New Developments in Government Airborne Broadband

Fast, Flexible, Responsive Global Conections

01. Introduction

While our armed forces have succeeded in putting broadband on airborne platforms in the past few years, the cost of space segment and high cost of service via satellite has prevented the technology from gaining the traction that it has today. Now it is a growing market space with many options for providing advanced services.

Applications are evolving as well. Manned ISR operations have typically been executed in a confined geographical area, so data requirements were fairly easy to accommodate by leasing capacity on a single satellite beam that covered a specific region of operations.

Now, data requirements are evolving as more and more government aircraft need to fly worldwide on command and control (C2) missions, transporting senior leadership or operational forces that need network connections while enroute. Those cases require a worldwide network that can stitch together multiple satellite network coverage areas and multiple satellite networks.

02. System Description

Today's global mobile satellite network for ISR and C2 integrates numerous satellite beams, and multiple satellites, to create wide area coverage. Analogous to a cell phone network, an aircraft flying around the world transitions from beam to beam just as you transition from cell site to cell site as you drive or otherwise travel on land.

Accomplishing this transition from satellite to satellite requires sophisticated ground infrastructure and background processing techniques borrowed from cellular networking, to assure that aircraft operate seamlessly without service interruptions.

The tracking antenna is also a key component of airborne broadband for mobility, and is very dependent on the size of the platform. Smaller aircraft, such as a King Air 350 or PC-12, require small antennas to allow options for either a fuselage or tail mount. With smaller airplanes and dishes as small as 11 cm, it's a complex technology challenge to squeeze data at the highest rate possible through that antenna.

For example, with typical ISR applications, the satcom terminal should have a very high throughput link to stream video content from the aircraft to the satellite and then to a hub or teleport – the exact opposite of traditional satcom networks.

