Maritime Network Solutions

February 2008

Abstract

The maritime market is primarily defined by four key application use areas; commercial shipping, cruise ships, offshore gas / oil exploration and development, and military. All of these markets have the same requirements for ubiquitous service independent of their vessels' locations. Commercial shipping of container, liquid, and bulk carrier deliveries require hemispheric or global coverage for office and crew communications. Cruise ships are focused on providing higher data rate services for their passengers with full Internet access and real-time interactive services such as VoIP and video. Offshore exploration and development require office communications with occasional bursts of large amounts of data gathered during exploration. Users within the military require higher data rate services for access to their online databases and synchronization between other departments and organizations within multiple regions.

The currently available low earth orbit (LEO) service available to these markets follows a usage-based price model for relatively modest bandwidth, resulting in fluctuating and extremely high operational expenses, making the estimation of monthly costs impossible or rendering users of the technology hesitant to use it.

The currently available geosynchronous earth orbit (GEO) Ku- or C-band satellite TDMA-based solutions require high initial and ongoing capital expense investments to launch and maintain services. These services are limited by the inherent drawbacks of using the TDMA technology with low-powered global satellites. Operating a TDMA-based platform within a mobile environment exacerbate the limitations of this solution.

In addition, the bandwidth requirements of the growing array of applications for this market no longer allow service providers to be able to offer a highly oversubscribed service, which is the key advantage of both the LEO and GEO TDMA solutions. These limitations with required services can have a secondary impact with the costs of staff retention, recruiting, and new employee training. Crews are now typically out to sea for months at a time with little or no port call ability. Internet access, telephone calls home, and video entertainment enable the ships to provide a better quality of life for the crew and thus lower these secondary costs.

Service providers are moving in the direction of offering a higher, "premium" level of service to remain competitive and differentiate their services from the many players providing best-effort services to the market. The Comtech EF Data solution allows a service provider to offer this premium level of service while keeping both capital expense and operating expense at a minimum.

Introduction

Comtech EF Data has developed Satellite On The Move (SOTM) technology that provides a method of global satellite coverage maintaining communications between different satellite transponders, beams, satellites and teleports within a Vipersat network. This method allows a shipboard satellite terminal to transition between satellite or hub coverage connections with minimal service interruption. The key components to this technology are hub and remote satellite modems, a stabilized mobile antenna system for tracking GEO satellites, a central management system maintaining the remote satellite network communication links, and a mobility controller that maintains the connectivity across multiple satellite service areas.

Though all of the unique considerations when deploying maritime solutions are addressed, the Comtech EF Data maritime solution is also designed to address any network requirement with a non-fixed endpoint. These include communications on the move, flyaway remote earth station platforms, and airborne applications, in addition to maritime. Services built on this solution can provide immediate network access at DSL data rates or higher.

The solution consists of a single platform that delivers seamless connectivity for all IP-based applications, including VoIP, video teleconference, file transfers, internet/intranet, and e-mail. It provides the ability to allocate bandwidth dynamically to mobile vessels based on traffic flow, including changes in the number

of types of applications being served. At the same time it is prioritizing by traffic types and maintaining roaming IP network connectivity.

Comtech EF Data can provide this cost saving solution by the company's strengths in all aspects of SCPC technology. Comtech's array of modulation and FEC methods allows the utilization of small aperture, low profile antennas that are desired due to mobile platform constraints. Our use of our SCPC technology minimizes the effects of Doppler shift that occurs with changes in the speed of a vessel while also allowing quick re-acquisition of the signal after a blockage condition occurs. Rounding out this solution is the automatic roaming function of the Vipersat product providing automatic and rapid beam-to-beam, satellite-to-satellite, or teleport-to-teleport transitions.

Desired Network Attributes

The maritime market has several desired network attributes for communication solutions:

- Service providers must be allowed to provide flat-rate services.

- Above-deck real estate constraints and pressure to reduce capital expense drive antenna size to a minimum.

- Global coverage considering that vessels are moving through multiple beams and satellites.

- A high level of network connectivity maintained with the highest availability possible regardless of where the vessel is located within a satellite footprint.

