DOCUMENT RESUME

ED 115 235	95	IR 002 778

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TITLE	The Satellite Technology Demonstration's Experiences with Varied Terrestrial Signal Distribution Methods. Satellite Technology Demonstration, Technical Report No. 0335.
INSTITUTION	Federation of Rocky Mountain States, Inc., Denver, Colo.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	75
NOTE	13p.; For related documents see IR 002 769-793
EDRS PRICE	MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS	Audiences; *Broadcast Reception Equipment; Broadcast Television; Closed Circuit Television; Communication Satellites; Community Antennas; *Delivery Systems; Demonstration Projects; Educational Television; Fixed Service Television; Microwave Relay Systems; Regional Programs; *Telecommunication; *Video Equipment
IDENTIFIERS	*Satellite Technology Demonstration

ABSTRACT

Though the Satellite Technology Demonstration (STD) system had the capacity to deliver quality broadcast signals to specially designed ground terminals its budget did not provide for more than one receiver in each rural community. In order to translate the satellite signal into a broadcast available to the individual home viewer, several systems were available: (1) rebroadcast the signal via standard public television; (2) use microwave for direct transmission from one location to another; (3) use a translator station to repeat and amplify the signal in isolated locations; and (4) rebroadcast the signal via community cable television. In each region where STD was employed, different combinations of technology were used to reach the largest audience possible. Unique plans were developed in Roundup, Montana; Ely, Nevada; Osborn, Idaho; and Elko, Neveda. Based on this experiment, future telecommunications managers are advised to learn to: (1) promote consensus among participants; (2) be willing to use a variety of technological adaptations; (3) provide potential users with sample programs; and (4) consider the size of the audience and the cost of the broadcast well in advance. (EMH)

SATELLITE TECHNOLOGY DEMONSTRATION

FEDERATION OF ROCKY MOUNTAIN STATES, INC.

technical report

TR0335

THE SATELLITE TECHNOLOGY DEMONSTRATION'S EXPERIENCES WITH VARIED TERRESTRIAL SIGNAL DISTRIBUTION METHODS

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INTRODUCTION

Future telecommunications experimenters and service providers may face constraints--budget limitations and federal restrictions--similar to those faced by the Satellite Technology Demonstration (STD) and, for selected program areas, may wish to broadcast directly to homes. This paper, therefore, describes the alternative delivery systems (open air or broadcast and cables and transponders) that augmented the STD's system.

PLANNING

The STD's early planning efforts centered on studying the potential interface of the satellite network with existing terrestrial communications systems. An interface was necessary for two reasons. First, if the communications satellite (the ATS-6) was used exclusively, the STD would have to equip each site (home) with a receiver, and this would cost more money than the STD's federal sponsors had provided for the Demonstration. Second, if the STD installed only one receiver per community (to stay within the budget), it would limit the scope of the Project. Project participants would have to come to one central location to view the programs; they could not view the programs in their homes. A single receiver per community not only limited an audience's access to programs, but it also limited the size of that audience. These limitations would affect the STD's programming in different ways.

Access was not a problem with career education programs, because the intended school audience was "captive" in the classroom or at the location of the receiver. With only one receiver per community, however, only one school community could be served. The size of the audience would be limited.

Both access and audience size was a problem with early childhood training. Child caretakers, including parents, conduct their services in schools, day care centers, Head Start centers, and private homes throughout the community. Each location usually employs only a small number of caretakers. A single receiver at any of these locations would, therefore, limit the size of the audience; it also would limit an audience's access to programming. The potential viewers (the caretakers) would be unable to leave the children while they viewed the programs. A possible solution to this problem would be to take the television signal to the caretakers, not to bring the caretakers to the television.

But to take the signal to the audience, the STD needed to develop an alternative delivery system. It began to investigate alternatives that would increase audience access to programming, as well as increase audience size.

