Routing Algorithms for Relay Node Selection in Wireless Sensor Networks - A Review

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Abstract - wireless sensor networks (WSNs), and wirelesses mesh networks (WMNs), have received in-creasing attention in the past decade due to their broad applications and the easy deployment at low cost without relying on existing infrastructure. Network protocol design in such networks presents a great challenge mainly due to the following reasons. First, an important feature of wireless networks is the time-varying channel caused by wireless channel propagation effects, mainly multipath fading, which can result in large fluctuations in signal strength and therefore intermittent link behavior. Second, wireless link is a "soft" concept. The property and quality of a link may vary with the transmission power, transmission rate, distance and path loss between two nodes. Third, since the wireless medium is broadcast in nature, the transmission on one link may interfere with the transmissions on other neighboring links. Fourth, wireless embedded devices, such as sensors, are typically battery powered. The lifetime of the battery imposes a limitation on the operation hours of the network. Energy efficiency has been a critical concern in wireless sensor network protocol design. Traditional routing protocols for multihop wireless networks have followed the concept of routing in wired networks by abstracting the wireless links as wired links, and find the shortest, least cost, or highest throughput path(s) between a source and destination. Since most routing protocols rely on the consistent and stable behavior of individual links, the intermittent behavior of wireless links can result in poor performance such as low packet delivery ratio and high control overhead. in these research a review on different energy efficient protocols has discussed.

Keywords- WSN, Energy-aware Routing, Opportunistic routing, Relay node, Queue network.

I. INTRODUCTION

Modern Wireless Sensor Network (WSN) platforms, which are characterized as one of the key technologies contributing to the so-called "digital evolution", are endowed with the ability to create networked artifacts (human and non-human) to sense their environment, and accordingly adapt their behaviour in beneficial manners. The potential applications are numerous, including effective monitoring and sustainable governance in structural health, disaster relief, transportation, law enforcement, and public safety and security. A major rationale for these WSN technologies is that they can enable the users to make decisions in a "smarter", more "aware" and "responsive" manner [1]. Indeed, a distributed monitoring capacity gives us a "novel" visualization of our environment that allows more effective planning: the ability to respond in a more timely fashion, and to develop more effective actions to resolve environmental problems. The social and economic implications can be enormous, for not only public, but also private organizations. Evidently, this technological innovation impacts many aspects of human life: health and safety, information and communications, energy and environment, as well as security, to name a few. And the application of wireless sensor network can be seen in Figure 1.1.

While there are irrefutable advantages to be reaped with the WSN infrastructures, these strategic values are not without caveats. On the one hand, the larger a sensor network becomes, the smarter and more responsive we become, as our visualization becomes more global and informative. On the other hand, as the size of the network increases, so does the associated complexity and management [2]. To facilitate deployment and acceptance of such networks, the network sensors must be inexpensive, non-intrusive, and communicate effectively. Together, these conditions imply two fundamental requirements that influence the operation of the network: scalability and sustainability. Without these two requirements, the operation and impact of the WSN would be questionably limited, if not short-lived.

An appealing solution for unattended surveillance and monitoring application is Self- Powered Wireless Sensor Networks (WSNs). One of the main reasons is that energy harvesting can be used to significantly extend the network lifetime and the network can work unattended for long periods. However, these networks are characterized by multihop lossy links and resource constrained nodes while they have to face the coexistence problem with other applications. An example of a WSN with a Self-Powered can be seen in Figure 1.2.

A number of sensor nodes works unattended in the field. The nodes should transmit the data to a control centre. The nodes availability can change over time while there are other wireless infrastructures in the area that use the same transmission band.

