WHITEPAPER

Physical Authentication of Aircraft Parts

Surface Fingerprint Technology as a Response to Structural Security Gaps in the Aviation Supply Chain

Publisher:	ID Systems AG, Grenzstrasse 20A, CH-3250 Lyss | idsystems.ch
Version:	1.0 / 04/2026
Target Audience:	MRO Management Teams, Quality Managers, Airline Engineers, OEM Executives, Aviation Regulators
Classification:	Public
Language:	English

Executive Summary

The aviation industry faces a structural security gap: all common methods of component identification – paper certificates, RFID tags, barcodes, laser engravings, and even blockchain – authenticate the accompanying document or data carrier, not the physical part itself. Whatever can be separated from the part can be forged or transferred to an unapproved replacement.

The AOG Technics case – ruling at Southwark Crown Court, February 2026 – painfully exposed this systemic weakness: 60,000 forged EASA Form 1 certificates, 145 CFM56 engines, fraud damages in the hundreds of millions, airlines affected on four continents. Most critically: the majority of forged parts were non-serialized small components – bolts, bushings, seals – for which no physical identification solution exists to this day.

The surface fingerprint technology of ID Systems AG addresses precisely this gap. Every metal surface – steel, titanium, aluminum, Inconel – possesses a microstructure that develops during the manufacturing process, which is unique, immutable, and physically non-reproducible. ID Systems AG captures this structure contactlessly using a high-precision optical sensor, converts it into a digital hash, and stores it securely – linkable with existing MRO systems, ERP platforms, or blockchain solutions.

> **The result: the part itself is its own identity document – independent of the quality of accompanying documentation, immutable across the entire lifecycle, EASA-compatible, and without any modification to the part.**

This whitepaper is aimed at Quality Managers, MRO Directors, Chief Engineers, and Regulatory Affairs executives at airlines, MRO organizations, and OEMs. It analyzes the structural weaknesses of existing approaches, explains the technology in detail, evaluates the regulatory framework, and describes a proven implementation pathway without regulatory lead time.

1. Problem Analysis: Systemic Weaknesses in the Aviation Parts Chain

1.1 The AOG Technics Scandal as Symptom – Not as Cause

The AOG Technics case is not an isolated incident but the visible consequence of a systemic weakness. Between 2019 and 2022, British company AOG Technics Ltd. (London) issued at least 60,000 forged EASA Form 1 certificates for aircraft parts without ever inspecting the parts. Primarily affected were components for the CFM56 turbofan – one of the world's most widely used engines – as well as other safety-critical parts.

Airlines affected: Ryanair, Delta Air Lines, American Airlines, TAP Air Portugal, WestJet, Virgin Australia, and other carriers.

Engines affected: At least 145 CFM56 units installed or resold on the basis of forged certificates.

Ruling: Judge at Southwark Crown Court, London, February 2026: "near-complete subversion of the regulatory framework".

CFM International – the joint venture of GE Aerospace and Safran Aircraft Engines – confirmed in its official statement that the majority of affected components were non-serialized small parts: bolts, bushings, seals, and washers. Precisely the parts for which existing tracking and certification systems offer no physical identification method.

> **Regulatory Assessment:** The case demonstrates not the failure of individual actors, but the failure of the conceptual approach: a system based on document verification can be circumvented through document forgery – regardless of the diligence of the inspectors involved.

1.2 The Four Structural Weaknesses

1.2.1 Paper-Based Certificates: The Document Is Not the Part

EASA Form 1 and FAA Form 8130-3 are the internationally recognized release documents for aviation parts. They certify that an authorized organization has confirmed the part's conformity with applicable requirements. The fundamental problem: the document is physically separable from the part. A printer, scanning software, and access to a blank template are sufficient to forge a formally correct certificate – as AOG Technics demonstrated convincingly.

Even when a genuine certificate is presented, the critical question remains unanswered: does the part at hand actually belong to this document? This question structurally cannot be answered with paper-based documentation.

