OTA Follow-up Conference Report

Rural America at the Crossroads

TVA RURAL STUDIES

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INTRODUCTION

There is now almost universal acceptance that changes in telecommunications and computer technology are in the process of changing the world to the same extent that the Industrial Revolution did several centuries ago. For urban and even suburban areas in America the change is taking place rapidly and there is little doubt that ongoing access to new technologies will be made available on a rapid basis. For metropolitan America the question will be the number of providers seeking to serve customers rather than whether services will be provided at all. For rural America the future is not so clear, nor so optimistic.

Certainly telecommunications advances have been seen by one group of analysts as promising relief from the disadvantage of distance that has made rural areas less able to fully participate in the national society and economy. For these individuals the potential for instantaneous communication, irrespective of physical distance, provides a means for rural people to communicate with New York just as easily as they do with their next door neighbor. By contrast others accept the potential for instantaneous communication but argue that another rural feature, low density, will make it unlikely that many rural places will gain access to new technologies on a timely enough basis for them to keep up with the evolution in telecommunications technology that is the basis for communicating in the information age society.

Almost ten years ago the Office of Technology Assessment (OTA) conducted a study that examined how rural areas would fare under the technologies present and emerging at that time. It's report *Rural America at the Crossroads* described a situation in which there was potential for advances in telecommunications to help reduce the rural disadvantage, but the report also noted that for this potential to be realized a carefully developed set of investments would be required. Without a clear public policy commitment to funding these investments, the report concluded that many rural areas would be unable to take advantage of the opportunity and would be left behind.

It is important to recognize that at the time the OTA report was being developed, the Internet was a narrowly based scientific communication system that was only used by scientists, personal computers were only starting to be linked in networks, e-mail was not widely used, cellular telephones were only available to the wealthy, and personal computers were relatively slow, expensive and difficult to operate. In ten years there have been major advances in the technologies of telecommunications and computing, but equally important there has been a huge increase in the penetration of these new technologies in our society. While ten years ago the digital society was just beginning to be recognized, today it is upon us and it is clear that those without access to it are at a serious disadvantage.

It was for this reason that TVA Rural Studies thought it would be useful to revisit the OTA report and discuss the extent to which rural America was keeping up with the rapid developments in modern telecommunications. Much of the original OTA report had been overtaken by events but it provided a useful structure for defining the important issues. To provide a bridge between the original report and the present we asked three experts to develop background papers on the changes that had taken place in the last decade and the implications they saw for rural areas. These three papers and the original report formed the basis for a one day workshop held in Nashville that had as its goal an assessment of whether rural America would benefit from the new telecommunications environment. Not surprisingly the individuals in the room did not come to a clear conclusion on this subject; but their discussion does provide a useful framework for examining the opportunities and constraints facing rural places as they try to remain connected to the rapidly increasing flow of information that now drives our society.

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CONFERENCE SUMMARY

RURAL AMERICA AT THE CROSSROADS CONFERENCE

INTRODUCTION

In 1991 the Office of Technology Assessment (OTA), a science research organization that was then an arm of the United States Congress, released an influential report entitled *Rural America At The Crossroads*. The study was in response to a congressional request to examine how the already pervasive changes in the telecommunications industry were affecting the future of rural residents, businesses and communities. Specifically, OTA was asked to address six questions:

- Will technological advances be available in a timely manner to rural America?
- Does information-age technology involve economies of scale and scope that will enable rural businesses and communities to adopt these technologies?
- What are the expected economic effects of information-age technologies in rural areas (including job creation, training needs, and job displacement) and investment (including capital requirements and public infrastructure)?
- Which rural areas are likely to have the greatest ability to make use of these new technologies?
- What roles can the various levels of government play in fostering information-age technology?
- Can rural America expect to be competitive in serving national and international markets for the goods and services of this new era?

In answering these questions, the report concluded that changes in telecommunications—particularly the growth in the use of computers, data transmission, conference calls and fax machines—were straining the capacity of the telephone system in many rural places. OTA pointed out the need for significant investments in rural telecommunications infrastructure to reduce the growing gap between the levels of technology available to urban and rural residents and businesses. As the OTA authors observed in the report:

> Although often isolated and remote, America's rural areas do not exist in a vacuum. They will inevitably change as the world around them changes. As telecommunications technologies extend rural ties and expand rural markets, these communities will become increasingly vulnerable to national and global trends and events. For rural America, the most critical of these developments will be the adjustment to a highly competitive, service-based, global economy and the emergence of major, world-wide environmental concerns that will compel them to reorient their economies. Since many rural communities lack essential financial and human resources, and often depend on a single industry for the lion's share of their wealth and vitality, their ability to adapt to these changes is limited. Without some form of intervention, these communities are headed for decline.
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> Advanced telecommunications and information technology are certainly not "the" solution to the many problems confronting rural America. In fact, one needs only to look historically to see examples of where the deployment of these technologies has left rural communities worse off. However, in the current economic environment, in which businesses are using these technologies strategically to gain a competitive advantage, communities and businesses that

> have limited access to them are unlikely to survive. While not a panacea, in a global, information-based economy, these technologies could help rural communities overcome a number of the barriers that have limited their economic well-being in the past.
>
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The better part of a decade has passed since those words were written and much has changed.

