International Research Journal of Computer Science (IRJCS)
Volume 1 Issue 3 (November 2014)
ISSN: 2393-9842
www.irjcs.com

A Study on Opportunistic Routing in Wireless Mesh Network

T.H.Feiroz Khan
Department of CSE
S.R.M University

B.Dojohn Loyd
Department of CSE
S.R.M University

Dr.J.Jagadeesan
Department of CSE
S.R.M University

Abstract: ***This paper surveys the various opportunistic routing protocols on Wireless Mesh Networks. The WMN has recently emerged and most of the classical routing algorithm failed to produce promising throughput in its highly dynamic and frequently varying connection environment. Opportunistic routing protocols have come as a solution and evolving still. In this paper, we discuss the various opportunistic routing mechanisms briefly and feasibility of opportunistic routing in WMN and different opportunistic methods applied in WMN. We have enlisted the observations of the study and open research issues of the opportunistic routing on WMN.***

Keywords: Wireless Mesh Network, Opportunistic Routing, EXOR,COPE,MORE,OPRAH,Geo Distance Based Protocol,OOMM,ROMER,CONSORT,

I. INTRODUCTION

Of late, wireless mesh network has become eminent and fast growing field gives challenging opportunities for research community. Multihop fashion data flow is an inherent characteristic of WMN. In multi-hop ad hoc networks, wireless devices cooperate in forwarding traffic between non-adjacent nodes. In this way, multi-hop network paths can be established between any pair of nodes without relying on a pre-existing network infrastructure or dedicated network devices[7].WMN experiences strong throughput degradation because not able to cope up the unreliable nature of wireless connection classical routing methods are being employed. The opportunistic routing exploits the intrinsic broadcast nature of wireless networks and compute the route on the fly dynamically rather than priori route. In classical routing when a wireless node transmits the packet, the intended node could not hear the packet in any case but neighbor nodes might have heard the packet due to broadcast nature of wireless. To be granted, this significant phenomenon gives the key idea of opportunistic routing. Considering Figure 1, the source S sends the packet to destination D and presume the probability of packet delivery reaching any node is 0.5. The legacy protocols, however takes the most reliable path still suffers with packet loss of 50%. By deploying opportunistic routing, the probability of the packet not delivered to any node is 0.06. Hence the reliability is significantly improved to 94%. [1]

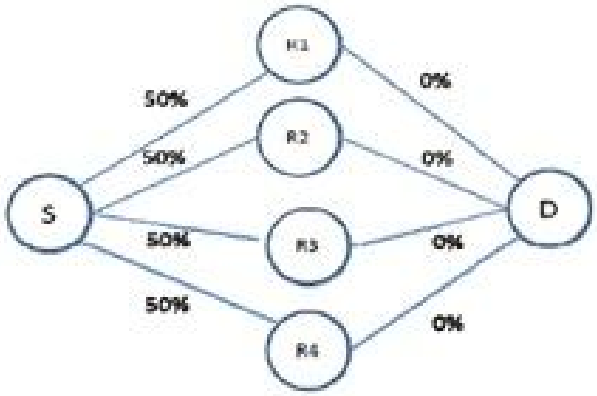

Fig.1 Probability of Packet Delivery

However for unreliable wireless networks, the forwarding capacity of intermediate nodes, which overhear packet transmissions, can be explored to improve the performance of WMNs. Opportunistic routing has recently been proposed as an effective routing paradigm for increasing forwarding reliability and network throughput in a WMN. Further, opportunistic routing can exploit those long but low-quality links to reduce the total number of transmissions for sending a packet to its destination, which can thus reduce the end-to-end delay. In this paper, numerous opportunistic routing algorithms are studied exhaustively. EXOR is advanced version of Simple Opportunistic Routing Protocol which routes opportunistically based on the

