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Secure Multipath SEAOMDV-ELB Routing Protocolwith an Efficient Load Balancing and Congestion Awarefor Wireless Mesh Network

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Abstract- **As new cost effective technology that is Wireless Mesh Network has gained a lot of popularity and it has conspicuouskind ofnetwork architecture as wireless multi-hop.In this paper, theproposed secure multipath SEAOMDV_ELB routing protocol used with an efficient load balancing and alsocongestion aware mechanism in wireless mesh networks. The proposed routing protocol called SEAOMDV_ELB definesthe several paths and also decides the best path from source to its destination using secure airtime congestion aware metric (SACA) for balancing the load across the congested network area. We likewise make use of an proficientscheme known as load balancing that upholdsthe communication of the node on best possible path and next is the computation of the queue utilization at every single node to know whether the specific node is qualified for sending the data packets over the network or not. In this paper, the main proposed work is to provide security over the network using RSA (Rivest-Shamir-Adleman) algorithm to accomplish secured data packets on optimal path and reach its destination securely. Most of the existing protocols that are not anticipated get adapted to congestion, the quality of link, and security over the network. The simulation outcomesusing Network Simulator-2 (NS-2) showsthat protocol SEAOMDV_ELBof proposed paper is better when contrasted with AOMDV regarding throughput, end-to-end delay and security over the network.**

Keywords: Wireless Mesh Network;congestion; secure ACA; queue utilization; round trip time;security;multiple interfaces and multiple channels; load balancing.

I. INTRODUCTION

The more flexibility, the network access that are done privately for communication of the access, of itsdesiredfeatures, that includes, yet not constrained to, multi-hop routing, auto-configuration,minimum cost, les bandwidth, where the deployment makes easy, organizing, its healing capacity by itself and so forth. WMN stands is said to be in middle of themthat can join the WMNsconstruction with all of its fixed features. Regularly, in WMNs we keep seeing theinternet gateways, the mesh routers and its mesh clients. Every node start with the router they go to the router,by sending the data packets to any other nodes. The nodethat is without any accessit can be in the network.It also can start a linking by overpowering the data packets from its neighbor node that has thenetwork connection; the devices that are useful can be made used. Those devices consist of an traditional things like desktops, laptops, etc,.[1].

The wireless mesh network is said to be promisingknowledge for severalpotential requeststhat can include the wireless broadband services, public networking,district networks, immediatesurveillance systems, the automation of the building and so on. For all this application applications, Qos is said to be an is a main issue. So we can report this as an issue by sufficiently capturing the network congestion and then start routing the data packets that are passed through a smaller amountof congested area. Some of the functionality of wireless mesh network can be grouped into three main categories namely, such as Infrastructure/backbone meshing, mesh client backbone and the mesh hybrid.The mesh routers which are utilized to frame a multi-hop WMN backbone that can able to communicatewithany of the gateways and its clients. The mesh clients can create self-structuredadhocnetworks by relaying request to its WMNs, they will make use of services. Next hybrid mesh network iscollection of backbone mesh, also the client meshing and it is expected to be the good selection.[2]

The massivemainstream of the present protocol routingin wireless mesh network that uses hop count or any other metric such as ETT,ETX, MIC and WCETT as the metric to find the path and making them to utilize single path for advancing. [3]. Those routes may not be the effectual routes, when the congestion in the network is seen and it cannot promise the path quality. It can prompt theadverse impacts, like less PDR fraction, and the longer delays, higher routing over-headings. Likewiseanynodes which can lie on various routes mightuse the superiorportion of their energy whilepackets need to be sending that consumes more time. In this manner inappropriate path selection for transmission of datalowers the performance of routing protocols. Hence, routing in WMN turns into challenging because of disorganized connection through the network and its energetic topology. In this way, we can utilize the benefits of responsive multiple routes with making use of routing metric that can take into consideration of round trip time and it can load balance the load and also to get aware of the path's congestion for multiple interfaces. [10].

