A COMPARATIVE STUDY ON CROSS LAYER CONGESTION FREE PROTOCOLS IN MANET

S.Sheeja[1], Ramachandra.V.Pujeri[2]

ABSTRACT

A Mobile Ad-hoc Network (MANET) is a dynamic wireless network that can be formed without the need for any pre-existing infrastructure in which each node can act as a router. Many routing protocols have been proposed and several of them have been extensively simulated. In this paper, we compare the performance of various types of cross layer protocols. This article compares the performance of the proposed routing protocols corresponding to network life time, packet delivery ratio, end to end delay, energy consumption and throughput. The ns-2 simulation results proves that EECCS has low end to end delay, minimum energy consumption, good throughput, less congestion than the existing schemes.

***Keywords** - Congestion Control, energy consumption, Mobile Ad hoc Networks, Routing Protocols, Cross Layer.*

I. INTRODUCTION

Ad-hoc wireless networks are a comparatively new concept in multi-hop wireless networking that is increasingly becoming popular and will become an essential part of the computing circumstances, consisting of infra-structured and infrastructure-less mobile networks [1].

Through intermediate nodes only MANET communicates with other nodes directly or indirectly. All nodes in a MANET basically function as mobile routers participating in some routing protocol required for deciding and maintaining the routes. While MANETs are self-organizing, speedy deployable, wireless networks they are tremendously suitable for applications involving special outdoor events such as communications in regions with no wireless network, emergency, natural disaster, military, mine site operations, urgent business meetings [2] and [3]. In general, routes between nodes in an ad hoc network may include multiple hops and, therefore it is suitable to call such networks "multi-hop wireless ad hoc networks".

An ad-hoc network is a collection of wireless mobile nodes (or routers) dynamically forming a temporary network without the use of any existing network infrastructure or centralized management. The routers are free to move randomly and organize themselves arbitrarily according to wireless topology, which may change rapidly and impulsively, such a network may be connected to the Internet.

[1]Research Scholar, Bharathiar University, Coimbatore. sheejaajize@gmail.com

[2]Vice-Principal, KGiSL Institute of Technology, Saravanampatti, Coimbatore.

In many WSN applications, the employment of sensor nodes is performed in an ad hoc fashion without cautious planning and engineering. Once employed, the sensor nodes must be able to autonomously organize themselves into a wireless communication network. Generally, in most of the cases it is difficult and even impossible to change or recharge batteries for the sensor nodes. The WSNs are characterized with dense levels of sensor node employment, higher unreliability of sensor nodes, sever power, computation, and memory constraints. Hence the unique characteristics and constraints present may create a way for many new challenges designed for the development and application of WSNs.

Topology changes in MANET usually occur due to the mobility [9] of a participating node or breakdown of a node due to loss of energy in that node. In addition, the multi-hop nature and the lack of fixed infrastructure generate new research problems such as discovery, configuration and maintenance as well as ad-hoc addressing and self-routing.

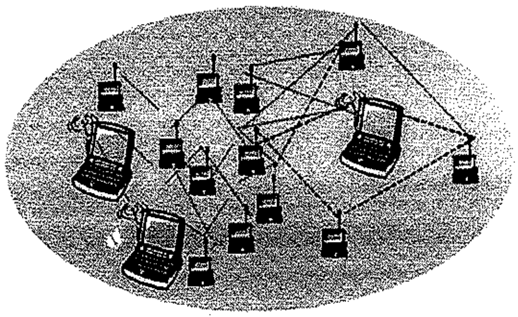

Figure 1 : Mobile Ad Hoc Network

The main objective is to ensure high energy efficiency, efficient security and congestion avoidance in MANETs. For that, it is focused and developed on several categories like congestion detection, congestion control, cross layer design, secure multipath routing and energy efficient model.

MANETS are seen as important components in 4G architecture and ad hoc networking capabilities are believed to form a significant part of overall functionalities of the next generation. The application of MANET has become widespread and varied from email to ftp to web services as shown in Figure 2. Some common MANET applications are:

- **Military Environments**
- **Civilian Environments**
- **Emergency Operations**
- **Local Level**

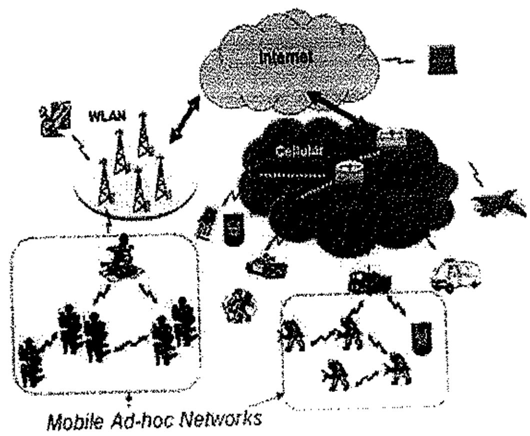

Figure 2 :Application of MANET

II. Main characteristics of MANET are:

Dynamic Topologies nodes are free to move randomly, the topological network changes rapidly and randomly at different times. The links may be unidirectional and bidirectional.

