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SATELLITE PROVIDED FIXED COMMUNICATIONS SERVICES: A FORECAST OF POTENTIAL DOMESTIC DEMAND THROUGH THE YEAR 2000

FINAL REPORT - VOLUME II - MAIN TEXT

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16. Abstract

The overall purpose of this study was to forecast the potential United States domestic telecommunications demand for satellite provided fixed communications voice, data and video services through the year 2000.

To accomplish this purpose the following objectives were achieved:

a. Development of a forecast of the total domestic telecommunications demand

b. Identification of that portion of the total demand suitable for transmission by satellite provided fixed communications systems

c. Estimation of the actual amount of traffic that could be captured by Ka-band systems.

The approach employed included the use of a variety of forecasting models, a parametric cost model, a market distribution model and a network optimization model. Forecasts were developed for: 1980, 1990, and 2000; voice, data and video services; terrestrial and satellite delivery modes; and C, Ku and Ka-bands.

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SECTION 1
OVERVIEW

1.1 BACKGROUND

In 1979 Western Union published the results of a NASA-sponsored study entitled "18/30 GHz Fixed Communications System Service Demand Assessment." This study was done as part of a broader communications program to define the telecommunications needs of the U.S. to the year 2000, to determine how space communication systems would best address these telecommunication needs, and to define where advanced technologies would be required. During the interim three years, significant changes have occurred in the satellite communications industry, (e.g., service mixes and service offerings have changed) that led to the need for an updated set of forecasts. Consequently, the present demand assessment study was commissioned. This study represents a fresh look at the demand for voice, data and video services to the year 2000. Overall forecasts were developed for the total telecommunications traffic demand of the U.S., that portion generated by the 313 Standard Metropolitan Statistical Areas, and that portion that could be potentially transmitted by satellite. In addition, that portion of the potential satellite traffic that could be captured by Ka-band systems was estimated. The final results are presented in terms of equivalent 36 MHz transponders for the satellite candidate traffic, the estimated geostationary arc capacity of the C- and Ku-bands, and an estimate of the actual C- and Ku-band transponders likely to be available over the time frame of interest.

1.2 PURPOSE, TASKS AND ACTIVITIES

1.2.1 Purpose

The overall purpose of this study was:

> To forecast the potential United States domestic telecommunications demand for satellite provided fixed communications voice, data and video services through the year 2000, so that this information on service demand would be available to aid in NASA communications program planning.

To accomplish this purpose the following objectives were achieved:

a. Development of a forecast of the total domestic telecommunications demand
b. Identification of that portion of the total demand suitable for transmission by satellite provided fixed communications systems
c. Estimation of the actual amount of traffic that could be captured by Ka-band systems.

1.2.2 Tasks and Activities

For each of the major study tasks the purpose and activities are outlined below:

Task 1.0

Demand forecasts for telecommunications services for the period 1980 - 2000

Task 1.1

Telecommunications service demand

Purpose

Forecast the telecommunication service demand for voice, data and video services for the years 1980, 1990 and 2000

Activities

1. Identify and characterize services
   a. Review market studies and telecommunications literature
   b. Collect input from users and providers
   c. Develop list of potential services
   d. Define and characterize services
2. Develop baseline forecasts
   a. Identify forecasting methodology for each service
   b. Develop estimate of current traffic for each service
   c. Develop estimate of future traffic for each service
3. Develop impacted baseline forecasts
   a. Develop impacted baseline model
   b. Develop and collect information on market determinant factors

c. Analyze results and develop forecasts

4. Develop net long haul forecasts

    a. Reduce traffic (e.g., intra SMSA, data on analog)

    b. Develop Market Distribution Model

    c. Convert forecasts to peak hour

Task 1.2

Net addressable market

Purpose

Determine that portion of the net long haul market that could be served by satellites considering pertinent technical, institutional and cost factors.

Activities

1. Reduce traffic (e.g., due to constraints plant in place)

2. Conduct cost analysis

    a. Define and cost earth stations

    b. Cost space segment

    c. Define and cost entrance/exit links

    d. Develop 1980 end-to-end user costs and crossover distances with terrestrial tariffs

    e. Describe future trends

    f. Develop 1990 and 2000 trunking costs and crossover distances with terrestrial tariffs

3. Develop net addressable forecasts

Task 1.3

Capacity Requirements

Purpose

Convert the net addressable forecasts from peak hour half voice circuits (voice), Mbps (data), and transponders (video) to equivalent transponders so that a comparision can be made among required, potential and actual capacities.

Activities

1. Analyze techniques for improving spectrum utilization

2. Specify high, expected and low estimates of technological change

3. Develop high, expected and low estimates of required satellite capacity

Task 1.4

Satellite system market development

Purpose

Compare required, potential and actual capacities so that estimates of when Ka-band will be needed can be made.

Activities

1. Develop potential capacity forecasts
   a. Specify factors influencing potential capacity
   b. Develop high, expected and low estimates of potential capacity
2. Develop actual capacity forecasts
   a. Specify factors influencing actual capacity
   b. Develop high, expected and low estimates of actual capacity
3. Compare capacities
   a. Indicate when Ka-band will be needed
   b. Specify areas of uncertainty

Task 2.0

Ka-band net accessible market

Task 2.1

Specialized carrier Ka-band net accessible market

Purpose

Develop the specialized carrier net accessible Ka-band market for the minimum, maximum and most efficient network sizes

Activities

1. Define specialized carriers
2. Established hubbing distance
3. Determine Ka-band re[illegible]irement capacity
4. Develop network optimization model
5. Develop scenarios
   a. Minimum network
   b. Maximum network
   c. Most efficient network
6. Summarize implications

Task 2.2

Established carrier Ka-band net accessible market

Purpose

Develop the established carrier net accessible Ka-band market for a 10 and a 20 earth station network

Activities

1. Define established carriers
2. Establish hubbing distance
3. Determine Ka-band required capacity
4. Develop network optimization model
5. Develop scenarios
   a. 10 earth station network
   b. 20 earth station network
6. Summarize implications

1.3 SATELLITE PROVIDED FIXED COMMUNICATION SERVICES VERSUS CUSTOMER PREMISES SERVICES

At first glance the differences between the networks for satellite provided fixed communications services (FCS) and customer premises services (CPS) appear clear. Networks for FCS have carriers which connect many users' systems end-to-end. The user's messages are combined with others, through various multiplexing techniques, in a bulk transmission. In most instances the only piece of transmission equipment the user has is the telephone. With CPS networks the user owns or rents his own earth stations and transponder space. He does not have to go through an intermediary and has much more control over his own transmission.

However, an examination of the various configurations for satellite provided FCS and CPS indicates that the differences are not always distinct. A network for satellite provided FCS can be either an established carrier network (i.e., a network with extensive terrestrial facilities) or a specialized carrier network (i.e., a network with leased lines). A CPS system may be either a dedicated network (i.e. only one user) or a shared network (i.e., several users sharing the facilities). The distinctions between specialized carrier networks and shared CPS networks are not so obvious. For example, an analysis of the cost to operate a specialized carrier earth station showed that its capacity could be as small as 15.7 Mbps and still be economical, while traffic projections and user profiles revealed that a few 32 Mbps earth stations would be economical and justified in a CPS shared/unshared system by 2000. Both of these systems are likely to have terrestrial tails connecting several users. Also, in some CPS shared systems the users may find it more convenient to allow a second party to operate the shared earth station, possibly allocating cost to the various users based on usage, similar to a FCS.

Still, there are some fundamental differences between satellite provided FCS and CPS networks. For instance, with a CPS network, the users have much more control over their transmissions; in most instances messages are not multiplexed together with other users. In addition, terrestrial tails connecting the users are short. Perhaps the feature which most clearly distinguishes FCS and CPS traffic is the size of the user (i.e., traffic volume of the user). Users in a CPS system, even a shared system, must be relatively large. In addition, surveys indicated that most CPS traffic would be internal to the company; therefore the company would have to be a national company or at least affiliated with a national company. These differences provided the conceptual framework for determining what would be FCS and what would be CPS traffic.

It should be pointed out that to model the networks a clear distinction between the various networks was not needed. All traffic can go via trunking networks either using specialized or established carriers. Therefore, the only determination which had to be made was which traffic could use a CPS system; how this was determined is discussed extensively in the CPS study (Satellite Provided CPS: A Forecast of Potential Domestic Demand Through the Year 2000).

1.4 FORECASTING METHODOLOGY

1.4.1 Study Activity Flow

A summary of the study activity flow is depicted in Figure 1-1. The details of this activity flow are presented in similar figures in each of the subsequent sections of this report.

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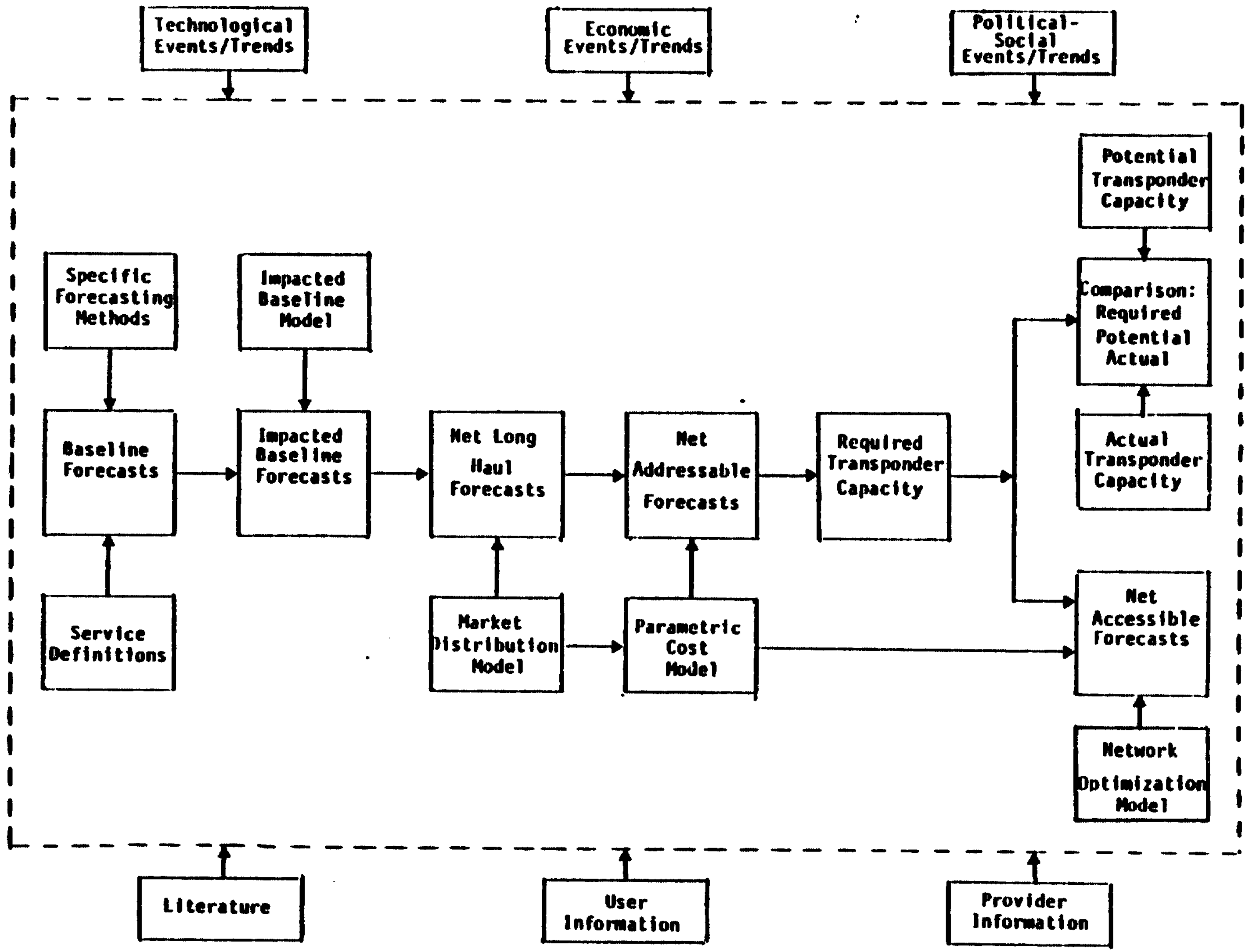

FIGURE 1-1. OVERALL ACTIVITY FLOW FOR THE STUDY

The first activities involved defining and characterizing the potential services and specifying forecasting methods for each. The products of these efforts were needed to develop the baseline forecasts which were estimates, of current and future volumes of traffic, reflecting the occurence of expected events and orderly growth. The baseline forecasts were then refined by considering the impact of events less predictable than those already considered; this refinement, which required the development of a trend-cross-impact or impacted baseline model, resulted in the impacted baseline forecasts. Next, traffic which was not considered long-haul was removed and a market distribution model was developed; the product from these activities was the net long haul forecast. A comprehensive cost analysis was conducted then to determine the crossover distances with terrestrial tariffs. The information from the cost analysis was the basis for developing the parametric cost model which was used to develop the net addressable forecasts; the net addressable market is that portion of the net long haul market that could be served by satellite considering pertinent technical, institutional and cost factors. The net addressable forecasts were then converted from peak hour half voice circuits for voice, Mbps for data and transponders for video to equivalent 36 MHz transponders; this conversion process resulted in the required transponder capacity or the capacity expected to be needed. Next, the potential capacity, or the capacity expected to be possible, and the actual capacity, or the capacity expected to be available or provided, were developed. These three capacities were compared then to determine when Ka-band would be needed. Development of the required capacity also was needed to develop the Ka-band net accessible traffic, or that portion of the net addressable Ka-band traffic likely to be implemented on Ka-band systems. To develop the Ka-band net accessible forecasts a network optimization model was developed and tested.

Throughout all of these activities, technological, economic and political-social events and trends were considered and the telecommunications literature and user and provider information were continually obtained and reviewed.

1.4.2 Forecasting Activity Flow

To provide a guide for understanding the sequence of forecasting activities, the following outline of the modifications to the forecast (i.e., traffic) at each point is presented.

a. Baseline forecasts
   1. 31 specific forecasts were developed using a variety of methods.
   2. For summary purposes, forecasts were grouped under voice (in half voice circuits), data (terabits/year) and video (transponders).

b. Impacted baseline forecasts
   1. The 31 specific baseline forecasts were modified by considering the impact of less predictable events on the baseline forecasts.
   2. The refinement resulted in changes that varied from -1.5 percent to 27 percent across services.
   3. Again, for summary purposes, forecasts were grouped under voice, data and video.

c. Net long haul forecasts
   1. The 31 specific impacted baseline forecasts were modified by removing several traffic elements:
      (a) Intra SMSA traffic was removed (removal varied from 0 to 75 percent across services)
      (b) Data on voice lines was removed (removal varied from 0 to 8.7 percent across services)
      (c) Hinterland traffic was removed (removal varied from 0 to 23 percent across services)
   2. Data efficiency factors were considered (traffic amounts increased from 0 to 323 percent).
   3. All traffic estimates were converted to peak hour estimates; most voice services were already in peak hour half voice circuits; all data services were converted from terabits/year to Mbps; all video services, except occasional video, were already in peak hour transponders.

4. Again, for summary purposes, forecasts were grouped under voice, data and video.

d. Net addressable forecasts

1. The 31 specific net long haul forecasts were modified by removing several traffic elements:
   (a) Traffic unsuitable for satellite transmission was removed.
   (b) Traffic less than crossover distance was removed. These refinements resulted in changes that varied from 0 to 67 percent across services.
2. Peak hour addressable forecasts were developed by service for C-, Ku- and Ka-bands.
3. A maximum addressable forecast was developed by taking the highest forecasts across bands for each service.
4. This maximum addressable forecast was refined by removing traffic due to established carrier (plant-in-place).
   (a) Three estimates of amount to remove were made: high, expected, low.
   (b) Three forecasts were developed: high, expected and low maximum net addressable. Percent change from the maximum addressable varied from 0 to 98 percent across the 31 services.
5. Again, for summary purposes, forecasts were grouped under voice, data and video.

e. Required transponder capacity forecasts

1. Voice, data and video forecasts were converted to equivalent 36 MHz transponders.
2. The following technological changes were considered: percent voice on analog, frequency/amplitude modulation improvements, coding technique improvements, and digital modulation improvements.
3. High, expected and low estimate of the maximum net addressable and estimates of the net addressable by band were developed in units of 36 MHz transponders.

f. Potential capacity forecasts

1. The following factors were considered: spacing (C- and Ku-bands), frequency reuse (Ku-band); and fill percentage (C- and Ku-transponders).
2. High, expected and low estimates of potential capacity were developed.

g. Actual capacity forecasts

1. The following factors were considered: fill percentage (C- and Ku-transponders) and growth beyond scheduled satellites.
2. High, expected and low estimates of actual capacity were developed.

h. Forecasts of when Ka-band will be needed

1. Required, potential and actual capacity forecasts were compared.
2. A variety of scenarios were possible using the high, expected and low estimates of each of the capacity forecasts.

i Net accessible forecasts

1. Ka-band required capacity was the difference between the low estimate of the maximum net addressable and the high estimate of the potential (C- and Ku-band) capacity
2. Specialized carrier scenarios included: minimum network, maximum network and most efficient network
3. Established carrier scenarios included: a 10 earth station network and a 20 earth station network.

1.5 SUMMARY OF RESULTS

The major forecasts from the baseline forecasts through the net accessible forecasts are summarized in Table 1-1. The corresponding growth rates are presented in Table 1-2. Starting with the net long haul forecasts, all traffic estimates are peak hour estimates, and starting with the required capacity forecasts all traffic estimates represent numbers of equivalent 36 MHz transponders. A comparision of the required, potential and actual capacities is presented in Figure 1-2. The reason the expected and low estimates of the actual forecast

TABLE 1-1. SUMMARY OF FORECASTS

FORECAST	1980	1990	2000
Baseline			
Voice (1000s HVCs)	2,829	8,045	18,405
Data (Terabits/Year)	1,892	9,084	26,879
Video (Transponders)	66	309	312
Impacted Baseline			
Voice (1000s HVCs)	2,829	8,227	19,876
Data (Terabits/Year)	1,892	9,840	31,103
Video (Transponders)	66	337	406
Net Long Haul			
Voice (1000s HVCs)	2,057	6,220	15,220
Data (Mbps)	12,045	24,873	32,117
Video (Transponders)	61	323	393
Net Addressable-Maximum			
High			
Voice (1000s HVCs)	227	1,902	9,036
Data (Mbps)	674	10,624	23,300
Video (Transponders)	61	323	393
Expected			
Voice (1000s HVCs)	227	1,724	7,800
Data (Mbps)	674	9,755	21,860
Video (Transponders)	61	323	393
Low			
Voice (1000s HVCs)	227	1,594	6,564
Data (Mbps)	674	8,886	20,420
Video (Transponders)	61	323	393
Required Capacity (Transponders)			
High			
Voice	189	782	2,280
Data	13	131	288
Video	61	323	393
Total	263	1,236	2,961
Expected			
Voice	189	601	1,806
Data	13	120	270
Video	61	323	393
Total	263	1,044	2,469
Low			
Voice	189	490	1,428
Data	13	110	252
Video	61	323	393
Total	263	923	2,073

TABLE 1-1. SUMMARY OF FORECASTS (CONTINUED)

	1980	1990	2000
Potential C + Ku Capacity (Transponders)			
High	681	1,282	1,455
Expected	605	960	1,140
Low	529	756	840
Actual C + Ku Capacity (Transponders)			
High	140	921	1,455
Expected	125	818	1,293
Low	109	716	1,131
Net Accessible (2073 - 1455 = 618 Transponders)			
Specialized Carrier			
Minimum (30.36%)			188
Maximum (100%)			618
Most Efficient (98.27%)			607
Established Carrier			
10 Earth Station (42.53%)			263
20 Earth Station (74.58%)			463

TABLE 1-2. SUMMARY OF GROWTH RATES (%)

FORECAST	TIME PERIOD		
	1980-1990	1990-2000	1980-2000
Baseline			
Voice	11.0	8.6	9.8
Data	17.0	11.5	14.2
Video	16.7	.1	8.1
Impacted Baseline			
Voice	11.3	9.2	10.2
Data	17.9	12.2	15.0
Video	17.7	1.9	9.5
Net Long Haul			
Voice	11.7	9.4	10.5
Data	7.5	2.6	5.0
Video	18.1	2.0	9.7
Net Addressable-Maximum			
High			
Voice	23.7	16.9	20.2
Data	31.8	8.2	19.4
Video	18.1	2.0	9.7
Expected			
Voice	22.5	16.3	19.3
Data	30.6	8.4	19.0
Video	18.1	2.0	9.7
Low			
Voice	21.5	15.2	18.3
Data	29.4	8.7	18.6
Video	18.1	2.0	9.7
Required Capacity			
High			
Voice	15.3	11.3	13.3
Data	23.0	8.2	16.8
Video	18.1	2.0	9.7
Total	16.7	9.1	12.9
Expected			
Voice	12.3	11.6	11.9
Data	24.9	8.4	16.8
Video	18.1	2.0	9.7
Total	14.8	9.0	11.8
Low			
Voice	10.0	11.3	10.6
Data	23.8	8.6	16.0
Video	18.1	2.0	9.7
Total	13.4	8.4	10.9

TABLE 1-2. SUMMARY OF GROWTH RATES (%) (CONTINUED)

	1980-1990	1990-2000	1980-2000
Potential C + Ku Capacity			
High	6.5	1.3	3.9
Expected	4.7	1.7	3.2
Low	3.6	1.1	2.3
Actual C + Ku Capacity			
High	20.7	4.7	12.4
Expected	20.7	4.7	12.4
Low	20.7	4.7	12.4

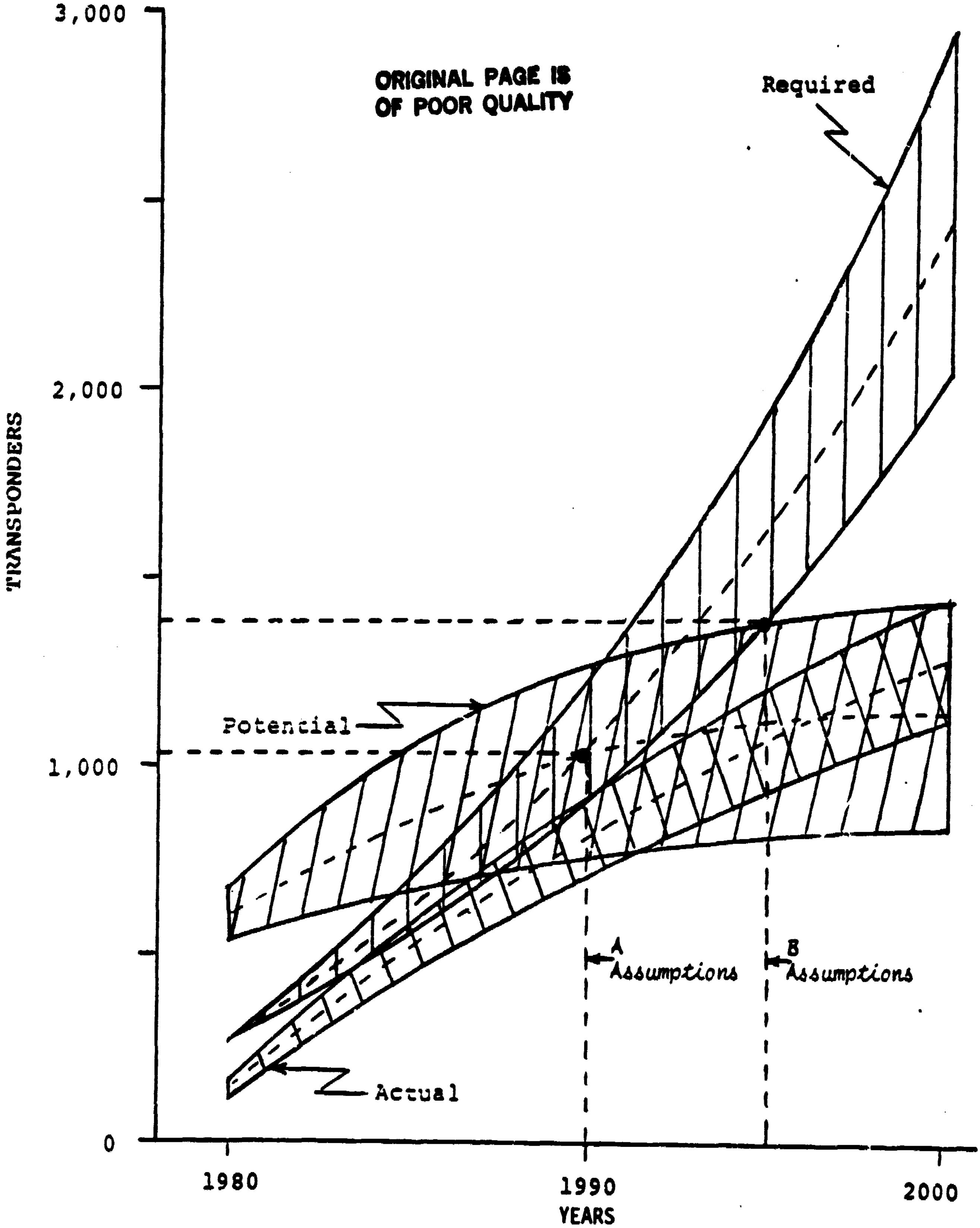

FIGURE 1-2. TWO SCENARIOS FOR SATURATION OF C- AND KU-BANDS

are higher than the expected and low estimates of the potential forecast in the year 2000 is that only one growth rate was used for projecting the actual forecast; the differences among the high, expected and low estimates of the actual forecast were determined solely by the fill factor. In reality, the actual capacity would always be less than or equal to the potential capacity.

Figure 1-2 can be used to determine possible saturation dates of C- and Ku-band, given various assumptions. For example, as indicated in Figure 1-2, the following assumptions can be made and their impact noted:

a. Assuming expected required and expected potential capacities with actual equalling potential, Ka-band will be needed around 1990

b. Assuming low required and high potential capacities with actual equalling potential, Ka-band will be needed around 1995.

There is some degree of uncertainty associated with each of the forecasts made in this study. The following are the major areas of uncertainty where sensitivity analyses need to be conducted to determine the impact on the forecasts of varying the various factors.

<u>Economic Factors</u>

a. National - International economic conditions (reflected in impacted baseline forecasts)

b. Relative costs of satellite and terrestrial systems (reflected in net addressable forecasts)

c. Provider requirements - Satellite/terrestrial differential, fill percentage (reflected in potential and actual capacity forecasts).

<u>Technological Factors</u>

a. Modulation and coding improvements: #HVC (i.e., half-voice circuits)/36 MHz transponder, #Mbps/36 MHz transponder, #Kbps/HVC (reflected in required capacity forecasts)

b. Spacing and frequency reuse (reflected in potential capacity forecasts)

c. Creative integration of technological improvements (reflected in impacted baseline forecasts).

1.6 ORGANIZATION OF STUDY REPORT

The report for this study consists of three volumes:

a. Volume I - Executive Summary
b. Volume II - Main Text
c. Volume III - Appendices

The Executive Summary highlights the major findings; also the purpose, tasks and methodology are briefly outlined. The main text describes the purpose, tasks and methodology in enough detail so that the reader can understand and review the major and specific findings which are presented. The appendices present comprehensive and detailed explanations of methodologies and include specific tables of forecasts that are summarized in the main text.

The main text, Volume II, includes the following sections:

a. Section 1 - Overview
b. Section 2 - Characterization of Services
c. Section 3 - Baseline Forecasts
d. Section 4 - Impacted Baseline Forecasts
e. Section 5 - Net Long Haul Forecasts
f. Section 6 - Cost Analysis
g. Section 7 - Net Addressable Forecasts
h. Section 8 - Capacity Requirements
i. Section 9 - Satellite System Market Development
j. Section 10 - Net Accessible Forecasts

SECTION 2
POTENTIAL SATELLITE PROVIDED FIXED COMMUNICATIONS SERVICES

2.1 INTRODUCTION

The first step in forecasting satellite provided fixed communications services was to identify and characterize those services which potentially could be delivered effectively via trunking networks using either specialized or established carriers. In order to develop a list of potential satellite provided fixed communications services several sources were used and several activities were conducted (see Figure 2-1). The initial list was obtained through a review of previous studies (e.g., studies on the 30/20 GHz or Ka-band market as indicated in Section 1) and an extensive literature search that followed this review indicated several changes that had to be made in this list. User and provider information also provided some input into modifying the initial list. The final list of potential satellite provided fixed communications services is presented in Table 2-1. Once the list was developed each service was described and characterized to insure it was unique. As indicated in Table 2-1, 34 unique services were identified; however, as pointed out in Section 3, forecasts were prepared for only 31 of these services. Each of the 34 services is described below under its grouping (e.g., Message Toll Service) and service category (e.g., Voice).

2.2 DESCRIPTION OF VOICE SERVICES

The most widely used services fell within the voice categories. There were several reasons for this. First, almost everyone and every business has a telephone. Second, there are no standardization problems as there are with data or video, so it is easy to use. Third, it requires very little bandwidth to transmit a high quality signal, so it is a relatively cheap way to communicate. As indicated in Table 2-1, voice applications are grouped, as follows, into three sections: message toll service, telephone and radio.

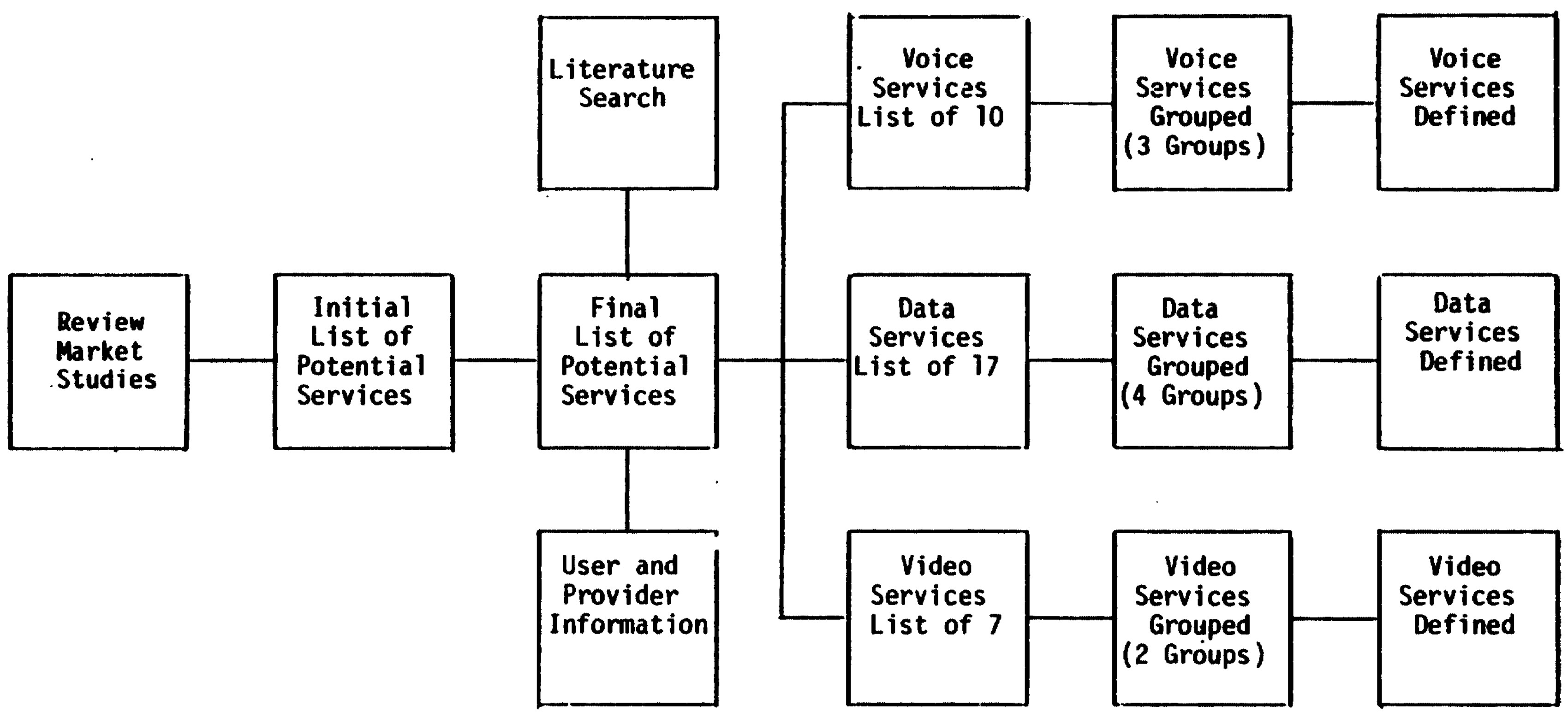

FIGURE 2-1. ACTIVITY FLOW FOR DEFINITION/DESCRIPTION OF POTENTIAL SERVICES

TABLE 2-1. NAMES OF SERVICES CONSIDERED IN THIS STUDY

	GROUPING	SERVICE
VOICE	Message Toll Service	Residential Business
	Other Telephone	Private Line Mobile Radio *Voice Store-and-Forward
	Radio	Public Commercial and Religious Occasional CATV Music Recording Channel
DATA	Terminal Operations	Data Transfer Batch Processing Data Entry Remote Job Entry Inquiry Response Timesharing
	Electronic Mail	USPS EMSS Mailbox Services Administrative Message Traffic Facsimile Communicating Word Processors
	Record Services	TWX/Telex Mailgram/Telegram/Money Order
	Other Terminal Services	Point of Sale Videotex/Teletext Telemonitoring Secure Voice
VIDEO	Broadcast	Network Video CATV Video Occasional Video Recording Channel
	Limited Broadcast	Teleconferencing *DBS *HDTV

*Forecasts were not prepared for these services which were considered as market determinant factors.

2.2.1 Message Toll Service

Message toll service (MTS) is basically a metered switched service used by both residential and business sectors. Residential MTS includes both typical household and coin operated categories of metered switched service as provided by the Bell system and other independent telephone operating companies. Business MTS includes regular business service and Wide Area Telephone Service (WATS).

Metered switched service works by monitoring the amount of time two parties are on the line and charging the call to the calling party. WATS is a long distance dial-up service offered by AT&T Long Lines and other Bell operating companies to and from specified zones. Five zones of coverage are provided at various tariffs.

There are two types of WATS service: 800 service (in-WATS) and out-WATS. 800 service is an inbound service, permitting the user to be called at no charge to the calling party. The receiving party subscribes to the service. With out-WATS, the call originator is connected to the WATS line and may call any subscriber within the specified zones.

2.2.2 Other Telephone

Three other telephone-related services are: private line, which is the leasing of a circuit; mobile radio, which is a car telephone; and voice store and forward, which is similar to a mailbox for telephone calls.

2.2.2.1 Private Line

Private lines are dedicated transmission lines connecting two points. They are leased through AT&T and other telephone companies on a monthly or yearly basis. In the last few years, the FCC has allowed others to enter this market. These companies often discount the most heavily used routes, capturing a larger share of the market each year.

2.2.2.2 Mobile Radio

Mobile radio telephone is a service connecting the public switched telephone network to mobile units. Bell Telephone operating companies and other radio common carriers provide the service. Conventional mobile radio telephone uses a single high powered transmitter to cover a service area. Because the signal level of each channel in the area is high enough to cause interference, each channel can only support one conversation within a given service area. The application of cellular technology, however, will alleviate this congestion, which has suppressed growth in the mobile radio market.

2.2.2.3 Voice Store-and-Forward

Voice store-and-forward, a computerized storage-retrieval system for distribution of voice message communications, is one of the features of the "office of the future"; it was considered as a market determinant factor. It is similar to its text counterpart, electronic mail, in that messages are stored in digital form for convenient delivery at a later time. With voice store-and-forward the user simply dictates the message over the telephone instead of typing it. Each user of the system is assigned a "mailbox" which stores voice messages from other users in digital form. To retrieve their messages, users simply call the system from any keypad-equipped telephone. After hearing the message, a user may reply immediately and the system will automatically deliver the response to the original caller. Ultimately, voice store-and-forward will be integrated with its text counterpart to form an integrated messaging system.

2.2.3 Radio Services

Radio services have been divided into five segments: Public Radio, Commercial Radio, Occasional Radio, CATV Music and Music Recording Channels.

2.2.3.1 Public Radio

The National Public Radio (NPR) network pioneered satellite transmission of radio programming in 1978. Under current plans, NPR will become the largest single radio network in terms of number of channels and variety of programming, going from 8 channels in 1980 to 24 in 1983. NPR will include dramatic programming, specialized audience programming, educational programming and extended program service. The wide range of NPR programming is the product of a variety of listener demand and NPR's attempt to meet this demand.

2.2.3.2 Commercial and Religious Radio

The number of commercial radio networks has increased greatly over the last two decades, from four networks in 1960 to over twenty today. These networks generally provide a combination of news and entertainment, although a few networks provide news or entertainment exclusively. Entertainment programming is predominantly music, with many networks airing live concerts. Available networks cover the entire range of today's music from top 40 to classical and pop to soul. There are also several religious broadcast networks, the PTL network being one example.

2.2.3.3 Occasional Radio

Most regional or national use of radio programming comes from the broadcast of an occasional event. Religious broadcasts, sports, live concerts, simulcast of live TV and other events fall under this category. Occasional radio is interspersed with a station's regular programming whereas network radio becomes a station's regular programming.

2.2.3.4 CATV Music

Cable operators are finding it very popular to include a channel or two of music along with their regular video broadcast. This can be supplemented with concerts or interviews to be a full channel offering. New franchises are offering around 100 stations and will need something to fill the gap between available programming and the number of stations offered.

2.2.3.5 Recording Channel

A new service which is in its infancy could revolutionalize the music recording industry by 1990. Digital Music Company is broadcasting two channels of very high quality music which may be recorded by making arrangements in advance. This is expected to provide a cheaper means of distribution, especially for recordings with low demand such as Mozart. Two audiences are expected to be attracted to this offering: those living in areas where certain music is difficult to obtain and music buffs wanting the highest quality recording available. Digital music is expected to start with two channels this year, which would be scrambled to households that had not paid to tape the record.

2.3 DESCRIPTION OF DATA SERVICES

As indicated in Table 2-1, data services, which included 17 applications, were grouped under four headings: Terminal Operations, Electronic Mail, Record Services and Other Terminal Services.

2.3.1 Terminal Operations

The first six of the data services have been classified as terminal operations which refer to general purpose terminals that are commonly used to input or receive information from a computer. They include home computers but not point of sale transactions which require unique equipment.

2.3.1.1 Data Transfer

Data transfer is a process in which information is electronically transferred from one storage bank to another in a non-update fashion. The transfer usually takes place during the off-peak transmission time. This application is used by insurance companies, financial institutions, the banking industry, and the like. The transmission speed in bits per second (bps) will depend on the volume of data to be transferred. For large amounts of data, the speed is usually 56 kbps or higher. Electronic fund transfer systems and point of sale systems could also make use of this application.

2.3.1.2 Batch Processing

Batch processing is a procedure that is volume rather than time oriented; it is prepared according to a schedule rather than on demand. Typical examples include daily sales orders and weekly payroll information. Usually batch processing is implemented on transmission facilities with speeds higher than 56 kbps.

2.3.1.3 Data Entry

In data entry, the information is captured in complete readable format at its source and added to an existing data base, eliminating the intermediate keypunch mode. Equipment used in this application includes general purpose as well as application unique terminals. The facility speed depends on the volume of data and may vary anywhere from 2.4 kbps to 56 kbps or higher. Typically, data entry can be utilized for electronic funds transfer systems such as those used by the banking industry and financial institutions and point of sale applications used by the retail industry.

2.3.1.4 Remote Job Entry

Remote job entry (RJE) is the process of remotely controlling the initiation and termination of computer processing related to a specific job or run. Essentially, this remote control capability affords an operator the same level of processing capability as if he were within the computer facility. It differs from data entry in that RJE involves manipulation of the received data and transmission of the output to the originator after processing. This application will typically be used by universities or any organizations with dispersed locations. The speed of transmission ranges from 1.2 to 9.6 kbps.

2.3.1.5 Inquiry/Response

Inquiry/response is characterized by its urgency and is usually transmitted in a real time manner through operator-entered inquiries to an existing data base which can then be manipulated and corrected. Common applications include airline reservation systems, stock exchange quotations, inventory status and account balances. The speed of transmission may vary from 1.2 to 9.6 kbps.

2.3.1.6 Timesharing

Timesharing is the shared use of centrally located computer facilities by several operating entities. The computer facilities can store, manipulate and transmit data simultaneously among the several users, generally on a real time basis. The supplier of the central computer facilities may be a commercial organization serving many unassociated users, known as commercial timesharing, or a private supplier serving in-house computing needs, referred to as private timesharing. The transmission speed will vary from 1.2 to 9.6 kbps.

2.3.2 Electronic Mail

Electronic mail is similar in many ways to regular first class mail. It is the handling of text by electronic means. The following services fall under electronic mail: USPS EMSS, Mailbox, Administrative Message Traffic, Facsimile, and Communicating Word Processor.

2.3.2.1 United States Post Office Electronic Mail Switching System

On January 4, 1982, the United States Postal Service (USPS) introduced Electronic Computer Oriented Mail (ECOM). ECOM users transmit correspondence in digital form via telephone lines to a serving post office (SPO) in one of 25 major cities. The SPO then automatically prints the letters out on paper, folds them, inserts them into envelopes, and mails them first class within two days to their destination. ECOM users can also send their messages to Western Union Electronic Mail, Inc. (WUEMI) from any compatible communicating word processor, computer-generated tape, or facsimile terminal for conversion to ECOM format. WUEMI has at least 43 types of on-line terminals made by 33 manufacturers which interface with ECOM hardware.

2.3.2.2 Mailbox

A computer mailbox system is related to computer message switching in the same relationship that a postal service box is related to home delivery. In message switching, the computer delivers the message to a terminal or notifies the terminal of a message that is waiting. In computer mailbox, the user must check the box, which is in some preassigned location in the computer's memory, typically a disk file. Mailbox service evolved within the scientific and academic communities among users who all shared the same computer network for timesharing purposes. Mailboxes are set up to allow store-and-forward message switching. It is a very useful service when the user travels and uses the network frequently. In an environment where many users share only a few terminals, message switching rather than mailbox service should be used. Presently, mailbox and message switching systems are often separate, with mailbox systems unable to deliver messages. In the future, these two will probably be merged so that a user can either call in as if the system had a mailbox or have the message delivered automatically when the assigned terminal registers that it is available for delivery.

2.3.2.3 Administrative Message Traffic

Administrative messages are usually short (approximately 1,000 characters) person-to-person messages. Examples include travel information, new product announcements, performance reports, and non-record keeping tasks. Administrative messages differ from data communication messages in that data communications are usually in numeric form. Some examples are data base entry, inquiry/response, remote job entry or batch processing data. Much of this traffic is still delivered manually through company mail rooms. However, there is a rapidly rising trend to transmit administrative messages via computer base message switching (CBMS) systems and communicating word processors (CWP). Companies may select from a variety of CBMS suppliers ranging from value-added carriers and vendors of public message services to software houses and manufacturers of larger mainframe computers and automated office equipment. A number of vendors, among them Telenet and Tymnet (non-military) and ARPANET and AUTODIN (military), provide external packet switching networks linking their users. AT&T's recently introduced Advanced Information System (AIS) will provide a packet network with a broad range of messaging capabilities. With the advent of office automation, many companies are purchasing their own private local networks providing high speed, short haul multi-dropped party line links to which a variety of electronic equipment may be attached.

2.3.2.3 Facsimile

Facsimile is made up of three subservices. The services are: Convenience Facsimile (CITT Classes 3 and 4), Operational Facsimile (CITT Classes 1 and 2), and Special Purpose Facsimile.

Convenience Facsimile is defined as the slow to medium speed (2 to 6 minutes per page) machines. Operational Facsimile includes medium speed, high speed and wideband facsimile equipment. This equipment operates with a range of one second per page to two minutes per page. Special Purpose Facsimile is the type used by the police for fingerprints or by the weather bureau for maps, and therefore must be very high quality.

2.3.2.5 Communicating Word Processor

A communicating word processor (CWP) adds communication capability to a printer/keyboard or CRT-based word processing system. This allows the input to be prepared on one system and sent via communication links, at a speed ranging from 1.2 to 9.6 kbps, to another system for output, editing or manipulation. The advantage to the user is the ability to transmit "original" quality documents with format control similar to letter and memo correspondence.

2.3.3 Record Services

Two of the potential services, TWX/Telex and mailgram, are record services.

2.3.3.1 TWX and TELEX

TWX was formed by AT&T in the mid-1930s and Telex was formed by Western Union. Western Union acquired TWX from AT&T in 1971. Basically, the TWX/Telex service is a switched teletypewriter service operating much as the telephone system does. It is a slow means of communicating, with an operating speed of 45 to 150 bps for TWX and 50 bps for telex. Because of these slow speeds, the network is expected to simply maintain, if not lose, its customer base over the next two decades. Western Union, in an attempt to keep its customers, has introduced new features such as store-and-forward and broadcast services.

2.3.3.2 Mailgram/Telegram/Money Order

Mailgrams, telegrams and money orders are managed by Western Union and are undergoing changes in response to customer needs. Mailgram message volume has grown steadily since Western Union introduced the electronic mail service in 1970. It combines the speed of Western Union's electronic switching and transmissions facilities with the economy of the U. S. Postal Service's local delivery capability for delivery the next business day anywhere in the U. S. and Canada. Through Western Union's Central Telephone Bureaus or public offices, telex subscribers can transmit mailgram messages directly from their terminals. Also, large volumes of mailgram messages prepared on computer tapes can be transmitted to the company's computer centers from designated offices or customer locations.