- Remote beam switching intelligence must be distributed to the vessels to eliminate a single point of failure.

- New high bandwidth and real-time interactive application services must be supported, such as full Internet access, VoIP telephone calls, video services, and vessel-to-vessel communications.

Comtech EF Data's maritime solution provides for these requirements with our existing bandwidth optimization and on-demand capabilities and enhances it with the addition of an integrated location server as the interface between the modems and the Antenna Control Unit (ACU).

Comtech EF Data Products for Maritime Network Solutions

Comtech EF Data's line of IP-enabled modem products and network control products provide the building blocks necessary to achieve a differentiated maritime solution. CEFD's family of IP-enabled modem products includes:

- Modems – the CDM-570 & SLM-5650

- Dual Demodulator – the CDD-562

- Quad Demodulator – the CDD-564

All are packaged in rack-mountable 1U enclosures. Each product is available in either L-Band or 70/140 Megahertz (MHz) and feature data rates from 2.4 kbps to 9.98 Mbps per second (the CDM-570), or up to 155Mbps (the SLM-5650 modem). These have fast acquisition, use second generation Turbo Product Coding (TPC) and a variety of modulation techniques. Featured modulation techniques include BPSK, QPSK, 8-PSK, 8-QAM and 16-QAM, with code rates spanning from Rate 5/16 through Rate 0.95. Designed with IP networking in mind, these robust products optimize satellite communications and provide many of the advanced features and data rates previously available only in higher-end modems.

Flexibility and cost-effective performance are integral to these offerings. The CDD-562L Dual Demodulator and CDD-564 and CDD-564L Quad Demodulators are ideally suited for star, partial mesh or full mesh topologies, reducing both the equipment cost and rack space requirements at the hub. All demodulators within a unit are fully programmable and independent. Each modem contains a high performance, feature-rich IP routing engine.

Vipersat Management System (VMS)

VMS is a feature-rich, capacity and network management system with an intuitive, user-friendly GUI and a high degree of configuration automation. VMS is designed to enable network administrators and satellite service providers to easily configure their networks and rapidly and effectively respond to network anomalies. Much more than just a network monitor and control platform, VMS automates the carrier switching and spectrum management processes within the satellite network. These capabilities allow SCPC carriers to be resized automatically based on a variety of user-defined policies, providing on-demand services and unparalleled space segment savings.

For the mobility market, the VMS topology display of the managed system has been enhanced with a 3D globe view of the network, Figure 1. Globe view displays the real-time status and operation of the network dynamically. Satellite terminals are automatically populated onto the global network and their location, heading, and actual movements are dynamically tracked and displayed on the globe map. The globe map display size, terminal location, rotation, and lighting source are customizable by the operator.

Some customers may not want the location of their remote sites to be transmitted over the network. For this reason we have made it an optional feature, so that location information can be suppressed.
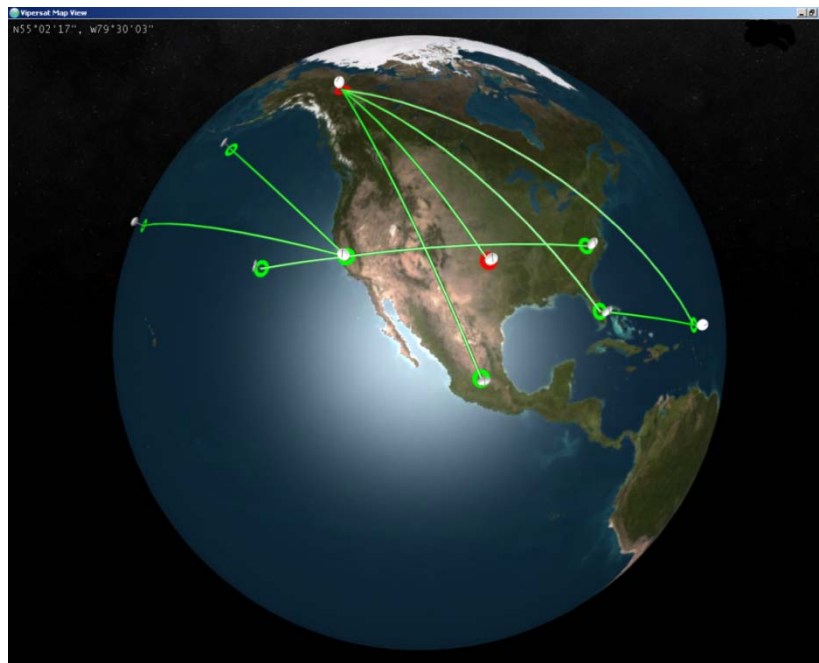

