AIRBORNE SATELLITE COMMUNICATIONS ON THE MOVE

ST Engineering

Introduction

Military forces require situational awareness no matter where they are located. From warfighters in the field, sailors on Navy ships, troops in flight and decision makers at central command, everyone must share a common operating picture to accomplish the mission. Yet, that can be significantly challenging when troops are constantly in motion, traveling across land, sea and air.

To keep mobile troops connected, military satcom providers have introduced innovative Communications on the Move (COTM) technology. With specialized satellite router antenna equipment and network features, a moving vehicle can be broadband-enabled, capable of supporting voice, data and video connectivity.

COTM has been widely adopted on the ground and at sea, dramatically improving the availability and exchange of data. Today, the VSAT industry is pushing forward the next COTM frontier: airborne mobility.

Airborne COTM provides an entirely new information lens. It enables an expanded view for decision-making and an uninterrupted flow of data, whether that involves a military battlefield or a domestic first-responder operation.

Military aircraft can stream high-definition Intelligence, Surveillance and Reconnaissance (ISR) video to forces on the ground or at other command locations.

Airborne command and control as well as tactical communications keep everyone informed and ready for action, e.g. delivering real-time information to troops over drop zones and in enemy locations.

Commanders in flight can conduct mission planning and will know what's unfolding at all times through videoconferencing as well as phone and data connectivity — prepared to execute strategic decisions at a moment's notice.

Customs and border patrol agents can gain a wide-area view to keep a sharper eye on borders.

First responders can monitor emergency situations as they develop, exchanging critical information to improve life-saving operations.

Coast Guard can analyze oil spills using aerial footage captured using satellite technology.

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Meeting Complex Technical Requirements

Designing a satellite airborne COTM infrastructure for the military is a significant technology advancement, yet it presents several distinct, technical challenges. Airborne COTM networks must be able to efficiently and reliably support a wide range of throughput rates from basic email, to flash override Voice over IP (VoIP), to high-definition video.

These applications must operate on fast-moving aircraft, using a very small antenna and overcoming issues like the Doppler Effect and rain fade. An airborne COTM network must also support near seamless global coverage, track deployed units and manage beam switching while meeting stringent security and budget requirements.

This paper presents the challenges to airborne COTM and how ST Engineering iDirect can enable a global airborne COTM network for militaries, civilian government agencies, first responders and anywhere secure airborne satcom is needed.

Solving Spectrum Spread

Providing high-speed connectivity through small mobile antennas is one of the toughest challenges of airborne COTM. Sub-one meter antennas required for COTM have low gain characteristics. Higher power is required to ensure the receiving terminal hears the remote over the background noise created when the satellite boosts the signal. These high-rate signals coming from small antennas often cause interference with adjacent satellites that may be using the same frequency and polarization.

Network engineers must provide broadband connectivity to moving platforms without causing, or being impacted by, adjacent satellite interference. The solution is spread spectrum technology. Spread spectrum is a satellite router feature that diffuses high rate signals by "spreading out" the transmissions to minimize the interference to adjacent satellites without limiting connectivity to the target satellite. Yet, this can come at high bandwidth cost.

Advancing this technology, ST Engineering iDirect has developed Direct Sequence Spread Spectrum (DSSS) over Adaptive TDMA (ATDMA). In DSSS, a pseudo noise code is added to the data stream at a given "chip" rate. The resulting data stream is modulated at a lower spectral density.

ATDMA ensures only one remote in the network transmits at a time. This means the total spread factor for a given network is a much lower rate than CDMA- or CRMA-based spread spectrum systems. ST Engineering iDirect's airborne units can support data rates up to 15 Msps, which is required to run video applications in a high-speed environment.

Waveform Enhancements

The ST Engineering iDirect platform features ATDMA as well as enhanced frequency and phase tracking of waveforms on inbound channels. More efficient Modulation and Coding (MODCOD) enables lower Signal-to-Noise Ratio for all MODCODs while also allowing for the introduction of new MODCODs. These two factors combined result in up to 40% bandwidth efficiency.

