This subtopic seeks innovative concepts and solutions for both addressing long-term ground processing and test complex operational challenges and driving down the cost of government and commercial access to space. Technology infusion and optimization of existing and future operational programs, while concurrently maintaining continued operations, are paramount for cost effectiveness, safety assurance, and supportability.

Strategies to optimize and support changes in operations concepts should consider:

- The needs of geographically distributed and mobile teams.
- Efficient configuration changes to support operations of different customers.
- Protection of information for the different customers.
- Infrastructure availability.
- Increased situational awareness for operators.

Technology areas of interest include:

- Strategies, technology innovations, and technology maturation of control room services to provide cost effective data handling and storage and standardized interfaces for data generated by dissimilar systems. Methods for rapid prototype of control and data systems software from engineering data, ensuring scalability of data presentation and streamlined communication, and methods to address and inform consumers of time delays in data transmission:
  - Cost effective solutions to connect control and data system software to facility models that provide for ease of use and maximize the return on investment for concurrent test and launch complex environments.
Approaches, such as a single console to perform command and control for a set of test resources or provisions for model-based diagnostic methods to provide rapid feedback on the test and launch complex environment state, can be explored.

- Methodologies for benchmarking, migrating, upgrading, and/or enhancing tools and control and data system architectures to lower the cost of technology infusion concurrently with the operational environment while reducing sustaining costs:
  
  - Focus should also be on system maintenance concepts for a highly COTS intensive environment to ensure configuration management and control, verification and validation approaches, technology refresh and security updates.
  
  - Innovative capabilities in information technology are required to provide robust and highly efficient information security for maintaining customer-specific intellectual property while providing a collaborative environment for launch and testing services.

- Optimization of ground controller and test conductor staffing and roles requirements through robust, innovative, and operator-infused simulation/training capabilities to efficiently train ground and test controllers in a collaborative environment. Objectives should focus on skills proficiency and maintenance for troubleshooting, decision making, and time management in critical situations.

- Migration of models used in the design and development of infrastructure to the operations/training phase (e.g., Model-Based System Engineering (MBSE) process).

- Cost effective solutions for operations automation including peer-to-peer planning, mixed initiatives, elicitation of constraints and preferences, and system software integration. Focus should be on the use of standards and open source software enabling staff reduction, fault isolation and recovery methods, and decrease of software integration costs. Additionally, on understanding the interfaces of planning/mixed initiative systems with diagnostic systems, as diagnostic systems will inform the planning system of the available resources.

- Prognostic technologies to optimize component maintenance, support, mission and test planning, evaluation of system component redundancy, monitoring of performance and safety margins, and critical decision making.

Proposed concepts would benefit from clean, well-defined, unambiguous interfaces that account for configuration changes over the ground processing and test complex timeline; such proposals will receive higher consideration. All concepts must place an emphasis on how the interfaces in the system behave. Approaches to model, verify, and validate interfaces will be of interest.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II demonstration, and delivering a demonstration package for NASA testing at the completion of the Phase II contract.

**Phase I Deliverables** - Research to identify and evaluate candidate technology applications to demonstrate the technical feasibility and show a path towards a demonstration. Concept methodology, infusion strategies (including risk trades), and business model. Identify improvements over the current state of the art and the feasibility of the approach in a multi-customer environment. Bench or lab-level demonstrations are desirable. The technology concept at the end of Phase I should be at a TRL of 4.

**Phase II Deliverables** - Emphasis should be placed on developing and demonstrating the technology under simulated mission conditions, including the mission of engine testing. The proposal shall outline a path showing how the technology could be developed into mission-worthy systems. The contract should deliver a demonstration
unit for functional and environmental testing at the completion of the Phase II contract. The technology concept at the end of Phase II should be at a TRL of 7