A PDA-Controlled Pico-Satellite, Cute-1.7, and its Radiation Protection

Masafumi Iai
Tokyo Institute of Technology

18th AIAA/USU Conference on Small Satellites
Aug 12, 2004
Cubical Tokyo Tech Engineering Satellite

CUTE-I was launched on June 30, 2003 and is functioning for more than a year with minor malfunctions.

CUTE-1.7 is being developed.
  - To be launched in Summer 2005 aboard M-V rocket by JAXA.
  - Primary mission is demonstration of APD charged particle detector.
Basic Concept

- **To make it more useful**
  - Bus system able to be reused with various payloads

- **To make it easier**
  - Use of PDA (personal digital assistants) and its peripheral devices.
  - Structure based on CubeSat standard

- **To make it not disruptive**
  - Packet repeater: amateur radio service
  - Satellite disposal system
Future Satellite Cores

Robotics

Observatory

For Larger Payload

Formation Flying

-Tethered

-Recovery
PDA as Main Computer

- Use of COTS devices is a trend.
  - CUTE-I was relied on COTS completely.
- PDA, Hitachi NPD-20, (a handheld computer) is to be used as the main computer.
- Benefits are:
  - Variety of peripheral devices available.
  - Common OS and more experienced programmers
- For reliability
  - Double module redundant system by Two PDAs
  - Radiation Test conducted
Radiation Test

- Conducted at Research Center for Nuclear Physics in Osaka University
- Proton beam with energy of 60MeV and lower.

Experiment Setup

[Diagram showing the setup with labels:
- PC
- Lan
- PC
- LAN
- PDA
- Proton Beam (60MeV)
- Absorber
- Plastic Scintillator
- Switch
- WDT
- Device under Test
- Plastic Scintillator]
Radiation Test Results

- SEU cross section was $\sim 10^{-10} \text{cm}^2$, and
- SEL cross section was $\sim 10^{11} \text{cm}^2$.
  - One Error every Two years in 800km circular orbit

- Watchdog timer was able to protect PDA.
Functionality for Radio Amateurs

- We have used and will use amateur radio frequencies
  - For quick licensing
  - For availability of small transceivers
- To return something to amateur radio community, Packet Repeater is installed.
  - Uplink: 1200MHz
  - Downlink: 430MHz (shared with telemetry line)
**Satellite Disposal by Tether**

- Small Satellites: Short lifetime & Many
  - Becomes Debris. Difficult to track.
  - Debris reduction measure affects if use of small satellites grow.

> Disposal by Electrodynamic Tether

- Electron Emitter
  - Lorentz Force
  - Separation Mechanism
  - High Voltage Power Supply
  - Carbon Nanotube Electron Emitter
  - Altitude Decrease
  - Reentry
Tokyo Tech’s second CubeSat, Cute-1.7, is:
- Composed of Satellite Core and Mission Container.
  - To be reused with various payloads
- Controlled by PDAs
  - Radiation test results showed PDAs are durable enough.
  - Radiation protection is mainly by watchdog timer.
  - Easier software programming and various peripherals.
- Equipped with Packet Repeater
  - To contribute to amateur radio community
- Deorbited by Electrodynamic Tether
  - Satellite Disposal is essential to the growth of small satellite utilization.