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Routing Techniques Study for D2D in Manet Based Environment: A Survey and Open Issues

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ABSTRACT

Over the years, Mobile Ad-hoc Networks(MANETs) has gained attention in a wide range of applications such as disaster recovery, traffic control, military, and smart cities. In MANET, independent node mobility can cause frequent changes in network configuration. High Quality-of-Service demands with end-user experience are increasing day-by-day. However, due to the dynamic nature of nodes, MANET suffers from challenges to supply a QoS. The Wireless network can provide the best services for delay-sensitive communications by establishing direct communication between nodes. Two devices reuse the spectrum band to form D2D pairs. Such D2D communications provide access to services even when the cellular network is overloaded or dysfunctional due to disaster or emergency crises. D2D is a single-hop communication so it is decisive to find a method to transmit via arbitrarily assembled network even for longer distances.

Therefore, in this paper, we present a study for QoS based routing protocols for D2D communication in Mobile Ad-hoc Networks where various schemes have been used for path selection and provide quality delivery of packets. We also suggest an approach to perform a QoS routing in terms of some metrics and address an optimization technique that can rise up to the challenge of Quality of Service constraints.

Keywords—*Routing algorithms, Optimization, D2D communications, MANET.*

I. INTRODUCTION

For wire or wireless networks, routing is an important function. Yet, designing routing algorithms in wireless networks is a major challenge as it has to deal with the mobility of nodes within the system as well as being designed to minimize communication overhead. Data communication in Mobile Ad-hoc Networks (MANETs) differs from that of wired networks in different aspects. The wireless communication medium does not have a foreseeable behavior as in a wired channel, On the contrary, the wireless communication medium has variable and unpredictable characteristics (1). Because of their special features, Mobile Ad-hoc Networks (MANETs) are involved in many applications for both

civilian and military usage. Such an infrastructure-less network is considered with less cost as a comparison to other traditional ones.

Mobile ad hoc network (MANETs) is a self-configured and infrastructure-free network based on ad-hoc communications. The routing in mobile ad hoc networks is very challenging due to the frequent updates for changes in topologies, and active routes may be disconnected as mobile nodes move from one place to another (2). Therefore, wireless nodes function as a host and as a router to keep the internal communications alive. Therefore, each node participates in the routing process in order to forward a packet to the destination node. As nodes are arbitrarily deployed and randomly organize themselves, Direct communications between nodes occur if they are within the range of radio transmission. Otherwise, multi-hop network communication is initiated via intermediate nodes to forward packets. Mobility and resource constraints are basic features in MANETs. It also has a lower bandwidth than that for a wired network. Since it operates on batteries; the implementation of routing protocol must be energy efficient to maximize the life span of the nodes and network by extension. The routing protocol delivering the data must be able to adapt to these changes by continually monitoring the link qualities and then route the data accordingly (3).

Ad Hoc mobile nodes can increase the capacity range, improve the system coverage, and reduce the transmission power at the same time. while the spectrum sharing mechanism allows D2D users to transmit data via alternative radio connection and keep the interference level within the required ranges can result in significant power saving. Based on mentioned facts, direct D2D communication is expected to be the main driver for future communication between devices.

the concept of D2D communications has been introduced to allow local peer-to-peer transmission among mobile devices (4) by direct communication without the need for infrastructure (access points or base stations). D2D communications will be the main feature supported by future wireless communications networks. Communication in the licensed spectrum bands is more controllable for communication operators than that in the unlicensed spectrum. By reusing cellular spectrum resources, D2D communications can improve the spectrum efficiency and thus contribute to a relatively high system capacity (3). D2D communications enhance energy efficiency and spectrum utilization that's why it's useful in dense networks. It presents a short-range direct mobile to mobile communication without the involvement of the network infrastructure.

