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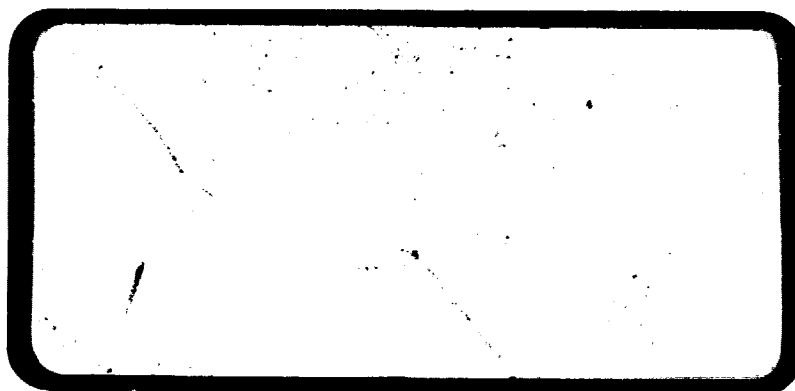
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SATELLITE PROVIDED CUSTOMER
PREMISES SERVICES: A FORECAST
OF POTENTIAL DOMESTIC DEMAND
THROUGH THE YEAR 2000
FINAL REPORT - VOLUME II - MAIN TEXT

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PREPARED FOR:
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER
CLEVELAND, OHIO 44135
NAS3-23255

AUGUST, 1983

1. Report No. CR-168143	2. Government Accession No. --------------	3. Recipient's Catalog No. ---------------
4. Title and Subtitle Satellite Provided Customer Premises Services: A Forecast of Potential Domestic Demand Through the Year 2000.		5. Report Date August, 1983
		6. Performing Organization Code ---------------
7. Author(s) D. Kratochvil, J. Bowyer, C. Bhushan, K. Steinnagel, D. Kaushal, G. Al-Kinani		8. Performing Organization Report No. -----------------
9. Performing Organization Name and Address The Western Union Telegraph Company Government Systems Division McLean, VA 22102		10. Work Unit No. -----------------
		11. Contract or Grant No. NAS3-23255
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Lewis Research Center Cleveland, OH		13. Type of Report and Period Covered Vol. II-Main Text
		14. Sponsoring Agency Code ----------------
15. Supplementary Notes NASA Project Manager: Jack Lekan Two other Volumes were also prepared: Volume I - Executive Summary, Volume III - Appendices		

16. Abstract

The overall purpose of this study was to forecast the potential United States domestic telecommunications demand for satellite provided customer premises voice, data and video services through the year 2000, so that this information on service demand would be available to aid in NASA program planning.

To accomplish this overall purpose the following objectives were achieved:

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

    b. Identification of that portion of the telecommunications demand suitable for transmission by satellite systems

    c. Identification of that portion of the satellite market addressable by CPS systems

    d. Identification of that portion of the satellite market addressable by Ka-band CPS system.

    e. Postulation of a Ka-band CPS network on a nationwide and local level.

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.

17. Key Words (Suggested by Author(s)) Telecommunications Forecast Satellite Telecommunications Customer Premises Service Traffic Demand		18. Distribution Statement Unclassified	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 318	22. Price*

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

NASA-C-168 (Rev. 10-75)

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SECTION 1
OVERVIEW

1.1   BACKGROUND

This report focuses on the results of a study designed to forecast the potential domestic demand for satellite provided customer premises services through the year 2000. It relates to the following two market demand studies that were performed by Western Union for NASA and that dealt primarily with trunking services:

a. Satellite Provided Fixed Communications Services. A Forecast of Potential Domestic Demand through the Year 2000. NASA Contract No. NAS-3-22894, August, 1983.

b. 18/30 GHz Fixed Communications System Service Demand Assessment. NASA Contract No. NAS-3-21359, July 1979.

The subject study was conducted because the provision of Customer Premises Services (CPS) has been recently identified as an important offering which could significantly impact the future growth of satellite communications and its advanced technology requirement. CPS is characterized as communications services supplied directly to the customer through small earth terminals located on the customer's premises or through a local customer-shared earth station with dedicated "tail" connections directly to the customer. Many interconnect systems between users and a shared earth station may be viable. While these may range from dedicated to existing or proposed tariffed systems, only dedicated lines were considered for this study.

In order to develop a CPS system that provides a viable alternative to other communications services delivery systems, and to determine the functional and technical requirements of a satellite system to provide such services, it was necessary to know the types, magnitudes, and characteristics of the traffic such a system could be expected to carry in the future. This study was, therefore, undertaken to provide such information. It was performed under NASA contract NAS3-23255.

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 customer premises voice, data and video services through the year 2000, so that this information on service demand would be available to aid in NASA program planning.

To accomplish this overall purpose the following objectives were achieved:

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

  b. Identification of that portion of the telecommunications demand suitable for transmission by satellite systems

  c. Identification of that portion of the satellite market addressable by CPS systems

  d. Identification of that portion of the satellite market addressable by Ka-band CPS systems

  e. Postulation of a Ka-band CPS network on a nationwide and local level.

1.2.2 Tasks and Activities

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

Task 1.0 - Market Demand Forecasts

Task 1.1 - Potential CPS Telecommunications Services

  Purpose: Identify and characterize those telecommunications services which can be effectively supplied directly to the customer through unshared or shared earth stations.

  Activities: 1. Review market studies and telecommunications literature

  2. Collect input from users and providers

3. Develop list of potential services

4. Define and characterize services.

Task 1.2 - Potential CPS User Classes

Purpose: Identify and characterize the classes of potential CPS users.

Activities: 1. Identify potential users

2. Develop user survey/procedures

3. Conduct survey interviews

4. Analyze survey results

5. Characterize user classes

Task 1.3 - Comparative Economics

Purpose: Develop current and projected service costs to users of various delivery systems and compare the competitiveness of these systems (includes C-, Ku- and Ka-bands).

Activities: 1. Define and cost CPS earth stations.

2. Cost CPS space segment.

3. Define and cost terrestrial transmission systems

4. Develop 1982 end-to-end user costs and crossover distances with terrestrial tariffs

5. Describe future trends

6. Develop 1990 and 2000 CPS costs and crossover distances with terrestrial tariffs

Task 1.4 - Market Demand Forecast Development

Purpose: Forecast the overall telecommunications, the overall satellite, the CPS, and the CPS Ka-band market demands for the years 1980, 1990 and 2000.

Activities: 1. Develop Baseline Forcasts

    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

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2. Develop Impacted Baseline Forecasts
   a. Develop impacted baseline model
   b. Develop and collect information on market determinant factors
   c. Analyze results and develop forecasts
3. Develop Net Long Haul Forecasts
   a. Reduce traffic (e.g., Intra SMSA, Data on analog)
   b. Convert forecasts to peak hour
   c. Develop Market Distribution Model
4. Develop CPS Forecasts
   a. Reduce traffic (e.g., due to constraints, plant in place)
   b. Use cost model to develop crossover distances
   c. Develop CPS satellite forecasts
5. Develop Overall Satellite Forecasts
   a. Merge CPS and trunking satellite forecasts
   b. Develop overall satellite forecasts
6. Develop Ka-band CPS Satellite Forecasts
   a. Reduce traffic (e.g., due to constraints, plant in place)
   b. Use cost model to develop crossover distances
   c. Develop Ka-band forecasts

Task 2.0 - CPS Network Traffic Model

Task 2.1 - Nationwide Traffic Distribution Model

Purpose: Postulate CPS nationwide networks based on the four CPS systems determined by the two design configurations and the two availability levels and describe the corresponding network and model characteristics.

Activities: 1. Segment Ka-band net addressable traffic into classes
2. Develop traffic models
3. Develop user models
4. Prepare Nationwide CPS network reports

Task 2.2 - Intra Urban Topology

      Purpose: Describe three traffic nodes based on secondary and site-visit information.

    Activities: 1. Conduct secondary research on sites

               2. Select and visit sites

               3. Describe sites at sub-nodal level

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 subsequent sections of this report.

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.

The first activities involved defining and characterizing services, characterizing potential users, and specifying forecasting methods for each service. The products of these efforts were needed to develop the baseline forecasts which were estimates, of current and future volumes of traffic, reflecting the occurrence 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

FIGURE 1-1. OVERALL ACTIVITY FLOW FOR THE STUDY

the net long haul forecasts. 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 CPS net addressable, the overall satellite and the Ka-band net addressable forecasts. The CPS net addressable forecast represents the total amount of net long haul traffic addressable by a CPS satellite system. The overall satellite forecast represents the total amount of traffic addressable by both CPS and trunking or FCS satellite systems. Similarly, the Ka-band net addressable forecast represents the total amount of traffic addressable by a Ka-band satellite system. A variety of Ka-band forecasts (e.g., by services, users, regions and mileage bands) were developed for each of four Ka-band systems: .999 availability and shared/unshared earth stations; .999 availability, unshared earth stations; .995 availability, shared/unshared earth stations; .995 availability, unshared earth stations. The Ka-band forecasts then were used to develop the Ka-band net accessible forecasts, which also required the development of a comprehensive nationwide traffic distribution model and an intra-urban topology study.

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. It should be pointed out that at each point forecasts were developed for 1980, 1990 and 2000.

      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 (transponder)

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)
   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. CPS 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 (this amount varied from 0 to 60 percent across services).
      (b) Traffic due to established carrier (plant in place) was removed (this amount varied from 0 to 98 percent across services).
      (c) Reduce traffic because of time zone considerations (constant 13 percent reduction).

(d) Traffic unsuitable for CPS transmission was removed (this amount varied from 0 to 100 percent).

(e) Traffic less than crossover distance was removed.

2. Traffic was converted to transponders

3. A CPS net addressable forecast, consisting of traffic from all three bands, was developed for each service.

4. Again, for summary purposes, forecasts were grouped under voice, data and video and were combined to make a total CPS satellite forecast.

e. Overall Satellite Forecasts

1. These forecasts consisted of the expected maximum, net addressable from trunking (see Satellite Provided Fixed Communication Services: A Forecast of Potential Domestic Demand Through 2000, NASA Contract No. NAS-3-22894, August, 1983) and the CPS net addressable.

2. Since the Trunking and CPS forecasts were overlapping, procedures were used to remove this overlap, to make certain traffic was counted only once.

3. Forecasts were developed for each of the 31 services, for the major categories of voice, data and video, and for the total satellite market.

f. Ka-band CPS 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 (this amount varied from 0 to 60 percent across services)

(b) Traffic due to established carrier (plant in place) was removed (this amount varied from 0 to 98 percent across services).

(c) Reduce traffic because of time zone considerations (constant 13 percent reductions).

(d) Traffic unsuitable for Ka-band CPS transmission was removed (this amount varied from 0 to 100 percent)

(e) Traffic less than crossover distance was removed.

2. Traffic was converted to transponders.

3. Ka-band CPS net addressable forecasts were developed for each of the four Ka-band systems (determined by earth station configuration and availability level) for each service by: user, region and mileage band.

4. For summary purposes, forecasts were grouped under voice, data and video and were combined to make a total Ka-band CPS forecast.

g. Ka-band CPS Net Accessible Forecasts

1. The Ka-band CPS net addressable forecasts were used to develop these forecasts.

2. These forecasts were developed by using the nationwide traffic distribution model.

3. The amount of traffic captured by each of the four (one for each Ka-band system) nationwide CPS networks is the Ka-band CPS net accessible forecast for that Ka-band system.

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 CPS satellite forecasts all traffic estimates represent number of equivalent 36 MHz transponders. It should also be pointed out that the CPS satellite forecasts represent a stand-alone system. Figure 1-2 indicates the integration of CPS and trunking forecasts in the development of the overall satellite forecast. The Ka-band net accessible forecasts represent the amount of addressable traffic captured by each of the four Ka-band systems. The percentages of captured traffic by system are indicated in Figure 1-3. The results summarized in Tables 1-1 and 1-2 and in other sections of the report indicated that the impact of moving from .999 to .995 availability had only a small impact and that the shared-unshared earth station configuration was the most likely to be implemented. Growth rates of satellite traffic were expected to be greater from 1980-1990 than from 1990-

2000, with voice traffic growing the fastest on CPS satellite systems and data traffic, growing the fastest on the overall satellite system.

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 - Potential CPS Telecommunications Services

    c.   Section 3 - Potential CPS User Classes

    d.   Section 4 - Comparative Economics

    e.   Section 5 - Baseline Forecasts

    f.   Section 6 - Impacted Baseline Forecasts

    g.   Section 7 - Net Long Haul Forecasts

    h.   Section 8 - Overall Satellite Forecasts

    i.   Section 9 - CPS Satellite Forecasts

    j.   Section 10 - Ka-band CPS Satellite Forecasts

    k.   Section 11 - Nationwide Traffic Distribution Model

    l.   Section 12 - Intra-Urban Topology

When the study discussed in these three volumes was completed, additional related work was begun. A sensitivity analysis was initiated to determine the effects on the forecasts (i.e., those presented in Volumes 1-3) of varying selected

key assumptions. The results of this followup effort will be presented in a separate report that will be available about six months after the release of Volumes 1-3.

TABLE 1-1. SUMMARY OF FORECASTS

FORECASTS	YEAR		
	1980	1990	2000
BASELINE			
Voice (1000s HVCs i.e., Half Voice Circuits)	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)	2,524	7,635	18,686
Data (Mbps)	15,165	31,279	40,344
Video (Transponders)	61	323	393
CPS SATELLITE (TRANSPONDERS)			
Voice	.9	17	100
Data	21.5	200	529
Video	.3	52	109
TOTAL	23.0	269	738
OVERALL SATELLITE (TRANSPONDERS)			
TRUNKING SEGMENT			
Voice	190	601	1,806
Data	0	3	13
Video	61	323	393
TOTAL	251	927	2,212
CPS SEGMENT			
Voice	0	3	18
Data	22	202	529
Video	0	10	20
TOTAL	22	215	567
TOTAL			
Voice	190	605	1,824
Data	22	204	542
Video	61	333	413
TOTAL	273	1,142	2,779
KA-BAND CPS SATELLITE (TRANSPONDERS)			
SHARED-UNSHARED/.999			
SERVICE CATEGORIES			
Voice	--	14 (6%)	85 (14%)
Data	--	176 (78%)	450 (74%)
Video	--	35 (16%)	78 (12)
TOTAL	--	225	608

TABLE 1-1. SUMMARY OF FORECASTS (CONTINUED)

	1980	1990	2000
USER CLASSES			
Business	--	111 (49%)	301 (49%)
Government	--	35 (16%)	94 (16%)
Institutions	--	74 (33%)	201 (33%)
Private	--	5 (2%)	12 (2%)
TOTAL	--	225	608
MILEAGE BANDS			
1-40	--	12 (6%)	34 (6%)
41-150	--	33 (15%)	89 (15%)
151-500	--	70 (31%)	190 (31%)
501-1000	--	62 (27%)	167 (27%)
1001-2100	--	39 (17%)	105 (17%)
2101+	--	9 (4%)	23 (4%)
TOTAL	--	225	608

SHARED-UNSHARED/.995

	1980	1990	2000
SERVICE CATEGORIES			
Voice	--	13 (6%)	77 (14%)
Data	--	158 (78%)	405 (74%)
Video	--	31 (16%)	66 (12%)
TOTAL	--	202	548
USER CLASSES			
Business	--	100 (49%)	271 (50%)
Government	--	31 (16%)	85 (15%)
Institutions	--	66 (33%)	181 (33%)
Private	--	5 (2%)	11 (2%)
TOTAL	--	202	548
MILEAGE BANDS			
1-40	--	11 (6%)	30 (6%)
41-150	--	29 (15%)	80 (15%)
151-500	--	63 (31%)	171 (31%)
501-1000	--	56 (27%)	151 (27%)
1001-2100	--	35 (17%)	95 (17%)
2101+	--	8 (4%)	21 (4%)
TOTAL	--	202	548

UNSHARED/.999

	1980	1990	2000
SERVICE CATEGORIES			
Voice	--	3 (1%)	28 (5%)
Data	--	176 (82%)	450 (82%)
Video	--	35 (17%)	73 (13%)
TOTAL	--	213	551

TABLE 1-1. SUMMARY OF FORECASTS (CONTINUED)

	1980	1990	2000
USER CLASSES			
Business	--	104 (49%)	266 (48%)
Government	--	33 (16%)	88 (16%)
Institution	--	71 (33%)	185 (34%)
Private	--	5 (2%)	12 (2%)
TOTAL	--	213	551
MILEAGE BANDS			
1-40	--	12 (6%)	31 (6%)
41-150	--	31 (15%)	80 (15%)
151-500	--	67 (31%)	172 (31%)
501-1000	--	59 (27%)	152 (27%)
1001-2100	--	36 (17%)	95 (17%)
2100+	--	8 (4%)	21 (4%)
TOTAL	--	213	551

UNSHARED/.995

	1980	1990	2000
SERVICE CATEGORIES			
Voice	--	2 (1%)	25 (5%)
Data	--	158 (82%)	405 (82%)
Video	--	31 (17%)	66 (13%)
TOTAL	--	192	496
USER CLASSES			
Business	--	93 (49%)	240 (48%)
Government	--	30 (16%)	79 (16%)
Institution	--	64 (33%)	166 (34%)
Private	--	5 (2%)	11 (2%)
TOTAL	--	192	496
MILEAGE BANDS			
1-40	--	11 (6%)	27 (6%)
41-150	--	28 (15%	72 (15%)
151-500	--	60 (31%)	155 (21%
501-1000	--	53 (27%)	137 (27%)
1001-2100	--	33 (17%)	86 (17%)
2101+	--	7 (4%)	19 (4%)
TOTAL	--	192	496

ᵢ A-BAND NET ACCESSIBLE (TRANSPONDERS)

	1980	1990	2000
SHARED-UNSHARED/.999	--	--	113 (19% of Addressable)
SHARED-UNSHARED/.995	--	--	93 (17% of Addressable)
UNSHARED/.999	--	--	110 (20% of Addressable)
UNSHARED/.995	--	--	90 (18% of Addressable)

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

FORECASTS	TIME PERIODS		
	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
CPS SATELLITE			
Voice	24.0	19.6	26.6
Data	25.0	10.2	17.4
Video	67.5	7.7	34.3
TOTAL	28.1	10.6	19.0
OVERALL SATELLITE			
TRUNKING SEGMENT			
Voice	12.3	11.6	11.9
Data	40.0	16.0	27.5
Video	18.1	2.0	9.7
TOTAL	14.0	9.1	11.5
CPS SEGMENT			
Voice	31.5	19.5	25.4
Data	25.0	10.1	17.3
Video	57.8	7.6	30.3
TOTAL	25.6	10.2	17.6
TOTAL			
Voice	12.3	11.7	12.0
Data	25.1	10.2	17.4
Video	18.4	2.2	10.0
TOTAL	15.4	9.3	12.3
KA-BAND CPS SATELLITE			
SHARED-UNSHARED/.999			
SERVICE CATEGORIES			
Voice	--	19.6	--
Data	--	9.9	--
Video	--	7.6	--
TOTAL	--	10.5	--

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

	1980-1990	1990-2000	1980-2000
USER CLASSES			
Business	--	10.5	--
Government	--	10.4	--
Institutions	--	10.5	--
Private	--	9.1	--
TOTAL	--	10.4	--
MILEAGE BANDS			
1-40	--	11.0	--
41-150	--	10.4	--
151-500	--	10.5	--
501-1000	--	10.4	--
1001-2100	--	10.4	--
2101+	--	9.8	--
TOTAL	--	10.4	--

SHARED-UNSHARED/.995

	1980-1990	1990-2000	1980-2000
SERVICE CATEGORIES			
Voice	--	19.5	--
Data	--	9.9	--
Video	--	7.8	--
TOTAL	--	10.5	--
USER CLASSES			
Business	--	10.5	--
Government	--	10.6	--
Institutions	--	10.6	--
Private	--	8.2	--
TOTAL	--	10.5	--
MILEAGE BANDS			
1-40	--	10.6	--
41-150	--	10.7	--
151-500	--	10.5	--
501-1000	--	10.4	--
1001-2100	--	10.5	--
2101+	--	10.1	--
TOTAL	--	10.5	--

UNSHARED/.999

	1980-1990	1990-2000	1980-2000
SERVICE CATEGORIES			
Voice	--	25.0	--
Data	--	9.8	--
Video	--	7.6	--
TOTAL	--	10.0	--

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

	1980-1990	1990-2000	1980-2000
USER CLASSES			
Business	--	9.8	--
Government	--	10.3	--
Institution	--	10.1	--
Private	--	9.1	--
TOTAL	--	10.0	--
MILEAGE BANDS			
1-40	--	10.0	--
41-150	--	9.9	--
151-500	--	9.9	--
501-1000	--	9.9	--
1001-2100	--	10.2	--
2101+	--	10.1	--
TOTAL	--	10.0	--

UNSHARED/.995

	1980-1990	1990-2000	1980-2000
SERVICE CATEGORIES			
Voice	--	28.7	--
Data	--	9.9	--
Video	--	7.8	--
TOTAL	--	10.0	--
USER CLASSES			
Business	--	9.9	--
Government	--	10.2	--
Institution	--	10.0	--
Private	--	8.2	--
TOTAL	--	10.0	--
MILEAGE BANDS			
1-40	--	9.4	--
41-150	--	9.9	--
151-500	--	10.0	--
501-1000	--	10.0	--
1001-2100	--	10.1	--
2101+	--	10.5	--
TOTAL	--	10.0	--

KA-BAND NET ACCESSIBLE (TRANSPONDERS)

	1980-1990	1990-2000	1980-2000
SHARED-UNSHARED/.999	--	--	--
SHARED-UNSHARED/.995	--	--	--
UNSHARED/.999	--	--	--
UNSHARED/.995	--	--	--

FIGURE 1-2. INTEGRATION OF CPS AND TRUNKING FORECASTS IN DEVELOPMENT OF OVERALL SATELLITE FORECAST (NUMBERS = # TRANSPONDERS IN 2000) (THE NUMBERS REPRESENT COMPLETE CIRCLES AND INCLUDE OVERLAP AREAS)

Labels within figure: CPS HINTERLAND 135; CPS 738; Ka BAND CPS 608; TRUNKING/CPS OVERLAP; OVERALL 2779; TRUNKING 2469
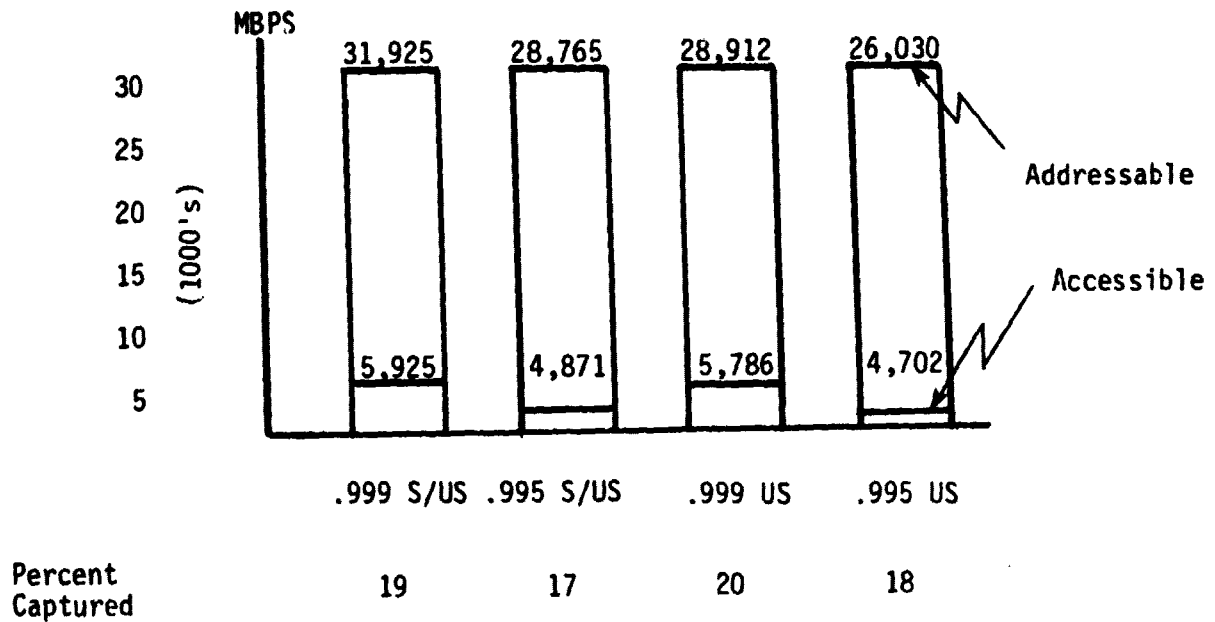
FIGURE 1-3. ADDRESSABLE AND ACCESSIBLE (CAPTURED) TRAFFIC

SECTION 2
POTENTIAL CPS TELECOMMUNICATIONS SERVICES

2.1 INTRODUCTION

The first step in forecasting potential CPS telecommunications services was to identify and characterize those services which potentially could be supplied effectively and directly to the customer through earth stations located on the customer's premises, or through earth stations shared by local communities of customers. In order to develop a list of potential CPS telecommunications 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 01 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 CPS 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 5, 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.
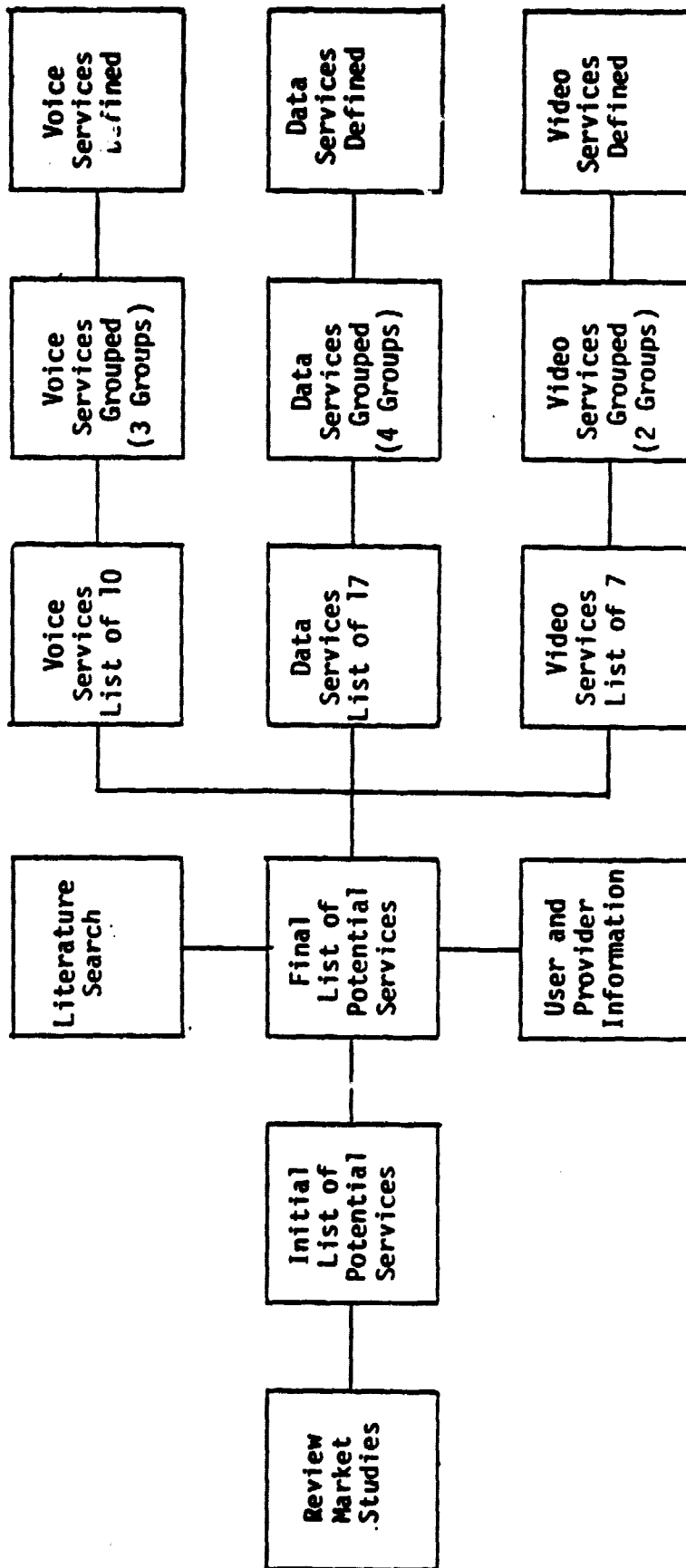
FIGURE 2-1. ACTIVITY FLOW FOR DEFINITION/DESCRIPTION OF POTENTIAL SERVICES

TABLE 2-1. POTENTIAL CPS SERVICES

	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 those 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) troduced 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.

2.3.2.4 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.

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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 num er 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

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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 building 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 Educationa' 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 continually being thought of. 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 hcurs (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 alsc 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 home-

owner, 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
POTENTIAL CPS USER CLASSES AND THEIR CHARACTERISTICS

3.1 INTRODUCTION

This section identifies and characterizes the classes of potential CPS users. The classes identified were subgroups of the general categories of business, Government, institutional and private users. Over 100 characteristics were used to describe each subgroup. Information used to identify and characterize the various users was obtained from primary and secondary research efforts.

3.2 PROCEDURES

The following major steps were conducted in the development of the descriptions of potential CPS user classes (see Figure 3-1):

      a.   Selection of a sample of users for telephone interviewing

      b.   Development of the interview procedure

      c.   Conducting the interviews

      d.   Analysis of the survey results.

Each of these steps are briefly outlined.

3.2.1 Selection of Sample

Selecting the sample of users to interview involved the following activities:

      a.   Conducting secondary research to identify potential user classes and representatives of the classes and to define these classes.

      b.   Reviewing lists of users representing most subclasses of users throughout the United States.

      c.   Identifying users through Western Union's network of 500 Sales Managers and Representatives throughout the United States.
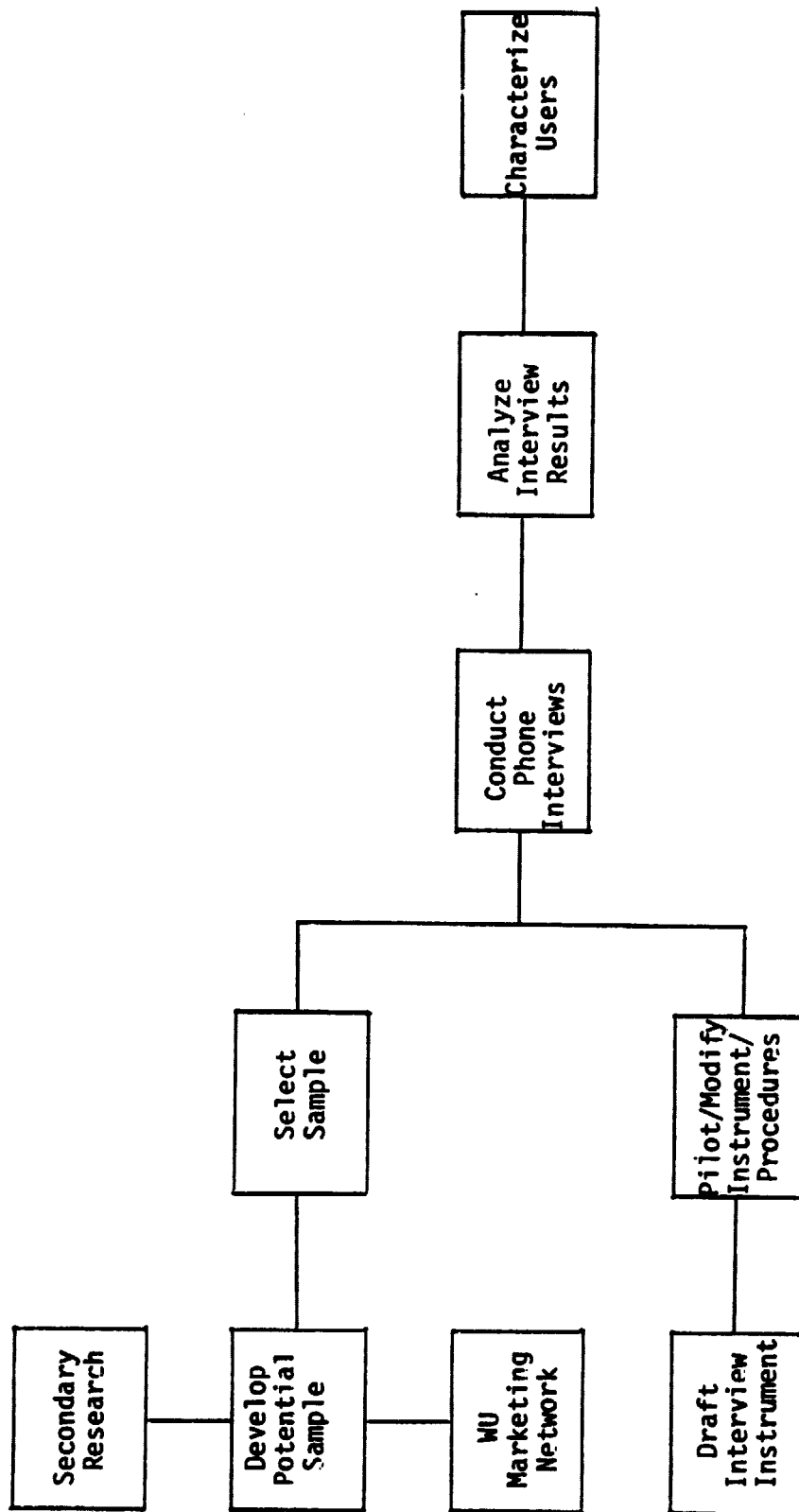
FIGURE 3-1. ACTIVITY FLOW FOR CHARACTERIZATION OF USERS

A list of the potential user classes is presented in Table 3-1; these user classes are defined in Appendix D, Table D-1. Over 1,500 representatives of business, Government and institutional classes were identified (the effort involving private users is described below), and about 20 percent (i.e., 300) were selected for interviewing. Representatives were selected on the basis of the total number of representatives in their user class, geography, and size. Size was defined in terms of sales dollars, number of employees, and/or number or customer/clients.

An effort was made to collect information on private users from public and private organizations known or believed to have relevant information about the telecommunication needs of private users. Some information was obtained on the volume of telephone traffic, interest in direct broadcast services, and price/demand relationships for residential homes, multi-family dwellings and farms. However, this information was very limited and too inconsistent to analyze and present. Consequently, no further effort was spent on characterizing the private users, and all subsequent discussions presented below pertain only to business, Government and institutional user classes.

3.2.2 Development of Interview Procedures

Development of the interview procedures and instrumentation involved the following activities:

a. Drafting the guidelines and the interview instrument
b. Field testing the procedure and the instrument
c. Making necessary modifications and improvements based on test results.

An outline of the final user survey is presented in Table 3-2. The complete survey is presented in Appendix D. As indicated in Table 3-2, the user survey included: introductory information, interviewee information, user information, and information on general communications, voice, data and video.

TABLE 3-1. LIST OF USER CLASSES AND SUBCLASSES

CLASS	SUBCLASS
Business	Manufacturing
	Transportation
	Utilities
	Retail/Wholesale
	Finance/Insurance
	Professional Business Services
	Other Miscellaneous Business
Government	Federal
	State
	Local
Institution	Education
	Health
	Religion
Private	Homes - Urban, Suburban
	Farms, Ranches
	Apartments, Condos

TABLE 3-2. OUTLINE OF USER SURVEY

Introductory Information
    Purpose of Call
    Feedback to Participants
    NASA's Role
    Definition of Customer Premises Services
    Overview of Interview Procedures

Interviewee Information
    Name
    Address
    Phone
    Title/Experience

User Information
    Class-Subclass
    Location
        Region
        # Locations
        CONUS Coverage
        Type (Urban - Rural)
    Size
        Sales
        # Employees

General Information
    Total Budget in $
    Budget Change Expected
    Service Volume Change Expected
    Reason for Volume Change
    Intra vs. Inter Organizational Needs
    Price-Demand-Performance
        Effects of Price Reductions
        Reasons for Effects
        Effects of Price Increases
        Reasons for Effects
        Effects of Improving Performance
        Reasons for Effects
        Effects of Lowering Performance
        Reasons for Effects
    Distribution of Traffic By Distance

CPS Information
    Current Fastest Data Rate
    Suitability of Facilities
    Current Use of CPS
    Provider of CPS
    Results of Use
    Features Influencing Use
    Future Use of CPS
    Reasons for Future Use
    Future Plans - New Services

Voice Information
    Annual Budget
    Budget Change Expected
    Service Volume Change Expected
    Use of Specific Applications
    Intra vs. Inter Organizational Needs
    Peak Hour

Data Information
    Annual Budget
    Budget Change Expected
    Service Volume Change Expected
    Centralized vs. Decentralized
    Use of Specific Applications
    Intra vs. Inter Organizational Needs
    Peak Hour

Video Information
    Annual Budget
    Budget Change Expected
    Service Volume Change Expected
    Video Teleconferencing
        Use
        Bit Rate
        One Way - Two Way
        Purpose
        Reason for Use
    Intra vs. Inter Organizational Needs
    Peak Hour

3.2.3   Conducting the Interviews

Of the 300 representatives selected for telephone interviewing, 253 were actually interviewed and provided information on the major items covered in the interview. About 15 percent (i.e., 47) were not included because they were not reachable, would not cooperate or provided insufficient information to be included.

3.3   SUMMARY OF SURVEY RESULTS

The results of the user survey are presented in detail in Appendix D, Tables D-3 through D-108. The information in these 106 Tables is presented in summary form (e.g., by user class rather than by user sub-class) in Tables 3-3 through 3-16. The information in these 14 tables is presented in terms of the sample, budget, volume, price-demand-performance, customer premise services (i.e., use, features influencing use, actual result of use), and needs and services (i.e., new delivery modes/applications, intra- inter-needs, channel rates in use, peak hours and traffic distribution by distance). Table 3-17 presents the highlights of the results.

3.3.1   The User Survey Sample

Tables 3-3 and 3-4 present summary information that describes the survey sample. The total sample included 253 users of which about 61 percent, 25 percent and 14 percent were, respectively, business, Government and institutional users. About half the users were classified as large and the other half were about equally divided between medium and small users. User sizes for the three classes of users were defined as follows:

	LARGE	MEDIUM	SMALL
Business	> $400 Million in Sales	$50-400 Million in Sales	< $50 Million in Sales
	> 5.000 Employees	1,500-5,000 Employees	< 4,500 Employees
Government	> 7,200 Employees	500-2,000 Employees	< 500 Employees
Institutions	> 20,000 Students	5,000-20,000 Students	< 5,000 Students
	> 7,800 Beds	200-800 Beds	< 200 Beds

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TABLE 3-3. SAMPLE SIZE BY USER CLASS, USER CLASS SIZE AND REGION

SAMPLE SIZE BY CLASS

CLASS	FREQUENCY	PCT
Business	153	60.5
Government	64	25.3
Institutions	36	14.2
TOTAL	253	100.0

SAMPLE SIZE BY USER CLASS SIZE

SIZE OF USER CLASS	FREQUENCY	PCT
Large	133	52.6
Medium	65	25.7
Small	55	21.7
TOTAL	253	100.0

SAMPLE SIZE BY REGION

REGION	FREQUENCY	PCT
ME,NH,MA,CT,RI,VT	18	7.1
NY,PA,NJ	39	15.4
DE,MD,WV,VA,NC,SC,GE,FL	58	22.9
KY,TN,MS,AL	18	7.1
MI,WI,IL,IN,OH	42	16.6
ND,SD,MN,IA,NE,KS,MO	23	9.1
TX,OK,AR,LA	19	7.5
MT,ID,WY,UT,CO,AZ,NV,NM	9	3.6
WA,OR,CA	27	10.7
TOTAL	253	100.0

TABLE 3-4. LOCATION AND NUMBER OF PREMISES OF USER SAMPLE

LOCATION OF USER PREMISES

CLASS	FREQ	THRU CONUS PCT	THRU 1/2 CONUS PCT	THRU 1/4 CONUS PCT	THRU 1/4 CONUS PCT
Business	148	75.7	5.4	4.1	14.9
Government	54	38.9	3.7	0.0	57.4
Institutions	32	21.9	0.0	3.1	75.0
TOTAL	234	59.8	4.3	3.0	32.9

R.

