

R3E: Reliable Reactive Routing Enhancement for Wireless Sensor Networks

Sayali P. Gaikwad¹, Dr. Achala Deshmukh²

Student, Department of Electronics & Telecommunication, Sinhgad College of Engineering, Pune, Savitribai Phule
Pune University, Pune, India

Professor, Department of Electronics & Telecommunication, Sinhgad College of Engineering, Pune, Savitribai Phule
Pune University, Pune, India

ABSTRACT: Giving dependable and effective correspondence under blurring channels is one of the real specialized difficulties in remote sensor systems (WSNs), particularly in mechanical WSNs (IWSNs) with dynamic and brutal situations. Here we present the Reliable Reactive Routing Enhancement (R3E) to increase the ability to quickly recover back from difficulties of link dynamics for WSNs/IWSNs. R3E is designed to improve existing reactive routing protocols to provide reliable and energy-efficient packet delivery against the unreliable wireless links by utilizing the local path diversity. Specifically, a biased backoff scheme is introduced during the route-discovery phase to find a strong and reliable guide path, which can provide more cooperative forwarding opportunities. In this technique, we quantify the link weight, define forward energy density, which constitutes forward aware factor with link weight, how much traffic congestion is experienced by the nodes and the impact of interference is analyzed. So, based on this the path is to be selected for routing. Analysis results in high packet delivery ratio and less delay, less energy consumption and less data transmission cost.

KEYWORDS: Industrial wireless sensor networks (IWSNs), opportunistic routing, reliable forwarding, unreliable wireless links.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have become an established technology for large number of applications ranging from monitoring, to event detection and target tracking. In industries too, the traditional wired communication has been replaced by WSNs since the Industrial Wireless Sensor Networks (IWSNs) offer several advantages including easy and fast installation and lowcost maintenance. In IWSNs, transmission failures can result in missing or delaying of process or control data, and missing a process or control deadline is normally intolerable for industrial applications, as it may cause chaos in industrial automation or possibly terminates the automation, ultimately resulting in economic losses. Reliable Reactive Routing Enhancement (R3E) is proposed, which increases the resilience to link dynamics for WSNs/IWSNs. R3E is design to augment existing reactive routing protocol to combat the channel variation by utilizing the local path diversity in the link layer. Again R3E is designed to enhance existing reactive routing protocol to provide reliable and energy efficient packet delivery against unreliable wireless links. So, here AODV protocol extended with R3E. This new protocols AODV-R3E can effectively improve robustness, end-to-end energy efficiency and latency in IWSN. The idea of opportunistic routing is to utilize the path diversity for cooperative caching that is, in each hop, neighboring nodes that hold the copies of a data packet serve as caches, thus the downstream node could retrieve the packet from any of them. The rationale is that, the path with higher spatial diversity (more potential helper nodes) may possibly provide more reliable and efficient packet delivery against the unreliable links. With this observation, we aim to find such a reliable virtual path to guide the packets to be progressed toward the destination. We call this virtual path a guide path, in which the nodes are named as guide nodes. The general direction toward the destination, and the routing decision is made a posteriori, i.e., the actual forwarders are chosen based on the packet reception results at each hop. Wireless Sensor Networks may fail due to lack of energy of the forwarding nodes. Hence, it is imperative to find the nodes that will provide services for longer duration. For IWSNs, due to harsh and dynamic nature of the links it is

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

necessary to ensure reliable data delivery from source to destination. The protocols may be classified into flat based, hierarchical-based and location-based in line with the network structure. During this paper, we have a tendency to specialize in the load equalization multi-path flat routing protocol in WSNs. Once all sensors have equal initial energy and equal probabilities to become sources, network might maximize its life if all detector sensors dissipate energy at a similar rate, since no loss of connectivity would result from node failure. In this paper, we have proposed a new methodology to balance energy consumption and keep approximate network wide energy equivalence by equalizing the network load. Our approach concentrates on a way to change the routing methods so as to equalize load. Many routing protocols are projected for WSNs; we will classify them into either proactive or reactive. Proactive routing protocols update routes for each try of nodes at regular intervals regardless of their demand. The reactive or on-demand routing protocols, verify route only if there is a desire to transmit a knowledge packet, employing a broadcasting query-reply (RREQ-RREP) procedure. Most of those protocols use min-hop because of the route choice metric. It is found that shortest path route has short life, particularly in extremely dense accidental networks even with low quality, attributable to edge impact. In rest of this paper, section II presents the connected work studies. In section III, discussed the proposed framework, algorithm steps and design. Section IV, presenting the system architecture.

