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A Review on Routing In Partially Connected Ad-Hoc Network

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ABSTRACT
A Mobile Ad Hoc Network (MANET) is a collection of mobile nodes that can communicate with each other using Multihop wireless links without using any fixed infrastructure and centralized controller. Communication links are susceptible to frequent failures due to intervening objects, which can cause intermittent connectivity. Due to Intermittent connectivity, there is no end-to-end path exists between source and destination all the time. Existing ad hoc routing protocols unable to deliver packets in the presence of a network partition between source and destination since they are designed for network where end to end connectivity exists between nodes. To deal with such networks researchers have suggested to use flooding-based routing schemes and Message Ferrying Schemes. Flooding scheme is not suitable if partitions last for a long duration of time. Message Ferry distributes messages between nodes which are located in different partitions which may be disconnected. Ferry moves around a fixed path for providing regular connectivity in a disconnected network. But this scheme needs huge buffer space and also online collaboration between Ferry and other nodes in the network. With this in mind, a new routing scheme with two types of Ferries and Gateways has been proposed. This scheme improves delivery rate and delay and it does not need any online collaboration between ferry and mobile nodes. In this paper we discuss about related work of routing in partitioned Ad Hoc network. The schemes "Epidemic Routing for Partially Connected Ad Hoc Networks, "Wearable computers as packet transport mechanisms in highly-partitioned ad-hoc networks" , "A message ferrying approach for data delivery in sparse ad hoc networks" and "Sending Messages to Mobile Users in Disconnected Ad-hoc Wireless Network" [9] are able to deliver data in partially connected networks.

KEYWORDS*:*
Disconnected, Message Ferry, Epidemic routing, Delivery rate,

1. INTRODUCTION TO AD HOC NETWORKS

Mobile Ad hoc networks (MANET) are considered as promising communication networks in situations where rapid deployment and self-configuration is essential. In ad hoc networks, nodes are allowed to communicate with each other without any existing infrastructure. Typically every node should also play the role of a router. This kind of networking can be applied to scenarios like conference room, disaster management, battle field communication and places where deployment of infrastructure is either difficult or costly. Ad hoc network can be defined as an assembly of communication nodes willing to communicate with one another over a wireless medium. There is no fixed infrastructure in an ad hoc network, unlike in the cellular networks. Such devices can communicate with another node that is immediately within their radio range (peer-to-peer communication) or one that is outside their radio range (remote2remote communication) using intermediate node(s) to relay or forward the packet from the source (sender) toward the destination (receiver) [6]. Power consumption is a serious issue in an ad hoc networks, since it rely on forwarding data packets sent by other nodes. Ad hoc networks are self-creating, self-organizing and self-administering. That is to say that a formed network can be deformed while on transit without the need for any system administration. Ad hoc network is mostly used in conditions where there is non-availability of infrastructure, unreliable or entrusted networks especially under emergency conditions.

2. PARTIALLY CONNECTED AD HOC NETWORK

Intermittently connected Mobile Ad hoc networks are mobile wireless networks where most of the time there does not exist a complete path from a source to a destination, or such a path is highly unstable and may change or break soon after it has been discovered. This is due to Node mobility, limited radio range, physical obstacles, severe weather, wide deployment area or other physical factors. Most ad hoc network routing algorithms are designed for networks that are always connected . While it is certainly desirable to maintain a connected network, various conditions may cause a mobile ad hoc network to become partitioned, meaning that there is no single-hop or multiple-hop route between some (or all) source/destination node pairs., might prevent some nodes from communicating with others and result in a partitioned network. The existence of network partitioning requires a new routing approach other than the traditional "store-and forward" routing paradigm used in most current ad hoc routing algorithms, in which messages are dropped if no route is found to reach a destination within a small amount of time.

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3. CONVENTIONAL MANET ROUTING PROTOCOLS

MANET routing protocols can be divided into two categories: Proactive (table-driven) and Reactive (on demand) routing based on when and how the routes are discovered. Table-driven routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. Routing table is updated periodically. On demand routing protocol creates routes only when desired by the source node. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route remains valid till the destination is reachable or until the route is no longer needed. Routing protocols for ad hoc networks must deal with limitations such as high power consumption, low bandwidth, high error rates and arbitrary movements of nodes.