URBAN-RURAL LOCATION

CLASS	FREQ	URBAN PCT	RURAL PCT	MIXED PCT
Business	146	35.6	14.4	50.0
Government	59	54.2	6.8	39.0
Institutions	3ː	70.6	2.9	26.5
TOTAL	239	45.2	10.9	43.9

NUMBER OF USER LOCATIONS

CLASS	FREQ	MEAN
Business	140	267
Government	56	152
Institutions	33	99
TOTAL	229	215

The percentage of users by region varied from about four percent to 33 percent, with over 50 percent of the users coming from three regions. About 60 percent of the users had premises throughout the CONUS and about a third were limited to one-fourth or less of the CONUS.

Close to half of the users were located in urban settings, slightly less in a combination of rural-urban settings, and about 11 percent in only rural settings. The mean number of locations per user was 215 locations.

3.3.2 Budget and Volume of Services

Information on the annual budgets and volumes of services is presented in Tables 3-5 through 3-8; Table 3-5 includes information on all services, while Tables 3-6 through 3-7 includes, respectively, information on voice, data and video services. The average total annual budget was about twenty million dollars, with business users having the largest average budget. The expected increase in total annual budget was about 13 percent, while the expected increase in volume of services was about 11 percent. About two-thirds of the users indicated that their reason for increasing volume of services was simply the desire for more services. The average annual voice budget was about three-fourths of the total budget, while the annual average video budget was very small (i.e., one half million dollars). However, the expected rates of budget increase were inversely related to current budgets; the expected rate of increase in the video budget was the highest (i.e., about 32 percent) and the expected rate of increase in voice budget was the lowest (i.e., about 15 percent). The only significant difference between expected increase in budget and expected increase in volume of services occurred for video services (i.e., 32 percent for budget vs. 52 percent for volume).

3.3.3 Price-Demand-Performance Relationships

Price-demand-performance relationships are summarized in Table 3-9. About 61 percent of the users said they would use a greater volume of services if costs were reduced; the major reason for not using a greater volume if costs were reduced was that services were cost insensitive. Slightly less than half of the users would use a smaller volume of services if costs were increased; again, the

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TABLE 3-5. COMMUNICATION BUDGET AND VOLUME OF SERVICES

ANNUAL COMMUNICATIONS BUDGET ($1000s)

CLASS	FREQUENCY	MEAN
Business	124	25,268
Government	56	17,014
Institutions	28	2,793
TOTAL	208	20,020

EXPECTED INCREASE IN BUDGET

CLASS	FREQUENCY	MEAN PCT
Business	137	+14
Government	54	9
Institutions	27	12
TOTAL	218	13

EXPECTED INCREASE IN VOLUME OF SERVICES

CLASS	FREQUENCY	MEAN PCT
Business	139	12
Government	51	7
Institutions	26	10
TOTAL	216	11

REASON FOR INCREASE IN VOLUME

CLASS	FREQ	EXPANDING ORG	REASONS DESIRE MORE SERVICES	BOTH REASONS
Business	128	30.5%	61.7%	7.8%
Government	28	3.6%	92.9%	3.6%
Institutions	26	30.8%	65.4%	3.8%
TOTAL	182	26.4%	67.0%	6.6%

TABLE 3-6. VOICE BUDGET AND VOLUME OF SERVICES

ANNUAL VOICE BUDGET ($1000s)

CLASS	FREQ	MEAN
Business	117	18,461
Government	50	14,219
Institution	27	1,755
TOTAL	194	15,043

EXPECTED INCREASE IN BUDGET

CLASS	FREQ	MEAN PCT
Business	140	13
Government	51	8
Institutions	29	11
TOTAL	220	11

EXPECTED INCREASE IN VOLUME OF SERVICES

CLASS	FREQ	MEAN PCT
Business	135	11
Government	53	5
Institutions	29	9
TOTAL	217	9

TABLE 3-7. DATA BUDGET AND VOLUME OF SERVICES

ANNUAL DATA BUDGET ($1000s)

CLASS	FREQ	MEAN
Business	108	8,152
Government	48	4,712
Institution	23	1,086
TOTAL	179	6,322

EXPECTED INCREASE IN BUDGET

CLASS	FREQ	MEAN PCT
Business	126	14
Government	47	18
Institutions	24	11
TOTAL	197	15

EXPECTED INCREASE IN VOLUME OF SERVICES

CLASS	FREQ	MEAN PCT
Business	124	13
Government	46	22
Institutions	24	10
TOTAL	194	15

TABLE 3-8. VIDEO BUDGET AND VOLUME OF SERVICES

ANNUAL VIDEO BUDGET ($1000s)

CLASS	FREQ	MEAN
Business	19	502
Government	1	100
Institution	1	860
TOTAL	21	500

EXPECTED INCREASE IN BUDGET

CLASS	FREQ	MEAN PCT
Business	19	31
Government	2	50
Institutions	2	16
TOTAL	23	32

EXPECTED INCREASE IN VOLUME OF SERVICES

CLASS	FREQ	MEAN PCT
Business	19	63
Government	2	50
Institutions	2	5
TOTAL	23	57

TABLE 3-9. PRICE-DEMAND-PERFORMANCE RELATIONSHIPS

WOULD YOU USE A GREATER VOLUME OF SERVICES IF COSTS WERE REDUCED?

CLASS	FREQ	YES-PCT
Business	151	64.2
Government	63	44.4
Institutions	34	73.5
TOTAL	248	60.5

REASON WOULD NOT USE GREATER VOLUME IF COSTS WERE REDUCED

FREQ	COST INSENS.	LIMITED BUDGET	COST EFFECT.
30	83.3	16.7	0.0
19	68.4	10.5	21.1
7	28.6	57.1	14.3
56	71.4	19.6	8.9

WOULD YOU USE A LESSER VOLUME OF SERVICES IF COSTS WERE INCREASED?

CLASS	FREQ	YES-PCT
Business	144	44.4
Government	60	56.7
Institutions	34	41.2
TOTAL	238	47.1

REASON WOULD NOT USE LESSER VOLUME IF COSTS WERE INCREASED

FREQ	COST INSENSITIVE	COST EFFECT.
38	89.5	10.5
12	66.7	33.3
14	71.4	28.6
64	81.3	18.8

WOULD YOU BE WILLING TO PAY MORE IF PERFORMANCE IMPROVED?

CLASS	FREQ	YES-PCT
Business	144	29.2
Government	56	23.2
Institutions	34	32.4
TOTAL	234	28.2

REASON WOULD NOT PAY MORE IF PERFORMANCE IMPROVED

FREQ	ALREADY SATISFIED	LIMITED BUDGET	COST EFFECT.
46	36.5	23.9	19.6
32	21.9	62.5	15.6
14	50.0	30.0	0.0
92	43.5	41.3	15.2

WOULD YOU ACCEPT A LOWER LEVEL OF PERFORMANCE IF COSTS WERE REDUCED?

CLASS	FREQ	YES-PCT
Business	135	8.9
Government	54	7.4
Institutions	31	9.7
TOTAL	220	8.6

REASON WOULD NOT ACCEPT LOWER PERFORMANCE IF COSTS WERE REDUCED

FREQ	CURRENT IS MINIMAL	COST EFFECT.
50	86.0	14.0
30	96.7	3.3
15	93.3	6.7
95	90.5	9.5

major reason for not using a lesser volume if costs were reduced was that services were cost insensitive. Less than 30 percent would be willing to pay more for improved performance; the two major reasons users could not pay more was that they were already satisfied and that they had limited budgets. Less than 10 percent would accept a lower level of performance if costs were reduced; the major reason for not accepting a lower performance was that their current level of performance was already minimal.

3.3.4   Customer Premises Services Information

Information on the potential users of CPS is presented in Tables 3-10 and 3-11. Over 90 percent of all users indicated that either all or some of their facilities were suitable for a 10 foot earth station. About 11 percent are currently using CPS and in about two-thirds of the cases the provider was Satellite Business Systems. Most said that the early results of using CPS were favorable; nearly 90 percent said it saved dollars, 75 percent said service was better and about two-thirds said productivity was better. About a third of those not currently using CPS are considering CPS in the future; businesses indicated the greatest likelihood of future use. The major reason for considering future use was the need to cut costs. Of some nine features that might influence future use of CPS, users indicated that five were important: low cost, reliability, need for high data rates, security and a need for an alternative to Telco.

3.3.5   Needs and Services

A variety of information on needs and services is summarized in Tables 3-12 through 3-16. Table 3-12 indicates that a variety of new delivery/applications are planned, with the most frequently mentioned addition being video tele-conferencing; currently about 15 percent of the users are using this service. In Table 3-13, it is clear that voice services are needed slightly more for intra-organizational needs than for inter-organizational needs, while data and video services are needed significantly more for intra-organizational needs. Users fastest channel data rates are indicated in Table 3-14; 9.6K is the most typical fastest data rate. Table 3-15 indicates that voice has two peak hours (10-11 a.m. and 2-3 p.m.) while data and video are even throughout the day.

TABLE 3-10. USE OF CPS

SUITABILITY OF FACILITIES FOR 10 FT. EARTH STATION

CLASS	FREQ	NUMBER SUITABLE		
		All-PCT	SOME-PCT	NONE-PCT
Business	145	60.0	32.4	7.6
Government	57	61.4	29.8	8.8
Institutions	34	61.8	23.5	14.7
TOTAL	236	60.6	30.5	8.9

	CURRENTLY USING CPS		PROVIDER IF USING CPS		
CLASS	FREQ	YES-PCT	FREQ	SBS-PCT	AMSAT-PCT
Business	134	15.7	19	63.2	36.8
Government	57	1.8	1	100.0	0.0
Institutions	28	10.7	1	0.0	100.0
TOTAL	219	11.4	21	61.9	38.1

RESULT OF USING CPS

CLASS	SAVE DOLLARS		BETTER SERVICE		BETTER PRODUCTIVITY	
	FREQ	YES-PCT	FREQ	YES-PCT	FREQ	YES-PCT
Business	20	90.0	18	77.8	19	68.4
Government	1	100.0	1	0.0	1	0.0
Institutions	2	50.0	1	100.0	1	100.0
TOTAL	23	87.0	20	75.0	21	66.7

TABLE 3-11. FUTURE USE OF CPS AND FEATURES THAT WOULD INFLUENCE THAT USE

	NOT USING BUT CONSIDERING FUTURE USE		REASON CONSIDERING FUTURE USE			
CLASS	FREQ	YES-PCT	FREQ	CUT COSTS	IMPROVE SERVICE	TECH HELP
Business	133	39.1	30	63.3	30.0	6.7
Government	56	17.9	6	66.7	16.7	16.7
Institutions	30	21.0	5	100.0	20.0	20.0
TOTAL	219	31.1	41	63.4	26.8	9.8

FEATURES INFLUENCING FUTURE USE

	LOW COST		RELIABILITY		HIGH DATA RATES	
		IMPORTANT		IMPORTANT		IMPORTANT
CLASS	FREQ	PCT	FREQ	PCT	FREQ	PCT
Business	144	93.1	144	92.3	141	45.4
Government	57	100.0	56	96.4	52	40.4
Institutions	34	91.2	34	94.2	34	41.2
TOTAL	235	94.4	234	93.6	227	43.6

	VIDEO CONF. CAPAB.		LOCAL LOOP SOLUTION		PRIVATE OWNERSHIP	
		IMPORTANT		IMPORTANT		IMPORTANT
CLASS	FREQ	PCT	FREQ	PCT	FREQ	PCT
Business	141	16.4	141	14.1	142	29.5
Government	55	14.5	55	16.4	57	15.8
Institutions	32	37.5	32	12.6	34	32.3
TOTAL	228	18.8	228	14.4	233	26.6

	SECURITY		ALTERNATE TO TELCO	
		IMPORTANT		IMPORTANT
CLASS	FREQ	PCT	FREQ	PCT
Business	141	51.0	139	39.5
Government	54	35.2	53	37.7
Institutions	34	32.3	34	20.6
TOTAL	229	44.6	226	36.3

TABLE 3-12. NEW DELIVERY/APPLICATIONS PLANNED

DELIVERY/APPLICATION	TOTAL-PCT (Freq=238)	BUS-PCT (Freq=134)	GOVT-PCT (Freq=68)	INST-PCT (Freq=36)
Satellite Services	2.1	2.2	2.9	0.0
Fiber Optics	1.7	2.2	0.0	2.8
Microwave	1.7	0.7	4.4	0.0
SBS	7.1	9.0	2.9	8.3
CPS	4.2	5.2	4.4	0.0
Private Networks	4.6	3.0	7.4	5.6
Digital Services	6.3	7.5	4.4	5.6
High Speed Services	4.2	5.2	2.9	2.8
Video Teleconferencing*	23.9	27.6	16.2	25.0
DBS	6.7	6.7	5.9	8.3
Videotext	0.0	0.0	0.0	0.0
Electronic Mail	2.9	2.2	2.9	5.6
More Services	28.2	21.6	39.7	30.6
None	6.3	6.7	5.9	5.6

*Compare Percentages With The Following Current Use Percentages

CURRENTLY USING VIDEO TELECONFERENCING?

CLASS	FREQ	YES-PCT
Business	145	17.2
Government	55	5.5
Institutions	34	17.6
TOTAL	234	14.5

TABLE 3-13. INTRA AND INTER ORGANIZATIONAL COMMUNICATIONS NEEDS

ALL SERVICES

CLASS	FREQ	INTRA-PCT	INTER-PCT
Business	122	56	44
Government	43	64	36
Institutions	30	62	38
TOTAL	195	58	42

VOICE SERVICES

CLASS	FREQ	INTRA-PCT	INTER-PCT
Business	140	54	46
Government	56	63	37
Institutions	32	60	40
TOTAL	228	57	43

DATA SERVICES

CLASS	FREQ	INTRA-PCT	INTER-PCT
Business	132	78	22
Government	50	82	18
Institutions	31	88	12
TOTAL	213	80	20

VIDEO SERVICES

CLASS	FREQ	INTRA-PCT	INTER-PCT
Business	22	92	8
Government	2	40	60
Institutions	2	100	0
TOTAL	26	89	11

TABLE 3-14. CURRENT FASTEST CHANNEL DATA RATE

CLASS	FREQ	2.4K PCT	4.8K PCT	9.6K PCT	56K PCT	1.5M PCT	6.3M PCT
Business	136	10.3	9.6	54.4	20.6	4.4	0.7
Government	52	13.5	26.9	46.2	11.5	1.9	0.0
Institutions	33	24.2	12.1	60.6	0.0	3.0	0.0
TOTAL	221	13.1	14.0	53.4	15.4	36	0.5

TABLE 3-15. PEAK HOURS FOR SERVICES

VOICE SERVICES	FIRST PEAK		SECOND PEAK	
	10:00 - 11:00 AM		2:00 - 3:00 PM	
CLASS	FREQ	PCT	FREQ	PCT
Business	135	51.1	111	58.6
Government	58	39.7	44	34.1
Institutions	34	50.0	32	46.9
TOTAL	227	48.0	187	50.8

DATA SERVICES	FIRST PEAK		SECOND PEAK	
	EVEN		EVEN	
CLASS	FREQ	PCT	FREQ	PCT
Business	114	29.8	79	43.0
Government	40	45.0	33	51.5
Institutions	26	53.8	24	54.2
TOTAL	180	36.7	136	47.1

VIDEO SERVICES	FIRST PEAK		SECOND PEAK	
	EVEN		EVEN	
CLASS	FREQ	PCT	FREQ	PCT
Business	15	26.7	8	50.0
Government	1	0.0	1	0.0
Institution	2	50.0	2	50.0
TOTAL	18	27.8	11	45.5

Table 3-16 indicates that about 50 percent of the traffic of users falls between 151 and 1000 miles.

3.3.6   Highlights of User Survey

The information discussed above is summarized in Table 3-17.

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TABLE 3-16. DISTRIBUTION OF TRAFFIC BY DISTANCE
(DOLLARS IN 1000s)

NUMBER OF USERS FOR WHICH TRAFFIC AND DISTANCE INFO AVAILABLE: 194
TOTAL COMMUNICATION DOLLARS FOR THESE USERS: 4068888
TOTAL COMMUNICATION DOLLARS FOR MAJOR ROUTES OF THESE USERS: 1711026.77
TOTAL NUMBER OF THESE MAJOR ROUTES: 861

MILEAGE BANDS	PCT DIST DOLLARS	PCT ROUTES
≤ 40	7.32	8.23
41 - 150	15.10	10.31
151 - 500	27.53	27.67
501 - 1000	22.07	16.68
1001 - 2100	16.38	26.58
2100+	11.61	10.53

TABLE 3-17. HIGHLIGHTS OF USER SURVEY

SAMPLE

Class	Business: 61%
	Government: 25%
	Institutions: 14%
Subclasses	3% to 25% (Medical, Manufacturing)
Size	Large: 52%
	Medium: 26%
	Small: 22%
Region	9 Regions, varied from 4% to 23%
Number of Locations	Range: 1 to 3200
	Mean: 215
CONUS Coverage	ALL CONUS: 60%
	½ CONUS: 4%
	¼ CONUS: 3%
	¾ CONUS: 33%
Urban/Rural	Urban: 45%
	Rural: 11%
	Both: 44%

BUDGET

1982 - Dollars

Total	Range: $5,000 to $500,000,000·	Mean: $20,020,000
Voice	Range: $5,000 to $300,000,000;	Mean: $15,043,000
Data	Range: $0 to $200,000,000;	Mean: $6,322,000
Video	Range: $0 to $3,000,000;	Mean: $502,000

Growth Rate

Total	Range: -20% to 100%	Mean: 13%
Voice	Range: -20% to 100%	Mean: 11%
Data	Range: -10% to 400%	Mean: 15%
Video	Range: 0% to 300%	Mean: 32%

VOLUME

Growth

Total	Range: -15% to 100%	Mean: 11%
Voice	Range: -10% to 100%	Mean: 9%
Data	Range: -10% to 600%	Mean: 15%
Video	Range: 0% to 600%	Mean: 57%

TABLE 3-17. HIGHLIGHTS OF USER SURVEY (Continued)

Reason

Organization Expansion: 26%
More Services: 67%
Both: 7%

PRICE DEMAND PERFORMANCE

Use More if Costs Reduced?   yes: 61%   no: 39%
     Reason No: 71% cost insensitive

Use Less if Costs Increased?   yes: 47%   no: 53%
     Reason No: 81% cost insensitive

Pay More if Performance Increased?   yes: 28%   no: 72%
     Reason No: 41% limited budget; 44% already satisfactory

Accept Lower Performance if Costs Reduced?   yes: 9%   no: 91%
     Reason No: 91% current is minimal

CUSTOMER PREMISE SERVICE

Use						
	Facilities Suitable?	All: 61%	Some:	30%	None:	9%
	Currently Using?	Yes: 11%	No:	89%		
	Provider?	SBS: 62%	AMSAT:	38%		
	Currently Considering	Yes: 31%	No:	69%		
	Consider in Future	Yes: 37%	No:	63%		

Features Influencing Use
     Low Cost: 94% (very: 1, 2)
     Reliability: 93% (very: 1, 2)
     High Data Speed: Mixed
     Video Conferencing Capability: Mixed
     Local Loop Solution: Mixed
     Private Ownership: Mixed
     Security: Mixed
     Telco Alternate: Mixed

Actual Results of Use
     Saved Dollars: 87%
     Service Better: 75%
     Productivity Better: 67%

TABLE 3-17. HIGHLIGHTS OF USER SURVEY (Continued)

NEEDS AND SERVICES

New Delivery/Applications Planned

Satellite Services:	2%	High Speed Services:	4%
Fiber Optics:	2%	Video Teleconferencing	24%
Microwave:	2%	DBS:	7%
SBS:	7%	Videotext:	0%
CPS:	4%	Electronic Mail:	3%
Private Networks:	5%	More Services:	28%
Digital Services	6%	None	6%

Intra-Inter Needs

Total	Intra:	58%	Inter:	42%
Voice	Intra:	57%	Inter:	43%
Data	Intra:	80%	Inter:	20%
Video	Intra:	89%	Inter:	11%

Current Fastest Channel Data Rate

<2.4K	13%
4.8K	14%
9.6K	53%
56K	15%
1.5M	4%
6.3M	1%

Peak Hour

Voice	First:	10:00 - 11:00 AM	48%
	Second:	2:00 - 3:00 PM	51%
Data	First:	Even	37%
	Second:	Even	47%
Video	First:	Even	28%
	Second:	Even	46%

Distribution of Traffic By Distance

Mileage Bands	PCT
<40	7.3
41 - 150	15.1
151 - 1000	27.5
1001 - 2100	22.1
2100+	16.4
	11.6

SECTION 4
COMPARATIVE ECONOMICS

4.1 INTRODUCTION

This section describes the cost analysis that was required to develop the CPS, overall satellite and Ka-band CPS forecasts. First, the methodology which was employed is summarized, and then 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 are delineated. For each step where key assumptions were made, the basis for each assumption is discussed. Lastly, the estimated costs and the crossover distances are presented in a summary of the cost analysis results. A more detailed discussion of the methodology and results are presented in Appendix F.

As noted in earlier sections, a customer premises services (CPS) network may be either a dedicated unshared network (i.e., only one user) or a shared network (i.e., several users sharing the facilities). In unshared applications the earth station is located on customer premises, whereas in shared applications, two or more customers share the earth station and are connected to the earth station through dedicated tails. A cost analysis was conducted for both types of networks, for both .999 and .995 availability levels, for C-, Ku- and Ka-bands for the years 1982, 1990 and 2000.

4.2 COST ANALYSIS METHODOLOGY

The steps used in estimating end-to-end satellite service costs for CPS systems and for estimating the crossover distances are outlined below, and diagrammed in Figure 4-1.

FIGURE 4-1. ACTIVITY FLOW FOR COST ANALYSIS

4.2.1   Earth Station Cost Analysis

Earth station costs were estimated using the steps outlined below:

a. **Define the CPS earth stations.**

    This step involved a survey of the literature on the traffic requirement for private user networks and the use of the obtained information to define the size of the earth stations.

b. **Develop earth station component costs.**

    Various vendors and technical literature were surveyed to obtain the cost of earth station components. These component costs included antenna subsystem, low noise amplifier, high power amplifier, upconverter, and terminal costs.

c. **Define typical satellite parameters.**

    In designing and sizing the CPS 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 the earth station sizing.

d. **Size the CPS 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 estimated. Normally link budget analysis establishes the uplink EIRP and downlink G/T requirement, from which HPA power requirement, LNA noise temperature and antenna size can be estimated.   he earth stations were designed and sized for .995 and .999 availability level.

e. **Calculate investment required for CPS earth stations.**

    Using the design and size of earth stations and the costs of various earth station components, the costs or investment requirement for various CPS earth stations were estimated.

f. **Determine annual payback requirement of CPS earth station.**

    Western Union's proprietary financial package which considers key factors that influence investments (e.g., cost of raising

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money, return on investment, operation and maintenance over-head, and tapes on income) was used to estimate the annual payback requirement of various CPS earth stations.

4.2.2   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 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 for .999 and .995 availability levels.

d.   Define a typical satellite system.

Various satellite carriers were surveyed and FCC filings were examined to determine the ratio of orbiting to ground spare satellites. These ratios were determined for C-, Ku- and Ka-bands.

e.   Caluclate investment cost of a typical satellite system.

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 or non-recurring cost

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

f. **Calculate payoff requirement of the system.**

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

g. **Develop annual payoff requirement of the transponder.**

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 payoff 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 payoff requirement of a satellite system and the average capacity usage of the system, the annual payoff requirement of a transponder was computed. These requirements were estimated for C-, Ku- and Ka-bands.

4.2.3   Define the Typical CPS System

A typical CPS 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, and a central network controlling facility.

4.2.4   Define the Services and the Data Rates

Various users and technical literature was surveyed to determine the service needs of private networks. Then the services and corresponding data rates (where applicable) were defined.

4.2.5   Develop Annual Payback Requirement of a Typical CPS System

Having defined a typical CPS system and estimated the earth segment and space segment, annual payback requirements, the annual payback requirement of a CPS system was calculated.

4.2.6   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.

4.2.7   Determine Crossover Distances for Unshared Earth Stations

For services under consideration for a CPS system, the equivalent AT&T tariffs were used, and the distance at which AT&T tariff cost was equal to the satellite service cost was computed for various services and different types of earth stations for the availability levels of .995 and .999.

4.2.8   Determine Crossover Distances for Shared Earth Stations

For the shared application it was assumed that only large and medium earth stations would be shared. Since in this application customers are not colocated with the earth station, dedicated tails are used to extend the services to the customer; the average length of the tail was assumed to be three miles. For tail extension costs, the AT&T tariffs were used for the service to be extended. The total service cost for a CPS satellite network was compared with the AT&T tariff for the equivalent service and the breakeven distance computed for various service types, various earth station types for the availability levels of .995 and .999.

4.3 COST ANALYSIS ASSUMPTIONS AND CONSIDERATIONS

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

4.3.1 CPS Earth Station Size

As noted above, a CPS network can be either an unshared network or a shared network, and the earth station in an unshared application is located on the customer's premise, whereas in the shared application, two or more customers share the earth station and are connected to the earth station through dedicated tails. In this study earth station sizes were defined as follows:

	CAPACITY
Large Earth Station	32 Mbps
Medium Earth Station	6.3 Mbps
Small Earth Station	1.5 Mbps
Mini Earth Station	64 Kbps

All four sizes were considered for unshared systems, while only the large and medium sizes were considered for shared systems. The modulation scheme that was used was quadature phase shift keying, and earth stations were designed with .999 and .995 availability levels.

4.3.2 CPS Space Segment

As indicated earlier, the three types of space segments that were considered were C-, Ku- and Ka-band space segments. A typical sate-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. The cost estimates were obtained by examining the costs associated with Westar IV (Western Union's domestic satellite in C-band) and looking at various FCC filings. While a typical satellite has emerged for C-band, various types of satellites are being planned for Ku-band. 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 has not been planned yet; these systems are still in the preliminary technology development and planning stages. The Ka-band space segment for CPS systems may be configured using a TDMA, FDMA or Hybrid approach. For the Hybrid approach, the uplink uses the FDMA approach, while the downlink uses the TDMA approach. For CPS applications the Ka-band satellite uses a number of scanning beams and on-board regeneration technique.

4.3.3   Satellite Systems

It was assumed that for C- and Ku-bands the satellite system would 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 the Ka-band spacecraft, the equivalent transponders concept was used. The equivalent transponders capacity was assumed to be 60 Mbps. In completing the price per equivalent transponders, the following assumptions are made:

a.   The average life expectancy for the spacecraft will be 10 years.
b.   The average capacity in use at any time will be 0.5.
c.   The space segment will consist of one in-orbit satellite and one ground spare.

4.3.4   CPS Networks

For estimating end-to-end user costs for various CPS earth station types, the following assumptions were made:

a.   Two nodes were considered for end-to-end user cost.
b.   The earth station at each node was the same type.
c.   The interface to the customers equipment was for voice, data and teleconferencing.

Further, and as noted earlier, two types of CPS applications were considered: the unshared CPS network, where no terrestrial tails are needed to extend the

service, and the shared CPS network where terrestrial tasks are needed to extend the service to the customers. For extensions, dedicated tail circuits of 3 miles were used, and only large and medium earth stations were assumed to be shared.

4.3.5   Dedicated Terrestrial Tails

For the purpose of this study the tails for shared earth stations were considered dedicated tails that would be leased from Telcos. The tarriffs used for tail extensions were:

SERVICE	FACILITY	TARIFF TYPE
Voice	300- 3000 hz	FCC No. 260
	Private Line	Type 2001
Data	2.4, 4.8, 9.6	FCC No. 267
	56 and 1544 kbps	

4.3.6   User Services

The CPS 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, 4.8, 9.6 56 and 1544 kbps
c.   Video service - 1544 kbps.

4.3.7   Comparative FCC Tariffs

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

SERVICE	FACILITY	TARIFF TYPES
Voice	300 - 3000 hz	FCC No. 260
	Private Line	Type 2001
Data	2.4, 4.8, 9.6,	FCC No.267
	5.6 kbps	
	1.544 Mbps	FCC No. 267
		FCC No. 271 for
		Terminations

4.3.8   Future Trends

Important future trends are outlined below.

4.3.8.1   Digital Trends

It was generally accepted that the communication trend is towards total digital systems, as opposed to analog systems; therefore it was assumed that in 1990 and 2000 communication would be entirely digital for CPS applications. The reasons were twofold.

        a.   The availability of digital microcircuitry at reasonable prices

        b.   The requirement for integrated services.

4.3.8.2   Capacity Improvement Techniques

Presently in digital transmission schemes, the TDM/TDMA approach with quadrature phase shift keying (QPSK) is being used. With this approach a typical C-band 36 Mhz wide transponder could transmit 60 Mbps of information. It was anticipated that by the year 1990 more spectrally efficient modulation schemes would be used. It was assumed that in 1990 transmit capacity of a typical C-band transponder would increase by 50% to 90 Mbps. For Ku-band, the present burst rate supported by 54 Mhz wide transponders is 60 Mbps. It was assumed that by the year 1990 the burst rate would increase by 50% to 90 Mbps (QPSK

modulation), and for the year 2000 the burst rate would increase by another 50% to 135 Mbps. It was assumed that these capacity improvement techniques would be used for single carrier full transponder large earth stations, but would not be applicable for multiple carrier partial transponder small earth stations. For Ka-band it was assumed that in the year 2000 a spacecraft with a 10 Gbps capacity would be used for CPS applications.

4.3.8.3   Costs

The following cost assumptions were made:

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 for each of these systems.

c.   Cost of TDM/TDMA terminals and channel units will reduce at an annual rate of 15% (in 82 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% per year.

e.   Cost of monitor and control subsystem is expected to decline at an annual 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 satellite was assumed to decline at a rate of 3.5% per year until the year 2000.

h.   For Ka-band, it was assumed that the satellite cost in year 2000 will remain the same as in year 1990.

4.4   DISCUSSION OF RESULTS

4.4.1   Earth Station Costs

The present costs of C-band earth stations are summarized in Table 4-1. The capacity, approach, uplink/downlink, availability level, earth station description, earth station cost, installation cost, total cost, and number of carriers per transponder are indicated for each earth station size or type. Similar information on the present costs of Ku-band earth stations is summarized in Table 4-2. The costs projected for 1990 and 2000 for C- and Ku-band earth stations are summarized in Tables 4-3 and 4-4 respectively. Projected Ka-band earth station costs are summarized in Table 4-5. As noted in the previous section and in Tables 4-1 through 4-5 all earth station costs are expected to decline. Also, Ka-band TDMA earth stations are expected to be less expensive than Ka-band FDMA earth stations.

4.4.2   Satellite Costs

Estimates of initial investment cost of the C-, Ku- and Ka-band satellite systems are summarized in Table 4-6. Using these estimates and Western Union's financial packages, the annual payoff requirements of C-, Ku- and Ka-band transponders were estimates and are presented in Figures 4-2, 4-3 and 4-4.

4.4.3   Break-Even Distances

Tables 4-7 through 4-38 lists the monthly payoff requirements and the corresponding crossover distances for C-, Ku- and Ka-bands for shared and unshared systems for the year 1982, 1990 and 2000. The following is a guide for reviewing these tables:

    a.   Tables 4-7 through 4-10: 1982 monthly payoff requirement in $ for C- and Ku-band CPS, unshared and shared systems
    b.   Tables 4-11 through 4-14: 1982 crossover distances in miles for C- and Ku-band CPS, unshared and shared systems

c. Tables 4-15 through 4-20: 1990 monthly payoff requirement in $ for C-, Ku- and Ka-band CPS, unshared and shared systems

d. Tables 4-21 through 4-26: 1990 crossover distances in miles for C-, Ku- and Ka-band CPS, unshared and shared systems

e. Tables 4-27 through 4-32: 2000 monthly payoff requirement in $ for C-, Ku and Ka-band CPS, unshared and shared systems

f. Tables 4-33 through 4-38: 2000 crossover distances in miles for C-, Ku and Ka-band CPS, unshared and shared systems.

A review of these tables will indicate that in 1982, C-band had a lower crossover distance than Ku-band for all four configurations (i.e., shared or unshared with .999 or .995 availability). For 1990 and 2000 for all unshared systems a majority of the crossover distances for Ka-band will be lower than those for C-band which, in turn, will be lower than those for Ku-band; however, for large and medium sized earth stations in 1990, Ka-band crossover distances will be the largest. The relative sizes of the crossover distances for shared systems for the three bands vary from 1990 to 2000 and across availability levels for these years. In general, the crossover distances for Ka-band, as compared with those for C- and Ku-bands, will be the lowest for unshared systems and the highest for shared systems in 1990 and 2000.

C - 2

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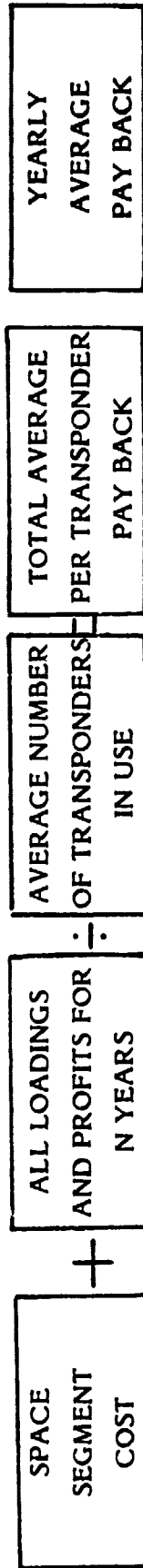
SPACE SEGMENT COST	+	ALL LOADINGS AND PROFITS FOR N YEARS	÷	AVERAGE NUMBER OF TRANSPONDERS IN USE	TOTAL AVERAGE PER TRANSPONDER PAY BACK	YEARLY AVERAGE PAY BACK
				N*		
201 Million		313 M		8 36	14.5 M	1.81 M
1 Million/Year		402.2 M		10 36	17 M	1.7 M

N* = The life of the satellite

FIGURE 4-2. C-BAND EQUIVALENT TRANSPONDER COST

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SPACE SEGMENT COST	+	ALL LOADINGS AND PROFITS FOR N YEARS	÷	AVERAGE NUMBER OF TRANSPONDERS IN USE	=	TOTAL AVERAGE PER TRANSPONDER PAY BACK	YEARLY AVERAGE PAY BACK
248.5 M 1 M/Year		N^* 8 398.4		24		27.5 M	3.43 M
		10 511 M		24		32.1	3.21 M

N^* = The life of the satellite

FIGURE 4-3. KU-BAND EQUIVALENT TRANSPONDER COST

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TDMA APPROACH

$$\text{SPACE SEGMENT COST} + \frac{\text{ALL LOADINGS AND PROFITS FOR N YEARS}}{\text{AVERAGE NUMBER OF TRANSPONDERS IN USE}} = \text{TOTAL AVERAGE PER TRANSPONDER PAY BACK}$$

	Life of Satellite	ALL LOADINGS AND PROFITS FOR N YEARS	AVERAGE NUMBER OF TRANSPONDERS IN USE	TOTAL AVERAGE PER TRANSPONDER PAY BACK	YEARLY AVERAGE PAY BACK
3 GBPS 335 M 2 M/Year	8	556.1	25	36.3	4.54
	10	707		42.5	4.25
5 GBPS 396.6 M 2 M/Year	8	658.4	42	25.5	3.2
	10	836.8		29.9	2.99
10 GBPS 500.0 2 M/Year	8	830	84	16.0	2.00
	10	1055		18.75	1.575

FIGURE 4-4. KA-BAND EQUIVALENT TRANSPONDER COST

TABLE 4-1. C-BAND CPS EARTH STATION (ES) COSTS IN THOUSANDS OF DOLLARS

ES TYPE	CAPACITY	UPLINK B.R.	DOWNLINK R.R.	AVLBLTY	EARTH STATION DESCRIPTION	1982			# OF CARRIERS PER TRNSPNDR
						ES COST	INSTLATION COST	TOTAL	
Lg.	32 MBPS	60 MBPS	60 MBPS	.995	11 Meter antenna, 50° LNA 3 KW HPA	483.8	193.5	677.5	1
"	"	"	:	.999	Same	688.5	275.4	964	1
Med.	6.3 MBPS	15 MBPS	15 MBPS	.995	7 M ant., 50° LNA 600 W HPA	184.1	73.7	258	2
"	"	"	"	.999	Same	339.8	135.6	474.6	2
Sm.	1.5 MBPS	8 MBPS	8 MBPS	.995	7 M ant., 100° LNA 300 W HPA	157	62.8	219.8	3
"	"	"	"	.999	Same	281	112	393	3
Sm.	1.5 MBPS	SCPC	SCPC	.995	(a) 5 M ant., 100° LNA 40 W HPA	60	24	84	3
"	"	1.5 MBPS	1.5 MBPS	.995	(b) 7 M ant., 100° LNA 20 W HPA	82	32.8	115	7 T-1 carr.
"	"	"	"	.999	(a) 5 M ant., 100° LNA 40 W HPA	136	54.4	190.4	3 SCPC carr.
"	"	"	"	.999	(b) 7 M ant., 100° LNA	154	61.6	216	7 T-1 carr.
Mini	1 VF 64 KBPS	SCPC	SCPC	.995	5 M ant., 100° LNA 5 W	45.5	18.2	63.7	155 VF carr.
"	"	Digital 64 KBPS	64 KBPS	.999	Same	98	39.2	137.2	155 VF carr.
1 Voice channel	Analog SCPC			.995	5 M ant., 100° LNA 5 W HPA	50	20	70	60 carriers per trnspndr.
				.999	Same	107	42.8	149.8	"

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TABLE 4-2. KU-BAND CPS EARTH STATION (ES) COSTS IN THOUSANDS OF DOLLARS

| ES Type | Capacity | | Rate in MBPS | | | Earth Station Description | | 1982 | | # of Carriers per Trnspndr |
		Approach	Uplnk	Dnlnk	Avlblty		ES Cost	Instlation Cost	Total	
Lg.	32 MBPS	TDMA	60	60	.995	5 Meter antenna 150° LNA 42 Watt HSA	385	154	539	single carrier
Lg.	"	"	"	"	.999	7.7 M Antenna Redundant Earth Station (Rain Zones 1, 2, 3)	642.8	257.12	900	"
Lg.	"	"	"	"	.999	Same as above with 11 meter antenna	705.8	282.32	988	"
Med.	6.3 MBPS	TDMA	60	60	.995	5.5 Meter antenna 150° LNA 42 Watt HSA	385	154	539	single carrier
Med.	"	"	"	"	.999	7.7 M ant., 42 WHSA 150° LNA (FR) RZ 1, 2, 3	642.8	257.12	900	"
Med.	"	"	"	"	.999	Same as above but with 11 M ant. for RZ 4	705.8	282.32	988	"
Sm.	For TDMA approach the costs are same as given above									
Med. & Sm.	6.3/1.5	TDMA	15	15	.995	5.5 M Ant. 300 WHPA 150° LNA	283	113.2	396.2	3 carriers
"	"	"	"	"	.999	7 M ant., 300 WHPA 150° LNA (RZ 1, 2, 3)	517.8	207.2	725	"
"	"	"	"	"	.999	11M ant, 300 WHPA	593	237	830	"
Sm/ Mini	1.5 MBPS	TDMA	8	8	.995	7.7 M ant, 12 WHPA 150° LNA	321	123.4	449.4	5 carrier per transponder
"	"	"	"	"	.999	11 M ant, 25 WHPA 150° LNA (RZ 1, 2, 3)	:419	167.6	585.6	"
"	"	"	"	"	.999	13 M ant. for RZ 4	474	189.6	663.6	"

TABLE 4-2. KU BAND CPS EARTH STATION (ES) COSTS IN THOUSANDS OF DOLLARS

ES Type	Capacity	Approach	Rate in MBPS		Avlblty	Earth Station Description	1982			# of Carriers per Trnspndr
			Uplnk	Dnlnk			ES Cost	Instlation Cost	Total	
Sm.	1.5 MBPS	SCPC	1.5	1.5	.995	5.5 M ant., 25 WHPA 150° LNA	172	68.8	240.8	16 T-1 carriers
"	"	"	"	"	.999	7 M ant., RZ 1, 2, 3	282.5	113	395.5	"
"	"	"	"	"	.999	11 M ant., RZ 4	302.5	121	423.5	
Mini	64 KBPS	SCPC	64 KBPS	64 KBPS	.995	5.5 M ant., 10 WHPA 150° LNA	136	54.4	190	562 carriers
"	"	"	"	"	.999	7 M ant. for RZ 1, 2, 3	288.5	115.4	404	"
"	"	"	"	"	.999	11 M ant. for RZ 4	308.5	123.4	431.9	"

TABLE 4-3. PROJECTED C-BAND CPS EARTH STATION (ES) COSTS
IN THOUSANDS OF 1982 DOLLARS

(ES) Type	Capacity	Approach	Availability	1990 (ES) Cost	1990 Installation	1990 Total	2000 (ES) Cost	2000 Installation	2000 Total
Large	32 MBPS	60 MBPS TDMA	.995 / .999	289.20 / 398.00	115.65 / 159.10	405.0 / 557.0	184.50 / 250.40	73.8 / 100.2	258.30 / 350.60
Medium	6.3 MBPS	15 MBPS TDMA	.995 / .999	108.00 / 206.30	43.16 / 82.50	151.0 / 288.8	68.20 / 132.30	27.3 / 52.9	95.50 / 185.20
Small	1.5 MBPS	8 MBPS TDMA	.995 / .999	91.90 / 171.60	36.70 / 68.60	128.6 / 240.2	58.00 / 110.20	23.2 / 44.1	81.30 / 154.20
Small	1.5 MBPS	SCPC	.995 / .999	50.10 / 107.80	20.00 / 43.20	70.1 / 151.0	33.60 / 72.50	13.4 / 29.0	47.00 / 101.50
Mini	1 V F 64 KBPS	SCPC Digital	.995 / .999	32.40 / 70.32	13.00 / 28.10	45.4 / 98.5	21.90 / 47.60	8.8 / 19.0	30.70 / 66.60

TABLE 4-4. PROJECTED KU BAND CPS EARTH STATION (ES) COSTS
IN THOUSANDS OF 1982 DOLLARS

E(S) Type	Capacity	Approach	Availability	1990			2000		
				E(S) Cost	Installation	Total	E(S) Cost	Installation	Total
Large	32 MBPS	60 MBPS TDMA	.995	213.2	85.3	298.4	131.1	52.5	183.6
			.999	363.3	145.3	503.5	225.7	90.3	316.0
			.999	412.4	165.0	577.3	259.8	104.0	363.7
Med/Small	6.3/1.5	15 MBPS TDMA	.995	179.8	71.9	251.7	116.3	46.5	162.8
			.999	311.0	124.3	435.3	204.8	81.9	286.7
			.999	369.7	147.9	517.5	245.4	98.2	343.6
Small/Mini	1.5 MBPS 64 KBPS	8 MBFS TDMA	.995	214.3	85.7	299.9	141.2	56.4	197.6
			.999	279.4	111.8	391.2	184.8	73.9	258.7
			.999	322.3	128.9	451.2	214.5	85.8	300.3
Small	1.5 MBPS	SCPC	.995	128.0	51.3	179.3	87.53	35.1	122.6
			.999	217.3	86.9	304.2	148.2	59.3	207.5
			.999	233.1	93.2	326.3	159.2	63.6	222.8
Mini	64 IVF	SCPS	.995	103.0	41.3	144.3	70.8	28.3	99.1
			.999	214.2	85.8	300	147.2	58.9	206.1
			.999	229.8	92.0	321.8	158.0	63.2	221.2

TABLE 4-5. KA-BAND CPS TERMINAL COSTS IN THOUSANDS OF 1982 DOLLARS*

	FDMA		TDMA	
	COST (W/N**)	CAPACITY	COST	CAPACITY
HIGH (32 MBS)	969/830	238	330	440
MED (6.3 MBS)	471/359	68	233	88
LOW (1.5 MBS)	329/165	14	208	22
MINI (64 KBPS)	95/85	1	109	1

*For .995 Availability in Rain Zone E and .999 in other areas.