II. RELATED WORK

Charles E Perkins and Elizabeth M Royer [3] present Ad-hoc on Demand Distance Vector Routing protocol. For the Ad-hoc network AODV is an efficient algorithm AODV provides loop free routes even while repairing broken links. AODV provides quick response to link breakage in active routes. This new routing algorithm is quite suitable for a dynamic self-starting network as required by users wishing to utilize a Ad-hoc networks. AODV provides most of the advantages of basic distance vector routing mechanisms. This algorithm scales to large populations of mobile nodes wishing to form ad-hoc networks.

Mahesh K. Marina and Samir R. Das [4] present on demand multipath distance vector protocol for mobile ad-hoc networks in each route discovery it find multiple routes between source and destination i.e Multipath extensions to single path routing protocol for simulating the performance using ns-2 simulations AOMDV with AODV. AOMDV is able to achieve remarkable improvement in the end-to-end delay able to reduce routing overheads. Primary design goal behind AOMDV is to provide efficient fault tolerance in the sense of faster and efficient recovery from route in dynamic routing.

David B. Johnson David A. Maltz [5] present Dynamic Source Routing (DSR) protocol for routing in Ad-hoc wireless network. In dynamic source routing host movement is frequent and the protocol adapts quickly to routing changes. In an ad hoc network, this protocol performs well over a variety of environmental conditions such as host density and movement rates.

Szymon Chachulski Michael Jennings [10] these two authors present MORE a MAC-independent opportunistic routing. Multiple nodes may hear a packet broadcast and unnecessarily forward the same packet. EXOR deals with this issue by tying the MAC to the routing, imposing a strict scheduler on routers access to the medium protocol. MORE randomly mixes packets before forwarding them. MORE provides both unicast and multicast traffic with significantly higher throughput than both traditional routing and prior work on opportunistic routing. So MORE provide some additional properties for better performance of WSN.

Raffaele Bruno a, Maddalena Nurchis [13] has done survey and presented the wireless diversitybased routing paradigm although very promising results have been obtained in terms of throughput and reliability improvements. The strong assumption behind their design is that an application can tolerate a certain delay in exchange for throughput gain. In other words, throughput improvement has been considered, while only a little attention has been directed to delay reduction. However, wireless mesh networks are expected to provide advanced communication services supporting real-time traffic.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

III. PROPOSED METHODOLOGY

The use of wireless sensor networks (WSNs) has grown enormously in the last decade, pointing out the crucial need for scalable and energy-efficient routing and data gathering and aggregation protocols in corresponding large-scale environments. SLQDEARP is an on-demand unipath routing protocol. The proposed SLQDEARP takes advantage of various features of AODV routing protocol and estimates link quality and also selects the delay and energy aware path towards the destination node. In SLQDEARP the first node based on the received signal strength estimates link quality. Then the delay and energy cost are also estimated. The node which is having more link quality is taken into account. If more than one node is having the same link quality, then the node which is having least delay and energy is chosen. An adaptive node stability mathematical modeling is proposed. Based on the estimated link quality, delay and residual energy of the nearby nodes SLQDEARP finds the efficient node and sends the data packets through that node. Also ad-hoc security algorithms are incorporated for the secure transmission. Thus comparison of AODV and ASA algorithm is been carried out to calculate energy consumption, end to end delay and packet lost.

A) Forward -aware factor based efficient selection routing method

Based on the detailed analysis of the data transmission mechanism of WSN, quantify the forward transmission area, define forward energy density, which constitutes forward-aware factor with link weight, how much traffic congestion is experienced by the nodes and the impact of interference is analyzed. So, based on this the path is to be selected for routing.

To extend the network lifetime an innovative technique is proposed which is called Efficient Selection of Route based on awareness of Link weight and Forward energy density, Traffic congestion, Interference level (ESR-LFTI).

