GRM for Data Transfer in AdHoc Networks

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Abstract

On the surface a packet is a chunk of information but at the deeper level a packet is one unit of binary data capable of being transferred through a network. The problem of delivering data packets for highly dynamic mobile ad hoc networks in a reliable and timely manner. Driven by this issue, an efficient Position-based Opportunistic Routing (POR) protocol which takes advantage of the stateless property of geographic routing and the broadcast nature of wireless medium. When a data packet is sent out, some of the neighbour nodes that have overheard the transmission will serve as forwarding candidates, and take turn to forward the packet if it is not relayed by the specific best forwarder within a certain period of time. By utilizing such in-the-air backup, communication is maintained without being interrupted. Both theoretical analysis and simulation results show that POR achieves excellent performance even under high node mobility with acceptable overhead and the new void handling scheme also works well.

KEYWORDS: AdHoc Network, MAC Layer, Data Packet

I. Introduction

Mobile ad hoc network is multichip adhoc network which consists of number of mobile nodes. Traditional topology-based MANET routing protocols (e.g., DSDV, AODV, DSR) 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 predict 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. Geographic routing (GR) uses location information to forward data packets, in a hop-by-hop routing fashion. Greedy forwarding is used to select next hop forwarder with the largest positive progress toward the destination while void handling mechanism is triggered to route around communication voids. No end-to-end route need to be maintained, leading to GR's high efficiency and scalability. In the operation of greedy forwarding, the neighbour which is relatively far away from the sender is chosen as the next hop. If the node moves out of the sender's coverage area, the transmission will fail. In GPSR (a very famous geographic routing protocol), the MAC-layer failure feedback is used to offer the packet another chance to reroute. However, our simulation reveals that it is still incapable of keeping up with the performance when node mobility increases. In fact, due to the broadcast nature of the wireless Medium, a single packet transmission will lead to multiple receptions.

If such transmission is used as backup, the robustness of the routing protocol can be significantly enhanced. The concept of such multicast-like routing strategy has already been demonstrated in opportunistic routing. However, most of them use link-state style topology database to select and prioritize the forwarding candidates. In order to acquire the internodes loss rates, periodic network-wide measurement is required, which is impractical for mobile environment. As mentioned in the batching used in these protocols also tends to delay packets and is not preferred for many delay sensitive applications. Recently, location-aided opportunistic routing has been proposed which directly uses location information to guide packet forwarding. However, just like the other opportunistic routing protocols, it is still designed for static mesh networks and focuses on network throughput while the robustness brought upon by opportunistic forwarding has not been well exploited. 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.

II. 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

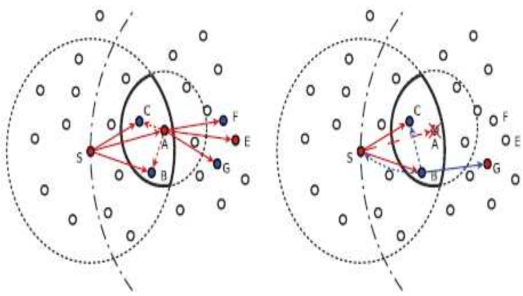


Figure1: Operations of POR in Normal Situation

II.I Selection and Prioritization of Forwarding

Candidates one of the key problems in POR is the selection and prioritization of forwarding candidates. Only the nodes located in the forwarding area would get the chance to be backup nodes. The forwarding area is determined by the sender and the next hop node. A node located in the forwarding area satisfies the following two conditions: it makes positive progress toward the destination; and its distance to the next hop node should not exceed half of the transmission range of a wireless node (i.e., R=2) so that really all the forwarding candidates can hear from one another. In Fig. 1, the area enclosed by the bold curve is defined as the forwarding area.

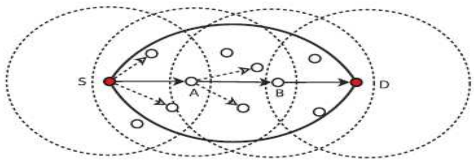


Fig 2: Duplicate Relaying Is Limited In The Region Enclosed By The Bold Curve

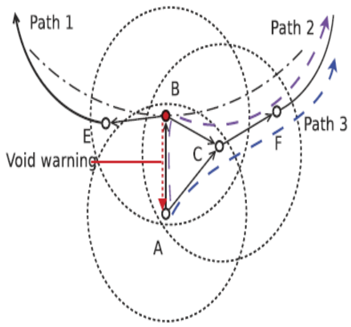


Fig 3: Potential paths around the void.

