Table 7-2 Overhead Annual Budget

Secretary	$22,000
Office lease (1200 sq. ft.)	$21,600
Telephone (4-lines)	$12,275
Office furniture lease	$4,225
Computer leasing	$20,640
Printer leasing	$3,640
Office machines lease	$4,750
Office supplies	$9,000
Accounting/Legal/Professional	$25,000
Contingency	$25,000
Total Overhead	$148,130

7.3 Equipment

The equipment costs include two leased Mac IIci computers, which will be used specifically in the experimental laboratory communications hardware configuration, are not available for general work-station usage and engineering development, and therefore were not included in overhead. Specific laboratory equipment leases are also included in this category, such as test and breadboard assembly equipment, oscilloscope, and logic analyzers.

7.4 Materials

In the materials category, three DSP co-processor cards are included during the first year—two for the laboratory communications development configuration and one for the modem simulation work. The second year allocation is mainly electrical components for the breadboards and prototypes.

7.5 Travel

Approximately eight cross-country man-trips are allocated annually. The project participants are not all collocated. This travel allocation may need augmantation if significant interaction at NASA facilities transpires.

7.6 Fringe Benefits

Fifteen percent of direct labor has been allocated for employee fringe benefits, including standard packages conforming with current regulations and providing adequate attractiveness..

7.7 Other Costs

The necessary software for the personal computers, including that needed for specific development applications and the Douglas software package for circuit design and simulation, is included in this category.

7.8 G&A

The G&A figure of 10% includes mainly the administration fee allocated to the Foundation for Educational Advancement Today (FEAT).

8.0 Personnel Qualifications

The qualifications of the proposing team members and key personnel are particularly appropriate for this project. Vitae of these and others are included in Appendix A:

Mr. Daniel H. Garner, President of Advanced Communications Corporation, has long been a proponent of innovative satellite broadcasting services (particularly for education) and has agreed to provide two DBS transponders to the Foundation (FEAT) for the YES Networks' educational broadcasting system.

Mr. Donald K. Dement has a 30-year history of innovative work and engineering management in satellite and other communications systems (with NASA and others), DBS (Direct Broadcast Satellites), and video data compression.

Dr. G. Gordon Apple has over 20 years work and project management experience in digital communications systems (including systems engineering on NASA projects such as Space Shuttle, TDRSS, and ACTS), particularly in video data compression, modems, error correction coding, computers, digital design, satellite communications (including highly-sophisticated signal processing ground terminals; e.g., MILSTAR), and many other relevant disciplines.

Mr. Gary S. Coe, the Foundation's administrator for this project, has a 25-year history in management of communications related activities.

9.0 Concluding Statement

It is apparent that the proposed digital satellite broadcasting development program has an across-the-board applicability to modern-day and future life, education, and work, that may not exist in any other space communications program. It is also clear that the time for this type of innovative program has arrived. This is the turning point where the United States can now regain the lead in electronic technology through innovative applications of space communications, digital signal processing, and computer technology. **It is the right technology development at the right time.**

NASA's pioneering investments in high EIRP transmission still await full commercialization. A decade has passed while other technology has developed in supporting ways, so that we now can look to needs of the '90s and beyond with the confidence that users' capabilities to acquire, sort, choose, interact, and absorb information based on DBS-delivered data broadcasts will be met. A key applied research effort must be made to achieve a technological understanding about the capability and economics of the user receiver. Support through the SCAR program as proposed herein should provide that understanding and enable public benefits in future years from planned integration with the DBS industry.

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7 Advanced Communications Engineering, Inc., *Proposal to the Public Satellite Service Consortium and NASA ACTS Program*, October 21, 1987.

8 Mark F. Medress, "Satellite Television Scrambling with VideoCipher", Communications Technology, September 1985, p 82.

Appendix A Vitae

Advanced Communications Engineering, Inc. (ACE)

Officers and Directors:

Mr. James M. Beggs - Chairman, Advanced Communications Engineering, Inc. Mr. Beggs was nominated and confirmed as the sixth NASA Administrator in June, 1981, shortly after the first flight of the Space Shuttle Columbia. Currently, he is also chairman of Spacehab, Inc.

AS NASA Administrator from 1981 through 1985 he was responsible for all aspects of the American Space and Aeronautics Program. During his tenure he directed the Space Shuttle program through the experimental flights into operational use of the shuttle for commercial launches, spacelab flights, scientific activities, and retrieval and repair operations.

During his administration the space science program was expanded and several new starts were initiated including a Venus mapper and a Mars Polar Observer. The science budget was increased to over 20% of the NASA budget. The Hubble space telescope, the Galileo Jupiter orbiter and probe, and several explorer spacecraft were completed, and are presently awaiting launch.

In 1984, he was credited with convincing the Reagan Administration to initiate and fund the next logical step in space exploration with the design and development of of a space station. He then embarked on a world wide space station effort which resulted in the European space community, Japan, and Canada joining in the program. Additionally, he initiated the NASA program for Quality and Productivity, which seeks to stimulate a drive for excellence within NASA and its contractor family.

Prior to service with NASA, Mr. Beggs was, from 1974 to 1981, Executive Vice President and a Director of General Dynamics in St. Louis, Missouri.

Mr. Beggs' first government post was that of Associate Administrator, Advanced Research and Technology, NASA to which he was appointed by President Johnson in 1968. In 1969 he was nominated by President Nixon and confirmed as Undersecretary, Department of Transportation. In that position he was involved in restructuring the department during a very active period of new legislation initiatives in Airports and Airways, Urban Mass Transit, Railroads (including Amtrac founding and the initial resolution of the Penn-Central bankruptcy), and the initiation of the deregulation legislation for the transportation system.

From 1955 to 1968, he was employed in various marketing and engineering positions with the Westinghouse Electric Corporation. His last assignment was that of Vice President of the Westinghouse Defense and Space Center and the General Manager Electronics Division.

He is a 1947 graduate of the U.S. Naval Academy and in 1955 received an MBA from the Harvard Graduate School of Business Administration. He has also been awarded six honorary doctorates.

