Enhancing PHM Functionality by Using Data Sharing Standards

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ABSTRACT

Nearly everything related to Prognostics and Health Management (PHM) in aviation is dependent on data: its generation, its transmission, its storage and its access and use. In each of these areas, many standards exist related to the underlying technologies, but this is not the case when it comes to standards for data governance. In this brief paper, we address the gaps in the landscape on data governance, especially those related to data sharing. This will be critical when artificial intelligence and in particular machine learning becomes more widespread in developing and maintaining PHM algorithms. We describe how aerospace consortia may be able to help fill some of these gaps. The path forward in this highly connected world will only be possible if strict rules exist for all entities within the ecosystem to be able to share data and thereby achieve common benefits no single organization can achieve on its own. In particular, we describe the role of the Independent Data Consortium for Aviation (IDCA) that has been established to do just this. Some examples of areas within aviation where governance standards can be critical are parts data tracking, AOG (aircraft on ground) situations, diagnostics and prognostics for aircraft systems, supporting the use of artificial intelligence (AI) and machine learning (ML). We show how issues can be resolved faster and more efficiently if data governance standards exist that are agreed to by all stakeholders. Additionally, mechanisms for ensuring trustworthiness would be critical in allowing automated enforcement and accounting. Here we are reporting on the progress we are making in developing these standards.

1. INTRODUCTION

Diagnosing issues related to modern aircraft engines is an important function of diagnostics, prognostics and health management in aerospace. (While this discipline should rightly be termed DPHM, traditional usage has shortened it to PHM, which is what will be used in this paper.) There is a history of the use of PHM for aeroengines stretching back to the 1970s when vibration monitoring was mandated by the FAA on all transport category aircraft (FAA 2026).

This paper discusses the use of governance standards for data sharing to facilitate PHM. The focus is on aircraft, but this is merely an example of the larger issue. The lessons learned here can apply to any organized engineering sector where multiple players have stakes in the manufacture, operations, and continued viability of complex products. The problem is illustrated in the context of specific issues that the commercial aviation sector faces today, and the case for the wider sharing of engineering and operational data is made with the goal of increasing the efficacy of diagnostics and prognostics within this context. Specifically, we contend that sharing data is beneficial not only to get to the root cause or any fault quicker, but also to enhance passenger safety. And we argue that having standards for sharing data would be essential for this to happen in an efficient, trustful manner. We describe what the IDCA is doing to effectuate this reality. While PHM – or more generally, digital data analytics – is one of the main areas of standards' development, IDCA is looking at other cases as well. Two of these are AOG and Part Tracking. Every operator deals with AOG situations each and every flying day, and every one of them maintains an AOG desk and dedicated staff to deal with AOGs. An aircraft stuck on the ground in one's home base is not as critical, because the chances of spare parts being available to remedy the situation are very high. AOG becomes a real problem when they occur in remote airports, where the operator does not have comparable facilities or staff. Today, the industry uses a consortium approach to solving this problem. The IATP (International Airlines Technical Pool), consisting of nearly all airlines in the world, agree to help each other out by lending or selling parts for compatible aircraft at remote locations so that aircraft can be put back into operation quickly, with minimal disruptions to passenger journeys. Another use case that IDCA is working on is related to parts tracking. High value parts that are critical to the safe operation of aircraft need to be tracked – with date of manufacture, precise technical and regulatory data, history of usage, etc. – to maintain safety and prevent fraud and counterfeiting. A recent case of fraud concluded in the UK where the CEO of AOG Technics, Jose Yrala, was sentenced for nearly five years (Feller 2026). Yrala created AOG

Technics to principally sell CFM56 engine parts (used by both Airbus and Boeing aircraft) with forged Authorized Release Certificates, thereby allowing older parts to be used with false life records, essentially the aviation equivalent of "rolling back the odometer." Standards for sharing data about the provenance of aircraft parts could have prevented such fraud. These, and other examples, demonstrate the need for such data sharing standards. In this paper we concentrate on PHM for engines as an example use case, but the principles remain the same for all.

