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Mobile Ad Hoc Networks and It's Routing Protocols

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***Abstract*—**A mobile ad hoc network (MANET) is a self configuring network, without any centralized control. The topology of this network is not always defined. The main objective of this paper is to introduce the fundamental concepts of MANETs to the researchers and practitioners, who are involved in the work in the area of modeling and simulation of MANETs. This paper begins with an overview of mobile ad hoc networks. Then it proceeds with the overview of routing protocols used in the MANETS, their properties and simulation methods. A brief tabular comparison between the routing protocols is also given in this paper considering different routing protocol parameters. This paper introduces a new routing scheme developed by the use of evolutionary algorithms (EA) and analytical hierarchy process (AHP) which will be used for getting the optimized output of MANET. In this paper cryptographic technique, ceaser cipher is also employed for making the optimized route secure.

***Keywords*—**AHP, AODV, Cryptography, EA, MANET, Optimized output.

I. Introduction

A MANET is defined as autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. As the nodes are mobile, the network topology may change rapidly and unpredictably over time. The origin of mobile adhoc networks can be traced back to DARPA packet radio network project in 1972. First generation of MANETs were used for different military scenarios for aiding combat operations around 1970 and packet radio networks was the first ad hoc networks. During the second generation from 1980 to mid 1990, named as survivable adaptive radio networks, developments were focused on next advancement of MANETs developed during their first generation. During the third generation of MANETs, notebook computers based on radio waves concept of commercial mobile ad hoc networks were invented. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes. Node mobility in an ad hoc network causes frequent changes of the network topology. The insecurity of the wireless links, energy constraints, relatively poor physical protection of nodes in a hostile environment, and the vulnerability of statically configured security schemes have been identified as the major challenges. No part of the network is dedicated to support individually any specific network functionality, with routing (topology discovery, data forwarding) being the most prominent example. Furthermore, performance issues such as delay constraints on acquiring responses from the assumed infrastructure would pose an additional challenge. MANETs operate in highly dynamic environment and due to which their topology can't be always defined and limitation poses a problem of security of the network and there is always a need for optimized and secured routing protocol. Till now a number of routing protocols have been developed for MANETs The set of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks [68], [49]. In ad hoc networks, nodes do not have a priori knowledge of topology of network around them, they have to discover it. Some ad-hoc network routing protocols are - Pro-active (Table-driven), Reactive (On-demand), Hybrid (Pro-active/Reactive), Hierarchical, Geographical, Power Aware, Multicast Geographical Multicast (Geocasting). Routing protocols select paths dynamically while the packets are being forwarded, or statically (in advance) as in source routing from a source node to a destination.

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II. Review of MANETs

There are two different classes of failures named simple and Byzantine failure for MANETs which continue to operate but in incorrect way [2]. A loop free routing protocol optimizes the frequency at which it sends updates to the networks and correspondingly reduce the bandwidth and energy used, leading to fully distributed and self-optimizing system which always delivers more than *80%* of the data messages by following the direction computed, without using any recovery procedure [3]. To build a highly available and highly secure key management service for MANETs, use of threshold cryptography to distribute trust among a set of servers was described and key management service employs share refreshing to achieve proactive security and adapt to changes in the network in a scalable way [4]. Another routing protocol was proposed which selects the routes and the corresponding power levels such that the time until the batteries of the nodes drain-out is maximized. The achievable lifetime was close to the optimal most of the time when there are multiple power levels [5]. A simple, efficient and scalable multi level fish eye scope routing algorithm reduced routing update overhead in large networks in which nodes exchange link state entries with their neighbors with a frequency which depends on distance to destination and from link state entries, nodes construct the topology map of the entire network and compute optimal routes [6]. Security aware routing protocol ensures that a node can process the packet or forward it if the node itself can provide the required security. It also provides customizable security to the flow of routing protocol messages themselves in MANET [7]. A detailed survey on evaluation of energy consumption in ad hoc routing protocols, localized routing algorithms that optimize based on power and other metrics, network topology generation designed to optimize power consumption, routing algorithms that balance power consumption among all network nodes, and algorithms that maximize node life times can be found in [8]. For a MANETs, a robust route discovery protocol that mitigates the detrimental effects of such malicious behavior, as to provide correct connectivity information was described in [9] which guaranteed that fabricated, compromised, or replayed route replies would either be rejected or never reach back the querying node. This resultant protocol was capable of operating without the existence of an on-line certification authority or the complete knowledge of keys of all network nodes.

