Tokyo Tec

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

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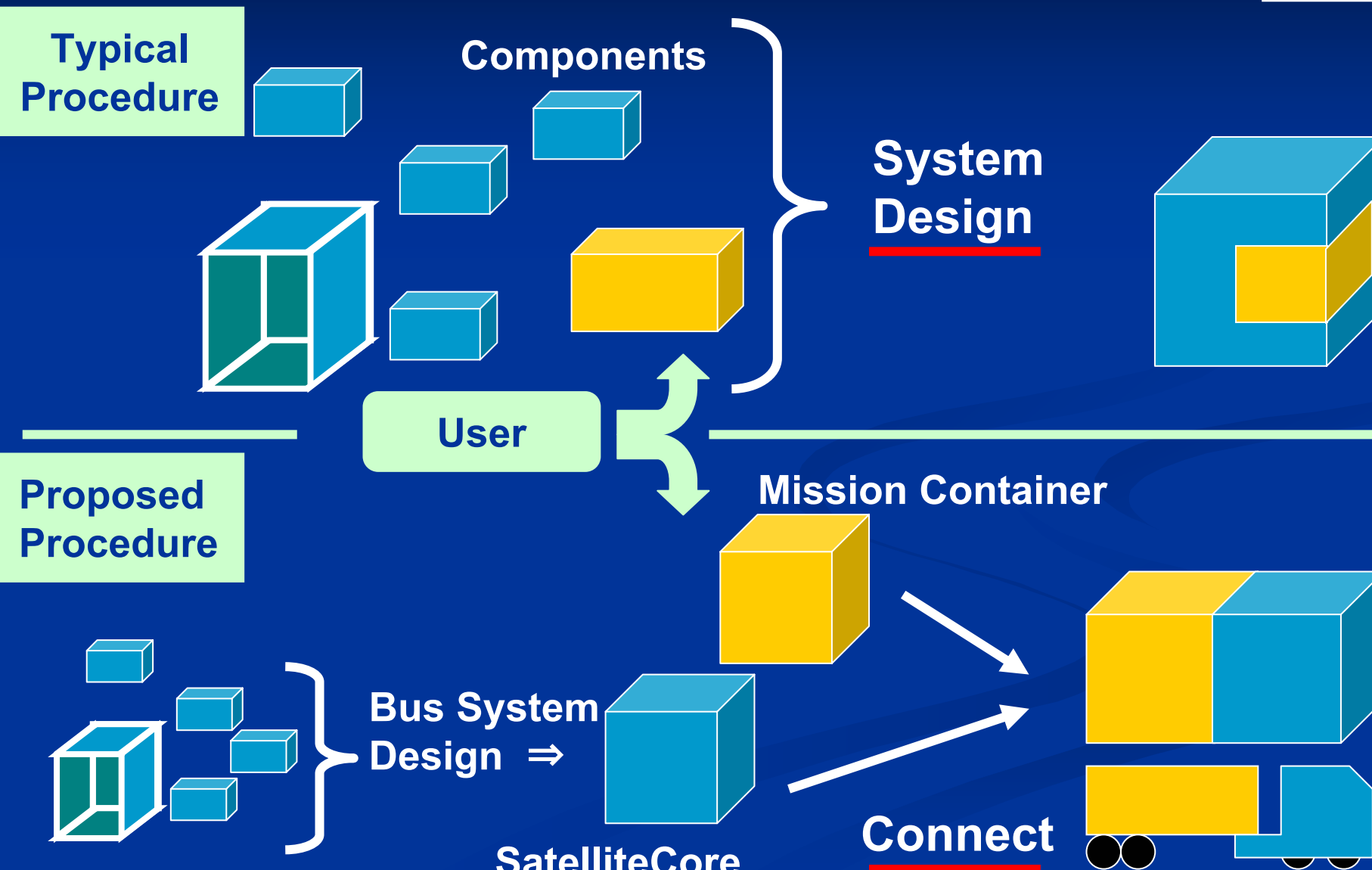
Satellites CUTE

- 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.

