European Union Aviation Safety Agency

This project has received funding from the European Union's Horizon Europe Programme

D-3.1 CHANGES REQUIRED TO REGULATORY MATERIALS AND IMPLEMENTATION ROADMAP

VIRTUA - Digital Transformation - Case Studies for Aviation Safety Standards – Virtualisation

An Agency of the European Union

Disclaimer

DELIVERABLE NUMBER AND TITLE:	VIRTUA, D-3.1 Report of the main changes required to regulatory materials and standards and proposed roadmap for implementation
CONTRACT NUMBER:	EASA.2022.C.26
CONTRACTOR / AUTHOR:	FPT Software
IPR OWNER:	European Union Aviation Safety Agency
DISTRIBUTION:	Public

DATE: 09 July 2024

SUMMARY

Problem area

Digital technologies are rapidly being integrated into various aspects of the aviation industry, and while they have the potential to enhance safety, productivity, accessibility, and sustainability, they also come with new security and privacy risks. Furthermore, their implementation necessitates significant changes to business models, working processes, standards, and regulations.

In order to keep pace with the changes and advancements in aviation standards, it is imperative to conduct timely and proactive investigations into the application of novel concepts and processes for aviation products, processes, and operations. As the EU Aviation Safety Regulator, EASA is tasked with addressing fundamental questions about how to adapt safety standards in response to the challenges outlined in Flightpath 2050, as well as the introduction of innovative products and processes.

The objective of this project on the implementation of blockchain technologies is to address the potential benefits and constraints (incl. costs) considering the different Stakeholders involved in the management of aircraft parts and components, by investigating different types of blockchains and different use cases for their implementation along the lifecycle of approved parts and components.

In the cases where the benefits are confirmed, the project shall also undertake the assessment of the main changes to be introduced in regulations, standards and working processes as well as the preparation of guidelines and supporting materials for regulatory evolutions and the deployment of the related solutions.

Description of work

The present document is the deliverable “D-3.1 Report of the main changes required to regulatory materials and standards, proposed roadmap for change implementation” of the VIRTUA (Digital Transformation – Case Studies for Aviation Safety Standards – Virtualisation) project (EASA.2022.HVP.01- Horizon Europe Project).

It presents a gap analysis between the selected Blockchain use cases with regulatory materials and industry standards. The analysis identifies necessary changes to regulations and standards to facilitate the integration of blockchain and other data management solutions in aviation parts tracking. A proposed roadmap outlines strategies for implementing these changes within the context of the VIRTUA project, focusing on digital transformation in aviation safety standards and virtualisation.

Results and Application

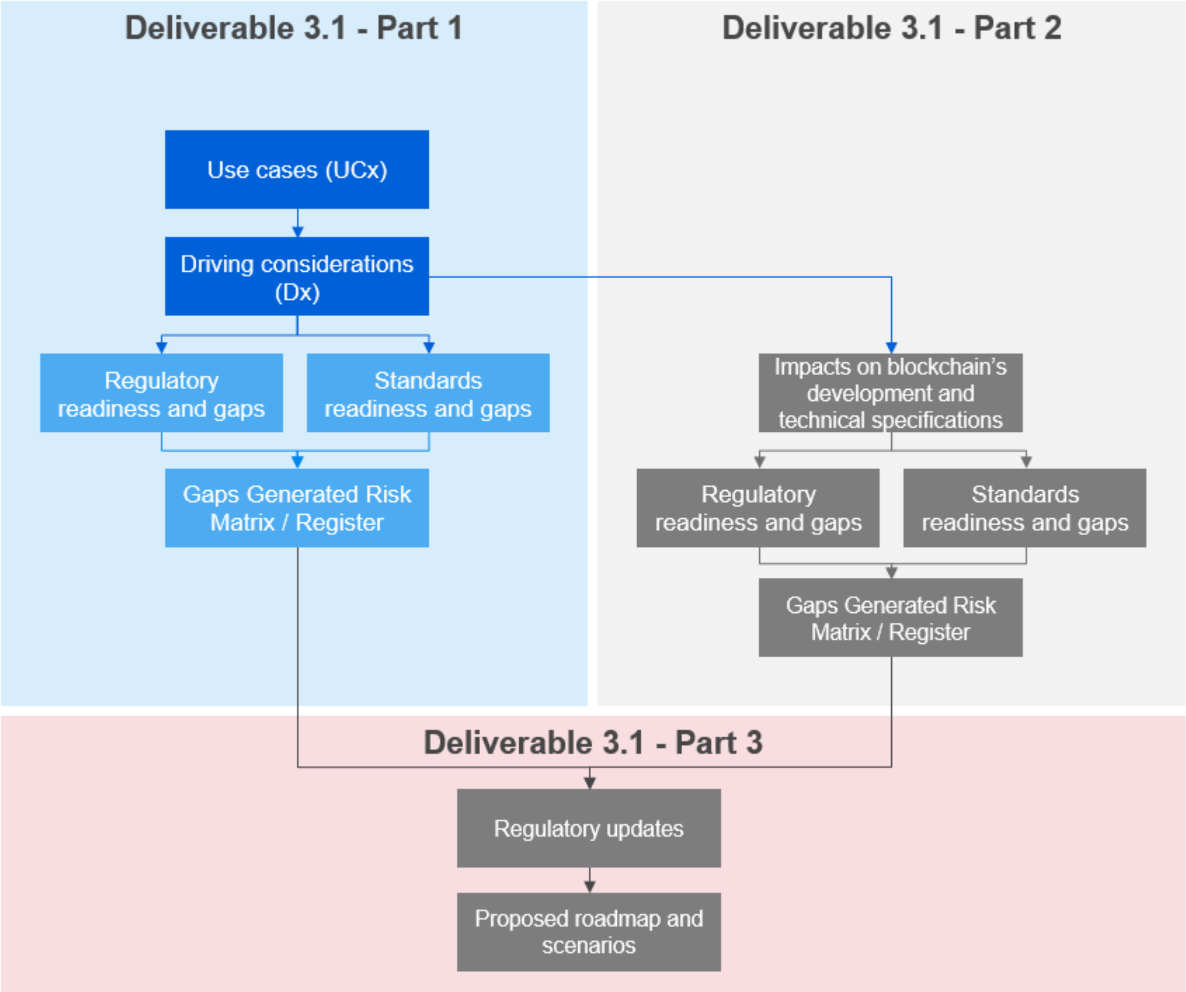
The document is divided into several sections, each of which addresses a specific aspect of the changes required to regulatory materials and standards.

The first section, "Regulatory and Standards Readiness for Blockchain in Aviation," assesses the readiness level of aviation governing regulations and industry-specific entities for establishing, implementing, and maintaining blockchain-based solutions in aviation. This section includes an analysis of nine use cases and their associated drivers for blockchain, as well as an identification of regulatory and standards readiness status and gaps, and a risk matrix and register of the gaps generated.

The second section, "Regulatory and Standards Readiness for Blockchain-Based Solutions," focuses on the use cases and their associated impacts on blockchain technical specifications, as well as the regulatory and standards readiness status and gaps for blockchain-based solutions development and implementation.

The third section, "Regulatory and Standards Recommended Actions," proposes the main changes to be considered for regulatory materials and standards, providing a roadmap for implementing these changes within the context of the VIRTUA project. This section also includes recommended regulatory actions.

The overall reasoning adopted in the construction of this analysis is detailed in the figure below.



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ABBREVIATIONS

ACRONYM	DESCRIPTION
AD	Airworthiness Directive
AMC	Alternative Means of Compliance
ATA	Airlines for America (Formerly Air Transport Association)
ATM	Air Traffic Management
BASA	Bilateral Aviation Safety Agreements
EASA	European Union Aviation Safety Agency
EASP	European Aviation Safety Programme
EPAS	European Plan for Aviation Safety
EPRS	European Parliamentary Research Service
EU	European Union
FAA	Federal Aviation Admnistration
GDPR	General Data Protection Regulation
ICAO	International Civil Aviation Organization
MAB	Member States Advisory Body
RES	Research Projects
SB	Service Bulleting
SUP	Suspected Unauthorised Part(s)

1. REGULATORY AND STANDARDS READINESS FOR BLOCKCHAIN IN AVIATION

This section is intended to assess the readiness level (or lack thereof) which the aviation governing regulations and the governed industry specific entities should reach for establishing, implementing and maintaining blockchain based solutions in aviation. While the assessment is built on practical elements profiled by the nine use cases (UC1 to UC9) investigated during the previous stage of this project, the gaps identified, the associated risk matrix/register and the recommended actions invite to a broader consideration by the aviation regulators and industry actors.

1.1 Use Cases and Associated Drivers for Blockchain

The below table is listing the nine use cases identified during this project and specifies the key driving considerations conducive to a potential blockchain solution in each of the cases.

Use Case ID	Use Case Name	Description	Main Driving Considerations
UC1	**Aircraft parts back-to-birth traceability and airworthiness management**	Ability to track-and-trace the entire lifecycle of aircraft parts from manufacture to disposal.	**(D1)** The blockchain functionality guarantees the authenticity, immutability/integrity, non-repudiation and regulatory required completeness of part's documented status along the entire lifecycle of the part (i.e., only a document conforming to regulation should enable a block addition in the blockchain and the mentioned attributes are intrinsic to the blockchain construct). **(D2)** The blockchain documented life of the part could host information depending on the regulatory requirements and the commercial expectation for the part (i.e., any airworthiness relevant physical event the part undergoes – e.g., production, installation, removal, repair, SB embodiment, and/or part's transactional events with commercial implication – e.g., selling, acquisition, relocated spare/inventory). **(D3)** Documenting beyond any reasonable doubt the start and end of the aviation part's life (i.e., the part entry in and exit from the aviation ecosystem; the birth and death/decommissioning/demise of the part). **(D4)** Potential storage in the blockchain of a "pairing/bridging proof" between the physical part and the blockchain hosted documents (i.e., could and should be the "pairing" between the document and the part be validated at each block addition? While feasible for uniquely serialized and accordingly

			marked parts, it is very challenging for the rest).
UC2	**Real-time pre-screening and smart contracts[1] for audits**	Real time pre-screening (conditioning the addition of the block in the chain) by cross-checking the authorization of an EASA Form 1 signatory person with the information available in the EASA Form 1 issuing organization database. Ability to automate data audits using smart contracts capacities of blockchain, ensuring EASA Form 1 status updates and compliance with regulatory standards.	**(D1)** The EASA Form1 (or equivalent – e.g. 8130-3) contained data validation of block 14d (i.e., name of the certification authorised person signing the Form 1) should confirm the existence of the signatory as authorised employee by the issuing Part 145 organization; this could be performed by the blockchain through oracle execution linked to the applicable list of authorised employees (at the time of signing the Form1) by the Part 145 organisation (list maintained i.a.w. MOE requirement, see Appendix IV to AMC M.A.604) and should constitute a precondition for acceptance of the block addition to the chain. **(D2)** Automation of the Part 145 org auditable details of issued Form1 documents could be accomplished via a smart contract. **(D3)** Extension of the above (D1) to production organizations (approved under Part 21 G) who are using Form 1. **(D4)** Extension of the above (D2) to production organizations (approved under Part 21 G) who are using Form 1.
UC3	**Maintenance and operational history for efficient life limit utilisation**	Ability to monitor LLPs configuration, operational and maintenance history, thanks to better cross-stakeholders' data transmission. This represents a valuable service offering significant benefits for airlines.	**(D1)** The LLP data trusted update could be executed in a blockchain type of structure each time the part undergoes an airworthiness related physical event (e.g., part production, repair, modification, SB/AD embodiment, installation/removal) and include part's use operational control parameter value (e.g., hrs, cycles, landings, calendar time) and operations condition details (e.g., the aircraft MTOW or Engine Variant/Thrust on which the part was fitted). **(D2)** Blockchain stored data could include pointers to regulatory documents relevant to

[1] A smart contract is a contract that is automatically executed when predefined clauses are fulfilled using computer technology. The initial advantage of using smart contracts is the automation of the trusted third party, based on the transparency and immutability of blockchain. Execution of the contract can trigger actions such as triggering a payment, transferring ownership of a digital twin, or updating a status on the blockchain network.

			the part Usage Based Lifing (UBL)[2] approvals which constitute the rationale for computation of part's life control parameter values.
UC4	**Registration systems**	Ability to track a variety of data such as pilot and mechanic's licences, experience or status of medical reports and share it across stakeholders.	**(D1)** Any licence identified personnel linked to a blockchain stored event could be validated via an oracle execution to crosscheck the existence of such a licence issued by the CA. **(D2)** Dedicated blockchain for hosting and sharing CA registered assets (e.g., State Register of aircraft) and licensed aviation personnel (e.g., State issued: pilot licenses, maintenance personnel licenses).
UC5	**Warranty adjudication** [3]	Ability to automate and validate warranty claims automatically using smart contracts and oracles.	**(D1)** The blockchain attributes would ensure that (blockchain hosted) documents tracking physical events the part undergoes could be trusted and free from any reason/basis to be challenged; establishing blockchain related smart contracts or oracles would automate warranty (and potentially guarantee as well) adjudication execution for the parties of the warranty/guarantee contract (e.g., OEM and Airline).
UC6	**Pre-screening for Suspected Unauthorised Parts (SUP) and facilitation of aircraft inspections**	Pre-screening of Suspected Unauthorised Parts (SUP) by cross-checking that the transacted part (as defined by P/N, S/N or other attributes of the respective part) is not under the incidence of an unapproved part notification issued by a Regulator and reflected in the corresponding	**(D1)** The blockchain hosted transaction of a part would enable as a precondition for adding the transaction block to the chain (and inherently complete the transaction) a pre-screening of part P/N and S/N vs. the SUP databases of various Regulators; such a pre-screening via oracle execution would be a timely implemented safety net to prevent access or continued presence of SUP in the aviation ecosystem. **(D2)** Blockchain stored aircraft configuration would enable automated screening for SUP during aircraft inspection/audit instances.

