Mission Idea Contest 2

- Seminar -

December 14, 2011

UNISEC

MIC2 Review Team

Agenda

- 9:00-9:10 MIC2 overview, Rei Kawashima
- 9:10-9:15 MIC2 Award, Dr. Jean-Michel Contant and Rei Kawashima
- 9:15- 9:25 Review of Excellent Ideas (1st, 2nd, 3rd Place) in the 1st MIC, Prof. Herman Steyn
- 9:25-9:35 Evaluation Criteria for category 1, Prof. Herman Steyn
- 9:35- 9:45 Tips: how to create mission idea, how to make satellite design, Prof. Sir Martin Sweeting
- 9:45-10:00 Q & A
- 10:00- 10:20 Explanation of Category2, Prof. Shinichi Nakasuka
- 10:20-10:30 Evaluation Criteria for category2, Prof. Hiroshi Kawahara
- 10:30-10:45 Q and A
- 10:45-11:00 Coffee Break
- 11:00-12:00 General Discussion

The 2nd Mission Idea Contest

Objective:

Encourage innovative exploitation of micro/nano-satellites to provide useful capabilities, services or data.

2 Categories:

1) Mission Idea and Satellite Design
2) Mission Idea and Business Model

Target satellite(s): weighing **less than 50 kg**,
(both constellation mission and non-constellation mission are welcome)

Organizer: University Space Engineering Consortium (UNISEC)

Sponsor: University of Tokyo (funded by Japanese government)

This contest is granted by the Japan Society for the Promotion of Science (JSPS) through the "Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program)," initiated by the Council for Science and Technology Policy (CSTP).

Changes from 1st MIC

	1st MIC	2nd MIC
Satellite mass	< 15 kg	<50 kg
Number of satellites	2 or more than 2 (constellations only)	1 or more than 1 (no requirement for constellations)
Category	Only 1 category: Mission idea for nano-satellite constellation	2 categories: 1) Mission idea and satellite design 2) Mission idea and business model

Schedule for 2nd Mission Idea Contest

- August 2011 Call for Paper
- August 2011- April 2012 Regional Seminar/Dissemination of info

1st round: extended abstract evaluation step

- **May 1, 2012 Abstract Deadline**
- July 1, 2012 Selection of Finalist

2nd round: paper and presentation step

- Sep 1, 2012 Final Paper Deadline
- **Oct 10, 2012 Final Presentation** at the 4th Nano-satellite Symposium (in Nagoya)

Free Ticket to Japan!

http://www.spacemic.net

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Category 1 : Mission Idea and Satellite Design

Requirement:

Exploitation of micro/nano-satellites (less than 50 kg)

(both constellation and non-constellation mission ideas will be welcome.)

Category 2：Mission Idea and Business Model

Requirement:

Proposal of business model using micro/nano-satellite (less than 50 kg) technology

(both constellation and non-constellation mission ideas will be welcome.)

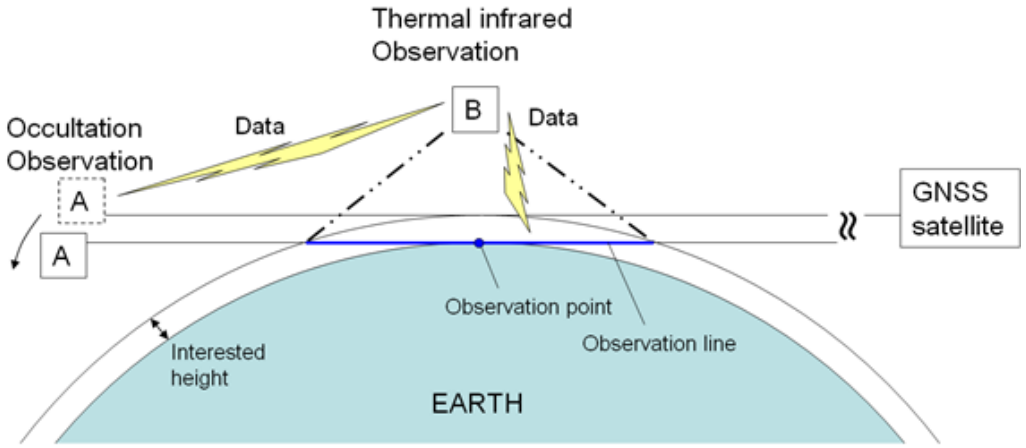
Applicants must use Cost-model and design guideline prepared by Prof. Nakasuka

Awards

- Free ticket to Japan for Finalists (one person from about 10 teams)
- 1st and 2nd place in category 1 (Mission Idea and Satellite Design)
- 1st and 2nd place in category 2 (Mission Idea and Business Model)
- Student Prize (for category 1)
  - the best proposal in Category 1 (Mission Idea and Satellite Design) submitted by a student, a student group or a University with involvement of a significant number of students
- IAA Award for environmental issues
  - the most imaginative application of micro/nano satellite technologies to environmental issues for the benefit of humankind

