

AEROSPACE RECOMMENDED PRACTICE

ARP6984™

Issued

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Determination of Cost Benefits from Implementing a Blockchain Solution

RATIONALE

The aerospace industry is rapidly digitalizing processes across its asset life cycle stages including most transactions, and with this are emerging novel ways of recording these electronic transactions. One such technology for recording electronic transactions securely is Blockchain, defined as distributed ledger technologies which includes enterprise blockchain, not having a wider use in the aerospace industry because of the lack of technical understanding as well as questions about its benefits. Assessing these benefits relative to the investments needed to implement such a blockchain solution is difficult, contributing to the slow adoption rate. The aerospace industry is conservative in its approach to technology adoption and hence it is difficult to change legacy processes. Additionally, the industry is very fragmented, technology is advancing at a faster rate and applies to a wide geographical range under different regulatory oversight that makes implementation challenging. This recommended practice lays out a methodology for qualifying and quantifying the benefits of replacing or augmenting a legacy process with a blockchain solution.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides insights on how to perform a Cost Benefit Analysis (CBA) to determine the Return on Investment (ROI) that would result from implementing a blockchain solution to a new or an existing business process. The word “blockchain” refers to a method of documenting when data transactions occur using a distributed ledger with desired immutable qualities. The scope of the current document is on enterprise blockchain which gives the benefit of standardized cryptography, legal enforceability and regulatory compliance. The document analyzes the complexity involved with this technology, lists some of the different approaches that can be used for conducting a CBA, and differentiates its analysis depending on whether the application uses a public or a private distributed network. This document is intended for people who do not have a deep technical understanding or familiarity with blockchain solutions to qualify and quantify its economic benefits (i.e., the value proposition).

1.1 Purpose

This ARP is not a standard or legal document because the approaches towards the end objective are many and varied. The document has been compiled to help the increasing number of people who want to compute a blockchain cost benefit analysis prior to implementing such a system on a platform.

1.2 Approach

The approach taken here identifies the parameters that are relevant for developing a CBA so that the boundaries of a specific problem could be defined from the outset. Several recent papers presented at conferences on the subject matter were studied and information obtained from various sources. Various methods were assessed for their application to specific scenarios and the parameters utilized by each scenario. The result is a document that offers the reader various solution paths so that the ones most appropriate to the specific situation can be used or adapted.

1.3 Intended Users

The document is intended for potential decision makers, sponsors, business analysts, functional analysts, architects, developers, users and other stakeholders of blockchain technology within the aerospace ecosystem such as original equipment manufacturers, suppliers, operators, owners, regulatory authorities, Maintenance, Repair and Overhaul Organizations (MROs), lessors, disposers, IT product suppliers, IT service providers, and others.

1.4 How to Use This Document

This ARP document will help users assess, evaluate, and quantify the cost and business benefits of blockchain solutions, and is intended to be a blueprint for conducting a CBA of a blockchain application. Section 4 presents a quick summary of various blockchain applications in aerospace. A typical blockchain application qualification process is given in Section 5. Factors, costs, and benefit considerations in blockchain CBA study are given in Section 6. Section 7 provides a perspective on challenges associated with completing a CBA for blockchains and Section 8 provides an ROI computational model. The entire cost benefit study has been illustrated through an example of blockchain based virtual store for aircraft spare parts in Section 9. Finally, Section 10 summarizes and concludes the current study.

2. REFERENCES

2.1 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.

2.2 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 Aerospace Ecosystem
- AIR7501 Aircraft Asset Lifecycle and Digital Data Standards Overview
- ARP6823 Electronic Transactions for Aerospace Systems: An Overview
- EPR2020021 Unsettled Topics Concerning Adopting Blockchain Technology in Aerospace

2.3 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.

- Spec 42 Aviation Industry Standards for Digital Information Security, Product Code 18044, Revision 2018.1
- Spec 1000BR_4.1 Civil Aviation Business Rules for S1000D Issue 4.1, Product Code 19120, Revision 2019.1
- Spec 1000BR_4.2 Civil Aviation Business Rules for S1000D Issue 4.2, Product Code 19121, Revision 2019.1
- Spec 2000 Aircraft Transfer Part List (Ch. 15), Product Code 1415AT, Revision 2014.1
- Spec 2000 Airline Inventory Redistribution System - AIRS (Ch. 12), Product Code 1412AR, Revision 2014.1
- Spec 2000 Authorized Release Certificate (Ch. 16), Product Code 1816ARC, Revision 2019.1
- Spec 2000 Automated Identification and Data Capture (Ch. 9), Product Code 16029, Revision 2016.1
- Spec 2000 Electronic Logbook (Ch. 17), Product Code 1817EL, Revision 2018.1
- Spec 2000 Electronic Work Package (Ch. 18), Product Code 1818W, Revision 2018.1
- Spec 2000 Industry Metrics (Ch. 13), Product Code 1413M, Revision 2014.1
- Spec 2000 Materials Management (Ch 3-4, 6), Product Code 1434MM, Revision 2014.1
- Spec 2000 Procurement Planning (Ch. 2), Product Code 1402PP, Revision 2014.1
- Spec 2000 Provisioning (Ch. 1), Product Code 1401P, Revision 2014.1
- Spec 2000 Reliability Data Collection/Exchange (Ch. 11), Product Code 19111, Revision 2019.1
- Spec 2000 Repair Order Administration (Ch. 7), Product Code 1407R, Revision 2014.1
- Spec 2000 Warranty Claims (Ch. 14), Product Code 1814WC, Revision 2018.1
- Spec 2000 Gen 2 Procurement, Product Code 18G2P, Revision 2018.1
- iSpec 2200 Information Standards for Aviation Maintenance, Revision 2018.1, A4A Publications, 2018
- Spec 2300 Data Exchange Standard for Flight Operations, Product Code 060319, Revision 2019.1