DELIVERY SYSTEMS

Three systems were involved in delivering STD programs from the point of origin to the destination--space, cable, and a combination of both. These systems included the following:

Open air	Standard broadcast (direct from sending antennas to home receiver); for example, public television stations
Microwave	Closed circuit relay service
Translator	Conversion of a radio frequency (RF) signal to a different carrier frequency (channel)
ITFS	Instructional Television Fixed Service
CCTV	Closed Circuit Television

Open Air

The open air or broadcast system of delivery is the most direct and least complicated. Broadcast television can be seen by anyone within reach of a station's broadcast signal. The station's primary purpose is to reach the entire community. Both UHF and VHF signals are broadcast by expensive transmission equipment and towers; the signals travel roughly to the horizon.

The majority of televised lessons are transmitted by noncommercial public television stations, but some are carried by regular commercial stations via public service broadcasting. Both are transmitted primarily by open air, and lessons televised in this way are available in the home, on an ordinary television receiver.

Microwave

Microwave is used primarily for long-distance relays between cities or from a centrally-located studio to a remote transmitter. Many coast-to-coast network programs are relayed via microwave. The nature of this signal allows only a straight line-of-sight path. Depending on the topography, the transmitting antenna and receiving antenna can be separated by one mile or as many as 200 miles. The determining factor is how high above the earth's surface the transmitting and receiving antennas are located so that they can "see" each other in a straight line of sight, with no obstacles between them. Because the general public cannot receive these microwave signals on normal television receivers, television programs relayed by microwave are converted into conventional VHF or UHF frequencies and retransmitted to the public on the airways.

Translator

A translator is a repeater station that allows an open air broadcast signal to be retransmitted from a better location on another channel. Its primary purpose is to cover an area in which the original signal is either weak or interrupted or distorted by manmade objects, such as buildings and water towers. A translator differs from a microwave relay in that: (1) a signal from a translator can be picked up directly by the home receiver; and (2) a translator emits an omnidirectional signal, rather than a unidirectional signal.

For example, a translator might provide coverage to a high mountain valley, completely surrounded by mountain peaks. The originating station's signal would be blocked by the peaks, but a translator (a low-powered, limited transmitter), located on top of one of the mountain peaks, would be able to pick up the signal and retransmit it to the community in the valley.

Instructional Television Fixed Service (ITFS)

In 1963, the FCC limited the 2,500 to 2,690 megahertz frequency band to instructional broadcasts. Often referred to as 2500 MHz, since the service is transmitted at that frequency, the ITFS is a hybrid transmission system that is used by educational institutions, medical institutions, and civil service organizations to send televised materials to restricted geographical areas, without the use of wires. Depending on the topography and the needs of the broadcaster, the 2500 MHz signal will cover 5 to 20 miles in all horizontal directions from the transmitting antenna. Each ITFS system can be designed to transmit four channels of radio frequency (RF) television simultaneously.

Community Cable Television (CCTV)

CCTV is a general category for many systems that transmit a television signal from one point, then to another point, and finally to selected audiences. In most cases, CCTV's must originate a television signal, whose path may involve the airways and/or cables. The ITFS system (mentioned above) is a closed-circuit, open-airway system. An example of a closed-circuit, cables-only system is Florida Atlantic University's CCTV, which has three television studios and which sends signals over seven RF channels throughout the university.

A closed-circuit television installation can operate in only one room, school, or factory; or it can cover an entire county or an entire state. But no matter what physical area is covered by the system, only those schools or buildings directly connected to the studio or videotape recorder can receive the programs. Television sets in ordinary homes that are not connected to the closed-circuit loop will be unable to receive the programs.

PUBLIC TELEVISION STATIONS

The factor which significantly increased the size of the STD's audience was the participation of the region's public television stations. This participation gave the STD a method other than direct satellite reception to transmit programming.

A satellite receiver was installed at 12 public television stations throughout the eight-state region, thus permitting these stations to receive the STD's signal and either to broadcast the programs in real time or to rebroadcast the programs at a more convenient time. Since public television stations are open air systems that broadcast directly to home television sets and to schools, the STD was able to service many metropolitan schools on an "open-site" basis. In addition, parents were able to view, at home, the same programs viewed by their children in the open-site schools.

