



WHITE PAPER

GOGO 5G™: HIGH-SPEED, AIR-TO-GROUND (ATG) BROADBAND FOR AVIATION



The 5G networks of tomorrow will need to strike the right balance of products and solutions in order to address the complexities of rolling out and servicing the applications that this new standard will foster. There is no silver bullet when it comes to transforming the ways networks are built today, which is why solutions need to be **flexible**, provide **bottom-line efficiencies, deliver value at the edge of the network**, and address **multiple vertical applications**.

The Challenge

Business aviation customers are seeking an inflight experience that is similar to their offices on the ground. The ability to download large files quickly, stay on top of personal and professional demands, and even video conference without delays is the goal with new advances in Air-to-Ground (ATG) technology.

Global adoption of 5G is currently taking place, which means that high-speed connectivity will become an essential part of daily life. Operators around the world are continuing to commercialize and increase investment in 5G deployments, in a number of use cases and applications—ranging from autonomous vehicles and private networks to robotics and AR/VR. The importance of having an agile, scalable, and low-latency solution will allow private network operators to rapidly monetize their 5G assets.

The inherent complexity of mobile cellular networks needs to be simplified in order to boost reliability and scalability in private network scenarios. Currently, thousands of airplanes and passengers are constrained by legacy systems that all share limited bandwidth. This is compounded by the fact that for the first time in history all over the world, the spectrum that is being made available, and the standards used, are as homogeneous as ever, which will truly enable innovation on a global level.

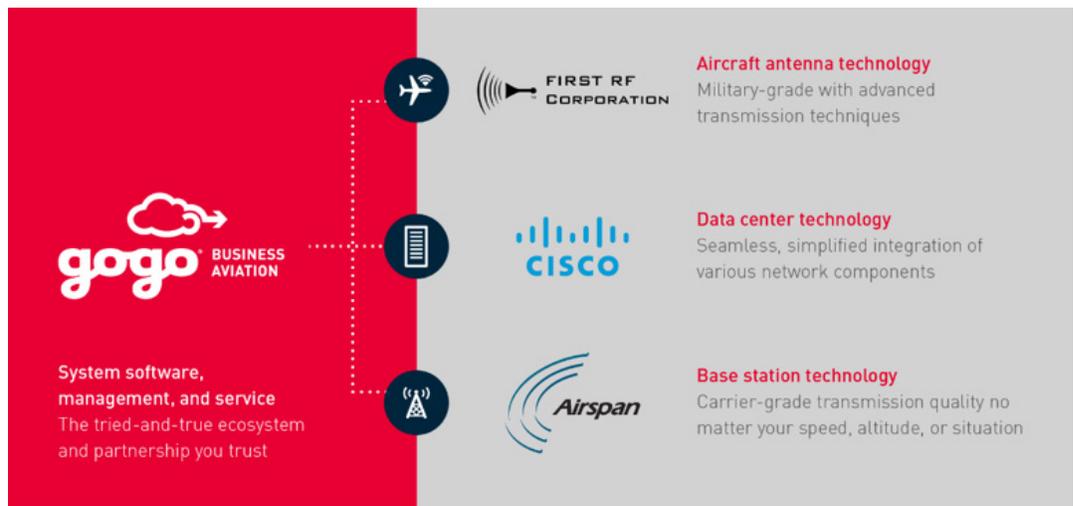
The solution must exceed 3GPP (<https://www.3gpp.org>) standards in order to adapt Gogo 5G™ to the strict requirements of wireless communication in the aviation world. Radios must adapt to compensate for high-speed Doppler shift, and allow communication with an aircraft traveling at hundreds of miles per hour. The network innovations must also increase the maximum range to serve aviation, and be able to deliver enhanced mobile broadband speeds.

The Network Solution

The Gogo 5G ATG network presents a new inflight experience, thanks to the combination of unlicensed and licensed spectrum. It will use unlicensed spectrum at 2.4 GHz. The Gogo 5G solution will adopt the same 5G technology that is currently being deployed by other ground operators, with the ability to augment 5G with their existing licensed spectrum network, giving Gogo a distinct competitive advantage.

