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WORKING PAPER

THIRTEENTH AIR NAVIGATION CONFERENCE

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COMMITTEE A

Agenda Item 2: Enabling the Global Air Navigation System
2.2: Integrated CNS and spectrum strategy

LONG-TERM EVOLUTION OF CNS SYSTEMS AND FREQUENCY SPECTRUM ACCESS

(Presented by the Secretariat)

EXECUTIVE SUMMARY

Frequency spectrum is a limited resource. The various sectors of industry, including aviation, compete for access to this resource for the provision of their expanding services. Existing aeronautical communications, navigation and surveillance (CNS) systems can all be said to be old, proven and with an exceptionally long active lifespan in comparison with any other industry. While new and ever more frequency-efficient system designs are evolved in some sectors of industry, the lifecycle of existing aeronautical CNS systems goes beyond fifty years. As the pressure on the spectrum resource increases, it becomes evident that aviation needs to find ways to keep up with the advances of technology.

Action: The Conference is invited to agree to Recommendation 2.2/X – Long term evolution of communication, navigation and surveillance systems and frequency spectrum access, in paragraph 5.

Strategic Objectives:	This working paper relates to the Safety and Air Navigation Capacity and Efficiency Strategic Objectives.
Financial implications:	*Impact for the aviation community:* As pressure mounts on the frequency spectrum resource, aviation will need to evolve and adapt its CNS strategy and systems. Unless the aviation sector agrees on a common proactive way forward, this process may be dictated in the future by external pressures, with a subsequent impact on the efficiency and safety of the air traffic system as a whole. *Impact for ICAO:* The on-going evolution of the current ICAO standardized CNS systems will continue in the short, medium and even longer term. ICAO will continue to play a significant role in aeronautical frequency spectrum defence for these systems under the auspices of the International Telecommunication Union (ITU) World Radiocommunication Conference (WRC) process. However, additional resources and efforts are required, both financial and human, to proactively evolve the CNS and frequency spectrum access strategy in the long term.
References:	Annex 10 — *Aeronautical Telecommunications* Doc 9718, *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation* Doc 9750, *Global Air Navigation Plan* Doc 10007, *Report of the Twelfth Air Navigation Conference (AN-Conf/12)* Doc 10075, *Assembly Resolutions in Force (as of 6 October 2016)*

1. INTRODUCTION

1.1 Aeronautical communications, navigation and surveillance (CNS) are considered to be three separate and distinct functions (referred to in this context hereafter as C, N and S), all of which are necessary for safe aircraft operations. These three functions, however, all rely on a common resource — continued and interference-free access to frequency spectrum.

1.2 Frequency spectrum is a limited resource shared between various users, ranging from space exploration, to television broadcast, to aeronautical CNS, to cellular phone communications. The process of dividing up the frequency spectrum resource is handled through the ITU WRCs held every four years. Aviation, as a major user of frequency spectrum, often seeks modifications to existing frequency allocations or access to new frequency bands during the WRCs. Aviation often also sees during the WRCs, its frequency bands under scrutiny or attack for potential use by other services.

1.3 The ICAO spectrum strategy is contained in Volume I of the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc 9718). It is based on the recognition that adequate and appropriate spectrum availability is essential to aviation safety and to support continuing air traffic growth and efficient aircraft operations. As recognized by Resolution A38-6 – *Support of the ICAO policy on radio frequency spectrum matters* and AN-Conf/12 Recommendation 1/12 – *Development of the aeronautical frequency spectrum resource*, this fundamental principle has been the long-standing basis for ICAO policy in spectrum matters. The ICAO spectrum strategy is consistent with the *Global Air Navigation* Plan (Doc 9750) and, in particular, with the technology roadmaps.

1.4 Due to the ever-increasing pressure on the frequency spectrum resource, looking past the GANP timeframe is required, especially considering the length of time it takes the aviation sector to develop and deploy new technologies. The long-term goal of aeronautical spectrum management is to ensure the perpetual availability of spectrum through continual improvements in technology, systems, practices and processes, while maintaining or improving the safety and regularity of flight as appropriate.

1.5 Continued evolution of the disparate C, N, and S functions cannot be in isolation. Opportunities, through flexible system design, to maximize the effectiveness of existing spectrum allocated to aeronautical services need to be fully explored while ensuring the mitigation of risks around potential single points of failure. Early identification of spectrum-related issues as well as technical and performance specifications will enable early resolution of spectrum congestion-related risks internal and external to aviation and ensure that optimal spectrum efficiency is incorporated into the system design.

2. SPECTRUM CONGESTION AND SPECTRUM TRENDS

2.1 The various sectors of industry, including aviation, rely on sufficient and continuing access to the frequency spectrum resource for the provision of their expanding services. Whilst aviation has, until recent years, enjoyed ample spectrum allocations for the majority of its systems, industries like those in the telecommunications sector are under constant pressure to find new and innovative ways of utilizing the frequency spectrum in the most efficient way possible. Utilizing rapid advances in digital signal processing, new and more efficient frequency access and modulation techniques are constantly under development. A typical lifecycle for a cellular phone technology, from conception to end-of-life, is perhaps less than ten years. In addition, the state of the art makes it possible to tweak modern software defined radios through over-the-air upgrades after they have entered active service. Overall, the expectation is increasingly that dissimilar services will share spectrum and that any spectrum user needs to make the most efficient use possible of the resource. During recent WRCs, aeronautical frequency bands have increasingly come under scrutiny for potential sharing with non-aeronautical services.

