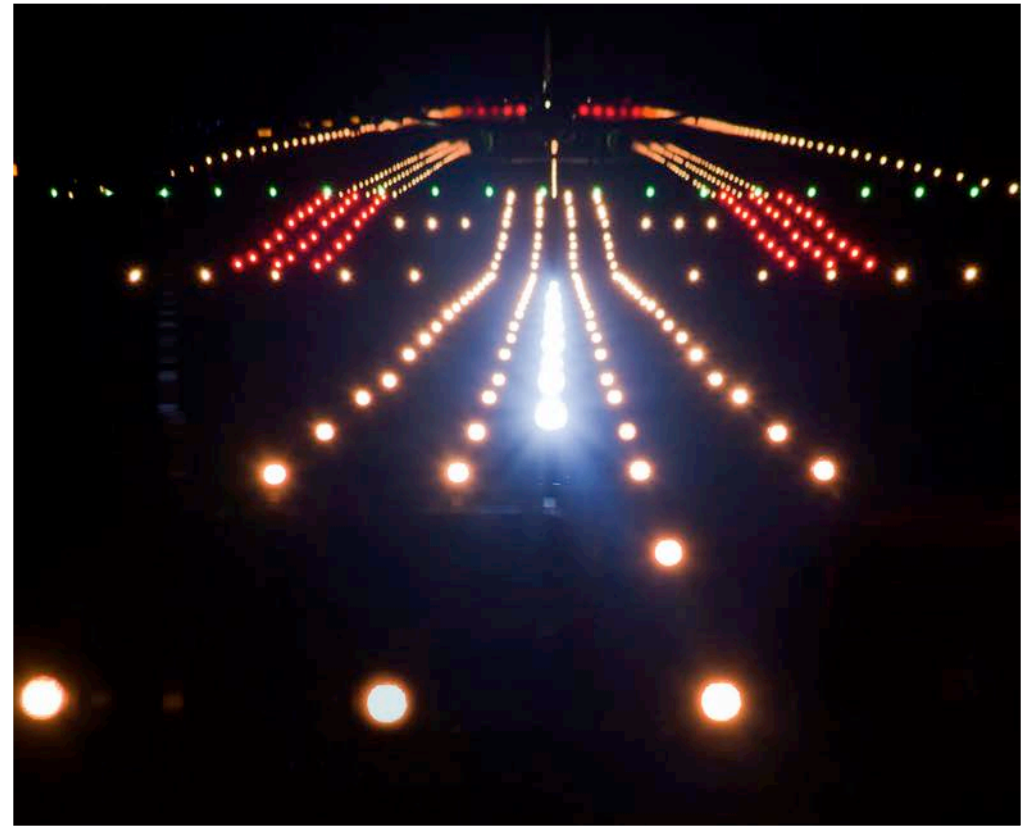# Data for the life
of the aircraft

**How the adoption of blockchain can provide
a boost of power and efficiency to the
aerospace industry**

April 2019

pwc

Contents

The opportunity

The aerospace industry is vast (2018 revenues: US$838bn[1]), complex and interconnected. Its recent performance has been strong. As millions of people and hundreds of millions of tons of cargo are ferried around the world daily, over distances long and short, profits are at an all-time high.[2] And the industry is poised for further growth. To accommodate the persistent growth of air travel in an increasingly interconnected world, demand for new commercial aircraft may reach approximately 40,000 planes over the next 20 years.[3] And yet, like every other industry, aerospace faces significant challenges. Companies that manufacture, operate and service aircraft are always on the lookout for capabilities, technologies and tools that will allow them to optimise performance, whether it is purchasing better yield-management software or creating more fuel-efficient designs. As the industry weighs the potential of technologies such as artificial intelligence and 3D printing to transform operations, there's another innovation it should consider: blockchain.

Why blockchain? What does this technology, most closely associated in the public mind with digital cryptocurrencies, have to do with the distinctly analogue process of moving 250-ton machines through the air? Simply put, what the aerospace industry doesn't know about its planes is costing it serious money. And what it could do with all that knowledge has the potential to create new streams of enduring value.

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1   Aviation Week ShowNews, 15 July 2018. *Aerospace industry is worth US$838 billion*, Aviation Week Network.
2   Thompson, S., 17 May 2018. *Aerospace and defense industry scores record profit in 2017; poised for significant growth in 2018*, PwC Industrial Insights.
3   Average of Airbus and Boeing 2018–37 delivery forecasts.