**W = 1.2 degree spacecraft beams.
N = 0.3 degree spacecraft beams.

TABLE 4-6. INVESTMENT COST OF C-, KU- AND KA-BAND
SATELLITES IN MILLIONS OF DOLLARS

COST ELEMENTS	C-BAND	KU-BAND	KA-BAND (TDMA)		
			3 Gbps	5 Gbps	10 Gbps
Development (NR)	0.0	34.0	180.0	220.0	280.0
2(R+L+IN)	156.0	163.8	--	--	--
1(R+L+IN)	--	--	74.9	86.6	110.0
TT&C	15.0	15.0	40.0	40.0	40.0
R	30.0	35.7	40.0	50.0	70.0
TOTAL	210.0	248.5	334.9	396.6	500.0

R = Satellite Recurring Cost

L = Launch Cost

IN = Insurance Cost

TABLE 4-7. 1982 MONTHLY PAYOFF REQUIREMENT IN $ FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

C I CPS
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 4 0.768 7 10.4

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	2308.0	350	364	400	720	506	11252	44398
LARGE	0.999	32000.0	2622.0	352	370	406	758	550	12297	48664
MEDIUM	0.995	6300.0	1046.5	370	407	481	1195	1048	24331	97765
MEDIUM	0.995	6300.0	1159.0	374	415	497	1287	1154	26884	108181
MEDIUM	0.995	6300.0	938.0	366	400	466	1105	946	21049	87719
MEDIUM	0.999	6300.0	1116.0	373	412	491	1252	1114	25708	104290
SMALL	0.995	1544.0	394.0	390	447	560	1656	1576	37065	
SMALL	0.999	1544.0	571.2	416	498	662	2252	2256	53472	
SMALL	0.999	1544.0	404.7	392	450	566	1692	1617	38054	
SMALL	0.995	1544.0	546.8	412	491	648	2170	2163	51213	
SMALL	0.999	1544.0	592.0	419	504	674	2321	2336	55398	
SMALL	0.999	1544.0	675.0	430	528	722	2600	2655	63083	
MINI	0.995	64.0	201.0	1031	1729	3125	16618	18475		
MINI	0.999	64.0	343.4	1526	2718	5103	28155	31860		
MINI	0.995	64.0	86.2	633	932	1531	7317	8045		
MINI	0.999	64.0	146.4	842	1350	2367	12194	13420		

TABLE 4-8. 1982 MONTHLY PAYOFF REQUIREMENT IN $ FOR C-BAND CPS SERVICES (SHARED EARTH STATIONS)

C 1   CPS2
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 .4 4 0.768 7 10.4

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	2388.0	1086	1536	2269	5320	664	21476	44390
LARGE	0.999	32000.0	2622.0	1088	1539	2274	5358	707	22541	48664
MEDIUM	0.995	6300.0	1046.5	1104	1577	2350	5774	1206	34575	97765
MEDIUM	0.998	6300.0	1159.0	1110	1585	2344	5887	1312	37129	108181
MEDIUM	0.995	6300.0	930.0	1102	1569	2335	5705	1104	32113	87719
MEDIUM	0.999	6300.0	1116.0	1109	1582	2360	5851	1221	34152	104200

TABLE 4-9. 1982 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

NU 1   CPS
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 0.768 7 10.4

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	3878.0	360	387	441	962	782	17909	71559
LARGE	0.999	32000.0	4174.0	362	391	449	1010	837	19231	76955
LARGE	0.999	32000.0	4246.0	363	392	451	1021	850	19553	78268
MEDIUM	0.995	6300.0	1128.0	373	413	492	1262	1125	26101	105311
MEDIUM	0.999	6300.0	1424.0	384	434	534	1505	1403	32898	132717
MEDIUM	0.999	6300.0	1496.0	386	439	544	1565	1471	34531	139305
MEDIUM	0.995	6300.0	1236.0	377	421	500	1351	1227	28631	115311
MEDIUM	0.999	6300.0	1505.0	386	440	546	1572	1480	34736	140219
MEDIUM	0.999	6300.	1592.0	389	446	558	1644	1561	36710	148274
SMALL	0.995	1544.0	551.0	413	492	651	2184	2179	51602	
SMALL	0.999	1544.0	820.5	451	570	806	3089	3213	76556	
SMALL	0.999	1544.0	907.5	464	595	856	3381	3547	84611	
SMALL	0.995	1544.0	621.0	423	512	691	2419	2447	58083	
SMALL	0.999	1544.0	733.0	439	544	755	2795	2877	68454	
SMALL	0.999	1544.0	797.0	448	563	792	3010	3123	74380	
SMALL	0.995	1544.0	611.0	421	509	685	2385	2409	57157	
SMALL	0.999	1544.0	737.6	439	546	758	2810	2095	68680	
SMALL	0.999	1544.0	760.2	443	552	771	2886	2982	70972	
MINI	0.995	64.0	391.0	1691	3049	5764	32012	36268		
MINI	0.999	64.0	502.5	2078	3823	7312	41045	46592		
MINI	0.999	64.0	566.5	2300	4267	8201	46230	52510		
MINI	0.995	64.0	178.0	955	1576	2819	14836	16630		
MINI	0.999	64.0	355.0	1566	2799	5264	29095	32934		
MINI	0.999	64.0	378.0	1646	2958	5583	30958	35064		

TABLE 4-10. 1982 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (SHARED EARTH STATIONS)

KU 1   CF62
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 0.768 7 10.4

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.0	9.6	56	64	1544	6300
LARGE	0.995	32000.0	3878.0	1096	1557	2311	5561	940	28152	71557
LARGE	0.999	32000.0	4174.0	1098	1561	2319	5609	974	29475	76955
LARGE	0.999	32000.0	4246.0	1097	1562	2321	5621	1008	29797	78268
MEDIUM	0.995	6300.0	1128.0	1109	1502	2362	5861	1283	36424	105311
MEDIUM	0.999	6300.0	1424.0	1120	1603	2404	6105	1561	43141	132719
MEDIUM	0.999	6300.0	1496.0	1122	1608	2414	6164	1629	44775	139385
MEDIUM	0.995	6300.0	1236.0	1113	1590	2377	5950	1384	38075	115311
MEDIUM	0.999	6300.0	1505.0	1122	1609	2415	6171	1637	44979	140219
MEDIUM	0.999	6300.0	1592.0	1126	1615	2427	6243	1719	46954	140274

TABLE 4-11. 1982 CROSSOVER DISTANCES IN MILES FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

C t CPS
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 4 0.780 7 10.4

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	2380.0	1	1	1	1	369	270	102	57
LARGE	0.999	32000.0	2622.0	1	1	1	1	416	316	227	48
MEDIUM	0.995	6300.0	1046.5	4	1	1	1	746	846	741	199
MEDIUM	0.995	6300.0	1159.0	5	1	1	1	1099	959	050	234
MEDIUM	0.995	6300.0	938.0	2	1	1	1	038	738	636	172
MEDIUM	0.999	6300.0	1116.0	5	1	1	1	1026	716	009	220
SMALL	0.995	1544.0	394.0	11	1	1	1	1852	1641	1469	375
SMALL	0.999	1544.0	571.2	23	1	1	1	3067	2034	2622	628
SMALL	0.995	1544.0	404.7	12	1	1	1	1926	1732	1539	309
SMALL	0.999	1544.0	546.8	21	1	1	1	2097	2672	2463	589
SMALL	0.995	1544.0	592.0	24	1	1	5	3209	2971	2757	661
SMALL	0.999	1544.0	675.0	31	1	1	30	3778	3520	3297	795
MINI	0.995	64.0	201.0	620	1214	3017	4170	32306	31142	30450	
MINI	0.999	64.0	343.4	1237	2919	6427	8157	55931	53875	52798	
MINI	0.995	64.0	86.2	176	204	547	982	13405	12815	12434	
MINI	0.999	64.0	146.4	419	729	1710	2653	23358	22425	21002	

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TABLE 4-12. 1982 CROSSOVER DISTANCES IN MILES FOR C-BAND CPS SERVICES (SHARED EARTH STATIONS)

C 1   CPS2
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4   4   4   0.768   7   10.4

CROSSOVER DISTANCE

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	2308.0	678	927	1542	557	537	437	345	91
LARGE	0.999	32000.0	2622.0	680	930	1553	565	583	483	389	102
MEDIUM	0.995	6300.0	1046.5	700	970	1682	658	1191	1022	904	241
MEDIUM	0.995	6300.0	1159.0	704	978	1709	678	1380	1205	1021	277
MEDIUM	0.995	6300.0	938.0	696	962	1656	639	1009	905	798	207
MEDIUM	0.999	6300.0	1116.0	703	975	1699	670	1308	1135	971	263

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TABLE 4-13. 1982 CROSSOVER DISTANCES IN MILES FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KU 1   CPS   TARIFF FACTORS 1 1
FILL FAC = 0.9
CHANNEL UNIT COSTS = 4 4 4 0.768 7 10.4

CROSSOVER DISTANCE

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	3878.0	1	1	1	1	663	563	467	129
LARGE	0.999	32000.0	4174.0	1	1	1	1	721	621	523	143
LARGE	0.999	32000.0	4246.0	1	1	1	1	736	636	537	147
MEDIUM	0.995	6300.0	1128.0	5	1	1	1	1047	928	820	224
MEDIUM	0.999	6300.0	1424.0	9	1	1	1	1544	1363	1176	317
MEDIUM	0.999	6300.0	1496.0	10	1	1	1	1665	1480	1291	340
MEDIUM	0.995	6300.0	1236.0	6	1	1	1	1220	1058	925	258
MEDIUM	0.999	6300.0	1505.0	10	1	1	1	1680	1494	1306	343
MEDIUM	0.999	6300.0	1592.0	11	1	1	1	1826	1636	1444	370
SMALL	0.995	1544.0	551.0	21	1	1	1	2928	2700	2490	596
SMALL	0.999	1544.0	820.5	44	1	1	90	4775	4483	4244	1028
SMALL	0.999	1544.0	907.5	52	7	1	145	5372	5059	4810	1160
SMALL	0.995	1544.0	621.0	26	1	1	12	3408	3163	2946	708
SMALL	0.999	1544.0	733.0	36	1	1	54	4176	3904	3674	088
SMALL	0.999	1544.0	797.0	42	1	1	80	4614	4328	4091	990
SMALL	0.995	1544.0	611.0	25	1	1	10	3339	3097	2881	692
SMALL	0.999	1544.0	737.6	37	1	1	55	4207	3935	3704	895
SMALL	0.999	1544.0	760.2	39	1	1	65	4362	4084	3851	931
MINI	0.995	64.0	391.0	1522	3489	7567	9407	63001	61474	60260	
MINI	0.999	64.0	502.5	2189	4824	10237	12602	82237	79274	77767	
MINI	0.999	64.0	566.5	2573	5590	11770	14390	92019	89491	87811	
MINI	0.995	64.0	179.0	539	970	2491	3564	20740	27630	26990	
MINI	0.999	64.0	355.0	1306	3058	6705	8481	57049	55727	54619	
MINI	0.999	64.0	378.0	1444	3333	7256	9123	61652	59399	50228	

TABLE 4-14. 1982 CROSSOVER DISTANCES IN MILES FOR KU-BAND
CPS SERVICES (SHARED EARTH STATIONS)

NU 1   CPS2
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 4 4 4 0.780 7 10.4

CROSSOVER DISTANCE

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	3870.0	689	949	1613	609	031	731	629	163
LARGE	0.999	32000.0	4174.0	692	953	1627	619	809	789	606	177
LARGE	0.995	32000.0	4246.0	692	954	1631	621	903	803	699	181
MEDIUM	0.999	6300.0	1128.0	703	976	1702	672	1320	1155	903	267
MEDIUM	0.999	6300.0	1424.0	714	978	1774	724	1025	1635	1443	360
MEDIUM	0.999	6300.0	1496.0	717	1006	1791	737	1946	1751	1558	303
MEDIUM	0.995	6300.0	1236.0	707	984	1728	691	1509	1330	1144	301
MEDIUM	0.999	6300.0	1505.0	717	1007	1794	730	1961	1766	1572	386
MEDIUM	0.999	6300.0	1592.0	721	1018	1815	754	2107	1907	1711	413

TABLE 4-15. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

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C   3   CPS
FILL FAC = 0.9      TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0
```

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1544.4	107	117	139	346	311	7066	28153
LARGE	0.999	32000.0	3213.4	118	140	185	617	620	14523	50578
MEDIUM	0.995	6300.0	573.5	116	136	177	568	564	13101	53102
MEDIUM	0.999	6300.0	698.2	120	145	194	670	682	16011	64640
MEDIUM	0.995	6300.0	841.2	126	155	215	708	816	19256	77889
MEDIUM	0.999	6300.0	954.2	129	163	230	881	923	21020	88352
SMALL	0.995	1544.0	297.1	139	181	267	1094	1165	27678	
SMALL	0.999	1544.0	410.2	155	214	332	1473	1599	38148	
SMALL	0.995	1544.0	321.8	142	188	281	1177	1260	29963	
SMALL	0.999	1544.0	302.5	139	183	270	1112	1184	28176	
SMALL	0.995	1544.0	546.0	174	253	410	1929	2121	50722	
SMALL	0.999	1544.0	613.2	104	272	449	2155	2370	56944	
MINI	0.995	64.0	130.3	548	1001	1906	10653	12090		
MINI	0.999	64.0	209.4	823	1550	3004	17061	19414		
MINI	0.995	64.0	51.8	276	456	815	4293	4021		
MINI	0.999	64.0	82.4	382	668	1240	6772	7655		

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TABLE 4-16. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR
C-BAND CPS SERVICES (SHARED EARTH STATIONS)

C 3   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 0.3 2 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1544.4	726	1083	1665	4177	467	10179	28153
LARGE	0.999	32000.0	3213.4	737	1106	1711	4447	776	17636	58578
MEDIUM	0.995	6300.0	573.5	735	1102	1703	4399	721	16294	53102
MEDIUM	0.999	6300.0	698.2	740	1111	1720	4501	838	19124	64640
MEDIUM	0.995	6300.0	841.2	745	1121	1740	4619	972	22369	77889
MEDIUM	0.999	6300.0	954.2	749	1129	1756	4712	1079	24933	88352

TABLE 4-17. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KU 2   CPS
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1960.0	109	123	150	413	388	8923	35729
LARGE	0.999	32000.0	2132.3	111	125	155	441	420	9693	38870
LARGE	0.999	32000.0	2188.7	111	126	157	450	430	9945	39898
MEDIUM	0.995	6300.0	585.1	116	137	170	577	575	13444	54176
MEDIUM	0.999	6300.0	757.4	123	149	203	719	737	17354	70130
MEDIUM	0.999	6300.0	813.8	125	153	211	766	790	18634	75352
MEDIUM	0.995	6300.0	883.8	127	158	221	823	856	20222	81833
MEDIUM	0.999	6300.0	1034.4	132	169	242	947	998	23640	95778
MEDIUM	0.999	6300.0	1101.8	135	174	251	1003	1061	25169	102019
SMALL	0.995	1544.0	374.9	150	204	312	1355	1464	34880	
SMALL	0.999	1544.0	525.5	171	247	398	1861	2042	48024	
SMALL	0.999	1544.0	592.9	181	267	437	2087	2301	55065	
SMALL	0.995	1544.0	435.1	158	221	346	1557	1695	40454	
SMALL	0.999	1544.0	510.0	169	243	389	1809	1982	47389	
SMALL	0.999	1544.0	559.2	176	257	418	1974	2171	51944	
SMALL	0.995	1544.0	451.3	161	226	356	1611	1757	41954	
SMALL	0.999	1544.0	553.8	176	255	415	1956	2151	51444	
SMALL	0.999	1544.0	517.1	170	245	394	1832	2010	48046	
MINI	0.995	64.0	257.2	989	1882	3668	20934	23840		
MINI	0.999	64.0	332.1	1249	2402	4708	27002	30775		
MINI	0.999	64.0	381.3	1420	2744	5392	30988	35331		
MINI	0.995	64.0	130.2	548	1000	1904	10644	12081		
MINI	0.999	64.0	257.9	991	1887	3678	20991	23905		
MINI	0.999	64.0	275.8	1053	2011	3926	22441	25562		

TABLE 4-18. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (SHARED EARTH STATIONS)

COST PER MONTH

KU 2   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 0.3 2 0

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1960.0	729	1087	1676	4244	544	12036	35729
LARGE	0.999	32000.0	2132.3	730	1091	1681	4272	576	12806	38070
LARGE	0.999	32000.0	2188.7	730	1092	1682	4281	587	13058	39898
MEDIUM	0.995	6300.0	585.1	736	1103	1704	4408	732	16557	54176
MEDIUM	0.999	6300.0	757.4	742	1115	1729	4550	894	20467	70130
MEDIUM	0.999	6300.0	813.8	744	1119	1736	4596	947	21747	75352
MEDIUM	0.995	6300.0	883.8	746	1124	1746	4654	1013	23335	81833
MEDIUM	0.999	6300.0	1034.4	751	1135	1768	4778	1154	26753	95770
MEDIUM	0.999	6300.0	1101.8	754	1139	1777	4833	1218	29282	102019

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TABLE 4-19. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR KA-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KA 3 CFS   TARIFF FACTORS 1 1
FILL FAC = 0.9
CHANNEL UNIT COSTS = 1 1 1 0.2 1.6 2.5

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.999	32000.0	2640.6	102	120	157	511	506	11930	40344
LARGE	0.999	32000.0	1610.6	95	106	128	344	315	7329	29560
LARGE	0.999	32000.0	3587.0	108	133	183	665	681	16159	65596
LARGE	0.999	32000.0	2648.6	102	120	157	513	567	11966	40490
LARGE	0.999	32000.0	2534.6	101	119	154	494	486	11457	46412
LARGE	0.999	32000.0	3473.6	107	132	160	646	660	15652	63529
MEDIUM	0.999	6300.0	507.2	101	119	155	501	494	11643	47171
MEDIUM	0.999	6300.0	652.1	106	129	175	620	630	14931	60588
MEDIUM	0.999	6300.0	952.2	117	151	218	867	912	21741	88375
MEDIUM	0.999	6300.0	860.4	114	144	205	791	826	19658	79875
MEDIUM	0.999	6300.0	767.3	110	137	192	715	738	17545	71255
MEDIUM	0.999	6300.0	675.6	107	131	179	639	652	15464	62764
SMALL	0.999	1544.0	299.1	126	169	256	1088	1165	27828	
SMALL	0.999	1544.0	263.6	121	159	235	969	1028	24541	
SMALL	0.999	1544.0	423.6	144	205	327	1506	1642	39356	
SMALL	0.999	1544.0	289.1	125	167	250	1054	1126	26902	
SMALL	0.999	1544.0	378.3	138	192	301	1354	1469	35161	
SMALL	0.999	1544.0	243.8	118	154	224	902	952	22707	
MINI	0.999	64.0	113.9	479	874	1665	9311	10563		
MINI	0.999	64.0	112.4	474	864	1644	9190	10424		
MINI	0.999	64.0	103.5	443	802	1521	8469	9600		
MINI	0.999	64.0	95.3	414	745	1407	7804	8841		
MINI	0.999	64.0	101.5	436	788	1493	8307	9415		
MINI	0.999	64.0	93.3	407	731	1379	7642	8656		

TABLE 4-20. 1990 MONTHLY PAYOFF REQUIREMENT IN $ FOR KA-BAND CPS SERVICES (SHARED EARTH STATIONS)

KA 3   CPS2
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 1 1 1 0.2 1.6 2.5

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.999	32000.0	2640.6	838	1289	2024	5111	663	15043	48344
LARGE	0.999	32000.0	1610.6	831	1275	1998	4944	472	10442	29560
LARGE	0.999	32000.0	3587.0	844	1303	2052	5264	838	19272	65576
LARGE	0.999	32000.0	2640.6	838	1290	2026	5112	655	15079	48490
LARGE	0.999	32000.0	2534.6	837	1288	2023	5093	644	14570	46412
LARGE	0.999	32000.0	3473.6	844	1301	2049	5246	817	18765	63529
MEDIUM	0.999	6300.0	507.2	837	1289	2024	5100	651	14756	47171
MEDIUM	0.999	6300.0	652.1	842	1299	2045	5219	788	18044	60588
MEDIUM	0.999	6300.0	952.2	853	1320	2087	5466	1070	24854	88375
MEDIUM	0.999	6300.0	860.4	850	1314	2074	5391	983	22771	79875
MEDIUM	0.999	6300.0	767.3	846	1307	2061	5314	896	20658	71255
MEDIUM	0.999	6300.0	675.6	843	1300	2048	5239	810	18577	62764

TABLE 4-21. 1990 CROSSOVER DISTANCE IN MILES FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

C 3 CPS
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1544.4	1	1	1	1	170	87	51	21
LARGE	0.999	32000.0	3213.4	1	1	1	1	544	430	327	112
MEDIUM	0.995	6300.0	573.5	1	1	1	1	477	363	262	96
MEDIUM	0.999	6300.0	698.2	1	1	1	1	610	505	399	131
MEDIUM	0.995	6300.0	841.2	1	1	1	1	701	667	557	171
MEDIUM	0.999	6300.0	954.2	1	1	1	1	910	796	681	202
SMALL	0.995	1544.0	297.1	1	1	1	1	1135	1090	966	261
SMALL	0.999	1544.0	410.2	1	1	1	1	2016	1796	1578	426
SMALL	0.995	1544.0	321.8	1	1	1	1	1327	1132	1077	297
SMALL	0.999	1544.0	302.5	1	1	1	1	1177	1114	990	268
SMALL	0.995	1544.0	546.0	1	1	1	4	3073	2818	2582	603
SMALL	0.999	1544.0	613.2	1	1	1	24	3597	3323	3078	726
MINI	0.995	64.0	130.3	177	515	1239	2424	23303	22350	21783	
MINI	0.999	64.0	209.4	509	1091	3391	4935	38165	36700	35889	
MINI	0.995	64.0	51.8	1	1	26	463	8554	8109	7783	
MINI	0.999	64.0	82.4	38	112	466	1063	14303	13660	13240	

TABLE 4-22. 1990 CROSSOVER DISTANCE IN MILES FOR C-BAND
CPS SERVICES (SHARED EARTH STATIONS)

C 3   CFS2
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.80
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0

CROSSOVER DISTANCE

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1544.4	392	614	979	435	359	246	148	59
LARGE	0.999	32000.0	3213.4	406	642	1035	501	733	619	510	151
MEDIUM	0.995	6300.0	573.5	403	637	1025	489	665	552	445	134
MEDIUM	0.999	6300.0	698.2	409	648	1046	514	807	694	582	169
MEDIUM	0.995	6300.0	841.2	415	660	1070	542	970	856	740	209
MEDIUM	0.999	6300.0	954.2	419	670	1090	565	1098	985	864	217

TABLE 4-23. 1990 CROSSOVER DISTANCE IN MILES FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KU 2   CPS
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0

CROSSOVER DISTANCE

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1960.0	1	1	1	1	263	150	80	44
LARGE	0.999	32000.0	2132.3	1	1	1	1	302	188	99	53
LARGE	0.999	32000.0	2188.7	1	1	1	1	314	201	105	56
MEDIUM	0.995	6300.0	585.1	1	1	1	1	490	376	275	99
MEDIUM	0.999	6300.0	757.4	1	1	1	1	686	572	464	147
MEDIUM	0.999	6300.0	813.8	1	1	1	1	750	636	527	163
MEDIUM	0.995	6300.0	883.8	1	1	1	1	829	716	604	103
MEDIUM	0.999	6300.0	1034.4	1	1	1	1	1001	887	770	225
MEDIUM	0.999	6300.0	1101.8	1	1	1	1	1077	964	844	221
SMALL	0.995	1544.0	374.9	1	1	1	1	1741	1531	1317	374
SMALL	0.999	1544.0	525.5	1	1	1	1	2913	2664	2430	566
SMALL	0.999	1544.0	592.9	1	1	1	16	3438	3170	2928	689
SMALL	0.995	1544.0	435.1	1	1	1	1	2209	1984	1762	462
SMALL	0.999	1544.0	510.0	1	1	1	1	2793	2527	2316	538
SMALL	0.999	1544.0	559.2	1	1	1	8	3176	2917	2679	628
SMALL	0.995	1544.0	451.3	1	1	1	1	2336	2106	1802	486
SMALL	0.999	1544.0	553.8	1	1	1	7	3134	2876	2639	618
SMALL	0.999	1544.0	517.1	1	1	1	1	2848	2600	2368	551
MINI	0.995	64.0	257.2	710	1741	4692	6452	47146	45371	44414	
MINI	0.999	64.0	332.1	1024	2760	6730	8830	61219	50959	57771	
MINI	0.999	64.0	381.3	1175	3430	8069	10392	70464	67884	66545	
MINI	0.995	64.0	130.2	177	514	1236	2420	23204	22332	21765	
MINI	0.999	64.0	257.9	713	1751	4711	6475	47278	45498	44539	
MINI	0.999	64.0	275.8	788	1994	5198	7043	50641	48745	47731	

TABLE 4-24. 1990 CROSSOVER DISTANCE IN MILES FOR KU-BAND CPS SERVICES (SHARED EARTH STATIONS)

KU 2   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.8 0.88
CHANNEL UNIT COSTS = 1.15 1.15 1.15 1.15 0.3 2 0

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1960.0	395	621	993	452	452	339	238	82
LARGE	0.999	32000.0	2132.3	397	624	998	458	491	377	275	91
LARGE	0.999	32000.0	2188.7	397	625	1000	461	503	390	288	94
MEDIUM	0.995	6300.0	585.1	404	638	1027	471	679	565	458	138
MEDIUM	0.999	6300.0	757.4	411	653	1056	526	875	761	647	186
MEDIUM	0.999	6300.0	813.8	413	658	1066	537	939	825	710	201
MEDIUM	0.995	6300.0	883.8	416	664	1078	551	1018	905	787	221
MEDIUM	0.999	6300.0	1034.4	423	677	1103	581	1112	1076	953	246
MEDIUM	0.999	6300.0	1101.8	426	682	1115	594	1241	1049	1027	270

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TABLE 4-25. 1990 CROSSOVER DISTANCE IN MILES FOR KA-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KA 3   CPS
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 1 1 1 1 0.2 1.6 2.5

	AVAIL	CAPAC	COST	CROSSOVER DISTANCE							
				2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.999	32000.0	2640.6	1	1	1	1	369	269	182	64
LARGE	0.999	32000.0	1610.6	1	1	1	1	166	84	51	14
LARGE	0.999	32000.0	3587.0	1	1	1	1	555	455	362	110
LARGE	0.999	32000.0	2648.6	1	1	1	1	370	271	103	65
LARGE	0.999	32000.0	2534.6	1	1	1	1	348	248	142	59
LARGE	0.999	32000.0	3473.6	1	1	1	1	533	433	341	105
MEDIUM	0.999	6300.0	507.2	1	1	1	1	356	256	169	61
MEDIUM	0.999	6300.0	652.1	1	1	1	1	501	401	310	97
MEDIUM	0.999	6300.0	952.2	1	1	1	1	801	702	601	171
MEDIUM	0.999	6300.0	860.4	1	1	1	1	710	610	512	148
MEDIUM	0.999	6300.0	767.3	1	1	1	1	616	517	422	125
MEDIUM	0.999	6300.0	675.6	1	1	1	1	525	425	333	103
SMALL	0.999	1544.0	299.1	1	1	1	1	1117	970	861	247
SMALL	0.999	1544.0	263.6	1	1	1	1	925	825	721	201
SMALL	0.999	1544.0	423.6	1	1	1	1	1971	1775	1581	407
SMALL	0.999	1544.0	289.1	1	1	1	1	1049	929	822	234
SMALL	0.999	1544.0	378.3	1	1	1	1	1660	1475	1287	348
SMALL	0.999	1544.0	243.8	1	1	1	1	844	744	642	181
MINI	0.999	64.0	113.9	61	223	692	1659	17900	17155	16701	
MINI	0.999	64.0	112.4	58	212	670	1617	17652	16916	16466	
MINI	0.999	64.0	103.5	39	146	538	1368	16180	15495	15069	
MINI	0.999	64.0	95.3	22	91	417	1139	14825	14186	13782	
MINI	0.999	64.0	101.5	34	131	509	1312	15850	15176	14755	
MINI	0.999	64.0	93.3	19	83	387	1083	14494	13057	13468	

TABLE 4-26. 1990 CROSSOVER DISTANCE IN MILES FOR KA-BAND CPS SERVICES (SHARED EARTH STATIONS)

KA 3   CPS2
FILL FAC = 0.9   TARIFF FACTORS 1 1
CHANNEL UNIT COSTS = 1 1 1 1 0.2 1.6 2.5

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.999	32000.0	2640.6	414	664	1123	513	536	437	344	78
LARGE	0.999	32000.0	1610.6	407	649	1074	477	333	234	147	48
LARGE	0.999	32000.0	3587.0	421	678	1168	545	723	623	525	144
LARGE	0.999	32000.0	2640.6	414	665	1123	513	530	430	346	98
LARGE	0.999	32000.0	2534.6	414	663	1118	509	516	416	324	93
LARGE	0.999	32000.0	3473.6	421	677	1163	541	701	601	503	138
MEDIUM	0.999	6300.0	507.2	414	663	1120	511	524	424	332	95
MEDIUM	0.999	6300.0	652.1	419	674	1155	536	669	569	472	131
MEDIUM	0.999	6300.0	952.2	431	697	1228	588	969	869	763	206
MEDIUM	0.999	6300.0	860.4	427	690	1206	572	877	777	674	182
MEDIUM	0.999	6300.0	767.3	424	683	1183	556	784	684	584	159
MEDIUM	0.999	6300.0	675.6	420	676	1161	540	692	592	495	136

TABLE 4-27. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

C 4 CPS
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.08 0.66 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1422.2	39	49	69	260	270	6409	25926
LARGE	0.999	32000.0	1497.7	40	50	71	272	284	6746	27302
MEDIUM	0.995	6300.0	451.1	45	61	93	400	431	10292	41769
MEDIUM	0.999	6300.0	239.3	38	46	63	226	232	5405	22157
MEDIUM	0.995	6300.0	793.5	57	85	141	682	753	10062	73472
MEDIUM	0.999	6300.0	837.1	59	88	147	718	794	19051	77509
SMALL	0.995	1544.0	249.5	65	101	173	867	764	23157	
SMALL	0.999	1544.0	323.1	76	122	215	1114	1247	29972	
SMALL	0.995	1544.0	280.9	70	110	191	973	1085	26064	
SMALL	0.999	1544.0	340.7	78	127	225	1173	1314	31601	
SMALL	0.995	1544.0	525.8	105	184	332	1795	2025	48740	
SMALL	0.999	1544.0	570.5	111	171	358	1945	2196	52079	
MINI	0.995	64.0	77.0	297	564	1099	6268	7136		
MINI	0.999	64.0	136.8	504	979	1929	11112	12673		
MINI	0.995	64.0	48.3	197	365	700	3942	4479		
MINI	0.999	64.0	77.7	299	569	1108	6324	7201		

TABLE 4-28. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR C-BAND CPS SERVICES (SHARED EARTH STATIONS)

C 4   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.66 0

COST PER MONTH

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	1422.2	588	893	1380	3630	426	9522	25926
LARGE	0.999	32000.0	1497.7	589	894	1391	3642	440	9859	27302
MEDIUM	0.995	6300.0	451.1	594	905	1413	3771	587	13405	41769
MEDIUM	0.999	6300.0	239.3	587	890	1303	3596	307	8578	22157
MEDIUM	0.995	6300.0	793.5	606	929	1461	4052	909	21175	73472
MEDIUM	0.999	6300.0	837.1	608	932	1467	4088	950	22164	77509

TABLE 4-29. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KU 3   CPS
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.35 0.08 0.66 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	958.4	36	42	56	184	104	4337	17471
LARGE	0.999	32000.0	1067.0	37	44	59	202	204	4822	19451
LARGE	0.999	32000.0	1106.1	37	45	60	208	211	4977	20163
MEDIUM	0.995	6300.0	310.6	40	51	73	285	299	7103	28759
MEDIUM	0.999	6300.0	419.2	44	59	88	374	401	9568	38815
MEDIUM	0.999	6300.0	458.3	45	61	94	406	438	10455	42435
MEDIUM	0.995	6300.0	611.1	51	72	115	532	581	13922	56583
MEDIUM	0.999	6300.0	712.7	54	79	130	616	677	16228	65991
MEDIUM	0.997	6300.0	759.4	56	83	136	654	721	17288	70315
SMALL	0.995	1544.0	253.8	66	102	175	881	901	23555	
SMALL	0.999	1544.0	355.4	80	131	234	1223	1371	32962	
SMALL	0.999	1544.0	402.1	87	145	261	1300	1550	37286	
SMALL	0.995	1544.0	291.1	71	113	197	1007	1124	27009	
SMALL	0.999	1544.0	341.2	78	127	226	1175	1316	31648	
SMALL	0.999	1544.0	375.3	83	137	245	1290	1447	34805	
SMALL	0.995	1544.0	314.4	74	120	210	1085	1213	29166	
SMALL	0.999	1544.0	384.1	84	140	250	1319	1481	35620	
SMALL	0.999	1544.0	396.6	86	143	257	1361	1529	36777	
MINI	0.995	64.0	168.8	615	1201	2374	13705	15636		
MINI	0.999	64.0	218.9	789	1549	3069	17764	20275		
MINI	0.999	64.0	254.0	908	1706	3543	20527	23433		
MINI	0.995	64.0	88.6	337	644	1260	7207	8210		
MINI	0.999	64.0	176.3	641	1253	2478	14313	16331		
MINI	0.999	64.0	188.7	684	1340	2650	15317	17479		

TABLE 4-30. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR KU-BAND CPS SERVICES (SHARED EARTH STATIONS)

KU 3   CPS2   TARIFF FACTORS 0.68 0.82
FILL FAC = 0.9
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.35 0.08 0.08 0.66 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.995	32000.0	958.4	585	886	1376	3555	340	7450	17471
LARGE	0.999	32000.0	1067.0	586	888	1379	3572	360	7935	19451
LARGE	0.999	32000.0	1106.1	586	888	1380	3579	367	8110	20163
MEDIUM	0.995	6300.0	310.6	589	895	1393	3655	454	10216	20759
MEDIUM	0.999	6300.0	419.2	593	903	1408	3744	557	12681	38815
MEDIUM	0.995	6300.0	458.3	594	905	1414	3777	593	13568	42435
MEDIUM	0.999	6300.0	611.1	600	916	1435	3902	737	17035	56583
MEDIUM	0.999	6300.0	712.7	603	923	1449	3986	833	19341	65991
MEDIUM			759.4	605	927	1456	4024	877	20401	70315

TABLE 4-31. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR KA-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KA 4 CPS
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.35 0.08 0.66 0

COST PER MONTH

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.999	32000.0	1072.8	37	44	59	203	205	4848	19556
MEDIUM	0.999	6300.0	329.0	41	52	76	300	316	7521	30463
SMALL	0.999	1544.0	187.2	56	83	137	658	725	17388	
MINI	0.999	64.0	88.0	335	640	1251	7159	8155		

TABLE 4-32. 2000 MONTHLY PAYOFF REQUIREMENT IN $ FOR
KA-BAND CPS SERVICES (SHARED EARTH STATIONS)

KA 4   CPS2   TARIFF FACTORS 0.68 0.82
FILL FAC = 0.9
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.35 0.08 0.66 0

COST PER MONTH

	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	1544	6300
LARGE	0.999	32000.0	1072.8	586	888	1379	3573	361	7961	17556
MEDIUM	0.999	6300.0	329.0	590	896	1395	3670	472	10634	30463

TABLE 4-33. 2000 CROSSOVER DISTANCE IN MILES FOR C-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

C 4 CPS
FILL FAC = 0.9   TARIFF FACTORS 0.60 0.02
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.35 0.08 0.66 0

						CROSSOVER DISTANCE					
	AVAIL	CAFAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1422.2	1	1	1		122	65	40	18
LARGE	0.999	32000.0	1497.7	1	1	1	1	140	74	41	23
MEDIUM	0.995	6300.0	451.1	1	1	1	1	331	209	106	70
MEDIUM	0.999	6300.0	737.3	1	1	1	1	101	41	29	6
MEDIUM	0.995	6300.0	793.5	1	1	1	1	749	627	511	172
MEDIUM	0.999	6300.0	837.1	1	1	1	1	802	680	562	105
SMALL	0.995	1544.0	249.5	1	1	1	1	1023	701	776	240
SMALL	0.999	1544.0	323.1	1	1	1	1	1322	1113	1131	310
SMALL	0.995	1544.0	280.9	1	1	1	1	1179	1057	928	244
SMALL	0.999	1544.0	340.7	1	1	1	1	1469	1255	1031	338
SMALL	0.995	1544.0	525.8	1	1	1	13	3016	2749	2479	577
SMALL	0.999	1544.0	570.5	1	1	1	26	3390	3410	2854	665
MINI	0.999	64.0	77.0	13	92	442	1062	14148	13497	13065	
MINI	0.995	64.0	136.8	171	596	1522	2817	26206	25139	24510	
MINI	0.999	64.0	48.3	1	1	20	459	8361	7909	7572	
MINI	0.995	64.0	77.7	15	95	455	1077	14207	13633	13199	

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TABLE 4-34. 2000 CROSSOVER DISTANCE IN MILES FOR C-BAND CPS SERVICES (SHARED EARTH STATIONS)

C 4   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.09 0.66 0

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	1422.2	280	484	818	377	324	202	104	60
LARGE	0.999	32000.0	1497.7	280	485	821	381	342	220	117	64
MEDIUM	0.995	6300.0	451.1	287	499	849	414	533	411	301	111
MEDIUM	0.999	6300.0	239.3	278	480	811	369	274	153	84	47
MEDIUM	0.995	6300.0	793.5	303	531	912	487	951	829	706	213
MEDIUM	0.999	6300.0	837.1	305	535	920	496	1004	882	758	227

TABLE 4-35. 2000 CROSSOVER DISTANCE IN MILES FOR KU-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KU 3   CPS
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.66 0

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	958.4	1	1	1	1	65	27	19	1
LARGE	0.999	32000.0	1067.0	1	1	1	1	80	33	24	1
LARGE	0.999	32000.0	1106.1	1	1	1	1	85	36	25	1
MEDIUM	0.995	6300.0	310.6	1	1	1	1	160	83	47	28
MEDIUM	0.999	6300.0	419.2	1	1	1	1	292	170	89	60
MEDIUM	0.999	6300.0	458.3	1	1	1	1	340	218	114	72
MEDIUM	0.995	6300.0	611.1	1	1	1	1	524	404	295	118
MEDIUM	0.999	6300.0	712.7	1	1	1	1	650	528	415	140
MEDIUM	0.999	6300.0	759.4	1	1	1	1	707	585	470	162
4SMALL	0.995	1544.0	253.8	1	1	1	1	1044	922	797	202
5SMALL	0.999	1544.0	355.4	1	1	1	1	1592	1374	1147	361
SMALL	0.999	1544.0	402.1	1	1	1	1	1982	1751	1518	434
SMALL	0.999	1544.0	291.1	1	1	1	1	1054	1108	977	260
SMALL	0.999	1544.0	341.2	1	1	1	1	1473	1259	1035	338
SMALL	0.999	1544.0	375.3	1	1	1	1	1758	1535	1305	392
SMALL	0.995	1544.0	314.4	1	1	1	1	1249	1043	1089	296
SMALL	0.999	1544.0	384.1	1	1	1	1	1832	1606	1375	406
SMALL	0.999	1544.0	396.6	1	1	1	1	1936	1706	1474	425
MINI	0.995	64.0	168.8	315	884	2456	3908	32658	31369	30634	
MINI	0.999	64.0	218.9	541	1224	3919	5615	42760	41123	40222	
MINI	0.999	64.0	253.0	694	1721	4915	6776	49636	47761	46749	
MINI	0.995	64.0	88.6	32	162	651	1175	16487	15755	15285	
MINI	0.999	64.0	176.3	349	952	2675	4163	34170	32829	32069	
MINI	0.999	64.0	188.7	405	1063	3037	4586	36671	35243	34443	

TABLE 4-36. 2000 CROSSOVER DISTANCE IN MILES FOR KU-BAND CPS SERVICES (SHARED EARTH STATIONS)

KU 3   CPS2
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.66 0

CROSSOVER DISTANCE

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.995	32000.0	958.4	275	475	801	358	213	109	64	32
LARGE	0.999	32000.0	1067.0	276	477	805	362	239	117	70	39
LARGE	0.999	32000.0	1106.1	377	478	807	364	248	126	74	41
MEDIUM	0.995	6300.0	310.6	281	486	824	384	361	240	135	67
MEDIUM	0.999	6300.0	419.2	286	496	843	407	494	372	264	101
MEDIUM	0.999	6300.0	458.3	288	500	851	415	542	420	310	113
MEDIUM	0.995	6300.0	611.1	295	514	879	448	728	606	491	159
MEDIUM	0.999	6300.0	712.7	299	523	897	470	852	730	611	189
MEDIUM	0.999	6300.0	759.4	302	527	906	480	909	787	666	203

TABLE 4-37. 2000 CROSSOVER DISTANCE IN MILES FOR KA-BAND CPS SERVICES (UNSHARED EARTH STATIONS)

KA 4   CPS
FILL FAC = 0.9   TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.66 0

				CROSSOVER DISTANCE							
	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
LARGE	0.999	32000.0	1072.8	1	1	1	1	81	33	24	1
MEDIUM	0.999	6300.0	329.0	1	1	1	1	102	94	54	33
SMALL	0.999	1544.0	187.2	1	1	1	1	713	591	476	163
MINI	0.999	64.0	88.0	30	156	640	1155	16366	15630	15170	

TABLE 4-38. 2000 CROSSOVER DISTANCE IN MILES FOR KA-BAND CPS SERVICES (SHARED EARTH STATIONS)

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KA 4   CPS2
FILL FAC = 0.9       TARIFF FACTORS 0.68 0.82
CHANNEL UNIT COSTS = 0.35 0.35 0.35 0.08 0.66 0
```

