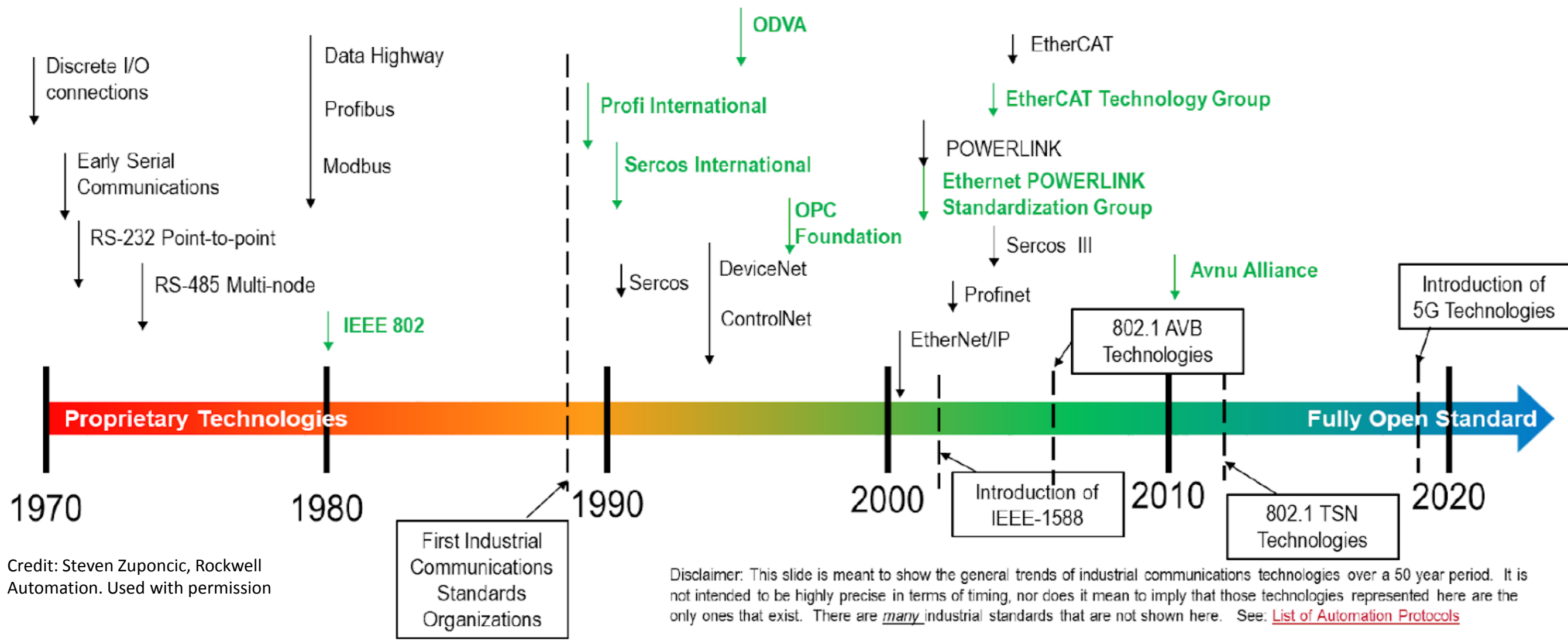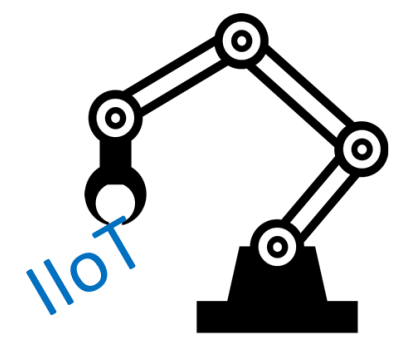# Emerging IIoT Communications and Connectivity Architectures with Deterministic Control

