Distributed Autonomy

(Team Sequence Execution)

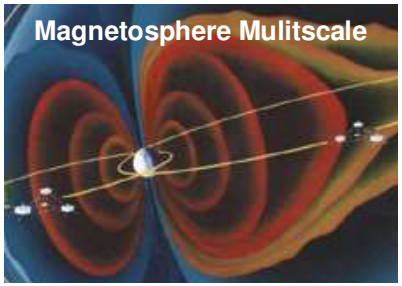
PI: Anthony Barrett

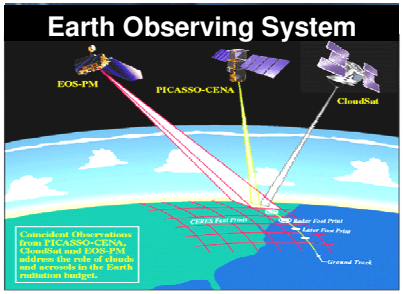
Team: Seung Chung

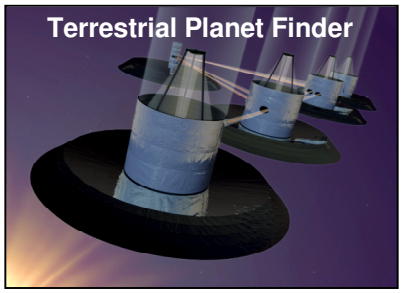
Summary of Objectives

- To simplify the implementation of joint activity sequences.
- Target Mission Class: Missions requiring joint activities.
  - Signal isolating formations like Terrestrial Planet Finder, MAXIM Pathfinder, Constellation-X, and LISA.
  - Signal space covering sensor webs like Magnetospheric Multiscale and Magnetospheric Constellation

Types of Multi-Platform Missions



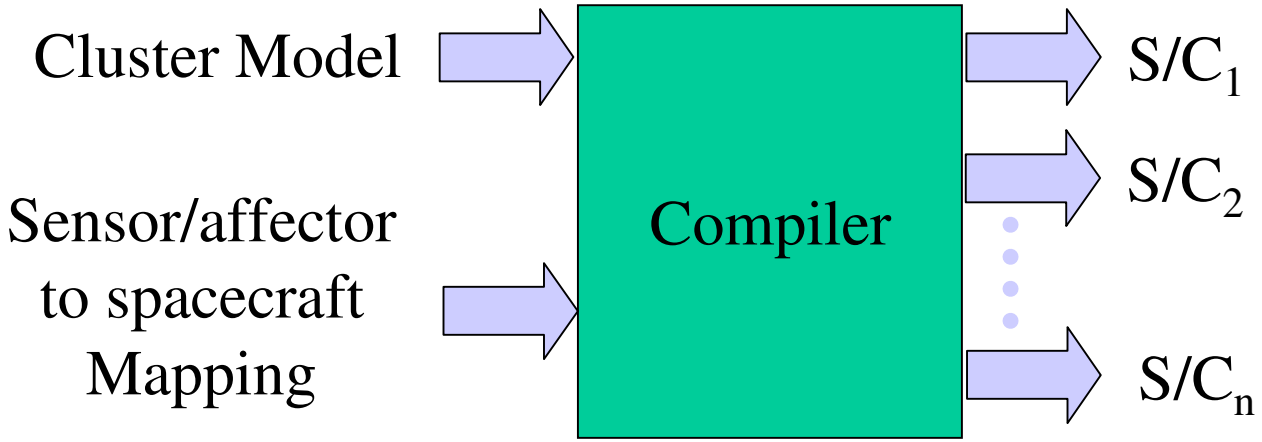




- Signal Space Coverage
  - Multi-point observations of global phenomena
- Signal Combination
  - Coincident observations with different sensors for signal response determination
- Signal Isolation
  - Synthetic apertures for high resolution

