The world is how we shape it*

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Traceability
in the aviation sector
White Paper

*Le monde est tel que nous le façonnons

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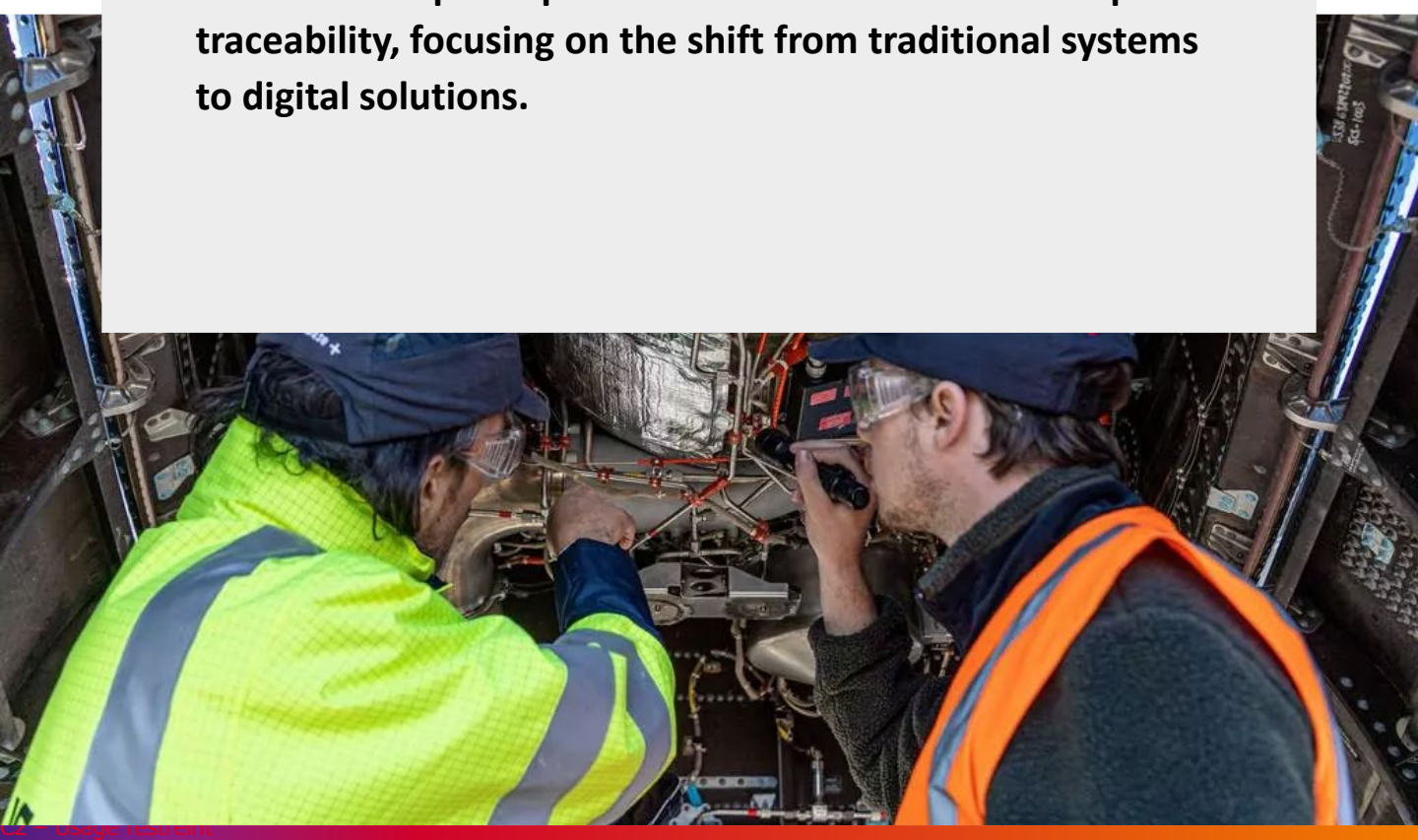
01 Abstract
Objectives of the White Paper

This White Paper explores the critical role of aircraft part traceability, focusing on the shift from traditional systems to digital solutions.