	AVAIL	CAPAC	COST	2.4	4.8	9.6	56	64	64	64	1544
							CROSSOVER DISTANCE				
LARGE	0.999	32000.0	1072.8	276	477	805	363	240	110	70	39
MEDIUM	0.999	6300.0	329.0	282	488	827	388	384	262	157	74

SECTION 5
BASELINE FORECAST

5.1   **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 5-1). 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 5-2).

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 5-1). 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
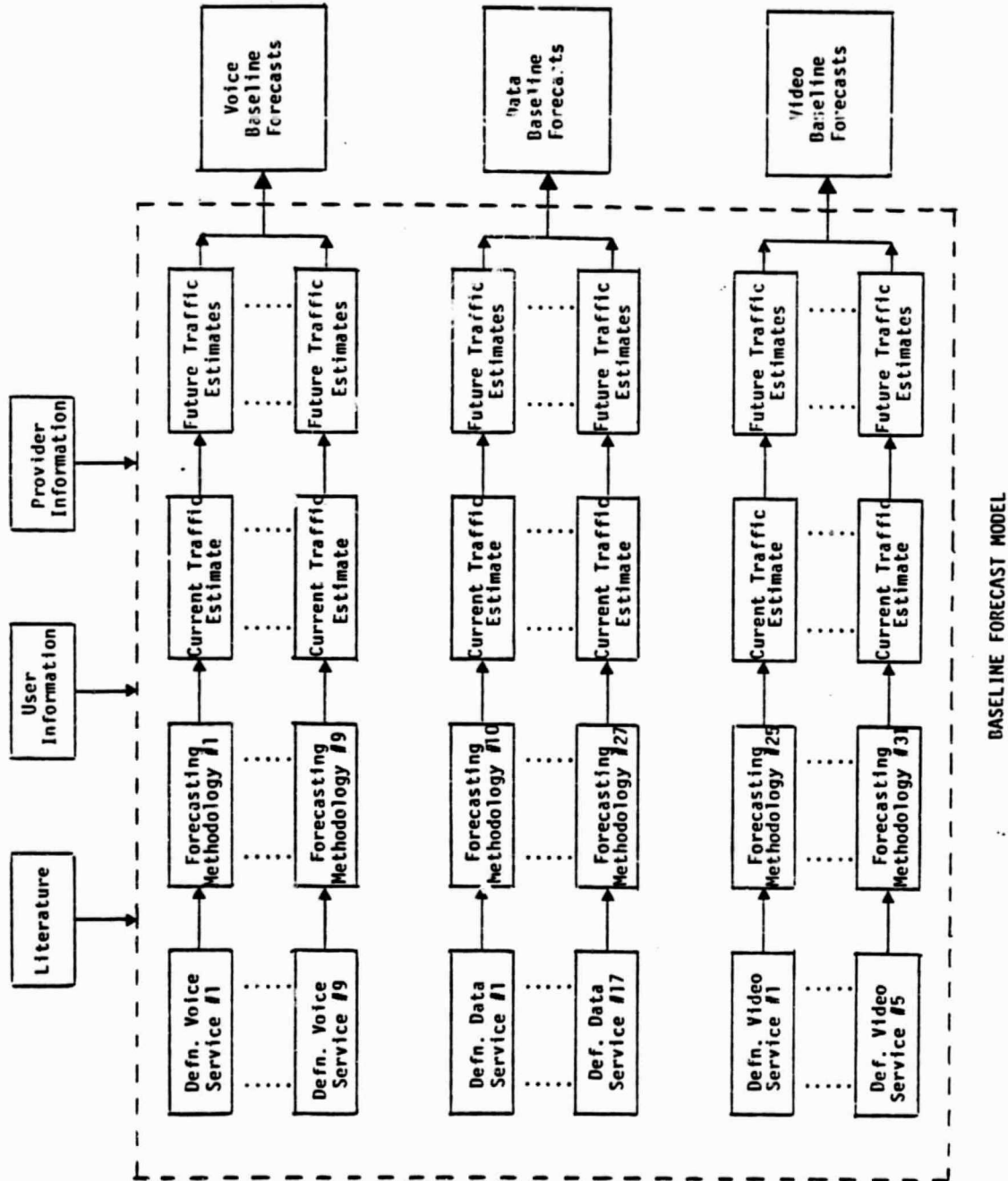
FIGURE 5-1. ACTIVITY FLOW FOR BASELINE FORECASTS

FORECASTING METHODS
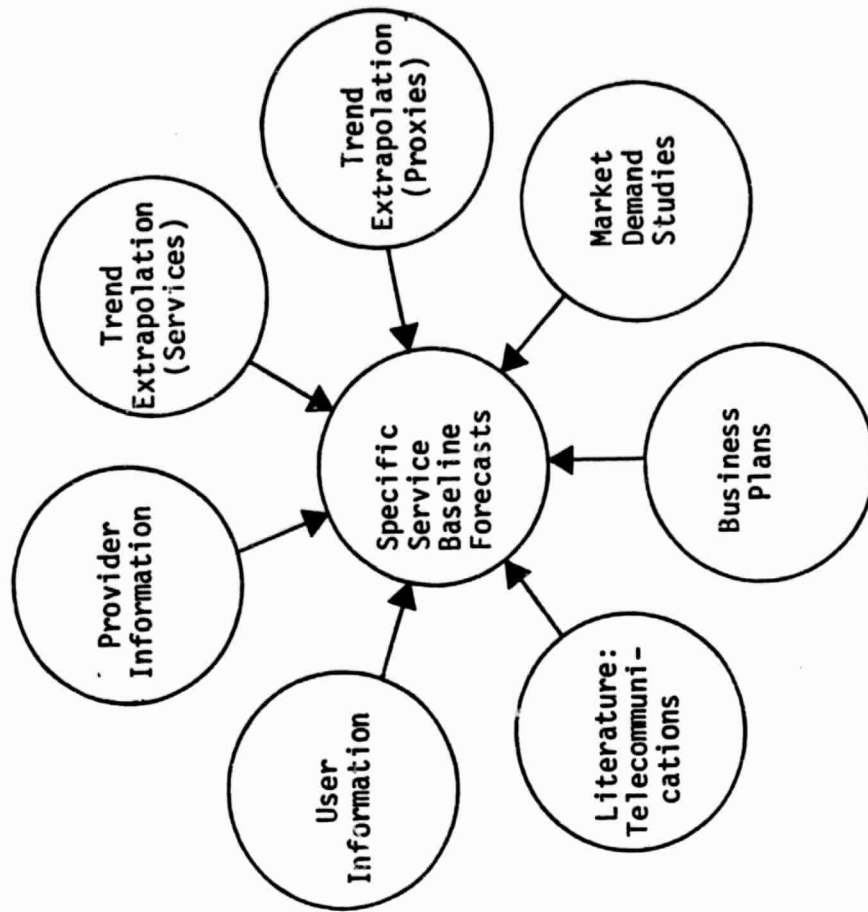
DEFINITION

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.

FIGURE 5-2. DEFINITION OF BASELINE FORECASTS AND BASELINE FORECASTING METHODS

TABLE 5-1. 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.

5.2   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.

5.2.1   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 5-2) 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 5-2
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 .9999 service availability.		1.588M		.5930M

TABLE 5-3
MESSAGE TOLL SERVICE TRAFFIC FORECAST (1000's OF HALF-VOICE CIRCUITS)

	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 5-3 on the previous page.

5.2.2   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 5-4) 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 5-4

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 5-5
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 5-5 on the previous page.

5.2.3   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 5-6). 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 5-6
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 5-6 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.

5.2.4   Voice Store-And-Forward

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

5.2.5   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 5-7) 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 5-7
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 5-7).

5.2.6   Summary of Voice Baseline Forecasts

Table 5-8 shows a summary of voice baseline forecasts in thousands of half-voice circuits and the corresponding annual growth rates.

5.3   DATA BASELINE METHODOLOGIES AND FORECASTS

As discussed in Section 2, 17 services were classified as data services (see Table 5-1). 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).

5.3.1   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 5-8
VOICE BASELINE SUMMARY

FORECASTS (Thousands of Half-Voice Circuits)

	YEAR		
	1980	1990	2000
SERVICE			
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	
	1980-1990	1990-2000
SERVICE		
MTS (Residential)	8.0	7.5
M.S (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 5-9)

    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 5-9).

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 5-9).

5.3.2   Electronic Mail

As indicated in Table 5-1, 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 5-9. SUMMARY OF FORECASTS FOR TERMINAL OPERATIONS

	Number of Terminals 1980 (X10³)	Bits per Year per Terminal (X10⁶)	Bits per Year 1980 (X10¹²) C1 x C2	Number of Terminals 1990 (X10³)	Bits per Year 1990 (X10¹²) C2 x C4	Number of Terminals 2000 (X10³)	Bits per Year per Terminal (X10⁶)	Bits per Year 2000 (X10¹²) 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 5-10 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 5-10.

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 (12 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 5-10.

TABLE 5-10. 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 5-10.

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 5-10.

5.3.3   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 5-11.

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 5-11).

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

5.3.4   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 5-11. 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 perce : 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 5-12.

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 5-12. 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 5-12).

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 5-12). 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 5-12) 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 5-12) 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.

5.3.5   Summary of Data Baseline Forecasts

In Table 5-13 is a summary of the data baseline forecasts in terabits per year; the corresponding annual growth rates are presented in Table 5-14.

5.4   VIDEO BASELINE METHODOLOGIES AND FORECASTS

As indicated in Section 2 and Table 5-1, 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.

5.4.1   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 5-13. DATA BASELINE - TERABITS/YEAR

SERVICE	YEAR		
	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 5-14. DATA BASELINE - ANNUAL GROWTH RATES (%)

	TIME PERIOD	
SERVICE	**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 5-15 for the 1980, 1990, and 2000 Broadcast Services forecasts.

5.4.2   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.

5.4.2.1   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 5-15. 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 5-16 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 5-17). Next divide this by the total number of conferences an equivalent 50MBPS 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).

TABLE 5-16
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 5-17. 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

TABLE 5-17. VIDEO CONFERENCING BASELINE FORECASTS (CONTINUED)

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

5.4.3   Summary of Video Baseline Forecasts

In Table 5-18 is a summary of the video baseline forecasts and the related annual growth rates.

5.5   SUMMARY OF BASELINE FORECASTS

A summary of the baseline forecasts and related annual growth rates is presented in Table 5-19.

TABLE 5-18. SUMMARY OF VIDEO BASELINE - NET ADDRESSABLE WIDEBAND FORECASTS (TRANSPONDERS) AND GROWTH RATES

FORECASTS

SERVICE	YEAR		
	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, %)*

SERVICE	TIME PERIOD	
	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 5-19. SUMMARY OF BASELINE FORECASTS

FORECASTS

SERVICES	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 6
IMPACTED BASELINE FORECASTS

6.1   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 6-1).

6.2   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

6-1
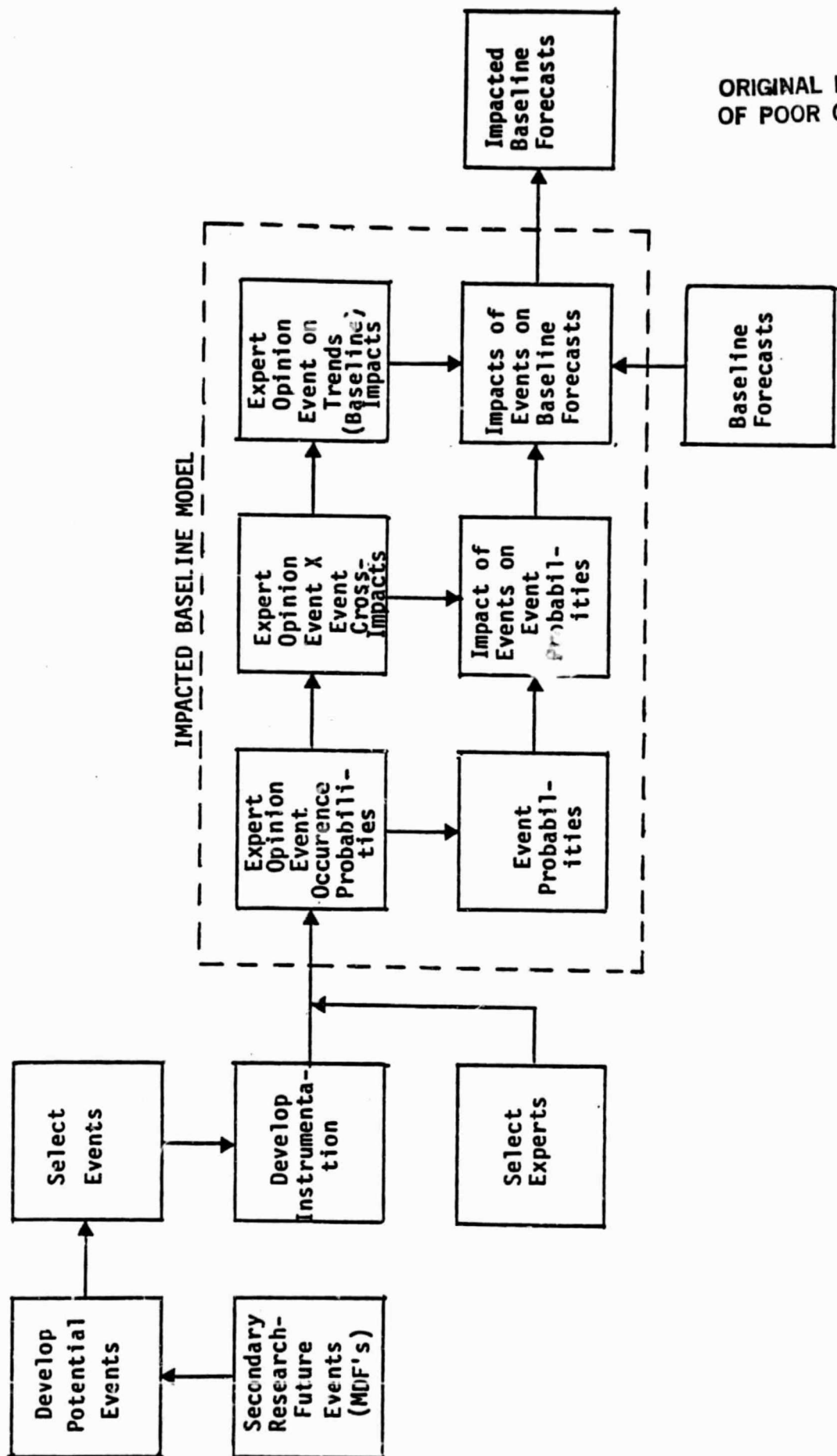
FIGURE 6-1. ACTIVITY FLOW FOR IMPACTED BASELINE FORECASTS

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.

6.3   PROCEDURES

6.3.1   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 of the service 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 6-1) with key providers, users and consultants, 36 events were identified. These events are

defined briefly in Table 6-1. The list of events should be considered representative of potential MDFs and should not be considered inclusive.

6.3.2   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 6-1). 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 6-1). The data collection form used for this purpose is presented in Appendix B, Table B-5.

6.3.3   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 6-1). 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 6-2. 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 6-1
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 6-2

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 6-3.

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 6-1). 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 6-4. The difference between the probabilities in Table 6-3 and Table 6-4 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 6-1). 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 6-1). 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 6-3. NORMALIZED PROBABILITY OF OCCURENCE FOR MDFs FOR EACH YEAR

YEARS

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	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				2.8	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											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 6-4. MODIFIED NORMALIZED PROBABILITY OF OCCURRENCE FOR MDFs FOR EACH YEAR

YEARS

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	8.9	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	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	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	7.6	7.1	7.6	8.4	7.6	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	4.9	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									2.0	1.1	0.1	0.4	0.7	1.1	1.5	2.0	2.4	2.8	3.3
PROSPERITY		0.8	1.5	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	10.3	10.5	10.5
RECESSION/DEPRESSION				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	7.2	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

6.4   IMPACTED BASELINE FORECAST

The impacted baseline forecasts for each service for each year appear in Table 6-5. The differences between the baseline and impacted baseline forecasts were calculated as percent changes in the baselines and these differences appear in Table 6-6. A summary of the impacted baseline forecast and growth rates are presented in Table 6-7. 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 6-5
IMPACTED BASELINE FORECAST FOR EACH SERVICE FOR EACH YEAR

SERVICE	YEAR		
	1980	1990	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
CATV	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

TABLE 6-6
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 6-7.
SUMMARY OF IMPACTED BASELINE FORECASTS AND GROWTH RATES

FORECASTS	YEAR		
SERVICE	1980	1990	2000
Voice (Thousands of Half-Voice Circuits)	2829	8227	19876
Data (Terabits Per Year)	1892	9894	31103
Video (Transponders)	66	337	406

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

SECTION 7
NET LONG HAUL FORECAST

7.1   INTRODUCTION

The impacted baseline was modified by the removal of the intra-SMSA traffic (i.e., traffic which flows within a Standard Metropolitan Statistical Areas (SMSA)) and data carried over voice lines. Three other adjustments were made to the traffic at this point: data carried by voice lines were removed, efficiency factors were applied to data traffic, and annual traffic was converted to peak hour units. Figure 7-1 depicts the basic flow of the analysis necessary to translate the impacted baselines into the net long haul traffic forecasts. It should be pointed out that traffic originated from, or terminated to, the hinterlands was retained; hinterland was defined as that area outside a SMSA.

7.2   PROCEDURES

7.2.1   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 7-1). The percent of intra SMSA traffic was determined through industry contacts, a literature search, the user survey and internal Western Union analysis. Removing intra SMSA traffic reduced the traffic by 4 percent.

7.2.1.1   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 was 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
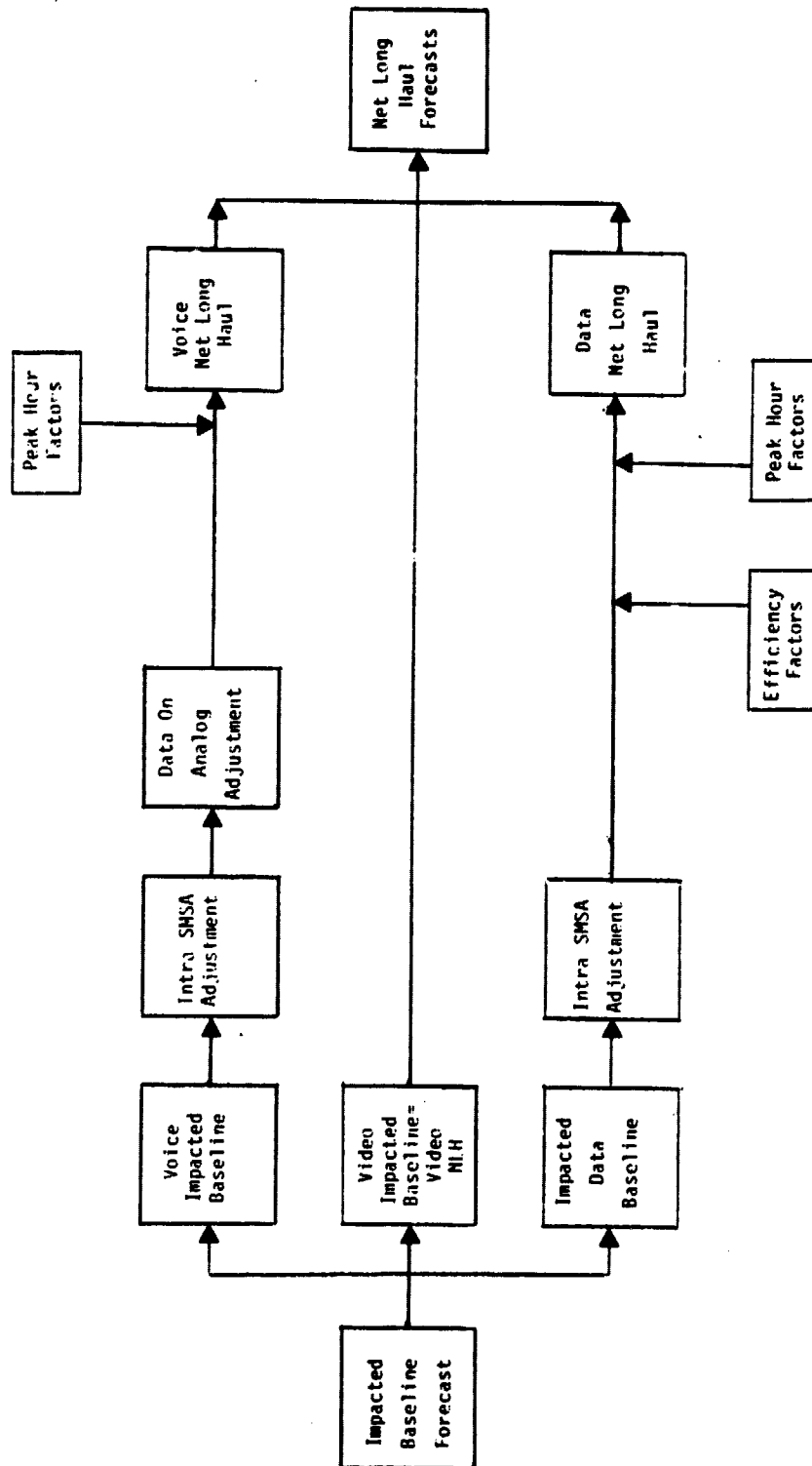
FIGURE 7-1. ACTIVITY FLOW FOR NET LONG HAUL FORECASTS

TABLE 7-1
PERCENT OF TRAFFIC REMOVED FROM THE IMPACTED BASELINE
TO GIVE NET LONG HAUL TRAFFIC FORECAST

SERVICE	INTRA SMSA	DATA CARRIED BY VOICE LINES		
		1980	1990	2000
VOICE				
MTS (Residential)	9.00	0.00	0.00	0.00
MTS (Business)	5.00	5.29	0.76	0.08
Private Line	5.00	8.69	3.61	1.01
Mobile	5.00	0.00	0.00	0.00
Public Radio	0.00	0.00	0.00	0.00
Commercial and Religious	0.00	0.00	0.00	0.00
Occasional	0.00	0.00	0.00	0.00
CATV Music	0.00	0.00	0.00	0.00
Recording	0.00	0.00	0.00	0.00
TOTAL	5.83	4.95	1.55	0.40
DATA				
Data Transfer	16.00	0.00	0.00	0.00
Batch Processing	20.00	0.00	0.00	0.00
Data Entry	60.00	0.00	0.00	0.00
Remote Job Entry	35.00	0.00	0.00	0.00
Inquiry/Response	50.00	0.00	0.00	0.00
Timesharing	30.00	0.00	0.00	0.00
USPS/EMSS	0.00	0.00	0.00	0.00
Mailbox	25.00	0.00	0.00	0.00
Administrative Messages	40.00	0.00	0.00	0.00
Facsimile	10.00	0.00	0.00	0.00
Communicating Word Processors	30.00	0.00	0.00	0.00
TWX/Telex	1.00	0.00	0.00	0.00
Mailgram/Telegram/Money Orders	2.00	0.00	0.00	0.00
Point of Sale	70.00	0.00	0.00	0.00
Videotext/Teletext	0.00	0.00	0.00	0.00
Telemonitoring Service	75.00	0.00	0.00	0.00
Secure Voice	10.00	0.00	0.00	0.00
TOTAL	31.11	0.00	0.00	0.00
VIDEO				
Network	0.00	0.00	0.00	0.00
CATV	0.00	0.00	0.00	0.00
Occasional	0.00	0.00	0.00	0.00
Recording Channel	0.00	0.00	0.00	0.00
Teleconferencing	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00

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

7.2.1.2   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 7-1).

7.2.1.3   Video

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

7.2.2 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.

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 7-2). The percent of data carried by voice lines is presented, by service and year, in Table 7-1.

7.2.3   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.

7.2.3.1   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 is 75 percent of the services peak hour.

TABLE 7-2. 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

7.2.3.2   Data

To determine the amount of data traffic occuring 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 7-3. 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 calculating 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)

7.2.3.3   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 benchmark year to reflect its unique peak hour factor.

7.2.4   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.

TABLE 7-3. 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

All data efficiency factors were determined on the basis 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 using a microcomputer 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 microcomputers 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 7-4 presents the efficiency factors found through this analysis.

7.2.5   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 7-2) 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 7-5) 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 7-6) 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.

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TABLE 7-4 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
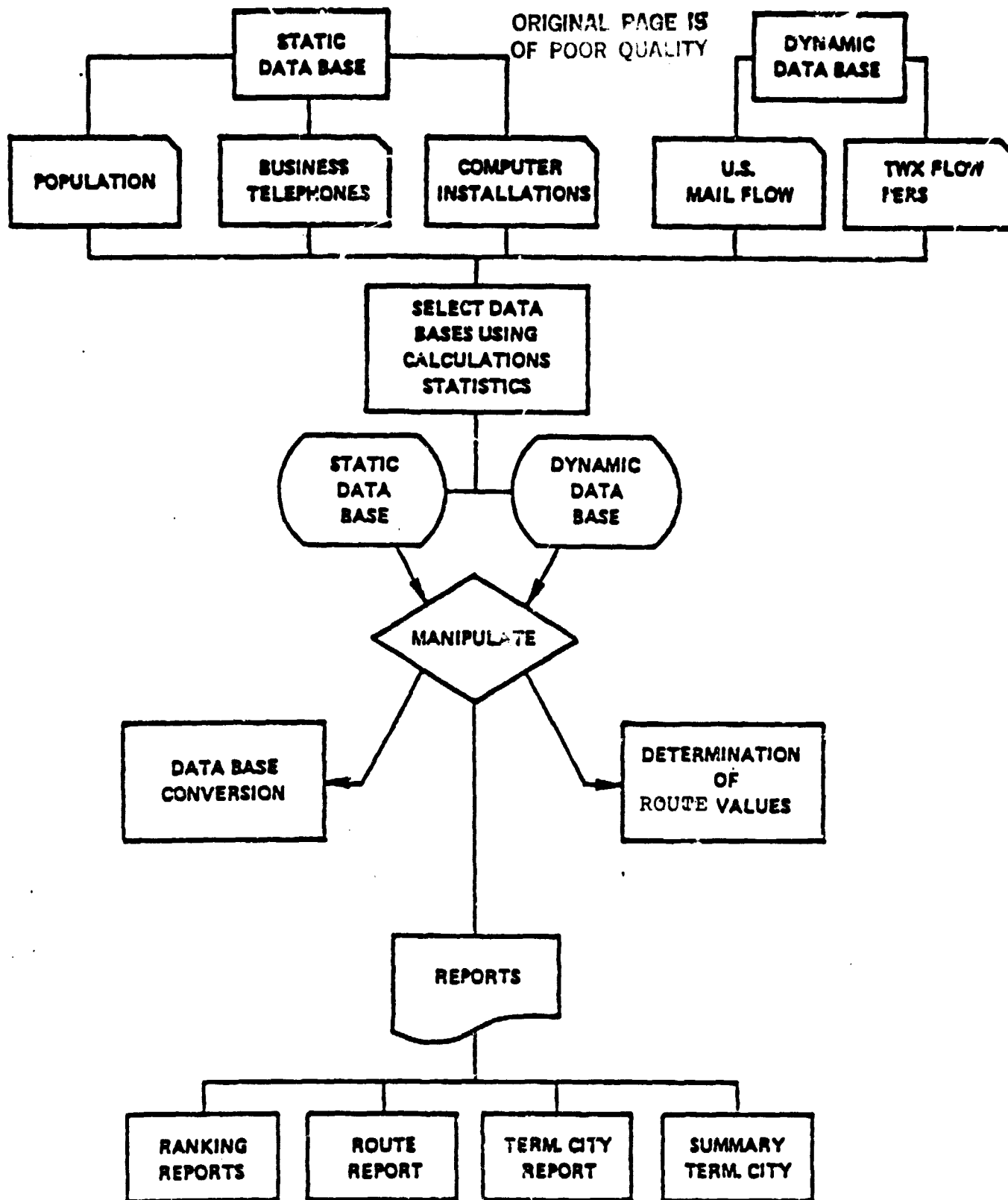
FIGURE 7-2. MARKET DISTRIBUTION MODEL

TABLE 7-5. 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)		
	197°	B.E.A.	
	1990	B.E.A.	
	2000	B.E.A.	

TABLE 7-5. FILES USED WITH MDM (Continued)

	FILE NAME	SMSA SOURCE	STATE SOURCE
21.	Transportation, Communica-tions 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 7-5. 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 7-5. 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 7-6. PERCENTAGES (WEIGHTINGS) USED TO REFLECT DATA BASE AND SERVICE RELATIONSHIPS

DATA BASES

SERVICES	8	9	26	30	37	60	31	19	21	23	22	50	20	24	61	59	38	52	53	43
MTS (Residential)	20																			
MTS (Business)			50					20	10	10			10	10						
Private Line				40	10	10				10						10			15	
Mobile		10		40	15	10				10	10					5				
Public Radio - LD				50	15															
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	10				15				10		5	5	5	10	
Mailbox		10		20	20	5		5				15	10			5	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												
Point of Sale		30		10			10				30		10					10		50
Videotext/Teletext	10	10	10	25	20					10						5	10			
Telemonitoring Service		50			10		15						20			5				
Secure Voice				20				20							60	5				
Network - LD*																				
CATV - LD																				
Occasional - LD																				
Recording Channel - LD																				
Teleconferencing - LD																				

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

c. Develop weighting factors for each selected data base. The weighting factor represents a statistical measure which assigns 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 7-7) and extensive internal information about Government usage. These statistics provided the means to adjust the distance sensitivity of various algorithms used by MDM.

A unique aspect of this model is the creation of "artifical SMSAs." An artificial SMSA was created to represent that area of a state located outside of the designated SMSA. 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 each of the real and artificial SMSAs. This prepared the data so that crossover analysis could be performed.

TABLE 7-7
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.

7.3 SUMMARY OF NET LONG HAUL FORECASTS

Table 7-8 shows the detailed results of the net long haul analysis. The voice traffic is given in terms of 1000's of half voice circuits; data is given in megabits per second; and video in transponders. Figure 7-3 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 7-9.