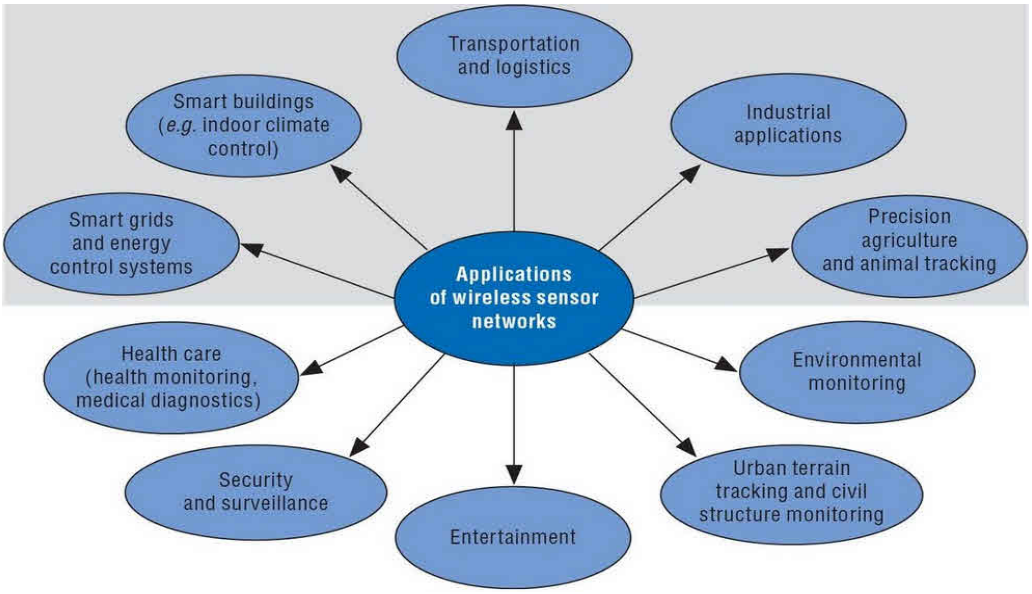

Figure 1.1 Application of WSN.

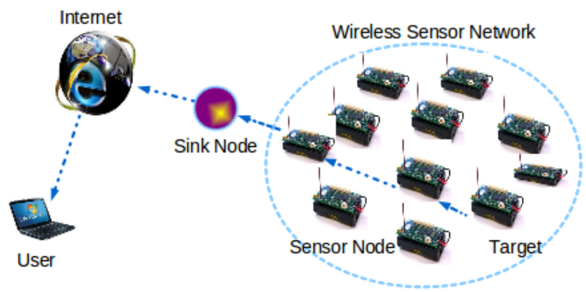

Figure 1.2 Example of WSN.

II. WSN SYSTEM MODEL

WSN consist of nodes, from few to several one, which work together to capture data from an environment region and send this data to a base station. This sensor nodes use to track and monitor heat, temperature, vibratory movement, etc. They are small with limited computing resources and base on a routing algorithm, they can transmit data to the user. This routing algorithm depends on the network architecture and they can be changed. Since the sensor node has limited memory and they can be located in places which are hard to access, a wireless communication between nodes is needed.

Each sensor node has different parts such as a radio transceiver with an internal antenna, a micro controller, an electronic circuit for interfacing with the sensors and energy source which is usually a battery or an embedded form of energy harvesting.

There are two types of WSN; structured and unstructured. An unstructured WSN contains a dense of sensor nodes which they connect to each other using an ad-hoc manner (sensor nodes randomly placed into the field.) For structured WSN, most of the sensors are located in a pre-planned manner.

A. Routing Principles in WSNs

In recent years, a lot of effort has been devoted to improve the performance of wireless ad hoc networks, in terms of power consumption and packet latency. One promising approach is to allow the relay nodes to cooperate, thus using the spatial diversity to increase the capacity of the system. However, one of the main drawbacks of this approach is that it requires information exchange between the nodes. This introduces overhead and increases the complexity of the receivers.

