BIRDS
International
Capacity Building Platform

革新的宇宙利用実証ラボラトリー
Laboratory of Lean Satellite Enterprises and In-Orbit Experiments

Sangkyun Kim

BIRDS Projects

- BIRDS – Joint Global Multi Nation Birds
  - Started in 2015 for ambitious international capacity building functions
  - Multi national joint project: each country sends students to Kyutech for CubeSat training
  - Project takes 2 years: from mission design, to building, to finally on-orbit operation
  - A new BIRDS project is started each year -- we are now in the 5th project
  - **51 students from 13 Countries** have been involved
  - We have a global community for satellite development and for tracking by ground stations
  - This year, 2020, we kick off the final generation of BIRDS, which is BIRDS-5

https://www.birds-project.com/

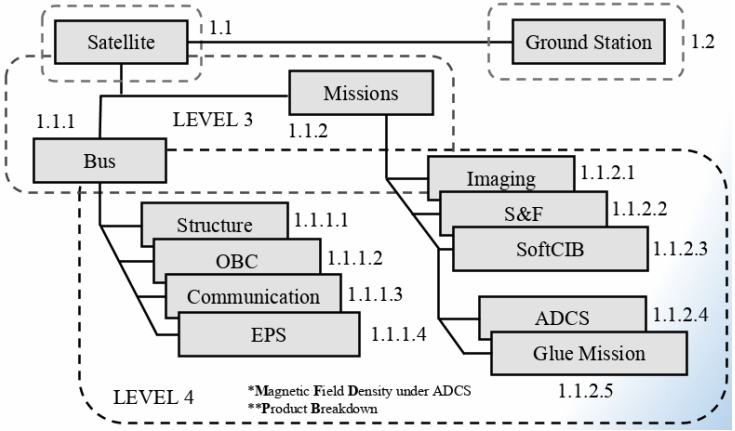
BIRDS Projects

- BIRDS – Winner of *GEDC Airbus Diversity Award* in 2017
  - Purpose of award: to foster diversity in engineering education at universities
  - Major consideration: how well the project can be replicated in other institutions and countries
  - For 2017 contest: 45 projects were submitted, from 18 countries and 38 institutions
  - Announced as the winner on 10th/October/2017 at ceremony in Toronto, Canada

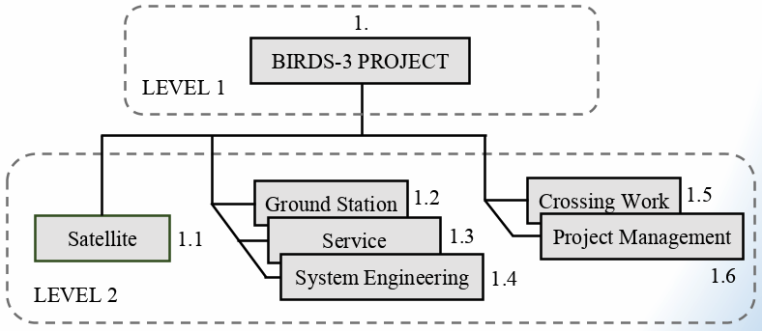
Flow of Project

Kick Off — MDR — PDR — CDR — Delivery — Launch — Deployment & Operation

- MDR (Mission Definition Review)
  - Project is introduced at “Kick Off” meeting of members
  - Absorb some lessons of previous projects
  - Members define the missions (of satellite) while consulting opinions of stakeholders
  - Concept design with PBS (Product Breakdown Structure)
  - Share development work via WBS (Work Breakdown Structure)