It explores the challenges associated with manual tracking methods and highlights the advantages of digital traceability in ensuring airworthiness and regulatory compliance.

By leveraging advanced technologies such as blockchain, IoT, PLM, and AI, the aviation industry can enhance safety, improve maintenance efficiency, and foster transparency across the supply chain.

Additionally, the paper examines the potential of digital traceability to support the Digital Product Passport initiative, promoting circular economy practices. The overarching goal is to demonstrate how digital innovations can streamline traceability processes, mitigate risks, and elevate the overall operational standards within the aviation sector.

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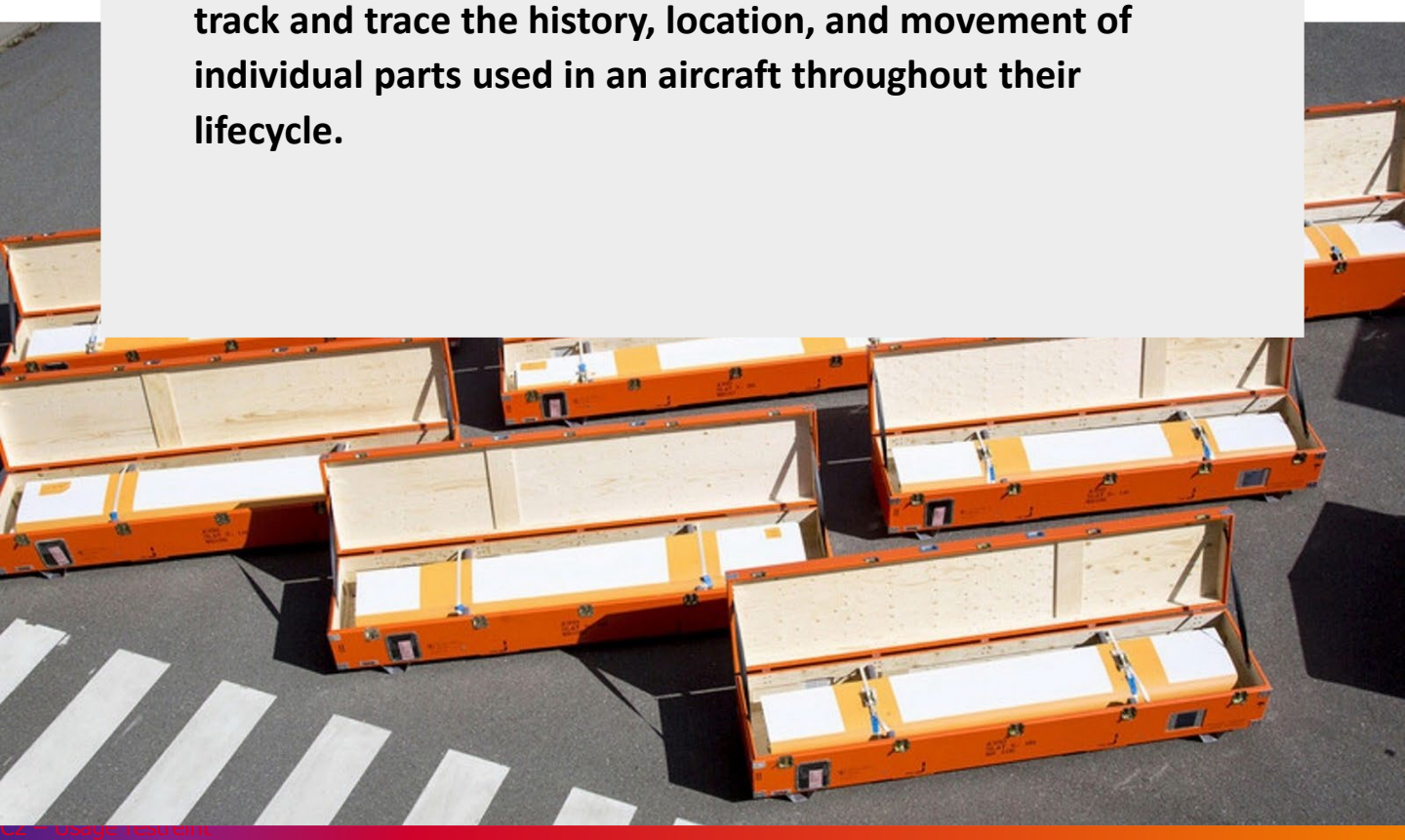
02 Aircraft part traceability

