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A STUDY OF ROUTING TECHNIQUES IN INTERMITTENTLY CONNECTED MANETS

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Abstract: *A Mobile Ad hoc Network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless. These are a kind of wireless Ad hoc Networks that usually has a routable networking environment on top of a Link Layer Ad hoc Network. The routing approach in MANET includes mainly three categories viz., Reactive Protocols, Proactive Protocols and Hybrid Protocols. These traditional routing schemes are not pertinent to the so called Intermittently Connected Mobile Ad hoc Network (ICMANET). ICMANET is a form of Delay Tolerant Network, where there never exists a complete end – to – end path between two nodes wishing to communicate. The intermittent connectivity araise when network is sparse or highly mobile. Routing in such a spasmodic environment is arduous. In this paper, we put forward the indication of prevailing routing approaches for ICMANET with their benefits and detriments.*

Keywords: *MANET, ICMANET, Delay Tolerant Networks, Routing Schemes, Performance Parameters.*

I. INTRODUCTION

MANET is well – thought – out to be the rapid deployment of independent mobile users. Substantial examples include establishing survivable, efficient and dynamic communication for emergency/rescue operations, disaster relief efforts, and military networks. Such network setups cannot count on centralized and organized connectivity and can be conceived as applications of Mobile Ad hoc Networks.

A MANET is an autonomous collection of mobile users that communicate over relatively Band Width constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. In quintessence, the network is decentralized; where all network activity including discovering the topology and delivering messages must be executed by nodes themselves, (i.e.) routing functionality will be assimilated into mobile nodes. The routing methodologies in such network are made through traditional routing protocols like AODV (Ad hoc on demand Distance Vector), DSR (Destination Source Routing) etc. Ample routing algorithms have been proposed for MANET. The MANET paves to a new form of network called the ICMANET.

ICMANET is painstaking to be one of the new areas in the field of wireless communication. Networks under this class are potentially deployed in challenged environments using isolated mobile devices with limited resources. These are emerging as a promising technology in applications such as in Wildlife Management, Military Surveillance, Underwater Networks and Vehicular Networks. ICMANET, also known as the Delay Tolerant Network (DTN), is typically different from traditional Mobile Ad hoc Networks (MANETs), which means that in the latter; communication between two nodes is possible at any time via a path of intermediate nodes although this path may vary with time. However, in an ICMANET paths between to nodes have to be established only by multihop paths that span over space and time. In other words, there is no end – to – end path between the two at any given instant. In this paper, we deliver a study of possible routing schemes in ICMANET. The traditional routing scheme that forms a basis for other routing schemes in ICMANET is the Flooding based routing. In this, one node sends packet to all other nodes in the network. Each node acts as both a transmitter and a receiver. Each node tries to forward every message to every one of its neighbors [15]. The results in every message eventually delivered to all reachable parts of the network. In rest of this paper, we will describe the various routing protocols available for ICMANET.

II. EPIDEMIC ROUTING

The Epidemic Routing protocol is a Flooding based routing protocol which states that periodic pair – wise connectivity is necessitated for message delivery. The protocol banks on immediate dissemination of messages across the network. Routing occurs based on the node mobility of carriers that are within distinctive position of the network as in Figure 1 and Figure 2. The protocol is designed in such a way that each host maintains a buffer. The buffer holds messages whose origin is in that particular host, as well as messages of the secondary hosts. It also sustains a hash table. The host value catalogs the directory of messages that are keyed by inimitable identifier associated with each message.

A Summary Vector [13] is associated with the host, to signpost which entries in table are set. The routing comprises an anti – entropy session. When two hosts are within the same communication range, one with the least identifier inducts the anti – entropy session to the one with larger identifier. Under this session two hosts barter their summary vector, to explore the messages that were not viewed by each other. Later they request copies of messages that were not reconnoitered by them. The routing scheme includes a message identifier, hop count and an acknowledgement request. (i) Message identifier – unique 32 – bit number; is a combination of host ID and a locally generated message ID (i.e.) 16 bit. (ii) Hop count – value implies the distribution of messages; similar to Time to Live (TTL) field. (iii) acknowledgement request – acts a signal to the destination requesting to endow acknowledgement for message delivery.

It is studied [13] that goals of this routing scheme include:

i. Maximum message delivery rate.
ii. Minimum message latency.
iii. Minimal resources consumption.

