Probabilistic Route Discovery

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***Abstract*— Blind Flooding is widely used in ad-hoc networks for on-demand route discovery where a node rebroadcasts a Route Request control packet (RREQ) until the destination is reached and a route is established between the source and destination. This leads to several deleterious effects such as Channel Contention, high amount of data redundancy, excessive packet collision creates the problem known as routing loop problem and broadcast storm phenomenon, which increases the end-to-end delay and communication overhead of the network. In this project, we propose a probabilistic method for route discovery, which aims to significantly improve the network performance, resource accessibility by reducing the overhead associated with the that is simple to implement and can significantly reduce the overhead associated with the propagation of RREQs. Our analysis shows that this proposed method results in significant improvement in good throughput while maintaining a simple infrastructure simultaneously.**

I. INTRODUCTION

Ad-hoc Network

An ad-hoc network is a spontaneously built network as devices connect. Instead of relying on a base station to synchronize the flow of messages to each and every node in the network, the individual network nodes forward packets to and from each other. In Latin, *ad hoc* exactly means "for this," meaning "for this special purpose" and also, by extension, improvised or impromptu. It is frequently used to describe solutions that are developed on-the-fly for a specific purpose. In computer networking, network connection is referred by an ad hoc network for establishment for a single session and does not require a router or a Wireless BS (Base Station).

For example, if you need to transfer a file to your friend's laptop, you might build an ad hoc network between your computer and his laptop to transfer the file. This may be done using the computers' wireless cards or Ethernet crossover cable to communicate with each other. If you need to share files with one computer or many more computers, you can set up a mutli-hop ad hoc network, which can transfer data over multiple nodes.

Basically, an ad hoc network is a short-term network connection created for a specific purpose (such as transferring data from one computer to another computer). If the network is set up for a longer period of time, it is just a plain old local area network (LAN).

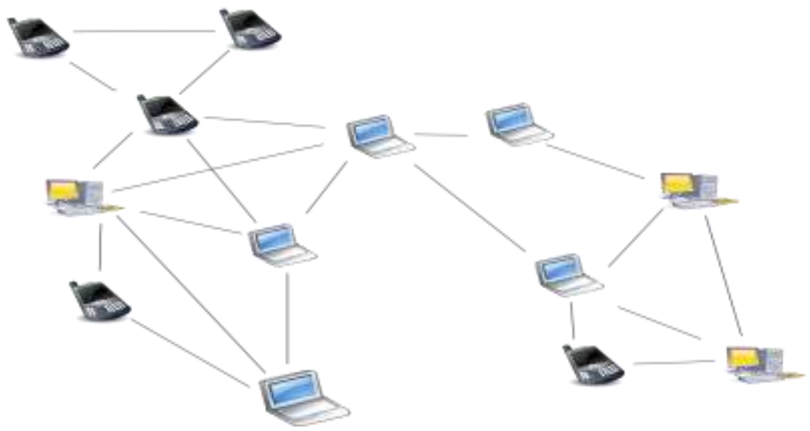

FIG. 1

AD-HOC NETWORK

II. AD-HOC NETWORKS ROUTING PROTOCOLS:

An ad-hoc routing protocol is a standard or convention, that controls how nodes decide which way to route packets amongst computing devices in a mobile ad hoc network . In ad-hoc networks, nodes are not familiar with the topology of their networks. In its place, they have to discover it. The explanations of Ad Hoc Network routing protocols is as follows:

Table-Driven (Pro-Active) Routing:
This type of protocols maintains fresh lists of destinations and their routes by regularly allotting routing tables throughout the network. The main disadvantages of such algorithms are:
1. Separate amount of data for maintenance.
2. Slow reaction on restructuring and failures.

Reactive (on-demand) routing:
In this type of protocols discovers a route on demand by flooding the network with Route Request packets. The disadvantages of such algorithms:
1. High latency time in route finding.
2. Excessive flooding can lead to network clogging.

