**Quarterly Progress Report:**
**Project Number and Title:** *4.3. Towards Quantitative Cybersecurity Risk Assessment in Transportation Infrastructure*
**Research Area:** *Thrust 4 Connectivity for enhanced asset and performance management*
**PI:** *Dr. Song Han, Assistant Professor and Castleman Term Professor in Engineering Innovation, Department of Computer Science and Engineering, University of Connecticut*
**Reporting Period:** *October 1, 2019 – December 31, 2019*
**Submission Date:** *December 31, 2019*

## Overview:

During the reporting period, the research team at UConn has continued to study cybersecurity risk assessment in low-power real-time wireless network infrastructure mainly for long-term structural monitoring.  The research team has completed the intrusion detection system (IDS) design and simulation-based performance evaluation on Rank-related attacks for 6TiSCH wireless networks. This work was submitted to ACM/IEEE IPSN 2019 and is now under review. In addition to the Rank-related attacks, the research team is also looking into other cybersecurity attacks, e.g., timing and synchronization attacks, which may break the time synchronization of the network and completely tear down the network topology. The research team is using the simulation tool, Cooja, to simulate the consequence of such attacks and assess their impact. Based on these findings, appropriate countermeasures will be designed to identify and mitigate such attacks.

In addition to simulation studies, the research team is developing a 6TiSCH network testbed to validate the designs and evaluate the performance of the proposed solutions in real systems. Figure 1 gives an overview of the current testbed prototype which consists of 100 nodes forming into a mesh network topology. Comprehensive web services are also being developed to support various network management functions to ensure real-time and reliable data services. Once the testbed is mature, the proposed IDS will be implemented on the testbed for design validation and performance evaluation.

During the reporting period, the research team led by PI Han won the UConn internal competition for the NSF MRI program. As reported in the last semi-annual report, the proposal is entitled: "The Acquisition of Autonomous Vehicles (AVs) to Advance AV Research under Challenging Topography and Weather Conditions" and aims to procure two AVs and requisite software and support to operate these vehicles.  PI Han is leading a research team at UConn (including 24 faculty from 7 departments across 3 schools at UCONN) to prepare the full proposal which will be submitted to the NSF MRI program on Jan. 21$^{st}$, 2020. The research activities that will be supported by these vehicles include but are not limited to V2X communication, resilient control, cybersecurity, machine learning and decision making.

| Table 1: Task Progress | | | |
|---|---|---|---|
| **Task Number** | **Start Date** | **End Date** | **Percent Complete** |
| Task 1: Context establishment | Oct. 1$^{st}$, 2018 | Sept. 30$^{th}$, 2019 | 80% |
| Task 2: Threat identification | Oct. 1$^{st}$, 2019 | Sept. 30$^{th}$, 2020 | 40% |
| Task 3: Consequence identification and impact assessment | Oct. 1$^{st}$, 2020 | Sept. 30$^{th}$, 2021 | 20% (some parts of Task 2 are concurrent with Task 3) |

| Table 2: Budget Progress | | |
|---|---|---|
| **Entire Project Budget** | **Spend Amount** | **Spend Percentage to Date** |
| $241,250 | $81,975.13 | 34% (12/31/2019) |

**Training/professional development:** During the reporting period, two PhD students have participated in this research project. One PhD student, Ms. Areej Althubaity, keeps focusing on the intrusion detection system (IDS) design for 6TiSCH wireless networks to identify Rank-related and timing-related attacks. She has completed new IDS methodology design for Rank-related attacks for 6TiSCH wireless networks and submitted the work to IEEE IPSN 2019, which is under review. Areej is ready for her research proposal exam, which is scheduled in January 2020.  The other student, Mr. Jiachen Wang, is a first-year PhD student.  He is now working on the cybersecurity risk assessment in V2X infrastructure and the development of the 6TiSCH wireless network testbed to help evaluate the performance of the proposed IDS.

