International Civil Aviation Organization

FIFTEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION/SURVEILLANCE AND METEOROLOGY SUB-GROUP (CNS/MET SG/15) OF APANPIRG

Bangkok, Thailand, 25 – 29 July 2011

Agenda Item 4: Aeronautical Mobile Service (AMS)

CONTINGENCY ARRANGEMENT OF AERONAUTICAL MOBILE SATELLITE (ROUTE) SERVICES SYSTEM

(Presented by Japan)

SUMMARY

This paper presents a case of reconfirming the importance of contingency arrangement in aeronautical safety communication infrastructure, which Japan experienced in the wake of Big Earthquake in Eastern Japan in March 2011. How contingency is adopted into the design of global or regional air navigation systems such as AMS(R)S System is one of the salient issues to be considered for the assurance of continuity and availability of air navigation service.

This paper relates to –

Strategic Objectives:
A: **Safety** – Enhance global civil aviation safety
E: **Continuity** –Maintain the continuity of aviation operations

Global Plan Initiatives:
GPI-17 Data link applications
GPI-22 Communication infrastructure

1. Introduction

1.1 Multi-functional Transport Satellite (the MTSAT) is a space segment of an Aeronautical Mobile Satellite (Route) Service (AMS(R)S) system (the MTSAT System). The MTSAT System consists of two MTSATs, four Ground Earth Stations (the GES) and terrestrial networks interconnecting GESs. Aeronautical Satellite Centers (the ASC) that are overlooking the operation of MTSAT System are located at Kobe and Hitachiota. One of the MTSATs, MTSAT-1R, is in the orbit of 140E and the other, MTSAT-2, is in the orbit of 145E.

1.2 The MTSAT System was built to facilitate the reduced aircraft separation operation (e.g. 30nm longitudinal) in the oceanic airspace to accommodate the traffic growth in the Asia and Pacific region. In order to realize uninterruptible data link communication, it was designed as follows:

- ✓ Safety critical functions of the system are multiplexed.
- ✓ The changeover time of multiplexed systems is second to millisecond orders.
- ✓ Two ASCs are disposed with about 600 km separation on Japan Mainland for space diversity.

1.3 On March 11 2011, an earthquake shook the Northeast Region of Japan Main Land. Hitachiota ASC was hit hard by the shaking. Power supplies, including redundant facility, were damaged. The ceiling of operation room collapsed. The AMSS by the MTSAT continued during that period thanks to the redundant configuration of the MTSAT System. Although electricity recovered in two days, repair and calibration of the equipment required almost one month. Hitachiota ASC went back-on-normal in April.

2. Discussion

2.1 Redundancy in the MTSAT System configuration

2.1.1 Key components are multiplexed. There are two satellites, two GESs for each satellite, two ASCs, and multiplexed power supplies. Each ASC is connected with two different commercial power lines for redundancy. Should all commercial power lines fail, battery-powered power supply provides electricity. The diesel engine power supply will take over the battery-powered power supply in a short while.

2.1.2 Four GESs are interconnected. If one GES fails, adjacent GES in the same ASC or the GES in the other ASC takes over the job of failed GES. This is inter-GES connection. It takes 100 milliseconds and is fully automatic. The data link communication in progress is in practice not affected by the GES failure.

2.1.3 If one satellite fails, the other satellite takes over the job of failed satellite within six seconds automatically. The data link communication is not affected by the satellite failure.

2.2 Influence to MTSAT AMSS by the March 11 Earthquake

2.2.1 Shut down of Hitachiota

2.2.1.1 Hitachiota ASC had been unable to transmit and receive signals for about one month because repair and calibration was needed for various parts of the whole system.

2.2.2 Kobe take-over

2.2.2.1 When Hitachiota lost electricity, Kobe took over the job in the order of millisecond. The take-over went as smoothly as originally designed and no communication failure was reported. The MTSAT System as a whole has been able to flawlessly provide services in spite of the damages caused by the earthquake.

2.2.3 Need for space diversity and redundancy

2.2.3.1 Despite all the preventive measures incorporated into the MTSAT System against conceivable damage wreaked by natural disaster, Hitachiota ASC suffered severe damage by the earthquake. But even under that situation, inter GES switch-over between Hitachiota and Kobe worked as originally designed. Had it not been for Kobe ASC, AMSS by MTSAT would have been suspended for one month or more. In the case satellite communication is lost in the era the 30nm separation in oceanic airspace is common, distance-based separation pairs have to be broken off according to the contingency procedure. In a dense airspace such as NOPAC, the procedure may take hours to make the transition from distance-based separation to time-based separation. While the transition is taking a place, no aircraft is allowed to go into the airspace. The situation may invoke flow control of the traffic in the surrounding airspace. The repercussions can spread sequentially and exponentially into the region. After the initial contingency handling of the situation, time-based separation is imposed during the outage of satellite communication. Many of the aircraft in a dense airspace cannot fly on desired altitude.

2.2.3.2 Given the prospect of strong growth in air traffic in the Asia and Pacific region, it is needed for aeronautical communication systems to have a certain level of redundancy in order to support orderly air traffic flow. In particular, satellite communication systems can provide AMSS over the entire region and span many FIRs, so the failure of satellite communication system has significant impact on safety operation of many aircraft flying in the satellite coverage. As the air traffic grows, airspace becomes dense and Aeronautical Mobile Service becomes more dependent on satellite systems in the region, this aspect should be taken well into account for the entire design of satellite communication systems.

2.2.3.3 The experience at the earthquake in Japan on March 11 this year shows that a certain level of redundancy of system is needed for the continuity of aeronautical satellite communication. Hereafter it is desirable to consider the experience shown in this paper in the discussion of the continuity of aeronautical satellite communication.

3. Action by the Meeting

3.1 The Meeting is invited to:

a) note the information contained in this paper.

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