Dr. Nicholas J. Kirsch, *UNH ECE and Director UNH Connectivity Research Center*

Bob Noseworthy, *UNH InterOperability Laboratory (UNH-IOL) Chief Engineer*

Industrial Need and Relevance

Credit: Steven Zuponcic, Rockwell Automation. Used with permission

Disclaimer: This slide is meant to show the general trends of industrial communications technologies over a 50 year period. It is not intended to be highly precise in terms of timing, nor does it mean to imply that those technologies represented here are the only ones that exist. There are *many* industrial standards that are not shown here. See: List of Automation Protocols
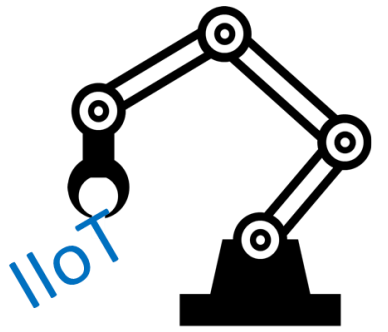
"Wireless communication in industrial communication systems are beneficial for many obvious reasons including reduced wiring cost and complexity as well as enabling mobility…"

Industrial Need and Relevance
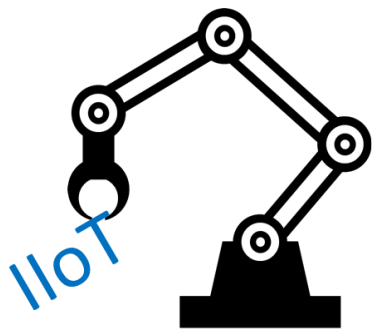
- IEEE 802.1 - ~26 TSN recent / ongoing standards
- IEEE 802.3 – New single-pair Ethernet
- IEC/IEEE 60802: TSN Profile for Industrial Automation
- & many updated Fieldbus protocols
  - OPC Unified Architecture (UA), Pub/Sub standard
  - Sercos, PROFINET, EtherNet/IP, etc - all integrating TSN
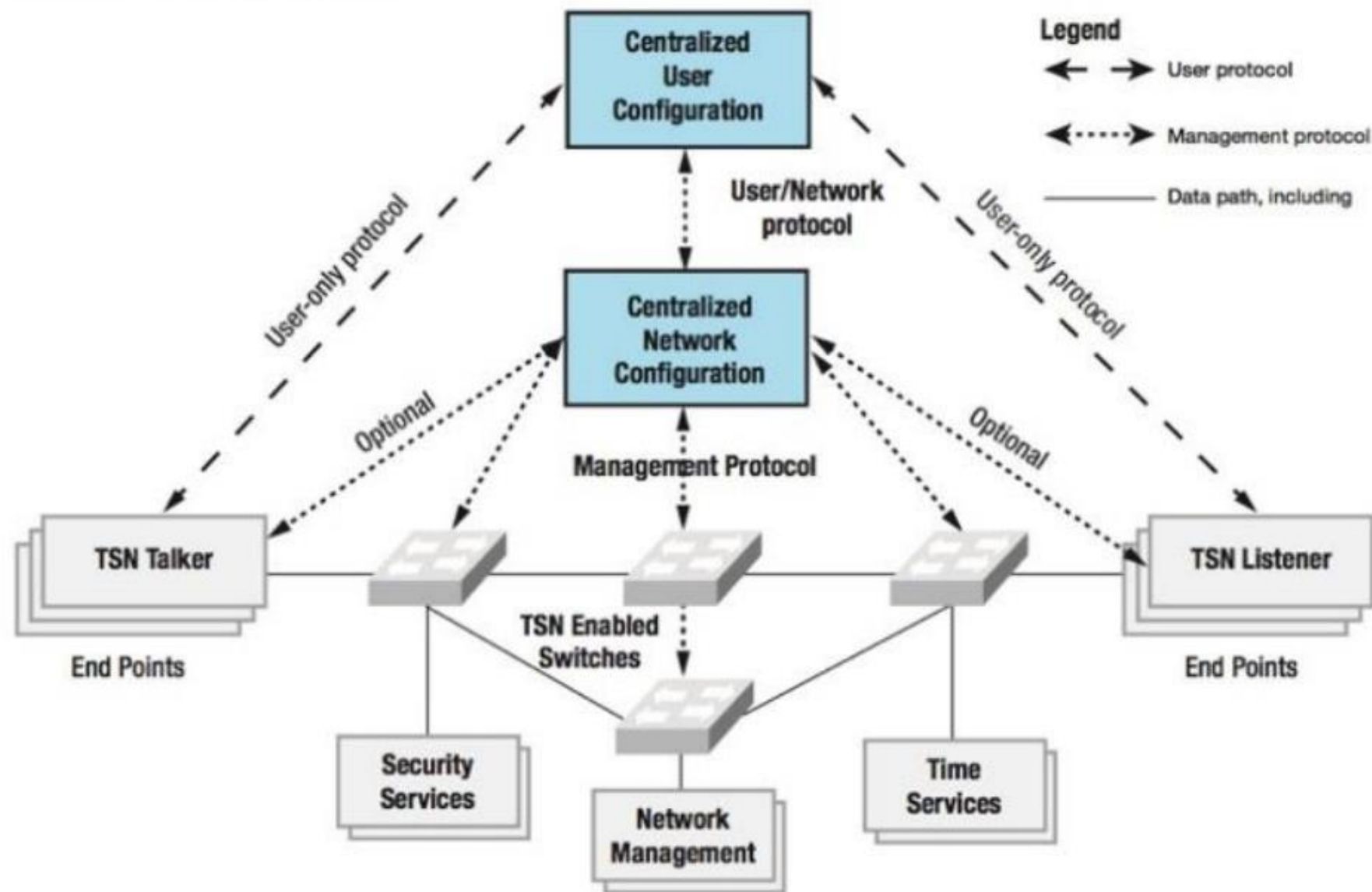
Project Objectives

