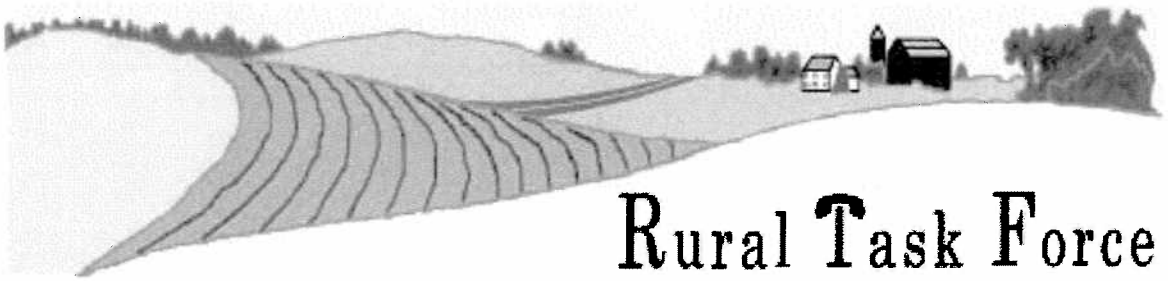

The Rural Difference

Rural Task Force
White Paper 2
January 2000

http://www.wutc.wa.gov/rtf

The Rural Task Force is an independent advisory panel appointed by the Federal – State Joint Board on Universal Service to provide guidance on universal service issues affecting rural telephone companies. Opinions expressed in this White Paper are the collective view of the Rural Task Force membership and are not intended to represent the views of organizations to which each member is affiliated or those of the FCC or the Joint Board on Universal Service.

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Rural Task Force White Paper 2

The Rural Difference

I. Introduction

Both Congress and the Federal Communications Commission (FCC or Commission) have recognized that "rural telephone companies" (Rural Carriers or RTCs), including carriers serving insular areas, are different in terms of the costs they face and the territories they serve.[1] White Paper 1 carefully outlined the policy and legal framework developed by the Telecommunications Act of 1996[2] (the 1996 Act) and the Commission in recognition of these differences and discussed the rationale for why universal service mechanisms and policies for Rural Carriers may be appropriately different than for non-Rural Carriers.[3]

Rural Task Force (Task Force, or RTF) White Paper 2 "The Rural Difference" follows through on our commitment to "factually document rural differences."[4] Analysis of publicly available industry and U.S. Census data, verified through numerous individual company interviews, and various case examples contributes to this first-of-its-kind overview of the broad operational and market differences distinguishing Rural Carriers from non-Rural Carriers. In addition, a detailed examination of the differences among Rural Carriers points out the

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[1] The terms Rural Carrier or RTC are meant to incorporate the statutory definition of "rural telephone company" in Section 3 of the 1996 Act and its application in the FCC rules, adopted pursuant to CC Docket No. 96-45, which set a separate schedule and additional scrutiny for "rural telephone companies," May 8, 1997 Decision, ¶ 96. FCC *Public Notice* CC Docket No. 96-45, DA 98-1205 (released June 22, 1998) lists recognized self-certified "Rural Telephone Companies." "Rural telephone company" means a local exchange carrier operating entity to the extent that such entity-- (A) provides common carrier service to any local exchange carrier study area that does not include either-- (i) any incorporated place of 10,000 inhabitants or more, or any part thereof, based on the most recently available population statistics of the Bureau of the Census; or (ii) any territory, incorporated or unincorporated, included in an urbanized area, as defined by the Bureau of the Census as of August 10, 1993; (B) provides telephone exchange service, including exchange access, to fewer than 50,000 access lines; (C) provides telephone exchange service to any local exchange carrier study area with fewer than 100,000 access lines; or (D) has less than 15 percent of its access lines in communities of more than 50,000 on the date of enactment of the Telecommunications Act of 1996 (47 U.S.C. Section 153 (37)).

[2] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat.56 (1996 Act).

[3] See Rural Task Force White Paper 1: Mission and Purpose, September 1999, available at http://www.wutc.wa.gov/rtf.

substantial diversity within the class of more than 1,300 study areas served by companies defined as Rural Carriers.[5]

White Paper 2 begins with a brief executive summary to highlight major findings and conclusions. Section II provides an overview emphasizing the dominance of Rural Carriers in the least populated regions of the nation and the associated challenges of providing universal service. Section III includes a detailed analysis of "customer related" and "operations related" variables which have particular implications for the cost of doing business and providing telecommunications services in areas served by Rural Carriers. Section IV briefly touches on remaining challenges for Rural Carriers, including increased service penetration levels and provision of advanced services. The final section draws several broad conclusions from the analysis. The analysis in the Paper is supported by additional data in appendices.[6]

The documentation and analysis contained in White Paper 2 provide an important foundation for future work of the Task Force. Specifically, these "rural differences" must be considered by the Task Force as we evaluate the appropriateness of proxy cost models and alternative universal service mechanisms as applied to the unique factors facing Rural Carriers. This report recognizes the universal service challenge framed by Congress and the importance of considering unique rural circumstances in designing appropriate mechanisms and policies to preserve and advance universal service in rural areas of the United States, its territories, and protectorates.

The Task Force anticipates reaching its ultimate recommendations in the context of these unique characteristics, and pursuant to its missions and purpose outlined in White Paper 1. Future White Papers will address technical issues specific to Forward Looking Economic Cost

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4 White Paper 1, page 8

5 A "study area" is generally the entire territory within a single state served by a telephone company.

(FLEC) proxy models, competitive issues, and alternatives to FLEC proxy models as a basis for universal service funding in areas served by Rural Carriers.

EXECUTIVE SUMMARY

There is a substantial "rural difference" between the operational scope and markets in theapproximately 1,300 study areas served by Rural Carriers and their non-Rural Carrier counterparts. These operational and market distinctions underlie sections of the 1996 Act which explicitly apply different regulatory standards to Rural Carriers for universal service, designating Eligible Telecommunications Carriers, interconnection and competitive entry. Indeed, the fact that the operations of Rural Carriers and the markets they serve are distinct from those of large, urban oriented non-Rural Carriers underlies the rationale for the formation of this Rural Task Force.

While the "rural difference" is generally recognized, it is largely undocumented. White Paper 2 describes data assembled for the first time on a national basis, systematically comparing and contrasting Rural Carriers and non-Rural Carriers. Equally important, the analysis presented here also documents a substantial diversity among Rural Carriers themselves. An understanding of differences between Rural Carriers and non-Rural Carriers, and diversity among Rural Carriers is key to designing appropriate mechanisms and policies necessary to achieve the universal service principles required by the 1996 Act.

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[6] Visit the RTF Internet web site at http://www.wutc.wa.gov/rtf for a more complete set of the data.

The following are major Rural Carrier differences identified in White Paper 2:

Both Rural Carriers and non-Rural Carriers serve rural communities. However, Rural Carriers' operations tend to be focused in the more geographically remote areas of the nation with widely dispersed populations.

- Nationwide, Rural Carriers serve about eight percent of the nation's access lines, 38 percent of the nation's land area, and 93 percent of the study areas.

- The average population density is only 13 persons per square mile for areas served by Rural Carriers compared with 105 persons per square mile in areas served by non-Rural Carriers.

- Evaluating proxy cost model output for a representative sample of 10 states, Rural Carriers serve 70 percent of the modeled serving areas with less than 5 lines, but only 10 percent of the modeled serving areas with over 100 lines.[7]

[7] A critical component in the design of a local exchange telephone network connecting every customer to a local central office switch is the definition of a "serving area" which consists of a group of customers served from a common remote terminal. Feeder plant connects every serving area to the central office and distribution plant connects every customer in a given serving area to a "serving area interface" (digital loop carrier or DLC). Clustering algorithms group customers to form serving areas so that no customer is farther from a potential DLC location than is permitted by the maximum copper distance. The maximum number of customers in a serving area depends on the capacity of the largest DLC terminal. (From: "The Hybrid Cost Proxy Model Customer Location and Loop Design Modules" by C. A. Bush, D. M. Kennet, J. Prisbrey and W. W. Sharkey – FCC, and Vaikunth Gupta - Panum Telecom, LLC.)

There is significant variation in study area sizes and customer bases among Rural Carriers.

- The vast majority of access lines served by Rural Carriers are clustered in the largest study areas.

- Rural Carriers serving the three smallest study area groupings (2,500 lines or less) encompass 48% of all study areas, but only 5% of all access lines served by Rural Carriers. On the other hand, Rural Carriers serving the three largest study area groupings (20,000 lines or more) contain only 10.5% of all study areas, but 67% of all access lines.

- The average population density of areas served by Rural Carriers varies radically. Rural Carriers in Alaska and Wyoming serve populations of 0.58 and 1.25 persons per square mile respectively, while Rural Carriers in some states serve populations of over 100 persons per square mile.

Isolation of areas served by Rural Carriers results in numerous operational challenges.

- Rural Carriers have relatively high loop costs because of the lack of economies of scale and density.

- Rural Carriers experience difficulty and high cost in moving personnel, equipment and supplies to remote and insular communities.

- Geographic surface conditions - such as coral, volcanic rock and permafrost - require expensive specialized outside plant construction practices.

- More resources, including duplicate facilities and backup equipment are required to protect network reliability.

Compared to non-Rural Carriers, the customer base of Rural Carriers generally includes fewer high-volume users, depriving Rural Carriers of economies of scale.

- On average, multi-line business customers represent about 13 percent of total business lines served by Rural Carriers compared to over 21 percent of the lines served by non-Rural Carriers.

- Non-Rural Carrier study areas typically have higher business customer density than Rural Carrier study areas.

- On average, special access services purchased by large users only represent about three percent of total interstate revenues for Rural Carriers compared to nearly 18 percent for non-Rural Carriers.

- There is substantial diversity among Rural Carriers in providing special access service to customers. Interstate special access revenues compared to total interstate revenues for Rural Carriers range from zero to 36 percent.

Compared to customers of non-Rural Carriers, customers of Rural Carriers tend to have a relatively small local calling scope and make proportionately more toll calls

- On average, local minutes comprise 85 percent of total intrastate minutes for non-Rural Carriers, but only about 69 percent of total intrastate minutes for Rural Carriers.

- Rural Carriers have a higher average proportion of interstate toll minutes to total minutes (21 percent) than non-Rural Carriers (16 percent).

- Seventy to 80 percent of customers of smaller Rural Carriers can reach less than 5,000 other customers with a local call. Only 10 percent of smaller Rural Carriers have local calling capability to as many as 25,000 other subscribers.

Rural Carriers frequently have substantially fewer lines per switch than do non-Rural Carriers, providing fewer customers to support high fixed network costs

- On average, Rural Carriers have only 1,254 customers per switch compared to over 7,000 customers per switch for non-Rural Carriers.

- For Rural Carriers, the number of lines per switch decreases dramatically as the line size of the study area served decreases. Rural Carrier study areas with more than 100,000 lines

average nearly 3,000 lines per switch, compared to an average of only 223 lines per switch for study areas with less than 500 lines.

Total investment in plant per loop is substantially higher for Rural Carriers compared to non-Rural Carriers

- On average, total plant investment per loop is over $5,000 for Rural Carriers compared to less than $3,000 for non-Rural Carriers.

- Average total plant investment per line for Rural Carriers increases as the line size of the study area decreases. Average total plant investment per line ranges from $3,000 for Rural Carriers with the largrest study areas to over $10,000 for Rural Carriers with the smallest study areas.

- The range of values for total plant investment per loop for Rural Carriers ($1,400 to $40,500) is far greater than the range for non-Rural Carriers ($1,570 to $4,350).

Plant specific and operations expenses for Rural Carriers tend to be substantially higher than for non-Rural Carriers

- On average, plant specific expenses per loop are $180 for Rural Carriers compared to $97 per loop for non-Rural Carriers.

- Average Rural Carrier plant specific expenses increase consistently as the number of lines served decreases, from approximately $110 per loop for carriers with more than 20,000 lines to $445 per loop for carriers with study areas having less than 500 lines.

- The range of total plant specific expenses per loop for Rural Carriers ($4 to $1,585) is substantially greater than for non-Rural Carriers ($38 to $163).

- Depreciation expenses and corporate operations expenses per loop tend to follow similar trends as for plant specific expenses, that is, they increase as the number of lines served decreases.

Income and demographic challenges, as well as advanced services issues, also impact Rural Carriers significantly.

- 1990 U.S. Census data indicates the average annual household income for customers in Rural Carrier Service areas was $31,211, 20 percent lower than that of non-Rural Carrier customers ($38,983).

- Native Americans are disproportionately represented among those without phone service. Rural Carriers serve a higher percentage of Native American customers than non-Rural Carriers.[8]

- The Kindergarten – 12th Grade school is the point of Internet access for 30 percent of students in rural areas, compared to only 21.8 percent for students in non-rural areas.

Documenting and understanding the "rural difference" is essential for the design of effective mechanisms and policies to achieve the national universal service principles set forth in the 1996 Act. Analysis of the "rural difference" in customer and operational variables, as well as in various case examples presented in White Paper 2, gives emphasis to a central conclusion of the Task Force's first White Paper. That is, "one-size-fits-all" national universal service policy is unlikely to be successful in fulfilling the national universal service principles contained in the 1996 Act. To be successful, policies and mechanisms ultimately adopted must be flexible enough to accommodate a wide range of market and operational circumstances faced by telecommunications carriers serving rural populations.

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[8] For more information on rural carrier service to Native Americans, *see* National Telephone Cooperative Association (NTCA) paper, Dial Tone is Not Enough: Serving Tribal Lands; NTCA, November 1999, and NTCA Member Serving Tribal Areas Survey Report, NTCA, December 10, 1999. <www.ntca.org>

II. One Nation, Diverse Circumstances

The 1996 Act made a fundamental shift in the way telecommunications services are to be delivered, but also firmly incorporated an underlying promise about how it would be done. The "shift" was an opening of local telecommunications markets to competition. The "promise" was that universal service would be preserved and advanced. In passing the 1996 Act Congress was clear that we are one nation, and that national universal service policy must ensure the benefits of telecommunications industry reform accrue to all Americans, including those in remote rural and insular regions, and unserved areas.[9] As an integral part of this mandate, Congress established statutory distinctions between Rural Carriers and non-Rural Carriers.[10] In carrying out Congress' mandate, the FCC has recognized that universal service support mechanisms for Rural Carriers and non-Rural Carriers may be appropriately different. The Task Force is charged with evaluating these differences and recommending an appropriate support system for Rural Carriers. In order to gain an understanding of the differences between Rural Carriers and non-Rural Carriers as well as the diversity among Rural Carriers, an overview of the unique challenges of Rural Carriers is necessary.

