NTIA Report 82-113

Modeling the Telephone Traffic for a National Forest

H. M. Gates
E. J. Alberts
A. P. Zollinger
H. D. Mead

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

Bernard J. Wunder, Jr., Assistant Secretary
for Communications and Information

November 1982

PREFACE

The study, partial results of which are presented in this report, was supported by the U. S. Department of Agriculture, Forest Service, Intermountain Region, Boise National Forest, Boise, Idaho, on Project Order Number 00-0261-1-818. Administration of this program was performed by Mr. James Conibear, Administrative Officer of the Boise National Forest. Mr. Harold D. Mead of the Boise National Forest served as a technical monitor of the program.

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of Commerce, National Telecommunications and Information Administration or Department of Agriculture, Forest Service, policy or decision unless designated by other official documentation.

Certain commercial equipment, instruments, services, protocols, and materials are identified in this report to adequately specify the research procedure. In no case does such identification imply recommendation or endorsement by the National Telecommunications and Information Administration, nor does it imply that the material, equipment, or services identified is necessarily the best available for the purpose.

Technical and management supervision at the National Telecommunications and Information Administration, Institute for Telecommunication Sciences, in Boulder, Colorado, was provided by Dr. Harvey M. Gates, Group Chief, Systems Performance Criteria Group. The program manager was Mr. Richard E. Skerjanec.

The authors of this report formed an ad hoc Special Action Committee (SAC) to address specific problem areas within the Intermountain Region (Region 4) and more specifically on the Forests in this Region. It was the desire of the SAC to publish these findings in hopes it would provide a broader base of information for other Forest Service telecommunication planners.

The authors would like to thank Mr. Barry Hortin of the Intermountain Region, Regional Office who compiled the basic information needed to perform the enclosed analysis. We would also like to extend our appreciation to those Forest Service personnel in Region 4 who allowed us to scrutinize their respective teletraffic materials.

TABLE OF CONTENTS

		Page
	LIST OF FIGURES	vi
	LIST OF TABLES	vi
	LIST OF ABBREVIATIONS	vii
	ABSTRACT	1
1.	INTRODUCTION	1
2.	REASONS FOR A MODEL	2
3.	WAYS TO ACCUMULATE DATA	3
4.	CRITERIA AND ASSUMPTIONS	5
5.	ANALYZING THE DATA	7
6.	COMMON SENSE OBSERVATIONS	10
7.	APPLICATION OF THE MODEL TO A SAMPLE FOREST	16
8.	OBSERVATIONS AND SUMMARY	31
9.	REFERENCES	33

LIST OF FIGURES

		Page
Figure 1.	Sample of the itemized monthly telephone bill from the local operating company	4
Figure 2.	Sample of the telephone "Marketing Toll Study"	6
Figure 3.	The Targhee National Forest Supervisor Office calls for November 1981	8
Figure 4.	The five WATS zones for the State of Idaho	9
Figure 5.	The average time of day for calls within the forest system compared to the national average	13
Figure 6.	The Boise National Forest in south-central Idaho	17
Figure 7.	The Boise SO teletraffic work-hour profile	24
Figure 8.	Compiled distribution of the Boise Supervisor Office generated teletraffic in toll minutes per month	28
Figure 9.	Compiled distribution of the Boise National Forest District Office generated teletraffic in toll minutes per month	28
Figure 10.	The Boise National Forest teletraffic patterns; all data is expressed in toll minutes per month	29
Figure 11.	Teletraffic patterns from the Boise National Forest	30

LIST OF TABLES

Table 1.	The Bridger-Teton National Forest Intrastate (Wyoming) Calls Ranked by Minutes Per Month for the SO (July 1981)	11
Table 2.	The Bridger-Teton National Forest Interstate Calls Ranked by Minutes Per Month for the SO (July 1981)	12
Table 3.	Summary of the Tolled Teletraffic Patterns Emanating from a Forest SO	15
Table 4.	Summary of Tolled Teletraffic Patterns Emanating from a Forest District Office	15
Table 5.	Boise National Forest District Office Fact Sheet	18
Table 6.	Boise National Forest SO Fact Sheet	19
Table 7.	Grand Totals of Toll Traffic from the Boise SO Per Month, Unadjusted	21
Table 8.	Grand Totals of Toll Traffic from the Boise SO Per Month, Adjusted	22
Table 9.	Unadjusted Toll Traffic from the Boise National Forest District Offices	25
Table 10.	Adjusted Toll Traffic from the Boise National Forest District Offices	26

LIST OF ABBREVIATIONS

CO	Central (telephone) Office
DDD	Direct Distance Dial
DO	District Office
DTMF	Dual Tone Multiple Frequency: Push-button telephone
FCC	Federal Communication Commission
FTS	Federal Telecommunication System
GSA	General Services Administration
KTS	Key Telephone System
NF	National Forest
NPA	Numbering Plan Area
OPX	Off Premise Exchange
PBX	Private Branch Exchange
R-4	Region 4, Intermountain Region
RO	Regional Office
SO	Supervisor Office
Type 500	Dial Telephone
WATS	Wide Area Telephone Service
WO	Washington Office

MODELING THE TELEPHONE TRAFFIC FOR A NATIONAL FOREST

H. M. Gates*, E. J. Alberts**, A. P. Zollinger**, and H. D. Mead**

The Forest Service is in the process of updating its telecommunication and information systems. Included in this update are proposed changes to the telephone systems of selected National Forests with an eye toward telephone cost reductions over current system architectures and modes of operation. This document defines a Forest teletraffic model derived from correlations between teletraffic statistics and real-world experiences. The model is developed through nine Forest Service teletraffic observations. An example of its application is made to the Boise National Forest. Effective teletraffic and switch engineering must be based on the communication manager's common sense appraisal of the model results and his or her own forest teletraffic statistics.

Key words: modeling; prediction; telecommunication; teletraffic

1. INTRODUCTION

Over the past several years it has become apparent that the U.S. Government is committed to a policy of deregulation, particularly in the common carrier industries including telecommunications. One of the many reasons for deregulating telecommunications is to allow more competition into the marketplace for broader and more cost-effective equipment and services. Various forms of the deregulation process have been under way for several years and should be completed within the next 2 to 3 years. This basically means that in order to capitalize on this broad based industrial change from a monopolistic to a competitive environment, Forest Service management must begin to direct more selected attention to telecommunication equipment and service procurements for tighter cost controls in which the Forest Service spent an estimated $14 million in telephony nationwide in 1981.

The Forest Service since its establishment in 1905 has been organized in a decentralized manner by delegating responsibility and authority to the lowest feasible level of organization. There are four basic levels of line management within the Forest Service -- District Rangers, Forest Supervisors, Regional Foresters, and the Chief of the Forest Service. There are 653 District Rangers

* This author is with the U.S. Department of Commerce, National Telecommunications and Information Administration, Institute for Telecommunication Sciences, Boulder, CO 80303.

**These authors are with the U.S. Department of Agriculture, Forest Service, Intermountain Region, with Headquarters in Ogden, UT 84401.

who are the first-line resource managers and operate from District Ranger Stations or District Offices. There are 121 Forest Supervisors who are responsible for the supervision of a National Forest consisting of from 3 to 8 District Offices. The 9 Regional Offices (RO's) and their respective Regional Foresters supervise from 6 to 22 National Forests. The Chief of the Forest Service who resides in the Washington Office (WO) of the Forest Service is responsible for the supervision of the 9 Regional Foresters and the management of the National Forest System at large.

This article addresses one of several fundamental elements needed to manage telecommunication and information sciences in the Forest Service. This article presents a telephone system teletraffic model of a National Forest which includes the Supervisor's Office (SO) and the associated District Offices. The model is underpinned with data accumulated from five SO's and their associated District Offices in the Intermountain Region (Region 4) and the Rocky Mountain Region (Region 2) of the National Forest System. There may be selected differences between the results presented here and a specific Forest in another region of the Forest Service System particularly outside the western states. For this reason, the method for obtaining these data is also presented so that one can compare and, if necessary, customize the results to his or her specific office or area.

2. REASONS FOR A MODEL

Telecommunications, like so many technologies today, is very dynamic. The tolls or charges for telephone services and offerings represent one of these propulsive elements. Adjustments are constantly being made at both the State and Federal levels to counter inflation and to prepare for the inevitable competitive market. The services, offerings, and equipment are also caught in this tide of change. Relatively speaking, there appears to be at least one item of stability in this situation and that is the behavioral patterns and, more specifically, the calling patterns of the Forest Service personnel. Any changes to their patterns are most certainly insignificant in comparison to the telecommunication industry at large.

It is the purpose of this article to replicate these patterns in the form of a model. Thus, management can establish a baseline for comparison and build alternatives and candidate configurations in which to make better decisions on how to better serve the wants and needs while optimizing costs.