[2] UBL is an alternate acceptable means of compliance (Alternate AMC) for cycle counting of engine critical parts on modern large civil engines; the UBL acronym designates a non-conventional, accurate and less conservative method of accounting for the life used during each flight, thus the remaining life of an engine Life Limited Part (LLP); already in-use by several engine OEMs, the UBL is referred to in aviation industry standards (see SAE ARP5987A) and regulatory documents (see FAA Policy PS-AIR-33.70-02).

[3] Although governing warranty adjudication is not directly under EASA's aviation safety regulatory umbrella, it was a blockchain use case mentioned by many stakeholders. See for reference, deliverable D2.2 Analysis of Investigations performed, page 11.

		regulatory database. Ability to combine physical and digital inspections to provide comprehensive oversight of an aircraft's condition, thanks to the facilitated audit trails generated by blockchain, could aid in the prevention of Suspected Unapproved Parts (SUP) cases, and ensuring up-to-date control status.	
UC7	**Configuration control**	Blockchain can benefit configuration control by providing a transparent and immutable record of changes, configurations, and the current state of aircraft components. For example, it can help when a configuration-based action is released (AD, SB), the operators can assess instantly the fleet's compliance (the same would work for OEMs and Authorities doing impact assessment)	**(D1)** Each part, at the time of entering the aviation ecosystem (e.g., as individual spare part or installed on a higher assy including a TC-ed product like engine or aircraft) should have its IPC related P/N and configuration info (e.g., aircraft installation applicability) specified; such info could be hosted on or linked to the blockchain. **(D2)** Parts undergoing maintenance events (e.g., installation, repair, modification, AD/SB embodiment) documented in Form1 stored in the blockchain would have the configuration control info inherently kept/updated. **(D3)** Establishing a trusted link and maintaining the match between the physical part and its documents is a challenge for the non-serialized parts.
UC8	**Parts scraping**	Ability to monitor and share across stakeholders all part scraping data.	**(D1)** Part scrapping of unsalvageable components is accompanied by part physical mutilation in a manner that ensures it cannot be restored for its intended aviation use; while this addresses the physical part issue, documenting the part as disposed from the aviation ecosystem and correspondent part identity follow-up would be protecting from emergence of bogus parts through identity theft; blockchain could facilitate such part documentation follow-up and be effective in raising SUP warnings accordingly. **(D2)** Recycling of scraped parts with appropriate documentation could answer the necessary "origin/sourcing" question posed by

			a functional circular economy in aviation industry. **(D3)** Potential storage in the blockchain of a "pairing/bridging proof" between the physical part and the blockchain hosted documents.
UC9	**Real time pre-screening of an EASA Form 1 and its issuing organization**	Real time pre-screening (conditioning the addition of the block in the chain) by cross-checking the identity of an EASA Form 1 issuing organization with the information available in Regulator's List of valid Part-145 organisations. The depth of this pre-screening could be extended to a full validity check of the issuers' credentials vs the EASA Form 1 actual use instance if real time access to the Part-145 Certificate with corresponding terms of approval (I.e. class/rating/limitations) would be achievable. A similar path could be applied for the use of the EASA Form 1 for production purposes (I.e. Part21 organizations).	**(D1)** The EASA Form1 (or equivalent – e.g. 8130-3) contained data minimum validation should confirm the existence of the issuing Part 145 organization; this could be performed by the blockchain (through oracle execution linked to the applicable list of approved Part 145 organisations maintained by the Competent Authority approving/overseeing the Part 145 organization) and should constitute a precondition for acceptance of the block addition to the chain. **(D2)** A more advanced validation of the EASA Form1 (or equivalent – e.g. 8130-3) contained data should confirm if the issuing Part 145 organization is acting within its scope, terms, limitations of approval – i.e., the ARC mentioned work performed is within the list of approved capabilities of the organization; this could be performed by the blockchain (through oracle execution linked to the CA approving/overseeing the Part 145 organization) and should constitute a precondition for acceptance of the block addition to the chain. **(D3)** Extension of the above (D1) to production organizations (approved under Part 21 F, G) who are using Form 1. **(D4)** Extension of the above (D2) to production organizations (approved under Part 21 F, G) who are using Form 1.

1.2 Regulatory Readiness Status and Gaps

This section presents, for each use case mentioned in 1.1, the main regulatory materials considered relevant to the use case and captures in a matrix format the regulatory documents readiness (see "+") and gaps (see "-", if any) identified as affecting the pursuit of each respective driving consideration of the use case. The same matrix format may include, on occasion, a mention of a regulatory document element (see "*") which, although presently assessed as neutral to the use case, should be closely monitored given its imminent evolution potential towards a "+" or a "-" impact to the respective use case. The table utilizes a matrix format where each row represents a specific regulation and each column represents a driving consideration.

UC1 - Aircraft parts back-to-birth traceability and airworthiness management	(D1) Authenticity, immutability, non-repudiation, and regulatory completeness	(D2) Hosting regulatory and commercial information	(D3) Documenting lifecycle entry and exit	(D4) Pairing/bridging physical parts with blockchain data
Continuing Airworthiness Regulation (EU) No 1321/2014	+Certification of maintenance of the part (be it ON or OFF aircraft) is required and regulated (e.g., see 145.A.50) + Rules authorizing use of Form 1 are under Appendix II to Part M and include the electronic system generated one; the latter guidance may prove valuable for info direct electronic entry in a blockchain + Form 1 info content and completion guidance is in Part M, Appendix II, Authorised Release Certificate — EASA Form 1 * There is no direct/specific requirement for the software tools used to track-and-trace the aircraft parts lifecycle.	+Certification of maintenance of the part (be it ON or OFF aircraft) is required and regulated (e.g., see 145.A.50) *There are no regulatory requirements for part's commercial implication transactional events (e.g., selling or buying the part, relocating the part in the inventory)	-There is no robust documentation requirement that accompanies the part withdrawal/disposal from the aviation ecosystem (i.e., a form that would document the part permanent withdrawal from service, the end of the part life cycle started with a part production Form1)	*Excepting serialized parts, there is no requirement to enable unique identification of a part to ensure trusted "pairing/bridging proof" between the physical part and its documents
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ Rules authorizing use of Form 1 are under 21.A.130 and 21.A.163 and include the electronic system generated one + Form 1 info content and completion guidance is in	*There are no explicit regulatory requirements and none is envisaged; for part's commercial life and related transactional events (e.g., selling or buying the part,	+The production of a new part has reasonably documentation requirements established (see Subparts G, K, Q); especially robust for the critical parts (see 21.A.805)	*Excepting critical parts (see 21.A.805), there is no requirement to enable unique identification of a part to ensure trusted "pairing/bridging proof" between the physical part and its documents beyond

	Appendix I to Annex 1 (Part 21) Authorised Release Certificate — EASA Form 1 * EASA's policy is to be less prescriptive to allow a level playing field and there is no direct/specific requirement for the software tools used to track-and-trace the aircraft parts lifecycle;	relocating the part in the inventory); only a clear aviation safety related element of commercial event origin would trigger introduction of said regulatory requirements.		part marking IAW 21.A.804

UC2 - Real-time pre-screening and smart contracts for audits	(D1) Validation of authorized signatory via blockchain oracles	(D2) Automation of auditing sequences using smart contracts	(D3) Extension of D1 to production organizations	(D4) Extension of D2 to production organizations
Continuing Airworthiness Regulation (EU) No 1321/2014	+ Rules authorizing use of Form 1 are under Appendix II to Part M + Form 1 info content and completion guidance is in Part M, Appendix II, Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable, the Form 1 issuing Part145 org. should allow access to the list of its certifying staff with their scope of authorisation (list required by 145.A.70)	+ Rules authorizing use of Form 1 are under Appendix II to Part M + Form 1 info content and completion guidance is in Part M, Appendix II, Authorised Release Certificate — EASA Form 1 - For executing the Form 1 auditing smart contract, all such forms issued by the Part145 should be stored on a blockchain having access to the list of Part145 certifying staff with their scope of authorisation which was valid at the time of issuing the Form1 (list required by 145.A.70)	N/A	N/A

Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	N/A	N/A	+ Rules authorizing use of Form 1 are under 21.A.130 and 21.A.163 + Form 1 info content and completion guidance is in Appendix I to Annex 1 (Part 21) Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable, the Part21G should allow access to a POA database containing the list of certifying staff authorised by the production org to sign-off Form1 (see 21.A.143(a)5)	+ Rules authorizing use of Form 1 are under 21.A.130 and 21.A.163 + Form 1 info content and completion guidance is in Appendix I to Annex 1 (Part 21) Authorised Release Certificate — EASA Form 1 - For executing the Form 1 auditing smart contract, all such forms issued by the Part21G should be stored on a blockchain having access to the list of Part21G certifying staff with their scope of authorisation valid at the time of issuing the Form1 (list required by 21.A.143(a)5)
Part-IS: Rules for Information Security (Regulations (EU) 2023/203 and 2022/1645)	+ General Information Security obligations established by Annex II (Part IS.I.OR) for Part-145 and Part-CAMO org. are neutral for blockchain use. * Specific provisions placeholder is Annex VII to Part IS; blank at this time; to be monitored for blockchain relevant provisions future emergence (low likelihood).		+ General Information Security obligations established by Part IS.D.OR for Part-21 G org. are neutral for blockchain use. * Specific provisions placeholder in Annex IV to Part IS; blank at this time; to be monitored for blockchain relevant provisions future emergence (low likelihood).	

UC3 - Maintenance and operational history for efficient life limit utilisation	(D1) Trusted update of LLP data	(D2) Inclusion of regulatory document pointers
Continuing Airworthiness Regulation (EU) No 1321/2014	+ Regulatory set requirements detail the obligation for implementing and maintaining the aircraft continuing airworthiness record system (see M.A.305) including the records from which the current status of life-limited and time-controlled parts can be	* There are no specific provisions to prevent or require use of e-documenting in general and blockchain solution in particular for part life, configuration, operational and/or maintenance status tracking and tracing

	determined and documenting each time a life-limited part is placed in service or removed from service. * There are no specific provisions to prevent or require use of e-documenting in general and blockchain solution in particular for part life, configuration, operational and/or maintenance status tracking and tracing.	* Algorithms to account for accumulated life consumption may have IP-ed alternatives which are not transparent to airline operators.
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ Regulatory provisions require the part designer/manufacturer to identify life-limited parts and define life limits expressed in operational trackable part usage parameters and any part inspection requirements related to part accumulated life + Regulatory requirements govern change management for related life-limit impact (e.g. see Subpart D) on product and parts * There are no specific provisions to prevent or require use of e-documenting in general and blockchain solution in particular for part life and configuration definition.	* There are no specific provisions to prevent or require use of e-documenting in general and blockchain solution in particular for part life and configuration definition. * While the obligation for obtaining regulatory approval of airworthiness limitations section of the instructions for continued airworthiness as defined by the applicable certification specifications is part of the Type Design (see 21.A.31), the algorithm to account for accumulated life consumption may have IP-ed alternatives without third party accessibility.

UC4 - Registration systems	(D1) Validation of licences via blockchain oracles	(D2) Dedicated blockchain for hosting and sharing CA registered assets
Continuing Airworthiness Regulation (EU) No 1321/2014	- For blockchain oracle to be executable, the Member State CA would have to allow access to the list of aircraft maintenance licence holders of maintenance licences issued by the State i.a.w. Part-66 Section B, Subpart B; there is no regulatory provision requiring the MS to make such info readily available to third parties (i.e., other than the CA and the Licence Holder)	* The maintenance personnel licensing rules are implemented by each State through the respective CA following EASA issued/enforced regulation; nevertheless, it is individual State rules & procedures which would grant or restrict access for a blockchain based solution for tracking such licenses.
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	N/A	N/A

UC5 - Warranty adjudication[4]	(D1) Trusted documentation and automated adjudication via smart contracts
Continuing Airworthiness Regulation (EU) No 1321/2014	+ The Operator obligation to follow the OEM issued ICAs is specified (e.g. see M.A.302; M.A.401; M.A.801) * Managing of commercial contract covered warranties and guarantees offered by the Seller (OEM) to the Buyer (Operator/Owner) is not addressed in the regulation; no regulatory restriction identified for using blockchain technology to execute such contract if/as agreed by the parties to the contract.
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ The OEM obligation to issue, maintain and make available ICAs is specified (see 21.A.7) * Managing of commercial contract covered warranties and guarantees offered by the Seller (OEM) to the Buyer (Operator/Owner) is not addressed in the regulation; no regulatory restriction identified for using blockchain technology to execute such contract if/as agreed by the parties to the contract.