- I. In this technique, the next-hop node is selected according to the awareness of link weight and forward energy density. Furthermore, a spontaneous reconstruction mechanism for local topology is designed additionally.
- II. Traffic congestion is experienced by the nodes when incoming traffic is much higher than outgoing traffic. Smart metering nodes buffer the incoming packets in finite size queue and start dropping any new incoming packets when queue is full. Nodes which serve maximum number of nodes in multi hop transmission (like the ones close to sink) are likely to experience maximum traffic load leading to traffic congestion.
- III. Many routing messages are propagated unnecessarily and may cause different interference characteristics during route discovery phase and in the actual application data transmission phase. As a result incorrect routes may be selected. The main intent is to design solutions which make more accurate routing decisions by reducing the interference level during the route discovery phase and making it more similar to that during the actual data transmission phase.

So, based on the four factors such as Link weight and Forward energy density, Traffic congestion, Interference level the path is selected for routing.

B) Reliable Guide Path Discovery

If a node has data packets to send to a destination, it initiates a route discovery by flooding an RREQ message. When a node receives a non-duplicate RREQ, it stores the upstream node id and RREQ's sequence number for reverse route learning. Instead of rebroadcasting the RREQ immediately in existing reactive routing protocols, we introduce a biased back-off scheme at the current RREQ forwarding node. The aim of this operation is to intentionally amplify the differences of RREQ's traversing delays along different paths.

When a node receives an RREP, it checks if it is the selected next-hop (the upstream guide node) of the RREP. If that is the case, the node realizes that it is on the guide path to the source, thus it marks itself as a guide node. Then, the node records its upstream guide node ID for this RREP and forwards it. In this way, the RREP is propagated by each guide node until it reaches the source via the reverse route of the corresponding RREQ.

C) Route selection algorithm design

In this module, the optimal path is selected based on awareness of link weight and forward energy density, traffic congestion, interference level.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

In this method, the remaining energy level is computed based on the subtraction from the initial energy to the processing energy.

IV. SYSTEM MODEL

Reliable Reactive Routing Enhancement (R3E) The project proposes an idea of R3E which is used as an extension over the AODV protocol. This enhances the AODV routing protocol to provide reliable and energy efficient packet delivery against the condition of Link Failure which may occur in a wireless sensor network. Figure below shows the functional architecture overview of R3E. It is a middle-ware design across the MAC and the network layer. The R3E enhancement layer module consists of three main modules. They are Reliable Route discovery module, potential forwarder selection and prioritization module and forwarding selection module. The reliable route discovery module finds and maintains the route information for each node. The other two modules are responsible for the runtime forwarding phase. Forwarding decision module will check whether the node receiving a packet is one of the intended receivers if it is true then the node will cache the incoming packet. The potential forwarder selection and prioritization module attaches the ordered forwarder list in the data packet header for the next hop. Lately the outgoing packet will be submitted to the MAC layer and forwarded towards the destination.

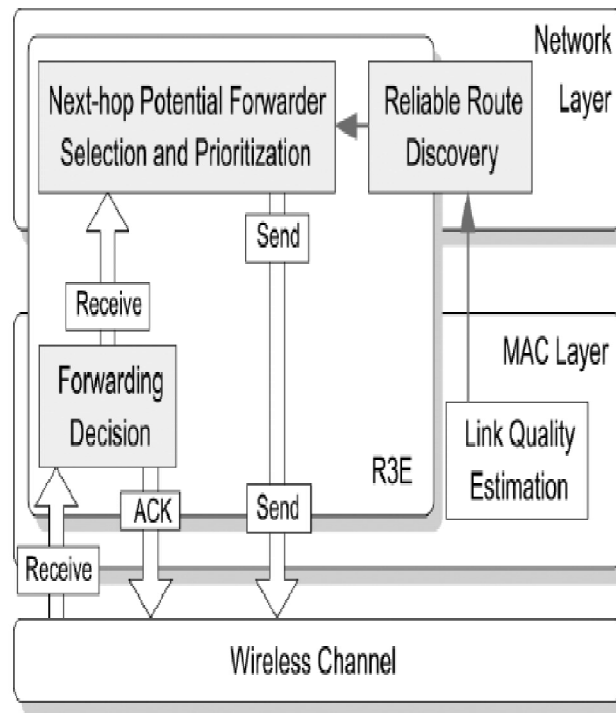


Figure No 01 System Architecture

V. SIMULATION RESULT

The simulation analyses for R3E while the data transmission and certificate revocation based security is implemented using Network Simulator NS2. The simulation is done by comparing the R3E protocol with the AODV protocol. The simulation is done for Energy Consumption, Packet delivery ratio, End-to-End Delay and Packet Lost using R3E whose results are shown in Figure below.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

