Landslide Prediction Mission
In Cooperation with Hillside Sensor Network Robots
Futaiten Project

MIC4
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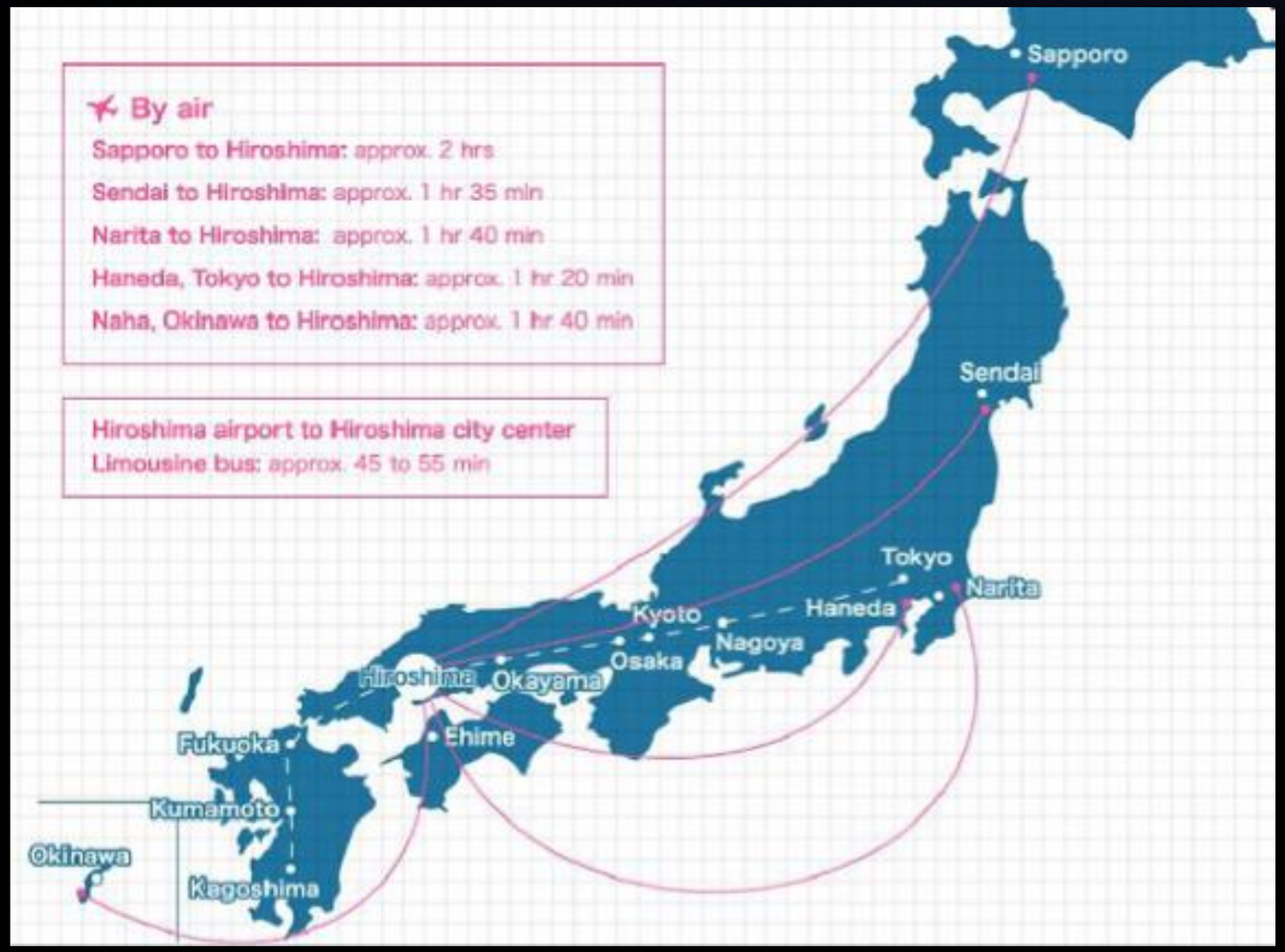
Hiroshima, Where?