UC6 - Pre-screening for Suspected Unauthorised Parts (SUP) and facilitation of aircraft inspections	(D1) Pre-screening of parts via blockchain oracles execution	(D2) Automated screening during aircraft inspection
Continuing Airworthiness Regulation (EU) No 1321/2014	+ The regulation mandates for the operator to execute both an incoming inspection of a part and the installation eligibility inspection of the part; in each of those events, the automatic screening of the part against various Regulator SUP lists/databases could be executed by a blockchain oracle. *storing/linking the above inspection info in/to a blockchain is not prohibited by the regulation. + For blockchain oracle to be executable, the various CAs should allow access to their SUP lists/databases (which they generally do via their website – e.g., see https://www.easa.europa.eu/en/domain	+ The aircraft configuration would be controlled as mentioned in UC7 - Configuration control (D1) and (D2) + For blockchain oracle to be executable at the time of inspection/audit instances, the various CAs should allow access to their SUP lists/databases (which they generally do via their website – e.g., see https://www.easa.europa.eu/en/domains/aircraft-products/suspected-unapproved-parts).

[4] Although governing warranty adjudication is not directly under EASA's aviation safety regulatory umbrella, it was a blockchain use case mentioned by many stakeholders. See for reference, deliverable D2.2 Analysis of Investigations performed, page 11.

	s/aircraft-products/suspected-unapproved-parts).	
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ The aircraft configuration would be controlled as mentioned in UC7 - Configuration control (D1) and (D2) + For blockchain oracle to be executable at the time of manufacturing installation of parts, the various CAs should allow access to their SUP lists/databases (which they generally do via their website – e.g., see https://www.easa.europa.eu/en/domains/aircraft-products/suspected-unapproved-parts).	+ The aircraft configuration would be controlled as mentioned in UC7 - Configuration control (D1) and (D2) + For blockchain oracle to be executable at the time of production process inspection/audit instances, the various CAs should allow access to their SUP lists/databases (which they generally do via their website – e.g., see https://www.easa.europa.eu/en/domains/aircraft-products/suspected-unapproved-parts).

UC7 - Configuration control	(D1) Detailed part entry with configuration information	(D2) Maintenance events updating configuration control	(D3) Linking documents to non-serialized parts
Continuing Airworthiness Regulation (EU) No 1321/2014	+ The newly delivered aircraft configuration is provided at the time of delivery by the manufacturer (see 21.A.165 and 21.A.129) and continually maintained by the operator through continuing airworthiness obligations it has for the aircraft it operates, including installation of new parts (see M.A.501) Subsequent modifications of the aircraft should be approved by Part 21 approved organizations, and modification implementation (by 145 organizations) registered under same maintenance requirementSuggested add	+ The regulation defines authorised release certificate (EASA Form 1 or equivalent) use, content and circulation obligations. *storing/linking such info in/to a blockchain is not prohibited by the regulation. Maintenance organizations have to make available on the blockchain all continuing airwrothiness data (AD, SB implementation, parts installed, etc) Suggested add	* Relying entirely on using the path initiated at manufacturing for part identification and marking through implementation of Part 21 Subpart Q

	+ The aircraft which is permanently transferred from one owner or operator to another (thus not a delivery of a new aircraft from the OEM), must be accompanied by the transfer of all necessary continuing airworthiness records including aircraft configuration relevant ones. *storing/linking the aircraft configuration relevant info in/to a blockchain is not prohibited by the regulation.		
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ The manufacturer has the obligation to provide to the operator technical records which identify the location and serial numbers of components that have traceability requirements for continued airworthiness (see 21.A.165 and 21.A.129); *storing/linking such info in/to a blockchain is not prohibited by the regulation.	+ The production inspections system (see 21.A.139 and 21.A.126) would ensure identification of incoming materials and parts and provide, following manufacturing of the product or part, the applicable statement of conformity (see 21.A.163 and 21.A.130) *storing/linking such info in/to a blockchain is not prohibited by the regulation.	* The Subpart Q is addressing identification of all manufactured products, parts and appliances; for products and critical parts the path robustness for unique individual identification is ensured; for other categories the regulation effects are limited to tracing batches of parts.

UC8 - Parts scraping	(D1) Documentation of scrapped parts to prevent bogus parts	(D2) Recycling of scrapped parts with appropriate documentation	(D3) Storing pairing/bridging proofs on the blockchain
Continuing Airworthiness Regulation (EU) No 1321/2014	+ Rules addressing disposal of LLPs, segregation of unsalvageable components and the mutilation of such components are specified in Part-M (M.A.504	– There is no robust documentation requirement that accompanies the part withdrawal/disposal from the aviation ecosystem (e.g., a sort of "death certificate" document closing the life of the respective which part	* Relying entirely on using the path initiated at "birth of the part" through implementation of Part 21 Subpart Q to address identification of products, parts and appliances; for products and critical parts

	including AMC and GM) and Part-145 (145.A.42 including AMC and GM) + Acceptance of parts for installation is conditional on them passing an incoming physical inspection (see Part-145; AMC1/GM1 145.A.42 (b)(i)) and thus would make mutilated part non-eligible for installation	started with a Form1 ARC); provision regarding the original part number or data plate information removal or keeping a record of the disposal of the part may be too weak and not sufficiently practical (see AMC1 145.A.42(c)) to guard against SUP.	the path is sufficiently robust.
Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	+ Rules addressing eligibility of parts and appliances for installation, and thus, implicitly the non-eligibility of discarded/scraped parts are specified in Part-21 Subpart K (21.A.305/307 including AMC and GM)	N/A	* The Subpart Q is addressing identification of products, parts and appliances; for products and critical parts the path is sufficiently robust.

UC9 - Real time pre-screening of an EASA Form 1 and its issuing organization	(D1) Basic validation of issuing Part-145 organization	(D2) Advanced validation of issuing organization's scope and limitations	(D3) Extension of D1 to production organizations	(D4) Extension of D2 to production organizations
Continuing Airworthiness Regulation (EU) No 1321/2014	+ Rules authorizing use of Form 1 are under Appendix II to Part M + Form 1 info content and completion guidance is in Part M, Appendix II, Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable, the CA should allow access to a database of Part145	+ Rules authorizing use of Form 1 are under Appendix II to Part M + Form 1 info content and completion guidance is in Part M, Appendix II, Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable, the CA should allow access to a database of Part145 which includes the scope	N/A	N/A

		of approval (i.e., rating and limitations) – note that is already embraced by EASA: see EASA link; for NAAs to catch-up;		
Rules for Airworthiness and Environmental Certification Regulation (EU) No 748/2012	N/A	N/A	+ Rules authorizing use of Form 1 are under 21.A.130 and 21.A.163 + Form 1 info content and completion guidance is in Appendix I to Annex 1 (Part 21) Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable and trusted, the CA should provide the means to prove that the database of POAs[5] (i.e., Issued Form 55) is up to date when queries are made by smart contracts.	+ Rules authorizing use of Form 1 are under 21.A.130 and 21.A.163 + Form 1 info content and completion guidance is in Appendix I to Annex 1 (Part 21) Authorised Release Certificate — EASA Form 1 - For blockchain oracle to be executable and trusted, the CA should provide the means to prove that the database of POAs (i.e., Issued Form 55) is up to date when queries are made by smart contracts. Also, the POA should allow access to the authorised person list (i.e., Block 13d eligible persons).
Part-IS: Rules for Information Security (Regulations (EU) 2023/203 and 2022/1645)	+ General Information Security obligations established by Annex II (Part IS.I.OR) for Part-145 and Part-CAMO org. are neutral for blockchain use. * Specific provisions placeholder is Annex VII to Part IS; blank at this time; to be monitored for blockchain relevant		+ General Information Security obligations established by Part IS.D.OR for Part-21 G org. are neutral for blockchain use. * Specific provisions placeholder in Annex IV to Part IS; blank at this time; to be monitored for blockchain relevant	

[5] Status of EASA Production Organisation Approvals, EASA Website, https://www.easa.europa.eu/en/datasets/status-easa-production-organisation-approvals

	provisions future emergence (low likelihood).	provisions future emergence (low likelihood).

It should be noted that, while only EASA body of regulation provisions were referred to above, there is a sufficiently robust equivalence to be found with aviation regulation in force in other regulatory jurisdictions - especially in the case of major ones (e.g. FAA) with which EASA has established Bilateral Aviation Safety Agreements (BASA).

1.3 Standards Readiness Status and Gaps

This section presents, for each use case mentioned in 1.1, the main standards documents considered relevant to the use case and captures in a matrix format the standards' readiness (see "+") and gaps (see "-", if any) identified as affecting the pursuit of each respective driving consideration of the use case. The same matrix format may include, on occasion, a mention of a standards document element (see "*") which, although presently assessed as neutral to the use case, should be closely monitored given its imminent evolution potential towards a "+" or a "-" impact to the respective use case.

<table>
<tr><th>UC1 - Aircraft parts back-to-birth traceability and airworthiness management</th><th>(D1) Authenticity, immutability, non-repudiation, and regulatory completeness</th><th>(D2) Hosting regulatory and commercial information</th><th>(D3) Documenting lifecycle entry and exit</th><th>(D4) Pairing/bridging physical parts with blockchain data</th></tr>
<tr><td>ATA Spec 2500

Aircraft Transfer Records</td><td colspan="4">- Addressing aircraft level and implicitly only on aircraft installed components.
*Specification facilitates communication of information between companies and therefore there is no need, nor is it desirable to standardize internal company processes. The XML datasets covered by the Specification are: AD Status, SB/Modification/STC Status, Repair Damage Status, Installed Component Status, Last Done Next Due Maintenance Status, Aircraft Status and Event List.

+Update to be released in 2024 addressing the LLP history data.

+New project has begun to provide back-to-birth traceability data exchange specification for components.</td></tr>
<tr><td>ATA Spec 2000 (Ch. 16) Authorized Release Certificate</td><td colspan="4">+Specification is describing the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies.
+The Electronic Part Certification Form (e-Form) is created for and used to transmit data corresponding to the applicable forms issued by CASA, EASA, FAA, TCCA.
* The reference to and alignment with Part-IS provisions must be validated.</td></tr>
<tr><td>Spec 42: Aviation Industry Standards for Digital Information Security</td><td colspan="4">+Specification provides recommendations on standardized methods to achieve the appropriate level of security for an application primarily relying on digital identities and transitioning in some cases from an existing manual process over time to a fully functioning automated digital identity-based solution. The specification's intent is to support various levels of users and security requirements and guide an airline through that transition process.
*Must validate that blockchain technology (although not specifically named in the present document) is conforming to this specification.
* The reference to (formally absent) and alignment with Part-IS provisions must be validated.</td></tr>
</table>

UC2 - Real-time pre-screening and smart contracts for audits	(D1) Validation of authorized signatory via blockchain oracles	(D2) Automation of auditing sequences using smart contracts	(D3) Extension of D1 to production organizations	(D4) Extension of D2 to production organizations
ATA Spec 2000 (Ch. 16) Authorized Release Certificate	* The blockchain implemented solution should be conversant with and take advantage of this specification which describes the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies (thus, implicitly between Part145 org, Part21 org, Airlines) +The Electronic Part Certification Form (e-Form) is created for and used to transmit data corresponding to the applicable forms issued by CASA, EASA, FAA, TCCA. * The reference to and alignment with Part-IS provisions must be validated. -The Form1 issuing organization's list of authorized employees is outside the specification focus; blockchain solution has to separately address that with applicable Part145 and/or Part21 organizations.			
Spec 42: Aviation Industry Standards for Digital Information Security	+Specification provides recommendations on standardized methods to achieve the appropriate level of security for an application primarily relying on digital identities and transitioning in some cases from an existing manual process over time to a fully functioning automated digital identity-based solution. The intent of the specification is to support a variety of levels of users and security requirements and guide an airline through that transition process. *Must validate that blockchain technology (although not specifically named in the present document) is conforming to this specification. * The reference to (formally absent) and alignment with Part-IS provisions must be validated.			

UC3 - Maintenance and operational history for efficient life limit utilisation	(D1) Trusted update of LLP data	(D2) Inclusion of regulatory document pointers
ATA Spec 2500 **Aircraft Transfer Records**	- Addressing aircraft level and implicitly only on aircraft installed components. +Specification facilitates tracking and tracing of all on-aircraft LLPs including their life consumption and should ensure a robust source of info to the blockchain solution.	- Addressing aircraft level and implicitly only on aircraft installed components. *Any life consumption algorithm specific regulatory approvals / considerations are not presently captured; the focus is presently on the numerical outcome, but relevant documented UBL approvals/rationale could be added/linked to.

UC4 - Registration systems	(D1) Validation of licences via blockchain oracles	(D2) Dedicated blockchain for hosting and sharing CA registered assets
There are no industry standards for CA	N/A	N/A

registration systems.		

UC5 - Warranty adjudication	(D1) Trusted documentation and automated adjudication via smart contracts
ATA Spec 2000 (Ch. 14) Warranty Claims	*A blockchain solution could rely on this specification focused on descriptions of the data and processes necessary for the exchange of electronic warranty claims but does not include the internal processes that companies use to generate the data, authorize users of the data, nor process, store, or repurpose the data; while it simplifies and standardizes warranty claim transactions between the claimant and the warrantor, it is not blockchain specific.