From an architectural perspective, D2D communications are similar to mobile ad-hoc networks (MANETs). They offer similar features and characteristics, however, the main distinction is that D2D is driven by the cellular network and expected to be controlled by a central entity. The presence of central entity management in D2D communications relieve the existing challenges of MANET, such as available spectrum detection, synchronization, and collision avoidance. Moreover, D2D communication is operating mainly in single-hop communications, hence, it does not inherit the multi-hop routing problem that is distinct in ad-hoc networks. D2D has an advantage over MANETs in their effective capability to be more controllable and scalable in large networks. D2D users can operate autonomously only if the cellular infrastructure is unavailable.

The main goal of our research is to propose a D2D routing algorithm that can establish an efficient route between nodes in the network so data can be delivered according to the expected QoS requirements. The idea of a device to device (D2D) communications is to increase the capacity of cellular networks, where D2D pairs communicate directly without referencing the base station and it also uses the same frequency band.

A route discovery will be performed and the path selection process will be optimized according to specific metrics and design constraints. The performance of an ad hoc network routing protocol depends on the communication between entities in the neighborhood.

The rest of this paper is arranged as follows. In section II we reviewed the state of the art of related topics. The problem statement is described in section III. In section IV we state the proposed solution details. Finally, the expected conclusion provided by this method is discussed in section V.

II. STATE OF THE ART

Over the research work so far, the authors conducted different issues in routing methods and protocols. New technologies and techniques have been addressed in the previous work.

In (5), the authors focused on MANET routing protocols by utilizing D2D communication when cellular network connection falls down. The selected MANET routing protocols were described and verified their suitability using NS-3. The authors addressed the question of direct communication between end devices in case of restricted connectivity to the cellular network due to disasters or emergency situations. Simulations were performed using two MANET routing protocols (AODV and DSDV) to route data traffic between end devices. Results confirmed that the propagation latency of both routing protocols was several tens of milliseconds at maximum. The overall delay in the combined scenario of D2D and LTE connection to a remote host on the Internet was up to 450 ms for DSDV and 83 ms AODV protocol both measured in 20 nodes. AODV protocol with less required hops was considered a suitable candidate for the D2D emergency system and using MANET routing protocols in case of malfunctioning cellular network/ infrastructure was a promising approach. The obtained results gave a rough idea of MANET routing protocols and their possible implementations as enablers for direct D2D communication.

In (6), the authors introduced a novel method of QoS routing in MANETs using Emergent Intelligence (EI). The EI is an intelligent group derived from a periodic interaction of a group of agents and nodes. MANET was logically divided into clusters by a static agent that's centrally located, and a mobile agent was deployed in each cluster. Mobile agent deal with nodes, neighboring mobile agents as well as a static agent that is responsible for collecting quality resource information (bandwidth, delay, packet loss rate, and cost) and selecting trusted reliable nodes to find an optimal QoS route. Analyzed simulation results showed that the proposed method quickly found the feasible QoS paths from the source node to the destination. Finally, results showed improvement in the service quality in MANET including an end to end delay, packet loss.

In (7), the researchers evaluated the performance of QoS in MANET and satisfied its constraint in the Ad-hoc On-Demand Distance Vector (AODV) protocol by enhancing the conventional Cuckoo Search algorithm (CS). The algorithm chose QoS path based on the best fitness value calculated Route Replay packet (RRPLY) instead of the shortest path. The fitness value was determined using three parameters (routing load, residual energy, and hop count). The algorithm was applied during the route discovery process protocol where multiple routes were available. The Cuckoo Search Optimization AODV (CSOAODV) protocol satisfied QoS routing parameters and constraints. The results were compared with Ant Colony Optimization, Particle Swarm Optimization, and basic AODV protocol and analyzed in terms of mobility, scalability, and congestion. Network simulation results were superior and effective as compared to other algorithms and could provide stringent QoS to numerous applications.

In (8), the authors suggested an energy-efficient multiple-path routing protocol for MANET and enhanced QoS and QoE metrics (EMRP-QQ) to minimize the data loss. An energy-efficient clustering was introduced using particle swarm optimization (PSO) and fuzzy optimization approach to calculate the next node with specifications (low mobility, packet loss ratio, routing cost, delay, energy consumption, and high throughput). The energy consumption of the introduced routing protocol was very low as compared to other energy-aware routing protocols. NS-2 simulation results showed that the proposed algorithm had better performance as compared to the FQ-MP-OLSR approach in terms of nodes' reduced energy consumption without affecting QoS and QoE.

