

**Maritime VSAT
Communications Solutions**

June 2010

Advancing a Connected World



Introduction

Across the maritime industry, there is a growing trend toward IP-based applications and a need to stay connected with land-based operations. Commercial vessels require high-speed connections to run onboard business, maintain vessel management and maintenance applications as well as provide their crew Internet and VoIP connectivity to retain their talents.

For years, narrowband L-Band services with usage-based plans were the only communication solution onboard vessels forcing expensive tradeoffs and inadequate connectivity. In recent years, VSAT technologies more adequately addressed the demand for always-on broadband access and, as a result, have been adopted rapidly -- fueled by reduced antenna prices and sizes.

Particularly shared bandwidth platforms are in high demand, providing an affordable, yet reliable service, which is critical in a market dominated by small- to mid-sized fleets.

This whitepaper takes a closer look at how technology advances in the maritime VSAT industry can help service providers offer high-speed, affordable broadband service at sea for the needs of today's vessel operators, shipping lines and yacht owners.

1. Bandwidth Efficiencies

Traditionally, transporting voice and data services over VSAT has been provided through Single Channel Per Carrier (SCPC) technology creating a continuously connected environment similar to a dedicated private line circuit. Using SCPC to support high-speed, enterprise-grade connectivity onboard the ship can be costly and inefficient since each connection needs to be over-dimensioned to guarantee reliable connectivity even in worst-case scenarios. By comparison, IP-based Time Division Multiple Access (TDMA) systems dynamically allocate bandwidth to each ship over a shared platform, significantly reducing the required satellite bandwidth without compromising quality.

The iDirect system incorporates a very efficient form of TDMA, called Multi-Frequency (MF), deterministic TDMA (D-TDMA), which allows multiple ships to share the same inbound capacity. This industry-leading MF D-TDMA protocol guarantees fast response times and is known for the dynamic nature in which a network can be designed to meet a variety of service level agreements (SLAs). The iDirect system allocates bandwidth to each site based on traffic demand and service provider-imposed QoS restrictions. The system constantly analyzes demand at all satellite routers and allocates bandwidth as frequently as eight times per second. This type of architecture is ideal for networks that have bursty TCP/IP traffic and which also support real-time traffic such as VoIP, video conferencing and mission critical applications that securely link the onboard communications network with the

shipping company's terrestrial IP network.

The iDirect system allows remotes to hop between inbound channels based on traffic demand. iDirect's MF-TDMA provides fast frequency hopping on a burst-by-burst basis and provides the highest efficiency in capacity usage and allocation.

iDirect was one of the pioneers of Turbo Product Coding (TPC), a forward error correction (FEC) scheme for the inbound/return channel that improves link performance and reduces latency. TPC FEC is based on an iterative decoding technique, which recycles partially decoded messages through the process. For the remote, this translates into a reduced need for retransmission, and allows for more efficient use of satellite bandwidth. The wide range of FEC options iDirect supports also allows service providers to keep antenna sizes onboard the ships to a minimum and guarantee availability and bandwidth efficiency regardless of the ship's location within the satellite beam.

For very large scale networks service providers can take advantage of even more efficient bandwidth technologies such as iDirect's DVB-S2 with Adaptive Coding and Modulation (ACM). DVB-S2 uses a new forward-error coding technology, Low-Density Parity-check Codes (LDPC) coupled with BCH coding resulting in over 30% bandwidth efficiency improvements over DVB-S. The DVB-S2 standard also incorporates new modulation and FEC schemes, supporting QPSK, 8PSK and 16APSK modulations on the DVB-S2 downstream and ACM. iDirect's ACM enables each ship's router to operate at its most efficient coding and modulation scheme, at any time, depending on location within the satellite beam and weather conditions resulting in additional bandwidth efficiencies.

2. Guaranteed High Quality of Service

Vessel operators need access to broadband IP applications to run their operations more efficiently and to seamlessly connect ships to shore, extending the shipping lines terrestrial IP network to the high seas. With VSAT connectivity, shipping lines can support a range of communication needs. Crew can use Web, e-mail and phone to stay close with friends and family, manage personal affairs and enjoy entertainment content. Vessels become mobile offices with VPNs covering entire fleets and supporting business applications such as cargo and inventory logistics. Ship operations benefit from instant communications with technicians, vendors and other skilled workers to address issues in real-time.