UC6 - Pre-screening for Suspected Unauthorised Parts (SUP) and facilitation of aircraft inspections	(D1) Pre-screening of parts via blockchain oracles execution	(D2) Automated screening during aircraft inspection
ATA Spec 2000 (Ch. 16) Authorized Release Certificate	* The blockchain implemented solution should be conversant with and take advantage of this specification which describes the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies (thus, implicitly between Part145 org, Part21 org, Airlines) +The Electronic Part Certification Form (e-Form) is created for and used to transmit data corresponding to the applicable forms issued by CASA, EASA, FAA, TCCA. * The reference to and alignment with Part-IS provisions must be validated. -The SUP databases of Regulators are not within the scope of this Specification and any P/N and S/N screening should be addressed by the blockchain solution separate of this Spec.	
ATA Spec 2400 Allowable Configuration Data Exchange Standard	N/A	+Addressing the standardized file which defines the Allowable Configuration of an aircraft and its major components applicable to maintenance and airworthiness, this specification is important to a blockchain storing aircraft configuration and enabling the auditing of aircraft Actual Configuration. -The SUP databases of Regulators are not within the scope of this Specification and any P/N and S/N screening should be addressed by the blockchain solution separate of this Spec.

UC7 - Configuration control	(D1) Detailed part entry with configuration information	(D2) Maintenance events updating configuration control	(D3) Linking documents to non-serialized parts

ATA Spec 2000 (Ch. 16) Authorized Release Certificate	+The Spec presented Electronic Part Certification Form (e-Form) is created for and used to transmit data corresponding to the applicable forms issued by CASA, EASA, FAA, TCCA. +This specification describes the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies (thus, implicitly between Part145 org, Part21 org, Airlines); it would cover any configuration change of a part requiring a Form1	N/A since out of the scope of this Spec.
ATA Spec 2400 Allowable Configuration Data Exchange Standard	+The Spec would enable blockchain visibility over on-aircraft installed parts Allowable and Actual Configuration (i.e., including the respective P/N; S/N; applicable ADs and SBs)	N/A since out of the scope of this Spec.

UC8 - Parts scraping	(D1) Documentation of scrapped parts to prevent bogus parts	(D2) Recycling of scrapped parts with appropriate documentation	(D3) Storing pairing/bridging proofs on the blockchain
There are no industry standards dedicated to scraping aviation individual parts. **Regarding aircraft asset decommissioning, some guidance is provided by:** **• The Best Management Practices (BMP) by the Aircraft Fleet Recycling Association (AFRA).** **• The Best Industry Practices for Aircraft Decommissioning (BIPAD) manual by IATA**	N/A	N/A	N/A

UC9 - Real time pre-screening of an EASA Form 1 and its issuing organization	(D1) Basic validation of issuing Part-145 organization	(D2) Advanced validation of issuing organization's scope and limitations	(D3) Extension of D1 to production organizations	(D4) Extension of D2 to production organizations
ATA Spec 2000 (Ch. 16) Authorized Release Certificate	* The blockchain implemented solution should be conversant with and take advantage of this specification which describes the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies (thus, implicitly between Part145 org, Part21 org, Airlines) -The Form1 issuing org scope of approval is outside the specification focus; blockchain solution has to separately address that with applicable Regulator (CA) database.			

	+The Electronic Part Certification Form (e-Form) is created for and used to transmit data corresponding to the applicable forms issued by CASA, EASA, FAA, TCCA. * The reference to and alignment with Part-IS provisions must be validated.
Spec 42: Aviation Industry Standards for Digital Information Security	+Specification provides recommendations on standardized methods to achieve the appropriate level of security for an application primarily relying on digital identities and transitioning in some cases from an existing manual process over time to a fully functioning automated digital identity-based solution. The specification's intent is to support various levels of users and security requirements and guide an airline through that transition process. *Must validate that blockchain technology (although not specifically named in the present document) is conforming to this specification. * The reference to (formally absent) and alignment with Part-IS provisions must be validated.

1.4 Gaps Generated Risk Matrix / Register

The regulatory provisions and industry standards gaps identified in the sections 1.2 and 1.3 constituted the basis of formalizing a series of perceived risks where regulation or standards would not optimally support the development of an aviation blockchain solution for use cases UC1-UC9. For each of the risks captured in the following table, a qualitative rating of low, medium or high was attached to the likelihood of the risk to occur and to the consequential impact of the risk on the development of a blockchain solution.

Risk No.	Risk Description	Risk Categorization	
		Likelihood	Impact
R1 – Pairing physical parts with blockchain documents	With practically unlimited extension of document tracking potential provided by a blockchain solution, the trusted and unequivocal pairing of the part documents with the physical part becomes essential to fully unlock the added value of such a solution. While this is mostly settled by regulation for serialized parts, the risk of mismatch of the two (accidental or on-purpose) is not robustly prevented for non-serialized parts.	Medium	Medium
R2 – Lack of documentation for Part Withdrawal	Permanent withdrawal of a part from service is not documented by a required form (thus, not closing the life-loop opened with a Form 1 at the time of part production). The absence of such regulatory provision risks lowering barriers preventing SUP from entering the aviation	Low	High

	market and could negatively affect the aviation circular economy efficiencies on long run (due to non-reliable source tracking of aviation recyclable materials).		
R3 – Part-IS compliance and blockchain integration	The Part-IS compliance of Part 21, Part 145 and Part CAMO organizations could bring Information Security Management System (ISMS) elements which an aviation blockchain solution should prioritize addressing. Not supporting that in the development of a block chain solution, risks jeopardizing Part-IS compliance of the mentioned organizations.	Low	Medium
R4 – Access to Part-145 approval lists	Accessing the list/database of Part-145 org approvals and scope of approvals issued by the CA is needed for executing blockchain oracles. The risk is that the CA may not grant such access outside the CA organization.	Low	High
R5 – Access to certifying staff authorization lists	Accessing the list/database of certifying staff authorized (and their scope of authorization) by Part-145 or Part-21 organizations is needed for executing blockchain oracles. The risk is that the Part-145 or Part-21 organizations may not grant such access outside the respective organization.	Medium	Medium
R6 – Access to aircraft maintenance licence holder lists	Accessing the CA list/database of aircraft maintenance licence holders of maintenance licences issued by the CA is needed for executing blockchain oracles. The risk is that the CA may not grant such access outside the CA organization.	Low	Medium
R7 – Knowledge gaps in blockchain technology for aviation	The knowledge and understanding of blockchain technology by aviation staff of industry stakeholders and CAs alike is necessary for considering and promoting such technology for aviation implementations. The risk is that the present low level of knowledge and understanding is not timely addressed, and apocryphal statements jeopardize technology's real attributes and potential delivered performance.	Medium	High
R8 – Initial implementation	The emergence of initial implementations of aviation blockchain based solutions will be met by CAs with the natural reserve and precaution towards a novel approach. The risk is that	Medium	High

challenges for aviation blockchain	blockchain solution providers may not allocate sufficient effort to socialize their solution with the CAs, engage regulators for product familiarity, address feedback and implement suggested improvements for an effective presence in the aviation market.		
R9 – Combining airworthiness and commercial records with blockchain	The blockchain solution for parts tracking combines elements of (the highly regulated) airworthiness records for aviation manufacturing and maintenance with (the less or non-regulated) commercial records for supply chain and logistics. The risk is of losing track of segregation between the "must-have" and the "nice-to-have" elements when penetrating the aviation market.	Medium	High

2. REGULATORY AND STANDARDS READINESS FOR BLOCKCHAIN-BASED SOLUTIONS

2.1 Use cases and associated impacts on blockchain technical specifications.

This section presents, for each use case and blockchain driving considerations mentioned in 1.1, the most significant impacts that these cases have on the blockchain development and technological specifications.

Use Case 1 (UC1) addresses the aircraft parts back-to-birth traceability and airworthiness management, and refers to the ability to track-and-trace the entire lifecycle of aircraft parts from manufacture to disposal.

UC1 Driving Considerations - Aircraft parts back-to-birth traceability and airworthiness management	(D1) Authenticity, immutability, non-repudiation, and regulatory completeness	(D2) Hosting regulatory and commercial information	(D3) Documenting lifecycle entry and exit	(D4) Pairing/bridging physical parts with blockchain data
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure compliance and controlled access. • The data model design, to manage effectively complex data structures and accommodate comprehensive documentation and regulatory requirements. • The selection of the data sharing protocol between nodes to enforce data immutability.	Affects: • The data model design, and specifically the split between On and Off-chain data to balance performance with cost and privacy considerations. • The data model design to include varied data types. • The decentralization approach in the data validation consensus mechanism.	Affects: • The blockchain type selection, to ensure compliance and controlled access. • The blockchain type selection, to manage strict regulatory controls on part lifecycle transitions. • The data model design, to track and verify the complete lifecycle of parts. • The selection of the data sharing protocol between nodes to enforce data immutability. • The decentralization approach in the data validation consensus mechanism.	Affects: • The choice of unique identifiers to use to securely link physical parts with blockchain records. • The data model design to incorporate proofs of linkage in physical-digital pairing. • The blockchain type selection, to support advanced functionalities such as smart contracts for automatic verification of parts and documents. • The decentralization approach to maintain transparency and trust while managing complex

				identification systems.

Use Case 2 (UC2) addresses the real-time pre-screening and smart contracts[6] for audits, by cross-checking the authorization of an EASA Form 1 signatory person with the information available in the EASA Form 1 issuing organization database. This use case also refers to the ability to automate data audits using smart contracts capacities of blockchain, ensuring EASA Form 1 status updates and compliance with regulatory standards.

<table>
<tr><th>UC2 Driving Considerations - Real-time pre-screening and smart contracts for audits</th><th>(D1) Validation of authorized signatory via blockchain oracles</th><th>(D2) Automation of auditing sequences using smart contracts</th><th>(D3) Extension of D1 to production organizations</th><th>(D4) Extension of D2 to production organizations</th></tr>
<tr><td>Impact on blockchain's development and technical specifications</td><td>Affects:
• The blockchain type selection, to support the integration of oracles to verify external data.
• The consensus mechanism design, to incorporate real-time checks and validations against an external database of authorized signatories
• The selection of the security protocols, to ensure secure and tamper-proof data interactions between the blockchain and external databases</td><td>Affects:
• The blockchain type selection, to support advanced smart contract functionalities, necessary for automating complex auditing processes.
• The data model design, to structure data in a way that can be efficiently managed and manipulated by smart contracts.</td><td colspan="2">Affects:
• The decentralization approach to facilitate broader industry participation and data sharing between different types of organizations.
• The data model design, to adapt to the additional requirements of production organizations using Form 1.</td></tr>
</table>

[6] A smart contract is a contract that is automatically executed when predefined clauses are fulfilled using computer technology. The initial advantage of using smart contracts is the automation of the trusted third party, based on the transparency and immutability of blockchain. Execution of the contract can trigger actions such as triggering a payment, transferring ownership of a digital twin, or updating a status on the blockchain network.

Use Case 3 (UC3) addresses the maintenance and operational history for efficient life limit utilisation, and the ability to monitor LLPs configuration, operational and maintenance history, thanks to better cross-stakeholders' data transmission.

UC3 Driving Considerations - Maintenance and operational history for efficient life limit utilisation	(D1) Trusted update of LLP data	(D2) Inclusion of regulatory document pointers
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure secure and authorized updates of LLP data. • The data model design to accurately track and record the operational control parameters and conditions. • The blockchain type selection, for efficient implementation of smart contracts to automate data updates and validations based on predefined conditions. • The selection of the data sharing protocol between nodes to enforce data immutability.	Affects: • The blockchain type selection, to ensure it can handle complex data structures, including pointers to external regulatory documents. • The data model design, to include secure and retrievable references to external documents. • The decentralization approach, to ensure all data associated with life control parameters are updated in accordance with current regulations and approvals. • The data model design and accessibility settings, ensuring that pointers to regulatory documents are accessible to authorized parties for review and compliance verification.

Use Case 4 (UC4) addresses registration systems, and the ability to track a variety of data such as pilot and mechanic's licenses, experience or status of medical reports and share it across stakeholders. In the case of medical reports data, the use of blockchain could be limited solely to the collection and sharing of a status, to avoid the decentralized storage of personal data and conflict with the GDPR. This potential conflict with the GDPR is detailed in a dedicated analysis in the Regulatory readiness status and gaps part.

UC4 Driving Considerations - Registration systems	(D1) Validation of licences via blockchain oracles	(D2) Dedicated blockchain for hosting and sharing CA registered assets
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure controlled access, verified data updates and GDPR compliance. • The blockchain type selection, for efficient implementation of smart contracts designed to automate the validation process using oracles to access external certification authority (CA) databases.	Affects: • The blockchain type selection, to manage and share sensitive information related to aviation assets and personnel, and to ensure compliance with the GDPR. • The data model design, to manage different types of licenses and registrations, including detailed attributes for each asset or personnel.

	• The blockchain type selection, for efficient implementation of oracles to securely verify licences against external databases. • The consensus mechanism and the level of decentralization, to ensure that only accurate and validated information is recorded and maintained.	• The data model design and accessibility settings, ensuring that stakeholders can retrieve up-to-date information as needed for operational and regulatory purposes, possibly at different levels of access.

