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WORKING PAPER

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Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of "One Sky" for international civil aviation
1.1: Global Air Navigation Plan (GANP) – framework for global planning
c) Navigation roadmap

EUROPEAN POSITION ON THE TRANSITION TOWARDS MULTI-CONSTELLATION MULTI-FREQUENCY GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

(Presented by the Presidency of the European Union on behalf of the European Union and its Member States[1]; by the other Member States of the European Civil Aviation Conference[2]; and by the Member States of EUROCONTROL)

SUMMARY

Building on the conclusions and recommendations of the Secretariat paper on GNSS implementation issues (AN-Conf/12-WP/21), this working paper presents the European position on the transition to multi-constellation multi-frequency GNSS. It recommends that a performance-based approach be adopted by all States without limiting or mandating the equipage or the use of specific GNSS elements.

Action: The Conference is invited to agree to the recommendations in paragraph 5.

1. INTRODUCTION

1.1 The global navigation satellite system (GNSS) is a key technology of the communications, navigation, and surveillance (CNS) infrastructure, essential for the introduction of performance-based navigation (PBN) and automatic dependent surveillance-broadcast (ADS-B). It is used in safety related systems such as ground proximity warning systems (GPWS), and provides the time reference that is used to synchronize systems and operations in air traffic management (ATM).

1.2 New satellite navigation constellations are being deployed by States or group of States in different parts of the world, and the existing constellations are planned to be significantly improved. Standardization of these new and upgraded constellations is already planned in the ICAO work programme. Such evolutions have the potential to enhance the performance and reliability of GNSS if

[1] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. All these 27 States are also Members of ECAC.

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

proper measures are taken by ICAO, Member States and aircraft operators to ensure a harmonized transition.

1.3 AN-Conf/12-WP/21, presented by the ICAO Secretariat, addresses the vulnerabilities of GNSS signals and also the benefits and implementation challenges of a multi-constellation multi-frequency GNSS environment.

1.4 Europe agrees with the conclusions of the Secretariat's paper and is willing to contribute to the implementation of its recommendations. Taking into account the international and political dimension of the transition to multi constellation multi-frequency GNSS, there is a need to reach an agreement on the approach and way forward during this Conference. This paper provides recommendations for moving towards a coordinated approach in this transition.

2. EUROPEAN PERSPECTIVE ON GNSS

2.1 Many navigation and surveillance applications (e.g. RNAV 5, RNP APCH or ADS-B) are already deployed on the basis of the Global Positioning System (GPS) service offered to the international civil aviation community, contained within ICAO SARPs which have been agreed by the provider State (USA). Around 65 per cent of the fleet operating in Europe is already equipped with GPS receivers

2.2 The European roadmaps for Navigation and Surveillance[3] show the plans for introducing more demanding applications based on GNSS. The Advanced RNP specification, as defined in the forthcoming fourth edition of the ICAO *Performance-based Navigation (PBN) Manual* (Doc 9613), is the basis of the next navigation step in Europe for en route and terminal area[4]. The shift from RNAV to RNP applications will be required to enable a reduction in route spacing and ATC workload. Europe is introducing RNP APCH (up to LNAV, LNAV/VNAV or LPV minima), one of the strategic objectives of the ICAO Resolution A37-11 adopted at the 37th Assembly.

2.3 GNSS provides the required navigation performance (RNP) for all phases of flight. GNSS avionics provide the on board monitoring and alerting capability required by RNP specifications that conventional navigation systems cannot provide for all types of aircraft.

2.4 Multiple interoperable constellations operating in multiple frequencies will provide additional ranging sources in diverse frequency bands that will improve navigation performance and increase service coverage. This offers an opportunity to realize the following operational and economic benefits:

a) the improved availability and continuity of service will reduce the likelihood of losing the GNSS service. This will increase operational robustness, defined as the capability to maintain the required operational performance by reducing the need to revert to a less capable backup/alternative system or operation (e.g. procedural, radar vectoring or conventional navaids) that in some cases would imply a loss of capacity;

b) increased performance to enable advanced applications;

[3] See An-Conf/12-WP/3, An-Conf/12-IP/3 and An-Conf/12-IP/4
[4] See An-Conf/12-IP/21

c) extended service areas;

d) provision of a diversified source of time reference; and

e) economic benefit coming from the optimization of existing networks of conventional navaids and radars, especially in areas of high density of traffic.

2.5 These benefits are further developed in the ICAO Secretariat Paper (AN-Conf/12-WP/21) and its Appendix B, Section 2.

2.6 Taking into account the progressive dependency on GNSS for ATM/CNS applications and the operational benefits listed above, EUROCONTROL policy on GNSS and the European ATM Master plan set a vision based on the combined use of signals coming from at least two constellations in diverse frequency bands.

