Performance Analysis of MWMCDS Algorithm in Ad-Hoc Networks using NS2

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Abstract:- Efficient routing among a set of mobile hosts (also called nodes) is one of the most important functions in ad-hoc wireless networks. Routing based on a connected dominating set is a frequently used approach, where the searching space for a route is reduced to nodes in the set. A set is dominating if all the nodes in the system are either in the set or neighbors of nodes in the set. We used existing heuristic MWMCDS Algorithm, which is also known as Maximal Weighted Connected Dominating Set. With help of AODV Routing protocol heuristic MWMCDS Algorithm is implemented in Ad-Hoc Networks and performance is analysed using NS2 Simulation. In existing, minimum connected dominating set with weight factor but here weight factor is depend on routing process. Existing system doesn't setup the effective routing. So we can choose the MWMCDS with support of AODV routing protocol. This MWMCDS algorithm with AODV routing protocols show better performance by considering the performance metrics such as packet delivery ratio, end-to-end delay, control overhead and energy consumption than existing approaches.

Keywords—MANETS, AODV, MWMCDS, NS-2.

I. INTRODUCTION

How to design a efficient routing among a set of mobile hosts (also called nodes) is one of the most important functions in ad hoc wireless networks. Routing based on a minimum connected dominating set (MCDS) is a promising approach, where the search space for a route is reduced to nodes in the set (also called gateway nodes). So, to determine this set is a very vital problem. In this paper we used introduced MWMCDS, a simple and efficient heuristic algorithm for calculating minimum connected dominating set with maximal weight in the topology graph G of a ad hoc wireless network[2].

The performance of MWMCDS improves compare to existing method. Existing method is normal routing without any heuristic algorithm. Proposed method use MWMCDS Algorithm. Here we can shows difference between two methods and set a possible routes as based on efficient algorithm. The routing performance is more comparing to existing.

The mobile Ad-hoc network is collection of wireless mobile hosts or nodes forming a temporary network without aid of any established infrastructure. The entire collection of nodes is interconnected by number of ways. MANET can be easily deployed plug and communicate. There is more than one path from one node to another[2]. The nodes in a MANET can be of varying capabilities. In MANET, mobile nodes are interconnected by multi hop communication paths or radio links. A MANET consists of mobile platforms, known as nodes, which can move at any speed in any direction and organize themselves randomly. The nodes in the networks behave as client, routers and servers. Ad hoc wireless networking is a temporary, and an autonomous multi-hop-system consisting of (mobile) hosts with wireless receiver and dispatcher, where each host assumes the role of a router for its neighbours (they are within the transmission range of each other) and relays packets toward final destinations. It also is called an infrastructure less network or a self-organized network. Wireless ad hoc networks can be flexibly and quickly deployed for many applications such as emergency search-and-rescue operations, decision making in the battlefield, and data acquisition operations in inhospitable terrain, etc [3].

Ad hoc wireless networks have no established infrastructure or centralized administration, where every host can move to any direction at any speed and any time. This induces a dynamic topology. The characteristic put special challenges in routing protocol design, because it must take much expense (bandwidth, CPU, battery, etc) to find a route again when topology changes and at the same time topology may change again before it reaches convergent. So routing algorithm should converge quickly and decrease protocol overhead for looking route up, and improve performance and efficiency of route discovery.