The cooperation of regional public television stations was solicited in early, 1971, during the STD's formative stages. The STD provided the stations with information regarding proposed programs and with periodic updates, as the Project moved through its developmental phase. As the operational year neared, Project personnel met (individually and collectively) with station personnel to work out procedures for public television participation. Among many items of discussion were scheduling, tape cost, video recording capability, program quality, and public information responsibilities. These negotiations led to contracts, or to letters of agreement, between 12 of the 13 stations in the region and the STD; the 13th station was outside the proposed satellite coverage area.

Applications

The participation of public television stations enabled the STD to transmit its programming not only to major population centers in the Rocky Mountains, but also to remote areas in the region. This expanded coverage was possible, because public television signals frequently are picked up by cable, translator, and microwave operators. Station KUED (Salt Lake City) signals, for example, are available to Western Wyoming and parts of Montana, Nevada, and Colorado; station KRMA (Denver) signals reach into Wyoming.

Public television station participation also enabled the STD to employ a variety of distribution methods. In Las Vegas, for example, receiving terminals were installed at the local public television station (KLVX) and on the University of Nevada, Las Vegas, campus. Reception at KLVX was distorted by the station's ITFS system that was used to distribute instructional programming to the Clark County School District. When the ITFS system was inoperative, the receiving terminal at KLVX operated without interference. To solve this interference problem, the University of Nevada at Las Vegas made video cassette recordings of programs received from their ground terminal. These recordings were hand carried to KLVX and rebroadcast via the ITFS system to junior high schools participating in the Demonstration. A "stop-gap" approach, this system demonstrated that various communication modes can be used to effect distribution.

The response to public television station participation, coupled with microwave, cable, translator, and/or ITFS systems, was favorable. Schools in all eight Project states participated actively in the program, and many of these schools purchased student and teacher guides at their own expense. These purchases helped the open sites to view programs, follow student and teacher guides, and implement useful career education training with a minimum of outside support.

In addition to the general applications described above, public television station participation enabled the STD to interface with translator and cable companies in four local communities that were selected as STD sites. STD antennas were installed at translator facilities in Roundup, Montana, and Ely, Nevada; and at cable facilities in Osburn, Idaho, and Elko, Nevada. These installations (which replaced the one installation per school requirement) allowed the STD to access entire communities, rather than one central location in each community.

Roundup, Montana

In Roundup, Montana, the STD found a community with no educational television service, but with strong interest in public television (PTV). The man who operated the local translator facility was highly supportive of PTV distribution via translator; he vigorously pursued an arrangement with the STD before Roundup was selected as a site. An agreement involving the STD, the school district, and the translator company was arranged, and an STD antenna was installed.

The Roundup experience demonstrated the value of delivering satellite programs via translator. Programming transmitted to the homes not only helped to increase community awareness about the STD, but also to increase community awareness about, and support of, the local school district. Further, the distribution of certain program elements--for example, educational films and/or tapes--to the homes was especially useful to Roundup's larger-than-normal retired population, whose access to public libraries and schools was limited.

Ely, Nevada

Ely, Nevada, further demonstrated the value of delivering satellite programs via translator. Ely's facility not only served Ely, but also the neighboring communities of Ruth, McGill, and East Ely. The superintendent of the White Pine County Schools (serving Ely, East Ely, Ruth, and McGill) asked that STD programs be brought to the area through the local community translator installation on Squaw Peak. Simple as this interface appeared, the logistics became extremely complex.

Initially, Project personnel negotiated for translator service with the White Pine Television District (WPTD), which was completing installation on Squaw Peak and was awaiting final authorization from the Federal Communications Commission (FCC) to broadcast educational television (ETV) programs over Channel 13. Before Project broadcasts began, however, the FCC received a request by the Western Communications Corporation (WCC) to bring its commercial programs (via station KORK-TV in Las Vegas) into Ely until the WPTD could bring ETV to the area. When the STD's request for translator service was brought to the WPTD, the Board of Directors approved it quickly. Meanwhile, the FCC granted a permit to the WCC to begin programming over Channel 13. A compromise agreement was reached, allowing the WCC to broadcast STD programs over Channel 13 and to honor the start of program service on September 9, 1974.

