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A Review on Bio-Inspired Techniques in Mobile Ad-hoc Network

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Abstract: *Over the years, users' demand for higher service levels has continued to increase. This has led to the rapid development and advancement of wireless communication in an effort to create a model that meets users' needs. In mobile ad hoc networks (MANETs), since there is no protocol in such networks, it is the responsibility of the mobile user to use the correct information. When the location is out of the radio range of the location, each cell in the network acts as a relay and sends information to the other cell until that location is reached. MANETs have more security than quality of service (QoS). In this paper, we conduct a comparative study of mobile self-organizing network applications based on different technologies and present some issues or problems that may be found in our data analysis studies*

Keywords: Bio-Inspired Technique, Mobile Ad hoc Network, Routing Algorithm, Quality of Service

I. INTRODUCTION

In the mobile ad hoc network (MANET) [1], each of them is equipped with a radio transmitter and receiver that allows them to connect to the system via two-way wireless communication. The most important reasons why MANET allows data transfer with comparable characteristics while maintaining its operational efficiency are: Surprisingly, the propagation of this transfer is more limited than before, making it difficult to exchange information throughout the system for many nodes. A major problem with Wi-Fi Ad-Hoc networks is that portable nodes depend on batteries, which are rare in most places and need to be recharged or replaced [1].

MANET consists of dynamically wireless mobile nodes that can move to any location without needing control from a central station or a central location. MANET is considered a multi-hop network; since the goal in a multi-hop network is to communicate between the source and the source, the source can communicate with its destination via [6]. MANET is considered a promising technology to provide a temporary connection without using the pre-existing system, which is useful in urgent or emergency situations such as emergencies, disaster areas and war. However, one of the biggest problems of MANETs is the formation of links that disrupt the connection. Many MANET systems plan to create a way to flood the network with data requests (RREQ). Therefore, flooding causes more control when establishing a connection to the desired destination and thus reduces the performance of MANETs. Also, flooding should be chosen to improve the network performance by limiting the number of cells broadcasting RREQs. Node movement can cause rapid changes in the network topology; therefore, they can create additional load that can disrupt the connection by causing delays. Interference events can affect the network performance, increase the delay, control the load, and reduce the packet delivery. These issues lead to the need for functional connectivity for prediction strategies to fail.

The major concern with the present wireless network is being the limitation of battery power, that is, energy used by the nodes, limited bandwidth, and the limited range of transmission. The mobile nodes forward packets to the neighboring nodes and while communicating with different nodes in the networks the nodes consumes the battery energy as the routes are being multihop and the nodes consume energy for their transmission/reception in the network. To consume less energy, one of the alternate methods is to budget the energy with limitation of the usage of its energy in the network. In general, the energy consumption can be affected by the variance in node energy levels, cost/packet, maximum node cost, and time to network partition, which provides the minimum energy route, by which the overall energy consumption for delivering a packet is minimized. The energy consumption in MANETs is

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affected mainly by, time to network partition, that is, the network should distribute energy consumption evenly to each of the node links in the network throughout the path providing minimum energy consumption path, and the path for data transmission is selected by the existing routing algorithm with it.

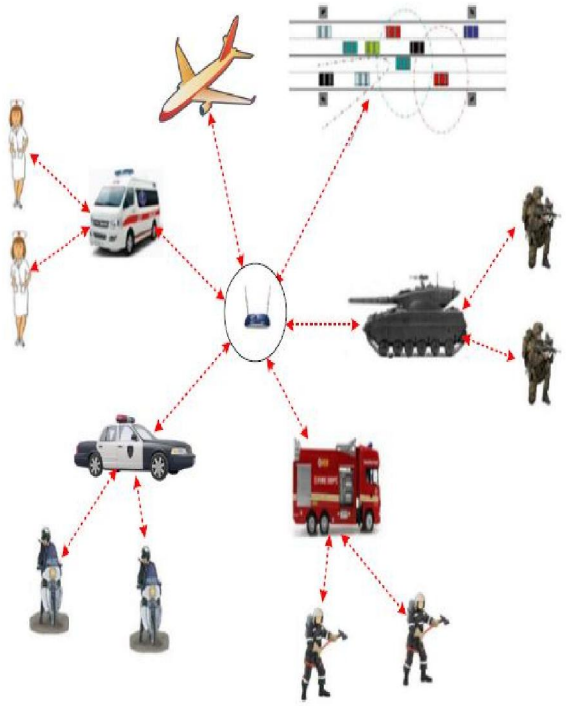

Figure 1: A general scenario of MANETs applications [7]

The rest of this paper is organized as follows in the first section we describe an introduction of about the mobile ad-hoc network, vehicular ad-hoc network. In section II we discuss about the wireless communication introduction and wireless communication in vehicular ad-hoc network, In section III we discuss about the literature survey in the vehicular ad-hoc network, In section IV we discuss the about protocol layers or OSI model, finally in section V we conclude the about our paper.