A. Unique Challenges of Rural Carriers

Rural Carriers and the areas they serve are extremely diverse. The following anecdotes illustrate the unique circumstances Rural Carriers can face, and the associated challenges in delivering service:

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9 See the 1996 Act, Section 254 (universal service) and Section 214(e)(3) (unserved territory).

10 These statutory distinctions were discussed in depth in Rural Task Force White Paper 1 "Mission and Purpose."

1. Arizona Telephone Company serves 10 exchanges with 3,606 access lines covering an area of approximately 5,162 square miles, a company-wide density of .70 access lines per square mile. The Supai, Arizona, exchange serves 92 access lines in a service territory of 1,508 square miles, a density of .06 access lines per square mile. Almost all of the customers in the Supai exchange live at the bottom of Havasu Canyon, a location 70 miles from the nearest town, Peach Spring, Arizona. Access to town is either by helicopter or by a nine-mile ride on horse- or mule-back. Service calls to the exchange are scheduled on a once-weekly basis by a technician located in Mormon Lake, Arizona, 190 miles from Supai. Emergency visits are limited to extreme outages, and are subject to mule, horse, or helicopter availability. Chartered helicopter flights normally require one week advance notice at a cost of $2,500 per trip.

2. The town of Sand Point, Alaska had a water and sewer project underway which required moving and installing new telephone cable. The only ferry that could carry a truck with cable to the island had been scheduled for use. However, the truck delivering the cable broke down and missed the annual ferry run. The cable reels were too large to be carried on the regular freight plane that serviced the area, so a CL123 (Hercules) airplane had to be chartered at a cost of $25,000 to deliver the cable. Otherwise, half of the town would have been without telephone service for a year.

3. Little Diomede Island is an inland in the middle of the Bering Strait, two miles from Russian Big Diomede Island. It has a small Native American community with 57 access lines. Access to the island is primarily by air. In the winter, a runway can be plowed on the pack ice in the Bering Sea and an air trip from Nome costs $175. In the summer, access to the island is by helicopter at the cost of $3,000 per trip. The Telephone Company in this area has placed two separate loops to each home to limit the number of service calls that are necessary.

4. The Island Telephone Company serves four islands off the coast of Maine with approximately 500 access lines on four islands. The smaller islands have 60 to 90 customers on each island. Distances of the islands from the mainland vary from six miles to 23 miles. Service calls are dependent on varying boat service or charter small plane flights capable of landing on a short, uphill, gravel runway that is on one island. Boat availability to one island is only once a month during the winter. Service to the islands is provided by digital microwave equipment, and in one case a spread spectrum radio. Weather conditions including fog, changes in the tides, and ocean temperature all impact service reliability. Daily service is provided by technicians from the mainland or by part-time technicians located on the islands. In order to provide mobility on the islands and to eliminate reliance on boat service, a service vehicle is permanently located on each island, although they may be in use only a few hours a week.

B. The Challenge of Low Population Density

The examples above illustrate the unique circumstances facing rural telephone companies. While not every Rural Carrier must deal with operational difficulties of the extreme nature illustrated by these examples, Rural Carriers in general must deal with the special challenge of low population density.

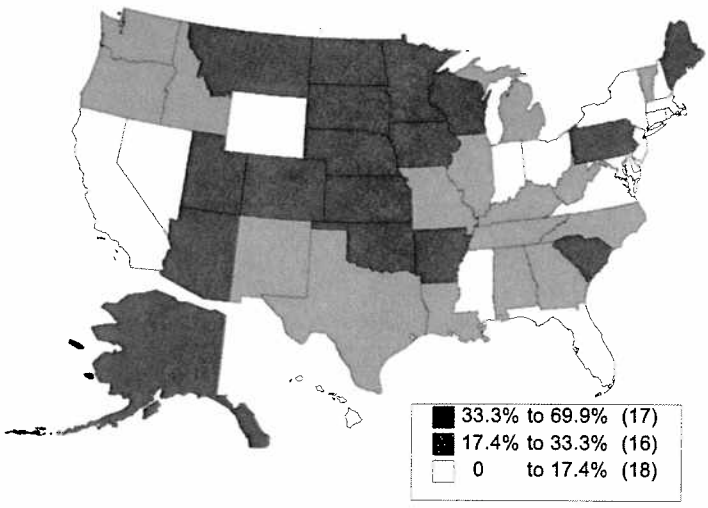
1. Comparison of Rural Carrier and Non-Rural Carrier Service Area

In response to a request from the Task Force, the Rural Policy Research Institute (RUPRI) with the University of Missouri Office of Social and Economic Data Analysis assembled detailed

data from the 1990 U.S. Census to illustrate the challenge of low density facing Rural Carriers.[11] We highlight several of the key findings here.[12] Information from the National Exchange Carrier Association (NECA) and the FCC, was assembled, analyzed and sorted as well.

Figure 1 shows that in 17 states Rural Carriers serve more than a third of the land area in that state.[13] For example Rural Carriers serve almost 70 percent of the land area in Alaska.

Figure 1. Percent Land Area Served by Rural Carriers by State



Nationally, Rural Carriers serve only about eight percent of all of the access lines in the nation, but cover over 38 percent of the nation's land area.[14] Typically customers of Rural Carriers are widely dispersed, presenting unique challenges for those companies in deploying and maintaining service. For example, Rural Carriers in South Dakota serve a population density of four persons per square mile and cover over half of the state's land area.

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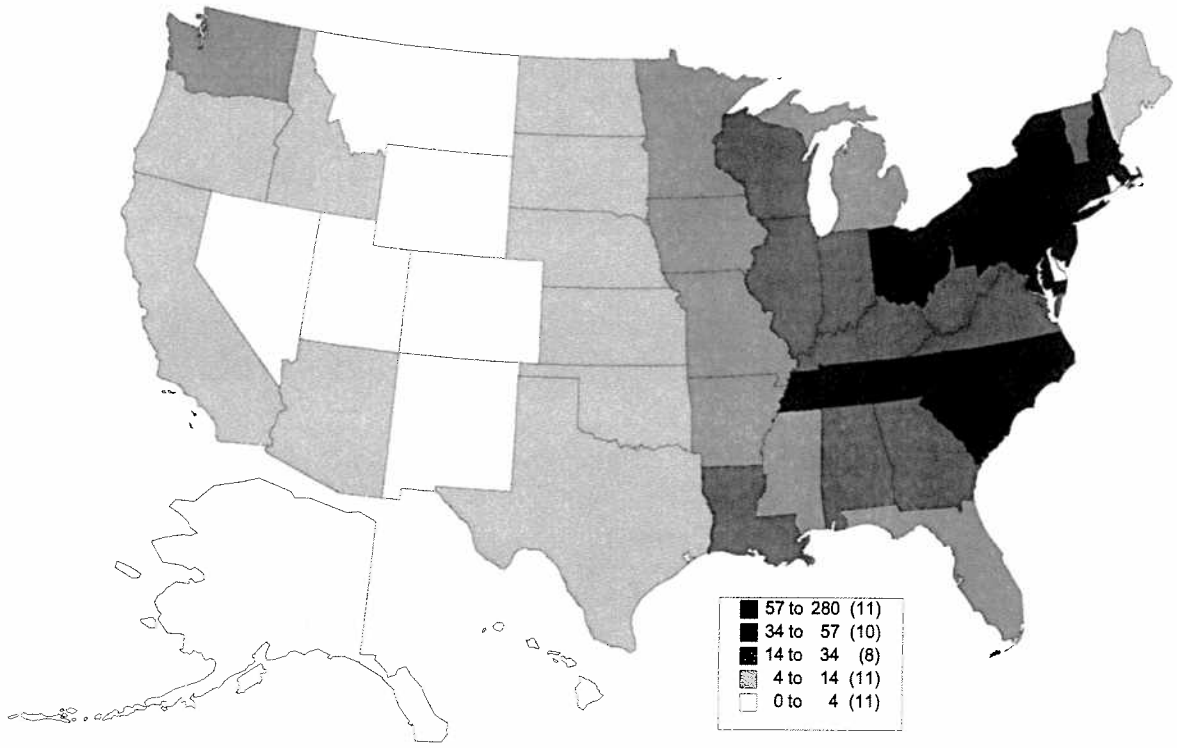
[11] The 1990 U.S. Census is the most comprehensive and current data available to make a comprehensive comparison of population density data across areas served by Rural Carriers and non-Rural Carriers.

[12] "The Rural Differential: An Analysis of Population Demographics in Areas Served by Rural Telephone Companies," August, 1999, by Vicki M. Hobbs, and John Blodgett. *See:* http://www.rupri.org.

[13] Based upon RUPRI analysis of 1990 U. S Census data shown in Table 1. The number of observations in each range shown in the legend sums to 51, i.e., fifty states plus the District of Columbia.

The map in Figure 2 shows the differences in population density of areas served by Rural Carriers.[15] Population density in Rural Carrier service areas in the Rocky Mountain West is less than four persons per square mile. In Alaska Rural Carriers serve approximately 234,000 access lines in an area with an average 0.58 persons per square mile. In ten more western states, plus Maine, population density is between four and 14 persons per square mile in Rural Carrier service area. At the high end of the scale, in eleven Eastern states population density in Rural Carrier service areas ranges from 57 to 280 persons per square mile.

Figure 2. Rural Carrier Population Density by State (persons Per Square Mile)



[14] Data-mapping software excluded the Commonwealth of Northern Marianas Islands (Micronesia), Guam, the U. S. Virgin Islands and Puerto Rico. The U. S. Virgin Islands are served entirely by a Rural Carrier, while Puerto Rico is served entirely by a non-Rural Carrier.

[15] Figure 2 is also based upon RUPRI analysis of U. S. Census data as shown in Table 1.

In every state, the population density per square mile served by Rural Carrier's is substantially less than for non-Rural Carriers. **Nationally the population density in areas served by Rural Carriers is only about 13 persons per square mile. This compares to a national average population density of 105 persons per square mile in areas served by non-Rural Carriers.** There is a wide variance in average population served by Rural Carriers in the different states (see **Table 1**). For instance, the mean population density of areas served by Rural Carriers ranges from 0.58 persons per square mile in Alaska and 1.25 in Wyoming, to 280 and 247 persons per square mile respectively in Connecticut and New Jersey. By comparison, non-Rural Carrier population density in Alaska is 2 persons per square mile, and in New Jersey it is 1,153 persons per square mile.

Figure 3 shows that Rural Carriers almost always serve the minority of the access lines in a given state, with exceptions being isolated areas such as Alaska (59 percent) and insular territories and protectorates (for example, Guam, Micronesia, and the Virgin Islands: 100 percent). In 26 states, Rural Carriers serve less than 12 percent of the access lines in the state. For example, Rural Carriers serve only four percent of the access lines in Colorado, but cover 46 percent of the land area.[16]

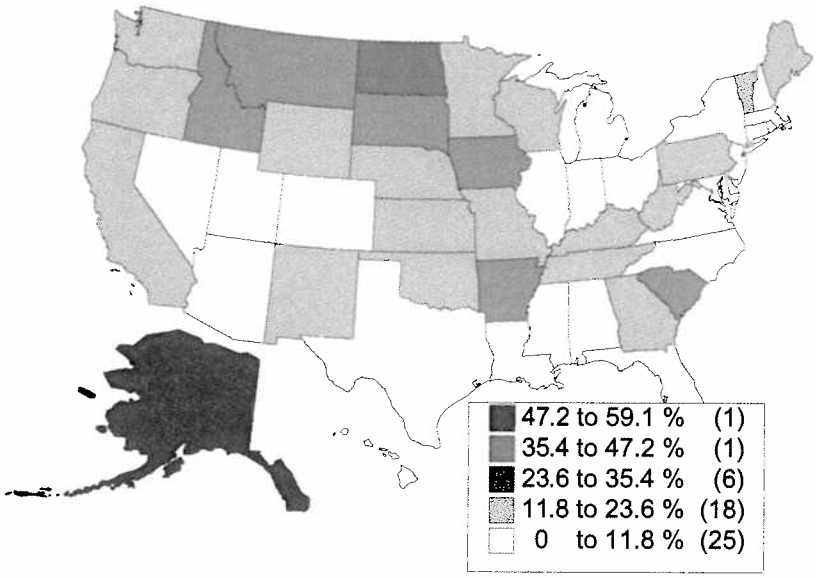
[16] See Second Quarter 1999 Universal Service Fund data in Table 1.