Despite the technological sophistication of modern commercial aircraft, much of the data that's crucial to keeping them airborne is collected manually. Depending on its size, a plane can include anywhere from a few hundred thousand to several million parts,[4] which its manufacturer must log in its records — often by hand. Airlines must do the same to keep the more than 40 systems they use across fleets up to date. Anyone providing a part — whether it is a maintenance, repair and overhaul (MRO) provider or a supplier restocking a warehouse — must evidence a part's history. In the absence of a part history provenance, the part's airworthiness must be established through testing and recertification. Only rarely is such data available digitally. As a result, there's no readily available single snapshot of an aircraft's condition or history. The data is spread across, and isolated in, multiple parties and systems. Though those parties may be part of the same ecosystem — suppliers, vendors and customers of the same manufacturer, for example — they may also compete against one another and therefore be reluctant to share data. Blockchain's decentralised, immutable and consensus-based nature makes it a perfect fit to help overcome these challenges.
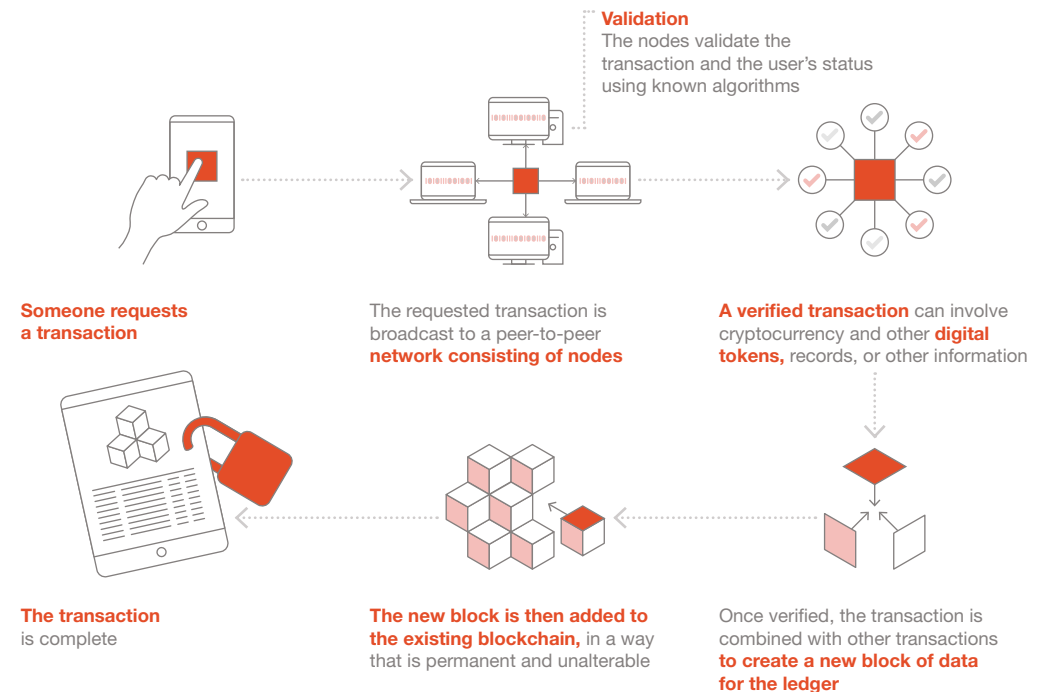
4   Golan, S., 24 October. 2017. *Overcoming supply chain challenges and seizing opportunities: An aerospace case study*, Quality Digest.

How blockchain works

Validation
The nodes validate the transaction and the user's status using known algorithms

Someone requests a transaction

The requested transaction is broadcast to a peer-to-peer **network consisting of nodes**

A verified transaction can involve cryptocurrency and other **digital tokens,** records, or other information

The transaction is complete

The new block is then added to the existing blockchain, in a way that is permanent and unalterable

Once verified, the transaction is combined with other transactions **to create a new block of data for the ledger**

Source: PwC, *How can blockchain power industrial manufacturing?*

Blockchain has the power to create a digital 'birth certificate' for every part that's installed in a plane and update it every time the plane is serviced or inspected.

Blockchain has gained notice — and notoriety — for its financial applications. But it has the potential to transform all kinds of businesses. Why? At the most basic level, every blockchain application is merely a digital ledger of transactions that take place on a peer-to-peer network.[5] The transactions that a blockchain records don't have to involve the exchange of money for goods or services, however. Instead, the technology could be used to record each time a part is installed in or removed from an airplane. It could capture other details as well, such as how long the part being replaced was in service and the identity and location of the technician performing the repair. And it could make sure that blockchain participants have access only to the information they're entitled to, vastly improving visibility into their own businesses while safeguarding their data from competitors.

Blockchain has the power to create a digital 'birth certificate' for every part that's installed in a plane and update it every time the plane is serviced or inspected by a technician. The data collected could include the aircraft's tail number and configuration, the part's location in the plane, its manufacturer, the identity of each technician who has touched the part, and the location where the service was performed. These birth certificates can be aggregated into a 'digital twin' of the aircraft that provides a real-time snapshot of its condition from the moment it exits the assembly line to the day 20 years later when it is returned to its lessor or retired from the airline's fleet.

Data for the life of the aircraft: People, parts and places, in real time

Today's commercial aircraft can have hundreds of thousands or even millions of parts. Blockchain can give airframers, airlines and suppliers the level of transparency they need.
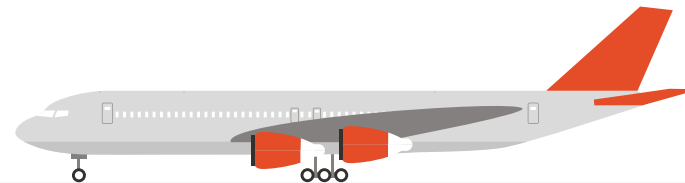
| Part traceability | + | Technician identity and credentials | + | Location and type of services performed | = | Real-time snapshot of aircraft configurations | x | Across the fleet |

Source: PwC, *How can blockchain power industrial manufacturing?*

5   PwC, 2017. *Making sense of bitcoin, cryptocurrency and blockchain*.

The impact for airlines alone is potentially massive. Having a more accurate view of a plane's configuration and maintenance history could help reduce costs and losses related to downtime and unplanned maintenance, boost the value of planes in the secondary market and at the end of leases, and improve worker productivity. PwC analysis has found that efficiency gains enabled by blockchain could increase industry revenue by as much as 4%, or US$40bn, while cutting MRO costs by about 5%, or US$3.5bn.

The transformative potential of blockchain is driving broad interest in the technology across all sectors. More than eight in ten executives say their company has at least some involvement with blockchain.[6] And we know that some aerospace leaders are already starting to think about it. Nearly a quarter of aerospace and defence executives who participated in PwC's fall 2018 Digital Trust Insights Survey (24%) said blockchain was critical to all their lines of business, compared with 20% for all respondents across sectors.[7]

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6 PwC's Global Blockchain Survey, 2018. *Blockchain is here. What's your next move?*

7 PwC's Digital Trust Insights Survey, 2018. *The journey to digital trust: Digital businesses that lead in safety, security, reliability, privacy and data ethics will be the titans of tomorrow.*

