9. The Synchronization and Demod section provides the following functions: front-end filtering for initial frame sync coarse acquisition; filtering for fine frame sync pull-in and basic bit sync; a measured statistic adequate for estimation of bit sync error both during normal operation and during resync preambles; a means of adjusting bit sync timing to within a resolution of 1 ns (could be continuous); a measured statistic adequate for estimation of carrier phase both during normal operation and during resync preambles; a means of adjusting carrier sync phase to within a resolution of 3 degrees (could be continuous); demodulation of the received bit-stream; timing and counting for basic frame functions.

10. The control and graphics processor coordinates user requests (from the remote control), initiates access procedures, coordinates appropriate demultiplexing and decoding operations, and tracks billing information and communicates through the telephone or to a "smart card" when necessary. It also has direct access to the video frame store for the purpose of implementing graphic overlays for full or partial screen graphical images or for text such as optional language subtitles, closed-captioning for the deaf, system messages, or personalized messages.

    The control and graphics processor will be a general purpose microprocessor having high-level language support (particularly C++) with the preferred processor being in the 68000 or 68020 family. Buss widths of either 16 or 32 bits will be considered. RISC architectures will also be considered.

    Processor RAM should be at least 2 Mbyte optionally expandable to at least 8 Mbyte. ROM size is <u>to be determined</u> (TBD) and will contain sufficient firmware and data base to allow the receiver to be set up, initialized, and properly authorized for initial operation. It will also contain display type-fonts and a sufficiently complete set of drawing primitives to allow a rich set of graphic displays including 24-bit shaded colorations (using the video frame store) and animated displays.

11. The Error Correction and Service Selection section provides for error correction decoding of appropriate blocks and extraction of necessary system information and selected user data. The access control section

provides for the authorized decryption of services and for the appropriate protection of decryption keys.

12. The Audio Section provides the appropriate audio decoding for whatever level of quality is received. Each receiver will be able to simultaneously decode and output at least two audio channels. The system and each receiver will provide for at least four types of audio formats and rates. This could be mono or stereo and could be any of several predefined quality levels. This will also be the audio output for radio stations received from the satellite.

    The data section is provided for direct output of digital information for use by computers and other peripheral equipment not directly related to TV or radio reception.

13. The Video Processor section is expanded in Figure 3.3-1. The channel buffer is a serial FIFO buffer which matches the timing of the transmitted bit-stream with that required by the video processor. The video controller decodes and interprets commands and coordinates the operations of the other elements. The variable length decoder converts the Huffman (or arithmetic) coded serial bit streams into single-word codes which will be further interpreted by the video processor. Other architectures may also be considered, e.g., variable length decoding prior to channel buffering and use of a separate command buffer.

    A digitally stored version of the complete image which will be displayed on the TV or monitor is stored in the frame store which is functionally equivalent to the video RAM used today in all computer display cards. Frame storage may be in any of several format depending on individual program requirements. The output processor performs any necessary output reconstruction filtering, matrix coding, and modulation (including audio) for the required output signal formats.

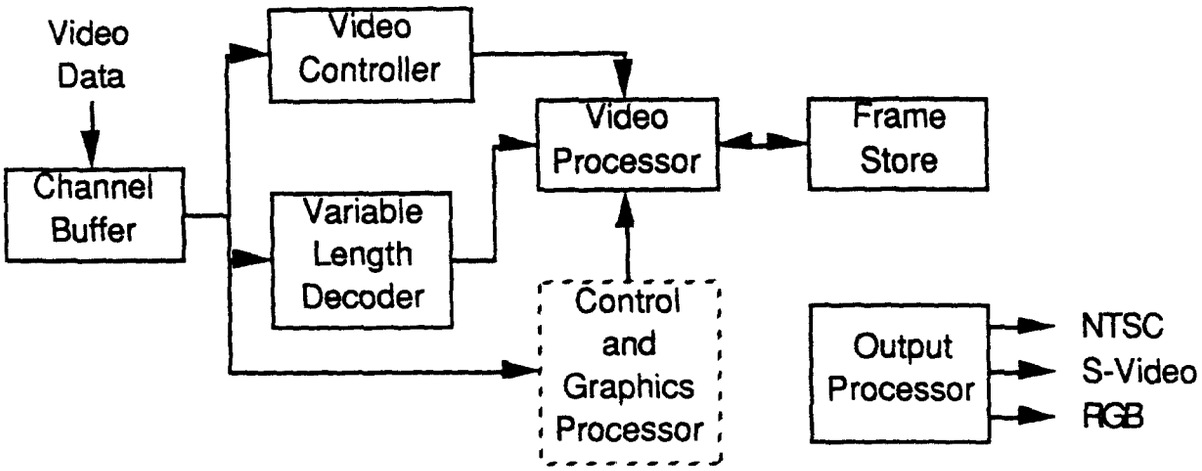


Figure 3.3-1 Video Section

14. The size of the channel buffer will be at least 1 Mbit and may be specified to be 4 Mbit.

15. The variable length decoder must be able to decode codewords of length between one and at least 16 bits (TBD). It must be able to process such decoding at a rate of one word per processing pixel clock (TBD).

16. The Video Processor is the heart of the receiver. The ACC approach is to maintain a high degree of flexibility in the processing architecture and algorithms to allow a wide range of services in addition to standard entertainment television. It is anticipated that the entire concept of source coding frame rate may eventually become irrelevant. However, source material that is organized as discrete frames will be coded as such.

17. The Frame Store will functionally operate as a two-port RAM with one port being random-access read/write and the second port being at least sequential access read-only. The addressable space will be at least 512 x 1024 = 512k words. The word width will be at least 24-bits (TBD). The required speed depends on the exact processing architecture and the types of displays which are to be supported (e.g., interlaced, sequential, wide screen, chrominance options). Comments are invited.