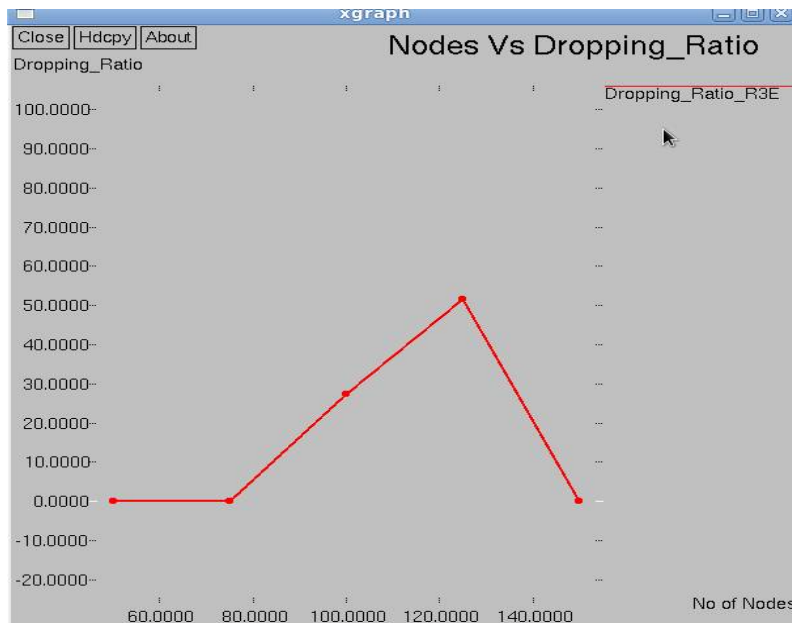


Figure 2: Graph of nodes versus packet dropping ratio

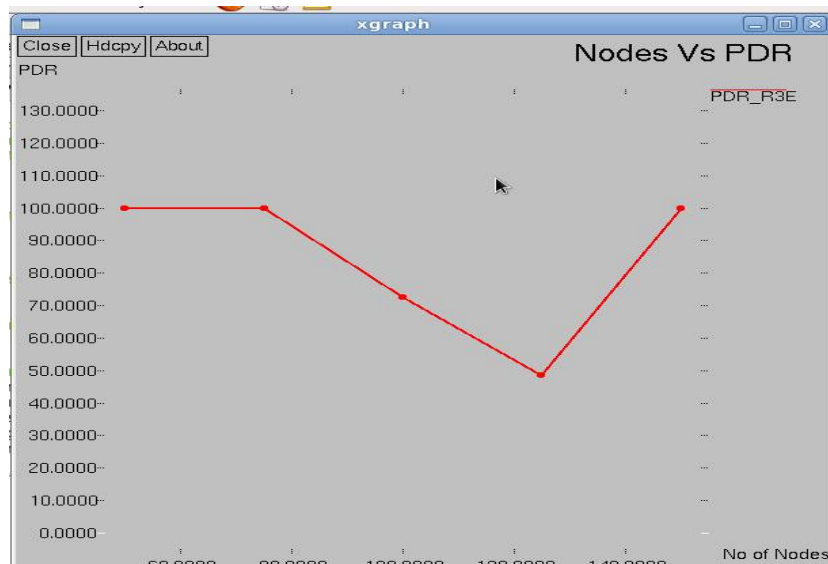


Figure 3: Graph of nodes versus packet delivery ratio.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

