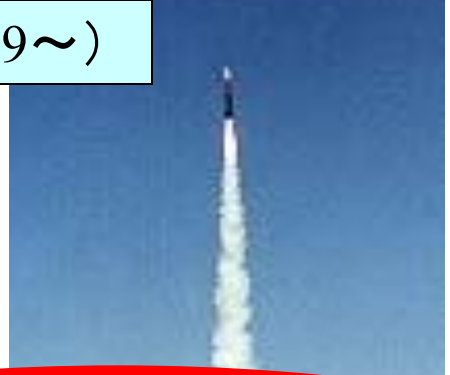
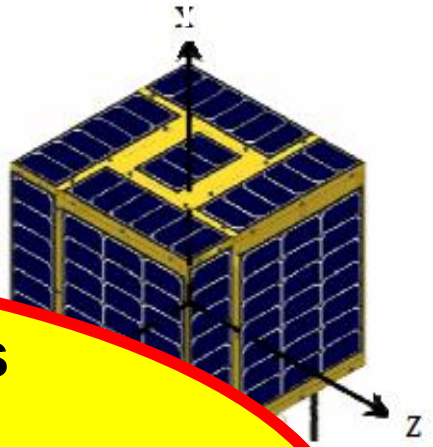
CanSat & Rocket Experiment(‘99～)



UNITEC-1 ’10 Venus



Micro/Nano-satellite Activities by Japanese Universities and Vision towards International Contribution

Shinichi Nakasuka and Rei Kawashima
University of Tokyo and UNISEC

CubeSat 03,05

PRISM ‘09

Nano-JASMINE ‘13

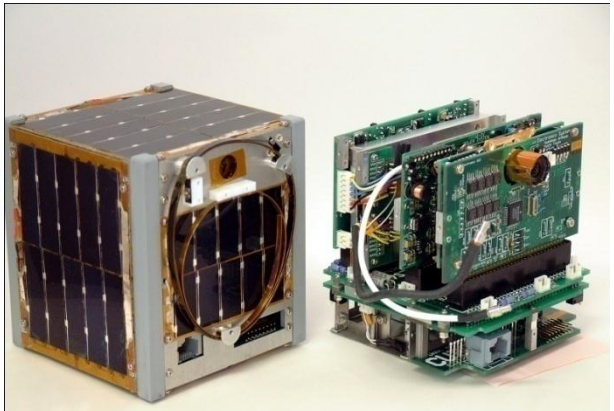
Contents

- Significance of micro/nano-satellite development
- Japanese universities' history of micro/nano/pico-satellite development and recent stepping-up from education to practical use
- Governmental "Hodoyoshi" program for micro/nano-satellite development and utilizations
- Future vision: How Japan can contribute to the other nations in this fields: education, capacity building, and collaborative missions, etc.

Emerge of Nano/pico-Satellites in Japan

Success of CubeSat(1kg)by Univ. Tokyo and Titech (2003.6.30)

- University level budget (30K$)
- Development within 2 years
- Surviving in space for >8 years
- Ground operations, frequency acquisitions, launch opportunity search processed by ourselves



CubeSat XI-IV & XI-V

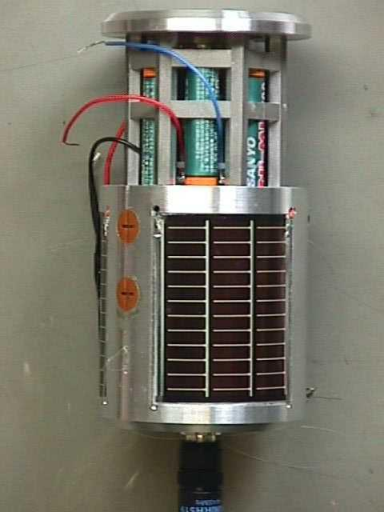
Russian Launch

1～50kg (Micro/Nano-sat):
Starting from education but higher level satellites appears

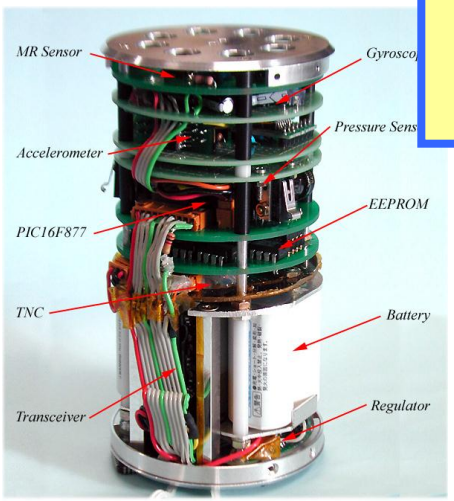
Significances of Micro/Nano/Pico-Satellite Projects