II.II MAC Modification

Leverage on the broadcast nature of 802.11MAC: all nodes within the coverage of the sender would receive the signal. However, its RTS/CTS/DATA/ACK mechanism is only designed for unicast. It simply sends out data for all broadcast packets with CSMA. Therefore, packet loss due to Collisions would dominate the performance of multicast-like routing protocols. Here, some alteration on the packet transmission scenario. In the network layer, we just send the packet via uncast, to the best node which is elected by greedy forwarding as the next hop. In this way, we make full utilization of the collision avoidance supported by 802.11 MAC. While on the receiver side, we do some modification of the MAC-layer address filter: even when the data packet's next hop is not the receiver, it is also delivered to the upper layer but with some hint set in the packet header indicating that this packet is overheard. It is then further processed by POR. Hence, the benefit of both broadcast and uncast (MAC support) can be achieved.

II.III MAC Call-back

When the MAC layer fails to forward a packet, the function implemented in POR—mac_callback will be executed. The item in the forwarding table corresponding to that destination will be deleted and the next hop node in the neighbour list will also be removed. If the transmission of the same packet by a forwarding candidate is overheard, then the packet will be dropped without reforwarding again; otherwise, it will be given a second chance to reroute. The packets with the same next hop in the interface queue which is located between the routing layer and MAC layer will also be pulled back for rerouting. As the location information of the neighbours is updated periodically, some items might become obsolete very quickly especially for nodes with high mobility. This scheme introduces a timely update which enables more packets to be delivered.

III. PERFORMANCE EVALUATION

To evaluate the performance of POR, we simulate the algorithm in a variety of mobile network topologies in NS-2 and compare it with AOMDV a famous multipath routing protocol and GPSR a representative geographic routing protocol the common parameters utilized in the Simulations. The improved random way point without pausing is used to model nodes' mobility. The minimum node speed is set to 1 m/s and we vary the maximum speed to change the mobility degree of the network. The following metrics aroused for performance comparison:

- **Packet delivery ratio.** The ratio of the number of data packets received at the destination(s) to the number of data packets sent by the source(s).
- **End-to-end delay**. The average and the median end-to end delay are evaluated, together with the cumulative distribution function of the delay.
- **Path length.** The average end-to-end path length (number of hops) for successful packet delivery.
- **Packet forwarding: times per hop (FTH).** The average number of times a packet is being forwarded from the perspective of routing layer to deliver a data packet over each hop.
- **Packet forwarding times per packet (FTP).** The average number of times a packet is being forwarded from the perspective of routing layer to deliver a data packet from the source to the destination. Among the metrics, FTH and FTP are designed to evaluate the amount of duplicate forwarding. For uni-cast style.
- **Network topology:** routing protocols, packet reroute caused by path break accounts for FTH being greater than 1

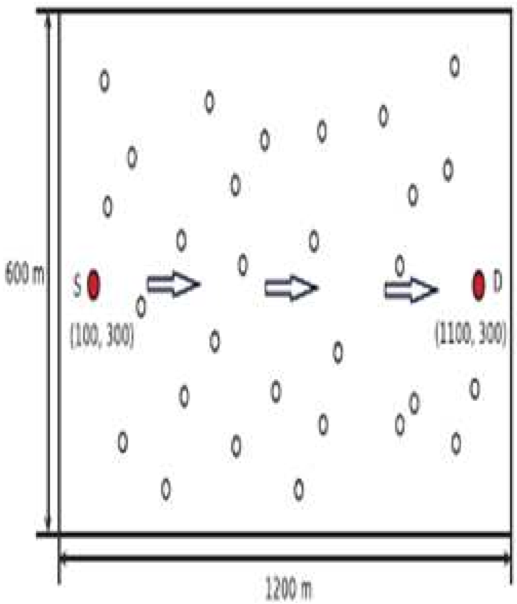


Fig 4: Network topology:

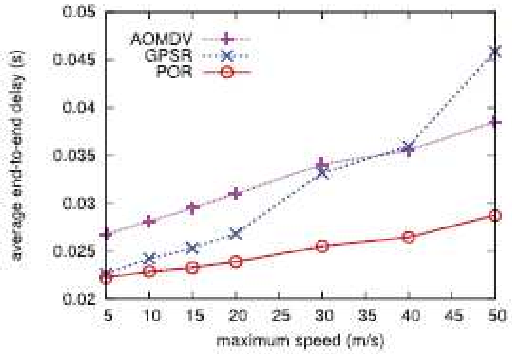
Routing protocols, packet reroute caused by path break accounts for FTH being greater than 1. On the other hand, for those packets who fail to be delivered to the destination the efforts that have already been made in forwarding the packets are still considered in the calculation of FTH, as FTH is calculated as follows:

$$FTH = \frac{N_s + N_f}{\sum_{i=1}^{N_r} N_{hi}}$$

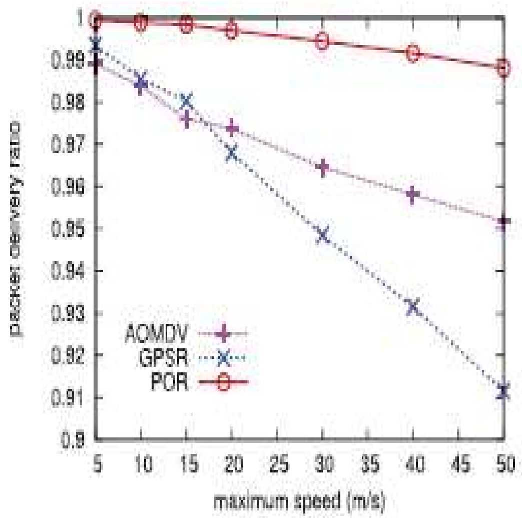
Where Ns, Nf and Nr are the number of packets sent at the source(s), forwarded at intermediate nodes, and received at the destination(s), respectively. Nhi is the number of hops for the ith packet that is successfully delivered. Unlike FTH, FTP averages the total number of times a packet is being forwarded on a per-packet basis: of forwarding candidates will also enlarge the packet header, thus introducing more overhead. Therefore, a trade-off between the robustness and the required resource exists, in which the number of forwarding candidates.

$$FTP = \frac{N_s + N_f}{N_r}.$$

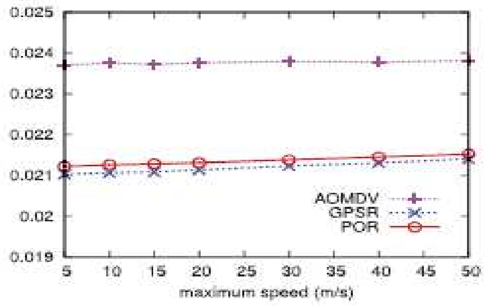
Forwarding Candidate Number Evaluation first evaluates the effect of the number of forwarding candidates (i.e., N) on POR's performance. Generally, larger value of N will result in higher robustness as more nodes serve as backups. However, it also means more memory resources need to be consumed and a higher percentage of duplicate. it can be seen that though more forwarding candidates yield a higher packet delivery ratio, only the involvement of the first forwarding candidate achieves the most significant performance gain, while the improvement becomes less and less observable when N continues to increase, which is consistent with our theoretical analysis presented. Note that in the operation of routing protocols when link break happens, some recovery scheme (e.g., packet rerouting) will be triggered to salvage the packet. Hence, the simulated delivery ratio tends to be higher than the analytical one, especially for the protocol Without forwarding candidates (i.e., POR(0)). On the other hand, the measured result should be lower than the analytical one due to the impact of wireless interference on the contrary. These two factors, together with ignoring the change of the path length (as mentioned in footnote contribute to the difference between the simulated delivery ratio and the analytical delivery ratio.



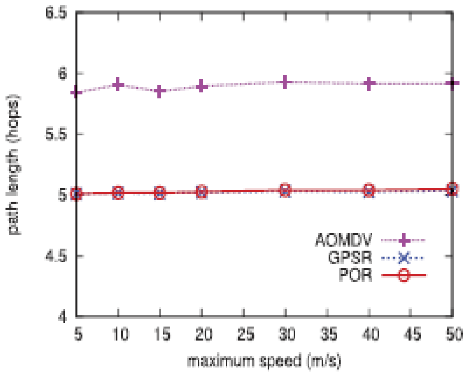
(b) Average end-to-end delay.



(a) Packet delivery ratio.



(c) Median end-to-end delay.



(d) Path length.

IV. Effect of communication hole

To test the effectiveness of VDVH, we further evaluate therouting performance in mobile networks with a communication hole. The source and destination nodes are fixed at the two ends of the rectangle while the remaining 78 nodes move in the annular region according to the RWP model. The central gray area is simulated as the communication hole with no mobile node distributed. By changing the maximum node speed, we obtain the simulation results shown in Fig. 16.

