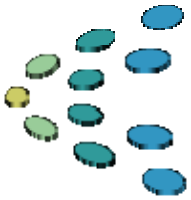


Mission Idea Contest

First Regional Seminar in Egypt
2nd August 2010

Mohammed Khalil Ibrahim, Ph.D
Associate Professor, Aerospace Engineering Department, Faculty of Engineering, University of Cairo.
Regional Coordinator for Mission Idea Contest.

Content

- Motivations
- Background
- Organizer and Sponsor
- Mission Idea Contest Guidelines
- Abstract Template

Acknowledgement

- Ms. Rei Kawashima, CMO, Axelspace Corporation.
- Prof. Shinichi Nakasuka, ISSL, Univ. of Tokyo.

Motivations

- **Jump up from Education to Practical Use Needed**
  - Technology pool for practical level equipment
  - From “educational reliability” to “customer reliability”
  - No theory/SE as to how to make nano-satellites
- **Sophisticated satellites are more than student manageable level**
  - Beyond the areas which students should cover
  - All-Japan organization is desirable to combine strength of each university
- **Training sessions for new companies needed**
  - First step to enter space related business
- **Necessity to create new non-government users**

Introduction

- Mid-Large Satellites ➔ Small Satellites
  - Limited utilization areas, only governmental mission
    - Communication/broadcast, remote sensing, space science, etc. only
    - Not so large contribution to society
    - Limited quantities hard to industrialize

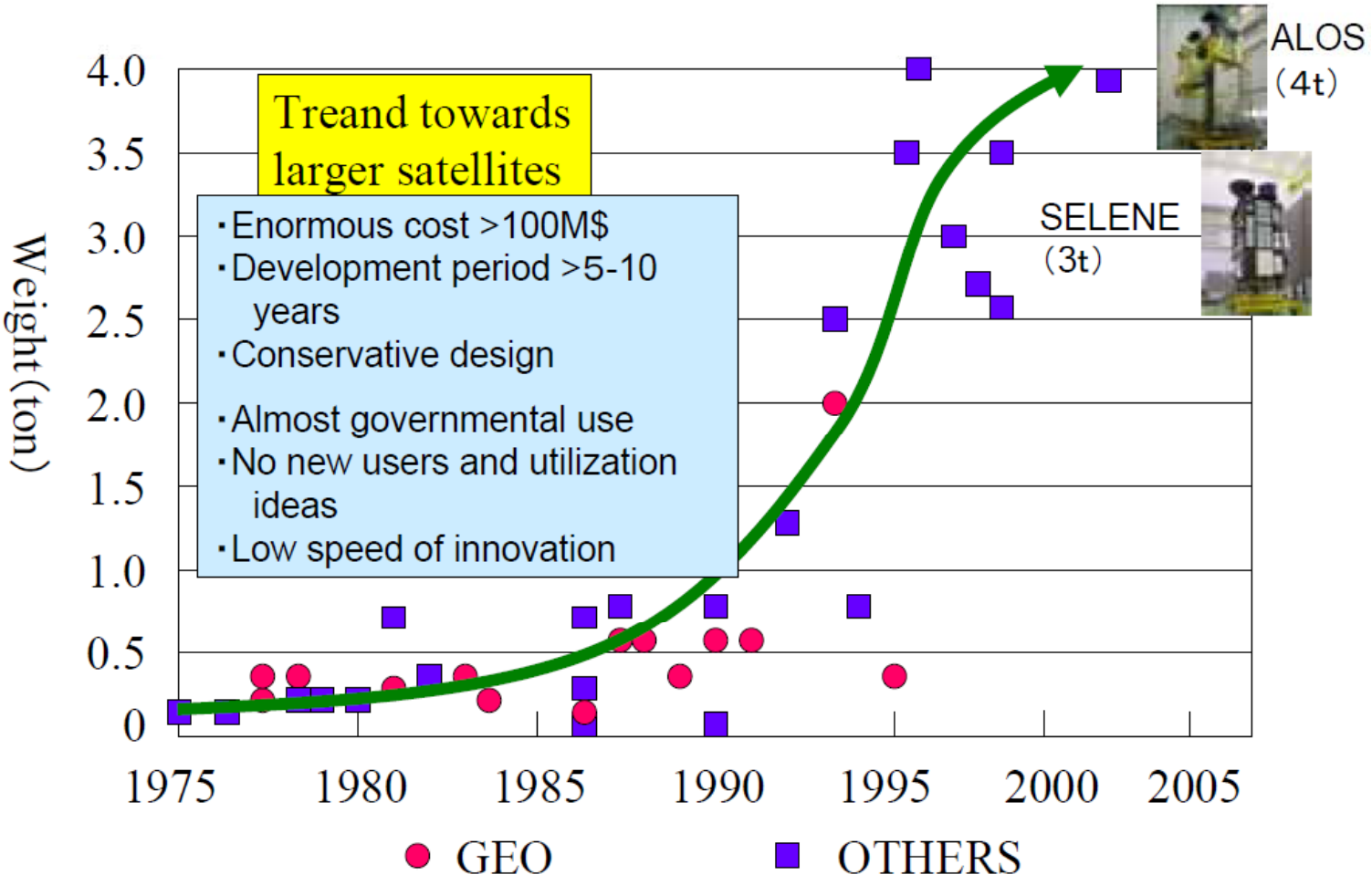
JAXA
ALOS, Advanced Land Observation Satellite
> 4t, > 400M$