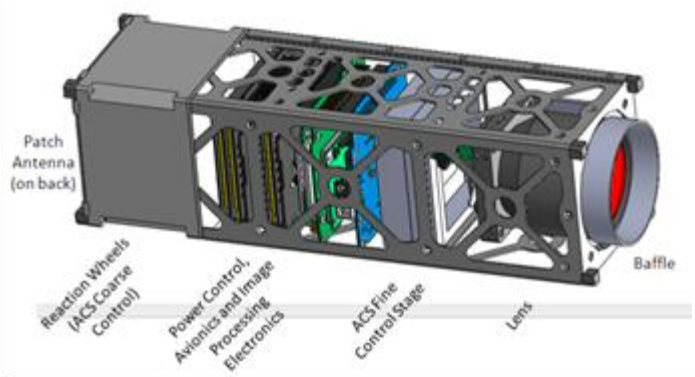
1st place: Integrated Meteorological / Precise Positioning Mission Utilizing Nano-Satellite Constellation

- This mission focuses on two needs; meteorological mission (more accurate rainfall prediction)and precise positioning mission are integrated utilizing nano-satellite constellation. The fundamental components of this mission are two nano-satellites, nano-satellite A that observes GNSS (Global Navigation Satellite Systems) radio occultation (RO) from edge-on, and nano-satellite B that acquires thermal infrared (TIR) images from the zenith.



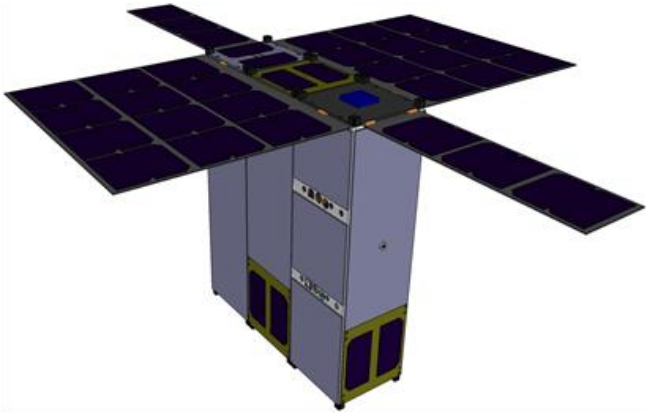
2nd place: ExoplanetSat Constellation

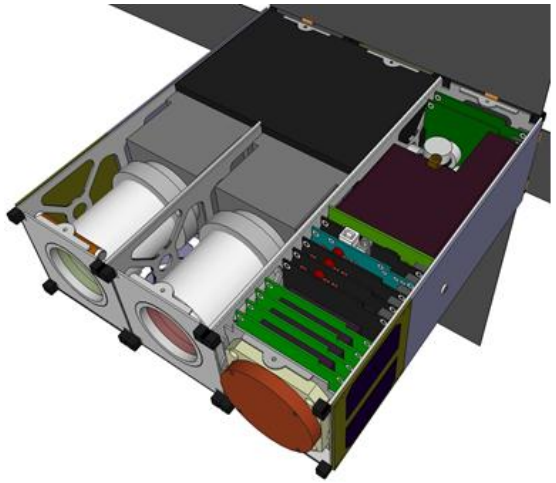
- Constellation of 3U CubeSat form factor to search for transiting Earth-sized planets in front of Sun-like stars in an attempt to locate a habitable planet. The ExoplanetSat Constellation shall use precision photometry to cooperatively monitor chosen Sun-like stars with a maximum measurement noise of 10 parts per million.



3rd place:A distributed multispectral imaging system

- This satellite constellation provides low-cost, sustainable, modular distributed multi-spectral Earth imaging capabilities with the flexibility for rapid upgrade, reconfiguration and augmentation. It is able to inform such applications as agriculture, disaster relief, cartography, national security and Earth Sciences;
- 23 m GSD imagery in the red, green, and blue spectral bands from a sun synchronous orbit altitude of 600 km.





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Evaluation Criteria (category 1)

Originality (50 points)

- Novel mission concept not yet realized or proposed, or a new implementation of an existing capability or service (25)
- Impact on society (25)

Feasibility (50 points)

- Technical (20)
- Programmatic (cost estimate, development schedule, infrastructure requirements) (15)
- Operational (description of ground segment and communications architecture, e.g., planned use of existing infrastructure) (15)

