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

Kyutech Kyushu Institute of Technology

IRS-Sat: Integrated Rescue Service Satellite

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The recent years have witnessed catastrophic natural disasters that went with thousands of human lives. We present an idea that would be used to provide a robust and secure satellite rescue system to guide in assessing the level and type of danger in Japan and Indonesia as faced during natural disasters by the habitants. It would also help the rescue troops to plan their logistics more efficiently and effectively. We call the satellite system, the Integrated Rescue Service Satellite (IRS-Sat) and the concept beyond it, is to develop a rescue based system that would enable its users to send messages before, during, and after disasters from their smart phones and/or special hand held units to the IRS-Sat satellite constellation via distributed communication nodes. IRS-Sat system is designed from 6 nano-satellites orbiting at an altitude of 600km with an inclination angle of 50.5º. Communication with the satellites constellation will take place through 4 ground stations where 2 stations act as main and 2 stations act as backup. The business feasibility study estimated the initial fixed cost at about USD 381.31M and the annual variable cost at USD 393.89M. The annual revenue is estimated to be USD 678.39M. These estimations show that the IRS-Sat project is viable and will reach its breakeven point approximately after1 year and 4 months within a total operating period of 5 years.

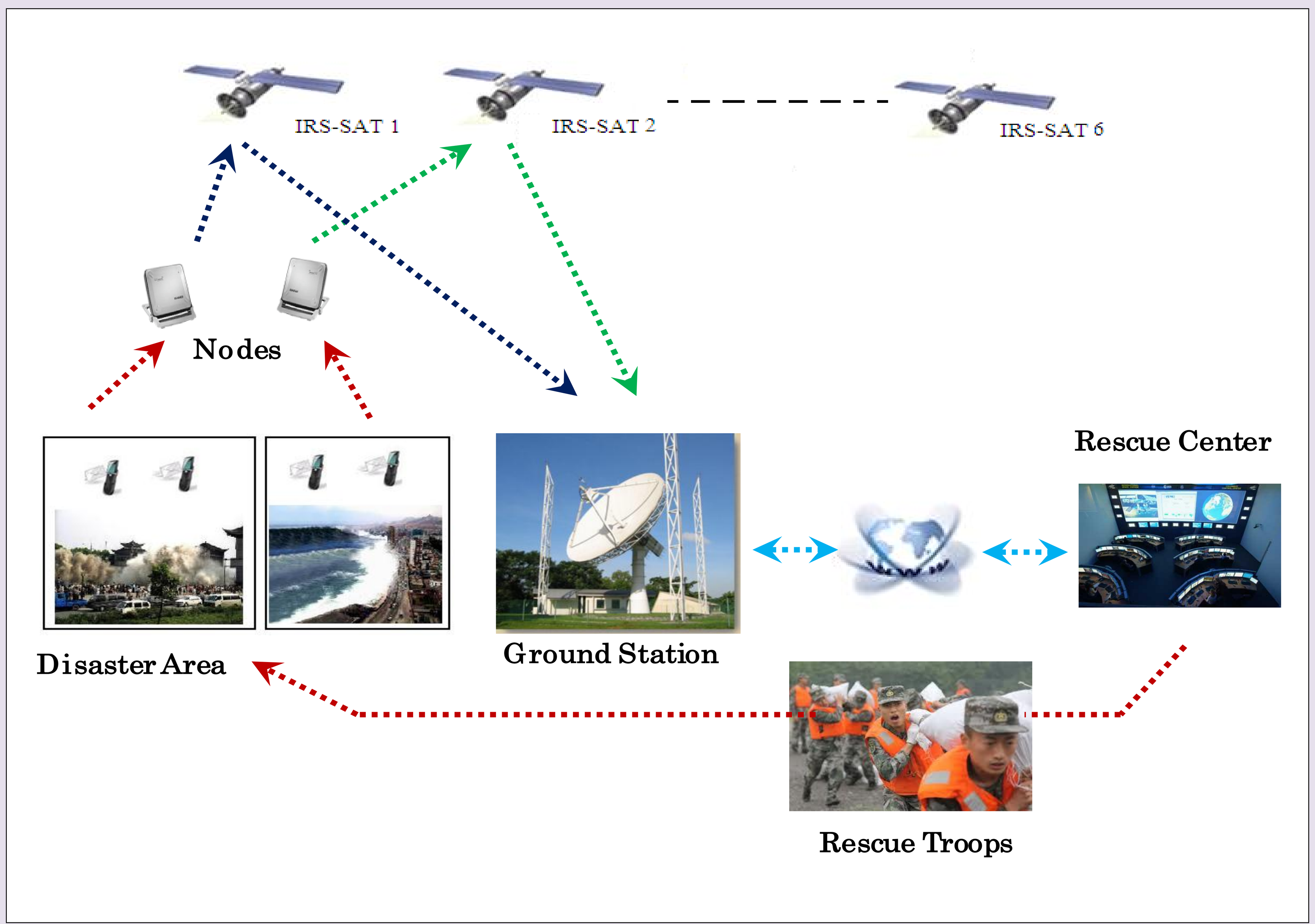

Fig. 1 IRS-Sat System Architecture

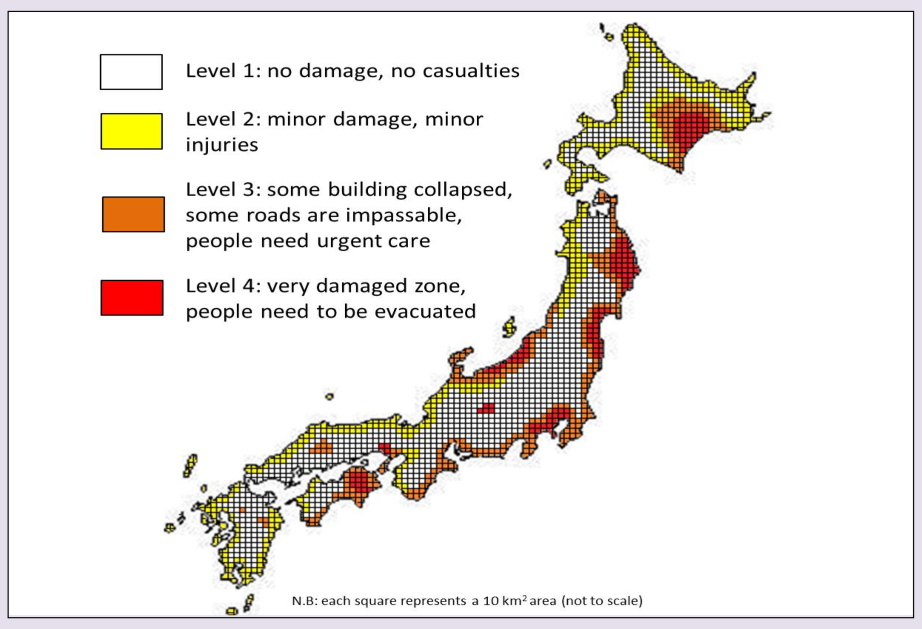

Fig. 2 Danger Map produced by feedback from distributed nodes