- The telecommunications industry has been largely deregulated;
- The Internet has become the driving force that links all manner of telecommunications activities including data, voice and images;
- E-mail use has increased astronomically;
- Each year computers have become far more powerful and their relative cost has declined; and
- Greatly expanded wireless telecommunications systems are beginning to challenge the natural monopoly of the pole and wire systems of conventional cable television and telephone net works.

Yet OTA's conclusions are as true today as they were in 1991. Advances in all forms of information-age technology continue to transform the economy and society and the stakes for rural America have increased as a result. Consequently, the six questions that framed the original report can guide current assessments of how telecommunications changes are currently shaping the future of rural America.

Such was the task of a one-day conference held in Nashville in November 1996 under the auspices of the TVA Rural Studies Program and the Foundation for Rural Service. A group of telecommunications industry professionals, regulators, electric utility providers and academics were brought together to reexamine those questions in light of current conditions and reassess the implications for rural areas. This report provides a synopsis of their discussions and also includes three background papers commissioned prior to the conference to assess the implications of technological change, deregulation, and competition for rural areas.

In general, participants believed that pressures to adopt advanced telecommunications in rural areas have increased. They also believed that access to the Internet is now vital for rural businesses, individuals and communities to fully participate in society. By contrast, the original OTA report did not even mention the Internet since at that time it was strictly a research tool for university scientists—a perfect example of the rapidity of change.

Participants were less certain that rural areas were likely to quickly adopt new technology. Even the most optimistic believed it would take a while to close the rural-urban gap in access to and use of telecommunications technology. Others felt that the gap could easily widen and impede economic development in much of rural America. Regardless, all participants believed that joint private-public efforts would be required to speed up the rate of access and adoption in rural areas. There were, however, significant differences of opinion on the size of the role the public sector could and should play in those efforts.

While the conference succeeded in advancing discussion about the implications of new telecommunications technology and policy for rural areas, it is clear that such meetings must continue in order to keep up with ongoing change. The record of this meeting may best serve as a guide for those involved in subsequent efforts to follow how ongoing change affects rural development opportunities.

BACKGROUND PAPER DISCUSSION

Although the authors of the three background papers followed different paths in developing their papers and emphasized different aspects of the changes taking place, they agreed (for the most part) on a small number of crucial issues facing rural areas.

1) Investment in additional telecommunications infrastructure is essential for rural economic development. Although a considerable amount of telecommunications infrastructure is now in place in rural areas, much of it is not capable of supporting advanced telecommunications services. Such advanced services require broadband capability, which is not possible on much of the equipment currently in use. Furthermore, building broadband capability would be expensive—perhaps prohibitively so—costing from $2,000 - $5,000 per subscriber, according to Egan and Malecki. Nonetheless, Egan says "the key to rapid adoption of advanced technology for rural subscribers is to take an infrastructure approach to the problem."

2) Local access to the Internet (which requires broadband capability) is essential if rural areas are to avoid being left behind. Businesses without local access to the Internet will face tough new competition from competitors who have adopted the technology. The Internet allows a business to deal with a customer located in another country, not just another county. Thus firms are exposed to an entirely new spectrum of competition. Further, many firms now require their suppliers to maintain electronic contacts. Those firms who have local access will be able to avail themselves of a new world of customer opportunities.

3) Because rural businesses tend to be less skilled in management and technological issues, significant additional investment in human capital is critical. Rural communities need to understand how they (especially businesses) can reap the economic benefits from enhanced telecommunications services. Therefore, training and technological support must accompany investments in infrastructure. Investment in infrastructure is of little value if no one understands it or desires to learn how to use it.

4) Large regional telephone companies are unlikely to provide rural areas with advanced services. (Connecting to those companies' networks would, however, facilitate adoption of advanced services in rural areas.) Phone company profit margins are higher in urban areas than rural due to higher volume and higher population density in urban areas, both of which reduce the cost of providing service. In addition, changes in policy have reduced or eliminated many subsidies for rural service. And finally, the absence of competition in rural areas reduces the incentive for companies to invest in new technologies.

5) The adoption of advanced telecommunications services in rural areas will be a lengthy process. Both Malecki and Egan believe it will take 10-20 years for rural areas to gain access to advanced services. Parker, on the other hand, is a bit more optimistic; saying it will take 5-10 years. In either case, the first step will be to bring basic local service up to current standards—single-party, touch-tone with digital switching, and line quality sufficient for voice, data, and fax transmission at 28,800 BPS.

6) Deregulation of the industry does not bode well for rural areas. The authors agree that deregulation and competition will lead to less access for most rural users. As new technologies are introduced, "equal access" will take on a new meaning. According to Egan, "The disparity between the "haves" and the "have nots" will become worse, not better, as will the lag between rural and urban adoption of advanced services."

Workshop participants agreed that the world described by the three authors was generally consistent with their experience and beliefs (no small point, given the diversity of background and interests represented at the meeting). Participants also agreed that though the problems facing rural areas are severe, they are not insurmountable. Consequently, a number of approaches were put forth in the papers and discussed at the workshop. These approaches represent the beginnings of a framework for improving rural access to modern telecommunications technology.

Rural Area Networks

The introduction of rural area networks (RANs) could provide the necessary scale economies for providers to supply advanced telecommunications services (and especially the required infrastructure). The concept of a RAN was first introduced in *Rural America At The Crossroads* as a way to link institutions (government, business, educational facilities) together in a way that aggregates demand for advanced services and provides a way to pay for them. Rather than having to identify individual users and connect them, a telecommunications provider need only connect to the network at a single point.