Tips: how to create mission idea, how to make satellite design

Micro-Satellite Project
Mission and Cost Model
– Category 2 Guidance Book –

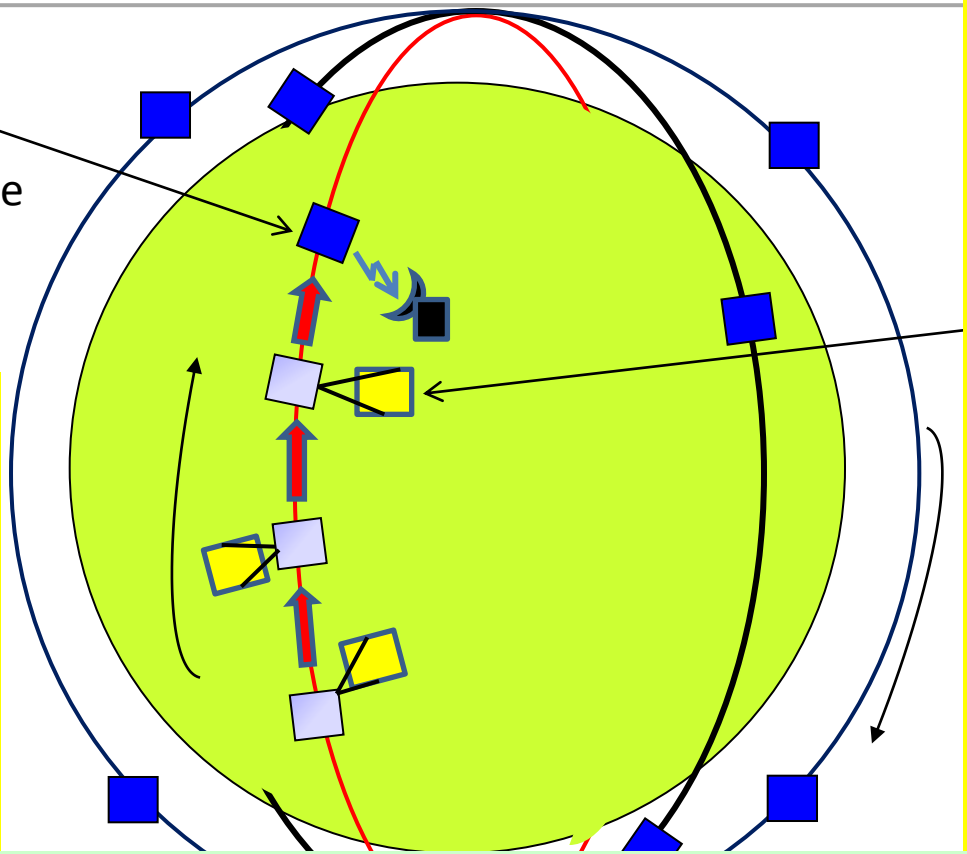
Shinichi Nakasuka/MIC2 Project Team
University of Tokyo, Japan

What you should do in Category 2

- Mission Idea is already fixed;
  - Remote sensing
  - Information collecting (from ground sensors)
  - Rental space (and optional internal camera)
- Create your own business plan which;
  - is interesting to (many) potential customers
  - will make more return than investment
- You should make clear;
  - Detailed plan on how to use the equipment
  - Optimal system configuration to maximize return
  - Calculate the amount of investment and return

Remote Sensing Mission

Only when satellite flies over a ground station, image data are downlinked to the ground with certain downlink speed.



Satellite takes images of the area below it flies using optical or infra-red camera and store them in the memory.
The mission specs include;
1)Optical (visible) or infra-red camera
2)Ground resolution (GSD)
3)Size of the image areas (such as 200km x 200km)
4)Temperature resolution level for infra-red sensor

A satellite waits to downlink image data until it flies over the ground station. This "latency" can be calculated as;

6 hours/G

where G is the number of ground stations.

A satellite can communicate with one ground station for 40 minutes (2400 sec) per day. With G ground stations, the satellite can downlink for 2400 x G sec per day. The number of images sent per day can be calculated as;

2400 x G x downlink speed /data size of one image

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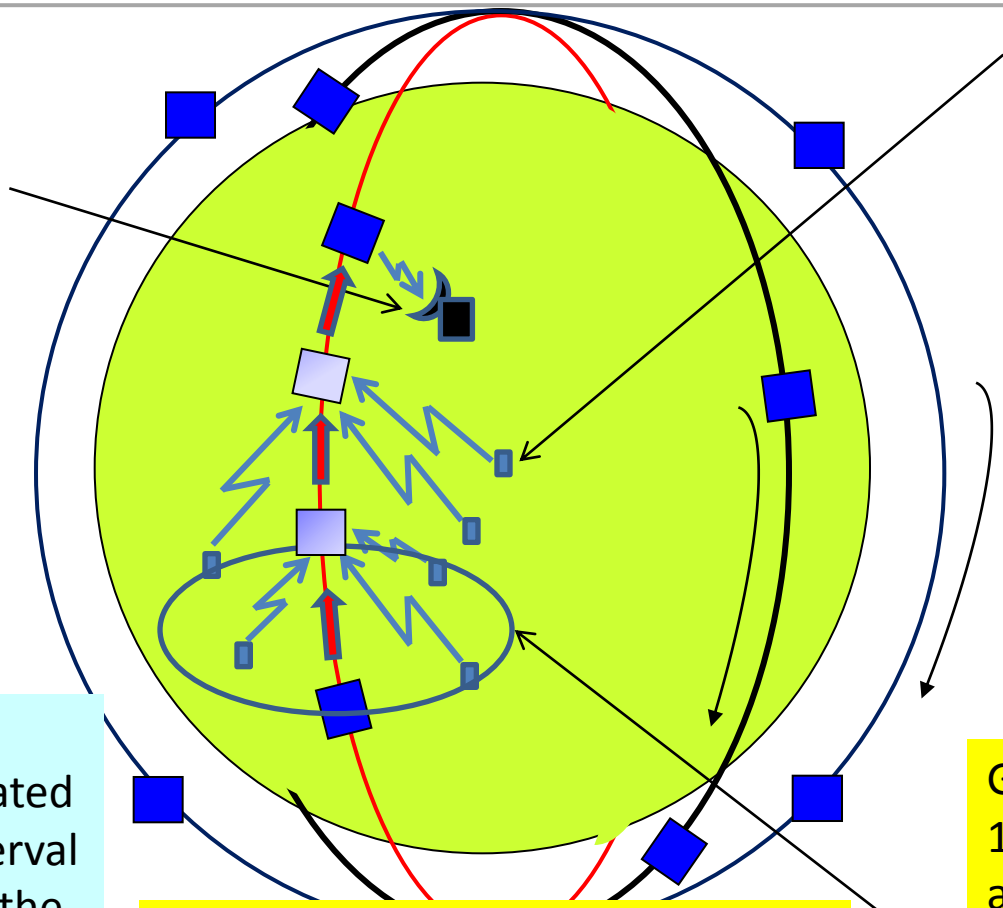
Information Collecting Mission