A new service known as "Stored Mailgram" is provided by a subsidiary, Western Union Electronic Mail, Inc. (WUEMI). It has grown substantially in the last five years, providing computer storage of frequently used mailgram message texts and address lists which can be accessed by a growing number of communicating word processors in the customer's offices. WUEMI also provides "Computer Letter" to commercial customers who do not need next day delivery. Messages are sent to WUEMI where they are processed and deposited with USPS as first class mail. Mailgram is also interfaced to Western Union's InfoMasters computer store-and-forward system.

One of the oldest forms of electronic communication, the telegram, is still used for urgent messages or to make an impact. In the U.S. it is handled exclusively by Western Union and the forecast is based on internal information.

The money order, which is a way of electronically transmitting funds, handles small payments and thus is different from electronic funds transfer. Money orders are also handled by Western Union as well as by other companies.

2.3.4 Other Terminal Services

Four of the potential services use special purpose terminals and fall outside the other categories. They are: Point of Sale,, Videotex/Teletext, Telemonitoring, and Secure Voice.

2.3.4.1 Point of Sale

A large amount of human energy will be saved when payments made by consumers in stores and restaurants are entered directly into the banking system instead of being made by credit card or check. Bank cards are the means of implementing such transactions. "Point of Sales" (POS) terminals are used for sales transactions, credit authorization and some inquiry functions. Data entry may be made by a magnetic or optical wand passed over a label which reads and identifies the item, or through entry on a numeric and function key keyboard. Instructions to the operator and data being entered are displayed; data provided in response to an inquiry may be printed.

Cash transactions are handled solely by the interactions of a terminal and a programmed cluster controller located in each store. The programmed controllers operate autonomously. Credit and check-cashing authorization, on the other hand, involve a check against a master file at a central computer location. Once a day, another central computer application draws data from all of the connected controllers so as to establish register balances and conduct an overall sales audit.

Another application of point of sale terminals concerns regulation of inventory flow. This application relies on separate display terminals in each store. Order entry is the function which creates purchase orders and inputs them into the purchase order data base. The receiving application verifies quantity and type of merchandise. Invoice data is then entered into the data base as accounts payable, and the cost calculated in terms of retail sales dollars. These functions are executed partly in the controller and partly in the central processor. The interaction is between each display terminal and the central computer via the same controller that handles the sales transactions.

2.3.4.2 Videotex/Teletext

Electronic text systems are still in their infancy, yet common requirements and distinguishing characteristics of such systems have already been identified. This attempt to define electronic text systems has helped reduce some of the confusion caused by the proliferation of generic terms and brand names used to describe electronic text systems. All electronic text systems, regardless of their individual names or technical features, display textual information on a video display screen. All of these systems require at least two components: a computerized data base to store information and a transmission system that links the data base to the people who want information from it. The data base can contain words, numbers, or graphic illustrations, while the transmission system can range from a common telephone line to a satellite. These systems are being developed and are intended to be used primarily by the consumer in his home or business.

Two of the major factors which distinguish one system from another, from the customer's point of view, are the amount of information that can be retrieved easily from the data base and the ability to add information to the data base. Some systems are like a telephone, in that they have a two-way capacity which allows them to function as electronic mailboxes or bulletin boards. Customers can use them to bank, shop, send a letter to a friend or advertise the sale of a used car. Other systems are more like a cross between a book and TV: they are strictly one-way and the customer can receive information from the data base, but cannot transmit or add information to the data base.

"Videotex" is a synonym for electronic text and an umbrella term that includes teletext and viewdata. Teletext refers to an electronic text system that usually relies on broadcast frequencies to transmit information. Teletext flashes pages of text in a continuous cycle. The user punches a code into his modified TV set and the requested information is pulled out the next time it is transmitted. The teletext data base is updated frequently and includes news, sports, weather and the like. Viewdata systems offer customers access to a library of information and allows them to dial up information such as a sports score, restaurant review or airline schedule. Because viewdata uses a technical design different from teletext, its customers can retrieve information more quickly and from a much larger data base. Also, it is not limited to broadcast or one-channel transmission; it can operate via telephone lines or two-way cable systems. This interactive feature makes possible services like home banking, tele-shopping and advertising.

2.3.4.3 Telemonitoring

Telemonitoring is a term used to describe electronic monitoring, from a central location, of the status or condition of a device at a remote and usually unoccupied location. Generally, telemonitoring falls into one of the following categories: Security, Civil defense and government agencies that protect citizens, Utilities, Communications systems, and Traffic control.

Most burglar and fire alarm systems that presently use telemonitoring are provided by professional alarm installers. Most systems are simple fire/smoke alarms or entry switches that are triggered when an alarm condition occurs. A wire pair is connected to an alarm panel at a central monitoring location, generally the local police station. The cost is high. In the future, 40 percent of the nation's businesses and 98 percent of future cable TV (CATV) customers may be offered a low-cost means of protecting their property. Where interactive cable is available, the communications link to a central monitoring station is already in place. The alarm industry, naturally, is trying to keep CATV from providing this service, but it would be a simple matter for the security system operators to lease a communications link from the cable company.

Nuclear explosion detectors operate in the following manner. Light waves strike the detector and give it time to respond with a "Red Alarm" before the nuclear shock waves arrive to destroy the device. The detectors are mounted in a circular fashion around a major target area; each has a completely different circuit route. Thus, if a direct hit occurs on one site, the other two sensors would be able to respond.

Other Government agencies also operate monitoring devices. EPA's air pollution monitors are one example. There are more than 8,000 air pollution monitors located throughout the United States. About 10 percent of those are remotely monitored at present. Budget restrictions will probably necessitate 100 percent remote monitoring within the next few years.

Air traffic control is perhaps the best example of a government monitoring system. All major airports have radar to monitor traffic and to radio landing and take-off instructions to pilots. Radar screens show the ground controller the flight paths of all air traffic. The flight controller advises the pilot on which altitude and direction to fly, in order to prevent collisions and promote air safety. There are approximately 20 Air Route Traffic Control Centers (ARTCCs) located throughout the United States.

Remote monitoring devices detect flood stages on rivers, earthquake tremors and other natural threats to life and property. No figures are available on these types of monitoring. On a more routine basis, remote weather monitors transmit barometric pressure, temperature readings and storm activity data for weather forecasters across the nation. (See also Traffic Control).

The technology behind CATV security services also supports meter reading devices to monitor gas, electric and water usage. Reduced labor and transportation costs will certainly make this capability attractive to utility suppliers. In some cases, utility information will be transmitted long distance to a state or regional office for billing purposes.

Most communications systems, landline, microwave, or satellite, have built-in testing which operates on a continuous basis. Remote unmanned sites, microwave stations or satellites have constant performance monitoring from a central office. Growth in this area is directly proportional to the overall growth projected in communications.

2.3.4.4 Secure Voice

Along with its many benefits, the age of electronics has provided the ability to intercept voice and data communications for as little as several hundred dollars. Concurrent advancements in technology have facilitated electronic surveillance and interception of proprietary or sensitive information. Typical security threats include:

a. Organized and intentional attempts to obtain economic or proprietary information from the competition
b. Determined attempts to obtain economic and sensitive information from government agencies dealing with the military and the private sector
c. Fraud through illegal access to computer data banks, including Electronic Funds Transfer (EFT)
d. Intentional or unintentional destruction of computer data banks.

Since a significant portion of daily transactions occurs over the telephone, the replacement of telephone wires with microwave radio transmissions has created a condition in which information can be intercepted without requiring a "physical tap" on the telephone line; therefore, interception can be accomplished undetected.

Communications common carriers are the providers of a variety of telecommunications services and are operated as regulated monopolies. The lion's share of telecommunications, whether voice or data messages, is transmitted by the common carriers' systems. A typical network consists of some combination of land lines, microwave radio transmission systems (terrestrial and satellite) and undersea cables. In the United States, between 65 and 70 percent of all toll messages are carried by microwave radio facilities at some point along their route.

There are two basic forms of telephone service: Public Telephone Network (switched lines) and Private Line Service (dedicated lines). Dedicated private lines are always transmitted over the identical route, transmission facility and circuit. Similarly, the dedicated private line always occupies the identical segment of the radio spectrum. Therefore, once the interceptor "locates" the frequency of the dedicated circuit of interest, electronic equipment can monitor every message over that circuit.

With the dial-up network and switched private lines, the interceptor can select calls of interest, since each call is preceded by a signal identifying the telephone number being called. With the use of computers, the interceptor can easily monitor and selectively screen large volumes of messages; the computer simply searches for key words, names, subject titles and/or telephone numbers of interest. A computer can perform this task on digital data extremely rapidly. In the case of voice communications, at least for now, technology is not well-developed enough to monitor large volumes of calls automatically except through use of the accompanying signaling information. With the recent and continuing advances in automatic speech recognition that employ word-spotting techniques, the expense of electronic interception of voice messages may be substantially reduced.

2.4 DESCRIPTION OF VIDEO SERVICES

The greatest use of satellites so far, outside of voice, has been with video applications. The reasons for this are the wide bandwidth required for video transmission and the need to reach a large number of locations throughout the United States. These video applications were divided into two sections (see Table 2-1), broadcast and limited broadcast. Broadcast services are transmitted to a large number of end users simultaneously. Limited broadcast is more directly aimed even though the number of users may still be quite large, as in the case of DBS.

2.4.1 Broadcast Services

Broadcast services include: Network Video, CATV Video, Occasional Video, and Recording Channel.

2.4.1.1 Network Video

Network video has traditionally used dedicated full time facilities for point to multipoint distribution. Since the introduction of satellites, the networks are doing more multipoint to multipoint distribution. For instance, ABC's Good Morning America show originates in New York, the news spot is done from Washington, and the weather from Atlanta as well as feeds from throughout the U.S. for other portions of the show. Besides commercial television, other applications fall under network video and are prime candidates for satellite transmission, including Public Broadcasting Service (PBS) and the Educational Networks.

The commercial networks, ABC, CBS and NBC, offer free programming paid for via advertising. Currently, almost all regular broadcasting for the commercial networks is carried to affiliated stations via AT&T long lines microwave networks. However, recently all three networks have signed agreements with AT&T to begin satellite transmission of programming to affiliated stations. From that point, it is retransmitted or aired to the local community. PBS, on the other hand, operates by fund raisers, company donations and some government support (although it has applied to the FCC for permission to allow advertising). PBS also uses affiliated stations to rebroadcast; however, it uses satellites to distribute the information to those stations. Educational networks, funded largely by states, local governments and universities to provide classroom instruction to large audiences, have grown rapidly in the last decade. Although most of this is fairly local, it is likely that as networks join together to provide better training at less cost satellite distribution to local stations will grow. Three states, Indiana, Florida and Michigan, already use satellite transmission to meet their statewide educational goals.

2.4.1.2 CATV Video

CATV video comprises program originators other than networks, who video broadcast their programs on a part-time regional or national basis. Distribution networks usually include terrestrial (cable), microwave and satellite facilities. In the case of satellite distribution, affiliated small earth stations interconnect the space segment (leased by the distributor) and the cable head end.

2.4.1.3 Occasional Video

Occasional video refers to event broadcasting such as news, sports events or movies. A large number of programmers use this type of transmission including the networks and various cable stations.

A number of companies, such as Wold or Satellite Syndicated Systems, offer this type of service for a few hours at a time, using remote hookups much of the time. Other uses for occasional video are thought of continually. One example is horse racing. In Connecticut, a highly successful theater was built in

1979 which broadcasts live horse races. This idea has been picked up by entrepreneurs in Las Vegas who plan to broadcast these races live.

2.4.1.4 Recording Channel

Recently, CBS announced plans for a video recording channel. Material suitable for programming is transmitted to the home via cable during low usage hours (after 1:00 A.M.). The growth of video recorders and the desire for uninterrupted programming that can be recorded along with the lower cost associated with these hours makes this a desirable offering. By the year 2000 one can expect that some recording channels will be offered during peak times or even 24 hours, based on the anticipated growth of video recorders.

2.4.2 Limited Broadcast

Broadcasting covers a very broad area whereas limited broadcasting is more directed. Three services are covered under limited broadcasting: teleconferencing and direct broadcast satellites/high definition television (DBS/HDTV). Teleconferencing is usually conceived as a meeting between two or more groups. DBS/HDTV, are discussed together since HDTV will be provided via DBS; DBS is similar to broadcast TV although the former is picked up by a rooftop satellite antenna.

2.4.2.1 Video Teleconferencing

Video-teleconferencing is expected to be a driving force behind transponder demand from 1985 through the end of this century. The basic purpose of video conferencing is moving meetings to people, rather than people to meetings. There are many variations of video-teleconferencing from fixed frame one-way video/two way audio, requiring simple phone lines, to high definition two-way video and audio, requiring a very large bandwidth. The number of sites involved may vary from two to dozens.

Video-teleconferencing is entering its growth phase. A number of companies, including ARCO and MACOM, have installed their own facilities to conduct video-teleconferences. Users report improved efficiency and increased cost effectiveness. As travel costs continue to rise and the cost of teleconferencing facilities declines, video-teleconferences will become more popular. Hotel chains are an example of this trend. Many major chains have established a network to handle video-teleconferences. They include: Holiday Inn, Raddisson, Hilton, Hyatt, and Marriott. Besides the hotel industry, a large number of private companies, including AT&T and SBS, now provide this service and are striving to expand their markets.

The three video-teleconferencing arrangements analyzed include: full motion, limited motion, and fixed frame. Full motion video-teleconferencing provides the most realistic conference atmosphere. It is, therefore, the most popular form of video-teleconferencing. It normally uses 22 MHz of bandwidth and is often used in conjunction with high speed facsimile or another data link. Digital technology is the most likely form of transmission and a 2:1 compression ratio can be expected by 1985. Limited motion video conferencing also transmits a picture; however, gaps are apparent as the equipment waits for the next transmission. This type of conferencing is useful where one person does much of the presentation. Limited motion video conferencing can be done using 1.5, 3.1 or 6.3 Mbps facilities. Better motion, color and details occur at the higher transmission rates. Western Union engineering analysis indicates that approximately 12 limited motion conferences could be held per transponder. Slow motion video conferencing is very useful where diagrams or charts are being presented and then discussed. This technique is useful with engineering drawings and shows promise for telemedicine. Although this type of conference can use between 1.2 kbps and 1.5 Mbps, it was assumed that the average conference uses 56 kbps. Using this average along with internal engineering analyses that considered such factors as channel spacing, it was determined that an equivalent 50 Mbps transponder could handle 300 one way video conferences.

2.4.2.2 Direct Broadcasting Service/High-Definition Television

Direct Broadcasting Service (DBS) is the direct reception of video or audio signals from satellites by individual receiving antennas, thus bypassing terrestrial transmission and receiving stations; this service, as well as high-definition television, was considered as a market determinant factor.

DBS provides an exceedingly flexible, distance-insensitive means of transmission with the potential of reaching geographical areas which are difficult or impossible to reach by terrestrial distribution networks. This factor is important when considering the difficulties of providing an equitable distribution of communications services between rural and urban areas of the country.

Rural communications can be substantially enhanced by the use of direct broadcasting services which can succcessfully transmit a smorgasboard of communications services in an efficient, cost-effective manner. Special interest television, commercial and non-commercial television, information services such as teletext, store-and-forward message systems, educational and public service programming are just a few of the telecommunications services which can be provided by a direct broadcasting service.

One disadvantage of DBS is a lessening of local service. One of the underlying concepts of the 1934 Communications Act was to encourage local ownership of broadcasting facilities and local programming to satisfy community needs.

Existing technology is sufficient to implement a DBS System: all indications are that DBS will become more economically feasible as the technology develops. The cost of a receiving antenna has already decreased and will continue to do so as DBS becomes a widespread reality.

The "footprint" of the transmission may be either broad beam, covering a large geographical area or a spot beam, focusing in on a more specific location. The power of the transmission and the geographical area targeted determines the size of the receiving antenna (the dish). The signal can then be retransmitted terrestrially by microwave or a similar system, although it is usually thought of as direct-to-home transmission.

A major factor in direct broadcasting is the earth terminal which picks up the satellite signal, amplifies it, and remodulates it for reception on television sets. Beyond conventional television reception, direct broadcasting service could also be the transmission mode for high-definition television (HDTV). HDTV uses a much wider bandwidth for transmission of a 1,125 line system that gives a much clearer television picture on a large screen than currently seen from the 525/625 line system used in conventional television broadcasting.

Japan, several European countries, and Canada have experimented successfully with a direct broadcasting system. In the United States, the FCC is considering deregulation of the cable industry which will have a great impact on the eventual development of DBS. There have been nine applications accepted by the FCC for permission to implement a DBS System (RCA, CBS, Western Union, Focus, STC, DBSC, Graphic, VSS and USSB) despite the high risks and high costs of first time entry into the market. Full implementation depends on economic conditions, market conditions and launch schedules over the next several years. Only 3 of the 9 proposals have indicated any preliminary launch dates, starting in late 1985/1986. Presently, we can anticipate that around 25 satellites dedicated to DBS will be operational around 1990 upon full implementation of these 9 proposals.

Comsat's DBS (STC) proposal envisions 6 satellites with four operational and two in-orbit spares with services to be marketed in areas where no cable or limited programming is available. It will be essentially a subscription TV service with three channels: one with major motion pictures, concerts, and stage productions; one with children's programming and one with sports, adult educational and experimental theater. The Comsat system will require a 30" antenna at a cost of around $500.00.

CBS has filed a DBS proposal to dedicate the entire DBS system to HDTV, a proposition which finds little support among DBS applicants who see it as an inefficient use of available spectrum. HDTV requires a channel width of 27MHz and may even go to 70MHz for optimum use. The CBS HDTV proposal would transmit 1,125 line HDTV signals to and from the satellite, requiring more power and a 150MHz channel. This requirement would use a whole spectrum at 12GHz. It has been suggested that it may be compatible with the Comsat DBS (STC) proposal by compressing HDTV signals to 50MHz. Increased transmission power in this satellite range enhances the ability to receive the transmission with a relatively uncomplicated small dish. This factor, in turn, makes individual home reception a feasible and effective use of DBS for the individual homeowner, hotels/motels, institutions, educational institutions, apartment buildings, condos, and others.

There has been little coordination in the Western Hemisphere in terms of allocating spectrum space for DBS, despite Canada's early use of a DBS System. Nor is there likely to be any decision before the 1983 World Radio Conference for Region II, North and South America. That conference will allocate spectrum for direct broadcasting service. Direct broadcasting service will transmit on Ku-band by international agreement, and will most likely be in accordance with standards set up by the 1977 WARC. There has also been an attempt to get the FCC to allocate a bandwith of the spectrum for DBS. Currently, DBS is expected to operate between 12.2 and 12.7GHz, a bandwidth allocated to fixed satellite service (FSS).

SECTION 3
BASELINE FORECAST

3.1 INTRODUCTION

The baseline forecast is an estimate of the current and future volume of traffic. To develop this forecast every service was examined with regard to its own unique past and future, taking into consideration only those events with a high probability of occurrence (see Figure 3-1). Several steps were incorporated to make certain all traffic in the United States was included , but none was counted more than once. Another consideration for each case was the fact that machines operate at different speeds and use different transmission media, such as digital and analog.

Given the definitions of the various services (see Section 2) specific forecasting methods were developed for each service. Basically, this involved gathering available information from users, providers, the literature and internal sources for each service. The basic approach for each service included a consideration of: historical information (such as telephone traffic); future volume of the machines producing the traffic (such as computer terminals for data traffic); and/or on the future volume of the actual service (such as electronic mail). The most appropriate basis was selected for developing the baseline for each service (see Figure 3-2).

Once the technique for forecasting the baseline was determined for each service, a detailed analysis was conducted. Vendors and users were contacted, the most recent industry studies were obtained, and government agencies were visited. After deriving the baseline, it was discussed with Western Union Product Line Managers, Engineers, and Market Researchers, and their feedback was used to fine tune the projections.

Individual baseline forecasts were developed for 31 of the 34 services listed in Table 2-1 of Section 2 (see Table 3-1). Forecasts were not made for voice store-and-forward, Direct Broadcast Satellites (DBS) and High Definition Television (HDTV). Voice store-and-forward is not actually a new service, but rather a way of aiding the business message telephone service. Therefore it was treated as a

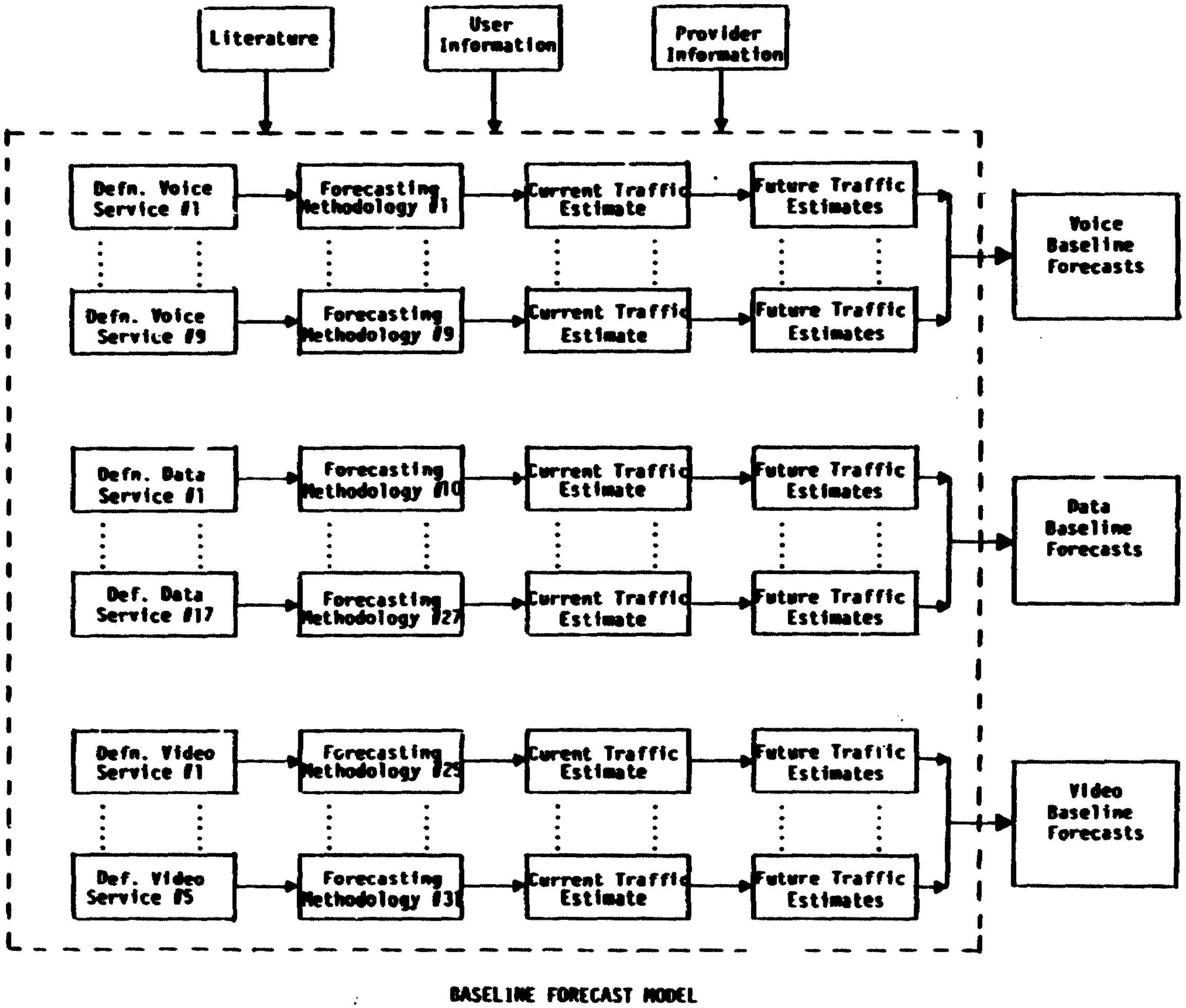

FIGURE 3-1. ACTIVITY FLOW FOR BASELINE FORECASTS

DEFINITION

THE BASELINE FORECASTS FOR EACH SERVICE ARE ESTIMATES OF THE CURRENT AND FUTURE VOLUMES OF TRAFFIC. ESTIMATES OF FUTURE VOLUMES ARE SCENARIOS REFLECTING THE OCCURRENCE OF EXPECTED EVENTS AND ORDERLY GROWTH.

FORECASTING METHODS

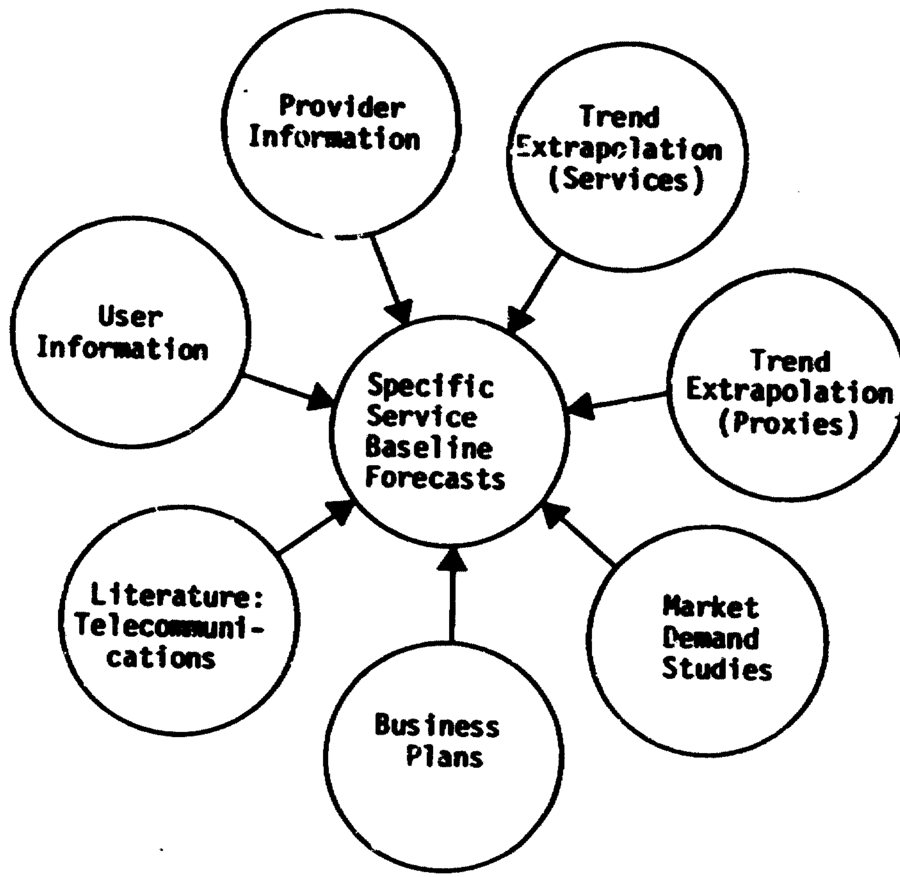

FIGURE 3-2. DEFINITION OF BASELINE FORECASTS AND BASELINE FORECASTING METHODS

TABLE 3-1. NAMES OF SERVICES FOR WHICH FORECASTS WERE DEVELOPED

	GROUPING	SERVICE
VOICE	Message Toll Service	Residential Business
	Other Telephone	Private Line Mobile Radio
	Radio	Public Commercial and Religious Occasional CATV Music Recording Channel
DATA	Terminal Operations	Data Transfer Batch Processing Data Entry Remote Job Entry Inquiry Response Timesharing
	Electronic Mail	USPS EMSS Mailbox Services Administrative Message Traffic Facsimile Communicating Word Processors
	Record Services	TWX/Telex Mailgram/Telegram/Money Order
	Other Terminal Services	Point of Sale Videotex/Teletext Telemonitoring Secure Voice
VIDEO	Broadcast	Network Video CATV Video Occasional Video Recording Channel
	Limited Broadcast	Teleconferencing

market determinant factor, and its effect shows up in the impacted baseline. DBS and HDTV are unique services and were discussed together. A forecast of these services was not made, however, since the 1983 World Administrative Radio Conference (WARC) and the FCC are likely to allocate a separate area of spectrum outside the C-, Ku- or Ka-bands normally used. It is likely that these services will have an impact on other video services, therefore, they are treated as market determinant factors.

The methodologies and baseline forecasts for each of the services are presented below. When appropriate, the approaches, techniques and results are presented for groups of services. More detailed discussions of these methodologies and forecasts are presented in Appendix A.

3.2 VOICE BASELINE METHODOLOGIES AND FORECASTS

As stated in Section 2, ten services were included in the voice category. Forecasts were developed for nine of these (as noted above, forecasts were not developed for voice store-and-forward): MTS (Residential), MTS (Business), Private Line, Mobile Radio, Public Radio, Commercial and Religious Radio, Occasional Radio, CATV, and Recording Channel.

3.2.1 Message Toll Service

The baseline for message telephone traffic was determined by using extensive FCC statistics along with studies completed by AT&T. The basic approach (see Table 3-2) began with the number of toll messages sent in the United States during 1980: 21,832 million. Then, on the basis of AT&T reports which indicated the average number of calls per business and residential phone, a ratio of business to residential calls was determined as 55:45. After splitting the traffic, the business and residential traffic was divided by the number of days they were used. The peaking factor, as determined by AT&T, was then applied. The next step was to ascertain the amount of inter and intrastate traffic. By doing some internal analysis using tariffs, a percentage for each type of traffic (60:40 for business; 40:60 for residential) was determined. The average holding time determined for each type of traffic was then applied. To the holding time a factor was added for transmission overhead. Once the traffic was in Erlangs an

TABLE 3-2

BUSINESS/RESIDENTIAL MTS 1980

	BUSINESS		RESIDENTIAL	
Number of toll messages: 21,832M				
Split		55%		45%
Toll messages		12,007.5M		9,824.3M
Percent of messages occurring between Sunday midnight and Friday midnight		98%		67%
Messages during normal work week (entire year)		11,767.4M		6,582.3M
Work days per year		250		250
Messages per work day		47.070M		26.329M
Percent during peak hour		14.9%		10.7%
Messages during peak hour		7.013M		2.817M
Interstate/intrastate split	60%	40%	40%	60%
Calls	4.208M	2.805M	1.127M	1.690M
Call-minutes/hour	.123	.085	.123	.085
Erlangs	.518M	.2384M	.1386M	.1437M
Half-voice circuits	1.0352M	.4769M	.2772M	.2873M
Half-voice circuits		1.521M		.5645M
Half-voice circuits needed for 0.9999 service availability		1.588M		.5930M

TABLE 3-3

MESSAGE TOLL SERVICE TRAFFIC FORECAST—HALF-VOICE CIRCUITS

(thousands)

	1980	1990	2000
Business MTS	1588	4118	8890
Residential MTS	593	1279	2639

estimate of the number of trunks (half-voice circuits) needed to provide a .9999 service availability was established. This would have involved separating the traffic into its different city pairs; since this was impractical an estimate of the overall percent of trunks was made based on Erlang tables, and five percent was used.

Historical FCC data, along with internal information, was used to arrive at the following projected growth rates for business and residential toll messages:

GROWTH RATES (%)	1980 to 1990	1990 to 2000
Business	10	8
Residential	8	7.5

No data was available to indicate a change in peaking factors or percent of interstate versus intrastate traffic. Holding times seem to be increasing slightly, and progress is being made on reducing overhead per call; therefore, the holding time plus the overhead is held constant. Based on these projections, it was possible to estimate the number of half-voice circuits required in 1990 and 2000 for message toll service. A summary of the 1980, 1990 and 2000 forecasts is presented in Table 3-3 on the previous page.

3.2.2 Private Line

Since private lines are leased full time, there was little need to determine the amount of traffic carried by them as has been done for other services. Instead, the important factor was the number of lines leased. To determine the number of lines leased (see Table 3-4) the revenue for toll private lines was used; this number included private line revenue from sources other than telephone usage. Based on internal discussions it was concluded that 70 percent of the revenue was from private line telephone. To this an estimate of the additional market (15 percent) held by companies other than the 68 telephone carriers was added. After determining the revenue, it was split between interstate and intrastate: 72 percent for interstate and 28 percent for intrastate. Next, average tariffs for interstate and intrastate were used to determine the average number of circuits leased during the year.

TABLE 3-4
PRIVATE LINE
(thousands)

Revenue	$ 3,874,545
Percent contributed to telephone	70
Revenue (Telephone Companies)	2,712,181
15% Revenue (Other Carriers)	426,827
	$ 3,139,008

	INTERSTATE	INTRASTATE
Percent	72	28
Revenue	2,260,085	878,922
Tariff Rates		
Average number of miles	1.0	.1
Rate	12.3	4.5
Circuits in 1981	183.7	195.3
Circuits in 1980	156.2	166.0

TABLE 3-5
FORECASTS OF INTERSTATE AND INTRASTATE PRIVATE LINE TRAFFIC
(IN THOUSANDS OF HALF-VOICE CIRCUITS)

	1980	1990	2000
Interstate	312.4	1263.8	3278.0
Intrastate	332.0	1343.1	3483.7
TOTAL	644.4	2606.9	6761.7

Reviewing the rapid increase in competition to provide MTS service and the changes in tariff rates, it was expected that the growth rate for private line service would be around 15 percent during much of the 1980s, gradually falling off at the end of the decade to an average of 10 percent in the 1990s. A summary of the interstate and intrastate private line forecasts are presented in Table 3-5 on the previous page.

3.2.3 Mobile Radio

Recently, there has been a great deal of interest in the mobile radio market. Numerous studies have been performed by AT&T, Motorola, MCI, Western Union and others in support of their tariff filings. Filings for the top 30 cities are currently at the FCC and much of the related marketing information has been reviewed. In addition, Western Union has gathered a great deal of information by having filed either along with or as a partner in 15 of the top 30 markets. This has involved a large market survey and extensive research in those markets. Western Union, along with dozens of other companies, is currently preparing filings for other cities.

Based on the information from these sources, it was possible to estimate the number of mobile phones in 1980, 1990 and 2000 (see Table 3-6). Using the Western Union market analysis for Kansas City, the projected average number of calls per day was three per phone. This number can be expected to rise over time, but just slightly, (B) and this number times the number of phones gives the number of calls per business day (C). Applying the peaking factor (D) based on Western Union's internal analysis, gives the number of calls during peak times (E). Average holding time per conversation is currently around 2.5 minutes. Using the results of the Chicago and Baltimore/Washington tests, this figure was expected to rise to 6.4 minutes by 1990 and seven minutes by 2000, which was much closer to the use of the average business telephone (F and G). Multiplying again gives the number of Erlangs (H). The ratio of phone calls between large and small systems was made based on an internal estimate. The number of systems was also projected to grow (J). Multiplying the percent of traffic times Erlangs gives Erlangs by large and small systems (K). Dividing by the number of cities in each system gives the number of Erlangs per city (L). Using the "Trunk-Loading Capacity --Full Availability Tables" and a service performance of .05

TABLE 3-6

MOBILE RADIO TRAFFIC FORECAST

	All Systems		
	1980	1990	2000
A. Phones	158K	1,600K	3,900K
B. Calls per phone	3	3.5	4
C. Total calls	474K	5,600K	15,600K
D. Percent peak hour	15%	15%	15%
E. Called during peak	71K	840K	2,340K
F. Holding time plus overhead	2.5	6.4	7.0
G. Holding time - minutes per hour	.042	.108	.117
H. Erlangs	2,986	90,720	273,780

	Large Systems			Other Systems		
	1980	1990	2000	1980	1990	2000
I. Percent of traffic	67	67	67	33	33	33
J. Number of systems	30	40	50	100	125	150
K. Erlangs	2,001	60,782	183,433	985	29,938	90,347
L. Erlangs per city	66.7	1,520	3,669	9,85	240	602
M. Trunks needed per city	73	1,600	3,815	16	263	640
N. Total trunk	2,190	64,000	190,750	1,600	32,875	96,000
O. Long distance	18	18	18	18	18	18
P. Long distance trunks required	394	11,520	34,335	288	5,918	17,280

	1980	1990	2000
Large	394	11,520	34,335
Small	288	5,918	17,280
TOTAL	682	17,438	51,615
Half-Voice Circuits	1,364	34,876	103,230

gives the number of duplex trunks needed to handle the traffic in each city (M). Multiplying by the number of cities in the system gives the total number of trunks required (N). Estimates of the percentage of long distance (i.e., message toll) traffic ranged from 10 to 25 percent of total traffic; 18 percent was chosen as a reasonable estimate (O). Multiplying the percent of long distance traffic by the number of trunks required gives the number of long distance trunks required.

Table 3-6 gives the number of full duplex trunks needed for each type of system. This number multiplied times two gives the number of half-voice circuits required for 1980, 1990 and 2000.

3.2.4 Voice Store-And-Forward

Voice store-and-forward systems will become an integral part of business telecommunications. Therefore, instead of determining the amount of traffic which it will eventually generate, it was decided to treat it as a market determinant factor under voice applications affecting business message telephone traffic.

3.2.5 Radio

In order to determine the baseline forecast for radio broadcast applications, each of the five services (i.e., Public, Commercial and Religious, Occasional, CATV Music and Recording Channel) were reviewed to determine their current and future demand. This demand was expressed in terms of channels (see Table 3-7) required to carry the service. This process included:

a. Determining what channels were currently using satellite transmission.
b. Determining the announced plans for new channels over the next five years.
c. Projecting a growth rate based on the expected changes in each service and making a judgement as to how many channels will be required in 1990 and 2000.

TABLE 3-7

RADIO TRAFFIC FORECAST

	CHANNELS		
	1980	1990	2000
Public	8	30	33
Commercial and Religious	13	33	40
Occasional (weekend peak)	30	40	45
CATV Music	2	10	15
Recording	0	5	10
TOTAL	53	118	143

	TRANSPONDERS		
	1980	1990	2000
Public	.267	1.000	1.100
Commercial and Religious	.433	1.100	1.330
Occasional (weekend peak)	1.000	1.330	1.500
CATV Music	.067	.333	.0.500
Recording	0	.167	.333
TOTAL	1.777	3.930	4.763

	HALF VOICE CIRCUITS		
	1980	1990	2000
Public	320.4	1800.0	2640.0
Commercial and Religious	519.6	1980.0	3192.0
Occasional (weekend peak)	1200.0	2394.0	3600.0
CATV Music	80.4	599.4	1200.0
Recording	0	300.6	799.2
TOTAL	2120	7074	11431

Channels were then converted into transponders by considering such things as using SCPC transmission and transmitting to 3 meter antennas across the nation. To insure a high quality transmission under these conditions, Western Union engineers estimated that 30 channels per transponder would be needed. In order to keep all voice transactions in half-voice circuits the number of transponders required was multiplied by the number of half-voice circuits per transponder in 1980, 1990, and 2000 (see Table 3-7).

3.2.6 Summary of Voice Baseline Forecasts

Table 3-8 shows a summary of voice baseline forecasts in thousands of half-voice circuits and the corresponding annual growth rates.

3.3 DATA BASELINE METHODOLOGIES AND FORECASTS

As discussed in Section 2, 17 services were classified as data services (see Table 3-1). Methodologies and forecasts are discussed below for the four groups of these data services (i.e., terminal operations, electronic mail, record services, and other terminal services).

3.3.1 Terminal Operations

The six services under Terminal Operations deal with general purpose terminals and the transfer of data. Traffic projections for these services were based primarily on the terminal population, and specific procedures included the following steps:

a. Estimate the number of data entry terminals in 1980 and the projected growth pattern for the years 1990 and 2000
b. Estimate the number of terminals being used for various services
c. Estimate the average thruput of each terminal. This estimated thruput is a function of the following:
   1. Number of bits transmitted per character
   2. Average number of characters per second transmitted
   3. Number of hours per year the terminal transmits.

TABLE 3-8
VOICE BASELINE SUMMARY

FORECASTS (Thousands of Half-Voice Circuits)

	YEAR		
SERVICE	**1980**	**1990**	**2000**
MTS (Residential)	593.0	1279.0	2639.0
MTS (Business)	1588.0	4118.0	8890.0
Private Line	644.4	2606.9	6761.7
Mobile	1.4	34.9	103.2
Public Radio	.3	1.8	2.6
Commercial & Religious	.5	2.0	3.2
Occasional	1.2	2.4	3.6
CATV	.1	.3	1.2
Recording	0	0	.8
TOTAL	2828.9	8045.3	18405.3

GROWTH RATES (Annual, %)

	TIME PERIOD	
SERVICE	**1980-1990**	**1990-2000**
MTS (Residential)	8.0	7.5
MTS (Business)	10.0	8.0
Private Line	15.0	10.0
Mobile	37.9	11.5
Public Radio	19.6	3.7
Commercial and Religious	14.9	4.8
Occasional (Radio)	7.2	4.1
CATV Music	11.6	14.9
Recording (Radio)	0.0	0.0

Based on market research studies, the following estimates were made:

a. The total installed base of terminals in 1980 was 7 million increasing to 21 million by 1990, an annual compounded growth rate of 11.6 percent

b. The number of terminals being used for the various services ranged from 235 to 1160 (see Table 3-9)

c. The number of bits per year per terminal was 400×10^6 for each service in 1980 and 1990 and ranged from 400×10^6 to 600×10^6 in 2000 (see Table 3-9).

The number of bits per year for each service was determined by multiplying the number of terminals times the number of bits per year per terminal for the particular service. These calculations are summarized in Table 3-9).

3.3.2 Electronic Mail

As indicated in Table 3-1, five services were classified under electronic mail: USPS EMSS, Mailbox Services, Administrative Message Traffic, Facsimile and Communicating Word Processors. Traffic projections for the first three services depended to a great extent on the amount of traffic which could be diverted from other forms such as first class mail or intercompany mail. The last two services were projected based on the number of machines in use, frequency of use, and the length of the average business transmission.

To estimate the United States Post Office Electronic Mail Switching System traffic, the following steps were conducted:

a. Determine the service and number of messages per year that could be diverted (44.73 billion in 1980)

b. Determine the growth rate of these messages through the year 2000 (4 billion per year increase) and divertion rate (50 percent)

c. Determine the number of bits per message (1,000 characters times 8 bits per character = 8,000 bits/message).

TABLE 3-9. SUMMARY OF FORECASTS FOR TERMINAL OPERATIONS

	Number of Terminals 1980 ($X10^3$)	Bits per Year per Terminal ($X10^6$)	Bits per Year 1980 ($X10^{12}$) C1 x C2	Number of Terminals 1990 ($X10^3$)	Bits per Year 1990 ($X10^{12}$) C2 x C4	Number of Terminals 2000 ($X10^3$)	Bits per Year per Terminal ($X10^6$)	Bits per Year 2000 ($X10^{12}$) C6 x C7
Data Transfer	1,160	400	464	3,500	1,400	10,400	600	6,240
Batch Processing	760	400	304	2,300	912	4,100	400	1,640
Data Entry	950	400	380	4,900	1,960	12,200	600	7,320
Remote Job Entry	412	400	165	3,200	1,295	5,800	400	2,320
Inquiry/Response	412	400	165	3,200	1,295	9,700	400	3,880
Timesharing	235	400	94	700	268	1,300	400	520
TOTAL	3,929		1,572	17,800	7,130	43,500		21,920

Note: Due to round-off some numbers may be slightly different

The resulting forecasts are presented in Table 3-10 with the forecasts for the other electronic mail services.

To project mailbox traffic, the following steps were conducted:

a. Determine the source and number of mailboxes (49,000 in 1981).
b. Determine the number of messages per box per year, assuming two to three messages per day per user, one user per mailbox, and 22 working days per month (about 784 messages per box per year).
c. Determine the number of bits per message (1,000 characters per message x 8 bits per character = 8,000 bits per message).
d. Determine the growth rate (50 percent between 1980 and 1981, 35 percent for 1980-1990, and 10 percent for 1990-2000).

Again, the resulting forecasts are presented in Table 3-10.

The administrative message traffic was estimated by performing the following steps:

a. Determine government (non-military and military) message traffic (68.5×10^{12} bits per year in 1982).
b. Determine percent of government message traffic that is administrative message traffic (25 percent or 17.1×10^{12} bits per year) in 1982.
c. Determine number of non-governmental terminals (3.5×10^{6} in 1982).
d. Determine percent of non-government terminals used for administrative message traffic (25 percent or .88 million).
e. Determine number of messages per day (20), number of days per month (20) and number of bits per message (8,000).
f. Determine growth rates (1.2 percent for 1980-1982), 20 percent for 1980-1990, and 12 percent 1990-2000).

The resulting forecasts for administrative message traffic are presented in Table 3-10.

TABLE 3-10. SUMMARY OF FORECASTS FOR ELECTRONIC MAIL
(Terabits/year)

SERVICE	YEAR 1980	1990	2000
USPS EMSS	0	338.4	996.8
Mailbox Services	.2	4.9	12.7
Administrative Message Traffic	48.5	300.0	933.0
Facsimile	235.5	543.7	1230.0
Communicating Word Processors	17.1	117.1	400.3
TOTAL	301.3	1300.1	2342.8

The approach used to project the facsimile markets was as follows:

a. Determine the current and forecasted market for each category of facsimile equipment.

b. Determine the usage associated with each category of equipment.

c. Analyze usage trends for each application.

d. Quantify usage in bits per year.

e. Calculate market demand for 1980, 1990 and 2000.