Innovation

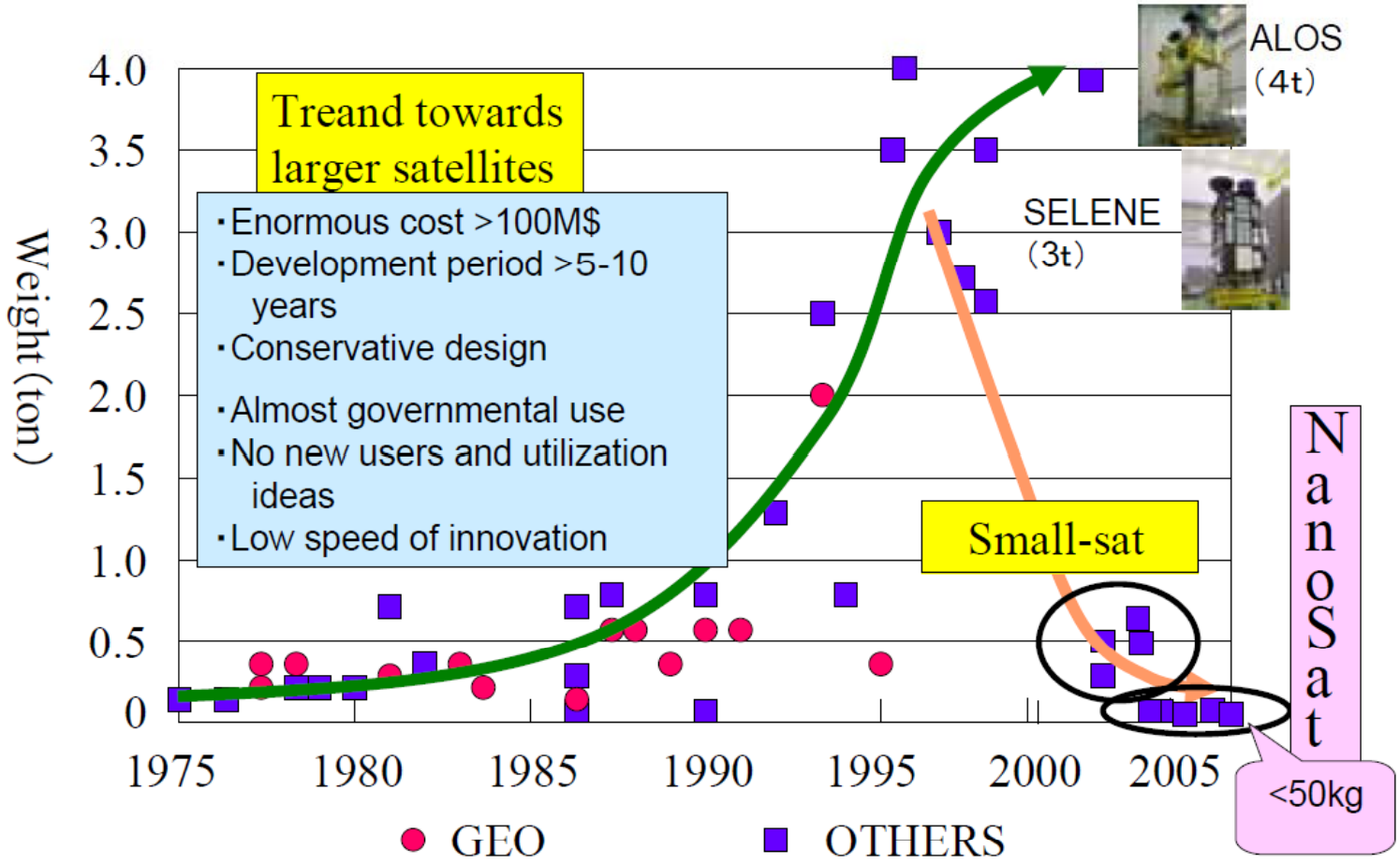
    - Small satellites (100kg ~ 500 kg)
    - 30M$ ~ 50 M$: Earth observation, communications, space science. etc

Surrey Satellite Technology Limited, SSTL
MicroSat 100
≈ 100 Kg

Demerits of mid-large Satellite



Small satellites / Nano-satellites Emerges



Nano-satellite

Nano-satellite is a low cost and short development-time satellite with mass of less than 50kg

"Normal" satellite
(LANDSAT 7/NASA)

Mass:1,973kg/Length:4.04m

Image courtesy of NASA

Nano-satellite
(Cute1.7+APD/Tokyo Tech)

Mass:3kg/Length:20cm

Source : the website of Laboratory for space systems, Tokyo institute of technology

