A Model for Development of a Telecommunications Satellite Network for Administrative, Educational and Other Purposes in a Private Organization

Allen Steele
Andrews University

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A MODEL FOR DEVELOPMENT OF A TELECOMMUNICATIONS SATELLITE NETWORK FOR ADMINISTRATIVE, EDUCATIONAL AND OTHER PURPOSES IN A PRIVATE ORGANIZATION

A Dissertation
Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Education

by
Allen Richard Steele
August 1984
A MODEL FOR THE DEVELOPMENT OF A TELECOMMUNICATIONS
SATELLITE NETWORK FOR ADMINISTRATIVE,
EDUCATIONAL AND OTHER PURPOSES
IN A PRIVATE ORGANIZATION

A dissertation
presented in partial fulfillment
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Doctor of Education

by
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Date: July 2, 1984

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ABSTRACT

A MODEL FOR DEVELOPMENT OF A TELECOMMUNICATIONS SATELLITE NETWORK FOR ADMINISTRATIVE, EDUCATIONAL AND OTHER PURPOSES IN A PRIVATE ORGANIZATION

by

Allen Richard Steele

Chairman: Edward A. Streeter
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Problem

While large organizations such as federal and state governments and large commercial corporations have expended their resources to take advantage of communication satellites, private organizations with more modest means have not been provided with a plan for utilization of this new technology. The purpose of this study was to design a model for development of a telecommunications network which private organizations could use to create their own telecommunications satellite networks.

Literature was reviewed to provide a perspective of the history and development of satellite technology. Two telecommunication
networks already in operation by private organizations were visited and a report about these networks provided concrete aspects of inter-connect systems.

A model for the development of a satellite network was then recommended with specific notes on potential areas of operation and administration. The model was validated by a jury, a panel of experts in the field of satellite communications, who provided comments with their evaluations.

Conclusion

Telecommunication satellite networks were shown to be successfully operated in two private organizations and are known to be in a developmental stage at others. A simple step-by-step procedure, as recommended in this study, would be helpful to other organizations interested in developing a network. The Seventh-day Adventist Church, object of this model, with its multi-faceted operation of administrative offices, schools, hospitals, printing plants, food factories, broadcast stations, emergency preparedness units, and approximately 3000 local churches in the United States could benefit from having a telecommunications network and should commence plans for developing an Adventist Telecommunications Network.
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CHAPTER I

INTRODUCTION

Throughout history various methods and techniques have been developed and refined to provide the best conditions for communication. At first, slate boards, books, and graphs were utilized to relay thoughts visually. Since that time, technology has brought mankind to instantaneous communications, orally and visually, via computer and the electronic media: film, radio, and television.

In America, the evolution from an industrial society to an information society greatly increased the volume, variety, and frequency of communications required to effectively manage business and industry. Complex organizations share in the growing need to gather and process more information faster on an ever broadening range of subjects.

Adding significantly to the communication needs of an organization are such factors as the increasing necessity to interrelate with other entities, service to constituents, heightened management challenges, over-advancing technology, and the geographic spread of administrative units and responsibilities. An examination of the current use of the telephone, mail, leased data line, audiovisual materials, and travel dramatize the dependence on communication in the 1980s.
Satellite communication systems have the capability of distributing large volumes of information to many locations at low cost and therefore have potential for helping organizations meet their growing telecommunications needs. Further technical advances hold promise of making satellites a daily tool for communications.

At the same time that satellite technology has advanced, for financial and efficiency reasons, the traditional concepts, practices, and institutions are being critically and widely questioned and reexamined. Out of this process fresh insights and perspectives have emerged, along with a new climate conducive to innovation.

**Statement of the Problem**

Increasingly tight fiscal constraints have forced administrators to discover and develop new methods to accomplish old tasks and meet new challenges of communication problems in administration. A model to develop a cost-effective telecommunications network for administrative, educational, and other purposes had not been developed to assist private organizations with multiple administrative units spread over a wide geographical area to take advantage of these new technologies.

**Purpose of the Study**

The purpose of this study was to design a model for the development of a cost-effective system of communication utilizing satellite technology whereby organizations could keep pace with growth trends and financial responsibility.

Related purposes, providing background for the model being developed, were:
1. To survey the accomplishments of other organizations that have already developed a satellite telecommunications system, and
2. To identify the criteria required to establish a satellite network with commonalities of need among the entities of a diverse organization.

Delimitations

For clarity and direction, and because the researcher was familiar with the organization, the Seventh-day Adventist church, school, and hospital system was chosen as an object for this model. The following delimitations, in addition to the obvious limitations imposed by considerations of time and finance, applied:

1. The model was limited to the Seventh-day Adventist organization.
2. The study and the model developed applied only to the Adventist organization in the United States, although it was understood that its scope could be expanded to include other countries in North America as well as overseas entities owned and operated by the church.
3. The data was largely drawn from other organizations which had developed networks to serve similar purposes, i.e., communications between administrative, educational, and/or medical units.

Basic Assumptions

1. The Seventh-day Adventist church and similar organizations would continue to find the financing of operating offices, schools, and medical institutions to be a problem.
2. The maintenance of quality programs of communication for
growth and nurture would be of vital importance to such organizations.

3. The ability of an organization of this type to maintain growth was directly related to its facilities and capabilities to communicate.

4. Church administrators would of necessity make decisions regarding the most cost-effective ways of providing complex services to the church constituency and workers.

5. The development of a model of this type could provide a means of coping with available financial resources and increased demands for communication services.

Significance of the Study

The significance of the study would be in providing a design model for a satellite network for the Seventh-day Adventist church that could be used by other organizations which face similar challenges.

Definition of Terms

Antenna: A device used to pick up on-air television or audio signals.

Apogee: The high point of a satellite's elliptical orbit.

Audio: Pertaining to sound, specifically to the sound accompanying the video portion of television.

Bandwidth: A measure of the capacity of an electronic communication system.

Bird: (slang) A satellite.

Cable television: Television signals distributed to homes and other places via cable connections.
Communication satellite: A satellite which carries electronic equipment capable of receiving signals from earth and retransmitting those signals back to a desired area.

Community Broadcast Satellites: High-powered satellites which transmit signals that can be received by inexpensive installations affordable by communities but not by individuals.

Cross-polarization: Electrical energy being transmitted by satellite which normally has its waves oriented either horizontally or vertically. When a satellite transmits both horizontal and vertical waves, it is said to be cross polarized, and thus can use the entire radio spectrum twice—once horizontally and once vertically.

Digital: The description of a system or device in which information is transferred by electrical on-off or high-low pulses instead of continuously varying signals.

Direct Broadcast Satellite: A satellite which can send a signal intended for reception by the public.

Dish: Industry jargon for a microwave antenna which has a circular reflecting surface. The name is derived from the shape, which looks like a dish.

Distribution Satellites: Medium-powered satellites which can send signals (usually TV) to earth stations and which cost between $30,000-$300,000.

Domestic Satellite: A satellite which provides communication services primarily to one nation.

Downlink: Satellite receiving station (see TVRO).

Earth Station: Equipment located on earth used for the transmission and/or reception of signals to a communication satellite.
EIRP: (Effective Isotropic Radiated Power) A measure of the power radiated by the satellite towards the earth.

Footprint: The area on earth in which a satellite's signal can be received is said to be 'in the footprint.'

Frequency: The number of waves of electrical energy sent out each second. Usually expressed in cycles per second or hertz.

Geo-Stationary Satellite: A synchronous satellite whose orbit is in the plane of the equator so that it not only has a 24-hour period but also has no north-south motion and appears to remain stationary over one point on earth.

Look Angle: The antenna at each earth station which is pointed at the satellite with which it is working. The angle above the horizon of that antenna is called its look angle. The higher the look angle, the lower the potential interference to that station.

Megahertz: A measure of frequency equal to one million hertz, where one hertz is one cycle/second of electronic energy.

Microwave: Method of transmitting television signals over the air from an origination point to receivers in line-of-sight at high frequency.

Monitor: A television or radio set that accepts direct cable feeds from TV cameras or broadcast signals.

Peragee: The low point of a satellite's elliptical orbit.

Period of a Satellite: The time it takes a satellite to complete one revolution of its orbit.

Satellite: A man-made object put in orbit around the earth.

Satellite Network: A satellite system or a part of a satellite system consisting of only one satellite and the cooperating earth stations.
Synchronous Satellite: An artificial satellite whose orbit is located 22,300 miles from earth so that its period of revolution is 24 hours, or synchronized with the earth's daily rotation.

Telecommunications: The science and technology of communication by electrical or electronic means.

Transponder: A piece of equipment on a satellite which receives the signal from an earth station, changes its frequency, amplifies it, and retransmits that signal back to the earth. Each transponder on a satellite operates on a different frequency and is capable of handling one television channel with audio. The radio spectrum assigned to satellites is 500 megahertz wide. Presently, each transponder is 40 megahertz wide, so that twelve transponders on a satellite occupy the entire band. Satellites that are cross-polarized can have twenty-four transponders.

TVRO: A television receive-only earth station.

Uplink: Satellite transmitting station; also capable of receiving.

Videotext: Two-way interaction of text and graphics to display usually involving a TV set and computer terminal.

Procedure and Methodology

The purpose of this study was the development of a model to provide guidance to the Seventh-day Adventist church in planning a live satellite interconnect among its schools, hospitals, churches, and administrative offices. Other systems of a similar nature could use the study in their planning. The development and validation of the model involved:
1. A review of literature and research, of which there were two aspects. The first involved a review of printed material which has evolved with this technology to reveal the need and value of a satellite interconnect. The second aspect of the review involved a survey of systems in operation and their applications. This section of the survey provided a basis for the foundation upon which a model could be built.

2. An analysis and evaluation of those systems which were in operation. This information was gained by visits to such facilities to evaluate their raison d'etre and method of operation. This observation provided concrete aspects of interconnect systems.

3. An identification of criteria required for establishment of a satellite distribution system and a survey of needs which church institutions had in common. This information formed the criteria for a satellite interconnect and a foundation for cooperative sharing of a communication system.

4. A recommended model designating the participants, processes, and sequence of decisions involved in development of an Adventist system.

5. The appraisal of the model, together with its explanatory note, by a panel of jurors. The panel included experts on satellite technology, officials of satellite networks, and satellite systems consultants. The jurors were asked to appraise critically the model as a useful aid to organizations in planning such a satellite network and to point out what they felt were the strengths and weaknesses of the model.
Review of Related Literature

In the early 1950s, when it appeared that the launching of artificial earth satellites would occur within the next few years (Mack, 1964), forward-looking communicators were seriously discussing their use for communication purposes. Sputnik I was successfully launched into earth orbit in October 1957. This successful event appeared to stimulate an increased emphasis on the uses of space by the United States.

The U.S. response was to create the National Aeronautics and Space Administration (NASA) and the Advanced Research Project Agency (ARPA) of the Department of Defense in 1958 (Bester, 1966). Most of the early communications satellite activities in this country were carried out under ARPA direction. In 1960, COURIER, the first active communication satellite, was launched by the United States.

The Bell Telephone Laboratories communications satellite, TELSTAR, was launched on June 7, 1962, by NASA. Mack (1964) said TELSTAR was designed for real-time relay of wide-band communications. It could relay television information or the band could be subdivided into individual band segments to permit large individual channel-handling capability for multiple simultaneous transmissions.

Polcyn (1975) said that with the launching of Telestar, and of SYNCOM in 1963, the first communications satellite in synchronous equatorial orbit, the era of communication satellites was inaugurated. During the 1970s such satellites as INTELSAT (1971), Anik (1972), Westar (1974), ATS-6 (1974), Satcom and Comstar (1976) provided communication by satellite at increasingly reduced cost and availability.

Basic satellite communications systems consist of a satellite
acting as a repeater for many earth stations, each of which desires to communicate with several others (Polcyn, 1975). Elements in a satellite communications system include the satellite, a network of earth stations, and multiple-access communications equipment which earth stations could operate through a single satellite.

In 1983 commercial communications satellites were in orbits that were synchronous with the earth's rotation. This allowed considerable system simplification since each earth station pointed continuously at the same satellite position. With the advent of satellite technology various entities attempted to take advantage of such systems (Brennan & Bremer, 1983) to communicate important messages. The review of literature attempts to look at those major events which had significance to the model developed.

Two authors outlined the historical aspects of satellite technology, Paul in *The Satellite Spin-off*, 1975, and Bester in *The Life and Death of a Satellite*, 1966. Paul presented the history in story form, first telling of the first balloon satellites and the Echo series, then unfolding the story as it developed into an explanation of the various unique uses of satellites for weather prediction, sea navigation, and other information.

Bester capitalized on the popular style of telling a story, and his readers were treated to a light-hearted, sometimes comical narrative which not only revealed how events in the international space race began but took a philosophical view of the political and strategic importance of the development of satellite technology.

Two published guides to satellite communication, *An Educator's Guide to Communication Satellite Technology* by Polcyn, 1975, and
Satellite Communications: A Guide for Hospitals, by Brennan and Bremer, 1983, were key sources for the study.

Polcyn took a practical view of satellite technology attempting to relate to and convince readers of the potential of satellite technology for educational purposes. Indeed, his treatise was based on the premise that educational purposes were the best applications of satellite technology. He surveyed the growing experiments in education using communications satellites.

Brennan and Bremer presented a concise overview of potential satellite technology use for hospitals, emphasizing the risks and rewards of technology to the local hospital. The authors inspected all aspects of satellite use including prices, facilities, and uses of satellite-distributed services.

Another writer, Hilton, gave a brief overview of the development of satellites and their potential in supporting manned space stations. This early treatment of the subject revealed a unique insight into a complex technology which was just beginning when this book was written in 1965.

Utilization of the findings of the Bibliographical Retrieval Services, Inc. revealed several organizations which considered the use of a satellite system for educational program distribution.

Gaudreau and Perritt reported (1981) on one of the early attempts, the Appalachian Community Service Network (ACSN), headquartered in Washington, D.C. It was organized in 1971 within the scope of the thirteen Appalachian states. The objective was to beam teacher-education courses a few hours a week via satellite to teachers at forty-five community receiving sites. Since that time, the
network's television courses delivered via satellite have expanded to further the concept of lifelong learning.

How to decide on a delivery system to meet a specific organization's specific needs was discussed by Baltzer (1981). She outlined types of alternative educational systems, including a satellite system. This study was of value because of its look at comparative distribution systems.

Another study, by West (1980), *A Survey and Report of Interest in and Availability of Systems for the Delivery of Instruction by Remote Methods*, was of note because of specific data and considerations investigated by West's study of the Rockford, Illinois, school system needs.