It is important to point out that the standards that are being proposed here are not technical standards. Standards for data sharing can be divided into three layers, an architecture illustrated in Figure 1. This way of considering data-related standards has been inspired by the work being done within the G-31 committee of SAE International (SAE 2026).

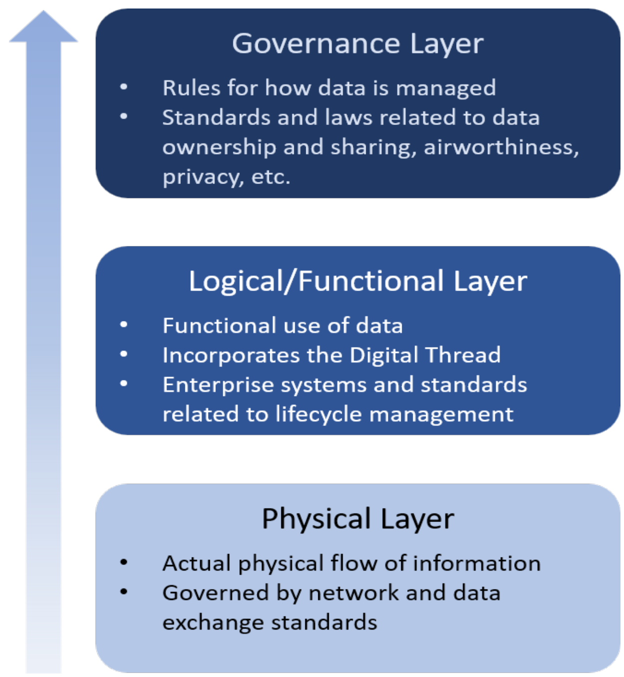

Figure 1. Framework for Data Standards

The base layer (in Figure 1) consists of physical attributes for data sharing; essentially the nuts and bolts of how data is transmitted and stored. Some well-used standards such as Ethernet, ARINC428, CAN, NTFS, etc. fall into this area. The next layer is the logical and functional layer consisting of higher-level manipulation of data. XML, SysML, FM, Blockchain standards, SQL, etc., would be a part of this category. But none of these layers discuss data governance; i.e., the rules and standards for data exchange, access & usage control, cyber security, etc. Most of the governance policies that exist today have been enacted by government agencies. Prominently, Europe has been very active in this area when compared to the US, but in certain areas, such as cybersecurity, the US, through NIST, has been taking a leading role. In fact, most countries have started to establish rules and regulations for how data is managed and who has rights and responsibilities related to data. Unfortunately, the same cannot be said of the aerospace industry; industry-led consensus governance standards for data sharing are sadly lacking. IDCA is trying to fill this gap. As mentioned above, there are several standard development organizations (SDO) that are active developing standards for the physical and the functional layers, so there is a need to build up the industry's capabilities with respect to rule-making at the governance level. The examples given below help to illustrate why this is important, specifically for the use of PHM for aerospace systems, but also to advance the cause of efficiency and airworthiness within the aviation ecosystem as a whole. More information about IDCA can be found on their website (*dataforaviation.org*). We must point out at the outset that no standards have yet been published, but good progress has been made in a couple of areas such as parts tracking and Aircraft on Ground (AOG) resolution. We wish we could report more definitively when any of these standards would be published. Unfortunately, because IDCA is run entirely on a voluntary basis, we are dependent on experts from airlines, OEMs, and suppliers to develop these standards. The recent economic downturn our member airlines are experiencing because of elevated fuel costs and supply chain issues has been quite detrimental to our efforts to accelerate work to complete these standards. Once economic pressures ease, it is hoped that teams can regroup and accelerate their work.

