RTCA, Inc.
1150 18th Street NW, Suite 910
Washington, DC 20036
USA

Concept of Use (CONUSE) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services

RTCA DO-340
September 26, 2012

Prepared by SC-206

FOREWORD

This report was prepared by Special Committee 206 (SC-206) and approved by the RTCA Program Management Committee on September 26, 2012.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal advisory committee, and develops consensus-based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;

- 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.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders and several advisory circulars.

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U.S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

The value and need for flight crew and cockpit access to timely updates of Aeronautical Information Services (AIS) and Meteorological (MET) information are well known, and established in current International Civil Aviation Organization (ICAO) air traffic procedures. The technologies for providing such updates, however, are rapidly moving from voice to data communications. This transition to data communications is a key component of the ICAO global Air Traffic Management (ATM) concepts and the supporting ICAO, U.S. Next Generation Air Transportation System (NextGen), and European Single European Sky ATM Research (SESAR) programs. In addition, new requirements for AIS and MET services are being generated based on these ICAO, NextGen, and SESAR initiatives.

An early assessment of the operational uses and benefits of AIS and MET data link services was documented in RTCA DO-232 (*Operational Concepts for Data Link Applications of Flight Information Services*). More recently, the joint RTCA DO-308/EUROCAE ED-151 (*Operational Services and Environment Definition for Aeronautical Information Services and Meteorological Data Link Services*) defined specific AIS and MET data link services. RTCA DO-324/EUROCAE ED-175 (*Safety and Performance Requirements (SPR) for AIS and MET Data Link Services*) was then published based on a notional architecture. It provides a framework and methodology for assessing implementation of candidate architectures; it is not intended for implementation and operational use until validation activities are completed.

This Concept of Use (ConUse) builds on the past work and provides an aviation industry view on how such AIS and MET data link services would be used to support flight operations. In this ConUse (Section 1.3), the data link services are considered as either the primary (Category 1) or useful (Category 2) means for communicating AIS and MET information, and voice becomes a secondary means for such communications. The operating environment and governing rules will determine when use of such AIS and MET data link services are appropriate. Also, implementation of such services will be evolutionary beginning with expected widespread use of useful (Category 2) AIS and MET data link services.

Note: In the SPR (Ref m), Category 1 was described, in part, as Normal Communications and Category 2 was termed Supplemental Communications. The Normal and Supplemental terminology were confusing and misleading when applied to AIS and MET data link services.

This document identifies the stakeholders, the operational needs, the justification for AIS and MET data link services, and the needed change processes. Operational scenarios and use cases (Appendix B) are also included along with examples of AIS and MET information that could be delivered by these services (Appendix C).

The AIS and MET data link services will be used to support tactical/near-term as well as strategic/planning decisions in multiple operating environments. In addition, there are multiple applications, both ground and airborne, that can benefit from the data link transmission of aircraft derived meteorological information.

In addition to the communications link, a Ground Data Link Processing Function (GDLPF), an Onboard Data Link Processing Function (ODLPF), and interfaces with installed aircraft systems or portable devices will be needed to support these AIS and MET data link services. There are existing data link systems that should be able to meet the requirements for providing such services at some level.

Certification (and operational approval) authorities will need a detailed statement of the intended function(s) and operational use(s) for such future AIS and MET data link services for use in evaluating whetherservices for use in evaluating whether the applicant's overall system is appropriate for those intended function(s) and the associated flight crew tasks. The operational concept and the use cases in Appendix B identify a set of envisioned high-level functional capabilities as listed below.

These functional capabilities should be considered for follow-on architectural recommendations, Minimum Aviation System Performance Standards (MASPS), and Minimum Operational Performance Standards (MOPS).

- Allow for multiple service providers to concurrently provide aeronautical information services and meteorological services to aircraft, through combinations of all modes of data link communications (broadcast, demand, and contract transmissions).
- Provide a means for a GDLPF to support multiple communications links.
- Provide a means for an ODLPF to support multiple communications links.
- Allow for the functionality of the ODLPF to be distributed and, in some cases, be housed virtually as software on portable devices.
- Provide a means for an ODLPF to provide information to multiple clients on the aircraft (e.g., Flight Management Function, displays, etc.) with operator-defined priority.
- Provide a means for an ODLPF or GDLPF to select from multiple communications links for weather downlink or crosslink applications with operator-defined priority.
- Support use of AIS and MET data link services for preflight planning.

