AN EFFICIENT ROUTING OPTIMIZATION USING SECURE REVERSE MULTICAST BELLMAN FORD ADHOC ROUTING USING AOMDV PROTOCOL IN MANET

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ABSTRACT

Route optimization is the basic requirement to improve the QOS of the ad hoc network. Multiple qualities of service (QoS) guarantees are required in most multicast applications in mobile ad hoc networks (MANET). In this paper introduce a novel multiple constraints QoS multicast routing optimization algorithm in MANET called SRMBAR (Secure Reverse Multicast Bellman Ford Adhoc Routing) that ensure QoS guarantee by allowing reverse multicast routing on possible multiple paths between source and destination and helps in decreasing the routing overhead through Routing Interference Communication (RIC) framework. The proposed SRMBAR can improve reliability of data transmission and optimize the maximum link utilization which achieves data integrity and then reduce the consumption of time and the transmission delay. Experimental results show that the reverse multicasting approach is efficient when compared with existing Bellman Ford Algorithm, has promising performance in multicast traffic engineering and for evaluating the route stability in dynamic mobile networks.

Keywords: quality of service (QoS), multicast, route optimization, SRMBAR, RIC.

1. INTRODUCTION

MANET is collection of mobile nodes that communicate with each other over a wireless medium [1] without fixed infrastructure. Since, the topology of the network changes frequently, the problem of routing packets between two nodes becomes a challenging task, which has a significant impact on the performance of the network. Moreover, routing plays a vital role in deciding the QoS (Quality of Service). Various metrics associated with QoS includes packet delivery ratio, delay, pause time, control overhead, routing overhead and so on. The QoS of the network can be improved by minimizing the link failure probability, by reducing delay in transferring the packets, by providing alternate path in case of link or node failure, by reversing the resources that are utilized in the path for packet transmission and also by ensuring security of the nodes. Ensuring QoS of the routing protocol optimizes the routing paths.

Another challenging issue of MANET is multicast routing. The multicast routing protocol transmits packet from a source to more than one destination. A major issue is to ensure the robustness of the link failures and flexibility to attackers. Multicasting supports a wide variety of applications that are described by the close degree of collaboration [2]. As the nodes of the MANET are mobile, link or node failure occurs or intruders arise to collapse the entire network. Thus, an optimized multicast routing is essential for ensuring robustness and resilience against these attacks.

In addition to these vulnerabilities, there exists another problem in MANET associated with communication. In MANET, nodes transfer packets from one node to another in a multi-hop fashion. Multi-hop refers to the situation where a node communicates with its intermediate node and the data passes through several intermediate nodes from source to the destination node. A problem that arises under this scenario is a hidden terminal problem. Under this condition, a blind / hidden node does not obtain any control packets, so that the packets sent to the visible nodes would result in packet loss or collision. There exist several situations, under which a node can be hidden. First, is the network with worst throughput, where all the nodes of the network are hidden, another case is where all the nodes are visible and contend with each other for resources and finally, both the contending and hidden nodes appear together.

This paper aims to overcome the above mentioned challenges. Ad hoc on demand multipath distance vector routing (AOMDV) is employed to achieve multicast routing. Here, a novel Secure Reverse Multicast Bellman Ford Ad hoc Routing has been proposed for achieving optimized multicast routing. Moreover, a Routing Interference Communication framework has been proposed to avoid routing overhead and the hidden terminal problem. The proposed approach also ensures QoS by allowing reverse multicast routing.

The rest of the paper are organized as follows: section II presents the related work, section III provides preliminary work done, section IV presents network models and routing issues, section V provides proposed methodology, section VI refers performance metrics, section VII presents simulation result and finally section VIII concludes the paper.

2. RELATED WORKS

To upgrade the performance of the Mobile Adhoc networks, a different variety of routing protocols have been proposed by many researchers in network environment. The routing protocols are always selected based on the protocol's popularity, interesting

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characteristics and features. The dynamic topology of MANET is a major challenge in the design of a MANET routing protocol. In the [3], the author compared the four popular protocols such as OLSR, AODV, DSR and TORA. The combined effect of these protocols is investigated on an 802.11 MANET in OPNET simulation environment. The results of OLSR and DSR protocols provides better performance with low mobility, OLSR and AODV offer better performance in medium-sized network with node mobility and finally TORA and OLSR offer better performance in large networks. Based on the QoS (end-to-end delay, throughput), load in routing and retransmissions of packets, the performance of four MANET routing protocols with the different simulation model and configurations are systematically analyzed and drew more complete conclusions.

