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Moving Towards Highly Reliable and Effective Sensor Networks

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Wireless Sensor Networks (WSNs) have been the preferred choice for the design and deployment of next generation monitoring and control systems [1]. In these networks, the sensor nodes forward their sensed data towards a centralized base station. The neighboring nodes frequently sense correlated data and forward towards the base station, using disjoints multiple paths [2]. As a result, the area around the base station becomes congested with all the traffic converging towards it. Apart from packet lost due to congestion, a significant number of packets are lost due to interference, packet collision, node failure and transmission errors [3]. For a successful monitoring of the deployed environment, the critical data collected by the sensor nodes need to be reliably and effectively delivered to the base station. Given the error-prone nature of the wireless links, ensuring reliable transmission of data from resource-constrained sensor nodes towards the base station continues to be one of the major challenges in the field of WSNs [4]. Retransmission and redundancy are classified as the two main approaches to achieve data transmission reliability in WSNs. However, retransmission and redundancy techniques perform better when using hop-by-hop transmission approach as compared to end-to-end transmission. Using hop-by-hop approach introduces in-node processing overhead and incurs high overall latency in reporting data to the base station. As a result, hybrid approaches need to be adopted to

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ensure highly reliable and effective data transmission towards the base stations in WSNs.

The specific objective of this special issue is to collect high quality research articles with solid background in both theoretical and practical aspects of reliability and effectiveness for WSNs. This special issue focuses on various topics pertaining to reliable and effective communication such as, fault-tolerance, energy-efficiency, topology control, load-balancing, propagation path-loss, co-channel interference, delay and throughput. In total, we received 47 papers and after rigorous review process, only 7 papers have finally been selected for this special issue. Below are the main ideas of each accepted paper.

The first paper is "A Novel Fault Tolerant and Energy-Efficient Load Balancing Technique in Wireless Sensor Networks with Stochastic Routing" by Zaiwar et al. In this paper, the authors have presented a decentralized energy efficient stochastic routing technique for Wireless Sensor Networks (WSNs) to improve the packet delivery ratio and load balancing effect. The proposed work significantly reduces the expected delivery delay to the destination nodes in WSNs. To improve expected delivery ratio, packets are transmitted out of the neighboring area of a sender node, as soon as possible. The proposed work selects a neighbor for routing, that is more reliable and nearer to a destination node. The authors have used the Markov chain to model and evaluate the expected delivery delay and delivery ratio to a destination node. Simulation results show that the proposed work performs better in terms of energy consumption, packets delivery, and delivery delay, in comparison to the existing decentralized methods.

The second accepted paper is "Topology Control Algorithm and Channel Allocation Algorithm Based on Load Balancing in Wireless Sensor Network" by XiaoChen et al. In this paper, the authors studied the influence of node distance and the neighbor-residual energy on a node load. A joint game algorithm of power control and channel allocation based on load balancing (JACLB) is constructed according to the game model. JACLB uses the best respond strategy to get the optimal power and channel for each node, which effectively balances the node load. Theoretical analysis and simulation results show that JACLB outperforms the existing studies for load balancing in terms of various performance metrics.

The third accepted paper is "Delay and Throughput analysis using node density as pivot value in Underwater Acoustic Sensor Networks (UWASNs)" by Adil et al. The authors analyzed the effects of node density on the performance of routing protocols in UASNs. For this purpose, two UASNs protocols, i.e. improved Adaptive Mobility of Courier Nodes in Threshold-optimized DBR (iAMCTD) and Sparsity-aware Energy Efficient Clustering (SEEC), are selected. Different density levels of nodes are considered for its effect on the delay and throughput of the aforementioned protocols. The performance analysis shows that cluster-based protocols perform well in sparse conditions

as compared to non-cluster based protocols, while non-cluster based protocols works efficiently when density of the nodes increases. Based on this study, it was concluded that customized and efficient MAC based protocols in dense network deployment, can highly increase the performance and reliability of cluster-based protocols for underwater sensor networks.