This innovative network delivers more bandwidth per plane, enabling a true mobile-enhanced broadband experience.

The nationwide Gogo 5G network is planned to go live in North America in 2021. Working closely with their partners to design a highly scalable network, and utilizing their existing infrastructure of over 250 towers, Gogo will be able to easily and cost-effectively add more capacity where it is needed—a shining example of U.S. technological innovation.



How Partners Enable the Gogo 5G Experience

Air-to-Ground (ATG) Architecture

Gogo’s ATG architecture is based on **four key elements** to enable high-speed, low-latency, inflight broadband.

1. Onboard Technology

Connecting the aircraft to the ground base station, the aircraft’s onboard technology consists of the radio receiver and transmitter, as well as electronic components such as servers and hard-drives, for handling inflight entertainment systems. Delivering a true enhanced mobile broadband experience, it is based on an advanced, active, beamforming antenna system to receive and transmit customer data at high speeds.

2. The Core Network

The virtual 5G Core Network (5GC) is connected to the public internet and private apps from Gogo. It handles the creation and maintenance of data paths towards the airplanes.



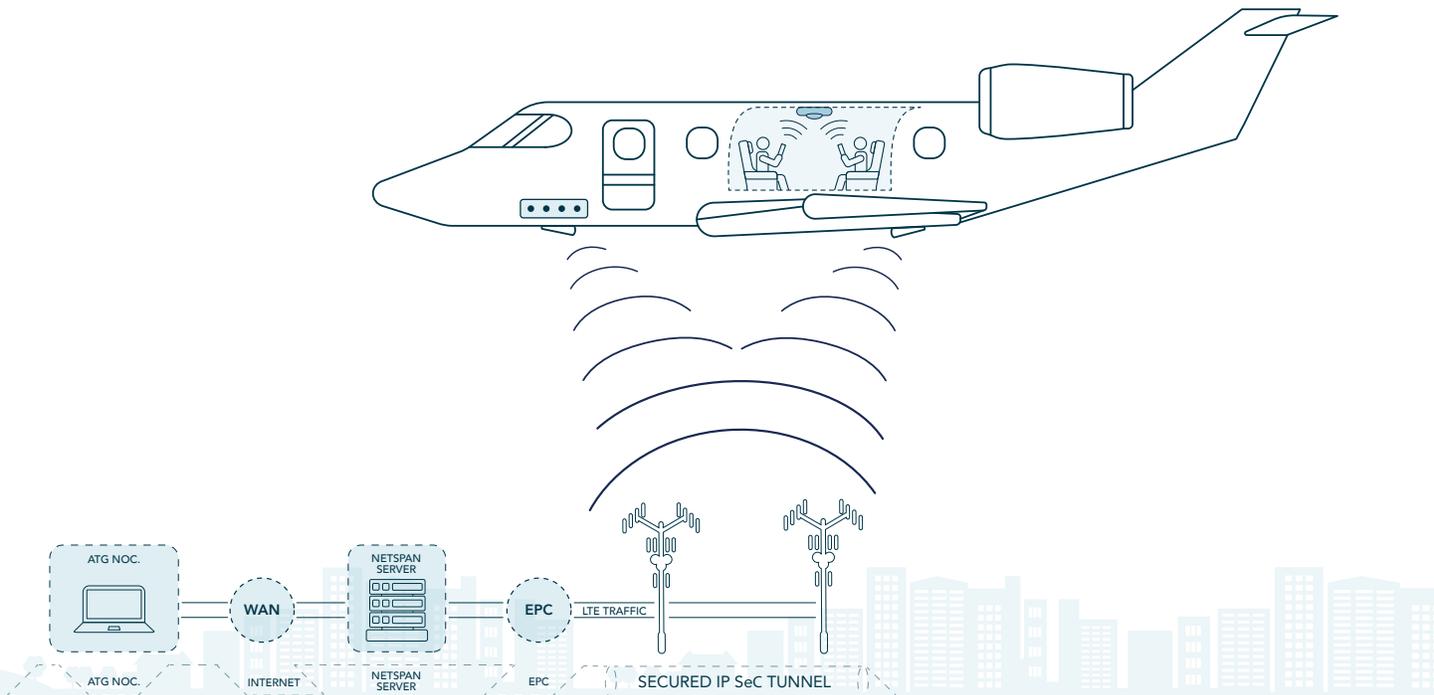
3. The Element Management System (EMS)

