

Starling Swarm Technology Mission Status and Extended Mission

Small Satellite Conference
NASA Short Talk



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Starling Summary

Mission:

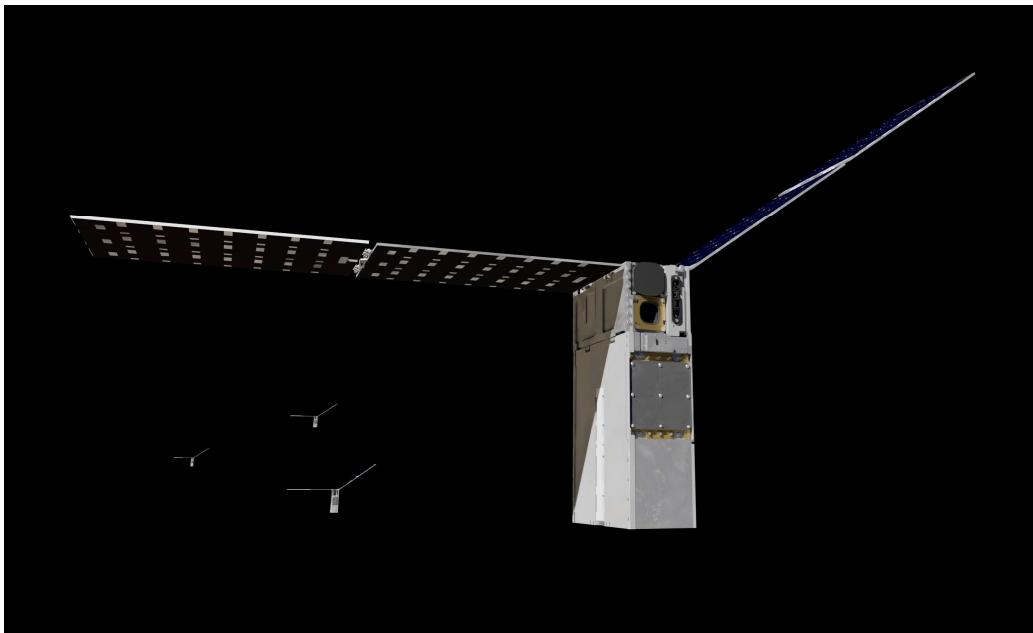
- Starling is operating 4 x 6U spacecraft in LEO
- Launched via Rocket Lab Electron from LC1 Complex in Mahia, New Zealand on July 17, 2023
- ~575 km, sun-synchronous orbit

Objectives:

- Primary Mission - Test and demonstrate multiple swarm technologies (6 months)
 - Reconfiguration and Orbit Maintenance Experiments Onboard (ROMEO)
 - Mobile Adhoc Network (MANET)
 - Starling Formation-Flying Optical Experiment (StarFOX)
 - Distributed Spacecraft Autonomy (DSA)
- Mission Extension - Demonstrate autonomous collision avoidance with SpaceX Starlink constellation (9 months)

Funding:

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



Partners/Vendors:

• NASA Ames Research Center	• Rocket Lab
• Blue Canyon Technologies	• NASA CARA Office
• Emergent Space Technologies Inc.	• SpaceX
• CesiumAstro Inc.	• Stanford University
• L3Harris Technologies Inc.	• US Dept of Commerce
	• UT Austin



Primary Mission Status

Mission Operations Phase:

- Launch and Deploy ✓
- Spacecraft Bus Commissioning ✓
- Payload Commissioning ○
- Propulsion Commissioning ○
- Drift Arrest Maneuver
- Begin Swarm Technology Experiments
- Passive Safety Ellipse Maneuver 1
- Passive Safety Ellipse Maneuver 2
- Swarm Technology Experiments complete
- Begin Mission Extension



Image Credit: Rocket Lab

Starling Extended Mission



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

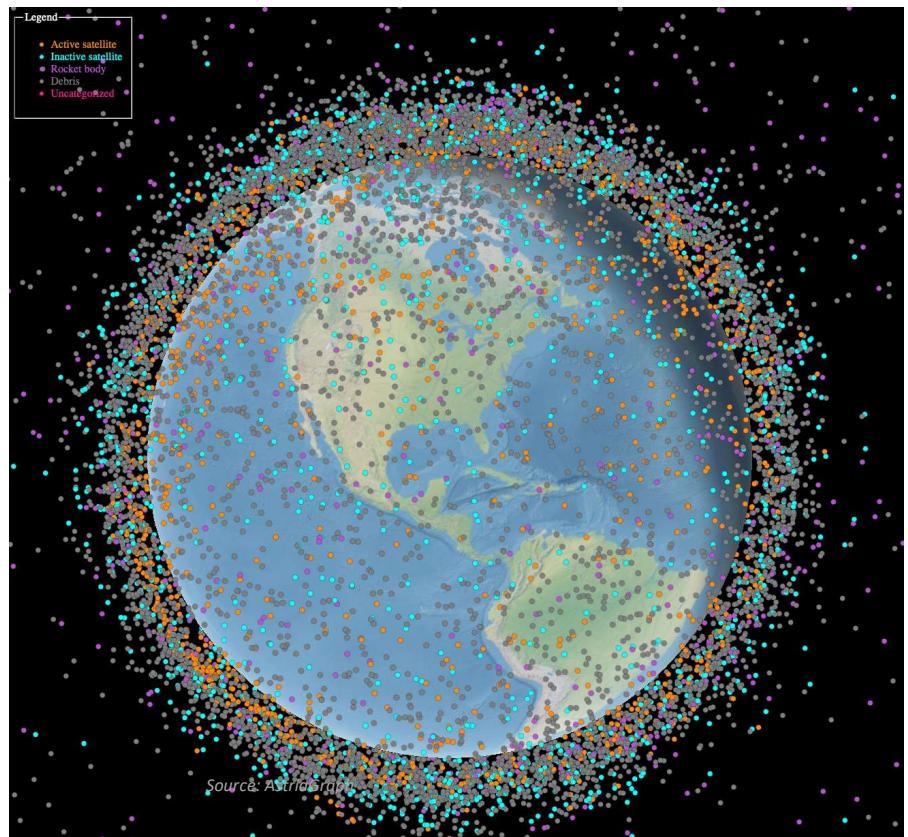
- Partner with SpaceX's Starlink constellation to demonstrate coordinated conjunction assessment and collision avoidance

Current State-of-the-Art

- 18th Space Defense 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



Extended Mission Demo Overview



- Satellites calculate Probability of collision (Pc) for conjunctions
- If high Pc event, plan collision avoidance (COLA) maneuvers
- Perform COLA maneuver once screened through the Ground Hub
- Maneuver responsibility claims and future trajectory intentions shared via Ground Hub
- Automates maneuver acceptance through the Ground Hub, rather than requiring operator-to-operator negotiation



Image Source: SpaceX

Conjunction Data Messages (CDMs)
Maneuvers Accepted/Rejected

Updated Orbit States
Proposed Maneuvers

Updated Orbit States
Proposed Maneuvers

Conjunction Data Messages (CDMs)

STM Ground Hub

- Receives planned trajectories from Starling/Starlink
- Provides CDMs w/ Pc for Starling/Starlink
- Tracks maneuver responsibility claims between owner/operators



Extended Mission Status

- Partnership and objectives established
- Requirements Assessment complete
- Critical Design Assessment complete
- Fully featured software development complete
- Further verification/validation in summer and fall '23
- Operational Readiness Assessment scheduled for Nov '23
- Starling 1.5 operations to commence Jan '24