MANETs are gaining popularity; their need to adapt real time and multimedia applications is rising as well. Hence a QoS estimation work is sorted out by (Mandeep, 2013) according to author such applications have Quality of Service (QoS) necessities like bandwidth, end-to-end delay, jitter and energy. Hence, it becomes extremely essential for MANETs to have an efficient routing and QoS mechanism to adapt these applications. This paper [4] presents an review of the QoS routing protocols alongside their strengths and weaknesses. A relative investigation of the QoS routing protocols is carried out and likewise, the current issues and future difficulties that are involved. It is found that there are a various unsolved difficulties that need to be tended to design QoS routing protocols for mobile ad-hoc networks. These are maximization of exactness of QoS routing protocols, minimization of control overhead, route maintenance, resource reservation, cross layer configuration, power utilization, robustness and security. Understanding the existing QoS routing issues require the design and development of new QoS routing protocols in MANETs which will permit future ad-hoc networks to meet client expectations. In [5], the proposed precaution algorithm improves the performance of AOMDV protocol which upgrades the QoS in Adhoc networks.

In a MANET optimal route, security plays a vital role in the functionality of the routing protocols for secure routing. The selfish and malicious nodes tries to compromise the functionality of routing protocol makes the MANET vulnerable to security attacks. In [6] a security-enhanced AODV (Ad hoc On-demand Distance Vector Routing) routing protocol called RAODV (Reliant Ad hoc On-demand Distance Vector Routing) proposed to find the trusted short path between the nodes by efficiently update the information of the neighboring nodes which has less hop count to the destination while broadcasting.

Since MANETs has in need of more energy consumption for broadcasting through the secured optimal route, which makes performance degradation. An algorithm called PARO (Power-aware Routing Optimization) presented for routing that minimizes the power consumed for packet transmission by avoiding the shorter lifetime nodes [7]. PARO is composed of three algorithms such as overhearing, redirecting route convergence and route maintenance algorithms. The overhearing algorithm receives the overhead packets and creates information about the current neighboring nodes, and then it passed to redirecting route convergence algorithm that computes whether the intermediate nodes would result in power savings. Route maintenance algorithm maintains the route which the packets passes through intermediate nodes and maintains a route maintenance record.

The Ad-Hoc On-demand Distance Vector (AODV) routing protocol improves the route maintenance for QoS with some modifications to provide QoS in terms of end-to-end delay. When performs routing for communication establishment among the different mobile nodes may cause disconnect of services in entire MANETs due to the power exhaustion of any one node. Because of battery driven mobile nodes, MANETs suffer from limited energy level problems. EPAR algorithm is on-demand routing protocol which uses battery lifetime prediction that minimizes the energy of all the nodes thereby it prolongs network lifetime [8].

[9] For enhancing the route operation, a new cross layer design called TAODV was proposed in order to reduce the routing overhead by providing the better connectivity in between the nodes. [10] QoS provision supported on delay and bandwidth requirement is incorporated to make sure guaranteed performance level to the QoS sensitive applications by using the NQoS-AODV protocol and [11] thus providing service guarantee (QoS) in terms of end-to-end delay using QAODV and QAODV-IRM protocol which achieves better performance. Power and Delay-aware Multi-path Routing Protocol [12] is to select multi-paths with the longest period of time within the network without performance degradation in terms of delay time and [13] selects the optimal route from different multiple paths using genetic algorithm.

3. PRELIMINARIES

3.1 Bellman ford routing algorithm

Bellman-Ford Routing Algorithm, also known as Ford-Fulkerson Algorithm, is utilized as an algorithm by distance vector routing protocols like RIP, BGP, ISO IDRP, NOVELL IPX. Routers that use Bellman Ford algorithm will maintain the distance tables, which work on the network to find the shortest path in a weighted digraph specifically used for negative edge weights across the entire network. The information in the distance table is always maintained and updated by exchanging information with the neighboring edges or nodes. However, if a graph has a "negative cycle" defines a cycle whose edges sum to a negative value, then walks of low weight arbitrarily can be constructed by repeatedly following the cycle in digraph, so there may not be a shortest path in graphs. In such a case, the algorithm can find negative cycles and report their existence, though it cannot produce a correct shortest path if a negative cycle is reachable from the source. Bellman-Ford algorithm is mainly designed for directed graphs. If G is undirected, replace every edge (u,v) with two directed edges (u,v) and (v,u), both with weight w(u,v). The number of data in the table equals to that of all nodes in networks. The columns of table represent the directly attached neighbors whereas the rows represent all destinations in the network. Every node contains the path for sending packets to each destination within the network and distance/or time to transmit on its path. The measurements in this algorithm are the hop count, latency, outgoing packets, etc.