Managing, configuring, and orchestrating the full 5G ATG network, the Element Management System (EMS) plays a critical role in maintaining connectivity.

4. Base Station Technology

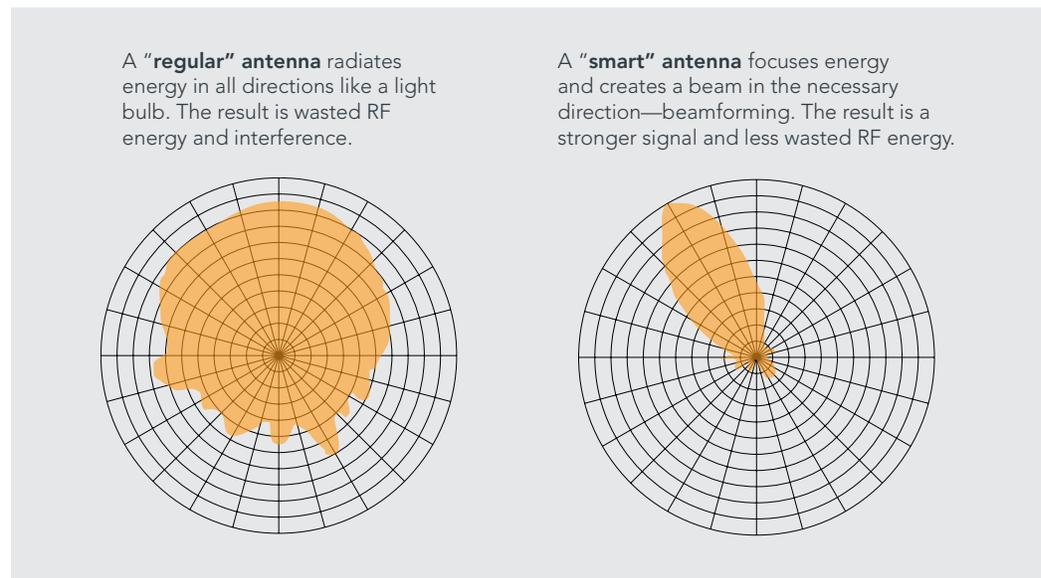
Consisting of 5G vRAN base stations with 16-antenna digital port beamforming antennas using massive MIMO technology, the base station communicates with aircraft passing overhead. These stations are similar to cellular towers, with the exception that their radio transmitters are directed upwards, and placed at much greater distances apart.

GOGO 5G™



Airspar Technology

The vast amount of Macro base stations will leverage state-of-the-art features and technologies, such as massive MIMO antenna arrays that use digital beamforming and advanced tracking algorithms. Virtualizing the Radio Access Network (RAN) brings an innovative 5G architecture, based on 3GPP (<https://www.3gpp.org>), O-RAN (<https://www.o-ran.org>), and TIP (<https://telecominfraproject.com>) standards. This will allow the teams to rapidly introduce new, advanced features to improve performance, scale resources based on cloud-native OpenRANGE Software and COTS, and centralize control of all radios to facilitate management and orchestration of the network. Achieving top performance is possible due to the network’s v-RAN architecture, interference minimization techniques, and advanced 16-port digital beamforming and tracking techniques that deliver an overwhelming 6-layer multi-user MIMO.