Superburst

With the introduction of ATDMA comes greatly improved acquisition, enabling up to five times faster remote acquisitions than current software releases. The introduction of this feature, called superburst, leads to significantly improved network entry times due to easier burst detection in lower Carrier-to-Noise (C/N) environments, as well as very high frequency offset tolerance.

Superburst is ideal for mobility applications, such as maritime or train applications, where the signal is frequently obscured and where frequent beam switching is an issue. It also allows for faster recovery when switching between networks in a geo-redundant hub configuration.

The Doppler Effect

The Doppler Effect is the change in frequency of a wave, as perceived by a receiving station, as either the transmitter or the receiver moves. Historically, the Doppler Effect in satellite transmission has been a secondary consideration arising from the satellite's motion in its station-keeping box. With high-speed COTM vehicles such as aircraft, the Doppler Effect has a great impact on the effectiveness of

demodulators. As aircraft travel at high speeds, our built-in Doppler Compensation features handle satellite frequency shifts to ensure seamless availability and performance.

Automatic Beam Switching

Military aircraft typically travel across multiple satellite beams. This presents an important service continuity challenge as an onboard remote must maintain a connection across these beams. ST Engineering iDirect handles this through a technology called Automatic Beam Switching (ABS).

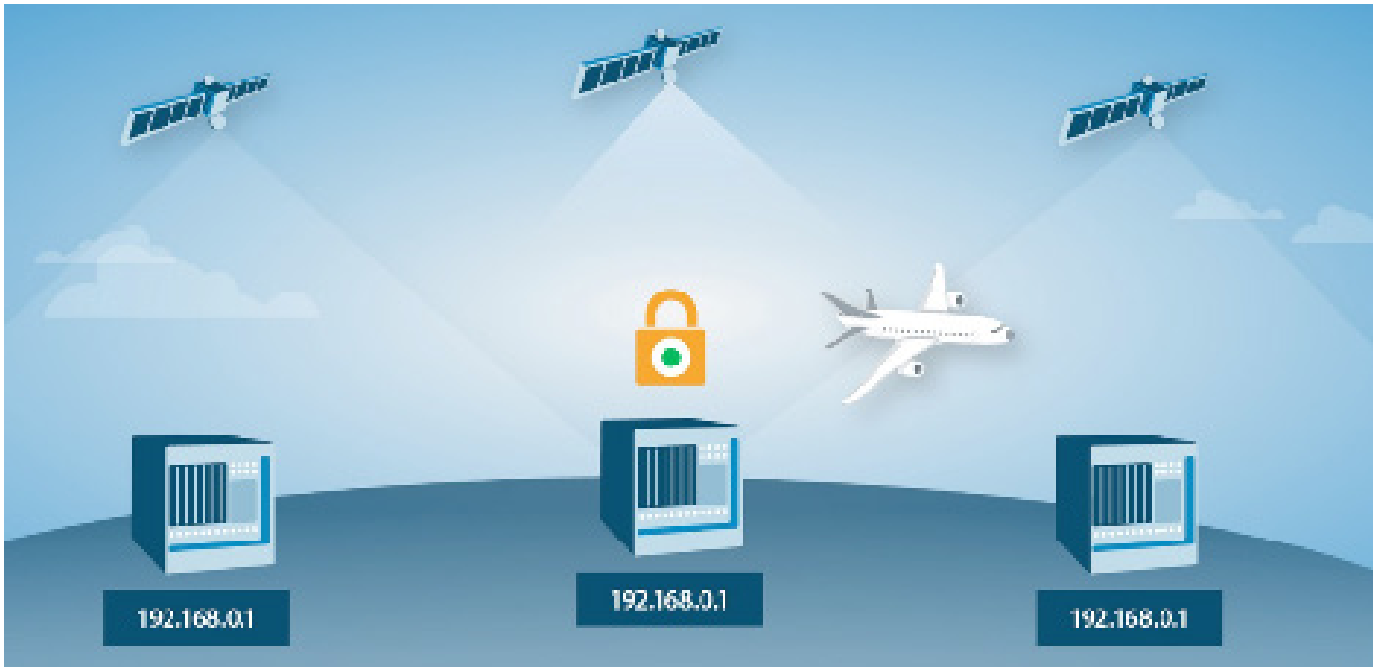
With ABS, our remotes can travel across satellite footprints and maintain seamless connectivity without the need for manual intervention. Through exact GPS positioning and constant data point comparison through files on the modem, the ST Engineering iDirect modem determines the best satellite coverage at any time. When it is determined that a travelling modem is reaching the beam edge, the router initiates an automatic repointing of the antenna and transfer of the connectivity to the new beam, enabling the continuous delivery of communication services.