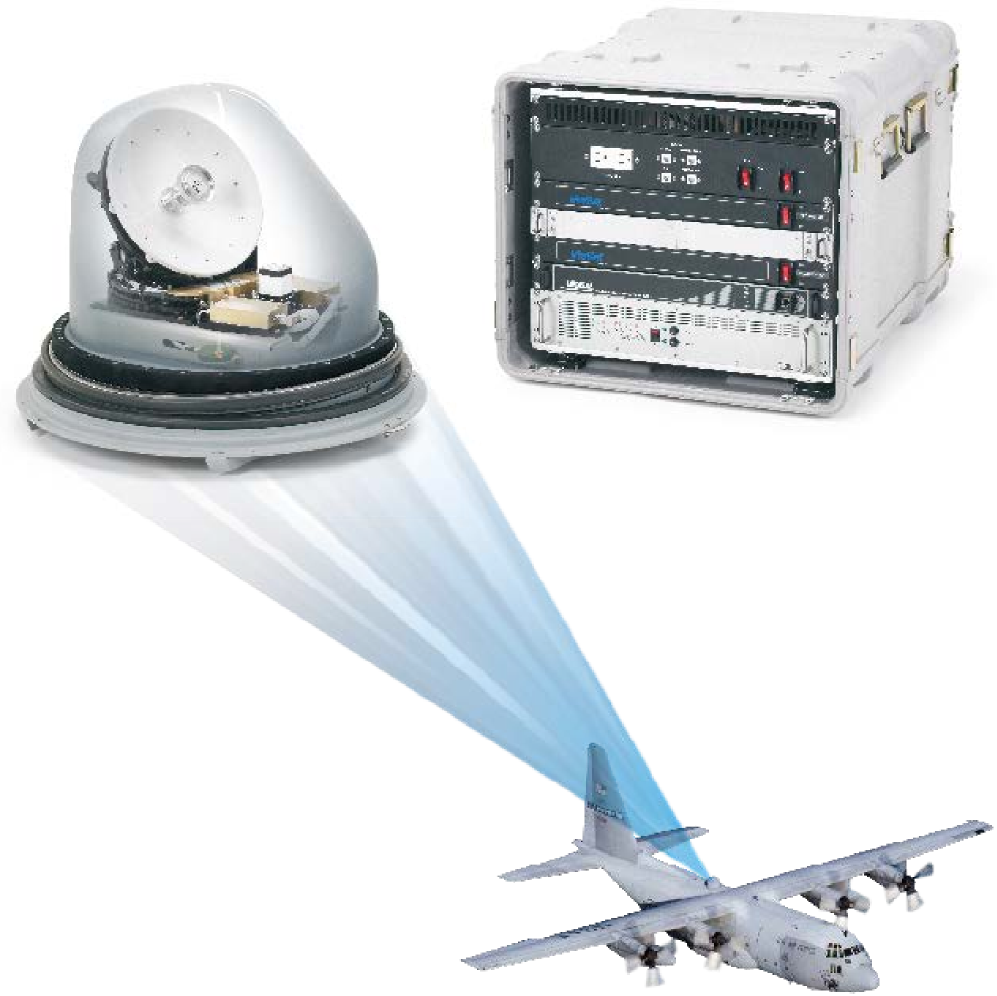

FIGURE I. Airborne shipset, including antenna and termina, in a quick-deploy hatchmount configuration..

In this case, a higher output RF amplifier will compensate for the lower gain from a small antenna aperture. But the higher output power, and inherently wider antenna beamwidth, may cause interference with adjacent satellites. Consequently the modem employs coding and modulation techniques to spread the transmitted energy and avoid any interference.

Larger airplanes, on the other hand, fly much faster, and require a fuselage radome that minimizes aerodynamic drag atop the aircraft. Flat-panel, phased-array antennas would be ideal to solve this challenge, but that technology isn't mature yet, especially for a moving platform. For now, the best technical option for larger planes is a medium to low-profile mechanically steered waveguide antenna and radome. This option is being used on government aircraft such as the C-17 and soon on commercial JetBlue Airways aircraft.

These adaptations represent some of the challenges in designing an optimum antenna and radome to meet a range of requirements, such as aircraft safety and aerodynamics, mission concepts of operation, and overall system performance.

Other innovations have included hatch-mounted systems that enable crews and operational personnel to configure aircraft for broadband satcom when the mission requires it, including options for Ku- or Ka-band antennas. See Figure 1. For the C-130 aircraft, this combination radome and antenna system is a deployable shipset that fits the C-130 escape hatch. Another hatch mount innovation targets the C-17. This mission deployable product, in development under a JCTD program called Celestial Reach, will deliver broadband satcom for any C-17 via a low profile Ka-band waveguide antenna system.

Broadband for rotary wing aircraft

A recent technology development brings high-speed broadband capabilities to airborne rotary wing aircraft for the first time. Helicopters are perhaps the most complex platforms for satcom since the antenna aperture requires direct line-of-sight visibility to the satellite. Moreover, the antenna needs to be on top of the aircraft for the best visibility. Of course that puts the aperture looking up through rapidly spinning rotor blades which periodically block the transmission to and from the satellite. In addition, high G-forces from mechanical vibration require aggressive mitigation to prevent the antenna from shaking apart while maintaining accurate positioning to aim and lock on the satellite location.

New patented signal and waveform technology includes techniques to overcome those short, but frequent bursts of blockage. Patented techniques for vibration compensation complete the key technical achievements.

03. Missions

One of the primary customers for high-speed airborne broadband is U.S. Special Forces, who often are required, at a moment's notice, to fly halfway around the world to deal with a problem. Airborne broadband mobility enables their en route communications. Rather than passing time traveling to their mission location, they can conduct mission planning, gather last-minute intelligence information, and convene meetings with commanders using high-speed downloads to the aircraft. The many hours of transition from their home base to wherever the mission might be becomes productive. En route communications allows them to be constantly connected, staying abreast of late occurring developments and avoiding a long gap between initial orders and arriving at their destination.

U.S. Army Rangers or Army airborne operators typically hitch a ride on U.S. Air Force aircraft to perform their missions. Again, next-generation airborne mobility allows their aircraft to be constantly connected to networks back home and enables mission planning. Forces gain the ability to be much more responsive and short-fuse reaction capable, making en route adjustment in real time. It also allows senior officers and decision makers – the command and control echelon – to remain connected while they fly to bases around the world.

