Energy Efficient Position Based Opportunistic Routing Protocol for MANETS

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Abstract
Reliable and on-time data delivery is a crucial parameter of network performance in highly dynamic mobile ad hoc networks. Leveraging on a modified 802.11 MAC tweak, guard nodes relay the packet with prioritized back off time when the intended node fails and becomes a contender nodes themselves. Previously used ad hoc routing protocols of MANETS are susceptible to node mobility, especially for large-scale networks because of this tweak. To address this issue a MAC independent approach called Position-based Opportunistic Routing (POR) protocol uses location information to guide the data flow and can always archive near optimal path. Utilizing in-the-air backup mechanism, communication is maintained without being interrupted. On the other hand, this scheme focuses on the route discovery from the perspective of network layer and no complex MAC modification is necessary. Forwarding candidates are coordinated using the candidate list comparison available at every node . Although this method addresses the problem of node mobility and communication voids, this type of comparison is a severe drain on power resources of each node involved in the communication. So we propose to use POR in combination with Quorum-based asynchronous power-saving (QAPS) protocol. The basic idea of the proposed approach is to extend POR protocol for MANETs for saving more energy and accommodating more hosts. According to the proposed protocol, all the hosts of a locality are divided into clusters. Every cluster has one cluster leader with others being cluster members. The members are one-hop neighbours of the head and are synchronous with it. Prior approaches operated within an individual cluster. And the QAPS protocol is operated among cluster heads. All the cluster heads are organized as a virtual backbone to help route data. We perform simulations and compare the protocol with the related protocols. We find that the proposed protocol is more power-efficient and more scalable.
Keywords
Ad hoc, Quorum, QAPS,POR, hop ,MANETS, cluster

I. INTRODUCTION

Over the last few years, personal communication devices have invaded most developed countries and today, the majority of the population owns a mobile phone and most people use personal digital assistants[1], mobile computers, etc. This tendency is reinforced and occurs at the same time with a new trend: most of these devices get equipped with one or several wireless networking interfaces. A mobile ad hoc network is a set of mobile nodes able to communicate with other nodes in their surroundings[2]. These wireless communications happen in a peer-to-peer manner, without relying on any predefined infrastructure. Today, mobile ad hoc networks are mainly used for sensing, gaming and military purposes. But the steadily wider adoption of wireless technologies in daily life let one foresee the next generation of mobile ad hoc network applications: environmental and medical monitoring, groupware, customer to customer applications, risk management, entertainment, advertising, etc. In this document we will consider a subclass of mobile ad hoc network called “delay tolerant networks”[2]. In such network, the mobility is hardly predictable and the disruption of connection is a common and normal phenomenon.

Traditional topology-based MANET routing protocols (e.g., POR, AODV, DSR [1]) are quite susceptible to node mobility. One of the main reasons is due to the predetermination of an end-to-end route before data transmission. Owing to the constantly and even fast changing network topology, it is very difficult to maintain a deterministic route. The discovery and recovery procedures are also time and energy consuming. Once the path breaks, data packets will get lost or be delayed for a long time until the reconstruction of the route, causing transmission interruption.

In this paper, a novel Position-based Opportunistic Routing (POR) protocol is proposed, in which several forwarding candidates cache the packet that has been received using MAC interception. If the best forwarder does not forward the packet in certain time slots, suboptimal candidates will take turn to forward the packet according to a locally formed order. In this way, as long as one of the candidates succeeds in receiving and forwarding the packet, the data transmission will not be interrupted. Potential multi paths are exploited on the fly on a per packet basis, leading to POR’s excellent robustness.

The main contributions of this paper can be summarized as follows:

1.We propose a position-based opportunistic routing mechanism which can be deployed without complex modification to MAC protocol and achieve multiple

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reception without losing the benefit of collision avoidance provided by 802.11.
2.The concept of in-the-air backup significantly enhances the robustness of the routing protocol and reduces the latency and duplicate forwarding caused by local route repair.
3.In the case of communication hole, we propose a Virtual Destination-based Void Handling (VDVH) scheme in which the advantages of greedy forwarding (e.g., large progress per hop) and opportunistic routing can still be achieved while handling communication voids.
4.We analyze the effect of node mobility on packet delivery and explain the improvement brought about by the participation of forwarding candidates.
5.The overhead of POR with focus on buffer usage and bandwidth consumption due to forwarding candidates' duplicate relaying is also discussed. Through analysis, we conclude that due to the selection of forwarding area and the properly designed duplication limitation scheme, POR's performance gain can be achieved at little overhead cost.
6.Finally, we evaluate the performance of POR through extensive simulations and verify that POR achieves excellent performance in the face of high node mobility while the overhead is acceptable.

