A Survey Of Communications Status And Needs For Distance Education And Teleconferencing Providers

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Takis Kasparis

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A Report of the
Space Communications Technology Center
and the
Institute for Simulation and Training
University of Central Florida

A Survey of Communications
Status and Needs for
Distance Education and
Teleconferencing Providers

William J. Bramble, Ph.D. • Takis Kasparis, Ph.D.

Institute for Simulation and Training
12424 Research Parkway, Suite 300
Orlando FL 32826

University of Central Florida
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I. INTRODUCTION

Background of SCTX-CCDS

The National Aeronautics and Space Administration (NASA) has stressed the need to adopt a "new customer focus" for developments in space-based communications. Customers are commercial users and suppliers of communications and remote sensing data. Centers for Commercial Development of Space (CCDSs) have been established as a result of the need for a "new customer focus." A CCDS is a not-for-profit, joint research and development organization formed by commercial firms, academic and research institutions, and non-NASA government organizations.

The intent of NASA's CCDS program is to stimulate and help sustain the further development of U.S. space-related activities which will contribute to U.S. leadership in the telecommunications sector in the 1990's and beyond. One requirement of each CCDS is to prepare a plan for increasing non-NASA financial and institutional contributions leading to eventual CCDS self-sufficiency. The objectives of CCDSs are self-sufficiency and the constructive "leveraging" of NASA's grant investments. These are important elements of the CCDS Program. The program seeks to expand, diversify, or provide completely new management and organizational approaches to further NASA's Guidelines Regarding Early Usage of Space for Industrial Purposes (SCTC, 1991).

In early 1991 the NASA Office of Commercial Programs announced a competition for the funding and support of one or two additional Centers in communications at an initial funding level of approximately one million dollars per year. Applications were restricted to CCDS concepts dealing with the commercialization of advanced satellite communications.
technologies and other space-based telecommunications technologies.

Program Description

The Space Communications Technology Center (SCTC) was one successful applicant in this competition. The SCTC-CCDS consists of Florida higher educational institutions including Florida Atlantic University (lead institution), University of Florida (Gainesville), the University of Central Florida and the University of South Florida.

The University of Central Florida’s (UCF) participation includes a joint effort between the UCF Institute for Simulation and Training (IST) and the UCF Space Education and Research Center (SERC). The research reported herein was one of the UCF projects of the SCTC. Dr. William Bramble of the Institute for Simulation and Training served as the principal investigator. He was assisted by Dr. Takis Kasparis, assistant Professor of Electrical Engineering at the University of Central Florida and Ms. Yvette Mihaly, a student assistant.

The research focused on a needs-assessment to establish communications requirements and needs for operators of teleconferencing and distance education networks. By extrapolation, the results of the effort may also be of use in identifying the digital communications requirements of some experimenters in the Advanced Communication Technology Satellite (ACTS) program for distance education and teleconferencing applications.
Program Purpose

The ultimate goal of the SCTC is to make the results of its research available to industry. The results of the current project provide information and identify priorities for technical requirements and research efforts related to space-based communications needs of distance education and teleconferencing providers. It is hoped that this input from these users provides information to both government and industry to better address their needs.

Purpose of Study

The purpose of this project was thus to identify current and future communication needs (especially digital communications needs) of distance education programs and teleconferencing services. User input was obtained from a multidimensional perspective, using survey methodology. Non-technical variables such as geographical distribution of sites or clients, types of services offered, competing options for the services, user characteristics, etc., were studied. Technical factors such as: data types, required transmission rates, multiplexing and user interfaces, needs for still and dynamic video, video resolution, operator requirements, support and training, and supportable user costs were also assessed.

The results of the project reveal present and future user requirements and specifications, suggesting areas for improving the attractiveness and utility of the technology for the chosen user groups. The results have potential utility for NASA, the communications industry, and communications researchers. They are also of potential value in making known the needs of distance education providers and providers of teleconferencing services. This research provides input into parallel and future development
efforts. Collectively, these efforts will benefit system users and may enhance the commercial viability of the developing technology for space-based ISDN/BISDN communication systems.

**Distance Education and Teleconferencing**

Distance education (see the report *Linking for Learning: A New Course for Education*, U.S. Congress, Office of Technology Assessment, 1989) is an approach to teaching and learning under conditions where the teacher and learner are at separate locations during the learning process. Sophisticated technologies such as: communication satellites, teleconferencing, advanced forms of video communication and data communication, and computers have opened many possibilities for linking teachers and students in distance education (Bramble, 1990). Teleconferencing (see *Applied Business TeleCommunications*, 1991) is a technique through which meetings can be held at a distance. Typically the meeting participants are located at two or more distant sites and inter-connected by audio or video communications.

The following scenarios illustrate distance education programs:

Purdue University's Krannert School of Business offers a 22-month degree program during which the students are required to attend only six two-week sessions. During the rest of the time they receive, complete, and submit their assignments using the Macintosh computer and Microsoft mail (Kaplan-Neher 1992).

The TI-IN Network, based in San Antonio, Texas, is the largest and the oldest commercial provider of distance education in the country, and has been
providing video-based distance education courses via satellite and cable for over a decade. This organization offers K-12 as well as college-level courses through its association with Mind Extension University (Kaplan-Neher 1992). National Technological University (NTU), headquartered in Fort Collins, Colorado, is a consortium of some 42 member universities. NTU provides graduate and continuing education for engineers directly into the workplace and uses digital compressed satellite communications to deliver multiple channels of video over a single transponder (Portway 1992).

Telecommunications brings education and training to those who might not otherwise be able to receive it and also expands the boundaries of the traditional classroom. Putney (1992) identified seventy-one entities worldwide that operate networks offering instructional programs. These networks deliver regular instructional programs in a prescribed curriculum to children enrolled in public and private schools or to students registered in college, university, and technical institute programs of study on or off campus (Putney 1992). Our own search of the literature identified additional providers of education and training.

Examples of organizations which operate distance education networks are universities and community colleges. The method may be used for students otherwise unable to attend the college for one reason or another. Hospitals use distance education for training nurses and medical personnel in developing skills using the newest forms of technology and methods of dealing with healthcare. Business and industry (e.g., the Chrysler Corporation) also use distance education for training and use teleconferencing to extend participation in special events and meetings.
The costs of communication systems can be a problem for small or medium sized companies. However, "it has been shown that for many applications (business, education, government) distance education can be a cost effective solution to education or training" (Bramble 1990).

Teleconferencing has evolved to facilitate business, educational, government, and other meetings without the need for costly travel to a common meeting location. Some examples of teleconferencing providers are:

US Sprint. The Meeting Channel is a full service provider of video teleconferencing services. Said to be the world's largest video teleconferencing network, the Meeting Channel has over 750 video conferencing rooms worldwide.

Florida Sunstar Network. Video teleconferencing is provided at public university and community college campuses throughout the state of Florida.

CTNA Telecommunications, Inc. offers live interactive teleconferences to Catholic dioceses/parishes, health care institutions, and college campus ministries.

