



INFLIGHT CONNECTIVITY FOR IT TEAMS

Managing risk, access, and integration at altitude







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CHAPTER 1

THE STATE OF THE NETWORK





MUST-HAVE CONNECTIVITY



Today, nobody on your IT team is likely to be shocked by the need to connect during a flight, whether you're talking about executives and other employees, pilots and crew, or family members and guests.

Business moves much too swiftly, and inflight connectivity (IFC) has gone from a nice-to-have to a must-have.

But with organizations facing skyrocketing data consumption and demand for more sophisticated technologies, the IT conversation around IFC can be difficult. Moreover, many IT teams — maybe even yours — feel like fitting IFC into a broader corporate IT strategy could expose them to risk, vulnerability, and added complexity.

This guide was written to allay those worries. After you've gone through it, you'll have a better picture of how these systems work, what's most important in selecting the right IFC solution, and how you can become an indispensable asset in the IFC conversation.

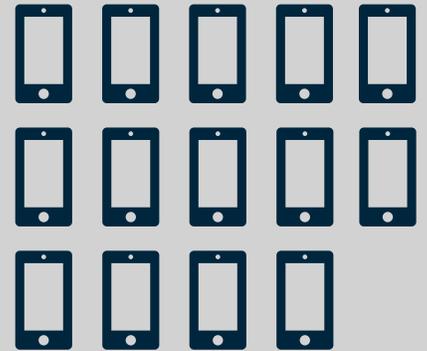
COME FLY THE CHANGING SKIES

2013

2018



AVERAGE
NUMBER OF
MOBILE DEVICES
ON A BUSINESS
AIRCRAFT



PRIMARY
DATA USES



**INFLIGHT CONNECTIVITY
EQUIPMENT ON THE
AIRCRAFT**

Remains unchanged with
fewer upgrades.



FIRST THINGS FIRST: THE ROLE OF THE PROVIDER



Although Gogo's bread and butter is creating better connectivity platforms for business aircraft, one of the most important things we do on behalf of our customers is manage and optimize our existing networks and systems.

Unlike other companies, we own and manage our air-to-ground (ATG) network at the infrastructure level, including ground towers and base stations, hardware and software, and specially licensed frequencies. This means we can modify almost any aspect of our system according to what's best for our customers, not what's feasible for a distant third-party provider. We continuously manage our network to ensure loads are balanced, traffic is routed properly, and finite bandwidth is distributed to serve everyone.

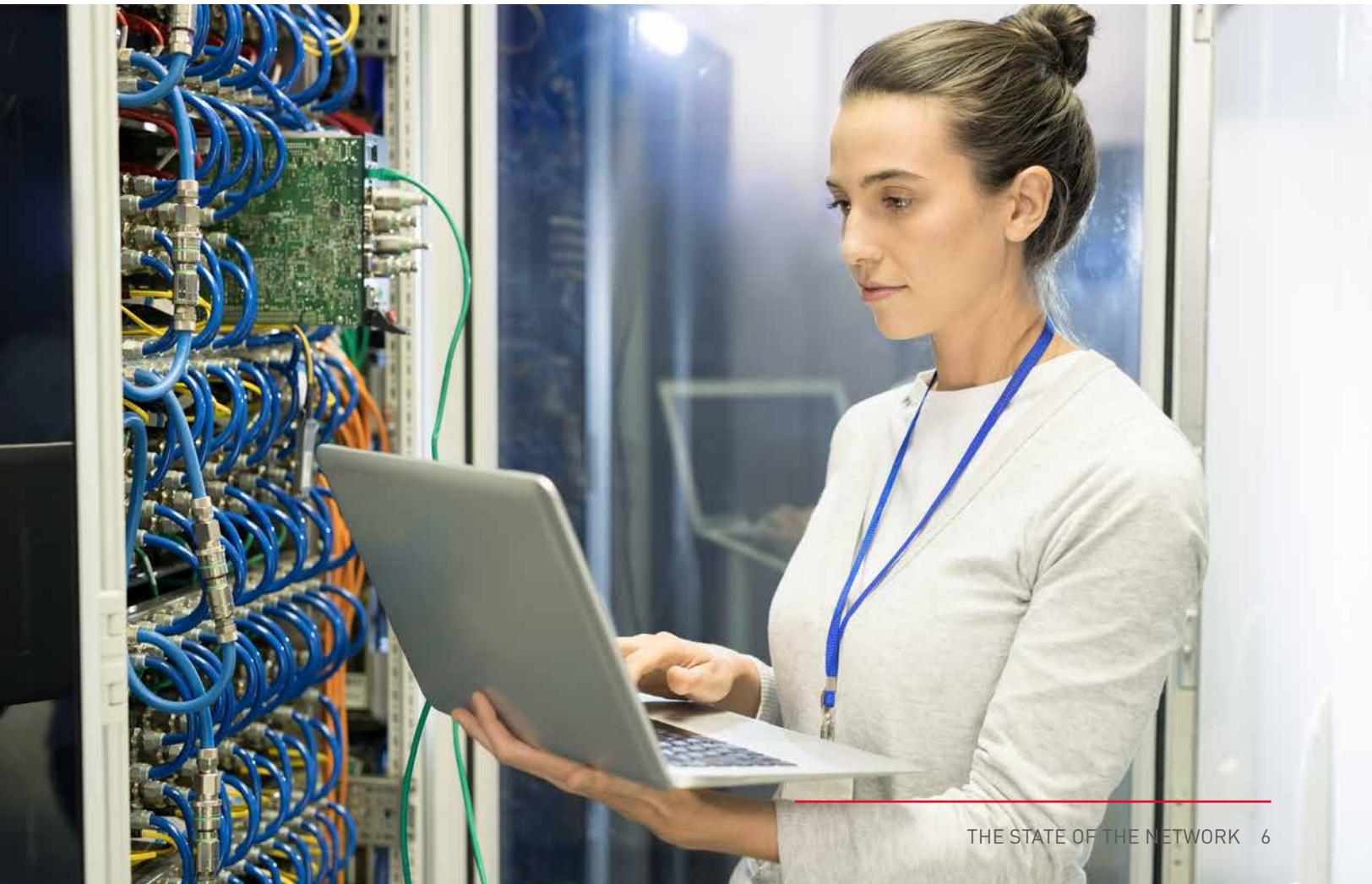
Translation: Your initial decisions, and your overall IT integration, are simplified by virtue of our simplicity and stability. We encourage you to check out other providers and evaluate their level of technical simplicity and consolidated service delivery.

