International Civil Aviation Organization

WORKING PAPER

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**(English and Russian only)**

# ASSEMBLY — 37TH SESSION

## TECHNICAL COMMISSION

**Agenda Item 37: Development of an up-to-date consolidated statement of continuing ICAO policies and practices related to a global ATM system and communications, navigation and surveillance/air traffic management (CNS/ATM) systems**

## CAPABILITIES TO EXPAND THE OPERATIONAL BENEFITS OF ADS-B IMPLEMENTATION AND ITS ASSOCIATED APPLICATIONS

(Presented by the Russian Federation)

**EXECUTIVE SUMMARY**

This working paper calls the Assembly's attention to the information on the results of a research project performed in the Russian Federation in order to expand the operational benefits of the ADS-B implementation and its adjacent applications aimed to improving the safety and efficiency of air traffic.

Along with the plans to deploy ADS-B based on 1090 ES data link, the Russian Federation is exploring the possibility to use an additional VHF Mode 4 data link (VDL-4) in order to provide a situational awareness of aircrews, to support the uplink of an aeronautical information, to control flights of unmanned aircraft systems in non-segregated airspace, to provide air-to-air interaction of the airborne wake vortex safety systems, and to increase efficiency of search and rescue operations.

**Action:** The Assembly is invited to:

a) request Council to initiate research of possible scenarios of the global ADS-B deployment paying special attention to the safety of flights and potential ecological and economic implications, caused by the reorganization of national ATM systems;
b) request Council to conduct consultations with the Secretariat of the International Satellite Search and Rescue System (COSPAS-SARSAT) concerning possible use of ADS-B information to increase efficiency of search and rescue operations together with decreasing its cost;
c) request Council to accelerate development of ICAO SARPs regulating flights of unmanned aircraft systems in non-segregated airspace with regards to the future global ADS-B deployment; and
d) in view of entering into operation of new larger aircrafts and of an urgent need to increase the airspace capacity in certain regions of the world along with further increasing of flight safety level, request Council to accelerate ICAO's work in the area of standardization of operation requirements for on-board wake vortex systems, taking into account existing and future technological solutions.

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| *Strategic Objectives:* | This working paper relates to Strategic Objectives A on safety. |

[1] English and Russian versions provided by the Russian Federation.

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| *Financial implications:* | Resources for the activities referred to in this paper are included in the proposed budget for 2011-2013. |
| *References:* | Annex 10 — *Aeronautical Telecommunications*, Volume V — *Aeronautical Radio Frequency Spectrum Utilization*<br>Doc 9816, *Manual on VHF Digital Link (VDL) Mode 4*<br>Doc 9750, *Global Air Navigation Plan*<br>Circ 278, *National Plan for CNS/ATM Systems*<br>RTCA DO-289, *MASPS for the airborne surveillance*<br>FAA Federal Register 14 CFR Part 91: *ADS-B out performance requirements; final rule* |

## 1. INTRODUCTION

1.1 The development of communications, navigation, and surveillance/air traffic management (CNS/ATM) technologies includes the introduction of data links allowing for a decrease in the workload of air traffic controllers and aircrews, to increase the reliability of aeronautical data exchange and, as a result, to improve flight safety. The Federal Target Programme "Modernization of United System of Air Traffic Management of the Russian Federation (2009-2015)" foresees the "wide introduction of the automatic dependent surveillance and ground-air-ground data links".

1.2 Along with the 1090 extended squitter data link (1090 ES), Russia (as well as Sweden) is also considering use of VHF Mode 4 data link (VDL-4) to provide a situational awareness of aircrews, to support uplink of aeronautical information, to control flights of unmanned aircraft systems in non-segregated airspace, to provide air-to-air interaction of the airborne wake vortex safety systems, and to increase efficiency of search and rescue operations.

## 2. SURVEILLANCE

2.1 The key elements of development of advanced air traffic control (ATC) systems is a wide introduction of the ADS-B infrastructure and its related operational procedures. Today current ADS-B technology implies three different data links standardized by ICAO. Two of them – 1090 ES (for commercial aviation) and universal access transceiver (UAT) (for general aviation) were adopted within the US NextGen programme. The EU SESAR programme also foresees the wide introduction of ADS-B based on 1090 ES data link.