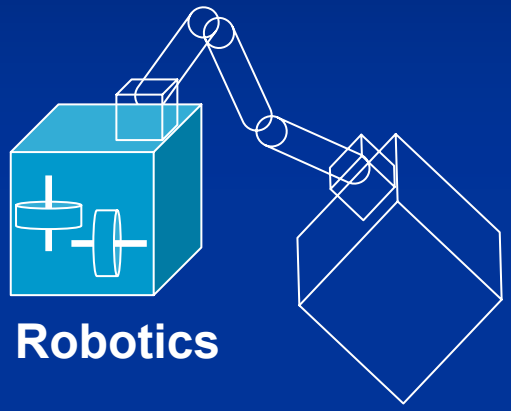
Basic Concept

- 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

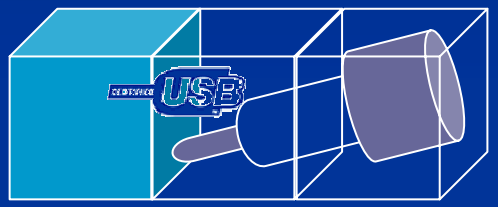
SatelliteCore concept



Future SatelliteCores

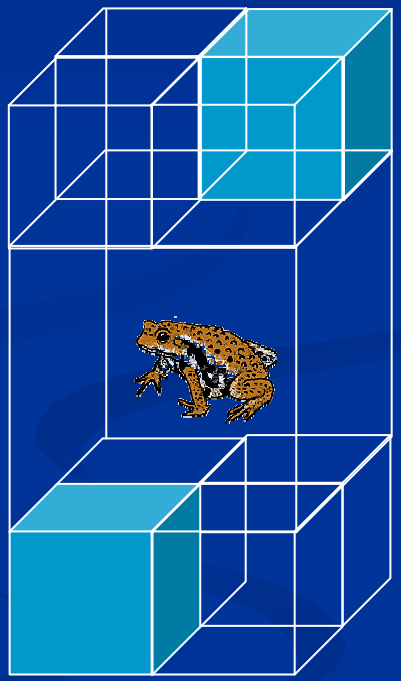


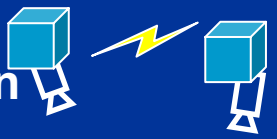
Robotics



Observatory

For Larger Payload





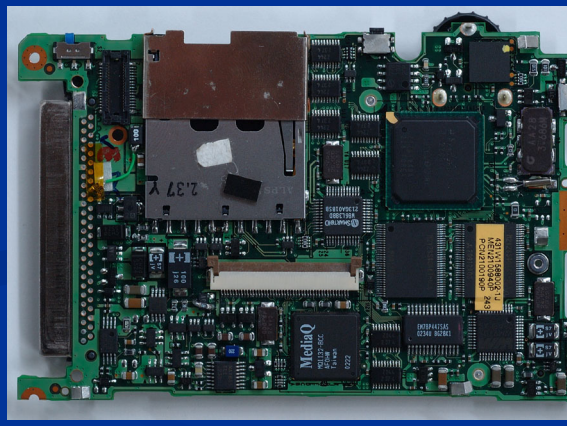
Formation Flying

-Tethered

-Recovery

PDA as Main Computer

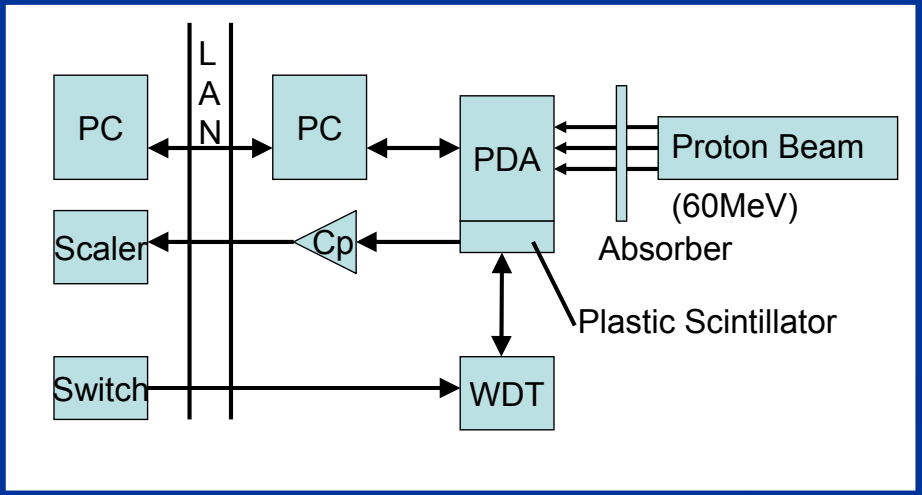
- Use of COTS devices is a trend.
  - CUTE-I was relied on COTS completely.
- PDA, Hitachi NPD-20, (a handheld computer) is to be used as the main computer.
- Benefits are:
