ViaSat Mobile Satcom System

On-the-Move Broadband IP Access

On-the-Move Broadband IP Access for Moving Airborne, Ground, and Maritime Platforms

Enables regulatory-compliant operation over commercial Ku-band with very small antennas through:

- Spread spectrum waveform technology
- Powerful low-rate forward error correction
- Closed-loop power control
- Advanced network management
- Burst transmission control

Enables inexpensive mobile system solutions:

- Waveform design allows lower-cost antenna implementations
- Hub-spoke architecture

Maximizes data throughput and bandwidth efficiency through:

- Locally controlled blockage detection and burst transmission
- Rapid acquisition/reacquisition
- Shared IP network media access
- Innovative frequency reuse (PCMA) allowing forward and return links to operate simultaneously on the same bandwidth

Systems Fielded:

- SKYLink℠ business jet service
- KVH® TracPhone® V7 broadband at sea service
- C-130 Hatch-mount terminals

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On-the-move satellite communications demand the use of very small aperture antennas and superior technology to combat the effects of blockage between the mobile antenna and the satellite. By leveraging ViaSat's ArcLight waveform and network technology, ViaSat's Mobile Satcom system meets the needs of tactical users and delivers superior on-the-move broadband network access. The system is designed to lower the dynamic performance threshold required of the mobile terminals, allowing for lower-cost implementations.

A hub-spoke network topology is implemented, allowing greater allocation of the link budget to the challenging satellite-to-mobile link. This avoids the unnecessary complexity of adding a second satellite-mobile link as would be found in a mesh architecture (a lesson learned by the commercial VSAT industry long ago). The system uses a shared forward link (hub-to-mobile) architecture that allows the highest possible peak throughput to individual terminals. Efficient use of the spectrum is enabled through dynamic bandwidth resource allocation on the forward link. Use of powerful low-rate forward error correction allows even very small antennas to receive this shared IP "pipe" at data rates up to 10 Mbps*. At lower data rates into extremely small antennas (for example, less than 30 cm), the forward link is spread in order to comply with regulatory limits on power flux density.

Bandwidth efficiency is maximized by use of ViaSat's patented Paired Carrier Multiple Access (PCMA) frequency reuse technology, which allows the return links (mobile-to-hub) to simultaneously share the same bandwidth as the forward link. The use of this technique not only greatly increases bandwidth efficiency, but allows the return links to spread their energy across the satellite transponder. Also enables the use of very small aperture antennas, since the spreading makes it possible to meet regulatory (FCC/ITU) requirements for adjacent satellite interference (ASI). In addition to spreading, the system's return links use a ViaSat-patented access technique called Code Reuse Multiple Access (CRMA) which enables efficient transmission in the presence of intermittent blockages. CRMA allows each terminal to decide when to transmit without needing bandwidth assignment from the hub, enabling the mobile to transmit when there is no blockage and to inhibit transmission when blockage is present.

This burst transmission technique is needed for on-the-move operations, which inevitably encounter blockage. Because individual terminals do not transmit sufficient power to approach regulatory limits (and therefore require extremely precise pointing antennas), the technique also enables the use of lower-cost antennas.

The Mobile Satcom system is inherently scalable in a similar manner to all commercial bandwidth-on-demand VSAT networks, since the forward link is a shared medium transporting IP packets and the return link uses a multiple-access method designed to handle many simultaneous users. What is unique about this system is the CRMA spread ALOHA access method, which allows up to a certain number of overlapping transmissions in time and frequency (typically between 12 to 20 for full transponder operation at 512 Kbps, and roughly 2x that for 256 Kbps, 4x for 128 Kbps, and so on). Since IP data is typically bursty in nature for typical net-centric applications, the total number of nodes that can typically operate on the network is between 10 to 50 times the number of simultaneous transmissions allowed by regulatory constraints. Advanced network management ensures that regulatory constraints are met. Unlike MFTDMA network protocol, Mobile Satcom system users are free to transmit at-will as their own traffic and blockage conditions dictate, except when the network is highly loaded. This optimizes network efficiency and minimizes latency.

The Mobile Satcom System operates on moving platforms ranging from commercial SUVs to private yachts to jet aircraft to helicopters.

ViaSat's ArcLight technology overcomes the challenges of blocked signals caused by line-of-sight obstructions.

The system has been deployed in commercial Ku-band, and offers similar advantages in commercial X-band and Ka-band applications. Current Ku-band implementations of the system include ViaSat's Yonder℠, SKYLink by ARINC Direct℠, KVH TracPhone V7 maritime broadband service, and systems fielded by U.S. Government users.

* Like any satellite system, achievable data rates and network capacity depend on the mobile terminal performance, network objectives, and satellite parameters.

Mobile Terminals

The Mobile Satcom system is designed to work with a variety of mobile terminals including ground mobile (vehicular, rail), airborne (fixed or rotary wing), and maritime. The system also supports ultra-small fixed terminals (manpack, transportable) of similar aperture size. In addition, specialized terminal types can also accommodate very high return-link data rates for applications such as video uplinks (e.g., satellite news gathering) by reusing transponders already in use through our PCMA frequency reuse technique.