Interconnection

Another way to mitigate many of the problems identified above is to connect to the urban portion of an existing network. Such "interconnection" eliminates the need to build duplicate infrastructure in rural areas and requires only that rural areas pay for the additional costs of extending a connection to the network. This would be the most efficient solution, enabling rural areas to exploit existing economies of scale (and possibly provide economies of scope).

Unfortunately, current monopoly suppliers have no incentive to interconnect. In fact, they have a disincentive—namely, foregone profit, because interconnection means instant competition to the current monopoly suppliers. This is not a step monopoly suppliers would take on their own account. Therefore, interconnection would have to be mandated by policy, such as an amendment to the 1996 Telecommunications Deregulation Act.

Wireless

The advent and proliferation of wireless technologies are particularly promising for rural areas. Because rural areas are, by definition, low-density and remote, they pay a "penalty" for obtaining telecommunications access. The fixed costs of the system are spread over a small population base and are higher to begin with because of the low-density settlement patterns and more difficult terrain. In addition, long-distance calls tend to account for a higher percentage of rural customers' calls since they must call outside of their local exchange more often than urban customer in order to reach a variety of businesses and services. The situation is exacerbated by the need to call long distance to gain access to advanced services like Internet, e-mail, or telephone support.

Wireless technologies (in combination with long distance service providers, cable television channels for local phone service, and wireless personal communications services (PCS) customer access) can mitigate these problems by bypassing the current network and providing an alternative path to new services. Interestingly, electric utilities are well-situated to provide alternative paths via fiber optic trunks along their power poles and rights of way. For example, Parker says that a scenario might emerge that would "combine Sprint long distance service, cable television channels for local phone service, and wireless PCS customer access, thus completely bypassing the existing network."

OTA QUESTION DISCUSSION

Will technological advances be available in a timely manner to rural America?

Although Egan and Malecki argue in their papers that rural areas are disadvantaged in their ability to gain access to technological advances, participants challenged this view and raised several points in support of their optimism:

- The advent of wireless technologies. Other types of telecommunication services could repeat the rapid proliferation of satellite television in rural areas. The development of such technologies might prompt existing providers—facing the threat of bypass—to improve their services. Participants agreed that wireless will become the dominant or critical technology for the most remote and lowest density local telephone loops, replacing wires as the fixed infrastructure. For example, Knowles offered the projection that "anywhere from 15% - 20% of traffic over the next ten years will come from fixed wireless."

- The existence of alternative providers. Alternative providers, including electric utilities, may decide to offer telecommunication services either because they are profitable in their own right or because they complement the services they currently provide. Another option might be for telephone companies to enter into joint ventures with power companies to take advantage of existing power lines. Regardless the form alternative providers might take, none of the participants believed that large phone companies would be the ones to take rural America into the information age. In fact, Knowles and Owens agree that, "it will be the small to medium size companies that can be the future of rural America, since the RBOCs are too large and too unwieldy".

- The promotion of interconnection. Regulators could actively promote interconnection, allowing rural areas to tap into the advanced services provided in urban areas. If this were to happen, the rural-urban gap would narrow, thereby promoting both economies of scale and of scope.

- The demand for advanced services. If information technology is demand-driven, then the rural-urban gap should close as rural residents and businesses become willing to pay for improvements.

Participants agreed that some combination of these factors might occur in some rural areas thereby shrinking the "rural disadvantage." However, there was little belief that all rural places will narrow the technology gap. And rural places that are slow to receive access will inevitably fall behind, making them even less likely to receive future investments. Especially at risk are those communities that are more costly to serve. Based on the rural impacts of deregulation in other industries, the group agreed that some rural areas would not receive advanced services in a pure market environment.

Furthermore, according to participants, the absence of broadband capability remains problematic. If rural areas are to avoid being left behind, they need local access to the Internet and other on-line services. But because rural businesses tend to be less skilled in management and technological issues, access to the technology is not enough. A parallel investment in human capital is critical if the investment in infrastructure is to have a positive return. With respect to human capital, Parker also included the need to reform social organizations (i.e., the way that people relate to each other, the coordination of efforts, and the need for local leadership and risk-taking entrepreneurs) to assure that the potential benefits of the technology are fully available.

Does information-age technology involve economies of scale and scope that will enable rural businesses and communities to adopt these technologies?

Opinions about the effect of the new telecommunications law on economies of scale and scope were mixed. It is unclear at this point whether deregulation will require larger- or smaller-size units to achieve minimum efficient scale. At issue is the so-called "threshold effect"—the minimum percentage of a community's population that must adopt a service for it to be viable—from both the provider's and the consumer's perspective. Determining the threshold is important, because it helps determine who will provide advanced services. Deregulation has been predicated on a belief that scale economies are now available at smaller sizes than before, but it is not clear how small a firm can be and still be efficient.

Because telecommunications is a network industry, the benefits from the use of the technology increase with the number of users: The more people connected, the more people can be reached. Likewise, additional users—because they require no additional infrastructure other than connections—reduce the average cost per user. Thus, though initial fixed costs are high, there is great potential for economies of scale and scope. But while deregulation has removed regulatory barriers to entry, it has not necessarily reduced the costs of entry. For a supplier to enter a market, the firm must expect to receive at least normal profits. This suggests that the threshold is the amount of people (or the market share), for which this average cost is minimized. If there are few potential customers in a market, even if they all participated, the average cost will likely be high because there are too few people to spread them over. However because the price does not fall as people join, the number of people who actually do participate will be limited . The result: little chance that a firm will choose to serve the market.