Table 1. Number of Loops and Density for Rural vs. Non-Rural Carriers[17]

State	Rural Carrier Loops (000 omitted)	non-Rural Carrier Loops (000 omitted)	Percentage Rural Carrier Loops	Population Density Per Square Mile Rural Carriers	Population Density Per Square Mile Non-Rural Carriers	Percent Land Area Served by Rural Carriers
Alabama	209	2,196	9%	35	91	19%
Alaska	234	164	59%	0.58	2	70%
Arizona	173	2,559	6%	5	51	41%
Arkansas	405	963	30%	25	59	40%
C.N.M.I. (Micronesia)	61	0	100%			100%
California	456	21,027	2%	8	211	14%
Colorado	118	2,526	4%	3	56	46%
Connecticut	22	2,131	1%	280	685	2%
DC	0	920	0%	0	9,880	
Delaware	0	532	0%	0	341	
Florida	168	10,323	2%	29	271	14%
Guam	73	0	100%			100%
Georgia	774	3,996	16%	42	132	24%
Hawaii	0.346	708	0%	0	172	
Idaho	193	488	28%	4	16	33%
Illinois	306	7,675	4%	43	253	22%
Indiana	158	3,313	5%	54	173	15%
Iowa	555	1,034	35%	22	80	53%
Kansas	253	1,331	16%	8	47	43%
Kentucky	267	1,797	13%	47	113	31%
Louisiana	174	2,262	7%	35	113	21%
Maine	130	679	16%	13	54	43%
Maryland	6	3,487	0%	208	489	
Massachusetts	4	4,460	0%	154	774	1%
Michigan	268	5,990	4%	22	211	25%
Minnesota	624	2,254	22%	24	91	53%
Mississippi	85	1,236	6%	28	59	15%
Missouri	462	2,862	14%	20	96	28%
Montana	157	351	31%	3	8	52%
Nebraska	194	802	19%	5	36	49%
Nevada	86	1,121	7%	2	12	12%
New Hampshire	51	767	6%	61	135	13%
New Jersey	208	5,993	3%	247	1,153	12%
New Mexico	134	768	15%	2	15	20%
New York	691	12,023	5%	88	432	15%
North Carolina	515	4,179	11%	82	148	17%
North Dakota	152	250	38%	5	15	56%
Ohio	488	6,241	7%	124	287	13%
Oklahoma	226	1,728	12%	13	73	44%
Oregon	248	1,774	12%	10	35	18%
Pennsylvania	1,266	6,686	16%	109	381	42%
Puerto Rico	0	1,263	0%			
Rhode Island	0	653	0%	0	960	
South Carolina	563	1,584	26%	60	153	40%
South Dakota	140	266	34%	4	17	58%
Tennessee	408	2,863	12%	57	142	27%
Texas	648	11,358	5%	12	90	32%
Utah	51	1,049	5%	3	30	34%
Vermont	60	334	15%	36	70	18%
Virginia	143	4,239	3%	39	171	11%
Virgin Islands	61	0	100%			100%
Washington	409	3,091	12%	14	97	29%
West Virginia	158	801	16%	45	83	23%
Wisconsin	605	2,691	18%	34	153	53%
Wyoming	47	237	17%	1.25	5	15%
US	13,847	160,024	8%	13	105	38%

[17] Loop data: Second Quarter, 1999, Universal Service Fund Quarterly Monitoring Report. Population and Land Area data: 1990 U. S. Census, sorted by RUPRI.

Figure 3. Percent of Access Lines Served by Rural Carriers by State

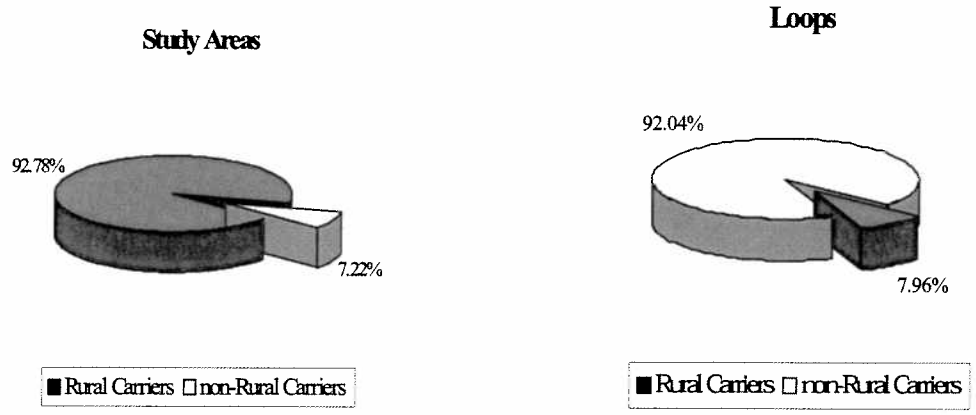


Although non-Rural Carriers also serve rural populations, their scale of operations is substantially different from that of smaller Rural Carriers. In addition, non-Rural Carriers have customers in remote areas, but these customers tend to make up a much smaller proportion of their total customer base than is the case for Rural Carriers.

Figure 4 shows that Rural Carriers serve 92.78 percent of the study areas nationwide, but only 7.96 percent of the loops.[18] Non-Rural Carriers have only 7.22 percent of the study areas, but 92.04 percent of the loops in the United States. Again, this data is consistent with the observation that Rural Carriers tend to serve the most widely dispersed population groups.

[18] Second Quarter, 1999, Universal Service Fund, see Table 1.

Figure 4. Comparison of Rural Carrier Study Areas and Loops to non-Rural Carriers



The concentration of Rural Carrier service in low population-density areas can also be illustrated by using intermediate customer clustering results from the federal cost model for non-Rural Carriers.[19] The federal cost model for non-Rural Carriers builds unloaded copper loops (less than 18,000 feet) to every customer from carrier serving areas. The model performs an elaborate optimization routine to assign customers to clusters so that they are served with the minimum amount of plant. The maximum cluster size is limited to the capacity of the subscriber carrier system (about 1,800 access lines).

As population density declines, costs tend to rise. The model shows one reason for this, as fewer subscribers are within range of the carrier system, the number of lines within a cluster drops. A small number of customers within a cluster means low customer density and is a measure of just how "rural" an area is. A one-customer cluster, for example, is extremely rural. The maximum area of a cluster is about 23 square miles. A cluster of the maximum area serving a single customer would have a customer density of only 0.0435 customers per square mile.

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[19] *See* CC Docket No. 96-45, FCC 99-304. Although the federal cost model has not been validated in terms of accuracy in predicting cost in Rural Carrier service areas, and may make errors as it clusters customers into serving

The clustering results of the cost model provide a unique analytical tool since they can be developed for wide geographic areas and compared between Rural Carriers and non-Rural Carriers. There is no comparable way of looking at historical data because carriers do not report (nor are they required to maintain) records with detail down to the serving area level, nor in many cases is the plant built to carrier serving area specifications.

An analysis of the serving area clusters produced by the federal cost model was made for a representative sample of ten states.[20] Clusters were grouped by the number of lines assigned to each cluster. Within each group an analysis was made of the percentage of lines served by Rural Carriers and non-Rural Carriers.

Figure 5 shows that as the line size of the cluster decreases, the percentage of clusters served by Rural Carriers increases. That demonstrates the low density of areas served by Rural Carriers. While both non-Rural Carriers and Rural Carriers serve low-density markets, the Rural Carriers tend to serve the most isolated population. For the largest cluster grouping with over 100 lines, 90 percent are served by non-Rural Carriers. For the smallest cluster grouping with less than five lines, 70 percent are served by Rural Carriers.

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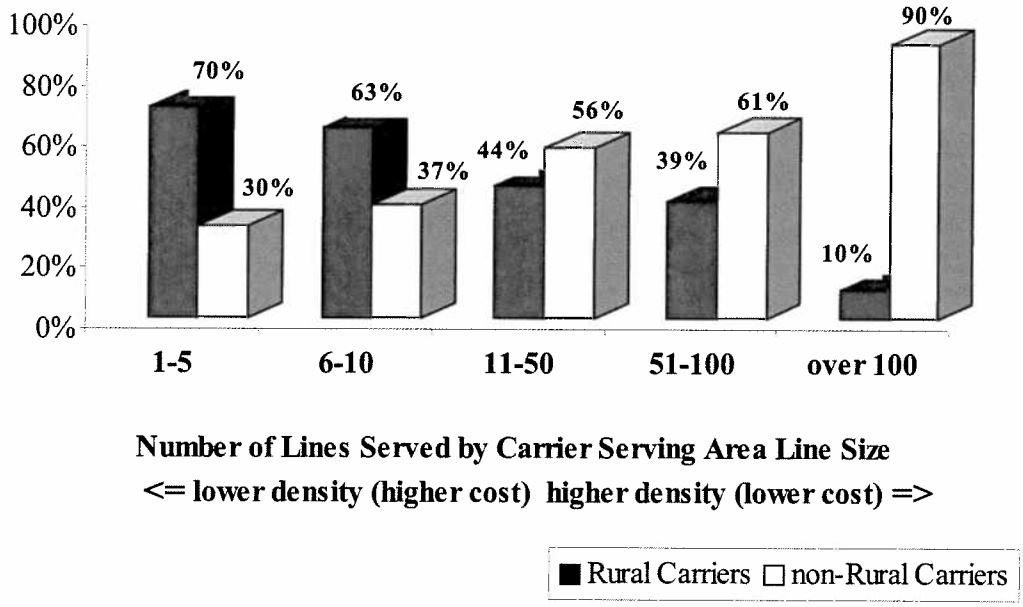
areas, the errors will are not relevant to the type of company serving the area. The model makes identical errors whether it is clustering customers of a Rural Carrier or a non-Rural Carrier.

[20] Georgia, Maine, Michigan, Mississippi, Montana, Nebraska, New Mexico, Pennsylvania, Texas, and Washington were chosen as representative. Additional states were not analyzed due to the resource intensive nature of the analysis. *See* Appendix.

Figure 5. Customer Distribution as Determined by the Federal Cost Model in Representative Sample of Ten States

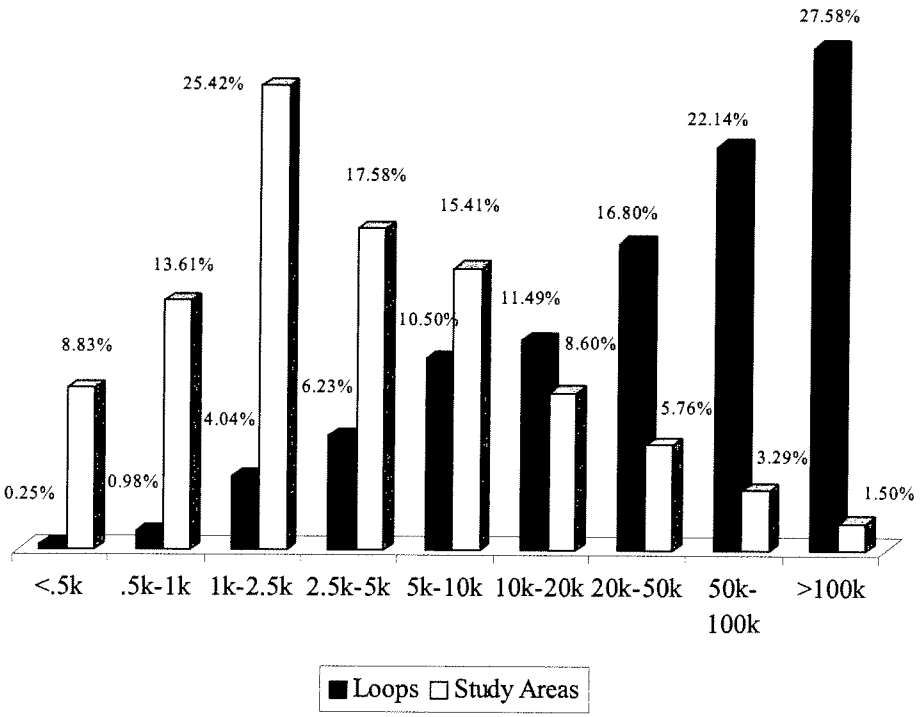


2. Differences Among Rural Carriers

While the significant differences between non-Rural Carrier and Rural Carrier study areas are perhaps expected, differences among Rural Carriers may be recognized less often. Figure 6 shows an analysis of the Rural Carriers placed into groups by study area size as defined by number of loops. These groupings are used throughout the paper in comparisons of Rural Carrier study areas. The figure demonstrates that within the class of Rural Carriers there is also a significant variation in study area sizes and customer bases. Rural Carriers serving the three smallest study area groupings (2,500 lines or less) encompass 48 percent of all study areas, but only five percent of all access lines served by Rural Carriers. On the other hand, Rural Carriers

serving the three largest study area groupings (20,000 lines or more) contain only 10.5 percent of all study areas, but serve 67 percent of all Rural Carrier access lines.

Figure 6. Distribution of Rural Carrier Loops and Study Areas by Line Size Group



For purposes of the analysis presented in this paper, size differences among Rural Carriers, as well as differences in the market and operations circumstances they face, are as critical as comparisons with the non-Rural Carriers.

C. The Challenge of Isolation

Those Rural Carriers serving isolated markets have higher loop costs because they generally lack economies of scale and customer density, and because the relatively fixed nature of some types of costs must be spread over smaller customer bases. Alaska and the insular

Territories present unique challenges, as do some specific individual Rural Carriers. In contrast to the majority of Rural Carriers in the continental United States which might generally be characterized as having long loops to service their sparsely populated service areas, Alaska and the insular Territories generally have shorter loops which may carry a much higher cost per foot. What Alaska and insular Territories may save in having shorter loops is more than offset by additional costs that can be attributed to their geography and other special and sometimes unique factors.

The geographic isolation of these areas contributes significantly to the higher comparative cost to build and maintain telephone plant. The movement of materials, manpower and equipment into these areas can significantly increase initial construction, as well as ongoing operational costs.

The lack of highways, integrated road systems, and in the case of the island Territories - no roads to them at all - indicates that ship, barge or air must deliver everything. Many times the Rural Carrier must pay for round trip transportation since there is little or no possibility that the shipper can sell cargo space on the return trip. This can increase materials cost substantially. The landed cost of a $500 utility pole may be $2,000, and the landed cost of a modular building may escalate from $22,000 to $47,000.

Geological surface conditions such as coral, volcanic rock and permafrost require specialized digging equipment. Earth saws, and trenching and boring equipment capable of dealing with rock and permafrost are often required. In many cases, when placing cables in these conditions, sand or other suitable back-fill must be shipped to the location because the native soil cannot be used for bedding the cable. Whether purchased by the carrier for limited use, or hired as part of a construction contract, just getting any equipment on site can be costly and

challenging. In many cases the carrier must not only pay to get the equipment into and out of the area, but often the carrier is required to pay an extra fee for the extended non-productive time that the equipment spends in transit. Additionally, it is almost always necessary to send in more equipment than would be required if equipment parts and maintenance facilities were readily available--there are no quick trips to the store in these areas if something breaks.

