

IV&V Assurance Case Design for Artemis II



IV&V Program



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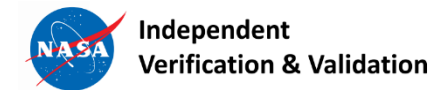
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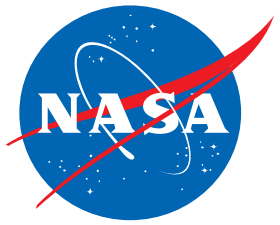


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NASA's IV&V Program

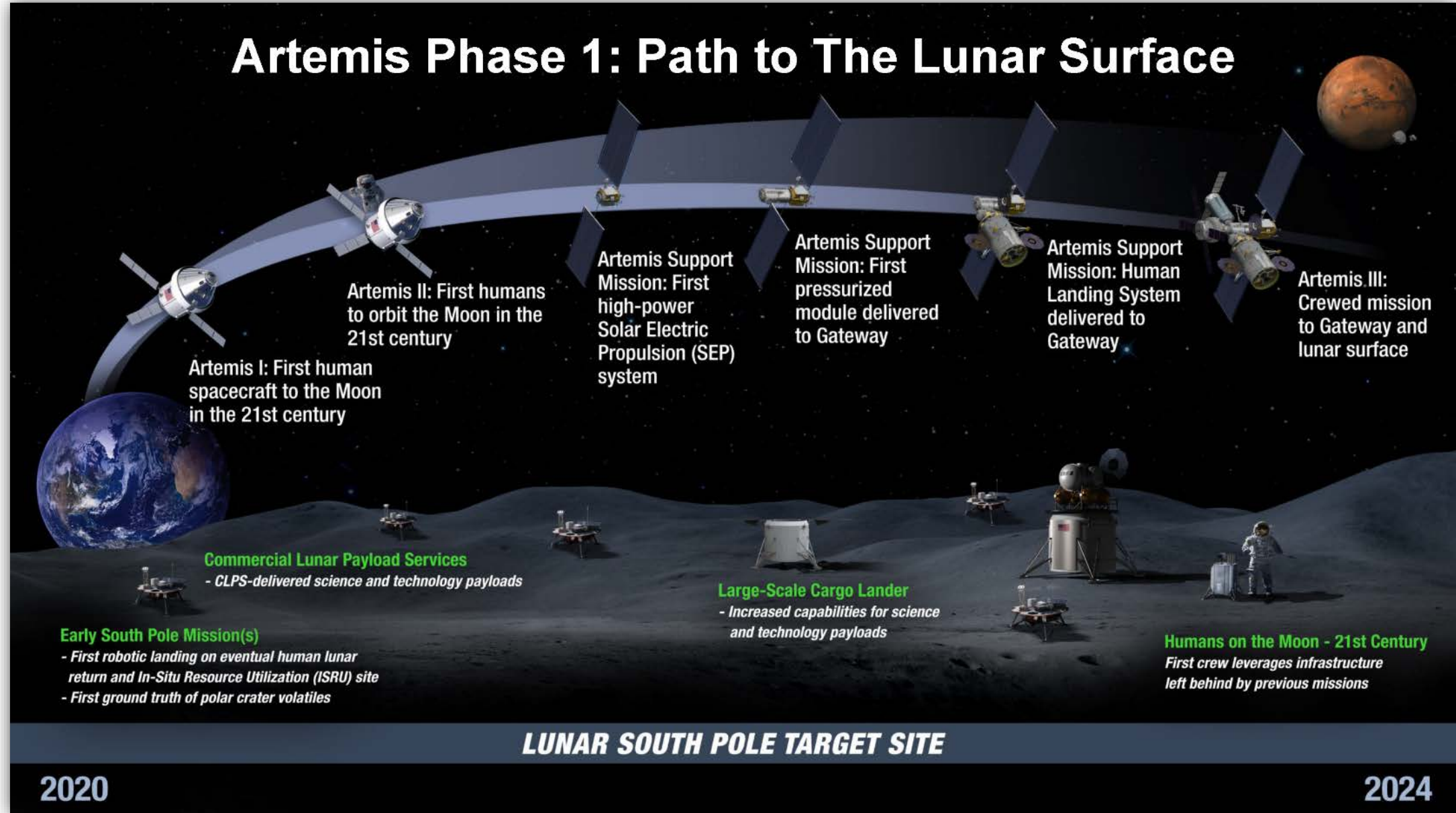


IV&V Program

- NASA's Independent Verification & Validation (IV&V) Program reports to the Office of Safety and Mission Assurance (OSMA)
 - Technically, Managerially, and Financially Independent
- Located in Fairmont, West Virginia