World Heritage Sites

A-bomb Dome

Miyajima Itsukushima Shrine



Agenda

1. Social Necessity
2. Mission Objective
3. Concept of Operations
4. Key Performance Parameters
5. Space Segment
6. Orbit/ Constellation
7, Implementation Plan

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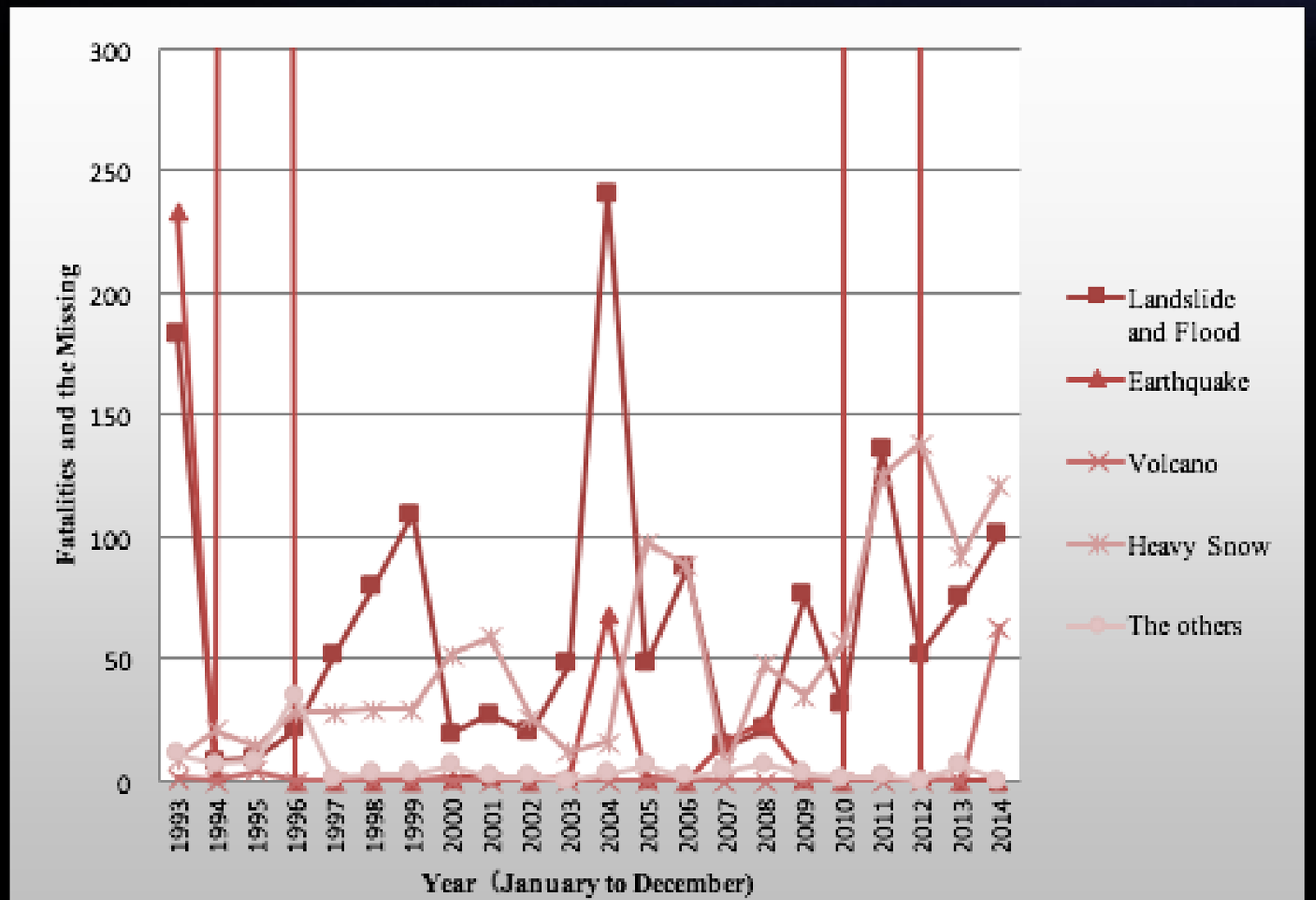
1. Social Necessity

- Japan: Fated to Landslide Disaster
- 530 thousand high risk hillside in Japan
- 42% of Fatalities and Missing come from Landslide past 40years
- Why we can’t save life from Landslide?
- Residents don’t evacuate from there house, if they accept precautionary disaster information.
- The Consciousness should be Solved.



