



AEROSPACE RECOMMENDED PRACTICE

ARP6823™

Issued

2021-03

Electronic Transactions for Aerospace Systems: An Overview

RATIONALE

Digitalization is impacting every system on an aircraft, and this process will continue to play an even more important role in the aerospace world in the coming years. Digital systems are widespread, constantly evolving, and their use in many applications within the aviation sector are yet to be standardized. The G-31 (Electronic Transactions for Aerospace) Committee has been established to develop guidelines and standards that will help the industry use digital data technology in a rational, consistent, secure, and safe manner. This "cornerstone" document outlines the activities of the G-31 Technical Committee with the objective of aligning them with where the industry is headed with all this new technology. This ARP addresses concepts such as data interoperability, connectivity, security, traceability, and transparency in the aerospace context; and in the process delineates how new technologies, such as blockchain, can be useful in solving some key technical problems.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose.....	3
2.	APPLICABLE DOCUMENTS.....	3
2.1	SAE Publications.....	3
2.2	FAA Publications.....	3
2.3	RTCA Publications.....	3
2.4	Airlines for America (A4A) Publications.....	4
2.5	IEEE Publications.....	4
2.6	IATA Publications.....	4
2.7	NIST Publications.....	4
2.8	Additional Publications.....	4
3.	ABBREVIATIONS.....	5
4.	INTRODUCTION.....	7
5.	AEROSPACE ECOSYSTEM.....	8
6.	LIFECYCLE STAGES AND THEIR IMPLICATIONS FOR DATA PROCESSES.....	8
6.1	Product Design and System Integration.....	9
6.1.1	Collaborations in Designs.....	9
6.1.2	Computer-Aided Tools.....	10
6.1.3	Model-Based Design Considerations.....	10
6.2	Build, Deliver, and Transfer.....	11
6.2.1	Certifying Production Capability.....	12
6.2.2	Testing and Product Certification.....	12
6.2.3	Authorized Release of Aircraft Parts.....	13
6.3	Operations.....	13

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2021 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE ARP6823

For more information on this standard, visit
<https://www.sae.org/standards/content/ARP6823>

Documents

Document Sharing Hub

6.3.1	Maintenance, Repair, and Overhaul	14
6.3.2	Logistics and Parts Tracking	15
6.3.3	Electronic Flight Bags	15
6.4	Modification and Redesign	16
6.5	Investigations	16
6.6	Disposal	16
7.	DIGITAL TECHNOLOGIES RELATED TO ALL PHASES OF THE LIFECYCLE	16
7.1	Digital Twin	16
7.2	Digital Thread	17
7.3	Artificial Intelligence (AI) and Machine Learning (ML)	17
7.4	Augmented Reality (AR) and Virtual Reality (VR)	18
7.5	Communications	18
7.5.1	Satellite Communications	18
7.5.2	Wi-Fi and Cellular Communications	18
7.6	Blockchain	19
7.6.1	Certification Process and Maintaining Type Certification (TC) Records	20
7.6.2	Supply Chain Traceability/Parts Provenance:	20
7.6.3	Technical Documents Version Control	20
7.6.4	Loadable Software Aircraft Parts Version Control	20
7.6.5	Vehicle Maintenance – As-Maintained BOM	20
7.6.6	Incident Investigation: Maintaining Regulatory Data Records	20
7.7	Cyber Security	21
8.	WORK OF OTHER ORGANIZATIONS IN THIS FIELD	21
9.	CONCLUSIONS	22
10.	NOTES	22
10.1	Revision Indicator	22
Figure 1	Aerospace ecosystem asset (product and data) flow	8
Figure 2	Schematic of manufacturing operations management (MOM)	12
Figure 3	Logical view of digital twin lifecycle	17
Figure 4	The core structure of the cyber security framework	22

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) offers an overview of the many key processes that are being transformed as the aerospace industry is rapidly digitalizing. The G-31 Electronic Transactions in Aerospace committee has been established to develop standards related to these processes. This report, also known as the “cornerstone” document for the committee, is a comprehensive look at processes associated with commercial aviation. Because of universal convergence of these technologies, the technologies described here are applicable to other domains as well.