Aircraft part traceability refers to the ability to accurately track and trace the history, location, and movement of individual parts used in an aircraft throughout their lifecycle.



Aircraft parts pass through numerous different states during their lifecycle. More specifically, they can change location, ownership, condition (i.e new/used, serviceable/unserviceable, scrap) and function (on wing /off wing). They can be installed, removed, repaired, maintained, stored, shipped and they can be exposed to various conditions (i.e. temperature, humidity, vibration).

Aircraft part traceability refers to the ability to accurately track and trace the history, location, and movement of individual parts used in an aircraft throughout their lifecycle. It involves capturing and recording information about each part, such as its origin, manufacturing details, maintenance and repair history, and subsequent installations.

When considering aircraft part traceability we need to consider three keys aspects : time, location and data.

A traceability system should provide comprehensive coverage across these three aspects. Multiple part data needs to be captured and tracked; for example, the physical location, the associated data relating to manufacturing and maintenance, and any other relevant activities. By considering these three aspects, aircraft part traceability ensures a complete and accurate understanding of the part's history, current status, and future requirements.

Tracing relates to the past

The trace aspect of traceability refers to the ability to trace the history and genealogy of an aircraft part. It involves documenting the part's entire lifecycle, including its manufacturing details, suppliers, maintenance and repair activities, and any relevant certifications or inspections it undergoes. This information is crucial for ensuring compliance with regulatory requirements, identifying potential issues or defects, and enabling effective maintenance and safety management.

Tracking refers to the present time

The track aspect of aircraft part traceability involves recording the movement and location of each part as it progresses through various stages, including manufacturing, distribution, maintenance, and installation. This is typically achieved using unique identifiers, such as serial numbers or barcodes, which are associated with each part and scanned at different checkpoints to update the part's location and status.

Predicting is for what happens next

The predictive aspect of aircraft part traceability involves using historical data and analytics to make informed predictions about the future performance and maintenance needs of the parts. By analyzing data collected throughout the traceability process, such as maintenance records, operational conditions, and known failure patterns, predictive analytics can help **identify potential issues or failure risks** before they occur. This enables **proactive** maintenance planning, **reduces downtime**, and enhances overall safety and efficiency.