18. The Output Processor performs any required output conversion, matrixing, and modulation to interface to a variety of displays in user selectable modes. The necessary conversion will depend on the frame storage mode chosen for a particular service. Digital filtering and

resampling may be required. At a minimum, the available outputs will be NTSC, S-video, and interlaced RGB. Sequential-scan RGB and wide-screen format are desirable options. User-adjustable pan and selectable letter-boxing are also desirable output options.

4.0 Response Structure

The foregoing parameters and requirements are meant to form an appropriate basis for discussion with prospective equipment suppliers. We emphasize that the final selection of many design features strongly depends on the feasibility of achieving high quality performance in a price range that will be acceptable to the consumers. This, in turn, requires significant interaction with manufacturers and the eventual selection of a primary organization with which ACC intends to form a relationship to firmly specify , develop, and implement, the receivers.

The basic approach taken by ACC is to specify the broad parameters of a digital system which it believes can lead to an open architecture receiver capable of being manufactured by several sources and sold at typical consumer electronics prices, e.g. less than $700, including antenna and LNB. Respondents to this RFI should keep in mind that, while a significant competitive advantage will accrue to the primary development partner, eventually the receiver manufacture must be opened to other organizations.

ACC does not intend to be a direct customer for the receiver equipment. ACC's primary business is to provide DBS services. The sale and/or lease of equipment will be handled by other organizations. However, ACC has considerable expertise in the technology of digital compression and receiver design. ACC is receptive to proposals for joint development arrangements.

We solicit a response from you which will indicate your interest in forming such a relationship, your background and capabilities, your comments on the technical parameters, your proposed approach to the design and implementation, your expectations regarding business arrangements, and your specific suggestions for the next steps to open detailed dialogue with you.

Your response to this RFI should be as specific as possible. It should contain your approach to the issues of signal compression and security, RF equipment, volume manufacturing and consumer price targets, means of distribution, technology trends, and suggested business arrangements. It should not contain proprietary design information.

4.1 Scenarios

ACC is open to recommendations for the development and implementation of the equipment. For example, one possibility is the formation of a joint development agreement between a primary organization and ACC's affiliate, Advanced Communications Engineering (ACE). ACE's primary role is that of system engineer for ACC, developing the technology and architecture for the system.

An organization might supply the engineering development and product design in its entirety. ACE would be responsible for assuring the system integrity by overseeing the consistency among inter-related system parameters and equipment specifications.

As another possibility, ACE could co-develop the designs with a suitable manufacturing partner by supplying specific expertise and personnel. The joint development organization would then cross license the designs for manufacture by others. The primary development partner would have a head start for its own manufactured receivers and would also have royalty rights for cross-licensed units.

ACC is open to other suggestions and requests that you outline your specific ideas in this regard.

4.2 Compression

Signal compression is of vital importance to the future success of DBS. Issues include:

Should a "standard" algorithm, be adopted at this time? A unique proprietary technique may have performance advantages but this may counter ACC's desire for multiple sources to supply the equipment and may not allow ACC to benefit from future advances in compression techniques. Our fundamental approach is to develop an architecture and set of standardized interfaces capable of exploiting future advances.

What is your approach to compression for other services such as educational TV and audio?

What are the tradeoffs regarding the development of an open, flexible, and extensible architecture as compared with a customized design (e.g. a custom IC) which may preclude future flexibility?

4.3 Channelization, Multiple Access, and Security

ACC's DBS services are predicated on the ability to offer a wide range of transmission rates, e.g., including kilobit data services, audio, educational services, NTSC grade TV and HDTV. The total number of individual addressable channels could be very high. What are the implications for receiver design?

Furthermore, multiple uplink sites are important for such applications as news gathering, institutional (e.g. school, corporate, hospital, hotel, etc.) broadcasts. One way to achieve this is to use TDMA. What are your comments on the impact of TDMA operation?

4.4 RF Equipment and Link Budgets

What are the implications of using QPSK on such factors as the cost of the RF equipment. Specifically, comment on the feasibility of manufacturing low cost, low noise block downconverters (LNBs) and demodulators with sufficient frequency stability and phase noise properties. Describe your approach to antenna implementation (e.g. dishes, flat panel antennas, other) and the cost, mounting, and "user friendliness" of your preferred approaches. Comment on your interest in supplying the uplink encoder equipment and your experience in this area.

4.5 Company Capabilities

Please describe your organization's qualifications; background; relevant product line experience; marketing, distribution, and sales channels; production capabilities (i.e. your ability to ramp up production to meet market demand); financial information sufficient to understand your ability to commit to this project); and any other information you believe to be relevant.

4.6 Business Issues

Describe your vision of the business arrangement between ACC, ACE, and your organization. Comment on the scenarios mentioned in Section 4.1 and propose alternatives.

4.7 Where to send Response

Please submit three copies of your response by March 1, 1991 to:

Mr. Daniel Garner, President
Advanced Communications Corporation
1111 19th St., NW
Washington, DC 20036

Questions of a technical nature may be directed at any time by facsimile to:

Mr. Donald K. Dement
or
Dr. G. Gordon Apple

Advanced Communications Engineering, Inc.
Fax. 301-280-3979

If a telephone conversation is required, please indicate in your facsimile when and with whom this should best be arranged.

5.0 Schedule

We need to have distributed and ready for retail sale at least one million complete receiver units by mid-November 1993. This must be followed by a production/distribution capability that responds to the market, which may be in a range of 2-3 million units per year for ten years. The following table depicts the tentative top-level schedule, in months relative to this RFI's release date.

