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Network Coding Combined With Rate Diversity Gains in MANET Based On an Opportunistic Routing Scheme

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ABSTRACT: This paper investigates the performance gains obtained by combining network coding and rate diversity gains in wireless environment. Network coding is a new research area which has a lot of interesting applications in practical networking systems. Link rate diversity provides another degree of freedom in wireless environment. Using network coding, intermediate nodes broadcast packets that are linear combinations of previously received information. Opportunistic networks are one another research area in which researchers are more interested in. In these type of networks nodes are able to communicate with other nodes even there is not a route connecting them. So opportunistic routing will open a new direction in MANET. In this paper we develop a new opportunistic routing strategy and which is used as the routing protocol for the proposed concept.

KEYWORDS:network coding; rate diversity; opportunistic routing.

I. INTRODUCTION

Network coding is a new research area which has a lot of interesting applications in practical networking systems and also gives rise potential performance gains. The major benefits of network coding are higher throughput, improved energy efficiency and robustness. Using network coding, intermediate nodes broadcast packets that are linear combinations of previously received information. Network coding effectively reduces the fraction of time the channels held by a single packet and also reduce the number of independent transmission needed, thereby helps to increase the overall network throughput. Link rate diversity provides another degree of freedom in wireless environment. Today most of the wireless nodes are able to perform adaptive modulation to vary the link rate corresponds to the signal to interference levels at the receiver. The link layer rate diversity helps to increase the rate and better rates reduces the fraction of time the channels held by a single packet and thereby increasing the overall network throughput. By using this forwarding node can transmit a packet more than once at different rates and this also results in better throughput. Opportunistic networks are one of the most interesting evolutions of MANETs. In these type of networks nodes are able to communicate with other nodes even there is not a route connecting them. Another important concern is a node doesn't have any knowledge about the network topology. Hence any possible node can opportunistically selected as next hop, provided that node likely to bring the message closer to the final destination. Because of these requirements opportunistic network become a challenging and promising research field. This communication paradigm is helpful for widespread applications such as e-mailing.

In this paper we discuss the potential performance improvements by using network coding and rate diversity gains. We also consider an opportunistic routing strategy other than the usual routing protocols such as AODV, DSR etc. So the proposed scheme includes two phases. In the first phase we develop an opportunistic routing scheme which will results in better performance compared to usual routing scheme. In the second phase perform network coding and rate diversity gains

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to illustrate the performance gains. The paper is organized as follows. In the next section we discuss the related works and motivation for selecting these ideas. In section III we discuss about the design of opportunistic routing scheme. In section IV we discuss about the network coding and rate diversity gains using the new routing scheme. Finally we conclude the paper and also include future work.

II. RELATED WORK

The early work on network coding was done by Ahlswede et al.which established the value of coding and provided bounds on the capacity of wireless networks.[1].[3] discuss CodeCast, an Adhoc multicast protocol which showed that network coding could improve the overall download latency for file sharing applications. [4] suggests that network coding is a new research area that may have interesting applications in practical networking systems. The use of link-layer transmission rate diversity for multicast and broadcast routing was first explored in [5]. Luiz Filipe and Mario given the importance of the network coding and multi-rate diversity gain in multicast wireless application, and thereby derive formal bounds on the throughput gain for such networks[6]. [7] investigate the impact that the use of such rate-diversity for link layer broadcasts may have on the performance of network coding. They demonstrated in this paper that multi-rate link layer broadcasts and network coding can be mutually combined to increase network throughput in multicast applications. Opportunistic routing has been introduced by Biswas and Morris, whose paper explains the potential throughput increase and proposes the ExOR protocol as a means to achieve it [9]. They develop ExOR, an integrated routing and MAC protocol which increases the throughput of large unicast transmissions in multi-hop wireless networks. The core idea is for forwarding nodes to perform some mathematical operation on the received packets such that the data contained in these packets are merged in a way that the original data can be recovered at the destination. Chachulski et al. develop a new protocol MORE[2] , addresses the limitations of ExOR by using random network coding.Here the source sends random linear combinations of packets and each forwarding node can also randomly combine the packet it has already received. YAN YAN et al. explore the combination of opportunistic routing and network coding for improving the performance of a Wireless Mesh Network[10]. They proposed a coding-aware opportunistic routing protocol called CORE for improving the throughput performance of a WMN. Hao et al. propose PNCO[11] that a partial network coding and combine with opportunistic routing. Simulation results show that PNCO provides significantly higher throughput than transitional routing and lower delay than conventional network coding. [12] propose a new scheme, CORMAN as an opportunistic routing scheme for mobile ad hoc networks.