II. MANET CHARACTERISTICS

Data transmission in MANETs can be done as unicast or multicast. When data should be transmitted to more than one destination, multicasting process is carried out. Indeed, multicasting is a group communication technique which is aimed at effective use of bandwidth in which messages are sent from one source to a group of destinations. As a result, communication costs for providing service quality are reduced. On the other hand, the majority of routing protocols in MANETs focus on finding an appropriate route from source to destination which results in the creation of delay. Hence, the major challenge in providing service quality is related to discovering a route with adequate accessible resources which is sustainable enough for sorting out service quality limitations. This problem can be solved by using multi-route process [34].

- Distributed operation: There is no background network for the central control of the network operations, the control of the network is distributed among the nodes. The nodes involved in a MANET should cooperate with each other and communicate among themselves and each node acts as a relay as needed, to implement specific functions such as routing and security.
- Multi hop routing: When a node tries to send information to other nodes, which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.
- Autonomous terminal: In MANET, each mobile node is an independent node, which could function as both a host and a router.

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- Dynamic topology: Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable times. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network
- Light-weight terminals: In maximum cases, the nodes at MANET are mobile with less CPU capability, low power storage and small memory size.
- Shared Physical Medium: The wireless communication medium is accessible to any entity with the appropriate equipment and adequate resources. Accordingly, access to the channel cannot be restricted.

III. POWER AWARE BASED ROUTING ALGORITHMS

Existing power-aware routing algorithms of the classical MANETs can be classified according to their attitude into activity-based and connectivity based routing. Activity based algorithms find solutions related to the data transmission between nodes in the network i.e. network activity. Connectivity-based algorithms find transmission connectivity maintenance solutions for an ad-hoc network. Connectivity- based can be divided into Passive energy saving protocols and Topology control protocol. Geographic Adaptive Fidelity (GAF) protocol belongs to Passive energy saving protocols, in which the network is divided into virtual grids, each grid tries to keep its vital nodes in the active state to ensure the network connectivity and turn the other nodes into sleeping state to save energy. In topology control protocols, such as Local Information No Topology (LINT) and Local Information Link-State Topology (LILT), each node has a high threshold (dh) and low threshold (dl),and its transmission signal is adjusted according to the number of (dh) and (dl) neighbors. LINT can't recognize network partitions as it uses only local information [43]. Activity- based can be divided into two categories, transmission power control and maximizing network lifetime. In the transmission power control protocols the transmission power is used as a metric. The Minimum Total Transmission Power Routing (MTPR) and Minimum Power Routing (MPR) belong to transmission power control protocols category, which its goal is to select an optimal path with minimum energy consumption. Maximizing network lifetime protocols distribute the consumption of the network power resources in a balanced manner to avoid node exhausting and extends its lifetime. Min-sum Battery Cost Routing (MBCR) protocol, that uses the path residual energy as a cost metric and the optimal path is the path with the maximum residual energy, where the path residual energy is the summation of residual energy of nodes that form this path. One drawback of this protocol is the optimal path selection. Paths with a large number of nodes, which may have a low level of remaining energy, can be selected as an optimal path.

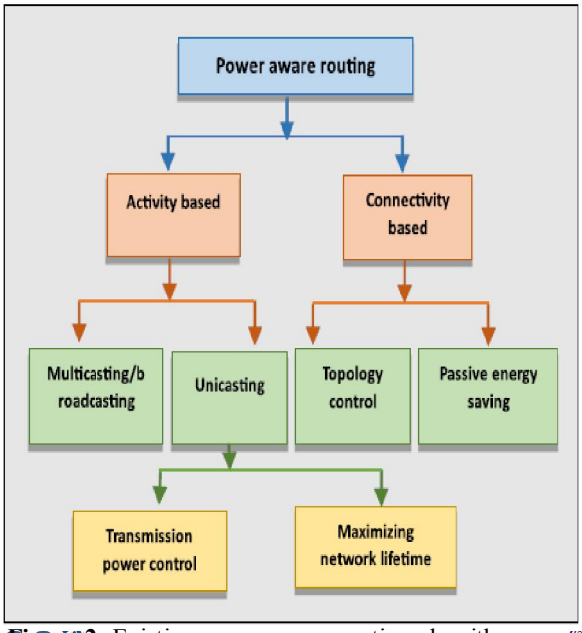

Figure 2: Existing power aware routing algorithms.