III. BEACONLESS ROUTING

The beaconless routing protocol is grounded on the hypothesis where there never exists an intervallic diffusion of beacons into the network. The convention relies upon the acquaintance of geographical position that aids in the reduction of overhead. Routing primarily makes a choice of forwarding node in a dispersed modus amidst its neighbors, without any form of erudition about their location prevalence. The forwarding of messages is accomplished by smearing Dynamic Forwarding Delay (DFD) that indicts one of the possible relay nodes, relays the message packets. Relay nodes refers to the intermediate nodes in a network.

The algorithm involves the following sequence of steps in routing:

i. As a node broadcasts a packet, its neighboring node receives it.
ii. DFD claims that only one of relay nodes transmits the packet.
iii. Nodes with least delay deliver the packet first and secondary relay nodes perceive the delivery and abandon its reserved transmission of the same packet.

From [12], it is known that some of the assumptions are allied to BLR. (i) Nodes have a predetermined knowledge of its own position via GPS, Galileo or any other kind of positioning services. (ii) Nodes are aware of two parameters viz., maximum delay and maximum transmission.

From [12], it is eminent that, if a sender holds a packet, it ascertain the destination, stores its topographical coordinates, associated with its own position, in the header of the packet. Each and every relay node supersedes previous node's position by its current position in packet header before forwarding. Packet is advertised to all neighbouring nodes. On reception of packet, the only offered information of the intermediate node is its own position, position of previous and destination node that were extracted from packet header. Nodes within forwarding area apply DFD, prior to broadcasting of packets and those nodes that are outside this area discard the received packet. Destination nodes use passive acknowledgement. The previous transmitting node also finds that the packets are further delayed and clinches that other node has received it successfully. The algorithm persists until destination is reached and destination has to send acknowledgement on reception. BLR applies an adaptive and restricted reactive protocol based on AODV in the vicinity of destination primarily to deal with inaccuracies.