3. EUROPEAN CONTRIBUTIONS TO GNSS

3.1 Europe is developing and/or already operating Galileo, a global core constellation; EGNOS, a satellite-based augmentation system (SBAS), as well as several ground-based augmentation systems (GBAS). Europe is an active player at ICAO working arrangements and promotes GNSS systems interoperability in discussions with international stakeholders.

3.2 Galileo is a global navigation satellite system that is being developed by the European Union in cooperation with the European Space Agency. The first two operational satellites were launched in October 2011, and it is expected that 18 satellites will be operational by 2015, enabling the provision of initial services in combination with GPS. It is planned that the Galileo constellation will be fully deployed by 2020. Work is on-going at ICAO and EUROCAE/RTCA levels to develop standards (SARPS and MOPS) to use the Galileo Open Service in aviation with an augmentation system (RAIM, SBAS or GBAS). Europe is cooperating with the US and other international partners to develop a robust and global integrity service based on innovative RAIM capabilities in the long term.

3.3 EGNOS is the European SBAS. The EGNOS critical (Safety-of-Life) service was declared operational to aviation in 2011 and today there are around 100 approach procedures published that can be flown with EGNOS. Plans from stakeholders show a growing interest in EGNOS as a key enabler to meet the ICAO Assembly Resolution A37-11 regarding deployment of approach procedures with vertical guidance (APV). The EGNOS system is evolving to augment GPS L1/L5 and Galileo in the 2020+ timeframe with the mission objective to provide more robust and enhanced services in all of the ECAC region and parts of Africa.

3.4 This year, CAT I operations based on GBAS have been approved in Germany and an approval process is under way in Spain. In the framework of the SESAR R&D Programme, Europe is developing GBAS systems to support CAT II/III precision approaches. These GBAS activities encompass operational aspects, standardization, validation and the development of prototypes for both ground stations and on-board equipment. Initial CAT II/III developments are based on an augmentation to GPS L1 only (GAST D concept). The SESAR Programme is drafting a work programme for multi-constellation multi-frequency augmentation GBAS CAT II/III, the development of which is set to start in 2013 with a view to developing a robust, widely available service that could allow rationalization of the ILS infrastructure.

4. TOWARDS A GLOBALLY HARMONIZED TRANSITION TO MULTI-CONSTELLATION MULTI-FREQUENCY GNSS

4.1 AN-Conf/12-WP/21, presented by the ICAO Secretariat, addresses the benefits and implementation challenges of the transition to multi-constellation multi-frequency GNSS. Europe is willing to work with ICAO, non-European States, standardization bodies, manufacturers and aircraft operators to mitigate GNSS vulnerabilities and overcome these implementation challenges.

4.2 It is expected that in the next decade 4 constellations developed by different States/regions (GPS by the US, GLONASS by the Russian Federation, Galileo by Europe and COMPASS by China) will have been offered for use by the international civil aviation community, standardized and agreed by the provider State(s) in ICAO Annex 10 — *Aeronautical Telecommunications* and will have been approved for operational use in some States. Additionally, developments and standardization activities are on-going to evolve augmentations systems (RAIM, SBAS and GBAS) to augment different combinations of these four constellations. Some States have already started the transition to multi-constellation multi-frequency GNSS.

4.3 Some of the identified implementation challenges for multi-constellation GNSS are coming from the lack of an adequate institutional/legal framework and from uncertainty about the GNSS elements that are and will be approved by States for use in their airspace.

4.4 The use of GPS is currently approved by many States. However this approbation process has been quite lengthy within some States, while others still limit the use of GPS within their airspace, due to the feeling of a lack of control over the constellation. Based on this situation, it is legitimate to expect that the approbation of other “foreign” GNSS elements will create similar issues. It is however important that actions are undertaken by ICAO to encourage its Member States to authorize the use of any available ICAO standardized GNSS elements to conduct operations in their airspace. A failure to do so would create unavoidable difficulties in the operational management of navigation services for both pilots and air navigation service providers. This would also be counter to the PBN approach being pursued by ICAO on a global level for a number of years. Work should be conducted to help States assess the performance of given GNSS services with a view to recognizing their use for given operations in their airspace. This work should be done in close cooperation with GNSS service providers, which should facilitate access to data on key system performance and characteristics as well as commit to given levels of performance.

