MAST: A Low-Cost Investigation of Space Tether Survivability and Dynamics

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• **Goals:** Use CubeSat platform to conduct low-cost flight experiment to obtain data on:
  – Tether survivability in Micrometeoroid/Orbital Debris environment
  – Tethered formation dynamics
  – Validation of tether dynamics models

• Three 1-kg, (10cm)³ CubeSats
  – Deployer, Inspector, Propulsion

• 1 km Hoytether™ constructed of metalized PBO or Aracon

• Middle “Inspector” CubeSat crawls along tether & scans tether for micrometeorite/orbital debris damage

• GPS units on CubeSats provide tether dynamics data

• Targeting flight in Mid ‘04
MAST Block Diagram

Deployer

Inspector

Communications/Propulsion

* denotes mission specific component not required
ONLY for MAST mission
Phase I effort has focused on a subset mission configuration of MAST called “STRING” to enable the student team to complete prototype hardware within manpower & academic schedule limitations.
Inspector CubeSat

• Middle CubeSat will crawl slowly along the tether
  ~ 3 months for full scan

• A small digital camera or linear array will be used to take electronic pictures of the tether

• MAST will downlink photos to ground station for analysis of M/OD damage rates

• Inspection of other M/OD damage to other tethers and other materials (solar sail, inflatables, etc.) is possible
Deployment

- MAST tether deployer is a smaller version of the deployer developed & tested for RETRIEVE project
- TiNi pin puller used to initiate deployment
- 4 springs provide ~3 m/s initial separation velocity
MAST Tether Spin-Up

- Addition of a microthruster to spin up tether system would enable study of rotating tether dynamics
- Would enhance MAST to obtain data on rotating tether dynamics relevant to:
  - MXER Tethers
  - Tethered Formation Flying
- At a commanded time, the Propulsion/Communications CubeSat will use a tether separation mechanism to release from the tether

- Spin-up of system simulated with TetherSim tool
  - Rough 1-axis stabilization achievable with MEMS gyros (<0.1° drift/sec) sufficient to enable thruster-based spinup
  - 25 mN for 100 sec
Phase I Mid-term Status & Plans

• Mission requirements & CONOPs defined
• Design and layout of Deployer & Communications CubeSats completed
• Concept design & proof-of-concept prototyping of Inspector CubeSat

• Targets for end of Phase I:
  – Prototype Deployer & Communications CubeSats
  – Preliminary design of Inspector CubeSat

• Phase II
  – Protolflight units of full MAST 3-CubeSat configuration
  – Flight test in ‘04 or ‘05