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Study and Design of Always an Alternate Route Available Protocol for MANET

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ABSTRACT: *Past few years, have witnessed a rapid growth in the field of mobile computing due to proliferation of inexpensive, widely available wireless devices. Thus, it has opened vast opportunity for researchers to work on Ad Hoc Networks. Routing is one of the most important open issues in MANET research. Some of the desirable properties of such networks are distributed operation, loop freedom, demand based operation, security, unidirectional link support, multiple route and power conservation. None of the proposed protocols from MANET have all these properties, but it is necessary to remember that the protocols are still under development and are probably extended with more functionality. The primary function is still to find a route to the destination, not to find the best/optimal/shortest-path route. In this paper, the Ad hoc On-demand Distance Vector (AODV) routing protocol is improved to support primary route and alternate route for route discovery process that can significantly reduce end-to-end delay and increase packet delivery ratio under conditions of high load and moderate to high mobility. In this paper, we propose Always an Alternate Route Available (AARA) protocol for utilizing and modifying the lower layer services, also presenting a Two Hop Routing (THR) with Buffered (Store and forward) Model. This work proposes to modify the functionality of the existing protocols and presents a system which provides an alternate route with packet buffering. The simulation of the work verifies that the presented model performs better by making the packet flow smoother; provide less end-to-end delay, produce low overhead with minimum packet drops.*

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I. INTRODUCTION

The field of wireless communication is becoming more popular than ever before due to the rapid advancement of wireless technologies and the wide spread of mobile devices. The deployment of a MANETs is easy due to the absence of setting up any infrastructure for communication. Mostly such kind of networks are required in military application and emergency rescue operations. But slowly MANETs have entered with the areas of gaming, sensing, and conferencing, collaborative and distributed computing [3]. This dynamic network is yet to capture most of the commercial applications. Research is still going on in this direction so that the MANET can be deployed in any area where a faster and cheaper network can be setup instantly for data communication. Furthermore, these nodes may be equipped with different transmission technologies [2] even though the transmission medium is shared. As a result, nodes are challenging to send their data, and they must wait a random amount of time. This generates undesirable delays, and in some cases, collisions may occur, which increases routing overhead. This is known as the Broadcast Storm Problem (BSP).

Routing in MANET is one of the most important open issues in research. Researchers have proposed number of routing protocols which discover route proactively, reactively or using hybrid approach. While proactive approaches generate a lot of overhead, reactive methods does not have pre-knowledge of the routes, and would discover when desired thus tending to be slow during dynamic situations. Since there is no central infrastructure in ad hoc network, the nodes themselves must act as the routers for route discovery and transmission as well. As such the path to destination may involve number of hops (multihop) and the node being mobile will lead to frequent route breakage. This multihop nature and mobility of the nodes further generates new research problems such as configuration advertising, discovery, and maintenance, as well as ad hoc addressing and self-routing. In this paper, the Ad hoc On-demand Distance Vector (AODV) routing protocol is improved to support primary route and alternate route for route discovery process that can significantly reduce end-to-end delay and increase packet delivery ratio under conditions of high load and moderate to high mobility. Recently, several routing protocols have been used in MANET, including the Ad hoc On-demand Distance Vector (AODV) protocol, Dynamic Source Routing (DSR), Location Aided Routing (LAR), Optimum Link State Routing (OLSR) and Dynamic Sequence Distance Vector Routing (DSDV) protocols.

The work presented in this paper is organized as follows. Section-II described the existing systems. In section-III describes the proposed protocol in detail. In section-IV presents simulation parameters and scenarios used to valid the proposed protocol. Section-V gives the results and discussion. Finally, the conclusions and future work are presented in Section VI.

II. EXISTING SYSTEM

In the original AODV each source node maintains an alternative route based on bandwidth parameter to the specified destination node. When the primary route fails, the source node will use the alternate route to send packets. In the proposed AARA protocol source node not only improves the packet routing process, packet delivery fraction and reduce the average end to end delay and the route discovery frequency. This model proposes number of methods at various layers of the reference model for achieving an alternate route. As the major thrust is on finding an alternate route at various layers have been explored for taking advantage of the existing systems.

A. Utilising lower layer services in routing

Physically a node in MANET consist of all the components such as transmitter, receiver, routing agent, error checking mechanism, flow mechanism, packet integrity checker etc. All these components, their position in the node and the functionalities are shown in below Fig.1 of the lower layer of the OSI model.