Data for the life of the aircraft: The commercial ecosystem
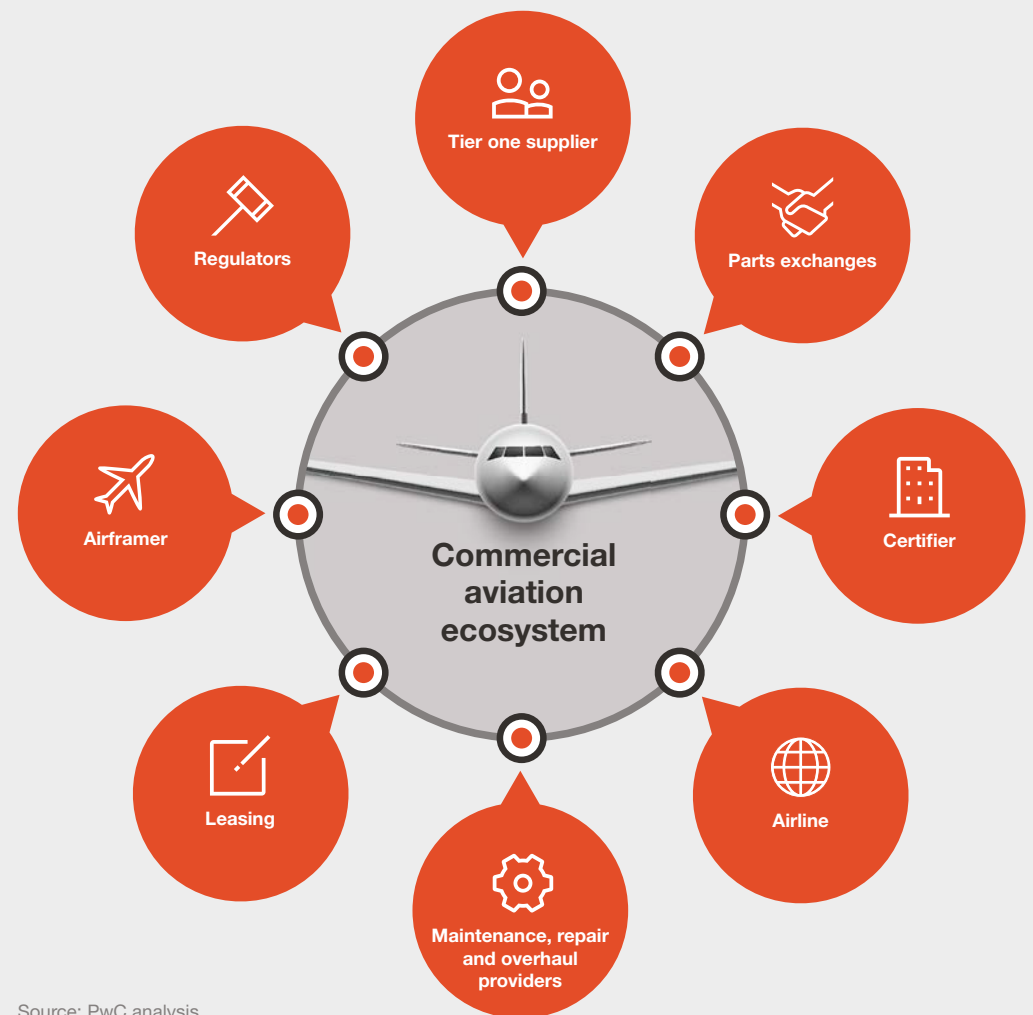
Source: PwC analysis

Blockchain won't revolutionise the aerospace industry overnight. (In fact, an important best practice for the technology is to start small.) Rather, it has the potential to help solve specific problems that players throughout the industry face every day. And it supercharges other innovations that companies are already adopting, like the Internet of Things (IoT), cloud computing and data analytics. Think of blockchain technology as a type of next-generation business process improvement software that has the power to help overcome long-standing hurdles to more efficient operations. Here's how.

Flying with eyes wide open

Blockchain technology's potential to offer unprecedented insight into supply chains is clear. From raw materials to finished product and from the factory floor through distribution networks to the customer's doorstep, it can track a component's progress at every stage of its journey. This power holds potential benefits for any company that makes or buys manufactured goods. But there are challenges specific to the aerospace industry's huge supply chain that blockchain is particularly well-suited to tackle.

One of the largest set of use cases for blockchain pertains to aircraft maintenance. Having the right part, in the right place, at the right time, in hundreds of locations is one of the fundamental operational challenges that airlines and MROs face. Indeed, supply chain challenges can be a significant driver of maintenance costs.[8] By improving visibility and transparency, participants would shift from a situation in which they are often flying blind into one in which they are flying with eyes wide open.

Potential maintenance use cases include:

Improve routine efficiency. A continually updated ledger of each part's condition and usage could help reduce time spent on routine inspection and maintenance by aircraft operators, so asset utilisation would rise. It could greatly streamline heavy maintenance visits, shaving days off a process that often requires significant labour. Combined with predictive analytics, it could also allow aircraft operators to cut spare parts inventories. Suppliers and MRO providers could realise similar benefits.

