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Integrated Network Platform for Next Generation Networks

S.ANAND KUMAR[1],DR.K.E.SREENIVASA MURTHY[2]

[1]Asst.Professor, Sreenivasa College of Engineering,Kurnool, AP-India,anand.80.kumar@gmail.com,

[2]Prof, ECE Dept,Sri Kottam Thulasi Reddy Memorial College of Engineering,MahabubNagar,AP-India.

Abstract: An **ad-hoc** network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. In such an environment, it may be necessary for one mobile host to enlist the aid of other hosts in forwarding a packet to its destination, due to the limited range of each mobile host's wireless transmissions. In this work we study the distributed implementation of multicost routing in mobile ad hoc networks. In contrast to single-cost routing, where each path is characterized by a scalar, in multicost routing a vector of cost parameters is assigned to each link, from which the cost vectors of the paths are calculated. These parameters are combined according to an optimization function for selecting the optimal path. Up until now the performance of multicost routing in ad hoc networks has been evaluated either at a theoretical level or by assuming that nodes are static and have full knowledge of the network topology and nodes' state. In the present paper we assess the performance of multicost routing, based on energy-related parameters, in mobile ad hoc networks by embedding its logic in the Dynamic Source Routing (DSR) algorithm, which is a well-known distributed routing algorithm. We compare the performance of the multicost-DSR algorithm to that of the original DSR algorithm under various node mobility scenarios. The results confirm that the multicost-DSR algorithm improves the performance of the network in comparison to the original DSR, by reducing energy consumption overall in the network, spreading energy consumption more uniformly across the network, and reducing the packet drop probability and delivery delay.

Keywords-- Ad hoc networks, routing, multicost, DSR.

I.INTRODUCTION

In recent years, the field of wireless networking emerges from the integration of personal computing, cellular technology, and the Internet. This is due to the increasing interactions between communication and computing, which is changing information access from "anytime anywhere" into "all the time, everywhere." At present, a large variety of networks exists, ranging from the well-known infrastructure of cellular networks to non-infrastructure wireless ad-hoc networks. So, wireless ad hoc networks have been a growing area of research. Almost all Ad-hoc networks to date are based on IEEE 802.11.

Wireless communication enables information transfer among a network of disconnected, and often mobile, users. Popular wireless networks such as mobile phone networks and wireless LANs are traditionally infrastructure-based, i.e. base stations, access points and servers are deployed before the network can be used. In contrast, mobile ad hoc networks (MANET's) are dynamically formed amongst a group of wireless users and require no existing infrastructure or pre-configuration. The resource, power limitations and variability further add to the need for QoS provisioning in MANET's.

An Ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. In such an environment, it may be necessary for one mobile host to enlist the aid of other hosts in forwarding a packet to its destination, due to the limited range of each mobile host's wireless transmissions. This project presents a protocol for routing in ad hoc networks that uses dynamic source routing and node failure prediction QoS routing. The protocols adapts quickly to routing changes when host movement is frequent, yet requires little or no overhead during periods in which hosts move less frequently and in addition NFPQR overcomes the problem of limited power capabilities which leads to node failure.

II. EVOLUTION OF NETWORKS

Mobile computers (such as note book computers) are the fastest growing segment of the computer industry. Many of the owners of these computers have desktop machines on LANs and WANs back at the office and want to be connected to their home base even when away from home. Since having a wired connection is impossible in cars and airplanes, there is a lot of interest in wireless networks. In the past few years wireless LANs have come to occupy a significant niche in the Local Area Network market. Increasingly, organizations are finding that wireless LANs are an indispensable adjunct to the traditional wired LANS, to satisfy requirements for mobility, relocation, ad hoc networking and coverage of locations difficult to wire.

A wireless LAN (WLAN) is a flexible data communication system implemented as an extension to, or as an alternative for, a wired LAN within a building or campus. Using electromagnetic waves, WLANs transmit and receive data over the air, minimizing the need for wired connections. Thus, WLANs combine data connectivity with user mobility, and, through simplified configuration, enable movable LANs.

Over the last seven years, WLANs have gained strong popularity in a number of vertical markets, including the health-care, retail, manufacturing, warehousing, and academic arenas. These industries have profited from the productivity gains of using hand-held terminals and notebook computers to transmit real-time information to centralized hosts for processing. Today WLANs are becoming more widely recognized as a general-purpose connectivity alternative for a broad range of business customers.

