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Architecture Recommendations for Aeronautical Information (AI) and Meteorological (MET) Data Link Services

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Prepared by SC-206
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FOREWORD

This report was prepared by RTCA Special Committee 206 (SC-206) and approved by the RTCA Program Management Committee (PMC) on March 18, 2014.

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- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- 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
- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

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EXECUTIVE SUMMARY

The availability of highly reliable, high-throughput, and low-cost wireless aircraft connectivity is growing rapidly. On the other hand, ground-based technologies and systems have far outstripped airborne capabilities in both speed and shear breadth of available functionality. Certification and approval techniques for airborne systems and capabilities have remained reactionary to the demand rather than leading the way. In some instances, standards and guidance have been created and/or updated, but overall have not evolved appreciably with the breakneck pace of digital data exchange technology.

These Aeronautical Information Services (AIS) and Meteorological (MET) Services Architecture Delivery Recommendations provide industry supported recommendations that will enable greater flexibility for the review and operational approval of systems delivering AIS and MET data services to aircraft cockpits. The delivery recommendations are built upon those applications and uses described in RTCA DO-340, *Concept of Use (ConUse) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services* and RTCA DO-339, *Aircraft Derived Meteorological Data via Data Link for Wake Vortex, Air Traffic Management and Weather Applications Operational Services and Environmental Definition (OSED)*. While these two documents provided the basis for the development of this document, other considerations were included in the development of the recommendations contained herein.

Several of the subjects discussed within this document are considered out of scope to the delivery of AIS and MET data link services to cockpits and aircraft in general; however, this document was developed with the purpose of holistically analyzing all of the issues that could enable or hinder AIS and MET data link services. The analysis revealed four main areas of concern:

- architectural ambiguity;
- information quality;
- cyber security; and
- lack of data link media suitability determination standardization.

This document, while describing these areas of concern and proposing recommended paths to solutions, does not specify the precise manner in which solutions must be defined. The specifics necessary to address these recommendations, in many cases, lie with future efforts. The analysis led to the creation of a set of recommendations detailed in Section 1.7. The recommendations were limited to assessed obstacles to achieving data link services. Further explanation as to the analysis and assessment that allowed the derivation of each recommendation is contained within the relevant sections.

Architecture:

RTCA DO-340 described a clarification of how to think of data link services. That document defined Category 1 and Category 2 data link services. This was an important first step in moving away from earlier concepts of how to differentiate data link services. What it did not provide was the means to apply these new definitions.

- What does it mean practically for a data link service to be classified as Category 1 versus Category 2?
- Is there a difference between a behavior and a required communication performance parameter?
- What functions need to be accomplished for which service?

This document describes a framework that answers the above questions and more. A holistic functional architecture, outlined in Section 3, attempts to capture identified needs. This architecture again does not provide a minimum requirement for all data link systems, but it does provide a structure from which functional choices can be made by implementers, regulators, and standards groups. Included in the architectural discussion are recommendations to achieve flexible development by implementers of data link services. The flexible approach outlined is a recommendation; and if applied correctly, it will allow the greatest amount of innovation, while still allowing for the appropriate amount of regulatory oversight to achieve safe operations.

Information Quality Assurance:

In order to achieve approval for operational use of data link services to aircraft for the purpose of supporting or satisfying the air traffic service function, the information delivered through those services must have some level of assurance as to its quality. The industry and regulatory agencies currently face two challenges to realizing this assurance.

On the one hand, the information delivered to aircraft is largely dependent upon the quality of the information as generated by the source prior to incorporation into the data link service. While various data quality standards exist, there is not a mandated minimum requirement that data producers must abide by for the full breadth of information that is to be dynamically data linked to aircraft in the next generation of aviation.

On the other hand, standards exist to assure the quality of aeronautical data as it moves along the data chain. These standards, while potentially adaptable for information made more contextually rich delivered via data link, their efficiency for information managed on a working and free flowing basis requires further investigations. A standardized process necessary to achieve either certification or operational approval of the developing high bandwidth data link delivery systems does not currently exist. This creates a situation where the industry has developed or is developing capabilities that can assist in the realization of the RTCA DO-340 described uses, but they languish in complex and ambiguous approval processes that are unique to each effort.

