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WORKING PAPER

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Agenda Item 6: Future direction
6.1: Implementation plans and methodologies

PROPER MANAGEMENT OF RADIO SPECTRUM ENVIRONMENT

(Presented by Japan)

SUMMARY

Stable and reliable operation of aeronautical radio systems is a prerequisite to the stable provision of air navigation services. Securing and maintaining radio spectrum environment allow the radio systems to function normally and to exercise its capability and performance as desired.

Without proper management of radio spectrum environment, the operation of radio systems would be undermined by harmful radio interference, lack of frequency spectrum and other detrimental factors. This in turn can lead to loss or degradation of air navigation service, which eventually will not merely compromise aeronautical safety but also cause loss in air transport economy.

This working paper addresses issues relating to radio spectrum environment surrounding the current and future aeronautical radio systems, and proposes actions to support the deployment and operation of future systems envisioned in aviation system block upgrades (ASBUs) of *"Global Air Navigation Capacity and Efficiency Plan" (GANP, Doc 9750)*from a practical standpoint.

Action: The Conference is invited to consider this working paper and agree to the proposals in Section 3.

1. INTRODUCTION

1.1 ICAO has proposed the 4th amendment of the *Global Air Navigation Plan* (Doc 9750) , which incorporates ASBUs and Technology roadmap as tools to support States and industry in introducing technological upgrades and operational improvement through step-by-step approach over the 2013-28 timeframe.

1.2 Stable and reliable operation of aeronautical radio systems is indispensable to the stable provision of air navigation services. Proper management of radio spectrum environment allow the radio systems to function normally and to exercise its capability and performance at a desired level.

1.3 It is observed that the importance of proper management of aeronautical radio spectrum environment will increase since future ATM improvement will greatly depend on orderly operation of a range of radio systems and, co-existence of different aeronautical radios and other radio systems, and is subject to the continued potentials of harmful interference to aeronautical radios, and to the scramble of finite spectrum bands among many spectrum users.

1.4 Meanwhile, the aviation community have recently experienced critical interference cases, some of which indicate that they are virtual or potential threat to aeronautical safety services, no matter which the interfering transmissions may be intentional or accidental. Interference to aeronautical radio system, especially, harmful translates into a detriment or a threat to the whole aviation operation because such interference will both compromise aeronautical safety and cause economical loss in air transportation.

1.5 With the above spectrum consideration on the future air navigation systems as well as the existing ones, Japan has long been engaged in research and development on radio interference resolution, radio spectrum management, methodology for efficient spectrum usage and so forth. This working paper, based on Japan's experiences and lessons learnt through the research and the daily operation of aeronautical radio systems, draws the attention of aviation community to the issues relating to radio spectrum environment, and also proposes practical actions to support the sound deployment and operation of future air navigation systems.

2. DISCUSSION

2.1 Roles and responsibilities of air navigation service providers (ANSPs) in the whole aviation system.

2.1.1 Radio administration services such as radio frequency assignment and resolution of radio interference, in principle, are executed by radio administration authority (RAA) of each State under its sovereignty. While an ANSP operates and maintains aeronautical radio systems as a spectrum user in cooperation with the RAA concerned, or in some cases as a radio regulator eligible for air navigation domain under domestic regulations or agreements in-between.

2.1.2 As the history and the status quo of aviation indicate, as air transportation grows both in quantity and quality, it pursues more efficiency and safety of air traffic through operational improvement and technical improvement.

2.1.3 To respond to such quest or needs of the air transport, ANSPs are strongly expected to execute their duties by providing reliable and stable air navigation services supported by aeronautical radio systems, which lay its foundation on stable and interference-free environment. At operational site, they operate and maintain radio systems in accordance with national regulations and operational rules. When there is a case of harmful interference, they take immediate resolutions against it by assuming the degree of disturbance to air traffic operation, locating the source, and analysing the recorded cases in cooperation with related authorities.