- Create, standardize, test, and enable wireless TSN for industrial applications
  - Including development of quality of time monitoring
- Research and create novel wireless communication schemes that thrive in industrial settings
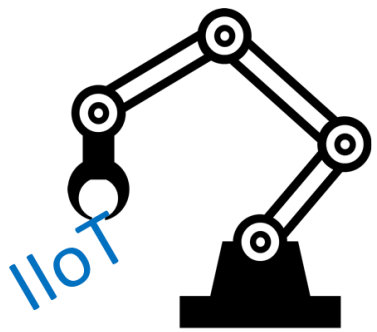
Approach/Methodology

Roles in the TSN System

Legend
←→ User protocol
◄┈┈► Management protocol
── Data path, including
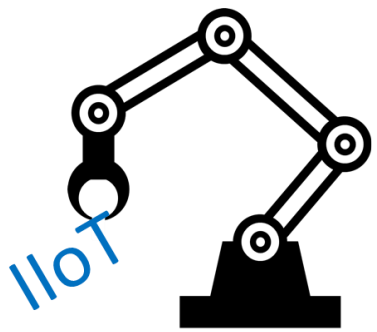
- *Common TSN architecture*
  - Centralized Network Controller (CNC) for path and schedule per Centralized User Configuration (CUC) needs.
  - Edge devices may be TSN Talker/Listeners, or brownfield solutions scheduled transparently
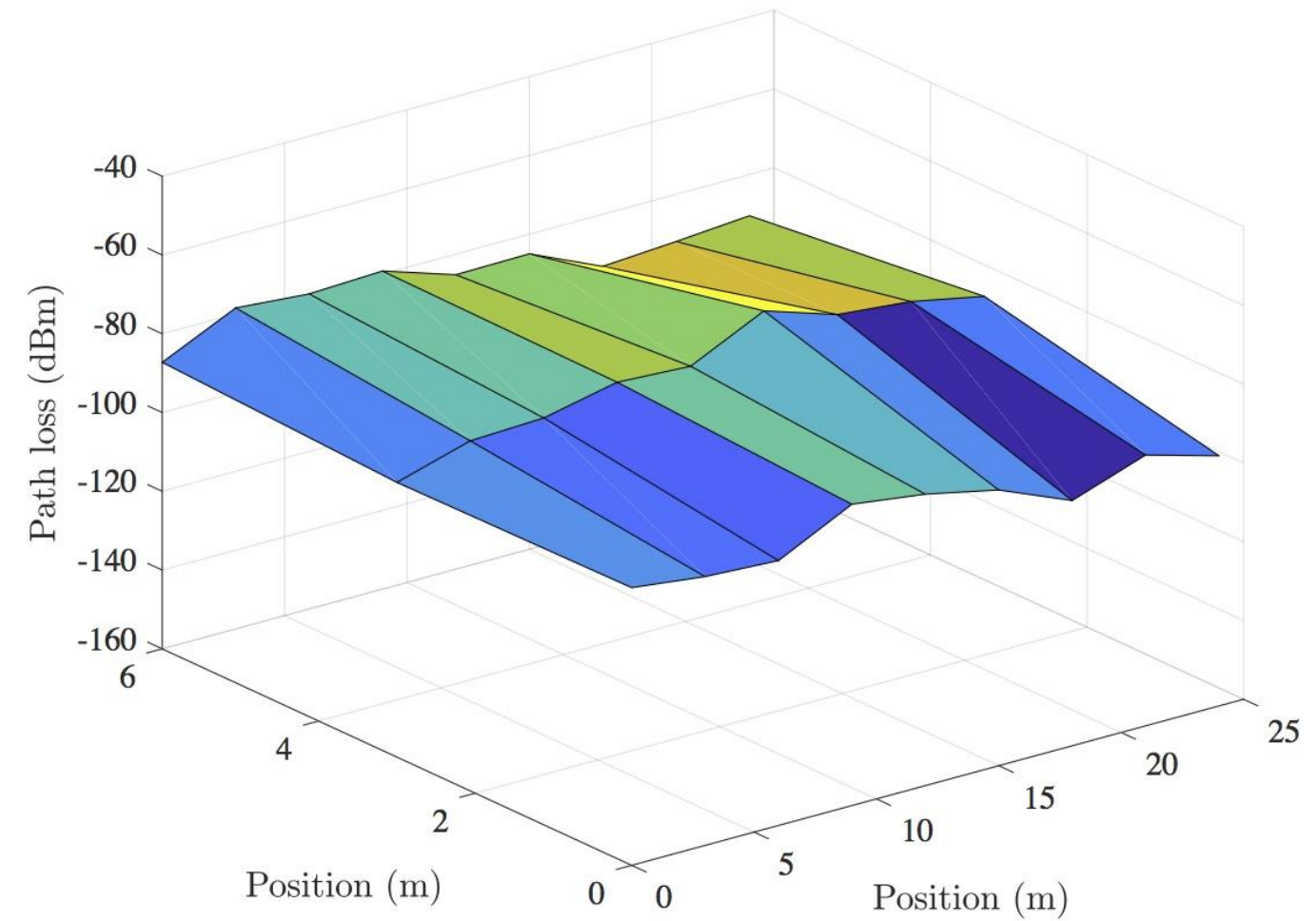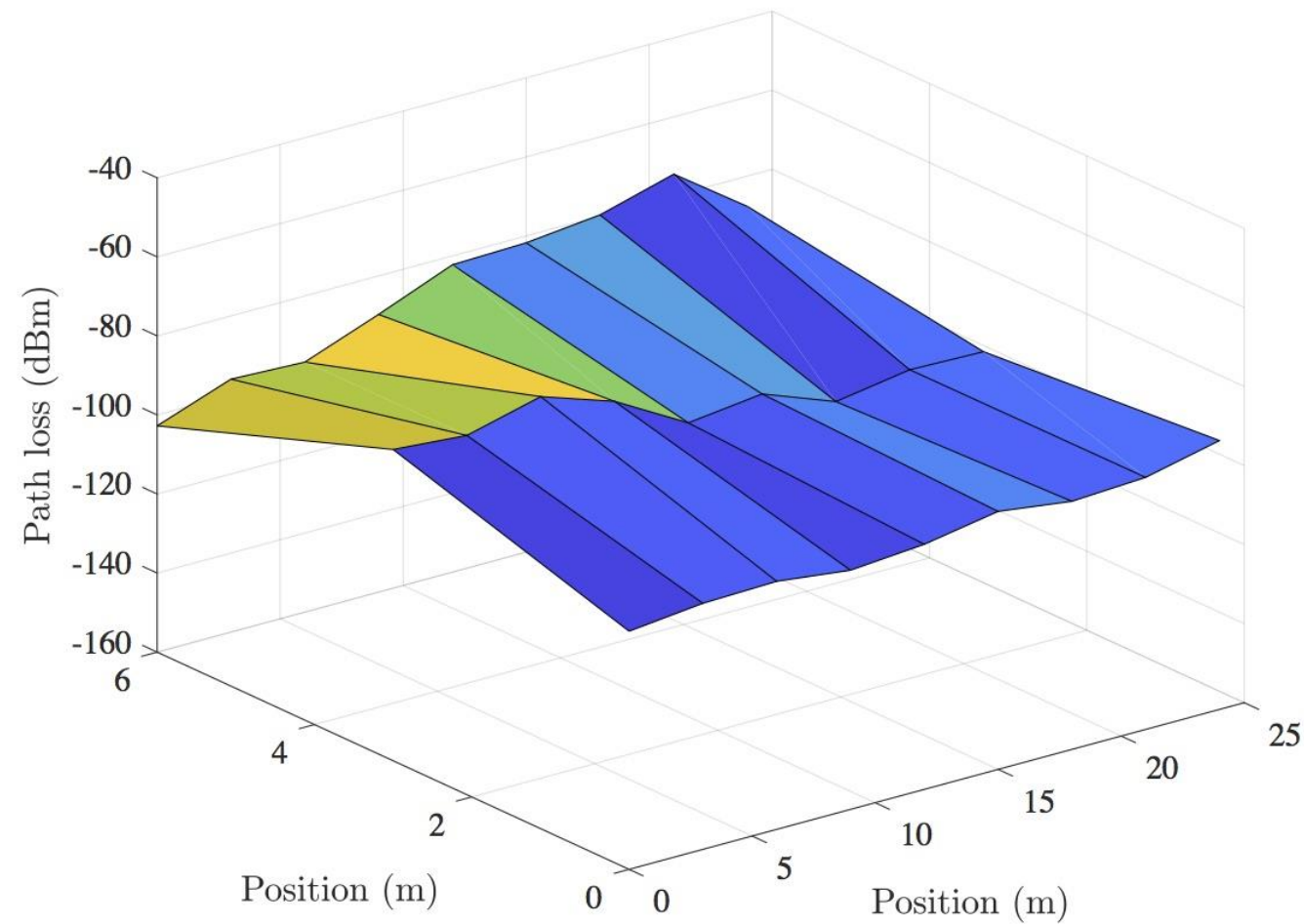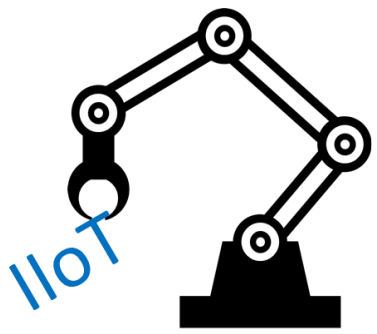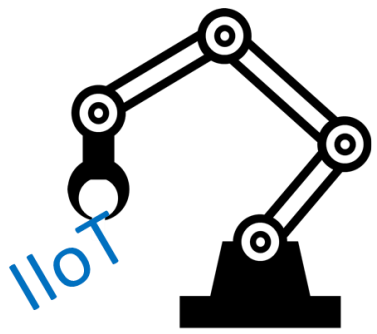
Approach/Methodology

