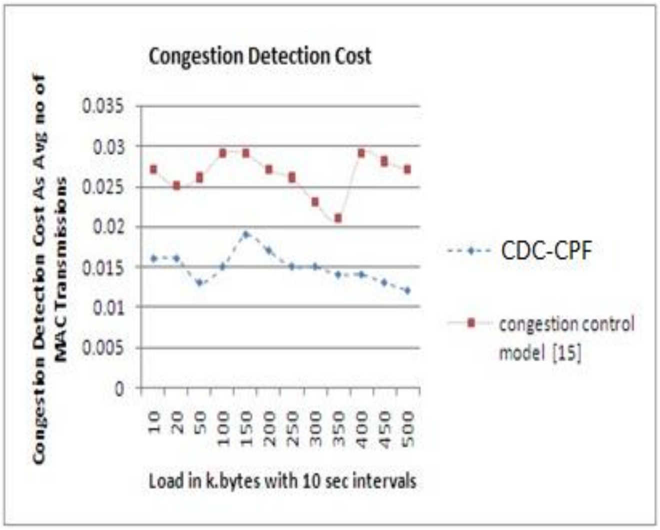

Fig 6: A line chart comparison of Congestion detection cost

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