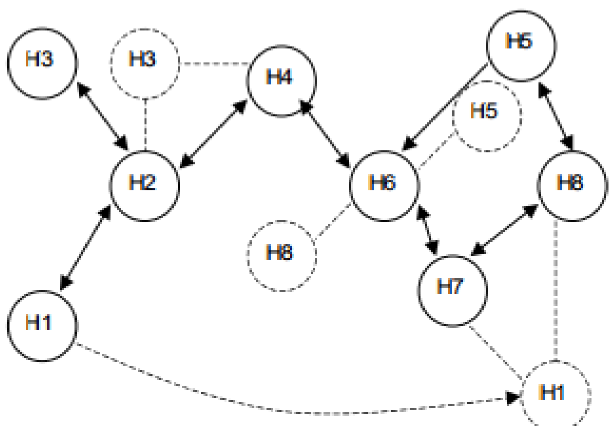


Figure 1: An example of the ad hoc networks

II LITERATURE REVIEW

First, my investigation of mobile ad hoc networking started with the study of broadcasting protocols for large-scale metropolitan ad hoc networks. This requires a simulation tools that enables to instantiate large amount of nodes[5]. It also requires the ability to simulate heterogeneous networks as well as to make the nodes move similarly to the way people move in reality. At the best of my knowledge, when this research started (mid-2003) none of the simulators[7] available were proposing all of these features in a single package.

The overhead inclusive of memory consumption and duplicate relaying will also be discussed. Since our focus lies on the effect of node mobility, an ideal wireless channel is assumed in the following part and the unit disc graph model will be used by default: a link between two nodes exists if and only if the distance between them is less than a certain threshold[1][5]. Over the past few years, a variety of new routing protocols targeted[9] specifically at the ad hoc networking environment have been proposed, but little performance information on each protocol and no detailed performance comparison between the protocols has previously been available[9][3].

Destination sequenced distance vector routing protocol

Destination sequenced distance vector routing (DSDV) is adapted from the conventional Routing Information Protocol (RIP) to ad hoc networks routing. It adds a new attribute, sequence number, to each route table entry of the conventional RIP. Using the newly added sequence number, the mobile nodes can distinguish stale route information from the new and thus prevent the formation of routing loops. In DSDV, each mobile node of an ad hoc network maintains a routing table, which lists all available destinations, the metric and next hop to each destination and a sequence number generated by the destination node. Using such routing table stored in each mobile node, the packets are transmitted between the nodes of an ad hoc network. Each node of the ad hoc network updates the routing table with advertisement periodically or when significant new information is available to maintain the consistency of the routing table with the dynamically changing topology of the ad hoc network.

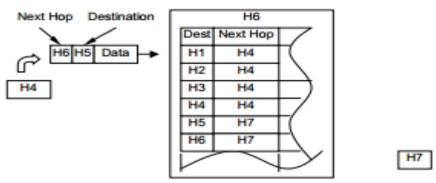
Table 1: The routing table of node H6 at one instant

Dest	Next Hop	Metric	Seq.No.	Install
H1	H4	3	S406_H1	T001_H6
H2	H4	2	S128_H2	T001_H6
H3	H4	3	S564_H3	T001_H6
H4	H4	1	S710_H4	T002_H6
H5	H7	3	S392_H5	T001_H6
H6	H6	0	S076_H6	T001_H6
H7	H7	1	S128_H7	T002_H6
H8	H7	2	S050_H8	T002_H6

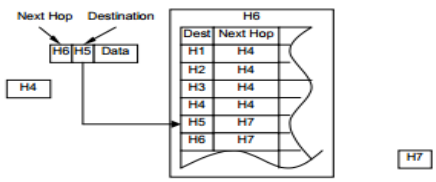
Table 1 is the routing table of the node H6 at the moment before the movement of the nodes. The Install time field in the routing table helps to determine when to delete state routes.