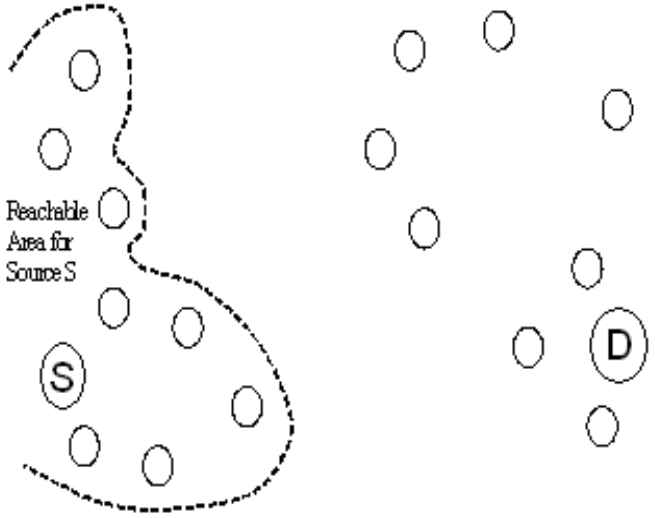

Fig 1: Network with partitions
Source S cannot communicate with destination node D.

3.1 CHALLENGES IN MANET

Two main challenges in MANETs (when traditional routing protocols fail) are Intermittent Connectivity and Network Partition.

Intermittent connectivity:

- When nodes are in motion, links can be obstructed by intervening objects
- When nodes conserve power, links are shutdown periodically Network partition:
- When no path exists between source and destination, it is perfectly possible that two nodes may never be part of the same connected portion of the network.

3.2 ISSUES IN CONVENTIONAL MANET ROUTING PROTOCOL

Intermittently Connected Mobile ad hoc network with long disconnection time creates network partition. In this context, conventional routing schemes fail, because they try to establish complete end-to-end path between source to destination before any data is sent. Existing Routing protocols [1],[2] simply discard the packets if the packet is not delivered within a small amount of time. These routing protocols fail in Intermittently Connected Mobile Ad hoc networks because of the following characteristics of Network:

- Intermittent network contacts
- End-to-end path between the source and the destination may have never existed
- Disconnection and reconnection is common
- Highly variable link performance

3.3 ROUTING PROTOCOL PARTIALLY CONNECTED AD HOC NETWORK

More number of works has been done on designing routing protocols in Mobile Ad hoc Networks. These routing protocols are all based on the assumption that the network is connected In reality, the network could be highly partitioned due to the various reasons specified earlier. These networks are known as delay-tolerant networks (DTNs), and also disruption-tolerant networks[4].Several models based on mobility assisted scheme have been proposed to deal routing in this type of network: The existing movement-assisted routing methods can be classified into two categories based on the mobility control. The first category uses the random mobility of nodes to transmit messages. The second category is controlled movement model, where nodes may change their original routes to collect and deliver messages.

4. EPIDEMIC ROUTING SCHEME

Epidemic routing scheme [6], is an early, brute force approach to deliver a message in a disconnected network. This approach makes use of the mobility of hosts. Hosts makes a hash table entry for message stored in a table called vector table. Hosts use this vector table to exchange message with neighboring nodes. With the help of vector table, nodes will come to know about messages stored in the other node. Only those message which are not buffered by the other node will be transferred. In this manner each node distributes messages which are buffered by it. This is a transitive distribution of message, and message will reach the destination which is on other partition of network with the help of mobile nodes. Consider an example for the above schema

Example

- Say at time Tl source S wants to send data to destination D, S will broadcast the message which will stored by the neighboring nodes Nl and N2. This propagation's of message is shown in Fig 2
- Suppose after a time delay, time T2, node Nl will move near to destination. Then Nl is able to deliver the data to the destination D. This is shown in Fig3.

4.1 PROS AND CONS OF EPIDEMIC ROUTING SCHEME

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Epidemic routing [5] is a very simple and effective approach, but it do not consider the constraints on the resource limitation.

