“Responsive Micro-Satellite Communication System”

Prepared by

FrontierX Technology LLC

Detailed proposal can be submitted upon written request and submission of detailed customer’s requirements

Responsive Micro-Satellite Communication System

1. Introduction

Emerging market countries is frequently subjects to natural disasters, such as floods and earthquakes. When there is a disaster, most of the fixed-line and mobile communication facilities in the area may be severely damaged, which result in many problems for bringing in urgently required aid. Micro-Satellites are satellites with a weight of less than 10 kg. They have the added advantages of a short development cycle, low research & manufacture costs, mission-oriented design, and are easy for multi-satellite cooperation. Therefore, they are especially suitable for countries. If a micro-satellite system is used for responsive communication, it can provide an efficient communication channel in harsh environments. The users in disaster areas can connect to external aid with hand-held terminals through a constellation of micro-satellites, which would result in enormous time reduction for aid efforts and therefore aid relief efforts.

In this presentation, the unique concept of a responsive micro-satellite communication system is presented.

The following are the features:

1. The satellite system consists of 5 (or more) micro-satellites weighting 5~10kg each.

2. All the satellites will be launched as piggy-back payloads, and work on coplanar or non-co-planar synchronous orbits at 800km.

3. The users can use hand-held and low-cost ground terminals for audio and data communication through the satellites.

4. The whole system is designed as a low-cost mission at a cost of approximately twenty million U.S. dollars (launch cost is not included) for series of Micro-Satellites and complete system.

2. Mission design and analysis

2.1 System construction and functions

The mission mainly consists of four systems as showed in Fig.1, which may be summarized as follows:

 Launch vehicle system: The satellites will be launched to intended orbits separately as piggy-back payloads.

 Satellite system: Five micro-satellites(or more) are used to construct the satellite system that provides non-continuous coverage service of audio and data transmission.

 Telemetry and Remote Control system: This is a ground receiving station that maintains satellite managements and operations.

 Ground application system: This includes UHF/VHF ground stations and communication terminals both in the disaster area and in the aid center, which connect to each other through satellites.

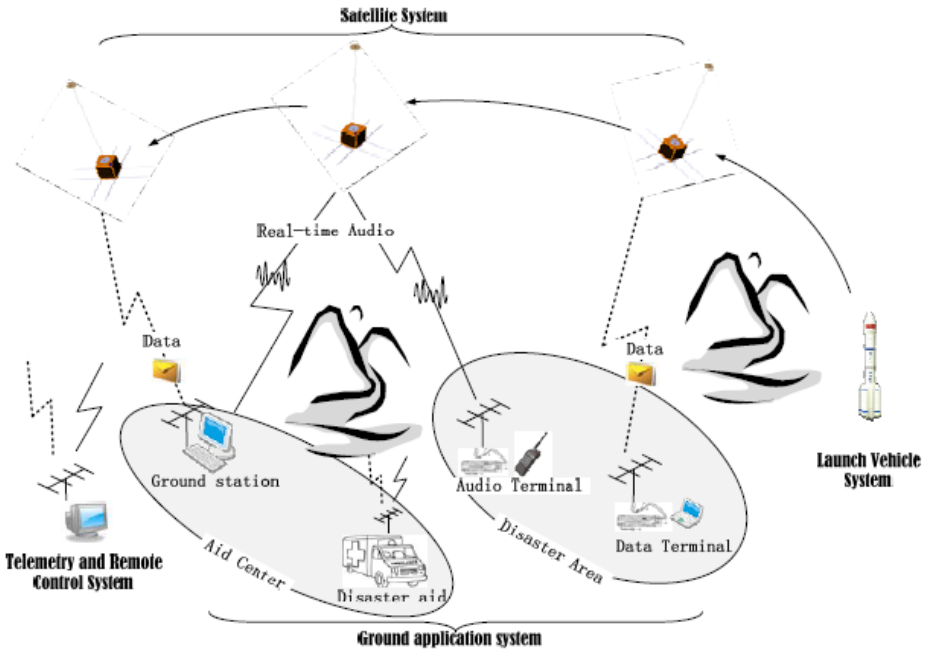

Fig. 1 Responsive Micro-Satellite Communication System

2.2 Orbit design and analysis

A Sun synchronous orbit at a height of 800km is selected for this mission. There are two orbital options: either a coplanar orbit or a non-coplanar orbit. These are depicted in Fig. 2

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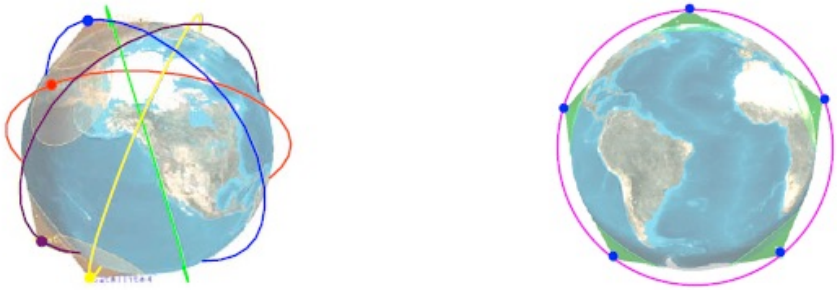

（a）noncoplanar orbit scheme　　(b) coplanar orbit scheme

Fig. 2 Two orbit options for micro-satellite communication system

□ non-co-planar orbit scheme

In this scheme, five satellites are located in five sun synchronous orbits at the same height but with different descending nodes. As shown in Fig. 2 (a), the local times of the descending node are evenly distributed in a day, which means that these orbital planes are distributed along the equator. All the orbital periods are 100 minutes with a minimal illumination time of 66 minutes. The sub-satellite points of the satellites cover all the earth. In Fig. 3, the areas marked with the white curve are orbital sections, which are visible for designed site. We define that when the elevation angle of a satellite is larger than 5 degrees, the satellite can be seen by the ground station. Thus, for a specified area on the earth, the visible time interval of one satellite ranges from 3.3 minutes to 12.6 minutes with an average of 10. The target area could be covered by five satellites 22 times every day. In this case, the coverage time intervals are distributed equally over a day.