III. SYSTEM ARCHIRECTURE

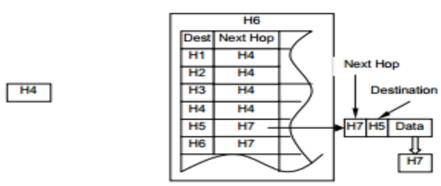
Traditional MANET routing protocols are quite susceptible to link failure as well as vulnerable to malicious node attacks.One of the main reasons is due to the property that a predetermined route must be established before packet transmission. (It is realized through periodic update for every node in proactive routing, or on-demand construction in reactive routing.) Such kind of route discovery and establishment process inevitably introduce a variety of control messages which can become an attacker's target and can be easily intercepted, modified or just dropped. The QoS of the communication is thus degraded and even worse, the transmission could never be established.



a) Node H4 transmits a packet to node H6 for forwarding



b) Node H6 looks up the destination and route for forwarding the packet in its routing table



a) Node H6 forwards the packet to the next hop

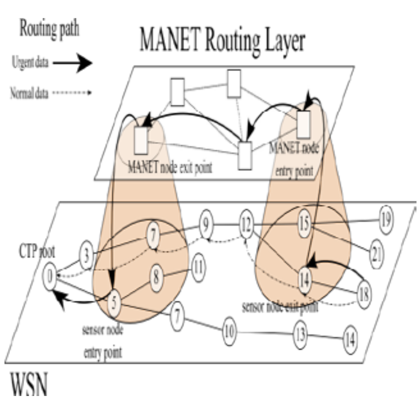


Fig 3.1:Shows the architecture of MANET Routing Protocol

IV PROPOSED WORK

Position-Based Opportunistic Routing

The design of POR is based on geographic routing and opportunistic forwarding. The nodes are assumed to be aware of their own location and the positions of their direct neighbours. Neighbourhood location information can be exchanged using one-hop beacon or piggyback in the data packet's header. While for the position of the destination, we assume that a location registration and lookup service which maps node addresses to locations is available just as in [5]. It could be realized using many kinds of location service ([11], [12]). In our scenario, some efficient and reliable way is also available. For example, the location of the destination could be transmitted by low bit rate but long range radios, which can be implemented as periodic beacon, as well as by replies when requested by the source. When a source node wants to transmit a packet, it gets the location of the destination first and then attaches it to the packet header. Due to the destination node's movement, the multihop path may diverge from the true location of the final destination and a packet would be dropped even if it has already been delivered into the neighbourhood of the destination. To deal with such issue, additional check for the destination node is introduced. At each hop, the node that forwards the packet will check its neighbour list to see whether the destination is within its transmission range. If yes, the packet will be directly forwarded to the destination, similar to the destination location prediction scheme described in [4]. By performing such identification check before greedy forwarding based on location information, the effect of the path divergence can be very much alleviated.

In conventional opportunistic forwarding, to have a packet received by multiple candidates, either IP broadcast or an integration of routing and MAC protocol is adopted. The former is susceptible to MAC collision because of the lack of collision avoidance support for broadcast packet in current 802.11, while the latter requires complex coordination and is not easy to be implemented. In POR, we use similar scheme as the MAC multicast mode described in [13]. The packet is transmitted as unicast (the best forwarder which makes the largest positive progress toward the destination is set as the next hop) in IP layer and multiple reception is achieved using MAC interception. The use of RTS/CTS/DATA/ACK significantly reduces the collision and all the nodes within the transmission range of the sender can eavesdrop on the packet successfully with higher probability due to medium reservation. As the data packets are transmitted in a multicast-like form, each of them is identified with a unique tuple (src_ip, seq_no) where src_ip is the IP address of the source node and seq_no is the corresponding sequence number. Every node maintains a monotonically increasing sequence number,

and an ID_Cache to record the ID (src_ip, seq_no) of the packets that have been recently received. If a packet with the same ID is received again, it will be discarded.