- Bandwidth constrained, variable capacity links: Wireless links have significantly lower capacity than their hardwired counterparts. Because of multiple access fading and noise occurs, which leads the wireless links have low throughput.
- Energy constrained operation: All or Some of the nodes in a MANET may rely on batteries. In this situation, the most important system design criteria for optimization may be energy conservation [5].
- Limited physical security: Mobile wireless networks are generally more prone to physical security threats than are fixed- cable nets. Spoofing, increased possibility of denial-of-service and eavesdropping attacks should be considered carefully. All the existing link security techniques are often applied within wireless networks to reduce security threats.
- Autonomous and infrastructure less: Network is self-organizing and is independent of any fixed infrastructure. The operation mode of each node is distributed peer-to-peer capable of acting as an independent router as well as generating independent data.

III. The Motivating Factors for Cross-Layer based Protocols

A. Cross-Layer Aspects: Nodes in wireless ad hoc networks [8] have to manage several performance aspects like system management, power management, and security management that cut across traditional layers. The strict boundary separation of layers in the layered architecture and standard interlayer interfaces in traditional approaches do not permit adequate communication among layers to make joint decisions to optimize these cross-layer aspects. Thus, has led to the proposal of new interaction models to support cross-layering ranging from a relaxed information flow and sharing between layers to full-fledged merging of layer functionalities.

B. Mobility: Mobility introduces an additional challenge for ad hoc network design. Routing protocols would have to cope with this mobility of the mobile terminals by constantly adapting routing state to the changing user positions. Mobility management poses an added challenge to the battery-powered nodes in ad hoc networks, which have to adjust their behaviour to the changing node locations.

C. Wireless Link Properties: Wireless links are more susceptible as compared to the wired links to interference variations and channel errors. For instance, in the example of the TCP congestion control problem over wireless links, in which TCP misinterprets a packet loss due to channel error as a sign of congestion. Wireless links are also more vulnerable to security attacks because of easy access to the wireless channel as the wireless channel is open.

D. Inherent Layer Dependencies: in a layered protocol stack there exist a number of interlayer dependencies which motivate cross-layer design [7] for ad hoc and sensor networks. The data link and routing layers in ad hoc networks exhibit both variable interaction as well as algorithmic interaction, telling the need for design through coupling of these layers. The data link layer is also closely related with the physical layer. The physical layer deals with the channel state and the data link layer with the error control and flow control. If the change in the channel state at the physical layer is provided to the data link layer then it can adapt error control mechanisms in a adaptive manner, thereby improving the throughput.

E **Security**: Security is an important concern in wireless networks due to their increased vulnerability and exposure to varying types of attacks. Unreliable wireless links, frequently changing network topology and lack of a centralized system to handle the security needs of the network contribute to insecure standalone systems in wireless networks. Intrusion detection systems located on concentrated points such as network gateways and wireless access points are not guaranteed to achieve the desired security level in the network. There exists a need of an efficient and reliable intrusion detection system [6] to manage the access control and provide a monitoring unit to detect any anomalous behaviour in the network [10]. In a wireless network protocol stack, every layer is vulnerable to attacks (internal and external) by adverse nodes in the network. Independent security solutions at different layers might lead to conflicting actions and result in performance degradation

IV. Performance Analysis

The proposed cross layer design is integrated with the Dynamic Source Routing (DSR) protocol. The Network Simulator (NS 2.34) is used to simulate our proposed algorithm. In our simulation, 300 mobile nodes move in a 1200 meter x 1200 meter square region for 120 seconds simulation time. Same transmission range of 250 meters is set to all the nodes. The simulated traffic is Constant Bit Rate (CBR) and Poisson traffic.

Table 1 : Simulation settings and parameters

No. of Nodes	300
Area Size	1200 X 1200
Radio Range	250 m
Simulation Time	120 sec
Traffic Source	CBR and Poisson
Packet Size	512 bytes
Mobility Model	Random Way Point
Protocol	DSR
Pause time	5 msec
Packet Queuing	Drop Tail

Our simulation settings and parameters are summarized in Table 1.

V. Performance Metrics

The performance is evaluated according to the following metrics.

Network Lifetime, overhead, throughput, End-to-end delay, Delivery Ratio, Packet Loss, Energy consumption.

