THE CONNECTED AIRCRAFT: HOW AVIATION IS CHANGING.

Honeywell

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THE IMPACT OF THE INTERNET OF THINGS (IOT) ON YOUR SUCCESS.

Few industries are as eager to adopt new technologies as the field of aviation. So it is natural that the Internet of Things (IoT), which promises to revolutionize all fields, is already dramatically changing aviation. The Connected Aircraft is the future, and it brings with it benefits for operators, maintainers, pilots, crew and passengers.

But with all the hype around IoT, it's worth asking: What exactly is it, and how will it be applied to aircraft and the systems that support them? We answer those questions here.

WHAT IS THE INTERNET OF THINGS?

IoT can be thought of as a network of connected devices that can communicate and exchange data with other devices and machines, or with human users. This includes everything from a wearable fitness tracker to sophisticated networks of weather sensors to autonomous machines.

At its most basic level, IoT can be broken into two categories:

— **Consumer IoT**
Wearable devices, smart home solutions and so on

— **Industrial IoT (IIoT)**
Automated manufacturing, connected machines and smart factories.

IDC forecasts that IoT spending will reach $1.2 trillion in 2022.[1] Both consumer and IIoT are experiencing this rapid growth, but many believe that IIoT will be the larger and more influential segment in the end.[2] This is largely due to the scale of IIoT systems. For example, in aerospace:

— A single twin-engine aircraft can generate up to 844 TB of data from a 12-hour flight

— An Airbus A380 can be fitted with as many as 25,000 sensors.

1. Worldwide Semiannual Internet of Things Spending Guide, *(version2H17), IDC*.
2. The Internet of Things: Mapping the Value beyond the Hype, *McKinsey & Company, June 2015*.

THE TRUE VALUE OF IIOT.

Industrial IoT solutions offer four large categories of capabilities: monitoring, control, optimization and autonomy. These capabilities are listed from simplest to most complex, and each capability requires that you first master the one before it. Monitoring, for instance, is a necessary first step for achieving the ability to control.

1.

MONITORING

Monitoring is the foundational capability of IIoT solutions. Monitoring solutions are generally easiest to establish, as they are often based on simple sensor technology or built-in status reporting features. The trick is to stream the data into a workflow so that valuable monitoring is easy and efficient.

2.

CONTROL

The next capability involves using embedded software to power remote control capabilities. Many systems in aircraft today have embedded software and software interfaces. However, not all are connected in a way that makes them true IIoT solutions. A connected solution will allow crew to access data remotely and make changes in the system to respond to events or the environment.

3.

OPTIMIZATION

Connecting the monitoring and control capabilities together lays the groundwork for optimization. Once you can gather and analyze historical data from your monitoring systems, you can then judge exactly which controls to manipulate to optimize the system function. Some systems can even be set to automatically optimize, which is the first step toward autonomy.

4.

AUTONOMY

Autonomy is the pinnacle of connected IIoT systems. A fully autonomous system monitors itself, can react to its setting and situation, and can optimize itself to maximize performance. While small, self-contained systems are achieving functional autonomy (such as robotic vacuums that can essentially be set and forgotten), few large-scale systems have reached this point. In aviation, many of the pieces of monitoring, control and optimization are just beginning to come together and reveal the potential for autonomy.

BENEFITS OF THE CONNECTED AIRCRAFT.

The Connected Aircraft is IIoT brought to aviation. Leveraging new technology and much more reliable high-speed Wi-Fi connections, the Connected Aircraft connects an airplane's components and equipment, enabling each to immediately send, receive and analyze data. This can enable more-informed decision making, operational cost reduction and an improved flying experience.

RECEIVE, TRANSMIT, ANALYZE AND SHARE DATA, ENABLING MORE-INFORMED DECISION MAKING, OPERATIONAL COST REDUCTION AND AN IMPROVED FLYING EXPERIENCE

A CONNECTED AIRCRAFT ANTICIPATES OPPORTUNITIES AND OFFERS UNIQUE INSIGHTS BY COMBINING THE POWER OF ANALYTICS WITH THE CONFIDENCE IF A SECURE COMMUNICATION LINK

The Connected Aircraft revolutionizes modern-day flying, dramatically improving fleet management, flight safety, passenger experience, aircraft maintenance, flight operations, aircraft turnaround time and costs.