Section 4 describes the situation as it relates to information quality assurance and provides specific and timely recommendations. Without clear regulatory oversight and rigorous attention to achieving quality information origination as well as delivery assurance, Category 1 delivery services as well as the uses that they intend to support will not be achievable in the near term.

Security:

The operational use of AIS and MET data link services introduces concerns related to cyber security threats and vulnerabilities. These security concerns are system-wide, which may impact the overall data link service, including aircraft systems. These concerns need to be addressed through both the aircraft system certification process and the aircraft operational approval process. Central to resolving issues surrounding data, data exchange, and data link security is that it be viewed on an end-to-end basis.

While there are several efforts underway to define systems and data security as it relates to aircraft systems and data link technologies, there continues to be a demand for an overarching security architecture set, which may satisfy the needs for safe operations of aircraft well into the future.

Allocation of Use to Data Link:

Underlying all of the above subjects lays the means to provide, via data link, the data that is the foundation of any data link service. The determination of which data link(s) is suitable to provide services for a given use(s) continues to focus frequently on incumbent safety service defined data links instead of broadening the field to other links for consideration. In turn, this causes delays in implementation, unrealized safety, cost, and user benefits and lastly a reduction in vendor competiveness and opportunity.

To begin to address these shortcomings, Section 6 describes and outlines a repeatable process for determining suitable delivery methods for current and future AIS and MET applications, uses, and data link technologies. This recommended and flexible approach provides a structure by which multiple disparate data link technologies may be comparatively analyzed as potential candidates to provide the specified level of service.

The analyses resulting from this process will inform FAA and industry decisions regarding acceptable delivery methods and the relevant architecture given limited spectrum for specific uses and services today. By standardizing the determination of data links' suitability, the recommended process is expected to have the following benefits: future implementation of services will be shortened, safety will be improved, costs will be reduced, and competition will increase.

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1 INTRODUCTION

This Aeronautical Information Services (AIS) and Meteorological (MET) Services Delivery Architecture Recommendations document was developed by RTCA Special Committee (SC-206). The document contains an initial set of industry supported delivery method recommendations for those applications and uses described in RTCA document DO-340, *Concept of Use (ConUse) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services*. A further service defined in RTCA DO-339, *Aircraft Derived Meteorological Data via Data Link for Wake Vortex, Air Traffic Management and Weather Applications Operational Services and Environmental Definition (OSED)* is included in the recommendations. These recommendations cover architectural, information sourcing, security, and allocation processes. The analyses resulting from this process will support the Federal Aviation Administration (FAA) and industry decisions regarding acceptable delivery methods and the relevant architecture given limited spectrum for specific uses and services.

This document has been developed to support the data communications needs of future Air Traffic Management (ATM) concepts (e.g., Next Generation Air Transportation System (NextGen) and potentially provides input for future efforts by the Single European Sky Air Traffic Management Research (SESAR) initiatives). A key objective of these future ATM concepts is to establish the aircraft as a primary participant in collaborative decision making (CDM), and in some cases, establish airspace regions for autonomous operations where the aircraft is primarily responsible for safe separation from other traffic, wake turbulence, weather, and designated/restricted airspace. Timely availability of high quality and reliable electronic AIS and MET information services are necessary to support these global ATM concepts.

1.1 Purpose

This document is to be used by multiple audiences for several purposes: approval authorities and non-regulators. Approval authority entities are the civil or military authorities that authorize the use and/or installation of Data Link Services as defined by RTCA DO-308/European Organisation for Civil Aviation Equipment (EUROCAE) European Document ED-151. The approval authority entity in the United States (U.S.) is the FAA, more specifically the Aviation Safety Services organization within the FAA, which includes Flight Standards Services and Aircraft Certification Services. This document is expected to be used as a decision support document for policy decisions and recommended guidance to FAA for approving AIS and MET data link architectures and systems.

