Portable and Mobile Classroom (PortMoC)

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Abstract

The Portable and Mobile Classroom (PortMoC) began as an idea to bring Internet connectivity to places where there was no connectivity for education and healthcare, but still make the connection reasonably sustainable in terms of cost and manpower. Through trial and error and several research iterations, Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) finally settled upon a tow-behind-style trailer combining a small form factor with a satellite dish, self-contained power and IP distribution, and 802.11b standard laptop computers. The PortMoC has gone through several iterations, including physical vehicles. However, the research approach has been the same: Does this technology work as we intended and is it a viable means to education? CERMUSA has surveyed the technology, such as upload/download speeds and laptop Internet connections, and is looking to roll this out into real-world situations. As it stands currently, the average download speed is 385 Kbs and the upload speed is 14 Kbs, with 8 laptops receiving separate low-bandwidth video streams. Items for future research and discussion are: Is it possible to raise the download/upload speeds for the benefit of the students while keeping the costs down? What applications are appropriate to use in the PortMoC environment?

Background

The PortMoC began as a method for providing electronic classrooms in any remote area. Early in the design of this prototype the targeted group for testing was the Human Resources Management & Industrial Relations (HRM/IR) program at Saint Francis University. This graduate program operates concurrently at three geographically separated sites in Pennsylvania: Loretto, Harrisburg, and Pittsburgh. The program had found it difficult to find electronic classrooms in these areas. CERMUSA had hoped to develop an inexpensive method of turning any room into a video teleconference capable classroom thereby allowing HRM/IR to use any available educational space. It was soon determined that the necessary bandwidth for quality videoconferencing would be excessively high and not a sustainable method.

The next phase was to create a connection to the Internet using a vehicle and use video streaming software to create the interactivity between the students and teacher. The satellite was purchased in 2002 and placed on the CERMUSA ambulance for testing. OptiStreams was contracted to provide the Internet connectivity. LearnLinc software was purchased as the e-learning suite of choice.

The current iteration of the PortMoC consists of a HaulMark brand trailer outfitted with the technology needed to connect a remote classroom with the Internet. Testing is currently in pro-

gress to determine what level of Internet interaction is feasible through the bandwidth allotted from the Internet connection.

Materials and Methods

Materials used:

The primary piece of equipment in the PortMoC prototype is the trailer. As stated before, it is a HaulMark brand trailer that weighs in at approximately 3400 pounds with all the equipment. Figure 1 shows a concept picture that was altered to display the PortMoC trailer. Figures 2 and 3 show exterior views of the trailer from different angles and that can be towed with a vehicle with an appropriate towing and engine package. Figures 4 and 5 show the interior of the trailer, and the computer and network switch, respectively.

Figure 1: The concept of the PortMoC

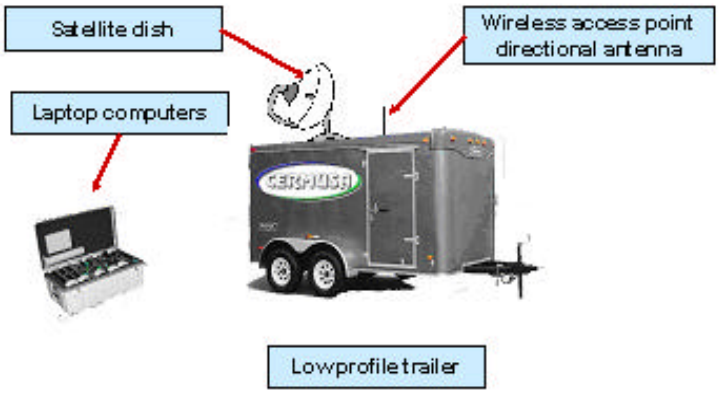

Figure 2: Trailer at the ready

Figure 3: Trailer parked at a location

Figure 4: Interior layout of the trailer

Figure 5: The satellite control unit and computer network switch

To deliver the Internet connection from the trailer to a classroom, the trailer needs to be connected to the Internet. To achieve this, we use a MotoSat satellite dish mounted to the top of the trailer which made the connection to our satellite Internet service provider, OptiStreams. The satellite dish is controlled by a rack-mounted computer located within the trailer. This computer is outfitted with all of the necessary software applications needed to control the satellite dish and have it connect to the Internet.

Once the computer within the trailer is connected to the Internet, the next step is to link the laptops located within the classroom to the Internet connection. This is achieved through a series of standard Ethernet equipment and wireless 802.11 links. First, the computer within the trailer is configured to act as a DHCP server to hand out IP addresses to all clients that connect to the network. This computer is then connected to a 3Com Ethernet switch located in the rack through a standard Category 5 wire. To create the wireless link between the building and the trailer, we use Proxim's Wireless Outdoor Router equipment. The "base" station is located within the trailer and connected to the 3Com switch, again using a standard Category 5 wire. An antenna, either directional or omni-directional depending upon the geography between the classroom and the trailer, is connected to the base station using standard LMR-400 cabling. These antennas are located on the exterior of the trailer and can be aimed in the general direction of the classroom. Through the use of these antennas, the trailer can be located up to 500 feet away from the classroom and still deliver a suitable signal.