A simpler way of exploiting the spatial diversity is Opportunistic Routing (OR), also called opportunistic forwarding. OR tries to benefit from the spacial diversity of the wireless medium. In contrast with traditional routing which involves only one relay candidate, OR involves a set of forwarding candidates? OR tries to overcome the drawback of unreliable wireless links by taking advantage of the broadcast nature of the wireless medium.

One transmission can be overheard by multiple nodes. As a consequence, a cluster of nodes can serve as relay candidate set. From the candidate set, only one node will become the next relay node and forward the packet. In this way, OR improves the reliability and efficiency of packets relay. In OR, intermediate nodes collaborate to packet forwarding in order to achieve high throughput in the face of lossy communication links. As it can be inferred, the task of routing in an opportunistic forwarding protocol is crucial for the network performance.

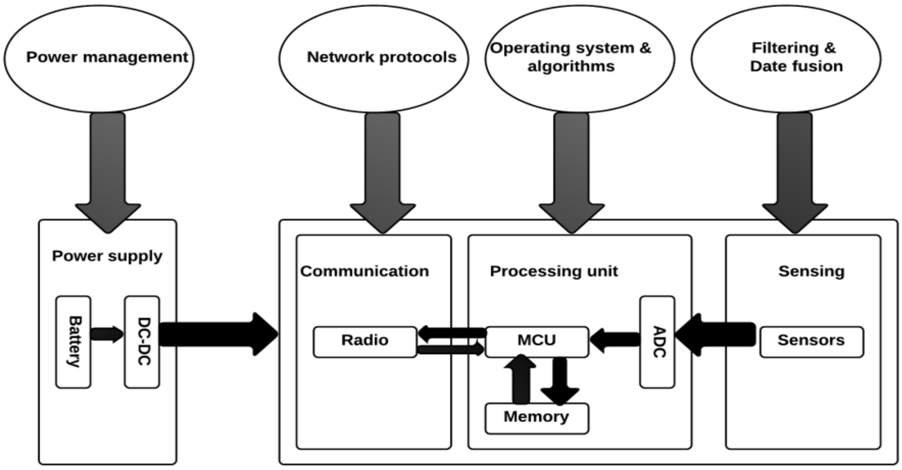

Figure 2.1 WSN sensor node system architecture.

III. PRIOR WORK

J. Luo, J. Hu, D. Wu and R. Li,[1] Energy savings optimization becomes one of the major concerns in the wireless sensor network (WSN) routing protocol design, due to the fact that most sensor nodes are equipped with the limited nonrechargeable battery power. In this research, we focus on minimizing energy consumption and maximizing network lifetime for data relay in one-dimensional (1-D) queue network. Following the principle of opportunistic routing theory, multihop relay decision to optimize the network energy efficiency is made based on the differences among sensor nodes, in terms of both their distance to sink and the residual energy of each other. Specifically, an Energy Saving via Opportunistic Routing (ENS_OR) algorithm is designed to ensure minimum power cost during data relay and protect the nodes with relatively low residual energy. Extensive simulations and real testbed results show that the proposed solution ENS_OR can significantly improve the network performance on energy saving and wireless connectivity in comparison with other existing WSN routing schemes.

D. Zhang, G. Li, K. Zheng, X. Ming and Z. H. Pan [2] As an important part of industrial application (IA), the wireless sensor network (WSN) has been an active research area over the past few years. 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. An energy-balanced routing method based on forward-aware factor (FAF-EBRM) is proposed in this research. In FAF-EBRM, 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. In the experiments, FAF-EBRM is compared with LEACH and EEUC, experimental results show that FAF-EBRM outperforms LEACH and EEUC, which balances the energy consumption, prolongs the function lifetime and guarantees high QoS of WSN.