Convenience Facsimile is defined as the slow to medium speed (2 to 6 minutes per page) machines. A review of market statistics of the machines shipped in this range revealed that in 1980 approximately 210,000 machines were in place. The number of pages sent in 1980 was estimated at 214 million, or 102 pages per month per machine. According to industry estimates the growth rate for slow facsimile was expected to remain high, at around 25 percent, through the middle of this decade. This growth was, however, expected to decline toward the end of the decade and remain around 10 percent during the 1990s. Using a typical analog machine in place, it was possible to estimate the total number of bits transmitted per year. A machine which scans 100 x 100 points per inch will transmit 935,000 bits per page. At 4800bps, a page takes three minutes to transmit. This times the estimated number of pages gave a yearly transmission of 200 terabits.

Operational Facsimile includes medium speed, high speed and wideband facsimile equipment. This equipment operates with a range of one second per page to two minutes per page. The growth in this service is projected at 20 to 35 percent until 1990. Medium speed machines (CITT Class 3) numbered approximately 17,000 and high speed machines 2,000, in 1980. Wideband facsimile machines came into use over SBS satellites in late 1981. Approximately 50 are now in use. Volume of pages transmitted was 200 per day for medium speed machines and 250 for the high speed and wideband machines. It seems unlikely that transmission volume will rise much for the medium speed machines while for the other two it should double by 1990 before leveling off. For a medium speed machine with a typical 8½ by 11-inch page and a resolution of 100 x 100 lines per inch, there are 935,000 bits of information transmitted. Compression ratios vary from 2:1 to 100:1; in this case, a ratio of 6:1 was used. This gave an actual transmission of 156,000 bits, which at 2400 bps is transmitted in 66 seconds. Similar methods were used for high speed and wideband equipment. The total traffic generated in 1980 by Operational Facsimile was 11.3 terabits.

Special Purpose Facsimile is the type used by the police for fingerprints or by the weather bureau for maps, and therefore must be very high quality. Industry sources indicated 14,000 machines in operation in 1980 with a growth rate of 15 percent through 1990 and only 10 percent after 1990 due to other technologies. Using a typical machine of 9600 bps with a transmission time of three minutes and no compression (because of the high resolution required) results in 1.73 million bits per page. With an annual usage of 14 million equivalent pages, yearly transmission is 24.2 terabits.

A summary of the facsimile traffic forecasts is presented in Table 3-10.

In forecasting the amount of traffic generated by communicating word processors for each time period, the following steps were taken:

a. Determine the current and projected number of machines in operation (79,000 in 1980, 270,000 in 1990, 923,000 in 2000).
b. Determine the usage time associated with each machine (1 percent of 5 hour/day operating time x 250 days/year = 45,000 seconds/year for 1980; this amount doubles to 90,000 for 1990 and 2000)
c. Estimate an average speed for each machine used (4.8 Kbps)
d. Calculate the amount of traffic for 1980, 1990 and 2000.

Multiplying the number of machines times the work time and then multiplying this product times the average speed yielded the forecasts for 1980, 1990 and 2000 which are presented in Table 3-10.

3.3.3 Record Services

Forecasts of record services, TWX/Telex and Mailgram/Telegram/Money Order which are predominantly managed by Western Union, were based on actual traffic figures and long-term trends.

In 1980, the installed base of TWX/Telex terminals was 130,000, with most of these terminals used by business, government or institutions. The estimated number of messages transmitted during 1980 was 150 million. An annual growth rate of 3 percent was expected during the 1980s and the 1990s. The average message is around 1,000 characters in length, or 8,000 bits, allowing for spaces. This figure times the annual number of messages produced a yearly transmission rate during 1980 of 1.2 terabits. Using this baseline figure and the expected growth rate, it was possible to predict the message numbers and transmission volumes; these are presented in Table 3-11.

For Mailgram/Telegram/Money Order the information for the market size and number of bits transferred came from internal analysis. The actual calculation of traffic may be understood by the following tables: Tables A and C are used to derive Table D; then using the number of bits per message (Table E) it is possible to determine the amount of traffic (see Table 3-11).

A. COMPARISON OF MESSAGE VOLUME

(millions)

	1977	1978	1979	1980	1981
Mailgram	28.4	32.7	37.4	39.0	40.9
Telegram (Domestic)	6.9	7.0	6.6	6.1	5.3
Money Orders	6.3	7.0	7.7	7.9	8.1

B. COMPARISON OF REVENUE

(dollars)

	1979	1980	1981
Mailgram	78,310	92,824	106,927
Telegram	67,154	64,433	71,008
Money Orders	60,940	70,407	80,718

C. GROWTH RATE

	(percent)	
	1980-1990	1990-2000
Mailgram	8	5
Telegram	-5	0
Money Orders	12	8

D. MESSAGE VOLUME

	(millions)		
	1980	1990	2000
Mailgram	39.0	84.2	137.1
Telegram	7.9	3.7	3.7
Money Orders	6.1	24.5	52.2

E. BITS TRANSMITTED PER MESSAGE

Mailgram	8000
Telegram	8000
Money Orders	2500

3.3.4 Other Terminal Services

Other terminal services include point of sale, videotext/teletext, telemonitoring and secure voice. Forecasts for these services were based largely on discussions with industry sources.

For point of sale forecasts it was assumed that credit card transactions would grow at an annual rate of 3 percent, and that the 50 billion transactions in 1980 would increase to 67 billion in 1990 and 90 billion in 2000. Presently, only 6 percent of these transactions are handled electronically, most of them primarily for credit card authorization. Each transaction involves on average four messages (two inquiries and two responses). Very little transfer of inventory information or direct debit transactions are performed (an estimated 1000 bits per transaction). As true point of sales terminals (electronic cash registers) become more widespread the percentage of transactions handled electronically will increase sharply with higher volumes of inventory and direct debit transfers

TABLE 3-11. SUMMARY OF FORECASTS FOR RECORD SERVICES

SERVICE	YEAR		
TWX AND TELEX	**1980**	**1990**	**2000**
Terminals (thousands)	130.0	174.7	234.8
Messages (millions)	150.0	201.6	270.9
Transmission (terabits)	1.2	1.6	2.2
MAILGRAM/TELEGRAM/ MONEY ORDER			
Mailgram	.31	.67	1.10
Telegram	.06	.03	.03
Money Orders	.02	.06	.13
TOTAL	.39	.76	1.26
RECORD SERVICE TOTAL	**1.59**	**2.36**	**3.46**

being made. By 1990 80 percent of these transactions should be accomplished electronically. By the year 2000, it is estimated that almost all credit card transactions will be handled in this manner. This information and the number of transactions per year and the number of messages per transactions are summarized as follows:

	1980	1990	2000
Credit card transactions at 3% growth rate per year (billions)	50.0	67.0	90.0
Percent of transactions sent electronically	6.0	80.0	100.0
Transactions per year sent electronically (billions)	3.0	53.6	90.0
Messages per year at 4 messages per transaction (billions)	12.0	214.4	360.0
Bits per year at 1000 bits per message (terabits)	12.0	214.4	360.0

The resulting traffic forecasts are presented in Table 3-12.

Videotex systems are still at the level of technical and market trials in the United States. The basic technologies are still evolving, as are potential applications. Consequently, the volume of traffic consists primarily of traffic generated in market trials and a few commercial offerings. The number of users, the amount of usage per week, and the time of usage will differ for business and home users. The ratio of business to home users was estimated at 2:1 for 1982, 1:1 by 1990 and 1:2 by year 2000. Average business usage per week will start very low (at about 10 minutes per week) and will grow to 5 or 6 hours per week. Home usage will also start low (at about 10 minutes per week) and will grow to 1 or 2 hours per week. Considering times of usage, it was estimated that about 75 percent of the total usage (business plus home) will occur from 9 a.m. to noon and 1 p.m. to 5 p.m.; the peak time will occur at about 2 p.m. The total users (home and business) presently involved in a videotex testing system or receiving commercial service number about 75,000. An estimate of traffic was based on the following assumptions: 75,000 users, 10 minutes of use per week

TABLE 3-12. SUMMARY OF FORECASTS FOR OTHER TERMINAL SERVICES
(Terabits)

SERVICE	YEAR		
	1980	1990	2000
Point of Sale	12.0	214.4	360.0
Videotext	.4	1835.0	6115.0
Telemonitoring	.1	.8	3.5
Secure Voice	5.2	157.0	894.0
TOTAL	17.7	2207.2	7372.5

per user for 52 weeks of the year, 2 pages per minute, 700 characters per page, and 8 bits per character = 5.424×10^6 bits.

Total estimated traffic is .44 terabits per year. About 10 percent, or .044 terabits, is estimated to be long haul traffic (see Table 3-12).

Based on interviews with providers and on a wide variety of articles and reports discussing videotex sytems, the total volume of future traffic generated by these systems is expected to increase from the current .44 terabits per year to 1,835 terabits in 1990 and 6,115 terabits in 2000. It is expected that about 10% of the traffic will be long haul: 184 terabits in 1990 and 612 terabits in 2000 (see Table 3-12). These growth rates are based on the following assumptions: estimated users = 15 million in 1990, 50 million in 2000; average minutes of usage per week per user = 210 minutes in 1990, 210 minutes in 2000; and 11,200 bits per minute, based on two 700-character pages per minute (with 8 bits per character).

The baseline (see Table 3-12) for telemonitoring was derived based on interviews with industry sources about the different uses of telemonitoring and Western Union's own internal analysis using information such as the projected growth in cable service subscriptions.

PROJECTED GROWTH IN CABLE SERVICE SUBSCRIPTIONS

	1980		1990		2000	
TV Households (TVHH)	80,700,000	(2)	95,000,000	(3)	100,000	(4)
CABLE TV (CATV)	18,672,000	(2)	58,900,000	(2)	90,200,000	(5)
PERCENT TVHH WITH CABLE	24%	(2)	62%	(2)	82%	(5)
NUMBER OF TVHH WITH SECURITY SYSTEMS (1)	12,335		7,600,000		38,500,000	
PERCENT ESTIMATED TVHH PROJECTED	.015%		5 TO 10%		30 TO 40%	

Due to the privacy constraints of users of communications privacy devices, it has been difficult to determine the quantity and volume of usage of secured voice devices and systems. However, making the following estimates a forecast (see Table 3-12) was determined.

a. Of the FCC reported 26 billion messages per year, 52 percent were estimated to be "business"
b. The number of bits per message were estimated to be 100,000
c. It was estimated that .4 percent of the messages were encrypted
d. The growth of encrypted messages was estimated at about 40 percent (to 1990) and about 19 percent from 1990 to 2000.

3.3.5 Summary of Data Baseline Forecasts

In Table 3-13 is a summary of the data baseline forecasts in terabits per year; the corresponding annual growth rates are presented in Table 3-14.

3.4 VIDEO BASELINE METHODOLOGIES AND FORECASTS

As indicated in Section 2 and Table 3-1, video applications were divided into two groups: broadcast which includes network video, CATV video, occassional video and recording channel; and limited broadcast which includes teleconferencing and DBS/HDTV. The methodologies and forecasts are discussed separately for the two groups.

3.4.1 Broadcast Services

To determine the broadcast services forecast, the actual number of transponders in use and their future growth rate were determined. The steps used to establish this baseline were as follows:

a. Determine the number of transponders used for commercial video, PBS, educational and occasional video
b. Determine future plans for each of the services and project onward.

TABLE 3-13. DATA BASELINE - TERABITS/YEAR

	YEAR		
SERVICE	1980	1990	2000
Data Transfer	464.0	1400.0	6240.0
Batch Processing	304.0	912.0	1640.0
Data Entry	380.0	1960.0	7320.0
Remote Job Entry	165.0	1295.0	2320.0
Inquiry/Response	165.0	1295.0	3088.0
Timesharing	94.0	268.0	520.0
USPS/EMSS	0	338.4	996.8
Mailbox	.2	4.9	12.7
Administrative Traffic	48.5	300.0	933.0
Facsimile	235.5	543.7	1230.0
Communicating Word Processors	17.1	117.1	400.3
TWX/Telex	1.2	1.6	2.2
Mailgram/Telegram/ Money Orders	.4	.8	1.3
Point of Sale	12.0	214.4	360.0
Videotex/Teletext	.1	275.0	917.0
Telemonitoring Service	.1	.8	3.5
Secure Voice	5.2	157.0	894.0
TOTAL	1892.3	9083.7	26878.8

TABLE 3-14. DATA BASELINE - A[illegible]NUAL GROWTH RATES (%)

SERVICE	TIME PERIOD 1980-1990	1990-2000
Data Transfer	11.7	16.1
Batch Processing	11.6	6.0
Data Entry	28.1	14.1
Remote Job Entry	22.9	6.0
Inquiry/Response	22.9	9.1
Timesharing	11.0	6.9
USPS/EMSS	0.0	11.4
Mailbox	37.7	10.0
Administrative Traffic	19.6	12.1
Fascimile	7.5	8.5
Communicating Word Processors	21.2	13.1
TWX/Telex	2.9	3.2
Mailgram/Telegram/Money Orders	4.8	7.2
Videotex/Teletext	120.8	12.8
Telemonitoring Service	23.1	15.9
Secure Voice	40.6	19.0

This technique gave the net addressable satellite forecast, and impact factors were considered subsequently in the impacted baseline forecasts.

To determine how each transponder is currently being used, those satellites currently in use were reviewed at the FCC. To ascertain the future growth of network video three sources were used. First, all announced plans for future transponder use were reviewed from such sources as trade magazines as well as new filings for satellite systems. Second, the future of satellite transmission was discussed with industry representatives from CBS, PSSC and others. Third, the future of the industry was discussed internally based on previous and current work; Western Union has prepared bids for both NBC and PBS on satellite use, is currently doing the distribution for PBS, and most of its WESTAR System is used either for cable or occasional distribution.

Compression of video signals is likely to occur in the early 1990s. This will not be accepted by everyone because of the high quality picture required. Other trends such as multilingual sound, stereo sound and high definition sound will also work against compression. Therefore, a factor of 1.5:1 was applied for the 2000 forecasts to calculate the expected number of transponders required. See Table 3-15 for the 1980, 1990, and 2000 Broadcast Services forecasts.

3.4.2 Limited Broadcast

No forecasts were developed for DBS/HDTV as these two services were treated as market determinant factors in the development of the impacted baseline forecasts.

3.4.2.1 Video-Teleconferencing

In order to determine the video-teleconferencing baseline forecast, a number of steps were taken. The major ad hoc vendors (such as Tymnet and PSSC) were contacted and the following questions were asked:

1. In the last year, how many teleconferences has your organization done?
2. Were these conferences full, limited, or fixed frame?

TABLE 3-15. BROADCAST SERVICES FORECAST
(transponders)

SERVICE	YEAR 1980	1990	2000*
Network			
Commercial	5	30	27
PBS	4	7	6
Educational	1	5	7
	9	42	40
CATV	34	76	57
Occasional	19	52	41
Recording Channel	0	0	2
TOTAL	63	170	140

*A compression factor of 1.5:1 was used in 2000.

3. Was the conference one-way video/two-way audio or two-way video/two-way audio?
4. On the average, how many sites were involved?
5. Over what distance was the conference usually held?
6. What was the typical length of the conference?
7. Was there a particular time of the day when conferences seemed to be held?
8. What type of growth do you feel will occur in teleconferencing in the next five years?
9. What are the prospects after that?
10. Do you have any other comments you would care to make?

The following is a summary of the findings from these interviews.

Video teleconferencing is a service that has a great potential for growth over the next few years. The possible applications are tremendous, both on an ad hoc basis for one-time conferences and in the context of a dedicated system serving the internal communication needs of a single business entity.

Most teleconferencing today is full motion (rather than slow scan type) with one-way video and two-way audio hook-ups. As technology improves, becoming more familiar and less costly, we can anticipate a wider use of two-way video and audio teleconferencing.

Any number of sites may be involved in a teleconference, depending greatly on the needs of a particular customer and the purpose to be served. The number of sites ranges from one to hundreds on a national and/or international scale. The average seems to be in the 15 to 25-site range, making a teleconference an economically feasible alternative to travel.

As a rule, a teleconference links a widely disparate geographical area which usually includes both east and west coasts. There is some tendency to cluster in large population areas along the west coast or the northeast corridor of the U.S. Teleconferencing can be useful in linking various regions, but is not often a factor within a very regional framework due to cost factors.

Most teleconferences last about two to three hours, although this is another factor which varies widely according to need. Typically, the actual time devoted to teleconferencing is padded somewhat by time spent in educating the participants in the most effective methods for using a relatively new service.

Given the geographical range of areas covered and differing time zones nationally and internationally, timing becomes a factor in planning which cannot be ignored. Teleconferencing between east and west coasts tends to center between 10:00 A.M. and 2:00 P.M. in order to compensate for time differences and to keep the teleconference within business hours. This problem grows more acute as the teleconference takes on an international rather than a purely national aspect.

Another limitation to be considered is the availability of transponder time to the organizations arranging teleconferencing. Limited transponder availability also dictates to what extent a customer may choose the day and time of the proposed teleconference. A fully dedicated system or continuous access to transponder use obviously makes teleconferencing a more flexible tool enjoyed by relatively few users at the present time. There are expected to be substantially more transponders available by 1985 (and/or transponders with greater capacity) which should alleviate the problem of transponder time. That should, in turn, make teleconferencing a more economically sound, less costly service, thereby opening up the market for ad hoc use of teleconferencing to smaller concerns who could not presently afford it.

One scenario for the growth of teleconferencing sees an explosive growth rate in ad hoc use of teleconferencing over the next couple of years (as much as 100% per year for 5 years) gradually tapering off. As familiarity increases and technology improves, teleconferencing will become a business necessity for large nationwide users, resulting in a less dramatic, though steadily increasing (25%) and continued growth rate as more dedicated systems are implemented. Eventually, the dedicated system will be the more widely used, despite the growth spurt in ad hoc use that has developed over the past couple of years and will probably continue for the next few years.

At the moment, there seem to be about 140 teleconferences (as an average) held on a yearly basis. This figure is constantly increasing and will continue to do so. Several factors enter into the actual planning of a teleconference. There is a need to familiarize the client with the technology itself so as to put it to its most effective use and to respond to that client's real needs. The cost factor is a consideration; so is availability of transponder time: all of which suggests a preferred lead time of six months. Teleconferencing can be done, and done successfully, in much less time given the appropriate set of circumstances. It does, however, require a certain amount of preparation to be most effective. Another consideration is the importance of social interaction. One benefit of teleconferencing is the ability to make those in more remote sites feel they are actually participating in the meeting and/or decision-making process. This sense of immediacy must be balanced against the trend of social interaction which results from informal contacts made when all conference participants are in the same location.

Next, the AT&T and SBS filings which discuss teleconferencing were reviewed. Current literature discussing the service and its use was also reviewed as well as many of the studies performed by industry analysts. Information provided by vendors and the user survey was used to establish the actual number of conferences held in 1980. All sources combined were used to determine a forecast for 1990 and 2000. After determining the forecast, the results were discussed with Western Union's product line people who are about to enter this field. The results were then modified to reflect their input and are presented below.

In Table 3-16 is information on the number of teleconferencing rooms, the average daily use per teleconferencing room, the average conference length, the number of conferences, and the type of conference. This information is used to determine the number of transponder hours required to handle traffic. To do this multiply the total number of conferences by the percentage of each type of conference held (A) (see Table 3-17). Next divide this by the total number of conferences an equivalent 50 Mbps transponder can carry (B). Then divide the conferences into private and public (C). Multiply this by the average length of the conference to get transponder hours (D and E). Estimate the amount of traffic likely to go over satellite (F). This estimate was based on case studies of current systems as well as future tariff estimates and the lowering of the crossover distance. Multiplying the number of transponder hours (E) by the traffic likely to go over satellite (F) gives the number of transponders required (G). Then estimate additional compression of the video signals (H) and apply this (I). Divide this by the number of hours in the typical work year available to video conference (J). This is based on 250 work days consisting of a five hour day. Factors such as the time zone effect and reluctance to have either very early or very late business meetings were considered in selecting a five hour work day. Peaking factors were applied in step K. An industry report cited 2.5 as the peaking factor in the 1980 to 1985 time frame. Interview information indicated this was a reasonable premise. In the future, as more sites are added and more impromptu conferences are held, this figure is likely to decline (1.2 was used in 1990 and the traffic was constant over the main 5 hours in 2000).

3.4.3 Summary of Video Baseline Forecasts

In Table 3-18 is a summary of the video baseline forecasts and the related annual growth rates.

3.5 SUMMARY OF BASELINE FORECASTS

A summary of the baseline forecasts and related annual growth rates is presented in Table 3-19.

TABLE 3-16
INFORMATION NEEDED TO DEVELOP VIDEO CONFERENCING BASELINE FORECASTS

	YEAR		
	1980	1990	2000
ROOMS			
Private	12	4287	13,963
Public	30	500	900
DAILY USE (hours)			
Private	5	4	3
Public	1	5	4
LENGTH (hours)			
Private	3.0	2.0	2.0
Public	4.0	2.5	2.0
ROOMS (Per Conference)			
Private	2.5	2.3	2.1
Public	4.0	4.0	4.0
NUMBER OF CONFERENCES			
Private	2,083	932,065	2,493,452
Public	488	62,500	112,500
TYPE OF CONFERENCE (% by year)			
2 way full motion 2 way audio	30%	5%	1%
1 way full motion 2 way audio	50%	10%	3%
2 way limited motion 2 way audio	5%	60%	68%
1 way limited motion 2 way audio	0%	5%	8%
Fixed Frame	15%	20%	20%

TABLE 3-17. VIDEO CONFERENCING BASELINE FORECASTS

	YEAR		
	1980	1990	2000
A. TYPE OF CONFERENCE			
2 way full motion	771	49,728	26,059
1 way full motion	1,286	99,457	78,179
2 way limited motion	129	596,739	1,772,047
1 way limited motion	0	49,728	208,477
fixed frame	386	198,913	521,190
B. TYPE OF CONFERENCE			
2 way full motion	771	49,728	26,059
1 way full motion	643	49,728	39,090
2 way limited motion	22	99,457	295,341
1 way limited motion	0	4,144	17,373
fixed frame	2	663	1,737
C. TYPE OF CONFERENCE			
PRIVATE:			
2 way full motion	625	46,603	24,934
1 way full motion	521	46,603	37,402
2 way limited motion	18	93,191	282,591
1 way limited motion	0	3,883	16,623
fixed frame	2	623	1,662
PUBLIC:			
2 way full motion	146	3,125	1,125
1 way full motion	122	3,125	1,688
2 way limited motion	4	6,250	12,751
1 way limited motion	0	261	750
fixed frame	0	40	75

D. TRANSPONDER HOURS PER TYPE OF CONFERENCE			
PRIVATE:			
2 way full motion	1,875	93,206	49,876
1 way full motion	1,563	93,206	74,818
2 way limited motion	54	186,414	565,454
1 way limited motion	0	7,766	33,252
fixed frame	6	1,246	3,324
PUBLIC:			
2 way full motion	584	7,833	2,250
1 way full motion	488	7,833	3,376
2 way limited motion	16	15,625	25,228
1 way limited motion	0	653	1,500
fixed frame	0	100	150
E. TOTAL TRANSPONDER HOURS ALL CONFERENCES	4,586	414,380	759,206
F. PERCENT OF TRAFFIC CARRIED VIA SATELLITE	33	70	85
G. TRANSPONDER HOURS REQUIRED FOR SATELLITE TRAFFIC	1,513	290,066	645,325
H. FUTURE VIDEO COMPRESSION	1:1	2:1	3:1
I. TRANSPONDER HOURS REQUIRED CONSIDERING COMPRESSION	1,513	145,033	215,108
J. TRANSPONDER HOURS REQUIRED DURING BUSINESS DAY	6.1	580.1	860.4
K. TRANSPONDERS REQUIRED FOR PEAK HOUR	3	139	172

TABLE 3-18. SUMMARY OF VIDEO BASELINE - NET ADDRESSABLE WIDEBAND FORECASTS (TRANSPONDERS) AND GROWTH RATES

FORECASTS	YEAR		
SERVICE	1980	1990	2000
Network	10	42	40
CATV	34	76	57
Occasional	19	52	41
Recording Channel	0	0	2
Teleconferencing	3	139	172
TOTAL	66	309	312

GROWTH RATES (Annual, %)*	TIME PERIOD	
SERVICE	1980-1990	1990-2000
Network	15.4	-.5
CATV	8.4	-2.8
Occasional (Video)	10.6	-2.3
Recording Channel	0.0	0.0
Teleconferencing	46.7	2.2

*The low or negative growth rates for video services is due to expected compression.

TABLE 3-19. SUMMARY OF BASELINE FORECASTS

FORECASTS

SERVICE	YEAR 1980	1990	2000
Voice (10^3 half-voice circuits)	2828.9	8045.3	18405.3
Data (terabits/yr.)	1892.3	9083.7	26878.8
Video (transponders)	66	309	312

GROWTH RATES (Annual, %)

SERVICE	TIME PERIOD 1980-1990	1990-2000	1980-2000
Voice	11.0	8.6	9.8
Data	17.0	11.5	14.2
Video	16.7	.1	8.1

SECTION 4
IMPACTED BASELINE FORECASTS

4.1 INTRODUCTION

The impacted baseline forecasts were developed by refining the baseline forecasts. As noted earlier, the baseline forecasts for each service were estimates of the current and future volume of traffic. The baseline forecasts were scenarios reflecting the occurrence of expected events and orderly growth and the results of a cross-impact analysis which eliminated duplicate demand. The impacted baseline forecasts were made by considering the impact of less predictable events or market determinant factors on the baseline forecasts (see Figure 4-1).

4.2 THE IMPACTED BASELINE MODEL

The Western Union impacted baseline model is designed to refine, update and adjust forecasts. The following can be changed at any time:

a. The number of MDFs or services
b. The event probabilities
c. The cross-impact of the events
d. The impact of the events on the services

Two techniques for calculating the impacted baseline forecasts are built into the model:

a. The multiplication method--impacts of an event on events or an event on services for a particular year are calculated by multiplying the event's probability for that year by its total impact. The event is treated as if it partially occurred.
b. The random-all-or-none method--the event's probability and a random number generator are used to determine whether or not the event occurs in a particular year. The event is treated as occurring completely or not at all and its impacts are treated

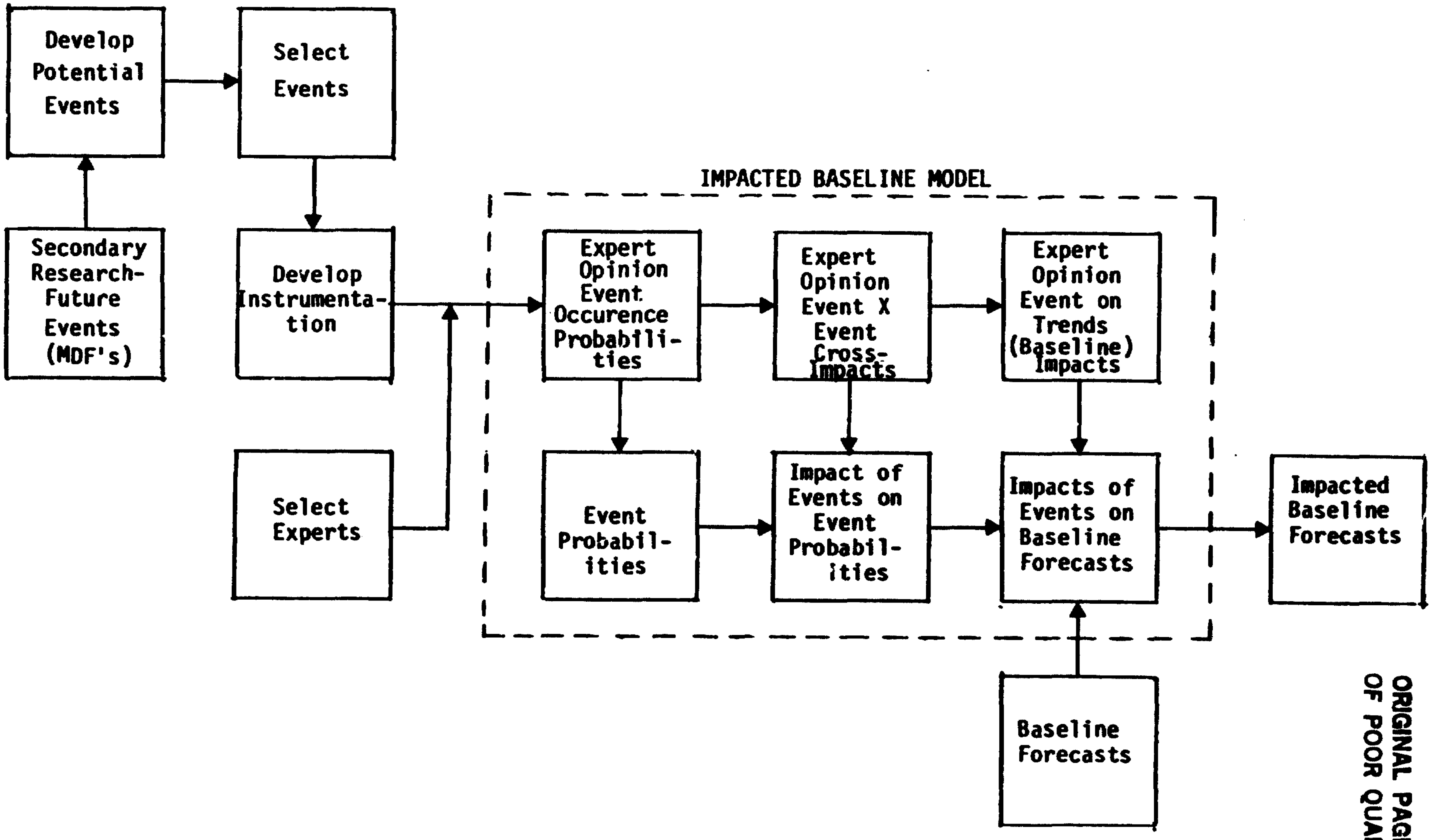

FIGURE 4-1. ACTIVITY FLOW FOR IMPACTED BASELINE FORECASTS

accordingly. The multiplication method approximates the average of all possible scenarios developed by the random method.

For this report, the multiplication method was employed and its use is reflected in the analysis discussed below. However, the random-all-or-none method can be employed at any time to examine the variety of scenarios possible. Either method can be employed to conduct sensitivity analyses. Most importantly, the model can be employed to develop a variety of scenarios which can be used in strategic and long-range planning.

4.3 PROCEDURES

4.3.1 Market Determinant Factors (Events)

A Market Determinant Factor (MDF) or an event was selected if it had the potential to impact the long haul market, significantly, uniquely and somewhat unexpectedly by 2000. In addition to these criteria, a matrix of criteria (see Appendix B, Table B-1), a review of current literature and interviews with experts guided the selection of MDFs.

The matrix noted above indicated the event or MDF classes and the different impact areas for each MDF. The event classes were technological, economic and social-political and the impact areas were cost, availability, ease of use and need. An event could impact cost by decreasing the cost of a service or increasing the cost of a competing means; it could impact availability by making it possible to provide more of a service or to provide the service to more people; it could impact ease of use by making a service easier to use or by making a service more acceptable; and it could impact need by creating either a greater need for an existing service or a new need for the service. As a pool of MDFs was generated, effort was made to ensure that each event class was well represented and that each potential event might have at least one of the eight different impacts.

Through a comprehensive literature review and interviews (see Figure 4-1) with key providers, users and consultants, 36 events were identified. These events are defined briefly in Table 4-1. The list of events should be considered representative of potential MDFs and should not be considered inclusive.

4.3.2 Collection of Data

In-person interviews (15) were conducted with representatives of major carriers, providers, users, consulting groups, Federal agencies and Western Union personnel to obtain information on the probability, timing and impact of each MDF (see Figure 4-1). Interviewees were asked to estimate when (i.e., the year) each event would have a 10 percent or slim chance, a 50/50 chance, and an almost certain or 100 percent chance of occurring. They were also asked to indicate their level of confidence in making their estimates. The data collection form used to record this information on probability of occurrences of the MDFs is presented in Appendix B, Table B-3.

Interviewees were then asked to estimate the potential impact of each of these events on the 31 specific voice, data and video services (see Figure 4-1). They were also asked to note, if possible, what the event would impact: cost, availability, ease of use or need. As with the information on probabilities, interviewees were asked to indicate the level of confidence in making their estimates of impact. The data collection form used to record this information is presented in Appendix B, Table B-4.

In addition to data on probability, timing and impact of MDFs, Western Union personnel estimated the cross-impact of the MDFs to provide a measure of the interaction of the various events (see Figure 4-1). The data collection form used for this purpose is presented in Appendix B, Table B-5.

4.3.3 Analysis of Data

The first steps of data analysis involved calculating the probability of occurrence of each event for each year from 1980 through 2000 (see Figure 4-1). The mean year of occurrence of each event was determined for 10 percent chance, 50/50 chance and 100 percent/certain chance. The results of this analysis appear in Table 4-2. Twenty-eight of the 36 events were judged to have a nearly certain chance of occurring by the year 2000. Biochips was the event least likely to

TABLE 4-1
EVENTS-MARKET DETERMINANT FACTORS

TECHNOLOGICAL

Input

Touch Input Devices:
Widespread use of inexpensive screens/tablets that respond to touch.

Smart Cards:
Plastic microcomputer "smart cards" which are programmable are used extensively in financial transactions.

Voice Recognition:
Inexpensive, voice-recognition devices (e.g., voicewriter that can recognize instructions from spoken voice) become available and are used widely for computer time-sharing and office and home terminals.

Hand-held Terminals:
Widespread use of low cost hand-held terminals that can communicate with a network of computers.

Output

Non-Impact Printing:
Non-impact printing techniques (e.g., thermal processes) replace impact printer for hard copy production.

Flat Output Panels:
Flat, solid-state panels (e.g., plasma panels) replace CRT for soft copy production.

Processing

Microprocessors:
100,000 components per chip, 1 millionth of a meter in size, with a speed of 10 million instructions per second, costing $.04 per logical unit become available (factor of 2 with 1980).

Micromemories:
Catch up to microprocessors in speed and capacity; inexpensive electric memory devices (using techniques like Josephson Junction) as fast as fastest RAM chips with capacities large enough for mass data storage become available.

Biochips:
Chips produced by bacteria make possible the molecular computer, the molecular switch, organic memory devices; computers become much smaller, faster and cheaper.

Fifth Generation Computers:
Emphasize logic, not just power; can hear, talk, develop knowledge; have active memory that incorporates parallel processing; are used on widespread basis.

Artificially Intelligent Expert Machines:
Knowledge-based system capable of bringing specialized knowledge to bear on non-numerical problems (e.g., medical diagnosis, problem solving) become available and are used widely in the home and in business.

Self-Programming Computers:
Computers that can program themselves become available and are used on a widespread basis.

Universal Programming Language:
A standard is established for programming languages reducing programming costs by 25 percent.

Standardization of Software:
Software packages are standardized so they can be used on all systems; one or several models are established for standardizing data base software.

Terminal/Computer Compatibility:
Standards are adopted by various terminal/computer types making possible the communication among all types of terminals/computers throughout the United States.

Transmission

Direct Broadcast Service:
Widespread use of the direct reception of video or audio signals from satellites to individual receiving antennas, by-passing terrestrial transmission and receiving stations.

High-Definition Television:
Widespread use of HDTV which uses a wider bandwidth than conventional TV and gives a higher resolution picture on a large screen.

Voice Store-and-Forward:
Widespread use of this computerized storage-retrieval system for distribution of voice message communication; users dictate messages over the telephone and call in to retrieve them.

Wrist Radio:
Stadium size antennas make possible communications by way of low power wrist radios.

Antenna Material:
Availability of inexpensive light weight antenna.

Satellite Material:

Availability of lighter, less expensive material developed for satellite production.

Fiber Optics:

Connector, capacity and light source (e.g., solid-state injection lasers) improvements made in fiber optics.

Geo-Stationary Platform:

A stationary place in space is developed and provides facilities for tasks ranging from maintaining and servicing to assembling satellites with high power and capacity.

ECONOMIC

Prosperity:

The following occurs - productivity and GNP up, interest rates and unemployment low, and new businesses and markets established.

Recession-Depression:

The following occurs - productivity and GNP down, interest rates and unemployment very high, business failures increase, market shares lost to foreign competition.

Communications Business Shake Down:

Marginal communications business drop out leaving only major corporations, despite pro-competition stance of Government.

Resources:

Battle between resource exploitation and resource conservation ends as need for critical natural resources increases sharply and requires extensive exploration and conservation.

Global Economy:

Domestic-national economies of both developed and developing countries make global economic planning a high priority.

Industries in Space:

The development of products (e.g., semi-conductors) and the providing of services (e.g., earth observation) in space is a multi-billion (dollar) industry.

SOCIAL-POLITICAL

Domestic-International Satellites:

Domestic satellite systems are connected to international networks via inter-satellite links.

Limited Wars:

Limited wars break out in several key corners of the globe (e.g., Middle East).

Orbit Share:

South America demands and obtains its own unique share of the geostationary orbit.

Acceptance of Technology:

Generation raised on computer games and space exploration not only accepts, but welcomes services like electronic mail to the home and the "Office of the Future" at work.

Work at Home:

Workers and management in a work world becoming more service and white-collar oriented spend more time working at home.

Satellite Importation of Workers:

Widespread use of satellites to obtain labor (i.e., the results of labor, like word processing) from other countries.

Self Help:

Decentralized in a world growing more interdependent causes significant increase in local control and self help groups who need many individual networks.

TABLE 4-2

MEAN YEAR OF OCCURENCE FOR MDF's

MARKET DETERMINANT FACTORS (MDFs)		PROBABILITY OF OCCURENCE 10 PCT	50 PCT	100 PCT
1	TOUCH INPUT DEVICES	1985	1990	1994
2	SMART CARDS	1986	1990	1993
3	VOICE RECOGNITION	1987	1994	1999
4	HAND HELD TERMINALS	1984	1989	1993
5	NON-IMPACT PRINTING	1985	1991	1996
6	FLAT OUTPUT PANELS	1987	1992	1998
7	MICROPROCESSOR	1983	1985	1988
8	MICROMEMORIES	1984	1987	1990
9	BIOCHIPS	1994	2001	2009
10	FIFTH GENERATION COMPUTERS	1989	1994	2000
11	ARTIF INTEL, EXP MACHINES	1989	1995	2004
12	SELF-PROGRAMMING COMPUTERS	1990	1996	2003
13	UNIVERSAL PROGRAMMING LANGUAGE	1989	1991	1996
14	TERMINAL/COMPUTER COMPATABILITY	1985	1988	1992
15	STANDARDIZATION OF SOFTWARE	1987	1992	1996
16	DIRECT BROADCAST SERVICE	1985	1989	1993
17	HIGH DEFINITION TELEVISION	1988	1990	1994
18	VOICE STORE AND FORWARD	1984	1987	1991
19	WRIST RADIO	1989	1994	2000
20	ANTENNA MATERIAL	1987	1990	1993
21	SATELLITE MATERIAL	1988	1993	1998
22	FIBER OPTICS	1985	1988	1994
23	GEO-STATIONARY PLATFORM	1994	2003	2004
24	PROSPERITY	1985	1988	1993
25	RECESSION/DEPRESSION	1983	1986	1989
26	COMMUNICATIONS BUSINESS SHAKE DOWN	1988	1989	1991
27	RESOURCES - CRITICAL NEED	1986	1988	1993
28	GLOBAL ECONOMY	1991	1996	2005
29	INDUSTRIES IN SPACE	1993	2000	2005
30	DOMESTIC INTERNATIONAL SATELLITE	1989	1994	1999
31	LIMITED WARS	1982	1984	1986
32	ORBIT SHARE	1984	1987	1994
33	ACCEPTANCE OF TECHNOLOGY	1985	1990	1994
34	WORK AT HOME	1988	1996	2001
35	SATELLITE IMPORTATION OF WORKERS	1992	1998	2005
36	SELF-HELP	1987	1993	1996

occur by the year 2000, while voice-store-and-forward and a communications business shake down were the most likely to occur by 2000. Using straight line interpolation up to the year when the event chance was 100 percent, these results were transformed to provide the probability of occurrence of each event for each year from the year of 10 percent chance through the year of 100 percent chance. Then the probabilities for each event were normalized. The normalized probabilities for each event for the 1980-2000 time period appear in Table 4-3.

Next, the effects of the event cross-impacts (i.e., the impacts of events on each other's probabilities of occurrence) were calculated (see Figure 4-1). This process, which involved converting cross-impact ratings to cross-impact scores converting event probabilities to odds, multiplying scores by odds, converting odds back to probabilities, summing the impacts across events, and normalizing the new probabilities is described in detail in Appendix B and Tables B-8 and B-9. The resulting modified normalized probabilities appear in Table 4-4. The difference between the probabilities in Table 4-3 and Table 4-4 reflect the cross-impacts of the MDFs. In general, a consideration of these impacts increased the probabilities of the various events occurring earlier.

The next major step involved calculating the impacts of the events on the individual services (see Figure 4-1). The mean impacts of events on services were calculated, and the Western Union personnel reviewed and modified these results so they would reflect considerations made when developing the baseline forecasts. The results of the modified impacts appear in the MDF-by-Service Matrix in Appendix B, Tables B-10.

Then these impacts and the modified normalized event probabilities were used to determine the impacted baseline forecast for each service for each year from 1980 through 2000 (see Figure 4-1). For a particular service for a particular year, the probability of each MDF was multiplied times its impact on the particular service, and the sum of these impacts were added to the baseline forecast for the particular service. These steps were repeated for each year and for each service.