Transition of Fatalities and Missing by Disaster

From Disaster Prevention White book on 2015

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1. Social Necessity

21 August 2014, Large Scale Landslide Disaster in Hiroshima

Fatalities: 78
Completely Destroyed House: 133
Inundation Above Floor Level: 1301
Agricultural Loss: Over 1.6 Billion yen (15 Million $)

1. Social Necessity

Past Research for Landslide Prediction

- Many Good Researches, Long Time but No Practical Use
- NEC : New Underground Moisture Measuring Sensor Network
  - Can Predict Landslide 40 minutes ahead the Occurrence ☜ Insufficient
- High Risk Landslide Hillside = Very Steep and Thickly-Wooded
  - No One can Approach, No One can Install Data Measurement Equipment

<u>Some Technical Breakthrough should be Needed</u>

NEC Demonstrative Test Condition

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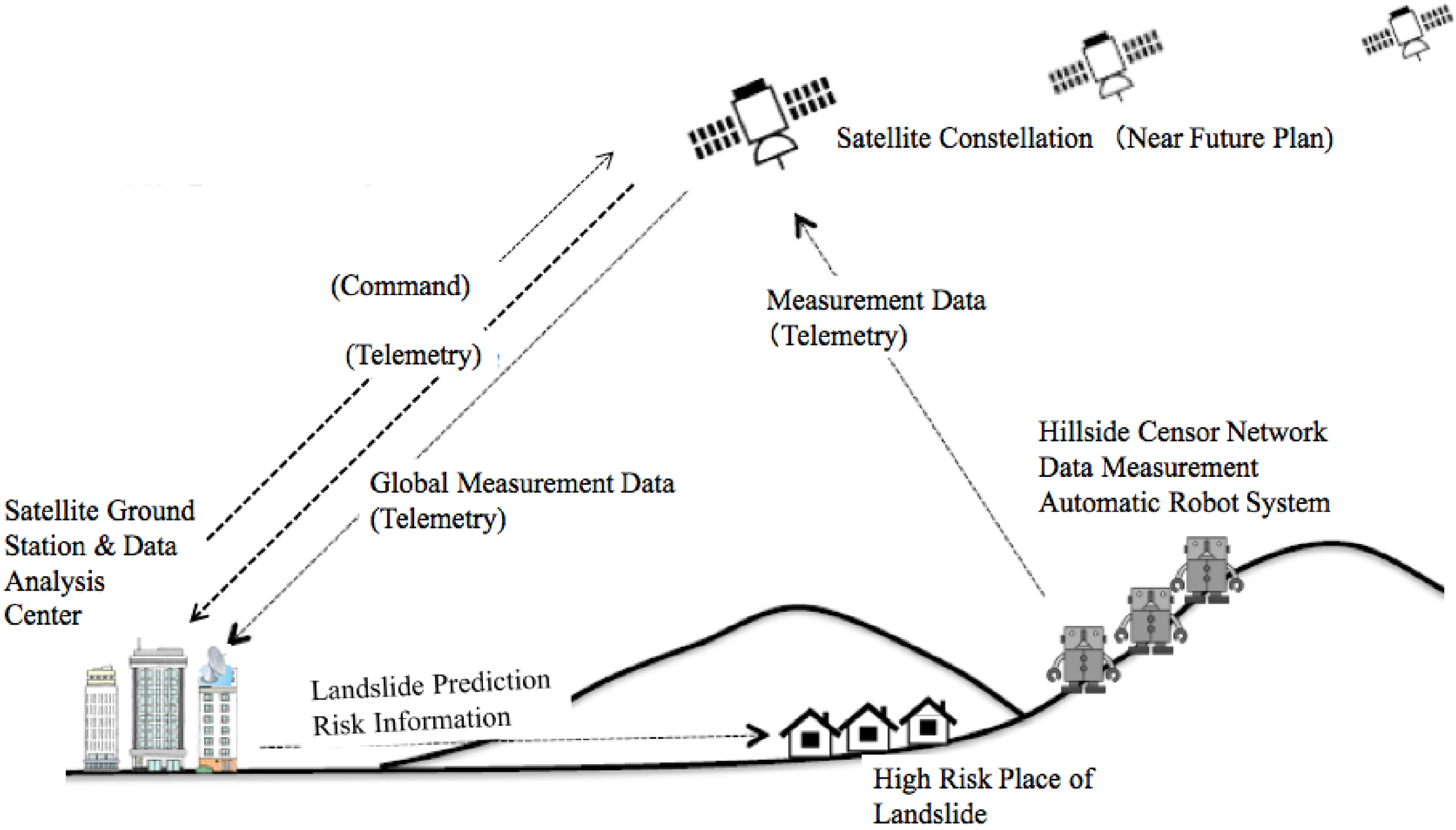
2. Mission Objective