4.5 Consistency and Planning of Carriage Mandates

4.5.1 As discussed above, many benefits are expected from the use of multi-constellation multi-frequency navigation systems in the future. Such benefits will however only materialize for air navigation service providers and airspace users when a large proportion of the fleet will be equipped. It is therefore logical to consider the development of carriage mandates for given capabilities by a given timeframe consistently with the overall ASBU concept.

4.5.2 However, in this mandating process, care should be taken that:

a) mandates are primarily focused on securing a given level of performance to support the harmonized deployment of CNS applications. For example, Europe is now preparing a mandate for PBN that considers multi-constellation multi-frequency GNSS as a means to provide higher levels of continuity and availability for the 2025 timeframe; and

b) Mandates considered in different States should be coordinated in terms of target dates in order to avoid placing additional burden on airspace users. The main risk is that mandates with different content coming at different times will require the successive retrofit of the aircraft's navigation capability, thus increasing significantly the burden on airlines. For example, the recent decision taken by the Russian Federation to mandate the use of GLONASS equipment on board its domestic fleet will require the development and certification by Airbus and Boeing of an intermediate aircraft navigation architecture by 2017, while next generation receivers with full multi-constellation multi-frequency capability will only become available a few years later.

4.5.3 Aviation is a global industry with businesses interconnected through manufacturers and airline operations. A series of desynchronized and heterogeneous non-performance based mandates, even if limited to the equipage of aircraft registered in specific State(s), would lead to confusion in terms of standardization, certification and multi-constellation liability concerns, resulting in unnecessary complexity for avionics development/integration and significant extra costs for aircraft operators.

4.6 ICAO, States and the aviation industry need to develop solutions to enable a gradual and globally harmonized transition to multi-constellation multi-frequency GNSS that will bring operational benefits based on interoperability and cost efficiency criteria. Europe wishes to see all ICAO States adopt a performance-based approach with regard to the use of GNSS constellations. According to this approach, operational requirements (e.g. availability and continuity) should drive the constellations and augmentations to be used, and not the particular use of one given GNSS element.

4.7 If States are not ready to adhere to this performance-based approach for institutional/political reasons, it would be preferable to agree on a globally coordinated approach for GNSS mandates to reconcile political and aviation industry interests, rather than face an uncoordinated, desynchronized, complex and expensive transition.

5. CONCLUSION AND RECOMMENDATIONS

5.1 The modernization of the current GNSS constellations (GPS and GLONASS) along with the deployment of additional constellations offers a unique opportunity to improve future navigation services and render them more robust to failure, ionospheric events or unintentional interference. This should allow the approval of GNSS for more and more demanding navigation operations while still relying on GNSS for timing and position reporting in ADS. Reaping the full benefits offered by such opportunities however will require a number of actions to be taken by ICAO, Member States, individual air navigation service providers, and airspace users.

5.2 Europe supports a performance-based approach with regard to the use of GNSS constellations and is preparing a PBN mandate based on performance needs. However, having different and desynchronized national/regional mandates requiring the use of specific GNSS elements would increase complexity and costs to the aviation industry.

5.3 Europe fully supports the set of recommendations on multi-constellation aspects included in ICAO Secretariat paper AN-Conf/12-WP/21. Consistently with that, the Conference is invited to agree to the following recommendations:

Recommendation 1/x – Enabling benefits from multi-constellation systems

That:

a) States pursue the introduction of new operations enabled by the improved robustness and availability brought by the existence of multiple global navigation satellite system constellations augmented with aircraft-based augmentation system, ground-based augmentation system and satellite-based augmentation system, provided that such operations offer new benefits to airspace users;

b) States consider the acquisition/evolution of satellite-based augmentation system, ground-based augmentation system and/or monitoring systems with multi-constellation multi-frequency capability, provided that they offer improved performance for the operations offered to airspace users; and

c) aircraft operators consider equipage with global navigation satellite system receivers able to process more than one constellation in order to support more demanding operations and get accrued benefits thereof.

Recommendation 2/x – Standardization of global navigation satellite system evolutions

That ICAO:

a) pursues the development of standards for new global navigation satellite system core constellations becoming available;

b) pursues the extension of existing aircraft-based augmentation system, ground-based augmentation system and satellite-based augmentation system standards to enable the use of dual frequency and multi-constellation services; and

c) limits the proliferation of additional non-interoperable local or regional augmentation standards.

Recommendation 1/ x – Modalities for implementation of carriage mandate for global navigation satellite system equipment

a) States are invited to adopt and adhere to a performance-based approach with regard to the use of global navigation satellite system (GNSS) constellations, without limiting or mandating the use of specific GNSS elements; and

b) That ICAO coordinates the content and timelines for implementation of potential carriage mandate for global navigation satellite system equipment in order to reduce implementation burden on airspace users.

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