Installation of Broadband Satellite on the Training Ship Golden Bear

California Maritime Academy

Written by Stephen Frazier, CIO

The silhouette of California Maritime Academy's Training Ship Golden Bear (TSGB) was noticeably changed by the installation of a C-band satellite antenna in April, 2008. The picture above depicts how the ship looked before the antenna was mounted above the bridge. Now, a 12-foot diameter white dome is mounted above the bridge and houses the satellite antenna. Along with the associated communications equipment, it provides the crew with a persistent, live Internet connection while the ship is anywhere in the world. The system supports eight telephone lines, network domain controller traffic and communications between the campus and ship's Exchange email servers.

This ambitious project began in earnest when contracts were signed in January 2008 and was completely operational and tested prior to the vessel's departure for Japan on April 27, 2008. The satellite system was made possible in part by project support and funding from the TIS Department in the Chancellor's Office of the California State University.

Onboard Communication Services Before 2008

Prior to 2008, the TSGB employed a store-and-forward methodology to provide email services for the two cruises each summer with three hundred students and faculty onboard. The University contracted services from TeamTalk to transmit and receive batched email through a satellite connection. Transmissions were initiated twice a day by the IT staff member onboard.

The use of TeamTalk necessitated assigning a superhub.com email address to each crew member. That required crew to notify friends and family of their new, temporary email addresses. Regrettably, some students inevitably went without email service several days to a week during the start of each cruise because of errors introduced by manually creating email addresses onboard the ship and the TeamTalk's Superhub.com server.

Two Iridium phones located in the hallways of the ship provided the only outgoing ship-to-shore telephone service for crew members. This precluded any sense of privacy because students often waited in line for their turn.

The Captain's computer had the only Internet access via a modem and an EarthLink account. Another company, Telenor, provided for some data, fax, telex & mobile services while ship was at sea.

The ship's PBX is an aging Fujitsu switch. It enabled intra-communications between state rooms and offices (and still does in early 2011).

Communication Problems during Past Cruises

The Iridium-based communication services proved to be stable albeit expensive. However, the store-and-forward email system, which had been problematic during the 2005 and 2006 cruises, failed completely for a period of several weeks during the second cruise in 2008. Although notices were posted on Cal Maritime's Follow-the-Voyage (a blog-type website), parents were obviously concerned about the communications blackout and some even expressed fears that some ill fate may have befallen the ship.

IT Department members on campus worked with TeamTalk's technicians over the phone to resolve that outage. When all efforts failed, the University flew one of TeamTalk's technicians from Florida to Subic Bay (at the University's expense) to meet the ship. Due to a misunderstanding of the ship's current date (as it was across the International dateline), the technician arrived the evening before the ship's scheduled departure the following morning. He worked right down to the wire, restored the service and disembarked shortly before the ship's departure.

Unbeknownst to the IT staff member onboard the ship, the numerous problems leading to this prolonged outage as well as the outage itself occurred because of the installation of new TeamTalk software just prior to cruise. The installation caused the program to run as a service in the background. When the IT technician would launch the application, it conflicted with the background service and resulted in aborted transmissions. Unfortunately, this was not addressed in documentation nor was TeamTalk able to identify the problem over the phone.

Problems with satellite transmissions during most of the 2007 cruises resulted in high transmission expenses and overtime as IT technicians attempted to send and resend the batched email. Some transmission sessions lasted hours while charges were accumulated literally by the second. In addition, because of problems during the first cruise that year, fewer students on the second cruise paid the $25 monthly fee for email service. As a result of the communications failure during the second cruise, some students requested refunds of the non-refundable fee.

