A STUDY OF DESIGN & IMPLEMENTATION OF ENERGY EFFICIENT ROUTING IN MANET

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Abstract: *Mobile Ad Hoc Networks (MANETs) also called mesh networks are self-configuring networks of mobile devices connected by wireless links. MANETs are deployed in situations where there is no existing infrastructure, such as emergency search and rescue, military, etc. Each application has a different set of requirements. In this work we concentrate on emergency search and rescue operations which rely heavily on the availability of the network. The availability is a direct cost of the overall network lifetime, i.e., energy of the nodes. Ad Hoc wireless networks are different from traditional cellular networks which have many striking features for effective communication that are much absent in ad hoc wireless networks. The basic objective of effective communication is to pass the information from source to destination with the view on energy consumption, reliability, security, cost factor and so on. The propose EER mechanism enhances intelligence to mobile nodes and creates and fires fuzzy rules to develop a new route during the discovery phase. By taking into account, nodal energy and current queue status, our mechanism applies fuzzy based rules to develop the route which provides higher life longevity and improves network performance significantly.*

Keywords: Energy Efficient, Routing, MANET, Mobile Ad Hoc Networks, MANETs, Ad Hoc Wireless Networks

Introduction

Wireless Mobile Ad Hoc Networks (MANETs) have emerged as an advanced networking concept based on collaborative efforts among numerous self-organized wireless devices. MANET is a network where no fixed infrastructure exists. Such networks are expected to play vital role in future civilian and military settings, being useful to provide communication support where no fixed infrastructure exists or the deployment of a fixed infrastructure is not economically profitable and movement of communicating parties is possible. The topology of MANETs is dynamic, because the link among the nodes may vary with time due to device mobility, new device arrivals, and the possibility of having mobile devices. The routing

protocol design must take into account the physical limitations and constraints imposed through the ad hoc atmosphere in order that the ensuing routing protocol does now not degrade process performances. Due to the fact that in MANET, there is no constant-infrastructure akin to base stations, cellular gadgets must function as routers with a view to maintain the know-how about the community connectivity, for that reason the traditional routing protocols are not able to be supported effectively by way of ad hoc networks.

Several research experiences have been launched to be trained this hassle, these defined with the aid of the IETF MANET group can be classified into two classes: proactive protocols and reactive protocols. MANET's technology offers each new challenges and possibilities for many functions. The major challenges for ad hoc technology is cozy and efficient routing, due basically to MANET aspects (e.g., open medium, lack of centralized administration, nodes mobility). A couple of techniques had been proposed to secure ad hoc routing. Some present options in Wireless networks hire mechanisms used to guard routing protocols in wired networks that are centered on the presence of a centralized infrastructure. These options aren't correct for a decentralized ad hoc community. In mobile advert hoc networks, neighbor discovery is the procedure through which a node in a community determines the whole number and identification of different nodes in its vicinity.

The field of networks and telecommunications is one of the key areas of Information Technologies (IT). This area has evolved in recent years to meet the needs of human. The networks are used as a tool for work or leisure. With the adoption of wireless technologies, new uses and perspectives have emerged. The wired interface has given way to wireless technologies to lead more flexible and less restrictive communication. This new technology has spawned a new environment called mobile environment, which allows the units of network a free mobility. To improve mobility, mesh topology is desirable. This topology allows wireless devices to connect from one to other in a dynamic and instantaneous way without a central hierarchy. The latter presents several profits in the implementation of wireless networks such as the significant cost reduction, the simple and easy installation, the robustness of infrastructure and above all a total elimination of the concept of cabling.

Nowadays, mesh-based wireless networks implement a routing protocol dedicated for a single path, borrowed from wire line networks. A routing protocol is a route selection policy between each pair of nodes in the network.

The function routing protocol can be devised in three different steps. The first step is a discovery neighboring nodes, the second step is a calculation metric and the third one is a calculation of optimum itineraries. To do this, several routing protocols have been implemented with mesh architecture such as OLSR (Optimized Link State Routing protocol), Mobile Mesh Routing Protocol (MMRP), and OSPF (Open Shortest Path First). These traditional and classical routing protocols do not benefit from the nature of wireless network broadcasting and require high performances of connected machines, giving rise to a new generation of routing protocols named opportunistic routing protocols.