- NASA IV&V employs systems engineering processes and rigorous methodologies for evaluating the correctness and quality of software products on NASA's highest profile missions
 - Full Lifecycle
 - Mission Oriented
 - Capability Based
 - In Phase
 - Product Focused
 - Risk Driven
- NASA IV&V goal: Add evidence-based assurance that minimizes the overall risk of NASA mission software

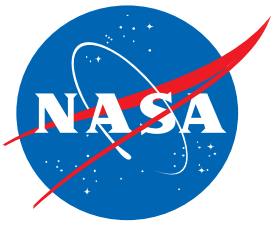


NASA's Artemis Program





Artemis IV&V

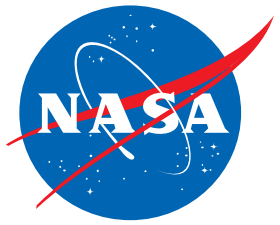


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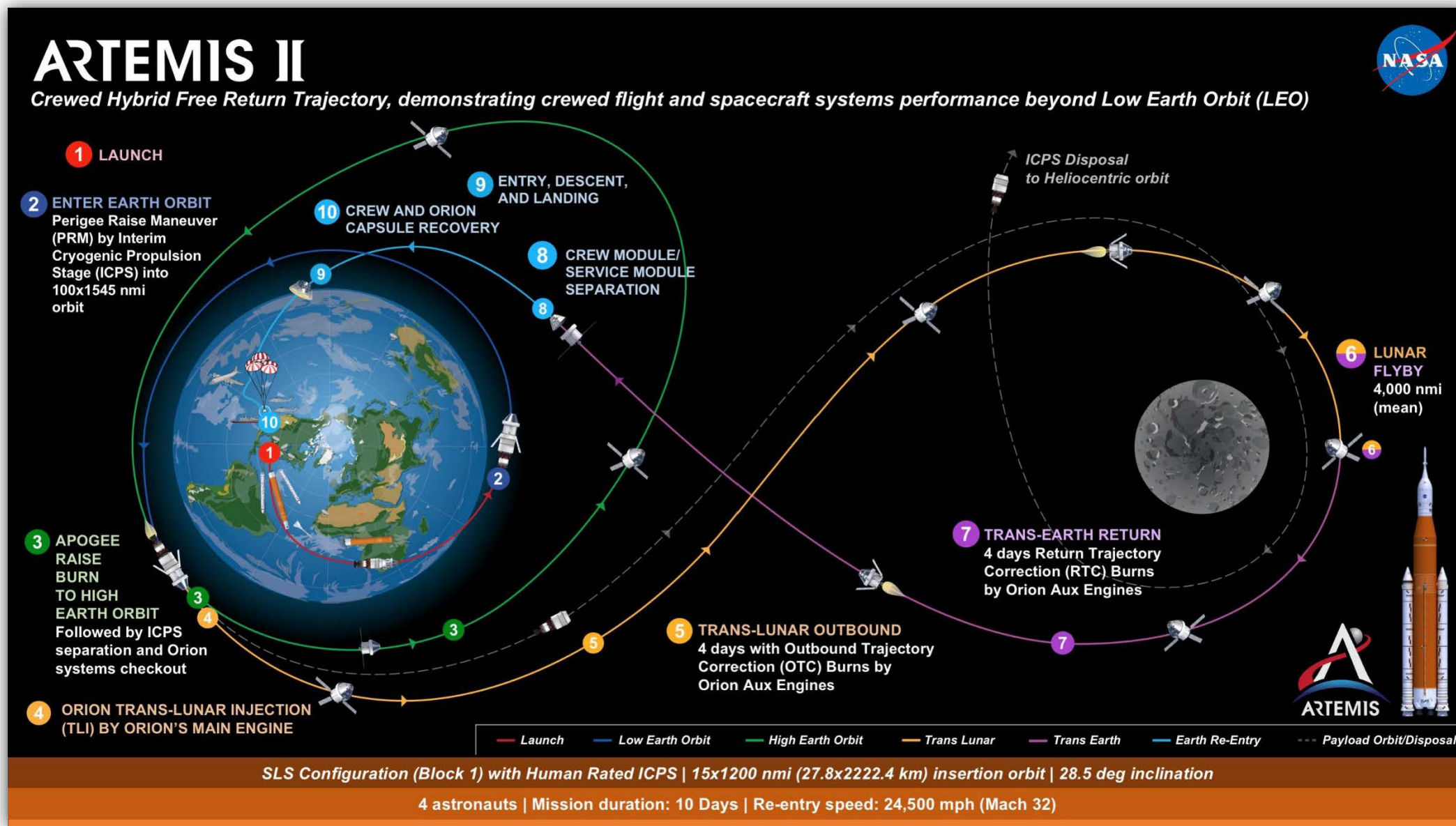
Challenges