Additionally, this document is being constructed with further standards work in mind. Similar efforts to define, refine, and constrain data delivery to airborne vehicles could

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take the recommendations contained herein into consideration for the development of their architectures. These efforts could include those efforts in other RTCA committees, Aeronautical Radio Incorporated's (ARINC) Airlines Electronic Engineering Committee, such as the Systems Architecture and Interfaces Subcommittee and Air Ground Information Exchange (AGIE) Subcommittee, as well as the burgeoning Information Technology (IT) standards being matured within an industry historically not associated with aviation. For example, the Open Geospatial Consortium (OGC) has been doing extensive work in defining geo-located IT standards that could potentially be used in aviation and is being leveraged by electronic flight bag (EFB) application developers.

Non-regulators, such as original equipment manufacturers (OEM), end users, data providers, and data link providers may use this document to help define an implementable architecture. In other words, non-regulators will have a set of "uses" that they may want to enable with their data link service. From those "uses," non-regulators may use this document to define their desired functions (see Section 2) as well as to use the defined process (see Section 6) to determine if a new technology or new combination of technologies is appropriate for their "uses."

1.2 Background

A key component of NextGen and SESAR ATM concepts, that progresses towards realizing future CDM, is data sharing with all participants in the collaborative environment. The aim of AIS and MET data link services is to provide aeronautical and MET information for flight efficiency and/or hazard avoidance in all flight environments. This information provides a common operating picture between the aircraft and the ground. The intention is to meet operational and regulatory requirements for flight crew decision support (i.e., enabling informed flight crew participation in CDM) and other actors on the ground.

The traditional product-centric provision of aeronautical and MET information is being replaced by contextualized data-centric services delivered via service oriented architecture (SOA) systems through concepts that are being implemented globally, such as System Wide Information Management (SWIM). Providing timely (and continuous) updates of data-centric information will facilitate the creation of a common picture of the airspace situation for all involved in the planning and execution of flights (e.g., pilots, controllers, dispatchers, etc.). It is expected there will be an increased need for information on the flight deck that can be integrated into flight decision support tools (DSTs) and/or visualized on displays, such as the navigation displays or EFBs.

One of the biggest changes in the future ATM concepts will be the increased use of information technology, with increased emphasis on the form of data that will drive all processes for the management of information. To support this evolution in information

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management, International Civil Aviation Organization (ICAO) is transitioning AIS to a global Aeronautical Information Management (AIM) concept. Through AIM, all AIS elements will be managed to ensure that timely, interoperable, quality-assured, and secure information is provided and exchanged on a worldwide basis. The ultimate goal of global AIM is to provide access to on-line, real-time, quality information to any aviation user, anytime, anywhere. It is envisioned that both forward-fit and retrofit systems will provide for the transmission and display of AIS and MET information to flight crews.

According to the operational services described in RTCA DO-339 and the concepts of use described in RTCA DO-340, in order to ensure data link services are operationally viable and requirements are met, information must be collected and carefully pre-processed. In this instance, information is then transmitted to the aircraft via data link, where it is received, stored, and processed by onboard information management systems. Depending on its operational use, information can be retrieved and displayed graphically to the flight crew, or made available via other appropriate onboard visual and/or aural system interfaces. Certain information can also be auto-loaded into various onboard systems, including the Flight Management Function (FMF), prior to or after departure. Data-linked information is intended to support operational decision making by the flight crew and provides a means to facilitate consistent information between ground and aircraft.

Presently, there is not a requirement in Title 14 of the Code of Federal Regulations (CFR) to have data link communications while operating in the National Airspace System (NAS). Operators that choose to use a data link system (in addition to voice communication system(s) when required) must obtain FAA design approval and a revision to their Title 14 CFR Parts 121, 125, 125M, or 135 operation specifications, Part 91 subpart K (Part 91K) management specifications, or part 91 letter of authorization (LOA), as applicable. For example, Advisory Circular (AC) 120-70B describes the process for obtaining operational authorization for data link communication systems, acceptable methods for training and maintenance, and operational policies for use. For more information on other guidelines and training, see AC 120-70B, AC 20-140A, AC 120-76B, AC 91.21-1B, AC 91-78, AC 20-177, and the reference documents listed within these ACs.