3.2 Adhoc On-demand multipath distance vector (AOMDV)

The Adhoc On-demand Multipath Distance Vector (AOMDV) is an On-demand multipath routing protocol based on the AODV (Adhoc On-demand Distance Vector). AOMDV's primary goal is to furnish efficient recovery from route failures and efficient fault tolerance in dynamic networks by computing multiple loop-free and link disjoint paths. From multiple available links, it can choose an alternate path if one path fails. The route discovery method is initiated only as soon as the specific destination fails. The AOMDV protocol has two main components:

1) Route Update Rule- Establish and maintain multiple loop-free paths at each node.

2) Distributed Protocol- Finds Link-disjoint Paths.

When a source needs a route to destination can floods the RREQ (Route Request) for the destination and at the intermediate nodes, all duplicate RREQ are unit examined and every RREQ packet outline an alternate route. Then after only the link disjoint routes must be selected. The destination node replies only k copies of out of many links disjoint path that is RREQ packets arrive through unique neighbors aside from the primary (first) hop are replied. Further, 'advertised hop count' is used within the routing table of node to avoid loop .The protocol only accepts alternate route with hop count but the advertised hop count. A node will receive a routing update via a RREQ or RREP (Route Reply) packet either forming or updating a forward or reverse path. Such that routing updates received through RREQ and RREP as Routing Promotional Material called Routing Advertisement.

4. NETWORK MODEL AND ROUTING ISSUES IN MANET

A network is typically represented as a weighted digraph G = (N, E), wherever N denotes the set of nodes and E denotes the set of established communication links connecting the nodes. jNj and jEj denote the number of nodes and links in the network, respectively. Only digraphs are considered in which there exists at most one link between a pair of ordered nodes without loss of generality.

In G(N, E), considering a QoS based multicast routing problem from a source node to multi-destination nodes, namely given a non-empty set M = {s, u1, u2, . . .,um}, M ⊆ N, s is the source node, U={u1, u2,. . ., um} is a set of destination nodes. In multicast tree T = (NT, ET), where NT⊆N, ET⊆E, then

Definition 1: The delay of path p(s, u) and bandwidth of the path p(s, u) are

$$D_{p(s,u)} = \sum_{(i,j)\in p(s,u)} d_{ij} \quad (1)$$

$$B_{p(s,u)} = \sum_{(i,j)\in p(s,u)}\{ b_{ij} \quad (2)$$

where d_{ij} is the delay of link(i, j), b_{ij} is the bandwidth of the link (i, j), and p(s, u) is the path from source node s to the destination u ∈ U.

Definition 2: The maximum link utilization of the tree T is

$$\alpha_m = \mathrm{Max}_{(i,j)\in T}({(\varphi + t_{ij})}/{Z_{ij}}) \quad (3)$$

where φ is the traffic demand, t_{ij} is the current traffic of link(i, j) and Z_{ij} is the capacity of the link (i, j).

Definition 3: The bandwidth of the multicast tree T is the minimum value of link bandwidth in the path source node s to each destination node u ∈ U.

$$B_s = \mathrm{Min}_{u\in U}\ \{B_{p(s,u)}\} \quad (4)$$

5. SRMBAR APPROACH

A novel Secure Reverse Multicast Bellman ford Adhoc Routing approach has been proposed for routing optimization which leads to improve the QoS in MANET. In addition, the proposed approach uses an Ad hoc On Demand Multipath Distance Vector (AOMDV) protocol provides a secure reverse multicast routing that eliminates the routing overhead between the nodes due to hidden terminal problem.