HOW WE BUILT OUR NETWORK

Starting in the early 2000s, Gogo secured important spectrum and began building our network infrastructure.

This was an audacious investment at the time, but it has provided significant long-term value for our customers. We also own our data centers (there are two in the U.S. — see chapter 2), and every other component of the ground network.

As a result, customers experience more uptime, standardization, system redundancy, efficiency, completely compatible system components, and quick resolution should any issues arise.



WHY VERTICAL INTEGRATION MATTERS



Inflight connectivity can feel like a complex beast, but there is glorious simplification in choosing systems that are vertically integrated —those that are owned, developed, and managed centrally rather than being at the mercy of third-party vendors. Naturally, there are some components that have to be subcontracted (Gogo won't be launching any satellites anytime soon), but to the degree that we can simplify and localize control, we can improve the customer experience.

GOGO SOLELY MANAGES MOST OR ALL OF THE FOLLOWING FUNCTIONS:



People know Gogo for customer service, in part because of the level of control and consistency demonstrated above.

It's practical: When your components are designed and built to be compatible and have been proven over time, there are fewer system issues. And if an issue arises, we can quickly diagnose it and provide the best course of action to resolve the issue.

HOW TO HANDLE PROCUREMENT



As an IT professional, your perspective and visibility into IFC systems will differ from your leadership, passengers, and flight crews. Here's a checklist for adding value to the procurement conversation, whether you're at that stage now or might be in the future.



1. Help everyone discern your travelers' real needs.

The boss will always want the best, but you'll be able to perceive the tradeoff between cost/complexity and capability. Once you understand the realistic usage parameters, you can guide the rest of your team to a happy balance of power and prudence.



2. Be an advocate for organizational consistency.

IFC technology continually evolves, but its principles, technologies, and security elements aren't so different than what you're already used to. From your chair in the IT department, you're well positioned to champion solutions that mesh with your organization's existing policies and infrastructures. Your IFC provider can help ensure that outcome.



3. Bring your expertise to the conversation.

When you bring your own know-how and perspective to the conversation, you show your value and make it more likely that the company will end up with the best solution. You can also serve as a crucial conduit between the provider's experts and your leaders.



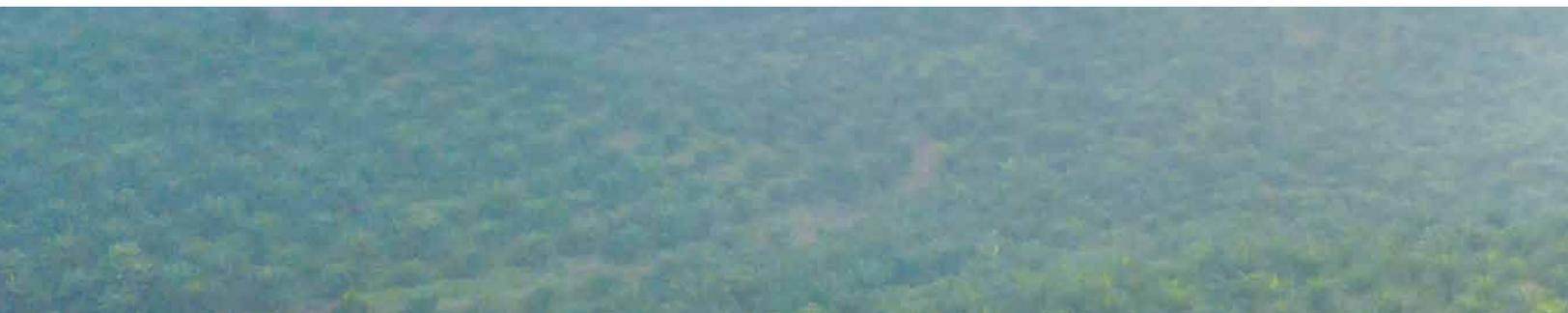
4. Help leaders make decisions based on evidence, not just intuition.

We'll be blunt: There are a lot of assumptions out there that aren't grounded in reality. Take airborne security: One reason Gogo loves to talk with IT pros is that you're swayed by evidence, not the fearful stories you see on the news. Security is a big deal, but for reasons you'll quickly understand, it's no riskier on an aircraft than when you're connecting on the ground. (See chapter 3 for more on security.)



CHAPTER 2

ANATOMY OF TODAY'S NETWORK





BUZZING THE TOWER: ATG IN DETAIL



If passengers want to send email from a business aircraft to somewhere else, they're using either an air-to-ground (ATG) or satellite network.

Which one depends on the aircraft type, mission, and route, but a general rule is that ATG serves most domestic customers, while satellite connectivity enables aircraft to stay connected overseas.

For most business passengers in North America, ATG is the most familiar form of connectivity. It's analogous to how your cell phone connects at (almost) any given point on the ground: A cell tower routes the data from your aircraft to and from the destination device or entity.