1.2.2 Non-Serialized Parts: The Industry's Blind Spot

The aviation industry processes millions of small components without individual serial numbers daily: fasteners (bolts, nuts, rivets), seals, bushings, washers, and similar standard parts. These parts are simply unmappable in existing digital tracking systems: no serial number means no unique record, no record means no traceability.

The economic significance of these parts is nonetheless considerable: small components in safety-critical joints can have catastrophic consequences upon failure, and their procurement from unverified sources is widespread – particularly in markets with parts shortages or under AOG (Aircraft on Ground) conditions.

1.2.3 RFID Tags and Codes: The Identification Paradox

RFID tags, barcode labels, and QR codes identify themselves – not the part to which they are attached. An RFID tag transferred to a forged or unapproved part confirms the identity of the tag upon reading, not of the part. The gap is conceptual, not technical: no RFID system can prove that the tag has not been transferred since initial registration.

Additional operational limitations apply: tags in high-temperature environments (engine section) fail, tags on small parts (bolts, M6 nuts) are mechanically unsustainable, and attaching a tag may in some cases itself be considered a modification requiring recertification.

1.2.4 Life-Limited Parts: The Million-Dollar Risk from Documentation Gaps

Life-Limited Parts (LLPs) – engine components, landing gear components, brake discs, and other safety-critical parts with defined service life – are subject to EASA and FAA requirements for seamless back-to-birth traceability. Any documentation gap in an LLP's usage history renders it regulatorily unusable – regardless of its actual condition.

In practice, this leads to significant economic losses: a turbine blade whose cycle count cannot be fully documented may lose its entire residual value – even though the physical part is technically sound. In leasing transactions and aircraft asset transfers, LLP verification is one of the most time-consuming and costly processes.

2. Regulatory Framework: Requirements and Scope for Innovation

2.1 EASA Regulation: Open Formulation as Opportunity

EASA Regulation (EU) No. 1321/2014, Art. 145.A.42 requires approved maintenance organizations (Part-145) to only install aircraft parts, equipment, and materials when their conformity and traceability have been demonstrated. The regulation defines the objective, not the means.

> **Key Principle:** EASA 145.A.42 does not define a specific inspection technology. This openness is deliberate and allows organizations to use innovative methods as 'Acceptable Means of Compliance' (AMC) – provided that traceability and documentation are ensured.

This regulatory flexibility is the key to implementing surface fingerprint technology. An organization that captures and documents the fingerprint of an incoming part during receiving inspection uses the technology as an internal inspection tool – without certification requirements for the inspection instrument itself. EASA approval relates to the aviation part, not to the measuring instrument used to inspect it.

2.2 FAA Advisory Circular AC 21-29D: The US Framework

The FAA regulates the handling of suspected unapproved parts (SUPs) in Advisory Circular AC 21-29D. This explicitly recommends that MRO organizations use additional inspection methods during receiving inspection when doubts arise about a part's authenticity. Using a surface fingerprint as an additional verification instrument is fully compliant with this framework.

In parallel, FAA AC 20-154 addresses the use of approved data and inspection aids in maintenance: internal inspection instruments that require no modification to the part and do not alter any approved maintenance data are not subject to FAA certification requirements.

2.3 Back-to-Birth Traceability: Requirement and Reality

Both EASA and FAA require seamless traceability for Life-Limited Parts from initial manufacture (birth) to retirement. In practice, gaps arise at three typical points: during ownership transfers between lessors, airlines, and MRO organizations; during changes in documentation systems (often following corporate acquisitions); and when procuring parts through brokers from the used-parts market.

The surface fingerprint closes these gaps not through retrospective document creation, but through physical identity proof: if the part today matches a fingerprint captured years ago, its identity is physically provable – regardless of gaps in the paper chain.

3. Technology: Surface Fingerprint in Detail

3.1 The Physical Principle

Every metallic material – whether steel, titanium, aluminum, or nickel-base superalloys such as Inconel – develops a unique surface microstructure during the manufacturing process. This arises from the interplay of tool geometry, cutting parameters, material grain structure, temperature profiles, and a multitude of other random influencing factors. The result is a complex three-dimensional topography at the micrometer scale that never arises identically twice, even under identical production conditions.