  - Variety of peripheral devices available.
  - Common OS and more experienced programmers
- For rediability
  - Double module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



Radiation Test

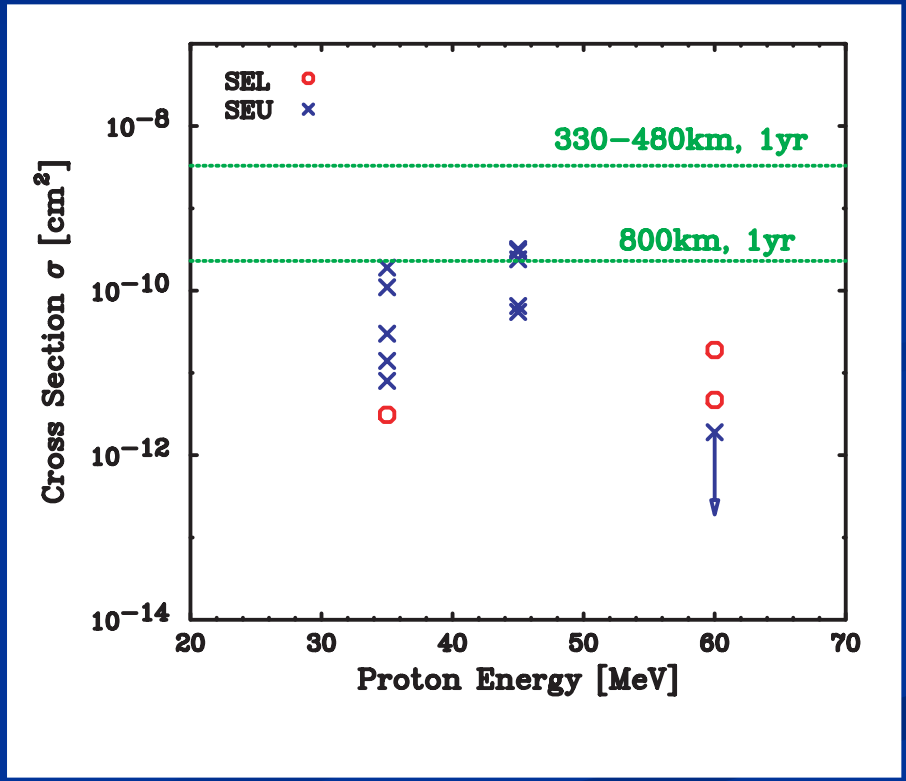
- Conducted at Research Center for Nuclear Physics in Osaka University
- Proton beam with energy of 60MeV and lower.

Experiment Setup



Radiation Test Results

- SEU cross section was ~10^{-10}cm^2, and SEL cross section was ~10^{11}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)

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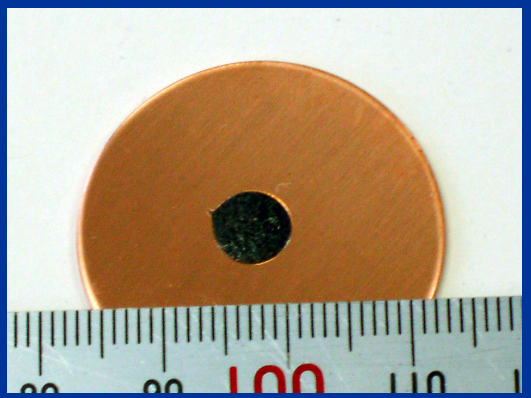
Satellite Disposal by Tether

