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Enhanced Network Coding based Opportunistic Routing with Collision Detection with Minimum Flooding Time

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Abstract— **Privacy threat is one of the critical issues in multi-hop wireless networks, where attacks such as traffic analysis and flow tracing can be easily launched by a malicious adversary due to the open wireless medium. So we propose our efficient system of local broadcast algorithm with Network Coding Technique with Collusion Detection with minimum flooding time. In the existing system, the idea of performing network coding on the feedback messages are shown and if the intermediate node waits until receiving only one feedback message from each next-hop node, the optimal level of network coding redundancy can be computed in a distributed manner. We enhance the system with additional collusion detection mechanism with minimum flooding time. The aim of this work is to investigate the speed of data propagation in opportunistic MANETs. In order to investigate the speed of data propagation, we consider the flooding time. The flooding is the simple broadcast protocol where every informed node sends the source message at every time-step (a node is said to be informed if it knows the source message). The flooding time is the first time-step in which all nodes are informed. It is a natural lower bound for any broadcast protocol, and it bounds the maximal speed of data propagation: the same role of the diameter in static networks.**

Index Terms— Wireless networks, cross-layer design, Network coding, feedback, link correlation, coded feedback.

I. INTRODUCTION

Multicasting is an important operation in wireless multi-hop networks. Its applications range from software updates to video/audio file downloads. Designing an efficient and reliable multicasting protocol for wireless multihop networks is not a straightforward extension from the protocols designed for wire line networks. This is due to the unique features of wireless multihop networks [1]. These features are the lossy behavior, the diversity of the links, the broadcast nature of the links, and the correlations among the links. Opportunistic routing [2] has been proposed as a way to exploit the unique features of wireless multihop networks. The protocol designer always minimizes the broadcast overhead for wireless sensor networks. The routing problem leads to decreased network lifetime with increased energy consumption. So, various routing protocols have been developed to minimize the energy consumption and to maximize the network lifetime [3].

The routing protocols can be categorized based on the nodes' participation, clustering protocols, mode of functioning and network structure. The various challenges in routing include energy consumption, node deployment, scalability, connectivity, coverage, security. In opportunistic routing, there is no specific next-hop node [4]. Therefore, any node that receives the packets can forward it. To avoid duplication, the receivers of a specific transmission need to coordinate to specify which one of them has to forward the packet that has been received by more than one receiver. This requires the design of a specific MAC protocol [5]. Another shortcoming of opportunistic routing is the difficulty of the extension to the multicast case as stated in [6].

Using intra-session network coding [6], the shortcomings of opportunistic routing can be eliminated. In intra-session network coding, the source node divides the message it wants to send into batches, each having K packets of the form P1, . . . , PK. The source node keeps sending coded packets of the form _K i=1 γiPi, where γi, ∀i is a random coefficient chosen over a finite field of large enough size, typically 28–216. Upon receiving a coded packet, the intermediate relay node checks to see if the coded packet is linearly independent to what it has received before [7]. If so, it keeps the coded packet, otherwise it drops the packet. When the destination receives K linearly independent packets, this means that it can decode all of the packets of the batch. Therefore, it sends a feedback to the source, using the traditional shortest path, that says: stop sending from this batch and move to the next one [8].

The advantage of using network coding is that the destination node does not need to receive the specific K original packets, but can receive any K linearly independent ones. This resolves the problem of designing a new MAC protocol because we do not insist on receiving a specific packet. Network coding-based opportunistic routing can also be generalized to the multicast case as network coding enhances the achievable throughput for the multicast case with low complexity and in a distributed way, even for wireline networks [9].

II. LITERATURE SURVEY

A. Pruning network coding traffic by network coding— A new class of max-flow algorithms

This work explores new graph-theoretic and algebraic behaviors of network codes and provides a new class of coding-based, distributed max-flow algorithms. The proposed algorithm starts from broadcasting the coded packets, followed by continuously trimming the redundant traffic that does not constitute the maximum flow of the network information. The convergence speed of the proposed algorithms is no slower than that of the existing push-relabel max-flow algorithms. The algorithmic results in this work also possess several unique features that are especially suitable for practical network implementation with low control, communication, and complexity overhead [10].