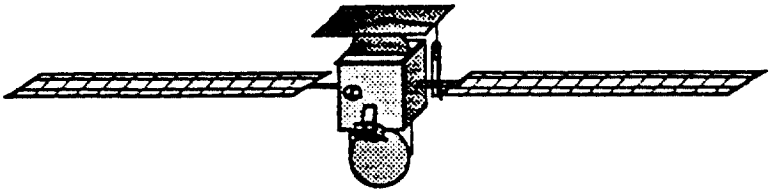
Item	Months After RFI Release
RFI Responses Due	2
Discussions with Candidate Suppliers	3 - 5
Negotiations with Primary Candidate	5
Contract	7
Development	7 - 25
Prototype Testing	25 - 31
Initial Production	36

Details of the start-up process you envision are welcomed in your response.

6.0 Conclusion and Summary

This design and the expected volume production will lead to the use of VLSI. We encourage earth terminal manufacturers and designers, and chip and component suppliers to respond to this largest potential microwave and integrated circuit market ever foreseen.

ACC's involvement with the earth terminal industry begins in a parallel direction with this RFI, on a similar schedule, and we expect with similar confidence that the many years of preparation for true DBS to small terminals are about to provide the rewards of being a vital, basic, and inexpensive wideband telecommunications means to homes, schools, libraries, and industries.



Wideband Digital Satellite Broadcast System Development

Abstract for DARPA's

High Definition Systems BAA#91-06

Topic Area: (7) Signal Distribution
Estimated Total Costs: Approx. $6-8M/yr for 3 years

Technical Contact: Dr. G. Gordon Apple, V.P. Eng., 213-540-6532

Submitted by

Advanced Communications Corporation
Advanced Communications Engineering, Inc.
University of Southern California

1111 19th St. NW, Suite 1000
Washington DC 20036

Daniel H. Garner 202-463-2946
James M. Beggs 202-488-3483

March 11, 1991

Abstract

Advanced Communications Corporation (ACC) and its associate company, Advanced Communications Engineering, Inc. (ACE) are in the process of establishing what will be the first nationwide **universal** broadcasting system — a true-DBS (high-power) system using a totally flexible, dynamically reconfigurable digital format. The University of Southern California (USC), as a result of concurrent discussions, has evinced an interest in this development and is expected to be a valuable and productive teammate in the proposed endeavors.

The U.S. Direct Broadcast Satellite (DBS) service has been allocated by international agreement an exclusive frequency band from 12.2 to 12.7 GHz and 9°-spaced orbital slots for use by high-power satellites. This soon will allow television and other service reception with inexpensive, easy-to-install antennas less than 18 in. in diameter. ACC is now authorized by the FCC to construct, launch and operate 32 high-power satellite transponders at prime orbital positions for complete U.S. coverage, and additional transponder authorization is expected soon. ACE's engineering activities support the technical development of this system.

DBS originally was seen as a means of offering analog television directly to homes in areas without adequate service, and as an alternative to cable in other areas. Operator's plans for DBS include entertainment, sports, news, radio, multiple pay-per-view movies, electronic publishing, and other innovative services. ACC views its digital DBS system as a wideband data pipe useful not only for entertainment television, but for a host of other innovative purposes.

A bit stream of approximately 1 Gbps (32 Mbps in each transponder) will be directly accessible to **small, inexpensive** but sophisticated, microprocessor-controlled receivers, fixed or transportable, anywhere in the nation, from the very first day of service. The system will deliver NTSC TV, HDTV, digital radio, data, educational services, electronic hypermedia publications, and an enormous variety of other new services, all of which will be **hard-encrypted,** and at a

wide variety of selectable data rates. Various degrees of subscriber access will be provided and additional encryption can be provided external to the delivery system.

From its initial concept, this broadcast system has been designed as a totally **flexible** amalgamation of services, the mix of which can be adjusted at will to constantly-varying needs. It is also **dynamically** allocated, providing utility far beyond what its 1 Gbps suggests even without considering planned **compression** techniques.

The system's unique combination of features provides a new, very efficient distribution resource which can also be used to great advantage by the military. One example is the YES Networks — a planned educational broadcasting system which will use up to four of ACC's high-power DBS transponders to provide a large number of courses to public and private schools (up to 200 simultaneously in each transponder). Clearly, this system could be augmented to meet special military training needs across the nation (and throughout the world on other satellites). In addition, personnel would also have access to conventional training through the YES Networks and could avail themselves of a high school or college education without regard to physical station, and uninterrupted by relocations. Training could include very realistic transmitted interactive simulations of equipment and situations. This capability will be greatly enhanced when commercial high definition systems become available.

Information acquisition, transmission, processing, and high-resolution displays are becoming essential elements of military systems and operations. The total flexibility of this system will allow direct interface into highly complex systems with high definition graphics such as command and control, battle management, training and simulation, intelligence analysis, weapons systems, and others. This will allow training exercise simulations to occur in the field in real-time, rather than in a simulation room with a main-frame.

As the YES Networks will assist the nation's schools, the described high definition transmission system can augment the capabilities of the military. A cornerstone of the YES

Networks educational course broadcast system is the ability to use high-resolution display systems to "combine, manipulate and overlay different data types (text, images, computer generated graphics, and video)" — similar to military requirements. The YES Networks concept actually goes much further than that. In addition to various types of data compression (appropriately and transparently applied), the system is based on extending the tenets of object oriented programming (OOP) to dynamic linking of persistent objects of varying lifetimes. Strong encapsulation, such as that provided in the Ada programming language or for "private" members and member functions in C++, is also an essential element and will be included.