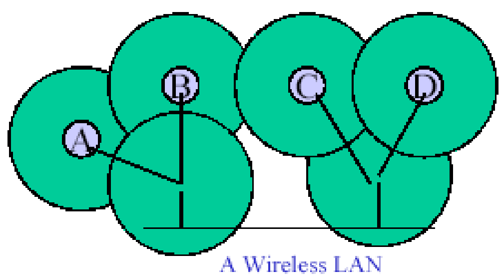


Figure1 Wireless LAN

a) Reliable infrastructure wireless networks

The wireless nodes also connected to the wired network and able to act as bridges in a network of this kind are called base-stations. An example of this is the cellular-phone Networks where a phone connects to the base-station with the best signal quality. When the phone moves out of range of a base-station it does a hand-off and switches to a new base station within the reach. The hand-off should be fast enough to be seamless for the user of the network. Other more recent networks of this kind is wireless networks for offices, cafes etc. which usually are called Wireless Local Area Networks (WLAN).

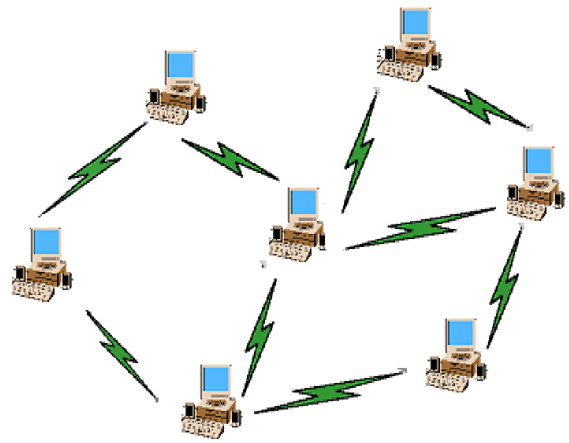


Figure2 Wireless AD-HOC network

b)Orthogonal kind

The other kind is the orthogonal kind. One where there is no infrastructure at all except the participating mobile nodes. This is called an infrastructureless network or more commonly an ad hoc network. The word ad hoc can be translated as improvised or into organized which often has a negative meaning, but the sense in this context is not negative but only describing the network situation, i.e. dynamic.

Ad hoc networks are an upcoming technology. With the advent of wireless and mobile devices they provide a new paradigm of computing. Ubiquitous computing and mutual data exchange without any existing infrastructure will become more and more important in the future. Business, safety and military applications already exist but the demand for higher data rates, more security and more convenient connection establishment is a driving force in the development of new ad hoc networking technologies. In Europe, few research groups concerning ad hoc networks exist. Along with the possible establishment of new research groups goes the need for a comprehensive view of ad hoc networking related topics, to help people getting involved as quickly as possible.

These examples of spontaneous, ad hoc wireless communication between devices might be loosely defined as a scheme, often referred to as ad hoc networking, which allows devices to establish communication, anytime and anywhere without the aid of a central infrastructure. Actually, ad hoc networking as such is not new, but the setting, usage and players are. In the past, the notion of ad hoc networks was often associated with the use of developing radio technologies communication on combat fields and at the site of a disaster area; now, as novel technologies such as

Bluetooth materialize, the scenario of ad hoc networking is likely to change, as is its importance.

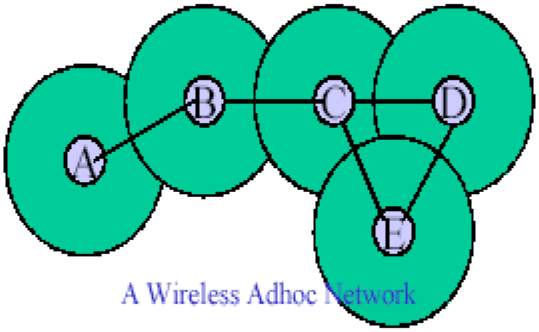


Figure 3 Wireless AD-HOC network

All or some nodes within an ad hoc are expected to be able to route data-packets for other nodes in the network who want to reach other nodes beyond their own transmission range. This is called peer-level multi-hopping and is the base for ad hoc networks that constructs the interconnecting structure for the mobile nodes. An ad hoc network is usually thought of as a network with nodes that are relatively mobile compared to a wired network. Hence the topology of the network is much more dynamic and the changes often unpredictable oppose to the Internet, which is a wired network. This fact creates many challenging research issues since the objectives of how routing should take place is often unclear because of the different resources like bandwidth, battery power and demands like latency and other types of QoS. The routing protocols used in ordinary wired networks are not well suited for this kind of dynamic environment. They are usually built on periodic updates of the routes and create a large overhead in a relative empty network and also cause slow convergence to changes in the topology. So, we go for RIMA algorithm to implement the topology in ad hoc networks.