Dr. G. Gordon Apple - President, Advanced Communications Engineering, Inc. Dr. Apple received his BSEE degree from the University of Arkansas in 1966 and an MSEE and PhD from Purdue University in 1967 and 1970 respectively. He has over 25 years experience in digital communications spanning the telephone, computer, space, and defense industries. Dr. Apple has patents in the fields of error correction coding, digital transmission, synchronization, and video data compression. He also has various publications and has made many presentations (including internationally) on these subjects. Dr. Apple is a Senior Member of IEEE, a member of Sigma Xi (research society), Eta Kappa Nu, Tau Beta Pi, Pi Mu Epsilon, and the Society of Motion Picture and Television Engineers. He is a Registered Professional Engineer and an instrument rated pilot.

While at Purdue, Dr. Apple developed a transform-coding digital filter for NASA and was a recipient of a NSF Traineeship (a fellowship with research funds). He then worked at Bell Telephone Laboratories on digital-interframe-coding video-compression techniques for PicturePhone® transmission. At North Electric he headed up a group which developed transmission, synchronization and multiplexing systems for a new digital telephone switching system. He then was Director of Engineering for Automation Products Company. At TRW, Dr. Apple was involved in and did project management for many digital communication system projects including satellites, modems, and data compression systems. He served as system engineer on the Space Shuttle's primary communications system (for which he received award recognition from NASA) and served as system engineer on a number of satellite programs including Mod-35, TDRSS, OMV (Orbiting Maneuverable Vehicle) and classified programs. He more recently served as the C-band system engineer on the Intelsat VII proposal, partly in Toulouse, France, jointly with MATRA.

Dr. Apple was a system engineer for development of a secure-voice terminal (for Ft. Meade) and developed the KDC (Key Distribution Center) protocols and signal formats used for exchanging crypto-keys in this system. He was the system engineer for the project that developed the television satellite transmission scrambling system that was TRW's entry into this field in competition with the (winning) VideoCipher scrambling system.

Dr. Apple was principal investigator and project manager for a joint effort with CBS Television to develop data compression for High Definition Television (HDTV) using digital transmission via Direct Broadcast Satellites. He also served as assistant Program Manager for VHSIC (Very High Speed Integrated Circuit) ground terminals for the MILSTAR satellite system—by far the most sophisticated communications satellite ever built. This was a pioneering program which was the first to incorporate the most powerful and advanced digital-signal-processor ever designed. He was then principle investigator for IRAD (Internal Research and Development) programs for small, light-weight EHF (Extremely High Frequency) terminals. He developed a system design for an ultra-small VHSIC Phase II (wafer-scale integrated circuit) EHF satellite communications terminal and proposed (to NSA) a unified cryptographic integrated circuit design for use by the Air Force.

In recent years Dr. Apple has devoted his efforts toward concept development, system design, and promotion of digital transmission for DBS broadcasting of television, HDTV, educational services (e.g., the YES Networks), electronic publishing, and other services. In particular, he pioneered the concept of using personal computers to (digitally) broadcast services directly to televisions and personal computers. He performed a study and preliminary system design for a small, relatively inexpensive receive-only terminal for the NASA ACTS program. He has also been actively engaged in extending the concept of "object-oriented programming" across boundaries between multiple diverse processors and dedicated hardware, particularly between personal computers and embedded signal processors.

Mr. Donald K. Dement - Vice-Chairman and Director, Advanced Communications Engineering, Inc. Mr. Dement received his BSEE from Drexel University, Washington, DC in 1959 and was an MSEE candidate at George Washington University, Washington, DC in 1966. He has over 30 years of practical experience in planning and management of engineering development in communications systems and technology. He is a member of many professional associations, a Senior Member of IEEE, a member of Eta Kappa Nu, an Associate Fellow of the American Institute of Aeronautics and Astronautics, and has served on IEEE's "Spectrum" and "Institute" editorial boards. Among other awards and honors, he is a recipient of the Air Force Meritorious Civilian Service Medal.

As President of Novacom, Inc. Mr. Dement has provided satellite systems engineering, management, planning, and evaluation for a wide variety of clients. Novacom executes design and integration studies, prepares regulatory filings, develops plans and schedules for tests and operation, and operates proprietary and customized planning software. Products have included studies, evaluations, specifications, and detailed plans for system developers and on-orbit operators, and for

medium-orbit remote sensing platform communications systems. Recent clients include NASA HQ, FAA HQ, and commercial space firms in fixed, mobile, and broadcast areas.

As Senior Director of Aeronautical Radio, Inc., Mr. Dement operated the systems architecture and engineering development office at ARINC for new aeronautical satellite communications systems, developed system design and specifications, business plans, satellite launch and integration plans for shared payloads, ground and airborne earth terminals, and overall integration and launch schedule planning.

As Director of NASA Headquarters Communications Division, Mr. Dement developed and promoted a new start for the first ten-year plan undertaken by NASA as the current ACTS (30/20 GHz) and MSAT (mobile) programs. He developed operational concepts for technology development programs. As Manager, Advanced Communications Research, he managed technology development for new hardware and techniques: compressed video, spectral-efficient modulation, monolithic DBS receiver.

As Engineer and then Division Chief at U.S. Dept. of Defense, he directed a range of ground station receiver engineering programs and contracts, and a major development of DoD's early satellite information efforts.

Advanced Communications Corporation (ACC)

Mr. Daniel H. Garner - President and Board Member, Advanced Communications Corporation—Secretary and Board Member, Advanced Communications Engineering, Inc. Mr. Garner has been associated with the broadcast industry since 1969 with interests in commercial radio and television. He has devoted the last seven years toward bringing innovative DBS broadcasting to the American people.

Foundation for Educational Advancement Today (FEAT)

Trustees:

The Honorable Wilbur D. Mills - Chairman, Foundation for Educational Advancement Today. The representative from Arkansas' 2nd congressional district in the 76th-94th Congresses, Mr. Mills provided extraordinary service to the nation as the longest serving Chairman of the United States House of Representatives Committee on Ways and Means. Currently, he is associated with the Washington, D.C. office of the prominent New York legal firm of Shea and Gould serving in the capacity of special tax counsel.

Mr. Wayne Wells - Vice-Chairman, Foundation for Educational Advancement Today. Mr. Wells was for many years a major asset to the General Dynamics Corporation as Treasurer and Director of the Company. He is now retired from General Dynamics, but remains active in investments and civic affairs.

