Online Journal of Space Communication

Volume 2
Issue 4 *Satellite Communication in Canada (Spring 2003)*

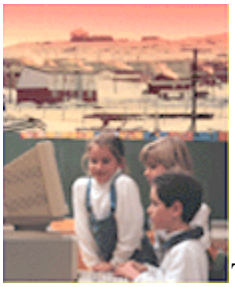
Article 18

May 2021

The Future of SatCom in Canada: Schoolnet

Paul Bush

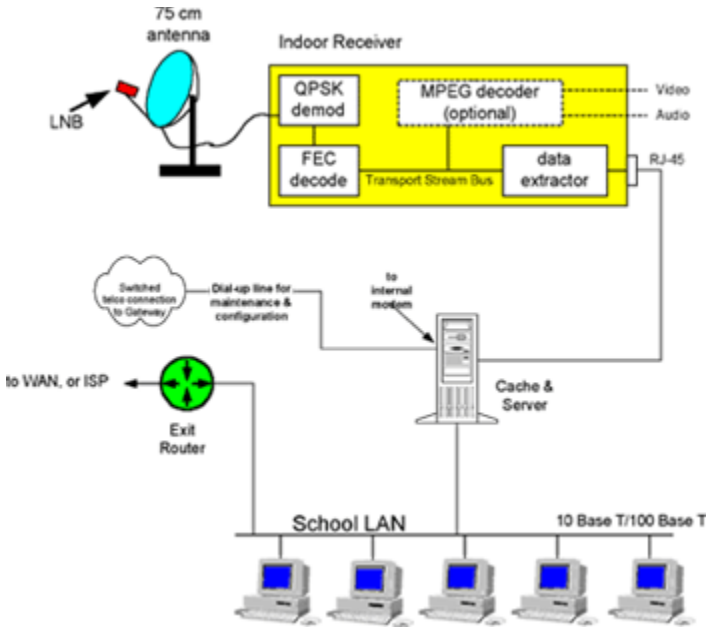
New Technologies Needed

 Telesat became involved in the Schoolnet I initiative by providing a satellite solution to facilitate Internet connectivity to approximately 1600 schools located in remote parts of Canada. Approximately 10% of the schools were connected under the Schoolnet I initiative.

The service was based upon a high-speed satellite connection integrated into the school local area network (LAN) providing the forward link, with a return link via telephone dial-up through an Internet Service Provider (ISP). Were it not for Telesat's innovations, it would not have been possible for many schools located in aboriginal and other remote communities to have access to the critically-important Internet. ExpressVu now provides this service through the Nimiq DBS satellite.

In 2000, Telesat expanded its Schoolnet involvement through the Schoolnet II over-the-satellite trial involving a dozen schools in off-net regions of Ontario and another dozen schools in Newfoundland and Labrador. The purpose of this project was to explore the potential advantages of remote caching by combining the strengths of satellite data broadcasting and the broadband content available from the fibre-optic backbone systems, such as the CA*Net II & III. Telesat installed a pilot satellite-based caching service to schools and communities to determine how and where this combination of technologies would be most effective. Protocols and connection issues were studied and an assessment was made as to the benefit of incorporating caching into service delivery networks for schools.

The trial network consisted of a gateway and remote terminals, twenty of which were installed at schools in two school districts - the Hastings & Prince Edward district in Ontario, and the Lewisporte & Gander district in Newfoundland and Labrador. A hub station was established at Telesat's Research and Development (R&D) Lab in Ottawa incorporating an intelligent caching engine and receivers that were developed in association with Canadian suppliers. Each school was equipped with a satellite receiver and a 20 GB cache. The satellite connection added a networking element, which effectively tied all the school caches together into a network of common interest. The most popular web objects, calculated by the intelligence engine at the satellite gateway or the most important web sites, selected by school administrators and teachers, were retrieved by the Gateway cache on a scheduled basis and transmitted by satellite to every school in the network. Each school cache accepted and stored this information, so that it was available for subsequent requests.



Schoolnet II brings the benefit of satellite web caching to off-net schools

These trials have already demonstrated the substantial benefit of satellite Web caching for schools in off-net areas. The cost of communications was reduced by 25% and student Web access response times were vastly improved.

In terms of a potential future service, this type of network could be used to extend the reach and benefits of the existing high-speed terrestrial fibre networks. Content-specific caching via satellite will extend reach to areas that would otherwise have limited access to high-speed interconnections. The use of a local cache, updated from a large gateway-based cache, on either a real-time basis or an off-hours basis, will leverage the benefits of satellite high-speed broadcast capabilities in a very economical fashion. The benefit to the users would be a significantly enhanced experience with faster access to Internet-based information sources than is possible with the low-speed access technologies currently available to many schools and remote communities.

