Stanford Lunar Analysis Mission: SLAM

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What is SLAM?

- Feasibility & preliminary design study
- Can we send CubeSats to the Moon?
Keypoints

- We *can* send CubeSats to the Moon
- Space Systems Development Lab (SSDL) future mission
- Low power CubeSats and high power, high gain carrier
- Hierarchical communication network
Motivation and Goals
Stanford on the Moon

- Stanford alumni organization
- Customer Goals
  - Multidisciplinary mission in next decade
  - Expand Stanford capabilities in space
  - Stanford initiative
  - Garner attention and fundraising for SOM future missions to establish Stanford presence on Moon
Lunar Mission Goals

- Satellite mission to Moon in next five years
- Collect data to further human missions
- Broadcast back to Earth
  - Beat Cal!
- Stanford science & engineering involvement

Images courtesy of Stanford Magazine
Lunar Mission Statement

- To design lunar satellite missions that can be carried out in large part by the Stanford community
- Determine existing Stanford infrastructure and capabilities

Image courtesy of www.stanford.edu
Why Do It?

- Educational opportunity
- Extend university capabilities in space
- Gather data about the moon
- Outreach tool
- PR opportunity for Stanford
- Increase public interest in space
- Competition
- To have FUN!!
Lunar Mission
Lunar Mission

- 6 CubeSats
- Carrier
  - Hybrid Engine
  - \(\Delta v \sim 7.7\text{km/s}\)
- Launch Vehicle
  - \(\Delta v \sim 3.1\text{km/s}\)
- Swing-by Mission
- Cost
  - \(~\$2\text{ million}\)

Courtesy of www.asi.org
CubeSats

- Volume: 10 x 10 x 10 cm³
- Mass ~ 1 kg
- Power ~ 1 W
- CubeSat Kit
- Advantages:
  - Lost cost (KISS)
  - Fast turnaround
  - COTS
- Prevalence: 70 universities worldwide
- Successes: ~10 launches

Images courtesy of © ISSL, University of Tokyo, JAPAN
Mission Organization

Sponsor - Stanford on the Moon

STANFORD Aeronautics & Astronautics

Space Systems Development Laboratory (SSDL)

Subsystems

Payloads and technology

Ground Operations

Launch Vehicle Provider

Hybrid Rocket

Adapted from KatySat.org
Communication

- **Architecture**
  - Earth-Moon distance 
    ~ 384,000km
  - Carrier-Earth
    - High power, high gain carrier
    - Attitude control
  - Local to Moon
    - Low power CubeSats and carrier
Communication

- Sat → Carrier → Ground
  - Routine reporting in cyclic order
  - Local IP networking
  - FIFO queuing of messages
  - Message flagging
  - Carrier onboard processing/direction

- Ground station networks
  - Mercury network
  - Purchase time

- Memory issues
  - Orbit vs. quick flyby storage requirements
Summary

- Feasible lunar CubeSat mission
- Preliminary mission design
- Hierarchical communication network

- *Let’s get to work!*
Thank you!

Questions?

For more info
http://ssdl.stanford.edu
http://www.stanford.edu/~kldavis/SLAM