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IV. RELATED WORK

Mobile ad hoc networks (MANETs) are self-organized networks without any fixed infrastructure. The topology changes are very frequent in MANETs due to nodes' mobility. The topology maintenance creates an extra overhead, as the mobility information of a single node is shared with all nodes in the network. To address the topology maintenance overhead problem in MANETs, the researchers proposed different cluster-based algorithms to reduce the size of a routing table. In this section we present the different literature work based on the comparative study, results simulation, different parameters and different techniques, in this literature journey we include the already done work in this filed form reputed journal/publications.

[1] Mobile ad hoc networks (MANET) are self-organizing, rapidly deployable wireless networks excellent for outdoor events, communications in places lacking radio infrastructure, disasters, and military activities. Because network topologies are flexible and dynamic, security may be the most vulnerable point in the network, open to attacks including eavesdropping, routing, and application changes. MANET has more security flaws than quality of service (QoS). It is thus recommended to use intrusion detection, which regulates system to detect further security problems. Monitoring for intrusions is crucial for prevention and additional security against unwanted access. The loss of a mobile node's power source may affect the node's ability to forward packets, which is reliant on the system's overall life. In this paper, the Bacteria for Aging Optimization Algorithm (BFOA), which finds the ideal hops in advancing the routing, is utilized to offer a trust-based protected and energy-efficient navigation in MANETs using a trust-based protected and energy efficient navigation algorithm.

[2] Multiple methods were suggested in literature for securing routing; these techniques tackle different aspects of security. In order to enhance fault tolerance, wireless network multipath routing is typically used instead of the original single path routing. The routing protocol Genetic Algorithm with Hill climbing (GAHC) described in this article shows a hybrid GA-Hill Climbing algorithm that picks the optimal route in multipath. Prior to this in the beginning, the Improved fuzzy C-means algorithm method was built on density peak, and cluster heads (CHs) were chosen in a predicted manner, based on recent, indirect, and direct trust.

[3] Vehicle ad-hoc networks (VANETs) are a subclass of mobile ad hoc networks (MANETs). The VANETs communication framework is used to provide communication between moving vehicles in highway and urban road scenarios. Dynamic properties of VANETs, such as high dynamic topology, frequent route failure, high mobility of nodes, and bandwidth constraints, reduce the efficiency of routing. The long length route between source and destination affects the efficiency of the protocol in the form of high overhead, frequent disconnections, high packet loss rate, low packet delivery rate, and low throughput.

[4] Energy consumption always represents a challenge in the ad hoc networks which spurred the researchers to benefit from the bio-inspired algorithms and their fitness functions to evaluate nodes energy through the path discovery stage. In this paper we propose energy efficient routing protocol based on the well-known Ad Hoc On-Demand Multipath Distance Vector (AOMDV) routing protocol and a bio-inspired algorithm called Elephant Herding Optimization (EHO). In the proposed EHO-AOMDV the overall consumed energy of nodes is optimized by classifying nodes into two classes, while paths are discovered from the class of the fittest nodes with sufficient energy for transmission to reduce the probability of path failure and the increasing number of dead nodes through higher data loads.

[5] Mobile ad-hoc network is an assortment of distinct attribute-based mobile devices that are autonomous and are cooperative in establishing communication. These nodes exploit wireless links for communication that causes injection of the adversaries in the network. Therefore, detection and mitigation of adversaries and anomalies in the network are mandatory to retain its performance. To strengthen this concept, in this article, a novel secure neighbor selection technique using recurrent reward-based learning is introduced. This proposed technique inherits the benefits of conventional routing and intelligent machine learning paradigm for classifying the states of the nodes based on their communication behavior. Thorough learning of the behavior of the nodes unanimously at all the hop-levels of communication enables establishing secure and consistent routing and transmission paths to the destination.

