Hindawi Publishing Corporation
International Journal of Distributed Sensor Networks
Volume 2015, Article ID 960170, 2 pages
http://dx.doi.org/10.1155/2015/960170

Editorial

Verification and Validation of the Performance of WSN

Seong-eun Yoo,[1] Poh Kit Chong,[2] Seong Hoon Kim,[3] and Minh-Long Pham[4]

[1] *Daegu University, Gyeongsan 712-714, Republic of Korea*
[2] *Universiti Tunku Abdul Rahman, 53300 Kuala Lumpur, Malaysia*
[3] *Korea Advanced Institute of Science and Technology, Daejeon 305-701, Republic of Korea*
[4] *Microsoft, 7030 Trondheim, Norway*

Correspondence should be addressed to Seong-eun Yoo; seyoo@daegu.ac.kr

Received 21 December 2014; Accepted 21 December 2014

Relevant technologies and standards related to wireless sensor networks (WSNs) have matured over the past few years, and WSNs have already achieved some commercial success in applications like smart metering systems and in environmental monitoring. As such, the rate of adoption of wireless sensor networks in diverse applications including industrial information systems, both for replacing traditional wired sensor systems and for new automation systems, will be increasing rapidly in the coming years due to some clear advantages: lower cost, easier deployment, more flexibility, and especially more opportunities for intelligent distributed data processing and collaboration. However, to meet the high requirements for fault tolerance, reliability, real-time processing, robustness, and automation in harsh industrial environments, there are still many issues that need to be addressed. In addition, the verification and validation of the performance (VVP) of WSN is nontrivial, with diverse approaches ranging from mathematical analysis to statistical simulations to testbed analysis. Each of them has its unique advantages and disadvantages.

This special issue focuses on the latest research, application, and adoption of wireless sensor networks from the perspective of the physical layer up to the application layer.

The special issue has been organized to focus on the state-of-the-art research and developments in WSNs with a special emphasis given to the technical and observational results in VVP obtained within the last few years. Through the peer-review process supervised by the lead guest editor, any conflict of interests has been avoided by an appropriate selection of a guest editor and invited reviewers. Finally, seven papers have been accepted among 17 submissions for publication in this special issue.

Some of the papers provide insights on verification and validation in wireless sensor networks. One paper surveys a number of experimental research testbeds in WSNs, while another one presents a testbed to evaluate energy-aware routing protocols. The other paper describes modeling the performance of a special class of sensor networks, namely, linear wireless sensor network. The following paragraphs summarize these papers.

The paper titled "Experimental Research Testbeds for Large-Scale WSNs: A Survey from the Architectural Perspective" by H. Kim et al. provides a framework to describe and classify WSN testbeds based on three core requirements, which are scalability, flexibility, and efficiency, and establishes a taxonomy for the design approaches of the testbeds. Currently, there exists a wide range of WSN testbeds due to the diverse nature of WSN applications. This paper examines existing testbeds and tries to identify the important aspects that are common to all. It then classifies the testbeds based on their design approaches and evaluates how the design approaches affect the core requirements. This approach allows researchers to systematically and qualitatively evaluate WSN testbeds to be utilized and improved upon.

One paper is titled "A Wireless Sensor Network Testbed for the Evaluation of Energy-Aware Routing Schemes" by M. J. Grobler et al. The authors begin their discussion with well-known, but frequently ignored, differences between the simulation results and the experimental results in energy-aware routing protocol evaluation. Many studies on energy-aware routing protocols use a statistical simulation because of time and cost efficiency of the approach. However, since the approach cannot reflect all the factors that influence the performance of WSN, the accuracy of the approach is not always 100%. The authors outline energy-aware routing schemes and existing sensor nodes, and they design a sensor node capable of measuring its own energy consumption and an architecture for a testbed consisting of such sensor nodes. A testbed of 20 such sensor nodes is used to evaluate some energy-aware routing protocols. The results show that the chip-level drain efficiency of low-power RF transceivers negatively affects the expected energy savings of the energy-aware routing protocols. The results here will without doubt contribute to the design of more energy efficient routing protocols in the future.