Always using lowest energy paths may not be optimal from the point of view of network lifetime and long-term connection and new scheme, that uses sub-optimal paths occasionally to provide substantial gains was presented in [10]. A routing scheme which is tunable and which also allowed for tradeoffs between setup overhead and delivery reliability was described in [12]. To protect the authenticity and integrity of the message in MANET, digital signatures can be used [11], [94]. For battery-powered nodes and externally powered nodes, an energy aware routing scheme was described which achieved better system lifetime compared to the conventional energy efficient routing protocols [13] [21]. The learning rule, reinforcement and rate at which forward ants are sent from a node to explore feasible paths to destination nodes in the network controlled the performance of the algorithm described in [14] and the scheme was compared with AODV by considering the throughput, delay and goodput and algorithm was robust against mobility and topology changes. An up to date survey on genetic algorithm based multicast routing in wireless sensor networks can be found in [101] in which a complete overview of the parameters such as localization, mobility, query based, energy efficiency, data aggregation and QoS for the GA based multicast routing in wireless sensor networks is provided

For MANET security, concept of a tunneling attack, in which collaborating malicious nodes can encapsulate messages between them to subvert routing metrics was described which provides authentication and non-repudiation services using pre-determined cryptographic certificates that guarantees end-to-end authentication [15]. The routing algorithms employed in Peer-to-Peer and mobile ad hoc networks are different, but some differences and similarities are there [16]. In Virtual Base station based protocol mobile station is elected from a set of nominees to act as temporary base stations and this routing utilized the mobility tracking mechanisms of virtual base station infrastructure creation protocol to route packets from source to destination node [17].

An authenticated routing scheme and secure node to node key agreement protocol was described for MANETs with use of symmetric cryptography with small communication cost [18]. To provide end-to-end quality of service support in mobile ad hoc networks with parameters bandwidth and end-to-end delay, a resource reservation-based routing was introduced for MANETs and results was justified that traffic measurements and admission decisions are accurate and provide high channel utilization [19]. To analyze the impact of mobility pattern on routing performance of mobile ad hoc network in a systematic manner, a framework was introduced and found that the mobility pattern does influence the performance of MA NET routing protocols [20]. The first ad-hoc algorithm to be both asymptotically optimal and average-case efficient was described which combined greedy and face routing and results showed that it provides not only worst-case guarantees but is also average-case efficient [22]. In mobile ad hoc networks route optimality can be obtained using metrics like path length and energy consumption along the path which enhances the performance in terms of bandwidth and latency without incurring any significant additional cost and also optimizes residual battery power [23].

For efficient route discovery in mobile ad hoc networks, a technique that uses iterated fresher encounter searches was described [24] which does not assume any hardware add-ons such as GPS receivers and performance depended on the nodes' mobility processes.

First Routing

A protocol that avoids congestion by reducing contentions was introduced [25] that takes advantage of channel spatial reuse to reduce contention and is able to deliver more than 80% data packets even under heavy traffic load. Bluetooth devices forms the basis of Bluetooth routing protocol which considered the capabilities of the node within the network's range and protocol made decisions by taking signal strength, power constraints, memory and location into account [26]. In MANET intermediate nodes are also called as redirectors elects to forward packets on behalf of source destination pairs thus reducing the aggregate transmission power consumed by wireless devices. This algorithm was compared in performance to MLSR and found that this algorithm consumed less power in order to find power efficient routes compared to MLSR due to its point-to-point on-demand design [27]. For MANET a new agent based ad hoc routing protocol was also introduced and which achieves better performance under more dynamic conditions and shows improvement in terms of delay and number of received packets compared to DSDV [28].