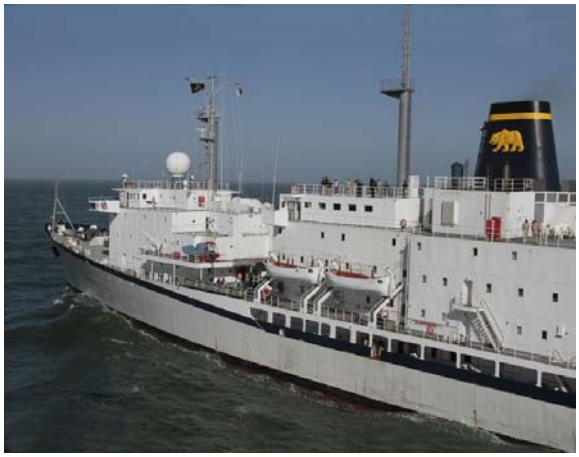
The Germination of a Dream

The roots of the broadband satellite project date back to the Spring of 1996 when Cal Maritime's new CIO, Steve Frazier, questioned why IT technicians needed to spend several days reconfiguring the network onboard the Training Ship Golden Bear prior to

that summer's cruise. In addition to the IT staff time required, reconfiguration of the network essentially resulted in the ship leaving campus with a new and untested network.

Seeking to mitigate these issues, the campus consulted with Cisco and met several times with their educational sales representative and an engineer. During one of the latter meetings, Cisco suggested that the campus consider a live, always-on Internet connection similar to that used on cruise ships. At the time, however, the cost seemed beyond our reach. After all, the campus spent around $90K per year for the store and forward satellite email system that was live only twice a day. Nevertheless, a persistent broadband satellite connection would afford intriguing opportunities and planted the seeds of a dream.

Barriers to the Dream



TSGB May 3, 2010

Before Cal Maritime could move forward with any communications upgrade for the TSGB, however, the issue of the ship's obsolete network equipment had to be addressed. The TSGB's network consisted of fifteen switches that were already at end-of-life. Unfortunately, the ship's network had not been included as part of the Chancellor's Office ITRP initiative that upgraded CSU campus network infrastructures some five or more years prior. Consequently, as campus network gear was upgraded over the years, old equipment ended up on the ship. While this equipment was now in need of replacement, the cost of this project alone was formidable.

In addition, there were a significant number of possible single points of failure in the ship's computer network. These were due to the lack of redundant cable paths between switches. A failure in one of several switches would bring down a major portion of the ship's network. In anticipation of this possibility, a spare old switch was always carried onboard and would need to be configured while at sea.

Cal Maritime's CIO engaged the Technology Infrastructure Services (TIS), headed by Mark Crase in the Chancellor's Office, in conversations about the need for a network refresh and an upgrade of its satellite communications system. At a CSU kickoff meeting, Steve Frazier and Michel Davidoff sat across the table from each other. Mr. Frazier shared his vision of a live, always-on Internet connection with Mr. Davidoff. Mr. Davidoff expressed interest and while he had traveled throughout the CSU networking buildings, he had never networked a ship. Mr. Davidoff later shared the idea with the other TIS team members in the Chancellor's Office.

Because classes are conducted onboard the ship during cruise (and throughout the regular academic year), TIS felt that it should be provided with the same network access as any building on a campus. (As we later discovered, that dream of similar bandwidth capabilities was too expensive but the foundation has been laid which will open doors in the future.) TIS funded the $121,000 ITRP project to replace the end-of-life switches and cut through red tape--completing the network upgrade in a couple months instead of what normally would have been over the course of a year. The project was managed and executed by Global Business Solutions of AT&T California. It got underway at the start of January, 2008 and the switches arrived on February 25, 2008.

Meeting the deadline for the network switch refresh was critical for work that followed on the satellite broadband communication system installation and synchronization of the campus and ship servers. Because of the severely compressed timelines, slippage of the milestone dates for any one of the projects (ITRP, satellite installation, and server synchronization) could have resulted in the ship departing for summer cruise without a communications system in place. Several drop-dead deadlines had to be incorporated into the timelines.

Obtaining Campus Buy-in

Following the initial meeting with TIS on campus, a meeting was convened with a small number of interested faculty, staff and TIS onboard the ship. At this meeting, TIS announced their intention to move forward with the broadband project.

The next step involved campus-wide discussions about the project on campus and get buy in. Several key stakeholders were onboard from the start and included Commodore Keever (Captain of the ship), Chief Engineer Bill Davidson, and Mark Nickerson (VP of Administration and Finance).

