Adopting Aircraft Electronic Records

Position Paper and Lessons from Industry Surveys

Digital Transformation Wave

The industry of civil aviation and air transport is well known as a data resource intensive operation in which documenting the actions and managing the inherent supporting records are enshrined in aviation regulation and standards. In a metadata rich environment, which is today's reality for all actors in the civil aviation ecosystem, digital transformation emerged as the one and only option individual entities have to secure their sustainable future in the aviation business.

The aviation digital transformation first steps resided with Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) and permeates today a robust intertwining of aircraft design-manufacturing-operation-maintenance-transfer-disposal and enables the Digital Threads and Digital Twins which define the Digital Identity of the aircraft joining and departing the global fleet.

Like any transformative process, the emergence of the digital way in aviation has its challenges to be tackled before accessing the benefits of it happening, and the costs of doing so must be sustainable for the aviation industry players.

Benefits

- Bringing the novel technology tools necessary to operate a modern aircraft global fleet (real-time searchable data and administrative error-free secure communication continuum; prompt data analysis and predictive maintenance support; increased system confidence; closure of communication loop).

- Providing the required means to facilitate achievement of aviation industry's 2050 objective for independence from fossil-carbon (lower the environmental impact; airborne weight savings; reduced shipping and storage costs); recycle parts and material at the end of an aircraft's operational life.

- Facilitating increased efficiency in and mutual recognition of regulatory compliance and oversight (real-time action visibility; better safety-management enabler; built-in data consistency and quality checks; implicit additional security nets addressing fraud prevention and control).

Challenges

- Securing regulatory consistency and harmonization of Civil Aviation Authorities (CAA) in the field of digital data availability and use (ensure the right balance between performance-based and prescriptive-based regulation).

- Industry agreement(s) on governance, ontology, taxonomy, and definitions required to enable data exchanges between the various stakeholders. Define appropriate industry global standards that will enable various systems to communicate with each other. Each stakeholder shall understand the
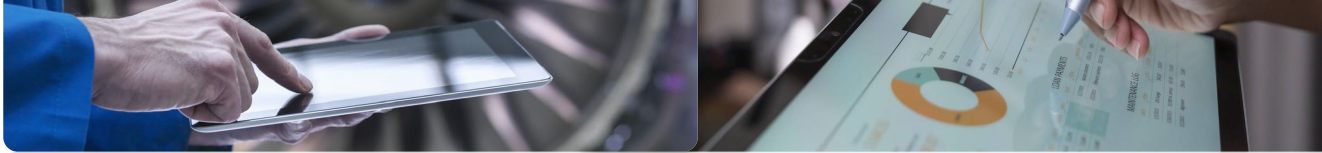
differences between adopted standards, ensure interoperability and facilitate transition between systems.

- Time-criticality of identifying and pursuing digital solutions development directions.

- Ensuring sustainability of "digital way" in a large variety of end-user environments (often having non-aviation specific limitations to be reckoned with).

Costs

- Allocation of dedicated budgets and resources (for digital transformation of existing operations or digital build-up of newly emerging ones).

- Supporting hybrid systems to address the limited digital capabilities legacy fleets/operations co-existing with new ones for largely variable transition periods (when stakeholders are sometimes "trading inefficiencies").

Securing Stakeholders' Traction

The potential benefits identified with adoption of aircraft electronic records represent a major driver for most, if not all, aviation stakeholders to facilitate such adoption. Note that for the purposes of this paper, the words electronic and digital are used interchangeably; however, the word digital ensures that record transfer occurs between systems without the intervention of any transitioning activity (i.e., printing, signing, scanning, imaging, etc.).

The technical level of the global fleet reached a critical mass whereby its operation in effective and efficient ways can't elude anymore the true digital transformation. From aircraft configuration control to aircraft technical performance visibility/awareness and to aircraft maintenance, which are all tenets of aviation safety, the attributes of electronic records make them an aviation business priority in the respective areas.

Aviation regulations and standards enabling use of electronic records proven technology solutions are either sufficiently robust or quickly maturing; successful practical implementations flourished and there are no reasonable grounds for any delays or stumbling blocks to integrating electronic records provisions in aviation commercial contracts at individual entity levels.

