Ground System Architectures Workshop

Stronger Together: Improving Interoperability for Users and Operations

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

Working Group A: Space Enterprise Integration

Lori Gordon, Ron Birk, Barbara Braun
The Aerospace Corporation

February 27, 2023

Ground System Architectures Workshop
Stronger Together: Improving Interoperability for Users and Operations

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

This working group will address challenges and opportunities associated with Space Enterprise Integration for high profile use cases such as

- Integrating Space for National Defense
- Harmonizing Space Traffic Coordination (STC)
- Master Planning a Sustainable Cislunar Ecosystem

U.S. government agency panelists address high profile use cases:

- Colonel Wallace 'Rhett' Turnbull - Deputy Director, Space Systems Integration Office, Space Systems Command
- Scott Leonard – Technical Director, Office of Space Commerce
- Wes Fuhrman – Senior Professional Staff, Johns Hopkins University Applied Physics Laboratory

The workshop includes a leadership panel and a town hall.

Information @ link : Working Group A – Ground System Architectures Workshop (gsaw.org)
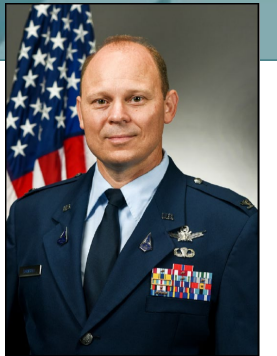
Col Rhett Turnbull

Scott Leonard

Wes Fuhrman

Ground System Architectures Workshop
Stronger Together: Improving Interoperability for Users and Operations

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

The discussion will be framed around a '3×3' approach to assess each of these three Use Cases through three lenses to gain insight into how organizations conduct enterprise integration:

- Interoperability
- Tactics, Techniques, Procedures (TTPs)
- Threats

The working group session consists of two parts:

Part 1 will include a moderated panel session with presentations and discussions related to strategic foundational elements for space enterprise integration, outlining applicability to several use cases to advance U.S space capabilities in the national interest.

Part 2 will be a town hall meeting to include key representatives from government and private sector organizations sharing a common goal to advance space capabilities in the national interest.
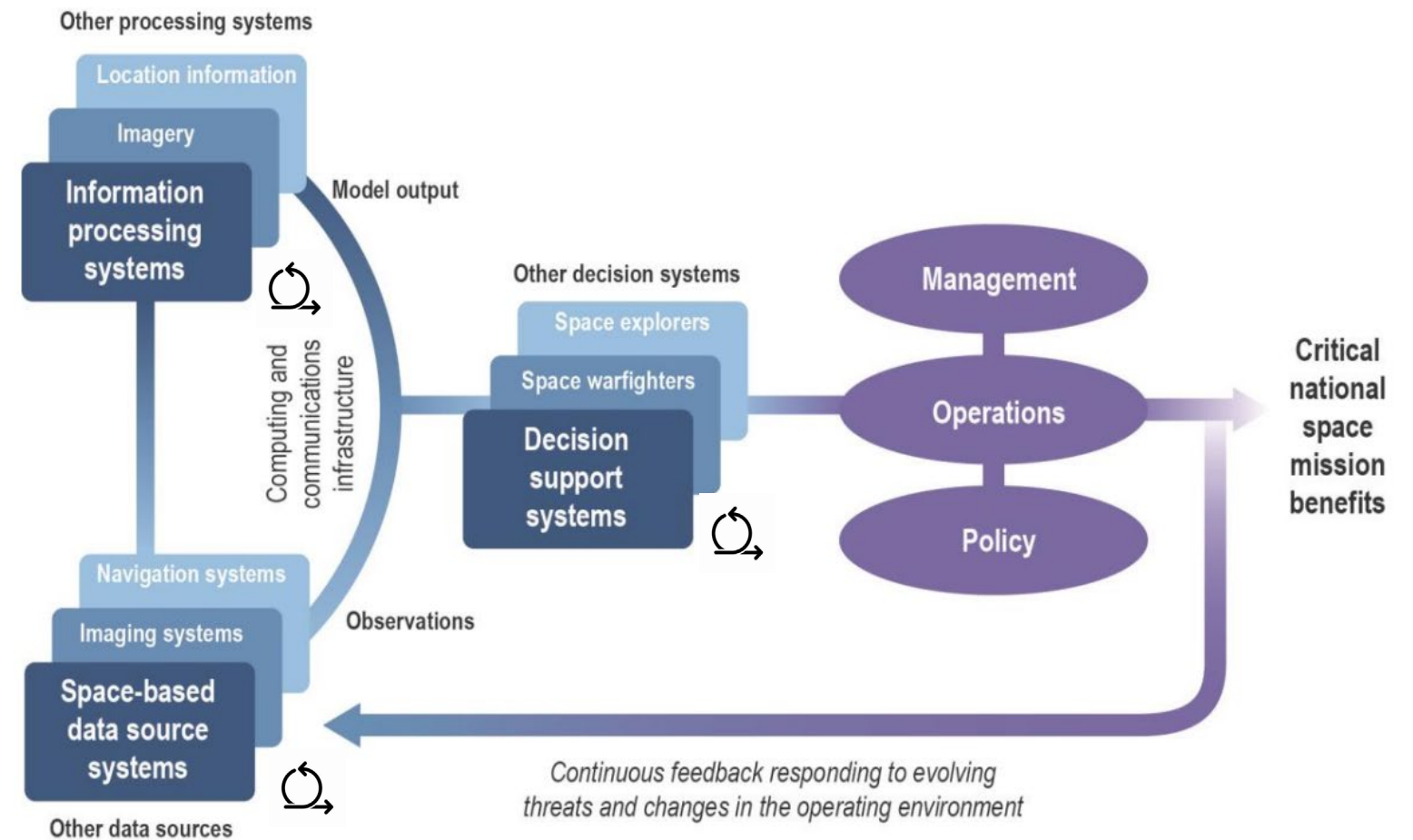
*Advancing understanding and best practices for enterprise integration*