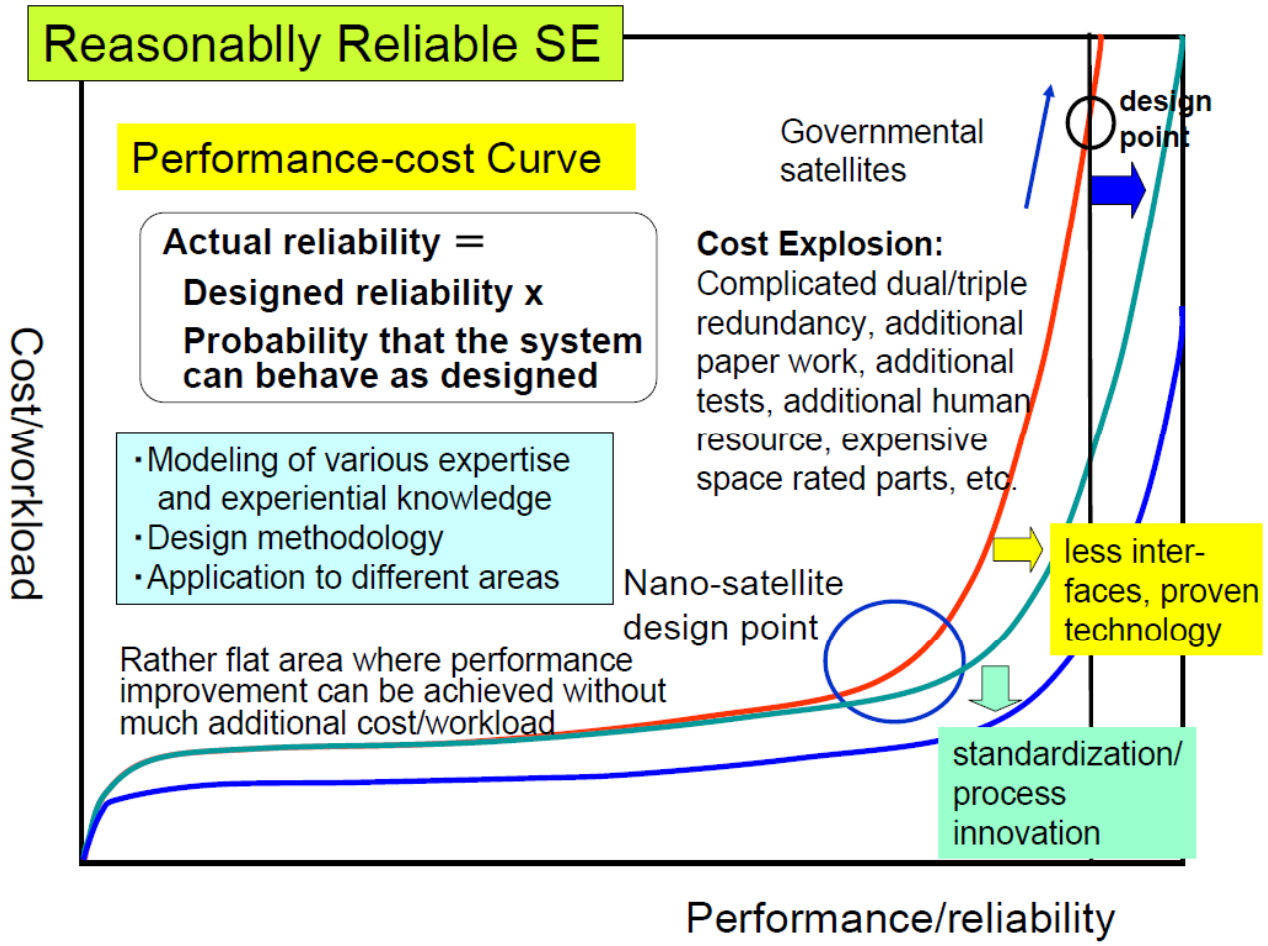
Nano-satellite

	Nano-satellite	"Normal" satellite
Mass	1 to 50 kilograms	Up to several thousands kilograms
Size	10 to 50 cm	Up to several ten meters (incl. deployable structure)
Development Term	6 months to 2years (depending upon the mission)	5 to10 years
Cost (excl. launch and operation costs)	Several million US dollars	Hundred million to billion US dollars
Orbit	Mainly Low Earth Orbit (LEO)	LEO to geostationary orbit
Mission	Need to consider an original mission subject to limited resource in comparison with "normal" satellite	High performance and multi-function
Flexibility of orbit, timing of launch and launcher	Basically need to be launched together with other satellite(s) (the "piggy-back")	Can choose a launcher because of the main payload.

What is “Nano-”

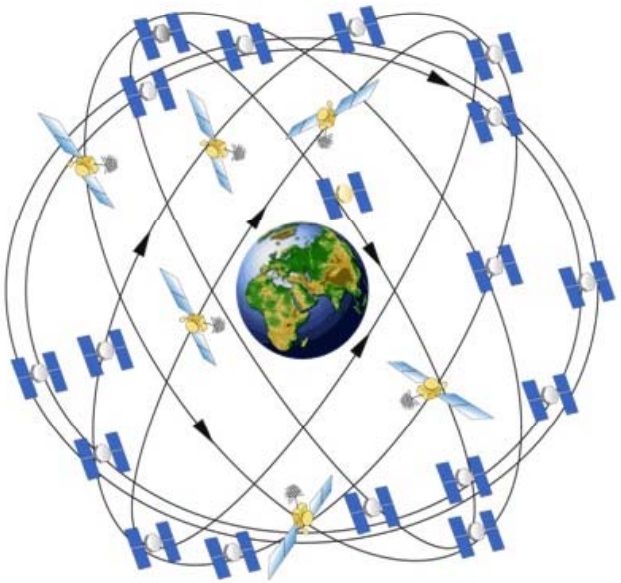
- Difference from mid-large satellite exist in “**the way of development**”
  - How and in what part we can take “simple and easy way” in satellite development to save cost and time?
  - Keep the situation that we can take “simple and easy way”
    - Small number of parts and interface
    - Not aiming for maximum performance/reliability
    - Keep using the same parts/equipment
  - Modularization and/or standardization are one methods of such strategy
- Appropriate balance between cost/workload and performance/reliability
    - Concept of “**Reasonably Reliable System Engineering**”

Reasonably Reliable SE



Constellation

A formation of multiple satellites in Earth orbit for a single mission. A constellation will provide satellite users with various advantages such as a higher time resolution, overall system robustness, wider coverage, etc.



Organizer and Sponsor

- Axelspace Corporation

- Intelligent space system laboratory at Tokyo University

Axelspace Corporation

- Space venture company specialized in nano-satellites.
- Developer and Manufacturer of nano-satellites
- Focus on potential market niches not well served by existing companies
- Provide total services from conceptual design to satellite operation
- Established in 8/8/2008.
- Young but Experienced Engineers (who have built 2-3 nano-satellites at their universities)
- Collaborative research agreement with University of Tokyo

AXELSPACE PRODUCTS

Satellite Bus System

Yayoi

Yayoi is a nano-satellite bus system featuring up to 50kg mass and three-axis attitude control system.

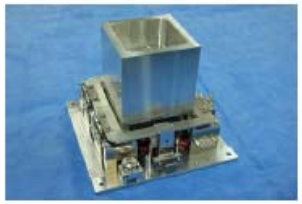
Basic Specifications

Orbit	Low Earth Orbit (Altitude < 1,000km)
Power	More than 2W for mission instrument
Mass	From 1 to 50 kg
Attitude Control	Three-axis control with magnetic torquers and reaction wheels

The practical configuration of the bus system will be designed in accordance with the requirements of the customers. It is expected that the satellites based on Yayoi bus system will be delivered within two years from the order intake.

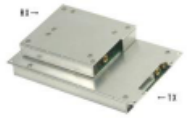
Satellite Component

AxelShooter (Separation Mechanism)



Reliable satellite separation mechanism for up to 30kg class satellites featuring open-type (not Pod-type) separation and flexible mechanical rocket-interface

SatCom HVU-301 (Comm. Controller)

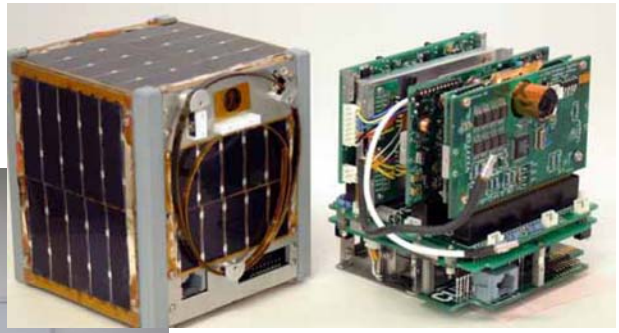


Flight-proven communication controller unit designed for 430MHz CW/FM transmitter and 430/145MHz FM receiver

