N83-31926

VOLUME II

FINAL REPORT

NASA REPORT NO. CR 168151

(NASA-CR-168151) CUSTOMER PREMISES SERVICES MARKET DEMAND ASSESSMENT 1980 - 2000: VOLUME 2 Final Report (International Telephone and Telegraph Corp.) 362 p HC A16/MF A01 CSCL 17B G3/32 N83-31926 Unclas 28543

CUSTOMER PREMISES SERVICES MARKET DEMAND ASSESSMENT 1980 - 2000

By: R. B. Gamble
ITT

L. Saporta
DATA INDUSTRIES

G. A. Heidenrich
INPUT

prepared for:

NASA

LEWIS RESEARCH CENTER

S. TELEPHONE AND TELEGRAPH CORPORATION ITT

VOLUME II

FINAL REPORT

CUSTOMER PREMISES SERVICES

MARKET DEMAND ASSESSMENT

1980-2000

PREPARED FOR: NASA LEWIS RESEARCH CENTER

BY: U.S. TELEPHONE AND TELEGRAPH CORP. - ITT

MAY, 1983

Authors:
R.B. Gamble, ITT
L. Saporta, Data Industries Corp.
G.A. Heidenrich, INPUT

1. Report No. CR-168151	2. Government Accession No. ----------------	3. Recipient's Catalog No. ----------------
4. Title and Subtitle CUSTOMER PREMISES SERVICES MARKET DEMAND ASSESSMENT 1980-2000		5. Report Date May, 1983
		6. Performing Organization Code ----------------
7. Author(s) R.B. Gamble, ITT; L. Saporta, Data Industries Corporation; G.A. Heidenrich, INPUT		8. Performing Organization Report No. ----------------
		10. Work Unit No. ----------------
9. Performing Organization Name and Address U.S. Telephone and Telegraph Corp. - ITT, 100 Plaza Drive, Secaucus, New Jersey 07096		11. Contract or Grant No. NAS3-22893
		13. Type of Report and Period Covered Vol. II - Final Report
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio		14. Sponsoring Agency Code ----------------

15. Supplementary Notes

NASA Project Manager, William A. Poley
Volume I (Report No. CR-168150) Provides an Executive Summary of this Material.

16. Abstract

This report provides estimates of market demand for domestic civilian telecommunications services for the years 1980 to 2000. It covers overall demand, demand for satellite services, demand for satellite delivered Customer Premises Service (CPS), and demand for 30/20 GHz Customer Premises Services.

Emphasis is placed on the CPS market and demand is segmented by market, by service, by user class and by geographic region. Prices for competing services are discussed and the distribution of traffic with respect to distance is estimated.

The report also provides a nationwide traffic distribution model for CPS in terms of demand for CPS traffic and earth stations for each of the major SMSAs in the United States.

17. Key Words (Suggested by Author(s)) Satellite Communications; Customer Premises Services; Communications Forecast; Traffic Demand; Market Analysis	18. Distribution Statement Unclassified

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	356	

* For sale by the National Technical Information Service, Springfield, Virginia 22161

VOLUME II

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

1.0 INTRODUCTION

This report discusses domestic non-military demand for Customer Premises Services provided via communications satellites. The work leading to this report was performed under NASA Contract NAS3-22893 during 1982 and early 1983. It is related to earlier market studies which deal primarily with demand for trunking services [Ref. 1-1, 1-2]. The report consists of the present volume (Volume 2) and a separately bound Executive Summary (Volume 1).

1.1 PURPOSE

The earlier studies referred to above forecast an expansion in telecommunications demand, over the next two decades, for both conventional and advanced communications services. The present study emphasizes that portion of the demand addressable by satellite systems capable of delivering services directly to the customer.

The results of the study are intended to provide support for systems design efforts, and to permit the timely development of the satellite technology required to satisfy emerging demand.

1.2 DEFINITION OF CUSTOMER PREMISES SERVICE

Customer Premises Service (CPS), as used in this report, refers to satellite telecommunications delivered to earth stations located on the premises of individual customers (dedicated earth station installations), or to earth stations shared by several nearby customers (shared earth station installations). In either case, it is intended that the satellite links terminate as directly as possible at the end user's location so that local distribution via common carrier is not required unless the customer desires further relay of some portion of the transmission.

For dedicated earth station installations the typical configuration involves the placement of an earth station on the roof, parking lot, or other utility areas of the customer's establishment. Depending on the communications services to be provided, the earth station will be linked to the adjacent building by means of twisted wire pairs, coaxial cables, or fiber optics links, traversing property owned or leased by the customer. In some cases, short range radio or optical links may also be appropriate.

Shared earth station installations are likely to occur in industrial parks, or large office buildings, where several nearby customers may reduce costs by combining their facilities. Where only a few establishments, occupying the same or nearby buildings, are involved, customer provided local links are practical. However, as the number of participants grows, and as the distance between buildings increases, the intervention of a common carrier becomes necessary to handle the right-of-way and technical problems of local distribution.

In cases where a common carrier is required for local distribution, CPS and trunking (in which the carrier combines the traffic of many users and provides common facilities for its transmission) begin to overlap. The viewpoint adopted in this report is that where participation by a common carrier is needed the application is best classified as trunking. Shared earth station CPS applications are, therefore, limited to those involving relatively few participants whose proximity permits customer control of the local distribution facilities.

It is not intended, however, that the limitations on shared earth station CPS configurations discussed above be too restrictively applied. The typical CPS user, whether oriented to dedicated or to shared earth stations, will usually require some links between the earth station and the local telephone exchange to accommodate the off-net requirements of incoming calls. Similarly, the ability to transmit calls from an originating CPS earth station to remote earth stations, maintained by common carriers, and offering common access to trunking facilities, will be desired by many CPS users. Such enhancements are within the province of CPS, and their use is contemplated in the forecasts and projections developed in this document.

1.3 DEFINITION OF ADDRESSABLE TRAFFIC

This report frequently refers to addressable traffic. Traffic is addressable by a transmission medium if there are no economic or technical reasons which prevent, or strongly discourage, the use of the medium for that type of traffic.

Other media may also compete for the addressable traffic so that the actual market share captured by a particular medium is, in general, less than the traffic it can address.

CPS facilities of the type considered here were not widely available in 1980. The estimates of CPS addressable demand made for 1980, therefore, refer to the traffic that hypothetically could have been addressed if suitable CPS systems had been in existence.

1.4 DIGITAL TRANSMISSION

To an increasing extent transmission facilities in the United States are being converted to digital operation. Examples of this may be found in the terrestrial plant which widely uses the digital T-1 carrier system for interexchange links, in satellite links such as those employed by Satellite Business Systems (SBS), and in the many direct digital networks such as the Bell System's DDS and various packet services.

It is assumed in this report that the satellite designs that will be developed for CPS over the next two decades will follow this trend and will be based on digital transmission technology. The market demand forecasts presented later, after some necessary conversions, therefore use units appropriate to digital transmission. Annual traffic demand is presented in terms of bits per year, and the busy hour traffic rate is presented in terms of bits per second during the busy hour. Voice, video and data traffic components are each converted to these digital measures which allows them to be conveniently compared and aggregated.

1.5 SCOPE

The report covers the period 1980-2000, with benchmark years at 1980, 1985, 1990, and 2000. Market demand, in terms of both annual traffic and busy hour traffic, is estimated for the following markets:

1. The overall telecommunications market
2. The satellite addressable market
3. The CPS addressable market
   a. Dedicated earth stations
   b. Shared and dedicated earth stations
4. The Ka band CPS addressable market
   a. Dedicated earth stations
   b. Shared and dedicated earth stations

The overall telecommunications market deals with that traffic, addressable by terrestrial or satellite transmission media, that travels beyond local boundaries. Each of the remaining markets in the list above represents a subset of the preceeding market.

Chapters 2, 3 and 5 offer background discussions of the technology, user characteristics, and economic factors that entered into the market estimates developed in later chapters. Most of this material rests on secondary research in reports, trade journals, news releases, tariffs and other documents. Chapter 4 supplements these documentary sources with a survey of users designed to uncover additional information on which to base the market estimates. The survey comprised on-site and telephone interviews with 370 organizations representing a cross-section of users of communications services.

Chapter 6 presents the basic demand estimates which cover the following service categories:

1. Voice- Switched
   Dedicated
2. Video- Broadcast
   Videoconferencing
3. Data - Message
   Computer

Within each of these service categories more specific sub-categories are defined, and are discussed in the text.

Chapter 7 presents distance distributions for the major service categories. The amount of traffic that travels substantial distances has an obvious bearing on the magnitude of the demand likely to develop for satellite derived communications in competition with terrestrial alternatives. The distance distributions presented here were used in developing the basic market demand estimates of Chapter 6.

Chapter 8 segments demand according to market, year, service, geographic region, user class, and various combinations of these parameters. Extensive tabulations of these results are included. Chapter 9 develops a nationwide traffic distribution model by further segmenting demand according to Standard Metropolitan Statistical Areas (SMSAs). Busy hour traffic demand is forecast for each of the top forty SMSAs, and for the remaining SMSAs in groups of twenty. A matrix showing traffic patterns among the top forty SMSAs is also provided.

The final chapter, Chapter 10, summarizes the principal findings and conclusions of the study.

2.0 POTENTIAL CPS TELECOMMUNICATIONS SERVICES

This section discusses those telecommunications services which can be effectively supplied directly to the customer via dedicated or shared CPS earth stations. The services are discussed under the headings of Voice, Video and Data.

2.1 VOICE SERVICES

Voice communication currently accounts for the largest fraction of telecommunications demand and, therefore, is of particular significance in developing traffic forecasts. Service offerings are of two basic types, those which use transmission facilities dedicated to a particular user (e.g., leased line service) and those which share transmission facilities among many users (e.g., switched network service). These are discussed in the following subsections.

2.1.1 DEDICATED VOICE SERVICES

Dedicated service is provided through the use of communications lines or networks reserved on a full or part time basis for the sole use of the purchaser. Most often the lines are leased on a monthly basis from a common carrier, but in some cases they are privately owned by the user.

Dedicated service is primarily used by business, government or institutional organizations rather than by residential users and, in the case of voice transmissions, is usually chosen as a means of reducing communications costs. Most often the dedicated lines link two or more geographically separated establishments within the same organization. Where traffic volume is high enough to keep the line, or lines, busy for several hours or more per day the cost of dedicated facilities is generally favorable in comparison with switched service.

Private, or leased lines, are commonly used to establish corporate voice networks. By linking the PBXs of the various establishments within the corporation via private or leased lines, users at one location are afforded the ability to dial the extension of a phone in another location without incurring the per call charges imposed by the public switched network. Many PBXs have the ability to select a private or leased line path between the two locations whenever one is available, but if all the dedicated trunks are busy, or if they are out of service, the PBX can establish the call through the switched telephone network. The switched network can, therefore, be used to provide fall-back protection to the dedicated network and can, to some degree, lessen the reliability requirements of private lines.

Current FCC regulations now also permit off-net service under which private users, and other carriers, can interconnect their dedicated networks with the switches and transmission plant of the public telephone network. A long distance call can, therefore, be routed at low cost within the dedicated network to a user's location in the vicinity of the desired destination. It can then be further distributed via the local telco central office to the called party.

2.1.2 SWITCHED VOICE SERVICES

In contrast with the dedicated transmission facilities supplied under private or leased line service, the transmission facilities used in switched telephone service are shared among many users. The most common form of switched service is provided by the public telephone network under the designation "Message Telephone Service" (MTS).

The distribution needs of switched telephone service are much wider than those of dedicated services. The Bell System in 1981 reported 142 million telephones and 84 million lines in service [Ref. 2-1]. In principle, telephone instruments on any of these lines can reach those on any other line.

MTS is provided to both business and residential customers. Since reliability needs, hours of peak usage, holding times, suitability for CPS and other characteristics differ for business and residential switched services, these services are separately considered in this report.

An important type of business switched service is the "Wide Area Telephone Service" (WATS). WATS uses the same transmission and switching facilities as MTS but offers billing rates favorable to businesses that have many calls to or from a central location. Outward WATS allows calls to be made from the central location to outlying locations, and 800 Service (formerly Inward WATS) allows the calls to be made from the outlying locations to the central location. Many WATS applications need the wide distribution typical of MTS, but in some applications the central location needs connectivity to only a relatively few remote locations (e.g., a network linking headquarters with a limited number of remote branch offices).

2.1.3 VOICE SERVICE DESIGN PARAMETERS

Since voice service is used in an immense number of businesses and residential applications, system design is based on satisfying an "average" set of needs at reasonable cost. A discussion of important design parameters for voice service, with emphasis on their implications for CPS is contained in the following subsections.

2.1.3.1 SPECTRUM REQUIREMENTS

The basic voiceband communications channel requires a relatively flat bandwidth extending from 300 cycles per second to 3300 cycles per second, with spacing between channels nominally equal to 4 kilohertz. Within these spectrum constraints it is possible, over short distances, to provide two-way voice conversations. Such simultaneous two-way (full duplex) transmission (typically using a single pair of wires) is the conventional means of linking most dial network telephone sets to their local central offices. However, this simultaneous two-way transmission capability is limited to local transmissions.

In the long haul communications plant unidirectional amplifiers, and other one-way transmission equipments, are inserted in the transmission path. The result is that each two-way voice transmission must be split into two separate one-way transmissions, one for each direction of travel. This is electrically equivalent to using four wires, one pair being used for transmission in one direction, and the second pair reserved for the reverse direction. Each of these one-way transmissions requires the full 4 kilohertz bandwidth that is used in the local plant for a single two-way conversation.

Satellite links, like other long haul media, are also basically unidirectional and consequently require that each two-way path be separated into two one-way paths. It is therefore important, when discussing the number of voice channels that can be provided by a given satellite configuration, to specify whether two-way or one-way channels are being referred to.

2.1.3.2 BANDWIDTH COMPRESSION

Since spectrum resources are generally scarce and the bandwidth available for voice channels is consequently limited, various bandwidth reducing equipments have been developed. Among the most important of these are speech interpolation devices which sense the gaps that occur in normal conversations and insert parts of other conversations in these gaps. Usually only one party to a conversation speaks at a time, and various pauses between words and syllables exist, so that the channel is idle for a large part of the time. Statistical sharing of this idle time among a number of users results, for a given overall bandwidth, in a net gain in capacity of about two-to-one [Ref. 2-2]. Other speech coding and compression methods also can be used to further increase the efficiency of bandwidth utilization.

A significant issue for future CPS system designs is the trade-off between the cost of speech compression equipment, and the costs of using the wider bandwidth, uncompressed, voice transmission.

2.1.3.3 DIGITIZED VOICE

While voice signals are fundamentally analog, the use of digital transmission and switching facilities is increasing. The voice signals must be digitized prior to entering the digital facilities and must be reconverted to analog form for presentation to the user. In the Bell System network, analog wire facilities total about 256 million circuit miles against 106 million circuit miles of digital wire facilities. Digital transmission in the microwave portions of the Bell System is also growing, but the relative mix is more heavily analog. About 622 million circuit miles of microwave analog systems exist against approximately 10 million circuit miles of microwave digital systems [Ref. 2-3]. Overall, about 12 percent of the transmission facilities are digital and during the next two decades both analog and digital transmissions will be commonly encountered in the terrestrial network.

Digitized voice channels require wide bandwidths for their transmission. However, the power levels needed to accurately transmit digital signals are reduced. This allows technical trade-offs to be made which provide a digital capacity comparable to, or better than, that of analog systems using the same spectrum and power resources. The Bell System uses 64 kilobits per second for a one-way digitized voice channel, but some carriers have been using 32 kilobits per second.

In some cases, specialized, and relatively sophisticated, equipment has been used to further compress voice signals into much slower digital streams, typically in the range of 2.4 to 9.6 kilobits per second. However, due to high costs, and a lowering of transmission quality, such high compression factors are likely to have limited applicability.

One of the advantages of digital voice is that it combines readily with data signals. Digital voice and data streams can be multiplexed to form wideband digital signals suitable for transmission over terrestrial and satellite links. The most common of these multiplex arrangements is the T1 carrier system, widely used in the Bell System for inter-exchange transmission. The T1 carrier system converts up to twenty-four one-way analog voice circuits (at 64 Kbps each) to a composite 1.544 Mbps time division multiplexed stream (DS1 multiplexer). A small fraction of the composite stream is used for framing.

Higher speed multiplexed digital rates are also used where capacity needs justify them. The DS2 multiplexer allows four DS1 signals (96 one-way voice channels) to be combined to produce a rate of 6.3 Mbps while the DS4 multiplexer allows 168 DS1 signals (4032 one-way voice channels) to be transmitted simultaneously at a rate of 274 Mbits/s.

CPS systems which originate at a user's location, and terminate at another location of that user, can, in principle, employ arbitrary digital rates. But where extension of the signal through portions of the terrestrial network are contemplated, or where commonality of equipment is a desirable feature, adherence to the digital rates in use in the terrestrial networks is recommended.

2.1.3.4 ECHO CANCELLATION

Many studies have shown that echoes returning after a delay of more than a few tens of milliseconds make it difficult to carry on a telephone conversation [Ref. 2-4]. Echo suppressors have been used for many years to alleviate this problem for long haul terrestrial paths, but have not been entirely satisfactory for use on paths with delays as long as those encountered on synchronous satellite links [Ref. 2-5]. Most long haul voice communications has, therefore, been confined to terrestrial links and, where satellite paths have been included, only a single direction of travel has been routed via the satellite with the return path routed terrestrially.

In recent years more sophisticated devices, referred to as echo cancellers, have proved more effective than the older echo suppressors but, until recently, have been too expensive for common use. The latest designs, however, have used large scale integration to reduce costs and it is therefore expected that the use of echo cancellers will become widespread and will make practical the use of satellite circuits for both directions of a voice conversation. As discussed in the next subsection, CPS may also avoid the echo problem by providing four-wire service to the users.

2.1.3.5 TWO-WIRE AND FOUR-WIRE SERVICE

As mentioned earlier, each voice channel in the long haul plant is split into two separate one-way channels. This provides the electrical equivalent of two separate pairs of wire for each channel and is often referred to as four-wire transmission. In the local switched telephone network, however, only a single pair of wires (two-wire service) is generally extended to the end user. A device referred to as a "hybrid transformer" is used to effect the transition from two-wire to four-wire operation and vice-versa.

The primary reason for the prevalence of two-wire operation in the local telephone plant is economy. It is clearly less costly to extend two, rather than four, wires from the local central offices to the many telephone subscribers connected to them. There are, however, some disadvantages to two-wire operation.

Two-wire operation complicates the use of digitized voice, requiring that special line timing protocols be used to keep the two directions of transmission from interfering with each other. In addition, the chief source of the disturbing echoes discussed previously occurs at the hybrid transformer needed for the transition between two-wire and four-wire transmission. If four-wire service is extended all the way to the end users, the echoes largely disappear and the need for echo cancellers (or suppressors) in the long haul plant is eliminated. Lastly, two-wire operation limits the speed of data transmissions and this can be a significant disadvantage when voicegrade lines are used for data or alternate voice/data transmission.

On the basis of technical performance, therefore, end-to-end four-wire service for voice channels is preferred and some OCCs now provide switched, as well as leased line, four-wire voice service to the user.* Cost, however, remains a factor and two-wire service to the end user remains much more common than four-wire service.

The cost advantage of two-wire distribution in the local plant, relative to four-wire distribution, largely disappears when CPS services are considered. To the extent that the CPS configuration brings the four-wire long haul transmission directly to the user, the costs of additional local distribution are minimized. It therefore becomes economically practical to provide end-to-end four-wire service via CPS, and provision for offering this service should be included in CPS network design.

For those CPS applications that require an interface with existing two-wire local plants, the ability to convert between two and four-wire operations should also be included. The local PBX is a suitable place for this conversion to take place, but other locations on the customers' premises are also possible. For those applications which do not require interface with two-wire service, the ability of CPS to extend economical four-wire service to the user is a valuable feature.

2.1.3.6 NOISE SPECIFICATIONS FOR VOICE CHANNELS

End-to-end noise performance objectives similar to those developed for terrestrial networks are equally appropriate for satellite transmission. Generally, an end-to-end signal-to-noise ratio of about 30 db has been accepted as a

---

*Four-wire voice service is available from the Bell Systems for users of leased lines, but not for users of the switched telephone network.

suitable design objective. A noise budget is used to apportion the end-to-end noise goal among the various links that make up a complete path. Since satellite paths have fewer links than terrestrial circuits of the same length, a more generous apportionment to the satellite link is usually appropriate. For CPS transmissions, where almost the entire path length is due to the satellite link, essentially the full noise budget can be allocated to this link.

When digitized voice is considered, error rate, rather than signal-to-noise ratio, becomes the more meaningful measure of noise performance. Voice transmission is relatively tolerant of error rates which would be unacceptable for data transmission. Intelligible voice signals can be transmitted with bit error rates in excess of 1 error for every 100 bits transmitted, and good voice quality is achieved with bit error rates in the range of 1 error per every 1000 to 10,000 bits.

When bandwidth compression techniques are used to conserve spectrum, however, the transmissions become more sensitive to error performance. For satellite circuits, where spectrum conservation is likely to be an important consideration, a design goal of 1 error per 10,000 bits is suggested as suitable for voice channel bit error probability.

2.1.3.7 RELIABILITY

Availability requirements for voice telephony users obviously vary widely among applications and users. Most users of voice services find the availability level of the common user telephone network (99.9 percent or slightly lower) acceptable. Few would elect to pay more for more reliable voice service. In some cases, particularly among residential users, a lower availability would be acceptable if cost savings could be offered.

As discussed later in this report (Subsection 6.4.2), about 45 percent of U.S. employment is represented by organizations which would accept availability levels of 99.5 percent if costs were suitably reduced.

2.1.3.8 CONNECTIVITY

Telephone lines are used in dedicated applications where a limited number of predetermined locations are linked, and in switched applications where calls are placed to a wide variety of locations which are likely to change from day to day. Connectivity requirements clearly differ in large measure in the two cases, and the implications for CPS are therefore separately discussed in the following two subsections.

2.1.3.8.1 CONNECTIVITY FOR SWITCHED NETWORK TELEPHONY

Switched network telephone users, including many with WATS applications, generally require full connectivity in the sense that any telephone in the common user network may be dialed from a particular location. However, since only a limited number of phones will be located on premises served by CPS, full connectivity of this type may be difficult to achieve with CPS systems.

The ability of CPS users to address telephones not served by corresponding CPS establishments may be enhanced by providing links between the CPS earth stations and local telephone company central offices. Figure 2.1-1 shows one possible arrangement which accomplishes this by allowing the CPS earth station to access the local central offices through each establishment's PBX.

With this arrangement CPS equipped establishments in two or more distant cities can reach telephones within the remote establishments, and can also use the remote PBXs to relay outside calls.

The above arrangement allows the CPS users to reach outside telephone instruments in the vicinity of cities where corresponding CPS establishments exist but does not provide this capability in regions where there are no corresponding CPS establishments. If sufficient demand develops, however, it is expected that common carriers will establish "common user" CPS facilities linked to strategically located central offices for use by those CPS users whose organizations are without CPS capabilities in the particular local area. Figure 2.1-2 illustrates this arrangement. This type of hybrid link, which combines CPS at one end with trunking at the other, will enhance the connectivity of CPS systems and allow them to address a wider range of applications.

ORIGINAL PAGE IS
OF POOR QUALITY

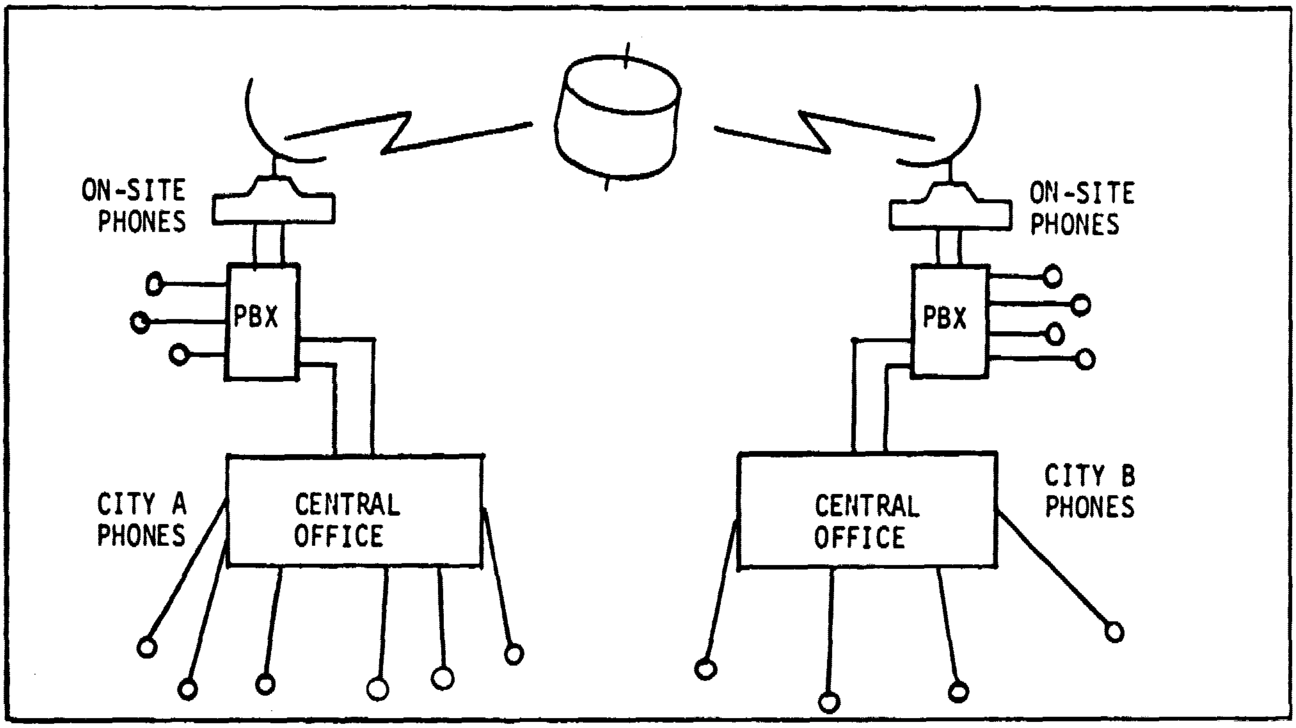


FIGURE 2.1-1 CONNECTION TO OUTSIDE PHONES VIA PBX LINKS TO LOCAL CENTRAL OFFICES

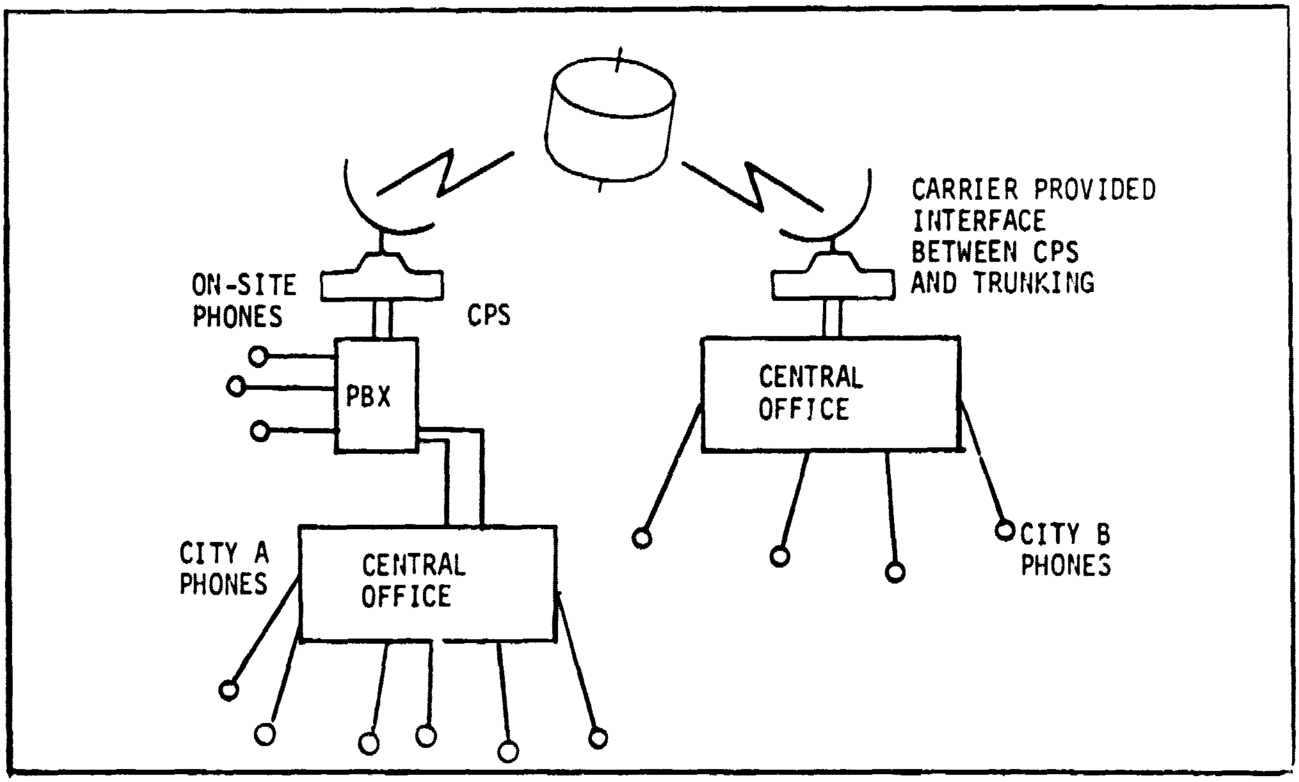


FIGURE 2.1-2 CONNECTION TO NON-CPS LOCATIONS USING COMMON CARRIER PROVIDED INTERFACE BETWEEN CPS AND TRUNKING

The provision of full network connectivity to CPS users also imposes some challenging problems of antenna pointing and satellite placement. Ideally all CPS antennas using such service would point toward a single satellite visible to all communicating earth stations. However, capacity limitations, orbital arc allocations, a competitive multiple common carrier environment, or other factors, may preclude this approach. In this event, special procedures will be needed to permit CPS users whose antennas point at one satellite to reach CPS users with antennas pointing to another. Some briefly noted possibilities are:

(a) Each user is equipped with multiple antennas or with multibeam or scanning antennas capable of pointing at more than one satellite. Depending on the number of satellites to be accessed, and progress made in the development of economical multibeam antennas, this may be an expensive proposition.

(b) Multiple hop satellite transmissions are used. For voice applications this suffers from undesirably long time delays.

(c) Intersatellite links are provided. The technology here is still to be developed, and the time delay, while less than in case (b), is longer than might be desired if the satellites are widely separated along the orbital arc.

(d) Intra-city terrestrial networks are established to link nearby earth stations to each other so that signals arriving from a particular satellite can be terrestrially routed to other earth stations which do not point to that satellite. This would appear to require common carrier cooperation and probably departs from the definiion of CPS acceptable to most people.

None of the above approaches is simple or can be clearly seen to be both technically and economically feasible. The ability to provide full connectivity while preserving a configuration that is completely recognizable as CPS may prove to be elusive and switched voice telephony, comparable to that provided by the terrestrial common user network may, as a result, be impractical in the conventional CPS environment. Early attempts at the establishment of switched voice networks via CPS should, therefore, concentrate on applications requiring more limited connectivity. An important example of this is provided by intracompany switched networks with relatively few, and well defined, destination nodes and with restricted needs for outside long distance dialing. Other switched network applications with limited connectivity requirements also exist in some WATS networks, (for example, dial-in networks linking a limited number of sales offices to a central sales headquarters).

2.1.3.8.2 CONNECTIVITY FOR DEDICATED NETWORKS

Connectivity requirements for dedicated voice applications are generally modest. In the simplest case, one or more lines will be established point-to-point between two locations. Somewhat more complex connectivity arrangements also are common in dedicated voice networks which link a number of widespread establishments within a corporation.

In network configurations such as the above, users at any site may require links to any other site. However, the destinations in the communicating group are predetermined, and the number of sites is generally relatively small, so that each CPS equipped member of the group can be assigned to the same mutually visible satellite. Furthermore, as long as the communications are kept within the limited CPS equipped group, or at most extended to local Central Offices as illustrated in Figure 2.1-1, the problems of distributing to distant non-CPS equipped locations do not arise.

Thus, dedicated voice applications which do not have to reach non-CPS equipped locations are well adapted to CPS operation and will be easier to address than switched network telephony.

2.1.4 SUMMARY OF TELEPHONY PERFORMANCE OBJECTIVES

Table 2.1-1 summarizes the previous discussion, and presents performance objectives for CPS telephony service.

TABLE 2.1-1. CPS TELEPHONY PERFORMANCE OBJECTIVES

SPECTRUM	- Analog nominal 4 Khz two-way channels; Digital 64 Kbps in each direction, compatible with T1 carrier.
BW COMPRESSION	- Usable where spectrum congestion is significant.
ECHO PERFORMANCE	- Echo cancellers required for two-wire service to users.
SIGNAL-TO-NOISE RATIO	- End-to-End 30 dB.
ERROR RATE	- One error in 10^4 bits.
SERVICE TYPE	- Four-wire to end user preferred. If provided, echo cancellers can be eliminated. Ability to convert to two-wire at interface with terrestrial network.
AVAILABILITY	- 99.9% at cost comparable to terrestrial networks, 99.5% as reduced cost offering.
CONNECTIVITY	- Full for general switched network telephony (may be difficult to achieve). Low to moderate for dedicated applications.

2.2 VIDEO SERVICES

Video services, particularly those associated with teleconferencing, are expected by many forecasters to exhibit rapid growth in the near future. Most of these video applications require wide transmission bandwidths. Expanding usage will therefore require long haul transmission media able to efficiently provide the needed spectrum. Furthermore, special local distribution facilities are required since these signals generally cannot be carried on ordinary local loops. Video services are, therefore, technically well suited for CPS systems which can deliver wide bandwidths and minimize local distribution problems.

2.2.1 TELECONFERENCING

The desire to reduce both travel costs and the time consumed in executive travel are the reasons most frequently advanced for teleconferencing. Teleconferencing also allows meetings to be scheduled when needed, rather than when travel bookings and travel schedules permit. The ability to remain near their home bases during the conference also allows participants to access any local files and resources that may be needed during the conference.

While there have been some negative reactions to the replacement of face-to-face meetings by remote conferencing, supporters of the service maintain that once people acclimate themselves to teleconferencing they tend to like it. Costs at present are also a deterent to teleconferencing, but decreasing communications costs and rising travel costs over the next few years may shift the balance toward teleconferencing.

Public interest in teleconferencing appears to be on the upswing. Some recent offerings, as discussed below, are likely to accelerate this trend and lead to further development of the market.

Picturephone Meeting Service (PMS) has been under evaluation by the Bell System for some years. Service was initiated between New York and Washington, D.C. in July of 1982. The service was expanded to 11 cities by the end of the year, with further expansion providing two-way videoconferencing to a total of 42 cities planned for the end of 1983 [Ref. 2-6].

In order to keep bandwidths and transmission costs in an acceptable range, Picturephone Meeting Service uses a picture processor to provide a high degree of bandwidth compression. This permits image and motion reproduction quality satisfactory for most teleconferencing uses at greatly reduced digital rates. The picture processor converts the analog video and audio signals to digital, encrypts them and combines them with control signals into two 1.544 Mbps T1 Carrier compatible digital streams using Bell's new High Speed Switched Digital Service. The signals are then transmitted, via local and exchange facilities, to a metropolitan switching center. At the switch the signals are routed to long haul channels for transmission to a distant switching center. The long-haul channels may use either terrestrial or satellite transmission facilities.

Even with bandwidth compression, PMS will not be cheap (see Chap. 5). Private conference rooms, suitable for 2 to 10 persons, may be built by the user at his own expense using an AT&T supplied design. Businesses using their own conference rooms typically face initial costs of $100,000 to $120,000 plus monthly rental charges of $15,000 to $20,000 for equipment. In addition, there is a charge for the call. A one hour New York to Chicago PMS call costs about $920 and a one hour conference call between New York City and Los Angeles costs $1640. Users who wish to use Bell supplied public conference rooms will pay $1660 per hour (New York to Chicago) and $2380 per hour (New York to Los Angeles).

PMS exemplifies one form of teleconferencing suitable for CPS. Companies that establish private conference facilities like those of PMS may use dedicated or shared CPS earth stations to derive the needed telecommunications links. In addition, providers of videoconferencing services who offer public conference room facilities may also find CPS a favorable alternative.

Another teleconferencing facility that has stimulated widespread public interest is currently being demonstrated by Satellite Business Systems (SBS). The service includes recently developed TV cameras with zoom capability for focusing on faces, charts or documents under comfortable lighting levels, and a special high-resolution graphic system using a table top scanner for documents. Among the options under consideration are full-motion video at 1.544 Mbps, and freeze frame. The latter uses 56 Kbps to achieve a four second refresh rate and allows projection onto a four square foot screen.

Targeting a somewhat different videoconferencing market, Holiday Inn has established a one-way videoconferencing network using the RCA Americom Satcom I satellite. The Holiday Inn approach emphasizes larger scale conferences and seminars using one-way video broadcasts supplemented by two-way voice circuits. Its network links more than 270 locations in 40 states. Costs are moderate, a $21,000 fee covers a group of 350 attendees in as many Holiday Inn locations as are required [Ref. 2-7]. At a cost of $60 per person, the economic comparison with air travel and hotel lodging is highly favorable.

Among other providers of videoconferencing transmission facilities is the American Satellite Corporation serving several customers with 56 Kbps freeze frame color video using a 10 second frame refresh rate. Videoconferencing services are also provided by companies who rent facilities from their owners and package them to suit the end user. An example is Videonet, a California company that subleases the Holiday Inn network to organize teleconferences and seminars for various companies. For 1982 Videonet is reported to have booked, via satellite facilities, 28 meetings involving attendance by 90,000 people. A typical meeting for 1200 people at 30 locations costs between $85,000 and $150,000 [Ref. 2-7].

Several studies have indicated that many teleconferences are adequately served by audio facilities and costs are much lower than for video conferencing. Audio conferencing is estimated to be a suitable replacement for 30 to 40 percent of face-to-face business meetings. Two-way video adds only another 5 to 10 percent.

Audio conferences can be considerably enhanced by the availability of facsimile units to allow the transmission of documents, by devices such as the electronic blackboard, or other graphic transmission aids. While audio/graphic conferences offer users low cost and reasonably effective capabilities, there is little in the technology that gives CPS systems a large advantage over terrestrial or trunking satellite system approaches. CPS systems are, therefore, likely to find a more receptive market in video rather than audio teleconferencing.

2.2.2 VIDEOTEX/TELETEXT

Videotex is a generic name recently adopted for a class of interactive information services accessed via a TV display and linked by cable to a computer. A related information service, Teletext, refers to the one-way transmission of information over broadcast frequencies and does not provide interactive capabilities. The types of information that can be handled by these systems include timetables, stock market prices, theater information, hotel information, classified advertisements, mail order catalogs, news items, telephone yellow pages and directories, and perhaps access to entire libraries.

In most cases, the transmission rates involved are low enough to be handled by ordinary telephone lines. However, to keep terminal costs low, some embodiments may use standard TV transmissions via existing cable or microwave links. Videotex and Teletext can therefore be clasified as either data or video services depending on the specific, and rapidly evolving, technology that is adopted.

Overseas, where developments have outpaced those in the United States, Videotex/Teletext services have evolved under a variety of names. The following are the names used in different countries:

Canada - Telidon, Vista
England - Prestel, Viewdata
Finland - Telset
France - Teltel, Antiope
Germany - Bildschirmtext
Japan - CAPTAINS
Sweden - Datavision

In the United States, the opportunities for interactive videotex service are being explored by AT&T and several large publishers. The Knights Ridder Company has participated with AT&T in a Coral Gables, Fla. experiment to test customer reaction. Capitol Cities Communications recently announced that Videotex service will be inaugurated for its Fort Worth and Kansas City daily papers. In addition, the French Antiope and Canadian Telidon systems have started U.S. marketing ventures. The U.S. Department of Commerce expects rapid growth for Videotex using in-place TV screens and projects revenues at the $15 billion level for the year 2000 [Ref. 2-8].

A European Videotex standard has been adopted by 26 European countries. AT&T, however, with support from an array of large U.S. corporations, has been advancing a standard for the American market which is incompatible with the European standard. A recent meeting involving the FCC, the State Department and U.S. and Foreign industry representatives was unable to reach a compromise position and it appears that a worldwide Videotex standard will be difficult to achieve.

While Videotex and Teletext signals can be transmitted by CPS it cannot be said that CPS offers special advantages in comparison with other transmission approaches. Most long haul applications are expected to be satisfied by voiceband transmissions. In addition, the large scale uses of Videotex/Teletext involve wide patterns of distribution to homes and offices and most such locations will not be suitable for CPS installations. Thus, the role of CPS in these applications is likely to focus on the distributors of the information services. A large information network with branches in several cities may find CPS an excellent method of updating files, sharing resources, and centralizing control and billing. Distribution to the final user would then, after suitable interface translation, be extended to the individual offices and homes subscribing to the service.

2.2.3 OTHER VIDEO APPLICATIONS

Important video applications exist in education, medicine, and government. The most significant of these for CPS will be further discussed in those sections of this report describing user classes. From the viewpoint of technical requirements, however, there is little to distinguish these applications from the general needs of teleconferencing. Both full-motion and freeze frame capabilities, together with support from various audio/graphic devices, will be required and applications involving two-way video and one-way video with audio return exist.

2.2.4 VIDEO SERVICE PERFORMANCE OBJECTIVES

Some aspects of the video services discussed in the previous pages are technically equivalent to the voice or data applications discussed in other sections. For example, where two-way voice transmission is required as part of a teleconferencing arrangement the requirements for echo cancellation, reliability, etc., previously discussed under voice services, apply equally to the audio component of the teleconference. Similarly, where voiceband data signals are associated with Videotex or Teletext systems, considerations of data rate, error performance, and other parameters parallel those discussed in the sections dealing with Data Service. Table 2.2-1, which presents performance objectives for CPS Video Services, therefore emphasizes the video portion of the transmission.

TABLE 2.2-1 PERFORMANCE OBJECTIVES FOR CPS VIDEO SERVICES

SPECTRUM	- Voiceband to 6.3 MBPS each direction to permit: Freeze frame using voiceband circuits Full motion compressed at 1.544 MBPS (T1) Full motion compressed with improved quality at 2x1.544 (2 T1 channels) and at 6.3 MBPS (D2 channel bank).
BW COMPRESSION	- Expected to be a cost effective and saleable feature giving better image quality for a given bandwidth.
ECHO AND DELAY	- Unimportant for one-way video. Two-way video implemented via 4-wire service to end user also avoids echo problem. Delay effects over round-trip satellite path acceptable.
ERROR RATE	- Depends on compression algorithm. Nominally 10^{-4} to 10^{-5}.
AVAILABILITY	- Low cost option at 99.5% or less. High cost option equivalent to telephony at 99.9%.
CONNECTIVITY	- Low for full TV bandwidth applications. Moderate for applications at T1 rate or below. High for information services such as Videotex or Teletext.

2.3 DATA SERVICES

Data communications, like voice communications, has major operational divisions depending on whether the transmission facilities are dedicated to a particular user or are shared among many users. Many of the requirements of data service parallel those of voice service, but as discussed below there are also some significant differences.

2.3.1 DEDICATED DATA SERVICES

Dedicated service for data is mainly provided through leased lines similar to those used for dedicated voice service. It is not uncommon for the same lines to be used alternately for both types of service, but because of technical enhancements that may be desired, and because of tariff regulations, lines are usually separately designated as intended for voice, data, or alternate voice/data applications.

As in the case of dedicated voice facilities, economy is an important consideration in the choice between dedicated and switched data service. If two establishments are in communication for more than a few hours per day it generally costs less to use dedicated lines. Furthermore, for data communications, technical performance factors may, in some cases, make dedicated service preferable to switched service.

2.3.2 SWITCHED DATA SERVICES

There are many data communications applications in which the transmission facilities are used infrequently, or for short durations. In these cases, switched service, despite some performance limitations for data, is preferable from a cost standpoint.

The public switched network is the most commonly used switched service for data communications. This network is a "circuit switched" network, which implies that the circuit is held open, and charges accrue, from the time the connection is made until it is broken down. Many data communications sessions, however, are bursty. That is, within the session the data flow is confined to short periods of time, with relatively long intervals between bursts. Recently "packet switched" networks have evolved which allow the transmission links to be shared with other users during the idle time between bursts. The result is a higher efficiency of line utilization and a better match between communications resources and the line occupancy for most data signals.

2.3.3 DATA SERVICE DESIGN PARAMETERS

Data communication applications are highly varied with requirements for speed, reliability, connectivity and other parameters that range over wide limits. The following discusses significant design parameters for data communications with emphasis on their implications for CPS.

2.3.3.1 SPECTRUM REQUIREMENTS/DATA RATES

Because of their widespread availability, voice transmission facilities are heavily used for data transmission. As a result most data modems generate signals that fall within the nominal 4 kilohertz voice channel bandwidth. The data rates supported within this bandwidth are usually in the range of 300 to 9600 bits per second for leased lines. While it is also possible to use speeds up to 9600 bits per second on the switched voice network, performance tends to be marginal, and a upper limit of 4800 bits per second is generally preferable. Table 2.3-1 lists some of the many data communications applications that are likely to use voiceband data communications facilities.

TABLE 2.3-1 APPLICATIONS LIKELY TO EMPLOY VOICEBAND DATA COMMUNICATIONS

AIRLINE RESERVATION	INFORMATION RETRIEVAL
BANKING	LIBRARY CATALOG
COMMUNICATING WORD PROCESSORS	ELECTRONIC MAIL
CREDIT INFORMATION	PRODUCTION DATA
ELECTRONIC FUNDS TRANSFER	MANAGEMENT INFORMATION
HOSPITAL INFORMATION	TIMESHARING
ORDER ENTRY	TICKET RESERVATION
POINT OF SALE	INVENTORY CONTROL
SALES INQUIRY	HOTEL RESERVATION
STOCK MARKET TRANSACTION	COMPUTER AIDED DESIGN
TEXT EDITING	DOCUMENT RETRIEVAL

For those data applications in which a single individual types at a keyboard, even the slowest of the rates mentioned above (300 bits per second) is faster than needed to keep up with the typed input. In the reverse direction, however, where a computer responds by delivering data to a cathode ray screen, the higher rates are sometimes desired. At 4800 bits per second it takes three to four seconds to completely fill up the approximately 2000 characters constituting a full screen display, and approximately half that time at 9600 bits per second. This is fast enough for the majority of interactive data sessions so that for most data applications involving interaction with a human operator, the data speeds that can be supported on a voice channel are adequate.

The general trend in voiceband data speeds has been toward the higher rates. Table 2.3-2 shows the results of 273 responses to a 1981 survey of data communications users [Ref. 2-9]. Since most users employ a variety of speeds, the percentages add up to more than 100 percent.

TABLE 2.3-2 DATA TRANSMISSION SPEEDS BASED ON 1981 SURVEY OF USERS

SPEED	PERCENT OF TOTAL RESPONSES
150 BPS OR LESS	18
300 to 1800 BPS	62
2000/2400 BPS	57
4800 BPS	69
9600 BPS	59
OVER 9600 BPS (WIDEBAND)	17

ORIGINAL PAGE IS
OF POOR QUALITY

Some further insight into current and projected speeds for voiceband data may be obtained from Figure 2.3-1 which shows worldwide modem shipments by speed for 1981 and 1984 [Ref. 2-10]. Not reflected in these figures are some recently introduced modems that achieve 14,000 to 16,000 bps (half duplex) over a voiceband circuit, but have not yet received widespread acceptance.

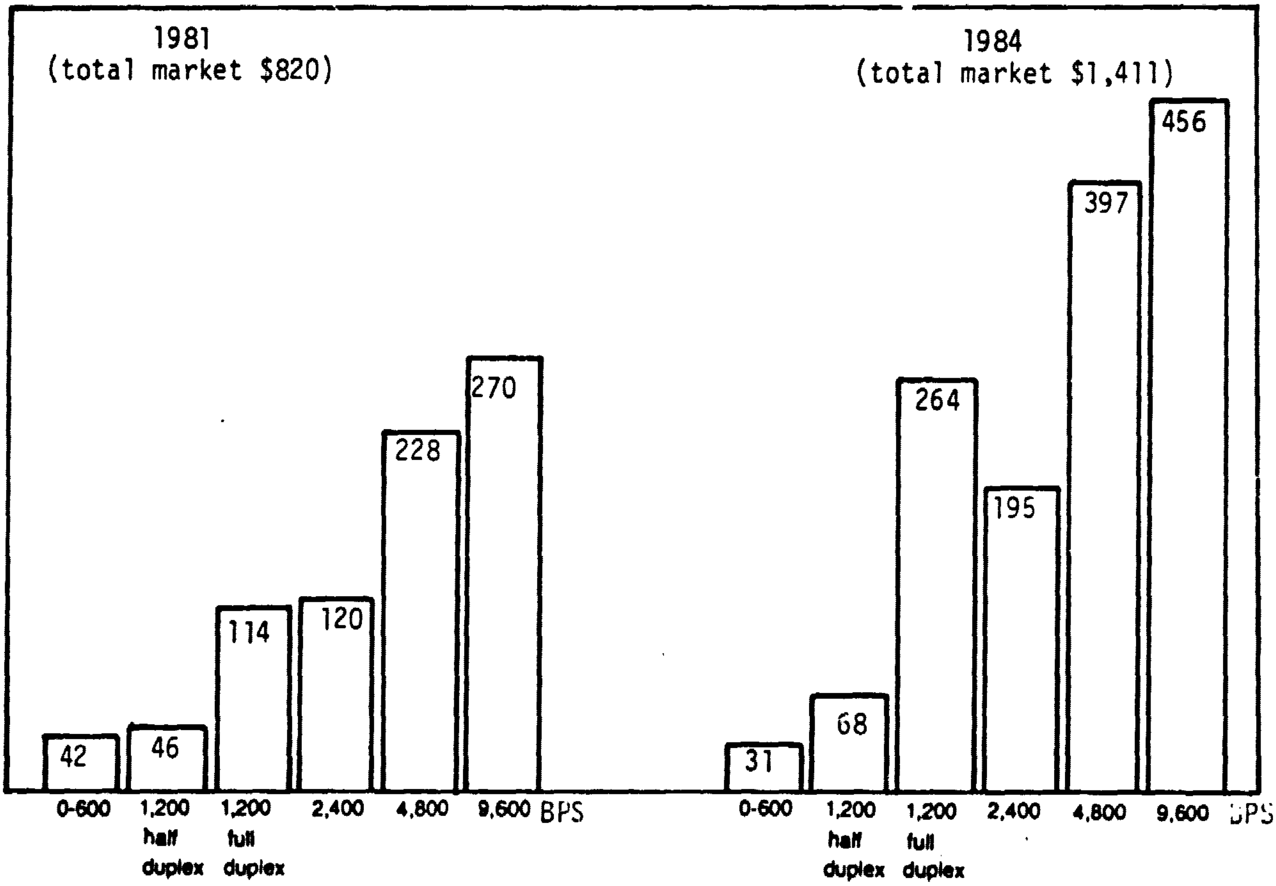


FIGURE 2.3-1 WORLDWIDE MODEM SHIPMENTS (MILLIONS OF DOLLARS)
SOURCE: GENERAL DATACOMM INDUSTRIES INC.

Data rates higher than those supported within a voiceband channel are also reasonably common. As discussed below, these arise in applications involving computer to computer communications, the transmission of graphic images, and where large volumes of data need to be sent. However, facilities for distributing wideband data signals on the terrestrial network are much less widespread than voiceband facilities. The ability of CPS to avoid terrestrial distribution, therefore, makes wideband data applications of particular signficance for CPS.

Figure 2.3-2 shows the maximum line speed supported by various telecommunications equipped minicomputers, as determined in a recent survey of 56 minicomputer models from 46 different manufacturers [Ref. 2-11]. Higher speeds are also

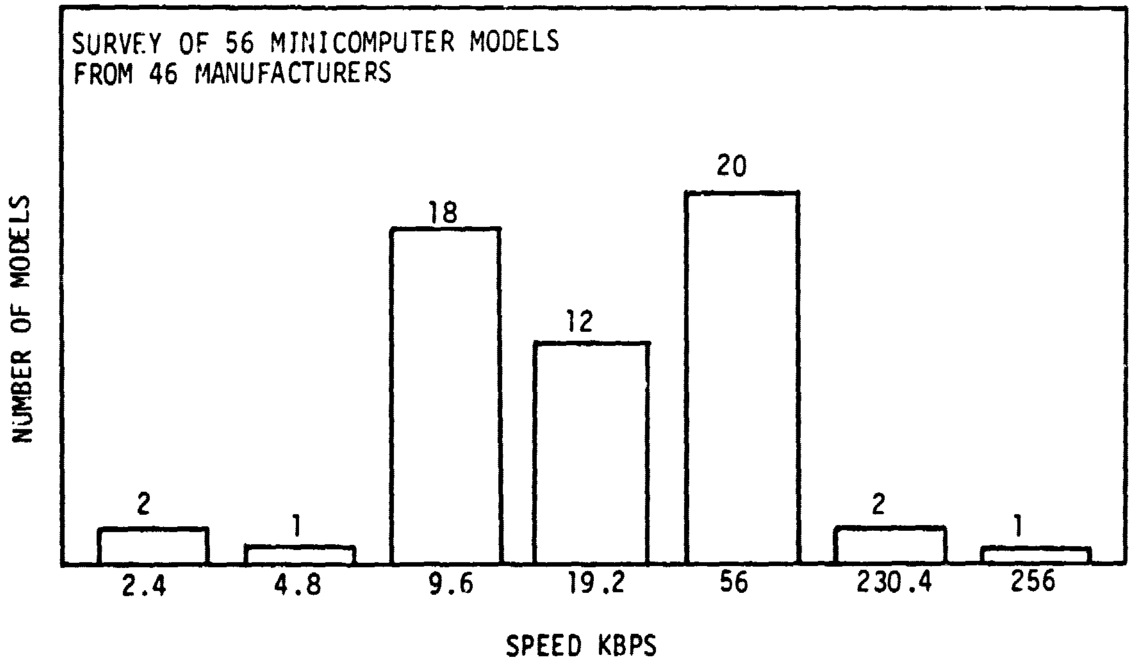


FIGURE 2.3-2 MAXIMUM LINE SPEEDS SUPPORTED BY VARIOUS MINICOMPUTER MODELS

possible in some cases with special hardware. While the machines have the capability of operating at the maximum speeds cited, only a few lines can operate simultaneously at these speeds. While occasional applications can be found at higher speeds, most of today's computer oriented data transmissions are likely to be satisfied at speeds of 56 Kbps or below. However, to accommodate a trend toward increasingly higher speeds, capabilities up to 1.544* megabits per second should be considered for advanced CPS earth station designs.

High data rates are also encountered when graphic images are transmitted digitally. Many of the newer digital facsimile machines, for example, use 4800 to 9600 bits per second transmissions plus sophisticated data compression algorithms, but still take 20 to 30 seconds to transmit a single page business letter. Data rates, above those available on voiceband circuits, would permit faster page transmission and/or better resolution, and might also reduce equipment costs by permitting simpler compression algorithms. Where high transmission rates to the user can be economically achieved, as may be the case for CPS systems, a suggested facsimile data rate of 56 kilobits per second, corresponding to 3 to 5 seconds per page, appears desirable.

Other special graphic applications such as the transmission of high resolution images for newspaper publishing, advertising copy, fingerprint identification, etc., also benefit when data rates higher than those achievable within a nominal voice channel are available. A machine for high volume uses, built by AM International under SBS sponsorship, achieves speeds as high as one page per second over SBS 1.544 Mbps T1 rate channels.

Bulk data transmission applications such as electronic mail can also lead to requirements for data rates higher than those supported within a voice channel. For example, electronic mail systems designed to replace the physical transportation of first class mail within the Postal Service would, if fully developed, require the linking of 100 or more nodes with full time capacity requirements between the average pair of nodes on the order of 100 two-way voiceband channels carrying data at 9600 bits per second. Requirements such as these are more efficiently handled by replacing the many individual voiceband channels with a single wideband data channel with rates in the range of one to ten megabits per second.

---

*Rates used should conform with the Bell Systems T1 carrier (DS-1) System to facilitate interconnection with terrestrial facilities. The 1.544 Mbps rate corresponds to the multiplexing of twenty-four 64 Kbps channels (plus some framing and timing bits).

Wideband data signals at megabit rates are also increasingly encountered in the rapidly growing technology of local area networks. Of 296 respondents to a recent survey covering a wide range of organizations, 124, or 42 percent, said they currently operate local networks [Ref. 2-12]. These networks, which are generally oriented to office of the future applications, use coaxial cable or twisted pairs to link together a large number of terminals and computers. A list compiled in December of 1981 includes 20 different local network systems, from as many suppliers, with speeds ranging from 64 Kbps to 50 Mbps [Ref. 2-13].

Table 2.3-3 presents a representative selection of local area networks introduced in 1981. Where large distances are indicated, repeaters are required. Also, in some cases,

TABLE 2.3-3 REPRESENTATIVE LOCAL AREA NETWORKS INTRODUCED IN 1981

LOCAL AREA NETWORK	VENDOR	MAX. DATA RATE, MEGA-BITS PER SECOND	MAXIMUM NUMBER OF TERMINALS	MAX. DISTANCE BETWEEN TERMS. MILES
ETHERNET	XEROX CORP.	10	1024	1.5
NET/ONE	UNGERMANN-BASS, INC.	10	200/segment	.8
HYPERchannel	NETWORK SYSTEMS CORP.	50	256	.6
Z-NET	ZILOG, INC.	0.8	256	1.2
MODWAY	MODICON DIVISION OF GOULD, INC.	1.544	250	2.8
WangNet	WANG LABORATORIES, INC.	12	65000	2.0
CableNet	AMDAX CORP.	14	16000	7.5
LOCALNET 40	SYTEK, INC.	2	64000	4.3

the maximum data rate decreases when a large number of terminals is connected. It should be noted that the high data rates of some of these networks are the result of simultaneous interworking of many terminals and computers. For example, the HYPER-channel network has a maximum bit rate of 50 Mbps, but no single machine in the minicomputer class operates at that rate [Ref. 2-14].

As the name implies, local area networks are designed for limited distances, and, in fact, are often contained within a single building. Gateways which allow many of these networks to access long distance transmission facilities exist, or are under development, but at lower data rates. However, as this rapidly developing technology expands, increasing needs to link local networks in one region of the country to those in a distant region may be expected. Furthermore, the capacity demanded of these links is also likely to increase and the high speeds used in the local area may require comparable speeds in the long haul links to allow full integration of distant automated offices. If this trend develops, CPS systems capable of delivering wideband data signals directly to the customers' premises will be well positioned to address a significant portion of the market.

2.3.3.2 DIRECT DIGITAL CONNECTION

Data signals can be sent over analog channels through the use of data modems. These convert the digital data signal to analog tones suitable for transmission over normal analog voiceband transmission facilities. Once converted to analog form by the modem there is no fundamental need to distinguish between voice and data signals so that flexibility in the use of the transmission facilities for either type of signal results.

However, when these analog signals reach digital transmission channels, such as those likely to be provided by advanced CPS facilities, it is necessary to convert them to digital form prior to transmission. For the voice signal this means that each one-way, 4 KHz, channel is converted to a 64 Kbps digital bit stream (or less, depending on the sophistication of compression circuitry that may be used). The modem output must be treated in the same way, becoming a one-way 64 Kbps digital stream.

This can result in very inefficient use of the transmission facility for data. For example, a data signal originating as a 300 bit per second stream may occupy 64,000 bits per second in the digital transmission channel. This inefficiency can be avoided for data signals traveling over digital transmission paths if the data signal is interfaced directly with the digital channel. With direct digital connection the 300 bit per second data signal referred to before occupies only 300 bits per second (instead of 64,000 bits per second) in the digital transmission stream.

The direct digital connection of data signals to digital transmission facilities clearly provides a large improvement in efficiency. However, to accomplish this it is necessary to identify those channels carrying data, and to segregate them from the channels used for voice. In the common user trunking environment a particular transmission link may be far removed from the signal source, and the signal may have passed through many other analog and digital links on its path through the network. It is difficult under these circumstances to identify the data signals and separate them from the voice signals. Thus, where direct digital connection for data is desired, current practice is to use separate digital and analog networks.

In the CPS environment, however, the signal sources are physically close to the transmission link being used, and the sorting of signals by the user into appropriate analog and digital categories is a relatively straightforward procedure. In addition, the signal in most cases will not have to pass through other analog and digital links (unless the CPS path is extended through other carrier facilities to a more distant destination as in some "off-net" applications). CPS system designs should, therefore, take advantage of this by providing facilities for the separate handling of data signals and analog signals. The separated data signals can then directly access the multiplexer for the digital transmission link and be transmitted at much higher levels of efficiency then would otherwise be possible.

2.3.3.3 TIME DELAY

Round-trip time delay through a satellite in synchronous orbit is about 0.5 seconds. Some data transmission protocols (for example, the commonly used bisynch protocol) use a type of error control which requires that each block of data be acknowledged by the receiver prior to the transmission of the next block. The resulting stop and wait transmission is strongly affected by the long delay time of satellite paths with a consequent large decrease in throughput. This loss in throughput makes satellite communications unsuitable for many data applications employing these currently important and widely used protocols.

A special device, referred to as a satellite delay compensator unit, is supplied by some common carriers as a means of overcoming this problem. The device accepts data blocks from the users, and locally acknowledges each block. As far as the user is concerned, this simulates the acknowledgment expected from the far end and allows transmission to proceed without delays.

Newer, more efficient, data communications protocols avoid the problems introduced by delay by allowing data transmission to proceed without waiting for the acknowledgment signal. In the long term, the newer protocols will supplant the less efficient ones, but for some time into the future existing user hardware and software may limit the acceptability of satellite circuits for many data applications.

Initial CPS system designs should include satellite delay compensation units as an option for those data applications using the older protocols. In the longer term, the use of newer data communications protocols suitable for both terrestrial and satellite environments should be encouraged.

2.3.3.4 TWO-WIRE AND FOUR-WIRE SERVICE

Most data communications require two-way transmission. As discussed earlier for voice transmission, the long haul plant provides a separate path (four-wire service) for each of the directions of travel. In the switched telephone network, however, the local lines between the telephone company's central offices and the users are almost always single pairs of wires (two-wire service) that must pass traffic in both directions. Unlike analog voice signals, two data signals are unable to occupy a single line at the same time.* The result is that data signals above 1200 bps, using the switched network, have to operate in one direction at a time (half-duplex), which adds complexity to hardware and software, and is a source of some inconvenience in many applications. CPS, by avoiding the existing local distribution plant, can provide four-wire

---

*An exception to this exists at speeds below about 1200 bps. At these lower speeds it is possible to use modems which split the voice bandwidth into two separate frequency bands, one for each direction.

service end-to-end to the user, thereby permitting simultaneous two-way (full-duplex) data transmission.

For voice, an important advantage of four-wire service is the reduction of echo problems, with the consequent ability to do without echo suppressors. This carries an additional advantage when voice and data signals are routed over the same facilities, since the echo suppressors needed for voice prevent full-duplex data transmission and slow down half-duplex data transmission. Problems such as these are avoided when end-to-end four-wire service is provided. The ability of CPS to support four-wire service to the user, therefore, is an advantage in data applications as well as in voice.

2.3.3.5 ERROR PERFORMANCE

The end-to-end error performance required for data signals varies widely as a function of the application. At the lower extreme are most textual message transmissions where an occasional character in error can be reconstructed by the reader from message context. Similarly, lower error performance is tolerable in those systems in which each key stroke is echoed back from the far end and displayed to the operator.* An error in transmission appears to the operator as a mistake in keying and is corrected by retransmitting the character. For systems such as these a bit error probability of 10^{-3} to 10^{-4} is often acceptable.

At the other extreme are applications such as the transmission of computer programs, or the clearing of financial accounts, where a single mistaken character can have significant consequences. In applications such as these, end-to-end bit error probabilities of 10^{-8} or better are appropriate.

For a general purpose transmission system, where both extremes of performance may be required, the system design must compromise between costly overdesign and performance standards that may be inadequate for some functions. In CPS systems a design goal near the lower performance limit appears appropriate and a bit error probability of about 10^{-4} to 10^{-5} is suggested for the reasons discussed below.

(a) CPS long haul transmission involves a single link. Essentially the full end-to-end performance budget can therefore be allocated to that link. In terrestrial long haul transmission performance factors must be allocated among many

---

*Such systems while common on terrestrial links, however, perform poorly on satellite links because of the long time delay.

links.

(b) Local distribution has often proved to be the largest contributor to the errors encountered on a path. To the extent that CPS avoids the local loops, end-to-end performance to the user is enhanced.

(c) A bit error probability in the range of 10^{-4} to 10^{-5} permits good quality digitized voice so that links designed to this standard can, without additional error control, be conveniently used for voice as well as data.

(d) A bit error probability in the range of 10^{-4} to 10^{-5} is satisfactory for many interactive applications involving terminal/computer communications and is acceptable to most users of this type.

(e) For those applications where it is needed, improved error performance can be provided by special hardware as an extra cost option.

2.3.3.6 RELIABILITY

Bulk data transmission for file updates, electronic mail, remote job entry, and similar applications are tolerant of communications outages. Most of the users in these categories would be able to use lower availability levels than those generally provided by terrestrial facilities. However, since the terrestrial transmission will remain a possible alternative for these users, some cost reductions will be required to motivate a transition to less reliable media. Thus, CPS systems designed to the 99.5% or 99.9% availability level will find a market among this group of data applications provided that the design permits substantial cost economies.

In contrast, a large number of data applications, including many in the important interactive terminal to computer category, require substantially better reliablity. It is not uncommon in these categories for redundant computer systems to be installed so that a computer outage will not interfere with critical ongoing operations. Similarly, the data communications links serving these computers are generally backed-up by alternative communications paths so that access can be assured.

It is probable that a large fraction of data communication users in the terminal to computer category will require availability levels at least equal to those of terrestrial communications. Some portion of these may also prefer higher availability levels even if a premium rate for such service is required. This area of data communications may, therefore, be a difficult one for high frequency CPS systems to address unless suitable back-up modes are available to the users.

2.3.3.7 CONNECTIVITY

Connectivity requirements for data transmission are generally less demanding than for voice, but, as in the case of voice, depend on whether dedicated or switched modes are employed.

For data applications using dedicated facilities the end points making up a community of interest are predetermined and limited in number. However, point to multipoint configurations, which are common in polled data applications may pose some problems for CPS networks.

In polled operation a computer at one end of a line interrogates a number of remote terminals distributed along the line. The particular terminal addressed responds with its message, and then releases the line so that the computer can address the next terminal. Typically the polled transmissions are synchronous at bit rates of 2400 to 9600 bps.

In the CPS environment the counterpart of a terrestrial polled line consists of a transmission through the satellite channel of the polling signal from the computer. The terminals at the remote CPS sites simultaneously listen to the broadcast poll and each responds in turn, on the return channel, when it recognizes its polled address.

Some protocol problems for polled systems may be introduced by the buffering and timing necessary to accommodate some of the potential satellite access methods (e.g., burst TDMA). An even more significant problem for polling may be introduced by the long satellite time delay which, unless taken care of, would greatly reduce the polling rate. Some interface hardware and/or software should therefore be included in the earth station design to address these problems if polled data systems are to be serviced by CPS.

A substantial portion of data communications is implemented via switched networks. The economic reasons for using switched communications for low volume data applications parallel those applying for voice. However, a special reason for the use of switched facilities is its ability to access many widespread locations on an ad-hoc basis, and with a minimum of prearrangement. At present this reason is of much less concern in the data communications environment than it is for voice communications.

Currently there are only a few data applications (for example, time sharing) which require the wide connectivity needed in switched voice applications. The problems inherent in supplying very wide connectivity, which were earlier seen to discourage the use of CPS for switched voice applications, therefore, do not apply with equal force to switched data applications. Most present day switched network data applications, therefore, remain suitable targets for CPS systems.

In the near future, high growth is anticipated for emerging switched data applications related to the proliferation of microcomputers. Examples of these are:

(a) Access to remote information services from offices and homes equipped with low cost microcomputers and terminals.

(b) Electronic mail and other message traffic between the microcomputers mentioned above.

(c) Electronic mail and other message traffic between communicating word processors in company-to-company applications (as opposed to the currently more common intracompany applications) and between companies and terminals in the home.

(d) Transaction type traffic in bank-by-phone, remote shopping, ticket purchase and similar uses.

The above are interesting and potentially high volume switched data applications but because their connectivity requirements are likely to be as extensive as those for general purpose switched voice, and because participation is heavily oriented towards homes and small businesses, their impact on CPS is not likely to be of great significance.

ORIGINAL PAGE IS
OF POOR QUALITY

In summary, the connectivity limitations inherent in the CPS environment are not expected to be a problem for dedicated data traffic, and for current switched data applications will be less of a problem than for voice. However, for some important emerging switched applications associated with personal computers, the difficulty of providing wide connectivity may limit the applicability of CPS.

2.3.4 SUMMARY OF DATA PERFORMANCE OBJECTIVES

Table 2.3-4 summarizes the previous discussion and presents performance objectives for CPS Data Service.

TABLE 2.3-4 PERFORMANCE OBJECTIVES FOR CPS DATA SERVICE

DATA RATES	- Standard Rates from 300 to 9600 bps compatible with those currently used in voiceband communications. Wideband rates of 56 Kbps through 1.544 Mbps.
DIRECT DIGITAL CONNECTION	- For systems using digital transmission links, the ability to interface data signals directly with the digital stream is desirable.
TIME DELAY	- Satellite delay compensation units needed for currently common data protocols.
SERVICE TYPE	- Four-wire to the end user preferred. Two-wire service provided for users equipped with current two-wire dial-up modems.
ERROR PERFORMANCE	- One error in 10^4 - 10^5 bits. Lower error rates available through optional error control.
AVAILABILITY	- 99.9% at cost comparable to terrestrial networks, 99.5% as reduced st offering.
CONNECTIVITY	- Low to most dedicated and switched appli itched applications may req tivity.

3.0 POTENTIAL CPS USER CLASSES

This chapter characterizes the communications requirements of potential CPS users in the Business, Government, Institutional and Private User classes. Factors which encourage or discourage the use of CPS systems are emphasized.

3.1 BUSINESS

Business users account for the largest volume of telecommunications activity among the various classes of communications users. Requirements of the business community are very diverse, ranging from low speed teletypewriter service to full motion videoconferencing and are best evaluated by examining a broad cross-section of users. In addition to the survey conducted as part of the present study and described in Chapter 4, there have been many other surveys by market research organizations and industry groups. Of particular interest is a 1978 survey [Ref. 3-1], sponsored by the International Communications Association (ICA), exploring the telecommunications activities of its members and summarizing their opinions on the benefits of competition in the telecommunications industry. Since the ICA survey provides a profile of telecommunications usage in a broad cross-section of the business community, and touches on several of the issues of concern in this study, its results are discussed in some detail in the following pages.

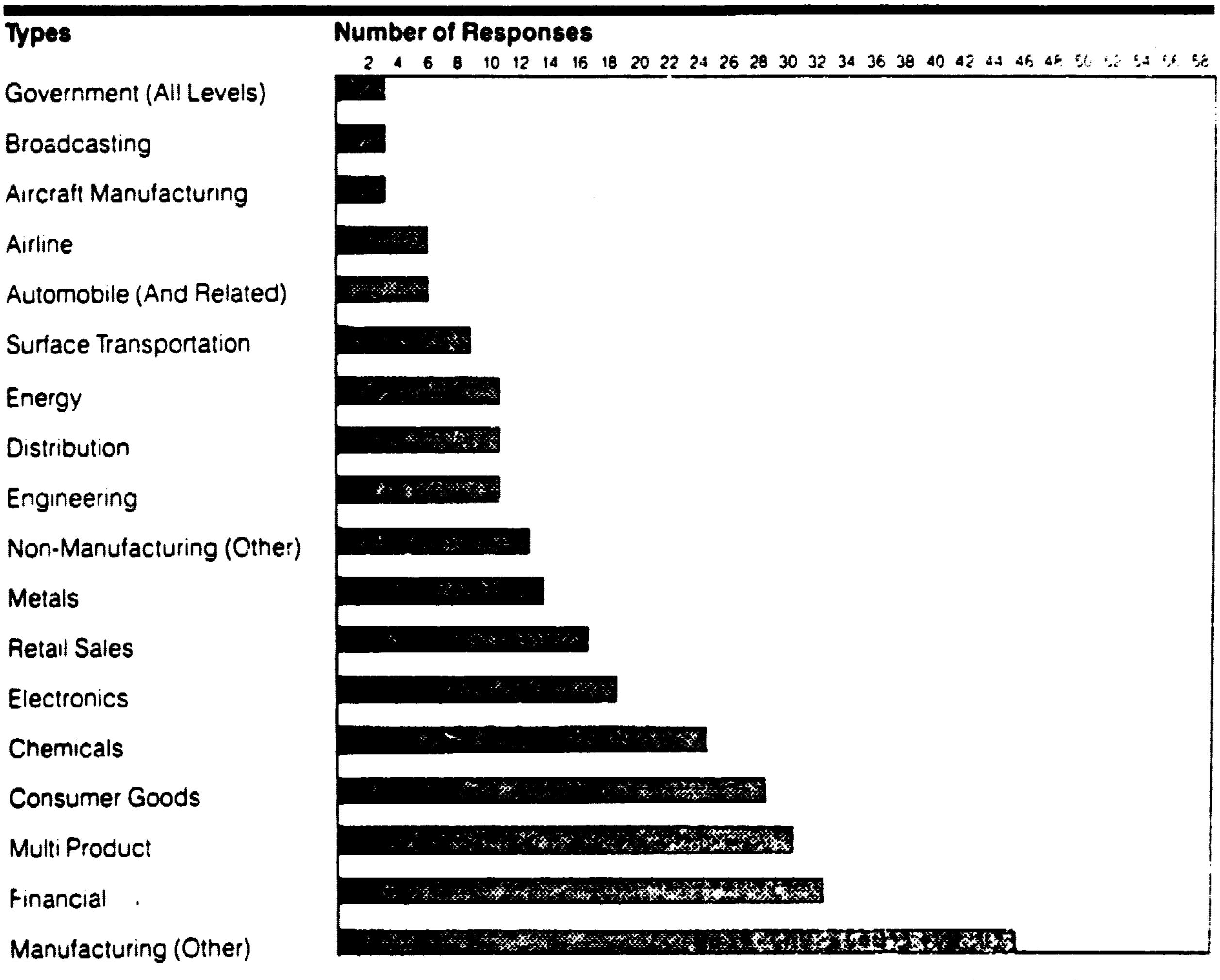
3.1.1 DESCRIPTION OF RESPONDENT POPULATION

The International Communications Association (ICA) is the largest and oldest organization of telecommunications users in the United States. Its broadly based membership accounts for approximately 13 percent of the annual revenues of the Bell System. While a few government organizations and foreign businesses are included, more than 95 percent of the respondents to the ICA survey represent businesses that are based principally in the United States. Individual organizations responding to the survey were not identified by name but it is believed that the expenditures discussed in the following pages represent a reasonable population sample with some emphasis on larger users but without distortions that might be occasioned by the inclusion of a few very large but atypical organizations.

ORIGINAL PAGE IS
OF POOR QUALITY

A 40 question, written, questionnaire was sent to ICA members in November of 1978. Ninety-six percent of the individuals responding stated that the acquisition and management of telecommunications is their principal function. The group, therefore, clearly represents an important and well informed segment of the U.S. telecommunications market.

Figure 3.1-1 shows the distribution of respondents by industry. Since many businesses engage in multiple activities, more than one response (an average of 1.5) was indicated by many respondents. All of the major U.S. industry groups are represented in the list.



*Respondents could indicate more than one area of activity.

FIGURE 3.1-1 DISTRIBUTION OF RESPONDENTS* BY INDUSTRY GROUP

3.1.2 EXPENDITURES FOR TELECOMMUNICATIONS EQUIPMENT AND SERVICES

Figure 3.1-2 shows the distribution of expenditures for domestic telecommunications equipment and services among the respondents. Expenditures ranged from one million to over 50 million dollars per year, and are well centered in the range suitable for dedicated or shared use of CPS facilities.

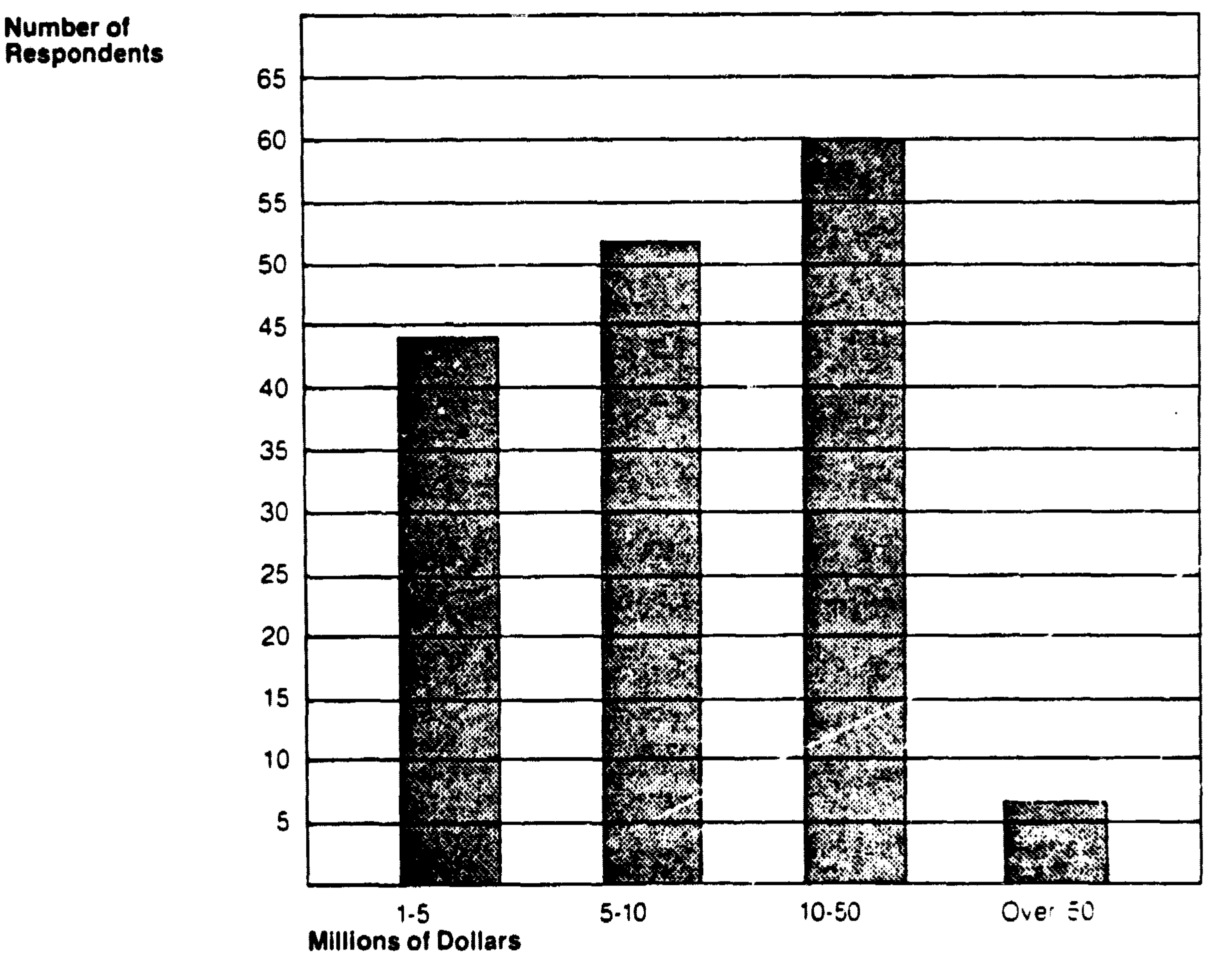
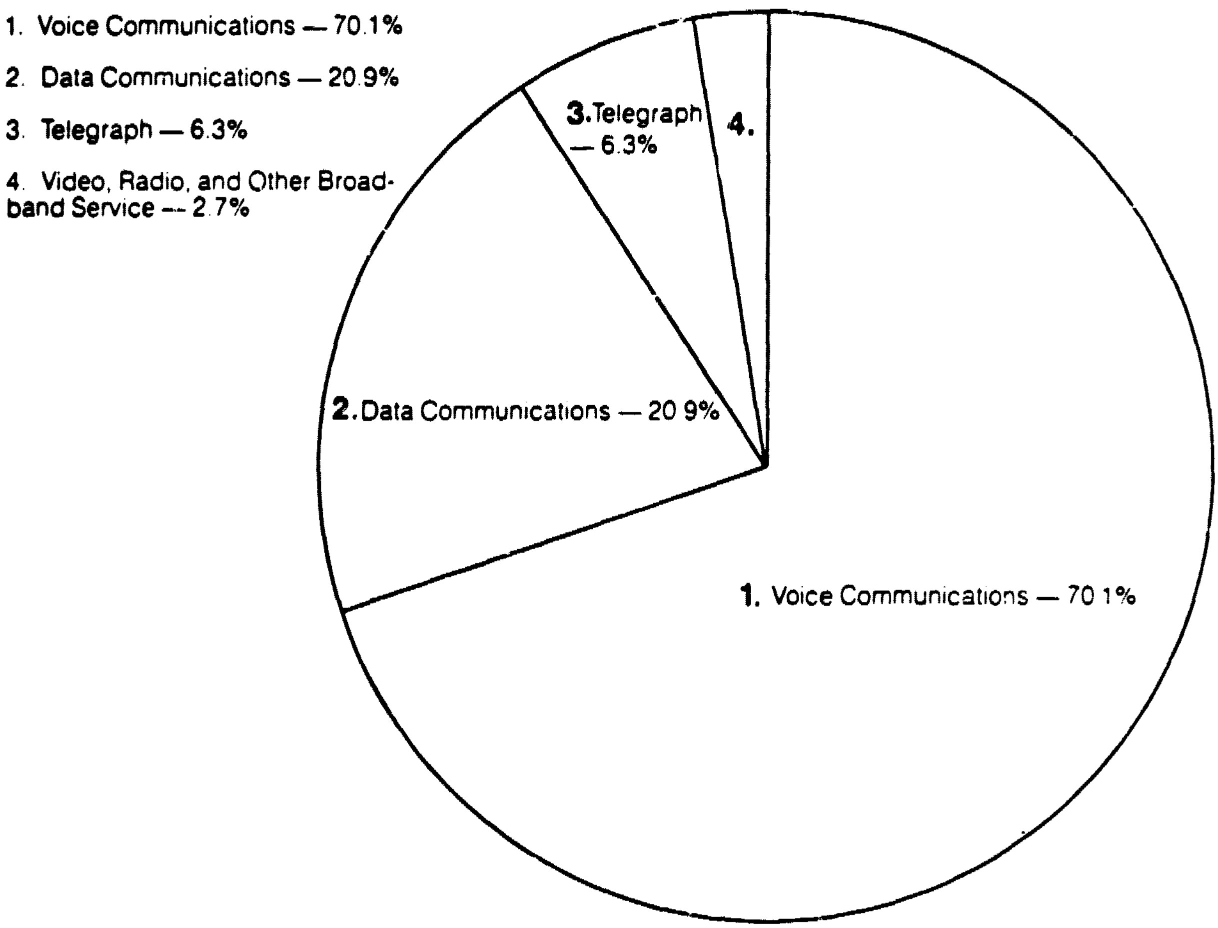


FIGURE 3.1-2 ANNUAL DOMESTIC TELECOMMUNICATIONS EXPENDITURES (1978 DOLLARS)

Figure 3.1-3 shows how these expenditures are used for voice, data and other services. Voice communications accounts for 70.1 percent of these expenditures, 20.9 percent is for data, 6.3 percent is for telegraph and the remaining 2.7 is for video, radio and other broadband services.

If telegraph services are added to the other data communications applications, the relative mix of expenditures for voice, data and video (plus other wideband) services becomes, respectively, 70.1, 27.2 and 2.7 percent.

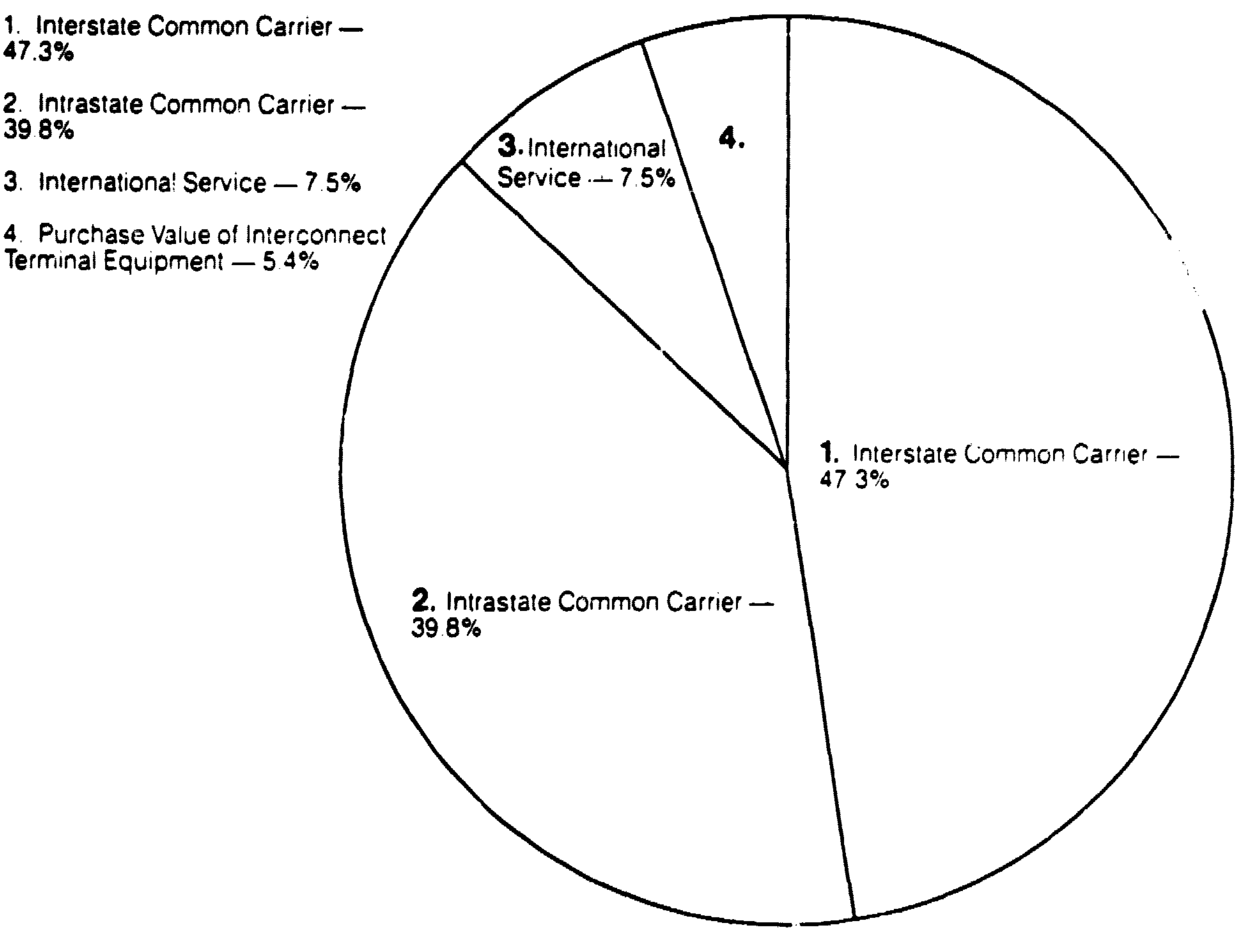


*Figures refer to percentages of annual telecommunications expenditures and are averages from 162 responses

FIGURE 3.1-3 MIX OF SERVICES USED - VOICE, DATA AND OTHER

3.1.3 INTERSTATE AND INTRASTATE SERVICE

Figure 3.1-4 provides a breakdown of expenditures for interstate and intrastate common carrier service, for international service and for the purchase value of interconnect terminal equipment. If the latter two items are removed so that expenditures for interstate and intrastate common carrier service can be more readily compared, the results become 54.3 percent for interstate and 45.7 percent for intrastate services.



*Figures refer to percentages of annual telecommunications expenditures and are averages from 162 responses

FIGURE 3.1-4 MIX OF EXPENDITURES - INTERSTATE, INTRASTATE, AND OTHERS

Expenditures for interstate traffic*are further broken down in Figure 3.1-5. When the categories shown in Figure 3.1-5 are combined into groups corresponding to switched and non-switched (including CCSA as non-switched) services, the results are 55.3 percent for switched services and 44.7 percent for non-switched services.

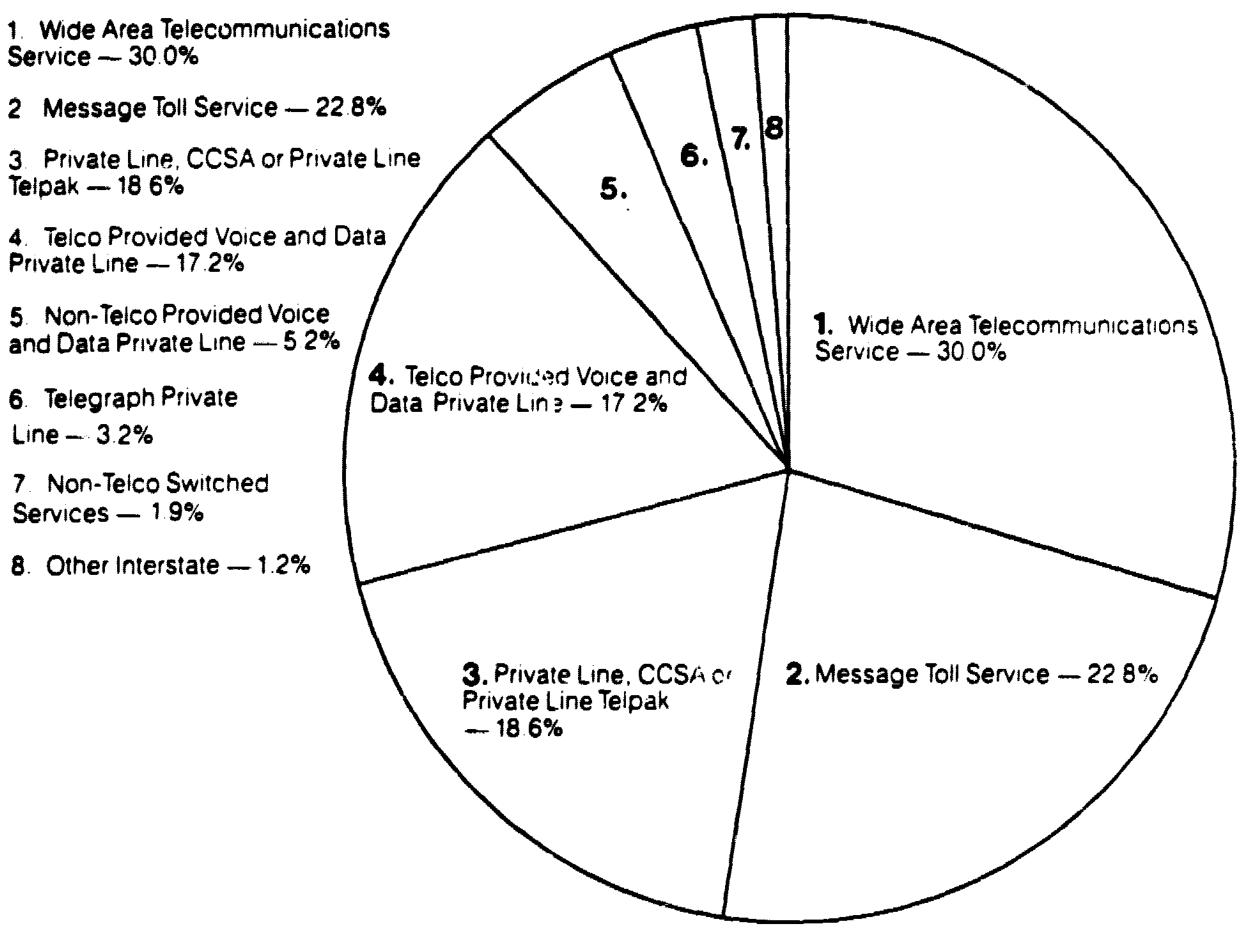


FIGURE 3.1-5 RESPONDENTS' INTERSTATE SERVICE EXPENDITURES

Figure 3.1-6 shows expenditures for intrastate services. Considering only items 2, 3 and 4, to eliminate the effects of equipment expenditures and local services, expenditures become 46 percent for Intrastate Toll service, 30 percent for Intrastate WATS, and 24 percent for Intrastate Private Lines.

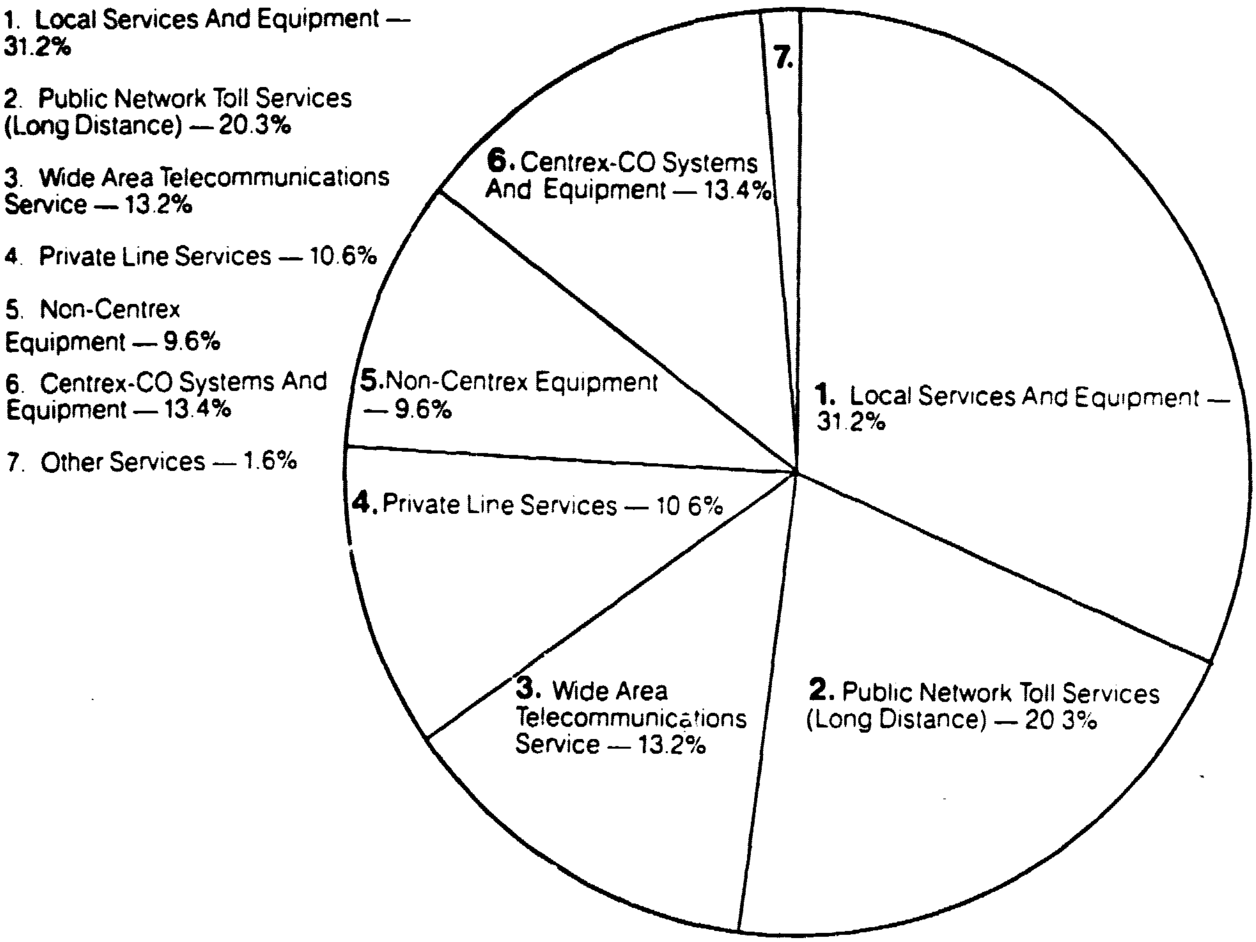


FIGURE 3.1-6 RESPONDENTS' INTRASTATE SERVICE EXPENDITURES

3.1.4 USE OF COMPETITIVELY SUPPLIED TELECOMMUNICATIONS SERVICES

The ICA survey also solicited responses to several questions pertaining to the use of competitively supplied services (i.e., those provided by other than traditional telephone companies). The degree to which users are willing to depart from traditional sources is probably a good indicator of the acceptability of new services such as CPS, assuming that technical and price performance are competitive.