All terminals have similar "in-vehicle" equipment, consisting of the ArcLight satellite modem, power distribution system, and baseband equipment such as TCP accelerators and encryptors. Customer application-specific devices can be added as can baseband equipment to support specific user applications. Because the Mobile Satcom system acts like a cable-modem-type access device, all applications that will run on cable modems will also run on the system. All common network-centric applications, both commercial (e.g. email, web-surfing, VoIP) and military-specific (e.g. situational awareness applications, intelligence dissemination, secure voice, video, text-messaging) will run seamlessly as if they were connected to a wired or stationary network. Terminal types may differ in the outdoor, or "top-side," equipment, including the antenna, RF, and necessary pointing electronics (which in some cases may actually reside inside the vehicle).

The specific needs of the mobile platform application (as well as the user's needs) drive the antenna aperture and the type of pointing required. For example, airborne applications typically have inertial altitude information available from the aircraft, thus open-loop pointing algorithms are used. Operation above weather means that additional margin to handle rain attenuation is not needed; furthermore, blockage is not a typical concern. By contrast, a ground vehicle application is designed to accommodate rain attenuation and must handle blockage with fast acquisition/reacquisition and data buffering. However, inertial attitude information is not typically provided with the vehicle, so that feature is included in the top-side equipment.

The Mobile Satcom system is also ideally suited for small-craft maritime applications that cannot support large VSAT antennas. Many additional configurations for mobile terminals are possible. Contact ViaSat to discuss your specific requirements.

Hub Equipment

The Mobile Satcom system hub is similar in many ways to a standard hub-spoke VSAT hub, consisting of outdoor equipment (ODU; antenna, RF, IFL cabling and related components) and indoor equipment (IDU; ArcLight forward and return link modulators and demodulators, network and other baseband equipment). Standard indoor hub equipment consists of the hardware and software required to detect and receive the incoming return link signals, provide the forward link transmission, manage the network, and provide the interface to the network accessed. The indoor equipment also includes the PCMA hub canceller that enables the sharing of the forward and return links on the same bandwidth. The relative size of the indoor equipment is approximately one-half of a standard 6-foot equipment rack. Outdoor equipment typically consists of a 3.7m (or larger) antenna and RF equipment, with HPA sizing typically in the range of 80W or larger.

The system needs a relatively small hub antenna, since the link characteristics are dominated by the mobile-to-satellite transmission path. Typically, the indoor equipment terminates into either the Internet or a dedicated circuit backhauling the system into a private network, the NIPRNET, SIPRNET, or another closed customer-specified network. Encryption devices in the mobile terminals tunnel through the hub equipment and the backhaul in order to access these types of networks. As a result, data is secure and the hub location itself is just a transmission point in the path to access these networks.

Satellite access services can be provided by ViaSat or its partners using a dedicated or shared network. Alternatively, hub equipment may be purchased and operated by your organization.

SYSTEM SPECIFICATIONS

Forward Link Data Rate (Hub to Modem)	Communication rate up to 10 Mbps (30 Mbps by end 2009) • 500 Kbps to 1 Mbps in 100 Kbps steps • 1 Mbps to 3.5 Mbps in 250 Kbps steps • 3.5 Mbps to 10 Mbps in 500 Kbps steps
Return Link Burst Data Rate (Modem to Hub)	• 32, 64, 128, 256, 512, 1024 kbps communication burst rates • Single network can simultaneously support multiple burst rates
Forward Link Waveform	• Spread/unspread modes supported • Spread factors K={1…23} • Time-division multiplexed (TDM) IP data • (O)QPSK (BPSK data modulation) • SRRC Pulse shaping (alpha = 0.35)
Return Link Waveform	• Direct Sequence Spread Spectrum with spreading factor $4 \leq K \leq 150$ • ViaSat-patented CRMA spread ALOHA burst multiple access minimum latency, packets sent immediately upon arrival • GMSK spreading modulation (constant envelope waveform)
Forward Error Correction	• Forward Link: Turbo coding, rates 1/3 (upgradable to higher rates) • Return Link: r=1/3 Turbo coding
Minimum Required Eb/No	• Quasi-error free @ 1.7 dB (Forward r=1/3) • Quasi-error free @ 2.25 dB (Return)
Mobile Terminal IF Interface	• 2-channel L-band, Tx/Rx (950-2050 MHz) • 10 MHz reference, DC power multiplexed on IFL cable
Hub IF Interface	L-band
Mobile Terminal I/O interfaces	• User interface: 10/100BaseT Ethernet
Mobile Terminal Modem Form Factor	1U 19-inch rack mount or 1/2 ATR
Networking	• Internet Protocol • DHCP server embedded • NAT • TCP/HTTP Acceleration
Network/Modem Support	• ArcLight network management control • Over-the-air and local field software upgradable
Network Size	Over 100 nodes on a single 36-MHz transponder, depending on traffic profile
Encryption	HAIPE Type 1 or FIPS 140-2 Inline Network Encryption options

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