TABLE 7-8
NET LONG HAUL FORECASTS

SERVICE	YEAR		
VOICE (1000s HVCs)	**1980**	**1990**	**2000**
MTS (Residential)	539.6	1200.5	2636.0
MTS (Business)	1424.6	3972.4	9209.2
Private Line	556.2	2421.2	6718.3
Mobile	1.3	34.9	111.8
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	0.0	0.4
TOTAL	2523.6	7634.8	18685.5
DATA (MBPS)			
Data Transfer	43.3	97.4	354.9
Batch Processing	77.2	159.2	222.9
Data Entry	10896.1	15538.6	16006.3
Remote Job Entry	273.9	1760.3	2345.3
Inquiry/Response	305.6	2031.9	3557.9
Timesharing	243.7	538.9	707.3
USPS/EMSS	0.0	142.3	256.0
Mailbox	8.1	100.9	133.5
Administrative Messages	2607.5	8361.0	13559.2
Facsimile	541.4	947.2	720.1
Communicating Word Processors	16.6	63.8	126.2
TWX/Telex	53.2	34.9	24.0
Mailgram/Telegram/Money Orders	0.3	0.4	0.5
Point of Sale	96.3	1003.9	924.7
Videotext/Teletext	0.2	446.8	1165.1
Telemonitoring Service	0.2	0.9	4.0
Secure Voice	1.3	40.8	236.1
TOTAL	15164.9	31279.3	40344.1
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 7-3. NET LONG HAUL TRAFFIC FORECAST

TABLE 7-9. SUMMARY OF NET LONG HAUL FORECASTS

FORECASTS	YEAR		
SERVICE	1980	1990	2000
Voice (1000s HVCs)	2523.6	7634.8	18685.5
Data (Mbps)	15164.9	31279.3	40344.1
Video (Transponders)	61.3	322.8	392.1

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

SECTION 8
CPS SATELLITE MARKET

8.1 INTRODUCTION

The CPS satellite forecast represents the total amount of traffic addressable by a CPS satellite system. The most distinguishing feature between a CPS system and a trunking system is the amount of traffic aggregation. Two types of systems exist with CPS: one with small earth stations located directly on the customer's premise and one with local customer shared earth stations with dedicated tail connections directly to the sharing customers. In contrast, trunking uses public lines to transmit the information over to, and from, a central earth station. Also, it should be pointed out that, for the CPS forecasts, the CPS satellite system is considered to be a stand-alone system; that is, competition from trunking systems was not considered. The CPS segment of the overall satellite system is indicated in Section 9.

8.2 METHODOLOGY

To derive the addressable CPS forecast it was necessary to begin with the net long haul (see Figure 8-1). Then, traffic was reduced for various reasons and comparisions were made of the crossover distances determined by the various bands. It was assumed that CPS traffic would be all digital; this assumption was based on trends to totally integrated networks. The following steps were performed to determine this traffic.

8.2.1 Remove Traffic Due to Satellite Constraints

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:
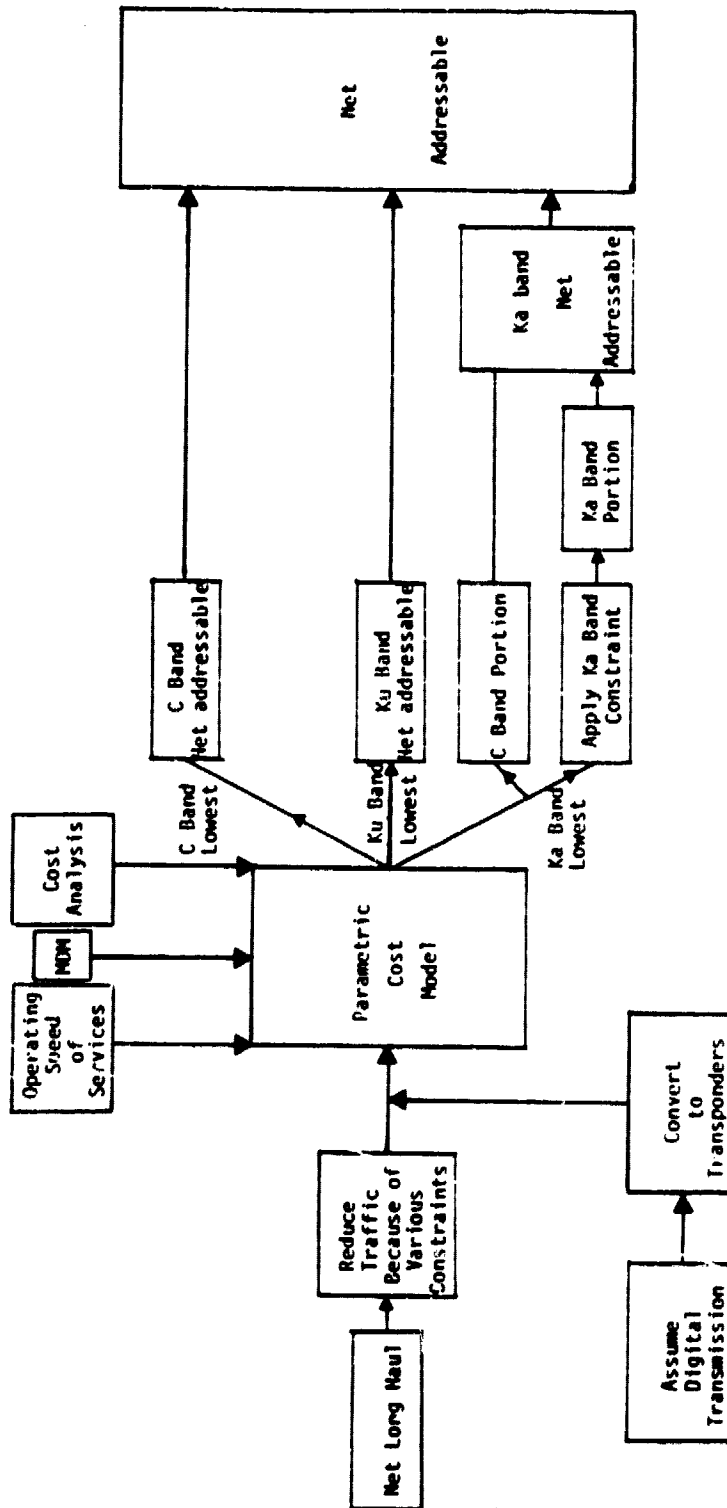
FIGURE 8-1. ACTIVITY FLOW FOR CPS SATELLITE FORECASTS

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.

b. **Accommodation of satellite delay**

   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. **Multipoint signal distribution**

   What are the requirements of each application for broadcast-type signal distribution? The C-band CONUS coverage easily accommodates multipoint requirements such as those associated with the Network Video application, while Ku-band implementation of multipoint distribution requires a separate half channel for each additional drop. (The Ka-band system model is a point-to-point system, not efficient for broadcast services.)

d. **Urgency of message delivery**

   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. **Miscellaneous characteristics**

   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 a 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 evaluation of the service applications were based on trends established by judgement and analysis. Intermediate years 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 modeling techniques (see Table 8-1). This completed the first step.

8.2.2   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, which satellite systems must recover, is in 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, the equipment becomes older, and the cost of providing services by satellite is reduced. This is reflected in the percent of traffic removed because of plant in place (Table 8-2). 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 7) times the percent of voice traffic to remove because of plant in place.

TABLE 8-1
PERCENT OF TRAFFIC NOT
SUITABLE FOR
SATELLITE TRANSMISSION

SERVICES	BAND		
	C	Ku	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 = Connectivity (i.e., time delay tolerance)

TABLE 8-2
PERCENT OF TRAFFIC REMOVED
BECAUSE OF PLANT IN PLACE

SERVICE	YEAR		
	1980	**1990**	**2000**
Voice	98	73.5	50.0
Data	93	49.5	16.5
Video	No effect since only satellite traffic forecasted		

8.2.3   Convert into Transponders

Up to this point voice, data, and video were all carried in unique units: half voice circuits for voice, terabits for data and transponders for video. In order to project the net addressable CPS traffic and the number of satellites this service requires it was necessary to convert these units into a common unit, transponders. Assuming that CPS traffic would be entirely digital, the following steps were performed to convert the various units to transponders.

a. **Voice**
    Converting half-voice circuits into transponders required two steps. The initial step was to determine the number of bits required to transmit a half-voice circuit. Relying on engineering analysis of future trends the following number of bits were determined to be needed to code a half-voice circuit.

1980	1990	2000
64	32	24

These were typical of the number of bits it would take to encode a half-voice circuit. While it has been shown possible to encode a half voice circuit in as few as 16 kbps (perhaps even less) the typical circuit today uses 64 kbps. By 1990 this typical is expected to decline to 32 kbps. By 2000 a mixture of 50 percent encoded at 32 kbps and 50 percent at 16 kbps is foreseen. Using these typical rates, the number of bits needed to transmit the voice traffic was calculated.

The second step to convert half-voice circuits into transponders was to divide by the amount of data throughput a CPS transponder managed. These numbers are explained in the data section.

b. **Data**
    Converting terabits into transponders required calculating the number of bits which a CPS transponder could manage. It was assumed that the typical CPS earth station would be small and that several would use the same transponder simultaneously.

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As more earth stations use the same transponder the overhead (bandwidth) required increases and the efficiency declines. Using this information the following data rates were found to be typical.

MBPS PER TRANSPONDER

1980	1990	2000
36	52.5	52.5

c. Video

The number of transponders needed for video was the basic unit established for those services in producing the baseline. Compression of video signals and the ability to transmit more than one signal over a transponder had been considered already. Therefore, adjustments were not needed to convert the video services to CPS transponders. (In addition all video services except teleconferencing were eliminated because of the very nature of CPS.)

8.2.4   Distributed Demand to all Real and Artificial SMSAs

In order to distribute the demand for transponders among the 313 SMSAs and the 48 artificial SMSAs it was necessary to use the market distribution model (see Section 7). Table 8-3 shows the files and weights used to perform this distribution.

8.2.5   Segment Services into Various Operation Speeds

The next step was to segment the 31 services into the various operating speeds. This analysis was performed by engineers and included a review of events such as the trend toward more high speed data. Services involving a great deal of CPU to CPU traffic which would normally go over high volume circuits (e.g., data transfer) were shown. Slower services, such as data entry, were segmented into the slower speeds. The operating speeds by service, by year are presented in Table 8-4 through 8-6.

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TABLE 8-3
WEIGHTING FOR MDM

FILE	SOURCE	WEIGHT
Population	1980 Census	30
1980 Business Telephones	AT&T	35
Bank Deposits	Dept. of Commerce	10
Non-Farm Employment	Bureau of Economic Affairs	15
Number of Computer Sites	International Data Corp.	10

TABLE 8-4
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					
Videotext/Teletext	70	20	10					
Telemonitoring Service	70	20	10					
Secure Voice	20	60	20					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 8-5
PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (1990)

SERVICES	2.4	4.8	9.6	56	T-1	Sc1	Sc2	Sc3
					OPERATING SPEEDS			
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					
Videotext/Teletext	20	70	10					
Telemonitoring Service	20	70	10					
Secure Voice	20	30	50					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 8-6
PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (2000)

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			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					
Videotext/Teletext	10	20	70					
Telemonitoring Service	10	20	70					
Secure Voice	10	20	70					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

8.2.6 Reduce Traffic Because of Time Zone Considerations

Peak hour traffic does not consider the different time zones within the continental United States. For instance if the peak hour traffic occurs at 2:00 p.m., it is calculated as 2:00 p.m. across the United States. If the satellite system has sufficient capability it may be reconfigured and the antennas reshaped to take advantage of the different time zones. An analysis of this effect and the impact on system traffic was performed by Western Union under contract to Motorola (30/20 GHz Satellite Switched FDMA Communications System for CPS, NASA Contract NAS3-22895 - Subcontract, 1982). It was found that a system may be designed for 13 percent less traffic if the system takes advantage of the various time zones. The time zones for the continental U.S. are shown in Appendix H, Figure H-2; Figure H-3 shows the peak hour traffic curve after time zones were considered.

Other aspects (e.g., seasonal variations or the effect of future population shifts) of modifying the peak hour were reviewed. Seasonal variations were found to have spikes during Christmas or tax time but were not sustained to justify a larger system. The effect of the population shift on traffic was also insignificant. In Appendix H, Figure H-4, the Motorola study shows this lack of effect.

8.2.7 Remove Traffic not Suitable for CPS Transmission

Not all traffic was suitable for inclusion in a CPS satellite system. Broadcast applications were considered difficult if not impossible for a CPS system and were largely removed. Private homes would not use a CPS system so traffic generated there, such as residential message toll service, was removed. In addition, a great deal of interbusiness traffic would be between companies not on the CPS system and therefore should not be included as addressable. In addition, because Ka-band has spot beams, an additional amount of traffic was removed. Table 8-7 shows the percentage of traffic removed as not suitable for CPS transmission.

TABLE 8-7
PERCENT OF TRAFFIC NOT SUITABLE FOR CPS

	BANDS	
SERVICE	C/KU	ADDITIONAL FOR KA
MTS (residential)	100	0
MTS (business)	60	0
Private Line	0	0
Mobile	70	0
Public Radio	100	0
Commercial and Religious	0	60
Occasional	0	60
CATV Music	0	60
Recording	0	60
Data Transfer	10	10
Batch Processing	10	10
Data Entry	0	0
Remote Job Entry	0	0
Inquiry/Response	0	0
Timesharing	0	0
USPS/EMSS	50	0
Mailbox	0	20
Administrative Messages	0	20
Facsimile	40	10
Communicating Word Processors	0	20
TWX/Telex	60	10
Mailgram/Telegram/Money Orders	100	0
Point of Sale	10	10
Videotext/Teletext	100	0
Telemonitoring Service	0	0
Secure Voice	0	0
Network	100	0
CATV	100	0
Occasional	100	0
Recording Channel	100	0
Teleconferencing	30	15

8.2.8   Crossover Distances

In Section 4 and in Appendix F a costing analysis is described in detail and crossover distances have been computed. Four types of earth stations with varying traffic capacity were considered. For the CPS application only the TDMA approach was used as it supports all types of traffic, i.e., voice, data and video. To satisfy different CPS network traffic requirements, the earth stations were designed with various burst rates. The earth stations were either unshared or shared by the customer. In the former case the customer was collocated with the earth station, and in the later case the customer had dedicated terrestrial tail circuits. A composite crossover concept was developed and used; the composite crossover distance was defined as the weighted sum of the individual crossover distances of the earth stations. Table 8-8 summarizes the CPS earth station characteristics and the weight assigned to each earth station type for the unshared application, while Table 8-9 summarizes the CPS earth station characteristics and the weight assigned to each earth station type for the shared application. Using these tables and the results of Section 4 and Appendix F the composite crossover distances were computed for shared and unshared applications with .995 and .999 availability. Tables 8-10 and 8-11 present the composite crossover distances for unshared earth stations with .999 and .995 availability, while Tables 8-12 and 8-13 present the composite crossovers for shared application with .999 and .995 availability.

In 1982, C-band had a lower crossover distance than Ku-band for all four configurations (i.e., shared or unshared with .999 or .995 availability). For 1990 and 2000 for all unshared systems (i.e., with .999 and .995 availability), the crossover distance for Ka-band will be lower than those for C-band which, in turn, will be lower than those for Ku-band. In 1990 and 2000 for the shared system with .999 availability, the crossover distances for Ku-band will be lower than those for C-band which, in turn, will be lower than those for Ka-band. In 1990 for the shared system with .995 availability, the crossover distances for C-band will be lower than those for Ku-band which, in turn, will be lower than those for Ka-band. In 2000 for the shared system with .995 availability, the crossover distances for Ku-band will be lower than those for C-band, with Ka-band again having the highest crossover distances. That is, the crossover

TABLE 8-8
UNSHARED EARTH STATION COMPOSITE CROSSOVER WEIGHTINGS

E/S TYPE	CAPACITY	B.R.	WEIGHT	
Large	32.0 Mbps	60 Mbps	10%	10%
Medium	6.3 Mbps	60 Mbps	50%	30%
Medium	6.3 Mbps	15 Mbps		70%
Small	1.5 Mbps	15 Mbps	35%	15%
Small	1.5 Mbps	8 Mbps		30%
Small	1.5 Mbps	SCPC		55%
Mini		SCPC	5%	70%
Mini		SCPC		30%

TABLE 8-9
SHARED EARTH STATION COMPOSITE CROSSOVER WEIGHTINGS

E/S TYPE	CAPACITY	B.R.	WEIGHT	
Large	32 Mbps	60 Mbps	50%	
Medium	32 Mbps	60 Mbps		30%
Medium	32 Mbps	15 Mbps	50%	70%

TABLE 8-10. CROSSOVER DISTANCE IN MILES
UNSHARED EARTH STATIONS .999 AVAILABILITY

	OPERATING SPEEDS							
YEAR/BAND	2.4	4.8	9.6	56	T1	V1	V2	V3
1982								
C	62	114	252	332	367	4066	3825	3640
KU	123	231	491	631	525	6461	6116	5856
1990								
C	19	41	127	194	292	2938	2738	2565
KU	51	137	334	440	316	4607	4338	4129
KA	5	15	42	92	205	2006	1824	1659
2000								
C	7	23	61	121	248	2318	2125	1978
KU	28	68	198	283	204	3069	2842	2661
KA	1	1	6	46	118	1283	1134	1007

TABLE 8-11. CROSSOVER DISTANCE IN MILES
UNSHARED EARTH STATIONS .995 AVAILABILITY

	OPERATING SPEEDS							
YEAR/BAND	2.4	4.8	9.6	56	T1	V1	V2	V3
1982								
C	32	48	115	163	284	2724	2535	2374
KU	98	195	419	525	376	5274	4977	4764
1990								
C	7	19	45	93	237	2096	1919	1779
KU	41	103	266	359	245	3731	3488	3298
KA	5	15	42	92	204	2003	1820	1655
2000								
C	1	4	17	47	222	1703	1536	1389
KU	20	50	146	222	140	2405	2237	2142
KA	1	1	6	46	117	1279	1130	1004

TABLE 8-12. CROSSOVER DISTANCE IN MILES
SHARED EARTH STATIONS .999 AVAILABILITY

	OPERATING SPEEDS							
YEAR/BAND	2.4	4.8	9.6	56	T1	V1	V2	V3
1982								
C	692	953	1628	619	185	956	820	688
KU	705	982	1715	682	287	1454	1305	1156
1990								
C	411	653	1056	535	177	872	758	645
KU	409	649	1048	516	167	805	683	595
KA	481	776	1228	618	173	875	750	652
2000								
C	288	502	854	419	119	564	442	336
KU	287	498	846	410	106	512	390	307
KA	410	713	1023	581	109	579	457	346

TABLE 8-13. CROSSOVER DISTANCE IN MILES
SHARED EARTH STATIONS .995 AVAILABILITY

	OPERATING SPEEDS							
YEAR/BAND	2.4	4.8	9.6	56	T1	V1	V2	V3
1982								
C	688	946	1603	601	154	800	689	587
KU	697	965	1667	647	227	1143	1004	862
1990								
C	402	634	1018	481	123	619	505	400
KU	404	639	1028	493	139	684	671	463
KA	481	775	1227	618	171	870	745	647
2000								
C	289	503	856	421	121	575	453	344
KU	283	490	832	393	82	415	303	224
KA	409	713	1022	579	108	574	452	341

distances for Ka-band, as compared with those of C- and Ku-bands, will be the lowest for unshared systems and the highest for shared systems in 1990 and 2000.

A comparision of the trunking and CPS crossovers were made next. Some traffic which economically would go trunking likely would be included on a CPS system as secondary traffic once the system was installed. The most likely candidate would be business message toll service. After establishing an intra business CPS system based on cost effectiveness, a company likely would include some of the intra business telephone service. For the same reason it was decided that, wherever the trunking/CPS crossover comparison favored trunking, 10 percent of the traffic would be addressable by CPS. The next step depended on which CPS crossover was the lowest.

8.2.9.1   C or Ku-band Crossover Lowest

If the C or Ku crossover was the lowest (see Appendix F), the crossover was applied for that particular speed across all 31 services and across all real and artificial SMSAs using MDM. This provided one set of cells, the three dimensions of each cell included year, operating speed and service. When all the crossovers were applied the cells were added to determine the traffic for each service.

8.2.9.2   Ka-band Crossover Lowest

If the Ka-band crossover was the lowest, two portions of the traffic had to be determined. One portion was that percentage of the traffic which was suitable for Ka-band CPS transmission. This was found by first applying the Ka-band CPS crossover using MDM and then multiplying the traffic by the percent of traffic suitable for Ka-band CPS transmission. The second portion was found by applying the next lowest crossover, either C or Ku, to the traffic using MDM and then multiplying by the percent of traffic suitable for CPS transmission but not suitable for Ka transmission.

8.3   SUMMARY OF CPS SATELLITE FORECASTS

The net addressable CPS satellite forecasts are presented in Table 8-14. These forecasts are composed of C, Ku and Ka traffic depending on the lowest

crossover for each particular service and speed. The first column gives the name of the service forecasted. The next three columns present the traffic forecast in transponders for 1980, 1990 and 2000. At the end of each group of services, voice, data and video subtotals are given. In Table 8-15 are the summary forecasts and the growth rates for voice, data and video CPS traffic. In the future CPS satellite traffic is expected to be significant. From today, when very few transponders are actually used and the potential market is only 23 transponders, CPS satellite traffic is expected to grow, as a stand-alone system, to a potential of 738 transponders by the year 2000. The growth rate is expected to be the greatest for video services (i.e., around 34 percent per year) and the lowest for data (i.e., around 17 percent). Still, the amount of data traffic in 2000 will be about five times that of voice or video.

TABLE 8-14
CPS SATELLITE TRAFFIC
(TRANSPONDERS)

SERVICES	YEAR		
	1980	1990	2000
VOICE			
MTS (residential)	0.0	0.0	0.0
MTS (business)	0.5	6.7	35.5
Private Line	0.4	10.1	64.4
Mobile	0.0	0.0	0.3
Public Radio	0.0	0.0	0.0
Commercial and Religious	0.0	0.0	0.1
Occasional	0.0	0.0	0.1
CATV Music	0.0	0.0	0.0
Recording	0.0	0.0	0.0
TOTAL	0.9	16.8	100.4
DATA			
Data Transfer	0.0	0.4	1.6
Batch Processing	0.1	1.1	3.0
Data Entry	16.1	102.2	219.9
Remote Job Entry	0.4	11.6	31.0
Inquiry/Response	0.2	5.3	19.6
Timesharing	0.1	1.4	3.7
USPS/EMSS	0.0	0.4	1.8
Mailbox	0.0	0.8	2.2
Administrative Messages	3.9	65.6	221.5
Facsimile	0.5	4.1	6.5
Communicating Word Processors	0.0	0.5	2.1
TWX/Telex	0.0	0.1	0.1
Mailgram/Telegram/Money Orders	0.0	0.0	0.0
Point of Sale	0.1	6.5	12.5
Videotext/Teletext	0.0	0.0	0.0
Telemonitoring Service	0.0	0.0	0.1
Secure Voice	0.0	0.3	3.3
TOTAL	21.5	200.2	528.8
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	0.3	52.2	109.1
TOTAL	0.3	52.2	109.1

TABLE 8-15. SUMMARY OF CPS SATELLITE FORECASTS AND GROWTH RATES

**FORECASTS
(TRANSPONDERS)**

	YEAR		
SERVICE	1980	1990	2000
Voice	.9	16.8	100.4
Data	21.5	200.2	528.8
Video	.3	52.2	109.1
Total	22.7	269.2	738.3

GROWTH RATES (%)	TIME PERIOD		
SERVICE	1980-1990	1990-2000	1980-2000
Voice	34.0	19.6	26.6
Data	25.0	10.2	17.4
Video	67.5	7.7	34.3
Total	28.1	10.6	19.0

SECTION 9
OVERALL SATELLITE FORECAST

9.1   INTRODUCTION

The overall satellite market represents the total amount of traffic addressable by both trunking and CPS satellite systems. These two systems overlap in many of the thirty-one services. However, in some instances traffic from one system cannot be a part of the other; for example, hinterland traffic applies only to CPS systems. An extensive analysis comparing both systems was undertaken in order to arrive at an overall forecast.

9.2   METHODOLOGY

The merging of trunking and CPS traffic required a comparision of the traffic addressable by each of these systems (see Figure 9-1). This comparision was performed on a cell by cell basis. The three dimensions of the cell included: year, speed and service (see Figure 9-2). The unit of the cell was a crossover distance. A comparision of these crossover distances between trunking and CPS was the initial step in determining the overall satellite forecast.

If the trunking crossover was the lowest, the net addressable trunking forecast for that cell became part of the overall satellite forecast. The CPS hinterland traffic was added since it does not exist in the trunking system; however, it does exist in the overall system. If the trunking crossover was determined by the Ka-band an additional amount of trunking traffic had to be added since not all trunking traffic could use the Ka-band. This was done by using the MDM and applying the next lowest trunking crossover, either C or Ku, for that cell, for the amount of traffic which could not go Ka-band trunking.

If the CPS crossover was the lowest, the net CPS forecast for that cell became part of the overall satellite forecast. If the CPS crossover was determined by Ka-band, an additional amount of CPS traffic had to be added since not all CPS traffic could use the Ka-band. This was done by using the MDM and applying the next lowest crossover, either C or Ku, for that cell, for the amount of traffic

9-1
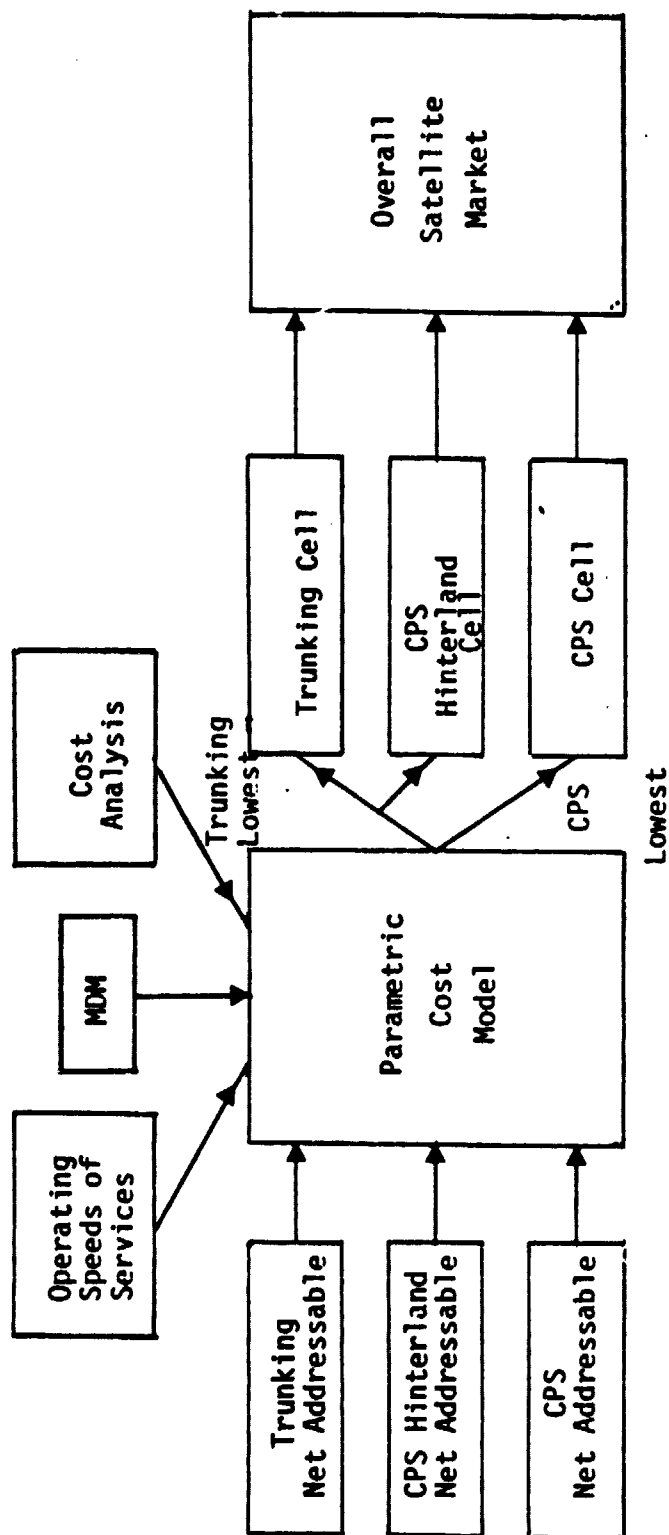
FIGURE 9-1. ACTIVITY FLOW FOR OVERALL SATELLITE FORECASTS
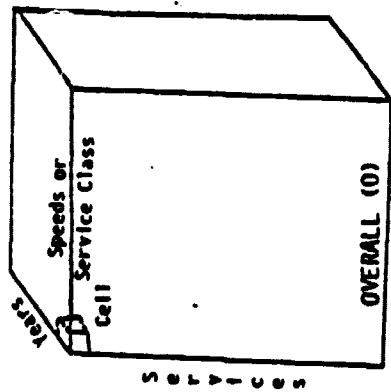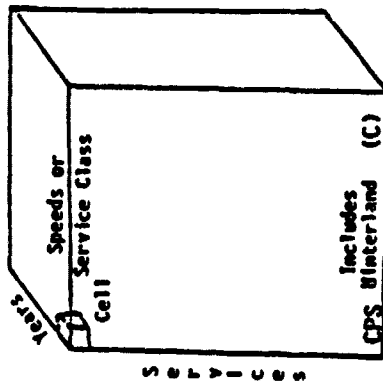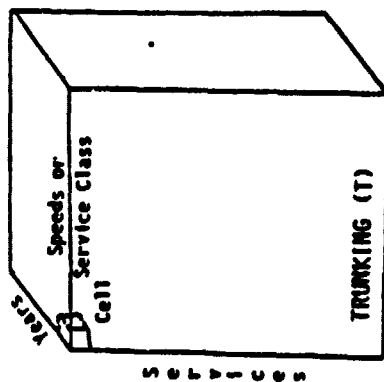
FIGURE 9-2. DIAGRAM OF CELL BY CELL ANALYSIS

which could not go Ka-band CPS. To that was added the portion of the traffic which could go trunking but which could not go CPS (see Section 8 and Appendix H for discussion). This portion of traffic was found by using the MDM and applying the trunking crossover for that cell, for that amount of traffic which could not go CPS.

9.2.1 Net Addressable Trunking Traffic

The net addressable trunking traffic forecast was determined in a study by the Western Union study of satellite provided fixed communications services which was referenced in Section 1. The following is a summary of the steps that were performed to determine this traffic.

a. Net Long Haul without Hinterland

Until this point in the analysis, CPS and Trunking forecasts were treated identically. At this point a distinction was made; traffic which fell outside the SMSAs was not considered suitable for transmission over trunking facilities. The percentages of traffic that fell outside were determined through the use of artificial SMSAs (as discussed in Section 7).

b. Remove Traffic Not Suitable

The percent of each service's traffic not suitable for satellite transmission was estimated on the basis of internal analysis conducted by engineers familiar with the various services. These percentages are listed by band in Table 9-1.

c. Cost Analysis

The comprehensive cost analysis required to develop the terrestrial/satellite crossover distances was applied in the same manner as for CPS. The major activities conducted during this analysis are listed in Table 9-2.

d. Determine Operating Speeds

The percent of each service's traffic transmitted at the various operating speeds was estimated on the basis of internal analysis conducted by engineers familiar with the various services. These are given in Tables 9-3 through 9-5.

TABLE 9-1
PERCENT OF TRAFFIC NOT
SUITABLE FOR
SATELLITE TRANSMISSION

SERVICES	BAND		
	C	Ku	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 = Connectivity (i.e., time delay tolerance)

TABLE 9-2
MAJOR TRUNKING COSTING ACTIVITIES

● Define the trunking earth stations

● Size the earth stations for C-, Ku- and Ka-band

● Vendor Survey to obtain the earth station component costs

● Cost of the earth station

● Cost of the space segment

● Cost of the terrestrial tails. Digital microwave, fiber optics, etc.

● End to end user costs for various trunking services

● Terrestrial tariffs for various services

● Crossover for terrestrial tariffs for various trunking services with satellite trunking systems

TABLE 9-3
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					
Videotext/Teletext	70	20	10					
Telemonitoring Service	70	20	10					
Secure Voice	20	60	20					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 9-4
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					
Videotext/Teletext	20	70	10					
Telemonitoring Service	20	70	10					
Secure Voice	20	30	50					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

TABLE 9-5
PERCENT OF TRAFFIC FOR SERVICES BY OPERATING SPEEDS (2000)

| | | | | OPERATING SPEEDS | | | | |
SERVICES	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			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		20	20	70				
USPS/EMSS		10	20	70				
Mailbox	10	20	70					
Administrative Messages	10	20	70					
Facsimile	10	20	70					
Communicating Word Processors	20	20	70					
TWX/Telex	10	20	70					
Mailgram/Telegram/ Money Order	10	20	70					
Point of Sale	10	20	70					
Videotext/Teletext	10	20	70					
Telemonitoring Service	10	20	70					
Secure Voice	10	20	70					
Network								
CATV								
Occasional								
Recording Channel								
Teleconferencing								

e.   Consider Effect of Common Carrier

The amount of traffic that should be removed because common carriers will choose terrestrial over satellite modes even though the latter were calculated as more cost efficient was removed. This is given in Table 9-6.

The trunking net addressable forecasts are presented in Table 9-7.

9.2.2   Net Addressable CPS Forecast

The net addressable CPS forecasts were explained in Section 8 and are presented in Table 9-8.

9.2.3   Net Addressable CPS Hinterland Forecast

The net addressable CPS hinterland forecast is a subset of the CPS forecasts in Table 9-8; it includes traffic to or from sites outside the SMSAs. These forecasts were determined by creating artificial SMSAs as explained in Section 7. This includes and represents 17,328 routes. The net addressable CPS hinterland forecasts by service are shown in Table 9-9.

9.3   SUMMARY OF OVERALL SATELLITE FORECASTS

The overall satellite forecasts include traffic from both CPS and trunking systems. Table 9-10 presents the overall satellite forecasts by service and year. Table 9-11 gives the summary forecasts for trunking, CPS and overall segments, and Table 9-12 shows the corresponding growth rates. Figure 9-3 indicates how the various CPS and trunking forecasts are integrated to give the overall forecasts; the numbers indicate the number of transponders for 2000. It is clear that trunking will dominate the overall satellite market for many years. However, its share of the market is projected to decline from 92 percent in 1980 to 80 percent by 2000. The major factor contributing to the increase of CPS is the rapid growth of data services and the dominance of CPS in these markets. This dominance reflects the fact that CPS is an all digital system that favors data services; it also reflects the findings from our users survey and other

studies which indicated that data was most often used either internally or between specific companies, such as on a timesharing network where CPS is ideal.