Under the new law, potential entrants may believe they will be unable to attract sufficient customers at a price that allows them to recover their investment costs. If the number of potential customers is too small then competition may not materialize. On the other hand, if new firms do enter, existing firms may not be able to cover their costs at the new lower prices and be forced to exit the industry. Thus the effect may be to exchange one monopoly provider for another.

All of that said, participants differed widely on their opinions about thresholds, ranging from 15 percent by Linda Garcia to 50 percent for Egan and Ray. Henry James asserted "that the threshold of use effects could be less important in rural areas." That is because of the importance of being connected to the rest of the world—not to just those in the same community (Metcalfe's Law). Thus even if competition does not occur and rural rates remain high, there may be sufficient benefits from being connected to other places to allow adoption even if it costs more per connection in rural areas.

What are the expected economic effects of information-age technologies in rural areas (including job creation, training needs, and job displacement) and investment (including capital requirements and public infrastructure)?

and

Which rural areas are likely to have the greatest ability to make use of these new technologies?

The traditional way of classifying rural areas by type of economic function (e.g., agriculture, manufacturing, retirement etc.) is not useful when it comes to determining the need for and benefits from advanced telecommunications. All types of rural areas require access. However, the exact type of services they will require and the exact nature of benefits they will receive is not known. Therefore the appropriate strategy is to focus on how a broad platform can be put in place to provide an array of services. And because communities' needs will vary considerably, localized control and decision-making (ala the cable industry) rather than state control and decision-making (ala the telephone industry) is desirable. Local regulation would allow greater flexibility in designing service delivery that is appropriate for local needs. This is particularly important if concentration continues to increase in the supplying industries, since multinationals have little attachment to specific places.

In essence the critical question for telecommunication services is "What is appropriate for the community?" This was the central issue that seemed to frame the discussion of technology and use. While this question does not have a clear resolution in the sense that certain types of community require specific types of services, it is often the case that after some careful thought a community can identify those services that it requires. If the question can be answered at the local level, then it should be relatively simple for individuals to find ways to gain local access. However, if the services are of a type that are not available in the area (because demand is insufficient or the technology has not been made available) then it will be very hard for individuals in remote rural places to gain access at reasonable cost to these services.

At the same time, the focus cannot be exclusively on the provision of services. People must be taught the value of the technology and how to apply it in their particular circumstances to meet their particular needs. Many of the new computer based technologies require considerable training before they can be used and even more for the user to get the maximum benefit from them. In so doing, two things can be accomplished: 1) benefits from the technology will increase and 2) demand for the technology (and consequently supply) will increase.

With regard to platforms, Garcia reiterated that rural areas need networks and network architectures, rather than types of technologies. For example people want access to e-mail or the Internet; they are not as concerned whether it comes over the phone lines or through cable, whether it uses one protocol or another, or whether the service is provided by a private company or by their local government. Individual technologies must be integrated into a package that delivers desired services to users at reasonable cost. Thus, rural areas require a system that is flexible enough to allow different types of applications to be provided. In *Rural America at the Crossroads*, OTA proposed a particular solution—Rural Area Networks—that could be configured around the geographic boundaries and needs of an entire community. To paraphrase Garcia:

> A RAN would link up as many users within the community as possible - including businesses, local government offices, educational and health facilities, which could then be linked statewide by "piggybacking on the State government and/or State educational network."

In addition, RANs have a number of advantages, among them:

> By pooling diverse users, RANs provide considerable economies of scale and scope, thus fostering the deployment of advanced technology to rural areas in an economically viable manner, without the need for subsidies.
>
> By aggregating demand, RANs may induce providers to be more responsive to the needs of rural communities.

According to Parker, the Internet is now the common application platform to which Garcia referred (via web pages, home pages, and other platforms for trade). But there was considerable debate over whether the Internet is only a technology, as opposed to a platform. The question revolves around whether one sees the Internet as a way to deliver various technologies and applications, or only as an application. Garcia argued that the former is what the communities need. Sterrs observed that at present the Internet still requires people to be conversant with the mechanics of the technology, not just how to use it. In addition, he felt that the applicability of the Internet to businesses is still not clear. Others pointed out examples of places where access to the Internet was readily available, but there was still limited interest in making use of it.

These observations led to a discussion about whether the lack of interest was specific to the Internet or part of a broader lack of interest in modernizing the community and accepting change. Dillman observed that "without Internet access one is going to go nowhere in society." But that is consistent with both a failure to recognize the value of the Internet and a larger lack of interest in change. In places where there is a mindset that resists change there will be little interest in either obtaining or using new telecommunications capacities. Conversely, Davis argued that if a community wants to change and modern telecommunications is presented as a way to do that, then the community would get behind it. Thus, there was a strong belief that while specific applications may or may not be important in a given community, general access to a broad array of services is critical for a successful future. But again, access alone is not sufficient. People must be educated as to how it can be used to provide economic benefit. There must be training and technical support. According to Sterrs, "People are being forced to be conversant in technologies rather than applications - not only do they need to know how to use (telecom) technology, but also need to be shown how their businesses can benefit economically from it."