Before the start of program service, the STD negotiated a contract with the WPTD for the installation of a satellite receiver on Squaw Peak. Since the WCC held the FCC broadcast permit, an arrangement had to be made to switch the STD signal manually from the WPTD equipment to the WCC translator equipment. Conveniently, the WPTD and WCC equipment was housed in the same building. With the transmission of STD programs to the area, the WPTD finally expedited its application for ETV use of Channel 13. However, no one at the FCC in Washington could locate the application. After additional discussions, the WPTD secured approval for a manual switch device and, later, an automatic switching unit, enabling the station to preempt Channel 13 programming for STD broadcasts.

During the Project, the WCC provided the air time for STD programs over Channel 13; the WPTD provided the switching equipment and, up until January, 1975, the person to do the manual switching at Squaw Peak. The WPTD also maintained records of satellite signal strength. Early in the first semester, the signal strength was approximately eight to nine decibels. When STD engineers changed the frequency of the radio on the satellite receiving equipment in November, 1974, from the northern footprint (2660 MHz) to the southern footprint (2560 MHz), the signal jumped to the 16 to 18 decibel range.

In sum, although first semester transmissions to Ely's schools were sporadic, second semester transmissions were characterized by excellent service and signal quality. The WPTD still is negotiating for the ETV allocation of Channel 13. WPTD personnel believe that they will be able to bring in the public television station from Las Vegas (KLVX-Channel 10) in the near future; this event may qualify the community translator district for the Channel 13 grant.

Osburn, Idaho

In Osburn, Idaho, the actual STD site was the Silver Hills Junior High School, which is part of the Wallace Idaho School System. Wallace is only five miles east of Osburn and both communities are served by the local cable company. The school administrators in the area have a strong orientation toward community education and were immediately interested in having the STD's programs delivered via cable. The STD entered into a contract with the cable company, and the antenna was installed at the company's headquarters in Silverton, which had an open channel to allocate to STD programs. The chief engineer of the cable company was designated as the key contact for the Project.

The channel allocated to the STD also was used to report local time and temperature (between program transmissions) by an automatic device that panned a camera back and forth from a clock to a thermometer. To deliver STD programs, it was necessary to travel to Silverton and switch from cable feed to satellite receiver. The engineer agreed to make the switch at scheduled times, but this arrangment proved to be unreliable. The engineer stated that he was not provided with accurate times; he was placed on the STD's mailing list to receive broadcast schedules, but this did not correct the problem. For a time, school personnel assumed responsibility for the switching. This arrangement also was unreliable, because school schedules often conflicted with broadcast schedules. As a result, relationships between the school staff and the cable company personnel became strained, and the school and community missed several STD programs. The school was disappointed in the cable service received by the community through this system.

Elko, Nevada

Rather than using the school as the conventional STD receiver site, the Elko, Nevada, school administrators wanted to use local TV facilities to reach several schools simultaneously, as well as to reach interested parents and adults in the community. To enable them to do this, Project personnel (in the state) arranged several meetings with the regional manager of Telecommunications Corporation, Incorporated (TCI) in Denver. TCI is the parent company which operates the local cable company in Elko (TV Pix, Inc.). The STD and TCI encouraged the manager of the local cable company in Elko to work out the details of Project participation with the Elko schools and the state STD office. A contract between TV Pix and the STD was signed to install a receiver on the roof of the cable company building. A second contract was negotiated to reimburse the local cable company manager for switching the STD programming for cable distribution. In return, the local manager agreed to turn on the cable equipment each day, record the program, and replay it once, at a time approved by the school office.