An additional study of import (Daniel, 1977) was one in which the needs of Canadian education were surveyed and a model created for use by the nation's education system. Daniel and others presented a needs survey and a cost analysis for such a system. It demonstrated that satellite communication had applications in education which went beyond the classical telelecture.

A similar study (1976) was prepared by the Syracuse University Research Corporation at the New York Educational Policy Research Center. It summarized the results of a two-year investigation into the feasibility of using a telecommunications satellite for educational purposes compared with the use of other delivery systems.

A prototype system for educational program delivery was discussed by O'Connel (1978) in his *Planning for Applications of Communications Satellites in Education*. It included a survey of progression toward an operational communication satellite system, a project description, and earth-station site maps.
Two doctoral dissertations concerning use of satellite for communication networking found in this research were written from a mathematical or electronics point of view. They were: "An Investigation of the Factors to Be Considered in Planning Communications Satellite Systems," by Mack in 1964, and "Cost Traffic Analysis of Demand Access Satellite Networks," by Latimer in 1978. The researcher did not find any dissertations written about satellite networking primarily for administrative or educational applications.

Information on an updated basis appears weekly in trade publications of the broadcasting industry and specialty magazines such as Broadcasting, Broadcast Communications, The Satellite Times, The Public Service Satellite, Consortium Newsletter, and others. These publications were monitored for the latest information pertinent to the study.

Organization of the Study

Chapter I provides an introduction to the study, and includes statements of background, the problem, the purpose of the study, basic assumptions, and delimitations of the study. Also included are definitions of terms used in the study, procedures to be followed, and the organization of the report.

Chapter II contains a review of literature and research. It contains material concerning the history, need for, and purpose of satellite interconnects and will serve as background.

Chapter III is an analysis of telecommunications satellite networks facilities visited. It looks chiefly at organization and operation of these facilities as well as the philosophical background that led to their creation.
Chapter IV first establishes the criteria developed for the recommended model as a result of the review of literature and visits to operating systems, then outlines the model itself. Information gathered is presented in a comparative manner and the value of different aspects of these operations in light of the need of the Adventist organization is considered.

Chapter V presents a summary of the study conclusions and recommendations for further research.
CHAPTER II

REVIEW OF THE LITERATURE

Satellite Communication Systems

The purpose of this chapter was to review the history of satellite communication and to relate that history to development of the technology that makes possible telecommunications satellite networking.

History of Communication Satellites

To better understand the history and technology of satellite communication, the satellite story has been logically organized into four periods of activity: The Experimental Years, 1944-1957; The Space Race, 1957-1962; The Development of Satellite Communications, 1962-1973, and The Domestication of Communication Satellites, 1973-Present.

The story of the communication satellite began with war related experiments by the Germans in 1944 which launched the experimental years. The launching of Sputnik by the Soviet Union in 1957 started the space race by the superpowers. TELSTAR marked an important beginning of the development of satellite communications and RCA commenced the domestication of communication satellites by its purchase of transponder time on a Canadian satellite in 1973.

The Experimental Years, 1944-1957. The first time a body
outside the earth was successfully utilized to transmit radio signals, according to Paul (1975), was in the year 1944. In the last months of World War II, the Germans directed a radar apparatus at the moon and a few seconds later were able to register the reflected signals on receivers--weak, but nonetheless perceptible.

Because of the confusion of the post-war years, radar experiments could not be continued in Germany. However, they were continued by the military in Britain and America. The American Army Signal Corp had success in 1946 in reflecting signals off the moon. Although the moon reflected no more than 7 percent of the energy that reached it, radio communications were established in this way.

These early experiments led to the idea of creating an "improved moon," recounted Paul. There were two basic ideas for improvement: improve reflection chances and bring the reflector closer to earth. A man-made moon in the form of an almost perfect sphere could be equipped with a metallic surface which would reflect back to earth almost 100 percent of the radio emissions hitting it. By hanging a man-made moon closer to the earth, the transmission time of signals from earth to moon would be short enough to allow a reasonable conversation.

Paul credited the first advancement of the idea for such a man-made moon to John R. Pierce of the California Institute of Technology in 1955. As a result of his prodding in Washington, the balloon satellite, Echo 1, was planned by the United States and eventually launched in 1960.

*The Space Race, 1957-1962.* Before Pierce's idea could be
realized, however, Russia launched Sputnik on October 10, 1957. Of the event, Bester (1966) said, "Sputnik went into orbit and the United States went into shock" (p. 26). Immediately the American space program was turned into a gigantic enterprise. In 1958, utilizing the knowledge and research of the German scientist, Werner Von Braun, the United States launched its first spacecraft, two small satellites called Vanguard and Explorer, in an effort to demonstrate a capacity to put man-made objects into orbit. That same year Congress established the National Aeronautics and Space Administration (NASA) charged with development of the country's space program. The potential of two-way satellite communication was demonstrated in 1960, with the launch of the 'Courier' satellite. It could receive radio messages from earth and store them on tape for later retransmission to earth (Alexander, 1979).

**The Development of Satellite Communications, 1962-1973.** Truly active communications on a commercial basis were achieved in 1962 when NASA launched TELSTAR. This satellite, explained Mack (1964), was designed to relay wide-band communications and had the capability to receive, amplify, and retransmit messages back to earth in real time. Primary power limitations permitted TELSTAR to be used for only about 100 minutes each day, but TELSTAR was able to dramatically demonstrate its capability to relay video information by providing the means for transatlantic relay of television.

All of the early satellites were placed in what was referred to as 'low orbit,' commented Alexander. They circled the earth every few hours and antennas had to be capable of tracking a moving body. As
a result, communications were lost as the satellite passed over the horizon.

The high cost of a satellite communication system using this nonsynchronous orbit, suggested Polcyn (1975), added impetus to explore the feasibility of synchronous satellite orbits. In February, 1963, SYNCOM I achieved the correct synchronous orbit, but it ceased transmitting within minutes because of a malfunction. In July of the same year, SYNCOM II successfully demonstrated the practicality of synchronous communications satellites. Polcyn believed it was the American SYNCOM satellite program that provided the basis for an international telecommunication satellite system after it proved instrumental in relaying the 1964 Olympics from Tokyo to the United States (p. 22).

The first INTELSAT satellite, also known as 'Early Bird' and sponsored by the International Telecommunications Satellite Consortium, was launched in 1965. It relayed signals to the northern Atlantic basin via 240 voice circuits or one TV channel. Subsequently newer and more powerful INTELSATS had been put into orbit, each with increasing transmission capability, serving ninety-five member nations (Alexander, 1979).

Polcyn (1975) pointed out (p. 23) that the United States was not the sole promoter of satellite technology. The Soviet Union, with its successful launch in 1965 of the MOLNIYA I satellite, began an international system called INTERSPUTNIK. In 1978, the European Space Agency launched the OTS-2 satellite, the forerunner of a satellite communications system capable of handling telephone, telex, and TV traffic of Europe. The same year Japan launched the YURI satellite,
the first communications satellite for direct home broadcast (Alexander, p. 3).

The Domestication of Communication Satellites, 1974-Present.
In America, domestic commercial satellite service began in 1973, reported Brennan and Bremer (1983), when RCA Global Communications leased transponder capacity on a Canadian satellite for a communications service between Alaska and the West Coast. The first United States domestic commercial satellite, Westar I, began service in 1974. RCA launched its own satellites in 1975 and 1976 (SATCOM I and II) to provide television networks with satellite program distribution. Numerous experiments attempting to apply the technology of satellite distribution to commercial, educational, and non-profit use were attempted in the 1970s and early 1980s. These experiments are discussed below.

How Satellites Work
When considering how satellite technology works, Alexander suggested reflection on a vision by Arthur C. Clark, physicist, astronomer, and coauthor of the book 2001: A Space Odyssey. Clark advanced the concept of synchronous space stations which could serve as radio relays for all points on earth.

In the October 1945 issue of Wireless World, Clark suggested that satellites positioned some 22,300 miles above the equator would orbit the earth at precisely the rate of the earth's revolution, thereby appearing to be stationary over one spot on the earth. Three such satellites equally spaced around the earth could see virtually the entire globe. A mere fifteen years later, writing in the UNESCO
Courier in March 1970, Clark was able to say there was no longer any need to argue that the communications satellite would have a profound effect upon society.

The technology proved that man-made satellites were not merely a repeater of signals. In their communication function, satellites could receive, amplify, and transmit voice, music, television, telephone, telegraph, and data signals from one point to another point or points on earth. A velocity of 25,000 miles per hour was required to launch a man-made satellite and once this velocity had been attained and the proper altitude reached, a satellite could be placed into orbit. The position of the satellite in space was controlled by a 'de-spin stabilizing mechanism' and small position and altitude correction jets (Polcyn, 1975, p. 2).

Concerning orbits, Polcyn explained that the velocity which a satellite achieved and its angle of ascent would determine its orbit, of which there were a number of patterns:

1. Polar (or near-Polar) orbits are inclined at an angle of approximately 90° to the equator. They permit surveillance of all or a major portion of the earth.
2. Retrograde orbits are those in which the satellite travels from east to west (counter to the earth's rotation). Satellites are put into such orbits to insure that they appear over illuminated areas of the earth at certain times.
3. Synchronous orbits are 22,300 miles above the earth, where a satellite's velocity matches that of a point on the earth's equator. Viewed from the earth, they appear to be stationary in the sky, if they are over the equator; if otherwise 'hung,' they trace a figure 8 on the earth below.
4. Sun-synchronous orbits have their planes directly in the sun. A satellite in a sun-synchronous polar orbit is ideal for taking pictures of the earth's equatorial and temperate zones with the sun always high in the sky. (p. 4)

Generally speaking, Polcyn said the equator-synchronous (geo-
stationary) orbit was found to be most effective for communication purposes because it was constantly visible from roughly 40 percent of the earth's surface. Confirming Clark (1945) Polcyn (1975) observed that as few as three such satellites, at 120° spacings, could reach the entire surface of the earth, exclusive of extreme northern and southern latitudes (p. 5). Also, earth stations could continuously receive from or transmit to a satellite in their geographic area. The M/A-COM Company, in their Television Receive-only (TVRO) Planner (1982), pointed out that with this fixed orbit, antennas could be used in lieu of continuous-satellite tracking, a characteristic of early satellite technology (p. 1).

Another advantage of a satellite in synchronous orbit, said Polcyn (1975), was its potential for broadcasting signals directly to small, inexpensive receivers by producing powerful signals on the earth's surface. Furthermore, the synchronous configuration would make frequency sharing with terrestrial relay stations feasible, because only a few antenna pointing angles need be cleared for possible non-interference with terrestrial communication systems.

Brennan and Bremer (1983) noted that a satellite was approximately the size of a small car, weighing 3,500-4,000 pounds. A good part of the weight was the correction rockets and fuel to keep the satellite in its fixed orbit. Power for its transmitters was provided by solar panels and supported by battery systems.

Hilton (1965) early speculated that an unmanned satellite should easily reach a life span of one year and that a twenty-year life could eventually be possible. The useful life of a satellite would be terminated:
1. When the power supply failed
2. When the radio failed
3. When the satellite lost altitude stabilization
4. When the orbit was too unsatisfactory.

By 1983 Brennan and Bremer could report the useful life of a satellite was eight to ten years, dependent upon the extent of its rocket fuel and battery life.

The M/A-COM Company specified that each satellite contained either twelve or twenty-four transponders, or channels. Each transponder received an uplink signal for its channels, changed its frequency, and transmitted a downlink signal to earth. The downlink signal strength radiated from the satellite was referred to as effective isotropic radiated power (EIRP). All satellite transponders were, to some extent, independent of each other. For that reason, these could separate footprints for different transponders, a footprint could be for one or several transponders, or may be an average footprint for all transponders on a satellite (p. 3).

Alexander (1979) confirmed that each transponder was capable of handling either one television channel or numerous voice channels. According to the Corporation for Public Broadcasting, the radio spectrum assigned to satellites were 500 megahertz wide so that twelve transponders on a satellite occupied the entire band.

The four earth-bound elements of a satellite system, observed Alexander, were:

1. The programming source
2. The uplink or transmitting station
3. The receiving terminal
4. The distribution system (pp. 5, 6).

**Program Source**

Programming was defined as the software of a satellite system and because a satellite operated on electronic impulses, any form of communication that could be translated into electronic symbols could serve as a program source.

Programming could include voice, television, videotape, printed materials, computer logic, data transmission, charts, graphs, and library services. Any organization having access to an uplink transmitter could originate programs and send them to the satellite for re-transmission to all the receivers pointed at the satellite (Alexander, 1979).

All too often the software was ignored or given low priority in system development, warned Polcyn (1975), who held little hope that software, unlike the hardware of a system, would eventually experience a decrease in cost. Software, the most important element in the communication system, he added, was the most difficult to produce and the most costly item of a system (p. 21). He found the average cost for production of an instructional/educational television or radio program in 1975 was estimated at $5,000.00 and $1,000.00 per hour, respectively. Using this average for 300 days of educational programs, six hours a day, the cost would be $9 million for television and $1.8 million for radio.

Costs were dependent upon certain variables, of which Polcyn identified quality, sophistication, and complexity. Per-hour production cost for "Sesame Street" in 1975 was approximately $48,000.00,
for example, while the "French Chef" television program cost approximately $17,000.00.

Uplink

The second of the four earth-bound elements of a satellite system, suggested by Alexander (1979), was the transmitting station known as the uplink. Typically, he said, the uplink facilities consisted of a directional antenna pointed at the satellite, a low power (10 to 50 watts) transmitter that broadcasts on the satellite's frequency, and the associated control equipment (p. 5).

In satellite broadcasting, it was not necessary for each user to install a privately owned uplink, he added. It would be sufficient merely for them to have access to one (p. 5). This meant that numerous organizations could use centralized transmitting facilities on a time-shared and cost-shared basis, thus reducing the need for individual users to purchase and maintain costly equipment. Typical costs for uplink facilities, excluding studio equipment, were $350,000.00 for a C-Band uplink and $450,000.00 for a KU band uplink, according to Ferris (interview, 1983).

Downlink

A receiving terminal, termed a downlink, consisted of a directional antenna (Parabolic dish) that pointed at the satellite, and an amplifier that received the signal and changed it back into a conventional television or radio frequency.

Parabolic dishes varied in size from three feet to thirty feet. They were made of either plastic or metal or a combination of both. The strength of the dish related to the wind load it would be
taking. Surface reflecting qualities required that the dishes be smooth and even. Typical list prices for various size dishes were (1983):

- 5.0 meter dish $6,700.00
- 3.7 meter dish $2,600.00
- 3.0 meter dish $2,400.00

Another important component was the low-noise amplifier (LNA). These pieces of electronics collected the signal and amplified it as it reflected from the dish. A typical list price for an LNA in 1983 ranged from $400.00 to $1,700.00 (Brennan & Bremer, p. 2).