Moving manpower into these isolated areas proves to be just as difficult and expensive as the equipment and materials. Air or ship fares (if there is scheduled service - special charter service if not) are often difficult to obtain and very expensive for Rural Carriers, particularly in Alaska and other remote areas. Moreover, advanced purchase discounts are rarely available for construction crew travel to remote rural locations. In some cases there are no hotels or restaurants, so everything to sustain the work force must be shipped in with them.

Geographic isolation also intensifies the costs of project management. Manpower and material shortages can create extended delays and project overruns. Efforts to minimize possible construction delays caused by loss of manpower, material shortages and equipment breakdowns by over-providing these resources only front-loads costs. The alternative to footing the expense of large front-end investment is to have even more volatile costs when significant resources are held up waiting for replacement shipments to arrive.

Operationally, isolation increases costs since more resources are required to produce the self-reliance necessary to provide any level of network reliability. This demand on self-reliance may range from increased levels of backup power, larger fuel tanks, larger inventories of materials and spares, and even increases in manpower to respond timely in emergencies. Insular and remote service conditions may also require additional expenditures because of the poor regional infrastructure often associated with these areas.

Weather conditions can also impact costs significantly, and in unexpected ways. In terms of initial construction, weather can drive up costs due to shortened construction seasons in Alaska, or wreak havoc with the unexpected arrival of severe tropical storms in the insular Territories. Additionally, weather can drive up operational costs due to its adverse affects on personnel and equipment with a concomitant contribution to shortened plant service lives. One company in Alaska, for example, purchased a mobile home in an attempt to save extremely high costs of building construction in a remote location. Within a year, however, all the windows and the siding on the building had to be reinforced and replaced because regular high winds, often of hurricane intensity, broke the windows and tore off the original siding. Recent experience with hurricanes in the Virgin Islands seems to indicate that with the current frequency of these severe natural disasters, plant service lives may be better measured in months instead of years.

These factors not only explain the high costs in these areas, they also illustrate the special or unique nature of Rural Carrier operations—characteristics that will make it very difficult to estimate Rural Carrier costs based upon models designed for estimating costs for non-Rural Carriers which use input assumptions based on national averages.

The data also illustrates the importance of not over-generalizing conclusions based on averages. We are a diverse nation with telecommunications carriers operating under a variety of circumstances. An understanding of the unique circumstances facing rural companies and rural customers is essential for the design of effective mechanisms and policies to achieve the national universal service principles set forth in the 1996 Act. We turn now to a broad overview of those unique circumstances.

III. Overview of Rural Telephone Carriers and Their Customer Base

While the data presented in this Paper illustrates the substantial differences among Rural Carriers, it can be generally said that Rural Carriers are small companies serving small markets with low customer access line density per square mile. As noted, remote locations served by Rural Carriers result in numerous operational challenges that inherently cause operating costs per subscriber to be higher and more variable than costs of non-Rural Carriers.

In addition to experiencing higher costs associated with serving a widely dispersed population base, Rural Carriers tend to obtain their revenue streams in a very different manner than larger non-Rural Carriers. Most Rural Carriers serve primarily residential and very small business customers. Rarely are there large business customers present in rural areas. In instances where a large business customer is present, that single customer can account for a disproportionate share of the Rural Carrier's business. Competitive loss of that single customer could have a severe detrimental impact on the Rural Carrier's business, and the rates of remaining customers.

Calling patterns in rural areas differ significantly from those in more populated areas. Because fewer people live within a rural local calling area, rural customers are more likely to make toll calls than their non-rural counterparts. Rural Carriers are much more dependent on access charges and universal service support revenues than are non-Rural Carriers.

Staffing costs of Rural Carriers vary significantly. Serving areas of Rural Carriers customarily include one small town, or a cluster of small towns. Optimum ratios of telephone company employees per customer achieved by non-Rural Carriers cannot be achieved by Rural Carriers. In fact, half of all Rural Carriers have fifteen or fewer employees. This presents

significant challenges to the planning, engineering, construction, operation, maintenance, and billing of service.

Rural Carriers often also differ significantly from non-Rural Carriers in the way they procure needed services. Non-Rural Carriers largely provide needed services using their own investments and staff resources. Rural Carriers, on the other hand, frequently contract with larger telephone companies, contracting companies, consultants, lawyers, and billing vendors to obtain specialized services. Operator services, directory assistance services, regulatory analysis and representation, plant construction, training, customer billing, carrier access billing, and legal services are frequently purchased from other providers rather than being provided by in-house staff.

Based on both market and operational characteristics, therefore, Rural Carriers differ significantly from their non-rural counterparts. More importantly, RTCs are not a homogenous group, but differ greatly from each other. For example, some Rural Carriers have high switching costs per line and low loop costs per line, while other RTCs may have both high switching and loop costs. The serving area of each RTC typically has a dominant terrain type that materially influences the cost of providing service. Among RTCs, however, terrain conditions vary substantially, including mountains, desert, waterways, swamps, and plains. Equipment chosen for dependability and cost effectiveness in one environment can be unreliable or cost ineffective in other environments. Some Rural Carriers have diverse terrain that is sometimes not even in a contiguous study area. Costs of facilities, operating costs, and customer composition vary significantly among Rural Carriers, emphasizing the importance of not over-generalizing from average-profile information.

A. NECA Data Sorted by Rural Carrier Line Size and Comparing Rural Carriers to Non-Rural Carriers

In order to better understand and document the customer and operational characteristics of Rural Carriers and the differences between Rural Carriers and non-Rural Carriers, the Rural Task Force requested that the National Exchange Carrier Association (NECA) assist in analyzing data regarding these characteristics. NECA compiled data from a number of publicly available data sources to develop this analysis. The study focused on two major areas:

- differences in customer characteristics; and
- differences in operations characteristics.

The compelling evidence is that Rural Carriers are significantly different from non-Rural Carriers and individual Rural Carriers vary widely from each other.

Compared to larger, non-Rural Carrier counterparts, Rural Carriers characteristically have:

- higher investments and higher costs per line;
- much smaller customer base for spreading costs;
- proportionately fewer large business customers;
- proportionately lower demand for such services as special access; and
- proportionately less local traffic and more toll calls.

B. Customer Related Variables

The customer related variables shown over the next few pages describe various characteristics of the customers of the Rural Carriers and their use of the telephone network. The reader is invited to review this data in detail in the appendices, and on the Task Force home page at *http://www.wutc.wa.gov/rtf*. In general, the data shows a very consistent average pattern

between the size of a study area, its calling scope, and the customers it serves. Smaller telephone companies have the following characteristics:

- Rural Carriers serve fewer customers per square mile;
- Rural Carriers serve proportionately fewer multi-line business customers;
- Rural Carriers serve proportionately fewer special access customers;
- Rural Carriers' customers have a relatively small local calling scope, even adjusting for extended area service; and
- Rural Carriers' customers make proportionately more toll calls.

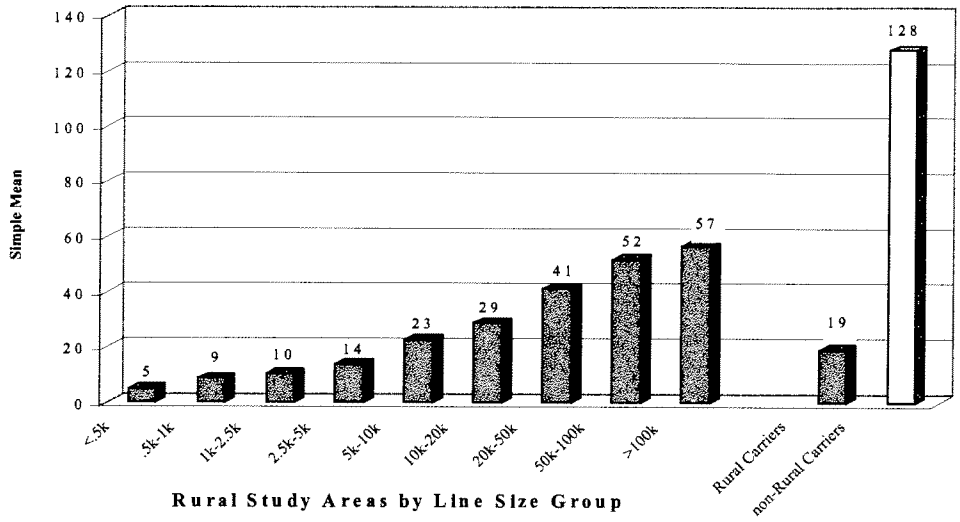
A more detailed look at each customer-related variable appears below.

1. Lines Per Square Mile

Lines per square mile measures customer density.[21] As shown in Figure 7, on average, the non-Rural Carriers serve 128 lines per square mile, while the Rural Carriers serve only 19 lines per square mile. The six to one ratio of non-Rural Carrier to Rural Carrier average access line density describes a significant diseconomy for Rural Carriers.

[21] Source: 1993 USF NOI database. The FCC collected but did not edit the publicly available data in the 1993 USF NOI database. NECA performed its own reasonability checks and contacted companies to determine whether data that appeared to be outliers were, in fact, correct. Results based on the 1993 USF NOI database are subject to these *caveats*. Due to differences in vintage and definition of the 1993 data available to NECA for this particular bit of analysis, these figures are slightly different from RUPRI data in Table 1 and analysis thereof.

Figure 7. Average Access Line Density by Company Line Size Group for Rural Carriers and non-Rural Carriers.

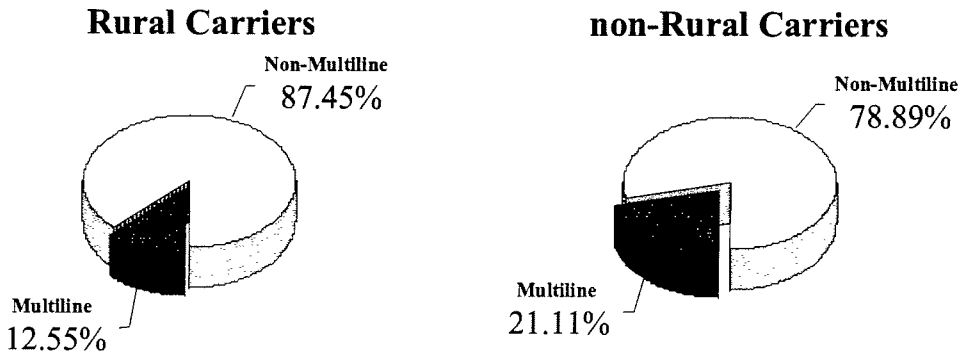


Larger study areas, as measured by number of lines, typically have higher customer density than smaller study areas. However, the large variability in customer density, especially among small study areas, makes it unlikely that an average profile will describe a particular study area accurately. For example, Delta Telephone Company, Inc., (Delta) in Mississippi and Lewis River Telephone Company in Washington (Lewis River) both have approximately 3,700 access lines. However, the customer densities in the service territories of the two companies vary widely. Delta's serving area is 855 square miles, while Lewis River serves 140 square miles, resulting in customer densities for the two companies of 4.34 customers per square mile and 26.3 customers per square mile, respectively.[22]

[22] Data from 1994 Statistical Report, Rural Telecommunications Borrowers, published by Rural Utilities Service of the United States Department of Agriculture.

2. Share of Multiline Business Customers as a Percentage of Total Lines

Figure 8. Average Share of Multiline Business as a Percent of Total Lines



Multiline business customers typically produce more revenue per line than residential or single line business customers. The percentage of multiline business customers served by a carrier is an indication of the diversity of the revenue base of a carrier. On average, larger study areas, as measured by line size, typically have higher multiline business customer density than smaller study areas. Average multi-line concentration increases consistently as the size of the study area group increases. The average Rural Carrier multiline business share is 12 percent, compared to 21 percent for non-Rural Carriers.[23] Interestingly, the highest individual study area

[23] 1997 Pooling data and ARMIS data.

business customer density level is that of a rural study area.[24] However, this is a very unique circumstance.

3. Interstate Special Access Revenue as a Percentage of Total Interstate Revenue

Variable Name	Measurement Explanation	Data Source	Rural Average	Non-Rural Average	Ratio of Difference
Interstate Special Access Percent of Total Interstate Access	Measures Business Market Share	1997 Pooling Data and 1997 ARMIS Data	3.11%	17.71%	1:5.69

Interstate Special Access Revenue as a percentage of Total Interstate Revenue also measures business line concentration. Patterns of special access revenue are very similar to those for the Business Multi-Line to Total Lines variable. On average, special access only represents about three percent of total interstate revenues for Rural Carriers compared to nearly 18 percent for non-Rural Carriers. The minimum special access share is 0 percent for a rural study area line-size ranges below 5,000 lines. Yet, the maximum share is 36 percent for a Rural Carrier study area in the 1,000 to 2,500 lines grouping. The minimum and maximum shares for the non-rural study areas are 5 percent and percent 41 percent respectively, roughly the same range as the rural study areas.

The smaller the Rural Carrier, the greater the variation in the data. The coefficient of variation declines from 230 percent for the less than 500 line size grouping to 36 percent for the less than 100,000 line size grouping, with the average for RTCs being 123 percent.[25] In

[24] Arctic Slope Telephone Association Coop, Inc., in Alaska had only 28.1 percent residential lines on a total company basis. The largest office served (Deadhorse) is in Prudhoe Bay, Alaska. The majority of lines in Prudhoe Bay are business lines related to the Alaska oil pipeline. This contributes, on a total company basis, to a lower than average percentage of residential lines.