8   PwC's Global MRO Supply Chain Benchmarking Study, 2013. *Advancing aviation.*
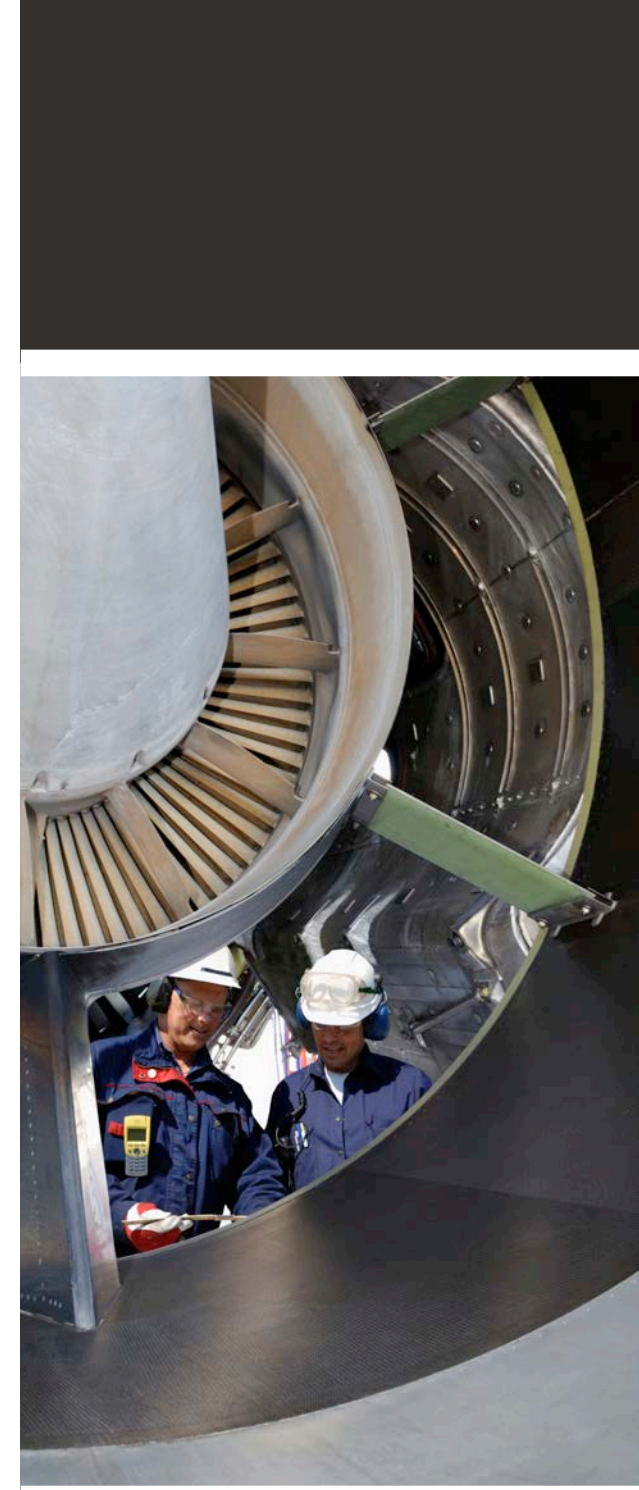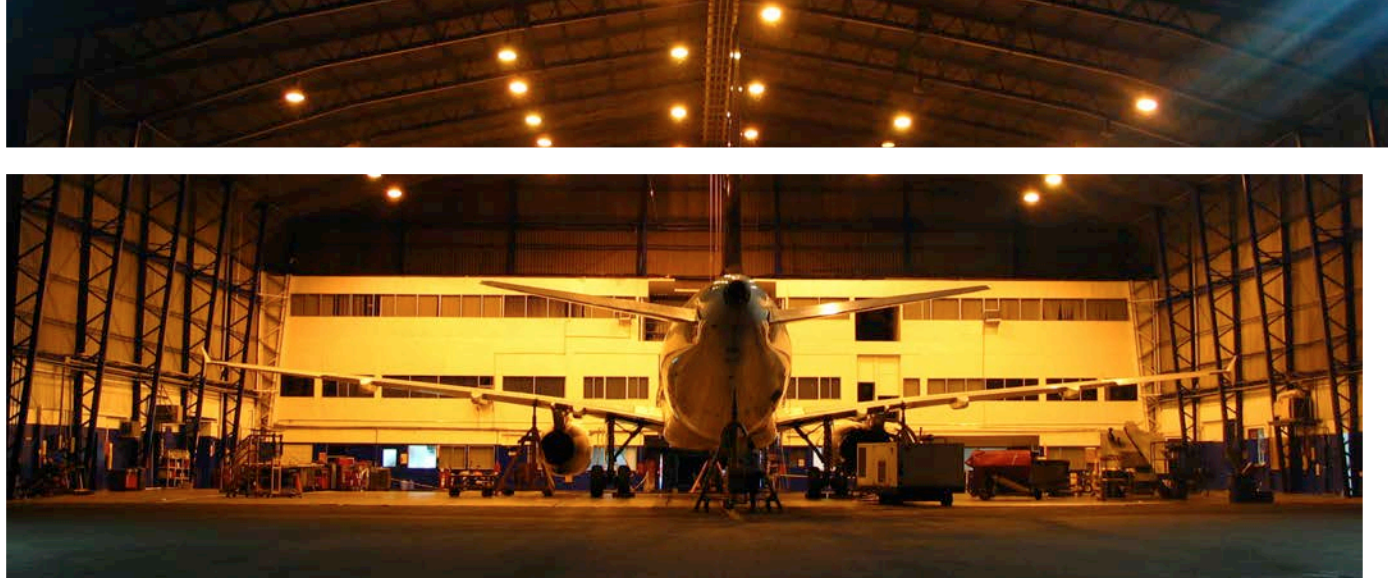
Defeat mercenary parts resellers. When an airline or MRO provider needs to procure an uncommon part, it often turns to vendors in the marketplace. Since there's no central clearinghouse of aircraft components, it can be difficult for them to know which vendor has a part and which doesn't. And it's not unusual to find that many vendors are offering to sell something they don't yet own themselves. Dealing with resellers adds unnecessary expense, in the form of marked-up prices, and hassle, because they may be delayed in obtaining the component they have promised to sell. Blockchain is perfectly designed to solve this problem. Participants in a blockchain-powered aerospace ecosystem would be able to compare the serial number of a part being offered against an indelible, real-time record of ownership, location and utilisation. That would allow them to cut out the middle man, reducing the cost to obtain scarce parts.

Reinvent aircraft maintenance. Today, much maintenance is reactive, conducted only after a problem surfaces or after a problem in a single component has created knock-on effects. Other maintenance is completed at regularly scheduled intervals. If technicians could review the configuration and history of every aircraft in a fleet on a blockchain ledger, they would be able to engage in more predictive maintenance, seeking to head problems off before they are evident. Not only could predictive maintenance reduce the delays and lost revenue associated with unplanned maintenance, but the ability to predict the cost of maintaining each individual plane with confidence could also significantly alter the economics of fixed-price MRO contracts. MRO providers that can offer predictive maintenance services stand to gain a competitive advantage over those without access to real-time, blockchain-enabled data.

Blockchain could also have important safety implications. Participants would be able to instantly access airworthiness tag information, for instance. And if aviation regulators or manufacturers require supersession of a part, operators could instantly see which planes have affected parts that require inspection or replacement, either immediately or as part of scheduled maintenance.