Satellite downlinks the stored data to the ground station when it flies over.



Many ground sensors on the Earth transmit data continually. The satellite can receives data signals when it flies over them (called "uplink"). The amount of data from each sensor, the number of sensors, and data transmission speed need to be specified.

When there are N satellites in coordinated orbit, the revisit interval of the satellite over the ground sensors is calculated as 0.5/N day (for non-coordinated orbit, 1/N day)

Then the time allotted to one ground sensor for transmitting data to the satellite per satellite visit is calculated as 600sec/M.

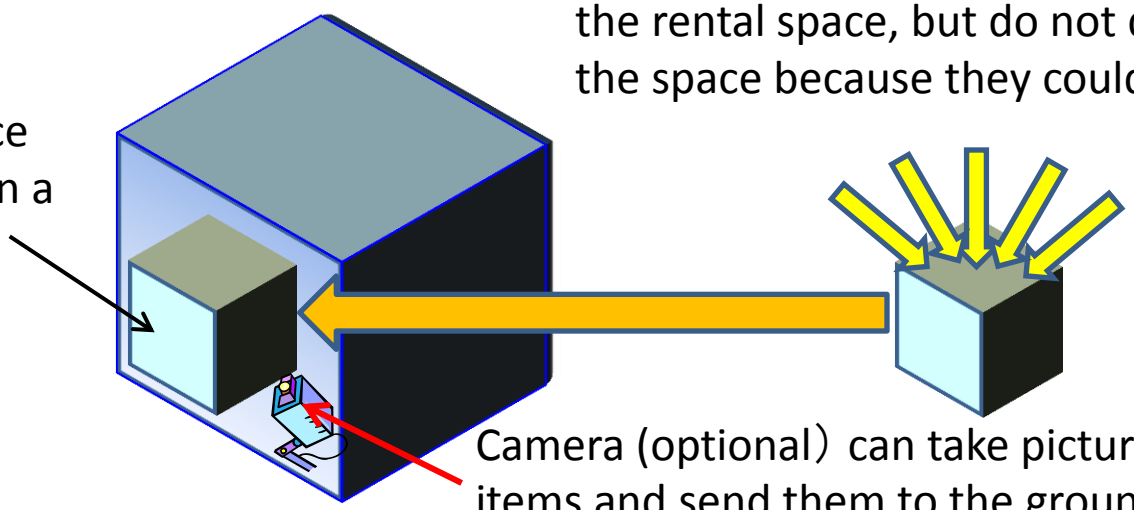
Ground sensors within 1000 km radius circular area can communicate with the satellite. First calculate the averaged number "M" of ground sensors within one circle.

Rental Space Mission

- Items of customers can be launched into space with “onboard fee” in “rental space” of the satellite.
- The items stored in the rental space can be photographed in space (with the Earth as background, for example) if an optional camera is also mounted . Images of the items can be downlinked to ground so that customers can purchase.

You can store as many items as you want in the rental space, but do not deploy them into the space because they could be debris.