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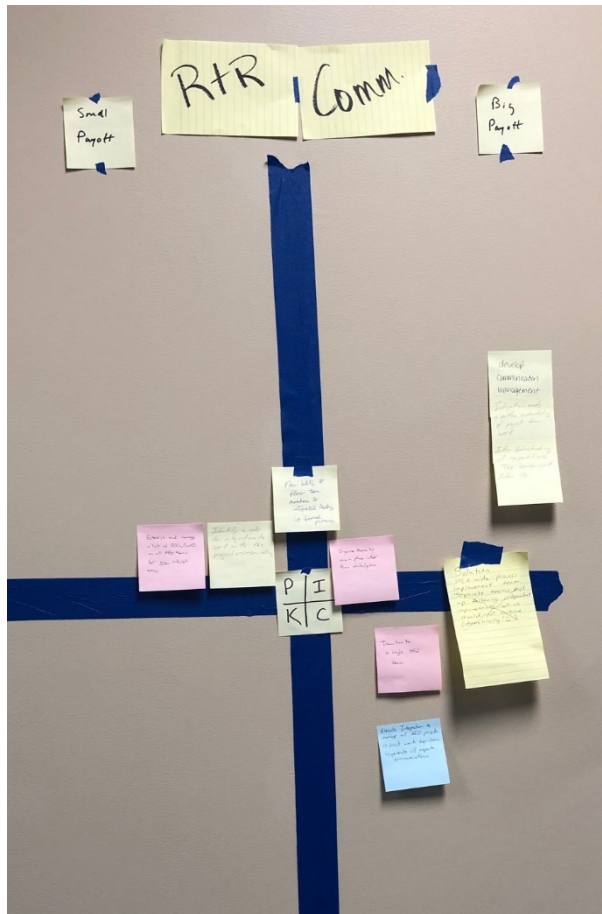
- NASA IV&V executes analysis on software artifacts, but in order to communicate effectively with stakeholders, we make assurance statements about mission capabilities
- Differences in planning and execution between the individual IV&V project teams introduced challenges
 - Risk assessment and prioritization approach was only loosely shared; analysis target priorities did not always line up across teams
 - Aggregation of assurance conclusions did not always result in a cohesive message across project teams
- Gaps in assurance, particularly with respect to system and software integration, were difficult to identify and address
- Assurance data is difficult to objectively quantify, and our tooling approach made it difficult to manage, track, and keep our qualitative data up-to-date