These satcom-equipped systems have become quite popular, and at times when high-level government officials, such as the secretary of defense and others, want to fly incognito to places like Afghanistan they will often request a C-17 with a fully outfitted VIP pod loaded inside. More often than not they use these particular aircraft because they are equipped with high-speed broadband that gives them and their staff the ability to continue working while they are flying.

04. Advantages

Leveraging commercial technologies

Much of the new technology enabling advances in broadband airborne mobility was adapted from commercial systems. Previous commercial R&D investments can now provide the government with advanced broadband capabilities and connectivity without requiring government expenditures on large DOD development programs. Even when military and government requirements don't match up to commercial systems 100 percent, the opportunity is there to take advantage of commercial off-the-shelf technology and get a 90 percent solution – one that really meets the majority of their needs, allows them to run their missions successfully and do it at a much lower system cost.

Nearly all of the antenna technology that ViaSat uses for the military has its origin on the commercial side. For example, smaller ISR-type aircraft use 12-inch antennas first developed for general aviation business jets. Modem technology adapted for mobility use with general aviation is now in a third generation of development for contemporary government and commercial applications. Similarly, for larger aircraft, new low-profile antennas are moving from commercial air in-flight systems to government aircraft such as the C-17 transport.

Responsiveness from global coverage

The ViaSat Global Network offers worldwide Ku-band satcom connectivity (Figure 2), with turnkey services and a range of service plans that have been augmented and upgraded to meet today's ISR and C2 requirements. For aircraft provisioned with ViaSat terminals, acquisition is a process akin to purchasing commercial cell phone service, including a flat-rate monthly subscription for bandwidth.

For government missions the theater of operations doesn't always include available satellite capacity. And the ability to predict locations, use cases, or bandwidth is a difficult task, but our procurement experience at quickly standing up new capacity enables military services to leverage broadband mobility and react far more quickly than they otherwise could. Our current worldwide network and stand-by agreements with satellite operators to quickly add transponder space eliminates the need for customers to predict and commit to satcom requirements in the same way. In addition to this service network, the model also enables quick setup of new, dedicated hubs (Figure 3) and additions of more capacity if needed.

Another important asset is the ground segment, which receives the satellite signal and can connect with SIPRNET, NIPRNET, or Internet communications infrastructure. The global network includes over 25 satellite hubs and has ground terminals and other equipment in various teleports worldwide. This efficiency is setting new standards for quick reaction. As an example, one government customer had an urgent need for a new satellite network in a remote international location and they were up and running in just a little over two days.