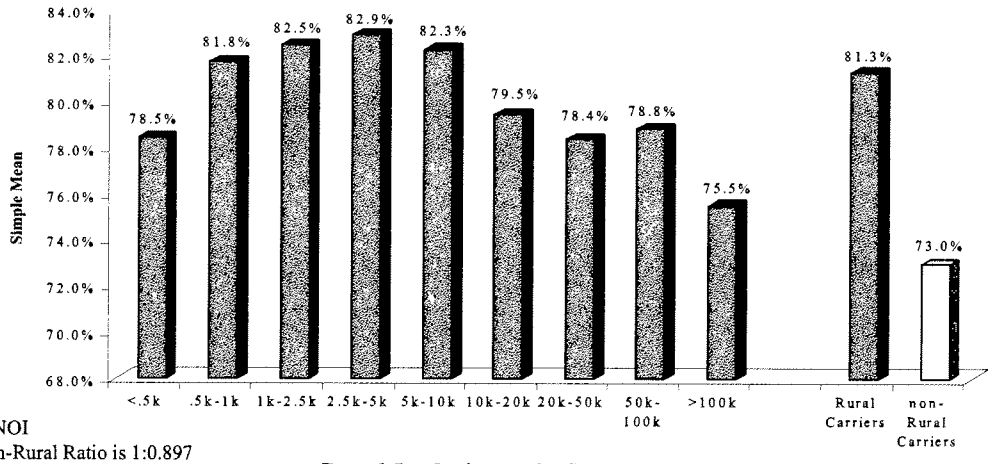
[25] The coefficient of variation statistic measures the range of values, from minimum to maximum, around the average value. The larger the coefficient of variation, the greater the variability of the data.

comparison, the non-Rural Carriers as a group are subject to considerably less variation in the data with a coefficient of variation of only 35 percent.

4. Percentage of Residential Lines

Residential telephone customers generally produce less revenue than business customers. The percentage of residential lines served by a telephone company is another indicator of the relative level of a company's revenue opportunities. Figure 9 shows that 81 percent of Rural Carriers' total lines are residential compared to 73% for non-Rural Carriers. Generally, companies serving larger study areas have a smaller percentage of residential customers, although the results are highly variable in the smallest line size categories. (*See* Appendix and http://www.wutc.wa.gov/rtf for details).

Figure 9. Residential Lines as an Average Percent of Total

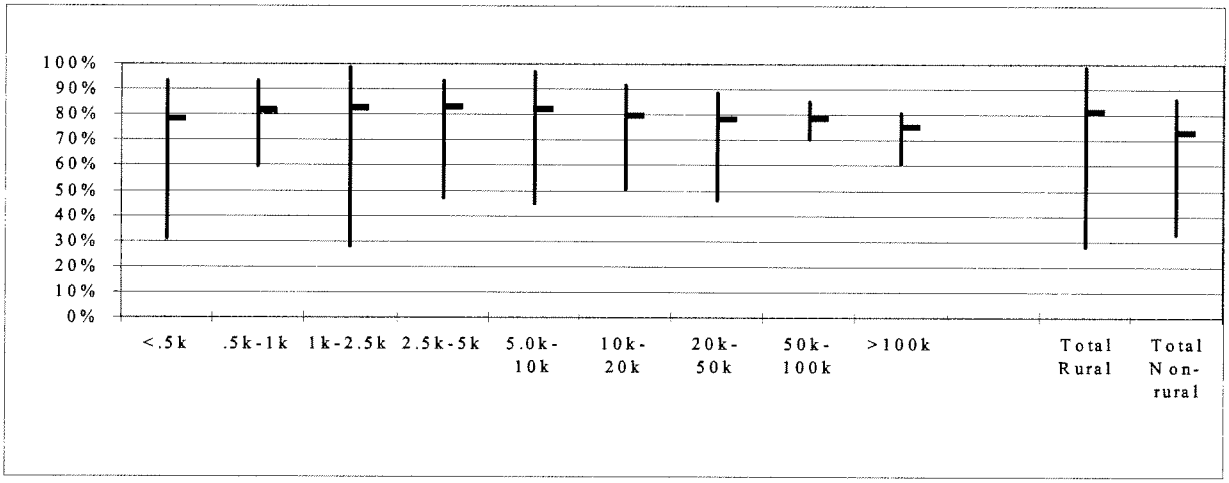


1993 USF NOI
Rural to non-Rural Ratio is 1:0.897

Figure 10 illustrates how averages can be deceiving. This chart shows the same median data as Figure 9 but in a format similar to one used to chart the stock market. It shows the high, the low, and the average value of a particular measure for a particular company grouping. Along the horizontal axis this chart first divides all rural study areas into line size categories. Then study areas are sorted into rural and non-rural totals. The vertical axis measures the percentage

of residential lines for individual companies in the group. The chart, itself, is a series of spikes, each with a horizontal tic mark. The size of the spike depends on the maximum and minimum values displayed for that particular measure. The tic mark is the simple average value for the line size category. When the tic mark is close to the minimum, it means that most study areas within the category are near the minimum. The opposite is true if the tic mark is close to the maximum. By examining the pattern of ticks and spikes in this chart, one can gauge in a general way the range and clustering of values within a grouping of study areas.

Figure 10. High, Low, Mean and Variation in Percent Residential Lines by Rural Carrier Line Size[26]



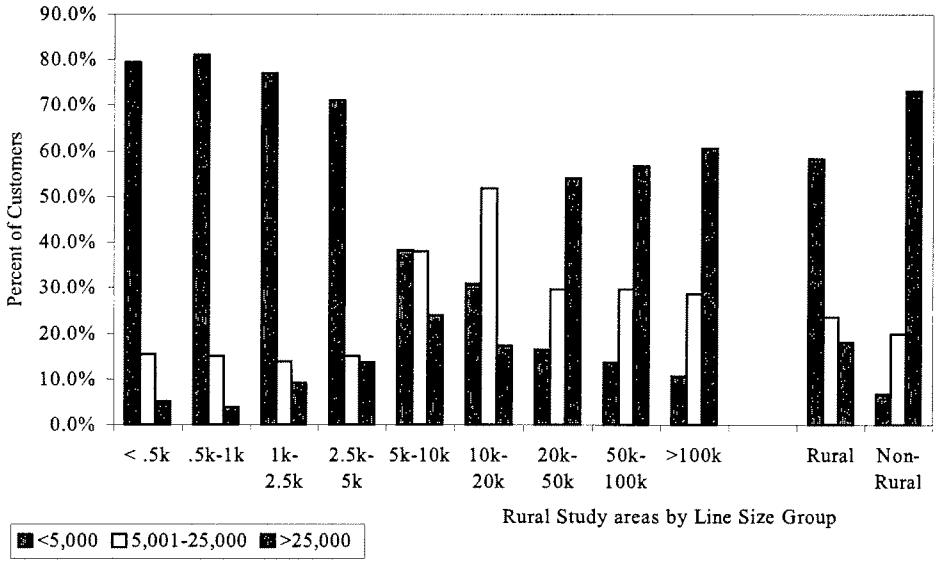
In general, the data illustrates the average percentage of residential lines served by Rural Carriers to be similar across all sizes of study areas. However, the spikes for the individual groups demonstrate the significant variation between individual companies with each group. The largest variation (longest spike) is for companies with less than 500 lines and between 1,000 and 2,500 lines.

[26] Source: USF NOI.

5. Local Calling Scope

Local Calling Scope is often described in terms of the number of customers that can be reached with a toll-free local call. Figure 11 provides a comparison of the relative size of the toll-free Local Calling Scopes for customers by line size groups. The chart illustrates the percentage of customers in each of the groups that have calling scopes of the size indicated. As would be anticipated, the smaller study areas have substantially smaller calling scopes on average than do the larger study areas.

Figure 11. Percent of Customers with Calling Scope Size



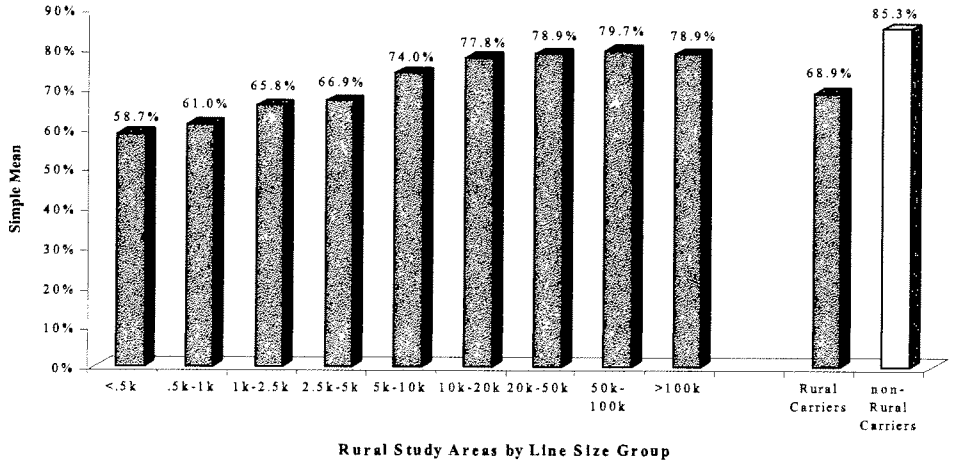
In the four smallest line size groupings the percent of customers having a local calling scope of less than 5,000 lines is between 70 percent and 80 percent, while the percentage of customers having a calling scope greater than 25,000 lines is less than 10 percent. In the three largest line size groupings the percent of customers having calling scopes of less than 5,000 lines ranges between 20 percent and 10 percent, while the percent with calling scopes greater than 25,000 is around 50 to 60 percent. For rural study areas overall, nearly 60 percent of the

customers have calling scopes of less than 5,000 lines but, less than 20 percent have calling scopes greater than 25,000. For non-rural study areas, less than 10 percent of the customers have calling scopes less than 5,000 lines, but over 70 percent have calling scopes greater than 25,000 lines.

6. Local Minutes to Total Intrastate Minutes

Figure 12 shows that on average, customers in small study areas use proportionately more intrastate toll usage than customers in larger study areas.[27] On average, 85 percent of non-Rural Carriers' minutes of use is local compared to only 68 percent for Rural Carriers. There is also wide variability in the data. The minimum local usage for non-Rural Carrier study areas is 51 percent while the minimum for Rural Carrier study areas is only four percent.

Figure 12. Average Local Minutes as a Percentage of Total Intrastate Minutes



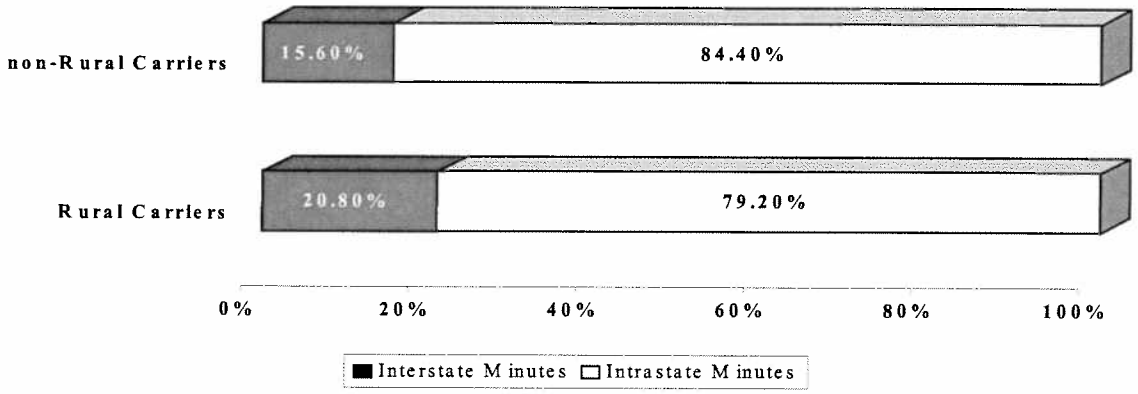
The lower ratio of local minutes to total intrastate minutes illustrates the impacts of the generally smaller local calling scopes of rural companies in general. This is particularly true for the smaller line size groups. The minimum local calling percentage of 4.36 percent is for Scott

County Telephone Company in Arkansas, a study area in the less than 500-line grouping. The maximum is 100 percent for Guam Telephone Authority with a study area in the 50,000 to 100,000 grouping. There is not a local/intrastate toll differentiation in Guam. All traffic is either local or international.

7. Interstate Toll Minutes to Total Minutes

Interstate toll calls, by definition, go across state lines, and interstate toll minutes as a percentage of total minutes of use is another indicator related to calling scope. Figure 13 shows that Rural Carriers have a higher percentage of interstate traffic than non-Rural Carriers (21 percent compared to 16 percent).[28] However the variation is smaller in non-Rural Carrier study areas (23 percent versus 42 percent for RTCs). Variations in interstate calling are not only impacted by individual calling habits, but also by the physical relationship of the study area to state boundaries.

Figure 13. Average Interstate Toll Minutes to Total Minutes.



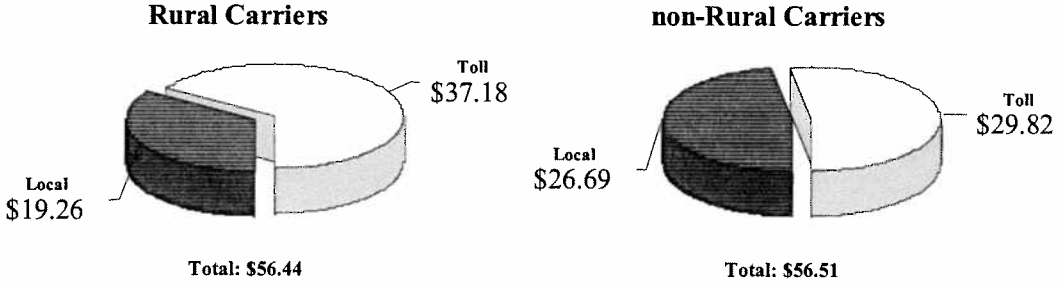
[27] March 1, 1999, Network Usage Filing.

[28] March 1, 1999 Network Usage Filing, Rural to non-Rural Ratio is 1:0.752

8. Monthly Local and Derived Toll Service Charges Per Customer

Although the average total monthly bill for customers served by Rural Carriers and non-Rural Carriers is very close, the make-up of the bill differs markedly.[29] As Figure 14 shows, total charges for customers of Rural Carriers are $56.44 per month, compared to $56.51 a month for customers for non-Rural Carriers.[30] However, within this total bill, a customer of a Rural Carrier pays a much higher amount for toll calls ($37.18 compared to $29.82), and a smaller amount for local service ($19.26 compared to $26.29). These differences reflect the smaller calling scope and greater toll use of customers of Rural Carriers discussed in previous sections.