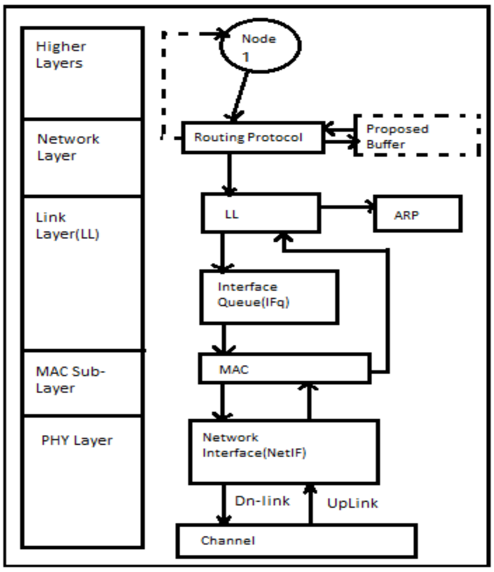

Fig.1: Physical Layout of Node, and its relation with OSI Model

B. Medium Access Control (MAC) layer

MAC layer must contain certain set of functionalities such as: carrier sense, collision detection, collision avoidance, etc. For sending, the MAC object must follow a certain medium access protocol before transmitting the packet on the channel.

This layer implements the medium access protocols that are necessary in the shared medium environment such as the wireless and local area networks. Because the sender and the receiver at this layer are tightly coupled in most types of MAC layers, the communication at this layer is duplex. The MAC layer is responsible for adding the MAC header at sending end and to transmit the packet onto the channel. On the receiving side, it asynchronously receives packets from the physical layer, 86 processes it, and passes it upstream to the link layer.

C. Logical Link Layer

The most important function of the link layer is setting the MAC destination address in the MAC header of the packet. Normally the layer is involved in two separate issues: finding the next-hop-node's IP address (routing) and resolving this IP address into the correct MAC address (ARP). For simplicity, the default mapping between MAC and IP addresses is one-to-one, which means that IP addresses are re-used at the MAC layer.

The link layer activities are divided in two parts by breaking it in two sub-layers. These are link layer and medium access layer. In this link layer, we take a brief look at the working principle of the protocol of this layer such as ARP, ARQ, and carrier sensing. IP operate independent of the lower layer, i.e. the node should be able to talk using the IP address. Thus, there should be an address resolution mechanism (like Address Resolution Protocol ARP) that maps IP addresses to link-layer addresses before transmitting datagram between IP peers attached. But ARP handles neighbor discovery and address resolution in infrastructure networks, so is inadequate for mobile ad hoc networks (MANETs).

In this paper, we propose to utilize the neighbor node discovery with the help of the Hello packet for one hop nodes and RREQ for nodes more than one hop.

D. Automatic Repeat request (ARQ)

Automatic Repeat request (ARQ), also known as Automatic Repeat Query, is an error-control method for data transmission that uses acknowledgements (messages sent by the receiver indicating that it has correctly received a data frame or packet) and timeouts (specified periods of time allowed to elapse before an acknowledgment is to be received) to achieve reliable data transmission over an unreliable service. If the sender does not receive an acknowledgment before the timeout, it usually re-transmits the frame/packet until the sender receives an acknowledgment or exceeds a predefined number of retransmissions. The ARQ is also called as Stop – and – Wait protocol.

E. Packet Buffering Model

The nodes in an Ad Hoc network have unpredictable movement and thus the dynamic topology. There are number of situations in which a route to the desired node may not be available and hence the communication is disrupted one such is illustrated in Fig.2. As discusses in our modified approach of ARQ, a node transmits a packet to the next hop, the next hop stores the packet till the acknowledgement is received from the next hop. In case of multi-source transmission, it is desirable that a node has sufficient buffer for the packet to be stored from different sources. We further bring out some of the situations leading to the need for a large buffer at every node.