Of those responding, 77.8 percent indicated that they presently used non-telco alternatives for intercity telecommunications services. Of the roughly 70 percent who had made a determination for the succeeding two years, 83.1 percent had decided to increase the percentage of non-telco intercity services. However, more recent results (see Table 4.3-7) indicate that circa 1981 only about 40 percent of users were availing themselves of non-telco services. A possible explanation for the differences is that the ICA sample had a higher proportion of large users then the later survey.

A question designed to indicate the areas where market penetration by non-telco suppliers is most likely to increase produced the results shown in Table 3.1-1. Of these responses,

TABLE 3.1-1 AREAS OF INCREASED MARKET PENETRATION

IF YOU PLAN TO ACQUIRE A HIGHER ANNUAL PERCENTAGE OF SERVICES OR EQUIPMENT NOT SUPPLIED BY A TELEPHONE COMPANY, IN WHAT AREAS DO YOU SPECIFICALLY EXPECT THIS INCREASE TO OCCUR?

	Percent of Respondents
PBX and Similar Customer Premises Switching Equipment	74.2%
Key Telephone Systems	31.8%
Data Communications Terminals	76.5%
Intercity Private Lines	61.4%
Intercity Switched Services	45.5%
Satellite-Based Services	44.7%
Other	6.8%

44.7 percent indicated satellite-based services as a specific area of anticipated increase. Again this result appears more optomistic than more recent results (see Table 4.3-9) which place the fraction of users employing satellites at about 18 percent.

Expenditures for non-telco provided services have grown over the last several years and most respondents expect this trend to continue. Figure 3.1-7 shows estimated annual expenditures for non-telco supplied intercity telecommunications services for the years 1974 through 1982. Since the survey was conducted in November of 1978 results beyond that date are projections.

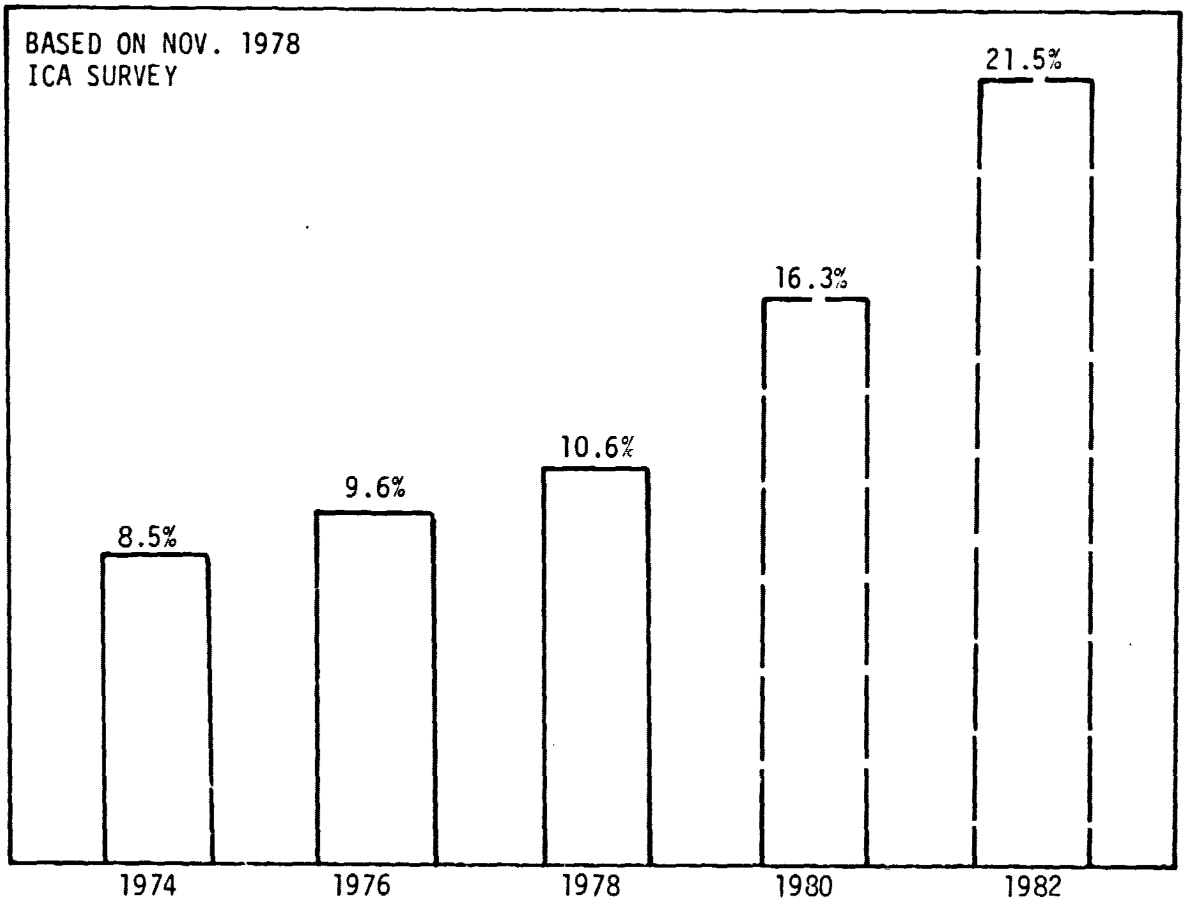


FIGURE 3.1-7 PERCENT OF TELECOMMUNICATIONS EXPENDITURES PAID TO NON-TELCO SUPPLIERS

3.1.5 REASONS FOR USING OR REJECTING NON-TELCO SERVICES

Reasons for using or rejecting non-telco services were explored by asking the respondents to select those factors which were significant in influencing their choice. The responses are shown in Tables 3.1-2 and 3.1-3. Similar factors can be assumed to be operative in influencing future decisions to use other, generally less familiar, services such as CPS. Some related results specific to CPS will be found in Tables 4.3-20 and 4.3-21.

TABLE 3.1-2 EXPLANATION FOR RESPONDENTS USING NON-TELCO INTERCITY SERVICES

If Respondent Uses Non-Telco Alternatives, Why?	Percent of Respondents Selecting Each Item
Competitive prices are lower	90.4%
The competitive system or service offers better design or features	50.0%
Competitive products or suppliers offer better service (including maintenance) or services not provided by telcos	41.6%
Competitive suppliers offer better financial packages which can be tailored to the overall company needs	32.0%
The competitive system or service is more comparable to respondents' specific company needs	34.4%
Other	6.4%

AVERAGE OF 2.5 RESPONSES PER RESPONDENT

TABLE 3.1-3 EXPLANATION FOR RESPONDENTS NOT USING NON-TELCO INTERCITY SERVICES

If Respondent Does Not Use Non-Telco Alternatives, Why?	Percent of Respondents Selecting Each Item
There is a question about the service capability and on-going reliability of non-telco suppliers	61.1%
The sole source supplier concept seems to be more efficient for overall company needs	22.2%
Telco products seem to be more compatible for specific company needs	19.4%
Non-telco prices seem to be higher than, or insignificantly different from, telco prices	16.7%
The non-telco system or equipment available is not as well designed as those provided by telcos	5.6%
Other	27.8%

AVERAGE OF 1.5 RESPONSES PER RESPONDENT

3.2 GOVERNMENT

Government employment accounts for a significant fraction of the total civilian employment of the United States and has commensurate impact on demand for communications facilities. Table 3.2-1 shows 1980 Federal civilian employment by major governmental function [Ref. 3-2]. This represents about 2.8 percent of the then current civilian labor force.

TABLE 3.2-1 FEDERAL CIVILIAN EMPLOYMENT 1980

FUNCTION	NUMBER OF EMPLOYEES (THOUSANDS)	% OF TOTAL U.S. CIVILIAN LABOR FORCE (105 MILLION)
NATIONAL DEFENSE	976	.929
POSTAL SERVICE	664	.632
NATURAL RESOURCES	291	.277
HEALTH & HOSPITALS	266	.253
FINANCIAL ADMIN.	110	.105
POLICE PROTECTION	56	.053
EDUCATION	26	.025
HIGHWAYS	5	.005
ALL OTHER	513	.489
TOTAL	2907	2.768

Employment by the various state governments also represents a major segment of U.S. employment. Table 3.2-2 shows state government employment and the functional areas in which these resources are deployed [Ref. 3-2]. State governments in 1979 employed almost 3.6 percent of the civilian labor force.

TABLE 3.2-2 STATE EMPLOYMENT 1980

FUNCTION	NUMBER OF EMPLOYEES (THOUSANDS)	% OF TOTAL U.S. CIVILIAN LABOR FORCE (105 MILLION)
EDUCATION	1599	1.523
HEALTH & HOSPITALS	690	.657
HIGHWAYS	258	.246
NATURAL RESOURCES	192	.183
PUBLIC WELFARE	174	.166
FINANCIAL ADMIN.	121	.115
POLICE PROTECTION	73	.070
SANITATION & SEWAGE	1	.001
ALL OTHER	644	.613
TOTAL	3753	3.574

The combined state and federal civilian employment for 1980 accounted for 6.3 percent of the civilian labor force. At a conservative estimate, government long distance telecommunications demand would be a corresponding percentage of total demand. However, government requirements for long distance communications services are several times higher than a strict per capita share would indicate. Government usage of telecommunications is both widespread and diverse, including many major special and general purpose voice and data networks. Among the federal agencies with large communications needs are the General Services Administraticn, the Postal Service, the Civil Corps of Engineers, the Department of the Interior, the Department of Transportatioon, and the Department of Defense.

The following discussion describes two large scale federal telecommunications applications, and considers the possible utility of CPS in these applications. The first is the Federal Telecommunications System (operated by the General Services Administration) which provides an example of a very large real-time voice and data federal network. The second is E-COM, which illustrates the use of telecommunications in deferred mode message applications relating to postal delivery. Lastly, a brief description of some typical state government telecommunications applications is presented.

3.2.1 THE FEDERAL TELECOMMUNICATIONS SYSTEM

The General Services Administration (GSA) of the federal government manages and operates the Federal Telecommunications Systems (FTS), one of the world's largest private line communications networks. It connects over a million telephones and thousands of computer and data terminals and has links to government agencies in all the states and in Puerto Rico. Table 3.2-3 compares the size of the GSA network with some other large private line systems, and Figure 3.2-1 shows its geographic extent [Ref. 3-3].

TABLE 3.2-3 LARGE PRIVATE LINE TELEPHONE SYSTEMS CIRCA 1980

ORGANIZATION	NO. OF TELEPHONES (THOUSANDS)	NO. OF TELEPHONE CALLS PER MONTH (MILLIONS)
GENERAL SERVICES ADMINISTRATION	1300	21.0
GENERAL MOTORS	200	5.5
GENERAL ELECTRIC	150	3.2
IBM	192	4.1
WESTINGHOUSE	70	2.0
FORD	80	2.4
HONEYWELL	35	1.7
ROCKWELL INTERNATIONAL	80	1.2
AMERICAN EXPRESS	40	1.1
XEROX	40	1.1
EXXON	35	1.0
DUPONT	40	1.1
ARCO	15	.5
AMERICAN AIRLINES	10	.5

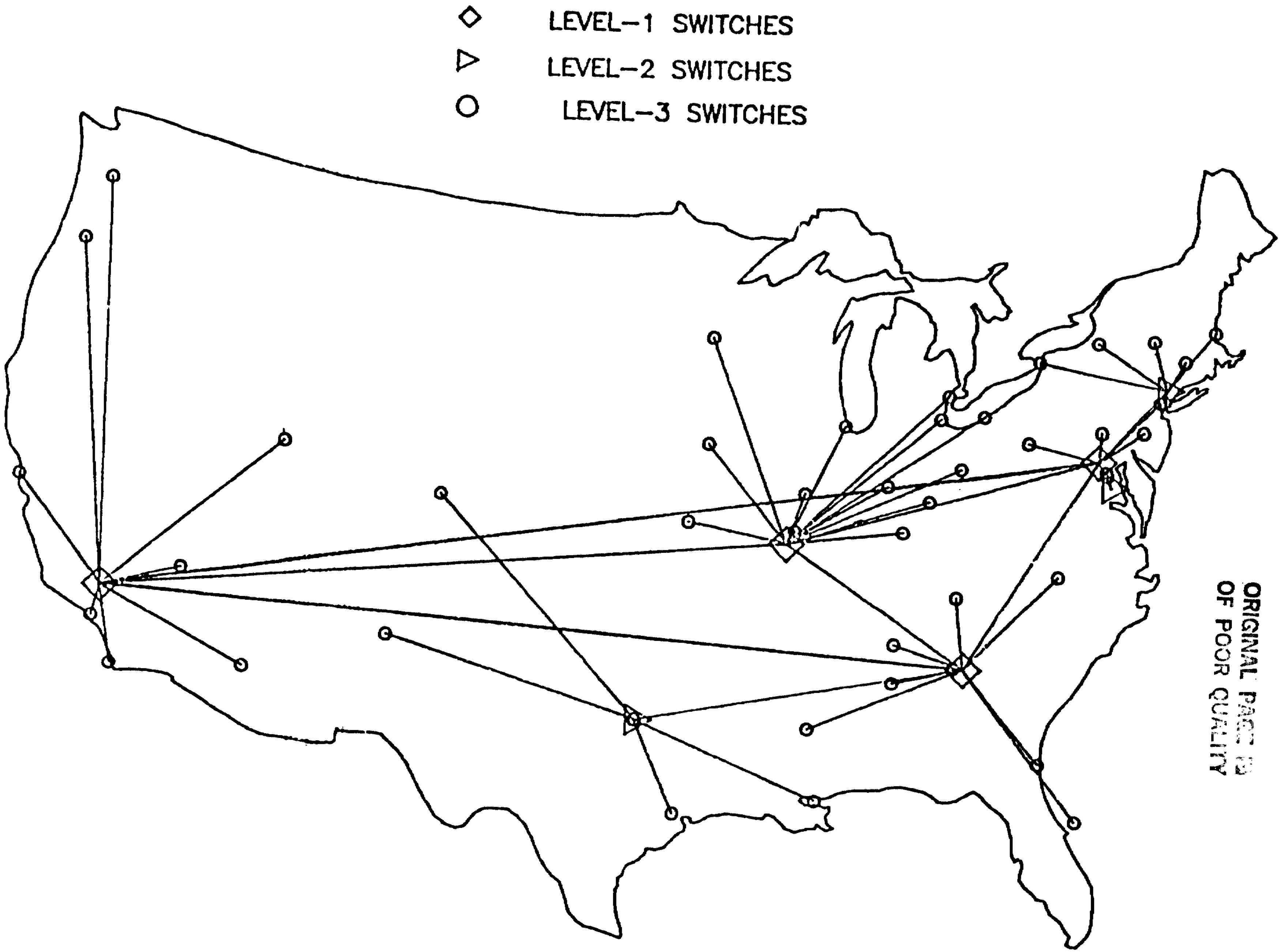


FIGURE 3.2-1 FEDERAL TELEPHONE NETWORK

The FTS is a Common Control Switched Arrangement (CCSA) network. CCSA networks use privately owned or leased lines dedicated to the network. The lines terminate at dedicated switches, located at the telephone companies' exchanges, which switch and route calls through the network. All stations connected to the private network may call one another without using the public or toll facilities. They may also dial outside the network via local, foreign exchange, or WATS lines. With this arrangement the FTS supplies federal agencies with a service similar to commercial long distance telephone service at about one-half the cost.

Table 3.2-4 summarizes some of the operating parameters of the Federal Telephone Network [Ref. 3-4].

TABLE 3.2-4 THE FEDERAL TELEPHONE NETWORK CIRCA 1979-1980
SOURCE OF DATA [REF. 3-4]

NO. OF INTER-CITY FED. ORIGINATED CALLS/YEAR*	220 MILLION
GROWTH RATE	7 PERCENT/YEAR
NUMBER OF SWITCHES*	54
NUMBER OF INTER-CITY LINES*	35,000
PERCENT OF INTERSWITCH TRUNKS VIA SATELLITE*	10 to 20 PERCENT
NUMBER OF LOCAL LINES*	25,000
NUMBER OF WATS LINES	2,500
NUMBER OF FOREIGN EXCHANGE LINES	3,000
NUMBER OF TIE LINES	5,000
AVERAGE DAILY TRAFFIC (24 HOURS)*	70,000 ERLANGS
BUSY HOUR TRAFFIC*	10,000 ERLANGS

*ADDITIONAL DATA VIA PRIVATE COMMUNICATIONS-JUNE 1982

Ten to twenty percent of the interswitch trunks are satellite derived, with the percentage in recent procurements lying near the upper end of this range. The satellite circuits handle voice traffic via uncompressed 64 Kbps digitized channels. The voice channels include echo cancellers, and are encrypted using the National Bureau of Standards Data Encryption Standard. Data signals are also transmitted over these channels via modems at rates up to 4800 bps.

While the FTS is referred to as a GSA provided service, the circuits, switches and other components of the system are leased or purchased from the telecommunications industry. The sale or lease of some portion of the transmission facilities of this network may, therefore, be an attractive target for telecommunications carriers able to offer suitable CPS satellite facilities.

The prime target for CPS transmission in the FTS is the backbone network of about 12,000 two-way voice grade lines linking 56 major switches throughout the United States. If implemented through a single satellite these lines would occupy all, or most of, the capacity of that satellite. With one ground station associated with each of the 56 switch locations, the average ground station would require a capacity of 214 lines. Actually, however, both the total number of lines and the average number of lines per node would be reduced in a satellite implementation because of the satellite's ability to directly link any two mutually visible nodes without traversing intermediate nodes. The switching arrangement also would probably be considerably modified and simplified if satellite implementation became widespread. Thus, implementation of a major portion of the FTS backbone network via satellite would involve major changes in the configuration of the network, but in principle could supply equal or superior connectivity and transmission capacity.

There are, however, a number of negative factors to consider relative to satellite implementation of a significant portion of the FTS backbone. First, this is a major network with a large investment in existing plant. Replacement of this plant would have to be evolutionary, and the interworking between terrestrial and satellite portions carefully worked out. Furthermore, much of the traffic on the system is critical in the day-to-day functioning of government. There undoubtedly would be a great deal of concern over vulnerablility to damage or jamming by unfriendly sources.

Similarly, if Ka band transmissions are considered, the problem of outages due to heavy rain must be addressed. In commenting on reliability problems in systems supplied by both tariffed carriers and interconnect vendors, Frank J. Carr, Commissioner for Automated Data and Telecommunications Services of the GSA, stated:

> "Service reliability is highly important to the government and we view the reported system outages as a major shortcoming of the industry." [Ref. 3-4].

In a network configuration of this type there is some question of whether the satellite configuration would be classified as CPS or as trunking. The earth stations located at the network nodes would be dedicated to supplying transmission capacity for the network and would play a CPS role to the extent that the nodes are considered to be the customers' premises. On the other hand, the transmissions fan-out to government facilities near the nodes in a configuration similar to trunking and also permits offnet calling. In either event, the definitional issue is of interest but is ultimately of lesser importance than the viability and practicality of the potential service. The FTS is an attractive target for CPS, but many obstacles will have to be overcome before such a system can successfully evolve.

3.2.2 POSTAL SERVICE

There is little doubt that the delivery of first class mail will increasingly depend on electronic transmission rather than the physical transport of paper documents. Private electronic mail systems using communicating word processors, home computers, and many other types of electronic terminals will account for some of this traffic, but a large amount of it will continue to be handled by the U.S. Postal Service. The Postal Service, therefore, has the potential to evolve into a major governmental consumer of telecommunications services.

The electronic transmission of mail between major postal centers is well matched to the capabilities of CPS systems for the following reasons:

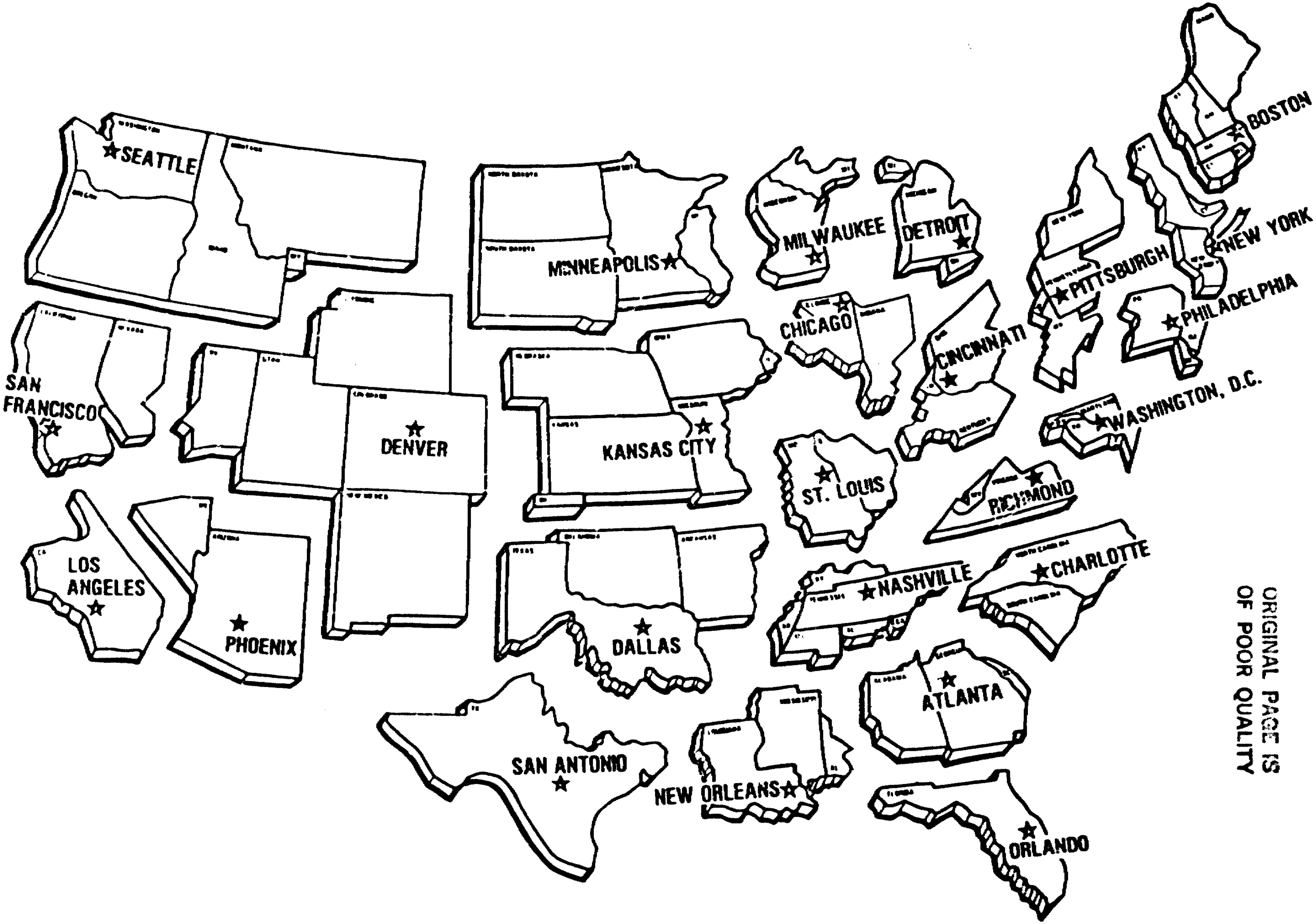
(a) High volumes of traffic are involved.
(b) Connectivity requirements are limited to a relatively few locations.
(c) Long distances are spanned, improving the cost effectiveness of satellite vs. terrestrial links.
(d) Facilities for the installtion of on-site earth stations are generally available.
(e) Delays in delivery from several hours to over one day are acceptable, allowing for efficient smoothing of traffic peaks and eliminating the rain outage problems that may be encountered with Ka band transmission.

A major step in the evolution of electronic postal transmission systems was taken with the recent introduction of Electronic Computer Originated Mail (E-COM) service. E-COM was inaugurated by the Postal Service as a subclass of first class mail on January 4, 1982. It is designed to serve high volume domestic mailers who generate mail from data stored in electronic form.

E-COM users are expected to include retail firms, banks, securities firms, insurance companies, credit unions, accounting companies, law firms, advertising agencies, wholesalers, credit card companies, utilities and any others who can produce messages via a computer. The types of computer generated messages presently envisioned include billings, invoices, intracompany correspondence, price lists, collection notices, statements, advertising/marketing messages, recall notices, and announcements.

Under its present configuration, twenty-five Serving Post Offices (SPOs), distributed throughout the contiguous forty-eight states, have been equipped with the machinery needed for E-COM. Figure 3.2-2 shows the location of the E-COM serving post offices and their service areas.

E-COM service is limited to mailers who generate at least 200 pieces of mail per transmission per destination SPO. Mailers with fewer than 200 pieces must use a telecommunications carrier who consolidates smaller mailings into one of the requisite size. When the messages reach the destination SPO, in electronic form, computers convert them into 8 1/2" x 11" plain white bond copy which is then automatically trimmed, folded, enveloped, and delivered as first class mail.



ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 3.2-2 E-COM SERVING POST OFFICE LOCATIONS AND SERVICE AREAS

Source [Ref. 3-5]

Messages are limited to two pages in length and may be transmitted to the destination SPO seven days a week, 24 hours a day, but are delivered during normal postal hours. Two day delivery service to the end user is provided. Charges are 26 cents for the first page of an E-COM message and 5 cents for the second page, including the costs of paper and envelope. The mailer must also pay for the telephone call and its own computer processing.

It is important to note that the SPOs are not electronically interlinked, and that the Postal Service does not provide telecommunications service to the destination SPO. It is the mailers' responsibility to arrange for the electronic transmission of the messages to receiving equipment at the destination SPO. This can be done by a dial-up connection to six access ports at each SPO. These ports are equipped with a variety of the most commonly used connection arrangements. An additional group of six dedicated ports are also provided at each SPO. These may be used by qualifying telecommunications companies.

Each telecommunications company awarded a dedicated access port has exclusive use of that port at a monthly cost which includes the expenses associated with the interface equipment requested by the company. The mailers then arrange with the telecommunications company for the transmission of their messages through the telecommunications facilities to the dedicated ports. At present only 16 companies have been certified to use the system and so far 70 percent of the messages have come from one company, Western Union Electronic Mail Inc., a division of the Western Union Corporation. It acts as a carrier for companies that do not want to do the computer processing and telephone transmission themselves. Western Union's charges range from 65 cents to $1.24 per message [Ref. 3-6].

E-COM service will accept three types of message formats:

(1) Single Address Messages in which a unique text accompanies each address.
(2) Common Text Messages in which a common text is accompanied by a list of addresses.
(3) Text Insertion Messages in which a common text

is accompanied by both a list of addresses and a unique text to be inserted in each printed message.

A variety of data protocols and transmission rates are supported by E-COM. The protocols include X.25, the most commonly accepted packet protocol; DDCMP, a commmunications protocol used by Digital Equipment Corporation on most of its widely used minicomputer systems; the 2780 and 3780 protocols encountered in IBM compatible systems; and, E-COM-A, an asynchronous protocol allowing dial-up connections for terminals with characteristics equivalent to TTY Models 33 or 35. ASCII and EBCIDIC alphabets are recognized and the capability of simple forms generation is provided. Data rates for public access via dial-up connections include 300 and 1200 bps asynchronous and 2400 and 4800 bps synchronous. Dedicated lines run at 2400, 4800 and 9600 bps synchronous and, for the New York and Chicago SPOs, a 56 Kbps synchronous link for DDCMP users exists. Table 3.2-5 summarizes the telecommunications interface capabilities of E-COM.

While E-COM is a step forward in the use of modern telecommunications by the Postal Service it nevertheless represents only a minor fraction of the potential application of telecommunications to the delivery of mail. Many of the limitations of E-COM appear to be the result of policy or regulatory restrictions rather than being due to fundamental technical or economic factors. Partly as a result of these limitations, volume in the first ten weeks of operation has been much lower than projected. The Postal Service had projected a first-year volume of at least 20 million letters, or 385,000 a week. Over the initial ten week period the average volume was only 6,650 a week [Ref. ?-6]. Total volume for calendar 1982 was 6.5 million letters, which over the year averages 125,000 pieces per week.

TABLE 3.2-5

E-COM TELECOMMUNICATIONS INPUT CAPABILITIES

Access Type	Protocol	Data Rates	Code	Access Means	Transmission Mode	Remarks
Public	E-COM-A	300 bps 1200 bps	ASCII	dial-up	Asynchronous	Available at all SPOs
	2780	2400 bps 4800 bps	EBCDIC	dial-up	Synchronous	Available at all SPOs
	3780	2400 bps 4800 bps	EBCDIC	dial-up	Synchronous	Available at all SPOs
Dedicated	2780	2400 bps 4800 bps 9600 bps	EBCDIC	direct point-to-point circuit	Synchronous	Available at all SPOs
	3780	2400 bps 4800 bps 9600 bps	EBCDIC	direct point-to-point circuit	Synchronous	Available at all SPOs
	X.25*	2400 bps 4800 bps 9600 bps	ASCII	via a Value Added Common Carrier	Synchronous	Available at all SPOs
	DDCMP**	56K bps 2400 bps*** 4800 bps*** 9600 bps***	ASCII	Direct point-to-point circuit or via a VACC	Synchronous	Available in New York and Chicago only; only 56K bps offered initially

* CCITT recommendation X.25, LAP.

** Digital Equipment Corporation standard.

*** These data rates not initially available; to be offered in near future.

SOURCE [REF. 3-7]

It is still too early to tell whether E-COM volumes will reach the originally anticipated levels or whether the limitations of the service will prevent its widespread acceptance. Whether implemented by the Postal Service or by private enterprise, it is reasonable, over a period of years, to expect expansion of telecommunications supported mail service in the following ways:

(a) Electronic transmission service directly to and from low cost terminals in home and office.
(b) Shorter than two day delivery capability.
(c) Capability for graphic transmission in addition to alphanumeric text.
(d) Adaptation to small users as well as large.
(e) Removal of page count limitation.
(f) Electronic mail transmission as widespread and conveniently available for the user as present paper based mail.

3.2.3 STATE GOVERNMENT TELECOMMUNICATIONS

The fifty states, and many of the larger counties and municipalities, are heavy consumers of telecommunications. About one-half of the states have statewide communications authorities which coordinate the procurement of communications services.

In 1974 a planning study was commissioned by the State of Michigan Department of Management and Budget [Ref. 3-8] which provided some detailed breakdowns of communications usages and projected needs. It appears from this study that the State of Michigan is reasonably representative* and provides a good example of conditions and projections typical of State government telecommunications usage among the large state governments. The State of Michigan's telecommunications network is briefly described in the following subsection.

3.2.3.1 STATE OF MICHIGAN TELECOMMUNICATIONS NETWORK

The State of Michigan planning study referred to above reviewed the status of communications in that state and projected needs through 1983. At the time of the study (1974) about $11 million, or one quarter of one percent of the state budget, was spent annually on telecommunications when costs for operating personnel are included. Roughly $8 million of the

*Michigan in 1980 ranks 23rd in area, 8th in population and employment, 6th in state expenditures and 8th in state employees.

1974 expenditures were for telecommunications equipment and services. A June 1982 communication from the Michigan Department of Management and Budget indicates the "annual telephone bill is now in the area of $19 million". This includes both equipment and usage, the major portion being for leased communication.

Figure 3.2-3 provides a breakdown of communications expenditures by type of service [Ref. 3-8]. Seventy percent of the 1974 telecommunications expenditures were for voice, 20 percent for data communications, and 10 percent for mobile radio. These figures have not changed significantly, and except for mobile radio, they are similar to those for business presented in Figure 3.1-3.

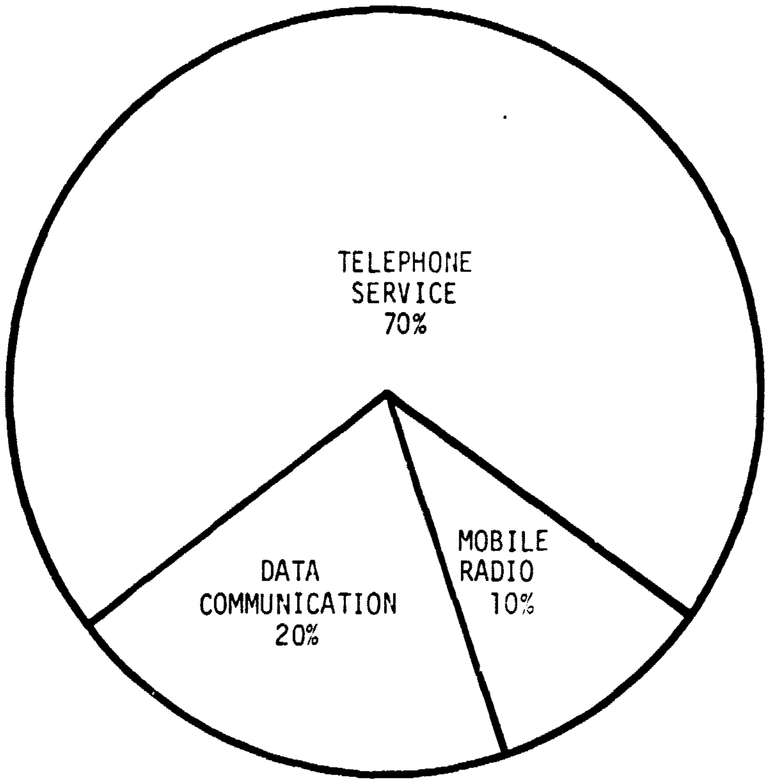


FIGURE 3.2-3 MICHIGAN TELECOM COSTS BY TYPE OF SERVICE (1974)

The major common carriers have historically supplied, installed, and maintained most telephone instruments, switchboards, etc., in Michigan's state telecommunications network. In 1974 only about one-seventh of external telecommunications expenditures were for non-common carrier purposes. The development of new specialized common carriers has opened alternatives for implementation of the state network and since cost consciousness is very apparent in the State's procurment policies, the outlook is for wider distribution of communications funds. However, the June 1982 communication cited above indicates that "specialized common carriers are not used to any extent" because most of the toll charges are for intrastate service, and the SCCs are for the most part interstate.

The existing state network has evolved in response to the total information transfer requirements of the departments and agencies served. The network concentrates the traffic flow geographically and permits economies of scale on dense traffic routes. For external communication (i.e., with the public) costs are reduced by the use of foreign exchange (FX) lines. For internal traffic (i.e., among government entities), the network includes leased lines for voice service plus data lines and various data terminal equipments.

The network configuration is radial with Lansing at the hub and with information flowing between the hub and various district offices, local offices, and the public. The leased line transmission systems consist of:

- An extensive dial-up common user network serving all departments.
- Individual networks of dedicated lines and special purpose circuits serving individual departments.

Figure 3.2-4 depicts the common user dial-up telephone network. The spokes of the network are leased lines which connect Lansing with the remote common carrier telephone exchanges at 16 major localities within the state. These remote offices are then used to complete the dialed-up connections without incurring long distance charges.

Calls can be made to and from the cities served by the leased lines. Outgoing calls from Lansing may be dialed to any number within the area served by the exchange at which the leased line terminated.

ORIGINAL PAGE IS
OF POOR QUALITY

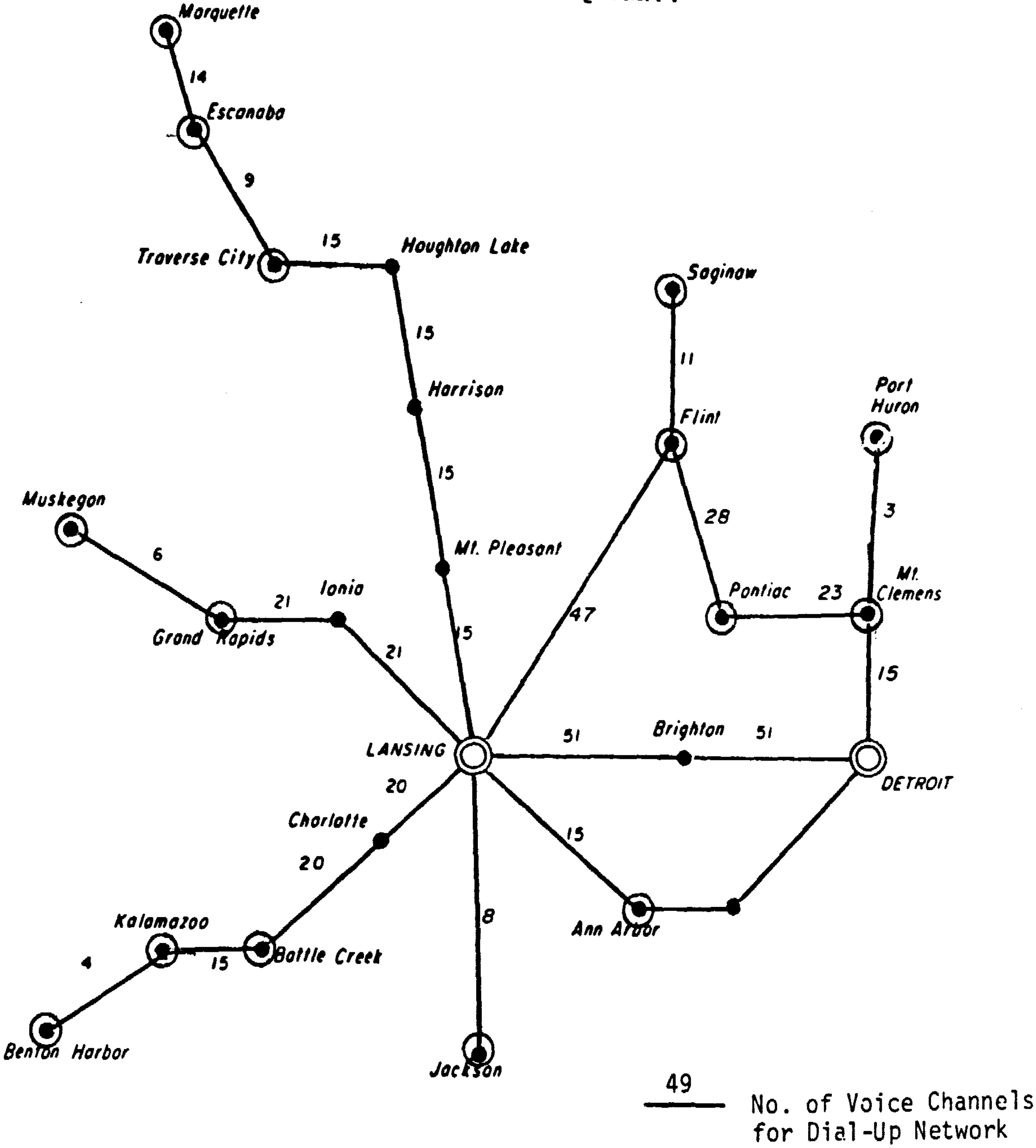


FIGURE 3.2-4 LEASED LINE NETWORK FOR COMMON-USER DIAL-UP SERVICE, STATE OF MICHIGAN 1974

Detroit users have access to the leased lines which terminate at Lansing. Leased line circuits between Lansing and Detroit are used to interconnect the Centrexes at these locations. This arrangement permits connections between Centrex subscribers in either of these cities by dialing a 5-digit number.

The common user network is supplemented by an out-WATS arrangement with 15 statewide and 12 limited area out-WATS lines originating at Lansing. Several departments also have in-WATS service for specific departmental operations.

Access to the public direct distance dialing (DDD) network is also available. However, efforts are made to restrict use of the DDD network to cases of urgency.

The common user dial-up leased line network is supplemented by a network of private lines requested by specific departments and dedicated to their exclusive use. The dedicated leased line network is shown in Figure 3.2-5. It provides administrative telephone service between departmental headquarters at Lansing and regional offices, and between state departments and particular localities pertaining to a department's operation.

The Departments of Highways, State Police, and Social Services are the largest users of voice private lines. To achieve economy the leased lines used for dedicated networks are included in a common pipeline with the leased lines used for the dial-up network.

Private lines are also used for remote access to computer data bases, and for the control of radio base stations serving mobile radio systems. The Departments of State, Social Services, and State Police are the largest users of private lines for data transmission. The Departments of Highways and State Police are the largest users of transmitter control lines. Figure 3.2-6 shows the data network configuration at speeds of 75, 150 and 1200/2400 bits per second.

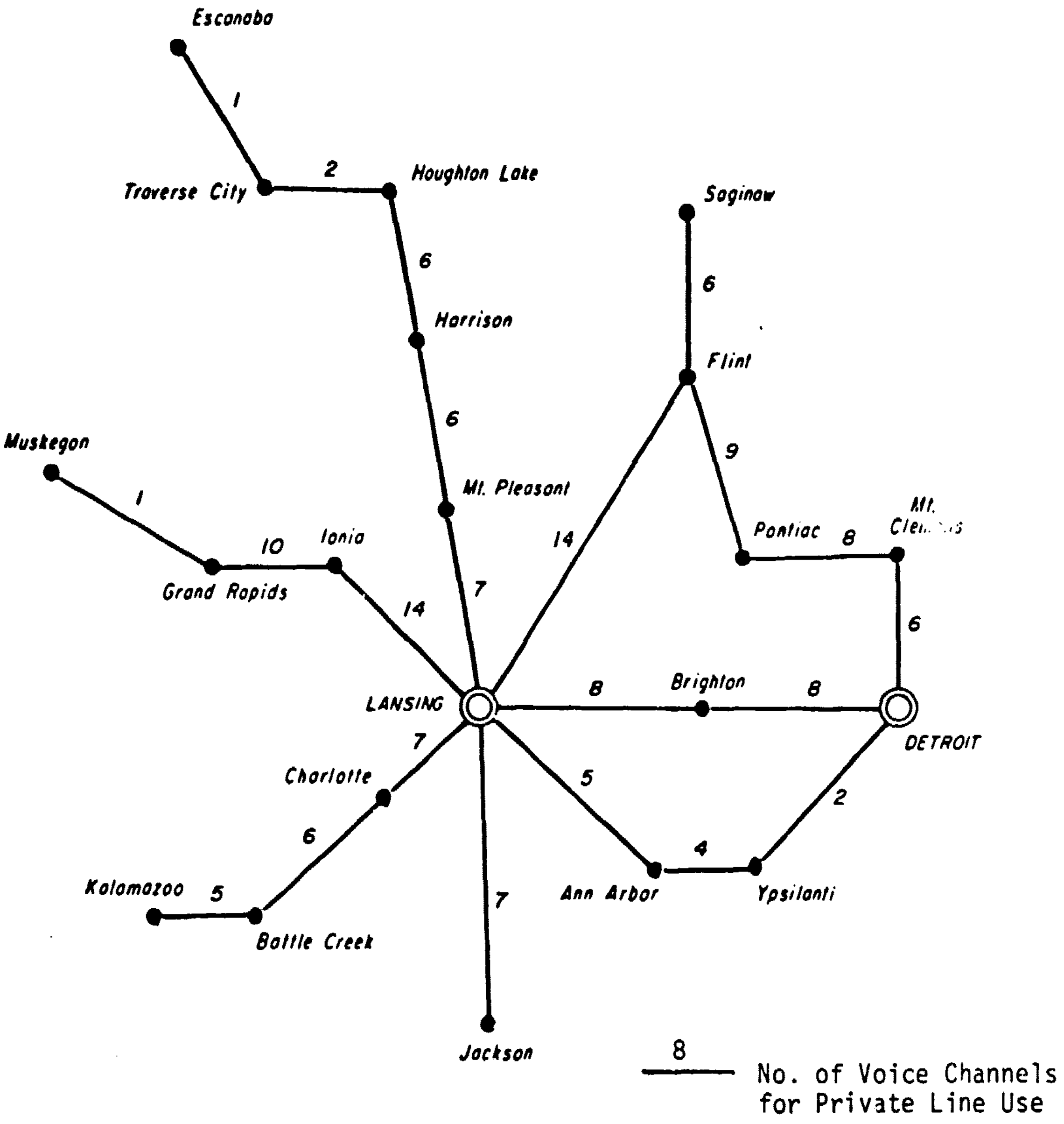


FIGURE 3.2-5 DEDICATED VOICE LINE NETWORK,
STATE OF MICHIGAN 1974

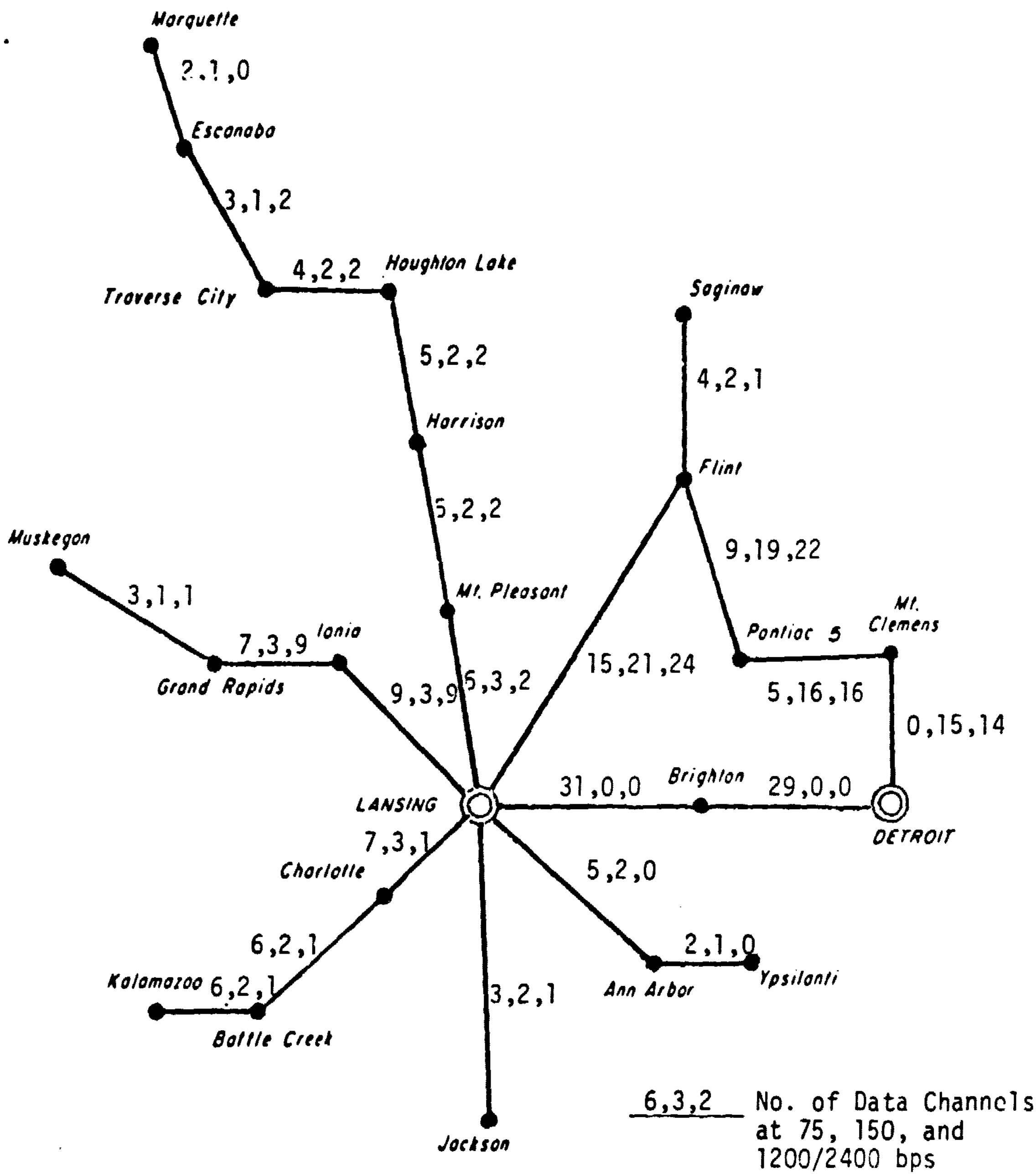


FIGURE 3.2-6 DATA LINES AT 75, 150 and 1200/2400 bps, STATE OF MICHIGAN 1974

The outlook for the use of CPS satellite transmission in state telecommunications networks like those in Michigan, or in other states with similar or larger communications needs, is basically favorable except that distances tend to be limited. Typically, there will be several nodes with large capacity requirements, and many with moderate requirements. In Michigan, for example, traffic requirements from Lansing are currently (1982) equivalent to about 300 two-way voice grade lines, about 50 of which link Lansing and Detroit, and with the remaining 250 going to twenty-two locations throughout the State.

Cost is of overriding concern for most state government telecommunications systems, and it would be necessary for CPS to be able to compete favorably in price with terrestrial media in order to prevail in this marketplace. This may be difficult due to the relatively short transmission distances generally encountered in intrastate communications. In Michigan, which is near the midpoint in the ranking of states by total area, the average airline distance between the state capital at Lansing and the other twenty-one cities in the network is 92 miles. The longest link (Lansing to Marquette) is 300 miles.

The communications services required in state applications are generally not complex and normal voice grade lines serve most of the applications. Reliability needs are modest except for some critical links in police and public safety applications. The wideband capabilities of CPS are probably not of major importance in most state applications, though growth of office-of-the-future technology should parallel that of the private sector. The availability of wide bandwidths through CPS may encourage teleconferencing uses in state government, but this will probably be a secondary rather than a primary justification for CPS. Teleconferencing applications, however, are advanced in the state university environment, as discussed subsequently in the section dealing with institutions. This may encourage similar usage in other branches of state government.

Overall, it appears that the key to introducing CPS transmission in the state government environment will substantially depend on the ability to provide a low cost, medium capacity, alternative to other transmission media.

3.3 INSTITUTIONS

This section discusses the communications requirements of institutional users and comments on the utility of CPS systems in these applications.

3.3.1 HIGHER EDUCATION

Institutions of higher education represent a significant fraction of the U.S. economy. In 1980 public and nonpublic colleges and universities spent 53.9 billion, or 2.24 percent, of the GNP [Ref. 3-9].

There were 2871 institutions of higher education in 1978 and about nine percent of these had branch campuses some distance from the main campus. Enrollment was 11.3 million and resident staff was 809,000 [Ref. 3-10].

In evaluating the role of CPS transmission networks in the college or university environment it is useful to consider two separate aspects of the problem:

(1) The institution as a quasi-business organization with voice, data and video requirements necessary for the logistic support of day-to-day operations.
(2) The institution in its special role as an education and research organization.

As a business-like enterprise the university must support the day-to-day telephone requirements of its staff and the data requirements of its billing, payroll and other support systems. In this respect it is very similar to any other business organization of comparable size and traffic volumes for these functions are probably best estimated on the basis of staff populations (0.8 percent of the labor force).

Bandwidths, data speeds, and other technical features of communications needed in support of the university's business activities also parallel those of the overall business community. Two exceptions to this general conclusion, however, are noted. Those universities with large resident student populations (5.2 percent of total U.S. population) must also provide for the communications needs of this population. Secondly, the universities' geographic dispersion tends to be more compact than that of typical large business organizations.

Most universities, including the nine percent with branch campuses, are contained within a single state, in contrast with the large number of businesses with establishments widely distributed across the nation. The potential cost advantage of satellites in long distance transmissions may therefore be less significant in the university environment than in the general business environment.

The basic research and educational role of institutions of higher education, as distinct from their day-to-day business-like operations, introduces some special telecommunications needs related to: (a) teleconferencing; and (b) sharing of remote computer resources. These needs are rapidly developing, and since they have potential significance with respect to CPS, are more fully discussed in the following subsections.

3.3.1.1 USE OF TELECONFERENCING

Colleges and universities are generally advanced in their use of teleconferencing. They routinely use a broad mix of conferencing equipment with capabilities ranging from audio to full-video. A 1979 survey [Ref. 3-11] of twenty-five universities (24 U.S. and 1 Canadian) indicated that eight utilize full-video conferencing via microwave facilities. Five of these eight also use CATV facilities for full-video conferencing. Of the twenty-five universities surveyed, twenty-one had ten or more conferencing sites.

Most of the universities surveyed use some form of audio conferencing supplemented in many cases by slide projections, charts, and other visual aids. However, more advanced teleconferencing technology is also in widespread use. Table 3.3-1 shows the usage of different technologies among these universities.

TABLE 3.3-1 USE OF ADVANCED TELECONFERENCING EQUIPMENT [REF. 3-11]

	IN USE 1979 OR PLANNED FOR 1980	UNDER CONSIDERATION	CONSIDERED BUT REJECTED	DISCONTINUED
FULL VIDEO	8	2	2	1
SLOW SCAN TV	0	3	2	1
FACSIMILE	3	3	4	0
GRAPHIC TABLETS	0	0	6	2
ELECTRONIC BLACKBOARD	1	6	4	1

(MULTIPLE RESPONSES. SELECTIONS SHOWN ARE NOT MUTUALLY EXCLUSIVE)

Rising tuition, lowered enrollment and the increasing costs of staff and travel are likely to encourage the use of teleconferencing to allow the institutions to reach larger audiences at modest cost. Except for the tendency for educational communications to be limited to moderate distances, CPS technology is a good candidate for providing the wideband videoconferencing facilities needed.

3.3.1.2 SHARING OF COMPUTER RESOURCES

Universities have consistently maintained a leading role in the development of data networks, and have been among the pioneers in the use of distributed data processing resources. On the campus, student and faculty needs for data processing have often been effectively met by using telecommunications to link several separate, moderately sized computer systems instead of relying on a single large centralized system.

A good example of the local-networking approach exists at Stanford University which uses a Decnet and an Ethernet for local wideband interconnection between Xerox personal computers and Digital Equipment Corporation (DEC) processors. The local network presently operates at 3 MHz and is being upgraded to 10 MHz to accommodate expanded access to other local DEC and IBM machines [Ref. 3-12]. The wideband local networks are geographically limited to a few miles because of the attenuation of the coaxial cable used for transmission. To span longer distances, gateways are needed to interface the local network with outside transmission networks. Many universities, including Stanford, have gateways to Arpanet, the DoD packet facility that was originally developed as a means of linking computer facilities of various university and research organizations.

Another example is provided by the MIT Computer Science Department which operates two local networks (at 1 Mbps and 10 Mbps) in addition to a Decnet, a 2 MHz Ethernet, and an MIT developed in-house network called Chaos. Each network interconnects a variety of large, small and midsize computers, many personal computers, and specialized peripherals like high speed multifont printers and book quality printers. Gateway connections to Arpanet are also included to allow more distant connections [Ref. 3-12]. The gateway functions discussed above are the main areas in which the potential for CPS transmission exists.

While still in its early development stages, the trend among universities and research organizations towards sharing of very high power, specialized computer resources by means of long distance data networks is clear. Outside the university environment, rapidly declining costs for computer hardware have, to some degree, lessened the need for resource sharing by making it economically practical to duplicate computer facilities where needed. In the university environment, however, there is a proliferation of large high speed computers with specialized and advanced hardware and software features which cannot be readily duplicated. The use of CPS links to support the wideband data signals needed for long distance access to these special facilities is a logical approach.

The campus environment is hospitable to the location of earth stations and favorable towards technical innovation, so that it is likely that colleges and universities will be at the leading edge in applying satellite technology to the sharing of computer resources.

3.3.2 HEALTH CARE

The health care activity in this country produces a massive amount of data. Most of this remains in the local area, but with the increasing use of computers in hospitals, telecommunication needs have been expanding.

In 1979 there were approximately 7,000 hospitals with a total of 1.4 million beds in the United States. Of these, 3749 had 100 beds or more [Ref. 3-13]. Expenditures in 1979 amounted to 8.9% of the GNP (9.4% in 1980)[Ref. 3-14]. While admissions and expenditures continue to grow, the number of hospitals and beds in the U.S. has been dropping from year to year. Consequently, the nation's hospitals are faced with problems similar to those of other business and service organizations. Demand and costs are rising, but facilities and qualified personnel are shrinking. Like other organizations, hospitals are looking to automation for solutions [Ref. 3-15].

There have been some suggestions for advanced technology uses of communications. For example, Dr. David G. Whitlock, Professor and Chairman of the Department of Anatomy at the University of Colorado Health Sciences Center, is sponsoring a program aimed at placing remote computerized tomography (CT) scanners in rural locations. The expensive central processing equipment associated with the scanner is kept in a central location to be shared by the remote units via satellite links [Ref. 3-16]. Under this approach a total CT scan unit costing in the $800,000 range can be replaced by remote units costing less than $100,000 each. The satellite links, conceived of as a megabit per second time-sharing channel, would carry the digitized picture from the remote scanners to the central location for computer processing and analysis by specialists who would interact in real time with physicians at the remote site. When not functioning as a CT channel the satellite equipment would be available for general consultation, educational programming, and administrative and management exchange.

While many other advanced technology approaches that may require special communications are under consideration, the general run of medical applications has concentrated on two areas:

(1) Interactive diagnostics which extend the expertise of medical center physicians into remote areas hundreds of miles away.
(2) Educational applications for doctors, nurses, technicians and other health industry personnel.

Several hospitals have used interactive satellite communications for diagnostic consultation between remote areas and a central medical facility. A prime example is the Alaska Area Native Health System centered in Anchorage. Using the ATS-1 satellite, 29 isolated communities are in daily voice contact with the Anchorage Native Health Center. A recent experiment using ATS-6 to supply a full-motion television channel clearly established the superiority of the video capability in these diagnostic situations [Ref. 3-16].

Millions of doctors, nurses and other health care personnel are required to complete accredited continuing education (CME) during their registration cycle. Many hospitals, medical schools, and professional organizations are now producing CME programming for media distribution. The Public Service Satellite Consortium (PSSC) is spearheading a program to consolidate the efforts of several organizations for the distribution of accredited CME prgramming via satellite. The PSSC uses the Public National Television Satellite System to distribute material to the more than 250 hospitals and 15 medical schools currently on health television networks.

A number of administrative and management uses of telecommunications have been proposed, and most can use satellite as well as other telecommunications facilities. Growth in this area is expected to increase as standardized practices (such as the new standardized business form UB-16 used for billing federal patients) become prevalent. The increasing use of computers and local networks in the hospital environment will also accelerate remote applications. As an example, the maintenance of state or national level data banks for medical records has been proposed for use in conjunction with school-age childrens' immunization records.

CPS systems are capable of competing for these health related applications. The largest traffic volumes are likely to evolve in response to the video requirements associated with diagnostic, educational and teleconferencing applications. The wide bandwidths, and the frequent need to locate one end of the link in inaccessible areas, are requirements that are well adapted to CPS operation.

Problems of cost effectiveness, acceptability to health care providers, and standardization of procedures, are issues which are currently being addressed in a number of programs. The resolution of these issues may be expected to lead to significant growth in an area in which CPS technology can offer important technical and social benefits. The volume of traffic produced by these activities, however, is expected to remain small.

3.4 PRIVATE USERS

Many signs point to the rapid growth of advanced telecommunications in home applications. The role of CPS satellite transmissions in this environment, however, is less clear. Direct broadcast of television signals from satellites to home roof-top antennas is an important application that is not far off. The satellite systems designed for this purpose will, however, provide receive-only, broadcast transmissions. They are not likely to include the interactive two-way features of the CPS systems considered in this study.

CPS designs that permit two-way interaction must, of course, include transmission capabilities as well as receive capabilities. This requirement increases earth station complexity and cost by a significant factor. Private users will not often have transmission volumes high enough to justify these costs and consequently demand from individual homes for direct use of CPS capabilities is likely to remain negligible. Private users, however, will increasingly be the recipients of telecommunications services brought to them through service providers and some of these service providers are potential customers for CPS.

Table 3.4-1 lists some of the newer types of service that exist or are on the horizon. Local distribution methods include phone lines, cable and microwave broadcast. The home terminals may be ordinary telephones, TV sets, personal computers, CRT monitors, printers, facsimile units, or special purpose devices.

TABLE 3.4-1 NEW TELECOMMUNICATIONS SERVICES TO THE HOME

TYPE	EXAMPLES
INFORMATION RETRIEVAL	DOW JONES, THE SOURCE, COMPUSERVE, VIDEOTEX, YELLOW PAGES
TRANSACTIONAL SERVICES	TICKETS, BANKING, CATALOG SHOPPING
MESSAGE	HARDCOPY, STORED VOICE, MAIL, FAX
TELEMONITORING	FIRE AND BURGLARY ALARMS, MEDICAL

Despite the growing public awareness of these new services, and the high volumes of usage that may evolve, the prospects for CPS are modest. For most applications of this type the bulk of the transmission volume takes place in the local area. In many cases local data bases in large population centers will be maintained and long distance transmissions will be needed only for occasional data base updates.

It is possible that high volumes may emerge in business/household and household/household electronic mail applications. For example, a decrease in the costs of facsimile terminals and a favorable regulatory climate may encourage the development of mail services which bypass the Postal Service. Networks of this type are presently under consideration in Japan [Ref. 3-17]. One logical approach would be for service providers to concentrate and store local area transmissions for later long distance transmission to the destination city via CPS facilities.

While applications such as those discussed above may excite a large amount of public interest, it appears that the opportunities for CPS in the private user market are likely to be small.

4.0 PRIMARY RESEARCH SURVEY

This chapter presents the results of the primary research survey performed under this contract. The survey solicited information from a wide range of communications users and providers to supplement the documentary research discussed earlier. The results of the survey were used to quantify the magnitude and interrelationships of various market factors which influence the forecasts and models developed in this study.

4.1 OBJECTIVES

The primary research effort reported here obtained direct inputs from the end users of voice, data and video services in order to accomplish the following objectives:

4.1.1 DETERMINE SERVICE CATEGORY AND USER CLASS INTERRELATIONS

Forecasts of market demand are done most accurately at the highest level of aggregation. Following a "step-down" process, individual components of market demand can then be estimated within the overall totals by interpolation, based upon observed relationships between the driving factors influencing the overall demand. In order to quantify these relationships, primary information concerning the present and likely future volumes of traffic in each of the subject service categories was gathered from a representative sampling of the users and potential users.

4.1.2 OBTAIN USER ATTITUDES TOWARD CPS

In order to interpret user-supplied estimates of future telecommunications demand it is essential to be able to gauge the attitudes, perceptions, and underlying factors which motivate users to choose one communications technique over another. These factors operate at technological, economic, and psychological levels to produce the actual demand decision. The survey of end users was designed to explore the strength and direction of each of these levels, and to determine the trade-offs between them.

4.1.3 DETERMINE CPS-FAVORABLE CHARACTERISTICS OF USER TRAFFIC

It was expected that not all classes of users might find Customer Premises Services an equally useful alternative. One of the objectives of the survey was to determine the users' perception of the benefits and disadvantages of CPS.

4.1.4 CHARACTERIZE SERVICE CATEGORIES

For the purpose of interpolating overall service demand, each of the three major service categories was divided into two subcategories. Thus, voice traffic is separated into private line (dedicated) traffic, and public access (switched) traffic. Data traffic is separated into computer and message subcategories. Video traffic, while also separated into subcategories of one-way video and two-way video elsewhere in this report, is treated as a single category in the primary research summary, because of the relatively low present incidence of use.

4.1.5 CHARACTERIZE USER CLASSES

Census data was used to design the survey sample. The survey attemped to include representative populations of each of the important user classes by industry and by geographic distribution.

4.2 METHODOLOGY

Inputs obtained directly from the end users of a service are, if properly based and interpreted, the most valid type of market information available. The principal problem in gathering and evaluating primary information derives from the user himself, his perception of the questions asked and his basis for providing information. Particularly in the telecommunications market, much of the user's demand for telecommunications is in fact a demand to perform some basic information transfer function.

Telecommunications provides the channel through which this transfer can be accomplished but is secondary to the basic information transfer need. Thus, in order to get a fundamental understanding of future telecommunications demand, particularly for new or rapidly growing services, the primary research must look beyond the telecommunications function and into the ultimately required information function.

The success or failure of the primary research depends on the ability to:

(a) Find the individual in an organization who may be in a position to understand these information functions.

(b) Identify the degree to which the contacted individuals truly understand these functions.

(c) Communicate with a common level of understanding between the knowledgeable individual and the researcher.

In order to achieve these ends, a professional market research organization with previous successful experience in the telecommunications market was enlisted to design, conduct, analyze and interpret the survey.

4.2.1 UNIVERSE TO BE SURVEYED

A limiting parameter in the planning of a field survey is the size of the survey (relative to the potential user population under study) which can be conducted within practical budgetary bounds. It is necessary that the survey design be highly efficient and interface to the greatest extent possible with ancillary sources of data to maximize the information inputs obtained for each resource dollar expended. Table 4.2-1 shows the number of establishments in the U.S. based on Bureau of the Census data [Ref. 4-1].

TABLE 4.2-1 USER POPULATION (ESTABLISHMENTS) (000s)

	CATEGORY TOTAL	ESTABLISHMENT SIZE*		
		LARGE	MEDIUM	SMALL
BUSINESS	3,596	10	425	3,161
MANUFACTURING	311	6	105	200
TRANSPORTATION	141	1	15	125
WHOLESALE/RETAIL	1,573	1	182	1,390
UTILITIES	14	0.2	4	10
FINANCE/INSURANCE	393	0.7	36	356
SERVICES	1,164	1.4	83	1,080
GOV'T. & INSTITUTIONS	163			
FEDERAL	0.2			
STATE	1			
LOCAL	65			
EDUCATION	88			
MEDICAL	9			
HOUSEHOLDS**	76,000			

* LARGE = MORE THAN 500 EMPLOYEES
MEDIUM = 20-500 EMPLOYEES
SMALL = LESS THAN 20 EMPLOYEES

** INCLUDES HOMES, FARMS, APARTMENT AND CONDOMINIUM COMPLEXES.

The broad categories used in this table could have been segmented into smaller groups, each with its own characteristic telecommunications requirements, but at the possible loss of some degree of certainty in its statistical significance. Instead, the design was selected to permit a comprehensive geographic distribution of respondents in order to identify any underlying geographic effects of telecommunications demand, both now and in the future. For this purpose, the grouping of size classes was adjusted to provide a better distribution between the numbers of large, medium, and small organizations by geographic region.

The survey sample shown in Table 4.2-2 was then drawn. It is intentionally weighted toward the larger organizations which tend to have more extensive requirements for long distance communications. Weighting in the sample design has also been given to the knowledgeable respondent within the user organization as opposed to ultimate end users of telecommunications services. This may be seen in the relative mix of interviews with communications managers as opposed to application managers (i.e., managers within an organization whose primary function is more than half-time concerned with some other aspect than telecommunications management).

Respondents' job titles do not necessarily indicate the scope of their telecommunications responsibilities. Thus, while Table 4.2-3 indicates that only 35% of the user respondents had communications-related titles, in fact all had communications-related responsibilities.

Most had responsibility for more than one service category, as indicated in Table 4.2-4. The fact that more had responsibility for data communications than voice communications is a function of the survey sample, not of the distribution of responsibilities of communications managers in general. In many of the organizations surveyed, the most knowledgeable individual about the broad range of telecommunications applications tended to be the MIS/EDP manager, rather than the individual responsible for voice communications. This apparent imbalance is one of the factors that has been taken into account in developing the service category interpolation factors described later.

TABLE 4.2-2 USER RESPONDENT DISTRIBUTION BY SIZE AND RESPONSIBILITY

USER CLASS N = 308	ORGANIZATION SIZE			RESPONSIBILITY		
	LARGE 1000+ EMPLOYEES	MEDIUM 100-499 EMPLOYEES	SMALL 1-99 EMPLOYEES	APPLI-CATION MANAGER	COMMUNI-CATION MANAGER	NO ANSWER
TOTAL	224	56	28	62	240	6
BUSINESS SUBTOTAL	183	50	23	48	202	6
MANUFACTURING	88	11	7	19	86	1
TRANSPORTATION	10	6	2	3	15	0
WHOLESALE/RETAIL	29	14	6	14	34	1
UTILITIES	17	0	0	4	12	1
BANK/FINANCE/ INSURANCE	20	9	3	3	28	1
SERVICE	19	10	5	5	27	2
GOV'T/INSTITUTION SUBTOTAL	41	6	5	14	38	0
FEDERAL	9	0	0	2	7	0
STATE	7	1	0	2	6	0
LOCAL	9	3	0	3	9	0
EDUCATION	10	2	2	4	10	0
MEDICAL	6	0	3	3	6	0

TABLE 4.2-3 RESPONDENT TITLE CATEGORIES

TITLE	NUMBER OF RESPONDENTS
GENERAL MANAGEMENT	96
FINANCIAL MANAGEMENT	18
MIS/EDP MANAGEMENT	60
APPLICATIONS MANAGEMENT	8
COMMUNICATIONS MANAGEMENT	58
COMMUNICATIONS TECHNICAL STAFF	50
OTHER, INCLUDING UNSPECIFIED	18
TOTAL	308

TABLE 4.2-4 COMMUNICATIONS RESPONSIBILITIES OF USER RESPONDENTS

RESPONSIBILITY	PRIMARY FUNCTION*	SECONDARY FUNCTION**
DATA COMMUNICATIONS	73.8%	82.3%
VOICE COMMUNICATIONS	67.9%	56.5%
MIS/DATA PROCESSING	42.5%	43.5%
OFFICE AUTOMATION	41.3%	29.0%
COMMUNICATING WORD PROCESSING	33.8%	24.2%
VIDEO CONFERENCING	21.7%	6.5%

NOTE: MULTIPLE RESPONSIBILITIES PER RESPONDENT
* N = 240 INDIVIDUALS LISTED ONE OR MORE SERVICE CLASS AS THE MAJOR ASPECT OF THEIR POSITION. ** N = 62 INDIVIDUALS WHO LISTED ONE OR MORE SERVICE CLASSES AS A MINOR ASPECT OF THEIR POSITION.
(6 INDIVIDUALS DECLINED TO QUANTIFY THEIR RELATIVE RESPONSIBILITIES.)

Data applications comprise both computer-related data and message-related data. User respondents were asked to indicate their five largest data applications from the list shown in Table 4.2-5, with the results producing the ranking of computer-related data plications in the top half of the frequency distribution, and message-related data applications in the bottom half. While this general distribution reflects the true overall traffic volume, the individual rankings more likely reflect the particular respondents surveyed.

TABLE 4.2-5 MOST FREQUENTLY MENTIONED DATA APPLICATIONS
(BY PERCENT OF RESPONDENTS)

APPLICATION	TOTAL	BUSINESS SUBTOTAL	GOVT/INST SUBTOTAL
DATA ENTRY	53.2%	49.5%	71.2%
DATA INQUIRY	49.4%	43.8%	76.9%
INTERACTIVE COMPUTING	42.9%	37.1%	71.2%
REMOTE JOB ENTRY	37.7%	34.4%	53.8%
COMPUTER TO COMPUTER	27.9%	25.4%	40.4%
ADMINISTRATIVE MESSAGES	19.8%	17.6%	30.8%
TELEX/TWX	12.7%	13.7%	7.7%
COMMUNICATING WORD PROCESSOR	12.0%	9.8%	23.1%
FACSIMILE	11.0%	10.9%	11.5%
INTELLIGENT COPIER	2.9%	3.1%	1.9%

MULTIPLE RESPONSES POSSIBLE, N = 308; NO ANSWER = 34.7%

Two special cases needed to be handled in the sample design. The first is the class of organizations that are very large generators of communications traffic, because they are providing this very service to users. This group includes organizations such as non-Bell common carriers, as well as companies providing information and data base services, broadcasting, and video conferencing.

The second case relates to the difficulty of adequately sampling the household class of users, who are not sufficiently knowledgeable to furnish a reliable demand requirement for services not presently available or readily distinguishable. However, the providers of household-related services (such as broadcasters and common carriers), as well as certain "expert witnesses" included in the "other" category, serve as proxies for the household class. The resulting distribution of 62 providers is shown in Table 4.2-6.

TABLE 4.2-6 PROVIDER RESPONDENT DISTRIBUTION BY SIZE

	SIZE		
PROVIDER CLASS N=62	LARGE 1000+ EMPLOYEES	MEDIUM 100-999 EMPLOYEES	SMALL 1-99 EMPLOYEES
TOTAL	30	13	19
COMMUNICATIONS SERVICES SUBTOTAL	21	8	4
COMMON CARRIERS	13	3	4
BROADCASTERS	4	4	-
INFORMATION SERVICES	4	1	-
SPECIAL SERVICES SUBTOTAL	9	5	15
VIDEO CONFERENCING	1	3	6
DATA BASE SERVICES	5	1	6
OTHER	3	1	3

The primary distinction in the field survey, therefore, is between the 308 "users" of telecommunications services, and the 62 "providers" of telecommunications services. Standard SIC categories [Ref. 4-2] were used to define the subclasses shown in Table 4.2-7.

TABLE 4.2-7 SUBCLASS COMPOSITION

INDUSTRY GROUP	SIC CODES INCLUDED
BUSINESS	
MANUFACTURING	2011-3999
TRANSPORTATION	4011-4789
WHOLESALE/RETAIL	5012-5999
UTILITIES	4911-4971
BANKING/FINANCE/INSURANCE/ REAL ESTATE	6011-6799
SERVICES	7011-7369, 7391-7999, 8111, 8911-8999
GOVERNMENT	
FEDERAL	9111-9721
STATE	By Jurisdiction
LOCAL	As Applicable
INSTITUTIONS	
EDUCATION	8211-8299
MEDICAL/HEALTH SERVICES	8011-8091
COMMUNICATIONS SERVICES	
COMMON CARRIERS	4811-4821
BROADCASTERS	4832-4833
INFORMATION SERVICES	7372-7379
SPECIAL SERVICES	
VIDEO CONFERENCING	As Appropriate
DATA BASE SERVICES	To Designated
OTHER	Sub-Group

Table 4.2-8 shows the distribution of respondents by geographic census region. The survey was limited to the contiguous 48 states. All census regions have been represented, but the uneven distribution reflects industry concentrations, particularly of manufacturing establishments in the mid-Atlantic and east north central regions of the U.S.

TABLE 4.2-8 RESPONDENT DISTRIBUTION BY U.S. CENSUS REGION

REGION	USERS N=308	PROVIDERS N=62
NEW ENGLAND	34	5
MID ATLANTIC	75	11
SOUTH ATLANTIC	37	7
EAST SOUTH CENTRAL	11	5
WEST SOUTH CENTRAL	8	2
EAST NORTH CENTRAL	59	9
WEST NORTH CENTRAL	17	4
MOUNTAIN	12	5
PACIFIC	21	7
UNCLASSIFIED	34	7

4.2.2 SURVEY DESIGN

A combination of on-site and telephone interviews was selected to strike a balance between the level of common understanding which can be achieved in a face-to-face interview and the practical economics of a large interview sample. The on-site interview program comprised the first thirty-five interviews, and was conducted by senior, experienced telecommunications professionals. This phase demonstrated the feasibility of obtaining the desired information from the respondent group, and also produced a few minor changes in the sequence and format of the questionnaires.

The on-site interview program incorporated additional free-form background questions and discussion at the discretion of the interviewer to determine the level of common understanding achievable and the qualify of information obtainable. Further clarification of present and potential application requirements was obtained that would later assist in the interpretation of data from the telephone interview program.

A team of experienced telephone interviewers was then trained in the necessary telecommunications concepts and the administration of the telephone questionnaires. The 335 telephone interviews were conducted over a period of twelve weeks in five successive waves, until the desired sampling distribution had been achieved. Altogether, the interviewing phase extended from February to June, 1982.

4.2.3 QUESTIONNAIRE DESIGN

The primary concept governing the design of the questionnaire was to incorporate multiple independent approaches to derive and validate the basic data. The ultimate goal was to arrive at a series of volume of traffic estimates that could be related to other independently verifiable user population characteristics whose growth or change over time was known. The characteristic that was most useful as a surrogate for estimating traffic volumes (because it can be readily interpolated across the various user classes) was the relationship between numbers of employees and the usage of the various service categories of telecommunications.

Thus it was necessary to obtain accurate data for each respondent organization on its present (1981) and future (1986) numbers of telephone handsets, trunk lines, long distance private lines, WATS lines (or equivalent), and time and dollar volumes of voice traffic. For computer data traffic, it was necessary to know the number of data communication terminals, lines, speeds, and volumes of data traffic in minutes and/or characters per day. For message traffic, it was necessary to know the number of devices in use and the volume of traffic carried by each. Answers to these questions were validated by other studies that have reported usage statistics, and relationships were computed between usage statistics and employment characteristics for each respondent and for the user classes represented.

The questionnaires also sought supporting information on telecommunications budgets, geographic distribution patterns of traffic, types of telecommunications and video applications in use or expected, factors that might have an impact on CPS feasibility (e.g., number of organizational locations, physical site descriptions, outage requirements, suitability for shared versus dedicated use, cost sensitivity). The nature of the user's experience with other common carriers (OCCs) in general, and satellite telecommunications in particular, was also explored.

Two separate but related questionnaires were used, one to survey the user population directly, and the other to survey the provider population. In the latter case, information was sought concerning both the provider's own characteristics as well as those of the provider's customers.

4.3 PRIMARY RESEARCH FINDINGS

Some of the data obtained from the field survey is meaningful directly as reported, while other data needs further processing or interpretation before proper conclusions can be drawn. The following summarizes the significant findings of the survey.

4.3.1 VOICE TRAFFIC CHARACTERISTICS

Factors useful in estimating voice traffic volumes include the distribution of handsets shown in Table 4.3-1 and the distribution of various types of voice lines shown in Table 4.3-2. Reported volumes of voice traffic in minutes or dollars per day were interpreted and converted to "per handset" and "per line" equivalent ranges for each of the respondent size classes. Per employee averages were derived and aggregated across all service classes and correlated with known total volumes of traffic.

TABLE 4.3-1 DISTRIBUTION PATTERN OF TELEPHONE HANDSETS

NUMBER OF HANDSETS	PERCENTAGE OF RESPONDENTS
1-9	1.6%
10-24	3.9%
25-99	8.4%
100-249	5.5%
250-999	14.6%
1000-2499	11.7%
2500-4999	7.8%
5000-9999	5.2%
10000+	6.2%
UNKNOWN	35.1%

TABLE 4.3-2 DISTRIBUTION PATTERN OF VOICE LINES

QUANTITIES OF EQUIPMENT	PERCENTAGE OF RESPONDENTS UTILIZING STATED EQUIPMENT TYPE			
	TRUNK LINES	LONG DISTANCE PRIVATE LINES	OUT WATS LINES	IN WATS LINES
NONE	2.9%	12.7%	13.6%	22.7%
1-9	10.0%	16.2%	23.0%	21.1%
10-24	8.8%	4.9%	10.7%	9.4%
25-99	11.7%	12.3%	10.1%	6.5%
100-249	8.1%	5.5%	3.9%	1.9%
250-999	8.1%	3.6%	1.6%	0.6%
1000+	4.9%	1.6%	0.3%	0.3%
UNKNOWN	45.5%	43.2%	36.6%	37.4%

4.3.2 DATA TRAFFIC CHARACTERISTICS

Data communications facilities were surveyed to determine the type of equipment used, the type of lines available, specialized communication equipment employed, and the volumes of traffic transmitted or received in either minutes or characters per day. The distributions of communications equipped data terminals and various categories of data communication lines are shown in Table 4.3-3.

These figures need to be factored by both transmission speeds and time in use to arrive at overall usage patterns. In all user classes a shift from the slower speed categories to higher speeds is evident, as shown in Table 4.3-4. Since most users transmit data in more than one category, the unweighted averages reported do not total to 100%.

4.3.3 VIDEO TRAFFIC CHARACTERISTICS

Few end users could speak from direct experience about video traffic volume characteristics. None were found who presently budget video communication expenditures as a separate item. In addition to the end users, the survey included information providers whose services were approximately evenly divided between video, message, and data, with the distribution shown in Table 4.3-5. This tends to emphasize the role of video and this situation has been taken into account in developing the forecast factors.

Transmission media used to deliver the provider's principal service currently emphasize wire, but a substantial representation of microwave and satellite services is shown in Table 4.3-6. Among the particular respondents interviewed who offer videoconferencing as a principal service, 25% offer two-way freeze frame mode, 75% offer two-way full motion mode, and all offer one-way video full motion.

TABLE 4.3-3 DISTRIBUTION PATTERN OF DATA EQUIPMENT

QUANTITIES OF EQUIPMENT	DATA TERMINALS	PERCENTAGE OF RESPONDENTS UTILIZING STATED EQUIPMENT TYPE			
		LEASED DATA LINES	MTS DATA LINES	DDS DATA LINES	PACKET LINES
NONE	2.9%	8.4%	33.1%	10.6%	50.0%
1-9	7.1%	23.3%	4.2%	10.6%	3.8%
10-24	6.2%	8.1%	1.9%	2.6%	0.3%
25-99	12.9%	14.0%	3.1%	3.9%	1.6%
100-249	11.4%	2.9%	-	-	-
250-999	11.7%	2.3%	-	-	-
1000+	6.2%	-	-	-	-
UNKNOWN	41.6%	40.9%	57.5%	47.1%	44.2%

TABLE 4.3-4 PERCENT OF DATA COMMUNICATIONS TRAFFIC BY TRANSMISSION SPEED

USER CLASS	1981			1986		
	0-1200 BPS	1201-9600 BPS	OVER 9600 BPS	0-1200 BPS	1201-9600 BPS	OVER 9600 BPS
	AVERAGE PERCENT	AVERAGE PERCENT	AVERAGE PERCENT	AVERAGE PERENT	AVERAGE PERCENT	AVERAGE PERCENT
BUSINESS SUBTOTAL	23.524	78.052	6.454	22.300	76.336	15.173
MANUFACT.	17.102	84.255	6.000	19.106	81.958	14.136
TRANSPORTATION	15.545	83.400	9.900	11.909	84.000	18.364
WHOLESALE/ RETAIL	32.737	65.000	1.500	29.611	63.476	6.250
UTILITIES	15.462	84.286	0.273	12.385	77.929	3.455
BANK/FIN./ INSURANCE	15.629	91.933	16.583	13.769	77.929	32.333
SERVICES	46.368	61.455	6.600	43.000	70.571	18.071
GOVT/INSTITUTION SUBTOTAL	29.523	64.979	12.450	23.791	69.600	22.225
FEDERAL	72.333	59.000	26.286	79.000	61.500	40.000
STATE	20.375	66.875	0.625	7.125	80.250	3.750
LOCAL	13.000	82.000	0.000	10.727	85.818	1.111
EDUCATION	25.385	52.154	17.667	12.083	53.364	33.300
MEDICAL	38.167	66.714	24.250	38.167	66.714	39.200

TABLE 4.3-5 PRINCIPAL SERVICE PROVIDED

SERVICE TYPE	PERCENT OF RESPONDENTS
NETWORK TV	9.7%
CATV	6.5%
VIDEO CONFERENCING	9.7%
EDUCATIONAL VIDEO	1.6%
MESSAGE SERVICES	32.2%
COMPUTER SERVICES/DATA BASE	25.9%
OTHER	14.6%

TABLE 4.3-6 TRANSMISSION MEDIUM OF PRINCIPAL SERVICE

TRANSMISSION MEDIUM	PERCENT OF RESPONDENTS
TELEPHONE NETWORK	41.9%
RF CABLE (CATV)	14.5%
MICROWAVE	12.9%
SATELLITE	11.3%
OTHER	4.[illegible]%
BROADCAST	3.2%
MOTION PICTURE	1.6%
DIGITAL PACKET	1.6%
NO ANSWER	8.1%

4.3.4 USE OF SPECIALIZED COMMUNICATION SERVICES

Both the business and government/institution sectors report a sizeable use of other common carriers in 1981 and, as shown in Table 4.3-7, from 1.5 to 2 times as many respondents expect to use OCC's in the immediate five-year future. An even more noticeable growth is the shift in the volume of traffic that is expected to be carried by OCC's in 1986, as reported in Table 4.3-8. Each volume band except the lowest shows an increase over the five year period, with nearly every reporting organization expecting to move at least into the next higher level of utilization during that time.

TABLE 4.3-7 BUSINESS/GOVERNMENT/INSTITUTION USE OF OTHER COMMON CARRIERS

USER CLASS N=308	PERCENT USING OCC'S	
	REPORTED 1981	EXPECTED 1986
TOTAL	38.6%	59.7%
BUSINESS SUBTOTAL	42.2%	62.9%
GOVERNMENT/INSTITUTION SUBTOTAL	21.2%	44.2%

TABLE 4.3-8 BUSINESS/GOVERNMENT/INSTITUTION USE AND EXPECTED USE OF OTHER COMMON CARRIERS - 1981 AND 1986

1981 USER CLASS N=119	NUMBER OF RESPONDENTS REPORTING STATED PERCENTAGE OF TOTAL TRAFFIC ON OCC'S					
	UNDER 20%	20-39%	40-59%	60-79%	80% & UP	DON'T KNOW
TOTAL	67	26	10	6	5	5
BUSINESS SUBTOTAL	60	24	9	6	4	5
GOVERNMENT/ INSTITUTION SUBTOTAL	7	2	1	-	1	-

1986 USER CLASS N=184	NUMBER OF RESPONDENTS EXPECTING STATED PERCENTAGE OF TOTAL TRAFFIC ON OCC'S					
	UNDER 20%	20-39%	40-59%	60-79%	80% & UP	DON'T KNOW
TOTAL	41	55	31	12	18	27
BUSINESS SUBTOTAL	33	51	30	10	15	22
GOVERNMENT/ INSTITUTION SUBTOTAL	8	4	1	2	3	5

Because users must specifically contract for communications services carried on satellites owned by companies other than the Bell System, and whereas the use of Bell System satellites is not always recognized by the user, it was found useful to track satellite useage patterns with respect to non-Bell satellites. Business sector use substantially exceeds government and institution sector use, as shown in Table 4.3-9. The pattern of use in the business sector peaks at the high and low end of the scale, as shown in Table 4.3-10. Three-fourths of the firms providing videoconferencing as a principal service fall into the highest usage category. No conclusion should be drawn about the distribution of the government and institutional sectors, however, because of the small sample size.

No satellite use for voice only was reported by government or institution users in Table 4.3-11, but this is probably a function of the particular sample population contacted in the field survey. Satisfaction levels with the use of satellites were higher for voice use than for data, but five of the six dissatisfaction votes shown in Table 4.3-12 were expressed by the same respondents for both voice and data.

4.3.5 RESPONDENT REACTIONS TO CPS PHYSICAL CHARACTERISTICS

About half of the user respondent organization sites were described as being located in a downtown city area, as shown in Table 4.3-13. (Multi-location organizations frequently occupied more than one type of site.) Providers' customer sites were more evenly divided.

Nevertheless, 78% of the user organizations, and 80% of the providers felt that it would be physically practical to mount a 10 foot diameter, 200-400 pound satellite antenna on the customer premises or within 500 feet of the major building location. There is some variation among user classes on this point as shown by Table 4.3-14 where utilities, governments, and institutions are notably more able physically to accommodate this type of antenna, and manufacturing organizations are somewhat less able. For those who are unable, the reasons given in Table 4.3-15 are predominantly not cost-related. However, respondents were not furnished any indication of what such a facility might cost, and were relying on their own estimates of cost.

TABLE 4.3-9 BUSINESS/GOVERNMENT/INSTITUTION USE OF SATELLITES - 1981

USER CLASS N=308	PERCENT USING SATELLITES
TOTAL	18.2%
BUSINESS SUBTOTAL	19.5%
GOVERNMENT/INSTITUTION SUBTOTAL	11.5%

TABLE 4.3-10 PERCENTAGE OF TRAFFIC ON SATELLITES - 1981

	NUMBER OF RESPONDENTS REPORTING STATED PERCENTAGE OF TRAFFIC ON SATELLITES					
	UNDER 20%	20-39%	40-59%	60-79%	80% & UP	DON'T KNOW
USER CLASS TOTAL (N=56)	24	7	2	2	13	8
BUSINESS SUBTOTAL	20	7	2	2	13	6
GOVERNMENT/ INSTITUTION SUBTOTAL	4	-	-	-	-	2
PROVIDER CLASS TOTAL (N=21)	6	1	1	1	11	1
COMMUNICATIONS SERVICES SUBTOTAL	4	1	1	-	3	1
SPECIAL SERVICES SUBTOTAL	2	-	-	1	8	-

TABLE 4.3-11 VOICE AND DATA USAGE OF SATELLITES

USER CLASS N=56	NUMBER OF RESPONDENTS REPORTING STATED USE			
	VOICE ONLY	DATA ONLY	BOTH	NO ANSWER
TOTAL	24	11	16	5
BUSINESS SUBTOTAL	24	8	15	3
GOVERNMENT/ INSTITUTION SUBTOTAL	-	3	1	2

TABLE 4.3-12 SATISFACTION WITH PRESENT NON-BELL SATELLITE SERVICE(S)

USER CLASS	VOICE (N=40)		DATA (N=27)		
	YES	NO	YES	NO	DON'T KNOW NO ANSWER
TOTAL	34	6	19	6	2
BUSINESS SUBTOTAL	33	6	16	6	1
GOVERNMENT/ INSTITUTION SUBTOTAL	1	-	3	-	1

TABLE 4.3-13 RESPONDENT SITE DESCRIPTION

USER CLASS	USER'S LOCATION				
	OFFICE PARK	INDUSTRIAL PARK	SHOPPING MALL	CITY AREA	COMBO OR OTHER
TOTAL (N=308)	55	43	2	138	70
BUSINESS SUBTOTAL	51	40	1	113	51
GOVERNMENT/ INSTITUTION SUBTOTAL	4	3	1	25	19
PROVIDER CLASS					
TOTAL (N=62)	33	32	26	41	21
COMMUNICA -TIONS SVS. SUBTOTAL	19	19	16	23	10
SPECIAL SVS. SUBTOTAL	14	13	10	18	11

MULTIPLE RESPONSES POSSIBLE IN BOTTOM HALF OF TABLE REFERRING TO PROVIDERS" CUSTOMERS. THREE PROVIDERS COULD NOT ANSWER THIS QUESTION.

TABLE 4.3-14 CPS ANTENNA MOUNTING PRACTICALITY

USER CLASS N=308	YES	NO	DON'T KNOW NO ANSWER
TOTAL	243	44	21
BUSINESS SUBTOTAL	198	41	17
MANUFACTURING	79	21	6
TRANSPORTATION	15	2	1
WHOLESALE/RETAIL	39	5	5
UTILITIES	16	1	-
BANK/FINANCE/INSURANCE	26	4	2
SERVICES	23	8	3
GOVERNMENT/INSTITUTION SUBTOTAL	45	3	4
FEDERAL	9	-	-
STATE	5	1	2
LOCAL	11	-	1
EDUCATION	13	-	1
MEDICAL	7	2	-

TABLE 4.3-15 REASONS WHY NOT POSSIBLE/PRACTICAL TO MOUNT SATELLITE ANTENNA

REASON	PERCENT OF USER RESPONDENTS	PERCENT OF PROVIDER RESPONDENTS
RENTAL/TEMPORARY FACILITY	34.9%	8.3%
INSUFFICIENT SPACE	27.0%	33.3%
PERMISSION/ZONING	19.0%	16.7%
LOW VOLUME/NO REASON TO INSTALL	12.7%	41.7%
DON'T KNOW/NO ANSWER	9.6%	8.3%
COST	3.2%	8.3%

NOTE: MULTIPLE RESPONSES POSSIBLE
N=63 USERS; 11 PROVIDERS

4.3.6 RESPONDENT REACTION TO CPS TECHNICAL CHARACTERISTICS

In order to calibrate reliability requirements in terms that would be known to the respondent and relatable to pricing sensitivity, respondents were first presented a scenario that described typical satellite communications outages of approximately four hours per year, and asked whether their own experience was better, the same, or worse than this. Their responses were distributed normally across this question, with 44.8% the same, 25.0% better, and 27.9% worse (2.3% did not answer).

The respondents were then asked how much more they would be willing to pay for a service that would be four times better in outages; i.e., about one hour per year, corresponding to an availability of 99.9%. Results and their interpretation are shown in detail in a later section.

Lastly, the respondents were asked whether a lower cost service with lower availability would be usable. Availability levels were described as "about 30 minutes of outages every couple of weeks," corresponding to an availability of 99.5%. User responses to this question are shown in Table 4.3-16 where they summarize to 53.2% who say no, and 43.8% who would or might use such a service. About 2.9% of the respondents did not know whether or not they could use such services. Among the group of respondents who said they would not be able to use the lower level of availability were the relatively large proportion of organizations in the utilities sector and the relatively small proportion in the banking/finance/insurance sector, at 70.6% and 34.4%, respectively.

Among service providers opinions were almost evenly divided between respondents who felt their applications were suitable for CPS and those who felt they were not, with the balance weighted slightly on the positive side, as indicated in Table 4.3-17. The more favorable applications were those of the common carriers and the videoconferencing firms, who cited such advantages as easy convertibility of voice-handling equipment to satellite transmission; the relative ease of reaching remote sites; and the availability of high bandwidths for videoconferencing. On the negative side, other firms cited low volumes of traffic, and the inability of customers to install antennas on their premises.

TABLE 4.3-16 USER ABILITY TO USE LOWER AVAILABILITY SATELLITES

USER CLASS N=308	PERCENT OF USER RESPONDENTS			
	YES	IT DEPENDS	NO	DON'T KNOW NO ANSWER
TOTAL	27.6%	16.2%	53.2%	2.9%
BUSINESS SUBTOTAL	28.1%	16.8%	52.0%	3.1%
MANUFACTURING	23.6%	18.9%	54.7%	2.8%
TRANSPORTATION	38.9%	11.1%	44.4%	5.6%
WHOLESALE/RETAIL	24.5%	14.3%	57.1%	4.1%
UTILITIES	5.9%	17.6%	70.6%	-
BANK/FINANCE/ INSURANCE	37.5%	25.0%	34.4%*	3.1%
SERVICE	44.1%	8.8%	47.1%	-
GOVERNMENT/INSTITUTION SUBTOTAL	25.0%	13.5%	59.6%	1.9%
FEDERAL GOVT	33.3%	22.2%	44.4%	-
STATE GOVT	37.5%	12.5%	50.0%	-
LOCAL GOVT	25.0%	25.0%	50.0%	-
EDUCATION	21.4%	7.1%	71.4%	-
MEDICAL	11.1%	-	77.8%	11.1%

TABLE 4.3-17 PROVIDER APPLICATION SUITABILITY FOR CPS

PROVIDER CLASS N = 62	APPLICATION SUITABILITY			
	YES	NO	DON'T KNOW	NO ANSWER
TOTAL	27	23	11	1
COMMUNICATIONS SERVICES SUBTOTAL	15	11	7	-
COMMON CARRIERS	10	6	4	-
BROADCASTERS	3	3	2	-
INFORMATION SERVICES	2	2	1	-
SPECIAL SERVICES SUBTOTAL	12	12	4	1
VIDEO CONFERENCING	6	4	-	-
DATA BASE SERVICES	3	6	3	-
OTHER	3	2	1	1

Very nearly one-third of the user respondent organizations are now using or would consider using customer premises systems (CPS), as shown in Table 4.3-18. Of this number, 44.8% would use CPS as a dedicated facility, 25.7% are or would share it, and 29.5% don't know or have not yet decided.

TABLE 4.3-18 CURRENT STATUS OF USE OF CUSTOMER PREMISE SYSTEMS

USER CLASS N=308	PERCENT OF RESPONDENTS			
	REJECTED FOR TIME BEING	CONSIDERING FOR FUTURE	USING NOW	DON'T KNOW NO ANSWER
TOTAL	54.2%	29.2%	4.9%	11.7%
BUSINESS SUBTOTAL	53.1%	29.7%	4.3%	12.9%
GOVERNMENT/ INSTITUTION SUBTOTAL	59.6%	26.9%	7.7%	5.8%

Table 4.3-19 presents a range of important applications, and the percentage of respondents who gave each as the primary application that would be considered for CPS. Because each respondent could name up to three applications, the percentage of respondents who named each application totals more than 100%. Reasons for using CPS for these applications are shown in Table 4.3-20, while the reasons for rejection are shown in Table 4.3-21.

TABLE 4.3-19 USERS' PRIMARY APPLICATION ON CPS NOW OR IN THE FUTURE

APPLICATIONS	PERCENT OF RESPONDENTS
DATA TRANSMISSION	43.8%
VOICE TRANSMISSION	32.4%
VIDEO CONFERENCING	18.1%
MISCELLANEOUS GENERAL COMMUNICATIONS/COMBINED DATA/VOICE	15.3%
DATA BASES/BIBLIOGRAPHICS	7.6%
ELECTRONIC MAIL	4.8%
FINANCIAL/BANKING APPLICATIONS	1.9%
DON'T KNOW/REFUSED/NO ANSWER	23.8%

NOTE: MULTIPLE RESPONSES POSSIBLE.
N = 105 RESPONDENTS WHO USE OR WOULD CONSIDER USING CPS IN THE FUTURE.