Replace warranties with guarantees. Parts warranties may help aircraft operators control maintenance costs to a degree, but they still require careful inventory management. In the future, blockchain technology could enable the spread of intelligent 'power-by-the-hour' service arrangements — under which a supplier guarantees the supply, repair and overhaul of the components and systems it provides — to every corner of the aircraft. Real-time configuration and maintenance data could allow original equipment manufacturers (OEMs) to predict the condition, usage and, ultimately, the life span of parts or systems and tailor their production processes to make sure spares are available on a just-in-time basis. That would improve service for customers while cutting their own inventory costs. And when analysing faulty components, they would be able to test parts or systems not in generic conditions but with precise data on their configuration at the time of failure. The resulting insight not only would make repairs easier and faster, but could also transform the business model of parts suppliers.

Aircraft finance

The wealth of information about a plane's makeup, usage and maintenance that could be stored and updated in real time using blockchain technology could have a large impact on how aircraft are valued. Finance use cases include:

Build value in the secondary market. Jet engines that are maintained to the standards of their manufacturer and that include only verified authentic parts fetch premium prices on the secondary market. Blockchain technology, with its ability to provide verifiable maintenance records that are updated in real time, could extend that dynamic to the entire aircraft. That has the potential to increase the end-of-service value of aircraft, as buyers in the secondary market would have greater confidence in their purchases and ability to select from the best-maintained planes.

Transform leasing. The potential for transformation of the aircraft leasing market is substantial. Today, about half the global commercial aircraft fleet of about 23,000 planes[9] is leased.[10] Leasing facilitates growth for airlines and creates balance-sheet flexibility across the industry. But the end-of-lease handoff is often cumbersome, typically requiring the full teardown of the aircraft in order to inventory its parts and assess their condition. That time-consuming and expensive step could be rendered unnecessary when the manufacturer, installer and servicer of every part, as well as usage over its life, can be examined via a blockchain-enabled solution. Instead, only parts showing high or unusual wear and parts required by regulations to be visually inspected might need to be examined more closely. Ultimately, this kind of transparency into the condition of leased aircraft could increase residual values.

Improve insurance. Data for the life of the aircraft could facilitate the introduction of more tailored insurance products. Rather than buying a policy to cover an entire fleet, operators armed with up-to-the-minute usage and configuration data might be able to insure individual planes with rates that reflect the risk of each. Paired with the improvements in maintenance discussed above, that could lead to cost savings.

Workforce

To stay in service, commercial aircraft require huge armies of people, from cabin crew to maintenance technicians. Many of those directly involved in operating or maintaining the plane must gain and demonstrate numerous credentials and qualifications to perform necessary tasks. Today, such data is often fragmentary or housed in many different systems. Blockchain technology could make it practical to ensure that the identity of every person who interacts with a plane — and the status of their credentials — is recorded and becomes part of the real-time snapshot of its condition.

Digitise credentials. Using a mobile app, workers could verify their identity biometrically — via facial recognition, for example — and validate their personal details and upload proof of credentials. This interface could also enable them to select from additional training options or enable their employer to assign required trainings to them. Once validated by the employer and issuing entity, a training certificate or other credential could become part of the worker's profile on the blockchain. Biometric identity verification could be required before beginning a task, to make sure the appropriate credentials and permissions are in place.

Each instance of biometric validation would be written to the blockchain, creating a digital record of the employee's work and experiences linked to his or her profile. That means that in addition to knowing the provenance and history of a part installed on a plane, parties with the appropriate permissions could see in an instant the verified identity and qualifications of the person who installed or serviced it — providing even greater confidence in the overall snapshot of the aircraft's health.

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9   Average of Airbus and Boeing estimates from 2018–37 outlooks.

10 CAPA Centre for Aviation, 7 March 2018. *Aircraft leasing accounts for half of world's commercial aircraft fleet. Lessors shun widebodies.*

Best practices for blockchain in aerospace

Building a blockchain solution for aerospace that has the power to deliver the solutions outlined above is no small task. Building trust among participants is important to the success of any blockchain initiative. That is likely to be especially true in the aerospace industry, where much of the value will come from including companies across the value chain — even, or perhaps especially, when they are fierce competitors. Lack of trust among users is one of the biggest perceived impediments to blockchain adoption over the next three to five years, trailing only regulatory uncertainty, according to PwC's Global Blockchain Survey of 600 executives across sectors. That may seem ironic, because blockchain technology is designed to foster trust. But with the right approach, this hurdle need not be insurmountable.

By focusing on four key steps early in their blockchain efforts, companies can set themselves on a path toward successful execution.

Make the business case

Creating a real-time, verifiable snapshot of every airplane in a fleet has real-world financial and operational benefits for a wide range of companies across the aerospace sector, as outlined above. It could improve asset utilisation for airlines, improve the efficiency of OEMs' manufacturing processes, make MRO providers more productive and provide lessors with greater visibility into their assets.

The blockchain checklist:
Is the technology right for you?

If your project checks four out of the six boxes, blockchain could be an applicable solution.

Multiple parties
share data ✓

Multiple parties
update data ✓

Requirement for
verification ✓

Intermediaries add
complexity ✓

Interactions are
time-sensitive ✓

Transactions
interact ✓

Source: PwC Global Blockchain Survey, 2018

But explaining the business value isn't the same as demonstrating it. Indeed, the risk of overpromising is real. In our Global Blockchain Survey, across industries, 54% of executives with blockchain projects in the pilot stage said the effort sometimes or often hasn't been justified by the result. That's why a successful blockchain data record for the life of an aircraft will necessarily start small — not with an entire airplane, but perhaps with one system or process. Demonstrated success in a workforce credentials use case could help build buy-in for bigger, more ambitious projects.

Companies with successful blockchain projects embrace new ways of working; the IoT, biometrics, process automation and data analytics are all key enablers. Taking prudent first steps through intelligently sized pilot programs can prevent digital culture shock.

Build an ecosystem

Bringing together stakeholders to agree on standards that will define the business model is perhaps the biggest challenge in blockchain.

Who 'owns' a blockchain project is one of the most important questions participants must answer. In some instances, a single, dominant company has enough sway to set standards and rules of its choosing and require others who want to participate to abide by them. This 'sponsor-led' model is unlikely to be appropriate for the multipolar aerospace industry, however. Instead, a consortium-based model is likely to be a better fit. Consortium members must work together to establish governance, oversight and audit mechanisms and to set rules for participation. They must do so with an eye to scalability and interoperability — identified by 91% and 86% of respondents to our survey, respectively, as crucial for blockchain success.