Despite the absence of a clear agreement that the Internet is the appropriate platform for rural access to telecommunications, participants did agree that high-speed, local access to the Internet is a vital component of such a platform. And as such, they concluded, it should be included in the definition of "Universal Service," with narrow band access to the home and broadband access to every community. However, there was little sentiment for government provision of the service. Rather, participants believed it should be available at reasonable cost to all rural residents.

The question concerning who would provide these services brought a variety of answers, ranging from "electric utilities will save the day" to "rural telephone cooperatives will be the 'first movers'" (from a National Telephone Cooperative Association study). Regardless, as discussed above, no one thought the large regional telephone companies would provide these advanced services, even though they are already present in most rural communities.

Regarding provision, Agha noted that no infrastructure has been put in place absent some sort of government policy (largely because of the public good nature of infrastructure). For example, Sterrs and

Imorde noted that both Tennessee and Maine have expressed clear commitment to support telecommunications development via public policy. The group discussed a variety of policies that might help narrow the rural-urban gap. One such policy would provide every county seat with the infrastructure it needs (e.g., high capacity lines, fiber optic transmission lines). From there, the diffusion process could begin. Alternatively, policy could encourage phone companies to provide "transparent backhaul." That is, provide a community with services that are not available on the local switch by sending them from an urban switch via interconnection. Finally, if broadband and fiber optical cable is available in a community, it should be priced as if it were provided locally. Again, a critical element is open interconnection at nondiscriminatory cost-based rates with an incumbent carrier.

Overall, the group felt that pressure to provide rural areas with access to advanced telecommunications was not being driven by business demand—despite the clear implications for rural businesses. Instead, pressure seems to be driven more by a sense that the infrastructure is a basic necessity and should be available as a public service. Garcia observed that this may help to explain why a higher proportion of the communities served by small cooperatives or investor owned systems have access to modern services than do places served by one of the large RBOCs, since those smaller systems are run by local residents and are likely to be more sensitive to community needs.

Finally, there was considerable agreement that demand is a learned phenomenon. According to Kneeshaw, "Before you can bring the technology in you're going to have to show them how they can use the tools productively." There are economic benefits from investments in telecommunications technology, but they may take a while to materialize.

What roles can the various levels of government play in fostering information-age technology?

Given current trends, the federal government will not likely play the same role it has in the past. Therefore, participants discussed alternative ways to support rural efforts to gain timely access to advanced telecommunications. As discussed above, participants were leery of state control. Rather, they supported more localized regulation and decision-making in order to address the diverse needs of communities and the diverse mix of providers.

As for the question of "access", the group did not resolve whether it should be defined as Internet presence at a central site in the community (e.g., a school, library or telecenter) or as presence in individual homes and businesses. Nor did the group answer the question about "relative equality of access." That is, the level of technology available in rural areas compared with the level available in urban areas. The group did, however, agree that access to the Internet is the minimum acceptable standard. Consequently, the bulk of discussion focused on ways to assure that rural areas get the Internet. According to Parker, while most current levels of telephone service allow narrow- band access to the Internet, it is critical to ensure broadband access at the community level. Freshwater noted that access requires a computer and the skills to operate it as well as a telephone line, so that for many people the notion of access advanced by Parker is illusory.

Egan noted, however, that access might not even be the issue. Instead, it might be "use" since the 1996 Act clearly requires equal access. This statement, of course, prompted considerable debate over just what equal access meant and the likelihood of it being fully implemented. In that regard, the Universal Service Fund was seen as the critical determinant in resolving the issue of access. And the amount of money in the Fund will be determined by who pays into it—just telephone companies or all telecommunications providers. Similarly, how monies from the Fund are allocated will determine who the providers are and what services they make available. At this point, it is unclear how new providers will be regulated and whether existing provisions of the law will apply to them.

Finally, while cooperatives may play a lead role in providing advanced telecommunications to rural areas, there was considerable agreement that the magnitude of the investments in equipment and training will require additional partners from both the public and private sectors.

Can rural America expect to be competitive in serving national and international markets for the goods and services of this new era?

While the authors of the background papers agreed that rural areas would be disadvantaged with respect to the new technologies, participants in the workshop were less certain. A considerable number believed that competition could reduce the gap by removing the control of the RBOCs over the rate at which technology is introduced. And by extension, allow rural areas to be competitive in the new era. The participants argued that alternative providers, including electric cooperatives, have a strong incentive to introduce new technology because it helps maintain the viability of their core business and because they have a commitment to the community. By contrast RBOCs do not have enough incentive, because the profit margins are so slim. Ray pointed out that the lag in electricity and basic phone service is smaller in rural areas served by cooperatives and small local investor-owned utilities than for regions served by large investor-owned firms.

Finally, it is clear that federal assistance played a critical role in bringing rural areas up to speed in the past. And if that is to be the case with advanced telecommunications, then a similar level of governmental commitment will be required.

