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From Inmarsat to broadband:

Developments within maritime communication

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Ten years ago only the most modern and forward thinking shipping companies equipped their vessels with PC to handle certain functions on board. Computers were often part of systems such as stock keeping, crew accounting, maintenance systems etc. Very few vessels, particularly in small and medium sized shipping companies, were equipped.

Today one can find PC's, often in networks, on board virtually any kind of vessels, from fishing vessels to VLCC. They are used for ships and crew accounting, purchasing, stock control, maintenance planning and voyage planning. Another prime use of PC's are in connection with communication between ship and shore.

The ongoing trend with increasingly larger and more sophisticated vessels – operated by smaller crews having to comply with an ever increasing amount of rules, regulations and requests for information and records introduced by Administrations, charterers, owners and ship managers – are forcing the shipping industry to introduce computer based systems on board their ships.

New systems for communication and information exchange, at continuously lower charges, are also fuelling the demand for more information.

When Inmarsat, the main mobile satellite communication provider was established 26

years ago, they were the only satellite communication provider available for commercial shipping. Today they are challenged by a number of new operators and service providers, both global and regional offering both terrestrial and satellite communication.

"Maritime users have grown increasingly sophisticated in their use of available communication facilities.

During the same time period, maritime users in particular have grown increasingly sophisticated in their use of available communication facilities. In the early days of Inmarsat, telegrams over HF and MF radio were still common, charged at roughly USD 0.80–1.00 per word.

To keep up with the continuous growing demand for more bandwidth and higher data rates, Inmarsat has now launched a fourth generation of satellites capable of delivering almost 500 Kbits on demand or packet switching services.

Constantly increasing speed

Over the last fifteen years Inmarsat have been facing growing competition from VSAT (Very Small Aperture Terminal) operators, usually providing data speeds up to 2 megabit per second in the forward direction and 0,5 megabit in the return direction.

In the early days the service was based on C-band followed by Ku-band. There is now also a pre-commercial service available via the Ka-band (20–30 Ghz) offering data speeds up to 45 Mbps.

As a result, an absolute majority of all communication to and from cruise vessels, seismic vessels and offshore installations are handled through VSAT and there are now 50–60 large and small VSAT providers competing for customers with all sorts of vessels from relatively small yachts up to large cruise vessels.

A growing number of satellites, with multiple beams also covering large parts of the oceans, are forcing the prices down to levels clearly competitive to Inmarsat. USD 2,000 per month for a continuos 128 Kbps DAMA (Demand Assigned Multiple Access)

The SeaTel 4006 antenna.

channel is roughly the present rate. This capacity is then often divided into several 8 Kbps voice channels and one larger data channel forming part of a WAN (Wide Area Network) for Intranet access between the head office and other ships in the fleet. The cost of hardware for a VSAT system, around USD 100,000 including installation, is the main threshold for many shipping companies. However, recent studies performed for some major shipping companies has shown that such investment could easily be recuperated, in savings on communication cost, over a 3–5 year period.

In the other end of the spectrum satellite service providers such as Iridium and Thuraya are starting to offer services competing strongly with Inmarsat and are now also coming up with broadband services at speeds between 128 Kbps and 500 Kbps. Iridium with its global coverage is launching a new terminal called Open Port at Q3 this year and Thuraya with its improved coverage with its third satellite is soon to launch a service with speeds up to almost 500 Kbps.

Present and future maritime communication systems make it feasible and cost-effective to fully integrate the daily operation of a shipping company and its ships. The integration may be in the form of a WAN including multimedia communication, such as live video transmission, high quality voice and real-time sharing of computer applications both within the company and as part of a wider network of suppliers, classification societies, Administrations and Authorities. An added, and probably necessary, advantage will be full accessibility to TV, voice and data communication for the seafarers.

These rapid developments in combination with increased operational, safety and social communication requirements are driving the international shipping community to increasingly look for IT solutions, supported by present and new communication services.

Many shipping companies are now planning to introduce onboard computerisation both for ship operation and to meet mandatory reporting requirements.

Many shipowners today are spending far to much time and efforts in trying to compare and value the cost of different maritime communication systems, instead they ought to concentrate much more on the applications they are planning to use over the broader bandwidths they have in mind.

Developments with Telemar Scandinavia

When Telemar Scandinavia installed the first maritime broadband system onboard an ordinary cargo vessel, MS Bro Atland, in the Broström fleet in September 2004, another milestone in the area of maritime communication was reached. Until then mainly cruise vessels, large ferries, offshore rigs and naval vessels where among the main users with the earliest adopters fitting vessels already around the mid 1980's and many wise men in the shipping industry really thought that broadband onboard an ordinary cargo vessel was taking it to far. This is still the situation in many shipping nations around the world, while we here in Sweden already have almost 150 vessels already fitted with either Ku- or C-band antennas for broadband access at sea world wide.