AxelStar (Star Sensor)

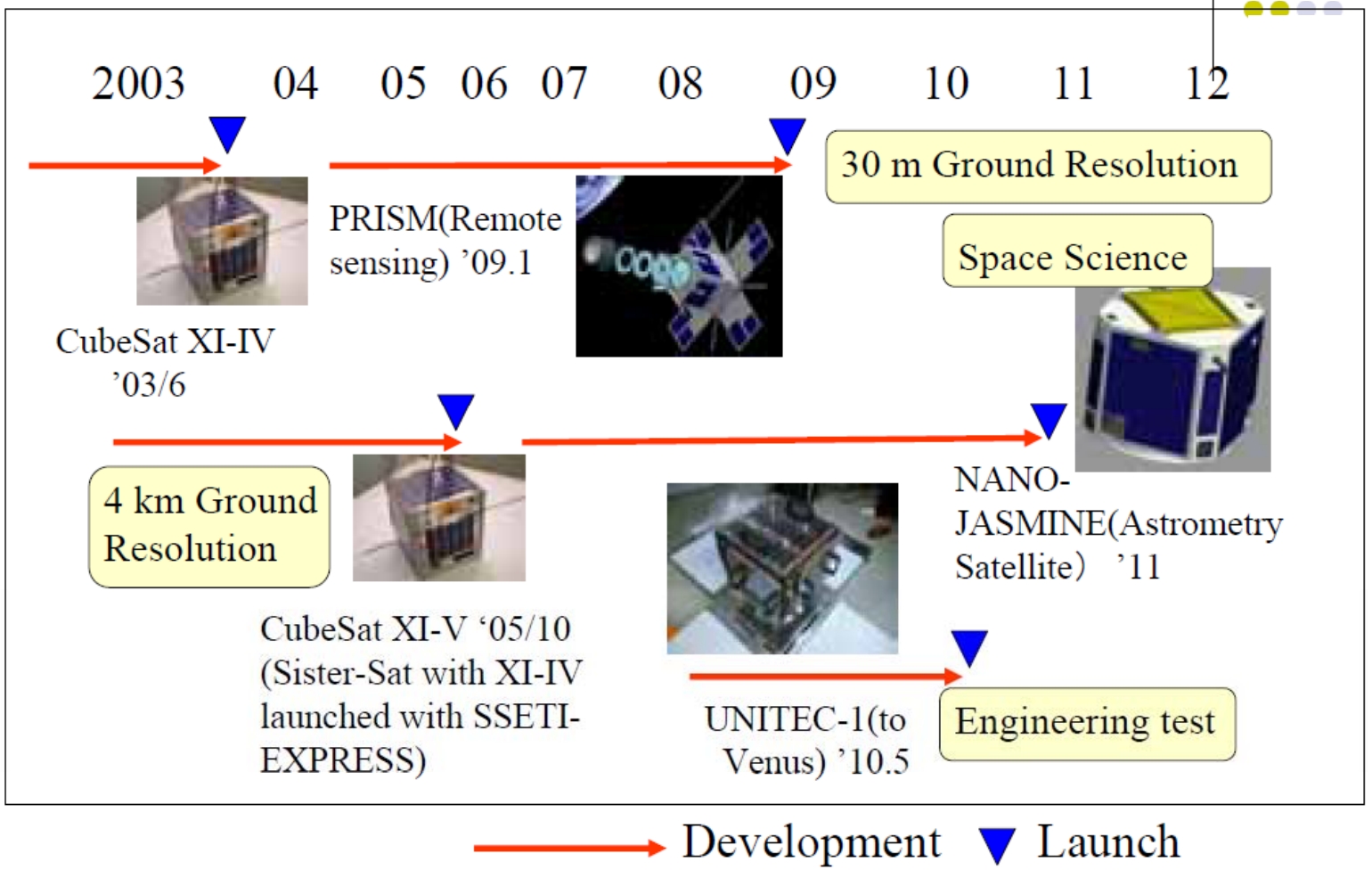
Nano-sized high-precision star sensor featuring 30 arcsec accuracy, 8 deg x 8 deg FOV and up to 1W power consumption

Intelligent Space System Laboratory (ISSL)