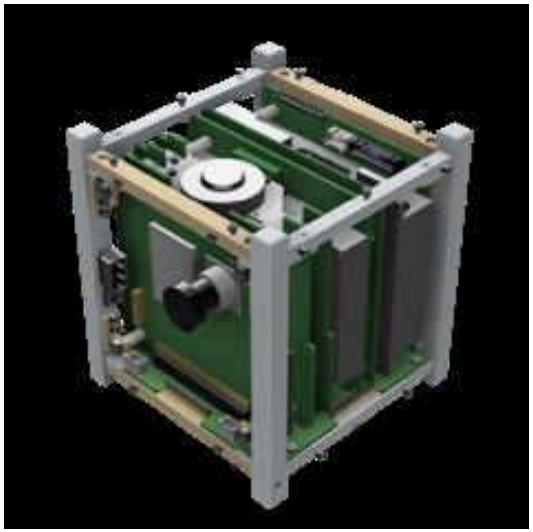
Example of PBS



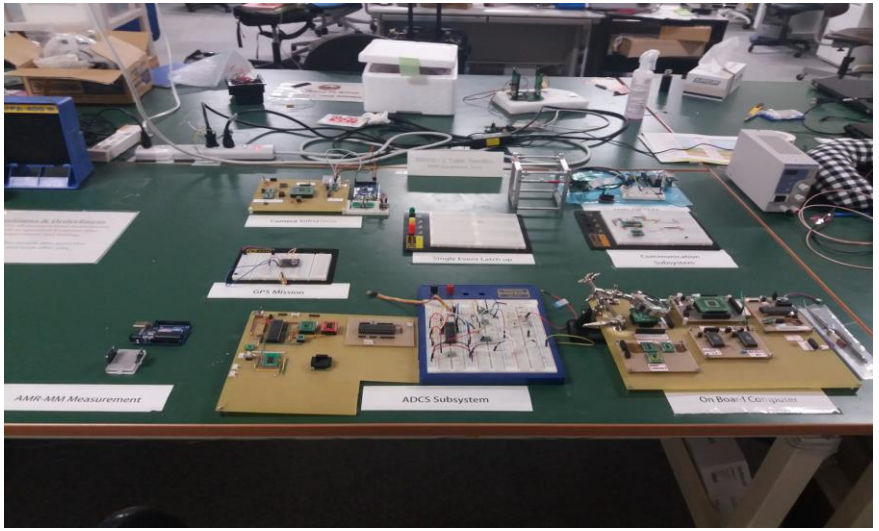
Example of WBS

Flow of Project

- PDR (Preliminary Design Review)
  - PDR checks overall design direction, and advances some design details
  - Develop satellite design with the defined mission ideas
  - Some BBM (Bread Board Model) tests for the functional check of some subsystems



3D CAD Model of BIRDS-4 satellite

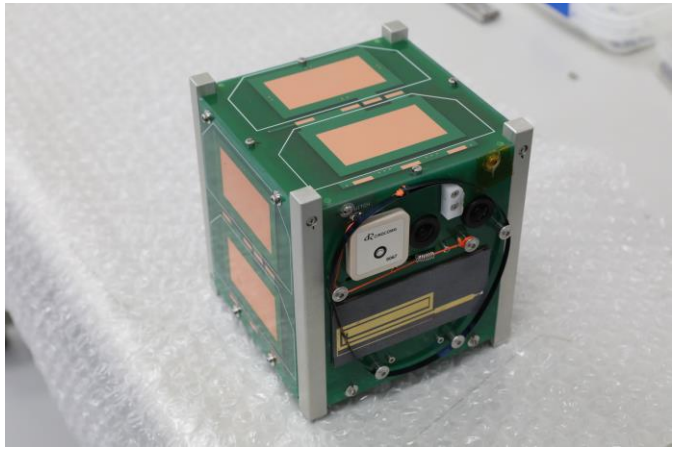


Example of BBM Test

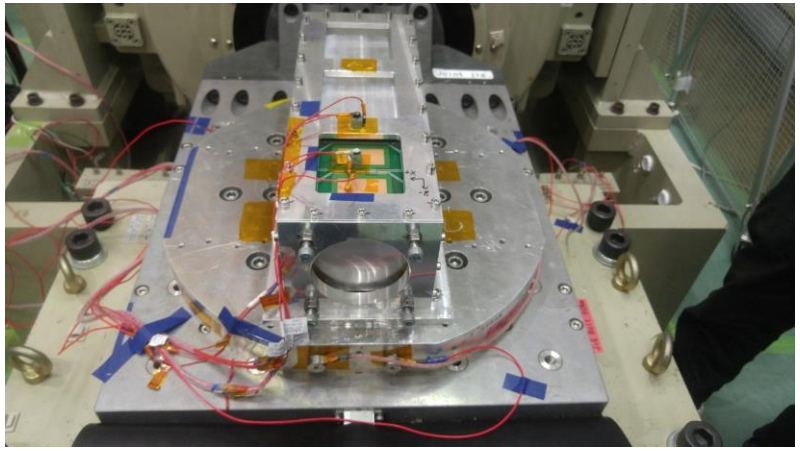
BIRDS Projects

Kick Off — MDR — PDR — CDR — Delivery — Launch — Deployment & Operation

- CDR (Critical Design Review)
  - EM (Engineering Model) is developed using detailed design
  - Functional tests for its performance
  - Environmental tests at qualification level to check its reliability and safety against harsh space environment
  - CDR confirms the design for the next stage of FM (Flight Model) fabrication



Engineering Model of BIRDS-2 satellite



Example of environmental test: Vibration test

BIRDS Projects

Kick Off — MDR — PDR — CDR — Delivery — Launch — Deployment & Operation

- Delivery
  - FMs (Flight Models) are built using the design established at CDR
  - They must pass long duration test and communication test to check their functionality
  - They must pass all environmental tests
  - They must pass safety requirements of launch provider
  - Frequency license issues must be cleared before delivery to launch provider