The engineers and Management of Telemar Scandinavia gained their first VSAT experiences already ten years ago in a joint operation with ViaSat Inc, when they equipped ten vessels in the Star Cruises fleet with C-band antennas from SeaTel.

By the end of 2007 more than 3,000 vessels world wide were equipped with maritime broadband with VSAT systems on board operating via a wide range of Ku- and C-band satellites. Another 150 vessels of all sizes and occupations are now being equipped every month.

The generic name for these kinds of installations is VSAT, meaning Very Small Aperture Terminal, and that really just describes the comparatively small antenna. The use of VSAT around the globe is a fairly mature technique developed and introduced in the middle of the 1970's, roughly at the same time as Marisat, the precursor of Inmarsat, was developed. Marisat began its operation over a new L-band satellite while the different VSAT technologies used C-band satellites mainly used for fixed point–point communication over large distances between the different continents prior to the introduction of fiber cables on the seabed. Later on Ku-band satellites mainly used for TV-broadcasting were also equipped with additional receivers for two-way communication.

The world wide Telemar Group have already installed broadband on more than 200 vessels and the company also has another 50 landbased VSAT terminals in operation for governments, military forces and large corporations world wide.

Based on this experience we have now developed a standard platform suitable for use over virtually any satellite network and using any kind of technique. The platform

is named SeaCall and is optimised for data and Voice over IP telephony (VoIP).

Telemar SeaCall – introduction

Telemar SeaCall is an IP based broadband service specifically designed for use at sea. The service is predominantly based on the DVB-RCS (Digital Video Broadcast – Return Channel System) technology from different providers including iDirect with shared access, where a given number of users share the common total capacity of a satellite segment. DVB/RCS is today a well established standard for bi-directional satellite communication systems. It is successfully implemented by many of the main satellite operators and has proven to be a suitable and scalable system in large worldwide installations.

In combination with SeaCall the service provides an always-on satellite broadband connection between ship and shore for Internet connectivity, including high class IP telephony.

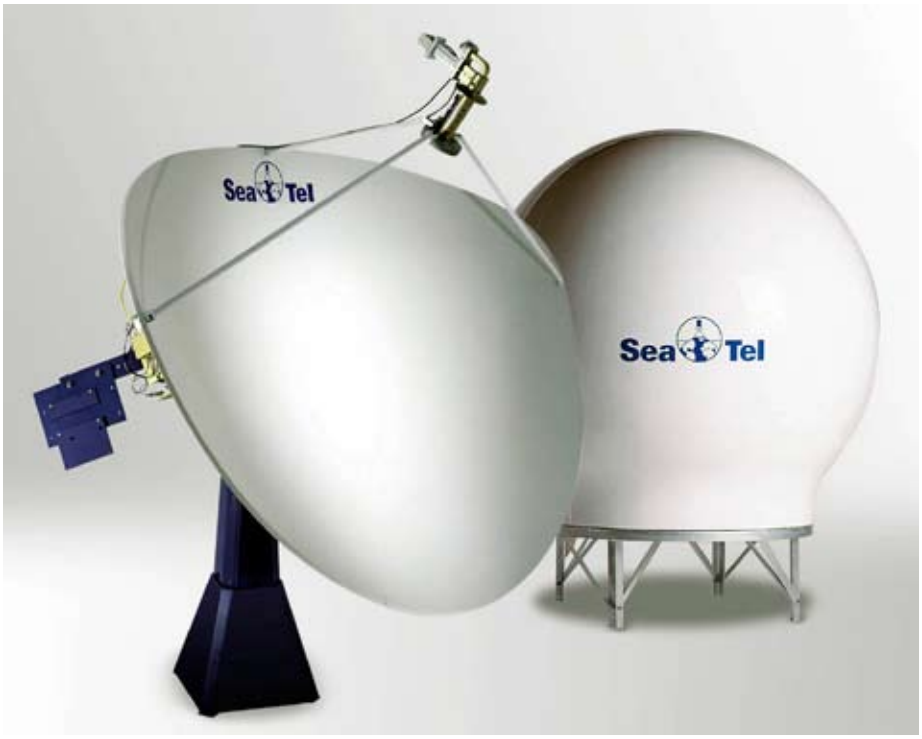
Coverage and service areas – regional and global

Services are available as described in the coverage maps below.

Ku-band is used for regional coverage, where several regional areas may be combined to form an extended area. C-band provides global coverage except for the poles, which are unreachable for geostationary satellites.