An opponentmight insert certain intruder nodes in the network and then utilize them to modify the data being dispersed or forge a data item. This might bring about some important factors being eradicated or the whole system being restarted with wrong data, in order to avoid we go with providing security over the network .We analysethe enactment of proposed scheme by using Network Simulator-2 and this simulation reveal that thesecure multipath using SEAOMDV-ELB routing protocol with an efficient load balancing and congestion aware in WMNs performs better than AOMDV and EAOMDV-LB protocols in positions of security ,throughput and delay(end-to-end delay).

This paper proposes mainly the security over the system so that packets transmission takes in secure order. The focal contributions of the proposed paper is into three foldings: (1) The protocol SEAOMDV-ELB (Secure Enhanced AdhocOn-demand Multipath Distance Vector routing- Efficient Load Balancing feature) totake care of multicast routing. We estimate all the paths grounded on Secure Airtime Congestion Aware metric (SACA) and also based on its Round Trip Time (RTT) instead of making use of hop count and other routing metric as ETT. (2) Next, is todetermine the level of congestion across the link by means of average node's queue utilization that can avoid greatly loaded nodes. (3)we balances the load of any path by using efficient LB (Load Balancing) mechanisms that maintains propagation of packets on prime path. (4) We provide security over the network by making use of RSA (Rivest-Shamir-Adleman) algorithm to maintain the data to be secured. When compared to other protocols our proposed approaches results in better performance.The rest section of this paper consists of Related Work which is discussed in part II. About proposed routing metric is explained in part III of Proposed Work. We have discussed about simulation parameters in part IV of Simulation Model. Next about results in part V and lastly, we conclude in part VI of Conclusion.

II. RELATED WORK

The routing metrics, when making used in routing protocols they are considered as an imperative technique as routes can be found or it can be choosn by any routing metrics. This can imply that routes are mainly depended on any routing metrics. Therefore, the routing metrics are speciallythe basics for determining anyconcert of the networks. Any decent kind of routing metrics will be able to determinethe path with relationsthat are havinggreat data rate, where loss ratio should be less, the level of interference should be reduced and the main thing is congestion level should be minimized. As of late numerous routing protocol metrics for wireless mesh networks (WMNs) were been proposed before, Few of them include namely: (1) Hop-Count(HC), (2) (ETT) Expected Transmission Count, (3)Weighted Cumulative ETT,(4) The Expected Transmission Time, (5) Interference-Aware routing metric (iAWARE), (6)Metric of Interference and Channel switchingand (7) Airtime link cost.

L.Zhao,A.Y Al-Dubai and G.Min[1], the author mainly discuss aboutcluster gatewayin visionof the load balancing feature, thismethod when used for multipathcommunication that is toaccomplish the quality of services. The load balancing in WMNs can be done by path based method, thegateway based or by it might be mesh router based. In gateway based (LB) load balancing conspire the actionthat is appropriated among the gateways by assessments that are carried out by the gateways, In path-based, the traffic is dispersed over multiple pathsthat can toward the gateways. Also, the load balancing on switch basedcan improve the network performance by allocating the traffic over complete network that can avoid any congested paths.

L.Ma and M.K.Denko[2], the author recommends a congestion aware LB methodbeside with routing metrics WCETT-LB (the weighted combined ETT_LB) that is to take care of the issue of queue utilization's interference and path's congestion is processed intermittently at every node, if it is greater than any threshold value, then the WCETT-LB is recomputed and the multicasting is done to its entire neighbour node until it reaches the source node. At the point when the distinction between metric cost of current path and if anyalternate path is said to bemore than any value of the threshold, then switching is made otherwise load is balanced at mesh switch. The above scheme can improvethe throughput as well as it reduces the end-to-end delay.

In the paper[3], here the author suggests specific gateways that help to organise and also to reroute flows to underutilized gatewayfrom congested gateway. The first sink nodes, they subordinate with its nearby gateway. If any domain has to be loadedmore or if its congestion occurs in the path, the traffic of border sink is asked to be moved to the domain that is closer to it. This scheme will not harm more to the other flows present in the domain and it also improves the network's enactment.In the paper [4],author has advisedabout the load balancing schemes that are based on cluster with the aware of congestion routing metric. The mesh network is alienated into multiple spread over the surfaceclusters. The cluster head assessments that in heightof the traffic load, then selection of the optimal route can be done which lowest link has cost. Thus, the above scheme will produce any path having great throughput and less congestion.