- Small Satellites: Short lifetime & Many

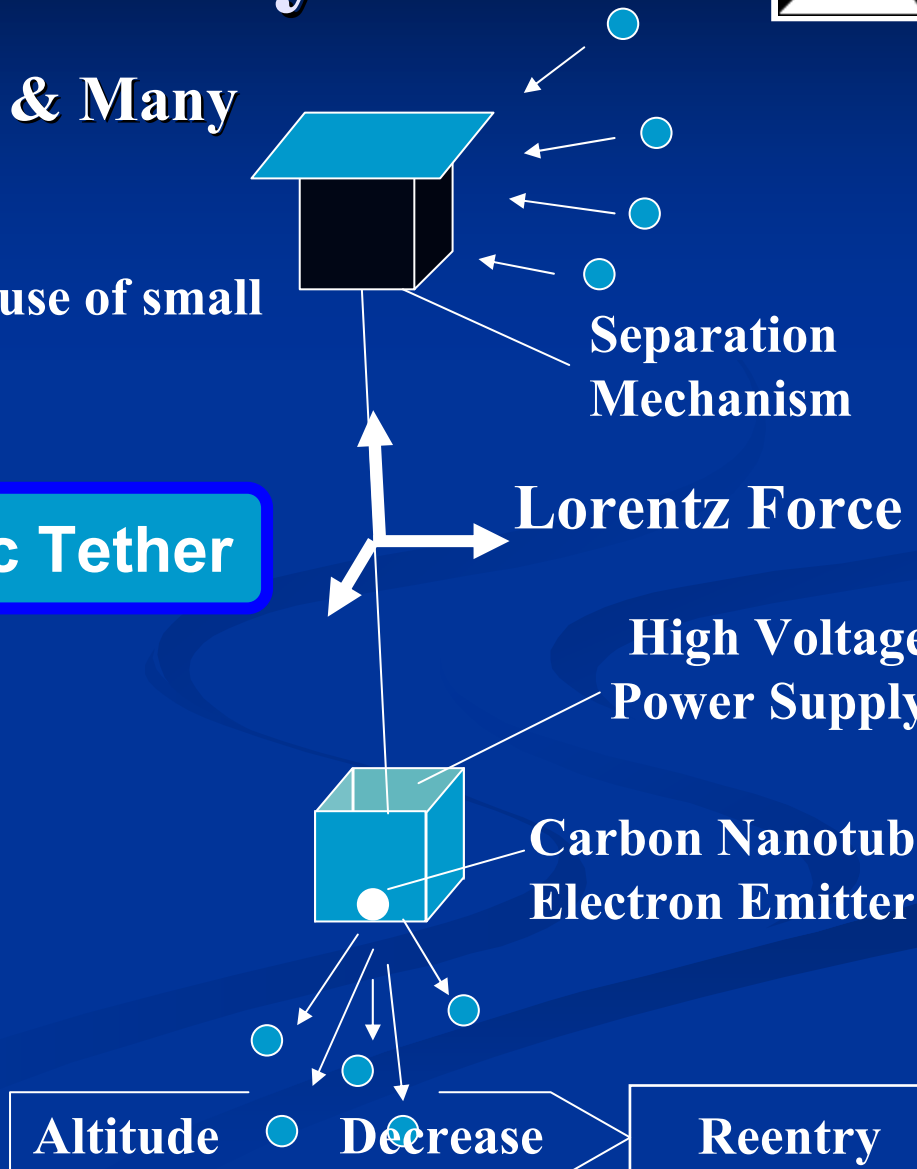
→ Becomes Debris. Difficult to track.

→ Debris reduction measure affects if use of small satellites grow.

Disposal by Electrodynamic Tether



Electron Emitter



Summary

- Tokyo Tech's second CubeSat, Cute-1.7, is:
- Composed of SatelliteCore 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.