Flow Oriented Routing:
This type of protocols finds a route on demand by following present flows. Only option is to unicast continually when advancing data while promoting a new link. The main disadvantages of such algorithms are:
1. Takes extensive time when exploring new routes without a prior knowledge.
2. May refer to tentative present traffic to counteract for missing knowledge on routes.

Hybrid Routing:
This type of protocols combines the advantages of reactive and of proactive routing. The main disadvantages of such algorithms are:
1. Advantage varies on sum of Math van nodes activated.
2. Response to traffic demand depends on gradient of traffic volume.

Hierarchical Routing Protocol:
In this type of protocols the choice of proactive and of reactive routing depends not only on the hierarchic level where a node exist in. The main disadvantages of such algorithms are:
1. Advantage depends on depth of nesting and addressing scheme.
2. Response to traffic demand depends on meshing parameters.

Backpressure Routing:
Pre-compute paths don't happen in this type of routing. It chooses next-hops dynamically as a packet is in progress toward its purpose. These judgments are based on congestion gradients of neighbor nodes.

III. Characteristics of Mobile Ad-hoc Networks (MANETs)

A MANET consists of several mobile components such as routers or wireless communication devices, which is simply termed as nodes. Nodes are mobile in nature and move freely and arbitrarily. The nodes maybe present on automobiles or even on people. A MANET is a self-configuring system of these nodes. The systems maybe stand-alone or may have gateways to interface with a fixed network. In the latter mode it is imagined to be operating as a Stub network connecting to a fixed internetwork. Stub networks carry traffic originating at internal nodes or destined for them. But do not allow exogenous traffic to be transmitted through the network.
MANET nodes are usually transmitters and receivers using antennas which maybe Omni-directional, highly directional or steerable or a combination of the above characteristics. Depending on the positions of the nodes and the coverage areas and pattern of the antennas, transmission power levels and co-channel interference pattern, a wireless network is created in the form of a random, grid, random grid, 1-hop or multi-hop ad-hoc networks between the nodes in the given topology.

MANETs have several salient characteristics:
1) Dynamic topologies: Nodes are freely moving and do not have specific movement pattern; hence the network topology which is typically multi-hop changes randomly and rapidly at any point of time.
2) Bandwidth-constrained, variable capacity links: Wireless links will continue to have significantly lower capacity than the wired networks. Additionally the throughput, which is realized at the end of transmission, is always less than the maximum transmission rate due to co-channel interference, fading, noise and several such deleterious factors acting on wireless links.
3) Energy-constrained operation: Most of the MANET nodes are battery-dependent or depend on exhaustible means of energy. The growth of battery technology has been relatively slower than the growth in the wireless routing protocol technology and hence it is important to design algorithms, which are highly energy efficient for the need of energy conservation.
4) Limited physical security: Mobile wireless networks are prone to several physical and network security breach. The services demanded by the customers include confidentiality, integrity of data, access control and full availability of resources. These services are often denied by passive attacks such as eavesdropping, spoofing, DOS attacks and so on. A major advantage of MANET is its decentralized nature, thereby it avoids bottleneck and single point of failure and provides additional robustness.

IV. ROUTING PROTOCOLS FOR MANETS

Generally the routing protocols for the MANET can be broadly classified into three types:

- Proactive
- Reactive
- Hybrid

Proactive Routing Protocols, aim at maintaining consistent up-to-date routing information from each node in the topology to any other node in the network. Each node is expected to periodically discover and update its routes to every possible destination.
Reactive Routing Protocols, aims on discovering and setting up routes between a node to the destination node in the network only when a request is made to do so, hence they maybe also known as On-Demand Protocols. Each node maintains **a** route for a node pair without the periodic updating of the routing table as in the case of Proactive Routing Protocols.
Additionally, there are Hybrid Routing Protocols, which is a conjunction of the Proactive and Reactive protocols. In these protocols, the nodes locally maintains a routing table, i.e., within its zone and outside the zone/cluster tends to follow the reactive routing protocols. The lack of periodic updating of routing table may cause broken links in the network and thereby updating of this kind may lead to large routing overhead in highly mobile environments. Hence, these protocols are not scalable in MANETs, which have limited bandwidth and where topologies are highly dynamic. In conventional On-Demand Routing protocol the node which needs to find a path through the network sends a Route Request control packet to its immediate neighboring nodes. Each mobile node blindly broadcasts the packets forward until a route is established. This process is commonly known as Blind Flooding. Since every node that receives a RREQ packet forwards the same with forwarding probability p=1, if we consider having a topology with N nodes, the maximum number of rebroadcasts are N-2. This can potentially lead to excessive data redundancy, channel contention, increase in end-to-end delay and packet collision.