Ad Hoc mobile networking is the uncharted frontier of contemporary networking technology, and a research area which at this time is being heavily funded in the US. In essence, Ad Hoc networking is all about providing connectivity between mobile nodes, which have no supporting connections to the fixed networking infrastructure. In an Ad Hoc mobile network, every node in the network carries its own router with it, and all nodes cooperate in carrying traffic. The whole philosophy of the Ad Hoc networking model is a radical departure from the highly structured, and frequently hierarchical models employed for both local area and wide area networking, currently in use.

In the established, fixed infrastructure model, the routers and supporting functions such as name resolution are all embedded within the networking infrastructure. Communication between a pair of nodes requires that the nodes hand the traffic over to the routers, which then forward the traffic over multiple router hops until it arrives at the destination router, which then passes the traffic to the recipient node.

In this model, with the exception of the odd host tasked with acting as a router, mostly the routing function is performed by the network, and the nodes are essentially clients of the "connectivity service" provided by the networking infrastructure. The model is hierarchical, in so far as traffic from small cells or subnets is concentrated as it flows up into the network, which aggregates the traffic associated with multiple virtual circuits or datagram connections, and carries it across specific point to point communications links to the geographical area within which the destination (or source) nodes are situated. An Ad Hoc mobile network is essentially incompatible with this basic model, since it is highly time variant in topology. At this point it is worth digressing into the practical, application oriented, aspects of the Ad Hoc network, since the technology promises many services which have hitherto been inconceivable.

The simplest Ad Hoc network can be envisaged as a wireless radio network between a collection of vehicles, ships, aircraft, or even people on foot, operating in a geographical area with no networking infrastructure. Many examples of such scenarios come to mind. A fleet of fishing vessels searching for schools of fish on the high seas, a seismic survey team in a remote area, a disaster relief operation, or aid operation, trying to function in an area which has been stripped by a natural disaster of its communications infrastructure, or if in the Third World, never had one in the first place. Scientists on field outings, or indeed even a class of school-children on an outing into a national park, all carrying laptops or wearables. Cars and trucks on country highways or freeways, with onboard Internet connectivity.

There are, of course, also a myriad of military applications involving the networking of aircraft, helicopters, tanks, ships, and even infantrymen with wearable computers. The range of possible situations in which Ad Hoc networking can be exploited is huge, and this is not an understatement by any measure. A robust Ad Hoc networking scheme frees the individual from the geographical constraints of the fixed network. In this respect it is fundamentally different from established mobile networking, in which mobile nodes are tied down by the need to remain within the coverage of a wireless hub, connected to the fixed network infrastructure.

An Ad Hoc network, by its nature, provides mutual connectivity between cooperating peer nodes. Nodes which cannot directly communicate, are assisted by other nodes between which connectivity exists, and which can connect to the end nodes which intend to communicate. Therefore, every node in an Ad Hoc network must have the capability to perform as a router if its peers require it to do so. Mutual connectivity does not imply the ability to access the fixed infrastructure, and if connectivity to the fixed infrastructure is required, then at least one node in the Ad Hoc network must have the ability to connect to the fixed infrastructure and carry traffic into and out of the Ad Hoc network.

III. ROUTING MODELS

The routing problem really decomposes into two problems. One is that of "route discovery", the other is that of "route maintenance" whereby the validity of discovered routing information is maintained. Topologies in Ad Hoc networking are an issue within themselves. In essence, nodes may move around with no clear geometrical interrelationship, or may form clusters associated with groups of individuals or vehicles moving around in relatively close mutual proximity, or nodes may also form "linear topologies", when vehicles travel down roads, railways, shipping lanes or air routes.