Using big data, analytics and secure communications technology, the Connected Aircraft can better anticipate issues and offer unique insights. By combining the power of analytics with the confidence of a secure communication link, operators can potentially avoid weather, flight disruption, and additional cost, and can drive faster turnaround times.

OUTCOMES FROM THE CONNECTED AIRCRAFT.

25%

Operators can potentially cut troubleshooting time by up to 25 percent via predictive maintenance.

OPTIMIZED OPERATIONS

Connected Aircraft solutions can help reduce fuel costs and emissions, saving operators up to $500,000 a year per aircraft. The application of an IIoT approach to aircraft operations can also help operators maximize profits by significantly improving operations in other ways, including:

– Reducing operational disruptions and avoiding costly hazards

– Saving up to 5 percent in flight time with air-traffic-control priority

– Improving integration between management and operations via more shared data.

INCREASED UPTIME

Predictive maintenance and related Connected Aircraft solutions can significantly reduce aircraft-on-ground (AOG) time, allowing you to get more from your aircraft and crew. Operators can potentially cut troubleshooting time by up to 25 percent via predictive maintenance and reduce inoperative equipment by up to 35 percent. This can also reduce overall maintenance and operations costs.

IMPROVED SAFETY

Better connections can lead to smoother and safer flights. With electronic-flight-bag apps, pilots can see and avoid real-time weather and clear-air turbulence. This can potentially improve arrival times. Connected solutions also have the potential to make ground crews, such as maintenance and baggage handling teams, more productive.

IMPROVED PASSENGER EXPERIENCES

Better connections make a big difference in the cabin, as well. Passengers can connect from the moment they step on an aircraft to the moment they step off. High-speed connections in the modern Connected Aircraft can provide 10- to 100-times-faster Wi-Fi speeds, with fewer drops, giving passengers Wi-Fi speeds similar to their home at any altitude, anywhere in the world.

TRANSFORMING FLIGHT FOR OWNERS AND OPERATORS.

The Connected Aircraft revolutionizes flight operations — dramatically improving aircraft turnaround time.

20—40%

Fuel use can account for 20 to 40 percent of an airline's operating costs, so even single-digit percentage improvements can save airlines tens of millions of dollars in fuel spending each year.

Access to real-time information can enable:

— Flight and fleet operations to translate aircraft data into actionable metrics to improve efficiency and save money

— Flight operation managers to better manage fleet trajectory and lock in schedules.

Fuel-efficiency software can analyze data and provides reports that empower operators to optimize fuel efficiency across flight operations, ground operations and maintenance. Airlines and other operators can easily integrate the software into their current technologies to immediately benefit from customized reports based on individual needs, reducing fuel costs by up to 5 percent.

Connected Aircraft solutions can also help manage the ground handling process effectively and efficiently. They give ground handlers tools to manage the aircraft turnaround process, while providing accurate, real-time information to operations on the status of each tail and the likelihood of it pushing back on time. These solutions can improve on-time performance or mission readiness, resource planning and utilization, and invoicing accuracy.

TRANSFORMING FLIGHT FOR PILOTS AND CREW.

The Connected Aircraft will provide the flight crew with more information about the flight environment than ever before, while at the same time helping all flight departments work together. With connected systems, the same data can be shared across scheduling, flight planning, tracking and postflight groups.

For instance, weather-related solutions enable flight crews to view, track and share weather data in real time. This improves strategic maneuvering, thus reducing flight times and optimizing route miles ahead of bad weather. Crews on the ground can adjust their own preparations in response to the same weather data and see the effect of pilot decisions on arrival time, for instance, helping keep the entire operation on the same page and functioning smoothly:

— Flight management systems provide pilots with access to updated and customized wind and temperature information throughout all phases of the flight. This can help optimize the vertical profile of a flight, thus improving fuel efficiency and reducing emissions.

— Electronic-flight-bag applications can increase pilots' situational awareness with 3D animated views of destination airports. Pilots can prepare visually and mentally for an approach like never before.

— Solutions for wireless data transfer can offer encryption, transmission and monitoring. They enable integration with electronic flight bags and pilot tablets, remote-send pilot maintenance manuals, remote databases and more. They help give your in-flight crew the same information as ground-based crew so that systems and departments can communicate and make decisions together.

TRANSFORMING FLIGHT FOR MAINTAINERS.

The Connected Aircraft will also help airlines keep their operations at optimal efficiency and their aircraft in optimal condition. Data gateways can enable operators to reap the benefits of an affordable and flexible approach to wireless data transfer.