V. METHODS TO MITIGATE RREQ FLOODS

Location Aided Routing (LAR)
This algorithm is an approach to mitigate the route discovery overhead by utilizing location-aided information for mobile nodes. Such location information can be obtained using the global positioning system (GPS) receivers [16].

The Routing On-demand Acyclic Multi-path (ROAM) Protocol
This protocol mitigates the number of retransmissions of RREQ floods by using directed acyclic sub graphs based upon the distance between the source and destination nodes.

Use of Directional antennas
It is an on demand routing method that employs the functionality of directional antenna systems. The use of directional antennas limits the direction and scope of the RREQ floods.

Connected Dominating Set (CDS) or Cluster Based Algorithms
Other suggested solutions towards mitigating the RREQ floods involve the construction and maintenance of virtual backbones based on the physical topology of the network, and running the route discovery protocol over the backbone. Nodes on the backbone are privileged to forward RREQ packets during route discovery. The construction and maintenance of virtual backbone that guarantees total coverage of the entire network is either based on Connected Dominating Set (CDS) or Cluster based algorithms. A CDS is a set of nodes such that every node in the network is either in the set or is the neighbor of a node in the set. In CDS-base routing, only the nodes in the dominating set are privileged to forward the RREQ packets. Undoubtedly, the efficiency of the CDS approach depends on the process of establishing and maintaining a CDS and the size of the corresponding sub-network. In cluster base virtual backbone construction, the network topology is divided into several disjoint overlapping clusters. Each cluster elects one node as the cluster-head. The cluster-head of each cluster is responsible for forwarding RREQ packets on behalf of its members. Cluster-heads communicate with each other by gateway nodes. A gateway is a node that has two or more cluster-heads as it neighbors.

VI. MOTIVATION

There has been a rising research activity on wireless mobile ad hoc networks (MANETs) over the past years due to their possible useful civilian and military applications. MANETs are formed dynamically by an autonomous system of mobile nodes that are linked via wireless links without using an existing fixed network infrastructure or centralized administration. The nodes are free to move erratically and organize themselves arbitrarily; thus, the network's wireless topology may change quickly and suddenly. Nodes in MANETs act as end points and sometimes as routers to forward packets in a wireless multi-hop environment.

VII. PROBLEM DEFINITION

In on-demand distance vector routing protocol, the source node initiates RREQ packet and broadcast to its neighbors. The broadcasting is referred as flooding. A straightforward flooding is very costly and will result serious redundancy, contention and collision. This project we have identified this broadcast storm problem and has sought a solution to improve it.

VIII. OBJECTIVE

A probabilistic route discovery approach is proposed, called Dynamic Probabilistic Route Discovery, which addresses the broadcast storm setback in existing on-demand routing protocols. In this approach, each node, upon receiving a broadcast packet, advances the packet with probability p determined by the neighborhood coverage and the local density of the node. The aim of this method is to achieve high reachability while keeping the routing overhead low and also reduce end-to-end delay while ensuring high overall network connectivity.