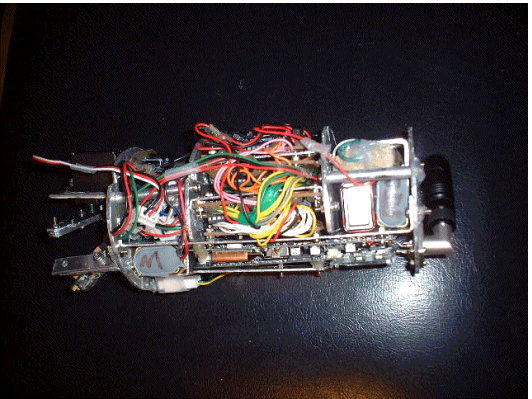
- ***Initial phase contributions: Education***
  - Practical Training of Whole Cycle of Space Project
  - Feedbacks from the real world to evaluate design, test, etc.
  - Learning from failures (while project cost is small)
  - Training for project management
  - International cooperation, negotiation, mutual understanding
    - ***Also contribute to other technology areas !***

- ***Create a new paradigm of space development and utilizations with low cost and quick development***
  - Will introduce new players(individual, company, local government, research institute, etc.) seeking for their own use
  - Will create novel ways of space utilizations
  - Will lead to participations of more nations



Starting Point: CanSat (since 1999)





ARLISS (A Rocket Launch for International Student Satellites)
- Annual suborbital launch experiment -

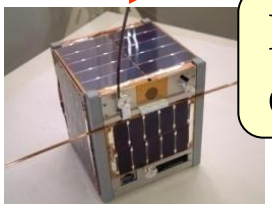
- ARLISS 1999 : Sept. 11 (Japan:2, USA:2)
  - Univ.of Tokyo, Titech, Arizona State, etc.
- ARLISS 2000: July 28-29 (Japan:4, USA:3)
- ARLISS 2001: August 24-25 (Japan:5, USA:2)
- ARLISS 2002: August 2-3 (Japan:6, USA:3)
- ARLISS 2003: Sept.26-27 (Japan:6, USA:3)
- ARLISS 2004: Sept.24-25 (Japan:6, USA:3)
- ARLISS 2005: Sept.21-23 (Japan:7, USA:3)
- ARLISS 2006 Sept.20-22 (Japan:8 USA:3 Europe:1)
- ARLISS 2007 Sept.12-15 (Japan:10 USA:3 Korea:1)
- ARLISS 2008 Sept.15-20: 10th Memorial ARLISS !
- ARLISS 2009 Sept.15-19 (Japan:12 USA:3 Korea:1)
- ARLISS 2010 Sept.13-17 (Japan:13 USA:2 Korea:1)
- ARLISS 2011 Sept.12-16 (Japan:14 USA:2 Korea:1)
- ARLISS 2012 Sept.10-14

University of Tokyo's History of Nano/pico-satellite Developments

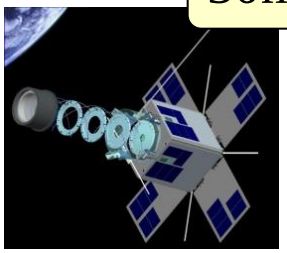
2003 04 05 06 07 08 09 10 11 12

30m GSD Remote Sensing

Education, camera test

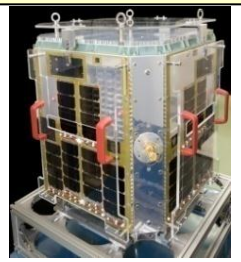


CubeSat XI-IV
（ROCKOT）2003/6

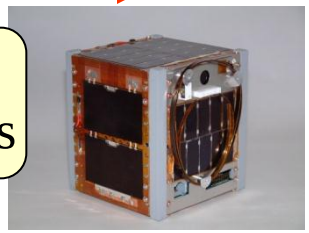


PRISM
(H-IIA) 2009/1

Astrometry (top-science)