This uniqueness is not a property added to the part – it is an intrinsic, immutable property of the material itself. It cannot be imitated, transferred, or forged, because no production process can reproduce an identical microstructure.

3.2 The Capture and Authentication Process

Step 1: Initial Capture (Enrollment)

A high-precision optical sensor captures the part's surface contactlessly at a defined measurement position. The process is non-destructive and leaves no traces on the part. Measurement time is typically a few seconds. The part remains unchanged – no marking, no engraving, no additional element that would require recertification.

Step 2: Digital Fingerprint Creation

The captured optical raw data is processed by proprietary algorithms and converted into a compact digital hash. This hash is simultaneously unique to the specific part – it cannot be replicated by any other part – and relatively robust against operational surface changes such as wear marks and cleaning.

The hash is stored in encrypted form and can be linked to existing IT systems: MRO management software (e.g., AMOS, TRAX), ERP systems (SAP), blockchain platforms, or dedicated parts databases.

Step 3: Authentication at Every Transaction

At every relevant transaction – receiving inspection, transfer between organizations, installation in an aircraft, return from overhaul – a new scan of the part is performed. The resulting hash is automatically compared against the stored reference hash. The system delivers a binary result within a short time: identical or not identical.

Step 4: Seamless Provenance

Each authentication event supplements the digital provenance chain of the part. The result is a complete, chronological record of every transaction in which the part was physically verified – as the technical foundation for the regulatorily required back-to-birth traceability.

3.3 Material Validation and Robustness

The technology is suitable for all metallic materials relevant to aviation: steel (various alloys), titanium (Ti-6Al-4V and others), aluminum (2xxx, 7xxx series), Inconel and other nickel-base superalloys. These materials cover the full spectrum from structural components to hot-section parts.

Validation testing in regulated industries – particularly in medical technology (ISO 13485-certified environments with sterilization requirements) – has shown that the fingerprint remains stable against cleaning, sterilization, moderate mechanical stress, and normal operational use. For aviation, this means: an engine LLP arriving for overhaul after 15,000 operating hours can be reliably compared with its enrollment fingerprint.

3.4 System Integration and Digital Infrastructure

The surface fingerprint solution is not designed as an isolated system, but as a physical anchor for existing and future digital infrastructures. Combined with blockchain platforms, the fingerprint provides for the first time a true physical anchor: blockchain entries, previously based exclusively on documents and data records, are linked to a physically non-transferable identity. The risk that a blockchain data record is applied to a different (forged) part is eliminated.

In conjunction with digital twin concepts, the fingerprint enables secure linking between the physical object and its digital counterpart – a fundamental prerequisite for reliable predictive maintenance and data-based service life forecasting.

4. Comparative Analysis: Why Existing Solutions Are Insufficient

The following table compares available authentication methods according to criteria relevant to aviation compliance:

Method	Phys. Bound	Non-serial. Parts	Part Modification	Forgeable	Assessment
EASA Form 1 / FAA 8130-3	No	Only with S/N	No	Yes – proven	Insufficient
RFID / Barcode / QR Tags	No	No	Tag attachment	Yes – tag transferable	Weak
Laser Engraving / Dot-Peen	Conditionally	Conditionally	Yes – material mod.	Limited	Medium
Blockchain (alone)	No	No	No	No part protection	Supplementary
Surface Fingerprint (IDS)	**Yes – inseparable**	**Yes – without S/N**	**No**	**No – physically impossible**	**100% secure**

The analysis shows: all existing methods share a conceptual fundamental flaw – the identification information is physically separable from the part. Only the surface fingerprint is intrinsic, i.e., inseparably connected to the material structure of the part. It can neither be removed nor transferred to another part, because it is not an external property but a physical material property.

5. Use Cases and Immediate Benefits

5.1 Non-Serialized Parts: The Most Urgent Need

Bolts, bushings, seals, and washers numerically constitute the largest parts category in any aircraft. A single CFM56 engine contains thousands of these fasteners. Until now, this category has been simply inaccessible to physical identification systems: no serial number, no surface for marking, no possibility of attaching a tag.