ETX parameter value that computes closeness of a node to destination. Opportunistic any path forwarding that calculates Expected Any Path Count and does routing based on that. EAX expects the forwarder also does routing opportunistically, so the phenomenon is recursive. The MORE technique is the advancement of Ex-OR technique [9]. By combining the intra-flow randomized network coding and ExOR, enjoys the advantages of both. The main advantage is it does not require any global coordination. The Opportunistic Routing in Ad Hoc Networks (OPRAH) Protocol is multipath opportunistic routing protocol which services on demand for wireless mobile ad-hoc networks. It is highly suitable for WMN environment. COPE, Coding Opportunistically extends the intra flow coding concept to packets belonging to other flows, an inter-flow network coding in ad hoc networks. The opportunistic routing is simplified by considering geographical location information and that can be used for forwarding node selection and assign priority to them. This protocol is pertained to real world parameter value rather than logical values. Having studied the opportunistic routing algorithms, the feasibility checking in WMN environment is studied. Different opportunistic algorithms which are producing considerable throughput on WMN is studied. Eventually observations and future trends are enlisted.

II. Brief Study on Opportunistic Routing Protocols

A. Extremely Opportunistic Routing:

In the Ex-OR opportunistic routing protocol is making decisions like forwarding bundle of packets ,choose the group of forwarders and assign priority to the forwarder nodes entirely based on ETX value to the destination. It propagates the information more towards destination rather than source by choosing nodes with smaller ETX value towards the destination. The priority is set to a node such way that the closer to destination higher is the priority. According to this routing technique, the higher priority nodes are expected to forward the packets first, if none of them could acknowledge then lower priority nodes will propagate the packets which is tracked by BITMAP option included in the packet. Since the ExOR seeks coordination among nodes globally, it restricts spatial frequency reuse.

B. Opportunistic Any Path Forwarding:

The disadvantage with Ex-OR is that the forwarding nodes may deliver the packets to low-quality routers for further propagation.[8]. It makes use of EAX- Expected Any Path Count metric. During the computation of forwarder set, the node assumes that the forwarder also perform opportunistic forwarding. So this method recursively perform forwarding packets opportunistically.

C. MAC Independent Opportunistic Routing & Encoding:

The MORE technique is the advancement of Ex-OR technique [9]. By combining intra-flow randomized network coding and ExOR, it introduces several advantages. Firstly, it splits the packets into groups, each containing k packets. Then the random linear combination of k packets in each batch is computed and source node often broadcasts it packet is a innovative if does not depend on any other packet in its group. Moreover, it exploits the credit based forwarding method at every intermediate node in order to reduce the total number of transmissions for end to end delivery. By receiving k linearly independent packets, the destination can reproduce k original packets and send the ACK back to source. The ACK intimates the source node that the destination node is ready to receive the next group. The drastic improvement is this method does not require any global coordination among forwarders.

D. Coding Opportunistically (COPE):

To extend the intra flow coding concept to packets belonging to other flows, an inter-flow network coding in ad hoc networks, the Coding Opportunistically, COPE, protocol is proposed in [9]. COPE uses a prevailing routing protocol to choose a minimum-cost path amid nodes. Packets from different unicast flows are encoded together by intermediate forwarders and every node is listening for any packet that is not targeted for it but it will be useful for effective coding. A local buffer is maintained to keep the overheard packets for a restricted period of time. As soon as a node is given resource to transmit by MAC protocol, that node picks the packets from its local buffer to code collectively. Besides, the encoding is carried out such a way that all the next hops of encoded packets able to rebuild their original version. COPE algorithm exploits the broadcast nature of the wireless channel and codes multiple packets accordingly so that multiple receivers could be the beneficiaries of a single transmission. The crucial part of this method is that every node should learn from local buffer state of next hop nodes.

E. Hop Count Based Protocol:

The Opportunistic Routing in Ad Hoc Networks (OPRAH) Protocol [10] is multipath opportunistic routing protocol which services on demand for wireless mobile ad-hoc networks. In the course of request-reply route search cycle, this algorithm produces a braid multiple-path set from source to destination. In this protocol, every intermediate node in the braid route set broadcasts every data packet received. It is suitable for highly dynamic mobile environment.