TABLE 4.3-20 USERS' REASONS FOR PRIMARY APPLICATIONS ON CPS NOW OR IN THE FUTURE

REASONS	PERCENT OF RESPONDENTS
COST	42.9%
IMPROVED CONTROL	11.4%
RELIABILITY	10.5%
PROVIDE/EXPAND SERVICE	8.6%
SPEED	8.6%
AVAILABILITY/DIRECT ACCESS	5.8%
DON'T KNOW/NO ANSWER	40.0%

NOTE: MULTIPLE RESPONSES POSSIBLE
N = 105 RESPONDENTS WHO USE OR WOULD CONSIDER USING CPS NOW OR IN THE FUTURE.

TABLE 4.3-21 REASON FOR REJECTING CPS FOR THE TIME BEING

REASONS	PERCENT OF RESPONDENTS
DON'T KNOW WHAT IT IS	35.9%
DOES NOT MEET NEEDS	15.0%
NOT PRACTICAL	12.0%
COST TOO HIGH	11.4%
MISCELLANEOUS	5.4%
RELIABILITY TOO LOW	4.2%
BELL SYSTEM LOYALTY	2.4%
POINT-TO-POINT REQUIREMENT	0.6%
TELEPHONE COMPANY RESPONDENT	0.6%
UNDETERMINED	13.2%

N = 167 RESPONDENTS WHO REJECTED CPS

Finally, respondents were asked to rate on a scale of 1 (no influence) to 5 (very influential) the factors or features shown in Table 4.3-22 that would affect their decision to use CPS.

Those companies who specifically offer videoconferencing were asked whether videoconferencing would be a primary or secondary consideration for installing CPS. Their answers were nearly evenly divided with 5 of the 14 respondents citing teleconferencing as a primary reason, 6 as a secondary reason, and 3 who don't know. But 3 of those who cite it as a secondary reason, and all of those who don't know, are now offering videoconferencing as their principal application.

TABLE 4.3-22 INFLUENCE OF VARIOUS FACTORS IN DECISION TO USE CPS

FACTORS	MEAN RATING*
LOW COST	4.50
RELIABILITY AT LEAST EQUAL TO EXISTING SERVICE	4.50
DIGITAL CAPABILITY WITHOUT MODEMS	3.79
SECURITY OF SYSTEM	3.73
HIGHER DATA TRANSMISSION SPEEDS	3.66
SECOND SOURCE ALTERNATIVE TO TELCO	3.15
SOLUTION TO ANY LOCAL LOOP PROBLEM	3.00
PRIVATE OWNERSHIP OPTION	2.93
VIDEO CONFERENCING CAPABILITY	2.68

*ON A SCALE OF 5=VERY INFLUENTIAL; 1=NO INFLUENCE
N = 105 RESPONDENTS WHO USE OR WOULD CONSIDER USING CPS NOW OR IN THE FUTURE.

4.4 DERIVED DATA

In addition to those discussed in the preceding sections, a number of questions were asked in the survey that are intended to cross-check, modify, or extend the results given above. These questions will be described below, together with the methodology used to process them.

The underlying subject being addressed, namely the potential use of Customer Premises Services, was not a subject to which most of the respondents could relate directly. To compensate for this, the interviewing process had to take a number of parallel paths to obtain usable information. The key elements to the forecasting process were as follows:

(a) Establish a sound foundation of data about the users' existing networks, applications and usage patterns.

(b) Determine the fundamental changes occurring in the users' environment. Usually the most fundamental change is the rate of growth of the organization.

(c) Obtain the respondents' opinions on the factors and applications which would be most impacted by CPS type systems.

(d) Analyze and interpret this data to produce a measure of the relative potential usage per employee in the different industry and geographic segments of the market.

(e) Interpolate these relative usage patterns against the total forecast size of the market segments.

Although seemingly straightforward facts are being sought, the survey process requires an indirect and strongly parallel approach. On many key issues the respondent may not have the information to provide answers to a direct question. Information on these key issues can be developed, however, by asking multiple questions on related issues for which the respondent is likely to have data.

For example, one of the fundamental items of information needed is the communication traffic volume per employee. Relatively few respondents can supply direct information on this subject discussed further in Section 4.5 and applied in Chapter 8. The survey process gets around this by asking supplementary questions (in addition to the direct question) about traffic-generating equipment, traffic-carrying lines, and traffic-related revenue. Using this supplementary information, as well as "traffic per unit" data and from other sources, the desired overall traffic estimates can be derived.

More specifically, the employee data that was used refers to administrative employees, the class of employees most directly involved in communication applications. An indirect approach is also used here. Since few communications managers are likely to have accurate figures on the administrative employee count in their organizations, the analogous figure used is that of telephone handsets, factored by the known ratios of handsets to employees in each of the industry segments. A further factoring by the ratio of total to administrative employees in each industry is used where projections based on overall employment trends are made, as in Chapter 8.

Users were asked to place a financial value on the acceptabitity of satellite services with the lower levels of availability associated with some Ka band CPS systems. In order to calibrate the responses users were also asked to place similar financial values on a higher availability service. From these responses interpretations were made of the level of acceptance likely to be obtained by Ka band systems.

CPS acceptance was also deduced from the users' responses to the types of applications which they would implement "if they had a CPS system in place." This question produced consistent results, both in the test interviews and in the production survey. When compared with the users' existing applications, these response provided a good basis for estimating the potential usage of a CPS system.

The data obtained in the steps described above was sorted by industry and geographic sectors to establish a differentiated pattern by market sector. The original sample was designed to produce such a differentiation. However, within a few sectors, particularly those related to geography, the differences were too small to be statistically significant.

Later sections of this report make use of the factors derived by the process described above to develop multidimensional forecasts of market size by service category, user class and distance.

4.5 TRAFFIC VOLUME DISTRIBUTION BY EMPLOYEE

An important output of the survey is a set of traffic volume indices showing relative per employee usage of communications services among the different user classes. These indices were derived from estimates of the traffic volume per administrative ("white collar") employee as defined in the user survey. Since few users could respond directly to the question of "traffic volume," a number of questions were asked on traffic related subjects, including communications, dollar expenditures, the number of communications lines of different types, and the quantity of traffic generating equipment such as data terminals and facsimile devices. From a composite of these answers an estimate was made, for each responding organization, of the traffic volume in each service class per employee. An overall size weighted average was then developed for each industry. These results were then normalized to an average of one for all industries.

The variation of traffic usage from one industry sector to another, on a per employee basis, can thus be expressed as an index number relative to one. For example, an administrative employee in the manufacturing sector accounts for 1.16 times the average dedicated line voice traffic computed for all administrative employees in the industries surveyed. Table 4.5-1 presents the distribution factors, for traffic outside the local area, for five service categories and ten user classes. Confidence intervals for these ten user classes are expressed in Table 4.5-2 for plus or minus one standard deviation from each of the averages in the previous table. In both tables, the column headed "other" comprises those administrative employees not included in the other nine user classes.

The factors in turn can be adjusted by the proportion of administrative employees to total employees in each user class, shown in the second column of Table 4.5-3. The balance of Table 4.5-3 shows the adjusted index figures for each service category, representing the relative traffic volume computed on a total employee basis.

TABLE 4.5-1 TRAFFIC VOLUME INDEX PER WHITE COLLAR EMPLOYEE

	SERVICE CATEGORY				
	VOICE (DEDICATED)	VOICE (SWITCHED)	VIDEO	MESSAGE	DATA
BUSINESS					
MANUFACTURING	1.16	2.04	1.50	2.71	0.86
TRADE	1.80	1.64	1.50	1.73	1.32
FINANCIAL/INSUR.	1.44	0.91	1.00	0.89	0.86
TRANSPORT./UTIL.	1.62	1.02	0.50	1.90	0.62
SERVICE	0.80	1.23	1.50	0.74	0.67
OTHER	0.28	0.79	0.50	0.52	0.61
GOVERNMENT					
FEDERAL	1.32	0.80	1.00	0.60	3.30
STATE AND LOCAL	1.02	0.81	1.50	0.60	1.08
INSTITUTIONS					
EDUCATIONAL	0.02	0.38	1.00	0.25	0.48
MEDICAL	0.54	0.38	0.00	0.14	0.20

TABLE 4.5-2 TRAFFIC VOLUME INDEX PER TOTAL EMPLOYEE

	RANGE*	SERVICE CATEGORY				
		VOICE (DEDICATED)	VOICE (SWITCHED)	VIDEO	MESSAGE	DATA
BUSINESS						
MANUFACTURING	+1 sd	1.42	2.49	2.16	3.31	1.00
	-1 sd	0.95	1.67	1.04	2.22	0.74
TRADE	+1 sd	2.38	2.16	2.46	2.28	1.64
	-1 sd	1.36	1.24	0.91	1.31	1.06
FINANCIAL/INSURANCE	+1 sd	2.02	1.27	1.80	1.25	1.12
	-1 sd	1.03	0.65	0.56	0.64	0.66
TRANSPORTATION/UTITLTIES	+1 sd	2.40	1.51	0.98	2.81	0.84
	-1 sd	1.09	0.69	0.26	1.28	0.46
SERVICE	+1 sd	1.10	1.70	2.64	1.02	0.86
	-1 sd	0.58	0.89	0.85	0.54	0.52
OTHER	+1 sd	0.45	1.26	1.10	0.83	0.88
	-1 sd	0.18	0.49	0.23	0.33	0.42
GOVERNMENT						
FEDERAL	+1 sd	2.05	1.24	2.10	0.93	4.66
	-1 sd	0.85	0.52	0.48	0.39	2.34
STATE & LOCAL	+1 sd	1.51	1.20	2.94	0.89	1.47
	-1 sd	0.69	0.55	0.77	0.41	0.79
INSTITUTIONS						
EDUCATIONAL	+1 sd	0.03	0.58	2.06	0.38	0.67
	-1 sd	0.01	0.25	0.49	0.16	0.34
MEDICAL	+1 sd	0.87	0.62	0.01	0.23	0.29
	-1 sd	0.33	0.23	0.00	0.09	0.14

*sd=Standard deviation from the mean.

TABLE 4.5-3 TRAFFIC VOLUME INDEX PER TOTAL EMPLOYEE

	ADMINISTRATIVE EMPLOYEES AS RATIO OF TOTAL EMPLOYEES	SERVICE CATEGORY				
		VOICE (DEDICATED)	VOICE (SWITCHED)	VIDEO	MESSAGE	DATA
BUSINESS						
MANUFACTURING	0.34	0.39	0.69	0.51	0.92	0.29
TRADE	0.60	1.08	0.98	0.90	1.04	0.79
FINANCIAL/INSURANCE	0.93	1.34	0.85	0.93	0.83	0.80
TRANSPORT/UTILITIES	0.45	0.73	0.46	0.23	0.86	0.28
SERVICE	0.82	0.66	1.01	1.23	0.61	0.55
OTHER	0.40	0.11	0.32	0.20	0.21	0.24
GOVERNMENT						
FEDERAL	0.68	0.90	0.54	0.68	0.41	2.24
STATE & LOCAL	0.68	0.69	0.55	1.02	0.41	0.73
INSTITUTIONS						
EDUCATIONAL	0.80	0.02	0.30	0.80	0.20	0.38
MEDICAL	0.80	0.43	0.30	0.01	0.11	0.16

4.6 ACCEPTABILITY OF CPS

Respondents were asked their current opinion and status relative to the potential use of Customer Premises Systems. To clarify the concept of CPS the Satellite Business System (SBS) was suggested an example. Even with this example, a high percentage of the respondents were unfamiliar with the technical and economic factors involved, and either did not answer the question or answered it without apparent understanding. These answers have been excluded from the following analysis.

A key factor in the acceptability of CPS is the economics involved. Since these are not yet fully determined, and therefore could not be presented to the respondents, the results presented here should be considered to be optimistic estimates of the real range of acceptability of such a service. The distribution of acceptability by respondent size and industry are presented in Table 4.6-1; there were no significant differences on a geographic basis.

TABLE 4.6-1 POTENTIAL ACCEPTANCE OF CPS SERVICES

CATEGORY	PERCENT THAT WOULD ACCEPT CPS
SIZE OF ORGANIZATION	
1000+ EMPLOYEES	57%
100-999 EMPLOYEES	40%
1-99 EMPLOYEES	20%
USER CLASS	
MANUFACTURING	51%
TRADE	46%
FINANCE/INSURANCE	50%
TRANSPORT./UTILITIES	43%
SERVICES	65%
OTHER	51%
FEDERAL GOVERNMENT	86%
STATE & LOCAL GOVERNMENT	45%
EDUCATION	25%
MEDICAL	67%

4.7 THE EFFECT OF RELIABILITY ON ACCEPTABILITY

As described earlier, to determine the acceptability of Ka band CPS services offering lower availability, users were asked to think in terms of their present experiences with outages. The sequence of questions produced responses that are differentiable by data and voice applications. Results shown in Table 4.7-1 represent the volume of traffic which respondents would send at various price differentials, given higher and lower levels of availability. The assumption is made that respondents would send all of their traffic on a better availability service at the same (100%) price and that they would send none of their traffic on a lower availability service at the same (100%) price.

TABLE 4.7-1 PRICE SENSITIVITY RELATIVE TO LEVELS OF AVAILABILITY

IF PRICED AT THIS PERCENT OF CURRENT PRICE:	THIS PERCENT OF RESPONDENTS WOULD BUY:			
	BETTER (99.9%) AVAILABILITY		POORER (99.5%) AVAILABILITY	
	VOICE	DATA	VOICE	DATA
OVER 110%	1%	2%	-	-
110%	15%	8%	-	-
105%	16%	27%	-	-
100%	ALL*	ALL*	NONE*	NONE*
90%	-	-	4%	3%
80%	-	-	23%	13%
70%	-	-	40%	30%
60%	-	-	58%	42%
50% OR LESS	-	-	62%	52%

* ASSUMPTION

4.8 CONCLUSIONS

Compressing thousands of data points into a small number of conclusions is a process fraught with peril. There are, nevertheless, some striking findings that suggest themselves. Four areas in particular are noted.

4.8.1 PRICING

It is clear that price is the ultimate key to user acceptance of CPS, except in the few instances where technical factors may override. CPS is of interest insofar as it provides cost advantages, and generally not for any other user-recognizable technical or operational reasons.

4.8.2 RELIABILITY

The level of reliability (availability) provided is considered an important factor, but present performance is the standard, and is generally considered to be adequate. There is some interaction between reliability and cost, and more than half the current users would settle for lower reliability if the cost were set low enough (i.e., at one-half or less of present costs.) Conversely, improved reliability would be worth only a small premium, and that to only to a small percentage of users.

4.8.3 CPS APPLICATIONS

Data transmission applications are the predominant target for CPS in the minds of the respondents of this survey. Video applications are still too new to have any significant place in either present operations or future plans for most organizations, but it should be kept in mind that users often have difficulty imagining how or how much they will use a new product or service until it becomes commonly available.

4.8.4 DIFFERENTIAL REQUIREMENTS BY USER CLASS

All user segments have some level of long distance requirements. These requirements are at least partially suitable for CPS, given a satisfactory volume of traffic or the ability to share resources.

Geographic location of the respondent has no perceptible effect on the users' responses on any of the issues addressed, but volume requirèments do tend to vary from region to region as the employment population varies.

Apart from the actual level of usage, which varies significantly from one user class to another, user classe has little observable effect on any of the acceptability issues addressed in this survey. The only exceptions are government agencies and utilities, which give extra weight to service reliability even if additional costs are required.

5.0 COMPARATIVE ECONOMICS

This chapter discusses service costs of various delivery systems for potential CPS traffic. It also discusses cost elasticity and pricing of new services that may be supplied by satellite CPS systems.

5.1 COST OF COMMUNICATION SERVICES

Most telecommunications services are offered in a highly competitive environment. Vendor charges for equivalent services are generally similar, but often show individual variations designed to attract one segment or another of the market. For example, one vendor's rates may be higher than another's for short distances but less expensive for longer distances. Other vendors offer attractive rates for high volume users, or offer discounts for yearly, rather than month-by-month, commitments.

Competitive offerings tend to be very volatile, with frequent changes occurring in both the rate structure and in the details of the services provided. Furthermore, the offerings are generally complex so that direct comparison of one offering with another should be made with reference to a specific set of circumstances.

5.1.1 VOICEBAND PRIVATE LINE COSTS

The voiceband private line market is a significant one for CPS satellite systems and therefore is discussed in some detail. Circuits of this type are important in leased line voice and data applications. Private line toll service accounts for about 11 percent of AT&T's revenues for all toll services [Ref. 5-1], and in the primarily large business environment, represented by the ICA membership discussed in Chapter 3, it accounts for over 40 percent of expenditures for telecommunications services.

To develop service costs for typical users the voiceband private line tariffs (as summarized in Reference 5-2) were analyzed and plotted for the common carriers listed below. Results are presented in the following subsections. Rates shown are those in effect in December, 1982.

Terrestrial Services:

American Telephone and Telegraph Co. (AT&T)
MCI Telecommunications (MCI)
Southern Pacific Communications Corp. (SPCC)
United States Transmission Systems (USTS)
Western Union (WU)

Satellite Services:

American Satellite Co. (ASC)
RCA American Communications Inc. (RCA)
Western Union (WU)

Satellite Business Service (SBS) is discussed in Subsection 5.1.3 with respect to its WATS-like Business Message Service. Private line service available from SBS, however, involves the installation of at least three earth stations on a customer's premises and is practical only if a substantial number of lines are installed. The SBS private line service is therefore not comparable with the offerings of the other private line vendors in the above list and so has not been included.

5.1.1.1 TERRESTRIAL VOICEBAND PRIVATE LINE OFFERINGS

For each terrestrial voiceband private line tariff listed above, typical monthly recurrent costs vs. distance were developed and plotted. The recurrent costs include the monthly cost of the long distance transmission plus the monthly cost of any local distribution that may be required. Where local distribution charges are specified in the tariff these values are used. Otherwise, typical local loop costs based on twenty miles at each end of the long distance link have been added. In each case the charges are for four-wire full duplex service. Results are presented in Figures 5.1-1 to 5.1-5 and are discussed below.

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 5.1-1 shows total costs under the AT&T Multi-Schedule Private Line (MPL) tariff (Tariff No. 260). Volume discounts are not available for this service but, in common with all of the terrestrial tariffs examined, incremental costs decrease as the mileage increases. The costs shown are for Schedule 1 Service (Schedule 1 terminations are in large cities, the more expensive Schedules 2 and 3 are used for calls between large and small cities, and between small city pairs, respectively).

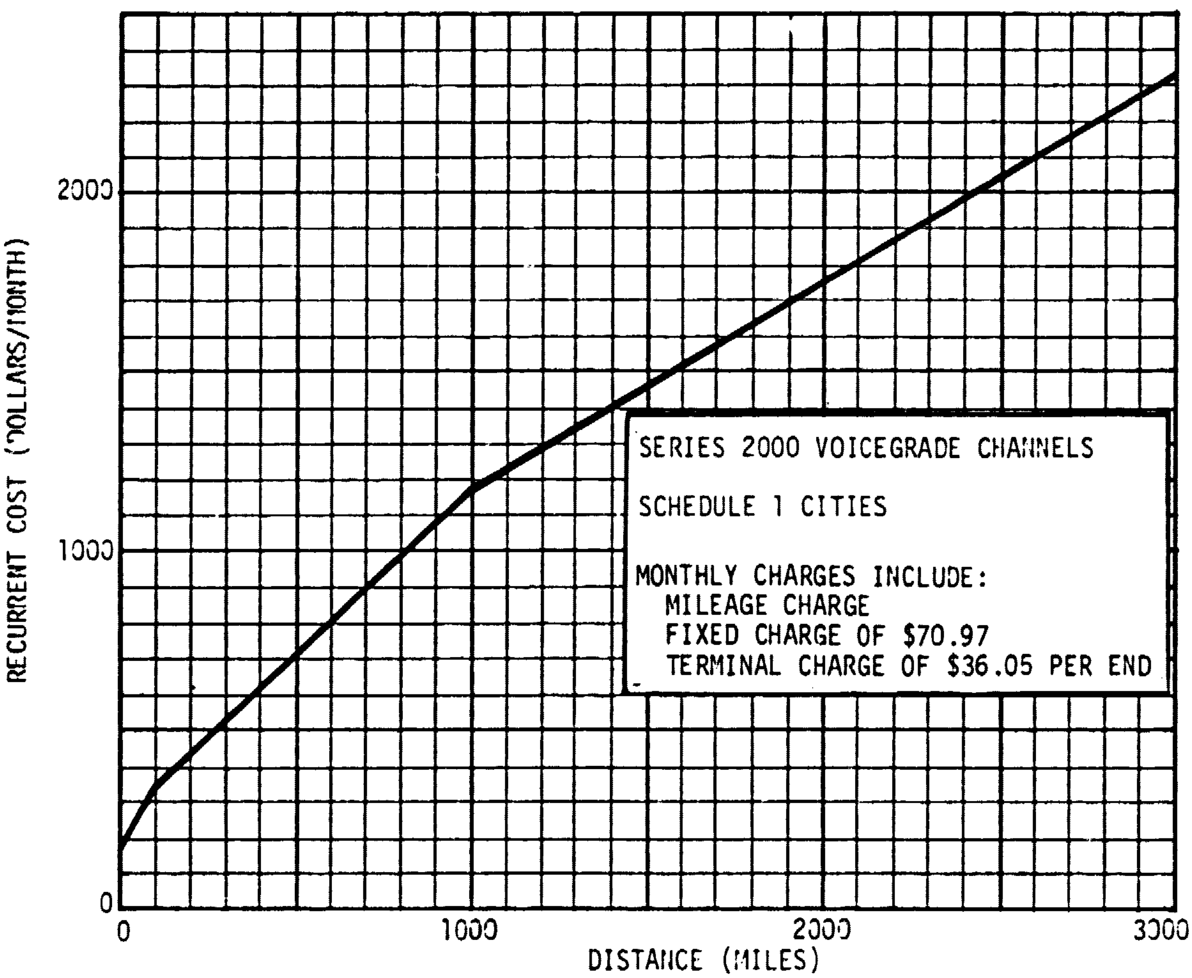


FIGURE 5.1-1 MONTHLY COSTS FOR AT&T VOICEBAND PRIVATE LINE SERVICE

Figure 5.1-2 plots the cost of MCI terrestrial voiceband private line service. The cost vs. distance plot is generally similar to that for AT&T, but for distances above 1000 miles MCI's costs are lower. MCI serves approximately 36 cities and extension line service is available at extra cost to others. Volume discounts are not offered.

Figure 5.1-3 shows cost vs. distance for terrestrial voiceband private line service provided by SPCC. Though some differences favoring one offering over the other exist in various distance bands, the cost of a single SPCC voiceband channel is somewhat higher than that offered by MCI at the longer distances. SPCC, however, offers a quantity discount for large users. As indicated by the lower curve in Figure 5.1-3, a user that purchases more than 50 circuits (which need not be confined to a single route between two points) receives a price reduction of 8 to 12 percent. The cost of local access lines provided by SPCC is distance sensitive. Within the local area, access line costs are $40.02 + $1.74 per mile. Twenty miles at each end is included in Figure 5.1-3 for costing purposes. Outside the local area, access lines are billed at cost plus 5 percent.

Figure 5.1-4 presents the costs for USTS's voiceband terrestrial private line service. Volume and distance sensitive rates are available for 1-23, 24-35, 36-47, 48-59, and 60 or more channels. As in the case of SPCC, the channels need not be confined to a single point-to-point route to qualify for the discounts.

Figure 5.1-5 shows costs for Western Union's voiceband terrestrial private line service. The costs illustrated are roughly comparable to those of the other common carriers and somewhat less than those for AT&T for channels connecting Western Union's approximately 50 "listed" rate centers. For channels connecting with or between non-listed rate centers the rate is the same as that of AT&T.

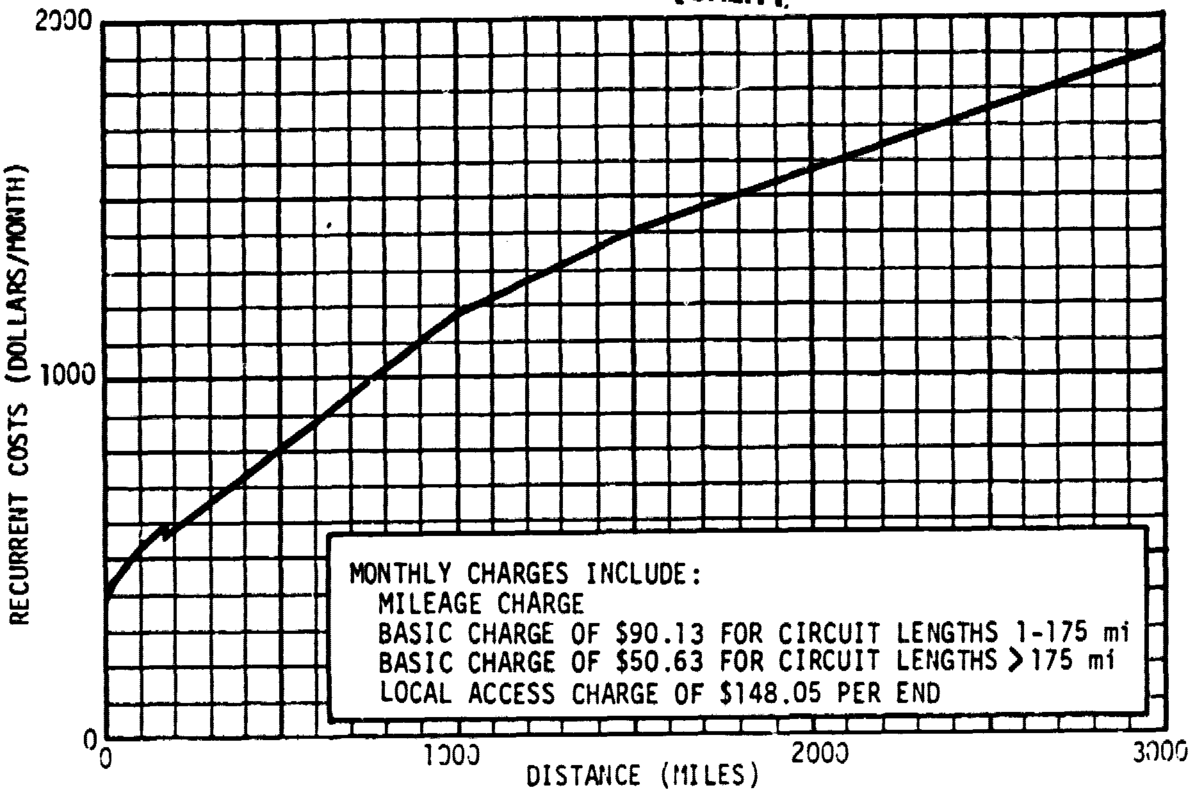


FIGURE 5.1-2 MONTHLY COSTS FOR MCI VOICEBAND PRIVATE LINE SERVICE

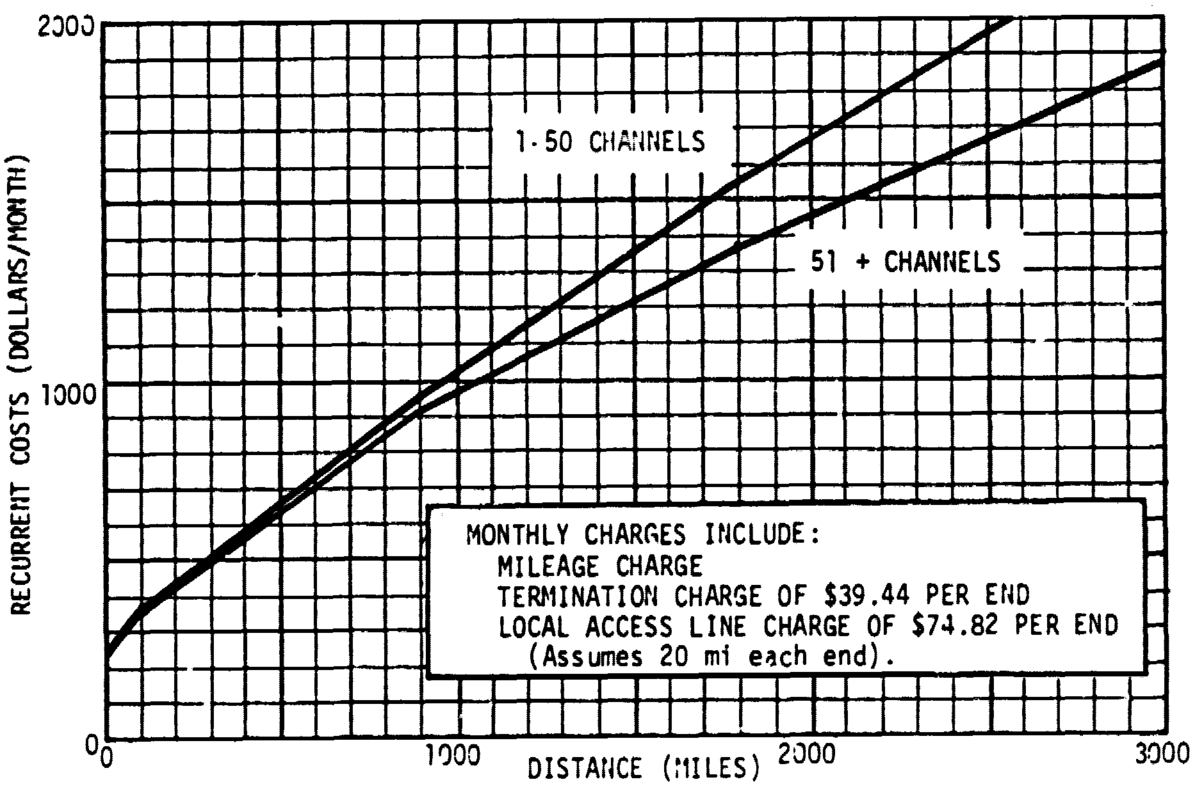


FIGURE 5.1-3 MONTHLY COSTS FOR SPCC VOICEBAND PRIVATE LINE SERVICE

ORIGINAL PAGE IS
OF POOR QUALITY

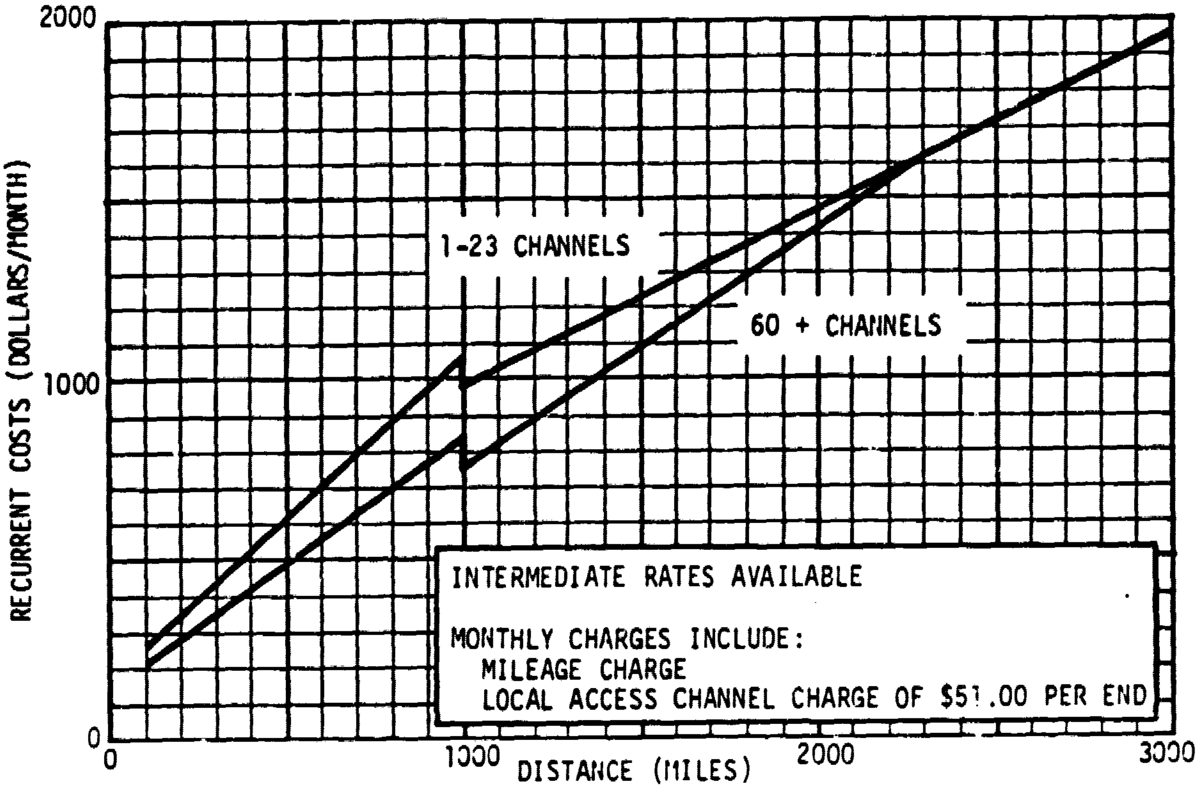


FIGURE 5.1-4 MONTHLY COSTS FOR USTS VOICEBAND PRIVATE LINE SERVICE

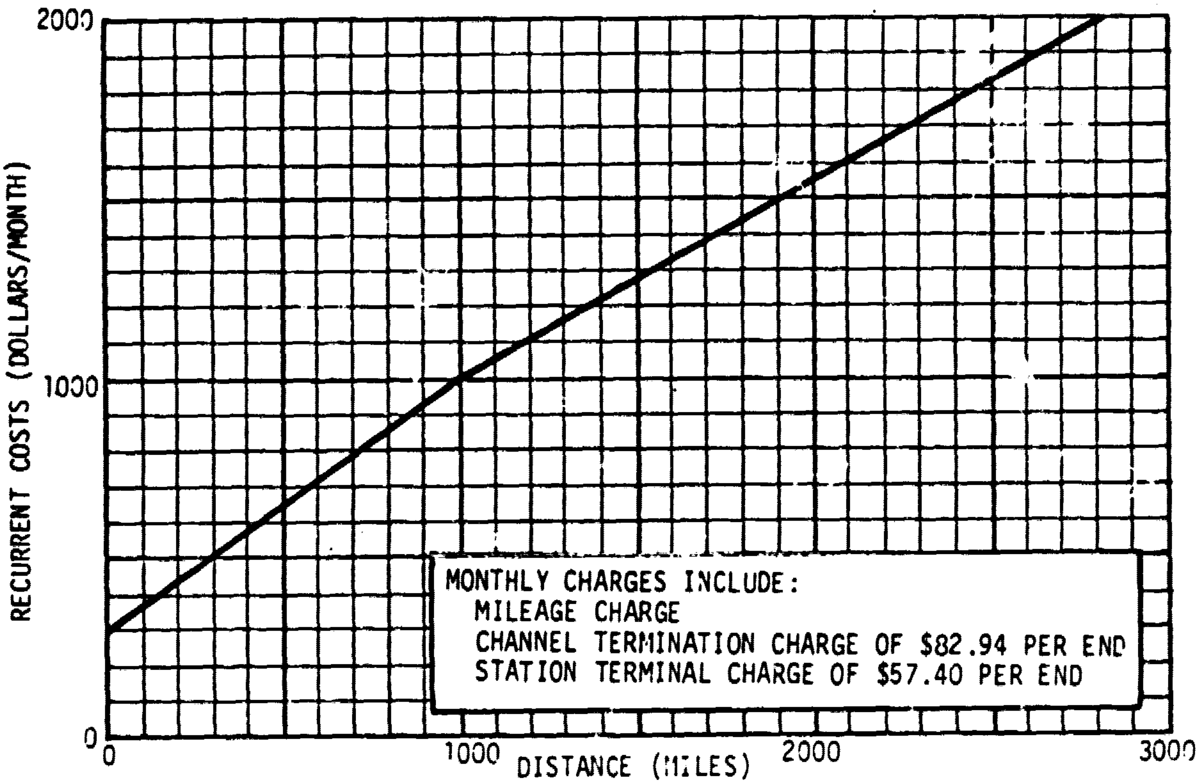


FIGURE 5.1-5 MONTHLY COSTS FOR WESTERN UNION VOICEBAND PRIVATE LINE SERVICE

5.1.1.2 SATELLITE VOICEBAND PRIVATE LINE OFFERINGS

Satellite voiceband private line offerings were also investigated and recurring monthly costs vs. distance were plotted for three representative common carrier offerings. Results are presented in Figures 5.1-6 through 5.1-8. The costs illustrated again include both the long distance component and typical local distribution costs for connection to the common carriers' facilities. Rates are those in effect in December, 1982.

Figure 5.1-6 shows the costs for satellite derived voiceband private lines offered by ASC. Costs increase slightly with distance but to a much smaller extent than for terrestrial circuits. The ASC offering does not provide volume discounts,but for selected cities an 18 to 23 percent discount from the month-by-month rate is available to users willing to commit to a one year contract. ASC offers a choice of echo suppressors ($28 per month) or echo cancellers ($58 per month). The costs shown in Figure 5.1-6 include the cost of an echo canceller.

As shown in Figure 5.1-7, costs for RCA's satellite derived voiceband private line channels are also slightly distance sensitive. Which of the curves applies depends on the specific city pairs in question. Discounts are based on a combination of bulk usage and long term commitment. Relative to month-by-month charges, typical cost reductions of 19 to 26 percent are available for a 12 month commitment, 22 to 24 percent for a 24 month commitment with a minimum buy of 150 channels, and 26 to 29 percent for a 36 month commitment with a minimum buy of 240 channels.

Costs for voiceband private line service on Western Union's Westar satellite are illustrated in Figure 5.1-8. Costs are slightly distance sensitive with a roughly 10 percent cost reduction applying if a fixed term (1 year) option is selected rather than month-by-month.

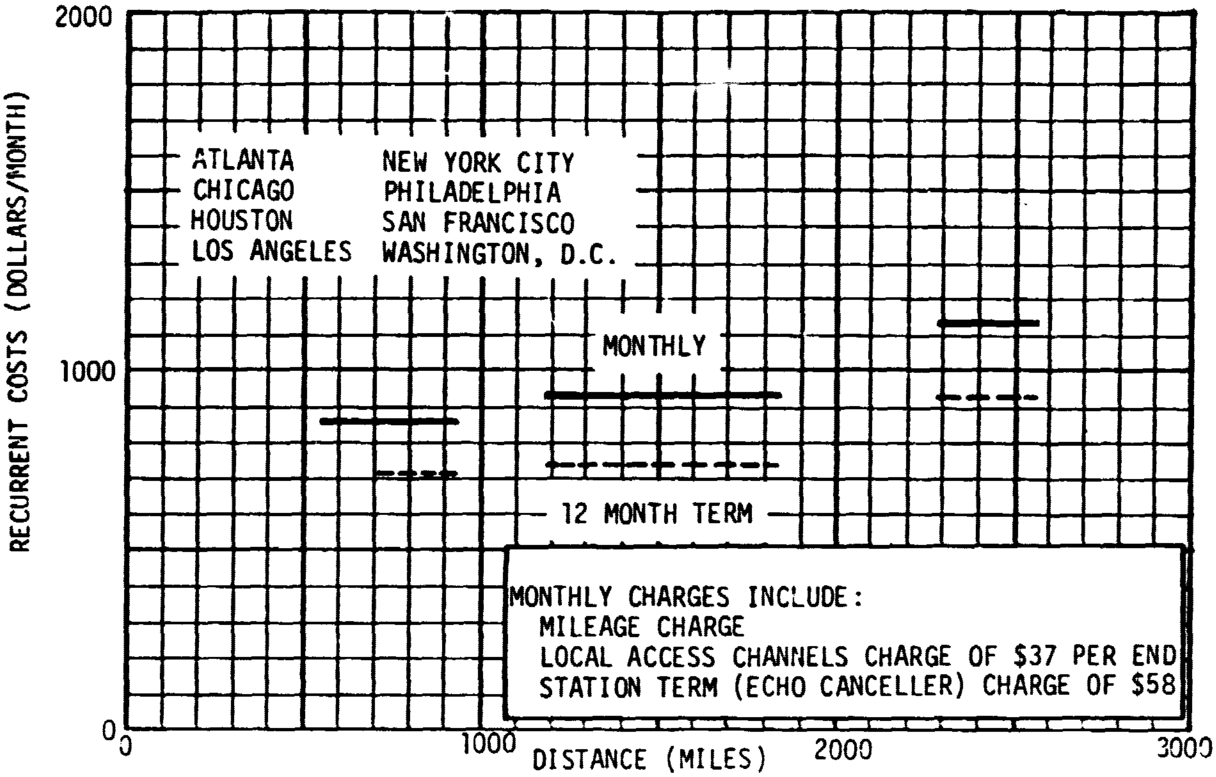


FIGURE 5.1-6 MONTHLY COSTS FOR ASC SATELLITE VOICEBAND PRIVATE LINE SERVICE

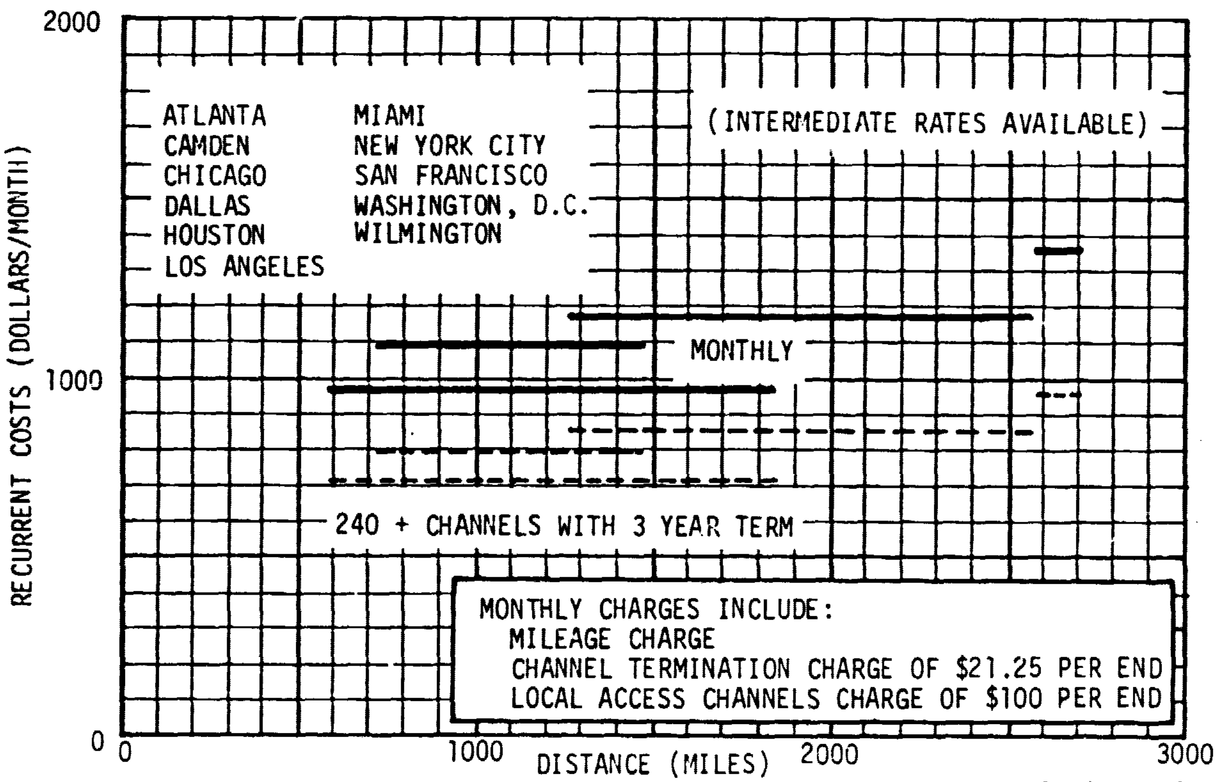


FIGURE 5.1-7 MONTHLY COSTS FOR RCA AMERICAN SATELLITE COMMUNICATIONS INC.
VOICEBAND SATELLITE PRIVATE LINE SERVICE

ORIGINAL PAGE IS
OF POOR QUALITY

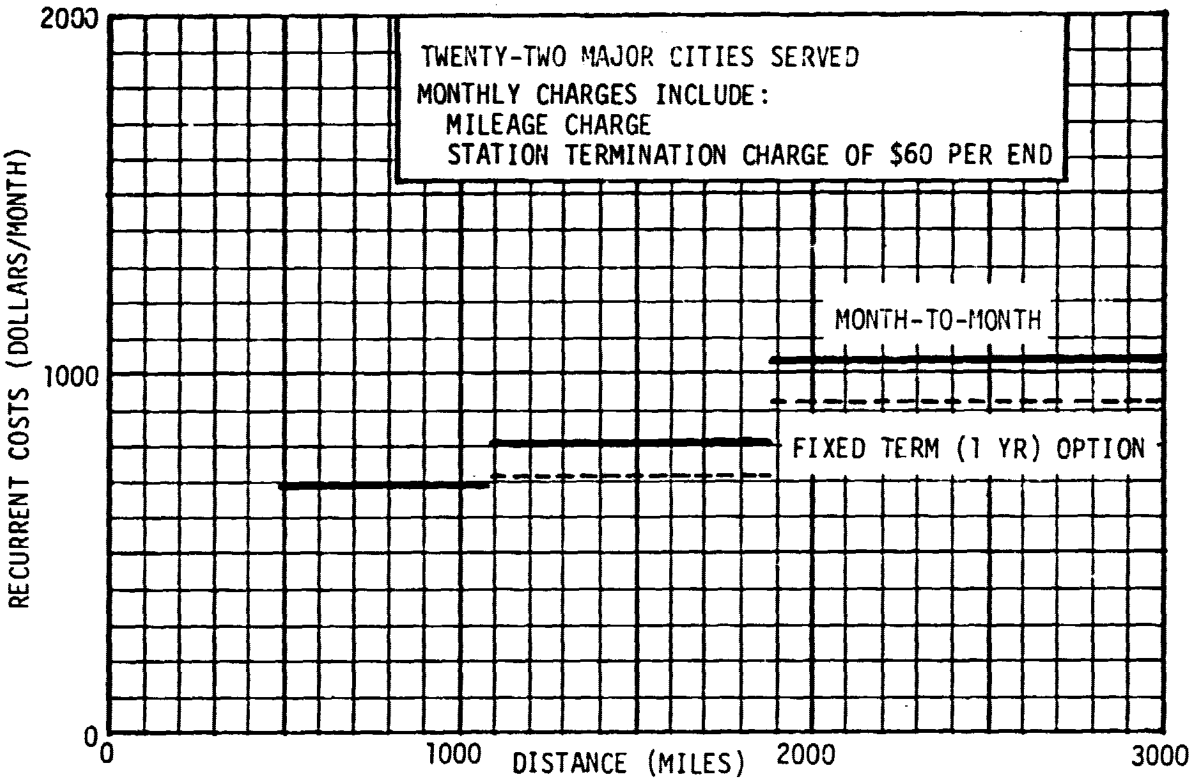


FIGURE 5.1-8 MONTHLY COSTS FOR WESTERN UNION VOICEBAND SATELLITE PRIVATE LINE SERVICE

ORIGINAL PAGE IS OF POOR QUALITY

5.1.1.3 COMPARISON OF SATELLITE AND TERRESTRIAL VOICEBAND PRIVATE LINE COSTS

Figure 5.1-9 summarizes the previous discussion for the basic month-by-month single channel costs of terrestrial and satellite voiceband private line services. The figure illustrates the competitive range of costs for terrestrial and satellite circuits and suggests some typical costs (dotted lines) applicable in various distance ranges. For distances between 500 and 1500 miles satellite costs and those of the terrestrial carriers overlap. Above 1500 miles satellite channels are less costly and below 500 miles costs favor terrestrial approaches.

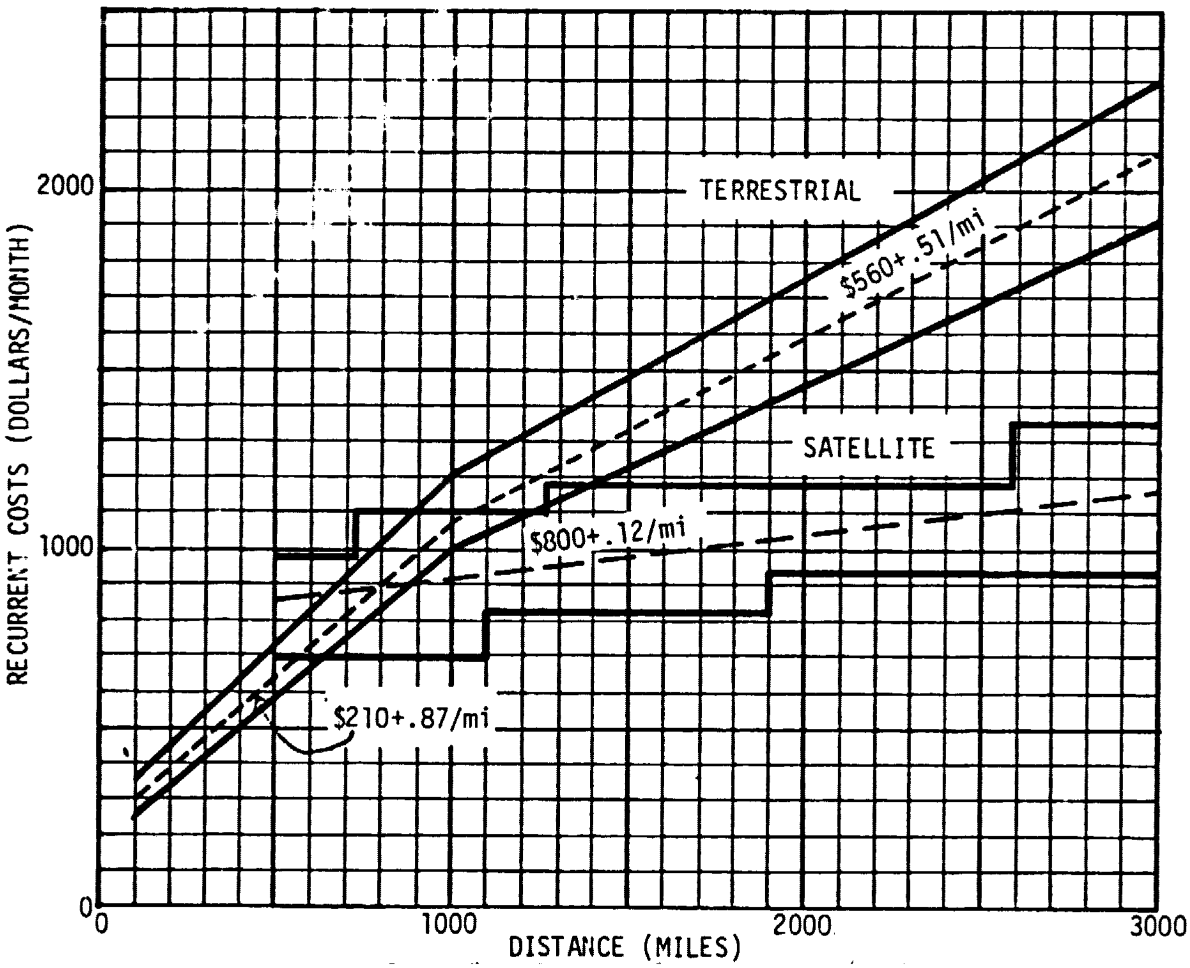


FIGURE 5.1-9 TYPICAL PRICES OF SATELLITE AND TERRESTRIAL VOICEBAND PRIVATE LINE SERVICE. SINGLE CHANNEL MONTH-BY-MONTH LEASE.

A typical customer, indifferent to any technical differences between terrestrial and satellite circuits, who requires a single 100 mile or longer voiceband private line channel might select terrestrial service and expect to pay monthly charges of about $210 plus 87 cents per mile up to a distance of about 800 miles. Above this he might choose to switch to satellite service with monthly charges then leveling off at approximately $800 plus 12 cents per mile for the longer distances over which satellite circuits are less costly.

5.1.2 SWITCHED VOICEBAND SERVICE

The greatest portion of switched voiceband service is provided by AT&T and its local operating companies through the Public Telephone Network under Tariff 263 (DDD) and through the Wide Area Telephone Service under Tariff 259 (WATS). Services similar to DDD, at rates advertised as being 20 to 40 percent lower, are also available from MCI (Execunet), SPCC (Sprint), USTS (City-Call), and Western Union (Metro 1). These competing services appear to be capturing a small but growing share of the market. The recently inaugurated SBS Business Message Service (Type 1) provides service similar to Outward WATS. Costs for service using the Public Telephone Network, WATS, and the SBS Business Message Service are discussed in the following subsections. Costs discussed in the following are those in effect in December, 1982.

5.1.2.1 PUBLIC TELEPHONE NETWORK (DDD)

Rates for long distance service on the Public Telephone Network are both time and distance dependent. Figure 5.1-10 shows costs vs. distance for DDD long distance calls based on station-to-station rates without operator assistance. The upper curve is for the first minute of each call and the lower curve is for each successive minute thereafter. For distances above 300 miles the first minute costs 40 to 50 percent more than the subsequent minutes, a factor of concern to users whose calling patterns include many short calls.

Charges are also dependent on the time of day at the originating station. As shown in Figure 5.1-10, discounts of 35 or 60 percent are available depending on the day of the week and the time slot used.

ORIGINAL PAGE IS
OF POOR QUALITY

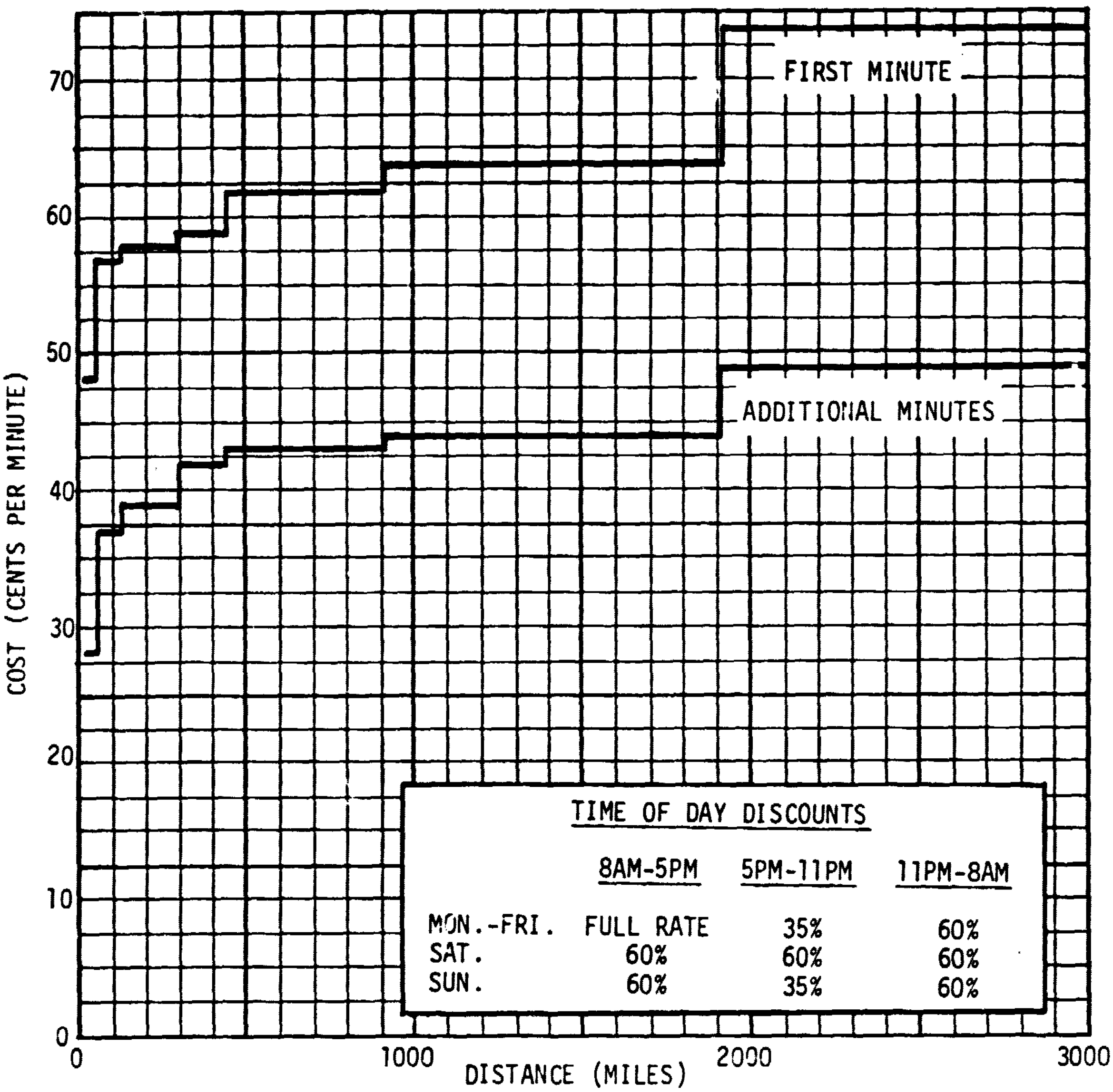


FIGURE 5.1-10 COSTS FOR CUSTOMER DIALED PUBLIC TELEPHONE NETWORK (DDD) CALLS

While dial-up costs are distance sensitive, a high degree of compression in price versus distance has developed over recent years, particularly for the longer distances. The lower curve in Figure 5.1-10, for example, shows that a ten-to-one distance increase (from 300 miles to 3000 miles) results in only a 17 percent increase in cost (from 42 cents per minute to 49 cents per minute).

As discussed in previous subsections of this report, the choice between switched service and dedicated private line service is only partially determined by price. The ability to reach many, rather than a few, predetermined destinations, plus other technical and operational requirements must also be considered. In those cases in which costs are a decisive factor, however, comparisons such as those illustrated in Figure 5.1-11 are helpful. The figure presents typical monthly costs vs. distance for terrestrial and satellite private lines as developed earlier in Figure 5.1-9 (dashed curves). Overlayed on these private line costs are the monthly costs of dial-up service for varying degrees of usage. The monthly costs for the dial-up service are based on the indicated number of hours per day, twenty days per month. A continuous connection is assumed for each day so that the rate per minute is close to that shown on the lower curve in Figure 5.1-10. Figure 5.1-11 shows that with four or more hours of daily use terrestrial private lines service is less costly than dial-up service to any point in the 48 contiguous states. Less than two hours of daily usage is needed to justify the selection of private line service when the dial-up Public Telephone Network is compared to typical private line service available from satellite common carriers. If many short calls are made, rather than the illustrated single continuous call each day, dial-up rates are higher than those illustrated and even few cumulative hours of dial-up calling are needed before the use of private line service becomes cost competitive.

5.1.2.2 WIDE AREA TELEPHONE SERVICE (WATS)

WATS service, offered by AT&T under Tariff No. 259, uses the same transmission facilities as the Public Switched Network. The WATS tariff permits high volume users of switched service to purchase the service in large time-blocks at rates generally lower than those for calls placed to the same locations on a call-by-call basis via DDD. Costs discussed are those in effect in December, 1982.

ORIGINAL PAGE IS
OF POOR QUALITY

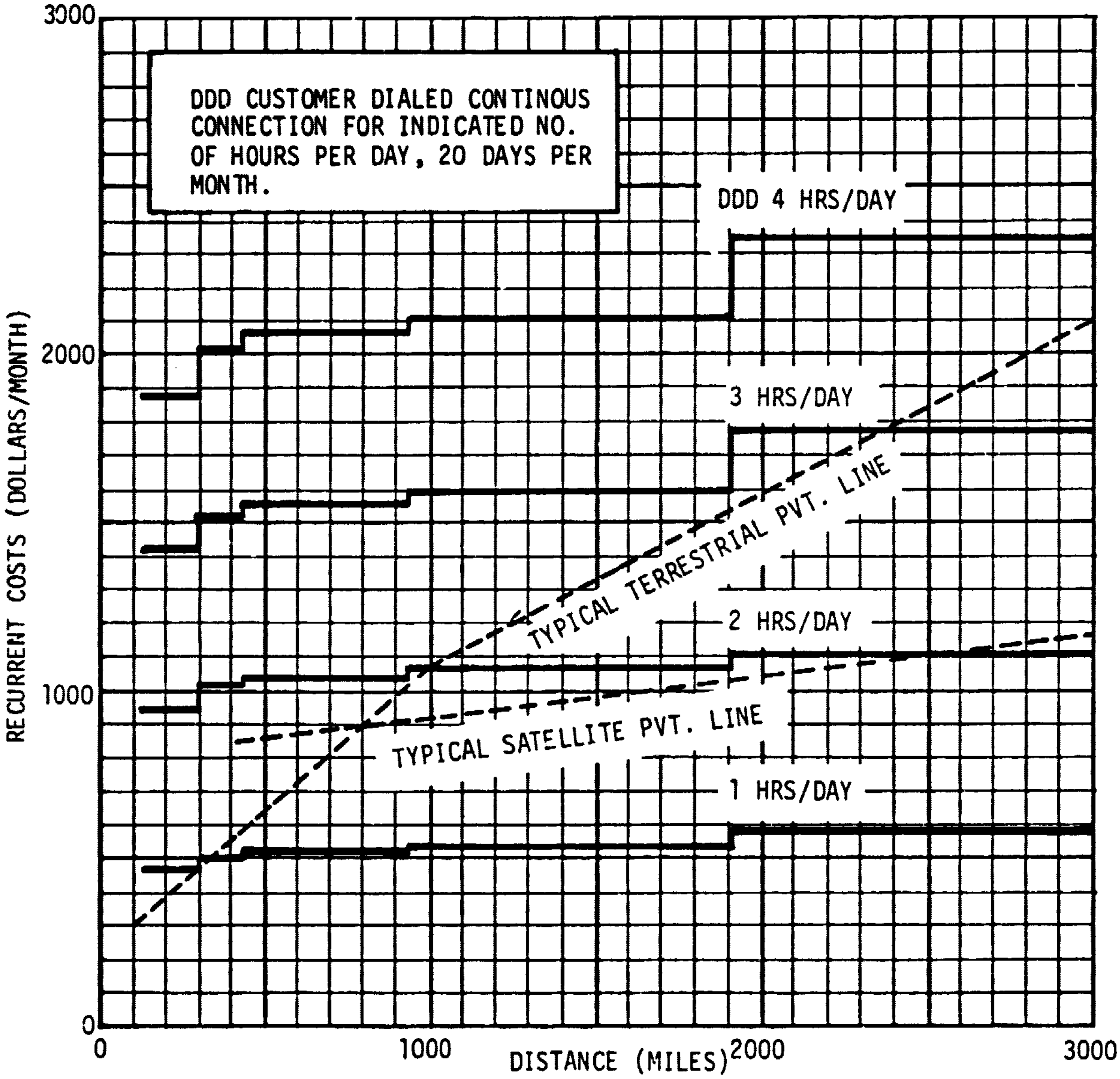


FIGURE 5.1-11 COMPARISON OF DIAL-UP AND PRIVATE LINE COSTS

For each state (or in some cases portions of a state) six service areas or bands are defined. Service Area 1 usually includes the states which border the home state. Service Area 2 includes the next layer of states surrounding those in Service Area 1. Purchasers of service to Service Area 2 can place calls to any point in the states contained in both Service Area 2 and Service Area 1. This pattern continues in expanding rings. Service Area 5 encompasses all points within the contiguous 48 states and Service Area 6 includes Alaska and Hawaii. Figures 5.1-12 and 5.1-13 show typical Service Area distributions.

There are two versions of WATS available:

(a) OUTWARD WATS which allows dialing from a central location to any point within the Service Areas subscribed to; and

(b) 800 SERVICE (Formerly Inward WATS) which allows calls from points within the Service Areas subscribed to, to the central location, with charges billed to the called central location rather than to the calling party.

A user can subscribe to Outward WATS, or 800 Service, or both. Separate lines are installed for each service. The one-time installation charge for each Outward WATS line is $123 and for each 800 Service line (minimum of two required per service area subscribed to) is $153. The user can pay for, and have installed, as many of each type of line that he requires but the Outward WATS lines cannot be grouped together with the lines for 800 Service. The cost for 800 Service differs from that of Outward WATS by a few percentage points. WATS type calling within the home state (sometimes referred to as Band 0) comes under separate Intrastate WATS tariffs which differ from state to state and are not covered by the Interstate tariff discussed above.

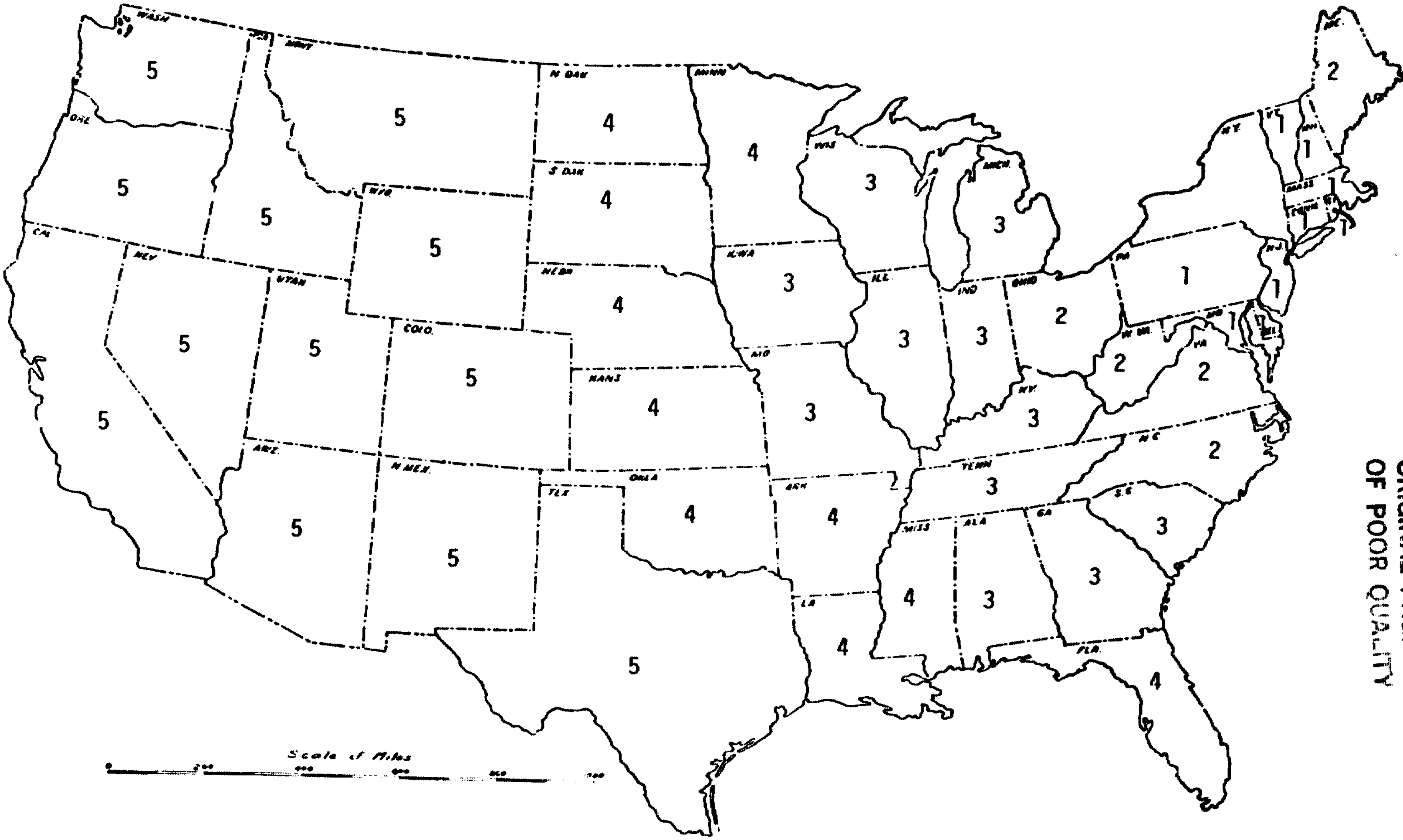


FIGURE 5.1-12 INTERSTATE WATS SERVICE AREAS FOR S.E. NEW YORK

ORIGINAL PAGE IS
OF POOR QUALITY

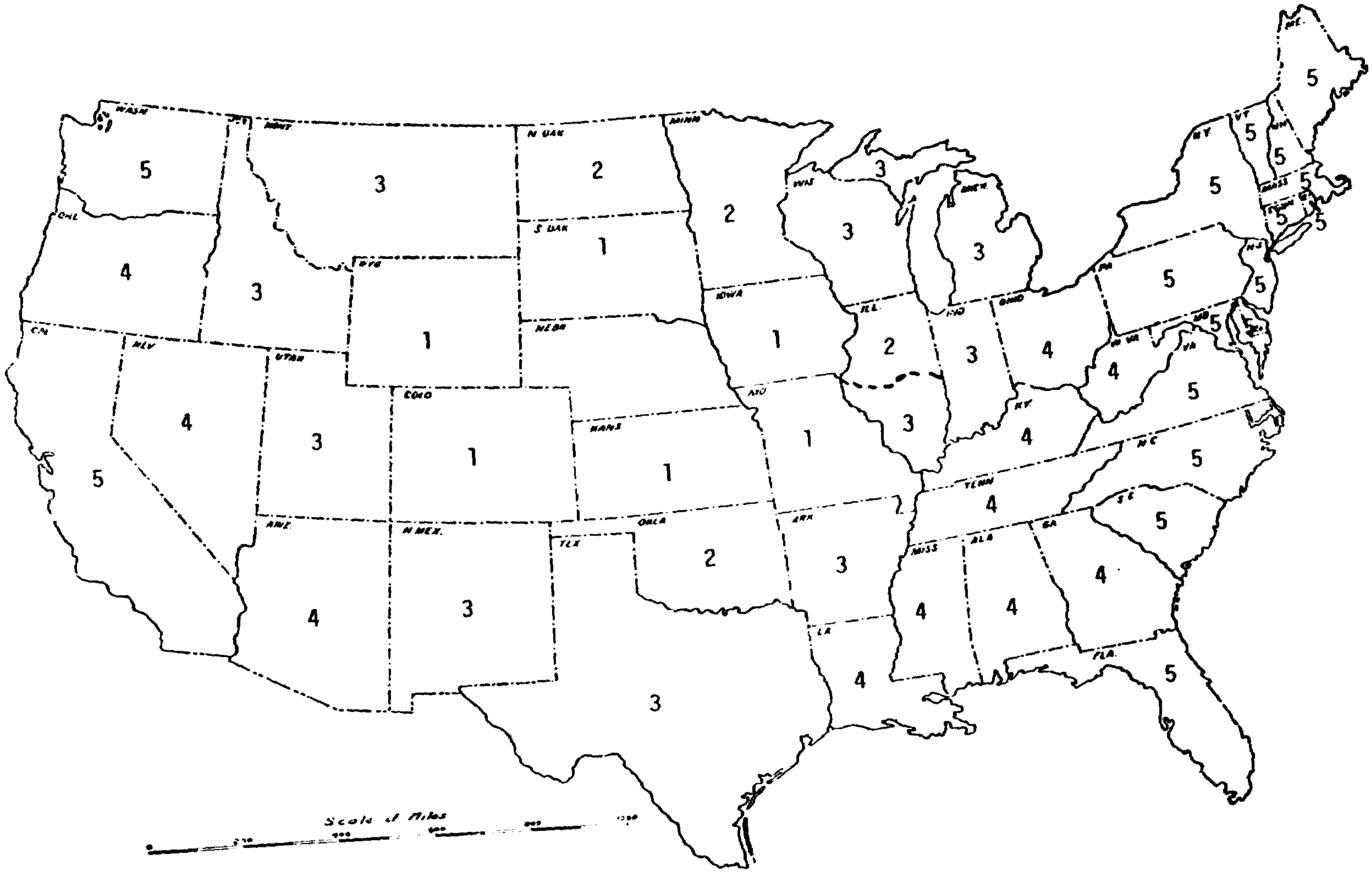


FIGURE 5.1-13 INTERSTATE WATS SERVICE AREAS FOR NEBRASKA

ORIGINAL PAGE IS
OF POOR QUALITY

In establishing charges for WATS and 800 Service a rate step is published for service between each home state and its six service areas. These are shown in Table 5.1-1. The cost per hour for each service rate step is then determined from Table 5.1-2 for Outward WATS and from Table 5.1-3 for 800 Service. There are also monthly access line charges of $31.65 for each Outward WATS line and $36.80 for each (minimum of two per service area subscribed to) 800 Service line.

TABLE 5.1-1 OUTWARD WATS AND 800 SERVICE RATE STEPS

STATE	SERVICE AREA 1	2	3	4	5	6
AL	4	7	9	11	17	22
AZ	6	9	12	15	18	20
AR	4	7	9	11	15	21
CA (N)	8	12	15	17	18	20
CA (S)	7	11	15	17	18	20
CO	7	8	10	12	16	21
CT	1	7	10	14	18	22
DE	1	5	9	13	18	22
DC	1	4	8	12	18	22
FL	7	10	12	13	18	22
GA	4	7	10	12	18	22
ID	5	9	13	15	18	19
IL (N)	3	6	8	10	15	21
IL (S)	3	6	8	10	15	21
IN	3	6	8	10	16	21
IA	4	7	9	11	14	21
KS	5	7	9	12	14	21
KY	3	5	8	10	17	22
LA	5	8	10	13	16	21
ME	6	9	12	16	18	22
MD	2	5	9	12	18	22
MA	2	7	11	14	18	22
MI (N)	5	8	9	12	17	21
MI (S)	4	7	9	12	17	21
MN	6	8	10	12	15	21
MS	5	7	9	11	16	22
MO	5	7	8	10	15	21
MT	7	10	12	14	17	20
NE	5	8	9	12	14	21

STATE	SERVICE AREA 1	2	3	4	5	6
NV	5	8	13	16	18	20
NH	2	7	11	15	18	22
NJ	1	5	9	13	18	22
NM	6	8	10	13	17	21
NY (NE)	3	7	10	14	18	22
NY (SE)	1	7	10	14	18	22
NY (W)	3	5	10	14	18	22
NC	4	7	8	12	18	22
ND	6	9	11	14	15	21
OH (N)	3	5	7	10	17	22
OH (S)	3	5	8	10	17	22
OK	5	7	9	12	15	21
OR	5	9	15	17	18	19
PA (E)	1	5	8	12	18	22
PA (W)	3	5	8	12	18	22
RI	1	6	11	14	18	22
SC	4	7	9	12	18	22
SD	5	8	10	12	15	21
TN	5	6	8	10	17	22
TX (E)	6	9	11	14	16	21
TX (S)	8	11	12	14	16	21
TX (W)	7	9	11	14	16	21
UT	6	7	11	14	18	20
VT	2	7	11	14	18	22
VA	3	5	8	11	18	22
WA	8	11	15	17	18	19
WV	2	5	7	11	18	22
WI	3	7	9	11	16	21
WY	5	9	10	13	16	21

TABLE 5.1-2 OUTWARD WATS COST/HOUR FOR EACH ACCESS LINE

RATE STEPS	FIRST 15 HOURS		NEXT 25 HOURS		NEXT 40 HOURS		OVER 80 HOURS		ALL HOURS
	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	NIGHT/ WEEKEND
1	$17.41	$11.31	$15.48	$10.07	$13.56	$ 8.81	$11.48	$ 7.46	$ 6.05
2	18.29	11.90	16.29	10.59	14.27	9.29	12.08	7.86	6.36
3	18.72	12.71	16.67	10.84	14.61	9.50	12.35	8.02	6.51
4	19.06	12.39	16.97	11.03	14.88	9.66	12.58	8.17	6.62
5	19.35	12.58	17.22	11.19	15.09	9.82	12.77	8.31	6.71
6	19.60	12.74	17.45	11.35	15.30	9.95	12.94	8.41	6.81
7	19.92	12.95	17.74	11.52	15.55	10.11	13.15	8.55	6.92
8	20.29	13.19	18.05	11.73	15.82	10.29	13.39	8.70	7.05
9	20.59	13.39	18.33	11.92	16.07	10.44	13.60	8.84	7.15
10	20.86	13.56	18.58	12.08	16.28	10.59	13.77	8.95	7.26
11	21.10	13.71	18.78	12.20	16.47	10.71	13.93	9.06	7.33
12	21.32	13.85	18.97	12.34	16.62	10.81	14.06	9.14	7.40
13	21.51	13.99	19.14	12.45	16.78	10.91	14.20	9.22	7.47
14	21.73	14.13	19.34	12.58	16.96	11.02	14.34	9.33	7.55
15	21.95	14.27	19.56	12.71	17.13	11.15	14.49	9.42	7.63
16	22.21	14.44	19.77	12.85	17.32	11.26	14.66	9.53	7.71
17	22.46	14.59	19.99	13.00	17.52	11.39	14.82	9.64	7.80
18	22.90	14.89	20.37	13.24	17.86	11.61	15.10	9.82	7.96
19	23.96	15.57	21.32	13.86	18.69	12.15	15.81	10.28	8.39
20	25.82	16.78	22.98	14.94	20.14	13.09	17.04	11.08	9.04
21	26.96	17.52	23.99	15.59	21.03	13.67	17.79	11.56	9.44
22	29.04	18.88	25.85	16.80	[illegible].65	14.72	19.17	12.46	10.16

NOTES:

	8AM-5PM	5PM-11PM	11PM-8AM
MON.-FRI.	BUS. DAY	EVENING	NIGHT/WEEKEND
SAT.	NIGHT/WEEKEND	NIGHT/WEEKEND	NIGHT/WEEKEND
SUN.	NIGHT/WEEKEND	EVENING	NIGHT/WEEKEND

LEGAL HOLIDAYS DURING BUSINESS DAYS CHARGED AT EVENING RATES

TABLE 5.1-3 800 SERVICE COST/HOUR FOR EACH ACCESS LINE

RATE STEPS	FIRST 15 HOURS		NEXT 25 HOURS		NEXT 40 HOURS		OVER 80 HOURS		ALL HOURS NIGHT/ WEEKEND
	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	BUSINESS DAY	EVENING	
1	$17.38	$12.51	$15.86	$11.42	$14.37	$10.34	$12.72	$ 9.16	$ 8.29
2	17.93	12.91	16.36	11.79	14.82	10.67	13.13	9.45	8.54
3	18.18	13.09	16.60	11.95	15.03	10.83	13.30	9.58	8.66
4	18.38	13.24	16.78	12.[illegible]	15.20	10.94	13.46	9.68	8.75
5	18.55	13.36	16.95	12.20	15.34	11.05	13.57	9.77	8.84
6	18.71	13.47	17.08	12.29	15.46	11.14	13.69	9.86	8.91
7	18.88	13.60	17.26	12.42	15.63	11.25	13.83	9.96	8.99
8	19.10	13.76	17.45	12.56	15.80	11.38	13.99	10.08	9.11
9	19.29	13.89	17.62	12.69	15.96	11.49	14.13	10.17	9.19
10	19.44	14.00	17.75	12.78	16.07	11.58	14.23	10.25	9.26
11	19.58	14.10	17.88	12.89	16.20	11.66	14.33	10.32	9.32
12	19.70	14.18	17.99	12.95	16.29	11.73	14.43	10.39	9.39
13	19.81	14.26	18.09	13.03	16.39	11.79	14.49	10.43	9.43
14	19.92	14.34	18.21	13.12	16.48	11.87	14.59	10.51	9.49
15	20.06	14.45	18.33	13.21	16.58	11.94	14.69	10.57	9.56
16	20.21	14.55	18.45	13.28	16.72	12.03	14.79	10.65	9.63
17	20.35	14.66	18.59	13.39	16.82	12.12	14.90	10.72	9.70
18	20.59	14.82	18.81	13.54	17.02	12.26	15.08	10.86	9.82
19	21.56	15.52	19.62	14.13	17.89	12.88	15.74	11.33	10.35
20	23.24	16.73	21.15	15.23	19.29	13.89	16.97	12.22	11.16
21	24.26	17.47	22.08	15.90	20.14	14.50	17.71	12.75	11.65
22	26.14	18.82	23.79	17.13	21.70	15.62	19.08	13.74	12.55

NOTES:

	8AM-5PM	5PM-11PM	11PM-8AM
MON.-FRI.	BUS. DAY	EVENING	NIGHT/WEEKEND
SAT.	NIGHT/WEEKEND	NIGHT/WEEKEND	NIGHT/WEEKEND
SUN.	NIGHT/WEEKEND	EVENING	NIGHT/WEEKEND

LEGAL HOLIDAYS DURING BUSINESS DAYS CHARGED AT EVENING RATES

Direct comparisons between costs for WATS and for other voiceband services are complicated by the fact that the distances corresponding to each Service Area are determined by irregular state boundaries and range between relatively wide limits. However, some general comparisons can be made by considering specific cases.

Figure 5.1-14 compares typical terrestrial private line costs with those of Outward WATS using the Southeast New York home state as a base. Costs for 800 Service from the same base are only slightly different than those for Outward WATS. Monthly costs versus distance ranges taken from the map in Figure 5.1-12 are shown for Service Areas 1 through 5. Service Area 5 encompasses all of the 48 contiguous states, the most distant point of which is approximately 2680 miles from New York City. The rates used are Business Day rates for usage time-blocks ranging from 15 hours per month to 160 hours per month. The latter corresponds to roughly 8 hours per day, five days a week, which represents full business day usage in many business situations. Again it should be remembered that Private Line Service and WATS Service offer different technical, operational and connectivity features so that cost comparisons are only meaningful in those cases where these other factors are not overriding. For example, private lines offer four wire connection, circuit conditioning, and direct connection to the destination without dialing. These operational features are not available with WATS and may in some applications be the deciding factor in the choice between Private Line and WATS Service.

WATS and 800 Service are much more closely related to DDD than they are to Private Line Service and cost comparisons with DDD, therefore, have more general application. In fact, other than the possible cost advantage there is little to distinguish Outward WATS from calls dialed via DDD on the Public Telephone Network. There is a slight distinction in the case of 800 Service, however, because the 800 Service automatically bills incoming calls to the recipient. Operator intervention to reverse the charges would be needed to accomplish the same effect using DDD.

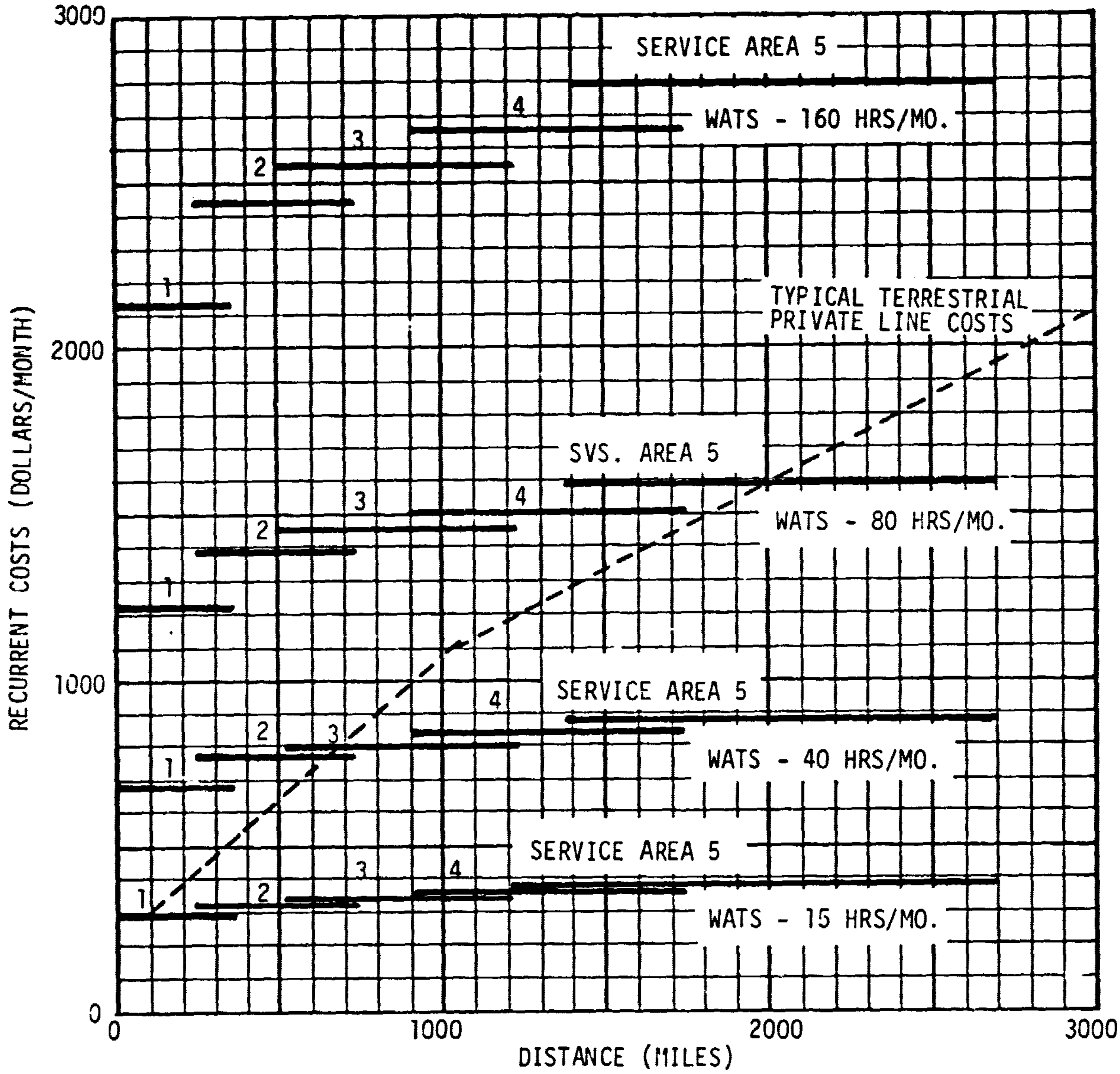


FIGURE 5.1-14 OUTWARD WATS COSTS COMPRED WITH PRIVATE LINE SERVICE. (WATS COSTS BASED ON BUSINESS DAY RATES FOR S.E. NEW YORK HOME STATE INCLUDING $31.65 PER MONTH ACCESS LINE CHARGE).

Figure 5.1-15 compares Outward WATS and 800 Service charges with those for DDD by plotting monthly charges against different amounts of usage during the month. For both DDD and WATS business day rates are shown and the comparison is between calls to the most distant points addressable within the 48 contiguous states. The increasing cost advantage of Outward WATS and 800 Service as usage volume increases is apparent from these curves. There has, however, been some recent regulatory consideration of removing the cost differentials and requiring that WATS and 800 Service be billed at the same rates as DDD but it will be some time before this issue is resolved.

As is the case for DDD there is also a great deal of compression in the rate structure of WATS as a function of distance. For example, as illustrated in Figure 5.1-14, the spread in costs for 160 hours of usage per month between Service Area 1 (adjacent states) and Service Area 5 (transcontinental distances) is only about 30 percent.

While WATS generally results in cost savings for high volume users who do a lot of long distance calling, (as illustrated in Figure 5.1-15), users who make mostly short distance calls, with only an occasional long distance call, pay less using DDD.

5.1.3 SBS BUSINESS MESSAGE SERVICE

In February of 1982 SBS inaugurated its Business Message Service (Type 1) which it describes as similar to AT&T's Outward WATS Service [Ref. 5-3]. Dedicated access channels obtained from other carriers are furnished by SBS to link the customer with the originating SBS switching center at rates dependent on location. Type 2 Service which is projected for the future will permit dial-up access to the SBS facilities. Calls are routed from the originating switching center over a satellite link and are completed via Exchange Network Facilities for Interstate Access (ENFIA) obtained from Bell System Operating Companies, WATS, or via similar facilities from other common carriers.

ORIGINAL PAGE IS
OF POOR QUALITY

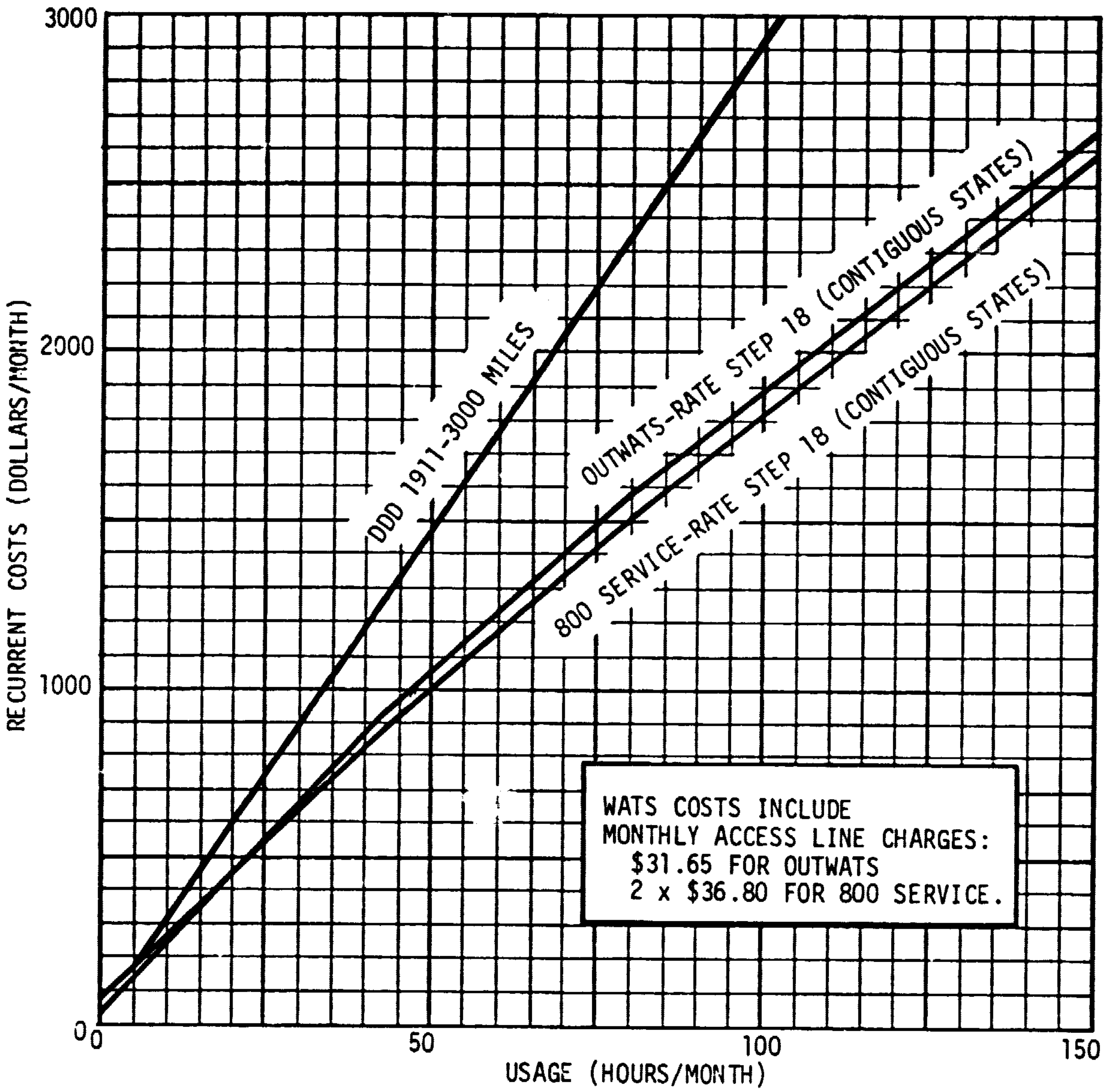


FIGURE 5.1-15 WATS COMPARED TO DDD (NEW YORK CITY TO ANY POINT WITHIN THE CONTIGUOUS STATES)

Charges are based on monthly usage (subject to a monthly minimum of $840 per access channel) and depend on average customer use per access channel and the Calling Area Tier of the called station. Charges for SBS service discussed in this section were effective February 1, 1982.

The three rate tiers are:

Tier I -- The local calling areas surrounding the 20 SBS earth station facilities;

Tier II -- The local calling areas of an additional 130 frequently called cities;

Tier III -- The remainder of the contiguous states and Puerto Rico.

A one minute minimum applies to the average call duration. Off-peak discounts were introduced in June, 1982.

Charges for access lines depend on location:

Co-located in the same building as earth station - $22/month

Local access - $86/month

Extended access - Cost plus $12/month administrative fee

Usage charges are volume dependent based on the average monthly hours of usage to all Tiers from all access lines at the same customer location. Figure 5.1-16 shows business hours costs vs. usage volume for Business Message Service (Type 1), and compares these costs with typical costs for similar service via Outward WATS. Rates illustrated were those in effect in December, 1982.

ORIGINAL PAGE IS
OF POOR QUALITY

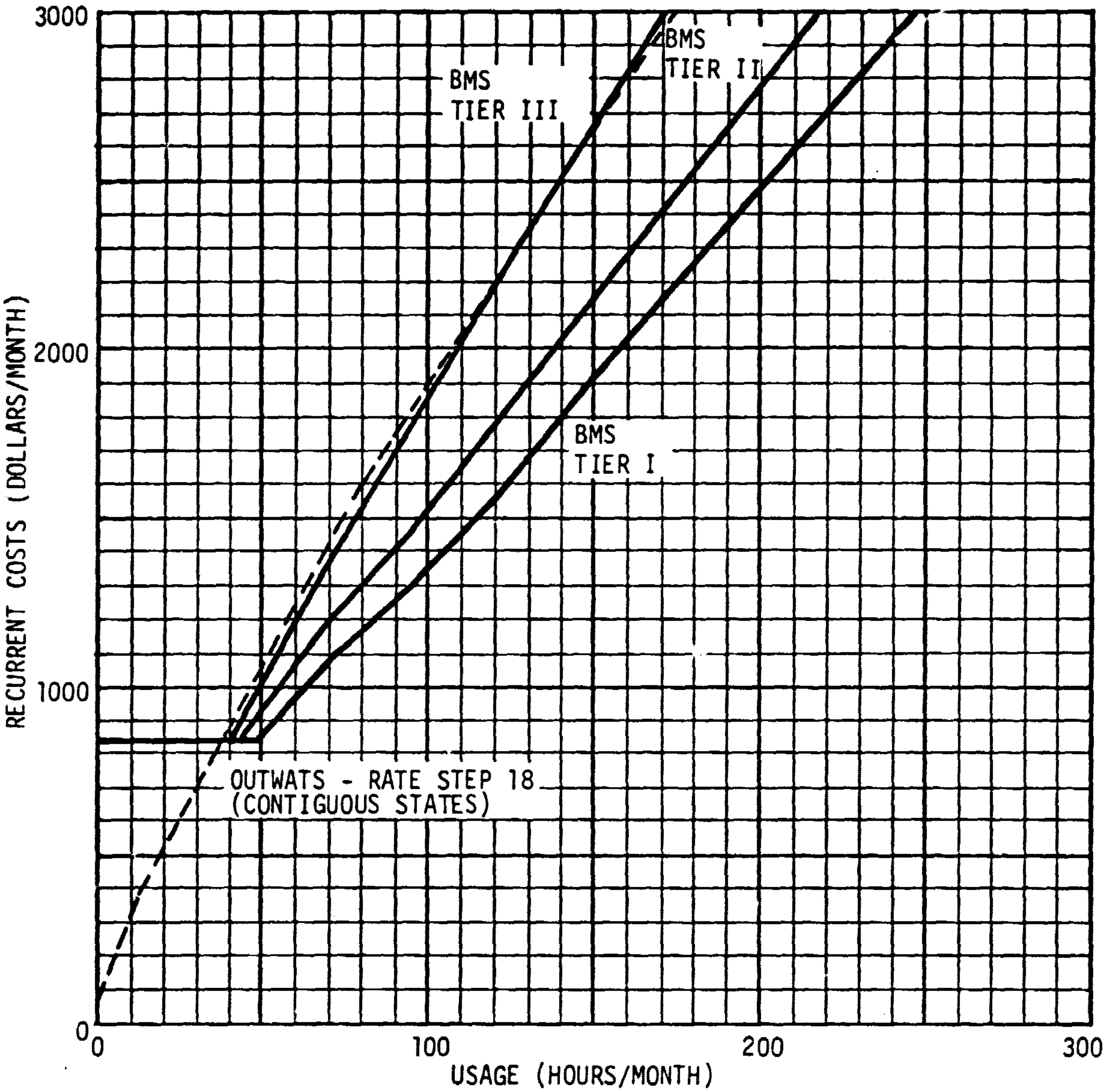


FIGURE 5.1-16 SBS BUSINESS MESSAGE SERVICE (TYPE 1)

5.1.4 PACKET SWITCHED SERVICE COSTS

Packet Switched Service is available from several sources, the most prominent of which are GTE Telenet, and Tymnet. Both of these companies base cost on the volume of data transmitted, independent of distance.