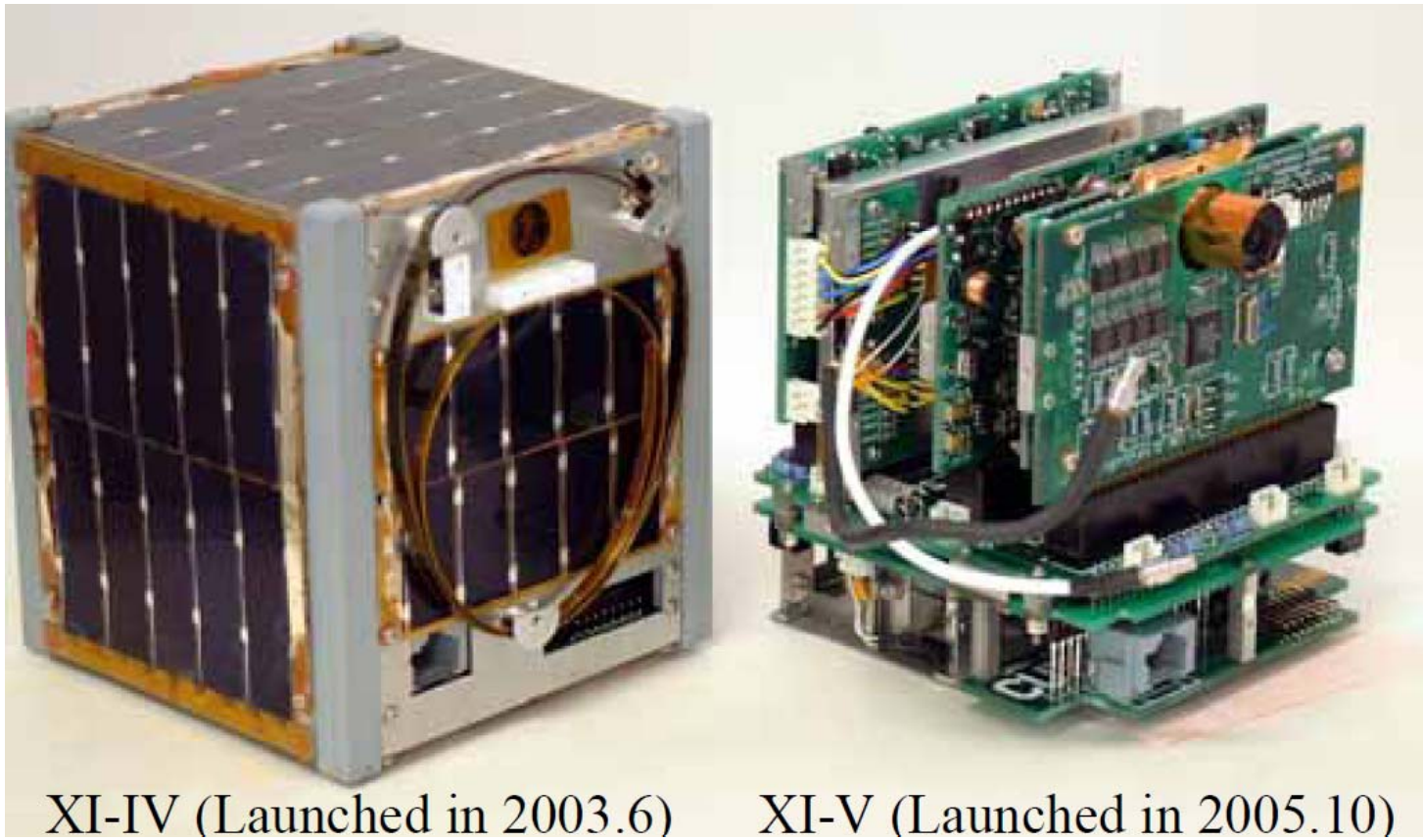


ISSL members during the celebration of CubeSat XI-IV on June 2010

ISSL Nano-satellite Development Program



ISSL CubeSat XI-IV



XI-IV (Launched in 2003.6)

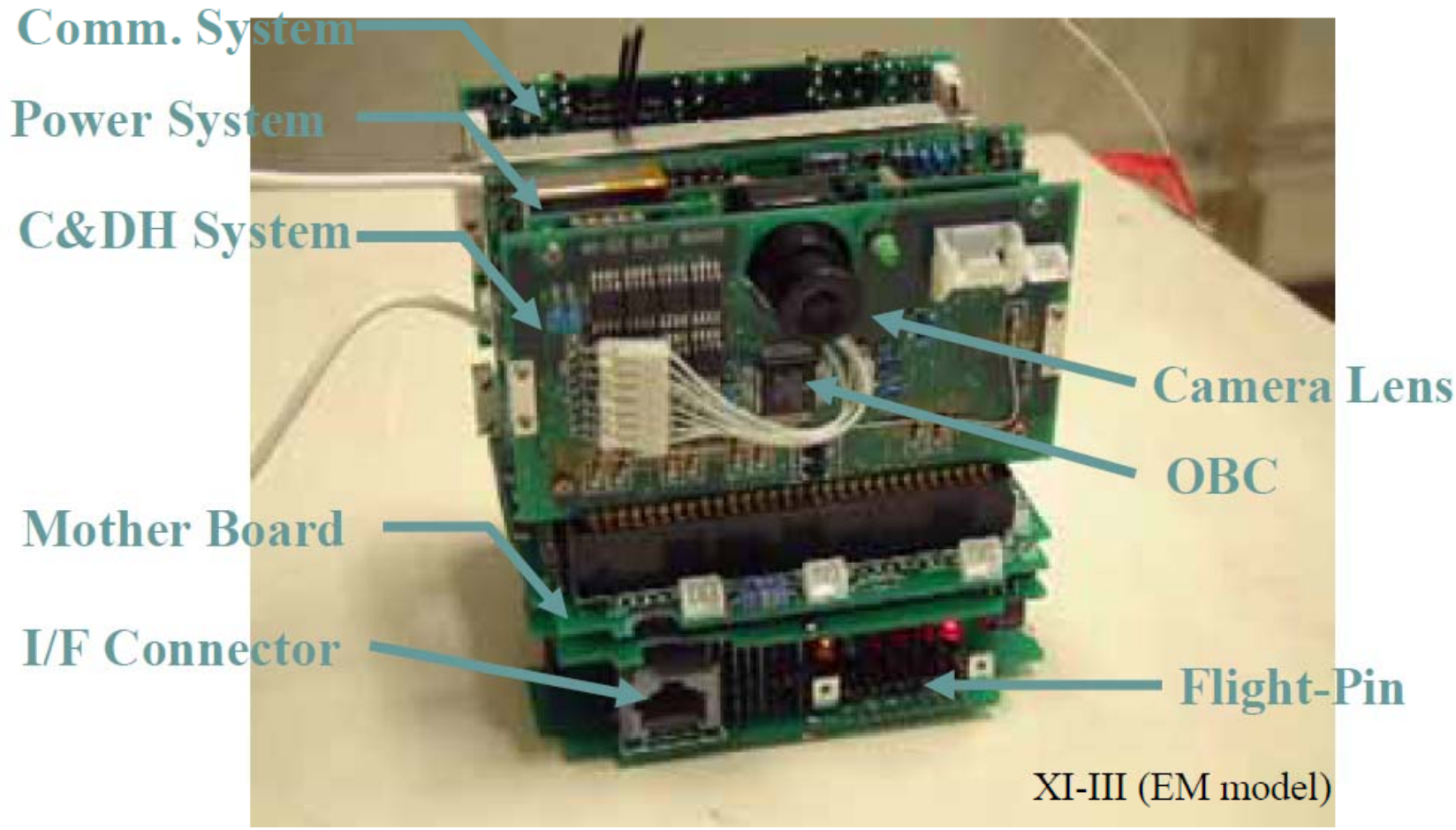
XI-V (Launched in 2005.10)

Basic Specifications of CubeSat XI-IV

● Structure		10cm cubic, 1kg, Aluminum A7075 body
● C&DH		
	OBC	PIC16F877 4MHz (Program memory 8k, RAM 368)
	Data Storage	EEPROM 32k + 224k
● Communication System		
	Downlink	430MHz band, FSK, 1200bps, 800mW
	Uplink	144MHz band, FSK, 1200bps
	Beacon	430MHz band, CW, 80mW
● Power System		
	Battery	Lithium-ion battery, 8 cells, 6.2AH
	Solar Cells	Monocrystal silicon, 60 cells, 1.1W(ave)
	Consumption	0.6W(ave), 5.4W(max)
● Attitude Control		Passive stabilization using permanent magnet and damper
● Sensors		Voltage, Current, Temperature, CMOS camera

