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Routing Protocol in Wireless Sensor Networks – Survey

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***Abstract-* Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. The focus, however, has been given to the routing protocols which might differ depending on the application and network architecture. In this paper, we present a survey of the state-of-the-art routing techniques in WSNs. This paper begins with the challenges and requirements in the design of WMSN routing, followed by an exhaustive survey on routing from the perspective of application requirements and key techniques. We study the design tradeoffs between energy and communication overhead savings in every routing paradigm. We also highlight the merits and limitations of each routing technique. We will discuss the open research issues in routing metrics and several potential research areas regarding routing in emerging WMSN application scenarios.**

***Index Terms*— Routing protocols, Wireless sensor network, Technical challenges, Design principles**

I. INTRODUCTION

Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible. The sensing electronics measure ambient condition related to the environment surrounding the sensor and transforms them into an electric signal. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. A large number of these disposable sensors can be networked in many applications that require unattended operations. A Wireless Sensor Network (WSN) contains hundreds or thousands of these sensor nodes. These sensors have the ability to communicate either among each other or directly to an external base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy.

Figure 1 shows the schematic diagram of sensor node components. Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position finding system, and power units (some of these components are optional like the mobilizer). The same figure shows the communication architecture of a WSN. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s) [1]. A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data.

Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad-hoc networks. First of all, it is not possible to build a global addressing scheme for the deployment of sheer number of sensor nodes. Therefore, classical IP-based protocols cannot be applied to sensor networks. Second, in contrary to typical communication networks almost all applications of sensor networks require the flow of sensed data from multiple regions (sources) to a particular sink. Third, generated data traffic has significant redundancy in it since multiple sensors may generate same data within the vicinity of a phenomenon. Such redundancy needs to be exploited by the routing protocols to improve energy and bandwidth utilization. Fourth, sensor nodes are tightly constrained in terms of transmission power, on-board

energy, processing capacity and storage and thus require careful resource management.
In this paper,

II. TAXONOMY OF ROUTING PROTOCOLS IN WSNS

In WSNs, the network layer is used to implement the routing of incoming data. In multi-hop networks, the source node cannot reach the sink directly. So, intermediate nodes have to relay their packets. The implementation os routing tables gives the solution. WSN routing protocols can be classified into four ways, according to the way of establishing the routing paths, according to the network structure, according to the network operation and according to the initiator of communications. The taxonomy of routing protocols is shown in figure 2.