- Measure industrial communication environments
- Study dynamic nature of noise
- Develop signaling schemes that meet industrial needs and alleviate channel effects
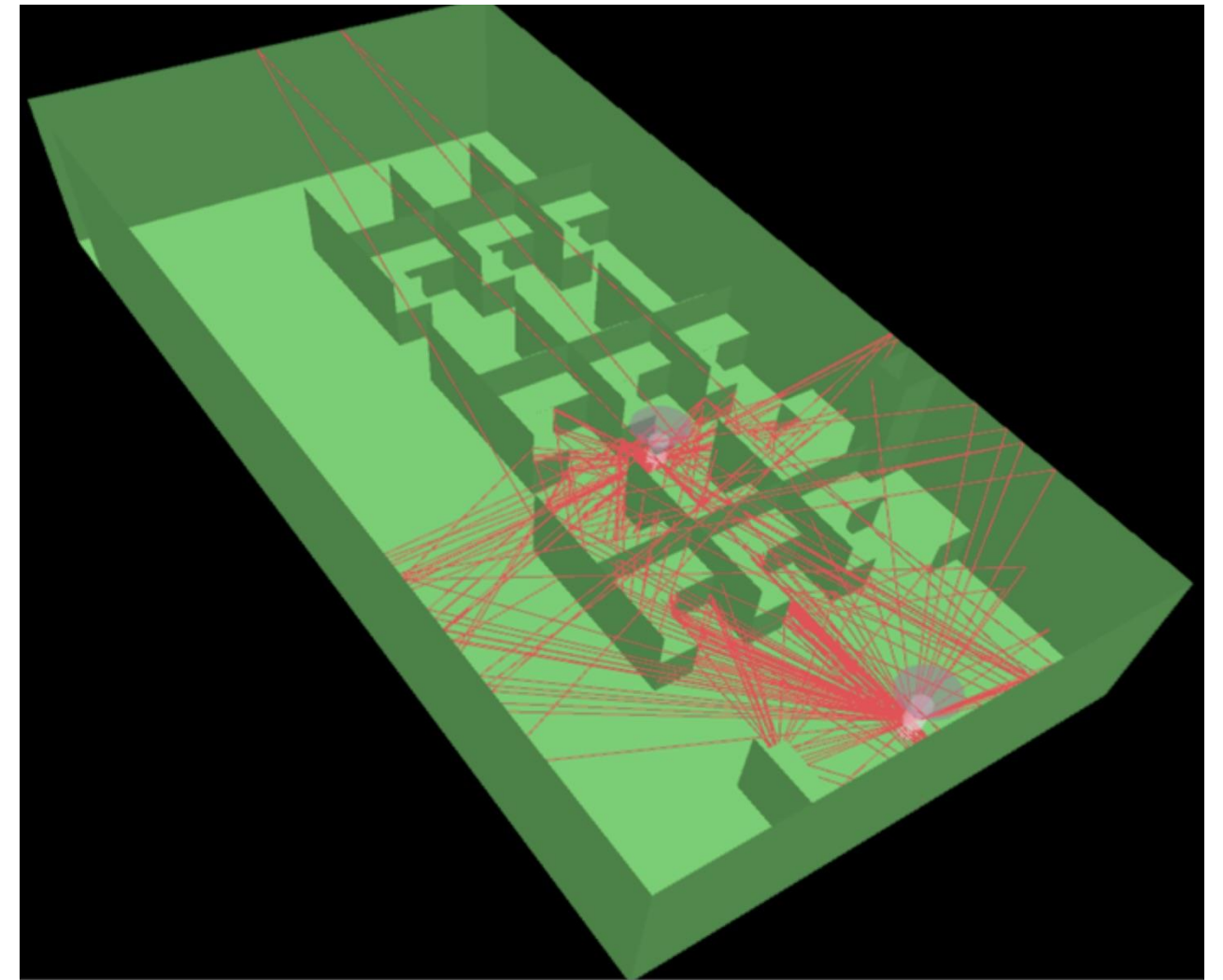
Results