Like other wireless networks, our ATG network is made up of the following key components:



Land-based network infrastructure

ATG systems that transmit, route, and receive data



Antenna technology

The equipment on the aircraft that receives and transmits data to and from other parts of the network infrastructure



In-cabin Wi-Fi network

Routers, servers, wireless antennas, personal devices and other elements that make data accessible to users

Gogo engineers were convinced early on that proprietary infrastructure and ATG systems were valuable to the customer. With so many parties interacting and competing within most connectivity infrastructures, providing good service can get complicated and bureaucratic unless you own your own systems.

For ATG, Gogo leverages a proprietary frequency (850 GHz) to provide connectivity to aircraft with our systems on board, over a network of more than 250 towers emitting their signals into the air.



ATG AT A GLANCE

NETWORK CAPABILITIES

3G

Gogo BIZ

- VPN support
- Web browsing (no streaming)
- Email
- Voice service

4G

Gogo BIZ 4G

- All Gogo Biz (3G) functions
- Email with large attachments
- Streaming video and audio
- 2-3Xs faster than 3G

SPECIFICATIONS



800

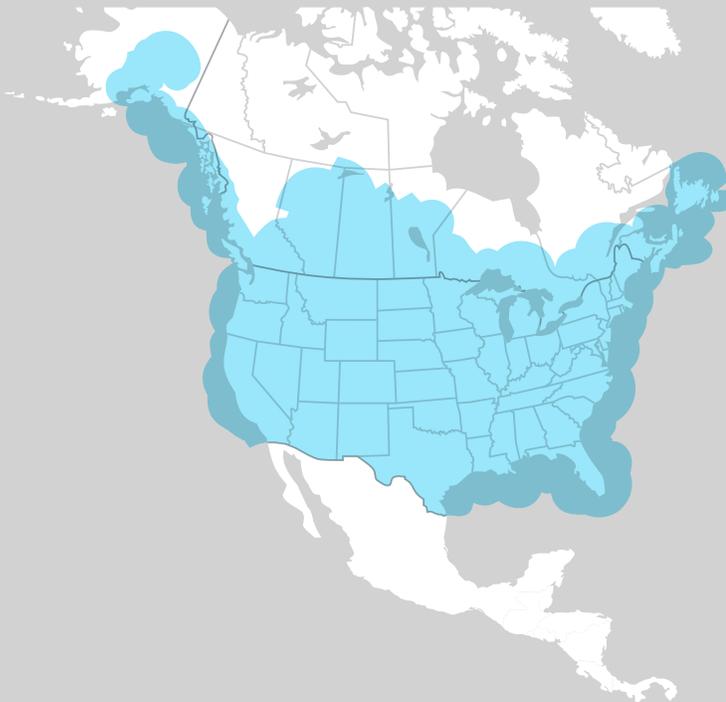
frequency



270+

cellular towers
in North America

APPROXIMATE COVERAGE



NUMBER OF AIRCRAFT



1800+

commercial
aircraft equipped

5000+

business
aircraft equipped

HOW TO THINK ABOUT DATA CENTERS

The data center is the hub of digital operations. IFC providers like to talk about their data centers as points of prestige, so here are some good questions to ask during the conversation. We'll give you ours up front.

Where are they located?

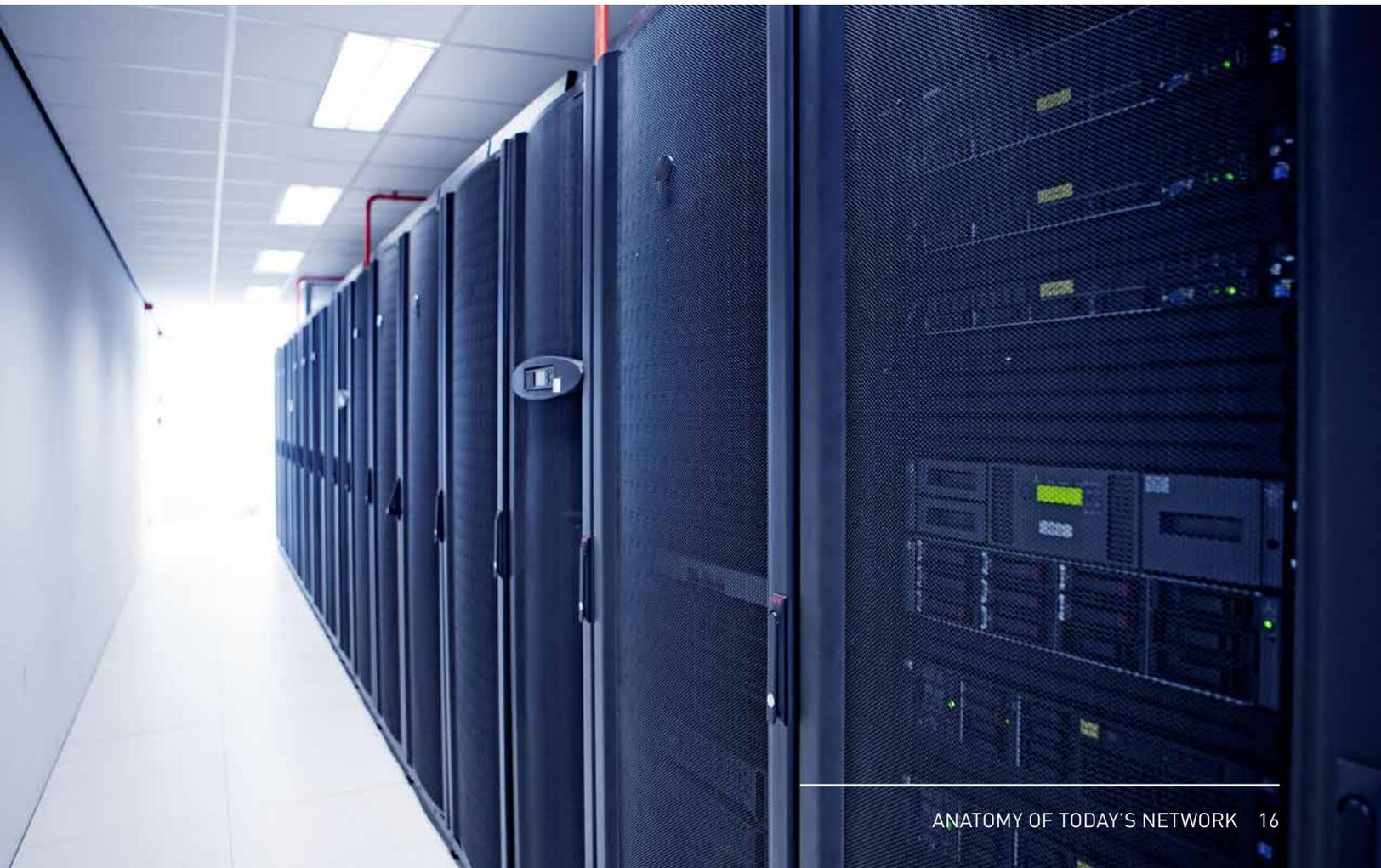
Gogo has two data centers, located in the middle of the country and away from natural disaster zones. This provides redundancy and stability to those who rely on the network, whether that be Gogo or its clients.