About 60% of the surveyed[1] industry players population are acknowledging they did not encounter challenges within their primary oversight Regulator/CAA related to the development or use of digital data. There is nevertheless significant room for timely improvement since almost half of the Aircraft Operators, one third of the Original Equipment Manufacturers (OEMs) and one quarter of the Maintenance Repair and Overhaul (MROs) entities still mention encountering such challenges.

Snapshot of Aviation Frontline Use Cases

Two recently run surveys gathered information about the pace of digital transformation emergence in aviation technical operation on several of its evolution coordinates: the IATA Digital Aircraft Operations Survey[2] and the

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[1] See below the footnote #3
[2] This Survey was run by IATA and contained several questions regarding the use of electronic documents on-board the aircraft and in aircraft technical operations; it was closed in Sep 2023 with 185 respondents from the global aviation community; for respondent population demographic details and results, contact dao@iata.org

Maintenance Management Team Digitalization Working Group Survey[3]. Benefiting the feedback of a balanced global geographic and business categories representation of the aviation industry community, the two surveyed populations and processing of their responses were independently pursued.

Whereas presenting the mentioned surveys' demographics, questions and collected feedback is not the mission of this IATA position paper, we extracted below some of the survey results with significance in the context of this document.

Electronic Authorized Release Certificates (e-ARC)

The ARC documents are essential to the aviation technical operations ecosystem; their adequate issuing, circulation and processing are foundational to the airworthiness framework of aircraft parts, tracking of regulatory compliance and sustenance of the supply chain functionality.

Regulatory conditions and clearance for use of digital type of such documents (i.e., e-ARCs) are recognized and well-articulated in aviation regulations (e.g., see EASA[4] and FAA[5]). ICAO's Airworthiness Manual (Doc 9760) provides the foundation for any CAA to adopt such provisions to ensure acceptance of electronic documentation. Industry standards are in-place to support the implementation of such e-ARC approach (e.g., see ATA e-business[6]).
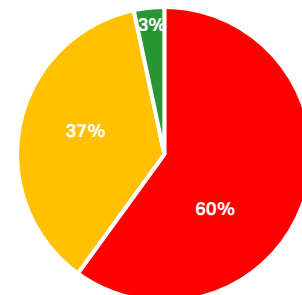
The responses received to the *question* addressed to Airline Operators and MROs / Repair Stations in view of quantifying how far the industry pursues the e-ARC path are aggregated as follows:

"Does your organization use (i.e., accept and/or issue) Authorized Release Certificates (ARC) in real electronic format (i.e., other format than a digitized image/copy of the paper based original source ARC document)?"
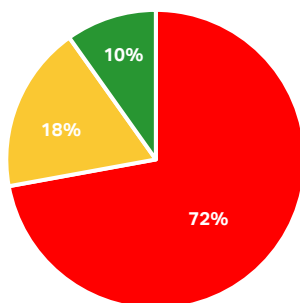
AOC Holders' Responses   *Source: IATA Survey, Aug 2023*   Part-145 Certificate Holders' Responses

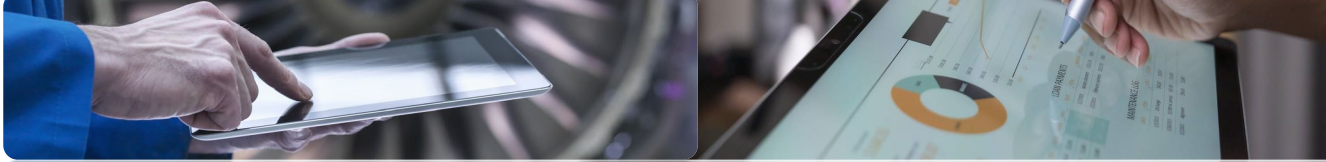While acknowledging several survey factual limitations, namely that:

- The two surveyed categories of stakeholders are not necessarily covering the same aircraft parts' sets/movements/transactions within the aviation industry business;

- Aircraft and aircraft parts OEMs, who are the initial source/point of entry of components in the aviation industry circuit, are not represented in the responses depicted in the above pie-charts;

- The responses processed are not accounting for the size of business which the respective respondents hold in the stakeholder category they belong to;

we could however conclude that marginally above one quarter of the aircraft operators are somehow active in the e-ARC arena but more than one third of the MRO entities are somehow engaged in the e-ARC pursuit.
At the same time, given the importance of the initial documentation of the parts' birth and entrance in the aviation ecosystem, the role of OEMs in increasing the percentage of instances whereby e-ARC is used in authorizing a part for release to service should not be neglected.