B. Rate control with pair wise intersession network coding

In this paper, we develop a distributed rate-control algorithm for networks with multiple unicast sessions when network coding is allowed across different sessions. Building on recent flow-based characterization of pair wise intersession network coding, the corresponding optimal rate-control problem is formulated as a convex optimization problem. The formulation exploits pair wise coding possibilities between any pair of sessions, where any coded symbol is formed by coding over at most two original symbols. The objective function is the sum of the utilities based on the rates supported by each unicast session. Working on the Lagrangian of the formulated problem, a distributed algorithm is developed with little coordination among intermediate nodes. Each unicast session has the freedom to choose its own utility function.

The only information exchange required by the source is the weighted sum of the queue length of each link, which can be piggybacked to the acknowledgment messages. In addition to the optimal rate-control algorithm, we propose a decentralized pairwise random coding scheme that decouples the decision of coding from that of rate control, which further enhances the distributiveness of the proposed scheme. The convergence of the rate-control algorithm is proven analytically and verified by extensive simulations. Simulation results also demonstrate the advantage of the proposed algorithm over the state-of-the-art in terms of both throughput and fairness [11].

C. CCACK: Efficient network coding based opportunistic routing through cumulative coded acknowledgments

The use of random linear network coding (NC) has significantly simplified the design of opportunistic routing (OR) protocols by removing the need of coordination among forwarding nodes for avoiding duplicate transmissions. However, NC-based OR protocols face a new challenge: How many coded packets should each forwarder transmit? To avoid the overhead of feedback exchange, most practical existing NC-based OR protocols compute offline the expected number of transmissions for each forwarder using heuristics based on periodic measurements of the average link loss rates and the ETX metric. Although attractive due to their minimal coordination overhead, these approaches may suffer significant performance degradation in dynamic wireless environments with continuously changing levels of channel gains, interference, and background traffic. In this paper, we propose CCACK, a new efficient NC-based OR protocol. CCACK exploits a novel Cumulative Coded ACKnowledgment scheme that allows nodes to acknowledge network coded traffic to their upstream nodes in a simple way, oblivious to loss rates, and with practically zero overhead. In addition, the cumulative coded acknowledgment scheme in CCACK enables an efficient credit-based, rate control algorithm. Our evaluation shows that, compared to MORE, a state-of-the-art NC-based OR protocol, CCACK improves both throughput and fairness, by up to 20Ã and 124%, respectively, with average improvements of 45% and 8.8%, respectively [12].

D. Flow-based XOR network coding for lossy wireless networks

A practical way for maximizing the throughput of a wireless network is to decompose the network into a superposition of small two-hop networks such that network coding can be performed inside these small networks to resolve bottlenecks. We call these networks 2-hop relay networks. Therefore, studying the capacity of 2-hop relay networks is very important. Most practical network coding protocols that perform the superposition ignores the diversity among the links by turning off coding when the channels are lossy. Other protocols deal with the packets separately - not as members of flows - which make the network coding problem with lossy links intractable. In this paper, we use a different approach by looking at flows or batches instead of individual packets. We characterize the capacity region of the 2-hop relay network with packet erasure channels when the coding operations are limited to XOR. We derive our results by constructing an upper bound on the capacity region and then providing a coding scheme that can achieve the upper bound. The capacity characterization is in terms of linear equations. We also extend our 2-hop relay networks results to multihop wireless networks by providing a linear program that can perform the superposition optimally. We perform extensive simulations for both the 2-hop relay and large wireless networks and show the superiority of our protocols over the network coding protocols that deal with the packets separately [13].

E. Distributed network codingbased opportunistic routing for multicast

In this paper, we tackle the network coding-based opportunistic routing problem for multicast. We present the factors that affect the performance of the multicast protocols. Then, we formulate the problem as an optimization problem. Using the duality approach, we show that a distributed solution can be used to achieve the optimal solution. The distributed solution consists of two phases. In the first phase, the most reliable broadcasting tree is formed based on the ETX metric. In the second phase, a credit assignment algorithm is run at each node to determine the number of coded packets that the node has to send.

The distributed algorithm adapts to the changes in the channel conditions and does not require explicit knowledge of the properties of the network. To reduce the number of feedback messages, and to resolve the problem of delayed feedback, we also perform network coding on the feedback messages. We evaluate our algorithm using simulations which show that in some realistic cases the throughput achieved by our algorithm can be double or triple that of the state-of-the-art [14].