In (9), the authors introduced a network graph preprocessing approach to managing the multicast routing issue in MANETs. They provided traffic engineering and energy efficiency enhancement by QoS provisioning. A prioritized admission control (PAC) scheme was implemented to formulate Device to Device communications into a cellular network to overcome MANET limitations. It enhanced the network performance by offloading cellular traffic onto the D2D scheme. Simulation performed for throughput, slot utilization, and energy efficiency and showed that the proposed system had enhanced

QoS multicast routing performance in MANETs, improved user's battery life, and overall energy efficiency of the network.

In (10), the researchers focused on D2D communications disaster response to extend the base stations coverage where disaster response is a modern cellular network main building blocks. They also used controller-assisted routing to increase the total end-to-end throughput to maximum using ant colony optimization. They evaluated route flows from the D2D users in a dead spot to active base stations serving as gateways. The proposed routing scheme outperforms shortest-path based routing schemes in terms of total throughput and fairness in flow rates allocation.

In (11), the authors formulated a quality of experience aware routing (QoE) over wireless multihop networks for SVC under time-constraints. They formulated mixed-integer linear programming and showed to be NP-hard in order to maximize the total MOS under time-constraints. They proposed a heuristic algorithm to speed up the procedure of finding solutions. where the multi-commodity network flows model described network flows. Results of simulation showed that the proposed method provided the optimal solution of the same video quality with less calculation time.

In (12), the writers enhanced the capacity of traffic offloading for cellular-assisted D2D relays. They introduced a unified model for D2D communication that supported three D2D communication modes (direct D2D mode, relay-assisted D2D mode, and local route mode). They designed a radio protocol architecture for the three D2D modes and suggested an algorithm for eNB scheduling. The scheduling algorithm was designed for an eNB to jointly perform communication mode selection, allocation of radio resource, and power coordination for all D2D-pairs in each sub-frame. The design was validated and results showed a significant improvement in traffic offloading capacity of D2D-capable UEs in LTE-A systems.

In (13), the authors utilized the OLSR routing algorithm to build a multi-hop D2D communications platform based on smartphones to expand the single-hop D2D scenarios. They performed experiments to measure performances of energy consumption, coverage, network latency, and link quality. Results highlighted the importance of multihop to D2D communications where a multi-hop showed better performances in terms of delay and delivery rate as compared to a single-hop for long-distance communications. Their experiment results provided a valuable reference to multi-hop D2D communications regarding mobile data offloading.

In (14), the researchers produced a secure adjacent position trust verification model and extended the standard ad hoc on-demand multipath distance vector protocol (AOMDV). They proposed a mesh-based multipath routing algorithm to discover all possible secured paths using the trust verification protocol. Dolphin Echolocation Algorithm was used to optimize the link path for efficient communication in MANET. Results analysis showed that the proposed routing protocol performs better in packet delivery rate, packet delay, and overhead reduction and provided security against attacks.

In (15), the authors proposed a hybrid model for D2D communications assisted by mobile operators for the LTE network. They used a D2D direct discovery stage and an optimized communication for proximity services. They introduced a D2D long term operator-assisted technique based on a trusted method for a Direct device to device discovery over E-UTRA. The operator authenticated and authorized D2D users and optimized signaling for D2D communication was proposed using a specified procedure to apply a per service QoS.

In (16), the writers introduced a cross-layer routing method to improve the main routing protocols. They have added decision measures to all the network layers using a fuzzy-based technique with QoS and QoE guarantees, mobility indicators and energy values. They have evaluated the proposed system in a network simulator to show its energy awareness, maximized the lifetime of the network and provided a better quality for the network. The fuzzy based technique improved the operation of mobile networks by using an intelligent decision engine.