In the paper[5], author talks about improving the reliability and load balancing, Here we see combination of metric for averting protocol is deliberated with Exclusive-ETT, IAWARE (metric ofinterference aware) and ILA (interference load aware metric). To send it to the next hop the source node has to select a path with minimum costs as prime path. The failure notification is observed in any of its main path, then the alternate path which has got next minimum cost gestsselected. Then the author in the paper[6], discuss about congestion aware load balancing and its transmission failure which approves it, established on residual capacity and back off stagesthe paths has to be chosen. Author counselled a RM (routing metric) that caninternments the interference and also offers load balancing.

The author in the paper[7], the proxy caching can reduce the load of gateway for maximum known clientsthey need mainly the modernize of antivirus, this update of OS and so on. The author in paper [8],has proposed a scheme this can selects the path that is efficient path that will be based on consumption of energy and larger power of any battery i.e of node's power. This modulecan improve the load dissemination at every nodes andit can alsoenrichesthe enactment of MANETs.The authorin thepaper [9], has introduced route discovery with congestion aware for MANETs,where optimal path to its destination is chosen based on low queue size of the nodes.The author in the paper[10], suggest about multiple interfaces that makes aware of the path's congestion in the network that can present for multiple paths so that it can improve the quality of service. Which outline the reckoning of maximumpaths that could be three pathsestablished on Round Trip Time , also routing path has to be chosen based on minimum queue utilization.

In the paper [11], the author talks the air time link's cost that can lower the load on any path in mobile networks and it gives an idea about queue length and the numbering the intermediate nodes traffic that uses the channel resources, In this paper [12], the authorsuggest the use of protocol that determines secure-airtime congestion aware (SACA) metric and finalisesload balancing by conniving queue utilization. Furthermore, the effective load balancing technique that can maintain the data transmission on ideal path but it does not provide security over the network.

A number of of the major technical contests in wireless mesh networkat the nodesare,the optimal routing, maintaining bandwidth fairness,load balancing, network auto configuration etc. The various metric used before such asWCETT protocol , ETX routing protocol metric , MIC metric and ETTthat was used formerly yet they cannot ensure efficiency of an path and its link quality. Distinctive shortest path using above metric or (HC) hop-count which can befinishedthrough inefficient use of the network capacity and the load imbalancing. Next, the proposed airtime link cost metric provides load balancing scheme but does not provide the security to the network. The data can be accessed by some intruder nodes and then use them to alter the data being disseminated which can result in transmitting wrong data across the network , In order to avoid we provide security over the network which helps in preventing unauthorized access or damage of data packets in the network.

III. PROPOSED WORK

The proposed scheme introduces SEAOMDV-ELB protocol based on (SACA) metric, then computing queue utilization that can avoid extremely loaded nodes using ELB scheme.

We also provide security over the network by which the data has to reach its destination securely without losing any original data by making use of RSA algorithm. The scheme of the load balancingmainly focus on balancing the load over specific link and then allows data to get transmitted through less congested path. The congestion aware arrangement provides steadfast communications at the perspective theme of the whole network and it measures the cost of link intermittently that helps in nodes' data transmissions to be retained as same path and the changes of the path won't be too as often as possible. The definite routing metric of proposed work are as follows. The detailed routing metricof proposed work are in following way.

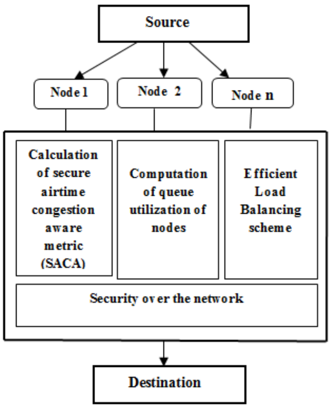

Source
Node 1
Node 2
Node n
Calculation of secure airtime congestion aware metric (SACA)
Computation of queue utilization of nodes
Efficient Load Balancing scheme
Security over the network
Destination

Fig. 1. Architectural diagram of SEAOMDV-ELB Routing Protocol.