Global Network Management

To achieve global coverage, airborne modems need to traverse networks on various transponders and satellites, controlled from a variety of hubs and networks. This poses a number of challenges for IP networks and Network Management Systems (NMS) regarding how to track and authenticate remote units, monitor service reliability and manage Service Level Agreements (SLAs).

To address this challenge, ST Engineering iDirect has developed a Global NMS, enabling network operators to monitor and manage each traveling remote, ensuring a consistent connection as it passes through separate networks around the world. Our Global NMS enables every remote to have a fixed global IP address and acquisition key for TRANSEC enabled networks. A remote can have multiple instances in different hubs, allowing for configuration differences across beams, including varying out-route

Automatic Beam Switching and Global NMS



On an ST Engineering iDirect network, an aircraft can travel seamlessly across multiple satellite beams. In Automatic Beam Switching, a persistent IP address and a global acquisition key enable secure global travel with minimal service interruptions.

and in-route sizes, as well as different Quality of Service (QoS) profiles. At the same time, the remote is uniquely identified when travelling around the globe, enabling secure travel with minimal service interruptions.

Facilitating Remote and Antenna Integration through OpenAMIP

A critical challenge for VSAT networks is manufacturers of VSAT infrastructure equipment being separate companies from those that produce stabilized VSAT antennas. This means that custom integration work may be required by a service provider or network integrator to ensure the components of a solution offered to a customer will work as designed.

To address this challenge, we developed the Open Antenna to Modem Interface Protocol (OpenAMIP) as an industry-wide, open-source standard for antenna-router integration. OpenAMIP facilitates the exchange of information between an Antenna Controller Unit and a satellite router, allowing the router to command the antenna without proprietary coding. We are antenna agnostic and work with all major stabilized VSAT manufacturers' products through OpenAMIP.

Our Open Architecture approach for antenna integration has been so successful, that ARINC adopted OpenAMIP and is incorporated as the antenna to satellite modem communications protocol in the ARINC 791 standard.

Meeting Military Security Standards

Security is a top priority for military operations. For mobile remotes on an IP satellite network, this means secure channel activity, control channel information, unit validation, physical security and data encryption. Militaries choosing our platform are assured that the content and size of all user and network link layer traffic is completely undetectable to adversaries, and all hardware is protected and tamper-evident. We are compliant with the highest level of security standards, including NSA-approved TRANSEC, and our routers and line cards are designed to meet FIPS 140-2 Level 3 validation.

Handling Diverse Data Rates

As militaries share mission critical information, it's imperative that any site on a network has sufficient bandwidth when needed. The ST Engineering iDirect platform is a shared, two-way Adaptive Time Division Multiple Access (ATDMA) system built to dynamically allocate bandwidth from a shared pool based on real-time usage requirements.

Conclusion

Airborne COTM provides a critical information advantage to military forces. And as troops withdraw with fewer boots on the ground, airborne surveillance will be even more pivotal to running safe, effective missions. ST Engineering iDirect has tackled the very challenging complexity associated with airborne COTM, while preserving the bandwidth efficiency, service reliability, security standards and network management that define the core ST Engineering iDirect platform.

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