Who owns the backhaul?

Gogo owns and manages its backhaul. This provides increased control, consistency, and the ability for our internal service teams to understand any issues without intermediaries and act swiftly.

Is there real redundancy?

Gogo's multiple data centers and integration of infrastructure provide exemplary redundancy across hardware, software, and services. As a result, we're able to act more swiftly when an issue arises.



THE BIG PICTURE: YOUR LAND-BASED NETWORK IN ACTION



Your inflight internet connection depends on the coverage and reliability of your land-based network infrastructure. When you make a call, send a text, or connect to the internet from your aircraft, that action triggers an intricate, interdependent set of wireless technologies that use available towers and network connections covering your flight path.

Gogo has more than 250 cellular towers covering the continental U.S., and portions of Canada and Alaska, linking the various components necessary to connect you to your life on the ground. Important elements of this infrastructure include RF antennas, spectrum (radio frequency), base stations, switching stations, and fiber-optic cables.

When you push send, the data from your device on the aircraft is transmitted, collected, directed, received, and rerouted through a complex process that takes place within seconds.



Gogo Biz®
Network



Air-to-Ground (ATG) network
secured through Gogo cybersecurity
practices and policies.



Gogo Data Center

Includes multiple data centers for
redundancy and failover.



**Gogo Network
Operations Center
(NOC)**



Your
work
life



Your
personal
life



Securely send emails,
presentations, spreadsheets,
and conduct video conferences.
Supports access to VPN.



Securely shop, bank, share, and
send messages online.

THE IN-CABIN WI-FI NETWORK



You're cleared for takeoff and your engines are rumbling to life, pushing you skyward. You're buckled in, ready to go — and already thinking business.

What happens next?
Here's a look at the technology that brings your business to altitude.

SERVERS

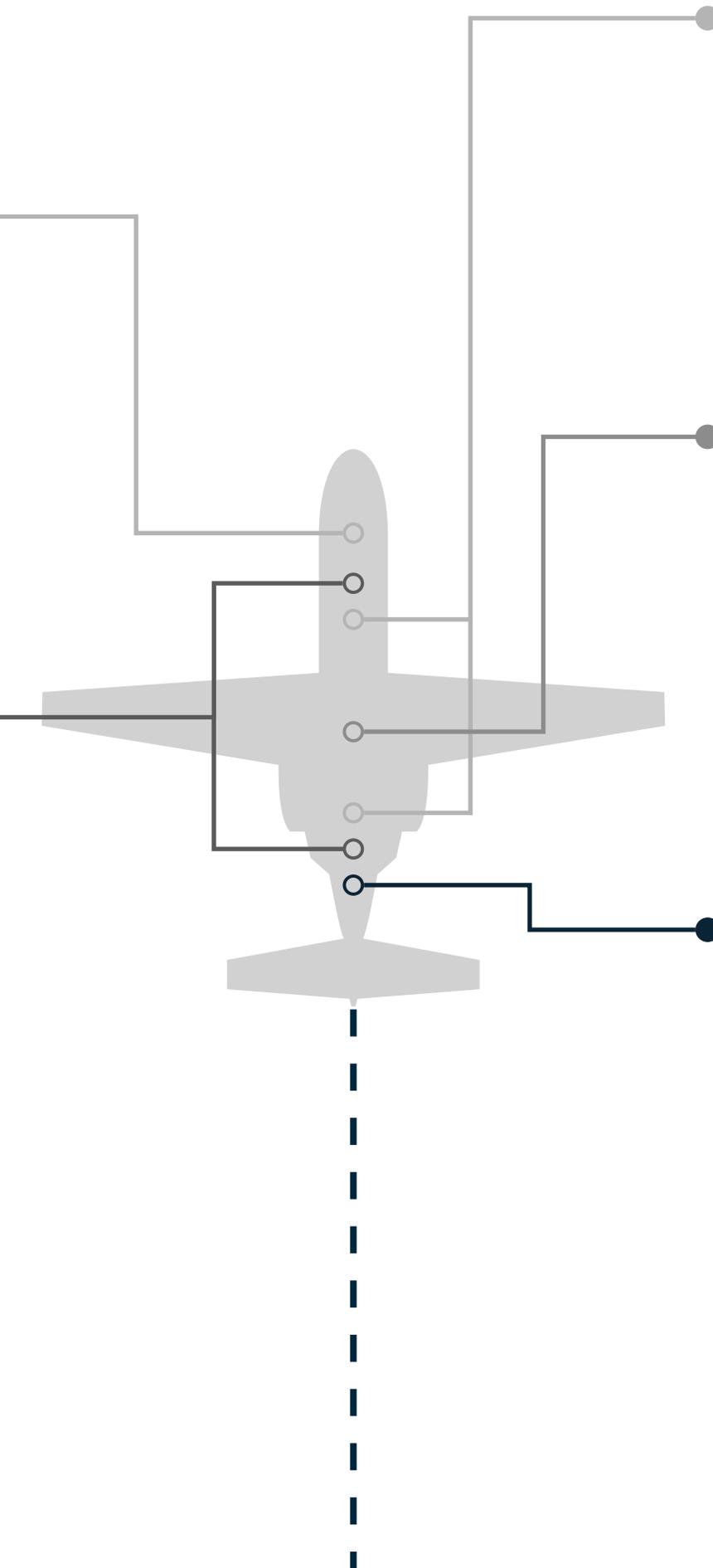
Servers provide and manage access to centralized storage and applications. Among other things, your onboard server allows you to pre-download and store content for inflight entertainment (easing network congestion and reducing data or service costs for streaming).