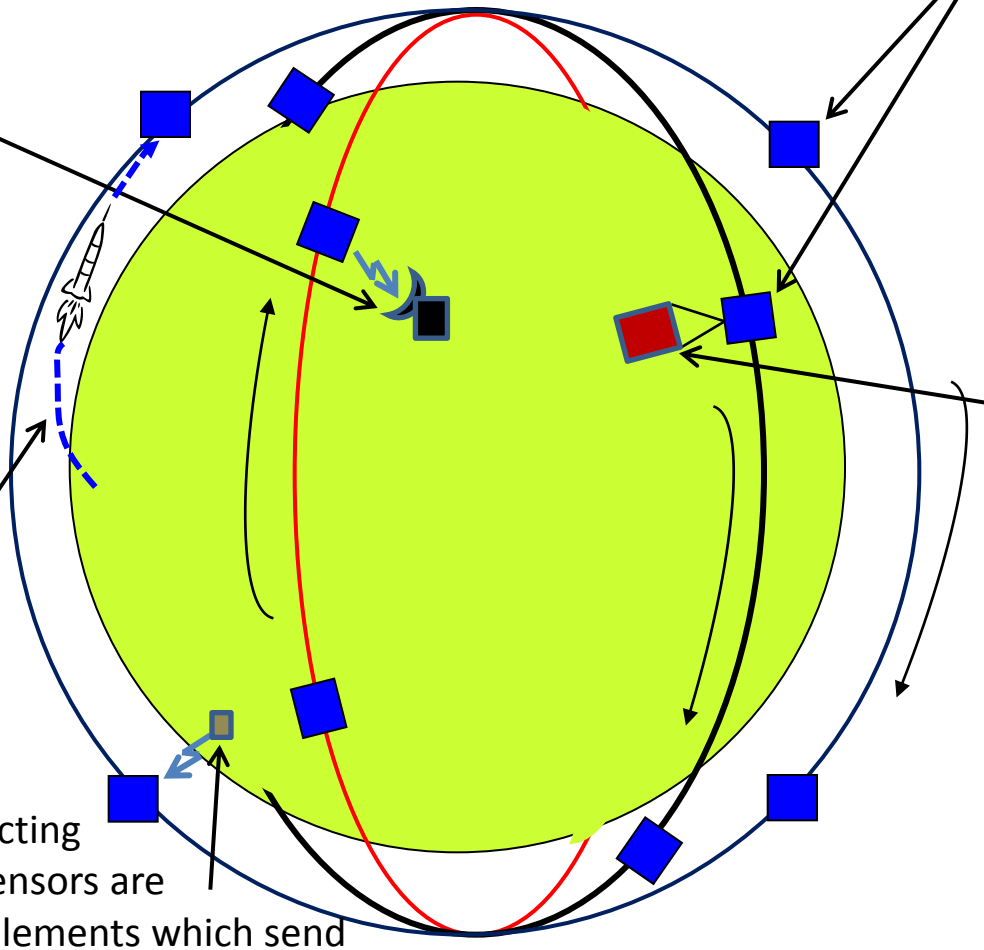
A rental space
10 to 40 cm^3 space can be provided in a satellite where customers’ items can be stored.



Camera (optional) can take pictures of the items and send them to the ground.

Key System Elements for Satellite Mission

(1)(2)(3) are the system elements and constitute the total cost.



(1) Satellites
In this figure, a total 12 satellites are placed in 3 orbital planes (4 satellites per plane).

(2) Ground Stations
Receive data such as images or sensor data from satellites. (The data transmission from satellite to ground is called "downlink")

(3) Launch Rocket
Launch satellite to the Earth orbit

Satellite Mission:
This figure shows remote sensing mission to capture Earth images using visible or infra-red sensor.
Other missions include;
-Rental space
-Information collecting

In the "Information Collecting Mission", small ground sensors are also included as system elements which send data to the satellite (sending data to satellite is called "uplink")

Effects of Increased Number of Satellites and Ground Stations

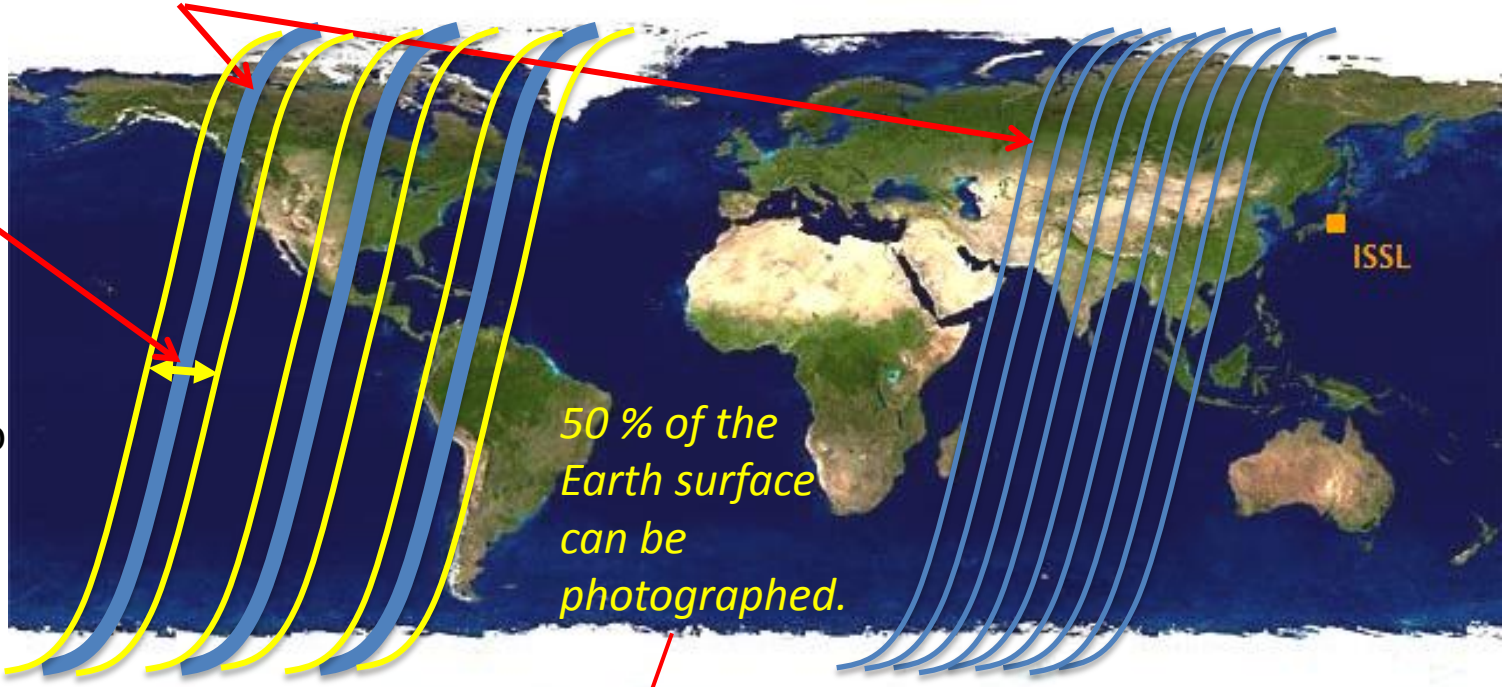
The number of satellites and ground stations are important design criteria. The merits of more satellites against the increased costs are trade-off.