Integrated VSAT Broadband Communications



Crew Communications

- Always-on, broadband Internet
- Cellular service and VoIP
- Online training
- Telemedicine
- Streaming video

Vessel Management

- Condition monitoring
- IT remote management
- Engine and operational data exchange
- Online supply and repair orders

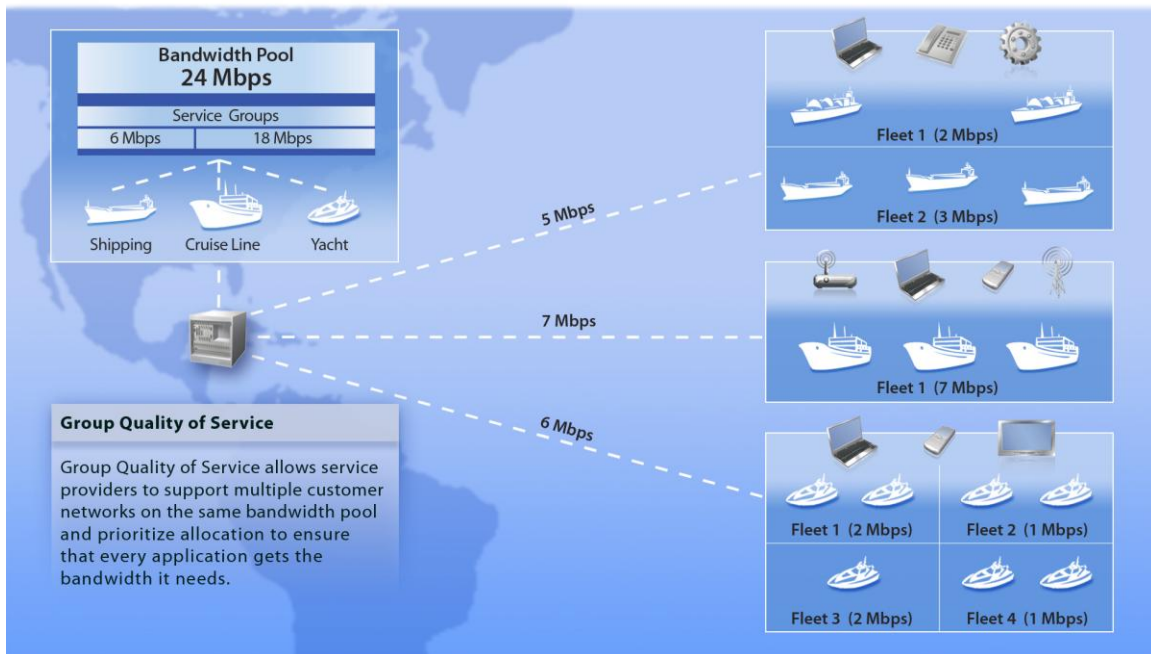
IP Enabled Bridge

- Common LAN infrastructure
- Real-time business applications
- Corporate voice and video Conferencing
- Electronic navigation/ECDIS

iDIRECT

Because of the dynamic nature of shared platforms, the challenge for service providers is to manage the traffic prioritization of these different applications in order to guarantee a reliable service. Within the iDirect platform, service providers can assign Committed Information Rates (CIR), a Minimum Information Rate and a Maximum Information Rate to each ship. The Maximum Information Rate is to be shared amongst all other ships on the network; this allows for a very cost-effective solution at the remote site without compromising quality and availability.

Group Quality of Service (GQoS), iDirect's award-winning bandwidth allocation algorithm, allows for countless possibilities of service levels, bandwidth management and traffic prioritization. GQoS enables the construction of very sophisticated allocation models and allows service providers to segment the bandwidth pool into distinct bandwidth groups to support multiple shipping fleets each with separate CIRs, MIRs and contention ratios. Service providers can establish customized Service Level Agreements (SLAs) across different fleets and even tailor them to the real-time needs of individual applications onboard. To the service provider the advantages of shared bandwidth result in more space segment savings and cost efficiencies on dedicated line cards, RF power and antenna sizes onboard the ship.



