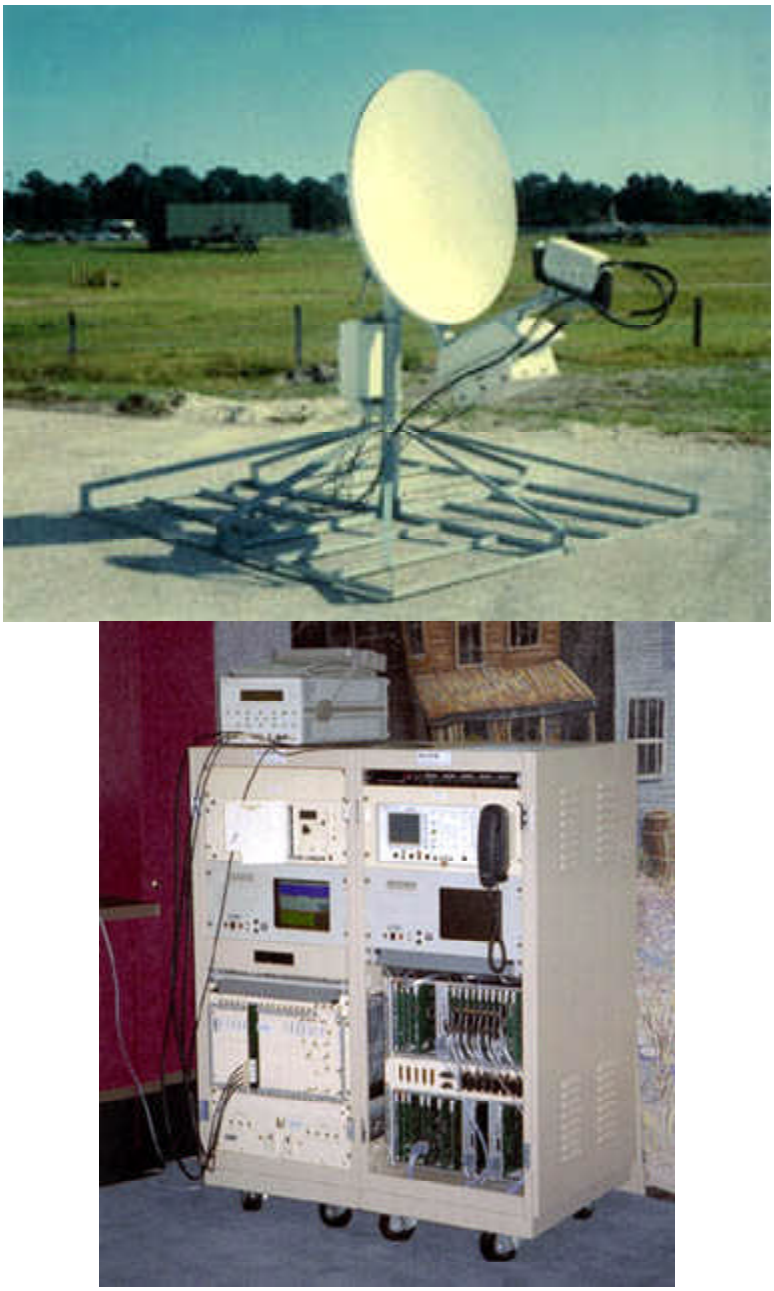
ACTS High-Speed VSAT Demonstrated

The Advanced Communication Technology Satellite (ACTS) developed by NASA has demonstrated the breakthrough technologies of Ka-band transmission, spot-beam antennas, and onboard processing. These technologies have enabled the development of very small and ultrasmall aperture terminals (VSAT's and USAT's), which have capabilities greater than have been possible with conventional satellite technologies.

The ACTS T1 VSAT operates at a burst rate of 27.5 Mbps, but the maximum user data rate is 1.792 Mbps. The throughput efficiency is slightly more than 6.5 percent. For an operational network, this level of overhead will greatly increase the cost of the user Earth stations, and that increased cost must be repeated thousands of times, which may ultimately reduce the market for such a system.

The ACTS High Speed VSAT (HS VSAT) is an effort at the NASA Glenn Research Center at Lewis Field to experimentally demonstrate the maximum user throughput data rate that can be achieved using the technologies developed and implemented on ACTS. This was done by operating the system uplinks as frequency division multiple access (FDMA), essentially assigning all available time division multiple access (TDMA) time slots to a single user on each of two uplink frequencies. Preliminary results show that, using a 1.2-m antenna in this mode, the High Speed VSAT can achieve between 22 and 24 Mbps of the 27.5 Mbps burst rate, for a throughput efficiency of 80 to 88 percent.

The High Speed VSAT is the result of an effort to improve the throughput efficiency of the ACTS VSAT by eliminating, in experimental scenarios, any uplink TDMA and devoting all the time slots in the frame to a single Earth station. Its design combines the individual channels in a single high-speed interface, rather than in multiple 64-kbps ports. Then, the channels are buffered and formatted to meet standard network protocols and data rates. The following photos show the outdoor and indoor units for a High Speed VSAT.