Otherwise, it will be forwarded at once if the receiver is the next hop, or cached in a Packet List if it is received by a forwarding candidate, or dropped if the receiver is not specified.

The packet in the Packet List will be sent out after waiting for a certain number of time slots or discarded if the same packet is received again during the waiting period (this implicitly means a better forwarder has already carried out the task). The basic routing scenario of POR can be simply illustrated in Fig. 1. In normal situation without link break, the packet is forwarded by the next hop node (e.g., nodes A, E) and the forwarding candidates (e.g., nodes B, C; nodes F, G) will be suppressed (i.e., the same packet in the Packet List will be dropped) by the next hop node's transmission. In case node A fails to deliver the packet (e.g., node A has moved out and cannot receive the packet), node B, the forwarding candidate with the highest priority, will relay the packet and suppress the lower priority candidate's forwarding (e.g., node C) as well as node S. By using the feedback from MAC layer, node S will remove node A from the neighbour list and select a new next hop node for the subsequent packets. The packets in the interface queue taking node A as the next hop will be given a second chance to reroute. For the packet pulled back from the MAC layer, it will not be rerouted as long as node S overhears node B's forwarding.

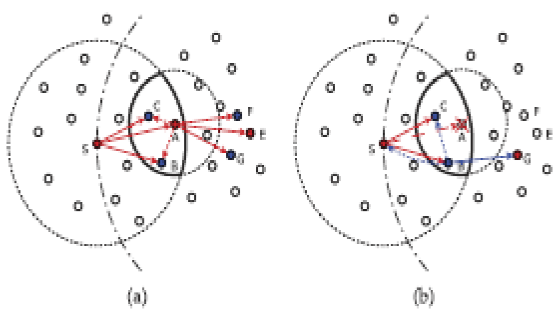


Fig. 4.1 (a) The operation of POR in normal situation. (b) The operation of POR when the next hop fails to receive the packet.

In case a dead-end appears, we argue that in a mobile network without huge obstacles, it has little adverse effects on routing, especially in a highly dynamic network. As a node's void will most likely be recovered by a node's movement in a very short time, it might be better to cache the packets for a while before discovering a new forwarder than routing around via a farther path [13].

According to the required number of backup nodes, some (maybe all) of them will be selected as forwarding candidates. The priority of a forwarding candidate is decided by its distance to the destination. The nearer it is to the destination, the higher priority it will get. When a node sends or forwards a packet, it selects the next hop forwarder as well as the forwarding candidates among its neighbours. The next hop and the candidate list comprise the forwarder list. Algorithm shows the procedure to select and prioritize the forwarder list. The candidate list will be attached to the packet header and updated hop by hop. Only the nodes specified in the candidate list will act as forwarding candidates. The design of POR is based on Geographic Routing and Opportunistic Forwarding, which transfers the data packet based on the location of the destination. The concept of in-the-air backup reduces the latency and duplicate relaying caused by local reroute. To increase the level of security we also encrypt the data, before transmission.

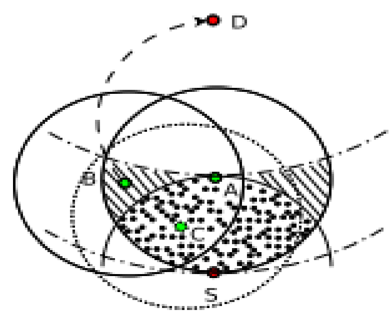


Fig 4.2 Dead-end in POR

Algorithm : Candidate Selection
ListN : Neighbor List
ListC : Candidate List, initialized as an empty list
ND : Destination Node
base : Distance between current node and ND
if find(ListN,ND) then
next_hop<-ND
return
end if
for i<- 0 to length(ListN) do
ListN[i]. dist<- dist (ListN[i], ND)
end for
ListN.sort()
next hop<- ListN[0]
for i <-1 to length(List N) do
if dist(ListN[i],ND)>= base or length(List C)=N
then
break
else if dist(listN[i], listN[0]) < R/2 then
ListC.add(ListN[i])
end if
end for

V IMPLEMENTATION

In this section, we analyze the performance of our new approach for positioning the objects and saving the energy using our newly proposed technique. This we compare with DSDV andQAPS. The Algorithms were implemented in JAVA using Swings concepts . Forms framework is used for designing GUI. The SQL Server 2000 data base is used for managing the performance results.

