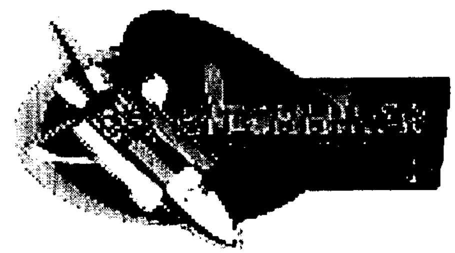
481306
45p

Hitchhiker Payload Mission

by

Stephen Horan

NMSU-ECE-99-017



Mission Objectives

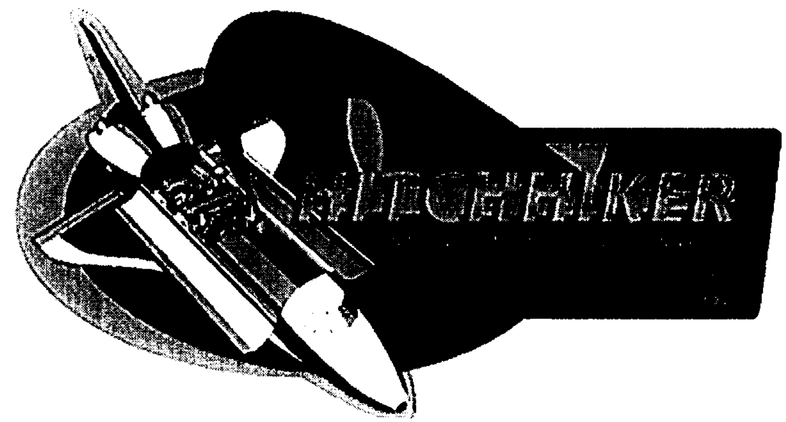
EE 498 - Capstone Design I
Fall 1999

Test Methodology

- Test primary objective via
  - operation of the payload on-orbit
  - obtaining valid engineering data
  - analyze the results
  - publish the results

Secondary Objectives

- Educational and program development for NMSU students and faculty through Undergraduate learning experience, NMSU gaining flight experience and congressional, NASA, and public good will



High-Level Mission Requirements

EE 498

Fall 1999

Functional Requirements

- Performance
- Coverage
- Responsiveness
- Secondary Mission

Mission Performance

- The mission will demonstrate and characterize optical and radio communications techniques for small satellites in a flight environment. Utilizing the following:
  - NASA's Hitchhiker Program.
  - Fixed antenna pointing
    - Send data through a TDRS to WSC using a non-gimbaled antenna, e.g. a patch antenna.
    - Measure contact times and data quality
  - Optical communication.
    - Transmit known data files to and from payload when the payload is near WSMR.
  - Real-time doppler tracking (Inter-satellite communication)
    - Show capabilities of real-time DSP to acquire and track Doppler-shifted signals for potential use in satellite communications.
- Capture and publish the experimental results.

Availability

- Trajectory
- Where will we be?
- Timing

Where will we be

- Depending on angle of orbit will we be in:
  - White Sands
  - Hawaii
  - Other location considering angle of orbit and maximizing time of availability

Cost

- we will consider based on our budget:
  - Location from where we will be transmitting
  - If it is a remote location, in order to minimize travel expenses we will choose only the best times based on the orbit to transmit over just a few of the optimum times to test responsiveness

Responsibilities

- On/Off Switch
- Duration of Response
- Analyzing the data

Duration of Response

- our experiment deals with faster communications
  - we will be mindful of the time it takes a signal we send to our receiver in space to return back to us on our station at the surface of the Earth

Secondary Mission

- Require extensive student involvement in all mission phases:
  - design
  - construction
  - operations
  - analysis
- Need to incorporate documentation and publicity into activities

Duration

Availability

Florencio /

Alan / David

Level of Survavility

- Parts must have a certain degree of radiation tolerance in order for them to last at least 10 days.
  - Probability of cosmic rays impair performance or disable equipment
    - Solar Flares
    - Van Allen radiation
    - Deep outer space radiation

Housekeeping during Mission

- Thermal
- Power Stability
- Parallel to serial shift on data provided by CPU to make sure it's on carrier.

Survivability is defined as the ability of a space system to perform its' intended function after being exposed to a stressing natural environment or an environment created by a hostile agent. The natural concerning this mission is near-Earth space.

