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Aircraft Derived Meteorological Data via Data Link for Wake Vortex, Air Traffic Management and Weather Applications

Operational Services and Environmental Definition (OSED)

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FOREWORD

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- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and

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1 SCOPE AND OBJECTIVE

This Operational Services and Environmental Definition (OSED) further defines a concept of operations for transmitting aircraft-derived meteorological data to enable a wide range of Next Generation Air Transportation System (NextGen) and Single European Sky ATM Research (SESAR) applications in the areas of wake turbulence, air traffic management, and meteorology. This concept was first published as informative appendices in DO-260B and DO-282B, Appendix V and Appendix S respectively (Ref 1, Ref 2).

This OSED takes a link agnostic approach and describes the information content necessary to support a broad range of applications without constraining the data elements or rates to stay within the limits of any specific link. A number of wake turbulence, air traffic management, and meteorological applications are described that can benefit from the downlink and crosslink of these aircraft-derived data. This OSED describes the specific data to be transmitted, including bit count and timing; addresses acquisition of required data from standard data labels on standard aircraft data buses as well as provisions for participation by aircraft not equipped with data buses and/or flight management systems; discusses constraints under which the proposed service must operate; and provides an overview of potentially applicable performance standards, error handling, system safety, and system security topics. Specific funded and/or planned projects and research in the areas of wake turbulence, air traffic management (ATM), weather situational awareness, and meteorological applications that could benefit from the proposed data service are identified.

SC-206 is performing a comprehensive analysis of data links to uplink, downlink, and crosslink meteorological data. This link analysis, together with the requirements of the data service described in this OSED, will inform the selection of the best available data link to support the information needs of NextGen and SESAR wake, ATM, and MET applications.

1.1 Motivation

It has been known for decades that aircraft, with appropriate provisioning, have the capability to measure and report meteorological data at a high resolution, under all weather conditions, and over areas of operational interest to a wide audience within the aviation community. Additionally, this data can have economic value to many non-aviation uses by communicating a dense picture of weather conditions from thousands of flights operating daily in the global airspace. While some commercial airlines already capture and communicate weather data internally, the capability of aggregating this data has far reaching potential.

Many proposed concepts within NextGen and SESAR require reliable and valid information about the current and predicted aircraft position. Predicting future aircraft positions reliably requires knowing both the planned trajectory and the effects actual winds and temperatures will have on that trajectory. Currently, wind data are limited by the accuracy and age of meteorological data along planned aircraft routes. These limitations create operational inefficiencies that degrade the benefits achievable through implementation of NextGen and SESAR.

1.2 Background and History

In 2009, leaders within the Federal Aviation Administration (FAA) and the aviation industry stepped forward to request that RTCA Special Committee 186 (SC-186) start to develop consensus standards and lay the groundwork for international agreement on the

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use of ADS-B as a vehicle for broadcasting a limited set of meteorological data. While awaiting the formation of an RTCA subgroup, an activity was begun in March 2009 to develop informative appendices for DO-260B (ADS-B MOPS)/ED-102A and DO-282B (Universal Access Transceiver Minimum Operational Performance Standards [UAT MOPS]). These informative appendices provided justification for introducing such broadcast data as requirements into future MOPS and also provided initial estimates of desired data elements, update rates, and signal provisioning. The appendices also facilitated the investigation of a range of applications enabled by the proposed data broadcasts, with the goals of: (1) advising aircraft operators on how they can provision their aircraft at present to support these potential ADS-B applications and (2) laying the groundwork for international agreement on the inclusion of support for these applications in future MOPS. Following publication of the informative appendices in DO-260B and DO-282B the RTCA Program Management Committee for SC-186 authorized the formation of an SC-186 subgroup to develop this OSED document. The OSED subgroup was subsequently placed under RTCA SC-206 where this OSED was completed, focusing on the necessary data content and delivery requirements to enable wake vortex, ATM, and weather applications.

In 2011, members of the ADS-B In Aviation Rulemaking Committee concluded ADS-B is likely an excellent candidate medium for transmitting wake parameters because the current ADS-B Out message set already includes position, time, and other required data envisioned for NextGen and SESAR operations. They noted: "In particular, a review of the Application Integrated Work Plan (AIWP) (as conducted by working group 1[of the ARC]) points to wake information as one opportunity to provide additional ADS–B Out message data to either enhance or enable applications such as AIWP 14, FIM–DS with Wake Risk Management, and en route traffic flow management applications" (Ref 3). In part, this finding was based on the fact that much of the infrastructure necessary to implement the capabilities described in this OSED will be deployed nationally and internationally as a result of 2020 ADS-B Out mandate. Aircraft operators, for example, will not need to add additional radios or antennae to participate. However, as noted in Section 4, aircraft operators may need to provision their aircraft to make certain data available for broadcast. Similarly, the national ADS-B ground-based infrastructure being deployed by the FAA's Surveillance and Broadcast Services Program (SBS) is already capable of receiving ADS-B messages, parsing them, and re-distributing data to external stakeholders. Some additional costs would be incurred to modify the ADS-B ground-based networks to process and distribute the additional data elements needed for the applications described in this OSED. However, these costs would likely be marginal relative to the potential benefits attainable. Although there are good reasons for why ADS-B might be the best available link to host this data service, there are concerns regarding the spectrum ability to support any additional applications. A comprehensive link analysis must be performed for this OSED to be implemented on any data link service. This OSED attempts to be link agnostic and to make no presupposition as to the best candidate for delivery of this information.