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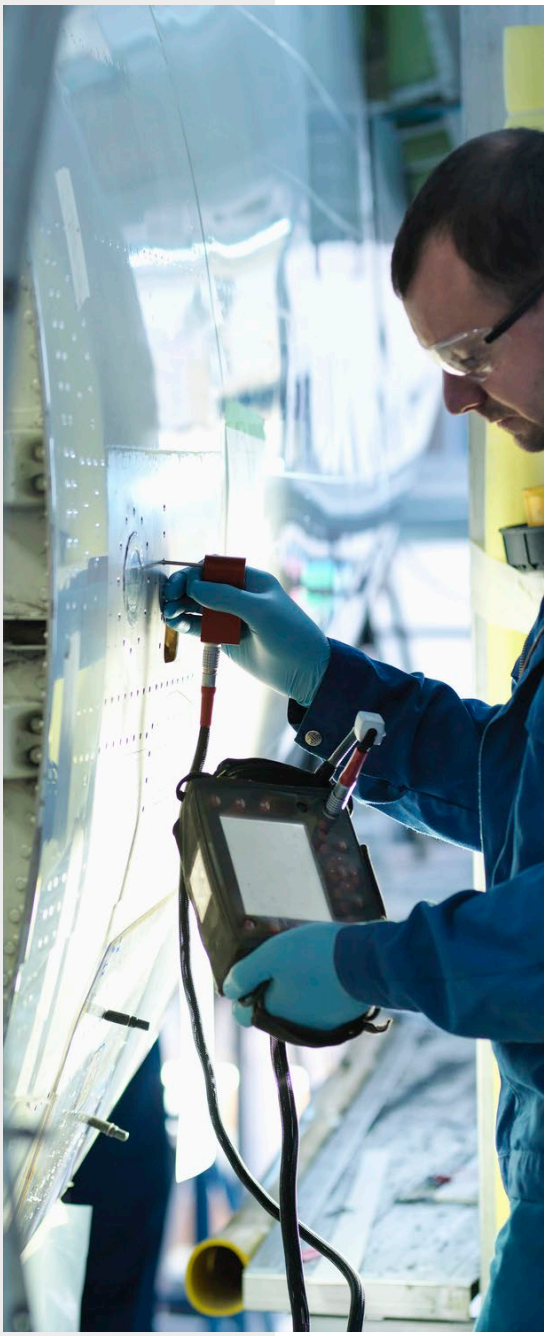
03 Challenges in traditional systems

The aviation industry is subject to stringent safety regulations, because any malfunction or failure of an aircraft part can have catastrophic consequences.



These rules vary depending on the stakeholder involved and the applicable regulations in force, but the aviation industry is highly committed to safety and efficiency.

In the dynamic world of aviation, where safety and efficiency are paramount, the concept of in-service traceability for aircraft plays a pivotal role in maintaining and enhancing operational standards.

Two key factors that significantly contribute to the effectiveness of in-service traceability are data availability and data quality.

Data Availability

Data availability is the Backbone of Traceability: Availability of data is the foundation upon which in-service traceability is built. This encompasses a comprehensive record of an aircraft's lifecycle, from its manufacturing and assembly to each maintenance operation and operational flight. Ability to retrieve real-time data enables Aircraft operators to make informed decisions regarding maintenance schedules, component replacements, and overall fleet management.

Data Quality

While data availability is crucial, its quality is equally significant. High-quality data ensures that the information is accurate, reliable, and up to date. Inaccurate or outdated information can lead to faulty decision-making, compromising the safety and reliability of the aircraft.

The current tracking & recording systems are being questioned as they have shown limitations in the present industrial context.

- **Paper-based processes**
  Manual documentation processes, involving paper-based records or spreadsheets. The teams must rely on physical logs and paper-based records to identify the service history of a defective component.
- **Record accuracy**
  To ensure that all data entered into records is accurate and complete, double-checking processes and verification steps are required to minimize errors.
- **Access control**
  Access to sensitive records is limited to authorized personnel only using locked cabinets or secured rooms to store records and maintain a log of who accesses them.
- **Audit trails**
  Maintain detailed logs of any changes or updates made to records. This includes information on who made the changes and when.
- **Physical Security**
  Protect the physical security of paper records by using locked storage, surveillance, and alarms to prevent unauthorized access or tampering.

- **Backup and Redundancy**
  Create duplicate copies of critical records and store them in secure off-site locations to prevent loss due to disasters or accidents.
- **Chain of Custody**
  Establish a clear chain of custody for paper records, especially when transferring them between different departments or organizations.
- **Training and awareness**
  Train employees on data security best practices and the importance of data integrity. Foster a culture of security awareness.
- **Regular audits**
  Conduct regular audits and inspections of paper records to ensure compliance with data integrity and security policies.