Digital Beamforming

Gogo 5G will also bring important innovations that will make the spectrum that is going to be used even more efficient. Special features, such as digital beamforming, will provide operators with unprecedented spectral efficiency, giving each private application the highest return on investment.

In Summary

Connectivity is critically important to the future of business aviation. Airspan has joined Gogo and its partners to develop one of the most disruptive 5G private networks to date, providing a true 5G-enabled, aviation experience that is designed from day one as a

standalone architecture that is fully virtualized. This ambitious project requires the right partners who are committed to understanding the requirements of end users. Airspan's collaboration with Gogo and its partners is a perfect example of how standards can be molded and adapted to meet the needs of tomorrow's networks and execute on the vision of true 5G.

About Gogo

Gogo is the inflight internet company. They are the leading global provider of broadband connectivity products and services for aviation. Gogo designs and sources innovative network solutions that connect aircraft to the internet, and develop software and platforms that enable customizable solutions for and by their aviation partners. Once connected, Gogo provides industry-leading reliability around the world.

With more than 27 years of innovation, Gogo Business Aviation's unparalleled experience makes it the world's most trusted provider of inflight connectivity and entertainment solutions. They are relentlessly innovative, quality obsessed, customer focused, and globally reliable. And that is why Gogo is the brand of choice for business aviators who want to connect with confidence.

About Airspan

With a track record of disruptive technology, Airspan has proven itself over the last 25 years as a leader in delivering U.S. innovation for wireless networks all over the world ranging from public safety and oil & gas, to Tier 1 mobile operators. Thanks to its innovative, flexible, cost-effective approach that allows both public and private network operators to deploy 5G solutions, Airspan ensures they will also keep pace with the ever-increasing demand for high-speed connectivity.

With a history of overcoming major technology challenges, Airspan differentiates itself through its ability to customize and tailor its scalable solutions to meet the challenges of business partners. Recognized as a market disruptor, Airspan is a logical choice that meets these challenges head on and proudly boasts:

- Nearly a million multi-award winning 4G cells deployed worldwide
- A disruptive 5G innovation program focused on mmWave, sub-6 GHz, massive MIMO, and open vRAN architectures
- A supporter of open standards and interfaces. Airspan's open RAN, virtual infrastructure brings scalability thanks to its cloud-native OpenRANGE software and its award-winning hardware solutions. It also creates a common ground for third-party apps to unleash productivity through open APIs and interfaces with direct access to the radio interface, while still allowing Airspan to develop cutting-edge features that differentiate its offerings for private networks.



Private Networks

Airspan has proven itself over the last 25 years as being a leader in delivering U.S. innovation for applications all over the world.



Additional Resources

Learn more about Gogo Business Aviation at <https://business.gogoair.com>

Learn more about Gogo 5G at <https://business.gogoair.com/gogo5g>

The Gogo 5G Network will consist of:

- Gogo (<https://business.gogoair.com>)
AVANCE L5 System; X3 (5G LRU); Tower Infrastructure
- Airspan (<https://www.airspan.com>)
Air5G OpenRANGE Virtualized Base Station Technology with Massive MIMO Antenna Arrays
- Cisco (<https://www.cisco.com>)
Ultra 5G Cloud Core and Data Center Support
- FIRST RF (<http://www.firstrf.com>)
Fuselage-Mounted, Blade-Style, Multiband Aircraft Antennas

Airspan is a U.S.-based, multi-award winning 4G and 5G RAN vendor that supports cloud-native open architectures, and boasts close to one million cells deployed in the most cutting-edge tier one networks, and vertical applications across the globe. With an expansive product portfolio of indoor and outdoor, compact Femto, Pico, Micro, and Macro base stations, Airspan has the perfect network densification tool kit to exploit the full potential of technologies such as mmWave, sub-6 GHz, massive MIMO, and Open V-RAN architectures, as well as an industry-leading Fixed Wireless access and backhaul solution portfolio for PTP and PTMP applications.