- With more satellites, you can obtain
  - More coverage of the Earth per day for remote sensing mission.
  - More frequent observation of the same area for remote sensing mission.
  - More data can be received from ground sensors for information collecting mission.
  - More space available for rental space mission.

- With more ground stations, you can obtain
  - More time to receive satellite data, resulting in, for example, more image data can be downlinked per day
  - Less latency to downlink urgent data

Coverage Area and Revisit Interval

Trajectory of satellite over the Earth



You can take photos within these two lines

Day 1 2 3 ------
11 12 13 ------
Revisit interval: 10 days
Coverage area: 50 %

Day 1 2 3 4 5 6 7 8 9 ----------
41 42 43 44 45 46 47 48 49 ------
Revisit interval: 40 days
Coverage area: 100 %

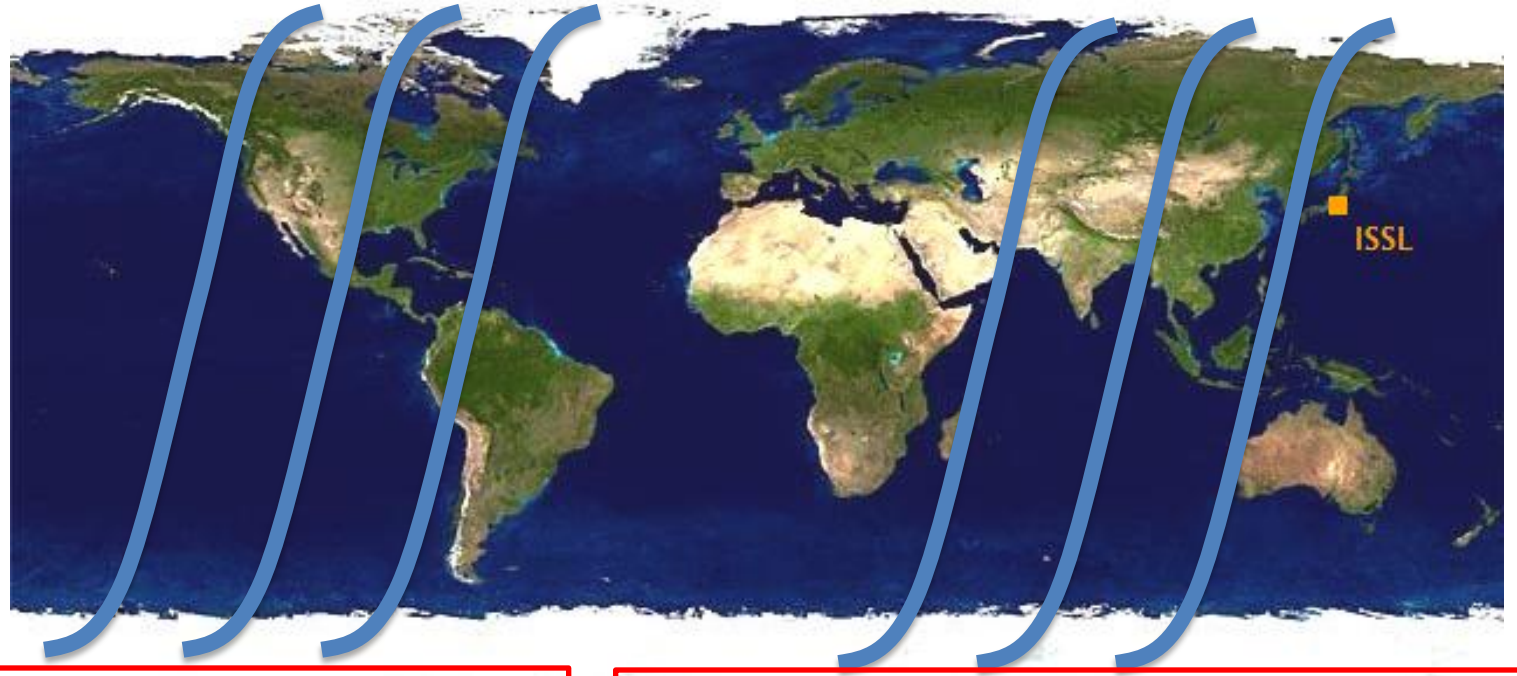
The satellite comes back to the same place after 40 days.