Performance keys: Viewing movies and other video content offline, rather than online, can help you conserve bandwidth for other inflight activities and help avoid higher fees.

AIRCRAFT ANTENNAS

Fuselage-mounted aircraft antennas send and receive signals to and from the cellular source. These antennas are designed to pick up the best signal in the closest range.

Performance keys: The antenna technology you use could depend on the aircraft you fly, the system you choose, and what you want to do when you connect during flight.



WI-FI ANTENNAS

Your in-cabin Wi-Fi antennas are optimized for your business aircraft. Their placement will depend on your usage needs and plane type.

Performance keys: Smart placement ensures optimized signal performance with minimal interference. This is especially important if you have multiple users accessing the system simultaneously.

DEVICES

The average flyer brings several mobile devices onboard, and their independent (sometimes invisible) data usage directly impacts system performance. Manage your servers and routers all you want, but if each of the devices you bring on board is gobbling up bandwidth, your system will be impacted.

Performance keys: Take inactive devices out of the in-cabin ecosystem by powering them down. (See next section for more related tips.)

ROUTERS

Routers can be mystifying, but they're the indispensable midpoints between your external antenna(s) and the in-cabin Wi-Fi antennas. The best routers provide a balance of processing speed and cost.

Performance keys: Avoid congesting the cabin with too many active devices, since this can degrade your router's capacity. The system you choose will determine how many is too many, but in general, fewer devices connecting at the same time yields better performance.

KEY PERFORMANCE INDICATORS DURING TRANSMISSION



Latency

In IFC, latency refers to how long it takes a packet of data to get from Point A to Point B. Because of the enormous distances and speeds involved, latency can impact performance on any airborne system.



Speed and bandwidth

Speed is an intuitive measure of a connection's quality, but bandwidth is the operative factor when determining performance. Consider this in automotive terms: A three-lane freeway and a six-lane freeway might have the same speed limit (throughput speed), but the larger one can allow higher amounts of traffic (data) to pass through.

WHAT THEY DON'T KNOW... CAN HURT YOU?

Your end users' inflight habits will impact the real and perceived performance of your IT ecosystem. Here are some ways you can educate others about how to be good stewards of the system and get the best performance, regardless of the system or plan you choose.



Routers and signal management

Router technology sets the bar for how well your in-cabin Wi-Fi network performs, and it's always evolving. Available data speeds, frequency ranges, wireless standards, and radio channels all affect your data transfer.



Handoffs

As an aircraft flies across the country, it is "handed off" from one ATG tower to the next. The moment of the handoff can be a point of service disruption (dropped calls, lost service) if the infrastructure isn't properly managed.



Backhaul and data center(s)

Outbound data is transmitted to base stations, which are connected to a data center through cables known as the backhaul. Gogo owns and secures its own data centers and backhaul. This offers full redundancy, and our data centers are staffed by experts who understand Gogo's protocols, software, and systems.

1. Turn off any devices (smartphones, laptops, tablets) that will not be used during the flight.

Many devices that have previously been on the network "remember" it and log on automatically, processing passive updates and iCloud transfers.

2. Turn off iCloud and automatic updates on connected devices, if you can.

These noncritical functions will happily resume when the plane lands.

3. Understand your options for streaming on connected devices.



MANAGING SUPPLY AND DEMAND IN THE SKIES



Network management is a common practice among data network providers, including any major wireless carrier or cable provider. Unfortunately, these companies aren't always transparent about it.



The reality is, without a network management protocol, a few extreme users can tie up an inordinate amount of connectivity resources with high-bandwidth activities, hampering the experience for everyone else. Gogo actively manages the network both for maximum availability and to ensure a good user experience. In practice, a drastic surge in bandwidth use from one user can trigger a slow down of that user's data stream on hour-long intervals. This intervention does wonders for keeping everyone else's experience uninterrupted — ensuring they're getting value for their connectivity investment.

A LITTLE DIRECTION, PLEASE

Your ATG aircraft antennas are constantly sweeping the ground for the connections that will keep you most productive. They come in two primary types.



An omnidirectional antenna transmits and receives signals in 360 degrees, whereas a dual-directional antenna does so along two distinct paths. You might think that a 360-degree sweep is innately better, but it's more complicated than that. Because dual-directional antennas' energy and field of reception are concentrated along distinct paths, they can offer more power and better performance for heavy streaming and other high-throughput tasks. On the other hand, omnidirectional antennas are more affordable to install and operate.

The option you should choose depends on the system you want, the type of aircraft you fly and its mission, and your budget.

IFC TECHNOLOGY: A LOOK AT DEVELOPMENT AND CERTIFICATION

IFC has a lot of moving parts, but there are consistencies in development that can help you and your team understand your connectivity partner's process and perspective. Here's an abbreviated development process.