Trends in Distance Education and Teleconferencing

Current trends identified in the research literature include the following:

Providers of distance education and teleconferencing while not high volume users of communication satellites in comparison to telephone utilities, commercial television networks, etc., do constitute a significant user group for U.S. communication satellites.
Since Ku-band satellite services emerged in the first half of the 1980's, there has been a steady growth in the U.S. market for goods and services related to private business television networks (used for training and teleconferencing). The market for goods and services associated with private business television networks is predicted to reach $1 billion by 1995. The video communications market is expected to increase to approximately $3.5 billion by 1995.

The survey results reported herein reveal that respondents believe their transmission costs are expensive. Despite these perceptions, North American transponder prices are some of the lowest anywhere. However, occasional-use transponder time has been increasingly difficult to obtain during peak business hours.

Computer technology (computers, CD-ROM drives, optical discs, and interactive videodiscs) are increasing in both storage capability and degree of interactivity. At the same time, computers are becoming even smaller, more powerful, more flexible, and more portable (Kaplan-Neher 1992). These developments offer additional possibilities for distance education.

It has also been proposed that "video-based distance education will make increasing use of computer technology, with course providers' offerings appearing on individual computer monitors rather than on a single video screen in a classroom or conference room" (Kaplan-Neher 1992).

Kaplan-Neher also asserts that distance education will make increasing use of fax technology in conjunction with computer storage to provide document delivery on demand.
The U.S. has held a traditionally pre-eminent position in space-based communications. Before 1983, Europe and Japan were not significant producers of communication satellites. However, in the last few years, the United States has built 36 communication satellites compared to 23 by Europe and Japan. These numbers indicate that the United States’ pre-eminent position in satellite communications may have eroded (Gedney 1992).

According to one study, the U.S. average of 138 programs per year per occasional use customer is far less than the Japanese average of 253 programs, but significantly more than the European average of 21 programs. Demand for satellite channels is increasing, but as more and more users require partial instead of full transponder channels, aggregate demand for transponders will decrease. Hardware prices are higher than most network operators anticipated, but, through additional competition both domestic and international costs will decrease (Putney 1992).

ACTS Satellite

The Advanced Communication Technology Satellite (ACTS) is an experimental satellite with a wide range of applications. It is scheduled for launch in summer 1993. It is expected to spawn and/or expedite the following emerging industries: customer premises services, flexible trunking, shared tenant services, efficient international communications, rapid database access and transfer, commercial video distribution, mobile communications, teleconferencing, high definition TV, and many other applications (Chetty 1991).
The purpose of the ACTS capabilities is to accommodate the projected increases in worldwide telecommunications demand for the 1990s, and beyond. Technological innovations which permit more cost effective satellite communications systems are needed. The ACTS system may be able to assist and alleviate many of the existing problems users face with their current communications systems. This will be accomplished by the use of multiple beam antennas, hopping beams and fixed spot beams for predetermined locations, and a high speed, base-band digital processor on board the satellite using transponder capacity by routing individual, circuit-switched messages to provide single hop connectivity in a full mesh network. The ACTS system will also have a dynamic reconfigurable, microwave, intermediate frequency switch which is capable of routing low or high volume point-to-point traffic and point-to-multipoint traffic over 900MHz channels. In the narrowband mobile markets ACTS technology offers the advantage of smaller antennas, no overcrowding in the Ka band, and higher bandwidth to carry voice, data, and fax for air-to-ground communications (McGuire 1992). While ACTS users are not studied directly in this project (since it is not yet in operation) the results of the study provide some insight as to its potential applications of its capabilities to distance learning and teleconferencing.
II. METHOD

Subjects

The subjects in this study were key representatives from organizations involved in distance education and teleconferencing and located in the United States and Canada. Organizations representing education, business and industry, government, and other sectors were chosen to participate in this survey in order to obtain a broad cross-section of users.

Procedures

Data were gathered for this study through survey methodology. The methodology used to conduct the survey utilized a three-step process as follows: 1) A telephone survey was conducted of 15 representative distance education, government, military, and business and industry organizations. These organizations were asked about major variables such as compression, bandwidth, complaints with their current transmission systems, etc. This pilot sample provided a basis for the development and refinement of the 30-item questionnaire used in this study. 2) The survey questionnaire was mailed to 300 qualified organizations, along with a letter explaining the purpose of the survey and describing how the information would be used. Qualified organizations were selected from three distance education and teleconferencing directories. These directories include: The 1988 Video Register and Teleconferencing Resources Directory (Knowledge Industries Publications, Inc., 1988), At a Distance (Ostendorf, 1991), and Teletraining & Distance Education Directory (Ostendorf, 1992). As a result of a first mailing, 97 responses were obtained. 3) A second copy of the
survey questionnaire was sent to organizations which did not respond to the first mailing, along with a follow-up letter reiterating the importance of the requested input for determining future trends for communications systems. An additional 77 completed questionnaires were returned from the second mailing. The resulting number of returned questionnaires was 174 or 58% of the population specified for the study. Thirty-one of the respondents did not fully complete the survey instrument (the typical reason being that many questions did not apply to their organizations). Thus there were 143 useable questionnaires available for the analysis.

Copies of the questionnaires were mailed to organizations in the United States and Canada between the months of May and August, 1992. They were addressed to the network managers of distance education and teleconference services. These organizations can be broadly classified as:

University/College
Business/Industry
Government
K-12 Education
Military
Religious
Other, non-profit

**Survey Instrument**

The survey questionnaire (see Appendix A) contained 30 questions beginning with the type of organization and the kinds of services each provides.

Questions addressed a number of technical factors in order to identify technological trends in communication systems. These factors include the following:

1) Major pathways and path providers of communications systems.
2) Satellite use, identification of the transmission band, (Ku versus C) and perceived problems with antenna and footprint sizes.

3) Types of information exchanged on the network (audio, video, data) and levels of interactivity.

4) Use of analog vs. digital video transmission and status of plans to convert analog systems to digital.

5) Use of compression techniques and problems encountered with current compression technology (if used). Also, the importance of privacy and security to the networks.

6) Identification of major manufacturers of communications equipment and compatibility across manufacturers. Also, portability/transportability of equipment and problems/complaints with existing communications systems.

7) Identification of desirable features which were currently considered too costly or unavailable and changes/improvements envisioned for the networks in the near future.

Finally, the participants were asked to provide any additional comments and suggestions regarding the communications requirements for their networks.
III. RESULTS

This section presents the detailed results of the survey of distance education and teleconferencing users. The order of presentation of the results follows the order of the questions on the survey questionnaire. As a reader of this report you may wish to read the detailed presentation of results or skip to the section entitled Major Conclusions at the end of this report.
Question 1: What is your current communications application?