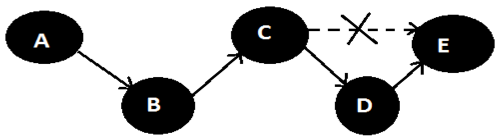

Fig.2: Situation of Link Breakage, requiring Packet Buffering

III. PROPOSED SYSTEM

AODV is a reactive routing protocol for MANETs that uses hop count as metric for route selection. It uses three main message types for route discovery and maintenance: Route Request (RREQ), Route Reply (RREP) and Route Errors (RERR) messages. When a source node needs to send data, it initiates a route discovery process by broadcasting a route RREQ) message to its neighbors until it reaches the destination. or an intermediate note with a valid route to the destination or any intermediate nodes having a fresh route to the destination generates a route reply (RREP) in response to the RREQ [4]. Each node stores only information of the next hop in a route to a destination. Whenever a link breakage occurs, any node detecting this immediately notifies all nodes that used the link that the link no longer exists. This is done by sending a RERR message to all these nodes.

A. Always an Alternate Route Request

Packet Structure

Few additions are made to the routing table entries and routing tables of AODV to satisfying primary route and alternate route for packet delivery. We add a flag in the aodv_rt_entry class to distinguish between primary routes and alternative routes, and we also add two functions in the aodv_rtable class which are used to add and find an alternative route in routing tables. As in AODV if either the destination or any intermediate nodes having a fresh route to the destination generates a route reply RREP in response to the RREQ. When a source node needs to send a packet to a destination node while there is not a valid route in the routing table, it broadcasts a route request packet RREQ to find a route to the destination node. A RREQ packet contains source identifier, destination identifier, source sequence number, broadcast identifier, time to live field, and a hop count. When each node receives the RREQ, it creates or updates a reverse route to the source node in the routing table based on the residual bandwidth and requested bandwidth and stores these values in the routing table of node. If the node does not have a valid route to the destination node in the routing table, it rebroadcasts the RREQ. If each node has a valid route to the destination node in the routing table when it receives the RREQ, it sends the RREP to the source node along with the reverse route. During the route discovery process, when each node receives the RREQ that it has been already processed, it discards the RREQ, which guarantees loop freedom. The Alternate Route Request Packet Structure is shown in below table 1.

Option Type	Flags	raodv_rt_entry	Hop Count
SRC IP address	Dest IP address		
Src Seq Num	Dest Seq Num		
RREQ ID			

Table 1: Alternate Route Request Packet Structure.

In Fig. 3 Node 1 broadcast the RREQ to find the best possible route to the destination by considering the Residual bandwidth and the Requested bandwidth with the different set of nodes in the transmission range.

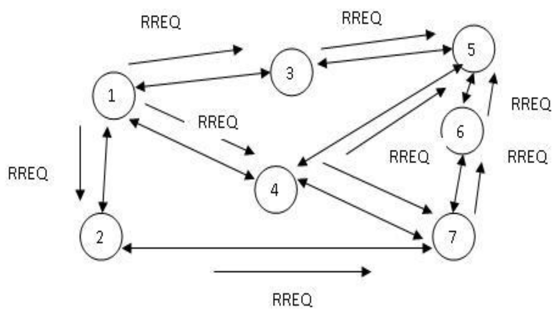

Fig.3: Route Request for finding route from source to destination.

When a node needs a new route to a destination, it initiates a route discovery process.

B. Two Hop Routing Protocol

Two Hop Routing (THR) is a hybrid of table driven and reactive routing protocol. Instead of maintaining the information about each node as in proactive routing protocol, THR only maintains the information about the immediate neighbor and its next neighbor i.e. information about the neighbor's neighbor. Thus, our approach will discover the destination route in less number of broadcasts and consume less power. The node will thus maintain one addition routing table called two hop tables. The basic principle of operation of the THR protocol is as follows: When a node wish to transmit data packet to some destination node, it first checks its own routing table which contains route to two hop distant node if the route is found then the packet is transmitted to the destination node else a route discovery is initiated by the source node avoiding the routing loops as discussed in many reactive routing protocols such as DSR, AODV etc.