Mr. Gary S. (Toby) Coe - Secretary/Treasurer, Foundation for Educational Advancement Today. Mr. Coe has over twenty years experience in ownership and management of broadcasting properties. Retiring in 1981 from an active role in the industry, he nonetheless maintains continuing communications interests.

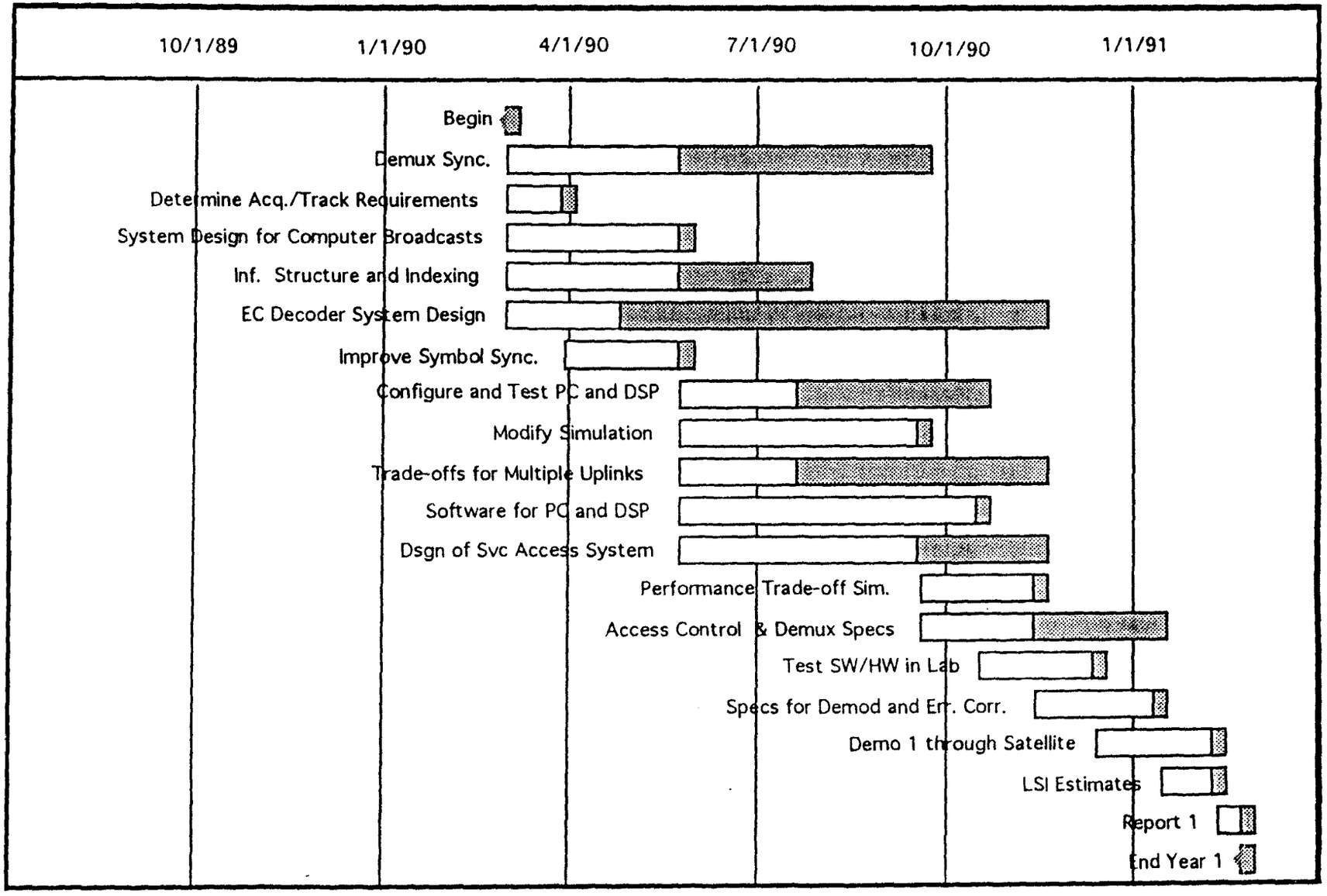
Appendix B Project Manpower and Tasks Schedules