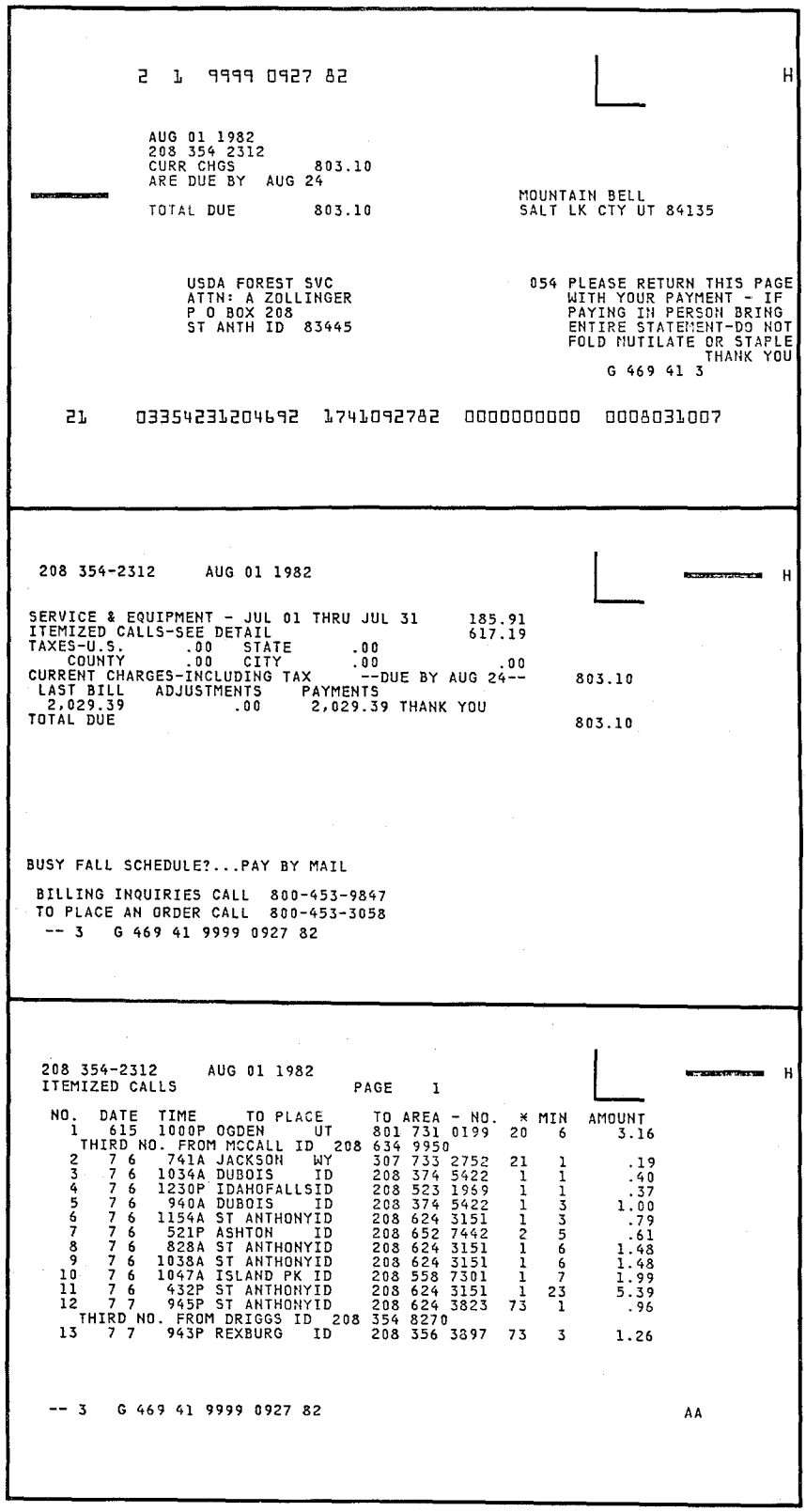
3. WAYS TO ACCUMULATE DATA

There are at least four basic sources for telephone traffic also referred to as teletraffic. One source is to use itemized monthly billing records from the local operating company. These billing records are based on per-month, per-call usage in which a toll is charged. Therefore, all calls within an office and all local calls are not included in this itemized monthly statement. These monthly statements, a sample of which is shown in Figure 1, currently include an itemized listing of each call including the phone number from which the call was made (which may be a general office number), the number called including area code, the city and state called, the date and time of day the call was placed, the duration of the call, a code for the applicable tariff (daytime vs. evening or weekends, for example), and the charge for that specific call. Specifically, Figure 1 represents the first three panels of a 45 panel document sent to the Targhee National Forest SO in which there is detailed teletraffic data for toll calls made from the telephone number (208) 354-2312. This is the phone number of the Driggs Ranger District Office in the Targhee Forest system. These charges are summarized into one total monthly call charge. In addition, there is a listing for equipment charges (phones, switch equipment, etc.) and special service charges (new phone installations, moving phones, etc.). The operating company generates these monthly bills from a computer file which is maintained for three to six months. In addition, each monthly bill is generally placed on microfiche and held for at least 12 months.

The second reliable source of information is to place a call recording device at the Private Branch Exchange (PBX) through which all the office calls are routed. These devices can measure all telephone traffic inside the office, to the local community, and all long distance calls including Wide Area Telephone Service (WATS) calls.

A third source of information comes from sampling, and one may sample using several techniques. One method is to ask employees to record the necessary data on a form for each toll (long distance) call for some pre-specified period of time. Another method used by the General Services Administration (GSA), Federal Telecommunications System (FTS), is to intercept randomly and manually a toll call to seek the necessary data.

It is impractical to measure incoming calls under any circumstances although a few collect calls and credit card calls do slip into the billing records which must be discounted or removed prior to performing this type of analysis.



2 1 9999 0927 82 H

AUG 01 1982
208 354 2312
CURR CHGS 803.10
ARE DUE BY AUG 24

TOTAL DUE 803.10

MOUNTAIN BELL
SALT LK CTY UT 84135

USDA FOREST SVC
ATTN: A ZOLLINGER
P O BOX 208
ST ANTH ID 83445

054 PLEASE RETURN THIS PAGE
WITH YOUR PAYMENT - IF
PAYING IN PERSON BRING
ENTIRE STATEMENT-DO NOT
FOLD MUTILATE OR STAPLE
THANK YOU
G 469 41 3

21 033542312046 92 1741092782 0000000000 0008031007

208 354-2312 AUG 01 1982 H

SERVICE & EQUIPMENT - JUL 01 THRU JUL 31 185.91
ITEMIZED CALLS-SEE DETAIL 617.19
TAXES-U.S. .00 STATE .00
COUNTY .00 CITY .00 .00
CURRENT CHARGES-INCLUDING TAX --DUE BY AUG 24-- 803.10
LAST BILL ADJUSTMENTS PAYMENTS
2,029.39 .00 2,029.39 THANK YOU
TOTAL DUE 803.10

BUSY FALL SCHEDULE?...PAY BY MAIL
BILLING INQUIRIES CALL 800-453-9847
TO PLACE AN ORDER CALL 800-453-3058
-- 3 G 469 41 9999 0927 82

208 354-2312 AUG 01 1982 H
ITEMIZED CALLS PAGE 1

NO.	DATE	TIME	TO PLACE		TO AREA - NO.	* MIN		AMOUNT
1	615	1000P	OGDEN	UT	801 731 0199	20	6	3.16
	THIRD NO. FROM MCCALL ID 208 634 9950							
2	7 6	741A	JACKSON	WY	307 733 2752	21	1	.19
3	7 6	1034A	DUBOIS	ID	208 374 5422	1	1	.40
4	7 6	1230P	IDAHOFALLS	ID	208 523 1969	1	1	.37
5	7 6	940A	DUBOIS	ID	208 374 5422	1	3	1.00
6	7 6	1154A	ST ANTHONY	ID	208 624 3151	1	3	.79
7	7 6	521P	ASHTON	ID	208 652 7442	2	5	.61
8	7 6	828A	ST ANTHONY	ID	208 624 3151	1	6	1.48
9	7 6	1038A	ST ANTHONY	ID	208 624 3151	1	6	1.48
10	7 6	1047A	ISLAND PK	ID	208 558 7301	1	7	1.99
11	7 6	432P	ST ANTHONY	ID	208 624 3151	1	23	5.39
12	7 7	945P	ST ANTHONY	ID	208 624 3823	73	1	.96
	THIRD NO. FROM DRIGGS ID 208 354 8270							
13	7 7	943P	REXBURG	ID	208 356 3897	73	3	1.26

-- 3 G 469 41 9999 0927 82 AA

Figure 1. Sample of the itemized monthly telephone bill from the local operating company.

Analyzing any of the above data is potentially time consuming. Many of the local operating companies have the capability to provide computer sorts on request. These sorts are often referred to as "Marketing Toll Study" reports; a sample of this report is shown in Figure 2. This represents a good fourth source of information.

4. CRITERIA AND ASSUMPTIONS

The major focus of this effort is placed on Forests in the Intermountain Region (Region 4) of the Forest Service which contains 16 Forests in five states. Six of these Forests are co-located in the same state as the RO. The criteria for establishing a model should include the following:

1. Accumulate data from forests in which SO to RO traffic is both intra- as well as interstate.
2. Gather data from a broad spectrum of forests -- small to large.
3. If possible, sample once for each quarter year to account for seasonal variations.
4. Preferably, sample forest facilities which do not use WATS or FTS.

It is possible, but not convenient, to obtain traffic information on WATS or FTS.

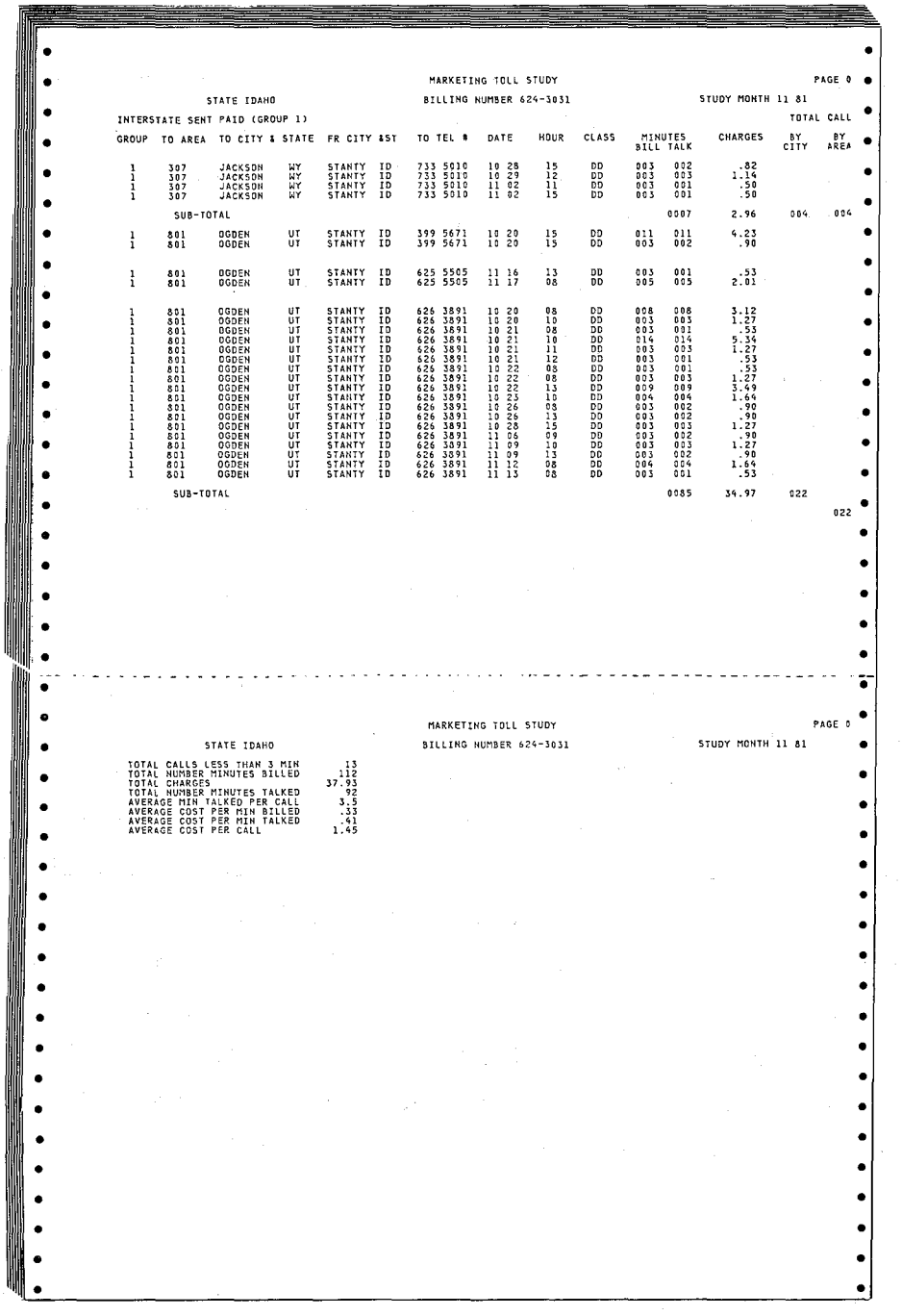
It is assumed that one can relate all teletraffic to the total of career and career conditional employees* at the various facilities in a National Forest. The terms "staff" or "staff members" and the term "career" and "career conditional employees" will be used interchangeably. It is also assumed that the bulk of digital traffic is currently being carried by other specialized common carriers and, therefore, is not included in the total volume.

