25th Ground System Architectures Workshop
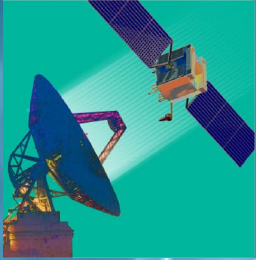**Adapting Critical Operations**
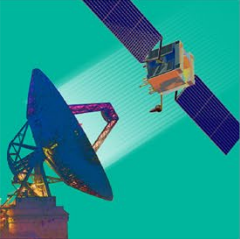Starts March 1, 2021 | Special Online Series of Events

Intelligent Systems / Machine Learning for Space Ground Systems

Leads:
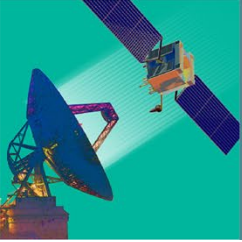*Jon Neff and Dan Balderston,*
The Aerospace Corporation

March 8, 2021

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 self-evolving, 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 year the GSAW "Intelligent Systems / Machine Learning for Space Ground Systems" working group will explore deeper the themes of:
  - *Where do intelligent systems and machine learning currently exist in space ground systems?*
  - *What underlying parts of the space ground systems, enterprise and operations are suited to intelligent systems and machine learning?*
  - *What emerging capabilities and technologies are being developed in the community?*
  - *What are real-world impediments for adoption in operations?*
  - *What capability and technology gaps exist and might seed further research and investment?*

- The goals of the Working Group are:
  - *To inform adopters, researchers and stakeholders to help integrate intelligent systems into operations.*
 - *To establish an enduring community for long-term collaboration.*

Working Group B

Presenters/Panelists

- "Recap of Past Years' IS/ML WG" - *Dan Balderston (The Aerospace Corporation)*
- "JPSS-2 Detection and Reporting Overview" – *Jon Neff (The Aerospace Corporation)*
- "Automated Data Accountability for Missions" - *Brian Kahovec (JPL)*
- "Slingshot Orbital Event Streaming Platform" – *Charlie McGillis, Brian Williams, Jason Stach (Slingshot Aerospace)*
- "NPP Satellite Telemetry Exploratory Data Analysis" - *Terry Cox (The Aerospace Corporation)*
- "Could Space Systems Use Some Kind of a Skin?" – *Kirstie Bellman (Topcy House Consulting)*
- Panel Discussion
  - *Jon Neff – Moderator (The Aerospace Corporation)*
  - *Erik Linstead (Chapman University / Aerospace Corporation)*
  - *Betty Cheng (Michigan State University)*
  - *Phil Feldman (ASRC)*
  - *Scott Neddermeyer (GVT LLC / NOAA)*
 - *Kirstie Bellman (Topcy House Consulting)*

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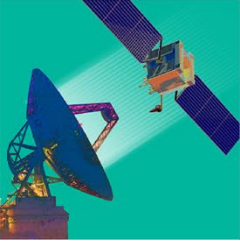
Key Points

- Anomaly detection, reporting, attribution remains strong focus area
  - *To improve decision timelines*
- Growing SDA applications
  - *Mega-constellations (Starlink), space debris, exploding space catalog volumes*
  - *Gov't, civil, commercial, amateur observer sources*
- Real-world adoption failure causes
  - *Access and quality of data, how to train, false positives*
  - *Data selection, filtering, cleansing, preparation are essential and involved steps*
  - *Operator interface non-intuitive*
- Algorithm selection is key
  - *Start simple, perform quick trials*
  - *Should include early sensitivity testing, test a variety of soutions*
- Explainable AI = Trusted AI
  - *"Applied ML" must be easy for user to understand*
  - *Remove friction (for user) and focus on understandability, but not underlying physics*
- Human interaction (operators) still overlooked
  - *Operators hesitant to change. Need value vignettes*
  - *Use knowledge to solve problems, don't use time to find problems*
- Biological metaphors (skin) offer valuable sensor/network model analogies
  - *Platform of diverse sensors, Passive vs. Active interaction, adaptability to change, elastic, evolving*

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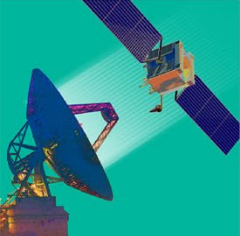
Conclusions

- Deep Learning must be developed for focused need (not cookie cutter applied)
- Understandable AI remains a challenge
  - *The internal model must be decoupled from how user understands it*
- Results only as good as engineered solution
  - *Problem Defined: What problem is addressed? How to ask the system questions?*
  - *Model and Algorithm Selection: Validate, test, evolve*
  - *Training data: Available, accessible, realistic, representative variety*
  - *Human-Machine Experience: Problem-centric, understandable results, psychological lens*
  - *SW engineered solutions are vital for sustainability (don't skip!)*
- Frameworks and Architectures = key enablers, are maturing
- The cultural battle is over, but …
  - *Value must be shown, risk understood and managed, solution trusted*

Working Group B