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Connectivity Index based Dynamic Routing Algorithm for MANETs

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Abstract: Mobile Ad-hoc Networks (MANETs) is an infrastructure less network composed of mobile nodes. The mobile nodes move in and out of the communication network at any time. Routing is considered to be the important feature in MANETs. Just finding a route from source to destination will be provide a Quality of Service (QoS) routing. More QoS constraints have to be satisfied to provide an efficient routing technique. In this paper, Connectivity Index based Dynamic Routing (CIDR) algorithm is proposed for MANETS. The intermediate nodes having maximum connectivity index are selected in routing. Simulation analysis shows that the CIDR protocol performs better compared to the existing schemes.

Keywords: Mobile ad-hoc network, connectivity index based dynamic routing, connectivity index.

1. INTRODUCTION

Mobile Ad-hoc Network (MANET) is an infrastructure less network consisting of nodes that exchange information dynamically without any fixed network structure. Because of the self organizing and self configuring characteristics, MANETs play an important role in military tactical and daily life applications. MANET has the potential to work in different networks including cellular networks. The applications of MANET are not limited to areas such as emergency and crisis management, local-level and battlefield applications.

Important characteristic feature of the wireless channel that affects the communication quality is the variation in its strength over time and frequency. As a result of the variation, communication links in wireless networks tend to be unpredictable. Moreover, this variation affects the connectivity between two nodes in the communication network.

QoS routing is important for a mobile network to interconnect wired networks with QoS. QoS routing protocol is also needed in a stand-alone multi-hop mobile network for real-time applications. QoS routing requires not only finding a route from a source to a destination, but a route that satisfies the end-to-end QoS requirement, often given in terms of bandwidth or delay. Quality of service is more difficult to guarantee in ad hoc networks than in most other type of networks, because the network topology changes as the nodes move and network state information is generally imprecise. This requires extensive collaboration between the nodes, both to establish the route and to secure the resources necessary to provide the QoS.

The remainder of this paper is structured as follows: the literature corresponding to the proposed CIDR are described in section 2. The detailed description of proposed CIDR is shown in section 3. The simulation analysis corresponding to CIDR is shown in section 4. Conclusion is followed by future works in section 5.

2. RELATED WORKS

A route stability-based multipath QoS routing protocol for MANET was developed for supporting throughput and delay sensitive real-time applications [1]. A hop-by-hop admission control and a soft resource reservation scheme in a route discovery process was incorportated to ensure QoS assurance to real-time applications. A simple route stability model is utilized during both route discovery and maintenance phases for selecting QoS routes with higher stability. The reliability of the multiple QoS routes is improved through node disjointness and stability properties of the discovered routes. Following an effective QoS violation detection and route maintenance mechanism, the protocol reduces the frequency of route recovery leading to a significant reduction in QoS disruption.

SMORT reduces the routing overhead incurred in recovering from route breaks, by using secondary paths [2]. SMORT computes fail-safe multiple paths, which provide all the intermediate nodes on the primary path with multiple routes to destination. SMORT was scalable and performs even at higher mobility and traffic loads, when compared to the disjoint multipath routing protocol (DMRP) and ad hoc on-demand distance vector (AODV) routing protocol.

In MANETs routing based on AODV protocol provides efficient route establishment between nodes with minimal control overhead and reduced route acquisition latency [4]. The normal AODV is extended to perform QoS routing based on bandwidth requirement and link stability constraints. Link stability parameter is considered in an opportunistic way so that effective path meeting the required bandwidth and will last for complete session is established.

Providing multipath routing is beneficial to avoid traffic congestion and break in communication in MANETs where routes are disconnected frequently due to mobility. Differentiated Services (DiffServ) have simple, efficient and scalable characteristics and can be used to classify network traffic into different priority levels and apply different scheduling and queuing mechanisms to obtain QoS guarantees [5]. A practical node-disjoint multipath QoS routing protocol of supporting DiffServ (MQRD) was developed, which provides low routing overhead and end-to-end QoS support.

In order to select a subset of end-to-end paths to provide increased stability and reliability of routes, a QoS metric, end-to-end reliability was defined. A distributed Multi Path Dynamic Source Routing protocol (MP-DSR) for wireless ad-hoc networks to improve QoS support with respect to end-to-end reliability was developed [6]. This protocol forwards outgoing packets along multiple paths that are subject to a particular end-to-end reliability requirement.