a) Flat topology

- **Sparse topology**

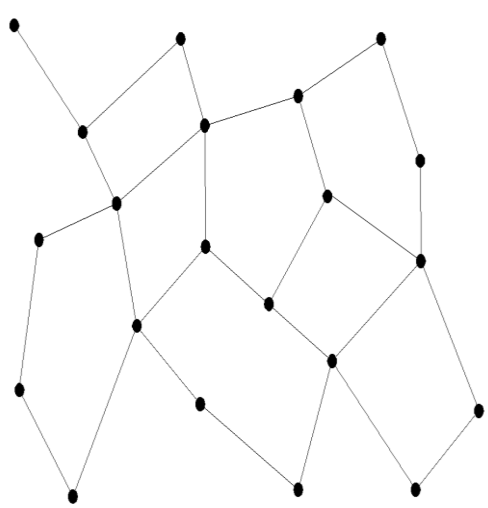


Figure4. Sparse topology

Two different architectures exist for an Ad-hoc network: flat and hierarchical. In a general sense, routing models are either based upon a "Flat Topology" model, or a "Hierarchical Topology" model. In the former, all nodes are peers, in the latter one node within a cluster gathers traffic on behalf of "lesser" nodes in the cluster, and is responsible for carrying this traffic in and out of the cluster. The Hierarchical Topology is in many respects an offshoot of the static networking model, and has generally not been a popular research area, since it can result in less than optimal routing behaviour. Flat Topologies are in most situations the best approach, since they can provide for redundant paths in and out of cells, and should protocol support exist, load balancing across multiple links.

- **Dense topology**

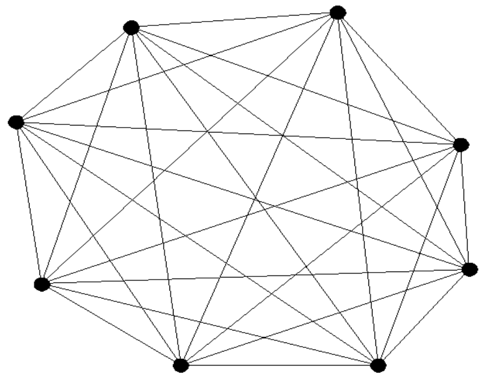


Figure5. Dense topology

b) Hierarchical topology

- **No strict topology**

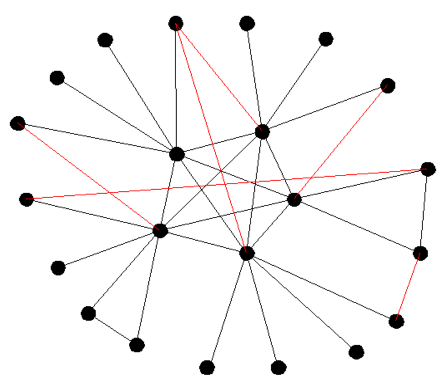


Figure6 No strict topology

- **Strict topology**

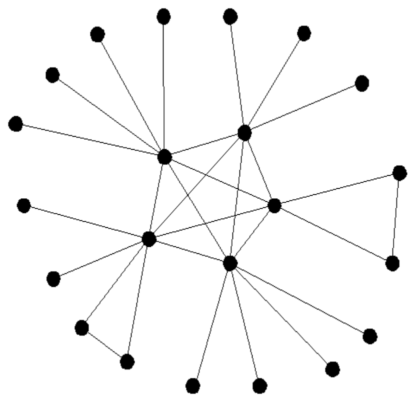


Figure7. No strict topology and Strict topology

IV. ADHOC NETWORK TOPOLOGIES

a)Static One Hop Topology

The static one hop topology consists of a number of nodes in direct mutual communication range. The maximum distance between two nodes is one radio hop, all stations are within that radio cell. The hidden node problem and exposed node problem do not exist by definition, since those effects only occur with multiple radio hops. The nodes within the network do not seem to move with respect to the connectivity. Since this network configuration is the simplest, it is the most appropriate way to demonstrate the different systems properties and behaviors and it will be used throughout this report unless otherwise stated.

b)Static Multi Hop Topology

The connections in static multi hop topology are static, too, i.e the nodes do not move significantly. However, the distance between two nodes may be more than one radio-hop. This implies the existence of hidden nodes and exposed nodes. Static multi hop topology involves the discovery of appropriate connections (routing).

c) Dynamic Multi Hop Topology

In addition to the increased size of the multi hop network, we now allow dynamic movements of the nodes within the whole network. The result is a constantly changing communications structure. This demands continuous observation of routes, and performing of handovers, to keep all nodes connected. Again, hidden nodes and exposed nodes exist.