First Year Labor and Material Costs

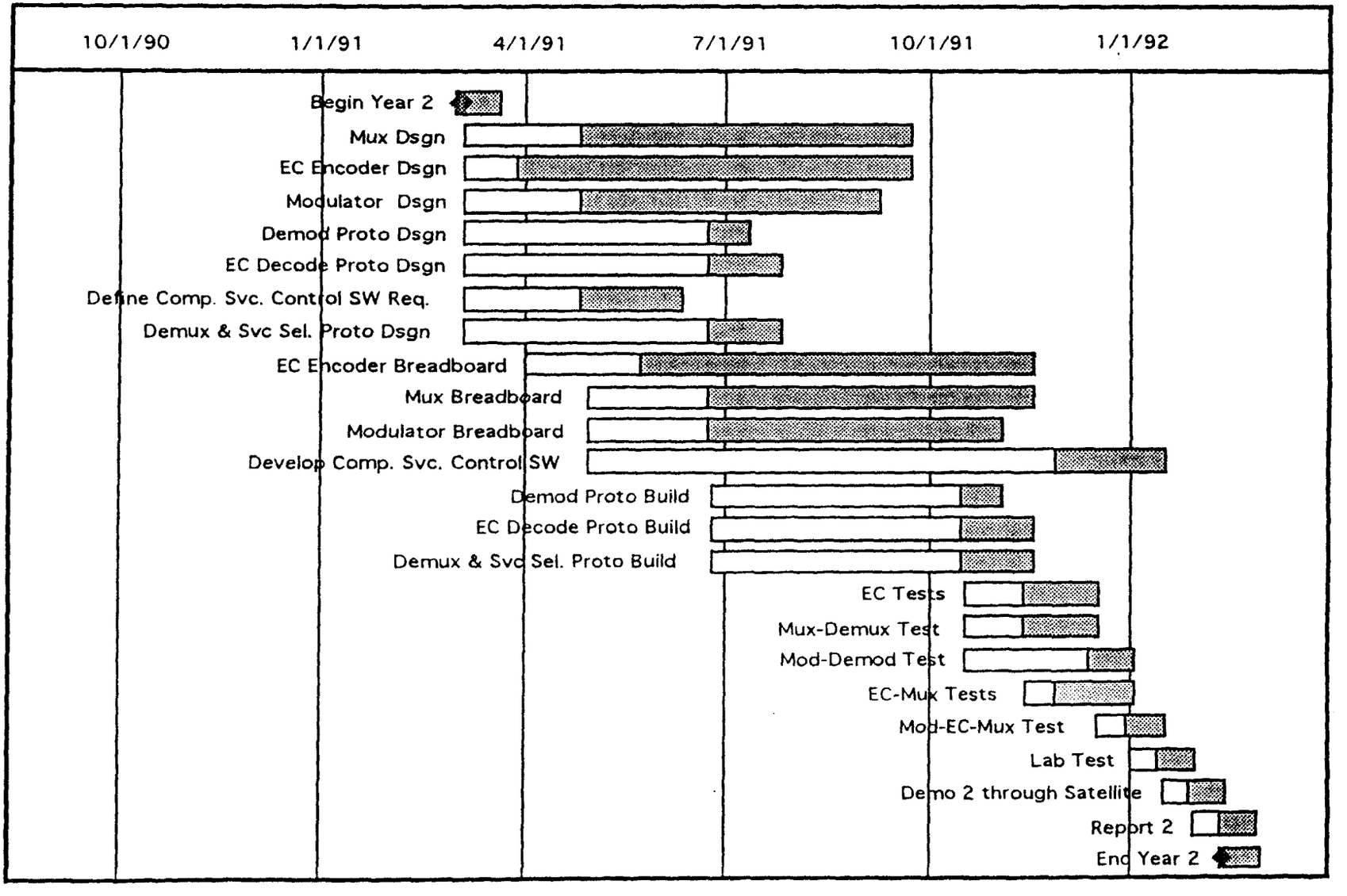
Personnel Resource	Systems Eng.		Digital Eng.		Software Eng.		Programmer		Technician		Totals by tasks		Materials
	Days	$	Days	$	Days	$	Days	$	Days	$	Days	$	$
Rate	1	300	1	250	1	250	1	200	1	150			
TASKS:													
Demux Sync.	20	6000	20	5000							40	11000	
Determine Acq./Track Requirements	10	3000	5	1250					10	1500	25	5750	
System Design for Computer Broadcasts	30	9000	20	5000	20	5000					70	19000	
Inf. Structure and Indexing	20	6000	20	5000	20	5000					60	16000	
EC Decoder System Design	10	3000	20	5000	5	1250					35	9250	
Improve Symbol Sync.	10	3000	10	2500	10	2500					30	8000	
Configure and Test PC and DSP	5	1500	10	2500	10	2500	10	2000	20	3000	55	11500	8000
Modify Simulation	30	9000	10	2500	60	15000	60	12000			160	38500	
Software for PC and DSP	20	6000			40	10000	60	12000			120	28000	
Dsgn of Svc Access System	10	3000	20	5000	10	2500					40	10500	
Performance Trade-off Sim.	10	3000	10	2500	10	2500	40	8000			70	16000	4000
Test SW/HW in Lab	10	3000	10	2500	20	5000	20	4000	20	3000	80	17500	
Specs for Demod and Err. Corr.	10	3000	20	5000	10	2500					40	10500	
Demo 1 through Satellite	15	4500	20	5000	10	2500	20	4000	20	3000	85	19000	5000
Access Control & Demux Specs	10	3000	20	5000	20	5000					50	13000	
LSI Estimates	10	3000	20	5000					5	750	35	8750	
Report 1	10	3000	10	2500	10	2500	10	2000			40	10000	
Total Days	240		245		255		220		75		1035		
Total $		72000		61250		63750		44000		11250		252250	17000

Second Year Labor and Material Costs

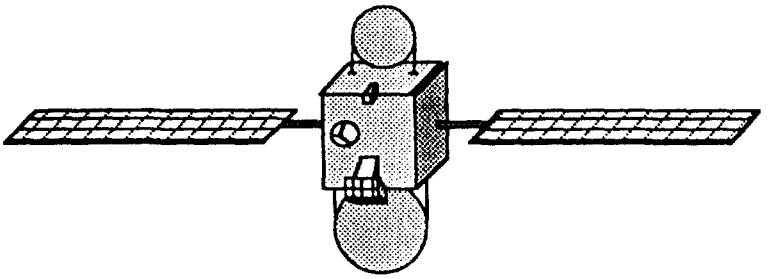
Personnel Resource	Systems Eng.		Digital Eng.		Software Eng.		Programmer		Technician		Totals by tasks		Materials
	Days	$	Days	$	Days	$	Days	$	Days	$	Days	$	$
Rate	1	300	1	250	1	250	1	200	1	150			
TASKS:													
Mux Dsg	10	3000	20	5000	10	2500					40	10500	
EC Encoder Dsgn	5	1500	10	2500							15	4000	
Modulator Dsgn	5	1500	10	2500							15	4000	
Demod Proto Dsgn	10	3000	20	5000	10	2500					40	10500	
EC Decode Proto Dsgn	10	3000	20	5000	10	2500					40	10500	
Define Comp. Svc. Control SW Req.	20	6000			20	5000	20	4000			60	15000	
Demux & Svc Sel. Proto Dsgn	10	3000	20	5000	10	2500					40	10500	
Mux Breadboard	5	1500	10	2500	10	2500			20	3000	45	9500	3000
EC Encoder Breadboard	5	1500	10	2500					20	3000	35	7000	2000
Modulator Breadboard	5	1500	10	2500					20	3000	35	7000	5000
Demod Proto Build	10	3000	20	5000	10	2500			40	6000	80	16500	8000
EC Decode Proto Build	10	3000	20	5000					20	3000	50	11000	5000
Demux & Svc Sel. Proto Build	10	3000	20	5000	20	5000			20	3000	70	16000	5000
Develop Comp. Svc. Control SW	20	6000			80	20000	80	16000	20	3000	200	45000	
EC Tests	5	1500	10	2500					10	1500	25	5500	
Mux-Demux Test	5	1500	10	2500					10	1500	25	5500	
Mod-Demod Test	10	3000	20	5000	10	2500			20	3000	60	13500	
EC-Mux Tests	5	1500	10	2500	5	1250			10	1500	30	6750	
Mod-EC-Mux Test	5	1500	5	1250	5	1250			5	750	20	4750	
Lab Test	10	3000	10	2500	10	2500			10	1500	40	9500	
Demo 2 through Satellite	10	3000	10	2500	10	2500			10	1500	40	9500	5000
Report 2	10	3000	10	2500	10	2500	10	2000	10	1500	50	11500	
Total Days	195		275		230		110		245		1055		
Total $		58500		68750		57500		22000		36750		243500	33000