III. EXISTING SYSTEM

The maximum multicast rate is the minimum of the min-cut max-flow between the source and each destination. For multiple multicast sessions in wire line networks, intra-session network coding -where coding is performed on the packets of every session separately- is used to share the bandwidth of the network [15]. Therefore, the optimal algorithm in wire line networks has to achieve the minimum of the min-cut max-flow value between the source and each destination for the single source multicast problem. Also, the same optimal algorithm can use intra-session network coding to share the resources of the network in the case of multiple multicast sessions. This is due to the difficulty of using intersession network coding [16], which codes packets of different flows together.

Due to the broadcast nature of wireless links and the correlations among the links, how we can find the min-cut max-flow between two nodes is not clear. One candidate solution (which has been used in the past in a different context [17]), attractive due to its simplicity, is null space- based (NSB) coded feedback, i.e., each node sends to each upstream node one vector randomly chosen among all vectors in the null space of the innovative vectors the node has received in the past.

IV. PROPOSED SYSTEM

So far, we have identified the structure of the optimal solution and discussed the major challenges that face its implementation. We have then designed a back-pressure algorithm that uses the coded feedback approach to resolve these challenges. In this section, we outline the details of implementing our algorithm under practical settings. In our protocol, every node maintains the following information: the received and sent coded packets, the available number of credits, and the batch and session number of the received and sent packets. We adopt a packet format similar to, such that each packet has 1500 bytes of data. The packet also contains the coefficients of the coding vector along with its session and batch numbers.

The packet contains the three most recent batches it has received, each with a vector from the null space of the packets in that batch. The packet contains the number of currently queued credits. The packets also contain the number of credits assigned to each next-hop node and the batch number for these credits. As can be seen, the overhead is about 1-2%, which is very small. In every time slot, the source node computes the source rate. This adds more credits to the source node's queue. The source node moves to the next batch when the number of credits assigned to the current batch equals the size of the batch. When an intermediate node transmits a packet, it fills the null space fields with randomly chosen vectors from the null spaces of the batches it is currently receiving coded packets from. Note that the coded packets that the node sends, and the null space vectors that the node generates at any given time, could be for different batches.

A node keeps sending packets from a batch until it makes sure using the coded feedback approach, that for each destination the total number of linearly independent packets received by all next-hop nodes that can reach that destination, is no less than the number of credits it has for this batch. At that time, the node transfers the credits to the next-hop nodes using Algorithm. An intermediate node sends the credit assignment information for the last three batches it has made assignments for. Note that there is a very small feedback or credit assignment overhead due to the integration with the data packets. Also, assigning the credits to next-hop nodes when enough packets have been sent from a batch serves two purposes. It gives enough time for the feedback packets and the credits to reach the intended nodes due to the lossy behavior of the links.

A. *ARCHITECTURE:*

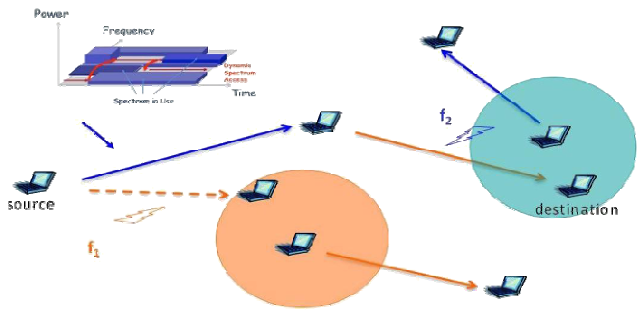

Fig. 1 Architecture diagram

Following are few other algorithms which are used:

1: Sort the next-hop nodes according to the backlog difference
2: Discard the nodes with negative backlog difference.
3: for Each sent packet P do
4: TAKENðPÞ 0
5: end for
6: for Each next-hop node v with positive backlog
difference in descending order do
7: for Each packet P do
8: if TAKENðPÞ ¼ 0 AND yiT
v _ P ¼ 0 then
9: Civ
Civ
þ 1
10: TAKENðPÞ 1
11: end if
12: end for
13: end for