IX. METHODOLOGY

- ALGORITHM:

Create neighbor table for host nodes
Send RREQ packets
Upon receiving a RREQ packet RQ a node
If node is source
then
Set rebroadcast probability to p=1
Else
Check for density
If
Density<average density then assign p1
Elseif
Density>average density then assign p2
Endif
Generate a random number RND over the range [0,1]
If RND <= p
Broadcast the RREQ packet
Else
Drop the packet

The probabilistic scheme is similar to blind flooding, except that the nodes broadcasts with a fixed probability assigned to them based on criteria such as the density of its neighborhood, that is, the complete topology is segregated into several clusters and the node maintains a neighbor table for the same purpose. It is observed that in dense networks it is likely that multiple nodes share similar transmission coverage. Thus the rebroadcast maybe reduced by a considerable amount without harming the efficiency in packet delivery, while in sparsely populated networks the shared network coverage is much less and therefore it may happen that all the nodes may not receive all the broadcast packets unless the forwarding probability is not high, as in blind flooding scheme where the forwarding probability is p=1, where p is the forwarding probability. The proposed algorithm automatically adjusts the re-broadcast probability at each mobile node according to the value of p held by immediate neighbors in its transmission range.

The value of probability changes when the node moves to a different location in the neighborhood. The rebroadcast probability is higher in sparsely populated networks as compared to denser networks. If the message is received for the first time, by a specific node then that node forwards the message with very high probability for example the source node, while on the consequent rebroadcasting of messages by the nodes is performed according to the density of the neighbors to the host node. If the density is greater than the average number of neighbors then low forwarding probability is set and if the number of neighbors are less than the average then high forwarding probability is set. These probabilities control the number of broadcasts requests, reduce the number considerably in comparison to blind flooding and thereby save/conserve network resources. The number of duplicate packet disseminated is also reduced, thereby reducing data redundancy. The scheme for density-based dissemination involves periodic signaling between the host node and its neighbors and thereby constructs a one-hop neighbor table for each host.

The table given below shows the parameters considered for simulation:

TABLE 1 Simulation Parameters

Simulation Parameter	**Value**
Transmitter range	10 units
Traffic type	CBR

No. Of Nodes	49
No. of packets transmitted	30
Topology size	100 units x 100 units

End-To-End Delay: Figure 2 measures the end-to-end delay of data packets that have been received at the destinations. A single source-destination pair is considered here. Significant Table 1. Simulation Parameters values are considered in taking the reading. Compared with the traditional AODV, the PDR can reduce latency in dense networks or where the distance between the source and destination is more than 2-Hop.

Figure 3 measures the end-to-end delay of data packets that have been received at the destinations. A double source-destination pair is considered here. We see the increased performance of PDR against the OD.

Figure 4 and Fig 5 displays the comparison between the number of broadcasts in the PDR and OD algorithm. It is observed that when the number of links required increases the performance of PDR also betters relative to that of OD, but in several test poor performance of PDR is observed in case of short distance links. The poor performance of PDR in relative to OD-existing algorithm is due to the flooding performed by the latter and for short distances tends to be more effective, for example for 1-hop or 2-hop source-destination pair. But when distance between source and destination increases, more RREQ packets fail to reach the destinations due to high chances of packet collision and data redundancy.