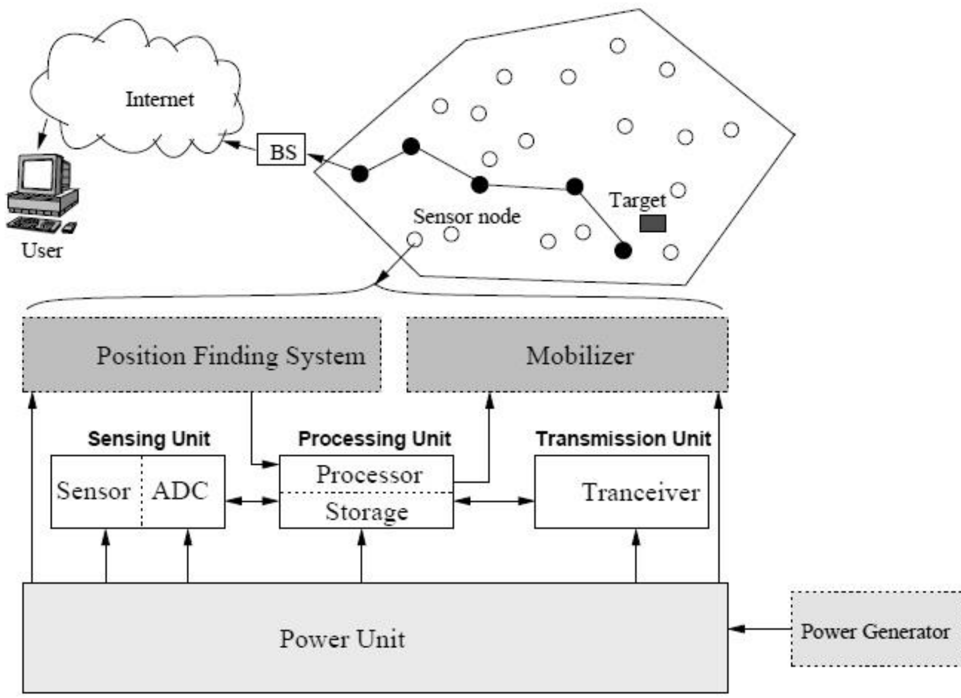

Figure 1. The components of a sensor node

III. TECHNOLOGICAL CHALLENGES

There are numerous challenges and difficulties in WMSN routing design and its performance optimization, including:
1. *Limited node energy*. Multimedia represents a resource-consuming application, but WMSNs are limited by their non-rechargeable or replaceable battery supply. Although energy harvesting allows sensors to power themselves, there are many difficulties and limitations in its practical application.
2. *Coexistence of multiple business requirements*. WMSNs handle heterogeneous data which can consist of scalar, audio, video, image and acoustic data, all of which have varied QoS requirements. Various services with a diverse set of requirements present a significant challenge to routing design.
3. *Bursty of multimedia traffic*. Compressed video often exhibits significant burstiness on a variety of time scales, due to the frame structure of the encoding scheme and natural variations within and between scenes [5]. This greatly increases the difficulty of analysis and evaluation for routing performance in WMSNs.
4. *Redundancy in multimedia traffic*. To obtain visual information of multiview, high signal-to-noise ratio (SNR), and fine grain, some redundant video sensor nodes are often placed in the monitoring areas. Although this approach helps to reduce coverage-blind areas, the redundant video information it has caused inevitably consumes network resources.

5. *Network dynamics*. A node might stop working because of energy depletion or malfunctions, or be temporarily added into a network due to application demand; thus, the number of nodes in the monitoring area is dynamic. The network topology structure could also change because of mutual interferences, terrain factors and so on; therefore, the expansibility and flexibility should be considered.
6. *Complexity of monitoring environment*. Events at the monitoring area often exhibit dynamic characteristics in spatiotemporal dimensions, increasing event capture difficulty and communication expenses [9]. The monitoring system must provide timeliness and coverage support. The former needs to control the delays in data processing and transmission, whereas the latter involves coordination and cooperation among nodes.