[6] The rapid advances in the wireless communication industry have paved the way for the enhancement of wireless mobile ad-hoc networks (MANETs) to support various domains including civilian environments, emergency operations, and military affairs. Source routing in MANETs is subject to some issues such as changes in the network topology, which lead to frequent link breakages that may increase the requests of route discoveries. Thus, this

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paper aims to enhance on-demand source routing protocols by proposing two mechanisms, a zone-based route discovery mechanism (ZRDM) and a link failure prediction mechanism (LFPM).

[7] In Mobile Ad hoc Networks (MANETs), node's mobility, traffic congestion, and link quality estimation of the intermediate nodes are very crucial factors for establishing a reliable forwarding path between a source and destination node pairs. The unpredictable movement of nodes and random data traffic flow at a single node can cause congestion and network topology instability, which significantly lowers the performance of the ad hoc network. Indeed, the above-highlighted issues can be mitigated by implementing a more reliable mobility-centric, contention, and link quality-aware routing protocol for efficient data transmissions in a mobile network.

[8] The Mobile Ad-Hoc Network (MANET) incorporates a collaborative networking scenario, where dynamic host movement results in frequent topology changes. In MANET, nodes cooperate during route establishment, and the data packet must travel from source to destination through multi- hop intermediate links. The nodes in a MANET can be localized in a restricted zone, where manual intervention to set-up fixed infrastructural support is practically infeasible. However, cooperative packet forwarding and data transmission is quite a common scenario in the context of MANET. Still, due to dynamic topological changes, weak, intermittent links appear within one-hop communication. This leads to a higher possibility of packet drop events and also increases the retransmission scenario, which affects the energy performance of the network.

[9] The trust-based routing mechanisms are proposed to enhance the security of the mobile ad hoc network (MANET), which use the performance metrics of a node to evaluate the trust value of the node. However, some performance metrics are fuzzy, which are easier to be described qualitatively than to be expressed quantitatively. Therefore, the inability to quantitatively express these performance metrics leads to the inaccuracy in the calculation of the trust values of nodes. Meanwhile, some routing mechanisms add the path with the highest credibility to routing table without considering the hop counts of the route in route selection, which reduces quality of service (QoS) of the routing. Aiming at the above problems, firstly, they use cloud model to deal with the fuzziness of performance metrics. Specifically, a trust reasoning model based on cloud model and fuzzy Petri net (FPN) is presented to evaluate the credibility of nodes.

[10] In a networking scenario, energy protocols with shortest path routing mechanisms are prevalent. The challenging issue in designing the routing protocols for a mobile ad hoc network (MANET) is to have a network, which is energy efficient so as to maximize network performance. This research article proposes a novel and energy efficient shortest path routing mechanism called the energy aware on demand routing protocol. The protocol maximizes the lifetime of the MANET and provides an economically efficient routing mechanism for the packets depending on the routing condition.

[11] Mobile ad hoc networks (MANETs) are self- organized networks without any fixed infrastructure. The topology changes are very frequent in MANETs due to nodes' mobility. The topology maintenance creates an extra overhead, as the mobility information of a single node is shared with all nodes in the network. To address the topology maintenance overhead problem in MANETs, the researchers proposed different cluster-based algorithms to reduce the size of a routing table. The clusters are formed to locally adjust the topology changes within the cluster. If a node wants to communicate with a node outside the cluster, it only communicates with its cluster head (CH).

[12] This paper proposes a local flooding-based on- demand routing protocol for mobile ad hoc networks to reduce the flooding overhead and offers effective alternative paths between the source and destination nodes. The proposed protocol first uses overhearing to identify the one- hop neighbors along the shortest path between the source and destination. Then, it performs periodic local flooding initiated by the destination node, which offers the latest route information along the routing path. This technique only involves one-hop neighbors along the shortest path, with the result that the flooding overhead is significantly reduced and seamless rerouting is possible when the current routing path is either disconnected or outdated.

[13] Mobile ad hoc network (commonly called MANET) comprises a large and relatively dense population of mobile units that move in any territory, and its only means of communication is the use of wireless interfaces without using pre-existing infrastructure or centralized administration. Moreover, routing should provide a strategy for sending data at any time between a pair of nodes (i.e., source and destination) across a network. However, the main problem is to determine an optimal routing of packets across the network. The main objective of the proposed

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protocol is to find the least-cost investment in nominal capacities that ensures the routing of nominal traffic and guarantees its survivability in case of any arc or node failure.