The surface fingerprint solves this problem for the first time: even a titanium M8 bolt has a unique microstructure – its identification requires only a defined measurement area of a few square millimeters. In receiving inspection, a physical identity proof can now be provided for these parts as well.

5.2 Life-Limited Parts: Back-to-Birth with Physical Anchoring

For LLPs, the surface fingerprint is the missing physical anchor of a robust back-to-birth documentation chain. Even when paper documents are incomplete or their authenticity is questioned, the physical identity of the part remains provable. A turbine blade that is fingerprinted at every overhaul and every transfer can be seamlessly assigned to its entire usage history – regardless of the quality of accompanying documentation.

For lessors and airlines, this significantly reduces the risk of value losses from documentation gaps. For insurance companies and financiers, the physical identity proof creates a new level of risk assessment.

5.3 MRO Receiving Inspection: Immediate Use Without Certification Effort

The entry point with the lowest regulatory and operational burden: in receiving inspection (per FAA AC 20-154), the fingerprint is used as an internal inspection tool. Since no modification to the part takes place, no EASA or FAA certification effort for the inspection instrument is required. Integration into existing receiving inspection processes is possible within a few weeks.

Immediate ROI: the integration of counterfeit or unapproved parts is prevented before they enter maintenance. The costs of a fleet grounding caused by a subsequently identified non-compliant part exceed the investment costs of a pilot program many times over.

5.4 Leasing Transactions and Asset Transfers

When transferring aircraft between lessors and airlines, verification of LLP identity and history is one of the most time-intensive processes. Technical experts spend weeks verifying documentation chains, closing gaps, and in doubtful cases declaring parts unusable. Documentation gaps can render parts with a market value of several hundred thousand dollars worthless.

A bilaterally verifiable physical fingerprint changes the baseline: the identity of the part is no longer proven exclusively through document inspection, but through physical comparison. This reduces transaction risks, accelerates the transfer process, and creates the foundation for standardized digital asset documentation.

5.5 OEM Integration: Back-to-Birth from Manufacturing

The strongest form of traceability is created when the fingerprint is captured during manufacturing – as an integral part of the OEM quality assurance process. This approach enables genuine back-to-birth traceability from the very first moment of the part's existence.

ID Systems AG has experience in OEM integration in the watchmaking industry and in ISO 13485-regulated medical technology. Both industries share with aviation the requirement for seamless traceability, high material precision, and regulatory conformity.

6. Market Data and Economic Dimension

The following key figures demonstrate the economic and safety-related dimension of the problem:

Key Figure	Value	Source
Aviation MRO Market Volume 2025	USD 87 Billion	Industry Analysis 2024
Counterfeit / unapproved parts per year	approx. 520,000	FAA Advisory Circular AC 21-29D
Fake EASA certificates – AOG Technics	60,000	SFO / Southwark Crown Court ruling, Feb. 2026
Affected engines (CFM56)	145 engines	UK Serious Fraud Office 2026
Value loss per LLP with documentation gap	up to 100% of part value	Aviation Finance / Lessor Analysis

These figures highlight the economic logic of early implementation. The global aviation MRO market is growing continuously – driven by the recovery of air travel following the pandemic and the persistent aircraft shortage that is extending service life of older fleets. With more parts trading, higher cost pressures, and growing supply chain challenges, the structural risk of non-certified parts entering the supply chain is also increasing.

The regulatory impetus is strengthening: following the AOG Technics ruling, EASA and FAA are expected to tighten their requirements for physical part verification. Organizations that establish physical authentication processes early will find themselves in a regulatorily preferred position.

7. Implementation Pathway: Three Seamless Phases

Based on implementation experience in regulated industries, ID Systems AG has developed a three-phase approach that enables organizations to start immediately and scale incrementally:

Phase	Timeframe	Measures	Regulatory Framework
Phase 1	0–12 months	Deployment as internal inspection tool in Receiving Inspection	No certification effort required (FAA AC 20-154)
Phase 2	12–24 months	Positioning as EASA-compliant compliance measure	Acceptable Means of Compliance per EASA 145.A.42
Phase 3	24–48 months	OEM integration in manufacturing, Digital Twin linkage	Back-to-birth from manufacturing, Blockchain anchor

7.1 Phase 1: Immediate Benefit Without Regulatory Lead Time (0–12 Months)

Phase 1 is the virtually risk-free entry point: the fingerprint is used exclusively as an internal inspection tool in receiving inspection. Since no modification to the part takes place and the inspection instrument does not form part of approved maintenance data, neither EASA nor FAA approval for the instrument is required.