- Data Store and Forward (S&F) for Landslide Prediction
  - Data Measurement Breakthrough
    - Sensor Network System with Many Kinds of Measurement Devices and Automatic Moving Robot using AI Engine
  - Data Collection from Sensor Network Robots
    - The Only Solution = Satellite Data Communication System with New Data S&F Technology
- Cooperation for Data Communication, Satellite and Small Robots
  - Hillside Sensor Network Robot Concept Design
    - Small Size fitting with Hillside Nature = Low Level Signal Output
    - Hidden in the Forest and Uncooperative with Outside System
  - Satellite can’t equipped with big size antenna, Secure Data Communication
  - Satellite need Innovative AI Engine using Multi Agent System for Cooperation
- Science Education for Children
  - Robots and Satellite are open to regional schools for using Science Experiments

3. Concept of Operations



4. Key Performance Parameters

I. High Accuracy Hillside Data Measurement for Landslide Prediction
   Measure Various Kind of Data—— Slight Ground Movement, Underground Moisture, Methane Content Data of Underground etc.

Autonomic Movable Robot with AI Engine
   Wide Range Covering Measurement, At least 500 meter square
   Sensor Network Robots should Move in Group Automatically using AI Engine
   Difficult Problem—— Robot Drive Subsystem and Robot Power Subsystem

Intelligence Cooperation System between Robots and Satellite
   Satellite S&F Subsystem Power On Timing, Robots Finding Method, Data Uplink Timing and Speed from Robots etc. should be Adjusted Appropriately

Data Uplink System from Robot to Satellite
   5.8 GHz 100kbps Ham Radio Band Transmitter
   Hodoyoshi's X-Band Over 100 Mbps S&F Subsystem

← Both Candidate, Tradeoff Study Install in Small Robot

High Speed Data Recorder
   Sensor Network Robots Sampling Time : Once per minute
   Global Measurement Data File Size: 200 Gigabytes—-Hodoyoshi's S&F 348Mbps is Good but Storage Capacity may be small

Data Downlink System from Satellite to Ground Station

- Hodoyoshi's X-Band Transmitter
- UHF Band Communication Module for Telemetry&Command Subsystem

5. Space Segment

- Futaiten Project is Now Undergoing Concept Design
  - Hillside Sensor Network Robot Subproject has many difficulty
  - Can’t fixed Interface Design between Satellite and Robot
- Key Spec. of Futaiten Satellite is now being studied are listed below
  - Mass: From ISO 3A size to 0.5m cubic size
  - Volume: From 5kg to 50kg
  - Average Power: From 5W to 50W, Solar Cell, Li-Ion Battery
  - Link Budget: About 20minutes per a link, once or twice per day

Weight and Power Rough Estimation of Futaiten Satellite

Subsystem	Max Weight (kg)	Max Power Consumption (w)
Power Supply	10.0	0.2
Communication Module	3.5	5.0
CPU	0.5	3.0
Data Recorder	3.5	3.0
Attitude Control	2.0	1.0
Propulsion (Near Future)	α	β
Structure	12.0	0.0
Harness	2.5	0.0
Total	34.0	12.2