A final aspect of the downlink unit was a receiver. Although usually considered the minor component of the downlink, M/A-COM (1983) referred to it as the most complex part of an earth station. Its function was to convert the downlink signal from the satellite into video and audio (pp. 7, 8). Furthermore, M/A-COM pointed out, receivers could be either fixed frequency or frequency agile. A fixed frequency receiver was set to receive a single channel indefinitely while frequency agile receivers could be switched over all twenty-four channels (p. 7).

**Distribution System**

The nature of satellites made it possible, according to Alexander (1979), for the message, once it came back to earth, to be fed into any conventional distribution system, whether it would be a television set, videotape machine, cable TV system, computer terminal, telex, auditorium facility, or broadcasting station. He declared such flexibility could "open the door to a great diversity of opportunities" (p. 6).
Satellite Distribution Applications

As outlined above, the early attempts at utilizing satellites were in the realm of military experimentation and necessity. Military applications included weather observation, geophysical research, astronomical observation, space exploration (Bester, 1966), and reconnaissance missions (Hilton, 1965), as well as communication purposes.

However, the milestone in satellite usage, according to Brennan and Bremer, occurred between 1973 and 1983 with the development of the commercial satellite communications industry. It began when RCA leased transponder capacity for a communications service between Alaska and the West Coast, noted above. Western Union launched Westar I and II in 1974 because of a projected need for commercial message traffic, television network traffic, and cable services. This was soon followed by RCA's own satellite (Satcom I and II).

Both Western Union and RCA based their actions on expectations that U.S. television networks would prefer satellite program distribution over traditional, increasingly expensive use of land lines. Although both companies were premature, because access to the satellite was restricted by the limited number of earth terminals that existed and by the high cost of establishing even receive-only earth terminals, their action prepared the way for rapid expansion of satellite systems for a variety of purposes.

In 1975, Home Box Office (HBO), a pay television programming service for cable television operators, changed its method of national distribution from land lines to satellite. Cable industry interest in
earth terminals intensified when, in 1976, the Federal Communications Commission announced it would routinely approve applications for earth terminals with antennas 4.5 meters in diameter or larger. In less than a year these two events, noted Brennan and Bremer (1983), led to an increasing production volume of smaller antennas and a 50 percent reduction in cost of hardware.

By 1983, the same authors found over four dozen full-time services distributed via satellite in addition to numerous part-time or occasional users. Full-time cable television broadcast organizations, in addition to HBO, included: WGN/Chicago, PTL (Praise the Lord) Christian Entertainment, The Movie Channel, WTBS Super Station, USA Cable, CBM Cable Network, Escapade/Playboy, TBN (Trinity Broadcasting Network), SIN (National Spanish Television Network, and The American Network--providing in-room entertainment for hotels and motels.

Robert Wold, president of the Robert N. Wold Company, Inc., referred to as the dean of the satellite networking business by Satellite Week newspaper, cited PBS (Public Broadcasting Service) as the first national television network to distribute all its programing via satellite to PBS affiliated stations. The three major commercial networks ABC, CBS, and NBC, were expecting to begin distributing their programs on a similar basis by late 1983, in time to accommodate demands for coverage of the 1984 elections. Up to that time their use of satellites was limited to occasional live coverage of major entertainment events and news actualities which were fed to their New York headquarters, integrated into their national program line-up, then distributed to local affiliates through traditional land line facilities (Wold, 1982).
National Public Radio, Wold reported, was the first radio network to distribute programs nationally in 1981 by way of approximately 250 local NPR stations. The second of the traditional radio networks to use satellite distribution in a major way was the Mutual Broadcasting System. In 1983 the two major broadcast services, Associated Press (AP) and United Press International (UPI), were distributing news to subscribing radio and TV stations by satellite (Wold, cassette recording, 1982).

By 1983, more than half a dozen full-time radio program services were available by satellite for cable or local radio station use. They were: Satellite Radio Network, WFMT/Chicago, Bonneville Broadcasting System, Seeburg/Lifestyle Music, Stardust, Moody Broadcasting Network, Family Radio Network, and others (Brennan & Bremer, 1983, p. 14).

Wold (1982) also noted an active use of satellite distribution by major newspapers. The Wall Street Journal was distributing copy by satellite to printing houses at locations across the country for regional distribution. In the spring of 1982 the New York Times announced it would resume publication of its West Coast edition. The edition had failed earlier because of lag time experienced in getting news copy across the country. Satellite provided a way to transmit copy instantaneously from New York to Los Angeles. In September of that year the Gannett Company introduced a national newspaper, USA Today, possible because of their ability to transmit page formats by facsimile on satellite.

Other nonbroadcast applications of satellite communication included teleconferencing, data transmission, and electronic mail. Two
major companies which pioneered in these areas were the Public Service Satellite Consortium (PSSC) and Satellite Business Systems (SBS).

By early 1982, PSSC had coordinated more than 200 video teleconferences and satellite-assisted events for national and international corporations, associations, and organizations. The PSSC was supported by fees for services performed under contract for member organizations, nonmember, nonprofit organizations, for-profit companies, and several federal agencies. The PSSC Denver Satellite Access facility consisted of a 35-foot earth station with a network control center and a user-oriented television studio suitable for teleconferencing. The facility also provided for transmission of conferences, conventions, workshops, and continuing-education programs. The PSSC also maintained a Transportable Earth Station, a mobile unit which could be transported to any site on a temporary basis when permanent installation of other communications facilities was not warranted (Rash, 1982).

According to its 1981 Annual Report, SBS brought the first of its Communications Network Service (CNS) into commercial use on March 12, 1981. The company was designed to handle a variety of satellite distribution services for seven large commercial customers such as IBM and Aetna Insurance. By the end of 1981, SBS had sixty earth stations installed around the United States to handle these services. By the same date SBS was handling over one million telephone calls per month. Through its CNS it created a private network service for an original seventeen businesses. Customers were using CNS for voice communications, high-speed (up to 1.544 million bits per second) data communications by computer, high-speed document distribution, and
video teleconferencing. The SBS launched its own satellites (SBS-2 and SBS-3) to handle its activities.

By 1983 the Robert N. Wold Company and similar service organizations were active in obtaining transponder time for any client with a permanent or temporary need for satellite distribution activities. Two private telecommunications networks, Bonneville Satellite and the Catholic Telecommunications Network, were active programming their own networks plus selling transponder time to clients. These two networks are discussed later in detail.

**Major Satellite Distribution Experiments**

Ever since satellite technology began, futurists suggested that its use would be valuable in specialized situations. These would include educational applications, religious networks, medical science, and others. Satellites were seen as especially useful in those conditions where communications over a wide geographical area were involved.

One of the earliest large-scale experiments of its kind was the Appalachian Community Service Network (ACSN), a community service network headquartered in Washington, D.C., with broadcast facilities in Lexington, Kentucky. It began in 1971 within the scope of the thirteen Appalachian states, broadcasting teacher-education courses a few hours a week to teachers at forty-five community receiving sites (Gaudreau & Perritt, 1981).

The network was originally conceptualized as the ideal medium to reach those in remote areas with the information they required to perform their jobs effectively. Since its inception, ACSN had evolved
into a much broader instructional organization mechanism, ideally suited to further the concept of lifelong learning. Originally offering only teacher-education courses, its scope broadened to include programs for social workers, engineers, nurses, and others. The network expanded to nationwide capabilities and from a few hours a week to over sixty.

Gaudreau and Perritt claimed the instructional approach of ACSN was indeed innovative compared to earlier TV classes. They said the college TV classes of the 1960s only remotely resembled the state-of-the-art as it appeared in the mid-1970s (p. 77). They referred to the ASCN services as an expanded, nontraditional concept including college-credit classes, continuing education courses, seminars and workshops, interactive professional development series, and community service offerings.

The Soviet Union and Canada both saw the potential of satellite communication as a means to maintain constant contact with their peoples in the vast otherwise difficult-to-reach stretches of their territories (Polcyn, 1975, pp. 23, 25).

With their MOLNIYA satellites, the Russians were able to advance voice, television, teletype, and facsimile information services as early as 1965. Polcyn relates that Canadian satellite efforts dated back to the early 1960s when the Defense Research Board built ALOUETTE I and II, which were launched in 1962 and 1963, respectively. In the early 1970s the ANIK series of satellites were launched to complement then existing terrestrial communication services and provide services to remote areas where terrestrial communications were poor or nonexistent.
Northern Canadian natives, in 1972, asked the government to stop deployment of satellite facilities in their area. Fearing cultural and linguistic annihilation, they inquired, "Hasn't the white man caused enough trouble already?" They asked to be left in peace so that they could follow the ways of their ancestors. A truce was reached, however, and Townley reported in 1983 that the Inuit Tapirisat, or Eskimo Brotherhood, was programming six hours a week on the satellite. Their documentaries and dramas about Eskimo life, such as interviews with old hunters on how to skin caribou, were an attempt to counter-balance the flood of soap operas and other TV fare channeled to them by satellite (Townley, 1983, p. 45).

Canada's early interest in uses of satellite communication prompted proposals for experiments in education. Daniel (1977) related the plans for a Canadian Universities Satellite System (CUSS) and a regional audio network (PETS) in 1977. CUSS was expected to link thirty universities providing capability to send and receive audio signals with a few having video capability as well. Daniel found, in a needs survey, that the majority of schools felt the network would be valuable in course exchanges and research seminars and colloquia. He felt one of the most exciting uses would be a medical program of remote diagnosis and consultation done through the University of Western Ontario (p. 17).

A later report by Townley (1983) indicated that a medical use was developed by the Memorial University of Newfoundland. Its project, called Telemedicine, was able to relay a picture of an oil attendant's eye laceration to an ophthalmologist on the mainland for diagnosis, exemplifying the new service.
In Alaska, the LearnAlaska Satellite Network in 1983 was able to reach about two-thirds of the population with courses ranging from beginning English to oceanography to child psychology. The students were able to study in their home communities and participate in the classroom via television and audioconferencing combined. With uplinks in four locations, LearnAlaska planned to bring TV to 250 communities by 1984 (Townley, p. 46).

India was planning a domestic broadcast satellite system as early as the late 1960s, according to Paul (1975, p. 85). An experiment was planned for 1975 using the ATS-F satellite. Pirard claimed many Indians had never been exposed to mass media before and did not know that they belonged to something called a nation. The network transmitted desperately needed information about fertilizers, voting rights, baby formulas, and other subjects to 2400 villages. Townley (1983, p. 46) said the impact was so profound that when the experiment ended and the equipment was removed some villagers wept. Polcyn (1975, p. 24) found the Indian government anxious to be able to build and launch its own communications satellites by the early 1980s.

Japan and Indonesia are two other Asian countries deeply involved with satellite technology. Japan had developed its own extensive satellite capability, having launched several scientific satellites and eventually pioneering the KU band satellites for a variety of domestic uses including broadcasting and telephone services for the Japanese Islands (Polcyn).

In the early 1980s, Indonesia was involved in an educational experiment which provided a two-way audio feature with graphic support. A teacher at a campus on one of Indonesia's 6000 inhabited
islands could write on a television screen with a light pen. The process was much like a blackboard, except that, as one wrote the image was transmitted to every other campus participating in the program (Townley, 1983, p. 45). On a second classroom screen the professor could be seen and heard lecturing. Students could speak directly to the professor on an audio channel and transmit images back to their professors.

Another country that expressed early interest in utilization of satellite networking was Brazil. First thoughts were for educational purposes, said Polcyn (1975), however, a multipurpose concept emerged as educational experiments were carried out with the ATS-3 satellite. Another system for Spanish-speaking countries in South America was proposed by Tabanera in 1967 and again in 1968. In his subsequent book, *Satellites y Educacion*, published in 1971, he envisioned a hybrid direct broadcast satellite system whereby inexpensive receiving dishes at schools or private homes could receive educational network signals direct from the satellite. He looked forward to the launching and maintaining of satellites by the space shuttle developed by the United States.

Private organizations, usually religious denominations in the United States, became more involved in satellite experimentation and networking by the early 1980s as they observed the utilitarian nature and cost effectiveness of satellite networking. In the spring of 1982, Cooper reported on several organizations which had begun religious broadcasts by satellite including the Praise the Lord (PTL) Television network, the Jesus Satellite Network, and the Christian Broadcasting Network. These entities were programming materials provided.
by various religious organizations over satellite for cable distribution.

The Catholic Church in America was one of the first denominations to envision what could be done for its local parishes via a national satellite network. Its activities are discussed in detail below.

The Mormon Church began satellite broadcasts to a limited number of local churches in 1980, and then dramatically expanded their network to nearly 600 downlinks in 1983. This network is also discussed in detail below.

Other denominations which showed early interest in having their own network were the Methodists and Baptists. The Dallas Morning News (February 4, 1982, p. 22A) reported a local Methodist conference in the Southwest proposed a regional network for Texas and New Mexico, with an uplink facility at the First United Methodist Church in Shreveport, Louisiana. By November 23, 1982, the plan had developed into the Wesleyan Satellite Network (WSNET) and the network launched its first programs nationally (the WSNET Society Newsletter, Vol. 1, No. 1, Fall 1982, p. 3).

Also in 1982, the Southern Baptist Convention had plans for two TV services by satellite. Their TELNET service was intended to broadcast only to denominational associations and churches as a tool for inter-church communications. The planned American Christian Television System (ACTS) was to broadcast to the general public over a potential 106 low-power TV stations, 150 cable systems, and a possible two dozen UHF educational TV stations (Newton, 1982).

The American Hospital Video Network (AHVN) was conceived by
Dr. Leslie C. Norins, M.D., in 1981. This was the first national satellite network to provide continuing education and medical news to hospitals via satellite. It was to provide forty hours of programming a week to affiliates including professional training classes, medical bulletins, medical news actualities, and regular medical news service (AHVN brochure, 1981).

Satellite Distribution

Cost Theory

By 1975, said Polcyn, communication technology had grown so rapidly that most countries were then utilizing satellites. The primary justification for their use, he asserted, was the economies of such a system compared with other distribution systems. He explained:

The advantage of satellite communications increases with the size of the area to be serviced and the amount of information to be transmitted. This advantage is due to the satellite's capability to use multiple information transmission and reception routes, as opposed to the single route capabilities of earth communication systems. Earth communication systems have interconnecting links that follow specific routes along the surface of the earth, and their cost increases with the number of locations they connect. The volume of information between cost per information-circuit diminishes as the number of circuits increases. It is the anticipation of heavy increases in information volume that justifies the investment in additional circuits and links. (p. 14)

On the other hand, he said, in a satellite system the expense involved only the cost of the transmitting or reception station, a generally one-time uniform cost. Consequently, he assumed the basic cost to link two earth stations, using a satellite, did not depend on the distance separating them. In addition, the basic investment per communication route would diminish as the number of such routes increased because the same satellite could transmit to or receive from many stations simultaneously.
Alexander (1979) dramatized this phenomenon by comparing costs of sending a video signal from his office in Nashville, Tennessee. By terrestrial hookup to the nearest satellite uplink in Atlanta, Georgia (240 miles from Nashville), the cost was $160.00 per hour plus a $280.00 connection fee and an additional $500.00 per day channel charge. Compared with this, if he had had a satellite uplink facility at his office, it would have cost only $90.00-$400.00 (depending on the time of day) per hour to reach all the receiving sites throughout the United States.