First Year Task Time-Line Chart



Second Year Task Time-Line Chart



September 26, 1989

DBS* Delivery of Electronic Publications

(* Direct Broadcast Satellite)

G. Gordon Apple, PhD

Advanced Communications Engineering, Inc.
Advanced Communications Corporation

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TABLE OF CONTENTS

1.0 Summary 1
2.0 Introduction 2
3.0 DBS 4
3.1 Television 4
3.2 ACC's Digital DBS 4
3.3 Educational and Data Services 6
3.4 Access Control 7
4.0 Electronic Publishing 8
4.1 Information Presentation 8
4.2 Organization and Access 9
4.2.1 Linear 9
4.2.2 Hierarchical 9
4.2.3 HyperMedia 10
4.2.4 Computer Search 12
4.3 Static Information 12
4.4 Dynamic Information 14
5.0 ACC's Digital DBS Delivery 17
5.1 News 17
5.2 General 17
5.3 Specialized 18
5.4 On Request 18
6.0 Conclusion 19
Acknowledgments 19
Appendix A Vita 20

1.0 Summary

"The days of physical delivery of ink-on-paper are numbered."

And the time is shorter than you think. We are on the threshold of an exciting new era in publishing. Electronic display and storage of information is now passing the point of economic crossover as compared to the Gutenberg method that has prevailed for hundreds of years. Electronic displays now can have the convenience of paper while allowing new means of information presentation not previously possible. Universal, economical delivery to the entire nation will be available due to ACC's Digital DBS (Direct Broadcast Satellites). In this paper we discuss the following:

- What is happening technologically in publishing;
- Why it is happening;
- Why electronic publishing will prevail;
- Why DBS will be an integral delivery component;
- What we must do now to be ready for it.

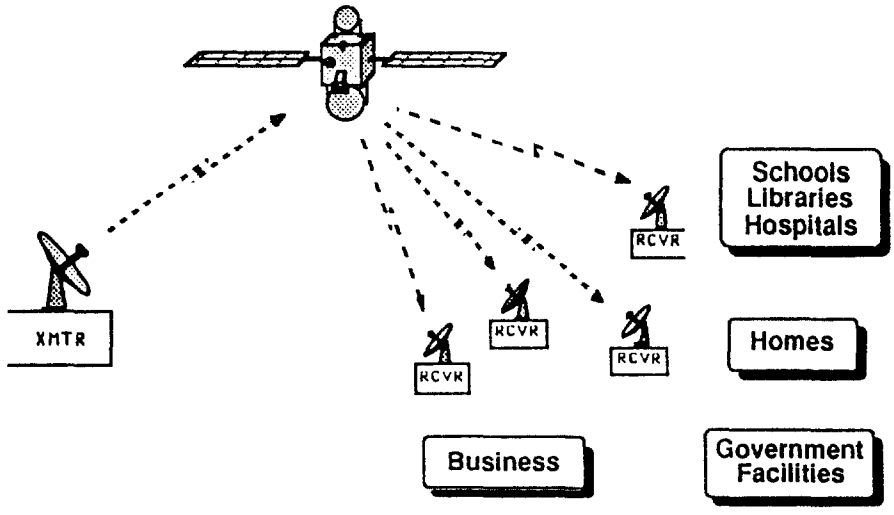

Figure 1-1 Direct Broadcast Satellites

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The publishing industry must recognize the fundamental changes that are taking place in the presentation, storage, and dissemination of information. For most applications, **the days of physical delivery of ink-on-paper are numbered.** The oblivious will perish. The insightful will prosper. In fact, ACC's Digital DBS delivery medium may allow publishers to regain much of the market previously lost to other media.

Some of what you will see just in the next five years is the following:

- Portability and convenience will be improved by high resolution, light-weight, thin, inexpensive displays (or special glasses) and small, inexpensive recording media;
- Dynamic visual and aural means of presentation will be included;
- Organization and accessibility of information will be vastly improved;
- Content and prioritization will be customized according to preferences and patterns;
- Information will be kept current;
- Delivery will be electronic.

The broadcasting system described here is unlike anything that exists today. It is transmitted by a digital bit stream, unlike the analog systems that now exist. Digital DBS can bring a multitude of much needed publishing services directly to America's schools, homes, businesses, government, and other institutions long before such services can be made available by other means.

This is truly the next revolution in publishing—the most significant advancement in information access since Gutenberg. Once established in this manner, publishing will never be the same. This type of service can be delivered nationwide by ACC's **Digital Direct Broadcast Satellites** (DBS). In the following sections, we present how DBS developed to where it is now, what electronic publishing is all about and why it is different, examples of publishing services that can be delivered by DBS, and what is needed at this time to prepare for the coming publishing revolution.

3.0 DBS

3.1 Television

Advanced Communications Corporation (ACC) is one of only four current FCC permit-holders now legally permitted to construct a direct broadcast satellite (DBS) system with suitable orbital locations. This is a new broadcast service using satellites designed for the smallest terminals. ACC has been approved to operate at least 27 television or data transponders, covering the entire U.S.