Mission: Education, Pico-bus demonstration in space

Inside Structure and Outlook



Inside Structure and Outlook

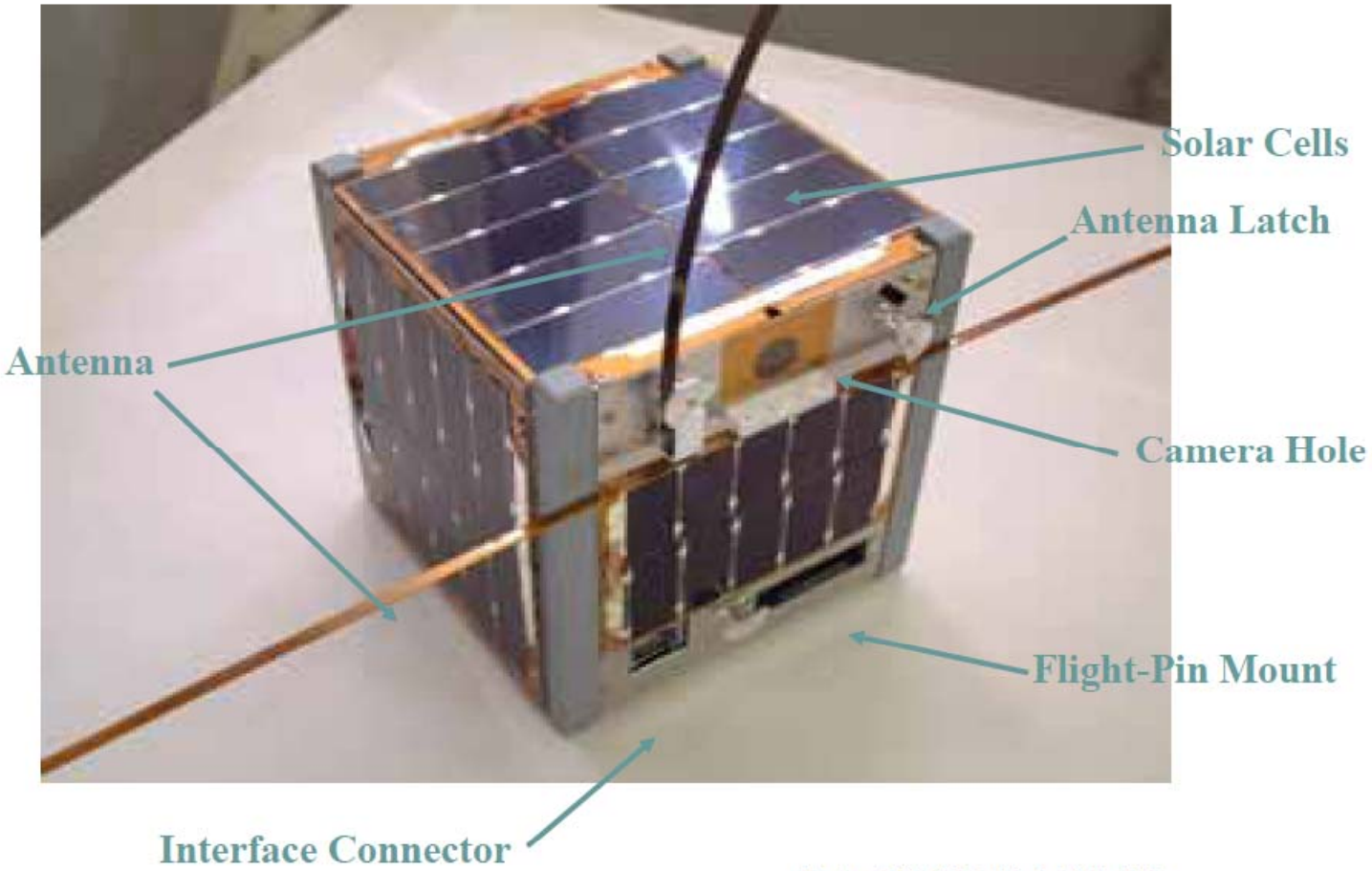
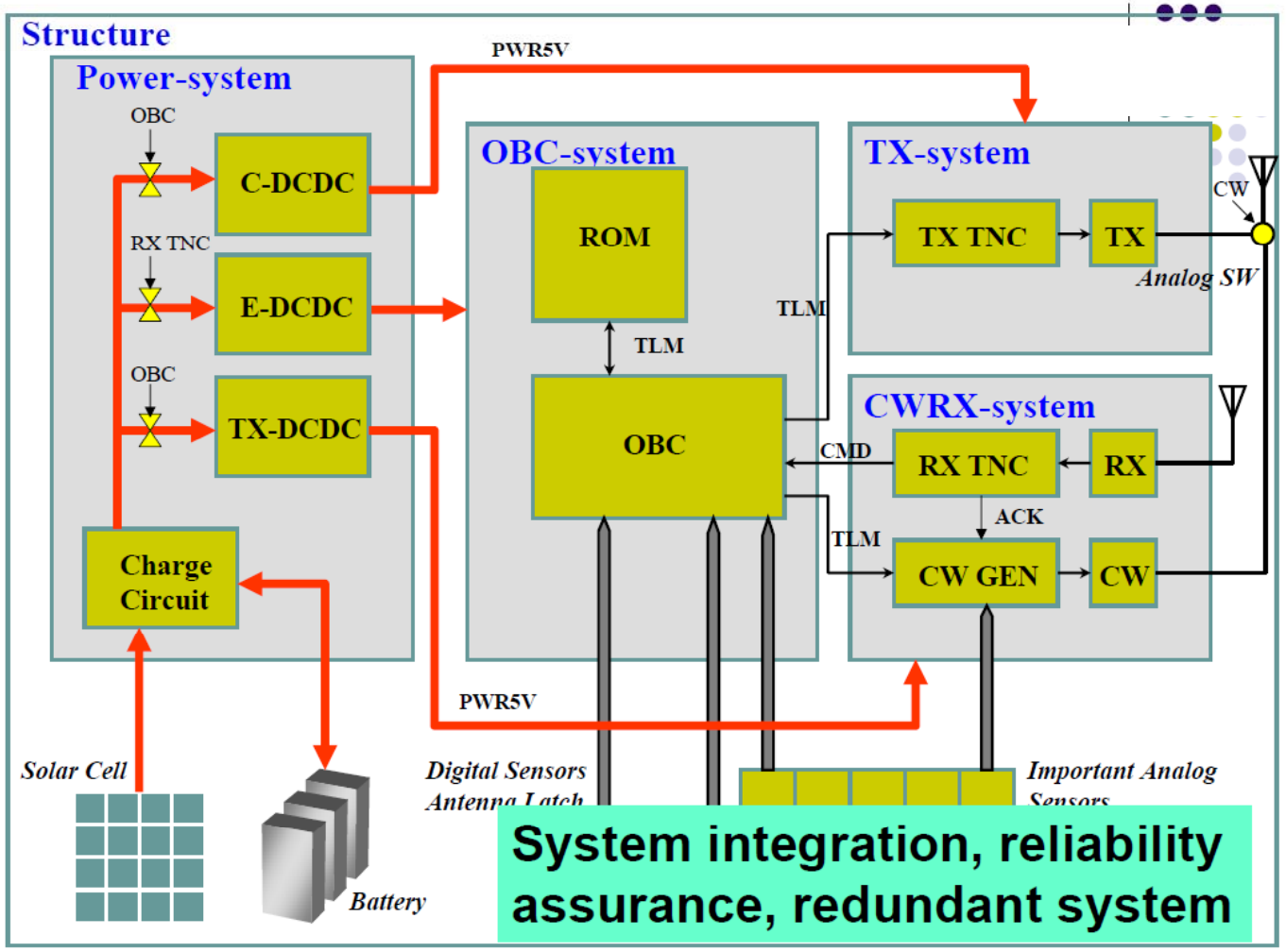
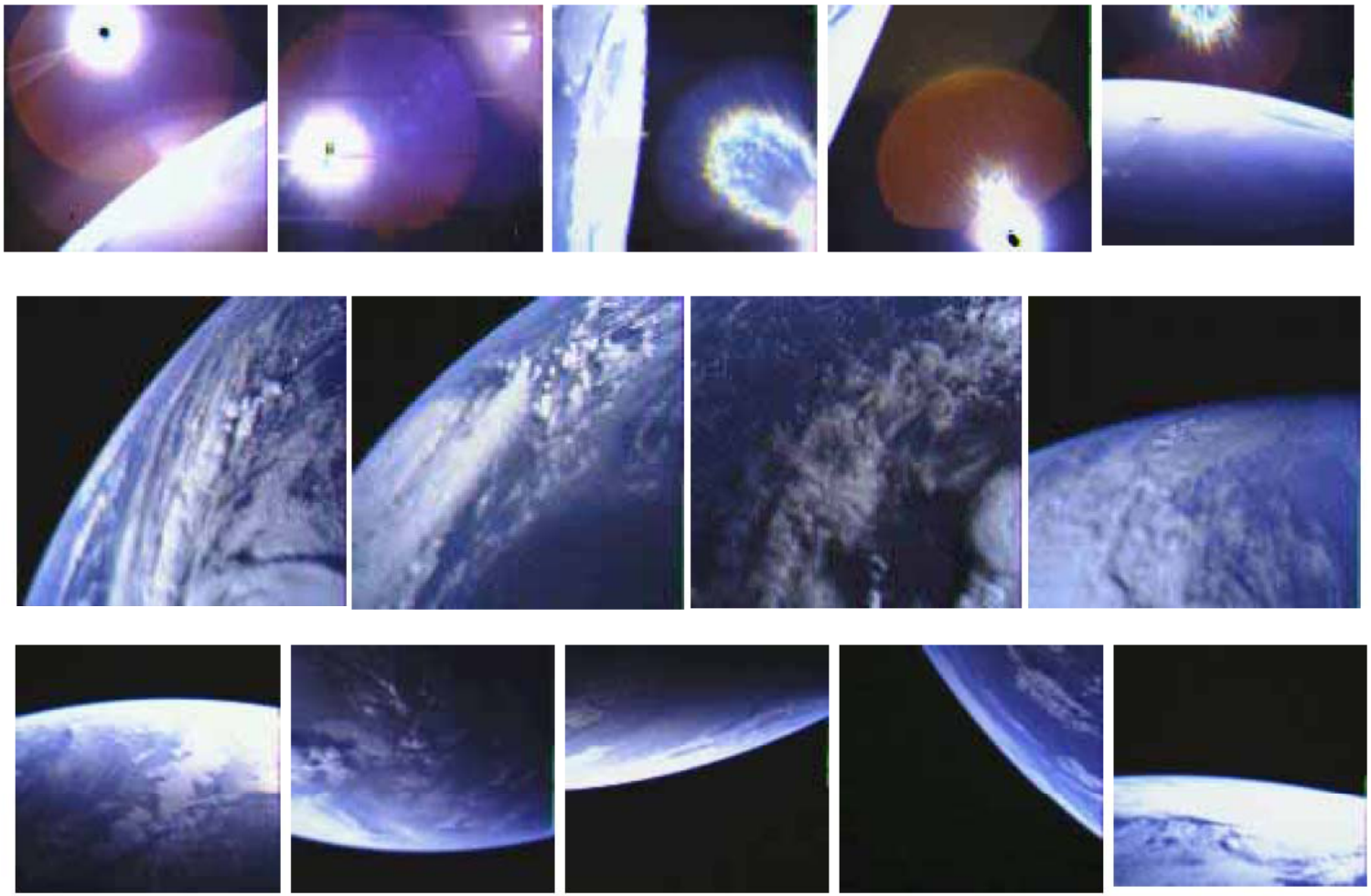


photo: XI-IV (Flight Model)

CubeSat XI-IV Structure



XI-IV survives in space for more than 5 years



Japanese Universities NanoSats Development Efforts

University	Name of Satellite	Year	Launcher	Outlook
University of Tokyo	XI-IV XI-V	2003 2005	ROCKOT(r) COSMOS(r)	
Tokyo Institute of Technology	CUTE-1 C-1.7+APD C-1.7+APDII	2003 2006 2008	ROCKOT(r) M-V(Japan) PSLV (India)	
Hokkaido Institute of Technology	HITSAT	2006	M-V(Japan)	
Nihon University	SEEDS	2008	PSLV(India)	