Spec 2400 Allowable Configuration Data Exchange Standard, Product Code 18S240, Revision 2018.1

Spec 2500 Aircraft Transfer Records, Product Code 174ATR, Revision 2017.2

2.4 Other Publications

Melanie, S., Blockchain Blueprint for a new economy, O'Reilly Media, 2015.

Robert J. R., Sumant H., Miles K., Peter K. R., Systemic Adoption of Blockchain Technology within the Aviation Ecosystem, Boeing ROI 17-00766-CORP, Oct 2017.

Top 10 Strategic Technology Trends for 2017: Blockchain and Distributed Ledgers, <https://www.gartner.com/document/3647619/workgroup/consume>.

Blockchain: Trust economy, pg. 93, Tech Trends 2017 – Deloitte University Press.

Why Airlines, Aftermarket Struggle with Digital Record-Keeping, Paul Seidenman and David J. Spanovich, Inside MRO, Sep 9, 2016.

Blockchain technology – What it is, what are its use cases, and what it means for you, https://thenextweb.com/contributors/2017/06/16/blockchain-technology-use-cases-means/#.tnw_jh0VhjQb.

A forrester emerging technology projection: The total economic impact of IBM blockchain, projected cost savings and business benefits enabled by IBM blockchain, 2018.

Michel R., Apolline B., Keith B. and Stephen M., 2nd Global Enterprise Blockchain Benchmarking Study, Cambridge Centre for Alternative Finance, University of Cambridge, Judge Business School, 2019.

Blockchain for Unmanned Aircraft Systems, U. S. Department of Transportation, Volpe Center, Transportation Innovation for the public good, April 2020.

Emerging Technology Projection: The total economic impact of IBM Blockchain, A Forrester Emerging Technology Projection: Total Economic Impact Study Commissioned by IBM, 2018.

MediLedger pilot project: <https://www.mediledger.com/fda-pilot-project>, accessed Nov 22, 2020.

Assessing the potential to improve grants management using blockchain technology, <https://www.mitre.org/publications/technical-papers/assessing-the-potential-to-improve-grants-management-using-blockchain>, accessed Mar 1, 2021.

A4A Passenger Airline Cost Index (PACI), <https://www.airlines.org/dataset/a4a-quarterly-passenger-airline-cost-index-u-s-passenger-airlines/#>.

U.S. Passenger Carrier Delay Costs, <https://www.airlines.org/dataset/per-minute-cost-of-delays-to-u-s-airlines/#>.

GoDirect Trade Blockchain for Parts Traceability, <https://www.godirecttrade.com/>.

MyBoeingFleet Aircraft operations, maintenance, repair suite of applications, <https://www.myboeingfleet.com/ReverseProxy/Authentication.html>.

Maintenance Cost Technical Group, Airline volunteer group that gathers and analyzes maintenance cost, www.iata.org/mctg.

Key industry partners launch MRO blockchain alliance, <https://www.evaint.com/key-industry-partners-launch-mro-blockchain-alliance/>, February 2020.

2.5 Abbreviations and Definitions

A4A	Airlines for America
a _F	Annual fee per airline
AFI-KLM E&M	Air France Industries and KLM Engineering & Maintenance
A _F	Annual Fee
AI	Artificial Intelligence
AOG	Aircraft on Ground
API	Application Program Interface
ARP	Aerospace Recommended Practice
ATA	Air Transport Association of America now referred to as Airlines for America or A4A
BOM	Bill of Material
B2B	Business-to-Business
CASM	Cost per Available Seat Mile
CASK	Cost per Available Seat Kilometer
CBA	Cost Benefit Analysis
COS	Continued Operational Safety
DHS	Department of Homeland Security
DSCSA	Drug Supply Chain Safety Act
DLT	Distributed Ledger Technologies
EASA	European Union Aviation Safety Agency
EDI	Electronic Data Interchange
ELFC	Engine Lease Finance Corporation
FAA	Federal Aviation Administration
FC	Flight Cycle
FH	Flight Hour
FDA	Food and Drug Administration
GDPR	General Data Protection Regulation
HAECO	Hong Kong Aircraft Engineering Company Limited
IATA	International Air Transport Association
IATP	International Airlines Technical Pool

