

Starling – Objectives and Preparation for Launch

Small Satellite Conference
NASA Short Talk



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August 9, 2022

Starling Summary

Mission:

- Starling will fly 4 x 6U spacecraft in LEO
- Launch via Firefly Alpha from Vandenberg (Fall, 2022)
- 565 km, sun-synchronous orbit

Objectives:

- Primary Mission - Test and demonstrate multiple swarm technologies (6 months)
- Mission Extension - Demonstrate autonomous collision avoidance with SpaceX Starlink constellation (12 months)

Funding:

- NASA Space Technology Mission Directorate (STMD)
 - NASA Small Spacecraft Technology Program (SST)
 - NASA Game Changing Development Program (GCD)



Partners:

- | | |
|------------------------------------|--------------------------------|
| • NASA Ames Research Center | • NASA Launch Services Program |
| • Blue Canyon Technologies | • NASA CARA Office |
| • Emergent Space Technologies Inc. | • SpaceX |
| • CesiumAstro Inc. | • Stanford University |
| • L3Harris Technologies Inc. | • US Dept of Commerce |
| | • UT Austin |

Swarm Technologies in Starling

Network communication protocols:

(MANET – Crosslink/Networking)

- Automatically create and maintain a mobile adhoc network in space
- Implement BATMAN routing protocol and demonstrate onboard network management (scalable to 100s of spacecraft)

Cluster flight control algorithms:

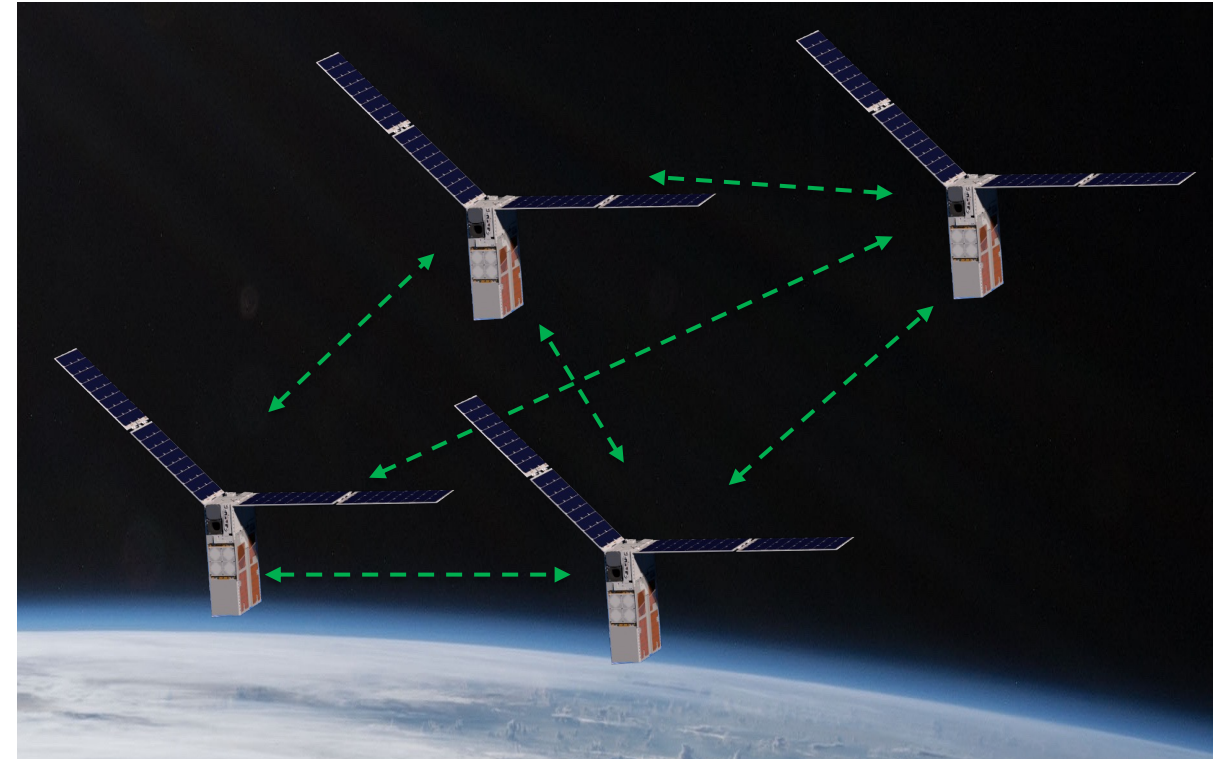
(ROMEO – Onboard Cluster Flight Control)

- Autonomously maintain relative vehicle positions (e.g., GPS, ADCS, Prop)
- Implement Cluster Flight Application (CFA) in payload software and demonstrate automated cluster/swarm station-keeping

Relative navigation algorithms:

(StarFOX –Relative Navigation)

- Continuously estimate relative vehicle positions using standard spacecraft components (i.e., star trackers)
- Implement Stanford's relative navigation algorithms in payload software and demonstrate for both in-train and passive safety ellipse formations



Autonomous reactive operations software:

(DSA – Distributed Spacecraft Autonomy)

- Autonomously adapt onboard science measurements in response to sensor data
- Detect Total Electron Count (TEC) using bus L1/L2 GPS receiver and have swarm autonomously change observation tactics

Extended Mission Overview

Goal: Demonstrate enhanced space traffic management between different owner/operators of Low Earth Orbit (LEO) spacecraft

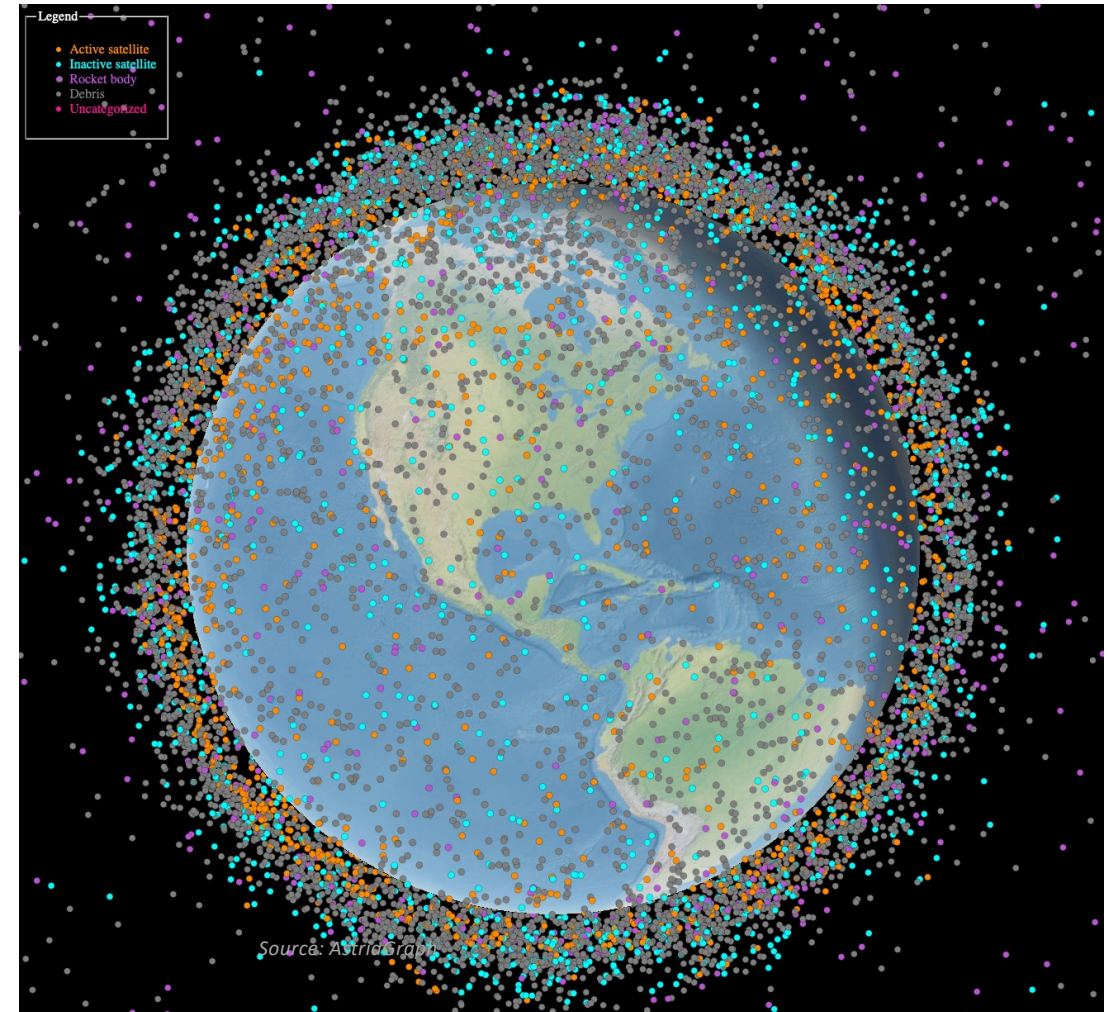
- Partner with SpaceX's Starlink constellation to demonstrate coordinated conjunction assessment and collision avoidance

Current State-of-the-Art

- 18th Space Control Squadron predicts conjunctions and issues warnings to owner/operators when a conjunction event passes a threshold
- Coordination via phone/email to arrive at a course of action
- Does not scale with the number of satellites being put into LEO including those with autonomous maneuvering

Objectives:

- Starling will demonstrate onboard CA:
 - Continuous checking of passive/active maneuvering objects
 - Planned Maneuvers
- Demonstrate a ground-based space situational awareness (SSA) / space traffic management (STM) hub that facilitates on-orbit autonomous CA/COLA
- Demonstrate collision avoidance (COLA) maneuver of Starling spacecraft in response to an onboard CA detection