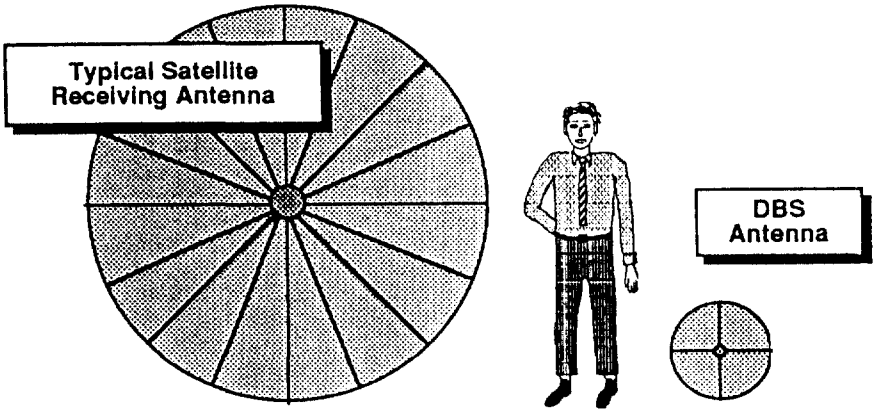

Figure 3-1 Antenna Size Comparison

DBS was originally envisaged as a **television** broadcasting service to homes with receiving antennas of less than one meter diameter. The FCC wisely has **not** mandated the form of the transmitted signal or its service content. Of the DBS Permittees, **ACC has taken the technological leadership position** and is the only permittee fully embracing digital technology and transmission–the same technology which revolutionized audio recording and made personal computers possible. **Only ACC's system** combines the smallest-terminal convenience and simultaneously **fulfills numerous other user needs** besides entertainment television.

3.2 ACC's Digital DBS

Digital transmission will allow ACC to offer to all areas of the nation not only the best cable-like entertainment television service but also:

- Economical, innovative educational services (K-12, university, professional, adult);
- Information services (e.g., detailed weather, markets, customized news coverage);
- **Electronic Publications** (newspapers, magazines, books, trade journals);
- CD-quality digital radio stations (vastly superior to FM);
- A natural pathway to compatible high-definition television (HDTV).

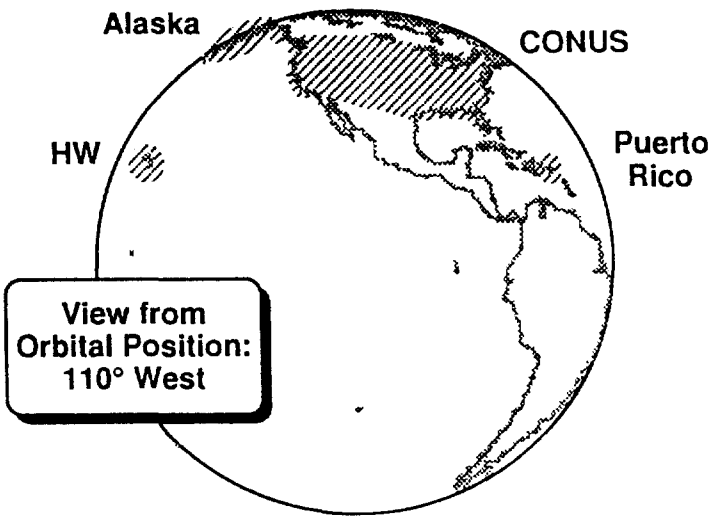

Figure 3-2 Orbital View of Coverage Area

The ACC Digital DBS system is designed to deliver a usable data rate of 25 Mbps in each DBS channel to a receiving antenna less than 2 feet in diameter. Without data "compression" techniques, normal (NTSC) television requires 90 to 140 Mbps for high-quality digital transmission. Digital image compression techniques, such as shown in Figure 3-3, can easily attain rates below 25 Mbps and even as low as 12 Mbps with little or no noticeable degradation.

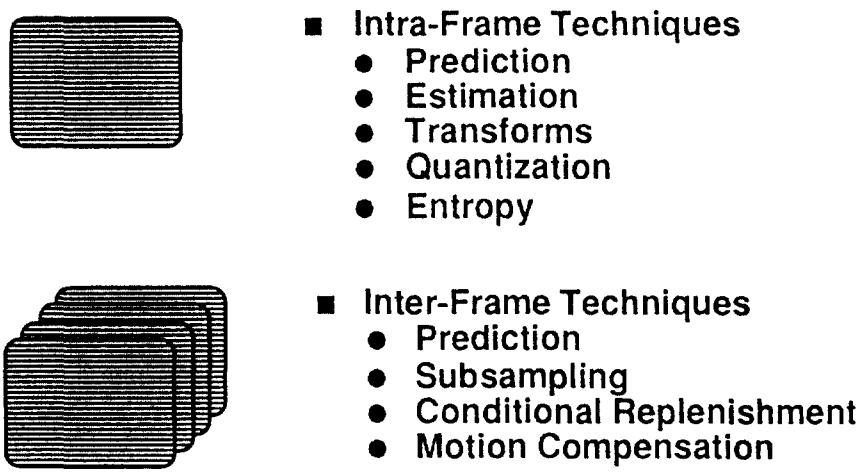

Figure 3-3 Video Data Compression Techniques

This technology is the culmination of advances developed over the last 20 years at Bell Telephone Laboratories, TRW, CBS, NASA, Advanced Communication Engineering (ACE, an affiliate of ACC), and many others. The continuing advancements in receiver and integrated circuit technology and in personal computer hardware and software make these services feasible now, and make this system an obvious choice for the future.

3.3 Educational and Data Services

In order to compensate for the present shortage of teachers, especially in math and science, numerous "distance-learning" methods have been attempted—some by satellite, some by telephone lines and other techniques—some successful, some not. Current satellite educational video transmission is generally expensive. It takes the same satellite capacity (one transponder) to send one video lecture to one classroom as to distribute a television program to millions of people.

To avoid the high cost of leasing an entire satellite transponder, various alternatives have been tried by others, such as electronic blackboards using telephone lines, expensive video compression equipment (originally designed for business conferencing), and interleaving and capturing of still-video television frames. While these techniques can be effective, they are either limited in capability or require high capital expenditures for terminal equipment. Most users of distance learning also have a need to transmit other information such as reading materials, homework assignments, and exams.