These gateways enable Connected Aircraft solutions such as connected data loading and connected maintenance that help airlines reduce aircraft-on-ground time and costs.

By wirelessly connecting multiple mechanical systems, connected maintenance solutions can drive improved predictive analysis. This allows ground crews to identify components that will require maintenance or replacement before the aircraft lands and ensure that spare parts are available, if needed. Capturing and analyzing aircraft data on usage and wear enables crew to more efficiently inspect auxiliary power units, wheels and brakes, as well as environmental control systems, leading to more rapid and streamlined maintenance processes and lower costs.

> " WE'VE BEEN ABLE TO ERADICATE DEFECTS BEFORE THEY EVEN HAPPEN "
>
> **Philippe Christol,** Cathay Pacific

TRANSFORMING FLIGHT FOR PASSENGERS.

The Connected Aircraft will bring significant benefits to the passenger.
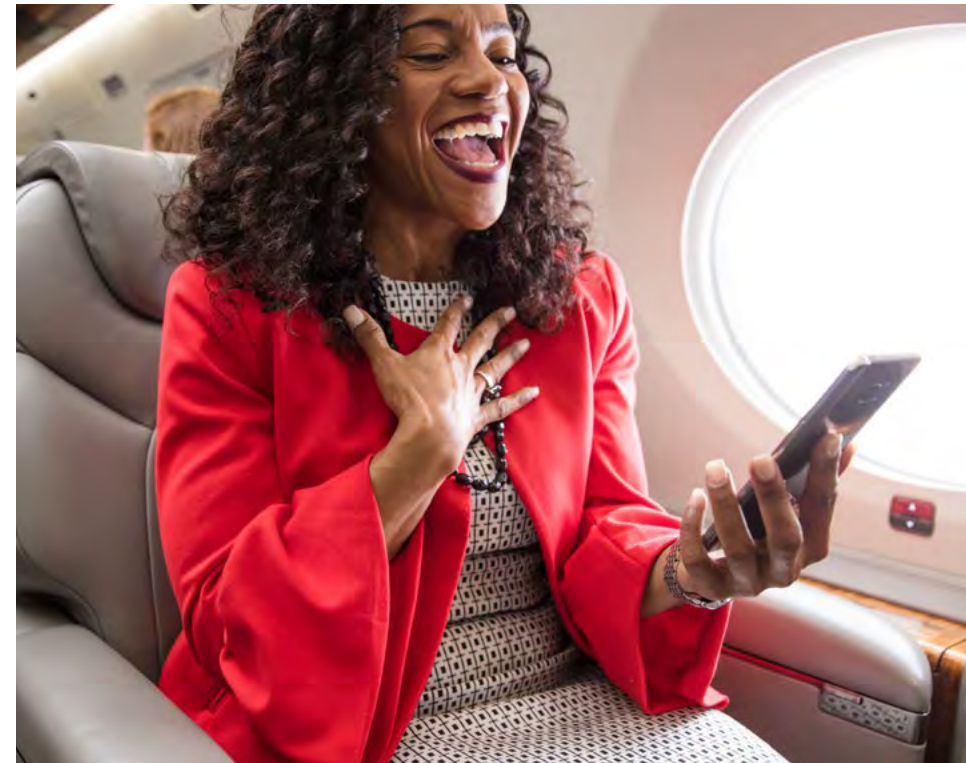
The Connected Aircraft will bring significant benefits to the passenger as well, including:

— Shorter flights

— More punctual departures

— Enhanced in-flight entertainment, connectivity and productivity

— Fewer in-flight bumps.

Modern satellite-powered networking can deliver home-equivalent connectivity, providing a consistently outstanding passenger experience all over the world. Connected weather solutions help the flight crew identify and avoid hazardous weather – making flights and the passenger experience smoother and safer.

Finally, connected maintenance solutions help keep an airline's operations efficient, thus improving on-time performance and reducing delays. Passengers will be able to complete their journeys as scheduled.

THE CONNECTED AIRCRAFT IN DEFENSE.

The Connected Aircraft promises similarly sweeping and important changes to the defense industry. As the very nature of warfare has changed, so has the way organizations engage adversaries on land, on sea, in the air and across the information environment. This is the age of connected defense.