Support for real-time applications

In addition to sophisticated QoS profiles there are other factors that improve quality of real-time applications. Providing toll-quality VoIP in a satellite environment can be challenging when faced with latency and jitter. Latency of geostationary satellites is fixed with a one-way propagation delay of 280 msec. Jitter, the variation of delayed packet arrival, is in strong correlation with insufficient bandwidth and results in degradation of voice quality. When a network system allocates bandwidth to a ship's remote to support a voice call, if the allocated timeslots are contiguous, the voice packets will arrive at the hub in batches creating an environment conducive to jitter. iDirect overcomes this problem by supporting feathering. iDirect's feathering feature significantly reduces jitter between voice packets by evenly spacing timeslots across a frame.

iDirect's solution is ideally suited for delivering high quality VoIP and cellular applications since it can deliver Bit-Error-Rates (BER), the quality measure of voice quality, of better than 10^{-9} , which is considered clear channel transmission.

Other features like SAR, Dynamic CIR, application-triggered CIR and VLAN tagging are also important when designing QoS prioritization for real-time traffic handling. SAR divides packets of varying sizes into equal sized cells, whereas Dynamic CIR can be dynamically controlled. Application-triggered CIR is dedicated bandwidth allocated to the ship's router only when voice traffic is present.

Support for end-to-end VLANs (802.1Q) or VLAN tagging allows for improved performance and flexible network segmentation by enabling the prioritization of sensitive packets over other applications onboard. Since each iDirect router can have multiple VLAN IDs associated with it, important voice calls from the bridge can be prioritized over private voice calls from the crew.

Support for non real-time applications

Just like real-time applications, non-real time applications such as Web browsing can also suffer under satellite latency, leading to inefficient retransmissions and longer download times. To improve the Web performance for the end-user, iDirect uses TCP acceleration built into the hub and routers to mitigate the effects of satellite latency while guaranteeing packet delivery in the event of data corruption or loss. TCP acceleration performs this task by buffering packets in the outbound and inbound direction supporting a highly responsive network of web applications.

For heavy Web browsing applications, iDirect features additional Web acceleration for a variety of traffic including HTTP, AJAX, and XML applications, through built-in Acceleration-on-Demand technologies. These technologies deliver improved response time and bandwidth utilization while reducing data loads and providing end-to-end data security.

Support for secure applications

An important feature for business applications and data sharing in the shipping industry is the ability to guarantee highly secure links. Therefore, it is important that the system allows for encryption of sensitive information on both transmit and receive. The industry standard of secure data transmission is the Advanced Encryption Standard (AES) that uses algorithms in symmetric key cryptography. iDirect AES Encryption comes with fast, dynamic key exchange of 256-bit providing a very high level of security within the network, without compromising acceleration performed on TCP traffic within the link. This is unlike other IPsec architectures that defeat TCP acceleration and thus are subject to severe throughput issues.

For military grade security iDirect has implemented TRANSEC and high encryption with FIPS 140-2 certification on its product line as well. TRANSEC is a military-grade transmission security standard that prevents an adversary from exploiting information in the dynamic data exchange between a hub and a remote.

VLAN's can also be used to improve the network security by serving as a logical boundary that locks out intruders. Another form of data security is the encryption through GRE tunneling. GRE tunnels are designed to encapsulate a wide variety of network layer packets inside the IP tunneling packets. It is used to secure Virtual Private Networks (VPNs), creating a virtual point-to-point link with routers at remote points.

If the organization needs to use external encryption for any security reason, iDirect's external Network Accelerator product line allows a network to use their own external encryption and security devices, while at the same time providing TCP/HTTP acceleration and Application QoS. The iDirect Network Accelerator product line provides line rate throughputs on TCP and HTTP performance.

3. Scalable Network Expansion

The iDirect solution provides one of the most scalable, flexible and bandwidth-efficient two-way IP broadband network solutions in the industry. iDirect enables service providers to operate on multiple satellites, multiple transponders and multiple topologies simultaneously, allowing them to flexibly build a network by adding new line cards and remote satellite routers as business scales. Space segment can be added gradually, starting with data rates as small as 128 kbps, and does not need to be contiguous, leaving maximum flexibility in a bandwidth-constrained satellite market.