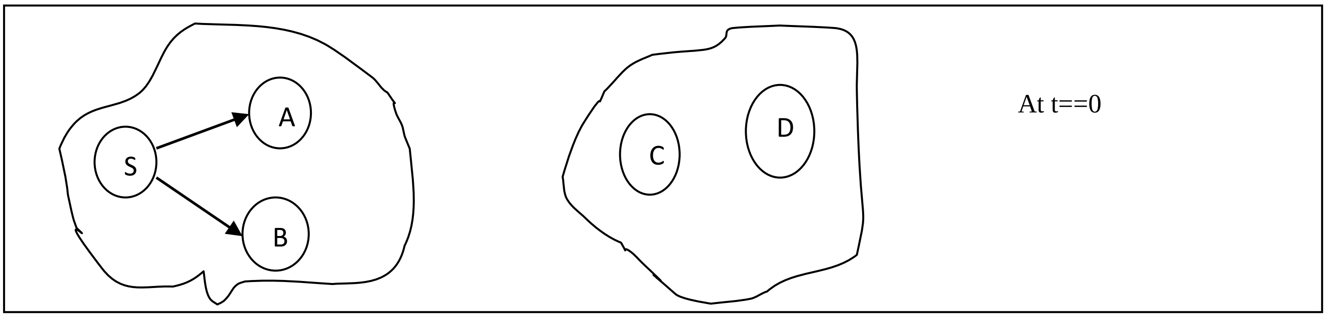

Figure 1: Routing of Messages at t==0

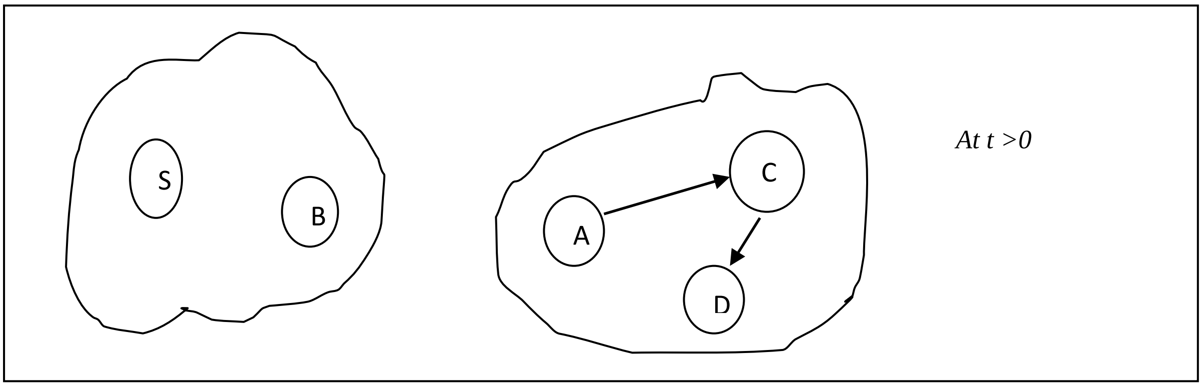

Figure 2: Routing of Messages at t > 0

The delay function is calculated using the formula [12],

Add_delay = Max_delay ((r-p)/r)

Where r = maximum transmission radius.

P = progress.

Significance of BLR is to minimize delay and may operate at promiscuous node. The performance of BLR is based on the greedy mode which insists the broadcast of all packets and do not hold any recovery strategy when no node is found to be in the forwarding area and the packets are just dropped. The advantage of BLR is found to be, extensive battery power usage.

IV. CONTEXT AWARE ROUTING

The Context Aware Routing (CAR) algorithm paves the forethought of asynchronous communication in ICMANET. The algorithm endows a basement of organizing the messages in the network. It addresses that the nodes are able to exploit the context information to make local decisions which imparts the good delivery ratios and latencies with less overhead.

CAR is pain staked as a general framework to predict and evaluate context information for superior delivery of messages. The context here refers to the aspects of system. The delivery process, in this algorithm is based on the presence of receiver within the identical set of nodes. The prospect of delivery of messages is generated from the context information. The algorithm states that if both source and destination nodes are in the same network, message is delivered synchronously. A proactive routing is used and is presumed that every single node host transmits jointly the information related to synchronously routing and a list of delivery probability for the other host nodes. In the mode of asynchronously routing, each host holds a list of entries whose tuples are destination, best host, and delivery probability. As a host is selected to be a carrier and receives the message, it inserts into the buffer.

The prediction of context information is as follows: [11]

i. The host calculates its own delivery probability based on (a) Prediction of future values. (b) Deriving estimated values with utility theory.

ii. Host maintains a forwarding table with tuples next hop and delivery probability for all known destinations.

iii. Each and every host uses the prediction of delivery probability at times of temporary disconnection.

iv. When a host does not hold any information about the receiver, messages are transmitted to nodes with higher mobility.

v. When carriers meets node with higher delivery probability during its mobility, message is delivered to it.

The evaluation of context information involves:

i. Local evaluation: - defines a static hierarchy or uses a pre-emptive methodology.

ii. Significance based evaluation: - uses a utility function.

$$Maximise \{f(U(xi)) = \sum_{i=1}^{n} wiUi(xi)\} \text{ [11]}$$

The performance of CAR is depicted as the number of messages exchanged is more or less constant regardless of buffer size, demonstrating its scalability.

V. BROWNIAN GOSSIP

The Brownian gossip is an amalgamation of gossip and the random node mobility which provides a scalable geographical routing. In this routing, each node forwards the query related to other nodes information with certain values of probability. Gossiping is a resourceful approach for information dissemination and is done with a probability viz., P_{gossip}. The probability value makes certain that the query can reach the secondary nodes in the network with highest probability. The algorithm is depicted Figure 3.

The reply message is routed to the query originator. To make a correct decision of propagating direction of a query, hints about the location of destination is used. The hints are obtained from the carriers. During the node mobility, several nodes will be encountered and this memory of encounters acts as hints.

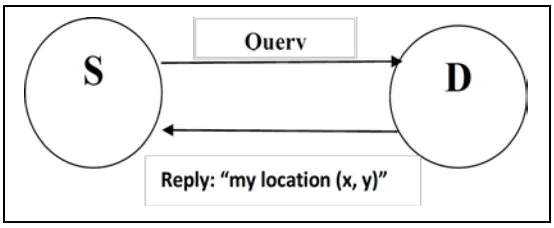

Figure 3: Working of Brownian

Assume that a node A receives a query, it has encountered node D at location (m, n) at time t_D units in the past. Node A forwards query to location (x, y), as the nodes A, B meet, they acquire information about the geographical position and updates its local caches as follows:

Node A updates as,

$\{Node\ B, t_i\ (X_B, Y_B), Is\ Neighbor\ TRUE\}$ [10]

Similarly node B updates its cache. The updating is performed periodically based on the frequency of beacon signals. When A, B are not immediate neighbours', the neighbour field is set FALSE. When these nodes encounter new nodes, they gossip their memory of encounters with probability P_{gossip}, [10] which is chosen on the ground of (i) mobility pattern of nodes (ii) traffic pattern in network .The query packet contains of

{Source S, Locations (Xs, Ys), Target D, tm, Hops h}[10]

When the propagated query reaches the receiver, it replies back its current location (i.e.) (XD, YD) to the sender.

The value of k copies is chosen as follows:

$$K = (min\frac{(tcurrent - tlast{-}encounter)}{c}, k_{max})\ [10]$$

Where c, k_{max} = constants.

The Pgossip is determined by using,

$$Pigossip = max\ \{f\ (Query\ Count_i), g\ (AvgSpeed_i)\}\ [10]$$

Where Query $Count_i$ = number of times queried within a time interval in past.

$AvgSpeed_i$ = average speed with which each node has travelled in past.

The gossip should take place at a time interval of $\frac{2R}{V}$, where R = communication range, V= Speed of node that is ready to gossip. The main advantage of gossip is that the overhead is lowered as the network does not transmit all the queries that were received.

VI. MOBILITY PROFILE BASED ROUTING

The mobility profile based routing addresses, a hub – level routing method and two versions of user – level routing methods. The routing involves a SOLAR–HUB (Sociological Orbit aware Location Approximation and Routing) which manipulates the user profiles that aids in hub – level routing. The multipath version of SOLAR–HUB delivers message to most visited and second most visited destination hubs via k – neighbor. The two user level routing protocols are viz., Static SOLAR–KSP and Dynamic SOLAR–KSP grounded on contact probability and k–shortest paths and KSP is K- shortest paths.

The SOLAR–HUB algorithm [14] states that source reaches destination by forwarding data to k of its own neighbors. Every user computes delivery probability to every hub as,

*Delivery probability = max (travel probability, max (contact probability (hub to k visit)*travel probability))* [9]

The Static SOLAR–KSP algorithm computes the contact probability P (U, V) and constructs a weighted graph W (U, V).

$$W\ (U, V) = log\left(\frac{1}{P(U,V)}\right)\ [9]$$

The KSP is determined by [9] (i) initially path with minimum total weight is chosen. (ii) Each path has different next hop, then the KSP are given delivery probability. The Dynamic SOLAR–KSP algorithm is a combination of Static hub based information and involves dynamic selection of next hop.

Regarding performance the HUB protocols are eminent as follows:

i. SOLAR–HUB shows maximum throughput and higher overhead.

ii. As user density increases, D–SOLAR KSP and S–SOLAR KSP shows increase in delivery probability and decrease in end – to – end delay.

iii. As number of hub increases and user density decreases, D–SOLAR KSP and S–SOLAR KSP shows a decrease in data throughput and increase in end – to – end delay.

iv. The overhead of D–SOLAR KSP is minimal in contrast to S–SOLAR KSP.

VII. DIRECTION BASED GEOGRAPHIC ROUTING

The Direction Based Geographic Routing (DIG) algorithm is grounded on geographic location of packets that are routed in an average approximate ideal path towards destination. The next hop in DIG is chosen by considering the following factors [8]:

i. Distance between relay node and destination node.
ii. Moving direction of the mobile node.

The algorithm postulates that when two nodes encounter each other, the nodes exchange the knowledge of their current location, moving direction and the packets. The packets are forwarded to nodes whose distance and moving direction are closest to destination. The algorithm includes three steps [8]:

Source forwards each part of packet to a number of neighbour nodes when it meets.

i. d>T (T is threshold distance) node chooses moving direction α that is between [θ-ξ, θ+ξ], ξ= Tn.arcsin$\left(\frac{r}{d}\right) \leq {}^{\pi}/_{2}$. [8]
ii. d<T node A forwards packet to node B if αB< αA.[8]

DIG has decreased delay as the resources required are less.

