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EDITORIAL

Introduction to the Special Issue on Computer Modeling for Future Communications and Networks

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The next generation of global communication networks is expected to deliver a transformative leap in connectivity, transcending beyond terrestrial limitations to achieve truly ubiquitous coverage. Rather than operating as fragmented regional systems, future infrastructures will leverage Satellite-Terrestrial Integrated Networks (STIN) and 6G technologies to form a unified global network [1]. This paradigm shift ensures continuous coverage across remote and aerial domains, providing exceptionally high reliability and robust protection against increasingly sophisticated cyberattacks by integrating Artificial Intelligence (AI) into secure network architectures [2]. Furthermore, the role of generative AI and edge intelligence is becoming critical for the autonomous management and orchestration of these complex, multi-layered networks [3]. Emerging technologies, including Software-Defined Networking (SDN) [4], Internet of Things (IoT) [5,6], and Machine Learning [7], form the bedrock of the ten articles accepted for this special issue, which bridge the gap between theoretical modeling and the deployment of next-generation infrastructures.

This paradigm shift is reflected in the diverse contributions of this special issue (eight research articles and two comprehensive reviews), which address fundamental challenges across the network stack. For instance, the need for efficient, context-aware routing in dynamic environments is explored through hybrid potential-based schemes [8] and optimized algorithms for mobile *ad-hoc* networks [9]. In the physical and link layers, novel strategies for joint angle estimation [10] and error mitigation in cooperative communications [11] enhance raw connectivity, while adaptive scheduling [12] and resource allocation reviews [13] ensure quality of service in 5G-Advanced and beyond. Furthermore, the issue addresses the critical intersection of reliability and security, presenting optimization for vehicular networks [14], SDN-based dynamic anonymization [15], and few-shot learning for detecting unseen IoT attacks [16], alongside a comprehensive review of signaling storms in mobile broadband [17].

In [8], the authors conducted an in-depth study on potential-based routing and its scheduling integration in the context of industrial wireless mesh networks. Inspired by the movement of charges in an electrostatic potential field, a hybrid-type routing strategy was proposed to leverage the advantages of both back-pressure routing and geographic routing. The routing scheme is specifically designed for one-to-many communication patterns. In addition, a novel scheduling strategy was proposed that is compatible with the routing algorithm, where a higher medium access priority is granted to links that have a larger potential difference.

In [9], the authors also proposed a routing algorithm for mobile *ad-hoc* networks. The algorithm is adapted from Dijkstra's algorithm for dynamically changing network topologies. The authors conducted extensive analysis on the proposed algorithm and demonstrated that the proposed routing algorithm outperformed the Bellman-Ford algorithm in terms of lower computational cost.

In [11], the authors proposed a novel strategy to mitigate error propagation in coded cooperative communication. The strategy is called hybrid decode-and-forward and soft information relaying. This scheme consists of two modes, where the relay operates in Decode-and-Forward (DF) mode when it successfully decodes the received message, and it switches to Soft Information Relaying (SIR) mode otherwise. The authors demonstrated that by combining DF and SIR forwarding, a better performance can be achieved than deploying the DF or SIR strategy alone.

In [14], the authors proposed to enhance the reliability and efficiency of intelligent transportation systems via optimal clustering of vehicular *ad-hoc* networks. The grasshopper optimization algorithm was used to carry out iterative and interactive optimization to dynamically adjust node positions and cluster configurations, ensuring robust adaptability to varying vehicular densities and transmission ranges.

In [15], the authors proposed a dynamic device identity anonymization framework using the moving target defense principles and implemented the proposed framework via software-defined networking (SDN). The SDN controller would periodically reconfigure the network addresses and routes of IoT devices using a constraint-aware backtracking algorithm. The proposed address-hopping scheme introduces continuous unpredictability at the network layer by dynamically changing device identifiers, routing paths, and network topology. The scheme was aimed at mitigating attacker reconnaissance while preserving normal communication.

In [10], the authors addressed a fundamental issue in the physical layer of wireless communication. More specifically, the authors proposed a novel and efficient framework for joint elevation and azimuth angle estimation using three spatially separated, parallel uniform linear arrays. The estimation is formulated as an optimization problem with a customized objective function based on the mean square error between measured and reconstructed array outputs, which is formulated to guide the estimation process. Three optimization schemes were experimented with, including the global Genetic Algorithm (GA), the local Pattern Search (PS), and a hybrid GA-PS method that combines global exploration with local refinement. In particular, the proposed framework supports automatic pairing of elevation and azimuth angles, which eliminates the need for manual post-processing.

In [12], the authors proposed a new cost-based flow scheduling framework to ensure optimal Quality of Service (QoS). The scheduling scheme dynamically prioritizes flows after taking into account key factors. The scheduling aims to reduce latency, optimize the utilization of radio resource blocks, and maximize the net benefits of the 5G network. The effectiveness of the proposed framework was validated via simulation in terms of network latency, resource utilization, and overall profitability.

In [16], the authors reported their findings of unseen attacks on IoT networks using few-shot learning. Three few-shot learning models were applied in the study, including prototypical networks, relation networks, and MetaOptNet. In addition, two decision-level ensemble methods (majority voting and probability averaging) were also experimented. Validated against the UQ-IoT-IDS-2021 dataset, the study found that MetaOptNet consistently achieves the best detection performance, with probability averaging generally outperforming majority voting.

In [17], the authors conducted a comprehensive review of signaling storms in the third-generation partnership project (3GPP) mobile broadband networks. Signaling storms refer to a phenomenon in which the network is overwhelmed by control signaling, potentially halting network operations due to resource exhaustion. The authors constructed analytical models to determine causes and compared existing countermeasures across architectural and signaling perspectives.

In [13], the authors presented a comparative review of resource allocation strategies in multi-tier ultra-dense heterogeneous networks. In addition to a literature survey, they numerically analyzed and evaluated selected algorithms through simulations. The study concludes that resource allocation strategies must be tailored to specific usage scenarios and network requirements.

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