Existing routing protocols [19] can be classified into three categories: proactive, reactive and the combination of the two. Proactive routing protocols ask each host (or many hosts) to maintain global topology information, thus a route can be provided immediately when requested. But large amount of control messages are required to keep
each host updated for the newest topology changes. Reactive routing protocols have the feature on-demand. Each host computes route for a specific destination only when necessary. Topology changes which do not influence active routes do not trigger any route maintenance function, thus communication overhead is lower compared to proactive routing protocol, but delay is too longer. The third category maintains partial topology information only in some hosts and routing decisions are made either proactively or reactively. The observations on these protocols show that none of them can avoid the involvement of flooding. For example, proactive protocols rely on flooding for the dissemination of topology update packets; Reactive protocols rely on flooding for route discovery. And that flooding suffers from the notorious broadcast storm problem [17], which refers to the fact that flooding, may result in excessive redundancy, contention, and collision. This causes high protocol overhead and interference to other ongoing communication sessions. Recently a hierarchical routing approach based on a virtual infrastructure on an ad hoc network is proposed in [11, 12, and 13]. Routing protocols are operated over this infrastructure, which is termed core. All core hosts (also called gateway nodes) form a dominating set. The gateway hosts in the connected dominating set form a high-level virtual backbone network. Each gateway host act as a control centre in own cluster and it simplifies the routing process to a smaller sub-network generated from the dominating set and introduces the new core broadcast mechanism which uses uni-cast to replace the flooding mechanism used by most on-demand routing protocols. In addition, we can use routing, mobility management and technology of network administration in the control centre-based network for reference, such as controlling the spatial reuse of the shared channel (e.g., in terms of time division or frequency division schemes). As a result, the method can minimize the amount of storage for communication information (e.g., routing and multicast tables) , minimize the amount of data to be exchanged in order to maintain routing and control information in a mobile environment, and optimize the use of the network bandwidth, distributing resources throughout the network etc. Clearly, the efficiency of this approach depends largely on the process of finding and maintaining a connected dominating set and the size of the corresponding sub-network. Unfortunately, computing an MCDS in a unit graph is NP-hard [14]. So the approximate algorithm for MCDS is needed to design in practical applications.

In ad hoc networks, all nodes are mobile and it can be connected dynamically in an arbitrary manner itself. As per the range of each host’s wireless transmission is limited, so it can communicate with hosts outside its transmission range, a host needs to enlisting the aid of its nearby hosts in that forwarding packets to the destination. So all nodes of these networks behave like as routers and takes a part in discovery and maintenance of routes to other nodes in the network configuration. Ad hoc Networks known that are very useful in emergency search-and rescue operations, meetings or conventions in which persons wish to quickly share information and data.[5]

MANET is type of Ad-hoc networks, is a collection of independent mobile nodes that can communicate to each other. The mobile nodes that are radio range of each user can directly communicate with users, whereas other nodes need to get the aid of intermediate nodes to route their packets. These networks are distributed, and can work together in that at any place without the help of any infrastructure. This property makes that these networks are highly flexible and robust.

In a MANET, each node not only works as a host but can also act as a router. While receiving data, nodes also need cooperation with each other to forward the data packets, thereby forming a wireless local area network. These great features also come with serious drawbacks from a security point of view. Indeed, the aforementioned applications impose some stringent constraints on the security of the network topology, routing, and data traffic. For instance, the presence and collaboration of malicious nodes in the network may disrupt the routing process, leading to a malfunctioning of the network operations [1].

The paper has been formed with the following sections. In section II, applications of Ad-hoc networks are depicted. In section III, various advantages of Ad-Hoc Networks are illustrated. Classifications of routing protocols are described in section IV. Various MANET routing protocols are depicted in section V. Heuristic algorithm used for the simulation has been illustrated in section VI. Various Steps for Simulation, Simulation environment and Simulation results are depicted in section VII, VIII and IX respectively. Conclusion is illustrated in section X.

II. Ad-Hoc Network Applications

1. Military Battlefield: Military equipment now routinely contains some sort of computer equipment [2]. Ad- hoc networking would allow the military to take advantage of common place network technology to maintain an information
network between the soldiers, vehicles, and military information headquarters. The basic techniques of ad hoc network came from this field.[4]

2. **Commercial Sector:** Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where non-existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small hand held [2]. Other commercial scenarios include e.g. ship-to-ship ad hoc mobile communication, law enforcement, etc.

