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Editorial: Recent Advances in Heterogeneous Networking for Quality, Reliability, Security and Robustness

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Editorial

Computer networking has been embracing heterogeneity since its inception, in terms of the range of the applications that it has to support, various communication technologies that it can run on, and hierarchical, hybrid and heterogeneous techniques that it has to rely on to meet the challenges from both the diverse application requirements and communication technologies. This special issue features twelve selected papers on recent advances related to heterogeneous networking, particularly for quality, experience, reliability, security and robustness to heterogeneous networking and infrastructure for future networks.

The article “Lightweight Cybersecurity Schemes using Elliptic Curve Cryptography in Publish-Subscribe Fog Computing" authored by Abebe Abeshu, Naveen Chilamkurti, and Neeraj Kumar, proposes a secure, lightweight, publish-subscribe protocol based on Elliptic Curve Cryptography (ECC) for the Internet of Things. They study two approaches using ECC for security key exchange and encryption mechanisms for IoT/Fog computing architecture. These lightweight schemes provide better scalability and less overheads as compared to RSA based schemes employed in SSL/TSL, while guaranteeing a similar level of security.

Another article "Markov-based Emergency Message Reduction Scheme for Roadside Assistance", authored by Hsin-Hung Cho, Fan-Hsun Tseng, Timothy K. Shih, Cong Zhang, and Han-Chieh Chao, proposes a Markov chain based prediction model to forecast vehicles behavior to identify which vehicles require the emergency message. Their proposed algorithm accurately sends emergency messages to relavant vehicles and reduces the unnecessary overhead.

The problem of resource allocation is targeted by the article "On Demand Resource Allocation for LTE Uplink Transmission Based on Logical Channel Groups" authored by Fang-Chang Kuo, Kuo-Chang Ting, Hwang-Cheng Wang, and Chih-Cheng Tseng. They propose a scheduling scheme for LTE which can ensure the QoS of Guaranteed Bit Rate (GBR) bearers and at the same time efficiently allocate RBs to non-GBR bearers so as to improve overall resource utilization.

The next article "Energy Efficient QoS-Aware Random Network Coding on Smartphones", authored by Heehoon Shin and Joon-Sang Park, proposes a duty cycling approach to minimise the energy consumption of Random Network Coding for smartphone environments, considering the given QoS requirements. They study their scheme using Android smartphones and find that by manipulating the processor clock frequency their approach can enhance energy efficiency.

Software-defined networking (SDN) is perceived as a new networking paradigm, which enables flexible network management. The fifth article, “IRIS-HiSA: Highly Scalable and Available Carrier-Grade SDN Controller Cluster” presents a novel SDN controller for highly scalable carrier-grad SDN. In particular, IRIS-HiSA provides transparency to switches and thus the switches can access the SDN controller cluster in as in a single controller case. In addition, IRIS-HiSA

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provides seamless load balancing and failover mechanisms. This article presents IRIS-HiSA implementation results and detailed evaluation results.

The article "A SDN-based Framework for Fine-grained Inter-domain Routing Diversity" addresses path diversity issues among autonomous systems (ASes) by means of SDN. In this article, the authors leveraged the programmability of SDN and proposed a new routing control plane, which allows flexible inter-domain forwarding control and network function chaining along inter-domain paths. Experimental results over the AS topology from CAIDA show that the proposed control plane can exploit potential path diversity than existing schemes.

The article "Multi-Phased Carrier Sense Multiple Access with Collision Resolution and its Extension to Dynamic Multi-Phases" investigates to improve the efficiency of carrier sense multiple access (CSMA)-based medium access control (MAC), which is widely used in wireless local area networks. The authors extended an interesting idea of CSMA with collision resolution (CSMA/CR) to support multi-phased collision resolution. In the proposed protocol, colliding stations are filtered in each CD phase and thus higher collision resolution probability can be achieved. The performance of the proposed protocol is evaluated by theoretical analysis as well as simulation study.

Energy-harvesting is an emerging technology where sensors absorb natural power (e.g., solar and wind power) and thus it can prolong lifetime of wireless sensor networks. The article, "Lifetime Enhancement of Dynamic Heterogeneous Wireless Sensor Networks with Energy-Harvesting Sensors" investigates the problem of extending the lifetime of dynamic heterogeneous wireless sensor networks with energy harvesting sensors. Specifically, a mathematical problem is formulated and a novel heuristic is proposed. Simulation results demonstrate that the proposed scheme performs better than the conventional algorithm in terms of average network lifetime for larger-scale environments.

The problem of extending the lifetime of wireless sensor networks is considered from a different perspective in the article "An Improved Hyper-Heuristic Clustering Algorithm for Wireless Sensor Networks" authored by Chun-Wei Tsai, Wei-Lun Chang, Kai-Cheng Hu, and Ming-Chao Chiang. The authors revisit the problem of cluster head election in sensor networks, considering also the physical topology of the sensor network. They propose a combination of meta-heuristic algorithms for obtaining an approximate solution to the cluster head election problem, and use simulations to show that the proposed heuristic can extend the network lifetime significantly, at the cost of increased computational overhead.

The next paper, "Optimizing Detection Quality and Transmission Quality of Barrier Coverage in Heterogeneous Wireless Sensor Networks", written by Yung-Liang Lai, and Jehn-Ruey Jiang, focuses on wireless sensor networks for intruder detection. The authors consider the barrier coverage problem, and address the trade-off between the detection quality and the transmission time in a network of detecting and forwarding sensors. Leveraging the analogy between coverage graphs and flow networks, they propose a solution based on an algorithm for the minimum cost maximum flow problem. Simulation results show that the proposed algorithm achieves higher detection quality and lower transmission time than existing algorithms.

Another emerging application area of wireless sensor networks is that of smart metering. The paper "Intermittent Interval Feedback Design for Multi-Stage Wireless Sensor Networks", written by Tomokazu Moriyama, Taiki Nakayama, and Takeo Fujii, considers the frame collision problem in the MAC protocol used in the Wi-SUN protocol stack adopted for gas metering. The authors propose a link topology estimation algorithm to be used for adapting the transmission cycle of sensor nodes in response to changes in the radio environment, based on an analytical model of the collision probability. Simulation results show that the proposed adaptive solution allows performance close to optimal.

Last but not least, the paper "ADC: An Adaptive Data Collection Protocol with Free Addressing and Dynamic Duty-cycling for Sensor Networks", written by Fei Tong and Jianping Pan, considers the problem of energy efficient data collection in sensor networks. They propose a solution based on adaptive duty cycling in a tree topology, in which addressing is established at the time the tree topology is created. Experimental results from a small-scale sensor testbed show that the proposed solution outperforms existing solutions both in terms of packet delivery ratio, latency and in terms of duty cycling.

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