2.1.4 Within an ANSP workforce, ATS engineering personnel (ATSEP), who are responsible for the stable and reliable operation of aeronautical radio systems as well as other ATS facilities, is expected to execute their duties including the above mission to support the air navigation systems. Next Generation Aviation Professionals (NGAP), an ICAO-led initiative is expected to ensure that enough qualified and competent aviation professionals including ATSEP are available to operate, manage and maintain the future air transport system.

2.2 Observation on radio spectrum environment affecting aeronautical radio systems

2.2.1 Appended to this working paper are some prime findings from a recent Japan's research at Electronic Navigation Research Institute (ENRI, www.enri.go.jp), which briefs on "the trend of usage of aeronautical radio spectrum", "recent interference cases observed", and "consideration for future spectrum environment management". As for the first two, most of them had been seemingly minor, infrequent or unnoticeable until the AN-Conf/11 period or the time when new technologies began emerging after AN-Conf/11 (see Appendix A).

2.2.2 Observed from the findings is that future aviation system will potentially encounter new type of interferences, which the co-existence of various radio systems for different applications under a dense spectrum environment can generate unless the spectrum environment is properly managed. The more demanding and the

more complex the requirements and desired performance for future aviation systems become, the more critical the spectrum environment management becomes for States and ANSPs.

2.3 Increasing significance of radio spectrum environment management

2.3.1 Based on the observation in Section 2.2 with details in APPENDIX A, ATM community should be mindful about the great potential that aeronautical radio systems will face unprecedented or inexperienced interferences in their ATM modernization. Proper management of spectrum environment and effective measures, which are both preventive and follow-up ones, need to be taken to reduce the risk of degradation of the whole aviation system.

2.3.2 With cognizance of the role and responsibility of ANSPs to support ATM enhancement, it is imperative that States take actions as follows through close coordination with ANSPs and RAA under the regulations and rules applicable to that State:

a) to prevent the harmful radio interferences by establishing and maintaining optimum radio spectrum environment for aeronautical radio systems;

b) to prevent the radio interference by assigning proper spectrum for aeronautical radio systems taking into account of the ICAO spectrum policy and strategy, which are stipulated in *"Handbook on Radio Frequency Spectrum for Civil Aviation"(Doc 9718)* and regional ones, if any, regarding regional spectrum managements for aeronautical safety services;

c) to sustain proper aeronautical radio spectrum environment by applying appropriate design of radio systems and operational measures. Operational efficiency of radio spectrum can be optimized by properly setting the implementation timeline of new radio systems, and by applying the optimum operational parameters for them; and

d) to reduce their response time for interference resolutions to minimize the risk on aviation safety and the loss in aviation economy. Those responsible for radio operations should be trained adequately so that they can cope with interference cases and other spectrum-related incidents expeditiously.

2.4 Consideration on the current relevant ICAO scheme and recent discussion

2.4.1 ICAO has been taking the leadership in addressing aviation frequency matters by developing SARPs and technical provisions, based on the interference cases reported of from relevant technical Panels and member States. ICAO SARPs and technical provisions, in basic, have been satisfactory from the viewpoint of standardization or system designing.

2.4.2 In practice, radio spectrum management is usually dealt with on national basis or on regional basis. When an interference case occurs or a spectrum management issue arises, States or ANSPs usually take actions under its own national rules, based on their individual experiences and lessons they have learnt in their daily operation. A potential risk underlying in the operation of future air navigation systems is the lack of experiences for interference resolutions by the personnel concerned. They need to first have adequate proper expertise and then sufficient accumulation of such experiences together with ample data of observation and evaluation to counter questions properly and expeditiously.

2.4.3 In light of the invisibly existing or eminent issues in operational scenes of real ATM environment, which can adversely influence regional or global air navigation systems, it is suggested that remedial actions be taken well in advance of progressive introduction of future aeronautical systems from global, operational and long-sighted perspectives as follows.

a) to develop a technical guidance, or amending *Doc 9718*, for States not solely to correctly understand the potential of interference and assumed consequences to future aeronautical

systems, but also technical and operational measures which can be practically taken by civil aviation authorities or ANSPs within their capacity; and

b) to develop an instrument, such as web-based platform, for States to share information as a reference database or showcase of good practices, regarding interference cases and resolving actions taken. ATM stakeholders other than State authorities may be allowed an access to the instrument subject to the conditions if their access is deemed appropriate.