It would be misleading, though, warned Polcyn (1975), not to point out that variable costs for satellites and earth stations increased with the number of routes served. As Polcyn indicated, the number of routes had less impact on the total cost simply because the satellite system did not require numerous duplications along the transmission path.

Polcyn quoted Walter Hinchman in his "Abstract of the Proposal: Educational Technology Demonstration of Rocky Mountain States" (1972):

To determine total cost of satellite service, one must add to these basic costs the per-circuit costs of both satellite and earth station facilities. Since both these facilities serve multiple routes, the volume of traffic over a given route has little effect on per-circuit costs. (p. 15)

Therefore, Polcyn concluded, satellites do present cost advantages for long, low-traffic routes, particularly when several routes were being served by one satellite and one earth station. But an earth system would be competitive for high-volume, short-route information transmission, especially if only one route was needed for a specific location.
Abitanto (1982) claimed another cost effective aspect of satellite distribution could be found in its reliability. Because a satellite system required fewer interfaces, the probability of malfunction was much less than with terrestrial systems. For satellite communications between two locations, for example, there are only three interfaces, an earth station at each end and a satellite in the sky. For terrestrial communications, on the other hand, there could be hundreds of different interfaces in moving a signal across the country. It would literally zigzag through dozens of cities and towns and a failure at any one of those interfaces could interrupt the transmission. "Statistically," he added, "would one prefer to have a probability of survival of one out of three, or one out of 200?" (p. 2).

Another economy inherent in satellite communications is the fact that many of the services it could provide would replace expenses of traditional distribution methods such as postage for mail and transportation costs. Gelineau (1982) claimed teleconferencing, for example, would permit maximum involvement by a participant without incurring the travel costs normally associated with such interaction. However, he warned, it should not be viewed simply as a substitute for travel. Rather, "it would accommodate those who, for whatever reason, could not travel" (p. 3).

In summary, Polcyn (1975) suggested there were five basic factors which would have a bearing on the cost of a satellite system:

1. The information desired
2. The numbers and types of receivers
3. The frequencies to be used
4. The satellite transmitting power
Information desired. Services greatly influenced the cost of the satellite system. Satellite radio, for example, was less expensive than television because radio signals require less transmitting power, less bandwidth, and less expensive receivers (Polcyn, 1975). As Brennan and Bremer outlined, audio services were available in 1983 and included voice, data, and electronic print distribution. They cited voice as an extremely effective use of transponder bandwidth because digital equipment permitted one transponder to carry up to 15,000 voice circuits simultaneously. Data distribution had been limited because the speed and volume transfer capacity of computers and distribution systems exceeded demand; however, as data software grew, the development of a cost effective satellite data network could be anticipated (p. 6). Electronic print distribution referred to hard copy delivery of messages from one transmitter to multiple receivers equipped with high-speed printers. A central computer could control message traffic and would activate only the receiving terminals of those locations addressed.

Television or video media were available in two modes: full-motion or slow-scan. Full-motion television of standard commercial broadcast quality, according to Brennan and Bremer, consumed most of the capacity of a transponder, making it the most expensive utilization of satellites. The 1983 cost of renting a full-motion transponder ran between $2-3 million annually. Slow-scan service was a technical application in which television picture frames or cycles were slowed from 30 per second to one every 80 seconds as a picture...
was built line upon line from top to bottom. Uses in teleconferencing and medical telediagnosis were likely applications of slow-scan (Brennan & Bremer, 1983, p. 5).

The numbers and types of receivers. The receiving equipment not only included the radio or TV receivers but the receiving terminal as well, pointed out Polcyn (1975). The receiving terminal was attached to a TV or radio receiver. Polcyn estimated receiving terminals, if purchased in lots of 100,000, would cost approximately $200.00 each plus an installation charge of $200.00. The costs of radio and television sets varied, but Polcyn estimated when purchased in quantity they might cost approximately $150.00 per TV set and as low as $15.00 per radio set.

The frequencies to be used. The frequency bands available for use helped dictate system cost by influencing the cost of the receivers. Terminals working with the 2.5 to 2.6 GHz bandwidth were less expensive than those working with the 11.7 to 12.5 GHz bandwidth. Polcyn expected further research to produce receivers that would be more economical in the high GHz frequencies.

Satellite transmitting power. The transmitting power of the satellite or space segment was inversely related to the cost of the receiver. As the power of the satellite increased, the sophistication and cost per unit of the receiver decreased. However, the amount of power needed to produce desired signals depended upon the frequency and services so that transmitting at 12 GHz required more power than transmitting at 2.6 GHz. In addition, Polcyn (1975) said, one television channel required more power than 100 radio frequencies.
A more recent development expected to have a great impact on all aspects of satellite communications activity was the interest in direct broadcast satellites (DBS). Broadcasting magazine reported that eight companies were granted authority in 1982 by the Federal Communications Commission to begin construction of DBS systems. This action opened up the possibility of widespread, direct-to-home, satellite broadcasting. The DBS satellites operated basically the same as other satellites; however, they operated with higher power so their signal could be received with much smaller, and therefore much more affordable, earth receiving dishes. These dishes, said UPI, were to be two to two and one-half feet in diameter and cost less than $300.00. In an international discussion on the topic of DBS, the International Conference sponsored by the Carnegie Endowment for International Peace and the Twentieth Century Fund predicted DBS services would come into use as early as 1985 (p. 24).

Area to be covered by the satellite signal. Coverage area could be traded for transmitting power, asserted Polcyn. For example, some satellite costs increased when smaller geographical areas were covered. The smaller the beam focus of the satellite antenna, the greater the required power of the transmitter.

Summary

This chapter reviews literature concerning satellite distribution technology and developing trends in the field which could apply to the planning of a network for a private organization.

The history, the nature of the technology, major experiments in satellite distribution, cost theory, and new developments were
surveyed. The chapter thus provides a background for the model presented in chapter 4.

Chapter 3 reports on observations made while visiting two networks in operation.
CHAPTER III

THE CATHOLIC TELECOMMUNICATIONS NETWORK AND
THE BONNEVILLE SATELLITE CORPORATION

Although religious organizations have utilized satellite
distribution for occasional or special program events, the Catholic
Church in America and the Church of Jesus Christ of Latter-day Saints
(the Mormons) have established their own networks by renting trans­
ponder space for permanently scheduled programming needs.

Visits were made to the satellite uplinking and headquarters
facilities of both organizations to observe and obtain information
that could be helpful in preparing a model for other private organiza­
tions. This chapter relates the information gathered and the observa­
tions made on those visits. Both reports are organized in identical
fashion to provide comparison outlines of their activities:

A. History
B. Goals and objectives
C. Organization
D. Facilities
E. Policies and procedures
F. Programming
The Catholic Telecommunications Network of America

History

According to the Most Reverend Louis E. Gelineau, chairman of the board for the Catholic Telecommunications Network of America (CTNA), the National Council of Catholic Bishops (NCCB) endorsed the idea of a church-owned and operated satellite network at their annual conference in 1979. The network plan for CTNA was to be presented at the next meeting of bishops in mid-November, 1980. By that time the elements of a network had been fully formulated and it was expected to serve instructional needs, as the distribution system for the National Catholic News Service to ninety diocesan newspapers, as a distributor for Catholic film, video, and audio syndicators, and as a teleconferencing system for the bishops and others.

Hurley (1983) reported in the National Catholic Educational Association Newsletter that in November 1981, after a two-year feasibility study, CTNA was chartered in the state of Delaware as a wholly owned corporation of the United States Catholic Conference. Hurley, CTNA director of program development, further said that while initial services would consist mainly of audio and video programming, it was the intent of the network to develop services in the area of teleconferences, teleseminars, data transmissions, videotext, and other services. Further, he said, these services would be developed to help the church carry out a variety of missions cost effectively, efficiently, creatively, and most important, pastorally. With such a network he felt the Catholic Church could realistically look at the dwindling human and financial resources at its disposal and increase
the productivity of both of those resources. He further declared the productivity increase would be reflected in the ability of the church to share its resources widely, without creating a burn-out situation for gifted personnel or a deficit situation with limited financial resources. He also saw that, in addition to the United States, the resources could be shared with any established or emerging nation outside the United States.

On November 20, 1981, one day after the CTNA was established by the NCCB, Gelineau convened the first meeting of the CTNA Board of Directors in Washington, D.C. The Board elected WasyL Lew, former program manager for communications satellites at NASA and more recently director of operations of the Bell and Howell Satellite Network, to be president of CTNA.

By November 23, CTNA opened temporary offices at the Department of Communication of the Catholic Church in New York City and soon had a permanent office at 95 Madison Avenue. To man the office, a director of administration, a business manager, a director of program development, and a director of technical services were hired.

The new staff had several immediate tasks which needed to be accomplished in a relatively short time, said Gelineau. An administrative configuration had to be developed to provide for immediate CTNA affiliation by archdioceses and dioceses as well as health-care and educational institutions, religious orders, and other church agencies. A contract had to be negotiated with an earth station supplier to provide the affiliates with a standard downlink. A service policy as well as personnel and employee-benefits policies had to be devised and implemented.
Church response was to be the success factor for the new network. At the time the service was inaugurated, reported Gelineau, the network had a total of thirty affiliated archdioceses and dioceses, ten more than the number projected for the start-up date. Nearly a year later thirty-three affiliates had joined the network, representing 19 percent of the archdioceses and dioceses of the church and 32.4 percent of the Catholic population in the United States.

Initial programming on CTNA was composed of three hours of service per day (12:30-3:30 p.m.), five days per week, (Monday through Friday) of what Lew called "moral value programming," including instructional and entertainment presentations. The range of services was, according to Gelineau, limited to the delivery of TV and radio programming suitable for distribution to local diocesan communicators for placement on broadcast and cable systems, thus providing local control of distribution of programming.

Furthermore, he said, the network would be of special value for teleconferencing and telelecturing. Both of these services would offer the possibility of one-way video and two-way radio transmission, and any affiliate with a downlink could participate. That would mean that participants would be able to both see and hear the lecturer or conference chairperson who would be able to receive and respond to comments and questions from participants who could be situated in as many locations as there were downlinks.

Thus, CTNA, according to its chairman, was conceived and created as a for-profit corporation. As such it was in a position to offer business and commercial interests the same kind of services it could offer to its own church affiliates. Such extra-church...
business would actively be sought on a time-sharing basis so that the network could adequately discharge its responsibility to serve the church first. While CTNA would provide services to its affiliates at "preferred customer" rates, business and commercial interest would be served at competitive rates.

Goals and Objectives

The goal of the CTNA, as outlined by the chairman of the Board of Directors, was to bring modern technology to the service of the church in the United States so that it could proclaim the gospel effectively and meet the local needs of the church.

Objectives identified by the chairman were to:

1. Obtain all 174 archdioceses and dioceses as affiliates

2. Offer a variety of services including:
   a. TV programs for instruction and entertainment
   b. electronic mail
   c. teleconferencing
   d. telelecturing
   e. news photo distribution
   f. news wire
   g. data distribution
   h. long-distance telephoning

3. Identify and meet the telecommunications needs of the church

4. Assist the bishops and communications departments of the church in the use of electronic technology

5. Encourage and support the development of programming services of the church, which will enhance the various apostolates

6. Protect the security and integrity of CTNA transmissions,

7. Obtain revenue from sale of sermons to extra-church entities.
Organization

As stated previously, CTNA was a wholly owned corporation of the United States Catholic Conference. The network was controlled by a board of directors and had a president and four assisting officers. See figure 1 for the organizational chart.

Facilities

The CTNA headquarters are located at 95 Madison Avenue in New York City where a suite of six offices house all the network activities. Although this facility does not include any production studios, programs on video tape are played back on tape machines housed in a small office size room where an engineer plays the programs as scheduled. The programs are then sent via microwave signal to the uplink dish located on the nearby Empire State Building. Production of the programs is done in the studios already existing for the production of materials for local television stations and national networks.

Policies and Procedures

As stated above, CTNA was a for-profit corporation whose outstanding capital stock was owned entirely by the United States Catholic Conference. According to the CTNA Services Policy (see appendix I), the constituent universe of affiliation with CTNA comprised, first, the dioceses of the United States and likewise included Catholic colleges and institutions of higher learning; hospitals and health-care centers; and the ministerial, administrative, or residential loci of the Catholic religious orders in the United States.

The dioceses of the church served as reference for an
Fig. 1. CTNA organization chart.
affiliation model and were the only category of affiliate permitted to redistribute programming. Policy also provided for co-affiliation, however, when more than one affiliate would share a downlink. Religious orders, hospitals, and colleges could affiliate independently with permission of their local diocese.

The network basic financing was cared for by a series of fees for affiliation. Each affiliate, upon signing contract with CTNA, would pay a one-time $5,000.00 fee. Each year afterward the diocese would pay $2,000.00, $3,000.00, or $5,000.00, depending on population size. The yearly programming fee, expected to be no more than $15,000.00 the first year, would be set according to service desired: affiliates receiving full service--five hours a day, five days a week--would pay the full fee; those receiving fifteen hours of programming would pay 70 percent of the fee; those receiving seven and a half hours of programming would pay 35 percent. The downlink satellite dish to receive the network's signals cost approximately $15,000.00 in 1982.

Programming

The director of program development was to initiate a program advisory board which would serve to advise on:

1. The appropriate mix of program categories
2. The establishment of criteria for quality, appropriateness to needs, allocation of schedules, etc.
3. The availability of known, sufficient quality, program product
4. Needs assessment
5. Program categorization.
Members of the Board were to be selected by the director of program development, approved by the president and executive committee, and chosen to represent various elements and ministries of the church, fully participate as members, serve as recognized specialists in their field of endeavor, and serve on a non-remunerative basis. In addition, the Board of directors was to select from among its members a committee to serve as a resource to review programming which, in the judgment of the director of program development, was appropriate to review.

By the spring of 1983, CTNA was broadcasting television programs three hours each weekday and nearly seven hours a week of radio programs.