In (17), the authors introduced a reliability-aware variant of AODV by conferring stability to routes. The selected routes are restricted with end-to-end delay and bandwidth variables to supply the QoS application layer. They also enhanced the reliability speed of intermediate nodes so that when the node moved slowly, route speed stability is not obstructed otherwise node had to adjust its

neighboring nodes to operate on its behalf as a part of the routing plan. Simulation has been executed on AODV, MAODV (Modified-AODV with end-to-end delay and bandwidth considered) and RA-AODV (Reliability AODV) and results were sorted and graphically presented for Packet Delivery Ratio, Throughput and End-to-End Delay regarding Mobility.

In (18), the authors suggested a QoS aware routing metric for reliable forwarding node using Link Stability cost Function (LSF). A multicast route mesh between a multicast source node and destination node has been established using nodes with a maximum LSF. The authors took median contention count as a basis for determination of link stability and the method depended on optimum contention count that was estimated based on the received signal strength. The suggested protocol performed the following steps: calculated the Link Stability Factor and determined the maximum LSF value then pruned the adjacent nodes to create a mesh consisting of more stable forwarding nodes and a mobile network where no node remains isolated and faced less contention. The suggested protocol was manifested on existing mesh-based Multicast routing protocols, ODMRP and simulated on Exata/Cyber simulator and results were compared with that of ODMRP. The analysis showed that the suggested protocol was more efficient regarding performance parameters (Packet Delivery Ratio (PDR), Average End-to-End Latency and Average Route Lifetime) as compared to ODMRP, LSMRP, and MMRNS. The obtained results were compared with minimum and maximum contention count cases and it can be concluded that contention count at a node influences the efficiency of a multicast routing method substantially. Large contention count increased competition for resources while small contention count reduced connectivity, a convenient contention count could balance connectivity and availability of resources in a network.

In (19), the researchers introduced a Multipath Battery and Mobility-Aware routing algorithm (MBMA-OLSR) based on MP-OLSRv2. They invested a Multi-Criteria Node Rank (MCNR) measurement that included the residual battery energy as well as the speed of nodes. It intended to rank the link stability using a link assessment formula and choose the best efficient and stable paths to the destination. The selection mechanism was introduced and performed by the MBMA-OLSR to set the readiness of nodes to assist as MPRs for flooding topological status. The authors executed the introduced scheme as an extension to the EXata network simulator. Simulation results proved the effectiveness of the algorithm during high mobility cases with heavy traffic load and outperformed the traditional MP-OLSRv2 routing protocol regarding QoS and energy-related measures.

In (20), the authors introduced a Cross-layer Threshold Multipath Routing Protocol (CTMRP), a MAC and Physical layers design through the network. It is designed to make a decision depending on the threshold of average paths signal for transmission of all multimedia. They modified an algorithm for DSR protocol that subjected to three adjustments; firstly, adjusted the mechanism of resending the intermediate nodes the RREQ broadcast message to neighboring nodes based on strength of the signal. Secondly, it adjusted the mechanism of route arrangement in memory according to the best signal strength of routes. Finally, permitted nodes to transmit data using multi-paths rather than a single path. The performance was evaluated using metrics such as route discovery delay, end-to-end delay, number of RREQ messages, number of RREP messages, throughput, packet delivery ratio. Results showed that the suggested algorithm had better performance and increased the stability of the transmission line.

In (21), the researchers introduced a hybrid optimized link-state routing protocol version2 that is multipath energy and QoS-aware (MEQSA-OLSRv2). It was presented to solve the limitation of energy resources, node mobility, and traffic congestion in WSN based MANET for IoT networks. They used a node rank of multi-criteria node rank metric MCNR that collected energy and QoS parameters. This significantly reduced the complexity of multiple constrained and avoided the control overhead MEQSA-OLSRv2 produced by broadcasting multiple parameters separately. Node's lifetime, remaining battery energy, node's speed, node's idle time and queuing length. A multiple-route computation was obtained by a new link quality assessment utilization as well as a multipoint relay mechanism for nodes was obtained using an energy and QoS-aware selection for flooding topology related information. The performance of the proposed routing protocol was evaluated using EXata-based simulations and validated using comparison with traditional routing protocols. The proposed

protocol outperformed existing ones by enhancing QoS as well as reducing energy consumption energy cost per packet.