3. **Local Level:** Ad hoc networks can autonomously link an instant and temporary multimedia network using notebook computers or palmtop computers to spread and share information among participants at e.g. conference or classroom [2]. Another appropriate local level application might be in home networks

### III. Advantages of Ad-Hoc Networks

The advantages of an ad hoc network include:
1. Separation from central network administration.
2. Self-configuring nodes are also routers.
3. Self-healing through continuous re-configuration.
4. Scalability incorporates the addition of more nodes.
5. Mobility allows ad hoc networks created on the fly in any situation where there are multiple wireless devices.
6. Flexible ad hoc can be temporarily setup at anytime, in any place.
7. Lower getting-started costs due to decentralized administration.
8. The nodes in ad hoc network need not rely on any hardware and software. So, it can be connected and communicated quickly [5].

### IV. Classification of routing protocols

Routing is the process of information exchange from one host to other host in the network. Routing is the mechanism of forwarding packets to the destination using efficient path is measure by various matrices like no. of hops, traffic, security,....etc[3]. In ADHOC network each host node acts as a specialized route itself. It is act of moving information from source to destination in and inter network. At least one intermediate node within the inter network is encountered during the transfer of information.

1. **PROACTIVE ROUTING PROTOCOLS**

Proactive protocols perform routing operations between all source destination pairs periodically, irrespective of the need of such routes. These protocols attempt to maintain shortest path routes by using periodically updated views of the network topology [4]. These are typically maintained in routing tables in each node and updated with the acquisition of new information. Proactive protocols have the advantage of providing lower latency in data delivery and the possibility of supporting applications that have quality-of-service constraints. Their main disadvantage is due to the wastage of bandwidth in sending update packets periodically even when they are not necessary, such as when there are no link breakages or when only a few routes are needed. Examples of Proactive MANET Protocols include: Optimized Link State Routing (OLSR), Fish-eye State Routing (FSR), Destination-Sequneced Distance Vector (DSDV) etc.

2. **REACTIVE ROUTING PROTOCOLS**

Reactive protocols are designed to minimize routing overhead. Instead of tracking the changes in the network topology to continuously maintain shortest path routes to all destinations, these protocols determine routes only when necessary [4]. Typically, these protocols perform a route discovery operation between the source and the desired destination when the source needs to send a data packet and the route to the destination is not known. As long as a route is live, reactive routing protocols only perform route maintenance operations and resort to a new route discovery only when the existing one breaks.

### V. MANET ROUTING PROTOCOL

Here we are described three MANET routing protocol these are (DSR) reactive, (ZRP) hybrid and (STAR) Proactive protocols in brief.

**A. Reactive (on demand) Routing Protocols**

In this routing information is acquired on-demand. Reactive routing protocols use two different operations to Route discovery and Route maintenance operation. Route maintenance is the process of responding to change in topology that happen after a route has initially been created, Route Maintenance is used to handle route breaks...
Dynamic Source Routing (DSR) [10] is a routing technique in which the sender of a packet determines the complete sequence of nodes through which the packet has to pass; the sender unambiguously lists this route in the packet’s header, identifying each forwarding hop by the address of the next node to which to transmit the packet on its way to the destination host. It also computes the routes when necessary and then maintains them. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. All aspects of the protocol operate entirely on demand, allowing the routing packet overhead of DSR to scale automatically to only what is needed to react to changes in the routes currently in use.

1.1) Route Discovery

Route Discovery [6] is used whenever a source node desires a route to a destination node. First, the source node looks up its route cache to determine if it already contains a route to the destination. If the source finds a valid route to the destination, it uses this route to send its data packets. If the node does not have a valid route to the destination, it initiates the route discovery process by broadcasting a route request message. The route request message contains the address of the source and the destination, and a unique identification number. An intermediate node that receives a route request message searches its route cache for a route to the destination. If no route is found, it appends its address to the route record of the message and forwards the message to its neighbours. The message propagates through the network until it reaches either the destination or an intermediate node with a route to the destination. Then a route reply message, containing the proper hop sequence for reaching the destination, is generated and unicast back to the source node.