5. Space Segment

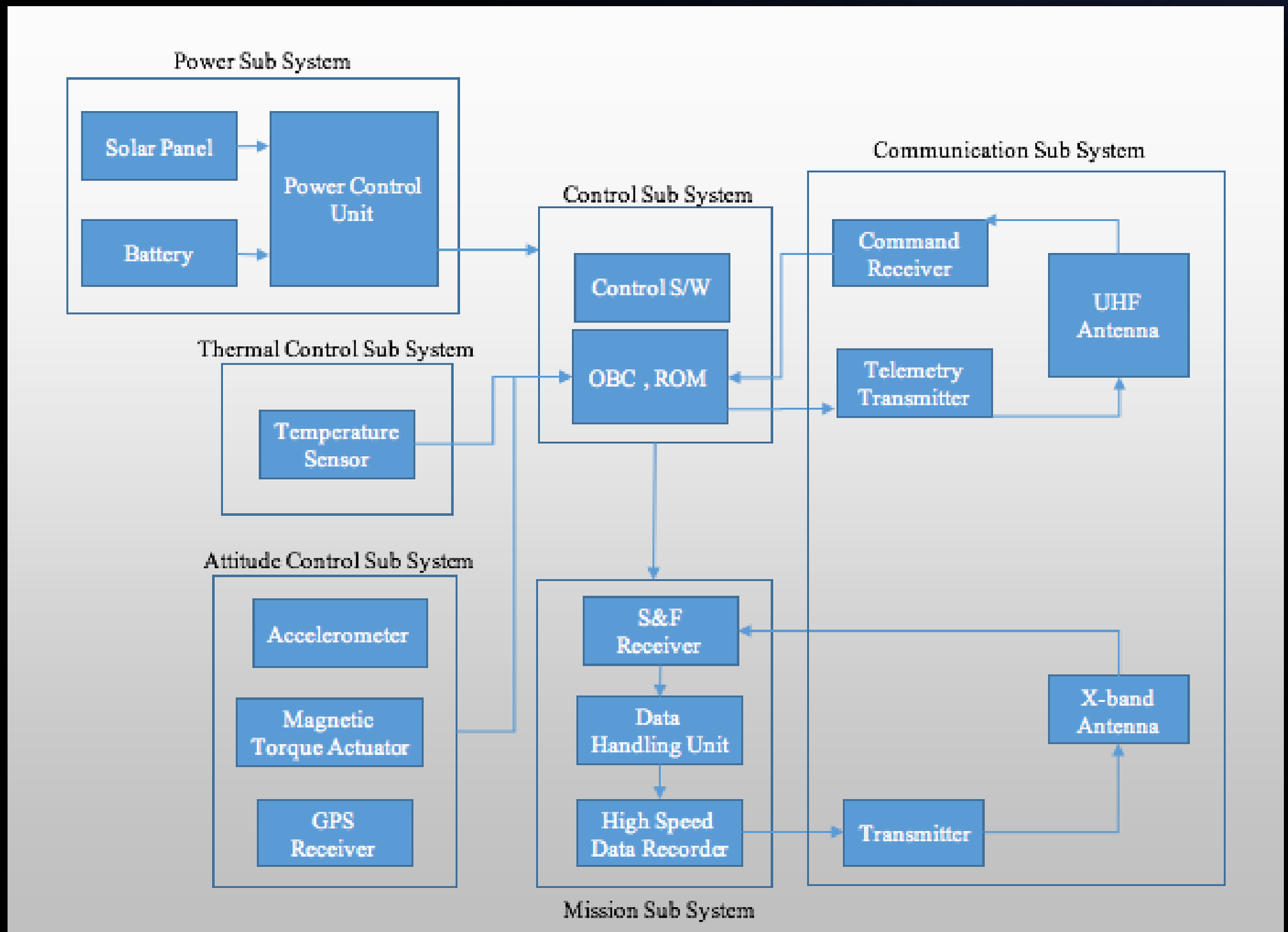