TABLE 4-3. NORMALIZED PROBABILITY OF OCCURENCE FOR MDFs FOR EACH YEAR

MDFs	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	YEARS																		
TOUCH INPUT DEVICES			0.2	0.9	1.6	2.3	3.1	3.8	4.5	5.6	6.8	7.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SMART CARDS					0.9	1.8	2.7	3.6	4.5	6.1	7.6	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
VOICE RECOGNITION					0.6	1.3	2.1	2.9	3.6	4.4	5.2	6.0	6.7	8.1	9.4	10.2	12.1	13.4	13.4
HAND HELD TERMINALS		0.2	0.8	1.5	2.2	2.8	3.5	4.1	5.2	6.2	7.2	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
NON-IMPACT PRINTING			0.3	1.0	1.6	2.3	3.0	3.6	4.3	4.9	5.9	6.9	7.9	8.9	9.9	9.9	9.9	9.9	9.9
FLAT OUTPUT PANELS					0.2	1.2	2.1	3.0	4.0	4.9	5.8	6.8	7.8	8.8	9.7	10.7	11.7	11.7	11.7
MICROPROCESSOR		0.6	1.9	3.2	4.3	5.4	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
MICROMEMORIES			0.7	1.7	2.7	3.6	4.9	6.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
BIOCHIPS												1.0	2.3	3.6	4.9	6.2	7.5	8.8	10.1
FIFTH GENERATION COMPUTER							0.3	1.5	2.7	4.0	5.2	6.4	7.6	8.9	10.1	11.4	12.7	14.0	15.2
ARTIF INTEL, EXP MACHINES							0.5	1.4	2.4	3.3	4.3	5.2	6.2	7.1	7.9	8.7	9.5	10.3	11.1
SELF-PROGRAMMING COMPUTER								0.5	1.6	2.7	3.8	4.9	5.9	7.0	8.1	9.3	10.4	11.6	12.7
UNIVERSAL PROGRAMMING LAN								1.1	3.4	5.6	6.7	7.9	9.0	10.1	11.2	11.2	11.2	11.2	11.2
TERMINAL/COMPUTER COMPATA				0.8	1.9	2.9	4.0	5.0	6.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
STANDARDIZATION OF SOFTWA					0.2	1.1	2.0	2.9	3.7	4.6	5.5	6.9	8.3	9.6	11.0	11.0	11.0	11.0	11.0
DIRECT BROADCAST SERVICE				0.9	1.7	2.6	3.4	4.3	5.3	6.4	7.4	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
HIGH DEFINITION TELEVISIO							1.0	3.0	4.9	6.2	7.4	8.6	9.9	9.9	9.9	9.9	9.9	9.9	9.9
VOICE STORE AND FORWARD			0.7	1.7	2.7	3.7	4.6	5.6	6.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
WRIST RADIO							0.3	1.5	2.7	4.0	6.2	6.4	7.6	8.9	10.1	11.4	12.7	14.0	15.2
ANTENNA MATERIAL						0.9	2.2	3.4	4.7	6.2	7.8	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
SATELLITE MATERIAL						0.3	1.3	2.3	3.3	4.3	5.4	6.4	7.7	9.0	10.2	11.5	12.8	12.8	12.8
FIBER OPTICS				0.8	2.0	3.1	4.2	4.9	5.6	6.3	7.0	7.7	8.4	8.4	8.4	8.4	8.4	8.4	8.4
GEO-STATIONARY PLATFORM											0.2	1.2	2.2	3.1	4.1	5.0	6.0	6.9	7.9
PROSPERITY				0.8	1.9	3.0	4.1	4.9	5.7	6.6	7.4	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
RECESSION/DEPRESSION		0.7	1.6	2.5	3.4	4.5	5.7	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
COMMUNICATIONS BUSINESS SH							0.9	4.4	6.6	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
RESOURCES - CRITICAL NEED					0.8	2.5	4.2	5.0	5.9	6.7	7.6	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
GLOBAL ECONOMY									0.3	1.7	3.0	4.3	5.6	6.9	8.3	9.2	10.1	11.0	11.9
INDUSTRIES IN SPARE											0.9	2.0	3.2	4.4	5.6	6.7	7.9	9.1	10.2
DOMESTIC INTERNATIONAL SA							0.3	1.5	2.6	3.8	5.0	6.2	7.3	8.8	10.3	11.7	13.2	14.7	14.7
LIMITED WARS	0.6	1.8	3.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
ORBIT SHARE			0.8	1.8	2.9	3.9	4.5	5.1	5.6	6.2	6.7	7.3	7.9	7.9	7.9	7.9	7.9	7.9	7.9
ACCEPTANCE OF TECHNOLOGY			0.2	0.9	1.6	2.3	3.1	3.8	4.5	5.6	6.8	7.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0
WORK AT HOME					0.0	0.8	1.6	2.3	3.1	3.9	4.7	5.5	6.3	7.0	7.8	9.4	11.0	12.5	14.1
SATELLITE INPORTATION OF										0.6	1.9	3.2	4.5	5.8	7.0	8.3	9.6	11.0	12.3
SELF-HELP					0.4	1.2	1.9	2.7	3.5	4.2	5.0	5.8	7.7	9.7	11.6	11.6	11.6	11.6	11.6

TABLE 4-4. MODIFIED NORMALIZED PROBABILITY OF OCCURENCE FOR MDFs FOR EACH YEAR

MDFs	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
TOUCH INPUT DEVICES			0.2	1.0	1.7	2.4	2.9	3.4	3.9	4.6	5.5	7.2	9.6	9.6	9.6	9.6	9.6	9.6	9.6
SMART CARDS					1.1	2.8	4.6	6.4	7.9	9.1	9.1	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
VOICE RECOGNITION					0.5	1.2	2.0	2.7	3.5	4.3	5.1	5.9	6.6	7.7	8.7	9.5	10.2	10.7	10.7
HAND HELD TERMINALS		0.1	1.0	2.1	3.5	4.0	6.1	7.2	8.3	8.3	8.2	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
NON-IMPACT PRINTING			0.3	0.9	1.6	2.4	3.1	3.0	4.5	5.2	6.1	6.0	7.5	8.0	8.4	8.4	8.4	8.4	8.4
FLAT OUTPUT PANELS					0.2	1.0	2.0	3.0	4.0	5.0	5.9	6.8	7.5	8.1	8.6	8.9	9.1	9.1	9.1
MICROPROCESSOR		0.8	2.8	4.8	5.9	6.4	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
MICROMEMORIES			0.8	2.3	3.8	5.2	6.4	7.0	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
BIOCHIPS												0.4	0.9	1.5	2.2	2.9	3.6	4.2	4.9
FIFTH GENERATION COMPUTER							0.2	1.1	2.3	3.5	4.9	6.2	7.3	8.3	9.0	9.4	9.4	9.0	8.1
ARTIF INTEL, EXP MACHINES							0.2	0.8	1.5	2.3	3.1	3.9	4.6	5.3	5.8	6.2	6.5	6.7	6.0
SELF-PROGRAMMING COMPUTER								0.3	0.9	1.7	2.6	3.5	4.5	5.3	6.1	6.8	7.4	7.7	7.9
UNIVERSAL PROGRAMMING LAN								1.1	3.6	6.0	7.1	8.1	8.9	9.6	10.1	10.1	10.1	10.1	10.1
TERMINAL/COMPUTER COMPATA				0.9	2.4	4.0	5.5	6.5	7.2	7.3	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
STANDARDIZATION OF SOFTWA					0.2	1.1	2.0	2.9	3.8	4.7	5.6	7.0	0.3	9.5	10.5	10.5	10.5	10.5	10.5
DIRECT BROADCAST SERVICE				0.8	1.8	2.8	3.8	4.8	5.8	6.6	7.2	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
HIGH DEFINITION TELEVISIO							1.0	3.4	5.8	7.1	7.9	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
VOICE STORE AND FORWARD			0.8	1.8	2.9	4.0	4.9	5.7	6.5	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
WRIST RADIO							0.2	1.1	2.3	3.6	4.99	6.3	7.4	8.4	9.2	9.5	9.4	8.9	7.9
ANTENNA MATERIAL						0.9	2.5	4.1	5.6	7.1	8.0	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
SATELLITE MATERIAL						0.2	1.1	2.1	3.2	4.4	5.5	6.5	7.6	8.5	9.1	9.4	9.3	9.3	9.3
FIBER OPTICS				0.8	2.1	3.3	4.5	5.1	5.7	6.3	6.8	7.3	7.8	7.8	7.8	7.8	7.8	7.8	7.8
GEO-STATIONARY PLATFORM											0.1	0.4	0.7	1.1	1.5	2.0	2.4	2.8	3.3
PROSPERITY				1.3	2.6	3.2	3.2	2.8	2.0	1.1	0.2	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
RECESSION/DEPRESSION		0.8	1.5	1.9	1.9	1.4	0.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
COMMUNICATIONS BUSINESS SH					0.9	2.6	4.2	4.9	5.7	6.5	7.4	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
GLOBAL ECONOMY											0.4	0.9	1.5	2.2	2.8	3.5	4.1	4.8	5.3
INDUSTRIES IN SPACE											0.4	0.9	1.5	2.2	2.8	3.5	4.1	4.8	5.3
DOMESTIC INTERNATIONAL SA							0.2	1.3	2.5	3.8	5.0	6.2	7.3	8.6	9.6	10.6	11.4	12.1	12.1
LIMITED WARS	0.6	1.7	2.7	3.9	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
ORBIT SHARE			0.8	2.0	3.2	4.3	4.8	5.2	5.6	6.0	6.4	6.8	7.3	7.3	7.3	7.3	7.3	7.3	7.3
ACCEPTANCE OF TECHNOLOGY			0.1	0.9	1.9	2.9	4.0	5.0	6.0	7.1	7.7	7.7	7.0	7.0	7.0	7.0	7.0	7.0	7.0
WORK AT HOME					0.0	0.4	0.9	1.5	2.2	3.0	3.7	4.5	5.2	5.9	6.6	7.5	8.0	7.9	7.1
SATELLITE IMPORTATION OF										0.4	1.3	2.1	2.9	3.6	4.4	5.0	5.6	6.2	6.8
SELF-HELP					0.3	1.1	2.0	3.0	4.1	5.1	6.1	7.0	8.8	9.5	8.7	8.7	8.7	8.7	8.7

TABLE 4-5
IMPACTED BASELINE FORECAST FOR EACH SERVICE FOR EACH YEAR

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE (1000s HVCs)			
MTS (RESIDENTIAL)	593.0	1319.2	2896.7
MTS (BUSINESS)	1588.0	4215.0	9702.4
PRIVATE LINE	644.4	2649.4	7147.7
MOBILE	1.4	36.7	117.6
PUBLIC RADIO	0.3	1.8	2.6
COMMERCIAL AND RELIGIOUS	0.5	2.0	3.2
OCCASIONAL	1.2	2.4	3.7
CATV MUSIC	0.1	0.3	1.2
RECORDING	0.0	0.0	0.9
TOTAL	2828.9	8226.8	19875.9
DATA (TERABITS/YR)			
DATA TRANSFER	464.0	1460.8	6844.5
BATCH PROCESSING	304.0	951.8	1755.6
DATA ENTRY	380.0	2167.6	8715.4
REMOTE JOB ENTRY	165.0	1413.6	2825.2
INQUIRY/RESPONSE	165.0	1462.9	3842.5
TIMESHARING	94.0	277.2	545.6
USPS/EMSS	0.0	361.7	1084.2
MAILBOX	0.2	5.1	13.5
ADMINISTRATIVE MESSAGES	48.5	316.0	1025.1
FACSIMILE	235.5	549.4	1253.0
COMMUNICATING WORD PROCE	17.1	131.2	519.3
TWX/TELEX	1.2	1.6	2.2
MAILGRAM/TELEGRAM/MONEY	0.4	0.9	1.8
POINT OF SALE	12.0	254.3	468.4
VIDEOTEXT/TELETEXT	0.1	321.7	1258.3
TELEMONITORING SERVICE	0.1	0.8	3.6
SECURE VOICE	5.3	163.3	944.4
TOTAL	1892.3	9839.9	31102.6
VIDEO (TRANSPONDERS)			
NETWORK	10.0	42.9	42.0
[illegible]	34.0	82.4	68.2
OCCASIONAL	19.0	55.4	47.9
RECORDING CHANNEL	0.0	0.0	2.7
TELECONFERENCING	3.0	155.9	245.3
TOTAL	66.0	336.7	406.0

4.4 IMPACTED BASELINE FORECAST

The impacted baseline forecasts for each service for each year appear in Table 4-5. The differences between the baseline and impacted baseline forecasts were calculated as percent changes in the baselines and these differences appear in Table 4-6. A summary of the impacted baseline forecast and growth rates are presented in Table 4-7. Much of the impact of the MDFs on the services does not occur until the 1990 to 2000 decade and this impact varies from a -1.5 to an 18.6 percent in 1990 and from a -1.9 percent to 37.2 percent in 2000. For the years 1990 and 2000, voice changed 2 and 8 percent, data changed 8 and 16 percent and video changed 9 and 27 percent, respectively. The largest change (37 percent) occurred in video teleconferencing and videotext in 2000.

TABLE 4-6
PERCENT DIFFERENCE BETWEEN BASELINE AND IMPACTED BASELINE FORECASTS

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (RESIDENTIAL)	0.0	3.1	9.8
MTS (BUSINESS)	0.0	2.4	9.1
PRIVATE LINE	0.0	1.6	5.7
MOBILE	0.0	5.2	14.0
PUBLIC RADIO	0.0	(1.5)	(0.9)
COMMERCIAL AND RELIGIOUS	0.0	(1.5)	(0.9)
OCCASIONAL	0.0	0.2	1.7
CATV MUSIC	0.0	1.0	1.8
RECORDING	0.0	0.0	8.6
TOTAL	0.0	2.3	8.0
DATA			
DATA TRANSFER	0.0	4.3	9.7
BATCH PROCESSING	0.0	4.4	7.0
DATA ENTRY	0.0	10.6	19.1
REMOTE JOB ENTRY	0.0	9.2	21.8
INQUIRY/RESPONSE	0.0	13.0	24.4
TIMESHARING	0.0	3.4	4.9
USPS/EMSS	0.0	6.9	8.8
MAILBOX	0.0	3.9	6.0
ADMINISTRATIVE MESSAGES	0.0	5.3	9.9
FACSIMILE	0.0	1.0	1.9
COMMUNICATING WORD PROCE	0.0	12.1	29.7
TWX/TELEX	0.0	0.0	0.0
MAILGRAM/TELEGRAM/MONEY	0.0	7.1	10.4
POINT OF SALE	0.0	18.6	30.1
VIDEOTEXT/TELETEXT	0.0	17.0	37.2
TELEMONITORING SERVICE	0.0	1.4	3.0
SECURE VOICE	0.0	4.0	5.6
TOTAL	0.0	8.3	15.7
VIDEO			
NETWORK	0.0	2.2	4.9
CATV	0.0	8.4	19.6
OCCASIONAL	0.0	6.6	16.9
RECORDING CHANNEL	0.0	0.0	32.6
TELECONFERENCING	0.0	12.2	42.6
TOTAL	0.0	9.0	30.1

TABLE 4-7.

SUMMARY OF IMPACTED BASELINE FORECASTS AND GROWTH RATES

FORECASTS	YEAR		
	1980	1990	2000
SERVICE			
Voice[1]	2829	8227	19376
Data[2]	1892	9894	31103
Video[3]	66	337	406

1. Thousands of Half-Voice Circuits
2. Terabits Per Year
3. Transponders

GROWTH RATES (%)	TIME PERIOD		
	1980-1990	1990-2000	1980-2000
SERVICE			
Voice	11.3	9.2	10.2
Data	17.9	12.2	15.0
Video	17.7	1.9	9.5

SECTION 5
NET LONG HAUL FORECAST

5.1 INTRODUCTION

The impacted baseline was modified by market constraints to produce the net long haul forecast. These market constraints required the removal of traffic which was intra SMSA in nature (i.e. traffic which flows within a Standard Metropolitan Statistical Areas (SMSA), traffic originated from, or terminated to, the hinterlands (rural area outside of the SMSA) and data carried over voice lines, usually via modems. Two other adjustments were made to the traffic at this point; efficiency factors were applied to data traffic and annual traffic was converted to peak hour units. Figure 5-1 depicts the basic flow of the analysis necessary to translate the impacted baselines into the net long haul traffic forecasts.

5.2 PROCEDURES

5.2.1 Intra SMSA Traffic

A certain proportion of the traffic of each service application does not leave the SMSA in which it originates. By definition this traffic did not qualify as long haul and was removed from the forecasts. Many services such as Network video already had this portion of the traffic removed. For other services the amount of intra SMSA traffic varied greatly. Therefore, each service was reviewed independently and a percent of traffic was removed (see Table 5-1). The percent of intra SMSA traffic was developed through industry contacts, a literature search, the user survey and internal Western Union analysis.

5.2.1.1 Voice

The voice traffic forecast was analyzed using AT&T statistics as well as the physical boundaries of SMSAs. Message toll service for both residential and business was almost all inter SMSA. The exception is in large SMSAs where some intra SMSA traffic was counted as toll; however, this traffic was found to be small in amount. Private line and mobile telephones were treated similarly to

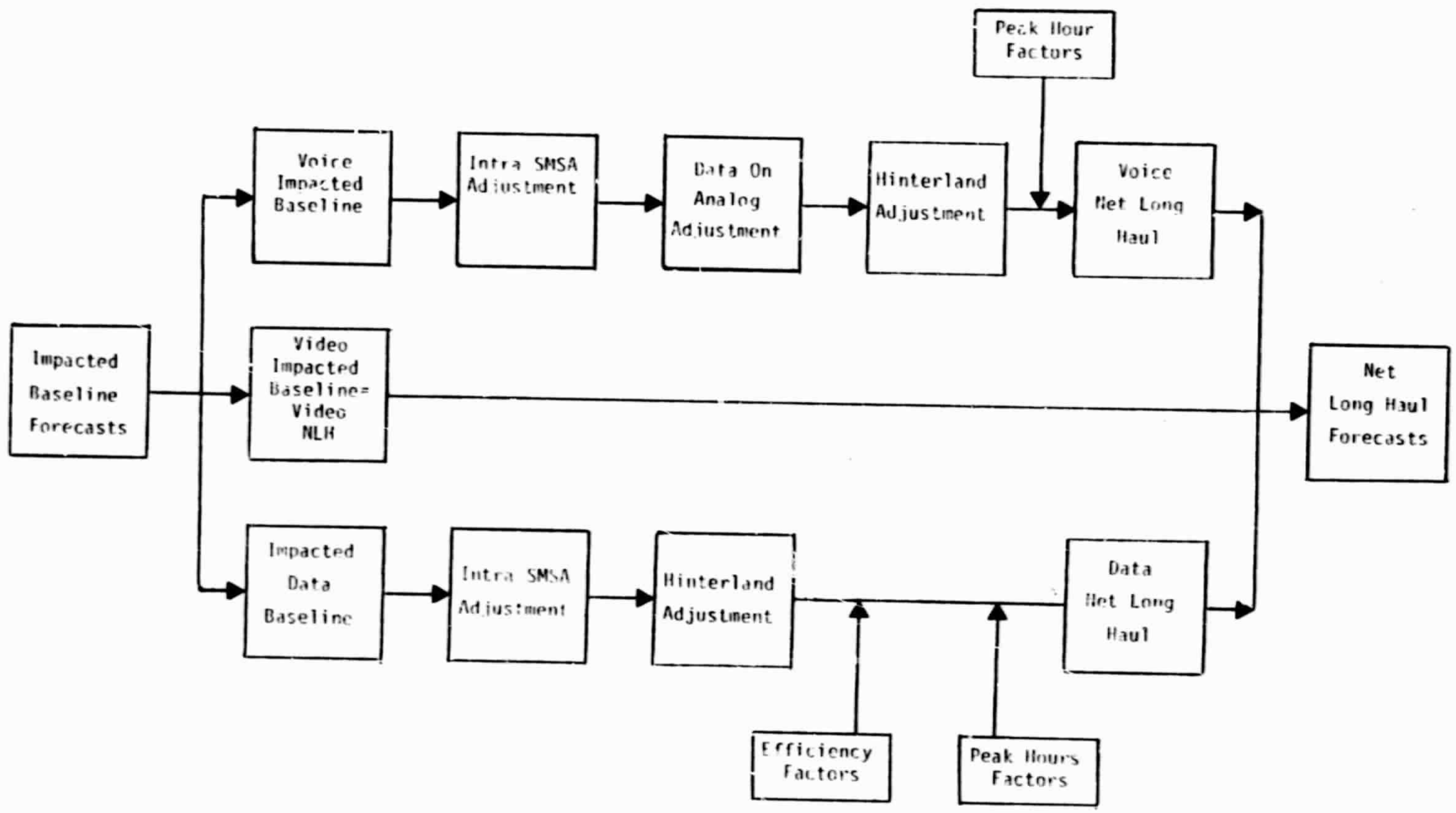

FIGURE 5-1. ACTIVITY FLOW FOR NET LONG HAUL FORECASTS

message toll services. The various radio services were defined as inter SMSA in the baseline and thus no traffic was removed.

5.2.1.2 Data

An internal analysis prepared by Western Union and studies by International Data Corporation provided information about line speed and the distance traffic travels. A review of the individual services based on Western Union's own experience was used to estimate the intra SMSA traffic (see Table 5-1).

5.2.1.3 Video

The baseline for all video services was defined as long haul and thus an estimate of the intra SMSA traffic was meaningless.

5.2.2 Data Traffic Carried on Analog (Voice) Facilities

The data service category net long haul traffic forecast was calculated on the basis of market demand - without consideration of the transmission facilities used. The voice service category was calculated in a similar manner. However, the voice forecasts, which were based on historical growth patterns, included facilities on which data traffic was implemented. If the forecasts were not modified to acknowledge this situation, a portion of the market demand would have been counted twice.

It was decided that the data service category forecasts should remain whole and that the voice service category should be reduced by the amount of the data traffic carried. This allowed the data market demand to remain intact as an aid to subsequent market analyses.

The methodology used to convert applicable data traffic (expressed in terabits per year) to voice traffic (expressed in half voice circuits) included the following steps:

a. Analyze each data application to determine the nature of the traffic: peak oriented; off-peak oriented; one-way; two-way or special.

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TABLE 5-1. PERCENT OF TRAFFIC REMOVED FROM THE IMPACTED BASELINE TO GIVE NET LONG HAUL TRAFFIC FORECAST

SERVICE	INTRA SMSA	DATA CARRIED BY VOICE LINES			HINTERLAND TRAFFIC		
		1980	1990	2000	1980	1990	2000
VOICE							
MTS (Residential)	9.00	0.00	0.00	0.00	15.53	15.53	15.53
MTS (Business)	5.00	5.29	0.76	0.08	17.04	17.90	13.03
Private Line	5.00	8.69	3.61	1.01	16.00	16.94	17.43
Mobile	5.00	0.00	0.00	0.00	17.26	17.26	17.26
Public Radio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial and Religious	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Occasional	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CATV Music	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recording	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	5.83	4.95	1.55	0.40	16.48	17.20	17.43
DATA							
Data Transfer	16.00	0.00	0.00	0.00	17.57	17.57	17.57
Batch Processing	20.00	0.00	0.00	0.00	16.73	16.73	16.73
Data Entry	60.00	0.00	0.00	0.00	8.37	8.37	8.37
Remote Job Entry	35.00	0.00	0.00	0.00	13.60	13.60	13.60
Inquiry/Response	50.00	0.00	0.00	0.00	10.46	10.46	10.46
Timesharing	30.00	0.00	0.00	0.00	14.64	14.64	14.64
USPS/EMSS	0.00	0.00	0.00	0.00	0.00	17.20	17.20
Mailbox	25.00	0.00	0.00	0.00	14.41	14.41	14.41
Administrative Messages	40.00	0.00	0.00	0.00	11.53	11.53	11.53
Facsimile	10.00	0.00	0.00	0.00	17.30	17.30	17.30
Communicating Word Processors	30.00	0.00	0.00	0.00	13.45	13.45	13.45
TWX/TELEX	1.00	0.00	0.00	0.00	19.99	19.99	19.99
Mailgram/Telegram/Money Orders	2.00	0.00	0.00	0.00	19.22	19.22	19.22
Point of Sale	70.00	0.00	0.00	0.00	6.77	6.77	6.77
Videotext/Teletext	0.00	0.00	0.00	0.00	22.96	22.96	22.96
Telemonitoring Service	75.00	0.00	0.00	0.00	5.85	5.85	5.85
Secure Voice	10.00	0.00	0.00	0.00	18.06	18.06	18.06
TOTAL	31.11	0.00	0.00	0.00	14.18	13.38	13.43
VIDEO							
Network	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CATV	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Occasional	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recording Channel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Teleconferencing	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00

b. Derive a conversion factor to convert terabits per year to half voice circuits which takes nature of traffic into account.
c. Calculate equivalent voice facilities load for all data traffic.
d. Analyze each data application to determine the proportion carried on voice facilities in 1978, 1980, 1990 and 2000.
e. Calculate net voice facilities carrying data traffic and reduce voice service category forecasts by a like amount.

Very few dedicated data facilities are currently in use. In 1980, approximately 90 percent of data traffic was carried on voice facilities. Anticipating the emergence of digital facilities, the weighted average of data on voice facilities is expected to decline to 67 percent in 1990 and 25 percent in 2000. (See Table 5-2). The percent of data carried by voice lines is presented, by service and year, in Table 5-1.

5.2.3 Market Distribution Model

In order to prepare the data for further analysis, computer modeling which required Western Union's market distribution model (MDM) was performed at this point. The MDM is a set of internal programs (see Figure 5-2) used to facilitate the interface between market research and the quantitative results which are needed to support market planning. It uses 64 data bases (see Table 5-3) along with algorithms relating size and distance to determine the attractiveness between standard metropolitan statistical areas (SMSAs). This relationship was developed for each of the 31 services in the baseline forecast (using the percentages given in Table 5-4) based on primary and secondary research as to the relationship of the data bases to the services. This allowed the traffic to be spread throughout the United States to the various SMSAs. The steps below explain in more detail the use of MDM.

a. Determine the desired geographic/market segment to be addressed.
b. Select a set of data bases from within the MDM which reflect the service's characteristics.
c. Develop weighting factors for each selected data base. The weighting factor represents a statistical measure which assigns

TABLE 5-2. DATA ON ANALOG

PERCENT OF LONG HAUL DATA TRAFFIC CARRIED ON ANALOG

1980	1990	2000
90	67	25

TYPE OF CIRCUITS DATA TRAFFIC CARRIED

	1980	1990	2000
MTS (Business)	40	25	10
Private Line	60	75	90

AVERAGE BIT RATE OF ANALOG (KBPS)

1980	1990	2000
1.2	4.8	9.6

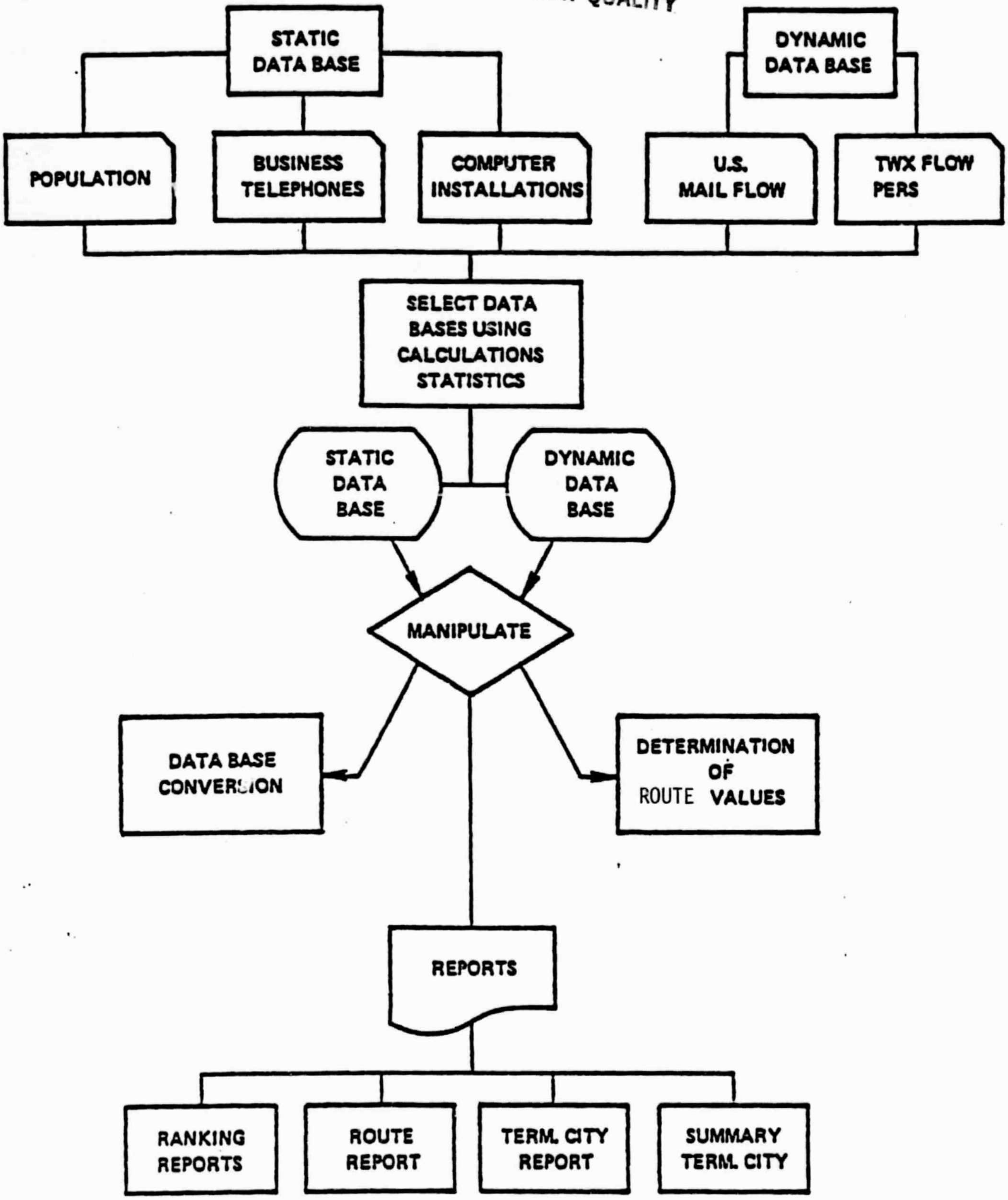

FIGURE 5-2. MARKET DISTRIBUTION MODEL

TABLE 5-3. FILES USED WITH MDM

	FILE NAME	SMSA SOURCE	STATE SOURCE
1.	SMSA Number		
2.	SMSA Name	Commerce	
3.	Regional Name	Commerce	
4.	SCSA Numbers	Commerce	
5.	Time Zones	Rand McNally	
6.	Artificial V&H Coordinates	Standard Table	
7.	State Capital		
8.	Land Area		Almanac
9.	Population	1980 Census	1980 Census
10.	Projected 1990 population in thousands and % change 1980 to 1990	Census of Governments	1981 Rand McNally (R/M)
11.	Number of locations over 100,000		R/M
12.	Number of locations over 50,000		R/M
13.	Number of locations over 25,000		R/M
14.	Number of locations over 10,000		R/M
15.	Number of locations over 5,000		R/M
16.	Number of locations over 2,500		R/M
17.	Number of locations over 1,000		R/M
18.	1979 Per Household Income (top 100, whole dollars)	Marketing Economics Institute	R/M
19.	Personal Income		
	1978	Bureau of Economic Affairs 1980 (B.E.A.)	
	1990	B.E.A.	
	2000	B.E.A.	
20.	Employment (Non Farm)		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	

TABLE 5-3. FILES USED WITH MDM (Continued)

	FILE NAME	SMSA SOURCE	STATE SOURCE
21.	Transportation, Communications and Public Utilities Employment		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	
22.	Retail Trade Employment		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	
23.	Finance, Insurance and Real Estate Employment		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	
24.	Service Employment		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	
25.	Population		
	1978	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	
26.	Number of Residential Telephones	FCC Common Carrier Statistics	FCC Stats 1980
27.	Number of One-Way CATV Households	Television Fact-Book 1980	Television Fact-Book 1980
28.	Number of Two-Way CATV Households	Television Fact-Book 1980	Television Fact-Book 1980
29.	College Population	1977 Census of Governments (Census Bureau 1979)	1977 Census of Governments
30.	Number of Business Telephones	FCC Stats 1980	FCC Stats 1980
31.	1977 Number of Hospital Beds (in thousands)	1977 Census (Data Book)	1977 Census (Data Book)

TABLE 5-3. FILES USED WITH MDM (Continued)

	FILE NAME	SMSA SOURCE	STATE SOURCE
32.	Number of Headquarters of Top 1,000 Industrial Corporations	Fortune Double 500 Directory	
33.	Number of Top 50 Commercial Bank Headquarters	R/M	
34.	Number of Top 50 Insurance Company Headquarters	R/M	
35.	Number of Top 50 Retailing Company Headquarters	R/M	
36.	Number of Top 50 Transportation Company Headquarters	R/M	
37.	1977 Total Bank Deposits in Millions of Dollars - June	State/Metropolitan Area Data Book 1979	
38.	Automatic Clearing House Locations and Federal Reserve Locations	Federal Reserve Board 1982	
39.	1978 Retail Sales ($1,000)	Federal Reserve Board 1981	
40.	Value Added by Manufacturing	R/M	
41.	Principal Business Center Interaction (City Rating)	R/M	
42.	TWX Billings	WU - 1978	
43.	TWX Billings Elapsed Time	WU - 1978	
44.	TWX Terminals	WU - 1978	
45.	Telex Terminals	WU - 1978	
46.	Microwave Circuits	WU - 1978	
47.	Prime AT&T Market	WU - 1982	
48.	WU Prime Rate Center	WU - 1982	
49.	Mail Flow	U.S.P.S. - 1977 (Mail Flow)	

TABLE 5-3. FILES USED WITH MDM (Continued)

	FILE NAME	SMSA SOURCE	STATE SOURCE
50.	P.O. Electronics Mail Facilities	1982 - U.S.P.S.	
51.	Number of Main Frames Used in Business, Finance and Insurance	International Data Corporation 1980	
52.	Computer Terminal Locations	1980	
53.	Computer and Data Processing Receipts	1977 Economic Census	
54.	Receipts of Management, Consulting and P.R. Services Industries (in millions of dollars)	1977 Economic Census	
55.	Manufacturing Industry Employment	1977 Census of Whole-Trade	
56.	EBI - Economic Business Indicator	Sales and Marketing Management Magazine	
57.	Number of Earth Stations	Satellite Review Book	
58.	1977 Local Full-Time Government Employees	1977 Census of Governments	
59.	Full-Time State/Local Employees (in thousands)		1977 Census of Government
60.	1976 Total Federal Employees (as of December) 1978 1990 2000	Commerce 1977 Census of Governments	1977 Census of Governments
61.	Total Military Employees 1978 1990 2000	Commerce 1977 Census of Governments	1977 Census of Governments
62.	Federal Government Data Processing Inventory	General Services Administration	
63.	Federal Government Workers in Data Processing	General Services Administration	
64.	WESTAR Services	WU - 1977	

TABLE 5-4. PERCENTAGES (WEIGHTINGS) USED TO REFLECT DATA BASE AND SERVICE RELATIONSHIPS

SERVICES	DATA BASES																			
	8	9	26	30	37	60	31	19	21	23	22	50	20	24	61	59	38	52	53	43
MTS (Residential)	20		50					20					10							
MTS (Business)				40	10	10			10	10				10		10				
Private Line				40	15	10				10						10			15	
Mobile		10		50	15					10	10					5				
Public Radio - LD																				
Commercial and Religious - LD																				
Occasional - LD																				
CATV Music - LD																				
Recording - LD																				
Data Transfer		10			20	10				15				10		5	5	15	10	
Batch Processing		10			20	10				15				10		5	5	15	10	
Data Entry		10			20	10				15				10		5	5	15	10	
Remote Job Entry		10			20	10				15				10		5	5	15	10	
Inquiry/Response		10			20	10				15				10		5	5	15	10	
Timesharing		10			20	10				15				10		5	5	15	10	
USPS/EMSS		10		20	20	10				15				10		5	5	5	10	
Mailbox		10		20	20	5		5				15	10			5			10	
Administrative Messages		10		20	20	5		5				15	10			5			10	
Facsimile		10		20	20	5		5				15	10			5			10	
Communicating Word Processors		10		20	20	5		5				15	10			5			10	
TWX/Telex		10		20	20	5		5				15	10			5			10	
Mailgram/Telegram/Money Orders		30		10				10												50
Point of Sale		30		10			10				30		10					10		
Videotext/Teletext	10	10	10	25	20	10				10						5				
Telemonitoring Service		50			10			20					20							
Secure Voice				20			15								60	5				
Network - LD*																				
CATV - LD																				
Occasional - LD																				
Recording Channel - LD																				
Teleconferencing - LD																				

*LD - All radio and video traffic is defined as satellite traffic.

a relative value to each data base to reflect their individual importance.

d. The computerized model is then utilized to record assumptions for the weighting factors, statistically validate applicability of data base selection to form a weighted sum of the data bases (all of which have been converted to percentages), and then use the distance sensitivity measure as an input to an algorithm which converts the total static data base to a dynamic (flow) one.

e. This newly formed dynamic data base is combined in a weighted fashion with the previously selected dynamic data bases to create a final SMSA paired service which contains a relative value measuring communications potential between all selected SMSAs

f. This result is normalized so that the total of all individual route values between SMSAs sums to 100 percent

g. The data file can now be used to examine the relative demand potential between SMSA pairs.

The resulting traffic patterns were verified using statistics from AT&T tariffs (Table 5-5) and extensive internal information about Government usage. These statistics provided the means to adjust the distance sensitivity of various algorithms used by MDM.

5.2.4 Hinterland Traffic

The assumption was made that traffic going to or coming from areas outside of the 313 continental SMSAs would not be routed through a trunking network and therefore should not be included. To determine the percent of traffic this includes artificial SMSAs were created using the market distribution model described above. This was done by gathering the same information on a statewide basis which was gathered on an SMSA basis. It was then possible to subtract these files and thus have data bases for every state convering those areas outside of the SMSAs. The V or H coordinates for the artificial SMSAs were then chosen so the artificial SMSA would be located in the center of the state. Using the market distribution model (MDM) traffic was then routed to

TABLE 5-5
AT&T STATISTICS ON LONG DISTANCE BUSINESS AND RESIDENTIAL CALLS

Long Distance Business Calls June 1980 to May 1981

MILEAGE BAND	CALLS (000)	PERCENT OF TOTAL
1-55	468.4	17.4
56-220	606.0	22.6
221-506	531.5	19.7
507-925	466.3	17.4
926-3000	613.4	22.8
	2685.5	100.0

Long Distance Residential Calls June 1980 to May 1981

MILEAGE BAND	CALLS (000)	PERCENT OF TOTAL
1-55	596.1	17.7
56-220	694.1	20.6
221-506	644.7	19.2
507-925	574.4	17.1
926-3000	856.8	25.5
	3366.1	100.0

SOURCE: AT&T -- Tariff Filing Practices (TFP) 1301 Revised March 1982.

each of the real and artificial SMSAs. The artificial routes were then removed. The percentage each service was reduced by is shown in Table 5-1.

5.2.5 Peak Hour Conversion

The next step in developing the long haul peak hour traffic forecast was to establish a peaking factor for every service. Since voice is a large share of the market and its peak occurs during the business day and most services are business oriented, all peak hours were made to coincide with the 10 to 11 a.m. and the 1 to 3 p.m. business peak time frames.

5.2.5.1 Voice

The baseline for most voice services was defined as the peak hour traffic and therefore no conversion was necessary. The exception to this was occasional radio which is peaked at nights and weekends. A review of Western Union's WESTAR satellite traffic indicated that the traffic during the business peak hour was 75 percent of the services peak hour.

5.2.5.2 Data

To determine the amount of data traffic occurring in a business day, it was first necessary to divide all data services by 250 (the number of business days per year). Then each service was reviewed to see what type of daily traffic pattern was followed. The user survey and Western Union's experience provided useful insights. Most data services occur during the day and are fairly constant. Some exceptions are data transfer and batch processing which occur largely after normal hours and secure voice which follows a traffic pattern similar to voice. The number of hours during the work day the service is used and the percentage of the service taking place during those hours was used to determine the amount of traffic in the peak hour. The percent used during the work day is given in column one of Table 5-6. The number of hours of constant use is given in the second column. The last column shows the factor applied to get the peak hour for each service. That is, the peak hour factor for each service was calculated by multiplying the percent during the business week (e.g., 25 for data) times 1/250 times 1/(#hours of use/day, e.g., 5 for data)

TABLE 5-6. DATA SERVICE PEAK HOUR CONVERSION

	PERCENT DURING BUSINESS WEEK 8 A.M. to 5 P.M. MONDAY THROUGH FRIDAY	NUMBER OF HOURS OF USE	PEAK HOUR FACTOR
DATA	25	5	.0002
BATCH	50	5	.0004
DATA ENTRY	95	5	.0008
REMOTE	85	5	.0007
INQUIRY/RESPONSE	90	4	.0010
TIME SHARING	90	4	.0010
USPS	80	6	.0005
MAILBOX	90	6	.0006
ADMINISTRATIVE	95	4	.0010
FACSIMILE	98	4	.0007
CWP	80	4	.0005
TWX/TELEX	80	4	.0005
MAILGRAM	80	6	.0005
POINT OF SALE	50	7	.0003
VIDEOTEXT	75	6	.0005
TELEMONITORING	30	10	.0001
SECURE VOICE	90	4	.0010

5.2.5.3 Video

The baseline for all video services, except Occasional Video, was defined as peak hour. The Occasional Video impacted baseline was reduced by 25 percent for each bench mark year to reflect its unique peak hour factor.

5.2.6 Efficiency Factor

The efficiency factor refers to how efficiently data is transmitted. In the case of data the rate of transmission is often less then the channel capacity. For instance the capacity of a voice channel in 1980 was 64 kbps, however, when a modem was introduced for data the rate of transmission was 300 or 1200 bps. In addition, when the actual data transmitted by a typist at a keyboard is considered, this rate is reduced considerably. Other factors, such as pauses made by the typist, must also be considered. Most data must have a return line, thus tying up a second 64 Kbps line, and error correction techniques may require retransmission.

All data efficiency factors were determined on the basis that that all data services were transmitted using one of two methods. In the first method the data are entered manually through some type of keyboard, such as through data entry, point of sale or telemonitoring. This type of transmission is very inefficient. In the second method data are transmitted in a batch mode, such as through: data transfer, batch processing and that portion of data entry done using a micro-computer as an input device. This type of data entry also is not very efficient. For instance the return line is underutilized and error correction schemes often call for retransmission. Several other factors were also considered in determining these factors. The use of micro-computers to store and forward data in burst is a growing trend. The use of all digital transmission will mean the elimination of modems and some inefficiency. Compression techniques and the use of higher speeds will increase efficiency. These trends combined to increase the efficiency of the transmission lines in 1990 and 2000. Table 5-7 presents the efficiency factors found through this analysis.

TABLE 5-7. EFFICIENCY FACTORS

	1980	1990	2000
Data Transfer	.5000	.7000	.9000
Batch Processing	.3500	.5000	.7000
Data Entry	.0031	.0124	.0484
Remote Job Entry	.0750	.1000	.1500
Inquiry/Response	.0750	.1000	.1500
Timesharing	.0750	.1000	.1500
VBPS Emss	.2000	.3000	.5000
Mailbox	.0031	.0063	.0126
Admin Traffic	.0031	.0063	.0126
Facsimile	.0750	.1000	.3000
Comm Word Processor	.1000	.2000	.4000
TWX/TELEX Mailgram/Telegram	.2000	.3000	.5000
Point of Sale	.0031	.0063	.0126
Video Text	.0750	.1000	.1500
Telemonitoring	.0031	.0063	.0063
Secure Voice	1.0000	1.0000	1.0000

5.3 SUMMARY OF NET LONG HAUL FORECASTS

Table 5-8 shows the detailed results of the net long haul analysis. The voice traffic is given in terms of 1000s of half voice circuits; data is given in megabits per second; and video in transponders. Figure 5-3 depicts the growth rates associated with each of the three service categories, based on the net long haul traffic forecast. The slope of the lines connecting the 1980, 1990 and 2000 market demand represents the average annual growth rate, the steeper the line - the greater the growth rate. These growth rates are given in Table 5-9.

TABLE 5-8. NET LONG HAUL FORECASTS

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE (1000's HVC's)			
MTS (Residential)	447.6	995.7	2186.3
MTS (Business)	1154.0	3217.7	7459.8
Private Line	453.1	1972.3	5472.7
Mobile	1.1	28.5	91.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording	0.0	0.0	0.4
TOTAL	2057.5	6220.1	15220.4
DATA (Mbps)			
Data Transfer	34.2	77.0	280.7
Batch Processing	61.1	133.8	176.3
Data Entry	8616.8	12288.2	12658.1
Remote Job Entry	216.6	1392.0	1854.7
Inquiry/Response	241.6	1606.8	2813.6
Timesharing	192.7	426.2	559.3
USPS/EMSS	0.0	113.5	204.2
Mailbox	6.5	81.5	107.8
Administrative Messages	2106.4	6754.1	10953.3
Facsimile	437.3	765.2	581.7
Communicating Word Processors	13.4	51.5	102.0
TWX/TELEX	42.5	27.9	19.2
Mailgram/Telegram/Money Orders	0.2	0.3	0.4
Point of Sale	74.6	777.4	716.0
Videotext/Teletext	0.1	344.2	897.6
Telemonitoring Service	0.2	0.7	3.0
Secure Voice	1.0	32.6	188.7
TOTAL	12045.4	24873.0	32116.7
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel	0.0	0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

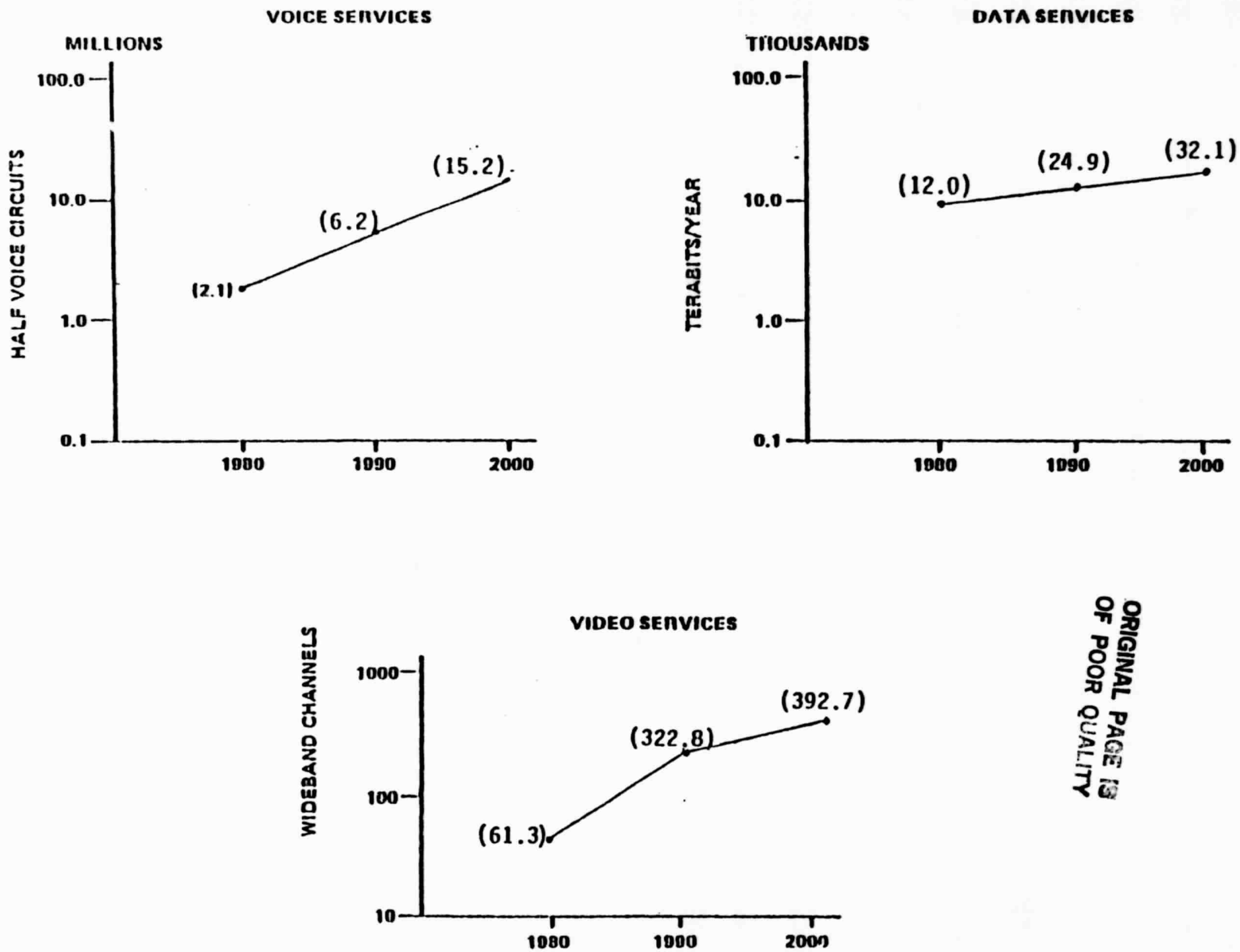

FIGURE 5-3. NET LONG HAUL TRAFFIC FORECAST

TABLE 5-9. SUMMARY OF NET LONG HAUL FORECAST

FORECASTS	YEAR		
SERVICE	1980	1990	2000
Voice	2057.5	6220.1	15220.4
Data	12045.4	24873.0	32116.7
Video	61.3	322.8	392.7

GROWTH RATE (Annual, %)	TIME PERIOD		
SERVICE	1980-1990	1990-2000	1980-2000
Voice	11.7	9.4	10.5
Data	7.5	2.6	5.0
Video	18.1	2.0	9.7

SECTION 6
COST ANALYSIS

6.1 INTRODUCTION

This section describes the cost analysis that was required to develop the trunking addressable forecasts. First, the methodology which was employed is summarized, and the major assumptions that were made are explained. Steps taken to estimate the end-to-end satellite service costs and to develop the crossover or breakeven distances with terrestrial service costs are delineated. The basis for each key assumption is discussed. Lastly, the estimated investment costs, service costs and crossover distances are presented in a summary of the cost analysis results. A more detailed discussion of the methodology and results is presented in Appendix E.