Use Case 5 (UC5) addresses warranty adjudication and the ability to automate and validate warranty claims automatically using smart contracts[7] and oracles.

UC5 Driving Considerations - Warranty adjudication	(D1) Trusted documentation and automated adjudication via smart contracts
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure compliance and controlled access by OEMs, airlines and MROs. • The blockchain type selection, to ensure efficient implementation of smart contracts and oracles that automatically execute warranty adjudications based on verified events recorded on the blockchain. These contracts would be programmed to assess warranty claims based on predefined criteria and automatically process valid claims. • The consensus mechanism, to ensure that all documents and event logs hosted on the blockchain are verifiable, thus eliminating disputes and reducing fraudulent claims. • The data model design, to structure complex event records and associated documentation that detail the part's lifecycle events pertinent to all warranty condition types. • The decentralization approach and the selection of compliance and audit mechanisms, to ensure that all warranty adjudications are conducted according to the terms agreed upon in the warranty contracts and are in line with regulatory standards.

Use Case 6 (UC6) addresses the pre-screening for Suspected Unauthorised Parts (SUP) and facilitation of aircraft inspections, by cross-checking that the transacted part (as defined by P/N, S/N or other attributes of the respective part) is not under the incidence of an unapproved part notification issued by a Regulator and reflected in the corresponding regulatory database. This use case refers to the ability to combine physical and digital inspections to provide comprehensive oversight of an aircraft's condition, thanks to the facilitated audit trails generated by blockchain, could aid in the prevention of Suspected Unapproved Parts (SUP) cases, and ensuring up-to-date control status.

UC6 Driving Considerations- Pre-screening for Suspected Unauthorised Parts	(D1) Pre-screening of parts via blockchain oracles execution	(D2) Automated screening during aircraft inspection

[7] A smart contract is a contract that is automatically executed when predefined clauses are fulfilled using computer technology. The initial advantage of using smart contracts is the automation of the trusted third party, based on the transparency and immutability of blockchain. Execution of the contract can trigger actions such as triggering a payment, transferring ownership of a digital twin, or updating a status on the blockchain network.

(SUP) and facilitation of aircraft inspections		
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure controlled access and verified updates. • The blockchain type selection, for efficient implementation of oracles to perform real-time checks against SUP databases maintained by regulators to validate part numbers (P/N) and serial numbers (S/N) before transaction completion. • The blockchain type selection, to ensure efficient implementation of smart contracts designed to automate the pre-screening process and enforce compliance checks before any blockchain transaction is finalized. • The consensus mechanism design, to ensure the real-time check and pre-screening of parts before transaction finalization.	Affects: • The data model design, to manage complex and various data types related to aircraft configurations and maintenance histories. • The blockchain type selection, to ensure efficient implementation of smart contracts designed to automate the screening process during aircraft inspections, checking current configurations against a registry of unapproved parts.

Use Case 7 (UC7) addresses configuration control enhanced by blockchain, by providing a transparent and immutable record of changes, configurations, and the current state of aircraft components. For example, it can help when a configuration-based action is released (AD, SB), the operators can assess instantly the fleet's compliance (the same would work for OEMs and Authorities doing impact assessment).

UC7 Driving Considerations - Configuration control	(D1) Detailed part entry with configuration information	(D2) Maintenance events updating configuration control	(D3) Linking documents to non-serialized parts
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure controlled access and verified updates. • The data model design, to include detailed configuration information for each part at the time of its entry into the aviation ecosystem • The consensus mechanism and level of decentralization, to ensure that the initial configuration data is accurately captured and remains immutable. • The blockchain type selection, to ensure efficient implementation of	Affects: • The blockchain type selection, to ensure efficient implementation of smart contracts to automate updates to configuration information following maintenance events like repairs or modifications. • The decentralization approach and the selection of compliance and audit mechanisms, to ensure that each part's configuration record is maintained up-to-date and is compliant with relevant Airworthiness Directives (AD) or Service Bulletins (SB).	Affects: • The blockchain type selection, to incorporate features that can manage complex relationships between parts and their associated documentation. • The blockchain type selection and the data model design, to incorporate linking techniques for the association of documents with non-serialized parts. • The choice of unique identifiers to use to securely link physical parts with blockchain records. • The decentralization approach, to maintain transparency and trust

	smart contracts to automate the recording and validation of part configurations upon entry.		while ensuring that the digital records accurately reflect the physical state of parts, even those without serial numbers.

Use Case 8 (UC8) addresses parts scraping and the ability to monitor and share across stakeholders all part scraping data.

UC8 Driving Considerations - Parts scraping	(D1) Documentation of scrapped parts to prevent bogus parts	(D2) Recycling of scrapped parts with appropriate documentation	(D3) Storing pairing/bridging proofs on the blockchain
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure controlled access and verified updates. • The blockchain type selection, to ensure efficient implementation of smart contracts to automatically update the blockchain when a part is scrapped and ensure compliance with future SUP warnings. • The data model design, to include detailed documentation of parts being scrapped, including the method of destruction and final disposition. • The selection of the data sharing protocol between nodes to enforce data immutability.	Affects: • The blockchain type selection, to facilitate the tracking of recycled parts, ensuring traceability throughout the recycling process, while ensuring controlled access. • The consensus mechanism design and decentralization approach, to certify that all recycling actions adhere to industry standards and regulations. • The data model design to manage the origin and current status of recycled materials, supporting a functional circular economy.	Affects: • The blockchain type selection, to incorporate features that can manage advanced functionalities capable of handling complex proofs of authenticity. • The data model design to incorporate proofs of linkage in physical-digital pairing. • The choice of unique identifiers to use to securely link physical parts with blockchain records. • The decentralization approach to maintain transparency and trust while ensuring that the digital records accurately reflect the physical state and integrity of parts.

Use Case 9 (UC9) addresses the real time pre-screening of an EASA Form 1 and its issuing organization, by cross-checking the identity of an EASA Form 1 issuing organization with the information available in Regulator's List of valid Part-145 organisations. The depth of this pre-screening could be extended to a full validity check of the issuers' credentials vs the EASA Form 1 actual use instance if real time access to the Part-145 Certificate with corresponding terms of approval (I.e. class/rating/limitations) would be achievable. A similar path could be applied for the use of the EASA Form 1 for production purposes (I.e. Part21 organizations).

UC9 Driving Considerations - Real time pre-screening of an	(D1) Basic validation of issuing Part-145 organization	(D2) Advanced validation of issuing organization's scope and limitations	(D3) Extension of D1 to	(D4) Extension of D2 to

EASA Form 1 and its issuing organization			production organizations	production organizations
Impact on blockchain's development and technical specifications	Affects: • The blockchain type selection, to ensure controlled access and verified updates. • The blockchain type selection, for efficient implementation of oracles to perform real-time checks against the list of approved Part 145 organizations maintained by the competent authority. • The blockchain type selection, to ensure efficient implementation of smart contracts to automate the validation process and set it as a precondition for transaction approvals on the blockchain. • The consensus mechanism, guaranteeing that only verified organizations can issue an EASA Form 1.	Affects: • The blockchain type selection to support enhanced validation features that can handle complex checks regarding an organization's scope and limitations. • The blockchain type selection, for efficient implementation of oracles to access detailed data about the issuing organization's certification and approved capabilities directly from regulatory databases. • The blockchain type selection, to ensure efficient implementation of smart contracts to include checks that validate the scope of work declared in the EASA Form 1 against the approved capabilities of the issuing organization.	Affects: • The blockchain type selection, to ensure it can accommodate extensions to cover Part 21 F and G organizations, which may have different regulatory requirements from Part-145. • The data model design, to differentiate and manage validations specific to Part 145 and Part 21 organizations, accommodating various forms and approval terms. • The scalability considerations to handle the inclusion of more organizations and more complex data validations as the system extends to cover additional parts of the industry.	

The table below summarizes all the impacts of the blockchain Driving consideration factors (D) on the development choices and technical specifications of the blockchain, across all Use Cases (UC).

Impacts on blockchain's development and technical Specifications	**Concerned use cases (UC) and driving considerations factors (D)**	**Regulatory materials considered relevant to the specification**	**Standard documents considered relevant to the specification**

Blockchain type selection, decentralization approach and consensus mechanism design	UC1 (D1, D2, D3, D4) UC2 (D1, D2, D3, D4) UC3 (D1, D2) UC4 (D1, D2) UC5 (D1) UC6 (D1, D2) UC7 (D1, D2, D3) UC8 (D1, D2, D3) UC9 (D1, D2, D3, D4)	• Part-IS - Information security and organization requirements (Regulations (EU) 2023/203 and 2022/1645). • Regulation (EU) 2017/373 - Assessment of information security risk • Regulation (EU) 2016/679 - General Data Protection Regulation • EU Regulation 910/2014 - eIDAS - electronic IDentification, Authentication and trust Services • Regulation (EU) 2019/ 27 - European Aero-Medical Repository	• Spec 42: Aviation Industry Standards for Digital Information Security • ATA Spec 2000 (Ch. 16) Authorized Release Certificate
Data model design and accessibility settings, data sharing and security protocols selection	UC1 (D1, D2, D3, D4) UC2 (D1, D2, D3, D4) UC3 (D1, D2) UC4 (D2) UC5 (D1) UC6 (D2) UC7 (D1, D3) UC8 (D1, D2, D3) UC9 (D3, D4)	• Part-IS - Information security and organization requirements (Regulations (EU) 2023/203 and 2022/1645). • Acceptable Means of Compliance M.B.104 Record-keeping in Annex I to Part-M of Regulation (EU) No 1321/2014. • Acceptable Means of Compliance to Appendix II to Part-M — Use of the EASA Form 1 for maintenance • Acceptable Means of Compliance No 1 to 21.A.163(c): computer-generated signatures and digital certificates • Acceptable Means of Compliance related to record-keeping in Commission Regulation (EC) No 2042/2003 - Continuing Airworthiness • Regulation (EU) 2017/373 - Assessment of information security risk • Regulation (EU) 2016/679 - General Data Protection Regulation • Regulation (EU) 2019/ 27 - European Aero-Medical Repository	• ATA Spec 2500 - Aircraft Transfer Records
Unique identifiers selection	UC1 (D4) UC7 (D3) UC8 (D3)	• Continuing Airworthiness Regulation (EU) No 1321/2014 • Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	• None
Scalability considerations for digital twin management	UC9 (D3, D4)	• There is no regulation in aviation related to scalability topics in information systems	• None

2.2 Regulatory Readiness Status and Gaps

This section presents, for each impact on blockchain technical specification mentioned in 2.1, the main regulatory materials considered relevant to the specification and captures in a matrix format the regulatory documents readiness (see "+") and gaps (see "-", if any) identified as affecting the pursuit of each respective technical specification. The same matrix format may include, on occasion, a mention of a regulatory document element (see "*") which, although presently assessed as neutral to the specification, should be closely monitored given its imminent evolution potential towards a "+" or a "-" impact to the respective specification.

To identify gaps with the European Union's General Data Protection Regulation (GDPR), the analysis was based on the work of the European Parliamentary Research Service (EPRS), which studied the complex relationship between blockchain technologies and the European Union's General Data Protection Regulation (GDPR)[8].

Blockchain type selection, decentralization approach and consensus mechanism design	**Regulatory Readiness Status and Gaps**
Part-IS - Information security and organization requirements (Regulations (EU) 2023/203 and 2022/1645).	* Part-IS does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. * Part-IS does not require the use of any specific information security framework to develop the risk assessment or in general to implement risk management. + Part-IS makes references to several information security frameworks, providing sufficient references to customize and tailor these frameworks to meet the overall needs of an organization as well as the specific need to consider aviation safety aspects. + Part-IS makes references to other organizations providing guidance on Information Security such as the Computer Emergency Response Teams (CERTs), the Computer Security Incident Response Teams (CSIRTs), or the Information Sharing and Analysis Centers (ISACs). These organizations cover the risks associated with the use of blockchain technologies and can meet the needs of aviation stakeholders.

[8] European Parliamentary Research Service, 2019, BLOCKCHAIN AND THE GENERAL DATA PROTECTION REGULATION, https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf

Regulation (EU) 2017/373 - Assessment of information security risk	* The regulation does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. + The regulation defines the requirements in terms of information systems security management without explicitly mentioning a type of solution or architecture (ATM/ANS.OR.D.010 Security management, Subpart C of Annex III), and the requirements do not conflict with the technical specificities of the different types or decentralization architecture of blockchain. + The regulation defines record-keeping requirements that do not conflict with the different types of blockchain architecture, indicating that systems must be able to provide adequate storage, accessibility and reliable traceability (ATM/ANS.AR.B.015 Record-keeping, SUBPART B — MANAGEMENT), adequacy not referring here to an architectural setup of the information system.
Regulation (EU) 2016/679 - General Data Protection Regulation	The compatibility of blockchain with GDPR cannot be universally applied but must be assessed based on specific cases and configurations. Private, consortium and permissioned blockchains are generally more adaptable to GDPR compliance than public and permissionless ones due to their controlled access and governance structures (European Parliamentary Research Service). + Blockchain can support some GDPR goals by enhancing data transparency and auditability, and by enabling secure, decentralized data management systems. - Blockchain's decentralized nature conflicts with GDPR's requirement for clear data controllership. GDPR assumes identifiable controllers for personal data who can address data subjects' rights, whereas blockchain distributes data across multiple nodes, complicating accountability. - Blockchains are designed to prevent data alteration to ensure integrity, which contradicts GDPR's provisions for data modification and deletion under data subjects' rights. - Current legal uncertainties around blockchain's application to GDPR include the definitions of 'erasure', data minimization, and the exact roles and responsibilities of different actors in the blockchain ecosystem.
EU Regulation 910/2014 - eIDAS - electronic IDentification, Authentication and trust Services	The regulation establishes a presumption of reliability of the process for qualified electronic signatures (art. 26), i.e. to be linked to the signatory; to enable the signatory to be identified; to use signature creation data under the signatory's exclusive control; and to detect any subsequent modification of the data.