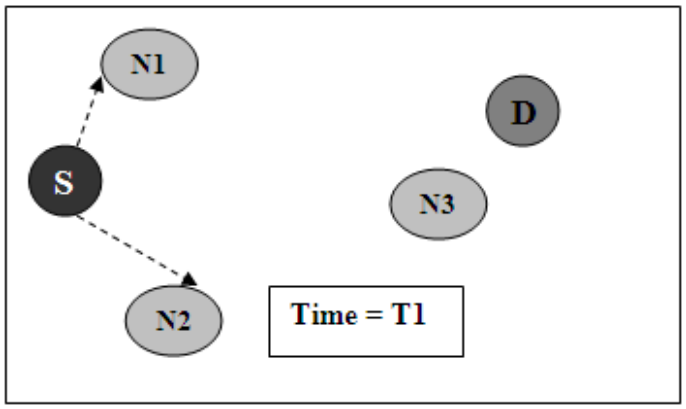


Fig 2: Network instance at time T1

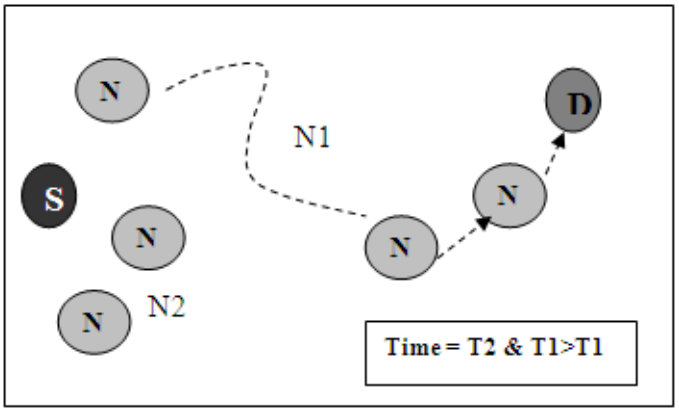


Fig 3: Network instance at time T2

5. HANDLING BUFFER

Nodes are having limited buffer to store messages. Epidemic scheme [5] is a flooding scheme due to this sometimes nodes memory will be exhausted. To deal with this kind of situation, authors of "Wearable computers as packet transport mechanisms in highly-partitioned ad-hoc networks" [8] proposed to drop the message whenever there is shortage of memory. They talk about four different kinds of dropping strategies. They are:

- **Drop-Random(DRA)**: The packet to be dropped is chosen at random.
- **Drop-least-Recently-Received(DLR):** The packet that has been in the host buffer for longest time duration is dropped.
- **Drop-oldest (DOA):** The packet that has been in the network for longest duration is dropped.
- **Drop-Least-Encountered (DLE):** The packet is dropped on the basis of the likelihood of delivery.

6. MESSAGE FERRYING APPROACH

We envision that Message ferrying [7] can be used effectively in the following four categories of applications. Message ferrying allows by-passing the existing infrastructure to obtain a different service, though with degraded performance.

7. CRISIS-DRIVEN

This category includes battlefield and disaster applications, where fixed and stable infrastructure is limited or un-available due to environmental conditions

8. GEOGRAPHY-DRIVEN

This category includes wide area sensing and surveillance applications. While sensor networks are normally densely deployed, there are situations where sensor networks are inherently sparse due to the geographic span involved.

9. COST-DRIVEN

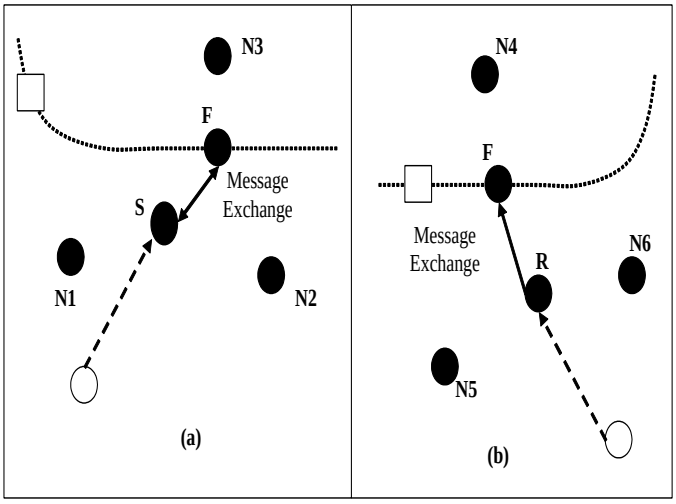
This category includes applications that could use other existing technologies, but where message ferries offer a cost- effective alternative..

10. SERVICE-DRIVEN

This category includes applications that require a service not provided by other available networking infrastructure.

11. NODE-INITIATED MESSAGE FERRYING

In NIMF approach, a node will move towards known route of ferry if it has data to transmit or receive. The node comes close enough to default path of ferry so that ferry will be in transmission range of node. Fig 4 explains the working of NIMF approach. In this node S wants to send data and node R wants to receive data, so they come closer to the default route of ferry.