Transport of data through mobile ad hoc network (MANET) is possible thanks to routing protocols, such as proactive, reactive, or their combination. When the mobile nodes have high mobility and/or the network is very sparse, MANET can be fragmented on many subnetworks (islands). It is impossible to find END-TO-END connection (path between source, S, and destination, D) or maintenance of this path during overall relation. Using of standard MANET routing protocol became ineffective or impossible in those situations [3]. However, mobility of nodes represents a big advantage in cases when the data are transported through a MANET controlled by Opportunistic Routing protocols. On the other site, data delivery delay is increasing. This type of the network is called Delay-Tolerant Network (DTN) .

REVIEW OF LITERATURE

Kang, M.W.; Chung, Y.W. (2020) Hybrid protocols combining a mobile ad hoc network (MANET) and a delay tolerant network (DTN) have recently been proposed. In these works, a whole network is fragmented, and MANET is generally used for intra-fragment communication, while DTN is used for inter-fragment communication. In this paper, an improved hybrid routing protocol was proposed, wherein virtual source nodes are selected based on the delivery predictability to the destination node if routing path to the destination node is not successfully established using MANET protocol. Then, messages are delivered to the destination node from the original source node and selected virtual source nodes. Performance evaluation results show that the proposed protocol with appropriate selection of delivery predictability threshold values has a better delivery ratio than conventional protocol, at the expense of overhead ratio in the considered parameter setting.

Mohamed OuwaisKabaou& Hassen Hamouda (2020) Current wireless networks are based on unicast routing protocol derived from wired networks. The purpose of this paper is to implement and to evaluate opportunistic routing protocols in new generation's wireless network. This is a comparative study between two opportunistic protocols, which are extremely opportunistic routing protocol and simple opportunistic adaptive routing protocol. The main goal of this survey is to show the benefits required by using opportunistic approach to optimize the new generation's wireless networks operations and implemented the most used protocols under MATLAB framework.

P. Sathyaraj (2020) the problem of routing in Manet is analyzed and different techniques are described towards QoS development of Manet. However, the modern IoT devices have been considered for the support of routing. Engaging IoT devices in Manet routing is considered and how the trust of IoT devices can measured is focused. Number of techniques discussed earlier with secure routing with IoT devices in Manet. They suffer to achieve higher performance in most QoS parameters. This paper proposes a real time secure route analysis (RSRA) approach for the secure routing in Manet. The method not only considers the strategy of intermediate nodes of route discovered, but also considers the presence of IoT devices and their trust. First, the method discovers the list of routes between any source and destination. For each mobile node, the trustworthy is verified by considering the location, mobility speed, energy, and number of transmission involved, their neighbor list and so on. The IoT devices are verified for their trustworthy based on their earlier support contributed to the network. The method measures mobile node secure route support (MSRS) for the mobile nodes where device support (DS) is measured for the IoT devices. Using these two measures, the method measure the data forwarding support (DFS) value by considering the number of IoT devices in the route. Based on the DFS measure, a single route has been selected which improves the QoS of Manet.

NeenavathVeeraiah (2020) Mobile ad-hoc network (MANET) is dynamic in nature that is susceptible to energy and security constraints. Among most of the existing techniques, energy optimization was a hectic challenge, which is addressed effectively using the routing protocols. Accordingly, this paper proposes an effective multipath routing protocol in MANET based on an optimization algorithm. The energy and the security crisis in the MANET are addressed effectively using the cluster head (CH) selection and intrusion detection strategies namely, fuzzy clustering and fuzzy Naive Bayes (fuzzy NB). Then, the

multipath routing progresses using the secure nodes based on the routing protocol, Bird swarm-whale optimization algorithm (BSWOA), which is the integration of bird swarm optimization (BSA) in whale optimization algorithm (WOA). The selection of the optimal routes is based on fitness factors, such as connectivity, energy, trust, and throughput. The analysis of the methods is done using the attacks, such as flooding, blackhole, and selective packet drop based on the performance metrics. The proposed BSWOA acquired the maximal energy, throughput, detection rate, and a minimal delay of 9.48 Joule, 0.676 bps, 69.9%, and 0.00372 ms in the presence of the attack.