Any dedicated tie lines, WATS, and FTS must be noted and dealt with on an individual basis. Their impact on any analysis can be substantial.

In almost all cases, it is very handy to have the Numbering Plan Area (NPA or area codes) and central office indexes for commercial Direct Distance Dial (DDD), FTS, and in some cases WATS to help analyze the data.

---

*One can also relate the teletraffic to the Permanent Full-Time Equivalent Staff in which such a staff member works an equivalent of from 20 to 26 full pay periods per year for the Forest Service.



MARKETING TOLL STUDY PAGE 0

STATE IDAHO BILLING NUMBER 624-3031 STUDY MONTH 11 81

INTERSTATE SENT PAID (GROUP 1)

GROUP	TO AREA	TO CITY & STATE	FR CITY &ST	TO TEL #	DATE	HOUR	CLASS	MINUTES BILL	MINUTES TALK	CHARGES	TOTAL CALL BY CITY	TOTAL CALL BY AREA
1	307	JACKSON WY	STANTY ID	733 5010	10 28	15	DD	003	002	.82		
1	307	JACKSON WY	STANTY ID	733 5010	10 29	12	DD	003	003	1.14		
1	307	JACKSON WY	STANTY ID	733 5010	11 02	11	DD	003	001	.50		
1	307	JACKSON WY	STANTY ID	733 5010	11 02	15	DD	003	001	.50		
	SUB-TOTAL								0007	2.96	004	004
1	801	OGDEN UT	STANTY ID	399 5671	10 20	15	DD	011	011	4.23		
1	801	OGDEN UT	STANTY ID	399 5671	10 20	15	DD	003	002	.90		
1	801	OGDEN UT	STANTY ID	625 5505	11 16	13	DD	003	001	.53		
1	801	OGDEN UT	STANTY ID	625 5505	11 17	08	DD	005	005	2.01		
1	801	OGDEN UT	STANTY ID	626 3891	10 20	08	DD	008	008	3.12		
1	801	OGDEN UT	STANTY ID	626 3891	10 20	10	DD	003	003	1.27		
1	801	OGDEN UT	STANTY ID	626 3891	10 21	08	DD	003	001	.53		
1	801	OGDEN UT	STANTY ID	626 3891	10 21	10	DD	016	014	5.34		
1	801	OGDEN UT	STANTY ID	626 3891	10 21	11	DD	003	003	1.27		
1	801	OGDEN UT	STANTY ID	626 3891	10 21	12	DD	003	001	.53		
1	801	OGDEN UT	STANTY ID	626 3891	10 22	08	DD	003	001	.53		
1	801	OGDEN UT	STANTY ID	626 3891	10 22	08	DD	003	003	1.27		
1	801	OGDEN UT	STANTY ID	626 3891	10 22	13	DD	009	009	3.49		
1	801	OGDEN UT	STANTY ID	626 3891	10 23	10	DD	004	004	1.64		
1	801	OGDEN UT	STANTY ID	626 3891	10 26	08	DD	003	002	.90		
1	801	OGDEN UT	STANTY ID	626 3891	10 26	13	DD	003	002	.90		
1	801	OGDEN UT	STANTY ID	626 3891	10 28	15	DD	003	003	1.27		
1	801	OGDEN UT	STANTY ID	626 3891	11 06	09	DD	003	002	.90		
1	801	OGDEN UT	STANTY ID	626 3891	11 09	10	DD	003	003	1.27		
1	801	OGDEN UT	STANTY ID	626 3891	11 09	13	DD	003	002	.90		
1	801	OGDEN UT	STANTY ID	626 3891	11 12	08	DD	004	004	1.64		
1	801	OGDEN UT	STANTY ID	626 3891	11 13	08	DD	003	001	.53		
	SUB-TOTAL								0085	34.97	022	022

MARKETING TOLL STUDY PAGE 0

STATE IDAHO BILLING NUMBER 624-3031 STUDY MONTH 11 81

TOTAL CALLS LESS THAN 3 MIN	13
TOTAL NUMBER MINUTES BILLED	112
TOTAL CHARGES	37.93
TOTAL NUMBER MINUTES TALKED	92
AVERAGE MIN TALKED PER CALL	3.5
AVERAGE COST PER MIN BILLED	.33
AVERAGE COST PER MIN TALKED	.41
AVERAGE COST PER CALL	1.45

Figure 2. Sample of the telephone "Marketing Toll Study"

5. ANALYZING THE DATA

There are several basic parameters one must have before proceeding with an analysis or developing a model. At minimum, one must separate the toll cost data, the equipment, and the special services information. It is necessary to have on a call-by-call basis:

1. The date and time each toll call was placed,
2. the originating number,
3. the destination number,
4. the length of call, and
5. the cost for that call.

There are other very helpful pieces of information which include:

1. Total number of calls less than 3 minutes long,
2. airline miles between major study sites (i.e., between the SO and the District Offices and between the SO and the RO), and
3. state and Federal tariff summaries.

The accumulated data can be processed either by hand or preferably by computer. It is recommended that summary data be prepared into a form similar to that shown in Figure 3 in which calls are sorted into intra- and interstate calls and sorted into WATS Bands. Figure 3 is a summary sheet for the Targhee National Forest SO located in the State of Idaho for the month of November 1981.

Interstate WATS divides the contiguous United States into five zones with the charges based on the zone-to-zone distance and on the length of calls. Calls are made in a normal manner over the switched public network. The five zones to which calls can be placed are relative to the caller and do not include the local or intrastate area.

Outward WATS are calls placed to another zone. Inward WATS are calls received from another zone. For interstate calls, both inward and outward WATS have the same zone designation. Figure 4 shows the five zones or bands for the State of Idaho. (Consult your local operating company for your state WATS Bands.) Notice that these WATS Bands are correlated to the distance from the reference state where Band 1 encompasses the adjacent states while Band 5 is the farthest from the reference state. We refer to intrastate traffic as Band 0. Band 6 teletraffic in Figure 3 were calls made to Alaska.

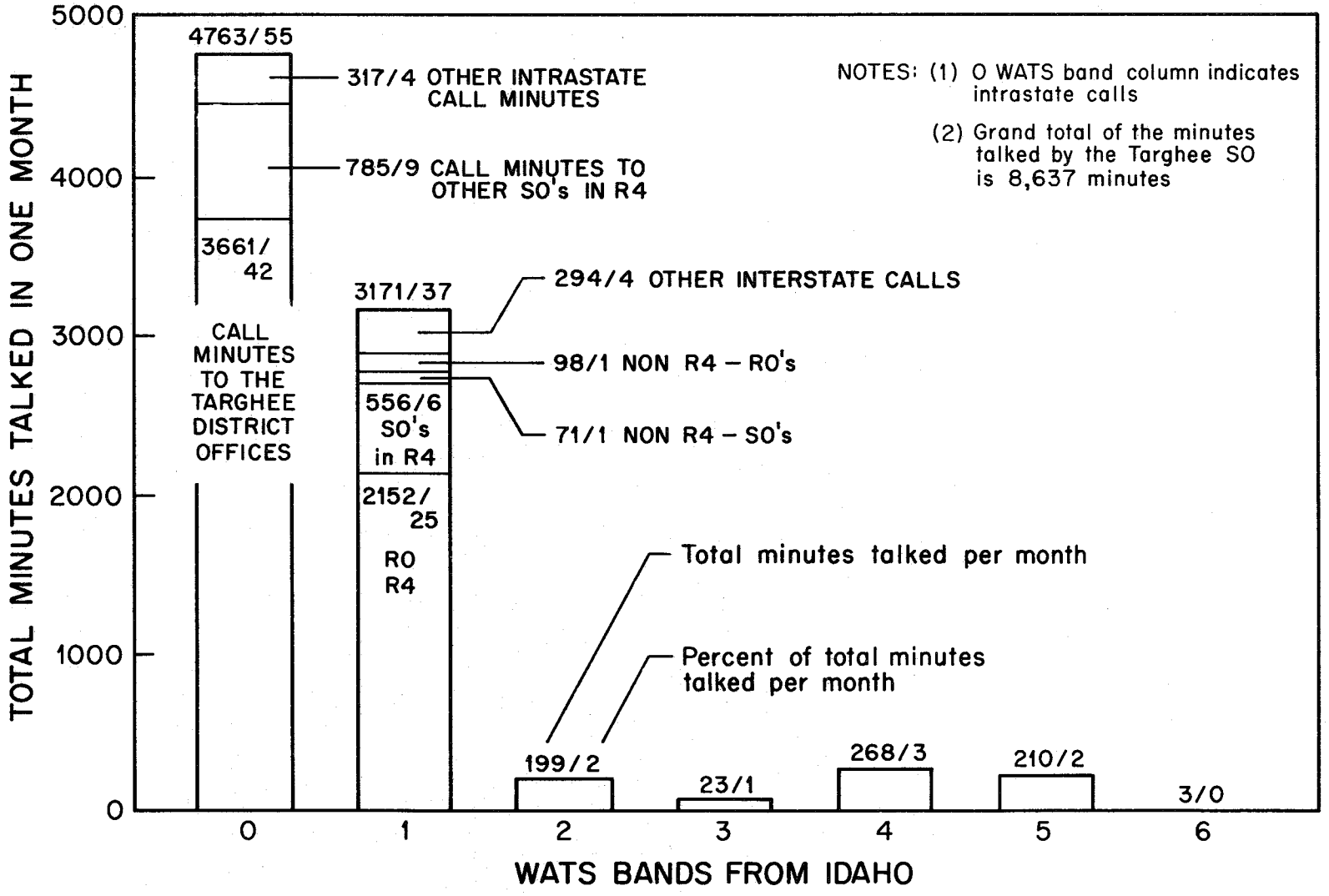


Figure 3. The Targhee National Forest Supervisor Office calls for November 1981.

Figure 4. The five WATS zones for the State of Idaho.

It is also useful to rank-order telephone traffic from the SO for intra- and interstate calling by total minutes talked. Tables 1 and 2 show such examples for the Bridger-Teton National Forest SO in Wyoming for July 1981. Notice how quickly one can identify major calling patterns from these two tables.

It is necessary to develop teletraffic loading as a function of the time of day. Such data are necessary in designing the peak capabilities of both networks and switching equipment. This will be shown in the next section of this article.

Those Forests analyzed in Regions 2 and 4 for this research include the Rio Grande, Targhee, Bridger-Teton, Humbolt, Dixie, Manti-La Sal, and Ashley. These Forests met most of the criteria specified above as well as providing relatively convenient access to toll data. We collected and analyzed approximately one-quarter of a million minutes of toll call data from these Forests.