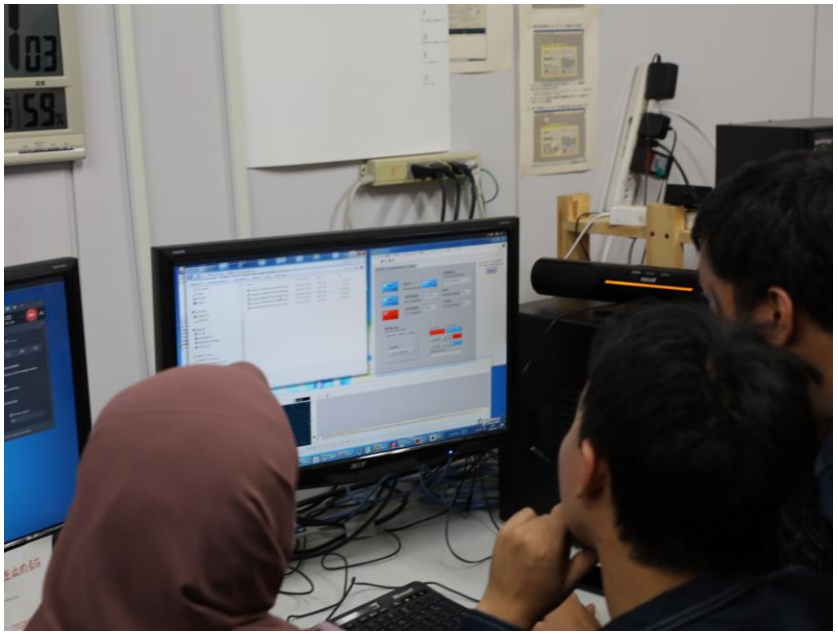
Flight Models of BIRDS-4

Example of long duration operation test

BIRDS Projects

- Launch
  - Satellites enter prolonged storage (up to several months) while waiting for launch
  - During storage time, ground stations at Kyutech and other sites around the world must be prepared so that first signals can be captured after ISS deployment

Antenna for BIRDS program

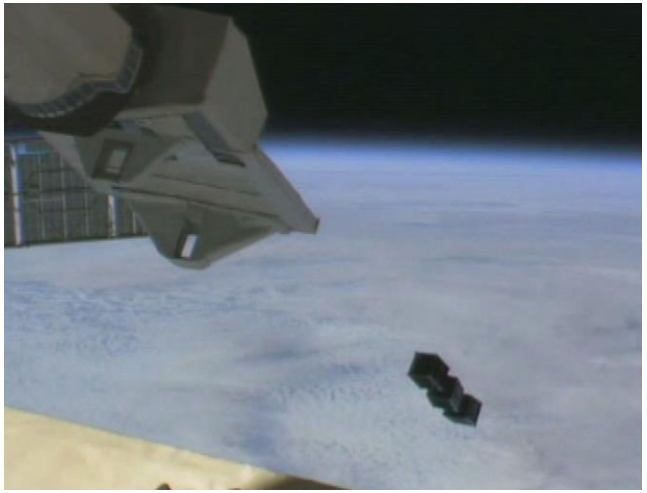


Operation software check

Launch to ISS © Space-X

BIRDS Projects

- Deployment & Operation
  - With conventional launch services, the satellite is directly deployed into space after some hours after launch
  - However, BIRDS uses *ISS deployment method* -- satellites are deployed by astronauts from the ISS several weeks after launch
  - Before graduating SEIC, most BIRDS students get on-orbit operations experience; and can acquire valuable data from their own satellites



Moment of ISS deployment, © JAXA

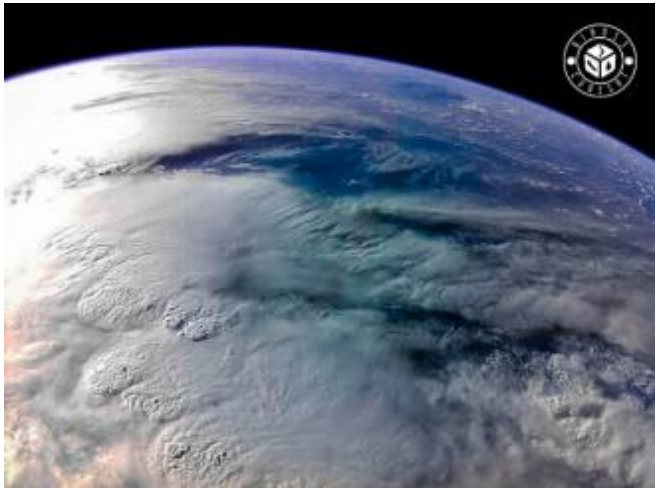


Image of Earth from BIRDS-3 satellite mission camera

BIRDS Projects

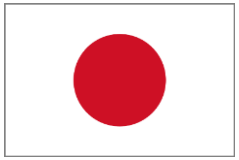
- BIRDS-1
  - Five countries; first satellite for 3 countries (Bangladesh, Mongolia, Ghana)
  - Camera, Digi-Singer, demonstration of ground station network
  - GS-based navigation, atmosphere density monitoring
  - Radiation hardness of SEL (Single Event Latch-up)
  - Deployed from ISS, 7th/July 2017
  - Operation has ended