2.2 The Russian Federation also has plans to deploy ADS-B based on 1090 ES data link. Meanwhile, it should be taken into account that the Eleventh Air Navigation Conference of ICAO agreed that "… in the longer term, the current SSR Mode S extended squitter technology may not be able to fully satisfy all of the requirements for ADS-B services in all airspaces" (Doc 9828, AN-Conf/11, paragraph 7.4.6.1). In addition, the current projects for the deployment of ADS-B (1090 ES) are considering one-way data transfer from the airplane to the ground station – so-called ADS-B Out (please refer to FAA Federal Register 14 CFR Part 91: ADS-B Out Performance Requirements; Final Rule).

2.3 An aircraft equipped with ADS-B Out autonomously locates its position and broadcasts it to a ground ATC station. This type of the ADS-B Out deployment looks like a replacement of radar surveillance. Within the frame work of the NextGen programme, 125 secondary surveillance radars (SSR) will be taken out of service by 2014 and 800 SSR − by 2020. Undoubtedly, even such scenarios of the

ADS-B deployment is operationally and economically reasonable because it provides at least the same and even greater services for significantly lesser cost. Russia is also going to follow this path. However, the potential of wide-scale ADS-B introduction based on two-way data links is much greater.

2.4 For the reasons mentioned above, along with the 1090 ES ADS-B deployment, Russia plans to expand the range of operational benefits from ADS-B and its associated applications with the support of additional data link, standardized by ICAO – VDL-4. Russia has developed and certified both ground and on-board equipment for ADS-B deployment based on VDL-4. Its efficiency was proved by the numerous test flights of different types of aircrafts over various regions, including Arctic and Antarctic.

2.5 One of the problems of the air traffic management in low airspace, especially over metropolitan areas, is the absence of feasibility for radar surveillance. This problem can be solved successfully by the use of ADS-B.

2.6 The low-level air traffic surveillance system based on ADS-B in the airspace over the city of Moscow has been deployed and is now ready for operation. The system includes five non-supervised networked VDL-4 transponders located on the roofs of high buildings. It creates a kind of a cellular structure providing for the continuous surveillance of low-flying aircraft (police and ambulance helicopters, fire-fighting helicopters) in any point of airspace over the city. This network is connected to the Moscow (Vnukovo) ATC centre and to the authorized departments of the Ministry of Defense. Beside the two-way data exchange with the ATC centre, aircraft are able to interact in order “to see” mutual location. This is very important, for instance, for the collective fire-fighting works. As a result, currently there is a low-level ADS-B surveillance field within 80-100 km radius from Moscow city centre. This allows the control of air traffic not only over Moscow but also along domestic routes around Moscow.

2.7 Oil and gas production in the northern and eastern parts of Siberia requires the transportation of many employees and cargo by helicopters. Several hundreds of helicopters are busy gas-pipelines patrolling under conditions of poorly developed ATC infrastructure. In many cases, it is ineffective to develop the radar surveillance infrastructure due to high expenses along with the difficulties in constructing heavy objects in the deep-frozen soil conditions. For this reason, to control helicopter flights it was decided to launch a pilot ADS-B (VDL-4) project at Yamal peninsula (a 180 000 $km^2$ territory in the northern part of the Tyumen region) with financial support of GASPROM Company.