Product design and development

- Hardware/software development
- Integration with existing systems
- System verification and validation
- If applicable, antenna audit: lightning, shock, vibration, crash (for new technology only)



Avionics equipment certifications and qualifications

- Hardware certification
- Software certification
- If applicable, antenna qualifications (for new technology only)



System tests (ground and inflight)

- Company ground test and network flight tests
- FAA ground test
- Antenna ground test



FAA confirmation

- FAA certification package submission for approval







CHAPTER 3

SECURITY OVER AIRBORNE NETWORKS





SOLUTIONS, NOT FEAR



Everybody knows that cybersecurity can be risky business, and your leadership is likely aware of the data breaches that make the news every so often.

But relying on news headlines and messages of fear can distract them, and you, from reality. Fortunately, despite the differences in scale and distance required for IFC, the principles of security are similar to any ground network or corporate environment. You already know most of them.

This matters to you because your existing corporate IT security practices will likely accommodate IFC seamlessly.

SECURITY MEASURES: WHAT HAPPENS WHEN YOU PUSH SEND



Aircraft to ground station:

Gogo uses a licensed spectrum and proprietary link encapsulation to secure data going from the aircraft to the ground.



Security work Gogo does for you

Here are a few of the ways we've built Gogo's infrastructure to be secure:

- Threat assessment and vulnerability testing built into product development
- State-of-the-art enterprise networking design
- Continuous monitoring and analysis of potential risks
- Partnerships with the FAA and other organizations to establish and update best practices
- Wireless access points secured via WPA2, an industry standard technology that has bypassed many old wireless vulnerabilities
- Routers equipped with firewalls and network segmentation to prevent intrusion from malicious actors online

VERTICAL INTEGRATION, REVISITED

You might have anticipated that security is another area where vertical integration is a huge benefit. Because Gogo owns and manages our infrastructure, we have a much better understanding of our risk exposure and can act quickly if needed. With ownership comes standardization and fewer points of vulnerability.



Ground station to data center:

Gogo owns and secures its ground stations and backhaul cables, ensuring security continuity.



Data center to internet:

Our two data centers are firewalled and segmented, protecting key components of the network and providing redundancy.

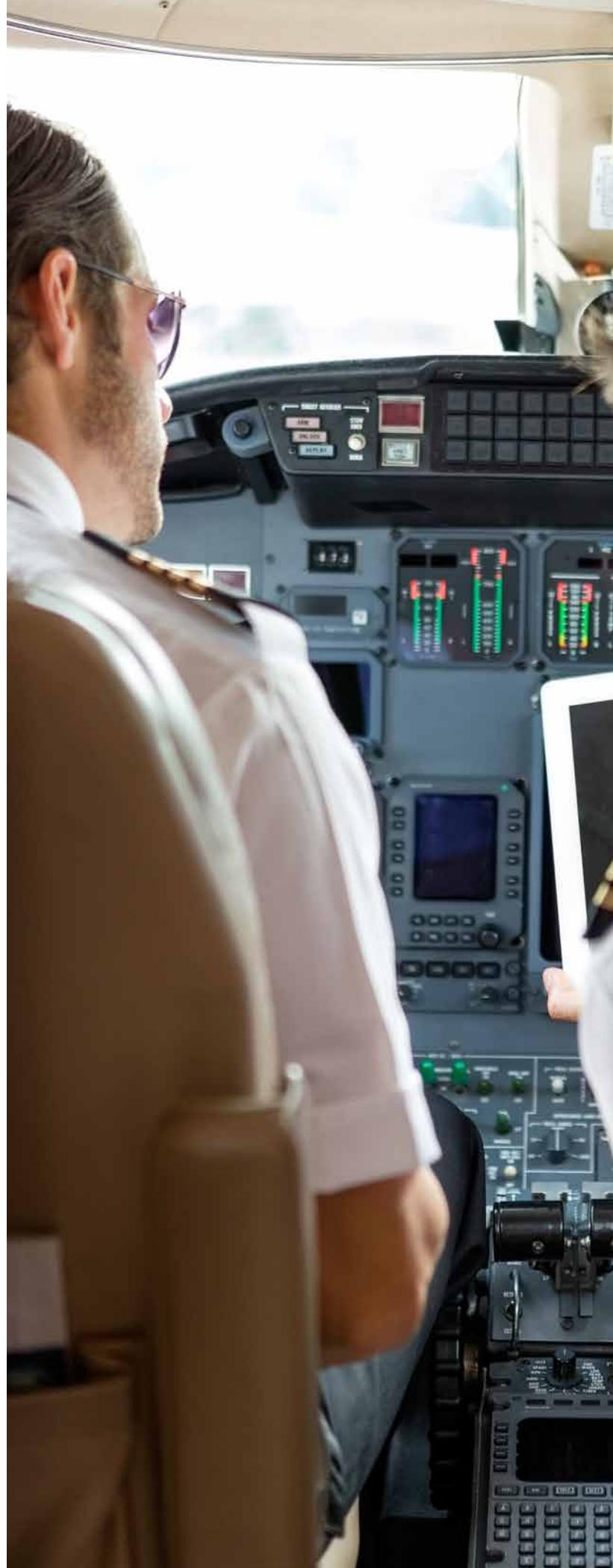


THE COCKPIT IS SECURE



One common concern about IFC is that by connecting your aircraft to Wi-Fi you're also providing a path for hackers to manipulate crucial cockpit and navigation systems. Can someone really disable your weather radar through your Wi-Fi?

The answer is no. Avionics and flight systems are separate from the Gogo inflight connectivity systems. In the few cases where Gogo needs information from the avionics, these connections are listen-only, meaning that the avionics are never accessible from Wi-Fi components.