GTE Telenet Communications Corporation has been offering commercial packet switched service since 1975. Access is through dial-up or dedicated ports to Telenet Central Offices in approximately 180 cities throughout the country. Eleven of these central offices support access at up to 56 Kbps, 112 up to 9.6 Kbps, and the remainder are limited to 1.2 Kbps or below. Costs depend on the number of packets sent plus an access charge dependent on the type and speed of access.

Table 5.1-4 shows the cost of GTE Telenet Packet Switched Service using dedicated access lines and public access through dial-up connections. Private Dial-In Ports for DDD and TWX are also available for a limited number of speeds. Rates shown are those in effect in December, 1982. There are volume discounts ranging up to 20 percent depending on the type of service and monthly charges.

TABLE 5.1-4 GTE TELENET - PACKET SWITCHED SERVICE

TRANSMITTING TERMINAL SPEED (BPS)	COST PER KILOPACKET (128,000 Char.)	PRIVATE LINE ACCESS (1)	DIAL ACCESS PORT $ PER HOUR	
			DDD(2)	800 SVS.
110-300,1200	$1.55	550	3.90	23.00
1800	"	700	-	-
2400	"	925	-	-
4800	"	925	-	-
9600	"	1400	-	-
56 Kbps	"	Avail. By Request Only	-	-

(1) Including Port, Modem, and Access Line (First 100 mi) charges. Each additional 100 miles costs $125 per month.
(2) $390 Charge is for Class A cities. For Class B cities charge is $6.90 per month.

Packet Switched Services are also available from Tymnet Inc. which was authorized to act as a common carrier in December of 1976. There is a usage charge per packet, independent of speed and distance, and a time dependent connection charge depending on the type of port, and whether the connection is to a high density center (28 centers) or to a low density center (126 centers). Charges for Tymnet Packet Switched Data Service are summarized in Table 5.1-5. Rates shown are those in effect in December of 1982. Connection to Private Access Ports may be made by either dial-up or dedicated lines.

TABLE 5.1-5 TYMNET - PACKET SWITCHED SERVICE

Cost Per Packet (1000 Characters) (1)		
First 50,000 Packets/Mo.	$0.05	
Next 50,000 Packets/Mo.	$0.03	
Next 100,000 Packets/Mo.	$0.02	
Over 200,000 Packets/Mo.	$0.01	
Private Line Ports (2)		
110-1200 Bps	$225/month	
24000-48000 Bps	$425/month	
Dial Access Ports (2) (110-1200 Bps)	DDD $/Hr	WATS $/Hr
First 1000 Hours/Mo.	4.25	23.00
Next 1000 Hours/Mo.	3.25	22.00
Next 3000 Hours/Mo.	2.50	21.25
Over 5000 Hours/Mo.	2.0	20.75

(1) Business Hours. For off-peak the rate is $0.005 per packet
(2) Hi-Density Cities. Higher costs for medium and low density. Access channel at OCC Rate plus 15 percent.

5.1.5 WIDEBAND SERVICES

CPS systems avoid the expenses and limitations of local distribution and as a result can efficiently provide wideband service to the users. Wideband services therefore represent an important market sector for CPS. Typical costs for wideband services are discussed in the following paragraphs.

Wideband transmissions are those which cannot be accommodated in the spectrum allocated to a voiceband channel. For data transmission, rates above 20 Kbps are generally considered to be wideband. Such rates are available from a number of carriers. AT&T offers Dataphone Digital Service (DDS) which in addition to the voiceband data rates of 2400, 4800, and 9600 bps also provides transmission at 56 Kbps and 1.544 Mbps. DDS is available in over 50 cities and provides a direct digital interface to the user so that no modems are required. Channel costs in effect in December, 1982 are distance sensitive and are plotted in Figure 5.1-17. The incremental mileage rates for the longer distances are $57.70 per mile per month and $2.90 per mile per month for 1.544 Mpbs and 56 Kbps, respectively. The roughly 20:1 cost ratio compares with a ratio between the transmission rates of about 28:1 so that a given volume of data can be sent at lesser expense at the higher transmission rates, provided that sufficient volume exists to justify the faster line.

Terrestrial wideband analog channels are offered by both AT&T and Western Union under the Series 8000 tariff. These channels provide bandwidths up to 48 KHz and can be used for voice, data or facsimile in various combinations according to the type of terminal equipment selected. The AT&T offering (rates current as of December, 1982) includes (a) Type 8800A Service for data or facsimile transmissions up to 56 Kbps; and (b) Type 8800B Service which can be used for 12 individual voice channels or for high speed facsimile and alternate voice/data transmissions. The Western Union channels (rates current as of May, 1982) provide the same nominal bandwidth but differ in some details. Rates are distance dependent as illustrated by the solid lines in Figure 5.1-18. In addition to the mileage charges there are channel end charges that typically range from $400 to $1000 per month for each termination depending on the type of service selected.

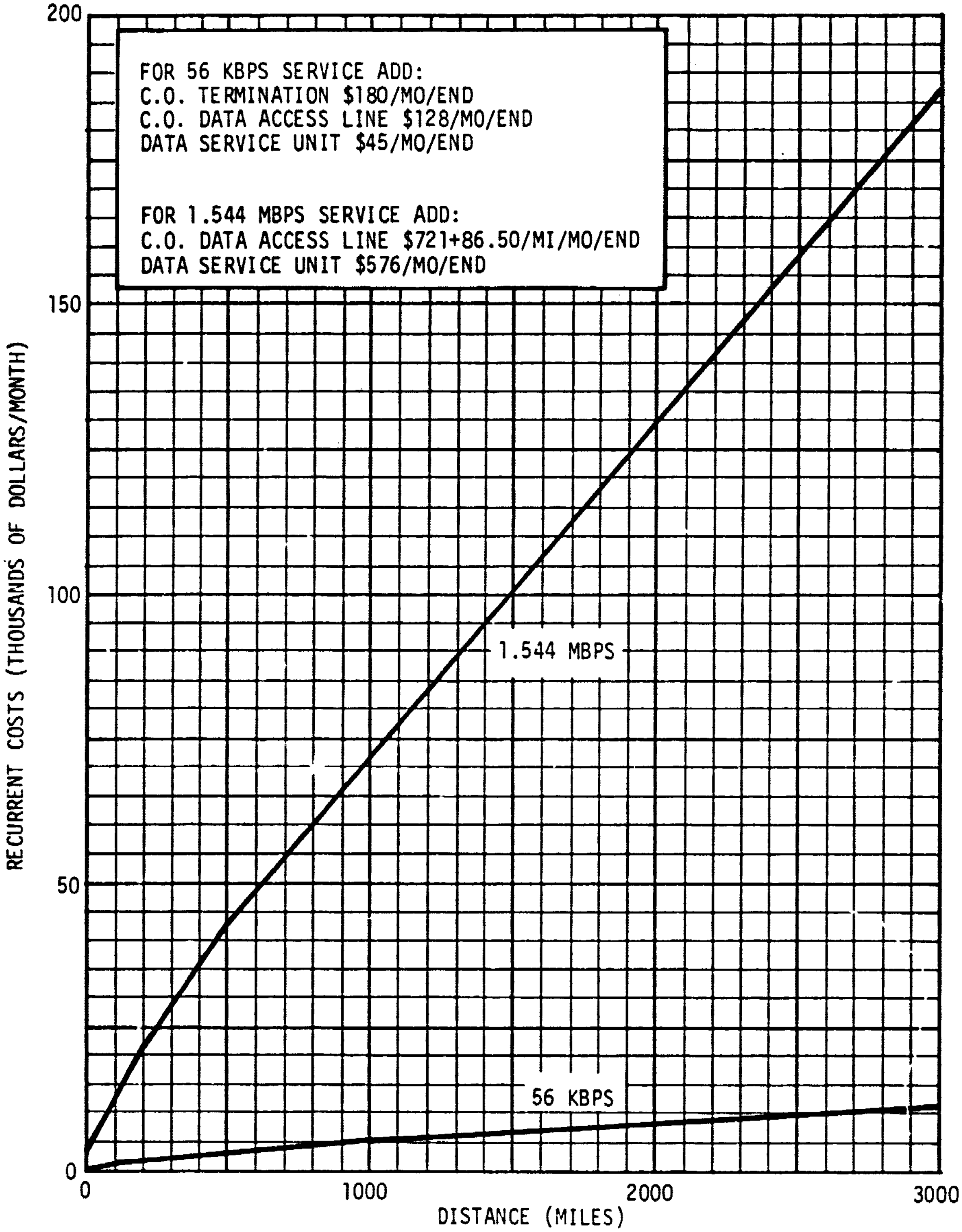


FIGURE 5.1-17 COSTS FOR DDS AT 56 KBPS AND 1.544 MBPS

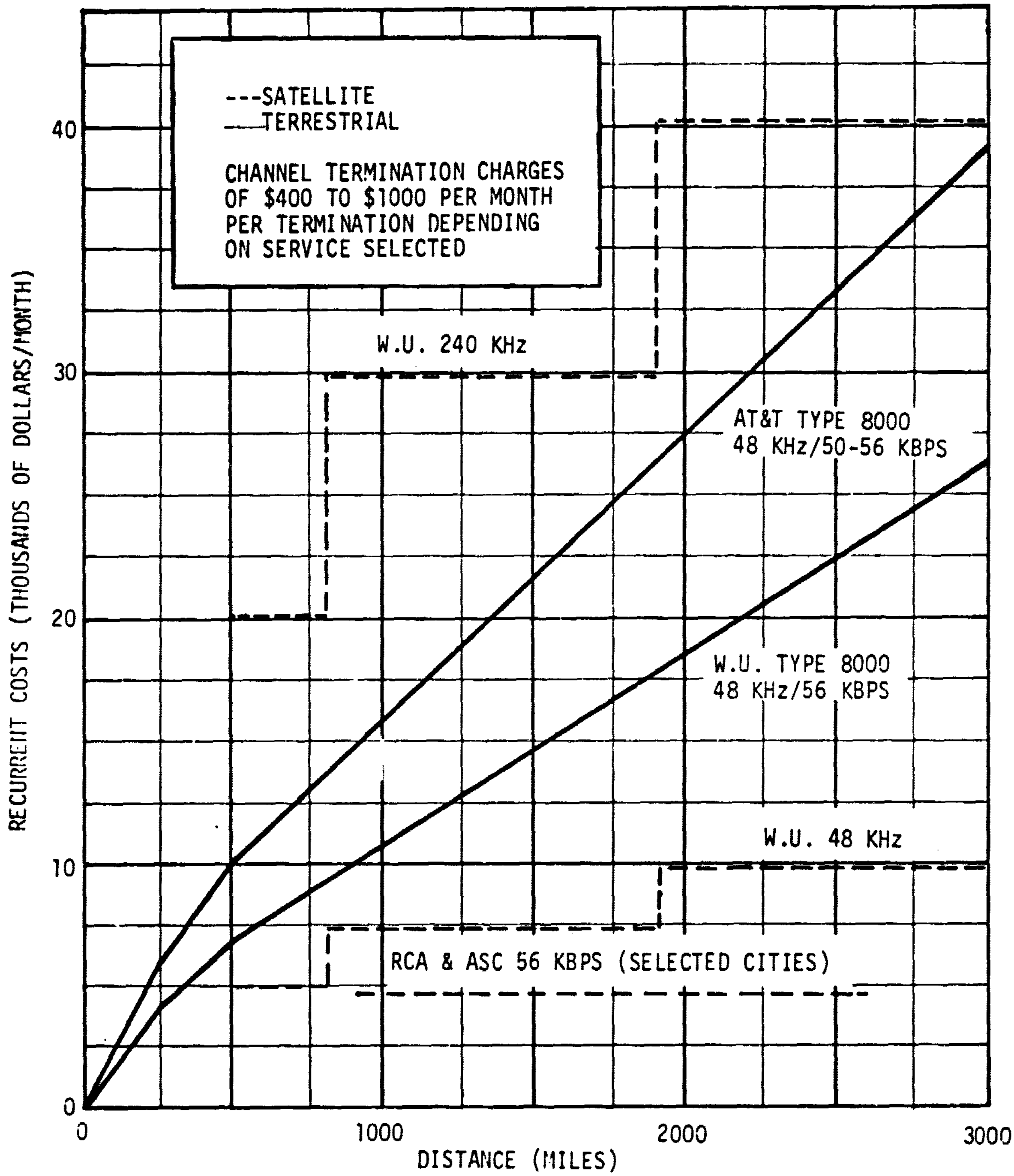


FIGURE 5.1-18 WIDEBAND SATELLITE AND TERRESTRIAL PRIVATE LINE SERVICE

Wideband satellite services are also available. For similar capabilities they are generally less costly than terrestrial lines for distances above a few hundred miles. The dashed curves in Figure 5.1-18 show Western Union's 48 KHz satellite service and 56 Kbps satellite service available between selected city pairs from RCA and ASC. Also illustrated is a 240 KHz wideband satellite service offered by Western Union. Rates illustrated for the wideband satellite services are those current in May of 1982.

Even wider bandwidths suitable for video transmissions are tariffed under the AT&T Series 7000 private line service. The type 7004 channel provides full-time color TV transmission between exchanges at a monthly rental of $39.03 per mile. A second channel can be added at $18.58 per mile per month. Video channels can also be leased on an hourly basis at the rate of $0.93 per hour per mile plus $99.10 per hour for each station connection. Rates quoted for these services are those current in May, 1982.

Satellite facilities can also be leased on a full-transponder basis. Table 5.1-6 shows the rates for 36 MHz transponders on Western Union's Westar satellite under W.U. Tariff 261 (effective date June, 1982).

TABLE 5.1-6 WESTAR TRANSPONDER COSTS

	MONTH-TO-MONTH TRANSPONDER LEASE	FIXED TERM (TWO YEAR) TRANSPONDER LEASE
PROTECTED	$230,000/Mo.	$172,500/Mo.
UNPROTECTED	$149,500/Mo.	$ 96,000/Mo.
UNPROTECTED & INTERRUPTIBLE	$115,000/Mo.	$ 75,900/Mo.

Transponders can also be purchased outright. A highly publicized auction in November of 1981 [Ref. 5-4] resulted in the sale of seven transponders on RCA's Satcom 4 satellite.

The seven transponders were sold in less than one hour at prices ranging up to $14 million dollars with an average price of $12.9 million. Subsequently the auction was set aside as a result of FCC rulings and a fixed price was developed approximately equal to the average auction price [Ref. 5-5]. It was generally accepted at the time of these sales that the high prices for these transponders reflected the growing scarcity of channel space for CATV and other video applications. However, more recent price trends have been downward and transponder prices during the first half of 1983 have been in the $9 to $10 million range.

5.1.6 VIDEOCONFERENCING

The following discusses costs for videoconferencing services offered by AT&T under its "High Speed Switched Digital Service" tariff and costs for similar services from the American Satellite Co.

5.1.6.1 AT HIGH SPEED SWITCHED DIGITAL SERVICE (VIDEOCONFERENCING)

This AT&T offering provides for the simultaneous two-way transmission of digital signals utilizing two parallel channels each operating at the T1 rate of 1.544 Mbps. When supplied with the appropriate terminal equipment these channels can be used to provide interactive color video and audio. Equipment is also available for transmitting visual aids such as transparencies, slides, documents and briefing charts. Customers have the choice of using Bell provided public conference rooms or constructing private, customer premises rooms. Since a common user network is employed any two compatibly equipped public or private rooms can conference with each other.

Cities served at year end 1982 are Atlanta, GA; Boston, MA; Chicago, IL; Detroit, MI; Houston, TX; Los Angeles, CA; New York, NY; Philadelphia, PA; Pittsburg PA; San Francisco, CA; and Washington, DC. Forty-two major metropolitan areas are planned to be served by the end of 1983.

Usage charges are time and distance sensitive. There are also charges for call set-up, access lines, the use of the Public Conference Room, or in the case of Customer Premises Conference Rooms, for the rental of station equipment. These charges are shown in Table 5.1-7.

TABLE 5.1-7 AT&T HIGH SPEED SWITCHED DIGITAL SERVICE RATE STRUCTURE

A. Customer Premises Conference Room

1. Usage Charge (for each 30 minutes or fraction thereof):

   a. Between two customer stations located in the same Digital City Serving Area. — $20.00

   b. Between two customer stations located in different Digital City Service Areas.

Miles	Charge
1-100	$200.00
101-600	40.00/each 100 miles
Over 600	40.00/each 200 miles

2. Access Line Charge (Minimum initial service 12 months):

   a. Within a Digital City Serving Area (Installation Charge $361.00) — $894.00/Mo.

   b. Between Digital City Serving Areas — $2884.00/Mo.

3. Set-Up Charge per Conference — $40.00

4. Station Equipment:

	Installation	Monthly
Room Controller	$19000.00	$ 3300.00
Picture Processor	70800.00	12500.00
Face-to-Face Camera	2000.00	350.00
Overview Camera	2000.00	335.00
Graphics Camera	3200.00	540.00
Multipurpose Camera	3400.00	600.00
Hard Copy Machine	2800.00	490.00
Video Tape Recorder	1800.00	280.00
Clip-On Microphone	0	18.00

(Discounts available for 24 and 48 Month Rentals)

B. Public Conference Room

(Room Includes Station Equipment)
Total Charge is Composed Of:

1. Usage Charge per Item A1 above.
2. Set-Up Charge per room per conference — $ 40.00
3. Conf. room use per 30 min. or fraction thereof — 147.00
4. Access Line Use per 30 min. or fraction thereof — 18.00

5.1.6.2 AMERICAN SATELLITE CO. VIDEO TELECONFERENCING SERVICE

American Satellite Company (ASC) offers a Video Teleconferencing Service featuring end-to-end, turnkey, interactive, private network conferencing. The system uses digital compression technology via satellite channels accessed through customer premises earth stations. Station equipment includes customized teleconferencing rooms or portable consoles plus graphic consoles for remote viewing of hard copy documents. Special terminal equipment can be installed to permit alternative use of the channel for voice (at 32 Kbps) or data.

Transmission is at 1.544 Mbps in each direction for near-full motion video. A 56 Kbps freeze frame transmission mode providing at 14 second refresh cycle is also available. If higher refresh rates are desired, intermediate data rates of 112, 223, and 448 Kbps can be obtained. The ASC system is designed to provide a 10^{-7} bit error rate or better with 99.5 percent equipment availability [Ref. 5-6]. A higher availability (99.9 percent) package using redundant equipment for back-up can be supplied as an option.

Charges are usage and distance insensitive as presented in Table 5.1-8. Users can choose between 1.544 Mbps and 56 Kbps operation and supplement this with a teleconferencing package which provides cameras and other conference room equipment. The standard contract is for three years with fixed rates guaranteed for the three years.

TABLE 5.1-8 ASC VIDEO TELECONFERENCING SERVICE RATE STRUCTURE

A. Full-Duplex 1.544 MBPS System, Including:		
Ten Meter Earth Stations (2) Space Segment Operations and Maintenance Video Digitizer		$57000-$65000/Mo.
B. Full-Duplex 56 KBPS System, Including:		
4.5 Meter Earth Stations (2) Space Segment Operations and Maintenance Video Digitizer		$20000-$22000/Mo.
C. Teleconferencing Package		
Main Console (Monitor, 2 Cameras, and Video Cassette Recorder) Graphic Console (Does not include hard copy output)		
	Per Site	$2400/Mo.

5.2 DEMAND AS A FUNCTION OF PRICE

This section discusses the effects of price on the demand for communication services. For most communications services the quantitative relationship between price and demand is poorly established. Where hard data does exist, it is usually privileged and unpublished. Furthermore, communications services of essentially the same type are differentiated in the view of many users by factors such as reliability, circuit quality, maintenance responsiveness, geographic areas served, installation timing, availability of planning support, and the general reputation of the communications carrier. These factors frequently are heavily weighted by the user and may overcome a substantial price incentive.

5.2.1 INSTALLATION COSTS

Partly because of the quality differences discussed above, there is a certain degree of inertia on the part of the typical user which often requires a cost differential of ten to fifteen percent before a switch to a new communications source will be considered. This resistance to change is also contributed to by the installation fees usually required at the initiation of new service. Disregarding real or apparent quality factors, the installation fee requires that the following relationship be satisfied before a change to a new service can be economically justified:

$$\text{Recurring cost of old service} > \text{Recurring cost of new service} + \text{Amortized installation charge}$$

The break-even point in this formula depends on the cost of money and the expected lifetime of the new service as well as the recurring costs and the installation fee. Figure 5.2-1 shows the relationship among these parameters under the assumption that the cost of money is eighteen percent per year. The abscissa represents the installation charge as a multiple of the recurring monthly costs while the ordinate shows the number of months before the installation charge is recovered at the indicated discount in monthly costs (old monthly costs minus new monthly costs divided by old monthly costs). For example, if the installation charge for the new service is equal to twice the monthly cost of the existing service (abscissa = 2), then Figure 5.2-1 shows that with a 10% discount (new monthly cost relative to old monthly cost) the installation charges will be recovered in 23.6 months.

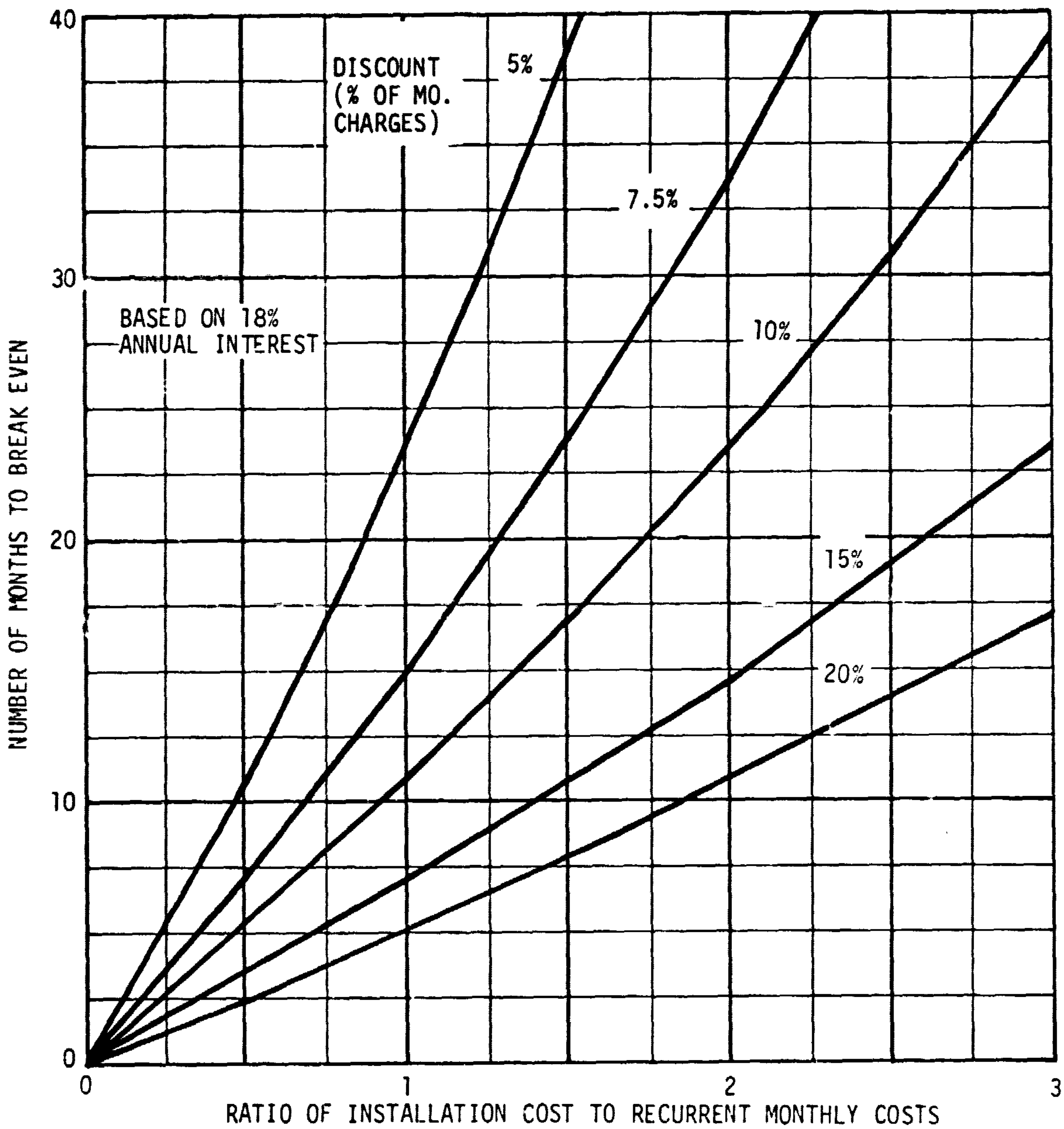


FIGURE 5.2-1 NUMBER OF MONTHS TO BREAK EVEN AS A FUNCTION OF INSTALLATION CHARGE AND DISCOUNT BELOW CURRENT MONTHLY COSTS

In practice, installation charges relative to monthly charges typically range from fractional values of a few tenths (for an expensive long distance line) to about 1.5 (for a short line). A two year recovery of installation charges would require monthly cost discounts ranging from one to two percent for lines with low installation charges, and up to 7.5 percent for the highest relative installation charges. The fact that higher discounts than these are usually needed to motivate a change indicates that installation charges are only partially responsible for the reluctance of many customers to abandon their familiar sources.

5.2.2 PRICE ELASTICITY OF CONVENTIONAL TELECOMMUNICATIONS SERVICES

The percentage change in demand resulting from a given percentage change in price is referred to as price elasticity. Price elasticity is generally a negative number reflecting the fact that as prices increase demand is reduced.

Price elasticity for telecommunications services is highly dependent on the availability of alternative sources. If a broad sector of telecommunications is considered (for example, the switched voice telecommunications market as a whole) demand tends to be inelastic. If prices rise across a broad front users are unable to find alternative sources for the same type of service at lower cost and must change to new methods of conducting business, or pay the price increase. Under these conditions demand may be expected to slacken with rising prices, but not to any great degree, since satisfactory alternatives are usually limited. As measured by the response to rate changes in AT&T's widely used MTS, during years when competition from other carriers was minor, price elasticity of this type is estimated to have the relatively inelastic value of -0.2 [Ref. 5-7, 5-8, 5-9]. This means that a rate increase of one percent in overall telecommunications costs would be expected to cause demand to fall by only two-tenths of one percent.

A much higher degree of price elasticity is encountered if an isolated segment of telecommunications is considered (for example, satellite communications in competition with widely available alternative telecommunications facilities). In this case demand is much more elastic. While the data (derived from a survey of potential users of voiceband private line service) on which the estimate is based is not as extensive as might be desired, a value of about -1.6 appears to be typical of the price elasticity applying to this more competitive situation [Ref. 5-9].

5.2.3 PRICING OF NEWER SERVICES

Some of the telecommunications services of most interest for CPS satellite systems are relatively new and are rapidly evolving. Prime examples are teleconferencing and electronic mail. While one form or another of these services has been in existence for some time, it is likely that quantum jumps in volume and capability are on the near horizon. There is, as a result, little past history on which to base pricing and elasticity estimates, and the best available procedure is to compare the newer telecommunications approaches with existing alternative methods of accomplishing the same objectives.

5.2.3.1 PRICING OF TELECONFERENCING SERVICES

Teleconferencing is frequently justified as providing an economic alternative to business travel. While not all business conferences can be successfully replaced by teleconferencing, studies show that a substantial portion can. Pricing of teleconferencing for these cases, however, must compare favorably with travel costs if the service is to be viable. There are, however, a wide range of opinions as to what travel costs are properly included. In particular, wages accrued by employees during travel can significantly affect cost comparisons. In some approaches wages have been included, while in others wages have been left out. In the following, both approaches are considered so that comparisons under either set of assumptions can be made.

Figure 5.2-2 shows typical round-trip coach airfares to forty-four major cities for travel originating in New York City as a function of distance traveled. For some of the larger cities a range of fares applies, but the lower fares are often coupled with travel restrictions, and reservations at these fares are sometimes difficult to obtain. For unrestricted business travel during prime weekday hours, the highest cost portions of the range are likely to be encountered. The dotted line in Figure 5.2-2 shows the result of a linear regression analysis using the upper end of each price range. The regression line illustrated corresponds to the following cost/distance approximation:

Round-trip Airfare (\$) = 0.15 x One-Way Distance (mi) + 61

A typical overnight trip involves many expenses in addition to the airfare. Estimates for these are:

(a)	Local Travel and Airport Expenses	\$75.00
(b)	Hotel	80.00
(c)	Meals	50.00
	TOTAL	\$205.00

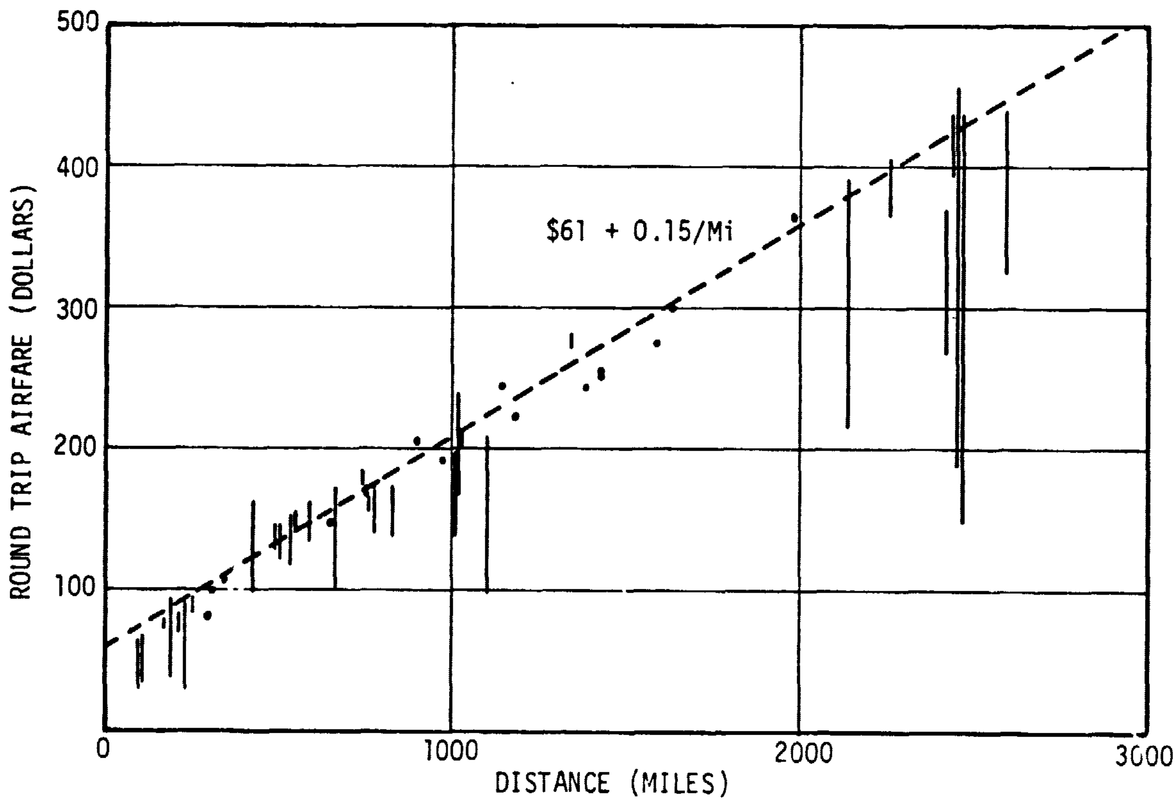


FIGURE 5.2-2 ROUND TRIP COACH AIRFARE

Depending on the analysis, wages may or may not be included in the travel costs. If included, a typical additional cost might be $352.00 (16 hours at $22 per hour).

Adding the various components together results in overall round-trip travel costs per employee for overnight trips as follows:

(a) $266 + 0.15 per mile, without wages
(b) $618 + 0.15 per mile, including wages

These costs linearly increase in rough proportion to the number of employees attending the conference.

Figures 5.2-3a and 5.2-3b show travel costs (as determined by the above relations) as a function of distance and the number of employees traveling. Teleconferencing to be cost competitive should equal or reduce these costs.

Typical costs under the AT&T High Speed Switched Digital Service tariff (rates current as of December, 1982) for a one hour teleconference via Picturephone Meeting Service (PMS) are shown in Table 5.2-1. The public conference facilities supplied by AT&T include the conference rooms, TV cameras and other conferencing equipment. If private facilities are used substantial costs should be added to the listed costs to amortize the costs of the rooms and equipment (See Subsection 5.1.6.1).

TABLE 5.2-1 COSTS OF PICTUREPHONE MEETING SERVICE FOR SELECTED CITY PAIRS

		COST FOR ONE HOUR CALL	
CITIES	MILEAGE	PUBLIC-PUBLIC* CONF. FACILITIES	PRIVATE-PRIVATE CONF. FACILITIES
NYC-WASH. DC	229	$1340	$ 600
NYC-CHICAGO	740	1660	920
NYC-HOUSTON	1470	1980	1240
NYC-LOS ANGELES	2475	2380	1640

*INCLUDES AT&T SUPPLIED CONFERENCE ROOMS AND EQUIPMENT

ORIGINAL PAGE IS
OF POOR QUALITY

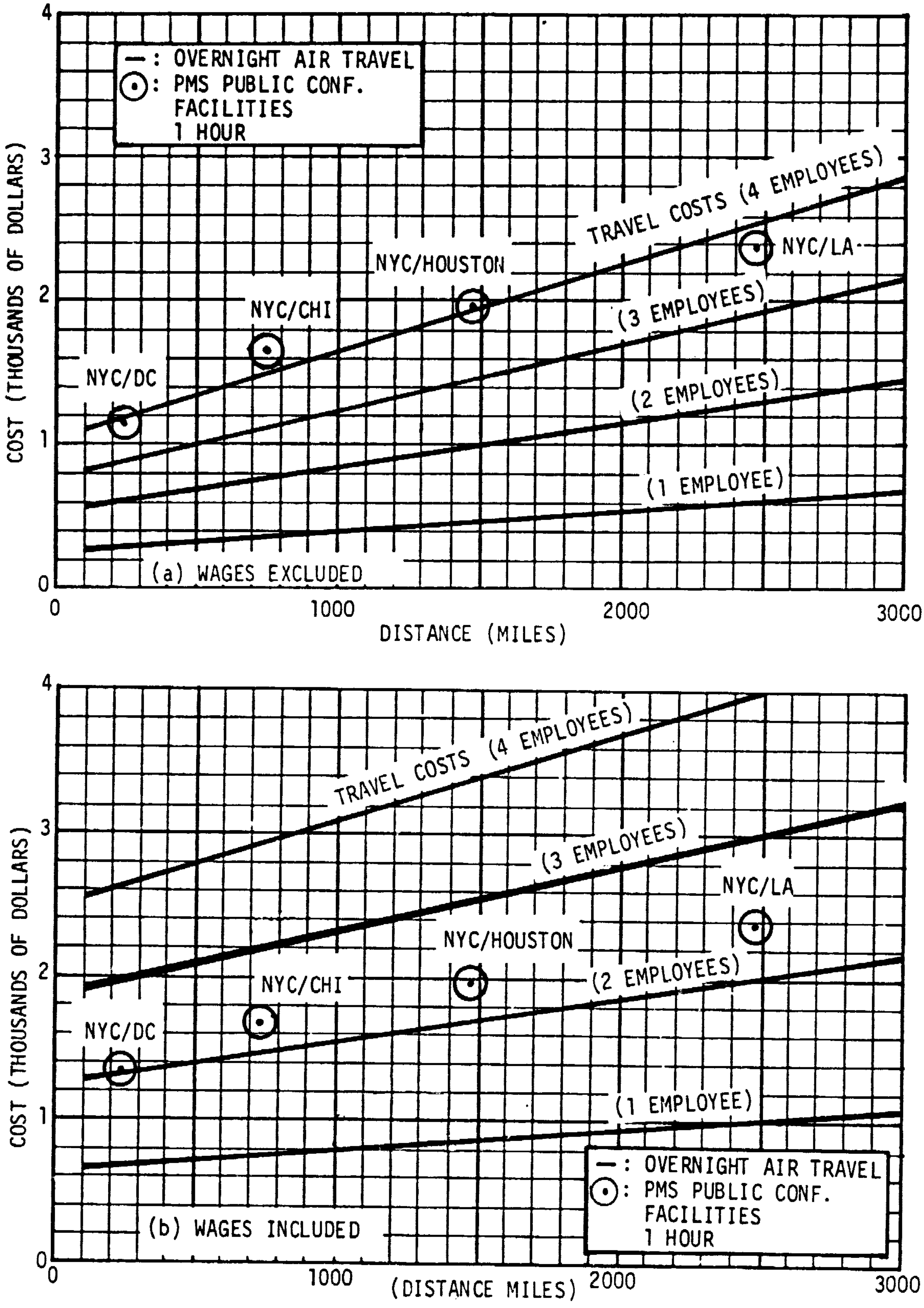


FIGURE 5.2-3 COST OF TRAVEL VS. DISTANCE COMPARED TO TELECONFERENCING

The PMS charges for a one hour teleconference using public conference facilities are plotted for comparison purposes in Figure 5.2-3a and 5.2-3b. If wages are included as part of the costs of travel, break-even for teleconferencing via PMS appears to occur when two or three employees travel to the conference. If wages are not considered, four or more employees would have to travel before teleconferencing becomes cost effective. This assumes, however, that one hour of teleconferencing is sufficient to accomplish the conference objectives. If, as is often the case, several hours of teleconferencing are needed, the current cost of teleconferencing as exemplified by PMS begins to look less favorable.

The competitive position of teleconferencing relative to travel costs would be better assured if coast to coast teleconferencing costs could be brought down to the range of $400 per hour (as was the case for an earlier PMS market trial circa 1978). If CPS systems can deliver such cost performance, perhaps on a secondary use basis, this application is likely to become an important one.

5.2.3.2 PRICING OF ELECTRONIC DELIVERY SYSTEMS

An evaluation of the cost of various document delivery services must take into account many factors including:

(a) Distances traversed;
(b) Speed of delivery;
(c) Volume;
(d) Whether many or only a few destinations are involved;
(e) Whether special equipment and/or labor costs are incurred;
(f) The quality and format of the delivered message and the need for graphics; and
(g) Whether off-peak hours delivery is acceptable.

Because of variability among these factors, direct comparisons between different services can be misleading. However, with some degree of caution, typical ranges of costs for different services can be defined.

A useful baseline is established by document delivery via U.S. First Class Mail. At present the cost for this service is 20 cents for the first ounce plus 17 cents for each additional ounce up to 12 ounces. Above 12 ounces First Class Zone Rates (Priority) Mail rates apply, with rates ranging from $2.58 for one pound to $70.96 (slightly more than $1.00/pound) for 70 pounds for delivery to Zone 8 (highest rate class).

Depending on the weight of the paper and envelope used, a one ounce letter may contain up to five pages. A one pound carton of documents directed to the same location might contain 100 pages. The dotted curve in Figure 5.2-4 illustrates the cost per page of sending documents by First Class Mail for various monthly volumes to any point in the contiguous states. The calculation assumes 20 working days per month, with the shipment each day of a single envelope or carton containing one-twentieth of the monthly volume. Costs range from 20 cents per page for the lowest volume users to slightly over one cent per page for users shipping 100,000 pages per month (5000 pages or 40 pounds per day).

The four curves labeled "Dial-Up" in Figure 5.2-4 show the cost of the transmission time needed by different techniques to send the same volumes of information via dial-up telephone sessions during business hours. The upper two of these curves assume graphic mode transmissions at 4 minutes and 2 minutes per page, respectively. The lower two curves illustrate the costs of character mode transmissions. It is assumed that each character oriented page contains 2250 eight bit characters per page, and that the transmissions take place at 1200 bps (15 seconds per page) or 4870 bps (3.75 seconds per page). The transmission distance assumed is transcontinental and each day's transmissions are accommodated in a single dial-up telephone call.

The curves labeled "Leased Line" in Figure 5.2-4 show similar telephone transmission costs, but uses a full-time leased satellite long distance circuit at a nominal $1100 monthly rental. The curve representing leased line graphic mode transmission levels off above 6000 pages per month because the capacity of a single leased line is exceeded and two or more lines must be used. If one minute per page transmission, rather than the illustrated four minutes per page, were to be used the curve would continue down and level off at about 24,000 pages per month. Similarly, leased line character oriented transmissions at 1200 bps or 4800 bps ultimately level off, but this occurs above 100,000 pages per month.

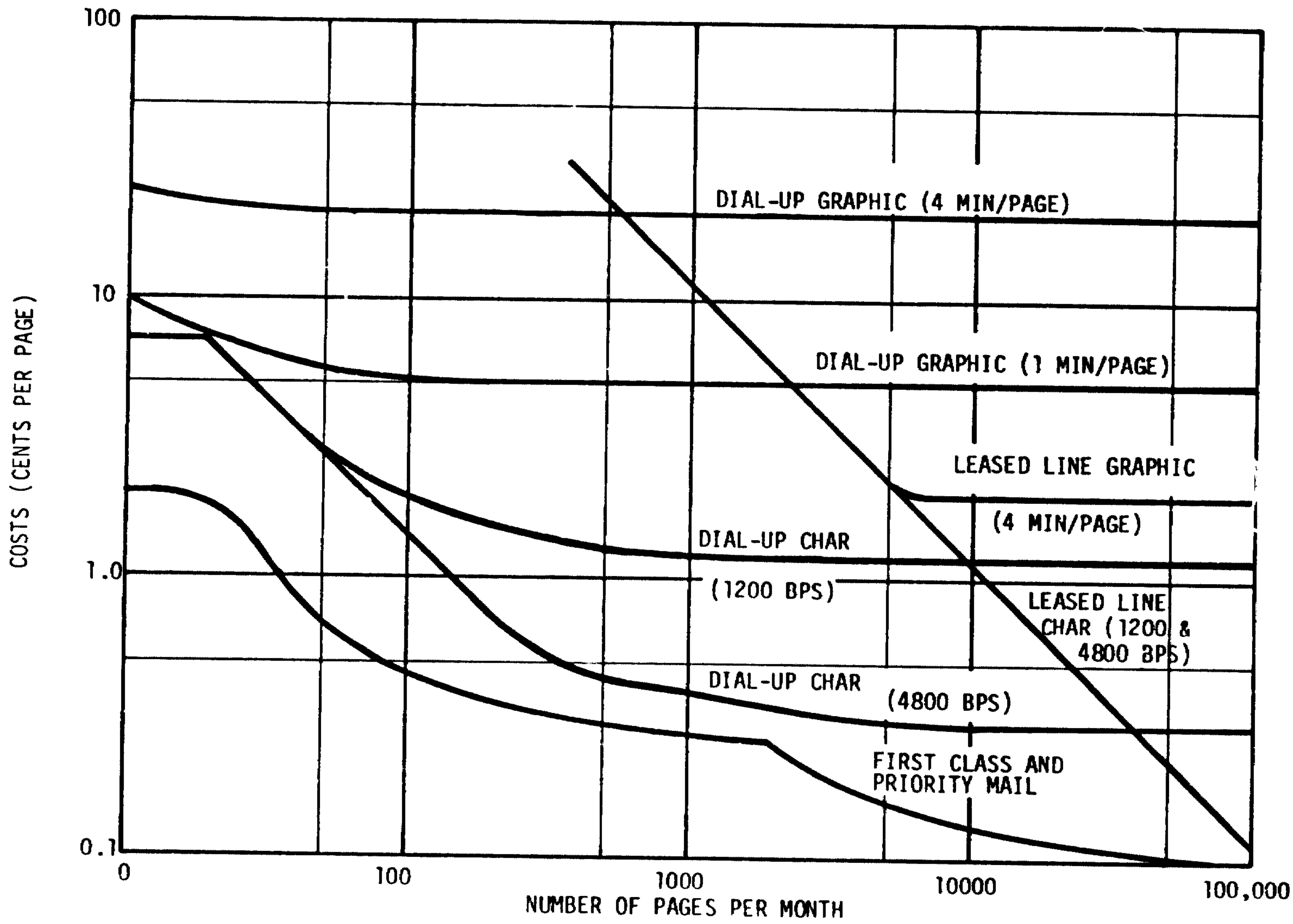


FIGURE 5.2-4 TYPICAL DOCUMENT DELIVERY COSTS BETWEEN ANY POINTS WITHIN THE CONTIGUOUS STATES

Figure 5.2-4 illustrates the fact that electronic delivery of documents is generally more expensive than First Class Mail. The differences, however, are not excessive if the more efficient, high volume, modes are used. If CPS satellite systems can offer further cost reductions in electronic delivery costs, either on a primary basis, or as a secondary use supplementing other transmission applications, a substantial market should be addressable.

5.2.4 FUTURE PRICE TRENDS

The communications industry is in a state of dynamic upheaval that makes the projection of future costs a hazardous undertaking. Certain long term trends have been reasonably consistent in the past, but because of increasing competition in the industry and the separation of long distance and local services in the Bell System, there can be no assurance that these trends will continue. The effect of these industry changes is most likely to be in the direction of overall price reductions, with additional reductions in long distance costs relative to those of local service. However, several years must elapse before the effects are likely to stabilize.

Subject to the caveats expressed above, some of the historical trends referred to above may profitably be examined. In the telephone industry, as exemplified chiefly by the Bell System, telephone cost increases have, for many years, averaged about half the rate of inflation, and productivity has been increasing about 3 percent per year. A useful indicator is the Telephone Rate Index published annually in the AT&T Statistical Reports. The Telephone Rate Index is based on Bell System revenues from MTS, WATS, Private Line and related services. Revenues from these services are combined with various volume related factors (for example, the number of messages in the case of MTS) to arrive at a year-end index number expressive of the relative price of service from year to year.

Figure 5.2-5 plots the Telephone Rate Index for the years 1960 through 1981 with 1960 chosen as the base year. A separate index is plotted for local and for long distance service, and a third curve showing the consumer price index [Ref. 5-10] is presented for comparison purposes. The curves are plotted with a logarithmic scale for the ordinate so that constant growth rates are reflected as straight lines. From 1970 to 1981 the long distance telephone rate index grew by 3.25 percent per year and the local telephone rate index grew by

5.43 percent per year. Both of these are substantially lower than the growth rate of the consumer price index which, over the same period, increased by 7.92 percent per year.

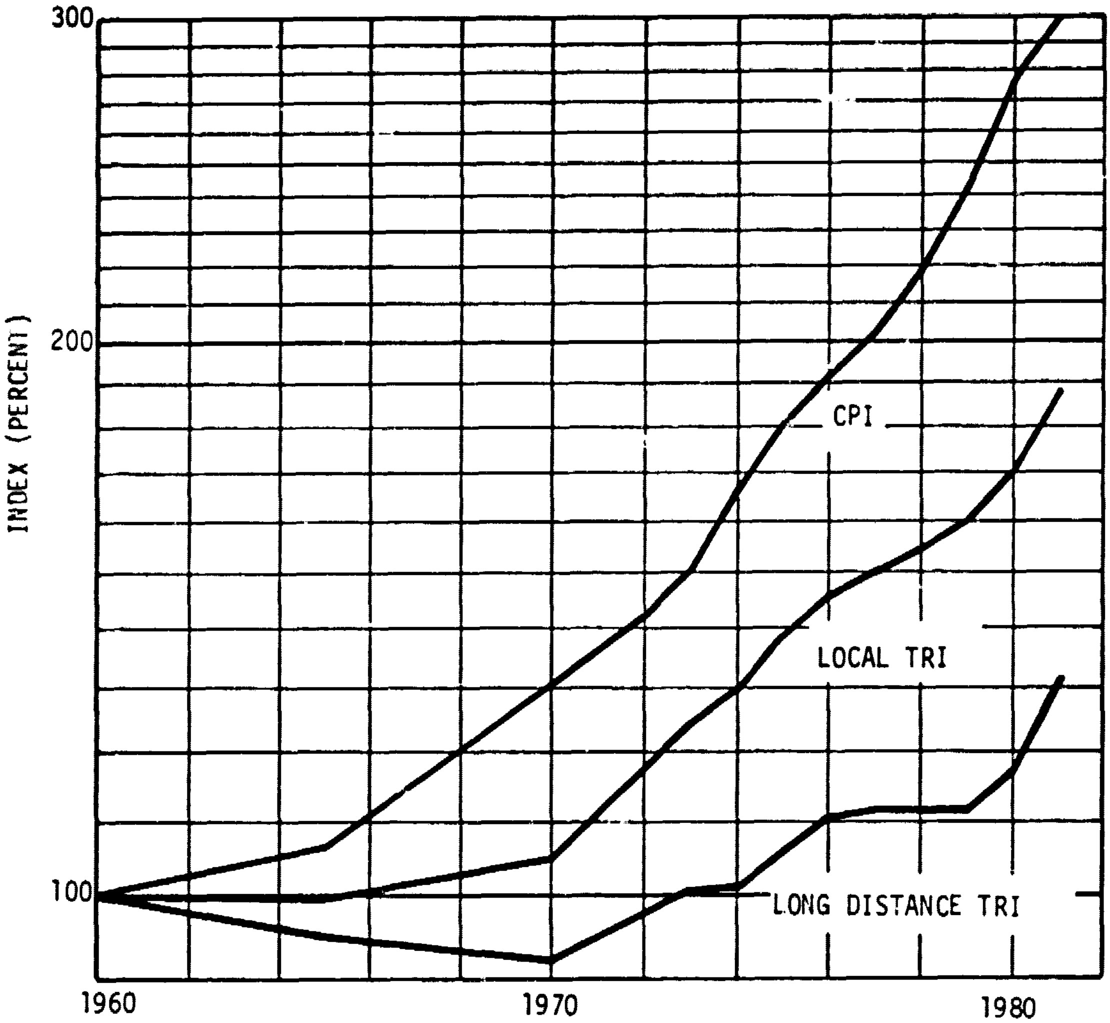


FIGURE 5.2-5 TELEPHONE RATE AND CONSUMER PRICE INDEXES

Figure 5.2-6 plots the local and long distance telephone rate indexes relative to the consumer price index to eliminate the effects of inflation. The results have been normalized to the year 1980 and show a generally declining trend. The sudden upturn at year-end 1981 is of interest since it may or may not signal the beginning of a trend reversal.

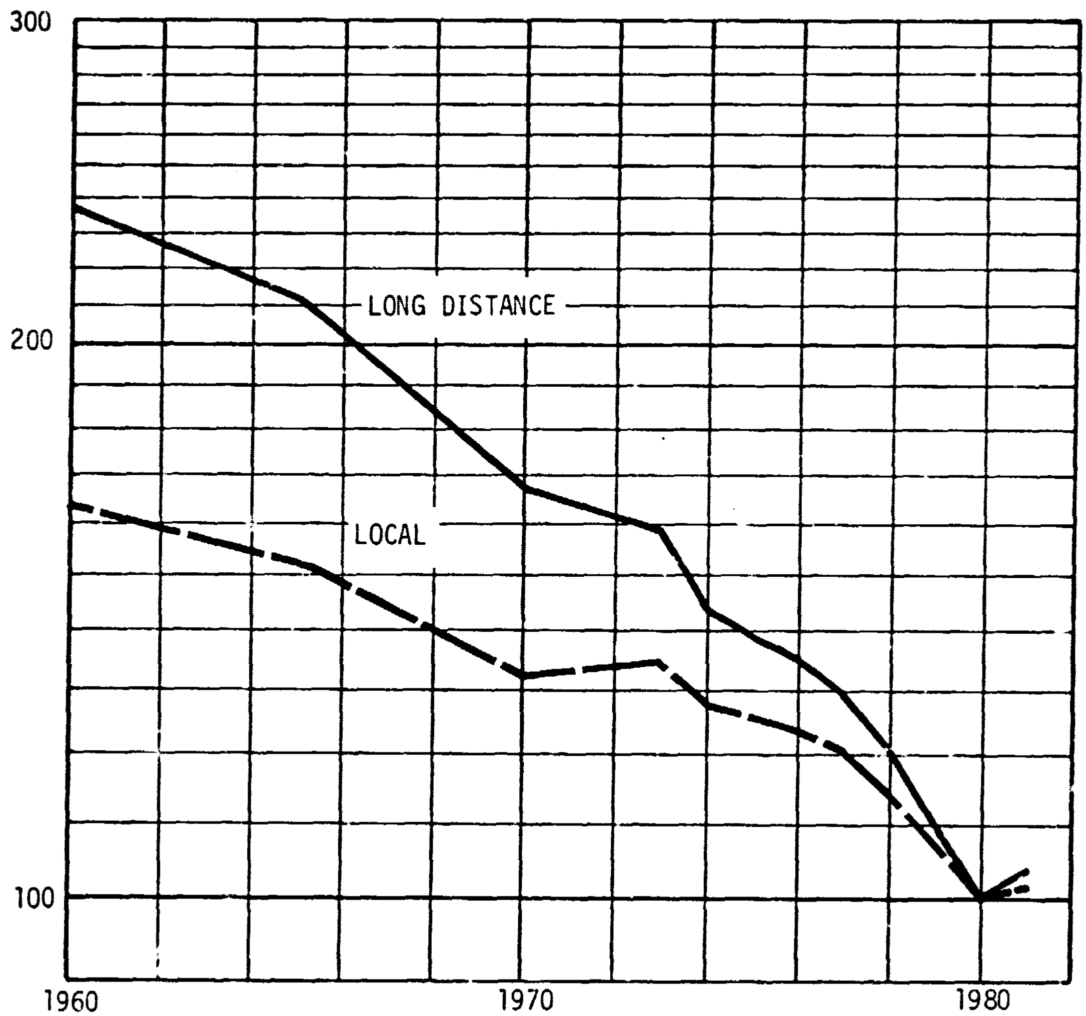


FIGURE 5.2-6 TELEPHONE RATE INDEXES RELATIVE TO CONSUMER PRICE INDEX

Logarithmic regression lines fitted to the data plotted in Figure 5.2-6 show that, relative to the consumer price index, the local service Telephone Price Index and the long distance Telephone Price Index have been decreasing at average annual rates of 2.30 percent and 4.31 percent, respectively. Should these trends continue to the year 2000, further declines of telephone costs (in constant dollars) would occur, resulting in local service prices being reduced to 63.5 percent and long distance prices being reduced to 44.5 percent of the corresponding prices in existence circa 1980.

6.0 MARKET DEMAND FORECASTS

This section presents estimates of market demand for the years 1980, 1985, 1990 and 2000. These estimates update and expand projections developed in earlier NASA sponsored studies [Ref. 6-1, 6-2].

Demand is estimated for the following markets:

(a) The overall telecommunications market - For MTS voice traffic this includes all interurban traffic (i.e., traffic estimated to travel outside of local service area boundaries). For other traffic components, estimates are based on a combination of interstate and intrastate traffic terminal counts, and other parameters as discussed more fully in the following text.

(b) The satellite addressable telecommunications market - This is a subset of the overall market with the primary selection factor being distance.

(c) The CPS addressable market - This is a subset of the satellite addressable market with selection based on establishment telecommunications expenditures, and in some applications based on traffic distribution patterns.

(d) The Ka band CPS market - This is a subset of the CPS addressable market that takes into account the fact that some Ka band designs will exhibit lower availability at a reduced cost.

For each of the above market projections, traffic demand estimates are developed for voice, video and data services, and for subcategories within each service. Later sections of this report then provide projections and interpolations of traffic demand by user class, geographic area, service category, distance and various combinations of these parameters.

6.1 THE OVERALL TELECOMMUNICATIONS MARKET

Overall traffic demand is developed for each of the benchmark years of this study. The service categories considered are:

(a) Voice - Switched
Dedicated

(b) Video - Broadcast
Videoconferencing

(c) Data - Message
Computer

6.1.1 VOICE TRAFFIC (OVERALL MARKET)

The traffic components considered in developing the forecasts for voice are:

(a) Switched Traffic

Residential
Business (Including WATS)

(b) Dedicated (Private Line) Traffic

6.1.1.1 SWITCHED VOICE TRAFFIC

Historical data showing the number of switched voice messages per year carried by Bell and independent carriers are available from several sources. The earlier studies [Ref. 6-1, 6-2] referred to above were based on data contained in "The World's Telephones" [Ref. 6-3], for the years 1965 through 1976. This data has been updated (Table 6.1-1) using issues of "The World's Telephones" through 1980 to include data covering the years 1977, 1978 and 1979.

The data in Table 6.1-1 is plotted semilogarithmically in Figure 6.1-1. The close approximation to a straight line for the years 1965 through 1979 indicates that a nearly constant compound growth factor has been operative over the period plotted. The dotted line is a logarithmic regression line fitting the historical data and displaying a 9.41 percent annual

TABLE 6.1-1 INTERURBAN TOLL CALLS COMPLETED 1965 TO 1979 (BILLIONS)

YEAR	CALLS COMPLETED	YEAR	CALLS COMPLETED	YEAR	CALLS COMPLETED
1965	4.7	1970	7.2	1975	11.5
1966	5.2	1971	8.0	1976	12.2
1967	5.6	1972	9.2	1977	13.5
1968	6.2	1973	9.9	1978	15.2
1969	6.8	1974	10.6	1979	17.2

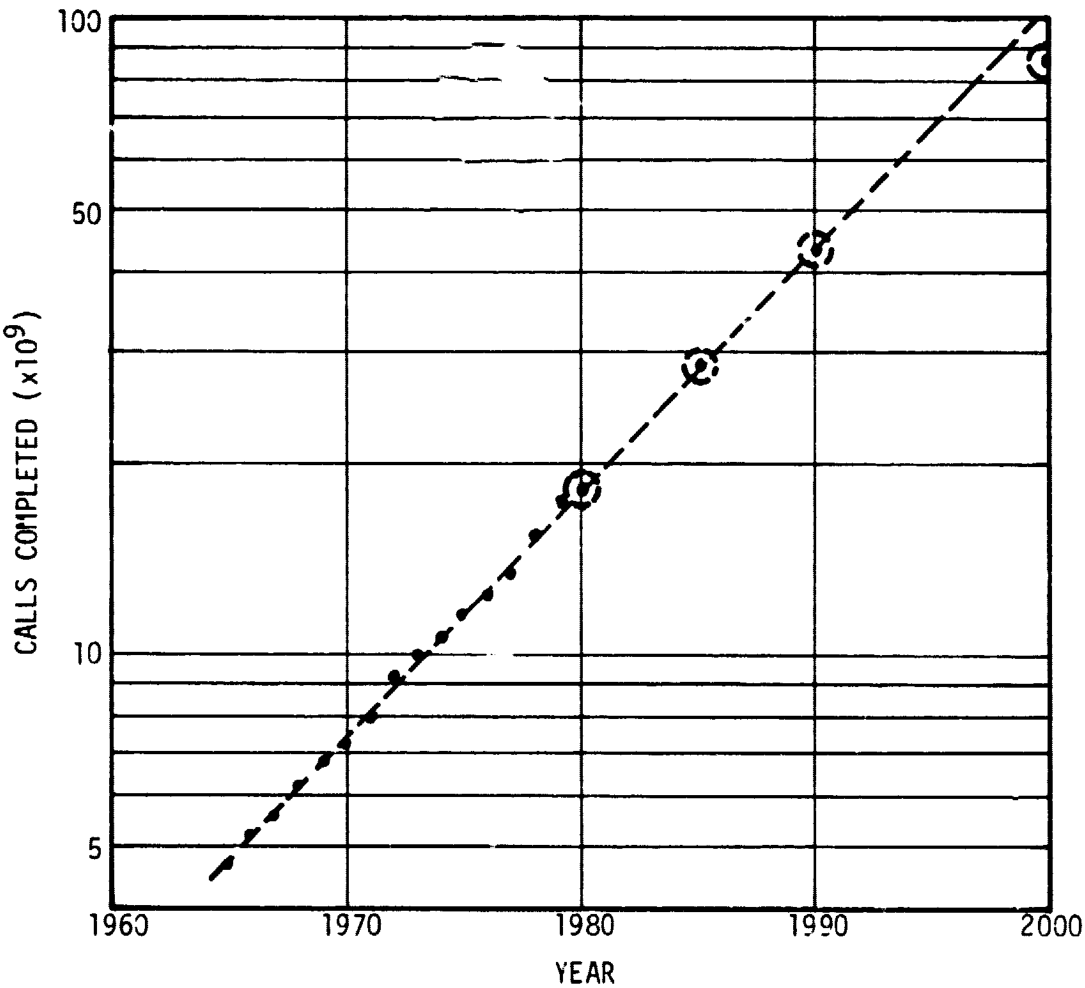


FIGURE 6.1-1 INTERURBAN TOLL CALLS COMPLETED

growth rate. Extension of this line to 1980 results in a estimate of 18.2 billion* completed calls, which is slightly higher than the earlier estimate of 17.1 billion calls presented in Reference 6-1. Further extension of the same growth rate to the year 1985 results in 28.5 billion completed calls.

Following the approach of Reference 6-1, the growth rate projected for 1985 through 1990 has been reduced slightly to 9 percent and further reduced during the decade of 1990 to 2000 to 7 percent to allow for a moderate degree of saturation. The resulting values for the years 1990 and 2000 are 43.8 and 86.2 billion completed calls, respectively. These values are slightly higher than those projected in the earlier study, reflecting the influence of the more recent data.

The revised values for the benchmark years of the present projection appear as dotted circles in Figure 6.1-1 and are summarized in column 2 of Table 6.1-2. Table 6.1-2 uses these values to project demand for interurban (calls outside the local service area) MTS demand for the benchmark years of this study.

The third column in Table 6.1-2 takes into account additional network traffic due to incomplete call attempts (misdialed calls, busy signals, wrong numbers, etc.). While this component of traffic is sizeable in terms of call attempts, the relatively low holding time associated with these incompleted calls reduces the overall effect to about five percent. Column three therefore recognizes this additional traffic by adding five percent to the completed calls listed in column two.

TABLE 6.1-2 INTERURBAN MTS DEMAND 1980-2000

1 YEAR	2 CALLS COMPLETED (10^9/Yr)	3 EQUIV. CALLS (10^9/Yr)	4 HOLDING TIME (SEC)	5 TOTAL CALL-SEC (10^{12}/Yr)	6 RES/BUS PERCENT	7 RESIDENT CALL-SEC (10^{12}/Yr)	8 BUSINESS CALL-SEC (10^{12}/Yr)
1980	18.2	19.1	360	6.88	48/52	3.30	3.58
1985	28.5	29.9	368	11.00	47/53	5.17	5.85
1990	43.8	46.0	375	17.25	46/54	7.94	9.32
2000	86.2	90.5	390	35.30	43/57	15.18	20.12

*Subsequent to this writing the 1981 issue of "The World's Telephones" was distributed providing a count of 19.2 billion completed calls for 1980.

Column four of Table 6.1-2 shows the average holding time for calls. The values for 1980, 1990 and 2000 were developed in Subsection 2.1.2.3 of Reference 6-1 which takes into account such factors as the dependence of holding time on distance, the fraction of inter- and intrastate calls, and a historical trend toward longer holding times. The 1980 value of the holding time was checked against more recent data and the previously estimated value used appears to be reasonable. The value for 1985 is linearly interpolated from the 1980 and 1990 values.

An important measure of traffic loading is the number of call-seconds per year. This is presented in column 5 of Table 6.1-2 as obtained from the product of the entries in columns 3 and 4.

The remaining columns of Table 6.1-2 sort the total call-seconds per year into residential and business oriented sectors. The percentages in each sector (column 6) are estimated from reported revenues modified by the average costs of toll calls for each sector (see Subsection 2.1.2.3 of Ref. 6-1). Columns 7 and 8 are then obtained by applying the percentages of column 6 to the total call-seconds shown in column 5.

To complete the projections of overall switched traffic, the traffic due to WATS (Outward WATS and 800 Service) must be included. While the regulatory future of WATS is somewhat uncertain the traffic presently carried by WATS, and similar services from non-Bell carriers, can be expected to continue on other switched voiceband facilities if WATS is discontinued.

The number of WATS messages per year (interstate and intrastate) as obtained from AT&T Statistical Reports [Ref. 6-4] covering the years 1974 through 1978 was used in Ref. 6-1 as the basis of projections of future WATS traffic. Over that period the annual growth rate for WATS averaged 22.7 percent per year. More recent Statistical Reports (1981) show that the high growth rate has continued over the years 1979, 1980 and 1981 but is beginning to diminish. Table 6.1-3 summarizes WATS messages and growth rates from 1974 through 1981.

TABLE 6.1-3 WATS MESSAGES AND GROWTH 1974-1981

YEAR	WATS MSGS (10^9/Yr)	PERCENT INCREASE	YEAR	WATS MSGS (10^9/Yr)	PERCENT INCREASE
1974	1.605	-	1978	3.631	19.2
1975	1.942	21.0	1979	4.244	16.9
1976	2.451	26.2	1980	4.874	14.8
1977	3.046	24.3	1981	5.655	16.0

Based on these values, and the decelerating growth rate, reasonable projections call for an average growth rate over the 1981 to 1985 period of 10 percent moderating to 9 percent for the remainder of the decade, and to 7 percent for the 1990 to 2000 decade. The resulting values for the benchmark years of this study are shown in column 1 of Table 6.1-4. These values are somewhat higher than those projected in Reference 6-1 due to the continued high growth rates experienced in the years subsequent to the earlier study.

TABLE 6.1-4 WATS DEMAND 1980-2000

1 YEAR	2 MSGS BELL SYS (10^9/Yr)	3 MSGS, BELL &NON-BELL (10^9/Yr)	4 TOTAL MESSAGES (10^9/Yr)	5 HOLDING TIME (SEC)	6 TOTAL WATS CALL-SEC (10^{12}/Yr)
1980	4.874	5.137	5.394	211	1.14
1985	8.279	8.726	9.162	216	1.98
1990	12.738	13.426	14.097	220	3.10
2000	25.057	26.410	27.731	229	6.35

Following the methodology of Subsection 2.1.3.1 of Reference 6-1, which is based on revenues of carriers outside the Bell System for WATS-like service as compared with those of Bell companies, the values in column 2 of Table 6.1-4 are incremented by 5.4 percent to arrive at estimates for total (Bell plus non-Bell) WATS messages. These values are in turn incremented by an additional 5 percent (column 4) to allow for incompleted calls, paralleling the similar step taken earlier for MTS.

Column 5 of Table 6.1-4 shows holding times estimated for WATS. The 1980 value is obtained from a 1981 AT&T filing [Ref. 6-5] presenting data on interstate WATS. It is assumed that these holding times apply to intrastate WATS as well. The values for subsequent years assume the same trend toward longer holding times postulated for MTS in Table 6.1-2.

Table 6.1-5 estimates overall demand for switched voice traffic, summarizing the results obtained in Tables 6.1-2 and 6.1-4 and combining WATS demand with MTS Business and Residential demand to obtain the total overall switched traffic demand.

TABLE 6.1-5 SUMMARY OF OVERALL SWITCHED VOICE TRAFFIC DEMAND
(CALL-SEC./YEAR x 10^{12})

YEAR	BUS. MTS	WATS	TOT. BUS.	RES. MTS	TOTAL
1980	3.58	1.14	4.72	3.30	8.02
1985	5.85	1.98	7.83	5.17	13.00
1990	9.32	3.10	12.42	7.94	20.36
2000	20.12	6.35	26.47	15.18	41.65

In order to compare and consolidate Switched Voice traffic demand with other components of traffic, it is necessary to use a common measure of traffic demand. Bits per year provides a convenient measure allowing the comparison and combination of voice, video and data signals. This measure has the added advantage of being compatible with digital transmission technology. An increasingly large share of the terrestrial network is being converted to digital transmission, and it is likely that many future satellite systems will be designed to digital standards.

Various bandwidth compression techniques are available, as discussed earlier in this report, which allow the transmission of analog voice signals at reduced bit rates and some carriers are offering voiceband channels at 32 Kbps or less. However, most terrestrial voice traffic is currently digitized at the 64 Kbps rate (one-way) encountered in the widespread and rapidly expanding T1 carrier system used by AT&T. In selecting a conversion rate for use in the projections included in this study a number of factors were weighed as discussed below.

The primary benefit of using the lower bit rates possible with compression is the resultant increase in the number of channels that can be served by a given facility. This has the effect of reducing per channel costs though, in view of the strong economy of scale typical of practical communications systems, the cost reduction will be far smaller than the corresponding change in bit rates. Furthermore, the voice compression equipment needed to achieve lower voice digitization rates is itself more costly than the relatively simple equipment used to digitize voice at the T1 rate. The cost of this equipment must be traded-off against the cost of the higher bit rates otherwise needed.

A number of disadvantages are also introduced at the lower bit rates, and must be considered. Channel quality is poorer, and though it may be adequate in single relay systems, quality rapidly degrades at each interface which extends the signal from link to link. The T1 rate, on the other hand, allows many successive relays of the signal without undue degradation in quality. The use of T1 rates also facilitates interconnection with widely available terrestrial transmission facilities, PBXs, switches, and other equipment built to terrestrial standards.

There are also potential problems introduced by bandwidth compression if the voicegrade line is to be used for alternate voice/data applications. The use of compression may degrade or preclude the transmission of data (particularly in full-duplex modes), requiring that the facilities be rigidly partitioned into separate voice and data sections. Lastly, it should be noted that bandwidth compression is most effective when the statistics of a large number of channels can be relied upon to achieve efficiency without degrading the conversation. For smaller systems involving a limited number of channels the bandwidth compression scheme becomes less effective.

While there will be some systems operating at lower bit rates than T1, in view of its general applicability, higher quality, lower equipment costs, and ease of interface with terrestrial facilities, the basic one-way 64 Kbps T1 voiceband channel has been assumed to be prevalent over the time frame of this study. This means that each call-second of two-way traffic will utilize 128,000 bits in the digital transmission stream. Using this conversion, Table 6.1-6 presents the data of Table 6.1-5 with demand represented in terms of bits per year.

TABLE 6.1-6 SUMMARY OF OVERALL SWITCHED VOICE TRAFFIC DEMAND (BITS PER YEAR x 10^{15})

YEAR	BUS. MTS	WATS	TOT.SW.BUS.	RES. MTS	TOTAL
1980	458.24	145.92	604.16	422.40	1026.56
1985	748.80	253.44	1002.24	661.76	1664.00
1990	1192.96	396.80	1589.76	1016.32	2606.08
2000	2575.36	812.80	3388.16	1943.04	5331.20

6.1.1.2 DEDICATED VOICE TRAFFIC

Private (Leased Line) traffic statistics are not regularly published and estimates for the number of private lines, their lengths, and the volume and type of traffic carried must be inferred from other data.

Projections for the number of private lines in use, based on published revenue data and an assumed average cost per line were presented in Reference 6-1. These were subsequently updated based on additional published data [Ref. 6-6] and consultation with Bell System sources. The updated results appear in Table 6.1-7. Column 2 shows projected demand for two-way private lines for the benchmark years of this study. These represent interurban private lines exclusive of short distance intracity lines.

Conversion to digital measure is accomplished in column 3 of Table 6.1-7, by allocating 128,000 bits per second times the number of seconds in a year (31.54 million) for each two-way circuit. Because private line facilities are dedicated for full-time use by the customer the transmission capacity needed to satisfy private line usage must be reserved whether or not the facilities are in active use. As a result private line demand expressed in bits per year is relatively high compared to requirements for MTS and WATS.

TABLE 6.1-7 OVERALL PRIVATE LINE DEMAND

YEAR	TWO-WAY CIRCUITS ($x10^3$)	BITS/YEAR ($x10^{15}$)
1980	435	1755.92
1985	701	2829.66
1990	1128	4553.29
2000	2670	10777.77

6.1.1.3 SUMMARY OF OVERALL VOICE TRAFFIC DEMAND

Table 6.1-8 summarizes overall demand for voice traffic as developed in the preceding subsections.

TABLE 6.1-8 OVERALL VOICE TRAFFIC DEMAND 1980 - 2000
(BITS/YEAR x 10^{15})

YEAR	SWITCHED	DEDICATED	TOTAL
1980	1026.56	1755.92	2782.48
1985	1664.00	2829.66	4493.66
1990	2606.08	4553.29	7159.37
2000	5331.20	10777.77	16108.97

6.1.2 VIDEO TRAFFIC (OVERALL MARKET)

Projections for video traffic demand through the year 2000 were developed in Reference 6-1. The projections included the following subcategories:

(a) Network TV - Commercial and non-commercial broadcasting systems delivering nationwide programming through affiliated stations;

(b) CATV - Other TV program sources including special interest, regional, ad-hoc and part time broadcasting;

(c) Educational Video - Primarily one-way video channels with or without two-way audio interactive capabilities. This includes systems used by universities, and those one-way videoconferencing systems used to address audiences of business executives, trade groups, etc.

(d) Public Systems- Video support of health, emergency, law enforcement and similar applications;

(e) Videoconferencing - Two-way real-time video communications between two or more points. Full motion and voiceband freeze-frame transmissions fall in this category but the latter add negligibly to the traffic volumes and are therefore not further considered; and

(f) Videotex/Teletext - These systems, discussed earlier in Subsection 2.2.2, use video display to present information to the user, but generally use data rates compatible with voice band data lines. Contributions to long haul data transmission are expected to be minor and are not explicitly considered in the following.

The projections developed in this report are based on these earlier estimates with the following modifications:

(1) CATV demand for 1980 has been updated and growth rates for CATV have been increased for the years subsequent to 1980 to reflect faster growth in this industry than originally anticipated.

(2) Compression ratios applicable to full motion videoconferencing have been increased to reflect recent technological advances.

(3) Airline enplanement figures used in projecting videoconferencing have been updated.

6.1.2.1 NETWORK TV

Table 6.1-9 shows demand for Network TV channels as developed in Reference 6-1. The estimates for commercial networks are based on the existence of three such networks using two-time-zone transmission for 1980 and 1985. A fourth network is projected for 1990 and beyond, and a switch from two-zone to three-zone transmission is forecast for the year 2000. The estimates for noncommercial network channel demand are based on projected needs for PBS.

TABLE 6.1-9 NETWORK TV CHANNEL DEMAND
(ONE-WAY FULL TIME VIDEO CHANNELS)

	1980	1985	1990	2000
COMMERCIAL NETWORKS	6	7	8	12
NONCOMMERCIAL NETWORKS	4	4	4	4
TOTAL	10	11	12	16

Additional occasional channels are needed for sports and news coverage but these generally share the off-peak capacity of other applications and are therefore not included in the demand projections.

C-3

6.1.2.2 CATV

CATV demand has been rising sharply with the result that on occasion satellite transponders have been reputed to be in short supply. In early 1980 approximately 29 transponders were employed by CATV distributors. By August 1982, according to the National Cable TV Association, this count had increased to 42. A constant growth rate projection of this 16 percent annual growth results in a projected demand for 61 video channels in 1985. Growth to the years 1990 and 2000 is postulated at 10 and 5 percent per annum respectively. Estimates for the benchmark years of this study are presented in Table 6.1-10.

TABLE 6.1-10 CATV CHANNEL DEMAND
(ONE-WAY FULL-TIME VIDEO CHANNELS)

	1980	1985	1990	2000
NUMBER OF CHANNELS	29	61	98	160

A high level of activity has recently been evidenced in direct satellite broadcast of TV to homes. However, this type of traffic is not likely to be compatible with the types of CPS systems of central interest in this study and has therefore not been included in the projections.

6.1.2.3 EDUCATIONAL VIDEO

Educational video includes a large number of applications which primarily require one-way, point-to-point or broadcast transmissions. In some cases return channels are required, but these are generally voiceband channels for relaying questions from the audience. In addition to the usual classroom applications, this category also includes video transmissions to groups of executives, sales personnel, special interest groups, etc. In this report the term "videoconferencing" is used to refer to conferences which use video transmissions in both directions and is discussed later.

Demand for educational video service is projected in terms of the following three components:

(a) Intrastate - This component includes higher education, adult education and extension courses conducted at remote campuses or company sites some distance from the primary educational center, but generally within state boundaries;

(b) Interstate - Facilities serving educational organizations with broader reach (e.g., executive seminars, training programs, etc.); and

(c) Specialized programs - Specific applications in agriculture, consumer education, vocational, etc. These generally fall within distance ranges typical of intrastate transmissions.

The projections shown in Table 6.1-11 follow those established in Reference 6-1 with estimates added for 1985. While only experimental usage was significant in 1980 the forecast for 1990 includes intrastate educational networks (four channels each) in thirty states plus five interstate systems (four channels each) and 25 channels for specialized purposes. Additional growth to the year 2000 as indicated in the last column of the table is anticipated.

TABLE 6.1-11 EDUCATIONAL CHANNEL DEMAND
(ONE-WAY FULL TIME VIDEO CHANNELS)

	1980	1985	1990	2000
INTRASTATE	15	30	120	400
INTERSTATE	-	-	20	50
SPECIALIZED	-	-	25	50
TOTAL	15	30	165	500

6.1.2.4 PUBLIC SERVICES

A moderate demand for video channels is anticipated for the following subcategories:

- Telemedicine - Extension of diagnostic and emergency treatment procedures to remote areas by medical practioners in central locations with the assistance of local paramedical attendants. (Medical conferences and education are included under teleconferencing and educational video.)

- Public Affairs - Public forums, opinion polls, consumer and related activities. The primary medium is one-way video with interactive voiceband response.

Table 6.1-12 provides projections through the year 2000 as developed in Reference 6-1, with added estimates for 1985. Only experimental uses are anticipated between 1980 and 1985.

TABLE 6.1-12 HEALTH AND PUBLIC AFFAIRS CHANNEL DEMAND (ONE-WAY FULL-TIME VIDEO CHANNELS)

	1980	1985	1990	2000
TELEMEDICINE	0	2	15	30
PUBLIC AFFAIRS	0	1	10	20
TOTAL	0	3	25	50

6.1.2.5 VIDEOCONFERENCING

Videoconferencing as used in this report refers to two-way video transmissions between remote locations. Both full motion and freeze frame technology fall under this classification but the latter contributes negligibly to traffic estimates and is therefore not explicitly discussed. One-way video applications are included among the previously discussed broadcast applications.

Videoconferencing demand was forecast in Reference 6-1 in terms of the displacement of air travel. The estimates developed in this subsection follow the methodology used in Reference 6-1, but use new estimates (10 to 14 percent higher) for domestic passenger enplanements developed in telephone contacts with the FAA. Table 6.1-13 shows the key elements of the forecast.

TABLE 6.1-13 VIDEOCONFERENCING DEMAND

	1980	1985	1990	2000
ENPLANEMENTS ($x10^6$)	278	324	421	655
CONFERENCES ($x10^6$)	75.1	87.5	113.7	176.9
REPLACEABLE BY VIDEO ($x10^6$)	6.01	7.00	9.10	14.15
REALIZED PERCENTAGE	-	1	10	25
NO. OF VIDEOCONF. ($x10^3$)	5*	70	910	3538
VIDEOCONF. SEC/YEAR ($x10^6$)	36	504	6552	25474

*BASED ON 15 PMS CENTERS PLUS BUSINESS AND GOVT. FACILITIES EST. FOR 1980

The number of conferences in Row 2 of Table 6.1-13 is based on 40 percent of enplanements being business related. It also assumes that two participants travel round-trip to the conference location (four enplanements) and hold an average of 2.7 conferences during their stay.

Row 3 of Table 6.1-13 shows the number of conferences for which videoconferencing is likely to be a suitable substitute. Based on the results of a 1977 SRI survey [Ref. 6-7] the number of conferences for which videoconferencing is a suitable substitute (Row 3) is estimated as eight percent of the conferences shown in Row 2. Row 4 shows the projected growth of videoconferencing as users become accustomed to the service and as suitable facilities are introduced.

Row 5 shows the expected annual number of videoconferences, as obtained by multiplying Rows 3 and 4. The value shown for 1980 reflects the existence, in that year, of 15 Picturephone Meeting Service centers in 12 cities plus a number of government and business conference centers. Lastly, Row 6 converts the number of videoconferences to videoconference call seconds (two-way) per year by assuming an average of two hours per conference.

6.1.2.6 SUMMARY OF OVERALL VIDEO TRAFFIC DEMAND

Table 6.1-14 summarizes video demand for the benchmark years of this study. Two subcategories are established:

(1) Broadcast - Network TV, CATV, Education and Public Applications; and

(2) Videoconferencing - Two-way video communications.

TABLE 6.1-14 OVERALL VIDEO TRAFFIC DEMAND

	1980	1985	1990	2000
BROADCAST	(NUMBER OF ONE-WAY VIDEO CHANNELS)			
NETWORK TV	10	11	12	16
CATV	29	61	98	160
EDUCATIONAL	15	30	165	500
PUBLIC SERVICES	0	3	25	50
TOTAL BROADCAST	54	105	300	726
VIDEOCONFERENCING	(TWO-WAY CALL-SECONDS PER YEAR x 10^6)			
	36	504	6552	25474

Different units are used in Table 6.1-14 to express broadcast mode and videoconferencing demand. A conversion to a common system of units (bits per year) is needed so that they can be compared and summed. For the one-way channels a basic 42 Megabit per second rate has been assumed prior to bandwidth compression. Full-time use of such a channel implies the occupancy of 1.325×10^{15} bits per year for each one-way video channel, divided by the compression factor assumed. Table 6.1-15 shows the compression factors selected for the broadcast mode applications for each benchmark year. These values are approximately the same as those used earlier in Reference 6-1.

TABLE 6.1-15 VIDEO BANDWIDTH COMPRESSION FACTORS
(RELATIVE TO A BASIC RATE OF 42 MBPS FOR AN UNCOMPRESSED ONE-WAY CHANNEL)

	1980	1985	1990	2000
NETWORK TV	1	1	1	2
CATV	1	1	2	3
EDUCATIONAL	1	3	6	6
PUBLIC SERVICES	1	3	6	6

For videoconferencing the conversion to bits per year assumes, for 1980, the use of the full uncompressed 42 Mbps digital channels in each direction. Call seconds per year from Table 6.1-13 are then converted to bits per year by multiplying by $2 \times 42 \times 10^6$. For 1985, however, it is assumed that rapid technology advances, (as exemplified by those being implemented for PMS), will permit satisfactory, two-way videoconferencing at the highly compressed rate of 3.088 Mbps (two T1 channels) for each two-way call-second used. By 1990, and through the year 2000 it is estimated that average rates for two-way videoconferencing channels will be 2.316 Mbps (reflecting a mix of systems employing one and two T1 data streams).

When these factors are applied to Table 6.1-14 the results presented in Table 6.1-16 are obtained.

While it is still a significant component, videoconferencing accounts for a smaller share of total video demand than that projected in Reference 6-1, chiefly as a result of the rapid improvements that have occurred in compression technology.

TABLE 6.1-16 OVERALL VIDEO TRAFFIC DEMAND
(BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
BROADCAST				
NETWORK TV	13.25	14.58	15.90	10.60
CATV	38.43	80.83	64.93	70.67
EDUCATIONAL	19.88	13.25	36.44	110.42
PUBLIC SERVICES	0	1.33	5.52	11.04
TOTAL BROADCAST	71.56	109.99	122.79	202.73
VIDEOCONFERENCING	3.02	1.56	15.17	59.00
TOTAL VIDEO	74.58	111.55	137.96	261.73

6.1.3 DATA TRAFFIC (OVERALL MARKET)

The data traffic category covers a wide range of applications and speeds. For the purposes of this report these have been collected in two major subcategories:

(a) Message Traffic - Record communications between individuals and/or organizations including TWX, Telex, Facsimile and Electronic Mail.

(b) Computer Traffic - Inquiry/response traffic between terminals and computers, plus computer to computer traffic for funds transfer and other data base exchanges.

The following discussion develops estimates for data traffic demand for the benchmark years of this study. With minor modifications, procedures developed in Reference 6-1 are retained. Where possible data sources have been updated.

The estimates for data are based on total terminal counts or message volumes. They therefore include some local traffic and are not precisely parallel to the corresponding estimates for interurban voice traffic. As a result, some magnification of the data volumes for the overall market relative to voice exists, but is estimated to be minor and is removed by the distance distributions applied in subsequent steps to obtain the satellite, CPS and Ka band market estimates.

6.1.3.1 MESSAGE TRAFFIC

Demand estimates for TWX, Telex, and Facsimile traffic are based on projections for the number of installed terminals of various types as obtained from published market research surveys. For each type of traffic, the number of terminals expected to be in place during the benchmark years of the study is multiplied by the estimated traffic generated per terminal to arrive at the traffic demand expressed in bits per year.

Estimates of traffic demand for Electronic Mail applications (in addition to those associated with TWX, Telex and Facsimile) are based on the conversion of a fraction of first class mail to electronic media.

6.1.3.1.1 TWX/TELEX

TWX and Telex are low speed (100 and 66 words per minute, respectively) message services offered by Western Union. Over the 1970 to 1980 decade, the growth rate averaged about 5 percent per year. It appears likely, however, that during the 1980s an evolution of this service to higher speeds, and to a technology compatible with newer forms of message traffic, such as those based on communicating word processors, will take place. In its existing form, therefore, TWX/Telex message volumes are expected to peak in the 1980 to 1990 decade and to decline thereafter with the displaced traffic volume being accommodated by other forms of message service.

Table 6.1-17 develops estimates of demand for TWX/Telex traffic following procedures established in Reference 6-1. The first row of Table 6.1-17 shows estimates of the number of TWX/Telex messages per year, as derived from information on the number of installed terminals plus revenue projections. The second row translates this to bits per year based on 120 words per message, 6 characters per word, and (including start-stop, priority and other message overhead) 8 bits per character. The third row introduces an efficiency factor which reflects the pauses encountered in real-time access by means of manual keyboards. Increased efficiency is projected as time progresses as the result of the introduction of more sophisticated terminals and the increasing use of packet switching protocols. The last row in Table 6.1-17 applies the efficiency factor to the information requirements of Row 2 to obtain overall traffic demand for these services. The results when compared in magnitude to other components of data traffic demand are generally insignificant.

TABLE 6.1-17 TWX/TELEX TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
MESSAGES/YR ($\times 10^6$)	151	161	145	90
BITS/YR ($\times 10^{12}$)	.870	.927	.835	.518
EFFICIENCY FACTOR	.01	.03	.1	.2
OVERALL DEMAND (BITS/YR$\times 10^{15}$)	.0870	.0309	.0084	.0026

6.1.3.1.2 FACSIMILE

As discussed in Reference 6-1, the facsimile traffic demand estimates are based on market research surveys which project an installed base of 290,000 terminals in 1980 with a 1980 growth rate of 16% (averaging 13% over the next 5 years and 12% over the full 1980 to 1990 decade, with a decrease to 10% over the 1990 to 2000 decade). Using these projections, overall traffic demand in support of facsimile transmissions is developed in Table 6.1-18.

TABLE 6.1-18 FACSIMILE TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
INSTALLED TERMINALS	290,000	534,000	901,000	2,340,000
PAGES/TERM/YEAR	1300	2000	2600	2600
PAGES/YEAR ($\times 10^9$)	.377	1.07	2.34	6.08
BITS/YEAR ($\times 10^{15}$)	.113	.321	.702	1.824
EFFICIENCY FACTOR	.15	.18	.2	.25
OVERALL DEMAND (BITS/YR$\times 10^{15}$)	.753	1.783	3.510	7.296

The first row in Table 6.1-18 shows the expected growth of installed facsimile terminals. There has been a trend toward increasing throughput in terminal usage and this is reflected in Row 2 by a progressive increase in the annual number of pages per terminals. Extension of these results produces Row 3 showing the number of pages transmitted via facsimile per year. The conversion between pages per year and bits per year shown in Row 4 assumes that each page requires the equivalent of 300,000 bits of transmission capacity using compression techniques similar to those in present day advanced digital facsimile machines.

Row 5 of Table 6.1-18 introduces an efficiency factor needed to translate the information transfer requirements of Row 4 to practical transmission demand. The efficiency factor takes into account the time necessary to coordinate the transmission at the two ends of the link, line overhead requirements, the seizure of a four wire bidirectional circuit in the long haul plant even though the transmission is primarily unidirectional, and a mix of less efficiently used dedicated circuits together with a preponderance of dial-up usage. As shown in Row 5, efficiency is expected to improve with time as new technology is introduced.

6.1.3.1.3 ELECTRONIC MAIL

This component of demand reflects the conversion of traditional paper document delivery systems to electronic modes of transmission. TWX/Telex and facsimile systems are existing forms of electronic mail which are expected to continue with moderate growths or declines over the decades of this study. The electronic mail systems referred to in this subsection, however, are in addition to these and are likely to use new technology to convert an increasing share of postal and other message delivery systems to electronic modes.

The estimation of communications demand imposed by electronic mail systems is based on the replacement of a fraction of the postal and private mail projected for the benchmark years of this study. The development of the estimates is summarized in Table 6.1-19. Additional details are contained in Reference 6-1.

Row 1 of Table 6.1-19 shows the estimated postal and private mail volumes suitable for conversion to electronic modes of transmission. The postal values are based on a George Washington University Study [Ref. 6-8] and the private mail volumes are based on a Xerox Corporation filing [Ref. 6-9]. Row 2 shows the estimated diversion to electronic modes. Initially this diversion is small but grows to sizeable proportions by the year 2000.

Row 3 of Table 6.1-19 presents conversion factors between pieces of mail and bits. The factors are based on a mix of image mode transmissions at 300,000 bits per page and character mode transmissions at 20,000 bits per page. Initially image modes predominate, but by the year 2000 it is assumed that a high percentage of the traffic will be via the more economical (i.e., fewer bits per page) character modes. Row 4 shows the results of applying the conversion factors of Row 3 to the number of pages estimated in Row 2.

It is assumed that the electronic mail component under discussion will use high volume bulk transmission under the direction of the Postal Service or other large volume service suppliers, and that efforts will be made to insure efficient use of transmission facilities, including store-and-forward transmissions. Efficiency factors are therefore expected to be high. The values shown in Row 5 take into account a changing mix between image mode transmissions at 50 percent efficiency and character mode transmissions at 40 percent efficiency. The last row in Table 6.1-19 arrives at overall demand for transmission capacity in support of electronic mail by applying the efficiency factors to the estimated bits per year of Row 4.

TABLE 6.1-19 ELECTRONIC MAIL TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
POSTAL & PRIVATE MAIL VOLUME (Pieces/Yr$\times 10^9$)	67.3	76.5	86.5	112.4
DIVERTED TO ELECTRONIC MODES (Pieces/Yr$\times 10^9$)	.22	1.11	35.9	69.9
COMPOSITE IMAGE AND CHARACTER MODE BITS/PAGE	272,000	244,000	160,000	76,000
BITS/YEAR ($\times 10^{15}$)	.060	.271	5.74	5.31
EFFICIENCY FACTOR	.49	.48	.45	.42
OVERALL DEMAND (Bits/Year$\times 10^{15}$)	.122*	.565	12.76	12.64

*1980 Component is included in other message traffic estimates

6.1.3.2 COMPUTER TRAFFIC

This component of traffic involves traffic originating or terminating at a computer. Two major subcategories are considered:

(a) Terminal/CPS Traffic - Inquiry/response traffic involving access to computer files by remote terminals, and remote access to computing resources as in time-sharing.

(b) CPU/CPU Traffic - Exchange of data between computers.

Each of these subcategories is discussed below. Terminal to terminal traffic has been classified as message traffic and is included in the message traffic estimates discussed previously.

6.1.3.2.1 TERMINAL/CPU TRAFFIC

Traffic volume for this important subcategory of data traffic is based on estimates of the number of installed terminals of various types projected for the benchmark years of this study. The projected number of terminals is multiplied by the number of bits per year generated by each terminal as estimated by considering typical patterns of usage for each type of terminal. This results in the information transfer requirements (bits per year) generated by terminal/CPU activity. A final step converts the information transfer requirements to demand for communications capacity by introducing an efficiency factor. The efficiency factor accounts for line idle time, overhead, etc. inherent in the practical transmission of the information on dial-up, leased line and packet facilities.

Table 6.1-20 illustrates the estimation of the annual information transfer requirements of a typical alphanumeric CRT terminal used in dial-up inquiry/response access of a remote data base. For this particular terminal type and activity the information transfer requirement as indicated at the bottom of the table is 286 million bits per year. By considering the other terminal types in the mix of terminals, their typical applications, and line occupancies (ranging from two to six hours per day), the weighted average information requirements

TABLE 6.1-20 INFORMATION TRANSFER REQUIREMENTS OF A TYPICAL CRT TERMINAL IN DIAL-UP INQUIRY/RESPONSE APPLICATIONS

ACTIVITY		TIME ELAPSED (SEC)	BITS TRANSMITTED
1. Operator types 80 characters at 5 characters (50 bits) per second.		16	400
2. Response time due to transmission delays, computer search, etc.		3	0
3. Computer responds by sending 500 characters (1/4 screen) at 2400 bits per second.		2	5000
4. Operator reads screen at 20 characters per second.		25	0
5. Dead time while operator takes any necessary actions and prepares for next transaction.		10	0
TOTALS	:	56 sec.	5400 bits
AVERAGE BIT RATE DURING SESSION	:	5400/56 = 96 bits/sec.	
INFORMATION TRANSFER REQUIREMENT (Assumes 3hrs/day,280 days/yr)	:	290 million bits per year	

for the expected terminal populations as a whole were estimated. The results are 383, 342, 325, and 314 million bits per year per terminal for the years 1980, 1985, 1990 and 2000, respectively. These values are used later in Table 6.1-22.

Terminal/CPU applications are primarily real-time and involve human operators. Line utilization therefore tends to be very inefficient, resulting in a large multiplication of the demand for capacity relative to the information transfer requirements discussed above. An appreciation of the magnitude of this multiplication can be obtained by considering the average bit rate during the typical terminal/CPS session illustrated in Table 6.1-20. During the on-line dial-up session illustrated, the average (two-way) bit rate is only 96 bits per second. In most cases, however, these bits occupy transmission facilities which, in the present day long haul plant, are capable of 9600 bits per second in each direction. This corresponds to an efficiency of line usage of only 0.5 percent so that a multiplication of the information transfer requirements by a factor of 200 is needed to arrive at the annual demand applicable to this type of dial-up terminal/CPU session.

The efficiency of line utilization in private line data transmission applications is even less than for the dial-up application illustrated above. This results from the long periods of time (including nights, weekends, holidays, etc.) during which capacity of the dedicated transmission facility is reserved, even though the terminal may be inactive. Allowing for some employment of multiplexing, which tends to improve the efficiency of private line usage, the net efficiency for this mode of transmission is projected to be one-sixth that of dial-up applications so that information requirements must be multiplied by 200 x 6 = 1200 to arrive at annual demand.

The most efficient of the transmission modes expected to have a significant role during the next decades is packet switching. Efficiencies of the order of 50 percent are anticipated for data transmissions using this mode so that information requirements are multiplied by only a factor of two to arrive at annual demand.

Table 6.1-21 summarizes the discussion of efficiency and develops average efficiencies applicable to data traffic for each of the benchmark years. The assumption is made that efficiencies for each mode of transmission remain the same as those discussed above, but that a trend toward increasing use of the higher efficiency modes will be operative. The second column in the table lists typical efficiencies appropriate to each transmissions mode, while the last four columns show the percentage of the information transfer requirements expected to be satisfied by each mode in each benchmark year. The last row of Table 6.1-21 shows the average efficiency expected. Despite the large role assigned to the highly efficient packet mode by the year 2000 (60 percent), the average efficiency remains low throughout the period covered by this study.

TABLE 6.1-21 EFFICIENCY FACTORS FOR TERMINAL/CPU TRANSMISSION

		PERCENT OF TOTAL			
	EFFICIENCY	1980	1985	1990	2000
DIAL NETWORK	.005	50	48	33	20
PRIVATE LINE	.005÷6	50	48	33	20
PACKET NETWORK	.5	0	4	33	60
AVERAGE EFFICIENCY		.0015	.0015	.0020	.0035

Table 6.1-22 develops overall annual demand for terminal/CPU traffic. Row 1 of Table 6.1-22 shows the expected installed terminal base as extrapolated from data presented in Reference 6-10 (updated to reflect more recent results scheduled for publication in a few months). The values shown represent a mix of various terminal types for which substantial communications activity is expected.

Row 2 of Table 6.1-22 shows the average number of bits per year generated by each terminal. As discussed earlier, the rate shown in Row 2 is a composite rate reflecting the application of the individual terminal rates to the mix of terminal types expected to exist in each of the benchmark years. The composite rate declines slightly as the mix of terminal types changes with time.

The extension of Rows 1 and 2 results in the information transfer requirements in bits per year (Row 3) needed to satisfy the demands of terminal/CPU applications.

Row 4 of Table 6.1-22 presents estimates of the efficiency with which practical telecommunications facilities will be utilized in applications of this type as obtained from Table 6.1-21. Row 5 shows overall demand calculated by dividing the entries of Row 3 by those of Row 4. Because terminal populations are high, and the efficiency of line utilization is quite low, terminal/CPU traffic amounts to the largest subcomponent of data traffic over the time frame of this study.