TABLE 9-6
PERCENT OF TRAFFIC REMOVED
BECAUSE OF PLANT IN PLACE

SERVICE	YEAR		
	1980	**1990**	**2000**
Voice	98	73.5	50.0
Data	93	49.5	16.5
Video	No effect since only satellite traffic forecasted		

TABLE 9-7. TRUNKING SEGMENT OF OVERALL SATELLITE FORECASTS
(TRANSPONDERS)

SERVICE	YEAR		
	1980	1990	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	189.3	601.4	1805.6
DATA			
DATA TRANSFER	0.0	0.4	2.7
BATCH PROCESSING	0.0	0.0	0.0
DATA ENTRY	0.0	0.0	0.0
REMOTE JOB ENTRY	0.0	0.0	0.0
INQUIRY/RESPONSE	0.0	0.0	0.0
TIMESHARING	0.0	0.0	0.0
USPS/EMSS	0.0	0.6	1.8
MAILBOX	0.0	0.0	0.0
ADMINISTRATIVE MESSAGES	0.0	0.0	0.0
FACSIMILE	0.0	0.0	0.0
COMMUNICATING WORD PROCESSORS	0.0	0.0	0.0
TWX/TELEX	0.0	0.1	0.2
MAILGRAM/TELEGRAM/MONEY ORDERS	0.0	0.0	0.0
POINT OF SALE	0.0	0.0	0.0
VIDEOTEXT/TELETEXT	0.0	1.8	8.1
TELEMONITORING SERVICE	0.0	0.0	0.0
SECURE VOICE	0.0	0.0	0.0
TOTAL	0.1	2.9	12.8
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 9-8. CPS SEGMENT OF OVERALL SATELLITE FORECASTS (TRANSPONDERS)

	YEAR		
SERVICE	1980	1990	2000
VOICE			
MTS (RESIDENTIAL)	0.0	0.0	0.0
MTS (BUSINESS)	0.1	1.2	6.5
PRIVATE LINE	0.1	1.8	11.8
MOBILE	0.0	0.0	0.1
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	0.2	3.1	18.4
DATA			
DATA TRANSFER	0.0	0.1	0.3
BATCH PROCESSING	0.1	1.1	3.1
DATA ENTRY	16.1	102.2	219.9
REMOTE JOB ENTRY	0.4	11.6	31.0
INQUIRY/RESPONSE	0.2	5.3	19.6
TIMESHARING	0.1	1.4	3.7
USPS/EMSS	0.0	0.1	0.3
MAILBOX	0.0	0.8	2.2
ADMINISTRATIVE MESSAGES	3.9	65.6	221.5
FACSIMILE	0.7	5.7	8.6
COMMUNICATING WORD PROCESSORS	0.0	0.5	2.1
TWX/TELEX	0.0	0.0	0.0
MAILGRAM/TELEGRAM/MONEY ORDERS	0.0	0.0	0.0
POINT OF SALE	0.1	6.9	13.2
VIDEOTEXT/TELETEXT	0.0	0.0	0.0
TELEMONITORING SERVICE	0.0	0.0	0.1
SECURE VOICE	0.0	0.3	3.3
TOTAL	21.7	201.5	528.8
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	0.1	9.6	20.0
TOTAL	0.1	9.6	20.0

TABLE 9-9. HINTERLAND CPS SEGMENT OF OVERALL SATELLITE FORECASTS (TRANSPONDERS)

SERVICE	YEAR		
	1980	**1990**	**2000**
VOICE			
MTS (RESIDENTIAL)	0.0	0.0	0.0
MTS (BUSINESS)	0.1	1.2	6.5
PRIVATE LINE	0.1	1.8	11.8
MOBILE	0.0	0.0	0.1
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	0.2	3.1	18.4
DATA			
DATA TRANSFER	0.0	0.1	0.3
BATCH PROCESSING	0.0	0.2	0.5
DATA ENTRY	2.9	18.7	40.2
REMOTE JOB ENTRY	0.1	2.1	5.7
INQUIRY/RESPONSE	0.0	1.0	3.6
TIMESHARING	0.0	0.3	0.7
USPS/EMSS	0.0	0.1	0.3
MAILBOX	0.0	0.1	0.4
ADMINISTRATIVE MESSAGES	0.7	12.0	40.5
FACSIMILE	0.1	0.7	1.2
COMMUNICATING WORD PROCESSORS	0.0	0.1	0.4
TWX/TELEX	0.0	0.0	0.0
MAILGRAM/TELEGRAM/MONEY ORDERS	0.0	0.0	0.0
POINT OF SALE	0.0	1.2	2.3
VIDEOTEXT/TELETEXT	0.0	0.0	0.0
TELEMONITORING SERVICE	0.0	0.0	0.0
SECURE VOICE	0.0	0.0	0.6
TOTAL	3.9	36.6	96.8
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	0.1	9.6	20.0
TOTAL	0.1	9.6	20.0

TABLE 9-10. OVERALL SATELLITE FORECASTS
(TRANSPONDERS)

SERVICE	YEAR		
	1980	1990	2000
VOICE			
MTS (RESIDENTIAL)	3.5	50.6	193.7
MTS (BUSINESS)	9.1	161.5	654.2
PRIVATE LINE	174.9	384.8	957.8
MOBILE	0.4	5.6	15.9
PUBLIC RADIO	0.3	0.6	0.6
COMMERCIAL AND RELIGIOUS	0.4	0.7	0.7
OCCASIONAL	0.8	0.6	0.6
CATV MUSIC	0.1	0.1	0.3
RECORDING	0.0	0.0	0.1
TOTAL	189.4	604.5	1824.0
DATA			
DATA TRANSFER	0.0	0.5	3.0
BATCH PROCESSING	0.1	1.1	3.1
DATA ENTRY	16.1	102.2	219.9
REMOTE JOB ENTRY	0.4	11.6	31.0
INQUIRY/RESPONSE	0.2	5.3	19.6
TIMESHARING	0.1	1.4	3.7
USPS/EMSS	0.0	0.6	2.2
MAILBOX	0.0	0.8	2.2
ADMINISTRATIVE MESSAGES	3.9	65.6	221.5
FACSIMILE	0.7	5.7	8.6
COMMUNICATING WORD PROCESSORS	0.0	0.5	2.1
TWX/TELEX	0.1	0.2	0.2
MAILGRAM/TELEGRAM/MONEY ORDERS	0.0	0.0	0.0
POINT OF SALE	0.1	6.9	13.2
VIDEOTEXT/TELETEXT	0.0	1.8	8.1
TELEMONITORING SERVICE	0.0	0.0	0.1
SECURE VOICE	0.0	0.3	3.3
TOTAL	21.7	204.4	541.6
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	3.1	165.5	265.3
TOTAL	61.3	332.4	412.7

TABLE 9-11. SUMMARY OF OVERALL SATELLITE FORECASTS
(TRANSPONDERS)

	YEAR		
FORECAST	1980	1990	2000
Trunking Segment			
Voice	189.3	601.4	1805.6
Data	.1	2.9	12.8
Video	61.3	322.8	392.7
Total	250.7	927.1	2211.1
% of Overall	92.0%	81.0%	80.0%
CPS Segment			
Voice	.2	3.1	18.4
Data	21.7	201.5	528.8
Video	.1	9.6	20.0
Total	22.0	214.2	567.2
% of Overall	8.0%	19.0%	20.0%
Overall			
Voice	189.5	604.5	1824.0
Data	21.8	204.4	541.6
Video	61.4	332.4	412.7
Total	272.7	1141.3	2778.3
% of Overall			
Voice	69.5%	53.0%	65.7%
Data	8.0%	17.9%	19.5%
Video	22.5%	29.1%	14.8%

TABLE 9-12. GROWTH RATES FOR OVERALL SATELLITE FORECASTS (%)

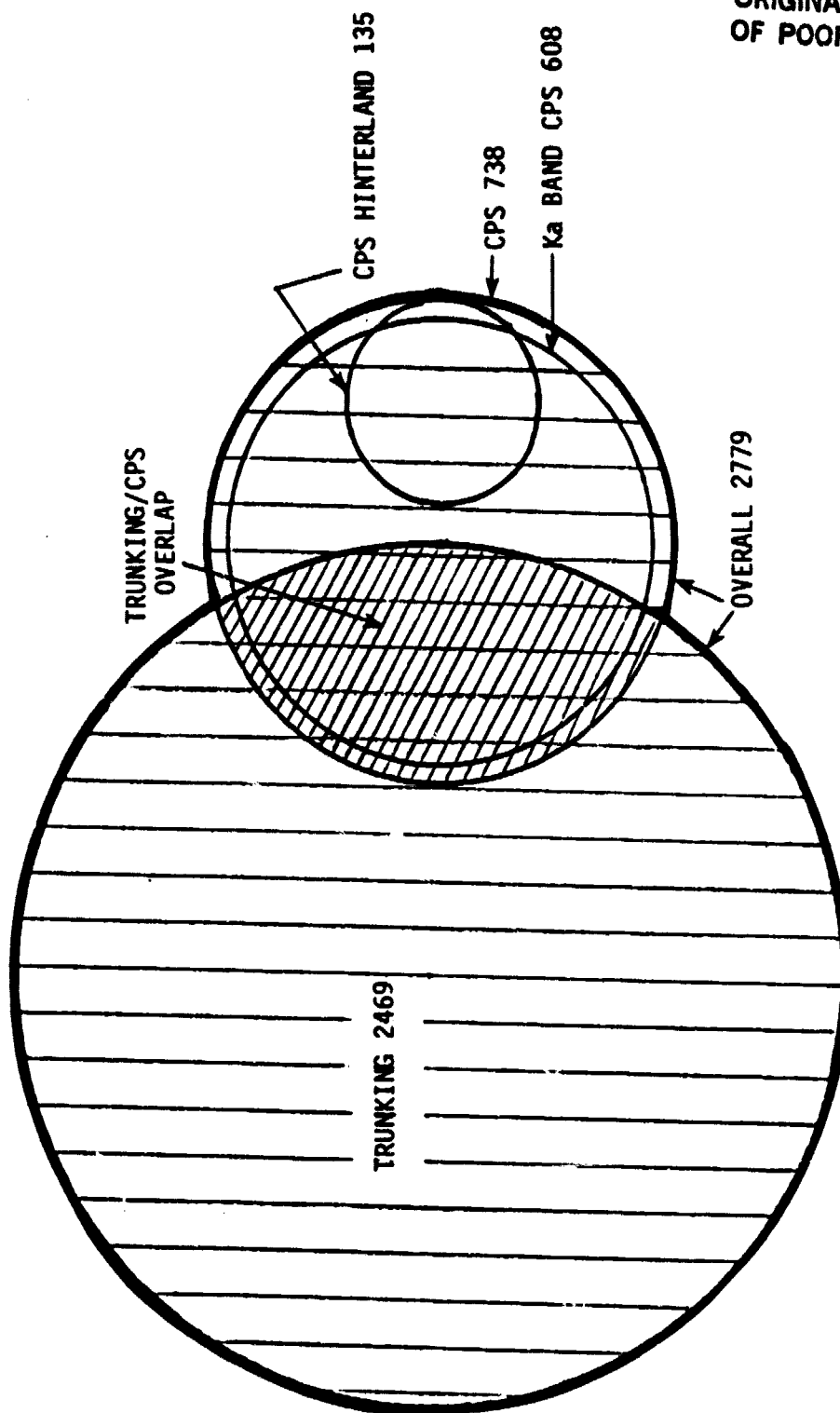| FORECAST	TIME PERIOD		
	1980-1990	1990-2000	1980-2000
Trunking Segment			
Voice	12.3	11.6	11.9
Data	40.0	16.0	27.5
Video	18.1	2.0	9.7
Total	14.0	9.1	11.5
CPS Segment			
Voice	31.5	19.5	25.4
Data	25.0	10.1	17.3
Video	57.8	7.6	30.3
Total	25.6	10.2	17.6
Overall			
Voice	12.3	11.7	12.0
Data	25.1	10.2	17.4
Video	18.4	2.2	10.0
Total	15.4	9.3	12.3

FIGURE 9-3. INTEGRATION OF CPS AND TRUNKING FORECASTS IN DEVELOPMENT
OF OVERALL SATELLITE FORECAST (NUMBERS = # TRANSPONDERS IN 2000)
(THE NUMBERS REPRESENT COMPLETE CIRCLES AND INCLUDE OVERLAP AREAS)

SECTION 10
Ka-BAND CPS SATELLITE FORECAST

10.1   INTRODUCTION

The Ka-band CPS satellite forecast represents the total amount of traffic addressable by a Ka-band (30/20 GHz) CPS satellite system. Two types of satellite systems were considered. One had unshared earth stations located directly on (or very close) to the customer's own premises, for example, on the roof or in an adjacent parking lot. The Western Union survey (see Section 3 and Appendix D) indicated that very few businesses would have a physical problem with locating such an earth station. The other type of system included shared earth stations combined with the unshared type. For example, an industrial park may share a system located near the center with links provided to the various offices by microwave or cable. Two types of availability levels, .995 and .999, were considered for each of the above system configurations.

10.2   METHODOLOGY

To de.ive the addressable Ka-band CPS forecast, it was necessary to begin with the net long haul (see Figure 10-1). A series of steps was performed to reduce the net long haul traffic for various reasons and to compare the crossovers determined by various configurations and availabilities. Several of these steps were identical to the steps taken in Section 8, CPS Satellite Market. Where this occurs the analysis is not repeated and the reader is referred back to this previous section. Also the assumption was made that Ka-band CPS traffic will be all digital; this was based on trends to integrate networks totally. The following steps were performed to determine the Ka-band CPS satellite forecasts.

10.2.1   Remove Traffic Due to Satellite Constraints

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 transmis-
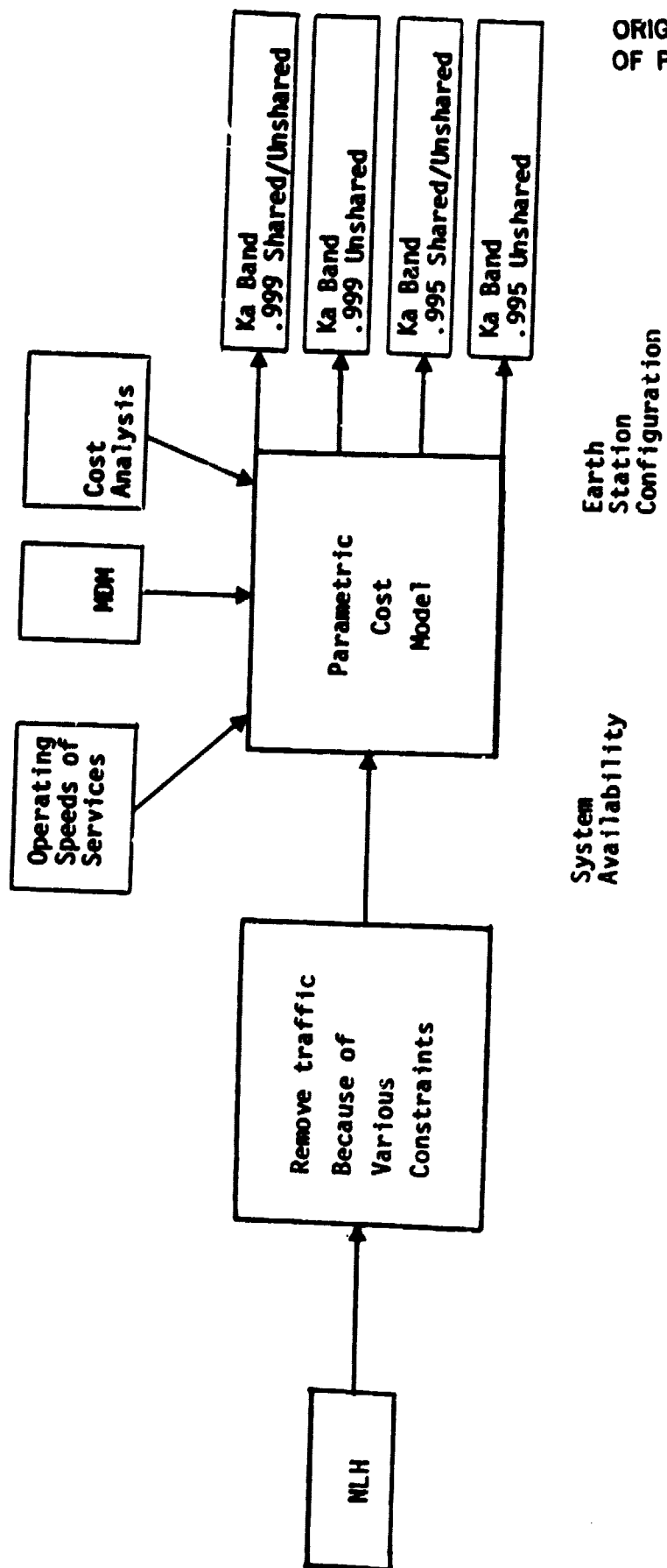
FIGURE 10-1. ACTIVITY FLOW FOR KA-BAND CPS SATELLITE FORECASTS

sion system. These constraints are the same as those explained in Section 8 on the CPS Satellite Market.

10.2.2   Remove Traffic Lost Because of Plant in Place

Across the United States a tremendous investment has been made in existing plant 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, which satellite systems must recover, is in 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. This analysis was also done in Section 8 and the percent of traffic removed was given in Table 8-2.

10.2.3   Reduce Traffic Because of Time Zone Considerations

Peak hour traffic does not consider the different time zones within the continental United States. For instance, if the peak hour for traffic occurs at 2:00 p.m., it is calculated as 2:00 p.m. across the United States. If the satellite system has sufficient compatability, it may be reconfigured and the antennas reshaped to take advantage of the different time zones. An analysis of this affect and the impact on system traffic was performed by Western Union under contract to Motorola. It was found that a system may be designed for 13 percent less traffic if the system takes advantage of the various time zones.

10.2.4   Remove Traffic not Suitable for Ka-band CPS Transmission

Not all traffic was suitable for inclusion in a Ka band CPS satellite system. First broadcast applications were considered difficult if not impossible for a CPS system and were largely removed. Private homes would not use a CPS system so traffic generated there, such as residential message toll service was removed. In addition, a great deal of interbusiness traffic would be between companies not on the CPS system and therefore should not be included as addressable. In addition,

10-3

because of the beam size and the multiple use of the Ka-band, an additional amount of traffic was removed. Table 8-7 showed the percentages of traffic removed because it was not suitable for Ka band CPS transmission.

10.2.5   Convert Into Transponders

Up to this point voice, data, and video were all carried in unique units: half voice circuits for voice, terabits for data and transponders for video. In order to project the net addressable CPS traffic and the number of satellites this service requires it was necessary to convert these units into a common unit, transponders. This step was identical to the conversion done in Section 8.

10.2.6   Distribute Demand to All Real and Artificial SMSAs

In order to distribute the demand for transponders among the 313 SMSA and the 48 artificial SMSAs, it was necessary to use the market distribution model (see Section 7). Table 8-3 showed the files and weights used to perform this distribution.

10.2.7   Segment Services into Various Operating Speeds

The next step was to segment the thirty-one services into the various operating speeds. This analysis was performed by engineers and included a review of such things as the trend toward more high speed data. Services involving a great deal of CPU to CPU traffic which would normally go over high volume circuits, (e.g., data transfer) were shown as such. Slower services, such as data entry, were segmented into the slower speeds. Operating speeds by service by year were presented in Tables 8-4 through 8-6.

10.2.8   Trunking/Ka-band CPS Crossover Comparison

Four comparisons of the Ka band crossover (.995 unshared, .999 unshared, .995 shared/unshared, .999 shared/unshared) were made with trunking. Some traffic which economically would go trunking likely would be included on a Ka-band CPS system as secondary traffic once the system was installed. The most likely

candidate would be business message toll service. After establishing an intrabusiness CPS system based on cost effectiveness, a company likely would include some of the intrabusiness telephone service. For the same reason, it was decided that wherever the trunking/Ka band CPS crossover comparison favored trunking, 10 percent of the traffic would be addressable by Ka band CPS. Since this 10 percent addition was not made when developing the overall satellite forecasts, the Ka-band CPS forecasts were greater than the CPS segment of the overall satellite forecasts.

10.2.9   Consider Traffic Differences Due to Availability

The acceptable level of availability for a service varies widely among users and depends upon the applications utilized and the importance of those applications in the user's business operations. For example, a 300 baud service used for time sharing is normally more sensitive to interruptions than the same service used for Administrative data traffic. Similarly, a time-share user may be willing to wait a considerable length of time for a circuit to be repaired but cannot tolerate a 10 second interruption. On the other hand, a stockbroker may easily tolerate a one minute interruption but cannot afford a half hour outage, because the telephone system in this case is an integral part of his business operations. For the purpose of this study the following parameters were used to define the levels of availability.

SUMMARY OF AVAILABILITIES

Availability	Percent Available	Availability Outage Per Year	Extended Frequency (Outage/Day)
High	99.9	9 Hours	1.5 Minutes
Medium	99.5	46.5 Hours	7.6 Minutes
Low	Less than 99.5	---	---

From a carrier's point of view, availability of a service is a discretely quantifiable design criterion, but for most users it is a qualitative measure of the service performance. Users (e.g., telecommunications managers) normally measure the reliability or quality of a service by the frequency of complaints

10-5

they get from their end users (e.g., management and clerical employees). It is difficult for them to define required reliability standards for each of the several applications the service is or will be used for. Furtheremore, from the users' point of view, it is the carrier who is responsible for the end-to-end availability of a service.

Previous user surveys, including the one conducted by Western Union, revealed that most users currently use the same network/service for their voice and data communications needs. Furthermore, the same service is being used for several voice and data applications among which are certain applications that could easily tolerate a lower availabiity than that of the present service. Most users were unable to assess their required circuit availability levels by application and even more hesitant about projecting the effect of availability changes. Using our survey and other sources we concluded the following:

    a.   Primarily, voice and video services support high reliability traffic and cannot be easily accommodated by a lower reliability transmission medium.

    b.   A large proportion of data traffic which is currently carried over high reliability, slow speed network systems/services may be delivered to a lower reliabiity system.

    c.   Telecommunicatins systems and services are becoming more and more important to users' business operations. Users, concerned about their escalating telecommunication costs, will use lower reliabiity service to reduce those costs but will normally maintain a considerable portion of their high reliability service. This high reliability serice may be maintained to provide a backup for the lower reliability service, in addition to carrying their high reliability service.

    c.   Telecommunicatins systems and services are becoming more and more important to users's business operations. Users, concerned about their escalating telecommunication costs, will use lower reliability service to reduce those costs but will normally maintain a considerable portion of their high reliability service. This high reliability service may be maintained

to provide a backup for the lower reliability service, in addition to carrying their high reliability service.

From the user's point of view, the acceptable level of availability is a very subjective and qualitative issue. Most user's are unable to define their service availability requirements by application and tend to employ a high reliability service for both their high and low reliability traffic demand. Based on this information it was concluded that the difference in .995 and .999 availability was not as critical as many thought. A factor of ten percent was applied across all services, therefore, to quantify this somewhat subjective factor.

10.2.10   Applying the Ka-band CPS Crossovers

The next step was to apply the crossover for each speed and each service to the remaining traffic using MDM. This was done for each of the four configurations. Aggregating the traffic from the various speeds yield the net addressable Ka band CPS traffic for that service and for that particular configuration.

10.2.11   Divide Services by User Group

Having estimated the addressable Ka band CPS traffic it was necessary to determine which sectors in the U.S. economy were potential users of CPS and project a level of demand for each. Four user categories were considered for this determination: Business, Government, Institutions and Private . Industry economic data, operating characteristics and telecommunications demand were analyzed on an individual basis in order to determine trends in each sector. Information for this analysis was obtained from the user survey (see Section 3 and Appendix D) and secondary research.

The telecommunications user population was grouped into fourteen industrial and one non-industrial (residential users) sector utilizing the Standard Industry Classification (SIC) system. As indicated below, these industry sectors were further grouped into the four user categories based upon the primary function of each in the U.S. economy and also its operating characteristics.

USER CATEGORY DEFINITION

USER CATEGORY	INDUSTRY SECTOR	SIC CODE
Business	Manufacturing (Discrete and Process)	20-39
	Wholesale Distribution	50-51
	Retail Distribution	52-59
	Finance and Banking	60-67
	Insurance	63-64
	Transportation	40-47
	Utilities	48-49
	Professional Business Service	73-89
	Other (Miscellaneous Businesses)	
Government	Federal	91-97, 43
	State and Local	91-97
Institution	Education	82
	Health Care	80
	Other Membership Organizations	83,86
*Private	U.S. Population (Households) not residing	-

*Non-Industrial
 Sector

Using the above classifications with the information obtained from the user survey and secondary resources, the CPS traffic pattern among the 31 services was analyzed. (This is presented Table 10-1. Note: The traffic pattern is indicated for all services, even those with no CPS traffic, for example residential message toll service).

10.3   SUMMARY OF KA-BAND CPS SATELLITE FORECASTS

The forecasts for each of the four basic configurations are presented by service, by year in Tables 10-2 through 10-5. These forecasts and their growth rates are summarized in Table 10-6. These forecasts which became the basis for the rest of the Ka traffic analysis (i.e., user, region, and mileage analysis), show that the

TABLE 10-1. PERCENT OF TRAFFIC BY SERVICE AND USER CLASS

SERVICE	Business	Institutional	Government	Private
MTS (Residential)	0	0	0	100
MTS (Business	50	15	35	0
Private Line	65	10	25	0
Mobile	80	5	15	0
Public Radio	0	0	100	0
Commercial and Religious	80	20	0	0
Occasional	80	20	0	0
CATV Music	100	0	0	0
Recording	100	0	0	0
Data Transfer	40	20	40	0
Batch Processing	50	30	20	0
Data Entry	45	15	35	5
Remote Job Entry	50	30	20	0
Inquiry/Response	65	10	20	5
Timesharing	40	20	40	0
USPS/EMSS	60	30	10	0
Mailbox	70	10	20	0
Administrative Messages	40	20	40	0
Facsimile	60	10	30	0
Communicating Word Processors	70	5	25	0
TWX/Telex	55	15	30	0
Mailgram/Telegram/Money Orders	40	25	10	25
Point of Sale	85	5	10	0
Videotext/Teletext	45	15	15	25
Telemonitoring Service	35	5	25	35
Secure Voice	20	0	80	0
Data				
Network	90	10	0	0
CATV	90	10	0	0
Occasional	90	10	0	0
Recording Channel	100	0	0	0
Teleconferencing	60	10	30	0

TABLE 10-2. KA-BAND CPS SATELLITE TRAFFIC
AVAIL=.999, SHARED/UNSHARED EARTH STATIONS
(TRANSPONDERS)

SERVICE	YEAR		
VOICE	**1980**	**1990**	**2000**
MTS (RESIDENTIAL)		0.0	0.0
MTS (BUSINESS)		4.1	21.7
PRIVATE LINE		10.0	63.0
MOBILE		0.0	0.3
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		14.2	85.1
DATA			
DATA TRANSFER		0.3	1.3
BATCH PROCESSING		0.9	2.4
DATA ENTRY		102.2	219.9
REMOTE JOB ENTRY		11.6	31.0
INQUIRY/RESPONSE		5.3	19.6
TIMESHARING		1.4	3.7
USPS/EMSS		0.4	1.8
MAILBOX		0.5	1.5
ADMINISTRATIVE MESSAGES		44.0	149.1
FACSIMILE		3.1	5.0
COMMUNICATING WORD PROCESSORS		0.3	1.4
TWX/TELEX		0.1	0.1
MAILGRAM/TELEGRAM/MONEY ORDERS		0.0	0.0
POINT OF SALE		5.3	10.2
VIDEOTEXT/TELETEXT		0.0	0.0
TELEMONITORING SERVICE		0.0	0.1
SECURE VOICE		0.3	3.3
TOTAL		175.7	450.2
VIDEO			
NETWORK		0.0	0.0
CATV		0.0	0.0
OCCASIONAL		0.0	0.0
RECORDING CHANNEL		0.0	0.0
TELECONFERENCING		34.9	72.8
TOTAL		34.9	72.8

TABLE 10-3. KA-BAND CPS SATELLITE TRAFFIC
AVAIL=.995, SHARED/UNSHARED EARTH STATIONS
(TRANSPONDERS)

SERVICE	YEAR		
VOICE	1980	1990	2000
MTS (RESIDENTIAL)		0.0	0.0
MTS (BUSINESS)		3.7	19.7
PRIVATE LINE		9.1	57.1
MOBILE		0.0	0.3
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		12.9	77.2
DATA			
DATA TRANSFER		0.3	1.2
BATCH PROCESSING		0.8	2.2
DATA ENTRY		91.9	198.0
REMOTE JOB ENTRY		10.4	27.9
INQUIRY/RESPONSE		4.8	17.6
TIMESHARING		1.2	3.4
USPS/EMSS		0.4	1.6
MAILBOX		0.5	1.3
ADMINISTRATIVE MESSAGES		39.6	134.2
FACSIMILE		2.8	4.5
COMMUNICATING WORD PROCESSORS		0.3	1.2
TWX/TELEX		0.1	0.1
MAILGRAM/TELEGRAM/MONEY ORDERS		0.0	0.0
POINT OF SALE		4.8	9.2
VIDEOTEXT/TELETEXT		0.0	0.0
TELEMONITORING SERVICE		0.0	0.0
SECURE VOICE		0.2	2.9
TOTAL		158.2	405.2
VIDEO			
NETWORK		0.0	0.0
CATV		0.0	0.0
OCCASIONAL		0.0	0.0
RECORDING CHANNEL		0.0	0.0
TELECONFERENCING		31.4	65.5
TOTAL		31.4	65.5

TABLE 10-4. KA-BAND CPS SATELLITE TRAFFIC
AVAIL=.999, UNSHARED EARTH STATIONS
(TRANSPONDERS)

SERVICE	YEAR		
VOICE	**1980**	**1990**	**2000**
MTS (RESIDENTIAL)		0.0	0.0
MTS (BUSINESS)		0.8	7.1
PRIVATE LINE		1.8	20.5
MOBILE		0.0	0.1
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		2.6	27.7
DATA			
DATA TRANSFER		0.3	1.3
BATCH PROCESSING		0.9	2.4
DATA ENTRY		102.2	219.9
REMOTE JOB ENTRY		11.6	31.0
INQUIRY/RESPONSE		5.3	19.6
TIMESHARING		1.4	3.7
USPS/EMSS		0.4	1.8
MAILBOX		0.5	1.5
ADMINISTRATIVE MESSAGES		44.0	149.1
FACSIMILE		3.1	5.0
COMMUNICATING WORD PROCESSORS		0.3	1.4
TWX/TELEX		0.1	0.1
MAILGRAM/TELEGRAM/MONEY ORDERS		0.0	0.0
POINT OF SALE		5.3	10.2
VIDEOTEXT/TELETEXT		0.0	0.0
TELEMONITORING SERVICE		0.0	0.1
SECURE VOICE		0.3	3.3
TOTAL		175.7	450.2
VIDEO			
NETWORK		0.0	0.0
CATV		0.0	0.0
OCCASIONAL		0.0	0.0
RECORDING CHANNEL		0.0	0.0
TELECONFERENCING		34.9	72.8
TOTAL		34.9	72.8

TABLE 10-5. KA-BAND CPS SATELLITE TRAFFIC
AVAIL=.995, UNSHARED EARTH STATIONS
(TRANSPONDERS)

SERVICE	YEAR		
VOICE	1980	1990	2000
MTS (RESIDENTIAL)		0.0	0.0
MTS (BUSINESS)		0.7	6.4
PRIVATE LINE		1.7	18.5
MOBILE		0.0	0.1
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		2.4	25.1
DATA			
DATA TRANSFER		0.3	1.2
BATCH PROCESSING		0.8	2.2
DATA ENTRY		91.9	198.0
REMOTE JOB ENTRY		10.4	27.9
INQUIRY/RESPONSE		4.8	17.6
TIMESHARING		1.2	3.4
USPS/EMSS		0.4	1.6
MAILBOX		0.5	1.3
ADMINISTRATIVE MESSAGES		39.6	134.2
FACSIMILE		2.8	4.5
COMMUNICATING WORD PROCESSORS		0.3	1.2
TWX/TELEX		0.1	0.1
MAILGRAM/TELEGRAM/MONEY ORDERS		0.0	0.0
POINT OF SALE		4.8	9.2
VIDEOTEXT/TELETEXT		0.0	0.0
TELEMONITORING SERVICE		0.0	0.0
SECURE VOICE		0.2	2.9
TOTAL		158.2	405.2
VIDEO			
NETWORK		0.0	0.0
CATV		0.0	0.0
OCCASIONAL		0.0	0.0
RECORDING CHANNEL		0.0	0.0
TELECONFERENCING		31.4	65.5
TOTAL		31.4	65.5

TABLE 10-6. SUMMARY OF KA-BAND CPS SATELLITE FORECASTS
AND GROWTH RATES:
SERVICE BY YEAR BY EARTH STATION CONFIGURATION BY AVAILABILITY

| | YEAR | | | | GROWTH RATES |
| | 1990 | | 2000 | | 1990-2000 |
SHARED-UNSHARED	T*	%	T	%	%
.999					
Voice	14.2	6.3	85.1	14.0	19.6
Data	175.7	78.2	450.2	74.0	9.9
Video	34.9	15.5	72.8	12.0	7.6
Total	224.8	100.0	608.1	100.0	
.995					
Voice	12.9	6.4	77.2	14.9	19.6
Data	158.2	78.1	405.2	74.0	9.9
Video	31.4	15.5	65.5	12.0	7.6
Total	262.5	100.0	547.9	100.0	
UNSHARED					
.999					
Voice	2.6	1.2	27.7	5.0	26.7
Data	175.7	82.4	450.2	81.8	9.9
Video	34.9	16.4	72.8	13.2	7.6
Total	213.2	100.0	550.7		
.995					
Voice	2.4	1.2	25.1	5.0	26.7
Data	158.2	82.4	405.2	81.7	9.9
Video	31.4	16.4	65.5	13.2	7.6
Total	192.0	100.0	495.8	100.0	

*Transponders

greatest Ka potential exists for the .999 shared/unshared network. The results for this configuration became the input to the development of the Nationwide Traffic Distribution Model discussed in Section 11.

10.3.1 Ka-band CPS Mileage Forecasts

In Appendix I, Tables I-6 through I-29 are a series of 24 reports showing the net addressable traffic for the various Ka band configurations by the mileage band it is transmitted. The MDM provided the capability of distributing traffic volumes as a function of distance. SMSA's less than the crossover distance were not included as part of the air line miles. SMSA longitues and latitudes were identified in terms of V & H coordinates and maintained as a part of the MDM. which permit the calculation of route distances.

Six airline mileage bands were established to develop a distribution of traffic by distance transmitted. The structure of the six mileage bands was designed to provide practical and usable mileage groupings that would satisfy the require-ments of the study. For ease of analysis the groupings were, as listed below, similar though not identical to AT&T Long Lines mileage bands:

MILEAGE BAND CATEGORIES

Report	Minimum Distance Transmitted (Miles)	Maximum Distance Transmitted (Miles)
1	1	40
2	41	150
3	151	500
4	501	1000
5	1001	2000
6	2001	---

A summary of the results from the 24 reports in Appendix I is given in Table 10-7. Figure 10-2 plots the amount of traffic and the number of routes against the various mileage bands for the largest addressable Ka-band CPS market (i.e.,

TABLE 10-7. SUMMARY OF KA-BAND CPS SATELLITE FORECASTS: MILEAGE BAND BY YEAR BY EARTH STATION BY AVAILABILITY

|	1990		2000	
	T*	%	T	%
SHARED/UNSHARED				
.999				
1-40	12.5	5.6	33.8	5.6
4-150	32.8	14.6	88.6	14.6
151-500	70.4	31.3	190.3	31.3
501-1000	61.9	27.5	167.5	27.5
1001-2100	38.8	17.2	105.1	17.3
2101+	8.4	3.7	22.8	3.8
.995				
1-40	11.3	5.6	30.5	5.6
41-150	29.5	14.6	79.8	14.6
151-500	63.4	31.3	171.4	31.3
501-1000	55.7	27.5	150.9	27.5
1001-2100	34.9	17.2	94.7	17.3
2101+	7.6	3.7	20.6	3.8
UNSHARED				
.999				
1-40	11.9	5.6	30.6	5.6
41-150	31.1	14.6	80.3	14.6
151-500	66.8	31.3	172.5	31.3
501-1000	58.7	27.5	151.8	27.6
1001-2100	36.7	17.2	95.0	17.3
2101+	8.0	3.7	20.6	3.7
.995				
1-40	10.7	5.6	27.5	5.6
41-150	28.0	14.6	72.3	14.6
151-500	60.1	31.3	155.3	31.3
501-1000	52.9	27.5	136.6	27.6
1001-2100	33.1	17.2	85.6	17.3
2101+	7.2	3.7	18.5	3.7

*Transponders
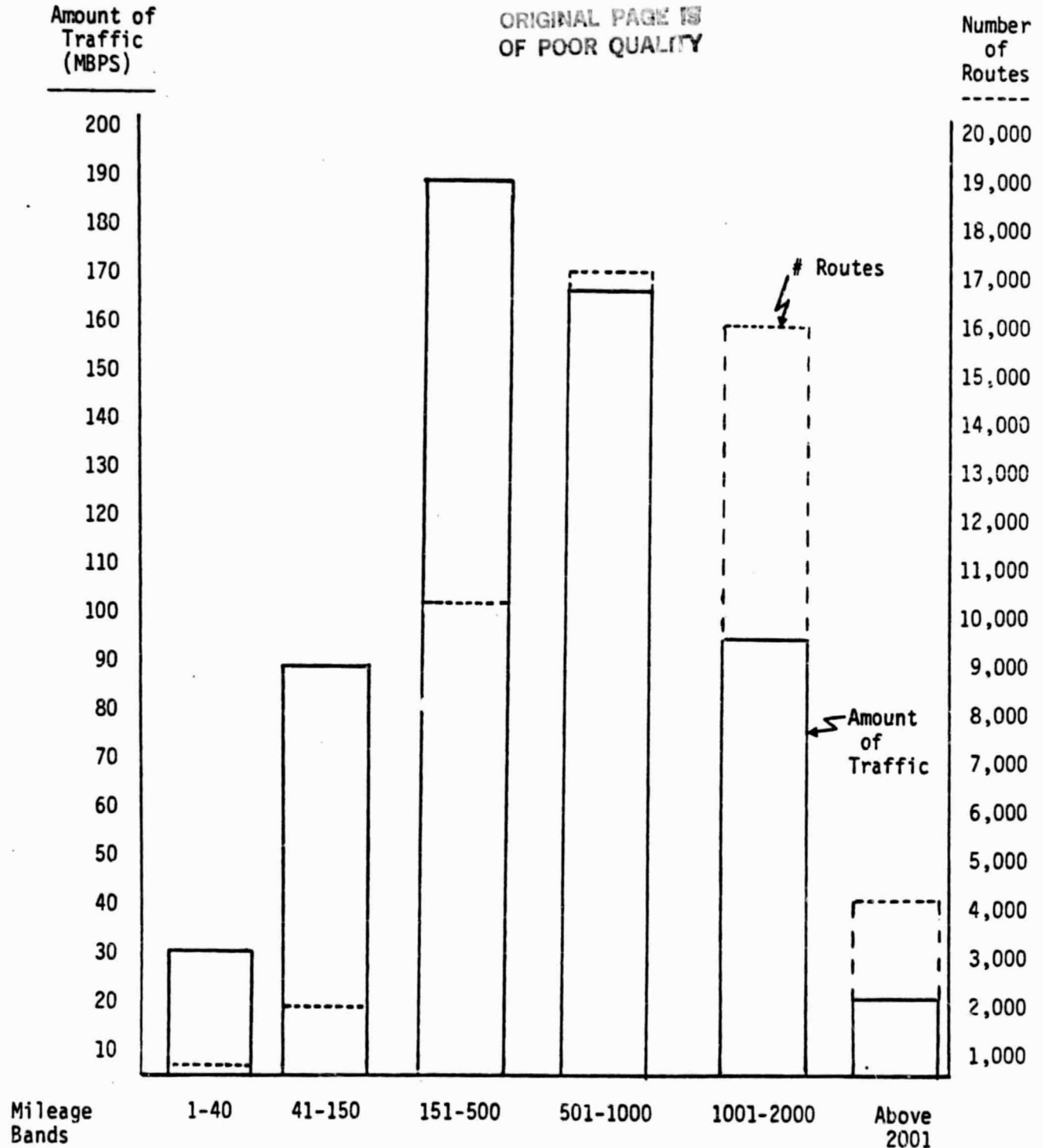
FIGURE 10-2. AMOUNT OF TRAFFIC AND NUMBER OF ROUTES BY MILEAGE BAND FOR KA-BAND CPS (SHARED/UNSHARED AND .999 AVAILABILITY)

the market for the .999 shared/unshared configuration). This graph shows that the majority of the traffic will be transmitted between 151 and 1000 miles. The effect of MDMs distance sensitivity factor is clearly shown by comparing the number of routes (i.e., population to population center lines of travel) and the amount of traffic for each mileage band. In the short haul mileage (i.e., 1-40 and 41-150) bands a relatively small number of routes (2028) generates almost the same amount of traffic that a large number of route (20, 253) going long haul (1001-2000 and above 2001).

10.3.2   Ka-band CPS User Class Forecasts

In Appendix I, Tables I-30 through I-45 are a series of 16 reports showing the net addressable traffic for the various Ka-band CPS configurations by user class; the user classes for the study are: business, Government, institutional and private. A summary of the results from these Tables is given in Table 10-8. Figure 10-3 shows the results for the largest Ka-band CPS market (i.e., .999 availability, shared (unshared earth stations). For all configurations, about 50 percent of the traffic will be for business with the other three users sharing the other 50 percent; percentages across users is fairly similar for 1990 and 2000.

10.3.3   Ka-band CPS Regional Forecasts

In Appendix I, Tables I-46 through I-81 are a series of thiry-six reports showing the net addressable traffic for the various Ka band CPS configurations by region. The Market Distributions Model (MDM) has assigned market demand values to each of the 361 SMSA's (313 real and 48 artificial) for each of the service categories based on the usage profiles of each category. The MDM has calculated market values for each of the routes connecting the 361 SMSA's using formulas internal to the model. By combining the route market values and the geographical areas, potential region/demand relationships can be interpreted for 1990 and 2000.