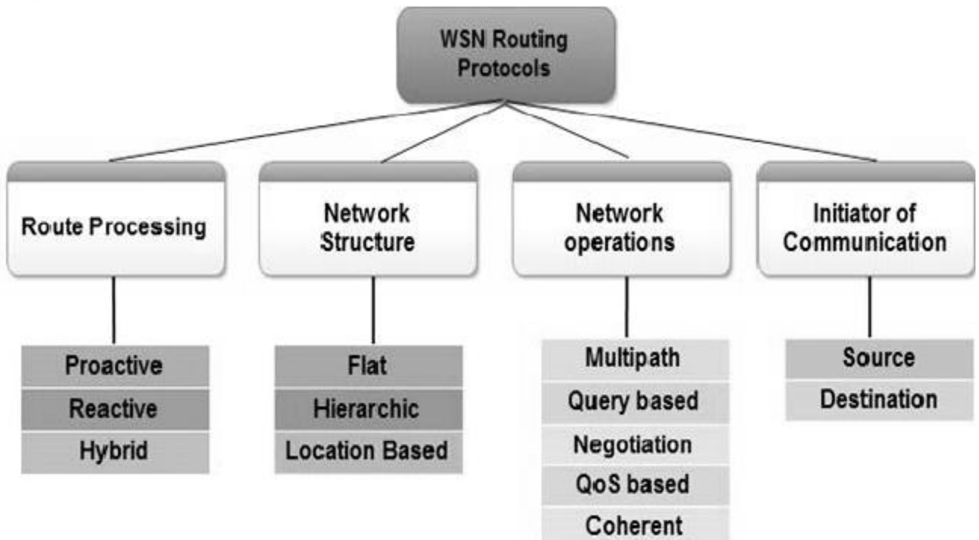

Figure 2. Taxonomy of routing protocols in WSNs

7. *Network heterogeneity*. Different types of nodes are required to communicate in order to facilitate data collection, processing, and transmission in an effective and efficient manner. Differences in functionality makes it impossible to have a uniform communication protocol platform, separating them from traditional wireless networks.
8. *Communication congestion issue*. The characteristic of many-to-one and mutual interference between wireless links as well as limited WMSN resources leave the network prone to congestion. If a node is overwhelmed by multiple high-rate streams, it will result in decreased network performance and increase the chances of node failure from energy depletion.
9. *Limited communication ability*. The radio frequency signal coverage of sensor nodes is typically below one hundred meters. If it is required to communicate with nodes outside of its coverage range, then a signal relay is needed. If the coverage range is extended by increasing transmission power, then it will consume more energy.
10. *Limited computation and storage ability*. Multimedia sensors are small, micro-embedded devices with a limited-capability processor and reduced storage capacity. However, in addition to data collection and transmission, nodes also are responsible for QoS provisioning as well as other tasks.

IV. DESIGN PRINCIPLES

WMSN routing can be considered as the inheritance and development of QoS routing in traditional WSNs. The design principles include the following items:
1. *Energy efficiency*. Energy-constrained WMSNs are expected to run autonomously for long periods, but it may be cost-prohibitive to replace exhausted batteries or even impossible in hostile environments [11]. This requires a routing protocol with energy efficiency.
2. *Provisioning of QoS guarantees*. WMSNs have increased information gathering capacity; it is able to

provide more services, including real-time video. Because of stringent multimedia QoS requirements, routing mechanism not only needs to take energy conservation, scalability and fault tolerance into consideration, but also should provide QoS guarantees.

3. *QoE awareness*. QoS is not accurate or satisfactory enough to guarantee wireless video quality in many cases, whereas QoE is more suitable scheme to overcome the main drawbacks of QoS based on the perspective of the user. This metric has played an important role in measuring the quality level of multimedia content.

4. *Provisioning of service differentiation*. Due to heterogeneous traffic flows and their differentiated requirements, supporting differentiated services becomes crucial for WMSNs. A routing protocol of differs is able to adapt to environments where multiple businesses coexist.

5. *In-network multimedia processing*. The nodes using in-network processing are able to compress and filter the redundancy to lower network load, saving bandwidth and energy. Thus, it has become necessary to set aside a certain operational space for in-network processing in routing design.

6. *Link quality awareness*. It is difficult to provide good routing performance consistently because the quality of an unstable link often changes dramatically [15]. Accurately capturing link quality can help choose those good links for routing, especially in reliability and latency.

7. *Bandwidth efficiency*. Multimedia transmission with large amounts of data requires high bandwidth, depending on frame rate, resolution, and compression format. This requires a routing protocol with capabilities of preventing disorderly competitions for bandwidth, and achieving load balancing.

8. *Congestion avoidance.* Because of bursty traffic, WMSNs are more prone to traffic congestion, and consequently, a large number of lost packets result in poor quality of reconstructed video [16]. So, it is necessary to consider congestion control and fairness in the design of routing protocol.

9. *Low cost and low complexity design*. Routing protocol design should follow flexible and simple principle to simplify as much as possible the expenses of computation and information exchange. In addition to adopting approximate or heuristic routing algorithms, it is worth investigating computation offloading in routing for energy-traffic tradeoff.

10. *Cross-layer cooperation.* Researchers have systematically studied QoS architecture of WMSN and the inherent relationship to various QoS parameters. The independent operations of various protocol layers are integrated into a unified design framework, facilitating cooperativity with each other to achieve optimal system performance.

V. OPEN ISSUES

- Self-configuration and reconfiguration is essential to lifetime of unattended systems in dynamic, and constrained energy environment. This is important for keeping the network up and running. As nodes die and leave the network, update and reconfiguration mechanisms should take place. A feature that is important in every routing protocol is to adapt to topology changes very quickly and to maintain the network functions
- The problem of intelligent utilization of the location information in order to aid energy efficient routing is the main research issue. Spatial queries and databases using distributed sensor nodes and interacting with the location-based routing protocol are open issues for further research.
- Although the performance of these protocols is promising in terms of energy efficiency, further research would be needed to address issues such as Quality of Service (QoS) posed by video and imaging sensors and real-time applications.
- Topology changes owed to territorial circumstances in realization of WSNs. So, it is important to focus on the strength of clustering method.
- Most of the applications in security and environmental monitoring require the data collected from the sensor nodes to be transmitted to a server so that further analysis can be done. On the other hand, the requests from the user should be made to the sink through Internet. Since the routing requirements of each environment are different, further research is necessary for handling these kinds of situations.