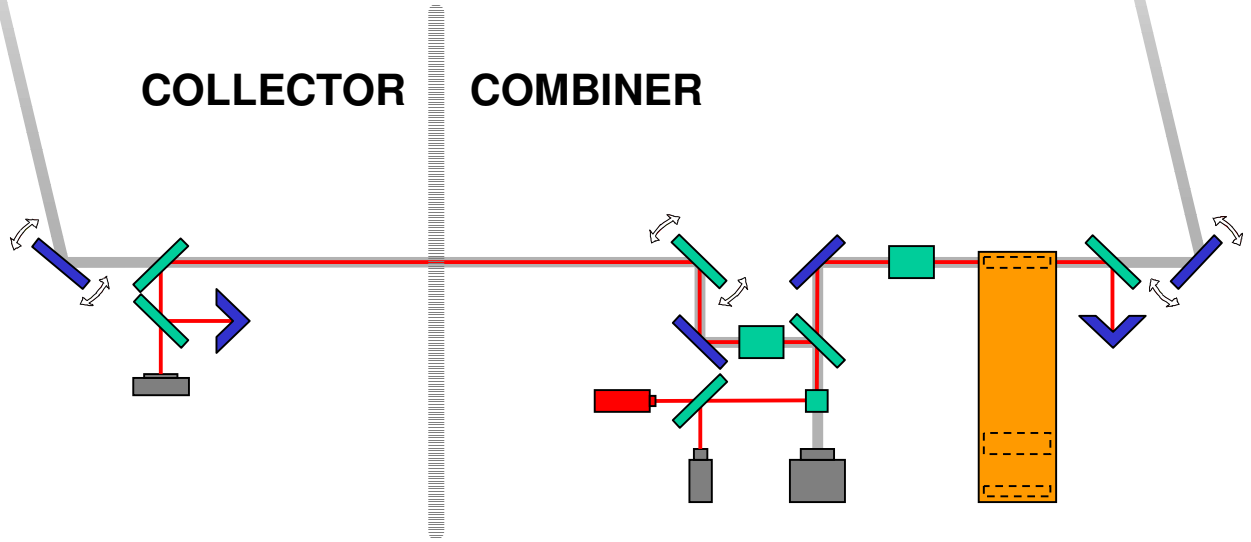
Approach

- Model the cluster as a single spacecraft
- Map control and sensor lines to actual spacecraft
- Compile the model and distribute it across the spacecraft.

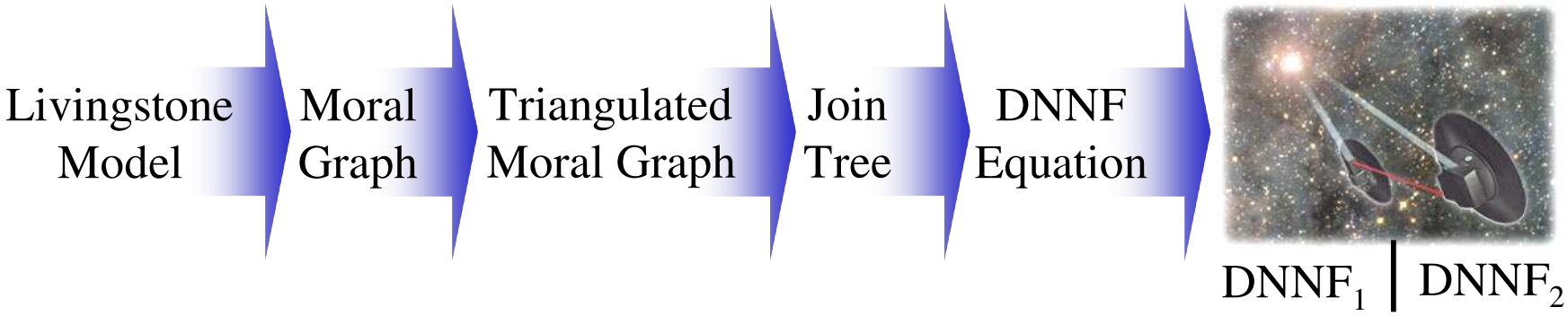


Test Model

- Model the interferometer as a single spacecraft
- Map control and sensor lines to actual spacecraft
- Compile the model and distribute it across the 2 spacecraft.