CDMA VS. GSM: IMPORTANT CHOICES

There are a lot of choices to be made when you're setting up IFC infrastructure, and it often takes decades of experience to discern their impacts.

For example, Gogo has chosen Code Division Multiple Access (CDMA) technology instead of Global System for Mobiles (GSM). These are the two most common wireless network technologies used around the world, but CDMA has several data security advantages over GSM and is the technology the military uses.

For example: CDMA is much more difficult to pick up if you're an unknown third party, and because it divides data packets among different frequencies, it's next to impossible to piece back together again unless you're the intended recipient.

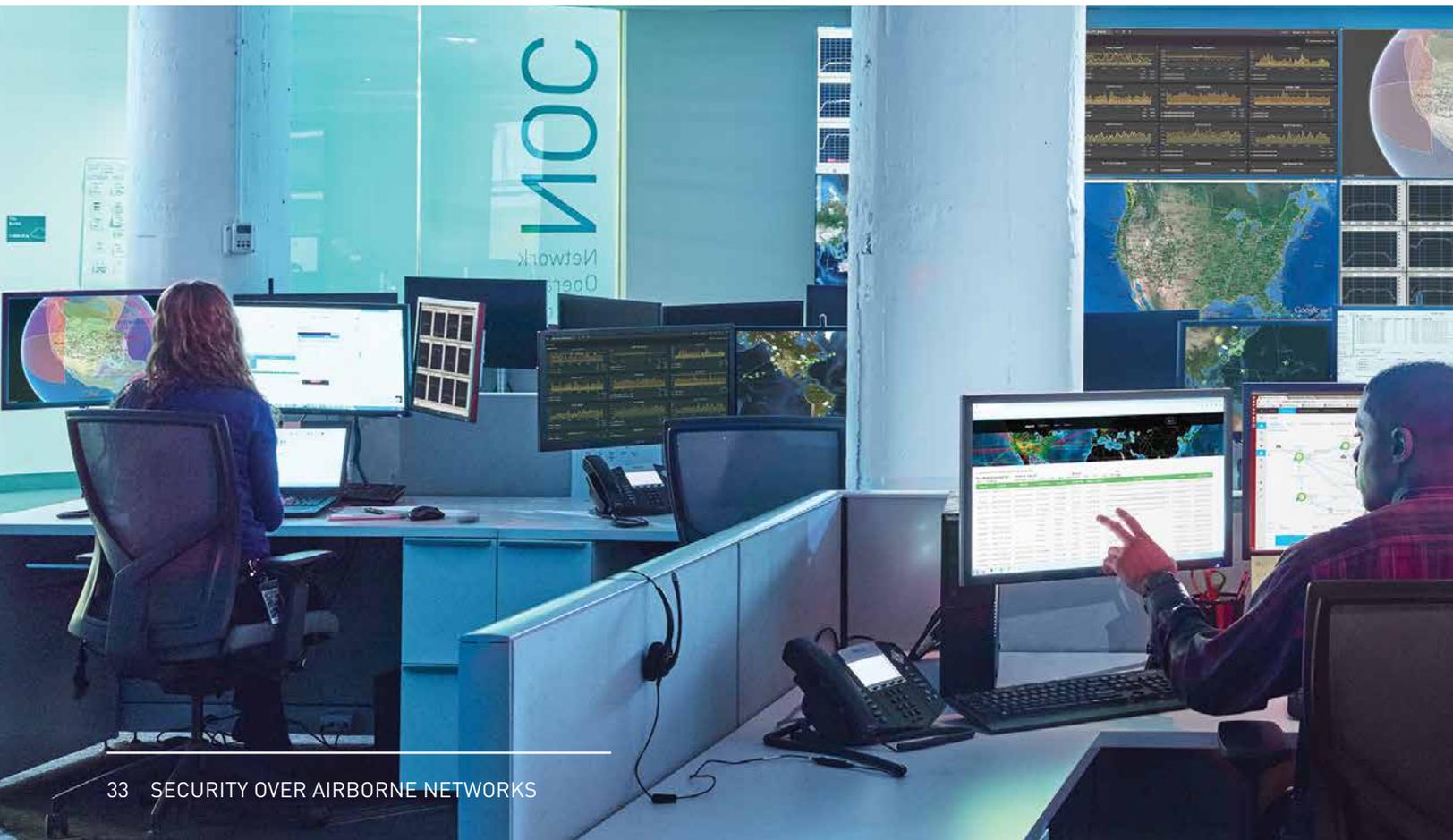
INSIDE THE NETWORK OPERATIONS CENTER



The Network Operations Center (NOC) is a beehive of activity, and it's all directed at supporting the customer experience.

Separate from our two data centers, the NOC is effectively the eyes looking in at the network's performance at all times. It provides:

- Continuous monitoring and support of the airborne network
- 24/7 tier 1 and tier 2 support
- A full staff of data systems, wireless, and IP support personnel directly available to users



TIPS FOR FLYING MORE SECURELY

Users can take control of their own security by following these easy practices:



Use the corporate VPN when connecting to their own network



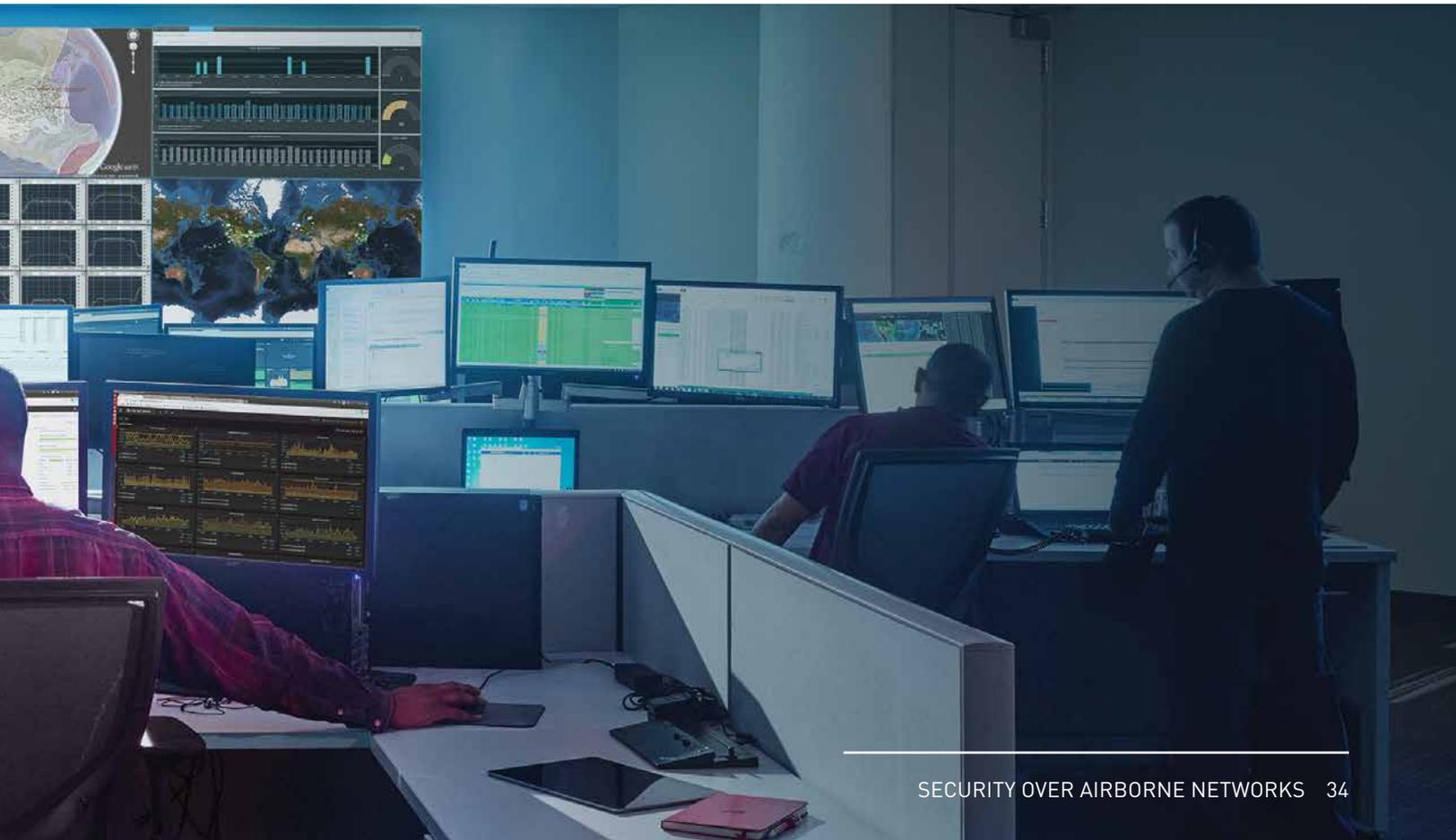
Install up-to-date anti-virus software



Use two-factor authentication



Use a password manager to securely store your passwords



THE FUTURE OF SECURITY



Data security isn't something you're ever finished with — it's an ever-changing field, and what matters is your posture to the evolving risks. Lunging from fad to fad won't do: Cybersecurity demands a steady, comprehensive approach born of experience.

There is a lot the average user can do to stay secure, too. Despite extreme scenarios of nation states hacking accounts (scary but exceedingly rare), most users are safe using our systems and their normal VPN. The reality is that an aircraft flying near Mach 1 at 35,000 feet is not the ideal target for anyone wanting your information — a hotel lobby, home office, or coffee shop are all much more desirable locations to target.

Obviously, you can never be 100 percent certain. But you can embrace some smart practices and pick a provider that's 100 percent diligent and tested over time.





EDUCATING FOR A BETTER PASSENGER EXPERIENCE

As an IT professional, you're well positioned to educate passengers on how to optimize their experience.

By helping them understand the value of turning off idle devices, avoiding streaming gobs of data, and so on, you're actually adding substantial value. Every efficiency you teach someone else is an efficiency you've contributed to the company.

PREFLIGHT CHECKLIST: GETTING STARTED WITH IFC



Your steps to success. Gogo will help with any or all of these.

- 1. Get leadership to define what they really need.**
At the end of the day, your leadership and travelers don't care about the hardware or software of the onboard connectivity system; they care about whether they can do what they need to while they are in flight. You need to understand just what those needs are before anything else.
- 2. Map your IFC solution to your broader IT ecosystem.**
Adding IFC is mostly a hardware issue from the client perspective, but you'll want to make sure you've allocated resources and manpower accordingly. Also consider the integration with existing applications and systems — anything that will be in use on the aircraft.



3.

Learn your aircraft fleet.

Aircraft and their systems can be bewildering, but once you understand the airframes you're dealing with, it's a shorter step to understanding the solutions that are right for them (and thus for those who occupy them). You're going to want to maintain fluency with these systems among your team, since IFC is moving toward a continuous development and deployment model.

4.

Leverage your IFC provider's expertise.

From an IT perspective, you're never on your own. Gogo is filled with IT experts ready to help — now or years after install.



YOU'RE READY. NOW LET'S CONNECT.

Just like the networks and hardware that power the data center or the cloud, inflight connectivity is constantly evolving. But it is knowable, and the business outcomes you can help unleash with it are remarkable.

Armed with the information we've presented in this guide, you should be more confident and prepared as a crucial partner in the IFC lifecycle.

Now let's continue the conversation and help you develop your company's system. Gogo is always ready.

business.gogoair.com/technology





| FLY SMARTERSM