SATELLITE COMMUNICATION SYSTEMS ONBOARD TWO SPANISH OCEANOGRAPHIC VESSELS

D. Afonso, E. Arilla, O. Garcia, A. Hernández, J. Olivé, J. L. Ruiz, X. Romero, A. Sandoval J. A. Serrano, J. Sorribas
Telematic and Communications Department, Unidad de Tecnología Marina. CSIC
http://www.utm.csic.es; utmtel@utm.csic.es

I. INTRODUCTION

Two Broadband Satellite Communication Systems were installed in two of our vessels during 2008. In BO Sarmiento de Gamboa a VSAT Communication System in C band was installed with a data transfer rate of 192 kbps (CIR, Commited Information Rate) and a burst capacity of 256 kbps (MIR, Maximum Information Rate) which can be increased to 5 Mbps. While in BIO Hesperides, following Navy specifications (the ship-owner) a TNX75 Communication System in X band was installed with a data transfer rate of 128 kbps (CIR) which can be also increased to 5 Mbps.

Apart from the advantages that an Internet access has had for the researchers, one of the most important characteristics of this Broadband System is the possibility of configuring a Virtual Private Network (VPN) between the vessels and the UTM main offices on shore (Land-Site). This network enables real-time data transmission and remote systems control and operation (Figure 1). Furthermore, web browsing is possible and an IP telephone system has been installed.

The installation of this kind of networks is not easy and several difficulties can appear. Therefore, an optimal configuration of protocol architecture has to be looked for. In satellite communication where TCP/IP protocols are used, data links are very sensitive to latency, asymmetric links, and package loss due to congestion or transmission errors.

Both vessels are managed by UTM owned by different ministries. Administrative requirements were different at the time of choosing the satellite service providers. During start-up their services and their architectures were very different and they were modified until the problems were overcome, so both systems can currently offer the same services. For analysing the resolution of those problems, the behaviour of four basic parameters (jitter, round time trip, package loss and throughput) has been studied.

II. SYSTEM DESCRIPTION

The broadband satellite service of UTM ships has a capacity which enables IP networking in permanent connection. For that, VSAT technology is used which connects the ships to the satellite network. The satellite service providers are Seamobile and Hisdesat. Both of them use geostationary satellites (orbiting at 35,786 km) and a large set of ground stations to provide coverage around the globe except the polar areas (their effective coverage is between 70 º N and 70 º S).

The terminals used onboard work with the C and X band. With the current contract the providers guarantee a link with a minimum symmetrical bandwidth of 128Kbps.

The diagram for the architecture of the system is detailed in Figure 2, referring to the three locations involved: vessel, land backbone or teleport site, and UTM Land Site.

a. Vessel Site: On board both ships there is a gyro-stabilized antenna and position control unit, one modem, and the network equipment that enables IP routing, VPN establishment, access control lists, management of service quality, and links to the vessel network. In both systems the IP equipment is the same brand and model (Cisco 2800 Series routers), while the electronic equipment for satellite link is specific to each case.

b. Teleport Site: In order to allow the link between the satellites and the data backbone network or public switched telephone network (PSTN), the provider needs specific equipment. In this site the following elements are available: a modem for the satellite link, IP router for Internet connection and firewall.

c. UTM Land Site: This equipment corresponds to the end of VPN and is located in the UTM Land Site (Barcelona). The VPN links are managed by a router. This is the central node in the Private Network which is extended between the UTM site and the oceanographic vessels.

III. SERVICE CHARACTERISTICS FROM START-UP TO OPTIMIZATION

Both systems were installed on the vessels almost simultaneously, but initially their performances were very different in each case, until the equipment configuration and optimization of the system were carried out.

The "BO Sarmiento de Gamboa" start-up system didn't have any differences to the initial design made by the satellite service provider. Network traffic measurements showed a symmetric bandwidth link according to the contract. The packet loss rate was close to 1.5% including traffic inside VPN. Currently there is no change in the configuration of the standard values on-board computing facilities, except the MTU which was modified to optimize the link between the ship and Land Site.