Admission control based approach is desirable and plays a vital role in maintaining QoS for MANET-based applications [7]. Flow Aware Admission Control (FAAC) protocol will maintain guaranteed throughput to the applications requiring QoS. FAAC protocol was designed to utilize the caching mechanism of the Dynamic Source Routing (DSR) protocol. It will be implemented in two stages: the first stage is searching the cache for untested paths from source to destinations and initiating the route search before checking the nodes resources. The second stage will include checking of local and carrier sensing neighbors' resources.

Traditional ad hoc routing protocols find the best path in terms of delay or hop count which can lead to network congestion in high traffic load situation [8]. Hence, many QoS routings for these networks have been developed to improve the network performances. MCP QoS routing based on nonlinear cost function is the combination of multiple additive QoS parameters. The routing protocol under this consideration is Optimized Link State Routing protocol (OLSR). The performance of OLSR algorithm demonstrates the import ant improvement over standard ad hoc routing protocol.

It is very difficult to offer QoS guarantee in ad hoc networks because of their characteristics like dynamic topologies and bandwidth-constrained [9]. An effective algorithm was developed to compute the feasible path by using Connectivity Index (CI) and delay to provide hop-by-hop QoS routing in ad hoc networks. CI is routing metric which indicates connectivity of each node in ad hoc networks; large value of CI indicates more branch node which makes a node more robust to link failure.

3. CIDR PROTOCOL

Connectivity is an important measurement of the robustness of the communication network. MANETs are dynamic due to mobility of the node, percentage of nodes joining/leaving the network, transmission power variation and the burst nodes traffic leaving the coverage area of the network. In this paper, a Connectivity Index based Dynamic Routing (CIDR) protocol is proposed. The main aim of the CIDR protocol is to preset the present variables of the network parameter through the connectivity index parameter. The extra RREQ packets are dropped using a dynamic connectivity index. The CIDR protocol is shown in Figure 1.

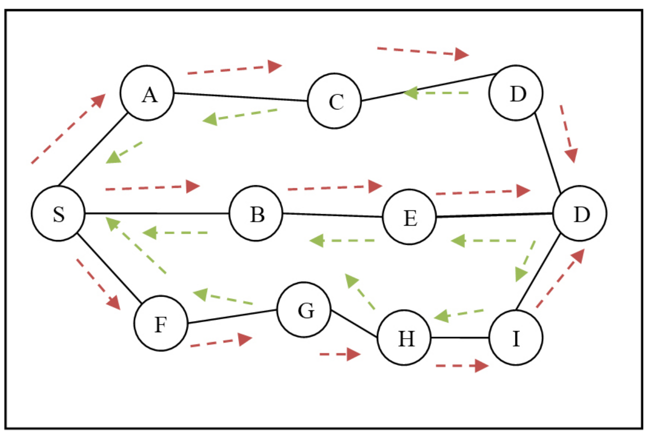

Figure 1: CIDR scheme

If any node needs to send any data in the network, the routing table is checked from the source to destination. The source initially sends a Route Request (RREQ) to find the route to the destination node. RREQ is broadcasted to each node and the node that has the route to the destination replies with the Route Reply (RREP) message.

The application agent specifies the requirements of the data session in the form of RREQ packet. The source node stores this information and tests its local capacity against the requested requirement of the data session. The source node initiates and propagates RREQ on satisfying the requirements else will reject the data session admission. The RREQ propagate till the destination and destination replies with RREP to all routes found between source and destination. When the source receives multiple route replies, then the source transmits dummy packets on these intended data route to calculate these routes delay.

The CIDR protocol enhances the overall network performance with low resource utilization when the network experiences both heavy and light traffic and with nodes located in dense networks. Initially the source node broadcast the data towards the destination. The source node checks about the possibility of route to node D. If there is possible route, then the data is sent to the destination or else the source node broadcast RREQ to all its neighbors. If the route is found, RREP is send back towards the source node. If there is no route, then the connectivity index value is calculated. Connectivity is a prerequisite to provide reliable applications to the users of a wireless ad-hoc network. To achieve a fully connected ad-hoc network there must be a path from any node to any other node. The path between the source and the destination may consist of one hop or several hops. When there is no path between at least one source-destination pair the network is said to be disconnected. Figure 2 shows the flowchart of CIDR Scheme.