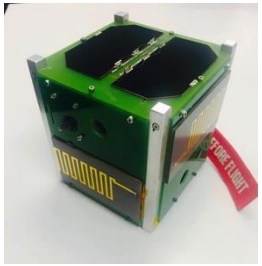

Nigeria


Bangladesh


Mongolia

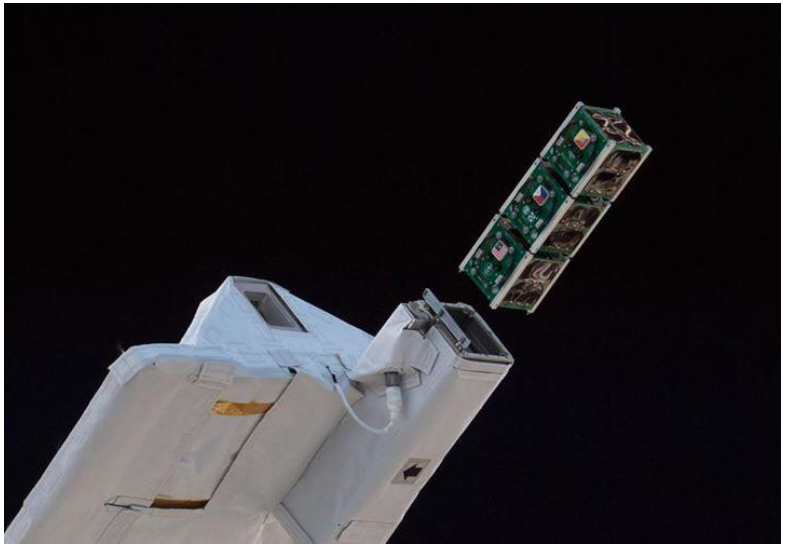

Ghana


Japan

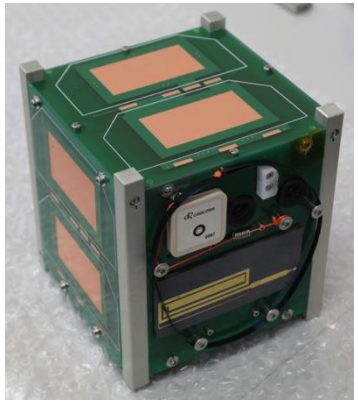


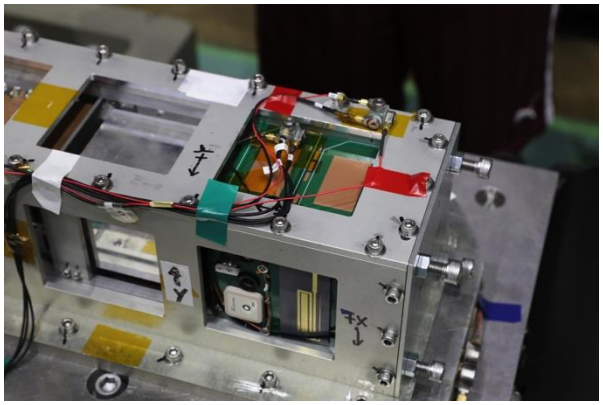
BIRDS Projects

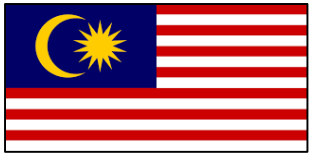
- BIRDS-2
  - 3 countries; first satellite for Bhutan
  - Camera, Store & Forward communication
  - APRS, GPS, Magnetic sensor, SEL
  - BIRDS-1 heritage, but improved
  - Deployed from ISS, August 2018
  - Under operation



Moment of deployment ©JAXA







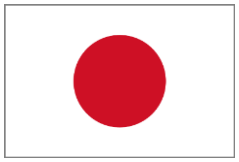
Malaysia

Bhutan

Philippines

BIRDS Projects

- BIRDS-3
  - 3 Countries; first satellite for Nepal and Sri Lanka
  - Camera, CW messaging, LoRa module test
  - BIRDS-1 and BIRDS-2 heritage maintained
  - Began to use Standard BUS, BIRDS BUS
  - Deployed from ISS in June of 2019
  - Under operation currently, without problems



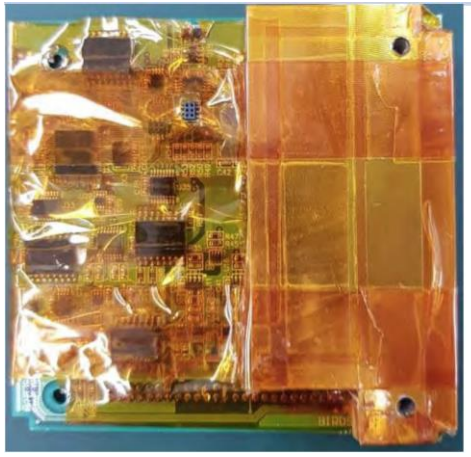
Japan

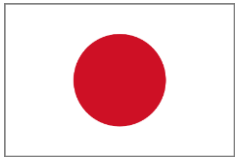
Nepal

Sri Lanka

BIRDS Projects

- BIRDS-4
  - 3 Countries; first satellite for Paraguay
  - Camera, S&F, TID, Organic solar cell, Hentenna
  - BIRDS-3 heritage continued
  - Use of Standard BUS of BIRDS BUS
  - Deploy from ISS during fiscal year of 2020
  - Under FM development