6. COMMON SENSE OBSERVATIONS

Even the most elaborate teletraffic engineering theories are meaningless unless they can be equated to the actual patterns experienced by the Forest staff. Shown below are nine basic observations which appear to be relevant to a typical Forest Service facility and some of which are used as the fundamental elements of our Forest model.

Observation Number One: The average call duration increases with distance. This observation of Forest Service teletraffic is somewhat comparable with national business averages. The average local call is generally three minutes. But Forest Service toll calls of from 15 to 50 miles average between 3 and 4 minutes, while calls to the east coast vary between 5 and 6 minutes. The reason for this phenomenon apparently has never been thoroughly explored although one can surmise that the more often two people converse with one another, the shorter their call will be.

Observation Number Two: The hour of day during which the heaviest telephone traffic load occurs on the District or Forest may vary from day to day but, for the most part, it usually falls between 8:00 a.m. and 9:00 a.m. Figure 5 shows a typical teletraffic profile of a Forest SO or District Office on a normal work day. It is interesting to compare once again these observations with the national average for business toll calls. The peak for the Forest Service offices occurs at least one or more hours earlier than the national business average. This is probably due to the work habits of selected employees who apparently arrive at work, make their calls, and then proceed to the field.

Table 1. The Bridger-Teton National Forest Intrastate (Wyoming) Calls Ranked by Minutes Per Month for the SO (July 1981)

City	Minutes	Charges (Dollars)	No. of Calls	% by Minute	Primary Facility/Center at this Location
Greys River	830	233	178	26	District Office
Pinedale	581	163	142	18	District Office
Kemmerer	518	161	124	16	District Office
Big Piney	392	122	90	12	District Office
Cheyenne	349	129	48	11	State Capitol
Baggs	180	45	5	6	Unknown
Rock Springs	84	29	21	3	Unknown
Lander	61	19	6	2	Unknown
Casper	37	13	7	1	Unknown
Buffalo	37	8	6	1	Unknown
Subtotal	3070	922	627	96	--
Others	130	42	28	4	--
TOTALS	3209	964	655	100	--

Table 2. The Bridger-Teton National Forest Interstate Calls Ranked by Minutes Per Month for the SO (July 1981)

City	Minutes	Charges (Dollars)	No. of Calls	% by Minute	Primary Facility/Center at this Location
Ogden	2411	808	332	50	R-4, RO
St. Anthony	303	96	49	6	R-4, SO
New Orleans	199	80	39	4	Federal Finance Center
Salt Lake	194	74	35	4	R-4, SO & State Capitol
McCall	174	55	13	4	R-4, SO
Lakewood	154	72	40	3	R-2, RO
Denver	145	57	28	3	St. Capitol & Fed. Center
Boise	100	33	7	2	R-4, SO
Pocatello	84	22	13	2	R-4, SO
Ft. Collins	64	27	20	1	Computer Center
Washington, DC	58	25	12	1	WO
Billings	50	18	10	1	R-1, SO
Durango	50	20	6	1	R-2, SO
Idaho Falls	46	16	20	1	R-4, District Office
Missoula	32	12	3	1	R-1, RO
Santa Fe	31	13	7	1	R-3, SO
Subtotal	4094	1428	634	85	--
Other	713	274	159	15	--
TOTALS	4807	1702	793	100	--

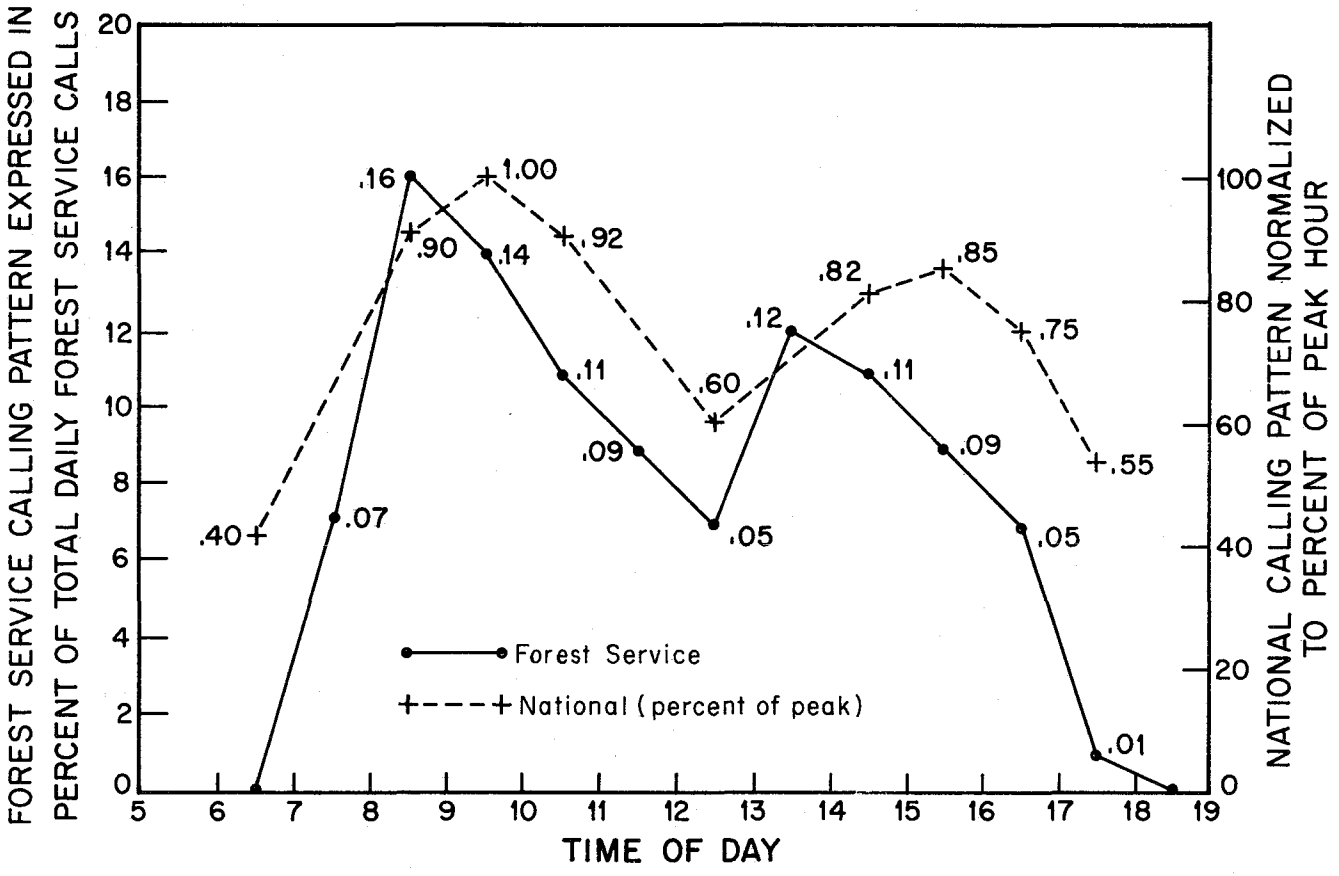


Figure 5. The average time of day for calls within the forest system compared to the national average.

Observation Number Three: On any average business day, approximately 16% of the day's toll calls are placed during the busy hour. Nationally one can observe variations in this figure due to the relative locations of facilities when the offices are split by a time zone. This time zone variation does not occur for the District Office, the SO, or the RO unless there is a change in time zones between these facilities. We observed some peaks as high as 20% in some Forests, particularly at the District Offices. However, the average business day peak is 16% of the total day's teletraffic for a National Forest.

Observation Number Four: The average Forest Service SO and District Office telephone user, each day, uses his or her phone for about 4.3 minutes for intrastate calls and about 5.3 minutes for interstate calls. Compared nationally, the Forest Service toll call lengths are generally several minutes shorter than their average business equivalents.

Observation Number Five: For each career and career conditional employee at the SO there are between 1.0 and 1.2 toll calls made per work day. There are differences between the SO and District Office long distance calling patterns. For each career and career conditional employee at a District Office there are between 0.70 and 0.90 toll calls made per work day. Forest wide, this averages to about one toll call per career and career conditional employee per work day. Incidentally, there is virtually a one-to-one correlation of telephone numbers or PBX extension numbers to the total number of career and career conditional employees. In other words, if a Forest SO has 68 telephones or PBX extension numbers, that same SO will have approximately 68 career and career conditional employees. These are very basic yet handy numbers to remember and use for first-cut estimates of toll teletraffic.

Observation Number Six: Almost 80% of all SO generated long distance calls go to one of three places. Of the total toll calls made from the SO, 38% are directed to their respective District Offices, 25% are to the parent RO, and 16% to other SO's within the parent Region. Table 3 summarizes all the call data for the SO.

Observation Number Seven: Almost 86% of all District Office long distance calls are intrastate. Only a small fraction of the calls (approximately 14%) go outside the state. More specifically, 56% of the total District Office long distance calls are made to the parent SO; 15.7% to establishments within their state other than their own SO or other District Offices in their Forest; and

Table 3. Summary of the Tolled Teletraffic Patterns Emanating from a Forest SO

Teletraffic to:	% of Total Calls
The Forest District Offices	38.0
The Parent RO	25.0
Other SO's in the Same Region	16.0
Miscellaneous Intrastate Calls	5.6
Other Band 1 WATS (Minus parent RO and in-region SO calls)	7.5
Band 2 WATS	1.3
Band 3 WATS	1.5
Band 4 WATS	2.5
Band 5 WATS	2.6

Table 4. Summary of the Tolled Teletraffic Patterns Emanating from a Forest District Office

Teletraffic to:	% of Total Calls	
The Parent SO	56.0	
Other District Offices within Own Forest	14.0	
Miscellaneous Intrastate Calls (Minus calls to the SO and other District Offices)	15.7	
Sub Total of Intrastate Calls	85.7	85.7
Band 1 WATS		12.0
Band 2 WATS		0.8
Band 3 WATS		0.7
Band 4 WATS		0.7
Band 5 WATS		0.1
GRAND TOTAL		100.0
The Parent RO	2.0*	
Other SO's in the Parent Region	3.6*	

*These figures are absorbed into the intra- and interstate teletraffic percentages.

14% to other District Offices within their Forest. Table 4 summarizes these District Office call data facts.

Observation Number Eight: Each month every SO career and career conditional employee talks an average of 114 minutes on long distance calls. It appears that the higher the level of management the greater the affinity to talking. For example, each District Office employee talks an average of 83 minutes on tolled calls each month.

Observation Number Nine: The volume of calls from the Forest Service SO's and District Offices dramatically decreases as the distance increases. This observation can be obtained from the examples shown in Figure 3. This fall-off rate is generally much faster for the Forest Service than the national average for commercial business traffic.

7. THE MODEL AND ITS APPLICATION TO A SAMPLE FOREST

The Boise National Forest shown in Figure 6 is located in the State of Idaho. It supports six District Offices. Table 5 lists the Districts by number, name, assumed staff count, percent of staff, the operating telephone company, and equipment summary. Table 6 lists these same basic items for the SO in Boise. Note the wide diversity of telephone service support. Accumulating toll data under such an arrangement can be and is difficult at best. The model derived here can be used to compare sampled data and provide a baseline for a variety of alternative telephone architectures. The following steps are used in applying the model to this Forest.