The flexibility and scalability of the iDirect product line allows the service provider to deploy tailored topologies and configurations to support the specific needs of different maritime segments. iDirect's wide range of FECs and modulations provide more options to service providers when designing their networks with line cards, routers and antennas. Specifically, when targeting the smaller vessel market and super-yachts, small antenna sizes are critical. Service providers can keep antenna sizes to a minimum by taking advantage of the various FEC options iDirect supports, ranging from the robust 0.495 FEC to the more efficient 0.879 FEC. Furthermore, the various modulation options, including 16APSK with DVB-S2, BPSK and Spread Spectrum, also allow for a cost-effective network design with very small antennas. The Spread Spectrum is a new waveform that enables the spreading of the carrier signal so that during transmission and receiving the power levels of very small antennas do not cause satellite interference with adjacent satellites.

For service providers looking to launch a maritime broadband service with minimal upfront investment in infrastructure, a highly scalable approach is iDirect's Virtual Network Operator (VNO) model. This model allows service providers to lease hub space from existing hub operators, Host Network Operators (HNO). With a VNO access license, service providers have full control over their networks and remotes through their own dedicated Network Management System (NMS). For hub owners this feature is advantageous since it allows them to expand business and accelerate return on investment through hosting capabilities.

4. Ease of Network Management

Because of the challenges of managing a large fleet of remotes that are inaccessible at most times, service providers need a management system that will configure, upgrade and monitor the health of the ship's communication services at all times. iDirect's iVantage Network Management System (NMS) is a complete suite of easy to use tools for monitoring, configuring and control of the entire satellite network from one central place. Service providers can rapidly create networks of any size with automated and semi-automated tools and can upgrade networks automatically without site visits. Service providers gain in-depth views into both real-time and historical performance of the network, including the health status of any remote with details on temperature, uptime, LAN port status and transmit power. Furthermore, it naturally anticipates potential network outages with automatic alerts and warnings that minimize troubleshooting time or could avoid network downtime.

Another powerful tool for network monitoring is a spectrum analyzer, useful for instant monitoring and troubleshooting. iDirect's SkyMonitor is a fully integrated spectrum analyzer integrated with iVantage. It can monitor multiple satellite carriers through up to eight always-connected L-band interfaces. Service providers can easily view the real-time spectrum of transmit and receive carriers and also connect SkyMonitor ports to display non-iDirect hub carriers within the same teleport. A powerful record and store capability creates a file containing a spectral display for post analysis. When used in conjunction with iMonitor standard features, SkyMonitor allows a network operator or engineer simultaneous analysis of RF and IP layers for improved troubleshooting capabilities.