2. Diagnosing Aircraft System Faults

Recently, Airbus engineers discovered a flaw in an aircraft engine bleed system that could have led to a catastrophic failure and loss of aircraft. We will briefly describe the scenario and how the root cause analysis could have benefited from having a pool of data available to the technical staff responsible for continued airworthiness. Continued airworthiness is defined as the process of ensuring an aircraft's long-term design integrity and structural safety throughout its service life. It is typically the responsibility of the original equipment manufacturers (OEM), i.e., the airframer. The OEMs fulfil their obligations in this regard in part by publishing instructions for continued airworthiness, which describe how aircraft are to be maintained so that they are able to carry out their functions over the course of their useful life.

New aircraft are equipped with many sensors which are constantly gathering data. Much of this data is never reviewed and is discarded after a length of time, which means that valuable operational information is lost. Having the means to process this data would be beneficial to the aircraft owner/operator to support continuing airworthiness processes to keep an aircraft legally and physically fit to fly. In both cases, novel Artificial Intelligence (AI) techniques give us advanced means of processing data. But the adage that AI models are only as good as the data they are fed is even more true in these cases. Data from a single operator depends critically on the number of aircraft and the number of flights that the aircraft manages to complete. This imposes a constraint on the amount of data that the operator can collect. The ability to share data from multiple operators could help remove this constraint. But no commercial enterprise is keen on sharing data; especially operational data. This is where governance rules come into play. If a community of stakeholders can agree first on a common benefit no single stakeholder can achieve on its own, and subsequently some consensus rules for sharing and exchanging data, they would be more willing to participate in common activities. Next to privacy, paramount concerns that must be addressed are the fear of losing control over their data (data sovereignty), and having their data used without any business benefit accruing to them.

The specific case involving the Airbus aircraft hinges on the use of data from the aircraft monitoring system (Skywise) rather than the Bleed Monitoring Computer (BMC) system. In other words, this is data that would not generally be used during flight to control any system or to trigger any alarms; it is meant to aid maintenance. Since the specifics of this case can be found in the very insightful article by E. Head (2025), and the SAE Aerotech presentation by G. Brown (2024), only a high-level description is provided here.

In 2022 it was discovered that high-pressure pressure regulating valve in the Airbus 330neo engine bleed air system was leaking. Airbus engineers utilized the company's Skywise platform to cross-reference operational and sensor data. They discovered a hidden, potentially catastrophic pneumatic design flaw: in certain high-performance take-off configurations – namely with APU bleed on and engine bleed (used for air conditioning) off – the BMC software failed to correctly control the high-pressure valve pressure regulating valve. The resulting excessive mechanical stress caused the valve's clamping pin to fail, damaging the seal and causing the reported leaks. If left unaddressed, the leaking valves could expose downstream pressure regulating valves to extreme pressure and temperature, potentially bursting the duct, allowing hot air to escape into the wing, and ultimately causing a total loss of aircraft control. Airbus immediately notified regulators, resulting in the European Union Aviation Safety Agency (EASA) issuing an immediate emergency airworthiness directive (EAD 2022-0170-E), which was adopted by the FAA a day later. To mitigate risk, the EAD prohibited flight crews from taking off in the suspected configurations. Over the next two years, Airbus developed a permanent solution. Subsequent ADs directed operators to physically replace the affected clamping pins and update the BMC software logic, which resolved the underlying issue and allowed the initial operational restrictions to be relaxed.

Why is this important? In this specific example, the original equipment manufacturer (OEM), i.e., Airbus, was able to get to the bottom of the issue because it had access to all the data via its Skywise data platform. This may not always be the case. Multiple airlines flying the same aircraft may not want to share data without some sort of guarantee that the data may not be used against them financially or legally. Considering its responsibility for continued airworthiness, it means that a design approval holder like Airbus may not be able to pool the data in order to diagnose often very rare faults without some standards in place. Consensus standards that have been developed by the industry itself may provide such a framework for data sharing. IDCA is facilitating the development of such standards.