Types of programs available on the TV channel included:

1. Pastoral programs, including programs on marriage enrichment, marriage crises, and counseling sessions on problems such as alcoholism and unemployment.

2. Christopher Close-ups, featuring interviews with stage, screen, and TV stars.

3. Programs of "Send Forth Your Spirit" about the Catholic Charismatic Renewal.

4. Programs of "Horizon: Christ in the Modern World," tracing the development of the Catholic faith in Jesus Christ through the study of history, literature, psychology, and theology.

5. Programs of "Innerversion: Exploring the Arts," which examined a variety of approaches to the holy through direct perception and contemplation of artistic forms. Programs in Spanish were also offered on the network.
History

According to Pace (1983), the impetus behind the idea of a satellite network for the Mormon Church began with a telephone conversation in May 1962. The person receiving the call was Arch L. Madsen, president of KSL-AM-FM-TV in Salt Lake City. The person making the call was Fred W. Friendly, president of CBS News in New York. Broadcasting magazine, on July 23, 1962, reported that Friendly was chairman of a pool committee of the three major U.S. broadcasting networks, ABC, CBS, and NBC, charged with coordinating a unique broadcasting event in conjunction with Eurovision, the consortium of European television networks. This telecast, utilizing the newly launched TELSTAR satellite, was to be the first international commercial satellite broadcast.

On the program agenda was the Mormon Tabernacle Choir of the Church of Jesus Christ of Latter-day Saints (LDS). Initial plans, stated Pace, were to have the choir broadcast live from the famous Tabernacle of the church in Salt Lake City. However, it was later decided that the location was to be at the base of the Mount Rushmore Memorial in South Dakota. The trip was arranged with the chartering of five DC-6 airliners to transport the 321-member choir to Mt. Rushmore for the July 23, 1962, broadcast. The Salt Lake Tribune reported on July 24, 1962, that the choir gave a three-minute performance in the thirty-minute telecast seen by an estimated 200 million people in America and Europe.

After this great event, related Pace, Arch Madsen concluded that there was a need for a more efficient method of relaying
audio-video messages over a great distance than had been done previously by the LDS church. The cost of moving a large number of people to a remote broadcast site was too high and the renting of telephone long lines was prohibitive. It was found that use of a satellite uplink would cost, in any case similar to the Mt. Rushmore telecast, nearly one-tenth of the amount. In addition to cost factors, technical, logistical, and critical scheduling problems could be avoided.

The LDS excitement for instantaneous worldwide communication did not begin with satellites, said Pace. From 1961 to 1974 the church owned and operated an international shortwave radio station, WNYW in Boston, which beamed New-York-originated programs worldwide.

Additionally, in 1961, said Pace, there were twenty-one television stations in the United States broadcasting the Semi-Annual General Conferences of the church. The number of stations carrying the conferences increased tenfold within five years. However, competition for air time as well as the cost to purchase air time for the targeted LDS audiences was increasing.

To take advantage of new communication technologies and to consolidate research and commercial interests, the Bonneville International Corporation (BIC) was formed on June 11, 1964. Its purpose, according to its constitution, was:

To build, construct, establish, use, maintain, operate, repair, purchase or otherwise acquire, sell or otherwise deal in and with respect to stations, transmitters and studios, for the broadcast, rebroadcast, telecast, transmission, retransmission, generation, publication, reproduction, dissemination, relay or reception by electricity, electromagnetic waves, radio, wire, cable or other methods or means of communication. (p. 1)
With Arch Madsen as president, BIC immediately began the acquisition of major radio and TV properties in Chicago, Dallas, Los Angeles, Kansas City, Salt Lake City, Seattle, San Francisco, and New York City. In addition, reported Pace, a number of auxiliary services were created such as Bonneville Productions for producing programs, a Washington news bureau for news reporting, and Bonneville Broadcast Consultants for management, legal, programming, and other consultation. This major expansion occurred between 1964 and 1977.

In an interview with Pace, Madsen related how BIC became interested in satellite technology. In 1978, F. William Gay, a prominent member of the church, invited the BIC Board of Directors to a presentation on satellites at the Hughes Aerospace facilities. Afterward, Gay approached Madsen and said, "Arch, go satellite." According to Madsen, Bonneville had had a choice. Either it was to forever pay exhorbitant long-line telephone fees and rent out satellite facilities whenever the need arose, or it would venture headlong into a new technology by acquiring its own satellite channel. It decided to investigate the latter.

In 1978, Bruce Hough, then director of Bonneville Productions (BP), was asked to supervise the distribution of sessions of the General Conferences of the church to members in America. In a later interview with Pace, Hough related how the Conferences were shown on fifty cable systems utilizing satellite space offered free of charge by RCA which wanted to demonstrate satellite capability. Within two years, over 3600 cable systems were carrying the church sessions by satellite.

According to Pace, the potential for widespread use and profit
of satellite downlinks was obvious, and in 1979 the church decided to test receive-only earth stations in Miami, Dallas, Indianapolis, Boston, Atlanta, and Salt Lake City. Three downlink vendors were sufficiently interested in the BP experiment to offer downlink hardware free of charge for their own testing purposes in the project.

On March 19, 1980, the Bonneville Satellite Corporation (BSC) was founded, with Bruce Hough as vice president and general manager, to direct the affairs of the common carrier service of its parent company, BIC. Article IV of the Articles of Incorporation of BIC state this purpose, in part:

To own and operate satellite earth stations and to engage in all business relating to transmission of electronic signals via satellite, including, but not limited to, operating terrestrial interconnections with satellite earth stations, operating as a satellite communications common carrier and otherwise engaging in the business of distributing electronic signals via satellite. (p. 1)

More specifically, according to Pace, BSC was created to provide seven major services: to provide uplink/downlink satellite service on a full-time basis; to make available ad hoc networking; to provide teleconferencing for businesses and institutions, to operate a Capitol Hill news studio in Washington, D.C.; to provide a satellite-services radio network; and to provide complete engineering and management consulting services for any phase of satellite communications.

Goals and Objectives

Recognizing the power and responsibility of operating a growing communications network, Spencer W. Kimball, president of The Church of Jesus Christ of Latter-day Saints and chairman of Bonneville
International Board of Directors, was quoted in the BIC promotional pamphlet of 1980 as saying--in reference to the goal--"Our great desire and obsession is to bring to the world the candle of understanding" (p. 2).

The BIC President and Chief Executive Officer, Arch L. Madsen, quoted in the same brochure (p. 2), said the goals and objectives of the corporation were, in order of priority:

1. Outstanding community service
2. Planned personnel development
3. Quality programming
4. Profitability
5. Provision of recognized leadership worldwide in the effective use of the mass media in dealing with significant issues of our day.

Organization

The Bonneville Satellite Corporation is one of a number of operations which make up the Bonneville International Corporation. According to promotional brochures printed by BIC in 1980, the Board of Directors of BIC included Chairman Spencer W. Kimball, President Arch L. Madsen, Executive Vice President Joseph A. Kjar, four senior vice-presidents, and twenty-two board members who were presidents and vice-presidentes of the various BIC activities and entities (see organizational chart in fig. 2).

Facilities

Bonneville International Corporation promotional brochures (1980) report that BSC had a full-time, long-term contract for a
Fig. 2. BSC organization chart.
transponder on the Westar Satellite System ever since it was established in 1980. On August 19, 1981, a BSC news bureau release announced an agreement had been reached with the Southern Pacific Communications Company to lease four more transponders on the Spacenet Satellite System. Three of the new transponders were to be on a new satellite, Spacenet I, scheduled for launch in early 1984, and one transponder was to be on Spacenet II, scheduled for launch in October 1984.

According to Hough in a personal interview September 6, 1983, three uplink stations were operated by BSC in 1983. The main uplink was maintained in Salt Lake City where the BSC operated the only full-service commercial satellite earth station in the Intermountain West area. Another uplink had been established in Washington, D.C., and a third had been erected in Los Angeles.

Although early experimentation by the LDS church involved only six churches in 1979, BSC announced on October 7, 1981, that it would develop the largest video downlink network in existence. It would consist of 500 television receive-only earth stations to be located throughout the forty-eight contiguous states and would be developed under contract to the LDS church to be used primarily for local reception of church communications and functions at its facilities across the country. Completion of the network installation was expected by early 1983.

Policies and Procedures

As a for-profit corporation, BSC provided no more binding conditions for affiliation other than those of normal business
procedures. With its commercial interest, said Hough, BSC was able to provide downlink receivers for its church affiliates while it continued to seek commercial customers.

Programming

Although BSC was active on a daily basis in sending programs by satellite for commercial users, Hough said programming to churches of the denomination was on an ad hoc basis except for the regularly scheduled General Conferences. More frequent programming was being investigated with the expanded network of downlinks.

Summary

This chapter reports on visits to two satellite network facilities operated by private organizations for internal communication purpose. It briefly reviews the history, goals and objectives, organization, facilities, policies and procedures, and programming of both networks. These operations were studied to assist in the creation of the model presented in the next chapter.
CHAPTER IV

A MODEL FOR THE DEVELOPMENT OF A TELECOMMUNICATIONS SATELLITE NETWORK FOR THE SEVENTH-DAY ADVENTIST CHURCH

This chapter describes a model provided specifically for the development of a multipurpose telecommunications satellite network for the Seventh-day Adventist church in the United States. To assist in understanding the nature of the church organization and its aims, a brief introduction to the philosophy, needs, and criteria of the church for the establishment of the network is provided. The model itself provides cost efficiency accomplished by utilizing personnel, hardware, and programming with a minimum of duplicated services. A basis for operation of the network is a unified effort, with common aims for all organizations within the church structure, thus eliminating competition for resources. The bases for the model as well as the process for development of the model are explained and outlined. The validation of the model was provided by a panel of experts.

The Bases for the Model

The model was developed on the following bases:

1. Concepts gained from a review of literature regarding the development and properties of satellite technology

2. Concepts gathered through an analysis and evaluation of
two functioning networks, the Catholic Telecommunications Network, and the Bonneville Satellite Network

3. Ideas gained from personal contact with directors of these networks and other professionals in the field of satellite communication

4. Practical needs and criteria required of such a service for this organization.

Validation of the Model

The model, as presented in this chapter, was sent to a panel of jurors for their evaluation and comments. A listing of the jurors who responded with an evaluation and written comments is given in appendix A. The comment sheet sent to the jurors for their convenience is shown in appendix B.

Comments from the jury were included in the model. All except one of the panel members endorsed the model as a useful and adequate guide to be used by a private organization in developing a telecommunications satellite network. All except one of the panel members agreed that the model, if adopted by the Seventh-day Adventist Church, would improve church communication and services that would be cost effective in the long term. The one juror who expressed a reservation did so because he felt the model did not emphasize sufficiently the cost savings potential of the network compared with possible expense already incurred by the church in utilizing conventional telecommunications methods. However, he said, "the model is certainly worth developing."

Narrative responses given by panel members, intended either to
support or to suggest modifications to the model, were clear in the support they gave. They are quoted in the following sentences but individuals are not identified in order to maintain the confidentiality of the members of the selected panel:

You have assumed the necessity of having a standalone system. This is not as cost effective as utilizing a facility-sharing plan. At Washington, for example, you could obtain microwave and dedicated uplink services from an existing carrier. Transponder time could also be obtained through a third party for only those hours you need, rather than 24 hours daily. Also, by adopting this approach, you could walk before you run.

It is a very thorough statement of the requirements, although as stated above, it is not necessary to start (or even continue long-term) with a standalone system."

Perhaps more attention could be paid to economics and technical options--especially C band and Ku band. Also, it would possibly be worth examining concepts of network sharing with others. Finally, as you move ahead, you should pay close attention to space-segment costs and options.

Very clear writing, definite statement of need--a solid foundation for future planning. Bravo!

The identification of multiple uses of the satellite system for hospitals, schools, churches, and broadcast outlets, along with such specialized applications as disaster preparedness, is excellent and will improve your cost/performance model.

The inherent overhead costs of establishing an engineering department to do all the downlink maintenance and sparing may exceed the cost of contracting that service with an outside vendor. You should include this consideration as an option perhaps.

To achieve the proper economies of scale, the downlink contract would necessarily need to be with the central body of the church. Your suggestions for local participation may include a combination of fundraising and tax-type fees (voluntary) but with specific deadlines to begin a Phase I of the network. It may be valid to conduct a field survey with cost estimates and a program and benefit plan which may allow you to estimate how successful a first phase may be.

It may also be worth considering the lease or rental of existing uplink facilities in Washington, D. C., until a
program schedule makes it cost effective to own. This could help especially in the start-up phase of the network. The same could apply with space segment.

In the description of hardware, another option may be to down convert the satellite signal at the antenna, thereby using a low noise amplifier/converter (LNC) and allowing the cable runs to be made with much smaller diameter cable. This improves installation speed, cost, and accessibility to buildings.

I don't know if there are second language needs in the network but certainly the use of the additional subcarriers can be used for that purpose as well. We happen to use them frequently for French and Spanish, and soon Tungan.

The subcarrier can also be used for radio broadcast distribution as we've experienced with our Beautiful Music format.

Data communication on a broadcast network can have many pitfalls. Most computer systems require some type of interaction and may require defeating the system protocol if the satellite is used for outbound communication.

Good luck on your network. I hope it is implemented in the near future.

Little provision is made for specific production of programs or the potentially high costs associated with production and acquisition. A “users fee” would be unlikely to cover these costs adequately.

It builds on successful models of others and is realistic in scope.

The model is certainly worth developing.

The only way in which the model could be further validated would be for several private organizations to use it in developing their own telecommunications network. Modifications and additions would no doubt become necessary in the light of such experience.

Presentation of the Model

The graphic presentation of the model is followed by notes explaining each of the steps shown in the model. In addition to the
notes, guidelines are given as part of the model. The guidelines present important principles intended to guide in the application of the model by an organization planning a telecommunications satellite network.

A Brief Philosophy of the Seventh-day Adventist Church

The Seventh-day Adventist Church offers its services to church members and the general public through its schools, hospitals, community centers, and churches. According to its constitution and policy, the church aims to contribute to the whole man, including his spiritual, physical, and temporal needs.

The church desires to provide a Christian education for all its own youth as well as any who might be interested from the public sector, so long as they seek an Adventist Christian education. Furthermore, it operates institutions of higher education for the purpose of providing opportunity for its members to gain advanced degrees for preparation in a lifework or a profession (Constitution and By-Laws and Working Policy, 1982, p. F10 05). Because of these efforts, it has created the second largest school system among Protestant denominations in the United States (Digest of Education Statistics, 1982, p. 49).