From Fig. 16 a, we can observe that in the face of communication hole, GPSR's void handling mechanism fails to work well. Even when the maximum node speed is 5 m/s, only 90 percent of the data packets get delivered which is relatively poor compared to the other protocols. As for POR, the improvement is not so significant since in the current implementation, VDVH is unable to deal with all cases of communication voids . However, when the node mobility is high (e.g., when the maximum node speed is larger than 25 m/s), POR still performs better. With respect to the path length, the end-to-end hops of GPSR are the largest due to the usage of perimeter mode. While the other leverages on the hop-by-hop redundancy which takes advantage of the broadcast nature of wireless medium and transmits the packets in an opportunistic cooperative way. Our scheme falls into the second category. Multipath routing, which is typically proposed to increase the reliability of data transmission in wireless ad hoc networks, allows the establishment of multiple paths between the source and the destination.

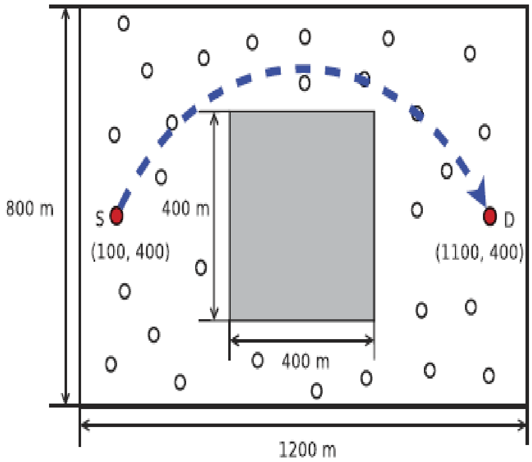


Fig5: network topology

V. Conclusion

It is observed that the problem of reliable data delivery in highly dynamic mobile ad hoc networks is addressed. Constantly changing network topology makes conventional Ad hoc routing protocols incapable of providing satisfactory performance. Inspired by opportunistic routing, this paper proposed a novel MANET routing protocol POR which takes advantage of the stateless property of geographic routing and broad cast 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 in the air, broken route can be recovered in a timely manner.

The efficiency of the involvement of forwarding candidates against node mobility, as well as the overhead due to Opportunistic forwarding is analyzed. Through simulation, here further it can be confirmed the effectiveness and efficiency of POR: high packet delivery ratio is achieved while the delay and duplication are the lowest.

References

[1] J. Brooch, D.A. Maltz, D.B. Johnson, Y.-C. Hu, and J. Jetcheva, “A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols,” Proc. ACM Modicum, pp.85-97,1998.

[2] M. Mauve, A. Widmer, and H. Hartenstein, “A Survey on Position-Based Routing in Mobile Ad Hoc Networks,” IEEE Network, vol. 15, no. 6, pp. 30-39, Nov./Dec. 2001.

[3] D. Chen and P. Varshney, “A Survey of Void Handling Techniques for Geographic Routing in Wireless Networks,” IEEE Comm. Surveys and Tutorials, vol. 9, no. 1, pp. 50-67, Jan.-Mar. 2007.

[4] D. Son, A. Helmy, and B. Krishnamachari, “The Effect of Mobility Induced Location Errors on Geographic Routing in Mobile AdHoc Sensor Networks: Analysis and

Improvement Using Mobility Prediction," IEEE Trans. Mobile Computing, vol. 3, no. 3, pp. 233-245, July/Aug. 2004.

[5] B. Karp and H.T. Kung, "GPSR: Greedy Perimeter Stateless Routing for Wireless Networks," Proc. ACM MobiCom, pp. 243-254, 2008.

[6] S. Biswas and R. Morris, "EXOR: Opportunistic Multi-Hop Routing for Wireless Networks," Proc. ACM SIGCOMM, pp. 133-144, 2005.

[7] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading Structure for Randomness in Wireless Opportunistic Routing,"Proc. ACM SIGCOMM, pp. 169-180, 2007.

[8] E. Rozner, J. Seshadri, Y. Mehta, and L. Qiu, "SOAR: Simple Opportunistic Adaptive Routing Protocol for Wireless Mesh Networks," IEEE Trans. Mobile Computing, vol. 8, no. 12, pp. 1622-1635, Dec. 2009.