Prep for Launch

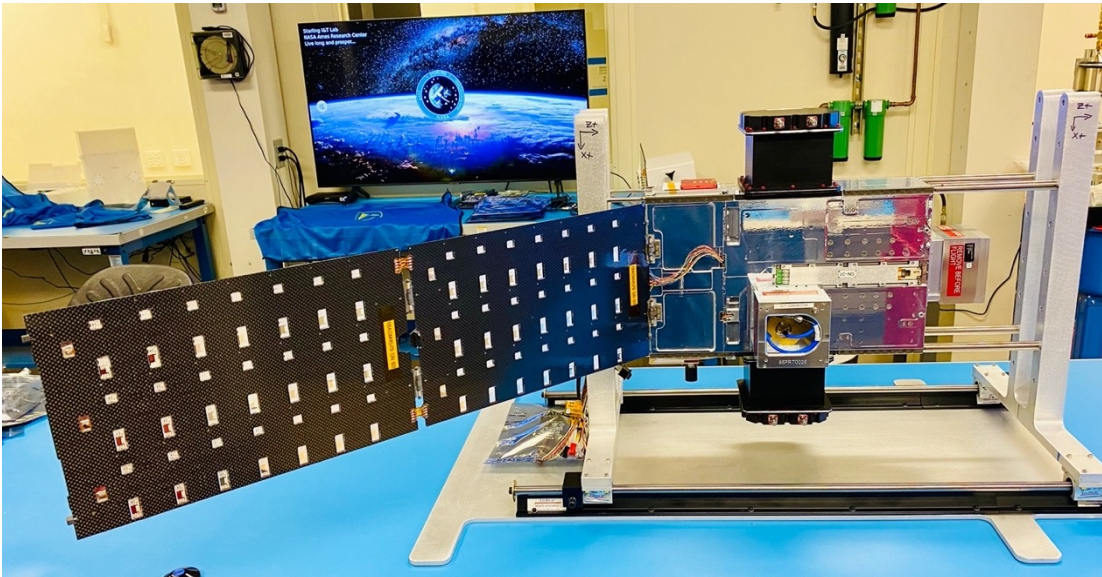
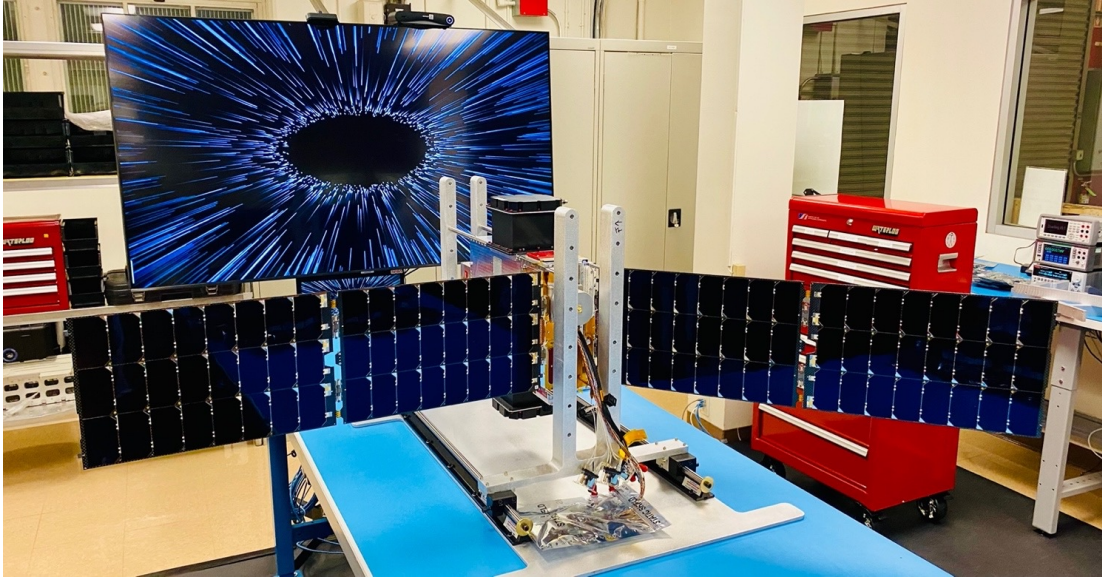
Progress
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Phase	Name
A	Concept & Tech Dev
B	Preliminary Design
C	Final Design
D	Integration & Test
E	Operations
F	Closeout

Phase D:

- Spacecraft Buses completed and shipped to NASA Ames ✓
- Payload/Prop assembled into all Flight Systems ✓
- Environmental tests on all Flight Systems (e.g. Vibe, TVAC) ✓
- End-to-End Testing with KSAT RF Compat Equipment ✓
- Software Update Testing ✓
- Completed fit check with Firefly Dispenser ✓
- Receive RF Spectrum licenses ✓
- Operations Security Agreements ✓
- Final release of Ground Data Systems Software ✓
- Mission Operations Sims and Readiness Tests ✓
- Day-in-the-Life and Swarm Communications Testing
- Final Payload/Prop Software load and regression test
- Pack and Ship Spacecraft to Launch Site

Spacecraft Hardware



Images show Starling Spacecraft in AI&T

Solar Array Deployment Demo



Blue Canyon Technologies spacecraft bus solar array deployment 7