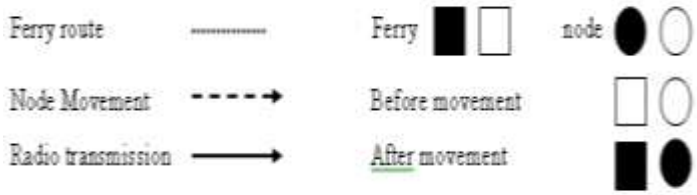


Fig 4. Working of NIFM

In the NIMF scheme A node operates in 4 modes: WORKING, GO TO FERRY, SEND/RECV, and GO TO WORK . A node is initially in the WORKING mode and moves according to its assigned task. The trajectory control mechanism of the node determines when it should proactively move to meet the ferry for sending or receiving messages. The node enters the GO TO FERRY mode when it decides to go to the ferry, and approaches the ferry. When the node detects the ferry is within its transmission range, the node enters the SEND/RECV mode and exchanges messages with the ferry. After completing message exchange or the ferry has moved out of range, the node enters the GO TO WORK mode to return to its location prior to the detour. Upon return to the prior location, the node enters the WORKING mode. In addition, nodes can switch to the SEND/RECV mode from the ferry "unintentionally", e.g., without proactive movement WORKING mode when they meet.

12. FERRY-INITIATED MESSAGE FERRYING

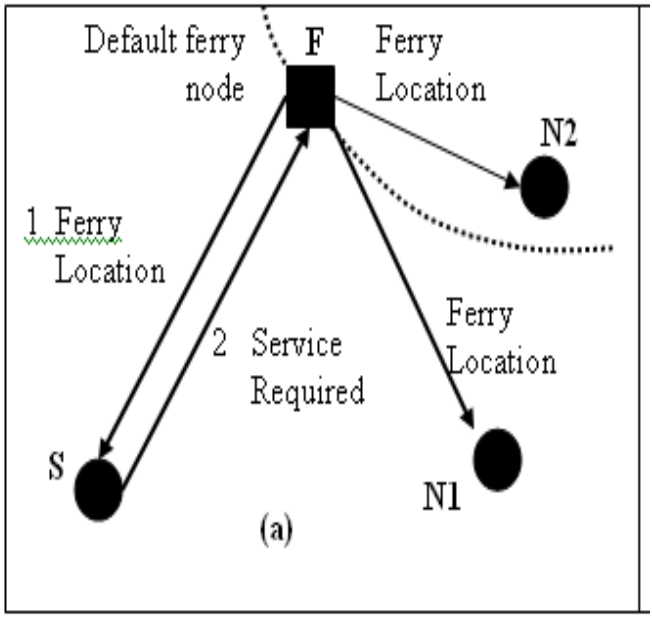
In the Ferry-Initiated Message Ferrying (FIMF) scheme, the ferry takes proactive movement to meet up with nodes for communication purposes. We assume that the ferry moves faster than nodes. In addition, we assume that nodes are equipped with a long range radio which is used for transmitting control messages. Note that while the ferry can broadcast data to all nodes in the area, the transmission range of nodes' long range radios may not necessarily cover the whole deployment area due to power constraints. Fig 5 shows a simplified example of how the FIMF scheme operates. Initially the ferry F follows a specific default route and periodically broadcasts its location to nodes using a long range radio. When a node S finds the ferry is nearby and wants to send or receive messages via the ferry, it sends a Service Request message to the ferry using its long range radio (Fig.5(a)). This message contains the node's location information. Upon reception of a request message, the ferry adjusts its trajectory to meet the node. To guide the ferry movement, the node occasionally transmits Location Update messages to notify the ferry of its new location (Fig.5(b)). When the ferry and the node are close enough, they exchange messages via short range radios (Fig.5(c)). After completing message exchange with the node, the ferry moves back to its default route (Fig. 5(d)).

12.1PROS AND CONS OF MESSAGE FERRYING APPROACH

Message Ferrying Approach delivers the messages efficiently and the nodes have significantly less overhead as compared to the ferry node. However, if the ferry node fails, then the system as a whole fails. So this is less reliable and more susceptible to failure. Also, it is required to fix the default route of the ferry node. This itself is challenging and involves a number of issues.

12.2REPLACE MESSAGE FERRY

In message ferrying approach, ferry node is a central point of failure for the system. New approaches have been proposed which focus on the reliability of the systems. One of the solutions to this problem is replacement of ferry as proposed in [9]. They proposed two protocols - either change the ferry node when the current ferry node fails, or change the ferry node periodically. The first method is centralized approach where successor ferry is always decided by the present ferry. Later is a distributed way of choosing the ferry node. Here each node declares its willingness to become ferry and on the basis of vote, one node will be chosen as ferry node.