1.2) Route Maintenance

Route Maintenance is used to handle route breaks. When a node encounters a fatal transmission problem at its data link layer, it removes the route from its route cache and generates a route error message. The route error message is sent to each node that has sent a packet routed over the broken link. When a node receives a route error message, it removes the hop in error from its route cache.

Acknowledgment messages are used to verify the correct operation of the route links. [6]

B. Hybrid Routing Protocol

Hybrid routing protocols are a new generation of protocol, which are both are Proactive and Reactive in nature. Most hybrid protocols proposed to date are zone based, which means that the network is partitioned or seen as a number of zones by each node. Normally, Hybrid routing protocols for MANETs exploit hierarchical network architectures [7][10]. The hybrid approach combines the table-driven and source initiated on-demand driven approaches such that the overhead incurred in route discovery and maintenance is minimized while the efficiency is maximized. The Zone Routing Protocol (ZRP) [10] partitions the network implicitly into zones, where a zone of a node includes all nearby nodes within the zone radius defined in hops. It applies proactive strategy inside the zone and reactive strategy outside the local zone. Each node may potentially be located in many zones. ZRP consists of two sub-protocols. The proactive intra zone routing protocol (IARP) is an adapted distance-vector algorithm. When a source has no IARP route to a destination, it invokes a reactive inter-zone routing protocol (IERP), which is very similar to DSR.

C. Proactive (Table Driven) Routing Protocol

Proactive routing protocols maintain information continuously. Typically, a node has a table containing information on how to reach every other node and the algorithm tries to keep this table up-to-date. Change in network topology is propagated throughout the network [8]. Examples: RIP STAR, RIPng, IGRP, OLSR INRIA, OLSRV2 etc. Source tree adaptive Routing (STAR) The STAR [16] protocol is based on the link state algorithm. Each router maintains a source tree, which is a set of links containing the preferred paths to destinations. This protocol has significantly reduced the amount of routing overhead disseminated into the network by using a least overhead routing approach (LORA) to exchange routing information. It also supports Optimum routing approach (ORA) if required. This approach eliminated the periodic updating procedure present in the Link State algorithm by making update dissemination conditional. As a result the Link State updates are exchanged only when certain event occurs. Therefore STAR will scale well in large network since it has significantly reduced the bandwidth consumption for the routing updates while at the same time reducing latency by using predetermined routes. However, this protocol may have significant memory and processing overheads in...
large and highly mobile networks, because each node is required to maintain a partial topology graph of the network. (It is determined from the source tree reported by its neighbours), which change frequently may as the neighbours keep reporting different source trees [8]

2) AODV ROUTING PROTOCOL

The main aim of AODV routing algorithm is to provide reliable and secure data transmission over the MANETS. The AODV [5] Routing Protocol uses an on demand approach for finding routes that is a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path the major difference AODV and DSR trunk out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed. In AODV the source node and the intermediate nodes store the next-hop information analogous to each flow for data packet transmission. In reactive routing protocol, the source node floods the Route Request (RREQ) packet in the network when a route is not available for the preferred destination. AODV and other on-demand routing protocols is that it uses a destination sequence number to determine an up-to-date path to the destination.

A Route Request carries the source identifier, destination identifier, source sequence number, destination sequence number, broadcast identifier, and time to live field. Destination sequence number indicates the freshness of the route that is accepted by the source. When an intermediate node receives a Route Request, it forwards a route reply if it has a valid route to the destination. The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the Route Request packet.

![Figure 1: AODV ROUTING PROTOCOL](image)

VI. Heuristic Algorithm used in Ad-Hoc Network

We used MWMCDs(Maximal Weighted Connected Dominating Set) Algorithm from paper “A Heuristic Algorithm for Minimum Connected Dominating” by YAN Xin-fang, SUN Yu-geng, HU Hua-don.

