# Introduction to the Cellular and Wireless Networks Minitrack

Edoardo Biagioni
University of Hawaii at Manoa
esb@hawaii.edu

John McEachen
Naval Postgraduate School
mceachen@nps.edu

Murali Tummala
Naval Postgraduate School
mtummala@nps.edu

## 1. Cellular and Wireless Networks

Welcome to HICSS, or welcome back!! Although we will not be meeting in person this year, this minitrack is proud to present three exciting papers in cellular and wireless networks.

This minitrack first appeared in 2005 with a focus on wireless sensor networks. It has evolved over the years, and while papers on new developments in wireless sensor networks are still very welcome in this minitrack, the majority of the papers we have considered in recent years have shifted towards other forms of wireless networks, particularly including cellular communications and most recently 5G.

In all wireless communications, the wireless medium combines tremendous opportunities for flexible communication with notable challenges. From the physical layer, where challenges range from interference to fading to optimization of encodings, through every other networking layer all the way to the human aspects of wireless communications, every year brings improvements and with each improvement, new challenges. Many of us are now for the first time using 5G cellular technology. While some researchers are forging ahead with their vision for 6G, two of the papers in this minitrack focus on improving the technology and our understanding of 5G.

The first paper in this minitrack, by Pimentel, Bordetsky, and Gera, has been nominated for best-paper award. This paper analyzes the performance of a proposed non-orthogonal multiple access extension to existing 5G protocols. In contrast to most wireless communication standards, when using non-orthogonal multiple access (NOMA), multiple senders may send using the same resource at the same time. It is up to the receiver(s) to differentiate simultaneously received signals from multiple senders, either by repeatedly subtracting from the overall signal any detected message from one of the senders, or by looking for different properties of the signal coding used by different senders.

Given such Multi-User Detection schemes, this paper uses a graph-theoretical approach to characterize the probability of being able to support all-to-all communication (affine graph) within a minimum number of communication frames. This analysis assumes random networks in which a wireless access point has a number of resource blocks, each of which can be shared among a small, fixed number of network devices. While the presentation is presented in terms of 5G non-orthogonal multiple access, the mathematical treatment can be applied beyond 5G.

The next paper, by Kundel, Meuser, Koppe, Hark, and Steinmetz, is also focused on 5G network technology. Achieving low end-to-end latency in such networks requires hardware acceleration of data forwarding. Data forwarding is the user plane of networking equipment – in contrast the control plane is responsible for setting up the forwarding tables, and is much less sensitive to latency. The combination of Software Defined Networking (SDN) with programmable hardware accelerators is designed to provide the optimal combination of flexibility and low latency communications. This paper considers the deployment of hardware accelerators at different points in the 5G Radio Access Network (RAN) and core network.

One of the strengths of this paper for other researchers is its description of the authors building "a 5G standalone campus network for evaluation, working end-to-end with real user equipment and open-source software components". This network relies on the free5gc open-source project to provide most of the needed functionality.

The final paper of this minitrack is by Lyth, Juric, and Larsson, and describes a specific algorithm for Group Key Management (GKM). Although the paper focuses on GKM in Wireless Sensor Networks, the algorithm should be applicable in other wireless networks.

URI: https://hdl.handle.net/10125/80233
978-0-9981331-5-7

In this paper a group key is a secret key shared among a small group of nodes. From time to time, the group of nodes must create a new key and distribute it to all the members of the group. As addressed in this paper, GKM determines which node in a group initiates the re-keying of a group key, and when, and the specific algorithm for doing so. Fundamentally, after each re-key operation each node randomly picks a time between constants $t_{min}$ and $t_{max}$. Each node then waits its randomly selected time. The first node in a group to reach its independently chosen wait time initiates the re-keying process. This is a very robust strategy, accomodating variability in node participation and making it hard for an attacker to know which node will initiate the next re-keying.

We hope you enjoy these papers as much as we did! As always, we are grateful to all the authors who have submitted papers to this minitrack, and to the many anonymous reviewers who generously volunteered their time and expertise.

We hope to see you in person at HICSS 2023!