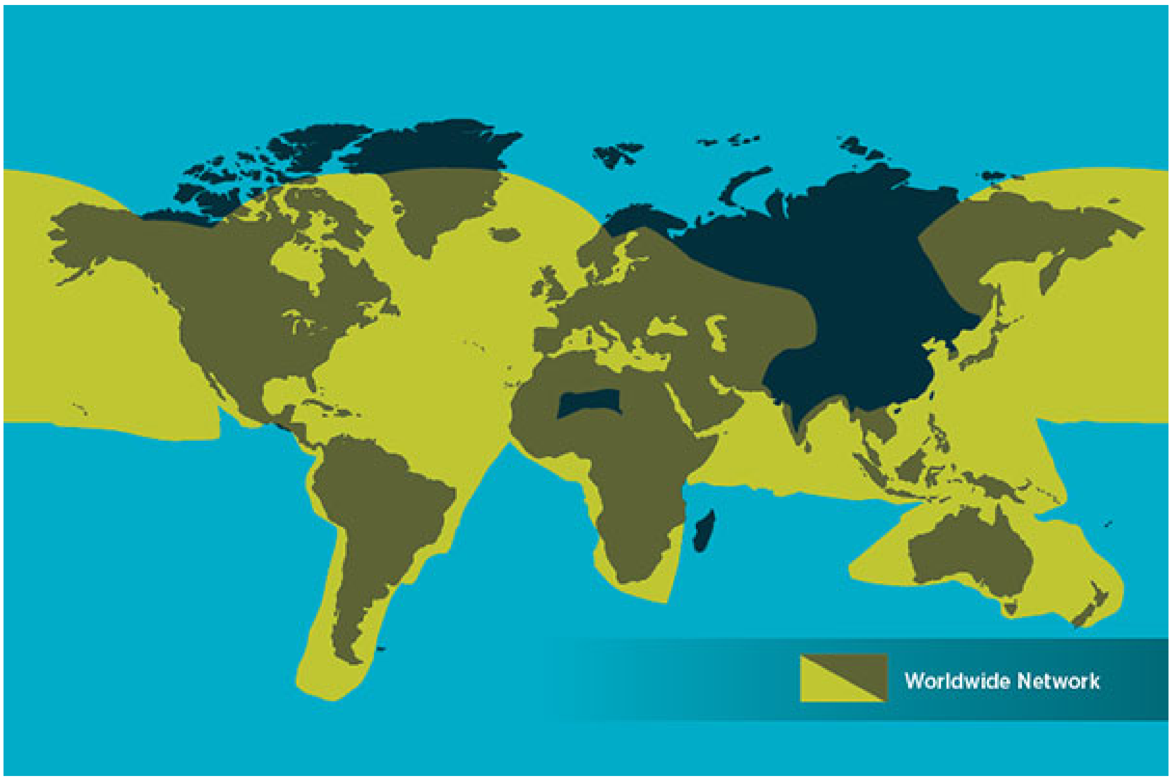

FIGURE 2. Current ViaSat Global Network coverage (June 2013).

Security

Various layers of security protect network customers. First is a layer on the satellite link from the airplane down to the ground to the hub. That link must be encrypted and protected in such a way that an adversary can't tap into the signal to try to extract information. Users on government aircraft using the ViaSat Global Network are also equipped with government-certified encryption on their communication links.

Other layers of security that are of special concern include the security of the network hubs. Many of these hubs connect to secure government networks, but a lot also connect directly to the Internet. Keeping these physical hub installations protected against vulnerability is a major focus of the continuing investment to keep ahead of adversaries.

FIGURE 3. In-theater private hub that can be setup in a matter of weeks.

05. A Future with Far Faster Speeds and Capacity

Today most of the airborne broadband capabilities provided to the government use Ku-band satellite frequencies. Historically, Ku-band satellites have been designed to provide maximum coverage, so satellite operators design satellites with a beam that covers an entire country, or a big portion of a continent. However, that imposes limitations on the capacity and capability of that coverage.

New Ka-band satellite designs provide more spectrum allocation and enable much higher data rates and capacity compared to Ku-band and X-band, and even new military Ka-band assets.

The ViaSat Ka-band high-capacity satellite system that produced the highest capacity satellite in the world, ViaSat-1, uses many small and very high-powered spot beams, but that adds complexity in mobile applications. When aircraft fly through these small spot beams, they have to transition from beam to beam very frequently. The handoff and the ability to transition beams becomes much more of a networking problem, but the challenge has been met with new technology.

New technology to deliver both deep capacity and coverage

In May of this year, ViaSat unveiled plans for another new high-capacity system design, when it announced the ViaSat-2 satellite. ViaSat-2 represents a significant breakthrough in broadband satellite technology – for the first time combining extremely high bandwidth capacity with very large coverage areas. The new system is designed for operational flexibility – solving historically challenging issues in geographical distribution of bandwidth demand, capital investments, and system performance. ViaSat-2 will make it possible to offer superior in-flight connectivity on applications ranging from U.S. government aircraft traveling to Europe or Latin America, to critical national and Homeland Security missions.

The road map

Demonstrations are underway to show government and military customers the advantages of these new high-capacity Ka-band technologies. Data rate improvements are expected to gain by a factor of 10 compared to Ku-band systems. Rather than 3 to 4 megabits per second off an aircraft, customers can look forward to 20, 30, or 40 Mbps in the future.