IT	Information Technology
IoT	Internet of Things
KUSD	Thousand United States Dollars
OEM	Original Equipment Manufacturer
M _{ai}	Target Number of Airlines
MCTG	Maintenance Cost Technical Group
MVP	Minimum Viable Product
MRO	Maintenance, Repair, and Overhaul
MUSD	Million United States Dollars
NPV	Net Present Value
N _{AOG}	Annual Number of AOG Conditions per Aircraft
N _{ai}	Average Number of Aircraft per Airline
N _{ac}	Number of Aircraft
O _F	Onboard Fee per Airline
O _F	Onboard Fee
PACI	Passenger Airline Cost Index
PII	Personally Identifiable Information
POC	Proof of Concept
P2P	Peer-to-Peer
RFID	Radio-Frequency Identification
ROI	Return on Investment
SITA	A multinational information technology company providing IT and telecommunication services to the air transport industry
SLAs	Service Level Agreements
SWOT	Strengths, Weaknesses, Opportunities, and Threats
S _T	Savings per Transaction
TPS	Transactions per Second
t _F	Transaction Fee per Transaction
t _s	Annual Number of Transactions per Aircraft
T _a	Number of Transactions per Aircraft

T _F	Transaction Fee
T _s	Number of Transactions
UI	User Interface
USD	United States Dollar
USM	Used Serviceable Material
UPS	United Parcel Service
UX	User Experience
WLFC	Willis Lease Finance Corporation
YoY	Year on Year
Y _s	Annual Savings per Aircraft for an Airline
Y _C	Annual Cost per Aircraft for an Airline
Y _R	Total Revenues
Y _{R1}	Year Wise Revenues
Y _{R3}	Total Revenues in 3 Years

3. INTRODUCTION

The typical aircraft operational service life span lasts more than thirty years. This longevity poses many challenges to the curation and accuracy of record keeping. The usefulness of the data transferred between various stakeholders is directly related to the accuracy and reliable access to aircraft historical data during the lifespan of the aircraft. The data being exchanged requires standardization to improve the overall confidence in record retention, transfer process efficiency, and accuracy. This confidence and trust are required in the transactional interaction between various key aerospace ecosystem stakeholders throughout the lifecycle of the aircraft. Currently, the industry's major stakeholders facilitate standards definition and scope of applicability. The scope of the current document includes the following stakeholders:

- Manufacturers
- Suppliers
- Owners
- Operators
- Lessors
- Maintenance and repair service providers
- Regulators
- Aircraft disposers

Thus, all other stakeholders in aerospace ecosystem have been excluded in the preview of the current document. Figure 1 depicts the aerospace asset lifecycle in terms of product and information flow. The details of each of these aerospace asset stakeholders and their responsibilities are given in Table 1 and the aerospace asset stakeholder interaction is presented in Figure 2. Figure 1 is a common view of the product and information interchanges that the G-31 Electronic Transactions for Aerospace Committee of SAE International is adopting across many of its documents, e.g., AIR6904, AIR7501, and ARP6823.

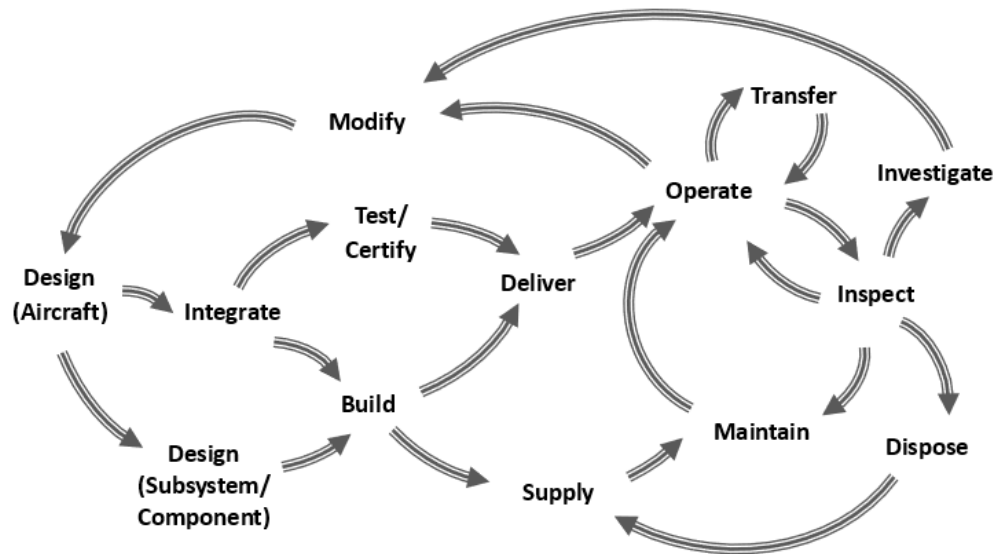


Figure 1 - Data producing and consuming processes in the aerospace ecosystem (extracted from AIR6904)