The types of organizations responding to the survey are depicted in Figure 1. As seen above, over one-half of the respondents (52%) offered both services -- teleconferencing and distance education. Some 14% offered these two services and television broadcasting. Other organizations offered various combinations of distance education, teleconferencing, broadcast, and information data services. Interestingly, only 6% offered exclusively teleconferencing and 4% distance education. The providers surveyed, given the nature of the systems they have developed and the groups they serve, tend to offer diversified services.
Question 2: What types of services do you provide?

The types of services offered by the respondents were further broken down to determine the kind of services they provide. As seen in Figure 2, the most common service (30%) is in offering courses for college credit. This includes courses, graduate degrees, four year college degrees as well as Associate of Arts degrees. This is followed by government and corporate training (19%), continuing education (19%), courses for K-12 schools (14%), healthcare courses (7%), teleconferencing (7%), and general information (4%).
Fig. 3  Number of People Served by Distance Education and/or Teleconferencing Programs

Question 3: How many people per year do you currently serve in your distance education and/or teleconferencing program(s)?

To get an idea of the number of customers served by the networks surveyed, the questionnaire asked the respondents to estimate the number of persons currently served by their network. The results are summarized in Figure 3. The majority (59%) reported that over 2,000 persons are served each year. All but 18% served over 500 persons per year. Taken collectively, we estimate that the networks included in the survey provide services to at least 300,000 persons annually.
Question 4: Where is your central transmission site located?

Question 5: Where are the majority of your remote sites located?

Respondents were asked where their transmission and receive sites were located in order to determine the types of geographic areas served. The majority (57%) of the central sites were located in urban areas as were 38% of the receive sites. Suburban transmission sites constituted 24% of the sample, as did 27% of the remote receive sites. Remote receive sites in rural areas constituted 35% of the sample, whereas central transmission sites were found in only 19% of the sample. To an extent, transmissions were urban to rural, although a great deal of variability was found in the sample.
Question 6: When did you begin using your current type of communications?

The survey attempted to determine when the respondents acquired their current communications systems. Figure 5 depicts these data graphically. As seen in this graph, relatively more of the current systems were purchased during the period 1988-1992 (40%) followed by 1983-1987 (35%). Fewer systems were nine years or more in age. Only 25% were purchased prior to 1983. Thus, the technology used by these networks is relatively new. However, with the rapid pace of improvement of this equipment, upgrades may be required for a majority of the systems.
Table 1  Communication Cost Factor Ratings

<table>
<thead>
<tr>
<th>Cost Factor</th>
<th>Ratings</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th># of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Time</td>
<td></td>
<td>0.50</td>
<td>0.14</td>
<td>0.18</td>
<td>0.04</td>
<td>0.14</td>
<td>83</td>
</tr>
<tr>
<td>Bandwidth</td>
<td></td>
<td>0.25</td>
<td>0.22</td>
<td>0.13</td>
<td>0.13</td>
<td>0.27</td>
<td>79</td>
</tr>
<tr>
<td>Time of Day</td>
<td></td>
<td>0.23</td>
<td>0.23</td>
<td>0.14</td>
<td>0.18</td>
<td>0.22</td>
<td>78</td>
</tr>
<tr>
<td>Distance</td>
<td></td>
<td>0.22</td>
<td>0.14</td>
<td>0.15</td>
<td>0.20</td>
<td>0.29</td>
<td>81</td>
</tr>
<tr>
<td>Day of Week</td>
<td></td>
<td>0.13</td>
<td>0.17</td>
<td>0.18</td>
<td>0.21</td>
<td>0.31</td>
<td>77</td>
</tr>
</tbody>
</table>

Note: 14% of the respondents rated costs of personnel, equipment and production as their major cost.

Question 7: On a scale of 1 to 5 (1 being highest and 5 lowest) rate the importance of each of the following as a major cost factor for communications (rate each item separately).

Item seven of the survey attempts to determine which of five cost factors were of greatest importance to networks in selecting communications equipment. Highest rated factors were transmission time, bandwidth, and time of day. Of lesser importance were distance and day of the week.
Table 2  Top Path Providers

<table>
<thead>
<tr>
<th>Path Provider</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTE</td>
<td>39%</td>
</tr>
<tr>
<td>Cable Companies</td>
<td>28%</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>20%</td>
</tr>
<tr>
<td>Hughes</td>
<td>13%</td>
</tr>
</tbody>
</table>

Question 8: Who is (are) your major path providers?

Question 9: What is your total monthly transmission expenditure?

Question 10: What is your monthly communications technical services expenditure (over and above what is paid to the path provider -- does not include technical services related to production)?

The top four path providers for the networks included in the sample were GTE (39%), Cable companies (28%), AT&T (20%), and Hughes Communications (13%).

Eighty-two percent of the networks surveyed reported spending less than $50,000/month on communications. Eight percent reported spending $50,000 to $100,000/month, and 10 percent reported spending over $200,000/month.

Eighty-one percent reported spending up to $25,000/month for technical services related to communications, 10% spent $25,000-$100,000/month and 9% spent over $100,000/month.
Table 3  Satellite Technical Services to be Purchased in the next 12 Months

<table>
<thead>
<tr>
<th>Technical Services</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maint. &amp; Operating Services</td>
<td>16%</td>
</tr>
<tr>
<td>System Hardware/Software</td>
<td>16%</td>
</tr>
<tr>
<td>Integration</td>
<td>16%</td>
</tr>
<tr>
<td>Other</td>
<td>15%</td>
</tr>
<tr>
<td>Construction, Install., &amp; Implementation</td>
<td>14%</td>
</tr>
<tr>
<td>Freq. Coord. &amp; License</td>
<td>11%</td>
</tr>
<tr>
<td>Preparation</td>
<td>10%</td>
</tr>
<tr>
<td>Design &amp; Engineering</td>
<td>5%</td>
</tr>
<tr>
<td>More than one</td>
<td>5%</td>
</tr>
<tr>
<td>None</td>
<td>29%</td>
</tr>
</tbody>
</table>

Question 11: In the next 12 months, do you plan to purchase any satellite technical services?

As seen in Table 3, 93 respondents (71%) stated that they had plans to purchase some additional services in the next year. Of these respondents 5% stated that they planned to purchase more than one of the technical services.
Question 12: Which pathway(s) of transmission do you currently use?

As seen in Figure 6, types of communications systems most commonly employed include: satellite communications (83%); RF Channels (non-satellite) (61%), telephone lines (64%), and cable television (63%). Forty-six percent of the respondents reported using fiber optic pathways and 38% reportedly employ broadcast television.

However, 74% reported employing a combination of two or more of the above pathways in completing their networks, of these the most common combinations were 1) satellite, telephone, cable-TV, fiber optic and TV broadcast; 2) Satellite, cable TV and telephone; and 3) Satellite and cable.
### Table 4
Top Communications Satellites Used

<table>
<thead>
<tr>
<th>Satellites</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBS6</td>
<td>22%</td>
</tr>
<tr>
<td>GSTAR 1</td>
<td>22%</td>
</tr>
<tr>
<td>Spacenet</td>
<td>19%</td>
</tr>
<tr>
<td>Galaxy 6</td>
<td>17%</td>
</tr>
<tr>
<td>SBS4</td>
<td>10%</td>
</tr>
<tr>
<td>SBS5</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Question 13:** Which (if any) satellites do you currently use for your transmission?