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Secure reverse multicast bellman ford Adhoc routing (SRMBAR) algorithm

SRMBAR algorithm is primarily used to obtain a secure and shortest routing path by reverse multicasting in MANET's using AOMDV protocol and avoids the routing overhead due to unobservability (anonymity) node. The Adhoc On-demand Multipath Distance Vector is a multicast protocol which quickly recovers from route failure and uses hop-by-hop routing. AOMDV routes on the on-demand basis used widely to compute multiple paths in route discovery. When a source node needs to discover the route to a destination node for transmitting data, it broadcasts RREQ (Route Request) packet. RREP (Route Reply) packet is generated either by neighboring intermediate node, which has a valid route to the destination or by the destination node. The Figures 1 and 2 shows the route request (RREQ) and route reply (RREP) in AOMDV protocol between the source and destination. AOMDV uses the advertised hop count concept which is used to maintain multi-hops for the same destination sequence number.

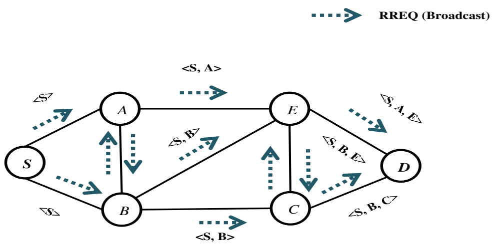

Figure-1. Route request (RREQ) in AOMDV.

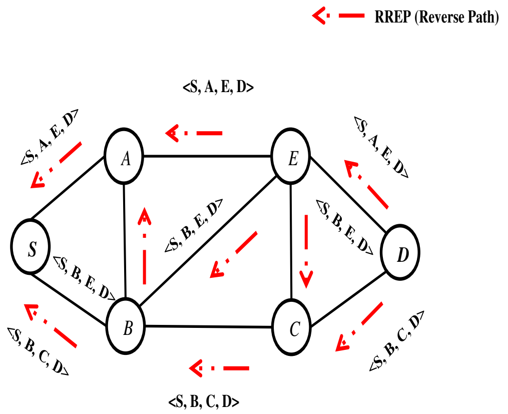

Figure-2. Route reply (RREP) in AOMDV.

When an active link breaks, the upstream node of broken link broadcasts a route error (RERR) message to the source and the route discovery method can be re-initiated. Once all the possible paths are discovered between the source and destination, SRMBAR ranks the path based on its Fast Fading Time (FFT) and edges to avoid the unobservability nodes. FFT specifies the remaining life time (time dispersion) of the active link that has completed its transmission earlier. The edges can be categorized in three ways: active connected edges, active sleep edges and faded or predecessor edges. The active connected edge specifies the current link that transfers the data over the ranked path, active sleep edges specifies the link that can be used for future transmission and then faded or predecessor edges specifies the erased link over the ranked path which the transmission ends early. The edges are ranked according to the following conditions: The life time of the edge is checked against the fast fading time,

a) if the life time is less than fast fading time (Life time < Fast Fading Time (FFT))

b) if the traffic is more than the threshold traffic (Traffic > Threshold Traffic)

c) if the path gets P_ACK (Acknowledge of Path), increase the rank by 1.

If the above conditions are not satisfied, then the rank is decreased by 1. Once the ranking process for each edge has done, it can be updated and the optimal path is selected that has the minimum rank and then route the destination through the links. The Figure-3 shows the process of ranking the path between the source and destination.

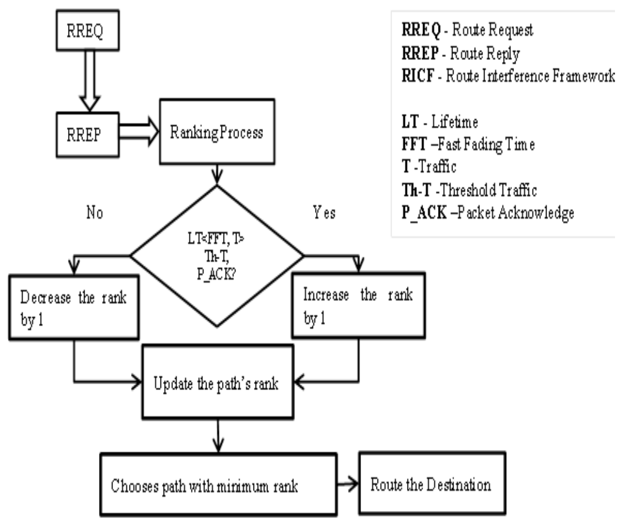

Figure-3. Ranking process in SRMBAR.