Figure 14. Comparison of Average Local and Toll Revenue Sources Between Rural Carriers and non-Rural Carriers



The non- Rural Carrier minimum local service bill is larger than the Rural Carrier minimum local bill ($15 versus $10), but the maximum local bill is largest in a Rural Carrier

[29] As the term "local service charge" is used here, it includes flat monthly charges, extended area service charges, local usage charges, local mileage and zone charges, taxes, federal and state subscriber line charges, and other mandatory charges, and optional charges such as touch tone, call waiting, call forwarding, etc.

[30] Source: 1993 USF NOI. Although the 1993 data is several years old, it is the latest known data source available. The Rural Task Force believes that the data is representative of the ratios between Rural Carrier and non-Rural Carrier customers although the absolute values are undoubtedly somewhat different now than in 1993.

study area ($48 compared to $36). Typically, customers served by small study areas have the lowest local service bills.

Toll charges are incurred when a customer makes a call outside the local exchange carrier's local calling scope, commonly referred to as "long distance." Monthly derived toll is a measure of the amount of toll service used by customers. Toll bills in areas served by Rural Carriers typically decline with study area size. The average monthly toll bill is $42 per month for the less than 500-line range, declining to $30 for study areas with greater than 100,000 lines.

Both the minimum and maximum monthly toll bills are in the smaller line size groupings ($2.20 for Foresthill Telephone Company, Inc., which is in the 1,000 – 2,500 line range and $121.79 for Bush-Tell, Inc. in Alaska in the 500 – 1,000 line grouping.) Relative variability of monthly toll bills declines somewhat as the line size grouping increases. Its biggest value is 38 percent variation in the 10,000 – 20,000 line size grouping, and its smallest value is 10 percent in the greater than 100,000 line size grouping.

C. Operational Related Variables

Variability in scale, scope and density effects, and the importance of variability, carry over from a study area's customer side to its operations side. On average, having fewer customers per square mile means that Rural Carrier study areas have longer loops, more switches, and higher operating expenses per customer than non-Rural Carriers.

The data show a very consistent pattern between the line size of a study area and its investment and operating expenses:

- Rural Carriers have proportionately fewer customers per switch;

- Rural Carriers have proportionately more loop, switching, and transport investment per line than larger telephone companies; and
- Rural Carriers have higher operating expenses than non-rural telephone companies.

However, just looking at the averages hides the significant variability among rural company study areas. Small study areas look very different from each other within a line size grouping. In most cases, the range of outcomes for small line size groupings encompasses those of the largest line size groupings. A particular small study area's profile, therefore, may look more like a large study area's profile than the profiles of most of its own line size grouping.

Small line size and variability go together. The smallest line size groupings have the largest coefficients of variation. One is much less likely to predict the actual network design and operating characteristics of a small study area than a large one.

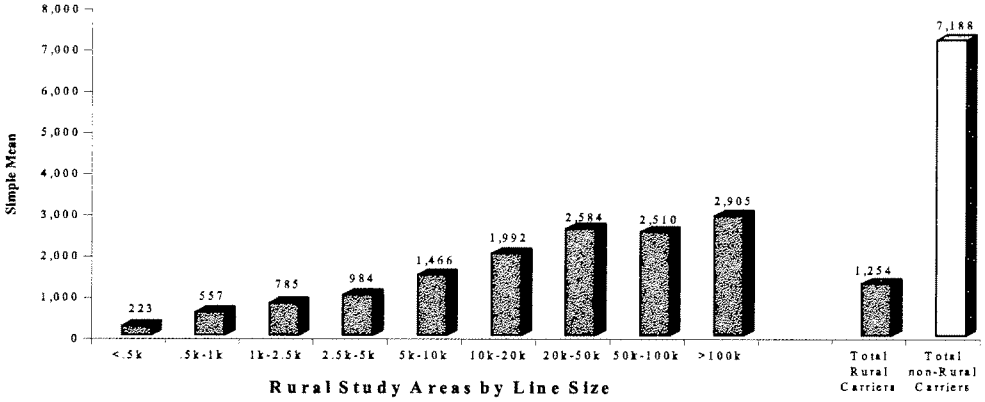
A more detailed look at each operational related variable appears below.

1. Lines per Local Switch

Because Rural Carriers, on average, have substantially fewer lines per switch than non-RTC, they cannot benefit from economies of density as well as their larger counterparts. As shown in Figure 15, on average, non-Rural Carriers serve 7,188 lines per switch whereas Rural Carrier switches serve less than a fifth as many customers per switch, on average only about 1,250 lines per switch.[31]

[31] Source: USF NOI.

Figure 15. Average Lines per Local Switch



Lines per switch for Rural Carriers rise consistently from 223 to 2905 as the line size of groupings of a study area increase. The smallest group minimum (34 lines per switch for Scott County Telephone Company in Arkansas) is in the less than 500-line grouping. The largest group maximum (23,423 for Century Telephone of San Marcos, Inc., in Texas) is in the 20,000 - 50,000 line grouping. The range of lines per switch for Rural Carriers is larger than for non-RTCs. This is confirmed by the larger relative variability of the rural lines per switch (139 percent) compared to the non-rural level (77 percent).

2. Loops per Sheath Mile (Cable Mile)

Loops per sheath mile is another indicator of economies of density, showing the relationship of the number of loops to the linear distance of cable needed to provide those loops. Figure 16 shows that non-Rural Carrier study areas, on average, have 29 loops per sheath mile compared to 8 per sheath mile for Rural Carrier study areas.[32]

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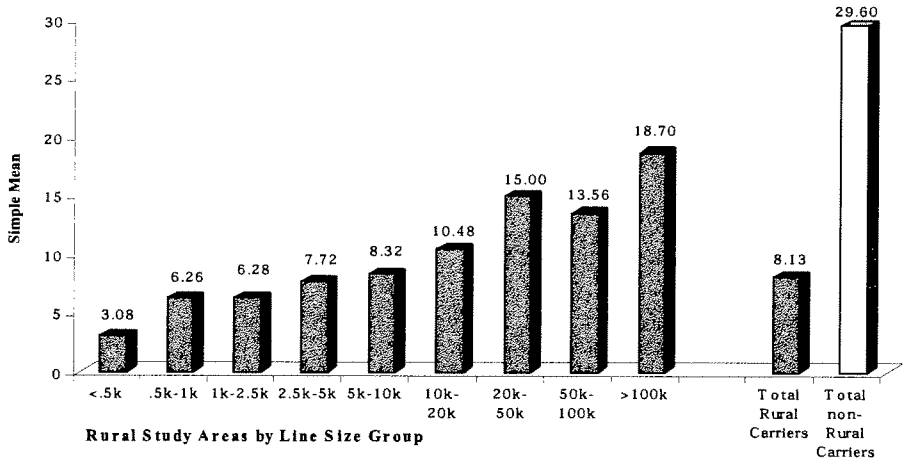
32 Id.

Figure 16. Average Loops per Sheath Mile



Loops per sheath mile for Rural Carriers rises consistently from 3 per mile to 18 per mile as the line size groupings of study areas increase. [33] In the 20,000 to 50,000 line group, a company in Florida has a low value of 0.09 loops per sheath mile. Within that same line group at the other extreme, the Chillicothe Telephone Company in Ohio has 81 loops per sheath mile.

While this measure gives some indication of the economics of density, it is not specific enough to give a clear and precise indication. The total sheath miles used in this measure includes interoffice cables in addition to the feeder and distribution cables that constitute the loop plant. Differences in ratios of interexchange plant to distribution plant make this a less than perfect measure of loop density.

Rural study areas, on average, have fewer lines per sheath mile than non-rural study areas. Therefore, they cannot benefit from economies of density as well as their larger counterparts. However, within the rural category, there are study areas with loops per sheath mile

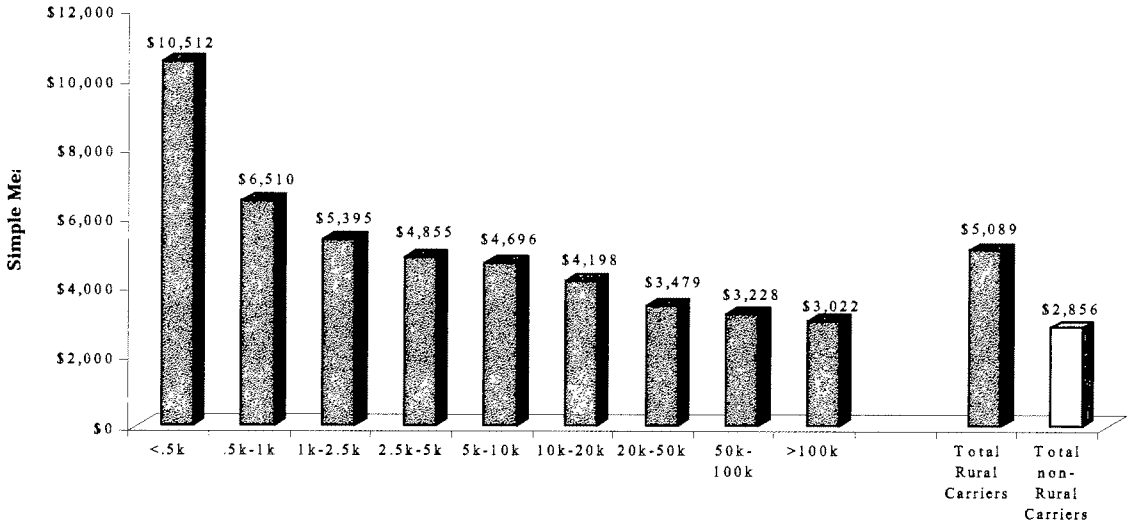
[33] A sheath mile of cable represents the linear miles of cable regardless of the number of cable pairs (6 to 2,000 or more) within the sheath (outer covering) of the cable.

almost as large as any non-rural study area (81 compared to 86), illustrating wide variation among Rural Carriers.

3. Total Plant (Gross) Investment Per Loop

Total Plant (Gross) Investment per Loop is another important measure of the economies of density. The gross plant investment represents the total original cost of the plant that is in service. Total Gross Plant Per Loop is much higher for smaller study areas as shown in Figure 17.[34]

Figure 17. Average Total Plant (Gross) Investment per Loop by Company Size



The average Total Gross Plant Per Loop for non-Rural Carriers is $2900 as compared to $5100 for Rural Carriers. The range of values for Rural Carriers ($1400 to $40,500) is far greater than for non-Rural Carriers ($1570 to $4350). This is confirmed by the large relative variability of the rural Total Gross Plant Per Loop (66 percent) compared to the non-Rural Carrier value of 19 percent. The simple mean for companies in the greater than 100,000 line-size

[34] Source: USF NOI.

grouping is $3,022 per loop, as compared to $10,512 per loop for those companies in the less than 500-line category.

The maximum Gross Plant value within the 500 – 1,000 grouping is $29,344 for Dell Telephone Cooperative in Texas (switching: $2,736, transmission: $5,721, Cable and Wire Facilities (C&WF): $15,894, and Other: $4,994). Dell serves 10,500 square miles, an area approximately the size of the state of Maryland. This computes to statistics that include serving 0.09 access lines per square mile, while serving 0.31 subscribers per route mile. The maximum Gross Plant value within the less than 500 lines group is $29,960 for South Park Telephone Company in Colorado (Switching: $1,028, Transmission: $10,682, C&WF: $1,151, and Other: $17,100). The lowest values, on the other hand, appear in the large line size groupings. The greater than 100,000-line grouping has the lowest maximum Gross Plant value at $4,500 per loop.

Relative variability is the highest in the small line size groupings with the less than 500 and 500 – 1,000 lines groupings showing coefficients of 70 percent and 77 percent respectively.

The lack of economies of scale opportunities due to customer sparseness and geographic differences in service areas is reflected in the higher rural study area investment per loop compared to non-rural investment per loop. However, the study area with the lowest investment per loop is rural (GTC, Inc. in Florida).

4. Total Plant (Net) Investment Per Loop [35]

Variable	Data Source	Rural Average	Non-Rural Average	Ratio of Difference
Net Plant Per Loop	1998 USF Data Submission	$1,881	$856	1:2.2

Another measure of economies of density, Total Net Plant Per Loop increases consistently as the line size of a study area decreases. The average Total Net Plant Per Loop for non-Rural Carriers is $860, as compared to $1900 for Rural Carriers. The range of values for Rural Carriers ($360 to $29,200) is far greater than for non-Rural Carriers ($205 to $529). This is confirmed by the large relative variability of the Rural Carrier Total Net Plant Per Loop (107 percent) compared to the non-rural value of 24 percent.

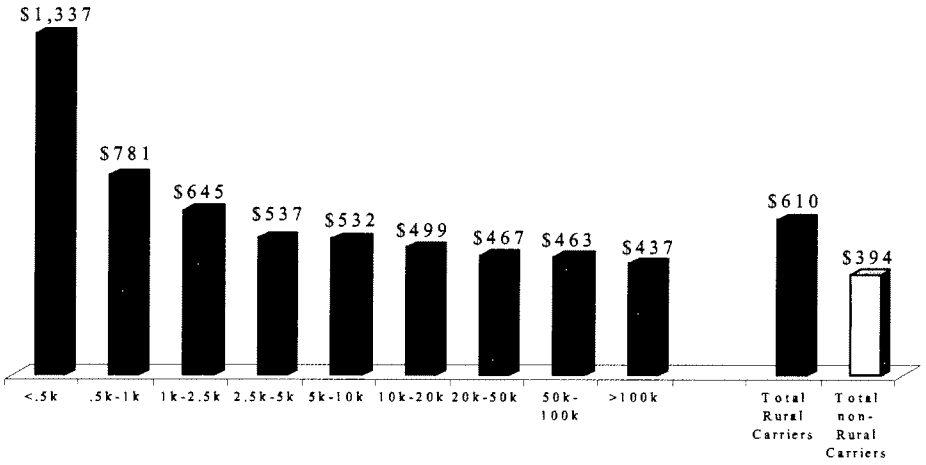
5. Central Office Equipment (COE) Switching (Gross) Investment Per Loop

Gross investment in switching equipment is a much bigger cost driver for Rural Carriers than for non-Rural Carriers. The average Gross COE Switching Investment Per Loop for non-RTCs is $394 as compared to $609 for RTCs. Investment in switching equipment per loop follows the same pattern as investment in total plant. Total switching investment per loop increases consistently as the number of lines in the study area gets smaller. Figure 18 shows that

[35] Investment per Loop (Net) reflects the depreciated value of the plant in service. It represents the original cost or gross investment less the depreciation that has been accumulated.