In (22), the researcher proposed an enhanced fuzzy logic Ant Colony Optimization - based routing algorithm. The Security Aware routing protocol used a distributed fuzzy logic unit to identify and exclude misbehaved nodes from the routing procedure. The SAFEACO routing protocol was implemented using the NS-3 simulator and many experiments have been performed in both MANET and VANET environments. The performance of the proposed system was compared with other approaches. Simulation results showed that SAFEACO has better performance in all relevant metrics (packet delivery ratio and end-to-end delay). It also provides a high level of durability against attacks (Sybil, black hole and flooding) due to its ability to identify misbehaving nodes.

In (23), the researchers proposed a Virtual Ad hoc Routing Protocol (VARP). This algorithm produced increased security and scalability and decrement routing overheads as compared to traditional ad hoc routing protocols. They reduced traffic overhead in the LTE environment by multi-hop D2D communications running under SDN-controller. They also developed a source-routing protocol referred to as VARP-S. they analyzed routing overhead in the VARP-S, as compared to the overhead analysis of their previously proposed Hybrid SDN structure for wireless distributed networks (HSAW). results showed that VARP-S achieved better scalability and lower consumed power for mobile nodes as compared to HSAW.

In (24), the researchers proposed a trust-based and secure QoS routing method. The base approach of the proposed method depended on relieving nodes with various packet forwarding misbehavior as well as on-path discovery to guarantee reliable communication. The approach depended on best node selection according to packet forwarding as well as QoS variables (residual energy, link, and channel quality). The researchers also suggested a model for packet dropping attack. Simulation performed using Network Simulator-2 NS2 and showed that mixing social and QoS trust variables improved security and QoS routing in terms of packet delivery ratio, overhead, and consumed energy.

In (25), the authors introduced an improved energy and mobility ant colony optimization (IEMACO) routing method. The method speeded up the convergence of the routing algorithm and reduced the route discovery packets using an offset value of the transition probability. According to the rate of consumed energy, the residual lifetime of nodes (RLTn) was held, and the position and velocity status predicted the residual lifetime of the link (RLTl). Then the algorithm merged RLTn and RLTl to produce the pheromone formula that selected the path with the best quality based on the transition probability to ensure continuous transmission. The simulation showed that the proposed method reduced the route discovery attempts, lowered end-to-end delay, and packet loss rate, and extended the network lifetime as compared to AOMDV and AntHocMMP algorithms.

In (26), the researchers proposed a network coding-based routing protocol over a cycle network topology to reduce latency and traffic load for transmission of online gaming (real-time communication application). They considered the infrastructure of Device to Device network and proposed a medium access scheduling. The performance was evaluated in terms of latency using a network simulator. The latency was calculated in a lossless network and showed the benefit of the proposed protocol in terms of latency compared to the NC-based multicast protocol. They also considered problems of packet loss caused by network delay variation or jitter and presented the significance of choosing a time unit related to the cycle size and produced an acceptable latency for such real-time application.

In (27), the authors proposed a new on-demand routing protocol called PRP (Performance Routing Protocol). It allowed MANETs to select optimal routes with the highest throughput and the lowest time delay for data transmission. The route is selected by PRP as it satisfied two conditions: hop number and throughput. The throughput constraint means that the throughput of each link must achieve the minimum threshold and the throughput of the entire route must be the highest among candidate routes. The efficiency of PRP performance was compared with traditional routing protocols on NS2 by making changes in the velocity of network nodes and traffic. The results showed that performance factors (throughput, average end-to-end delay, and packet delivery ratio) of the network employing PRP was improved.

