Active Project (2015 - 2017)

Fault Management Technologies, Phase II Project

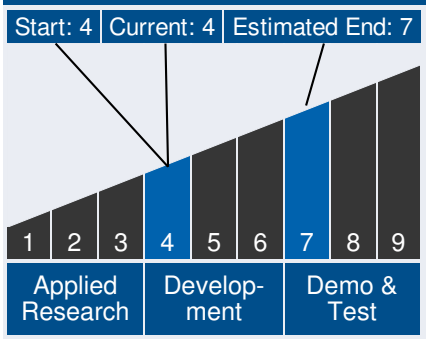
SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

There has been a renewed push across NASA centers and programs to make Systems Engineering & Integration (SE&I) processes more efficient and results-oriented than the current cumbersome and expensive cross-checking processes using text documents, and transition to a repeatable and a cost-effective process of Model Based Systems Engineering (MBSE). In parallel, Systems Health management (SHM), with its operational subset Fault Management (FM), has also been developing with rigorous model-based practices, but largely separate from the mainstream of Systems Engineering and Design activities in NASA and the DoD. The technical and knowledge gap between the SE&I and SHM processes results in significant inefficiencies during product design, verification and validation, and excessive operational maintenance costs, collectively yielding unacceptably high life cycle costs and failure rates. To address these challenged, QSI with Dr. Stephen Johnson, intends to develop tool neutral architecture, processes and interfaces for integration of model-based SE&I designed in SysML (Systems Modeling Language), with SHM modeling and analysis performed in TEAMS® (Testability Engineering And Maintenance System). It is our intention to reduce the duplicative and disjoint effort by NASA's subject matter experts in the development of systems engineering and design models as well as systems health management/fault management models. The benefits realized through this effort are (a) Reduced systems engineering and fault management costs, combined with improved quality and traceability, as well as enhanced communication and coordination among stakeholders, (b) Improved quality of SE&I and SHM products by having inherent traceability across models and ability to catch defects in design and FM earlier, and (c) Establishment of modeling recommendations for NASA community as it develops its MBSE approaches and models.

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed effort will have significant range of applications across various NASA multi-disciplinary engineering centers that are in charge of System Design where FM is an integral part of the System Design process. Clearly establishing the relationships between the design goals/intents and the consequent sub-goals, and derived state variables in the success space, with their complements in the Failure-space domain as practiced in TEAMS® Toolset widely used across NASA will be of tremendous value to NASA's Systems Engineering and SHM communities. One such clear application is the Space Launch System (SLS), managed by Marshall Space Flight Center. The QSI team has close relationship with the NASA MSFC SHM team responsible for the design of the FM system who are also current users of the TEAMS® software. Likewise other immediate applications of this technology will be with the Orion Multi-purpose Crew Vehicle (MPCV) Program, managed by Johnson Space Center, and the Ground Systems Development and Operations Program, the operations and launch facilities at NASA's Kennedy Space Center in Cape Canaveral, Florida. Other strong users of SysML, with strong FM programs include Glenn Research Center, Ames Research Center, and Jet Propulsion Laboratory. The aviation programs at ARC and at Langley Research Center are also likely long-term beneficiaries of this project, to translate design information into operations and maintenance models such as TEAMS® specializes in.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Among the other agencies that follow a strict system engineering and design process somewhat similar to NASA's are DoD institutions such as the Missile Defense Agency, Air Force and Navy. These are the most likely potential customers for the resulting technologies. Design verification and validation of Complex

Management Team *(cont.)*

Principal Investigator:

- Sudipto Ghoshal

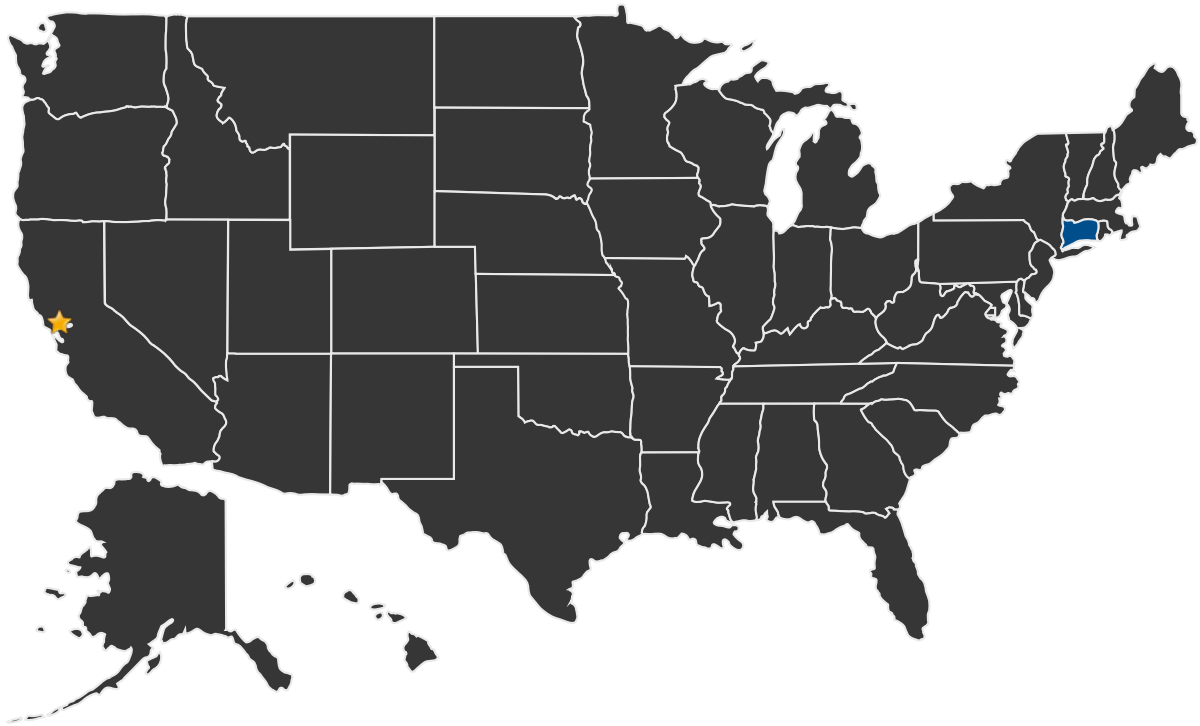
Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
- Revolutionary Concepts (TA 5.6)
  - Reconfigurable Large Apertures (TA 5.6.7)
    - Reconfigurable Large Aperture Technologies (TA 5.6.7.1)

Secondary Technology Area:
Robotics and Autonomous Systems (TA 4)
- System-Level Autonomy (TA 4.5)
  - System Health Management (TA 4.5.1)

military systems (systems of systems) such as NORAD, Space Command ground segments, the Joint Strike Fighter fleet, the Navy shipboard platforms, Ballistic Missile Defense (BMD), etc. for the purpose of reliable and cost effective system and FM design can be ensured by using the targeted capabilities implemented in TEAMS®. In addition, UAVs, UMGs and other unmanned submersible vehicle markets where the FM aspects of system design is required to be highly efficient and cost-effective because of the natural budgetary pressures, could also be potential targets for the proposed technology. The product is also expected to be of commercial value to the manufacturers of DoD and military's remotely guided weapons and reconnaissance systems where the vendors supply health management systems/schemes for them. Outside of the DoD, electrical power and nuclear power utilities also require rigorous modeling techniques such as those developed here. The automotive industry is also now adopting more formal methods than in the past, largely drawn from aerospace applications but adapted to the automotive context.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Other Organizations Performing Work:

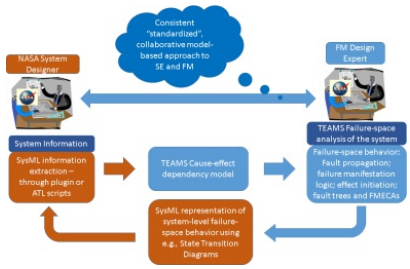
- Qualtech Systems, Inc. (East Hartford, CT)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/22868)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

Fault Management Technologies

Potential Applications

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