(r) Russia

Mission Idea Contest Guidelines

- Objectives
- Ground Rules
- Awards
- Contest Timeline
- Application
- Reviewers
- Review Criteria
- Coordinators

Objective

Encourage innovation exploitation of nano-satellites in constellations to provide useful and sustainable capabilities, services or data

Ground Rules

- Eligibility
  - Any individual, group or company with suitable space systems expertise and an enthusiasm for nanosats
- Requirements
  - Exploitation of Nanosats e.g. Individual free-flying satellites typically <15 kg
  - Exploitation of a constellation = a synergistic collection of 2 or more satellites providing a common service or multi-point data.
  - Mission capable of <~2 yr development time with total lifecycle cost < ~$6M (excluding launch)
- Assumptions
  - Single, Secondary launch to Earth orbit to achieve initial operational capability

Awards

- Finalists will be invited to present in Japan at the 2nd Nanosat symposium
- Award 1st prize: 500,000 JPY , 2nd prize: 300,000, 3rd prize: 200,000
- Best papers published in a peer-reviewed journal: e.g. Acta Astronautica or Journal of the British Interplanetary Society (TBR)
- High visibility for your ideas, potential for future collaboration and support

Contest Timeline

- June 2010: Announcement of Contest Details
- July-September 2010: Regional seminars to introduce the competition details in each region:
- December 20, 2010: Submission Deadline
  - Evaluation by reviewers: Dec.20 – Jan.20
- January 2011: Announcement of Finalists
  - Each team of finalists shall prepare formal paper describing their proposed idea (detailed guidelines to be provided)
  - One representative from each team of finalists will be invited to Japan (expenses paid) to participate in the final presentation stage.
- March 1, 2011: Submit final papers for review
- March 14, 2011: Final Presentations and selection of winners in Tokyo

Application

- Submit extended abstract not to exceed 5 pages (in English) no later than 20 Dec describing:
  - Need your mission idea addresses
  - Prioritized list of Mission objectives
  - Concept of operations (description of key mission elements and their interfaces)
  - 3-5 Key Performance Parameters (e.g. Resolution, data rate, coverage)
  - Space segment description (conceptual design, e.g. Mass, volume, power,link budget,
  - orbit)
  - Implementation plan (estimated cost and schedule, infrastructure requirements)
  - Detailed instruction for submissions to be found on website
- Work with your regional coordinators for assistance
- If selected as finalist, prepare and submit final paper and presentation for 2nd Nanosat Symposium in Tokyo March 2011

Reviewers

Dr. Jerry Sellers (Chair)
Teaching Science & Technology, Inc.

Prof. Herman Steyn
Stellenbosch Univ.

Prof. Sir Martin Sweeting
SSTL, SSC

Prof. Shinichi Nakasuka
ISSL, Univ. of Tokyo

Dr. Masaya Yamamoto
Weathernews Inc.

Dr. Rainer Sandau
DLR

Prof. Hiroshi Kawahara
Cyber Univ.

Review Criteria

- Original, sustainable Nanosat mission idea
  - Novel mission concept not yet realized or proposed, or a new implementation of an existing capability or service
  - This is not intended to be a single mission but rather an on-going application providing a continuous useful capability
  - Impact on society
- Mission Feasibility
  - Technical
  - Programatic (cost estimate, development schedule, infrastructure requirements
  - Operational (Description of ground segment and communications architecture, e.g. planned use of existing infrastructure)

Coordinators

Prof. Mohammed Khalil Ibrahim
Cairo University, Egypt

Prof. Hyochoong Bang
KAIST, Korea

Dr. Fernando Agelet
University of Vigo, Spain

Prof. Low Kay Soon
Nanyang Technological University, Singapore

Dipl. Inform. Marco Schmidt
Würzburg University, Germany

Prof. Jordi Puig-Suari and Roland Coelho
Cal Poly, USA

Dr. Esaú Vicente Vivas
Instituto de Ingeniería, UNAM, Mexico

Mr. John Mugwe
Afrosoft, Kenya

Dr. Fernando Stancato
University of São Paulo, Brazil

Proposal Format

- Title
- Primary POC, Affiliation
- Needs
- Mission Objective
- Concept of Operation
- Key Performance Parameters
- Space Segment Description
- Orbit/Constellation Description
- Implementation plan
- References

Proposal Format

- Needs
  - In 2-3 sentences describe the fundamental need (humanitarian, business, scientific, etc.) your mission idea addresses. For example "Equatorial countries need timely tsunami warnings," and why this need is not being fully addressed by current or conventional large space systems.
- Mission Objective
  - List and describe no more than 5 mission objectives and priortize them. These should be quantitative in nature and serve as overall measures of effectiveness for the mission.
- Concept of Operation
  - List and describe key mission elements (ground segments, space segments, launch, etc.) and describe their primary interfaces. Use diagrams and tables as appropriate.
- Key Performance Parameters
  - List and explain the technical rationale for 3-5 key performance parameters that enable the successful conduct of your mission idea. For example, tsunami detection may depend on better than 20 m spatial resolution in the visible spectrum.
- Space Segment Description
  - Describe the conceptual design for your satellite system or systems. List key specifications (e.g. mass, volume, peak and average power, link budget, delta-V, etc.). Diagrams or simple CAD drawings are encouraged.
- Orbit/Constellation Description
  - Describe the orbital elements for the desired mission constellation and explain the technical rationale for its selection. Presentation of analytical results ground coverage or user access computations or simulations is encouraged.
- Implementation plan
  - Describe how your organization, or your organization working with others, could implement your idea. Provide a reasonable estimate of total life cycle cost to include design, development, assembly, integration, testing, launch, operations and disposal. Provide considerations about project sustainability where applicable (e.g. "the next round constellations")".List any facilities or other infrastructure to be used or needed. Describe the project organization. Present a top-level project schedule starting from authority to proceed. List and describe the top 5 project risks (technical or programmatic).
- References
  - List any technical references for your idea

Mission Idea Contest Web Site

http://www.axelspace.com/missionideacontest/index.html