Other processing systems

Location information

Imagery

Information processing systems

Model output

Computing and communications infrastructure

Other decision systems

Space explorers

Space warfighters

Decision support systems

Management

Operations

Policy

Critical national space mission benefits

Navigation systems

Imaging systems

Observations

Space-based data source systems

Other data sources

Continuous feedback responding to evolving threats and changes in the operating environment

↻ *Rapidly develop, deploy, evolve*

End-to-end integration of systems, data flows, decision processes across an enterprise to sustain operations
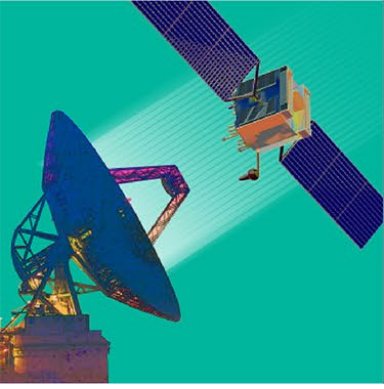
Town Hall Discussion

	Integrating Space for National Defense	Harmonizing Space Traffic Coordination	Master Planning a Sustainable Cislunar Ecosystem
Interoperability	- Others think interoperability is easy for the military – just issue an order – but it's not; many chains of command - No one reports to a single authority – it's a "wicked problem" – but we are making a tremendous amount of progress - Having an integrated view of the architecture will help in the priority decision-making identified below - Space is a commons for all our agencies – and it's easy to screw up for everyone	- How do we convince multiple players to interoperate? Thought this was easy for the military! - Have to partner with people you have no control over – see "wicked problems" - Vendor agnostic has obstacles in the cloud world - Can be mitigated: Infrastructure as code through Kubernetes - In STC, the model is the system. - Imperative we build strong relationships among agencies and internationally.	- Strict coordinate systems on the lunar surface - Decomposition of architectures – need to focus on interfaces. - What are the DE gaps for interoperability? - Need to understand how models fit together and how models can be chained together - We need to be out there setting the norms now, before it's decided by someone else.
Tactics, Techniques, Procedures	- No longer possible to go through central node - How do we define what data goes to the edge, and what's the format? - How does that data make it to the edge? What networks are needed? - Decision making hybrid – mission command empowerment - Enterprise roadmap – how is it evolving? Conducting workshops now. Going to publish soon, want feedback	- Learned a lot about getting the data "there," vetting data, and data security - But still need to determine how to balance data vetting and security with getting new data and tools more quickly - Also need to balance doing the thing that is fast, and doing the thing that is sustainable. - How to get feedback? Sent out RFPs / RFIs asking users "what do you want?" What do you need in a modeling and sim environment to do stuff with our data? Currently recruiting beta users for their new systems. - Getting to good enough: STC conops is to do a general screening, followed by more detailed analysis of high-interest conjunctions. Basic screening first, followed by filling in gaps - How good is good enough? How close is close enough? How do we determine that? Ground truth is absent for debris.	- Need to standardize on coordinate systems, TLEs, etc. Data interoperability is critical. - Lunar surface is going to go through regular comms outages – need for autonomous decision making = mission command empowerment - Maybe 10-15 percent respond to RFIs – it's an opportunity for your voice to be heard. - Roadmaps must invite feedback and be built to evolve over time