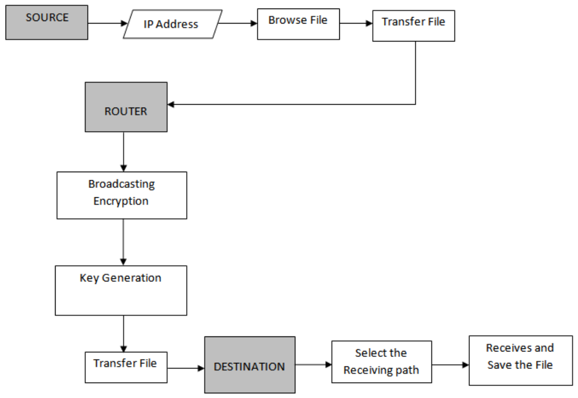

Fig. 2 Block Diagram

The results show that our protocol always results in more gain compared to MORE; also, the gain of our protocol is maximized when we have low delivery rate links. MORE does not exploit the benefit of having uncorrelated or independent broadcast links, as the gain of our protocol is maximized in these cases. This is aligned with the expectations in that we have many coding opportunities under these cases which are not fully captured by MORE.

B. *MODULES*

1. Structure of the Optimal Solution
2. The Coded Feedback Approach
3. Integrating the Coded Feedback Approach with the Algorithm
4. Results on Topologies

1) *Structure of the Optimal Solution*

In this paper, we consider a network represented by a set of nodes V. The links between the nodes are lossy and time-varying. A transmission by a node can be received by any subset of next-hop nodes. We represent this by a hyper-edge, where u is the node that performs transmission, and J is a subset of the set of next-hop nodes. There are N unicast sessions in the network, each with a source, a destination, a rate, and a utility function. Similar to most of the opportunistic routing protocols, we are interested in the transmission of large files. Therefore, the throughput is the most important factor, and the individual packet delays are of no importance.

Since we are using intra-session network coding, one important factor to decide is the rate of linearly independent packets that a node has to successfully deliver to next-hop nodes. To model this factor, we use the concept of credits. The first set of constraints represents balance equations for the credits, so that the total received credits at a node should be equal to the total amount of sent credits. This guarantees that node di will receive linearly independent packets at a rate of no less than Ri. The second set of constraints represents the fact that if a packet is received by many nodes, only one of them can use this packet to increase its credits, which is a unique property of the wireless links.

2) *The Coded Feedback Approach*

In this module, we implement the coded feedback approach. In our system, we limit the coded feedback messages to be used by the previous one-hop-away nodes, but we show that our method achieves the optimal solution. The common way of using the coded feedback is through the null space. The null space of the matrix A is the linear space of vectors such that the result of multiplying any one of them by A equals zero.

Note that in the coded feedback approach, only one feedback message from the node can acknowledge all of its previous one-hop away nodes; therefore, it allows for the exploitation of the broadcast nature of wireless networks in the reverse direction of transmission. Also, as we will explain, these coded feedback messages can be integrated with the original packets with very low overhead.

3) *Integrating the Coded Feedback Approach with the Algorithm*

In this module, we move to apply the gradient algorithm that we adopted in the previous section in a batch-by batch fashion. Therefore, the index t will refer to the batch number.

A batch-by-batch manner by performing the transfer of the credits for a given batch, and the queue length updates at a node after making sure that the next-hop nodes have collectively received linearly independent packets equal to the number of credits for that batch at that node. After that, the node will move to the next batch. Therefore, what needs to be specified is how to use the coded feedback approach at the relay node u to perform the following two decisions that lead to maximizing. Node u has to decide the session that the current packet should be sent from. Node u has to also decide the number of credits to be assigned to each next-hop node.

4) *Results on topology:*

We simulate one session using the topology with sixteen nodes. We vary two parameters: the delivery rates of all of the links, and the correlation between the links of the source node. The delivery rate values change from 0.3 to 0.8. For each one of these delivery rate values, we make the correlations between the links independent. We assume very large files. Therefore, we run the simulations until the steady state throughput is reached, and then we record that value. The highest throughput is achieved by our protocol when the links are negatively correlated, whereas the lowest throughput is achieved when the links are positively correlated. This is due to the fact that the source node has to send more packets when the links are positively correlated.

C. *IMPLEMENTATION*

The results of the proposed system are shown below.

