NASA

DUST-Off! Advancing the DUST Concept to Flight

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Program: SURP

Project Objective:

Distributed Universal Satellite Technology (DUST) aims to demonstrate spaceborne mesh networking via three 3U CubeSats, each capable of crosslink and downlink communications. A DUST Tech Demo would enable superior LEO, lunar, and interplanetary communications architectures with a constellation of distributed satellite nodes. While advancing the DUST project to the stage of a CubeSat flight demonstration, the DUST team and JPL partners will train the next generation of space system architects on the steps relevant to flight subsystem TRL advancement.
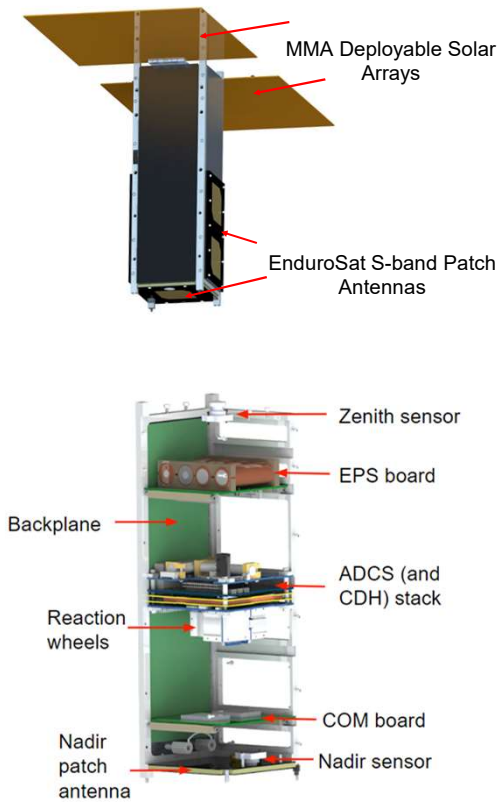
Significance of Results

- Development of low-cost, high reliability, scalable spaceborne intersatellite communications network
- Enable distributed sensing and mesh networks for exploration/communications in LEO, lunar, and interplanetary applications
- Demonstrate low-cost CubeSat technology mission viability
- Train the next generation of satellite engineers on mission development and technology maturation.
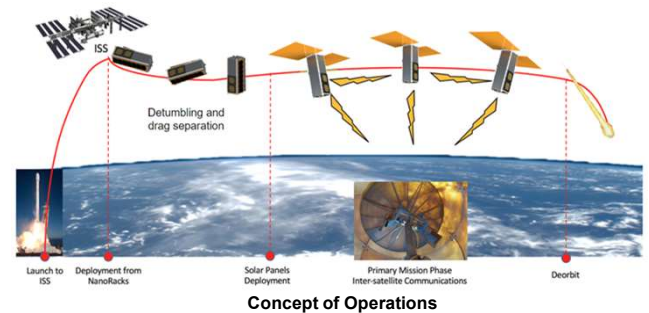
FY18/19 Results:

- Developing standalone communications board
- Testing of the BATMAN communications protocol with openWRT OS on the VoCore2
- Improvements to thermal modeling via Thermal Desktop and Ansys Icepak
- Improvements to systems engineering documentation
  - Requirements
  - Concept of Operations
  - Interface Control
  - Team Organization

CubeSat Structure:

MMA Deployable Solar Arrays

EnduroSat S-band Patch Antennas

Zenith sensor
EPS board
Backplane
ADCS (and CDH) stack
Reaction wheels
COM board
Nadir patch antenna
Nadir sensor

LEO Mission Concept:

- 3 CubeSats in LEO (400km)
- 2 accesses to GS per day
- Link status monitored as separation increases
- Low-cost, high reliability, scalable mission concept

ISS
Detumbling and drag separation

Launch to ISS | Deployment from NanoRacks | Solar Panels Deployment | Primary Mission Phase Inter-satellite Communications | Deorbit
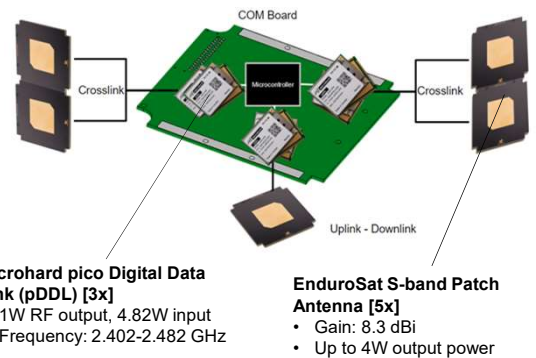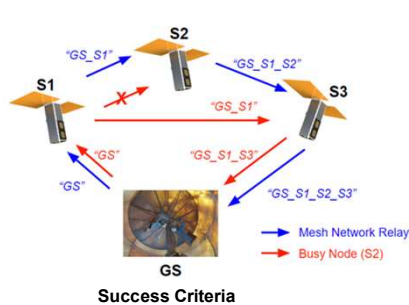
Concept of Operations

Mesh Network

- Network is self-repairing, adaptive to faulty/busy nodes
- Shortest path, multi-hop method of message transfer
- Can autonomously add compatible nodes

Communications Link

- S-band, megabit communications
- Each CubeSat capable of up/down-link and cross-link
- Frequency Division Multiple Access multiplexing between interfering links

S2
S1
S3
"GS_S1"
"GS_S1_S2"
"GS_S1"
"GS"
"GS_S1_S3"
"GS"
"GS_S1_S2_S3"
→ Mesh Network Relay
→ Busy Node (S2)
GS
Success Criteria

COM Board
Crosslink
Microcontroller
Crosslink
Uplink - Downlink

Microhard pico Digital Data Link (pDDL) [3x]
- 1W RF output, 4.82W input
- Frequency: 2.402-2.482 GHz

EnduroSat S-band Patch Antenna [5x]
- Gain: 8.3 dBi
- Up to 4W output power

Publications:
Della Bosca, Emanuela, D. McKague, J. Velazco, J. Smith, P. Ahnn, M. Beam, J. Boyce, M. Black, "The Distributed Universal Satellite Technology (DUST) Tech Demo: an Inter-satellite Communications Mission," 14th Annual Pre-conference Workshop, Small Satellite Conference, Aug 5, 2017, Logan, UT USA.

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