TABLE 6.1-22 TERMINAL/CPU TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
INSTALLED TERMINALS ($x10^3$)	2897	5592	9154	18671
BITS/YR/TERM ($x10^6$)	383	342	325	314
INFO.TRANSF.REQ.($B/Yx10^{12}$)	1110	1912	2975	5863
EFFICIENCY FACTOR	.0015	.0015	.002	.0035
OVERALL DEMAND (Bits/Year x 10^{15})	740.00	1274.97	1487.50	1675.05

6.1.3.2.2 CPU/CPU TRAFFIC

CPU/CPU traffic is discussed in terms of two sub-categories:

(a) Distributed Processing; and
(b) Electronic Funds Transfer.

(a) DISTRIBUTED PROCESSING

Distributed processing traffic is the result of data updates and adjustments needed to refresh local computer files. The end use of these files is through terminal/CPU access which brings the information to the human operator. To an increasing extent, however, the files themselves are established and re-freshed through computer to computer exchanges.

The estimation of traffic volumes for distributed processing is based on the assumption that CPU/CPU data base exchanges are proportional in volume to the terminal/CPU activity motivating these exchanges. Reference 6-1 estimates the proportionality constant as growing from 5 percent in 1980 to as much as 50 percent by the year 2000.

Table 6.1-23 presents estimates of CPU/CPU traffic volumes in support of distributed processing. Row 1 repeats the information requirements for terminal/CPU traffic as obtained from Row 3 of Table 6.1-20. Row 2 of Table 6.1-23 shows the assumed proportionality constant for each year. The extension of these two rows results in the distributed processing information requirements in bits per year shown in Row 3.

TABLE 6.1-23 DISTRIBUTED PROCESSING TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
TERMINAL/CPU INFO REQUIREMENTS (Bits/Year x 10^{12})	1110	1912	2975	5863
RATIO OF CPU/CPU TRAFFIC TO TERMINAL/CPU TRAFFIC (%)	5	8	13	50
DISTRIB. PROC. INFO. REQUIRE-MENTS (Bits/Year x 10^{12})	55.50	152.96	386.75	2931.50
EFFICIENCY FACTOR	.007	.008	.01	.02
OVERALL DEMAND (Bits/Year x 10^{15})	7.93	19.12	38.68	146.58

Row 4 of Table 6.1-23 provides estimates for the efficiency factors applicable to this category of traffic. Since the transactions are between computers, the major inefficiencies associated with human interactions via keyboards and CRTs are absent. However, various inefficiencies associated with protocols, overhead, file access delays, idle line time on dedicated facilities, etc. remain. CPU/CPU traffic in support of distributed processing is therefore expected to be more efficient than terminal/CPU traffic, but still relatively inefficient in comparison with some of the other categories of data traffic.

Row 5 of Table 6.1-23 extends the values presented in Rows 3 and 4 to obtain the overall traffic volumes required in support of distributed processing.

(b) ELECTRONIC FUNDS TRANSFER

A second component of CPU/CPU trafic demand is the result of electronic funds transfer (EFT) activities. The major portion of this component results from clearing house activities which transfer funds in response to the large number of business and personal checks written each year.

Table 6.1-24 develops estimates for CPU/CPU data traffic demand in support of electronic funds transfers. Row 1 shows the estimated annual number of checks as extrapolated from data presented in an Arthur D. Little Co. study [Ref. 6-11]. Row 2 shows the estimated percentage of these checks to be handled by EFT. The percentage grows from 10 percent in 1980 to 90 percent by the year 2000.

TABLE 6.1-24 EFT TRAFFIC DEMAND (OVERALL MARKET)

	1980	1985	1990	2000
NO. OF CHECKS/YEAR ($x10^9$)	36.3	43.2	50.1	63.8
PERCENT HANDLED BY EFT	10	15	60	90
EFT INFO REQUIREMENTS ($B/Yx10^{12}$)	3.63	6.48	30.06	57.42
EFFICIENCY FACTOR	.1	.15	.2	.4
OVERALL DEMAND (Bits/Year$x10^{15}$)	.036	.043	.150	.144

Row 3 of Table 6.1-24 shows the estimated CPU/CPU information transfer requirements resulting from the EFT transactions. It is assumed that 1000 bits of data are required for each EFT-handled check to electronically transfer account numbers, bank identifications, dates, amounts and similar information.

Row 4 of Table 6.1-24 provides estimates of the efficiency with which transmission facilities will be utilized in this application. Since most of the transactions are capable of using deferred transmission modes the efficiency factors are considerably higher than those postulated for those data traffic applications requiring larger portions of real-time traffic. The last row of the table extends the previous rows to arrive at overall traffic demand in support of EFT.

6.1.3.3 SUMMARY OF DATA TRAFFIC DEMAND (OVERALL MARKET)

Table 6.1-25 summarizes data traffic demand in support of the categories and subcategories discussed above.

TABLE 6.1-25 DATA TRAFFIC DEMAND (OVERALL MARKET)
(BITS/YEAR x 10^{15})

	1980	1985	1990	2000
TWX/TELEX	.087	.031	.008	.003
FACSIMILE	.753	1.783	3.510	7.296
ELECTRONIC MAIL	-	.565	12.76	12.64
TOTAL MESSAGE TRAFFIC	.840	2.38	16.28	19.94
TERMINAL/CPU	740.00	1274.97	1487.50	1675.05
CPU/CPU (DISTRIB. PROCESS)	7.93	19.12	38.68	146.58
CPU/CPU (EFT)	.036	.043	.150	.144
TOTAL COMPUTER TRAFFIC	747.97	1294.13	1526.33	1821.77
TOTAL DATA TRAFFIC DEMAND	748.81	1296.51	1542.61	1841.71

The message traffic components (TWX/Telex, Facsimile and Electronic Mail) generally allow for relatively efficient utilization of transmission facilities. As a result, in terms of demand on telecommunications facilities, message traffic is of much less significance than computer traffic.

By far the largest component of demand, over the time frame of this projection, results from computer related traffic. Of this, the major portion is ascribable to terminal/CPU traffic, which, because of the large number of terminals projected, and because of the inherent inefficiency of line usage in real-time, human/machine interfaces, is very much larger than any other component.

6.1.4 SUMMARY OF OVERALL MARKET DEMAND

Table 6.1-26 summarizes voice, video and data traffic demand as developed in the preceding sections. Values are rounded to two places to the right of the decimal point.

TABLE 6.1-26 DEMAND FOR TELECOMMUNICATIONS (OVERALL MARKET) (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	2782.48	4493.66	7159.37	16108.97
SWITCHED	1026.56	1664.00	2606.08	5331.20
DEDICATED	1755.92	2829.66	4553.29	10777.77
TOTAL VIDEO	74.58	111.55	137.96	261.73
BROADCAST	71.56	109.99	122.79	202.73
VIDEOCONF.	3.02	1.56	15.17	59.00
TOTAL DATA	748.81	1296.51	1542.61	1841.71
MESSAGE	.840	2.38	16.28	19.94
COMPUTER	747.97	1294.13	1526.33	1821.77
TOTAL DEMAND	3605.87	5901.42	8839.94	18212.41

6.2 THE SATELLITE TELECOMMUNICATIONS MARKET

Earlier sections of this report discussed some technical limitations of the satellite medium which result primarily from the time delay inherent in transmitting from ground to synchronous altitude and return.

For voice transmissions, this limitation causes delayed echoes which most users find disturbing. It appears, however, that rapid progress has been made in the practical implementation of echo cancellers so that this limitation is of only slight concern. The estimates developed in this section assume, therefore, that subject to economic considerations, the entire voice market can be successfully addressed by satellites.

For data transmissions, the time delay limitation reduces the efficiency of certain important data transmission protocols. Some account of this limitation is therefore included in the demand estimates for 1980 and 1985. For 1990 and beyond, however, it is anticipated that protocols which are insensitive to time delay will be in widespread use so that, as in the case of voice, economic considerations become the controlling factor influencing the addressable demand.

Transmission time delay is not considered to be an important limitation for most video transmissions. One-way video transmissions are completely insensitive to this effect and those video transmissions using two-way transmissions are likely to employ a separate path for each of the two directions so that electrically introduced echoes are minimal.

The following pages develop estimates for the traffic addressable by satellite systems for the benchmark years of this study. Voice, video and data traffic components are separately treated and are then summarized and combined.

6.2.1 VOICE TRAFFIC (SATELLITE ADDRESSABLE)

As indicated above, there is no important reason, other than cost, why the full voice market cannot be successfully addressed by satellites. Private line costs probably provide the best measure of relative transmission facility costs since these costs do not include the costs of the switching plant. For this reason private line cost trade-offs between satellite and terrestrial circuits, as discussed in Subsection 5.1.1.3, are used here as a model for switched applications as well as for private line applications.

At present the private line cost trade-off between satellite and terrestrial media takes place at about 800 miles. It is reasonable to assume, however, that as demand grows to exceed conveniently available terrestrial capacity the cost of satellite derived voice circuits will drop relative to that of terrestrially derived circuits. A cost reduction of two-to-one relative to terrestrial voiceband circuits has been selected as a practical goal for satellite technology over the time frame of this study.

The assumption referred to above, that by the year 2000 satellite voiceband costs relative to terrestrial voiceband costs will improve uniformly by a factor of roughly two, implies that the distance range at which satellite transmission can compete with terrestrial transmission will progressively drop from a value of 800 miles circa 1980 to values of 600, 400, and 200 miles for the years 1985, 1990 and 2000, respectively (See Figure 5.1-9). These values are used in the following to estimate the fraction of traffic traveling a sufficient distance in each of the benchmark years to be economically addressable by satellite facilities.

Table 6.2-1 tabulates distance factors to be applied to the overall interurban voice traffic demand presented in Table 6.1-6 to obtain the satellite addressable portion of voice traffic demand. The derivation of these distance factors is discussed in Chapter 7.

TABLE 6.2-1 DISTANCE FACTORS FOR VOICE TRAFFIC

1 YEAR	2 SATELLITE COST-EFF.DIST	3 MTS DISTANCE FACTOR	4 WATS DISTANCE FACTOR	5 PVT. LINE DISTANCE FACTOR
1980	800 mi.	.093	.243	.080
1985	600 mi.	.127	.317	.124
1990	400 mi.	.173	.400	.205
2000	200 mi.	.247	.523	.374

Column 2 of Table 6.2-1 tabulates the distances beyond which satellite transmission is assumed to be cost-effective relative to terrestrial service. As discussed earlier, these distances decrease with time. Column 3 shows the fraction of interurban MTS traffic traveling more than the cost competitive distance as obtained from Table 7.1-2. As will be discussed in Section 7.1, the distance distributions for residential and business components differ negligibly so that separate treatment of the two MTS components is unnecessary.

Column 4 shows distance factors for WATS as obtained from Table 7.2-1. WATS traffic tends to be longer-haul than MTS.

The distance distribution for private lines tends towards shorter lengths than MTS and WATS. Column 5 shows the distance distribution of interstate private lines as derived from Table 7.3-1.

Table 6.2-2 presents estimates of the satellite addressable voice traffic as obtained by multiplying the appropriate entries of Table 6.1-6 and Table 6.1-7 by the distance factors shown in Table 6.2-1.

TABLE 6.2-2 SATELLITE ADDRESSABLE VOICE TRAFFIC
(BITS PER YEAR x 10^{15})

YEAR	BUS.MTS	WATS	PVT.LINE	TOTAL BUS.	RES.MTS	TOTAL
1980	42.62	35.46	140.47	218.55	39.28	257.83
1985	95.10	80.34	350.88	526.32	84.04	610.36
1990	206.38	158.72	933.42	1298.52	175.82	1474.34
2000	636.11	425.09	4030.89	5092.09	479.93	5572.03

Table 6.2-3 further summarizes the satellite addressable voice traffic by grouping the entries in Table 6.2-2 into switched and dedicated traffic categories.

TABLE 6.2-3 SUMMARY OF SATELLITE ADDRESSABLE VOICE TRAFFIC 1980-2000 (BITS/YEAR x 10^{15})

YEAR	SWITCHED	DEDICATED	TOTAL
1980	117.36	140.47	257.83
1985	259.48	350.88	610.36
1990	540.95	933.42	1474.38
2000	1541.15	4030.89	5572.03

6.2.2 VIDEO TRAFFIC (SATELLITE ADDRESSABLE)

Video traffic is well adapted to the satellite medium as reflected currently in the heavy use of satellites for video transmissions. As discussed below, each of the video applications considered in Subsection 6.1.2 (dealing with the overall video market) has one or more characteristics that either favors satellite transmission or at least places it on a par with terrestrial alternatives.

Among the broadcast mode tranmissions, Network TV and CATV require one-to-many connectivity patterns and this is generally easier to accomplish via a single mutually visible satellite than by establishing a complex network of terrestrial links. These transmissions are broadband and generally span substantial distances, factors which also tend to enhance the competitive position of satellite transmissions.

The Educational Video and Public Systems applications generally require one-to-several connectivity patterns and also use wide bandwidths, although the bandwidths are somewhat lower than those anticipated for Network TV and CATV. Distances may be lower in some cases as well. The competetive advantages of satellite transmissions are consequently less firmly established for these applications. Nevertheless, satellite systems are expected to be able to compete effectively with terrestrial media for these Educational and Public System applications.

One advantage of satellites for these applications is flexibility. A network can be established, or extended, more readily by the installation of small earth stations than by the laying of cable, or the installation of microwave facilities. Part-time or shared use of the satellite transponder by a number of users is also a practical benefit in these applications.

Videoconferencing applications tend to be long distance. The costs of the conference facilities are such that conference links are not likely to be established between points that are a short distance apart. Once established for long distance conferencing, however, they may secondarily be used for shorter distances.

The factors discussed above indicate that both broadcast and videoconference applications have one or more characteristics making them well suited for satellite transmission, and none that discourage such transmission. Satellite addressable video demand is therefore substantially synonymous with overall video demand and the demand estimates presented earlier in Table 6.1-16 apply equally to the case of satellite addressable video demand.

6.2.3 DATA TRAFFIC (SATELLITE ADDRESSABLE)

The message traffic subcategories of data traffic (TWX/Telex, facsimile and electronic mail) are well adapted to the technical features of satellite transmission. As in the case of voice, economic considerations, chiefly manifested in terms of transmission distances, will be the major factor determining that fraction of the overall traffic of this type that can be successfully addressed by satellites.

Using the progressively decreasing break-even distances of 800, 600, 400 and 200 miles for the years 1980, 1985, 1990 and 2000, respectively, that were developed earlier for voiceband channels, and the distance factors developed in Section 7.4 for message type traffic, results in the estimates presented in Table 6.2-4. Satellite cost competitive distances are shorter for wideband data but the use of voiceband distance are shorter for wideband data but the use of voiceband distance factors is justified by the much higher volumes of traffic associated with voiceband data.

TABLE 6.2-4 SATELLITE ADDRESSABLE MESSAGE TRAFFIC

1 YEAR	2 SATELLITE COST-EFF. DISTANCE	3 MESSAGE TRAFFIC $(B/Y \times 10^{15})$	4 MESSAGE TRAFFIC DIST.FACTOR	5 SATELLITE ADDRESSABLE MESS. TRAFF. $(B/Y \times 10^{15})$
1980	800 mi	.84	.145	.12
1985	600 mi	2.38	.186	.44
1990	400 mi	16.28	.235	3.83
2000	200 mi	19.94	.324	6.46

Columns 1 and 2 of Table 6.2-4 list the benchmark years and the distances over which satellite transmissions are expected to compete favorably with terrestrial alternatives. The third column shows the estimated overall message traffic as developed in Table 6.1-26. Column 4 shows the distance factors appropriate to message type traffic taken from Table 7.4-1 and the last column extends these results to obtain the satellite suitable data traffic in the message traffic subcategory.

Some fraction of present day computer traffic (terminal/CPU and CPU/CPU traffic) is negatively affected by the time delay inherent in satellite transmission. As explained earlier, the problem is amenable to hardware and software solutions but will continue to act as a deterrent to data transmission via satellites for some time in the future. It is estimated that the amount of computer traffic addressable by satellites in 1980 is reduced by 25 percent because of time delay limitations, but that by 1985 the reduction will decrease to 15 percent and will become negligible for the years 1990 and 2000.

Table 6.2-5 develops estimates for the satellite addressable portion of the computer traffic subcategory. Columns 1 and 2 show the benchmark years and the distances for which satellite transmission is expected to be cost competitive with terrestrial traffic. Column 3 shows overall computer traffic demand as presented in Table 6.1-26 reduced by 25 percent for 1980 and 15 percent for 1985 to account for time delay limitations. Column 4 of Table 6.2-5 shows distance factors appropriate to the computer subcategory of data traffic. Since portions of this traffic travel via both dial-up lines and private lines, the distance factors used are the average* of the MTS Interurban distribution factors and private line distance factors displayed in Tables 7.1-2 and 7.3-1.

TABLE 6.2-5 SATELLITE ADDRESSABLE COMPUTER TRAFFIC

1 YEAR	2 SATELLITE COST-EFF DISTANCE	3 COMPUTER TRAFFIC ($Bits/Yr \times 10^{15}$)	4 COMPUTER TRAFFIC DIST. FACTORS	5 SATELLITE ADDRES. COMPUTER TRAFF. ($Bits/Yr \times 10^{15}$)
1980	800 mi	560.97	.087	48.80
1985	600 mi	1100.01	.126	138.60
1990	400 mi	1526.33	.189	288.48
2000	200 mi	1821.77	.311	566.57

*Weighted average in proportion to relative traffic volumes would be more accurate but since the two distributions are close to each other the additional complexity is not necessary.

Table 6.2-6 summarizes data traffic demand by combining the results of Tables 6.2-4 and 6.2-5. As in the case of overall data traffic, the computer traffic category far exceeds the message subcategory.

TABLE 6.2-6 SUMMARY OF SATELLITE ADDRESSABLE DATA TRAFFIC DEMAND (BITS/YEAR x 10^{15})

	MESSAGE TRAFFIC	COMPUTER TRAFFIC	TOTAL DATA TRAFFIC
1980	.12	48.80	48.93
1985	.44	138.60	139.04
1990	3.83	288.48	292.30
2000	6.46	566.57	573.03

6.2.4 SUMMARY OF SATELLITE ADDRESSABLE DEMAND

Table 6.2-7 summarizes the satellite addressable portion of voice, video and data traffic demand as developed in the preceding subsections. The satellite addressable market grows from 11 percent of the overall market in 1980 to 35 percent in the year 2000.

TABLE 6.2-7 SATELLITE ADDRESSABLE DEMAND (BITS/YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	257.83	610.36	1474.38	5572.03
SWITCHED	117.36	259.48	540.95	1541.15
DEDICATED	140.47	350.88	933.42	4030.89
TOTAL VIDEO	74.58	111.55	137.96	261.73
BROADCAST	71.56	109.99	122.79	202.73
VIDEOCONF.	3.02	1.56	15.17	59.00
TOTAL DATA	48.93	139.04	292.30	573.03
MESSAGE	.12	.44	3.83	6.46
COMPUTER	48.80	138.60	288.48	566.57
TOTAL DEMAND	381.34	860.95	1904.64	6406.79

6.3 THE CPS TELECOMMUNICATIONS MARKET

This section discusses the traffic demand addressable by dedicated and shared earth station CPS systems. Estimates are made for each of the benchmark years of this study, including 1980. However CPS facilities of the type considered here were not available in 1980. The estimates for 1980 therefore refer to that portion of traffic demand that hypothetically could have been addressed, if suitable CPS systems had been available.

Traffic addressable by CPS forms a subset of the satellite addressable traffic discussed in Section 6.2. The primary factors determining the applicability of CPS to a given establishment are:

(a) The need for wide distribution to establishments which may not be CPS equipped; and

(b) The existence of establishment traffic volumes large enough to justify the cost of CPS facilities.

These factors are discussed in the following subsections.

6.3.1 DISTRIBUTION AND CONNECTIVITY CONSIDERATIONS

The need for wide distribution and connectivity pertains primarily to switched communication services where ad-hoc connection to many remote locations may be required whether or not these locations are CPS equipped. The ability of CPS to address the bulk of MTS and WATS type service depends on the CPS configurations assumed and the arrangements made for interfacing with trunking facilities capable of providing the necessary connectivity. Some systems alternatives that enhance CPS connectivity were discussed in Subsection 2.1.3.8. These include the possible development of common user earth stations which would allow CPS equipped establishments to call locations in which their company does not maintain CPS facilities.

Without reference to a specific CPS systems approach, it is difficult to predict the way in which such systems will evolve with respect to switched traffic. Clearly the problem of distributing switched traffic via CPS is more complex than that of distributing dedicated traffic. On the other hand, the technology needed to address the switched market exists and the traffic volumes involved are high enough to attract innovative marketing approaches.

Balancing these considerations, the scenario adopted in this study assumes that CPS systems will initially address a minor part of the switched voice market but that as they grow in sophistication, the CPS share of this traffic will increase. Following this approach, the projections made in this section assume that no switched traffic will be addressed by CPS through the year 1985, that twenty-five percent will be addressed by 1990, and fifty percent will be addressed by the year 2000.

6.3.2 TRAFFIC VOLUME CONSIDERATIONS

A second major factor influencing the fraction of the satellite suitable traffic that is addressable by CPS systems is the traffic volume generated by individual establishments. Unless expenditures for communications are sufficiently high, the cost of an earth station cannot be justified. To estimate the fraction of traffic addressable by CPS, the assumptions shown in Table 6.3-1 were made for earth station costs and related items.

TABLE 6.3-1 EARTH STATION COST RELATED FACTORS

TYPE	NO. OF ESTAB.	CAPACITY	EARTH STATION PURCHASE PRICE	ANNUALIZED ES COST	ANNUALIZED ES COST PER ESTAB.
DEDICATED	1	1.5-6.3MBPS	$250,000	$75,000	$ 75,000
SHARED	5	20-32 MBPS	$350,000	$105,000	$ 21,000

The costs shown in Table 6.1-3 are for Ka band earth stations but, depending on the applications, are probably reasonable for other bands as well. Two types of earth stations are considered:

(a) a small to medium size station with a maximum throughput of 6.3 Mbps suitable to dedicated use by a single establishment; and

(b) a more expensive, higher capacity earth station (maximum of 32 Mbps) that typically would be shared among perhaps five nearby establishments.*

Based on estimates suggested by TRW [Ref. 6-12] the following factors relating annualized costs to purchase price have been assumed:

DEPRECIATION	10%
MAINTENANCE	5%
OPERATION	3%
COST OF MONEY	12%
OVERALL	30%

This overall percentage is applied to the earth station purchase prices in Table 6.3-1 to arrive at annualized earth station costs. The last column of Table 6.3-1 shows the annualized earth station costs divided by the number of establishments sharing the earth station.

For an establishment to be able to justify the purchase of an earth station, savings in transmission costs should result that are equal to, or higher than, the annualized expenditures discussed above. If it is assumed that CPS systems will be capable of delivering transmission cost savings on the order of 30 percent, candidates for the use of dedicated CPS should anticipate placing at least $250,000 per year of their existing transmission charges on the CPS link (i.e., thirty percent of $250,000 represents a $75,000 annual saving, which is the break-even level for the $75,000 annualized cost of a dedicated earth station shown in Table 6.3-1). Similarly, candidates for shared earth station CPS should plan to place $70,000 or more of their existing annual traffic expenditures on the CPS link.

*The throughput capacity of the earth station does not necessarily imply that corresponding throughput will be demanded of the space segment by all users. Low volume users will require (and will presumably pay for) only that portion of the transponder capacity appropriate to their needs.

It is estimated that about 29 percent of overall traffic volume is of a type suitable for CPS transmission (excluding establishment size limitations). However, in terms of expenditures, the longer distance, more costly, transmissions suitable for CPS are likely to magnify this 29 percent and account for about 50 percent of the transmission budgets of typical CPS candidates. Thus candidates for dedicated CPS earth station systems should have total annual transmission budgets in excess of $500,000 (two times the $250,000 CPS budget discussed above), and candidates for shared earth systems should spend at least $140,000 annually (two times $70,000).

These communications budgets can be translated into establishment size, in terms of the number of employees, by dividing by the average expenditure for communications per employee. Table 6.3-2 presents estimates of total U.S. communications expenditures circa 1980 based on data obtained from a Quantum Sciences report [Ref. 6-13]. Corresponding employment figures [Ref. 6-14] are 94.51 million* resulting in average annual transmission expenditures per employee of $22,710/94.51 = $240.

TABLE 6.3-2 END USER EXPENDITURES FOR COMMUNICATIONS (CIRCA 1980)

ITEM	ANNUAL EXPENDITURES ($ MILLIONS)
EQUIPMENT	$ 7888
LINE COSTS (1)	22710
LABOR	3699
TOTAL COMM. EXPENDITURES	$34297

(1) Short and Long Haul

*The employment quoted here is slightly lower than the corresponding figures derived from Bureau of Labor statistics used elsewhere in this report.

Table 6.3-3 summarizes the discussion above and presents estimates of establishment size suitable for each type of CPS installation (item 5). Following this analysis, a typical establishment for which a dedicated earth station CPS installation is appropriate is likely to employ in excess of 2083 employees while the corresponding number for shared earth station installations is 583.

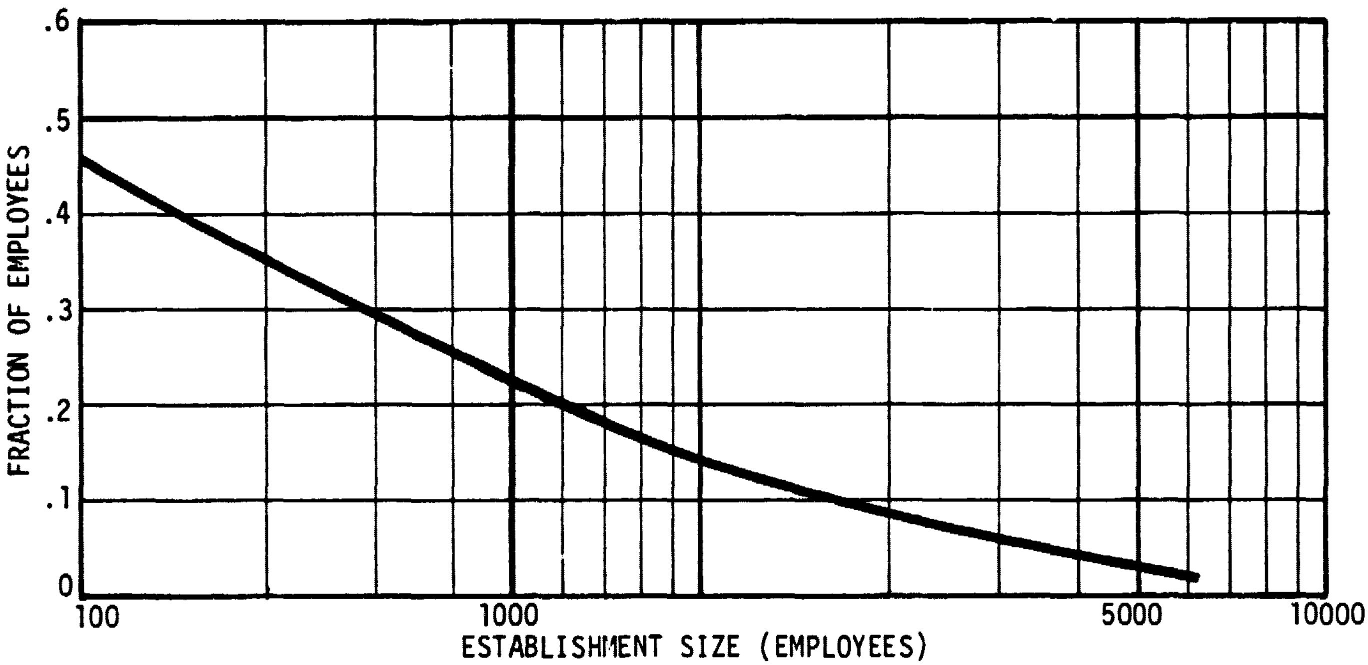
TABLE 6.3-3 ESTABLISHMENT SIZE AND FRACTION OF EMPLOYMENT ADDRESSABLE BY CPS

1. EXPENDITURES FOR TRANSMISSION U.S. TOTAL ($ MILLION PER YEAR)	$ 22,710
2. EMPLOYMENT BASE U.S. TOTAL (MILLIONS OF EMPLOYEES)	94.51
3. U.S. AVERAGE TRANSMISSION EXPENDITURE PER EMPLOYEES (DOLLARS)	$240
4. MINIMUM ESTABLISHMENT EXPENDITURES TO JUSTIFY CPS (DOLLARS PER YEAR)	
(a) DEDICATED EARTH STATION	$500,000
(b) SHARED EARTH STATION	$140,000
5. MINIMUM ESTABLISHMENT SIZE TO JUSTIFY CPS (EMPLOYEES)	
(a) DEDICATED EARTH STATION	2083
(b) SHARED EARTH STATION	583
6. PERCENT OF U.S. EMPLOYMENT IN ESTABLISHMENTS ADDRESSABLE BY CPS	
(a) DEDICATED EARTH STATION	8.5%
(b) DEDICATED & SHARED EARTH STATION	21.0%

ORIGINAL PAGE IS
OF POOR QUALITY

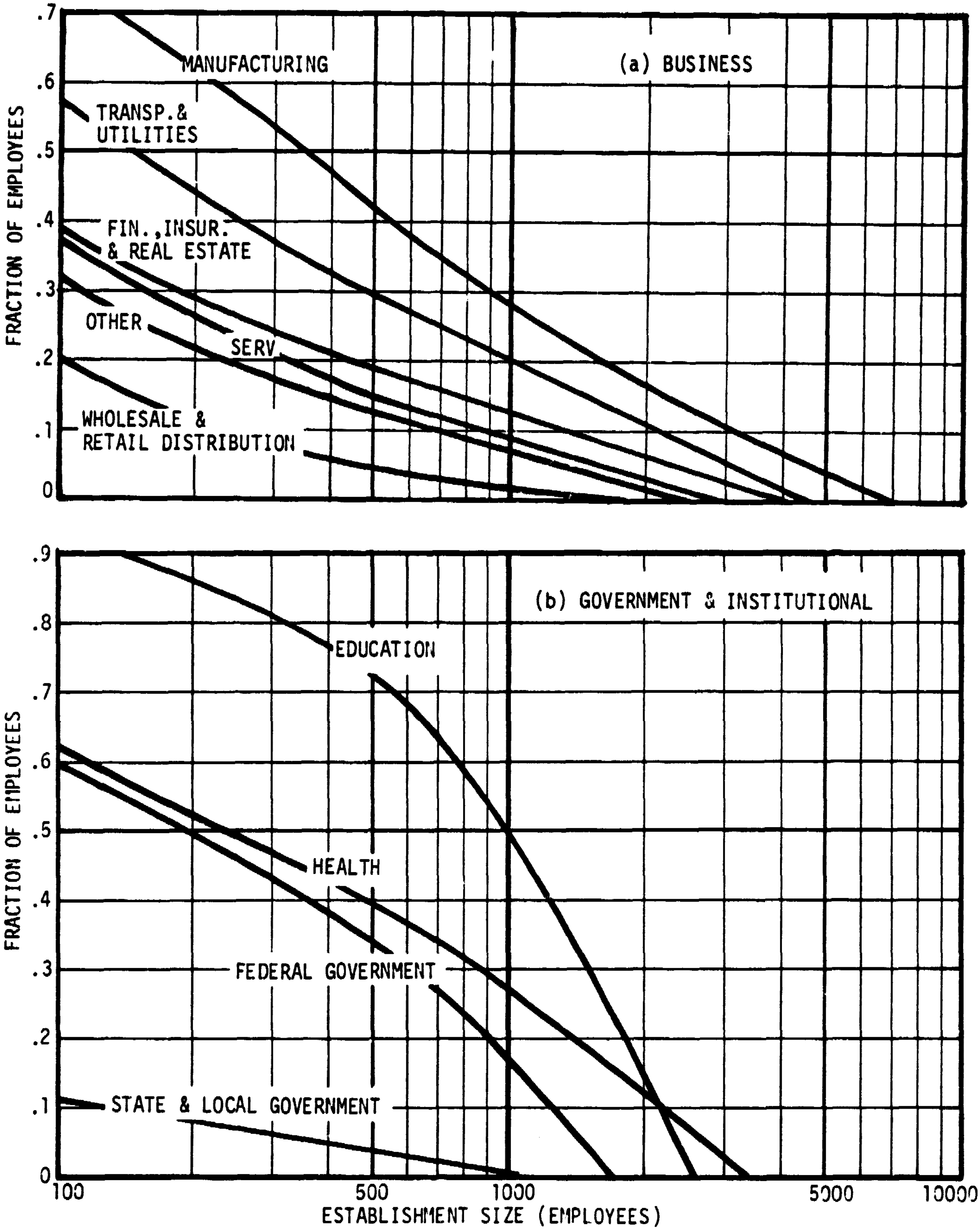
The last item in Table 6.3-3 shows the fraction of total U.S. employment in establishments large enough to justify the purchase of an earth station. These values were obtained from Figure 6.3-1 which plots the fraction of U.S. employment vs. establishment size [Ref. 6-15]. Figures 6.3-2(a) and 6.3-2(b) provide a further breakdown by user category of employment vs. establishment size. The latter curves are based on the Bureau of the Census data of Reference 6-15, supplemented, for the government and educational categories, with information from References 6-14 and 6-16.

FIGURE 6.3-1 FRACTION OF TOTAL EMPLOYEES IN ESTABLISHMENTS OF SIZE GREATER THAN ABSCISSA (TOTAL EMPLOYMENT)



ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 6.3-2 FRACTION OF EMPLOYEES IN ESTABLISHMENTS OF SIZE GREATER THAN ABSCISSA



As shown in Table 6.3-3 the overall number of employees in establishments addressable by dedicated CPS facilities is estimated to be 8.5 percent of total employment, while those in establishments addressable by shared and dedicated CPS systems combined represent 21.0 percent of this total. These values are used in subsequent pages of this report to arrive at estimates for that portion of satellite traffic addressable by CPS.

6.3.3 VOICE TRAFFIC (CPS ADDRESSABLE)

The distribution and connectivity considerations discussed in Subsection 6.3.1 and the traffic volume considerations discussed in Subsection 6.3.2 are combined in this section to develop the voice traffic addressable by dedicated and shared CPS systems. The starting point for this calculation is Table 6.2-2 which shows the satellite addressable voice market. The switched residential traffic components in Table 6.2-2 are first eliminated and the switched business components (Business MTS and WATS) are multiplied by factors of 0, 0, .25 and .50 for the years 1980, 1985, 1990 and 2000, respectively, to account for distribution and connectivity limitations. The result is then multiplied by .085 as derived in Table 6.3-3 to reflect the fraction of traffic in establishments with sufficient volume for dedicated CPS. The results appear in Column 2 of Table 6.3-4.

The third column of Table 6.3-4 shows the dedicated (private line) traffic suitable for dedicated earth station CPS systems. Since distribution and connectivity limitations do not impact this traffic component, Column 3 of Table 6.3-4 is obtained by multiplying the corresponding column of Table 6.2-2 by .085 as derived in Table 6.3-3 to reflect traffic volume considerations.

Table 6.3-5 repeats the process just described to obtain the traffic addressable via shared or dedicated earth stations. In this case, however, the appropriate factor taken from Table 6.3-3 is .21 rather than the previously used value of .085.

TABLE 6.3-4 VOICE TRAFFIC ADDRESSABLE VIA DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

YEAR	SWITCHED (MTS & WATS)	DEDICATED (PRIVATE LINE)	TOTAL
1980	0	11.94	11.94
1985	0	29.82	29.82
1990	7.76	79.82	87.10
2000	45.10	342.63	387.73

TABLE 6.3-5 VOICE TRAFFIC ADDRESSABLE VIA SHARED OR DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

YEAR	SWITCHED (MTS & WATS)	DEDICATED (PRIVATE LINE)	TOTAL
1980	0	29.50	29.50
1985	0	73.68	73.68
1990	19.17	196.02	215.19
2000	111.43	846.49	957.91

CPS addressable voice traffic is a small but growing fraction of the satellite addressable voice market. By the year 2000, voice traffic addressable by dedicated CPS is expected to represent 6.1 percent of all satellite addressable voice traffic, while dedicated and shared systems combined are expected to represent 15.0 percent of this total.

6.3.4 VIDEO TRAFFIC (CPS ADDRESSABLE)

This subsection discusses that portion of video traffic demand addressable by dedicated and shared CPS systems.

6.3.4.1 BROADCAST SUBCATEGORIES

The broadcast mode subcategories of video traffic include Network TV, CATV, Educational Video and Public Systems. Broadcast mode video transmissions are usually one-way transmissions from a single originator to several, or many, receive-only locations. Return channels, if any, are likely to be audio circuits easily served by conventional voiceband transmission facilities. The CPS systems under consideration in this study, on the other hand, are systems which provide two-way transmission between origins and destinations and are likely to employ technology not oriented towards these broadcast applications. The broadcast subcomponents of video demand have therefore been excluded from the estimates of traffic by CPS systems.

6.3.4.2 VIDEOCONFERENCING

Videoconferencing traffic provides a good target for CPS systems. Like voice traffic, the major considerations determining the fraction of traffic addressable by CPS are:

(a) Establishment size; and
(b) Distribution needs.

With respect to establishment size, only those establishments with communications budgets capable of justifying the cost of a CPS earth station are candidates for CPS. Much of the videoconferencing activity projected is expected to be secondary to voice, and will share voice transmission capacity by using transmission facilities when lines are lightly loaded. The establishment size criteria developed in Subsection 6.3.2, and applied earlier for voice, therefore offer reasonable values for videoconferencing as well. Establishment size criteria are thus assumed to limit video traffic demand addressable by dedicated CPS systems to 8.5 percent of satellite addressable videoconferencing. The corresponding limitation for establishments whose videoconferencing needs are addressable through shared as well as dedicated CPS facilities is 21.0 percent.

Beyond the limitations imposed by establishment size, the need for widespread distribution is expected to additionally limit the amount of videoconferencing traffic addressable by CPS. While this is likely to be a deterrent to the acceptability of CPS for videoconferencing, it is not considered to be as strongly negative in its effect as the corresponding limitation for switched voice traffic. To a large extent, videoconferencing is likely to focus on prearranged intracompany exchanges with lesser needs for ad-hoc transmissions to outside organizations. As a new service, videoconferencing is likely to be accepted in the form in which it is offered. In addition, the ability of CPS to avoid the problems and expenses of wideband local distribution will also tend to encourage its use within the CPS community.

While few guidelines are available in this newly developing field, the values of 25, 25, 50 and 50 percent of satellite addressable videoconferencing traffic are suggested as reasonable estimates for the fraction of traffic addressable by CPS in the years 1980, 1985, 1990 and 2000, respectively.

6.3.4.3 SUMMARY OF CPS ADDRESSABLE VIDEO TRAFFIC DEMAND

Table 6.3-6 applies the percentages discussed above to the estimation of video traffic demand addressable by dedicated CPS systems. The fact that broadcast mode video traffic is not included as a suitable component of CPS traffic is indicated by the zeros entered in Row 1. Row 2 shows the overall videoconferencing demand (synonymous with satellite addressable demand) developed earlier in Table 6.1-16. Row 3 shows the multiplying factors to be applied to Row 2 to arrive at videoconferencing traffic addressable by dedicated CPS systems. The multiplying factors are 8.5 percent of 25, 25, 50 and 50 percent for the years 1980, 1985, 1990 and 2000, respectively, to account for establishment size and distribution limitations as discussed above. The last row shows the total video traffic addressable by dedicated CPS systems.

Table 6.3-7 repeats the procedure of Table 6.3-6 but uses 21.0 percent as the multiplier expressing establishment size limitations appropriate to the combined dedicated and shared earth station CPS community.

TABLE 6.3-6 VIDEO TRAFFIC ADDRESSABLE VIA DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
BROADCAST MODE	0	0	0	0
VIDEOCONF. (OVERALL DEMAND)	3.02	1.56	15.17	59.00
CPS ADDRESSABLE FRACTION	2.125%	2.125%	4.25%	4.25%
CPS ADDRESSABLE DEMAND	.064	.033	.645	2.508

TABLE 6.3-7 VIDEO TRAFFIC ADDRESSABLE VIA SHARED AND DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
BROADCAST MODE	0	0	0	0
VIDEOCONF. (OVERALL DEMAND)	3.02	1.56	15.17	59.0
CPS ADDRESSABLE FRACTION	5.25%	5.25%	10.5%	10.5%
CPS ADDRESSABLE DEMAND	.1586	.0819	1.593	6.195

6.3.5 DATA TRAFFIC (CPS ADDRESSABLE)

This subsection discussses that portion of data traffic demand addressable by dedicated and shared CPS systems. The starting point for this analysis is Table 6.2-6 which presents satellite addressable data traffic demand. The CPS addressable portion is a subset differentiated as in the case of voice and video by distribution needs and establishment size considerations.

It is estimated that data traffic volumes (adjusted for the respective efficiencies of switched and leased line transmission modes as presented in Table 6.2-6) consist of approximately 20 percent switched mode and 80 percent leased line traffic. The switched mode data transmissions, like the switched component of business voice traffic, require wide distribution and high connectivity and are therefore not good candidates for CPS transmission, particularly in the earlier periods prior to the growth of interconnection arrangements between CPS and other transmission facilities. The 20 percent of data traffic estimated as switched mode traffic is multiplied by factors of 0, 0, .25 and .50 for the years 1980, 1985, 1990 and 2000, respectively, to account for this limitation. The remaining 80 percent of data traffic is estimated to use dedicated (leased line) modes, and is insensitive to distribution and connectivity limitations.

In addition to the distribution and connectivity limitations discussed above, limitations are also imposed by establishment size. Unless telecommunications expenditures are high enough to justify earth station costs CPS will not be an attractive alternative. Following the earlier discussion in Subsection 6.3.2, this limitation is estimated to reduce data traffic addressable by dedicated CPS systems by a factor of .085. The corresponding factor for traffic addressable by either dedicated or shared CPS systems is .21.

Table 6.3-8 presents estimates for the data traffic addressable by dedicated CPS systems. The entries are obtained by first multiplying the corresponding entries of Table 6.2-6 by .8, .8, .85 and .9 to account for distribution related limitations. The results are then multiplied by .085 to account for establishment size limitations.

Table 6.3-9 repeats the procedure just described but uses the value .21 in place of .085 to arrive at the data traffic demand addressable by the combined dedicated and shared earth station CPS community.

TABLE 6.3-8 DATA TRAFFIC ADDRESSABLE VIA DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
MESSAGE TRAFFIC	.008	.03	.276	.494
COMPUTER TRAFFIC	3.32	9.42	20.84	43.34
TOTAL DATA TRAFFIC	3.33	9.45	21.12	43.84

TABLE 6.3-9 DATA TRAFFIC ADDRESSABLE VIA SHARED OR DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
MESSAGE TRAFFIC	.020	.074	.683	1.221
COMPUTER TRAFFIC	8.20	23.29	51.49	107.08
TOTAL DATA TRAFFIC	8.22	23.36	52.18	108.30

6.3.6 SUMMARY OF CPS ADDRESSABLE DEMAND

Table 6.3-10 summarizes dedicated CPS traffic demand as developed in the preceding sections. Table 6.3-11 does the same for combined shared and dedicated CPS traffic demand. Results are rounded to two places to the right of the decimal point.

TABLE 6.3-10 TRAFFIC ADDRESSABLE BY DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	11.94	29.82	87.10	387.73
SWITCHED	0	0	7.76	45.o0
DEDICATED	11.94	29.82	79.34	342.63
TOTAL VIDEO	.06	.03	.64	2.51
BROADCAST	0	0	0	0
VIDEOCONF.	.06	.03	.64	2.51
TOTAL DATA	3.33	9.46	21.12	43.84
MESSAGE	.008	.03	.28	.49
COMPUTER	3.32	9.42	20.84	43.34
TOTAL DEMAND	15.33	39.31	108.86	434.07

TABLE 6.3-11 TRAFFIC ADDRESSABLE BY SHARED AND DEDICATED CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	29.50	73.68	215.19	951.91
SWITCHED	0	0	19.17	111.43
DEDICATED	29.50	73.68	196.02	846.49
TOTAL VIDEO	.16	.08	1.59	6.20
BROADCAST	0	0	0	0
VIDEOCONF.	.16	.08	1.59	6.20
TOTAL DATA	8.22	23.36	52.18	108.30
MESSAGE	.02	.07	.68	1.22
COMPUTER	8.20	23.29	51.49	107.08
TOTAL DEMAND	37.88	97.13	268.96	1072.41

Traffic demand addressable by dedicated CPS systems reaches 6.8 percent of the satellite addressable market by the year 2000 while demand addressable by both shared and dedicated CPS systems reaches 16.7 percent of the satellite addressable market.

6.4 THE Ka BAND CPS MARKET

Ka band CPS systems may, depending on the design, differ from lower frequency CPS systems in the following respects:

(a) Earth station size;
(b) Availability; and
(c) Cost.

6.4.1 EARTH STATION SIZE

The survey of potential users carried out under this program and described elsewhere in this report contained several questions designed to clarify the effects of these factors on addressable traffic.

Relative to item (a), the survey showed that the ability to place an earth station on their premises was not of significant concern to most of the organizations surveyed. Overall, only 14 percent of the respondents had definite reservations about locating an earth station on their premises, and in only a fraction of these can the physical size reduction possible with Ka be expected to be a decisive factor. Earth station size can, therefore, be neglected as a significant factor.

6.4.2 LOWER AVAILABILITY SERVICE

Ka band CPS systems can be designed to attain various levels of availability at increasing cost. To the extent that cost and availability duplicate the performance characteristics of lower frequency satellites, the traffic addressable by Ka band CPS systems will be similar to that of other CPS systems. The addressable traffic for Ka band CPS will, in these cases, be the same as that shown in Table 6.3-4 and Table 6.3-5.

Ka band CPS technology, however, may favor system designs which deliver lower availability at a reduced cost. The survey referred to above, therefore, included questions that permit the evaluation of user acceptance of such lower availability service.

TABLE 6.4-1 FRACTION OF USERS ADDRESSABLE WITH LOWER AVAILABILITY SERVICE

USER CLASS	FRACTION OF U.S. EMPLOYMENT	FRACTION WHO MIGHT USE LOWER AVAIL. COMM. SERVICE
MANUFACTURING	.216	.437
WHOLESALE & RETAIL TRADE	.224	.405
TRANSPORTATION & UTILITIES	.053	.488
FINANCE, INSURANCE & REAL ESTATE	.055	.645
SERVICES	.147	.529
OTHER	.073	*
TOTAL BUSINESS	.769	.467
FEDERAL GOVERNMENT	.029	.556
STATE & LOCAL GOVERNMENT	.132	.500
TOTAL GOVERNMENT	.161	.510
EDUCATION	.013	.285
HEALTH SERVICES	.058	.125
TOTAL INSTITUTION	.071	.155
TOTAL	1.000	.450

*ASSUMES WEIGHTED AVERAGE VALUE OF REMAINDER OF BUSINESS CLASSES

Table 6.4-1 shows responses to a survey question asking whether the respondents would be able to use "a lower cost communications service with lower availability - about 30 minutes of outage every couple of weeks", chosen to represent an approximate availability level of 99.5 percent. Columns 1 and 2 identify the user classes and relative employment populations, circa 1980. Column 3 shows the number of respondents who answered "yes" or "it depends" to the question above, divided by the number who answered "yes", "it depends" or "no". The relatively small number of users who did not answer, or who answered "don't know" have been excluded from this calculation. The rows identified as "Total Business", "Total Government", "Total Institution" and "Total" refer in Column 3 to weighted averages as obtained by combining the appropriate entries in Columns 2 and 3. These entries indicate that 46.7 percent of business, 51.0 percent of government, 15.5 percent of institutional, and 45.0 percent of total employment are addressable by lower reliability systems at a reduced price.

6.4.3 COST REDUCTION EXPECTED FOR LOWER AVAILABILITY

While the overall total of 45.0 percent of employment estimated above as addressable by lower availability systems is significant, this percentage will be realized only if costs are reduced sufficiently to motivate the user to accept the lower performance level. Table 6.4-2 shows the responses of those willing to consider lower availability service when asked "What fraction of your current costs would you expect to pay for this lower availability service?"

TABLE 6.4-2 PERCENT OF CURRENT COST EXPECTED FOR LOWER AVAILABILITY SERVICE

EXPECTING TO PAY	PERCENT OF RESPONDENTS
ABOUT 90%	8.9
ABOUT 80%	15.6
ABOUT 70%	19.3
ABOUT 60%	8.1
50% OR LESS	32.6
DON'T KNOW, NO ANSWER	15.6

Leaving the "Don't know" and "No answer" responses out, and counting the "50 percent or less" answers at 50 percent, results in an expected price among respondents which averages 65.3 percent of their current costs. Thus, among those able to consider lower availability communicatons, substantial cost reductions are expected as compensation for the reduced performance.

6.4.4 VOICE TRAFFIC (ADDRESSABLE BY LOWER AVAILABILITY Ka BAND SYSTEMS)

For those Ka band CPS systems designed to lower availability criteria, a sizeable portion (45.0 percent as per Table 6.4-1) of the CPS addressable voice traffic can be addressed provided that substantial cost reductions are available. Table 6.4-3 and 6.4-4 provide estimates of the amount of voice traffic addressable by lower availability Ka band CPS as obtained by taking 45.0 percent of the CPS voice traffic shown in Tables 6.3-4 and 6.3-5.

The traffic addressable via these lower availability CPS systems in common with that of satellite systems in general tends to grow as time progresses. By the year 2000, lower availability dedicated CPS earth stations are expected to be able to address 2.72 percent of all satellite addressable voice traffic, and lower availability dedicated and shared CPS is expected to address 6.73 percent of this total.

6.4.5 VIDEO TRAFFIC (ADDRESSABLE BY LOWER AVAILABILITY Ka BAND SYSTEMS)

Since the broadcast subcategories of video traffic are considered not addressable by CPS systems, only videoconferencing remains as a potential target for the lower availability CPS services characteristic of some Ka band configurations.

There is little data available regarding the acceptability of lower availability service in videoconferencing applications. The high cost of establishing and maintaining conference room facilities, and the frequency of use by high level management, argues in favor of highly reliable service. On the other hand, the supporting wideband transmission facilities are also expensive, and reductions in these costs, at some inconvenience to the user, may be favorably considered by corporate management.

TABLE 6.4-3 VOICE TRAFFIC ADDRESSABLE VIA DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

YEAR	SWITCHED (MTS & WATS)	DEDICATED (PRIVATE LINE)	TOTAL
1980	0	5.37	5.37
1985	0	13.42	13.42
1990	3.49	35.70	39.19
2000	20.30	154.18	174.48

TABLE 6.4-4 VOICE TRAFFIC ADDRESSABLE VIA SHARED OR DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

YEAR	SWITCHED (MTS & WATS)	DEDICATED (PRIVATE LINE)	TOTAL
1980	0	13.27	13.27
1985	0	33.16	33.16
1990	8.63	88.21	96.83
2000	50.14	380.92	431.06

In the absence of specific information to the contrary, a level of acceptance equal to that applicable to voice transmissions has been assumed. Tables 6.4-5 and 6.4-6, therefore, provide estimates for video traffic demand addressable by lower availability Ka band CPS based on 45.0 percent (as per Table 6.4-1) of the CPS addressable traffic demand shown in Tables 6.3-6 and 6.3-7.

TABLE 6.4-5 VIDEO TRAFFIC ADDRESSABLE VIA DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
BROADCAST MODE	0	0	0	0
VIDEOCONF.	.029	.015	.290	1.128
TOTAL VIDEO	.029	.015	.290	1.128

TABLE 6.4-6 VIDEO TRAFFIC ADDRESSABLE VIA SHARED AND DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
BROADCAST MODE	0	0	0	0
VIDEOCONF.	.071	.037	.717	2.79
TOTAL VIDEO	.071	.037	.717	2.79

6.4.6 DATA TRAFFIC (ADDRESSABLE BY LOWER AVAILABILITY Ka BAND SYSTEMS)

Applications for data traffic are diverse and requirements for transmission reliability vary over wide ranges. Most data applications, however, are considered by the user community to be more critical than voice applications. This general observation is borne out by an analysis of the responses to the primary research survey discussed elsewhere in this report. Those respondents whose primary concern was data transmission were less willing to accept lower availability service despite offered price incentives.

Generally, it appears that an offering of lower availability service at a given cost reduction would result in a reduction of data traffic demand to 75 percent of the value that would pertain to voice transmissions (45.0 percent as per Table 6.4-1). The result is a reduction to 33.75 percent of the traffic estimated for the higher availability service. This reduction, however, applies only to the more critical computer subcategory of traffic demand. The less critical message traffic subcategory is better able to use lower availability systems. Taking into account a mix of TWX/Telex, facsimile, and electronic mail components, this latter value is placed at approximately 80 percent of the traffic estimated for the higher availability service.

Following the discussion above, Tables 6.4-7 and 6.4-8 present data traffic demand addressable by lower availability Ka band CPS systems. The message traffic subcategories are taken as 80 percent of the corresponding CPS addressable subcategories in Tables 6.3-8 and 6.3-9, and the computer traffic subcategories are taken as 33.75 percent (.75 x 45.0 percent) of the corresponding values in the same tables.

6.4.7 SUMMARY OF TRAFFIC DEMAND ADDRESSABLE BY LOWER AVAILABILITY Ka BAND CPS SYSTEMS

Table 6.4-9 summarizes traffic demand for lower availability dedicated earth station CPS systems. Table 6.4-10 repeats this for combined shared and dedicated lower availability CPS demand. Results are rounded to two places to the right of the decimal point.

TABLE 6.4-7 DATA TRAFFIC ADDRESSABLE VIA DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
MESSAGE TRAFFIC	.007	.024	.221	.395
COMPUTER TRAFFIC	1.120	3.180	7.03	14.63
TOTAL DATA TRAFFIC	1.13	3.20	7.26	15.02

TABLE 6.4-8 DATA TRAFFIC ADDRESSABLE VIA SHARED AND DEDICATED LOWER AVAILABILITY Ka BAND CPS SYSTEMS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
MESSAGE TRAFFIC	.016	.059	.546	.977
COMPUTER TRAFFIC	2.767	7.86	17.38	36.14
TOTAL DATA TRAFFIC	2.784	7.92	17.93	37.11

TABLE 6.4-9 TRAFFIC ADDRESSABLE BY LOWER AVAILABILITY Ka BAND CPS - DEDICATED EARTH STATIONS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	5.37	13.42	39.19	174.48
SWITCHED	0	0	3.49	20.30
DEDICATED	5.37	13.42	35.70	154.18
TOTAL VIDEO	.029	.015	.29	1.13
BROADCAST	0	0	0	0
VIDEOCONF.	.029	.015	.29	1.13
TOTAL DATA	1.13	3.20	7.26	15.02
MESSAGE	.007	.02	.22	.40
COMPUTER	1.12	3.18	7.03	14.63
TOTAL DEMAND	6.53	16.64	46.74	190.63

TABLE 6.4-10 TRAFFIC ADDRESSABLE BY LOWER AVAILABILITY Ka BAND CPS - SHARED AND DEDICATED EARTH STATIONS (BITS PER YEAR x 10^{15})

	1980	1985	1990	2000
TOTAL VOICE	13.27	33.16	96.83	431.06
SWITCHED	0	0	8.63	50.14
DEDICATED	13.27	33.16	88.21	380.92
TOTAL VIDEO	.07	.04	.72	2.79
BROADCAST	0	0	0	0
VIDEOCONF.	.07	.04	.72	2.79
TOTAL DATA	2.78	7.92	17.93	37.12
MESSAGE	.02	.06	.55	.98
COMPUTER	2.77	7.86	17.38	36.14
TOTAL DEMAND	16.13	41.11	115.48	470.97

Traffic demand addressable by lower availability dedicated CPS systems reaches 3.0 percent of the satellite addressable market by the year 2000, while demand addressable by both shared and dedicated lower availability CPS systems reaches 7.4 percent of the satellite addressable market.

6.5 BUSY HOUR TRAFFIC

The previous sections of this chapter presented estimates for annual traffic volumes (bits per year). In designing telecommunications systems it is necessary to design for peak loads, taking account of the variation of demand from day to day and the tendency of traffic to concentrate during certain hours of the day. The generally accepted practice is to evaluate traffic rates (bits per second) during the busy hour (i.e., the peak hour of the average day), and to design the communications facilities to handle this busy hour traffic at the desired grade of service.

The following subsections discuss peak factors appropriate to the traffic subcategories under consideration and apply these factors to the estimation of busy hour traffic rates.

6.5.1 PEAK FACTORS

Table 6.5-1 presents peak factors applicable to the various traffic subcategories introduced earlier. The peak factors are developed for each subcategory by first establishing the number of days per year during which substantial traffic activity exists. As indicated in Column 2 of Table 6.5-1, the business oriented subcategories are typically active for 250 days per year while other subcategories are active for 365 days per year. By dividing the annual traffic in each subcategory (bits per year) by the number of days shown in Column 2 the average daily traffic on active days is obtained (bits per day). Division by 24 results in the average hourly traffic during an active day.

Column 3 of Table 6.5-1 expresses the tendency for traffic volumes during some hours of the active day to be higher than the average hourly traffic. As discussed later in this section, the peak factor varies from traffic subcategory to subcategory and, for most data subcategories, from year to year.

By multiplying the average hourly traffic by the peak factor the traffic volume during the busy hour (bits per hour) is obtained. A further division by 3600 converts this hourly traffic volume to a traffic rate (bits per second) during the busy hour. The net result of these operations is to convert annual traffic, in bits per year, to a busy hour traffic rate, expressed in bits per second.

TABLE 6.5-1 PEAK FACTORS

1	2 ACTIVE DAYS PER YEAR	3 PEAK FACTOR 1980	1985	1990	2000
VOICE					
MTS RES.	365	.44	.44	.44	.44
MTS BUS.	250	3.1	3.1	3.1	3.1
WATS	250	3.1	3.1	3.1	3.1
PVT.LINE	365	1.0	1.0	1.0	1.0
VIDEO					
NET.TV	365	1.0	1.0	1.0	1.0
CATV	365	1.0	1.0	1.0	1.0
EDUC.	365	1.0	1.0	1.0	1.0
PUB.SVS.	250	1.0	1.0	1.0	1.0
VIDEOCONF.	250	2.66	2.66	2.66	2.66
DATA					
TWX/TELEX	250	4.0	4.0	4.0	4.0
FACSIMILE	250	1.4	1.5	2.0	4.0
ELECT.MAIL	250	1.4	1.5	2.0	2.1
TERM/CPU	250	1.4	1.5	2.0	4.0
DISTRIB.PROC.	250	1.4	1.5	2.0	3.0
EFT	250	1.4	1.5	2.0	2.0

6.5.1.1 VOICE PEAK FACTORS

The peak factors for the voice traffic components shown in Column 3 of Table 6.5-1 were developed in Reference 6-1 and are briefly summarized here. Hourly volume profiles over the 24 hour day for typical local telephone switching offices are well established and documented in the technical literature. Profiles for the longer distance components of traffic of interest in this study are less well documented but suitable estimates were arrived at in Reference 6-1.

Residential MTS traffic requires some special consideration. Residential MTS traffic peaks during the evening hours, partly in response to rate reductions in force during these hours. Business MTS, on the other hand, peaks during the business day. Since the composite busy hour traffic determines the communications capacity needed it is necessary to determine which of these two major traffic components establishes the dominant peak hour, and to select the appropriate off-peak value of traffic for the other. When WATS, MTS business, data traffic, and other business oriented traffic are combined it is found that the business peak hour dominates so that an off-peak value for Residential MTS traffic must be used. This explains why the peak factor corresponding to Residential MTS traffic shown in Column 3 of Table 6.5-1 is less than one.

The actual values shown for the Residential and Business MTS peak factors are based on an analysis of published literature showing traffic volume patterns as discussed in Reference 6-1. WATS traffic is assumed to have a peak factor similar to that of Business MTS. Private lines demand uniform access to the communications facilities throughout the 24 hour period and the applicable peak factor is therefore unity.

6.5.1.2 VIDEO PEAK FACTORS

In the video categories, Network TV, CATV and Educational Video are assumed to required full time dedicated service with continuous access to the communications facilities. The peak factor, as in the case of private line voice, is therefore unity.

The peak factor for videoconferencing is obtained from a calculation which assumes a uniform traffic distribution over a 10 hour business day for the Eastern and Central time zones (50 percent of the traffic) and a similar distribution for the Western and Mountain time zones (25 percent of the traffic) displaced by 3 hours. To this is added an east-west component (25 percent of the traffic) uniformly distributed over the seven overlapping business hours in the two other time displaced periods.

6.5.1.3 DATA PEAK FACTORS

Each of the data traffic subcategories shown in Table 6.5-1, to varying degrees, uses both switched and dedicated transmission facilities. Data traffic using switched facilities tends to concentrate in business hours and exhibits peaking similar to, and somewhat higher than, that associated with business voice traffic. The data traffic traveling via dedicated facilities has a peak factor of unity reflecting the constant level of demand imposed by dedicated service. The peak factors shown in Table 6.5-1 reflect a mix of these traffic modes.

Peaking also increases as real-time data transmission applications become more significant relative to deferred modes of transmission. It is anticipated that data traffic will evolve towards higher proportions of real-time, as opposed to deferred modes of operation. The peak factors shown in Table 6.5-1 increase with time to reflect the influence of this trend.

6.5.2 BUSY HOUR TRAFFIC RATES

Busy hour traffic rates are obtained by applying the conversions discussed in Subsection 6.5.1 to the appropriate estimates of annual traffic for each of the traffic subcategories discussed earlier.

For calculations relating to the overall market the appropriate annual estimates were obtained from Tables 6.1-6 and 6.1-7 for voice, Table 6.1-16 for video, and Table 6.1-25 for data. The results of the subcategory by subcategory conversions were then summed to obtain the overall market busy hour traffic presented in Table 6.5-2. Results in this table, and in subsequent tables in this section, are rounded to two places following the decimal point.

A similar procedure was followed to obtain the busy hour demand for the satellite market (as presented in Table 6.5-3), the CPS market (Tables 6.5-4 and 6.5-5), and the lower availability Ka band CPS market (Tables 6.5-6 and 6.5-7). Since the annual demand for these markets, as presented earlier, was summed into broader categories some additional steps of disaggregation were used to explicitly obtain the detailed traffic subcategories, against which the peak factor conversions were applied, prior to re-summing, to obtain the busy hour results presented here.

TABLE 6.5-2 ADDRESSABLE BUSY HOUR TRAFFIC OVERALL MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	148.28	242.80	386.72	855.14
SWITCHED	92.60	153.07	242.34	513.37
DEDICATED	55.68	89.73	144.38	341.76
TOTAL VIDEO	2.64	3.70	5.84	13.86
BROADCAST	2.27	3.51	3.97	6.59
VIDEOCONF.	.37	.19	1.87	7.27
TOTAL DATA	48.53	90.11	142.85	333.15
MESSAGE	.06	.17	1.51	2.58
COMPUTER	48.47	89.94	141.34	330.57
TOTAL TRAFFIC	199.46	336.12	535.41	1202.15

TABLE 6.5-3 ADDRESSABLE BUSY HOUR TRAFFIC SATELLITE MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	16.21	37.48	84.45	286.82
SWITCHED	11.75	26.35	54.85	159.00
DEDICATED	4.45	11.13	29.60	127.82
TOTAL VIDEO	2.64	3.70	5.84	13.86
BROADCAST	2.27	3.51	3.97	6.59
VIDEOCONF.	.37	.19	1.87	7.27
TOTAL DATA	3.17	9.66	27.07	103.64
MESSAGE	.01	.03	.35	.84
COMPUTER	3.16	9.63	26.71	102.81
TOTAL TRAFFIC	22.02	50.84	117.36	404.32

TABLE 6.5-4 ADDRESSABLE BUSY HOUR TRAFFIC CPS DEDICATED EARTH STATION MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	.38	.95	3.63	17.34
SWITCHED	0	0	1.11	6.47
DEDICATED	.38	.95	2.52	10.86
TOTAL VIDEO	.007	.004	.079	.31
BROADCAST	0	0	0	0
VIDEOCONF.	.007	.004	.079	.31
TOTAL DATA	.22	.66	1.96	7.93
MESSAGE	.001	.002	.03	.06
COMPUTER	.22	.66	1.93	7.86
TOTAL TRAFFIC	.60	1.61	5.66	25.58

TABLE 6.5-5 ADDRESSABLE BUSY HOUR TRAFFIC CPS DEDICATED AND SHARED EARTH STATION MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	.94	2.34	8.97	42.83
SWITCHED	0	0	2.75	15.99
DEDICATED	.94	2.34	6.22	26.84
TOTAL VIDEO	.02	.01	.20	.76
BROADCAST	0	0	0	0
VIDEOCONF.	.02	.01	.20	.76
TOTAL DATA	.53	1.62	4.83	19.59
MESSAGE	.001	.01	.06	.16
COMPUTER	.53	1.62	4.77	19.43
TOTAL TRAFFIC	1.49	3.97	13.99	63.19

TABLE 6.5-6 ADDRESSABLE BUSY HOUR TRAFFIC LOWER AVAILABILITY Ka CPS DEDICATED EARTH STATION MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	.17	.43	1.63	7.80
SWITCHED	0	0	.50	2.91
DEDICATED	.17	.43	1.13	4.89
TOTAL VIDEO	.004	.002	.036	.14
BROADCAST	0	0	0	0
VIDEOCONF.	.004	.002	.036	.14
TOTAL DATA	.07	.22	.67	2.71
MESSAGE	.001	.001	.02	.05
COMPUTER	.07	.22	.65	2.65
TOTAL TRAFFIC	.25	.65	2.34	10.65

TABLE 6.5-7 ADDRESSABLE BUSY HOUR TRAFFIC LOWER AVAILABILITY Ka CPS DEDICATED AND SHARED EARTH STATION MARKET (BPS x 10^9)

	1980	1985	1990	2000
TOTAL VOICE	.42	1.05	4.04	19.28
SWITCHED	0	0	1.24	7.20
DEDICATED	.42	1.05	2.80	12.08
TOTAL VIDEO	.009	.005	.09	.34
BROADCAST	0	0	0	0
VIDEOCONF.	.009	.005	.09	.34
TOTAL DATA	.18	.55	1.66	6.68
MESSAGE	.001	.004	.05	.13
COMPUTER	.18	.55	1.61	6.56
TOTAL TRAFFIC	.61	1.61	5.78	26.30

7.0 DISTANCE DISTRIBUTION OF TRAFFIC

This chapter discusses the distance distribution of traffic and develops the distance factors that were used in Section 6.2 to select the fraction of traffic traveling far enough to be addressable by satellite systems.

The distance distributions presented are derived from sources pertaining primarily to voice traffic but are expected to apply with reasonable accuracy to data traffic as well. As discussed in Subsection 6.2.2, the overall video traffic components and the satellite suitable video traffic components are essentially equivalent, so that distance distributions for video traffic are not required.

7.1 MTS TRAFFIC

Business MTS calls follow a distance distribution which tends towards slightly longer distances than is the case for residential MTS. The difference in distances at any given percentage level, however, is less than 10 percent, so that for the purposes of this report business and residential components can be treated jointly.

Figure 7.1-1 shows the distribution of interstate MTS messages versus distance. The curves for 1960, 1965, 1970 and 1975 are plotted from data contained in a 1977 AT&T filing [Ref. 7-1]. The curve for 1980 derives from more recent data presented in a 1981 AT&T filing [Ref. 7-2]. The trend toward increasing distance implicit in Figure 7.1-1 is extrapolated to the year 2000 in Figure 7.1-2 for distances of 200, 400, 600 and 800 miles. The solid portion of the curves represents historical data read from Figure 7.1-1 and the dotted portion shows the expected continuation of the trend.

Table 7.1-1 tabulates the extrapolations of Figure 7.1-2 for the benchmark years of this study. The distance factors in Table 7.1-1 refer to interstate MTS traffic, whereas the projections in Section 6.1 are in terms of interurban traffic which includes both interstate and intrastate components. To develop distance factors applicable to interurban MTS traffic, a weighted average of the interstate and intrastate components is required.

ORIGINAL PAGE IS
OF POOR QUALITY

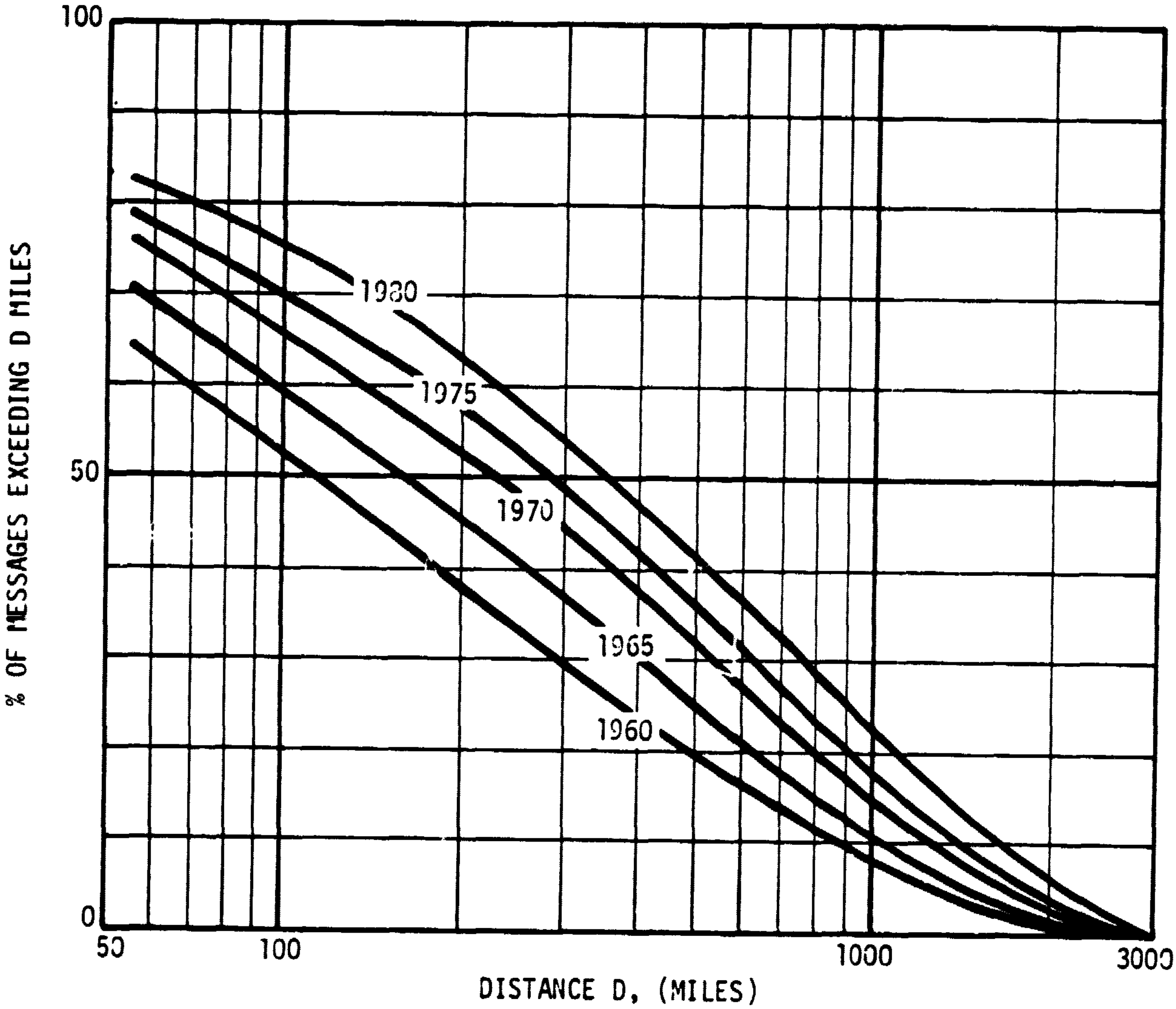


FIGURE 7.1-1 DISTANCE DISTRIBUTION OF INTERSTATE MTS MESSAGES

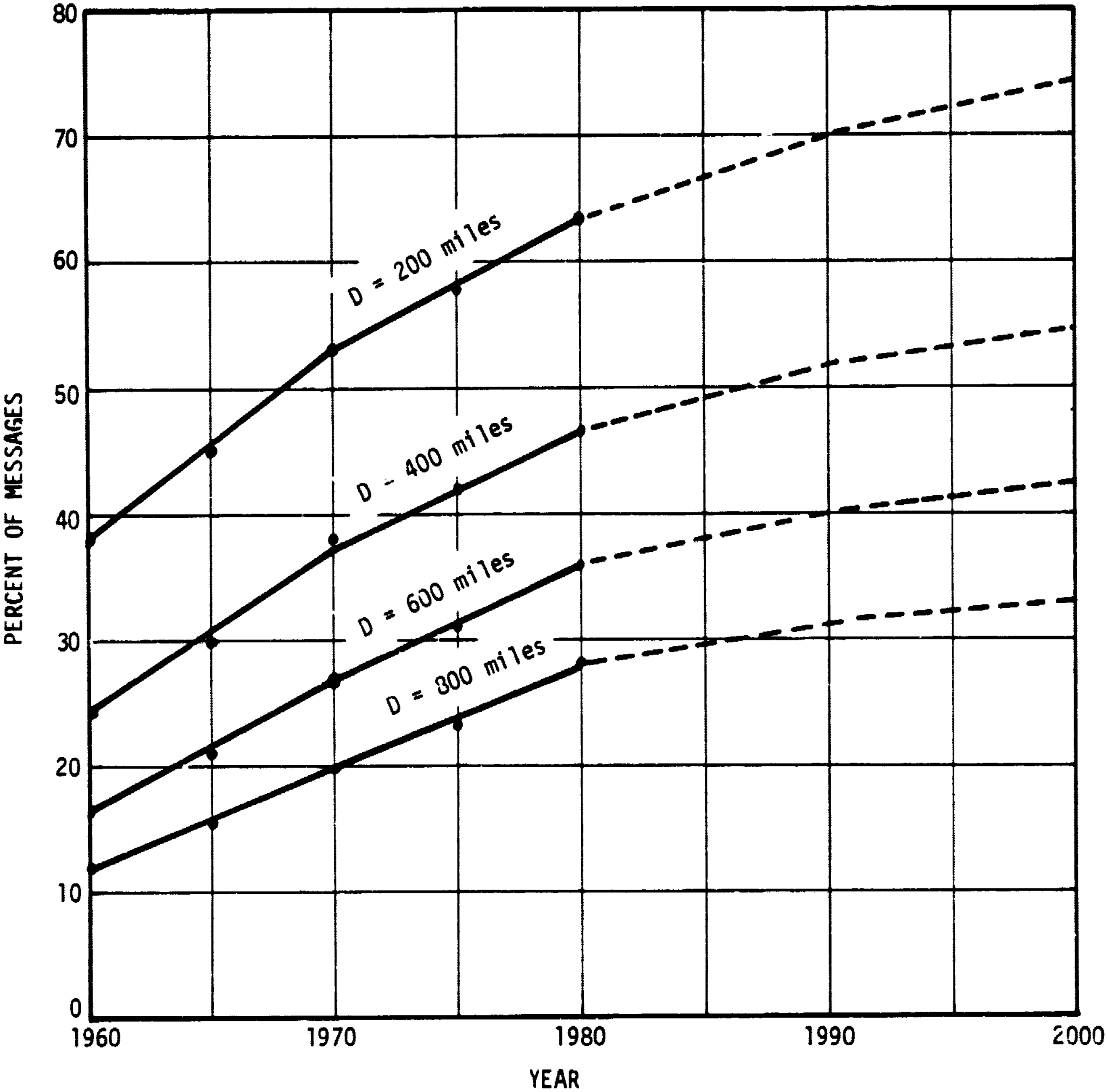


FIGURE 7.1-2 PERCENT OF INTERSTATE MTS MESSAGES EXCEEDING DISTANCE, D

Published data on the relative mix of interstate and intrastate message volumes is scarce, but informal estimates place this mix at approximately 1/3 interstate and 2/3 intrastate. Since, in comparison with interstate traffic, only a negligible amount of intrastate traffic travels distances in excess of 200 miles, the weighted average distance factors appropriate to interurban MTS are simply obtained by multiplying the interstate factors of Table 7.1-1 by 1/3. These operations are summarized in Table 7.1-2, which provides adjusted distance factors applicable to interurban MTS traffic for the selected years and distances used in Section 6.2.

TABLE 7.1-1 INTERSTATE MTS DISTANCE FACTORS
(FRACTION OF MESSAGES EXCEEDING DISTANCE, D)

YEAR	DISTANCE, D (MILES) 200	400	600	800
1980	.635	.465	.360	.280
1985	.665	.490	.380	.295
1990	.700	.520	.400	.310
2000	.740	.545	.425	.330

TABLE 7.1-2 INTERURBAN MTS DISTANCE FACTORS

YEAR	DISTANCE (mi)	INTERSTATE DIST. FACTOR	INTERSTATE PORTION	INTERURBAN MTS DIST. FACTOR
1980	800	.280	1/3	.093
1985	600	.380	1/3	.127
1990	400	.520	1/3	.173
2000	200	.740	1/3	.247

7.2 WATS TRAFFIC

Figure 7.2-1 shows the fraction of WATS messages traveling more than a given distance as developed from data contained in Reference 7-2. Table 7.2-1 tabulates the results for particular distances of interest in forming the projections of Section 6.2. Since approximately 1/3 of WATS traffic is intrastate, and contributes negligibly to traffic in excess of 200 miles, the distance factors are modified by multiplying by 2/3 to obtain factors applicable to the total interstate and intrastate WATS traffic projected in Subsection 6.1.1.1.

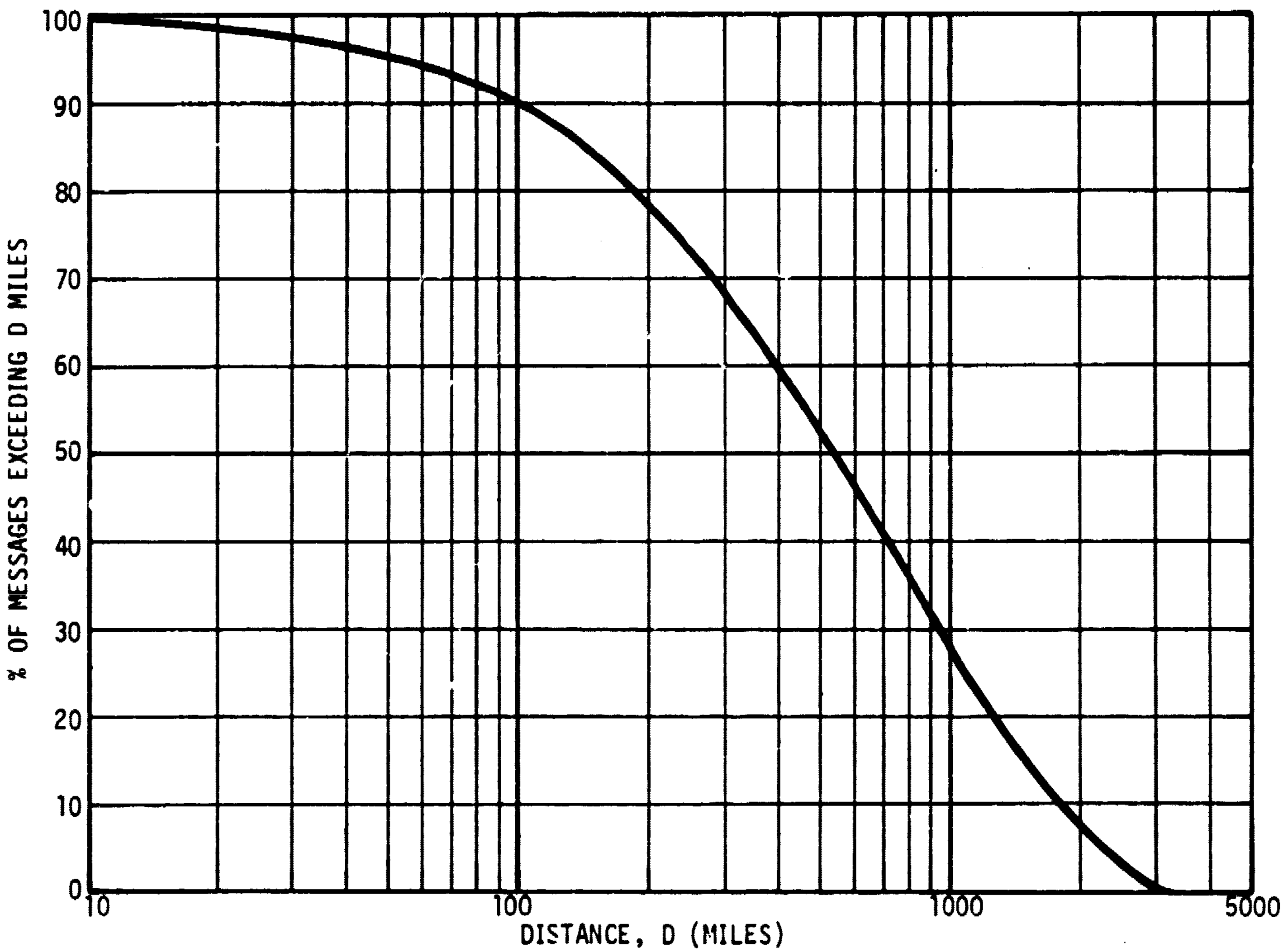


FIGURE 7.2-1 DISTANCE DISTRIBUTION OF INTERSTATE WATS MESSAGES

TABLE 7.2-1 WATS DISTANCE FACTORS

DISTANCE (MILES)	INTERSTATE WATS DISTANCE FACTOR	INTERSTATE PORTION	WATS DIST. FACTOR APPLICABLE TO INTER- + INTRASTATE
800	.365	2/3	.243
600	.475	2/3	.317
400	.600	2/3	.400
200	.785	2/3	.523

Since data (similar to that for MTS) showing a trend toward increasing distances was not uncovered for WATS, the assumption was made that the distance distribution shown in Figure 7.2-1 remains unchanged over the time frame of this study. If WATS traffic does, in fact, tend toward longer distances the effect will be to increase somewhat the market share of satellite (and CPS) systems above that projected. Similar considerations apply also to the distance distribution of private line and message traffic which, in the next two sections, are considered to have distance distributions that are unchanging over the projected period.

ORIGINAL PAGE IS
OF POOR QUALITY

7.3 PRIVATE LINE TRAFFIC

Figure 7.3-1 shows the distance distribution of interstate private lines as developed from data contained in Reference 7-3. Results for particular distances of interest in forming the projections of Section 6.2 are tabulated in Table 7.3-1.

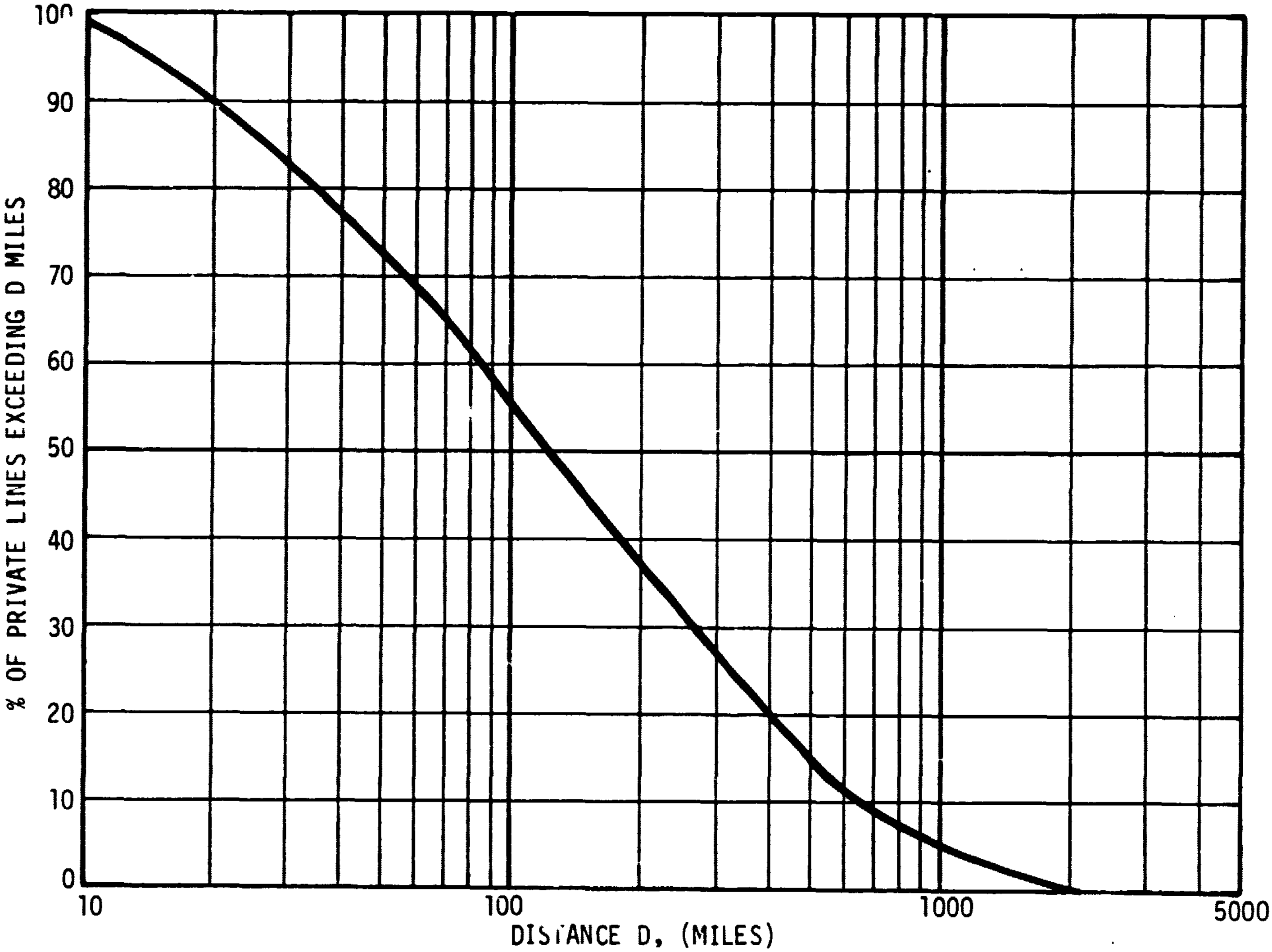


FIGURE 7.3-1 DISTANCE DISTRIBUTION OF PRIVATE LINES

TABLE 7.3-1 PRIVATE LINE DISTANCE FACTORS

DISTANCE (MILES)	PRIVATE LINE DIST. FACTOR
800	.080
600	.124
400	.205
200	.374

7.4 MESSAGE TRAFFIC

Some forms of telecommunications (e.g., TWX/Telex, Facsimile and Electronic Mail) are essentially electronic substitutes for the physical delivery of paper documents. The distance distribution applicable to these subcategories of traffic is, therefore, likely to follow patterns similar to those of the paper document delivery system being replaced. First class mail offers a reasonable model for the distance distribution of these traffic subcategories.

First class mail is routed between major postal facilities referred to as Section Center Facilities (SCFs). There are approximately 530 SCFs in the United States. About 40% of first class mail is classified as intra-SCF and the remaining 60% is inter-SCF. Using data published in Reference 7-4 together with the assumption that most intra-SCF mail travels less than 150 miles results in the distance distribution for first class mail presented in Figure 7.4-1.

Table 7.4-1 tabulates distance factors for message type traffic, patterned on first class mail delivery volumes, for distances of particular interest in forming the projections of Section 6.2.

TABLE 7.4-1 MESSAGE TRAFFIC DISTANCE FACTORS

DISTANCE (MILES)	MESSAGE TRAFFIC DIST. FACTOR
800	.145
600	.186
400	.235
200	.324

ORIGINAL PAGE IS
OF POOR QUALITY

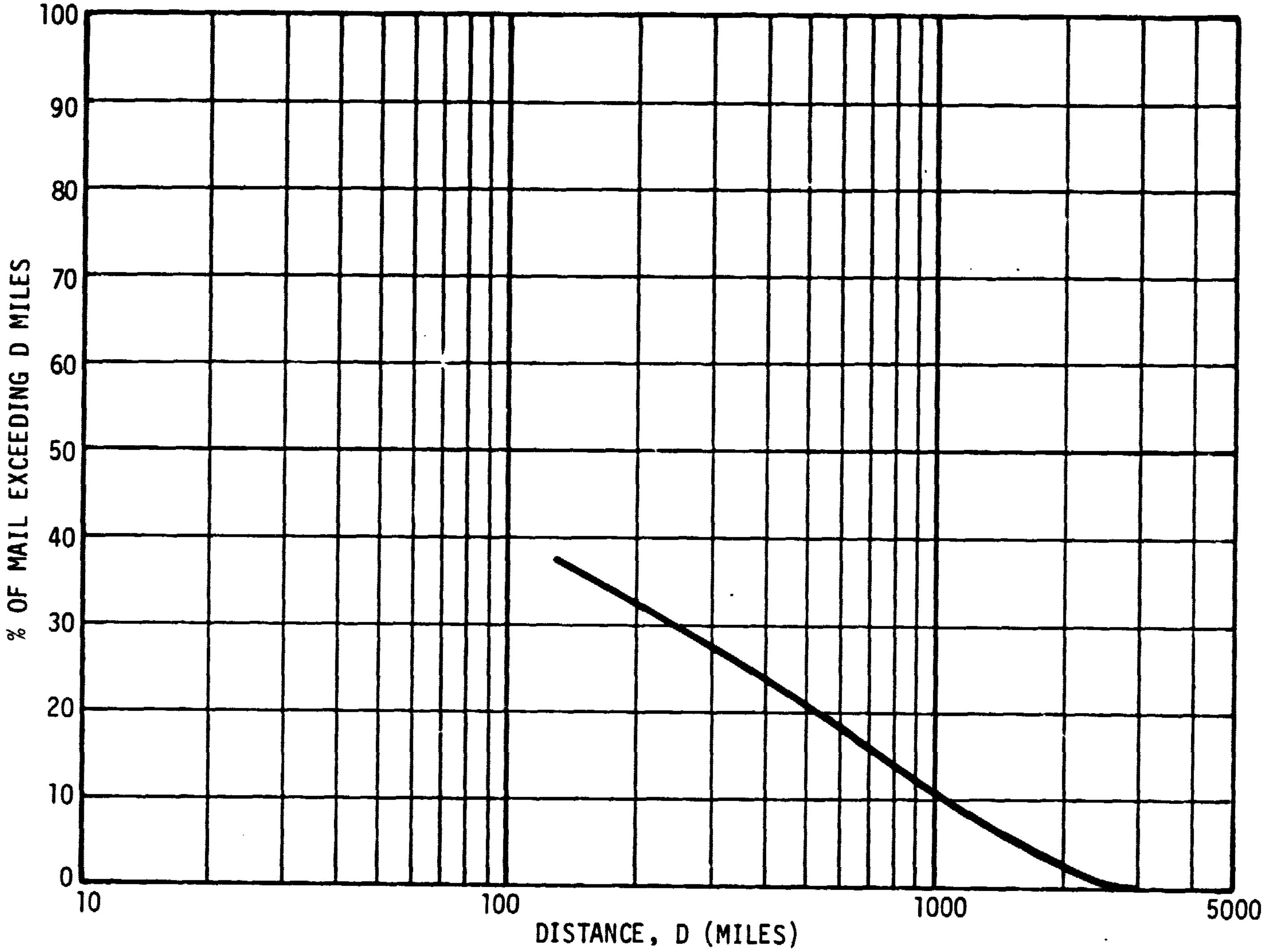


FIGURE 7.4-1 DISTANCE DISTRIBUTION OF FIRST CLASS MAIL

7.5 DISTANCE DISTRIBUTION BY MARKET

The previous sections discussed distance distributions appropriate to the various service categories and subcategories. The mix of traffic demand for the service categories and subcategories varies from market to market and from year to year. This section presents overall distance distributions, applicable to each market and year, obtained by weighting the distance distributions appropriate to each service category/subcategory by the relative annual volumes applicable to that market and year.

In addition to the distance distributions by service subcategory presented earlier for MTS, WATS, Private Lines and Message traffic, it has been assumed that broadcast video traffic is uniformly distributed with distance, that videoconferencing traffic follows the same distribution as the weighted average of MTS business, WATS and Private Line traffic, and that the computer traffic distance distribution is the average of the distributions for MTS and Private Lines.

Table 7.5-1 shows the weighted average distance distributions appropriate to the various markets. The CPS and lower availability Ka band markets differ very slightly and have therefore been combined in the table. These results apply to both the shared and dedicated earth station configurations.

TABLE 7.5-1 FRACTION OF TRAFFIC BEYOND INDICATED DISTANCE

DIST.	OVERALL MKT				SATELLITE MKT				CPS and Ka MKTS			
(mi.)	1980	1985	1990	2000	1980	1985	1990	2000	1980	1985	1990	2000
100	.456	.459	.466	.477	1	1	1	1	1	1	1	1
200	.335	.338	.341	.349	1	1	1	1	1	1	1	1
400	.209	.211	.212	.214	1	1	1	.615	1	1	1	.577
600	.144	.145	.145	.146	1	1	.686	.418	1	1	.633	.368
800	.104	.104	.104	.104	1	.727	.494	.298	1	.660	.425	.248
1000	.076	.077	.075	.073	.740	.538	.358	.211	.644	.429	.280	.165
2000	.022	.023	.027	.023	.227	.161	.127	.066	.138	.094	.075	.045
3000	0	0	0	0	0	0	0	0	0	0	0	0

8.0 SEGMENTATION OF MARKET DEMAND

This chapter further segments the basic market demand forecasts developed in Chapter 6 and distributes the demand according to service category, user class and geographic region.

8.1 METHODOLOGY

Chapter 6 presents estimates of total U.S. communications demand for the benchmark years 1980, 1985, 1990 and 2000 for each of the markets analyzed (i.e., the overall market, the satellite market, the CPS market, and the lower availability Ka band CPS market). As discussed in the following pages, these market demand estimates are apportioned among the various user classes and geographic regions of the U.S. on the basis of expected employment levels and activity factors. The activity factors represent relative demand per employee for long distance communications services for each of the user classes. For residential traffic, population, rather than employment, is used as the basis for distributing the traffic.

8.1.1 EMPLOYMENT PROJECTIONS BY USER CLASS AND REGION

Employment projections by user class for the nine census regions of the U.S. (excluding the States of Alaska and Hawaii) were developed. The user classes selected are defined in Table 8.1-1 and the census regions are defined in Table 8.1-2.

Table 8.1-3 shows projected employment for the benchmark years of the study by user class and geographic region. The source of the data is the U.S. Bureau of Economic Analysis [Ref. 8-1].

TABLE 8.1-1 USER CLASSES AND SUBTOTALS

USER CLASS		ABBREVIATION
BUSINESS	MANUFACTURING	MFG
	WHOLESALE AND RETAIL TRADE	WH/RE
	FINANCE, INSURANCE & REAL ESTATE	F/I/R
	TRANSPORTATION & UTILITIES	TR/UT
	SERVICES	SVS
	OTHER	OTHER
	BUSINESS SUBTOTAL	BTOT
GOVERNMENT	FEDERAL	FGOV
	STATE AND LOCAL	SLGOV
	GOVERNMENT SUBTOTAL	GTOT
INSTITUTIONS	EDUCATION	EDU
	HEALTH CARE	HEAL
	INSTITUTIONAL SUBTOTAL	ITOT
RESIDENTIAL	-	RESIDENT

TABLE 8.1-2 U.S. CENSUS REGIONS

REGION	ABBR	STATES INCLUDED
NEW ENGLAND	NE	MAINE, N.H., VT., MASS., R.I., CONN.
MIDDLE ATLANTIC	MA	N.Y., N.J., PA.
EAST NORTH CENTRAL	ENC	OHIO, IND., ILL., MICH., WIS.
WEST NORTH CENTRAL	WNC	MINN., IOWA, MISSOURI, N.DAK., S.DAK., NEBR., KANS.
SOUTH ATLANTIC	SA	DEL., MD., D.C., VA., W.VA., N.C., S.C., GA., FLA.
EAST SOUTH CENTRAL	ESC	KY., TENN., ALA., MISS.
WEST SOUTH CENTRAL	WSC	ARK., LA., OKLA., TEX.
MOUNTAIN	MT	MONT., IDAHO, WYO., COLO., N.MEX., ARIZ., UTAH, NEV.
PACIFIC	PAC	WASH., OREG., CALIF.

Reference 8-1 presents employment projections by user class and by state for the years 1978, 1985, 1990 and 2000. The entries in Table 8.1-3 were obtained by accumulating the state employment figures of Reference 8-1 to obtain regional values and by interpolating between 1978 and 1985 to obtain estimates for the year 1980. In addition, the employment projections for education and health care were removed from the "Services" category in which they are included in Reference 8-1 and are separately listed in Table 8.1-3 under the overall heading of "Institutions".