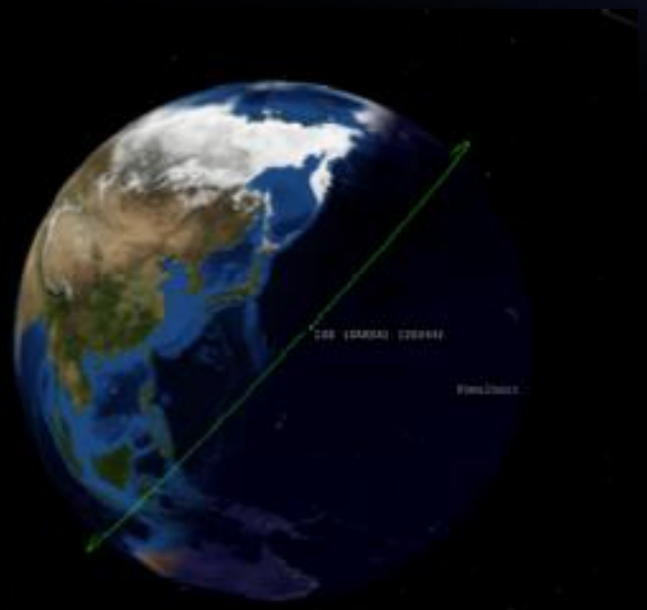
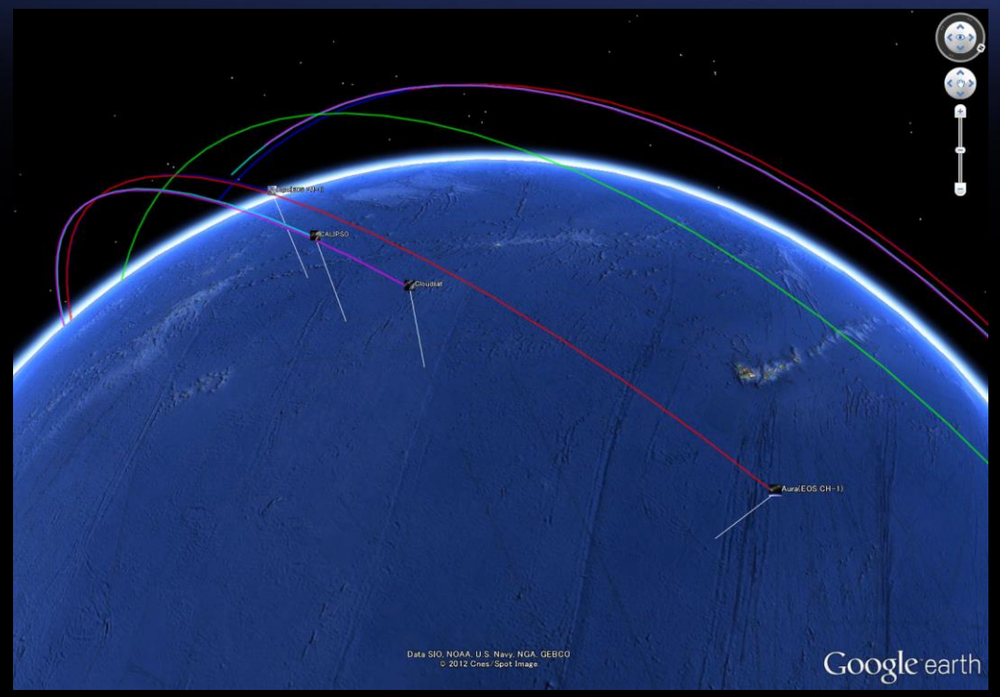