The Conference Summary was prepared from conference transcripts by:

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Transcripts of the conference are available on our website at http://www.rural.org/workshops/rural_telecom/transcripts.pdf

IMPROVING RURAL TELECOMMUNICATIONS INFRASTRUCTURE

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1. Introduction

Advanced (digital) telecommunications technology has the potential to dramatically improve the quality of life and the rate of economic development in rural America[1]. Public access to advanced telecommunications technology needn't imply that one has to be physically located in proximity to urban areas where most information and production is generated. But while technology adoption in communication networks continues at a very rapid pace, increased market competition among telephone network operators forces them to invest where the money is, in dense urban and suburban areas. Thus, while a modern and effective telecommunications infrastructure is crucial for rural economic development, its financing raises a multitude of difficult public policy issues.

The analysis herein examines the rural telecommunications infrastructure focusing on technological developments and the costs and financing of network modernization. While there has been considerable hype in the industry and trade press about digital information "superhighways" (as if we all can just sit back and wait for "it" to happen), a look at the facts would lead to a more pessimistic view, especially for rural areas of the country[2].

There are some recent technological developments which provide exciting prospects for new digital wireless technologies to come to the rescue for some rural services, however, the government needs to pay more attention to spectrum allocations for rural radio services in order for these to fulfill their promise[3]. Because the cost characteristics of such technologies are not nearly as sensitive to the physical distances involved, these technologies hold special promise for rural applications, but will likely not be deployed in rural areas until well after they appear in dense urban and suburban markets.

Much of rural America is served by small independent telephone companies. There are over 1300 local telephone companies in the US, the top 10 of which serve over 90% of all subscribers. The rest serve mostly rural areas with a relative handful of subscribers. Historically, financing for the modernization of rural company network facilities has come from a combination of the local tariff rates charged by the rural telco and cross subsidies derived from: 1) rural company charges to interconnecting toll carriers and, 2) other revenue sharing arrangements with larger local telephone carriers which serve relatively dense areas with lower cost (higher profit) subscribers. Increased competition has added considerable uncertainty to the traditional revenue flows derived from these sources.

Market competition is the natural enemy of cross subsidies. While direct competition for telephone subscribers may be long in coming to many rural areas, the competitive erosion of cross subsidies currently provided by toll calling, business and high profit residential market segments is surely going to proceed rapidly. Naturally, the political lobbies for competitive network operators do not want to provide any subsidies for rural development. At the same time however, small telephone companies want the government to assure that the rural network infrastructures and individual subscriber service in rural areas is affordable and equivalent to that available in urban and suburban areas[4]. The reality, of course, is that the outcome for the future will be similar to that of the past, namely, that rural network infrastructures will lag behind urban areas in terms of advanced service capability. In the new competitive environment, the risk (assuming the status quo of competitive entry with no proportional subsidy funding requirement from entrants) is that the disparity will become much worse.

In order to prevent the erosion of rural subsidies from newly competitive services, a number of federal and state initiatives are under way with the goal of preserving subsidy flows, usually under the rubric of so-called Universal Service Objectives. At the federal level, the FCC is investigating ways to better target subsidies to rural areas in need, and pending legislation in both houses of Congress contain provisions for maintaining subsidies for high cost areas[5].

Rural Network Technology

The following analysis indicates that now and in the future, fiber optics will continue to be the technology of choice for all shared network facilities where terrain permits. At times, local conditions may call for microwave radio trunk transmission lines instead of fiber. In the future, however, digital fiber optics will dominate local network trunking. For the dedicated subscriber loop plant, there are several alternatives depending on local terrain and the spatial distribution of individual subscribers, including coaxial cable, copper wire and digital radio. Due to significant variations in local demographics and topography, some of the overall analysis and conclusions may not apply in many specific rural areas although they are relevant for broad public policy considerations. For example, new digital satellite systems may be the only realistic way to get relatively low cost and high quality digital service to certain remote locations.

The most important conclusion of all is that technological solutions must be tailored to specific circumstances regarding topology, terrain, subscriber demand and spatial distribution. A "cookie cutter" approach to technology deployment, while easier from a network standards perspective, is usually not the least cost method to optimize the network for local supply and demand conditions or for planning future network upgrades[6]. Indeed, flexibility in network deployment strategies is the key to successful low cost investment. This means that flexible standards must be developed by both wireline and wireless network equipment manufacturers to allow efficient interconnection between networks and a high degree of connectivity between end users[7].

The cost of advanced rural communication network infrastructures is substantial. In a future competitive market environment, it may not be possible to finance its construction without significant increases in subscriber rates unless a new stable source of subsidy funding is adopted by regulators[8]. Assuming a construction interval of 10-20 years—a normal time span for turning over telephone plants—one estimate of the cost of digital service is about $1,000 per subscriber[9]. This would endow rural subscribers with digital communication capability comparable to narrowband ISDN service. While this may suffice for residential subscribers using home computers or other devices, such narrowband service capability may not meet the communication requirements of business customers. As subscriber needs develop, broadband services using fiber-optic technology or other suitable media may be necessary.

Achieving broadband communication capability in rural areas is a very costly proposition at about $4,000-$5,000 per rural subscriber[10]. Broadband communication facilities would allow consumers to enjoy high quality service, including entertainment video and multimedia applications where more than one communication activity may occur simultaneously. For example, with broadband telephony one may access an on-line database while viewing a movie, reading, or listening to the news. The cost of such capability is high because it requires new alternatives for the subscriber loop plant to replace traditional twisted-pair copper phone lines.