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.1-3 PROJECTED U.S. EMPLOYMENT (000)

	BUSINESS							GOVERNMENT			INSTITUTIONS			TOTAL
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	
1980														
NE	1514	1260	240	337	791	300	4443	114	701	815	158	437	595	5853
MA	3694	3458	947	1075	2492	805	12470	357	2089	2446	332	1027	1358	16275
ENC	5311	4188	924	946	2379	1079	14827	307	2386	2693	202	1172	1373	18894
WNC	1470	1924	464	416	1097	574	5946	179	1092	1271	93	508	602	7819
SA	3143	3484	819	836	2483	1264	12028	812	2152	2963	201	744	945	15937
ESC	1511	1268	291	252	809	509	4641	200	812	1012	61	289	350	6003
WSC	1703	2400	597	527	1480	1188	7895	267	1312	1579	81	505	586	10059
MT	578	1164	272	269	863	559	3705	198	734	932	41	243	284	4921
PAC	2563	3144	704	843	2232	954	10440	418	1826	2244	160	801	961	13644
TOT	21488	22290	5256	5501	14626	7232	76394	2853	13102	15755	1328	5727	7056	99404
1985														
NE	1574	1375	251	383	862	334	4779	118	727	846	164	515	680	6305
MA	3708	3645	969	1183	2709	900	13114	360	2144	2504	356	1196	1552	17170
ENC	5576	4599	974	1088	2626	1203	16066	312	2508	2820	213	1419	1632	20518
WNC	1591	2088	495	478	1203	622	6477	181	1148	1329	99	612	712	8518
SA	3402	3921	888	990	2739	1428	13368	840	2313	3152	222	927	1148	17668
ESC	1674	1450	322	303	885	589	5223	210	893	1103	67	369	436	6762
WSC	1985	2736	654	632	1659	1275	8941	272	1438	1710	88	641	729	11380
MT	683	1371	311	334	1023	640	4362	208	813	1021	48	314	361	5744
PAC	2864	3548	761	990	2552	1071	11786	425	1940	2365	175	986	1161	15312
TOT	23057	24734	5625	6381	16258	8060	84115	2927	13923	16850	1431	6979	8412	109377
1990														
NE	1595	1445	260	407	897	359	4963	119	742	861	166	588	754	6578
MA	3627	3719	974	1228	2821	961	13330	363	2155	2518	364	1351	1715	17563
ENC	5693	4847	1003	1174	2786	1260	16763	315	2587	2902	215	1655	1870	21535
WNC	1675	2193	513	518	1274	641	6814	182	1186	1368	102	716	818	9000
SA	3605	4262	945	1100	2937	1498	14347	857	2439	3296	232	1120	1352	18995
ESC	1817	1597	348	343	944	634	5683	219	954	1173	71	454	525	7381
WSC	2269	3014	699	710	1796	1276	9764	280	1544	1824	94	788	882	12470
MT	767	1522	341	382	1142	689	4843	216	879	1095	52	389	441	6379
PAC	3071	3824	798	1085	2780	1125	12683	433	2042	2475	183	1178	1361	16519
TOT	24117	26423	5881	6947	17377	8443	89190	2984	14528	17512	1479	8239	9718	116420
2000														
NE	1585	1520	267	433	924	393	5122	124	752	876	166	685	851	6849
MA	3347	3695	949	1231	2869	1040	13131	367	2122	2489	366	1551	1917	17537
ENC	5697	5078	1024	1270	2937	1309	17315	315	2635	2950	214	1976	2190	22455
WNC	1767	2310	530	571	1364	661	7203	182	1234	1416	104	865	969	9588
SA	3885	4772	1022	1263	3216	1586	15744	885	2629	3514	249	1443	1692	20950
ESC	2026	1790	384	397	1016	678	6291	207	1028	1235	76	592	668	8194
WSC	2683	3447	767	830	2012	1241	10980	288	1712	2000	104	1038	1142	14122
MT	910	1756	391	456	1327	758	5598	225	982	1207	60	523	583	7388
PAC	3380	4223	847	1220	3107	1207	13984	448	2200	2648	196	1481	1677	18309
TOT	[illegible]280	28591	6181	7671	18772	8873	95368	3041	15294	18335	1535	10154	11689	125392

Table 8.1-4 shows population in each of the census regions for the years 1980, 1985, 1990 and 2000. The population projections were obtained from Reference 8-2 with interpolation between 1979 and 1985 used to obtain the results for 1980. Population by region is used to segment residential traffic in place of employment, which is used for the other user classes.

TABLE 8.1-4 PROJECTED U.S. POPULATION (THOUSANDS)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	12420	36877	41460	17192	35761	14205	22693	10870	29319	220797
1985	13070	37700	42314	17550	39675	14822	23742	11857	30169	230899
1990	13600	38196	43260	18101	42727	15526	25254	12936	31828	241428
2000	14449	38703	44398	18909	47949	16661	27792	14732	34540	258133

8.1.2 ACTIVITY FACTORS

The employment estimates of Table 8.1-3 form part of the basis for segmenting the U.S. market according to user class and region. It is apparent, however, from the primary research survey conducted under this study, and from other sources, that per employee demand for communications varies significantly from user class to user class. To take this variation into account in apportioning traffic demand among the user classes, a set of "activity factors" is introduced. The activity factors are based on the traffic volume index (Table 4.5-3) developed in the primary research survey and, within each service category, express the relative long distance communications demand generated per employee.

Table 8.1-5 shows the activity factors applicable to the various markets. For the overall market these factors are assumed to remain unchanged from year to year and from region to region. The entries indicate, for example, that per employee demand for switched voice traffic in manufacturing is in the ratio 0.69 : 0.46 relative to the per employee demand for switched voice traffic in the transportation/utilities user class. Similarly, for these two user classes the per employee demands for dedicated voice traffic is in the ratio of 0.39 : 0.73. The activity factors are consistent only within the individual rows of the table and do not imply an relative measure between demand for dedicated voice traffic and switched voice traffic, or between any other pairs of rows.

TABLE 8.1-5 ACTIVITY FACTORS

ACTIVITY FACTORS

	BUSINESS						GOVERNMENT		INSTITUTIONS	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	EDU	HEAL
1980										
OVERALL										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.55	.3	.3
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.69	.02	.43
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.41	.2	.11
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.73	.38	.16
SATELLITE & CPS										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	0	0	0
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	0	0	0
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	0	0	0
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	0	0	0
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	0	0	0
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	0	0	0
Ka BAND										
VOICE SWITCHED	.567	.882	.499	1.218	1.188	.332	.667	0	0	0
DEDICATED	.321	.972	.791	1.92	.776	.114	1.112	0	0	0
VIDEO BROADCAST	.419	.81	.249	1.333	1.446	.208	.84	0	0	0
CONFERENCE	.419	.81	.249	1.333	1.446	.208	.84	0	0	0
DATA MESSAGE	.756	.936	.932	1.189	.717	.218	.507	0	0	0
COMPUTER	.238	.711	.304	1.146	.647	.249	2.769	0	0	0
1985										
OVERALL										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.55	.3	.3
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.69	.02	.43
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.41	.2	.11
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.73	.38	.16
SATELLITE & CPS										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	0	0	0
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	0	0	0
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	0	0	0
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	0	0	0
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	0	0	0
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	0	0	0
Ka BAND										
VOICE SWITCHED	.567	.882	.499	1.218	1.188	.332	.667	0	0	0
DEDICATED	.321	.972	.791	1.92	.776	.114	1.112	0	0	0
VIDEO BROADCAST	.419	.81	.249	1.333	1.446	.208	.84	0	0	0
CONFERENCE	.419	.81	.249	1.333	1.446	.208	.84	0	0	0
DATA MESSAGE	.756	.936	.932	1.189	.717	.218	.507	0	0	0
COMPUTER	.238	.711	.304	1.146	.647	.249	2.769	0	0	0

TABLE 8.1-5 ACTIVITY FACTORS (CONTINUED)

ACTIVITY FACTORS

	BUSINESS						GOVERNMENT		INSTITUTIONS	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	EDU	HEAL
1990										
OVERALL										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.55	.3	.3
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.69	.02	.43
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.41	.2	.11
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.73	.38	.16
SATELLITE & CPS										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.0065	.0126	.0126
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.0091	.0009	.0202
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	.0028	.0077	.0001
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	.0028	.0077	.0001
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.0047	.0082	.0045
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.0068	.0194	.0082
Ka BAND										
VOICE SWITCHED	.567	.882	.499	1.218	1.188	.332	.667	.0072	.0008	.0035
DEDICATED	.321	.972	.791	1.92	.776	.114	1.112	.0101	.00006	.00562
VIDEO BROADCAST	.419	.81	.249	1.333	1.446	.208	.84	.0031	.00049	.00003
CONFERENCE	.419	.81	.249	1.333	1.446	.208	.84	.0031	.00049	.00003
DATA MESSAGE	.756	.936	.932	1.189	.717	.218	.507	.0052	.00052	.00125
COMPUTER	.238	.711	.304	1.146	.647	.249	2.769	.0076	.00123	.0023
2000										
OVERALL										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.55	.3	.3
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.69	.02	.43
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	1.02	.8	.01
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.41	.2	.11
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.73	.38	.16
SATELLITE & CPS										
VOICE SWITCHED	.69	.98	.46	.85	1.01	.32	.54	.0588	.1141	.1141
DEDICATED	.39	1.08	.73	1.34	.66	.11	.9	.0617	.0064	.1368
VIDEO BROADCAST	.51	.9	.23	.93	1.23	.2	.68	.0341	.0952	.0012
CONFERENCE	.51	.9	.23	.93	1.23	.2	.68	.0341	.0952	.0012
DATA MESSAGE	.92	1.04	.86	.83	.61	.21	.41	.0423	.0735	.0404
COMPUTER	.29	.79	.28	.8	.55	.24	2.24	.0785	.1454	.0612
Ka BAND										
VOICE SWITCHED	.567	.882	.499	1.218	1.188	.332	.667	.0653	.00722	.0317
DEDICATED	.321	.972	.791	1.92	.776	.114	1.112	.0685	.00041	.038
VIDEO BROADCAST	.419	.81	.249	1.333	1.446	.208	.84	.0379	.00602	.00033
CONFERENCE	.419	.81	.249	1.333	1.446	.208	.84	.0379	.00602	.00033
DATA MESSAGE	.756	.936	.932	1.189	.717	.218	.507	.0469	.00465	.01123
COMPUTER	.238	.711	.304	1.146	.647	.249	2.769	.0872	.0092	.017

Most of the activity factors for the satellite and CPS markets are identical with the corresponding factors applicable to the overall market. The only exceptions are in the columns representing the state and local government, the education, and the health care user classes. Communications in these user classes tend to be localized within state boundaries to a greater extent than those of the other user classes. The distance distributions appropriate to these user classes are therefore more limited in range, and per employee demand for satellite transmission is corrospondingly reduced.

The activity factors shown in Table 8.1-5 account for these effects. Based on the average geographic dimensions of the states, 0, 0, .964, 11.9 percent of education and health care traffic is expected to travel more than 800, 600, 400 and 200 miles, respectively, and the overall market activity factors have been multiplied by these factors to arrive at the corresponding activity factors applicable to the satellite and CPS markets. For the state and local government user class, the activity factors are further multiplied by a factor of .281 (the estimated ratio of state government employees to the total of state and local government employees) to eliminate demand by local government employees, none of whose traffic is expected to have appreciable long distance components.

Similar distance related considerations apply to the activity factors applicable to the lower availability Ka band CPS market, and the same distance related reductions have been made. In addition, the primary research survey uncovered some significant variation among the user classes with respect to the acceptance of lower availability service (See Table 6.4-1), and the market activity factors were further adjusted to reflect this variation. To accomplish this, the satellite market activity factors of Table 8.1-5 were multiplied by the factors shown in the last column of Table 6.4-1 (normalized by dividing each entry by the sum of the entries in that column) to obtain the activity factors applicable to the lower availability Ka band market.

8.1.3 CONSTRUCTION OF THE COMMUNICATIONS DEMAND DATA BASE

The employment projections of Subsection 8.1.1 when multiplied by the activity factors discussed in Subsection 8.1.2 provide the basis for assigning demand to the elementary cells of a matrix with rows and columns representing user class and geographic region. Since there are ten user classes (excluding residential), as defined in Table 8.1.1, and nine geographic regions, as defined in Table 8.1-2, each matrix contains 90 cells. A separate matrix for each service category, market, and benchmark year was created and each of these matrices was normalized by dividing each cell entry by the sum of the 90 cell entries.

When the cells of these normalized matrices are further multiplied by the corresponding U.S. demand for traffic as developed in Chapter 6, for each benchmark year and service type, a new set of matrices is obtained whose elements represent annual traffic demand for the particular benchmark year and service type segmented by user class and geographic region. This set of matrices is referred to as the "Communications Demand Data Base". The format of this data base is illustrated in Figure 8.1-1 for the overall market, and for the year 1980. The format for the other markets and years is the same. For the switched voice category, an additional column (not illustrated) is appended to accommodace demand by residcntial users in those markets where residential demand can be addressed.

All of the segmentations presented in the following sections are developed by various additions of rows or columns and other specializations of the general Communications Demand Data Base discussed above.

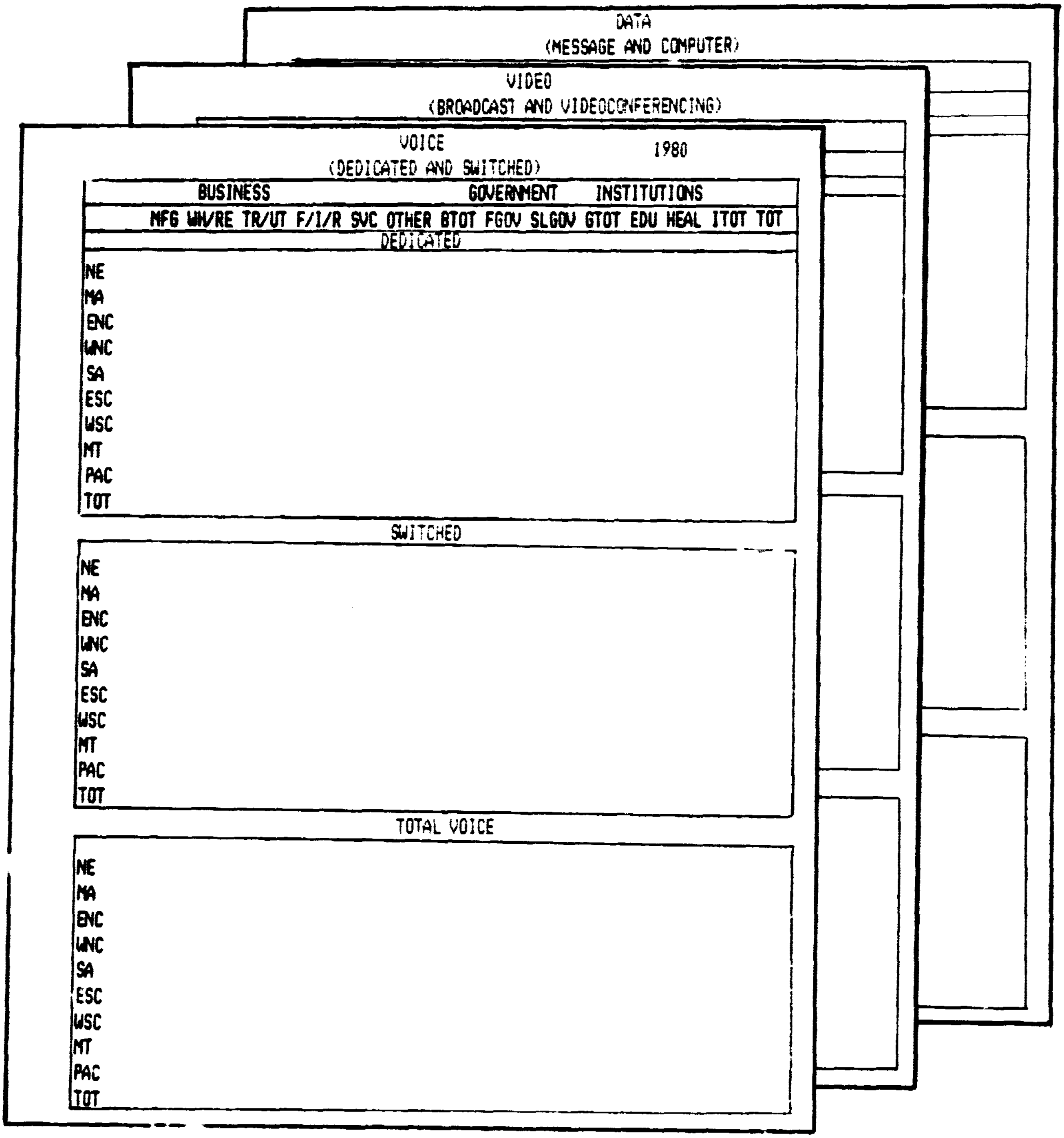


FIGURE 8.1-1 FORMAT OF COMMUNICATIONS DEMAND DATA BASE

8.2 SEGMENTED DEMAND MATRICES

This section presents annual communications demand (for each of the markets and benchmark years) segmented by service category, user class, and geographic region. The segmentations are developed by various specializations of the general Communications Demand Data Base described in Subsection 8.1.3. For each market the following results are presented:

(a) Demand by Service Category:
A matrix presenting annual demand (bits per year) for the benchmark years of the study for each of six service subcategories. The matrix is organized by service category, and subtotals for each service category (voice, video and data) are included as well as total demand for each year. The data included in this matrix is the same as that of the basic annual demand forecasts developed in Chapter 6, but is included here in compact form for ready reference.

(b) Demand by Geographic Area:
A matrix presenting annual demand for the benchmark years of the study organized according to the nine Census Bureau regions defined in Table 8.1-2.

(c) Demand by User Class:
A matrix presenting annual demand for the benchmark years of the study organized by the user classes defined in Table 8.1-1. Subtotals are presented for Business, Government, Institutional and Residential demand.

(d) Demand by Service Category and User Class:
A set of four matrices (one for each benchmark year) showing the annual demand for each service category/subcategory by user class.

(e) Demand by Service Category and Geographic Region:
A set of four matrices (one for each benchmark year) showing the annual demand for each service category/subcategory by geographic region.

(f) Demand by User Class and Geographic Region:
A set of four matrices (one for each benchmark year) showing the total annual demand by user class and geographic region.

Results are presented in the following tables:

Table 8.2-1	Overall Market
Table 8.2-2	Satellite Market
Table 8.2-3	CPS Market (Dedicated Earth Station)
Table 8.2-4	CPS Market (Dedicated and Shared E.S.)
Table 8.2-5	Ka Band Market (Lower Availability Dedicated Earth Stations)
Table 8.2-6	Ka Band Market (Lower Availability Dedicated and Shared E.S.)

TABLE 8.2-1 SEGMENTATION OF DEMAND (OVERALL MARKET)

DEMAND BY SERVICE CATEGORY
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
1980	1755.9	1026.6	2782.5	71.56	3.02	74.58	.84	747.97	748.81	3605.87
1985	2829.7	1664	4493.7	109.99	1.56	111.55	2.379	1294.1	1[illegible]96.5	5901.72
1990	4553.3	2606.1	7159.4	122.79	15.17	137.96	16.278	1526.3	1542.6	8839.94
2000	10778.1	5331.2	16109.3	202.73	59	261.73	19.939	1821.8	1841.7	18212.42

DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	205.908	591.933	667.121	285.823	590.381	214.412	363.727	183.345	503.216	3605.87
1985	331.56	930.546	1077.32	461.555	979.33	357.612	610.45	317.63	835.714	5901.72
1990	488.249	1341.2	1594.15	685.099	1481.44	547.045	941.738	494.716	1266.3	8839.94
2000	976.638	2563.5	3188.77	1393.69	3123.69	1152.94	2045.5	1090.28	2677.97	18212.4

DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980	433.99	1056.1	139.84	292.30	497.19	64.296	2483.7	165.07	432.98	598.04	11.772	89.972	101.74	422.4	3605.9
1985	696.39	1750.8	222.01	5[illegible]5.10	826.29	108.69	4109.3	258.35	690.07	948.41	19.462	162.81	182.27	661.76	5901.7
1990	1035.7	2638.3	336.30	780.71	1241.8	153.97	6186.8	341.47	991.45	1332.9	25.094	278.78	303.88	1016.3	8839.9
2000	2114.7	5561.5	718.57	1705.2	2590.7	288.79	1297[illegible].	584.83	1964.8	2549.6	39.812	700.53	740.34	1943.0	18212.

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-1 OVERALL MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
VOICE TOTAL	340.63	803.75	119.19	229.15	372.95	39.976	1905.65	79.052	293.48	372.53	4.0431	77.856	81.899	422.4	2782.48
SWITCHED	124.90	184.03	20.376	39.391	124.45	19.496	512.639	12.974	60.717	73.691	3.3588	14.472	17.830	422.4	1026.56
DEDICATED	215.73	619.72	98.812	189.76	248.50	20.479	1393.01	66.078	232.76	298.84	.68426	63.385	64.069	0	1755.92
VIDEO TOTAL	11.164	20.437	1.2320	5.2119	18.327	1.4735	57.8460	1.9757	13.617	15.593	1.0831	.05833	1.1415	0	74.5800
BROADCAST	10.712	19.610	1.1821	5.0008	17.585	1.4139	55.5036	1.8957	13.065	14.961	1.0393	.05597	1.0953	0	71.5600
VIDEOCONF	.45206	.82758	.04989	.21105	.74214	.05967	2.34238	.08000	.55139	.63139	.04386	.00236	.04622	0	3.02000
DATA TOTAL	82.193	231.88	19.418	57.936	105.91	22.847	520.185	84.038	125.88	209.92	6.6454	12.057	18.703	0	748.806
MESSAGE	.23750	.27852	.05433	.05486	.10719	.01825	.750641	.01405	.06455	.07860	.00319	.00757	.01076	0	.840000
COMPUTER	81.956	231.60	19.364	57.881	105.80	22.828	519.434	84.024	125.82	209.84	6.6423	12.050	18.692	0	747.966
TOTAL	433.99	1056.1	139.84	292.30	497.19	64.296	2483.68	165.07	432.98	598.04	11.772	89.972	101.74	422.4	3605.87
1985															
VOICE TOTAL	540.18	1312.3	187.27	390.42	612.03	66.110	3108.30	119.09	458.54	577.63	6.5326	139.44	145.97	661.76	4493.36
SWITCHED	202.04	307.81	32.859	68.879	208.53	32.762	852.877	20.065	97.254	117.32	5.4556	26.588	32.044	661.76	1664.00
DEDICATED	338.15	1004.5	154.41	321.54	403.50	33.348	2255.42	99.027	361.29	460.31	1.0770	112.85	113.93	0	2829.66
VIDEO TOTAL	16.343	30.936	1.7980	8.2475	27.792	2.2409	87.3572	2.7652	19.738	22.504	1.5921	.09699	1.6891	0	111.55
BROADCAST	16.114	30.504	1.7729	8.1321	27.403	2.2096	86.1356	2.7266	19.462	22.189	1.5699	.09564	1.6655	0	109.99
VIDEOCONF	.22855	.43264	.02515	.11534	.38866	.03134	1.22167	.03867	.27604	.31471	.02227	.00136	.02362	0	1.56
DATA TOTAL	139.86	407.58	32.940	106.44	186.47	40.334	913.624	136.49	211.79	348.28	11.338	23.271	34.609	0	1296.51
MESSAGE	.65845	.79844	.15016	.16440	.30784	.05255	2.13184	.03724	.17721	.21444	.00889	.02383	.03272	0	2.379
COMPUTER	139.21	406.78	32.790	106.28	186.16	40.282	911.493	136.45	211.61	348.06	11.329	23.247	34.576	0	1294.1
TOTAL	696.39	1750.8	222.01	505.10	826.29	108.69	4109.28	258.35	690.07	948.41	19.462	162.81	182.27	661.76	5901.72
1990															
VOICE TOTAL	849.15	2110.2	294.91	640.21	983.42	103.89	4981.80	182.95	720.32	903.27	10.085	247.90	257.98	1016.3	7159.37
SWITCHED	315.28	490.56	51.250	111.87	332.49	51.184	1352.63	30.526	151.37	181.90	8.4057	46.825	55.231	1016.3	2606.08
DEDICATED	533.87	1619.6	243.66	528.34	650.93	52.711	3629.17	152.42	568.94	721.37	1.6789	201.07	202.75	0	4553.29
VIDEO TOTAL	19.948	38.566	2.1936	10.477	34.662	2.7384	108.585	3.2907	24.032	27.322	1.9188	.13361	2.0524	0	137.960
BROADCAST	17.755	34.325	1.9524	9.3254	30.851	2.4373	96.6454	2.9288	21.389	24.318	1.7078	.11892	1.8267	0	122.790
VIDEOCONF	2.1935	4.2406	.24121	1.1521	3.8114	.30112	11.9400	.36184	2.6425	3.0043	.21099	.01469	.22568	0	15.17
DATA TOTAL	166.63	489.52	39.195	130.02	223.73	47.340	1096.43	155.23	247.10	402.34	13.091	30.748	43.839	0	1542.61
MESSAGE	4.4456	5.5056	1.0133	1.1552	2.1237	.35523	14.5987	.24512	1.1934	1.4385	.05926	.18157	.24084	0	16.2780
COMPUTER	162.18	484.01	36.182	128.87	221.61	46.985	1081.84	154.99	245.91	400.90	13.032	30.566	43.598	0	1526.33
TOTAL	1035.7	2638.3	336.30	780.71	1241.8	153.97	6186.81	341.47	991.45	1332.9	25.094	278.78	303.88	1016.3	8839.94
2000															
VOICE TOTAL	1882.6	4896.4	668.50	1524.5	2254.6	228.17	11454.8	402.39	1629.7	2032.0	21.122	657.96	679.08	1943.0	16109.0
SWITCHED	655.32	1052.6	106.82	244.96	712.29	106.67	2878.71	61.693	316.02	377.71	17.300	114.44	131.74	1943.0	5331.2
DEDICATED	1227.3	3843.8	561.68	1279.6	1542.3	121.50	8576.10	340.69	1313.6	1654.3	3.8216	543.52	547.34	0	10777.8
VIDEO TOTAL	37.065	73.975	4.0869	20.509	66.379	5.1017	207.116	5.9448	44.847	50.792	3.5303	.29191	3.8222	0	261.73
BROADCAST	28.709	57.299	3.1657	15.886	51.415	3.9516	160.427	4.6047	34.737	39.342	2.7345	.22611	2.9606	0	202.73
VIDEOCONF	8.3552	16.676	.92129	4.6232	14.963	1.1500	46.6887	1.3401	10.110	11.450	.79581	.06580	.86161	0	59.0000
DATA TOTAL	194.98	591.11	45.990	160.21	269.71	55.515	1317.52	176.50	290.25	466.75	15.160	42.283	57.443	0	1841.71
MESSAGE	5.3345	6.8202	1.2192	1.4604	2.6265	.42739	17.8882	.28598	1.4383	1.7242	.07042	.25619	.32661	0	19.939
COMPUTER	189.65	584.29	44.770	158.75	267.08	55.088	1299.63	176.21	288.81	465.03	15.089	42.027	57.116	0	1821.77
TOTAL	2114.7	5561.5	718.57	1705.2	2590.7	288.79	12979.4	584.83	1964.8	2549.6	39.812	700.53	740.34	1943.0	18212.4

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-1 OVERALL MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
1980										
NE	100.6682	59.11632	159.7845	4.135806	.1745407	4.310347	.0498448	41.76378	41.81362	205.908
MA	289.6466	170.0496	459.6963	11.81730	.4987178	12.31602	.1390422	119.7816	119.9207	591.933
ENC	325.8062	194.1944	520.0006	13.22355	.5580647	13.78161	.1654719	133.1736	133.3391	667.121
WNC	140.8009	80.37030	221.1712	5.624602	.2373714	5.861974	.0658752	58.72347	58.78935	285.823
SA	283.7952	165.1953	448.9904	11.65840	.4920117	12.15041	.1325258	129.1074	129.2399	590.381
ESC	102.0604	63.17166	165.2320	4.228581	.1784561	4.407037	.0507919	44.72203	44.77282	214.412
WSC	176.8562	103.7844	280.6407	7.139293	.3012949	7.440587	.0827199	75.56309	75.64581	363.727
MT	89.13876	50.61460	139.7534	3.662656	.1545727	3.817228	.0391718	39.73554	39.77471	183.345
PAC	247.1475	140.0634	387.2109	10.06982	.4249700	10.49479	.1145565	105.3955	105.5100	503.216
TOT	1755.920	1026.56	2782.480	71.56000	3.020000	74.58000	.8400000	747.9660	748.8060	3605.87
1985										
NE	159.1989	94.85121	254.0501	6.220500	.0882260	6.308726	.1379349	71.06290	71.20084	331.560
MA	447.0026	266.0939	713.0965	17.45162	.2475182	17.69914	.3752279	199.3754	199.7507	930.546
ENC	519.0046	309.2474	828.2520	20.06770	.2846223	20.35232	.4613551	228.2592	228.7206	1077.32
WNC	224.1201	128.2028	352.3229	8.540641	.1211328	8.661773	.1848203	100.3854	100.5702	461.555
SA	460.8834	275.4185	736.3019	18.03485	.2557903	18.29064	.3787836	224.3590	224.7378	979.330
ESC	168.2420	103.4291	271.6711	6.621383	.0939118	6.715294	.1473266	79.07856	79.22588	357.612
WSC	293.4236	171.2779	464.7016	11.28762	.1600935	11.44771	.2429733	134.0581	134.3011	610.450
MT	152.3489	86.65783	239.0067	5.978716	.0847968	6.063512	.1185771	72.44069	72.55927	317.630
PAC	405.4359	228.8213	634.2572	15.78697	.2239083	16.01088	.3320013	185.1137	185.4457	835.714
TOT	2829.660	1664.000	4493.660	109.99	1.56	111.55	2.379	1294.133	1296.512	5901.72
1990										
NE	251.1231	146.3206	397.4437	6.789453	.8387979	7.628250	.9226208	82.25393	83.17656	488.249
MA	689.9883	401.2269	1091.215	18.72748	2.313672	21.04115	2.451853	226.4900	228.9418	1341.20
ENC	824.2285	475.9098	1300.138	22.09622	2.729861	24.82608	3.104287	266.0832	269.1875	1594.15
WNC	357.2081	198.7507	555.9588	9.447218	1.167150	10.61437	1.255115	117.2710	118.5261	685.099
SA	750.1155	439.2050	1189.320	20.34342	2.513312	22.85673	2.624955	266.6388	269.2637	1481.44
ESC	277.6425	164.3854	442.0279	7.555101	.9333894	8.488490	1.035914	95.49311	96.52903	547.045
WSC	487.2818	275.5158	762.7976	12.99560	1.605532	14.60113	1.728879	162.6105	164.3393	941.738
MT	255.5416	141.7642	397.3058	6.965922	.8605997	7.826522	.8499400	88.73405	89.58399	494.716
PAC	660.1606	363.0016	1023.162	17.86960	2.207686	20.07728	2.304436	220.7555	223.0600	1266.30
TOT	4553.290	2606.08	7159.370	122.7900	15.17	137.9600	16.27800	1526.33	1542.608	8839.94
2000										
NE	574.6461	291.6832	866.3292	10.79226	3.140845	13.93311	1.087635	95.28784	96.37547	976.638
MA	1508.088	764.1044	2272.192	28.62469	8.330570	36.95526	2.750735	251.6016	254.3523	2563.50
ENC	1891.305	939.7860	2831.091	35.31551	10.27778	45.59329	3.668325	308.4215	312.0898	3188.77
WNC	833.8063	400.3938	1234.200	15.40332	4.482789	19.88611	1.519589	138.0813	139.6008	1393.69
SA	1822.464	927.7633	2750.228	34.41640	10.01612	44.43252	3.304814	325.1582	328.4630	3123.12
ESC	676.2458	342.8198	1019.066	12.78864	3.721844	16.51048	1.315211	116.0466	117.3618	1152.94
WSC	1219.247	590.7693	1810.017	22.66318	6.595607	29.25878	2.258047	203.9710	206.2290	2045.50
MT	648.9518	311.3426	960.2944	12.35905	3.596822	15.95587	1.126476	112.9044	114.0308	1090.28
PAC	1603.015	762.5377	2365.553	30.36696	8.837620	39.20458	2.908166	270.3017	273.2099	2677.97
TOT	10777.77	5331.2	16108.97	202.73	59.00000	261.73	19.939	1821.774	1841.713	18212.4

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-1 OVERALL MARKET (CONTINUED)

USER CLASS DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
								1980							
NE	30.579	59.697	6.3828	17.907	26.889	2.6671	144.122	6.5980	23.162	29.760	1.3995	6.8665	8.2660	23.760	205.908
MA	74.610	163.84	25.186	57.121	84.712	7.1568	412.621	20.662	69.024	89.686	2.9407	16.137	19.078	70.548	591.933
ENC	107.27	198.42	24.574	50.267	80.871	9.5928	470.995	17.768	78.837	96.606	1.7892	18.415	20.205	79.316	667.121
WNC	29.690	91.156	12.340	22.105	37.291	5.1031	197.686	10.360	36.082	46.442	.82375	7.9821	8.8059	32.889	285.823
SA	63.481	165.07	21.781	44.422	84.406	11.238	390.395	46.996	71.106	118.10	1.7804	11.690	13.471	68.413	590.381
ESC	30.519	60.076	7.7392	13.390	27.501	4.5252	143.750	11.575	26.830	38.405	.54031	4.5410	5.0813	27.175	214.412
WSC	34.396	113.71	15.877	28.003	50.318	10.562	252.857	15.453	43.351	58.804	.71746	7.9350	8.6525	43.413	363.727
MT	11.674	55.149	7.2339	14.294	29.336	4.9698	122.657	11.460	24.253	35.712	.36316	3.8182	4.1814	20.795	183.345
PAC	51.766	148.96	18.723	44.794	75.874	8.4815	348.596	24.193	60.334	84.527	1.4172	12.586	14.003	56.089	503.216
TOT	433.99	1056.1	139.84	292.30	497.19	64.296	2483.68	165.07	432.98	598.04	11.772	89.972	101.74	422.4	3605.87
								1985							
NE	47.539	97.333	9.9066	30.317	43.810	4.5027	233.410	10.419	36.030	46.448	2.2289	12.014	14.243	37.459	331.560
MA	111.99	258.02	38.245	93.643	137.68	12.133	651.717	31.786	106.26	138.04	4.8384	27.900	32.739	108.05	930.546
ENC	168.41	325.55	38.442	86.123	133.46	16.218	768.212	27.548	124.30	151.84	2.8949	33.102	35.997	121.27	1077.32
WNC	48.053	147.81	19.537	37.837	61.141	8.3853	322.759	15.981	56.894	72.876	1.3455	14.277	15.622	50.299	461.555
SA	102.75	277.56	35.048	78.366	139.21	19.251	652.181	74.166	114.63	188.80	3.0172	21.625	24.642	113.71	979.330
ESC	50.560	102.64	12.709	23.985	44.979	7.9404	242.815	18.542	44.257	62.798	.91060	8.6080	9.5186	42.480	357.612
WSC	59.953	193.68	25.812	50.028	84.317	17.189	430.974	24.016	71.267	95.283	1.1960	14.953	16.149	68.045	610.450
MT	20.629	97.050	12.275	26.439	51.993	8.6280	217.013	18.365	40.292	58.657	.65237	7.3250	7.9773	33.982	317.630
PAC	86.501	251.16	30.035	78.366	129.70	14.438	590.199	37.525	96.146	133.67	2.3784	23.001	25.380	86.465	835.714
TOT	696.39	1750.8	222.01	505.10	826.29	108.69	4109.28	258.35	690.07	948.41	19.462	162.81	182.27	661.76	5901.72
								1990							
NE	68.493	144.28	14.868	45.739	64.102	6.5470	344.030	13.618	50.637	64.255	2.8165	19.896	22.713	57.251	488.249
MA	155.75	371.34	55.698	138.00	201.60	17.526	939.912	41.540	147.07	188.61	6.1760	45.714	51.890	160.79	1341.20
ENC	244.47	483.96	57.356	131.93	199.10	22.978	1139.80	36.047	176.55	212.60	3.6479	56.000	59.648	182.11	1594.15
WNC	71.929	218.97	29.336	58.213	91.044	11.690	481.178	20.827	80.938	101.76	1.7306	24.227	25.958	76.198	685.099
SA	154.81	425.55	54.039	123.62	209.89	27.319	995.224	98.071	166.45	264.52	3.9364	37.897	41.834	179.86	1481.44
ESC	78.026	159.46	19.900	38.547	67.461	11.562	374.954	25.061	65.105	90.166	1.2047	15.362	16.567	65.359	547.045
WSC	97.436	300.94	39.972	79.790	128.35	23.270	669.759	32.042	105.37	137.41	1.5949	26.663	28.258	106.31	941.738
MT	32.937	151.97	19.500	42.929	81.611	12.565	341.511	24.718	59.987	84.705	.88229	13.163	14.045	54.456	494.716
PAC	131.88	381.82	45.633	121.93	198.67	20.516	900.446	49.550	139.35	188.91	3.1050	39.860	42.965	133.98	1266.30
TOT	1035.7	2638.3	336.30	780.71	1241.8	153.97	6186.81	341.47	991.45	1332.9	25.094	278.78	303.88	1016.3	8839.94
								2000							
NE	132.58	295.67	31.040	96.255	127.52	12.791	695.859	23.847	96.606	120.45	4.3054	47.259	51.564	108.76	976.638
MA	279.97	718.75	110.33	273.65	395.91	33.848	1812.49	70.580	272.60	343.18	9.4926	107.00	116.50	291.33	2563.50
ENC	476.55	987.77	119.05	282.32	405.32	42.604	2313.62	60.579	338.51	399.09	5.5503	136.33	141.88	334.20	3188.77
WNC	147.81	449.34	61.615	126.93	188.24	21.513	995.451	35.001	158.53	193.53	2.6974	59.677	62.374	142.33	1393.69
SA	324.98	928.25	118.81	280.76	443.83	51.619	2148.25	170.20	337.74	507.94	6.4581	99.554	106.01	360.93	3123.12
ESC	169.47	348.19	44.642	88.252	140.21	22.067	812.840	39.809	132.06	171.87	1.9711	40.843	42.814	125.41	1152.94
WSC	224.43	670.51	89.168	184.51	277.67	40.390	1486.68	55.387	219.93	275.32	2.6974	71.612	74.310	209.20	2045.50
MT	76.121	341.58	45.456	101.37	183.13	24.670	772.326	43.271	126.15	169.42	1.5562	36.082	37.638	110.89	1090.28
PAC	282.74	821.46	98.468	271.20	428.79	39.284	1941.93	86.157	282.62	368.78	5.0835	102.18	107.26	259.99	2677.97
TOT	2114.7	5561.5	718.57	1705.2	2590.7	288.79	12979.4	584.83	1764.8	2549.6	39.812	706.53	740.34	1943.0	18212.4

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-2 SEGMENTATION OF DEMAND (SATELLITE MARKET)

DEMAND BY SERVICE CATEGORY
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
1980	140.47	117.35	257.83	71.56	3.02	74.58	.1218	48.805	48.927	381.34
1985	350.88	259.48	610.36	109.99	1.56	111.55	.4425	138.6	139.04	553.18
1990	933.42	540.92	1474.3	122.79	15.17	137.96	3.8253	288.48	292.3	1904.6
2000	4030.9	1541.1	5572	202.73	59	261.73	6.4602	566.57	573.03	6406.8

DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	21.777	62.669	70.341	29.856	62.47	22.607	38.596	19.172	53.349	381.34
1985	544.94	88.621	101.19	42.796	92.534	33.283	56.752	28.986	77.83	553.18
1990	104.77	288.01	343.27	146.08	320.05	117.19	204.06	106.34	274.86	1904.6
2000	342.71	897.16	1121.1	486.76	1099	402.91	723.96	383.3	949.92	6406.8

DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980	59.906	131.25	15.650	35.308	73.833	8.5538	324.51	17.550	0	17.550	0	0	0	39.28	381.34
1985	78.096	179.25	19.133	48.419	101.49	12.980	439.38	29.766	0	29.766	0	0	0	84.04	553.18
1990	277.58	688.52	85.199	202.42	342.21	40.808	1636.7	85.624	2.9318	88.556	.28947	3.2063	3.4958	175.82	1904.6
2000	884.46	2360.9	305.25	730.39	1105.8	117.39	5504.3	243.43	76.662	320.09	5.5044	96.998	102.50	479.93	6406.8

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-2 SATELLITE MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
VOICE TOTAL	39.322	86.999	12.540	24.121	42.410	4.8676	210.260	8.2889	0	8.2889	0	0	0	39.28	257.828
SWITCHED	18.553	27.335	3.0267	5.8512	18.486	2.8960	76.1477	1.9272	0	1.9272	0	0	0	39.28	117.355
DEDICATED	20.769	59.664	9.5131	18.269	23.925	1.9716	134.112	6.3617	0	6.3617	0	0	0	0	140.474
VIDEO TOTAL	13.918	25.479	1.5360	6.4977	22.849	1.8371	72.1168	2.4632	0	2.4632	0	0	0	0	74.58
BROADCAST	13.354	24.447	1.4738	6.2346	21.924	1.7627	69.1966	2.3634	0	2.3634	0	0	0	0	71.56
VIDEOCONF	.56359	1.0317	.06220	.26311	.92523	.07439	2.92026	.09974	0	.09974	0	0	0	0	3.02
DATA TOTAL	6.6660	18.775	1.5747	4.6899	8.5738	1.8492	42.1289	6.7977	0	6.7977	0	0	0	0	48.9266
MESSAGE	.03783	.04436	.00865	.00874	.01707	.00291	.119562	.00224	0	.00224	0	0	0	0	.1218
COMPUTER	6.6282	18.731	1.5660	4.6812	8.5568	1.8463	42.0093	6.7955	0	6.7955	0	0	0	0	48.8048
TOTAL	59.906	131.25	15.650	35.308	73.833	8.5538	324.505	17.550	0	17.550	0	0	0	39.28	381.335
1985															
VOICE TOTAL	90.997	211.56	29.616	61.761	102.04	11.554	507.526	18.790	0	18.790	0	0	0	84.04	610.356
SWITCHED	40.604	61.862	6.6039	13.843	41.909	6.5843	171.405	4.0326	0	4.0326	0	0	0	84.04	259.478
DEDICATED	50.393	149.69	23.012	47.918	60.133	4.9698	336.120	14.758	0	14.758	0	0	0	0	350.878
VIDEO TOTAL	20.228	38.292	2.2255	10.208	34.400	2.7737	108.127	3.4227	0	3.4227	0	0	0	0	111.55
BROADCAST	19.945	37.756	2.1944	10.066	33.919	2.7349	106.615	3.3748	0	3.3748	0	0	0	0	109.99
VIDEOCONF	.28289	.53550	.03112	.14276	.48107	.03879	1.51213	.04787	0	.04787	0	0	0	0	1.56000
DATA TOTAL	18.546	53.964	4.3674	14.090	24.684	5.3384	120.989	18.055	0	18.055	0	0	0	0	139.044
MESSAGE	.13433	.16288	.03063	.03354	.06280	.01072	.434903	.00760	0	.00760	0	0	0	0	.442500
COMPUTER	18.411	53.801	4.3368	14.056	24.622	5.3277	120.554	18.047	0	18.047	0	0	0	0	138.602
TOTAL	78.096	179.25	19.133	48.419	101.49	12.980	439.376	29.766	0	29.766	0	0	0	84.04	553.183
1990															
VOICE TOTAL	214.16	527.10	73.363	159.27	247.46	26.423	1247.77	45.489	2.3146	47.804	.11148	2.8387	2.9502	175.82	1474.[illegible]5
SWITCHED	82.975	129.11	13.488	29.441	87.506	13.471	355.987	8.0340	.47082	8.5048	.09291	.51759	.61050	175.82	540.922
DEDICATED	131.19	397.99	59.875	129.83	159.95	12.953	891.786	37.455	1.8438	39.299	.01856	2.3211	2.3397	0	933.424
VIDEO TOTAL	24.580	47.521	2.7029	12.910	42.711	3.3743	133.800	4.0548	.08129	4.1361	.02276	.00165	.02440	0	137.96
BROADCAST	21.877	42.295	2.4057	11.491	38.014	3.0033	119.087	3.6089	.07235	3.6813	.02025	.00147	.02172	0	122.79
VIDEOCONF	2.7028	5.2254	.29721	1.4196	4.6965	.37104	14.7125	.44586	.00894	.45480	.00250	.00018	.00268	0	15.1700
DATA TOTAL	38.834	113.90	9.1338	30.244	52.046	11.010	255.164	36.080	.53585	36.616	.15523	.36596	.52119	0	292.302
MESSAGE	1.1438	1.4166	.26072	.29723	.54642	.09140	3.75618	.06307	.00352	.06659	.00063	.00191	.00254	0	3.8253
COMPUTER	37.690	112.48	8.8731	29.947	51.500	10.919	251.408	36.017	.53233	36.550	.15461	.36404	.51865	0	288.476
TOTAL	277.58	688.52	85.199	202.42	342.21	40.808	1636.74	85.624	2.9318	88.556	.28947	3.2063	3.4958	175.82	1904.61
2000															
VOICE TOTAL	767.18	2051.9	283.35	646.07	925.05	90.615	4764.23	170.78	63.275	234.06	2.8442	90.964	93.809	479.93	5572.02
SWITCHED	229.95	369.37	37.482	85.956	249.94	37.430	1010.12	21.648	11.855	33.503	2.3089	15.273	17.582	479.93	1541.14
DEDICATED	537.24	1682.6	245.87	560.12	675.11	53.185	3754.10	149.14	51.420	200.56	.53532	75.691	76.227	0	4030.89
VIDEO TOTAL	45.117	90.047	4.9749	24.965	80.800	6.2101	252.115	7.2364	1.8250	9.0614	.51138	.04264	.55402	0	261.73
BROADCAST	34.947	69.748	3.8534	19.337	62.586	4.8102	195.282	5.6051	1.4136	7.0188	.39610	.03303	.42913	0	202.73
VIDEOCONF	10.171	20.299	1.1215	5.6277	18.214	1.3999	56.8325	1.6313	.41141	2.0427	.11528	.00961	.12489	0	59.0000
DATA TOTAL	72.154	218.93	17.019	59.346	99.904	20.566	487.924	65.407	11.562	76.969	2.1488	5.9907	8.1395	0	573.032
MESSAGE	1.8686	2.3890	.42709	.51155	.92003	.14971	6.26606	.10018	.05198	.15215	.00906	.03296	.04202	0	6.46024
COMPUTER	70.286	216.54	16.592	58.835	98.984	20.416	481.658	65.306	11.510	76.817	2.1398	5.9577	8.0975	0	566.572
TOTAL	864.46	2360.9	305.33	730.39	1105.8	117.39	5504.27	243.43	76.662	320.09	5.5044	96.998	102.50	479.93	6406.79

TABLE 8.2-2 SATELLITE MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
					1980					
NE	8.019480	6.755495	14.77498	4.125398	.1741015	4.299499	.0072368	2.695081	2.702318	21.7768
MA	23.20234	19.39250	42.59484	11.79979	.4979789	12.29777	.0201644	7.756250	7.776414	62.6690
ENC	26.02761	22.28191	48.30952	13.30876	.5616608	13.87042	.0241603	8.636573	8.660734	70.8407
WNC	11.14216	9.134105	20.27627	5.557965	.2345592	5.792525	.0094933	3.777275	3.786768	29.8556
SA	22.83935	18.90208	41.74143	11.65454	.4918490	12.14639	.0191867	8.562667	8.581854	62.4697
ESC	8.126227	7.183770	15.31000	4.199455	.1772269	4.376682	.0073689	2.912535	2.919904	22.6066
WSC	14.24095	11.88169	26.12265	7.184604	.3032072	7.487811	.0120089	4.973711	4.985720	38.5962
MT	7.065604	5.751400	12.81700	3.610929	.1523897	3.763319	.0055966	2.585732	2.591329	19.1717
PAC	19.80988	16.07192	35.88180	10.11856	.4270269	10.54558	.0165841	6.904976	6.921560	53.3489
TOT	140.4736	117.3549	257.8285	71.56	3.02	74.58	.1218	48.8048	48.9266	381.335
					1985					
NE	19.65445	14.75102	34.40547	6.210442	.0880834	6.298525	.0256854	7.539015	7.564700	544.936
MA	55.40331	41.28659	96.68990	17.38826	.2466195	17.63488	.0696976	21.16052	21.23022	88.6211
ENC	64.20474	48.40880	112.6135	20.18684	.2863122	20.47316	.0863486	24.30043	24.38678	101.195
WNC	27.47511	19.88847	47.36358	8.440407	.1197112	8.560119	.0341719	10.59626	10.63043	42.7960
SA	57.48170	42.81318	100.2949	18.00417	.2553551	18.25952	.0703413	24.38389	24.45423	92.5337
ESC	20.72293	16.05653	36.77946	6.553542	.0929496	6.646492	.0273949	8.431316	8.458711	33.2829
WSC	36.61323	26.81170	63.42494	11.35322	.1610239	11.51424	.0452761	14.46565	14.51093	56.7520
MT	18.79843	13.48355	32.28198	5.923196	.0840093	6.007206	.0217999	7.758304	7.780104	28.9861
PAC	50.52390	35.97826	86.50216	15.92993	.2259359	16.15586	.0617844	19.96622	20.02800	77.8304
TOT	350.8778	259.4781	610.3559	109.99	1.560000	111.55	.4425000	138.6016	139.0441	553.183
					1990					
NE	51.25680	30.25462	81.51143	6.779340	.8375486	7.616889	.2170449	15.41997	15.63701	104.765
MA	141.2663	82.79751	224.0638	18.64067	2.302948	20.94361	.5748813	42.42379	42.99867	788.006
ENC	168.4527	99.13743	267.5901	22.21470	2.744499	24.95920	.7335440	49.98226	50.71580	343.265
WNC	72.39397	41.04961	113.4436	9.338923	1.153770	10.49269	.2932544	21.84700	22.14025	146.077
SA	154.6997	90.82306	245.5227	20.30811	2.508951	22.81706	.6160475	51.09269	51.70874	320.049
ESC	56.55131	34.03140	90.58271	7.475466	.9235509	8.399017	.2434336	17.96467	18.20810	117.190
WSC	100.5476	57.47532	158.0229	13.07359	1.615167	14.68876	.4073598	30.94500	31.35236	204.064
MT	52.20928	29.38479	81.59407	6.913080	.8540714	7.767152	.1976915	16.77629	16.97398	106.335
PAC	136.0469	75.96836	212.0152	18.04612	2.229494	20.27561	.5420428	42.02473	42.56677	274.858
TOT	933.4245	540.9221	1474.347	122.79	15.17000	137.96	3.8253	288.4764	292.3017	1904.61
					2000					
NE	214.7328	84.09530	298.8281	10.79394	3.141333	13.93527	.3532549	29.59548	29.94873	342.712
MA	562.4498	219.4140	781.8638	28.43682	8.275896	36.71272	.8884746	77.69984	78.58831	897.165
ENC	705.9588	272.6151	978.5740	35.49064	10.32875	45.81939	1.193911	95.49299	96.68690	1121.08
WNC	308.8458	115.3431	424.1889	15.23289	4.433188	19.66607	.4899484	42.41354	42.90349	486.758
SA	684.5194	266.8786	951.3980	34.35807	9.999143	44.35722	1.069378	102.1594	103.2288	1098.98
ESC	251.3103	98.97025	350.2806	12.66064	3.684593	16.34523	.4262537	35.85552	36.28177	402.908
WSC	458.4399	171.6707	630.1186	22.78853	6.632087	29.42061	.7335346	63.68350	64.41703	723.956
MT	242.0518	89.93983	331.9917	12.29285	3.577558	15.87041	.3620489	35.07962	35.44167	383.304
PAC	602.5773	222.2030	824.7803	30.67562	8.927450	39.60307	.9434362	84.59179	85.53523	949.919
TOT	4030.886	1541.138	5572.024	202.73	59.00000	261.73	6.46024	366.5717	573.0319	6406.79

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-2 SATELLITE MARKET (CONTINUED)

USER CLASS DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
							1980								
NE	4.2211	7.4195	.71436	2.1630	3.9930	.35483	18.8658	.70150	0	.70150	0	0	0	2.20953	21.777
MA	10.299	20.362	2.8187	6.8999	12.580	.95214	53.9118	2.1968	0	2.1968	0	0	0	6.56045	62.669
ENC	14.807	24.661	2.7503	6.0719	12.009	1.2762	61.5758	1.8891	0	1.8891	0	0	0	7.37577	70.841
WNC	4.0984	11.329	1.3811	2.6701	5.5377	.67891	25.6956	1.1015	0	1.1015	0	0	0	3.05847	29.856
SA	8.7627	20.515	2.4377	5.3659	12.534	1.4950	51.1111	4.9966	0	4.9966	0	0	0	6.36192	62.470
ESC	4.2127	7.4666	.86616	1.6175	4.0839	.60203	18.8488	1.2307	0	1.2307	0	0	0	2.52708	22.607
WSC	4.7480	14.132	1.7770	3.3826	7.4711	1.4051	32.9161	1.6430	0	1.6430	0	0	0	4.03711	38.596
MT	1.6115	6.8542	.80961	1.7266	4.3565	.66117	16.0195	1.2184	0	1.2184	0	0	0	1.93378	19.172
PAC	7.1457	18.513	2.0955	5.4108	11.267	1.1284	45.5609	2.5722	0	2.5722	0	0	0	5.21588	53.349
TOT	59.906	131.25	15.650	35.308	73.833	8.5538	324.505	17.550	0	17.550	0	0	0	39.28	381.34
							1985								
NE	93.644	216.68	29.910	63.219	105.17	11.890	520.523	19.657	0	19.657	0	0	0	4.75707	544.94
MA	12.996	27.093	3.3942	9.2183	17.071	1.4474	71.2195	3.6800	0	3.6800	0	0	0	13.7216	88.621
ENC	19.096	33.501	3.3452	8.2910	16.442	1.9367	82.6113	3.1824	0	3.1824	0	0	0	15.4010	101.19
WNC	5.3657	15.298	1.6868	3.6442	7.5528	1.0122	34.5595	1.8488	0	1.8488	0	0	0	6.38765	42.796
SA	11.473	28.224	2.9940	7.4355	17.154	2.2876	69.5676	8.5257	0	8.5257	0	0	0	14.4405	92.534
ESC	5.5803	10.358	1.0714	2.2587	5.5621	.93525	25.7654	2.1227	0	2.1227	0	0	0	5.39474	33.283
WSC	6.4546	19.573	2.1903	4.7173	10.321	2.0825	45.3382	2.7725	0	2.7725	0	0	0	8.64134	56.752
MT	2.2063	9.6571	1.0132	2.4513	6.2202	1.0202	22.5683	2.1022	0	2.1022	0	0	0	4.31558	28.986
PAC	9.5067	25.505	2.5709	7.4662	15.746	1.7198	62.5154	4.3344	0	4.3344	0	0	0	10.9806	77.830
TOT	78.096	179.25	19.133	48.419	101.49	12.980	439.376	29.766	0	29.766	0	0	0	84.04	553.18
							1990								
NE	18.356	37.653	3.7667	11.859	17.665	1.7352	91.0354	3.4146	.14974	3.5644	.03249	.22883	.26132	9.90420	104.77
MA	41.742	96.908	14.111	35.782	55.555	4.6448	248.742	10.416	.43488	10.851	.07124	.52576	.59700	27.8163	288.01
ENC	65.519	126.30	14.531	34.208	54.866	6.0900	301.514	9.0388	.52206	9.5608	.04208	.64406	.68614	31.5041	343.27
WNC	19.277	57.144	7.4319	15.094	25.089	3.0982	127.134	5.2224	.23934	5.4617	.01996	.27864	.29860	13.1821	146.08
SA	41.489	111.06	13.690	32.052	57.840	7.2403	263.368	24.591	.49219	25.083	.04541	.43586	.48127	31.1160	320.05
ESC	20.911	41.614	5.0416	9.9945	18.591	3.0643	99.2158	6.2841	.19252	6.4766	.01390	.17668	.19057	11.3068	117.19
WSC	26.113	78.537	10.127	20.688	35.369	6.1673	177.002	8.0344	.31158	8.3460	.01840	.30666	.32506	18.3912	204.06
MT	8.8271	39.659	4.9401	11.131	22.490	3.3302	90.3776	6.1980	.17738	6.3754	.01018	.15138	.16156	9.42065	106.34
PAC	35.343	99.644	11.561	31.615	54.748	5.4375	238.348	12.425	.41208	12.837	.03582	.45843	.49425	23.1788	274.86
TOT	277.58	688.52	85.199	202.42	342.21	40.808	1636.74	85.624	2.9318	88.556	.28947	3.2063	3.4958	175.82	1904.6
							2000								
NE	55.453	125.52	13.190	41.228	54.428	5.1994	295.014	9.9260	3.7694	13.695	.59526	6.5436	7.1388	26.8641	342.71
MA	117.10	305.12	46.881	117.21	169.00	13.759	769.064	29.378	10.637	40.014	1.3124	14.816	16.129	71.9580	897.16
ENC	199.32	419.32	50.586	120.92	173.00	17.318	980.467	25.215	13.208	38.423	.76739	18.876	19.643	82.5463	1121.1
WNC	61.821	190.75	26.182	54.367	80.346	8.7451	422.212	14.569	6.1855	20.754	.37293	8.2631	8.6360	35.1563	406.76
SA	135.92	394.05	50.487	120.26	189.44	20.983	911.138	70.843	13.178	84.021	.89289	13.784	14.677	89.1485	1099.0
ESC	70.882	147.81	18.970	37.800	59.847	8.9700	344.280	16.570	5.1529	21.723	.27253	5.6552	5.9277	30.9767	402.91
WSC	93.868	284.64	37.890	79.027	118.52	16.419	630.360	23.054	8.5915	31.635	.37293	9.9157	10.289	51.6719	723.96
MT	31.838	145.00	19.316	43.418	78.167	10.028	327.769	18.011	4.9223	22.933	.21515	4.9960	5.2112	27.3903	383.30
PAC	118.25	348.72	41.842	116.16	183.02	15.969	823.961	35.862	11.028	46.889	.70284	14.147	14.850	64.2180	949.92
TOT	884.46	2360.9	305.35	730.39	1105.8	117.39	5504.27	243.43	76.662	320.09	5.5044	96.998	102.50	479.93	6406.8

TABLE 8.2-3 SEGMENTATION OF DEMAND (CPS DEDICATED EARTH STATION MARKET)

DEMAND BY SERVICE CATEGORY
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BR	CONF	TOTAL	MSSG	COMP	TOTAL	
1980	11.94	0	11.94	0	.0642	.0642	.00828	3.3187	3.327	15.3315
1985	29.825	0	29.825	0	.0332	.0332	.03009	9.4249	9.455	39.3128
1990	79.341	7.7584	87.1	0	.0642	.0642	.27638	20.842	21.119	108.282
2000	342.63	45.101	387.73	0	2.5075	2.5075	.49421	43.343	43.837	434.071

DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	.869115	2.51158	2.81322	1.20957	2.53537	.893051	1.55596	.780027	2.16359	15.3315
1985	2.1869	6.15818	7.12179	3.0608	6.55426	2.33862	4.10229	2.1287	5.66124	39.3128
1990	5.92259	16.2924	19.4315	8.35019	18.1648	6.6092	11.6491	6.09201	15.7706	108.282
2000	23.1092	60.4388	75.9199	33.1304	74.0597	27.1833	49.2774	26.0961	64.8563	434.071

DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980	2.2306	6.3701	.91702	1.8774	2.6363	.29491	14.326	1.0051	0	1.0051	0	0	0	0	15.331
1985	3.0325	8.7524	1.1063	2.5140	3.7224	.53143	19.659	1.7695	0	1.7695	0	0	0	0	21.428
1990	15.731	44.824	6.0371	13.852	19.236	2.1843	101.86	5.9631	.20548	6.1686	.01478	.23473	.24951	0	108.28
2000	61.390	176.33	23.842	56.042	76.424	7.7443	401.77	18.670	5.7765	24.446	.31291	7.5416	7.8545	0	434.07

TABLE 8.2-3 CPS DEDICATED EARTH STATION MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
VOICE TOTAL	1.7654	5.0715	.80862	1.5529	2.0336	.16759	11.3996	.54074	0	.54074	0	0	0	0	11.9403
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	1.7654	5.0715	.80862	1.5529	2.0336	.16759	11.3996	.54074	0	.54074	0	0	0	0	11.9403
VIDEO TOTAL	.01198	.02193	.00132	.00559	.01967	.00158	.062080	.00212	0	.00212	0	0	0	0	.064200
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.01198	.02193	.00132	.00559	.01967	.00158	.062080	.00212	0	.00212	0	0	0	0	.064200
DATA TOTAL	.45329	1.2767	.10708	.31891	.58302	.12574	2.86474	.46224	0	.46224	0	0	0	0	3.32698
MESSAGE	.00257	.00302	.00059	.00059	.00116	.00020	.008128	.00015	0	.00015	0	0	0	0	.00828
COMPUTER	.45071	1.2737	.10649	.31832	.58186	.12554	2.85661	.46209	0	.46209	0	0	0	0	3.3187
TOTAL	2.2306	6.3701	.91702	1.8774	2.6363	.29491	14.3264	1.0051	0	1.0051	0	0	0	0	15.3315
1985															
VOICE TOTAL	4.2834	12.724	1.956	4.073	5.1113	.42243	28.57	1.2544	0	1.2544	0	0	0	0	29.825
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	4.2834	12.724	1.956	4.073	5.1113	.42243	28.57	1.2544	0	1.2544	0	0	0	0	29.825
VIDEO TOTAL	.00602	.01140	.00066	.00304	.01024	.00083	.032181	.00102	0	.00102	0	0	0	0	.0332
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.00602	.01140	.00066	.00304	.01024	.00083	.032181	.00102	0	.00102	0	0	0	0	.0332
DATA TOTAL	1.2611	3.6695	.29698	.95809	1.6785	.36301	8.22727	1.2277	0	1.2277	0	0	0	0	9.45499
MESSAGE	.00913	.01108	.00208	.00228	.00427	.00073	.029573	.00052	0	.00052	0	0	0	0	.03009
COMPUTER	1.2520	3.6585	.29490	.95581	1.6743	.36228	8.19770	1.2272	0	1.2272	0	0	0	0	9.42490
TOTAL	5.5505	16.405	2.2536	5.0342	6.8001	.78627	36.8296	2.4831	0	2.4831	0	0	0	0	39.3128
1990															
VOICE TOTAL	12.914	36.573	5.3760	11.661	15.455	1.3872	83.3665	3.3544	.16673	3.5211	.00355	.208292	.21184	0	87.0995
SWITCHED	1.7632	2.7435	.28662	.62562	1.8595	.28625	7.56470	.17072	.01000	.18073	.00197	.010999	.01297	0	7.75840
DEDICATED	11.151	33.829	5.0893	11.035	13.596	1.1010	75.8018	3.1837	.15672	3.3404	.00158	.197294	.19887	0	79.3411
VIDEO TOTAL	.01144	.02211	.00126	.00601	.01988	.00157	.062264	.00189	.00004	.00192	.00001	.000001	.00001	0	.064200
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.01144	.02211	.00126	.00601	.01988	.00157	.062264	.00189	.00004	.00192	.00001	.000001	.00001	0	.064200
DATA TOTAL	2.8057	8.2290	.65992	2.1851	3.7603	.79548	18.4356	2.6068	.03872	2.6455	.01122	.026440	.03766	0	21.1188
MESSAGE	.08264	.10235	.01884	.02148	.03948	.00660	.271386	.00456	.00025	.00481	.00005	.000138	.00018	0	.27638
COMPUTER	2.7231	8.1267	.64108	2.1637	3.7208	.78888	18.1642	2.6023	.03846	2.6407	.01117	.026302	.03747	0	20.8424
TOTAL	15.731	44.824	6.0371	13.852	19.236	2.1843	101.864	5.9631	.20548	6.1686	.01478	.234733	.24951	0	108.282
2000															
VOICE TOTAL	55.438	158.72	22.492	51.263	68.007	6.1115	362.029	13.597	4.8745	18.471	.14363	7.08287	7.2265	0	387.727
SWITCHED	9.7728	15.698	1.5930	3.6531	10.622	1.5908	42.9303	.92003	.50384	1.4239	.09813	.649106	.74723	0	45.1014
DEDICATED	45.665	143.02	20.899	47.610	57.385	4.5207	319.099	12.677	4.3707	17.047	.04550	6.43376	6.4793	0	342.625
VIDEO TOTAL	.43225	.86269	.04766	.23918	.77411	.05950	2.41538	.06933	.01748	.08681	.00490	.000409	.00531	0	2.50750
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.43225	.86269	.04766	.23918	.77411	.05950	2.41538	.06933	.01748	.08681	.00490	.000409	.00531	0	2.50750
DATA TOTAL	5.5198	16.748	1.3020	4.5400	7.6426	1.5733	37.3261	5.0036	.88450	5.8881	.1[illegible]438	.458287	.62267	0	43.8369
MESSAGE	.14295	.18276	.03247	.03913	.07038	.01145	.479355	.00766	.00398	.01164	.00069	.002521	.00321	0	.494210
COMPUTER	5.3768	16.566	1.2693	4.5008	7.5723	1.5618	36.8468	4.9959	.88053	5.8765	.16369	.455765	.61946	0	43.3427
TOTAL	61.390	176.33	23.842	56.042	76.424	7.7443	401.771	18.670	5.7765	24.446	.31291	7.54157	7.8545	0	434.071

TABLE 8.2-3 CPS DEDICATED EARTH STATION MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE DED	VOICE SW	VOICE TOTAL	VIDEO BROAD	VIDEO CONF	VIDEO TOTAL	DATA MSSG	DATA COMP	DATA TOTAL	TOTAL
1980										
NE	.6816583	0	.6816583	0	.0037011	.0037011	.0004920	.1832641	.1837560	.869115
MA	1.972206	0	1.972206	0	.0105862	.0105862	.0013708	.5274208	.5287916	2.51158
ENC	2.212355	0	2.212355	0	.0119399	.0119399	.0016424	.5872823	.5889247	2.81322
WNC	.9470873	0	.9470873	0	.0049863	.0049863	.0006454	.2568527	.2574980	1.20957
SA	1.941352	0	1.941352	0	.0104559	.0104559	.0013043	.5822567	.5835610	2.53537
ESC	.6907318	0	.6907318	0	.0037675	.0037675	.0005009	.1980508	.1985517	.893051
WSC	1.210485	0	1.210485	0	.0064457	.0064457	.0008164	.3382096	.3390260	1.55596
MT	.6005786	0	.6005786	0	.0032395	.0032395	.0003805	.1758284	.1762088	.780027
PAC	1.683846	0	1.683846	0	.0090779	.0090779	.0011274	.4695346	.4706620	2.16359
TOT	11.9403	0	11.9403	0	.0642000	.0642000	.00828	3.3187	3.32698	15.3315
1985										
NE	1.6706	0	1.6706	0	.0018746	.0018746	.0017466	.5126525	.5143991	2.18690
MA	4.7093	0	4.7093	0	.0052486	.0052486	.0047394	1.438914	1.443654	6.15818
ENC	5.4574	0	5.4574	0	.0060933	.0060933	.0058717	1.652428	1.658299	7.12179
WNC	2.3354	0	2.3354	0	.0025477	.0025477	.0023237	.7205450	.7228687	3.06080
SA	4.8859	0	4.8859	0	.0054345	.0054345	.0047832	1.658103	1.662886	6.55426
ESC	1.7614	0	1.7614	0	.0019782	.0019782	.0018628	.5733289	.5751918	2.33862
WSC	3.1121	0	3.1121	0	.0034269	.0034269	.0030788	.9836633	.9867421	4.10229
MT	1.5979	0	1.5979	0	.0017879	.0017879	.0014824	.5275642	.5290466	2.12870
PAC	4.2945	0	4.2945	0	.0048084	.0048084	.0042013	1.357702	1.361903	5.66124
TOT	29.825	0	29.825	0	.0332000	.0332000	.03009	9.424900	9.454990	39.3128
1990										
NE	4.356829	.4324453	4.789275	0	.0035445	.0035445	.0156816	1.114091	1.129773	5.92259
MA	12.00764	1.168349	13.17599	0	.0097462	.0097462	.0415355	3.065116	3.106652	16.2924
ENC	14.31848	1.437204	15.75568	0	.0116148	.0116148	.0529989	3.611215	3.664214	19.4315
WNC	6.153488	.5921839	6.745672	0	.0048828	.0048828	.0211878	1.578444	1.599632	8.35019
SA	13.14948	1.268773	14.41825	0	.0106180	.0106180	.0445098	3.691444	3.735953	18.1648
ESC	4.806862	.4828964	5.289759	0	.0039085	.0039085	.0175882	1.297946	1.315534	6.60920
WSC	8.546549	.8305348	9.377084	0	.0068354	.0068354	.0294320	2.235774	2.265206	11.6491
MT	4.437790	.4242371	4.862027	0	.0036145	.0036145	.0142833	1.212086	1.226369	6.09201
PAC	11.56399	1.121776	12.68576	0	.0094353	.0094353	.0391629	3.036284	3.075447	15.7706
TOT	79.34110	7.758400	87.09950	0	.0642000	.0642000	.27638	20.84240	21.11878	108.282
2000										
NE	18.25229	2.432330	20.68462	0	.1335067	.1335067	.0270241	2.264052	2.291076	23.1092
MA	47.80823	6.266889	54.07512	0	.3517256	.3517256	.0679685	5.944033	6.012001	60.4388
ENC	60.00650	8.077935	68.08443	0	.4389719	.4389719	.0913345	7.305208	7.396542	75.9199
WNC	26.25190	3.407944	29.65984	0	.1884105	.1884105	.0374812	3.244633	3.282114	33.1304
SA	58.18415	7.553542	65.73769	0	.4249636	.4249636	.0818077	7.815190	7.896998	74.0597
ESC	21.36138	2.889729	24.25111	0	.1565952	.1565952	.0326085	2.742945	2.775553	27.1833
WSC	38.96739	5.100298	44.06768	0	.2818637	.2818637	.0561156	4.871784	4.927899	49.2774
MT	20.57440	2.658360	23.23277	0	.1520462	.1520462	.0276968	2.683589	2.711286	26.0961
PAC	51.21907	6.714374	57.93344	0	.3794166	.3794166	.0721731	6.471267	6.543440	64.8563
TOT	342.6253	45.10140	387.7267	0	2.507500	2.507500	.4942100	43.3427	43.83691	434.071

C-4

TABLE 8.2-3 CPS DEDICATED EARTH STATION MARKET (CONTINUED)

USER CLASS DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
NE	.15717	.36009	.04186	.11501	.14258	.01223	.828940	.04018	0	.04018	0	0	0	0	.869115
MA	.38349	.98824	.16516	.36688	.44918	.03283	2.38577	.12581	0	.12581	0	0	0	0	2.51158
ENC	.55136	1.1969	.16115	.32286	.42881	.04400	2.70503	.10819	0	.10819	0	0	0	0	2.81322
WNC	.15261	.54985	.08092	.14197	.19773	.02341	1.14649	.06308	0	.06308	0	0	0	0	1.20957
SA	.32629	.99567	.14284	.28531	.44755	.05154	2.24920	.28617	0	.28617	0	0	0	0	2.53537
ESC	.15686	.36237	.05075	.08600	.14582	.02076	.822567	.07048	0	.07048	0	0	0	0	.893051
WSC	.17680	.68588	.10412	.17986	.26677	.04845	1.46186	.09410	0	.09410	0	0	0	0	1.55596
MT	.06000	.33265	.04744	.09101	.15555	.02280	.710248	.06978	0	.06978	0	0	0	0	.780027
PAC	.26608	.89850	.12278	.28770	.40231	.03890	2.01627	.14731	0	.14731	0	0	0	0	2.16359
TOT	2.2386	6.3701	.91702	1.8774	2.6363	.29491	14.3264	1.0051	0	1.0051	0	0	0	0	15.3315
1985															
NE	.37891	.91201	.10056	.30216	.36054	.03257	2.08676	.10014	0	.10014	0	0	0	0	2.18690
MA	.89263	2.4177	.38823	.93330	1.1331	.08778	5.85267	.30551	0	.30551	0	0	0	0	6.15818
ENC	1.3423	3.0504	.39023	.85835	1.0984	.11733	6.85701	.26478	0	.26478	0	0	0	0	7.12179
WNC	.38300	1.3849	.19832	.37711	.50317	.06066	2.90719	.15361	0	.15361	0	0	0	0	3.06080
SA	.81897	2.6007	.35578	.78104	1.1456	.13927	5.84140	.71287	0	.71287	0	0	0	0	6.55426
ESC	.40298	.96176	.12901	.23905	.37016	.05744	2.16040	.17822	0	.17822	0	0	0	0	2.33862
WSC	.47785	1.8147	.26202	.49860	.69390	.12435	3.87146	.23083	0	.23083	0	0	0	0	4.10229
MT	.16442	.90936	.12460	.26350	.42788	.06242	1.95218	.17652	0	.17652	0	0	0	0	2.12870
PAC	.68945	2.3533	.30489	.78104	1.0674	.10445	5.30056	.36068	0	.36068	0	0	0	0	5.66124
TOT	5.5505	16.405	2.2536	5.0342	6.8001	.78627	36.8296	2.4831	0	2.4831	0	0	0	0	39.3128
1990															
NE	1.0403	2.4513	.26690	.81155	.99294	.09288	5.65588	.23780	.01049	.24830	.00166	.01675	.01841	0	5.92259
MA	2.3657	6.3089	.99986	2.4486	3.1227	.24862	15.4944	.72540	.03048	.75588	.00364	.03849	.04213	0	16.2924
ENC	3.7132	8.2224	1.0296	2.3409	3.0840	.32597	18.7161	.62948	.03659	.66607	.00215	.04715	.04930	0	19.4315
WNC	1.0925	3.7202	.52662	1.0329	1.4103	.16583	7.94829	.36370	.01677	.38048	.00102	.02040	.02142	0	8.35019
SA	2.3513	7.2301	.97009	2.1934	3.2511	.38755	16.3835	1.7126	.03450	1.7471	.00232	.03191	.03423	0	18.1648
ESC	1.1851	2.7091	.35724	.68394	1.0450	.16402	6.14442	.43764	.01349	.45113	.00071	.01293	.01364	0	6.60920
WSC	1.4799	5.1129	.71756	1.4157	1.9881	.33011	11.0444	.55954	.02184	.58138	.00094	.02245	.02339	0	11.6491
MT	.58027	2.5819	.35005	.76170	1.2641	.17825	5.63633	.43165	.01243	.44408	.00052	.01108	.01160	0	6.09201
PAC	2.0030	6.4870	.81919	2.1635	3.0773	.29185	14.8411	.86529	.02888	.89417	.00183	.03356	.03539	0	15.7706
TOT	15.731	44.824	6.0371	13.852	19.236	2.1843	101.864	5.9631	.20548	6.1686	.01478	.23473	.24951	0	108.282
2000															
NE	3.8490	9.3743	1.0299	3.1634	3.7618	.34301	21.5213	.76127	.28403	1.0453	.03384	.50876	.54260	0	23.1092
MA	8.1278	22.788	3.6605	8.9934	11.680	.90770	56.1577	2.2531	.80147	3.0546	.07461	1.1520	1.2266	0	60.4388
ENC	13.835	31.317	3.9498	9.2783	11.957	1.1425	71.4796	1.9339	.99523	2.9291	.04362	1.4676	1.5112	0	75.9199
WNC	4.2910	14.246	2.0443	4.1716	5.5531	.57691	30.8833	1.1173	.46608	1.5834	.02120	.64245	.66365	0	33.1304
SA	9.4343	29.430	3.9421	9.2272	13.093	1.3842	66.5109	5.4332	.99297	6.4262	.05076	1.0717	1.1225	0	74.0597
ESC	4.9199	11.039	1.4812	2.9004	4.1363	.59175	25.0690	1.2708	.38827	1.6591	.01549	.43969	.45518	0	27.1833
WSC	6.5154	21.259	2.9585	6.0638	8.1912	1.0831	46.0706	1.7681	.64662	2.4147	.02120	.77094	.79214	0	49.2774
MT	2.2098	10.830	1.5082	3.3314	5.4024	.66157	23.9432	1.3813	.37090	1.7522	.01223	.38844	.40067	0	26.0961
PAC	8.2080	26.044	3.2671	8.9130	12.649	1.0535	60.1351	2.7504	.83093	3.5813	.03995	1.1000	1.1399	0	64.8563
TOT	61.390	176.33	23.842	56.042	76.424	7.7443	401.771	18.670	5.7765	24.446	.31291	7.5416	7.8545	0	434.071

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-4 SEGMENTATION OF DEMAND (CPS DEDICATED & SHARED EARTH STATION MARKET)

DEMAND BY SERVICE CATEGORY
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
1980	29.5	0	29.5	0	.1586	.1586	.02046	8.1992	8.2197	37.8778
1985	73.684	0	73.684	0	.0819	.0819	.07434	23.285	23.359	97.1257
1990	196.02	19.168	215.19	0	1.5929	1.5929	.68282	51.493	52.176	268.956
2000	846.49	111.43	957.91	0	6.195	6.195	1.221	107.08	108.3	1072.41

DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	2.14723	6.20509	6.9503	2.98835	6.26385	2.20636	3.84413	1.92712	5.34533	37.8778
1985	5.40293	15.2143	17.595	7.56198	16.1929	5.77776	10.1351	5.25914	13.9866	97.1257
1990	14.7115	40.4695	48.2668	20.739	45.115	16.4159	28.9329	15.1316	39.1736	268.956
2000	57.0933	149.32	187.567	81.8515	182.971	67.1586	121.744	64.4727	160.233	1072.41

DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980	5.5110	15.738	2.2656	4.6383	6.5132	.72861	35.395	2.4832	0	2.4832	0	0	0	0	37.878
1985	13.713	40.53	5.5678	12.437	16.800	1.9426	90.991	6.1348	0	6.1348	0	0	0	0	97.126
1990	39.121	111.24	14.943	34.357	47.967	5.4315	253.06	14.775	.50851	15.283	.03675	.57995	.61670	0	268.96
2000	151.67	435.64	58.903	138.46	188.81	19.133	992.61	46.125	14.271	60.396	.77308	18.632	19.405	0	1072.4

TABLE 8.2-4 CPS DEDICATED & SHARED EARTH STATION MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-DENT	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
VOICE TOTAL	4.3615	12.529	1.9978	3.8366	5.0242	.41405	28.1636	1.3359	0	1.3359	0	0	0	0	29.4995
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	4.3615	12.529	1.9978	3.8366	5.0242	.41405	28.1636	1.3359	0	1.3359	0	0	0	0	29.4995
VIDEO TOTAL	.02960	.05418	.00327	.01382	.04859	.00391	.153362	.00524	0	.00524	0	0	0	0	.1586
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.02960	.05418	.00327	.01382	.04859	.00391	.153362	.00524	0	.00524	0	0	0	0	.1586
DATA TOTAL	1.1199	3.1542	.26455	.78790	1.4404	.31066	7.07765	1.1420	0	1.1420	0	0	0	0	8.21966
MESSAGE	.00635	.00745	.00145	.00147	.00287	.00049	.020084	.00038	0	.00038	0	0	0	0	.02046
COMPUTER	1.1135	3.1468	.26309	.78643	1.4375	.31017	7.05756	1.1416	0	1.1416	0	0	0	0	8.19920
TOTAL	5.5110	15.738	2.2656	4.6383	6.5132	.72861	35.3946	2.4832	0	2.4832	0	0	0	0	37.8778
1985															
VOICE TOTAL	10.583	31.436	4.8325	10.063	12.628	1.0437	70.5853	3.0991	0	3.0991	0	0	0	0	73.6844
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	10.583	31.436	4.8325	10.063	12.628	1.0437	70.5853	3.0991	0	3.0991	0	0	0	0	73.6844
VIDEO TOTAL	.01485	.02811	.00163	.00749	.02526	.00204	.079387	.00251	0	.00251	0	0	0	0	.081900
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.01485	.02811	.00163	.00749	.02526	.00204	.079387	.00251	0	.00251	0	0	0	0	.081900
DATA TOTAL	3.1157	9.0659	.73372	2.3671	4.1470	.89686	20.3262	3.0332	0	3.0332	0	0	0	0	23.3594
MESSAGE	.02257	.02736	.00515	.00563	.01055	.00180	.073064	.00128	0	.00128	0	0	0	0	.074340
COMPUTER	3.0931	9.0386	.72858	2.3614	4.1364	.89506	20.2532	3.0319	0	3.0319	0	0	0	0	23.2851
TOTAL	13.713	40.530	5.5678	12.437	16.800	1.9426	90.9909	6.1348	0	6.1348	0	0	0	0	97.1257
1990															
VOICE TOTAL	31.906	90.356	13.282	28.810	38.184	3.4273	205.964	8.2873	.41192	8.6992	.00878	.51460	.52338	0	215.187
SWITCHED	4.3562	6.7781	.70812	1.5457	4.5941	.70721	18.6893	.42179	.02472	.44650	.00488	.02717	.03205	0	19.1679
DEDICATED	27.549	83.578	12.574	27.264	33.590	2.7201	187.275	7.8655	.38720	8.2527	.00390	.48743	.49133	0	196.019
VIDEO TOTAL	.28381	.54868	.03121	.14906	.49314	.03896	1.54486	.04682	.00094	.04776	.00026	.00002	.00028	0	1.5929
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.28381	.54868	.03121	.14906	.49314	.03896	1.54486	.04682	.00094	.04776	.00026	.00002	.00028	0	1.5929
DATA TOTAL	6.9318	20.331	1.6304	5.3986	9.2902	1.9653	45.5468	6.4404	.09565	6.5360	.02771	.06532	.09303	0	52.1758
MESSAGE	.20418	.25286	.04654	.05306	.09754	.01631	.670481	.01126	.00063	.01189	.00011	.00034	.00045	0	.682820
COMPUTER	6.7276	20.078	1.5838	5.3455	9.1927	1.9490	44.8763	6.4291	.09502	6.5241	.02760	.06498	.09258	0	51.493
TOTAL	39.121	111.24	14.943	34.357	47.967	5.4315	253.056	14.775	.50851	15.283	.03675	.57995	.61670	0	268.956
2000															
VOICE TOTAL	136.96	392.13	55.568	126.65	168.02	15.099	894.425	33.592	12.043	45.634	.35485	17.499	17.854	0	957.913
SWITCHED	24.145	38.784	3.9356	9.0253	26.244	3.9302	106.063	2.2730	1.2448	3.5178	.24243	1.6037	1.8461	0	111.427
DEDICATED	112.82	353.34	51.633	117.62	141.77	11.169	788.362	31.319	10.798	42.117	.11242	15.895	16.008	0	846.486
VIDEO TOTAL	1.0679	2.1314	.11775	.59091	1.9125	.14699	5.96741	.17128	.04320	.21448	.01210	.00101	.01311	0	6.19500
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	1.0679	2.1314	.11775	.59091	1.9125	.14699	5.96741	.17128	.04320	.21448	.01210	.00101	.01311	0	6.19500
DATA TOTAL	13.637	41.379	3.2167	11.216	18.882	3.8869	92.2176	12.362	2.1852	14.547	.40613	1.1322	1.5384	0	108.303
MESSAGE	.35317	.45153	.08072	.09668	.17389	.02830	1.18429	.01893	.00982	.02876	.00171	.00623	.00794	0	1.22099
COMPUTER	13.284	40.927	3.1360	11.120	18.708	3.8586	91.0333	12.343	2.1754	14.518	.40441	1.1260	1.5304	0	107.082
TOTAL	151.67	435.64	58.903	138.46	188.81	19.133	992.610	46.125	14.271	60.396	.77308	18.632	19.405	0	1072.41

TABLE 8.2-4 CPS DEDICATED & SHARED EARTH STATION MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA		TOTAL
	DED	SW	TOTAL		CONF	TOTAL	MSSG	COMP	TOTAL	
1980										
NE	1.684093	0	1.684093	0	.0091432	.0091432	.0012156	.4527733	.4539889	2.14723
MA	4.872498	0	4.872498	0	.0261521	.0261521	.0033872	1.303049	1.306436	6.20509
ENC	5.465806	0	5.465806	0	.0294965	.0294965	.0040585	1.450943	1.455002	6.95030
WNC	2.339858	0	2.339858	0	.0123182	.0123182	.0015947	.6345817	.6361764	2.98835
SA	4.796270	0	4.796270	0	.0258302	.0258302	.0032230	1.438527	1.441750	6.26385
ESC	1.706510	0	1.706510	0	.0093073	.0093073	.0012378	.4893055	.4905433	2.20636
WSC	2.990605	0	2.990605	0	.0159234	.0159234	.0020173	.8355827	.8376000	3.84413
MT	1.483779	0	1.483779	0	.0080030	.0080030	.0009401	.4344027	.4353428	1.92712
PAC	4.160081	0	4.160081	0	.0224260	.0224260	.0027858	1.160035	1.162821	5.34533
TOT	29.49950	0	29.49950	0	.1586	.1586	.02046	8.199200	8.219660	37.8778
1985										
NE	4.127439	0	4.127439	0	.0046244	.0046244	.0043151	1.266556	1.270871	5.40293
MA	11.63471	0	11.63471	0	.0129475	.0129475	.0117092	3.554973	3.566682	15.2143
ENC	13.48301	0	13.48301	0	.0150314	.0150314	.0145066	4.082477	4.096984	17.5950
WNC	5.769778	0	5.769778	0	.0062848	.0062848	.0057409	1.780174	1.785915	7.56198
SA	12.07117	0	12.07117	0	.0134061	.0134061	.0118173	4.096498	4.108316	16.1929
ESC	4.351818	0	4.351818	0	.0048799	.0048799	.0046023	1.416463	1.421065	5.77776
WSC	7.688785	0	7.688785	0	.0084538	.0084538	.0076064	2.430233	2.437839	10.1351
MT	3.947674	0	3.947674	0	.0044105	.0044105	.0036624	1.303397	1.307059	5.25914
PAC	10.61003	0	10.61003	0	.0118616	.0118616	.0103798	3.354329	3.364709	13.9866
TOT	73.68440	0	73.68440	0	.0819000	.0819000	.0743400	23.28510	23.35944	97.1257
1990										
NE	10.76393	1.068399	11.83233	0	.0879454	.0879454	.0387427	2.752462	2.791205	14.7115
MA	29.66592	2.886522	32.55244	0	.2418171	.2418171	.1026169	7.572642	7.675259	40.4695
ENC	35.37505	3.550756	38.92581	0	.2881815	.2881815	.1309384	8.921826	9.052765	48.2668
WNC	15.20273	1.463049	16.66578	0	.1211497	.1211497	.0523462	3.899686	3.952032	20.7390
SA	32.48692	3.134630	35.62155	0	.2634481	.2634481	.1099651	9.120039	9.230004	45.1150
ESC	11.87577	1.193044	13.06882	0	.0969759	.0969759	.0434532	3.206691	3.250145	16.4159
WSC	21.11499	2.051919	23.16691	0	.1695979	.1695979	.0727142	5.523679	5.596393	28.9329
MT	10.96395	1.048120	12.01207	0	.0896803	.0896803	.0352881	2.994565	3.029853	15.1316
PAC	28.56983	2.771460	31.34130	0	.2341042	.2341042	.0967552	7.501409	7.598164	39.1736
TOT	196.0191	19.1679	215.187	0	1.5929	1.5929	.6828200	51.493	52.17582	268.956
2000										
NE	45.09390	6.009281	51.10318	0	.3298400	.3298400	.0667654	5.593548	5.660313	57.0933
MA	118.1145	15.48289	133.5974	0	.8689691	.8689691	.1679223	14.68528	14.85320	149.320
ENC	148.2514	19.95723	168.2086	0	1.084519	1.084519	.2256580	18.04818	18.27383	187.567
WNC	64.85763	8.419619	73.27725	0	.4654848	.4654848	.0926006	8.016162	8.108763	81.8515
SA	143.7491	18.66168	162.4108	0	1.049910	1.049910	.2021132	19.30814	19.51025	182.971
ESC	52.77518	7.139324	59.91450	0	.3868823	.3868823	.0805623	6.776696	6.857258	67.1586
WSC	96.27237	12.60073	108.8731	0	.6963692	.6963692	.1386386	12.03619	12.17483	121.744
MT	50.83089	6.567708	57.39860	0	.3756436	.3756436	.0684275	6.630052	6.698479	64.4727
PAC	126.5412	16.58844	143.1297	0	.9373822	.9373822	.1783101	15.98786	16.16617	160.233
TOT	846.4861	111.4269	957.9130	0	6.195000	6.195000	1.22099	107.0821	108.3031	1072.41

TABLE 8.2-4 CPS DEDICATED & SHARED EARTH STATION MARKET (CONTINUED)

USER CLASS DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
								1980							
NE	.38831	.88962	.10341	.28415	.35225	.03022	2.04797	.09926	0	.09926	0	0	0	0	2.14723
MA	.94744	2.4415	.40804	.90641	1.1097	.08110	5.89425	.31084	0	.31084	0	0	0	0	6.20509
ENC	1.3622	2.9569	.39813	.79764	1.0594	.10871	6.68300	.26730	0	.26730	0	0	0	0	6.95030
WNC	.37703	1.3504	.19993	.35076	.48851	.05783	2.83250	.15585	0	.15585	0	0	0	0	2.98835
SA	.80612	2.4599	.35289	.70489	1.1057	.12735	5.55685	.70700	0	.70700	0	0	0	0	6.26385
ESC	.38754	.89527	.12539	.21248	.36026	.05128	2.03222	.17414	0	.17414	0	0	0	0	2.20636
WSC	.43679	1.6945	.25724	.44435	.65907	.11969	3.61165	.23247	0	.23247	0	0	0	0	3.84413
MT	.14825	.82184	.11720	.22681	.38431	.05632	1.75473	.17240	0	.17240	0	0	0	0	1.92712
PAC	.65736	2.2198	.30334	.71080	.99395	.09611	4.98138	.36395	0	.36395	0	0	0	0	5.34533
TOT	5.5110	15.738	2.2656	4.6383	6.5132	.72861	35.3946	2.4832	0	2.4832	0	0	0	0	37.8778
								1985							
NE	.93613	2.2532	.24845	.74651	.89075	.08048	5.15553	.24741	0	.24741	0	0	0	0	5.40293
MA	2.2053	5.9730	.95915	2.3058	2.7994	.21686	14.4595	.75480	0	.75480	0	0	0	0	15.2143
ENC	3.3163	7.5364	.96410	2.1206	2.7136	.28987	16.9409	.65416	0	.65416	0	0	0	0	17.5950
WNC	.94624	3.4216	.48997	.93168	1.2431	.14987	7.18248	.37950	0	.37950	0	0	0	0	7.56198
SA	2.0233	6.4253	.87897	1.9296	2.8304	.34408	14.4317	1.7612	0	1.7612	0	0	0	0	16.1929
ESC	.99561	2.3761	.31873	.59058	.91452	.14192	5.33746	.44030	0	.44030	0	0	0	0	5.77776
WSC	1.1806	4.4835	.64735	1.2318	1.7143	.30721	9.56478	.57029	0	.57029	0	0	0	0	10.1351
MT	.40621	2.2467	.30784	.65101	1.0571	.15421	4.82304	.43611	0	.43611	0	0	0	0	5.25914
PAC	1.7034	5.8141	.75327	1.9296	2.6371	.25806	13.0955	.89108	0	.89108	0	0	0	0	13.9866
TOT	13.713	40.530	5.5678	12.437	16.800	1.9426	90.9909	6.1348	0	6.1348	0	0	0	0	97.1257
								1990							
NE	2.5871	6.0832	.66065	2.0129	2.4761	.23095	14.0508	.58920	.02597	.61517	.00412	.04139	.04551	0	14.7115
MA	5.8830	15.656	2.4749	6.0732	7.7870	.61823	38.4926	1.7973	.07543	1.8727	.00904	.09510	.10414	0	40.4695
ENC	9.2341	20.405	2.5486	5.8062	7.6904	.81058	46.4947	1.5596	.09055	1.6502	.00534	.11650	.12184	0	48.2668
WNC	2.7169	9.2321	1.3035	2.5618	3.5167	.41237	19.7434	.90113	.04151	.94264	.00253	.05040	.05293	0	20.7390
SA	5.8473	17.942	2.4012	5.4402	8.1072	.96369	40.7018	4.2432	.08537	4.3286	.00576	.07884	.08460	0	45.1150
ESC	2.9472	6.7231	.88425	1.6964	2.6058	.40786	15.2645	1.0843	.03339	1.1177	.00176	.03196	.03372	0	16.4159
WSC	3.6803	12.688	1.7761	3.5114	4.9576	.82087	27.4347	1.3863	.05404	1.4404	.00234	.05547	.05780	0	28.[illegible]329
MT	1.2441	6.4073	.86647	1.8892	3.1524	.44325	14.0027	1.0695	.03077	1.1002	.00129	.02738	.02867	0	15.1316
PAC	4.9812	16.098	2.0277	5.3660	7.6739	.72373	36.8707	2.1439	.07147	2.2154	.00455	.08292	.08747	0	39.1736
TOT	39.121	111.24	14.943	34.357	47.967	5.4315	253.056	14.775	.50851	15.283	.03675	.57995	.61670	0	268.956
								2000							
NE	9.5093	23.160	2.5444	7.8154	9.2938	.84743	53.1703	1.8808	.70172	2.5825	.08360	1.2569	1.3405	0	57.0933
MA	20.081	56.300	9.0436	22.219	28.857	2.2426	138.743	5.5665	1.9801	7.5466	.18433	2.8460	3.0303	0	149.320
ENC	34.180	77.373	9.7583	22.923	29.541	2.8226	176.597	4.7778	2.4588	7.2366	.10778	3.6259	3.7336	0	187.567
WNC	10.601	35.197	5.0507	10.306	13.719	1.4253	76.2999	2.7605	1.1515	3.9120	.05238	1.5872	1.6396	0	81.8515
SA	23.308	72.710	9.7393	22.796	32.347	3.4199	164.321	13.423	2.4532	15.877	.12540	2.6478	2.7732	0	182.971
ESC	12.155	27.274	3.6594	7.1656	10.219	1.4620	61.9351	3.1397	.95926	4.0990	.03828	1.0863	1.1246	0	67.1586
WSC	16.097	52.521	7.3092	14.981	20.237	2.6760	113.821	4.3683	1.5975	5.9658	.05238	1.9047	1.9571	0	121.744
MT	5.4596	26.756	3.7261	8.2306	13.347	1.6345	59.1538	3.4127	.91634	4.3290	.03022	.95968	.98990	0	64.4727
PAC	20.279	64.345	8.0716	22.020	31.251	2.6027	148.569	6.7951	2.0529	8.8480	.09871	2.7176	2.8163	0	160.233
TOT	151.67	435.64	58.903	138.46	188.81	19.133	992.610	46.125	14.271	60.396	.77308	18.632	19.405	0	1072.41

TABLE 8.2-5 SEGMENTATION OF DEMAND
(LOWER AVAILABILITY Ka BAND DEDICATED EARTH STATION MARKET)

DEMAND BY SERVICE CATEGORY
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	
1980	5.3731	0	5.3731	0	.02888	.02888	.00663	1.1201	1.1267	6.56403
1985	13.421	0	13.421	0	.01492	.01492	.02407	3.1809	3.205	16.641
1990	35.704	3.4913	39.195	0	.29013	.29013	.2211	7.0343	7.2554	46.7403
2000	154.18	20.296	174.48	0	1.1284	1.1284	.39537	14.628	15.024	190.629

DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PAC	TOTAL
1980	.370048	1.10513	1.18046	.515142	1.09395	.376525	.665917	.339371	.936216	6.56403
1985	.920229	2.63948	2.95662	1.28898	2.79439	.973279	1.73271	.914884	2.42042	16.641
1990	2.53961	7.12706	8.2324	3.58615	7.89527	2.80313	5.01027	2.67179	6.87464	46.7403
2000	10.0478	26.8936	32.7326	14.4715	32.8052	11.7154	21.5453	11.6621	29.7555	190.629

DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980	.76509	2.3793	.42028	1.1213	1.2816	.11931	6.0869	.47710	0	.47710	0	0	0	0	6.5640
1985	1.8692	6.0426	1.0250	2.9781	3.2517	.31207	15.479	1.1624	0	1.1624	0	0	0	0	16.641
1990	5.4475	16.839	2.7798	8.3265	9.4660	.90441	43.764	2.8541	.09473	2.9488	.00034	.02760	.02794	0	46.740
2000	21.776	68.113	11.206	34.557	38.561	3.3599	177.57	9.4325	2.7094	12.142	.00761	.90651	.91412	0	190.63

