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A Survey on the Novel Hybrid Techniques in Efficient QoS Routing MANET

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Abstract- Hybrid Wireless Networks are the next generation of wireless networks that provide scalability for mobile ad hoc networks while expanding the coverage of wireless infrastructure networks. MANET is a network that consists of wireless mobile devices, mobility, and scalability. MANETs are famous because of these key details. A thorough survey of QoS and routing protocols is conducted. This study examines the benefits and drawbacks of various QoS routing protocols. A thorough investigation has also been conducted on the current problems and feature trials in the field of MANETs. Every routing protocol must provide quality Service to improve bandwidth, delay, and energy consumption. Any ad hoc network routing protocol aims to address these issues. As a result, it becomes a critical parameter for MANETs to develop competent routing and QoS procedures. Increasing application demand and end-user support necessitate performance optimisation. In order to meet this requirement, this paper proposes a hybrid optimisation technique that combines Ant Colony Optimization and Fitness Distance Ratio-based Particle Swarm Optimisation. To mitigate the trade-offs in QoS achievement, ACO is focused on maximising network throughput. At the same time, FDRPSO is directed to fine-tune the ACO solution concerning energy and overhead. This survey will be useful for the newly proposed routing protocols with improved QoS in MANETs. This survey paper examines the taxonomy of ad hoc routing techniques a compares the features of routing protocols.

Keywords: MANET, Routing, ACO, FDR PSO, QoS routing, Hybrid Optimization, QoS, Scalability, Security

I. INTRODUCTION

Mobile ad hoc networks (MANETs) have gained increasing popularity for a range of applications, such as emergency/rescue operations, military sector applications (e.g., battlefield), health monitoring of civil structures, homeland monitoring, and ubiquitous computing. A MANET consists of mobile nodes that communicate with each other without any infrastructure. These mobile radio autonomous nodes are arranged in a mesh topology and form a dynamic, multi-hop radio network in a decentralised way. The impression of forming a MANET came from the Defense Advanced Research Projects Agency (DARPA) packet radio network. Several researchers have focused on selecting and managing the optimum ad hoc routers in the past few decades. In contrast, some researchers have suggested other effective techniques for routing issues, leveraging existing features of accessible Internet routing algorithms [1].

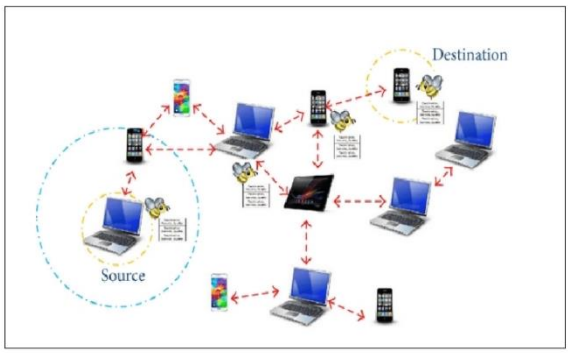

Fig 1. Mobile ad-hoc networks.

1.1 Various Categories of Routing Protocols

According to the primary architectural framework, the routing protocols are divided into two types [2,3].

(a) Topology-based Routing Protocols

In a topology-based routing protocol, for forwarding packets, information about the link that exists in the network is used. Furthermore, topology-based routing is divided into Proactive/table driven, reactive/on-demand and hybrid routing approaches, as shown in figure 2. In proactive routing, each Mobile node maintains a routing table containing destinations and

possible paths towards the destination. These tables are periodically broadcast to each node throughout the network. However, the disadvantages are that the respective amount of data for maintenance creates a lot of traffic and a slow reaction to restructuring and failures. An example of proactive routing protocol is OLSR and DSDV [1].