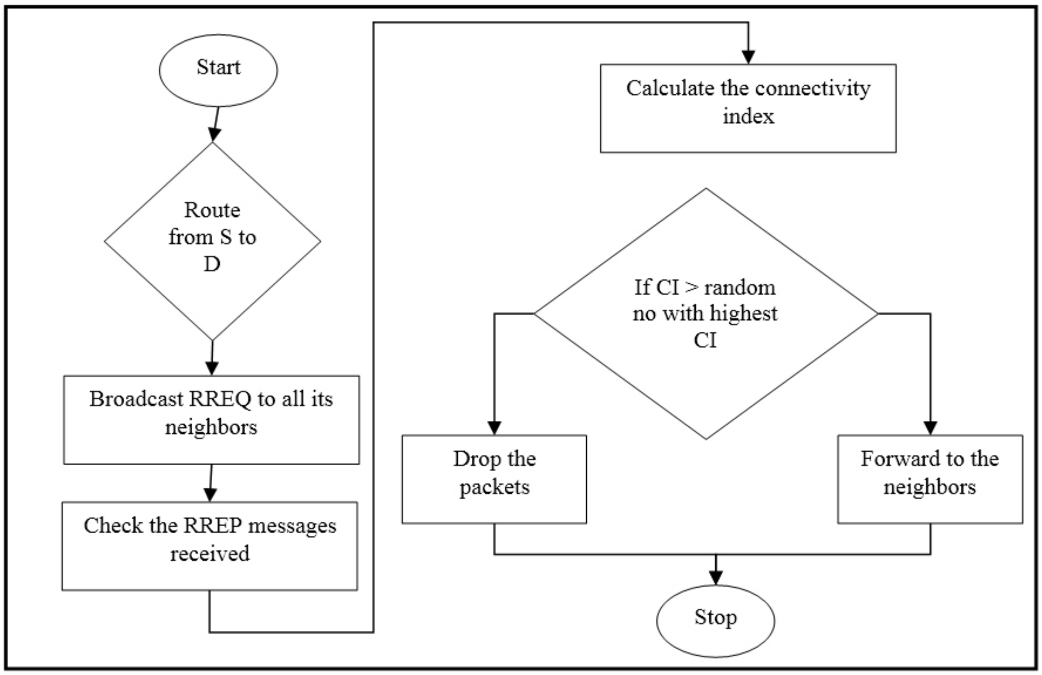

Figure 2: Flowchart of CIDR

The connectivity value ranges from 0 to 1. The value is compared with a random number between 0 and 1. If the connectivity value is greater than the random number, the packets are forwarded to the next intermediate node or else the intermediate node is dropped. The same process is repeated till the source reaches the destination. Simulation analysis is carried out using ns2 to find the performance of this protocol.

4. PERFORMANCE EVALUATION

Network simulator is used to perform simulation between the FAAC-MM and the CIDR protocols. NS-2 used programming in Object Oriented Tool Command Language (OTCL) and C++ for simulation of various wired and wireless scenarios. Both the protocols discussed here are simulated with the parameters indicated in the Table 1.

The simulation of the proposed scheme has 50 nodes deployed in the simulation area 1000×1500. The nodes are communicated with each other by using the communication protocol Transmission Control Protocol (TCP). The traffic is handled using the Variable Bit Rate (VBR). The radio waves are propagated by using the propagation model two-ray ground. All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the proposed scheme is evaluated by the parameters packet delivery ratio, packet loss ratio, average delay, throughput and residual energy.

Table 1
Simulation parameters of CIDR Scheme

Parameter	*Value*
Simulation Area	1200x800m
Number of Nodes	50
Simulation Time	100ms
Channel Type	Wireless Channel
Radio Propagation model	TwoRayGround
Network interface type	WirelessPhy
MAC Type	IEEE 802.11
Interface Queue Type	PriQueue
Link Layer Type	LL
Antenna Model	Omni Antenna

1. Packet Delivery Rate

Packet Delivery Rate (PDR) is the ratio of number of packets delivered to all receivers to the number of data packets sent by the source node. The CIDR is calculated by Equation 1.

$$PDR = \frac{\text{Total Packets Received}}{\text{Total Packets Send}} \tag{1}$$

The Figure 3 shows the PDR of the proposed scheme CIDR is higher than the PDR of the existing method FAAC-MM. The greater value of PDR means the better performance of the protocol.