F. Geo Distance Based protocol:

The opportunistic routing is simplified by considering geographical location information and that can be used for forwarding node selection and assign priority to them. [12]. The Geographic Random Forwarding Protocol (GeRaF) is an exemplary protocol of this kind and as dynamically changing topology information of wireless mesh networks can be acquired and made use effectively by deploying this protocol on WMN. Precisely, each node which needs to send the packet will acquire the geo-distance parameter information from the neighbor nodes, enlist nodes having minimum distance from destination node into forwarders list and chooses node which has lowest distance from destination. Since it works hop-by-hop, it shows good scalability in WMN. But it requires the constant updating of geo distance of neighboring nodes.

III. FEASIBILITY OF OPPORTUNISTIC ROUTING IN WMN

However considering the channel as deterministic one will not allow leveraging the opportunistic routing with full potential. So the network model to be designed to take the advantage of multitude wireless links with the probabilistic approach that urges the deployment of log-normal shadowing and Rayleigh fading models.[6]. Applying opportunistic routing in wireless mesh networks will make use of high density and broadcast nature. Instead of using predetermined node for next hop, allow the all possible next hop nodes to receive the packets and coordinate among them to choose the next node to broadcast the packet based on any parameter like closest node to destination only may propagate the packet further, rest of the nodes may drop the packet. As a result, opportunistic routing can take advantage of the potentially numerous, yet unreliable wireless links in the network when they actually deliver. In contrast, traditional routing in wireless networks only targets a packet to the preselected next-hop forwarder, which is the node on a preselected path towards the destination of the packet that is highly inefficient in Wireless Mesh Networks. The systematic study with proper network configurations and radio propagation environment shows that the potential gain of opportunistic routing on Wireless Mesh Network. The analytical modeling of opportunistic routing in wireless adhoc network using log-normal shadowing and Rayleigh fading. The mean propagation per transmission is measured where the wireless mesh nodes are uniformly distributed. This shows the opportunistic routing has higher propagation during log-normal shadowing but performance is drastically poor under the influence of Rayleigh fading that is strict Line Of Sight is required. The Figure2 shows that opportunistic routing performance is considerably higher when comparing with classical routing algorithms.

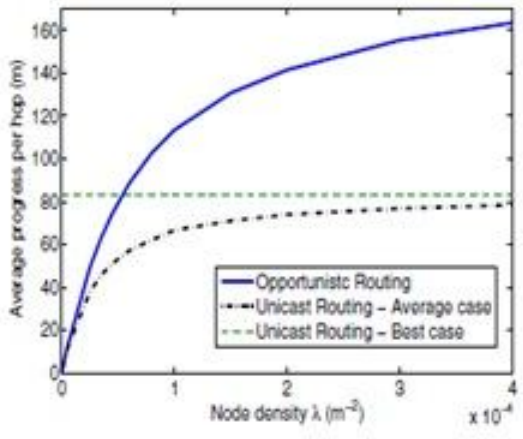

Fig.2 Performance of Opportunistic Routing against Legacy Routing

IV. OPPORTUNISTIC ROUTING IN WMN

A.Coding Aware Opportunistic Routing:

In this routing technique, every packet forwarding decision is taken with the consciousness of possible coding chances [3]. By making use of the state information kept in local buffers of nodes it does the packet forwading . This is the corrolory that additional coding gain is possible if packet forwarding is done with the knowledge of coding opportunities. This routing technique meritoriously joins intra-flow network coding with opportunistic routing. This algorithm is highly localized and its implementation nevertheless needs synchronization amid nodes. The Figure 3 shows that the Coding Aware Algorithm shows drastic throughput over other algorithms such as COPE.