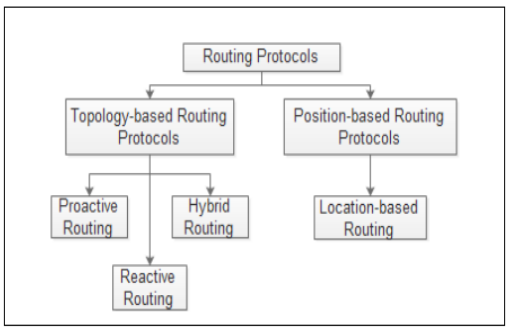

Fig 2. Types of Routing Protocols

II. Reactive routing protocols maintain only routes discovered when the source mobile node MN needs to transmit the data packets, reducing the network's routing overhead. However, reactive routing still has some drawbacks. First, delay in the first packet transmission because every time, it is typically required to perform route discovery before exchanging packets. Second, keeping the route available may generate significant traffic even in the route maintenance phase. An example of reactive routing protocol is DSR, TORA and AODV. The ant colony-based routing algorithm (ARA) proposed an innovative mechanism for on-demand, multi-hop ad hoc routing based on swarm intelligence and the ant colony metaheuristic. ARA is designed with the primary objective of reducing the overhead without any direct link among the participants. This type of algorithm solves the complex optimisation and collaboration problem. Adhoc QoS on-demand routing (AQOR): AQOR, an on-demand routing protocol enabling QoS support in terms of bandwidth and end-end delay, is developed. AQOR mechanism estimates the bandwidth and end-end delay requirements and exploits these metrics to determine accurate admission control and resource reservation decision. TTL prevents the unnecessary forwarding of packets by a node, reducing control overhead.

III. Hybrid routing combines proactive and reactive protocol. The advantages of these protocols are hybrid routing, usually initiating routing through proactive routing by determining routes and then certain nodes demands are served according to reactive routing. An example of a hybrid routing protocol is ZRP [1]. Position-based routing protocol uses additional information to overcome the disadvantages of topology-based routing protocol. Here protocol used the physical location information of a particular node for communication. Each node is aware of its position, the position of the neighbour's node within range, and a destination node through GPS or other positioning services. Senders use Location Services to determine the location of a destination node. Node use broadcast to know the location of one hope neighbours. This position-based routing requires minimal overhead and avoids delay and latency due to localised forwarding [4].

1.2 Design Requirements and Challenges

The unique requirements of WMSNs give rise to new challenges to the design of routing protocols for WMSNs. This section presents the most dominant and challenging factors that must be addressed to achieve effective communication in WMSNs[5]. In multimedia applications, QoS requirements, such as bounded latency or delay, bandwidth, jitter, and reliability, may differ. In the following, we describe these various QoS requirements elaborately:

(i) Latency: In some applications, WMSNs must ensure stringent deadlines (i.e., a physical event must be reported within a certain period). For example, many applications, such as intruder tracking, wildfire monitoring, medical care and structural health diagnosis, are extremely time critical. In intruder tracking, surveillance may require the position of an intruder to be reported to a command centre within 15 sec so that appropriate actions can be taken in time. Timeliness can be provided on a guaranteed or a best-effort basis, depending on the tolerance level of applications. Besides, end-to-end delay guarantees can be categorised into deterministic (or hard-latency bounded) and predictive (or soft-latency bounded). In hard-latency bounded systems, service that cannot be provided within its deadline is considered a failure of the whole

system. Whereas, in soft-latency bounded systems, the probabilistic guarantee only is required; i.e., typically, some delay of a fraction of traffic can be tolerated. More importantly, in some applications, data in the same system may have different deadline requirements. For example, sensory location data for a fast-moving target has a shorter deadline than for a slow-moving target. End-to-end delay measurements are facilitated through timestamps across a priori synchronised network environment, and packet forwarding over least-delay paths is preferred to maintain different deadline requirements. Priority schemes can also be applied to differentiate among different classes of data.

(ii)Reliability delivers data to the destination with minimum packet loss. For example, applications, such as forest fire detection, may require that packets reach the destination or monitoring station without any loss. Again, different reliability constraints must be imposed based on the sensed data's content. For example, in fire-monitoring applications, temperature information about regions with normal temperatures can endure a certain percentage of loss. On the other hand, sensor data containing information about the regions experiencing abnormally high temperatures should be delivered to the control centre with a high probability of success since it can be a sign of fire [22]. To ensure such a lossless data transaction, prioritised forwarding or multipath routing can be adopted. Sending copies of the same packet over different paths increases the probability that at least one of the copies reaches the base station correctly. Since the unreliability of the wireless link is largely due to interference and congestion, the reliability metric is often considered reciprocal to the packet loss rate metric. Some applications of WMSNs demand assurances in terms of both timeliness and reliability. For example, in monitoring a volcanic eruption, toxic gases or a wildfire, intruder or enemy detection, and detection of the location of survivors for rescue services, fast and reliable delivery is obligatory since late or failed delivery may result in severe disasters. Therefore, appropriate routing protocols should be carefully designed to fulfil the demand of these sophisticated applications.