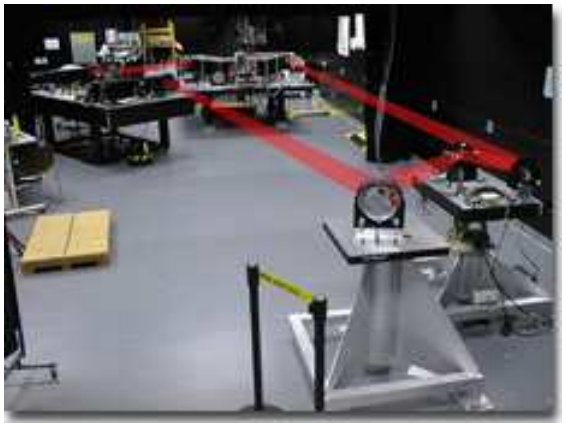


Obtained Results



- Compiled a interferometer model into Decomposable Negation Normal Form (DNNF) Boolean equation (of variable assignments) with breakdown for each spacecraft.
- Analyzed communication during distributed mode estimation to determine that it rises with interaction complexity (not spacecraft complexity).
- Paper abstract “Distributed Real-time Model-based Diagnosis” by S. Chung and A. Barrett accepted for publication at next IEEE Aerospace Conference.

Current/Future Activity



- Negotiating with Starlight personnel to integrate with their Formation Interferometer Testbed (FIT) in order to retire perceived complexity related risks to the Terrestrial Planet Finder mission.
- Extending the system for distributed mode reconfiguration.
- Combining teamwork with RMPL.

Team Sequence Execution for Cluster Operations

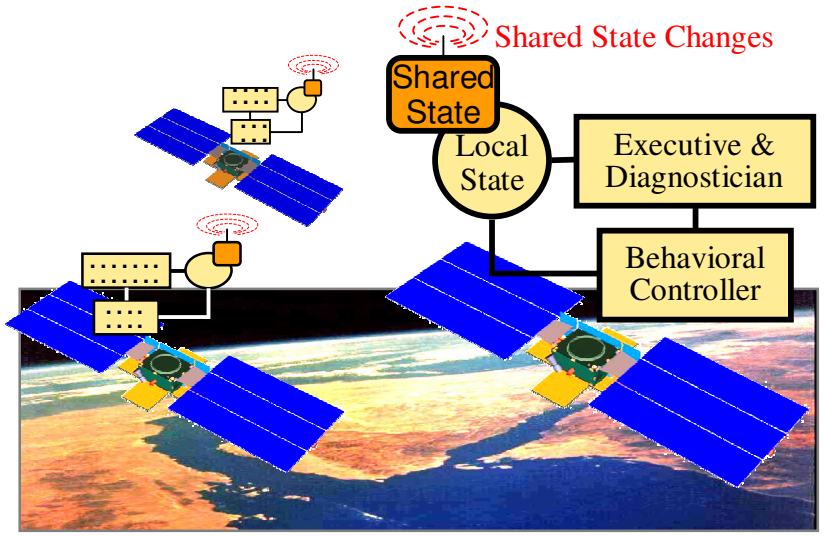
Anthony Barrett/JPL

Goal: Enable collective commanding of distributed missions that require close coordination.

Objectives: Develop an integrated cluster management system that controls a cluster of spacecraft with a single hierarchical team plan instead of explicit command sequences for each spacecraft.

Key Innovations:

- Flexible behavior-based teamwork infrastructure
- Distributed Multiple-Objective Behavior Coordination
- Negotiation based distributed diagnosis



NASA Relevance:

- Enable missions with multiple spacecraft that closely coordinate. Such missions include: Bidirectional Reflectance Distribution Function (BRDF) S/C Clusters; Synthetic Aperture Radar (SAR) S/C Clusters; and Radio and Optical Interferometers
- Reduce Operations Tedium and Costs.

Accomplishments to date:

- Paper: “Representation and Execution of Plan Sequences for Multi-Agent Systems,” IROS-01
- Paper: “Distributed Real-time Model-based Diagnosis,” To appear in IEEE Aerospace 2003

Schedule:

- FY01: Teamwork infrastructure prototype on top of CAMPOUT multi-robot control system (for TechSat-21 scenario).
- FY02: Model-based teamwork executive for performing team sequences with distributed diagnosis and error recovery mechanisms.
- FY03: Demonstration of system retargeted to a Magnetospheric Multi-scale scenario (simulation) or for hardware tests on Formation Interferometer Testbed.