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04 Digital traceability for continuing airworthiness and regulatory compliance

The aviation industry needs a robust traceability system to uphold the airworthiness of aircraft and ensure regulatory compliance.

Digital traceability refers to the capability to accurately track and record the history, location, and status of aircraft parts and components in a digital format.

This advanced method offers considerable improvements over traditional paper-based systems, providing real-time access to comprehensive data and facilitating streamlined workflows. It encompasses numerous benefits for in-service operations:

- **Enhanced safety**
  Thanks to accurate identification and tracking of aircraft parts, maintenance activities are performed at the recommended intervals. This helps prevent failures and reduces the risk of accidents caused by faulty components.
- **Regulatory compliance**
  digital traceability helps manufacturers to meet regulatory requirements, such as documentation of inspections, repairs, and part replacements. It enables easy retrieval of historical records, simplifies audits, and ensures adherence to industry standards.
- **Improved maintenance efficiency**
  By digitally tracking the history of aircraft parts, operators can efficiently plan and execute maintenance tasks, optimizing resource allocation and reducing aircraft downtime. Real-time data access enables predictive maintenance and facilitates proactive decision-making.
- **Enhanced inventory management**
  By providing accurate inventory data, inventory is better controlled and optimized. Operators can easily track parts locations, usage, and condition, reducing inventory costs and minimizing the risk of unauthorized or counterfeited parts.

In addition to its potential for airworthiness digital traceability is also an enabler for the Digital Product Passport (DPP).

The DPP initiative is part of the proposed Ecodesign for Sustainable Products Regulation and one of the key actions of the Circular Economy Action Plan (CEAP). The goal of this initiative is to lay the groundwork for a gradual introduction of a Digital Product Passport.

The European commission defines a 'product passport' as a product-specific dataset that can be electronically accessed via a data carrier to facilitate the electronic registration, processing, and sharing of product-related information among supply chain entities, authorities, and consumers.

The DPP serves as a means to provide comprehensive details regarding the origin, composition, repairability and disassembly options of a product.

Additionally, it includes information on the use phase of a product, and recyclability or appropriate end-of-life disposal methods for various components.

Digital traceability is fundamentally interconnected with the Digital Product Passport (DPP) and acts as a crucial enabler for its successful implementation.

By ensuring the accurate and comprehensive tracking of aircraft parts and components throughout their lifecycle, digital traceability provides the necessary foundation for the DPP to function effectively.

The system of digital traceability thus not only supports but also enhances the functionality and benefits of the DPP, making it a pivotal element in achieving the objectives of the Circular Economy Action Plan.

The DPP holds the promise of bringing transparency and fostering circular practices. It disseminates **comprehensive product information** across the value chain, **simplifying** the assessment of a product's environmental footprint and enabling informed **decision-making**. The DPP approach could be extended to the continuing airworthiness management by addressing the traceability needs for airworthiness and compliance. It provides a reliable foundation and framework for maintaining safety and regulatory standards.

Gain a comprehensive overview of your product lifecycle

Leverage digital product passports to meticulously trace products as they move through the value chain. This extends visibility beyond direct suppliers, offering a thorough understanding of your products' journey. Ultimately, this enhances transparency and ensures compliance with quality, airworthiness, sustainability, and other requirements.