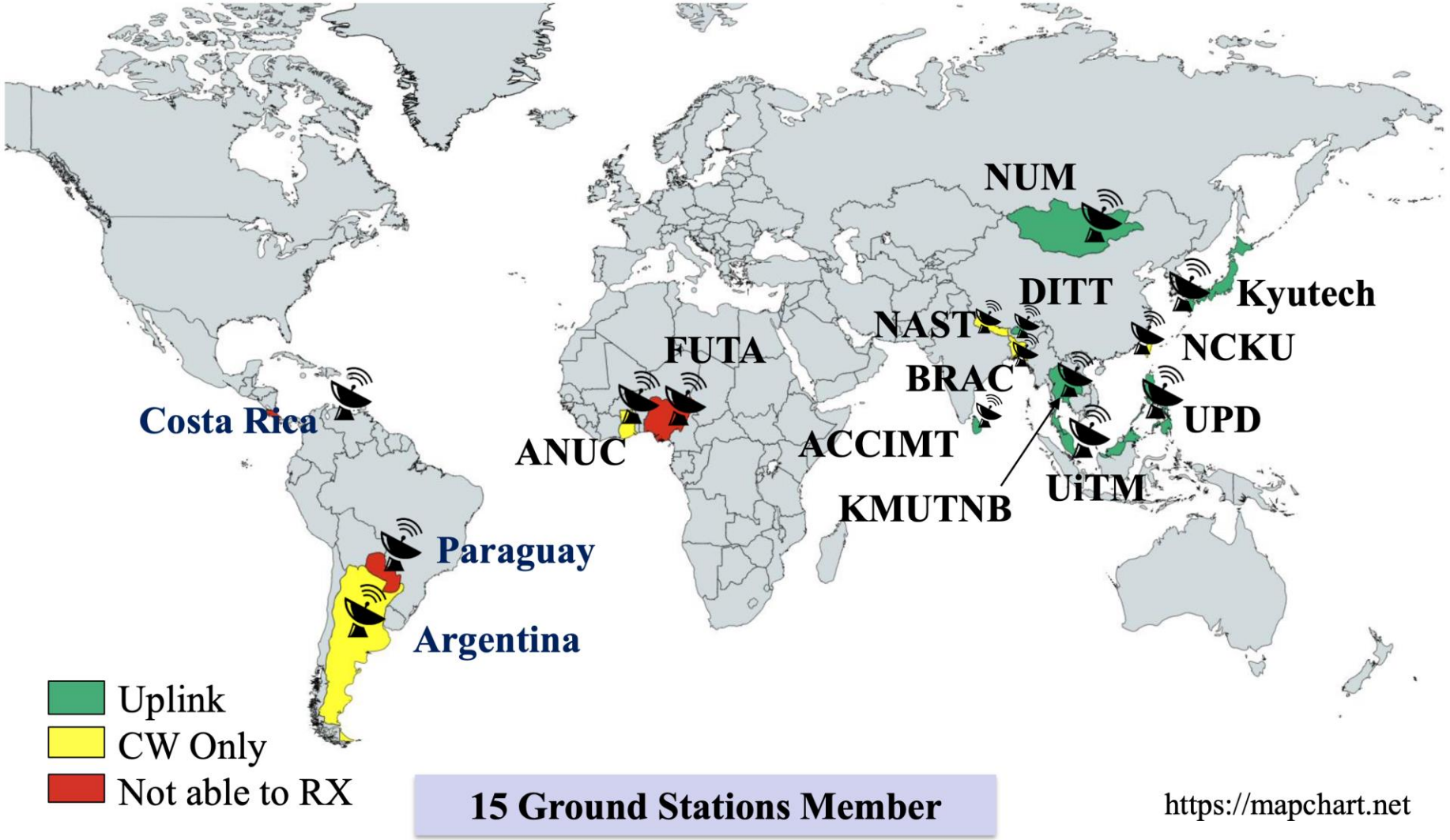
Japan

Philippines

Paraguay

BIRDS-4
JOINT GLOBAL MULTI-NATION BIRDS SATELLITE PROJECT

Ground Station Network



15 Ground Stations Member

https://mapchart.net

BIRDS Program Textbook


BIRDS Program Digital Textbook

Document number: CubeSTD-2019-001D

Sangkyun Kim, George Maeda
and
Mengu Cho

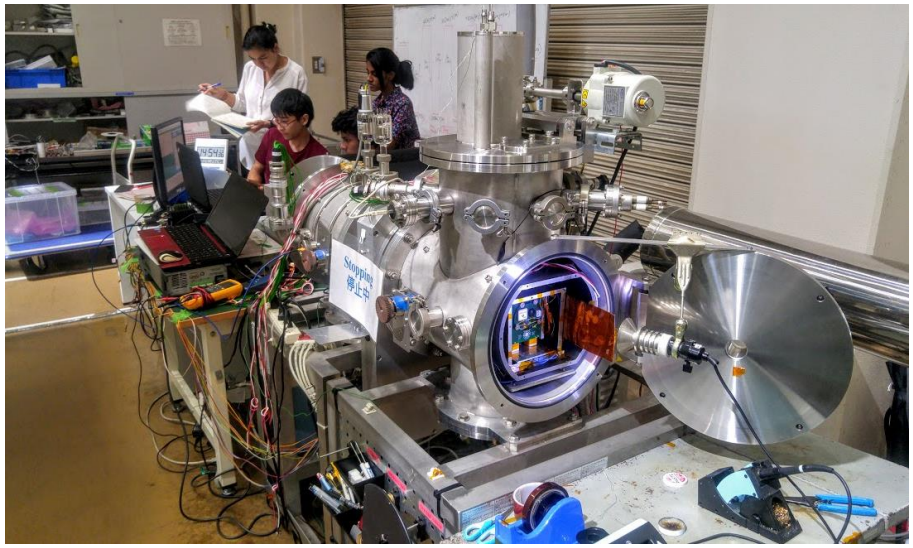
Laboratory of Spacecraft Environment
Interaction Engineering
Kyushu Institute of Technology

2019

- Purpose of textbook
  - Introduce BIRDS program
  - Present CubeSat system development for the purpose of capacity building
- Contents of textbook
  - General project management