	- In a public or permissionless blockchain, it is difficult to guarantee the identity of the signatory. Although each user has a "personal" private key enabling them to authenticate themselves in the network, this key has been created by the blockchain protocol without verifying the identity of the creator. The immediate consequence of this situation is that the identity of users is arbitrarily self-declared. + Private, consortium and permissioned blockchains can overcome this difficulty by incorporating a procedure for certifying or verifying the identity of participants. For an electronic signature issued from a blockchain to be considered qualified, it must be based on a qualified electronic signature creation device and a qualified electronic signature certificate. These services can only be offered by a Qualified Trust Service Provider (QTSP), as time stamping cannot be considered as qualified due to the absence of QTSP. - Public and permissionless blockchains that advocate total disintermediation rule out the intervention of a QTSP. + Private, consortium and permissioned blockchain can meet these requirements. The regulation introduces a new trust service, the "electronic register", definition directly aimed at blockchain system (defined in art. 3 pt 52). The regulation provides the requirements for the obtention of the certification of this trust service (Article 45). + Although public and permissionless blockchains may not obtain this level of certification, due to the absence of QTSP, these electronic registers retain legal effects and may be sufficient for most uses of blockchain in aviation. Private, consortium and permissioned blockchain might be eligible for the obtention of the certification of trust service.
Regulation (EU) 2019/ 27 - European Aero-Medical Repository	- The regulation defines the use of a centralized repository for medical certificates (ARA.MED.160 - Exchange of information on medical certificates through a central repository).

Data model design and accessibility settings, data sharing and security protocols selection	**Regulatory Readiness Status and Gaps**

Part-IS - Information security and organization requirements (Regulations (EU) 2023/203 and 2022/1645).	* Part-IS does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. * The regulation does not define specific security protocols, data sharing protocols or other technological measures.
Acceptable Means of Compliance M.B.104 Record-keeping in Annex I to Part-M of Regulation (EU) No 1321/2014.	* Part-M does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. * The regulation does not define specific security protocols, data sharing protocols or other technological measures (M.B.104 Record-keeping).
Acceptable Means of Compliance to Appendix II to Part-M — Use of the EASA Form 1 for maintenance	* Part-M does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. - The regulation defines the computer-generated signature as "a representation of the hand-written signature of the person signing (i.e. scanned signature)", visual representation that may not correspond to the electronic signature methods that can be used on blockchain systems and must be examined on a case-by-case basis. - The regulation states that the electronic system "must be active only at the location where the part is being released", a definition that may prohibit the use of software operating on architectures other than those operating in the location concerned, such as blockchain or cloud architectures. + The regulations states that the computer-generated signature must not permit modification after signature and must ensure the integrity of the data certified by the signature of the Form and be able to show evidence of the authenticity of the EASA Form 1, functionalities covered by data record-keeping methods in blockchain systems.
Acceptable Means of Compliance related to record-keeping in Commission Regulation (EC) No 2042/2003 - Continuing Airworthiness	* The regulation does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in general, including hardware, software, network and computing resources. * The regulation does not define specific security protocols, data sharing protocols or other technological measures.
Regulation (EU) 2017/373 - Assessment of information security risk	* The regulation does not specifically address decentralized ledger technologies (DLTs) nor blockchain, but information technologies in

	general, including hardware, software, network and computing resources. + The regulation defines the requirements in terms of information systems security management without explicitly mentioning a type of solution or architecture (ATM/ANS.OR.D.010 Security management, Subpart C of Annex III), and the requirements do not conflict with the common security protocols used in blockchain.
Regulation (EU) 2016/679 - General Data Protection Regulation	The compatibility of blockchain with GDPR cannot be universally applied but must be assessed based on specific cases and configurations, specifically in the design of data models, and the selection of the data sharing and the security protocols. + Blockchain can support some GDPR goals by enhancing data transparency and auditability, enabled using strong security protocols and data sharing techniques. - Current legal uncertainties around blockchain's application to GDPR include the definitions of 'erasure', data minimization, and the exact roles and responsibilities of different actors in the blockchain ecosystem.
Regulation (EU) 2019/ 27 - European Aero-Medical Repository	* The regulation does not define specific security protocols, data sharing protocols or other technological measures necessary to ensure the integrity and security of the EAMR. - The regulation states that any information contained in EAMR is deleted after a period of 10 years, and that holders of certificates can request modifications and data deletion. This contradicts the blockchain's inability to delete information definitively and completely. For more details, please refer to the analysis of the General Data Protection Regulation above). - Data required for the obtention of a class 1 medical certificate covers several personal data fields, which could conflict with the General Data Protection Regulation (see analysis above). + Several data fields such as the status of the certificate (new, released, suspended or revoked) are not in conflict with the General Data Protection Regulation (see analysis above).

Unique identifiers selection for digital twin management	Regulatory Readiness Status and Gaps
Continuing Airworthiness Regulation (EU) No 1321/2014	*Excepting serialized parts, there is no requirement to enable unique identification of a part to ensure trusted “pairing/bridging proof” between the physical part and its documents.

Rules for Airworthiness and Environmental Certification - Regulation (EU) No 748/2012	*Excepting critical parts (see 21.A.805), there is no requirement to enable unique identification of a part to ensure trusted "pairing/bridging proof" between the physical part and its documents.

Scalability considerations	Regulatory Readiness Status and Gaps
There is no regulation in aviation related to scalability topics in information systems	N/A

2.3 Standards Readiness Status and Gaps

This section presents, for each technical specification mentioned in 2.2, the main standard documents considered relevant to the specification and captures in a matrix format the standards' readiness (see "+") and gaps (see "-", if any) identified as affecting the pursuit of each respective technical specification. The same matrix format may include, on occasion, a mention of a standards document element (see "*") which, although presently assessed as neutral to the specification, should be closely monitored given its imminent evolution potential towards a "+" or a "-" impact to the respective specification.

Blockchain type selection, decentralization approach and consensus mechanism design	Standards Readiness Status and Gaps
Spec 42: Aviation Industry Standards for Digital Information Security	+Specification provides recommendations on standardized methods to achieve the appropriate level of security for an application primarily relying on digital identities and transitioning in some cases from an existing manual process over time to a fully functioning automated digital identity-based solution. The specification's intent is to support various levels of users and security requirements and guide an airline through that transition process. *Must validate that blockchain technology (although not specifically named in the present document) is conforming to this specification. * The reference to (formally absent) and alignment with Part-IS provisions must be validated.
ATA Spec 2000 (Ch. 16) Authorized Release Certificate	* The blockchain implemented solution should be conversant with and take advantage of this specification which describes the data and processes necessary for the exchange of electronic part certification forms and facilitates communication of such information between companies

	* The reference to and alignment with Part-IS provisions must be validated.
Outside aviation, some guidance is provided by: **• ISO 23257:2022 - Blockchain and distributed ledger technologies reference architecture** **• ISO/IEC 27001 – Requirements for an Information Security Management System**	N/A

Data model design and accessibility settings, data sharing and security protocols selection	**Standards Readiness Status and Gaps**
ATA Spec 2500 **Aircraft Transfer Records**	* Although ATA Spec 2500 defines the data, the data model and format for aircraft transfer records, it does not cover data accessibility settings and data sharing protocols.
Outside EASA scope, some guidance is provided by: **• EUROCAE ED-201A, EUROCAE ED-202A, EUROCAE ED-203A and EUROCAE ED-205A for generic risk assessments.** **• EUROCAE ED-206 for risk management specific guidance for aviation organizations, and Chapter 2.6 for record-keeping and data retention policies.** **Outside aviation, some guidance is provided by:** **• ISO 23257:2022 - Blockchain and distributed ledger technologies reference architecture**	

• ISO/TR 6277:2024 - Data flow models for blockchain and DLT use cases	

Unique identifiers selection for digital twin management	Standards Readiness Status and Gaps
There are no standards in aviation related to the selection of unique identifiers and digital twin management. Outside aviation, some guidance is provided by: • ISO/TR 6039:2023 - Subject and object identifiers for blockchain system design	N/A

Scalability considerations	Standards Readiness Status and Gaps
There are no standards in aviation related to scalability topics in information systems. Outside aviation, some guidance is provided by: • GS1 Blockchain standards • The World Economic Forum Blockchain Toolkit	N/A

2.4 Gaps generated Risk Matrix / Register

The regulatory provisions and industry standards gaps identified in the sections 2.2 and 2.3 constituted the basis of formalizing a series of perceived risks where regulation or standards would not optimally support the development of an aviation blockchain solution for use cases UC1-UC9. For each of the risks captured in the following table, a qualitative rating of low, medium or high was attached to the likelihood of the risk to occur and to the consequential impact of the risk on the development of a blockchain solution.

Risk No.	Risk Description	Risk Categorization	
		Likelihood	Impact
R10 – Centralization vs blockchain in data management	By default, centralization remains the norm in data management and transmission methods. However, technologies such as blockchain and cloud services may conflict with this centralization because of their network architecture. The lack of regulatory clarity on the compliance of decentralized solutions, or their exclusion from information system definitions, risks preventing the widespread adoption of blockchain-based solutions.	Medium	High
R11 – GDPR Compliance uncertainty for blockchain	Although not all blockchain use cases in aviation deal with personal data and digital identities, the lack of clarity on the compatibility of blockchain technology with the GDPR brings the risk that developers and aviation organizations will limit themselves to other applications of blockchain and will not benefit from all its capabilities. Despite some use cases not inherently involving personal data, organizations seeking to expand their applications scope in the future may hesitate to invest in blockchain solutions due to the uncertainty of ensuring GDPR compliance.	High	High
R12 – Diverse blockchain types and compliance challenges	Although the different types of blockchain (public, private, hybrid, consortium, permissioned and permissionless) have different management rules and capabilities, and some may not meet all the requirements of the regulation (electronic signature, digital identity, etc.), software architectures deployed with specific additional application layers can meet these requirements. Defining compliance of blockchain-based solutions solely by blockchain type represents a risk to innovation, development and adoption of blockchain-based solutions and new blockchain use cases by industry organizations.	Medium	High

3. REGULATORY AND STANDARDS RECOMMENDED ACTIONS

The development, adoption, implementation and maintenance of blockchain-based solutions or any other data sharing system in aviation parts tracking would imply a non-trivial expense of resources from aviation industry various stakeholders involved in operationalizing this approach. Committing the resources requires a minimum level of certainty regarding the direction and level of regulatory expectations from such stakeholders. In this context, the regulators should indicate the main definitory elements of the approach they would prioritize for assessment and acceptance / approval of the novel solutions.

It was noted during the project that several of the interviewed CAs are expecting an indication of the EASA leading direction before engaging firmly in the acceptance and oversight of blockchain solutions in their State individual aviation jurisdictions[9].

The potential for transforming the way aviation products is tracked-and-traced should start by recognizing a broad categorization of "aviation assets" which, for the benefit of airworthiness focus in the aviation ecosystem, transcends the traditional economic/accounting understanding of the "asset" definition. As such, asset should be understood as any aviation part or assembly which enters the aviation ecosystem, following its production/manufacturing, with a "birth certificate" recognition through a Form-1 or equivalent. While an initial focus on the serialized parts subset being issued a Form 1 should be prioritized, the equivalency mentioned could be extended to:

- high complexity of the part/product - e.g., the individual aircraft for which a Form 52 (AIRCRAFT STATEMENT OF CONFORMITY) must be issued (i.e., a documented provenance which is perceived as equivalent although "above the Form1")
- low complexity of the part/product – e.g., the standardized parts with Certification Statement, Pack Slip, Certificate of Conformance accompanying a batch of such parts (e.g. nuts, bolts, rivets; i.e., a documented provenance which is perceived as equivalent although "below the Form1")

The following proposed updates/changes and their implementation roadmaps should be ideally staggered such as to enable robust blockchain-based and other decentralized data sharing solutions emergence in the aviation ecosystem.

3.1 Main changes to be considered for regulatory materials

The following regulatory update proposals were formalized to address Risk Register entries identified in chapter 1.4 and 2.4, generating the following regulatory revision proposals for addressing the high and medium risk identified elements.