5. Global Network Management with Seamless Coverage

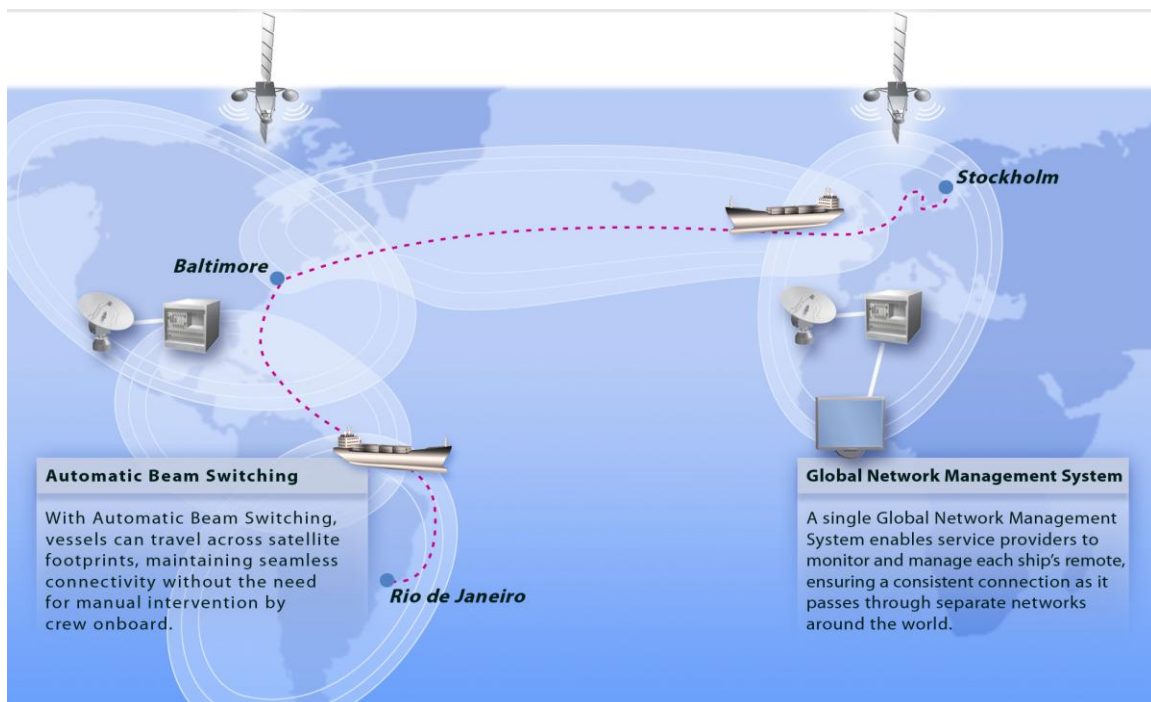
For multi-regional, seasonal and global shipping lines such as cargo vessels, cruises and yachts, global connectivity and seamless coverage are a critical driver. Customers want to rely on the same user experience they would get from traditional landline networks without the geographic constraints. Providing global coverage requires a seamless operation of several C- or Ku-Band beams, multiple hubs and teleports. iDirect has developed several features that allow service providers to manage a global network delivering to their customers seamless and effortless global connectivity.

Global NMS

In a scenario where the ship's course crosses several satellite beams, networks, teleports and hubs, the remote on the ship can be managed by one Global Network Management System (NMS). Global NMS allows service providers to monitor and manage each ship's remote from a single location, ensuring a consistent connection as it passes through separate networks around the world. This is made possible because Global NMS allows every remote to have multiple instances in hubs and teleports around the globe, but identified by a fixed global IP address.

Automatic Beam Selection

Whether in a Ku-Band or C-Band network, multiple regions means using multiple satellite beams are required to provide continuous coverage to the ship. In the past when a satellite beam switch is imminent, intervention from the NOC or an onboard technician was required to manually re-point the antenna to acquire the new satellite beam and to make the router tune to a new outbound carrier. iDirect's Automatic Beam Switching (ABS) eliminates the need for manual intervention. The ship's router reads the current location from the antenna's GPS and decides what beam will provide optimal performance for that location based on the map server information located at the hub. The beam map file is a large data file containing beam quality information for each point on the earth's surface. Depending on signal quality and location, the router either will remain in the current beam or automatically switch to a higher quality beam. The fact that the router (and not the NMS) selects a beam is critical because the router must be able to select a beam even if it is not communicating with the network. With ABS there will be no intervention necessary from the ship or the Network Operation Center (NOC), to allow the continuous delivery of communication services around the globe.



Location Tracking

The web-based Location Tracking package available with SatManage supports real-time tracking of all remotes worldwide on an easy and powerful graphical mapping system. The Location Tracker shows precise location and summary data for individual mobile assets or entire groups or fleets of remotes. The color-coded health status of individual remotes and exact location and heading of the terminals can be checked at regular intervals. Through pop-up windows, all live and historical indicators, including lat/long data, Radio Frequency (RF) and IP performance is displayed. Available in both 2D and 3D interactive versions, the location tracker allows for real-time overlay of external data sources including weather, radar, roadmap, satellite footprint, imagery or other custom overlays. Also, the module has a built-in database that displays out-of-transmission coastal or embargo areas. When a mobile VSAT terminal enters one of these areas the Location Tracker will raise a variety of alerts. The Location Tracker allows a real-time snapshot of the health, status and exact location of each remote. This simplifies the control of the customer's mobile assets.