A. Computation of the metric as Secure (ACA) Airtime Congestion Aware.

The proposed secured multicast routing protocol called SEAOMDV-ELB ascertains multiple ways in view of proposed Secure Airtime Congestion Aware metric and RTT (Round Trip Time), rather than ETT (Expected Transmission Time) and other proposed routing metric , we usually make utilize of an secured airtime link cost since that can telecast several paths over network where the source node occasionally update the metric cost of every single conceivable link, and process SACA value and RTT using equations 1 and 2. The metric secure-airtime link cost is demarcated as the amountof any channel's resources that are inspired by passing on the packet over a specific link firmly. This secure kind of metric will enhance the throughput of the system providing with the retreatment to WMNs. The airtime link cost for every path is computed as following [12].

$$\mathrm{Ca}_l = [\mathrm{O}_{ca} + \mathrm{O}_p + \frac{\mathrm{B}_t}{\mathrm{r}}]\frac{1}{1-e_f} \qquad (1)$$

Where Oca, Op and Btare known as constants qualities,we are considering data rate (DR) to be in Mbps for all the input factor as 'r' and 'ef' and the'Bt'is based on as frame's error ratefor this test frame size,. The'ef' to be the(FER)frame error rate.

An efficient LB (Load Balancing) feature in secure ACA, that could be defined as RTT this is dignified by unicast probes between neighbouring nodes.

a) *Calculation of RTT by making use of following method.*

Step 1: Firstly thesource node tries to send a probe packet 'P' it carries an timestamp 'T" that also sends it to its neighbour node at its probe interval 'I'.

Step 2: the neighbours start immediately responding its probe in the network by responding with an probe acknowledgement 'ACK', by ringing the timestamp 'T'.

Step 3: If either one node or its neighbour node gets overloaded.

Step 4: Then probe 'P' or 'ACK' of probe (probe acknowledgement) experiencesthe node's queuing delay and results in larger value of RTT.

Step 5: Avoids highly loaded links.

In diminutive the RTT metric is intended to keep away from extremely loaded links. In the suggestedmethod, we assimilate thecongestion aware part which is known as RTT (Round Trip Time) into secure airtime link metric. The combination of above metricaffordsa smaller amountof congested paths and also the best quality paths. For path p, the proposedmetrics can be calculated as following.

$$\mathrm{ACA(p)} = (1-\alpha)\sum_{\mathrm{link}\,l\in p}\mathrm{Ca}_l + \alpha\sum_{\mathrm{link}\,l\in p}\mathrm{RTT}_l \qquad (2)$$

Where,ca1 is the present airtime-link cost dignified at a node in a explicit link l, α beingtunablefactor that is being subjected to 0.3, RTT (round trip time) of link l. The routing algorithms are such that finest path used for data transmission is chosen established on least ACA cost value.[12].

B.*Calculation of Queue Utilization*

The proposed routing metric protocol called SEAOMDV-ELB is based on calculation of queue utilization for balancing the load which is carried out in route request procedure which guarantees that path selected to destination is less congested.

b). Calculation of queue utilization of the nodes to choose less congested path to destination by making use of following steps.

Step 1: When source node tries to interact with itsdestination node and it has not been provided with anyaccessible routing information about destination node over the network.

Step 2: It will start initiating the route request procedure (RRP) for finding the path toward destination by distributinga(RREQ), Route Request message. But, not every node's intermediate that will receivean message will answer to the RREQ.

Step 3: Before starting to broadcast the message RREQ over again, first the intermediate node will itself make an decision whether its been qualified to send the data packets. The decision is established on queuing utilization (Queue_Util) of any node by using equation 3.

Step 4: If nodes queue utilization of interfaces (Queue_Util) is below than threshold value, then that node is said to be as qualified and it gets ready for broadcasting theRREQmessage.

Step 5: If node's average interface (Queue_Util) queue utilization is above than threshold value, itwill drop the RREQ message as it is not qualified.

Step 6: Depending on particular threshold value, specific node are supposed to take an decision that can switch to very less congested path.

Thusly, the nodesthat are loaded more are rejected from the freshly created paths. The queue utilization(QU) of any node is figured using node's own existing queue utilization and node's neighbor queue utilization in the network. Every node evaluatesqueue utilization (Queue-Util) of various links by following equation.

$$\text{Queue\_Util} = \frac{\sum_{i=1}^{n} \text{interface\_queue}_i}{n} \quad (3)$$

Where, Interface_ quej :- average queue utilization of 'i' interfaces of neighbor and 'n' :- number of the neighbour interfaces. Next, depending on tvalue of hreshold, node will take a choice to switch to the less congested path.