From an industry and regulatory viewpoint, the timing of this effort is opportune, as high regional adoption, certification, and operational approval of AIS and MET services has taken place over the last decade in the United States (e.g., satellite-broadcast weather and Notices to Airmen (NOTAM)). More recently, air transport has begun to provide the means for flight crews to access AIS and MET data link services with the issuance of tablet computers for use on the flight deck. Along with aircraft cabin broadband and onboard local area connection (LAN) connectivity the use of these tablets, or other portable wireless devices, to gain access to AIS and MET information for flight crew use is a logical development. RTCA Special Committee 206 recognizes that there will be significant experience gained in this process that will help drive future needs and progression toward data link becoming the primary (Category 1) means for disseminating AIS and MET information.

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Background 1
1.2 Purpose 1
1.3 AIS and MET Data Link Services Delivery 1
1.4 Document Overview 3
1.5 Services Overview 4
1.5.1 Data Link Service Descriptions 4
1.5.1.1 AIS Data Link Services 4
1.5.1.2 MET Data Link Services 5
1.5.2 Data Link Modes 6
1.5.3 Candidate AIS, MET, and ATM Information 6
1.6 Security Considerations 6
1.7 References 7

2 STAKEHOLDER IDENTIFICATION 11

2.1 Aircraft and UAS Manufacturers/Integrators 13
2.2 Avionics/Sensor and Computer Vendors 13
2.3 Data Link Service Providers 13
2.4 Approved Data Originator 14
2.5 Approved Information Source 14
2.6 Air Navigation Service Providers 14
2.7 AIS/MET Service Provider/Intermediary 15
2.8 Flight Operations Center/Airline Operations Center 15
2.9 Flight (Support) Services 15
2.10 Onboard End Users 15
2.11 Ground End Users 16
2.12 Aviation Regulators 16
2.13 Airline Management 17
2.14 Atmospheric Science Community 17
2.15 Standards Committees 17
2.16 General Public 17
2.17 Operators 17

3 OPERATIONAL NEED AND PROPOSED SERVICES 19

3.1 Overview 20
3.2 Operational Objectives and Scope 21
3.3 Existing Operations Requiring Changes 22
3.4 Proposed AIS and MET Data Link Services 23
3.4.1 AIS Services 23
3.4.1.1 Data Link Aeronautical Update Service (AUS) 24
3.4.1.2 Effective Time(s) of AUS Information 25
3.4.2 MET Services 26
3.4.2.1 Data Link Weather Planning Decision Service (WPDS) 26
3.4.2.2 Data Link Weather Near-Term Decision Service (WNDS) 27
3.4.2.3 Data Link Weather Immediate Decision Service (WIDS) 28
3.4.2.4 Effective Time(s) and Latency of MET Data Link Services 28
3.4.3 Aircraft Downlink and Crosslink of Meteorological Data 29
3.4.4 AIS and MET Data Link Service Examples 30

4 SERVICES JUSTIFICATION 31

4.1 Potential Benefit of Proposed Services 32

4.1.1 AIS Uplink Services 34
4.1.2 MET Uplink Services 35
4.1.3 MET Downlink Services 35
4.1.4 MET Crosslink Services 36
4.2 MASPS/MOPS Follow-on Approach 36
4.2.1 Preflight 37
4.2.2 Surface – Departure 37
4.2.3 Terminal Maneuvering Area (TMA) – Departure 37
4.2.4 En Route (Domestic, Oceanic, Remote, and Polar Operations) 38
4.2.5 Terminal Maneuvering Area (TMA) – Arrival 38
4.2.6 Surface – Arrival 39
4.3 Roadmap 39
4.3.1 Uplinked AIS 39
4.3.2 Global AIS Usability 40
4.3.3 Understanding of Usage of Uplinked AIS and MET Data Link Products 40
4.3.4 Advanced Global MET Data Link Products and Services 41
4.3.5 Downlinked MET 42
4.3.6 Crosslinked MET 42

5 OPERATIONAL CONCEPT 43

5.1 Airspace Domains and Operating Environment 43
5.2 Assumptions and Constraints 45
5.3 Operational Roles and Procedures 46
5.3.1 Roles Description 46
5.3.2 Safety and "Fall Back" Procedures 48
5.3.3 ATC Procedures and Communications 48
5.4 Day-in-the-Life Scenarios 49
5.4.1 Overview 50
5.4.2 High-End Aircraft Equipage with Dispatcher Support 50
5.4.3 High-End GA Aircraft Equipage without Dispatcher Support 53
5.4.4 Medium Aircraft Equipage Level 54
5.4.5 Minimum Aircraft Equipage – Recreational GA Aircraft Equipage, VFR Flight at Low Altitude 56
5.4.6 Unmanned Aircraft Systems (UAS) Scenario 57
5.5 Operational and System Recommendations 59
5.5.1 General Recommendations 59
5.5.2 Specialized Recommendations – Air Carrier 60
5.5.3 Specialized Recommendations – General Aviation 61
5.5.4 Systems Recommendations Summary 62