VIII. SINGLE COPY ROUTING

The single copy routing, from its nomenclature it postulates that only a single copy of message packet is carried to destination. This routing (i) employed when low resource usage is critical (ii) improves the design of routing schemes that uses multiple copies.

The routing schemes of single copy are, [7]

i. Direct transmission in which packets are delivered directly to destination.
ii. Randomized routing in which one custodian forwards to another one it meets with certain probability P ∈(0, 1].
iii. Utility based routing that ground upon the usefulness of a node in delivering message to another node.
iv. Seek and focus (hybrid) has three phases [7]
    a. Seek phase: - based on Utility<U_f (focus threshold) and performs randomized routing.
    b. Focus phase: - based on Utility>U_f, receives the message then resets a timer and later performs utility based function.
    c. Reseek phase: - if t_{focus} expires, the timer is modified and randomized routing is performed based on utility functions.
v. Oracle – based optimal algorithm is aware of movement with which, an optimal set of forwarding decisions are made whose delivery probability occurs at minimum time.

IX. MULTIPLE COPY ROUTING

The multiple copy scheme deals with the mechanism of spraying a few copies of message and then routing each copy in isolated manner to the destination. The advantage of this scheme is stated as [6]

i. Less transmission.
ii. Less delays.
iii. Higher scalability.

The design goals of multiple copy case is to, [6]

i. Perform fewer transmissions at all circumstances.
ii. Quicker message delivery.
iii. Maximum amount of messages generated are to be delivered.
iv. Achieve high scalability.
v. Providing simple and minimum knowledge about network.

The algorithm that holds multiple copy case routing are Spray & Wait and Spray & Focus. The Spray and Wait involves spraying multiple copies into the network and waiting for the destination to be reached before delivering the packet. The Spray and focus engross spraying of fewer copies of message packets into network and forwards packet based on the utility function if and only if utility function of node B to reach destination is greater than the sum of the utility function of node A to reach destination and the utility threshold.

X. SEMI PROBABLISTIC ROUTING

Semi Probabilistic Routing (SPR) algorithm considers that the network is partitioned into tiny portions that have a stable topology. The protocol upholds the information about host mobility and connectivity changes for more accurate message forwarding. Information is also used to handle the buffer space. In this, the mobile node maintains h hops from itself. When the receiving node is present within the sane zone of sending node, datas are delivered synchronously whereas when synchronous deliveries of messages are not admitted, datas are forwarded towards a group of nodes that has the highest delivery probability. The routing is a combination of both probabilistic routing with deterministic decisions. The algorithm has profile information that is described as a set of attributes exploiting the overall aspects of the system.

The probability of message delivery is calculated for node i for data j as follows: [5]

$$P_{ij} = \begin{cases} 1\ , if\ node i\ is\ a\ receiver\ of\ data\ j \\ Pijd\ , otherwise \end{cases} \quad [5]$$

The Pijd denotes the intermediate node and is calculated as,

$$P_{ij}^{\ d} = w_{cdc}\, U_{cdc}, i + w_{col}, U_{col}, ij \quad [5]$$

Where U_{cdc}, i = change degree of connectivity.

U_{col}, ij = history of co-location of I with data j.

$$U_{cdc}, i = \frac{|n(t-T) \cup n(t)| - |n-(t-T) \cap n(t)|}{|n(t-T) \cup n(t)} \text{ [5]}$$

$$U_{col}, ij = \begin{cases} 1, if\ j's receiver\ is\ in\ i's\ zone \\ 0, otherwise \end{cases} \text{ [5]}$$

The data j is sent to nodes in the routing zone of node i when the delivery probability is greater than the forwarding threshold. This algorithm shows maximum message delivery and minimum blind message forwarding.

XI. CONTENTION BASED ROUTING

The Contention Based Routing postulates that the efficiency of routing can be achieved only by taking into account the contention and dead end [4]. The Spray Select and Focus provides a better performance considering the contention and dead ends. The contention is referred to be as the competition for resources. It is a condition, where two or more nodes attempts to forward messages across network simultaneously. The operation of Spray Select Focus is depicted pictorially in Figure 4. Source node sends multiple copies of message to various relay nodes. When one of the relay nodes reaches destination, the other copies are dropped [4]. Hence the route is minimized and contention is avoided.

The algorithm holds three phases: [4]

i. In Spray phase L message copies are sprayed by source.
ii. Select phase selects node and finds a shortest route with the hop distance to destination.
iii. In Focus phase, the utility of node X to the destination Y is calculated.