The "remote" wireless outdoor station is placed near a window with line-of-sight to the trailer. If needed, an antenna is attached to this wireless router as well. Proxim software is installed on one of the classroom laptops which display the signal strength between the trailer and the classroom. This software is used to locate the optimum position of the remote wireless router within the classroom to locate the best possible signal.

The remote wireless outdoor station also doubles as an 802.11b access point. Classroom laptops equipped with wireless radios connect with the access point which in turn provides connection to the LAN originating within the trailer. The connection to the wireless network varies in speeds from 1 to 11 Megabits (Mbs) per second, depending upon the distance from the laptop to the access point.

The costs associated with the construction of this prototype were approximately $40,000. Monthly satellite connection fees and fuel for the generator are approximately $390/month.

Methods:

The methods used by CERMUSA to collect the data are to measure the average upload and download speeds on the satellite and the number of laptop computers using and interacting with the bandwidth doled out by the wireless network. At the time of this writing, two tests have been run, with several more planned. The following sections explain the testing procedure for the two areas. In addition, the PortMoC trailer will be doing these tests in various locations in the Cambria and Blair Counties of Pennsylvania to ensure proper connectivity in different environments and to give the trailer a "road test."

Satellite download:

A pair of Internet-based speed tests has proven reliable to gauge the connection speed. In the experiment, two were used to give a general idea. Both tests were run at the same time to ensure no differences based on time. A double bandwidth test was run at the start of the test sessions to get a baseline for the day. Then, as computers were added to the network and interacting with predetermined and distinct video clips from CERMUSA's Weapons of Mass Destruction (WMD) Prototype, the bandwidth was tested again and recorded.

The reasoning behind testing the bandwidth with regard to the number of computers on the PortMoC network is to see the amount of bandwidth available to students and other users of the trailer. With this information, CERMUSA can match appropriate current instructional media and future productions of instructional media that would be used in this prototype. It also gives us a benchmark should we upgrade the satellite to a unit with higher throughput.

Computer tests:

The computers are set up in the location to be tested. Current computer tests are interacting solely with the Windows Media files within the WMD prototype. Once underway with the satellite tests, CERMUSA will test further computer/Internet interaction. Testers will go to websites, interact with them to a depth of three layers, and then they will be surveyed on the response time. The testing of response time and quickness of information retrieval is important to learning via the web and other computer-based training.

These computer tests measure what can be reasonably viewed on a computer or computers within the PortMoC network. If the satellite connection is only downloading 200 Kbs, a computer wouldn't be able to load and stream a 500 Kbs Windows Media file. The bandwidth would be stripped out and also block any other computers utilizing the PortMoC network from receiving data. Thus, testing various commercial and educational websites, with their differing levels of data to be pushed through, while on the satellite downlink gives us another perspective on the capabilities of the PortMoC.

Results of the Research

Past results using the ambulance and the WMD prototype showed that there is promise with this modality of connectivity. However, the Windows Media clips that are the keystone of that prototype were encoded in such a way that they could be downloaded on a 16 Kbs dial-up modem speed. This was done to conserve the already limited bandwidth in rural areas and in areas where cell phone modems are used.

Initial testing of the PortMoC began in 2002. Findings from the testing are presented in Table 1:

Table 1

Date	Avg. Download/Upload (in Kbs)	Location	Notes
10/31/2002	92.1/28.4	Rural Loretto (1.5 mi from Saint Francis University (SFU) campus)	Cloudy weather
11/01/2002	76.8/11.9	Rural Loretto	Cloudy weather with drizzle
11/05/2002	54.5/28.9	Miners Hospital, Hastings, PA	Difficulty setting room up due to it being at the center of the building.
11/22/2002	76.8/21.2	SFU Library 2nd floor	Cloudy weather

WMD training took place in the second half of 2003. The PortMoC, in its ambulance iteration, was used to provide the connectivity and laptop usage to the various fire departments that participated in the research. Findings regarding connectivity time and speed are presented in Table 2:

Table 2

Date	Location	# of Laptops	Time Connected	Notes
06/20/2003	Colver Fire Hall, Colver, PA	0	N/A	Site survey and pre-testing. No laptops deployed.
06/21/2003	Colver Fire Hall, Colver, PA	4	6 hours	No problems reported
07/14/2003	Cresson Fire Hall, Cresson, PA	8	6 hours	Site survey and class in the same day. No problems reported.
09/22/2003	Lilly Fire Hall, Lilly, PA	0	N/A	Site survey and pre-testing.
09/23/2003 & 09/24/2003	Lilly Fire Hall, Lilly, PA		6 hours	Stayed connected
10/06/2003	West End Ambulance Co., Johnstown, PA	0	N/A	Site survey and pre-testing.
10/07/2003 & 10/14/2003	West End Ambulance Co., Johnstown, PA		10/07: 6 Hours. 10/14: See notes.	No problems reported on the 7th. Storms on the 14th caused signal failure and class was cancelled.

