Chain Mail

AEROSPACE

Network messaging to accurately determine satellite positions

Sabine Neutron, Owen Torque

JO 8888-88

Venture Line	Prairie	Burn Rate	30	hrs/wk		
RFP Target	Zero-24-7 SSA	ODC	$5K	($K)	Capital	$10K ($K)

Proposal Pitch

Chain Mail is for quickly determining satellite position, addressing a major challenge for operators of proliferated LEO constellations.

This is done by routing a message through the on-orbit satellite network and using AI to reverse engineer locations at the end of the message.

End-of-Sprint Summary

Simple operations tasks with individual satellites become exponentially more difficult and time-consuming with proliferated constellations containing thousands of satellites.

At the end of the first sprint, we will demonstrate the protocols, algorithms, and AI methods needed to route a message across a network of nodes (satellites) and determine their physical location when the message was routed through each one.

As a proof-of-concept, we will demonstrate this with crosslinked robot cars. We will focus on function first and then optimize performance using objects moving in three dimensions in a subsequent sprint.

We are requesting $10K in capital to purchase a motion monitoring system to give us truth data.

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Use Case/Reference Mission

Passive tracking of satellites using ground-based sensors will be inefficient with proliferated constellations, which can have thousands of satellites. These constellations will have to participate in helping operators gain Space Situational Awareness (SSA) by actively providing their location.

FY20 Project Plans

We will build an AI framework using TensorFlow and possibly SageMaker. With this framework, we can quickly test out the best AI approaches found in the open literature. In parallel, we will partner with a project in the Dynamic Venture Line to test the algorithms on their testbed of robot cars.

Additional Information

There is a direct analogy between determining the position of satellites in an on-orbit network and the same problem applied to a mesh network of smart objects in an Internet of Things (IoT) architecture. We can leverage the algorithms and methods developed for terrestrial (mostly consumer products) IoT and apply that to satellites.

We are focused on the AI aspects of this project and are partnering with a comm and robotics team to assist us with the planned demonstrations.

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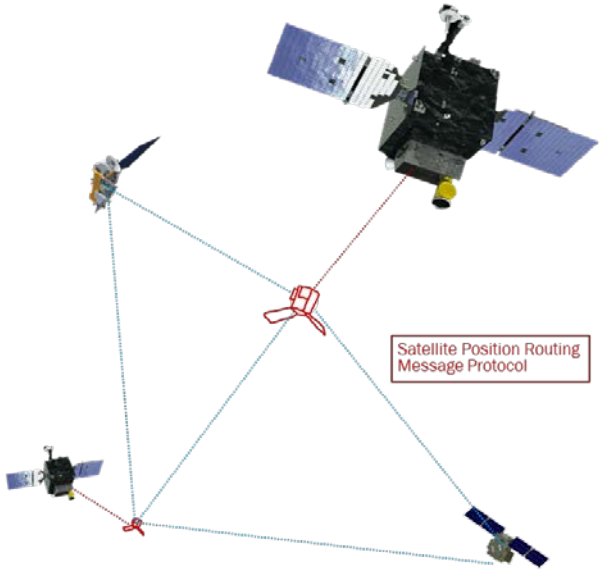
With the Chain Mail project we created the **Satellite Position Routing Message Protocol** (SPRMP), a lightweight approach for satellites to share key position information that can be processed on the ground to get an accurate picture of their positions in space. For FY20, we will focus on accommodating satellites that do not generate robust position information onboard.



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FY20 (Gen 1)

Demonstrate, using robot cars, that routing network messages can yield position. Show through simulations that the approach works for giving relative position between satellites.

Key Enablers

- Simple and fast to program robot cars for the demonstration
- Satellites are crosslinked
- AI algorithms to determine position of nodes in a mesh network

FY21 (Gen 2)

Demonstrate, using drones or on-orbit satellites, accurate enough position to support lasercom. Show through simulations we can predict when a satellite is not where it is expected.

Key Enablers

- Simple and fast to program drones for the demonstration
- Sufficient on-board processing capabilities to support real-time AI
- Predictive analytics AI to predict the satellite positions of nearest neighbors

FY22 (Gen 3)

Routinely demonstrate real-time position determination with on-orbit satellites. Shownthrough simulations, improved processing efficiency to support real-time, on-board AI.

Key Enablers

- Satellite fleet with crosslinks for the demonstration
- Truth data from a secondary source