For MANET, AntHocNet hybrid algorithm for routing in mobile ad hoc networks based on the nature-inspired Ant Colony Optimization framework was introduced which was more scalable than AODV [32]. A novel distributed routing protocol which guarantees security, anonymity and high reliability of the established route in a hostile environment, by encrypting routing packet header and abstaining from using unreliable intermediate node was described with its main features as non-source-based routing, flexible and reliable route selection, and resilience against path hijacking [33]. Several routing algorithms that find near-optimal solutions for the joint optimization problem was presented in [34] and the routing objective is to minimize communication cost, while maximizing information gain, differing from routing considerations for more general ad hoc networks and information-directed routing is a significant improvement over reported greedy algorithm [34], [41], [73].

For high node mobility and low traffic loads, simple changes like limiting replies by destination, one route per destination and preferring fresher routes over short ones improve the performance [35]. In MANET for provision of asynchronous communication in partially-connected mobile ad hoc networks, based on the intelligent placement of messages, a new routing protocol can be designed. Results showed that it is possible for nodes to exploit context information in making local decisions that lead to good delivery ratios and latencies with small overheads [36]. MANET routing protocols relies only on symmetric cryptographic techniques and dynamically discover the routes between nodes when needed and design is based on basic operation of DSR protocol. Ariadane performs better on some metrics than unoptimized DSR [37]. Genetic Algorithms (GA) can be used for route discovery for QoS routing in MANETS based on reinforcement learning (RL) based on route discovery and GA based route expansion. RL techniques can play an important role in controlling flooding in route searching to improve performance of network in environments in which the route selection is only based on local network information [38], [50], [59], [65], [66], [89]. Biometrics and Genetic algorithm provide data security in MANET to strengthen the encryption algorithm and key [69], [85]. Genetic algorithms and dijkstra algorithm can be used to better the optimization problems in MANETs [71], [98]. The soft techniques like neural network, genetic algorithms and fuzzy logic based more routing techniques are described in [79], [80], [87] and to improve the routing mechanism in MANETs with genetic algorithms, buffer size, end to end delay and shortest path as the parameters for GA in route discovery can be used and alternative path or backup path to avoid reroute discovery in the case of link failure or node failure can be obtained [91].

AOMDV protocol achieve best performance in high mobility case, whereas AODV Multipath performs better in case of low mobility and higher node density and total routing overhead gets lower [39]. To ensure the complete data secrecy between communicating nodes in MANETs, three anonymity guarantee identity anonymity, route anonymity and location anonymity can be used and asymmetric key cryptographic schemes are practicable for wireless ad hoc networks [40]. A newly developed MANET routing protocol AODVLRT decreased both of the routing message overhead and the average end to end delay than the well known AODV routing protocol and increased the throughput. This routing protocol enhances the network performance than the AODV routing for a network sizes ranging from 50 up to 300 nodes [42].

To adapt to network topology variations Adaptive Backup Route technique can be used in MANETs named as AODV-ABL, it can solve the collision and congestion problems of packets in AODV-BR by choosing a backup route among many backup routes [43]. Genetic algorithm can be used to find a very good path between source and destination in ad-hoc network nodes and can optimize the route in MANET.GA can reduce the number of clusters, cluster heads and loads among clusters can be evenly balanced [44], [55]. A fully localized algorithm that efficiently delivers multicast data messages to multiple destinations in which each node propagating a multicast data message needs to select a subset of its neighbors as relay nodes towards destinations was described which optimizes the cost over progress ratio where the cost is equal to the number of neighbors selected for relaying and the progress is the overall reduction of the remaining distances to destinations [45].