Where possible, existing coaxial cable television loops could be interconnected to a fiber backbone of shared network facilities to provide broadband capability. Elsewhere, fiber-to-the-home (or "near"-the-home) is required. Current satellite and microwave radio will not be the best option for most service applications because bandwidth limitations and delay times make these technologies unsuitable for a multimedia real-time environment. However, both radio and satellite are useful for infrastructure development in some applications. Satellites, for example, are preferred for delivery of distant video programming and may be interconnected to the wireline network infrastructure. But the use of satellites for voice service or other real-time two-way communications will likely be minimal[11]. This could change, however, with the future deployment of new Low and Medium Earth Orbit (LEO/MEO) digital satellite systems[12].

Microwave radio is useful and cost effective in many situations where fiber is not practical, such as over rough terrain or water. Much of the existing microwave facilities are useful for providing advanced telecommunications because they are already digital and may feature high bandwidth and capacity for new service applications. However, for distribution of basic local service, both satellite and microwave will generally be limited to relatively high cost applications. The FCC-approved Basic Exchange

Telecommunications Radio Service (BETRS) is the primary application of microwave radio technology for local service. It is expected to be the preferred alternative when wireline service is not feasible, but as such cases are rare, rural radio service, as currently defined by the FCC, is not being widely deployed as an alternative to traditional wireline service in rural areas[13]. The FCC could change this if new spectrum assignments for high powered rural radio systems were made. High powered digital radio systems for fixed telephone service are cost effective in rural applications compared to wireline systems, but only if there is enough spectrum and only if system power restrictions allow for large "macrocell" radio coverage areas (e.g., 15-30 mile radius) featuring maximum sharing of available spectrum within single base station area. Foreign countries, especially those with nascent network infrastructures are deploying new digital wireless systems as an alternative to traditional wireline connections[14]. The US government's recent focus for radio spectrum policy has been on new convenient low power cellular and advanced paging and cordless telephone services which, while ideal for pedestrian and mobile applications in congested urban environments, is not cost effective or feasible in rural settings.

The best way to establish rural objectives for a network infrastructure is to begin at the state level. The reason: telecommunications depreciation policy, basic rates and economic development planning are set at the state level; each state determines its objectives, timetables and financing requirements. There is an important gap in telecommunications infrastructure planning in most states, especially regarding coordination with the important transportation and energy sectors. We find the synergies of telecommunication network providers and public power grid operators to be underutilized for fiber optic transmission and recommend more cooperation in this area. The same is true, but to a lesser degree, in the case of the transportation sector. The early beneficiaries of more cooperation between these sectors is rural education, health care and income growth.

2. What is Rural?

There is no standard definition of rural telecommunication subscribers; however, some general observations should be made. Government data indicates that about a third of all residence subscribers (some 30 million households) are in non urban areas of the U.S. (called Metropolitan Statistical Areas or MSAs). Non-metropolitan counties are those with no urban areas greater than 50,000 population, but there are many possibilities for classification errors. For example, there could be metropolitan areas close to the border of adjacent non-MSA counties, or there could be many towns of less than 50,000 people each. It is potentially misleading for policy makers to use such data for policy purposes without adjusting it for classification problems[15].

It is very important to distinguish "rural" from "remote" subscribers; The latter refers to those whose access to the telephone network is difficult due to physical "remoteness" caused by either extreme distance or terrain. While remote subscribers with no telephone service might represent a socially deserving segment of the general population, for public policy purposes they should be separated from the general body of rural subscribers. Public policy must be able to focus on upgrading communication infrastructures for those customers already hooked up to the network regardless of policies for reaching customers who are not only rural, but physically remote. Otherwise, policy debates over the subsidies required to provide service to remote non-subscribers can derail progress in technology adoption for the vast majority of rural subscribers. Furthermore, the available evidence is that remoteness is neither a particularly common problem nor one which requires much total subsidy to solve. Pockets of truly remote subscribers will be most economically served by new digital satellite communication networks.

There are few truly "remote" subscribers relative to the base of all rural subscribers. One estimate puts the number of remote customers at 183,000, or only about 1% of all rural subscribers[16]. Fortunately, a wealth of information exists for small independent telephone companies from industry trade groups such as United States Telephone Association (USTA), the National Telephone Cooperative Association (NTCA), and an agency of the United States Department of Agriculture which for many years was called the Rural Electrification Administration (REA). The REA's areas of responsibilities were recently combined with other areas and the new agency is called the Rural Utilities Service (RUS). RUS provides investment and financial data for almost 900 small telephone companies serving about 6M subscribers in very thin markets. Thus, for purposes herein, the RUS data will be representative of "rural" subscribers. While many other data sources will be used in this analysis, the basis for most statistics will be the RUS data[17]. Depending upon one's view as to the absolute number of rural telephone subscribers in the US, for broad policy analysis the per subscriber results based on RUS data may be increased by an appropriate factor to arrive at universal results.

Beyond the distinction of rural vs. remote, there is also an important distinction between existing and new customers. Costs of technology adoption may be very sensitive to the fact that the necessity of starting from scratch in some areas renders moot the issue of whether or not to use some of the existing facilities in a network upgrade. For most subscribers, a network upgrade must consider the embedded base of technology to ensure a cost effective construction decision. Keeping in mind the distinctions between rural vs. remote and existing vs. new subscribers, this analysis concentrates on the cost of network upgrades for existing subscribers—the vast majority. Remote and new subscribers will be considered separately.