The reverse multicast transmission between the source and destination nodes can be done only by the active and passive links. The active links are used to send the packets to destination from source and the passive links are used to send the packets to source from

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destination. If the node's Fast Fading Time is not obtained, repeat the same procedure for next links in the active connected edges. Finally the algorithm checks the routing overhead by using a Routing Interference Communication (RIC) Framework.

Routing interference communication framework (RICF)

Once the routing has to be done by utilizing the SRMBAR algorithm for broadcasting the data packets, Routing Interference Communication Framework (RICF), a novel innovative technique is used. The efficient and effective technique works by observing every set of packets and its corresponding acknowledgement forwarded between the nodes. Each node is examined for transmission, reception of data packets and its corresponding acknowledgement. The time at which the packet is being initiated from the source and the time taken by the node to forward the packet are observed. The time taken by the node to forward a set of 'n' packets is always same. The observed value can be change when the node communicates with other node or receives the communication from the other node. If a new node enters the network, it is examined using Intrusion Detection System (IDS)/ Intrusion Prevention System (IPS). Once the node is error free, then communications are enabled and the newly arrived node is also grouped under RICF. If not, the node considered as unobservability node. Then it is restricted and eliminated from the routing path can avoids the routing overhead due to unobservability nodes (Hidden Terminal Problem).

6. PERFORMANCE ANALYSIS

A) Simulation setup

Simulation can be done by utilizing the NS2 (Network Simulator Version 2) simulating Environment. It is an event driven simulation tool used for the dynamic nature of the communication networks. The objective of this work is to simulate and analyzed the performance evaluation of AOMDV routing protocol by using Network Simulator 2(NS-2) tool. A simulation can be serviceable because it is attainable to scale the networks easily and therefore to extinguish the need for time consuming and costly real world experiments. While the simulator is a powerful tool, it is important to remember that the ability to do forecast about the performance in the real world is dependent on the accuracy of the models in the simulator.
The parameters were different routing protocols like as DSDV and AOMDV are chosen for simulation using the performance metrics such as Throughput, Transmission Overhead, Routing Overhead and Transmission Delay in different scenarios i.e., for 50,75 and 100 nodes.

Table-1. Simulation parameters.

Simulation and network parameters	
Network Area	1000 x 800
Protocol	AOMDV
No. of Mobile Nodes	100
Network Topology	Flat Grid
IEEE Standard	802.11
Broadcasting Range	550mts
Application Type	CBR /FTP
Application rate	512Kb
Protocols	TCP/UDP
No. of Packets	1500
Simulation Time	50s
Data Rate	1.0mb per second
Delay	10ms

B) Performance metrics

The metrics considered for simulating the MANET environment are Throughput, Transmission Delay and Data Rate.

Throughput - Defines the data packets correctly delivered to the destination (or) measures the effectiveness of the network in delivering data packets, i.e. the total number of packets received by the destination per unit time.

Transmission delay- Amount of time consumed to transfer all of the packets bits onto the link which depends on the data rate.

Data transfer rate- It represents the average number of bits transferred over a given period in time.

Routing overhead- It represents total number of control or routing packets generated by routing protocol over the number of received packets. Each routing packet sent or forwarded by the mobile node is counted.

7. SIMULATION RESULTS AND DISCUSSIONS

The performance of the proposed method is evaluated using NS2 simulator. The Figure-4 shows the routing overhead of proposed method when compared with existing Bellman Ford algorithm (BFA). In this case, the comparison can be computed for each transmission in seconds. The results shows that the routing overhead of SRMBAR with RIC (SRIC) is moreover less than the BFA.

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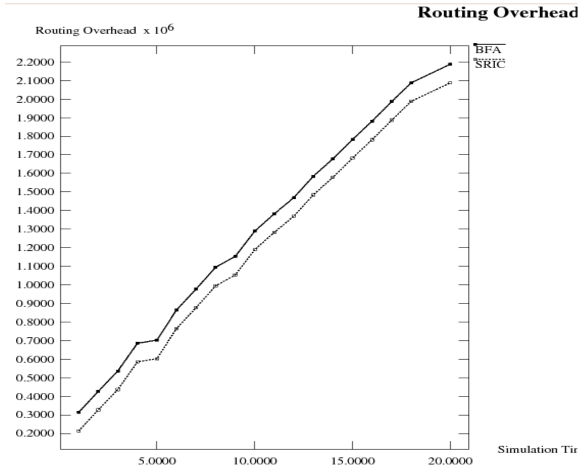

Figure-4. Routing overhead

The Figure-5 shows the transmission overhead which can be computed in seconds. The result of proposed method proves the minimum transmission overhead when compared with the existing BFA.