**Dissemination of research results:** During the reporting period, the research team submitted two research papers. The details of these two papers can be found in Table 4. The PI is also actively disseminating the research and development effort on the 6TiSCH wireless network testbed by sharing the 6TiSCH network management service to the research community and collecting comments and feedback to make further improvement.

| Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events | | | | |
|---|---|---|---|---|
| **Title** | **Event** | **Type** | **Location** | **Date(s)** |
| 6TiSCH wireless network testbed | Online web service https://6tisch.amyang.xyz/ | Public testbed | ITE Building at UConn Storrs Campus | Starting from Nov. 1st, 2019 |

| Table 4: Publications and Submitted Papers and Reports | | | | |
|---|---|---|---|---|
| **Type** | **Title** | **Citation** | **Date** | **Status** |
| Conference Paper | Specification-based Detection of Rank-related Attacks in RPL-based Resource-Constrained Real-Time Wireless Networks | Not available | Oct. 23rd, 2019 | Submitted to IEEE IPSN 2019 and under review |
| Conference Paper | Bike Station Traffic Prediction with Multi-level Spatial-Temporal Attention Neural Networks | Not available | Dec. 23rd, 2019 | Submitted to IEEE DASFAA 2020 and under review |
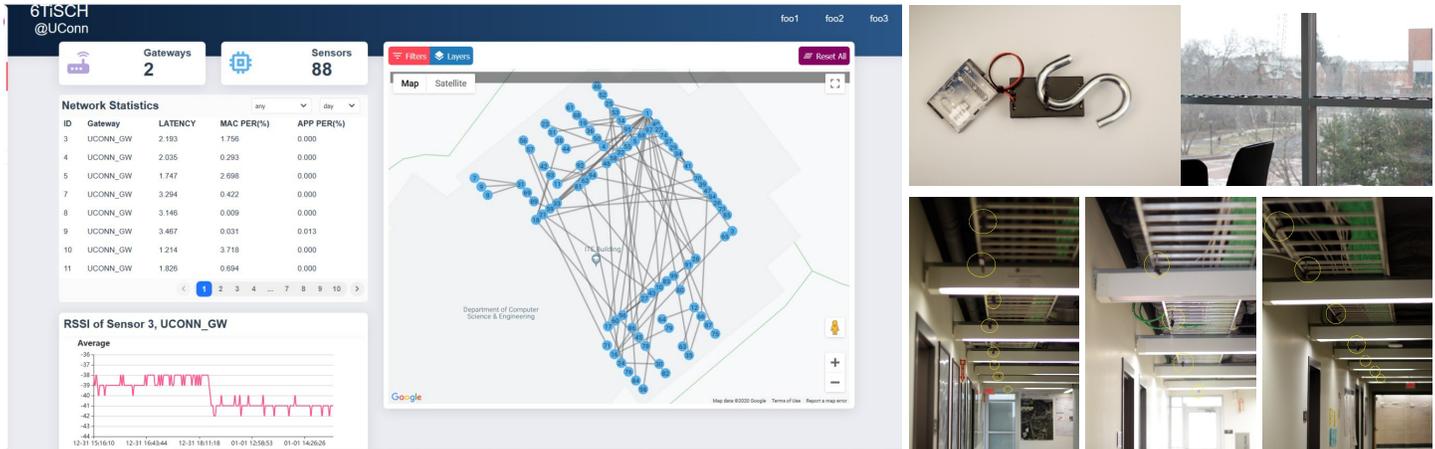


Figure 1. An overview of the prototypical 6TiSCH real-time wireless network testbed (https://6tisch.amyang.xyz/)

**Participants and Collaborators:**

| Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members | | | |
|---|---|---|---|
| **Individual Name** | **Email Address** | **Department** | **Role in Research** |
| Song Han | song.han@uconn.edu | CSE@UConn | Principle Investigator |

| Table 6: Student Participants during the reporting period | | | | |
|---|---|---|---|---|
| **Student Name** | **Email Address** | **Class** | **Major** | **Role in research** |
| Jiachen Wang | | PhD | Computer Science | Student Researcher |
| Areej Althubaity | | PhD | Computer Science | Student Researcher |

**Changes:** No significant changes on the scope and methodology design in the project.

**Planned Activities:** Based on the study in this reporting period, we are planning the following activities in the project:

- We plan to continue the designs of IDS for 6TiSCH wireless networks, focusing on the timing and synchronization attacks. We will continue to work on the 6TiSCH network testbed design and development. Once the testbed is mature, the proposed IDS will be implemented on the testbed for design validation and performance evaluation.
- PI Han will continue to develop and finalize the NSF proposal for the MRI program (due date is Jan. 21st, 2020).
- PI Han will recruit undergraduate students at UConn to join the PI's research lab to work with the PhD student researchers on R&D tasks related to this project. These undergraduate students will work with the PI in the form of independent studies in the Spring semester of 2020.