III. OPPORTUNISTIC ROUTING

For developing an opportunistic routing scheme, we have two steps and they describing in the following sections.

A. Route Discovery

The first step is Route discovery. For this we need to calculate the distance between each node in the network. Let the node i having the position (x1; y1) and node j having the position (x2; y2), then the distance between the node can be calculated using the equation d (i, j) =√ ((x1-x2)2) + ((y1-y2)2). We find the distance and store it in a two dimensional array. These results can be used for further processing In order to find the path between source and destination use the steps given below

1. Select the neighbour nodes of the source from the previous distance array and store it to another list source1
2. Sort the list source1 based on the ascending order of distance value
3. Find the distance between each of the nodes in the list source1 and the destination node and select the node in the minimum total distance as a next hop neighbour.
4. Select the next hop neighbour as a source and repeat the above three steps.
5. The process repeated until source and destination become equal.

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For each communication we find two paths using this procedure and store it in two files. Then select the path having the minimum distance, which is the list constituting the first node in the source list in each of the iteration. Then the packets routed through the path with minimum distance between source and destination calculated using the previous method.
Fig. 1. Network with 10 nodes

For example consider a network with 10 nodes as shown in Fig 1. In the above network node 4 is act as a source and 9 acts as a destination. By performing the routing procedure we got two lists having minimum distance between them. The first list includes the following nodes 4, 2, 6, 7, 9. The second list includes 4, 5, 8, 1, and 9. Here select the first list as the optimal path and data packets will be sent through the optimal path. Here we also consider the link failures. When the distance between two nodes increases, the energy needed also increases and this may increase the link failures. So always select minimum distance between the intermediate nodes for minimizing the link failures.

B. Route Updation

When the packets are forwarded to the destination node along a specified route, if an intermediate node is aware of a new route, it can use this new route to forward the packets. This new path will be used for subsequent packets and this list also replaces the old one. This can be explained using the Fig 2. Fig. 2. Route Updation Here node 1 is the source node and node 7 is the destination node. In the route discovery phase node1 Selects the best route to 7 which is 1,5,3,2,6,7. Whenever the packets reached at node 3, it finds a new route to the destination; 3, 5, 8, 7. Now the packets will be forwarded along the new route and the node can replace the old forwarder list. The upstream nodes can also overwhelm these packets due to the broadcasting nature and thus able to update their forwarder list too.

IV. NETWORK CODING COMBINED WITH RATE DIVERSITY GAINS

Here we combine the concepts of network coding and rate diversity gains. The effect of this can be illustrated using an example. Consider a network formed by 5 nodes.

Fig. 3. Sample network topology with 5 nodes Node 1 has packet A and node 2 has packet B. The link rate at each pair of nodes is 10 Mbps other than 1 and 2 which is 1 Mbps. In our scenario only one node can transmit in a specified time slot and broadcast happens at a minimum rate available. To For receiving the packet by all neighboring nodes, nodes have to transmit with the lowest rate among neighboring links. For rate diversity unaware and without using network coding, Fig 4 shows the optimal transmission schedule, which takes 22 time units. Fig. 4. Optimal broadcast scheduling for rate diversity unaware routing For rate diversity with network coding , the transmission schedule is given below in Fig 5. The gain in throughput occurs by using multi-rate diversity to first transmit to neighbors at a higher rate, to allow nodes with better transmission rates to transmit more than once and also by applying network coding and combining packets Fig. 5. Broadcast scheduling, Rate diversity aware with network coding

Here we use the routing strategy described in section III as the underlying protocol instead of the usual protocol such as AODV, DSR etc.