On-Board Carriage of Electronic Documents

The introduction of Electronic Flight Bags (EFB) created the opportunity of a fundamental shift towards replacing the high amount of paperwork and hard copy documents carried on-board the aircraft with their corresponding electronic ones. The all-around operational gains in improving handling and control of the documents are compelling arguments for transitioning to electronic documents while eliminating a costly dead-weight load of each flight. However, the transition process is requiring airlines to commit some up-front investment and resource allocation and in practice that happens neither smooth nor fast.

The *questions* asked to Airline Operators about the regulatory acceptance of electronic documents:

"Does your Civil Aviation Authority allow carrying the following documents on-board the aircraft in electronic format?"

and the actual implementation of such acceptance by the airlines

"Does your airline carry the following documents on-board the aircraft in electronic format at least on one of airline's fleets?"

produced the following feedback regarding some of the technical operations related documents which must be carried on-board (namely the Certificate of Airworthiness, the aircraft Technical Log and any applicable ICAO Art83bis Agreements for aircraft maintenance oversight):
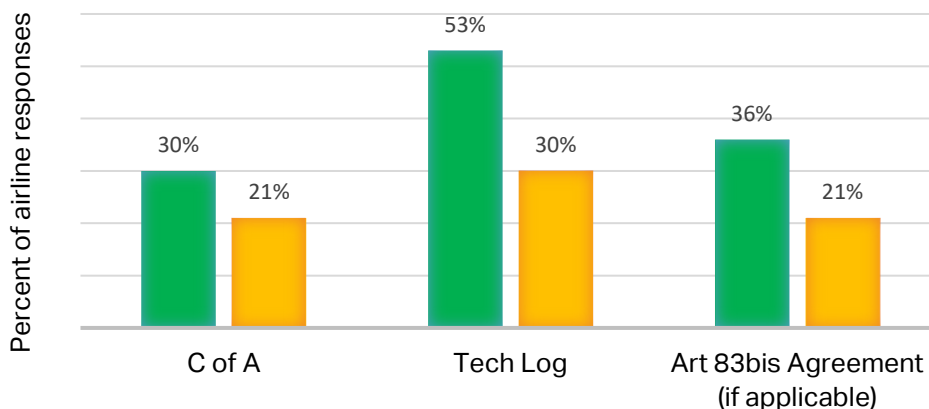
Source: IATA Survey, Aug 2023

Legend:
- ■ Airline allowed to use e-doc per CAA regulation
- ■ Airline not using e-doc although allowed per CAA regulation

We conclude that in general more than half of the regulatory frameworks need to be updated to enable on-board carriage of electronic documents and the airlines should vigorously pursue such regulatory provisions once they
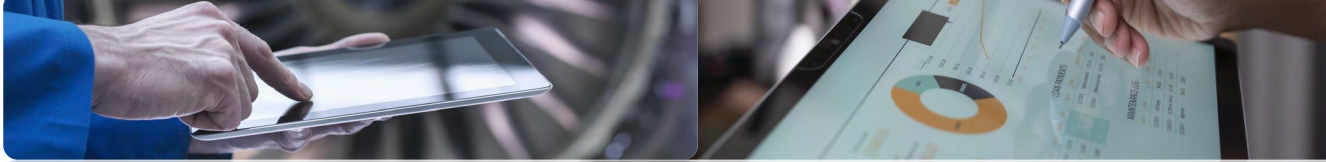
exist. The process should be accelerated for both categories of stakeholders given the potential gains for each one of them. It is to be noted that regulatory conditions the airlines have to comply with regarding the on-board carriage of only originals or certified true copies of some documents is successfully undergoing revisions and that should enable a faster transition to e-docs (e.g., see work by EASA[7], ICAO[8]).