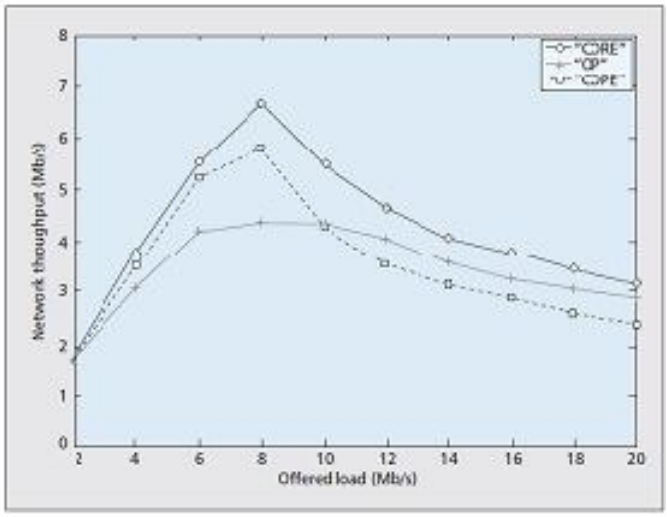

Fig.3 Network Throughput of CORE

B. OOMM:

An opportunistic routing Over Multirate Multi-hop ad hoc network (OOMM) studies the amalgamation of the multi-rate capability into opportunistic routing [4]. The issue of computing the number of retransmission n which is needed to send a packet and the expected overall time of all retransmission which is rate per retransmission must be minimized during target end to end PER is fulfilled. It is possibly denoted that the first transmission is done by the source node and the following n-1 retransmissions are done by relay nodes. Besides of that, each retransmission is done by the closest intermediate forwarder to the destination node. This is identical to the NP-hard issue which is solved by an approximate solution called OOMM. The rudimentary notion of OOMM is that the source node computes the maximum probable amount of retransmissions which is nmax, supposing that the source node itself will carry out every retransmission by the maximum transmission rate for every, maximum PER which will be deliberated in every single retransmission. Every possible amount of retransmissions n where $1 \leq n \leq nmax$, the source node exploits overhearing-based rate assignment (OBRA) technique to identify the finest combination of transmission rates which minimizes the expected total transmission time for entire retransmissions and fulfills the target PER. Lastly, the source node making decision to balance among the good amount of retransmission n and the associated rate assignment that result in the minimum channel-time and that satiate the target PER.The Figure4 illustrates the proposed OOMM model

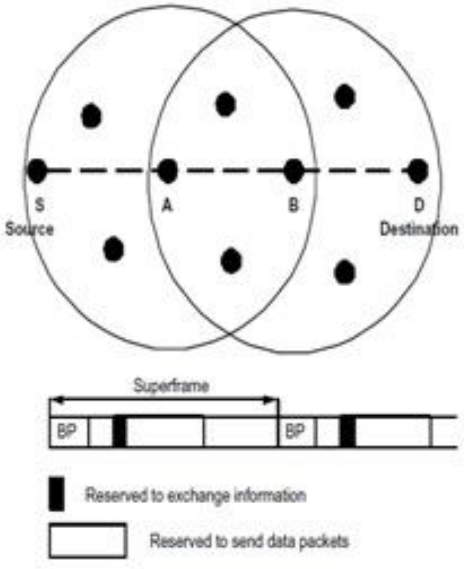

Fig.4 OOMM Model Design

C. ROMER:

In Resilient and Opportunistic Routing Solution for Mesh Networks (ROMER) [11], with each data packet a credit value is associated which shows how much a packet could diverge from the shortest distance from the source to destination nodes in hop by hop fashion forwarding. Besides, every node on the shortest path from a source to destination propagates the packet with probability 1.Contradictingly; a node not on the shortest path propagates the packet with a probability depending upon the throughput of its outgoing link. This forwarding nature creates a resilient ellipse-type forwarding region, centered on the long-term shortest path which connects the source to destination. But it requires distance information from the complete network and yield number of duplicate end to end transmissions.

D. CONSORT:

Node-constrained Opportunistic Routing is one of the recent breakthroughs in Wireless Mesh Networks. It studies the issues during the selection of opportunistic route for every user in order to optimize the total utility of several simultaneous users in a wireless mesh network [5]. In the other end, another type of dynamic network entities have their native constraints and own behaviors. The exemplary constraints of nodes are individual requirement and social requirement. The CONSORT makes the choices of how to select an opportunistic route for every user to optimize the total utility and while number of simultaneous users in a wireless mesh network subject to node constraints. This introduces two problems that are node constrained user utility optimization problem (NCUUOP) and node-constrained user profit optimization problem (NCUPOP). CONSORT deliberates that the selected node load requirements as constraints and it allocates resource subject to them to optimize the total utility of multiple simultaneous users existing in a WMN by using opportunistic routing. Furthermore, this algorithm is distributed, and thus enhances network scalability and self-organization.