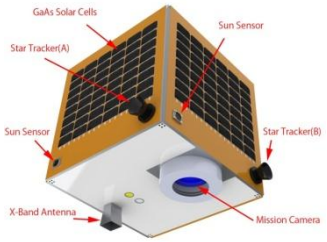
Education, CIGS solar cells



CubeSat XI-V
（COSMOS) 2005/10

NANO-JASMINE
(CYCLONE-4）2013

7m GSD Remote Sensing



HODOYOSHI-1
2012

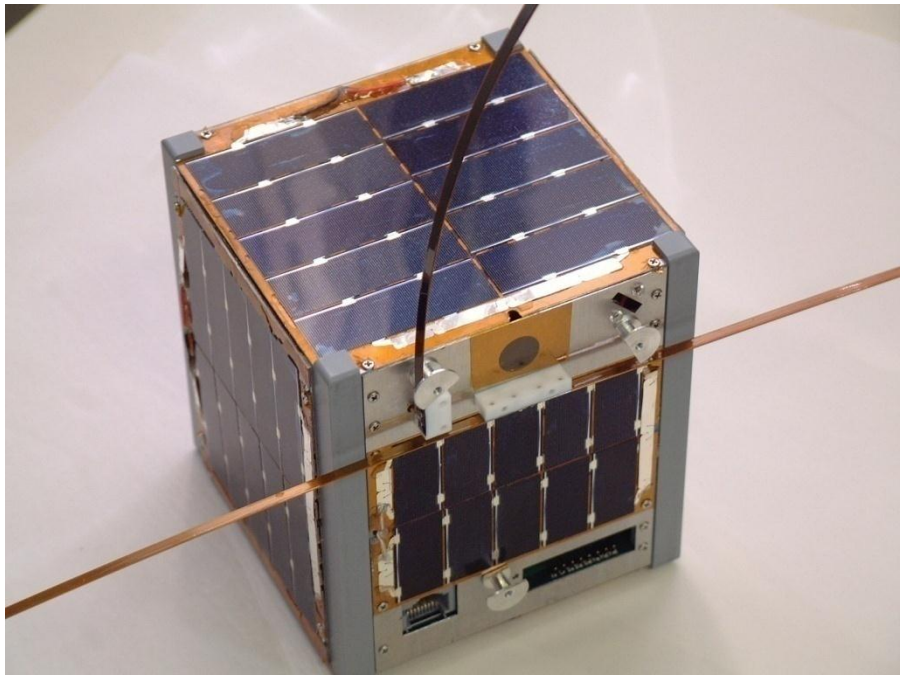
Development launch

CubeSat "XI-IV (Sai Four)"

Intelligent Space Systems Laboratory
University of Tokyo
ISSL

Mission: Pico-bus technology demonstration in space, Camera experiment
Developer: University of Tokyo
Launch: ROCKOT (June 30, 2003) in Multiple Payload Piggyback Launch

Size	10x10x10[cm] CubeSat
Weight	1 [kg]
Attitude control	Passive stabilization with permanent magnet and damper
OBC	PIC16F877 x 3
Communication	VHF/UHF (max 1200bps) amateur frequency band
Power	Si solar cells for 1.1 W
Camera	640 x 480 CMOS
Mission life	more than 8 years



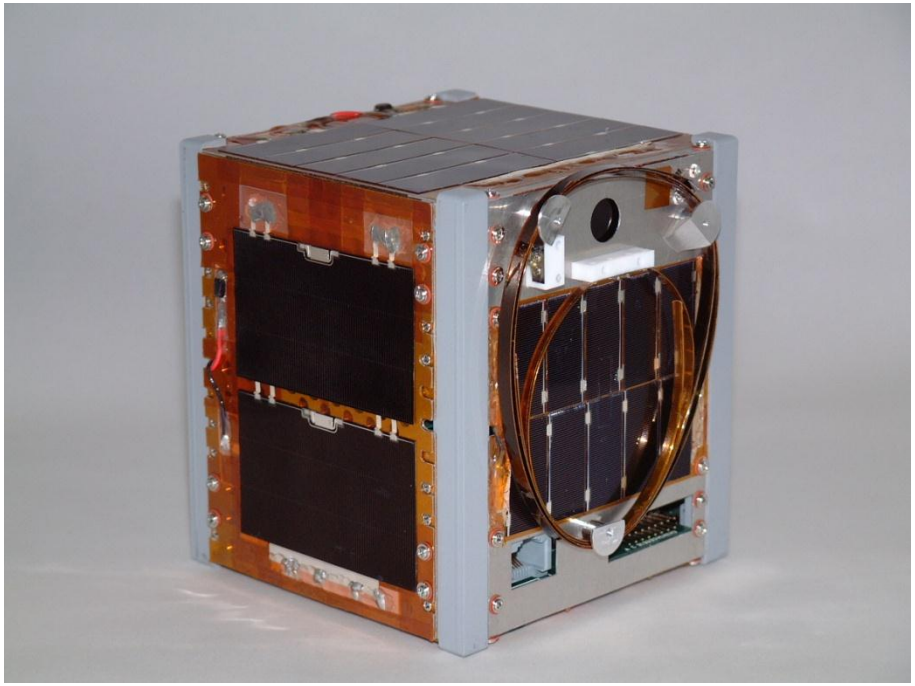
Captured Earth Images and Distribution to Mobile Phones

CubeSat "XI-V (Sai Five)"