3. Recovery of an Aircraft After AOG

AOG situations are inevitable in airline operations. An AOG occurs when a technical, maintenance, or engineering issue renders an aircraft temporarily unairworthy and therefore unable to fly. Mitigating an AOG situation with absolute urgency is paramount because a grounded plane generates zero revenue while costing the airline a lot. Boeing has contended that typical AOG delays cost an airline between \$10,000 and \$20,000 per hour, with prolonged or complex disruptions on premium routes escalating these costs to \$150,000 (Grous 2018). These massive losses stem from a combination of hard costs—such as emergency part procurement and rush shipping, immediate flight delay penalties, and secondary ripple effects like crew overtime, passenger compensation, and missed connections (Ashford et al. 2013). Consequently, airlines are prepared to spend large sums of money to ensure that they have the resources to rapidly respond to AOG situations and prevent their assets from being stranded on the tarmac.

The industry has come together to create the International Airlines Technical Pool (IATP) to respond to AOG situations by facilitating the borrowing or purchase of parts from one another at times of need. (For more information, please visit *iatp.com*.) This allows a foreign airline to secure a part from a local airline quickly to be able to diffuse the AOG and get back in the air. The borrowed part – or a comparable rotable part – can be returned within a specified length of time.

This is where the sharing of data related to part availability can be critically important. While the IATP provides a secure mechanism to reach out to fellow airlines to facilitate such part transfers, the communications are typically still via email and phone calls. Needless to say, this can be very inefficient. A more automated means to share data related to appropriate parts can be very useful, but to be able to do this, there must be established standards for data sharing that all parties agree to. Otherwise, airlines, in a highly competitive marketplace, will not allow key inventory information to be open to outside visibility.

With industry-developed consensus standards for sharing sensitive data, the risk this barrier represents can become more manageable if not eliminated. Key pieces of parts inventory can be shared to facilitate rapid resolution of AOG and other sourcing issues. The impact, immediately for the flying public, and overall, on the aviation industry will be dramatic. That is why IDCA has taken on the task of developing a systematic set of data sharing standards for parts tracking information. Because it is led by industry professionals, there is little chance of these standards allowing proprietary information to be shared, unless the owner agrees to it, and the necessary safeguards and accountability measures are in place.

The immediate benefit of this action will be the improvement of aircraft availability, and consequently a reduction in D&C (delay and cancellation) metrics, which are tracked continuously by airlines. IDCA is working with IATP to ensure that the data-sharing standards that are developed have the industry's approval, which will allow them to be used without much resistance.

4. Data Analytics Using AI

A third use case that is being tackled by the team at IDCA is one related to the development of AI using machine learning (ML) based models for PHM.

AI and ML are concepts rapidly entering the commercial aviation space. Regulators such as EASA, the FAA, and the UK CAA have already published roadmaps for the introduction of certified AI/ML algorithms to support air travel (EASA 2022, FAA 2024). As said, AI development depends critically on the availability of sufficient amounts of data to train and validate algorithms. The aviation industry is fortunate in that the types of commercial aircraft are limited. There are still only three major original equipment manufacturers (OEM) in the west: Airbus, Boeing, and Embraer. This means that issues that arise in any specific type of equipment due to internal engineering issues would be common to all carriers. However, because of the very nature of this business, a particular airline may or may not have a significant number of any particular aircraft model. This means that if they are depending on operating data to diagnose or prognose the problem, it might be limited in quantity.

This can be mitigated to an extent if airline operators agree to share aircraft operational data for very specific and well-defined purposes. By doing so, they can obtain common benefits no single airline can achieve on their own. Of course, one must be careful to take different operating conditions into account for different operators. However, that is a technical problem that can be resolved and is addressed in SAE G-34 / EuroCAE WG 114. Once normalized, data can be used by ML algorithms to develop more accurate algorithms for AI-based methods or even pattern recognition in the data that could indicate a safety issue.