Step 1: Derive Forest fact sheets for the District Offices and SO. These fact sheets like those shown in Tables 5 and 6 begin the organizational process for the analysis. Place a date on these sheets and define only the systems that are in place. Projecting even a few months will distort the data.

Step 2: Compute the SO total minutes talked per month. Observation Number Eight states that each staff member talks an average of 114 minutes per month. Table 6 indicates that the Boise SO employs 124 staff members (career and career conditional employees). Therefore, we can estimate the total minutes of toll traffic from the Boise SO:

$$124 \text{ staff members} \times 114 \text{ min./staff/mo.} = 14{,}136 \text{ total min./mo.}$$

This is probably one of the most important numbers for the analysis. If at all possible, verify the total toll minutes talked per month for your SO through any or all means. It may be necessary to first estimate your total minutes talked per month from this report and make any adjustments later as the data become available through sampling and measurements.

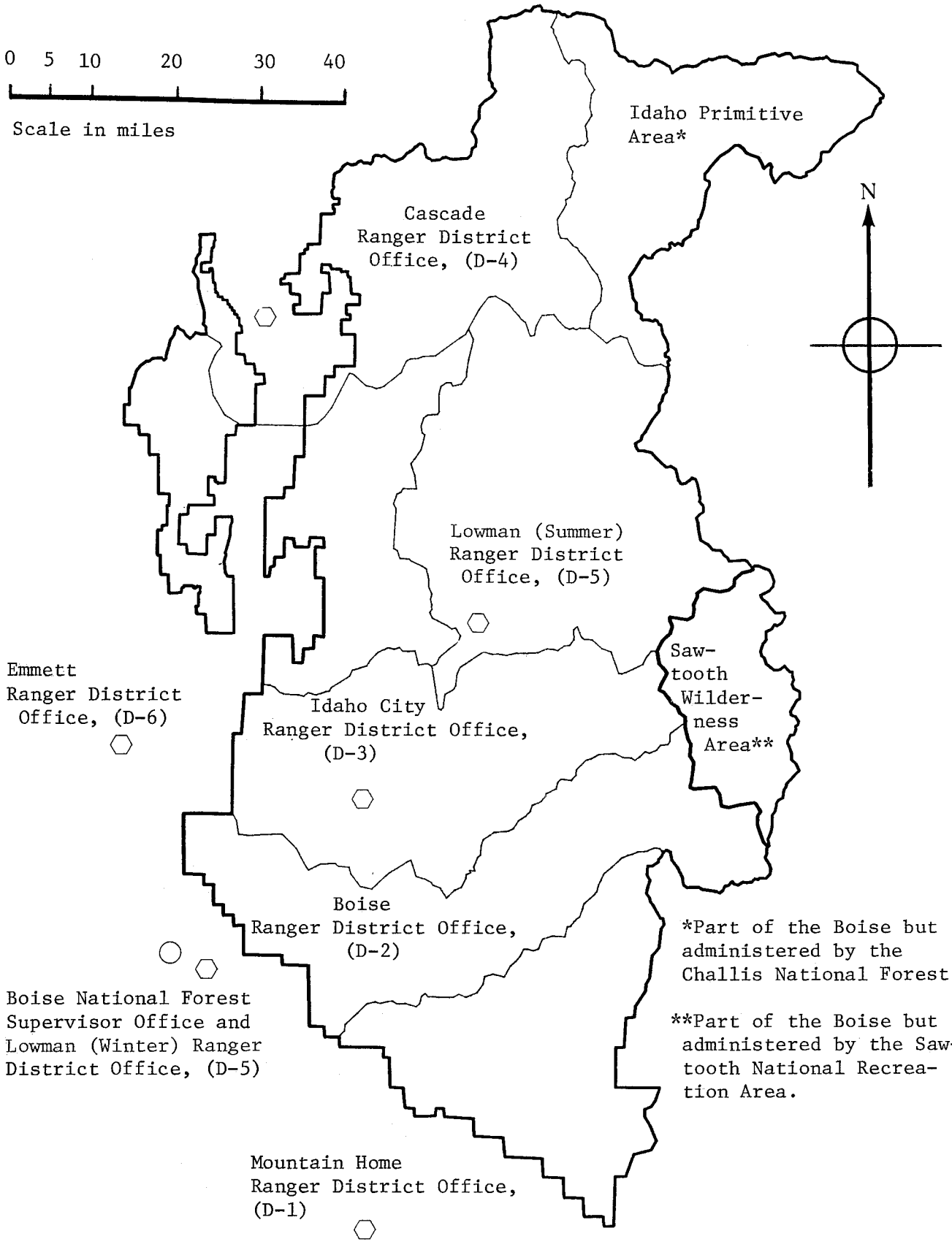


Figure 6. The Boise National Forest in south-central Idaho.

Table 5. Boise National Forest District Office Fact Sheet

District Number	District Name	Career and Career Conditional Count	Percent of Total Staff	Servicing Phone Company & Location	Equipment Summary	
					Trunks	Instruments
D-1	Mountain Home	28	17.83%	Mountain Bell, Mountain Home, ID	2 local 2 FTS OPX	1 ten key call director 29 six key DTMF phones
D-2	Boise	19	12.10%	Mountain Bell, Boise, ID	4 FTS OPX All other Centrex into Boise CO	1 ten key call director 22 DTMF phones
D-3	Idaho City	27	17.20%	Mountain Bell, Idaho City, ID	4 OPX-Boise 2 local 1 local data link	1 thirty key call director 27 ten key speaker phones (dial types)
D-4	Cascade	27	17.20%	Continental, Cascade, ID	1 OPX-Boise 2 local 1 local data link	10 six key DTMF phones
	Cascade Extension Office	--	--	Continental, Cascade, ID	1 local	2 dial phones
D-5	Lowman (Summer Office)	29	18.47%	Forest Service, Lowman, ID	1 OPX-Boise (microwave/ UHF)	6 six key DTMF phones
	Lowman (Winter Office)	--	--	Mountain Bell, Boise, ID	4 FTS OPX All other Centrex into Boise CO	22 DTMF phones
D-6	Emmett	27	17.20%	Mountain Bell, Emmett, ID	2 OPX-Boise 2 local	1 thirty key call director 19 DTMF phones
	Garden Valley Guard Station	--	--	Continental, Crouch, ID	2 local	8 six key dial phones
	High Valley Guard Station	--	--	Continental, Sweet, ID	1 local	2 dial phones

Abbreviation Definitions:

CO	Central Office - Telephone Office
OPX	Off Premise Exchange
DTMF	Push Button Telephone, also Touch Tone Telephone

Table 6. Boise National Forest SO Fact Sheet (This SO is serviced by Mountain Bell. There are a total of 124 career and career conditional employees at this facility.)

Facility	Facility Address or Location	Equipment Summary	
		Trunks	Instruments
Main Office	1750 Front Street, Boise, ID	112 Centrex circuits into Boise, ID	120 DTMF phones 3 DTMF speaker phones
Zone Lands Appraisal Team	1750 Front Street, Boise, ID	8 Centrex circuits into Boise, ID	7 DTMF phones 1 DTMF speaker phone
Forest Pest Management	1750 Front Street, Boise, ID	4 Centrex circuits into Boise, ID	1 DTMF speaker phone 3 DTMF phones
Lucky Peak Nursery	Idaho City Highway, 10 miles East of Boise	1 OPX Boise	3 dial phones
Airport Facility Radio Shop Warehouse Fire Dispatch Fleet Management Road & Maintenance Facility	1918 Commerce Avenue, Boise, ID	17 Centrex circuits into Boise, ID 1 local data link	3 ten key DTMF call directors 3 five key dial phones 6 DTMF phones 2 dial phones

Step 3: Compute the call distribution from the SO. From Observation Number Six and the accompanying table (Table 3) we basically have the call distribution data for the SO. Of the 14,136 total minutes talked per month, 38% or 5,371.7 minutes are to the Boise District Offices, 25% or 3,534.0 minutes are to the RO, 16% or 2,261.8 minutes are to the other Region 4 SO's, and so on. We noted that the Region 4 SO's are distributed such that 47% of the Forest workforce is located in Idaho (minus the Boise National Forest), 10% in Nevada, 7% in Wyoming, and 36% in Utah. Therefore, of the 2,261.8 minutes of total calls to other SO's in R-4, 1,063.0 minutes are in Idaho, 226.2 minutes to Nevada, 158.3 minutes to Wyoming, and 814.2 minutes are to Utah SO's. These results are tabulated in Table 7. This table assumes that there are no tie lines and other voice grade private lines between any Forest centers, that all District Offices are out of town and must access the SO through toll calls, and that all District Offices operate year around.

Step 4: Adjust the computed toll traffic for any variations such as tie lines and other voice grade private lines, District Offices that are co-located within the same city as the SO, and any other special or unusual situations. The Boise National Forest has two variations worth noting. First, D-2 which is the Boise District Office, is located in the same town as the SO. Second, D-5 which is the Summer Lowman District Office winters in Boise, Idaho, where the SO is located. In addition, this summer facility has a voice grade private line between the summer office and the SO which is comprised of Forest Service owned microwave and UHF radio. For the Lowman District Office, it appears to be co-located in the town of Boise winter and summer as far as the teletraffic is concerned. It is important now to revise Table 7 to reflect these variations. This is displayed in Table 8. Notice the changes in SO-to-District traffic between D-2 and D-5 which then are reflected in the total teletraffic percentages.

Step 5: Compute the traffic profiles for a working day. The SO generates an adjusted 12,494 minutes of toll traffic per month. There are approximately 23 working days per month. Therefore, there are 543 minutes of toll teletraffic from the Boise SO per work day:

$$\frac{12{,}494 \text{ toll minutes/month}}{23 \text{ working days/month}} = 543 \text{ minutes/work day}$$

Table 7. Grand Totals of Toll Traffic from the Boise SO Per Month, Unadjusted (This assumes that the Boise District Office (D-2) is remote from the SO.)

Traffic to	Number of Toll Minutes Per Month				Per Work Day Peak Hour Toll Call Minutes			
	Sub-total	Per-cent	Total	Per-cent	Sub-total	Per-cent	Total	Per-cent
District Office			5,371.7	38.0			37.37	38.0
D-1	957.8	17.83			6.66	17.83		
D-2 (Boise)	650.0	12.10			4.52	12.10		
D-3	923.9	17.20			6.43	17.20		
D-4	923.9	17.20			6.43	17.20		
D-5 (Summer)	992.2	18.47			6.90	18.47		
D-6	923.9	17.20			6.43	17.20		
Subtotals	5,371.7	100.00			37.37	100.00		
Regional Office			3,534.0	25.0			24.58	25.0
All Other SO's in R-4			2,261.8	16.0			15.73	16.0
SO's in Idaho	1,063.0	47.00						
SO's in Nevada	226.2	10.00						
SO's in Utah	814.2	36.00						
SO's in Wyoming	158.3	7.00						
Subtotals	2,261.7	100.00						
All Other Intrastate			791.6	5.6			5.51	5.6
All Other Band 1 WATS			1,060.2	7.5			7.38	7.5
Band 2 WATS			183.8	1.3			1.28	1.3
Band 3 WATS			212.0	1.5			1.48	1.5
Band 4 WATS			353.4	2.5			2.46	2.5
Band 5 WATS			367.5	2.6			2.56	2.6
Grand totals			14,136.0	100.0				100.0

Table 8. Grand Totals of Toll Traffic from the Boise SO Per Month, Adjusted (This accounts for the Boise District Office (D-2) and the Lowman Office (D-5) being collocated in the same city as the SO.)