V. OBSERVATIONS AND FUTURE TRENDS

Although most of the opportunistic routing schemes are promising but still suffering in some scenarios because of their traditional parameters such as next hop, ETX and geo distance. These traditional parameters considerably reduce the throughput of opportunistic routing in WMN. Some opportunistic routing techniques unavoidably require strong coordination among nodes globally or locally. This requirement may introduce hindrances in WMN because of highly dynamic mobile environment. Even in reliable ROMER, which computes the divergence from shortest path from source to destination nodes, as the shortest path may vary drastically time to time is not enough for highly dynamic topology of WMN. Moreover every node on shortest path is assigned with probability 1 but how long the same node in the shortest trajectory is nondeterministic. More importantly nodes can switch from between traditional routing method and opportunistic routing method based on the expected gain of the system. In CONSORT, the definition of utility is subjective which differs among users that could not be optimized without a strong and complex model which captures this scenario completely.

ACKNOWLEDGMENT

I take this opportunity to express my profound gratitude and deep regards to almighty god for his invisible help and Dr.J.Jagadeesan, Head of the Department of Computer Science & Engineering, SRM University, Ramapuram Campus for his continuous encouragement and persistence support through our research career and

REFRENCES:

[1.] S. Biswas and R. Morris, “ExOR: Opportunistic Routing in Multi-Hop Wireless Networks,” *Proc. ACM SIGCOMM ‘05*, Philadelphia, PA, Aug. 2005, pp. 133–44.
[2.] S. Chachulski *et al.*, “Trading Structure for Randomness in Wireless Opportunistic Routing,” *Proc. ACM SIGCOMM ‘07*, Kyoto, Japan, Oct. 2007, pp. 169–80.
[3.] C. Westphal, “Opportunistic Routing in Dynamic Ad Hoc Networks: The OPRAH Protocol,” *Proc. IEEE MASS ‘06*, Vancouver, Canada, Oct. 2006, pp. 570–73
[4.] Y. Yuan *et al.*, “ROMER: Resilient Opportunistic Mesh Routing for Wireless Mesh Networks,” *Proc. IEEE WiMesh ‘05*, Santa Clara, CA, Sept. 2005.
[5.] M. Zorzi and R. R. Rao, “Geographic Random Forwarding (GeRaF) for Ad Hoc and Sensor Networks: Multihop Performance,” *IEEE Trans. Mobile Comp.*, vol. 2, no. 4, Oct.–Dec. 2003, pp. 337–48.
[6.] An Analysis of Opportunistic Routing in Wireless Mesh Network Chun-Pong Luk, Wing-Cheong Lau and On-Ching Yue ICC 2008 proceedings.
[7.] Survey on diversity-based routing in wireless mesh networks: Challenges and solutions Raffaele Bruno a,Maddalena Nurchis Computer Communications 33 (2010) 269–282
[8.] An Overview of Opportunistic Routing in Mobile Ad Hoc Networks Zhensheng Zhang,Rajesh Krishnan 2013 IEEE

Military Communications Conference

[9.] Z. Zhong *et al*., "On Selection of Candidates for Opportunistic AnyPath Forwarding," *ACM SIGMOBILE Mobile Comp. Commun. Rev*., Oct. 2006, pp. 1–2.
[10.] CORE: A Coding-Aware Opportunistic Routing Mechanism For Wireless Mesh Networks Yan Yan And Baoxian Zhang et al. IEEE Wireless Communications • June 2010
[11.] Practical Coding-Aware Mechanism for Opportunistic Routing in Wireless Mesh Networks Yan Yan et al IEEE Communications 2008 proceedings.
[12.] Opportunistic Routing in Multi-rate Multi-hop Ad Hoc Networks Raed Taleb Al-Zubi,Marwan Krunz IEEE ICC 2012 - Ad-hoc and Sensor Networking Symposium
[13.] Consort: Node-constrained Opportunistic Routing in Wireless Mesh Networks Xi Fang, Dejun Yang, and Guoliang Xue IEEEINFOCOM 2011