The benefit of sharing data is obvious in these situations, but data-sharing can raise challenges of trust that may not be easily overcome. This is particularly true when dealing with commercial entities that compete in the same marketplace. One way to address trust issues in such public transactions is by establishing governance rules whereby both users and suppliers of data define and subsequently organize the required level of trust – through an avenue such as a consortium – to ensure:

- Data sovereignty: Each supplier of data shall always remain in full control of their data.
- Trustworthiness: Data processing never reveals sensitive or personal information and protects IP.
- Fairness: Created value is fairly shared amongst participating members.
- Accountability: All data transactions should be registered in an immutable way such that members can be held accountable during the resolution of any dispute.
- Common baseline for all members: When signing a membership agreement, members declare compliance with a commonly defined set of rules of engagement.
- Common (local) law always takes precedence over consortium rules.

This is where a neutral consortium can help. IDCA is establishing just such a medium to develop the consensus-based rules all members will use to share data in a pre-competitive manner. This is particularly relevant to the problem of generating models and algorithms for AI solutions. This is because, while airlines operate similar equipment, they do so from operating bases that are located in different jurisdictions. Often local laws prevent data from being exported even if the end result may benefit a global public.

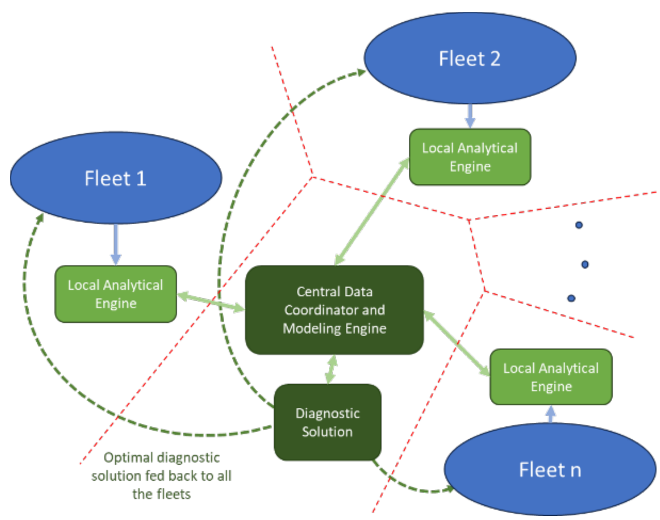

Figure 1. Federated Learning for AI Algorithms

Therefore, the problem of optimal – and legal – data sharing becomes even more critical. Federated Learning (showcased in Figure 2) is a technique whereby distributed data sources can be used to arrive at a common AI solution by bringing the training process to the data rather than bringing the data to a centralized training process. Only training results are consolidated, not the data itself. In other words, data contained within different sovereign domains will never leave the borders of their respective jurisdictions. However, advanced algorithm-development methods can nevertheless be employed to develop centralized models under these “data-siloed” constraints. Several methods for constrained learning have been studied, including by some graduate students at the University of Amsterdam working on IDCA-related projects. Their work has not yet been published, but it is similar to research described in Dalgkitsis (2024), and Landau (2026).

5. Conclusion

This paper points out some of the gaps that exist in the standards landscape, especially when it comes to the governance of data sharing in the aerospace industry. It describes three use cases where having such standards would be beneficial for all the parties involved. It also describes steps taken by several leading industry players to come together to form the IDCA, that will fill these gaps. It must be pointed out that IDCA has not yet published a standard, even though it is making good progress in two areas: Data sharing for parts tracking and for resolving AOG situations. Additionally, technical work on a framework for federated learning for AI modeling is underway in conjunction with the University of Amsterdam. Progress on all these fronts will be reported in the future.

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6. Abbreviations

Term	Definition
A4A	Airlines for America
AC	Advisory Circular (FAA)
AD	Airworthiness Directive (FAA)
AOG	Aircraft on Ground
EASA	European Union Aviation Safety Agency
FAA	Federal Aviation Administration
IATP	International Airlines Technical Pool
IDCA	Independent Data Consortium for Aviation
IVHM	Integrated Vehicle Health Management
OEM	Original Equipment Manufacturer
SDO	Standards Development Organization

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