2.8 Test flights are scheduled to begin in 2011. By now the necessary ground infrastructure has been constructed. In view of insufficient ground-based infrastructure, communication between heliports is maintained via the GAZPROM communications satellite. The ground-based satellite communication stations installation is in progress, as well as manufacturing of both ground-based ADS-B stations and on-board equipment integrated with helicopter avionics. The simulation of integration of real ADS-B avionics with the full-size ATC system is conducted at the test-bed of semi-natural modelling. Along with refining of VDL-4 based surveillance in air-to-ground and air-to-air modes, they perform: simulations of the uplink delivery of the meteorological data, aeronautical data management, modelling of final approach and landing with the support of the satellite local area augmentation system (LAAS), simulation of aeronautical operational communications (AOC) between helicopter and flight operation centre of airline, etc. It is provided by the model that, in case of losing direct radio contact, ADS-B surveillance will be automatically channelled via Inmarsat satellites (IsatM2M/D+ protocol). In case of successful implementation of the Yamal project, the GAZPROM Company will continue financial support of further ADS-B deployment in the regions of its gas-pipelines, as well as in the Stockman’s gas field region.

2.9 In the Russian Federation, general aviation (GA) has experienced significant growth recently. Effective November 2010, a notification order procedure to request ATC clearance for GA flights has been introduced into the national aviation legislation. Even today, ADS-B deployment based on VDL-4 can be one of the elements providing a required level of flight safety for GA through ATC surveillance as well as mutual surveillance to prevent midair collisions.

2.10 An ADS-B surveillance system can be a substantial addition to the COSPAS-SARSAT search and rescue system, which is characterized by certain imperfections – it starts working only at the moment an incident/accident occurs. Statistics show that in many cases COSPAS-SARSAT on-board emergency location transmitters (ELT) were broken or unable to send signals because of various circumstances. Besides, in high latitude regions, where it is critical to begin search and rescue operations immediately, the accident location process may take several hours (even with properly working ELTs). Continuous information on ADS-B aircraft position in case of an accident allows rapid and precise definition of the search region according to the latest message. In the ADS-B environment, all search and rescue means of transport – aircraft, ships, vehicles – can coordinate their actions by means of two-way communications within the common information network based on VDL-4 with the common mobile control centre on the ground or in the air.

## 3. ASSOCIATED APPLICATIONS

### 3.1 Aeronautical information management (D-AIM)

3.1.1 Operational benefits of ADS-B implementation on VDL-4 are not limited by surveillance but can include other useful applications like FIS-B (flight information services – broadcast) which has been shown by Eurocontrol and CAA of Sweden (LFV) within the D-AIM project. Similar works are conducted in Russia within the framework of the Yamal project. Every 15-20 minutes textual and/or graphical weather reports will be transmitted to helicopters, including 3D synthetic presentation. Meanwhile, meteorological parameters, measured by on-board sensors, will be transmitted via air-ground data link to the common meteorological databank (AMDAR). It will contribute to a further increase of weather forecast accuracy. In addition, it is planned to send onboard NOTAM information supplemented by graphical presentations of zones with the flight restrictions, abruptly closed runways, etc.

### 3.2 Wake vortex safety

3.2.1 Introduction into operation of new larger aircraft (A-380, B-787, B-747-8) together with the urgent necessity to increase the airspace capacity in some regions of the world highlights the extreme importance of wake vortex safety for the international civil aviation. Existing ICAO SARPs stipulate reasonably large separation minima related to wake vortex turbulence caused by the worst combination of unfavourable factors. In some cases, this approach leads to unjustified restrictions of the airspace usage especially in the airport’s terminal area. At the same time, an aircraft interaction with the vortex turbulence zone has a transient and critical, in terms of potential impact, character and can cause heavy flight incidents. The Russian Federation has carried out studies based on approach when an aircraft, following in path of another aircraft, receives a modelled information about the configuration and intensity of the wake vortex broadcasted by the aircraft ahead. Received wake vortex information allows the calculation of the potential impact of the turbulence zone and to generate control commands to avoid entering into a dangerous wake vortex. It is very important to underline that now this approach presumes data broadcast by means of VDL-4. This is the way the on-board wake vortex safety system was engineered in the Russian Federation. Efficiency of this system was proven by test flights.

Tupolev-154 aircraft was used as a wake vortex generator and an L-39 aircraft was the recipient of the broadcasted wake vortex information. These test flights also confirmed the feasibility of this solution.