As noted in earlier sections, a typical trunking network is designed to accommodate large amounts of traffic from a relatively small number of terminals. The traffic is concentrated to one trunking node and then transmitted. The trunking network basically consists of high density routes, and as such, it needs an extensive local distribution facility at each trunking node. A trunking network can be provided by terrestrial facilities such as microwave or coaxial cable, or by interconnecting trunking earth stations through communication satellites parked in geosynchronous orbit.

A cost analysis was conducted for C-, Ku- and Ka-bands for the benchmark years 1982, 1990 and 2000.

6.2 COST ANALYSIS METHODOLOGY

The steps used in estimating end-to-end satellite service costs for trunking systems and for estimating the crossover distances are outlined below, and diagrammed in Figure 6-1.

6.2.1 Earth Station Cost Analysis

Earth Station costs were estimated using the steps outlined below.

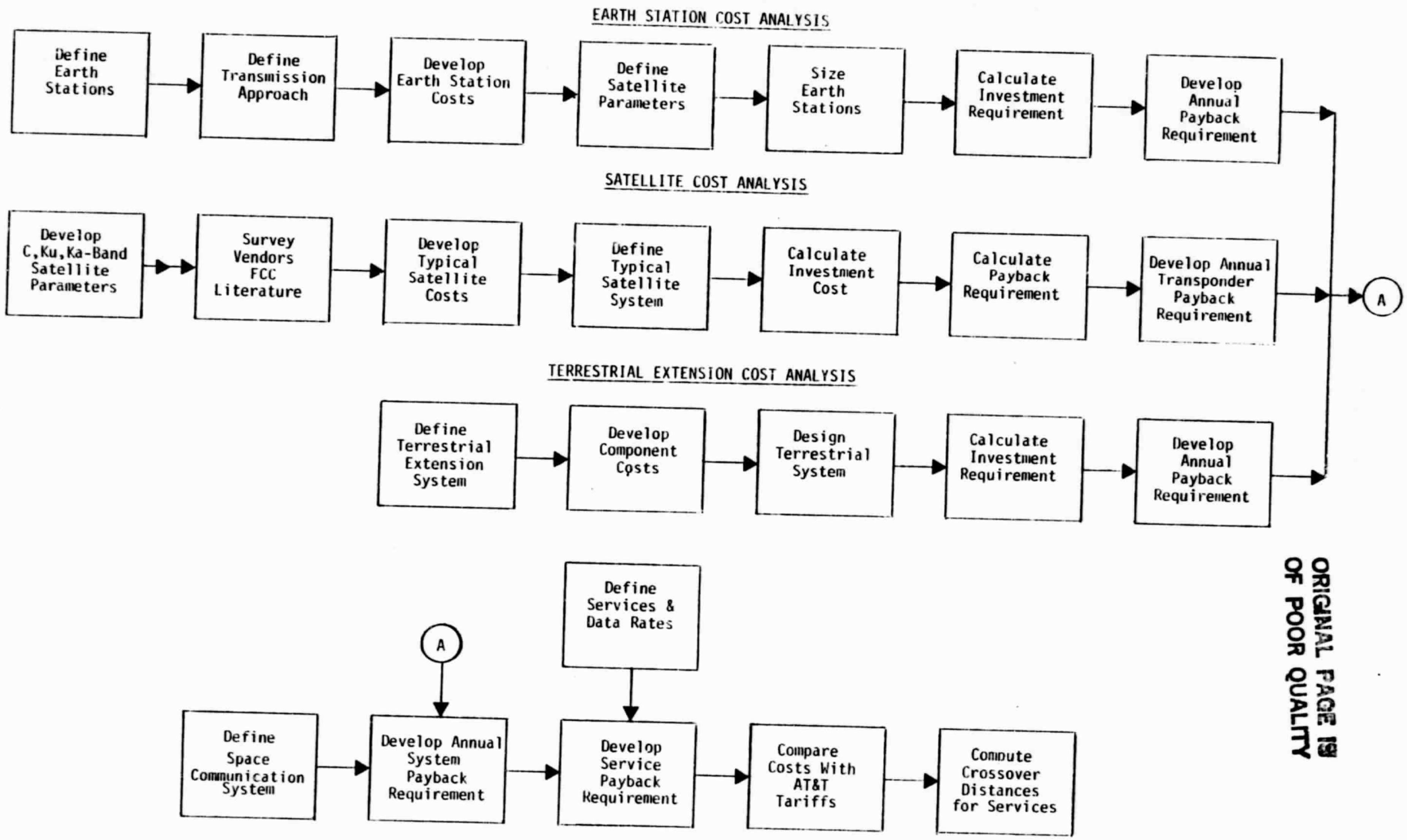

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FIGURE 6-1. ACTIVITY FLOW FOR COST ANALYSIS

a. Define the trunking earth stations.

Because the trunking network consists of high density routes and needs an extensive local distribution facility, the trunking earth station must be a large earth station with a high throughput capacity. In this study it was defined as that earth station which supports a capacity corresponding to a single carrier per transponder.

b. Define the transmission approach.

The transmission approach considered was either TDM/TDMA, which is Time Division Multiplex (TDM) in conjunction with Time Division Multiplex Access (TDMA), or FDM/FDMA which is Frequency Division Multiplex (FDM) in conjunction with Frequency Division Multiplex Access (FDMA).

c. Obtain earth station component costs.

Various vendors and technical literature were surveyed to obtain the cost of earth station components. These component costs included antenna subsystems, low noise amplifier, high power amplifier, converter, and terminal costs. Costs were estimated by band and transmission approach.

d. Define typical satellite parameters.

In designing and sizing the trunking earth stations, relevant satellite parameters such as effective isotropic radiated power (EIRP) and receive G/T were defined. The existing satellites in the orbit and the satellites planned for future launch were examined, and typical values for EIRP and G/T were selected and used for earth station sizing.

e. Size the trunking earth stations.

Using the capacity requirement of various earth stations and the typical satellite parameters, the earth station link budget was analyzed and the size of various earth station components was estimated. Normally, link budget analysis establishes the uplink EIRP and downlink G/T requirements, from which HPA power requirement, LNA noise temperature and antenna size can be estimated.

f. Calculate trunking earth station costs.

Using the design and size of earth stations and the costs of various earth station components, the costs for various trunking earth stations were estimated.

g. Develop annual payback requirement of trunking earth station.

Western Union's proprietary financial package which considers key factors that influence investments (e.g., cost of raising money, return on investment, overhead and taxes on income) was used to estimate the annual payback requirement of various earth stations.

6.2.2 Satellite Cost Analysis

Various FCC filings, satellite vendors and technical literature were surveyed to determine the satellite costs. The steps are outlined below.

a. Develop typical C, Ku and Ka band satellite parameters.

The satellites in orbit and those to be launched in the near future were examined to determine typical C-, Ku- and Ka-band satellite parameters.

b. Survey vendors, filings and literature.

The FCC filings for various existing domestic satellites and satellites planned for the future and the technical literature were surveyed to obtain information on: the development cost for the satellite, recurring cost per satellite, TT&C cost, launch cost, and typical insurance costs.

c. Develop typical satellite costs.

Using the information obtained from the surveys noted above, the typical satellite costs were estimated for C-, Ku-, and Ka-bands.

d. Define a typical satellite system.

Various satellite carriers were surveyed and FCC filings were examined to determine the ratio of on-orbit to ground spare satellites. These ratios were determined for C-, Ku-, and Ka-bands. The number of on-orbit satellites and ground spares required for each type of satellite system (i.e., for C-, Ku- and

Ka-bands) was determined by surveying various satellite service providers and examining FCC filings.

e. <u>Calculate investment cost of a typical satellite system</u>.

Having defined the typical satellite system and estimated the cost of such a system, the investment cost of a satellite system was determined as follows:

$$I = N(R + L + IN) + R + NR + TT\&C$$

where

I = Investment cost of the system

N = Number of satellites launched

R = Recurring cost for a satellite (refers to ground spare as well as in-orbit satellite)

L = Launch cost of a satellite

IN = Insurance cost of a satellite

NR = One time development cost

TT&C = TT&C cost of the system.

f. <u>Calculate annual payback requirement of the system</u>.

Western Union's proprietary financial package was used to determine the annual payback requirement for the satellite system. As noted earlier, this package takes into consideration such factors as cost of money, return on investment, and life of the system.

g. <u>Develop annual payback requirement of a transponder</u>.

When a satellite is launched, all its transponders are not used immediately; the number of transponders used, gradually increases. The average number of transponders in use through the life of the system is needed to determine the annual payback requirement of a transponder. The average number of active transponders through the life of a satellite was estimated for C-, Ku- and Ka-bands. Using the annual payback requirement of a satellite system and the average capacity usage of the system, the annual payback requirement of a transponder was computed. These requirements were estimated for C-, Ku-, and Ka-bands.

6.2.3 Terrestrial Extension Cost Analysis

C-band earth stations cannot be colocated with the central office because of the frequency coordination and electromagnetic interference; therefore, a C-band system requires a terrestrial extension.

In contrast, in Ku- and Ka-band earth stations and the central office can be colocated. The following steps were conducted to determine terrestrial extension costs where terrestrial extensions are needed.

a. Define the terrestrial extension systems.

   The terrestrial systems considered for earth station tail extension were

   1. Analog microwave
   2. Digital microwave
   3. Fiber optic system.

   The size of each of these systems in number of voice circuits or data rate was estimated.

b. Develop component costs.

   Various vendors and technical literature were surveyed to estimate the costs of the terminal repeater and other components.

c. Design the terrestrial system.

   The three terrestrial systems as defined above were engineered and repeater spacing was estimated for each of the systems.

d. Calculate the investment requirement.

   Having engineered the terrestrial system and using component costs, the terrestrial system investment requirement was estimated.

e. Develop annual payback requirement.

   Western Union's proprietary financial package was used to estimate the annual payback requirement of each terrestrial system. The annual payback requirement of each service was estimated by proportionally allocating the total payback requirement to each service.

6.2.4 Define the Typical Space Communication System

A typical trunking space communication system was defined for C-, Ku- and Ka-bands. A typical system consists of a space segment (i.e., a number of transponders), an earth segment (i.e., a number of earth stations), a terrestrial segment (i.e., terrestrial extensions) and a central network control facility.

6.2.5 Define the Services and the Data Rates

Various operating companies and technical literature were examined to determine the services provided by trunking networks. Then the services and the corresponding data rates (where applicable) were defined.

6.2.6 Develop Annual Payback Requirement of a Typical Trunking System

Having defined a typical trunking system and estimated the earth station, space segment and terrestrial extension annual payback requirements, the annual payback requirement of a trunking system was estimated.

6.2.7 Develop Annual Payback Requirement of Various Services

The total payback requirement of the system was allocated in proportion to the capacity used for the services under consideration and added to the channel dependent cost to compute the annual payback requirement of various services.

6.2.8 Compare Costs With AT&T Tariffs

The end-to-end user costs, including the cost of local loops based on terrestrial tariffs, was determined for each service and then compared with the AT&T tariff for the equivalent service. These calculations were made for each band for each benchmark year.

6.2.9 Compute Crossover Distances for Services

The breakeven or crossover distance was defined as the distance at which the end-to-end user service cost of the trunking satellite system was equal to the end-to-end user cost determined by using the AT&T tariff. At distances above the crossover, the end-to-end user service cost of the trunking satellite system was cheaper; this is because satellite service costs are invariant with distance but terrestrial service costs are a function of distance. Crossover distances were developed for each band for each benchmark year.

6.3 COST ANALYSIS ASSUMPTIONS AND CONSIDERATIONS

In conducting the cost analysis steps outlined above, key assumptions and considerations were made; these are discussed below.

6.3.1 Trunking Earth Station Size

As noted above, the trunking earth stations considered were large earth stations that support a capacity corresponding to a single carrier per transponder, and the transmission approach considered was either TDM/TDMA or FDM/FDMA. The C-band single carrier TDMA approach supports a burst rate of 60 Mbps. A Ku-band full transponder TDMA terminal can support 90 Mbps burst rate, but presently TDMA terminals and earth station are planned for 60 Mbps burst rate operation. The modulation scheme used is quadrature phase shift keying (QPSK). The C-band FDM/FDMA earth station can support 1200-1800 VF circuits. The earth station is engineered to achieve the CCIR recommended noise objective of 1×10^4 PWPO (Picowatt Psophometrically Weighted Referenced to Zero Transmission Level Point) and a capacity of 1200 VF. The Ku-band FDM/FDMA earth station is engineered to achieve the CCIR recommended noise objective and a capacity of 1500 VF. Higher voice capacity is achieved in Ku-band since the Ku-band transponder is wider than a C-band transponder. For Ka-band it is generally accepted that a satellite switched TDMA approach with an on-board IF switch would be used. The trunking terminal planned for Ka-band supports 512 Mbps burst rate.

6.3.2 Satellites

A typical state-of-the-art C-band satellite has 24, 36 MHz wide transponders and uses horizontal and vertical polarization. In the cost analysis of the C-band space segment the typical satellite was used. While a more or less typical satellite has emerged in C-band, in Ku-band various types of satellites are being planned. For this study a Ku-band satellite similar to that planned by GTE was considered typical. This satellite has 16, 54 MHz wide transponders and uses dual polarization. A Ka-band satellite system has not been planned yet; these systems are still in the preliminary technology development and planning stages. The approach most generally accepted for the Ka-band satellite is TDMA, with an on-board SS-TDMA switch. The trunking service is expected to be provided by 18 fixed beams each connected to a 500 MHz dual output power (75W/10W) transponder. Three separate carrier frequencies, each reused on 6 of the fixed beams will be used. Complete trunking interconnectivity will be provided using 512 Mbps satellite switched TDMA channels which requires a 20x20 IF (i.e., intermediate frequency) switch matrix in the satellite, programmable from a master control station to satisfy changing traffic patterns.

6.3.3 Satellite Systems

It was assumed that for C-band and Ku-bands the satellite system will consist of two satellites in orbit and one ground spare. For these two bands, half the number of transponders will be used at the start of the system, and demand will uniformly grow to include the total number of transponders. The satellite life was assumed to be 10 years, and, on the average, three-fourths of the number of transponders will be used. For Ka-band, it was assumed that the satellite system will include one satellite in orbit and one ground spare. The total capacity available is 150. Due to unbalanced traffic a more realistic achievable throughput is about 67 transponders. It was assumed that the average number of equivalent transponders used through the life of a trunking Ka-satellite will be 40, which corresponds to an average usage of 60%. Again the satellite life was assumed to be 10 years.

6.3.4 Trunking Networks

The network assumptions for the C-, Ku-band TDM/TDMA and FDM/FDMA approaches and the networking assumptions for Ka-band TDM/TDMA approach are discussed below.

6.3.4.1 C- and Ku-band TDM/TDMA Trunking Network

The following assumptions were made.

a. The network consists of 10 nodes.

b. The transmit and receive capacity at each node is 60 Mbps.

c. At the frame efficiency of 0.95 the transmit capacity between any two nodes is 6.3 Mbps.

d. The interface to terrestrial segment is at the T1 level.

e. The terrestrial segment is assumed to be digital to retain the full flexibility of the TDMA approach.

f. For C-band, the earth station is located on the average of two microwave hops away from the central office, while for Ku-band it was assumed that the earth station is colocated with the central office.

6.3.4.2 C- and Ku-band FDM/FDMA Trunking Network

The following assumptions were made.

a. The network consists of 10 nodes.

b. The transmit and receive capacity at each node is 1200 VF for C-band and 1500 VF for Ku-band.

c. At a fill factor of 0.9, the transmit capacity between any two nodes is 120 VF for C-band and 150 VF for Ku-band.

d. For C-band, the earth station is located on the average two microwave hops away from the central office, whereas for Ku-band the earth station is colocated with the central office.

e. The terrestrial segment used is analog radio.

f. The interface at the earth station is at the supergroup level.

6.3.4.3 Ka-band Trunking Network

For Ka-band trunking networks it was assumed that:

a. The trunking network consists of 18 nodes.

b. Each node is connected to a 500 MHz beam; trunking services are provided by 18 fixed beams.
c. Three separate carrier frequencies are each reused on 6 of the fixed beams.
d. Complete trunking interconnectivity is provided by using a satellite switched TDMA approach.
e. A 20 by 20 IF switch matrix is used on board the satellite, programmable from a master control station to satisfy changing traffic patterns.
f. Maximum throughput is 9 Gbps. Due to traffic imbalance, realistic achievable throughput is assumed to be 4 Gbps.
g. For Ka-band, the satellite earth station is colocated with the central office.

6.3.5 Trunking Entrance/Exit Links

Assumptions concerning analog and digital radio, optical fiber cable systems and future costs are discussed below.

6.3.5.1 Analog and Digital Radios

a. Analog systems will be designed using heterodyne hot standby radios with a capacity of 1200 VF channels. Digital systems will be designed using solid-state duplex protected microwave radio utilizing 8 PSK modulation with a capacity of 1344 digitized voice channels.
b. Single antenna system using elliptical waveguide will be used throughout.
c. A fault and alarm sytem will be tied to an existing master station. Costs for remote control operation is included at terminals.
d. A typical 5 KVA diesel engine generator with automatic switching is included at city terminals and 10 KVA at repeaters.
e. City sites will be leased and no land costs are included.
f. A prefabricated building will be used at all repeater locations.

g. Civil work and land estimates are based on average costs. Actual costs will vary considerably from site to site.

h. A single polarization scheme with standard RF branching configuration is priced in.

i. Average test equipment costs are included for city terminals and repeaters.

j. The interface at the earth station is at the supergroup level on the receive side and at the IF level on the send side for the analog radio. For the digital radio, the interface is at the DS1 level (38T1).

6.3.5.2 Optical Fiber Cable System

a. The terminal is comprised of a protected 90 Mbps optical terminal, all the required alarms and power distribution panels and two M13 multiplexers with redundant common equipment.

b. The repeater is placed at a distance of 25 km from each terminal and housed in a weather-proof enclosure which includes chargers and standby batteries (8 hours).

c. A typical 5 KVA diesel engine generator with automatic switching is incuded at each city terminal.

d. The cable to be used is of premium quality, consists of four fibers, one fiber working and one spare for each direction of transmission. The cable attenuation is less than 1 db/km at 1300 nm and has an end-to-end dispersion of less than 6 ns.

e. The installation of the 50 km cable is distributed as follows:

   1. 15 km through rural areas (trenching)
   2. 20 km through suburb areas
   3. 15 km through a large city.

f. The interface at the earth station is at the DS1 level (38T1).

6.3.5.3 Future Costs

a. For digital radio systems, the cost is anticipated to be reduced by 5% and 15% in 1990 and 2000 respectively, due to the use of LSI and minaturization of equipment. Higher capacity entrance/exit radio systems will have no impact on the total cost as the earth station capacity is limited to less than 90 Mbps.

b. For optical fiber systems, the cost is anticipated to be reduced by 30% and 40% in 1990 and 2000 respectively.

6.3.6 User Services

The trunking services considered for this study were described in detail in Section 2. For cost computation purposes the services were categorized by the occupied bandwidth or data rate as follows:

a. Voice service (4 khz voice) channel
b. Data service of speeds 2.4 kbps, 4.8 kbps. 9.6 kbps, 56 kbps and 1.544 Mbps
c. Video Service - 1.544 Mbps.

6.3.7 Comparative FCC Tariffs

As noted earlier, the breakeven distance was defined to be that distance where end-to-end user costs by satellite were equal to that of the terrestrial costs as determined by using terrestrial tariffs for an equivalent service. Comparative service tariffs used were as follows:

Service	Facility	Tariff Type
Voice	300 - 3000 hz	FCC No 260
	Private Line	Type 2001
Data	2-4, 4-8, 9-6, 5-6 kbps	FCC No 267
	1.544 Mbps	FCC No 267
		FCC No 271 for
		Termination

The end user was assumed to be within a distance of 5 km from a central office.

6.3.8 Assumptions on Future Trends

Important future trends are outlined below.

6.3.8.1 Capacity Improvement Techniques

a. Presently, a C-band transponder supports 60 Mbps burst rate using QPSK modulation. It was assumed that by 1990, the burst rate capacity will increase by 50% to 90 Mbs.

b. For Ku-band the present burst rate supported by 54 MHz wide transponder is 60 Mbps. It was assumed that by the year 1990, the burst rate will increase by 50% to 90 Mbps (still using QPSK modulation). For the year 2000 the burst rate will increase to 135 Mbps.

c. For Ka-band the capacity was assumed to be the same in the year 2000 as it was in 1990.

6.3.8.2 Cost Assumptions

a. Cost reductions and future costs were expressed in 1982 dollars.

b. For the C-band satellite system, development cost was assumed to be zero. However, for Ku- and Ka-band satellite systems, where designs are not standardized, a finite development cost was included.

c. Cost of TDM/TDMA terminals and channel units will reduce at a rate of 15% (in 1982 dollars) until 1990 and 10% until the year 2000.

d. It is expected that costs of the RF portion of the earth stations will reduce at a rate of 3% a year.

e. Cost of the monitor and control subsystem is expected to decline at a rate of 15% until 1990 and 10% until the year 2000.

f. Cost of C-band satellites will stay at the same level as they are today since these satellites have been used for domestic communications for over a decade and technology seems to have matured.

g. Since the Ku-band technology is not mature, the cost of Ku-band satellites was assumed to reduce at a rate of 3.5% per year until year 2000 when it will have the same value as C-band satellite.

h. For Ka-band it was assumed that the satellite cost in year 2000 will remain the same as in year 1980.

6.4 DISCUSSION OF RESULTS

6.4.1 Earth Station Costs

The present costs of C- and Ku-band earth stations with both the TDM/TDMA approach and the FDM/FDMA approach are summarized in Table 6-1. Presently, for both C- and Ku-bands, an earth station using a TDM/TDMA terminal is more costly. The projected costs of C-, Ku- and Ka-band earth stations are presented in Table 6-2. For the years 1990 and 2000, for both C- and Ku-bands, the TDM/TDMA earth station is less costly than the FDM/FDMA earth station. This is due to the fact that the technology for digital processing is progressing at a faster rate and a TDM/TDMA terminal uses digital technology. The cost of a Ka-band earth station is much higher than the cost of a C- or Ku-band earth station. The reason is that the Ka-band earth station is much larger in terms of the burst rate it can support. The annual payoff requirement for an earth station was estimated to be 41% of the initial investment with a 10 year life.

6.4.2 Satellite Costs

Estimates of initial investment cost of the C-, Ku- and Ka-band satellite systems are summarized in Table 6-3. Using these estimates and Western Union's financial packages the annual payoff requirement of C-, Ku- and Ka-band transponder was estimated to be, respectively, 1.7 M$/year, 3.21 M$/year and 2.54 M$/year. For Ka-band the concept of equivalent 36 MHz transponders was used. The above payoff requirements were based on a 10 year life of the satellite system. The payoff requirement of both a C-band and a Ka-band transponder was assumed to remain constant, whereas for a Ku-band it declines at a rate of 3.5% per year, as explained in Section 6.3.8.2.

TABLE 6-1. COSTS OF TRUNKING EARTH STATIONS
(in thousands of dollars)

BAND	APPROACH	UPLINK BURST RATE	DOWNLINK BURST RATE	CAPACITY	1982 EARTH STATION COST	1982 INTE-GRATION COST	1982 TOTAL
C-Band	TDM/TDMA	60 MBPS	60 MBPS	Anywhere up to 60 MPBS	709	284	993
C-Band	FDM/FDMA	N/A	N/A	Up to 1200 VF Channels	506	202.6	709.1
Ku-Band	TDM/TDMA	60 MBPS	60 MBPS	Anywhere up to 60 MBPS	642.8	257.23	900
Ku-Band	FDM/FDMA	N/A	N/A	Up to 1500 VF Channels	429.5	171.8	601.5

TABLE 6-2. PROJECTED TRUNKING EARTH STATION COSTS (in thousands of dollars for the year 1982) INCLUDING TRANSPONDER HOPPING

		1990			2000		
BAND	APPROACH	E/S COST	INSTALLA-TION AND INTEGRATION	TOTAL	E/S COST	INSTALLATION	TOTAL
C-Band	60 MBPS TDMA	715.5	286.1	1001.6	448.5	179.4	627.8
	1200 VF FDM/FDMA	662.2	264.9	927.1	455.5	182.2	637.7
Ku-Band	60 MBPS TDMA	601.0	240.4	841.4	392.0	158.8	548.8
	1500 VF FDM/FDMA	602.1	240.9	843.0	413.8	165.5	579.3
Ka-Band*	512 MBPS TDMA	3650.0	1255.0	4905.0	2996.0	806.98	3803.0
Ka-Band**	512 MBPS TDMA	2290.0	546.0	2836.0	1308.0	523.2	1831.2

*Dollar estimates provided by NASA

**Dollar estimates developed by Western Union

TABLE 6-3. INVESTMENT COST OF C-, KU- AND KA-BAND SATELLITES
(in millions of dollars)

	BAND		
COST ELEMENTS	**C**	**Ku**	**Ka**
Development (NR)	0	34	160
2 x (R + L + IN)	156	164	--
1 x (R + L + IN)	--	--	109
1 x R	30	36	45
TT + C	15	15	40
TOTAL	201	249	354

R = Satellite Recurring Cost
L = Launch Cost
IN = Insurance Cost

6.4.3 Terrestrial Entrance/Exit Link Costs

As noted earlier, for the C-band trunking earth station it was assumed that the earth station would be located, on the average, two microwave hops away from the central office. The annual costs per channel for digital radio fiber optic system and analog radio for the years 1980, 1990 and 2000 are summarized in Table 6-4. It is clear that for the present it is cheaper to use digital radio for digital systems. Analog radio is cheaper if only voice services are desired.

6.4.4 Breakeven Distances

Table 6-5 summarizes the breakeven distances for the C-, Ku- and Ka-band trunking networks for years 1982, 1990 and 2000. The crossover distances for Ka-band in year 1982 are not presented as there is no domestic Ka-band satellite system in existence. The first experimental Ka-band system is being planned for near the end of this decade.

In 1982 the C-band crossover is lower than the Ku-band crossover for all operating speeds. In 1990 the ranking of the crossover distances across bands is variable across operating speed; no one band is expected to have the lowest or highest crossover distances. In 2000, it is expected that Ku-band will have the lowest crossover distances, with the crossovers for C- and Ka-bands being similar.

TABLE 6-4. ANNUAL COSTS PER CHANNEL IN DOLLARS

CHANNEL TYPE	DIGITAL RADIO 1980	DIGITAL RADIO 1990	DIGITAL RADIO 2000	FIBER OPTIC 1980	FIBER OPTIC 1990	FIBER OPTIC 2000	ANALOG RADIO 1980
DS2	60120	57100	51400	116200	81340	73200	
DS1	14400	13700	12300	27600	19340	17390	
56 kbps	1560	1500	1400	2100	1470	1320	10,116
VF	900	900	800	1400	980	880	843
9.6	2660	2500	2300	2770	1940	1750	
4.8	1400	1300	1200	1450	1000	900	
2.4	840	800	700	870	610	550	

TABLE 6-5. BREAKEVEN DISTANCE IN MILES FOR TRUNKING NETWORKS

YEAR	BAND AND APPROACH	OPERATING SPEEDS 2.4	4.8	9.6	56	T1	VF SCHEDULE 1	VF SCHEDULE 2	VF SCHEDULE 3
1982	C-BAND	95	158	307	112	92	566	479	395
	KU-BAND	380	410	469	204	158	778	691	600
	KA-BAND	---	---	---	---	---	---	---	---
1990	C-BAND	94	142	291	98	62	449	335	235
	KU-BAND	1[illegible]7	134	170	104	74	485	371	270
	KA-BAND	112	124	155	102	75	480	366	265
	KA-BAND	110	121	149	98	64	436	322	222
2000	C-BAND	94	131	277	90	61	489	367	249
	KU-BAND	71	76	87	74	21	230	117	70
	KA-AND	72	83	104	96	76	462	340	233
	KA-BAND	71	81	100	91	65	417	295	189

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SECTION 7
NET ADDRESSABLE FORECASTS

7.1 INTRODUCTION

Pertinent technical, institutional and cost factors were considered in the development of the net addressable forecasts, or that portion of the net long haul forecasts that could be served by satellites.

7.2 METHODOLOGY

This analysis required input from our product line managers and tariff experts. Also included was a user survey conducted as part of a parallel effort involving the forecast of satellite provided customer premise services. The following major steps were conducted in the development of the net addressable forecasts (see Figure 7-1):

a. Remove traffic not suitable for satellite transmission
b. Develop and use parametric cost model
c. Develop addressable forecasts for each band
d. Consider the effect of common carrier (plant in place) - determine net addressable forecasts.

7.2.1 Remove Traffic Not Suitable

Satellite constraints, or unacceptable user and application characteristics which refer to usage and technical considerations, were reviewed to determine the suitability of a particular application for implementation on a satellite transmission system. The following are examples of these constraints which were considered in determining satellite implementation suitability:

a. Satellite delay. What is the ability of an application to tolerate a 600 millisecond delay caused by transmission via satellite? In data applications, this represents the delay between sending a block of information and the acknowledgement of its correct reception.

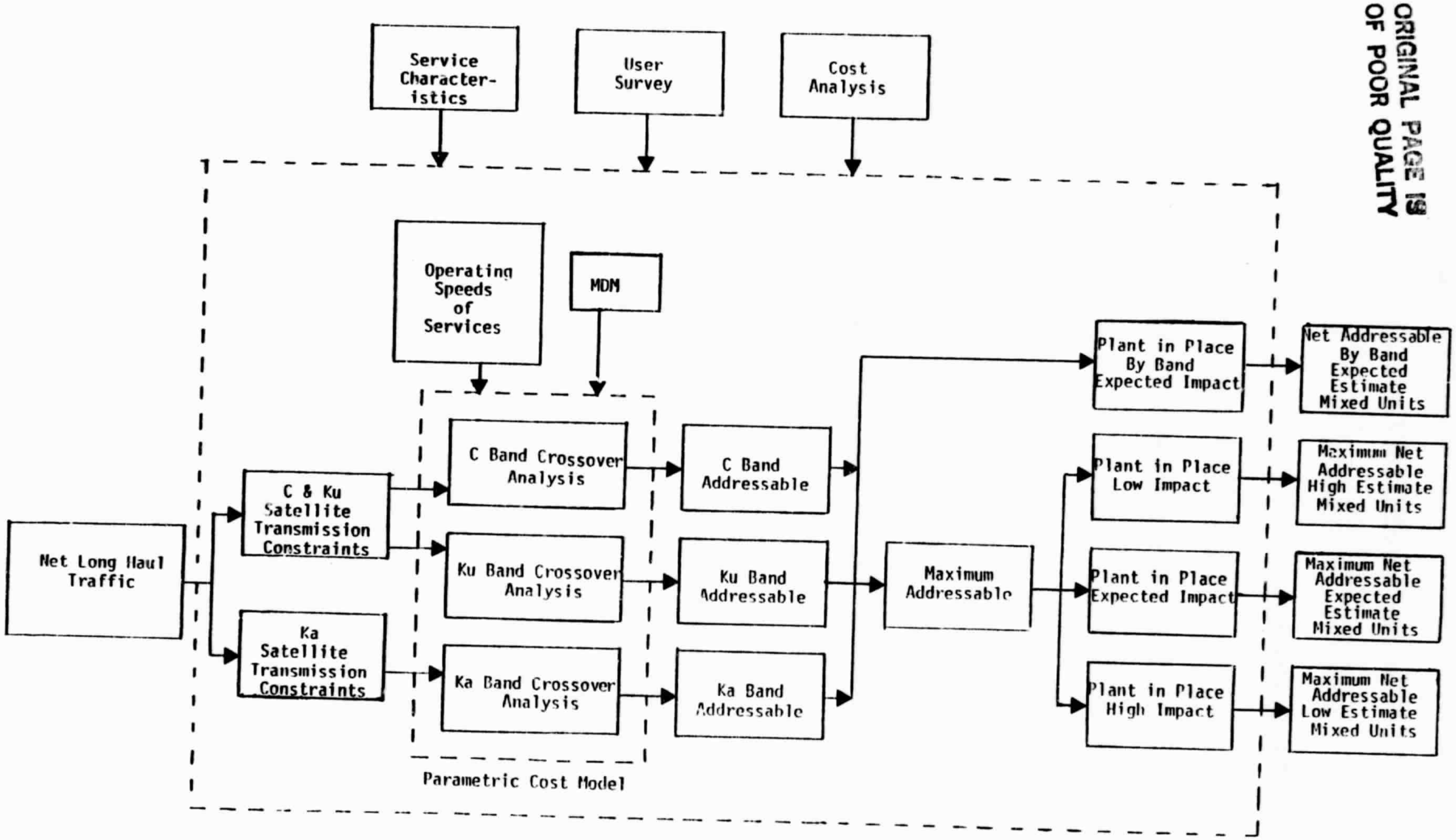

FIGURE 7-1. ACTIVITY FLOW FOR NET ADDRESSABLE FORECASTS

b. <u>Accommodation of satellite delay</u>. What effect will the cost and required technology necessary to overcome some satellite delay problems have on demand? Included are the costs of software conversion or special equipment, the projection of their availability and ease of implementation.

c. <u>Multipoint signal distribution</u>. What are the requirements of each application for broadcast-type signal distribution? The C-band CONUS coverage easily accommodates multipoint requirements such as are associated with the Network Video application, while Ku-band implementation of multipoint distribution requires a separate half channel for each additional drop. (The Ku-band system model is a point-to-point system, not efficient for broadcast services. However, some anticipated Ku-band systems will be capable of broadcast distribution.)

d. <u>Urgency of message delivery</u>. How tolerant will users be to service interruptions and outages in excess of that experienced on terrestrial transmission media such as the public switched network? Movement to higher transmission frequencies is accompanied by the potential for lower levels of service availability. The impact of reduced availability varies with each application.

e. <u>Miscellaneous characteristics</u>. Several minor service considerations were also evaluated. They included: joint use of existing facilities, which may cause facility requirements to reflect the principal usage rather than the subordinate usage; and, insufficient traffic volume of a specific application to justify special communications facilities.

Some of these constraints were fundamental to the separation of satellite and terrestrial traffic (e.g., satellite delay), some were necessary to separate different forms of satellite transmission (e.g., multipoint signal distribution), and some were time oriented (e.g., accommodation of satellite delay). Each of the 31 service applications were evaluated on the above constraints in current terms (1980) and for the year 2000. The evaluations of the service applications were based on trends established by judgment and analysis. Intermediate years also were evaluated if a significant change in trend was anticipated. A factor was established for each constraint for 1980 and 2000 to define the proportion of market demand associated with a particular service application that could tolerate the requirements of the constraint. The individual factors derived for each constraint were consolidated into a composite qualifying factor and applied to the net long haul market demand for each application and each year of the 1980-2000 time span by computer modelling techniques. This completed the first step and the results are presented in Table 7-1.

7.2.2 Develop and Use Parametric Cost Model

7.2.2.1 Develop Cost Model

The parametric cost model considered a broad number of system alternatives. These alternatives included the choice of terrestrial medium (e.g., microwave or fiber optics) as well as the choice of satellite frequency (i.e., 6/4, 14/12, 30/20 GHz). Cost for each medium were projected forward from 1980 to 1990 and 2000 (see Section 6 on Cost Analysis).

Three reasons were postulated for estimating alternate transmission service costs:

a. Service cost is a key factor in determining user service selection. The evaluation of satellite service costs can assist in the segragation of traffic demand between satellite and terrestrial means.

b. The economic advantages of satellite transmission are expected to improve over time, due essentially to more efficient satellite systems. The cost model examines projected changes in the service costs over the 1980-2000 period to determine whether the economic analyses will favor satellite systems.

c. Comparisons of alternative satellite systems (TDMA, FDM) and three frequencies (6/4, 14/12, 30/20 GHz) will indicate the optimum system configuration for delivery of individual services. The economics of providing end-to-end satellite service can thus be compared under a variety of system configurations.

TABLE 7-1. PERCENT OF TRAFFIC NOT SUITABLE FOR SATELLITE TRANSMISSION

SERVICES	BAND C	BAND Ku	BAND Ka
MTS (Residential)			
MTS (Business)			
Private Line			
Mobile			
Public Radio			
Commercial and Religious			30A
Occasional			30A
CATV Music			30A
Recording			
Data Transfer			
Batch Processing			
Data Entry			
Remote Job Entry			
Inquiry/Response	60B	60B	60B
Timesharing	60B	60B	60B
USPS/EMSS			
Mailbox			
Administrative Messages			
Facsimile			
Communicating Word Processors			
TWX/Telex			
Mailgram/Telegram/Money Order			
Point of Sale			
Videotext/Teletext			
Telemonitoring Service			
Secure Voice			
Network			30A
CATV			30A
Occasional			30A
Recording Channel			30A
Teleconferencing			15A

A = Availability B = Time delay tolerance

Two other components were included in the parametric cost model. The market distribution model had to be used to route the traffic throughout the United States, and the traffic had to be segmented into its various operating speeds. For voice services, the present tariffs were structured according to the division of cities. The cities were segmented into type A and type B cities. Schedule 1 (SC1) tariffs are used for traffic between listed (type A) cities. Schedule (SC2) tariffs are used for traffic between listed cities (type A) and unlisted cities (type B), while schedule 3 (SC3) tariffs are used for traffic between unlisted (type B) cities.

7.2.2.2 Removal of Traffic Corresponding to Distances Less Than Crossover Distances

Section 6 presented the cost analysis of trunking networks for C, Ku and Ka band using the full transponder TDM/TDMA approach and FDM/FDMA approach. The same section also presented the crossover distances for various data speeds and voice. The crossover distances were based upon the comparison of end to end user services satellite costs with existing Bell Systems tariffs.

The next step in determining the net addressable forecast was to eliminate the traffic transmitted within a distance less than crossover. This was equivalent to removing all the traffic that could be more economically implemented by terrestrial facilities.

The cost analysis, presented in Section 6, tabulated the crossover distance for voice and data. For data the standard data rates were used and they were: 2.4, 4.8, 9.6, 19.2, 56 kbps and 1.544 Mbps.

For voice, three crossover distances were computed corresponding to schedule 1, schedule 2 and schedule 3 of FCC No 260 Type 2001 tariff. A composite crossover distance for voice was calculated by appropriately weighting the crossover distances corresponding to schedule 1, 2 and 3. The weights used in determining the composite crossover distance were 65, 30 and 5 percent for schedules 1, 2 and 3 respectively.

It was seen in Section 6 that the crossover distances for digital services were lower with the full transponder TDM/TDMA approach, whereas for voice the FDM/FDMA approach yielded lower crossover distances. Also, many of the future systems are planned to be digital for all the bands whether C, Ku and Ka band. Considering these facts, the crossover distances for C Ku or Ka band were computed for years 1990 and 2000 using the TDM/TDMA approach. The crossover distances used in determining the net addressable market correspond to the TDMA approach (see Table 7-2).

7.2.2.3 Distribute Demand to all SMSAs

In order to distribute the demand for traffic among the 313 SMSAs it was necessary to use the market distribution model. This was done for each of the 31 services. The same weighting and files given in Section 5 and Appendix C were used.

7.2.2.4 Determine Operating Speeds

The next step was to segment the thirty one services into the various operating speeds. This analysis was performed by engineers who reviewed, for example, the trend toward more high speed data. Services (e.g., data transfer) involving a great deal of CPU to CPU traffic which would normally go over high volume circuits were shown as such. Slower services, such as data entry, were segmented into the slower speeds. The operating speeds of each service for 1980, 1990 and 2000 are indicated in Tables 7-3, 7-4 and 7-5.