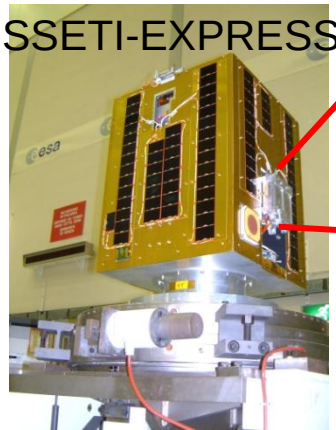
Intelligent Space Systems Laboratory
University of Tokyo
ISSL

Mission: CIGS solar cell demonstration, Advanced camera experiment
Developer: University of Tokyo
Launch: COSMOS (October 27, 2005) deployed from "SSETI-EXPRESS"

Size	10x10x10[cm] CubeSat
Weight	1 [kg]
Attitude control	Passive stabilization with permanent magnet and damper
OBC	PIC16F877 x 3
Communication	VHF/UHF (max 1200bps) amateur frequency band
Power	Si, GaAs, CIGS cells
Camera	640 x 480 CMOS
Mission life	> 5 years



SSETI-EXPRESS

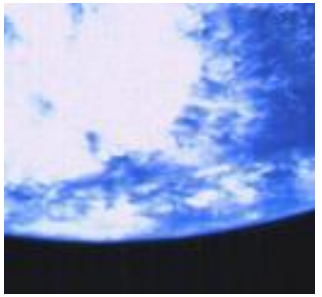


T-POD deployment System

Deployed from SSETI-EXPRESS in space

JAXA/NEDO CIGS Solar Cells

Captured Earth Images

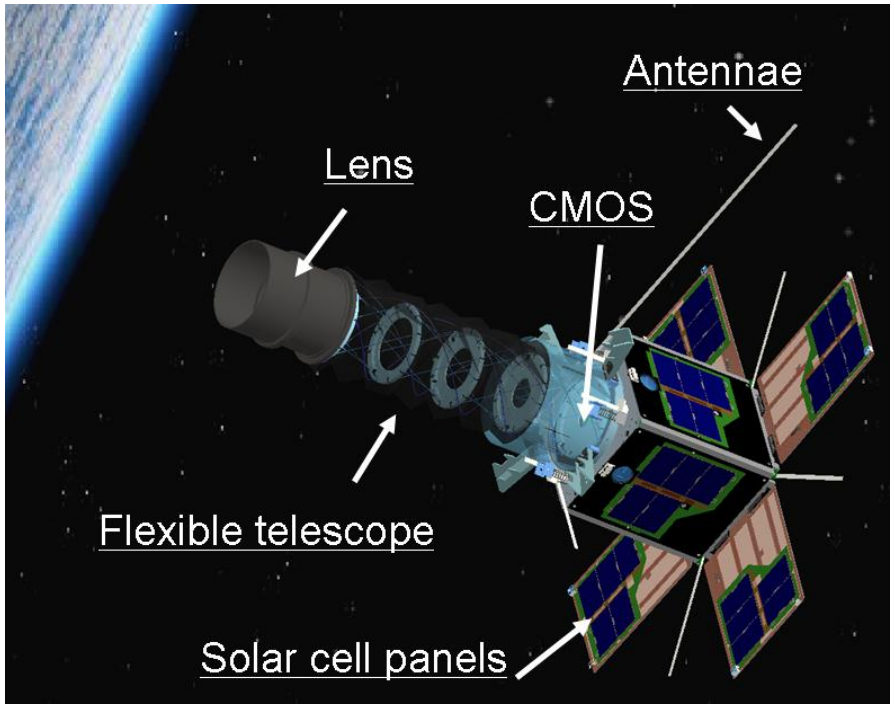


PRISM “Hitomi”

Intelligent Space Systems Laboratory
University of Tokyo
ISSL

Mission: Earth Remote Sensing (20 m GSD, RGB) with Deployable Boom
Developer: University of Tokyo
Launch: H-IIA (Jan 23, 2009) Piggyback with GOSAT (CO_2 monitoring sat)

Size	20x20x40[cm] in rocket 20x20x80[cm] in space
Weight	8.5 [kg]
Attitude control	3-axis stabilization with Sun, Magnet sensor, MEMS gyro magnetic torquers
OBC	SH2, H8 x 2, PIC x 2
Communication	VHF/UHF (max 9600bps)
Mission life	> 2.5 years



Captured images

Mexico Seashore

US Desert

Kita-Kyushu (Japan)

