KiboCUBE Academy

Lecture 10

Introduction to CubeSat Command and Data Handing System

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Department of Aerospace Engineering

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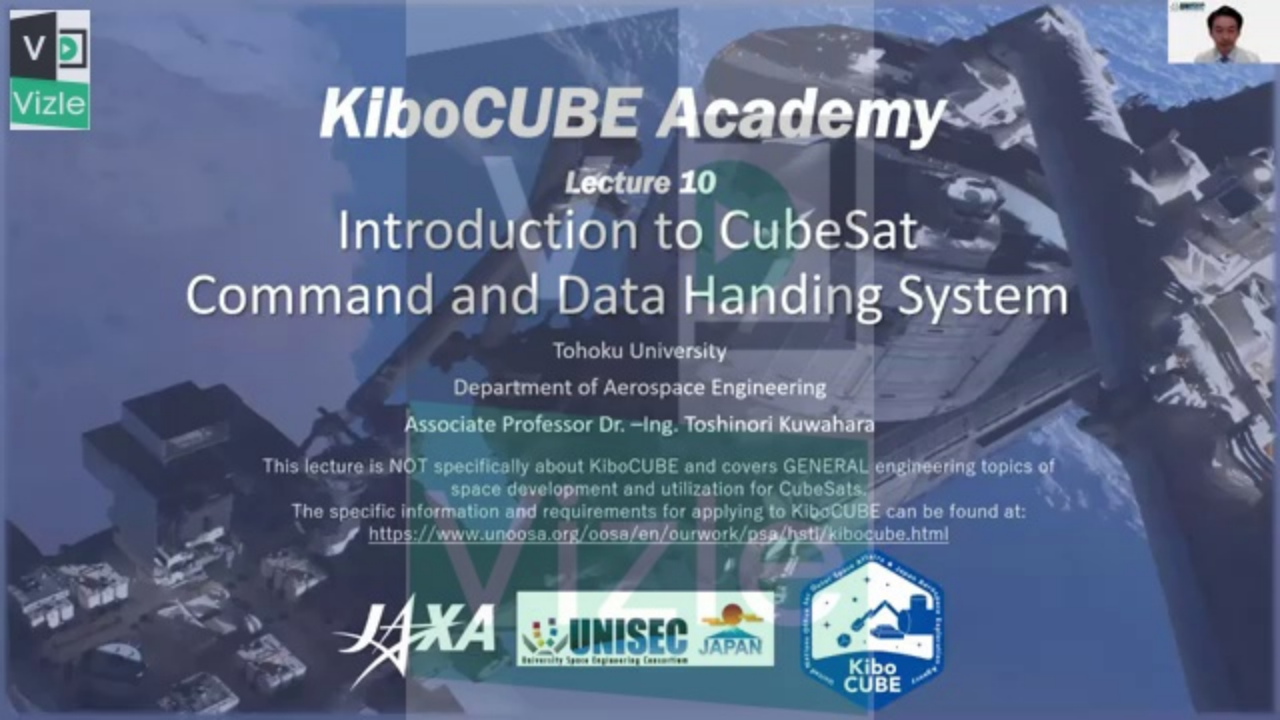
This lecture is NOT specifically about KiboCUBE and covers GENERAL engineering topics of space development and utilization for CubeSats.

The specific information and requirements for applying to KiboCUBE can be found at:
https://www.unoosa.org/oosa/en/ourwork/psa/hsti/kibocube.html