7.3 ADDRESSABLE FORECASTS

Using the percentages of traffic not suitable for satellite transmission and the parametric cost model described above, the addressable forecasts were developed for each band. These forecasts are in Tables 7-6, 7-8 and 7-10; voice traffic is in thousands of half voice circuits, data traffic is in megabits per second, and video traffic is in 36 MHz Transponders. The percent changes from the net long haul forecasts (that is the percent of the net long haul which is not satellite addressable) appear in Tables 7-7, 7-9 and 7-11. Summaries of the

TABLE 7-2. BREAKEVEN DISTANCE IN MILES FOR TRUNKING NETWORKS

YEAR	BAND AND APPROACH	2.4	4.8	9.6	56	T1	SCHEDULE 1	VF SCHEDULE 2	SCHEDULE 3
		OPERATING SPEEDS							
1982	C-BAND	95	158	307	112	92	566	479	395
	Ku-BAND	380	410	469	304	158	778	691	600
	Ka-BAND	---	---	---	---	---	---	---	---
1990	C-BAND	94	142	291	98	62	449	335	235
	Ku-BAND	117	134	170	104	74	485	371	270
	Ka-BAND	112	124	155	102	75	480	366	265
	Ka-BAND	110	121	149	98	64	436	322	222
2000	C-BAND	94	131	277	90	61	489	367	259
	Ku-BAND	71	76	87	74	21	239	117	70
	Ka-BAND	72	83	104	96	76	462	340	233
	Ka-BAND	71	81	100	91	65	417	295	189

TABLE 7-3. PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (1980)

SERVICES	OPERATING SPEEDS							
	2.4	4.8	9.6	56	T-1	SC1	SC2	SC3
MTS (residential)						65	30	5
MTS (business)						65	30	5
Private Line						65	30	5
Mobile						65	30	5
Public Radio								
Commercial and Religious								
Occasional								
CATV Music								
Recording								
Data Transfer			25	70	5			
Batch Processing	70	20	10					
Data Entry	70	20	10					
Remote Job Entry	70	20	10					
Inquiry/Response	70	20	10					
Timesharing	50	20	20	10				
USPS/EMSS	20	10	60	10				
Mailbox	70	20	10					
Administrative Messages	70	20	10					
Facsimile	70	20	10					
Communicating Word Processors	70	20	10					
TWX/Telex	70	20	10					
Mailgram/Telegram/Money Order	70	20	10					
Point of Sale	70	20	10					
Telemonitoring Service	70	20	10					
Secure Voice	20	60	20					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 7-4. PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (1990)

SERVICES	OPERATING SPEEDS 2.4	4.8	9.6	56	T-1	SC1	SC2	SC3
MTS (residential)						65	30	5
MTS (business)						65	30	5
Private Line						65	30	5
Mobile						65	30	5
Public Radio								
Commercial and Religious								
Occasional								
CATV Music								
Recording								
Data Transfer			20	50	30			
Batch Processing	20	30	40	10				
Data Entry	20	70	10					
Remote Job Entry	20	70	10					
Inquiry/Response	20	70	10					
Timesharing	20	20	40	20				
USPS/EMSS		10	60	30				
Mailbox	20	70	10					
Administrative Messages	20	70	10					
Facsimile	20	70	10					
Communicating Word Processors	20	70	10					
TWX/Telex	20	70	10					
Mailgram/Telegram/Money Order	20	70	10					
Point of Sale	20	70	10					
Telemonitoring Service	20	70	10					
Secure Voice	20	30	50					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 7-5. PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (2000)

SERVICES	OPERATING SPEEDS							
	2.4	4.8	9.6	56	T1	SC1	SC2	SC3
MTS (residential)						65	30	5
MTS (business)						65	30	5
Private Line						65	30	5
Mobile						65	30	5
Public Radio								
Commercial and Religious								
Occasional								
CATV Music								
Recording								
Data Transfer			10	20	70			
Batch Processing		30	40	30				
Data Entry	10	20	70					
Remote Job Entry		10	20	70				
Inquiry/Response	10	20	70					
Timesharing		10	20	70				
USPS/EMSS		10	20	70				
Mailbox	10	20	70					
Administrative Messages	10	20	70					
Facsimile	10	20	70					
Communicating Word Processors	10	20	70					
TWX/Telex	10	20	70					
Mailgram/Telegram/Money Order	10	20	70					
Point of Sale	10	20	70					
Telemonitoring Service	10	20	70					
Secure Voice	10	20	70					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 7-6. ADDRESSABLE C-BAND FORECASTS

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)	211.3	568.5	1186.3
MTS (Business)	538.1	1802.3	3977.6
Private Line	209.8	1098.0	2900.0
Mobile	0.5	16.0	48.8
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	961.5	3490.6	8122.9
DATA (Mbps)			
Data Transfer	26.7	63.6	238.2
Batch Processing	49.8	100.4	134.3
Data Entry	7033.9	9716.8	8903.0
Remote Job Entry	176.8	1100.7	1511.1
Inquiry/Response	78.9	508.2	791.6
Timesharing	61.0	128.9	182.3
USPS/EMSS		81.5	143.4
Mailbox	5.4	65.0	76.6
Administrative Messages	1731.4	5382.5	7777.4
Facsimile	359.5	609.8	413.1
Communicating Word Processors	11.0	41.1	72.4
TWX/TELEX	34.9	22.2	13.6
Mailgram/Telegram/Money Orders	0.2	0.2	0.3
Point of Sale	61.0	615.8	503.9
Videotext/Teletext	0.1	272.7	633.5
Telemonitoring Service	0.1	0.5	2.1
Secure Voice	0.8	25.1	140.8
TOTAL	9631.6	18735.1	21537.5
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 7-7. ADDRESSABLE C-BAND: PERCENT OF NLH NOT ADDRESSABLE

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	52.8	42.9	45.7
MTS (Business)	53.4	44.0	46.7
Private Line	53.7	44.3	47.0
Mobile	53.3	44.0	46.6
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	53.3	43.9	46.6
DATA			
Data Transfer	21.9	17.4	15.1
Batch Processing	18.4	25.0	23.8
Data Entry	18.4	20.9	29.7
Remote Job Entry	18.4	20.9	18.5
Inquiry/Response	18.4	20.8	29.7
Timesharing	20.9	24.4	18.5
USPS/EMSS	29.5	28.2	29.7
Mailbox	17.8	20.3	29.0
Administrative Messages	17.8	20.3	29.0
Facsimile	17.8	20.3	29.0
Communicating Word Processors	17.8	20.3	29.0
TWX/TELEX	17.9	20.4	29.1
Mailgram/Telegram/Money Orders	22.6	25.4	34.1
Point of Sale	18.2	20.8	29.6
Videotext/Teletext	18.3	20.8	29.4
Telemonitoring Service	18.2	20.8	29.6
Secure Voice	20.0	23.0	25.4
TOTAL	18.3	20.8	28.4
VIDEO			
Network	0.0	0.0	0.0
CATV	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
Recording Channel	0.0	0.0	0.0
Teleconferencing	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0

TABLE 7-8. ADDRESSABLE KU-BAND FORECASTS

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE (1000's HVC's)			
MTS (Residential)	150.2	540.4	1673.2
MTS (Business)	385.4	1715.8	5596.3
Private Line	149.9	1045.2	4086.8
Mobile	0.4	15.2	68.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	687.7	3322.4	11434.9
DATA (Mbps)			
Data Transfer	22.9	64.7	259.8
Batch Processing	34.0	106.4	155.0
Data Entry	4795.2	9880.1	11055.5
Remote Job Entry	120.6	1119.2	1639.5
Inquiry/Response	21.5	206.7	393.2
Timesharing	17.4	54.5	79.1
USPS/EMSS		89.5	178.1
Mailbox	3.7	66.1	94.7
Administrative Messages	1184.8	5471.6	9620.4
Facsimile	246.0	619.9	510.9
Communicating Word Processors	7.6	41.7	89.6
TWX/TELEX	23.8	22.6	16.8
Mailgram/Telegram/Money Orders	0.1	0.2	0.3
Point of Sale	41.5	626.2	627.8
Videotext/Teletext	0.1	277.1	784.2
Telemonitoring Service	0.1	0.6	2.7
Secure Voice	0.6	26.9	170.2
TOTAL	6519.7	18673.9	25678.0
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 7-9. ADDRESSABLE KU-BAND: PERCENT OF NLH NOT ADDRESSABLE

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	66.4	45.7	23.5
MTS (Business)	66.6	46.7	25.0
Private Line	66.9	47.0	25.3
Mobile	66.5	46.6	25.2
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	66.6	46.6	24.9
DATA			
Data Transfer	33.2	16.0	7.4
Batch Processing	44.4	20.5	12.1
Data Entry	44.4	19.6	12.7
Remote Job Entry	44.4	19.6	11.6
Inquiry/Response	44.4	19.6	12.7
Timesharing	43.5	20.1	11.6
USPS/EMSS	45.9	21.1	12.8
Mailbox	43.8	19.0	12.2
Administrative Messages	43.8	19.0	12.2
Facsimile	43.8	19.0	12.2
Communicating Word Processors	43.8	19.0	12.2
TWX/TELEX	43.9	19.1	12.2
Mailgram/Telegram/Money Orders	43.2	24.1	16.6
Point of Sale	44.3	19.4	12.3
Videotext/Teletext	43.9	19.5	12.6
Telemonitoring Service	44.4	19.5	12.5
Secure Voice	41.8	17.4	9.8
TOTAL	44.2	19.4	12.3
VIDEO			
Network	0.0	0.0	0.0
CATV	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
Recording Channel	0.0	0.0	0.0
Teleconferencing	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0

TABLE 7-10. ADDRESSABLE KA-BAND FORECASTS

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)		544.0	1233.4
MTS (Business)		1727.2	4130.7
Private Line		1052.1	3011.8
Mobile		15.3	50.7
Public Radio		1.2	1.8
Commercial and Religious		1.4	2.2
Occasional		1.3	1.9
CATV Music		0.3	1.2
Recording		0.0	0.4
TOTAL		3342.8	8434.2
DATA (Mbps)			
Data Transfer		65.1	243.7
Batch Processing		108.1	150.8
Data Entry		10024.1	10800.2
Remote Job Entry		1135.6	1584.2
Inquiry/Response		83.9	153.6
Timesharing		22.1	30.6
USPS/EMSS		91.1	173.9
Mailbox		67.0	92.6
Administrative Messages		5549.7	9402.5
Facsimile		628.7	499.4
Communicating Word Processors		42.3	87.5
TWX/TELEX		22.9	16.4
Mailgram/Telegram/Money Orders		0.2	0.3
Point of Sale		635.9	613.2
Videotext/Teletext		281.1	766.2
Telemonitoring Service		0.6	2.6
Secure Voice		27.4	167.0
TOTAL		18785.6	24784.8
VIDEO (Transponders)			
Network		30.0	29.4
CATV		57.7	47.7
Occasional		29.1	25.2
Recording Channel		0.0	0.9
Teleconferencing		132.6	208.5
TOTAL		249.4	311.7

TABLE 7-11. ADDRESSABLE KA-BAND: PERCENT OF NLH NOT ADDRESSABLE

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)		45.4	43.6
MTS (Business)		46.3	44.6
Private Line		46.7	45.0
Mobile		46.3	44.6
Public Radio		0.0	0.0
Commercial and Religious		0.0	0.0
Occasional		0.0	0.0
CATV Music		0.0	0.0
Recording		0.0	0.0
TOTAL		46.2	44.6
DATA			
Data Transfer		15.5	13.2
Batch Processing		19.2	14.5
Data Entry		18.4	14.7
Remote Job Entry		18.4	14.6
Inquiry/Response		18.4	14.7
Timesharing		18.9	14.6
USPS/EMSS		19.8	14.8
Mailbox		17.8	14.2
Administrative Messages		17.8	14.2
Facsimile		17.8	14.2
Communicating Word Processors		17.8	14.2
TWX/TELEX		17.9	14.2
Mailgram/Telegram/Money Orders		22.9	18.9
Point of Sale		18.2	14.4
Videotext/Teletext		18.3	14.6
Telemonitoring Service		18.3	14.5
Secure Voice		16.2	11.5
TOTAL		18.2	14.4
VIDEO			
Network		0.0	0.0
CATV		0.0	0.0
Occasional		0.0	0.0
Recording Channel		0.0	0.0
Teleconferencing		0.0	0.0
TOTAL		0.0	0.0

addressable traffic by band and of the percent of the net long haul that is not addressable appear, respectively, in Tables 7-12 and 7-13.

7.4 NET ADDRESSABLE FORECASTS (REMOVE TRAFFIC LOST BECAUSE OF PLANT IN PLACE)

Across the United States a tremendous investment has been made in existing plants in place. Installed plants, such as AT&T's and Western Union's extensive microwave systems, become sunk costs. The marginal cost, or true cost with which satellite systems must recover, is the cost of maintaining the system. As competition increases companies will compete more on a service than tariff basis, for example, a voice grade line New York to Los Angeles. Terrestrial systems will tend to underbid their true cost of offering the service in order to cover the cost of maintaining their present system and to recover some of the sunk cost.

A higher percentage of the market will be captured by satellites as the marginal cost of maintaining the plant in place increases, as the equipment becomes older, and as the cost of providing services by satellite is reduced. This is reflected in the percent of traffic removed by year because of plant-in-place (Table 7-14). These percentages were developed by tariff experts and engineers. The major impact was expected to be on voice since the majority of this type of traffic is managed by the current plant in place. The percent of data to remove was estimated by using the percent of data which uses voice facilities (see Section 5) times the percent of voice traffic to remove because of plant in place.

At this point in the forecasting process, a maximum addressable was developed by selecting the highest forecast across the three bands for each service for each year (see Table 7-15); in all cases either C or Ku band forecasts were the highest so the maximum consisted of only C and Ku traffic. Then the high, expected and low estimates of the amount of traffic that should be removed due to common carrier (see Table 7-14) were used to calculate the high, expected and low maximum net addressable forecasts (see Tables 7-16, 7-18 and 7-20); the percentage changes from the maximum addressable forecasts to the maximum net addressable forecasts (i.e., the percent of the maximum addressable which is not included in the maximum net addressable) appear in Tables 7-17, 7-19 and

7-21. Summaries of the maximum net addressable forecasts and the percent of maximum addressable not included in the maximum net addressable appear, respectively in Tables 7-22 and 7-23). In preparation for developing the net accessible forecasts the expected net addressable forecasts considering common carrier also were calculated separately for Ka-band. These forecasts appear in Table 7-24.

TABLE 7-12. SUMMARY OF ADDRESSABLE TRAFFIC BY BANDS

		YEAR		
SERVICE	BAND	1980	1990	2000
VOICE (1000's of Half-voice Circuits)	C	961.5	3,490.6	8,122.9
	Ku	687.7	3,322.4	11,434.9
	Ka	--	3,342.8	8,434.2
Data (MBPS)	C	9,631.6	18,735.1	21,537.5
	Ku	6,519.7	18,673.9	25,678.0
	Ka	--	18,785.6	24,784.8
Video (Transponders)	C	61.3	322.8	392.7
	Ku	61.3	322.8	392.7
	Ka	--	249.4	311.8

TABLE 7-13. SUMMARY OF THE PERCENT OF THE NET LONG HAUL NOT ADDRESSABLE BY BAND

SERVICE	BAND	YEAR 1980	1990	2000
VOICE	C	53.3	43.9	46.6
	Ku	66.6	46.6	24.9
	Ka	--	46.2	44.6
DATA	C	18.3	20.8	28.4
	Ku	44.2	19.4	12.3
	Ka	--	18.2	14.4
VIDEO	C	No change since all video traffic was projected as satellite traffic.		
	Ku			
	Ka			

TABLE 7-14. ESTIMATES (PERCENTAGES) OF TRAFFIC TO BE REMOVED DUE TO COMMON CARRIER

SERVICE		YEAR 1980	1990	2000
Voice (MTS) -	High	98	67.0	33.0
	Expected	98	73.5	50.0
	Low	98	80.0	67.0
Data (All) -	High	93	45.0	11.0
	Expected	93	49.5	16.5
	Low	93	54.0	22.0

TABLE 7-15. MAXIMUM ADDRESSABLE FORECASTS

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)	211.3	568.5	1673.2
MTS (Business)	538.1	1802.3	5596.3
Private Line	209.8	1098.0	4086.8
Mobile	0.5	16.0	68.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	961.5	3490.6	11434.9
DATA (Mbps)			
Data Transfer	26.7	65.1	259.8
Batch Processing	49.8	108.1	155.0
Data Entry	7033.9	10024.1	11055.5
Remote Job Entry	176.8	1135.6	1639.5
Inquiry/Response	78.9	508.2	791.6
Timesharing	61.0	128.9	182.3
USPS/EMSS		91.1	178.1
Mailbox	5.4	67.0	94.7
Administrative Messages	1731.4	5549.7	9620.4
Facsimile	359.5	628.7	510.9
Communicating Word Processors	11.0	42.3	89.6
TWX/TELEX	34.9	22.9	16.8
Mailgram/Telegram/Money Orders	0.2	0.2	0.3
Point of Sale	61.0	635.9	627.8
Videotext/Teletext	0.1	281.1	784.2
Telemonitoring Service	0.1	0.6	2.7
Secure Voice	0.8	27.4	170.2
TOTAL	9631.6	19316.7	26179.5
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 7-16. MAXIMUM NET ADDRESSABLE, HIGH ESTIMATE

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)	4.2	187.6	1121.1
MTS (Business)	10.8	594.8	3749.5
Private Line	209.8	1098.0	4086.8
Mobile	0.5	16.0	68.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	227.1	1902.2	9036.0
DATA (Mbps)			
Data Transfer	1.9	35.8	231.3
Batch Processing	3.5	59.4	137.9
Data Entry	492.4	5513.2	9839.4
Remote Job Entry	12.4	624.6	1459.1
Inquiry/Response	5.5	279.5	704.5
Timesharing	4.3	70.9	162.2
USPS/EMSS		50.1	158.5
Mailbox	0.4	36.9	84.3
Administrative Messages	121.2	3052.3	8562.2
Facsimile	25.2	345.8	454.7
Communicating Word Processors	0.8	23.3	79.7
TWX/TELEX	2.4	12.6	15.0
Mailgram/Telegram/Money Orders	0.0	0.1	0.3
Point of Sale	4.3	349.7	558.8
Videotext/Teletext	0.0	154.6	698.0
Telemonitoring Service	0.0	0.3	2.4
Secure Voice	0.1	15.0	151.5
TOTAL	674.2	10624.2	23299.8
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

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TABLE 7-17. MAXIMUM NET ADDRESSABLE, HIGH ESTIMATE: PERCENT OF MAXIMUM ADDRESSABLE NOT INCLUDED

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	98.0	67.0	33.0
MTS (Business)	98.0	67.0	33.0
Private Line	0.0	0.0	0.0
Mobile	0.0	0.0	0.0
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	76.3	45.5	21.0
DATA			
Data Transfer	93.0	45.0	11.0
Batch Processing	93.0	45.0	11.0
Data Entry	93.0	45.0	11.0
Remote Job Entry	93.0	45.0	11.0
Inquiry/Response	93.0	45.0	11.0
Timesharing	93.0	45.0	11.0
USPS/EMSS		45.0	11.0
Mailbox	93.0	45.0	11.0
Administrative Messages	93.0	45.0	11.0
Facsimile	93.0	45.0	11.0
Communicating Word Processors	93.0	45.0	11.0
TWX/TELEX	93.0	45.0	11.0
Mailgram/Telegram/Money Orders	93.0	45.0	11.0
Point of Sale	93.0	45.0	11.0
Videotext/Teletext	93.0	45.0	11.0
Telemonitoring Service	93.0	45.0	11.0
Secure Voice	93.0	45.0	11.0
TOTAL	93.0	45.0	11.0
VIDEO			
Network	0.0	0.0	0.0
CATV	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
Recording Channel	0.0	0.0	0.0
Teleconferencing	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0

TABLE 7-18. MAXIMUM NET ADDRESSABLE, EXPECTED ESTIMATE

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)	4.2	145.0	836.6
MTS (Business)	10.8	459.6	2798.2
Private Line	209.8	1098.0	4086.8
Mobile	0.5	16.0	68.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	227.1	1724.4	7800.2
DATA (Mbps)			
Data Transfer	1.9	32.9	217.0
Batch Processing	3.5	54.6	129.4
Data Entry	492.4	5062.2	9231.4
Remote Job Entry	12.4	573.5	1369.0
Inquiry/Response	5.5	256.7	661.0
Timesharing	4.3	65.1	152.2
USPS/EMSS		46.0	148.7
Mailbox	0.4	33.8	79.1
Administrative Messages	121.2	2802.6	8033.1
Facsimile	25.2	317.5	426.6
Communicating Word Processors	0.8	21.4	74.8
TWX/TELEX	2.4	11.6	14.0
Mailgram/Telegram/Money Orders	0.0	0.1	0.3
Point of Sale	4.3	321.1	524.2
Videotext/Teletext	0.0	141.9	654.8
Telemonitoring Service	0.0	0.3	2.2
Secure Voice	0.1	13.8	142.1
TOTAL	674.2	9755.0	21859.9
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 7-19. MAXIMUM NET ADDRESSABLE, EXPECTED ESTIMATE: PERCENT OF MAXIMUM ADDRESSABLE NOT INCLUDED

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE			
MTS (Residential)	98.0	74.5	50.0
MTS (Business)	98.0	74.5	50.0
Private Line	0.0	0.0	0.0
Mobile	0.0	0.0	0.0
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	76.3	50.6	31.8
DATA			
Data Transfer	93.0	49.5	16.5
Batch Processing	93.0	49.5	16.5
Data Entry	93.0	49.5	16.5
Remote Job Entry	93.0	49.5	16.5
Inquiry/Response	93.0	49.5	16.5
Timesharing	93.0	49.5	16.5
USPS/EMSS		49.5	16.5
Mailbox	93.0	49.5	16.5
Administrative Messages	93.0	49.5	16.5
Facsimile	93.0	49.5	16.5
Communicating Word Processors	93.0	49.5	16.5
TWX/TELEX	93.0	49.5	16.5
Mailgram/Telegram/Money Orders	93.0	49.5	16.5
Point of Sale	93.0	49.5	16.5
Videotext/Teletext	93.0	49.5	16.5
Telemonitoring Service	93.0	49.5	16.5
Secure Voice	93.0	49.5	16.5
TOTAL	93.0	49.5	16.5
VIDEO			
Network	0.0	0.0	0.0
CATV	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
Recording Channel	0.0	0.0	0.0
Teleconferencing	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0

TABLE 7-20. MAXIMUM NET ADDRESSABLE, LOW ESTIMATE

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE (1000's HVC's)			
MTS (Residential)	4.2	113.7	552.2
MTS (Business)	10.8	360.5	1846.8
Private Line	209.8	1098.0	4086.8
Mobile	0.5	16.0	68.4
Public Radio	0.3	1.8	2.6
Commercial and Religious	0.5	2.0	3.2
Occasional	0.9	1.8	2.7
CATV Music	0.1	0.3	1.2
Recording		0.0	0.4
TOTAL	227.1	1594.0	6564.3
DATA (Mbps)			
Data Transfer	1.9	29.9	202.7
Batch Processing	3.5	49.7	120.9
Data Entry	492.4	4611.1	8623.3
Remote Job Entry	12.4	522.4	1278.8
Inquiry/Response	5.5	233.8	617.4
Timesharing	4.3	59.3	142.2
USPS/EMSS		41.9	138.9
Mailbox	0.4	30.8	73.9
Administrative Messages	121.2	2552.8	7503.9
Facsimile	25.2	289.2	398.5
Communicating Word Processors	0.8	19.5	69.9
TWX/TELEX	2.4	10.5	13.1
Mailgram/Telegram/Money Orders	0.0	0.1	0.3
Point of Sale	4.3	292.5	489.7
Videotext/Teletext	0.0	129.3	611.7
Telemonitoring Service	0.0	0.3	2.1
Secure Voice	0.1	12.6	132.8
TOTAL	674.2	9885.7	20420.0
VIDEO (Transponders)			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel		0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 7-21. MAXIMUM NET ADDRESSABLE, LOW ESTIMATE: PERCENT OF MAXIMUM ADDRESSABLE NOT INCLUDED

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	98.0	80.0	67.0
MTS (Business)	98.0	80.0	67.0
Private Line	0.0	0.0	0.0
Mobile	0.0	0.0	0.0
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	76.3	54.3	42.6
DATA			
Data Transfer	93.0	54.0	22.0
Batch Processing	93.0	54.0	22.0
Data Entry	93.0	54.0	22.0
Remote Job Entry	93.0	54.0	22.0
Inquiry/Response	93.0	54.0	22.0
Timesharing	93.0	54.0	22.0
USPS/EMSS		54.0	22.0
Mailbox	93.0	54.0	22.0
Administrative Messages	93.0	54.0	22.0
Facsimile	93.0	54.0	22.0
Communicating Word Processors	93.0	54.0	22.0
TWX/TELEX	93.0	54.0	22.0
Mailgram/Telegram/Money Orders	93.0	54.0	22.0
Point of Sale	93.0	54.0	22.0
Videotext/Teletext	93.0	54.0	22.0
Telemonitoring Service	93.0	54.0	22.0
Secure Voice	93.0	54.0	22.0
TOTAL	93.0	54.0	22.0
VIDEO			
Network	0.0	0.0	0.0
CATV	0.0	0.0	0.0
Occasional	0.0	0.0	0.0
Recording Channel	0.0	0.0	0.0
Teleconferencing	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0

TABLE 7-22. SUMMARY OF MAXIMUM NET ADDRESSABLE

SERVICE	ESTIMATE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE	H	227.1	1,902.2	9,036.0
(Half-voice	E	227.1	1,724.4	7,800.2
Circuits)	L	227.1	1,594.0	6,464.3
DATA	H	674.2	10,624.2	23,299.8
(MBPS)	E	674.2	9,755.0	21,859.9
	L	674.2	8,885.7	20,420.0
VIDEO	H	61.3	322.8	392.7
(Transponders)	E	61.3	322.8	392.7
	L	61.3	322.8	392.7

TABLE 7-23. SUMMARY OF THE PERCENT OF THE MAXIMUM ADDRESSABLE NOT INCLUDED IN NET ADDRESSABLE

SERVICE	ESTIMATE	YEAR 1980	1990	2000
VOICE	H	76.3	45.5	21.0
	E	76.3	50.6	31.8
	L	76.3	54.3	42.6
DATA	H	93.0	45.0	11.0
	E	93.0	49.5	16.5
	L	93.0	54.0	22.0
VIDEO	H	No change		
	E			
	L			

TABLE 7-24. KA-BAND NET ADDRESSABLE, EXPECTED ESTIMATE

SERVICE	YEAR 1980	1990	2000
VOICE (1000's HVC's)			
MTS (Residential)		138.7	616.7
MTS (Business)		440.4	2065.4
Private Line		1052.1	3011.8
Mobile		15.3	50.7
Public Radio		1.2	1.8
Commercial and Religious		1.4	2.2
Occasional		1.3	1.9
CATV Music		0.3	1.2
Recording		0.0	0.4
TOTAL		1650.8	5752.1
DATA (Mbps)			
Data Transfer		32.9	203.4
Batch Processing		54.6	125.9
Data Entry		5062.2	9018.1
Remote Job Entry		573.5	1322.8
Inquiry/Response		42.4	128.3
Timesharing		11.2	25.5
USPS/EMSS		46.0	145.2
Mailbox		33.8	77.3
Administrative Messages		2802.6	7851.1
Facsimile		317.5	417.0
Communicating Word Processors		21.4	73.1
TWX/TELEX		11.6	13.7
Mailgram/Telegram/Money Orders		0.1	0.3
Point of Sale		321.1	512.1
Videotext/Teletext		141.9	639.8
Telemonitoring Service		0.3	2.2
Secure Voice		13.8	139.4
TOTAL		9486.7	20695.3
VIDEO (Transponders)			
Network		30.0	29.4
CATV		57.7	47.7
Occasional		29.1	25.2
Recording Channel		0.0	0.9
Teleconferencing		132.6	208.5
TOTAL		249.4	311.7

SECTION 8
CAPACITY REQUIREMENTS

8.1 INTRODUCTION

This section discusses the conversion of the net addressable forecasts from peak-hour half voice circuits (voice), Mbps (Data), and transponders (video) to equivalent transponders in order to make a comparison among required, potential and actual capacities. To accomplish this purpose the following steps were performed (see Figure 8-1):

a. Conducting a thorough analysis of techniques for improving spectrum utilization

b. Specification of high, expected and low estimates of technological changes

c. Presentation of high, expected and low estimates of capacity requirements.

8.2 IMPROVING SPECTRUM UTILIZATION

The results of a thorough analysis of techniques for improving spectrum utilization are presented in Appendix G. Appendix G covers three major topics: modulation techniques, frequency reuse and reduced satellite spacing. The information in these topics was used to specify estimates of technological improvements.

8.3 ESTIMATES OF TECHNOLOGICAL CHANGES

Improvements in modulation and coding techniques and the percent of voice on analog and the percent on digital were considered in the development of capacity requirements. The numbers of half voice circuits per 36 MHz transponder were based on expected improvements in frequency and amplitude modulation techniques. The numbers of kbps per half voice circuit were considered a function of improvements in coding techniques. The numbers of Mbps per 36 MHz transponder were based on expected improvements in digital modulation techniques. The percentages of voice on analog and digital were based on trends

TECHNOLOGICAL CHANGE MODEL

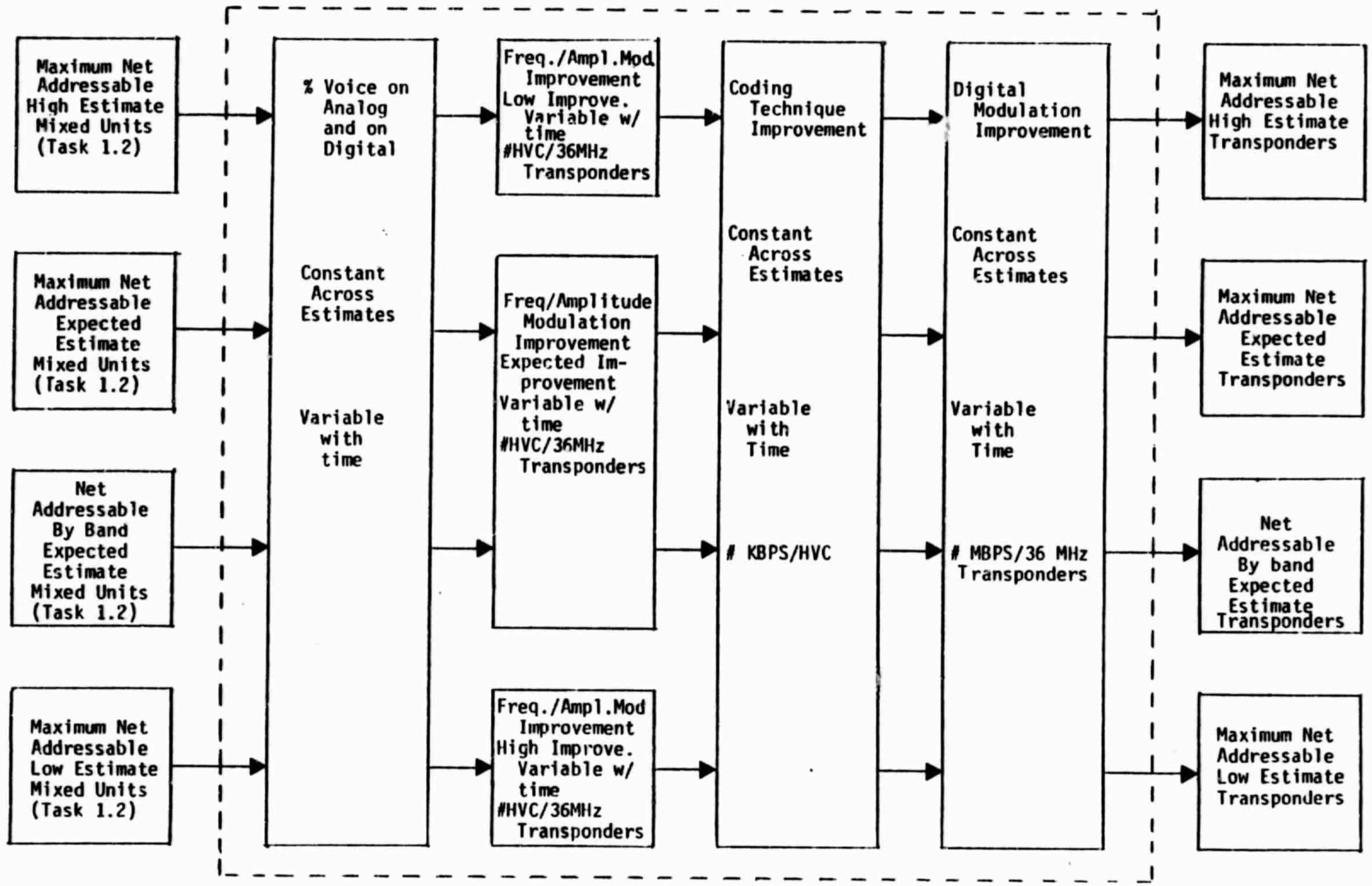

FIGURE 8-1. ACTIVITY FLOW FOR REQUIRED CAPACITY FORECASTS

indicating a growth in digital services. The estimates of these technological changes are presented in Table 8-1. Estimates #1, #2 and #3 correspond to improvements that will result in high, expected and low capacity requirements; that is, a lesser technological improvement will result in a higher capacity requirement.

8.4 ESTIMATES OF CAPACITY REQUIREMENTS

Estimates of capacity requirements are presented in Tables 8-2 through 8-4, and the following points should be considered when reviewing these forecasts:

a. Forecasts are in equivalent 36 MHz transponders to facilitate comparison with potential and actual capacities.
b. High, expected and low estimates of demand or capacity requirements were developed as follows:
    1. High estimate - Low percentage removed for common carrier consideration (see Section 7). Low estimate of analog modulation improvement
    2. Expected estimate - Expected percentage removed for common carrier consideration. Expected analog modulation improvement
    3. Low estimate - High percentage removed for common carrier consideration. High estimate of analog modulation improvement
c. All other technology considerations (i.e., kbps/HVS (i.e., half voice circuit), #Mbps/Trans, Percent on Analog/Digital) were the same for all three estimates.

The actual conversion of voice, data and video forecasts to equivalent transponders included the following:

a. Voice - Consider:
    1. Percent on analog and on digital by year
    2. For percent on analog: - # HVC/Transponder; by year
    3. For percent on digital: X # kbps/HVC; - # Mbps/Transponder; by year

TABLE 8-1. ESTIMATES OF SELECTED TECHNOLOGICAL CHANGES THROUGH 2000

	YEAR		
	1980	1990	2000
# Half Voice Circuits/36 MHz Transponder (Function of frequency and amplitude modulation techniques)			
Estimate # 1 (High Requirement)	1200	2400	4800
Estimate # 2 (Expected Requirement)	1200	3000	6000
Estimate # 3 (Low Requirement)	1200	3600	7200
# kbps/Half Voice Circuit (Function of Coding Techniques - three estimates are the same)			
Estimate # 1 (High Requirement)	64	32	24
Estimate # 2 (Expected Requirement)	64	32	24
Estimate # 3 (Low Requirement)	69	32	24
# Mbps/36 MHz Transponder (Function of digital modulation techniques - three estimates are the same)			
Estimate # 1 (High Requirement)	60	90	90
Estimate # 2 (Expected Requirement)	60	90	90
Estimate # 3 (Low Requirement)	60	90	90
% Voice on Analog/Digital (Function of trends - three estimates are the same)			
Estimate # 1 (High Requirement)			
Analog	100	75	50
Digital	0	25	50
Estimate # 2 (Expected Requirement)			
Analog	100	75	50
Digital	0	25	50
Estimate # 3 (Low Requirement)			
Analog	100	75	50
Digital	0	25	50

TABLE 8-2. MAXIMUM NET ADDRESSABLE, HIGH ESTIMATE IN TRANSPONDERS

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	3.5	77.2	282.9
MTS (Business)	9.0	244.6	946.1
Private Line	174.9	451.6	1031.2
Mobile	0.4	6.6	17.3
Public Radio	0.3	0.7	0.6
Commercial and Religious	0.4	0.8	0.8
Occasional	0.7	0.7	0.7
CATV Music	0.1	0.1	0.3
Recording	0.0	0.0	0.1
TOTAL	189.3	782.3	2279.9
DATA			
Data Transfer	0.0	0.4	2.9
Batch Processing	0.1	0.7	1.7
Data Entry	9.1	68.1	121.5
Remote Job Entry	0.2	7.7	18.0
Inquiry/Response	0.1	3.5	8.7
Timesharing	0.1	0.9	2.0
USPS/EMSS	0.0	0.6	2.0
Mailbox	0.0	0.5	1.0
Administrative Messages	2.2	37.7	105.7
Facsimile	0.5	4.3	5.6
Communicating Word Processors	0.0	0.3	1.0
TWX/TELEX	0.0	0.2	0.2
Mailgram/Telegram/Money Orders	0.0	0.0	0.0
Point of Sale	0.1	4.3	6.9
Videotext/Teletext	0.0	1.9	8.6
Telemonitoring Service	0.0	0.0	0.0
Secure Voice	0.0	0.2	1.9
TOTAL	12.5	131.2	287.7
VIDEO			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel	0.0	0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 8-3. MAXIMUM NET ADDRESSABLE, EXPECTED ESTIMATE IN TRANSPONDERS

SERVICE	YEAR 1980	YEAR 1990	YEAR 2000
VOICE			
MTS (Residential)	3.5	50.6	193.7
MTS (Business)	9.0	160.3	647.7
Private Line	174.9	382.9	946.0
Mobile	0.4	5.6	15.8
Public Radio	0.3	0.6	0.6
Commercial and Religious	0.4	0.7	0.7
Occasional	0.7	0.6	0.6
CATV Music	0.1	0.1	0.3
Recording	0.0	0.0	0.1
TOTAL	180.3	601.4	1805.6
DATA			
Data Transfer	0.0	0.4	2.7
Batch Processing	0.1	0.7	1.6
Data Entry	9.1	62.5	114.0
Remote Job Entry	0.2	7.1	6.9
Inquiry/Response	0.1	3.2	8.2
Timesharing	0.1	0.8	1.9
USPS/EMSS	0.0	0.6	1.8
Mailbox	0.0	0.4	1.0
Administrative Messages	2.2	34.6	99.2
Facsimile	0.5	3.9	5.3
Communicating Word Processors	0.0	0.3	0.9
TWX/TELEX	0.0	0.1	0.2
Mailgram/Telegram/Money Orders	0.0	0.0	0.0
Point of Sale	0.1	4.0	6.5
Videotext/Teletext	0.0	1.8	8.1
Telemonitoring Service	0.0	0.0	0.0
Secure Voice	0.0	0.2	1.8
TOTAL	12.5	120.4	269.9
VIDEO			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel	0.0	0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

TABLE 8-4. MAXIMUM NET ADDRESSABLE, LOW ESTIMATE, IN TRANSPONDERS

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)	3.5	34.9	120.1
MTS (Business)	9.0	110.7	401.8
Private Line	174.9	337.2	889.3
Mobile	0.4	4.9	14.9
Public Radio	0.3	0.5	0.6
Commercial and Religious	0.4	0.6	0.7
Occasional	0.7	0.6	0.6
CATV Music	0.1	0.1	0.3
Recording	0.0	0.0	0.1
TOTAL	189.3	489.5	1428.4
DATA			
Data Transfer	0.0	0.4	2.5
Batch Processing	0.1	0.6	1.5
Data Entry	9.1	56.9	106.5
Remote Job Entry	0.2	6.4	15.8
Inquiry/Response	0.1	2.9	7.6
Timesharing	0.1	0.7	1.8
USPS/EMSS	0.0	0.5	1.7
Mailbox	0.0	0.4	0.9
Administrative Messages	2.2	31.5	92.6
Facsimile	0.5	3.6	4.9
Communicating Word Processors	0.0	0.2	0.9
TWX/TELEX	0.0	0.1	0.2
Mailgram/Telegram/Money Orders	0.0	0.0	0.0
Point of Sale	0.1	3.6	6.0
Videotext/Teletext	0.0	1.6	7.6
Telemonitoring Service	0.0	0.0	0.0
Secure Voice	0.0	0.2	1.6
TOTAL	12.5	109.7	752.1
VIDEO			
Network	10.0	42.9	42.0
CATV	34.0	82.4	68.2
Occasional	14.3	41.6	36.0
Recording Channel	0.0	0.0	1.3
Teleconferencing	3.0	155.9	245.3
TOTAL	61.3	322.8	392.7

b. Data - Consider: - # Mbps/Transponder; by year

c. Video - Consider: Net addressable already expressed in equivalent 36 MHz transponders.

The information from Tables 8-2 through 8-4 is graphed in Figure 8-2 and indicates the high, expected and low estimates of required capacity over time; this information also is summarized in Table 8-5 which shows the growth rates for each scenario. While the slopes of the curves in Figure 8-2 and the growth rates in Table 8-5 suggest that the high, expected and low scenarios are not significantly different, it should be pointed out that the total number of transponders required in 2000 by the high scenario is about 43 percent greater than that required by the low scenario. Estimates of capacity requirements for Ka-band are presented in Table 8-6; these forecasts were calculated in preparation for the development of the Ka-band net accessable forecasts (see Section 10).

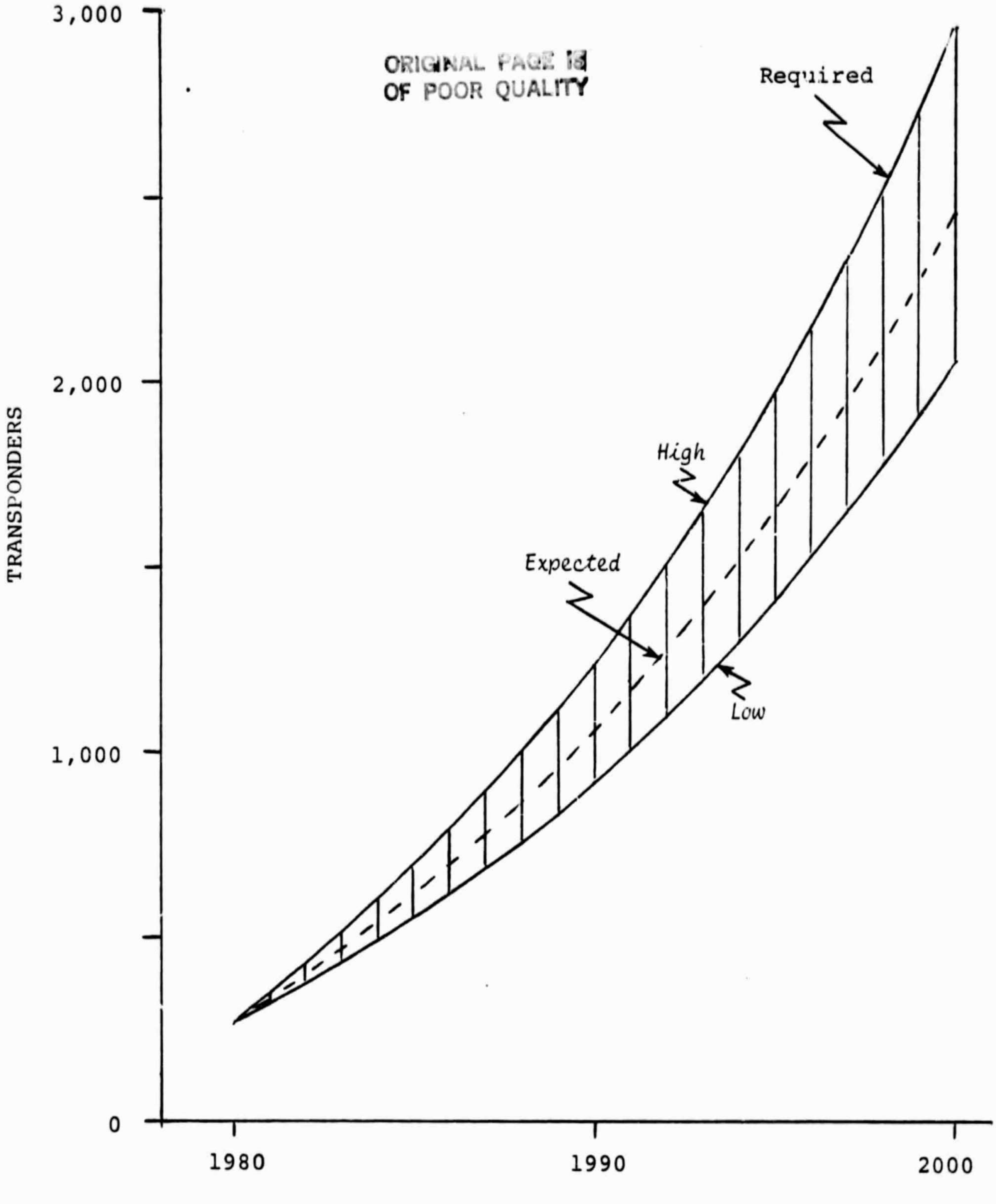

FIGURE 8-2. HIGH, EXPECTED AND LOW ESTIMATES OF REQUIRED CAPACITY

TABLE 8-5
SUMMARY OF MAXIMUM NET ADDRESSABLE FORECASTS AND GROWTH RATES

FORECASTS (Transponders)	YEAR 1980	1990	2000
High			
Voice	189.3	782.3	2279.9
Data	12.5	131.2	287.7
Video	61.3	322.8	392.7
TOTAL	263.1	1236.3	2960.3
Expected			
Voice	189.3	601.4	1805.6
Data	12.5	120.4	269.9
Video	61.3	322.8	392.7
TOTAL	263.1	1044.6	2468.2
Low			
Voice	189.3	489.5	1428.4
Data	12.5	109.7	252.1
Video	61.3	322.8	392.7
TOTAL	263.1	922.0	2072.8

GROWTH RATES (%)	TIME PERIOD 1980-1990	1990-2000	1980-2000
High			
Voice	15.2	11.3	13.3
Data	26.5	8.2	17.0
Video	18.1	2.0	9.7
TOTAL	16.7	9.1	12.9
Expected			
Voice	12.3	11.6	11.9
Data	25.4	8.4	16.6
Video	18.1	2.0	9.7
TOTAL	14.8	9.0	11.8
Low			
Voice	10.0	11.3	10.6
Data	24.3	8.7	16.2
Video	18.1	2.0	9.7
TOTAL	13.4	8.4	10.9

TABLE 8-6. KA-BAND NET ADDRESSABLE, EXPECTED ESTIMATE, IN TRANSPONDERS

SERVICE	YEAR 1980	1990	2000
VOICE			
MTS (Residential)		48.4	142.8
MTS (Business)		153.6	478.1
Private Line		366.9	697.2
Mobile		5.3	11.7
Public Radio		0.4	0.4
Commercial and Religious		0.5	0.5
Occasional		0.4	0.4
CATV Music		0.1	0.1
Recording		0.0	0.1
TOTAL		575.7	1331.5
DATA			
Data Transfer		0.4	2.5
Batch Processing		0.7	1.6
Data Entry		62.5	111.3
Remote Job Entry		7.1	16.3
Inquiry/Response		0.5	1.6
Timesharing		0.1	0.3
USPS/EMSS		0.6	1.8
Mailbox		0.4	1.0
Administrative Messages		34.6	96.9
Facsimile		3.9	5.1
Communicating Word Processors		0.3	0.9
TWX/TELEX		0.1	0.2
Mailgram/Telegram/Money Orders		0.0	0.0
Point of Sale		4.0	6.3
Videotext/Teletext		1.8	7.9
Telemonitoring Service		0.0	0.0
Secure Voice		0.2	1.7
TOTAL		117.1	255.5
VIDEO			
Network		30.0	29.4
CATV		57.7	47.7
Occasional		29.1	25.2
Recording Channel		0.0	0.9
Teleconferencing		132.6	208.5
TOTAL		249.4	311.7

SECTION 9
SATELLITE SYSTEM MARKET DEVELOPMENT

9.1 INTRODUCTION

This section compares the required, potential (C- and Ku-band) and actual (C- and Ku-band) capacities so that estimates of when Ka-band will be needed could be made. Required capacity refers to the capacity expected to be needed (as specified in Section 8); potential capacity refers to the capacity expected to be possible; and actual capacity refers to the capacity expected to be available. The major steps conducted to accomplish this purpose were (see Figures 9-1 and 9-2):

a. Specify factors influencing potential capacity.
b. Develop high, expected and low estimate of potential capacity.
c. Specify factors influencing actual capacity.
d. Develop high, expected and low estimates of actual capacity.
e. Compare required, potential and actual capacities.
f. Specify areas of uncertainty.

9.2 FACTORS INFLUENCING POTENTIAL C- PLUS KU-BAND CAPACITY

Three factors were considered when determining potential C- plus Ku-band capacity:

a. Spacing (C- and Ku-bands) - see Appendix G for detailed discussion of spacing for C- & Ku-bands.
b. Frequency reuse (Ku-band) - See Appendix G.
c. Fill percentage (C- and Ku transponders) - for potential capacity, this is the average percentage of satellite capacity that must be sold or leased before it is put into use.

The impact of each of these factors on potential capacity is specified in Table 9-1.