Wide Angle Camera

Nano-JASMINE

Intelligent Space Systems Laboratory
University of Tokyo
ISSL

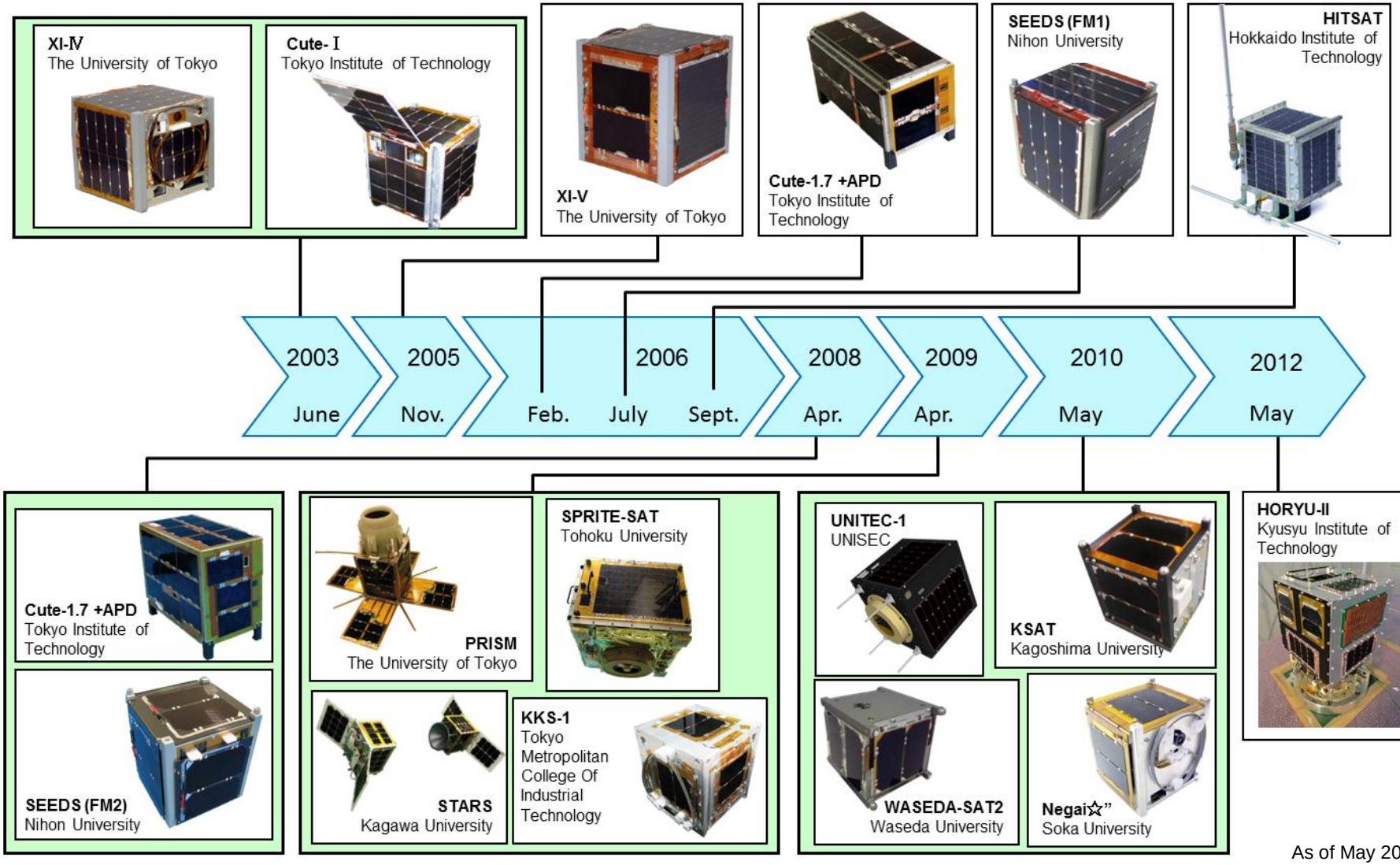
Mission: Astrometry (Getting precise 3D map of stars and their movements)
Developer: University of Tokyo, National Astronomical Observatory of Japan, Shinshu University, Kyoto University
Launch: Cyclone-4 (planned within 2013) from Alcantara Launch Site

Size	50 [cm-cubic]
Weight	33 [kg]
Attitude control	3-axis stabilization with Star, Sun, Magnet sensor, FOG, RW, Magnetic torquers
OBC	FPGA
Communication	S-band 100 [kbps]
Mission life	2 [year]

Special features:

-Attitude Stability	0.8 arcsec for 8.8 sec
-Thermal Stability	< 0.1K (at -50 degree)
-Map Accuracy	Compatible with “Hipparcos” Satellite (‘89)
-Telescope	two CCDs with TDI