Managing the IT Required Resources

The individual business entity approach to management of the IT resources which support its operation is essential in adoption of electronic records. The pros and cons may be determining a different equilibrium point and consequential decision the entity makes regarding the reliance on in-house or external IT resource.

While there is no "always right" decision, it is interesting to note the factual statistics emerged from the survey.

The *question* asked to industry players about *"How is your company's IT managed?"* received the following answer:
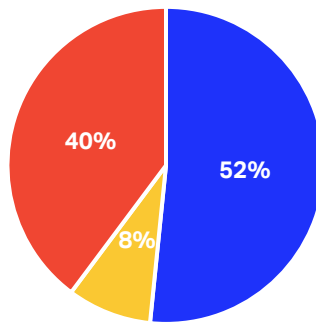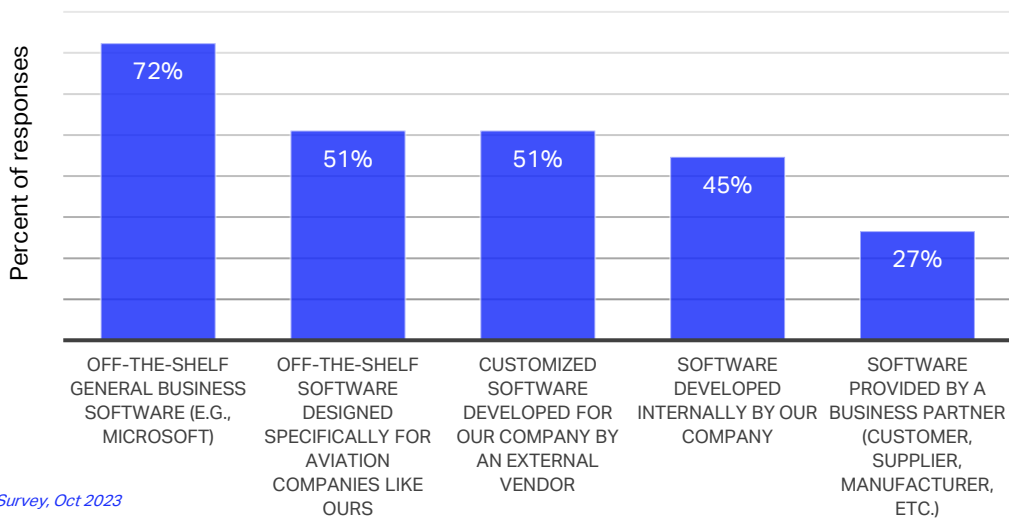

- In-house IT department   - Outside IT vendor   - Both   *Source: ARSA Coordinated Survey, Oct 2023*

The question intended to mine deeper into the used type of software resource was:

"Which of the following does your company utilize to create, complete, store and secure digital data?"
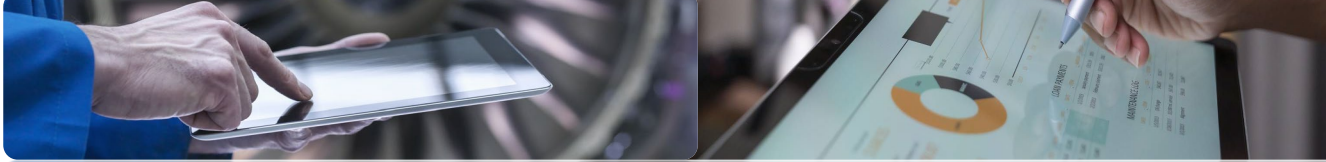
and received the following feedback regarding the software sources employed:

Source: ARSA Coordinated Survey, Oct 2023

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[7] https://www.easa.europa.eu/en/document-library/general-publications/carriage-electronic-documents-board-aircraft
[8] https://www.icao.tv/videos/anw2023-anw-electronic-certificates-and-documents

To note that the choices offered were not requiring a mutually exclusive selection by the respondent.

The extremes of popularity seem to be firstly with the general business Commercial-of-the-Shelve (COTS) software (mentioned by almost three quarters of responses) and lastly with the purposed "to-be-used" business partner provided software (mentioned by slightly over one quarter of responses). The variety of software sources indicate a robust market for aviation industry business software support in which companies focused on aviation categories' specific software packages (either kept at the category generic level or tailored to the individual user level) are present in approximately half of the market.