Schoolnet-3: multimedia satellite trials for schools

Telesat and its partners, as shown in Figure 4.1.1, have installed a network of thirteen schools in three provinces. The system installation was completed in June 2002, and the trial officially started in September 2002 to coincide with the start of the school year.

The schools selected for this trial are a sample of the diverse and innovative schools of Canada. The network has been designed to support experiments with new and emerging applications.

The system that Telesat has installed at schools for this project provides a unique platform, which would not have been practical with any other type of network. It bypasses the normal bottlenecks of other networks, allowing schools the most direct access to information, training, and educational resources. It offers two-way access to World Wide Web. It also makes it possible to reliably deliver multi-media material (video, audio, text, & files) to schools upon request. Finally it creates a platform for effective collaboration amongst schools, and between schools and resource centres such as electronic libraries, higher education centres, and adult learning centres. The initial capabilities that are supported are the following:

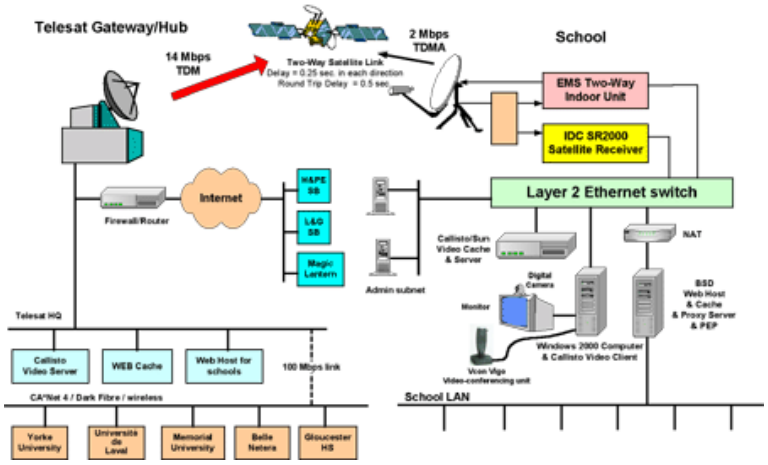
- Enriched and collaborative video-conferencing, with tools such as electronic whiteboard, collaborative file and document editing, and remote application sharing.
- High speed two way access to the Internet, including a very high speed (14 Mbps) satellite link from the Telesat hub in Ottawa to the schools, and a satellite return link (2 Mbps, max) from the schools.
- Reliable video streaming or downloads over satellite to the schools. In addition, the schools are equipped with a video storage cache and server, thus permitting students and staff to locally search a list of contents to play the clip or segment of video material any time they need it. The cache has a capacity to hold up to 25 hours of material. Through satellite-based reservation system, the students and staff are also able to request additional material stored in central repository connected to the Telesat hub in Ottawa.

- Web Caching and Hosting. A medium sized web cache is installed to support satellite web access from the schools by holding and maintaining a current selection of popular web objects - based on student requests. It can also serve as a web host site for the school, and could be accessed from anywhere in the country, over satellite, through a proxy address at Telesat's hub.

The initial applications will serve as the starting point for further enhancements, and to provide a platform to allow the schools to experiment with their own applications, and to support a variety of school projects.

The Network

An overview of the network is depicted in Figure 4.1.2, and it shows the major connections - both satellite and terrestrial. The major terrestrial connections include a 3 Mbps access to the Internet through Telesat's ISP, and a 100 Mbps link to the CANARIE cross-Canada experimental fibre optic network - CA*Net 4.



The Network

The satellite link provides two-way access for all schools. The link is asymmetric, with a 14 Mbps transmission from the Telesat hub in Ottawa (the forward link) that is received by all schools, and a maximum 2 Mbps transmission from any school (the return link) that is received by the hub.

The forward link carrier uses an access technique called "Time-Division-Multiplex", or TDM. All the traffic for all the schools is contained in this carrier. The traffic is always in the form of IP datagrams, and is always transmitted on a first-come-first-served basis. Each school will receive the entire 14 Mbps stream, but it will be able to extract only its own traffic from the stream. For special applications, such as video conferencing and live video streaming, the hub equipment ensures that these transmissions are given priority and are not impeded by other routine non-real-time applications.

On the return link there are three separate carrier frequencies available to the schools, resulting in a total return link capacity of 6 Mbps for the whole network. Whenever a school wants to transmit, it uses an initial pre-assigned time slot on one of the carrier frequencies. Time slots are shared by all the schools using an access technique called "Multi-Frequency, Time-Division, Multiple-Access," or MF-TDMA. The initial time slot assignment permits the school to transmit at a rate of 64 kbps. The hub will then assign it more available time slots, to accommodate its transmission requirements. The number of slots that a school is assigned also depends on the traffic requirements of all schools in the network. The transmission limits for each school are between 64 kbps and 2 Mbps, the upper limit for its 7-Watt transmission amplifier and 1.8 meter antenna.