  - System engineering for CubeSat development
  - Overall technical information of CubeSat system
  - Satellite operation
  - Frequency license issue
  - Safety regulation
  - Environmental tests
  - Issues facing sustainable educational programs
- Textbook is available as digital version

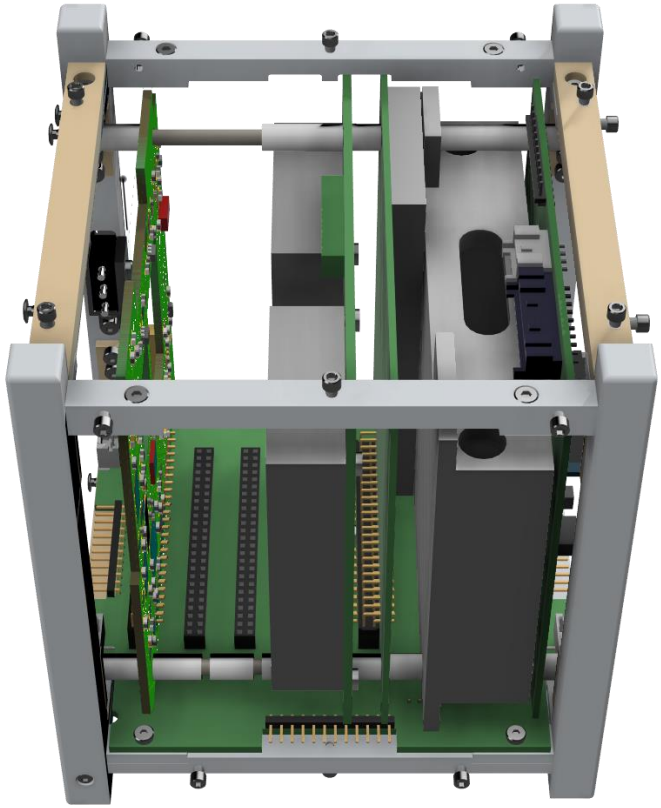
BIRDS Platform

- Reliable CubeSat platform from accumulated experience
  - Heritage of multiple CubeSats on orbit
  - Abundant reference data of functional tests and environmental tests
  - Strong background for critical safety regulation
  - Standard BUS and easy design for first comers to space engineering