D. Zhang, G. Li, K. Zheng, X. Ming and Z. H. Pan, [3] QoS routing is an important research issue in wireless sensor networks (WSNs), especially for mission-critical monitoring and surveillance systems which requires timely and reliable data delivery. Existing work exploits multipath routing to guarantee both reliability and delay QoS constraints in WSNs. However, the multipath routing approach suffers from a significant energy cost. In this work, we exploit the geographic opportunistic routing (GOR) for QoS provisioning with both end-to-end reliability and delay constraints in WSNs. Existing GOR protocols are not efficient for QoS provisioning in WSNs, in terms of the energy efficiency and computation delay at each hop. To improve the efficiency of QoS routing in WSNs, we define the problem of efficient GOR for multiconstrained QoS provisioning in WSNs, which can be formulated as a multiobjective multiconstraint optimization problem. Based on the analysis and observations of different routing metrics in GOR, we then propose an Efficient QoS-aware GOR (EQGOR) protocol for QoS provisioning in WSNs. EQGOR selects and prioritizes the forwarding candidate set in an efficient manner, which is suitable for WSNs in respect of energy efficiency, latency, and time complexity. We comprehensively evaluate EQGOR by comparing it with the multipath routing approach and other baseline protocols through ns-2 simulation and evaluate its time complexity through measurement on the MicaZ node. Evaluation results demonstrate the effectiveness of the GOR approach for QoS provisioning in WSNs. EQGOR significantly improves both the end-to-end energy efficiency and latency, and it is characterized by the low time complexity.

Table 1: Summary of Literature Work

SR. NO.	TITLE	AUTHOR	YEAR	METHODOLOGY
1	Opportunistic Routing Algorithm for Relay Node Selection in Wireless Sensor Networks,	J. Luo, J. Hu, D. Wu and R. Li	2015	An Energy Saving via Opportunistic Routing (ENS_OR) algorithm is designed
2	An Energy-Balanced Routing Method Based on Forward-Aware Factor for Wireless Sensor Networks,	D. Zhang, G.Li,K. Zheng, X. Ming, and Z.-H. Pan	2014	An energy-balanced routing method based on forward-aware factor (FAF-EBRM)
3	Qos aware geographic opportunistic routing in wireless sensor networks,	L. Cheng, J. Niu, J. Cao, S. Das, and Y. Gu,	2014	An Efficient QoS-aware GOR (EQGOR) protocol for QoS provisioning in WSNs.
4	Hierarchical Semantic Processing Architecture for Smart Sensors in Surveillance Networks,"	D. Bruckner, C. Picus, R. Velik, W. Herzner and G. Zucker,	2012	A hierarchical processing architecture for observation and surveillance systems
5	optimal Hop Distance and Power Control for a Single Cell, Dense, Ad Hoc Wireless Network	V. Ramaiyan, A. Kumar and E. Altman,	2012	Operating the dense ad hoc wireless network (described above) as a single cell,
6	Energy-Efficient Opportunistic Routing in Wireless Sensor Networks,	X. Mao, S. Tang, X. Xu, X. Y. Li and H. Ma	2011	Focus on selecting and prioritizing forwarder list to minimize energy consumption by all nodes

D. Bruckner, C. Picus, R. Velik, W. Herzner and G. Zucker,[4] Data acquisition by multidomain data acquisition provides means for environment perception usable for detecting unusual and possibly dangerous situations. When being automated, this approach can simplify surveillance tasks required in, for example, airports or other security sensitive infrastructures. This research describes a novel architecture for surveillance networks based on combining multimodal sensor information. Compared to previous methodologies using only video information, the proposed approach also uses audio data thus increasing its ability to obtain valuable information about the sensed environment. A hierarchical processing architecture for observation and surveillance systems is proposed, which recognizes a set of predefined behaviors and learns about normal behaviors. Deviations from "normality" are reported in a way understandable even for staff without special training. The processing architecture, including the physical sensor nodes, is called smart embedded network of sensing entities (SENSE).