On the terrestrial side, Telesat has 3 Mbps ISP access to the Internet, to provide excellent response times for the schools. In addition, Telesat also has a 100 Mbps connection to CA*Net 4, which permits high quality video-conferencing between the satellite schools and the Universities connected to CA*Net 4. Through a partnership with the Netera Alliance, Telesat is also involved in the "Belle Project", which gives it access, via CA*Net 4, to another video server located at the University of Calgary. The Belle project has been sponsored and partially funded by CANARIE. Belle stands for "Broadband Enabled Lifelong Learning Environment", and Belle project partners have developed a prototype educational object repository, which includes the video server mentioned above. A more detailed description of the Belle project can be found at http://belle.netera.ca

The Schools

There are 13 schools connected to the network:

Ontario

1. Kente Public School Ameliasburg
2. Bayside Secondary Quinte West
3. HPEDSB Education Belleville
4. Pelican Falls First Nations High School Sioux Lookout

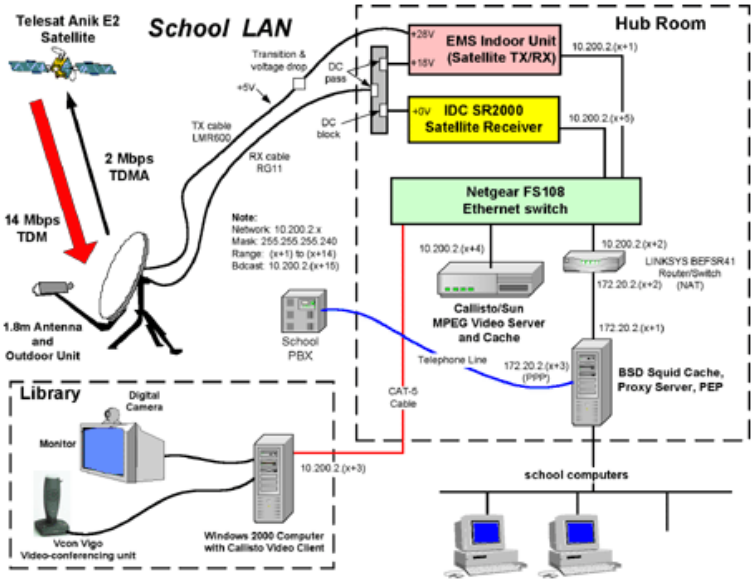
Newfoundland

5. St. Paul's Intermediate Gander
6. Glovertown Academy Glovertown
7. Fatima Academy St. Brides
8. Roncalli Central High Port Saunders

Quebec

9. Sainte-Agathe Academy Sainte-Agathe-des-Monts
10. Ecole Saint-Damase Saint-Damase
11. Ecole Hamelin Wotton

12. Ecole Ulluriaq Kangiqsualujjuaq
13. Ecole Secondaire Otapi Manouane

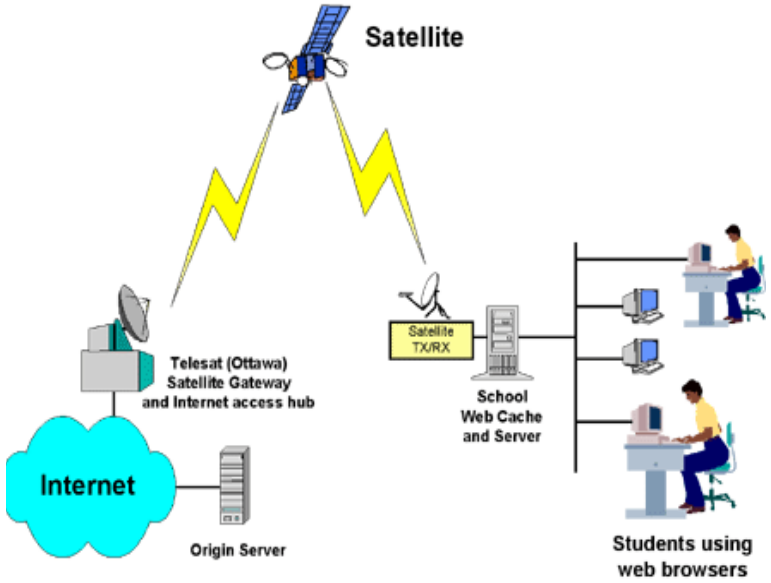


School Internal Connections

The Applications

Internet Access

Internet access from any school is provided over the satellite link. A student using an Internet browser requests access to a website. The request is sent over the satellite link to Telesat's hub and then over the Internet through Telesat's ISP. The response travels in the opposite direction and is displayed on the student's computer. All cacheable objects contained in the response are in the school's web cache, so that the next time the same object is requested, it will be served directly from the cache, rather than from the origin server. We have found that this technique will result in a cache "hit rate" in excess of 50%, thus greatly speeding up the average response time to requests.



