

# RESEARCH SEMINAR

## Toward the Next Generation of GPS: Navigation Security, New Codes, and Lunar Exploration

THURSDAY APRIL 25TH 9:00AM-10:15AM  
ARMS 2008 OR WEBEX

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#### ABSTRACT

Today, billions of users rely on satellite navigation systems, including the Global Positioning System (GPS), on a daily basis. Woven into the fabric of modern civilization, GPS underlies nearly every aspect of society's functions, including transportation, agriculture, energy, and communications. Yet, despite its importance, the current civilian GPS service is (1) unencrypted, meaning that an attacker can spoof a user's position or timing solution, and (2) uses navigation codes which were designed before the recent boom in computing.

Furthermore, we are entering a second Space Race, with dozens of lunar exploration missions over the coming decade. To facilitate these missions, government space agencies are planning the design of a GPS-like satellite system for the Moon.

In this talk, we explore strategies to advance the next generation of GPS and satellite navigation. In the first part of the talk, we discuss strategies to perform GPS spoofing detection and attack-resilient navigation using a new GPS security feature and available, self-contained sensors onboard a vehicle (e.g., IMU, wheel encoders). In the second part, we present a new framework to design the GPS codes, leveraging stochastic optimization algorithms and present-day computational tools. We demonstrate the new codes have lower self- and inter-signal interference than codes used by GPS today. Finally, we conclude with next steps in the future of satellite navigation, including key research challenges in the design of a lunar GPS-like satellite system and associated user algorithms for localization on the Moon.

#### BIOGRAPHY

Tara Mina is a postdoctoral scholar in the Aeronautics and Astronautics Department at Stanford University. She received her Ph.D. in 2023 from the Electrical Engineering Department at Stanford University. Her research focuses on enabling secure and reliable navigation through next-generation satellite systems, including GPS, which will undergo significant modernization efforts in the coming decade. In particular, her research interests include attack-resilient localization and timing, GPS spreading code design, and lunar navigation via a GPS-like satellite system. She is the recipient of multiple research awards, including the National Science Foundation (NSF) Graduate Research Fellowship, the National Defense Science and Engineering Graduate (NDSEG) Fellowship, and the Amelia Earhart Fellowship, awarded to top female doctoral students in aerospace engineering and space sciences. Her research work has also won four Best Presentation of the Session awards at the Institute of Navigation GNSS+ conference, the leading conference in the field of satellite navigation. Outside of her research work, Tara has won two graduate student teaching awards and the Stanford Community Impact Award for her leadership and volunteer work as the co-president of Engineering Students for Diversity, Equity, and Inclusion (DEI).