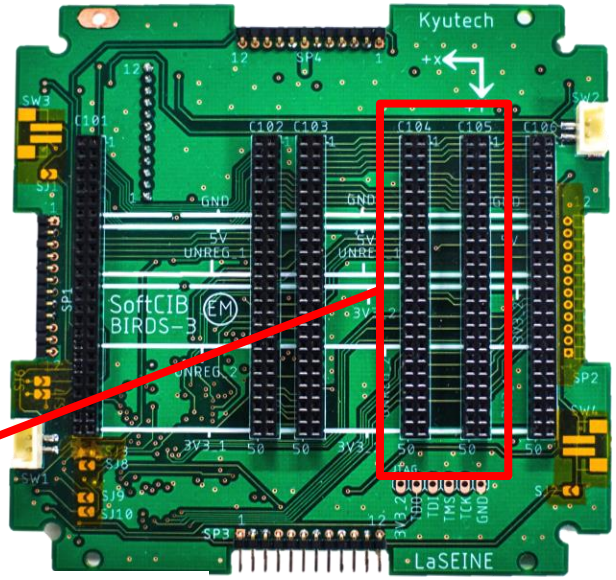
BIRDS Platform

- BIRDS 1U CubeSat Platform
  - Heritage since BIRDS-3
  - Use of Standard BUS of BIRDS BUS
  - Simple mission with 1U CubeSat
  - Mission system space : 0.2U (Two boards)
  - Mission system mass : 0.5 [kg]
  - Continuous power for mission : 0.4 [W]
  - Power : 3.3 [V], 5 [V], unregulated battery power
  - Available Interface : UART, SPI, shared memory
  - Data downlink (UHF) speed to ground station : 4800 [bps]

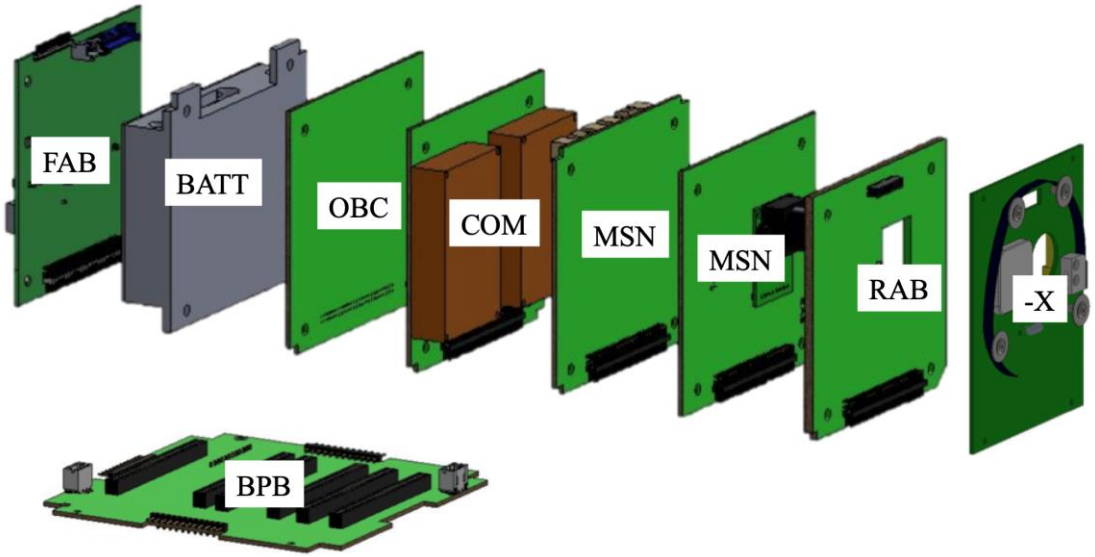


BIRDS Platform

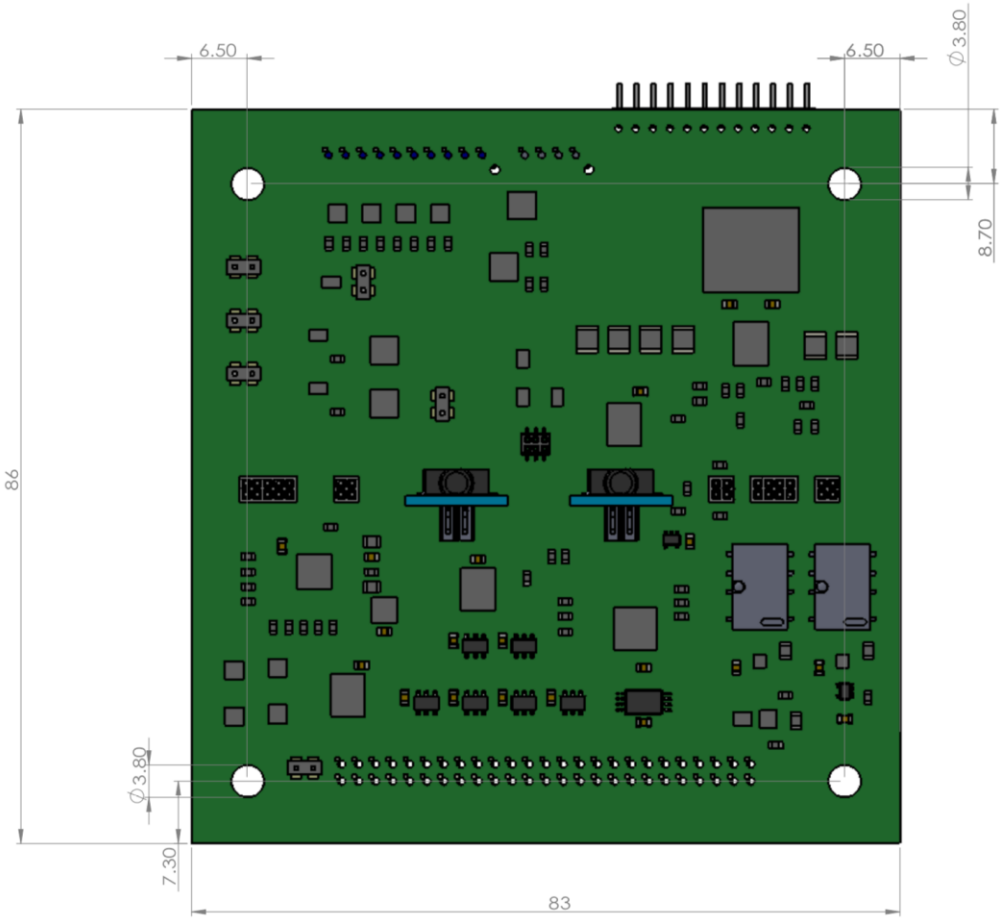
- Backplane board (BPB) style integration
  - Connect sub boards without harness
  - 50-pin connector is used
  - Two 50-pin connectors for mission boards (MSN)