Artemis II Mission Overview



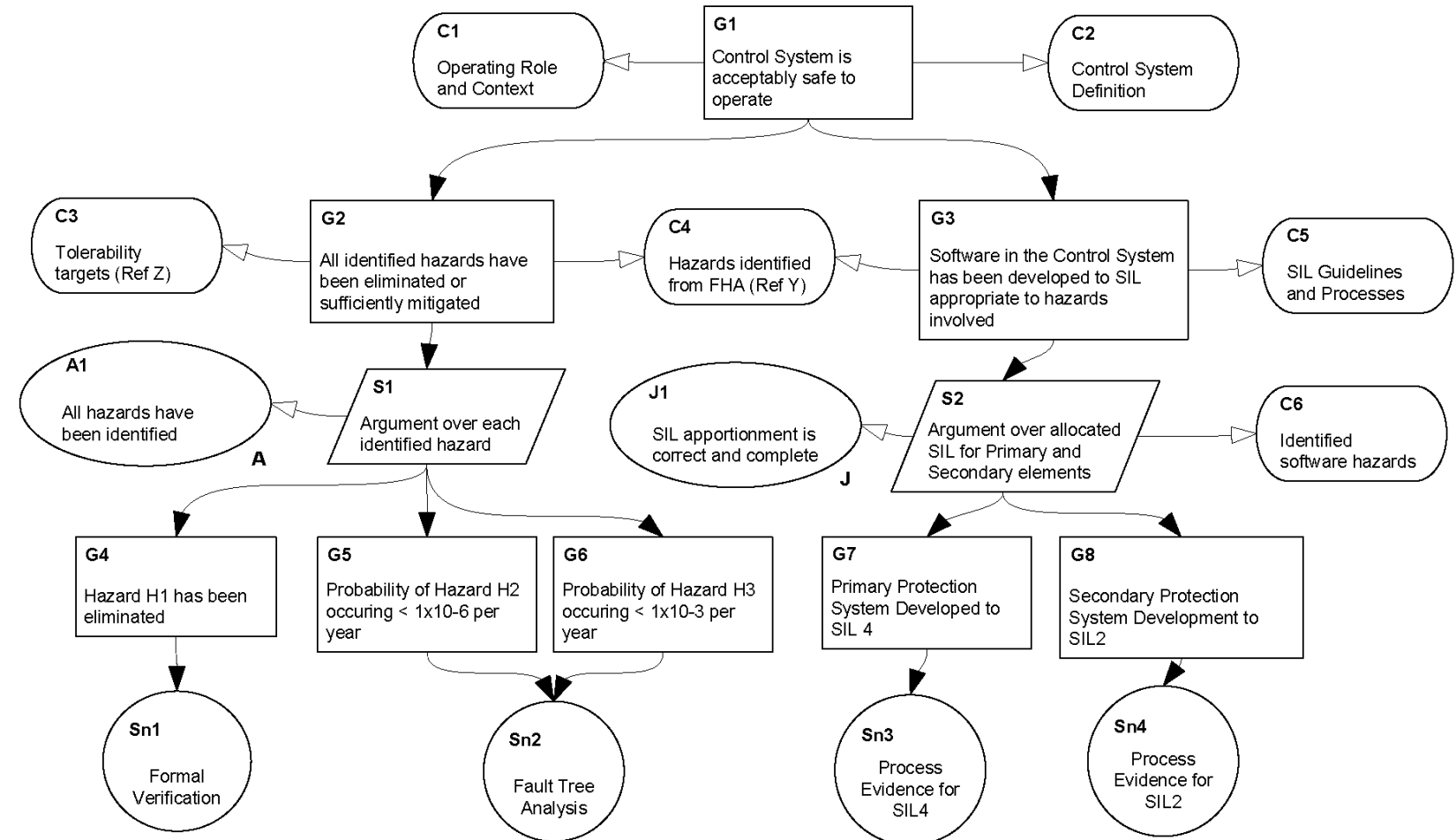
Solutioning

- The IV&V project teams gathered for a Process Development Kaizen (PDK) Lean event
 - Problem Statement: Our Artemis IV&V projects operate as independent projects. The projects' outputs are varied in some form and make it difficult to communicate across projects, roll-up assurance to the mission level, and prioritize work and resources across projects. This approach results in numerous process inefficiencies and variation in the deliverables with Artemis IV&V.
 - Primary Objective: For Artemis II and beyond, determine an Artemis-wide workflow to support scoping, performing, capturing and reporting assurance analysis independent of mission.
 - Primary output was an Implementation Plan identifying three further process development initiatives, as well as further requests from IV&V leadership



Assurance Cases

- An assurance case is a structured argument
- The GSN syntax provides a graphical notation for documenting an assurance case that supports scalability
- IV&V realized that we can build an assurance case that captures:
 - The decomposition of capabilities down to software components/functions
 - The strategy IV&V employs in planning analysis
 - The evidence captured as a result of analysis
- We still needed a way to build in a risk assessment layer over top of the assurance case to determine which branches should be in focus