As the YES Networks becomes operational, instead of requiring a full transponder, one class will require (on average) only about 1% of a transponder and therefore only about 1% of its cost. The receiving antenna will be an inexpensive 18 inch unit (compared to today's 8-12 ft.). Students can watch a lecture or presentation on a standard TV, high definition screen, or any of a variety of other high resolution imaging devices. A variety of low-cost but highly effective, high-resolution animation, graphics, video, and interactive materials will be used. Printouts can be included and computer disks can be downloaded with interactive lesson materials,. Questions can be called-in, computer-networked or voice-mailed. Exams and homework can be computer-networked for grading, record keeping, and real-time effectiveness evaluation. The system exploits the convergence of computing, communications and video technologies. The system development is being continued by the people who originally envisioned it about five years ago and has recently been augmented by a grant from the U.S. Dept. of Education.

It should be noted that this revolutionary broadcast and educational system already has a long lineage and deep roots in high technology originally developed for Defense. The high-speed A/Ds, digital demodulation, data compression, signal processing, and integrated circuits necessary for this mainly-commercial system may not have been possible without the original groundwork laid by Defense needs. This project has benefited immensely from its team members' involvement with NASA and DoD on many programs. One of the first block-

transform coders was designed and mostly built by one of the team members on a NASA grant. The need for secure voice processing (e.g., ANDVT, and programs for Ft. Meade) spurred development of TRW's parallel multiplier chips, and TI's DSP series. Techniques that our personnel have developed for VHSIC and MILSTAR have influenced system design and engineering. Receivers may also benefit from GaAs, HEMT, and MMIC technologies.

The areas in which DARPA funds are requested are as follows:

- Implementation of a system study to determine methods of integration of military high definition systems with the described flexible DBS signal distribution system.

- Development of transmission operating system and tool-box software for real-time supervision and control of a large number of simultaneous, dynamically varying services.

- Development of authoring software for real-time integration-for-broadcast of a course, presentation, seminar, or other program, including video, computer graphics, animation, simulation, audio, and interactive applications (similar to what MacroMind's "MediaMaker" is now doing for non-real-time video tape).

- Development and study of the use of broadcast software objects, persistent objects, encapsulated code, and dynamic linking for presentations, simulations, external device control, and results reporting. Determine feasibility of such systems using random start-up times and under the assumption of occasional signal interruption or uncorrectable corruption. Explore memory management options, validation of object references, and garbage collection.

- Development of the receiver hardware necessary for multi-media data-decompression and management of displays for high-definition systems.

- Signal processing simulation studies to aid in the development of a fast sync digital demodulator, and to complete the definition of and simulate the flexible multiplexing and service allocation algorithms including broadcast traffic simulations (many types of variable-rate sources).

- Simulation or implementation of video compression algorithms to determine minimum processing feature set and required functional throughput rate.

Useful digital technology implementations have changed the world forever. The funding of enabling technology for initial development and trials of a Defense high definition signal distribution system allow an increase in military capabilities while greatly reducing costs. It is rare to find a technology with so much obvious mutual benefit.

Expected Accomplishments — The proposed work will allow the military to leverage the impact of its high definition systems endeavors through a digital direct broadcast satellite signal distribution system. The program will have major emphasis on allowing capabilities for interactive training and simulations using high definition systems. Access of military personnel to conventional educational programs, regardless of location, will also be made possible.

Diagrams and Illustrations

Comparison	Present Systems	YES Networks
Recipients of Services	Schools, Businesses	Schools, Businesses, Homes (also mobile), Hospitals, Libraries, Community Centers, Child Care Facilities
Receiver Antenna Size	8 to 12 ft. diameter	1.5 ft. Square Plate or Other Miniature Antenna
Local Zoning for Antenna	Very Restrictive	Not Restricted (Preempted by FCC)
Installation	Construction, Pedestal, Sometimes Needs Fencing	No Construction or Pedestal, Set up Indoors Through Window or Skylight
Types of Services	TV Lectures	TV Lectures, Computer Lectures, Written Materials, Teacher Aids, Remedial/Advanced Programmed Learning, Interactive HyperMedia, and Others
Simultaneous Courses in One Satellite Transponder	One (Possibly Two)	100 (Estimated)
Satellite Transmission Cost of One Course	100% (Reference)	1% to 5% (of Reference)
Flexibility of Service	Very Limited	Extremely Flexible
Support for Interactivity	Only by Telephone Line	Classroom System Interactivity, Both During Broadcasts and Off-Line, using HyperMedia, Computer Networks, Voice Mail
Origination Facilities	TV Studio and Crew (Relatively Expensive)	YES Networks Studio, College Campus, Instructor's Office, or Other Location (No Studio or Crew Required)