There is a well-defined concept of Required Communication Performance (RCP) that relates to the communications component of the Communication, Navigation, and Surveillance (CNS)/ATM framework, and complements Required Navigation Performance and Required Surveillance Performance. In general, the requirements for operation in a defined airspace, or performance of a defined procedure, include elements of CNS functionality and performance, as well as ATM functionality and performance. The guidance provided in AC 20-140A and AC 120-70B regarding RCP is consistent

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with ICAO Document 9869, *Manual on Required Communication Performance*. RCP is a statement of the performance requirements for operational communication in support of specific Air Traffic Services (ATS) functions. The RCP is determined by knowledgeable authorities in consideration of air traffic operations, target levels of safety, separation assurance, and functional hazard analysis associated with the airspace, operation, or procedure. Thus, the specific RCP value to be used is operationally derived and not based on any specific technology or combination of technologies that may be utilized for communications.

With the progressing work of enabling AI and MET data link services, the definitions used to describe those services are gradually being refined. This evolution is evident in the documents developed. In RTCA DO-308/EUROCAE ED-151 and RTCA DO-324/EUROCAE ED-175, the terms Normal Communications and Supplemental Communications were used to categorize different data link uses. However, the Normal and Supplemental terminology were found confusing and misleading when applied to AIS and MET data link services. Thus, new terminology was developed in RTCA DO-340. Category 1 is in part Normal Communications (exclusive use) information. Category 2 may replace what was termed as Supplemental Communications (enhanced situational awareness), but until specific requirements are vetted for these categories any operational replacement of the old terms with new should be done selectively and under careful review. This document will continue the evolution and will use the new terms as a replacement for the old. See Section 2.1.1 for more information.

RTCA DO-308/EUROCAE ED-151, *Operational Services and Environment Definition (OSED) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services* describes Broadcast, Demand, and Contract data link modes of operation for aircraft to receive AIS and MET information from approved ground data sources. RTCA DO-324/EUROCAE ED-175, *Safety and Performance Requirements (SPR) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services* leverages those modes and concepts defined in RTCA DO-308/EUROCAE ED-151. RTCA DO-324/ED-175 describes a framework of safety and performance requirements for Category 1 services in managed airspace, a far-term operational airspace environment. RTCA DO-267A, *Minimum Aviation System Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B) Data Link*, provides standards for timely access to data link updates of non-control information that is to be used for Category 2 strategic/planning purposes and not for crew alerting. The data link information supported by RTCA DO-267A is intended to enable pilots to determine if action should be taken well before it is required, and should be used in conjunction with other information sources to support in-flight decisions. The Data Link – Flight Information Service (D-FIS) under RTCA DO-267A is considered a good representation of what a Category 2 service may look like, augmenting information that is available

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through Air Traffic Control (ATC), flight service stations (FSSs), and/or airline dispatch. This is in contrast to the RTCA DO-308/EUROCAE ED-151 and RTCA DO-324/EUROCAE ED-175 AIS and MET services, which support Category 1 means for cockpit receipt. Currently, there is no architectural guidance on how to develop Category 1 AIS and MET data delivery systems.

Inthe highly automated NextGen environment, improved data link services are critical to achieving a common operating picture between the ground and air. Therefore, data link independent performance and human factors standards are needed that support interoperability at the application level, and provide consistent identification and description of hazards between the ground and air and across data delivery mechanisms. In addition, guidance is necessary to avoid hazardously misleading display of information provided by data link systems.

1.3 Scope

The scope of this document addresses top-level functions necessary for the delivery of AIS and MET data link services, as depicted in Figure 1-1. The functions are described in RTCA DO-308/EUROCAE ED-151, RTCA DO-324/EUROCAE ED-175, RTCA DO-339, and RTCA DO-340; however, they are further decomposed and described in Section 3.3.2 of this document.

Note 1: *The terms Onboard Data Link Processing Function (ODLPF) and Ground Data Link Processing Function (GDLPF) represent an evolution that began in RTCA DO-308/EUROCAE ED-151 as aircraft data systems and ground-based data systems respectively ending in the terms used in the figure below in RTCA DO-340.*

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