Standard data throughput rates

Ku-band:	
Ship to shore	up to 512 kbit/s
Shore to ship	up to 2,048 kbit/s
C-band:	
Ship to shore	up to 256 kbit/s
Shore to ship	up to 1,024 kbit/s



The SeaTel 9707 antenna.

Satellite communication equipment

The satellite communication equipment on board includes:

Out-door unit (ODU):

- Antenna SeaTel 4006 Ku-band or SeaTel 9707 C-band
- BUC 4W (Ku-band) or 25W (C-band) with LNB (Transmitter/receiver)

In-door unit (IDU):

- STM Satlink 1910 modem
- Software including NAT, GRE, QoS and TCP Acceleration (PEP)

The shipboard SeaCall cabinet

The standard shipboard cabinet includes two Linux-based 19" rack mounted PCs, of which one is configured as a firewall/router and the other one as a VoIP server. Integral components are as follows:

- PCI card for connection of up to four analogue phones
- VoIP server
- Web proxy with blacklist
- Mail server
- POP server
- Web server
- DHCP server
- IP filter firewall
- Eight public IP addresses for modem, VoIP server, router and additional use
- 24 ports network switch
- Caching DNS
- UPS

Access to the Internet is provided

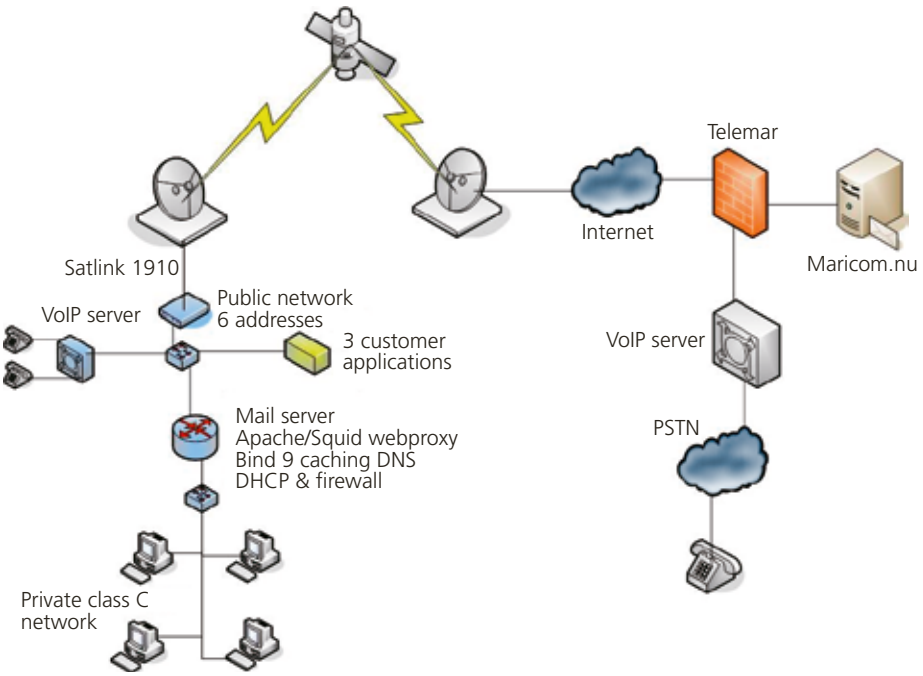


Figure 1. SeaCall system overview.

through gateways via the earth station. The Internet performance is enhanced by several features assembled in a firewall/router. VPN may be provided as an option. In the standard configuration, the service includes two analogue telephone lines. Two additional lines may be added as an option.

SeaCall operates through a VoIP server in Sweden with access to the terrestrial and cellular public telephone networks worldwide, and includes a range of numbers in the Swedish national telephone numbering plan. Calls from the ship to the international telephone networks are provided at highly competitive rates.

SeaCall system overview

The Internet access solution includes several functions for enhanced performance, such as DNS and Web caching. This is provided by Telemar through a firewall/router that also contains a mail server (POP3) and a DHPC server. For further performance enhancement, the modem is equipped with a TCP accelerator for a more balanced and improved bandwidth compared to traditional TCP/IP. DECT telephones, as well as computers on a WLAN, may be connected to the SeaCall system.

Features

Firewall: The router includes a firewall, primarily configured to permit passage of all outgoing IP traffic from the inside to the Internet. In the reverse direction, i.e. from the Internet, all IP traffic is blocked by default. The firewall can be opened for two way access for specific services, as well as re-routing of certain services to specific IP addresses.

TCP Accelerator: A TCP accelerator, included in the satellite modem, is used to improve the performance of the Internet protocol on network paths. The use of the accelerator is of vital importance when using link environments like satellite communications that have a performance differing from that of ordinary terrestrial communications. The transparent and multi-layer acceleration for satellite communication links aims at enhancing the data communication between peers with different link latencies.