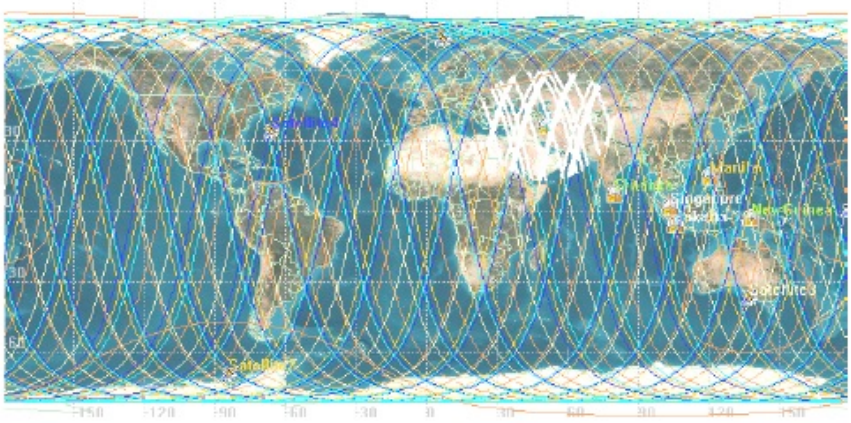

Fig.3 Track of sub-satellite point of noncoplanar orbit scheme

- **co-planar orbit scheme**

This means that the five satellites are located in the same orbit but evenly at different phases, which is shown in Fig. 2 (b). The orbital period is 100 minutes. The orbital illumination time differs in terms of local time of descending node, with a minimum of 66 minutes in case of 12:00 or 0:00 and maximum of 100 minutes in case of twilight Orbit (6:00 or 18:00).

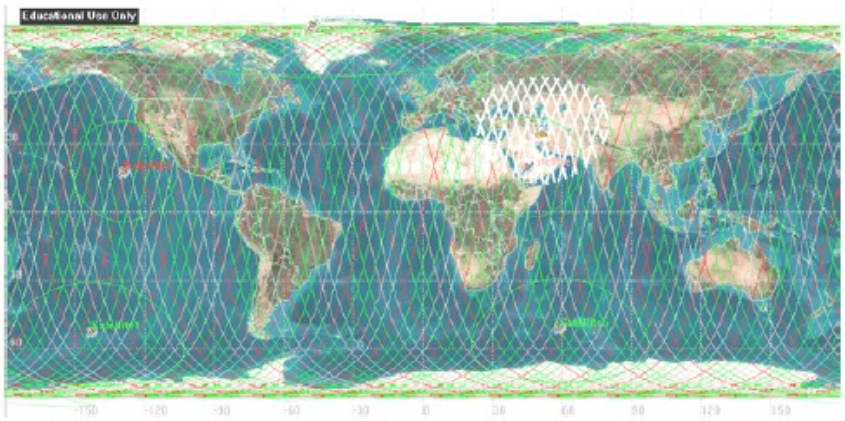

Fig. 4 Track of sub-satellite point of co-planar orbit scheme

The sub-satellite points cover all the earth. Similar to Fig. 3, Fig. 4 shows the orbit sections, which are visible for the designed site. The visible time intervals of a satellite range from 1.8 minutes to 12.6 minutes with an average of 10. For a specified target region, it can be covered by the five satellites for 24 times every day in two intervals of 3 hours for each. But besides these 2 time intervals (6 hours in total), the satellites could not be visible for the target region during the other 18 hours of the day.

2.3 Payloads and ground application system

- **payloads of micro-satellites**

Each micro-satellite has three UHF/VHF transceiver devices, which are used for telemetry and remote control, audio transmission and data transmission separately. As the hardware of the three devices are the same, one can work as a backup by reconfiguration when another breaks down.

All the radio devices use the frequency band of amateur radio and protocol of AX.25. In order to make the communication feasible, both antennas of ground stations and satellites are designed Omni-directionally.

- **Ground application system**

The Ground application system consists of UHF/VHF stations, which are simple, low cost and mobile. The uplink channel uses VHF while the downlink uses UHF. Only the satellite control center has the authority of satellite management and operation, while ordinary users could use communication services. The two kinds of communication services are:

(a) Audio transmission: it is available when a satellite is in an orbital region that is visible for two users. In this case, two users can hear and speak to each other as well as transmit real-time data. This works just likes using an interphone;

(b) Data transmission: it is available when two users are in different coverage areas. In this case, satellite receives and saves message from the user, and transmits it down to ground when it passes by another user. This mechanism works like mail delivering.

3. Micro-Satellite System

3.1 Satellite Construction

The Micro-Satellite system consists of seven sub-systems, which are:

i) Structure and mechanism,
ii) Attitude control system,
iii) Thermal control,
iv) Data handing,
v) Telemetry and remote control transceiver(TT&C),
vi) Power
vii) Payload subsystems.

3.2 Power distribution

4. Budgets
5. Analysis of mission orbits
6. Transfer of technology
7. Project Management
8. Conclusion

DETAILS OF THE SECTIONS 3 THROUGH 8 TO BE PROVIDED UPON WRITTEN REQUEST