Madni, M.A.A.; Iranmanesh, S.; Raad,(2020) CubeSats, which are limited by size and mass, have limited functionality. These miniaturised satellites suffer from a low power budget, short radio range, low transmission speeds, and limited data storage capacity. Regardless of these limitations, CubeSats have been deployed to carry out many research missions, such as gravity mapping and the tracking of forest fires. One method of increasing their functionality and reducing their limitations is to form CubeSat networks, or swarms, where many CubeSats work together to carry out a mission. Nevertheless, the network might have intermittent connectivity and, accordingly, data communication becomes challenging in such a disjointed network where there is no contemporaneous path between source and destination due to satellites' mobility pattern and given the limitations of range. In this survey, various inter-satellite routing protocols that are Delay Tolerant (DTN) and Non Delay Tolerant (Non-DTN) are considered. DTN routing protocols are considered for the scenarios where the network is disjointed with no contemporaneous path between a source and a destination. We qualitatively compare all of the above routing protocols to highlight the positive and negative points under different network constraints. We conclude that the performance of routing protocols used in aerospace communications is highly dependent on the evolving topology of the network over time.

O. S. Oubbati, M. Atiquzzaman, P. Lorenz, M. H. Tareque and M. S. Hossain (2019) Owing to the explosive expansion of wireless communication and networking technologies, cost-effective unmanned aerial vehicles (UAVs) have recently emerged and soon they will occupy the major part of our sky. UAVs can be exploited to efficiently accomplish complex missions when cooperatively organized as an ad hoc network, thus creating the well-known flying ad hoc networks (FANETs). The establishment of such networks is not feasible without deploying an efficient networking model allowing a reliable exchange of information

between UAVs. FANET inherits common features and characteristics from mobile ad hoc networks (MANETs) and their sub-classes, such as vehicular ad hoc networks (VANETs) and wireless sensor networks (WSNs). Unfortunately, UAVs are often deployed in the sky adopting a mobility model dictated by the nature of missions that they are expected to handle, and therefore, differentiate themselves from any traditional networks. Moreover, several flying constraints and the highly dynamic topology of FANETs make the design of routing protocols a complicated task. In this paper, a comprehensive survey is presented covering the architecture, the constraints, the mobility models, the routing techniques, and the simulation tools dedicated to FANETs.

ENERGY EFFICIENT ROUTING FOR EFFECTIVE COMMUNICATION IN MANET

Mobile ad hoc networks are taking account of resource poor devices, inadequate bandwidth, and high error rates and continuously changing topology. Beside all the resources, battery power is the most crucial resource factor. Hence we must deliberately think about the following aspects when designing a routing protocol as smallest processing overhead, nominal control overhead, dynamic adaptability on topology maintenance, loop deterrence, multi-hop routing aptitude and also keeping an eye over node's state whether in active state or inactive state of communication.

The conventional routing techniques and path finding metrics can't be used in MANET that leads to give a lot of opportunities in research fields. The major classifications of routing protocols based on energy efficient routing for effective communication are proactive or table-driven routing protocols, reactive or on-demand routing protocols and hybrid routing protocols. And it may be classified under routing information update mechanism due to a lot of information sharing between various nodes in the network.

- ***Proactive Approaches***

The proactive approaches in mobile ad hoc network are developed from the influences of conventional principles followed in wired networks. The primary design goal of proactive method is that each node in the network keeps up all relevant information from time to time and provides a route to all remaining nodes in the network at all times. The strategy to implement on route choice and preservation criteria is being carried out by periodic updating scheme which is characterized to switch over routing information among all other nodes and

upholding timing mechanism to avoid bewilderments. The updates take place at particular intervals, not caring about movement of the nodes and traffic conditions of the network. Proactive approaches possess some pros that whenever we want a route that route is immediately provided which is possible only if each node in the network should always maintain current status about all relevant things without any delay and fail. Moreover it is well performed if the network working area is strictly confined. The demerits of proactive approaches are the fast movement of nodes and traffic burden that should be a huge botheration if the size of the network is large. And routing strategy is going to be complicated whenever nodes in the network are increased. As for security, quality of services and other factors significant to effective communication, proactive approaches can command well over those issues.