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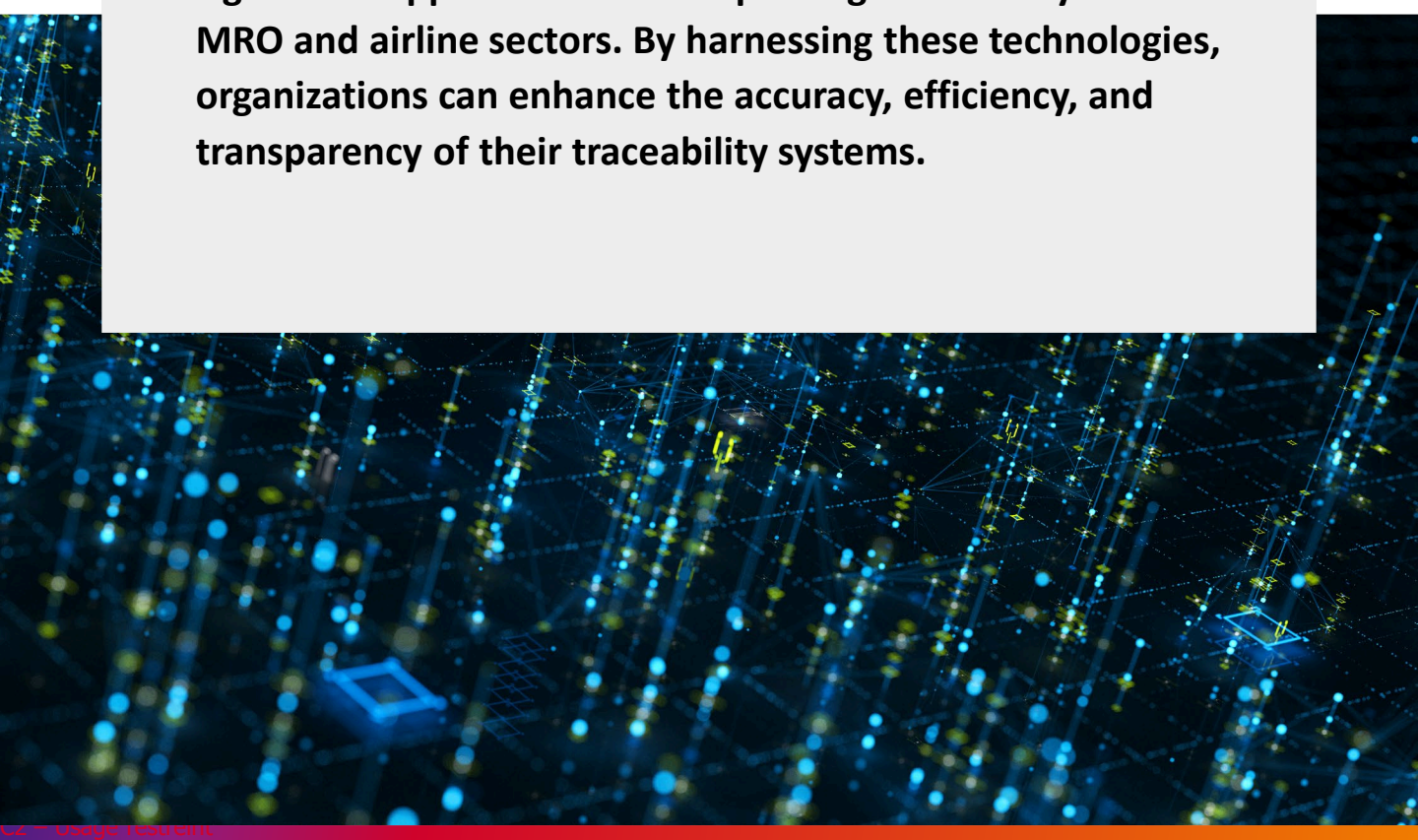