Although the system was relatively simple, it functioned sporadically throughout the broadcast year. Part of the trouble was traceable to the cable TV company equipment; part to equipment failures at either the point of origin (the cable company) or at the destination (Elko's junior high school). Elko's school administrator, who was in charge of all STD activities, couldn't decide whether to use the programs directly from the cable transmission or to replay them, using the school videotape recorder. This indecision caused confusion in the school-TV Pix relationship, and less-than-ideal results were obtained.

Western and Northern Nevada

One of the STD's most successful interfaces was, ironically, the most complicated. Tremendous enthusiasm was generated in Nevada when the Federation of Rocky Mountain States (the STD's parent organization) announced that it would offer satellite programming to the state. Since no statewide ETV transmission system was available in Nevada, the Federation's offer of educational program service was accepted eagerly by state school administrators. However, when the Federation also announced that the STD's footprint would cover only the eastern and southern areas of the state, school personnel in the western and northern areas were dismayed. These "blacked out" areas are covered only by commercial TV reception.

The STD's state coordinator, with encouragement from Project personnel in Denver, was able to establish a cooperative network arrangement among the Western Communications Corp., the University of Nevada at Las Vegas, and Teleprompter Cable TV in Reno. The negotiations were complex, because many organizations and people were involved, including two commercial broadcasters, a public university, a public school system, a federally-funded project, and the Nevada Educational Communications Commission. The system that evolved as a result of these negotiations was, however, extremely reliable and effective.

The system worked as follows:

1. A satellite receiver was placed at the University of Nevada at Las Vegas.
2. The University, which used portions of the program for in-service training, microwaved the signal to KORK, a commercial station operated by the Western Communications Corp. (WCC).
3. The signal then was relayed (through a series of microwave towers owned by the WCC) to Slide Mountain, which overlooked Reno.
4. From Slide Mountain, the signals were carried by cable to Teleprompter's pickup point in Reno, then relayed through Teleprompter's cable television system to junior high schools in Washoe County, as well as to Teleprompter's regular subscribers.

This network was a unique blend of public and private agencies. Some problems occasionally were experienced with the microwave links between Las Vegas and Reno, but the network was successful in making programming available to students who, without the system, would not have been exposed to the Demonstration. School personnel in Reno were pleased with the programs. The most significant result of this arrangement, however, was the development of viable public-private relationships, for it was these relationships that made program transmission possible.

In conclusion, the STD, representing celestrial communications, interfaced with a variety of terrestrial television systems and with several combinations of those systems. Through these arrangements, the Project demonstrated the possibility of delivering social service programs to homes, while obtaining program acceptance among the receiving audiences.

RECOMMENDATIONS

The following factors affect the success of a satellite-terrestrial interface.

1. Project participants must be committed to solving problems through consensus. In some participating communities, the STD's link was successful; in others, personal and organizational conflicts made a technically-acceptable system inoperative.

2. Project personnel must be willing to commit resources to lengthy negotiations. These negotiations involve many national, regional, state, and local agencies. In the STD's Project, participating cable and translator facilities had to be cleared not only by state and local agencies, but also by the FCC. There is an excessive amount of paperwork involved in these clearances. Future planners should, therefore, develop in-depth plans for all ground links and obtain clearances well in advance of actual operation.

3. Project personnel must be willing to provide samples of program materials to participants. The STD found that extensive planning and discussions were necessary to secure the cooperation of the public television stations in the region. Future planners should allow ample time for these negotiations and should be prepared to distribute program samples to help the stations decide whether to participate in the program.

4. Before contracting for supplemental ground systems, future planners must consider all administrative costs and constraints associated with increasing audience access to programming, as well as the size of that audience. The STD's satellite-ground links served as case studies. Capital costs, operating costs, and revenue requirements for cable, translator, telephone, satellite delivery systems, and/or any combination of these systems must be considered in future planning.

This report was produced with funding from the National Institute of Education. The views expressed do not necessarily reflect those of the National Institute of Education or the U.S. Department of Health, Education, and Welfare.