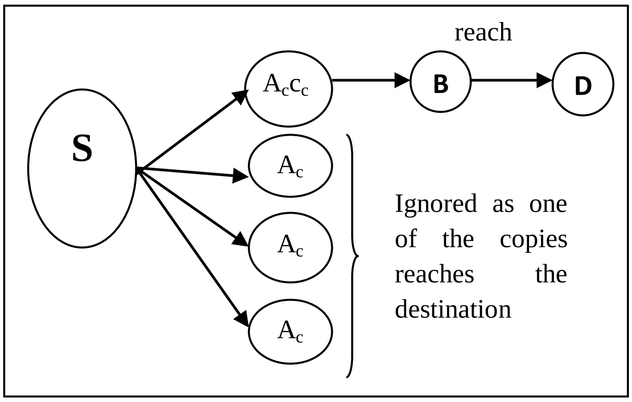

Figure: 4 Spray Select Focus

Node A forwards to node B only if the utility function of B to D is greater than A (i.e) A broadcasts to relay node B if and only if $U_B(D)>U_A(D)$ [4].The dead end is a situation, that occurs due to hardware or power failure and hence the nod gets struck. This algorithm proposes two ways [4] to recover from dead ends.

i. By routing copies using bypass recovery.
ii. No routing is done; the focus phase will transmit the copies directly.

XII. SPRAY AND HOP

The Spray and Hop is a routing protocol that holds two phases namely, Spray phase that sprays few copies of message into the network. Hop phase which occurs after the spraying phase, a node that was not able to find the destination, switches to the hop phase.

Spray Phase:

When a message is generated at the source node, it creates k forwarding tokens. The spray phase maintains a summary vector and its fields are shown in Figure 7 [3].

Spray phase includes certain rules for forwarding the messages and is described as follows:

i. When two nodes encounter each other, they exchange their summary vectors and check for messages that are in common.
ii. A node that has a message copy has k forwarding tokens. When that encounters a node without message, forwards the message copy and handover certain forwarding tokens.
iii. A node transmits data to another node that has greater remaining power.
iv. When more than one node possesses the same message, node with greater residual energy has the responsibility to forward message.
v. When a node has data packet and has a single token, it forwards according to the hop phase.

Spraying is of two forms viz.,

a. Source Spray, in which the source node issues one forward token each time and retains k-1 tokens for itself.
b. Binary Spray, in which the source node issues half of its token at each forward.

Hop Phase:

The hop phase occurs only when one forwarding token is left with the source node. The utility function is used to make a choice for relay node based on the residual power and rediscovery interval. This technique outperforms when the number of transmissions are considered. It is said that as it uses utility function [3] to choose the relay node rather than waiting to encounter the destination, it is estimated that it has better performance than spray and wait.

XIII. SPRAY AND WAIT

The Spray and Wait is a scheme that sprays into the network a fewer number of message copies and waits until one of these nodes that holds the copies reaches the destination. It is simple to implement and can be optimized to achieve the depicted performance. The Spray and wait has certain features as (i) Performing fewer transmissions, (ii) Generating low contention (iii) Achieving better delivery delay (iv) High scalability.

The protocol has two phases [2]

a. Spray phase: L message copies are initially spread by the source and other L distinct relay nodes receives the copies.
b. Wait phase: When destination is not determined during the spray phase, the relay node wait until they determine the destination and then performs direct transmission.

In this, when enough copies are spread into the network, it is guaranteed that at least one node will reach the destination. At this point, the source node stops spraying and lets each custodian node to perform the direct transmission. In choosing the L copies to be sprayed initially two ways were used. The simplest way is to spread the L copies to all L distinct nodes that source node encounters initially. The secondary technique is to use binary spray and wait [2], in which the source node handoffs $^{n}/_{2}$ copies to the relay nodes it encounters by keeping $^{n}/_{2}$ copies for itself. When the source node is left with only one copy of message it performs direct transmission. The spray and wait [2] technique, that is highly robust and scalable. It is stated that it is the only routing scheme that achieves both low delivery delay and higher energy efficiency. It also holds fewer transmissions for a single message to be delivered.