The table lists the six satellites most frequently used by the respondents. Possible reasons for the use of these satellites are cost, availability, and accessibility and coverage provided by the satellites.
Question 13a: List the Band (C, Ku, etc.).

Ku-band is used by more respondents (40%) than C-band (15%), although many respondents (45%) use a combination of Ku and C. Ku-band (12-18 GHz) may be more popular because of the smaller dish size used and the capability for more bandwidth. However, Ku-band is more susceptible to bad weather conditions. C-band, (4-8 GHz) on the other hand, is still popular among users.
Question 13b&c: Is the dish size a problem at the central site? At the remote site?

The antenna size is more often reported to be problematic at remote sites than at central sites. Only 5% of the respondents stated that dish size was a problem at central transmission sites, whereas 25% indicated that the (large) dish size was a problem at remote receive sites.
Table 5
Satellite Footprint or Transmitted Power Problems

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>24%</td>
<td>76%</td>
</tr>
</tbody>
</table>

Question 13e: Is the size of the available satellite footprint or the transmitted power a problem?

Table 5 shows that most users (76%) did not report problems with the available satellite footprint or power. Those who reported problems served large geographic areas and cited problems with the size of the footprint or transmission power in fringe areas.
Question 14: What are you transmitting?

Audio and video dominate with 55% of the survey respondents reporting that they transmit audio and video more than any other single or combined transmission. Twenty-nine percent of the users reported transmitting audio, video, and data simultaneously.
Question 15: What provisions do you have for interactivity?

A key provision for the educational and teleconferencing services surveyed is interactivity among the sites served. Seventeen percent of the systems reportedly employed a system based upon one-way video which includes limited real-time interactivity. Full duplex audio with one-way video is the most popular level of interactivity with 25% using this method. Full duplex audio with two-way video was reported by 11% of the respondents and full duplex audio by itself 12%.

Note: 86% believe that their current level of interactivity is sufficient for their use, and 75% of the 14% which do not believe their interactivity is sufficient, believe that lack of realtime interaction is the main problem.
Question 16: Is your current transmission analog, digital or both?

Analog transmission still dominates (58%). However, 33% of the respondents reportedly use both analog and digital transmissions. Nine percent of the systems are exclusively digital. The transition from analog to digital appears to be underway.
When & Why did Respondents Begin Using Compression

Question 19c&d: When and why did you begin using compression?

Evidently, there has been a surge in the use of compression during the last few years. Most respondents who reported switching to a compression format have done so in the past two to three years. This could be attributed to theoretical innovations in compression, as well as technological breakthroughs. Most users began using compression to decrease cost and increase data flow. As compression technology continues to improve additional usage can be expected in the coming year.

* 42 respondents gave reasons why compression has advantages. These responses are summarized in the above pie chart.

* There were 36 respondents who answered the question out of 42 respondents eligible to answer.
Fig. 14  Compression Usage Types

Question 19c: If you use compression, do you have any problems?

Those respondents who use compression apply it to audio and video signals possibly because these signals use most of the bandwidth when transmitting. However, compression was applied to other combinations. The least frequent usage for the networks was for data, probably because of the nature of the service providers studied and because it requires lossless compression techniques.

About 50% of the complaints concerning compression are motion response, while fidelity loss (22%) and synchronization loss (18%) are also reported to be problems. This indicates the need for high-performance compression algorithms.
Question 20&20a: If you use analog transmission, do you plan to switch to digital soon? Why?

Almost one-half of those who use analog transmission state that they do not have immediate plans to switch to digital transmissions. The most common reason is equipment replacement costs. Those who plan to switch to digital transmission believe that they will gain increased flexibility (42%), improve quality (24%) and lower costs (25%). It appears that lowering the cost of equipment could enable the networks to switch to digital transmission more rapidly.

Question 21: Would you be willing to lower costs by tolerating some audio/video degradation?

Over one-half of the respondents (59%) stated that they are not willing to tolerate signal degradations to lower costs. This indicates that future compression techniques must be of high performance to attract additional users.

Question 22: Is privacy or security important for your current or future needs?

Forty-five percent of the respondents indicate that privacy or security is important for their application, but only 25% stated that they presently use any scrambling or encryption. This may indicate a need for lower cost security equipment.
Table 6
Major Manufacturers of Communications Equipment

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Atlanta</td>
<td>31%</td>
</tr>
<tr>
<td>CLI/Hughes</td>
<td>20%</td>
</tr>
<tr>
<td>Other</td>
<td>49%</td>
</tr>
</tbody>
</table>

Other includes:
- Microdyne
- Videotelecom
- Commwave
- Chaparral
- Grass Valley
- Sony
- Varian

Note: 90% of the respondents own their communications equipment, while only 10% lease.

Question 24: Who is (are) the major manufacturer(s) of your communications equipment?

For the group studied, Scientific Atlanta ranked first with (31%) and Compression Laboratories, Inc. (CLI)/Hughes was rated second with (20%). Most users (81%) indicated they had no problems with their communications systems. Ninety percent of users own their equipment rather than lease it.
### Table 7

**Problems with Communications Systems**

<table>
<thead>
<tr>
<th>Complaints</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdated Equipment</td>
<td>19%</td>
</tr>
<tr>
<td>Costs</td>
<td>18%</td>
</tr>
<tr>
<td>Susceptible to bad weather</td>
<td>17%</td>
</tr>
<tr>
<td>Poor picture or audio quality</td>
<td>13%</td>
</tr>
<tr>
<td>Equipment failure</td>
<td>11%</td>
</tr>
<tr>
<td>Channel availability</td>
<td>11%</td>
</tr>
<tr>
<td>Equipment complexity</td>
<td>7%</td>
</tr>
<tr>
<td>Excessive echo</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
<tr>
<td>None</td>
<td>21%</td>
</tr>
</tbody>
</table>

**Question 25: Do you have any problems or complaints with your current communications system?**

Outdated equipment ranked as the highest complaint (19%). Users stated that their equipment was difficult to tune and suffered from drifts. Costs ranked second (18%). Susceptibility to bad weather ranked third (17%), mostly from satellite users in the Ku-band. Other complaints include poor picture or audio quality, equipment failures, channel availability, etc. However, 21% stated that they have no problems with their system.
Table 8  Desirable Features
(Not Currently Available or Affordable)

<table>
<thead>
<tr>
<th>Features</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-way Video (point-to-multipoint capability)</td>
<td>27%</td>
</tr>
<tr>
<td>High definition TV</td>
<td>17%</td>
</tr>
<tr>
<td>3 or more-way video</td>
<td>14%</td>
</tr>
<tr>
<td>Mobility between sites</td>
<td>13%</td>
</tr>
<tr>
<td>Smaller aperture terminals</td>
<td>13%</td>
</tr>
<tr>
<td>Higher data rates</td>
<td>8%</td>
</tr>
<tr>
<td>Mobility within site</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

Question 27: What features would you like to have which you cannot currently afford or are not available?