While most embraced the idea, one faculty used the campus email distribution list to express his thoughtful concerns. He noted that with the advent of recent communication technologies and personal devices, the camaraderie amongst crew had diminished compared to days when ship to shore communication virtually non-existent. Whereas in the past they used to throw up a sheet on the fantail of the ship and show movies to students, the current generation of students brings their own electronic devices and disappear into their staterooms. Understandably, the faculty member didn't want to see the new technology further erode this past heritage.

Others argued that things had not worked in the past. Each of the cruises had been plagued with one communication problem or another. Now that we were completely changing things, it was bound not to work again on the next cruise. What went unsaid, however, was that we needed to completely overhaul the system just for that very reason--things had not worked in the past!

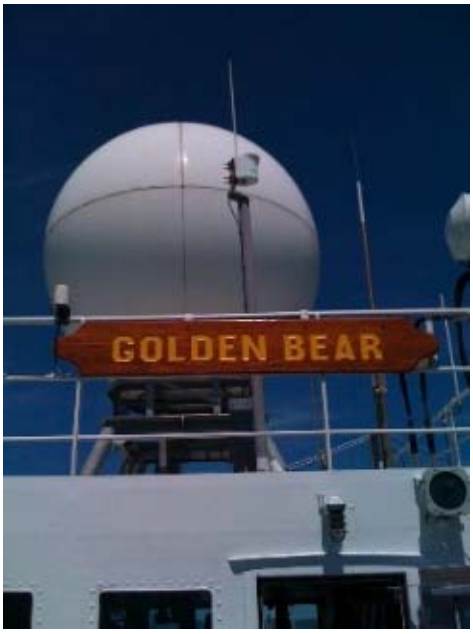
As these discussions were taking place on campus, President Eisenhardt convened a task force to reexamine the TSGB because of upcoming changes in executive leadership, the

rising cost of fuel, etc. The task force asked the CIO to present the case for broadband. The outcome of that meeting was a consensus that everyone wanted the new technology but policies were needed regarding the use of it. Faculty did not want students to browse the web while on cruise—particularly from their state rooms. As it turned out, the limited bandwidth that the University acquired could not support web browsing beyond a couple of people given the network and telecommunication traffic over the link.

Cal Maritime was also interested in broadband capability for another reason--disaster recovery. Two fiber routes currently enter the Cal Maritime campus. In the event both of these connections were lost as the result of a cataclysmic event, a broadband connection would provide a route to the Internet if the ship when the ship is docked at campus (i.e., eight months out of the year).

Contracts Signed

In December 2008, the campus did not have any contracts in place for a new satellite system. From January until the ship departed campus on April 28, 2008, a new network was installed ($121,000) requiring network downtime onboard the ship (we allowed three days for this but essentially one day of full network outage was used and portions of the network were down during the second day). This was funded by ITRP. The campus bought $3,000 fiber to create redundant paths while the ship was at sea that summer.



Satellite Antenna Above TSGB's Bridge

A contract was signed with Vizada in Norway to supply the broadband satellite C-Band antenna and communication gear. While coordinating the shipment and installation of the dome and C-band equipment, the campus also contracted with AT&T Consulting Services (CLSMA) to establish the ship as a site on Cal Maritime's campus network. The challenge was how to handle the Domain Name Server (DNS) traffic, relayed email messages by the Exchange servers and eight telephone lines over a 196 Kb connection.

CSU Support

John Rolon in the Chancellor's Office Technology Infrastructure Services served as a project lead. He and the others in TIS cut through red tape and made what would have taken a year happen in weeks and months. A number of vendors made comments to that effect. Each time a serious obstacle was encountered, the campus was able to turn to TIS for willing assistance. TIS provided both internal and external consultants as necessary and exactly when needed.

TIS also shared the costs of the project. A memorandum of understanding between CSU and Cal Maritime was executed. The campus and the CO each contribute $80,000 per year during the five-year lease.

Costs of the Project

Satellite Antenna Lowered by Helicopter onto Pedestal

The main contract does not provide sufficient bandwidth. For the term of the five-year contract (60 months), the main contract's fee is $4,000 per month (USD). It provides 128kbit/second. It is activated one to two months in advance of cruise for a minimum 6 months per year at a rate of $5,300 per month. This included the cost of operation/support.