[14] Performance and security are two critical functions of wireless ad-hoc networks (WANETs). Network security ensures the integrity, availability, and performance of WANETs. It helps to prevent critical service interruptions and increases economic productivity by keeping networks functioning properly. Since there is no centralized network management in WANETs, these networks are susceptible to packet drop attacks. In selective drop attack, the neighboring nodes are not loyal in forwarding the messages to the next node. It is critical to identify the illegitimate node, which overloads the host node and isolating them from the network is also a complicated task. In this paper, they present a resistive to selective drop attack (RSDA) scheme to provide effective security against selective drop attack.

V. CHALLENGES IN MANET ROUTING

Although the MANET network has numerous advantages such as self configuration, easy deployment, and nodes mobility. MANET has many limitations including devices is powered by portable batteries, limited bandwidth, memory, and low processing resources. Routing packets in such a highly dynamic and rapidly changing topology is the main challenge. In absence of a central control unit, a packet needs to find a reliable path throughout intermediate nodes from its source to destination. Nodes mobility as well as limited power resources resulting in link breakages and network partition problems. Hence, increasing the transmission range of nodes causes more connectivity/paths but also more power-draining, therefore a suitable balance is required. The disaster area scenario is characterized by mobility patterns of nodes, the velocity of nodes, the number of involved nodes, nodes various wireless scope in one hand. On the other hand, disaster area size, if the area has obstacles that affect transmission signal and their characteristics, type of disaster (fire, earthquake or flooding), and weather conditions, all these factors involved in routing protocol selection. A protocol that seems to work perfectly in some scenarios may not be a suitable selection for another scenario. Therefore, an area required a scenario that has to be studied and evaluated for network routing protocol choice. MANET is very flexible and provides such a high degree of consistency in the transfer of data across mobile nodes. Thanks to the low transmitting capacity of the nodes, the radio coverage of the nodes is very small. That is why communications between sender and receiver pairs will depend on forwarding to other nodes. Also, the nodes in the MANET are handheld computers with minimal resources and processing capacities. Mobile nodes may join or exit the network dynamically without any constraints. However, the mutual presence of the transmission system and the lack of resources in the MANET play it more challenging for an attacker to work in different types of offensive attacks and more likely to refuse participation. However, since the behavior of the node's changes over time and the environment, these features allow the node part to be careful while communicating or engaging with other nodes. This is also evident that there is an essential need to fix the security issue.

VI. BIO-INSPIRED ALGORITHM IN MANETS

Simple and Heuristic Rules Increase Bandwidth Utilization: Bio-inspired algorithms evolve to achieve a given purpose and obtain an optimal result by following a set of simple and heuristic rules for operation without the aid of a central coordinator. These decentralized approaches can decrease the complexity of resource allocation; signaling overhead can also be reduced. Thus, bio-inspired resource allocation algorithms increase bandwidth utilization by reducing signaling overhead in MANETs [29].

Convergence Ensures Fairness: In some bio-inspired algorithms, each entity modifies its own event-generating behavior through mutual interactions. By repeating this procedure, the target metric for all nodes converge. This property of these algorithms ensures fair resource allocation in MANETs even when the network topology changes dynamically.

Self-Organization Ensures Scalability: Bio-inspired algorithms are modeled on the principles of living things that maintain ecosystems through autonomous and independent behavior. Self-organization technology is designed to achieve self-planning, self-configuration, self-management, self- optimization, and self-healing. In MANETs, this self-organization allows MNs to optimally plan and allocate available resources, and to autonomously manage and heal the network, which means that bio-inspired resource allocation algorithms ensure scalability.

Selecting the Good Fitness Value Would Improve QoS: In bio-inspired algorithms, each entity adjusts its behaviors (i.e., phase adjustment, finding routes to food, flying direction adjustment, and gene selection) by selecting the one with

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the best fitness value. Good choices probably have similar or better results, and, after a number of selections, the results will be good enough to solve the problem. In MANETs, this process allows the MN to select the optimal resources with shorter delay, lower cost, and less interference as much as possible. Gaining the Most Benefit with Minimum Cost Would Increase Energy Efficiency: In bio-inspired algorithms, each entity tries to gain the maximum benefit at the minimum cost in order to achieve its goal. In MANETs, this characteristic allows MNs to occupy resources efficiently with low signaling overhead and complexity, so energy efficiency can be increased.