V. CONCLUSION

In this paper we combine network coding and rate diversity gains in wireless environments. The major benefits of network coding are higher throughput, improved energy efficiency and robustness. Using network coding, intermediate nodes broadcast packets that are linear combinations of previously received information. Here we also incorporate the concept of opportunistic routing which uses the broadcasting nature of wireless channels. The performance gains can be verified using the simulations.

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REFERENCES

[1]. R. Ahlswede, Ning Cai, S.-Y.R. Li, and R.W. Yeung. Network information flow. Information Theory, IEEE Transactions on, 46(4):1204–1216, Jul 2000.
[2] . S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading structure for randomness in wireless opportunistic routing," in Proc. of ACM SIGCOMM, 2007.
[3]. Joon-Sang Park, M. Gerla, D.S. Lun, Yunjung Yi, and M. Medard. Codecast: a network-coding-based ad hoc multicast protocol. Wireless Communications, IEEE, 13(5):76–81, October 2006.
[4]. C. Fragouli, J.Y. L. Boudec, and J. Widmer, Network coding: an instant prime, SIGCOMM Computer Communication Review 36 (2006), 63-68
[5]. Chun Tung Chou, A. Misra, and J. Qadir. Low-latency broadcast in multirate wireless mesh networks. Selected Areas in Communications, IEEE Journal on, 24(11):2081–2091, Nov. 2006.
[6] Vieira, Luiz Filipe M., Mario Gerla, and Archan Misra. "Bounds on network coding and multi-rate diversity gain in multicast wireless applications." Wireless Communication Systems, 2009. ISWCS 2009. 6th International Symposium on. IEEE, 2009.
[7]] Vieira, Luiz Filipe M., Archan Misra, and Mario Gerla. "Performance of network-coding in multi-rate wireless environments for multicast applications." Military Communications Conference, 2007. MILCOM 2007. IEEE. IEEE, 2007.
[8]. Park, Joon-Sang, et al. "Performance of network coding in ad hoc networks."Military Communications Conference, 2006. MILCOM 2006. IEEE. IEEE, 2006.
[9]. S. Biswas and R. Morris, "ExOR: Opportunistic Multi-Hop Routing for Wireless Networks," in Proc. ACM Conference of the Special Interest Group on Data Communication (SIGCOMM), Philadelphia, PA, USA, August 2005, pp. 133–144.
[10]. Yan, Yan, et al. "Core: a coding-aware opportunistic routing mechanism for wireless mesh networks [accepted from open call]." Wireless Communications, IEEE 17.3 (2010): 96-103..
[11]. Kun, Hao, Jin Zhigang, and Wang Ying. "Partial network coding for wireless opportunistic routing." Wireless Mobile and Computing (CCWMC 2009), IET International Communication Conference on. IET, 2009.
[12]. Wang, Zehua, Yuanzhu Chen, and Cheng Li. "CORMAN: a novel cooperative opportunistic routing scheme in mobile ad hoc networks." Selected Areas in Communications, IEEE Journal on 30.2 (2012): 289-296.
[13]. Dr. A. Subramani K. Prabu, Performance comparison of routing pro tocols in manet, Advanced Research in Computer Science and Software Engineering 2 (2012).
[14]. J.Bicket D.De Couto, D.Aguayo, A high throughput path metric for multihop wireless routing, ACM/IEEE MobiCom, 1988.
[15]. M.-H. Lu, P. Steenkiste, and T. Chen, Design, implementation and evaluation of an effcient opportunistic retransmission protocol, Proceeding of the 15th Annual International Conference on Mobile Computing and Networking (MobiCom) (2009), 73-84.