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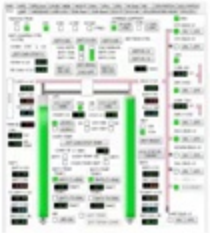
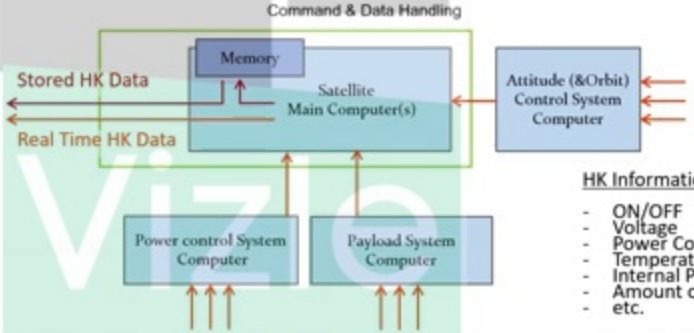
Satellite Monitoring

- The most common way of implementing satellite monitoring functionality is that the all the satellite components that are powered on deliver their housekeeping data periodically and continuously to upstream devices.
- The main computer receives, processes, and formats these HK data and stores it to the on-board memory, often configured in a ring-buffer manner.
- When ground contact is available, the on-board computer sends the real time HK data and stored HK data to the communication system for the downlink.



Satellite Control Software



HK Information

- ON/OFF
- Voltage
- Power Consumption
- Temperature
- Internal Parameter
- Amount of Mission Data
- etc.

Electrical Interface

Types of electrical interface can be classified as follows:

Power supply interface

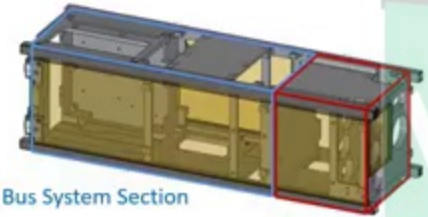
- Unregulated/Bus: Satellite bus voltage, which fluctuates depending on the state of charge (SOC) of the battery.
- Regulated: Voltages-regulated power supply through DC/DC converters, such as 3.3V, 5V, 12, 28V, etc.

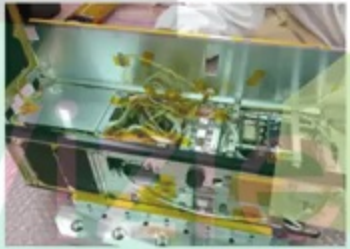
Signal interface

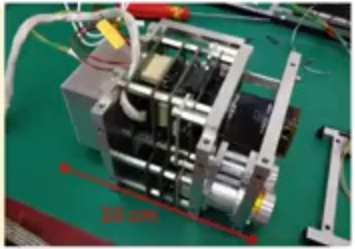
- Analog signal
  - Active analog: voltage output from analog sensors, voltage output from powered devices.
  - Passive analog: thermistors (power is supplied from outside to measure the value)
- Digital signal
  - Discrete signal: ON/OFF status of mechanical switches, status of electrical circuits, etc.
  - Synchronous Serial: Communication interface with dedicated clock signals, suitable for high-speed communication.
  - Asynchronous Serial: Communication interface without dedicated clock signals, suitable for low-speed communication with less cables.
- Radio Frequency
  - Communication between satellite and ground station. Require international radio frequency coordination (before launch), and license.
  - Communication between satellites, between components inside a satellite, etc.

Payload Interface

- Payload instruments usually tend to have custom interfaces with a combination of different types of electrical interfaces.
- Due to the limitation of mechanical envelope and maintainability, payload instruments need to be assembled as a unit by defining the mechanical, electrical, and thermal interfaces very clearly.
- Payload instruments related with radio frequency measurements are equipped with large antennas, which needs to be held down during the launch and deployed in orbit.







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Operational Planning

- Command list to be uploaded shall be verified beforehand, by means of ground verification before flight using the actual flight model or through ground verification using satellite simulator and satellite Engineering Model if available.
- A set of verified command sequence, i.e., the contents of the command, parameters, and time intervals, can be handled as a macro command, which can be further combined with other verified set of command lists.

Ground Verification before Flight

Verified Command List

Ground Verification using Satellite Simulator

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Verified Command List

Ground Station

Uplink Command List

Satellite Control Software

Transmitter

Receiver

Command Uplink

Telemetry Downlink

Satellite System

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