The features respondents would like to have, but cannot currently afford, or which are not available, are point-to-point or point-to-multipoint interactive video, which ranked first with 41%, and high definition TV which ranked second with 17%. Mobility of equipment between sites (13%) and smaller aperture terminals (13%) also received votes. Interestingly most of these features were suggested by the survey instrument and few additional features were suggested by the respondents.
Question 29: What changes do you envision for your system in the future?

Most frequently listed changes envisioned for the future are shown in Table 9. General changes include network expansion, expanding the types of pathways, and increasing the distance covered by their system. Specific technical changes envisioned include adding compression, moving to digital communications, and increasing the use of fiber optics.
IV. MAJOR CONCLUSIONS

Respondent Characteristics

The majority of the 143 networks responding to the survey provided multiple services, especially distance education and teleconferencing. Specific services included credit college courses, government and corporate training, continuing education, K-12 instruction, and teleconferencing. The systems provide service to over 300,000 clients per year. There is a slight preponderance of services provided from urban transmission sites to rural reception sites.

Most of the systems studied in this project purchased their current equipment in the past 5-10 years. However, one-quarter of the systems purchased equipment over 10 years ago.

Cost Considerations

When asked to identify major cost factors in communications systems, the respondents ranked transmission time as the most influential cost factor. Other important factors are the bandwidth occupied, time of the day, and distance. The day of the week seemed to be the least important cost factor. In reducing the total cost, most of these cost factors depend on the application and are difficult to change. The most significant cost factor that can be reduced is the bandwidth, and this can be achieved by using compression.
Transition to Digital Communications

A conclusion from this survey is that for the networks studied analog transmission still dominates over digital transmission. Only 9% reported using exclusively digital systems, where 33% stated using both analog and digital systems. It appears that as older analog systems become obsolete, users are slowly upgrading to newer digital systems. The growing use of compression, the reliability and the flexibility of digital systems attract more and more users, but lower cost digital equipment is probably needed to accelerate this transition.

Compression Usage

Compression is definitely a "hot" area both in application and theory. A conclusion from this survey is that there is a surge in the use of compression. Already some 40% of the respondents indicated that they currently use some form of compression in their system. Motives to use compression were mostly to decrease cost and increase data flow. However, from the complaints of many respondents it is evident that compression technology needs improvement. Complaints such as slow motion response and fidelity degradation indicate the need for more efficient and effective compression techniques. Low equipment cost is also needed to make the use of compression more widespread.

Fiber Optics Usage

Another interesting conclusion from this survey is that fiber optics is already popular and that there is an increasing trend for more usage. The major limitation is that fiber optics is reportedly used for local, rather than long-haul distribution, but it does seem that
fiber optics competes with satellite transmission. According to a report published by World
Information Technologies, demand for fiber products will grow almost 10% annually
between 1991 and 1996, while at the same time demand for copper products will drop almost
7% each year during the same period. The company predicts that by 1996 fiber's share of
the outside plant market will reach 45% (Brown 1992).

The recent decision by the FCC to allow local telephone companies to carry video
programming may provide a boost for fiber optic technology. It is also believed that the
decision will lead to more video transmission by the telephone companies, translating into
a greater need for fiber optic transmission.

It has been reported that President Clinton backs the creation of a universal, door-to-
door fiber optics network. This attention and interest from both Clinton and Vice President
Al Gore may enhance the implementation of a fiber optic infrastructure (Brown 1992).

Problems

The communications problems reported were less than might be expected. The most
frequent complaints were outdated equipment, high cost, and weather susceptibility. The
latter complaint may explain the observed preference for C-band transmissions and fiber
optics. Another complaint was channel availability, which supports importance of
compression to reduce the bandwidth used and effectively increase the number of channels.
The results of this study point to the need for lower cost equipment (especially for digital
transmission and compression) and more efficient usage of bandwidth. Fiber optics with its
weather immunity is getting increased attention.
Desirable Features

Users appear to be satisfied with their present systems, but as technological advances and competition play major roles, users want more from their systems. Some trends identified from the responses to this survey are network expansions to include more users and increase the customer base with additional types of pathways that can span greater distances. Increased levels of technical interactivity can allow more live interactions with the use of high-definition compressed video signals. Equipment must also be inexpensive, reliable and portable. Most of these features can be achieved in exclusively digital systems. Fiber optics with its wide-bandwidth and weather immunity can also be an efficient pathway, but only satellites can offer maximum flexibility for point-to-multipoint communications.
BIBLIOGRAPHY


Kaplan-Neher, Anne (1992, October). Distance Education Goes Interactive, *Syllabus*, p.3.


Communications Survey

Date: ____________________________ Street Address: ____________________________

Person completing form: ___________________________________________________________

Your position in the company: _______________________________________________________

Name of your institution/company: __________________________________________________

Division: _______________________________________________________________________

Questions:

1) What is your current communications application (check all that apply)?
   ____ Teleconferencing
   ____ Distance Learning
   ____ Information/Data Services
   ____ Broadcasting
   ____ Other, please specify _______________________________________________________

2) What type of services do you provide? (e.g., graduate engineering courses, military training, healthcare seminars, etc.).
   _____________________________________________________________________________

3) How many people do you currently serve per year in your distance learning and/or teleconferencing program(s)?
   ____ Under 500
   ____ 500 -1000
   ____ 1001-2000
   ____ Over 2000

4) Where is your central transmission site located?
   ____ Urban
   ____ Suburban
   ____ Rural

5) Where are the majority of your remote sites located?
   ____ Urban
   ____ Suburban
   ____ Rural
6) When did you begin using your current type of communications?

(Month/Year)

7) On a scale of 1 to 5 (1 being highest and 5 lowest) rate the importance of each of the following as a major cost factor for communications (rate each item separately).

- Transmission time
- Bandwidth
- Time of Day
- Day of week
- Distance
- Other, please specify

---

8) Who is (are) your major path provider(s)?

---

9) What is your total monthly transmission expenditure (payment to the above path provider(s))?

- Up to $50,000
- $50,001 - $100,000
- $100,001 - $200,000
- $200,001 - $500,000
- Over $500,000

---

10) What is your monthly communications technical services expenditure (over what is paid to the path provider—does not include technical services related to production)?

- Up to $25,000
- $25,001 - $50,000
- $50,001 - $100,000
- $100,001 - $200,000
- Over $200,000, please specify

---

11) In the next 12 months, do you plan to purchase any satellite technical services (check all that apply)?

- Design, Engineering
- Construction, Installation, and Implementation
- Frequency Coordination and License Preparation
- Maint. and Operating Services
- System Hardware/Software Integration
- Other, please specify

---

12) Which pathway(s) of transmission do you currently use (check all that apply)?

- Satellite
- RF Channel (Non-Satellite)
- Cable TV
- TV Broadcast
- Telephone Lines
- Fiber-Optic
- Other, please specify

---
13) Which (if any) satellites do you currently use for your transmissions?