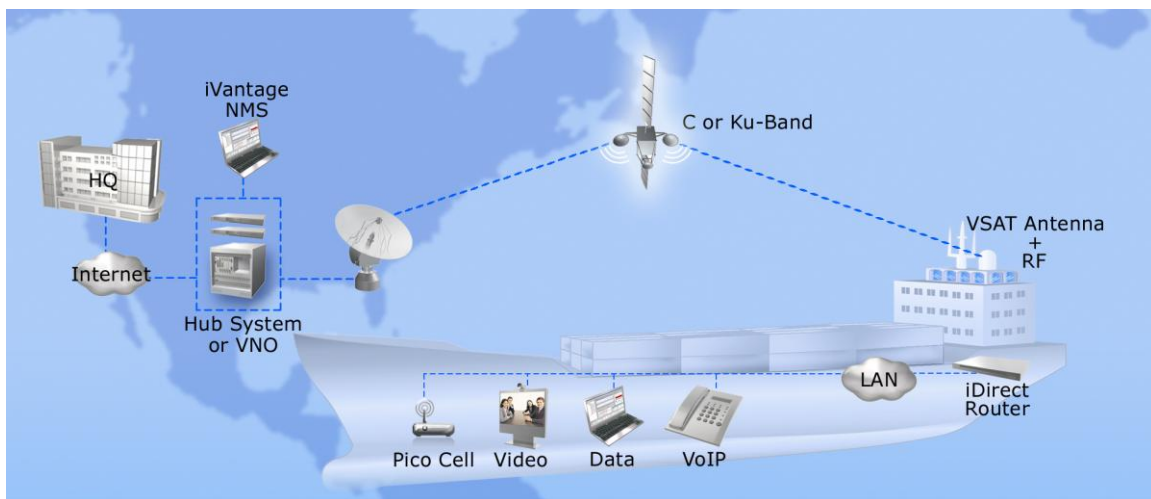
Multi-Homing

The Multi-homing system provides users with the ability to seamlessly track remotes to readily identify problems. The Multi-homing system displays a unified view of a remote's performance data regardless of which network the remote currently resides. As a result, each remote has a complete history of reports which simplifies issue tracking for beam switches and multiple network configuration conflicts. The Multi-homing system eases fault finding for highly mobile remotes. This lends to reduced downtimes, improved overall performance, and cost savings.

6. VSAT Maritime Equipment

VSAT systems on a vessel consist of a remote router connected to a stabilized VSAT antenna. The antenna connects to the teleport, hub and backbone onshore via C- or Ku-band. In an iDirect network, the hub consists of a universal hub chassis and individual line cards that can be added as business grows. iVantage, iDirect's NMS, controls the entire network from a single location.

Onboard the ship the below-deck equipment typically consists of an iDirect Evolution X5 Router or an iNFINITI 5000 Series Router equipped with an eight-port switch and GPS input. The iNFINITI 5000 Series Router connects to the ship's LAN enabling VoIP, cellular, data and video applications. Which model is the correct fit depends on the exact customer requirements and network design.



Antenna Agnostic

iDirect's platform works well with the majority of the stabilized antenna systems, therefore the service provider can choose any antenna model.

However, when implementing Automatic Beam Switching (ABS) the antenna needs to have additional features in order to ensure that the iDirect router is able to control the antenna for automatic re-pointing. The antenna system, more specifically the antenna control unit (ACU), must work well with iDirect's interfaces such as hardware flow control and GPS input in order to communicate with the iDirect router over the local LAN.

In order to standardize the communication between the ship's router and the antenna's ACU, iDirect has developed an open-source standard called OpenAMIP that several antenna manufacturers are integrating as part of their antenna system. All ACU's that have adopted the OpenAMIP standard are guaranteed to work with iDirect's Automatic Beam Switching feature.

Conclusion

The number of vessels enabled with VSAT technology will increase by more than 400 percent through 2012, according to the Comsys Maritime VSAT Report and, as the market leader in maritime TDMA networks, iDirect is helping spur this growth. The many submarkets all have different needs ranging from large office bandwidth applications in the global seas to supporting ultra-small antennas on regional super yachts and increased passenger cellular traffic on cruise ships. Service providers need to offer cost-efficient services with customized SLA's and seamless coverage. Whatever the operational challenges that are faced, iDirect's scalable platform and advanced maritime features enable regional and global service providers of all sizes overcome these challenges and capitalize on the growing opportunities in the maritime industry.