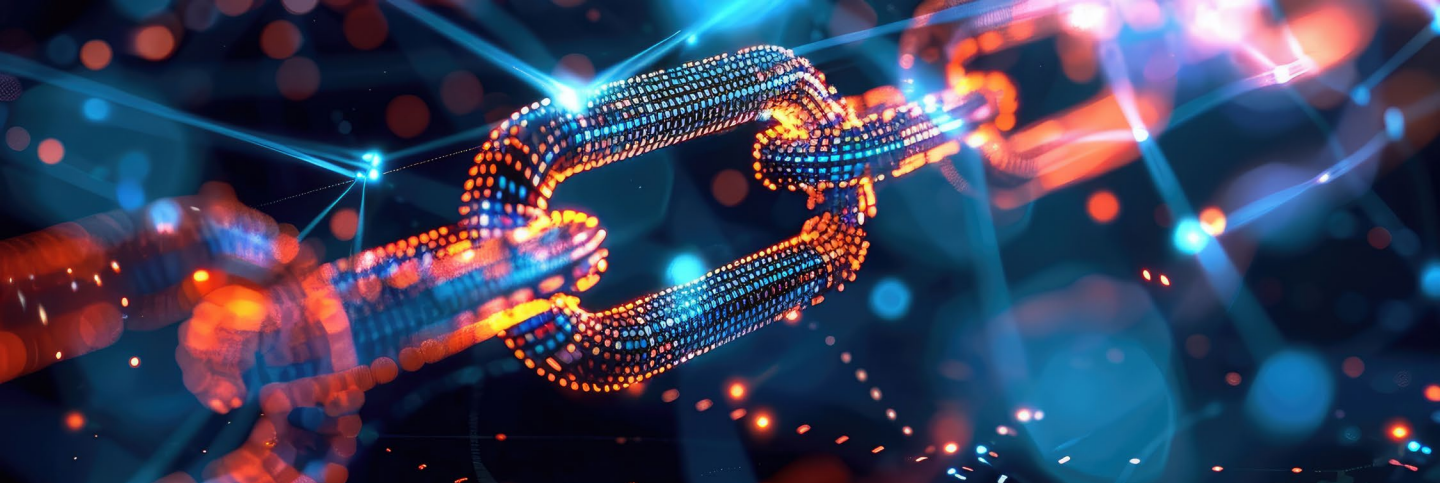
05 Leveraging technology for traceability