The "BIO Hesperides" system presented a very different scenario on its installation. Although connection with HTTP servers was possible, the VPN link was extremely poor, despite using same IPSec protocol and encryption parameters used on the "BO Sarmiento de Gamboa" system. The analysis of the performance in this situation showed high packet loss rate (reaching 80%), and continuous changes on throughput values.

The PING tool was used to verify if packet fragmentation exists, and to look for the optimum MTU value. In the "BO Sarmiento" system, iDirect modems are capable of reassembling fragmented packets, but PD-25 modems in the "BIO Hesperides" cannot do that, causing high packet loss rate. Several tests with different MTU values were done to find the optimal MTU value that was set finally around 1400. After this change the quality link was improved considerably (Figure 3).

After this, the geographic location and configuration of the accelerators were changed to work within the VPN link. The accelerator on the teleport site was moved and integrated on the UTM Land Site.

IV. ANALYSIS OF EQUIPMENT CONFIGURATION AND PROTOCOLS

In order to evaluate the communication performances in the network, IPERF and PING tools were used.

In this case we use the bandwidth between the vessel and the CMIMA to send packets in both directions, evaluating packet loss and jitter variations under different conditions. This value in communications between vessels is significantly higher than jitter in a terrestrial connection (100ms).

The measurements presented were made with this tool sending packets in both directions into the VPN link, using a bandwidth of 117kbps along 1800 seconds probe.

PING lets us know the round-trip delay time or round-trip time (RTT) corresponding to the period of time in milliseconds that is needed to go and come back between source and destination hosts. Usually, this delay should be not higher than 200 ms in terrestrial communications, and around 700 ms in satellite communications.

In the "BIO Hesperides", several tests were done with IPERF tools. Initially the delay between the two hosts, connected directly to the vessel modem and the teleport modem. This measure should avoid any interaction or effects introduced by other network equipment (routers and accelerators).

The next measurement set was made through the routers after configuring the VPN and the accelerators in "BYPASS" mode. Finally, the accelerators were activated in "LAN" mode and the different results were compared. Then a new measurement set was made using PING for 1200 seconds.

In the "BO Sarmiento de Gamboa", IPERF and PING tool measurements were made.

All the tests were done with the vessels working in two surveys in different locations. "BIO Hesperides" was in Brandsfield Sea (Antarctica), and "BO Sarmiento de Gamboa" was in front of the NW Spanish coast.

The results are showed in Figure 3. Different conditions are used for plotting the data:

- In all the figures, situation "1": tests made through accelerators in LAN mode and the MTU value to 1400 (Optimal situation).
- Situation "2"corresponds to tests through accelerators in LAN mode and the default MTU value (1500) .
- Situation "3" corresponds to tests through accelerators in BYPASS mode and the MTU value to 1400.
- Finally, situation "4" corresponds to tests through accelerators in BYPASS mode and the default MTU value (1500) (Worst situation).

V. CONCLUSION

After the optimization of equipment configuration and network parameters on VSAT links of both vessels, stable links have been obtained for web navigation and VPN communication.

Accelerators reduce jitter values, and MTU optimization improves the observed asymmetry between the uplink and downlink regarding this parameter.

With respect to throughput both link senses are shown to be symmetric in optimal conditions. The action of accelerators is notable onboard the "BIO Hesperides" to reach the contractual values.

MTU optimization is quite important to reduce packet loss on both vessels. The action of accelerators is indispensable on the "BIO Hesperides".

Changes introduced by the optimizations are not significant over median RTT but can reduce extreme values.

The right selection of hardware is fundamental for successful implantation of this kind of communication systems to guarantee the quality of satellite links and for administrating the particularities of TCP/IP protocols for these links.