1.1 Purpose

The purpose of this document is to provide an overview of the processes and the technologies associated with digitalizing key aerospace functions and processes.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR6904	Rationale, Considerations, and Framework for Data Interoperability for Health Management within the Aerospace Ecosystem
AIR7501	Aircraft Asset Lifecycle and Digital Data Standards Overview
ARP4754A	Guidelines for Development of Civil Aircraft and Systems
ARP6803	IVHM Concepts, Technology and Implementation Overview
AS5395	Health and Usage Monitoring System Data Interchange Specification
JA6268	Design & Run-Time Information Exchange for Health-Ready Components

2.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC120-78A	Advisory Circular: Electronic Signatures, Electronic Record Keeping and Electronic Manuals
AC29-2C (MG15)	Miscellaneous Guidance 15, Airworthiness Approval of Rotorcraft Health Usage Monitoring Systems (HUMS), in Advisory Circular: Certification of Normal Category Rotorcraft
Form 8130-3	Authorized Release Certificate, Airworthiness Approval Tag

2.3 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

DO-178C	Software Considerations in Airborne Systems and Equipment Certification
DO-331	Model-Based Development and Verification Supplement to DO-178C and DO-278A

DO-330 Software Tool Qualification Considerations

2.4 Airlines for America (A4A) Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

ATA e-Business Program, <http://www.ataebiz.org/Pages/standards.aspx> specifications and standards

Spec 2000 ATA Authorized Release Certificate (Ch. 16), Rev 20142019.1. Spec 2000 Chapter 16. 2014.

iSpec 2200 Information Standards for Aviation Maintenance, Revision 2018.1, A4A Publications, 2018

MSG-3 Operator/Manufacturer Scheduled Maintenance Development, Volume 1 – Fixed wing Aircraft, Product Code 18123, Revision 2018.1

MSG-3 Operator/Manufacturer Scheduled Maintenance Development, Volume 2 – Rotorcraft, Product Code 18123R, Revision 2018.1

ASD/AIA/A4A

S1000D International Specification for Technical Publications, Product Code 020713, Revision 4.1, S1000D-B6865-01000-00, Issue No. 5.0, 2019

2.5 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 802.1 is a working group of the IEEE 802 project of the IEEE Standards Association. WLAN computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.

2.6 IATA Publications

Available from International Air Transport Association, Publications Assistant, 800 Place Victoria, P.O. Box 113, Montreal, Quebec H4Z 1M1, Canada, Tel: 1-514-874-0202, www.iata.org.

Airlines' Business Requirements for Original Equipment Identification (RFID) and 2D Barcode Tagging for Aircraft Cabin Equipment, June 2018.

Aviation Identification & Authorization System, Whitepaper, August 2015.

Guidance Material for the implementation of Paperless Aircraft Operations in Technical Operations (PAO:TO), November 2017.

2.7 NIST Publications

Available from NIST, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, Tel: 301-975-6478, www.nist.gov.

Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, April 2018.

2.8 Additional Publications

Kraft, E. "The U.S. Air Force Digital Thread/Digital Twin – Life Cycle Integration and Use of Computational and Experimental Knowledge", 54th AIAA Aerospace Sciences Meeting, Jan 2016, San Diego, CA, USA.

Rencher, R., and Wang, G., Lifecycle of the Aircraft Digital Twin, 2017, Remote Engineering and Virtual Instrumentation 2017, Columbia University, New York

Rencher, R. Disintermediation of Commercial Aviation Industry Ecosystem, 2019, SAE International

Swan, M. "Blockchain Blueprint for a new economy," O'Reilly Media, 2015

Southwest Research Institute, "Numerical Propulsion System Simulation (NPSS) Consortium," <http://www.npssconsortium.org>. Retrieved Nov 2020.

Wolf, F. (May 2020), Electronic Flight Bag Applications Advance, Including Those with NASA's TASAR. Avionics International. <http://interactive.aviationtoday.com/avionicsmagazine/june-july-2020/electronic-flight-bag-applications-advance-including-those-with-nasas-tasar/>. Retrieved Nov 2020.

Lynch, J. (Sep 2017), The Worst Computer Bugs in History: The Ariane 5 Disaster," <https://www.bugsnag.com/blog/bug-day-ariane-5-disaster>. Retrieved Nov 2020.