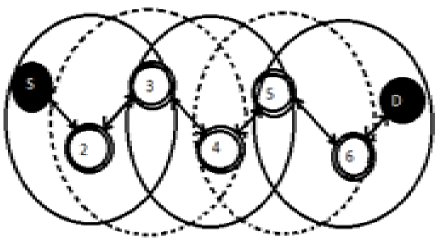

Fig.4: Route Discovery in THR

In our proposed routing protocol, a routing path is constructed by the combined proactive and reactive process in that short beacons are transmitted by every node to know about their immediate and the next node a in Fig.4. Unlike the pure proactive protocol, the n^{th} node in our approach gets info about $n+1^{st}$ and $n+2^{nd}$ in the visibility range. The information so obtained is stored by the nodes in their internal table known as LRT (local route table). When a node (S) needs to send data to some destination node (D), the node S will first check a route in its LRT If a route to destination exists, data packet is transmitted to destination. On the other hand, if destination info is not found in LRT, a path (the main route) from source node S to destination node D need to be constructed before source node S can start the data transmission. The process of finding such a routing path is called the main route construction, which begins with the source node S sending a main route request (MRREQ) to all its neighbors. Every host that receives the MRREQ acts exactly same as the source node does. MRREQ is thus flooded over the network, and would eventually arrive at node D - 2. Node D - 2 will send a route reply (RREP) to the source in h-2 hop counts, where h represents the hop count from source to the destination. Every node that receives the RREP will also keep a record of the main route to the destination node D, thus keep the details of the most recent and newer route that a node has seen. The formation of the local routing table shown in Table 2 is built by using short interval Hello packets.

Source Node	Intermediate One Hop Node	Two Hop Node	Hop Count
S	2	3	2
2	3	5	2
2	S	-	1
3	2	S	2
3	4	5	2
4	3	2	2
4	5	6	2
5	4	3	2
5	6	D	2
D	6	5	2

Table 2: Two Hop Table

IV. NETWORK SIMULATOR

A network simulator is a software program that imitates the working of a computer network. In simulators, the computer network is typically modelled with devices, traffic etc and the performance is analyzed. Typically, users can then customize the simulator to fulfil their specific analysis needs. Simulators typically come with support for the most popular protocols in the use today, such as Wireless LAN, Wi-Max, UDP, and TCP. A network simulator is a piece of software or hardware that predicts the behaviour of a network, without an actual network being present. NS is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend.

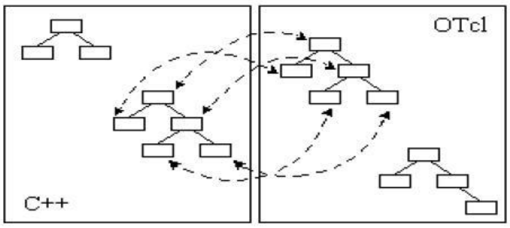

Fig. 5. Flow chart for C++ and OTcl

The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. The two hierarchies are closely related to each other; from the users perspective, there is one-to-one correspondence between a class in the interpreted hierarchy and one in the compiled hierarchy. The root of this hierarchy is the class Tcl object. Users create a new simulator objects through the interpreter; these objects are instantiated within the hierarchy. The interpreted class hierarchy is automatically established through methods defined in the class Tcl object. There are other hierarchies in the C++ code and OTcl scripts; these other hierarchies are not mirrored in the manner of Tcl object is shown in the figure 5.

A. USES OF NETWORK SIMULATORS

Network simulators serve a variety of needs. Compared to the cost and time involved in setting up an entire test bed containing multiple networked computers, routers and data links, network simulators are relatively fast and inexpensive. They allow engineers to test scenarios that might be particularly difficult or expensive to emulate using real hardware- for instance, simulating the effects of sudden bursts in the traffic or a Dos attack on a network service. Networking simulators are particularly useful in allowing designers to test new networking protocols or changed to existing protocols in a controlled and reproducible environment. Typical network simulators encompasses a wide range of networking technologies and help the users to build complex networks from basic building blocks like variety of nodes and links. With the help of simulators, one can design hierarchical networks using various types of nodes like computers, hubs, bridges, routers, optical cross-connects, multicast routers, mobile units, etc. various types of Wide Area Network (WAN) technologies like TCP, ATM, IP etc and Local Area Network (LAN) technologies like Ethernet, token rings etc, can all be simulated with the typical simulator and the user can test, analyze various routing etc.

C. SIMULATION AND RESULTS

We use NS simulator for simulating different routing protocols. It uses a virtual tool called NAM. NAM is a Tcl based animation tool for viewing network simulation traces and real-world packet trace data. The design theory behind NAM was to create an animator that can read large animation data sets and be extensible enough so that it could be used in different network visualization situations.