VI. EXPERIMENTAL RESULTS

In order to evaluate the performance of our proposed algorithm, we have conducted experiments on a PC (CPU: Intel(R) Core2Duo, 3.16GHz) with 4GByte of main memory running Windows XP. The following shows the results of Position Based Opportunistic Routing Algorithm.

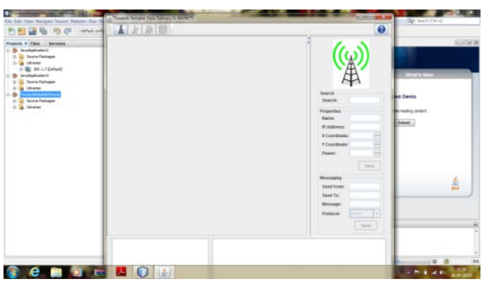


Fig 6.1 Shows the home page of POR for MANETS

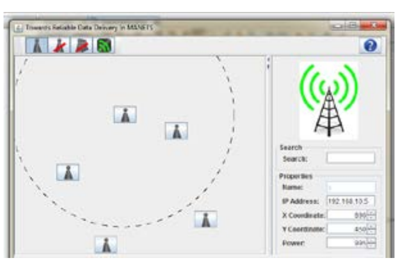


Fig 6.2 Represents the selection of nodes

Fig 6.3 Represents the working of MANET in SDV protocol

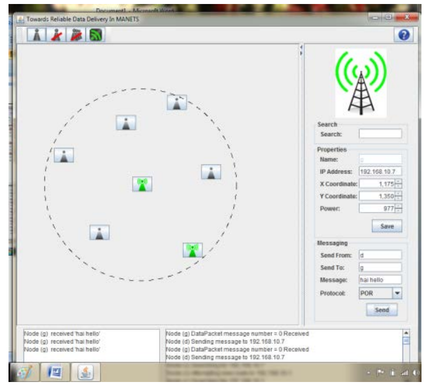


Fig 6.4 Represents the working of MANET in POR protocol

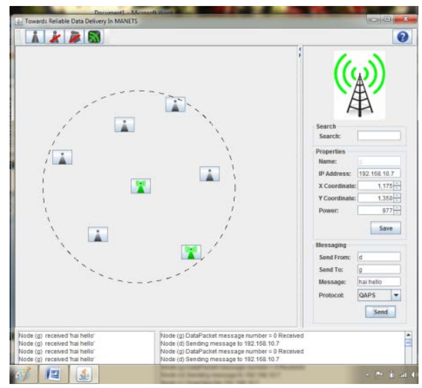


Fig 6.5 Represents the working of MANET in QAPS protocol

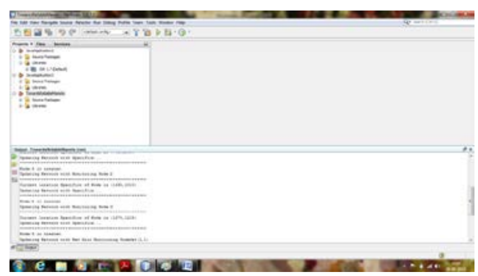


Fig 6.6 Shows the node mobility in various protocols.

VII. CONCLUSION AND FUTURE WORK

In this paper, we propose a novel MANET routing protocol POR which takes advantage of the stateless property of geographic routing and broadcast nature of wireless medium. Besides selecting the next hop, several forwarding candidates are also explicitly specified in case of link break. Leveraging on such natural backup inthe air, broken route can be recovered in a timely manner.The efficacy of the involvement of forwarding candidates against node mobility, as well as the overhead due to opportunistic forwarding is analyzed. Through simulation, we further confirm the effectiveness and efficiency of POR:

high packet delivery ratio is achieved while the delay and duplication are the lowest. We compare our proposed technique with many traditional algorithms like DSDV and QAPS in terms of energy saving, which results in our POS is better in energy saving.

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