Connectors for mission system



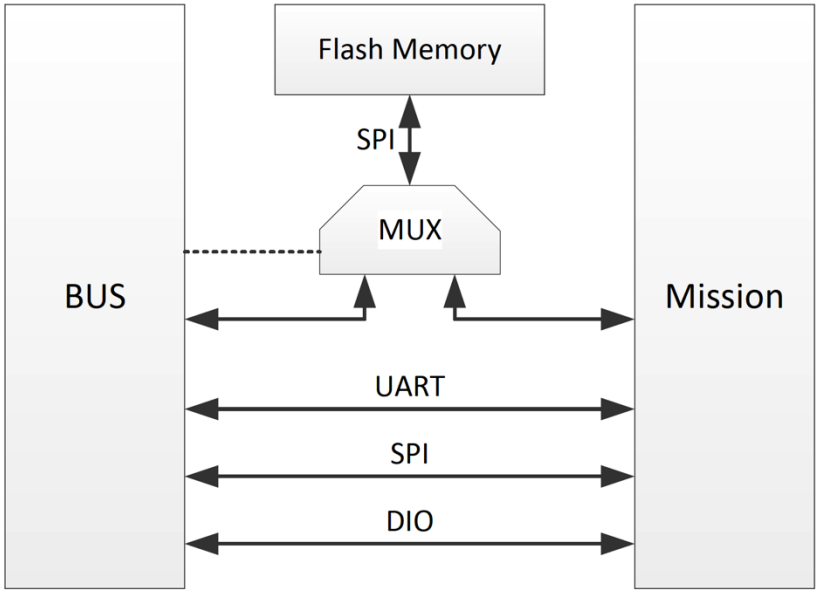
BIRDS Platform



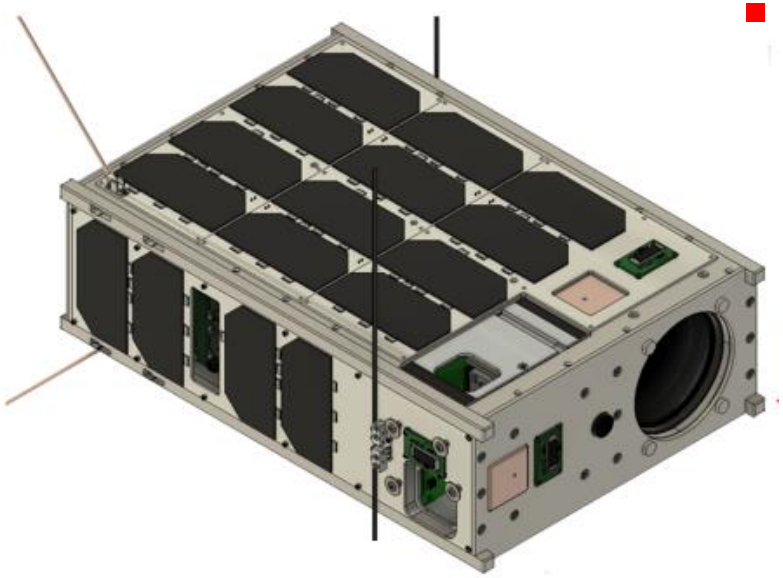
- Board sample
  - Need to fit 1U CubeSat
  - 50-pin connector at bottom side
  - Four holes for mechanical assembly

BIRDS Platform

- Simple Interface, BUS and Mission
  - Serial communication using UART/SPI
  - General DIO (Digital Input Output) available
  - Shared memory (Flash + MUX) for large data handling



BIRDS Platform



- Extendable to bigger applications
  - Support for bigger size CubeSat -- up to 6U
  - Minor modification is required
  - Big + Little Concept
  - 1U CubeSat platform acts as little part of basic function
  - Mission system acts as big part with more resources