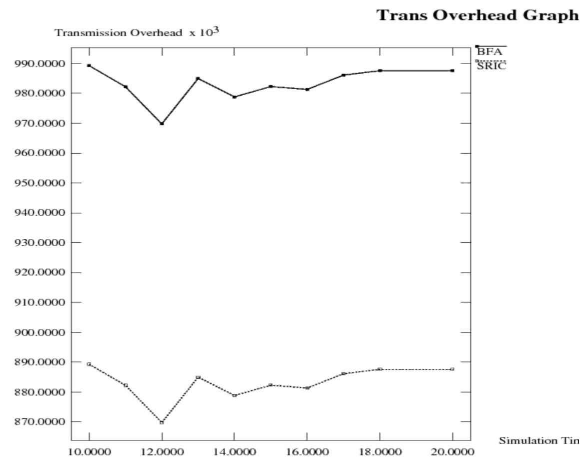

Figure-5. Transmission overhead.

The Figure-6 shows the delivery ratio of the transferred packets between the source and destination which can be computed in seconds. The reverse multicasting improves the packet transmission over the mobile nodes. We observed that the throughput of proposed method is remarkably good with respect to both CBR and TCP traffic achieves less number of packet loss.

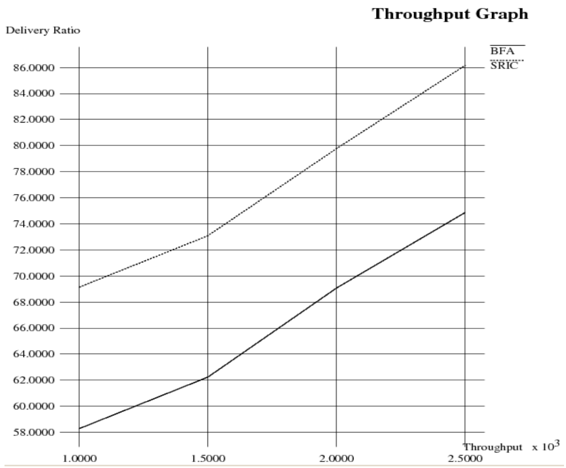

Figure-6. Throughput achieved.

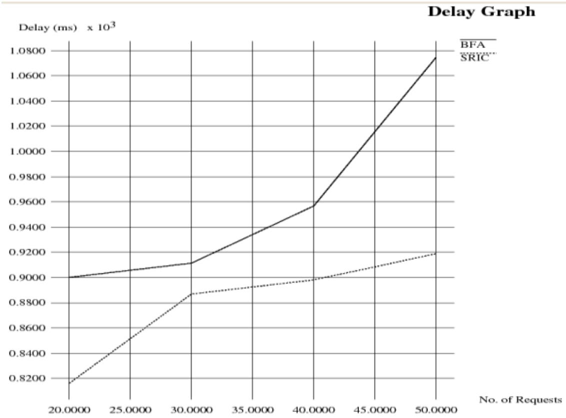

Figure-7. Delay.

The transmission delay of proposed method is very less when compared to the existing algorithm with respect to both CBR and TCP traffic as shown in the Figure-7. We observed that the delay is too less by degrades the packet loss of AOMDV protocol with respect to time (seconds) and traffic which improves the QoS in the network.

8. CONCLUSIONS AND FUTURE WORK

The proposed algorithm (SRMBAR) is a secure algorithm which utilizes reverse multicast AOMDV protocol for efficiently optimizing the secure shortest path from multiple paths between the source and destination. The AOMDV protocol achieves a great efficiency by improving throughput by degrading the packet loss in between the nodes by ranking the multiple paths. The node with minimum rank can be chosen as secure routing path for transmission by utilizing the ranking process. This algorithm also eliminates the routing overhead between the nodes in transmission due to the hidden nodes by using Route Interface Communication Framework. The framework observes each and every packet over transmission and its acknowledgement about the source packet initiation time and time taken to forward it to its destination. The simulation result achieves a great improvement in QoS by detecting the secure routing path compared with the other techniques which eliminates the routing overhead. The future work is to improve the routing path by using the efficient protocols which improves the performance, QoS and by reducing the delay in communications.

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