__________________________________________________________

List the band (C, Ku, etc.).

__________________________________________________________

Is the dish size a problem at the central site?

____ Yes    ____ No

At the remote sites?

____ Yes    ____ No

If yes to either of the above, please explain?

__________________________________________________________

__________________________________________________________

Is the size of the available satellite footprint or the transmitted power a problem?

____ Yes    ____ No

If yes, please explain.

__________________________________________________________

14) What are you transmitting (check all that apply)?

____ Audio
____ Video
____ Data
____ Other, please specify

15) What provisions do you have for interactivity (check all that apply)?

____ Half duplex audio
____ Full duplex audio
____ One-way video
____ Two-way video
____ Low-rate video
____ Other, please specify

__________________________________________________________

Is this level of interactivity sufficient for your use?

____ Yes    ____ No

If no, please explain.

__________________________________________________________

__________________________________________________________

16) Is your current transmission analog, digital, or both?

__________________________________________________________

17) If transmission is analog: What is the bandwidth used (in KHz or MHz)?

__________________________________________________________

Is this bandwidth sufficient for your use?

____ Yes    ____ No

If known, what type of modulation is used (AM, FM, etc.)?

__________________________________________________________

18) If transmission is digital: What data rate do you use (in Kb/s or Mb/s)?

__________________________________________________________

44
Are these rates sufficient for your use?

_____ Yes  _____ No

If known, what type of modulation is used (PM, FSK, etc.)?


---

19) Do you use compression in any of the following (check all that apply)?

_____ Audio
_____ Video
_____ Data
_____ None

If you checked 'None' skip to question 20.

What type of compression is used (if known)?

_____ Lossless (exact data recovery)
_____ Lossy (approx. data recovery)

If known, what algorithm is used for compression (DPCM, Coding, Prediction, etc.).

---

When did you begin using compression?  

(Month/Year)

Why did you begin using compression (check all that apply)?

_____ Decrease cost
_____ Increase data flow
_____ Reduce storage requirements
_____ Other, please specify

---

If you use compression, do you have problems with any of the following (check all that apply)?

_____ Loss of data
_____ Fidelity
_____ Motion response
_____ Loss of synchronization
_____ Other, please specify

---

20) If you use analog transmission, do you plan to switch to digital soon?

_____ Yes  _____ No

Why (check all that apply)?

_____ Decrease cost
_____ Improve quality
_____ Increase flexibility
_____ Other, please specify

---

21) Would you be willing to lower costs by tolerating some audio/video degradation?

_____ Yes  _____ No

22) Is privacy or security important for your current or future needs?

_____ Yes  _____ No

23) Do you currently use:

_____ Scrambling
_____ Encryption

If scrambling or encryption is used, what type (if known)?

---

45
24) Who is (are) the major manufacturer(s) of your communications equipment?

__________________________________________

__________________________________________

Do you have compatibility problems between equipment from various manufacturers?

____ Yes  _____ No

If yes, please explain.

__________________________________________

__________________________________________

Do you own or lease the majority of your communications equipment?

____ Own  _____ Lease

25) Do you have any problems or complaints with your current communications system (check all that apply)?

____ Equipment Failure

____ Poor picture or audio quality

____ Costs

____ Equipment complexity

____ Channel availability

____ Error rates

____ Excessive echo

____ Susceptible to bad weather

____ Outdated equipment

____ Other, please specify

__________________________________________

__________________________________________

26) In your current system do you have the capability of mobility/transportability of your equipment between sites?

____ Yes  _____ No

within sites?

____ Yes  _____ No

Please explain any problems you may experience with mobility/transportability.

__________________________________________

__________________________________________

27) What features would you like to have which you cannot currently afford or are not available?

____ 2-way Video (point-to-multipoint capability)

____ 3 or more-way video

____ Mobility within site

____ Mobility between sites

____ Smaller aperture terminals

____ Higher data rates

____ High definition TV

____ Other, please specify

__________________________________________

__________________________________________

28) Do you consider your costs of maintenance and/or operator training excessive?

____ Yes  _____ No
29) What changes do you envision for your system in the near future? Why?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

30) Additional comments:

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

PLEASE RETURN QUESTIONNAIRE IN BUSINESS REPLY ENVELOPE PROVIDED OR SEND TO:

Institute for Simulation and Training (IST)
12424 Research Parkway
Suite 300
Orlando, Florida 32826
ATTN: Yvette Mihaly

If you would like to receive a short summary of the results of this survey, please check this box:

☐
## Communications Survey

**Person completing form:**


**Your position in the company:**


**Name of your institution/company:**


**Division:**


### Questions:

1) What is your current communications application (check all that apply)?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>Teleconferencing</td>
</tr>
<tr>
<td>4%</td>
<td>Distance Learning</td>
</tr>
<tr>
<td>0%</td>
<td>Information/Data Services</td>
</tr>
<tr>
<td>1%</td>
<td>Broadcasting</td>
</tr>
<tr>
<td>4%</td>
<td>Other, please specify</td>
</tr>
<tr>
<td>52%</td>
<td>Teleconf. &amp; Distance Ed.</td>
</tr>
<tr>
<td>8%</td>
<td>Teleconf., D.E., Info.</td>
</tr>
<tr>
<td>14%</td>
<td>Teleconf., D.E., and broadcasting</td>
</tr>
<tr>
<td>11%</td>
<td>All of the above</td>
</tr>
</tbody>
</table>

2) What type of services do you provide? (e.g., graduate engineering courses, military training, healthcare seminars, etc.).

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Service Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>College Credit</td>
</tr>
<tr>
<td>19%</td>
<td>Gov't &amp; Corp. Training</td>
</tr>
<tr>
<td>19%</td>
<td>Continuing education</td>
</tr>
<tr>
<td>14%</td>
<td>Courses for K-12 Ed.</td>
</tr>
<tr>
<td>7%</td>
<td>Healthcare courses</td>
</tr>
<tr>
<td>7%</td>
<td>Teleconferencing</td>
</tr>
<tr>
<td>4%</td>
<td>General Information</td>
</tr>
</tbody>
</table>

3) How many people do you currently serve per year in your distance learning and/or teleconferencing program(s)?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>18%</td>
<td>Under 500</td>
</tr>
<tr>
<td>12%</td>
<td>500-1000</td>
</tr>
<tr>
<td>11%</td>
<td>1001-2000</td>
</tr>
<tr>
<td>59%</td>
<td>Over 2000</td>
</tr>
</tbody>
</table>

4) Where is your central transmission site located?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>57%</td>
<td>Urban</td>
</tr>
<tr>
<td>24%</td>
<td>Suburban</td>
</tr>
<tr>
<td>19%</td>
<td>Rural</td>
</tr>
</tbody>
</table>