Traffic to	Number of Toll Minutes Per Month				Per Work Day Peak Hour Toll Call Minutes			
	Sub-total	Per-cent	Total	Per-cent	Sub-total	Per-cent	Total	Per-cent
District Office			3,729.5	29.9			25.95	29.9
D-1	957.8	25.68			6.66	25.68		
D-2 (Boise)	00.0	00.00			0.00	00.00		
D-3	923.9	24.77			6.43	24.77		
D-4	923.9	24.77			6.43	24.77		
D-5 (Summer)	00.0	00.00			0.00	00.00		
D-6	923.9	24.77			6.43	24.77		
Subtotals	3,729.5	100.00			25.95	100.00		
Regional Office			3,534.0	28.3			24.58	28.3
All Other SO's in R-4			2,261.8	18.1			2,261.80	18.1
SO's in Idaho	1,063.0	47.00						
SO's in Nevada	226.2	10.00						
SO's in Utah	814.2	36.00						
SO's in Wyoming	158.3	7.00						
Subtotals	2,261.7	100.00						
All Other Intrastate			791.6	6.3			5.51	6.3
All Other Band 1 WATS			1,060.2	8.5			7.38	8.5
Band 2 WATS			183.8	1.5			1.28	1.5
Band 3 WATS			212.0	1.7			1.48	1.7
Band 4 WATS			353.4	2.8			2.46	2.8
Band 5 WATS			367.5	2.9			2.56	2.9
Grand Totals			12,493.8	100.0				100.0

Observation Number Two and its associated figure (Figure 5) provide the teletraffic daily profile for us to adapt to our Forest. Figure 7 is our best estimate of the Boise teletraffic as a function of work hours.

Step 6: Compute the peak traffic rate for each major pattern. The major patterns for the Forest SO's are those calls to each of the District Offices (33% total) and to the RO (25% total). We know from Observation Number Three and Four, the peak hour occurs between 8:00 a.m. to 9:00 a.m. and constitutes 16% of the total daily teletraffic. These data are reflected in the last column of Table 7 and 8. This provides the planner with sufficient data to determine "grades of service" between two points. A planner can provide improved grades of service by adding more circuits or paths between two facilities and downgrade the service by limiting or reducing the number of connections or paths. The grade of service is quantitatively expressed in terms of calls blocked by circuit crowding versus all calls attempted. The number P.10 simply means that 10% of all calls attempted from one facility to another will be blocked by crowding; P.01 means only 1% of the calls are blocked. There are two excellent sources (Finefrock, 1974a; Finefrock, 1974b) which expand on this subject and provide the appropriate tables to compute grades of service as well as provide some basic guidelines.

Step 7: Compute the District Office total toll minutes talked per month assuming no special conditions or features. Observation Number Eight states that each District Office staff member talks an average of 83 minutes per month. From our fact sheets (Tables 5 and 6), we know there are 157 staff members in the Districts. Therefore:

157 staff members × 83 min./staff/mo. = 13,031 min./mo.

This is the unadjusted total toll minutes per month for all District Offices.

Step 8: Compute the unadjusted call distributions for each District Office. From Observation Number Seven, its associated table (Table 4), and our District Office fact sheet (Table 5), we can compute all of the necessary data for every District Office for every major call pattern. This is displayed in Table 9.

Step 9: Adjust the District Office computed toll traffic for any variations. Table 10 displays the adjusted District teletraffic. As before, the Boise and Lowman District Offices (D-2 and D-5, respectively) appear electronically to be co-located within the same city as the Boise National Forest SO, and therefore traffic between these centers is treated as local calling. Both of these

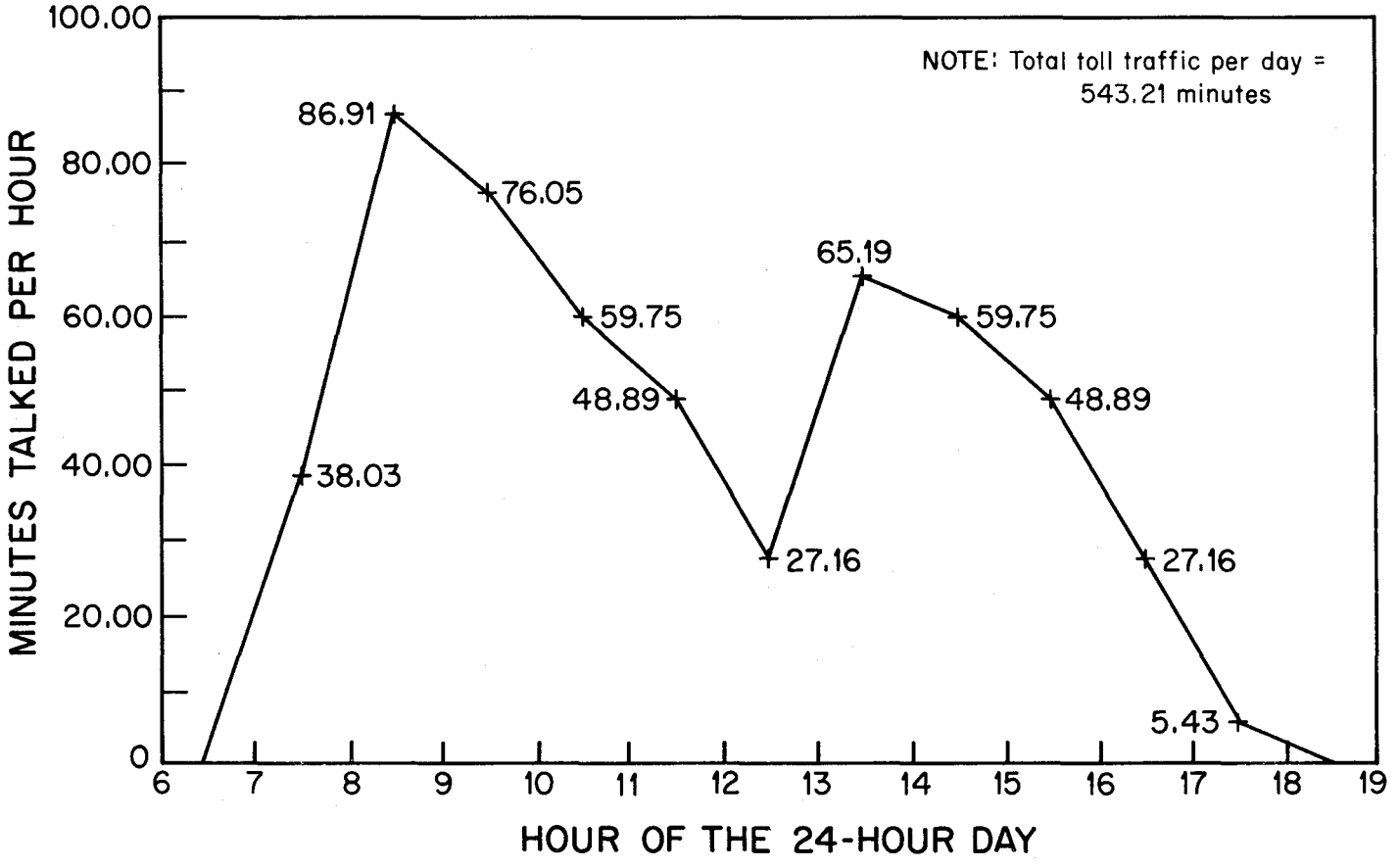


Figure 7. The Boise SO teletraffic work-hour profile.

Table 9. Unadjusted Toll Traffic from the Boise National Forest District Offices

District Office to	District Office codes and the percent of total District staff. All other figures are expressed in toll minutes per month							
	% of Total	Sub-Totals	D-1 17.83%	D-2 12.10%	D-3 17.20%	D-4 17.20%	D-5 18.47%	D-6 17.20%
SO	56.0	7,297.36	1,301.12	882.98	1,255.15	1,255.15	1,347.82	1,255.15
R-4 RO	2.0	260.62	46.47	31.54	44.83	44.83	48.14	44.83
Other SO's in R-4	3.6	469.12	83.64	56.76	80.69	80.69	86.65	80.69
Other Districts in the Boise NF	14.0	1,824.34	325.27	220.75	313.79	313.79	336.96	313.79
All Other Intrastate	15.7	2,045.87	364.78	247.55	351.89	351.89	377.87	351.89
Intrastate Total	85.7	11,167.57	1,991.18	1,351.28	1,920.82	1,920.82	2,062.65	1,920.82
Band 1 WATS	12.0	1,563.72	278.81	189.21	268.96	268.96	288.82	268.96
Band 2 WATS	0.8	104.25	18.59	12.61	17.93	17.93	19.26	17.93
Band 3 WATS	0.7	91.22	16.26	11.04	15.69	15.69	16.85	15.69
Band 4 WATS	0.7	91.22	16.26	11.04	15.69	15.69	16.85	15.69
Band 5 WATS	0.1	13.03	2.32	1.58	2.24	2.24	2.41	2.24
Grand Totals	100.0	13,031.0	2,323.4	1,576.8	2,241.3	2,241.3	2,406.8	2,241.3

NOTE: Slight roundoff errors may occur.

Table 10. Adjusted Toll Traffic from the Boise National Forest District Offices

District Office to	District Office codes and the percent of total District staff. All other figures are expressed in toll minutes per month							
	% of Total	Sub-Totals	D-1 17.83%	D-2 12.10%	D-3 17.20%	D-4 17.20%	D-5 18.47%	D-6 17.20%
SO	47.2	5,066.57	1,301.12	000.00	1,255.15	1,255.15	000.00	1,255.15
R-4 RO	2.4	260.62	46.47	31.54	44.83	44.83	48.14	44.83
Other SO's in R-4	4.4	469.12	83.64	56.76	80.69	80.69	86.65	80.69
Other Districts in the Boise NF	16.3	1,742.81	325.27	179.98	313.79	313.79	296.19	313.79
All Other Intrastate	19.1	2,045.87	364.78	247.55	351.89	351.89	377.87	351.89
Intrastate Total	82.6	8,855.25	1,991.18	427.53	1,920.82	1,920.82	674.06	1,920.82
Band 1 WATS	14.5	1,563.72	278.81	189.21	268.96	268.96	288.82	268.96
Band 2 WATS	1.0	104.25	18.59	12.61	17.93	17.93	19.26	17.93
Band 3 WATS	0.9	91.22	16.26	11.04	15.69	15.69	16.85	15.69
Band 4 WATS	0.9	91.22	16.26	11.04	15.69	15.69	16.85	15.69
Band 5 WATS	0.1	13.03	2.32	1.58	2.24	2.24	2.41	2.24
Grand Totals	100.0	10,718.7	2,323.4	653.0	2,241.3	2,241.3	1,018.3	2,241.3

NOTE: Slight roundoff errors may occur.