2.4.4 When it comes to global implication of interference cases such as one for GNSS, it is advisable that the proposed recommendation in WP/21*"GNSS IMPLEMENTATION ISSUES"*, regarding the actions against GNSS interference be applicable to other radio systems rather than confining them to GNSS because GNSS is not the sole radio system supporting ATM modernization at regional/global scale, and ATM improvement is to be implemented over regions aiming at seamless operation. Hence, it is appropriate that air navigation aspects of such interference be dealt with under a generic subject covering all possible radio systems when crystallizing the relevant recommendations in WP/21 after this Conference and, if deemed appropriate, be consolidated with a part of actions notified in State Letter (*AN 13/4.5-12/50*) regarding the conclusions of the 196th Session of ICAO Council, and a part of recommendations adopted at the 2nd High Level Conference of Aviation Security (see Appendix B).

3. CONCLUSION

3.1 Based on the consideration on the significance of spectrum management (Section 2.3) and the expected work by ICAO in this subject matter(Section 2.4), and recalling the recent relevant ICAO actions and recommendations, the Conference is invited to agree to the following recommendation.

Recommendation 6/x – Spectrum environment management in air navigation system

That the Conference request:

ICAO to:

a) study methodologies for sharing information among States on States' experiences of harmful interferences as well as resolving measures taken by States;

b) augment relevant chapter of *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies* (Doc 9718) with focus on the practical usage under future air navigation infrastructure by underlining spectrum environment management including interference measures ; and

c) study a formal scheme for the coordination with ITU and appropriate UN bodies on the critical cases of harmful interference to the air navigation systems reported by States.

States to:

a) contribute to the relevant ICAO work by feeding their experiences of harmful interferences as well as resolving measures through ICAO panels, PIRGs or other new schemes.

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APPENDIX A

Findings from a Japan's research on radio spectrum environment

Note: The followings are complementary notes to Section 2.2.

1. Trend of usage of aeronautical radio spectrum

- 1030/1090 MHz bands are more increasingly used by new surveillance systems such as ADS-B, MLAT and Mode-S based DAPs applications and the trend is projected to continue in the next decade or so. In their adjacent band, DMEs are expected to increase to expand PBN environment to satisfy local operational requirements. Besides, new signals such as GPS-L5 have been introduced.
- More VHF voice and data communication channels have been assigned to accommodate more users at burgeoning airports and ATC sectors.
- In addition to these aeronautical applications, the usage of radio spectrum in other applications is on the increase and is anticipated to grow rapidly.

2. Recent cases of interference observed

- A terminal DME at an international airport was driven to shut down by interference from a radio-networking camera.
- Radio navigation systems of a foreign military force caused a shut down of DMEs serving arriving and departing aircraft in the vast airspace over metropolitan airports
- In UHF communication, an emergency communication channel at 243 MHz was interfered by wireless home telephone with damaged transmitter circuit.
- Intermittent transmission from a source outside Japan caused disturbance to oceanic HF operations for a few months.
- In addition to these cases, potential sources of interference have been found for GPS-L5 and for Galileo-E5 bands by flight measurement in a radio spectrum research.

3. Aspects to be considered for future spectrum management and preventive measures against harmful interference

- It is observed that more aspects need to be taken into account in addition to the trend of spectrum usage and the experienced interferences above when considering future spectrum management and preventive measures against harmful interference.
- Spectrum management for the DME band should be conducted with great care because change in and growth of usage of spectrum in its adjacent bands increase the likelihood of interference to DME.

- Attention should be heeded to the environment where more and more radio systems will co-exist in a common band. For example, GPS-L5, Galileo-E5, LDACS and datalink for UAS are under technical test to verify the compatibility with DME in a shared band.
- Expansion of datalink applications for enhanced aircraft operation such as trajectory-based operation (TBO) need more volume and interaction of two-way data communication, which may cause spectrum congestion, interference and other adverse effects to radio spectrum environment, especially in densely operated terminal areas, trunk routes and connecting segments.