5) Where are the majority of your remote sites located?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>38%</td>
<td>Urban</td>
</tr>
<tr>
<td>27%</td>
<td>Suburban</td>
</tr>
<tr>
<td>35%</td>
<td>Rural</td>
</tr>
</tbody>
</table>
6) When did you begin using your current type of communications?
18% 1966-1980 41% 1981-1987
41% 1988-1992 (Month/Year)

7) On a scale of 1 to 5 (1 being highest and 5 lowest) rate the importance of each of the following as a major cost factor for communications (rate each item separately).
- Transmission time
- Bandwidth
- Time of Day
- Day of week
- Distance
- Other, please specify

8) Who is (are) your major path provider(s)?
39% GTE, 28% Cable Co.'s
20% AT&T, 13% Hughes

9) What is your total monthly transmission expenditure (payment to the above path provider(s)?)
82% Up to $50,000
16% $50,001 - $100,000
5% $100,001 - $200,000
2% $200,001 - $500,000
3% Over $500,000

10) What is your monthly communications technical services expenditure (over what is paid to the path provider—does not include technical services related to production)?
81% Up to $25,000
7% $25,001 - $50,000
3% $50,001 - $100,000
5% $100,001 - $200,000
4% Over $200,000, please specify

11) In the next 12 months, do you plan to purchase any satellite technical services (check all that apply)?
10% Design, Engineering
15% Construction, Installation, and Implementation
11% Frequency Coordination and License Preparation
16% Maint. and Operating Services
14% System Hardware/Software Integration
5% Other, please specify

12) Which pathway(s) of transmission do you currently use (check all that apply)?
83% Satellite
61% RF Channel (Non-Satellite)
63% Cable TV
38% TV Broadcast
64% Telephone Lines
46% Fiber-Optic
74% Other, please specify
- This consists of 2 or more of the above.
13) Which (if any) satellites do you currently use for your transmissions?

- 22% SBS6, 22% GSTAR1
- 19% Spacenet, 17% Galaxy 6
- 10% SBS4, 10% SBS5

List the band (C, Ku, etc.).

- 45% Ku and C
- 15% C and 40% Ku

Is the dish size a problem at the central site?

- 5% Yes
- 95% No

At the remote sites?

- 25% Yes
- 75% No

If yes to either of the above, please explain:


14) What are you transmitting (check all that apply)?

- 7% Audio
- 4% Video
- 0% Data
- 89% Other, please specify
- 55% Audio and Video
- 5% Audio and Data
- 29% Audio, Video and Data

15) What provisions do you have for interactivity (check all that apply)?

- 3% Half duplex audio
- 11% Full aud/2-way vid.
- 12% Full duplex audio
- 17% One-way video
- 25% Full aud/1-way vid.
- 5% Two-way video
- 0% Low-rate video
- 8% Other, please specify
- 4% 1-800 Number
- 4% 1&2-way video
- 4% 1/2 full aud, 1&2 way video

Is this level of interactivity sufficient for your use?

- 86% Yes
- 14% No

If no, please explain.

76% believe real-time interactivity is the problem.

16) Is your current transmission analog, digital, or both?

- 58% Analog
- 9% Digital
- 33% Both

17) If transmission is analog: What is the bandwidth used (in KHz or MHz)?

Is this bandwidth sufficient for your use?

- Yes
- No

If known, what type of modulation is used (AM, FM, etc.)?

18) If transmission is digital: What data rate do you use (in Kb/s or Mb/s)?
Are these rates sufficient for your use?

_____ Yes   _____ No

If known, what type of modulation is used (PM, FSK, etc.)?

19) Do you use compression in any of the following (check all that apply)?

  9% Audio, Video and Data
  10% Video    14% Audio & Video
  3% Data       61% None            4% Other

If you checked "None" skip to question 20.

What type of compression is used (if known)?

  42% Lossless (exact data recovery)
  58% Lossy (approx. data recovery)

If known, what algorithm is used for compression (DPCM, Coding, Prediction, etc.).

  32% DPC
  51% CLI
  11% Proprietary
  26% CL1
  31% Other

When did you begin using compression? (Month/Year)

Why did you begin using compression (check all that apply)?

  46% Decrease cost
  34% Increase data flow
  4% Reduce storage requirements
  16% Other, please specify

If you use compression, do you have problems with any of the following (check all that apply)?

  8% Loss of data
  22% Fidelity
  49% Motion response
  18% Loss of synchronization
  3% Other, please specify

20) If you use analog transmission, do you plan to switch to digital soon?

  46% Yes   48% No   6% Maybe

Why (check all that apply)?

  25% Decrease cost
  24% Improve quality
  42% Increase flexibility
  9% Other, please specify

21) Would you be willing to lower costs by tolerating some audio/video degradation?

  37% Yes    59% No    4% Other

22) Is privacy or security important for your current or future needs?

  45% Yes    55% No

23) Do you currently use:

  58% Scrambling
  20% Encryption
  75% Neither

If scrambling or encryption is used, what type (if known)?

  33% B-Mac
  17% Videocipher 2+
  22% OakOrion
  28% Other
24) Who is (are) the major manufacturer(s) of your communications equipment?

31% Scientific Atlanta
20% CLT/Hughes
49% Other

Do you have compatibility problems between equipment from various manufacturers?

19% Yes  81% No

If yes, please explain.

Do you own or lease the majority of your communications equipment?

90% Own  10% Lease

25) Do you have any problems or complaints with your current communications system (check all that apply)?

11% Equipment Failure
13% Poor picture or audio quality
18% Costs
7% Equipment complexity
11% Channel availability
0% Error rates
5% Excessive echo
17% Susceptible to bad weather
19% Outdated equipment
2% Other, please specify
21% None

26) In your current system do you have the capability of mobility/transportability of your equipment between sites?

33% Yes  67% No

within sites?

46% Yes  54% No

Please explain any problems you may experience with mobility/transportability.

41% said costs

27) What features would you like to have which you cannot currently afford or are not available?

27% 2-way Video (point-to-multipoint capability)
14% 3 or more-way video
6% Mobility within site
13% Mobility between sites
13% Smaller aperture terminals
8% Higher data rates
17% High definition TV
2% Other, please specify

28) Do you consider your costs of maintenance and/or operator training excessive?

10% Yes  90% No
29) What changes do you envision for your system in the near future? Why?