VII. TRUST BASED MECHANISM

In order to enhance the security of MANET, it is necessary to establish a trust-based routing mechanism [9]. This kind of routing mechanism includes two aspects: trust model and trust-based routing protocol. A malicious attack has its special behavior model, which can be used to identify malicious nodes. On this basis, a trust model is proposed to collect trust factors, which can reflect the behavior and motivation of nodes. The trust model allows nodes to evaluate the credibility of other nodes in the network, so as to find out the malicious nodes which are not allowed to participate in routing operations. Traditional routing protocols select routes with the shortest-path or minimum hop counts, while trust-based routing protocols aim to establish the most trusted routes. Trust-based routing mechanisms use the performance metrics of a node to evaluate the credibility of the node. However, some performance metrics are fuzzy and random, they are easier to be described qualitatively than to be expressed quantitatively. Specifically, for the trust model based on FPN, we need to collect the truth degree of a series of conditional propositions of the node to calculate the credibility of the node, as shown in Section IV.B. One of the conditional propositions is that the routing operations of the node is normal. We need to judge whether the routing operation of the node is normal according to the number of TC messages sent by the node, and then calculate the truth degree of this proposition. In particular, in order to calculate the truth of this proposition, we tried to set a threshold in the FPN model. We assume that if the number of normal TC messages sent by the node is higher than the threshold, then the routing operation of the node is completely normal, thus the truth degree of the proposition is set to 1. And if the number of normal TC messages sent by the node is lower than the threshold, then the routing operation of the node is completely abnormal, thus the truth degree of the proposition is set to 0. However, we found that when the number of normal TC messages sent by some nodes was lower than the threshold, the routing operation of these nodes was normal. This is because the increase of malicious nodes leads to network congestion, which leads to the loss of TC messages sent by the nodes. In this case, we cannot think that the routing operation of these nodes is completely abnormal. A better expression is to indicate the performance of routing operation of the node according to the number of TC messages sent by the node in a given period as shown in Section IV.C, that is, the performance of routing operation of the node is very poor, poor, good, very good, etc. But in order to calculate the truth degree of this proposition, we need to transform this qualitative description into a quantitative expression. The cloud model can implement the uncertain transformation between a qualitative concept and its quantitative instantiations. Thus in order to make the representation parameters more reliable, we choose the cloud model to synthetically describe the fuzziness of concepts. Besides, some trust mechanisms in MANET add the path with the highest credibility to the routing table. Since the hop counts of route is not taken into account, the route with large hop counts is generated, which reduces the QoS of the routing [9]. Providing secure routing in WSN becomes a challenging task, hence many research works have been presented. Still, there is a vacuum for research in the routing protocol for WSN.

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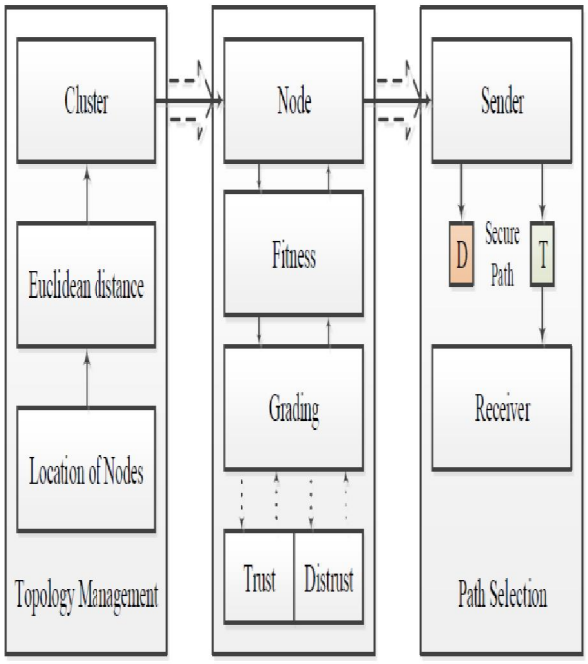

Figure 3: Architecture of trust/distrust protocol [7].

VIII. CONCLUSION

In the recent years, the evolution of wireless communication technologies and the emergence of mobile devices (laptops, smart phones, etc.), made the access of these devices to the network possible anywhere and anytime without connecting the communicating devices to an infrastructure. Mobile ad-hoc network offers a unique art of network formation and can be established in the absence of any fixed infrastructure. Mobile ad-hoc network is deployed in various numbers of applications such as disaster recovery, traffic control, and security and distributed collaborative computing, where routes are mostly multi-hop and network hosts communicate via packet radios. In this paper we present the literature work for mobile ad-hoc network using different technique in different applications with find some issues and challenges, in future we try to solve these issue using some bio-inspired based optimization technique.

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