AERONAUTICAL SURVEILLANCE PANEL (ASP)

WORKING GROUP
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Updates on Signal Environment Measurement Activities in Japan

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SUMMARY

This is an information paper on the signal environment measurement activities in Japan.

1030/1090 MHz band are under monitoring when required. In addition, flight measurements for 1090 MHz band were conducted to estimate the performance for airborne surveillance with mode S extended squitter.

References

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[2]. S. Ozeki, T. Otsuyama: "Signal environment measurement with long time waveform recorders", ICAO/ASP/WG/ASP01-26, November, 2006
[3]. S. Ozeki, T. Otsuyama: "Measurement for Reply Signal Quality with Wideband Waveform Recorder", ICAO/ASP/WG/ASP02-27, April, 2007.
[4]. S. Ozeki: "Reply failure to low power interrogations", ICAO/SCRSP/WG/WP-A8-14, June, 2005.
[5]. S. Ozeki and H. Miyazaki: "WG-A discussions on reply failure to low power interrogations", ICAO/SCRSP/WG/WP-B9-13, October, 2005.

1. Introduction

1.1 The list of tasks for ASP was also revised by the ANC. The list includes the task on signal environment as follows.

CSN-9601 CNS-9701 CNS-7901	5) Report on the radio frequency (RF) pollution problem associated with the use of 1 030 and 1 090 MHz frequencies.	2008-6-30

1.2 The investigations in this area have been reported to WG and TSG meetings by organizations including US FAA, DFS, UK NATS and ENRI. In 1990's of later SICASP era, the investigations have been mainly focused onto three issues, i.e., the evaluation of ACAS interference limitation algorithm, the performance estimation of mode S extended squitter as surveillance data link, and the performance estimation of SSR in future environment with assuming the applications of squitter and mode S data link.

1.3 Authors have kept providing the information on signal environment investigation in Japan since early '90s under the coordination with SICASP/SCRSP/ASP WG activities. Early measurement for signal environment in 1090MHz band provides an experimental basis to support the statistical performance estimation with the Poisson distribution model for asynchronous interference to mode S extended squitter. Recently, the purpose of signal environment investigation in Japan covers study areas including the error source of signal environment estimation and the effect to its adjacent bands.

1.4 This paper updates the information on 1090/1030 MHz signal monitoring activities in Japan.

2. Signal environment measurement activities by ENRI

2.1 The various wave form recorders have been used to analyse the signal parameters that gives basic information to estimate surveillance performance at decoder output including ATC transponder, ACAS, SSR and so on. For example, if the decoder output of SSR mode S gives us an indication of abnormal operation, then it is required to observe the waveform of received signals for investigation.

2.2 ENRI is now using some types of waveform recorder to investigate the signal environment in ARNS band including 1030/1090 MHz. The systems have been introduced to ASP/WG meeting in 2006.

2.3 In 2007, ENRI has conducted some measurement activities including flight experiments as follows.

3. On-Ground Signal measurement in 1090 MHz band

3.1 The on-ground signal measurement in 1090 MHz band are continued to accumulate the signal environment data. This data is also used to analyse the quality of transponder signals which are found with SSR surveillance problem as reported in WP ASP02-027.

3.2 The waveform data file is processed to obtain the signal parameters including frequency spectrum, pulse shape parameters, signal structures, bit decisions, its confidence, interferences, and so on. In addition, the time duration to search mode S signal is chosen with specified start and stop time, if they had been provided by JCAB after the detection problem with SSR mode S in Japan. In the latter case, software decoder is used to detect candidates of preamble even with abnormal waveform. The mode S error detection and correction is applied after this processing to readout the mode S address of transponder which transmitted the signal under processing.

3.3 This activity contributes to identify the “abnormal” transponder under operation.

4. On-board measurement for 1090 MHz band

4.1 A series of flight experiments are conducted to measure the signal environment in 1090 MHz band in October, 2007, and February 2008. The flight path includes air routes from the Sendai Airport to the south west islands of Japan, via Tokyo, Miyazaki and Ishigaki. The altitude was around 10,000 feet.

4.2 Onboard dual channel receiver is used to receive the signals in 1090 MHz band with bottom and bottom antenna of aircraft. The waveform of their log video outputs are recorded with dual 10MHz 8 bits AD converter. The waveform was recorded for about 200 micro seconds by more than 4 times in every second. The software decoder will be used to detect signals from recorded waveform data.

4.3 At the same time, wide band waveform recorder was used to record the IF signal of top antenna channel. The application of waveform recording will be useful for signal quality analysis. In addition, it will be useful to investigate the problems of radio system operation in the field. Also, the measured data will be useful to evaluate the decoder operation under real signal inputs by replaying the measured data.

4.4 Some more trials for northern airspaces in Japan are scheduled on July 2008. The results will be compared with those by measurements in 2004 when that airspace was operated without SSR mode S.

5. On-ground measurement for 1030 MHz band

5.1 The 1030 MHz band was observed to monitor the activities and interferences in this band. The experimental mode S transponder is used to receive and discriminate signals in this band. The receiving antenna was installed at the top of tower of the Tokyo Heliport that is distant more than 5 NM from the SSR in Tokyo-Haneda Airport and others.

5.2 The discriminator circuit in experimental transponder generates trigger pulses for each type of interrogation signal and for something else. The trigger pulses are counted for each type of signal. In addition, the waveform of log video receiver output was recorded with the "something else" trigger. The most of "something else" signals were identified as low power interrogation signals around MTL, i.e. Minimum Triggering Level.

5.3 The problems with low power interrogation signals around MTL have already been reported with SCRSP WPA8-14 and WPB9-013. The transponders may discriminate those signals with false, for example, to reply in wrong mode.

6. Other measurements for signal environment

6.1 The onboard and on-ground measurements for signal environment in GPS-L5 band have been conducted as reported in ASP01-26. The activities are on going to cover some more major airspace in Japan. Some potential interference sources including wireless video camera are identified in this band.

6.2 The identified "1.2 GHz" wireless video camera has the capability to tune on other frequencies in ARNS band including 1080 MHz for its carrier. Then, it will be a potential interference source for 1090 MHz band.

6.3 The frequency for wide band signal environment measurements are expanding to include whole ARNS band, 960 to 1215 MHz. With this expansion, the measurement requirements for AMRS, SSR, Galileo-E5 and other systems will be covered.

6.4 The application of waveform recording will be useful for signal quality analysis. In addition, it will be useful to investigate the problems of radio system operation in the field. Also, the measured data will be useful to evaluate the decoder operation under real signal inputs by feeding measured data to them after some processing for noise and band width.

7. Conclusions

7.1 ASP/WG members are invited to note the information in this paper. ENRI continues the measurements for signal environments in the ARNS band including 1030 and 1090 MHz.

7.2 The application of waveform recording will be useful for the analysis of signal environment, quality and for improving the operational performance of radio systems in the field. The onboard measurements will be useful to estimate the performance of airborne surveillance systems.