Source: [GSN Community Standard \(Version 2\)](#)

Implementation

Assurance Architecture Focus Group

Objective: Develop the process and determine the tooling by which Artemis IV&V will develop and maintain the Assurance Case

Additional Goals:

- Lay out the first few levels of claims in the Artemis Assurance Case
- Map existing assurance architecture from Artemis I into the new Assurance Case
- Identify training needs

Risk Assessment Team

Objective: Develop the process and criteria by which all Artemis IV&V teams will conduct risk assessments for prioritizing at each level of decomposition

Additional Goals:

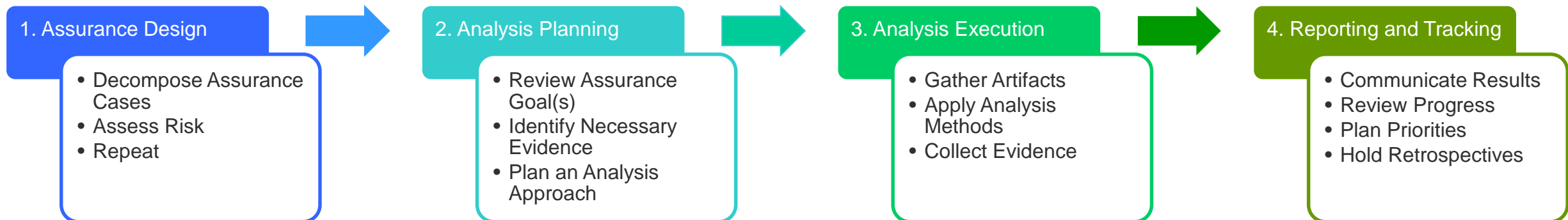
- Support selection of risk criteria and scoring with relevant industry research
- Validate the choice of criteria with a scoping/prioritization exercise based on Artemis I data
- Define an appropriate cadence to revisit risk assessments

Pilot Team

Objective: Test the approaches developed by the other two teams in an actual IV&V assurance case development exercise

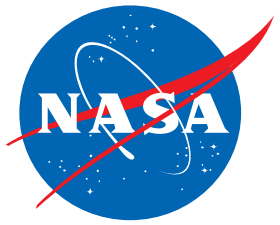
Additional Goals:

- Test the utility of the assurance case for “roll-up” of assurance and communication
- Identify and develop new work instructions for operating with the assurance case
- Collect lessons learned for use in training other team members





The Experience Thus Far



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Benefits

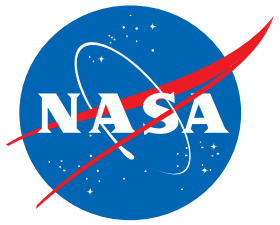
- The Lean event had the immediate effect of increasing cross-team communication, which continues almost a year later
- Establishing an Artemis IV&V Program has begun synchronizing planning and execution across all of the project teams
- The Artemis assurance case has made it easier to see the integration points where additional risk could exist
- Analysts have found building the assurance case to be an intuitive activity that helps build their system understanding

Drawbacks

- New training necessary to teach analysts how to build and use the assurance case
- A single tool solution that supports our process and requirements (esp. for multi-user platform) does not yet exist
- Growing pains across the Artemis team as analysts adapt to these new methods of planning and executing their work
- Building the assurance case requires additional effort to formally represent the assurance design



Looking Ahead

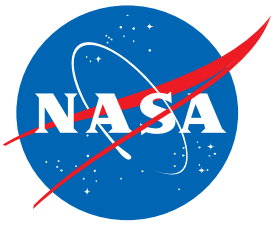


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- Stepping up adoption and use of the Artemis assurance case from ~10 analysts (currently) to the whole Artemis IV&V team (~85 analysts)
- Integrating the assurance case with our other tools
- Simultaneous development of assurance cases for Artemis II and III
- Migrating evidence and assurance from previous Artemis I assurance design constructs into the Artemis assurance case
- Building external communication and reporting features using the assurance case and toolchain
- Maintaining continuous improvement activities across the entire Artemis team



Questions?



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