d) Scatter Ad Hoc Topology

The term scatter Ad hoc network has been introduced with bluetooth to describe multiple overlapping independent networks. The single networks are usually considered as being single hop, and the overlapping networks as mainly not interfering with each other. Nodes of an Ad hoc network can range in complexity from simple sensors located in the field to fully functional computers, such as laptops. An implication of this diversity is that not all nodes will be able to contribute equally to the management task. For instance, it is likely that sensors and small personal digital assistant (PDA) type devices will contribute minimally to the task of management, while more powerful machines will need to take on responsibilities such as collating data before forwarding it to the management station, tracking other mobiles in the neighborhood. As they move, etc.. thus, the management protocol needs to function in very heterogeneous environments.

One mission of network management protocol is to present the topology of the network to the network manager. In wire line networks, this is a very simple task because changes to the topology are very infrequent (example a new node gets added, failure of a node or addition or deletion of a subnet, etc.,). In mobile networks, on the other hand, the topology change very frequently because the nodes move about constantly, thus, the management station needs to collect connectivity information from nodes periodically. An implication of this is an increased message overhead in collecting topology information.

V. Technological challenges of Ad-Hoc routing

The technological challenges of Ad Hoc routing are very much non-trivial, The first "package" of problems derive from the continuously varying topology, and potential throughput, of the Ad Hoc network.

1. Topology varies simply because some nodes will move in and out of wireless link range of other nodes in the network, be it through distance, or concealment behind terrain or other obstacles which prevent transmission, such as inclement weather or rain which soaks up microwaves and laser beams.

2. Network throughput will vary for two reasons. The first, and obvious reason, is that the larger the number of hops your traffic has to travel across to get to where it is going, the greater the routing delays you incur, which cumulatively add up to increase the latency of your link, and thus potential throughput, for a finite buffer size in participating nodes. Since the network topology is continuously changing, frequently in an unpredictable manner, the number of hops between you and your destination node will also vary. This has other implications we will discuss later.

The second reason why network throughput will vary is a consequence of Shannon's information theory, since for a constant power output and receiver sensitivity, as distance increases between two wireless nodes, the signal/noise ratio declines and thus achievable link bit rate drops. Therefore, as the signal weakens, the range of potentially available services declines, or the bit error rate increases. This variation of throughput with time is usually referred to as "fading", as much as this term is used and abused in various niches of communications theory.

At this time very few protocols for MAC layer connections exist which can adaptively adjust their throughput to accommodate variations in link performance. We are seeing the first steps with the IEEE 802.11 wireless Ethernet, where link quality degradation forces a reduction in link bit rate, albeit in large and discrete chunks. We have yet to see a genuinely robust protocol which dynamically "rubber bands" the bit rate through the channel to achieve a desired balance of speed and bit error rate. In wireless networking, where power and bandwidth come at a big premium, every snippet of usable bit rate is valuable. By far the biggest problem in current Ad Hoc networking research is that of routing in a situation where the topology of the network changes continuously, somewhere within the network.

VI. PROTOCOLS PROPOSED FOR ADHOC NETWORKS

Routing models are divided into:

- "Proactive Routing" is any scheme which continuously monitors the topology and maintains current routing tables regardless of instantaneous demand. DV and LS schemes fall into this category. While routing information is always available for a sender, the network is being continuously flooded with routing management traffic, much of which is unused.

- "Reactive Routing" is any scheme where routing information is gathered only on demand. In such schemes, a route is discovered only when needed, and thus routing management traffic is kept to its bare minimum. Reactive schemes have been most popular to date, since they minimize the route management traffic overheads.

Static networks mostly use either Distance Vector (DV) or Link State routing algorithms, neither of which are spectacularly well suited to highly dynamic topologies.

DSR, or Bellman-Ford schemes, such as those used in the DARPA packet radio protocol, RIP, XNS or IPX, are based on the idea of periodically broadcast tables of distances, typically in hops, between a node and all possible destinations. A necessary requirement is that the update rate is greater than the rate of topology change. In a highly dynamic wireless network, such protocols run into a number of difficulties:

* Topologies may be highly redundant, with some nodes being in the situation of being able to connect to a very large number of neighbours, while others see very few neighbours.

* Bandwidth is scarce and cannot be wasted.

* High rates of topology change require high update rates.