V. Ramaiyan, A. Kumar and E. Altman,[5] We consider a dense, ad hoc wireless network, confined to a small region. The wireless network is operated as a single cell, i.e., only one successful transmission is supported at a time. Data packets are sent between source-destination pairs by multihop relaying. We assume that nodes self-organize into a multihop network such that all hops are of length d meters, where d is a design parameter. There is a contention-based multiaccess scheme, and it is assumed that every node always has data to send, either originated from it or a transit packet (saturation assumption). In this scenario, we seek to maximize a measure of the transport capacity of the network (measured in bit-meters per second) over power controls (in a fading environment) and over the hop distance d, subject to an average power constraint. We first motivate that for a dense collection of nodes confined to a small region, single cell operation is efficient for single user decoding transceivers. Then, operating the dense ad hoc wireless network (described above) as a single cell, we study the hop length and power control that maximizes the transport capacity for a given network power constraint. More specifically, for a fading channel and for a fixed transmission time strategy (akin to the IEEE 802.11 TXOP), we find that there exists an intrinsic aggregate bit rate (Theta_{opt} bits per second, depending on the contention mechanism and the channel fading characteristics) carried by the network, when operating at the optimal hop length and power control. The optimal transport capacity is of the form d_{opt}(bar{P_t}) times Theta_{opt} with d_{opt} scaling as bar{P_t}^{{1over eta}}, where bar{P_t} is the available time average transmit power and eta is the path loss exponent. Under certain conditions on the fading distribution, we then provide a simple characterization of the optimal operating point. Simulation results are provided comparing the performance of the optimal strategy derived here w- th some simple strategies for operating the network.

X. Mao, S. Tang, X. Xu, X. Y. Li and H. Ma,[6] opportunistic routing, has been shown to improve the network throughput, by allowing nodes that overhear the transmission and closer to the destination to participate in forwarding packets, i.e., in forwarder list. The nodes in forwarder list are prioritized and the lower priority forwarder will discard the packet if the packet has been forwarded by a higher priority forwarder. One challenging problem is to select and prioritize forwarder list such that a certain network performance is optimized. In this research, we focus on selecting and prioritizing forwarder list to minimize energy consumption by all nodes. We study both cases where the transmission power of each node is fixed or dynamically adjustable. We present an energy-efficient opportunistic routing strategy, denoted as EEOR. Our extensive simulations in TOSSIM show that our protocol EEOR performs better than the well-known ExOR protocol (when adapted in sensor networks) in terms of the energy consumption, the packet loss ratio, and the average delivery delay.

IV. PROBLEM STATEMENT

Opportunistic routing (OR) takes advantages of the spatial diversity and broadcast nature of wireless networks to combat the time-varying links by involving multiple neighboring nodes (forwarding candidates) for each packet relay. This research studies the properties, energy efficiency, capacity, throughput, and protocol design and security issues about OR in multihop wireless networks. Concept of routing in wired networks by abstracting the wireless links as wired links, and finds the shortest, least cost, or highest throughput path(s) between a source and destination. Since most routing protocols rely on the consistent and stable behavior of individual links, the intermittent behavior of wireless links can result in poor performance such as low packet delivery ratio and high control overhead. When a packet is unicast to a specific next-hop node of the sender at the network layer, all the neighboring nodes in the effective communication range of the sender may be able to overhear the packet at the physical layer. It’s possible that some of the neighbors may have received the packet correctly while the designated next-hop node did not.

V. CONCLUSION

Energy savings optimization becomes one of the major concerns in the wireless sensor network (WSN) routing protocol design, due to the fact that most sensor nodes are equipped with the limited nonrechargeable battery power. Focus on minimizing energy consumption and maximizing network lifetime for data relay in queue network. Following the principle of opportunistic routing theory, multihop relay decision to optimize the network energy efficiency is made based on the differences among sensor nodes, in terms of both their distance to sink and the residual energy of each other. Protocol design of OR in a contention-based medium access environment is an important and challenging issue. in these research different protocols and methods has discussed to optimize power consumption and optimal performance.

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