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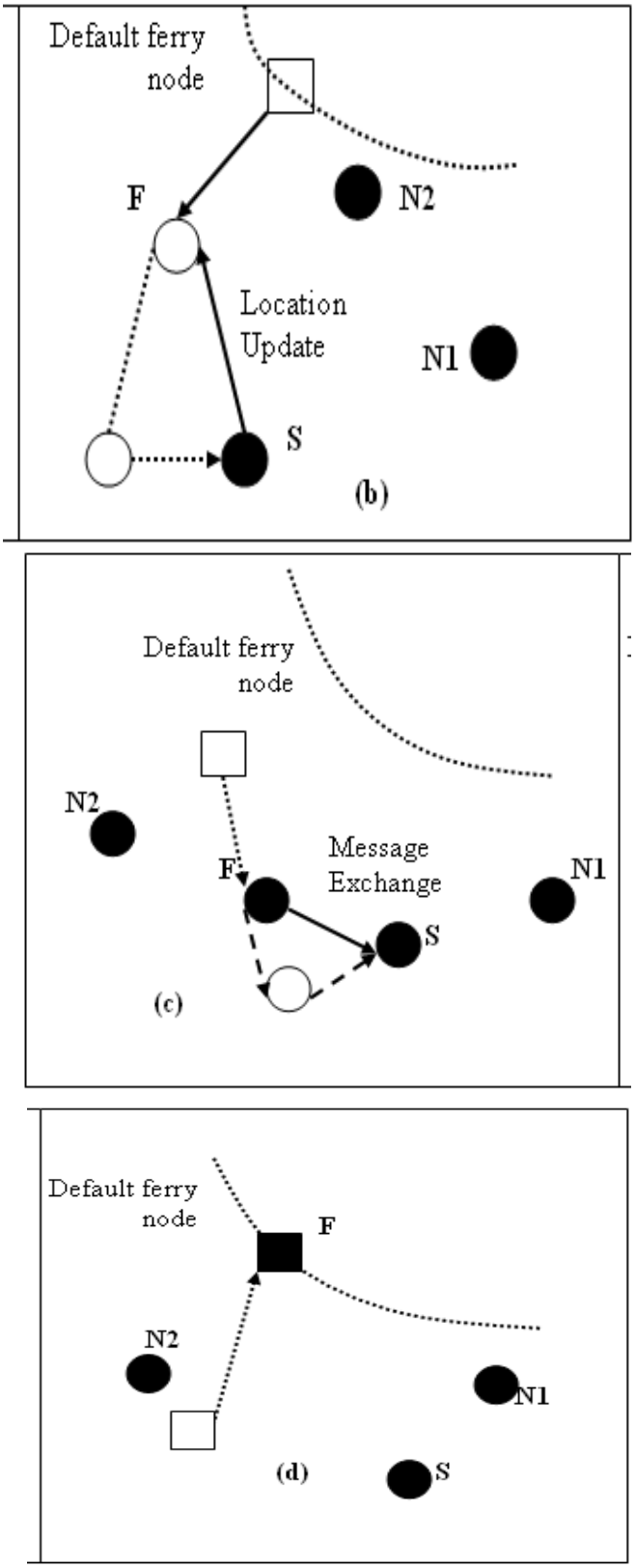

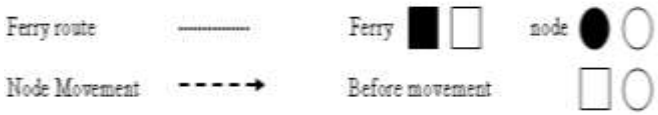

Fig 5: Ferry-Initiated Message Ferrying

13. FLOODING BASED APPROACHES

Knowledge about the network helps in deciding the best next hop. It can happen that the network has absolutely no knowledge about the network. In such a scenario, all nodes are made relay nodes. Such schemes are called epidemic routing schemes. The basic concept of epidemic routing is to flood the packets, like the virus spreading in an epidemic. That is, a node copies its message to all the nodes that come in contact with it, provided the recipient node does not have a copy of it already. Vahdat and Becker [13] is perhaps the earliest proponent of such a scheme. Probably they were inspired by the algorithm proposed by Demers et al [14]. To identify if the node has already seen a message, each node maintains a summary vector. This is an index of the messages that it has already seen. When two nodes meet, this summary vector is exchanged. This enables the nodes to identify the new messages and request for them. In order to control the resource utilization, the authors propose the use of a hop counter and limit the hop of each message. Undoubtedly, flooding the network with messages will consume network resources like bandwidth, buffer, node energy etc. As demonstrated by Tseng, this can seriously degrade the performance, if the resources are scarce. Hence there is a need to control the flooding.