District Offices are still charged for calls to other District Offices, the RO, and so on. There are 1,824.34 minutes of District-to-District calls per month. Normally, D-2 contributes 220.75 minutes to these calls. But 14.47% or 40.77 minutes of the 220.75 minutes are to D-5 and must be removed from the D-2 toll count. Therefore, D-2 makes 179.98 minutes of toll calls (220.75-40.77) to all other District Offices in the Forest. Likewise, D-5 normally contributes 336.96 minutes to the toll call count. But 12.10% of D-5 teletraffic or 40.77 minutes are assumed to go to D-2. Therefore, D-5 will only generate 296.19 minutes of District-to-District toll teletraffic (336.96-40.77).

Remember to account for as many important variations as possible before preparing Table 10. Otherwise you will be required to redo Table 10 with each revelation, much as we did in preparing this example. A computer will help.

Step 10: Prepare several composite figures which display overviews of the teletraffic situation on your Forest. We are now loaded for the proverbial bear. Armed with the adjusted SO and District Office results found in Tables 8 and 10, we can lay out our best estimate of the overall traffic for the Boise National Forest. Figure 8 is the compiled distribution of the SO generated teletraffic which was derived from the information in Table 8. Compare these results with Figure 9 which is basically the same material for the District Offices. Notice the dramatic differences in each telepattern outreach.

There are two basic diagrams that should be drawn from these data. Figure 10 graphically portrays the entire Forest facilities. There are really four facilities which form part of the local SO teletraffic: the Airport facility, the Lucky Peak Nursery, the Boise District Office, and the Lowman District Office (both summer and winter). We always considered the Airport facility and Nursery an integral part of the SO. These four facilities are considered integral to the Boise SO by virtue of the Off-Premise Exchanges (OPX's) which connect them to the same centrex as the SO. A second drawing is perhaps even more interesting; Figure 11 shows the teletraffic as it emanates from the entire Boise Forest.

There are now more than ample data to prepare any combination of interconnect and switching alternatives. There are several excellent introductions to teletraffic planning (Mina, 1974; Bridges and White, 1979; Staff, 1977; Brackett, 1976) plus a series of references on various interconnect options (Rider, 1974; Finefrock, May 1974; Finefrock, November 1976). It will also be necessary to understand some of the basic principles associated with traffic as a function of time (Goeller, 1980), and grades of service calculations and tools (Goeller, 1979b),

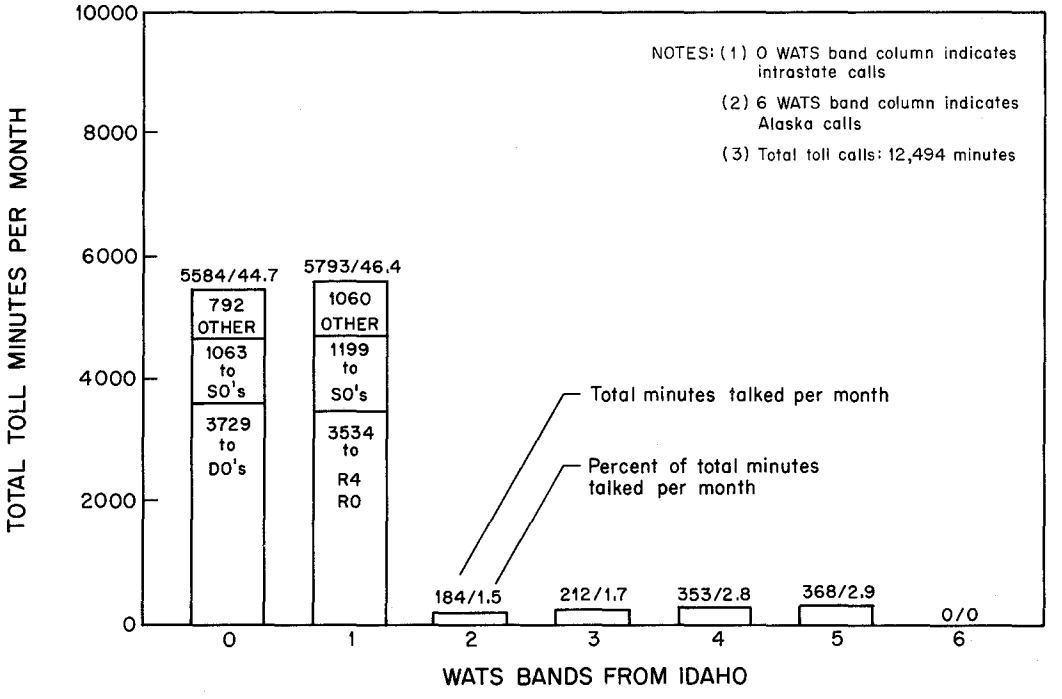


Figure 8. Compiled distribution of the Boise Supervisor Office generated teletraffic in toll minutes per month.

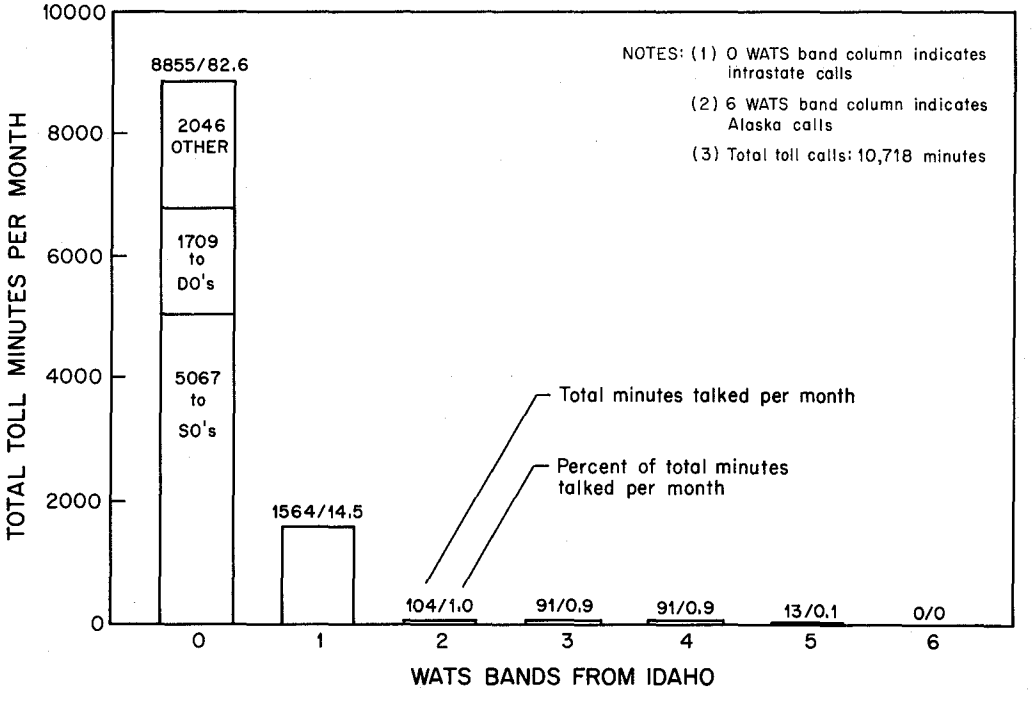


Figure 9. Compiled distribution of the Boise National Forest District Office generated teletraffic in toll minutes per month.

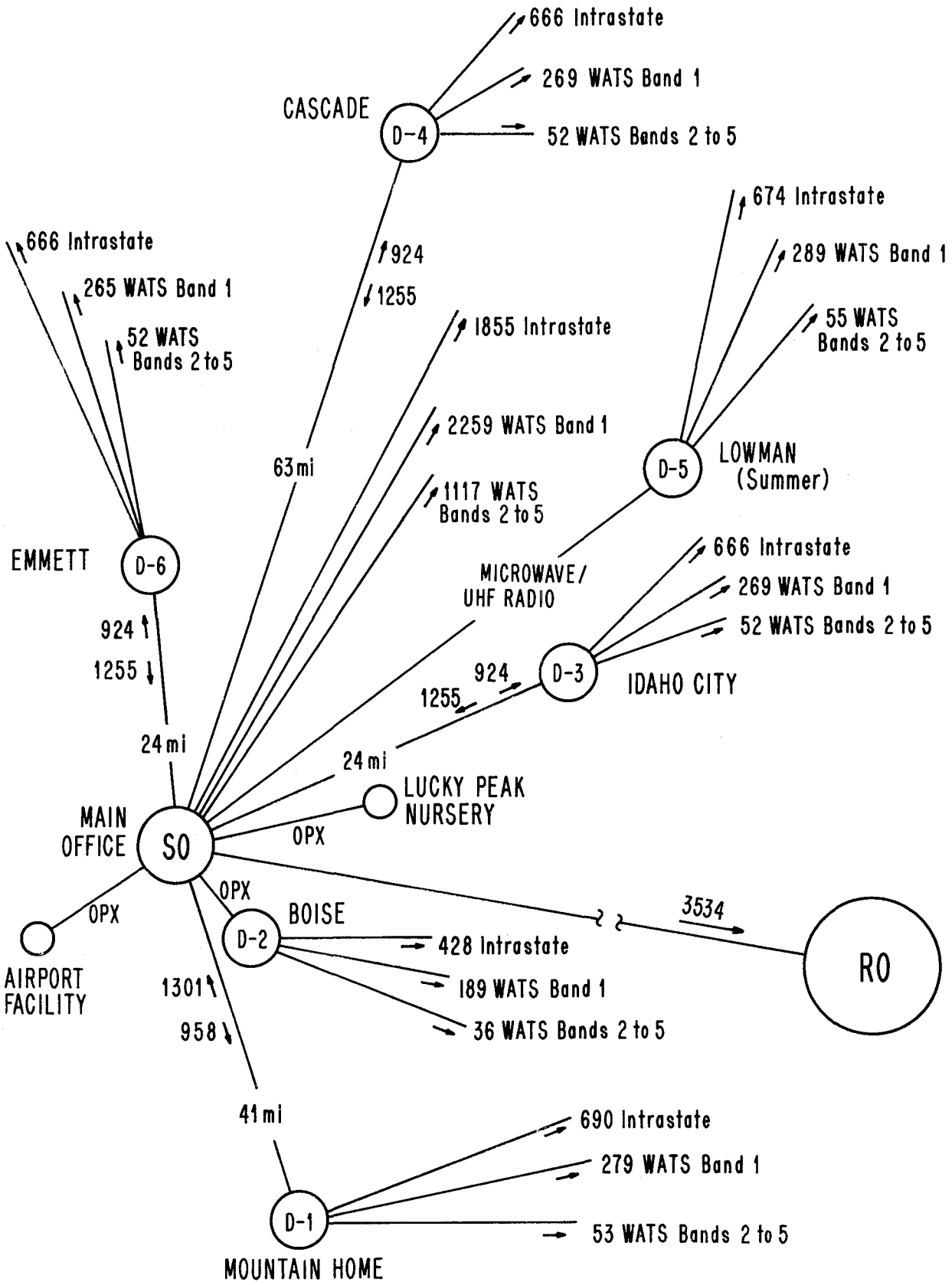


Figure 10. The Boise National Forest teletraffic patterns; all data is expressed in toll minutes per month.