While acknowledging the complexities of EASA's rulemaking processes, the project also echoes the industry's concern about the time required to adapt regulations to accommodate technological advancements. Lengthy timelines can delay innovation and slow down the adoption of beneficial technologies like blockchain and other data management solutions. This project encourages a continuous dialogue between EASA and industry stakeholders to explore ways to expedite the integration of such technologies within a robust safety

[9] The EASA "Guidelines on the use of electronic documents, records, and signatures" already include a reference to blockchain use – see "4.7. Use of blockchain for tracking life of serialised parts and aircraft"; however, additional procedural guidance expectation was alluded to by several CAs.

framework. This could involve pilot projects, sandbox environments, or more agile regulatory frameworks that allow for faster evaluation and implementation of promising innovations.

Note: The timeframes indicated represent general categories of implementation priority (short, medium, long term) and are subject to EASA's rulemaking processes, which involve stakeholder consultations, impact assessments, and formal procedures. These processes can be lengthy, and specific timelines cannot be guaranteed at this stage. However, these categories aim to provide a high-level roadmap for prioritizing and sequencing potential regulatory updates.

Regulatory Update No.	**Regulatory or Regulatory Procedure Update Description**	**Regulatory Update Estimated Feasibility**	
		Impact	Time-horizon
RU1 – Visual recognition for Part Serialization	Components with traceability requirements do presently have a serialization requirement (see 21.A.805); however, there is a pool of cases where the serialization generated unique identification of a part is not achieved/achievable; creation of a "part recognition" algorithm based on visual recognition elements could be considered, if not prohibitively expensive to establish / implement / maintain.	High	Long-term
RU2 – Documentation of Part withdrawal from aviation	Aviation parts first entering the aviation ecosystem (as individual spare new parts, or installed on a spare new higher assembly, or spare new equipment, or even a new TC-ed product like aircraft/engine/propeller) are accompanied by a Form1; however, final withdrawal of such part from aviation use is not accompanied by any regulatory established form. Documenting the permanent withdrawal of parts (especially critical ones, but in general any serialized or time-controlled ones) should be considered in order to avoid re-emergence of such parts (or of their individual identities) back into the aviation ecosystem.	Medium	Medium-term
RU3 – Blockchain for CA approval access	Certification and oversight CAs who issue approvals to any Part-21 or Part-145 organizations, should make accessible their up-to-date lists of approved organizations including the scope of such approvals; this type of info access would enable the execution of blockchain oracles which would be capable to pre-screen Form1 for fraudulent organizational identity/scope before adding to the chain a block based on that Form1 transaction; this would limit cases of info manipulation to create fraudulent Form1 documents.	Medium	Short-term
RU4 – Blockchain in Part-21 and Part-145 organizations	All approved Part-21 or Part-145 organizations who established the organization internal list of authorized certifying staff (as required for example by 21.A.143(a)5 and 145.A.70), should make such up-to-date lists accessible to the respective permissioned blockchains they	Medium	Short-term

	are involved with; this type of info access would enable the execution of blockchain oracles which would be capable to pre-screen Form1 for unauthorized staff signed-off Form1 before adding to the chain a block based on that Form1 transaction; this would limit cases of info manipulation to create fraudulent Form1 documents.		
RU5 – Blockchain for aircraft maintenance licence holder information	The CAs issuing Part-66 aircraft maintenance licences, should make accessible their up-to-date Aircraft Maintenance Licence Holders information (in a limited access form acceptable within GDPR compliance); such access would enable the execution of blockchain oracles capable to pre-screen any documents mentioning the AML Holder intervention related to the part transaction, before adding to the chain a block based on the transaction respective document; this would limit cases of info manipulation for fictitious AML Holder identities involvement in documenting the parts.	Medium	Short-term
RU6 – Flexible network architecture for Aero-Medical Repository	Regulation (EU) 2019/27 for a European Aero-Medical Repository should allow different types of network architecture in its definition of a repository, as the current definition totally excludes blockchain and partially exclude Cloud architectures by specifying that the repository must be centralized.	Low	Open[10]
RU7 – Modernizing EASA Form 1 digital requirements	The use of the EASA Form 1 for maintenance in its digital form (AMC to Appendix II to Part-M) must comply with overly restrictive computer-generated signature requirements that fail to align with modern approaches to managing and editing digital signatures. Part-M also implicitly mentions that the solution used to generate Form 1s in digital form must be centralized, which may conflict with the decentralized nature of blockchain-based systems. The requirements imposed in Part-M could prevent the adoption of blockchain for the generation, storage or transmission of Form 1 between industry players.	High	Medium-term
RU8 – Harmonizing blockchain with GDPR compliance	To resolve potential conflicts between blockchain and the GDPR, or to facilitate the detection of blockchain use cases where there is no conflict with the GDPR, the promotion of codes of conduct and certification mechanisms could clarify GDPR compliance pathways for blockchain applications. Providing some regulatory guidance to resolve uncertainties in how GDPR applies to blockchain	Medium	Medium-term

[10] Dependent on clarification of the GDPR impact to the use case.

	technologies, such as anonymization techniques (Article 29), could also make it easier for aviation organizations to identify GDPR compliance.		

3.2 Main changes to be considered for standards

The Risk Register construct in section 1.4 generated the following standards revision proposals for addressing the high-risk and medium risk identified elements, considering the feedback received from stakeholders' perspective:

Given the novelty of these standards within the aviation industry, EASA should actively support the formation and operation of industry working groups dedicated to their development. This support should prioritize facilitating the necessary changes, providing technical expertise, and offering guidance, while respecting the independence of these working groups to ensure industry ownership and innovation. Drawing inspiration and best practices from other industries where these standards have been successfully implemented is encouraged but tailoring them to the specific needs and challenges of the aviation sector is crucial. Ultimately, EASA's endorsement of the developed standards will be instrumental in accelerating their adoption and ensuring alignment with regulatory objectives.

Standards Update No.	**Standards or Standards Procedure Update Description**	**Standards Update Estimated Feasibility**	
		Impact	**Time-horizon**
SU1 – Data Format and Interface Standardization for Blockchain Integration	Establish a standardised data format and interface for sharing aircraft parts and maintenance data across blockchain platforms. This should encompass elements such as part numbers, serial numbers, maintenance records, airworthiness directives, and service bulletins. Prioritise alignment with existing industry standards (e.g., ATA Spec 2000, Spec 2500) and seek input from relevant stakeholders, including OEMs, MROs, and lessors, to ensure compatibility and ease of integration.	High	Medium-term
SU2 – Blockchain Interoperability Framework for Aviation	Develop a framework for achieving interoperability between different blockchain solutions deployed within the aviation industry. This would involve defining common protocols, data exchange standards, and authentication mechanisms to facilitate seamless data sharing across platforms. Consider leveraging existing initiatives and standards from other industries (e.g., GS1 Blockchain standards, The World Economic Forum Blockchain Toolkit) as a starting point.	Medium	Long-term

SU3 - Blockchain Security Standards for Aviation	Define specific security standards for blockchain implementations within the aviation industry, covering aspects such as data encryption, access control, key management, and node security. Align these standards with existing aviation cybersecurity frameworks (e.g., ATA Spec 42) and best practices to ensure a high level of security and data integrity.	Medium	Short-term
SU4 – Standardized Digital Certificate Format for Blockchain	Establish a standard format for digital certificates representing airworthiness documentation (e.g., EASA Form 1) on blockchain platforms. This format should ensure authenticity, integrity, and non-repudiation while being easily verifiable by stakeholders. Consider incorporating features such as digital signatures, timestamps, and unique identifiers to enhance trust and security.	High	Short-term

3.3 Implementation roadmaps

This chapter presents implementation roadmaps outlining the recommended sequence of actions for the successful integration of blockchain and other decentralized data sharing solutions into the aviation ecosystem. These roadmaps address the regulatory updates and standards changes proposed in Chapters 3.1 and 3.2.

Recognizing that various stakeholders may have different levels of readiness and that the technological landscape is constantly evolving, we propose three scenarios, each with varying degrees of change and timelines. This approach offers flexibility and adaptability, allowing stakeholders to choose a path that aligns with their specific needs and capabilities.

3.3.1 Roadmap Principles

Phased approach: the roadmaps adopt a phased implementation strategy, starting with "quick wins" – high-impact changes with short time horizons – and gradually progressing towards more complex and longer-term initiatives.

Stakeholder collaboration: successful implementation requires active collaboration between regulators, industry actors, and blockchain developers. The roadmaps emphasize the importance of establishing partnerships, engaging in pilot projects, and sharing best practices.

Adaptability and iteration: the roadmaps are not static documents but are designed to be adaptable and iterative. As the technology evolves and we gain more experience, refinements and adjustments to the timelines will be necessary.

The figure below summarises the different scenarios and main actions, by timeframe.

	Short-term initiatives (0-1 year)	Medium-term initiatives (1-3 years)	Long-term initiatives (3-5 years)
Scenario 1 – Evolutionary Minimal Regulatory Change	Education and awareness campaigns	Pilot projects and public-private partnerships	Gradual industry-led adoption
Scenario 2 – Proactive Moderate Regulatory Change	Regulatory consultations	Implementation of regulatory changes	Continuous monitoring and regulations refinements
Scenario 3 – Transformational Significant Regulatory Change	Comprehensive regulatory review	Phased implementation of new framework	Continuous improvement and expansion

3.3.2 Scenario 1: Minimal Regulatory Change (Evolutionary)

This scenario emphasizes leveraging existing regulations and industry standards to facilitate blockchain adoption. It prioritizes education, pilot projects, and the development of industry-led guidelines.

- **Short-Term:**

  Focus: education and awareness campaigns targeting regulators and industry stakeholders. Highlight the benefits, challenges, and practical applications of blockchain in aviation.

  Actions:

  - Host workshops and webinars.
  - Develop educational materials (e.g., white papers, case studies).
  - Facilitate knowledge sharing through industry forums and publications.
  - **EPAS Initiatives:** include SPTs (Safety Promotion Tasks) within EPAS focused on blockchain awareness and education. Example: *SPT.XXXX: Blockchain Awareness Campaign for Aviation Stakeholders*.

  Outcome: increased understanding and acceptance of blockchain within the aviation community.

- **Medium-Term:**

  Focus: carrying out pilot projects testing the feasibility and value of blockchain solutions for specific use cases (e.g., Warranty Adjudication - UC5, Parts Scraping - UC8) within an ecosystem of varied partners.

Actions:

  - Select suitable use cases with high potential for return on investment and minimal regulatory barriers.
  - Establish public-private partnerships to collaborate on pilot project execution and knowledge sharing.
  - **EPAS Initiatives:**

        - Include RES (Research Projects) within EPAS to support blockchain pilot projects. Example: *RES.XXXX: Blockchain Pilot Project for Warranty Adjudication*.
        - Introduce ISTs (Implementation Support Tasks) to assist stakeholders in participating in pilot projects and adopting blockchain solutions. Example: *IST.XXXX: Blockchain Implementation Support for Pilot Projects*.

  Outcome: proof of concept and proof of value for blockchain solutions, identification of challenges, and generation of valuable insights for future development.

- **Long-Term:**

  Focus: gradual, industry-led adoption of blockchain solutions. Start with low-hanging fruit and progressively expand to more complex use cases.

  Actions:

    - Encourage knowledge sharing and best practice dissemination.
    - Encourage international collaboration through the SMICG (Safety Management International Collaboration Group) and other relevant bodies to align blockchain pilot projects approaches.
    - **EPAS Initiatives:**
        - Introduce MSTs (Member State Tasks) to encourage the adoption of blockchain by national authorities. Example: *MST.XXXX: Integration of Blockchain into National Aviation Oversight Systems*.

  Outcome: increased efficiency, transparency, and security in aviation parts tracking.

Scenario 1 – Evolutionary Minimal Regulatory Change	Short-term initiatives (0-1 year)	Medium-term initiatives (1-3 years)	Long-term initiatives (3-5 years)
	Education and awareness campaigns	Pilot projects and public-private partnerships	Gradual industry-led adoption
Initiatives	• Host workshops and webinars • Develop educational materials (e.g., white papers, case studies) • Facilitate knowledge sharing through industry forums and publications	• Select suitable use cases for blockchain • Establish public-private partnerships • Support pilot projects through research and implementation support tasks	• Develop standardized data formats and processes • Encourage international collaboration • Introduce Member State Tasks for blockchain adoption
Outcomes	Increased understanding and acceptance of blockchain within the aviation community	Proof of concept and value for blockchain solutions, identification of challenges, and generation of valuable insights for future development	Increased efficiency, transparency, and security in aviation parts tracking

3.3.3 Scenario 2: Moderate Regulatory Change (Proactive)

This scenario takes a more proactive stance, suggesting moderate updates to existing regulations and standards to accommodate blockchain. It involves regulatory consultations, pilot projects, and targeted amendments to address the high-priority gaps identified in the gap analysis (D3.1 Chapters 1 & 2).

- **Short-Term:**

  Focus: regulatory consultations with industry actors and blockchain developers to discuss proposed changes and gather feedback.

  Actions:

  - Host workshops and meetings focusing on specific regulatory challenges and potential blockchain solutions.
  - Develop draft regulatory amendments and standards updates (RU1, RU2) to address the highest priority gaps and risks.
  - **EPAS Initiatives:** Include specific regulatory objectives related to blockchain in the EPAS strategic priorities. Example: *"Facilitate the safe and secure integration of blockchain technology into the aviation ecosystem."*

  Outcome: consensus on the direction of regulatory changes and a clearly defined roadmap for implementation.