Nine geographical areas were selected in conformance with Department of Commerce standards and as set forth in Rand McNally statistical work. The selected regions are shown below and in Figure 10-4 and are:

TABLE 10-8. SUMMARY OF KA-BAND CPS SATELLITE FORECASTS: USERS BY YEAR BY EARTH STATION CONFIGURATION BY AVAILABILITY

	1990		2000	
	T*	%	T	%
SHARED/UNSHARED				
.999				
Business	110.8	49.3	301.3	49.5
Institution	34.6	15.4	94.4	15.5
Government	74.0	32.9	200.5	33.0
Private	5.4	2.4	12.0	2.0
.995				
Business	99.8	49.3	271.5	49.6
Insitution	31.2	15.4	85.1	15.5
Government	66.6	32.9	180.6	33.0
Private	4.8	2.4	10.8	2.0
UNSHARED				
.999				
Business	103.8	48.7	266.1	48.3
Insitution	33.3	15.6	88.0	16.0
Government	70.7	33.2	184.7	33.5
Private	5.4	2.5	12.0	2.2
.995				
Business	93.4	48.7	239.6	48.3
Institution	30.0	15.6	79.2	16.0
Government	63.7	33.2	166.2	33.5
Private	4.8	2.5	10.8	2.2

*Transponders

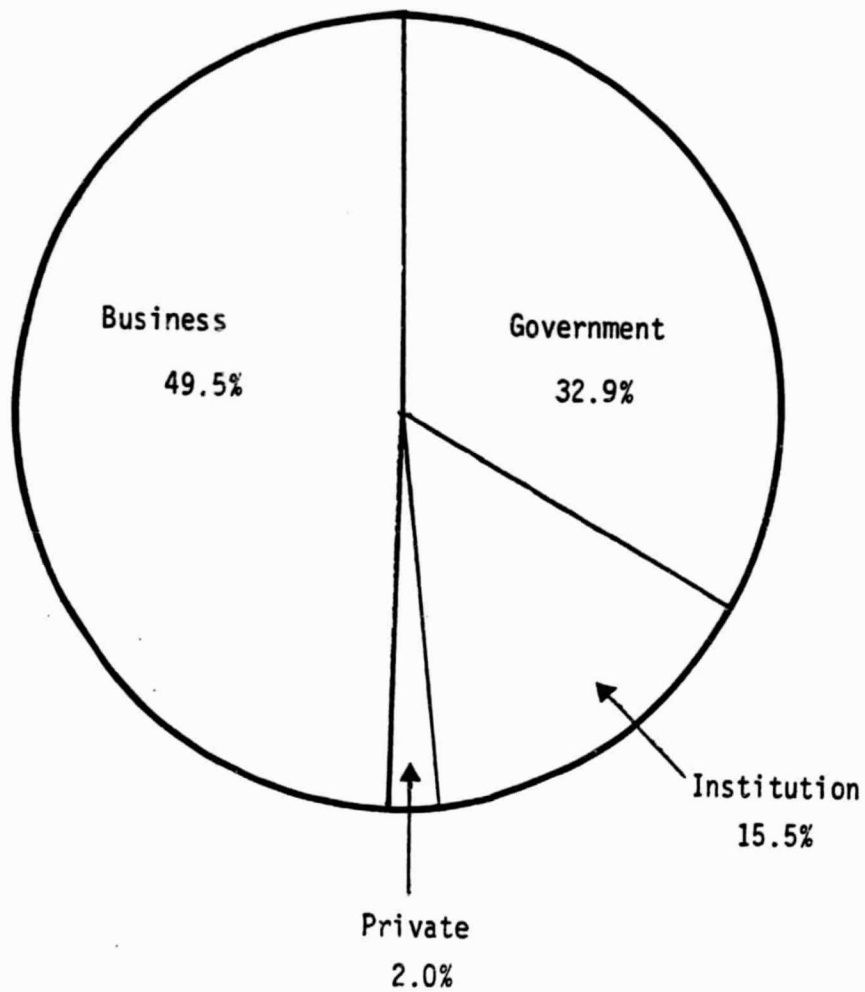FIGURE 10-3. PERCENT OF KA-BAND CPS TRAFFIC BY USER CLASS
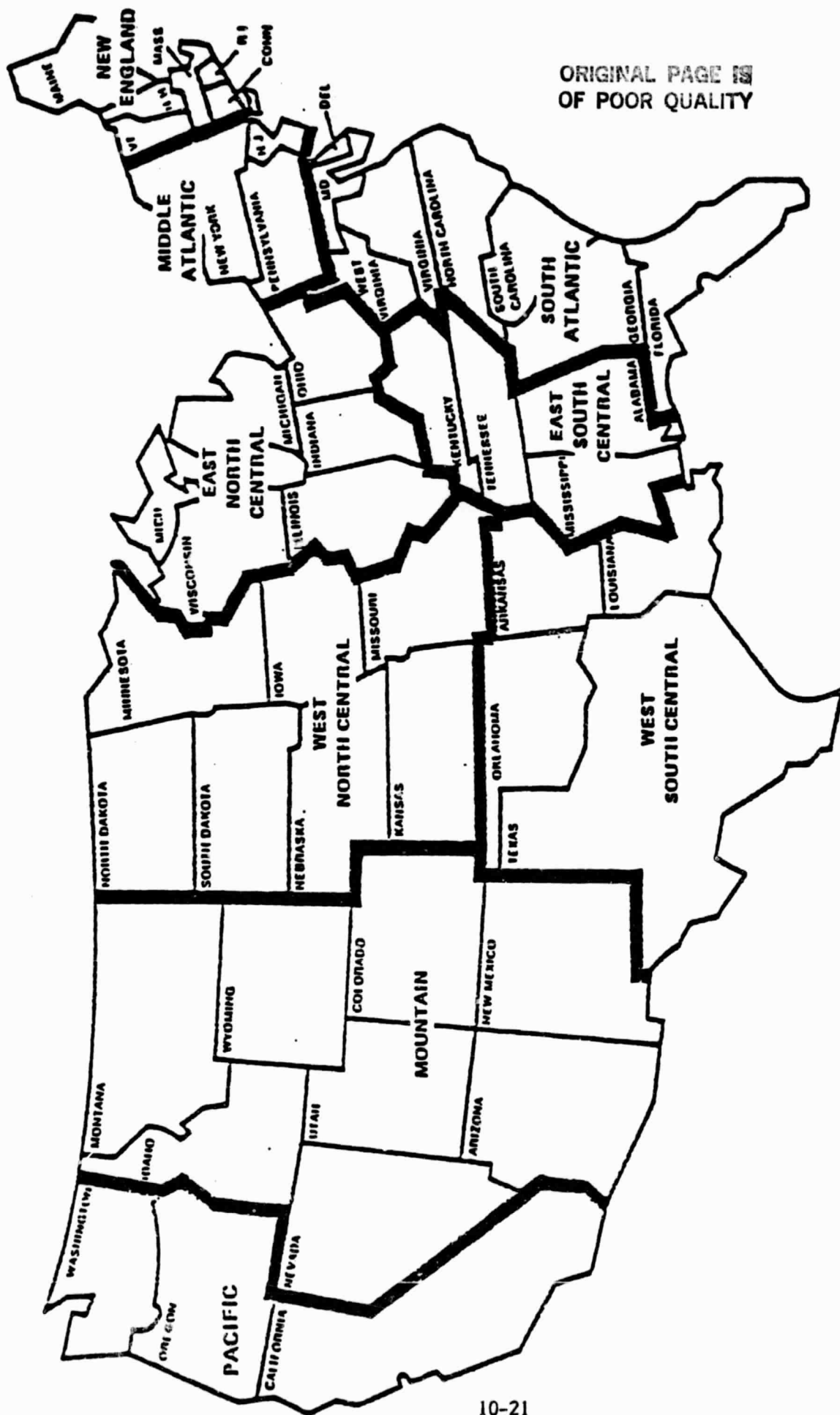
FIGURE 10-4. GEOGRAPHIC TRAFFIC REGIONS

a. New England

b. Middle Atlantic

c. South Atlantic

d. East North Central

e. West North Central

f. East South Central

g. West South Central

h. Mountain

i. Pacific

The 361 SMSA's were assigned to the appropriate regions. (SMSA's which crossed regional boundaries were assigned to the region where the greatest portion of its population resided.) The traffic market values for each route were distributed among the 361 SMSA's by the MDM. Appropriate weight was given to each region on the basis of traffic originating and terminating at each SMSA. This meant that the market demand for traffic which crossed regional boundaries was split between the applicable regions and that the market demand for traffic which both originated and terminated within a particular region was credited solely to that region. Summaries for the various reports are given in Table 10-9. Figure 10-5 graphically shows the results for the largest addressable Ka-band CPS market. For all systems Regions 2, 3 and 5 account for over 50 percent of the traffic. The percentages are very similar for 1990 and 2000.

10.3.4   Ka-band CPS User By Region Forecasts

In Appendix I, Tables I-82 through I-85 are a set of four reports showing the net addressable traffic for the various Ka band CPS configurations by region and user type. The information for these reports was derived from the Ka band CPS satellite traffic regional and user reports explained above. Figure 10-6 shows the distribution of user traffic across the United States. In all regions the percent of private traffic was less than one percent, therefore it was not plotted.

TABLE 10-9. SUMMARY OF KA-BAND CPS SATELLITE FORECASTS: REGION BY YEAR BY EARTH STATION CONFIGURATION BY AVAILABILITY

|		1990		2000	
		T*	%	T	%
SHARED/UNSHARED					
.999					
Region	1	21.6	9.6	58.1	9.6
	2	47.1	21.0	127.2	20.9
	3	46.7	20.8	126.2	20.7
	4	15.5	6.9	42.0	6.9
	5	35.8	15.9	96.9	15.9
	6	13.5	6.0	36.5	6.0
	7	19.4	8.6	52.6	8.6
	8	8.2	3.7	22.4	3.7
	9	17.0	7.6	46.2	7.6
.995					
Region	1	19.4	9.6	52.4	9.6
	2	42.4	21.0	114.6	20.9
	3	42.0	20.8	113.7	20.7
	4	14.0	6.9	37.8	6.9
	5	32.2	15.9	87.3	15.9
	6	12.2	6.0	32.9	6.0
	7	17.4	8.6	47.4	8.6
	8	7.4	3.7	20.2	3.7
	9	15.3	7.6	41.6	7.6
UNSHARED					
.999					
Region	1	20.5	9.6	52.8	9.6
	2	44.7	21.0	115.2	20.9
	3	44.3	20.8	114.3	20.8
	4	14.7	6.9	38.1	6.9
	5	33.9	15.9	87.7	15.9
	6	12.8	6.0	33.2	6.0
	7	18.4	8.6	47.6	8.6
	8	7.8	3.7	20.3	3.7
	9	16.1	7.5	41.6	7.6
.995					
Region	1	18.5	9.6	47.5	9.6
	2	40.3	21.0	103.7	20.9
	3	39.8	20.8	102.9	20.8
	4	13.3	6.9	34.3	6.9
	5	30.5	15.9	79.0	15.9
	6	11.6	6.0	29.9	6.0
	7	16.5	8.6	42.9	8.6
	8	7.0	3.7	18.2	3.7
	9	14.5	7.5	37.5	7.6

*Transponders
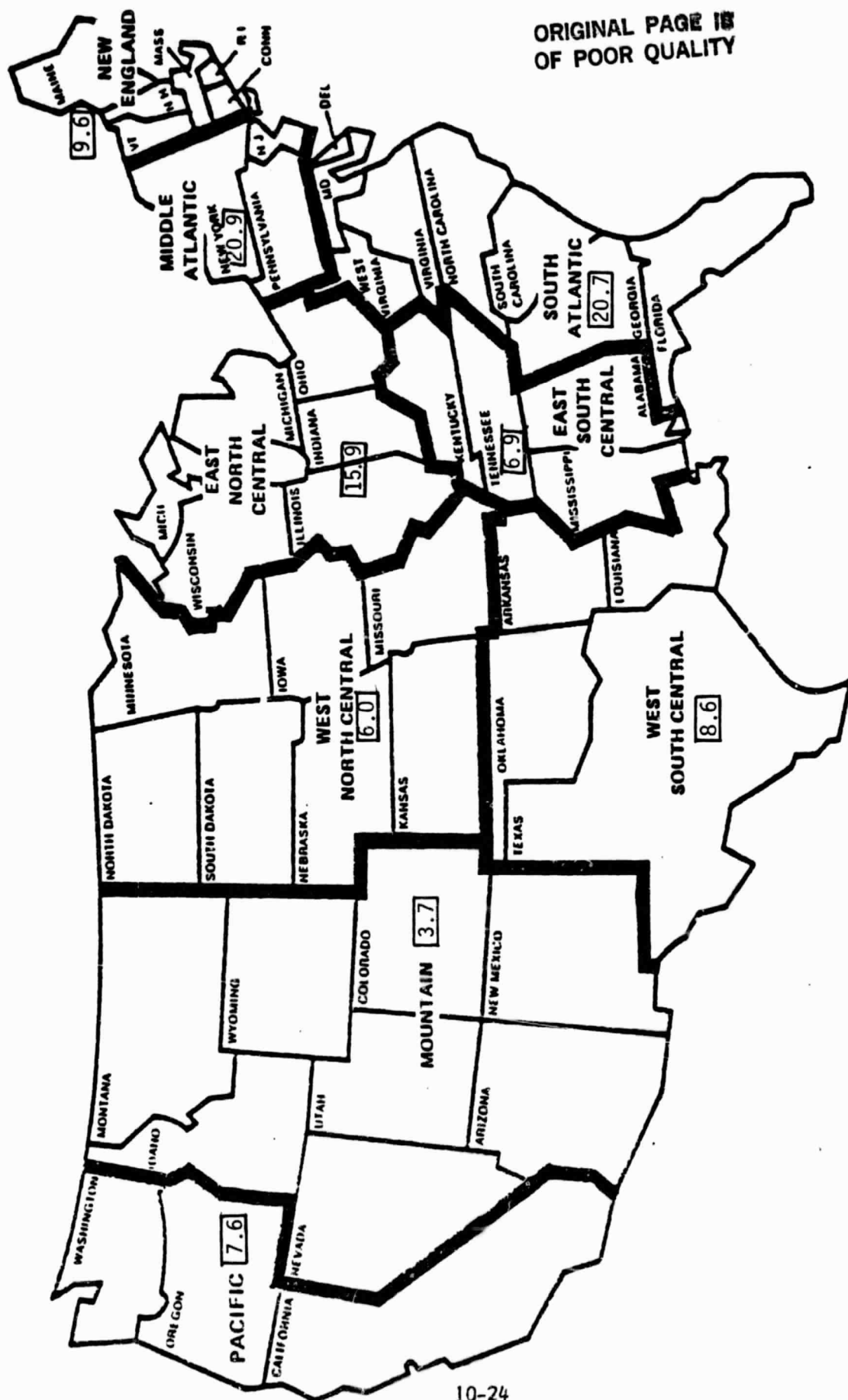
FIGURE 10-5. PERCENT OF TRAFFIC BY REGIONS FOR KA-BAND CPS SHARED/UNSHARED AND .999 AVAILABILITY
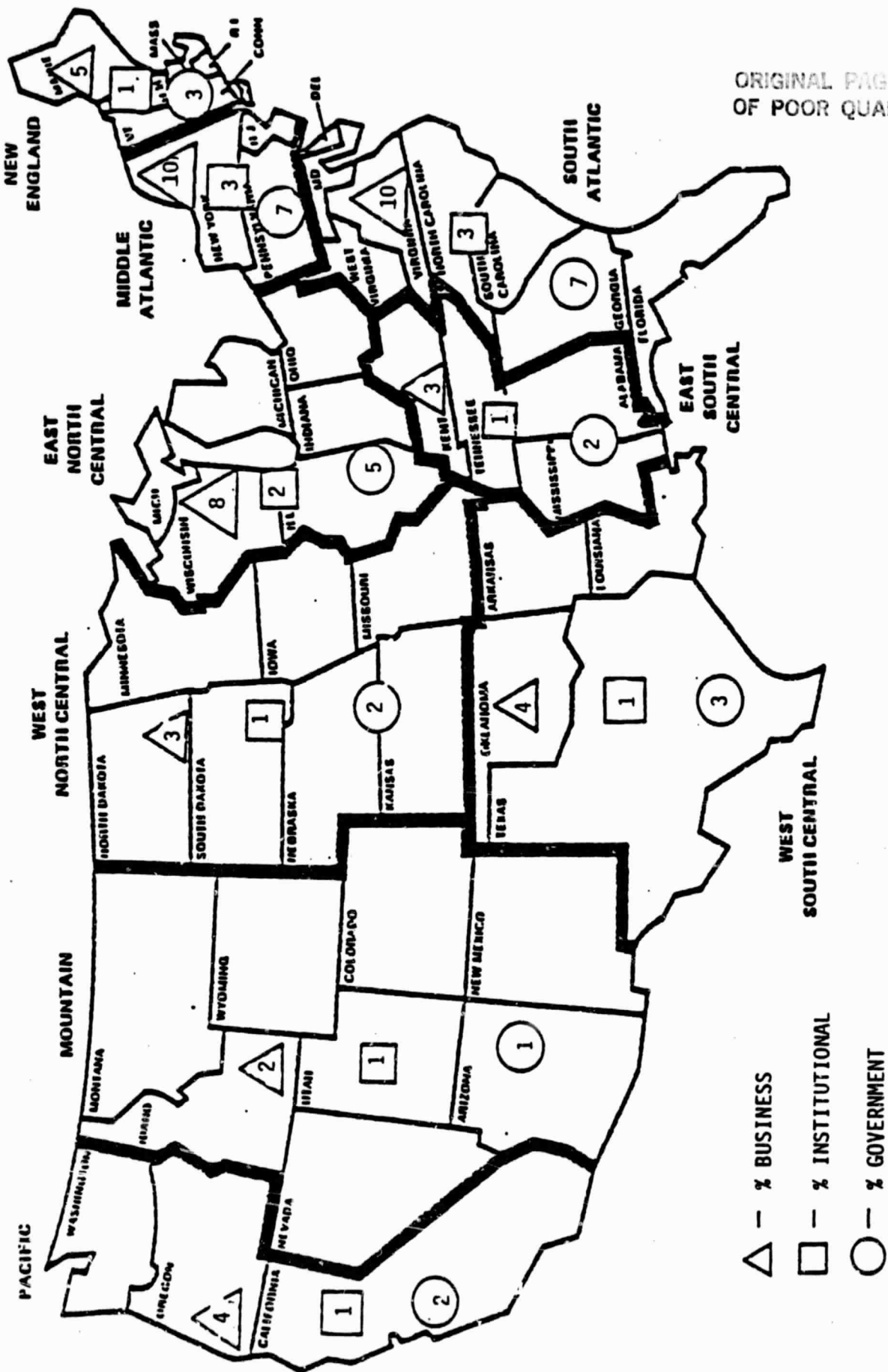
FIGURE 10-6. PERCENT OF TRAFFIC FOR USER CLASSES BY REGION FOR KA-BAND CPS
SHARED/UNSHARED AND .999 AVAILABILITY

△ — % BUSINESS

☐ — % INSTITUTIONAL

◯ — % GOVERNMENT

10.3.5   Ka-band CPS User By Mileage Reports

In Appendix I, Tables I-86 through I-89, are a set of four reports showing the net addressable traffic, for the various Ka-band CPS configurations, by mileage and user type. Table 10-10 presents a summary of the Ka-band CPS User by Mileage forecasts for the shared/unshared and .999 availability configurations. About half of the Ka-band CPS traffic, in both 1990 and 2000, will be business and Government traffic between 151 and 1000 miles.

TABLE 10-10. SUMMARY OF KA-BAND CPS SATELLITE TRAFFIC:
MILEAGE BAND BY USER CLASS FOR SHARED/UNSHARED EARTH STATIONS
AND .999 AVAILABILITY

			1990					2000		
Miles	Buss	Inst	Govt	Priv	Band Tot	Buss	Inst	Govt	Priv	Band Tot
1-40										
Transponders	6.2	1.9	4.1	.3	12.5	16.8	5.3	11.1	.7	33.9
% Mil. Band	49.6	15.2	32.8	2.4	--	49.6	15.6	32.7	2.1	--
% User	5.6	5.5	5.5	5.6	--	5.6	5.6	5.5	5.8	--
% Total	2.8	.8	1.8	.1	5.6	2.6	.8	1.7	.1	5.2
41-150										
Transponders	16.2	5.1	10.8	.8	32.9	43.9	13.8	29.2	1.8	88.7
% Mil. Band	49.2	15.5	32.8	2.4	--	49.5	15.6	32.9	2.0	--
% User	14.6	14.7	14.6	14.8	--	14.6	14.6	14.6	14.9	--
% Total	7.2	2.3	4.8	.4	14.6	6.7	2.1	4.4	.3	13.5
151-500										
Transponders	34.7	10.9	23.2	1.7	70.5	94.2	29.6	62.7	3.8	190.3
% Mil. Band	49.2	15.5	32.8	2.4	--	49.5	15.6	32.9	2.0	--
% User	31.3	31.4	31.3	31.5	--	31.3	31.3	31.3	31.4	--
% Total	15.4	4.8	10.3	.7	31.3	14.3	4.5	9.5	.6	29.0
501-1000										
Transponders	30.5	9.5	20.4	1.5	61.9	82.9	26.0	55.3	3.3	167.5
% Mil. Band	49.3	15.3	33.0	2.4	--	49.5	15.5	33.0	2.0	--
% User	27.5	27.4	27.4	27.8	--	27.5	27.5	27.6	27.3	--
% Total	13.5	4.2	9.5	.7	27.4	12.6	4.0	8.4	.5	25.5
1001-2100										
Transponders	19.1	6.0	12.8	.9	38.8	52.1	16.3	34.7	2.1	105.2
% Mil. Band	49.2	15.5	33.0	2.3	--	49.5	15.5	33.0	2.0	--
% User	17.2	17.3	17.3	16.7	--	17.3	17.2	17.3	17.3	--
% Total	8.5	2.7	5.7	.4	17.2	7.9	2.5	5.2	.3	16.0
2101+										
Transponders	4.2	1.3	2.8	.2	8.5	11.3	3.5	7.5	.4	22.7
% Mil. Band	49.4	15.3	33.0	2.4	--	49.8	15.4	33.0	1.8	--
% User	3.8	3.7	3.8	3.7	--	3.8	3.7	3.7	3.3	--
% Total	1.9	.6	1.2	.1	3.8	1.7	.5	1.1	.1	3.5

SECTION 11
NATIONWIDE TRAFFIC DISTRIBUTION MODEL

11.1   INTRODUCTION

The objective of this section was to postulate a nationwide CPS network which considered several sizes of earth stations arranged in different configurations (shared and unshared) and having different availabilities (.995 and .999). The output of this task was the net accessible Ka-band forecast and detailed reports showing the size and location of every earth station predicted by the nationwide model.

11.2   METHODOLOGY

The starting point for determining the net accessible forecast was the Ka-band net addressable forecasts. The net addressable forecasts were for the two types of earth station configurations and the two availabilities noted above. These forecasts were segmented into various clusters depending on where the traffic originated and terminated. Models were developed which would simulate the typical SMSA and hinterlands and user profiles were developed which allowed the traffic to be segmented among the various users. The amount of traffic captured by a specific user determined whether the user would be a candidate for a CPS earth station; this captured or accessible traffic was the output for this task. Figure 11-1 presents the activity flow for these various steps. A more detailed description of these steps is presented in Appendix J.

11.2.1   Net Addressable Forecast

The input to the nationwide network model was the Ka-band net addressable forecast (see Section 10). The following configurations and availabilities were used.

Net
Accessable
Forecast

Appendix D

User
Survey

User
Model

Appendix K

IntraUrban
Topology

SMSA
Traffic
Model

Hinterland
Traffic
Model

Central City

Other SMSA

Concentrated
Hinterland

Dispersed
Hinterland

Appendix C

Various
Files
In
MDM

Segment
Traffic
Into
Classes

Appendix I

Ka Net
Addressable
Forecast

11-2
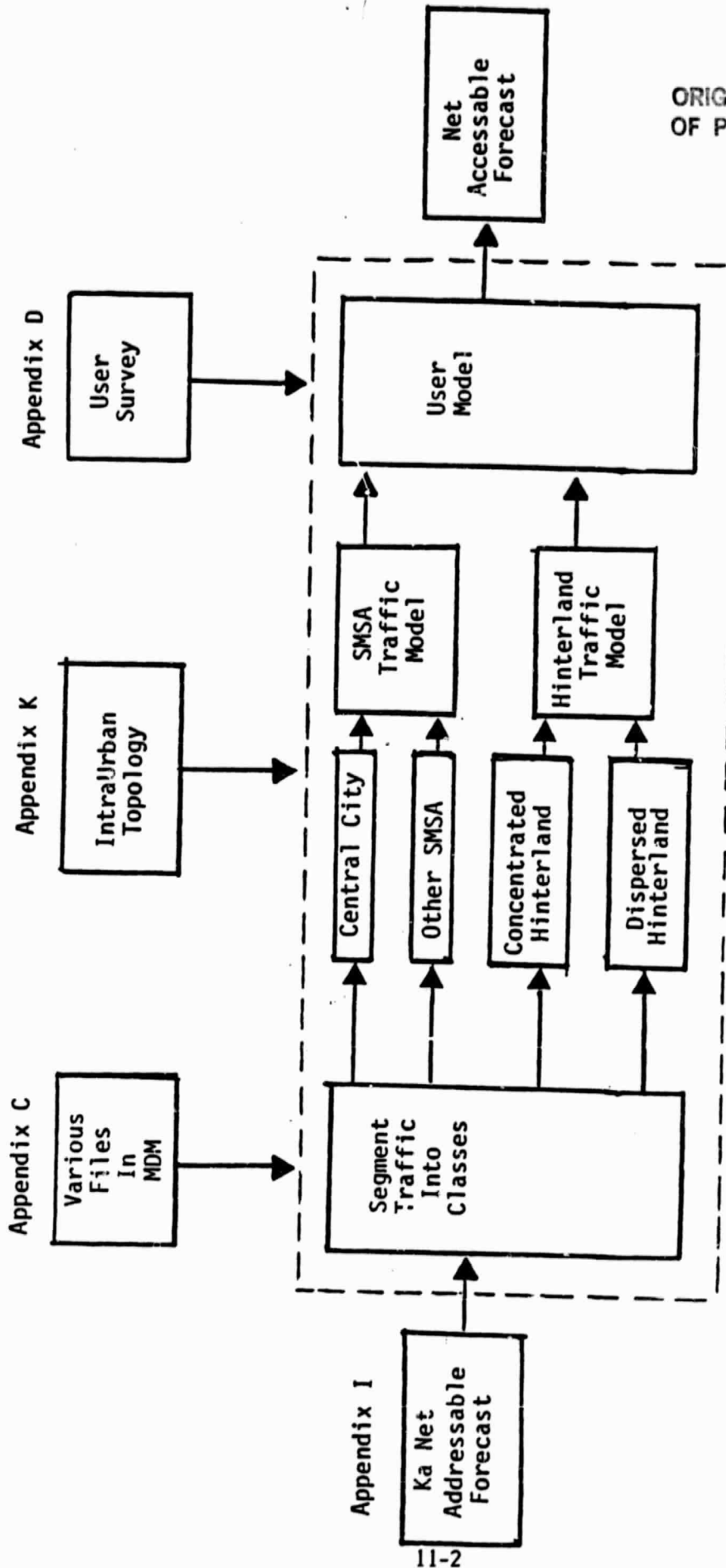
FIGURE 11-1. ACTIVITY FLOW FOR NATIONWIDE TRAFFIC DISTRIBUTION MODEL

Availability	Earth Station Configuration
.999	Unshared
.999	Shared/Unshared
.995	Unshared
.995	Shared/Unshared

These forecasts were distributed to all real and artificial SMSAs. This allowed the use of the nationwide CPS traffic model to analyze traffic on a specific SMSA or state hinterland basis.

11.2.2   Segment Traffic Into Classes

In order to develop the nationwide network it was necessary to segment the traffic into various classes depending on where it originated or terminated. All traffic originates or terminates in one of the areas listed below. Figure 11-2 depicts these four classes.

CLASSES OF TRAFFIC
Central city
Other SMSA
Concentrated Pockets in Hinterland
Dispersed Throughout Hinterland

11.2.2.1   Central City

The central city refers to a concept developed by the U.S. Department of Commerce. The central city is that area commonly referred to as the "downtown area." The Census Bureau, in defining the central city (or central business district) describes it as "an area of very high land valuation, characterized by a high concentration of retail businesses, offices, theatres, hotels, and "service" businesses, and an area of high automobile traffic." Information about the central city is compiled based on census tracts. Much of this information was analyzed using the MDM and other computer models. In addition, in order to estimate the percent of SMSA traffic which is generated or terminated within the central city, three site visits were made (see Section 12). From this analysis
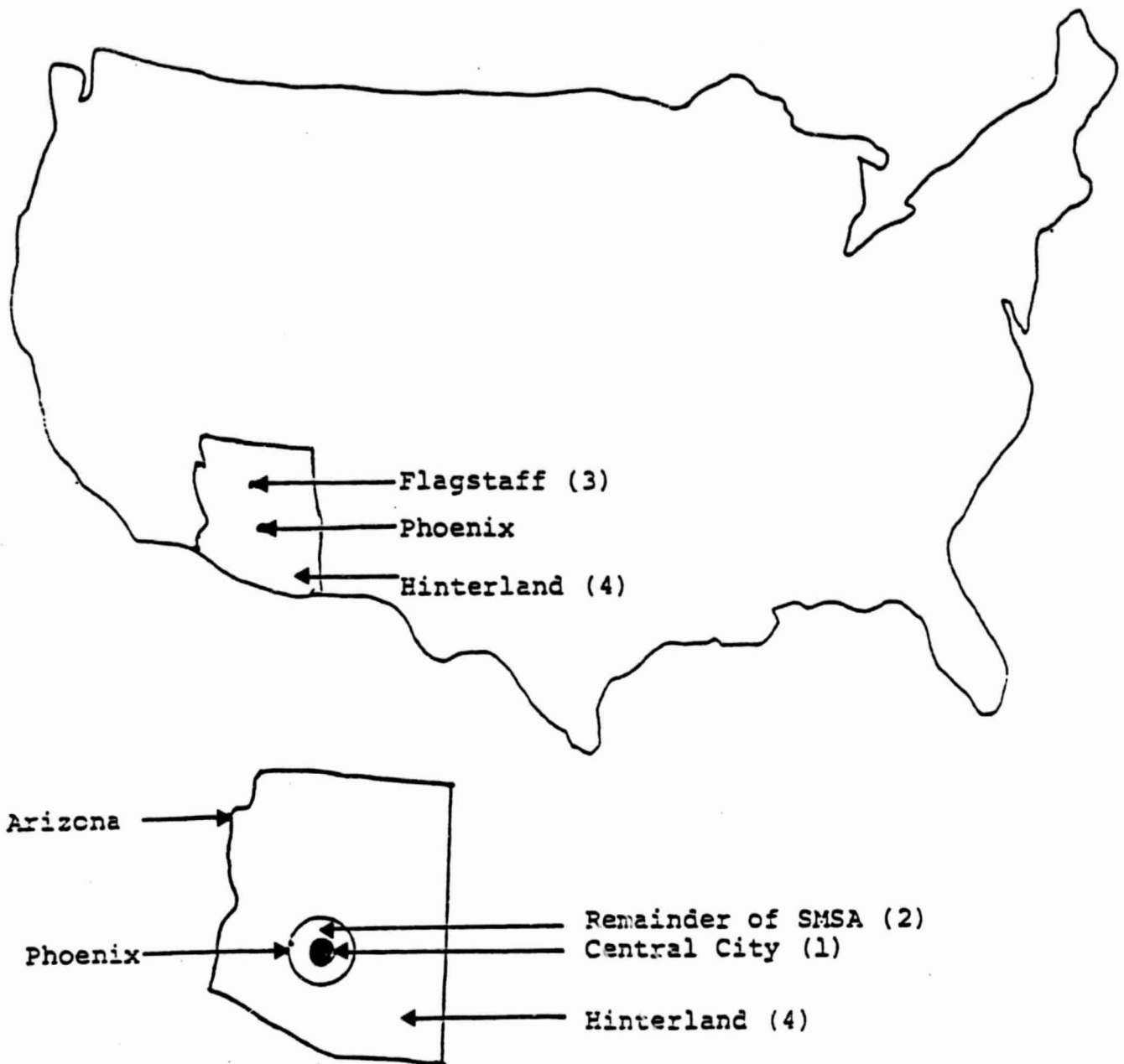
FIGURE 11-2. TRAFFIC CLASSES

C-4

it was concluded that 60 percent of the traffic going to or from an SMSA was central city traffic.

11.2.2.2   Other SMSA

The area of the SMSA located outside the central city was defined as "other SMSA" to distinguish it. The percent of SMSA traffic generated or terminated by this area is 40 percent.

11.2.2.3   Concentrated Hinterland

The hinterland refers to all areas which fall outside the 313 designated SMSAs. Using information from Rand McNally and the Census Bureau, the number of locations over 25,000 in population and outside the designated SMSAs were determined for each state. Population statistics revealed that 70 pecent of the rural population lived in such places. This was defined as the concentrated hinterland.

11.2.2.4   Dispersed Hinterland

Hinterland not located in cities over 25,000 was defined as dispersed hinterland. This includes a large portion of the west which is sparsely populated. Thirty percent of the population was found to live in such areas.

11.3   MODELS

11.3.1   Traffic Models

In order to provide the detailed information required for a nationwide CPS network, it was necessary to develop SMSA and hinterland models. Traffic forecast had to be distributed to areas within a 4 mile radius.

11.3.1.1   SMSA Traffic Models

A model which would approximate the typical SMSA was developed. This model allowed all SMSAs to be broken down into areas within a 4 mile radius, defined as

a node. The center node was a circle with a 4 mile radius in the center of the SMSA. It was also assumed that the central city would be located in a circular area surrounding the center of the SMSA. The next group of nodes surrounded the initial node so that each node in that "ring" was exactly the same distance from the center and included the same area. The second ring contained eight nodes. Figure 11-3 shows the model applied to Phoenix. As seen by the first through fourth rings, the outside radius of each successive ring becomes smaller as one moves away from the center of the SMSA. (The fifth and sixth ring are not drawn to scale, to show the central city boundary.)

Since each node in a node ring was exactly alike, it was necessary to calculate the traffic for only one node in each ring. To make these calculations two assumptions were made about the dispersion of traffic. First, traffic was evenly dispersed across the central city. This assumption was based on the definition of central city, a built-up business area. The second assumption made was that traffic outside the central city declined as one moved out from the central city. Thus a node located directly outside the central city had more traffic than a node located two rings away. Using these assumptions and the geometry of the SMSA model it was possible to develop the formula to calculate the traffic in a given SMSA node. This formula is discussed in Appendix J, Paragraph 5.1.

11.3.1.2   Hinterland Traffic Model

Statistics show that small cities are very concentrated with most significant business located within a small radius of downtown. This area was treated as the central city, with a radius of 4 miles. As in the SMSA model, 60 percent of the traffic generated or terminated within the city was because of businesses located within this area. Traffic located outside the central city was too dispersed to justify an earth station. Likewise the "dispersed hinterland" class of traffic was too dispersed to justify an earth station and therefore was not involved in the model.

Another important concept of this model was the distribution factor. Census information revealed that cities over 25,000 vary widely in population and the number of businesses. It followed from this that a distribution of traffic must behave in a similar fashion. In order to approximate this, the distribution factor
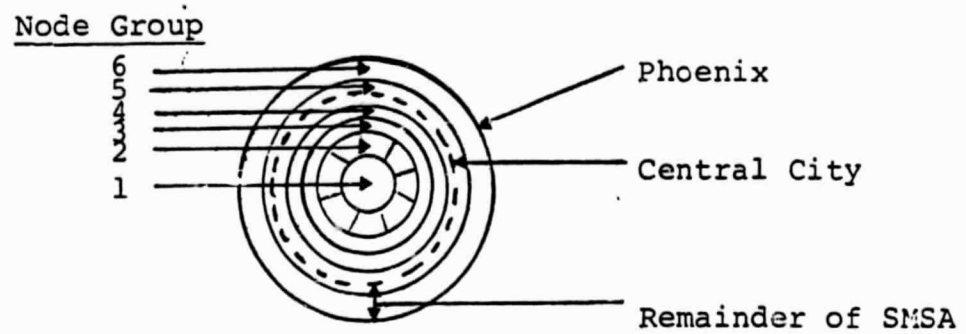
Figure 11-3. SMSA Model

was included in the model. This factor adjusted the traffic for every state, distributing the traffic over the number of locations over 25,000 in population located within that state.

Using information from census along with the assumptions and concepts stated above, the hinterland model was developed to calculate the traffic in a given hinterland city. The exact formula is given in Appendix J, Paragraph 5.2.

11.3.2   User Models

Since a CPS nationwide network by definition is user oriented, some assumptions about the amount of traffic which can be expected from specific users were necessary. Several sources of information were relied on to make these assumptions. Western Union's 135 years of providing services to specific users provided a good base of knowledge. In addition, a number of statistics were available on customer volumes of specific services. A computer analysis of the Dun and Bradstreet business file allowed a study of how organizations interact. From this file the locations of headquarters, subsidiaries and branches were located; the dollar volume of the business at each location and the number of employees could be determined. The intra-urban-topology research (see Section 12) provided a great deal of information about three specific SMSAs. Using these sources, an estimate was made of the percent of traffic which some particularly large users would have.

The nationwide CPS model required two sets of approximations since one network used only private earth stations (unshared network) while the other used a combination of private and shared stations (shared/unshared network).

Another aspect of the user model was the size of earth station which a particular customer would install. Based on experience in this area and the site visits it was concluded that the minimum amount of traffic required to install a particular earth station was 50 percent of that earth station's burst rate.

11.3.2.1 Unshared Network Customers

The unshared network customer sizes allowed them to potentially capture up to 50 percent of the traffic which fell into a particular node. The remaining 50 percent of the traffic was scattered over users too small to effectively utilize a CPS earth station. Traffic was captured, therefore, in the following manner:

  a. The largest customer within a node has traffic equal to 3/16 of that node.
  b. The next largest customers within a node have traffic equal to 1/8 of that node. There can be 2 of these.
  c. The next largest customers within a node have traffic equal to 1/16 of that node.

11.3.2.2 Shared/Unshared Network Customers

The shared/unshared network customer sizes allowed them to potentially capture up to 75 percent of the traffic which fell into a particular node. The remaining 25 percent of the traffic was scattered over users too small or too scattered to effectively utilize a CPS earth station. Thus, traffic was captured in the following fashion:

  a. The largest customer within a node has traffic equal to 1/4 of that node.
  b. The next largest customer within a node has traffic equal to 3/16 of that node.
  c. The next largest customers within a node have traffic equal to 1/8 of that node. There can be 2 of these.
  d. The next largest customer within a node has traffic equal to 1/16 of that node.
  e. Traffic will go shared if the crossover favors this method.

11.3.3 Earth Station Size

The size of the earth station which a particular user or group of users would install depends on the amount of traffic they have and whether it is an unshared

11-9

or shared earth station. The types of earth station considered in this analysis are indicated below. A full description of each of these earth stations can be found in the cost analysis sections (Section 4 and Appendix F).

Earth Station Sizes

Unshared	Shared
6.2 MBPS	32.0 MBPS
1.5 MBPS	6.2 MBPS
64 KBPS	1.5 MBPS

11.4 NATIONWIDE CPS NETWORK REPORTS

The output of the nationwide CPS network model is a series of four reports (see Appendix J, Tables J-4 through J-7); the following is a reference to these reports.