Want to expand network
Want to expand types of pathways
Increase distance
Add compression
Move to digital systems
Increase use of fiber optics

30) Additional comments:

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

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Institute for Simulation and Training (IST)
12424 Research Parkway
Suite 300
Orlando, Florida 32826
ATTN: Yvette Mihaly

If you would like to receive a short summary of the results of this survey, please check this box:

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Appendix C
List of Survey Respondents

AACJC, Washington, D.C.
Aetna Life and Casualty, Hartford, CT
Alderson-Broads College, Philippi, WV
American Chemical Society, Washington, D.C.
American Law Network, Philadelphia, PA
American Management, New York, NY
Ameritech, Hoffman Estates, IL
Arizona Department of Education, Phoenix, AZ
Arizona State University, Tempe, AZ
Arizona Western College, Yuma, AZ
Arkansas Department of Education, Little Rock, AR
Austin Community College, Austin, TX
Barnes Hospital, St. Louis, MO
Bay de Noc Community College, Escanaba, MI
Booth Memorial Medical Center, Flushing, NY
Carleton University, Ottawa, Ontario, Canada
Catonsville Community College, Catonsville, MD
Chesapeake Community College, Salem, OR
Chicago State University, Chicago, IL
Chippewa Valley Technical College, Eau Claire, WI
Chrysler Corporation, Highland Park, MI
CLATSOP Community College, Astoria, OR
Colorado State University, Fort Collins, CO
Colorado Video, Boulder, CO
Communication Development Corporation, Danbury, CT
Compression Labs, Inc., San Jose, CA
Conference Call Service, Chatham, NJ
Confertech International, Inc., Golden, CO
CTNA Healthnet, Washington, D.C.
CTNA Telecommunications, Inc., Washington, D.C.
De Anza College, Cupertino, CA
Distance Learning Systems, Hoboken, NJ
Eastern Iowa Community College District, Davenport, IA
Eastern Kentucky University, Richmond, KY
Educational Communications Board, Madison, WI
Fleetwood Electronics, Holland, MI
Florida Department of Education, Tallahassee, FL
Florida Department of Health and Rehabilitative Services, Tallahassee, FL
George Washington University, Washington, D.C.
GMI Engineering and Management Institute, Flint, MI
Governor's State University, University Park, IL
GPT Video, Norcross, GA
Greenville Technical College, Greenville, SC
Harbor Branch Oceanographic Institution, Ft. Pierce, FL
Hawaii Public Television, Honolulu, HI
Hawaii State Department of Education, Honolulu, HI
Henrico County Public Schools, Richmond, VA
Hezel Associates, Syracuse, NY
IIS Technologies, Mississauga, Ontario, Canada
Indiana Vocational Technical College, South Bend, IN
Industry Education Council, Cupertino, CA
Iowa State University, Ames, IA
Jackson Community College, Jackson, MI
JC Penney Company, Dallas, TX
Jefferson County Public Schools, Lakewood, CO
Kansas Regents Continuing Education Network, Manhattan, KS
Kentucky Educational Television, Lexington, KY
Kirkwood Community College, Cedar Rapids, IA
Lakeshore Technical College, Cleveland, OH
Little Crow Telemedia Network, Hutchinson, MN
Los Angeles County Office of Education, Downey, CA
Louisiana Public Broadcasting, Baton Rouge, LA
Manitoba Department of Education and Technology, Winnipeg, Manitoba, Canada
MEDSOURCE Corporation, Dewey, OK
MGMA, Englewood, CO
Michigan Community College Association, Lansing, MI
Miles Community College, Miles City, MT
Mind Extension University, Englewood, CO
Montgomery County Public Schools, Rockville, MD
Moraine Park Technical College, Ford Du Lac, WI
National Technological University, Fort Collins, CO
National University Teleconference Network (NUTN), Stillwater, OK
NDMA, Inc., Ridgefield, CT
Nebraska ETV, Lincoln, NE
North Carolina Department of Community Colleges, Raleigh, NC
North Carolina Department of Public Instruction, Raleigh, NC
North Carolina State University, Raleigh, NC
Northcentral Technical College, Wausau, WI
Northern Virginia Community College, Annandale, VA
Northwestern State University of Louisiana, Natchitoches, LA
Ohio Educational Broadcasting Network, Columbus, OH
Oklahoma City Community College, Oklahoma City, OK
Oklahoma State University, Stillwater, OK
Old Dominion University, Norfolk, VA
PACE Telecommunications Consultants, Indian River, MI
Pacific Mountain Network, Denver, CO
Paducah Community College, Paducah, KY
Palm Beach County School Board, Boynton Beach, FL
Pennsylvania State University, University Park, PA
Peralta Colleges Television, Oakland, CA
Phoebus Communications, Ft. Washington, MD
PROSTAR, Stafford, TX
Public Broadcasting Service - PBS Adult Learning Service, Alexandria, VA
Radford University, Radford, VA
Region IV Educational Service Center, Houston, TX
REMC, Saginaw, MI
Riverview I.U., Shippenville, PA
Roanoke Valley Graduate Center, Roanoke, VA
Robert Morris College, Pittsburgh, PA
Rogue Community College, Grants Pass, OR
Saddleback College, Mission Viejo, CA
San Diego State University (Extended Studies), San Diego, CA
San Diego State University (KPBS), San Diego, CA
Sante Fe Community College, Gainesville, FL
Sault College, Sault ST. Marie, Ontario, Canada
Sayville Public Schools, Sayville, NY
South Central Association of Blood Banks, Austin, TX
Southwest Wisconsin Technical College, Fennimore, WI
St. Cloud Technical College, St. Cloud, MN
St. Vincent Hospital, Green Bay, WI
Stanford University, Stanford, CA
SUNY Institute of Technology at Utica/Rome, Utica, NY
Tandem Computers, Cupertino, CA
Telecommunications and Computer Consultants (TCC), Charleston, IL
Telemanagement Resources International, Lake Wylie, SC
Temple University, Philadelphia, PA
UN Network, National Association of Community Broadcasters, Providence, RI
U.S. Air Force Institute of Technology, Wright Patterson Air Force Base, OH
U.S. Army, Director of Visual Information Services Europe (VISE), APO AE 09227
U.S. Army Logistics Management College, Fort Lee, VA
U.S. Army Training Support Center, Fort Eustis, VA
Uintah Basin Applied Technology Center, Roosevelt, UT
Ulster County Community College, Stone Ridge, NY
United Cerebral Palsy Associations, Washington, D.C.
University of Alaska System, Anchorage, AK
University of Arizona, Tuscon, AZ
University of Central Florida (Education), Orlando, FL
University of Central Florida (Office of Instructional Resources), Orlando, FL
University of Colorado, Boulder, CO
University of Maine, Augusta, ME
University of Maryland (Engineering), College Park, MD
University of Maryland-Baltimore, Baltimore, MD
University of Missouri Instructional Video Network, Kansas City, MO
University of Missouri-Columbia, Columbia, MO
University of New Mexico (engineering), Albuquerque, NM
University of South Carolina, Columbia, SC
University of Southern California, Los Angeles, CA
University of Tennessee, Knoxville, TN
University of Texas (TeleLearning Center), Austin, TX
University of Texas Health Science Center, San Antonio, TX
University of Vermont-KULC/EDNET, VT
University of Washington, Seattle, WA
University of Waterloo, Waterloo, Ontario, Canada
University of Windsor, Ontario, Canada
University of Wisconsin Hospitals and Clinics, Madison, WI
University of Wisconsin-River Falls, River Falls, WI
Utah State University, Logan, UT
Vermont Interactive Television, Randolph Center, VA
Valders Public Schools, Valders, WI
Washington State University, Pullman, WA
Western Illinois University, Macomb, IL
Yuma School District #1, Yuma, AZ