3. CURRENT STATUS AND EVOLUTION OF AERONAUTICAL CNS

3.1 The ICAO standardized C, N and S systems can all be said to be old, proven and with an exceptionally long active lifespan in comparison with any other industry, their average age being over fifty years. Very high frequency double side band – amplitude modulation (VHF DSB-AM) voice has served aviation since the early twentieth century. Non-directional beacon (NDB); high frequency (HF), VHF omnidirectional range (VOR); distance measuring equipment (DME), instrument landing systems (ILS); secondary surveillance radar (SSR), these technologies are all over half a century old. Even the more modern systems, such as VHF digital link Mode 2, automatic dependent surveillance-broadcast (ADS-B), the global positioning system (GPS) and satcom were developed in the early 1990s.

3.2 Currently, all of the above systems serve aviation well. Some of these systems are undergoing incremental upgrades for increased efficiency, e.g. SSR Mode-S and other SSR-related enhancements and the move towards 8.33 kHz DSB-AM voice in Europe. While some of the aeronautical frequency bands are increasingly congested, the level of service provided by these systems is still considered sufficient; significant difficulties are not foreseen in the near-future.

3.3 A typical commercial aircraft remains in service for twenty to thirty years. Usually there will be no system retrofit during the lifespan of an aircraft unless there is a strong business case to justify it. The development of Standards and Recommended Practices (SARPs) for any new technology typically takes more than ten years.

3.4 As air traffic continues to increase, some of the systems used for the provision of C, N and S are starting to show signs of congestion/overloading. Some of those systems cannot be considered as being very spectrum efficient or resilient against changes in the frequency environment. To accommodate the increasingly crowded airways, new procedures such as 4D trajectory management are under development. However, some of the existing systems may no longer have the capacity to support the new and more efficient air traffic management techniques. More importantly, in the future, external factors such as adjacent frequency band use and frequency band sharing with non-aeronautical services will inevitably impact the availability, performance and system design of aeronautical systems.

3.5 For the last decade, aviation safety-related updates to the ITU Radio Regulations reference “internationally recognized aeronautical standards” (read: ICAO SARPs). While ensuring that the new frequency allocations will be used as intended, this also places the burden on ICAO to develop SARPs in a timely manner. It should be noted that the majority of those new allocations share frequency bands with existing aeronautical safety allocations, e.g. a new allocation to the aeronautical mobile (route) service may share frequency band with an existing allocation to the aeronautical radionavigation service. A frequency band which is shared between ICAO standardized systems can be managed by aviation itself, thus enhancing the flexibility of its use and easing any transition from an existing system to a new one. However, if a frequency band is shared with non-aeronautical users, any such flexibility is normally lost.

4. A POTENTIAL VISION OF HOW TO MODERNIZE CNS

4.1 Consider the thought experiment below:

4.1.1 Although C, N and S have traditionally been treated as separate functions, the addition of accurate timing to a communications system gives the potential for the provision of navigation and surveillance by that same system. Realizing the evolving airspace requirements, the increasing congestion of the frequency spectrum, and lastly but not the least, the more functionally agile radio system designs made possible by modern radio technologies, any future aeronautical CNS systems could be made agile and thus adaptable to the evolving requirements.

4.1.2 If any given airspace has well-defined required communication performance (RCP), required navigation performance (RNP) as a component of performance-based navigation (PBN), and required surveillance performance (RSP) characteristics, then those characteristics could be utilized to apportion appropriate resources to the C, N and S functions as required, utilizing the frequency spectrum resource more effectively. Rather than using separate systems for the three functions, for redundancy one could envisage three (or more) separate frequency bands, each being leveraged by an independent radio system providing all three functions in appropriate portions. An additional benefit of such an approach would be to avoid single point of failure issues, such as those existing with current C, N, and S systems.

4.2 The current ICAO standardized C, N and S systems will continue to serve aviation for the next two decades, probably more. These systems will evolve in an incremental manner, adapting to the evolving needs of the industry. However, considering the ever-mounting congestion of the frequencies, pressure from non-aviation industries, the long time it takes to develop new system standards and, not least, the continuous evolution of airspace requirements (e.g. inclusion of remotely piloted aircraft systems), aviation needs to find a way forward in the longer term.

4.3 The thought experiment in paragraph 4.1 above may neither be the only nor the best way forward. However, noting the exceptionally long lifespan of the current aeronautical C, N and S systems in comparison to other spectrum users, aviation needs to engage in proactive and long-term planning of how to evolve those systems and/or the functions they provide. This process may be further accelerated if a transition is made from the traditional approach of developing aviation-specific technologies in isolation to a more performance-based approach leveraging existing industry standards. The spectrum requirements of any future C, N or S systems need to be considered in a holistic manner. As pressure on the existing global aeronautical frequency allocations mounts, no single function can be considered in isolation any more when allotting its required access to frequency spectrum.

5. CONCLUSION

5.1 The continually increasing congestion of the frequency spectrum resource requires every spectrum user to adapt by using more flexible and spectrally efficient system designs. Increased use of frequency bands adjacent to those used by aeronautical systems providing safety critical C, N and S functions is already increasing incidents of interference to aeronautical systems. Also, there is increasing pressure to share the existing global aeronautical frequency allocations with non-aviation frequency spectrum users. Unless aviation adapts accordingly, an involuntary reduction in the safety and efficiency of the air traffic system as a whole can be envisaged. To avoid this result, aviation needs to engage in proactive and long-term planning for the best way forward. On this basis, the Conference is invited to agree to the following recommendation:

Recommendation 2.2/X – Long-term evolution of communication, navigation and surveillance systems and frequency spectrum access

That the Conference:

a) request ICAO to launch a study on evolving the required CNS and spectrum access strategy in the long term, to ensure that CNS systems remain efficient users of the spectrum resource; and

b) request States to engage in the spectrum regulatory process to ensure the continued necessary access and protection of the safety critical aeronautical CNS systems.

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