Table 1 Comparison of Features

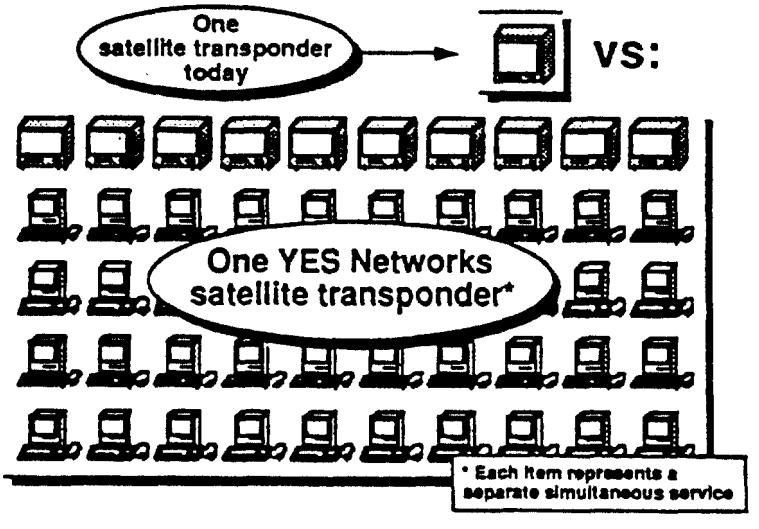


Figure 1 Comparison of Service Offerings

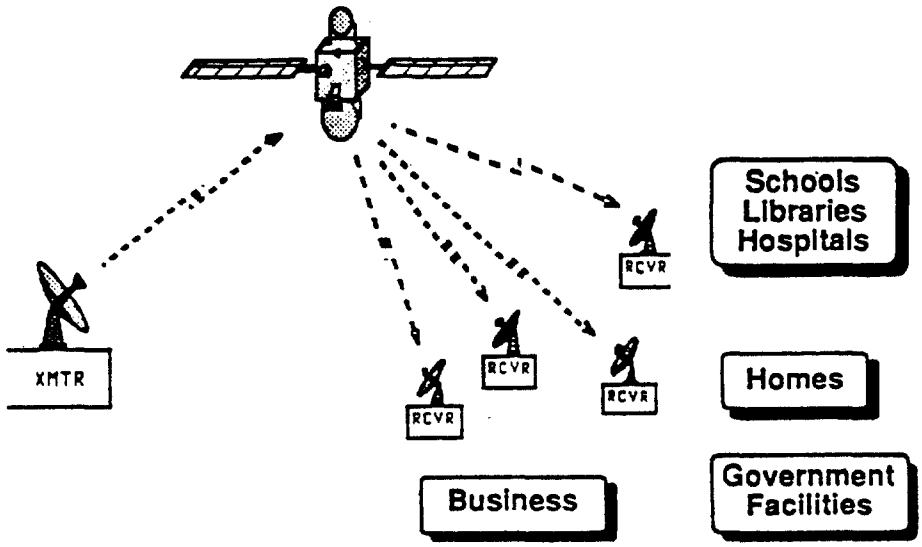
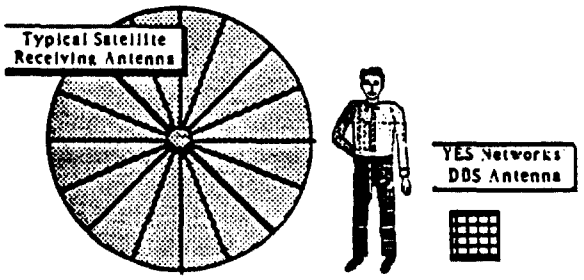
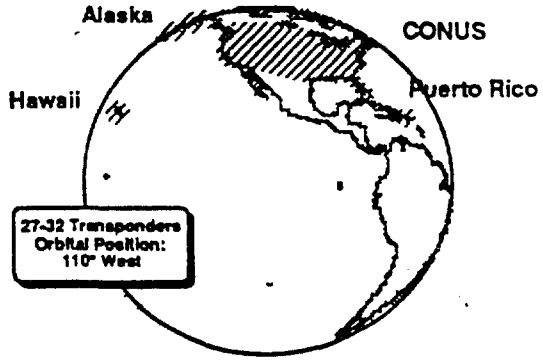


Figure 2 Many Types of Subscribers

Direct Broadcast Satellites

The DBS (Direct Broadcast Satellite) service has been allocated by international agreement an exclusive frequency band from 12.2 to 12.7 GHz and 9°-spaced orbital slots for use by high-power satellites. This will allow television and other service reception with inexpensive, easy-to-install antennas less than 2 ft. in diameter and possibly as small as 1 ft. This compares with antenna sizes of 8 ft. to 10 ft. typically required by services today and which many communities have banned. The FCC has preempted such bans for antennas smaller than 1 meter.





DBS originally was seen as a means of offering analog television directly to homes in areas without adequate service, and as an alternative to cable in other areas. Operator's plans for DBS include entertainment, sports, news, radio, multiple pay-per-view movies, electronic publishing, and other innovative services. ACC views its digital DBS system as a wideband data pipe useful not only for entertainment television, but for a host of other innovative purposes.

The FCC has authorized Advanced Communications Corporation (ACC) to construct, launch and operate a 27-transponder high-power DBS system located at 110° W longitude, one of two premier orbital positions which allow full U.S. coverage.