A) Description of the Algorithm

1. Initially, every node v in the network is assigned a unique identifier (ID) randomly and let m(v) = 0. All nodes are in S0 (i.e., each node’s role is undecided).

2. Each node v exchange its open neighbor set N1(v) with all its neighbors. Thus, node v knows information of N2(v); that is, its neighbor’s neighbor information.

3. Every node just with one neighbor first decides its own role based on rule (a), then this neighbor’s role is decided based on rule (b).

4. For v ∈ V each node first checks whether its own role has decided. If m(v) ≠ 0, then just record G(t) or join(u, t) that is received from its neighbors in the gateway routing table or gateway domain member list and continue next node. Otherwise, it calculates its own new state based on N2(v) information of node v.

The algorithm rule is as follows :

(a) If node u just has one neighbor t, then let m(u) = 1 and go to state S1, and u will broadcast the message join(u, t). Turn to next node.

(b) On receiving a join(u, t) message, node t sets m(t) = 2 and go to state S1, and broadcast a G(t) message to its neighbors stating that it will be a gateway node.

(c) Record node u in its gateway domain member list G(u)=t and turn to next node.

(d) If node v has received m(z) ≠ 0 from all its neighbors z such that wz > w, then calculates its own role based on rule (d); else turns to the node with the biggest weight among the neighbors of v’s in S0.

(e) If node v exists two unconnected neighbors x and y, i.e., satisfy: (x, v) ∈ E and (v, y) ∈ E, but (x, y) ∈ E, then it checks whether those gateway nodes among its N2(v) are connected. If they are unconnected, then sets m(v) = 2 and go to state S2. v will broadcast the message G(t). Turn to next node; else calculates its own role based on rule (e).

(f) Go to state S1, node v selects the gateway node with biggest weight among all its neighbor nodes. If t is not existent, v will keep waiting until tis
appeared, and then \( v \) will set \( m(v) = 1 \) and broadcast the message \( join(v, t) \). Turn to next node.

5. We will show that all the nodes terminate the algorithms being either gateway nodes or non-gateway nodes, and that the set of the gateway nodes in \( S2 \) is indeed a MWMCDS [1].

VII. Various Steps for Simulation

- Network initialized
- Nodes deployment in network
- Source and destination statically and remaining nodes are randomly placed
- Create the connectivity dominating set for every node in network
- Based on source, destination, routes and time interval CDS selection is available
- Route selection depend on neighbor node information
- Neighbor node it means like weight factor calculate for all nodes
- Based on CDS and weight factor passing information from source to destination
- Any two routes comparison and take information: hop nodes are less and weight factor is more these nodes select and through these nodes network process occur it means data transfer
- Here data delivering from source to destination efficiently based MWMCDS algorithm
- Packet delivery ratio, dropping ratio, energy consumption and delay these metrics wise, we proved this method is efficient.

VIII. Simulation environment

A) Network Simulator

According to dictionary, Simulation can be defined as "reproduction of essential features of something as an aid to study or training. In simulation, we can construct a mathematical model to reproduce the features of a phenomenon, system, or process often using a computer in order to information or solve problems. In this section we will introduce the most commonly used simulator NS2.

Architecture

Figure 2 shows the architecture of ns2. It provides that users with executable command ns which take on input argument and its name as Tcl scripting language. Users are feeding the name of Tcl script as an input argument of ns2 executable command of ns. In more cases, simulation trace file is created.

Ns2 consists of two key languages which are C++ and Otcl. C++ defines internal mechanism of simulation object. Otcl set the simulation by assembling and configure the objects and scheduling discrete events. Both two languages are link together using Tcl. The mapping to C++ object, variables in the otcl language referred to as handles. The handle is a string in otcl language and does not contain the any functionality. It means receiving a packet and defines in mapped object. In otcl language, a handle act as frontend and which interacts with users and other otcl objects. It defines own procedures and variables to facilitate the interaction. Before going to procedure of programming reads learn the both languages.