VI. CONCLUSION

Routing in sensor networks has attracted a lot of attention in the recent years and introduced unique challenges compared to traditional data routing in wired networks. The objective of this survey is to highlight important topics in WSNs, i.e., the challenges and current trends in routing. Moreover, we have pointed out the open research issues and potential research areas that need to be solved in future WSN systems. We hope that this survey will help to improve the understanding of the issues and challenges in WSNs and the examination of the routing issues.

REFERENCE

[1]. H. M. Ammari and S. K. Das, “Promoting Heterogeneity, Mobility, and Energy-aware Voronoi diagram in wireless sensor networks,” IEEE Trans. Parallel Distributing System”, vol. 19, no. 7, pp. 995–1008, 2008

[2]. Hang Shen, Guangwei Bai, “Routing in wireless multimedia sensor networks: A survey and challenges ahead”, Journal of Network and Computer Applications, 2016 [Accepted]

[3]. Hang Shen, Guangwei Bai, Ding Ma, Lu Zhao, and Zhenmin Tang, “C2em: cloud-assisted complex event monitoring in wireless multimedia sensor networks”, EURASIP Journal on Wireless Communications and Networking, 2015:1–13, 2015.

[4]. J. Deng, “INSENS: Intrusion-tolerant Routing for Wireless Sensor networks,” Computer Communication”., vol. 29, no. 2, pp. 216– 230, 2006

[5]. Jingjing Li, Jiannong Cao, and Xuefeng Liu, “Distributed coverage preserving routing algorithm for wireless sensor networks”, In Proceedings of IEEE International Conference on Communications (ICC), pages 1–5, 2011

[6]. Kemal Akkaya and Mohamed Younis, “A Survey on Routing Protocols for Wireless Sensor Networks”, 2004

[7]. Moad YMowafi, Fahed H Awad, andWalid A Aljoby, “A novel approach for extracting spatial correlation of visual information in heterogeneous wireless multimedia sensor networks”, Computer Networks, 71:31–47, 2014

[8]. N R Wankhade and D N Choudhari, “Novel energy efficient election based routing algorithm for wireless sensor network”, 7th International Conference on Communication, Computing and Virtualization 2016, Procedia Computer Science 79 (2016) 772 – 780

[9]. Pantazis, N.A.; Nikolidakis, S.A.; Vergados, D.D., "Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey," in Communications Surveys & Tutorials, IEEE , vol.15, no.2, pp.551-591, Second Quarter 2013

[10]. Payal Jadhav and Prof. Rachna Satao, “A Survey on Opportunistic Routing Protocols for Wireless Sensor Networks”, 7th International Conference on Communication, Computing and Virtualization 2016, Procedia Computer Science 79 (2016) 603 – 609

[11]. Santar pal singh, S.C. Sharma, “A survey on cluster based routing protocols in wireless sensor network”, International conference on advanced computing technologies and applications (ICACTA - 2015), Procedia of computer science 45, 687-695

[12]. Shahin Mahdizadeh Aghdam, Mohammad Khansari, Hamid R Rabiee, and Mostafa Salehi, “Wccp: A congestion control protocol for wireless multimedia communication in sensor networks”, Ad Hoc Networks, 13(1):516–534, 2014.

[13]. Shan Lin, Gang Zhou, Motaz Al-Hami, Kamin Whitehouse, Yafeng Wu, John A Stankovic, Tian He, Xiaobing Wu, and Hengchang Liu, “Toward stable network performance in wireless sensor networks: A multilevel perspective”, ACM Transactions on Sensor Networks (TOSN), 11(3):42, 2015.

[14]. Tifenn Rault, Abdelmadjid Bouabdallah, and Yacine Challal, “Energy efficiency in wireless sensor networks: A top-down survey”, Computer Networks, 67:104–122, 2014.

[15]. W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Microsensor Networks," Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS '00), January 2000.

[16]. Will E. Leland, Murad S. Taqqu, Walter Willinger, and Daniel V. Wilson, “On the self-similar nature of ethernet traffic”, IEEE/ACM Transactions on Networking, 2(1):1–15, 1994.