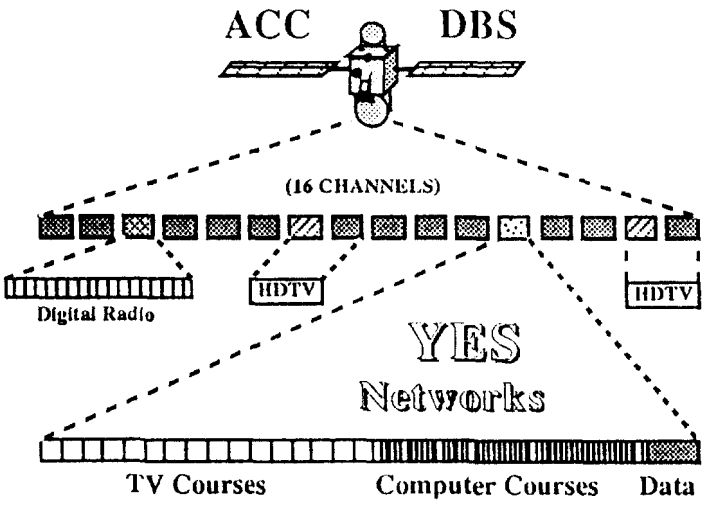

Figure 3.4 Satellite Channelization and Capacity

The **YES (Your Educational Services) Networks'** all-digital educational broadcasting system provides extremely efficient solutions for all of these needs. Using a single DBS transponder, a complete spectrum of educational services will be offered to schools, homes and businesses, using techniques ranging from still-frames (plus voice) to moderate-motion video. A new factor is the ability today to use a personal computer to easily generate highly stimulating presentations which can be transmitted directly to television receivers or to classroom computers, the latter being much more efficient and versatile.

Depending on the particular mix of services, present estimates are that the **YES Networks** can simultaneously carry anywhere from **20 to 200** or more individual courses where only one is possible by conventional techniques. In addition, the ability to inexpensively "download" (send data from the central source to the user) support materials for the courses and implement innovative educational techniques and programs is an inherent part of this uniquely flexible system.

3.4 Access Control

Access control is either inadequate or non-existent on satellite television transmissions today. The standard protection system that is used today (VideoCipher) does not encrypt the video—it simply inverts it and replaces the standard sync pulses with digital sound and data. The digital audio and certain control signals are encrypted. The system presently has inherent weaknesses that have resulted in approximately half of the sold units being modified for pirate reception. Although a new program is being instituted and new hardware is being manufactured to alleviate the problem for new purchases, It is still difficult to adequately protect an analog video signal.

Because all of ACC's DBS transmissions will be digital, it is relatively easy to individually hard-encrypt any service in its entirety whether video, audio, data, or MultiMedia. The inherently high data rate provided by ACC's Digital DBS will insure that adequate capacity is available for individually addressing receivers for specific service access. Thus, the level of security provided by this system will be several orders of magnitude better than that previously available.

4.0 Electronic Publishing

4.1 Information Presentation

Electronic information presentation can be simply more-of-the-same, mimicking the printed page of a newspaper, magazine or book, or it can be radically different by including sound, graphics, and animation. Although all of this could be done on some of today's personal computers (such as the Mac IIcx), there is an unmistakable trend towards small portable computers with flat panel screens, and toward notebook computers. The first description of such a device is usually attributed to Alan Kay of Apple Computer (formerly of Xerox PARC). It was an intelligent device which he called the "Dynabook."

The concept promoted here is less ambitious than the Dynabook, but has many of the same attributes. The internal processing power and storage would be somewhat limited in order to conserve electrical power and keep down cost. Static active-matrix display technology (similar to that used by the Macintosh portable computer) could be used to reduce screen interaction and eliminate the raster scan, thus improving visibility and reducing battery power drain. We call this device the "Eltron."

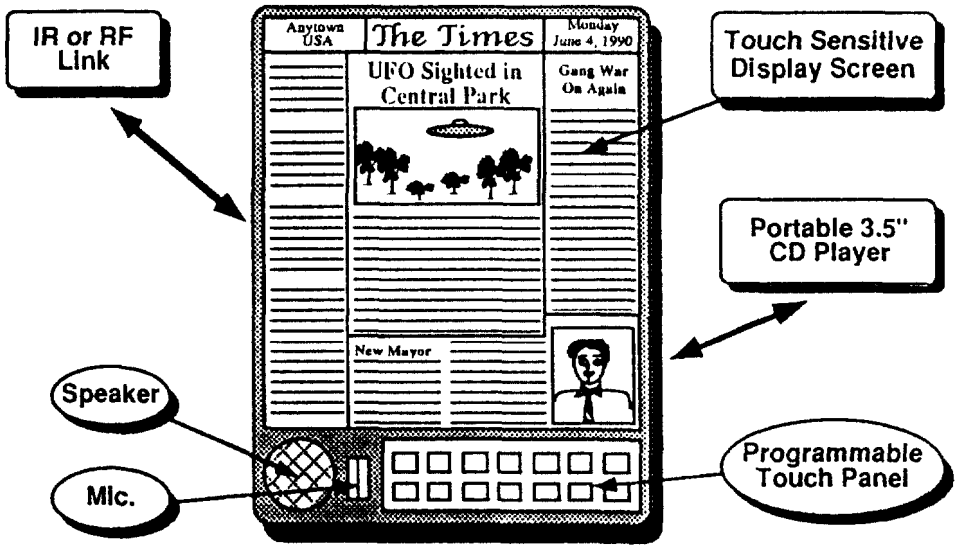

Figure 4-1 The "Eltron"

An infra-red or RF link provides communication which allows the Eltron to operate as an extension of a more powerful personal computer which can be located anywhere on the premises. For remote use, a portable CD (Compact Disk) player can be used for the information source. The

player can either use a CD-ROM or a recordable CD which has been downloaded from the main computer. The Eltron would also be capable of animation and sound. Voice commands are possible, but may require processing by the main computer or by including more on-board processing (at a cost of shorter battery-operation time).

Initially, the Eltron would only have a two-level (one bit) display similar to most of today's portable computers. Later, gray-scale would be available, and eventually color. The Eltron (or something similar) would be mass-produced and would eventually become a standard, inexpensive (< $100) item, much as the pocket calculator is today. An entire semester's worth of textbooks and references could easily be contained on one small CD. Today, one CD-ROM disk costs less than $2 to produce—the equivalent of a few cents per book. This is obviously a small percentage of the cost of (physically) publishing a book today—yet the information will be in much more usable form.

Most people do not want to sit and stare at a CRT (computer monitor or TV set) for the purpose of general reading or for studying. The Eltron is an obvious choice for this purpose. An electronic newspaper, magazine, or book could be viewed, either relying on a main computer for mass-storage or on a CD for portable storage. Portable and notebook computers exist in large numbers today. **The Eltron is an extension of this concept and is feasible now.**

Another display concept which is being tested today is electronic glasses which place a virtual image in front of the person in full "3–D." A wired glove can be used to allow hand manipulation of the virtual image. In the totally-far-out category, at some time in the not-too-distant future, brain stimulators (presently used experimentally to give blind people some semblance of sight) could be implanted at the back of the brain for direct visual input. However, we won't wait for this one.