The simulation results are presented in the following analysis. We compare our Effective Congestion Avoidance Scheme [ECAS], Cross Layer Based Congestion Control Scheme [CLCCS], Cross Layer based Secure Multipath Routing Scheme for Congestion Avoidance [CLSMRSCA] and Efficient Energy based Congestion Control Scheme [EECCS] with existing Energy Efficient Secure Authenticated Routing Protocol [EESARP] in presence of congestion environment.

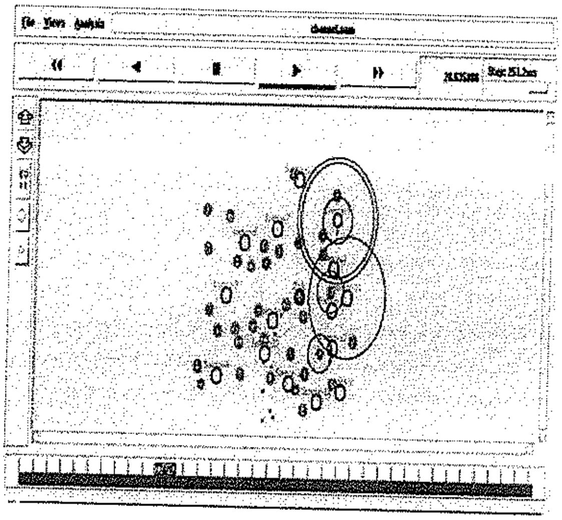

Figure 3 : Topology and Traffic creation

VI. Comparative Analysis Of Proposed Algorithms With Existing Algorithms

To evaluate the EECCS, we compare proposed algorithm with the ECAS, CLCCS, CLSMRSCA and EESARP[4] in presence of congestion environment. The simulation results are presented in the following analysis.

Figure 4 shows the results of packet delivery ratio for varying the nodes 10, 20,...300. From the results, we can see that EECCS scheme has higher delivery ratio than the CLSMRSCA, CLCCS, ECAS schemes and existing EESARP.

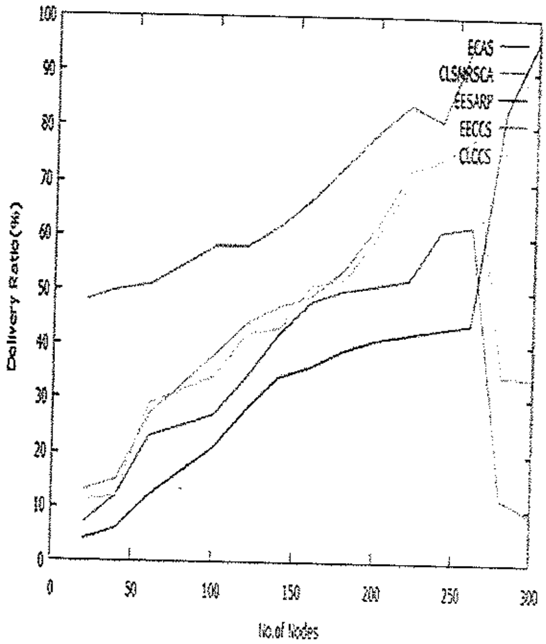

Figure 4 : No. of Nodes Vs delivery ratio

Figure 5 presents the comparison of energy consumption and No. of Nodes. It is clearly shown that the EECCS has low energy consumption than the ECAS, CLCCS, EESARP and CLSMRSCA.

Figure 6 presents the comparison of End to end delay while varying the time from 10 to 100. It is clearly shown that the delay of EECCS has low than the ECAS, CLCCS, ESARP and CLSMRSCA protocol.

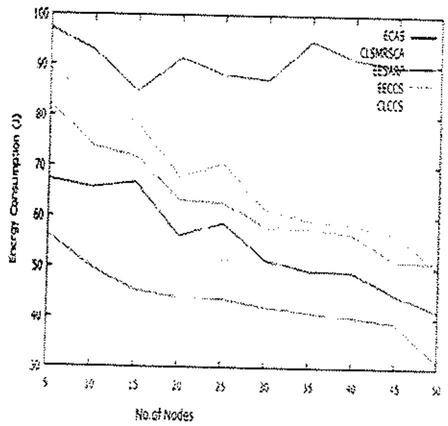

Figure 5 : No. of Nodes Vs Energy Consumption

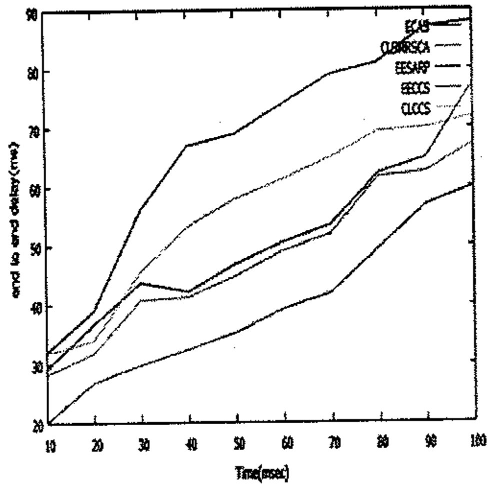

Figure 6 : Time Vs End to End Delay

Figure 7 presents the comparison of Congestion Ratio while varying average traffic from 5 to 25 sec. It is clearly shown that the Congestion ratio of EECCS is kept low than ECAS, CLSMRSCA, CLCCS and EESARP protocol.