Signing-off Maintenance Records

With clear regulatory requirements regarding the maintenance records sign-off obligations, the procedural approaches adopted by the individual aviation stakeholders to comply with such requirements is dependent on the technology implemented and its approval status.

The *question* asked to assess the prevalence of signature digitization options was:

"How does your company sign and/or obtain signatures for the following types of records?"


Source: ARSA Coordinated Survey, Oct 2023
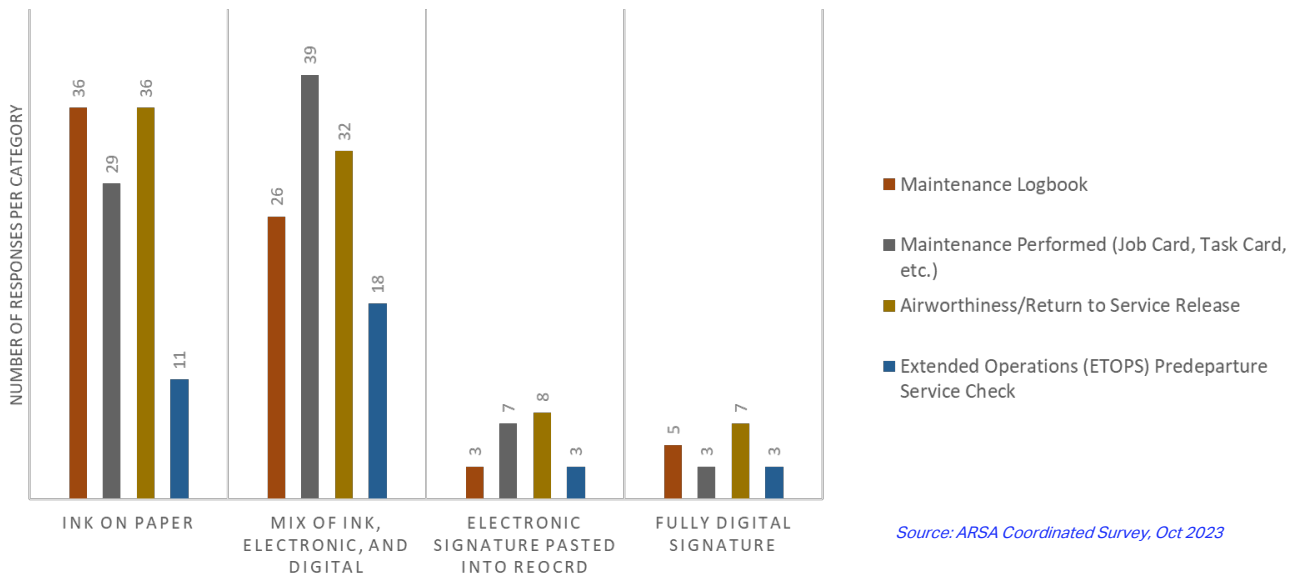
Answers received from the aviation industry entities involved in the creation and processing of those type of records are indicative of a well-started transition away from the "ink on paper" legacy; however, with most legacy departed companies being captive to a mixture of ink-electronic-digital reality in their business, the aimed for future dominance of a "fully digital signature" is still a remote perspective.

The positive take-away would be that use cases exist to demonstrate a successful implementation of digital signature in all surveyed categories of aviation technical records.

Going Forward Steps

Aviation stakeholders are unanimous in agreeing that electronic aircraft maintenance records are imperative to aviation's future. The safety and sustainability of the aviation ecosystem are dependent on adopting effective and efficient ways for digital transformation of technical operations. Timely executing such transformation should be enabled with several considerations in mind:
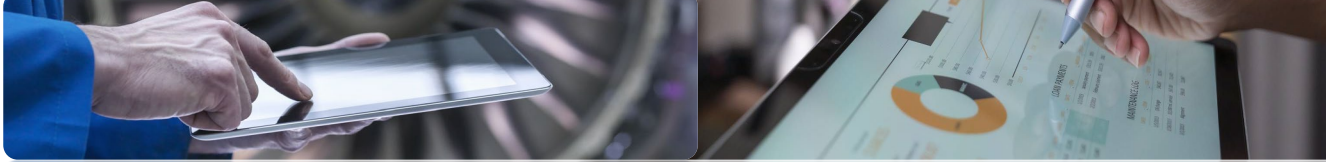
Performance-Based Regulation and Standards