- ***Reactive Approaches***

Reactive routing approaches in another name called as on-demand routing is different from proactive routing approach. They don't regularly maintain network topology information at all times. In On-demand routing approach, routing are discovered only whenever it demands by using connection establishment scheme in the network. So, in this routing approach it isn't necessary to periodically update or exchange routing messages to all the nodes. Route discovery and Route maintenance are two essential procedures in reactive approaching method. In mobile ad hoc network, however link connection isn't stable and it is continuously changing as a result control overhead would become more cost. These things can well be maneuvered by On-demand routing. When a node necessarily wants to forward data packets to some node, the sending node verifies its routing information updates to make a decision whether it is a convenient route with respect to all manners. If any such root is not able to be found out, it undergoes a route discovery process to locate a fair path to the destination or receiving node. So, route discovery process is demanded. If considering a situation in which there is no chance to be having communication between two nodes, it is not obligatory to maintain routing information updates among those kinds of nodes. The route discovery process has naturally had bias to spread out of a request message all over the network. And optimization techniques can be adapted to minimize overhead substantially. The ultimate benefit of reactive approach compared with proactive approach is reducing overhead and demerit is route acquisition latency which has had lack of execution a path when it is demanded by the source node. Ad hoc On Demand Distance Vector routing protocol (AODV), Location-Aided Routing (LAR), Temporally Ordered Routing Algorithm (TORA),

Associativity Based Routing (ABR) and Dynamic Source Routing protocol (DSR), are some of the examples of reactive routing approach.

- ***Hybrid Approaches***

In hybrid routing approach, it blends well the highlighted attributes of reactive and proactive routing approaches that have opposite contrast in overhead and latency. So, we need a good trade- off between these two approaches. Hybrid routing exactly does this job and it is much appropriate for huge network. However merging best features of reactive and proactive approaches and produce effective routing design in hybrid domain is never an easy job that is obviously too complex. And, working only with single routing protocol is not enough for increasing applications in mobile ad hoc networks used at various environments. In hybrid approach, proactive mechanism is utilized to cover confined region that may be defined based on our requirements and reactive mechanism is utilized beyond that region. Frankly saying, zone routing scheme is well suited for hybrid routing approach. Generally, multipath routing is favoured for hybrid approaches for effective communication and has the tendency to adapt heterogeneous type of environment. Core Extraction Distributed Ad hoc Routing (CEDAR), Zone Routing Protocol (ZRP), Zone based Hierarchical Link State routing protocol (ZHLS) are some of the examples of hybrid route approach.

ENERGY EFFICIENT ROUTING MECHANISM FOR MOBILE AD HOC NETWORKS

I. Ad hoc On-demand Distance Vector

AODV is a reactive routing protocol instead of proactive. It minimizes the number of broadcasts by creating routes based on demand, which is not the case for DSDV. The Ad hoc On-Demand Distance Vector (AODV) routing protocol offers an ability of quick adaption to dynamic link conditions, low processing and memory overhead, low network utilization and determines unicast routes to destinations within the ad-hoc network. It uses destination sequence numbers to ensure the elimination of loops, and consequently the counting to infinity problem, at all times, thus avoiding related problems associated with classical distance vector protocols. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet.

The neighbouring nodes in turn broadcast the packet to their neighbours and the process continues until the packet reaches the destination. During the process of forwarding the route request, intermediate nodes record the address of the neighbour from which the first copy of the broadcast packet is received. This record is stored in their route tables, which helps for establishing a reverse path. If additional copies of the same RREQ are later received, these packets are discarded. The reply is sent using the reverse path. For route maintenance, when a source node moves, it can reinitiate a r oute discovery process. If any intermediate node moves within a particular route, the neighbour of the drifted node can detect the link failure and sends a link failure notification to its upstream neighbour. This process continues until the failure notification reaches the source node. Based on the received information, the source might decide to reinitiate the route discovery phase.

Energy management in MANETs is the basis on which routing protocols are improved to attain energy efficiency. The choice of the routing protocol affects each of the dimensions along which energy is consumed, such as transmission, battery, device and processor energy. These dimensions are discussed in detail in the remainder of the section. Along with these schemes there is also a description of the energy cost metrics which measure the amount of energy saved by using different path selection schemes.

II. Fuzzy Logic

As mentioned earlier, EER introduces fuzzy based rules and the nodes in the network apply these rules during the route discovery process. A brief description of fuzzy logic is described in this section. Fuzzy logic was proposed by L.A. Zadeh for realize control system where the real world problems cannot express by mathematical models in an efficient way. In traditional crisp set theory an object x in a set A is either true (1) or false (0). According to fuzzy logic, if x is a member of A then, it may give some degree that has a value in [0, 1]. A fuzzy set A in a universe of discourse U is characterized by a membership function expressed using membership function as follows:

$\mu_{Æ}$: U ‹ [0,1] (1)