The advancement of digital technologies has presented significant opportunities for improving traceability in the MRO and airline sectors. By harnessing these technologies, organizations can enhance the accuracy, efficiency, and transparency of their traceability systems.





Several emerging technologies can enhance aircraft part traceability:

- **PLM solution**
  Product Lifecycle Management (PLM) systems can play a crucial role in enabling and managing traceability. They can help organizations to manage and control product data and related processes throughout their lifecycle. They provide a centralized repository for storing and managing information about parts, including design specifications, manufacturing details, maintenance records, and other relevant data.

- **Blockchain solution**
  Blockchain technology offers a decentralized and immutable ledger that can revolutionize traceability in the aviation industry. With blockchain, each transaction or event related to an aircraft part can be securely recorded in a transparent and tamper-resistant manner. This ensures a single source of truth throughout the entire supply chain, eliminating the risk of counterfeit or unauthorized parts. Blockchain technology also facilitates faster and more efficient auditing and verification processes, reducing the time and effort required for compliance checks. By implementing blockchain-based traceability systems, MRO providers and airlines can enhance trust, accountability, and visibility across the entire lifecycle of aircraft parts.

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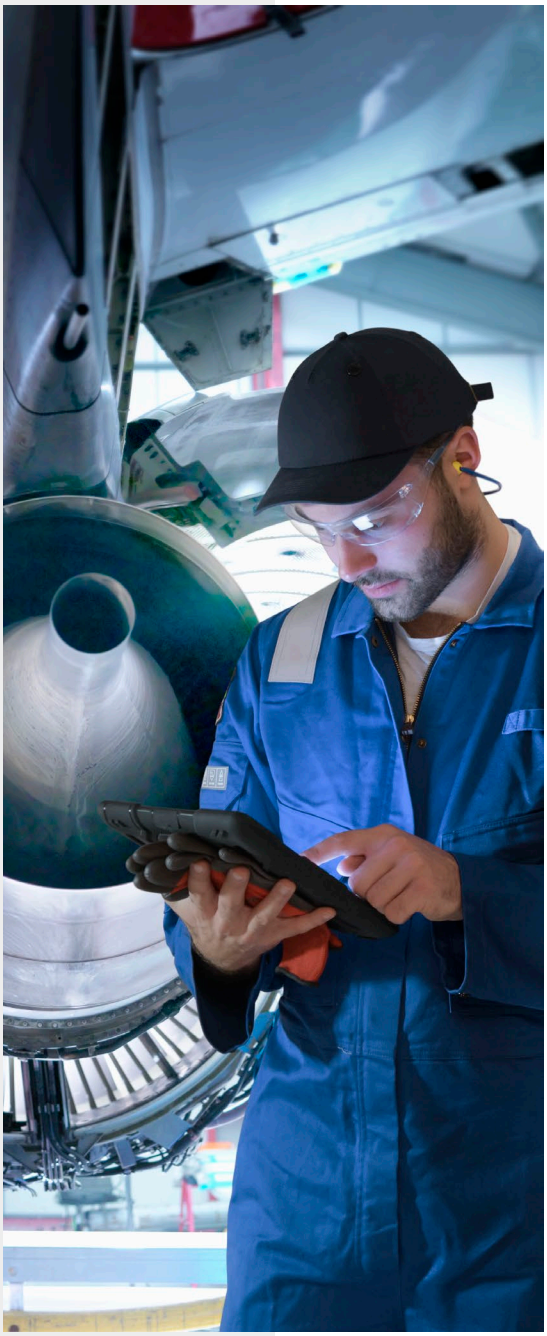
These digital solutions are empowered by technological connectivity and data analysis capabilities, which elevate traceability to a higher standard:

- **The Internet of Things (IoT)**
  The IoT enables the interconnection of various devices and sensors, allowing real-time monitoring and data collection. IoT devices can be utilized to track and monitor aircraft parts throughout their lifecycle. For instance, RFID tags or sensors embedded in parts can transmit data such as location, temperature, vibration, and usage information. This continuous flow of real-time data enables proactive maintenance and improves the accuracy of traceability records. Additionally, IoT technology enables predictive analytics, enabling organizations to identify potential issues or failures in advance, reducing downtime and enhancing operational efficiency.

- **Artificial Intelligence (AI)**
  The AI technologies have the potential to transform traceability processes by automating data analysis and facilitating decision-making. AI algorithms can process large volumes of data collected from various sources, such as maintenance records, flight data, and historical performance data, to identify patterns, anomalies, and potential risks. AI-powered systems can provide predictive maintenance insights, alerting maintenance teams to potential part failures or the need for preventive actions. By harnessing AI, MRO providers and airlines can optimize maintenance schedules, reduce costs, and ensure timely part replacements.

By leveraging these digital technologies, MRO and airlines can establish robust and reliable traceability systems.



These technologies enhance data accuracy, enable real-time monitoring, ease decision-making, and drive operational efficiency.

To fully implement a digital traceability model, certain key conditions are necessary. One of these conditions is: Adopting a global product lifecycle management (PLM) approach which enhances teamwork within and outside the company, promotes innovation, and boosts performance across all stages of the value chain.

PLM combines solutions, technologies, and organizational changes to achieve significant results.

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06 Conclusion

In conclusion, the aviation industry faces significant challenges in ensuring the traceability of aircraft parts, particularly with traditional systems that rely on manual processes and outdated technologies.

However, with the advent of digitalization, promising solutions are available to enhance transparency, efficiency, and safety within the industry.

By leveraging cutting-edge technologies, stakeholders can now achieve unprecedented levels of traceability, enabling real-time monitoring, data analytics, and proactive maintenance strategies.

Embracing these advancements will not only streamline regulatory compliance but also foster greater trust among all stakeholders of the operating chain. As we embark on this journey towards a more connected and accountable aviation ecosystem, it is imperative for industry leaders to embrace innovation and collaborate to realize the full potential of digital traceability in shaping the future of aviation.

Our Conviction

In the future, it is foreseeable that every component will possess a reliable digital identity and a readily accessible historical record, accessible to authorized individuals with appropriate credentials.

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