(iii) Jitter: Typically, each packet is assumed to have an expected jitter requirement for real-time multimedia traffic. Jitter is defined as the accepted variability of delay between received packets. The presence of jitter in multimedia transmission can cause glitches, discontinuity and errors in video and audio data, which is not acceptable in some applications (such as monitoring, detection or surveillance etc.) where timely and accurate delivery of information is necessary. Therefore, synchronisation should be done at the receiving point. One way to handle jitter is to buffer complete data streams before presentations.

(iv) Bandwidth: By its nature, Multimedia traffic requires high bandwidth. For example, the size of a monochrome uncompressed video frame in a QCIF format (176x144) is approximately 25 Kbytes. In addition to transmitting their data, nodes may work as relay nodes due to the intrinsic, low-range, multi-hop communication paradigm of WSN. If a large chunk of video data is sent using a single path, it can exhaust the path and result in early failure. In order to address the problem mentioned earlier, the available bandwidth can, for example, be utilised using multiple paths and multiple channels in a spatially overlapped manner to meet high bandwidths. Therefore, high bandwidth demands should be considered when designing routing protocols for WMSNs. Energy efficiency is similar to WSNs, and the energy consumption is a prime concern in WMSNs. In some applications (e.g., environmental and habitat monitoring), WMSNs are deployed in remote and inaccessible regions (mountains, deserts, forests and rural areas) to collect multimedia information for a prolonged duration. Being the same irreplaceable, battery-operated devices, sensors in WMSNs usually consume even more energy than WSNs. This is because multimedia applications generate high traffic volumes requiring high transmission rates and extensive processing. While the energy consumption of traditional sensor nodes is known to be dominated by communication functionalities, this may not necessarily be true in WMSNs. Therefore, energy-aware routing

protocols for WMSNs should be designed while accounting for all forms of energy consumption. Architectural issues since the network architecture greatly impacts the performance of routing protocols, and some architectural issues can serve as guidelines while designing routing protocols for WMSNs. Hole detection and bypassing due to the high bandwidth demands and the burst nature of multimedia streaming data, some paths in WMSNs can get exhausted (i.e., residual energy of the nodes falls below a threshold value). These scenarios are called dynamic holes. These holes may impair the performance of multimedia applications by encumbering some routing paths. Hence, new hole-bypassing routing algorithms should be designed to facilitate multimedia data streaming while balancing energy usage throughout the whole network. Although we have covered the most dominant design objectives, it is impractical to design a" one-for-all" routing approach that addresses all the mentioned design objectives and requirements. All the existing WMSNs routing designs and implementations focus on specific application scenarios and emphasise different objectives. Hence, design challenges are mainly application and network-specific [6].

II. RELATED WORK

This section describes various existing Ant and swarm optimisation systems for increased reliability and efficient data transmission under mobile ad hoc networks. Here the work is briefly elaborated to improve the QoS of MANET. Rangaraj et al. in [7] proposed ACO that improves the packet transmission rate of the links, achieving a fair solution for path selection. The source node initialises forward Ant randomly to visit all the available nodes in the path. The ants drop some amount of pheromone over the visited links during traversal. On reaching the destination, the ants update the pheromone of all the nodes visited during traversal. Here throughput of a node is considered a pheromone.