Small Rural Carriers must bear a significantly higher switching cost per loop than non-Rural Carriers.[36]

Figure 18. Average Gross COE Investment per Loop by Company Size



Moreover, the range in Rural Carrier gross investment in central office switching equipment (from very small amounts to as much as $9,191 per loop for Sandwich Isles Communications in Hawaii) is far greater than for non-Rural Carriers ($173 to $705 per loop). This is confirmed by the large relative variability of the switching investment for Rural Carriers compared to non-Rural Carriers (76 percent compared to 23 percent).

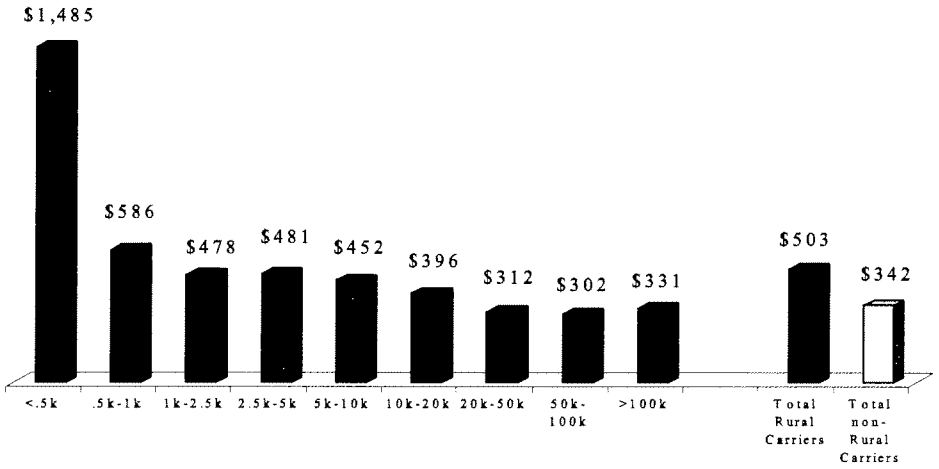
6. COE Transmission (Gross) Investment Per Loop

Central office transmission plant is used to facilitate communication both in distribution plant (from the customer to central office) and in interoffice plant (between central offices). In many cases, it may be used as a technology to substitute for the use of cable and wire facilities. More recently it has been used in conjunction with fiber cable to improve transmission quality in distribution plant in rural areas. Following the trend for Rural Carriers, COE transmission investment is much higher for small company study areas (as measured by line size) as shown in

[36] Source: 1998 USF Data Submission.

Figure 19.[37] The average Gross COE Transmission Investment Per Loop for non-Rural Carriers is $342 as compared to $503 for Rural Carriers.

Figure 19. Average COE Transmission Investment (Gross) per Loop



The range of investment values per loop for Rural Carriers ($43 to $10,682 for South Park Telephone Company in Colorado) is far greater than for non-Rural Carriers ($101 to $687). Maximum values are widely variable across line size groupings. However, as expected the highest value appears in the smallest line size grouping. The lowest values, on the other hand, appear in the large line size groupings.

Figure 20 shows how relative variability is the highest in the small line size groupings, with the less than 500 grouping showing a coefficient of 156 percent.[38]

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37 Source: 1998 USF Data Submission

38 Id.

Figure 20. Variability in COE Transmission Investment per Loop

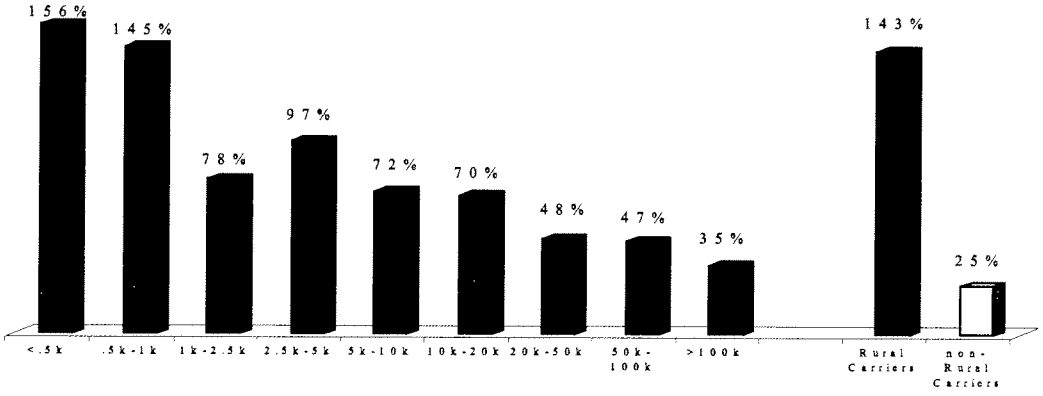


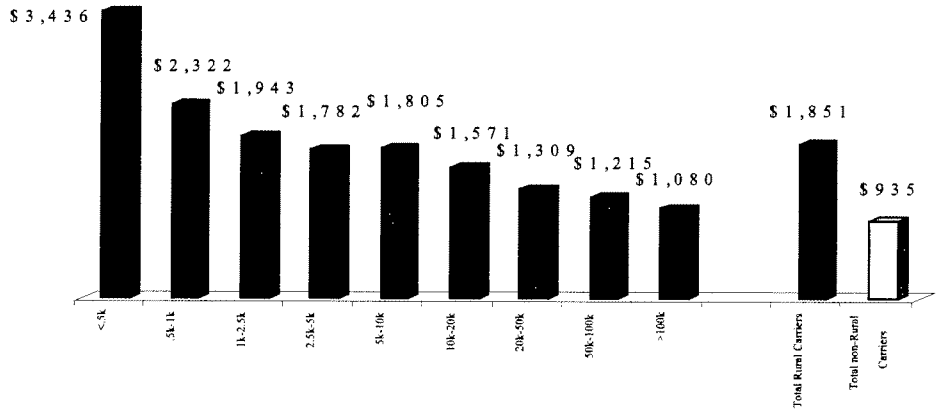
Figure 20 also highlights the wide degree of variation in the amount of this equipment in rural study areas. Rural Carrier Gross COE Transmission Investment Per Loop shows variability of 143 percent compared to the non-Rural Carrier value of 25 percent. Variations can come from the timing of investments, the differences in usage in distribution or interoffice plant, and the choice of technologies used to provide service. The more recent usage of fiber cable combined with COE transmission equipment to eliminate "loaded" loops and improve transmission quality will likely lead to an increasing usage of this type of investment in the future.

7. Cable and Wire Facilities (C&WF) (Gross) Investment Per Loop

Cable and wire facilities are a major investment expense for rural carriers. On average Rural Carrier C&WF investment is twice as much as for non-Rural Carriers. Figure 21 shows that the average gross C&WF investment per loop for non-Rural Carriers is $935 as compared to $1851 for Rural Carriers.[39]

[39] Source: USF data.

Figure 21. Average C&WF Investment per Loop by Study Area Size



Total Gross C&WF Investment Per Loop is much larger for small Rural Carriers than for larger companies. The maximum values for the less than 500 and 500 – 1,000 groupings are $15,742 (Beehive Telephone Company, Inc.,– Nevada) and $15,894 (Dell Telephone Cooperative in Texas) respectively. The lowest values, on the other hand, appear in the large line size groupings. The greater than 100,000 grouping has the lowest maximum value at $1,747 per loop (ALLTEL Arkansas, Inc.). The range of values for Rural Carriers ($369 to $15,894) is far greater than for non-Rural Carriers ($312 to $1767). This is confirmed by the large relative variability of the RTC gross C&WF investment per loop (71 percent) compared to the non-rural value of 27 percent.

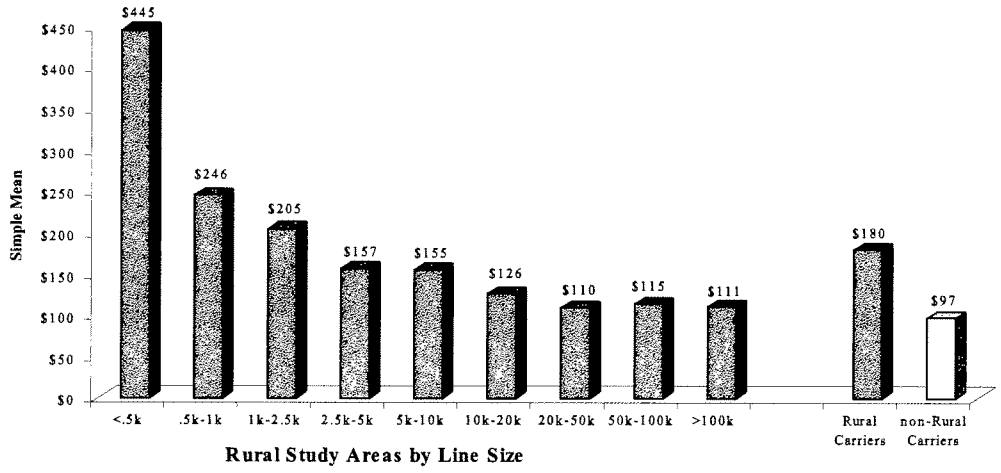
8. Plant Specific Expenses Per Loop

Plant Specific Expenses per Loop measures economies of scale related to operating a telephone network. Rural Carrier study areas, on average, have much higher expenses per loop than non-Rural Carrier study areas. Relating this to the sparseness of customers, Rural Carrier study areas do not have the concentration of plant to produce the cost savings that their larger counterparts do. Expense levels per loop are undoubtedly somewhat related to investment levels per loop and to the fact that Rural Carrier areas require larger investments to support their service

offerings. Minimum service requirements desired by customers or imposed by regulatory bodies have an impact on expense levels. Employee levels per loop are often higher in Rural Carriers because of the need to be located within minimum driving distances. In addition, driving times and other transportation costs impact expense levels.

Figure 22 shows that the Rural Carrier average annual Plant Specific Expense per Loop of $180 is nearly twice as high as that of non-Rural Carriers - $97 per loop per year.[40] The range in expense per loop per year is far larger for Rural Carrier study areas than for non-Rural Carrier study areas ($4 to $1,585 for RTCs versus $38 to $163 for non-Rural Carriers).

Figure 22. Average Plant Expenses per Loop by Company Size



Average expenses per loop declines consistently with increasing company size for Rural Carriers, from $445 per loop per year for the less than 500 grouping, down to $110 per loop per year for the 20,000 – 50,000 grouping. The minimum expense per loop varies considerably across groupings. The highest group minima are at both extremes, the less than 500 grouping ($67 for Hat Island Telephone Company in Washington) and the greater than 100,000 grouping ($76 for Frontier Communications of Minnesota, Inc.). The smallest recorded minimum is $4

per loop per year, which is in the 2,500 – 5,000 grouping. The highest value is $1,585 (Border to Border Communications in Texas) per loop per year for the under 500 grouping.

9. Plant Depreciation Expenses Per Loop

Variable	Data Source	Rural Average	Non-Rural Average	Ratio of Difference
Plant Depreciation Expenses Per Loop	1998 USF Data Submission	$191/yr.	$116/yr.	1.65:1

Depreciation per loop declines consistently as Rural Carriers become larger. The Rural Carrier average is $191 per loop per year compared to $116 per loop per year for non-Rural Carriers. The range in expense per loop per year is far larger for Rural Carriers than for non-Rural Carriers ($30 to $1,514 for Rural Carriers versus $61 to $182 for non-Rural Carriers).

10. Corporate Operations Expenses Per Loop

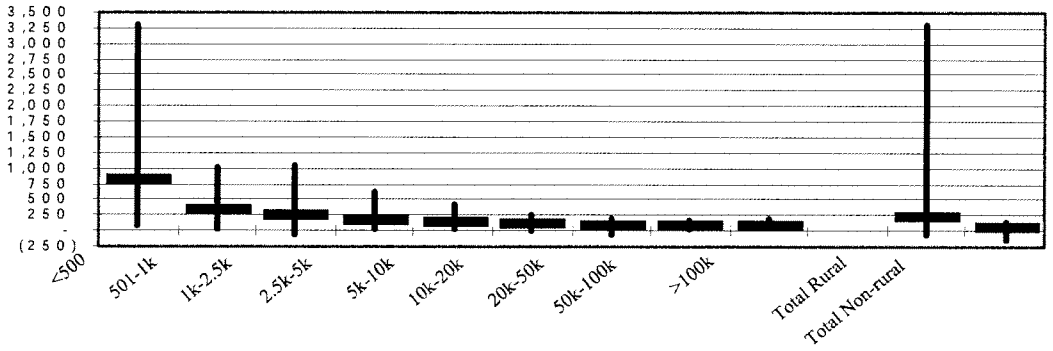
Corporate expenses are the common overhead to many services and represent the overall costs of running the firm. They include overall company management functions, accounting and financial analysis functions, legal and consulting services, and other expenses related to overall corporate management. They are somewhat insensitive to the size of the network and to the size of the company. This is apparent, particularly for very small study areas, where the relatively fixed nature of costs such as minimum salary requirements for a manager and bookkeeper, audit costs, and cost separations study costs, for example, cause the cost per loop to be higher than in larger study areas. Individual management decisions regarding performing services via employees vs. purchasing consulting and accounting services from external firms, and the level of participation in state and federal regulatory activities impact the variability of results. Location and prevailing wage scales, the longevity of employees, and state regulatory activity

[40] Source: USF data.

and requirements can also have a significant impact. The latter impacts can change fairly significantly from year to year. Rural study areas, because of their small size, typically have higher corporate expenses per loop than non-rural study areas.