6 CHANGE PROCESSES NEEDED 65

6.1 Operations and Equipage 65
6.1.1 Flight Deck Workload 65
6.1.2 Training of Flight Crews and Single Pilot Operations 65
6.1.3 Evolution from Current Technologies/Legacy Systems 65
6.1.4 Rapid Evolution of Software and Avionics Technologies 66
6.1.5 Flight Deck Alerting 66
6.1.6 Source Data and Processing Considerations 67
6.1.7 Flight Deck – AOC – ATC – FSS – Communications/Collaboration 67
6.1.8 Supporting Ground Infrastructure Requirements 67
6.2 Standards and Policies Required 68
6.3 Cultural Changes Required 69
6.3.1 Reduced Reliance on Voice Communications 69

6.3.2 Maturity and User Interest in Air-Ground Data Link Connectivity 69
6.3.2.1 Collaborative Decision Making 70
6.3.3 Master Data Management and Approved Source 70
6.4 Personnel Skill Changes Required 70
6.5 Other Considerations 70
6.5.1 Relationship to NextGen/SESAR Joint Undertaking (JU) 70
6.5.2 Need for ICAO Harmonization 71
6.5.3 ICAO/WMO Coordination 71
6.5.4 Opportunities for WMO Harmonization 72
6.5.4.1 WMO Commission for Basic Systems (CBS) 72
6.5.4.2 Commission for Aeronautical Meteorology (CAeM) 72
6.5.5 Other Industry Coordination 73

APPENDIX A. DEFINITION OF TERMS A-1

APPENDIX B. USE CASE DESCRIPTIONS B-1

B.1 General Use Case Descriptions B-1
B.1.1 Wind Field Data to Flight Management Function (FMF) B-1
B.1.1.1 Description B-1
B.1.1.2 Sequence Diagram B-1
B.1.2 Weather Information Provided to Portable and Installed Displays B-2
B.1.2.1 Description B-2
B.1.2.2 Sequence Diagram B-3
B.1.3 Aviation Weather (Mountain Pass) Cameras (Broadcast) B-4
B.1.3.1 Description B-4
B.1.3.2 Sequence Diagram B-5
B.1.4 Hazardous Meteorological Events during Critical Phases of Flight (WIDS) (Contract) .. B-5
B.1.4.1 Description B-5
B.1.4.2 Sequence Diagram B-6
B.1.5 Runway Threshold Winds (Broadcast) B-6
B.1.5.1 Description B-6
B.1.5.2 Sequence Diagram B-7
B.1.6 Runway Status Change to Flight Deck Display (AUS) (Contract) B-8
B.1.6.1 Description B-8
B.1.6.2 Sequence Diagram B-8
B.1.7 Arrival D-ATIS to Flight Deck Display (AUS) (Demand) B-8
B.1.7.1 Description B-8
B.1.7.2 Sequence Diagram B-9
B.1.8 Obstacle Information Update to Flight Deck Display (AUS) (Contract) B-9
B.1.8.1 Description B-9
B.1.8.2 Sequence Diagram B-10
B.1.9 Temporary Obstacle Notice to Flight Deck Display (AUS) (Broadcast) B-10
B.1.9.1 Description B-10
B.1.9.2 Sequence Diagram B-11
B.1.10 Airport Mapping Data Base (AMDB) Update to Flight Deck Display (AUS) (Contract) B-11
B.1.10.1 Description B-11
B.1.10.2 Sequence Diagram B-12
B.1.11 Special Activity Airspace (SAA), Aerodrome, and other Operationally Significant NOTAMs (AUS) (Contract) B-12
B.1.11.1 Description B-12
B.1.11.1.1 Special Activity Airspace NOTAMs B-12
B.1.11.1.2 Aerodrome NOTAMs B-13
B.1.11.1.3 Aerodrome NOTAM Data Link B-13