Fig. 3 Data Format of Packet sent from User to Node

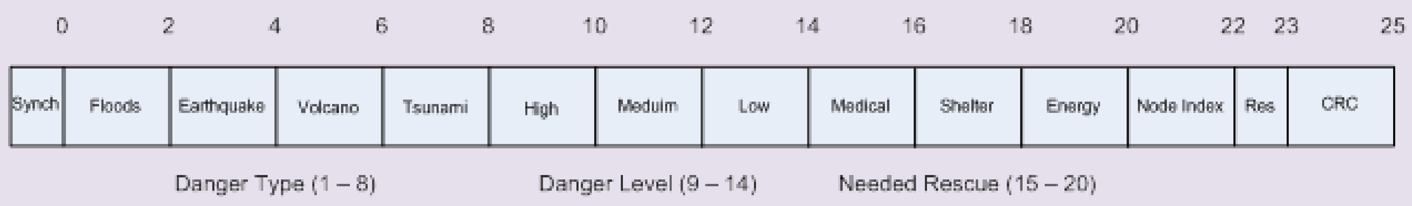

Fig. 4 Data Format of Packet sent from Node to Satellite

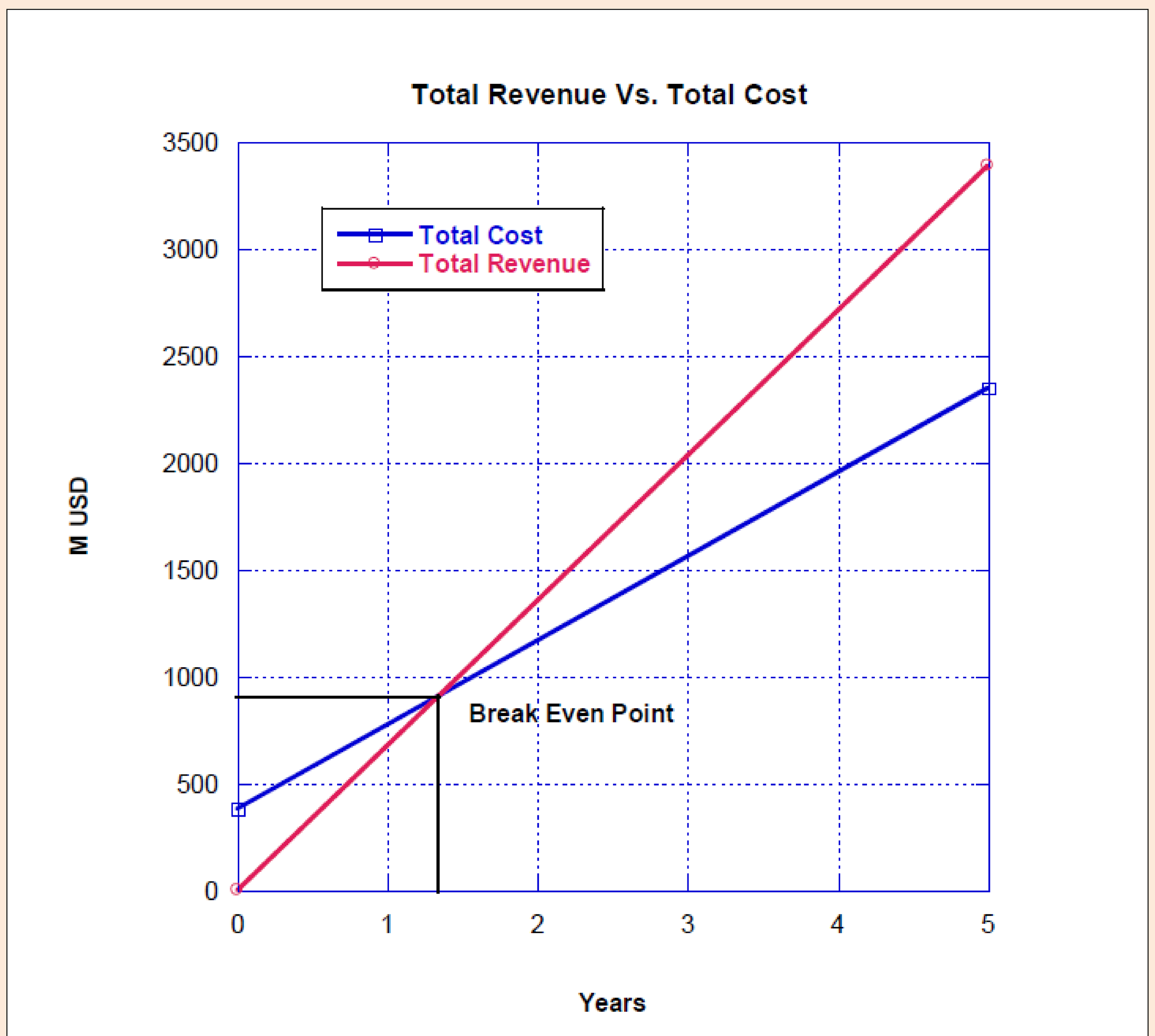

Fig. 5 Breakeven Analysis

Table 1 Initial Fixed Cost

	Item	Level	Quantity	Cost [M USD]	Total cost [M USD]
1	Ground Station	20 Mbps downlink[a]	4[b]	0.5	2.0
2	Satellite	Payload(9.6 kbps uplink)[c]	6[d]	0.8	4.8
3		Bus (high level)	6	4.0	24.0
4	Software development	Smart phone application	1	0.1	0.1
5	Launching	Coordinated orbit	6	4	24.0
6	Node	Ruggedized design	326,409[e]	0.001[f]	326.41
TOTAL					381.31

[a]Uplink speed: 1.2 kbytes/s; [b]one main and one backup ground stations in each country; [c]details in logistical feasibility section; [d]from orbit and coverage simulations; [e]36,449 nodes for Japan and 181,157 nodes for Indonesia plus half of this quantity as backups; [f]cost include the installation of the nodes