The paper titled "Modeling the Performance of Faulty Linear Wireless Sensor Networks" by N. Mohamed et al. analyzes node faults in linear wireless sensor networks by identifying the different types of faults and developing an analytical model to study them. Linear sensor networks (LSN) are a class of sensor networks that are deployed in a straight line along pipes, railways, and so forth. A break in communications along the line may severely affect the performance of the whole network if they are deployed for maximizing coverage with no redundancy. The model developed in this paper provides researchers and users with a method to evaluate the placement of nodes in future deployments to minimize the risk of network failures of LSN due to the loss of a single node or multiple nodes and to estimate the interval for periodic maintenance of the system.

Another group of papers study MAC and routing protocol issues in underwater acoustic sensor networks (UASNs). Since the acoustic communication channel characteristics of UASNs are totally different from the conventional terrestrial radio channel, there are additional research issues in UASNs. These two papers tackle the unique challenges in MAC layer and routing protocols of UASNs and achieve verification and validation on the proposed schemes. The following are their short descriptions.

The paper titled "The Feasibility of Exploiting IEEE 802.11n for Addressing MAC Layer Overheads in UASNs" by A. Sayakkara et al. begins with the unique challenges of acoustic communication in UASNs. The authors highlight three main overheads introduced by the MAC layer of UASNs: (a) increased transmission delay, (b) high energy consumption, and (c) wastage of limited bandwidth. To alleviate the overheads, the paper evaluates the feasibility of exploiting two frame aggregation schemes, namely, A-MSDU and A-MPDU, which are well defined in the IEEE 802.11n amendment. The simulation shows that the frame aggregation schemes outperform CSMA/CA with RTS/CTS to a considerable level in the following aspects: throughput efficiency, average packet deliver ratio, and average end-to-end delay.

The paper titled "Delay-Sensitive Routing Schemes for Underwater Acoustic Sensor Networks" by N. Javaid et al. begins with the discussion of the problem caused by the slow propagation speed of the acoustic channel in underwater environment while there are many time-critical applications. They present extensions of well-known routing schemes, depth-based routing (DBR), energy efficient depth-based routing (EEDBR), and adaptive mobility of courier nodes in threshold-optimized depth-based routing (AMCTD), for UASNs focusing on the minimization of end-to-end delay for time-critical applications. To achieve the improvements, the authors propose improved delay-sensitive versions by applying delay-efficient priority factors and delay-sensitive holding time for the original routing schemes. With common scenarios, the simulations show that the extended routing protocols, which are named delay-sensitive DBR (DSDBR), delay-sensitive EEDBR (DSEEDBR), and delay-sensitive AMCTD (DSAMCTD), largely minimize end-to-end delay while reducing the transmission loss of the network.

The other papers deal with the research results of a MAC-level verification tool and routing protocols relevant to wireless sensor network standards, IEEE 802.15.4 and IEEE 802.15.4a. The short summary of these works follows.

The paper titled "Multi-Channel Packet-Analysis System Based on IEEE 802.15.4 Packet-Capturing Modules" by S. Yoo et al. proposes a multi-channel packet-analysis system (MPAS) architecture for research and development of multi-channel communication protocols. The system can be easily scaled to monitor multiple numbers of channels and provide accurate synchronization between packet sniffing modules. By implementing MPAS, the authors show the feasibility of a COTS packet-analysis system, while the analysis of the evaluation for the implementation raises some interesting issues such as clock drifts, delays in serial communications, and varying interrupt handling delays that need to be taken into account to improve the performance. MPAS will without doubt help researchers and developers in debugging and verification for multichannel protocols and applications.

The paper titled "Design and Performance Verification of Dynamic Load Aware Geographic Routing Protocol in IEEE 802.15.4a Networks" by Y.-D. Kim et al. analyzes problems (e.g., bottleneck, long transmission delay, and poor delivery ratio near the sink node) occurring in geographic routing schemes. To mitigate the problem, the paper proposes a dynamic load aware geographic routing protocol (DLAG) which monitors the channel load status and avoids the bottlenecked neighbor nodes. In addition to route selection procedure, DLAG controls the MAC layer backoff algorithm to support a prioritized channel access. The simulation study based on ns-2 simulator shows that DLAG outperforms the conventional geographical forwarding schemes especially in heavily loaded traffic condition.

Acknowledgments

We would like to thank all the authors for their submissions to this special issue. We are also grateful to the reviewers for contributing long hours in reviewing papers and submitting their assessments in a professional and timely manner. This work was supported by the Daegu University Research Grant (no. 20110358).

Seong-eun Yoo
Poh Kit Chong
Seong Hoon Kim
Minh-Long Pham