Figure 1: VMS Globe view of network topology

Key features of the VMS include:

- Centralized network and capacity management
- Dynamic SCPC (dSCPC) carrier allocation and true bandwidth on-demand capability
- Automation of space segment capacity efficiencies

- User-defined policies for upstream carrier switching
- Star and mesh capabilities using Dynamic Mesh
- Redundancy configurations for hub and remote hardware
- Use of higher order modulation and Forward Error Correction (FEC) techniques
- Site distribution list in multi-point automatic policy-based switching for IP multicast and mesh topologies
- Switching protocol enabling external messaging to switch carriers to multi-point destinations
- Operates over multiple transponders and satellites
- Scalable from small to large networks
- Auto detection of new nodes
- Detailed event logs able to be filtered and exported
- Ability to generate SNMP traps can be forwarded to hierarchal NMS management platforms
- Complete IP based digital services over satellite

Roaming Oceanic Satellite Server (ROSS)

The Roaming Oceanic Satellite Server (ROSS) is an integrated location server that works in conjunction with our Vipersat Management System (VMS) to facilitate on-the-move satellite communications for oceanic vessels or other mobile platforms. ROSS enables remote modems to interface with stabilized, auto-tracking antennas, maintaining connectivity as vessels move through footprints of different satellites. Vessel position data, satellite signal and management status are constantly monitored to determine when satellite handoff is necessary. It is important to note that this decision is made by the vessel and not by a map server located at a central site. This significantly increases the availability of a service in two ways. First, a solution that requires a centrally located server to make a beam switch decision for a remote inserts a single point of failure. Should this server go down, all remotes will eventually lose synchronization, possibly in as little as 4 hours at maritime vessel speed. A remote that is intelligent enough to make its own beam switching decisions does not suffer from this "dead server" since it maintains this information locally. Second, under blockage conditions, either due to link fade or physical obstruction, remotes lose communications with the central site. The modem itself may not understand the reason for blocking and therefore may re-point to a different satellite inadvertently.

ROSS stores the operational and configuration information on-board remote terminals, including satellite footprint maps, shoreline contour vector maps, exclusion areas, link budget information, multiple modem configurations and other administrative information. ROSS is implemented in the remote terminals in a fully distributed architecture, eliminating a potential single point of failure in the mobility system. It is the ideal complement to Comtech EF Data's Vipersat Management System and bandwidth-efficient modems. Key features of the ROSS include:

- Link budget mapping
- World vector shoreline database
- Antenna Control Unit interface
- Event log capable of storing system events identified with category type and time stamp
- Tracking log capable of storing 450+ days of vessel position, frequency, transmit status, data rates, and modulation

The ROSS server operates as an intermediary device between the Satellite Modem and ACU subsystem. Its primary role is to poll information from third party devices, determine the current location and push the appropriate command files setting of new communications parameters. The ROSS unit communicates to modem and ACU/PCU on an Ethernet LAN interface connection using SNMP or proprietary IP protocols. Each unit's IP address is programmed into ROSS starting a poll process that gathers location, status and current configurations. As each unit responds to the queried messages, the ROSS compares the received information to set database files making decisions to mute carrier, change service area or continue to operate without interruption within the current service area.

The ROSS hosts a set of configuration, database, and map files that are used for controlling satellite communications for the local remote terminal. This data provides the required reference points for managing satellite handoff operations and for enabling/disabling the remote modem transmitter. Shoreline boundaries provide a demarcation point for muting the modem transmitter to prevent potential interference with fixed terrestrial systems. This Coordinated Area Map (CAM) can be updated either over the satellite, or locally.