Factors that affect survivability:

- Military threats - not applicable to this mission
- Electronics - thermal fluctuations, component selection,RFI
- Orbital debris - shuttle will avoid large objects (>2″ radius), smaller object impact risk is acceptable
- Orbit selection - selected orbit is ~300km(thermosphere)
- Hardness - defines the environmental stress level which the system can survive. The single most effective action to increase survivability.

Summary

Although there are many factors affecting survivability, many of them can be eliminated. The remaining factors can be accounted for by appropriate component selection and adherence to NASA HitchHiker program specifications.

Data Distribution

- Real-time status data will need to be provided to the operations point at NASA GSFC
- Real-time shuttle positional data will need to be provided to laser ground station
- TDRS status data will need to be captured at WSC

Data Communications Format

John Alexander MacCannell

Communication Goals

- Provide command access to experiments
- Provide telemetry reports from experiments
- Provide dual paths for data from experiments via the experimental communications link and the shuttle's telemetry tracking system

Communication Paths Cont. Experimental

- Data transmission of experimental data
- Antenna
  - RF emission to a TDRS satellite
  - Shuttle bay oriented towards Space
- Laser Communications
  - Laser beam emission to ground station
  - Shuttle bay oriented towards earth

Data Format - External

- External data sent via Shuttle telemetry
- Determine telemetry format
- Determine time share rate
- Determine telemetry coverage

Data Format - Frames

- Fixed sized
- Needed Overhead
  - Unique start character
  - Sequence Number / times-tamp
- Allows for both synchronous and asynchronous communication
- May Include
  - Process ID
  - Padding
  - Bit Stuffing
  - Error checking/correcting information

Constraints

- Cost
- Schedule
- Regulations
- Political
- Environment
- Interfaces
- Development Constraints

Cost

A system's cost depends on:

- Size
- Complexity
- Technological Innovation
- Design Life
- Schedule

Cost

- Maximum Hardware Development Cost allowed by sponsor: $50,000
- Travel Costs to be supplied by research grant and NMSU funding

Mission Schedule

- 9-13-99 Define the mission
- 10-11-99 Systems Review
- mm-dd-yy Time to develop the payload
- Dec. 1999 Preliminary – Hazard Identification *(Safety 1 of 3)*
- Dec 1999 Preliminary design review
- April 2000 Final Design Saftey Review *(Saftey 2 of 3)*
- May 2000 Critical Design Review
- mm-dd-yy Manufacturing Time (PSL)
- mm-dd-yy Pre-Launch testing
- mm-dd-yy Saftey Testing of Complete Product *(Saftey 3 of 3)*
- mm-dd-yy Product shipping
- mm-dd-yy Astronaut Briefing
- mm-dd-yy Launch time (TBA)
- mm-dd-yy On orbit operating times

SPACE LAW

Conflicts:
US vs. International Law

- Satellite communications
- Commmercial launches
- Military Space Activities
- Patent Issues

Responsibility

Liability and Insurance

Remote Sensing

Key points

b. when a patent involves military technology
c. stems from the Arms Control Act

FireSat Legal and policy issues

- US gov’t project or project with private financing

Environment

Shuttle Payload Bay Thermal Limits

- What are the minimum and maximum thermal limits?
  - The tempeature control range is 10-35 degrees Celsius.
  - Will we be able to operate in full sun and under dark conditions?

Launching Without Power

- Will we need a battery for any of our components?

Shock and Vibration

- What are the g values?
  - 5-7 g
- What is the standard shock value?
  - 4,000 g
- What is the standard vibration value?
  - $0.1 g^2/Hz$
- What is the standard acoustic value?
  - 140dB

Overview

- Manual
- Computer
  - NASA Space Network
  - New Mexico State University
- Other
  - Sensors
  - Shuttle

Computer Interface - NASA

- What is standard Interface?
- What is training time?
- What is training Cost?
- Computability Issues
  - Translation between NMSU interface and NASA Interface
  - Will we need two interface translators i.e. Will the two interfaces need different instruction code

Other - Sensor

- Housekeeping information
- Sensor levels e.g. TTL CMOS
- Sensor design
- Number of sensors

Development Constraints

- None identified beyond those already mentioned