XIV. LOCATION AWARE ROUTING ON DELAY TOLERANT NETWORKS – LOCATION DISSEMINATION

The Location Aware Routing On Delay tolerant networks – Location Dissemination (LAROD-LODIS) is a new form of routing that complements efficient routing in the Intermittently Connected Mobile Ad hoc Networks. The LAROD-LODIS, as the name indicates it is an amalgamation of LAROD-Location Aware Routing for Delay Tolerant Networks and LODIS-Location Dissemination Services. The amalgamation of these techniques suits ICMANET in a well – versed way.

LAROD [1] routes packet only with partial knowledge of the geographic positions. To impose low overhead, it uses beaconless protocol to route packets. It combines the routing scheme with store-carry-forward technique and uses greedy packet forwarding whenever required.

To broadcast a message, the custodian transmits message. All nodes that stay within the specified transmission range receive the packet. A delay timer is set for each custodian; node whose delay timer expires first becomes the new custodian. New custodian forwards message. Relay nodes hearing this, assumes that new custodian has taken form. If no such transmission is heard, the old custodian retransmits with some retransmission time t_r. It is stated that, all nodes do not hear the broadcast; hence duplication of packets may occur. When paths of two copies cross each other, only one forwards, while the other is discarded. Each packet has a TTL [1], when it expires the custodian discards the packet. When the destination receives packet, it transmits acknowledgement to source.

LODIS [1] maintains a local database, and updates it by using the gossiping technique in addition to routing. The database is updated by exchanging their information in database as nodes encounter each other. When the routing protocol requests a location from LODIS, it provides the location with which the packets are forwarded to destination and reduces delay. The LAROD-LODIS maintains a constant overhead for all possible loads and it has increased delivery ratio [1].

Source IP	Data IP	Destination	Power of node	Neighbour list	Timeout

Figure 6: Data Field of Summary Vector

XV. COMPARISION OF ASSORTED PERFORMANCE METRICS

Table 1: Comparison of Assorted Performance Metrics

S.NO	ROUTING TECHNIQUE	OVERHEAD	DELIVERY LATENCY	TRANSMISSION	DELIVERY RATE
1.	Flooding	Maximum	Maximum	More number of transmissions	-
2.	Epidemic	Maximum	Minimum	-	Maximum

3.	BLR	Minimum (since it's based on position)	Reduced delay	Based on the position of nodes	Independent of the node mobility
4.	CAR	Minimum	Good	-	Good
5.	Brownian Gossip	Minimum	Comparatively good	Based on the probability P_{gossip}	Comparatively good
6.	SOLAR-HUB	Maximum	-	-	Maximum
7.	D-SOLAR KSP	Minimum	Decreased at higher user density Increased as number of hubs increases	-	Increased with high user density Decreased as number of hubs increases
8.	S-SOLAR KSP	Maximum	Decreased at higher user density Increased as number of hubs increases	-	Increased with high user density Decreased as number of hubs increases
9.	DIG	Minimum	Optimal	Increases as delay increases	Increases as queue size increases. With large queue size more messages is buffered and fewer messages are dropped.
10.	Single Copy	Minimum	Good	Bad as copy gets lost	Poor
11.	Multiple Copy	Maximum	Optimal	Fewer transmission	Maximum
12.	SPR	Less as minimum message forwarding	-	-	Maximum
13.	Binary Spray and Wait	-	Good	Good	-
14.	Seek and Focus	-	-	Bad as single copy gets lost	-
15.	Spray Select Focus	Optimal	-	-	Maximum as route is minimised
16.	Spray and Hop	Highly Scalable	Slightly high	Decreased number of transmissions	Maximum
17.	LAROD-LODIS	Constant at all nodes	Optimal	Fewer transmissions	Maximum with high probability

XVI. CONCLUSION AND FUTURE WORK

This paper depicts the various routing techniques that were possibly adapted in ICMANET, Intermittently connected Mobile Ad hoc Network. It also out frames the performance metrics of various algorithms and their comparisons with each other. The techniques described in this paper are analyzed in well versed manner and their comparative evaluation is depicted in the Table 15.1. These techniques prove the possibility of routing in the partially connected ad hoc networks. The study of these routing methodologies aids in developing new techniques. As a result of this study, it is found that the secure routing in this network has not been accomplished. In accordance to enhancement of this study, we would apply security measures to the existing routing protocol and adhere to secure communication between nodes in the network.

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