In the final test of the PortMoC as an ambulance, it was brought down to provide connectivity for a Master's level course in Business Communication. In addition to basic site and connec-

tivity testing, LearnLinc learning software was tested within the PortMoC infrastructure. LearnLinc has an audio interface that allows an instructor to lecture virtually to the students. This would be one of the primary items tested.

In the preliminary testing on October 17, 2003, twenty-two laptops were set up in and around the second floor of the SFU library with LearnLinc, the PortMoC was beaming the signal in from the parking lot, and the instructor was seated at his desk running the class via LearnLinc on his computer, which was connected to the CERMUSA LAN. Findings were that LearnLinc worked, albeit with a small delay in the audio.

The actual class which took place in Johnstown, Pennsylvania on October 20 wasn't as successful. Twenty-two student laptops, plus the one the instructor was using in a separate room, were all receiving the same lecture and running the LearnLinc program. The bandwidth was stripped fairly quickly, and LearnLinc on the lower bandwidth satellite connection was not a suitable test, as it interfered with the instruction of class. However, this is research and it was fortunate that CERMUSA was able to find limitations on the connectivity of the PortMoC.

Current testing has been done primarily at the in terms of the current tests, one key piece of data showed that as computers are added to the network, the available bandwidth to both current and additional computers on the network decreases. Table 3 shows the upload and download speeds taken from two separate sites: PC Pit Stop (http://www.pcpitstop.com) is #1 and DSL reports (http://www.dslreports.com) is #2.

Table 3

Speed Up (Kbs) #1:	Speed Down (Kbs) #1:	Speed Up (Kbs) #2:	Speed Down (Kbs) #2:	# of laptops	Time tested:	Notes:
28	748	15	674	0	09:48	Initial setup
-2	303	8	614	1	10:02	WMD video
-2	362	20	716	2	10:41	WMD video x2
22	396	13	730	3	10:51	WMD video x3
25	337	18	240	4	11:00	WMD video x4
-2	326	16	207	5	11:09	WMD video x5 & virus updates
14	227	12	141	6	11:17	WMD video x6
11	131			7	11:25	WMD video x7
9	186	11	164	8	11:35	WMD video x8

The computers, as currently tested, have been pulling in Windows Media files residing in the WMD prototype. Up to the writing of this report, eight laptops have been tested. As shown in Table 3, all eight laptops were streaming eight different WMD clips without problems. In addition, virus updates on several of the laptops were executed while the streams were running.

Conclusions/Discussions/Lessons Learned

CERMUSA is finding that the PortMoC, in its current configuration, is a reliable means of providing education in a low- to medium-bandwidth situation. It is a viable means of bringing Internet and computer-based education to areas where connectivity is poor or non-existent. However, several questions have come up during the research:

- How can we get more bandwidth, but keep the overall prototype sustainable?
- What are appropriate ways of using the prototype?

To answer the first question, more bandwidth is needed. The table regarding satellite download/upload speed demonstrates this. One note with computer connections is that the connection is only as fast as its slowest part. Whether the connection is being used for a single unit, such as a video teleconference presentation or for a classroom setting (multiple computers), the upload speed needs to be more in line with the download speed, especially to facilitate 2-way communication. Newer satellite dish models are boasting a 700 Kbs/300 Kbs download/upload speed. Although the upload speed is only half that of the download, the connection is faster overall and would support higher-bandwidth needs.

So what's the hold up? Get more bandwidth. However, this raises the costs. Current cost estimates on the dish that was mentioned would raise the monthly connection fees from $300/month to $1000/month. Add into that the cost of purchasing the dish and one can see that we have gone from a $40,000-to-build, $390/month-to-run mobile classroom to a $60,000-to-build, $1100/month to run.

The second question is more of an outlook on the future. The PortMoC was designed to be versatile, but sometimes, a chalkboard and lecturer is all you need to get the point across. This situation presented itself clearly with the Johnstown class in Fall 2003. While LearnLinc is a viable education tool, the use of LearnLinc in the classroom wasn't truly appropriate. LearnLinc was designed to bring students and faculty together from differing physical locations. In the Fall 2003 class test, all of the students were in the same room and the instructor and students were sharing the same lower bandwidth. Bandwidth issues aside, this application of LearnLinc and the subsequent application of the PortMoC was not entirely appropriate for the education of the students. Fortunately, this was done in a research arena and was reported and CERMUSA can use this data in the future.

What applications are appropriate for the PortMoC in its current configuration? This author would have to say most websites, web-based Course Management Tools, low-bandwidth streaming media, and audio conference calls. With higher bandwidth potentially available, video teleconferencing, higher-quality streaming, and Internet 2 access could be possible and bring a new level of collaboration to students in areas where Internet connection is poor.

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