Even though blockchain consortium members can't dictate terms the same way sole sponsors can, there are significant benefits to participation — especially for those willing to step into a leadership role. Of survey respondents who said they had live blockchain projects, 50% were consortium leaders and an additional 38% were members. Successful blockchain initiatives start with just a few participants before growing, and those at the table first are influential.

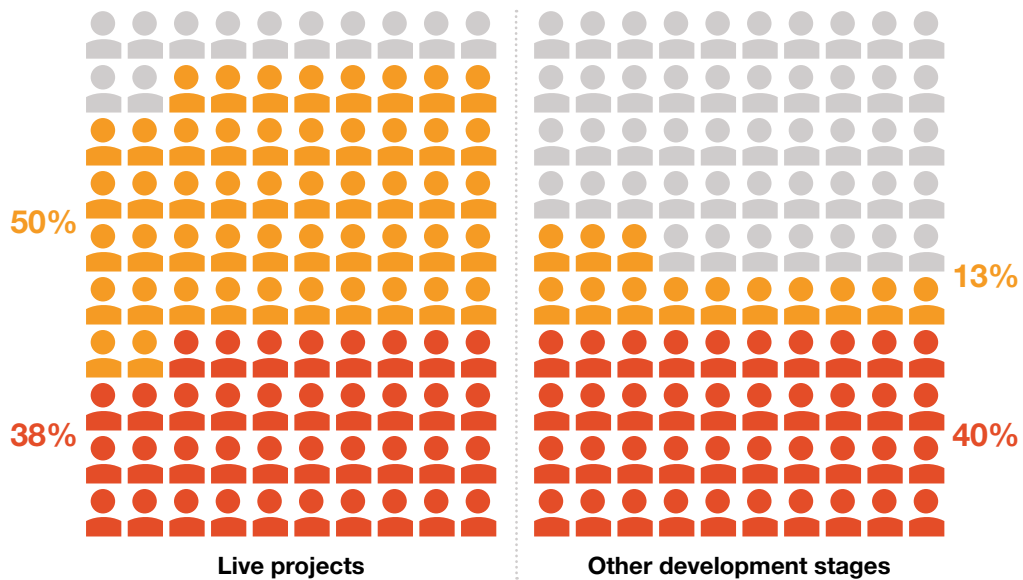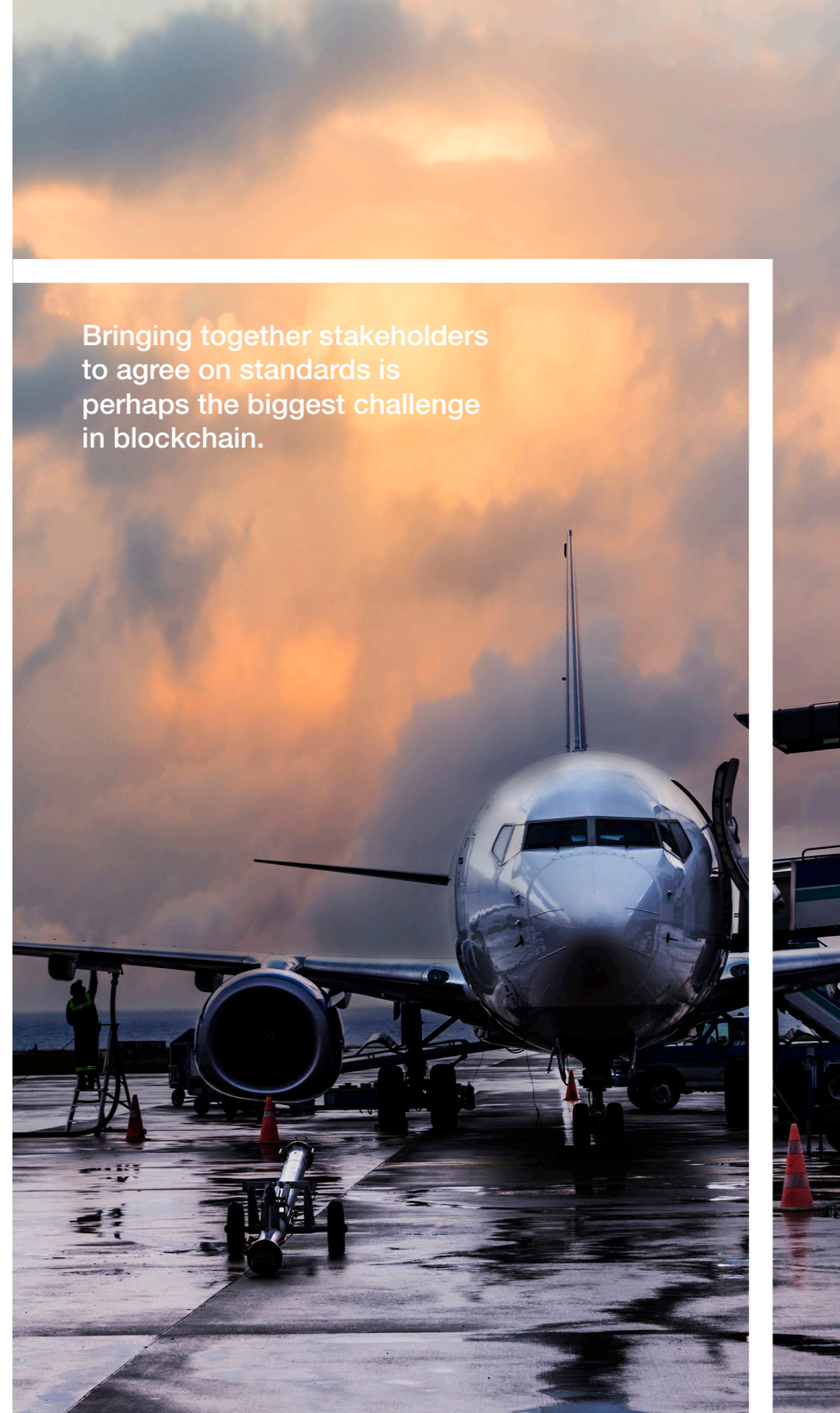## Consortia engagement by type of blockchain project