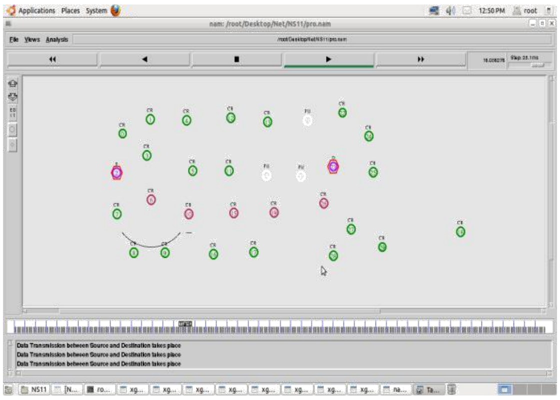

Fig.6. Route establishment between Different Types of Cluster Head

In Fig.6 the routing establishment between different types of cluster head, in this the data packets are transmitted from source node to destination node using intermediate nodes. In above figure, all the nodes are divided into different clusters and the information is transmitted through these clusters. To evaluate and compare the performance of the proposed work with various routing protocols based on different parameters.

Packet delivery ratio: Packet delivery ratio is defined as ratio of number of packets received by the destination to the number of packets originated by the source. It specifies the packet loss rate, which limits the maximum throughput of the network. Better the packet delivery ratio indicates the efficient routing protocol and its performance increased. The packet delivery ratio vs number of nodes is plotted in below figure 7.

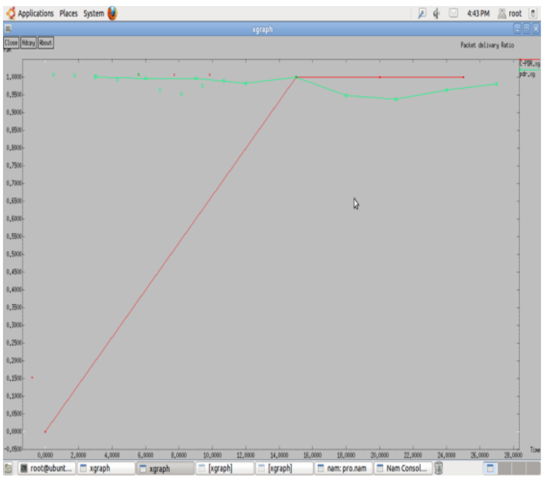

Fig.7: Packet delivery ratio Vs no. of nodes

The above figure 7 shows highest improvement in packet delivery ratio when increased the number of nodes.

Average End-to-End Delay: It is defined as the average time it takes a data packet to reach the destination. This metric is calculated by subtracting time at which first packet was transmitted by source node from time at which first data packet arrived at the destination node. The plot of end-to-end delay vs number of nodes is shown in below figure 8.

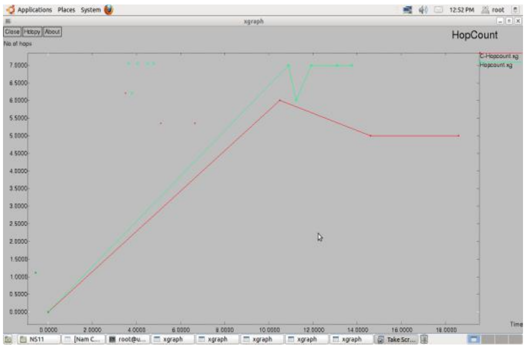

Fig.8: Average End-to-End Delay Vs no. of nodes.

It is observed that there is a significant improvement in the delay in DSDV routing protocol as the number of nodes increase. As the nodes increase, AAR protocol and THR shows the least delay among the different protocols.

V. CONCLUSION AND FUTURE DIRECTIONS

The research in MANET has been going on, with the researchers presenting new and smarter techniques. Modifications at lower layer as explained in this work, further require implementation up-gradation in the hardware/software model

The presented work suits to situations where the link break frequently and where terminating the current traffic and retransmitting the whole proves to be a costlier affair. The simulation work proves the performance of this work. This research can be extended for the development and implementation in the mobile devices and use in real time situations and the overhead of keeping the alternate route information and the buffering model presented in this work demands additional memory requirement. This opens scope better memory handling routines and hardware design. Modifications at lower layer as proposed in this work, further require implementation up-gradation in the hardware/software model

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VII. BIOGRAPHIES

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