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Ph.D. DISSERTATION DEFENSE

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Date:	Monday, June 2nd, 2025
Time/Location:	10:00 a.m. / Buchard 219
Title:	Harnessing Physical-Layer Signals for Distributed Security and Confidential Computation in NextG Wireless Systems
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ABSTRACT

The wireless landscape is undergoing a transformative shift as networks evolve toward more open, intelligent, and software-defined architectures. This dissertation investigates how physical-layer signals can be harnessed to enable distributed security and confidential computation in emerging wireless ecosystems, particularly within the context of NextG and Open Radio Access Networks (O-RAN).

We propose novel techniques that exploit the intrinsic properties of wireless signals to construct robust physical-layer security protocols. These mechanisms enable the secure distribution of computational tasks across heterogeneous and resource-constrained network nodes while preserving data privacy and integrity. By eliminating the reliance on traditional cryptographic infrastructure, our solutions offer lightweight, scalable alternatives suitable for latency-sensitive and energy-efficient NextG applications.

Our framework further integrates these physical-layer security primitives with AI-driven functionalities and Integrated Sensing and Communication (ISAC) technologies within the O-RAN paradigm. This strategic convergence enhances computational efficiency, improves environmental awareness, and reinforces end-to-end trust guarantees across the wireless infrastructure.

Through rigorous theoretical analysis, simulation, and prototype-based experimental validation, this work establishes a scalable, resilient, and secure foundation for trusted distributed computation in NextG wireless systems. Our contributions address critical challenges at the intersection of security, privacy, and performance, offering practical insights for the design of future intelligent and decentralized wireless infrastructures.