Satellites made by Japanese Universities



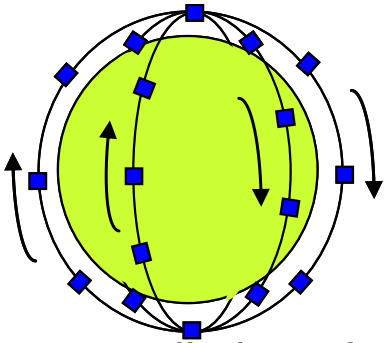
As of May 2012

Governmental "First" Program
"Hodoyoshi-project" (2010-2015)

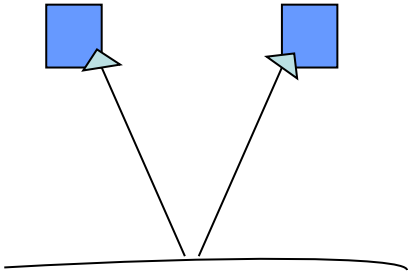
- Reliability concept for micro/nano/pico-satellites
  - "So-so and not expensive (Hodoyoshi)" reliability
    (compromise between cost (workload) vs. reliability)
- Component technology development
  - Should solve "size and power problem"
- Development process innovation
  - Software architecture
  - Ground test, etc.
- Create novel applications and use communities
  - Non-government users as individuals, companies, local government, research institute can seek for their interest

Missions Creation for Hodoyoshi Program

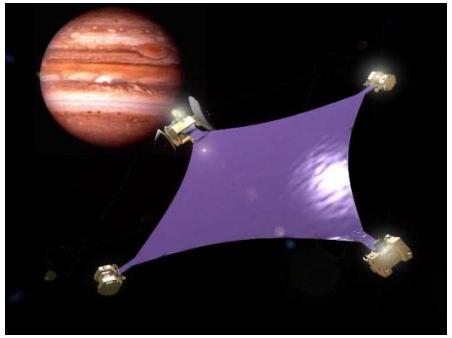
- Low-cost and small size realize satellite constellation
  - More frequent (ex. semi-daily) observation of the same areas
- Formation flight
  - Many scientific applications such as interferometer, multi-site observation, stereo vision
- “Personal Satellite” “My Satellite”
  - Novel ways of utilization including entertainment, education, contents, etc
  - Just like “PC and internet” innovation which has changed the world



Constellation of a hundred satellites



Stereo Vision

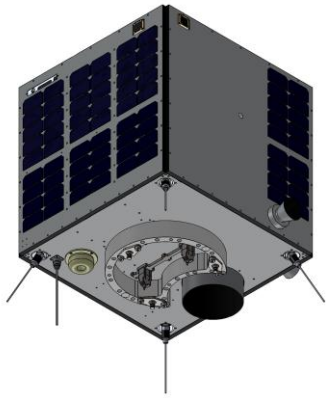


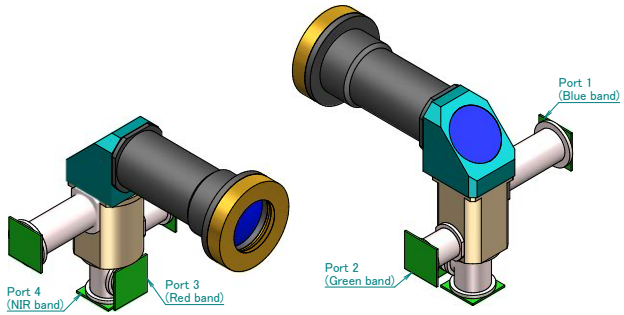
“Furoshiki” satellite

Satellite Development Plan (4 satellites in 4 years)

#1 : 6.8m GSD 4 band remote sensing

– *Data is open to private users so that they can test their utilizations*





Dnepr launch in 12/2012

(developed by AXELSPACE)

#2 : Foreign space science mission

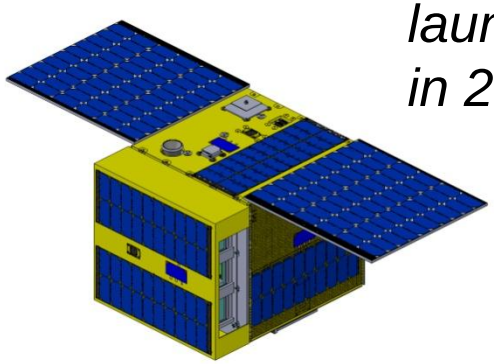
– *5 Mission payloads will be onboard (from foreign research institutes)*

to be launched in 2013

(developed by Tohoku University)