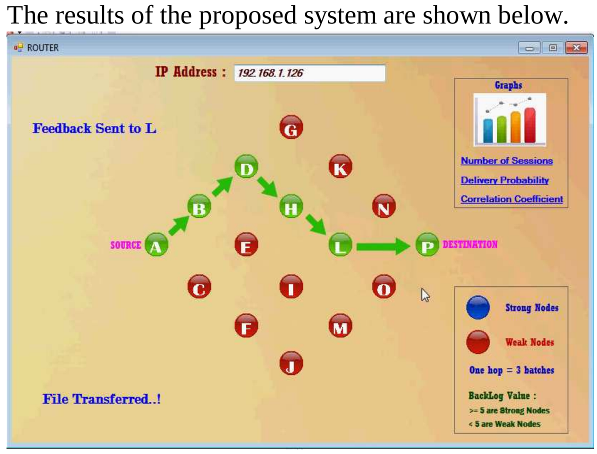

Fig. 3 File transfer

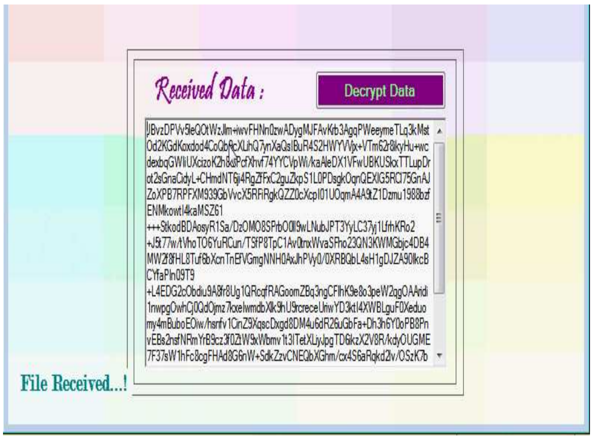

Fig. 4 Data Encryption

V. CONCLUSION

Selecting the best route is more challenging in the field of WSN. The selection depends upon lot of parameters. Hence, various parametric features of the routing protocols have been discussed and analyzed in this paper. The design of our algorithm is inspired by recent results in the literature that showed the sensitivity of the opportunistic routing and network coding protocols to the correlations among the wireless links. Our algorithm adapts to changes in the channel loss rates and the correlations among the links. The future challenges include security routing, energy demand and multi objective routing.

REFERENCES

[1] A. Khreishah, I. Khalil, and J. Wu, “Universal opportunistic routing scheme using network coding,” in Proc. IEEE Conf. Sensor, Mesh Ad Hoc Commun. Netw., Jun. 2012, pp. 353–361.

[2] D. Aguayo, J. Bicket, S. Biswas, G. Judd, and R. Morris, “Linklevel measurements from an 802.11b mesh network,” in Proc. Conf. Appl., Technol., Archit., Protocols Comput. Commun., Aug. 2004, pp. 121–132.

[3] MIT Roofnet. [Online]. Available: http://www.pdos.lcs.mit.edu/ roofnet

[4] S. Biswas and R. Morris, “Opportunistic routing in multi-hop wireless networks,” in Proc. ACM Special Interest Group Data Commun., Philadelphia, PA, USA, Sep. 2005.

[5] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, “Trading structure for randomness in wireless opportunistic routing,” in Proc. Conf. Appl., Technol., Archit., Protocols Comput. Commun., Aug. 2007, pp. 169–180.

[6] T. Ho, M. Medard, R. Koetter, D. Karger, M. Effros, J. Shi, and B. Leong, “A random linear network coding approach to multicast,” IEEE Trans. Inf. Theory, vol. 52, no. 10, pp. 4413–4430, Oct. 2006.

[7] C.-C. Wang, A. Khreishah, and N. Shroff, “On cross-layer optimizations for intersession network coding on practical 2-hop relay networks,” in Proc. Conf. Rec. 43rd Asilomar Conf. Signals, Syst. Comput., Nov. 2009, pp. 771–775.

[8] A. Khreishah, I. Khalil, and J. Wu, “Distributed network codingbased opportunistic routing for multicast,” in Proc. 13th ACM Int. Symp. Mobile Ad Hoc Netw. Comput., 2012, pp. 115–124.

[9] A. Khreishah, I. Khalil, P. Ostovari, and J. Wu, “Flow-based XOR network coding for lossy wireless networks,” IEEE Trans. Wireless Commun., vol. 11, no. 6, pp. 2321–2329, Jun. 2012.