C-3

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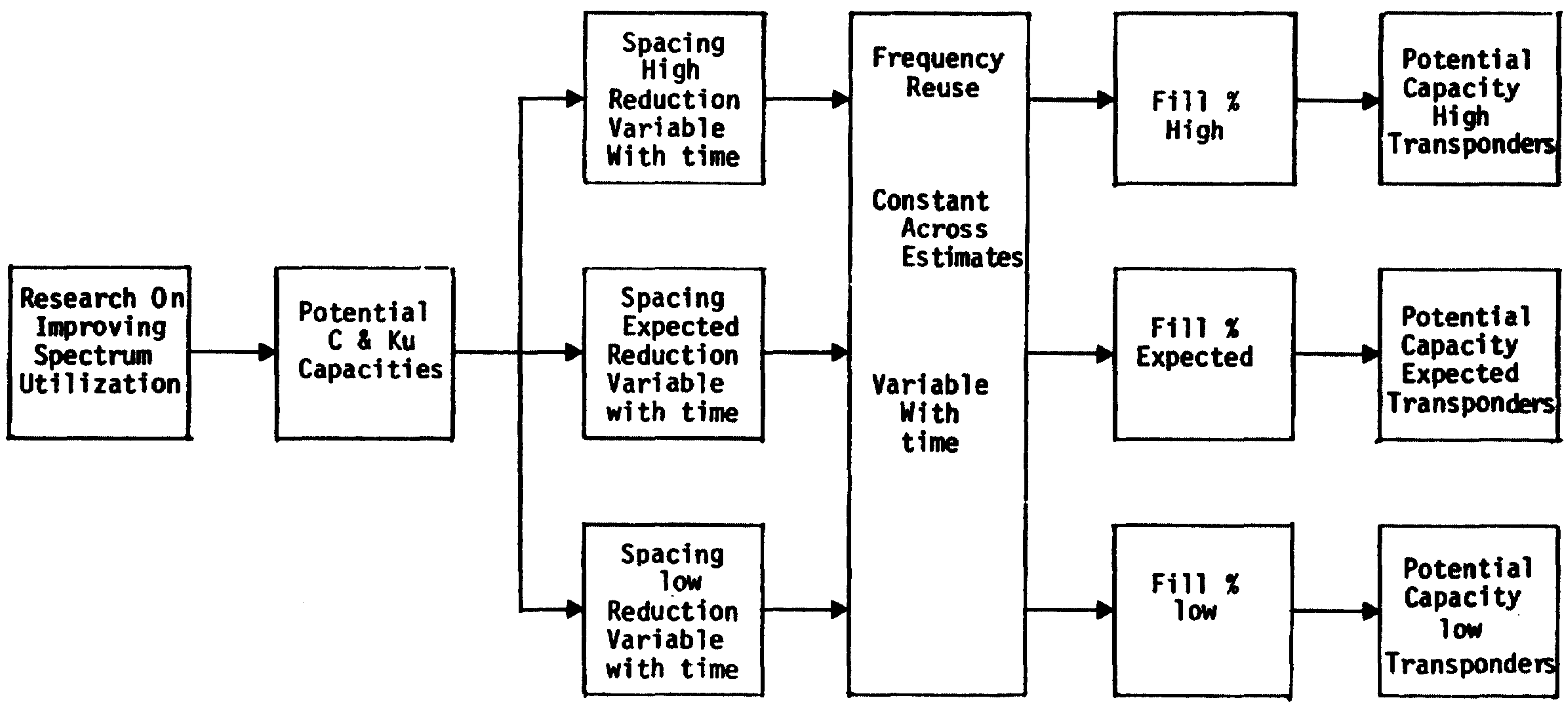

FIGURE 9-1. ACTIVITY FLOW FOR POTENTIAL CAPACITY FORECASTS

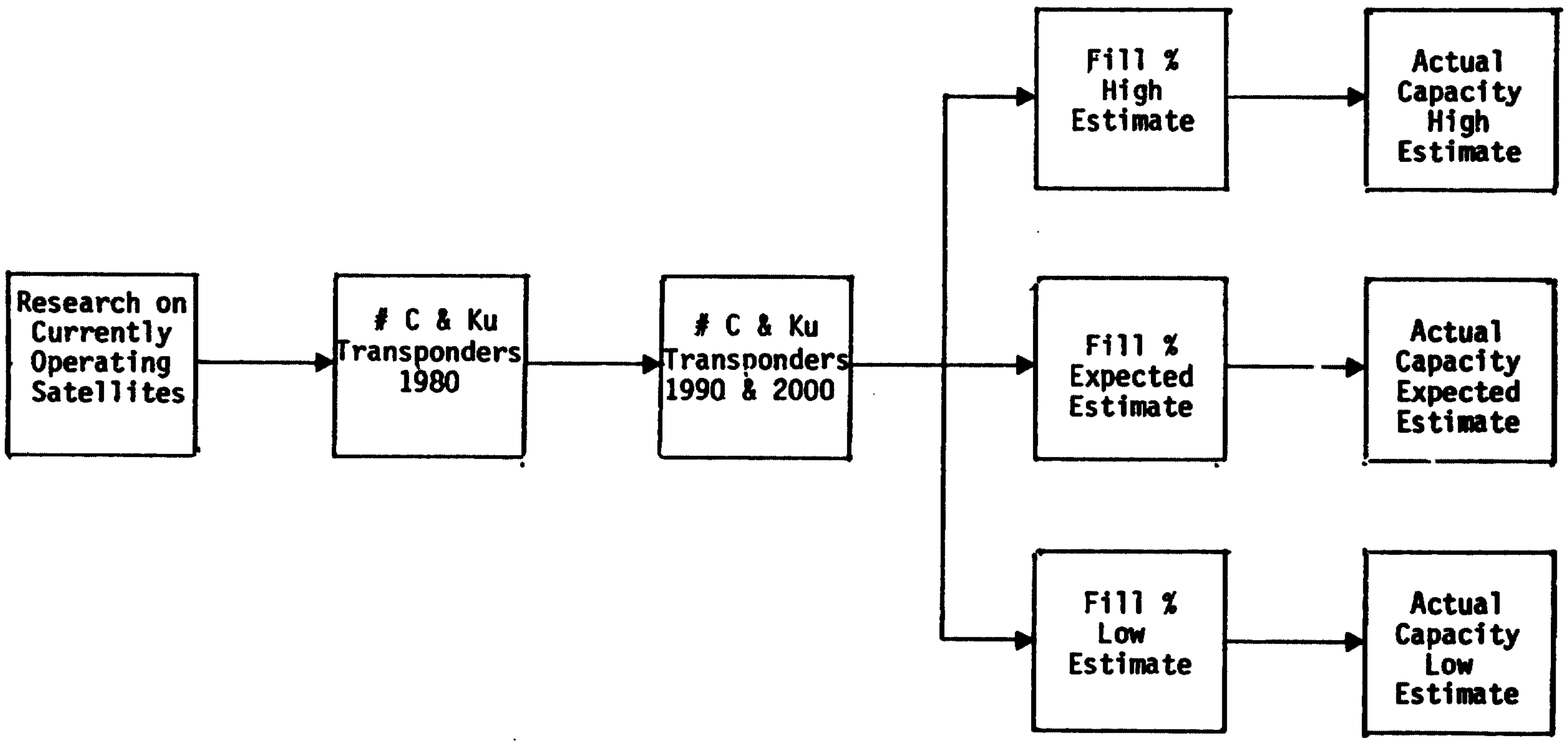

FIGURE 9-2. ACTIVITY FLOW FOR ACTUAL CAPACITY FORECASTS

TABLE 9-1. COMPOSITE IMPACTS OF SELECTED FACTORS ON POTENTIAL CAPACITIES OF C AND Ku BANDS

BAND	SPACING # DEGREES	REUSE Y/N	#36 MHz TRANSPONDERS	FILL PERCENT .9	.8	.7
C	4	Y	432	389	346	302
	3	Y	552	497	442	386
	2	Y	744	670	595	521
Ku	3	N	324	292	259	227
	2	N	436	392	349	305
	3	Y	648	583	518	454
	2	Y	872	785	698	610

9.3 ESTIMATES OF POTENTIAL C- PLUS KU-BAND CAPACITY

High, expected and low estimates of potential C- plus Ku-band capacity were developed by projecting spacing, frequency reuse, and fill percentage changes. These projections were based on the report on improving spectrum utilization presented at the end of Appendix G and on interviews with providers and representatives of Government agencies. Table 9-2 shows three scenarios that correspond to the high, expected and low estimates of potential capacity and that reflect factor forecasts or changes in spacing, reuse and fill percentage over time. Also presented in Table 9-2 are the high, expected and low forecasts of potential capacity. These forecasts also are graphed in Figure 9-3.

9.4 FACTORS INFLUENCING ACTUAL C- PLUS KU-BAND CAPACITY

Only two factors were considered when determining actual C- plus Ku-band capacity:

a. Fill percentage - for actual capacity, this is the average percentage of satellite capacity actually being used.
b. Growth beyond scheduled satellites.

For growth beyond scheduled satellites, actual capacity was expected to approach potential capacity by 2000 because of market demand (i.e., required capacity). As with estimates of potential capacity, .9, .8 and .7 were the fill percentages used to develop high, expected and low estimates of actual capacity.

9.5 ESTIMATES OF ACTUAL C- PLUS KU-BAND CAPACITY

High, expected and low estimates of actual capacity for C and Ku-bands were developed on the basis of available information on current satellites in operation, plans for future satellites and fill percentages, as discussed above (See Appendix G). Forecasts considering growth rates are presented in Table 9-3. The high, expected and low estimates also are presented in Table 9-3 and are graphed in Figure 9-4.

TABLE 9-2. DEVELOPMENT OF ESTIMATES OF POTENTIAL C- PLUS KU-BAND CAPACITY

FACTOR FORECASTS

		High			Expected			Low		
		1980	1990	2000	1980	1990	2000	1980	1990	2000
Spacing	C	4	3	2	4	3	3	4	4	3
	Ku	3	2	2	3	3	2	3	3	3
Reuse	C	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ku	N	Y	Y	N	Y	Y	N	Y	Y
Fill Percent		.9	.9	.9	.8	8	.8	.7	.7	.7

CAPACITY FORECASTS	1980	1990	2000
(36 MHz Transponders)			
High	681	1282	1455
Expected	605	960	1140
Low	529	756	840

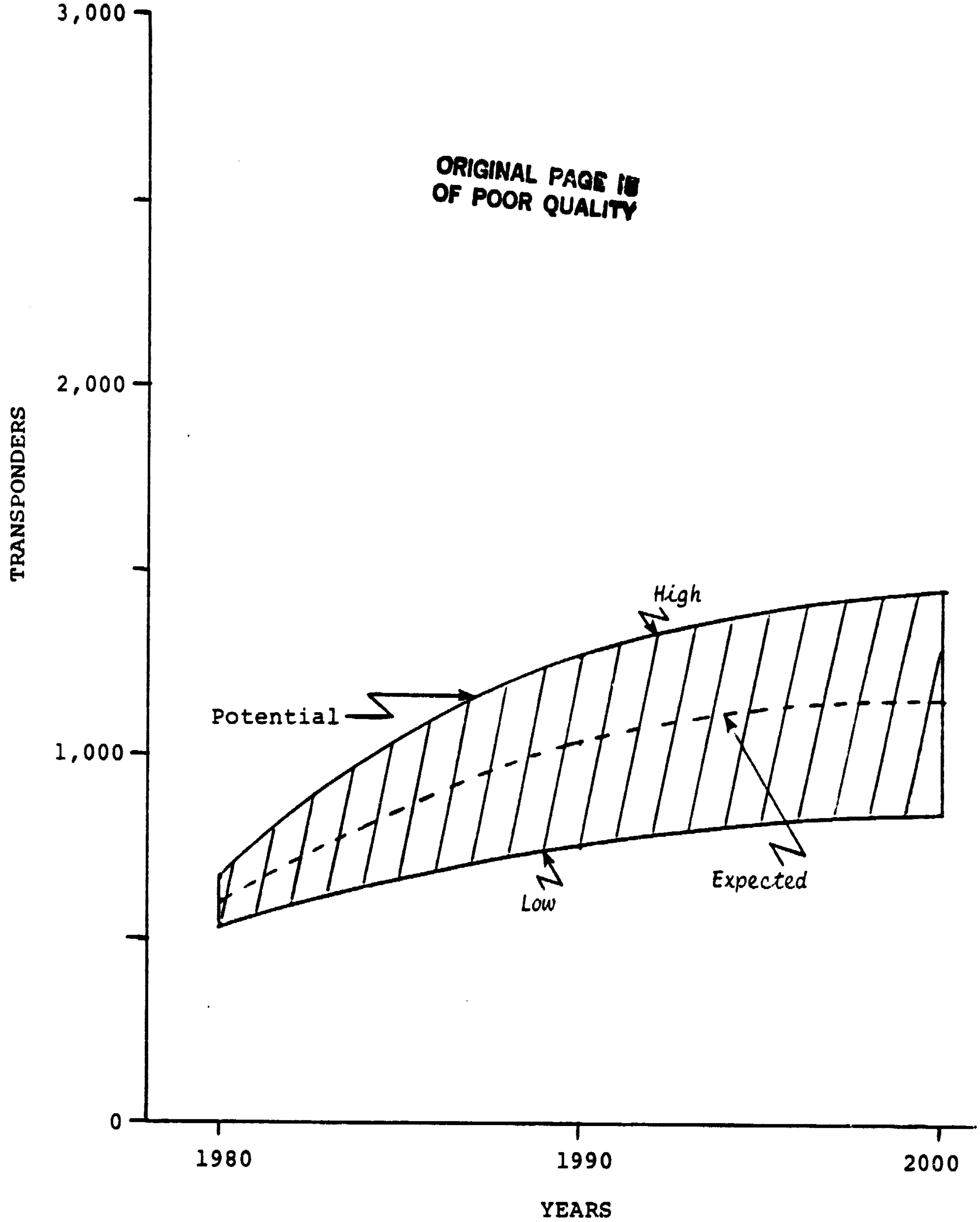

FIGURE 9-3. HIGH, EXPECTED AND LOW ESTIMATES OF POTENTIAL C- PLUS KU-BAND CAPACITY

TABLE 9-3. ESTIMATED ACTUAL CAPACITIES FOR C AND KU BANDS FOR 1980, 1990 and 2000

FORECASTS CONSIDERING GROWTH RATES

Band	1980	1990	2000
C	156	528	744
Ku	0	495	872
Total	156	1023	1616

FORECASTS CONSIDERING FILL PERCENTAGE

	1980	1990	2000
High Estimate (Fill % = 90)	140	921	1455
Expected Estimate (Fill % = 80)	125	818	1293
Low Estimate (Fill % = 70)	109	716	1131

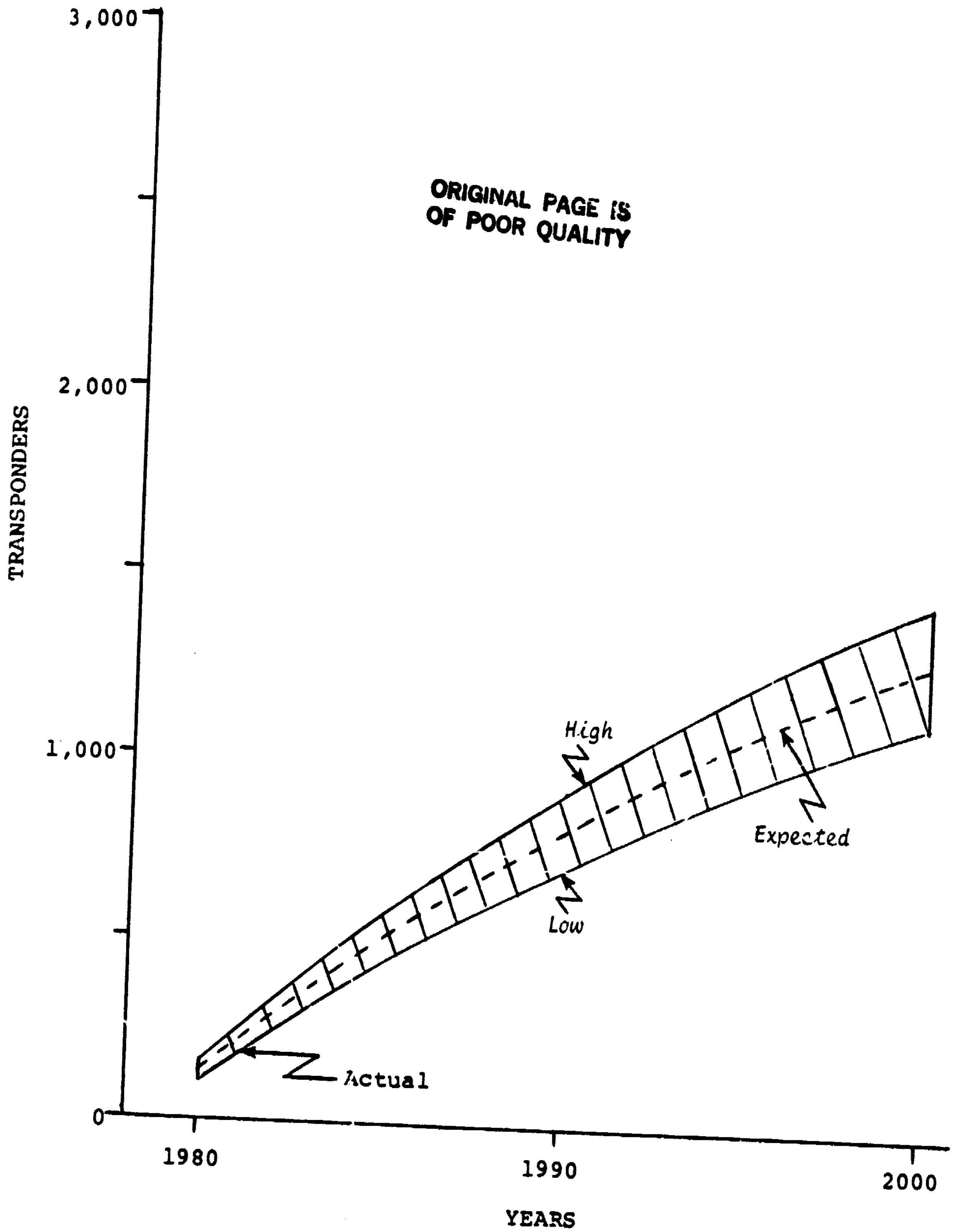

FIGURE 9-4. HIGH, EXPECTED AND LOW ESTIMATES OF ACTUAL C- PLUS KU-BAND CAPACITY

9.6 REQUIRED, POTENTIAL AND ACTUAL CAPACITIES

The factors which vary and those which are constant across high, expected and low estimates of required, potential and actual capacity are outlined in Table 9-4. The high, expected and low estimates for required, potential and actual capacities are listed, by year, in Table 9-5. These capacities are graphed in Figure 9-5. The reason the expected and low estimates of the actual forecast are higher than the expected and low estimates of the potential forecast in the year 2000 is that only one growth rate was used for projecting the actual forecast; the differences among the high, expected and low estimates of the actual forecast were determined solely by the fill factor. In reality, the actual capacity would always be less than or equal to the potential capacity. Figure 9-5 can be used to determine the saturation date of C and Ku-bands, given various assumptions. For example the following assumptions can be made and their impact noted as in Figure 9-6.

a. Assuming expected-required and expected-potential capacities with actual equalling potential, Ka-band will be needed around 1990.

b. Assuming low required and high potential capacities with actual equalling potential, Ka-band will be needed around 1995.

9.7 AREAS OF UNCERTAINTY

The following are the major areas of uncertainty where sensitivity analyses need to be conducted to determine the impact on the forecasts of varying the various factors.

9.7.1 Economic Factors

a. National - International economic conditions (reflected in impacted baseline forecasts)

b. Relative costs of satellite and terrestrial systems (reflected in net addressable forecasts)

c. Provider requirements - Satellite/terrestrial differential, fill percentage (reflected in potential and actual capacity forecasts).

9.7.2 Technological Factors

a. Modulation and coding improvements: Number of Half Voice Circuits/36 MHz Transponders, #Mbps/36 MHz, #kbps/HVC (reflected in required capacity forecasts)

b. Spacing and frequency reuse (reflected in potential capacity forecasts)

c. Creative integration of technological improvements (reflected in impacted baseline forecasts).

TABLE 9-4. SUMMARY OF FACTORS, VARIED AND HELD CONSTANT, IN DEVELOPING HIGH, EXPECTED AND LOW ESTIMATES OF REQUIRED, POTENTIAL AND ACTUAL CAPACITIES

FACTORS	CAPACITIES		
	Required	Potential	Actual
Factors that varied	1. Percent removed - common carrier consideration 2. Analog modulation techniques, #HVC/Transponder	1. Spacing 2. Fill Factor	1. Fill Factor
Factors Held Constant	1. Analog coding techniques, #kbps/HVC 2. Digital Modulation techniques, #Mbps/Transponder 3. Percent voice on analog and digital	1. Reuse	1. Growth beyond schedules

TABLE 9-5. SUMMARY OF REQUIRED, POTENTIAL AND ACTUAL CAPACITIES

	YEAR								
	1980			1990			2000		
CAPACITY	High	Expected	Low	High	Expected	Low	High	Expected	Low
Required	263	263	263	1236	1045	922	2960	2468	2073
Potential	681	605	529	1282	960	756	1455	1140	840
Actual	140	125	109	921	818	716	1455	1293	1131

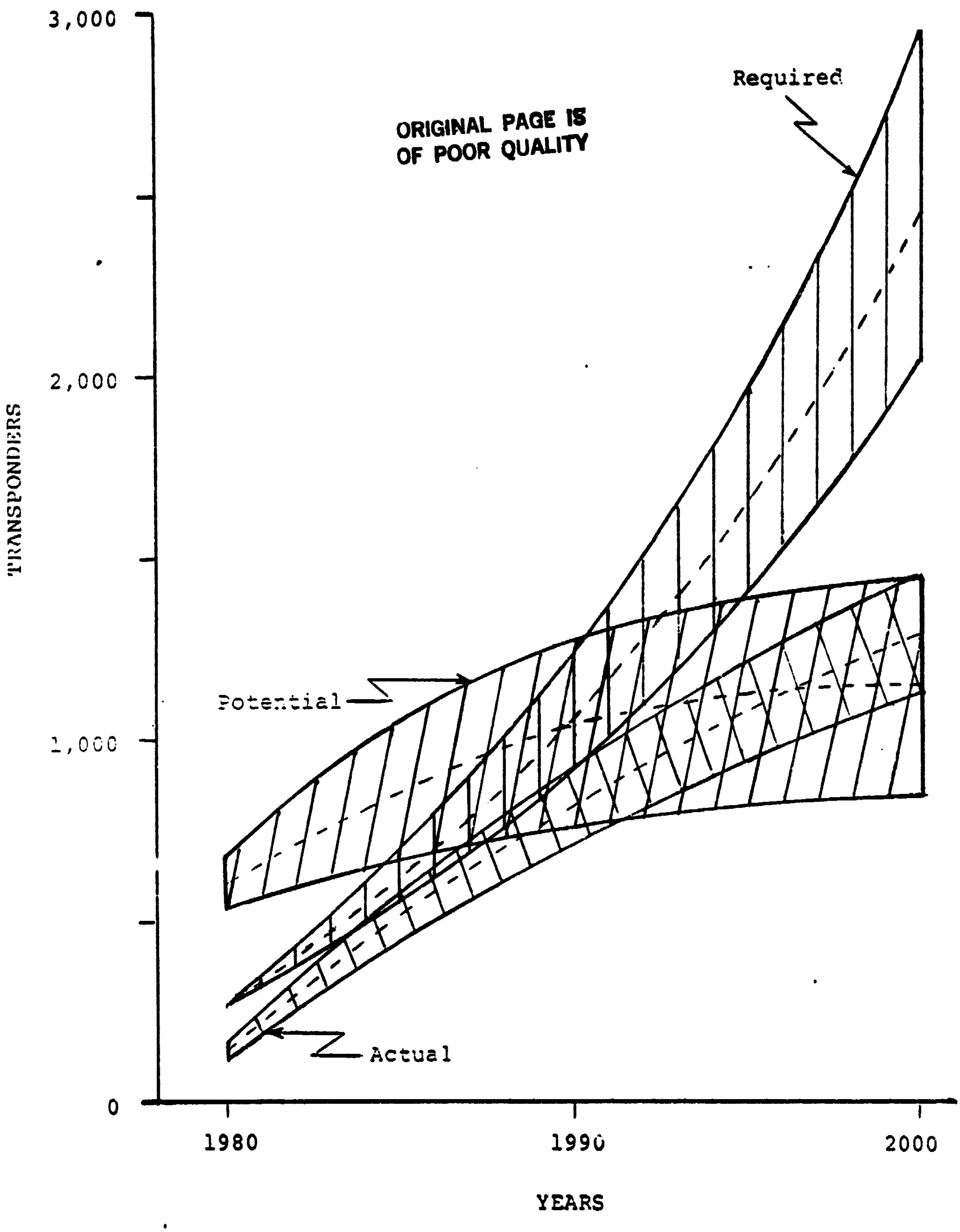

FIGURE 9-5. COMPARISON OF ESTIMATES OF CAPACITIES

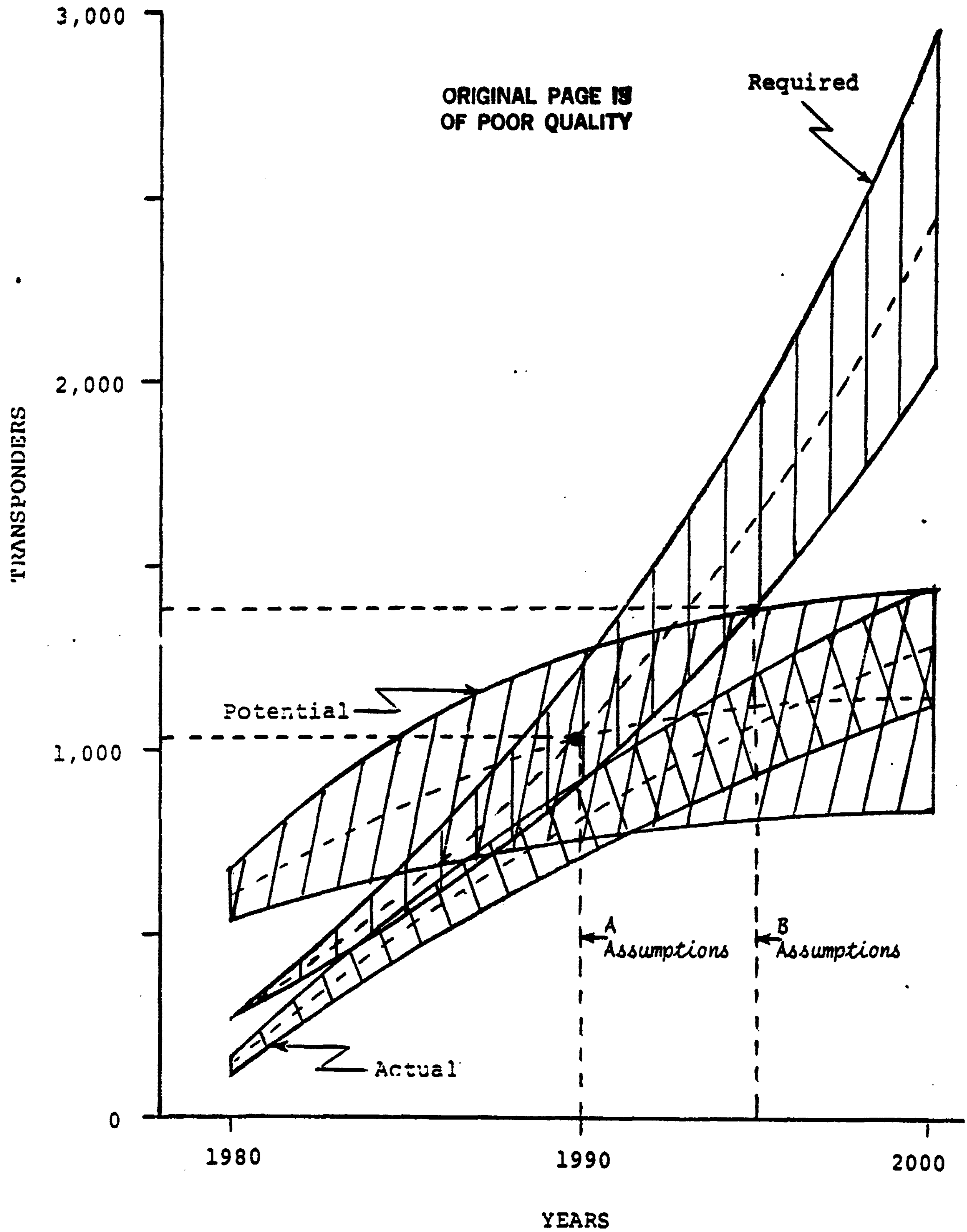

FIGURE 9-6. TWO SCENARIOS FOR SATURATION OF C AND KU-BANDS

SECTION 10
KA-BAND NET ACCESSIBLE FORECASTS

10.1 INTRODUCTION

This section discusses the Ka-band net accessible traffic which is that portion of the net addressable Ka-band traffic likely to be implemented on a Ka-band system. Two approaches to implementation are considered: an established carrier network and a specialized carrier network. In addition, various scenarios are drawn based on network size, economic feasibility and competition.

10.1.1 Specialized Carrier

Specialized common carriers do not have extensive terrestrial distribution systems augmenting a satellite network. These carriers must use a network approach which strategically locates a number of earth stations close to the major areas of market demand. Terrestrial distribution is limited for economic reasons, but subordinate areas of market demand can be linked where the traffic demand and tariffs (charged by established carriers for terrestrial facilities) indicate it is cost effective. The terrestrial extensions are required to create the "critical mass" of market demand necessary for a viable network. Areas of market demand may include multiple corporate users, joint (shared) user groups and dedicated users. Earth stations may be equipped with small, medium or large antennas depending on the type and quantity of traffic.

10.1.2 Established Carrier

Established common carriers have extensive terrestrial distribution systems which augment a satellite network. The established carrier network requires a limited number of high volume earth station locations serving large geographical areas. Two market coverage models for the established carrier or trunking approach were investigated. The first was based on ten earth station locations, the second on 20 locations. Market coverage for each model was calculated through use of a computer-based network optimization model.

Each earth station location serves the local Standard Metropolitan Statistical Area (SMSA), plus all neighboring SMSAs of a minimum threshold market size through terrestrial extension. The number of earth station locations within a given network also provides insight into the point of diminishing return where the incremental traffic is insufficient to support an additional earth station.

10.2 METHODOLOGY

The methodologies used for both specialized and established carriers were similar. Four major steps were involved in moving from Ka-band net addressable traffic to the Ka-band net accessible traffic (see Figure 10-1). These steps involved the:

a. Market distribution model
b. Parametric cost model
c. Ka-band net addressible forecast
d. Various market scenarios.

10.2.1 Market Distribution Model

The MDM was explained in detail in Section 5 and was used to establish the market profiles (route value matrices) used to determine the specialized and established carrier networks. Five principle data bases were used in the MDM to reflect the market profiles used. They were weighted individually and combined statistically within the model. The data bases selected and their weights are:

FILE	WEIGHT
Population in 1980	30
1980 Business Telephones	35
Bank Deposits	10
Non-Farm Employment	15
Number of Computer Sites	10

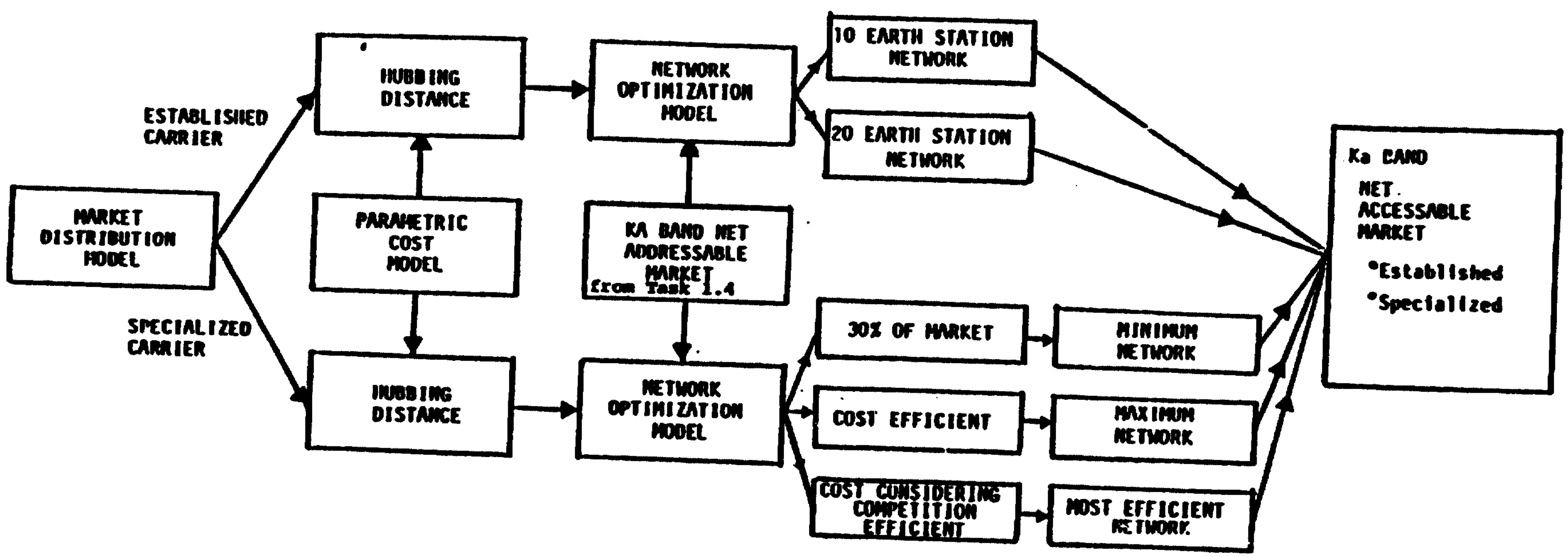

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FIGURE 10-1. ACTIVITY FLOW FOR NET ACCESSIBLE FORECASTS

10.2.2 Parametric Cost Model

The parametric cost model was explained in Section 6 and was used here to establish the hubbing distance. This is the same distance obtained from the terrestrial/satellite crossover (170 miles) used to determine satellite addressable traffic. This is only true for the established carriers, however, with an extensive terrestrial network. For specialized carriers which must lease lines from the established carriers the hubbing distance is 85 miles. In addition since specialized carriers must lease lines they must be concerned with the amount of traffic they gain through such a lease and the cost to lease a line. Thus a fringe area exists where the cost of the leased line becomes critical and it is necessary to look at the additional contribution which can be gained by adding an additional earth station. This fringe was found to begin 60 miles from the central SMSA. There are two ways which a SMSA located on the fringe can be included in a specialized carrier network. The amount of traffic generated to and from that particular SMSA to the rest of the network might justify adding it. If the traffic is not enough a SMSA still can be included if there is another SMSA within 25 miles (the fringe distance) with enough traffic to be justified. Figure 10-2 depicts the two types of network hubbing arrangements.

10.2.3 Ka-band Capacity Required

The key input to the network optimization model was the Ka-band capacity required. This was based on the Ka-band net addressable traffic forecast (Section 7) and the following assumptions:

a. Both C- and Ku-bands will fill up before Ka-band is used; only 2 Ka-band crossovers are less than crossovers for C- or Ku-bands
b. All traffic beyond the crossover distance will be satellite traffic; no margin is added to reflect a needed incentive to switch to satellite
c. Demand for satellite traffic will be a "minimum" demand forecast
d. C- and Ku-band capacity will be a "maximum" capacity forecast.

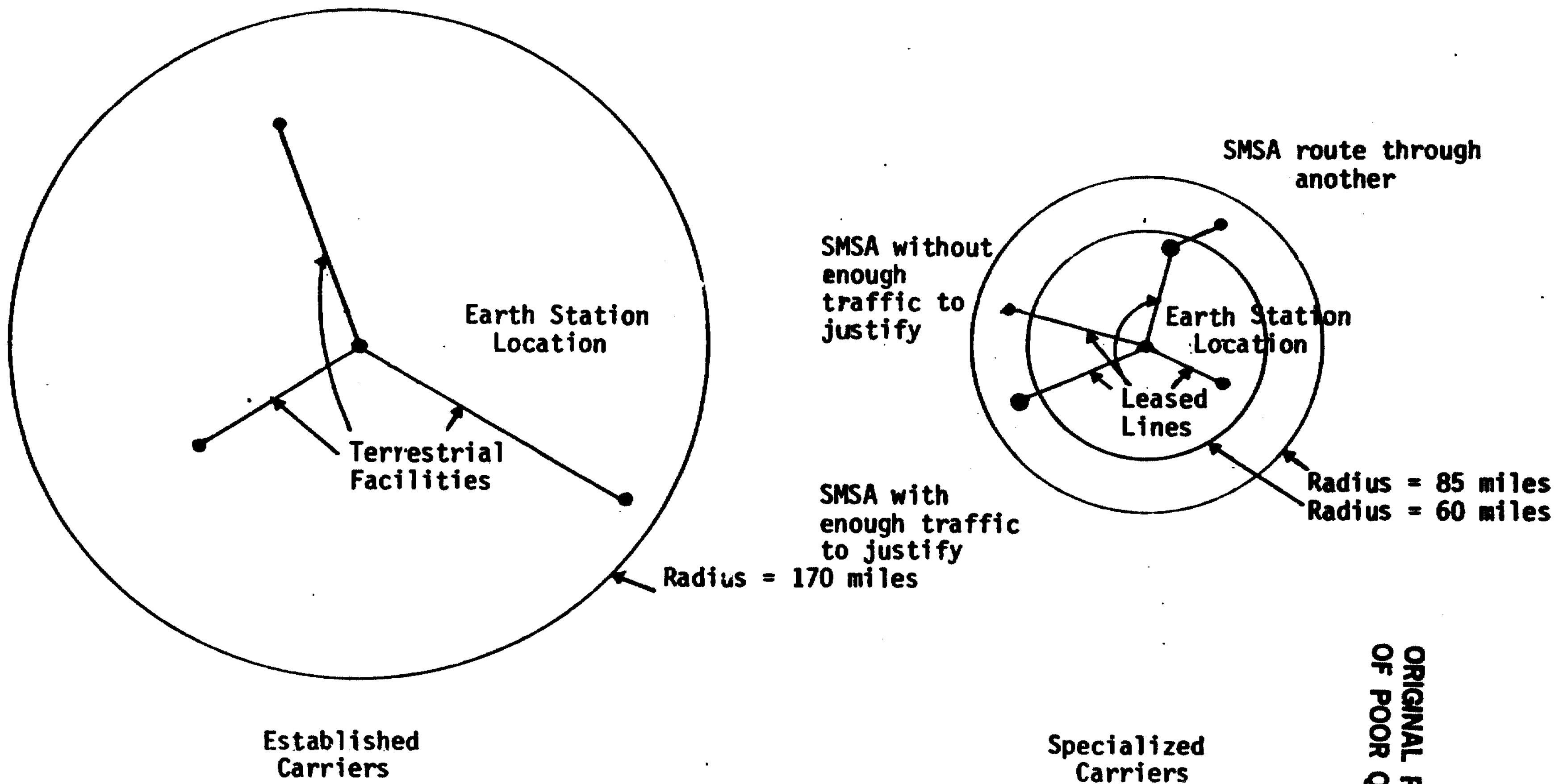

FIGURE 10-2. ESTABLISHED CARRIER AND SPECIALIZED CARRIER HUBBING ARRANGEMENTS

Using these assumptions, which resulted in a very conservative estimate (using maximum orbital capacity and minimum demand makes the estimate of when Ka-band will be needed as far into the future as possible), it was possible to determine the Ka-band capacity required (see Table 10-1). No additional capacity beyond the C-and Ku-bands is required in 1990. In 2000, 618 transponders or 55,620 Mbps of additional capacity is required, which given assumptions about technology must come from the Ka-band; the Ka-band net addressable for the year 2000 is more than sufficient to meet this requirement.

10.2.4 Network Optimization Model

The network market optimization model is a technique for attaining the maximum market value for "N" number of earth station locations. It does this by consecutively selecting the optimum earth station location given the network already in place. The incremental market value is that addition to the network which can be obtained by adding one more earth station along with its subordinate SMSAs. Thus the network is built by adding earth stations until some threshold coverage is achieved as determined by the various scenarios. In general the incremental market value declines as earth stations are added (see Figure 10-3).

10.2.4.1 Initial Selection

Using the market profiles and hubbing distances as inputs, it was possible to use the network optimization model to design various networks. The initial step was to determine all possible hubbed groups. This was performed by using each SMSA as a center and then hubbing all SMSAs within the hubbing distance. Thus 313 groups were formed with 97,969 routes using a hubbing distance of 170 miles for the established carriers and 60 miles, with an additional 25 mile fringe, for specialized carriers.

Once all the groups were formed it was necessary to determine the initial group to begin the network. This was done by summing all the route values for the different groups. A route value is the percent of traffic which could be expected between any two SMSAs (based on market profiles). Once all route values were

TABLE 10-1. CALCULATION OF REQUIRED KA-BAND CAPACITY

	1990	2000
Max C & Ku Capacity		
Transponders	1282	1455
Mbps	115380	130950
Min Satellite Demand		
Transponders	922	2073.2
Mbps	82980	186588
Needed Capacity (Capacity - Demand)		
Transponders	+360*	-618**
Mbps	+32400*	-55620

*Excess Capacity

**Needed Capacity = Ka-band Traffic

	1990	2000
Ka-band Net Addressable Forecast		
Transponders	942	1899
Mbps	84780	170910

Ka-band Capacity Required

	1990		2000	
	Ka-Net	Need	Ka-Net	Need
Transponders	942	0	1899	618
Mbps	84780	0	170910	55620

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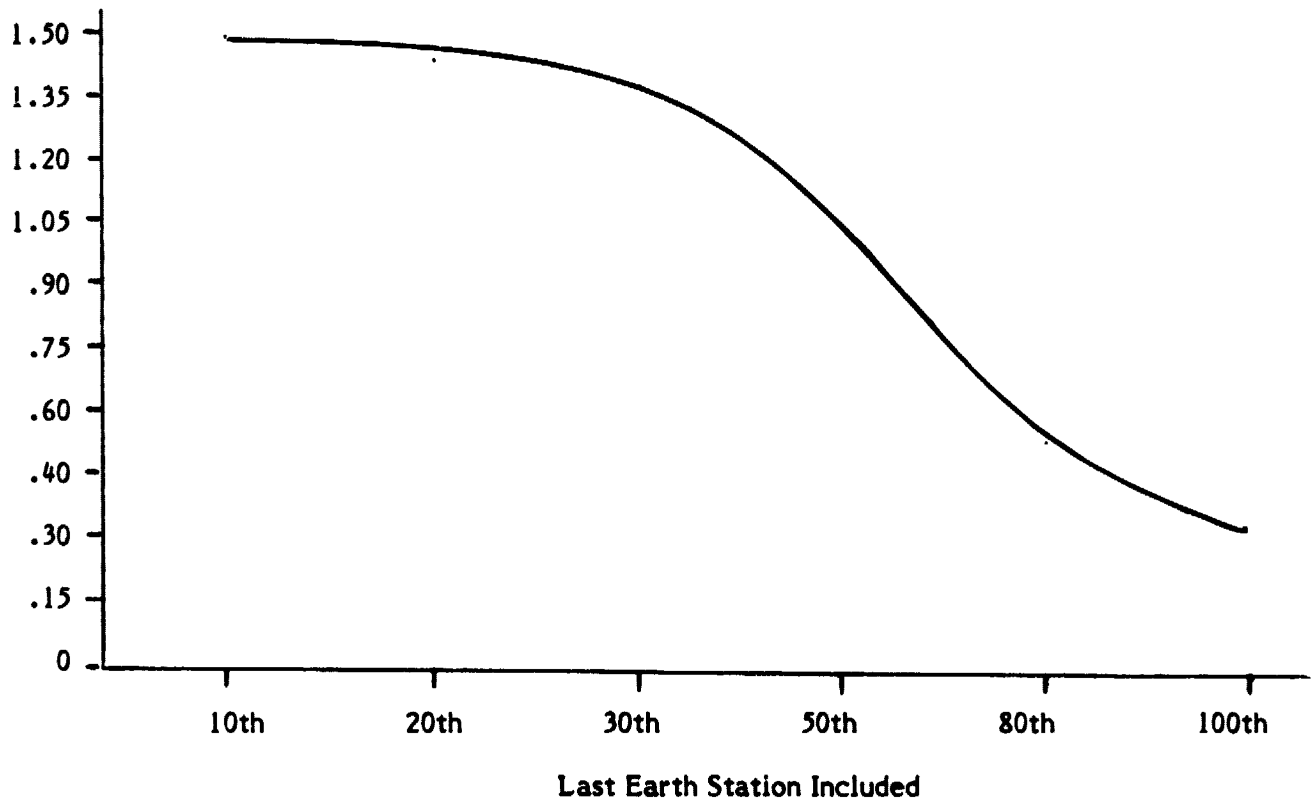

FIGURE 10-3. INCREMENTAL MARKET VALUE

summed for the 313 SMSA groups it was only necessary to select the group with the highest value to initiate the network.

10.2.4.2 Second Group Selection

Since SMSAs and therefore routes could be in more than one group when the groups were formed, it was necessary to eliminate the SMSAs and routes associated with the initial group selected from the remaining groups. Once the initial network group was selected it was possible to consecutively build the nationwide network. This was done by only considering routes to those SMSAs already in the network. The route values of these routes were called market values once the route was included in the network. Using only those routes to the initial group selected and summing the route values for the remaining 312 groups it was possible to select the second network group. This was done by selecting the group with the highest group route value. The route value of the group was then called the market value of adding that particular group.

10.2.4.3 Remaining Group Selection

The process for selecting the remaining groups was very similar to the selection of the second group. Every time a group was chosen those SMSAs and routes which overlapped with remaining groups were removed from the remaining groups. The route values of SMSAs not chosen were recomputed for the existing network and the highest group route value was selected.

This technique of forming all possible groups and selecting the largest for inclusion in the network established two important principles for the network optimization model. First, it allowed any SMSA to be the central hub (i.e. earth station location) of the group. Second, by selecting the group with the largest route value, it assured the network value (the sum of the group market value) was always maximized for the number of groups in the network.

10.2.5 Market Scenarios

The five market scenarios created as a part of this study effort defined two basic approaches to Ka-band system implementation: the specialized carrier model and the established carrier model as described above. Each approach included an analysis of network characteristics which affect the accessible market demand and serving capabilities.