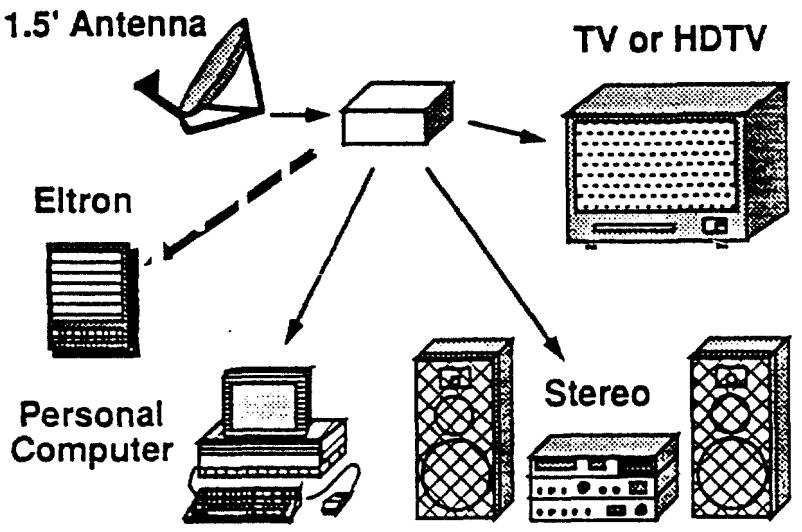


Figure 3 Flexibility of Services

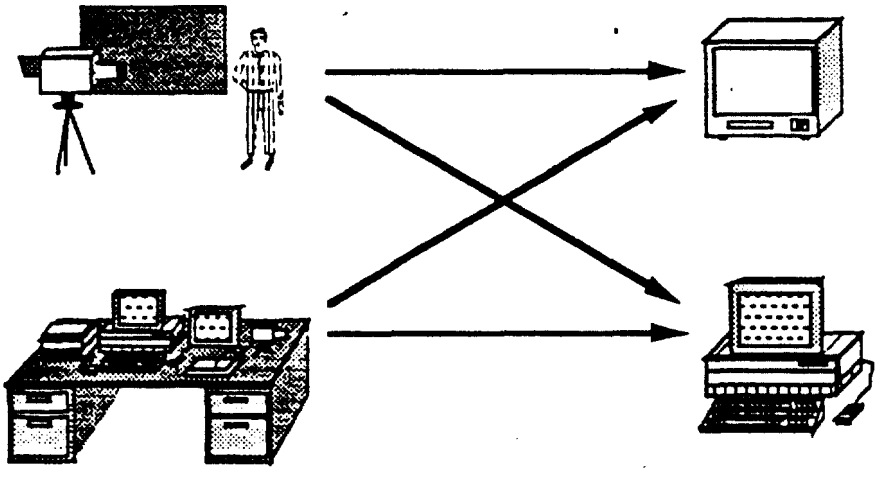
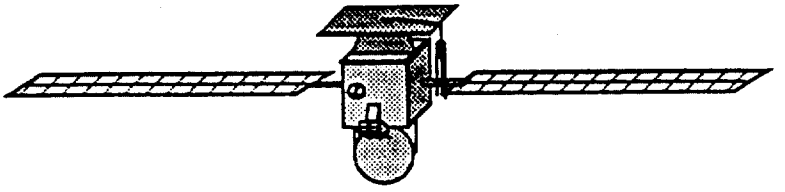


Figure 4 New Types of Offerings — New Kinds of Reception



YES* Networks Planning

*(Your Educational Services)

A Grant Application to the
Roy and Christine Sturgis Charitable and Educational Trust
by the

Foundation for Educational Advancement Today

1100 Tower Building
Little Rock, AR 72201
Attn. Ms. Debbie Wilbanks

1111 19th St., N.W., Suite 1000
Washington, DC 20036
202-463-2946
Attn. Wilbur D. Mills

February 27, 1991

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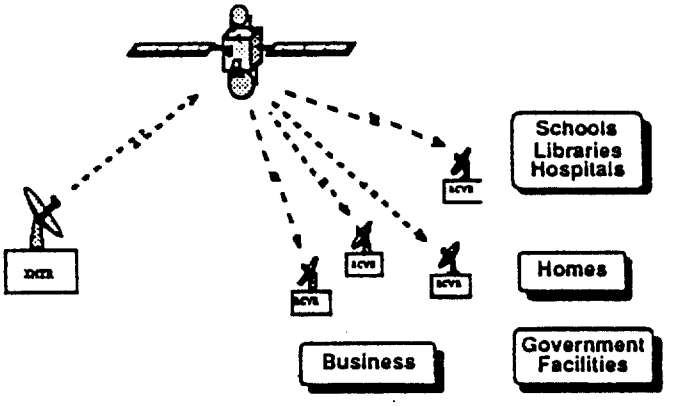
Appendix B Advanced Communications Engineering, Inc. 16

or can be computer-networked or voice-mailed either during the class or even from the student's home (if an inexpensive computer is available). Exams and homework can be computer-networked back to the instructor for grading, record keeping, and real-time effectiveness evaluation.

The **Foundation for Educational Advancement Today** (FEAT) believes the next practical step in harnessing the positive power of the telecommunications revolution is to apply the full potential of new technologies in video broadcasting and personal computers to the service of satellite distance learning.[1] FEAT is working to achieve this through an exciting new concept called "Your Educational Services" (YES) Networks



The **YES Networks** is being developed to make possible a large quantity and variety of innovative educational services to public and private schools, libraries, health-care facilities, and homes. It will vastly surpass the capabilities possible with currently employed technologies. It will do this by using digital transmission through high-power direct broadcast satellites (DBS) to 18 in. receiving antennas. Receivers will make optimum use of both television and personal computer technologies. Although it is primarily a broadcast medium, the inclusion of computer-interactive hypermedia[2] and data-voice networks has the potential of bringing distance learning to such a level that its effectiveness could equal or even surpass that of attending live lectures (if they were locally available, which they often aren't). FEAT's underwritten YES Networks concept has received the endorsement of National Education Association, American Federation of Teachers, National School Boards Association, and American Association of School Administrators, among others.

FEAT will inaugurate the YES Networks and will make available four high-powered DBS transponders, increasing dramatically the volume of course programming which can be made available throughout Arkansas and ultimately the entire United States. Because each transponder is capable of simultaneously carrying a large number of services, transmission costs will be greatly reduced. Mass-market development of much of this technology for reception of entertainment