The fourth accepted paper is "A Cascading Failure Model of Directed Scale-Free Topology with Hierarchical Structure" by Qian-Yue et al. To study cascading failure of a directed hierarchical network, the difference between a directed network cascading failure process and an undirected network cascading failure process is analyzed by the authors. Based on this analysis, a directed scale-free cascading failure model is proposed. The initial node's load in the directed hierarchical network is defined and the proportional relation between the node capacity and initial load is established. The authors have taken hierarchical heterogeneity into account for load redistribution after node failure so that the additional load is allocated to the same or higher layer nodes. The authors deduce the relationship between network parameters and network robustness from the analyses of network cascading failure. The effectiveness of the proposed model is experimented with numerical and simulation analysis.

The fifth accepted paper is "Understanding Propagation Path Delay Using 3D Scattered Model in LoRaWAN" by Zulfiqar et al. Low Power Wide Area Network (LPWAN) aims to realize low-power connectivity solutions for the Internet of Things (IoTs). The propagation characteristics of the underlying channel and the large-scale path loss caused by free space path loss and shadowing, adversely affect the quality of received signal strength. Moreover, path loss due to multi-path propagation may also cause rapid fluctuations to the quality of received signal strength. A change in angle of interest is related with a significant effect on propagation path delay (PPD) in a wireless environment. The authors presented different propagation considerations for the design of LoRa physical layer. This paper largely contributes by investigating the propagation path delay experienced by LoRaWAN under 3D semi-ellipsoid model. Rigorous analysis and experimental evaluation results present promising research directions for the LoRaWAN network.

The sixth accepted paper is "A Dynamic Replication Aware Load Balanced Scheduling for Data Grids in Distributed Environments of Internet of Things" by Said et al. The authors proposed a novel dynamic Replication Aware Load Balanced Scheduling (DRALBS) algorithm that considers the replica location dynamically at the time of scheduling of a job in an IoT-based environment. Each job is allocated to a node where replica of the data for the job is already present. The proposed technique is efficient for improving response time and reducing the data migration rate. The simulation results outperform the existing schemes in term of response time and data migrations.

Finally, the last accepted paper is "Wet Environmental Conditions Affecting Narrow Band On-Body Communication Channel for WBANs" by Irfan et al. Wireless Body Area Networks (WBANs) is the key building blocks of next generation networks in modern health care systems. In these networks, less attention has been paid to the on-body channel propagation analysis. This paper presents the propagation effects of wet clothing on the on-body channel at 0.9GHz, 1.8GHz and 2.5GHz and is germane to signal budgets in body-centric and mobile communication systems. A number of transmission measurements between simple monopoles above a square ground plane, placed on the opposing shoulder and hip, wearing single and multi-layered "rainwater wet" and dry cotton T-Shirts for standing, bending, torso left and right are used to gain insight into general levels of the effect of rainwater on propagation. Measured results are statistically processed to extract the level of transmission enhancement due to a wet on-body channel. Results show that wet clothing is generally beneficial to the channel at popular mobile communications frequencies.

In conclusion, this special issue would not have been possible without the help of many people. As Guest Editors, we would like to express our deep gratitude to all the authors who have submitted their valuable contributions. We are extremely thankful to all anonymous reviewers who gave their precious time in reviewing the papers. We also would like to thank the Editors-in-Chief of Ad Hoc & Sensor Wireless Networks for their valuable feedback, suggestion and for helping us in improving the quality of selected papers, further. Without their support, we would not have been able to achieve the desire outcomes.

REFERENCES

[1] Yick, J., Mukherjee, B., & Ghosal, D. (2008). Wireless sensor network survey. Computer networks, 52(12), 2292-2330.

[2] Yuan, Fei, Yiju Zhan, and Yonghua Wang. "Data density correlation degree clustering method for data aggregation in WSN." IEEE Sensors Journal 14.4 (2014): 1089-1098.

[3] Jan, Mian Ahmad, et al. "PASCCC: Priority-based application-specific congestion control clustering protocol." Computer Networks 74 (2014): 92-102.

[4] Mahmood, Muhammad Adeel, Winston KG Seah, and Ian Welch. "Reliability in wireless sensor networks: A survey and challenges ahead." Computer Networks 79 (2015): 166-187.

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