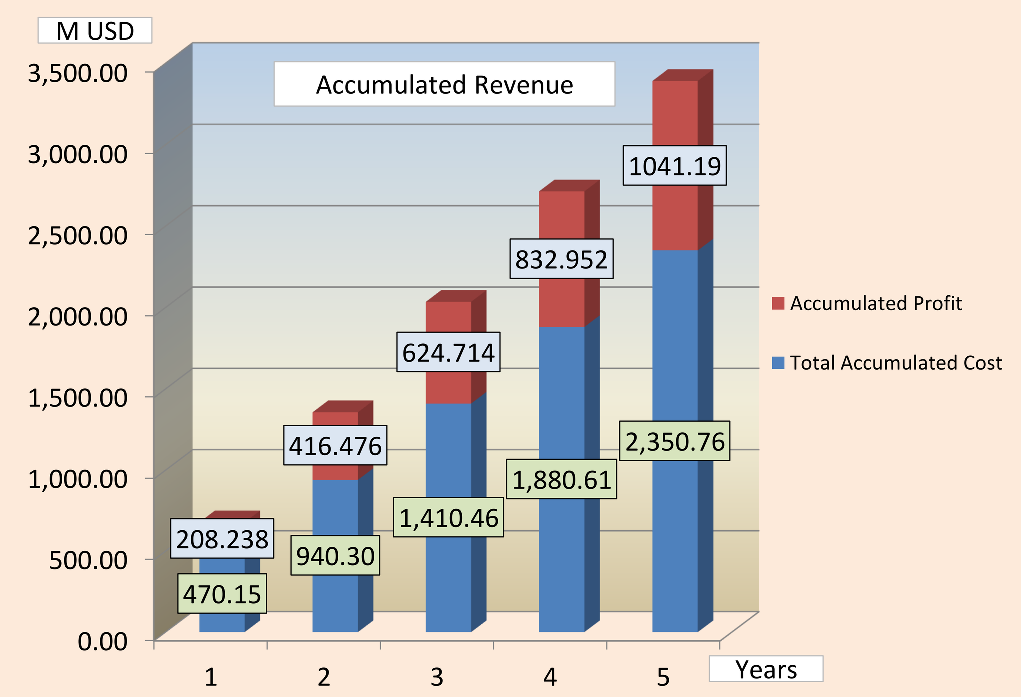

Fig. 6 Accumulated Revenue

Table 2 Annual Variable Cost

	Item	Quantity	Cost [M USD]	Total Cost [M USD]
1	Ground Stations operation and maintenance	4	0.4	1.60
2	Node maintenance	326,409	0.0001/month/node	391.69
3	Marketing			0.60[a]
TOTAL				393.89

[a]Around 10% of the total revenue

Table 3 Annual Revenue

	Item	Smartphone users	Annual subscribers	Monthly fee [USD]	Annual Revenue [M USD]
1	Subscription in Japan	21,590,000[a]	4,318,000	10	518.2
	Subscription in Indonesia	12,410,000[b]	2,482,000	5	148.9
2	SW package in Japan	21,590,000[a]	4,318,000	0.17	8.81
	SW package in Indonesia	12,410,000[b]	2,482,000	0.08	2.48
TOTAL					678.39

[a]October 2011, 17% of Japanese had a smart phone; [b]estimate of number of Indonesians having a smart phone

Table 4 Summary of System Specifications

Payload and Bus Level	Communication payload: 9.6 kbps (Medium) Bus: 20 Mbps (High)
Number of Satellites and Orbit Coordination	6 nano-satellites in the same coordinated LEO orbit at 50.5º inclination and 600 km altitude
Ground Stations	4 ground stations (1 main + 1 backup stations in each country)
Launch Rocket	DNEPR rocket goes to 50.5º orbits compared to other rockets, delta, H2A, Ariane, and VEGA.

Table 5 Risk Analysis

No	Risk	L[a]	S[b]	APO[c]	A[d]	Contingency Plan
1	Early failures due to technical difficulties during the satellites development	D	3	Scope	Medium	Sub-contracting based on companies' competency level Insurance on the satellites to re-build in case of failures
2	Service unavailability during disasters due to malfunctions	C	5	Quality	High	Backups for the nodes, ground stations, and satellites
3	Service cost is high	C	5	Cost	High	Use price discrimination policy
4	Legal and Political constraints	C	4	Scope	Medium	Coordination with local governments and authorities
5	Destruction of any of the ground segment components during disasters	D	5	Quality	Very high	Use ruggedized components Modular design for quick repair Insurance premiums for revitalization
6	Securing the needed financial resources for building the whole system	D	4	Cost	High	Issuing common stocks in the securities market Public-private partnership Insurance companies and banks as target investors

[a]L: likelihood, [b]S: severity, [c]APO: affected project objective, [d]Assessment