Manufacturing Floor Measurements

Next Steps

- Further involvement with TSN standardization
  - UNH's InterOperability Laboratory has been testing network technologies for 30 years iol.unh.edu   (Tour this afternoon)
  - Provides Certification services for Ethernet Alliance (EA), Avnu Alliance and IEEE Standards Association
    - Avnu Certification: iol.unh.edu/avnu
    - IEEE-SA PTP Certification: iol.unh.edu/1588
    - EA PoE Certification: iol.unh.edu/poe
    - Ethernet Single-Pair PHY Compliance & Interop: iol.unh.edu/ae
    - Industrial TSN Compliance & Interoperability: iol.unh.edu/tsn

- Investigate industrial wireless channels and communication needs

References
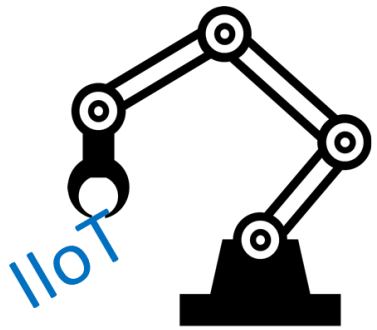
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2. Theory of Operation for TSN-enabled Systems Applied to Industrial Markets https://avnu.org/knowledgebase/theory-of-operation/
3. IIC Time Sensitive Networks for Flexible Manufacturing Testbed - Description of Converged Traffic Types https://www.iiconsortium.org/pdf/IIC_TSN_Testbed_Traffic_Whitepaper_20180418.pdf
4. IEEE 802.1 Time-Sensitive Networking (TSN) Task Group https://1.ieee802.org/tsn/

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