#3 : Constellation of 2 satellites

– *5, 40, 200m GSD, rental space, Store and forward missions*



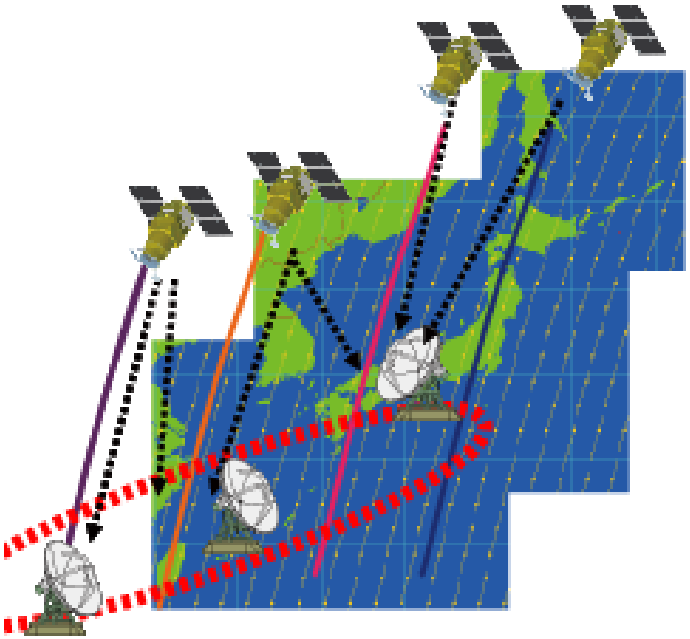
(developed by Univ. Tokyo and NESTRA)

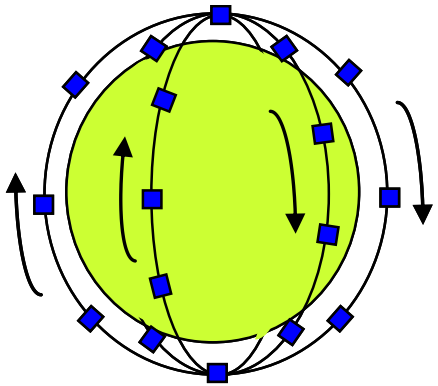
Capacity Building Support Program

UNIFORM (UNiversity International FOrmation Mission)

(Funded by MEXT, Japan)

- **Each country develops one micro-satellite (< 50kg)**
  - To be operated in constellation manner
  - Standardization of bus/component
  - Training of satellite development is supported by Japanese Universities
  - Equipment cost partially supported by Japanese government (in negotiation)
- **Ground Station Network**
  - Low-cost GS is developed to realize one GS in each country (S/X-band)
- **Missions**
  - Common mission + individual mission
  - Common mission will be determined by discussions within community





Operation in constellation

Introduction to UNISEC
University Space Engineering Consortium

- UNISEC is a non-profitable organization to facilitate and promote practical space development activities, such as designing, developing, manufacturing, and launching micro/nano satellites and hybrid rockets at university level.
- Established in 2002
- 57 laboratories/groups from 39 universities
- About 500 student members and 220 supporters

Vision 2020-100

By the end of 2020, let's create the world where university students can participate in practical space projects in more than 100 countries.

<Examples of programs>

1) CanSat Leader Training Program (CLTP)
2) Nano-Satellite Mission Idea Contest (MIC)
3) Nano-Satellite Symposium

Let's establish UNISEC-xxx (your country)
Let's start "UNISEC-International" together!

1)CanSat Leader Training Program (CLTP)

CLTP was established in 2011 to contribute to capacity building in space technology and to improve teaching methods in space engineering education.

- A one month course gives training through whole cycle of CanSat development including sub-orbital launch experiments
- Participants are expected to teach their students CanSat program in their countries
- Aiming at “international CanSat education network”

http://www.cltp.info

CLTP Participants

CLTP1 (Wakayama Univ. in Feb-March, 2011)
12 participants from 10 countries, namely Algeria, Australia, Egypt, Guatemala, Mexico, Nigeria, Peru, Sri Lanka, Turkey, Vietnam.

CLTP2 (**Nihon Univ. in Nov-Dec, 2011)**
10 participants from 10 countries, namely Indonesia, Malaysia, Nigeria, Vietnam, Ghana, Peru, Singapore, Mongolia, Thailand, Turkey.

CLTP3 (Tokyo Metropolitan Univ. in July-August, 2012)
10 participants from 9 countries, namely Egypt, Nigeria, Namibia, Turkey, Lithuania, Mongolia, Israel, Philippines, Brazil