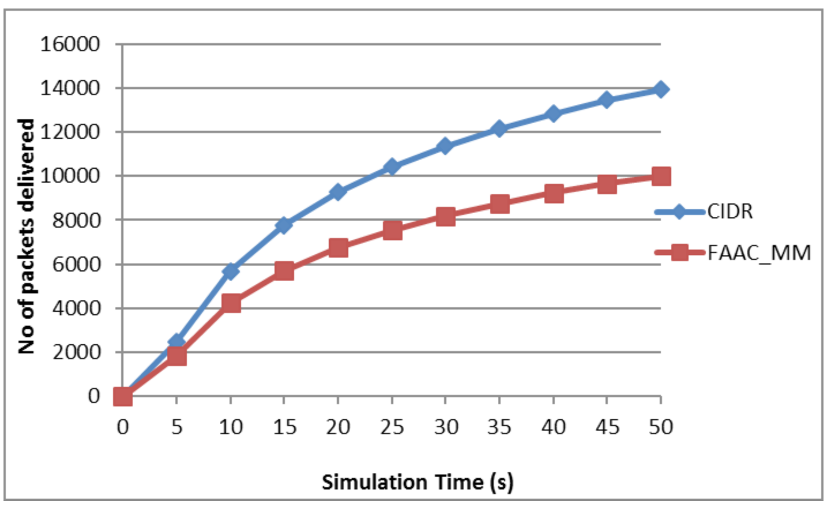

Figure 3: Packet Delivery Rate of FAAC-MM and CIDR

2. Packet Loss Rate

The Packet Loss Rate (PLR) is the ratio of the number of packets dropped to the number of data packets sent. The formula used to calculate the PLR is given in Equation. 7.

$$PLR = \frac{\text{Total Packets Dropped}}{\text{Total Packets Send}} \tag{2}$$

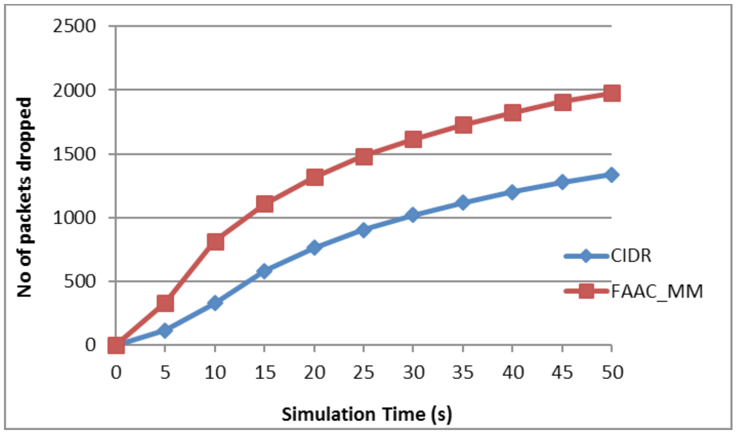

Figure 4: Packet Loss Rate

The PLR of the proposed scheme CIDR is lower than the existing scheme FAAC-MM in Figure 4. Lower the PLR indicates the higher performance of the network.

3. Average Delay

The average delay is defined as the difference between the current packets received time and the previous packet received time. The delay in the network degrades the performance of the network. The average delay is measured by equation 3.

$$\text{Delay} = \frac{\sum_{0}^{n} \text{Pkt Send Time-Pkt Recvd Time}}{\text{Time}} \tag{3}$$