There is a long-term roadmap in place to eventually transition all ISR and C2 missions from Ku to high-capacity Ka. Already, some key government aircraft are being outfitted with Ka technology, and some are starting to deploy in regions like North Africa and the Middle East.

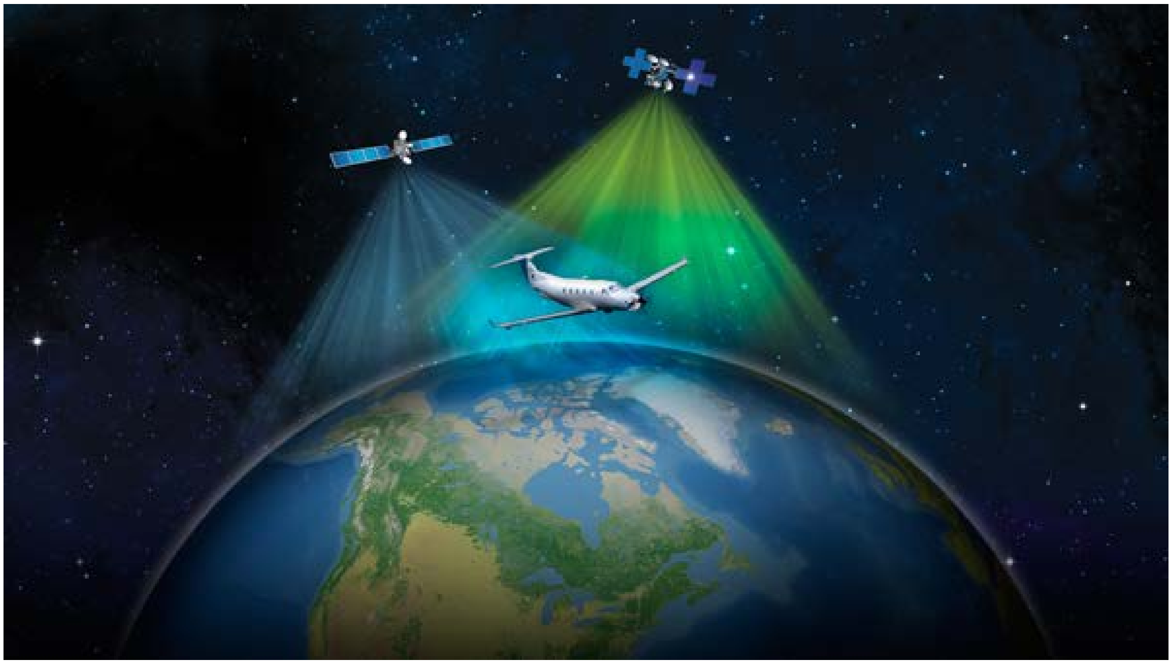

FIGURE 4. Aircraft can seamlessly transition from beam to beam or satellite to satellite as new capacity is added.

This won't be a simple or fast flip of a switch. Many aircraft will remain on Ku networks for many years. In the meantime, developing technology will likely enable future government customers to seamlessly roam from Ka networks to Ku networks.

06. Conclusion

Our armed forces are moving fast in finding new ways to improve the effectiveness of their missions with high-speed airborne broadband. Fortunately a number of attributes of today's most advanced mobile satellite communications enable them to be nimble and quickly get the coverage and service they need for critical operations:

- Available commercial technology that can be quickly adapted to military use.
- High-speed global network coverage with capacity at the ready for new regions of activity.
- Quickly deployed additional gateways and bandwidth for dedicated private networks.
- Multi-layer security to protect information between the ground to the aircraft.

- Terminals for aircraft large and small, either permantently installed or quickly added to an aircraft within hours to convert it for C2 or ISR operations.

In addition, there is a roadmap ahead that will continue to make the global network more capable. New high-capacity Ka-band holds the potential to increase speeds 10-fold and is in demonstrations for the DoD now. And, with coverage already across North America, Europe, the Middle East and Mediterranean basin, new plans have recently been announced to begin bridging this deep capacity across the oceans, on the way to future global coverage.

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