Temperature can play important role in routing data packets towards internet gateways and this protocol does not require flooding of control messages, but every node in the network determines its temperature considering only the temperature of its direct neighbors, which makes the protocol scalable to the network size [46]. For sparse and dense environments in MANETs a new routing protocol which does not require location information and insensitive to void and obstacles was described in [47]. For Interoperation among MANETs can be established with IDRM (Inter-Domain Routing Protocol for MANETs) routing protocol which is challenge for inter domain routing [48]. For MANETs position based routing was devised and which tackled the local minimum problem by constructing a virtual small world network and this was the first geometric routing protocol applicable in 3D networks [51]. A robust protocol against attackers trying to create incorrect routing state in the other node was described in [53] and nodes exchange their routing tables periodically and broadcast their hash value to their neighbors, so that the neighbors can verify the correctness of the value by one way hash function [53]. For MANETs a multipath routing protocol with extended security schemes was developed and which was better in discovering and maintaining the new routes than other protocols [54]. Mobility prediction can improve routing protocol performance of MANET [56]. With the use of temporary secret keys and pseudonyms, an adversary in MANET can't trace the packet flow and parameters like Privacy of the Location of Source and Destination Nodes and Privacy of the Route and Impossibility of Packet Tracing may be considered for designing the new routing protocol [57]. The GPS enable nodes in MANET can wake up periodically to listen for changes and go back to the sleep mode to conserve energy. Lower dependence on specialized GPS hardware can reduce the cost of implementing a new routing protocol [58]. The problem of crashing a node can also be handled in MANET routing protocols [60]. Trusting a node is a very important factor, while thinking about the security in MANETs and accordingly the routing information can be low-level, medium level, high level encrypted and using the same kind of encryption for all the information exchanged will not provide the security. Battery value is also one of the metric in designing a routing algorithm. Fuzzy logic controller can be used to evaluate the trust level of nodes based on packet forwarding status of nodes [62], [78], [82]. In MANETs parameters like Distance-Velocity and power level of nodes deciding about to which neighbor, the given packet should be forwarded [63]. For MANETs a novel opportunistic routing protocol which incorporated adaptive rate control to dynamically adjust sending rates according to network conditions and recovers lost packets using efficient local feedback and recovery was described in [61].

Modified ant colony optimization framework can also be used in designing the proactive routing algorithms for MANETs and algorithm exhibits superior performance with respect to reactive AODV routing algorithm in terms of packet delivery ration and end-to-end delay [67], [93], [99], [100]. Mobile ad hoc networks can be made more effective and efficient with Listen First, Broadcast Later (LFBL), a multi-hop wireless protocol comprising of a distributed forwarding capability with essentially no routing protocol [70]. SNAODV (Secure node-AODV) protocol provide node to node authentication and ensures the authenticity of user of peer node in MANET [72]. Neural network based approach can also be used in designing routing protocols for MANETs which is based on two things, one is routing metric and finding optimal path based on multi criteria optimization and second is detecting and sharing all routing information which were changed during the time [74], [95]. A protocol which used comprehensive neighborhood trust model to provide efficient and confidential ad hoc network environments for military applications was described in [75] and which was having the advantages like use of trust monitoring to mitigate internal attacks, securing of control messages to prevent topology information leakage and confidential neighborhood authentication to protect anonymity and prevent leakage of command hierarchy. A method which exploits local broadcasting to contact multiple neighboring nodes was described in [64] and the results of which showed that it exhibits very low end to end packet delays and offers good immunity to rapidly changing topologies.

Trustful authenticated routing for MANETs was described in [77] which uses cryptographic certificates to prevent and detect most of the security attacks that most of the ad hoc networks face and it guarantees end to end authentication and only authorized nodes participate at each hop between source and destination. A low energy consumption adaptive clustering routing protocol facilitated by its orthogonality and incoherence was described in [83], [92] which effectively reduces network delay and improves the node energy consumption efficiency, and then prolongs the network lifetime. The performance of conventional Dynamic source routing (DSR) protocol can be increased by incorporating a new technique into it which was described in [81] which increases the power saving and throughput performance.

For MANETs, to compute available bandwidth of the nodes in distributed way and QoS reservation mechanism, a new method was developed in [84] and which provided the enhancement on overall performance of reactive routing mechanisms on ad hoc networks [96].