The extensive hospital system operated by the church reflects the Adventist desire to serve the Lord by ministry to mankind. The church wishes to serve American communities by:

(a) Providing facilities for the treatment of the ill by physicians, nurses and other qualified personnel, utilizing accepted and scientifically proved methods,
(b) Disseminating a common knowledge of the laws of health to the end that sickness may be avoided,
(c) Ministering to the whole man thus giving promise, both of
the life that is now and of that which is to come, and
(d) Conducting formal training programs calculated to prepare
others to share in and to continue this ministry
(Constitution, p. G05).

Local Adventist congregations are encouraged to participate in
a world-wide disaster preparedness program. Through this service,
relief and medical-aid centers are scattered around the United States
and the world, all funded by offerings of the local churches. Mobile
disaster-aid units include small and large vans especially equipped to
ferry food, blankets, and clothing to areas hit by natural or man-
made disasters (A Quick Look at Seventh-day Adventists, 1982, p. 9).

To administer these activities, the church maintains adminis­
trative units located in nearly every state of the United States.
Fourteen world divisions constitute the church world headquarters,
termed the General Conference, with the United States as part of the
North American Division. This division is subdivided administratively
into union conferences (groups of states) which are subdivided into
local conferences, frequently representing territorial boundaries of
states. Within this administrative organization should be included
printing plants, a food company, transportation offices, and a media
center (Seventh-day Adventist Yearbook, 1983). See figure 3.

Local churches located in every state are encouraged by church
philosophy to construct and maintain, where possible, local village,
town, or city church schools. These educational units are often
located adjacent to the church building.
Fig. 3. Division of the continental United States as currently used to indicate unions.

Source: Seventh-day Adventist Yearbook, 1983
Communication Needs of the Church

A brief study of the communication needs of the church are here presented by type of facilities involved.

1. Adventist Higher Education. The Adventist secondary-school system in the United States operated in 1982 eleven senior colleges and universities and eighty-one academies (boarding or day high schools) (A Quick Look, p. 2). Even though the General Conference maintains a special administrative and curriculum board for the K-12 schools, these academies are referred to in this higher education section because of their predominant location on separate individual campuses. Most of these schools offered general education courses augmented by religion classes distinctive to the church. These schools could utilize audio, print, data, and television services for academic courses, teacher training, continuing education, and administrative functions such as personnel procurement, electronic mail, computer communication, purchasing, and teleconferencing. See figure 4.

2. Adventist Hospital Systems. The Adventist Health System in the United States was divided into four regional corporations: Sunbelt, North, West, and Eastern/Mid-America (Yearbook, 1983). Fifty-nine hospitals and twenty-one retirement and nursing homes comprised this system. Audio, print, data, and television services could be utilized here for patient entertainment and education, personnel procurement, electronic mail services, and teleconferencing. See figure 5.

3. Adventist Radio Network. This broadcast network included ten radio stations in the United States (Adventist Radio Network Directory, p. 1982). All ten stations were FM and programmed to the
general public but occasionally broadcast special programs to a large segment of the Adventist church membership. These stations were sponsored by institutions of the higher education system. This network could utilize audio distribution by satellite for program sharing, including news and special broadcasts to the church members. Print and data transmission and administrative services could also be important. See figure 6.

4. Adventist Administrative Offices. The United States territory of the North American Division of the church was divided into eight union conferences composed of forty-nine local conferences and missions. To these fifty-seven administrative units should be added three printing plants (Hagerstown, MD; Lincoln, NB; and Mountain View, CA), one food company (Loma Linda, CA), two transportation offices (Baltimore, MD; and San Francisco, CA), the Adventist Media Center (Thousand Oaks, CA), and one insurance office (Riverside, CA), increasing the number of administrative offices to sixty-five. For these units, administrative services such as data transmission, personnel procurement, purchasing, and teleconferencing would be important. Emergency activities of the Seventh-day Adventist Welfare Service (SAWS) would be included in this system. See figure 7.

5. Adventist Churches and Elementary Schools. With approximately 3,500 local churches (Seventh-day Adventist Directory of Churches in North America, Revised 1982) in the United States, many of which operated elementary schools, a broad range of satellite distributed services could be utilized. Meetings of churchwide interest such as General Conference sessions, youth congresses, and mission reports could be televised to each local church. Workshops, seminars,
Fig. 7. Geographical distribution of administrative offices of the Seventh-day Adventist church by state, including General Conference, union conferences and local conferences.
Bible studies, and other training events could be carried by satellite to each local congregation. Local church schools could benefit from education courses or presentations by TV or radio. See figure 8.

Criteria to Be Consider by the Church for the Recommended Network

Whenever a new technology appears, a comparison with the advantages and disadvantages of current methods in use is necessary. Consideration of the following items is recommended.

1. Costs. A dual comparison of costs and services should be considered. The number of services and their value to the growth and administration of the church should be weighed against the cost of improving or implementing new services.

2. Distance. With thousands of units spread over a wide geographical area, the church must decide if it can best serve its constituents with all the services it would like to provide using conventional methods or whether a full range of services by satellite would, indeed, promote growth and communication to a greater extent.

3. Resources. By surveying the resources already existing within the church organization, decisions can be made about the advisability of attempting to support a new method of providing the suggested services.

4. Change. With a growth-oriented philosophy such as that of the church here discussed, leadership must face the probability that change will be necessary in the future and ask if this new technology would hinder or help the church as it encounters the future.

5. Ethicality. With a churchwide system as here presented, considerable funding would be necessary. In its traditional
conservative attitude, the church must study whether the use of funds could ethically and wisely be spent to take advantage of this new technology.

6. Theology. Seventh-day Adventists have written in their name the fact that they look forward to the second return of Christ. In view of His imminent return, the church must ask itself if investment in such a complex network as envisioned in this study would be prudent in light of the expected short-term life of the world as Adventists know it.

These criteria emphasize the seriousness of a consideration of the model here presented. To assist in visualizing the process which would be required in establishing a satellite network, a simplified developmental model is outlined.

A Model for Establishing the Recommended Network

In attempting to define the steps that appear to be inherent in the process of establishing a satellite network, a linear procedure containing the following phases was chosen:

Phase I--Preparation for planning
Phase II--Analysis of situation
Phase III--Development of alternatives
Phase IV--Selection of a plan
Phase V--Implementation of the plan
Phase VI--Evaluation of the plan and the process.

In order to provide a well-defined and functional structure for the model, the following diagram for a planning process was selected: It follows a basic PERT (Program Evaluation and Review Technique)
form of a planning process adapted from a planning guide published by the North Carolina Department of Public Instruction, Planning for Education, People and Processes. PERT is a method for sequentially ordering tasks which must be accomplished to move a project in an orderly manner with a minimum of omissions and duplications. It is a standard process model for organizing and planning with an aim at producing maximum efficiency in an organization.

The numbers appearing in each circle are necessary for identifying the various tasks and the circles represent the completion of those tasks. The connecting lines represent activities that began at the preceding circle and end at the following circle. There may be communication between the groups or people involved, but for simplicity of the diagram, only horizontal lines are indicated to emphasize the onward thrust of the process.

1. Church administration recognizes need for and makes decision to plan.
2. Administration instructs communication staff to organize for in-house planning.
3. Staff develops philosophy, goals, and objectives for network.
5. Staff completes situation analysis.
6. Consultants complete situation analysis.
7. Staff develops alternative plans to accomplish goals.
8. Consultants develop alternative plans.
9. Staff makes recommendations to church administration.
10. Consultants make recommendations to church administration.
11. Staff recommends to administration.
12. Administration adopts a plan.
13. The plan is implemented.
14. The plan and the planning process are evaluated.

Phase I--Preparation for Planning

Step 1. Church administration recognizes need for and makes decision to plan a telecommunications satellite network. The decision to plan a network must be an organizationwide decision if full participation and support is to be achieved. If administrators from all branches of the church operation, i.e., hospital system, higher education system, and administrative offices, participate in the planning, then any of the systems that desire to do so may take the initiative to create a network to serve their own needs. By doing this, however, economies of scale may not be realized as much as if all systems were committed to being involved.

Step 2. Administration instructs Communication Department staff to organize for in-house planning. The departmental leadership, in consultation with church administration, should appoint a steering committee which should include representatives from other church departments vitally interested in a telecommunications network. These
may include staff from the health, education, ministerial, publishing, and youth departments as well as representatives from administrative departments such as the treasury, secretariat, and personnel. Sub-committees may be appointed to evaluate the various facets of the project such as growth, membership, demographics, organizational trends, and time tables for various steps in the planning process.

Step 3. Staff develops philosophy, goals, and objectives for the network. By studying the evaluations prepared earlier, staff may at this point prepare statements to reflect the aims, goals, and objectives for a telecommunications network in relationship to the aims, goals, and objectives of the church as a whole. This would probably involve group discussions with all the systems involved in the project and an updating of general church purposes and goals.

Step 4. Administration contracts for out-of-house consultation. Consultants for satellite technology should be contracted to bring advice to the administration concerning the technological, legal, financial, and programming aspects of the network. These consultants may be part of a consulting team or may work separately.

Phase II--Analysis of Situation

Step 5. Staff completes situation analysis.

Step 6. Consultants complete situation analysis. Both groups, working separately but perhaps sometimes sharing information, develop an information base upon which the network planning will be supported. This compilation of information may include maps, locations of church units, satellite channels available, methods of obtaining satellite channels, production units already in existence,
personnel with abilities that pertain to telecommunications, and
general availability of facilities that could be used by the network.
Local committees could at this point be formed to discuss local needs
in various parts of the country. The staff committee and/or consul-
tants compare and analyze initial data. A determination is made
relative to further data collection and tasks are cooperatively
assigned for securing further data. Finally in this step, the staff
and/or consultants complete the situation analysis and make a written
report.

Phase III--Development of Alternatives

Step 7. Staff develops alternative plans to accomplish goals.

Step 8. Consultants develop alternative plans to accomplish
goals. Both groups review purposes and what was identified as
desirable in a network organization. This may include the network
organization, the personnel, financing, facilities, and special ser-
vices. Organization options should recognize personnel needs for
operation of a network including a director, program director, engi-
neer, financial expert, and office personnel. Financial options may
be a pay-as-you-go method, a capital fundraising event, service or
tax-type fees by participating units within the church, or a loan
arrangement. Facility considerations must include location of down-
link facilities. These may be arbitrarily placed, located at major
administrative, hospital, and or educational institutions. An organ-
izational structure might consider how the network would relate to
other segments of the church and who would have controlling author-
ity--a board or committee already functioning or a new board
appointed? These questions should be formed into alternative statements for presentation to the church administration.

**Phase IV--Selection of a Plan**

Step 9. Staff makes recommendation to church administration.

Step 10. Consultants make recommendations to church administration. Both groups submit one recommended and one or more alternate, long-range plans. Each long-range plan is broken down into phases or short-range plans. A long-range plan may be presented with one or more strategies each having the same net effect. All recommendations are made in writing although verbal reports may also be presented. At the request of administration, consultants may make other verbal and media presentations to other audiences.

Step 11. Staff recommends to administration its decision on which plan to follow. The Communication Department leadership carefully studies the several alternatives that are available to the church and weighs the pros and cons of each against the purposes of the church and against the human, financial, technological, political, and social factors that influence the decision-making process. After thorough consideration of the alternatives, the staff, through the departmental director, makes a recommendation to the church administration.

Step 12. Administration adopts a plan. The administrative council, after considering the data and the cost earnings potential and the rationale behind the recommendation, adopts a plan.

**Phase V--Implementation of the Plan**

Step 13. The plan is implemented. Implementation of the adopted plan is begins. Some possible implementation principles are
that staff and administration should be involved whenever possible, recognition should be given to staff and administration representatives for exceptional service, consultants should be utilized whenever needed. A short-range calendar of due dates for completion of short-range tasks should be developed and a continuous evaluation procedure for refining the on-going implementation process should be designed and utilized. Open lines of communication with the staff, administration, and people served should be maintained. The components of the network should be implemented in an orderly fashion.

Notes on the Model

The following notes may not follow exactly the steps of the model but are some additional features gleaned from the review of literature, the observations of networks in operation and discussions with experts in satellite technology. These notes provide a more technical background while the model is a plan for procedural steps in developing a network.

Implementation of organization component. with the centralized organization of the church in mind (General Conference, union conferences, and local conferences), a structure for network operation should take advantage of existing organizational channels to carry out its aims and objectives, thus causing as little realignment and change in administrative structure as possible. This was the attempt of the CTNA and appears to have provided cohesiveness and support within the church for the network. See figure 1.

In the Seventh-day Adventist church, representatives of local congregations are members of the local conference committees and the
members of the local conference committee sit on the union conference committee. Members of the union conference committee are elected to represent their union territory on the General Conference Committee. These same administrative committees could assume the decision-making functions for the network concerning installation of equipment which would involve a decision to purchase satellite downlink dishes and video/audio monitors in churches, schools, hospitals, and offices. Each conference level could serve as a decision-making group for the church entities under its supervision.

An organization with this structure could provide local autonomy and supervision of network activities locally. An involvement by local parishes, schools, hospitals, and offices would also provide grass-roots support and interest in the network's programs. This involvement would also create an appropriate feed-back mechanism for evaluation of network programming once it is established.

The network could appropriately have a headquarters office located, if not jointly, then nearby the General Conference which would appoint members of its governing board. An advantage of this relationship would be a sharing of the world view held by church leaders and network directors alike. The governing board would likely consist of church leaders charged with leadership and liaison activities with the different types of organizations which will be utilizing the network's services, i.e., hospital and education systems, all administrative personnel, ministerial representatives, emergency preparedness directors, and broadcasters.

The network's main office, for efficiency, could be structured for centralized operation, as are both the Catholic and Mormon Networks.
with a president or director, an engineering department, a finance department, a programming department, and appropriate office personnel. This structure would follow that established by the Catholic Telecommunications Network, utilizing existing church channels of administration with a central coordinating network headquarters office. As envisioned for the Adventist church, the organizational structure could be outlined as seen in figure 9.

As can be seen by the structure in figure 9, the president of the network would be the focal point of network activities. It is (s)he who would sit on the Board of Directors, would be responsible to the Board for network operation, and represent the Board as well as the network on union conference and local conference committees which serve as decision-making units and evaluation centers of network service. (S)He also would serve as liaison between the leaders of the church (in health, education, broadcast, and administrative sectors) and the network. An important responsibility of the president would be the direct supervision of the network departments. (S)He would be charged with formulation of network philosophies, goals, and objectives and see that they are carried out by the network departments.

Responsibilities of the departments could be as follows:

1. Engineering Department. The engineering department would be critical because of its responsibility to provide consultation for equipment specifications and purchases and then installation and maintenance of all network facilities. These facilities, discussed in detail below, include uplink and downlink dishes, transmitters and receivers, and their related accessories. Once the network is established, this department would have as its major function the operation
Fig. 9. Organizational structure diagram for the proposed Adventist Telecommunications Network.
of uplink stations as well as networkwide maintenance programs for uplinks and downlinks.