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 8.2-5 LOWER AVAILABILITY Ka BAND DEDICATED E.S. MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY USER CLASS
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
1980															
VOICE TOTAL	.63210	1.9856	.38116	.96794	1.0401	.07556	5.08246	.29064	0	.29064	0	0	0	0	5.37310
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	.63210	1.9856	.38116	.96794	1.0401	.07556	5.08246	.29064	0	.29064	0	0	0	0	5.37310
VIDEO TOTAL	.00428	.00858	.00062	.00349	.01005	.00072	.027741	.00114	0	.00114	0	0	0	0	.02888
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.00428	.00858	.00062	.00349	.01005	.00072	.027741	.00114	0	.00114	0	0	0	0	.02888
DATA TOTAL	.12101	.37186	.03700	.14773	.22183	.04217	.942390	.18434	0	.18434	0	0	0	0	1.12673
MESSAGE	.00174	.00223	.00052	.00070	.00112	.00017	.006476	.00015	0	.00015	0	0	0	0	.006630
COMPUTER	.11927	.36963	.03728	.14703	.22071	.04200	.935914	.18419	0	.18419	0	0	0	0	1.1201
TOTAL	.76509	2.3793	.42028	1.1213	1.2816	.11931	6.08693	.47710	0	.47710	0	0	0	0	6.56403
1985															
VOICE TOTAL	1.5298	4.9691	.91967	2.5323	2.6077	.18997	12.7486	.67253	0	.67253	0	0	0	0	13.4211
SWITCHED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEDICATED	1.5298	4.9691	.91967	2.5323	2.6077	.18997	12.7486	.67253	0	.67253	0	0	0	0	13.4211
VIDEO TOTAL	.00214	.00444	.00031	.00189	.00522	.00037	.014375	.00055	0	.00055	0	0	0	0	.01492
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.00214	.00444	.00031	.00189	.00522	.00037	.014375	.00055	0	.00055	0	0	0	0	.01492
DATA TOTAL	.33721	1.0691	.10501	.44385	.63873	.12173	2.71564	.48933	0	.48933	0	0	0	0	3.20497
MESSAGE	.00614	.00816	.00185	.00267	.00411	.00062	.023547	.00052	0	.00052	0	0	0	0	.024070
COMPUTER	.33107	1.0609	.10317	.44118	.63462	.12111	2.69209	.48881	0	.48881	0	0	0	0	3.1809
TOTAL	1.8692	6.0426	1.0250	2.9781	3.2517	.31207	15.4786	1.1624	0	1.1624	0	0	0	0	16.6410
1990															
VOICE TOTAL	4.6302	14.318	2.5327	7.2641	7.9145	.62770	37.2874	1.8017	.08046	1.8822	.000102	.025192	.025293	0	39.1948
SWITCHED	.64565	1.1003	.13855	.39949	.97465	.13234	3.39098	.09397	.00494	.09891	.000056	.001361	.001417	0	3.4913
DEDICATED	3.9846	13.218	2.3941	6.8646	6.9399	.49536	33.8964	1.7077	.07552	1.7832	.000046	.023830	.023876	0	35.7035
VIDEO TOTAL	.04091	.08664	.00593	.03749	.10172	.00711	.279797	.01015	.00018	.01033	.000003	.000001	.000004	0	.29013
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.04091	.08664	.00593	.03749	.10172	.00711	.279797	.01015	.00018	.01033	.000003	.000001	.000004	0	.29013
DATA TOTAL	.77639	2.4345	.24120	1.0249	1.4498	.26961	6.19644	1.0422	.01410	1.0563	.000231	.002411	.002642	0	7.25540
MESSAGE	.05553	.07531	.01669	.02515	.03794	.00560	.216229	.00461	.00023	.00484	.000002	.000031	.000034	0	.221100
COMPUTER	.72086	2.3592	.22451	.99976	1.4119	.26400	5.98021	1.0376	.01387	1.0515	.000228	.002380	.002608	0	7.03430
TOTAL	5.4475	16.839	2.7798	8.3265	9.4660	.90441	43.7636	2.8541	.09473	2.9488	.000335	.027604	.027939	0	46.7403
2000															
VOICE TOTAL	20.091	62.791	10.706	32.265	35.201	2.7962	163.850	7.3786	2.3792	9.7578	.004069	.864700	.868769	0	174.477
SWITCHED	3.6100	6.3510	.77679	2.3531	5.6166	.74191	19.4494	.51084	.25152	.76237	.002791	.081066	.083858	0	20.2956
DEDICATED	16.481	56.440	9.9295	29.912	29.585	2.0543	144.401	6.8677	2.1277	8.9954	.001278	.783633	.784912	0	154.181
VIDEO TOTAL	.15392	.33653	.02236	.14859	.39445	.02682	1.08267	.03712	.00842	.04554	.000134	.000049	.000183	0	1.1284
BROADCAST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIDEOCONF	.15392	.33653	.02236	.14859	.39445	.02682	1.08267	.03712	.00842	.04554	.000134	.000049	.000183	0	1.1284
DATA TOTAL	1.5317	4.9849	.47732	2.1434	2.9656	.53688	12.6398	2.0168	.32181	2.3386	.003405	.041759	.045165	0	15.0236
MESSAGE	.09622	.13474	.02900	.04592	.06777	.00974	.383386	.00776	.00361	.01137	.000036	.000574	.000610	0	.395370
COMPUTER	1.4355	4.8501	.44832	2.0975	2.8978	.52714	12.2564	2.0091	.31819	2.3273	.003369	.041185	.044555	0	14.6282
	21.776	68.113	11.206	34.557	38.561	3.3599	177.573	9.4325	2.7094	12.142	.007609	.906508	.914117	0	190.629

TABLE 8.2-5 LOWER AVAILABILITY Ka BAND DEDICATED E.S. MARKET (CONTINUED)

SERVICE CATEGORY DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	VOICE			VIDEO			DATA			TOTAL
	DED	SW	TOTAL	BROAD	CONF	TOTAL	MSSG	COMP	TOTAL	.
					1980					
NE	.3044775	0	.3044775	0	.0016477	.0016477	.0003887	.0610478	.0614365	.370048
MA	.8965184	0	.8965184	0	.0047960	.0047960	.0011040	.1786293	.1797333	1.10513
ENC	.9744796	0	.9744796	0	.0052441	.0052441	.0012839	.1927564	.1940403	1.18046
WNC	.4237179	0	.4237179	0	.0022346	.0022346	.0005173	.0859206	.0864379	.515142
SA	.8818164	0	.8818164	0	.0047505	.0047505	.0010536	.2006207	.2016743	1.09395
ESC	.3060702	0	.3060702	0	.0016697	.0016697	.0003945	.0662928	.0666873	.376525
WSC	.5447663	0	.5447663	0	.0029095	.0029095	.0006594	.1140455	.1147049	.665917
MT	.2751320	0	.2751320	0	.0014936	.0014936	.0003142	.0606850	.0609992	.339371
PAC	.7661218	0	.7661218	0	.0041343	.0041343	.0009144	.1601019	.1610163	.936216
TOT	5.373100	0	5.373100	0	.02888	.02888	.0066300	1.1201	1.12673	6.56403
					1985					
NE	.7469694	0	.7469694	0	.0008345	.0008345	.0013802	.1710443	.1724245	.920229
MA	2.144707	0	2.144707	0	.0023810	.0023810	.0038217	.4885668	.4923886	2.63948
ENC	2.406224	0	2.406224	0	.0026767	.0026767	.0045896	.5431282	.5477178	2.95662
WNC	1.044901	0	1.044901	0	.0011403	.0011403	.0018594	.2410783	.2429376	1.28898
SA	2.217597	0	2.217597	0	.0024640	.0024640	.0038577	.5704732	.5743309	2.79439
ESC	.7793758	0	.7793758	0	.0008739	.0008739	.0014632	.1915662	.1930295	.973279
WSC	1.397786	0	1.397786	0	.0015411	.0015411	.0024764	.3309073	.3333837	1.73271
MT	.7311326	0	.7311326	0	.0008224	.0008224	.0012210	.1817082	.1829292	.914884
PAC	1.952406	0	1.952406	0	.0021861	.0021861	.0034008	.4624274	.4658282	2.42042
TOT	13.4211	0	13.4211	0	.01492	.01492	.0240700	3.1809	3.20497	16.6410
					1990					
NE	1.947331	.1924409	2.139771	0	.0158694	.0158694	.0123970	.3715765	.3839735	2.53961
MA	5.475407	.5312101	6.006617	0	.0445399	.0445399	.0335584	1.042347	1.075905	7.12706
ENC	6.318653	.6324689	6.951122	0	.0513697	.0513697	.0414723	1.188437	1.229909	8.23240
WNC	2.753245	.2657929	3.019037	0	.0219758	.0219758	.0169482	.5281927	.5451409	3.58615
SA	5.966468	.5757220	6.542190	0	.0483775	.0483775	.0358856	1.268821	1.304706	7.89527
ESC	2.125472	.2132482	2.338720	0	.0173369	.0173369	.0138016	.4332714	.4470730	2.80313
WSC	3.831397	.3737556	4.205153	0	.0308270	.0308270	.0235973	.7506881	.7742854	5.01027
MT	2.030184	.1959310	2.226115	0	.0167075	.0167075	.0117546	.4172089	.4289636	2.67179
PAC	5.255343	.5107305	5.766073	0	.0431264	.0431264	.0316851	1.033758	1.065443	6.87464
TOT	35.70350	3.4913	39.19480	0	.29013	.29013	.2211000	7.034300	7.255400	46.7403
					2000					
NE	8.136070	1.078649	9.214718	0	.0594442	.0594442	.0213445	.7523091	.7736536	10.0478
MA	21.80709	2.850572	24.65766	0	.1602659	.1602659	.0550069	2.020669	2.075676	26.8936
ENC	26.49784	3.560406	30.05825	0	.1937582	.1937582	.0716040	2.409015	2.480619	32.7326
WNC	11.74220	1.528559	13.27075	0	.0845002	.0845002	.0299734	1.086252	1.116225	14.4715
SA	26.43116	3.429381	29.86054	0	.1926355	.1926355	.0659492	2.686044	2.751993	32.8052
ESC	9.433706	1.274192	10.70790	0	.0689848	.0689848	.0255435	.9129325	.9384760	11.7154
WSC	17.44928	2.290589	19.73987	0	.1262622	.1262622	.0448497	1.634318	1.679168	21.5453
MT	9.417916	1.227681	10.64560	0	.0699271	.0699271	.0227628	.9238141	.9465769	11.6621
PAC	23.26614	3.055572	26.32171	0	.1726218	.1726218	.0583360	2.202847	2.261183	28.7555
TOT	154.1814	20.2956	174.477	0	1.1284	1.1284	.3953700	14.6282	15.02357	190.629

TABLE 8.2-5 LOWER AVAILABILITY Ka BAND DEDICATED E.S. MARKET (CONTINUED)

USER CLASS DEMAND BY GEOGRAPHIC AREA
(ANNUAL TRAFFIC - BITS PER YEAR *E15)

	BUSINESS							GOVERNMENT			INSTITUTIONS			RESI-	
	MFG	WH/RE	TR/UT	F/I/R	SVS	OTHER	BTOT	FGOV	SLGOV	GTOT	EDU	HEAL	ITOT	DENT	TOTAL
							1980								
NE	.05358	.13447	.01921	.06888	.06978	.00498	.350895	.01915	0	.01915	0	0	0	0	.370048
MA	.13375	.37430	.07608	.22151	.22507	.01382	1.04454	.06060	0	.06060	0	0	0	0	1.10513
ENC	.18911	.44705	.07386	.19282	.20847	.01780	1.12910	.05136	0	.05136	0	0	0	0	1.18046
WNC	.05234	.20538	.03709	.08479	.09613	.00947	.485198	.02994	0	.02994	0	0	0	0	.515142
SA	.11191	.37190	.06546	.17040	.21758	.02085	.958109	.13584	0	.13584	0	0	0	0	1.09395
ESC	.05380	.13535	.02326	.05136	.07089	.00840	.343068	.03346	0	.03346	0	0	0	0	.376525
WSC	.06864	.25619	.04772	.10742	.12969	.01960	.621251	.04467	0	.04467	0	0	0	0	.665917
MT	.02058	.12425	.02174	.05483	.07562	.00922	.306248	.03312	0	.03312	0	0	0	0	.339371
PAC	.09126	.33561	.05627	.17183	.19558	.01574	.866290	.06993	0	.06993	0	0	0	0	.936216
TOT	.76509	2.3793	.42028	1.1213	1.2816	.11931	6.08693	.47710	0	.47710	0	0	0	0	6.56403
							1985								
NE	.12760	.33593	.04574	.17875	.17240	.01293	.873351	.04688	0	.04688	0	0	0	0	.920229
MA	.30060	.89052	.17657	.55212	.54181	.03484	2.49646	.14302	0	.14302	0	0	0	0	2.63948
ENC	.45203	1.1236	.17748	.50778	.52521	.04657	2.83267	.12395	0	.12395	0	0	0	0	2.95662
WNC	.12898	.51013	.09020	.22309	.24060	.02408	1.21707	.07191	0	.07191	0	0	0	0	1.28898
SA	.27579	.95795	.16181	.46204	.54781	.05528	2.46069	.33371	0	.33371	0	0	0	0	2.79439
ESC	.13571	.35425	.05868	.14141	.17700	.02280	.889853	.08343	0	.08343	0	0	0	0	.973279
WSC	.16092	.66844	.11917	.29496	.33181	.04935	1.62465	.10806	0	.10806	0	0	0	0	1.73271
MT	.05537	.33495	.05667	.15588	.20460	.02477	.832252	.08263	0	.08263	0	0	0	0	.914884
PAC	.23218	.86682	.13867	.46204	.51041	.04146	2.25158	.16884	0	.16884	0	0	0	0	2.42042
TOT	1.8692	6.0426	1.0250	2.9781	3.2517	.31207	15.4786	1.1624	0	1.1624	0	0	0	0	16.6410
							1990								
NE	.36025	.92090	.12289	.48782	.48864	.03846	2.41895	.11382	.00484	.11866	.00004	.00197	.00201	0	2.53961
MA	.81919	2.3701	.46038	1.4718	1.5367	.10294	6.76121	.34719	.01405	.36125	.00008	.00453	.00461	0	7.12706
ENC	1.2858	3.0890	.47409	1.4071	1.5177	.13497	7.90865	.30128	.01687	.31815	.00005	.00554	.00559	0	8.23240
WNC	.37831	1.3976	.24248	.62086	.69401	.06866	3.40192	.17408	.00773	.18181	.00002	.00240	.00242	0	3.58615
SA	.81422	2.7162	.44667	1.3184	1.5999	.16047	7.05588	.81968	.01590	.83559	.00005	.00375	.00380	0	7.89527
ESC	.41039	1.0178	.16449	.41111	.51424	.06791	2.58591	.20946	.00622	.21568	.00002	.00152	.00154	0	2.80313
WSC	.51247	1.9208	.33040	.85098	.97836	.13669	4.72973	.26781	.01007	.27788	.00002	.00264	.00266	0	5.01027
MT	.17323	.96997	.16118	.45785	.62210	.07381	2.45815	.20659	.00573	.21233	.00001	.00130	.00132	0	2.[illegible]179
PAC	.69361	2.4370	.37719	1.3004	1.5144	.12051	6.44319	.41415	.01332	.42746	.00004	.00395	.00399	0	6.87464
TOT	5.4475	16.839	2.7798	8.3265	9.4660	.90441	43.7636	2.8541	.09473	2.9488	.00034	.02760	.02794	0	46.7403
							2000								
NE	1.3653	3.6211	.46406	1.9586	1.8981	.14882	9.46800	.38462	.13322	.51784	.00082	.06115	.06198	0	10.0478
MA	2.8831	8.8026	1.7205	5.5455	5.8934	.39382	25.2390	1.1384	.37592	1.5143	.00181	.13847	.14028	0	26.8936
ENC	4.9074	12.097	1.8565	5.7212	6.0331	.49568	31.1113	.97706	.46681	1.4439	.00106	.17641	.17747	0	32.7326
WNC	1.5221	5.5031	.96088	2.5723	2.8019	.25030	13.6106	.56452	.21861	.78313	.00052	.07722	.07774	0	14.4715
SA	3.3466	11.368	1.8529	5.6897	6.6063	.60057	29.4643	2.7451	.46574	3.2108	.00123	.12883	.13006	0	32.8052
ESC	1.7452	4.2643	.69618	1.7884	2.0870	.25674	10.8379	.64207	.18212	.82419	.00038	.05285	.05323	0	11.7154
WSC	2.3111	8.2118	1.3905	3.7391	4.1330	.46993	20.2555	.89331	.30329	1.1966	.00052	.09267	.09318	0	21.5453
MT	.78388	4.1833	.70887	2.0542	2.7259	.28703	10.7432	.69790	.17397	.87187	.00030	.04669	.04699	0	11.6621
PAC	2.9[illegible]15	10.060	1.5356	5.4960	6.3823	.45705	26.8430	1.3896	.38974	1.7793	.00097	.13222	.13319	0	28.7555
TOT	21.776	68.113	11.206	34.557	38.561	3.3599	177.573	9.4325	2.7094	12.142	.00761	.90651	.91412	0	190.629

9.0 NATIONWIDE TRAFFIC DISTRIBUTION MODEL

This chapter discusses the distribution of traffic and earth stations among the SMSAs and the non-urban areas of the contiguous United States.

Section 9.1 provides estimates for the addressable traffic demand originating in each of the major SMSAs and classifies this traffic according to user class and service category. An allocation of earth stations among the SMSAs is also provided, as well as a discussion of the potential United States market for CPS earth stations.

Section 9.2 discusses inter-SMSA traffic patterns and estimates the fraction of traffic originating at each of the major SMSAs which is directed to each of the other major SMSAs and to areas outside these SMSAs.

Section 9.3 discusses connectivity requirements between CPS and trunking facilities.

9.1 TRAFFIC DEMAND AND EARTH STATION ALLOCATION BY SMSA

To arrive at traffic demand and earth station allocations among the SMSAs, the SMSAs were first ranked in order of expected traffic volumes for the year 2000. For each of the top 40 SMSAs, the busy hour CPS traffic was developed, by service and by user category, using the methodology described in Subsection 9.1.1. For each of these SMSAs, estimates were also developed for the number of shared and dedicated earth stations using the methodology of Subsection 9.1.2.

The remaining SMSAs were combined in groups of twenty. Busy hour traffic and the number of earth stations for each group of twenty was developed using the same methodologies.

The totals for all SMSAs were then subtracted from the U.S. total to arrive at estimates for the traffic and earth stations ascribable to areas outside the SMSAs.

9.1.1 METHODOLOGY FOR ESTIMATION OF BUSY HOUR TRAFFIC BY SMSA

The following describes the methodology used for distributing busy hour traffic among the SMSAs. The methodology is similar to that employed earlier to estimate regional traffic except that busy hour CPS traffic from Tables 6.5-4 and 6.5-5 rather than annual traffic estimates are used.

For each SMSA, or group of twenty SMSAs, projected employment figures in each user class were developed for the year 2000. The source of the employment projections is Reference 9-1, which lists employment by SMSA and by user class for the U.S. and for each of 264 SMSAs within the contiguous 48 states. Institutional employment, which earlier was separately reported under the user class headings of Health and Education, but which accounts for less than one percent of projected CPS traffic, has been included in the Services class.

To estimate the busy hour traffic addressable by a particular SMSA, the projected employment in each user class of that SMSA is multiplied by the appropriate activity factor as obtained from Table 8.1-5. The activity-factor-weighted employment for the user class within the SMSA is then compared with the sum of the activity-factor-weighted employments (over all user classes) for the total U.S. to arrive at the fraction of U.S. traffic ascribable to that user class and SMSA. By multiplying the total U.S. traffic (in each service subcategory) by the fractions described above, the busy hour traffic addressable by user class and service subcategory within the SMSA is obtained. Various aggregations are then developed to arrive at total SMSA traffic by user class and service category for each SMSA and for groups of SMSAs.

9.1.2 METHODOLOGY FOR EARTH STATION ALLOCATION AMONG THE SMSAS

The number of addressable dedicated and shared CPS earth stations projected for the U.S. is based on the number of establishments meeting employment criteria discussed in Subsection 6.3.2. In terms of employment, an establishment likely to have sufficient traffic to justify the installation of a dedicated CPS earth station will, on the average, employ in excess of 2083 employees. The corresponding employment level for establishments using shared earth stations is 583.

Figure 9.1-1 plots the number of establishments in the U.S. during 1979 whose employment exceeded indicated levels. The curve is based on data contained in Reference 9-2 which estimates that there were 4.54 million establishments in the U.S. in 1979. The curve indicates that of this total there were 1500 establishments (.033 percent of the total) with employment in excess of 2083 employees, and 9040 (.199 percent of the total) whose employment was between 583 and 2083. These values are shown in Column 1 of Table 9.1-1. Columns 2 and 3 shows extrapolations of these values for the years 1990 and 2000, respectively. The extrapolations are based on projected total United States employment for these two years relative to employment for 1979, under the assumption that the number of establishments of any given size increases linearly with overall employment.

Table 9.1-1 also shows the addressable year 1990 and 2000 markets for dedicated earth stations (equal to the number of establishments with more than 2083 employees) and for shared earth stations (one-fifth of the number of establishments with between 583 and 2083 employees to account for sharing of the earth station by an average of five establishments). The last row of Table 9.1-1 adds the dedicated and shared earth station estimates to arrive at the combined U.S. addressable market for shared and dedicated earth stations.

TABLE 9.1-1 ADDRESSABLE MARKET FOR CPS EARTH STATIONS (U.S. TOTAL)

	1 1979	2 1990	3 2000
NO. OF ESTAB. WITH EMPLOYMENT >2083	1500	1784	1922
NO. OF ESTAB. WITH EMPL. BETWEEN 583 and 2083	9040	10750	11585
NO. OF DEDICATED EARTH STATIONS	--	1784	1922
NO. OF SHARED EARTH STATIONS	--	2150	2317
NO. OF DEDICATED & SHARED EARTH STATIONS	--	3934	4239

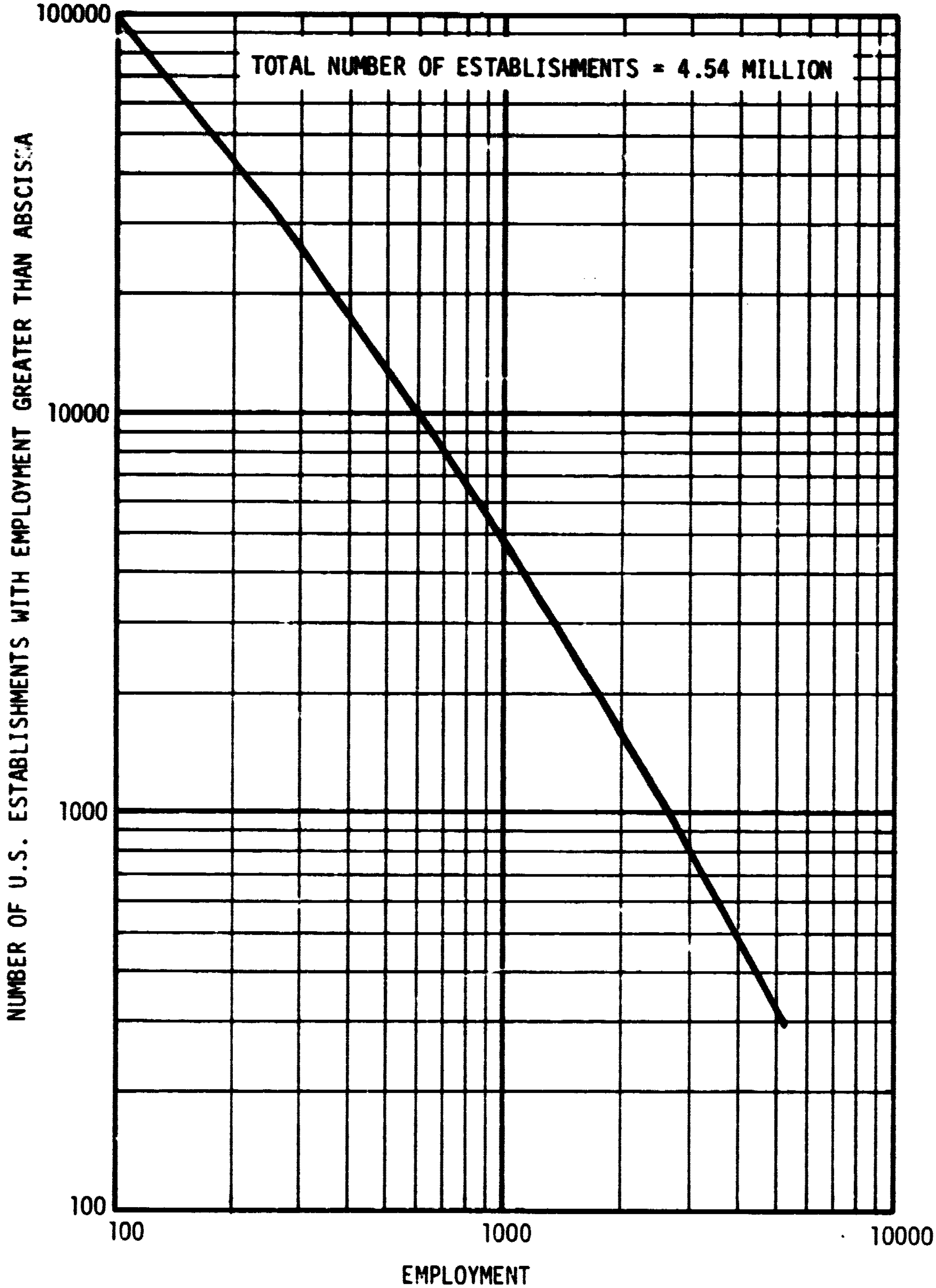


FIGURE 9.1-1 NUMBER OF ESTABLISHMENTS BY EMPLOYMENT SIZE

The U.S. addressable markets for dedicated and for dedicated and shared earth stations are distributed among the SMSAs in proportion to the ratio of the SMSA's busy hour CPS traffic to the total U.S. busy hour CPS traffic. Thus, for example, an SMSA whose busy hour CPS traffic (as developed per Subsection 9.1.˙) is one percent of the total U.S. busy hour CPS traffic, is ssumed to have one percent of the earth stations.

9.1.3 BUSY HOUR CPS TRAFFIC AND EARTH STATIONS BY SMSA

Table 9.1-2 identifies 264 SMSAs within the contiguous 48 states for which employment projections covering the time frame of this study are available [Ref. 9-1]. The SMSAs are ranked according to projected CPS addressable traffic volumes for the year 2000.

Table 9.1-3 shows the year 2000 CPS addressable busy hour traffic by user class and service category for the United States, for the top 40 SMSAs (ranked by traffic) and for the remaining SMSAs (in descending order of traffic volume) in groups of twenty. Also shown are the potential number of dedicated CPS earth stations and the potential number of dedicated and shared CPS earth stations.

Table 9.1-4 shows the percentage of the year 2000 total United States busy hour CPS traffic addressable by SMSAs taken in groups of twenty. Of the total U.S. CPS addressable traffic, 78.23 percent is contained within the SMSAs, the remaining 21.75 percent being in areas not contained within the SMSAs. The top 40 SMSAs account for 47.58 percent of the United States CPS traffic.

TABLE 9.1-2 SMSAs RANKED BY CPS ADDRESSABLE TRAFFIC

RANK YEAR 2000	SMSA	RANK YEAR 2000	SMSA
1	LOS ANGELES-LONG BEACH, CALIFORNIA	51	DAYTON, OHIO
2	NEW YORK, NEW YORK-NEW JERSEY	52	BRIDGEPORT-STAMFORD-NORWALK-DANBURY, CONN.
3	CHICAGO, ILLINOIS	53	NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA.-N.C.
4	DETROIT, MICHIGAN	54	ORLANDO, FLORIDA
5	PHILADELPHIA, PENNSYLVANIA-NEW JERSEY	55	TULSA, OKLAHOMA
6	SAN FRANCISCO-OAKLAND, CALIFORNIA	56	NEW HAVEN-WATERBURY-MERIDEN, CONNECTICUT
7	DALLAS-FORT WORTH, TEXAS	57	ROCHESTER, NEW YORK
8	WASHINGTON, D.C.-MARYLAND-VIRGINIA	58	LAS VEGAS, NEVADA
9	BOST.-LOWELL-BROCKT.-HAVER.-LAWR.,MASS.-NH.	59	TOLEDO, OHIO-MICHIGAN
10	HOUSTON, TEXAS	60	GREENVILLE-SPARTANBURG, SOUTH CAROLINA
11	MINNEAPOLIS-ST.PAUL, MINNESOTA-WISCONSIN	61	GRAND RAPIDS, MICHIGAN
12	ATLANTA, GEORGIA	62	OMAHA, NEBRASKA-IOWA
13	DENVER-BOULDER, COLORADO	63	RALEIGH-DURHAM, NORTH CAROLINA
14	ST.LOUIS, MISSOURI-ILLINOIS	64	GARY-HAMMOND-EAST CHICAGO, INDIANA
15	NEWARK, NEW JERSEY	65	AKRON, OHIO
16	CLEVELAND, OHIO	66	AUSTIN, TEXAS
17	MIAMI, FLORIDA	67	ALBANY-SCHENECTADY-TROY, NEW YORK
18	BALTIMORE, MARYLAND	68	NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ
19	ANAHEIM-SANTA ANA-GARDEN GROVE, CALIFORNIA	69	WEST PALM BEACH-BOCA RATON, FLORIDA
20	PITTSBURG, PENNSYLVANIA	70	ALLENTOWN-BETHLEHEM-EASTON, PA.-N.Y.
21	SEATTLE-EVERETT, WASHINGTON	71	WILMINGTON, DELAWARE-NEW JERSEY-MARYLAND
22	NASSAU-SUFFOLK, NEW YORK	72	KNOXVILLE, TENNESSEE
23	PHOENIX, ARIZONA	73	WORCESTER-FITCHBURG-LEOMINSTER, MASS.
24	PORTLAND, OREGON-WASHINGTON	74	ALBUQUERQUE, NEW MEXICO
25	MILWAUKEE, WISCONSIN	75	JERSEY CITY, NEW JERSEY
26	SAN DIEGO, CALIFORNIA	76	NORTHEAST PENNSYLVANIA, PENNSYLVANIA
27	SAN JOSE, CALIFORNIA	77	WICHITA, KANSAS
28	TAMPA-ST. PETERSBURG, FLORIDA	78	CHATTANOOGA, TENNESSEE-GEORGIA
29	KANSAS CITY, MISSOURI-KANSAS	79	FLINT, MICHIGAN
30	CINCINNATI, OHIO-KENTUCKY-INDIANA	80	FRESNO, CALIFORNIA
31	NEW ORLEANS, LOUISIANA	81	LITTLE ROCK-NORTH LITTLE ROCK, ARKANSAS
32	INDIANAPOLIS, INDIANA	82	SYRACUSE, NEW YORK
33	HARTFORD-NEW BRITAIN-BRISTOL, CONNECTICUT	83	YOUNGSTOWN-WARREN, OHIO
34	SALT LAKE CITY-OGDEN, UTAH	84	SPRINGFIELD-CHICOPEE-HOLYOKE, MASS.
35	SAN ANTONIO, TEXAS	85	BATON ROUGE, LOUISIANA
36	COLUMBUS, OHIO	86	DES MOINES, IOWA
37	LOUISVILLE, KENTUCKY-INDIANA	87	COLUMBIA, SOUTH CAROLINA
38	MEMPHIS, TENNESSEE-ARKANSAS-MISSISSIPPI	88	TUCSON, ARIZONA
39	RIVERSIDE-SAN BERNADINO-ONTARIO, CALIFORNIA	89	EL PASO, TEXAS
40	NASHVILLE-DAVIDSON, TENNESSEE	90	HARRISBURG, PENNSYLVANIA
41	GREENSBORO-WINSTON SALEM-HIGH POINT, N.C.	91	FORT WAYNE, INDIANA
42	FORT LAUDERDALE-HOLLYWOOD, FLORIDA	92	PATERSON-CLIFTON-PASSAIC, NEW JERSEY
43	OKLAHOMA CITY, OKLAHOMA	93	JACKSON, MISSISSIPPI
44	BUFFALO, NEW YORK	94	BEAUMONT-PORT ARTHUR-ORANGE, TEXAS
45	BIRMINGHAM, ALABAMA	95	JOHNSON CITY-KINGSPORT-BRISTOL, TENN.-VA.
46	SACRAMENTO, CALIFORNIA	96	RENO, NEVADA
47	JACKSONVILLE, FLORIDA	97	SHREVEPORT, LOUISIANA
48	PROVIDENCE-WARWICK-PAWTUCKET, RHODE ISLAND	98	CHARLESTON-NORTH CHARLESTON, S.C.
49	CHARLOTTE-GASTONIA, NORTH CAROLINA	99	LONG BRANCH-ASBURY PARK, NEW JERSEY
50	RICHMOND, VIRGINIA	100	DAVENPORT-ROCK ISLAND-MOLINE, IOWA-ILL.

TABLE 9.1-2 (CONTINUED)

RANK YEAR 2000	SMSA	RANK YEAR 2000	SMSA
101	LANSING-EAST LANSING, MICHIGAN	151	NEW LONDON-NORWICH, CONNECTICUT
102	LEXINGTON-FAYETTE, KENTUCKY	152	SAGINAW, MICHIGAN
103	MOBILE, ALABAMA	153	SAVANNAH, GEORGIA
104	TACOMA, WASHINGTON	154	LINCOLN, NEBRASKA
105	NEWPORT NEWS-HAMPTON, VIRGINIA	155	LORAIN-ELYRIA, OHIO
106	OXNARD-SIMI VALLEY-VENTURA, CALIFORNIA	156	SARASOTA, FLORIDA
107	MANCHESTER-NASHUA, NEW HAMPSHIRE	157	TOPEKA, KANSAS
108	SPOKANE, WASHINGTON	158	UTICA-ROME, NEW YORK
109	CANTON, OHIO	159	WACO, TEXAS
110	NEW BEDFORD-FALL RIVER, MASSACHUSETTS	160	AMARILLO, TEXAS
111	PEORIA, ILLINOIS	161	BINGHAMTON, NEW YORK-PENNSYLVANIA
112	MADISON, WISCONSIN	162	ASHEVILLE, NORTH CAROLINA
113	TRENTON, NEW JERSEY	163	CEDAR RAPIDS, IOWA
114	COLORADO SPRINGS, COLORADO	164	SPRINGFIELD, ILLINOIS
115	EVANSVILLE, INDIANA-KENTUCKY	165	ATLANTIC CITY, NEW JERSEY
116	LANCASTER, PENNSYLVANIA	166	FORT SMITH, ARKANSAS-OKLAHOMA
117	BAKERSFIELD, CALIFORNIA	167	GREEN BAY, WISCONSIN
118	CORPUS CHRISTI, TEXAS	168	LIMA, OHIO
119	PORTLAND, MAINE	169	LONGVIEW-MARSHALL, TEXAS
120	SANTA BARBARA-SANTA MARIA-LOMPOC, CALIFORNIA	170	SPRINGFIELD, MISSOURI
121	CHARLESTON, WEST VIRGINIA	171	BILOXI-GULFPORT, MISSISSIPPI
122	EUGENE-SPRINGFIELD, OREGON	172	FAYETTEVILLE, NORTH CAROLINA
123	HUNTSVILLE, ALABAMA	173	FORT MYERS-CAPE CORAL, FLORIDA
124	YORK, PENNSYLVANIA	174	GALVESTON-TEXAS CITY, TEXAS
125	LAKELAND-WINTER HAVEN, FLORIDA	175	HAMILTON-MIDDLETOWN, OHIO
126	STOCKTON, CALIFORNIA	176	JOHNSTOWN, PENNSYLVANIA
127	APPLETON, OSHKOSH, WISCONSIN	177	LYNCHBURG, VIRGINIA
128	AUGUSTA, GEORGIA-SOUTH CAROLINA	178	PROVO-OREM, UTAH
129	ROANOKE, VIRGINIA	179	BATTLE CREEK, MICHIGAN
130	SOUTH BEND, INDIANA	180	BROWNSVILLE-HARLINGEN-SAN BENITO, TEXAS
131	ANN ARBOR, MICHIGAN	181	FARGO-MOORHEAD, NORTH DAKOTA-MINNESOTA
132	HUNTINGTON-ASHLAND, W.V.-KENTUCKY-OHIO	182	KILLEEN-TEMPLE, TEXAS
133	PENSACOLA, FLORIDA	183	LAFAYETTE, LOUISIANA
134	READING, PENNSYLVANIA	184	MCALLEN-PHARR-EDINBURG, TEXAS
135	MACON, GEORGIA	185	RACINE, WISCONSIN
136	MONTGOMERY, ALABAMA	186	WHEELING, WEST VIRGINIS-OHIO
137	ROCKFORD, ILLINOIS	187	FAYETTEVILLE-SPRINGDALE, ARKANSAS
138	LUBBOCK, TEXAS	188	LAKE CHARLES, LOUISIANA
139	KALAMAZOO-PORTAGE, MICHIGAN	189	POUGHKEEPSIE, NEW YORK
140	MELBOURNE-TITUSVILLE-COCOA, FLORIDA	190	TYLER, TEXAS
141	SALINAS-SEASIDE-MONTEREY, CALIFORNIA	191	FORT COLLINS, COLORADO
142	ERIE, PENNSYLVANIA	192	PARKERSBURG-MARETTA, WEST VIRGINIA-OHIO
143	VALLEJO-FAIRFIELD-NAPA, CALIFORNIA	193	SANTA CRUZ, CALIFORNIA
144	BOISE CITY, IDAHO	194	TERRE HAUTE, INDIANA
145	DULUTH-SUPERIOR, MINNESOTA-WISCONSIN	195	WATERLOO-CEDAR FALLS, IOWA
146	SALEM, OREGON	196	WICHITA FALLS, TEXAS
147	SANTA ROSA, CALIFORNIA	197	YAKIMA, WASHINGTON
148	COLUMBUS, GEORGIA-ALABAMA	198	ABILENE, TEXAS
149	DAYTONA BEACH, FLORIDA	199	GAINESVILLE, FLORIDA
150	MODESTO, CALIFORNIA	200	MONROE, LOUISIANA

TABLE 9.1-2 (CONTINUED)

RANK YEAR 2000	SMSA	RANK YEAR 2000	SMSA
201	MUSKEGON-NORTH SHORES-MUSKEGON HEIGHTS, MICH.	233	BURLINGTON, NORTH CAROLINA
202	PUEBLO, COLORADO	234	DUBUQUE, IOWA
203	SIOUX FALLS, SOUTH DAKOTA	235	EAU CLAIRE, WISCONSIN
204	STEUBENVILLE-WEIRTON, OHIO-WEST VIRGINIA	236	GREELEY, COLORADO
205	TALLAHASSEE, FLORIDA	237	KOKOMO, INDIANA
206	BILLINGS, MONTANA	238	LA CROSSE, WISCONSIN
207	CHAMPAIGN-URBANA-RANTOUL, ILLINOIS	239	MUNCIE, INDIANA
208	JACKSON, MICHIGAN	240	SHERMAN-DENISON, TEXAS
209	PASCAGOULA-MOSS POINT, MISSISSIPPI	241	VINELAND-MILLVILLE-BRIDGETON, NEW JERSEY
210	RICHLAND-KENNEWICK-PASCO, WASHINGTON	242	KENOSHA, WISCONSIN
211	ST. CLOUD, MINNESOTA	243	LEWISTON-AUBURN, MAINE
212	SPRINGFIELD, OHIO	244	MIDLAND, TEXAS
213	TEXARKANA, TEXAS-TEXARKANA, ARKANSAS	245	PANAMA CITY, FLORIDA
214	WILMINGTON, NORTH CAROLINA	246	TUSCALOOSA, ALABAMA
215	ALEXANDRIA, LOUISIANA	247	WILLIAMSPORT, PENNSYLVANIA
216	ANDERSON, INDIANA	248	BAY CITY, MICHIGAN
217	BURLINGTON, VERMONT	249	CHEYENNE, WYOMING
218	CLARKSVILLE-HOPKINSVILLE, TENNESSEE-KENTUCKY	250	GREAT FALLS, MONTANA
219	DECATUR, ILLINOIS	251	SAN ANGELO, TEXAS
220	MANSFIELD, OHIO	252	COLUMBIA, MISSOURI
221	ODESSA, TEXAS	253	GADSDEN, ALABAMA
222	PITTSFIELD, MASSACHUSETTS	254	GRAND FORKS, NORTH DAKOTA-MINNESOTA
223	ROCHESTER, MINNESOTA	255	LAREDO, TEXAS
224	SIOUX CITY, IOWA-NEBRASKA	256	OWENSBORO, KENTUCKY
225	BLOOMINGTON-NORMAL, ILLINOIS	257	PINE BLUFF, ARKANSAS
226	BRADENTON, FLORIDA	258	ST. JOSEPH, MISSOURI
227	FLORENCE, ALABAMA	259	BLOOMINGTON, INDIANA
228	LAFAYETTE-WEST LAFAYETTE, INDIANA	260	BRYAN-COLLEGE STATION, TEXAS
229	PETERSBURG-COLONIAL HEIGHTS-HOPEWELL, VIRGINIA	261	KANKAKEE, ILLINOIS
230	ALBANY, GEORGIA	262	LAWTON, OKLAHOMA
231	ALTOONA, PENNSYLVANIA	263	ELMIRA, NEW YORK
232	ANNISTON,ALABAMA	264	LAWRENCE, KANSAS

TABLE 9.1-3 BUSY HOUR CPS ADDRESSABLE TRAFFIC AND EARTH STATIONS YEAR 2000

	NUMBER OF EARTH STATIONS		CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS)				YEAR 2000				
			MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
TOTAL U.S.											
		VOICE	2557.734	6163.291	815.2504	1858.248	4909.625	334.2819	492.7552	191.5716	17322.76
DEDICATED		VIDEO	44.62444	89.55734	4.969603	24.91086	130.5754	6.187043	7.289986	1.816665	309.9313
EARTH	1922	DATA	2269.595	2221.307	173.0562	604.3217	1647.440	209.1417	[illegible]	117.5271	7915.557
STATIONS		TOTAL	4871.954	8474.155	993.2762	2487.480	6687.641	549.6106	[illegible]	310.9154	25548.24
		VOICE	6319.107	15226.95	2014.148	4590.965	12129.66	825.8729	1217.395	473.2945	42797.40
DEDICATED		VIDEO	110.2486	221.2593	12.27784	61.54448	322.5980	15.28563	18.01055	4.488230	765.7127
& SHARED	4239	DATA	5607.235	5487.935	427.5505	1493.030	4070.147	516.7030	1663.119	290.3612	19556.08
STATIONS		TOTAL	12036.59	20936.15	2453.977	6145.540	16522.41	1357.862	2898.525	768.1439	63119.19
LOS ANGELES-LONG BEACH, CALIFORNIA											
		VOICE	122.8714	252.8884	30.95918	84.91112	231.2869	7.911214	12.04432	6.106412	748.9789
DEDICATED		VIDEO	2.143721	3.674662	.1887210	1.138281	6.151257	.1464244	.1781877	.0579068	13.67916
EARTH	83	DATA	109.0295	91.14331	6.571818	27.61399	77.60904	4.949609	16.45409	3.746219	337.1175
STATIONS		TOTAL	234.0446	347.7063	37.71972	113.6634	315.0472	13.00725	28.67659	9.910539	1099.776
		VOICE	303.5647	624.7830	76.48739	209.7804	571.4146	19.54535	29.75654	15.08643	1850.418
DEDICATED		VIDEO	5.296252	9.078576	.4662518	2.812225	15.19722	.3617543	.4402283	.1430639	33.79558
& SHARED	182	DATA	269.3669	225.1776	16.23626	68.22279	191.7400	12.22845	40.65128	9.255365	832.8786
STATIONS		TOTAL	578.2278	859.0392	93.18990	280.8154	778.3518	32.13555	70 34805	24.48486	2717.093
NEW YORK, NEW YORK-NEW JERSEY											
		VOICE	63.89426	195.1426	40.25648	126.6655	238.4996	6.846544	15.26906	6.122240	692.6962
DEDICATED		VIDEO	1.114755	2.835571	.2453954	1.698022	6.343086	.1267190	.2258956	.0580569	12.64750
EARTH	75	DATA	56.69633	70.33118	8.545388	41.19295	80.02929	4.283504	20.85950	3.755929	285.6941
STATIONS		TOTAL	121.7053	268.3093	49.04726	169.5565	324.8720	11.25677	36.35446	9.936226	991.0378
		VOICE	157.8564	482.1169	99.45718	312.9383	589.2343	16.91499	37.72356	15.12553	1711.367
DEDICATED		VIDEO	2.754100	7.005528	.6062710	4.195114	15.67115	.3130704	.5580950	.1434348	31.24677
& SHARED	164	DATA	140.0733	173.7594	21.11214	101.7708	197.7194	10.58277	51.53525	9.279355	705.8324
STATIONS		TOTAL	300.6838	662.8818	121.1756	418.9042	802.6249	27.81084	89.81690	24.54832	2448.446
CHICAGO, ILLINOIS											
		VOICE	86.59544	209.9970	27.70313	80.39840	164.7763	7.090965	10.95098	4.854339	592.3665
DEDICATED		VIDEO	1.510819	3.051417	.1688727	1.077786	4.382356	.1312428	.1620125	.0460335	10.53054
EARTH	65	DATA	76.84013	75.68486	5.880644	26.14640	55.29120	4.436424	14.96045	2.978086	262.2182
STATIONS		TOTAL	164.9464	288.7333	33.75265	107.6226	224.4498	11.65863	26.07344	7.878459	865.1153
		VOICE	213.9417	518.8161	68.44303	198.6313	407.0943	17.51885	27.05536	11.99307	1463.494
DEDICATED		VIDEO	3.732612	7.538795	.4172150	2.662765	10.82700	.3242470	.4002661	.1137298	26.01663
& SHARED	144	DATA	189.8403	186.9861	14.52865	64.59700	136.6018	10.96058	36.96111	7.357624	647.8332
STATIONS		TOTAL	407.5146	713.3410	83.38890	265.8911	554.5231	28.80368	64.41674	19.46443	2137.344

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
DETROIT, MICHIGAN											
DEDICATED EARTH STATIONS	39	VOICE	70.12883	119.3468	13.81129	33.71810	96.05207	4.569925	4.913260	3.304498	345.8448
		VIDEO	1.223528	1.734201	.0841908	.4520102	2.554581	.0845823	.0726884	.0313364	6.237118
		DATA	62.22855	43.01370	2.931772	10.96548	32.23057	2.859150	6.712147	2.027274	162.9686
		TOTAL	133.5809	164.0947	16.82725	45.13559	130.8372	7.513657	11.69810	5.363109	515.0506
DEDICATED & SHARED STATIONS	85	VOICE	173.2595	294.8569	34.12200	83.30355	237.3051	11.29040	12.13864	8.164054	854.4401
		VIDEO	3.022835	4.284496	.2080009	1.116731	6.311317	.2089680	.1795832	.0774194	15.40935
		DATA	153.7411	106.2692	7.243201	27.09119	79.62848	7.063781	16.58295	5.008560	402.6284
		TOTAL	330.0234	405.4105	41.57320	111.5115	323.2449	18.56315	28.90118	13.25003	1272.478
PHILADELPHIA, PENNSYLVANIA-NEW JERSEY											
DEDICATED EARTH STATIONS	37	VOICE	43.36746	114.2156	14.28474	41.20694	106.6694	4.770330	10.47649	3.125350	338.1163
		VIDEO	.7566262	1.659640	.0870769	.5524023	2.836958	.0882915	.1549927	.0296376	6.165625
		DATA	38.48194	41.16436	3.032274	13.40093	35.79326	2.984532	14.31223	1.917369	151.0869
		TOTAL	82.60603	157.0396	17.40409	55.16027	145.2997	7.843154	24.94371	5.072357	495.3689
DEDICATED & SHARED STATIONS	82	VOICE	107.1431	282.1797	35.29171	101.8054	263.5362	11.78552	25.88309	7.721453	835.3463
		VIDEO	1.869312	4.100298	.2151312	1.364759	7.008955	.2181318	.3829231	.0732222	15.23272
		DATA	95.073[illegible]4	101.7002	7.491500	33.10818	88.43042	7.373549	35.35963	4.737029	373.2735
		TOTAL	204.0855	387.9802	42.99835	136.2783	358.9756	19.37720	61.62564	12.53170	1223.853
SAN FRANCISCO-OAKLAND, CALIFORNIA											
DEDICATED EARTH STATIONS	36	VOICE	28.29797	110.4336	19.88265	52.25576	102.7326	4.415739	11.14837	3.691853	332.8585
		VIDEO	.4937110	1.604685	.1212006	.7005180	2.732254	.0817285	.1649327	.0350097	5.934039
		DATA	25.11010	39.80128	4.220562	16.99412	34.47223	2.762684	15.23011	2.264912	140.8560
		TOTAL	53.90178	151.8395	24.2[illegible]	69.95040	139.9370	7.260151	26.54341	5.991775	479.6485
DEDICATED & SHARED STATIONS	80	VOICE	69.91264	272.8359	49.12183	129.1025	253.8098	10.90947	27.54303	9.121048	822.3562
		VIDEO	1.219757	3.964515	.2994369	1.730691	6.750274	.2019175	.4074808	.0864945	14.66057
		DATA	62.03671	98.33258	10.42727	41.98548	85.16670	6.825454	37.62733	5.595666	347.9972
		TOTAL	133.1691	375.1330	59.84854	172.8186	345.7268	17.93684	65.57784	14.80321	1185.014
DALLAS-FORT WORTH, TEXAS											
DEDICATED EARTH STATIONS	36	VOICE	52.57271	125.8619	15.25942	42.08969	76.79896	4.665499	5.378384	2.415392	325.0420
		VIDEO	.9172291	1.828870	.0930184	.5642360	2.042529	.0863512	.0795696	.0229051	5.634709
		DATA	46.65019	45.36180	3.239172	13.68801	25.77013	2.918944	7.347566	1.481817	146.4576
		TOTAL	100.1401	173.0526	18.59161	56.34193	104.6116	7.670794	12.80552	3.920115	477.1343
DEDICATED & SHARED STATIONS	79	VOICE	129.8855	310.9530	37.69974	103.9863	189.7386	11.52653	13.28777	5.967439	803.0449
		VIDEO	2.266095	4.518385	.2298101	1.393995	5.046249	.2133382	.1965838	.0565890	13.92104
		DATA	115.2534	112.0703	8.002660	33.81743	63.66739	7.211510	18.15281	3.660961	361.8365
		TOTAL	247.4050	427.5417	45.93221	139.1977	258.4522	18.95137	31.63717	9.684989	1178.802

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
WASHINGTON, D.C.-MARYLAND-VIRGINIA											
		VOICE	5.774342	77.41647	9.945299	29.09945	100.1222	4.147761	61.31460	2.613561	290.4337
DEDICATED		VIDEO	.1007442	1.124921	.0606246	.3900945	2.662829	.0767687	.9071087	.0247843	5.347875
EARTH	35	DATA	5.123840	27.90161	2.111125	9.463446	33.59632	2.595025	83.76364	1.603392	166.1584
STATIONS		TOTAL	10.99893	106.4430	12.11705	38.95299	136.3813	6.819554	145.9854	4.241737	461.9400
		VOICE	14.26602	191.2642	24.57074	71.89275	247.3607	10.24741	151.4831	6.457032	717.5420
DEDICATED		VIDEO	.2488974	2.779216	.1497783	.9637629	6.578754	.1896638	2.241092	.0612317	13.21240
& SHARED	77	DATA	12.65890	68.93340	5.215720	23.38028	83.00267	6.411237	206.9455	3.961321	410.5090
STATIONS		TOTAL	27.17382	262.9768	29.93624	96.23679	336.9421	16.84831	360.6697	10.47958	1141.263
BOSTON-LOWELL-BROCKTON-LAWRENCE-HAVERHILL, MASSACHUSETTS-NEW HAMPSHIRE											
		VOICE	42.44994	105.1523	12.35429	34.39760	97.17677	4.288806	7.179966	2.846118	305.8458
DEDICATED		VIDEO	.7406184	1.527944	.0753093	.4611192	2.584493	.0793792	.1062228	.0269896	5.602076
EARTH	34	DATA	37.66779	37.89788	2.622490	11.18646	32.60797	2.683269	9.808759	1.746063	136.2207
STATIONS		TOTAL	80.85835	144.5782	15.05209	46.04518	132.3692	7.051454	17.09495	4.619170	447.6686
		VOICE	104.8763	259.7882	30.52236	84.98230	240.0838	10.59587	17.73874	7.031585	755.6191
DEDICATED		VIDEO	1.829763	3.774921	.1860582	1.139236	6.385219	.1961133	.2624329	.0666802	13.84042
& SHARED	74	DATA	93.06160	93.63006	6.479093	27.63714	80.56088	6.629252	24.23341	4.313803	336.5452
STATIONS		TOTAL	199.7677	357.1931	37.18751	113.7587	327.0299	17.42124	42.23458	11.41207	1106.005
HOUSTON, TEXAS											
		VOICE	38.56012	112.4235	16.92120	33.57525	80.15918	8.642945	3.525352	2.129314	295.9368
DEDICATED		VIDEO	.6727532	1.633599	.1031483	.4500952	2.131897	.1599676	.0521552	.0201922	5.223808
EARTH	32	DATA	34.21617	40.51845	3.591925	10.91902	26.89767	5.407413	4.816085	1.306312	127.6730
STATIONS		TOTAL	73.44904	154.5755	20.61628	44.94437	109.1887	14.21033	8.393591	3.455818	428.8337
		VOICE	95.26617	277.7521	41.80533	82.95062	198.0403	21.35316	8.709692	5.260659	731.1380
DEDICATED		VIDEO	1.662096	4.035950	.2548369	1.112000	5.267039	.3952141	.1288541	.0498866	12.90588
& SHARED	71	DATA	84.53407	100.1044	8.874169	26.97641	66.45306	13.35949	11.89856	3.227359	315.4275
STATIONS		TOTAL	181.4623	381.8924	50.93433	111.0390	269.7604	35.10786	20.73711	8.537904	1059.471
MINNEAPOLIS-ST.PAUL, MINNESOTA-WISCONSIN											
		VOICE	33.14692	79.02502	10.04580	26.75129	60.25640	2.971465	3.303508	1.972019	217.4724
DEDICATED		VIDEO	.5783099	1.148294	.0612372	.3586162	1.602567	.0549972	.0488732	.0187006	3.871595
EARTH	24	DATA	29.41279	28.48135	2.132459	8.699801	20.21922	1.859081	4.513018	1.209813	96.52754
STATIONS		TOTAL	63.13803	108.6547	12.23950	35.80971	82.07819	4.885544	7.865400	3.200533	317.8716
		VOICE	81.89240	195.2383	24.81905	66.09143	148.8687	7.341267	8.161609	4.872048	537.2848
DEDICATED		VIDEO	1.428766	2.836962	.1512919	.8859929	3.959282	.1358755	.1207456	.0462014	9.565117
& SHARED	53	DATA	72.66690	70.36569	5.268429	21.49363	49.95338	4.593024	11.14981	2.988950	238.4798
STATIONS		TOTAL	155.9881	268.4409	30.23877	88.47104	202.7814	12.07017	19.43217	7.907199	785.3297

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
ATLANTA, GEORGIA											
		VOICE	17.52319	80.99029	14.04032	25.48122	49.46839	2.879775	5.685820	1.841882	197.9109
DEDICATED		VIDEO	.3057248	1.176851	.0855870	.3415902	1.315651	.0533002	.0841179	.0174665	3.380288
EARTH	21	DATA	15.54914	29.18965	2.980390	8.286761	16.59927	1.801716	7.767564	1.129975	83.30447
STATIONS		TOTAL	33.37806	111.3568	17.10630	34.10957	67.38331	4.734791	13.53750	2.989324	284.5956
		VOICE	43.29260	200.0937	34.68786	62.95360	122.2160	7.114737	14.04732	4.550533	488.9563
DEDICATED		VIDEO	.7553202	2.907514	.2114502	.8439286	3.250432	.1316828	.2078208	.0431525	8.351301
& SHARED	47	DATA	38.41552	72.11561	7.363317	20.47317	41.00997	4.451298	19.19045	2.791704	205.8110
STATIONS		TOTAL	82.46343	275.1168	42.26262	84.27071	166.4764	11.69772	33.44559	7.385390	703.1187
DENVER-BOULDER, COLORADO											
		VOICE	20.26685	69.36923	10.41484	25.51550	54.22766	4.318561	5.805396	1.811370	191.7294
DEDICATED		VIDEO	.3535931	1.007988	.0634868	.3420496	1.442228	.0799299	.0858870	.0171771	3.392339
EARTH	21	DATA	17.98372	25.00131	2.210797	8.297907	18.19626	2.701884	7.930920	1.111256	83.43405
STATIONS		TOTAL	38.60416	95.37853	12.68913	34.15545	73.86615	7.100375	13.82220	2.939804	278.5558
		VOICE	50.07105	171.3828	25.73079	63.03828	133.9742	10.66939	14.34274	4.475150	473.6844
DEDICATED		VIDEO	.8735830	2.490323	.1568497	.8450638	3.563150	.1974739	.2121914	.0424376	8.381073
& SHARED	46	DATA	44.43036	61.76795	5.461968	20.50071	44.95547	6.675244	19.59404	2.745457	206.1312
STATIONS		TOTAL	95.37499	235.6411	31.34961	84.38406	182.4928	17.54210	34.14897	7.263044	688.1967
ST.LOUIS, MISSOURI-ILLINOIS											
		VOICE	29.44575	63.48284	10.45382	19.32549	55.83826	2.657978	5.210374	1.636570	188.0511
DEDICATED		VIDEO	.5137361	.9224543	.0637244	.2590691	1.485063	.0491951	.0770840	.0155195	3.385845
EARTH	21	DATA	26.12857	22.87980	2.219070	6.284852	18.73671	1.662950	7.118043	1.004019	86.03402
STATIONS		TOTAL	56.08806	87.28509	12.73662	25.86941	76.06003	4.370123	12.40550	2.656109	277.4709
		VOICE	72.74833	156.8399	25.82709	47.74533	137.9534	6.566769	12.87269	4.043292	464.5968
DEDICATED		VIDEO	1.269230	2.279005	.1574367	.6400531	3.668979	.1215408	.1904429	.0383424	8.365030
& SHARED	46	DATA	64.55295	56.52657	5.482409	15.52728	46.29068	4.108464	17.58575	2.480517	212.5546
STATIONS		TOTAL	138.5705	215.6455	31.46693	63.91266	187.9130	10.79677	30.64889	6.562151	685.5164
NEWARK, NEW JERSEY											
		VOICE	24.22889	48.92029	16.46691	21.67317	52.72986	2.365621	4.526266	1.611102	172.5221
DEDICATED		VIDEO	.4227182	.7108493	.1003790	.2905410	1.402392	.0437840	.0669631	.0152780	3.052905
EARTH	19	DATA	21.49941	17.63133	3.495491	7.048342	17.69367	1.480038	6.183462	.9883940	76.02013
STATIONS		TOTAL	46.15102	67.26247	20.06278	29.01205	71.82592	3.889444	10.77669	2.614774	251.5951
		VOICE	59.85961	120.8619	40.68296	53.54547	130.2738	5.844476	11.18254	3.980370	426.2311
DEDICATED		VIDEO	1.044363	1.756216	.2479952	.7178073	3.464734	.1081722	.1654382	.0377457	7.542471
& SHARED	42	DATA	53.11619	43.55975	8.635919	17.41355	43.71378	3.656565	15.27679	2.441915	187.8144
STATIONS		TOTAL	114.0202	166.1779	49.56687	71.67683	177.4523	9.609213	26.62477	6.460030	621.5880

TABLE 9.1-3 (CONTINUED)

ORIGINAL PAGE IS
OF POOR QUALITY

	NUMBER OF EARTH STATIONS		CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000 MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
CLEVELAND, OHIO											
DEDICATED EARTH STATIONS	18	VOICE	30.75532	59.10635	7.465525	16.76665	44.86698	2.111456	3.059275	1.408399	165.5400
		VIDEO	.5365840	.8588605	.0455083	.2247665	1.193273	.0390798	.0452599	.0133558	2.956688
		DATA	27.29062	21.30247	1.584734	5.452692	15.05526	1.321021	4.179364	.8640378	77.05020
		TOTAL	58.58252	81.26768	9.095767	22.44411	61.11551	3.471558	7.283898	2.285793	245.5468
DEDICATED & SHARED STATIONS	41	VOICE	75.98373	146.0274	18.44424	41.42350	110.8478	5.216539	7.558208	3.479574	408.9811
		VIDEO	1.325678	2.121891	.1124324	.5553054	2.948086	.0965501	.1118187	.0329966	7.304758
		DATA	67.42387	52.62964	3.915225	13.47136	37.19534	3.263700	10.32549	2.134682	190.3593
		TOTAL	144.7333	200.7790	22.47190	55.45016	150.9913	8.576790	17.99551	5.647252	606.6451
MIAMI, FLORIDA											
DEDICATED EARTH STATIONS	18	VOICE	14.58007	61.51329	11.67591	23.42500	52.54132	1.998635	2.846642	1.249253	169.8301
		VIDEO	.2543766	.8938352	.0711740	.3140253	1.397378	.0369917	.0421142	.0118466	3.021742
		DATA	12.93757	22.16996	2.478489	7.618055	17.63041	1.250436	3.888880	.7664034	68.74020
		TOTAL	27.77202	84.57708	14.22558	31.35708	71.56910	3.286063	6.777636	2.027503	241.5921
DEDICATED & SHARED STATIONS	40	VOICE	36.02136	151.9740	28.84638	57.87352	129.8080	4.937805	7.032880	3.086390	419.5803
		VIDEO	.6284598	2.208299	.1758417	.7758272	3.452345	.0913912	.1040468	.0292681	7.465479
		DATA	31.96341	54.77284	6.123325	18.82108	43.55747	3.089311	9.607821	1.893467	169.8287
		TOTAL	68.61323	208.9551	35.14554	77.47042	176.8178	8.118508	16.74475	5.009125	596.8745
BALTIMORE, MARYLAND											
DEDICATED EARTH STATIONS	18	VOICE	16.34421	55.69516	8.688009	18.35454	47.93943	2.286400	10.12967	1.965870	161.4033
		VIDEO	.2851552	.8092934	.0529604	.2460530	1.274987	.0423177	.1498617	.0186423	2.879271
		DATA	14.50297	20.07305	1.844235	5.969090	16.08623	1.430474	13.83843	1.206040	74.95052
		TOTAL	31.13233	76.57751	10.58521	24.56968	65.30065	3.759192	24.11796	3.190552	239.2331
DEDICATED & SHARED STATIONS	40	VOICE	40.37981	137.5998	21.46449	45.34652	118.4386	5.648753	25.02624	4.856855	398.7611
		VIDEO	.7045011	1.999431	.1308433	.6078956	3.149968	.1045497	.3702466	.0460573	7.113493
		DATA	35.83087	49.59224	4.556346	14.74716	39.74245	3.534112	34.18907	2.979629	185.1719
		TOTAL	76.91518	189.1915	26.15168	60.70157	161.3310	9.287415	59.58556	7.882541	591.0464
ANAHEIM-SANTA ANA-GARDEN GROVE, CALIFORNIA											
DEDICATED EARTH STATIONS	18	VOICE	27.66112	59.35243	4.014985	19.46930	44.50651	3.082345	1.803328	1.246681	161.1367
		VIDEO	.4825998	.8624364	.0244745	.2609969	1.183686	.0570495	.0266790	.0118222	2.909744
		DATA	24.54498	21.39117	.8522753	6.331621	14.93430	1.928453	2.463579	.7648257	73.21121
		TOTAL	52.68870	81.60604	4.891734	26.06192	60.62450	5.067847	4.293587	2.023329	237.2576
DEDICATED & SHARED STATIONS	39	VOICE	68.33923	146.6354	9.919374	48.10062	109.9573	7.615205	4.455282	3.080036	398.1024
		VIDEO	1.192305	2.130725	.0604665	.6448160	2.924401	.1409457	.0659129	.0292078	7.188780
		DATA	60.64055	52.84876	2.105621	15.64283	36.89651	4.764412	6.086490	1.889569	180.8747
		TOTAL	130.1721	201.6149	12.08546	64.38826	149.7782	12.52056	10.60768	4.998813	586.1660

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
PITTSBURGH, PENNSYLVANIA											
		VOICE	24.71446	55.40884	8.353254	15.04958	49.44522	3.323742	2.451707	1.407194	160.1540
DEDICATED		VIDEO	.4311899	.8051330	.0509198	.2017481	1.315035	.0615173	.0362714	.0133444	2.915159
EARTH	18	DATA	21.93028	19.96986	1.773175	4.894281	16.59150	2.079481	3.349348	.8632985	71.45122
STATIONS		TOTAL	47.07593	76.18384	10.17735	20.14561	67.35175	5.464740	5.837327	2.283837	234.5204
		VOICE	61.05925	136.8924	20.63745	37.18131	122.1588	8.211597	6.057159	3.476597	395.6746
DEDICATED		VIDEO	1.065293	1.989152	.1258018	.4984365	3.248909	.1519840	.0896116	.0329684	7.202156
& SHARED	39	DATA	54.18069	49.33730	4.380786	12.09175	40.99076	5.137542	8.274860	2.132855	176.5266
STATIONS		TOTAL	116.3052	188.2189	25.14404	49.77150	166.3984	13.50112	14.42163	5.642420	579.4033
SEATTLE-EVERETT, WASHINGTON											
		VOICE	21.26426	56.46744	8.327313	22.79392	42.97724	2.732756	3.417368	1.361997	159.3423
DEDICATED		VIDEO	.3709946	.8205152	.0507616	.3055653	1.143014	.0505791	.0505577	.0129158	2.804903
EARTH	17	DATA	18.86876	20.35139	1.767669	7.412821	14.42115	1.709734	4.668565	.8355707	70.03565
STATIONS		TOTAL	40.50401	77.63935	10.14574	30.51230	58.54140	4.493070	8.136490	2.210483	232.1828
		VOICE	52.53522	139.5078	20.57336	56.31438	106.1791	6.751516	8.442909	3.364934	393.6692
DEDICATED		VIDEO	.9165750	2.027155	.1254111	.7549261	2.823916	.1249601	.1249072	.0319095	6.929760
& SHARED	39	DATA	46.61692	50.27990	4.367182	18.31403	35.62872	4.224050	11.53410	2.064351	173.0293
STATIONS		TOTAL	100.0687	191.8149	25.06595	75.38333	144.6317	11.10053	20.10192	5.461194	573.6282
NASSAU-SUFFOLK, NEW YORK											
		VOICE	13.98381	52.05180	5.093295	14.20926	43.30239	2.822356	2.855058	1.662411	135.9804
DEDICATED		VIDEO	.2439737	.7563525	.0310477	.1904831	1.151661	.0522375	.0422387	.0157646	2.483759
EARTH	15	DATA	12.40848	18.75995	1.081172	4.621000	14.53026	1.765792	3.900378	1.019872	58.08690
STATIONS		TOTAL	26.63627	71.56810	6.205515	19.02074	58.98431	4.640386	6.797675	2.698048	196.5510
		VOICE	34.54825	128.5986	12.58343	35.10522	106.9824	6.972880	7.053674	4.107134	335.9515
DEDICATED		VIDEO	.6027586	1.868636	.0767061	.4706053	2.845281	.1290573	.1043544	.0389478	6.136346
& SHARED	33	DATA	30.65625	46.34811	2.671131	11.41659	35.89828	4.362545	9.636227	2.519683	143.5088
STATIONS		TOTAL	65.80726	176.8153	15.33127	46.99241	145.7259	11.46448	16.79426	6.665765	485.5967
PHOENIX, ARIZONA											
		VOICE	16.07345	51.58808	5.797481	18.47654	36.17643	2.923268	2.984798	1.385974	135.4060
DEDICATED		VIDEO	.2804313	.7496144	.0353403	.2476884	.9621408	.0541052	.0441581	.0131431	2.386622
EARTH	15	DATA	14.26271	18.59282	1.230652	6.008765	12.13912	1.828927	4.077618	.8502806	58.99089
STATIONS		TOTAL	30.61659	70.93052	7.063474	24.73299	49.27769	4.806300	7.106574	2.249398	196.7835
		VOICE	39.71087	127.4529	14.32319	45.64792	89.37706	7.222191	7.374206	3.424172	334.5325
DEDICATED		VIDEO	.6928303	1.851988	.0873113	.6119362	2.377054	.1336716	.1090965	.0324713	5.896359
& SHARED	33	DATA	35.23729	45.93521	3.040435	14.84518	29.99076	4.518526	10.07412	2.100693	145.7422
STATIONS		TOTAL	75.64099	175.2401	17.45094	61.10504	121.7449	11.87439	17.55742	5.557337	486.1711

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
PORTLAND, OREGON-WASHINGTON											
		VOICE	17.56632	48.99112	6.650666	18.00796	36.31880	2.291776	3.265079	1.145727	134.2374
DEDICATED		VIDEO	.3064772	.7118785	.0405411	.2414069	.9659272	.0424172	.0483047	.0108649	2.367818
EARTH	15	DATA	15.58740	17.65685	1.411761	5.856379	12.18689	1.433837	4.460519	.7028915	59.29653
STATIONS		TOTAL	33.46020	67.35985	8.102968	24.10575	49.47161	3.768031	7.773902	1.859484	195.9018
		VOICE	43.39914	121.0369	16.43106	44.49026	89.72879	5.662035	8.066666	2.830620	331.6455
DEDICATED		VIDEO	.7571790	1.758759	.1001604	.5964171	2.386408	.1047955	.1193410	.0268426	5.849903
& SHARED	33	DATA	38.51006	43.62281	3.487880	14.46870	30.10878	3.542422	11.02011	1.736556	146.4973
STATIONS		TOTAL	82.66637	166.4185	20.01910	59.55538	122.2240	9.309252	19.20611	4.594018	483.9927
MILWAUKEE, WISCONSIN											
		VOICE	25.67672	44.79310	4.842749	14.23538	37.33885	1.526594	1.751719	1.061471	131.2266
DEDICATED		VIDEO	.4479782	.6508781	.0295204	.1908333	.9930562	.0282549	.0259155	.0100659	2.376503
EARTH	15	DATA	22.78413	16.14385	1.027988	4.629496	12.52917	.9551053	2.393073	.6512009	61.11401
STATIONS		TOTAL	48.90883	61.58782	5.900258	19.05571	50.86107	2.509954	4.170708	1.722737	194.7171
		VOICE	63.43659	110.6653	11.96444	35.16977	92.24891	3.771585	4.327775	2.622457	324.2068
DEDICATED		VIDEO	1.106770	1.608052	.0729328	.4714706	2.453433	.0698062	.0640266	.0248686	5.871359
& SHARED	32	DATA	56.29021	39.88480	2.539735	11.43758	30.95441	2.359672	5.912299	1.608849	150.9876
STATIONS		TOTAL	120.8336	152.1582	14.57711	47.07882	125.6568	6.201063	10.30410	4.256175	481.0658
SAN DIEGO, CALIFORNIA											
		VOICE	12.49650	45.55319	4.318976	14.44822	36.02400	3.827666	6.834894	1.402137	124.9056
DEDICATED		VIDEO	.2180247	.6619227	.0263276	.1936865	.9580868	.0708442	.1011177	.0132964	2.243307
EARTH	14	DATA	11.08872	16.41779	.9168048	4.698713	12.08797	2.394759	9.337347	.8601965	57.80230
STATIONS		TOTAL	23.80324	62.63290	5.262109	19.34062	49.07005	6.293269	16.27336	2.275630	184.9512
		VOICE	30.87370	112.5432	10.67041	35.69560	89.00047	9.456586	16.88621	3.464104	308.5902
DEDICATED		VIDEO	.5386494	1.635338	.0650447	.4785197	2.367038	.1750268	.2498203	.0328499	5.542287
& SHARED	31	DATA	27.39566	40.56160	2.265047	11.60858	29.86439	5.916463	23.06874	2.125191	142.8057
STATIONS		TOTAL	58.80801	154.7401	13.00050	47.78270	121.2319	15.54808	40.20477	5.622146	456.9382
SAN JOSE, CALIFORNIA											
		VOICE	27.82028	36.01658	3.415996	9.915609	38.27453	1.564898	1.860338	1.004148	119.8724
DEDICATED		VIDEO	.4853767	.5233486	.0208232	.1329243	1.017941	.0289638	.0275225	.0095223	2.246423
EARTH	14	DATA	24.68622	12.98071	.7251258	3.224660	12.84314	.9790699	2.341461	.6160342	58.59642
STATIONS		TOTAL	52.99187	49.52064	4.161945	13.27319	52.13561	2.572931	4.429321	1.629705	180.7152
		VOICE	68.73245	88.98215	8.439519	24.49739	94.56060	3.866218	4.596128	2.480837	296.1553
DEDICATED		VIDEO	1.199166	1.292979	.0514456	.3284013	2.514914	.0715577	.0679967	.0235257	5.549986
& SHARED	30	DATA	60.98948	32.06999	1.791487	7.966807	31.73011	2.418879	6.278903	1.521967	144.7676
STATIONS		TOTAL	130.9211	122.3451	10.28245	32.79259	128.8056	6.356654	10.94303	4.026329	446.4729

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

	NUMBER OF EARTH STATIONS	CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000	MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
TAMPA-ST.PETERSBURG, FLORIDA											
		VOICE	10.58946	50.48241	5.523341	17.04444	36.42122	2.464144	2.255749	1.066105	125.8469
DEDICATED		VIDEO	.1847529	.7335480	.0336692	.2284904	.9686511	.0456075	.0333723	.0101098	2.238201
EARTH	14	DATA	9.396515	18.19433	1.172460	5.543032	12.22125	1.541678	3.081643	.6540438	51.80495
STATIONS		TOTAL	20.17073	69.41028	6.729470	22.81597	49.61112	4.051429	5.370764	1.730258	179.8900
		VOICE	26.16219	124.7212	13.64590	42.10980	89.98183	6.087884	5.573026	2.633905	310.9158
DEDICATED		VIDEO	.4564483	1.812295	.0831827	.5645057	2.393138	.1126774	.0824492	.0249772	5.529674
& SHARED	30	DATA	23.21492	44.95069	2.896665	13.69455	30.19369	3.808852	7.613472	1.615873	127.9887
STATIONS		TOTAL	49.83356	171.4842	16.62575	56.36886	122.5687	10.00941	13.26895	4.274756	444.4342
KANSAS CITY, MISSOURI-KANSAS											
		VOICE	15.11917	45.26238	8.496776	15.54716	31.98167	1.694407	3.822783	1.014435	122.9388
DEDICATED		VIDEO	.2637821	.6576970	.0517946	.2084184	.8505779	.0313609	.0565555	.0096198	2.129806
EARTH	13	DATA	13.41594	16.31298	1.803642	5.056099	10.73155	1.060097	5.222415	.6223450	54.22506
STATIONS		TOTAL	28.79889	62.23305	10.35221	20.81167	43.56380	2.785864	9.101753	1.646400	179.2936
		VOICE	37.35324	111.8247	20.99204	38.41062	79.01354	4.186181	9.444523	2.506251	303.7311
DEDICATED		VIDEO	.6516971	1.624898	.1279632	.5149161	2.101428	.0774798	.1397254	.0237667	5.261874
& SHARED	30	DATA	33.14526	40.30265	4.456056	12.49154	26.51324	2.619062	12.90244	1.537558	133.9678
STATIONS		TOTAL	71.15020	153.7522	25.57605	51.41708	107.6282	6.882723	22.48669	4.067576	442.9608
CINCINNATI, OHIO-KENTUCKY-INDIANA											
		VOICE	19.19240	40.75963	5.346838	11.64131	31.55761	1.654759	2.140460	.8405420	113.1336
DEDICATED		VIDEO	.3348472	.5922687	.0325933	.1560584	.8392996	.0306270	.0316667	.0079708	2.025332
EARTH	13	DATA	17.03030	14.69015	1.134993	3.785877	10.58926	1.035291	2.924144	.5156636	51.70567
STATIONS		TOTAL	36.55754	56.04205	6.514424	15.58325	42.98616	2.720677	5.096271	1.364177	166.8646
		VOICE	47.41651	100.7003	13.20984	28.76089	77.96586	4.088228	5.288195	2.076633	279.5064
DEDICATED		VIDEO	.8272695	1.463252	.0805245	.3855560	2.073564	.0756668	.0782353	.0196926	5.003761
& SHARED	28	DATA	42.07486	36.29331	2.804100	9.353344	26.16169	2.557778	7.224357	1.273993	127.7434
STATIONS		TOTAL	90.31863	138.4568	16.09446	38.49979	106.2011	6.721672	12.59079	3.370318	412.2536
NEW ORLEANS, LOUISIANA											
		VOICE	9.269488	42.42296	8.931385	13.85764	33.39383	2.209195	3.246341	1.044189	114.3750
DEDICATED		VIDEO	.1617235	.6164382	.0544439	.1857695	.8881352	.0408888	.0480275	.0099020	2.005329
EARTH	12	DATA	8.225244	15.28963	1.895898	4.506652	11.20540	1.382171	4.434920	.6405991	47.58052
STATIONS		TOTAL	17.65646	58.32903	10.88173	18.55007	45.48736	3.632255	7.729288	1.694690	163.9609
		VOICE	22.90109	104.8097	22.06578	34.23653	82.50239	5.458011	8.020371	2.579762	282.5736
DEDICATED		VIDEO	.3995522	1.522965	.1345085	.4589601	2.194216	.1010194	.1186561	.0244638	4.954341
& SHARED	27	DATA	20.32119	37.77438	4.683982	11.13408	27.68394	3.414775	10.95686	1.582657	117.5519
STATIONS		TOTAL	43.62183	144.1070	26.88427	45.82957	112.3805	8.973806	19.09589	4.186882	405.0798

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
INDIANAPOLIS, INDIANA											
		VOICE	15.65170	36.57616	5.225346	13.76657	25.68849	1.591068	3.049747	.9708405	102.5199
DEDICATED		VIDEO	.2730732	.5314797	.0318527	.1845486	.6832058	.0294482	.0451190	.0092044	1.787934
EARTH	11	DATA	13.88848	13.18239	1.109203	4.477032	8.619855	.9954434	4.166347	.5956004	47.03435
STATIONS		TOTAL	29.81326	50.29003	6.366402	18.42815	34.99155	2.615960	7.261213	1.575647	151.3422
		VOICE	38.66891	90.36464	12.90968	34.01151	63.46569	3.930875	7.534668	2.398547	253.2845
DEDICATED		VIDEO	.6746514	1.313067	.0786948	.4559436	1.687920	.0727544	.1114704	.0227453	4.417248
& SHARED	25	DATA	34.31271	32.56825	2.740384	11.06090	21.29611	2.459331	10.29333	1.471483	116.2025
STATIONS		TOTAL	73.65628	124.2460	15.72876	45.52836	86.44972	6.462960	17.93947	3.892776	373.9043
HARTFORD-NEW BRITAIN-BRISTOL, CONNECTICUT											
		VOICE	14.01138	31.50143	2.767602	20.53684	23.97850	1.227629	1.433643	.9259790	96.38301
DEDICATED		VIDEO	.2444548	.4577399	.0168707	.2753079	.6377273	.0227215	.0212098	.0087810	1.684813
EARTH	11	DATA	12.43295	11.35341	.5874889	6.678796	8.046063	.7680596	1.958541	.5680783	42.39338
STATIONS		TOTAL	26.68879	43.31258	3.371961	27.49094	32.66229	2.018410	3.413394	1.502838	140.4612
		VOICE	34.61636	77.82704	6.837605	50.73807	59.24101	3.032966	3.541941	2.287713	238.1227
DEDICATED		VIDEO	.6039470	1.130887	.0416807	.6801725	1.575562	.0561355	.0524007	.0216943	4.162479
& SHARED	23	DATA	30.71669	28.04959	1.451443	16.50055	19.87851	1.897559	4.838749	1.403488	104.7366
STATIONS		TOTAL	65.93700	107.0075	8.330728	67.91880	80.69508	4.986661	8.433091	3.712895	347.0218
SALT LAKE CITY-OGDEN, UTAH											
		VOICE	9.768895	35.39538	4.983534	10.59582	23.75625	1.996619	5.158923	.9687658	92.62418
DEDICATED		VIDEO	.1704366	.5143219	.0303786	.1420430	.6318162	.0369543	.0763228	.0091868	1.611460
EARTH	10	DATA	8.668391	12.75682	1.057873	3.445873	7.971484	1.249174	7.047754	.5943275	42.79170
STATIONS		TOTAL	18.60772	48.66652	6.071786	14.18374	32.35955	3.282748	12.28300	1.572280	137.0273
		VOICE	24.13492	87.44740	12.31226	26.17792	58.69190	4.932824	12.74557	2.393421	228.8362
DEDICATED		VIDEO	.4210787	1.270678	.0750531	.3509298	1.560958	.0912990	.1885623	.0226967	3.981255
& SHARED	23	DATA	21.41603	31.51685	2.613568	8.513334	19.69425	3.086195	17.41210	1.468339	105.7207
STATIONS		TOTAL	45.97202	120.2349	15.00088	35.04218	79.94712	8.110319	30.34624	3.884457	338.5381
SAN ANTONIO, TEXAS											
		VOICE	8.443774	34.25667	2.917251	10.74491	23.12191	1.360909	6.837753	.9670513	88.65222
DEDICATED		VIDEO	.1473174	.4978047	.0177830	.1440415	.6149456	.0251883	.1011600	.0091705	1.557411
EARTH	10	DATA	7.492550	12.34714	.6192555	3.494356	7.758631	.8514454	9.341252	.5932757	42.49791
STATIONS		TOTAL	16.08364	47.10362	3.554290	14.38330	31.49549	2.237543	16.28016	1.569498	132.7075
		VOICE	20.86109	84.63907	7.207327	26.54624	57.12472	3.362245	16.89327	2.389186	219.0231
DEDICATED		VIDEO	.3639606	1.229870	.0439344	.3558673	1.519277	.0622300	.2499247	.0226565	3.847721
& SHARED	22	DATA	18.51101	30.50470	1.529925	8.633115	19.16838	2.103571	23.07839	1.465740	104.9948
STATIONS		TOTAL	39.73605	116.3736	8.781187	35.53522	77.81238	5.528046	40.22158	3.877582	327.8657

TABLE 9.1-3 (CONTINUED)

	NUMBER OF EARTH STATIONS	CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000									
			MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
COLUMBUS, OHIO											
		VOICE	11.18663	33.55144	3.964537	12.40781	25.13293	1.367256	1.770139	1.009503	90.39024
DEDICATED		VIDEO	.1951716	.4075281	.0241670	.1663337	.6684302	.0253058	.0261880	.0095731	1.602698
EARTH	10	DATA	9.926410	12.09225	.8415666	4.035151	8.433434	.8554161	2.418239	.6193192	39.22178
STATIONS		TOTAL	21.30821	46.13122	4.830270	16.60930	34.23479	2.247977	4.214566	1.638395	131.2147
		VOICE	27.63755	82.89179	9.794737	30.65460	62.09312	3.377925	4.373285	2.494066	223.3171
DEDICATED		VIDEO	.4821886	1.204481	.0597068	.4109422	1.651416	.0625202	.0646999	.0236511	3.959606
& SHARED	22	DATA	24.52407	29.87497	2.079164	9.969197	20.83554	2.113381	5.974472	1.530083	96.90088
STATIONS		TOTAL	52.64381	113.9712	11.93361	41.03474	84.58008	5.553827	10.41246	4.047799	324.1776
LOUISVILLE, KENTUCKY-INDIANA											
		VOICE	15.30227	31.06960	4.419481	10.15960	23.54182	1.369234	2.094091	.7640252	88.72013
DEDICATED		VIDEO	.2669767	.4514651	.0269403	.1361952	.6261133	.0253424	.0309807	.0072452	1.571259
EARTH	10	DATA	13.57841	11.197[illegible]	.9381393	3.304010	7.899532	.8566541	2.860798	.4687214	41.10404
STATIONS		TOTAL	29.14766	42.71884	5.384561	13.59981	32.06746	2.251231	4.985869	1.239992	131.3954
		VOICE	37.80561	76.76019	10.91872	25.10020	58.16214	3.382814	5.173636	1.887592	219.1909
DEDICATED		VIDEO	.6595894	1.115384	.0665583	.3364823	1.546868	.0626107	.0765405	.0178999	3.881934
& SHARED	22	DATA	33.54666	27.66508	2.317756	8.162848	19.51649	2.116439	7.067853	1.158018	101.5511
STATIONS		TOTAL	72.01186	105.5407	13.30303	33.59953	79.22550	5.561864	12.31803	3.063509	324.6240
MEMPHIS, TENNESSEE-ARKANSAS-MISSISSIPPI											
		VOICE	10.03339	37.42698	5.101768	8.898881	23.69649	1.207021	2.465840	.8898637	89.72024
DEDICATED		VIDEO	.1750513	.5[illegible]2427	.0310994	.1192945	.6302269	.0223401	.0364805	.0084385	1.566774
EARTH	10	DATA	8.903094	13.48903	1.082971	2.894010	7.951432	.7551664	3.368656	.5459219	38.99028
STATIONS		TOTAL	19.11154	51.45985	6.215838	11.91219	32.27815	1.984528	5.870977	1.444224	130.2773
		VOICE	24.78839	92.46666	12.60437	21.98547	58.54427	2.982052	6.092076	2.198487	221.6618
DEDICATED		VIDEO	.4324797	1.343611	.0768337	.2947277	1.557031	.0551932	.0901282	.0208482	3.870853
& SHARED	22	DATA	21.99588	33.32584	2.675575	7.149906	19.64471	1.865705	8.322562	1.348748	96.32893
STATIONS		TOTAL	47.21674	127.1361	15.35678	29.43011	79.74601	4.902951	14.50477	3.568083	321.8615
RIVERSIDE-SAN BERNADINO-ONTARIO, CALIFORNIA											
		VOICE	9.038114	32.97260	3.681923	7.514243	27.40120	2.059041	2.690224	1.216480	86.57382
DEDICATED		VIDEO	.1576868	.4791171	.0224443	.1007327	.7287565	.0381097	.0398001	.0115358	1.578183
EARTH	9	DATA	8.019936	11.88363	.7815752	2.443711	9.194558	1.288228	3.675193	.7462973	38.03313
STATIONS		TOTAL	17.21574	45.33535	4.485943	10.05869	37.32451	3.385378	6.405218	1.974313	126.1851
		VOICE	22.32946	81.46172	9.096517	18.56460	67.69707	5.087041	6.646437	3.005420	213.8883
DEDICATED		VIDEO	.3895791	1.183701	.0554505	.2488690	1.800457	.0941533	.0983296	.0285003	3.899040
& SHARED	21	DATA	19.81396	29.35956	1.930951	6.037403	22.71597	3.182680	9.079889	1.843793	93.96420
STATIONS		TOTAL	42.53300	112.0050	11.08292	24.850[illegible]	92.21350	8.363875	15.82466	4.877714	311.7515

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
NASHVILLE-DAVIDSON, TENNESSEE											
		VOICE	11.66674	30.21600	3.929731	10.02826	22.35719	1.565794	1.359484	.8744708	81.99768
DEDICATED		VIDEO	.2035481	.4390617	.0239549	.1344345	.5946073	.0289804	.0201127	.0082926	1.452992
EARTH	9	DATA	10.35244	10.89013	.8341783	3.261295	7.502027	.9796305	1.857230	.5364786	36.21341
STATIONS		TOTAL	22.22273	41.54519	4.787865	13.42399	30.45363	2.574405	3.236626	1.419242	119.6641
		VOICE	28.82372	74.65130	9.708748	24.77570	55.23542	3.868432	3.358724	2.160457	202.5825
DEDICATED		VIDEO	.5028836	1.084741	.0591826	.3321322	1.469030	.0715987	.0496901	.0204875	3.589745
& SHARED	20	DATA	25.57662	26.90502	2.060911	8.057317	18.53442	2.420264	4.588450	1.325418	89.46842
STATIONS		TOTAL	54.90322	102.6411	11.82884	33.16515	75.23887	6.360294	7.996864	3.506363	295.6407
SMSA 41-60											
		VOICE	191.8286	476.4539	64.09727	146.5547	373.0876	23.98101	35.93747	13.37408	1325.307
DEDICATED		VIDEO	3.346669	6.923241	.3907241	1.964649	9.922560	.4438516	.5316709	.1268258	23.65019
EARTH	147	DATA	170.2113	171.7184	13.60616	47.66113	125.1907	15.00359	49.09521	8.204857	600.6914
STATIONS		TOTAL	365.3786	655.0956	78.09416	196.1805	508.2009	39.42845	85.56435	21.70576	1949.648
		VOICE	473.9098	1177.121	158.3580	362.0763	921.7458	59.24720	88.78668	33.04185	3274.287
DEDICATED		VIDEO	8.268242	17.10448	.9653185	4.853838	24.51456	1.096574	1.313540	.3133344	58.42988
& SHARED	323	DATA	420.5221	424.2455	33.61522	117.7510	309.2947	37.06770	121.2941	20.27082	1484.061
STATIONS		TOTAL	902.7001	1618.471	192.9385	484.6812	1255.555	97.41148	211.3943	53.62601	4816.778
SMSA 61-80											
		VOICE	147.0608	305.6151	40.25309	84.66401	234.9158	16.00894	20.30602	10.10846	858.9323
DEDICATED		VIDEO	2.565750	4.440821	.2453748	1.134969	6.247773	.2963009	.3004142	.0958580	15.32726
EARTH	96	DATA	130.4938	110.1465	8.544669	27.53362	78.82675	10.01591	27.74065	6.201431	399.5034
STATIONS		TOTAL	280.1204	420.2024	49.04313	113.3326	319.9904	26.32116	48.34709	16.40575	1273.763
		VOICE	363.3267	755.0490	99.44881	209.1699	580.3803	39.55151	50.16783	24.97384	2122.068
DEDICATED		VIDEO	6.338913	10.97144	.6062200	2.804041	15.43567	.7320375	.7421997	.2368258	37.86735
& SHARED	211	DATA	322.3966	272.1267	21.11036	68.02425	194.7484	24.74519	68.53572	15.32118	987.0084
STATIONS		TOTAL	692.0622	1038.147	121.1654	279.9982	790.5644	65.02874	119.4457	40.53184	3146.944
SMSA 81-100											
		VOICE	97.22772	246.8259	33.33167	75.56835	191.8090	12.76506	22.01995	8.082855	687.6305
DEDICATED		VIDEO	1.696319	3.586569	.2031832	1.013036	5.101313	.2362616	.3257705	.0766493	12.23910
EARTH	76	DATA	86.27464	88.95833	7.075435	24.57562	64.36212	7.986391	30.08209	4.958746	314.2734
STATIONS		TOTAL	185.1987	339.3708	40.61029	101.1570	261.2725	20.98771	52.42781	13.11825	1014.143
		VOICE	240.2097	609.8051	82.34884	166.6983	473.8811	31.53720	54.40223	19.96941	1698.852
DEDICATED		VIDEO	4.190906	8.860935	.5019820	2.502796	12.60324	.5837050	.8048448	.1893690	30.23778
& SHARED	168	DATA	213.1491	219.7794	17.48049	60.71624	159.0123	19.73108	74.32046	12.25102	776.4401
STATIONS		TOTAL	457.5497	838.4454	100.3313	249.9173	645.4966	51.85199	129.5275	32.40979	2505.530

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

	NUMBER OF EARTH STATIONS		CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000								
			MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
SMSA 101-120											
		VOICE	79.22714	200.5109	21.83265	53.65574	160.8031	11.55542	16.72843	6.942557	551.2559
DEDICATED		VIDEO	1.382265	2.913577	.1330075	.7192855	4.276687	.2130731	.2474860	.0658360	9.952097
EARTH	61	DATA	70.30109	72.26598	4.634496	17.44941	53.95800	7.229589	22.85319	4.259185	252.9517
STATIONS		TOTAL	150.9113	275.6904	26.60024	71.82443	219.0378	18.99889	39.82910	11.26758	814.1598
		VOICE	195.7376	495.3798	53.93949	132.5612	397.2783	28.54869	41.32906	17.15220	1361.926
DEDICATED		VIDEO	3.415008	7.198248	.3288043	1.777058	10.56593	.5283923	.6114360	.1626535	24.58753
& SHARED	135	DATA	173.6870	178.5395	11.44993	43.11031	133.3080	17.86134	56.46082	10.52269	624.9396
STATIONS		TOTAL	372.8397	681.1175	65.71823	177.4486	541.1523	46.93843	98.40132	27.83754	2011.454
SMSA 121-140											
		VOICE	73.76718	160.9278	19.62728	38.54049	119.0340	9.233296	15.53124	5.239818	441.9011
DEDICATED		VIDEO	1.287006	2.338404	.1196440	.5166570	3.165804	.1708941	.2297744	.0496890	7.877872
EARTH	50	DATA	65.45702	57.99985	4.166354	12.53377	39.94224	5.776762	21.21767	3.214573	210.3082
STATIONS		TOTAL	140.5112	221.2660	23.91328	51.59092	162.1421	15.18095	36.97869	8.504080	660.0872
		VOICE	182.2483	397.5862	48.49892	95.21767	294.0840	22.81167	38.37129	12.94543	1091.756
DEDICATED		VIDEO	3.179662	5.777232	.2955910	1.276447	7.821398	.4222089	.5676778	.1227610	19.46298
& SHARED	110	DATA	161.7174	143.2938	10.29334	30.96579	98.68082	14.27200	52.42013	7.941886	519.5851
STATIONS		TOTAL	347.1453	546.6572	59.07986	127.4599	400.5862	37.50588	91.35911	21.01008	1630.804
SMSA 141-160											
		VOICE	46.06173	130.0142	16.07219	35.34338	101.2106	7.287861	11.47820	4.577405	352.0455
DEDICATED		VIDEO	.8036329	1.889205	.0979729	.4737980	2.691777	.1348871	.1698123	.0434073	6.304493
EARTH	39	DATA	40.87270	46.85830	3.411702	11.49404	33.96155	4.559611	15.68069	2.808190	159.6468
STATIONS		TOTAL	87.73806	178.7617	19.58187	47.31122	137.8640	11.98236	27.32870	7.429002	517.9968
		VOICE	113.7996	321.2114	39.70777	87.31894	250.0498	18.00530	28.35789	11.30888	869.7596
DEDICATED		VIDEO	1.985446	4.667448	.2420506	1.170560	6.650273	.3332504	.4195362	.1072416	15.57581
& SHARED	86	DATA	100.9796	115.7676	8.428912	28.39704	83.90500	11.26492	38.74054	6.937880	394.4215
STATIONS		TOTAL	216.7646	441.6465	48.37873	116.8865	340.6051	29.60347	67.51797	18.35401	1279.757
SMSA 161-180											
		VOICE	48.12208	101.8300	12.96488	27.96480	77.55313	6.044663	7.508840	3.500057	285.4884
DEDICATED		VIDEO	.8395795	1.479667	.0790313	.3748839	2.062587	.1118774	.1110883	.0331909	5.091906
EARTH	32	DATA	42.70094	36.70046	2.752102	9.094446	26.02320	3.781811	10.25804	2.147248	133.4583
STATIONS		TOTAL	91.66260	140.0101	15.79601	37.43413	105.6389	9.938352	17.87797	5.680497	424.0386
		VOICE	118.8898	251.5799	32.03088	69.08950	191.6019	14.93387	18.55125	8.64720[illegible]	705.3243
DEDICATED		VIDEO	2.074255	3.655649	.1952538	.9261837	5.095803	.2764030	.2744534	.0820[illegible]10	12.58000
& SHARED	70	DATA	105.4964	90.67173	6.799311	22.46863	64.29261	9.343299	25.34340	5.304966	329.7204
STATIONS		TOTAL	226.4605	345.9073	39.02545	92.48431	260.9903	24.55358	44.16911	14.03417	1047.625

TABLE 9.1-3 (CONTINUED)

ORIGINAL PAGE IS OF POOR QUALITY

CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000

	NUMBER OF EARTH STATIONS		MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
SMSA 181-200											
DEDICATED EARTH STATIONS	27	VOICE	35.31937	98.05949	10.06249	21.00925	67.31589	6.242343	5.478904	3.404483	246.8922
		VIDEO	.6162123	1.424880	.0613389	.2816409	1.790319	.1155361	.0810568	.0322846	4.403269
		DATA	31.34051	35.34155	2.136001	6.832429	22.58806	3.905489	7.484890	2.088614	111.7175
		TOTAL	67.27609	134.8259	12.25983	28.12332	91.69427	10.26337	13.04485	5.525382	363.0130
DEDICATED & SHARED STATIONS	60	VOICE	87.25962	242.2646	24.86027	51.90521	166.3098	15.42226	13.53612	8.411075	609.9690
		VIDEO	1.522407	3.520291	.1515432	.6958186	4.423142	.2854422	.2002579	.0797618	10.87866
		DATA	77.42949	87.31441	5.277179	16.88012	55.80588	9.648854	18.49208	5.160106	276.0080
		TOTAL	166.2115	333.0993	30.28899	69.48114	226.5388	25.35656	32.22846	13.65094	896.8557
SMSA 201-220											
DEDICATED EARTH STATIONS	23	VOICE	36.40777	75.12209	10.29674	17.54921	57.18906	3.955831	5.614678	2.817519	208.9529
		VIDEO	.6352014	1.091581	.0627669	.2352571	1.520988	.0732163	.0830654	.0267184	3.728795
		DATA	32.30629	27.07470	2.185727	5.707189	19.18997	2.474945	7.670374	1.728518	98.33771
		TOTAL	69.34926	103.2884	12.54523	23.49166	77.90002	6.503992	13.36812	4.572755	311.0194
DEDICATED & SHARED STATIONS	52	VOICE	89.94860	185.5957	25.43901	43.35688	141.2906	9.773229	13.87156	6.960928	516.2366
		VIDEO	1.569321	2.696848	.1550711	.5812235	3.757736	.1808874	.2052205	.0660102	9.212318
		DATA	79.81554	66.89042	5.400030	14.10011	47.41051	6.114569	18.95034	4.270456	242.9520
		TOTAL	171.3335	255.1830	30.99411	58.03822	192.4589	16.06869	33.02711	11.29739	768.4009
SMSA 221-240											
DEDICATED EARTH STATIONS	20	VOICE	31.75757	64.86135	7.782943	15.55051	47.27202	3.381982	4.457029	2.103374	177.1668
		VIDEO	.5540701	.9424851	.0474433	.2084634	1.257237	.0625953	.0659388	.0199462	3.158179
		DATA	28.17996	23.37663	1.652114	5.057190	15.86228	2.115919	6.088876	1.290398	83.62336
		TOTAL	60.49160	89.18046	9.482500	20.81617	64.39153	5.560496	10.61184	3.413718	263.9483
DEDICATED & SHARED STATIONS	44	VOICE	78.45988	160.2457	19.22845	38.41891	116.7897	8.355484	11.01148	5.196571	437.7062
		VIDEO	1.368879	2.328493	.1172128	.5150272	3.106115	.1546471	.1629076	.0492788	7.802560
		DATA	69.62107	57.75403	4.081692	12.49423	39.18915	5.227564	15.04311	3.188041	206.5989
		TOTAL	149.4498	220.3282	23.42735	51.42817	159.0850	13.73769	26.21750	8.433891	652.1076
SMSA 241-260											
DEDICATED EARTH STATIONS	16	VOICE	19.94166	55.16361	8.341652	13.23759	37.79359	3.062596	3.400376	2.240568	143.1816
		VIDEO	.3479195	.8015696	.0508490	.1774574	1.005150	.0566839	.0503063	.0212472	2.511183
		DATA	17.69515	19.88148	1.770713	4.305003	12.68176	1.916097	4.645352	1.374564	64.27012
		TOTAL	37.98473	75.84666	10.16321	17.72005	51.48049	5.035376	8.096035	3.636379	209.9629
DEDICATED & SHARED STATIONS	35	VOICE	49.26763	136.2866	20.60879	32.70463	93.37239	7.566413	8.400929	5.535520	353.7429
		VIDEO	.8595657	1.980348	.1256270	.4384241	2.483313	.1400426	.1242862	.0524931	6.204100
		DATA	43.71744	49.11894	4.374702	10.63589	31.33140	4.733886	11.47675	3.395983	158.7850
		TOTAL	93.84463	187.3859	25.10912	43.77895	127.1871	12.44034	20.00197	8.963996	518.7320

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.1-3 (CONTINUED)

	NUMBER OF EARTH STATIONS		CPS ADDRESSABLE BUSY HOUR TRAFFIC (MBPS) YEAR 2000 MFG	WH/RT	TR/UT	F/I/R	SVS	OTHER	FGOV	SLGOV	TOTAL
SMSA 261-266											
		VOICE	2.898078	8.214583	.8239843	1.631749	6.152571	.4826442	.9318362	.3942250	21.52967
DEDICATED		VIDEO	.0505624	.1193642	.0050228	.0218745	.1636325	.0089330	.0137859	.0037384	.3869137
EARTH	2	DATA	2.571599	2.960612	.1749101	.5306620	2.064515	.3019638	1.273008	.2418529	10.11912
STATIONS		TOTAL	5.520239	11.29456	1.003917	2.184286	8.380718	.7935410	2.218630	.6398163	32.03571
		VOICE	7.159958	20.29485	2.035726	4.031380	15.20047	1.192415	2.302183	.9739676	53.19095
DEDICATED		VIDEO	.1249188	.2948997	.0124094	.0540429	.4042685	.0220698	.0340593	.0092361	.9559045
& SHARED	5	DATA	6.353361	7.314452	.4321309	1.311047	5.100565	.7460282	3.145079	.5975188	25.00018
STATIONS		TOTAL	13.63824	27.90420	2.480266	5.396471	20.70530	1.960513	5.481322	1.580723	79.14704
TOTAL SMSA											
		VOICE	1896.946	4796.707	652.2199	1576.316	3902.672	228.8037	397.7101	137.7209	13589.10
DEDICATED		VIDEO	33.09576	69.69983	3.975802	21.13141	103.7946	4.234805	5.883858	1.306001	243.1221
EARTH	1503	DATA	1683.247	1728.778	138.4491	512.6345	1309.554	143.1498	543.3233	84.49033	6143.626
STATIONS		TOTAL	3613.289	6595.185	794.6448	2110.082	5316.020	376.1884	946.9173	223.5173	19975.84
		VOICE	4686.572	11850.69	1611.367	3894.428	9641.895	565.2799	982.5780	340.2517	33573.06
DEDICATED		VIDEO	81.76599	172.1996	9.822569	52.20700	256.4338	10.46246	14.53659	3.226592	600.6546
& SHARED	3314	DATA	4158.611	4271.098	342.0507	1266.509	3235.368	353.6643	1342.328	208.7408	15178.37
STATIONS		TOTAL	8926.949	16293.99	1963.240	5213.144	13133.70	929.4066	2339.443	552.2191	49352.08
TOTAL NON-SMSA											
		VOICE	651.6988	1366.584	163.0305	281.9319	1006.954	105.4781	95.04506	53.85065	3724.572
DEDICATED		VIDEO	11.37010	19.85751	.9938015	3.779456	26.78073	1.952238	1.406129	.5106633	66.65063
EARTH	418	DATA	578.2824	492.5294	34.60708	91.68721	337.8865	65.99184	129.8438	33.03680	1763.865
STATIONS		TOTAL	1241.351	1878.970	198.6314	377.3986	1371.621	173.4222	226.2950	87.39811	5555.088
		VOICE	1610.079	3376.265	402.7813	696.5376	2487.768	260.5931	234.8172	133.0428	9201.885
DEDICATED		VIDEO	28.09084	49.05972	2.455274	9.337480	66.16416	4.823176	3.473965	1.261639	164.6663
& SHARED	922	DATA	1428.698	1216.837	85.49985	226.5213	834.7784	163.0387	320.7906	81.62033	4357.784
STATIONS		TOTAL	3066.868	4642.162	490.7364	932.3964	3388.710	428.4549	559.0818	215.9247	13724.34

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.1-4 DISTRIBUTION OF YEAR 2000 U.S. CPS ADDRESSABLE TRAFFIC BY SMSA RANK

SMSA RANK BY CPS TRAFFIC	% OF TRAFF.	CUM. %
1-20	34.70	34.70
21-40	12.88	47.58
41-60	7.62	55.20
61-80	4.98	60.18
81-100	3.96	64.14
101-120	3.18	67.32
121-140	2.59	69.91
141-160	2.03	71.94
161-180	1.65	73.59
181-200	1.42	75.01
201-220	1.23	76.24
221-240	1.04	77.28
241-260	.83	78.11
261-264	.12	78.23
NON SMSA	21.75	100.00

9.1.4 EARTH STATION MARKET

Table 9.1-1 presented estimates of a potential market by 1990 of 1784 dedicated earth stations and 2150 shared earth stations. The corresponding numbers for the year 2000 were 1922 and 2317. Using earlier estimates (Table 6.3-1) of $250,000 and $350,000 for typical dedicated and shared earth station costs, the fully saturated CPS earth station market would amount to $1.3 billion when cumulated through the year 2000.