Akash Shaw et al. [8], Mobile Ad Hoc Network or MANET is defined as a network with many free nodes mostly composed of mobile devices or its particle. The network is continuously moving, or we can say it is a mobile network. Particle Swarm Optimisation may sound convoluted. However, it's extremely an exceptionally straightforward calculation. Particle swarm Optimisation is a heuristic worldwide advancement technique and an enhancement calculation that depends on swarm insight. It originates from the examination of the fledgling and fish-run development conduct. The calculation is generally utilised and quickly created for its simple usage, and a couple of particles must be tuned. The primary thought of the rule of PSO is introduced; the favourable circumstances and the deficiencies are abridged. Finally, this paper displays a few enhanced renditions of PSO and research circumstances, and future research issues are likewise given. PSO finds out the optimal solution from the search space. In PSO, iterations are applied over the number of iterations and different variables, and the best is found and found closest to the target. The initial problem was routing, finding the optimum way between the nodes, and transferring data into different locations. By implementing this, the conclusion could be found that the data could be transferred from one place to another by finding the optimal solution from different continuous solutions and the search space available for the particle. Hassan et al. in paper [9] A Mobile Ad-Hoc Network (MANET) comprises wireless mobile nodes that do not require a central infrastructure or administration to establish a network. The MANET nodes can function as a router or hosts. MANET works with an independent multi-hop mobile network which can be used in several real-time applications. Thus, an important issue associated with MANET is the identification of paths with high-level Quality of Service (QoS), like topology. The purpose of having a QoS-aware protocol in MANETs is to discover more efficient paths between the source and destination nodes of the network and hence, the need for QoS. This paper presents a novel algorithm that can be used in the African Buffalo Optimization (ABO) to improve the QoS of routing protocol MANETs. With ABO, path selection is optimised in the Ad-hoc On-demand Distance Vector (AODV) routing protocol. The test results revealed that delay and energy-aware routing protocols are manifested when ABO is used in AODV. Rajalakshmi, S et al. in [10] A hybrid computational intelligent algorithm is proposed by integrating the salient features of

two different heuristic techniques to solve a multiconstrained Quality of Service Routing (QoSR) problem in Mobile Ad Hoc Networks (MANETs) is presented. The QoSR is always a tricky problem to determine an optimum route that satisfies various constraints in a MANET.

The problem is also declared as NP-hard due to the nature of the constant topology variation of the MANETs. Thus a solution technique that embarks upon the challenges of the QoSR problem is needed to be underpinned. This paper proposes a hybrid algorithm by modifying the Cuckoo Search Algorithm (CSA) with the new position updating mechanism. This updating mechanism is derived from the differential evolution (DE) algorithm, where the candidates learn from diversified search regions. Thus the CSA will act as the main search procedure guided by the updating mechanism derived from DE, called tuned CSA (TCSA). Numerical simulations on MANETs are performed to demonstrate the effectiveness of the proposed TCSA method by determining an optimum route that satisfies various Quality of Service (QoS) constraints. The results are compared with some of the existing techniques in the literature; therefore, the superiority of the proposed method is established.

L. Raghavendra et al. [11] MANET is a collection of wireless mobile devices, mobility and scalable network. These key details are behind the fame of MANETs. A good survey is done on QoS and routing protocols. This study presents some QoS routing protocols' merits and demerits. Also, a thorough investigation has been carried out on the current problems and feature trials that are in the field of MANETs. Every routing protocol must provide Quality of Service (QoS): To improve bandwidth, delay, jitter, and energy consumption. The purpose of any ad-hoc network routing protocol is to meet these challenges. Therefore, it becomes an essential parameter for MANETs to develop proficient routing and QoS procedures. Some QoS routing protocols are proposed newly by various characteristics. A similar survey is done on QoS and routing protocols. It has been observed that Maximising accuracy, Minimising overhead, Maintaining routes, Reserving resources, reducing power utilisation, and reliability is unsolved issues. Designing these routing protocols is an interesting task because of mobility and the dynamic behaviour of Mobile Ad-hoc Networks. This study helps design new routing protocols with improved QoS in MANETs. S. Kabilan et al. [12]. Hybrid Wireless Networks are the next generation of wireless networks that extends the coverage of the wireless infrastructure networks and provides scalability for Mobile ad hoc network. Two types of wireless transmissions are allowed in hybrid wireless networks: infrastructure and IEEE 802.11. The infrastructure network consists of wireless devices connected through a base station or an access point (AP).MANET is a mobile ad-hoc network connected to devices without any infrastructure. This paper discusses hybrid wireless networks' benefits, including the survey of their evolving architectures. We discuss the achievement of QoS in wireless infrastructure and MANET. We also discuss the process of achieving QoS in Hybrid Wireless Networks.