3. ABBREVIATIONS

3PL	Third Party logistics
A&D	Aerospace and Defense
ACARS	Aircraft Communications Addressing and Reporting System
AFRA	Aircraft Fleet Recycle Association
AI	Artificial Intelligence
AIA	Aerospace Industries Association
AIR	Aerospace Information Report
ARC	Authorized Release Certificate
ARP	Aerospace Recommended Practice
A4A	Airlines for America
BOM	Bill of Material
CAA	Civil Aviation Authorities
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CFD	Computational Fluid Dynamics
COTS	Commercial off the Shelf
DLT	Distributed Ledger Technology
EA	Engine Alliance
EAM	Enterprise Asset Management
EASA	European Union Aviation Safety Agency
ERP	Enterprise Resource Planning

ETA	Electronic Transactions in Aerospace
FAA	Federal Aviation Administration
FEA	Finite Element Analysis
FMI	Functional Mockup Interface
GE	General Electric
GEO	Geostationary Earth Orbit
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
HCM	Human Capital Management
IAE	International Aero Engines
IATA	International Air Transport Association
IEEE	Institute of Electrical and Electronic Engineers
IGES	Initial Graphic Exchange Specification
IoT	Internet of Things
IP	Intellectual Property
IVHM	Integrated Vehicle Health Management
JSF	Joint Strike Fighter
KBE	Knowledge Based Engineering
OEM	Original Equipment Manufacturer
MBSE	Model Based Systems Engineering
MEL	Minimum Equipment List
MES	Manufacturing Execution System
MIS	Maintenance Information Systems
ML	Machine Learning
MOM	Manufacturing Operations Management
MPIG	Maintenance Programs Industry Group
MRB	Material Review Board
MRO	Maintenance Repair and Overhaul
MSP	Maintenance Service Provider.
M&E	Maintenance and Engineering

NASA	National Aeronautics and Space Administration
NIST	National Institutes of Standards and Technology
NM	Nautical Miles
NPSS	Numerical Propulsion System Simulation
PHM	Prognostics and Health Management
PLM	Product Lifecycle Management
PMA	Parts Manufacturer Approval
PW	Pratt & Whitney
RFID	Radio Frequency Identification
RR	Rolls Royce
SatCom	Satellite Communication
STC	Supplemental Type Certificate
STEP	Standards for the Exchange of Product
SWRI	Southwest Research Institute
TC	Type Certification
TSO	Technical Standard Order
UML	Universal Modeling Language and SysML (its systems engineering extension)
WLAN	Wireless Local Area Network
WM	Warehouse Management

4. INTRODUCTION

Around the globe every minute of every day, companies and individuals are involved in the transaction of business, and increasingly these transactions are being carried out via electronic means. Digital communication services form the basis for all these transactions, and it is essential that all parties involved in these transactions trust that data is secure and uncorrupted (either unintentionally or maliciously). There is a need to ensure that the underlying mechanisms for data generation, transmission, storage, and retrieval follow certain standards and protocols that have been tested and validated under normal and adverse conditions. In the age of increasing cyber-security threats and a fast-changing landscape, it is vital that all this be done with the highest sense of rigor and urgency. To facilitate this, the G-31 Electronic Transactions in Aerospace (ETA) Committee is developing standards and methods as well as other informational reports in coordination with other committees within and outside SAE International. The documents developed by the G-31 Committee, which is composed of representatives from every sector of aviation, including the regulatory authorities, will be reviewed by regulators so that any approvals or qualifications that need to be issued in conjunction, can be done by them within their standard framework. The collaboration across industry will ensure that time and effort is not wasted in duplicate products. Because of the visibility surrounding aviation, any incident involving an aircraft gets a bright spotlight shone on it, to an extent far more intense than in other industries; this work, therefore, takes on an added sense of importance and urgency.

Data does not have any intrinsic value; the importance it garners essentially encapsulates the value various stakeholders place on it. This value is derived from interactions with internal and external stakeholders, such as manufacturers (suppliers and integrators), operators, maintenance, repair and overhaul (MRO) providers, third-party logistics (3PL) providers and cost