[10] P. Ostovari, J. Wu, and A. Khreishah, “Network coding techniques for wireless and sensor networks,” The Art Wireless Sensor Netw., vol. 1, pp. 129–162, 2013.

[11] K. Srinivasan, M. Jain, J. Choi, T. Azim, E. Kim, P. Levis, and B. Krishnamachari, “The k-factor: Inferring protocol performance using inter-link reception correlation,” presented at the ACM 19th Annu. Int. Conf. Mobile Comput. Netw., Chicago, IL, USA, Sep. 2010.

[12] B. L. Y. Lin and B. Liang, “CodeOR: Opportunistic routing in wireless mesh networks with segmented network coding,” in Proc. 16th IEEE Int. Conf. Netw. Protocols, Oct. 2008, pp. 13–22.

[13] C. Gkantsidis, B. Radunovic, P. Key, S. Gheorgiu, W. Hu, and P. Rodriguez, “Multipath code casting for wireless mesh networks,” in Proc. ACM Int. Conf. Emerging Netw. Experiments Technol. Conf., 2007, p. 10.

[14] X. Zhang, and B. Li, “Optimized multipath network coding in lossy wireless networks,” IEEE J. Sel. Areas Commun., vol. 27, no. 5, pp. 622–634, Jun. 2009.

[15] D. Koutsonikolas, C.-C. Wang, and Y. Hu, “CCACK: Efficient network coding based opportunistic routing through cumulative coded acknowledgments,” in Proc. 29th Conf. Comput. Commun., San Diego, CA, USA, Mar. 2010, pp. 1–9.

[16] B. Radunovic, C. Gkantsidis, P. Key, and P. Rodriguez, “Toward practical opportunistic routing with intra-session network coding for mesh networks,” IEEE/ACM Trans. Netw., vol. 18, no. 2, pp. 420–433, Apr. 2010.

[17] D. Lun, M. Medard, and R. Koetter, “Network coding for efficient wireless unicast,” in Proc. Int. Zurich Seminar Commun., 2006, pp. 74–77.

[18] S. Chachulski, “Trading structure for randomness in wireless opportunistic,” M.S. thesis, Massachusetts Inst. Technol., Dept. Electrical Eng. Comput. Sci., Cambridge, MA, USA, May 2007.

[19] T. Bonald and L. Massoulie, “Impact of fairness on Internet performance,” in Proc. ACM Joint Int. Conf. Meas. Model. Comput. Syst., Cambridge, MA, USA, Jun. 2001, pp. 82–91.

[20] X. Lin and N. Shroff, “The impact of imperfect scheduling on cross-layer congestion control in wireless networks,” IEEE/ACM Trans. Netw., vol. 14, no. 2, pp. 302–315, Apr. 2006.

[21] T. Cui, L. Chen, and T. Ho, “Distributed optimization in wireless networks using broadcast advantage,” in Proc. IEEE Conf. Decision Control, Dec. 2007, pp. 5839–5844.

[22] S. Boyd and L. Vandenberghe, Convex Optimization. Cambridge,U.K.: Cambridge Univ. Press, 2004.

[23] D. Bertsekas and J. N. Tsitsikalis, Parallel and Distributed Computation: Numerical Methods. Belmont, MA, USA: Athena Scientific, 1997.

[24] J. Park, M. Gerla, D. Lun, Y. Yunjung, and M. Medard, “Codecast: A network-coding-based ad hoc multicast protocol,” IEEE Wireless Commun., vol. 13, no. 5, pp. 76–81, Oct. 2006.

[25] C.-C. Wang, “Pruning network coding traffic by network coding— A new class of max-flow algorithms,” IEEE Trans. Inf. Theory, vol. 56, no. 4, pp. 1909–1929, Apr. 2010.

[26] A. Khreishah, C.-C. Wang, and N. Shroff, “Rate control with pairwise intersession network coding,” IEEE/ACM Trans. Netw., vol. 18, no. 3, pp. 816–829, Jun. 2010.

[27] X. Lin and N. Shroff, “Joint rate control and scheduling in multihop wireless networks,” in Proc. 43rd IEEE Conf. Decision Control, Dec. 2004, pp. 1484–1489.

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