For Unmanned Aerial Vehicles mobile Ad- Hoc networks Directional Optimized Link State Routing (DOLSR) protocol was described in [86] which has the capacity of reducing the number of the multipoint relays in the network and accordingly end-to-end delay is reduced and the overall throughput is increased. Basic concepts of geographic routing in vehicular ad hoc networks can be demonstrated by greedy perimeter stateless routing (GPSR) which is a purely local decision strategy as no route setup or maintenance is required [88]. For MANETs, a position based geometric routing technique can be found in [102] which can be used to determine the routes having same delay though they may differ in terms of geographical distances and data rates and can be efficient for multimedia transmission over parallel links with minimum delay jitters.

TABLE I
BRIEF COMPARISON BETWEEN PREVIOUSLY DEVELOPED MANET ROUTING PROTOCOLS

Protocol	ARAN	ARIADNE	SAODV	SEAD	SRP
Type	Reactive	Reactive	Reactive	proactive	Reactive
Encryption Algorithms	Asymmetric	Symmetric	Asymmetric	Symmetric	Symmetric
MANET protocol Synchronization	AODV/DSR X	DSR √	AODV X	DSDV √X	DSR/ZRP X
Authentication	√	√	√	√	√
Confidentiality	√	X	X	X	X
Integrity	√	√	√	X	√
Non Repudiation	√	X	√	X	X
Anti Spoofing	√	√	√	X	√
DOS Attacks	X	√	X	√	√
Optimized output based on Multi Decision Criteria	X	X	X	X	X

III. PROPOSED MODEL

A. Problem Formulation

The main objective of our proposed routing model is to select an optimized and secured route among the different zones and each zone having certain number of nodes. When the optimized route gets selected with its respective cost function (high throughput route), the message is sent through the route using ceaser encryption with a message divided into various packets (letters) and then the encrypted message will be transmitted through the selected route. On the other side each letter is decrypted according to the agent code and the original message is retrieved. In this, we have taken up a

MANET between two places on a map and have divided the region into various zones consisting in each region, so as to standardize input data for normalization [76]. After that we have taken up the shortest path as the backbone and assigned it the highest priority. In order to achieve the desired result, evolutionary algorithms and analytical hierarchy process will be used for optimizing and securing the route [30], [90].

B. Evolutionary Algorithm: (EA)

An evolutionary algorithms is a search technique used in computing to find the true or approximate solutions to optimization [52] and search problems and the evolution usually starts from a population of randomly generated individuals and happens in generations [1], [31], [97]. The various steps involved in evolutionary algorithm are as follows –

1. Start] Generate random population of n chromosomes (suitable solutions for the problem)
2. [Fitness] Evaluate the fitness f (x) of each chromosome x in the population.
3. [New population] create a new population by repeating following steps until the new population is complete.
   a. [Selection] Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected
   b. [Crossover] With a crossover probability cross-over the parents to form new offspring (children). If no crossover was performed offspring is the exact copy of parents.
   c. [Mutation] with a mutation probability mutates new offspring at each locus (position in chromosome).
4. [Replace] Use newly generated population for a further run of the program.
5. [Test] If the end condition is satisfied ,stops ,and returns the best solution in the current population
6. [Loop] go to step 2.

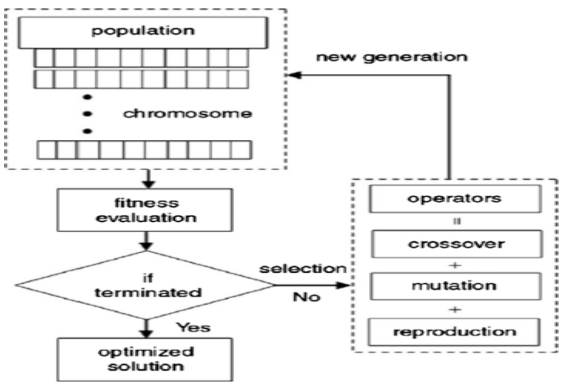

Fig. 1 Evolutionary Algorithm Flow Chart

C. Analytical Hierarchy Process

AHP is a method for comparing a list of objectives or alternatives. It is comprehensive, logical and structured framework. The incorporation of all the relevant decision criteria and their pairwise comparison allows the decision maker to determine tradeoffs among objectives [29]. AHP is based on three principles: decomposition of decision problem, comparative judgment of elements and synthesis of priorities, which are briefly written in steps as below