In fuzzy logic, each object x can be labeled by a linguistic variable and a fuzzy set is defined as a linguistic terms i.e. a word such as low, medium, high, etc. The main component of a fuzzy logic is the Fuzzy Control Logic (FLC) shown in figure 3.2. Fuzzy Logic Controllers (FLCs) contains a fuzzy rule base consists of fuzzy rules of the form:

IF (*a set of conditions are satisfied*)

THEN (*a set of consequences can be inferred*)

The IF part of the fuzzy rule, implies a set of evidences and the THEN part, implies the corresponding consequence or output. Let consider for two mobile nodes of a link of an active route. If the mobility of two mobile nodes is very high, then link will exist for shorter period of time. So a fuzzy rule can be defined to determine whether the link is exists or not as follows.

IF (*The velocity of the two nodes is high*)

AND (*They moves in opposite direction*)

THEN (*The link lifetime is shorter*).

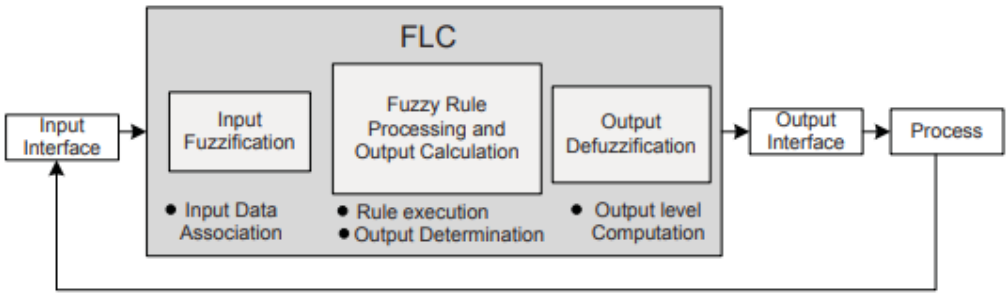

Figure 1: Operations of Fuzzy Logic Controller

A FLC the following performs three basic operations as follows:

- Fuzzification
- Fuzzy processing
- Defuzzification

Fuzzification is the process of translate the real world input data into fuzzy input form, that can understand by the FLC. The *Fuzzy processing* involves the evaluation of the input information by executing the rules stored in fuzzy rule base that has an *IF...THEN* forms. Once FLC completes rules processing, *defuzzification* is started. Finally the fuzzy control logic converts the output into real world output data.

III. Network Model and Assumption

In a MANET network, nodes lifetime is mainly depends on their battery energy. Since size of the nodes is small so the network lifetime entirely depends on individual battery energy. For this reason, the routing protocol should operate in efficient way so that, it ensures higher longevity of the overall network.

In our propose mechanism, EER considers a highly deploy-able mobile nodes connected with each other via intermediate nodes. For simulation purpose, we also assume that all the nodes of the network have equal energy level. Based on packet transmission, nodes will consume their energy. For comparing the performance of our mechanism, we modify AODV, one of the widely used on demand routing protocol.

CONCLUSION

In MANETs, based upon the energy efficient mechanism the opportunistic protocols will be used. This research will use the cooperative behavior of the nodes to improve the performance of the opportunistic routing with energy efficiency. Another protocol which is called EMORP will be proposed for optimizing the multicast routing in MANETS. The source node can transmit the data packet with reference to the multicast group ID. The intermediate multicast forwarder node will also be selected based on the energy factors. The performance will be calculated based on different network parameters. The proposed method will be compared with the existing MAODV and thus obtained the expected results. Security is the main concern for the implementation of this work in the packet communication. It is also possible to implement trust-based mechanism among the nodes in the quadrants to achieve the better results. In this work, it could be extended to include a few more possible research directions will introduce enhancement of energy efficient routing algorithm based on AODV by considering physical layer reliability of the communication link between two nodes involved in the path. The proposed method aimed at reducing the amount of time that packet spends in the buffers. Simulation studies reveal that the proposed routing approaches outperforms the existing methods.

Energy optimization in MANETs is tedious tasks as the energy of the nodes is limited whereas communication relies upon the available battery power. The proposed ACO-FDR PSO is a hybrid optimization approach that considers energy as its fitness function. Through

the hybrid approach, ACO selects energy efficient path based on available energy and FDRPSO optimizes energy consumed by each nodes. Duty cycle algorithm helps in increasing the lifetime of nodes by swapping nodes between active and idle states.

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