One satellite case: You can choose the revisit interval (L days) to estimate the percentage of the Earth coverage, which can be roughly calculated as 5 x L (%). (If this value exceeds 100 %, then it is recognized as 100% which means the satellite can take photos of the entire Earth surface.)

Multi-Satellites Orbit Designs (Coordinated Orbits)

One Satellite Case

2 Satellites Case

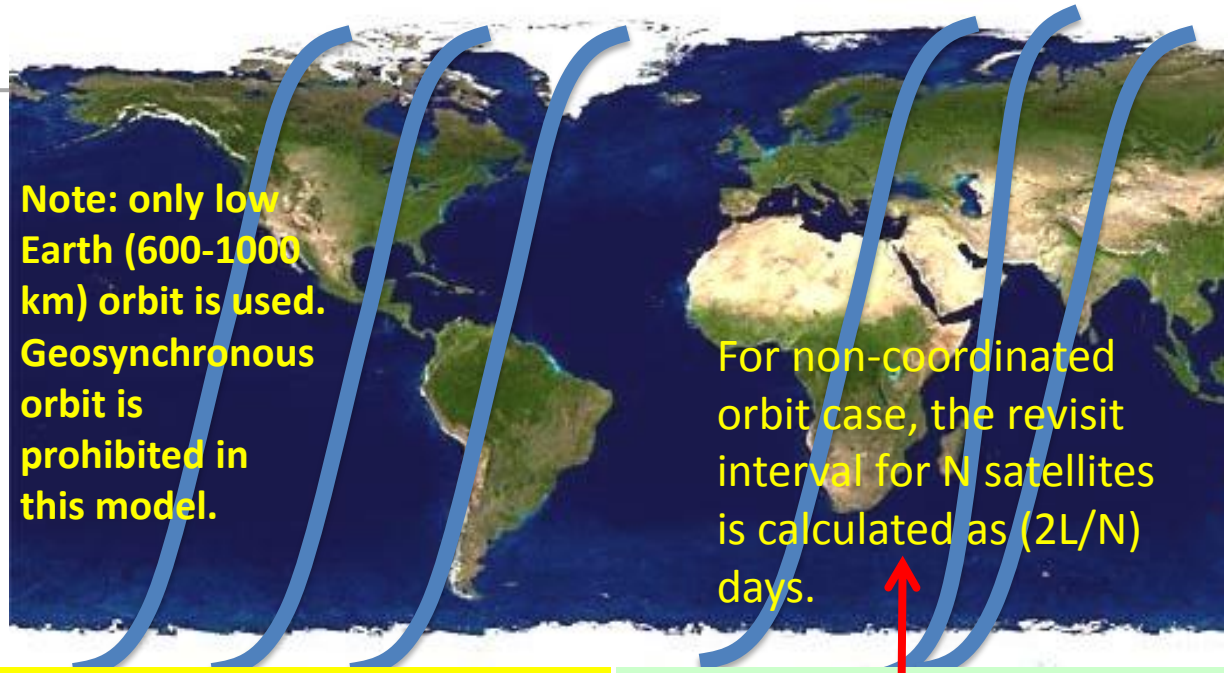


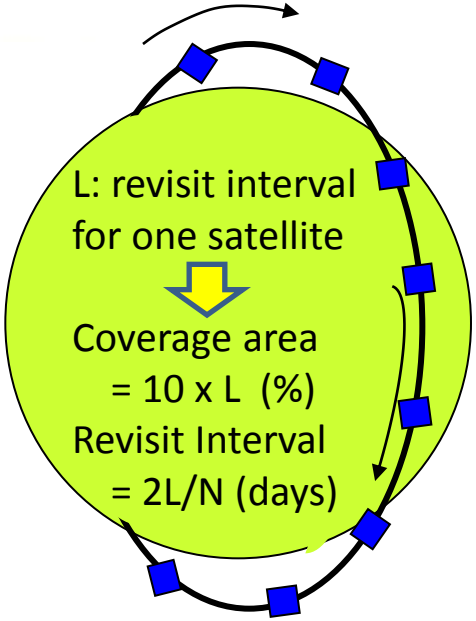
Day 1 2 3 ------
11 12 13 ------
Revisit interval: 10 days
Coverage area: 50 %

Sat #1 day 1 2 ---
6 7
Sat #2 day 1 -----
6 -----
Revisit interval: 5 days
Coverage area: 50 %

N (more than one) satellites can reduce the revisit interval to (L/N) days where L is revisit interval for one satellite. Coverage area will be the same as one satellite case.

Dependency on Launch Configuration





Sat #1 #2 #3

If you choose "coordinated launch", the equally spacing orbits can be achieved with higher costs.