Diagram of Futaiten Satellite

6. Orbit/Constellation





Orbit:

- Over 90% Coverage is Needed but Not need Special Design Orbit
  - ISS orbit Altitude 400km, Sun Synchronous Circulars Orbit is Good

Constellation:

- Futaiten Satellite Correct the Landslide Prediction Data Globally
- Real Time Landslide Prediction:
  - From Another Research Result, Data Communication should be Executed in 8hour Cycle——- 3 Satellites in Same Orbit, 8hour interval
  - Certain Data Communication Satellite and Robots——- 3 Satellite in Same Around Orbit
  - Then 3 times 3= 9 Satellite may be needed for Ideal Futaiten Project

7. Implementation Plan

- Futaiten Project Team is Established for this Mission in 2015
- Fukuyama University: Leading Role and Implement the Mission
- Many Companies around Fukuyama City are Each Subjects Function Members

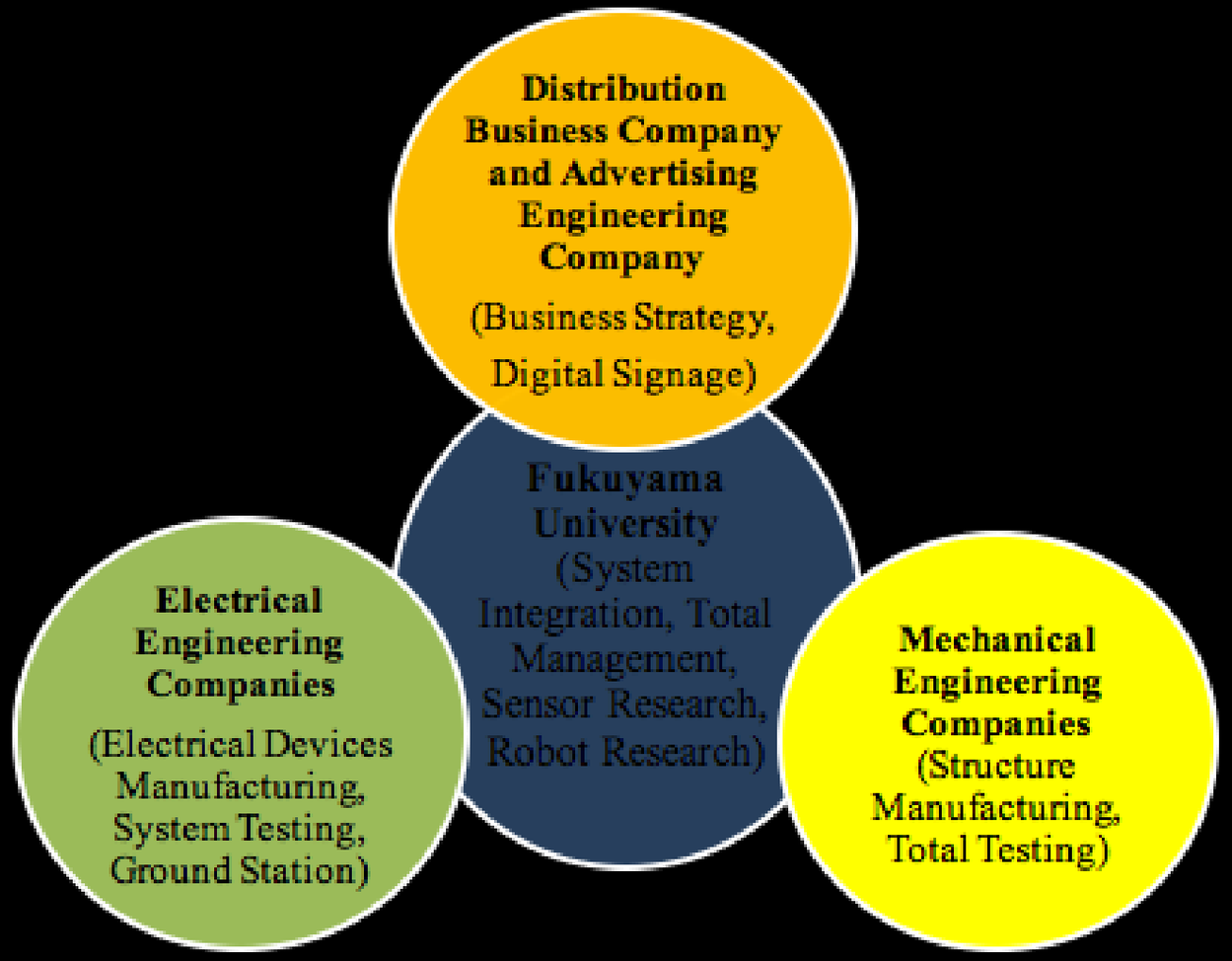
Facilities

- Doesn't have below Facilities, then rent from Some Public Test Center or University
  - Shock Test Facility
  - Vibration Test Facility
  - Thermal & Vacuum Chamber
  - Radiation Exposure Facility

Lifecycle Cost (One Satellite)

About 122 MillionYen

(1.1 Million$)