### 3.3 Flights of unmanned aircraft systems in non-segregated airspace

3.3.1 Another example of a possible ADS-B application, which can be performed only by means of VDL-4, is the ATC management of unmanned aircraft systems (UAS) flights in non-segregated airspace. Today commercial interests dictate an expeditious development of civil UAS applications and consequently an urgent need to develop a regulatory base and to adapt the ATC system to control the UAS flights in the common civil airspace. ICAO established the Unmanned Aircraft Systems Study Group (UASSG), which was tasked to create the conceptual basis for the future development of UAS international standards. The basic principle used in this work is the safety of flights of all airspace users.

3.3.2 Within the framework of the concept developed by the UASSG, it is stated that UAS flight management shall be performed in accordance with the existing ATC procedures and by using standard ATC means for international civil aviation. It is supposed that information about flight plans and real-time position of the UAS should be continuously available for ATC controllers and other airspace users, while UAS flights themselves should not negatively influence the general air traffic management process. Thus, this concept raises questions about the development of new separate data links for the surveillance and for UAS control. In order to prevent aircraft midair collisions, the UASSG is considering a possibility to introduce a new “see and avoid” technology based on the information from various sensors (televisual, infrared, radar-location, etc.) which are not used currently in civil aviation. It is evident that in the foreseeable future such technology will fail to provide the required level of flight safety and will require substantial resources and time to create ICAO UAS SARPs while it is not driven by internal needs of the existing ATC systems for the international civil aviation.

3.3.3 The draft ICAO Circular on *Unmanned Aircraft Systems* notes that UAS integration in non-segregated airspace will take many years and will require a lot of effort as well as the development of new technological solutions. Meanwhile, Russian industry has already engineered equipment both for surveillance and for execution of UAS control commands set. All test flights were successful. For these test flights the ADS-B surveillance was based on VDL-4. The control was performed by means of the same data link in the “point-to-point” mode. Furthermore, this technological solution provides for a feasibility of UAV surveillance not only by ATC controllers but on the cockpit displays of aircrafts equipped with ADS-B In. UAS pilots are also able to observe other aircrafts in the proximity of the UAS through ADS-B or TIS-B.

3.3.4 In the common airspace, where ADS-B is based on non-VDL-4 data links, but where it is necessary to manage UAS flights, some kind of closed shell (which includes ADS-B ground station, UAS control stations of and UAVs, which are equipped with VDL-4 data link) could be used. Such a structure can provide for UAS functioning in a manner, described above, and operational data exchange with a designated ATC centre can be maintained through a computer network connected to ADS-B ground station.

## 4. POSSIBLE SETS OF DATA LINKS

4.1 The list of main components able to support a required operational digital data exchange of any civil aircraft should include:

a) a broadcasting data link for ADS-B surveillance by the ATC centre;

b) a two-way broadcasting data link for the situational awareness of aircrew related to the flights of civil aircrafts and UAS;

c) a two-way broadcasting data link for aeronautical data exchange, including wake vortex information;

d) a broadcasting data link for a collision avoidance system; and

e) a CPDLC data link for the pilot-controller communications, including a warning about wind share, wake vortex and aeronautical operational communications (AOC).

4.2 At the present time in the United States the function of on-board situational awareness for the general aviation is provided by means of re-broadcasting (ADS-R) with the support of the UAT data link. ADS-R application for the commercial aircrafts requires an additional VDL-2 data link. It seems ineffective to use such a data link for uplinking voluminous aeronautical data (for example, graphical weather). It is also impossible to transmit warning information related to wake vortex in air-to-air mode. Performing of simultaneous broadcasting and point-to-point data exchange is required to use at least two different data links – 1090 ES and VDL-2 (UAT and VDL-2 for the GA).

4.3 All requirements listed in paragraph 4.1 for operational data exchange can be provided by only one data link – VDL-4. A possibility to broadcast an aircraft's position data within 400-450 km radius gives an opportunity to elaborate a completely new separation and collision avoidance system. Only this data link is able to broadcast simultaneously with data exchange in point-to-point mode as well as to support wake vortex systems and to provide ATC control of unmanned aircraft systems in the common airspace.

— END —