C. An Effective way of Load Balancing Scheme

However, the transmission efficiency of the paths gets decreased so path quality gets changed every time by this load on the link gets increased, and also we cannot change the path frequently by doing so it might lead to unstable network. Therefore, we instead make use of an scheme that can measure the path's metric cost every so oftenthat its transmission efficiency takes place on optimal path and changing of path is not required.Hence,in WMNs we can say that the metric of load balancing has to takes place and it secets the minimum cost.

The source node starts updatingoccasionallyall possible path's cost, thencontrasts the metric cost current path with any other path's cost. So this is provided that currentcost of path is still with minimum cost from other likely paths, our load balancing scheme that efficiently concerns the current path's load to be balanced. Then again, once the other path has minimum cost on the next periodical update, the flow gets changed from the current path to any other path on thisupdate. So we make utilization of this scheme and maintain its transmission of the data on optimal path by making use ofanproficient load balancing way that can improve themesh network's performance [12].

The AOMDV protocol calculates numerous paths based on ACA value. In this method,We use an SEAOMDV-ELB protocol that selects ideal path with less ACA and also interfaces of queue that how much it has utilised. This proposed scheme improves the performance of the network.

D. Security over the network

WMNs lack efficient and accessible security keys, because their security is more easily transferred due to several reasons: their distributed networking system, the vulnerability of channels over the networkand nodes in the shared wireless medium, and of network topology changingdynamically. So we present security to the network so that data is reached to its destination safely. Using an algorithm known asRivest-Shamir-Adleman (RSA). The RSA algorithm providesconfidentiality over the network and usage of the data. The proposed SEAOMDV_ELB protocol makes use of security to protect the data and utilizes manyalternative paths across the network, which can provide security, more bandwith and also redusing the fault tolerance.The proposed protocol is enhancedthan existing AOMDV protocol.