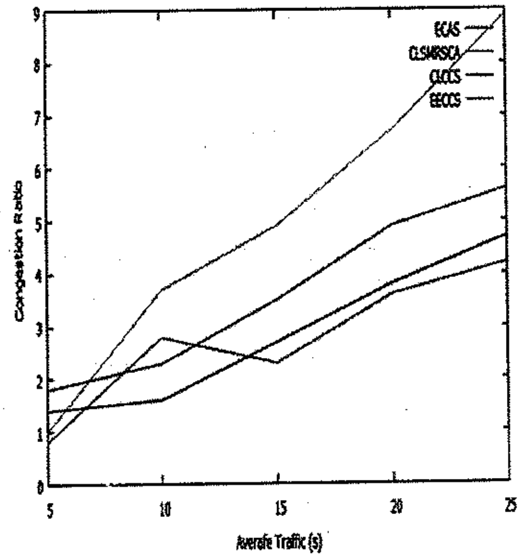

Figure 7 : Average Traffic Vs Congestion Ratio

Figure 8 shows the results of Speed Vs Network Lifetime. From the results, we can see that EECCS scheme has higher Network Lifetime than the CLSMRCSA, CLCCS, EESARP and ECAS while varying the speed from 20 to 200.

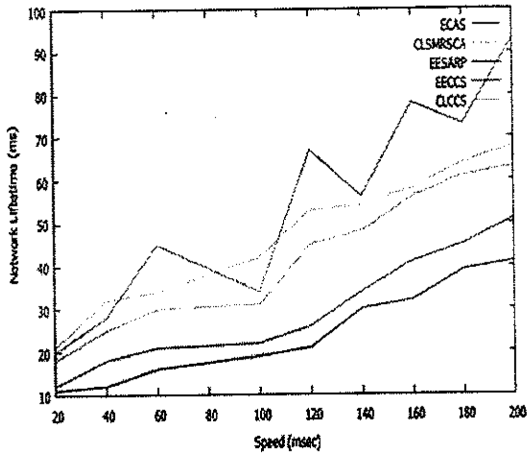

Figure 8 : Speed Vs Network lifetime

Analysis of the proposed scheme is shown in Table 2.

Table 2 : Analysis of Proposed Method (EECCS) and Existing Methods (ECAS, CLSMRSCA, EESARP and CLCCS) in terms of different Parameters

Metrics	EECCS	CLSMRSCA	ECAS	EESARP	CLCCS
Packet Delivery Ratio (pkts)	48-96	23-34	7-9	4-93	11-76
End to end delay (msec)	20.2-59.9	28.2-67.2	29.2-77.4	32-88	31.8-71.8
Packet Loss Ratio	12-57	22-62	29-82	37-92	12-57
Network Lifetime (msec)	20-93	18-63	12-51	11-41	21-68
Energy Consumption (J)	56.34-31.34	82.2-51.2	97.2-89.9	67.2-41.4	88.9-49.8

VII. Conclusion

Comparative Analysis of Proposed Method EECCS with proposed Previous Methods ECAS, CLSMRSCA, CLCCS and Existing Method EESARP in terms of different parameters is done and By using the extensive simulation results, it is proved that the proposed scheme EECCS achieves the better packet delivery ratio, high network lifetime, low delay and overhead, minimum energy consumption than the previous proposed schemes such as ECAS, CLCCS, CLSMRSCA and with existing EESARP scheme while varying the mobility, time, speed, throughput and number of nodes.

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Author's Biography

S.Sheeja, She has 10 years of teaching experience. She is currently pursuing doctoral research in Computer Networks in Bharathiar University. Her primary research interests are related to Computer Networks. Currently, she is working as Assistant Professor in Department of Computer Applications in Karpagam University, Coimbatore.

Dr. Ramachandra.V. Pujeri, He is active life member of ISTE, SSI, MIE, ACS and IEE. His has written three textbooks. He is having around 23 years of teaching experience in the various top ten engineering colleges in India. He is an active expert committee member of AICTE, NBA, DoEACC, NACC and various Universities in India. Currently, under him ten research scholars pursuing their Ph.D. His research interests lie in the areas of Computer Networking, Software Reliability, Modeling and Simulation, Quality of Services and Data.