Service Areas are fundamental to the overall operation of ROSS logic as they contain control logic and are associated to three separate database/configuration files. Each service area is configured with ACU set controls and linked to a modem parameter file, which are bound together through geographical operational binding. The third element is the coordination area(s) that is referenced and used by all service areas. The overall binding is geographical longitude/latitude coordinates combined to create a closed polygon that in turn forms an operational area or handoff boundary. Through the polling of coordinate (GPS) information from the ACU/PCU the ROSS process hundreds of checks per minute, first against the contour (Shoreline) database, second against coordination areas, and third against the current service area. If anyone or all represent a change of shoreline, coordinated or service area, the ROSS initiates the proper action.

The Service Area as previously described is the foundation of each sublevel component. It is comprised of all the elements necessary to calculate coordinates, determine operational or non-operational areas pushing updates and controls to transmission equipment. Simply described, it is a container holding the necessary pieces to construct the transmission configurations. Each unique service area with associated files is generated through uploaded information from the ROSS configuration editor. The editor consolidates database elements into a single structure that is uploaded to the ROSS file manger. The file manger labels each file element through logical renaming appending each with the same sequential number grouping them all into a service area. As an example, the ACU command information sets the base reference with modem configuration file and Service Boundaries added to the group. The service area number is irrelevant to the user as it is assigned at the time of reception during uploads to ROSS. The number assignment is only relevant to ROSS as grouped database information.

The ROSS server has multiple communications paths for configuration management. These connection paths can be established locally via RS-232, LAN-based or over the satellite transmission link. All access the same application interface that provides menu driven configurations and upload/download exchange of parameter files. The ROSS client connections are accessed by an open source Telnet application, configurable for serial or LAN-based IP communications. It is a small, Windows-based application that provides a user-friendly graphical user interface that establishes local connections to the ROSS.

Conclusion
Comtech EF Data's maritime solution is a new option for satellite service providers with customers in the maritime industry or that have mobile platform requirements. As a service provider you are faced with delivering communications to ships that are transiting between satellite or hub coverage connections and doing so with minimal service interruption. Comtech EF Data's maritime network solution provides unique benefits in combining the best satellite network efficiency optimizations with an enhanced integrated location server for continuous communications to and between remote vessels on the move.

The office environment is extended enabling seamless connectivity between applications like telephone calls, Internet access, video entertainment, data communications, streaming video, web surfing, etc.. There are multiple modulation and FEC rates available allowing users to choose the best fit between bandwidth, data rate, and mod/FEC rates to maintain communications when the vessel is at the edge of a satellite footprint. The use of dynamically managed SCPC (dSCPC) links provides low latency and low jitter connections for real-time applications such as VoIP and VTC. Bandwidth is automatically provided based on application, load, QoS rule, schedule, or manual set-up.

The intelligence required to make these decisions is distributed to the remote sites facilitating a faster decision making process. The remotes can operate independently of the hub resources thus eliminating any single point of failure.

End users benefit from Comtech EF Data's maritime solution from its ease of use in not requiring manual satellite handoff coordination. Remote vessels can experience greatly reduced standard satellite equipment size and the corresponding required real estate. In addition, operating expenses and capital expenses have substantial savings realized through the use of the Comtech EF Data mobility solution when compared with TDMA solutions. Enhanced reliability and quality of the service offerings can limit the need for any oversubscription requirements as well.

The net result of utilizing Comtech EF Data's maritime network solution is realized by service operators and their customers by the ability to launch new enhanced high bandwidth services across all of their service regions, while simultaneously reducing network capital expense and operating expense when compared to other solutions previously available.

Additional Resources
Related White Papers from the Comtech EF Data Web site:

- "Solutions for Flexible, Efficient and Secure Satellite-based IP Networks"
- "Implementing Satellite VoIP Network"
- "Optimizing Cellular Solutions"

Please contact Comtech EF Data Sales for more information about this innovative technology.

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