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APPENDIX B

Actions and recommendations in recent ICAO discussions with regards to radio interference case (supplement to Section 2.4.4)

Note 1: For ease of reference, actions and recommendations to be taken by States and ICAO and pertinent to the subject of this WP are underlined.

Note 2: The information below is intended for the discussion on radio interference in a generic way under the subject agenda only, neither for the discussion on any specific case or for any security discussion.

1. ICAO Council actions notified by State Letter (AN 13/4.5-12/50) dated 9 July 2012

The Council of ICAO, during the fourth meeting of its 196th Session on 18 June 2012, considered C-WP/13872 on the matter of GNSS interference and its implications on the safety and security of international civil aviation, and took the following action:

a) noted with grave concern the recurrence of global positioning system (GPS) interference incidents affecting the safety of international air navigation in the Incheon Flight Information Region (FIR);

b) urged the Contracting State with the source of such GPS interference signals to ensure that any similar incidents do not take place again;

c) noted that GPS interference can cause a hazard to aviation safety and even lead to accidents through the malfunctioning of GPS receivers and the ground proximity warning system (GPWS);

d) recognized that GPS interference, if it is intended to jeopardize the safety of civil aviation, is not only in contravention of the principles of the Convention on International Civil Aviation, but also poses a hazard to civil aviation in a manner that undermines the objectives of Annex 17 .Security to the Convention;

e) requested the Secretary General to study, in collaboration with the ITU, when necessary, the implications of GNSS interference on the safety of international civil aviation with a view to preventing or addressing any similar incidents in the future;

f) noted that the Twelfth Air Navigation Conference (AN-Conf/12) would consider the issue of interference with the GNSS; and

g) requested the Secretary General to issue a State letter informing States of the Council's decision on this subject.

Furthermore, you may wish to consult Electronic Bulletin 2011/56 Interference to Global Navigation Satellite System (GNSS) Signals available on the ICAO-NET website. Finally, in light of these recent GNSS interference incidents affecting the safety of international air navigation, I would urge all ICAO Member States to take action to ensure that sources of GPS interference signals are identified and mitigated to ensure that the integrity of international air navigation is maintained.

2. Recommendations adopted at the 2nd High Level Conference of Aviation Security

Explicit remarks on GNSS interference do not appear on *the HLASC_2 COMMUNIQUÉ*, but the Conference had fruitful discussion on WP/16 and WP/39, which address GNSS interference issues from aviation security perspective.

3. Recommendations proposed in ANConf/12-WP/21

Recommendation 6/x – Assistance to States in mitigating global navigation satellite system (GNSS) vulnerabilities

The Conference request ICAO to:

a) continue technical evaluation of known threats to the global navigation satellite system, including space weather issues, and make the information available to States;
b) compile and publish more detailed guidance for States to use in the assessment of global navigation satellite system vulnerabilities;
c) develop a formal mechanism with the International Telecommunication Union and other appropriate UN bodies to address specific cases of harmful interference to the global navigation satellite system reported by States to ICAO; and
d) assess the need for and feasibility of an alternative position, navigation and timing system.

Recommendation 6/x – Planning for mitigation of global navigation satellite system (GNSS) vulnerabilities

The Conference request States to:

a) assess the likelihood and effects of global navigation satellite system vulnerabilities in their airspace and apply, as necessary, recognized and available mitigation methods;
b) provide effective spectrum management and protection of global navigation satellite system (GNSS) frequencies to reduce the likelihood of unintentional interference or degradation of GNSS performance;
c) report to ICAO cases of harmful interference to global navigation satellite system that may have an impact on international civil aviation operations;
d) develop and enforce a strong regulatory framework governing the use of global navigation satellite system repeaters, pseudolites, spoofers and jammers;
e) allow for realization of the full advantages of on-board mitigation techniques, particularly inertial navigation systems; and
f) where it is determined that terrestrial aids are needed as part of a mitigation strategy, give priority to retention of distance measuring equipment (DME) in support of inertial navigation system (INS)/DME or DME/DME area navigation, and of instrument landing system at selected runways.

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