Link State, and Distance Vector routing schemes fall foul of these issues since they distribute a lot of routing information, and with high rates of topology change this will eat into bandwidth and thus battery power, more so in highly redundant topologies, where much of the information is effectively wasted. Maintaining a current routing table on a node which does not communicate much with its neighbours is a drain on critical resources for no return. Hence to overcome the dynamic wireless Ad hoc network problems we go for the DSR and Bellman-ford protocols but even these protocols suffer with a problem of finite resource battery power on a portable equipment and node power failures, so we choose NFPQR protocol to have an advantage over this.

a)ROUTING ALGORITHMS

The term “Routing” refers to the overall, network wide process that determines end-to-end paths that data grams will take from source to destinations. Using a driving analogy, we can think of routing as the process of building maps and giving directions from source to destinations. There are mainly two types of routing algorithms, Dynamic Source Routing Algorithm and NFPQR Algorithm.

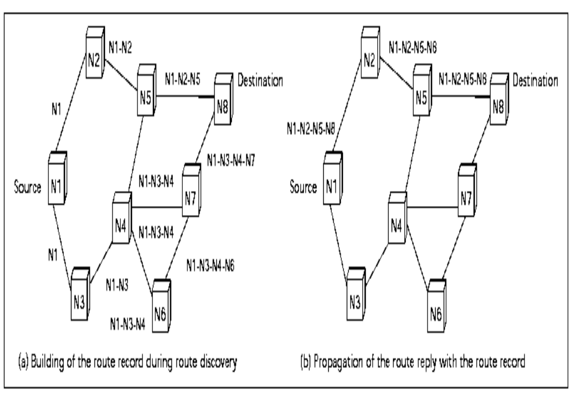
b)DYNAMIC SOURCE ROUTING

The Dynamic Source Routing (DSR) protocol is an on-demand routing protocol that is based on the concept of source routing. Mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated as new routes are learned.

The protocol consists of two major phases: route discovery and route maintenance. When a mobile node has a packet to send to some destination, it first consults its route cache to determine whether it already has a route to the destination. If it has an unexpired route to the destination, it will use this route to send the packet. On the other hand, if the node does not have such a route, it initiates route discovery by broadcasting a route request packet. This route request contains the address of the destination, along with the source node's address and a unique identification number. Each node receiving the packet checks whether it knows of a route to the destination. If it does not, it adds its own address to the route record of the packet and then forwards the packet along its outgoing links.

To limit the number of route requests propagated on the outgoing links of a node, a mobile only forwards the route request if the request has not yet been seen by the mobile and if the mobile's address does not already appear in the route record. A route reply is generated when the route request reaches either the destination itself, or an intermediate node which contains in its route cache an unexpired route to the destination. By the time the packet reaches either the destination or such an intermediate node, it contains a route record yielding the sequence of hops taken. Figure 3.2 illustrates the formation of the route record as the route request propagates through the network.

A route reply is generated when the route request reaches either the destination itself, or an intermediate node which contains in its route cache an unexpired route to the destination. If the node generating the route reply is the destination, it places the route record contained in the route request into the route reply. If the responding node is an intermediate node, it will append its cached route to the route record and then generate the route reply.



(a) Building of the route record during route discovery (b) Propagation of the route reply with the route record

Figure9 Creation of the route record in DSR.

The Dynamic Source Routing protocol (DSR) [5, 6] is a simple and efficient routing protocol designed specifically for use in multi-hop wireless Ad-hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the Ad-hoc network. The use of source routing allows packet routing to be trivially loop-free, avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allows nodes forwarding or overhearing packets to cache the routing information in them for their own future use. All aspects of the protocol operate entirely on-demand, allowing the routing packet overhead of DSR to scale automatically to only that needed to react to changes in the routes currently in use.

To send a packet to another host, the sender constructs a source route in the packet's header, giving the address of each host in the network through which the packet should be forwarded in order to reach the destination host. The sender then transmits the packet over its wireless network interface to the first hop identified in the source route. When a host receives a packet, if this host is not the final destination of the packet, it simply transmits the packet to the next hop identified in the source route in the packet's header. Once the packet reaches its final destination, the packet is delivered to the network layer software on that host. Each mobile host participating in the Ad-hoc network maintains a route cache in which it caches source routes that it has learned. When one host sends a packet to another host, the sender first checks its route cache for a source route to the destination. If a route is found, the sender uses this route to transmit the packet. If no route is found, the sender may attempt to discover one using the route discovery protocol.