10.2.5.1 Specialized Carrier Scenarios

The specialized carrier network demand was evaluated on the basis of three different earth station networks: minimum, most efficient and, maximum network sizes. Each network size represented a Ka-band system consisting of earth stations located in principal SMSAs and a number of subordinated SMSAs within a 60-85 mile radius.

a. Minimum Network

The minimum network size was defined as the smallest viable network based on geographical market coverage. From other common carrier experience it was clear that a network serving only a few markets and offering limited market coverage could not remain viable. In the early years of the specialized microwave carriers, for example, it took time for them to expand their network coverage to sufficient geographical coverage to attract new customers. Large communications users have a need to communicate to most of the principal U.S. cities and normally will seek a competitively priced carrier which offers service to the largest 15-20 metropolitan areas.

From market experience, it was determined that the minimum required market coverage is 30 percent of the total accessible market. At a 30 percent coverage level almost all of the principal centers of business activity would be served. Accordingly, an analysis was conducted to determine the total number of SMSA market values necessary to generate a 30 percent market coverage. Results of that analysis are discussed below.

b. Maximum Network

Determination of the maximum or largest earth station network involved consideration of economic trade-offs. As the incremental market value became progressively smaller until the last earth station location was included, it was necessary to identify the threshold where the incremental market value of adding N+1 earth stations could not be economically justified. A specialized carrier earth station site cost model was developed to serve this purpose. The major premise was that the incremental revenue/traffic accessible by any principal SMSA had to be sufficiently large to cover the annual cost of capital and operations of a 30/20 GHz earth station in that SMSA. The calculation of the number of circuits required to install a Ka-band earth station is summarized in Table 10-2. Market penetration of that incremental traffic was not a factor at this point.

c. Most Efficient Network Size

The earth station network which represented the most efficient size was the number of stations where each one incrementally generated sufficient traffic to economically justify it within a competitive carrier environment. An important step in this analysis was an attempt to define the extent of the competition in the 1990-2000 time period for 30/20 GHz markets. A competitive market scenario was created in which as many as four specialized carriers would be operating 30/20 GHz satellite networks. It was foreseen that the need for greater capacity and the availability of this higher frequency spectrum may attract four major specialized carrier competitors.

A further effort involved defining the relative market shares of each of these competitors for 30/20 GHz traffic. In the absence of any perceived clear-cut advantage one carrier may have over the others, it was decided that their respective market shares would be divided equally in fourths or 25 percent of the accessible market traffic in the smallest location served. Thus, given a market environment, where, due to competition, only 25 percent of the accessible market was available to one specialized carrier network, a minimum traffic requirement level could be established for the smallest SMSA.

For the maximum network scenario, the minimum traffic level per location was converted into minimum market value per end location required to economically

TABLE 10-2.
NUMBER OF CIRCUITS REQUIRED TO INSTALL A KA-BAND EARTH STATION

Annual Revenue Required for Ka-band Earth Station = \$1.73 million

Annual Space Segment Cost for VF Circuit = \$1.63 K

Minimum number of voice channels required to justify Ka-band Earth Station is calculated as follows:

$$n = \frac{\$173M + n \times \$1.63 \times 10^{3}M}{\text{VF Yearly Tariff}}$$

n (VF yearly tariff - 1.63×10^{-3}m) = \$1.73 M

n (8940 - 1630) = 1.73×10^{-6}

n = 236.7 = 237 VF Circuits

Minimum traffic required on an Earth Station to be cost justified is 15.3 Mbps.

Since the minimum earth station was designed for constant use, a usage curve must be assumed and a peaking factor used to relate the traffic needed to justify an earth station with the peak hour traffic in the system.

Peaking Factor = 3

Minimum Peak Hour Traffic to Justify E/S = 45.6 Mbps justify locating a 30/20 GHz common earth station in a SMSA. The most efficient network sizing minimum market value criteria was developed with the assumption that only one-fourth of the SMSAs accessible traffic would be available to justify locating the 30/20 GHz earth station. Therefore, the minimum market value per end location was increased by a factor of four to .33 percent. Accordingly an analysis was conducted to determine where the incremental market value of adding one more earth station was not cost effective. Results of that analysis are shown below.

10.2.6 Established Carrier Scenarios

Two market coverage models for the Ka-band established carrier network approach were analyzed. The first market model contained 10 earth station locations, the second contained 20 locations. Calculations of the respective market coverages and net accessible markets for each model were made, taking into account the terrestrial extensions necessary to reach the maximum market. Variations in service price were not considered because a public carrier's justification for use of a 30/20 GHz satellite system may have little to do with service price. For an established carrier the use of a high capacity satellite system may be based on it providing network backup, the more efficient handling of specialized service, or competitive necessity. The market coverage of these networks was expressed in terms of the proportion of the served accessible market. The market values also represent the satellite communications activity being served by the established carrier network earth stations. The 30/20 GHz market forecasts by service and peak traffic load are presented below.

10.3 RESULTS

10.3.1 Market Development

Both the specialized and established carrier accessible 30/20 GHz markets were developed from the net addressable market traffic forecast discussed in Section 7. The final step in development of the 30/20 GHz net accessible market was the application of the market values obtained in the network sizing efforts (discussed above) to the accessible market demand traffic. The addressable market assumes nationwide geographic coverage, whereas the cumulative market values for each network reflect only the markets actually served by the 30/20 GHz earth stations and their subordinate SMSAs. The net accessible market forecasts for 2000 were developed by applying the market values, defined by specific geographic coverage for each of the earth station networks. The detailed results of these analyses are presented in Appendix I, while summary results are presented below.

10.3.2 Specialized Carrier

A summary of the specialized carrier network is given in Table 10-3. This table shows that 110 earth stations with 203 subordinate SMSAs is enough to cover the entire Ka-band addressable market. This printout was key in the analysis of the accessible traffic due to the various specialized carrier scenarios.

10.3.2.1 Minimum Market Network

Using the criterion that the minimum market network must be 30 percent of the total market along with Table 10-3 revealed that 22 earth stations were needed and 116 subordinate SMSAs were included in the top 30 percent. Figure 10-4 shows the earth station locations for the minimum market network.

10.3.2.2 Maximum Market Network

As discussed earlier, the development of the maximum market network required the creation of an earth station site cost model to determine the smallest amount of traffic in a SMSA location to economically justify placement of a specialized carrier earth station. From this the smallest incremental market value for the last principal SMSA was determined to be .082 percent (45.6/55,620 = 0.082%; 45.6 from Table 10-2 and 55,620 from Table 10-1). Using the smallest incremental value and Table 10-3 it was possible to conclude that all earth stations could be economically justified (i.e., .24% > .082%).

10.3.2.3 Most Efficient Market Network

The most efficient specialized network was defined as one in which the smallest incremental SMSA generates sufficient communications traffic within a competitive carrier environment. In the selected competitive market scenario for the

TABLE 10-3. SUMMARY OF SPECIALIZED CARRIER NETWORK

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		NO. SMSA'S	GROUP MARKET VALUE	CUM GROUP MARKET VALUE
1	NEW YORK NY-NJ	20		
2	CANTON OH	9	1.33	1.33
3	RACINE WI	5	1.21	2.54
4	JACKSON MI	6	0.93	3.47
5	SPRINGFIELD-CHICOPEE-HOLYOKE CT-MA	12	1.16	4.63
6	HAGERSTOWN MD	8	1.81	6.43
7	MUNCIE IN	6	1.15	7.58
8	GREENSBORO-WINSTON-SALEM-HIGH NC	7	1.92	9.50
9	ANNISTON AL	5	1.44	10.94
10	SPRINGFIELD IL	5	1.36	12.30
11	DUBUQUE IA	6	1.18	13.48
12	OXNARD-SIMI VALLEY-VENTURA CA	4	1.44	14.92
13	STOCKTON CA	6	1.42	16.34
14	PETERSBURG-COLONIAL HEIGHTS-HO VA	5	1.64	17.97
15	LAKELAND-WINTER HAVEN FL	4	1.10	19.07
16	ELMIRA NY	6	1.67	20.74
17	LEXINGTON-FAYETTE KY	3	1.64	22.38
18	ROCHESTER MN	4	1.62	24.01
19	ASHEVILLE NC	5	1.66	25.67
20	LIMA OH	4	1.59	27.25
21	BEAUMONT-PORT ARTHUR-ORANGE TX	4	1.58	28.83
22	KANSAS CITY MO-KS	4	1.53	30.36
23	BENTON HARBOR MI	5	1.51	31.87
24	BILOXI-GULFPORT MS	4	1.44	33.31
25	JACKSONVILLE NC	4	1.45	34.76
26	PARKERSBURG-MARIETTA WV-OH	4	1.46	36.22
27	COLUMBIA SC	4	1.46	37.68
28	DENVER-BOULDER CO	4	1.46	39.14
29	FORT LAUDERDALE-HOLLYWOOD FL	3	1.48	40.62
30	OCALA FL	4	1.44	42.05
31	COLUMBUS GA-AL	4	1.41	43.46
32	DALLAS-FORT WORTH TX	2	1.37	44.83
33	PROVIDENCE-WARWICK-PAWTUCKET RI-MA	4	1.32	46.16
34	TERRE HAUTE IN	4	1.33	47.49
35	BUFFALO NY	2	1.31	48.80
36	GLENS FALLS NY	4	1.34	50.14
37	APPLETON-OSHKOSH WI	4	1.35	51.48
38	BREMERTON WA	4	1.17	52.65
39	VINELAND-MILLVILLE-BRIDGETON NJ	4	1.31	53.96
40	LONGVIEW TX	4	1.28	55.24
41	LAWTON OK	3	1.28	56.52
42	AUSTIN TX	3	1.29	57.81
43	CLARKSVILLE-HOPKINSVILLE TN-KY	2	1.25	59.06
44	BAY CITY MI	3	1.24	60.30
45	JOPLIN MO	3	1.15	61.45
46	LAFAYETTE LA	3	1.15	62.60
47	FORT WALTON BEACH FL	3	1.10	63.70
48	LINCOLN NE	2	1.07	64.77
49	SALEM OR	3	1.00	65.78
50	BRADENTON FL	3	0.96	66.74
51	CHARLESTON-NORTH CHARLESTON SC	2	0.97	67.70
52	LITTLE ROCK-NORTH LITTLE ROCK AR	2	0.96	68.66
53	EVANSVILLE IN-KY	2	0.93	69.59

TABLE 10-3. SUMMARY OF SPECIALIZED CARRIER NETWORK (CONTINUED)

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		NO. SMSA'S	GROUP MARKET VALUE	CUM GROUP MARKET VALUE
54	MEMPHIS TN-AR	1	0.91	70.50
55	PROVO-OREM UT	2	0.85	71.35
56	VISALIA-TULARE-PORTERVILLE CA	3	0.78	72.13
57	PHOENIX AZ	1	0.78	72.91
58	CEDAR RAPIDS IA	2	0.76	73.67
59	LEWISTON-AUBURN ME	2	0.76	74.43
60	YUBA CITY CA	3	0.74	75.17
61	SAN DIEGO CA	1	0.75	75.92
62	SIOUX CITY NE-IA	2	0.74	76.67
63	BANGOR ME	2	0.74	77.40
64	TULSA OK	1	0.72	78.13
65	EL PASO TX	2	0.72	78.84
66	FARGO-MOORHEAD ND-MN	2	0.70	79.54
67	MIDLAND TX	2	0.68	80.21
68	CORPUS CHRISTI TX	2	0.67	80.89
69	ALTOONA PA	2	0.67	81.56
70	BROWNSVILLE-HARLINGEN-SAN BENI TX	2	0.67	82.23
71	BRYAN-COLLEGE STATION TX	2	0.66	82.89
72	ABILENE TX	2	0.66	83.55
73	CHATTANOOGA TN-GA	1	0.64	84.19
74	DES MOINES IA	1	0.64	84.83
75	WICHITA KS	1	0.59	85.42
76	JACKSON MS	1	0.57	85.99
77	SALINAS-SEASIDE-MONTEREY CA	2	0.55	86.54
78	DULUTH-SUPERIOR MN-WI	1	0.52	87.06
79	RICHLAND-KENNEWICK WA	2	0.51	87.57
80	ALBUQUERQUE NM	1	0.51	88.08
81	RIVERSIDE-SAN BERNARDINO-ONTAR CA	1	0.51	88.59
82	HAMILTON-MIDDLETOWN OH	1	0.50	89.09
83	LORAIN-ELYRIA OH	1	0.48	89.57
84	LYNCHBURG VA	1	0.48	90.05
85	LAS VEGAS NV	1	0.48	90.52
86	TUCSON AZ	1	0.48	91.00
87	FORT SMITH AR-OK	1	0.48	91.48
88	ATHENS GE	1	0.45	91.93
89	FLORENCE AL	1	0.45	92.38
90	TALLAHASSEE FL	1	0.45	92.83
91	LUBBOCK TX	1	0.44	93.27
92	TUSCALOOSA AL	1	0.43	93.71
93	COLUMBIA MO	1	0.43	94.14
94	MONROE LA	1	0.43	94.58
95	AMARILLO TX	1	0.43	95.00
96	ST CLOUD MN	1	0.41	95.42
97	KANKAKEE IL	1	0.39	95.80
98	SPOKANE WA	1	0.38	96.18
99	ENID OK	1	0.37	96.55
100	PUEBLO CO	1	0.36	96.91
101	BOISE CITY ID	1	0.36	97.26
102	RENO NV	1	0.34	97.60
103	BISMARK ND	1	0.33	97.93
104	BILLINGS MT	1	0.33	98.27
105	LAREDO TX	1	0.32	98.59
106	CASPER WY	1	0.31	98.90
107	GREAT FALLS MT	1	0.30	99.20
108	MEDFORD OR	1	0.29	99.49
109	REDDING CA	1	0.27	99.76
110	BELLINGHAM WA	1	0.24	100.00

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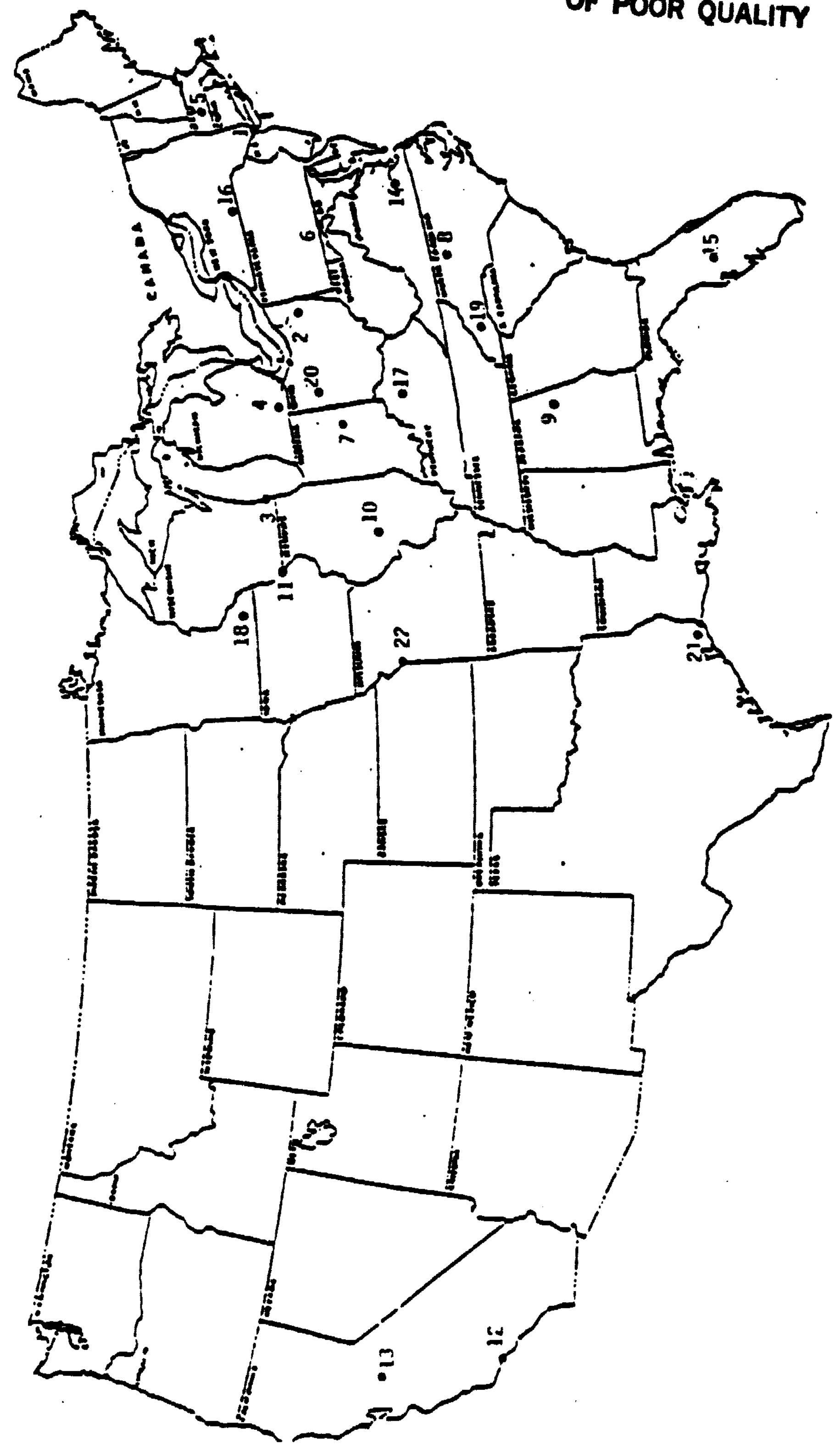

FIGURE 10-4. SPECIALIZED COMMON CARRIER - MINIMUM NETWORK

30/20 GHz satellite market four carriers will be vying for an equal share of each principal SMSA. Therefore, the minimal amount of traffic per location will have to be four times larger than in the maximum network model. This translates into a minimum market value for any SMSA of .328 percent of the accessible market (i.e., 4 x .082% = .328%). Using the minimum market value and Table 10-3 it was possible to conclude that the first 104 earth station locations, including 203 subordinate SMSAs, were economically feasible in a competitive environment.

Figure 10-5 presents a map of the continental U.S. showing the earth station location. The names corresponding with the numbers can be found using Table 10-3. In addition now that the number of earth stations justified for the most efficient market was known it was possible to recompute the market value so it represents the percent of the accessible market each SMSA and group contributes to the entire network. The recomputed network is presented in Table 10-4. An interesting thing to note is that the percent of accessible traffic contributed by adding the last earth station (104) is .17 less than the incremental value to justify an earth station (i.e., .328). The reason an earth station is justified is that when the market value was originally computed it included all traffic which adding the last earth station brought to the network, both to and from. When the network is recomputed, knowing which earth stations are in the network, only the information sent by an earth station is counted, so that traffic is not counted twice.

10.3.3 Established Carrier

Two established carrier earth station network models were created as a result of the previous methodology. The market coverage of these networks was expressed in terms of the proportion of the served accessible market. The market value also represented the satellite communications activity being served by the established carrier or trunking network earth stations.

10.3.3.1 Ten Earth Station Networks

The ten earth station locations selected for the trunking network are displayed in Figure 10-6. These locations, representing the optimum market coverage are indicated in Table 10-5. In addition to the ten earth station locations, a total of

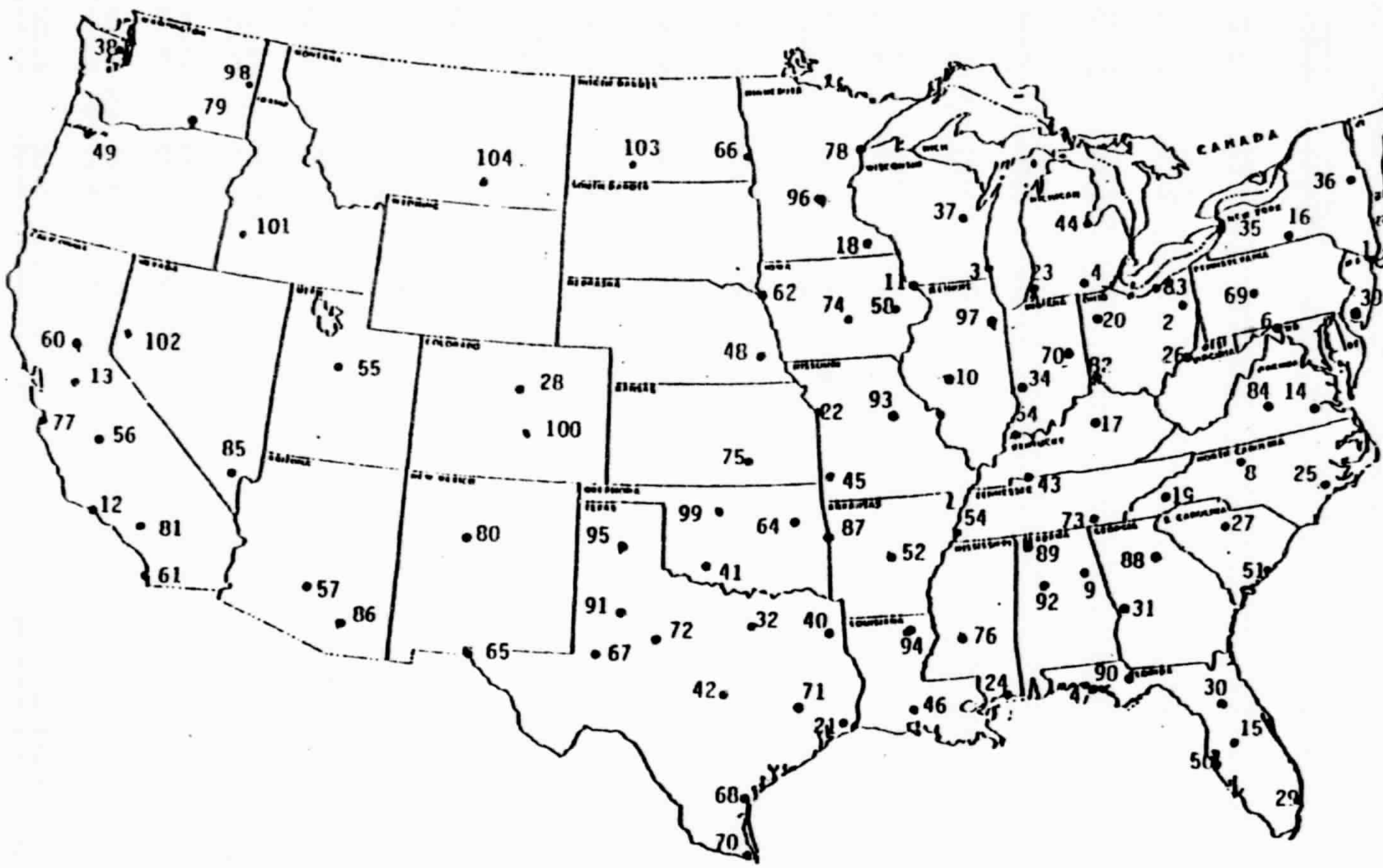

FIGURE 10-5. SPECIALIZED COMMON CARRIER - MOST EFFICIENT NETWORK

TABLE 10-4. SUMMARY MOST EFFICIENT NETWORK REPORT

		NO. SMSA'S	GROUP MARKET VALUE	CUM GROUP MARKET VALUE
1	NEW YORK NY-NJ	20	9.77	9.77
2	CANTON OH	9	3.85	13.62
3	RACINE WI	5	4.02	17.64
4	JACKSON MI	6	2.75	20.40
5	SPRINGFIELD-CHICOPEE-HOLYOKE CT-MA	12	3.17	23.56
6	HAGERSTOWN MD	8	3.56	27.12
7	MUNCIE IN	6	1.88	29.00
8	GREENSBORO-WINSTON-SALEM-HIGH NC	7	2.32	31.33
9	ANNISTON AL	5	2.15	33.48
10	SPRINGFIELD IL	5	2.00	35.48
11	DUBUQUE IA	6	1.47	36.95
12	OXNARD-SIMI VALLEY-VENTURA CA	4	2.83	39.78
13	STOCKTON CA	6	1.89	41.67
14	PETERSBURG-COLONIAL HEIGHTS-HO VA	5	1.63	43.30
15	LAKELAND-WINTER HAVEN FL	4	1.20	44.50
16	ELMIRA NY	6	1.68	46.18
17	LEXINGTON-FAYETTE KY	3	1.60	47.78
18	ROCHESTER MN	4	1.68	49.46
19	ASHEVILLE NC	5	1.41	50.87
20	LIMA OH	4	1.47	52.34
21	BEAUMONT-PORT ARTHUR-ORANGE TX	4	1.70	54.04
22	KANSAS CITY MO-KS	4	1.36	55.40
23	BENTON HARBOR MI	5	1.24	56.64
24	BILOXI-GULFPORT MS	4	1.25	57.89
25	JACKSONVILLE NC	4	1.07	58.96
26	PARKERSBURG-MARIETTA WV-OH	4	1.07	60.03
27	COLUMBIA SC	4	1.07	61.10
28	DENVER-BOULDER CO	4	1.31	62.41
29	FORT LAUDERDALE-HOLLYWOOD FL	3	1.21	63.62
30	OCALA FL	4	1.02	64.63
31	COLUMBUS GA-AL	4	0.98	65.61
32	DALLAS-FORT WORTH TX	2	1.13	66.74
33	PROVIDENCE-WARWICK-PAWTUCKET RI-MA	4	0.92	67.66
34	TERRE HAUTE IN	4	0.91	68.57
35	BUFFALO NY	2	0.87	69.45
36	GLENS FALLS NY	4	0.88	70.32
37	APPLETON-OSHKOSH WI	4	0.87	71.19
38	BREMERTON WA	4	0.85	72.04
39	VINELAND-MILLVILLE-BRIDGETON NJ	4	0.85	72.89
40	LONGVIEW TX	4	0.86	73.75
41	LAWTON OK	3	0.89	74.64
42	AUSTIN TX	3	0.89	75.53
43	CLARKSVILLE-HOPKINSVILLE TN-KY	2	0.78	76.30
44	BAY CITY MI	3	0.75	77.06
45	JOPLIN MO	3	0.70	77.75
46	LAFAYETTE LA	3	0.73	78.48
47	FORT WALTON BEACH FL	3	0.65	79.13
48	LINCOLN NE	2	0.67	79.80
49	SALEM OR	3	0.66	80.46
50	BRADENTON FL	3	0.56	81.02
51	CHARLESTON-NORTH CHARLESTON SC	2	0.55	81.57
52	LITTLE ROCK-NORTH LITTLE ROCK AR	2	0.56	82.13
53	EVANSVILLE IN-KY	2	0.53	82.66

TABLE 10-4. SUMMARY MOST EFFICIENT NETWORK REPORT (CONTINUED)

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		NO. SMSA'S	GROUP MARKET VALUE	CUM GROUP MARKET VALUE
54	MEMPHIS TN-AR	1	0.54	83.20
55	PROVO-OREM UT	2	0.54	83.74
56	VISALIA-TULARE-PORTERVILLE CA	3	0.48	84.22
57	PHOENIX AZ	1	0.50	84.72
58	CEDAR RAPIDS IA	2	0.43	85.15
59	LEWISTON-AUBURN ME	2	0.41	85.56
60	YUBA CITY CA	3	0.42	85.98
61	SAN DIEGO CA	1	0.47	86.45
62	SIOUX CITY NE-IA	2	0.41	86.86
63	BANGOR ME	2	0.39	87.25
64	TULSA OK	1	0.42	87.67
65	EL PASO TX	2	0.41	88.08
66	FARGO-MOORHEAD ND-MN	2	0.38	88.46
67	MIDLAND TX	2	0.37	88.83
68	CORPUS CHRISTI TX	2	0.37	89.19
69	ALTOONA PA	2	0.36	89.55
70	BROWNSVILLE-HARLINGEN-SAN BENI TX	2	0.37	89.92
71	BRYAN-COLLEGE STATION TX	2	0.36	90.28
72	ABILENE TX	2	0.35	90.63
73	CHATTANOOGA TN-GA	1	0.34	90.97
74	DES MOINES IA	1	0.35	91.32
75	WICHITA KS	1	0.32	91.64
76	JACKSON MS	1	0.30	91.94
77	SALINAS-SEASIDE-MONTEREY CA	2	0.30	92.24
78	DULUTH-SUPERIOR MN-WI	1	0.27	92.51
79	RICHLAND-KENNEWICK WA	2	0.27	92.78
80	ALBUQUERQUE NM	1	0.28	93.05
81	RIVERSIDE-SAN BERNARDINO-ONTAR CA	1	0.27	93.33
82	HAMILTON-MIDDLETOWN OH	1	0.26	93.58
83	LORAIN-ELYRIA OH	1	0.25	93.83
84	LYNCHBURG VA	1	0.25	94.08
85	LAS VEGAS NV	1	0.25	94.33
86	TUCSON AZ	1	0.25	94.58
87	FORT SMITH AR-OK	1	0.25	94.83
88	ATHENS GE	1	0.23	95.06
89	FLORENCE AL	1	0.23	95.29
90	TALLAHASSEE FL	1	0.23	95.52
91	LUBBOCK TX	1	0.23	95.74
92	TUSCALOOSA AL	1	0.22	95.96
93	COLUMBIA MO	1	0.22	96.18
94	MONROE LA	1	0.22	96.40
95	AMARILLO TX	1	0.22	96.62
96	ST CLOUD MN	1	0.21	96.83
97	KANKAKEE IL	1	0.20	97.03
98	SPOKANE WA	1	0.19	97.22
99	ENID OK	1	0.19	97.40
100	PUEBLO CO	1	0.18	97.58
101	BOISE CITY ID	1	0.18	97.76
102	RENO NV	1	0.17	97.93
103	BISMARK ND	1	0.17	98.10
104	BILLINGS MT	1	0.17	98.27

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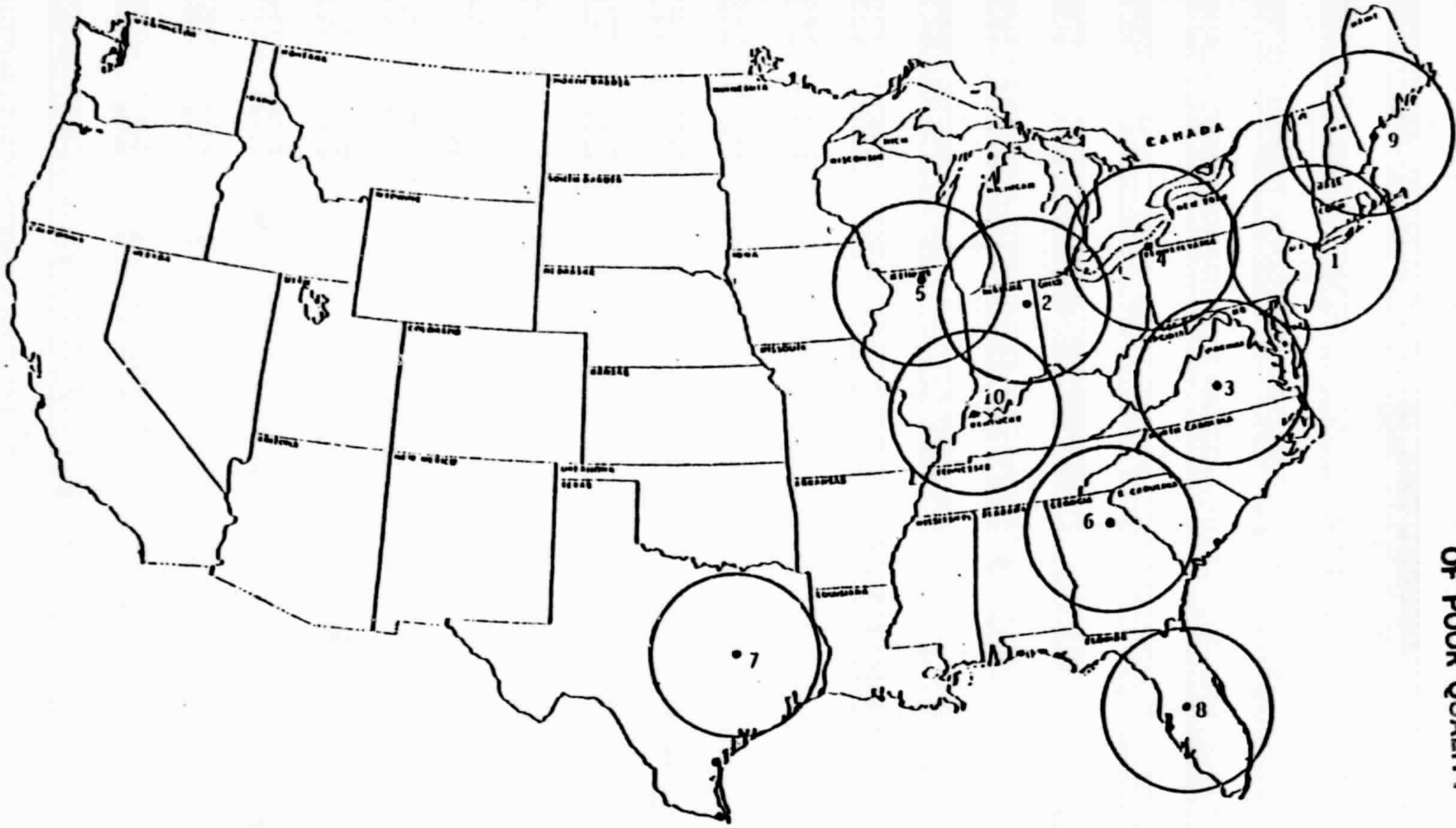

PERCENT CAPTURED = 42.53

FIGURE 10-6. ESTABLISHED COMMON CARRIER - 10 EARTH STATION MODEL

TABLE 10-5. SUMMARY OF 10 EARTH STATION REPORT

ORDER OF SELECTION	EARTH STATION LOCATION	LARGEST SMSA IN GROUP	NUMBER OF SUBORDINATES SMSAS	GROUP MARKET VALUE	CUM GROUP MARKET VALUE
1.	NEW YORK, NY-NJ	NEW YORK	41	10.02	10.02
2.	FT. WAYNE, IN	CHICAGO	32	8.09	18.11
3.	Lynchburg, VA	Washington	18	4.69	22.80
4.	Erie, PA	Pittsburgh	14	4.18	26.97
5.	Rockford, IL	Milwaukee	19	3.31	30.29
6.	Athens, GE	Atlanta	14	3.34	33.62
7.	Bryan - College Stn, TX	Dallas	11	2.35	35.98
8.	Lakeland-Winterhaven, FL	Tampa	12	2.25	38.23
9.	Portland, ME	Boston	11	2.19	40.42
10.	Evansville In, KY	Indianapolis	6	2.11	42.53

178 subordinate SMSAs would be interconnected to the network. The 10 locations plus their subordinate SMSAs would provide market coverage for 42.5 percent of the addressible market.

10.3.3.2 Twenty Earth Station Networks

The optimal 20 trunking earth station network's approximate geographical coverage is shown in Figure 10-7. It was determined that the first 10 stations were identical in both the twenty and ten station model because of their very large market values. However, the market values for these top ten locations were greater in the twenty station network because their universe of communications (10 other stations plus their subordinate SMSAs) is larger than the ten station network. For example, New York and its subordinate SMSAs have a smaller market value in the ten station model and than in the larger model. The twenty earth station location selected for the established carrier model are indicated in Table 10-6. The 20 locations plus their 245 subordinate SMSAs provide market coverage for 75 percent of the addressable market.

It is interesting to note that in both the 10 and 20 established carrier network's, the east coast is heavily weighted with earth stations. An analysis of how the model works reveals why this is correct. The model always selects the group which will contribute the maximum percentage of traffic to the existing network. In addition, the attractiveness of SMSAs to communicate with one another declines as the distance between them increases. Thus the model selects several places in the east before jumping to the west coast. In reality an established carrier may prefer to haul long distance traffic (over 2000 miles) rather than the shorter distances because the profit margins are significantly higher.

Another area profit margins may affect is the location of the earth station and the terrestrial distance traffic must be transmitted. The model currently selects the location which will maximize the coverage of the earth station. In some instances this may mean carrying large amounts of traffic over a long distance. Although this distance is still within the hubbing distance and therefore economically feasible it may not provide the maximum profit margin.

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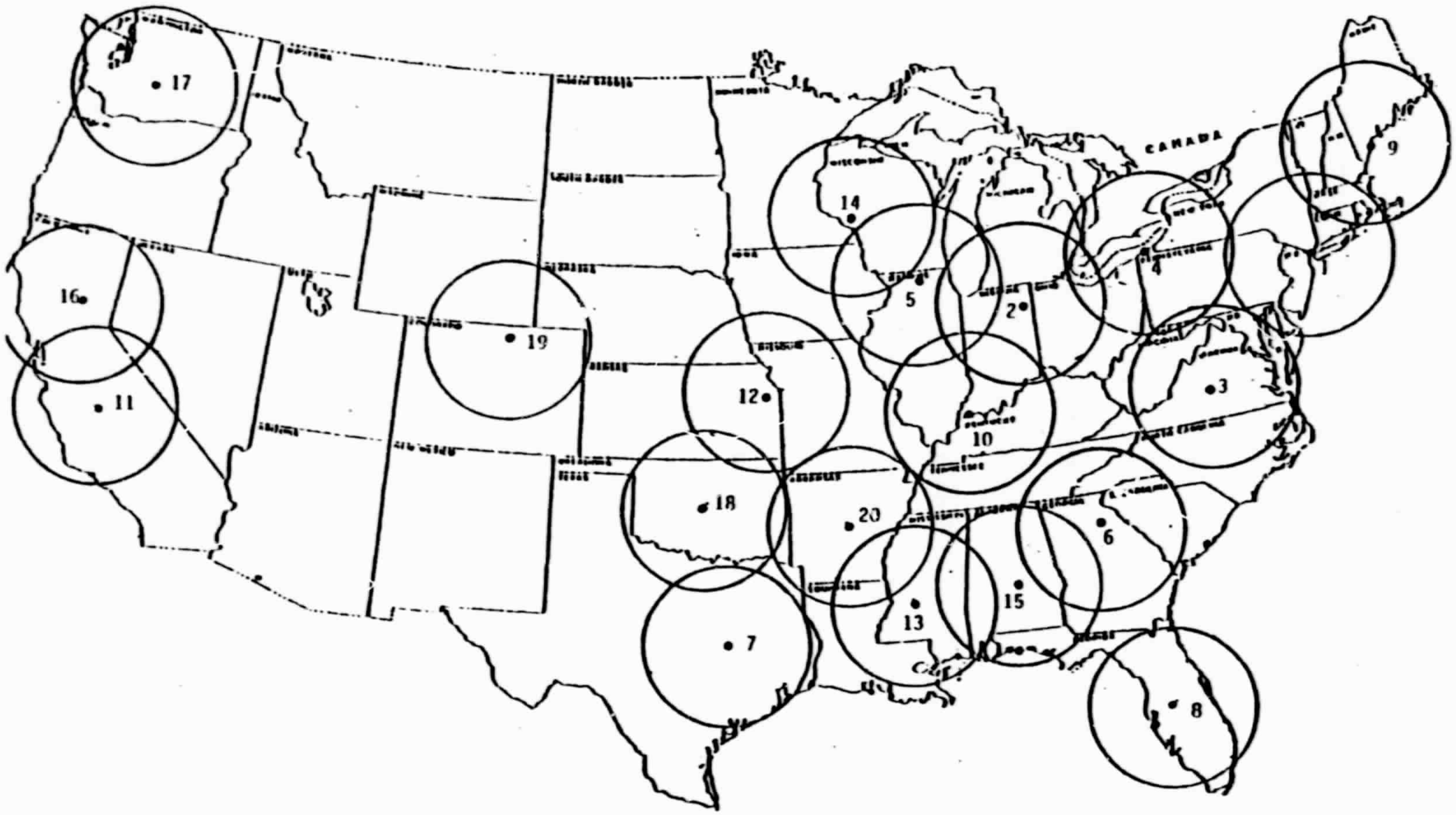

PERCENT CAPTURED = 74.98

FIGURE 10-7. ESTABLISHED COMMON CARRIER - 20 EARTH STATION MODEL

TABLE 10-6. SUMMARY OF 20 EARTH STATION NETWORK REPORT

ORDER OF SELECTION	EARTH STATION LOCATION	LARGEST SMSA IN GROUP	NUMBER OF SUBORDINATES SMSAS	GROUP VALUE	CUM GROUP MARKET VALUE
1.	NEW YORK, NY-NJ	NEW YORK	41	13.13	13.13
2.	Fort Wayen, IN	Chicago	32	11.03	24.16
3.	Lynchburgh, VA	Washington	18	5.82	29.98
4.	Erie, PA	Pittsburgh	14	5.20	35.18
5.	Rockford, IL	Milwaukee	19	4.53	39.71
6.	Athens, GE	Atlanta	14	4.28	43.99
7.	Bryan-College Stn, TX	Dallas	11	3.59	47.57
8.	Lakeland-Winter Haven, FL	Tampa	12	2.98	50.56
9.	Portland, ME	Boston	11	2.73	53.28
10.	Evansville, IN-KY	Louisville	6	2.80	56.08
11.	Visalia-Tulare-Porterville, CA	Los Angeles	10	3.07	59.15
12.	Lawrence, KS	Kansas City	9	2.67	61.82
13.	Jackson, MS	New Orleans	9	2.39	64.21
14.	Eau Claire, WI	Minneapolis	5	1.93	66.14
15.	Montgomery, AL	Birmingham	5	1.50	67.64
16.	Chico, CA	San Francisco	7	1.59	69.24
17.	Yakima, WA	Seattle	8	1.53	70.77
18.	Oklahoma City, OK	Oklahoma City	5	1.45	72.22
19.	Fort Collins, CO	Denver	5	1.39	73.61
20.	Little Rock-North Little Rock, AR	Memphis	4	1.37	74.98

10.4 SUMMARY

A summary of the minimum, maximum and most efficient specialized network scenarios is given in Figure 10-8. The most likely implementation of a specialized carrier network is the most efficient network; the transponders that would be required for this network are shown in Figure 10-8.

A summary of the 10 and 20 earth station established carrier network scenarios is given in Figure 10-9. The most likely implementation of the established carrier network is the 20 earth station model; the transponders that would be required for this network are shown in Figure 10-9.

The percentage of traffic captured by the two basic methods indicates that the established carrier is favored. However, this does not mean the specialized carrier does not have a role. There are some markets where specialized carriers are able to make an impact. As the FCC continues to open up the market place to competition the role of the specialized carrier is likely to grow.

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Network	Earth Stations	Subordinate SMSAs	Percent of Traffic Captured
Minimum	22	116	30.36
Maximum	110	203	100.00
Most Efficient	104	203	98.27

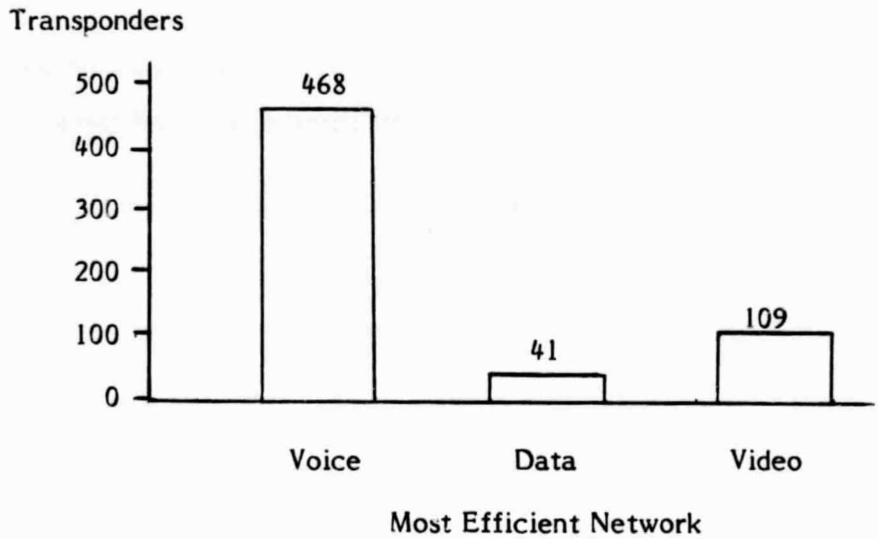

FIGURE 10-8. SPECIALIZED CARRIER SUMMARY

Network	Subordinate SMSAs	Percent of Traffic Captured
10 Earth Stations	178	42.53
20 Earth Stations	245	74.98

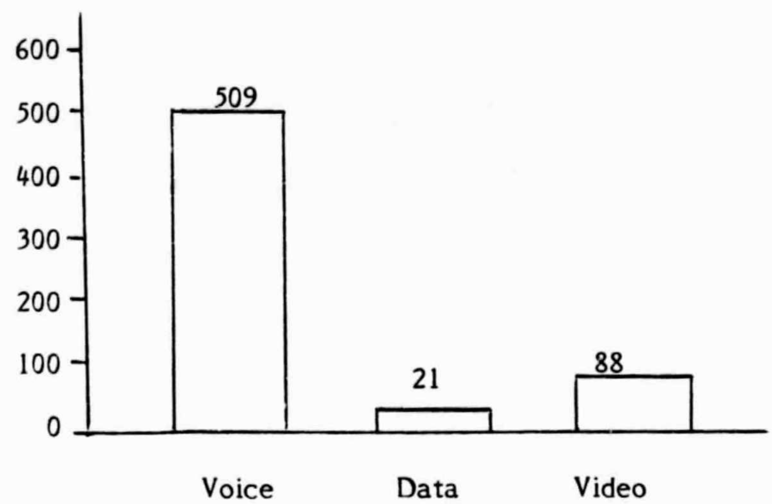

FIGURE 10-9. ESTABLISHED CARRIER SUMMARY