Cal Maritime ordered an additional 64kbit/s bandwidth at $2,500 per month for 6 months. This provided a total bandwidth of 192 Kbits/second (of which 64 Kb was dynamically dedicated to phone service as needed). At the time that the contract was signed, Cal Maritime ordered the first 6 months of this coverage.

The grand total per year for Vizada services is $94,800. The following provides a breakdown of this annual cost.

- Monthly fixed fee USD $4,000 x 12 months = $48,000
- 128 Kbit/second for 6 months at $5,300/month = $31,800
- Additional 64Kb/s for 6 months at $2,500/month = $15,000

Other costs incurred included a one-time $15,000 Vizada installation fee. The helicopter and physical installation was another $30,000. Foundation design and construction was approximately $24,000. Network site configuration and Exchange email synchronization was $48,800. In addition, new servers were also purchased.

Although not directly associated with the satellite communications system, the network was redesigned and new switches (totaling $121,000 and funded by the Chancellor's Office ITRP project) were installed just prior to the satellite installation. Additional fiber cable was purchased for $3,000 by Cal Maritime and laid during cruise for redundant paths. To help offset ongoing costs, Cal Maritime sells calling cards and charges $25/month for email access. Calling cards can be purchased in the Pirate's Cove onboard the ship.

Installation of Satellite Antenna and Equipment

Six “awkward” shaped crates containing antenna parts arrived on February 25, 2008 and were placed at the end of the dock and covered with tarps. Two engineers from Vizada were dispatched from Texas to put the antenna together, install it (including lift and mount), mount and configure the indoor unit, wire and test the installation March 10-14. It needed to be in place for testing during the sea trial March 15. With the pending sea trial and upcoming cruise, everyone was very busy that week. However, intense cooperation and coordination was given to this important project.

Chief Engineer Bill Davidson oversaw the placement of the pedestal and dish installation on the roof of the ship’s bridge. He also served as the designated Single Point of Contact (SPoC) with Vizada during this period. When technical assistance was needed from Vizada, the campus encountered difficulty because Vizada refused to speak to anyone except the SPoC. They would not even acknowledge messages from the campus’s Network Analyst or the CIO. As a result, valuable time was lost and nearly put the project in jeopardy. The IT Department had to work through the Chief Engineer (who did not understand the technical aspects on the IT side but truly did a remarkable job). Finally, on April 2, we designated Walter Abarca, our network analyst, as the SPoC. Vizada confirmed the change on April 3.

Synchronization of Domain and Exchange Servers

Instead of assigning new email addresses to crew as had been done in the past, Cal Maritime wanted students and faculty onboard the ship to continue to use their current university assigned email addresses. They would no longer be required to notify family and friends of their new addresses (often while at sea) and would not experience delays imposed by a store and forward batch email system. Whether at sea or on campus, crew would have the same email environment and experience (therefore, they would need access to all of their email folders and messages). Incoming emails sent to their campus address should be instantly available to them while at sea. When they responded, emails should be transmitted in real time. Thus, domain controller traffic would be needed to establish the ship as a site on our network regardless of the ship’s location. Obviously, these presented challenges with a limited bandwidth.

Challenge of Change-over in Hawaii

While Cal Maritime certainly was not the first to set up this type of communications link on a ship, the changeover of 300 students leaving the ship while another 300 boarded it in Honolulu presented a unique challenge. It became apparent that migrating the accounts both ways over the satellite link while the ship was docked was not possible in the amount of time available. There just wasn’t sufficient bandwidth. We investigated the possibility of getting a DSL or other broadband connection to the dock in Honolulu but to no avail. As a fall back, AT&T devised a plan and process to migrate accounts using a laptop running Exchange.

Problems Communicating With Norway

Communicating with a company located across the ocean presented another set of challenges. Although the technicians spoke fairly good English, they were not used to colloquialisms and this lead to misunderstandings. Responses to some of our emails did not include the information that we requested. At one point, the Vizada technician

TSGB with Satellite Antenna

responding told us that we did not ask a question and therefore he did not send us the requested information.