While a host is using any source route, it monitors the continued correct operation of that route. For example, if the sender, the destination, or any of the other hosts named as hops along a route move out of wireless transmission range of the next or previous hop along the route, the route can no longer be used to reach the destination. A route will also no longer work if any of the hosts along the route is failed or is powered off. This monitoring of the correct operation of a route in use is called route maintenance. When route maintenance detects a problem with a route in use, route discovery may be used again to discover a new, correct route to the destination.

c) NFPQR Algorithm

When node j receives a route request message (RREQ in AODV) from node i, then node j predicts its future condition by considering power level of node j. If its power level is above the threshold, that is the power level is above the initial power given(0:1xTr) then the node j will forward this RREQ to next hop; otherwise it will drop the route request message. The same procedure is repeated for all the nodes till the destination node is reached. In NFPQR algorithm, more stable paths are found during route discovery. Here, the stable path means the packets, which traverse on these paths, will not experience long delays and improves the delivery ratio also, NFPQR increases the network lifetime of the MANET. In addition, algorithm implementation is simple. In the following section, the simulation and achieved results are presented.

d) ROUTING (DSR & NFPQR)

Using DSR and NFQR protocols the optimal path satisfying their algorithmic nature is found. This function is used to determine the path in Dynamic Source Routing algorithm. Here its checks for the best optimal path from the various paths obtained in the evaluation of route. This function is used to determine the path in Node Failure Prediction QoS Routing algorithm. Here the optimal path which satisfies the power conditions is selected from the various paths obtained in the evaluation of route. Based on the path selected, the packet data is transferred from the source node to the destination node through different intermediate nodes of the determined optimal path. Now an analysis is made by comparing the convergence time, delay and the power levels at each node of the paths using both the DSR and NFPQR routing protocols. Finally we conclude that NFPQR has an advantage of good convergence time, less delay and better node power levels and hop-node performance than DSR.

VII. SIMULATION RESULTS

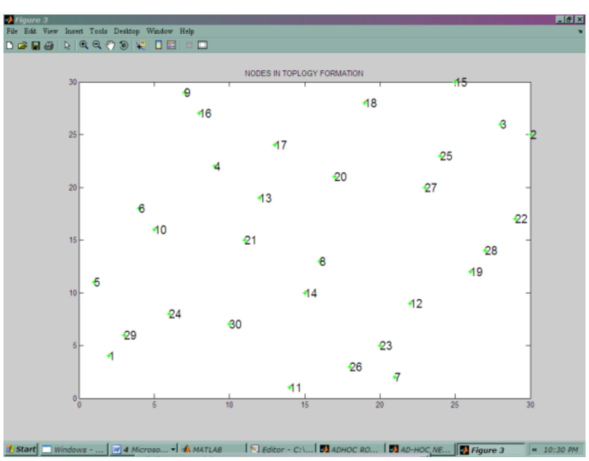


Figure10. Random ad hoc network creation

Network Specifications:

Network Area: 30X30units

No. of Nodes: 30

Node density: Average

Mobility: Random

Nodes: Static Power Allocation: Random Communication Standard: IEEE 802.11b

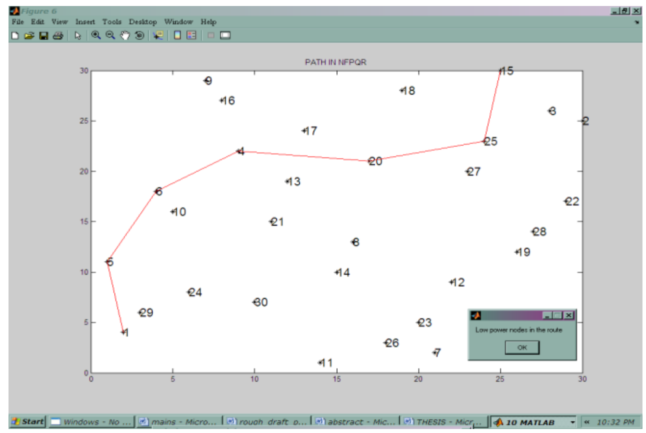


Figure11. NFPQR protocol applied on the random network for route selection

For the created random ad hoc network the route is selected considering the source node as the node with **id: 1** and destination node as the node with **id: 15** using NFPQR as routing protocol. The communication route selected for considered source and destination contains node with **id: 5, id: 6, id: 4, id: 20 and id: 25** as intermediate nodes .The arrows indicate the path traversed by the route request and acknowledgement packet. After the route selection the data packet will traverse the same path for the communication between the considered source and destination.