Threats	- What role do adversary TTPs play? - In the past we have used admin systems to send mission data – how do we secure these against the threat? CTIO is working on developing architecture - How do we remain flexible while preserving our roadmaps from major changes? Revisit on two-year boundaries - Resource contention – who gets access to the systems first? Priorities – Need to continue to involve with combatant commanders - Across the board – how do we help all these domains understand the threat? Share at different levels. DoD is Sharing openly more now than ever.	- Cloud aspect can become a cost sink - "Storage will eat our lunch if we're not careful." Data grows stale quickly – archive it quickly - Timelines help us envision how the roadmap changes. Analogy of hopping from rock to rock – need our current rock to be stable. - Use of proving grounds to show stability with little risk. - Need consensus on where we need to be in 10 years. One system for all has drawbacks in the short term, you get more feedback and buy-in by taking smaller steps. - Threat detection and reporting – Report threats to DoD. What can we learn about adversary action from telemetry?	- Important to remember that adversaries still exist in the civil world too - How do we avoid analysis paralysis? Coordination, and communication – faster decision making - Need sustainment of purpose - Cislunar orbits are energetically complex - Custody problems – like the rocket body that hit the moon – are exponentially harder in the vast area of cislunar - Key is to shift countermeasures far left – need to be thinking right now - Priorities / resource contention: human safety first - "We need a department of the exterior" to share threats

- Interoperability is a "wicked problem"
  - *Many stakeholders with different priorities*
  - *No single authority or decision-maker (and there never will be); must partner with agencies you have no control over*
  - *No closed-form solution – the problem can never be solved definitively*

- How do we tackle the "wicked problem" of interoperability?
  - *Have an integrated view of the architecture*
  - *Focus on the interfaces*
  - *Understand how models chain together*

Image used under Creative Commons Share Alike 4.0 International License. https://commons.wikimedia.org/wiki/File:Wickedproperties.jpg

Key Takeaways

- Techniques, Tactics, and Procedures (TTPs) that empower decision-making at the edge are increasingly critical
    - *Lunar surface will go through regular comms outages*
    - *Users (especially military users) are in austere, contested, and disrupted environments*
    - *No longer possible to aggregate data and decision-making at a central node*

- Understand what is "good enough" for decision-making and iterate
    - *CONOPS for Space Traffic Coordination provides a model: basic screening first, followed by "filling in the gaps" with more refined analysis*
    - *Avoid "analysis paralysis" and make decisions quickly*
    - *Embrace a hybrid model that empowers decision-makers in the field who have most relevant data, backed up by strategists who can evaluate the longer view*

Key Takeaways

- Envision – and evolve – the end state
  - *Need consensus on where we need to be in 10 years*
  - *Need "sustainment of purpose" for the long haul*
  - *Yet, "always in motion, is the future" – Yoda*

- Build roadmaps to evolve over time and invite feedback
  - *"Hop from rock to rock" – ensure you are stable where you are, then take small steps*
  - *Invite feedback through workshops, RFIs, and RFPs – and participate by giving feedback*
  - *Use cislunar as a proving ground*

- Threats are multidimensional
  - *Capacity / capability ("storage will eat our lunch")*
  - *Resource contention*
  - *Complexity (e.g., cislunar orbits and debris)*
  - *As well as traditional adversary threats*

- Share data and shift planning left
  - *National defense is sharing more openly now than ever*
  - *Sharing goes both ways: civil / commercial "satellite as a sensor" telemetry can augment threat reporting*
  - *Civil and commercial space is not immune to adversary threat*
  - *"We need a Department of the Exterior to share threats"*
  - *Need to be thinking of countermeasures in the planning phase*

Ground System Architectures Workshop
Stronger Together: Improving Interoperability
for Users and Operations

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

Thank you