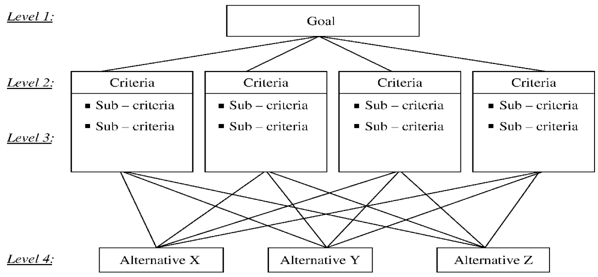

Fig. 2 AHP Multiobjective Selection Criteria

Step 1. Creating hierarchies to resolve the problem
Step 2. Comparison of alternatives and the criteria
Step 3. Synthesize the comparisons to get the priorities of alternatives w.r.t. each criteria and weights to each criterion with respect to the goal.

D. Encryption Algorithm

Following are steps involved in encryption –

a. Enter the agent key which will decide the encryption pattern of the message at the transmitting side.
b. Once the agent key is entered, the message is passed to the transmitting end which gets encrypted according to the agent key (ceaser encryption). This sort of encryption is safe from brute force attack as the message gets randomly shuffled infinite no of times which makes the information more secure.
c. Once each of the packet reaches to the receiving side it gets decrypted and the original message is received

IV. Simulations and Results

The simulation is done for various zones (the user defines the number of zones) and the optimized routing is determined by the value of cost function. The optimized route is selected with the use of analytical hierarchy process and genetic algorithm. Once the optimized route is selected the encryption algorithm is applied to make the routing secure.

$$\text{Cost Function} = A_1\lambda_1 + A_2\lambda_2 + A_3\lambda_3 \quad (1)$$

where λ's are weights and will be calculated using comparison matrix and A1-A3 are local constants and the values of local constants are given as below:-

$$A_1 = 0.45,\ A_2 = 0.25,\ A_3 = 0.30$$

Enter the agent code: - a,
Enter the message: - YOU,
Enter the encrypted message: - QWR

1. For the transfer of the first alphabet 'Q' the optimized path is to be decided with the help of analytical hierarchy process and evolutionary algorithm. Since we have taken 3 zones with each zone consisting of 3 nodes, in total there are 27 values.

Performance indices for AHP: -
1 - Equally important
2 - Moderately important
4- Strongly important
6- More strongly important
8- Most strongly important
Following tables will generate the weights associated for each node in the three regions:-

For zone 1:-

NODE 1:

TABLE II
COMPARISON MATRIX FOR NODE 1 IN ZONE 1

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	2	4
Power Consumption	0.5	1	4
Network Congestion	0.25	0.25	1

NODE 2:

TABLE III
COMPARISON MATRIX FOR NODE 2 IN ZONE 1

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	4	6
Power Consumption	0.25	1	2
Network Congestion	0.16	0.5	1

NODE 3:

TABLE IV
COMPARISON MATRIX FOR NODE 3 IN ZONE 1

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	6	8
Power Consumption	0.16	1	4
Network Congestion	0.25	0.125	1

For ZONE 2

NODE 1:

TABLE V
COMPARISON MATRIX FOR NODE 1 IN ZONE 2

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	1	1
Power Consumption	1	1	1
Network Congestion	1	1	1

NODE 2:

TABLE VI
COMPARISON MATRIX FOR NODE 2 IN ZONE 2

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	1	1
Power Consumption	1	1	1
Network Congestion	1	1	1

NODE 3:

TABLE VII
COMPARISON MATRIX FOR NODE 3 IN ZONE 2

Attributes	Latency	Power Consumption	Network Congestion
Latency	1	4	2
Power Consumption	0.25	1	8
Network Congestion	0.5	0.125	1

In a similar way, comparison matrix for all nodes in remaining zone can be obtained.