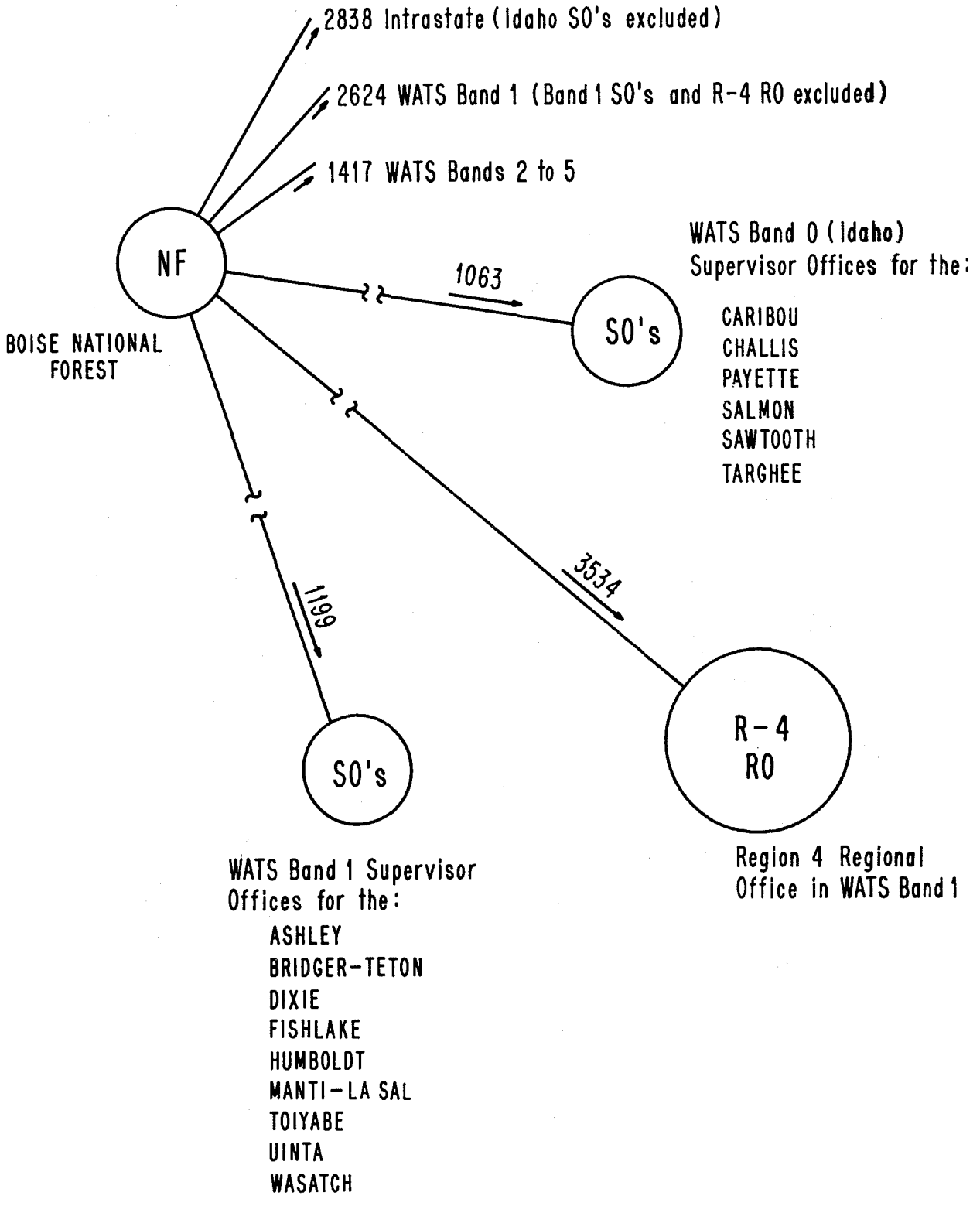


Figure 11. Teletraffic patterns from the Boise National Forest.

and basic queuing options for lines and networks (Goeller, 1979a; Jewett, 1977).

Keep in mind that the basic nonvarying parameters of teletraffic are the location and number of people. Their teletraffic patterns appear to be predictable. Once one can establish these patterns, then and only then can one proceed with the various systems and network options.

There is an important point to be made before concluding this report. It concerns a problem in using the data collected through billings, toll studies, and traffic recording devices. These data sources measure current use of the telephone systems on a forest. These sources, however, do not reflect the quality as to whether they truly meet the required demands of the user force or not. It is quite conceivable that the user force may be either disguntled with the service because toll circuits are difficult to access or they may be completely satisfied. In other words, the "carried traffic" can either meet or not meet the true user requirements. When the needs of the user are not being met, the service could be enhanced by offering more traffic capability to adequately meet this demand. This is called "offered traffic". As one collects teletraffic data one must also assess whether the carried versus offered traffic is in proper proportion. The carried traffic collected in this effort was, for the most part, well matched with the offered services. This was verified by sample interviews with the system users.

Also note that signal quality is independent of the carried versus offered traffic issue. Our sample interviews, for example, indicated that they had adequate access to toll circuits, but did complain on occasion about the quality of the line.

You must verify for yourself whether your data properly reflects a balance of carried versus offered service.

8. OBSERVATIONS AND SUMMARY

Effective teletraffic engineering must be based on the communication manager's common-sense appraisal of the world around him or her with a sharp eye toward telephone cost reduction. In this article we have given attention to a tool which one can use to estimate the teletraffic patterns of a National Forest. This tool or model is not in itself sufficient. It is necessary to correlate or compare the statistics of this model and the real-world experiences of the Forest which is being analyzed. These real-world experiences are reflected in billing records,

sampling, system performance, communication channel quality, service performance, and so on. There must be the task of subjectively evaluating the available data and arriving at the optimum balance between economy and efficiency.

The "how to" example of the Boise National Forest reflects both the attributes as well as the shortfalls of modeling. Notice in Table 5 that D-3 has 27 employees with 28 telephones but D-4 has 27 employees and only 10 telephones. Thus, D-3 has basically the same number of employees but three times the number of telephones as D-4. Yet, the model indicates their teletraffic is identical. Are their calling patterns and habits different, since they are imposed with this 10 phone restriction? And the D-5 Summer Office has a similar situation.

This precisely is where common-sense appraisals of real-world situations must be imposed by the planning staff. For D-3 to SO and D-4 to SO tie lines, the analysis suggests the use of one, two, or three lines with grades of service of P.24, P.03, and P.005, respectively. It appears that we must provide two or three lines under the circumstances. It is strictly a judgment call at this point based on accumulated data, fact sheets, and District personalities.

9. REFERENCES

Brackett, G.R. (1976), Telephony's Telephone Traffic Engineering Handbook, Telephony Publishing, Chicago, IL.

Bridges, J.W., and D.E. White (1979), The Design Process for Private Voice Networks, Business Communications Review, Hinsdale, IL.

Finefrock, J.W. (1974a), Poisson Traffic Tables Designed for Practical Use, Business Communications Review, Hinsdale, IL, March-April.

Finefrock, J.W. (1974b), Teletraffic Engineering Guidelines, Business Communications Review, Hinsdale, IL, May-June.

Finefrock, J.W. (1976), Tie Lines and Other Voice-Grade Private Lines, Business Communications Review, Hinsdale, IL, November-December.

Goeller, L.F. (1979a), To Queue or Not to Queue, Business Communications Review, Hinsdale, IL, March-April.

Goeller, L.F. (1979b), Programs for Traffic Calculation, Business Communications Review, Hinsdale, IL, May-June.

Goeller, L.F. (1980), Hourly Traffic Versus Monthly Data in Engineering Telephone Facilities, Business Communications Review, Hinsdale, IL, July-August.

Jewett, J.E. (1977), Network Design For Queuing Situations: Equivalent Queue EEB Tables and Examples, Business Communications Review, Hinsdale, IL, May-June.

Mina, R.R. (1974), Introduction to Teletraffic Engineering, Telephony Publishing, Chicago, IL.

Rider, M. (1974), Private Line Network Configurations, Business Communications Review, Hinsdale, IL, March-April.

Staff (1977), A Profile of Telecommunications Users, Business Communications Review, Hinsdale, IL, September-October.

FORM **NTIA-29**
(4-80)

U.S. DEPARTMENT OF COMMERCE
NAT'L. TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

BIBLIOGRAPHIC DATA SHEET

	1. PUBLICATION NO.	2. Gov't Accession No.	3. Recipient's Accession No.
	NTIA Report 82-113		

4. TITLE AND SUBTITLE

MODELING THE TELEPHONE TRAFFIC FOR A NATIONAL FOREST

5. Publication Date
November 1982

6. Performing Organization Code

7. AUTHOR(S) H.M. Gates, E.J. Alberts, A. P. Zollinger, and H.D. Mead

9. Project/Task/Work Unit No.
9104484

8. PERFORMING ORGANIZATION NAME AND ADDRESS

Institute for Telecommunication Sciences
National Telecommunications and Information Administration
U.S. Department of Commerce, Boulder, CO 80303

10. Contract/Grant No.

11. Sponsoring Organization Name and Address

U.S. Department of Agriculture
Forest Service
Intermountain Region, Boise National Forest
Boise, ID

12. Type of Report and Period Covered
Technical Report

13.

14. SUPPLEMENTARY NOTES

15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The Forest Service is in the process of updating its telecommunication and information systems. Included in this update are proposed changes to the telephone systems of selected National Forests with an eye toward telephone cost reductions over current system architectures and modes of operation. This document defines a Forest teletraffic model derived from correlations between teletraffic statistics and real-world experiences. The model is developed through nine Forest Service teletraffic observations. An example of its application is made to the Boise National Forest. Effective teletraffic and switch engineering must be based on the communication manager's common sense appraisal of the model results and his or her own Forest teletraffic statistics.

16. Key Words *(Alphabetical order, separated by semicolons)*

modeling; prediction; telecommunication; teletraffic

17. AVAILABILITY STATEMENT	18. Security Class. *(This report)*	20. Number of pages
☒ UNLIMITED.	Unclassified	46
☐ FOR OFFICIAL DISTRIBUTION.	19. Security Class. *(This page)* Unclassified	21. Price:

★U.S. GOVERNMENT PRINTING OFFICE: 1983-0-677-282/80