Working Group E Outbrief

Ground System Architectures Workshop

Stronger Together: Improving Interoperability for Users and Operations

February 22–March 2, 2023 | The Aerospace Corporation | El Segundo | California

Intelligent Systems and Machine Learning for Space Ground Systems

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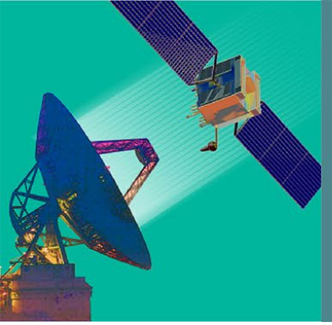


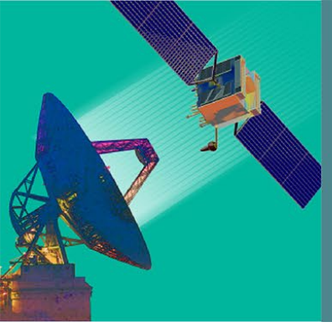
Session Goals

- Adaptive, reliable automation and intelligent decision making are essential for the success of our space ground systems.

- One big challenge is migrating capabilities out of the lab to supporting critical mission operations. In the past, these approaches were often misunderstood, misapplied, too complex or costly to sustain, or insufficient for mission needs.

- Applied intelligent systems and machine learning technologies have begun to address this challenge through efficient, and value-focused capabilities. In addition, un-realized opportunities exist for applying established, or rapidly emerging technologies, solutions and architectures to the area of ground system space control and mission processing.

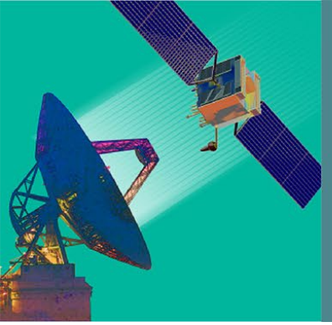
- This working group explored these areas through a series of presentations and an interactive panel discussion



Presenters/Panelists

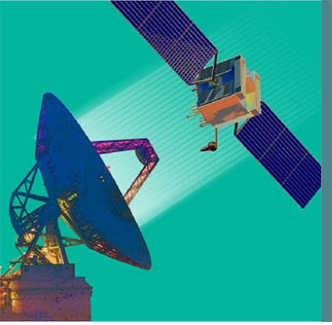
- Presentations
  - *Dr. Seung Chung – "Autonomy & Automation in Deep Space Mission Operations" (Jet Propulsion Laboratory)*
  - *Dr. Klara Nahrstedt – "Security Evaluation of Distributed Machine Learning Models" (University of Illinois)*
  - *Renee Yazdi – "A Machine Learning Toolset for PNT Threat Detection and Response" (Canyon Consulting)*
  - *Dr. Phil Slingerland – "Aerospace's Trusted AI Framework" (The Aerospace Corporation)*

- Panel Discussion
  - *Dr. Nick Perlongo – Moderator (The Aerospace Corporation)*
  - *Dr. Philip Feldman (ASRC Federal)*
  - *Dr. Seung Chung (JPL)*
  - *Scott Leonard (NOAA)*
  - *Dr. Christopher Lawson (The Aerospace Corporation)*



Key Points

- Intelligent Systems are helping to fulfill mission needs
  - *Where timeliness / latency / cost is critical*
  - *In deep space missions*
  - *In enabling responses to GPS jamming by better characterization*
- There are tradeoffs when to apply on the ground vs in space
  - *Latency, compute power, maintainability, etc.*
- Moved further with function automation vs system level autonomy
- Challenges
  - *Unique concerns with securely using ML models*
  - *How models fit into large complex systems*
    - Distribution and Fusion
    - May not be all under your control
  - *Explainability / Interpretability*
  - *Failure modes*
- Continued desire to include more physics informed solutions



Conclusions

- Start simple
  - *Not all intelligent systems require deep learning / machine learning*
  - *Deployment environments often more constrained than development*

- Want to leverage commercial advances thoughtfully
  - *Automation used in managing large commercial constellations*
  - *Reuse of foundational models*
  - *With needed assurance*

- Apply methods to appropriately address trust of intelligent systems
  - *Address technical correctness and stakeholder needs*
  - *Need a structured approach to building trust that starts as early as possible and covers the entire lifecycle*
    - Ensure all key stakeholders are in the loop
  - *Tailor approach to building trust based on mission needs*