2. Programming Department. The programming department is not envisioned as a production unit within the network structure. It would serve as a network-scheduling coordinator, programming-planning office, and purchasing agent for network programs. This would involve both audio and visual needs of the various church components such as the hospital, education, broadcast, and administrative branches. A major duty of this department would be the searching for and procurement of quality programming from within and without the church for inclusion in the network program schedule. This department is discussed in detail later.

3. Finance Department. Depending upon the method of financing for the network, the finance department could have a very complicated and demanding responsibility for ascertaining charges for services, appropriate billing methods, and schedules and supervision of network expenditures. As a caretaker of network funds, these functions would be of vital importance to the sound operation of the network. Potential methods for financing of the network are discussed below.

Implementation of the finance component. The successful implementation of the finance component must be based on several assumptions which have been referred to throughout this study, especially in the Catholic and Mormon networks, but which deserve review at this point:

1. Economy of scale would make network operations feasible financially. With a potential network of 5,000 downlinks, each paying
for the services it receives, the network would be able to provide programs to its subscribers at a price that would make cost of participation very reasonable to users.

2. Participation by all segments of church organization would spread costs widely over the system so that no one component or branch of the church would be unduly burdened financially by the cost of network installation or operation.

3. Program production for the network would rely upon production studios already involved in this type of activity on a local basis. It should be understood, however, that upgrading of some local studios may be necessary if their products are to be aired nationwide on the network. The network should be seen merely as a new distribution system to enhance the functions of the church rather than a whole new administrative and production activity.

4. As costs of conventional methods (i.e., telephone-line rental, postage, and travel) of communication increase, the pooling of financial and communication resources by the church as envisioned in this network would provide more economical ways to operate. An important alternative, for example, to a stand-alone uplinking system might be a facility-sharing plan with an organization that provides this service.

5. As coordinator and supervisor of the network, the General conference should be considered the home of the network headquarters and uplink activities. With its position of trust as the organization charged by the church to oversee the world work, it would logically be the site of network headquarters, perhaps even as an office of the General Conference Communication Department, already in existence.
As specific costs of the network are considered, for convenience they may be divided into the following categories:

1. Financing installation of the network. In consideration of the assumption that the network will be the result of all branches of the church cooperating to utilize this service, it would seem appropriate that the cost of installation of the network hardware be shared at all levels of the church structure. These costs could be shared in the following ways:

   a. Uplink/s. Because operation of the network headquarters and uplinks was seen as a function of the General Conference and to provide the best possible conditions for continued high quality of network services, it would be well if the cost of installing the uplink/s could be borne by the General Conference itself. Perhaps these funds could be generated by a nationwide offering appeal in the Seventh-day Adventist churches.

   b. Downlinks. Cost of purchasing downlink dishes and their installation would logically be the concern of the local user, i.e., local church, hospital, school, or administrative office. In the case of small churches where funding would be difficult to appropriate from small budgets, perhaps the union and local conferences could create a matching-fund program. Cost of receivers in the form of radio and/or TV sets should also be the responsibility of the local unit.

2. Financing of the network operation. Here again, assuming that costs of the network would be shared at all levels of the church organization, funding of network operation could be distributed as follows:
a. Headquarters/Uplink personnel. As members of the church world headquarters staff, cost of network headquarters and uplink personnel would logically be borne by the General Conference in its general operating budget. To assist in these costs, a portion of a users' fee may be allocated to this overhead. See (b) below.

b. Program production. Because the network will be user-oriented, it would be appropriate for the network to institute user fees, a fee charged each local unit based upon use of the programming available from the network. If production would expand beyond what is already done on a local basis, a General Conference supplemental subsidy might be appropriate. This is the method practiced by the two networks observed in this study.

c. Uplink/transponder time. This would logically be a part of the user fees as described in (b) above.

d. Equipment maintenance. Local personnel, where possible, should be assigned by the local unit to maintain the downlink equipment. This light maintenance work should be made as simple as possible with a local users' guidebook developed by the network engineering department. The engineering department should also maintain a users' telephone hotline for immediate communication with the local user. A parts depot should be maintained to provide for convenient replacement and repair of defective downlink accessories. This department would also be expected to provide routine inspection and maintenance of equipment in the field. Maintenance and operation of uplink equipment is the responsibility of the engineering department unless this activity is contracted out to an engineering
firm, then the engineering department would serve a liaison/supervisory function. Although these services must be available, it is generally recognized that downlink and uplink equipment is very reliable and basically maintenance free.

For the convenience of the church, several financing packages could be created to provide payment of the installation costs and/or network operation. Consideration of these packages could be investigated by the General Conference and the local units who are faced with financing the network project. These may include:

1. Loans. The cost of installation could be financed by applying for a loan with banking institutions or, perhaps, in the case of local churches, with a local, union, or General Conference, with regular installment payments as money becomes available. This would make immediate installation and use of the network services possible but also would involve risk of default of the loan should it be difficult to raise enough money for the payments. Interest rates would make this a more expensive way to finance the project.

2. Fundraising. The funding could be raised by presenting the project to local church congregations and then appealing for funds to be donated toward the project. This could be a very lengthy and time-consuming task but would provide solid funding with the possibility of earning interest.

3. Pay as you go. This method would provide the most secure basis for funding but may cause costs to rise because the network may not be able to realize economy of scale in its purchases. It would also have the potential of being costly because the technology could expand faster than the ability of the network to integrate new advances.
4. Tax-type fees. All units of the church could be arbitrarily taxed for a fixed amount which would contribute to the set-up and operation of the network. This would provide instant funds for investment into the project but may be too taxing on local budgets.

**Implementation of the personnel component.** The organizational structure (see page 21) emphasizes the necessary resourcefulness of the network in identifying a director and sufficient assistants to carry out the functions of the department. As mentioned in the discussion of the finance component, the network would rely heavily on communication directors in each conference to coordinate its programming services. This would permit the network to economize on coordinating personnel needs and concentrate on services as arranged by network headquarters. Thus, the programming and finance departments could function sufficiently with the headquarters office personnel only. The engineering department, on the other hand, would, because of its nature, need to maintain some engineers at uplink facilities wherever they may be located and also some engineers in the field for inspection and maintenance services. With this background statement, it is time to turn to the job descriptions of the department directors and their staffs. These positions were especially noted in the Catholic and Mormon operations.

1. Network president. The overall leadership of the network lies with the network president. (S)He is administrator, public-relations expert, negotiations liaison, promoter, and manager all at the same time. The health of the network would rely to a great extent upon his/her ability to promote the concept of satellite communication within the church, plan the network installation, programming, and
operation, and to successfully guide its activities using fiscal restraint and prudent management. (S)He would initiate negotiations with the conferences for planning of the network and the financing of its installation. (S)He would guide, helped by the program director, the planning of program services and their use by the various church entities. (S)He would then maintain good relations with network users and their conference committees. (S)He will be responsible for recruitment of personnel needed to operate the network and coordination of their activities as employees. (S)He would be charged with the adaptation of new technologies for incorporation into the network. In summary, (s)he would be responsible for the smooth and efficient administration of the network.

2. Engineering Director. The engineering director or Chief Engineer would have the responsibility of coordinating and directing all activities of the engineering department. This begins with the planning of the network and initial contacts with equipment suppliers. The engineer would negotiate bids for equipment and present them for Board approval. With the network president, (s)he would promote and discuss with conference committees the services to be supplied with the network and then plan the facilities with local representatives and schedule installation of equipment. The continued maintenance and operation of all network technical facilities would rest with the Chief Engineer. (S)He would also devise methods for evaluation of the network operation.

3. Program Director. The program director would be involved early in the planning of the network to ascertain the needs of the church for services of a satellite network. This would involve
in-depth study of educational programs, administrative functions, hospital operations, and congregational demands for programming. From this list of needs, (s)he would commission certain programs to be produced in church production studios, contract for the purchase of needed programming from sources outside the church, or select programs from those already being produced by Adventist producers. It would then be his/her responsibility to schedule the programs and publish the programming guide for users of the network. (S)He would insure that the programs air when scheduled and are evaluated frequently.

4. Finance Director. With a potential 5,000 users of the network, the finance director would need to give full-time attention to the financial operation of the network. Unlike some organizations where business activities consist mainly of paying bills and receiving payments, this network would require accurate and efficient business practices in estimating costs of services, scheduling payments, and establishing prices for continuing services. The finance director would supervise all functions of the network concerned with finances including user fees, budget preparation, and payroll maintenance.

5. Uplink engineers. The uplink/s of the network are a key factor in its programming efforts and services rendered. While required personnel for an uplink are not numerous, those who are given this responsibility must be alert and professional. Each uplink must have a chief engineer and assistants to insure that the uplinking schedule for network programming is closely followed.

6. Office personnel. Each department has a variety of functions to perform and each department director must allocate those duties to assistants who would see that they are professionally accomplished. According to the size and growth of the network, assistant
directors for each function may be employed. Included in this classification would be program experts, secretaries, engineers, accountants, and administrative assistants.

Implementation of the facilities component. Facilities for the network include three basic units: the headquarters offices, the Uplink/Operations Center, and the Downlink receiving stations. These components are discussed in detail here.

1. Headquarters offices. Presumably located at the General Conference, the headquarters offices should be adequate to house the three different departments, with the president in close proximity. Instant communication and consultation must be possible for this group which would function as a team. An office for each of the directors plus working space for the personnel of each department would be necessary. The finance department should have a work area with space sufficient for business machines and filing. A computer terminal, typewriters, and calculators would be needed.

The programs department would need a work space with TV monitors and video tape recorders (VTR's) for program previewing. This office must also have the ability to prepare program brochures and schedules. The engineering department must have space sufficient to house a parts depot, a repair shop, a planning room, and a general work area. A parts warehouse could be located separately.

The spatial relationships of this office are indicated in figure 10.

2. The Uplink/operations Center. The main uplink/operations facility may be located with the headquarters office or separately. The Operations Center (OC) is the heart of the network. That is where
Fig. 10. Space relationship needed in headquarters office.
all operational decisions are made and where the programming originates. From there the programming is transferred to the Uplink, most commonly by microwave if the center is not located at the Uplink site. The Uplink has a high power transmitter which transmits to the satellite in the 6 GHz frequency range. The satellite transforms the signal to a frequency range of 3.7 to 4.2 GHz and retransmits to earth. The OC consists of a room large enough to house an equipment rack with video recorders for playback over the network. A video chain with mixing capabilities from VTR's, slides, and electronic effects would be preferable. Uplink facility specifications follow:

   a. An antenna area of 25 ft. x 25 ft. would allow for sufficient space for the uplink dish.

   b. An equipment room of 20 ft. x 20 ft. would allow sufficient space for maintenance and operation of the uplink facilities.

   c. An ambient temperature rating of 70°F. maximum would be required for optimum operation of equipment.

   d. A conference room and studio facilities, if the uplink is located at a production center, would also be required. Specifications for such facilities are given below.

In the case of the Seventh-day Adventist Church, it may be advisable to establish, in the initial stages of the proposed network, a principle uplink facility at the General Conference world headquarters in Washington, D.C. It would be convenient to have this equipment and operations center located at network and church headquarters to facilitate administration and operation of the network.
Secondary uplink facilities might logically be located at the church's two universities where the educational training of ministers, educators, medical personnel, and other professionals takes place. The resources of the universities--Loma Linda University in California and Andrews University in Michigan--could provide substance for network programming and operation as well as provide an educational training function for university students.

Later requirements for the network may involve establishment of other uplink OC studios at major medical or educational centers of the church.

3. A basic production facility. If a production studio does not already exist, the following specifications would be useful in planning for inclusion of such a facility:

a. The main production studio of rectangular shape of sufficient size to allow full movement of equipment and to accommodate stage sets. Two sets of lights and a low velocity air flow for heating and cooling would also be required.

b. A control/editing room would double as a control room and a post-production editing room with an elevated floor at least two feet above the studio floor.

c. A photographic lab, a windowless room, should provide for photocopying, process-camera work, and darkroom work.

d. An equipment storage room with limited access would be needed. It should contain locking cabinets with racks for electronic hardware.

e. A dressing room adjacent to the studio with appropriate lighting and make-up mirror would be needed.
f. A master tape-storage room adjacent to the control room should provide vertical tape storage.

g. A maintenance and repair room should be located adjacent to the studio and control rooms.

h. A video distribution area next to the control room and the tape storage room should be provided as an area for shipping and distribution.

Spatial relationships for such a facility are noted in figure 11.

A useful reference and discussion of a basic production unit is Paul Denton's *A Model for Development and Administration of a Modern Television Complex* (1982).

4. Downlink receiving stations. Downlink stations consist of three main components: the antenna, the low noise amplifier, and the receiver. The antenna is the most visible and therefore the most familiar component. The dish is generally made of light-weight aluminum, metal mesh, or fiberglass. The low noise amplifier, or LNA, is situated at the focal point of the antenna about four feet from the face of the dish. The LNA picks up the signal transmitted by the satellite and amplifies it to a level strong enough to be picked up by the receiver. The signal is transferred by a special cable from the LNA to the last component, the receiver, which is usually located indoors. The receiver converts the 3.7 to 4.2 GHz satellite signal to a 70 MHz base band video signal. Through the use of a TV modulator, this signal can be transformed to a frequency compatible with a typical TV set. Specifications for this facility are as follows:
Fig. 11. Spatial relationships recommended for the basic production facility.
a. An antenna area of 18 ft. x 18 ft. allows for one foot of clearance on either side of the antenna in any position of a 360° radius.

b. An equipment area of 12 ft. x 12 ft. would allow for enough area for accessibility and growth.

c. A cable run of 160 ft. is the maximum suggested length. Approximately 25 ft. of this length would be used to dress the antenna for aesthetics and allow for movement to other satellites.

d. VIDEO/AUDIO runs in excess of 1,000 ft. tend to deteriorate both audio and video. The added expense of strip amplifiers would allow for a greater distance.

e. The ambient temperature rating of most equipment is 0° to 50° C. This is not the case when equipment is stacked in a rack; this is why an air conditioner/heater to maintain 70° is required.

f. A conference room capable of containing forty persons or more would allow for large teleconferences.