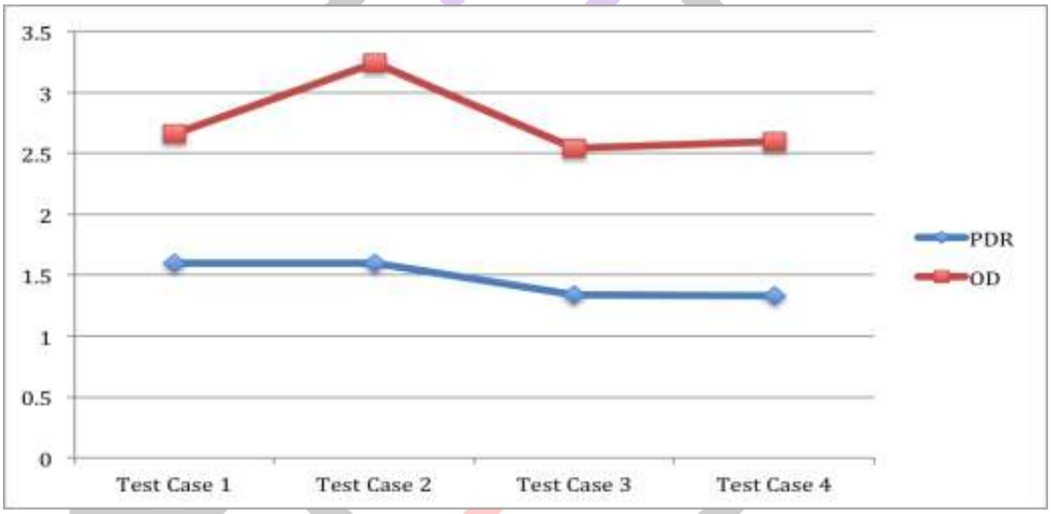

FIG 2. END-TO-END DELAY PERFORMANCE FOR SINGLE SOURCE-DESTINATION PAIR

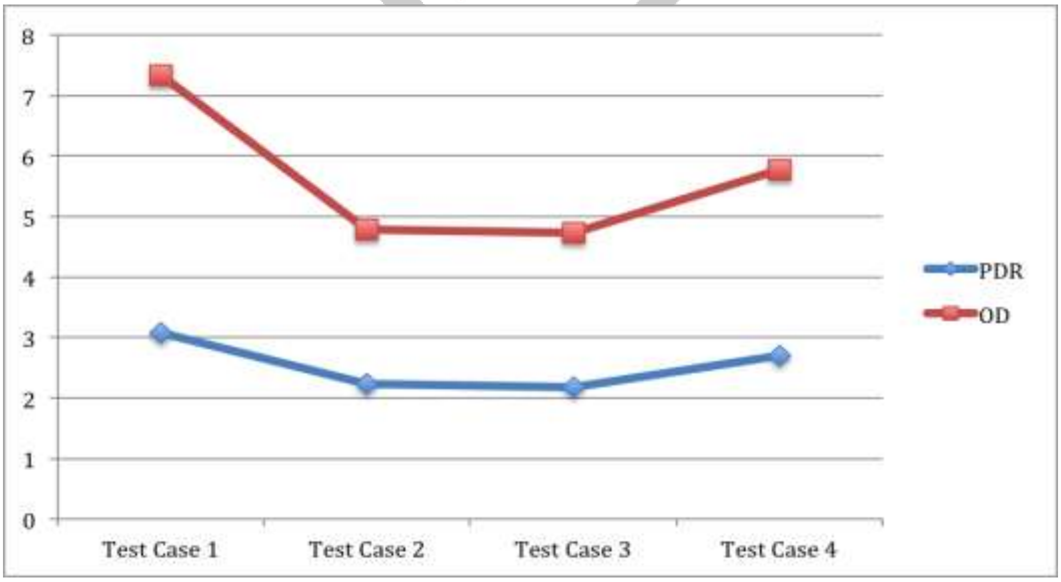

FIG 3. END-TO-END DELAY PERFORMANCE FOR DOUBLE SOURCE-DESTINATION PAIR

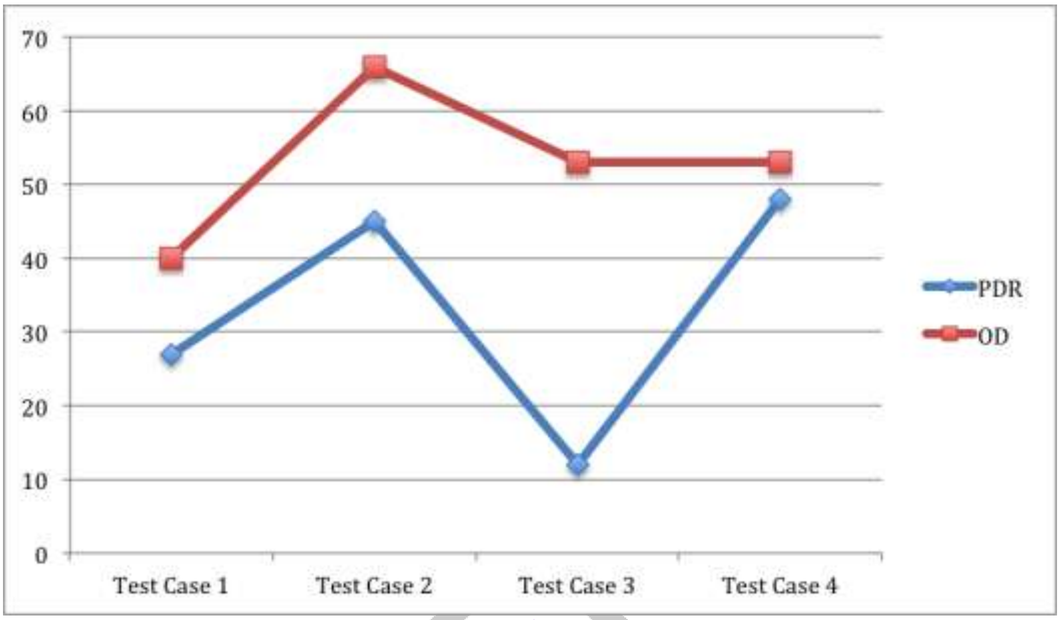

FIG. 4 NUMBER OF BROADCASTS FOR SINGLE SOURCE-DESTINATION PAIR

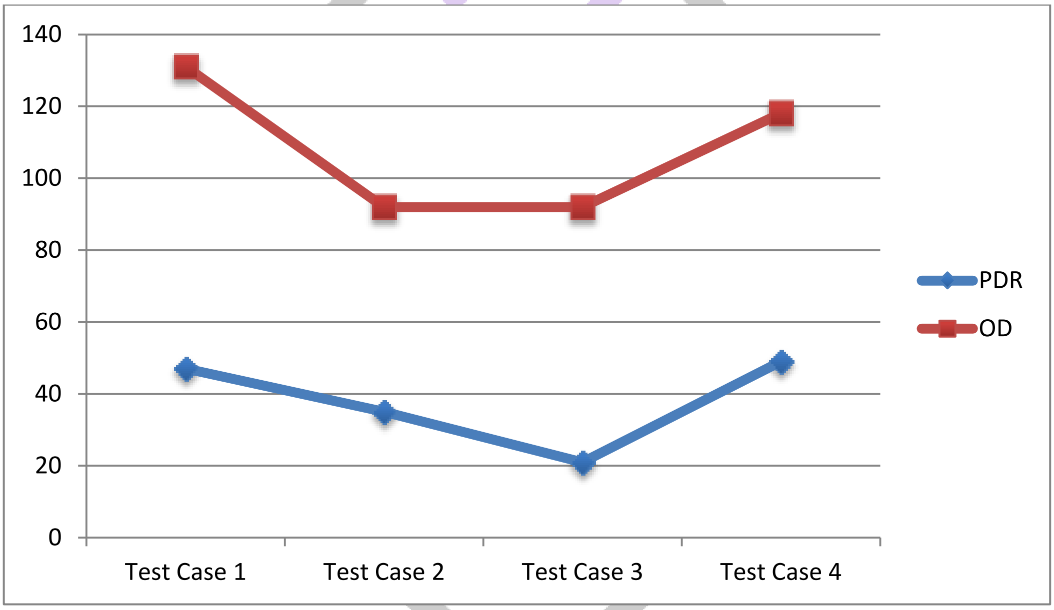

FIG. 4 NUMBER OF BROADCASTS FOR DOUBLE SOURCE-DESTINATION PAIR

X. CONCLUSION

The scope for improvement in this experiment is wide and much improvement can be achieved. This project has proposed and evaluated the performance of probabilistic route discovery using AODV as the base routing protocol, which traditionally uses the blind flooding. Compared to the AODV, results obtained from the simulations have shown that the proposed PDR algorithm generates a much lower routing overhead, especially in dense networks or in cases where there are more than one links to be established at the same time or also in the case when the distance between the source and destination is large, thus significantly reducing the number of packet collisions. As a continuation of this research in the future, we plan to further explore the performance of the probabilistic route discovery in proactive routing protocols such as OLSR. Secondly, we plan to refine our analytic model for probabilistic route discovery approaches. And also the simulation output for a wide range of topologies needs to be done for a more concrete data analysis. Security factors, Queuing of requests, packet drop and so on are some of the parameters, which can be inculcated, and its performance after such inclusion needs to be measured.

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