In (28), the authors presented a new concept of route availability (RA) as a measurement of route no uniformity in a MANET as it represents the quality of service (QoS) of a network or the quality of experience (QoE) of video streaming. They checked RA as a useful indicator of network QoS and video streaming QoE by emulating MANET environment that's capable of sending streaming videos, and performed a method of measuring RA for two representative MANET routing methods: Ad hoc On-Demand Distance Vector (AODV) and Optimized Link State Routing (OLSR). They confirmed that RA had a linear correlation with the two QoS metrics (packet loss rate and throughput) and founded that RA is more sensitive to changes in video quality.

In (29), The researchers streamed a High Definition (HD) videos over MANETs. They designed a transmission system followed by a distortion system in order to evaluate network distortions such as packet-loss rate and end-to-end delay. The proposed design allowed a video framework to utilize the available bandwidth in MANETs efficiently, minimized distortions caused by the network and improved Quality of Service QoS. They also used an Error Concealment (EC) method to recover the lost/dropped video frames to improve the Quality of Experience QoE. Results showed that the suggested video streaming framework operates better than other MANET protocols such as Destination-Sequenced Distance Vector (DSDV) and Optimized Link State Routing (OLSR) protocols.

In (30), the authors proposed an optimized routing method to enhance the performance of the network and overcome network problems such as path destruction within a specific time. All possible paths between source and destination nodes are discovered and subjected to a three metric Quality of Service (QoS), where a maximum bit rate, minimum packet loss rate, and minimum delay are considered. The decision of path selection relies on three methods: Weighted Sum optimization method, Weighted Sum Based Genetic Algorithm optimization method and the Non-Dominated Sorting based Genetic Algorithm-II (NSGA-II) with two types of Crossover. The result of the three methods was compared with the Bellman-ford algorithm (based Ad Hoc on Demand Distance Vector (AODV) protocol) and with NSGA-II priority-based encoding. A Matlab (2017a) simulator was used to test the system by finding the best path based on QoS requirements in both static and dynamic environments. Under varying sensor nodes, the proposed method achieved an important decrease in packet loss rate as well as an increase in bitrate. In addition, it saves energy (the network lifetime by extension) due to no rerouting discovery process whenever a route failure occurs.

In (31), the researchers introduced a routing algorithm called Network Assisted Routing NAR for device-to-device communication in 5G architectures. The aim was to extend the coverage of base stations. NAR took into account that D2D communications are managed by base stations. NAR results were compared with the Load Balancing Based Selective Ad Hoc On-Demand Multipath Distance Vector algorithm. The proposed algorithm was implemented in SimuLTE, and the results showed an improvement of 35% in energy savings with a slight increase of 5% in the number of total packets sent.

Also in (32), the authors validated a trust-based protocol to mitigate security and performance issues in D2D networks. 'neighborhood as a routing metrics' was used to produce a secure and efficient trust-based protocol. The coefficients of neighborhood peers' similarity have been taken into consideration to enhance the routing performance in mobile HetNets environments. The authors demonstrated that the connectivity of peers' neighborhood in the network is a property that can affect peers' routing performance. The analysis proved that only message with a higher probability of packet delivery is forwarded to the companions, thus it enhanced delivery rate, reduced latency and alleviated the problem of malicious peers by packet dropping method.

In (33), the researchers aimed to determine the multi-hop route between a device-to-device source-destination pair that meets with the required quality-of-service. They modeled a D2D-QoS routing problem as a Markov decision process and proposed a distributed multi-agent routing algorithm. The researchers assigned the QoS requirements in terms of bandwidth, delay, and packet loss rate, and the routing path was allocated according to link information over time (dynamic environments). They decomposed the Q-function into several local Q-functions where each agent computed its own optimal strategy using local observations, which in turn reduced learning costs and searching in large-scale systems. The simulation results showed that the proposed routing algorithm

reduced the average end-to-end delay, the average packet loss rate, and service rejection rate as compared with both the minimum hop algorithm and traditional routing algorithm (only considers static parameters).