- The commonality of ground-rules and performance-based requirements primacy over prescriptive regulation provisions must overcome differences between aviation regulatory systems; using the ICAO reference basis[9] should be an opportunity to consider if the digital aviation domain receives active engagement and prompt responsiveness at the ICAO level.

- Technology agnostic set-up of regulation and standards is required given the fast pace of evolution in the industry. An encouraging recent example[10] is that several major Regulators are considering criteria for accepting alternatives to a couple legacy certification standards.

Readiness for Emergence of Aviation-AI

- The induction and adoption of AI technology in aviation is prioritized by regulatory efforts (e.g., see EASA[11]) and industry actions (e.g., see SAE[12]).

- Providing a robust data training base for AI requires availability of digitally transformed records and processes.

Global Interoperability

- While the diversity of solutions for digital transformation is a natural aviation business occurrence and global full scalability of a single one is not likely possible (and not desirable either), data and information portability between solutions is essential.

- Transactions of aviation assets and components must be supported through adoption of standardized formats and business rules which enable generating a comprehensive "digital identity and passport"[13] of the assets/components involved in the transaction.

Cybersecurity as Collateral to Safety

- Pairing the digital-life of an aviation asset/component with the respective physical asset/component real-life is critical to parts' digital identity and their service life-long twining; caution must be exercised to prevent both "clerical mistakes" and "malicious actions" since inaccurate or forged records could have dire safety consequences.

- A successful cybersecure solution of entirely digital records is very appealing from the data and information real-time availability potential, the practical endless criteria for searchability in data mining or the virtual immutable "unique source of truth" when processed with distributed ledger technologies like blockchain.

Sustainability

- Aircraft decommissioning and its implications in re-use of parts and material recycling are expected to grow in importance as sustainability efforts grow worldwide to preserve raw materials and natural resources. Electronic recordkeeping is essential to keep up with the requirements of these efforts that are currently led by the EU Green Taxonomy Act[14].

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[9] Some provisions were already included by ICAO in Annex 8 – Airworthiness of Aircraft and in Doc. 9760 – Airworthiness Manual

[10] https://www.easa.europa.eu/en/newsroom-and-events/press-releases/easafaa-task-force-defines-alternative-approach-authorising

[11] https://www.easa.europa.eu/en/document-library/general-publications/easa-artificial-intelligence-roadmap-20

[12] https://standardsworks.sae.org/standards-committees/g-34-artificial-intelligence-aviation

[13] A recent (i.e., fall 2023) example of an initiative in this direction belongs to the Aircraft Transfer Records Working Group (ATRWG) of the ATA e-Business Program

[14] https://ec.europa.eu/finance/docs/level-2-measures/taxonomy-regulation-delegated-act-2022-climate-annex-1_en.pdf
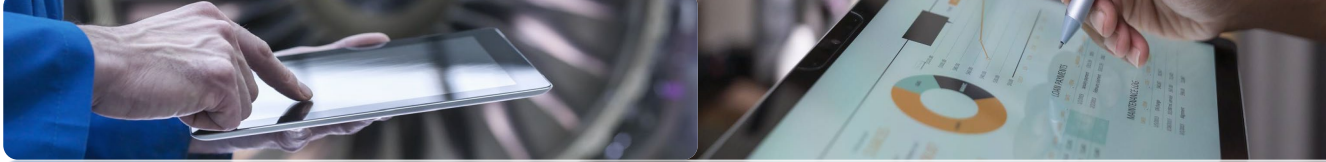
Concluding Commitment

From the neutrality of a not-for-profit aviation association advocating airline industry interests, the IATA position is to actively engage in supporting the adoption of aircraft electronic records; such adoption, positively associated with the many facets highlighted in the previous pages, would be a win across the aviation industry and mark a step forward for all its stakeholders.

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