We also found that Vizada's Help Desk was too cumbersome and unresponsive. To get the support we needed, we had to talk to the people on day shift. Because there was a nine hour time difference, that meant we sometimes needed to place the call after midnight. While dealing with a crucial issue, one of our AT&T consultants met with the CIO at midnight to place such a call. They we were able to speak to people on the day shift in person and got things done. Differences in time and their holidays slowed the process down considerably.

Sea Trial Satellite Problems

During the mini cruise on March 15, 2008, the ship made its first turn. During that maneuver, our two Vizada technicians were testing the satellite system and it suddenly failed. They then determined that a low noise block (LNB) unit failed. The technicians

were able to procure the part from a local facility after the weekend and brought the system back online before they finished their work.

Two theories began to circulate as to why the LNB had failed. The Vizada technicians had indicated that although the component seldom fails, it was possible that moisture caused the breakdown. The other possibility, attributed to the Chief Engineer, was that as the ship made the turn, the dish inside the dome was tracking the satellite position and turned to face directly into the radar. If that was the case, the filter burned out from the strong RF signals of the radar.

TSGB Passes Beneath the Golden Gate Bridge

Excessive Packet Loss

After the satellite was operational, we discovered that the servers would stop communicating because of excessive packet loss and timeouts. On April 7, only weeks away from the ship's departure, ping traces revealed that there was in excess of a 1000 millisecond delay and that over 32 hops were involved in getting the signal from the satellite downlink in Norway, across the transatlantic cable and across the United States to our campus in California. In April, Vizada changed the downlink from Aike, Norway to Santa Paulo, California which brought it down to a more under 700 millisecond lag time and 20 hops.

Subsequently, we sent the first test messages through the satellite and confirmed that throughput was good. The Active Directory and server infrastructure as responding wonderfully. First call through the satellite system was made to the CIO's cell phone while he stood in chart room right next to the PBX and satellite's Indoor Unit. Listening to the caller's voice in the next room, there was a very noticeable delay over the phone. However, when the CIO went down to the Chief Engineer's office where couldn't hear the person speaking, the delay was not noticeable.

Email Size Limits

All mailboxes were limited to 100K messages initially. We also created an external mailbox where larger messages can be sent. Key individuals such as the Captain and

Chief Engineer were permitted to retrieve larger messages by using a web browser and logging into the campus Exchange web interface (OWA). Because web browsing could potentially use up available bandwidth, on the Chief Engineer and Captain were given browsing capability. Faculty who needed access to the Internet for research purposes or courses made arrangements with the CE or Captain.

Ship's Departure for Summer Cruise

The reason for the LNB failure was still unknown at the time of the ship's departure for four months that summer. As the ship departed campus and made its way to the Golden Gate Bridge, IT staff members onboard made frequent calls to the campus to report on the satellite status. Fortunately, it made it to open sea without the problem reoccurring.

Looking Back Years Later

There were problems with the 2008 and 2009 cruises. The LNB unit failed at least once each cruise. Despite preventative maintenance checks by Vizada prior to the 2009 cruise, other problems arose with the phones. Two phones were unreliable for an extended period of time. Unfortunately, they happened to be the two most important phones on the ship... the Captain's and the one belonging to the Chief Engineer. Despite the best efforts of the IT staff, the problem could not be resolved. Then, Vizada made a change on their end and suddenly everything started working again. The company did not provide us with any explanation. Also, one of the components in the satellite system failed and a spare was used to bring it online again in short order.

We were fortunate that Arve Tengesdal, a Field Engineer from Marlink, took interest in the problems that the satellite system was having. He said that most ships go twelve or fifteen years without any satellite problems whereas the Golden Bear was encountering several each summer. He flew from Norway to do the maintenance himself prior to the ship's departure for the summer of 2010. He found, among other things, that the wrong filters had been installed. The 2010 cruises went virtually without a hitch!

Video About the Satellite Project: http://www.youtube.com/watch?v=BeBfIgetrlo

Project Participants

John Keever, Commodore
Bill Davidson, Chief Engineer
Mark Crase, Michel Davidoff, and John Rolon of the CSU Chancellor's Office TIS
AT&T (network services)
AT&T Consulting (CLSMA), Brian, Chris, Scott
Cal Maritime's IT Department
Tom Taricco, Marlink
Bjorn Christenson, Vizada