- **Medium-Term:**

  Focus: implementation of regulatory changes and standards updates.

  Actions:

  - Finalize and implement regulatory amendments and standards updates.
  - Support financially, directly or indirectly, the development and deployment of blockchain-based solutions compliant with the new regulatory framework (RU3, RU4, RU5).
  - Develop and implement standardized data formats and processes for blockchain-based parts tracking, leveraging existing industry standards (e.g., ATA Spec 2000, Spec 2500).
  - Continue pilot projects to validate the effectiveness of the updated framework and identify potential areas for refinement.
  - **EPAS Initiatives:**
    - Introduce RMTs (Rulemaking Tasks) to amend existing regulations or create new regulations to support blockchain implementation. Example: *RMT.XXXX: Amendments to Part 21 to Enable Blockchain Integration*.
    - Continue with RES and ISTs to support ongoing blockchain projects and adoption.

  Outcome: a regulatory environment that actively supports blockchain adoption, encourages innovation, and ensures ongoing development.

- **Long-Term:**

  Focus: continuous monitoring and evaluation of blockchain implementation, with further refinements to regulations and standards as needed.

Actions:

- Establish a collaborative governance framework involving regulators, industry actors, and blockchain developers to oversee the ongoing development and adoption of blockchain in aviation.
- **EPAS Initiatives:**
  - Include blockchain-related objectives in standardisation assessments (SYS phase 2.0).
  - Encourage international collaboration through the SMICG (Safety Management International Collaboration Group) and other relevant bodies to align regulatory approaches.

Outcome: a mature, adaptable regulatory framework that effectively manages the integration of blockchain while maintaining high safety standards.

Scenario 2 – Proactive Moderate Regulatory Change	Short-term initiatives (0-1 year)	Medium-term initiatives (1-3 years)	Long-term initiatives (3-5 years)
	Regulatory consultations	Implementation of regulatory changes	Continuous monitoring and regulations refinements
Initiatives	• Host workshops and meetings • Develop draft regulatory amendments and standards updates • Include blockchain in EPAS strategic priorities	• Finalize and implement regulatory amendments • Financially support blockchain-based solutions • Continue pilot projects for framework validation	• Establish collaborative governance framework • Include blockchain objectives in standardization assessments • Encourage international collaboration for regulatory alignment
Outcomes	Consensus on the direction of regulatory changes and a clearly defined roadmap for implementation	A regulatory environment that actively supports blockchain adoption, encourages innovation, and ensures ongoing development	A mature, adaptable regulatory framework that effectively manages the integration of blockchain while maintaining high safety standards

3.3.4 Scenario 3: Significant Regulatory Change (Transformational)

This scenario envisions a transformative approach, proposing significant changes to existing regulations and standards to fully harness blockchain's potential. It involves a comprehensive review of regulations, the development of new frameworks, and close collaboration with international bodies.

Short-Term:

Focus: a comprehensive review of existing regulations and standards to identify areas for major overhaul.

Actions:

- Establish a dedicated working group comprising regulators, industry experts, and blockchain developers to conduct a thorough analysis of the current regulatory landscape.
- Develop a comprehensive vision for a blockchain-enabled aviation ecosystem.
- Outline a strategic roadmap for blockchain implementation, including potential new regulations, standards, and governance frameworks.
- **Annex A 5959 Initiatives:**
  - Define blockchain as a key enabler within the EASP (European Aviation Safety Programme).
  - Introduce a dedicated section on blockchain in EPAS Volume I, outlining the vision for a blockchain-enabled aviation industry.

Outcome: a clear vision for a transformed aviation industry, with blockchain as a core enabler for enhanced safety, efficiency, and sustainability.

Medium-Term:

Focus: phased implementation of the new regulatory framework and standards.

Actions:

- Draft and implement new regulations and standards that fully embrace blockchain technology.
- Develop and deploy blockchain-based solutions that leverage the technology's full potential.
- Foster international collaboration to align regulatory approaches and enable global interoperability.
- **EPAS Initiatives:**
  - Include ambitious blockchain-related MSTs to drive adoption and implementation at the national level.
  - Continue with RMTs, RES, and ISTs, prioritizing transformative blockchain projects.

Outcome: a regulatory environment that drives innovation and facilitates the development of cutting-edge blockchain applications within the aviation industry.

- **Long-Term:**

Focus: continuous improvement and expansion of blockchain applications within the broader aviation ecosystem.

Actions:

- Explore new use cases and develop advanced blockchain-based solutions for various aspects of the industry (e.g., supply chain management, aircraft leasing, maintenance training).
- Refine the regulatory framework based on implementation experience and ongoing technological advancements.
- **EPAS Initiatives:**

- Evaluate the effectiveness of existing blockchain regulations and initiatives through EVTs (Evaluation Tasks).
- Work with ICAO to develop global standards and guidelines for blockchain in aviation.

Outcome: a fully integrated blockchain ecosystem transforming aviation processes, enhancing safety and efficiency at a global scale.

Scenario 3 – Transformational Significant Regulatory Change	Short-term initiatives (0-1 year)	Medium-term initiatives (1-3 years)	Long-term initiatives (3-5 years)
	Comprehensive regulatory review	Phased implementation of new framework	Continuous improvement and expansion
Initiatives	• Establish a dedicated working group • Develop a comprehensive vision for blockchain in aviation • Outline a strategic roadmap for blockchain implementation	• Draft and implement new regulations and standards • Deploy blockchain-based solutions • Foster international collaboration	• Explore new use cases for blockchain • Refine regulatory framework based on experience • Evaluate the effectiveness of blockchain regulations through evaluation tasks
Outcomes	A clear vision for a transformed aviation industry with blockchain as a core enabler for enhanced safety, efficiency, and sustainability	A regulatory environment that drives innovation and facilitates the development of cutting-edge blockchain applications within the aviation industry	A fully integrated blockchain ecosystem transforming aviation processes and enhancing safety and efficiency at a global scale

3.3.5 Scenario Selection and Conclusion

The choice of which scenario to adopt will depend on numerous factors, including the pace of blockchain's technological evolution, the industry's readiness to invest and adopt new solutions, the willingness of regulators to embrace change, and the level of international collaboration.

Regardless of the chosen path, a clear roadmap with well-defined milestones, timelines, and risk mitigation strategies is essential to the successful implementation of blockchain in aviation parts tracking. The roadmaps presented in this chapter provide a framework for collaborative action, enabling stakeholders to navigate the complexities of blockchain integration and unlock its transformative potential for the benefit of the aviation industry.

3.4 Potential Regulatory Actions

This section presents a set of potential regulatory actions that EASA could take to facilitate the adoption and integration of blockchain and other data management solutions within the aviation ecosystem. These actions are designed to address identified gaps, facilitate industry collaboration, and ensure that the implementation of these technologies is aligned with safety and efficiency objectives.

1. **Blockchain as a Tool for Enhanced Traceability and Security**

Position blockchain as a means to address existing challenges in parts tracking, documentation management, and regulatory compliance.

Emphasize its ability to enable initiatives that were previously difficult or costly to implement, such as:

- **Enhanced traceability of parts:** Achieving complete and irrefutable back-to-birth traceability for all parts, including non-serialized components.
- **Secure documentation management:** Eliminating the risks of loss, damage, and falsification of critical records.
- **Streamlined audits and aircraft transitions:** Facilitating faster and more efficient verification of compliance and aircraft records.
- **Robust parts scraping processes:** Ensuring scrapped parts are permanently removed from the aviation ecosystem and preventing their re-entry.
- **Real-time Form 1 validation:** Enabling instant verification of the authenticity and validity of EASA Form 1 certificates.

2. Establish a Clear Regulatory Framework for Blockchain

Develop a dedicated guidance document specifically addressing blockchain applications in aviation. This framework should:

- Define acceptable types of blockchain (public, private, consortium) and their respective use cases.
- Outline data management and governance standards.
- Address data security and privacy concerns, ensuring compliance with GDPR and other relevant regulations.
- Specify requirements for blockchain interoperability and integration with existing systems.
- Provide guidance on digital signatures and certificate management on blockchain platforms.

Promote the use of existing industry standards (e.g., ATA Spec 2000, Spec 2500) as a starting point for developing blockchain-specific standards.

3. Facilitate Blockchain Adoption by Industry Stakeholders

Collaborate with industry actors and blockchain developers to establish pilot projects testing the feasibility and value of blockchain solutions for various use cases.

Provide financial incentives or subsidies to encourage smaller organizations to adopt blockchain technologies.

Develop educational programs and training materials to increase awareness and understanding of blockchain among regulators and industry personnel.

4. Address Specific Regulatory Gaps

Amend regulations to enable secure and standardized linkage of non-serialized parts to blockchain records. Explore options such as visual recognition technologies or the adoption of unique identifiers like UUIDs (Universally Unique Identifiers).

Introduce a standardized form for documenting part withdrawal from service. This will enhance traceability, prevent re-entry of unapproved parts, and support circular economy initiatives.

Update the AMC to Appendix II to Part-M to align with modern digital signature practices and facilitate the use of blockchain-based systems for EASA Form 1.

Engage in discussions with national authorities to explore options for providing controlled and secure access to public databases for aviation approvals. This will enable the development of effective blockchain oracles and real-time data validation.

Provide clarity on the application of GDPR to blockchain in aviation. Publish guidance documents or develop specific regulations to address data privacy concerns.

5. **Enable International Collaboration**

   Work with ICAO and other international regulatory bodies to develop global standards and guidelines for blockchain in aviation.

   Promote knowledge sharing and best practice dissemination through international forums and workshops.

6. **Embrace a Proactive and Collaborative Approach**

   Establish a dedicated blockchain working group within EASA comprising experts in aviation safety, regulations, and blockchain technology.

   Engage with industry stakeholders and blockchain developers in a continuous dialogue to understand their needs and address emerging challenges.

   Monitor blockchain advancements in other sectors and explore their applicability to aviation.

Annex A Understanding EPAS: A Framework for Aviation Safety

A.1 Introduction

The European Plan for Aviation Safety (EPAS) serves as the regional aviation safety plan for all European Union (EU) Member States. It's a comprehensive roadmap outlining strategic priorities, identifying key safety risks, and defining the actions necessary to mitigate those risks and enhance aviation safety across Europe.

A.2 EPAS: A Key Component of the European Aviation Safety System

The EPAS is a crucial element of the European Aviation Safety Programme (EASP), a framework managed by the European Commission to oversee civil aviation safety at a European level. The EASP defines the integrated set of regulations, the interrelationships between various safety plans and programs, and the processes used to manage aviation safety across the EU.

EPAS aligns with international aviation safety standards and plans, including the International Civil Aviation Organization (ICAO) global plans and the European ATM Master Plan. This harmonization ensures consistency and facilitates international collaboration.

A.3 EPAS Objectives

The primary objectives of EPAS are to:

- **Maintain and Improve Aviation Safety:** Drive continuous improvement in aviation safety across all domains within the EU.
- **Enhance Environmental Performance:** Promote initiatives to improve the environmental performance of the aviation system, contributing to sustainability goals.
- **Ensure a Level Playing Field:** Establish a fair and competitive environment for all aviation stakeholders by harmonizing regulations and ensuring their consistent application.
- **Foster Efficiency and Proportionality:** Promote efficient and cost-effective regulatory processes, minimizing unnecessary burden while achieving safety objectives.

A.4 EPAS Structure

The EPAS consists of three distinct volumes:

- **Volume I: Strategic Priorities**
    - Provides an executive summary and introduction, outlining the operational context and defining strategic priorities for the reference period (currently three years).
- **Volume II: EPAS Actions**
    - Presents a detailed list and description of all actions necessary to achieve the strategic priorities. These actions are categorized by type:
        - Rulemaking Tasks (RMTs)
        - Implementation Support Tasks (ISTs)
        - Safety Promotion Tasks (SPTs)
        - Research Projects (RES)
        - Evaluation Tasks (EVTs)

- Member State Tasks (MSTs)

- **Volume III: Safety Risk Portfolios**
  - Details the main safety risks and underlying safety issues affecting the European aviation system, organized by domain-specific Safety Risk Portfolios (SRPs).

A.5 EPAS Development and Implementation

The EPAS is developed collaboratively with key aviation stakeholders:

- **Member States:** Through the Member States Advisory Body (MAB) and domain-specific technical bodies.
- **Industry:** Through the Stakeholder Advisory Body (SAB) and sectorial committees.
- **Collaborative Analysis Groups (CAGs):** Expert groups responsible for analysing safety within specific domains.
- **Network of Analysts (NoAs):** Supporting the analysis of safety data and contributing to the identification of emerging safety issues.

The development of EPAS follows the principles of the European Commission's Better Regulation agenda, ensuring:

- **Evidence-Based Decision Making:** Actions are based on thorough safety data analysis, risk assessments, and impact evaluations.
- **Transparency:** Processes are open and transparent, with stakeholders actively involved in discussions and consultations.
- **Proportionality:** Regulations and actions are proportionate to the identified risks and strive to minimize unnecessary burden.

The EPAS is a living document, undergoing annual reviews and updates to reflect evolving safety challenges, new technologies, and changes in the operational environment. This ensures its continued relevance and effectiveness in guiding the EU towards a safer and more sustainable aviation system.

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