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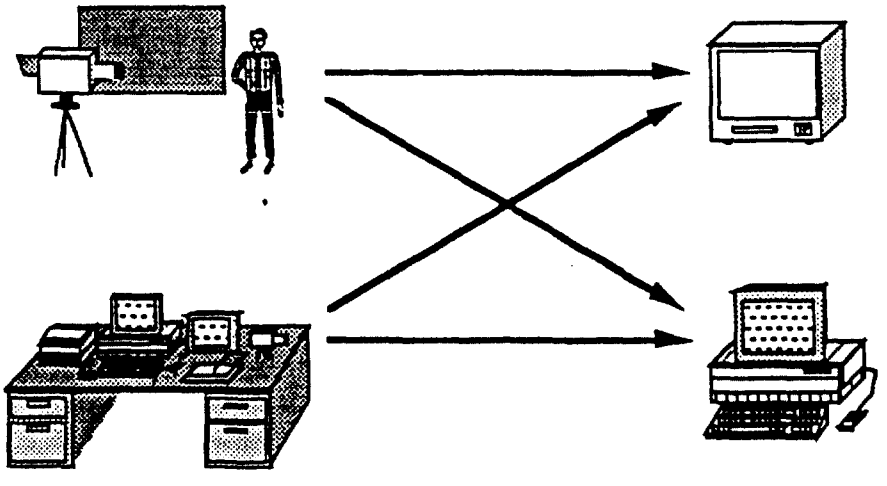
1 Foundation for Educational Advancement Today, "A Means to Re-establish America's Leadership in Technology and Education", prepared for President George Bush, March 1989.

2 Hypermedia is a term used to denote actively-linked information with audio, video, text, and graphic components, that may be accessed in an associative as opposed to sequential fashion.

television and other innovative services will insure economies of scale necessary to lower receiver prices to a few hundred dollars.

The YES Networks envisions making available easy-to-use equipment and services which will allow economical use of new technologies to enhance educational access and improve health-care regardless of proximity to institutions. It will greatly benefit everyone, but will especially increase educational access to the physically, economically, and geographically disadvantaged. It is an ambitious endeavor, but both practical and necessary. Planning and establishing the steps for the operational network requires creation of the appropriate infrastructure at the earliest possible date. Personal funding and several years of contributed labor from the Arkansas people who originally envisioned and created this system, and an initial grant from the U.S. Department of Education have allowed this work to begin. However, in-depth planning, system design, and concept demonstrations are necessary. FEAT requests funding for these purposes.

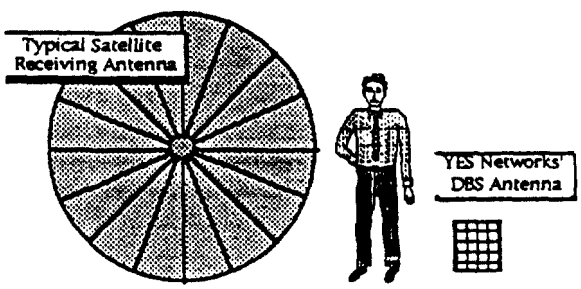


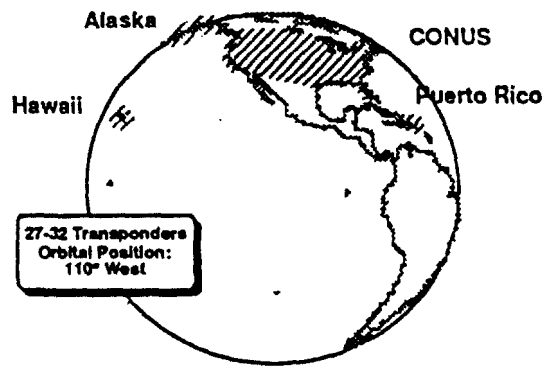
Background

In its original DBS (Direct Broadcast Satellite) filing[1] with the FCC in 1984, ACC (Advanced Communications Corporation) stated its commitment to providing educational programming, making it universally accessible to homes, schools, and businesses. ACC was the first broadcaster in history to commit to using totally-digital transmission. In 1987 a white paper was issued outlining the enormous benefits that digital transmission could provide for educational course broadcasts.[2] Based in part on this paper, the Foundation for Educational Advancement Today (FEAT) was formed and the **YES Networks** concept was initiated. Since then, numerous papers have been written and proposals and presentations made promoting the YES Networks.

Direct Broadcast Satellites

The DBS (Direct Broadcast Satellite) service has been allocated by international agreement an exclusive frequency band from 12.2 to 12.7 GHz and 9°-spaced orbital slots for use by high-power satellites. This will allow television and other service reception with inexpensive, easy-to-install antennas less than 2 ft. in diameter and possibly as small as 1 ft. This compares with antenna sizes of 8 ft. to 10 ft. typically required by services today. Size is especially significant because many communities have banned larger antennas, whereas the FCC has preempted such bans for antennas smaller than 1 meter.





DBS originally was seen as a means of offering high-quality television directly to homes in areas without adequate service, and as an alternative to cable in other areas. Operator's plans for DBS include entertainment, sports, news, radio, multiple pay-per-view movies, electronic publishing, and other innovative services.

The FCC has authorized Advanced Communications Corporation (ACC) to construct, launch and operate a 27-transponder high-power DBS system located at 110° W longitude, one of two premier orbital positions which allow full U.S. coverage.

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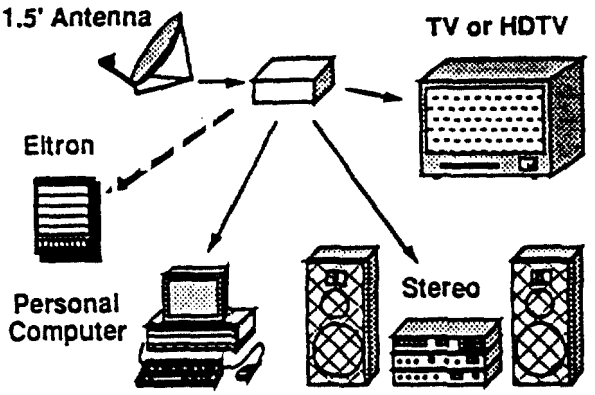
1 "ACC Application for Authority to Construct and Operate a Direct Broadcast Satellite System," FCC DBS 84-01.