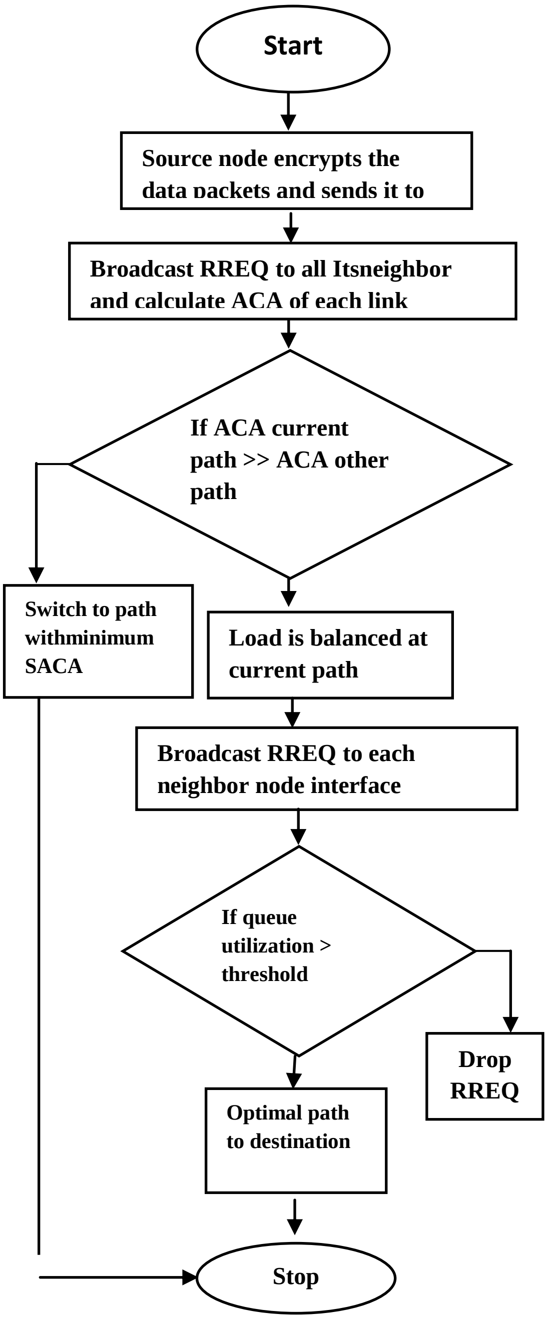

Start
Source node encrypts the data packets and sends it to
Broadcast RREQ to all Itsneighbor and calculate ACA of each link
If ACA current path >> ACA other path
Switch to path withminimum SACA
Load is balanced at current path
Broadcast RREQ to each neighbor node interface
If queue utilization > threshold
Drop RREQ
Optimal path to destination
Stop

Fig. 2.The flow chart formultipath routing protocol using metrics.

As in the flow chart the source node encrypts the packets and send to its destination, before sending it calculates air time link cost for each link and compares the current SACA metric cost with SACA metric cost of other path.The path which has minimum SACA metric cost is selected to transmit the data packets, the load is balanced at current path, Then it selects the best path with minimum Que-Util and send RREP(route request procedure). If there is no path to its destination broadcast RREQ to each interface n compute queue utilization of the nodes. If Que-Util is greater than threshold, then drop the RREQ if it is less than threshold then choose that path to transmit the data to the destination on optimal path. The destination node will decrypt the message and gets the original data. By this, we can tell that the data packets travel through less congested path by making use of above metrics and also security is been provided over the network by making use of RSA algorithm.

IV. SIMULATION MODEL

This area designates the parameters of the simulation tool they are selected to put on the routing metrics. The execution measurements are likewise described.

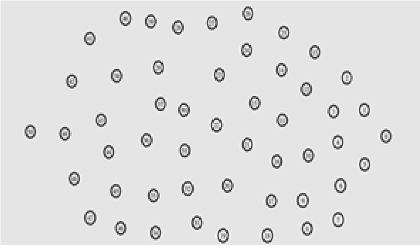


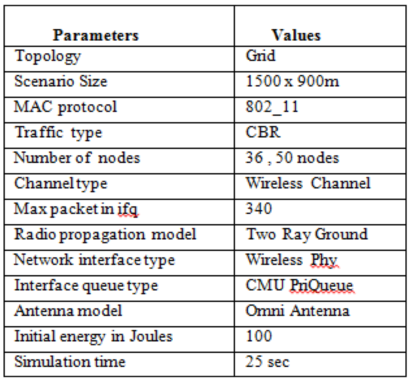
Fig.3. The deployment of nodes in WMNs fashion done in simulation.

A. The Simulation Environment

We also conduct an extensive simulation in NS-2.[16].Which evaluates our proposed scheme using 802.11 networks, thenhad setup the size of scenario to 1500 x 900m. The CMU tool is designedfor wireless network topology that can grid the traffic flows. We also set up the topology of grid traffic connections of any CBR flows that are between the nodes using traffic scenario script cbrgen.tcl. The nodes used are 36 nodes and also 50nodes used for better comparison.

We evaluate the performance of proposed protocol in static scenario which represents infrastructuralwireless mesh network. The other related parameters are listed in Table I.

Table I. SIMULATION PARAMETERS AND ITS VALUE



Parameters	Values
Topology	Grid
Scenario Size	1500 x 900m
MAC protocol	802_11
Traffic type	CBR
Number of nodes	36 , 50 nodes
Channel type	Wireless Channel
Max packet in ifq	340
Radio propagation model	Two Ray Ground
Network interface type	Wireless Phy
Interface queue type	CMU PriQueue
Antenna model	Omni Antenna
Initial energy in Joules	100
Simulation time	25 sec

A. *Performance Metrics*

We evaluate our proposed performance that are based on the three metrics, throughput, delay and PDR features, the number of channels and its simulation time are to be varied.

Throughput-- The amount of packets received by the destination per second is throughput. At extreme rate the successful PD (packet delivery) should be in time interval, then it is said to have maximum throughput.

End-to-End Delay— delay is measured as the delay rate between the time at which the data packets were created at the source node and the time at which they got reached to its destination node. The delay is said to be less in this proposed work using the above protocol based on its metrics.