In (34), the authors introduced a novel Joint Routing and Wireless allocation in D2D communications (JRW-D2D) that is based on the branch-and-cut method. They implemented the standard LTED2D protocol stack with the proposed scheme using the NS3 network simulator. The obtained results were satisfying in reliability, optimality, admitted D2D flows ratio and latency as compared to other basic one-sided optimal schemes.

In (35), the authors investigated the performance of various D2D communications routing protocols. Cellular networks are composed of D2D pair where relays arranged in clusters. D2D and cellular users are supposed to transmit over the same channel. The authors called interference generated from the relays to the base station and from the cellular user to the relays as mutual interference. They investigate D2D communication optimal and suboptimal routing in the existence of interference. Optimal routing was included to select the path with the largest end-to-end SINR. Also, a one-hop sub-optimal routing was suggested where the relay with the largest SINR was chosen. The result of optimal routing reduced outage probability than sub-optimal routing. Due to interference, it was shown that as the distance between D2D users and cellular users decreases, D2D outage probability increases.

In (36), the authors introduced a routing algorithm named Mobility, Residual energy and Link quality Aware Multipath (MRLAM) in MANETs. The proposed method took optimal routing decisions for energy-efficient nodes to sustain the reliability and lifetime of the network for a specified period of time. MRLAM method used a Q-Learning procedure for optimal intermediate node selection according to energy level, mobility, and link quality values, and then supplied positive and negative values. The suggested routing algorithm reduced energy cost, end to end delay, packet loss ratio and convergence time as compared to other routing schemes (Multipath Optimized Link State Routing protocol (MP-OLSR) and MP-OLSRv2). Results showed that the suggested MRLAM routing algorithm improves the overall performance of the network.

III. PROBLEM STATEMENT

Due to MANET characteristics such as node mobility, topology changes, resource shortage, Non-centralized control, etc., the challenge of designing a Quality of Service routing algorithm is raised. Different issues were addressed in the research area so far [5] – [36], yet continues improvements and enhancement are a need in such a thriving network business. One of the important issues is keeping the QoS in the required and allowed ranges.

QoS routing is the process of transferring data packets from source node to destination node by taking into account resource constraints, such as delay, energy, bit rate, packet loss rate, cost, etc. The required solutions should tackle the enhancement in the QoS in the proposed routing protocol including the use of optimization methods.

IV. PROPOSED APPROACH

A Quality of Service Routing is always a hard task due to the dynamic nature of MANET. Direct communication between devices D2D in such an environment can be realized in a single or multi-hop manner. The integration of wireless and multi-hop networks provides guaranteed Quality of Service (QoS), flexibility and adaptability. To achieve such a QoS routing, a multi-Objective QoS Routing between devices in MANET could be suggested. An intelligent algorithm should be used for path selection, a multiple criteria decision making optimization involving more than one objective function to be optimized simultaneously between the source and destination where optimal decisions need to be taken in the presence of trade-offs between two or more conflicting objectives.

The mathematical optimization strategy of Lagrange's multipliers rises up to this challenge. Due to its ability to find the local maximum and minimum of a function that subjected to equality constraints like the constraint in QoS Routing.

QoS constraints, such as maximize the bite rate, minimize the packet loss as well as minimize the delay, where the conditions of one or more equations have to be satisfied precisely by the selected values of the variables. The major advantage of this method is that it allows the optimization to be solved without explicit parameterization in terms of the constraints. As a result, the method of Lagrange multipliers is the best choice to solve challenging constrained optimization problems.

CONCLUSION

An intense state of the art has been performed to explore the various smart methods and techniques for route selection such as Fuzzy Logic Ant colony, PSO, Genetic to enhance objectives like traffic offloading, energy consumption, throughput, packet loss ratio, routing cost, delay…etc.

Also a suggestion to use the Lagrange's multiplier to optimize a QoS routing function subject to a given constraint in terms of bit rate, packet loss, and delay. This technique finds the maxima or minima of a multivariable function bounded by a constraint function.

It is expected to enhance the QoS routing for D2D in the MANET environment by maximizing the bit rate, minimizing the delay and minimizing the packet loss rate. Some other constraint parameters might be added later on.

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