2 Apple, G.Gordon, "Digital DBS Educational Services", ACC white paper, July 31,1987, filed with the FCC.

The Foundation for Educational Advancement Today is a 501(c)3 public charity which was formed for the purpose of planning and underwriting the YES Networks and to place a free receiver in each school and library in the United States. ACC is donating to FEAT the use of four of its DBS transponders for their useful life to broadcast the YES Networks. The system is based on the digital transmission and processing technologies developed by Advanced Communications Engineering, Inc. (ACE).



Analog or Digital?

All television broadcasting systems today (including satellites) use analog transmission. In the western world the predominant system is NTSC[1]— a standard now over 40 years old. It is extremely inefficient in transmitting images which change infrequently (e.g., business conferences and classroom lectures). Much work has been done over the last 20 years to improve the efficiency of transmitting such images. From the beginning, these efforts have used digital techniques.

Until recently, most DBS operators had planned to use analog TV transmission—the method that is presently used exclusively for standard television on today's domestic low-power satellites. Advanced Communications Corporation's leadership[2] in promoting digital DBS[3] has now been validated by a virtually complete industry turnabout. For example, the Hughes-Murdoch-NBC-CableVision group followed ACC's lead by announcing in February of 1990 that it would be transmitting digitally over its DBS satellites.

The advantages of digital transmission are well known to NASA and the space communications community. Indeed, deep space probes would have been impossible without it. Digital transmission allows system design flexibility and a reliability of fidelity that cannot be attained otherwise. Telephone distance transmission and switching are rapidly becoming all-digital and the digital local (ISDN) telephone loop is not far behind. Introducing a digital format to the DBS transmission capability will open vast new applications of technology for both public and private user services and especially computer users.

The **YES Networks** is being developed for the purpose of simultaneously providing a large number and variety of educational services using digital transmission through high-power direct

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1 National Television Standards Committee

2 Apple, G. Gordon, "Digital DBS Television Transmission," Advanced Communications Corporation, June 5, 1987.

3 Apple, G. Gordon,"Final Report: High Definition Television Data Compression; Algorithm Analysis and System Design," TRW, June, 1982, prepared for CBS, Inc.

broadcast satellites. These services will be received by inexpensive, easy-to-install receivers in schools, libraries, health-care facilities, and homes — virtually anywhere needed. The system combines a variety of existing technologies[1,2] to very efficiently send voice, video, computer files, control, and configuration information. Examples of these services include:

- Preschool and primary level programming
- Secondary school programming, all subjects
- Computer simulations and lab demonstrations making aggressive use of graphic output for physics, chemistry, biology, and mathematics (e.g., math graphing)
- Vocational and training programming
- Adult education, literacy improvement, home study programs
- Undergraduate and graduate level courses, seminars, lectures
- Teacher training for both distance learning techniques and subject-focused teaching methods
- Broadcasting supplementary or enrichment teaching materials such as reference materials, software, indexes, exam preparation, etc.
- Broadcasting educational materials with a time sensitive value such as current events

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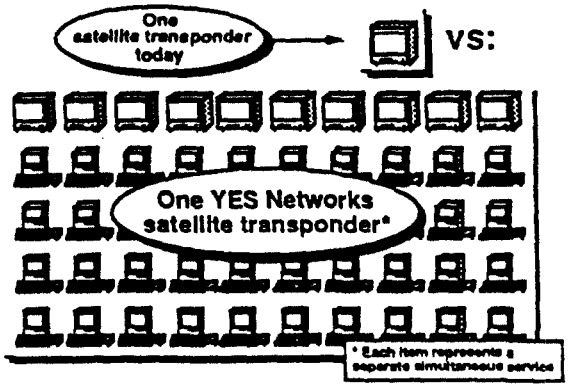
1 FEAT, ACE, ACC, "An Integrated-Services Digital DBS Receiver," Submitted to NASA, October 13, 1989.

2 Advanced Communications Engineering, Inc., *Final Report: ACTS Educational Broadcasting*, Submitted to the NASA ACTS Program and Public Service Satellite Consortium, April 30, 1988.

Narrative



The **YES Networks** will greatly enhance educational course broadcasts in the following ways:

Capacity - The YES Networks will insure that adequate satellite course transmission capacity will be available to meet the nation's educational needs and will offer all types of courses, including math, science,[1] foreign languages, health care, management, and vocational education. Compared to today's single course per transponder, each of the YES Networks' four DBS transponders can simultaneously carry from **50 to 200 courses**, depending on the service mix. Each DBS transponder carries approximately **30,000,000** bps (bits per second) which is more than **12,000 times** the transmission rate of a 2400 bps computer modem typically used on a telephone line. For example, this bit rate translates to **120** courses, each having an average rate of 250,000 bps and peak rates of 1,500,000 bps or more (something no other system can do). The YES Networks uses a combination of video compression, computer graphic techniques, and efficient statistical allocation techniques to provide a large number of high-image-quality educational broadcasts;

Economy - The YES Networks will substantially reduce the cost of providing both teacher training and student instruction by efficiently using the capacity of satellite transponders through digital techniques; and by making possible the use of very small receiver systems that are easily mounted on any building structure, including indoors;

Flexibility - The YES Networks will enhance the widest use of the transmission capacity by offering superior video quality, and by transmitting supplementary materials that can be interactive and used off-line by both students and teachers. Individual instructors will determine what techniques and tools meet their requirements. The system is an open pipe — to be used as needed. It will continuously evolve to meet the demand, and will never become obsolete;

Accessibility - The YES Networks will expand the availability of valuable courses into areas where special-emphasis instruction is not otherwise possible because of isolation, funding, transportation, available time or other reasons; and to the industry worker who otherwise could not

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1 Apple, G. Gordon,"Math, Science, and Engineering: A New Means to Achieve Our National Goals," December, 1988.