In either the case of a Downlink or Uplink facility, site selection is critical to proper use of the system. The antenna site for each user would generally be located on the user's property, as close as possible to the location of the inside equipment. Selection of the actual antenna location would be made at the time of a site frequency coordination survey by the network engineering department. Location would be based on factors such as interference shielding, general appearance, proximity of equipment-room facilities, security protection, underground pipes, highpower lines, etc. When selecting antenna locations, obstacles must be considered and locations selected accordingly. Two good guides for considering the installation of
satellite equipment and the topic of satellite communication in general are:


Implementation of the program component. As was suggested by the Catholic Telecommunications Network of America, a program advisory committee should be organized by the network program director. This committee would assist the program director in deciding:

1. The appropriate mix of program categories
2. The establishment of criteria for quality, appropriateness to needs, and allocation to the network program schedule
3. The availability of known, sufficient quality programs
4. The needs of the church as revealed by a needs assessment.

Since three distinct services are revealed in the Adventist church organization, primary education, secondary and hospital education, and entertainment, for television programs, a schedule which would serve all three would be best. When considering the time of day most appropriate for each of the three types of TV programs, it might be well to play primary education programs for mornings, secondary programs for afternoons, hospital education late afternoon, and entertainment programs in the evening.

The morning primary education segment might feature classes in curriculum areas such as biology, history, and art where local school resources are scarce or weak. In addition to classes, film features on various topics, or special graphic presentations often used in
learning situations could be broadcast to local schools.

The early afternoon schedule could present a number of classes for college level participation. A well-known professor or guest speaker could be televised for distribution among a number of campuses where students could participate in the class discussion by utilizing a microphone to talk with the professor during a question/answer period. Here again, as in the primary offerings, certain subjects may be more enhanced by this method. Various types of extension courses and continuing education workshops, seminars and lectures could be distributed in this manner, with active participation by the viewing students. This service would be especially valuable for Bible conferences, Creation seminars, and special emphasis subjects for concentrated courses.

Late afternoon programs on the network could be of value to hospital administrators who may receive an update on medical news, participate in teleconferences, or view continuing education courses for administrators. Other medical personnel may benefit in like manner as courses and seminars are aired for their specialty areas.

Evening hours on the network could be reserved for patient entertainment and education. Well planned religious programs such as major church services, television programs produced by the church, feature films of redeeming value, information about Adventist teachings and belief and informational programs about the Seventh-day Adventist hospital system. Health and religious programs permitting patients to participate using a microphone at their bedside might also be aired.

The above hypothetical schedule would be affected by many
variables. Each program would probably not be aired each day but rather on a rotating basis. Some programs would be weekly, others would be less frequent. Weekends could be devoted to special-audience programs such as religious education, special workshops, teleconferences, and seminars. The above schedule also assumes that only one TV channel would be economically feasible when the network is just beginning, but additional channels could be leased with further growth.

In addition to TV programming, audio channels would also be available. One audio channel might be a classical music service and another a religious channel. Both of these would be available from one of the Adventist broadcasters already providing this type of programming for the public.

Television and audio programming are only part of satellite communication technology, as demonstrated earlier in this study. Data distribution would also be a major programming function of the network. The hospital computer system or secondary-school computer systems could be linked by satellite data distribution. This connection could also provide electronic mail and personnel and purchasing data. These functions would take place at the same time the TV and radio broadcast programs are operating.

Phase VI--Evaluation of the Plan and Process

Step 14. Administration evaluates the plans and the planning process. Objectives of the evaluation process should be to assess the effectiveness of the planning process and the plan in achieving the stated goals (short- or long-range) of the network, to generate information for making adjustments determined to be desirable, and to
further refine the planning process for more efficient operation in the future. Principles of evaluation should be that the process must be practiced continuously throughout the process, not reserved as a culminating activity. The evaluation should be a dynamic activity, but it is also cooperative, involving many levels in the church organization. Evaluation is most effective when there is a definite, well-defined channel for feedback to the appropriate operating level. It may be critical but should always be constructive. Objective data for evaluation may be obtained by opinion polls, outside evaluation by a team of professionals, and a study of operation of the network.

Summary

This chapter describes in detail a model provided specifically for the development and administration of a multipurpose telecommunications satellite network for the Seventh-day Adventist Church in the United States. The model was validated by a panel of experts.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to develop a model which could be used by private organizations in planning a telecommunications satellite network for their current and expanding administrative, educational, and other needs.

Premises upon which the study was based assumed that the communications needs of organizations with units spread over a wide geographical area require more economical and improved methods of distribution in the present and would need to increase quality and quantity of communication in the future. Satellite communication technology has advanced the art of distributing information incredibly in recent years to make that dream a possibility, but a model for a telecommunications network had not been provided to assist private organizations to take advantage of this new technology.

The methodology used to develop the model was to research all the literature possible on the subject, observe networks already established for telecommunications purposes, then combine the knowledge gained into a usable model. The model was then submitted to a panel of experts, a jury, for their evaluation. Their suggestions were noted and recorded in the study. Final conclusions and recommendations were then made.

The literature reviewed covered the development and history of
the first satellites and their contribution to development of the sophisticated satellite systems in use today. The review also related satellite history to the technology itself and how satellites work in serving mankind's communications needs. The programming, uplinking, downlinking and terrestrial distribution properties of satellite communication were explained along with the cost and applications of the services provided.

The literature reviewed major experiments which have contributed to the expanding use of satellites for educational and administrative purposes such as televising academic classes from one campus to others, distribution of basic information from governments to their people scattered in remote areas, medical telediagnosis, and uses by religious organizations to distribute spiritual programs to their congregations.

A special section of the literature review focused on cost theory of satellite use for telecommunications purposes. The basic variables which determine cost: the information desired, the numbers and types of receivers, the frequencies to be used, the satellite power and the area to be covered by its signal, were all discussed.

The authors of two published works that were found to be especially helpful were Kenneth A. Polcyn (An Educator's Guide to Communication Satellite Technology, 1975) and Bruce Brennan and Brian Bremer (Satellite Communications: A Guide for Hospitals, 1983). Their concise presentation of satellite technology and specific outlines of its use were very basic to understanding the application potential of the medium.

In addition to a review of available literature,
telecommunications satellite networks in operation were visited to observe how the technology was being used. The author visited the facilities of the Catholic Telecommunication Network of America in New York City and the Bonneville Satellite Corporation offices in Washington, D.C., and headquarters in Salt Lake City, Utah. Network officials in these locations were interviewed about their operations, programming, organizational structure, and satellite technology in general. The author also attended the Secrets of Successful Satellite Networking Seminar sponsored by Satellite Week magazine and Services by Satellite, Inc., held in Washington, D.C., April 22-23, 1982. This activity provided contact with current authorities in the field of satellite technology who were able to provide valuable counsel for the model developed.

Because of familiarity with the organization, the author chose the Seventh-day Adventist Church as the object for the model. A brief review of church purposes and needs along with potential criteria the church should consider in pursuing a network were presented.

The information gained from the literature review, visits to networks in operation, and the survey of church needs and criteria were consolidated to form the basis for the recommended model. Intended to be a working model more than a mere outline of suggestions for a network, the model envisioned fourteen steps leading to an operational network:

1. Church administration recognizes need for and makes decision to plan.

2. Administration instructs communication staff to organize for in-house planning.
3. Staff develops philosophy, goals, and objectives for network.


5. Staff completes situation analysis.

6. Consultants complete situation analysis.

7. Staff develops alternative plans to accomplish goals.

8. Consultants develop alternative plans.

9. Staff makes recommendations to church administration.

10. Consultants make recommendations to church administration.

11. Staff recommends to administration.

12. Administration adopts a plan.

13. The plan is implemented.

14. The plan and the planning process are evaluated.

The first four steps were included in a first phase of the developmental process, termed "Preparation for Planning." The first step in this phase called for the organization's leadership to make a decision to begin planning for a telecommunications satellite network. Once the decision was made, the administration would instruct its communication department to organize for in-house planning. This would lead to a third step, the establishment of a philosophy and the goals and objectives for the network. At the same time, the administration would contract for out-of-house consultation, step 4.

The second phase of the model called for a situation analysis, steps 5 and 6, by both staff and consultants. By compiling data about the resources of the organizations, both groups could present a written report to serve as a basic work paper for network development.

The third phase included steps 7 and 8, calling for both staff
and consultants to develop plans to accomplish the goals of the network. The plans, including finances, organization, and facilities, would become part of a report for consideration by the church administration.

Steps 9, 10, 11, and 12 constituted a fourth phase of the model and addressed the critical selection of a final plan. Both staff and consultants would recommend their plans to church administration (steps 9 and 10). The staff would be further directed, after study of these plans, to present a recommended plan for administration approval (steps 11 and 12).

Phase five had only one step (13), implementation of the approved plan. This would involve actual establishment of the network as a distinct entity with its own personnel and leadership.

The sixth and final phase called for a continuing evaluation of the network as it performed its objectives and goals. This evaluation would proceed on various levels: by the network staff itself, by network users and by church administration as well as outside consultants.

Notes on the model were supplied as an additional aid in understanding the network concept. They provided specific suggestions of possible details of the network taking into consideration the unique characteristics of the Seventh-day Adventist Church. They included outlines of possible organization, locations of major components of the network, and specifications for production and uplink facilities.
Conclusions

Major conclusions drawn as a result of the literature surveyed, the findings of the study, and development of the model were that:

1. Telecommunications satellite networks are in use, are continuing to be developed as a modern communication method, and will continue to provide a needed service in the future to a variety of organizations.

2. Limited funds will be a serious problem in the development of satellite networks and must be taken into account at each step of the planning process. Although a presentation of detailed specifications for a network was outside the scope of this study and because of constant fluctuation of prices for network hardware due to advancing achievements in satellite technology, the cost of a telecommunications satellite network should continue to receive serious consideration.

3. Private organizations spread over a wide geographical area have particular potential for making effective use of the capabilities of a telecommunications satellite network.

4. Much of the success of a telecommunications network will depend upon its universal appeal and flexibility in serving all entities within the organization. In the Seventh-day Adventist organization, the network may need to serve a variety of entities, i.e., medical, educational, and administrative branches of the church, but not one at the expense of another.

5. Within any organization there is a conservative element that will be resistant to change. Some members of the Church will claim that the Church, in light of current events, has more important
priorities. Nevertheless, full consideration must be given to taking advantage of new technology to further the cause of the organization.

6. Communication systems must be built to meet the projected needs of the future. Since satellite networking is part of a new technology which includes advances ranging from home video recorders to direct broadcast satellites, the Adventist Church should plan to utilize its abilities to go beyond the mere connecting of its own institutions, a first step, to establishing a full-time communication link to the general public.

7. Even with the above concerns which challenge the idea of a Seventh-day Adventist Telecommunications Network, it is possible to provide a simple step by step process for developing a satellite network.

**Personal Conclusions**

Major conclusions drawn as a result of personal observation and contemplation while conducting this research were that:

1. To realize the potential of a telecommunications network, it must be seen by everyone in the organization as a system to benefit all and not subject to personal empire building or regional dominance. In planning an equitable system, network planners must put personal ambitions aside.

2. Because of its cost effectiveness and universal application, the Seventh-day Adventist Church and other similar private organizations will in the future utilize satellite communications on a daily basis. To take early advantage of the technology as it develops and to secure sufficient facilities to meet its needs before they come into short supply because of heavy demand, the church should act now
to develop its network rather than later.

**Recommendations**

Based upon the findings of this study, the following recommendations are presented for consideration:

1. If an organization does decide to establish a telecommunications satellite network, great care should be given to the steps provided in this model and a close watch should be given to those other networks in existence so that much can be learned from others experiences.

2. Since the model is based upon six distinct phases, the General Conference of Seventh-day Adventists should proceed with the initial steps outlined to determine the network's potential, realizing that later steps may be altered or require more time in the process.

3. Short seminars to increase the understanding of the church membership and leadership should be developed and presented so that the advantages of a satellite network could be appreciated. A book or articles written in popular style in church journals would also be helpful.

4. Even though the model here provided includes the normal steps usually followed in developing a system, a simultaneous study of the costs to determine the feasibility of a network should be conducted. The network should be considered a prototype requiring research and development needing special funding appropriations.
APPENDIX A

Panel of Jurors
PANEL OF JURORS

Bruce Hough, Vice-President
Bonneville Satellite Corporation
165 Social Hall Ave.
Salt Lake City, Utah

Wasyl Lew, President
Catholic Telecommunications Network of America
93 Madison Avenue
New York, New York

Jonathan Miller, Managing Editor
Communications Daily
1836 Jefferson Place, N.W.
Washington, D.C.

Alan Pearce, Consulting Economist
Bethesda, Maryland

Robert Wold, President
Robert N. Wold Company, Inc.
Los Angeles, California

Elizabeth Young, President
SatServ
Washington, D.C.
APPENDIX B

Response Sheet Sent to the Panel of Jurors
After my reading of *A Model for the Development and Administration of a Telecommunications Satellite Network for the Seventh-day Adventist Church*:

1. I feel that the model, and its notes, are useful and adequate as a planning guide to help a private organization develop a telecommunications satellite network for its own purposes.

   - [ ] yes
   - [ ] no
   - [ ] uncertain

2. I feel that the model, if adopted by the Seventh-day Adventist church, would improve church communication and services that would be cost effective in the long term.

   - [ ] yes
   - [ ] no
   - [ ] uncertain

3. I have noted the following *weaknesses* in the model and its notes:

   

   

   

   

   

4. I have noted the following *strengths* in the model and its notes:

   

   

   

   

Signed: ___________________________ Date: ___________________________

Thank you very much for your help.
APPENDIX C

Letter Sent with the Model
I know you are busy and I will take as little of your time as possible. You have been selected, with six others, to serve on a panel of experts to evaluate my project—an important part of my doctoral program. As I discussed with you already by telephone, I wish to complete this study by June, so I will be grateful if you could respond, with the evaluation sheet provided, as soon as possible.

The topic of a telecommunications satellite network is an important one and it is my hope that the model which will be developed with your help will be one of great use to many organizations.

Please take a few minutes to read the enclosed document which will be chapter IV of the final dissertation, and then respond as soon as you can on the evaluation sheet. A pre-stamped envelope is enclosed for your convenience.

Your comments will be incorporated into the model but you can be sure your name will not appear in published reports. Your comments will be in strict confidence.

Thank you in advance for your assistance and I wish you well in your work.

Yours sincerely,

Allen Steele
Doctoral Candidate

Dr. E. A. Streeter
Chairman of Doctoral Committee
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EDUCATION

1962 Fletcher Academy, Fletcher, North Carolina, High School Diploma

1967 Southern College of Seventh-day Adventists, Collegedale, Tennessee

1977 Andrews University, Berrien Springs, Michigan, Master of Arts in Religion

1984 Andrews University, Berrien Springs, Michigan, Doctor of Education

PROFESSIONAL EXPERIENCE:

1965-1967 Station Manager, WSMC, Collegedale, Tennessee

1967-1969 Military Service, Clerk, United States Army/Europe

1969-1971 Public Relations Director, Riverdale Hospital, Washington, D. C.

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