Packet Delivery Ratio—is defined as the generated packets at source node should be equal when reached to its destination node. The destination node should receive same number of packets.

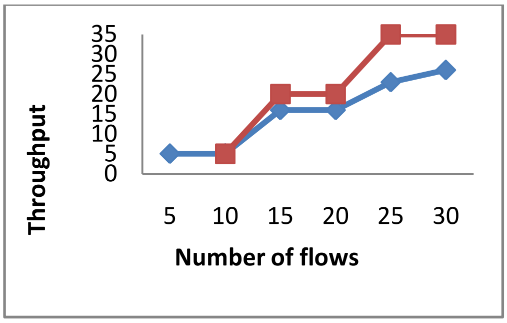


Fig. 4. Throughput Vs Number of flows

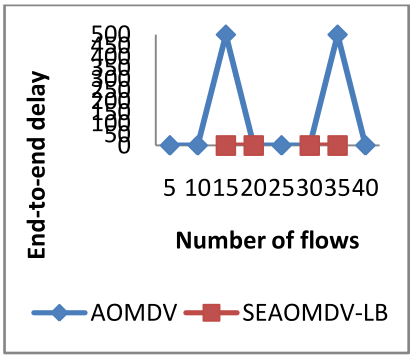


Fig. 5. The End-To_End DelayVs Number of flows

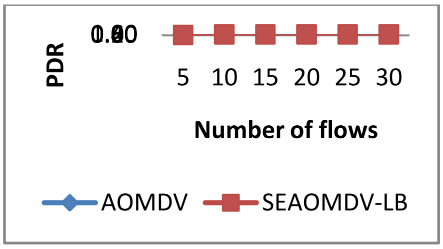


Fig. 6. PDR Vs Number of flow.

V. RESULTS AND DISCUSSION

This scenario, we make use of staticnodes that are of 36, and 50 nodes. in this network we keep on varying the data flows. The graphs which are shown inthe Fig 3 and 4.The graph as shown in Fig. 4, The proposed scheme of efficient load balancing SEAOMDV_ELB will experience the maximum throughput when compared to AOMDV protocol as there is more congestion in the network , it will experience high packet loss so there will not be path with less traffic. It has lower throughput when compared to proposed protocol. The SEAOMDV_ELB can capturethe congestion by computing round trip time and SACA metric and it also uses an load balancing organizationis used by calculating node's queue utilization. Hence results in maximum throughput with less packet loss, less congestion.

In Fig. 5, the end-to-end delayof SEAOMDV-ELB is said to be better than AOMDV routing scheme. The congestion aware of multiple pathdiscovering mechanism is said to be done by using round trip time. The data packets make use of more time to reach its destination in AOMDVas it experiences higher delay due to congestion over the link. As many of the cases, in SEAOMDV-ELB the end-to-end delay is less than the existing AOMDV whenflows starts increasing in the network. SEAOMDV_ELB protocol uses efficient load balancing mechanism by capturing the link quality based on computation of queue utilization of the nodes to minimize the congestion among by calculating secure airtime congestion aware cost (SACA) metric.Thus, it commendablydispenses the traffic to less congested zones. Data packets that take less time for reaching its destination and making use of network resources that are consumed properly. Henceforththe end-to-end delay of SEAOMDV_ELB protocolis lower than protocol AOMDV .

As shown in Fig. 6, The proposedmetric improvesthe performanceof packet deliveryratioandreduces the a end-to-end delay and maximizes the throughput.Asaresult, proposedmetric canbethought better in performance. The proposedmetric is able to discover routes thatavoiding bottleneck linksbyconsidering trafficload.

VI. CONCLUSION

The SEAOMDV-ELB routing metric that can select the less congested path based on SACA metric and queue utilization of the nodes and also uses an effective load balancing mechanism when congestion is seen in the network path this mechanism helps to balance the load and also security is been provided over the network using RSA (Rivest-Shamir-Adleman) algorithm provides data confidentiality helps the data packets to reach its destination safely. The simulation outcomes that the SEAOMDV-ELB proposed protocol is said to be better in performance when compared to AOMDV protocol regarding of packet delivery ratio, throughput, security and end-to-end delay.

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