Ahmed et al. [13] used Mobile Ad hoc Networks (MANETs) as self-organised and self-configured networks that don't need any cellular infrastructure such as an access point (AP), a base station (BS) or fixed transmission links. Routing has been the point of research focus since the invention of commercialised mobile ad-hoc networks. In the literature, the classical taxonomy of MANETs routing protocols based on the route computation process is subdivided into the proactive (Table -Driven), Reactive (On-Demand) and Hybrid (inherit both features of the proactive and reactive). However, this classification hides other types of MANETs routing protocols that play significant roles nowadays, such as (Multicast, Energy and Power-aware, Geographical routing and Hierarchical routing). This paper comprehensively studies MANET's basic taxonomy of routing protocols. In addition, an intense comparison between some examples of each routing protocols category has been made to facilitate research in this area further.

Manoranjini J et al. [14] performed secured routing as a major research in MANETs. The behaviour of malicious nodes in this network increases the risk of threats and induces abnormal operations in MANETs. This affects the security of data transmitted between the nodes in the

network. Hence, an effective technique is needed to prevent abnormal nodes after the process of detection. This paper proposes an improved Trust Detection Algorithm to increase the probability of detecting and preventing Black Hole nodes in MANETs. The proposed framework observes the behaviour of each node using various trust metrics, including the relationship between the sensor nodes, social and service attribute trust and QoS metric trusts. The behaviour of sensor nodes is found through each node's communication and mobility behaviour. This method avoids the black hole nodes in MANETs when the routing is carried out with Zone Routing Protocol (ZRP). Hence, the privacy of data is retained using the proposed method. The proposed method is tested in terms of combinations of with and without trusts. The result shows that the proposed method is effective through various QoS metrics like overall throughput, packet loss, energy consumption, trust level, false acceptance rate and missed detection rate.

Kaur, N. et al. [15] Mobile Ad hoc Network (MANET) is a self-organised wireless network with no central control station or rigid infrastructure. The main objective of the ad hoc network is that the nodes move arbitrarily, which needs the routing protocols to counter the network topology change rapidly. Limited energy resource availability is the core issue in MANET. For energy efficiency enhancement, this research has acquainted a hybrid routing algorithm which is an amalgamation of Ad hoc On-Demand Distance Vector Routing (AODV) and Temporally-Ordered Routing Algorithm (TORA) routing protocols for the route discovery process using Low Energy Adaptive Clustering Hierarchy (LEACH). Artificial Bee Colony (ABC) algorithm has been used for optimisation if distortion occurs within the network. The simulation has been executed in MATLAB simulation tool using QoS parameters, such as throughput, energy consumption, PDR and delay in comparative analysis to portray the proposed work effectiveness.

Srinivas Sethi et al. [16] have introduced a novel meta-heuristic on-demand routing protocol Ant-E, using the Blocking Expanding Ring Search (Blocking-ERS) to control the overhead and local retransmission to improve the reliability in terms of packet delivery ratio (PDR). This method enhances the efficiency of the MANET routing protocol. Ant-E is inspired by the ant colony optimisation (ACO) used to solve complex optimisation problems and utilises a collection of mobile agents as "ants" to perform optimal routing activities.

III. PROBLEM FORMULATION

The QoS routing problem is modelled as an optimisation problem whose prime objective is to determine a multicast tree by considering the cost function, which has to be minimised subject to some practical constraints. The present formulation considers four constraints: Data Receiving Analysis, delay analysis, overhead analysis, packet loss and Throughput Analysis. The nature of mobile ad hoc networks makes it necessary to optimise the routing behaviour of MANETs. Overcome the problem, and our goal is to design a route optimisation approach using the Ant-PSO technique in MANETs for reliable communication. Mobile ad hoc networks are very dynamic (LACPSO).

IV. CONCLUSION

MANET routing processes and strategies that are currently in use. Most authors in the literature classified MANET routing protocols as proactive, reactive, or hybrid. In hybrid wireless networks, route identification and packet transmission become the most important issues during provisioning for any QoS architecture. This paper surveys various methods of QoS provisioning in various networks. The procedure for achieving QoS in various networks has been described various types of parameters have been required for estimating network performance metrics. Maximising accuracy, minimising overhead, maintaining routes, reserving resources, reducing power utilisation, improving reliability, and improving security are some of them. Solving the issues mentioned earlier will necessitate the development of new QoS protocols. This study discovered that most available protocols, particularly QoS protocols, do not consider scalability when holding multicast sessions.

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