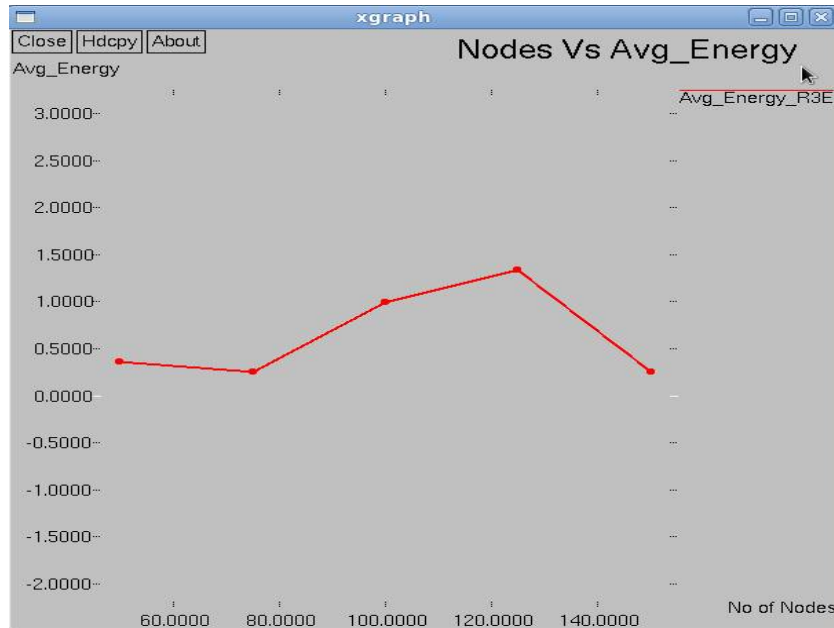


Figure 4: Graph of nodes versus energy consumption.

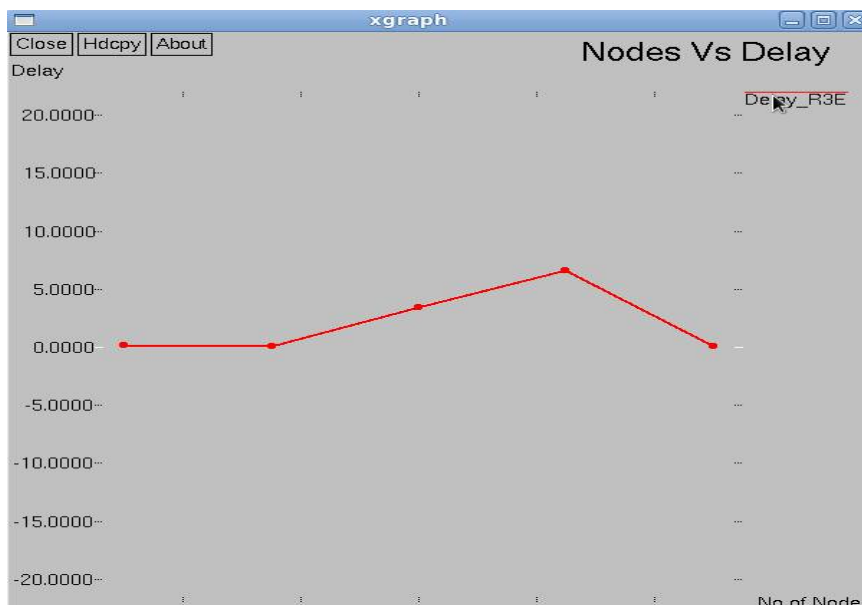


Figure 5: Graph of nodes versus packet delay.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

Table 1: Simulation Settings and Parameters

No. of Nodes	50, 75, 100, 125, 150 and 200
Area Size	1500 X 1500 meters
MAC	802.11b
Radio Range	250 meters
Simulation Time	100 seconds
Traffic Source	CBR
Packet Size	512 KB
Mobility Model	Random Waypoint Model
Speed	5 m/s
Initial Energy	0.5 Joules

The output design includes the following parameters

- Packet drop = Number of packets received – Number of packets sent
- Packet delivery ratio = (Number of packets received/ Number of packets sent)*100
- Energy consumption = Average energy consumption on idle, sleep, transmit & received.
- Delay = (Interval of 1st packet delivery time & 2nd packet delivery time)/ Total data packet delivery time

VI. CONCLUSION AND FUTURE WORK

In this work, we presented R3E, with a very good scalability; this approach is applicable to both small size WSNs and WSNs with larger number of nodes. Using R3E in WSNs it provides reliable and energy-efficient packet delivery against the unreliable wireless links. A biased back-off scheme is used in the route discovery phase to find a strong guiding path with low overhead. But the disadvantage is due to the limited energy and communication ability of sensor nodes, it seems especially important to design a routing protocol for WSNs so that sensing data can be transmitted to the receiver effectively. So, in the proposed system a new technique is introduced which is called Efficient Selection of Route (ESR-LFTI) based on awareness of Link weight and Forward energy density so, based on this the path is to be selected for routing. The proposed SLQDEARP takes advantage of various features of AODV routing protocol and estimates link quality and also selects the delay and energy aware path towards the destination node. SLQDEARP finds the efficient node and sends the data packets through that node. Also ad-hoc security algorithms are incorporated for the secure transmission. Thus comparison of AODV and ASA algorithm is been carried out to calculate energy consumption, end to end delay and packet lost.