REFERENCES

[1] T.R. Henderson, R.H. Katz, "Transport Protocols for Internet-Compatible Satellite Networks," IEEE Journal on Selected Areas in Communications, Vol. 17, No. 2, pp. 345-359, February 1999

[2] M. Allman, D. Glover, L. Sanchez, RFC2488 - Enhancing TCP Over Satellite Channels using Standard. (1998)

[3] A. Tirumala, M. Gates, F. Qin, J. Dugan and J. Ferguson. "Iperf – The TCP/UDP bandwidth measurement tool". [Online]. Available: http://dast.nlanr.net/Projects/Iperf

[4] H. Newton, "Newtons Telecom Dictionary", CMP Books (2001)

[5] W. Stallings, "Data and computer communications" Fifth Edition, Prentice Hall International (1997) Hping - Active Network Security Tool. [Online] .Available: www.hping.org

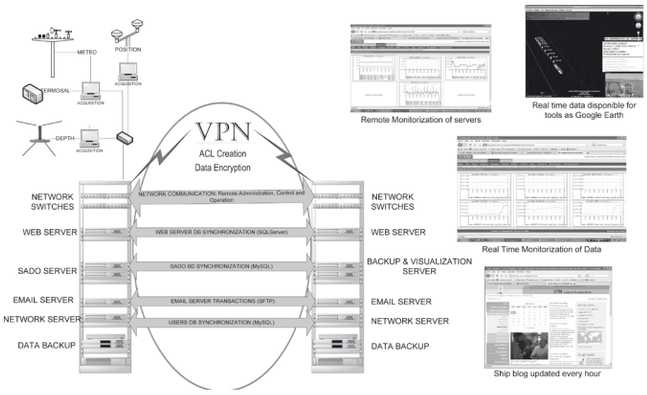

Figure 1: VPN allows remote control and operation of servers, and BD synchronization, supplying real time data for UTM web based applications.

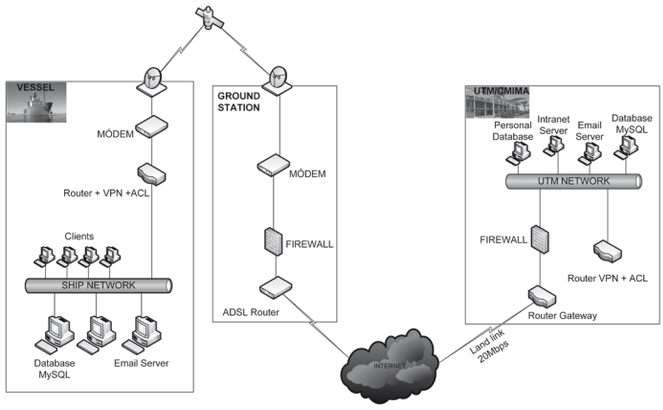

Figure 2: General schema of system communication on board "BO Sarmiento de Gamboa" and "BIO Hesperides"

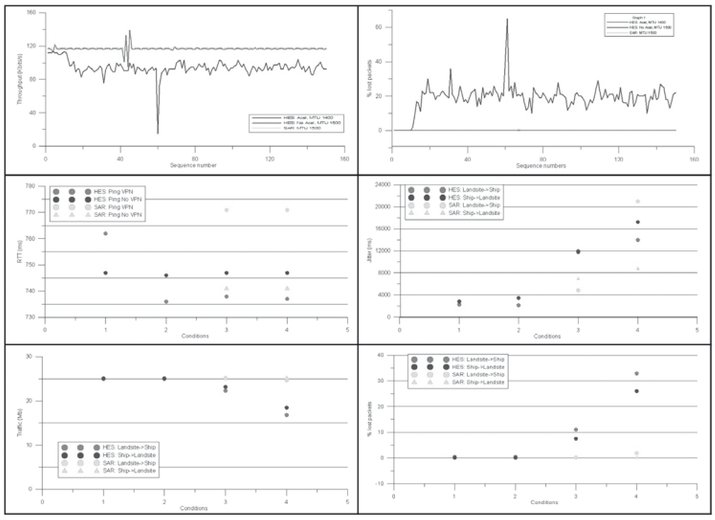

Figure 3: Results of test are showed below. In the first to graphics, we can see the improvement obtained when MTU value is set to 1400 on Hesperides. Throughput increases and percentage of lost packets decreases significantly. On next graphics, we can see the evolution of RTT, jitter, quantity of data transmitted and percentage of lost packets along four different conditions.