50%

38%

13%

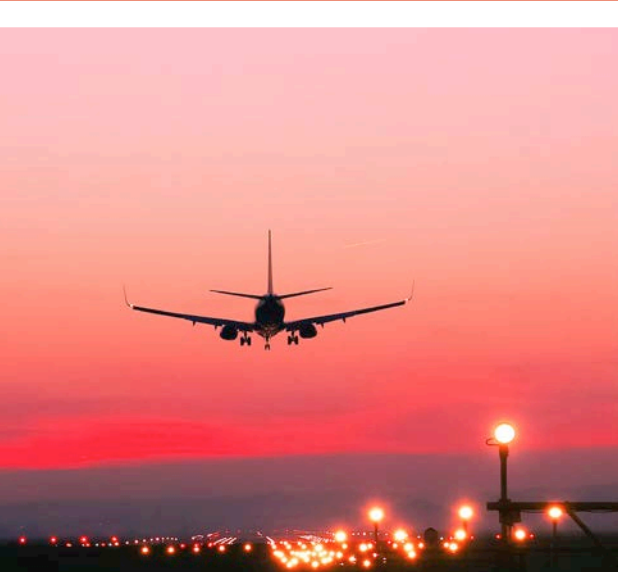40%

Live projects

Other development stages

Image not to scale

■ Leadership role ■ Member

Source: PwC Global Blockchain Survey, 2018

Bringing together stakeholders to agree on standards is perhaps the biggest challenge in blockchain.

Design deliberately

A great deal of consideration must be given to a blockchain's design. Will it be permissionless, meaning anyone can initiate and view transactions, or permissioned, meaning access is restricted to certain parties? Privacy will be a primary concern of any company considering whether to participate in a blockchain project.

Though permissionless blockchains have many valuable uses, an aerospace-industry-specific blockchain project with the goal of providing data for the life of the aircraft will likely need to have a rigorous array of permissions to make sure sensitive information is available only to parties that need it. The governing body, likely an industry consortium, would have the power — and responsibility — to set those ground rules.

No matter which model is chosen, it's important to include cybersecurity, compliance, audit and legal specialists in design decisions from the beginning. The challenges presented by blockchain may fall under existing corporate processes, but they're unlikely to have many precedents.[11] Assembling the right team will help avoid costly missteps and build trust among all members of the ecosystem.

How business leaders are designing their blockchains

38% | **34%** | **26%**

- ■ **Permissioned:** restricted access
- ■ **Permissionless:** open access
- ■ **Hybrid:** mix of permissioned and permissionless

Source: PwC Global Blockchain Survey, 2018

11 Smith, A.M., 15 March 2018. *The blockchain challenge nobody is talking about*, PwC Next in Tech.
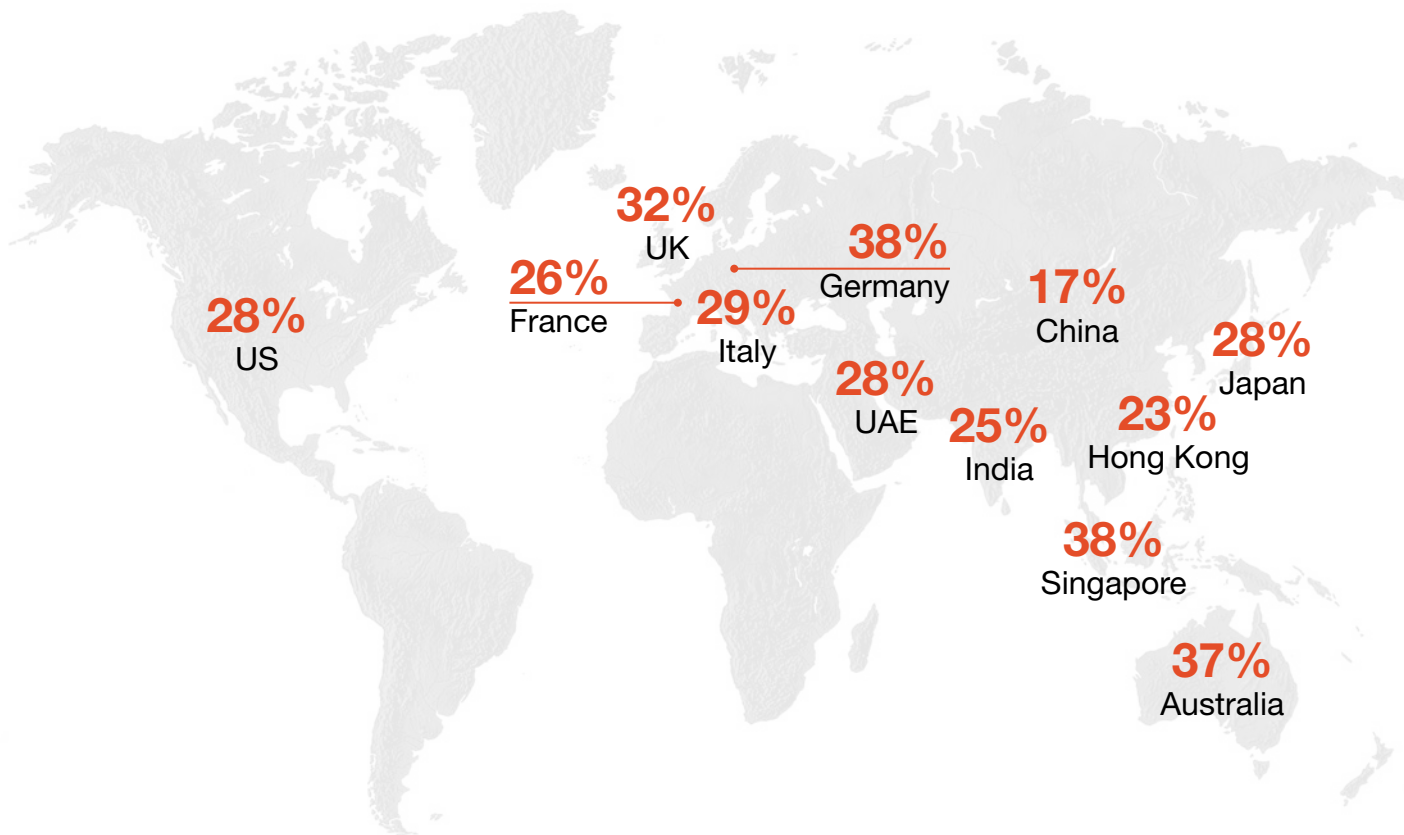
Navigate regulatory uncertainty

Aerospace is a global industry; regulations affecting blockchain are largely national and regional. Managing that dynamic will be an important consideration. The industry has been slow to adopt digital solutions in general, and blockchain will encounter similar headwinds. However, the very trust that blockchain creates should be an opportunity to demonstrate the transparency required to address regulatory information needs.