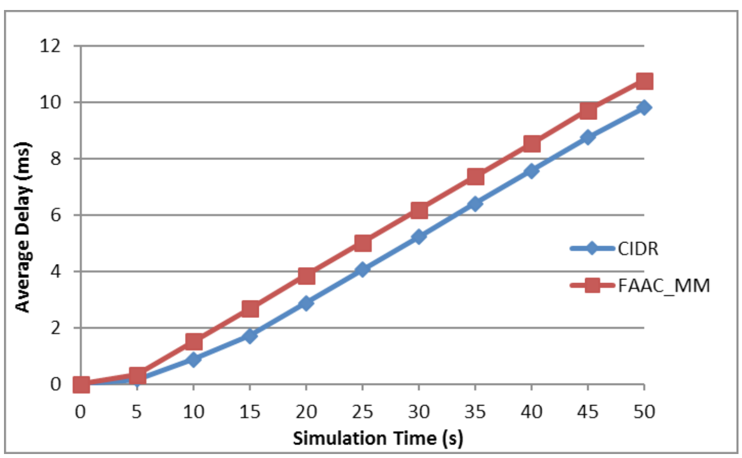

Figure 5: Average delay

Figure 5 shows that the delay value is low for the proposed scheme CIDR than the existing scheme FAAC-MM. The minimum value of delay means that higher value of the throughput of the network.

4. Throughput

Throughput is the average of successful messages delivered to the destination. The average throughput is estimated using equation 4.

$$\text{Throughput} = \frac{\sum_{0}^{n} \text{Pkts Received}(n) \times \text{Pkt Size}}{1000} \quad (4)$$

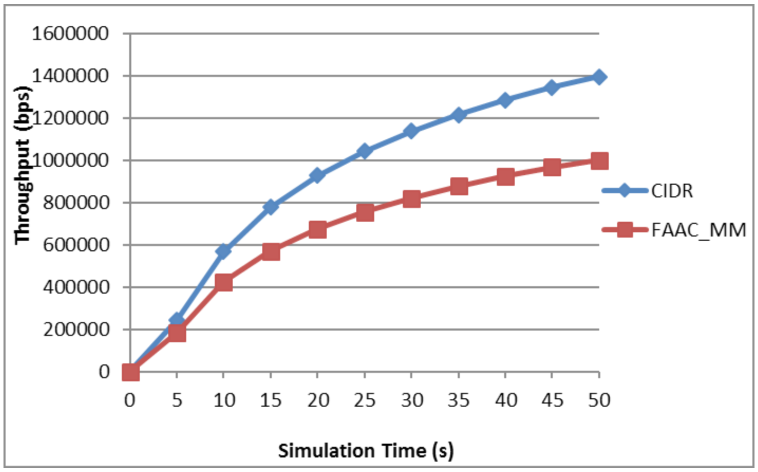

Figure 6: Throughput of FAAC-MM and CIDR

Figure 6 shows that proposed scheme CIDR has greater average throughput when compared to the existing scheme FAAC-MM.

5. Residual Energy

The amount of energy remaining in a node at the current instance of time is called as residual energy. A measure of the residual energy gives the rate at which energy is consumed by the network operations.

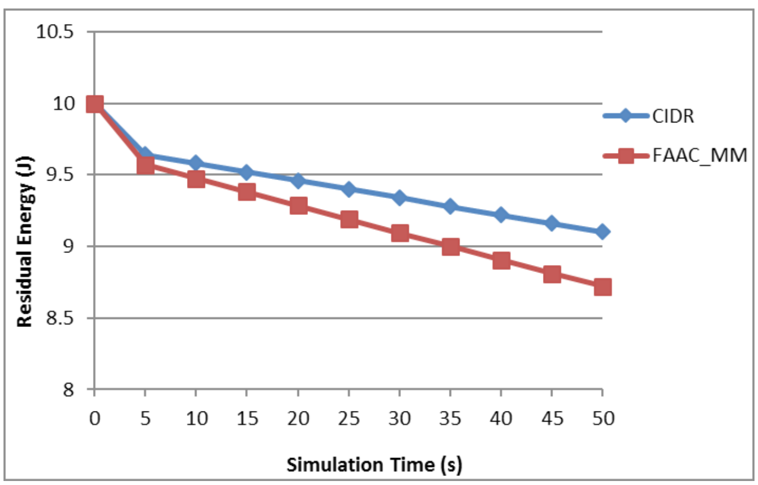

Figure 7: Residual Energy of FAAC-MM and TEEHC

Figure 7 shows that the residual energy of the network is better for the proposed scheme CIDR when compared with the existing scheme FAAC-MM.

5. CONCLUSION

QOS support is an integral part of the ad-hoc design. Connectivity Index based Dynamic Routing (CIDR) algorithm is proposed in this paper for MANETS. The intermediate nodes having maximum connectivity index are selected in routing in the communication network. Simulation analysis shows that the CIDR protocol performs better compared to the existing scheme FAAC-MM.

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