13.1 MEASURES TO CONTROL FLOODING

Several methods have been proposed to control the flooding. Most of the routing strategies were designed with the aim to avoid flooding. Even when flooding is adopted, care has been taken to conserve the resources. Some approaches also take care to free the buffer, after the message has been delivered.

14. BOUNDING THE NUMBER OF COPIES

In a flooding based approach, resources can be conserved by limiting the number of copies in the network. Spyropoulos et al [15] proposed several single copy schemes. The simplest of them was the case where the source directly delivers the message to the destination. The authors also proposed other single copy schemes such as randomized routing algorithm, utility based routing and as seek and focus routing algorithm. In the randomized routing protocol, the message is handed over to another node, which has a better delivery probability. This is based on the principle that handing over the message to another node is better than holding it. The utility-based routing protocol takes into account the relative positions of the different nodes. But this scheme has a slow start, as the location information has to be built up. The seek and focus algorithm is a combination of randomized routing protocol and utility-based routing protocol. It initially performs a randomized routing and later switches to utility-based routing. Grossglauser et al [16]

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suggested another single-copy scheme. The source copies the message to the first node it meets. If this is not the destination, then this node will do a direct delivery. The authors assume that all the nodes move around randomly and meet every other node. Also each node is assumed to have infinite buffer. Thus it is a single copy, two hop scheme. The single-copy schemes cannot be categorized as epidemic scheme. However, it can be seen as an extreme case of controlling the number of copies in the network, into one. Groenevelt et al [17] proposed a controlled flooding scheme, which is an improvement of the single-copy scheme. The source makes n copies in the first phase. Each of these copies will try for a direct delivery. Thus this algorithm can be viewed as a multicopy, two-hop scheme. The Spray and Wait algorithm proposed by Spyropoulos et al [18] is another modification of the same scheme, to bound the number of copies in the network. Here, the authors show that this scheme is optimal when inter-node contact probabilities are independent and identically distributed . However, tuning the parameters becomes a challenge here. Though these schemes improve the delivery ratio, the buffer utilization is more. In order to improve buffer utilization, Hanbali et al [19] suggested to limit the life time of each message copy. Harras et al [20] suggested three parameters to control the message flooding: viz. willingness probability, time-to-live, and kill time. Balasubramanian proposed the RAPID algorithm. This algorithm can optimise a specific metric, for example, the average delay. They considered routing as a resource allocation problem. Before replicating packets, the algorithm checks if the replication justifies the resource utilization. It also maintains the number of replicas available in the network as well as their location. PRioritized Epidemic routing (PREP) described by Ramanathan et al [21] is another algorithm that keeps track of the priority of a packet and disseminates it in an epidemic manner. Priority of a packet depends on its cost, expiry time etc.

15. EMBEDDING ADDITIONAL INFORMATION

Another technique to conserve resources in a flooding approach was by embedding additional information into the message so that the number of copies can be limited. There are two such popular methods: network coding and erasure coding. In network coding, decoding algorithm is embedded into the coded message blocks. Erasure coding embeds redundancy into the message blocks. Widmer et al [22] proposed a network coding approach, which encoded the packets before flooding.

16. CONCLUSION

During This paper We discussed about the various Routing protocols for partially Connected ADHOC Network. In "Messaging in Difficult Environment" [10] problems encountered in implementing communication in partially connected networks are discussed. The major issues in such kind of environments like, asynchronous message delivery, routing and fragmentation, naming system, reliability have been discussed. In epidemic [5] approach, authors start with assumption that source and destination will never have connected path, which is a very restrictive assumption even for a sparse ad hoc networks. Message Ferry [6] approach can work only for static kind of partitioned network because of fixed route of ferry node. The single ferry approach is simple, but doesn't perform well at high traffic load and large network scenarios. Replace Message ferry Approach will try to reduce the chance of single point of failure. Undoubtedly, flooding the network with messages will consume network resources like bandwidth, buffer, node energy etc. , this can seriously degrade the performance, if the resources are scarce. Hence there is a need to control the flooding.

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