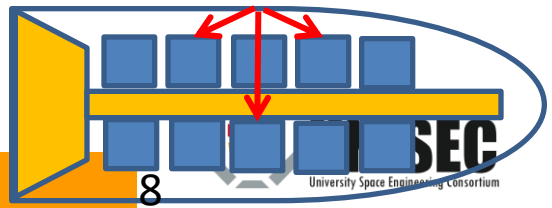
Sat #1 #2 #3

If you choose non-coordinated launch, orbit paths could be poorly coordinated, but at lower costs.

If you purchase one whole rocket, you can launch maximum of 15 satellites into the same orbital plane as shown above.

This launch is called "piggyback" which means small-satellites get "hitch-a-ride" on a rocket launching a larger main satellite.

Many small satellites are installed in one rocket



Project Cost Breakdown (1)

- Satellite Cost Model (*1.1 and 1.2 are both required*)
  - 1.1 Bus Cost
    - Cost depends on bus performance level (low, medium, high)
  - 2.1 Payload Cost
    - Cost depends on mission category and performance
    - Four categories (*you can select from 2.1.1 – 2.1.4*)
      - 2.1.1 Remote sensing with visible light (R,G,B, near infra red + panchromatic image acquisition. "GSD 5m" means that the sensor can detect 5m object on the Earth ground)
      - 2.1.2 Infra-red sensor to detect temperature of the ground ("temperature resolution X" means the sensor can discriminate X Kelvin temperature difference and ground resolution means GSD)
      - 2.1.3 Communication payload can receives data from many sensors on the ground and sends them back to the ground station. Cost depends on data rate to receive data from ground sensors)
      - 2.1.4 Rental space provides a "space" for bringing some items to space in which you can put anything. An optional camera can capture images of the items with space or the Earth as background. Cost depends on the size of the space and whether the optional camera is installed or not)

Project Cost Breakdown (2)

- Ground Station Cost Model *(3.1-3.3 are all required.)*
  - 3.1 Development cost is required one time when the project starts
  - 3.2 Operation cost is required for personnel to operate the ground station to receive data from satellites (yearly cost)
  - 3.3 Data analysis cost is required to process the date from satellites (system and personnel cost per year)
- Launch Cost Model *(you can select 4.1 or 4.2)*
  - 4.1 One whole rocket can be purchased to launch many (maximum 15) satellites to the same orbital plane.
  - 4.2 Single satellite launch by piggyback style can be possible to launch satellites to "coordinated orbits" (with higher cost) or "non-coordinated orbits" (with lower cost).

- Cost for ground sensors with uplink capability (2.1.4) should be added for information collecting mission

Nomenclatures

Term	Description
bus	Key components that most satellites are equipped with such as computer, control system, battery, solar panel, communication system, and frame structure of the satellite.
payload	Components of satellite which serve the mission function such as a camera system for remote sensing, a rental space/camera for rental space and an antenna/receiver for information collection.
remote sensing	A type of satellite mission to obtain information such as images of the ground surface and temperature distributions.
GSD (Ground Sample Distance)	Resolution on the Earth surface. GSD 5m means the satellite camera can recognize almost 5-m size object on the Earth surface.
Kelvin	Unit of temperature. 0 degree Celsius equal to 273 Kelvin.
uplink	Sending data signals from a ground sensor to satellite(s)
downlink	Sending data signals from a satellite to ground station(s)
piggyback launch	A launch style where small satellites ride on a rocket to carry a main medium to large size satellite.
downlink period	Total time to send signals from the satellite to ground stations per day.
downlink latency	The time it takes from satellite emergent data collection to downlink.

Category 2：Mission Idea and Business Model

We provide:

- “Cost vs. performance" model for each segment such as satellite bus, mission components (e.g., Earth observing camera or communication system), launch, and ground operation.

- Several mission ideas including Earth observation by visible sensors, launching something into space, launching into space and recovering at the ground of some payloads, data collection from ground sensors by satellites, etc.

Check the details on the website

http://spacemic.net

Evaluation Criteria
- Category 2 -

Hiroshi Kawahara, Sc.D.
Cyber University

Category 2：Mission Idea and Business Model

Requirements:

Proposal of business model using micro/nano-satellite (less than 50 kg) technology

(both constellation and non-constellation mission ideas will be welcome.)

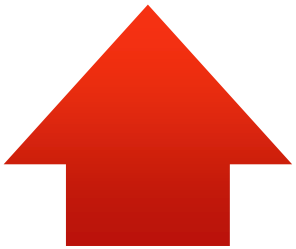
Applicants must use Cost-model and design guideline prepared by Prof. Nakasuka

Category 2 "Mission Objective"

Seek as many satellite applications as possible!

Category 2 Evaluation Policy

Business Ideas



Business Plan

Category 2 Message

Dream "Possible Dream!

Category 2 Evaluation Criteria

- Eye Opening
- Scientific and Practical Feasibility
- Economical Feasibility

Category 2 Evaluation Criteria Breakdown

- Key concept and impact on society and environment (40)

- Logistical feasibility based upon the cost model provided by the organizer. (15)
- Risk Analysis (15)

- Business model structure (5W2H: who, to whom, what, when, where, how, how much). (15)
- Business feasibility (15)

Category 2 Bottom Line

YOU WANT TO SEE IT HAPPENS!

Contact

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