ACKNOWLEDGMENT

I would like to express my true sense and sincerest gratitude to my respected HOD of Electronics & Telecommunication department Dr. M. B. Mali for his dynamic and valuable guidance. I am grateful to him for constant encouragement in fulfilment of paper. This work is result of combined efforts put in by my guide and me. I would also like to thank her for providing me with all necessary infrastructure and facilities to complete this paper. I extend my special thanks to Dr. S. D. Lokhande, principal of SCOE, Pune and all staff members. We are thankful to the authorities of Savitribai Phule University, Pune and concerned members of, for their valuable guidelines and support. Finally, we would like to extend a heartfelt gratitude to friends and family members.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

REFERENCES

- [1] V. Gungor and G. Hancke, "Industrial wireless sensor networks: Challenges, design principles, and technical approaches," *IEEE Trans. Ind. Electron.*, vol. 56, no. 10, pp. 4258–4265, Oct. 2009.
- [2] S. eun Yoo, P. K. Chong, D. Kim, Y. Doh, M.-L. Pham, E. Choi, and J. Huh, "Guaranteeing real-time services for industrial wireless sensor networks with IEEE 802.15.4," *IEEE Trans. Ind. Electron.*, vol. 57, no. 11, pp. 3868–3876, Nov. 2010.
- [3] C. Perkins and E. Royer, "Ad-hoc on-demand distance vector routing," in *Proc. IEEE WMCSA*, 1999, pp. 90–100.
- [4] M. Marina and S. Das, "On-demand multipath distance vector routing in ad hoc networks," in *Proc. IEEE ICNP*, Nov. 2001, pp. 14–23.
- [5] D. B. Johnson and D. A. Maltz, "Dynamic source routing in ad hoc wireless networks," *Mobile Computing*, pp. 153–181, 1996.
- [6] K. A. Agha, M.-H. Bertin, T. Dang, A. Guitton, P. Minet, T. Val, and J.-B. Viollet, "Which wireless technology for industrial wireless sensor networks? the development of Ocarri technology," *IEEE Trans. Ind. Electron.*, vol. 56, no. 10, pp. 4266–4278, Oct. 2009.
- [7] K. Yu, M. Gidlund, J. Åkerberg, and M. Björkman, "Reliable RSS-based routing protocol for industrial wireless sensor networks," in *Proc. IECON*, 2012, pp. 3231–3237.
- [8] "U. D. of Energy, Industrial wireless technology for the 21st century," Office of Energy and Renewable Energy Report, 2002.
- [9] V. Gungor, O. Akan, and I. Akyildiz, "A real-time and reliable transport protocol for wireless sensor and actor networks," *IEEE/ACM Trans. Netw.*, vol. 16, no. 2, pp. 359–370, Apr. 2008. [10] S. Biswas and R. Morris, "ExOr: opportunistic multi-hop routing for wireless networks," in *Proc. ACM SIGCOMM*, 2005, pp. 133–144. [11] S. Katti, H. Rahul, W. Hu, D. Katabi, M. Medard, and J. Crowcroft, "XORs in the air: Practical wireless network coding," *IEEE/ACM Trans. Netw.*, vol. 16, no. 3, pp. 497–510, Jun. 2008.
- [10] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading structure for randomness in wireless opportunistic routing," in *Proc. ACM SIGCOMM*, 2007, pp. 169–180.
- [11] K. Zeng, W. Lou, J. Yang, and D. Brown, "On geographic collaborative forwarding in wireless ad hoc and sensor networks," in *Proc. WASA*, 2007, pp. 11–18.
- [12] X. Mao, S. Tang, X. Xu, Li X.-Y., and H. Ma, "Energy-efficient opportunistic routing in wireless sensor networks," *IEEE Trans. Parallel Distrib. Syst.*, vol. 22, no. 11, pp. 1934–1942, Nov. 2011.
- [13] R. Bruno and M. Nurchis, "Survey on diversity-based routing in wireless mesh networks: Challenges and solutions," *Computer Commun.*, vol. 33, no. 3, pp. 269–282, Feb. 2010.