4.2 Organization and Access

4.2.1 Linear

Almost all published information today has a **linear** physical organization. It has a beginning, an end, and a continuum of information in between. For a single-pass reading of a novel this may be adequate. However, without additional aids, specific information is most difficult to locate. The entire work must be perused to find particular information.

4.2.2 Hierarchical

Most printed information (including novels) is organized at least with single-level partitioning such as "chapters" or "sections" and includes page numbering and a "table of contents" which allows relatively quick access to a general area of information. Many textbooks and reference books further subpartition the information several layers deep. This allows a full "outline" table of contents which

uses progressively increasing levels of preordained specificity to guide the user to the desired information. This is a type of strict **hierarchical** organization of information.

Such a hierarchy may still require that the user have some knowledge of the partitioning categories at each level in order to properly navigate the hierarchy. If one reaches the end of one path without finding the required or desired information, then he can retreat to some higher (less specific) level of the hierarchy and pursue other downward (more specific) paths until successful. There are now many examples of hierarchical information structures in the computer world. Among them are:

- File-folder (directory) structure of any personal computer;
- File or message area of any electronic bulletin-board or information service;
- "Outline" mode of Microsoft Word (word processor for Macintosh and IBM PCs);
- "Notebooks" in Mathematica (a sophisticated symbolic mathematics program, available on most types of computers;
- Information paths in "Prodigy," an on-line data service.

In the last three examples, only the highest level of the hierarchy is initially visible. At each stage of the search the user makes a selection which is then expanded to show a new set of choices. Whenever the user returns to a higher level to open other paths, previously explored paths may either remain open or be re-collapsed, as desired. In this manner, **the system shows only the information desired and the path(s) used to reach it.**

This type of structure serves well as a direct electronic replacement for a textbook or reference book where the information is entirely in the form of either text or stationary graphics. "Mathematica" carries the concept a step further with the inclusion of **animated** graphics (e.g., illustrating the effect of changing one equation parameter on a two or three dimensional plot). Although not presently included in the above-mentioned software, it is obvious (at least conceptually) that **sound** could also be included. Indeed, the recent buzzword, "Multi-Media," encompasses this and much more.

As we can easily see, **electronic publications**, even within a strict hierarchical structure, **can offer vastly more than what is possible with the printed page alone.**

4.2.3 HyperMedia

Part of the problem that has already been noted with the strict hierarchical structure is that the user must know the prioritization of partitioning of the hierarchy to be able to successfully navigate it. Many other prioritizations and partitionings of the same information are possible. One common

method is to provide a subject or key-word listing which gives the page or paragraph number of every occurrence of the word within the document. Sub-categories may also be included. Such a listing comprises the "index" of most books. Electronic publishing media often include and make much use of extensive computerized indices.

Some fifteen to twenty years ago, Ted Nelson developed a concept which he called "**HyperText.**" This is an information text environment where one can branch from any selected word or phrase to other related subjects or to other usages of similar words or phrases. This allows "browsing" through information by following related thought, rather than proceeding linearly (from start to finish) as though printed in a book. In a way, this is an extension of browsing through an encyclopædia by continuing to look-up "See also..." or "related topics." Part of the theory behind hypertext is that it is supposedly organized much closer to the way the human brain operates, associatively rather than linearly.

In 1987, Apple computer started including with every Macintosh computer purchase a program developed by Bill Atkinson originally called "WildCard" but later rechristened "**HyperCard.**" Whatever it was called, it was nothing short of revolutionary. In a single, inexpensive ("free") software package, HyperCard combined an easy-to-use, easy-to-customize graphical user interface with text, graphics, sound, animation, data-base, hypertext, script-programming, object-oriented-programming, and extendibility (external commands and functions).

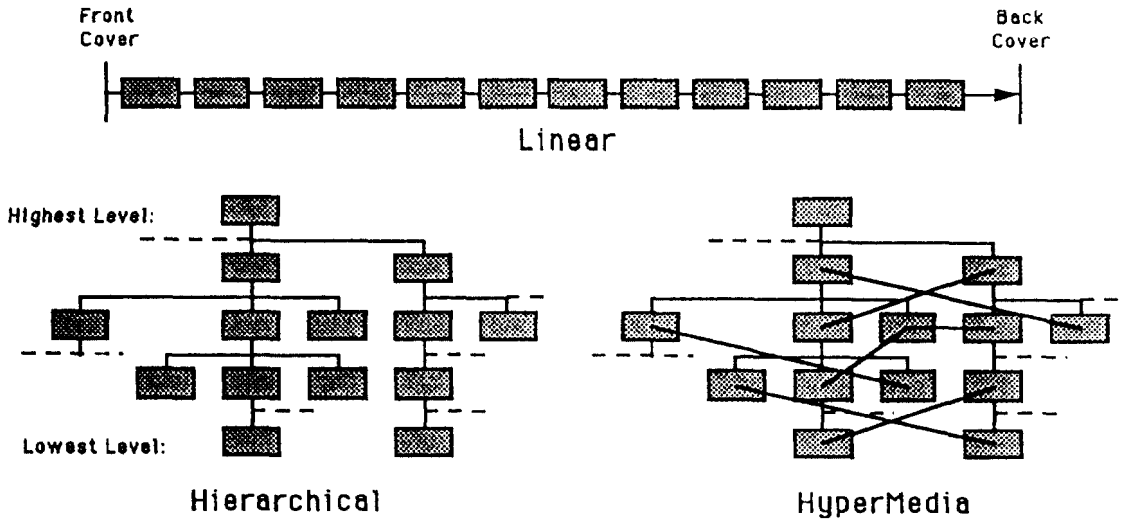

Figure 4-2 Media Linkage

The ease of adding "externals" to HyperCard has allowed the inclusion of data communications, sophisticated object and screen animation (e.g., MacroMind's "Director"), control of CD (ROM) and LaserDisk players, and a multitude of other software and hardware. Further extensions of the