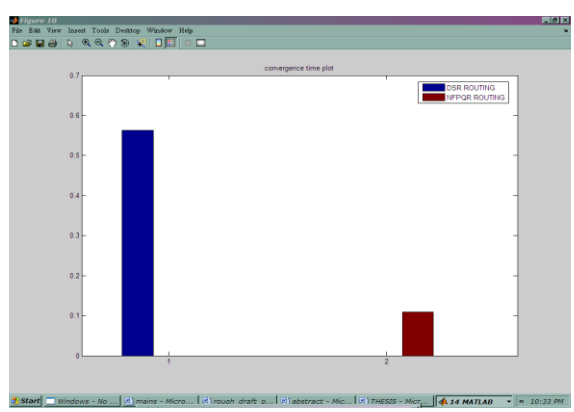


Figure12.. Convergence time plot for DSR and NFPQR

When the analysis button is clicked the program is set to display the various plots and first among them is convergence plot. This convergence plot is bar graph which displays the convergence times of DSR and NFPQR .

Convergence Time of DSR = 0.58

Convergence Time of NFPQR = 0.145

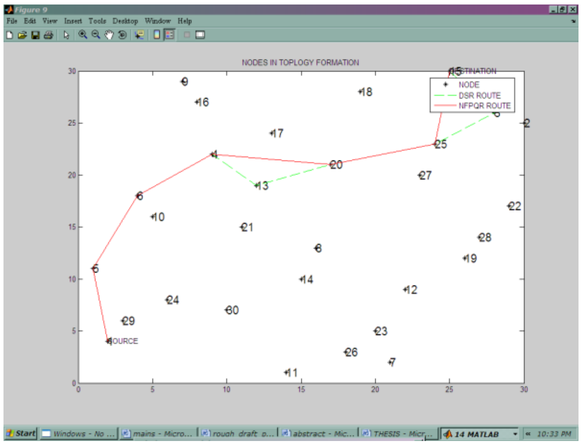


Figure10. NFPQR & DSR protocols applied on the random network for route selection

For the created random ad hoc network the route is selected considering the source node as the node with **id: 1** and destination node as the node with **id: 15** using both the DSR and NFPQR as routing protocols.

Path in DSR = 1-5-6-4-13-20-25-3-15

Path in NFPQR = 1-5-6-4-20-25-15

After the route selection the data packet will traverse the same path for the communication between the considered source and destination.

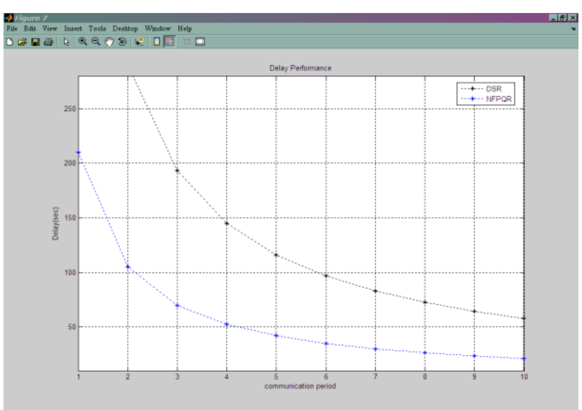


Figure11. Delay Performance Plot.

VIII.CONCLUSION

In this project work performance of NFPQR and DSR protocols for random Ad-Hoc network has been evaluated and compared for QoS parameters such as power consumption and delay. To analyze the performance an average node density random Ad-Hoc network with 30 nodes is considered for simulations. The power level of each node and the respective geographical position is randomly defined in the network. Simulations have been run for 3 seconds considering almost no mobility of nodes during routing and communication.The aforementioned QoS parameters have been evaluated for a defined source and destination using NFPQR and DSR protocols. Route selection and communication has been performed by all the protocols individually in accordance with the respective algorithms. The performance plots of all the protocols reflect the efficiency of each in terms of quality of route and power optimization. The simulation results of DSR and NFPQR for an average node density in random Ad hoc network shows that DSR protocol does not provide optimization of QoS. Thus the QoS parameters evaluated for it reflect poor performance. Better QoS routing is provided through NFPQR protocol as it provides stable routes in comparison to DSR due to node failure prediction based on power to some extent improvement in QoS .

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