By comparing CPS addressable traffic from Tables 6.5-4 and 6.5-5 with the potential number of earth stations from Table 9.1-1, the busy hour traffic of a typical earth station can be estimated as shown in Table 9.1-5.

TABLE 9.1-5 BUSY HOUR TRAFFIC PER CPS EARTH STATION

	1990		2000	
	DED.E.S.	SHARED E.S.	DED.E.S.	SHARED E.S.
NUMBER OF EARTH STATIONS	1784	2150	1922	2317
BUSY HR. CPS TRAFF.(BPSx10^9)	5.66	8.33	25.58	37.61
BUSY HR. TRAFF. PER E.S.(MBPS)	3.17	3.87	13.31	16.23

For both 1990 and 2000, the busy hour traffic per shared earth station is only slightly higher than that of dedicated earth stations. This suggests that a common earth station design may be practical for both dedicated and shared use, rather than the separate designs implied in the figures postulated in Table 6.3-1.

For 1990 this common earth station design, if sized for the average installation, would be closer in capacity to the smaller dedicated earth station rather than to the larger, shared earth station of Table 6.3-1. However, by the year 2000 the busy hour traffic per earth station grows by sizeable factors for both dedicated and shared earth stations, and the larger earth station design becomes appropriate. This occurs because the number of earth stations grows slowly, in proportion to employment, while traffic demand reflects the higher growth rates historically exhibited by most sectors of the communications market. A station adequate for 1990 whether dedicated or shared, is likely to be outgrown by the year 2000 so that ready expandability to higher capacity is a desirable design feature.

9.2 INTER-SMSA TRAFFIC PATTERNS

This section provides projections of CPS traffic patterns among the forty SMSAs having the largest addressable year 2000 CPS busy hour traffic (See Table 9.1-2).

9.2.1 METHODOLOGY FOR DEVELOPING INTER-SMSA TRAFFIC

To arrive at these projections data was obtained which shows the number of completed MTS toll calls between each pair of Numbering Plan Areas (Area Codes) for one full day, in this case April 2, 1980. Outward WATS calls are included but 800 Service calls are not since their destinations were not recorded. The number of MTS calls completed is assumed to be a good indicator of community of interest patterns for general communications services between various sections of the country. It is further assumed that these patterns remain unchanged over the time frame of this forecast except as reflected in changes in employment levels in the SMSAs and states.

Numbering Plan Areas (NPAs) do not cross state boundaries, but aside from this restriction do not follow simple geographic or political boundaries. As a result, several transformations, as described below, are needed to convert the NPA to NPA call competion data to the desired SMSA to SMSA results.

Figure 9.2-1 illustrates the procedures used to develop SMSA to SMSA traffic projections. In this illustration, traffic originates at SMSA1 and is directed to SMSA2 and SMSA3 in State A, as well as to destinations in other states. SMSA1, in common with all other SMSAs contains a central city which serves to identify a particular NPA (NPA1 in Figure 9.2-1) which is the originating NPA in the analysis. The number of completed calls from NPA1 to State A (which contains the central city of the destination SMSA, SMSA2) is obtained from the call completion data by summing calls from NPA1 to all of the NPAs in State A. This is compared to the number of calls from NPA1 to all of the contiguous 48 states and the District of Columbia to arrive at that fraction of NPA1's calls that are directed to State A. The fraction of SMSA1's traffic to State A is assumed to be equal to the fraction of NPA1's traffic to State A.

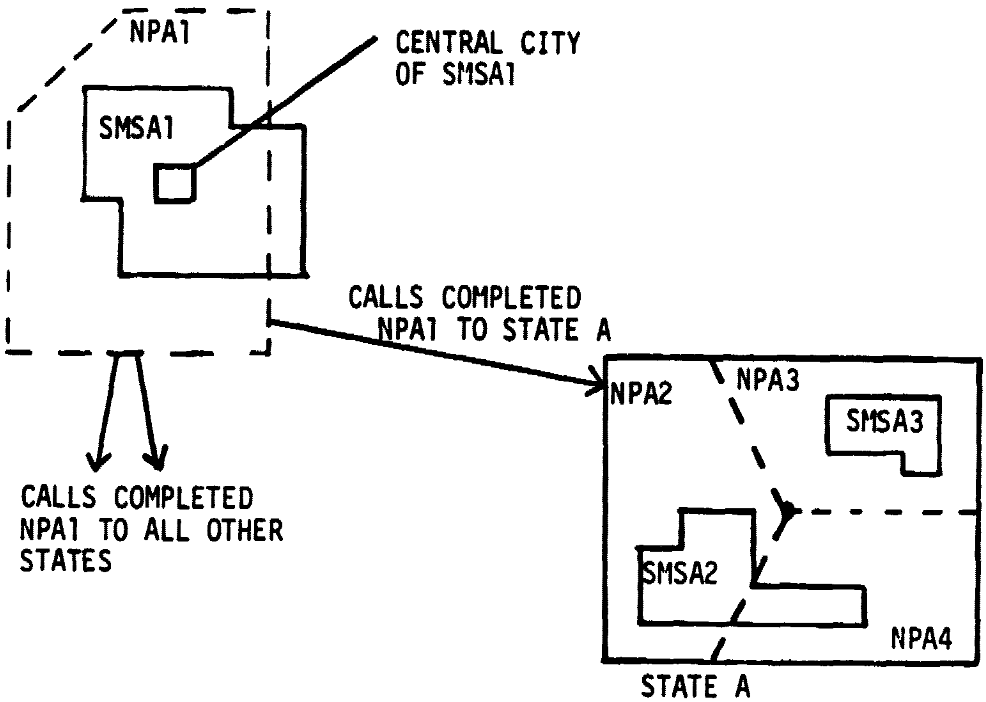


FIGURE 9.2-1 INTER-SMSA TRAFFIC ANALYSIS

The fraction of SMSA1's traffic directed to State A based on 1980 call completion data is modified to account for expected changes in employment by the year 2000 by multiplying by the ratio of year 2000 to year 1980 state employments [Ref. 9-3]. This is repeated for each state and the results are renormalized by dividing by the sum of the modified values for all states, resulting in estimates for the fraction of SMSA1's traffic to each of that states applicable to the year 2000. A similar procedure is followed for each of the 40 originating SMSAs.

ORIGINAL PAGE IS
OF POOR QUALITY

A las[illegible] is [illegible]quire[illegible] to apportion the traffic arriving in St[illegible] among the S[illegible]As and other areas in that state. This i[illegible]plish[illegible] for S[illegible]A1 and SMSA2 traffic, for example, by [illegible]ying [illegible]he ye[illegible] 2000 fraction of SMSA1 to State A traffi[illegible]e rati[illegible] of SM[illegible]2 to State A employment for the year 2000. [illegible]milar [illegible]rocedu[illegible] using year 2000 employment in SMSA3 relat[illegible] total State A [illegible]ployment is used to arrive at the fractio[illegible] A1 (or SMSA1) [illegible]raffic arriving at SMSA3, and the whole [illegible]s is r[illegible]peated [illegible]or each of the SMSAs in the top forty as [illegible] according [illegible] projected year 2000 CPS addressable tr[illegible]

Where t[illegible]ginati[illegible] and [illegible]tination SMSAs are in the same state, a[illegible]tional adjust[illegible]t is made by excluding the employment of [illegible]iginat[illegible]ng SM[illegible] from the state employment total prior to[illegible] the [illegible]ploym[illegible] ratio. This in part compensates f[illegible] earli[illegible]r excl[illegible]on of the traffic from the NPA containing [illegible]iginating SM[illegible]. Further detailed adjustments are also [illegible] in t[illegible] case [illegible] the New York City to Nassau/Suffolk [illegible] bec[illegible]e of [illegible]he geographic complexity applying in th[illegible]rby S[illegible]s. [illegible] each case the CPS addressable traffic f[illegible]SMSA t[illegible] itsel[illegible]s considered to be zero.

9.2.2 SMSA TO [illegible]AFFIC

The pro[illegible]s desc[illegible]ibed i[illegible] the previous subsection were followed 1[illegible] to th[illegible] result[illegible] presented in Tables 9.2-1, 9.2-2 and 9.2-3.

Table [illegible] shows the [illegible]rcentage of the traffic originating in [illegible]f 38 selecte[illegible] NPAs going to each of the contiguous 48 s[illegible]and th[illegible] Distri[illegible] of Columbia. This matrix is obtained fr[illegible] call c[illegible]pleti[illegible] data circa 1980. As shown in Column 2, th[illegible] select[illegible]d eac[illegible] ontain one of the year 2000 top fort[illegible] as de[illegible]ined i[illegible] able 9.1-2 (except for NPA 714 which incl[illegible]ee S[illegible]As). [illegible]he matrix excludes traffic from a NPA to i[illegible]o tha[illegible] those [illegible]ates which have only a single NPA sho[illegible] on th[illegible] row co[illegible]esponding to that NPA.

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.2-1 PERCENT OF TRAFFIC FROM ORIGINATING NPAs (and SMSAs) TO DESTINATION STATES - CIRCA 1980

PERCENT OF TRAFFIC TO STATE

ORIGINATING NPA	SMSA #	AL	AZ	AR	CA	CO	CT	DE	DC	FL	GA	ID	IL	IN	IA	KS	KY	LA
201	15	.36	.34	.14	3.32	.47	3.19	.38	.86	3.34	1.19	.04	2.41	.65	.21	.08	.28	.38
202	8	.70	.61	.25	6.26	1.18	2.02	.77	.00	4.41	2.18	.16	3.66	.84	.41	.15	.60	.86
203	33	.50	.56	.19	4.54	.73	.00	.26	1.07	3.85	1.52	.09	2.90	.96	.33	.17	.51	.49
206	21	.30	1.28	.22	20.92	1.63	.55	.06	.77	1.11	.64	2.61	2.38	.56	.42	.24	.21	.41
212	2	.51	.42	.20	5.99	.65	5.94	.30	2.01	5.38	1.51	.08	3.44	.65	.30	.10	.42	.67
213	1	.41	2.27	.28	57.79	1.36	.72	.09	.62	1.78	.83	.32	2.69	.62	.39	.21	.28	.66
214	7	.89	1.00	2.85	6.30	1.66	.67	.09	.48	2.36	1.50	.16	2.87	.85	.55	.71	.49	5.67
215	5	.28	.29	.09	2.57	.38	1.54	5.24	1.45	3.11	.92	.04	1.91	.59	.20	.07	.29	.28
216	16	1.15	.69	.38	4.40	.75	1.36	.21	.86	4.83	1.86	.10	5.[illegible]0	2.91	.51	.17	1.59	.59
301	18	.67	.44	.19	4.20	.71	1.65	5.56	6.87	5.41	1.79	.07	2.49	.90	.27	.11	.60	.57
303	13	.49	3.94	.51	14.17	.00	.83	.10	1.02	2.48	1.08	1.19	4.92	1.17	1.66	1.94	.45	.84
305	17	1.30	.59	.48	5.79	.91	1.77	.26	1.01	20.26	5.58	.16	4.37	1.40	.63	.24	.90	1.01
312	3	.79	1.00	.68	6.33	1.23	1.07	.14	.78	4.00	1.61	.17	18.19	8.29	2.14	.41	1.12	.85
313	4	1.05	.72	.46	4.37	.76	.89	.14	.80	5.22	1.38	.07	6.95	3.16	.63	.15	1.29	.56
314	14	.98	.74	3.65	4.79	1.37	.83	.14	.63	3.00	1.44	.17	27.66	2.83	1.85	1.08	1.81	1.29
317	32	.78	.65	.52	2.76	.53	.74	.08	.44	4.17	1.41	.05	10.42	33.86	.94	.20	5.00	.60
404	12	8.39	.37	.61	3.15	.55	.81	.18	.86	14.18	11.04	.07	3.25	1.12	.31	.18	1.91	1.95
408	27	.18	1.17	.12	77.09	.96	.46	.03	.28	.85	.35	.31	1.38	.34	.19	.08	.11	.19
412	20	.51	.53	.14	3.07	.59	1.07	.31	1.26	4.53	1.09	.07	3.23	1.37	.25	.10	.75	.35
414	25	.58	.82	.04	4.23	.98	.87	.10	.53	2.83	1.27	.14	20.33	2.50	1.97	.28	.52	.55
415	6	.20	1.12	.21	66.82	1.29	.55	.07	.68	1.03	.54	.46	2.06	.43	.22	.10	.19	.47
502	37	2.17	.37	.64	2.49	.57	.65	.09	.57	3.77	2.74	.07	7.55	14.92	.53	.21	17.15	.87
503	24	.33	1.47	.29	24.96	1.66	.46	.05	.51	.95	.67	4.83	2.22	.67	.54	.20	.30	.48
504	31	4.48	.37	1.32	4.09	.82	.65	.15	.81	5.58	2.72	.04	2.74	.71	.28	.21	.58	22.93
512	35	.68	.94	.80	5.61	1.46	.57	.09	.71	2.35	1.08	.15	2.56	.79	.50	.45	.56	2.30
513	30	.98	.63	.38	4.16	.84	1.14	.16	.76	4.68	2.04	.11	5.97	9.13	.57	.22	8.60	.60
516	22	.41	.54	.12	5.14	.56	4.78	.25	.94	6.60	1.18	.08	2.79	.77	.35	.14	.44	.42
602	23	.49	.00	.79	28.02	5.11	.90	.14	.78	2.87	1.53	.69	4.94	1.66	1.07	.48	.71	.90
612	11	.54	1.11	.36	5.72	1.64	.86	.10	.60	2.74	1.15	.30	7.68	1.50	4.87	.44	.64	.58
614	36	.60	.43	.23	2.68	.55	.72	.16	.69	3.25	1.41	.06	4.08	3.36	.38	.16	3.60	.44
615	40	9.30	.42	1.29	3.44	.66	.67	.15	.71	5.56	11.17	.08	4.30	2.78	.49	.20	10.05	1.27
617	9	.39	.49	.15	5.48	.72	8.11	.25	1.60	2.97	1.20	.07	3.10	.73	.27	.09	.33	.40
713	10	1.19	.75	1.33	6.48	1.87	.79	.15	.71	3.09	1.62	.11	3.11	.78	.37	.50	.58	11.17
714	19,26,39	.24	2.49	.21	69.02	1.14	.49	.05	.35	1.22	.53	.32	1.83	.56	.36	.18	.24	.37
801	34	.33	4.25	.24	21.69	11.31	.58	.13	.67	1.11	.67	13.07	2.65	.72	.91	.31	.30	.46
813	28	1.50	.44	.29	2.74	.90	1.57	.23	.58	32.01	5.46	.04	4.68	2.30	.45	.14	1.16	.79
816	29	.56	1.15	4.41	5.00	3.08	.53	.08	.67	1.81	1.09	.30	7.54	1.36	5.57	6.01	.67	.94
901	38	3.89	.50	10.03	4.35	.66	.59	.11	.55	3.42	3.91	.07	5.27	1.68	.52	.26	3.81	3.15

SMSA'S NUMBERED IN RANK ORDER OF YEAR 2000 CPS TRAFFIC

TABLE 9.2-1 (CONTINUED)

PERCENT OF TRAFFIC TO STATE

ORIGINATING NPA	SMSA #	ME	MD	MA	MI	MN	MS	MO	MT	NE	NV	NH	NJ	NM	NY	NC	ND	OH
201	15	.22	1.63	3.00	1.13	.45	.14	.74	.04	.14	.12	.35	10.17	.10	47.69	1.05	.03	1.80
202	8	.29	12.45	3.77	1.83	.83	.30	1.13	.12	.26	.20	.33	5.58	.27	17.05	3.90	.08	2.71
203	33	1.10	1.41	15.43	1.51	.71	.26	.82	.05	.16	.18	1.47	7.60	.15	31.29	1.41	.03	2.35
206	21	.09	.52	.84	1.02	1.15	.20	.99	1.66	.38	.76	.12	1.09	.31	3.32	.44	.25	1.22
212	2	.28	1.63	4.35	1.40	.75	.22	.93	.06	.18	.17	.33	27.68	.13	15.49	1.58	.05	2.13
213	1	.08	.57	1.10	1.25	.71	.26	.91	.21	.29	1.49	.11	1.52	.46	5.61	.54	.09	1.54
214	7	.06	.48	.96	1.06	.69	.96	2.31	.12	.39	.29	.11	1.29	1.13	3.66	1.03	.10	1.59
215	5	.20	3.87	2.28	1.09	.38	.11	.57	.03	.13	.09	.23	35.88	.07	10.97	1.21	.02	2.00
216	16	.16	1.36	1.85	6.66	.89	.46	1.35	.08	.24	.21	.19	2.81	.15	7.32	1.49	.06	21.93
301	18	.30	.00	2.71	1.46	.59	.28	.85	.06	.18	.16	.30	6.82	.16	10.97	3.63	.04	3.04
303	13	.15	.80	1.33	1.84	1.89	.28	2.76	1.77	3.86	.97	.21	1.93	4.58	4.89	.62	.64	2.20
305	17	.28	1.77	2.66	2.65	.90	.57	1.23	.10	.33	.30	.28	4.90	.26	15.00	2.28	.09	3.54
312	3	.14	.86	1.69	5.32	2.71	.87	2.98	.21	.81	.28	.18	2.52	.23	6.40	1.03	.26	4.75
313	4	.10	.79	1.33	34.16	1.02	.52	1.40	.06	.23	.23	.19	1.91	.16	5.42	.99	.07	11.14
314	14	.09	.72	1.18	2.22	1.47	1.00	8.57	.10	.80	.27	.14	1.92	.21	4.52	.98	.11	3.11
317	32	.07	.45	.96	4.20	.78	.38	2.13	.07	.38	.13	.12	1.27	.20	2.87	.91	.05	10.78
404	12	.13	1.21	1.21	1.37	.57	2.09	1.17	.05	.19	.13	.12	2.29	.11	5.09	7.71	.06	2.65
408	27	.05	.44	.85	.62	.51	.09	.50	.13	.15	.95	.09	.91	.25	1.93	.26	.05	.78
412	20	.11	3.02	1.59	2.41	.53	.15	.89	.05	.16	.19	.19	3.50	.11	7.86	1.15	.04	19.68
414	25	.13	.63	1.30	5.24	4.40	.05	1.86	.13	.54	.23	1.08	1.59	.18	4.11	.93	.20	3.77
415	6	.09	.49	.96	.75	.52	.15	.61	.21	.19	1.72	.09	1.28	.29	4.23	.29	.05	.98
502	37	.06	.70	.76	2.58	.69	.75	3.00	.06	.22	.14	.09	1.60	.11	3.35	1.63	.06	7.74
503	24	.16	.44	.70	.96	1.10	.25	.99	1.48	.46	1.13	.15	.96	.27	2.50	.50	.22	1.22
504	31	.09	.63	.91	.98	.50	13.13	1.62	.09	.18	.20	.08	1.65	.20	4.23	1.04	.04	1.46
512	35	.08	.64	.76	1.10	.76	.61	1.81	.09	.38	.27	.10	1.03	.84	3.17	.77	.12	1.37
513	30	.18	1.22	1.58	4.84	.93	.37	1.66	.11	.26	.17	.23	2.54	.20	5.65	1.36	.08	21.85
516	22	.33	1.85	3.99	1.38	.66	.24	.78	.08	.21	.19	.46	14.69	.16	33.64	1.12	.09	2.10
602	23	.20	.76	1.37	2.46	1.82	.32	2.17	.54	1.19	2.49	.16	1.69	3.37	5.13	.80	.30	2.79
612	11	.13	.67	1.39	2.82	20.77	.33	2.19	.79	2.12	.30	.19	1.64	.22	4.16	.85	3.63	2.68
614	36	.14	1.02	1.06	3.80	.77	.22	1.13	.06	.18	.13	.13	1.70	.10	4.15	1.12	.06	41.55
615	40	.15	.88	.92	2.69	.64	1.88	2.19	.06	.33	.15	.11	1.51	.18	4.03	4.63	.05	4.68
617	9	3.04	1.63	6.76	1.46	.73	.19	.81	.06	.14	.13	11.94	5.63	.18	16.37	1.08	.03	2.28
713	10	.09	.61	1.01	1.34	.57	1.32	1.84	.11	.32	.28	.09	1.99	.67	5.46	.78	.09	2.07
714	19,26,39	.09	.46	.76	1.03	.63	.18	.73	.19	.25	1.17	.10	1.04	.41	2.36	.41	.08	1.24
801	34	.10	.53	.83	1.16	.93	.16	1.19	2.24	.67	4.31	.12	1.17	1.43	2.96	.47	.19	1.49
813	28	.35	1.42	2.32	4.59	.93	.47	1.25	.07	.16	.24	.40	3.24	.13	8.60	2.11	.05	5.32
816	29	.08	.53	.86	1.49	1.96	.40	22.58	.32	4.07	.43	.10	1.77	.62	3.68	.71	.30	2.10
901	38	.08	.58	.72	1.83	.72	14.82	4.46	.05	.29	.41	.09	1.28	.17	4.18	1.84	.05	2.63

SMSA'S NUMBERED IN RANK ORDER OF YEAR 2000 CPS TRAFFIC

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.2-1 (CONTINUED)

PERCENT OF TRAFFIC TO STATE

ORIGINATING NPA	SMSA #	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY	TOTAL
201	15	.22	.29	7.73	.40	.49	.03	.50	1.66	.11	.25	.79	.36	.21	.50	.03	100%
202	8	.49	.42	7.48	.41	1.53	.10	1.09	3.16	.24	.24	5.96	.72	1.14	.79	.08	100%
203	33	.34	.26	4.68	2.96	.76	.03	.79	2.07	.20	.95	.78	.53	.26	.72	.07	100%
206	21	.48	28.59	1.02	.11	.21	.17	.42	2.49	1.18	.06	.30	15.17	.12	.73	.23	100%
212	2	.36	.36	5.51	.56	.83	.04	.81	2.79	.16	.28	.87	.57	.20	.71	.04	100%
213	1	.58	1.34	1.51	.12	.27	.08	.59	3.48	.77	.05	.30	1.97	.12	.63	.14	100%
214	7	5.71	.37	1.33	.11	.39	.10	1.42	42.85	.33	.05	.36	.59	.12	.71	.21	100%
215	5	.19	.26	15.98	.29	.58	.02	.58	1.27	.10	.16	1.15	.26	.31	.44	.03	100%
216	16	.51	.33	13.39	.27	.72	.06	1.62	2.87	.19	.10	.74	.50	2.13	1.23	.08	100%
301	18	.37	.23	18.48	.33	1.24	.05	1.08	2.07	.17	.20	6.34	.44	4.28	.61	.05	100%
303	13	2.44	1.33	1.94	.15	.27	.87	1.56	9.03	4.48	.10	.38	1.98	.19	1.25	6.50	100%
305	17	.58	.35	4.68	.37	1.17	.09	1.50	4.08	.21	.17	.87	.63	.43	1.00	.09	100%
312	3	.69	.55	3.01	.18	.50	.26	1.56	3.67	.30	.09	.47	.86	.29	7.42	.12	100%
313	4	.39	.24	3.07	.16	.55	.20	1.63	2.23	.17	.09	.45	.45	.43	1.56	.07	100%
314	14	2.62	.35	2.10	.14	.46	.13	3.23	6.22	.24	.04	.42	.56	.25	1.43	.13	100%
317	32	.59	.23	2.12	.11	.38	.06	2.09	2.49	.19	.05	.40	.35	.40	1.26	.06	100%
404	12	.61	.29	2.19	.13	7.06	.07	7.18	4.27	.13	.05	1.49	.36	.37	.68	.06	100%
406	27	.25	1.25	.85	.06	.12	.04	.26	1.77	.55	.03	.18	1.53	.05	.31	.08	100%
412	20	.30	.16	25.80	.21	.57	.03	.88	1.97	.14	.10	.97	.26	6.61	1.11	.07	100%
414	25	.51	.46	2.47	.19	.42	.22	1.15	2.80	.27	.08	.40	.63	.16	25.24	.10	100%
415	6	.35	2.09	1.06	.07	.13	.06	.38	2.32	.74	.04	.18	2.66	.06	.41	.10	100%
502	37	.58	.18	2.20	.09	.77	.07	11.07	2.89	.13	.05	.84	.29	.93	.95	.06	100%
503	24	.49	.00	.99	.08	.19	.15	.44	2.48	1.27	.08	.20	38.26	.09	.76	.44	100%
504	31	1.22	.23	1.46	.14	.60	.04	2.34	16.48	.13	.03	.55	.41	.26	.52	.07	100%
512	35	2.31	.32	1.29	.10	.36	.11	.99	56.30	.22	.05	.45	.81	.14	.91	.13	100%
513	30	.45	.36	3.97	.19	.75	.05	2.55	2.62	.16	.13	.77	.64	1.60	1.41	.12	100%
516	22	.35	.36	5.06	.53	.55	.07	.63	2.25	.16	.32	.76	.48	.21	.69	.05	100%
602	23	1.19	1.49	2.26	.16	.36	.36	.96	7.21	2.18	.11	.51	2.29	.30	1.49	.49	100%
612	11	.66	.67	1.96	.20	.38	2.90	.87	3.14	.38	.08	.35	1.13	.17	11.11	.28	100%
614	36	.36	.21	5.89	.13	.38	.05	1.25	1.97	.14	.08	.62	.38	7.25	.92	.04	100%
615	40	.85	.24	2.35	.12	1.98	.06	9.36	4.10	.19	.06	1.06	.39	.69	.87	.06	100%
617	9	.27	.25	4.50	9.05	.45	.03	.63	2.03	.15	1.73	.68	.50	.18	.72	.04	100%
713	10	3.85	.28	2.10	.14	.46	.10	1.29	35.94	.31	.05	.41	.60	.26	.64	.32	100%
714	19,26,39	.53	1.13	1.17	.10	.18	.10	.39	2.54	.67	.04	.24	1.40	.11	.51	.13	100%
801	34	.81	2.52	1.48	.10	.25	.24	.61	4.05	.00	.10	.26	3.67	.18	.71	5.68	100%
813	28	.36	.17	3.73	.29	.99	.05	1.62	2.61	.09	.17	.80	.34	.60	1.22	.06	100%
816	29	3.54	.50	1.58	.10	.32	.54	1.30	5.78	.45	.05	.30	.94	.15	1.09	.56	100%
901	38	1.02	.20	1.63	.13	1.12	.06	10.87	5.68	.17	.05	.57	.35	.31	.83	.04	100%

SMSA'S NUMBERED IN RANK ORDER OF YEAR 2000 CPS TRAFFIC

Table 9.2-2 shows the projected employment of each of the top forty SMSAs in the year 2000, and the employment for the corresponding states in the years 1980 and 2000 (as interpolated from 1978 and 1985 figures in Reference 9-1). The first column shows the originating SMSA rank according to the year 2000 CPS addressable traffic of the SMSA. The second and third columns briefly identify the SMSA by listing the central city and state for each of the 40 originating SMSAs. The fourth, fifth and sixth columns present SMSA and state employment figures. The last two columns in this table show the ratio of state employments for the year 2000 relative to the year 1980, and the ratio of SMSA to state employment for the year 2000.*

Table 9.2-3 combines the percentage of orginating SMSA traffic arriving at a given destination state from Table 9.2-1 with the ratios developed in Table 9.2-2, to obtain projections for SMSA to SMSA traffic distributions appropriate to the year 2000. Table 9.2-3 is organized with the originating SMSAs described in the left-most columns and the destination SMSAs listed across the top row with SMSAs in rank order of projected year 2000 CPS addressable traffic. The second column shows the fraction of year 2000 U.S. CPS addressable traffic originating in the SMSAs as calculated from values obtained from Table 9.1-3. The remaining entries in Table 9.2-3 show the fraction of each originating SMSA's traffic directed to each of the other SMSAs, and to other areas not included in the SMSAs.

As discussed earlier, some special adjustments have been made for traffic contained within a single state. Some adjustments were also made for New York, N.Y. and Newark, N.J. which each have appreciable traffic in NPA 201. The values in this table can be used to arrive at the year 2000 busy hour addressable CPS traffic between SMSAs by applying the fractions shown to the traffic estimates presented in Table 9.1-3.

---

*The District of Columbia is treated as if its "State" is NPA 202. Since the D.C. SMSA is associated with several NPAs the ratio of SMSA traffic to "State" traffic in this case is greater than unity.

TABLE 9.2-2 PROJECTED SMSA AND STATE EMPLOYMENT RATIOS

SMSA RANK	CENTRAL CITY	STATE	SMSA EMPL YEAR 2000	STATE EMPLOYMENT 1980	STATE EMPLOYMENT 2000	RATIO OF STATE EMPL YEAR 2000 TO YR.1980	RATIO OF SMSA TO STATE EMPL YEAR 2000
1	LOS ANGELES	CA	5285676	10707524	14120685	1.319	.374
2	NEW YORK	NY	4684450	7748981	7863947	1.015	.596
3	CHICAGO	IL	4122108	5312605	6061163	1.141	.680
4	DETROIT	MI	2541449	4048755	5026190	1.241	.506
5	PHILADELPHIA	PA	2405075	5227973	5760223	1.102	.418
6	SAN FRANCISCO	CA	2329214	10707524	14120685	1.319	.165
7	DALLAS	TX	2259181	6224162	8945449	1.437	.253
8	WASHINGTON	DC	2028538	644078	686083	1.065	2.96
9	BOSTON	MA	2176888	2763923	3024393	1.094	.720
10	HOUSTON	TX	2119294	6224162	8945449	1.437	.237
11	MINNEAPOLIS	MN	1546443	1930084	2524375	1.308	.613
12	ATLANTA	GA	1352522	2373325	3038194	1.280	.445
13	DENVER	CO	1369243	1371993	2124053	1.548	.645
14	ST. LOUIS	MO	1358836	2239608	2608861	1.165	.521
15	NEWARK	NJ	1202710	3297002	3911196	1.186	.308
16	CLEVELAND	OH	1191621	4903390	5713520	1.165	.209
17	MIAMI	FL	1145658	3824957	5477305	1.432	.209
18	BALTIMORE	MD	1181934	1781168	2075690	1.165	.569
19	ANAHEIM	CA	1161921	10707524	14120685	1.319	.082
20	PITTSBURGH	PA	1169244	5227973	5760223	1.102	.203
21	SEATTLE	WA	1123747	1749267	2378854	1.360	.472
22	NASSAU	NY	994728	7748981	7863947	1.015	.126
23	PHOENIX	AZ	982512	1062629	1538565	1.448	.639
24	PORTLAND	OR	948672	1187932	1811321	1.525	.524
25	MILWAUKEE	WI	943759	2160376	2649909	1.227	.356
26	SAN DIEGO	CA	1039853	10707524	14120685	1.319	.074
27	SAN JOSE	CA	900595	10707524	14120685	1.319	.064
28	TAMPA	FL	867267	3824957	5477305	1.432	.158
29	KANSAS CITY	MO	854515	2239608	2608861	1.165	.328
30	CINCINNATI	OH	802435	4903390	5713520	1.165	.140
31	NEW ORLEANS	LA	797704	1711059	2361350	1.380	.338
32	INDIANAPOLIS	IN	739042	2469035	3004350	1.217	.246
33	HARTFORD	CT	666981	1511923	1767892	1.169	.377
34	SALT LAKE CITY	UT	670084	601818	93343[illegible]	1.551	.718
35	SAN ANTONIO	TX	656648	6224162	8945449	1.437	.073
36	COLUMBUS	OH	648017	4903390	5713520	1.165	.113
37	LOUISVILLE	KY	638236	1428919	1990068	1.393	.321
38	MEMPHIS	TN	636211	2050233	2840431	1.385	.224
39	RIVERSIDE	CA	687830	10707524	14120685	1.319	.049
40	NASHVILLE	TN	599082	2050233	2840431	1.385	.211

SMSAs RANKED IN ORDER OF YEAR 2000 CPS TRAFFIC

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 9.2-3 FRACTION OF TRAFFIC FROM ORIGINATING SMSAs TO TO DESTINATION SMSAs - YEAR 2000

ORIGINATING SMSA				DESTINATION SMSA													
RANK	FRACT OF US TRAFF	CENTRAL CITY	STATE	1: LOS ANGELES	2: NEW YORK	3: CHICAGO	4: DETROIT	5: PHILADELPHIA	6: SAN FRANCISCO	7: DALLAS	8: WASHINGTON	9: BOSTON	10: HOUSTON	11: MINNEAPOLIS	12: ATLANTA	13: DENVER	14: ST. LOUIS
1	.0429	LOS ANGELES	CA	0	.0284	.0169	.0063	.0059	.1529	.0093	.0159	.0074	.0088	.0045	.0036	.0101	.0044
2	.0387	NEW YORK	NY	.0226	0	.0216	.0071	.0214	.0099	.0075	.0518	.0292	.0071	.0047	.0066	.0046	.0046
3	.0340	CHICAGO	IL	.0239	.0323	0	.0270	.0117	.0105	.0098	.0201	.0113	.0093	.0171	.0070	.0092	.0145
4	.0201	DETROIT	MI	.0165	.0274	.0436	0	.0119	.0072	.0060	.0207	.0089	.0057	.0064	.0060	.0057	.0069
5	.0193	PHILADELPHIA	PA	.0097	.0555	.0120	.0055	0	.0043	.0034	.0374	.0153	.0032	.0024	.0040	.0028	.0028
6	.0189	SAN FRANCISCO	CA	.3024	.0214	.0129	.0038	.0041	0	.0062	.0174	.0064	.0059	.0033	.0024	.0096	.0030
7	.0186	DALLAS	TX	.0238	.0185	.0180	.0054	.0052	.0104	0	.0125	.0065	.1458	.0044	.0066	.0123	.0113
8	.0182	WASHINGTON	DC	.0237	.0862	.0229	.0093	.0291	.0104	.0085	0	.0253	.0080	.0052	.0096	.0088	.0055
9	.0175	BOSTON	MA	.0207	.0828	.0195	.0074	.0175	.0091	.0054	.0411	0	.0052	.0046	.0052	.0054	.0040
10	.0167	HOUSTON	TX	.0245	.0276	.0195	.0068	.0082	.0107	.1262	.0183	.0068	0	.0036	.0071	.0139	.0090
11	.0125	MINNEAPOLIS	MN	.0216	.0211	.0482	.0143	.0076	.0095	.0084	.0155	.0093	.0080	0	.0050	.0122	.0107
12	.0111	ATLANTA	GA	.0119	.0257	.0204	.0069	.0065	.0052	.0114	.0220	.0081	.0109	.0036	0	.0041	.0057
13	.0109	DENVER	CO	.0535	.0248	.0309	.0093	.0076	.0235	.0242	.0262	.0089	.0230	.0119	.0047	0	.0135
14	.0109	ST. LOUIS	MO	.0181	.0228	.1736	.0113	.0082	.0079	.0167	.0163	.0079	.0158	.0093	.0063	.0102	0
15	.0099	NEWARK	NJ	.0125	.2412	.0151	.0057	.0301	.0055	.0044	.0221	.0201	.0042	.0026	.0052	.0035	.0036
16	.0097	CLEVELAND	OH	.0166	.0370	.0357	.0337	.0521	.0073	.0077	.0220	.0124	.0073	.0056	.0052	.0056	.0066
17	.0094	MIAMI	FL	.0219	.0759	.0274	.0134	.0182	.0096	.0109	.0259	.0179	.0104	.0057	.0244	.0067	.0060
18	.0094	BALTIMORE	MD	.0159	.0555	.0156	.0074	.0719	.0069	.0055	.1766	.0182	.0052	.0037	.0078	.0053	.0042
19	.0092	ANAHEIM	CA	.2841	.0119	.0115	.0052	.0046	.1244	.0068	.0090	.0051	.0065	.0039	.0023	.0085	.0036
20	.0092	PITTSBURGH	PA	.0116	.0398	.0203	.0122	.1258	.0051	.0053	.0323	.0106	.0050	.0034	.0048	.0044	.0043
21	.0092	SEATTLE	WA	.0790	.0168	.0149	.0052	.0040	.0346	.0067	.0199	.0057	.0063	.0072	.0028	.0121	.0048
22	.0078	NASSAU	NY	.0194	.3369	.0175	.0070	.0197	.0085	.0060	.0243	.0268	.0057	.0041	.0052	.0042	.0038
23	.0078	PHOENIX	AZ	.1059	.0259	.0310	.0124	.0088	.0464	.0193	.0201	.0092	.0183	.0115	.0067	.0380	.0106
24	.0078	PORTLAND	OR	.0943	.0126	.0139	.0049	.0039	.0413	.0066	.0132	.0047	.0063	.0069	.0029	.0123	.0049
25	.0075	MILWAUKEE	WI	.0160	.0208	.1276	.0265	.0096	.0070	.0075	.0135	.0087	.0071	.0277	.0056	.0073	.0091
26	.0073	SAN DIEGO	CA	.2816	.0119	.0115	.0052	.0046	.1233	.0068	.0090	.0051	.0065	.0039	.0023	.0085	.0036
27	.0071	SAN JOSE	CA	.3112	.0098	.0087	.0031	.0033	.1363	.0048	.0072	.0057	.0045	.0032	.0016	.0071	.0025
28	.0071	TAMPA	FL	.0104	.0435	.0293	.0233	.0145	.0045	.0070	.0149	.0155	.0066	.0058	.0239	.0067	.0061
29	.0071	KANSAS CITY	MO	.0189	.0186	.0473	.0076	.0062	.0083	.0155	.0173	.0058	.0147	.0123	.0048	.0229	.1641
30	.0066	CINCINNATI	OH	.0157	.0286	.0374	.0245	.0154	.0069	.0070	.0196	.0106	.0067	.0059	.0090	.0063	.0081
31	.0064	NEW ORLEANS	LA	.0155	.0214	.0172	.0049	.0057	.0068	.0441	.0209	.0061	.0419	.0031	.0119	.0061	.0079
32	.0059	INDIANAPOLIS	IN	.0105	.0145	.0654	.0213	.0082	.0046	.0067	.0113	.0065	.0063	.0049	.0062	.0062	.0104
33	.0054	HARTFORD	CT	.0172	.1583	.0182	.0077	.0182	.0075	.0055	.0276	.1035	.0053	.0045	.0067	.0054	.0040
34	.0054	SALT LAKE CTY	UT	.0820	.0150	.0166	.0059	.0057	.0359	.0109	.0172	.0056	.0103	.0059	.0029	.0841	.0058
35	.0052	SAN ANTONIO	TX	.0212	.0160	.0161	.0056	.0050	.0093	.1627	.0182	.0051	.1544	.0048	.0047	.0109	.0069
36	.0052	COLUMBUS	OH	.0101	.0210	.0256	.0193	.0229	.0044	.0053	.0177	.0071	.0050	.0049	.0062	.0041	.0055
37	.0052	LOUISVILLE	KY	.0094	.0169	.0474	.0131	.0085	.0041	.0077	.0147	.0051	.0073	.0043	.0120	.0042	.0146
38	.0052	MEMPHIS	TN	.0164	.0212	.0331	.0093	.0063	.0072	.0152	.0141	.0048	.0144	.0046	.0171	.0049	.0218
39	.0050	RIVERSIDE	CA	.2742	.0119	.0115	.0052	.0046	.1201	.0068	.0090	.0051	.0065	.0039	.0023	.0085	.0036
40	.0047	NASHVILLE	TN	.0130	.0204	.0270	.0136	.0091	.0057	.0110	.0182	.0062	.0104	.0040	.0490	.0049	.0107

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 9.2-3 (CONTINUED)

DESTINATION SMSA

ORIGINATING SMSA

RANK	FRACT OF US TRAFF	CENTRAL CITY	STATE	15: NEWARK	16: CLEVELAND	17: MIAMI	18: BALTIMORE	19: ANAHEIM	20: PITTSBURGH	21: SEATTLE	22: NASSAU	23: PHOENIX	24: PORTLAND	25: MILWAUKEE	26: SAN DIEGO	27: SAN JOSE	28: TAMPA
1	.0429	LOS ANGELES	CA	.0049	.0031	.0042	.0031	.0760	.0028	.0092	.0062	.0159	.0080	.0022	.0681	.0589	.0031
2	.0387	NEW YORK	NY	.0896	.0042	.0128	.0089	.0049	.0103	.0027	.0645	.0029	.0021	.0025	.0044	.0038	.0095
3	.0340	CHICAGO	IL	.0082	.0095	.0095	.0047	.0052	.0056	.0040	.0070	.0370	.0033	.0263	.0047	.0040	.0071
4	.0201	DETROIT	MI	.0062	.0223	.0124	.0043	.0036	.0057	.0021	.0060	.0050	.0014	.0056	.0032	.0028	.0092
5	.0193	PHILADELPHIA	PA	.1161	.0040	.0074	.0213	.0021	.0514	.0012	.0121	.0020	.0015	.0016	.0019	.0016	.0055
6	.0189	SAN FRANCISCO	CA	.0041	.0020	.0024	.0027	.0659	.0020	.0124	.0047	.0079	.0125	.0015	.0589	.0510	.0015
7	.0186	DALLAS	TX	.0042	.0032	.0056	.0027	.0052	.0025	.0027	.0040	.0070	.0022	.0025	.0046	.0040	.0042
8	.0182	WASHINGTON	DC	.0181	.0054	.0105	.0684	.0052	.0140	.0033	.0188	.0043	.0025	.0028	.0046	.0040	.0078
9	.0175	BOSTON	MA	.0182	.0046	.0071	.0089	.0045	.0084	.0023	.0180	.0034	.0015	.0026	.0040	.0035	.0052
10	.0167	HOUSTON	TX	.0064	.0041	.0074	.0033	.0053	.0039	.0028	.0060	.0053	.0017	.0023	.0048	.0041	.0055
11	.0125	MINNEAPOLIS	MN	.0053	.0054	.0065	.0037	.0047	.0037	.0053	.0046	.0078	.0040	.0394	.0042	.0037	.0048
12	.0111	ATLANTA	GA	.0074	.0053	.0338	.0066	.0026	.0041	.0017	.0056	.0026	.0017	.0024	.0023	.0020	.0250
13	.0109	DENVER	CO	.0062	.0044	.0059	.0044	.0117	.0036	.0092	.0054	.0276	.0080	.0044	.0104	.0090	.0044
14	.0109	ST. LOUIS	MO	.0052	.0062	.0072	.0040	.0039	.0039	.0026	.0050	.0052	.0021	.0051	.0035	.0031	.0053
15	.0099	NEWARK	NJ	0	.0036	.0080	.0089	.0027	.0145	.0017	.0525	.0024	.0017	.0018	.0024	.0021	.0059
16	.0097	CLEVELAND	OH	.0091	0	.0115	.0075	.0036	.0251	.0023	.0081	.0048	.0020	.0044	.0032	.0028	.0085
17	.0094	MIAMI	FL	.0158	.0071	0	.0097	.0048	.0088	.0029	.0165	.0041	.0021	.0036	.0043	.0037	.0453
18	.0094	BALTIMORE	MD	.0221	.0061	.0129	0	.0035	.0346	.0021	.0121	.0031	.0014	.0022	.0031	.0027	.0096
19	.0092	ANAHEIM	CA	.0034	.0025	.0029	.0026	0	.0022	.0065	.0026	.0175	.0068	.0018	.0554	.0479	.0022
20	.0092	PITTSBURGH	PA	.0113	.0393	.0108	.0166	.0025	0	.0012	.0087	.0037	.0009	.0039	.0023	.0020	.0080
21	.0092	SEATTLE	WA	.0035	.0024	.0026	.0029	.0172	.0019	0	.0037	.0090	.1711	.0026	.0154	.0133	.0020
22	.0078	NASSAU	NY	.0475	.0042	.0157	.0102	.0042	.0095	.0022	0	.0038	.0021	.0024	.0038	.0033	.0117
23	.0078	PHOENIX	AZ	.0055	.0056	.0068	.0041	.0231	.0042	.0107	.0056	0	.0089	.0053	.0206	.0179	.0051
24	.0078	PORTLAND	OR	.0031	.0024	.0023	.0024	.0206	.0019	.1784	.0027	.0103	0	.0027	.0184	.0159	.0017
25	.0075	MILWAUKEE	WI	.0051	.0075	.0067	.0035	.0035	.0046	.0029	.0045	.0057	.0027	0	.0031	.0027	.0050
26	.0073	SAN DIEGO	CA	.0034	.0025	.0029	.0026	.0613	.0022	.0065	.0026	.0175	.0068	.0018	0	.0475	.0022
27	.0071	SAN JOSE	CA	.0029	.0016	.0020	.0024	.0678	.0016	.0071	.0021	.0082	.0075	.0011	.0607	0	.0015
28	.0071	TAMPA	FL	.0105	.0106	.0906	.0078	.0023	.0070	.0016	.0095	.0031	.0010	.0043	.0020	.0017	0
29	.0071	KANSAS CITY	MO	.0057	.0042	.0043	.0029	.0041	.0030	.0044	.0041	.0081	.0030	.0039	.0037	.0032	.0032
30	.0066	CINCINNATI	OH	.0082	.0507	.0112	.0067	.0034	.0074	.0030	.0062	.0044	.0021	.0050	.0031	.0027	.0083
31	.0064	NEW ORLEANS	LA	.0053	.0029	.0133	.0035	.0034	.0027	.0019	.0047	.0026	.0014	.0018	.0030	.0026	.0098
32	.0059	INDIANAPOLIS	IN	.0041	.0215	.0099	.0025	.0023	.0040	.0016	.0032	.0046	.0014	.0045	.0020	.0018	.0074
33	.0054	HARTFORD	CT	.0246	.0047	.0092	.0077	.0037	.0088	.0025	.0344	.0039	.0016	.0026	.0033	.0029	.0068
34	.0054	SALT LAKE CTY	UT	.0038	.0030	.0026	.0029	.0179	.0028	.0171	.0053	.0298	.0151	.0025	.0160	.0138	.0020
35	.0052	SAN ANTONIO	TX	.0033	.0027	.0056	.0035	.0046	.0024	.0038	.0035	.0066	.0019	.0032	.0041	.0036	.0042
36	.0052	COLUMBUS	OH	.0055	.0936	.0078	.0056	.0022	.0110	.0018	.0046	.0030	.0012	.0033	.0020	.0017	.0057
37	.0052	LOUISVILLE	KY	.0052	.0155	.0090	.0038	.0020	.0041	.0014	.0037	.0026	.0011	.0034	.0018	.0016	.0057
38	.0052	MEMPHIS	TN	.0041	.0053	.0082	.0032	.0036	.0031	.0016	.0046	.0035	.0012	.0029	.0032	.0028	.0060
39	.0050	RIVERSIDE	CA	.0034	.0025	.0029	.0026	.0597	.0022	.0065	.0026	.0175	.0065	.0018	.0535	.0463	.0022
40	.0047	NASHVILLE	TN	.0049	.0093	.0133	.0048	.0028	.0044	.0018	.0044	.0029	.0014	.0031	.0025	.0022	.0098

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 9.2-3 (CONTINUED)

DESTINATION SMSA

ORIGINATING SMSA

RANK	FRACT OF US TRAFF	CENTRAL CITY	STATE	29: KANSAS CITY	30: CINCINNATI	31: NEW ORLEANS	32: INDIANAPOLIS	33: HARTFORD	34: SALT LAKE CITY	35: SAN ANTONIO	36: COLUMBUS	37: LOUISVILLE	38: MEMPHIS	39: RIVERSIDE	40: NASHVILLE	OTHER	TOTAL
1	.0429	LOS ANGELES	CA	.0027	.0020	.0023	.0015	.0028	.0062	.0027	.0017	.0010	.0014	.0450	.0013	.3891	1.00
2	.0387	NEW YORK	NY	.0028	.0028	.0023	.0016	.0228	.0013	.0021	.0023	.0015	.0019	.0029	.0018	.5317	1.00
3	.0340	CHICAGO	IL	.0089	.0063	.0030	.0200	.0041	.0024	.0028	.0052	.0039	.0037	.0031	.0034	.6232	1.00
4	.0201	DETROIT	MI	.0042	.0147	.0019	.0076	.0034	.0014	.0017	.0121	.0045	.0039	.0021	.0036	.6761	1.00
5	.0193	PHILADELPHIA	PA	.0017	.0026	.0010	.0014	.0059	.0008	.0010	.0022	.0010	.0014	.0013	.0013	.5904	1.00
6	.0189	SAN FRANCISCO	CA	.0018	.0013	.0016	.0010	.0021	.0360	.0018	.0011	.0007	.0009	.0390	.0008	.3133	1.00
7	.0186	DALLAS	TX	.0069	.0021	.0197	.0021	.0026	.0027	.0442	.0017	.0017	.0033	.0031	.0031	.5717	1.00
8	.0182	WASHINGTON	DC	.0034	.0036	.0030	.0020	.0075	.0020	.0024	.0029	.0021	.0026	.0031	.0024	.5408	1.00
9	.0175	BOSTON	MA	.0024	.0030	.0014	.0018	.0312	.0012	.0016	.0025	.0011	.0015	.0027	.0014	.6282	1.00
10	.0167	HOUSTON	TX	.0055	.0027	.0389	.0019	.0030	.0025	.0363	.0022	.0020	.0030	.0032	.0028	.5508	1.00
11	.0125	MINNEAPOLIS	MN	.0065	.0035	.0020	.0036	.0033	.0031	.0024	.0029	.0022	.0021	.0028	.0019	.6692	1.00
12	.0111	ATLANTA	GA	.0035	.0035	.0068	.0027	.0031	.0011	.0033	.0029	.0067	.0170	.0015	.0158	.6846	1.00
13	.0109	DENVER	CO	.0083	.0029	.0029	.0038	.0032	.0360	.0070	.0024	.0016	.0037	.0069	.0034	.5424	1.00
14	.0109	ST. LOUIS	MO	.0534	.0041	.0045	[illegible]	.0052	.0020	.0048	.0034	.0063	.0076	.0023	.0071	.5070	1.00
15	.0099	NEWARK	NJ	.0022	.0024	.0013	[illegible]	.0122	.0009	.0013	.0019	.0010	.0012	.0016	.0011	.4869	1.00
16	.0097	CLEVELAND	OH	.0040	.0365	.0021	.0070	.0052	.0015	.0022	.0301	.0055	.0038	.0021	.0035	.5455	1.00
17	.0094	MIAMI	FL	.0037	.0047	.0035	.0034	.0068	.0017	.0031	.0038	.0031	.0036	.0028	.0033	.5536	1.00
18	.0094	BALTIMORE	MD	.0025	.0040	.0020	.0022	.0064	.0014	.0016	.0033	.0021	.0026	.0020	.0024	.4527	1.00
19	.0092	ANAHEIM	CA	.0022	.0016	.0013	.0013	.0019	.0054	.0020	.0013	.0008	.0009	.0366	.0009	.3023	1.00
20	.0092	PITTSBURGH	PA	.0027	.0259	.0012	.0033	.0041	.0011	.0015	.0213	.0026	.0021	.0015	.0019	.5348	1.00
21	.0092	SEATTLE	WA	.0030	.0016	.0014	.0014	.0021	.0095	.0019	.0013	.0007	.0010	.0102	.0009	.4972	1.00
22	.0078	NASSAU	NY	.0023	.0028	.0015	.0019	.0184	.0013	.0017	.0023	.0016	.0015	.0025	.0014	.3511	1.00
23	.0078	PHOENIX	AZ	.0065	.0037	.0031	.0040	.0035	.0176	.0056	.0030	.0025	.0025	.0137	.0021	.4452	1.00
24	.0078	PORTLAND	OR	.0030	.0016	.0017	.0016	.0018	.0102	.0019	.0013	.0010	.0010	.0122	.0010	.4702	1.00
25	.0075	MILWAUKEE	WI	.0055	.0050	.0019	.0060	.0033	.0022	.0022	.0041	.0018	.0027	.0021	.0025	.6089	1.00
26	.0073	SAN DIEGO	CA	.0022	.0016	.0013	.0013	.0019	.0054	.0020	.0013	.0008	.0009	.0363	.0009	.3007	1.00
27	.0071	SAN JOSE	CA	.0015	.0010	.0007	.0008	.0018	.0044	.0014	.0008	.0004	.0006	.0402	.0006	.2703	1.00
28	.0071	TAMPA	FL	.0037	.0070	.0027	.0056	.0060	.0007	.0020	.0058	.0041	.0038	.0013	.0036	.5896	1.00
29	.0071	KANSAS CITY	MO	0	.0028	.0033	.0033	.0020	.0036	.0044	.0023	.0023	.0031	.0024	.0028	.5457	1.00
30	.0066	CINCINNATI	OH	.0050	0	.0021	.0220	.0044	.0013	.0020	.0276	.0300	.0060	.0020	.0056	.5679	1.00
31	.0064	NEW ORLEANS	LA	.0048	.0019	0	.0017	.0025	.0011	.0127	.0016	.0020	.0055	.0020	.0051	.6864	1.00
32	.0059	INDIANAPOLIS	IN	.0064	.0142	.0021	0	.0028	.0015	.0019	.0117	.0174	.0050	.0014	.0046	.6774	1.00
33	.0054	HARTFORD	CT	.0024	.0031	.0017	.0023	0	.0016	.0016	.0025	.0018	.0019	.0022	.0017	.4710	1.00
34	.0054	SALT LAKE CTY	UT	.0036	.0020	.0016	.0017	.0022	0	.0031	.0016	.0010	.0014	.0106	.0013	.5335	1.00
35	.0052	SAN ANTONIO	TX	.0054	.0018	.0080	.0019	.0022	.0018	0	.0015	.0020	.0023	.0027	.0022	.4722	1.00
36	.0052	COLUMBUS	OH	.0034	.0617	.0015	.0081	.0028	.0012	.0015	0	.0126	.0030	.0013	.0027	.5922	1.00
37	.0052	LOUISVILLE	KY	.0089	.0102	.0030	.0360	.0025	.0010	.0022	.0084	0	.0262	.0012	.0243	.6447	1.00
38	.0052	MEMPHIS	TN	.0133	.0035	.0110	.0041	.0023	.0013	.0044	.0029	.0133	0	.0021	.0307	.6675	1.00
39	.0050	RIVERSIDE	CA	.0022	.0016	.0013	.0013	.0019	.0054	.0020	.0013	.0008	.0009	0	.0009	.2969	1.00
40	.0047	NASHVILLE	TN	.0066	.0062	.0044	.0067	.0026	.0015	.0032	.0051	.0350	.0281	.0017	0	.6280	1.00

9.3 CONNECTIVITY BETWEEN CPS AND TRUNKING EARTH STATIONS

Economic considerations, as discussed in Subsection 6.3.2, limit the CPS community to those establishments with traffic volumes large enough to justify earth station costs. In consequence, it is estimated that the CPS equipped community (including both dedicated and shared earth station users) will include establishments accounting for approximately 21 percent of U.S. employment (see Table 6.3-3).

If the destination selected for CPS originating traffic were strictly in proportion to employment, roughly 21 percent of the CPS traffic originating in one SMSA would be directed toward CPS earth stations in the destination SMSAs. The remaining 79 percent of arriving CPS traffic would seek destinations in non-CPS equipped locations.

Those establishments electing CPS approaches, however, are more likely than the average establishment to belong to large organizations having intracompany communications needs between more than one CPS qualified establishment. There is, therefore, a greater tendency for CPS originating traffic to concentrate in CPS destinations than would be the case if strict proportionality to employment were operative. While demographic statistics quantifying this additional concentration have not been uncovered, it is nevertheless clear that a large fraction of CPS originating traffic, probably ranging between 50 and 79 percent will be directed to non-CPS destinations.

Overall CPS system planning should take cognizance of this large fraction of CPS originated traffic potentially directed to non-CPS destinations and provide for the facilities to receive it and to route it to trunking facilities which can reach the non-CPS user. Since it is reasonable to assume that incoming traffic to an SMSA is approximately equal to the originating traffic shown in Table 9.1-3, each SMSA should be provided with an interface to trunking facilities having a capacity of .5 to .79 times the busy hour traffic shown in these tables. The installation of one or more common carrier operated earth station in each SMSA, with suitable links to nearby terrestrial central offices, would be one method of satisfying this CPS to trunking connectivity requirement.

10.0 CONCLUSIONS

The following discussion summarizes the findings and conclusions of this study of traffic demand through the year 2000. The report discusses the following markets, with special emphasis on the CPS market:

1. The overall market
2. The satellite market
3. The CPS market
   a. Dedicated earth stations
   b. Shared and dedicated earth stations
4. The lower availability CPS market
   a. Dedicated earth stations
   b. Shared and dedicated earth stations

Annual and busy hour traffic demand is evaluated for each market, and for each of the major telecommunications services. Demand is also distributed by distance, and is segmented by user class and geographic area. A nationwide traffic distribution model is also developed by allocating traffic demand, and earth stations, among the SMSAs and other areas of the United States.

10.1 POTENTIAL CPS TELECOMMUNICATIONS SERVICES

Most of the conventional voice, video, and data applications are represented in the CPS market. The following summarizes those special considerations which are of particular importance in the CPS environment.

10.1.1 VOICE

Voice communications plays a major role in the CPS market, as well as in the various other markets discussed in this study. The limited distribution capabilities of CPS, however, are a significant disadvantage in many voice applications, particularly those using switched, rather than dedicated, modes. CPS installations are likely to be restricted to those establishments with substantial traffic volumes and, compared to the wide distribution of telephones in our society, only a small fraction of users will be directly reachable through CPS.

System configurations which enhance the connectivity of CPS will, therefore, increase the CPS share of voice traffic.

The connectivity and distribution capabilities of CPS can be enhanced by several methods. The establishment of off-net service by means of links between CPS earth stations and nearby telephone central offices is one with wide applicability. CPS users can use the off-net links of a distant CPS earth station to complete calls, via trunking, to non-CPS equipped users in the vicinity of the distant earth station.

Connectivity for CPS voice users can also be enhanced by placing earth stations, operated by common carriers, at selected locations to serve as additional interfaces between CPS and trunking. Distant CPS users, who do not maintain CPS facilities in the localities served by the common carrier earth stations, can address these earth stations and reach otherwise inaccessible destinations.

These, and other methods of broadening the distribution and connectivity available to CPS users, will be important in allowing the use of CPS in many voice applications. The development of the technology that permits this should, therefore, be encouraged. The market estimates presented in this report assume that such technology will be available as needed.

Time delay and echoes are potential problems for voice users of satellite circuits. Echo cancellers, or equivalent devices, are needed to alleviate this problem, but add to cost and complexity. However, many of the echo problems are caused by the conversion of the four-wire links used in long haul transmission to the two-wire links used in most of the local plant. CPS, by avoiding the local links, can economically deliver four-wire service directly to the user thereby avoiding the cost and circuit quality penalties of satellite time delay and echo.

It is likely that the technology employed by future CPS systems will favor digital transmission. Many devices have been developed for the digitization of voice signals with output rates for a one-way transmission ranging from 2400 bits per second or less to 64,000 bits per second. As a general rule, cost, and voice quality, are inversely related to the digitization rate but, of course, the higher rates demand higher throughputs and wider bandwidths. While some satellite common carriers have adopted a 32 kbps voiceband rate the terrestrial, de facto, standard is likely to remain the one-way 64 kbps rate widely used in the T1 carrier system.

Use of the 64 kbps rate for CPS voice channels will facilitate the interconnection of CPS with terrestrial facilities, and will also assure the maintenance of satisfactory voice quality when CPS voice signals are extended through additional terrestrial relays. The assumption underlying the market estimates of this report is, therefore, that voice signals will be digitized at a 64 kbps rate for transmission over CPS. It is recognized, however, that lower digitization rates may become more attractive if the spectrum resources set aside for CPS transmissions become scarce, or if cost tradeoffs between bandwidth and digitizing equipment begin to favor the more expensive, lower bandwidth, approaches.

10.1.2 VIDEO

Video traffic demand in this report is discussed under two major headings:

a. Videoconferencing, which refers to two-way interactive video and audio communications.

b. Broadcast, which refers to one-way transmissions from a single originator to many receive only locations.

Videoconferencing provides a good target for CPS systems provided that costs can be kept competitive with travel costs. For many videoconferencing applications limited distribution is satisfactory. The traffic demand estimates presented in this report assume that bandwidth compression equipment is used to reduce the bit rates needed for videoconferencing channels. The use of one or two T1 channels (at 1.544 Mbps each) appears to provide an acceptable compromise between satisfactory picture quality and link capacity.

The broadcast mode video transmissions include network TV, CATV, and various applications in health care, public affairs, and education (including remotely conducted seminars and presentations). Return channels, if any, for these transmissions are generally conventional voiceband channels used for questions and comments from the audience. While included in the overall and the satellite markets, these one-way video broadcasts are not likely to be compatible with the two-way transmission capabilities associated with CPS designs of the type considered here. Broadcast mode video is, therefore, not included as a significant generator of CPS traffic.

10.1.3 DATA

Most data applications use voiceband lines and many of the considerations applicable to voice apply also to data. The need for wide distribution, for example, is a requirement of many data applications. However, a greater portion of data transmission uses dedicated facilities and, as a result, the limited distribution capabilities of CPS are less restricting for data than for voice.

The time delay of satellite links is a potential problem for data. Many of the current data communication protocols become inefficient when delays are large. The immediate solution, in these cases, is the installation of delay compensation hardware in the earth stations but, in the long term, an evolution to newer, delay tolerant, protocols will eliminate the need for this hardware.

Depending on the mode used for handling the data signal, the digital transmission links envisioned for CPS may result in either high, or very low, efficiencies. Packet modes, for example, are well suited to data transmissions and make efficient use of capacity. On the other hand, most of the commonly used methods of data transmission inefficiently use a full voiceband channel, even for data signals operating at much lower rates. The problem is compounded when the applications involve real time interaction with human operators whose limited typing and reading speeds result in long idle periods on the line. When the various modes of data transmission are combined in proportion to their expected usage, the low efficiency applications dominate, so that average line efficiencies of less than one percent are expected to prevail over the time frame of this study.

Most data transmission takes place over voiceband channels but wideband data links are of growing importance and are expected to account for substantial demand as suitable transmission facilities become widely available. The ability of CPS to avoid the difficulties of wideband local distribution is a positive factor in addressing this market.

The proliferation of microcomputers promises to have an important influence on business methods and life styles. The impact on CPS data traffic, however, is not likely to be intense because most of the applications will require wide distribution and because a large portion of the traffic will involve homes and small businesses not readily addressed by CPS.

10.2 POTENTIAL CPS USER CLASSES

The study considers four user classes under the headings of Business, Government, Institutions and Residential. Suitable subclasses are introduced where needed. Each class is discussed below with emphasis on factors favorable to, or opposing, the use of CPS.

10.2.1 BUSINESS

Business users account for the largest volume of telecommunications demand. Circa 1980 expenditures among large business users were approximately 70 percent for voice, 27 percent for data, and 3 percent for video and other wideband services.

While both intrastate and interstate markets are addressable by CPS, the longer distances, characteristic of the interstate market, are better suited to CPS (and other satellite based) approaches. The division of expenditures among large business users is roughly 54 percent for interstate service as compared to 46 percent for intrastate.

As discussed earlier, wide distribution is more diffucult to achieve with CPS than with some other communications approaches. Switched applications need wide distribution and are consequently less attractive targets for CPS than are applications using dedicated communications. Among large business users recent interstate expenditures have been in the ratio of 55 percent for switched service versus 45 percent for dedicated.

Increasing use of non-telco services is a positive indicator of the acceptability of new and innovative services such as CPS. Large business users spent 10.6 percent of their budgets on non-telco services in 1978 and anticipate substantial growth in this percentage during the next decade.

10.2.2 GOVERNMENT

Federal civil employment accounts for 2.8 percent of the U.S. total. Demand for long distance communications from this sector is more than proportional to this percentage and some of the major federal systems offer important targets for CPS. The Federal Telecommunications System (FTS), one of the world's largest private line networks, is an excellent example. The FTS is nationwide in extent and contains approximately 35,000 inter-city voiceband lines. The prime target for CPS is the backbone network of about 12,000 two-way voiceband trunks linking some 54 switching centers, which provide logical locations for earth stations. Between 10 and 20 percent of the interswitch trunks are presently supplied by satellites, with recent additions favoring the higher end of this range.

The postal system also offers enormous potential for CPS participation. The recently introduced Electronic Computer Originated Mail (E-COM) service, which has 25 serving post offices throughout the nation, is only a first step in the application of telecommunications technology to mail delivery. First class mail, with its requirements for nationwide, high volume delivery service to major population centers, appears ideal for CPS. Most mail can tolerate delays ranging from hours to days so that the higher frequency satellite transmission bands can be used without too much concern over possible weather induced outages.

State governments are also heavy users of telecommunications but the more limited geographic dispersion of most state communications is less favorable to CPS. Nevertheless, potential uses exist and add to the CPS addressable market. The key to this market appears to be cost competitiveness. To the extent that CPS systems can offer competetive rates for the shorter distances used in state communications a smaller, but significant, market can be addressed.

10.2.3 INSTITUTIONS

Institutions that are potential contributors to CPS demand generally fall in the educational or health care fields. Each of these is discussed below.

There are about 2800 institutions of higher education in the United States and expenditures in 1980 amounted to 2.24 percent of the gross national product. Advanced uses of telecommunications are readily accepted in this environment, and applications using special computer networks and teleconferencing are frequently encountered. Tending to discourage CPS usage, however, are the relatively short distances involved. While nine percent of the colleges and universities have branch campuses some distance from the main campus, the entire complex is generally confined within the boundaries of a particular state. CPS installations in the college and university environment are, therefore, more likely to be motivated by requirements for advanced wideband transmission, than by strictly economic tradeoffs.

Health care also is a major area of economic activity. There are about 7000 hospitals in the United States and expenditures in 1980 were 9.4 percent of the gross national product. Massive amounts of data accompany these activities but most of this remains in the local area. As computers take a more dominant role, however, the emergence of nationwide data networks is a possibility. While many advanced uses of telecommunications for health care are under consideration, most applications have focused on remote video diagnosis, and educational seminars for doctors, nurses, technicians, and other health industry personnel. Applications for CPS will be found in these areas but the overall volume of demand is expected to be small.

10.2.4 RESIDENTIAL

Many signs point to the rapid growth of advanced telecommunications in home applications. The role of CPS satellite transmissions in this environment, however, is less clear.

Direct broadcast of television signals to home roof-top antennas is not far off, but the special one-way broadcast satellite systems designed for this purpose are not likely to be compatible with the two-way CPS systems that are the subject of this report.

Other emerging residential applications are related to the proliferation of home terminals with their ability to extend shopping, banking, information and message services to the home. Despite the growing public awareness of these new services, the impact on CPS demand is likely to be slight. In most cases, the transmissions will be local, and individual users will not generate sufficient traffic to make an earth station installation practical. Where demand for CPS does emerge it will require the mediation of a service provider to concentrate and consolidate traffic to volume levels suitable for CPS transmission. Such uses, where anticipated, are included under the projections for business applications.

10.3 PRIMARY RESEARCH RESULTS

To supplement the data base obtained from documentary sources a survey of communications customers was conducted using questionnaires developed for the purpose. During the survey, which was completed in mid-1982, some 308 "users of communications services" were interviewed. An additional 62 respondents, who were classified as "providers of communications services", were also contacted. About ten percent of the interviews took place at the respondents' establishments. The remaining interviews were conducted by telephone.

The survey collected data on present and projected uses of telecommunications with the goal of arriving at volume of traffic estimates that could be related to other independent user population parameters. The most important information of this type was the relative per employee useage of telecommunications services among the various user classes.

The survey also developed supporting information on telecommunications budgets, geographic distribution patterns, applications in use or projected, sensitivity to cost and reliability, and any special factors which might influence the acceptability of CPS. Results appear as a series of tables with explanatory text. These results were used in arriving at the basic traffic estimates developed in this report, and also in segmenting traffic according to user class and service category.

Among other general conclusions it was clear from the responses to the survey that price is the key to user acceptance of CPS. CPS is of interest only as it provides cost advantages, and generally not for any other user-recognized reason, including bandwidth, digital operation, or other technical features.

The level of reliability (availability) provided is an important issue to most users. However, most of the respondents consider the availability of conventional communications services adequate and few would pay more than a small premium for an improvement. However, some tradeoffs between cost and availability in the downward direction would be considered by many respondents. Over half stated that they would settle for lower availability if the costs were set low enough (i.e., at less than half of the present costs).

Data transmission applications for CPS are predominant in the thinking of the users interviewed. Video applications appear to be too new to have any significant place in either the present operations, or future plans, of most organizations.

Apart from the level of usage, which varies from one user class to another, there was little differentiation among user classes with respect to any of the issues explored. Similarly, geographic location of the respondent had little influence on the nature of the responses received.

10.4 COMPARATIVE ECONOMICS

As indicated by the responses received in the user survey cited above, pricing of service will be very significant in determining the acceptability of CPS. Tariff information was, therefore, compiled for a number of the more important common carrier service offerings, and serves as a useful guide for potential CPS pricings.

Voiceband private line prices are perhaps the best guide to comparative transmission costs. These circuits are very commonly available, are offered competitively by many terrestrial and satellite common carriers, and do not intermix the charges for transmission with other charges, such as those for switching.

The price of terrestrial two-way voiceband private lines is distance sensitive. The price of satellite derived lines is also distance sensitive, but to a much smaller extent. There is, as a result, a cost cross-over, in the vicinity of 800 miles, above which satellite prices are generally lower than terrestrial prices. Other factors being equal, 800 miles can, therefore, be taken as the current boundary above which satellite services should find high acceptance. This report uses this boundary, together with traffic distance distributions, to develop estimates of satellite addressable traffic. The report also makes the assumption that, as satellite technology advances, the cost competitive distance for satellite transmission will gradually be lowered.

Comparisons between the cost of current videoconferencing services and the cost of travel are not favorable to widespread use of videoconferencing. Depending on the travel charges included, from two to four employees can fly to their destination, attend one or more meetings, and return the next day at approximately the cost of a one hour videoconference. A desirable goal for CPS systems would be to deliver videoconferencing capabilities at a fraction of travel costs. The ability to use existing CPS facilities for videoconferencing on a secondary basis, during periods when the traffic volume of the primary applications is low, may assist in this respect.

Future price trends for telecommunications are difficult to quantify but, in fixed value dollars, the cost of communications has been declining for many years. Relative to the Consumer Price Index, the long distance Telephone Price Index (computed and published annually by the Bell System) has been declining at an average rate of 4.31 percent over the last two decades. If this long term trend continues to the year 2000, the price of long distance service would, in constant dollars, be only 44.5 percent of the comparable price circa 1980.

10.5 MARKET DEMAND FORECASTS

Estimates of annual and busy hour traffic demand have been developed for the overall market, the satellite market, the CPS market, and the market for lower availability CPS services. Each of these markets is a subset of the preceeding market, with demand reduced by considerations of the cost competitive distance ranges of the transmission medium, limitations in the ability to provide wide distribution, and lowered availability. For each market, the report presents data for the benchmark years 1980, 1985, 1990 and 2000, and for the voice, video, and data service categories.

Within each market the basic estimates of traffic demand were developed by considering subcategories of the major voice, video, and data services. The traffic demands of the service subcategories were then combined to arrive at various totals and subtotals.

In the voice category, dedicated voice (private line) and switched voice applications (MTS and WATS) are all significant contributors to demand. The fact that dedicated applications require full time reservation of communications capacity, even though the channel may be inactive for large portions of the day, magnifies the relative importance of these applications in the estimates of annual traffic demand. On the other hand, when busy hour traffic, rather than annual traffic, is considered, the switched voice components, because of their higher peak factors, receive extra emphasis.

The major contributors to demand for video services in the overall and satellite markets are the broadcast video components (primarily educational uses and CATV). Videoconferencing demand, though smaller than that of the broadcast video categories, is also of importance. The estimates for videoconferencing demand in this report, however, are lower than those offered in earlier studies, reflecting important advances in bandwidth compression technology. In the CPS market the broadcast transmissions are excluded, leaving videoconferencing as the only significant contributor to demand.

Data traffic demand is chiefly the result of computer related traffic, the major subcategory of which is interactive, terminal to computer communications. Message oriented data traffic demand, including electronic mail and facsimile, is only about one percent of demand for computer traffic.

The relative sizes of the various markets may be visualized with the aid of Figure 10.5-1 which shows the busy hour traffic projected for the year 2000. In this figure the overall market, which represents traffic leaving the local calling area, is taken as a reference. Satellite addressable traffic, amounting to 34 percent of the overall market, is that portion of the overall traffic which travels a sufficient distance (200 miles for the year 2000) to be cost competitive with terrestrial communications. The CPS market (including both dedicated and shared earth station installations) is limited by needs for wide distribution, and by the relatively high level of communications volume needed to justify an earth station. These limitations restrict the addressable CPS market to about 15 percent of the satellite market (5.2 percent of the overall market). For those CPS designs that deliver lower levels of availability the addressable market is further reduced and, in the year 2000, is estimated to be 41.6 percent of the CPS market (2.2 percent of the overall market).

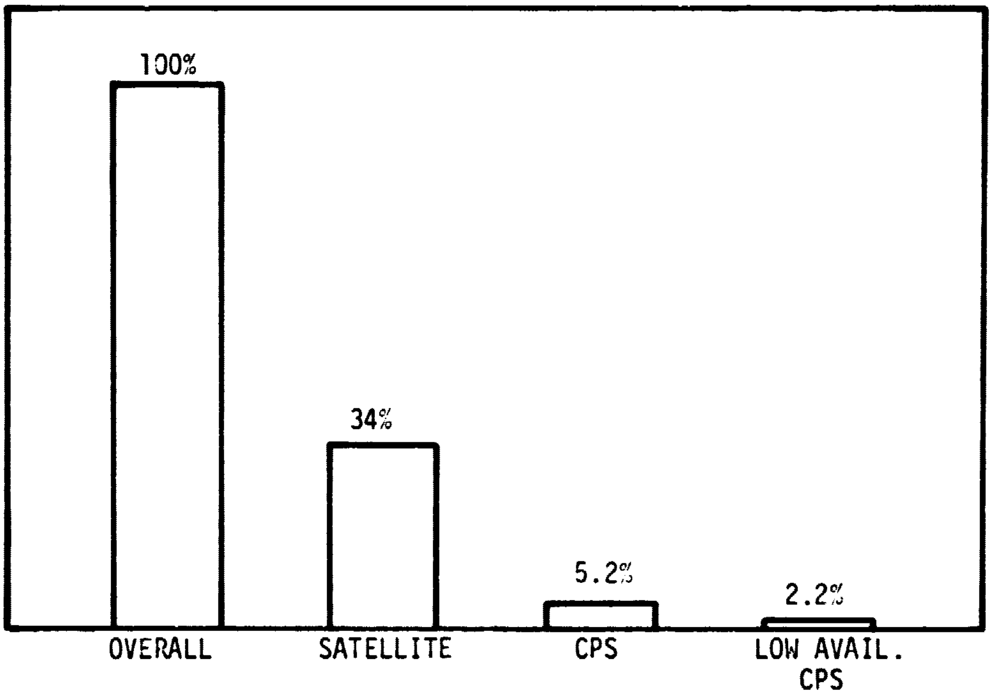


FIGURE 10.5-1 COMPARISON OF MARKET SIZES - YEAR 2000

While there is some variation from market to market in the relative importance of the different service categories, the variation is not large. For busy hour traffic in the year 2000, depending on the market, voice traffic accounts for 68 to 73 percent of addressable demand, data traffic accounts for 25 to 27 percent of addressable demand, and video traffic accounts for one to three percent.

10.6 DISTANCE DISTRIBUTION OF TRAFFIC

The distribution of traffic with distance plays a key role in selecting that portion of traffic that travels far enough for satellite transmissions to be cost competitive with terrestrial media. This study assumes a gradual decrease in the cost competitive threshold distance, from the 800 mile distance characteristic of transmission costs circa 1980, to 600, 400 and 200 miles for the years 1985, 1990 and 2000. By comparing these threshold distances with the distance distribution of traffic,the study arrives at estimates of the amount of traffic addressable by satellites.

The distance distribution of traffic, as obtained from various published traffic studies, is presented for each of the major service subcategories. Composite distance distributions for each market are also developed by weighing the distributions of each service subcategory in accordance with its relative volume. For the overall market, about 35 percent of the traffic leaving the local area is estimated to travel beyond 200 miles, about 21 percent travels more than 400 miles, 15 percent travels more than 600 miles and 10 percent travels more than 800 miles. For the satellite and CPS markets, demand is based on traffic components which exceed the cost competitive threshold distances. As a result, the composite distance distributions for these markets more heavily favor longer distance transmissions.

10.7 SEGMENTATION OF MARKET DEMAND

The market demand forecasts discussed above develop addressable traffic demand by market, by service, and by year. Further segmentation is also provided according to user class, by geographic region, and by various combinations of all of these parameters.

User classes that are representative of the common business, government, institutional, and residential communities were selected. Traffic demand among these classes was distributed on the basis of employment, or, in the case of residential traffic, population. There is a considerable variation in the per employee traffic demand from user class to user class, and the model used for the distribution of traffic among the classes takes this into account. This is accomplished by weighting the employment estimate with user-dependent activity factors developed during the primary research survey. The activity factors vary from year to year, and from service subcategory to subcategory and, in effect, indicate the relative per employee demand for service of a given type emanating from each user class.

Because its activity factors and employment levels are both high, wholesale and retail trades generally account for the largest portion of demand, with the services and manufacturing user classes ranking second and third.

The same activity factors are used in distributing demand among the nine geographic census regions. Those regions which contain higher concentrations of communications intensive activities are apportioned correspondingly higher fractions of the total demand. Demand varies from year to year and from market to market but the East North Central region generally ranks first, followed closely by the South Atlantic, Pacific, and Mid Atlantic regions.

10.8 NATIONWIDE TRAFFIC DISTRIBUTION MODEL

Employment, weighted by the activity factors appropriate to each user class, is again used to distribute traffic among the SMSA and the non-SMSA areas of the United States. Demand for CPS traffic is estimated for each of the top 40 SMSAs and for the remaining SMSAs in groups of 20, as ranked in order of addressable busy hour traffic. The sum of the demand from all of the 264 SMSAs considered is subtracted from the U.S. total to arrive at estimates of demand originating in areas not included in the SMSAs.

In terms of the year 2000 busy hour CPS traffic, the top 20 SMSAs account for 35 percent of total U.S. demand. The top 40 SMSAs account for 48 percent, the top 60 account for 55 percent, and all of the 264 SMSAs together account for 78 percent of this traffic. The remaining 22 percent of traffic originates in smaller urban and rural areas outside the SMSAs.

Based on estimates of the number of establishments meeting the employment size criteria considered appropriate for the installation of earth stations, about 1900 dedicated, and 2300 shared potential earth stations are projected for the U.S. in the year 2000. These earth stations are distributed among the individual SMSAs in proportion to each SMSA's fraction of the total busy hour traffic. The Los Angeles-Long Beach SMSA ranks first with a total of 182 shared and dedicated earth stations. The New York and Chicago SMSAs rank second and third with 164 and 144 shared and dedicated earth stations, respectively.

As part of the nationwide traffic distribution model, the year 2000 busy hour CPS traffic between pairs of SMSAs is projected for the top 40 SMSAs. Results are presented as a matrix showing the fraction of CPS traffic that originates in each of these SMSAs that is destined for each of the other SMSAs and for the areas not included in the SMSAs.

The CPS equipped community is expected to be relatively compact, encompassing some 21 percent of U.S. employment. However, many important telecommunications applications require wide distribution to establishments outside of, as well as within, the CPS community. As discussed earlier, interfaces between CPS and trunking facilities are, therefore, of importance in allowing CPS systems to address the widest possible market. It is estimated that these interfaces will require capacity in the range of 50 to 80 percent of the CPS originated traffic arriving at an SMSA.

REFERENCES

CHAPTER 1

1-1 "30/20 GHz Fixed Communications Systems Service Demand Assessment," NASA Report No. CR 159620, Prepared by ITT-U.S. Telephone and Telegraph Corp., July 1979.

1-2 "Market Capture by 30/20 GHz Satellite Systems," NASA Report No. CR 165232, Prepared by ITT-U.S. Telephone and Telegraph Corp., April 1981.

CHAPTER 2

2-1 American Telephone and Telegraph Company, 1980 Annual Report.

2-2 S.J. Campanella, "Digital Speech Interpolation," Comsat Technical Review, Spring 1976.

2-3 C.E. White, "Evolving Carrier Services: The Future," Telecommunications, October 1981.

2-4 Stephen B. Weinstein, "Echo Cancellation in the Telephone Network," IEEE Communications Society Magazine, January 1977.

2-5 M. Onufry, "Echo Control in Telephone Communications," National Telecommunications Conf., Vol. 1, Nov. 29 - Dec. 1, 1976.

2-6 "Rate Request Filed on Bell TV-Phone," N.Y. Times, December 23, 1982.

2-7 "Teleconferencing: Shortcut to Business Communication," Computer Decisions, November 1981.

2-8 "AT&T Videotex Compromise is Rejected by Europeans," Bryan Wilkins, MIS Week, December 2, 1981.

2-9 "All About Data Communications," Datapro Research Corp., 1981.

2-10 "Modems and Multiplexers," Electronic News, March 22, 1982.

2-11 "Minicomputer Update," Edwin E. Mier, Data Communications, March 1982.

2-12 "Survey: Users Leaning to Broadband for Future Local Nets," Data Communications , March 1982.

2-13 "Local Networks At A Glance," Data Communications, December 1981.

2-14 "Bell Labs Local Networks," Data Communications, October 1981, pg. 102.

CHAPTER 3

3-1 "The Communications Act of 1978, User Perspectives on Regulatory Reform," International Communications Association, December 1978.

3-2 Statistical Abstract of the United States, 1981, U.S. Department of Commerce, Bureau of the Census, Table 507.

3-3 "Planning for Federal Government Information Systems," Roy Daniel Rosner, EASCON 1981 Record, IEEE Publication 81CH1724-4, pg. 152.

3-4 "Government Telecommunications Needs for Civilian Agencies," Frank J. Carr, Telecommunications, June 1979.

3-5 "E-COM Customer Information Booklet," U.S. Postal Service, Washington, D.C., November 1981.

3-6 "Electronic Mail's Slow Start," Andrew Pollack, The New York Times, March 19, 1982.

3-7 "E-COM Users Guide," Handbook DM-501, November 1981, U.S. Postal Service, Washington, D.C.

3-8 "State of Michigan Telecommunications Master Plan," State of Michigan Bureau of Management Sciences, Department of Management and Budget, Lansing, Michigan, 1974.

3-9 Statistical Abstract of the United States, 1981, U.S. Department of Commerce, Bureau of the Census, Table 217.

3-10 Statistical Abstract of the United States, 1980, U.S. Department of Commerce, Bureau of the Census, Table 266.

3-11 "Teleconferencing Enters its Growth Stage," W. Sonneville, Telecommunications, June 1980.

3-12 "Universities are Setting Trends in Data Communications Nets." Wendy Rauch-Hindin, Data Communications, October 1981.

3-13 Statistical Abstract of the United States, 1981, U.S. Department of Commerce, Bureau of the Census, Table 175.

3-14 Statistical Abstract of the United States, 1981, U.S. Department of Commerce, Bureau of the Census, Table 149.

3-15 "Networking Tonic Prescribed for Better Health Care," J. Peter Schmader, Data Communications, August 1981.

3-16 "Medical Applications of Satellite Technology," John Paul Rossie, Telecommunications, December 1979.

3-17 "Public Facsimile Communication Network," Takahiko Kamae, IEEE Communications, March 1982.

CHAPTER 4

4-1 County Business Patterns 1976, U.S. Department of Commerce, Bureau of the Census, August 1978.

4-2 Standard Industrial Classification Manual, Executive Office of Management and Budget, 1972.

CHAPTER 5

5-1 American Telephone and Telegraph Company, 1981 Annual Report.

5-2 Executive Communication Planning Guide, Center for Communications Management, Inc.

5-3 SBS Tariff No. 4, Message Services, February 1, 1982.

5-4 "FCC Sets Review of Satellite Policy," N.Y. Times, January 28, 1982 .

5-5 "FCC Approves $13 Mil. RCA Transponder Tariff," FCC Week, March 29, 1982 .

5-6 "Video Teleconferencing, American Satellite Co.," Telecommunications, August 1982 .

5-7 "Recent Studies of Price Elasticity and Rate Increases," Probe Telecommunications Reports, May - June 1977.

5-8 R.R. Auray, "Customer Response to Changes in Interstate MTS Rates," Proceeding of the Institute of Public Utilities Ninth Annual Conference, 1978.

5-9 "30/20 GHz Fixed Communications Systems Service Demand Assessment," NASA Report No. CR 159620, ITT, August 1979.

5-10 Statistical Abstract of the United States, 1981, pg. 467.

CHAPTER 6

6-1 "30/20 GHz Fixed Communications Systems Service Demand Assessment," NASA Report No. CR 159620, Prepared by ITT-U.S. Telephone and Telegraph Corp., August 1979.

6-2 "Market Capture by 30/20 GHz Satellite Systems," NASA Report No. CR 165232, Prepared by ITT-U.S. Telephone and Telegraph Corp., April 1979.

6-3 "The World's Telephones as of January 1, 1965 (and separate volumes for subsequent years)," American Telephone and Telegraph Long Lines.

6-4 "Statistical Reports," American Telephone and Telegraph Company, 1978.

6-5 AT&T Response to Appendix B Data Request for 1980 FCC Docket No. 81-412 dated August 1981, Vol. 4 - Supporting Data, Length of Haul for MTS and WATS Messages and Minutes.

6-6 "Fully Distributed Costs (FDC-7)," Report to the FCC, June 1978.

6-7 "Technology Assessment of Telecommunication Transportation Interaction, Vol. II, Detailed Impact Analysis," Stanford Research Institute, (NTIS No. PB272695), National Science Foundation, Washington, D.C., 1977.

6-8 "USPS and the Commmunications Revolution: Impacts, Options, and Issues," George Washington University for the Commission of Postal Service, Contract CPS-004, March 5, 1977.

6-9 "Petition for Rule Making Before the FCC, Appendix C," Xerox Corporation, November 16, 1978.

6-10 "Computer Equipment Strategy Program," Vol. III, pg. 337, Quantum Science Corp., 1980.

6-11 "Impacts of Electronic Communications Systems on the U.S. Postal Service 1975-1985." Report to the Commission on Postal Service C-80209, A.D. Little, February 15, 1977.

6-12 "Customer Service Study for 30/20 GHz Satellite Systems," First Interim Report, Pages 3-18, TRW, September 11, 1981.

6-13 "Communications Strategy Program Vol. III Executive Commentary - Spending for Data Communications Continues to Accelerate," Quantum Science Corp., 1980.

6-14 "Computer Equipment Strategy Program: Vol. III," pp. 103-305, Quantum Science Corp., 1980.

6-15 "County Business Patterns 1979," U.S. Department of Commerce, Bureau of the Census.

6-16 "The World Almanac and Book of Facts 1981," Newspaper Enterprise Association, pp. 240-263.

CHAPTER 7

7-1 AT&T Exhibit to FCC Docket 18128, Vol. 16, "Market Analysis MTS Domestic and Overseas," July 8, 1977.

7-2 AT&T Response to Appendix B Data Request for 1980 FCC Docket No. 81-412, Vol. 4, "Supporting Data - Length of Haul for MTS and WATS Messages and Minutes," August 1981.

7-3 1978 Annual FDC Report Vol. 4, "Private Line Telephone Channels and Telpack, Private Line Other," AT&T, June 29, 1979.

7-4 "Origin-Destination Information System Quarterly Statistics," Postal Quarter III PFY 1982, March 20, 1982 - June 11, 1982.

CHATPER 8

8-1 "1980 OBERS - BEA Regional Projections," Vol. I, U.S. Department of Commerce, Bureau of Economic Analysis, 1980.

8-2 State and Metropolitan Area Data Book 1979, U.S. Department of Commerce, Bureau of the Census, Issued 1979, Reprinted April 1981.

CHAPTER 9

9-1 "1980 OBERS - BEA Regional Projections," Vol. 3, Standard Metropolitan Statistical Areas, U.S. Department of Commerce, Bureau of Economic Analysis, 1980.

9-2 County Business Patterns, 1979, CPB-79-1 U.S. Department of Commerce, Bureau of the Census, Issued August 1981.

9-3 "1980 OBERS - BEA Regional Projections," Vol. 1, Methodology, Concepts and State Data, U.S. Department of Commerce, Bureau of Economic Analysis, 1980.