Table Numbers of CPS Reports

Availability	Configuration	Table Numbers
.999	Shared/Unshared	J-4
.995	Shared/Unshared	J-5
.999	Unshared	J-6
.995	Unshared	J-7

In Table 11-1 is the report for the top 50 SMSAs for the .999 shared/unshared system; this table is presented to indicate the output of the nationwide CPS network model. Column 1 is the order in which the SMSA or the group of cities comprising the states hinterlands ranks when the amount of traffic which could be captured by a nationwide CPS network in the year 2000 is used. Column 2 presents the SMSA or state (in addition, states include a " " to easily identify them). Column 3 is the amount of traffic expected to be captured. The next four columns show the number of each type of earth station to expect in each location. The next three columns show the amount of traffic by service type which was either transmitted or terminated within a particular area. The next column is a summary of the traffic allocated to a specific area. The captured

TABLE 11-1. TOP 50 SMSA'S (OR STATE HINTERLANDS) FOR THE .999 SHARED/UNSHARED SYSTEM

.999 SHARED/UNSHARED

	CAPTURED MBPS	LRG ES	MED ES	SML ES	MINI ES	VOICE MBPS	IATA MBPS	VIDEO MBPS	TOTAL MBPS	CAPTURED PCT	METRO SQ MI	CITY SQ MI
1 NEW YORK NY-NJ	692.60	2	139	297	4	833.03	66.25	460.18	1380.25	50.18	1304	237
2 CHICAGO IL	347.10	3	64	130	6	529.30	41.00	285.32	855.76	40.56	3500	140
3 LOS ANGELES-LONG BEA	259.25	2	50	93	4	347.53	26.97	187.30	561.80	46.15	3500	140
4 PHILADELPHIA PA-NJ	153.75	0	15	142	4	305.92	23.74	164.80	494.53	31.09	3500	140
5 DETROIT MI	144.75	0	15	130	3	279.77	21.71	150.78	452.26	32.01	3500	140
6 WASHINGTON DC-MD	130.60	0	14	126	3	262.70	20.30	141.58	424.64	32.64	2012	146
7 BOSTON MA	92.70	0	3	111	3	189.74	14.72	102.26	306.73	30.22	1233	200
8 BALTIMORE MD	87.15	0	6	91	2	176.00	13.72	95.29	285.01	30.49	2259	130
9 HOUSTON TX	86.55	0	7	86	3	179.74	13.95	96.87	290.57	29.79	3500	140
10 ATLANTA GA	85.65	0	6	89	2	160.47	12.45	86.48	259.40	33.02	3500	140
11 MINNEAPOLIS-ST PAUL	82.95	0	8	77	3	169.95	13.19	91.60	274.74	30.19	3500	140
12 DALLAS-FORT WORTH TX	82.05	0	7	80	3	155.07	12.09	84.61	251.77	32.56	3500	140
13 NASSAU-SUFFOLK NY	79.95	0	3	94	2	160.55	13.00	90.84	272.47	29.34	1218	202
14 ST LOUIS MO-IL	79.95	0	9	73	2	150.13	12.27	85.22	255.62	31.28	3500	140
15 CLEVELAND OH	76.35	0	3	64	2	169.40	13.15	91.34	273.98	27.07	1519	117
16 MILWAUKEE WI	70.20	0	1	81	2	134.79	10.46	72.65	217.90	32.27	1455	161
17 NEWARK NJ	69.15	0	1	80	2	130.13	10.10	70.14	210.37	32.87	1000	217
18 PITTSBURGH PA	67.65	0	6	65	2	178.28	13.03	96.08	288.19	23.47	3049	146
19 SAN FRANCISCO-OAKLAN	67.50	0	5	69	3	128.32	9.96	69.16	207.43	32.54	2400	143
20 DENVER-BOULDER CO	58.50	0	5	57	2	106.69	8.28	57.50	172.47	33.92	3500	140
21 CINCINNATI OH-KY	55.50	0	5	53	2	133.32	10.34	71.85	215.52	25.75	2147	136
22 JERSEY CITY NJ	53.25	0	15	8	0	56.78	4.41	30.60	91.79	58.01	47	21
23 MIAMI FL	50.25	0	5	46	1	92.09	7.15	47.63	146.86	33.76	2042	133
24 KANSAS CITY MO-KS	47.55	0	2	55	2	105.69	8.20	56.96	170.85	27.03	3341	143
25 * NEW YORK	42.75	0	0	57	0	173.14	13.43	93.31	279.88	15.27	6	
26 COLUMBUS OH	42.30	0	2	48	2	110.20	8.55	59.40	178.15	23.74	2457	142
27 NEW HAVEN-WEST HAVEN	42.15	0	1	52	1	74.50	5.77	40.19	120.56	34.96	337	135
28 INDIANAPOLIS IN	38.70	0	3	39	2	117.13	9.09	63.13	189.34	20.44	3072	145
29 MERIDEN CT	35.40	0	4	22	0	41.26	3.20	22.24	66.71	53.07	24	24
30 BUFFALO NY	33.60	0	4	28	2	99.84	7.75	53.81	161.39	20.82	1590	114
31 DAYTON OH	29.55	0	2	31	2	84.99	6.59	45.80	137.39	21.51	1707	121
32 NEW ORLEANS LA	29.55	0	2	31	1	85.92	6.67	46.31	138.90	21.27	1966	130
33 LOUISVILLE KY-IN	29.25	0	0	39	2	95.25	7.39	51.33	153.97	19.00	1392	174
34 BRIDGEPORT CT	29.25	0	0	39	1	62.00	4.87	34.65	101.52	20.01	193	120
35 AKRON OH	28.50	0	2	38	2	72.85	5.65	39.26	117.77	24.20	903	216
36 TAMPA-ST PETERSBURG	28.05	0	0	29	2	74.27	5.76	40.03	120.06	23.36	2045	133
37 BRISTOL CT	27.90	0	6	12	0	41.16	3.19	22.18	66.53	41.93	79	34
38 SAN DIEGO CA	27.30	0	2	28	1	78.91	6.12	42.53	127.56	21.40	3500	140
39 OKLAHOMA CITY OK	27.30	0	2	28	0	76.56	5.94	41.26	123.76	22.06	3471	140
40 MEMPHIS TN-AR	25.80	0	2	26	2	81.61	6.33	43.99	131.93	19.56	2278	139
41 PHOENIX AZ	25.80	0	2	26	1	72.68	5.64	39.17	117.50	21.96	3500	140
42 HARTFORD CT	25.50	0	0	34	2	87.23	6.77	47.01	141.01	18.00	1032	216
43 PROVIDENCE-WARWICK-P	25.50	0	0	34	2	77.78	6.04	41.92	125.74	20.28	747	204
44 SEATTLE-EVERETT WA	25.05	0	0	35	1	66.79	5.18	36.00	107.96	23.20	3500	140
45 BIRMINGHAM AL	24.90	0	1	29	2	76.62	5.95	41.29	123.86	20.10	3358	142
46 SPRINGFIELD-CHICOPEE	24.75	0	0	33	2	66.66	5.17	35.93	107.75	22.97	633	191
47 ROCHESTER NY	24.15	0	1	28	1	86.69	6.73	46.72	140.13	17.23	2966	146
48 TULSA OK	24.15	0	0	28	2	66.48	5.16	35.83	107.47	22.47	3500	140
49 TOLEDO OH-MI	23.25	0	0	31	2	76.64	5.95	41.30	123.06	18.77	2107	137
50 NEW BRUNSWICK-PERTH	23.25	0	0	31	1	61.31	4.76	33.05	99.12	23.46	312	110

column is the ratio of the traffic captured to the total amount of traffic allocated. The number of square miles in the metropolitan area is given in the next column. The last column gives the number of square miles in the central city.

A critical point to be made from this analysis is that users and therefore traffic is dispersed differently throughout the United States. Central cities are highly concentrated while the area outside but still within the SMSA has diminishing traffic as you move away from the central city. Hinterland traffic is both concentrated in small cities and dispersed in villages and towns across rural America. These locations vary greatly across the US and it is necessary to gather facts about each SMSA (artificial or real) in order to make a good approximation of the user and traffic concentrations.

Figures 11-4 and 11-5 show a summary of the various scenarios suggested by the four nationwide CPS network reports. Figures 11-4 focuses on traffic and the amount actually captured. Figures 11-5 gives the number and type of earth stations required for the various scenarios. Figure 11-5 shows that very few large earth stations will be required in either unshared system. Therefore, in future analyses the use of large earth stations might be dropped. A large number of small earth stations are indicated by all scenarios suggesting that the small earth station could become the standard transmission burst rate. Medium earth stations (4 times a small station) are also likely to be used, especially in the shared/unshared system. Mini earth stations which operate at one voice channel likely are to be implemented only in those companies that have an isolated site or two that needs to be connected into a larger network. The location for these earth stations are likely to be on the fringe of an SMSA or in the hinterland.

Interviews done for the use survey as well as visits to three of the SMSAs suggested that the shared/unshared network was the most feasible. The majority of companies interviewed saw cost as the major factor in deciding to use a shared earth station. They foresaw security or other problems with sharing, but felt these problems could be handled effectively and efficiently.

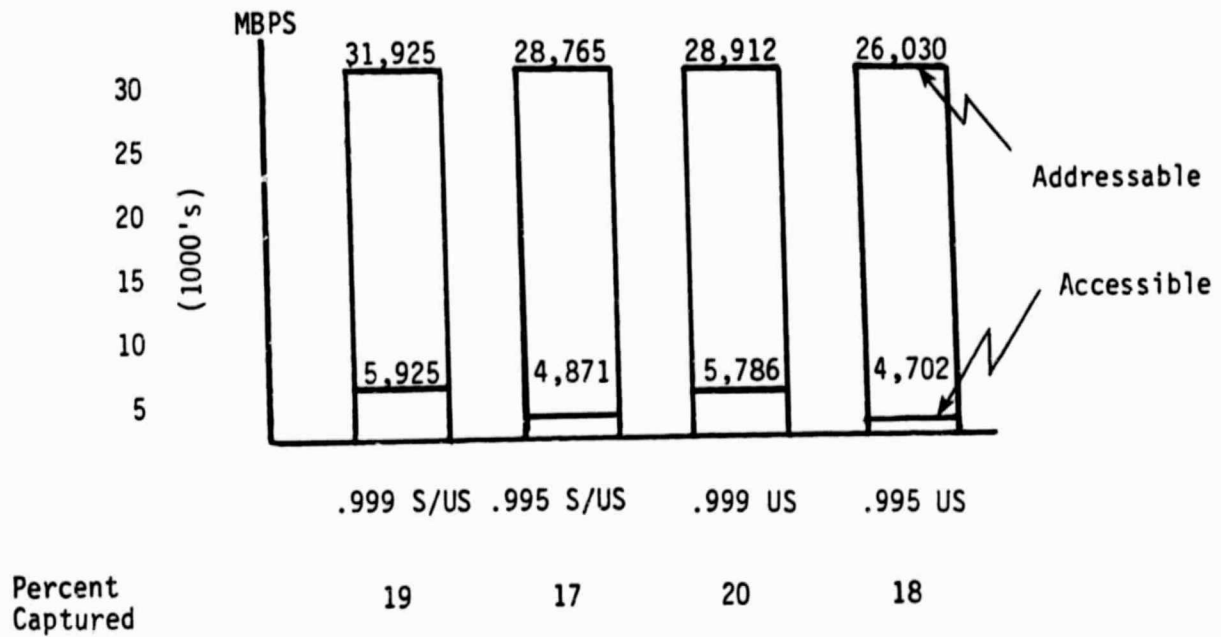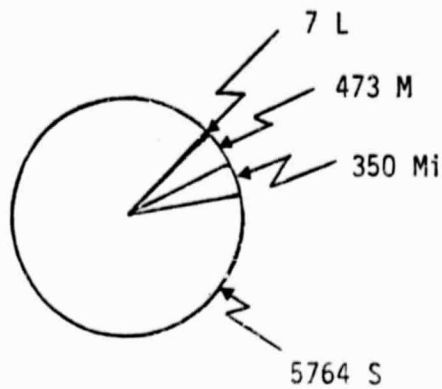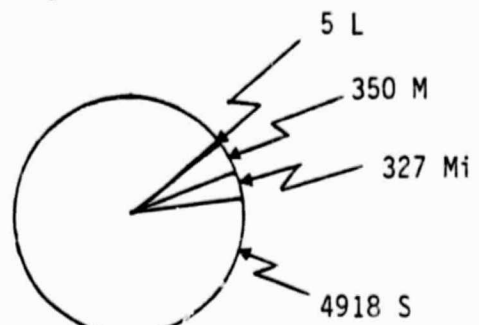|	.999 S/US	.995 S/US	.999 US	.995 US
Addressable	31,925	28,765	28,912	26,030
Accessible	5,925	4,871	5,786	4,702
Percent Captured	19	17	20	18

FIGURE 11-4. ADDRESSABLE AND ACCESSIBLE (CAPTURED TRAFFIC)

.999 S/US

.995 S/US
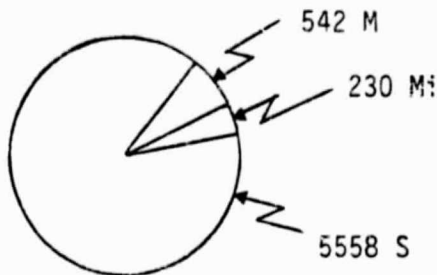
.999 US
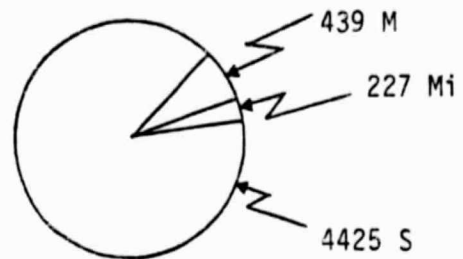
.995 US

Symbol	Type	Burst Rate
L	Large	32.0 MBPS
M	Medium	6.0 MBPS
S	Small	1.5 MBPS
Mi	Mini	64.0 KBPS

FIGURE 11-5. EARTH STATIONS DISTRIBUTION

SECTION 12
INTRA-URBAN TOPOLOGY

12.1   INTRODUCTION

The purpose of this section was to describe three traffic nodes based on secondary and primary research (i.e., site visit) information so that the results of the nationwide traffic distribution model described in Section 11 could be evaluated and fine-tuned. By using sub-nodal information to locate earth stations within an SMSA, the number, size and location of earth stations for the entire SMSA were compared with that postulated by the nationwide traffic distribution model and appropriate modifications were made in the model.

The following steps were conducted to accomplish this purpose (see Figure 12.1):

    a.   The selection of three traffic nodes

    b.   Secondary research to describe each node

    c.   Site visits to each node to verify and add to secondary research information

    d.   Description of each node based on secondary and primary research findings.

12.2   PROCEDURES

12.2.1   Selection of Sites

In selecting the three sites the intent was to select sites whose analyses would lead to the greatest amount of information on intra-urban topology. The criteria included such variables as: geography (i.e., North, South, East or West), size (number of square miles), number and variety of users (i.e., businesses, institutions, Government agencies) and growth trends (e.g., in population or new industries). While diversity was a top priority, only those SMSAs which were large enough to have a variety of users and to be potential CPS users were considered. The three selected sites were Boston, Denver and Seattle.
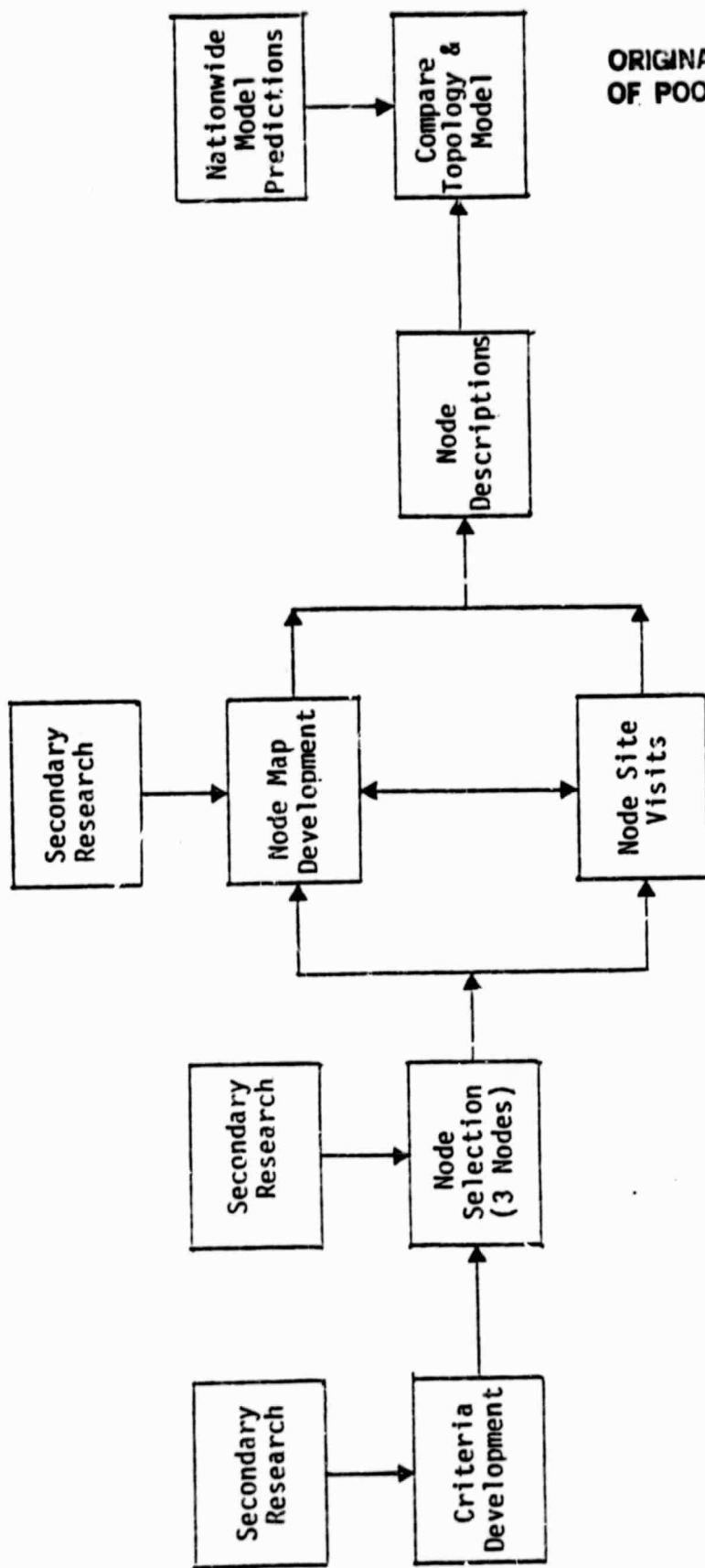
FIGURE 12-1. ACTIVITY FLOW FOR INTRA-URBAN TOPOLOGY

12.2.2   Secondary Research

Secondary research involved identifying, collecting, reviewing and summarizing a variety of sources of information on each of the three sites. Information was obtained from: the Dun and Bradstreet files on business (e.g., number of businesses and number of employees by zip code), local Governmental agencies (e.g., Industrial Park Guides and Directories of Manufacturers); Federal Government Reports (e.g., Distribution of Personnel by SMSA); and several key sources (e.g., Rand McNally) used to determine location and size of universities. After reviewing this information, it was organized and represented on a map of the particular SMSA and this map was used to guide the site visits (see Figures 12-1, 2 and 3).

12.2.3   Site Visits

A site visit was conducted for each of the three selected SMSA's to collect information from specific users of the various telecommunication services. Onsite interviews were conducted with the communications managers of a variety of businesses, institutions and Governmental agencies. Three to four days were spent interviewing 12 to 15 people at each site. In each case, current users of CPS type services were interviewed. Information obtained during these interviews focused on current and future traffic projections, plans concerning CPS type services, and reasons for expectations about future use of CPS type services. The intent was to obtain information from current or potential CPS users so that their plans could be used to determine where earth stations should be placed in the particular SMSA.

12.2.4   Description of Nodes

The secondary research and site-visit information were integrated for each of the three SMSAs and then used to determine the size and placement of earth stations by zip code (sub-node) area for each SMSA. The market distribution model was used to determine the expected amount of CPS traffic in the year 2000 for each of the three sites. These traffic amounts and the secondary and site-visit research findings were used to project how many of each size of earth station will be operating in each zip code area of each site in the year 2000.

12-3

On the maps for the three sites (i.e., Figures 12-1, 2 and 3), three symbols were used to indicate the proportion of the earth stations, that should be allotted, as projected by the nationwide model, to each zip code area. The three symbols indicated: number of businesses, number of businesses with more than ten thousand employees, and the number of major institutions and government agencies. For number of businesses, one circle indicated between 100 and 200 businesses; two indicated greater than 200 businesses. For number of businesses with more than ten thousand employees, one circle was given if three to four businesses had more than this number of employees; two circles were given if five or more did. For number of major institutions, one circle was given if at least one major institution or government agency existed in the zip code area. The number of circles was then used to determine how many of each type of earth stations should be allotted to each zip code area.

12.3   DISCUSSION

The information on each node and sub-node is summarized in Tables 12-1 through 12-6 and Figures 12-2 through 12-4. The first table for each site (i.e., Tables 12-1, 3 and 5) indicates the number of each type of earth station projected for the site. This table is followed by the map for the site (i.e., Figures 12-2, 3 and 4). The second table for each site (i.e., Tables 12-2, 4 and 6) indicates the number of each type of earth station for each sub-node (i.e., zip code). Also indicated as Table 12-7 is the number of earth stations projected by the model for New York; this table was presented so the three sites could be compared with New York.

For Boston, the Nationwide Model projected all earth stations within a 12 mile radius as did the intra-urban topology. For Denver, the Nationwide Model projected all earth stations within a 12 mile radius as did the intra-urban topology. For Seattle, the Nationwide Model projected all earth stations within a 12 mile radius, while intra-urban topology projects 82 percent of the earth stations within a 12 mile radius. The nationwide model projected that New York would have earth stations in its third ring. This information on nodes and sub-nodes was used, as noted above, to fine-tune the nationwide traffic distribution model discussed in Section 11.

12-4

TABLE 12-1. EARTH STATION PROJECTIONS FOR BOSTON

BOSTON MA   TOTAL TRAFFIC: 306.94

                             CAPTURED TRAFFIC: 92.70

	LRG		MED		SML		MINI	
RING	NODE	TOT	NODE	TOT	NODE	TOT	NODE	TOT
1	0	0	3	3	23	23	0	0
2	0	0	0	0	11	88	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
	0		3		111		3	

* RADII IN MILES, DOTTED LINE REPRESENTS CENTRAL CITY

12-5
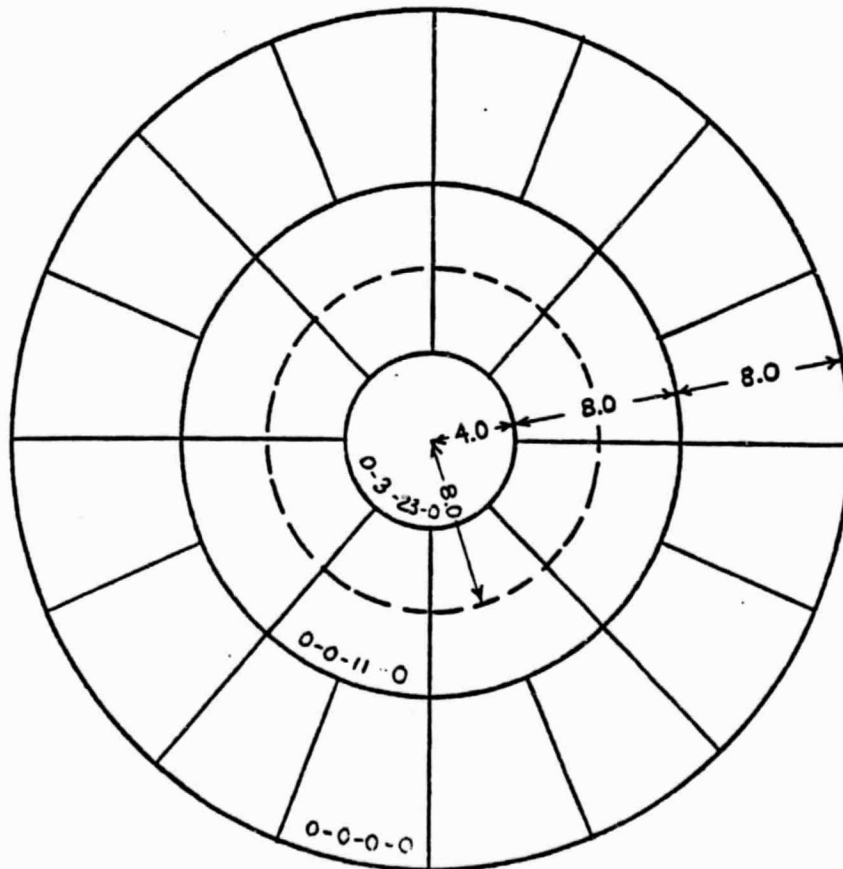
POSTAL ZIP CODES FOR BOSTON AREA

FIGURE 12-2

(SEE TEXT FOR EXPLANATION)
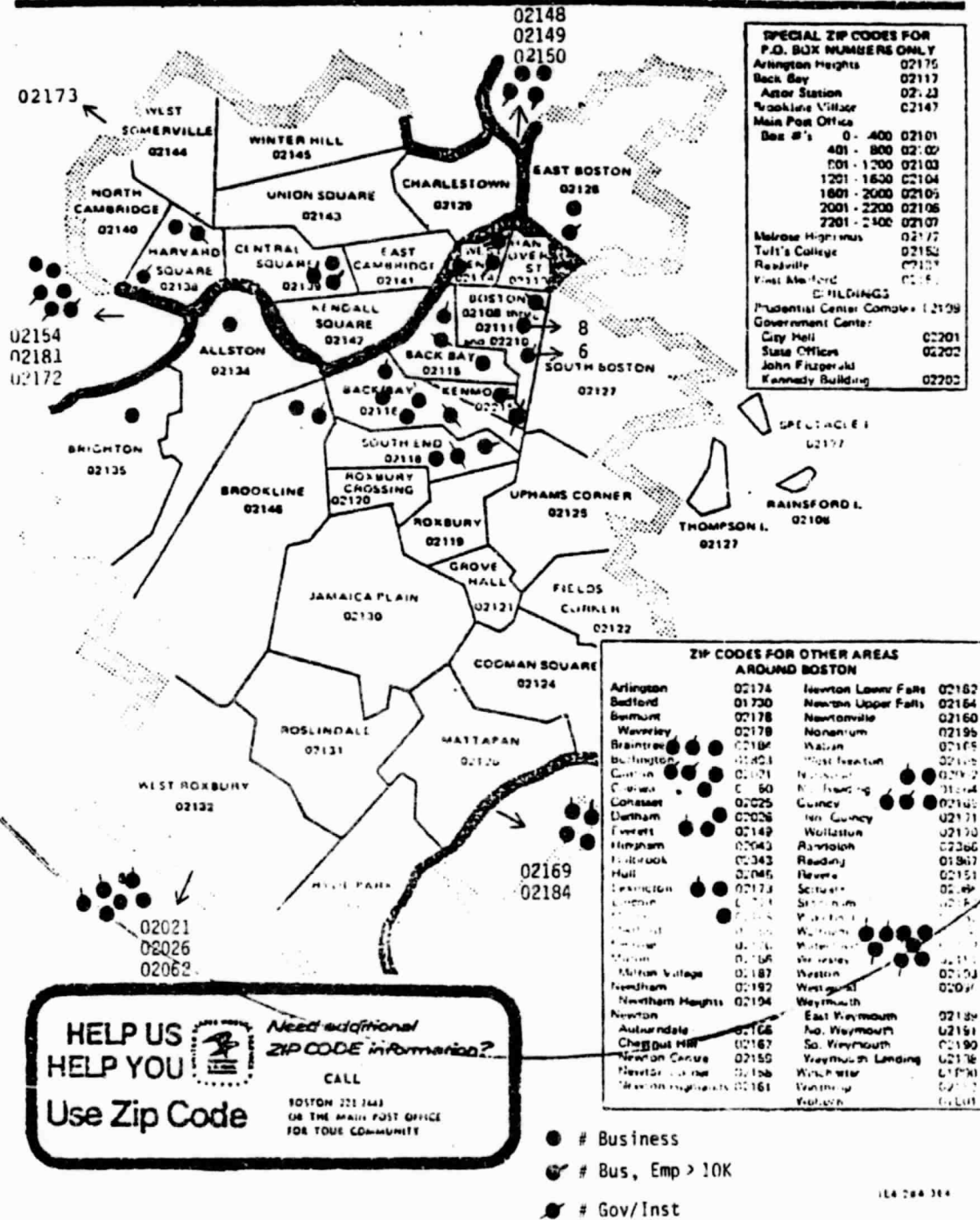
TABLE 12-2. BOSTON
INTRA URBAN TOPOLOGY

(Configuration: Shared/Unshared: Availability: .999)

Distribution of Earth Stations by Zip Code

Criteria:
1. Number of Businesses
2. Number of Businesses with more than 10,000 employees
3. Number of major Government agencies and institutions

ZIP CODE	EARTH STATION SIZE		
BOSTON	**MEDIUM**	**SMALL**	**MINI**
02108 - 02111 + 02210	2	25	
02116	1	6	
02114		5	
02115		5	
02118		5	
02138		5	
02139		5	
02128		4	
02146		4	
02215		4	
02134		1	
02135		1	
AROUND BOSTON	**MEDIUM**	**SMALL**	**MINI**
02154		7	
02184		5	
02021		5	
02169		5	
02149		4	
02173		3	
02062		3	
02172		3	1
02181		3	1
02148		1	
02150		1	1
02026		1	1
	3	111	3

TABLE 12-3. EARTH STATION PROJECTIONS FOR DENVER

DENVER-BOULDER CO

TOTAL TRAFFIC: 172.58

CAPTURED TRAFFIC: 58.50

	LRG		MED		SML		MINI	
RING	NODE	TOT	NODE	TOT	NODE	TOT	NODE	TOT
1	0	0	5	5	9	9	0	0
2	0	0	0	0	6	48	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0 ·	0
5 ·	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
		0		5		57		2

* RADII IN MILES, DOTTED LINE REPRESENTS CENTRAL CITY
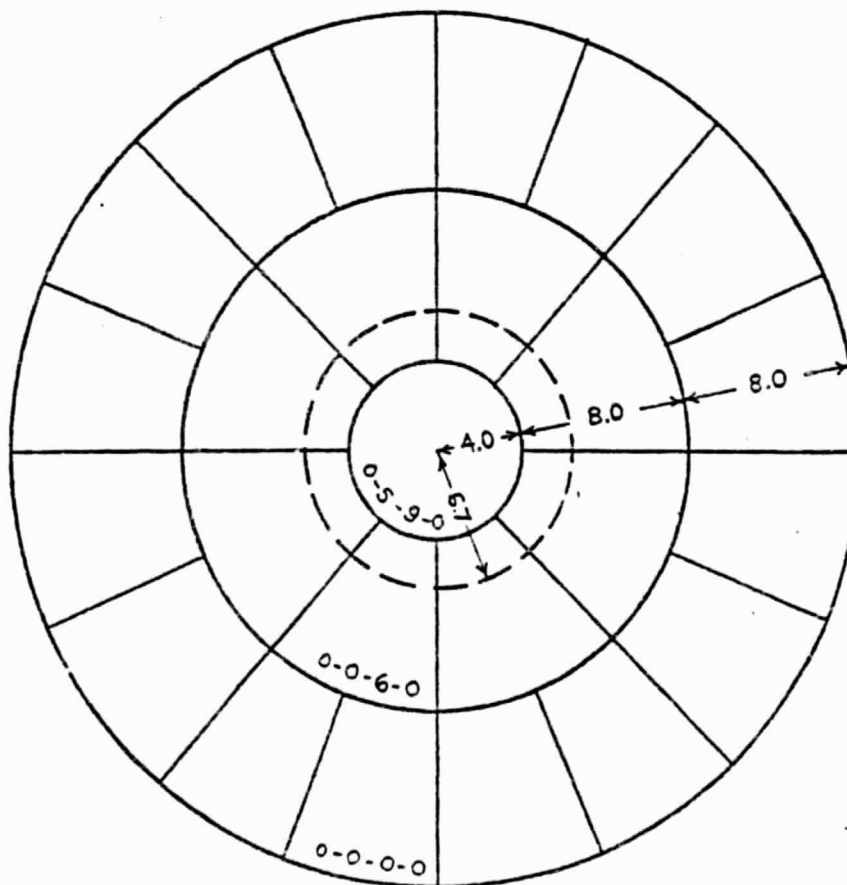
DENVER

FIGURE 12-3

(SEE TEXT FOR EXPLANATION)

TABLE 12-4. DENVER
INTRA URBAN TOPOLOGY

(Configuration: Shared/Unshared: Availability .999)

Distribution of Earth Stations by Zip Code:

Criteria: 1. Number of Businesses

2. Number of Busineeses with more than 10,000 employees

3. Number of major Government agencies and institutions

ZIP CODE	EARTH STATION SIZE		
	MEDIUM	SMALL	MINI
80202	1	9	
80203	1	6	
80216	1	6	
80204	1	4	
80222	1	3	
80223		7	
80110		7	
80206		2	
80215		2	
80022		2	
80111		2	
80112		1	1
80239		1	1
80205		1	
80207		1	
80120		1	
80221		1	
80210		1	
	5	57	2

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TABLE 12-5. EARTH STATION PROJECTIONS FOR SEATTLE

SEATTLE-EVERETT WA   TOTAL TRAFFIC: 108.04

                                   CAPTURED TRAFFIC: 25.05

	LRG		MED		SML		MINI	
RING	NODE	TOT	NODE	TOT	NODE	TOT	NODE	TOT
1	0	0	2	2	9	9	0	0
2	0	0	0	0	2	16	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
		0		2		25		1

* RADII IN MILES, DOTTED LINE REPRESENTS CENTRAL CITY

SEATTLE

**U.S. POSTAL SERVICE
LOCAL DEL. AREA ·981·
STATIONS & BRANCHES
SEATTLE, WA.**

● # Businesses

● # Businesses, Emp > 10K

● # Gov/Inst

98004

98055

98031
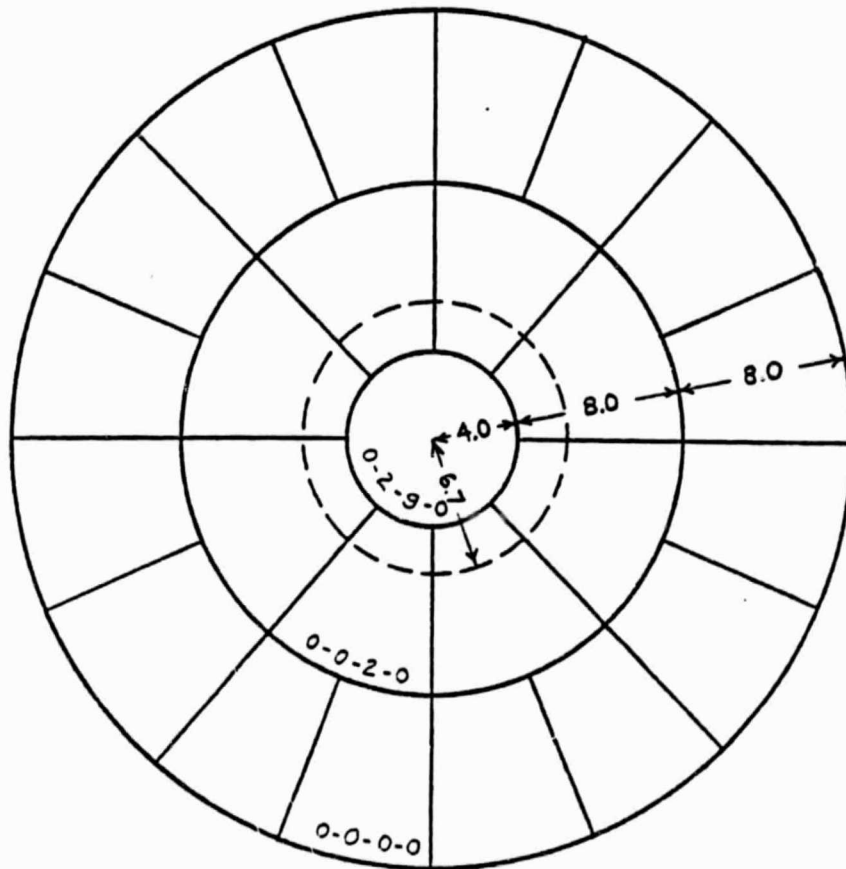
FIGURE 12-4

(SEE TEXT FOR EXPLANATION)

ORIGINAL PAGE IS
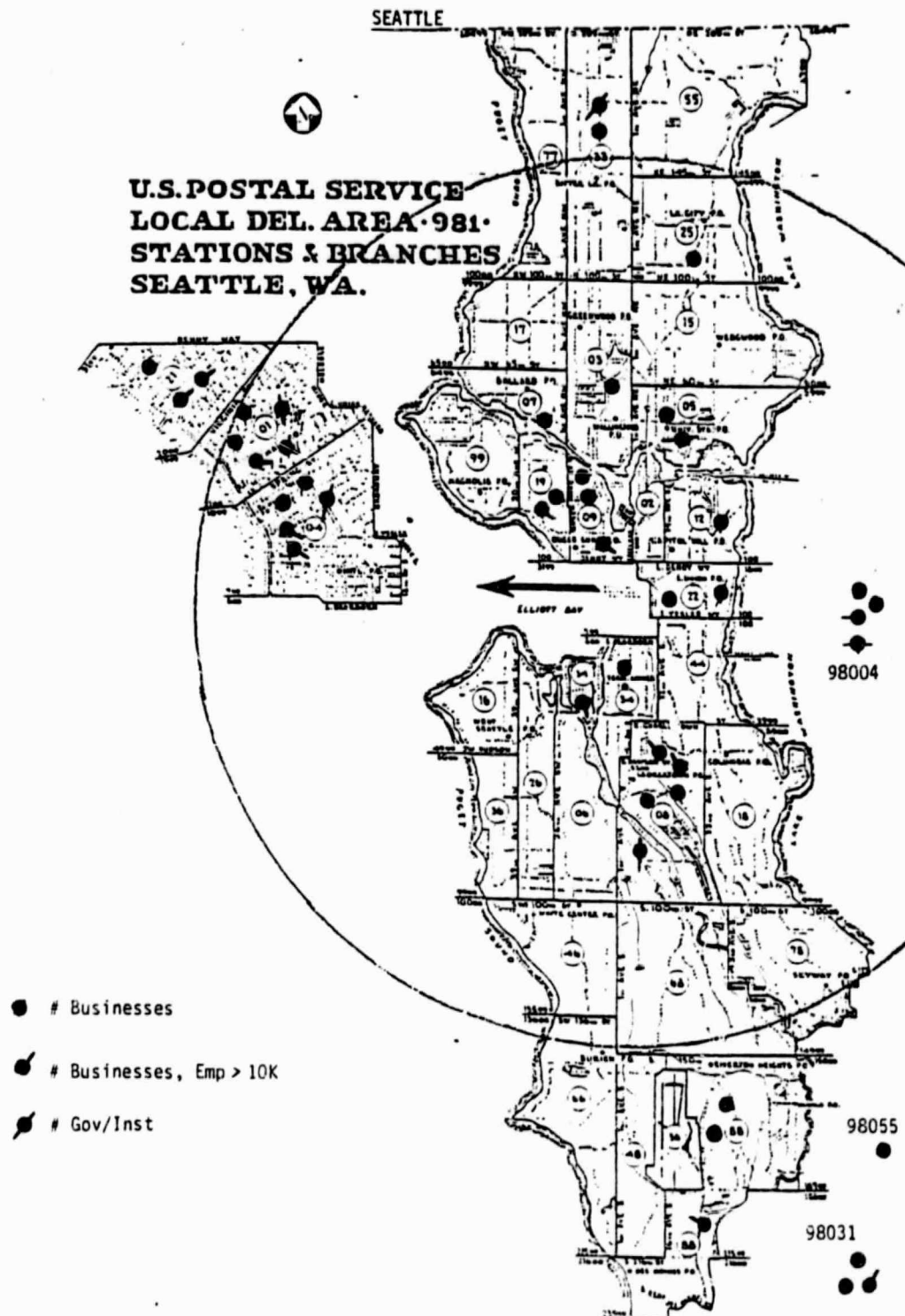OF POOR QUALITY

TABLE 12-6. SEATTLE
INTRA URBAN TOPOLOGY

(Configuration: Shared/Unshared: Availability: .999)

Distribution of Earth Stations by Zip Code:

Criteria:
1. Number of businesses.
2. Number of businesses with more than 10,000 employees
3. Number of major Government agencies and institutions

ZIP CODE	EARTH STATION SIZE		
	MEDIUM	SMALL	MINI
98101	1	0	
98104		4	
98108		4	
98004	1	0	
98031		2	
98188		2	
98109		2	1
98121		1	
98119		1	
98134		1	
98122		1	
98105		1	
98133		1	
98125		1	
98103		1	
98107		1	
98112		1	
98055		1	
	2	25	1

TABLE 12-7. EARTH STATION PROJECTIONS FOR NEW YORK

NEW YORK NY-NJ

TOTAL TRAFFIC: 1381.20

CAPTURED TRAFFIC: 692.60

RING	LRG NODE	LRG TOT	MED NODE	MED TOT	SKL NODE	SKL TOT	MINI NODE	MINI TOT
1	2	2	19	19	17	17	0	0
2	0	0	15	120	13	104	0	0
3	0	0	0	0	11	176	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
		2		139		297		4

* RADII IN MILES, DOTTED LINE REPRESENTS CENTRAL CITY

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