B.1.11.1.4 Digital ATIS B-13
B.1.11.1.5 Other Operationally Significant NOTAMs B-13
B.1.11.2 Sequence Diagram B-14
B.1.12 Automated Aircraft Observations and Reports (PIREPs/AUTOMETs) B-14
B.1.12.1 Descriptions B-15
B.1.12.1.1 Automated Routine Air Reports (AR) to Service Provider(s) B-15
B.1.12.1.2 On Demand Air Reports (AR) to Service Provider(s) B-15
B.1.12.1.3 Special Air Reports (SAR) to Aircraft in the Vicinity and/or to Service Provider(s) 15
B.1.12.2 Sequence Diagrams B-16
B.1.13 Life-Cycle of AUTOMET Turbulence Downlink, Processing, and Uplink B-18
B.1.13.1 Description B-18
B.1.13.2 Sequence Diagram B-18
B.1.14 Runway Braking Action Reports B-19
B.1.14.1 Description B-19
B.1.14.2 Sequence Diagram B-20
B.1.15 Downlink of Ice Observations to Service Provider(s) or ATM System (Triggered) B-21
B.1.15.1 Description B-21
B.1.15.2 Sequence Diagram B-21
B.1.16 Controller-Alerted Weather Advisories B-22
B.1.16.1 Description B-22
B.1.16.2 Sequence Diagram B-23
B.1.17 AIS Database Update to Flight Deck Display (BSS) (Contract) B-24
B.1.17.1 Description B-24
B.1.17.2 Sequence Diagram B-24
B.1.18 Aeronautical Information Corrections Using AOC (Contract) B-25
B.1.18.1 Description B-25
B.1.18.2 Sequence Diagram B-26
B.1.19 Interactive AIS and MET Briefings during Preflight and Airport/Aerodrome Surface Operations B-26
B.1.19.1 Description B-26
B.1.19.1.1 Preflight Briefing (Flight Crew Not Onboard Aircraft) B-26
B.1.19.1.2 Updated Briefing (Flight Crew Onboard Aircraft) B-27
B.1.19.1.3 Summary B-27
B.1.19.2 Sequence Diagram B-28
B.2 Time-Critical, Prioritized Use Cases B-29
B.2.1 En Route CONUS Hazardous Weather Route Deviation B-30
B.2.1.1 Description B-30
B.2.1.2 Sequence Diagram B-32
B.2.1.3 Preliminary Bandwidth Assessment B-33
B.2.2 Terminal Airspace Operations (Hazard Avoidance) (Contract) B-33
B.2.2.1 Description B-33
B.2.2.2 Sequence Diagram B-34
B.2.2.3 Sample Bandwidth Analysis B-35
B.3 ACTORS B-36
B.4 DATA FLOW B-38
APPENDIX C. AIS, MET, AND ATM TABLES C-1
APPENDIX D. MEMBERSHIP D-1

TABLE OF FIGURES

Figure 3-1 AIS and MET services physical architecture (notional) 21
Figure 3-2 AIS and MET services functional architecture 22
Figure 3-3 CDM is a key enabler for better operational efficiency 23
Figure 3-4 Effective periods of AUS information 26
Figure 3-5 Weather latency factors and effective time periods 29
Figure 4-1 Sharing of AIS and MET information is central to future collaboration in both the NextGen and SESAR concepts 31
Figure 4-2 Key elements of data link services, and potential benefits realized when made available as a complete system 34
Figure 5-1 Domains of flight as used in this ConUse [adapted from Ref y] 43
Figure B-1 Sequence diagram of wind field to FMF (contract) B-2
Figure B-2 Sequence diagram of weather information provided to PaIDs (contract) B-3
Figure B-3 Sequence diagram of weather information provided to PaIDs (demand) B-4
Figure B-4 Sequence diagram for aviation weather cams (mountain pass and aerodrome status/condition) to a flight deck display (broadcast) B-5
Figure B-5 Sequence diagram of hazardous meteorological event, WIDS (HzWxEvent) (contract) B-6
Figure B-6 Sequence diagram for runway threshold winds (broadcast) B-7
Figure B-7 Sequence diagram for runway status change to flight deck display (contract) B-8
Figure B-8 Sequence diagram for D-ATIS to flight deck display (demand) B-9
Figure B-9 Sequence diagram for obstacle database update to flight deck display (contract) B-10
Figure B-10 Sequence diagram for temporary obstacle notice to flight deck display (broadcast) B-11
Figure B-11 Sequence diagram for AMDB update to flight deck display (contract) B-12
Figure B-12 Sequence diagram for Special Activity Airspace (SAA), Aerodrome, and other operationally significant NOTAMs (contract) B-14
Figure B-13 Sequence diagram for Air Reports (AR) (routine) to service provider B-16
Figure B-14 Sequence diagram for Air Reports (AR) to service provider (demand) B-17
Figure B-15 Sequence diagram for Special Air Reports (SAR) to service provider B-17
Figure B-16 Sequence diagram for update SIGMET to aircraft avionics B-18
Figure B-17 Sequence diagram of AUTOMET (triggers and periodic) with uplink turbulence products from shared reporting by aircraft B-19
Figure B-18 Sequence diagram of braking action and contract delivery (contract) B-20
Figure B-19 Sequence diagram for Significant Weather Icing Alert (trigger) B-22
Figure B-20 Flow of events leading to an “AIRWOLF” notification B-22
Figure B-21 Prototype AIRWOLF advisory display concept (R-side controller display is shown here) B-23
Figure B-22 Sequence diagram for controller-alerted weather advisories B-24
Figure B-23 Sequence diagram for BSS services to flight deck display (contract) B-25
Figure B-24 Sequence diagram for information corrections using AUS (contract) B-26
Figure B-25 Sequence diagram for interactive AIS and MET briefings during preflight and airport/aerodrome surface operations (contract and demand) B-28
Figure B-26 High priority scenarios identified for NextGen reprioritization [Ref mm] B-29
Figure B-27 Initial flight plan from KIAD to KORD, with an unforecast SIGMET requiring diversion from the original filed flight plan (Note: times are shown in minutes after takeoff (off time)). B-31
Figure B-28 Sequence diagram showing the necessary actors and information flow of this service for a route deviation due to hazardous weather B-32
Figure B-29 Bandwidth assessment estimates showing necessary data link sizes and time sequence (Note: times are shown in minutes after takeoff) B-33
Figure B-30 Initial flight plan to New York Kennedy International Airport (KJFK) (Note: times are shown in minutes after takeoff (off time)) B-34
Figure B-31 Sequence diagram for terminal airspace operations (hazard avoidance, contract) B-35
Figure B-32 Bandwidth assessment for B-777-200 LR series aircraft arriving at New York Kennedy International Airport (KJFK), depicting necessary data link size estimates B-36