1.3 Purpose of Document

The purpose of this OSED document is two-fold. The first is to describe the technical concepts of transmitting Meteorological (MET) and aircraft operational data. The second is to describe a range of applications in the areas of next generation air traffic management systems, wake vortex dependent separation procedures and enhanced weather forecasts where consumers may benefit. Existing business cases associated with the representative applications discussed in this OSED are intended to provide justification for enabling the transmission of MET data and aircraft operational data. General descriptions of envisioned capabilities in each of the primary application areas will be provided in this OSED. Further details concerning applications in each of the

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primary application areas will be included by reference to existing program documentation.

The scope of this work is as follows. Identifying the necessary parameters, including data resolution and update rates, for the transmission of both MET and aircraft operational data are key focuses of this OSED." This OSED contains provisions for unequipped aircraft to report "no data available" and for partially equipped aircraft to report subsets of the full data list. No mandating of onboard equipage or addition of sensors is envisioned in this OSED. Transmission of the aircraft-derived meteorological data is intended to occur during all phases of flight and during all flight operations. On board automation will routinely transmit these data at transmission rates based on a time schedule. Conditional transmission criteria are also applied to further control the reporting frequency of some data.

1.4 Document Outline

Section 1 – Describes the scope and purpose of this document and also includes a brief description of prior work under SC-186, SC-206, and the FAA Aviation Rulemaking Committee for ADS-B In which guided development of this OSED.

Section 2 – Provides a high-level overview of the types of direct and supplemental benefits to aviation and non-aviation related applications which may be attainable through enabling the transmission of aircraft-derived data. This section also presents an overview of technology-related and non-technology-related constraints assumed to be applicable to any data services system.

Section 3 –This section introduces the basic data parameters needed for the envisioned wake turbulence, air traffic management, and meteorological applications. Visions for use of these data in mid-term and long-term wake turbulence, air traffic management, and weather applications are introduced.

Section 4 – This section describes in detail a proposed service to be enabled via data link transmissions. Bit counts, data quality flags, and the range and resolution of each data parameter are specified. The feasibility of obtaining most of the required additional data elements from standard aircraft data buses using standard data labels is demonstrated using aircraft equipped with an ARINC 429 data bus as an example. Provisions for aircraft not equipped with a standard data bus or a flight management system to report data from onboard sensors are discussed. For these non-equipped aircraft, data flags are identified to allow reporting of "no data available", if necessary." Overviews of assumed error handling, safety assessment, and security topics relative to the fully automated transmission of aircraft-derived data are provided. The roles and responsibilities of users of the proposed data service as well as the anticipated timeframes for ground-based and air-to-air applications utilizing the transmitted data are discussed.

Section 5 – Leverages current and planned NextGen, SESAR, and Russian Federation wake turbulence applications under development by the FAA, EUROCONTROL, International Aeronavigation Systems, and others to provide the reader with a sense of emerging wake turbulence applications that could feasibly utilize the data service proposed. A notional system architecture that could support both ground-based and air-to-air wake turbulence solutions is presented. The manner in which the proposed transmissions could potentially support and enhance specific FAA and European wake solutions under development is discussed.

Section 6 – Discusses current and planned NextGen ATM applications under development by the FAA and others to provide the reader with a sense of emerging applications in traffic flow management, separation assurance, and airline operations that could feasibly utilize the data service proposed. A notional system architecture that could support both ground-based and air-to-air traffic management solutions is presented.

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Selected ATM solutions and concepts are discussed to indicate opportunities to leverage the service proposed in this OSED to enhance trajectory predictions and provide operational efficiencies.

Section 7 – Discusses collection and dissemination of meteorological data to enable improved real-time ground and in flight decision making as specified in both NextGen and SESAR concepts. Use of meteorological data obtained from aircraft to enable time-critical operational decisions as well as supplement existing meteorological data collection methods for the more traditional weather forecasting and weather observation applications is discussed. A notional system architecture that could support both ground-based and air-to-air weather situational awareness is presented. Potential use of the proposed messages to move from the current 'encounter and escape' practice when dealing with hazardous weather conditions to a safer 'identify and avoid' methodology is discussed.

Appendix A - Retains and documents, for future consideration, additional concepts that could potentially leverage the data service described in this OSED. These additional concepts were not included in the body of the OSED simply due to a lack of a thorough understanding of how access to real-time aircraft and MET data could enhance the concept. Additional research on the incorporation of real-time aircraft and MET data to these concepts would be necessary should the capability be considered

Appendix B – Acknowledges individuals and organizations that contributed to the development of this OSED document.

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