Although the solution is global, in order to reflect the industry's needs, specific jurisdiction requirements will require thoughtful design. For example, the European Union's General Data Protection Regulation (GDPR) requires that personally identifiable data be erasable. The regulation is regional, but a global design has to account for it in the workforce-related blockchain use cases. We expect similar regulations to influence the design and execution of the proposed use cases.

National aviation and transportation safety regulators will likely also need to be satisfied that blockchain meets their requirements for record-keeping and is at least as reliable and auditable as existing systems. As our Global Blockchain Survey has found, the idea here is to develop solutions alongside efforts to gain regulatory comfort (versus waiting for approval) — to 'show, not tell' how transparency works to gain support.

Mapping compliance concerns

Percentage of respondents in territory who report that regulatory uncertainty is the biggest barrier to adoption in the next three to five years

32% UK

26% France

38% Germany

29% Italy

17% China

28% Japan

28% US

28% UAE

25% India

23% Hong Kong

38% Singapore

37% Australia

Source: PwC Global Blockchain Survey, 2018

Approaching liftoff

The stage is set for the growth of blockchain in the aerospace sector. The US, the industry's largest market,[12] is perceived as the global leader in blockchain, with 29% of respondents in PwC's survey identifying it as the most advanced nation today. China, the third-biggest aerospace market,[13] was most frequently seen as being the leader by 2023. The interest and the opportunity are there; all that's left is for pioneers to take the first step.

The stakes are high. The impact for airlines alone, for example, is potentially massive. A picture of each plane's configuration and maintenance history, accurate up to the second, could allow airlines to reduce some of the measures they take to guard against disruptions due to unplanned maintenance — for instance, they could shorten block times or cut spare parts inventories. It would become easier to predict when serious maintenance issues could ground a plane, and to analyse its condition and diagnose potential issues during MRO. As noted, that could increase industry revenue by as much as 4%, or US$40bn, while cutting MRO costs by about 5%, or US$3.5bn.[14]

Trust is the most important ingredient in successful blockchain implementations. That may seem ironic for a technology designed to be 'trustless,' but bringing together an ecosystem to realise a shared goal with rules all parties can agree to and abide by is no easy feat. Yet it's essential if blockchain is to deliver on its immense promise. PwC is well-positioned to help. With deep experience working with aerospace companies as well as blockchain-enabling solutions — including Air Trace,[15] our proprietary solution built for the industry — we're ready to help convene the right stakeholders to make data for the life of the aircraft a reality.

12 Aviation Week ShowNews, 15 July 2018. *Aerospace industry is worth US$838 billion*, Aviation Week Network.

13 Ibid.

14 PwC analysis.

15 www.pwc.com/gx/en/issues/blockchain/air-trace.html

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Contacts

China

Jamin Klotz
PwC's Air Trace Technology Solution Director, PwC Hong Kong
+852 2289 1844
jamin.j.klotz@hk.pwc.com

Andrew Watkins
PwC China and Hong Kong Technology and Disruption Leader
Partner, PwC Hong Kong
+852 2289 2716
andrew.watkins@hk.pwc.com

France

Matthieu Lemasson
Aerospace and Defence
Partner, PwC France
+33 1 56 57 71 29
matthieu.lemasson@pwc.com

United States

Glenn Brady
Global Aerospace and Defence Leader
Partner, PwC US
+314 206 8118
glenn.brady@pwc.com

Chuck Marx
Senior Adviser and Retired Partner, PwC US
+602 364 8161
charles.a.marx@pwc.com

Rachel Parker Sealy
Industrial Products Technology
Principal, PwC US
+314 206 8183
rachel.parker.sealy@pwc.com

Scott Thompson
US Aerospace and Defence Leader
Partner, PwC US
+703 918 1976
scott.thompson@pwc.com

Authors

Matthieu Lemasson, Chuck Marx, Rachel Parker Sealy, Scott Thompson and Andrew Watkins

Editorial contributor: Tim Catts

Author bios

Matthieu Lemasson
Matthieu Lemasson works in advisory services as a leader in the Aeronautic, Defence and Space sector for PwC France. He is a member of the Strategy and Technology competency, where he focuses on helping large organisations translate their business objectives into digital technology strategies that maximise impact.

Chuck Marx
Chuck Marx is a senior adviser and retired partner who led the Aerospace and Defence practice for PwC US. He has advised Fortune 500 companies for more than 30 years, specialising in the deployment of value-based management, enterprise resource planning systems, performance-management systems, activity-based costing systems, financial consolidation systems, MRO and supply chain systems.

Rachel Parker Sealy
Rachel Parker Sealy is a technology specialist in the Industrial Products practice for PwC US. Rachel drives efforts focusing on traceability in the industrial products space, with a particular focus on the applicability of blockchain. Sealy has more than 20 years of experience designing industry operating models and helping clients embrace transformation.

Scott Thompson
Scott Thompson leads the Aerospace and Defence (A&D) practice for PwC US. He leads a cross-functional team to deliver audit, tax and advisory services to the world's largest A&D clients, with a focus on developing long-term models to help clients measure return on investment.

Andrew Watkins
Andrew Watkins is the Technology and Disruption leader for PwC China and Hong Kong, responsible for driving the identification and commercialisation of new digital- and technology-based businesses.