The Rural Carrier study area average corporate operations expense is $220 per loop per year compared to an average $59 per loop per year for non-Rural Carrier study areas. The range of corporate operations expense per loop per year is far larger for Rural Carriers than for non-Rural Carriers. As can be seen in Figure 23, the variability in values is very broad in the under 500 line group, and is substantially larger in the four smallest line group sizes than in the four largest line group sizes. The relative variability of corporate expense per loop is confirmed by the coefficient of variation for rural study areas (118 percent) compared to non-rural areas (47 percent).

Figure 23. High, Low, Mean and variation in Corporate Operations Expenses Per Loop.



For Rural Carriers, average corporate operations expense per loop declines consistently from $822 per loop per year for the less than 500 grouping to $75 for the greater than 100,000 grouping. The highest group minima are at both extremes: $75 for Gem State Utilities Corporation - Nevada, which is in the less than 500 grouping, and $50 for the greater than

100,000 grouping (GTE Northwest, Inc., in Idaho). The smallest positive minimum is $12 per year, which is in the 10,000 – 20,000 grouping (PTI Communications of Michigan, Inc.). In contrast, the group maximum declines consistently as the study area size grouping increases. The highest value is $3,299 per loop per year (Accipiter Communications, Inc., in Arizona) for the less than 500 grouping and the highest value is $196 per loop per year for the greater than 100,000 grouping.

IV. Raising the Bar–The Challenge Not Yet Met

For decades, national telecommunications policy has promoted and facilitated the universal deployment of basic telecommunications service to all Americans. In general, most would likely agree that these policies have been a tremendous success with over 95 percent of the nation's households receiving telecommunications service.

While past national policies supporting universal service have been largely successful, in passing the Telecommunications Act of 1996, Congress has raised the bar a notch higher. For example, Section 254 (b)(3) states:

> "Consumers in all regions of the Nation, including low-income consumers and those in rural, insular, and high cost areas, should have access to telecommunications and information services, including interexchange services and advanced telecommunications and information services, that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas."

Congress was explicit that competitive reforms must be balanced by a commitment to not only preserve, but also advance universal service. The discussion in this section is not intended to be exhaustive, but it is included to describe a variety of emerging universal service issues and their importance to Rural Carriers. The Rural Task Force recognizes that a broader discussion of

these issues and their implications for universal service and the introduction of competition into rural areas is ongoing at the FCC and in other settings.[41]

The final section of this white paper recognizes that there are still rural citizens that do not have access to basic phone service. Congress, in drafting Section 254 of the 1996 Act, was clear that rural communities are to have reasonably comparable access to all telecommunications services, including advanced services.[42] These broader policy challenges tend to be even more significant for areas served by rural telephone companies.

A. Customers Without Service

As part of the 1990 Census, long-form respondents were asked whether there was a telephone present in the home. At that time, 94.9 percent residing in non-Rural Carrier areas and 92.5 percent residing in Rural Carrier areas indicated that a telephone was located in the housing unit.

1. Income Differences.

National surveys consistently indicate that the lowest income groups are less likely to have access to basic phone service .[43] Relying upon data provided by RUPRI, Table 2 demonstrates that on average, income levels are substantially less in areas served by Rural Carriers compared with areas served by non-Rural Carriers.

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[41] *See* Joint Conference on Advanced Services, CC Docket No. 99-294, FCC 99-293 (Federal State Joint Conference On Advanced Telecommunications Services), and *see* CC Docket No. 96-45, FCC 99-204 (Promoting Deployment and Subscribership in Unserved and Underserved Areas, Including Tribal and Insular Areas), and *see* CC Docket No. 98-147, FCC 98-197 (Deployment of Wireline Services Offering Advanced Telecommunications Capability).

[42] Section 254(b)(2) of the 1996 Act.

Table 2: Household Income in Rural and Non-Rural Telephone Service Areas[44]

	Rural Service Areas	Non-Rural Service Areas
Less than $10,000	18.6%	15.2%
$10,000 - $24,999	30.9%	26.0%
$25,000 - $49,999	34.2%	33.7%
$50,000 - $99,999	14.3%	20.6%
$100,000 and over	2.9%	4.6%
Median Household Income	$25,282	$30,418
Average Household Income	$31,211	$38,983

While this general trend holds across all states, again there is wide diversity among states.

- For example, in 1990 the median household income among households served by Rural Carriers ranged from a state low of $21,112 in Kentucky to a state high of $59,133 in New Jersey.
- Among households served by non-Rural Carriers, median household income ranged from a state low of $24,296 in Mississippi to a high of $49,082 in Connecticut.

The fact that the average household income is more than 20 percent lower in Rural Carrier service areas than in non-Rural Carrier service areas emphasizes the potential impact of increases in basic phone rates in RTC service areas.

2. Native American Issues

Native American populations tend to be disproportionately represented among those currently not receiving telephone service. In states such as Arizona, Alaska, New Mexico, South Dakota and Oklahoma, a portion of the Rural Carriers' customers is Native American (see Figure

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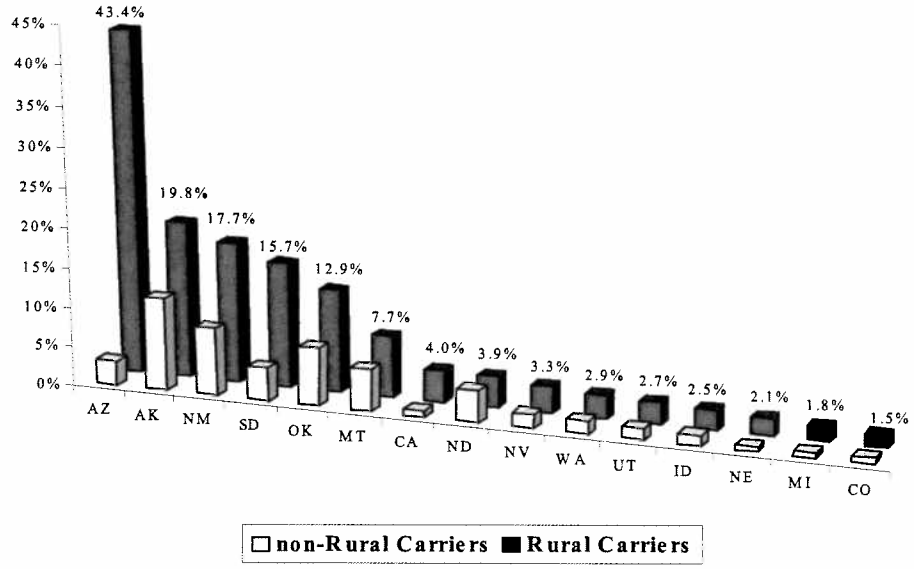
[43] See "Falling Through the Net: Defining the Digital Divide" by NTIA.

[44] Source: RUPRI.

24).[45] While there exist substantial differences from area to area, tribal reservations often have a significant portion of unserved customers. Cultural and income differences raise additional problems in the delivery of services to Native American populations. Other demographic variables – such as types of households, education levels and occupations - tend to track closely with income trends, and may affect marketing opportunities for Rural Carriers.

Figure 24. Percent of Native American Population by Service Area for Selected States



3. Seeing Past the Cities

Using 1990 Census data, RUS has compared subscription patterns in Metropolitan Statistical Areas (MSAs) with those in rural areas (census designated places of less than 2,500 population). The 1990 population in census designated rural areas was approximately 61 million or about 25 percent of the total population. In addition, about 43 percent of the rural population resided within MSAs. The distinction between MSA and non-MSA areas is important because

[45] Source RUPRI. See Appendix for non-Rural Carrier values not shown in Figure 24.

of significantly different rural telephone service penetration rates across the two areas. For this discussion, the geographic areas are broken into areas served by Rural Carriers (RTCs) and those served by their non-Rural Carriers (NRTCs). The Rural Carrier and non-Rural Carrier service areas are defined by On Target Mapping[46] wire center boundary maps used by RUPRI. Each of the service area categories are further subdivided by MSA and non-MSA, as well as by the following geographic categories:

(1) urban areas (places with at least 2,500 in population),

(2) rural places (mostly towns of less than 2,500 population), and

(3) areas not included in the rural town or urban areas.

Analysis of the RUPRI service area census data shows the dichotomy in telephone service penetration ratios between MSAs and non-MSAs (not including DC):

Table 3. Comparison of Urban and Rural Telephone Penetration

Unserved Households	NRTC Service Areas MSA	NRTC Service Areas non-MSA	RTC Service Areas MSA	RTC Service Areas non-MSA	Total	RTC % of Category
Urban						
% Unserved	4.44%	8.26%	4.23%	8.34%	4.90%	
# Unserved	2,460,167	569,065	30,383	70,783	3,130,398	3.23%
Rural Town						
% Unserved	4.75%	9.76%	6.01%	9.06%	7.90%	
# Unserved	65,359	197,960	15,093	82,841	361,253	27.11%
Non-Town						
% Unserved	3.28%	8.89%	4.90%	9.02%	5.64%	
# Unserved	431,360	685,881	24,189	173,461	1,314,891	15.03%
Grand Total						
% Unserved	4.23%	8.75%	4.76%	8.87%	5.24%	
# Unserved	2,956,886	1,452,906	69,665	327,085	4,806,542	8.25%

[46] Commercial data source, now owned by MapInfo Corporation, that provided wire center boundary data used to delineate NRTC and RTC service areas.

As can be seen, the percentage of unserved households in non-MSAs is significantly higher than in MSAs. While both the rural and urban portions of non-MSAs exceed the national average unserved rate, rural non-MSAs exhibit the lowest rates of subscribership. Lower rates of unserved households in rural portions of MSAs may result from the occurrence of relatively high-density housing developments with social and economic characteristics that resemble their suburban neighbors. The non-MSA portion of rural America has lower average levels of education and income, characteristics they share with many inner city areas, and which are closely associated with low subscribership rates. Where low density intersects with high poverty and low educational levels, appropriate universal service policies are needed to assure affordable and equal access to telephone service for all.

B. The Advanced Services Challenge – The Digital Divide

In the 1996 Act Congress was clear that consumers in all regions of the Nation, including low-income consumers and those in rural, insular and high cost areas, should have reasonably comparable access to advanced services. The work of the Task Force is primarily focused on mechanisms and policies necessary to provide specific, predictable and sufficient support for universal service. The Task Force believes that this means ensuring that all communities have affordable access to currently available supported services (keeping in mind that the list of supported services will evolve over time), and providing the foundation for the ubiquitous availability of cost-efficient advanced services capability. This support, made available on a competitively neutral basis, provides the foundation for telecommunications investment directed to high-cost rural communities, by both incumbents and new entrants.

The Task Force was clear in its Mission Statement that its recommendations must conform with requirements of the 1996 Act, including specifically the universal service

principles outlined by Section 254(b). Consequently, the recommendations of the Task Force must consider implications for access to advanced telecommunications and information services in all regions of the nation.

The available data on the extent of advanced service deployment in rural areas and in particular in areas served by Rural Carriers is very limited. One of the most current surveys documenting rural versus urban personal computer and Internet penetration was conducted by the United States Department of Commerce's National Telecommunications Information Administration (NTIA).[47] Among its key findings are the following:

- Disadvantaged groups in rural areas - - such as the very poor, minorities, and the youngest householders - - rank at the bottom of the scale with respect to telephone penetration. The unemployed in rural areas also fare less well, registering an 82.8 percent telephone market penetration rate compared to 85.6 percent for their counterparts in urban areas.
- At every income level, households in rural areas are significantly less likely -- sometimes half as likely -- to have home Internet access than those in urban or central city areas.
- African-American households in rural areas are one third less likely to own a computer and 2/5 less likely to access the Internet than the average U.S. African-American household.
- For rural areas, the Kindergarten-12th grade school is a popular point of Internet access: 30 percent of rural persons use the school for Internet access outside the home, compared to a national average of 21.8 percent .

This NTIA report indicates that computers and Internet penetration tend to be lower in rural areas and, in particular, those rural areas characterized by both low income and a high proportion of minority residents. This points to a challenge in many areas served by Rural Carriers. However, additional data is required to fully assess the extent that advanced services

infrastructure deployment is available in areas served by Rural Carriers compared with those served by non-Rural Carriers. It is likely, however, that the same operational and market challenges affecting the cost of deploying basic service in areas served by Rural Carriers – lack of density and economies of scope and scale - will likely affect the cost of deploying advanced services.

V. Conclusion

This second Rural Task Force White Paper highlights the operational and market differences distinguishing Rural Carriers from non-Rural Carriers as well as differences among rural carriers. Documenting and understanding the unique circumstances facing rural companies and their customers is essential for the design of effective mechanisms and policies to achieve the national universal service principles set forth in the 1996 Act. The analysis and data presented here provides the foundation for the Rural Task Force in developing its ultimate recommendation to the Federal-State Joint Board on Universal Service.

While the Regional Bell Operating Companies and other large urban-oriented telecommunications corporations do serve substantial segments of the nation's rural population, data presented in this report illustrate that Rural Carriers tend to dominate in the most remote and costly to serve regions. The average total plant investment per loop for rural telephone companies is nearly twice that of non-rural companies. Rural Carriers tend to serve areas with proportionately less high-volume users and have operations of substantially smaller scale than non-Rural Carriers. These are just several examples of the significant differences between Rural and non-Rural Carriers.

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[47] "Falling Through the Net: Defining the Digital Divide" July 1999, see http://www.ntia.doc.gov.

Equally important is the wide variation among rural companies themselves. These differences are illustrated by the charts presented in the appendix for each of the customer and operational variables analyzed in this report as well as by the various case examples presented in the text.

The analysis and findings of this second Rural Task Force White Paper provide additional emphasis to a central conclusion of the Task Force's first White Paper. That is, "one-size-fits-all" national universal service policy is unlikely to be successful in fulfilling the national universal service principles contained in the 1996 Act. To be successful, policies and mechanisms ultimately adopted must be flexible enough to accommodate a wide range of market and operational circumstances faced by telecommunications carriers serving rural populations. As the definition of universal service evolves, so must these policies and mechanisms.

It is with this background in mind that the Task Force continues to develop specific recommendations of appropriate federal universal service mechanisms and policies for Rural Carriers.