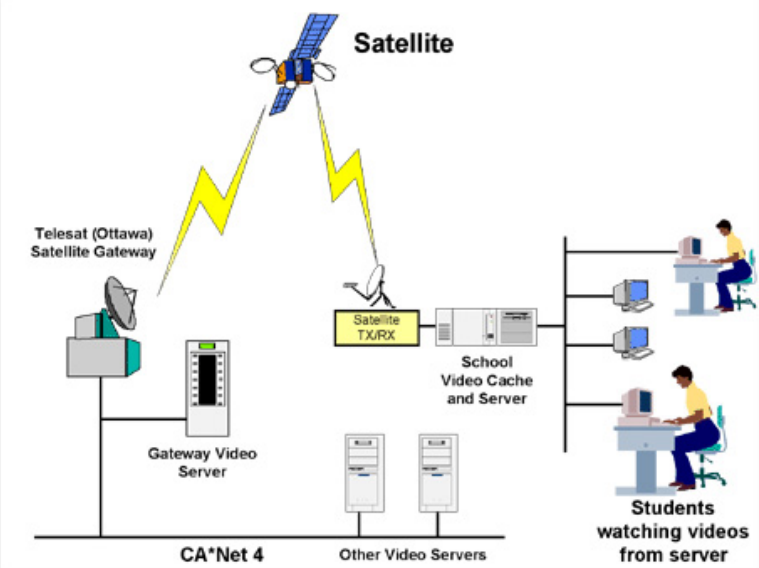
Internet Access

Video Distribution

The video distribution and server system allows students to play MPEG video files from their school server. A student has access to a graphical interface in any computer that has been loaded with the Callisto Voyager client. The client presents a hierarchical menu, showing categories and titles that are loaded on the Callisto/SUN server. The student selects a title and hits the "play" button. It's as simple as that.

An administrator or librarian has additional access privileges, which allows them to use the satellite link to view the titles of videos located at Telesat's central server, or on other compatible servers located at CA*Net 4 sites. An example of such a server is the one located at the University of Calgary through the Belle project. They may select from the titles and request a download to their local server. The satellite download takes place on a scheduled basis within a transmission window - usually between midnight and 6:00 AM.

The students may also create their own videos, which they can then compress into MPEG-1 files, using the ATI "All in Wonder" card that was supplied with the Windows 2000 computers. From there they can be loaded on the school's video server for local playback or "FTP'd" to Telesat's central server and made available to the whole satellite network.



Video Distribution and Servers

Video-Conferencing

An open standard (ITU H.323) video-conferencing platform has been installed at all the schools. This allows any two schools to have interactive video-conferencing sessions between each other, as shown in Figure 4.1.6, or between a school and resource centre as shown in Figure 4.1.7. They may also use the system for distance education sessions as shown in Figure 4.1.8.

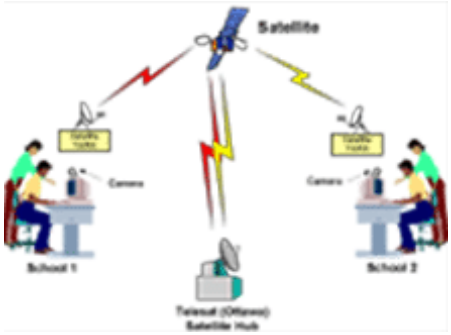


Figure 4.1.6: School-to-school video-conferencing

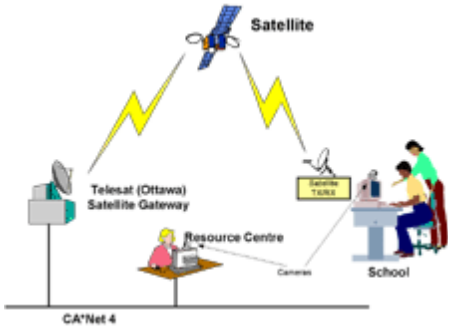


Figure 4.1.7: School-to-resource-centre video-conferencing

Figure 4.1.8: Distance Education

Conclusions

This network has been installed to give schools exposure to satellite-based platforms and services, and to provide an opportunity to learn about the possible applications that such a network could support. It is also intended as an experimental platform to test and improve existing and emerging services. The schools have already begun to organize projects for which they intend use this network.

The final stage in this development program will follow the launch of Anik F2. Telesat's Ka-band payload on Anik F2 will enable Schoolnet III type services using small, affordable user terminals in combination with low-cost airtime.