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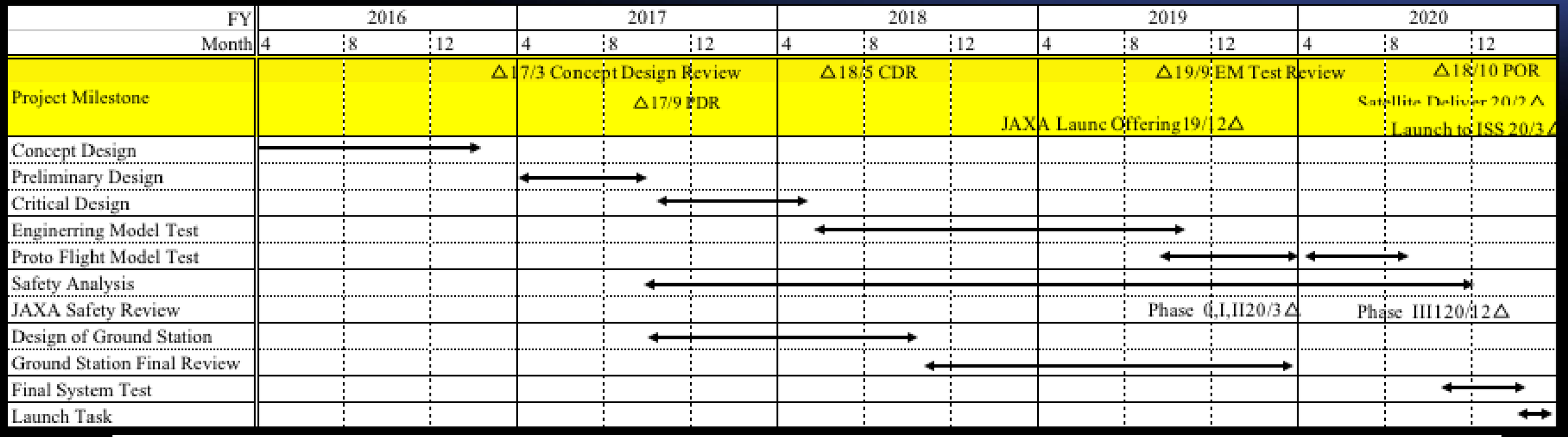
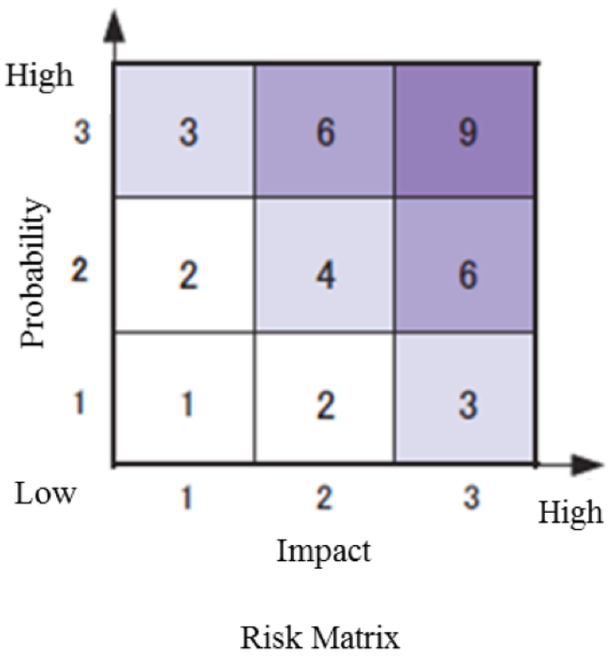
7. Implementation Plan



Risk	Probability	Impact	Assesment	Prevention
Incomplete research of S&F communication technology	1	3	3	Procurement of existing some S&F communication device
Incomplete research of inteligence cooperation system between satellite and robots	2	2	4	Improvement of satellite mission operations
Incomplete development of hillside censor network robots	3	3	9	In this case, mission will be failed. Do everything in Futaiten project's robot research
Decrease of Fukuyama University student member and company member	2	3	6	Carry on a publicity campaign for Hiroshima people
Lack of lifecycle cost	2	3	6	Apply for many research fund, raise contributions and apply for new clud funding



Risk Matrix

Fukuyama University

Futaiten Project

For Society Safety
For People