DNS cache: In order to eliminate the effect of the latency (typically 0,6 s round trip) in all satellite communications via geostationary satellites, the once retrieved DNS directory information is saved in the firewall/router for later local re-use.

Web proxy/cache: The firewall/router includes a function for local storage of earlier downloaded web pages. This provides for a fast retrieval on the next call to the very same page. Web page content is not retrieved in sequential mode, which is the normal procedure for browsers like Internet Explorer, but in a parallel mode. This means that the download of a page starts even before the request arrives from the browser. The experience of the download speed is thereby enhanced.

Blacklist: In the web proxy, an optional function may be activated to block the user's access to undesired web sites, or filter out undesired components in a specific page, such as advertisement banners. Scheduled updates of the generic blacklist can be configured. In addition, the list can be extended by the onboard administrator.

DHCP server: Web browsing is offered via a local LAN connected to the Internet via Telemar's firewall/router. To facilitate the set-ups for DNS and IP addresses a DHCP server manages the dynamic allocation on the private LAN. The DHCP server can be deactivated to allow allocation of static IP addresses.

Mail server: It is assumed that Telemar SeaCall customers will use their corporate mail server for the routing of e-mail to and from the ship. However, the mail server included in the shipboard router can be optionally used for both administrative e-mail and crew e-mail.

As mentioned earlier the SeaCall standard system is now successfully deployed via both Ku-and C-band utilising both i-Direct and DVB-RCS services.

A growing number of terminals are being used in multiple Ku-band coverage areas where now also automatic handover is being introduced.

DVB-IP in combination with other services including VSAT

A fast growing number of vessels are being equipped with stabilised TV-antennas which is also a significant step in the direction of crew welfare. In Europe a large number of the viewers are watching programmes on Hotbird, Eurobird and the Thor satellites.

By utilising a service called DVB-IP the TV-antenna may also easily be used for broadband reception simultaneously to receiving TV-signals. As Internet access is asymmetrical by its very nature it only then takes a fairly narrow back-channel in order to provide a broadband link to the ships. The back-channel may be provided by an already existing Fleet terminal onboard or in the future a Fleet broadband terminal. Also GSM or Thuraya services may be used for back channel purposes. The great advantage and big cost savings in combining these two services this way is that Inmarsat terminals are just being used for the brief requests and acknowledgements

required by the Internet, the main bulk of data is received via the TV-antenna.

The main provider of these services is Wired Ocean, a British company having developed a highly cost efficient software based on Linux. This software is running on a satellite broadband server (SBS) developed in-house by Wired Ocean. The SBS is integrated into the ships communication network and it enables the use of the satellite TV antenna for data download and handles the upload process using the other satcoms or cellular systems onboard.

The SBS is able to act as a switching device for the ship's entire network, and a competent caching device means that only new content of previously viewed web pages needs to be downloaded for faster and more economical browsing.

The future of Ku- and C-band

During the World Radio Conference 2007 (WRC-07) the global satellite industry managed successfully to protect the C-band from terrestrial interference. The World Radio Conference is arranged every fourth year by the International Telecommunication Union in Geneva. In WRC-07 191 countries participated and voted in favour of protecting a significant section of the C-band in favour of the satellite industry. In addition to ensuring uninterrupted use of the C-band, WRC-07 also gave satellite operators assurances that any future international mobile telecommunications networks will provide them with full protection from interference. The endorsement of the satellite industry's use of 3,4–4,2 GHz band will ensure that operators will also have adequate bandwidth to roll out future services.

This was an important step to ensure to future growth of maritime C-band communication that will for the foreseeable future continue to be the only viable alternative for shipowners who wants proper global coverage and also for those operating in areas with frequent heavy rainfall, as in West Africa and in South East Asia.

The Ku-band is already protected by its very nature of being the main provider of TV via satellite. The main concern with regard to Ku-band for the maritime industry is the growing demand for more bandwidth by TV-providers. This is caused by a rapid increase in number TV-channels as well as the rapid introduction of High Definition TV. By its very nature the main coverage areas of Ku-band is over the landmasses where a majority of the viewers are located.

The next frequency band that has been in the pipeline for a while is the Ka-band, however the band will even more be concentrated on the landmasses and as a result not very useful for the maritime industry.

Conclusion

The fast growing shortage of competent maritime officers and engineers is causing a strong interest among shipowners worldwide to provide broadband access and low cost telephony onboard their vessels. Recruitment and retention of professional and competent crews are fast becoming the number one priority for the shipowners.

It is becoming quite common that shipowners looking for new crew members, already in their advertisements, include information such as "Internet onboard" in order to create additional interest and to show that they are keeping up with new demands from an increasingly selective work force.