The operational flow in Phase 1: incoming parts are fingerprinted upon initial registration. On return from overhaul or when procured from the used-parts market, a comparison with the database is performed. If the fingerprint matches, the physical identity is verified; if it does not match, this is a clear signal for in-depth inspection.

7.2 Phase 2: Regulatory Positioning (12–24 Months)

In Phase 2, the established process history from Phase 1 is used to position the fingerprint as an Acceptable Means of Compliance with the competent authority. ID Systems AG supports the preparation of required documentation, evidence, and communication with EASA/FOCA or FAA.

7.3 Phase 3: OEM Integration and Blockchain Linkage (24–48 Months)

Phase 3 realizes the full potential: integration into the OEM manufacturing process to create genuine back-to-birth traceability. Linkage with blockchain platforms and digital twin systems. Standardization as an industry standard in the aviation supply chain.

8. ID Systems AG: Competency Profile

ID Systems AG (founded 1995, Lyss/Switzerland) is a Swiss specialist in industrial identification and authentication technologies. The company develops and markets physical authentication solutions for industries where component identification is safety-critical.

Reference industries: Watchmaking industry (high-value cases and mechanisms), medical technology (ISO 13485-certified implants and instruments), pharma/manufacturing, industrial logistics.

Core technology: Surface fingerprint technology for metallic materials. Validated for steel, titanium, aluminum, Inconel.

Contact:
ID Systems AG ·
Grenzstrasse 20A ·
CH-3250 Lyss ·
+41 32 374 71 11 ·
info@idsystems.ch ·
idsystems.ch

Pilot Programme: ID Systems AG offers structured pilot programmes with defined test scenarios and measurable success criteria. Entry into Phase 1 requires no certification effort and can be operationally active within a few weeks.

9. Conclusion and Strategic Recommendation

The aviation industry stands at a turning point in component identification. The AOG Technics scandal is not the last event of its kind – it is the predictable consequence of a system built on document-based authentication. As long as the document, not the physical part, serves as proof of identity, the system remains structurally vulnerable.

The surface fingerprint technology of ID Systems AG is the first practically deployable method that uses the physical part itself as the identity carrier. It requires no modification to the part, no regulatory lead time for immediate deployment, and it closes the most critical of all gaps: the identifiability of non-serialized parts.

> **The strategic recommendation for Quality Managers, MRO Directors, and Chief Engineers: initiate a pilot in Receiving Inspection now. The technology is ready. The regulations permit it. The economic logic is clear. And the window of opportunity for early adopters – before physical authentication becomes an industry standard – is open now.**

ID Systems AG accompanies you through all phases – from pilot definition through process integration to regulatory positioning. Contact us.

Sources and Regulatory References

- EASA Regulation (EU) No. 1321/2014, Article 145.A.42 – Traceability requirements for aviation parts in Part-145 organizations
- FAA Advisory Circular AC 21-29D – Detecting and Reporting Suspected Unapproved Parts
- FAA Advisory Circular AC 20-154 – Maintenance Documentation and Authorized Data
- UK Serious Fraud Office (SFO) – Ruling in the case of AOG Technics Ltd., Southwark Crown Court, February 2026
- CFM International – Official statement on AOG Technics counterfeits, 2023/2024
- EASA Form 1 / FAA Form 8130-3 – Authorized Release Certificate, current edition
- Aviation Week Network – MRO Market Forecast 2025 (market volume USD 87 bn)
- ID Systems AG – Technical Dossier Surface Fingerprint Technology, 2024/2025
- ISO 13485:2016 – Medical Devices Quality Management Systems (reference framework medical technology)