Fig2: Basic Architecture of NS-2

Ns2 provides a large number of built in C++ objects. These C++ objects use to setup a simulation using Tcl simulation script. Advance users are found these objects insufficient. They need to develop their own C++ objects and use otcl configuration to together these objects.

After simulation, ns2 outputs are text based or animation based results. To interpret these results graphically or interactively we have to use tools such as nam and xgraphs. To analyze a particular behavior of network, user can extract a relevant subset of text based data and transform to conceivable presentation.

Table: Simulation parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td>Ns-2.35</td>
</tr>
<tr>
<td>MAC Type</td>
<td>802.11</td>
</tr>
<tr>
<td>Protocols</td>
<td>AODV</td>
</tr>
<tr>
<td>No. of Nodes</td>
<td>30</td>
</tr>
</tbody>
</table>
Here data delivering from source to destination efficiently based on MWMCDS algorithm. This output was obtained by after running the NS2 simulator. Existing method implies AODV routing algorithm. This has been shown by red color in graph1. Our proposed method is MWMCDS with support of AODV routing protocol. This has been shown by green color in graph1. One part of the ns-allinone package is ‘xgraph’, a plotting program which can be used to create graphic representations of simulation results. Graph values taken from trace files. In Network, from starting to end of the process all values and variables and different set of values while considering all tracing and set up into one file that is called trace file. Here, we are showing the network process through Nam Window and represents total process in trace file and given graphical representation. Here with routing protocols AODV (Ad hoc distance vector routing protocol) and using heuristic algorithm MWMCDS in Ad Hoc Networks we are given following graph. Packet delivery ratio, dropping ratio, energy consumption and delay these metrics wise, we proved this method is efficient.

**IX. Simulation Results**

**Explanation:**

The above graph shows and represents energy consumption and it shows a simulation time versus energy. The performance of MWMCDS improves compared to existing method. Here, we can show the difference between two methods and set a possible route as based on efficient algorithm. The routing performance is more compared to existing. The proposed system efficient based on weight and neighbour information with energy level of nodes.

**Graph1: A Comparative Study on Packet delivery ratio**

**Explanation:**

The above graph shows and represents packet delivery ratio and it shows a simulation time versus delivery ratio. The performance of MWMCDS improves compared to existing method. Here, we can show the difference between two methods and set a possible route as based on efficient algorithm. The
routing performance is more comparing to existing. The proposed system efficient based on weight and neighbour information. Here set of rules based on and based on routing performance dropping occur.

![Graph4: A Comparative Study on End to End delay](image)

**Explanation:**
The above graph shows and represents end to end delay and it shows a simulation time versus delay. The performance of MWMCDS improves compare to existing method. Here we can shows difference between two methods and set a possible routes as based on efficient algorithm. The routing performance is more comparing to existing. The proposed system efficient based on weight and neighbour information. The delay of network depends on transmission time and bandwidth of nodes.

X. Conclusion

This paper focuses on application of MWMCDS for routing in ad hoc and wireless networks. Here, a communication network is modelled as a graph and a weight metric is assigned to each node and communication link. In existing, minimum connected dominating set with weight factor but here weight factor is depend on routing process existing system doesn't setup the effective routing so we can choose the MWMCDS with support of AODV routing protocol. The performance of MWMCDS improves compare to existing method. Existing method is normal routing without any heuristic algorithm. Proposed method uses MWMCDS Algorithm. The existing MWMCDS algorithm with AODV routing protocols show better performance by considering the performance metrics such as packet delivery ratio, end-to-end delay, control overhead and energy consumption. In future we can also add any another heuristic algorithm with AODV routing protocols to show better performance.

XI. References