TABLE OF TABLES

Table 1-1 AIS-MET service overview 5
Table 2-1 Stakeholder examples 11
Table 4-1 Preflight services 37
Table 4-2 Surface departure services 37
Table 4-3 TMA departure services 37
Table 4-4 En route services 38
Table 4-5 TMA arrival services 38
Table 4-6 Surface arrival services 39
Table 5-1 NextGen/SESAR Functional Capabilities Roadmap (2012) 44
Table A-1 Definitions A-1
Table A-2 Acronyms and Abbreviations A-4
Table B-1 Actors B-36
Table B-2 Data flow terms B-38
Table C-1 AIS, MET, and ATM information categories C-1
Table C-2 MET products C-3
Table C-3 AIS products C-6
Table C-4 ATM Products C-9
Table D-1 Membership D-1

1 INTRODUCTION

1.1 Background

Throughout the history of aviation, it has been a challenge to communicate with the flight crew onboard aircraft. Hand signals and light signals were used initially, and capabilities expanded tremendously with the advent of Very High Frequency (VHF)/High Frequency (HF) radio communication.

Today, affordable high-bandwidth data link communications are available nearly globally, and there is considerable bandwidth available everywhere of high quality. Based on this technology, a set of data link services has evolved to the point that reliable communication with aircraft is possible regardless of location, phase of flight, or what information is required. Data link services can provide high-quality, time-critical, and flight-critical information.

To ensure data link services are operationally viable, and stringent quality requirements are met, information must be collected and carefully pre-processed. 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.

1.2 Purpose

This Concept of Use (ConUse) document describes system concepts and user applications for using data link for communicating aeronautical information service (AIS) and meteorological (MET) information to and from aircraft. Data link communications are a key performance-based capability in the future Next Generation Air Transportation System (NextGen) and Single European Sky Air Traffic Management (ATM) Research (SESAR) concepts.

Both NextGen and SESAR require new digital information services that enable improved data-driven decision support tools on the flight deck and in general aviation cockpits, as well as in ground-based ATM systems and dispatch functions, such as Flight Operations Centers (FOC). The future ATM concepts also make use of the aircraft as a platform to provide valuable automatic collection and reporting of aircraft-derived information. This ConUse addresses communication of such information to proximate aircraft (i.e., crosslink) and to ground users (i.e., downlink).

Note: Today, there are existing commercial and government data link systems that are used for communicating AIS and MET information. Most of those data link systems may only be used for strategic decision support; they are not intended to be used for tactical decision support. An example of such a system is the Federal Aviation Administration's (FAA) Flight Information Services – Broadcast (FIS-B) system.

1.3 AIS and MET Data Link Services Delivery

AIS and MET data link services support Flight Information Services (FIS), a component of Air Traffic Services (ATS) as defined in International Civil Aviation Organization (ICAO) *Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM)*