2) Mission Idea Contest (MIC)

for Micro/nano Satellite Utilization

The 2nd Mission Idea Contest for Micro/Nano-satellite Utilization

- Objective: Encourage innovative exploitation of micro/nano-satellites to provide useful capabilities, services or data.
- Requirement: Propose innovative
  - category1: mission idea and satellite design
  - category 2: mission idea and business model using micro/nano satellite weighing less than 50kg.
- Regional coordinators: 33 regions
- 72 applications from 29 countries.
- **Oct 10, 2012 Final Presentation**

http://www.spacemic.net

3) UN/Japan Nano-Satellite Symposium

UNITED NATIONS

THE UNIVERSITY OF TOKYO

Oct. 10-13, 2012

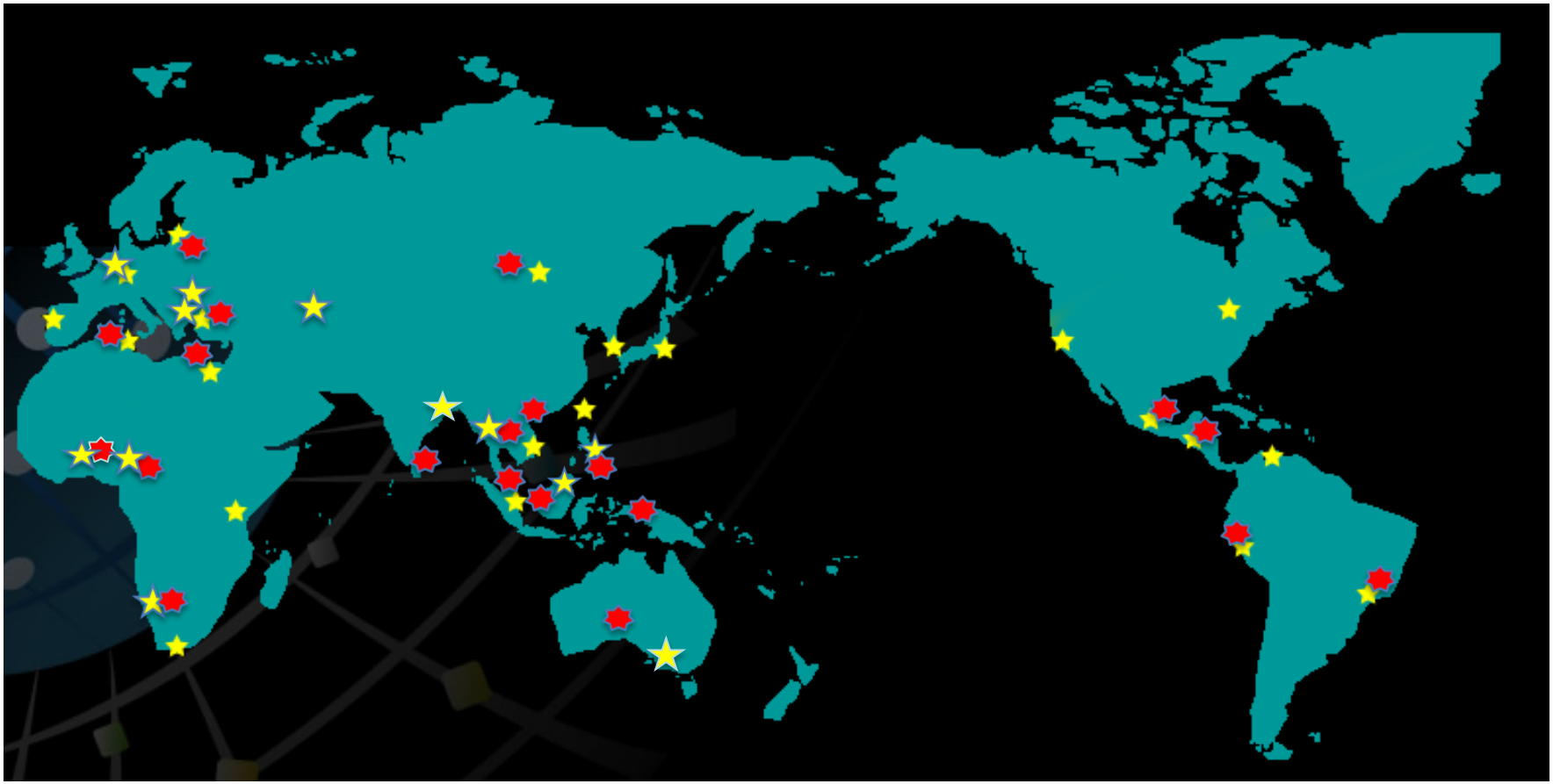
NAGOYA, Japan

Under the Basic Space Technology Initiative (BSTI) of the United Nations Programme on Space Applications

JAPAN INTERNATIONAL EXHIBITION AEROSPACE 2012

http://www.nanosat.jp/

Global network through Mission Idea Contest and CanSat Leader Training Program (MIC:33, CLTP: 21 countries) 38 countries in total



: CLTP participant　　: MIC coordinator

Micro/nano-satellite and future

- Large educational effect not only for space, but also for many technological areas
- New paradigm of space development and utilization with low-cost and quick development
- International network through micro/nano-satellites