NB

Any solution considered by the defense industry must have cybersecurity built in, and it should be supported by additional services, such as vulnerability assessments, predicative analytics, and intrusion detection and prevention systems.

When it comes to mission success, there is no substitute for seamless, reliable, fast and secure communication capabilities. Organizations need technologies that enable informed, reliable situational awareness to support command decision making and the peak performance of air, land and sea assets anywhere they are positioned.

Connected defense solutions can deliver not only the trusted data that commanders need to make informed decisions, but also and the secure channels to communicate with warfighters and assets in the field. They enable mobile, ground and airborne command,

control, communications, computers and intelligence (C4I) throughout the battlespace, accelerating decision speed for mission effectiveness; improving situational understanding; reducing disruptions; and increasing availability, safety and efficiency across all combat domains.

Connected technologies improve operational and mission performance by turning aircraft systems data into actionable information for flight crews, command-post decision makers and maintenance chiefs.

WHAT MOBILITY HAS BROUGHT TO AVIATION.

Mobility has brought major changes from cabin to cockpit to ground crew. Smartphones and tablets are ubiquitous; that means higher customer expectations — but also lighter flight bags and more streamlined ground operations.

	CABIN	COCKPIT	GROUND CREW
THEN	Passengers were happy with a movie.	Flight bags weighed up to 40 lbs. Printed weather reports could be hours old.	Across luggage handling, maintenance and restocking, paper checklists and analog systems ruled.
NOW	Wi-Fi is expected and demand is enormous.	Modern electronic-flight-bag applications offer constantly updated information on weather, conditions at airports, flight plans and more.	Ground services solutions provide mobile devices that connect crews to operations to help manage turnarounds.
WITH THE CONNECTED AIRCRAFT	Home-like connectivity can keep passengers happy anywhere in the world.	Constantly updated data can empower much safer and smoother flights.	Connected crews can reduce flight delays by 22 percent and improve on-time performance by 30 percent.

THE TECHNOLOGY BEHIND
THE CONNECTED AIRCRAFT.

The network connections that allow for a Connected Aircraft are only a part of what is actually required to make a completely and holistically Connected Aircraft.

The full technology stack involves many pieces working together.

THE CHALLENGE OF MANAGING DATA.

Modern aircraft can produce terabytes of data per flight. This massive influx of data holds potential only if organizations find ways to manage it properly.

Doing so is no easy task, and operators will want to partner with an experienced technology company — preferably one that is also experienced in the world of aviation.

Connected Aircraft providers should offer a series of software and data analysis services to meet various user needs. The goal of those providers should never be to own the data, but to help operators turn their data into insights on the performance of an aircraft over time.

Look for a suite of offerings such as:

— Data transmission and collection solutions

— Server access to store and back up data

— Full engineering data analysis and reports.

BRINGING THE CONNECTED AIRCRAFT TO LIFE.

The future of aviation lies in the Connected Aircraft. With Connected Aircraft solutions, organizations will turn terabytes of information into new insights that will help them optimize operations, get more from their assets, make flights safer and improve passenger experiences. The key to realizing these benefits? Finding a provider that understands the potential of the Connected Aircraft in your field of aviation. The following checklist should help you do just that.

CHECKLIST: WHAT TO LOOK FOR IN A CONNECTED AIRCRAFT PROVIDER?

1.

DEEP EXPERIENCE IN AEROSPACE
No technology provider can offer a true Connected Aircraft solution if that vendor doesn't have a deep understanding of the issues and challenges of the aerospace industry.

2.

EXPERIENCE IN TECHNOLOGY AND DATA
The Connected Aircraft is as much about software and data management as it is about aviation hardware. Experience in software development and integration, as well as data management and analysis, is vital.

3.

UNDERSTANDING OF YOUR CHALLENGES
Commercial aviation can be as different from defense aviation as fixed wing is from helicopters. Your provider should understand your particular place in the aerospace industry.

4.

ANALYTICAL TOOLS AND APPROACHES
Gathering insight from your data will require sophisticated analysis. A provider of Connected Aircraft should offer tools in this area.

5.

IMPLEMENTATION CAPABILITIES AND SUPPORT
Bringing a Connected Aircraft solution to life is no simple task. Providers should have experience in installing or helping install solutions, and in providing training and support for your crews.

TRANSFORMING FLIGHT WITH HONEYWELL.