Cost functions in the binary form for the first alphabet:-

00100011
00100111
00101000
00100001
00100001
00100011
00100111
00100001
00100001
No of generations: - 1

Crossover point: - 2

Cost functions after the cross over are:-
00100111
00100011
00101000
00100001
00100011
00100001
00100111
00100001
00100001

Evolutionary Algorithm Result:-

The optimized route for the encrypted message transmission is

Zone1 node3 (source node: - value 40) then zone 2 node3 (intermediate node:- value 35) zone 3 node 1(destination node :- value 39)

So the letter which reaches the destination node: - Q

In a similar way the optimized route for the next word can also be determined. The screenshots given below shows the result of simulations.

Simulations:

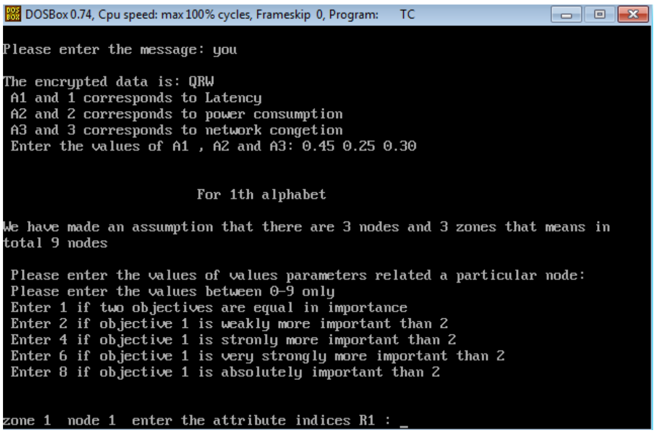

Fig. 3 Simulations results showing AHP Multiobjective criteria importances

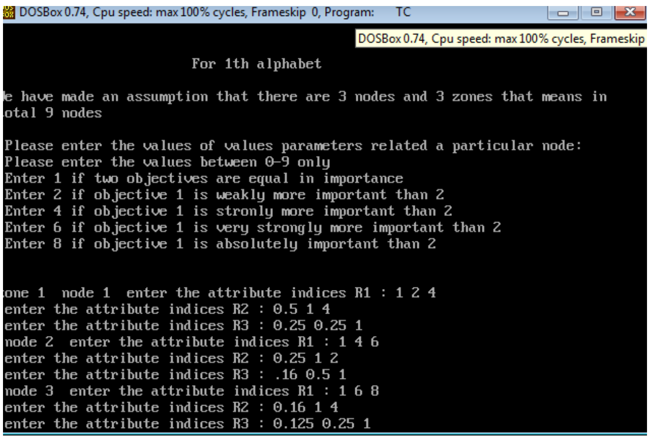

Fig. 4 Simulations results showing the input values for all nodes in zone 1 to make comparison matrix

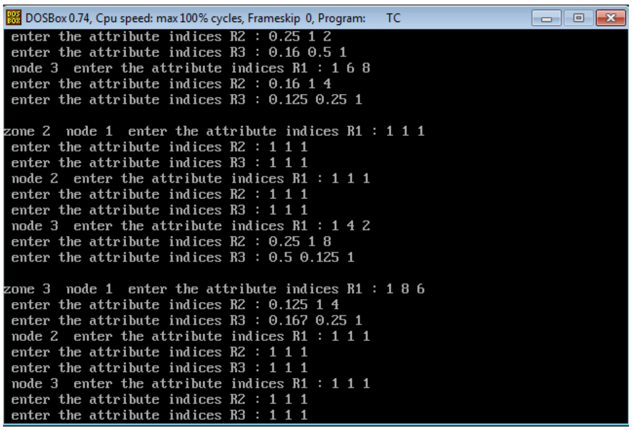

Fig. 5 Simulations results showing the input values for all nodes in zone 2 and 3 to make comparison matrix