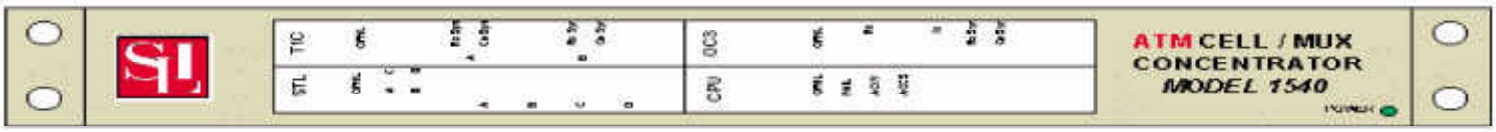


High Speed VSAT. Left: Outdoor unit. Right: Indoor unit.

Development of the high-speed port involved the replication of the T1 VSAT circuit buffer cards, whose primary function is buffering data between the modem bus and the serial port connection. It also involved the definition of a high-speed port address in the address space, and implementation of the custom T1 VSAT address and data bus interfaces on the board. Initial experiments used a prototype high-speed interface; an improved high-speed interface has been developed to support further experimentation.

The new High Speed VSAT interface board for the ACTS satellite will enable services in the 25-Mbps range, thus increasing user throughput efficiency from 6.5 to over 80

percent. To maximize the number of services provided and accommodate the maximum number of users, the High Speed VSAT architecture includes a commercial asynchronous transfer mode (ATM) concentrator (the Cell Mux Concentrator) in addition to the high-speed board. This off-the-shelf device, diagrammed in the following figure, allows several high-data-rate interfaces while it does all the processing for ATM transmission.

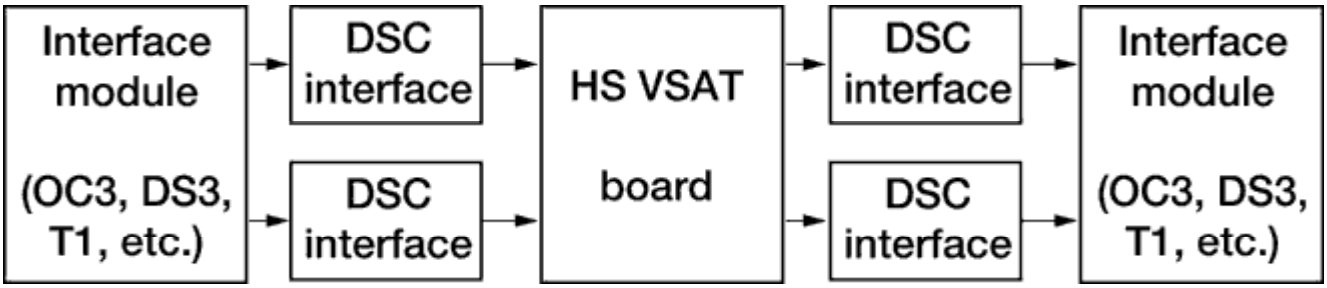


Off-the-shelf Cell Mux Concentrator for the High Speed VSAT.

The Cell Mux Concentrator (ref. 4) is a flexible, modular, scaleable, and cost-effective ATM cell multiplexer (Mux) that uses ATM cell bus architecture. It provides the system/network integrator with an ATM cell platform that operates on the "net edge" to concentrate both cell traffic (frame relay and ATM) and legacy (non-ATM) traffic. It supports both ATM cell and legacy data applications and networks, performs HEC byte search functions, multiplexes and switches ATM cell traffic, provides synchronous interfaces for satellite and secure networks, and gives cost-effective access to ATM networks for legacy communications equipment and applications.

There are several applications for this interface (ref. 4), but the most interesting is the transmission of ATM/SONET through the satellite. This ATM concentrator allows a satellite transmission network to transport ATM cell-bearing traffic at user programmable rates in 8 kbps increments. This facilitates an "ATM anywhere" capability, whereby remote users can tap into ATM networks via satellite access. Users can program the device to gain access via any available or economical satellite segment.

By using the HS VSAT interface to the ATM programmable concentrator, any number of possible applications can be transmitted through ACTS. The ATM concentrator can be configured to process and format ATM cells from any of its interface modules and route them to the DSC interface module. The following figure shows a block diagram of the end-to-end user interface.



End-to-end user interface for the High Speed VSAT. (Data rates: OC3 = 155 Mbps, DS3 = 43 Mbps, T1 = 1.544 Mbps.)

This new flexible, scaleable interface will allow cost-effective access to ATM networks

and the transmission of ATM cells at low speeds over commercial systems. It is expected to be fully operational by fall of 1998. Experiments being planned include a telemedicine/telemammography demonstration, ATM over satellite, TCP/IP (Internet protocol) over satellite, videoconferencing and distance education, LAN to ATM networks, and a high-speed Internet demonstration. New experiments can be scheduled through the ACTS experiments office.

References

1. Campanella, S.J.: An Onboard Processing Beam Hopping Satellite. AIAA Ninth International Conference on Digital Satellite Communications, May 1992.

2. Dendy, R.P.: ACTS: Next Generation Satellite Technologies for Tomorrow's Communication Satellite Applications. National Engineering Consortium Annual Review of Communications, vol. 46, 1992, pp. 892–902.

3. O'Reilly, M.; Jirberg, R.; and Spisz, E.: LBR–2 Earth Stations for the ACTS Program. AIAA Paper 90–0838, 1990.

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