To create a truly Connected Aircraft, you need to understand aircraft. Honeywell has more than 100 years of aviation expertise, and our solutions are a part of almost every aircraft in the world. Our unique understanding of aviation means we're well suited to helping you create the modern Connected Aircraft.

With a unique portfolio that spans network connectivity, hardware, software and services, we have solutions to help you harness your data to predict maintenance, save fuel, shorten aircraft turnaround time, reduce delays and turbulence, and give pilots up-to-the-minute information while in flight.
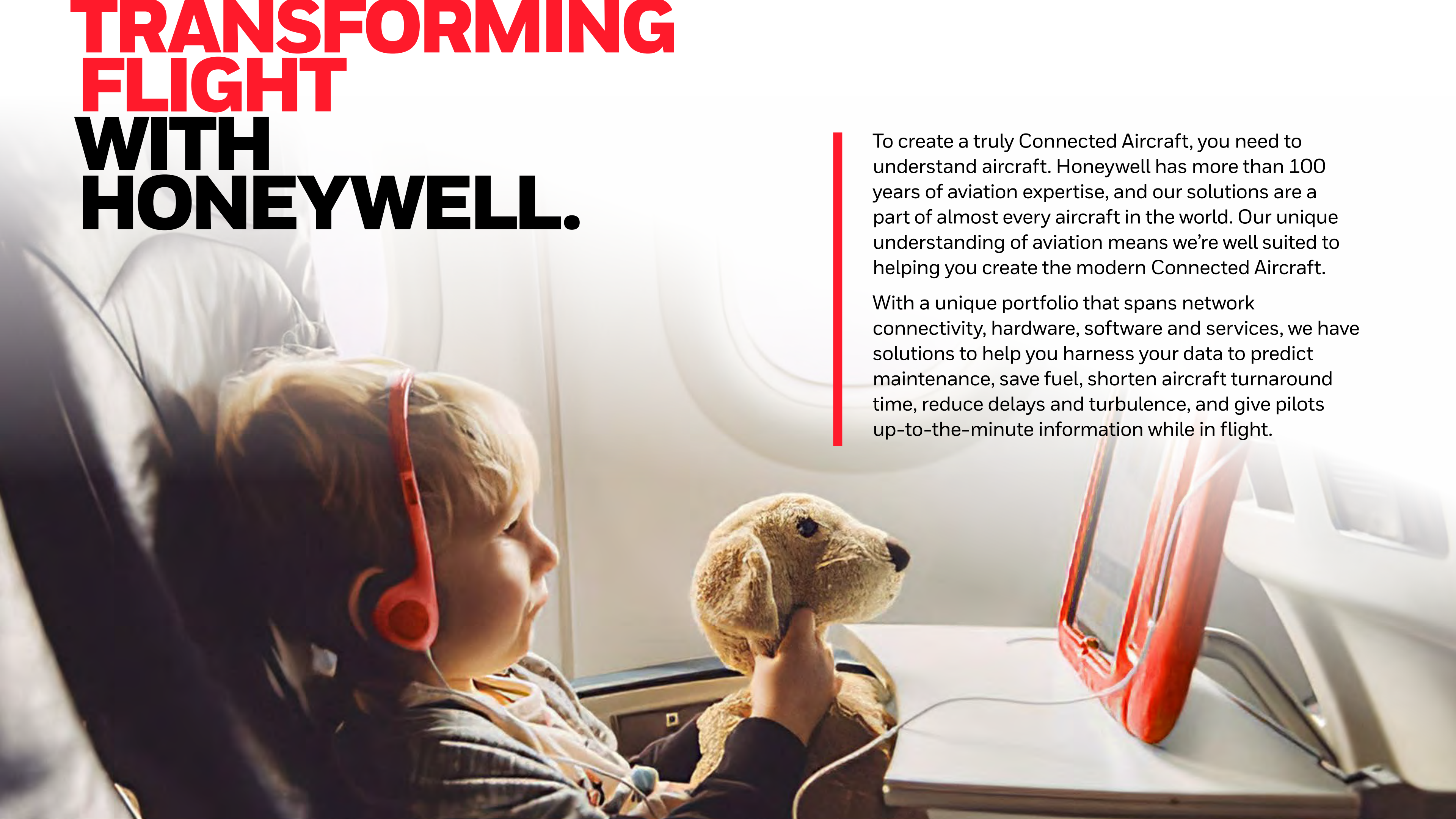
THE FUTURE IS WHAT WE MAKE IT.

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