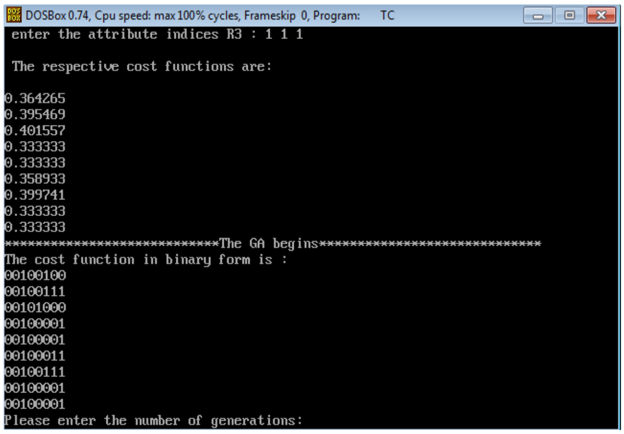

Fig. 6 Simulation results showing Cost functions of comparison matrix in binary form

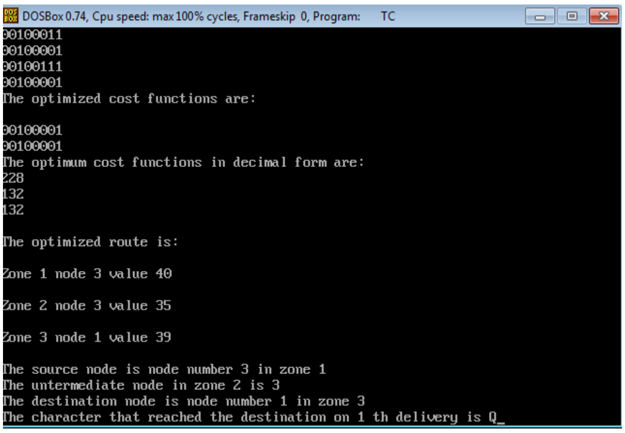

Fig. 7 Delivery of 1st character of encrypted message

V. DISCUSSIONS

Simulation results using Evolutionary algorithms and Analytical Hierarchy Process along with cipher encryption show an average throughput gain (where throughput gain is the amount of information passing from input to output) of 55% to 75%, depending on network density, over traditional minimum hop route selection in 802.11b networks. Also in this case the message is more secure as the message is encrypted and sent through the optimized route. If the traffic patterns are not clear in a large network, even an optimal routing algorithm will achieve low throughput. The definition of realistic mobility models is one of the most critical and, at the same time, difficult aspects of the simulations of applications and systems designed for mobile environments. Currently, there is no publicly available data capturing node movement in real large-scale mobile ad hoc environments. Taken together, for those systems in which mobility is important and for which a synthetic mobility model is an essential ingredient, it would appear to be important to consider the influence of the human-level social network as something that informs likely individual and group mobility patterns.

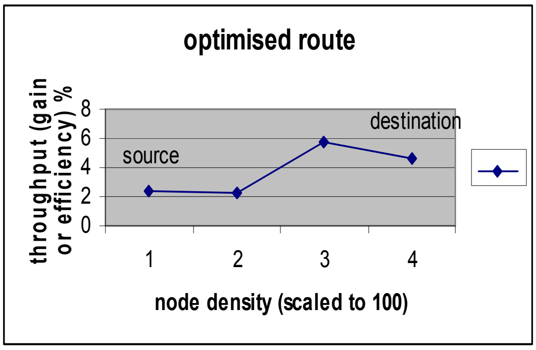

Fig. 8 Throughput Vs Node density characteristics

VI. Conclusions

From the results obtained it is concluded that the use of adaptive techniques in combination with the mathematical tools such as AHP, brings a pronounced throughput improvement in ad-hoc networks which results in a more secured and protected message transmission. By using Evolutionary Algorithms and Analytical Hierarchy Process for routing, the MANET throughput has shown an improvement of 65% to 75% in comparison to the existing routing algorithms. Also in this algorithm the message that is sent through the optimized route is secured from hacking, as the security concern has been taken care of cipher encryption. Also, by using EA and AHP we found that the chance of a particular node appears once in 3 iterations. These results in probability of 33.33% resulting in saving of near about 70% (of the particular characteristic of node) we have been very pessimistic about our results so we have reduced it to 50-60%.

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