3. Financial Profile for Rural Telephone Companies

There are over 1300 telephone companies in the US, about 900 of which are borrowers in the federal government RUS financial assistance program. The top 53 Local Exchange Carriers (LECs) which report annually to the FCC, account for about 90% of the approximately 150M access lines in the US[18]. The seven Regional Bell Operating Companies (RBOCs) alone account for about 70% of all telephone lines; adding GTE and Sprint accounts for nearly 85%. However, despite the huge differences in the scale and scope of the operations among US LECs, when comparing statistics for average per line financial results between large and small companies, the data are surprisingly similar. One reason for this is that, while the larger LECs may enjoy the low average per line costs of serving large metropolitan areas and spreading fixed network costs over a large subscriber base, they also serve a considerable number of rural service areas. Similarly, while small rural LECs may serve much less dense areas overall, they too serve relatively dense towns within those rural areas. Furthermore, larger LECs tend to have a scope of operations which is very different from that of smaller LECs including investments in regional toll service network facilities and specialized and business services.

Tables 1 and 2 provide financial benchmark data for key operating ratios, costs and revenues for large and small LECs.

3.1 Operations, Investment and Expenses

A comparison of the FCC and RUS data for large and small LECs indicates that large LECs enjoy substantial capital and labor productivity advantages due to their large scale of operations and dense subscriber base. For example, large LECs support on average about 30% more telephone lines per employee than small LECs.

Average annual expenses per line are $607 for small LECs and $446 for large LECs. However this includes annual depreciation charges per line which, due to the small LECs larger investment in physical plant per line, would be expected to cause annual capital related expenses to be higher. Since depreciation expense requires no cash outlay, operations expense net of depreciation provides a better measure of relative expense performance. Net of depreciation expense, small LECs annual expense per line is $450 and the large LEC is $330.

Even though small LECs have 40% more investment per subscriber line, the annual network related expense ($128) is almost the same as for large LECs ($120). Annual customer operations expense is $70 per line for small LECs and $84 for large LECs. Corporate operations expense (i.e., overhead) per line for small LECs is $120 and for large LECs is $70. This cursory analysis of average expense data reveals that small LECs are quite efficient relative to their larger LEC counterparts when considering the on-going network and business office operations. This is especially significant considering that conventional wisdom is that there are important production cost economies associated with larger scale and scope of network operations. Overhead expense performance for smaller LECs relative to larger LECs is not good. But, per line corporate overhead involves expenses which are more easily reduced by "spreading" them over more access lines.

3.2 Revenue and Operating Margins

Chart 1 portrays major sources of revenue and expense for small LECs in average percentage terms and Table 3 provides some indication of the variability of per subscriber revenue and expense among individual firms. The data presented earlier in Table 1 showed that annual revenue per line for small LECs is $799 per year or $66 per month and corresponding amounts for large LEC revenue is $605 per year or $50 per month. Basic local monthly service charges per line are similar for both large and small LECs at about $16 per month. Regulation continues to achieve the social objective of rate parity between rural and non-rural areas for Plain Old Telephone Service (POTS). The quality of POTS service is similar with RUS companies reporting that 98.5% of residential subscribers have single party service (the remainder have shared party line service).

These average revenue numbers reflect both business and residence lines. The FCC reports that 64% of access lines for large LECs are residential, while the RUS reports that small LECs have 82% residential lines. Throughout the US, business basic local service rates are higher than residential and therefore, the basic rates for residential service for rural subscribers is somewhat higher than that for large LECs once the higher ratio of business to residential lines is accounted for.

Table 1 shows operating margins per line for small LECs of 24% of revenue ($191.37 per year), for large LECs the corresponding margin is similar at 26%. So, for now, the cash flow performance is similar for both large and small LECs.

The most important difference in the revenue streams of small and large LECs is that a whopping 67% of small LEC revenue is derived from toll and toll carrier access services, while for large LECs the number is 45%. Per dollar of household income, rural telephone subscribers spend almost twice as much on toll service than urban customers. Relative to large LECs, small LECs provide very little toll service directly, but instead share in the use of the toll network facilities of interconnected large LECs and interexchange carriers (IXCs). This is a harbinger of future problems for small LECs who have little hope of increasing their toll operations. Large LECs on the other hand, especially the RBOCs, have much to gain when the government removes restrictions into the huge interLATA toll market. Carrier access charges and toll settlements paid from larger telephone companies to smaller ones increase the ratio of toll and carrier access revenues. As competition in the industry for toll and carrier access services escalates, this very important revenue support for small telephone companies is increasingly at risk. The fact that some very high cost rural telephone companies depend on toll subsidies for their very existence represents a special problem for the future. For such companies, average loop costs can easily run two to ten times the overall rural average.

3.3 Financial Trends

Whatever the prospects for the financial future of rural LECs, the trend for the last five years is certainly a healthy one. For the time period 1989 to 1993 RUS LECs achieved an 8% increase in per line revenue and operating margins. Basic service revenue for RUS LECs increased over the period by 8% and toll and network access revenue increased by 11%. This is impressive considering that the corresponding FCC data for large LECs indicates percentage reductions in revenue per line (-10%) and operating margins per line (-18%)[19].

Furthermore, investment in rural networks is proceeding apace. From 1989 to 1993 the per line investment for RUS LECs increased by 9%. The depreciation reserve ratio (an indicator of the rate of capital replacement) has steadily increased (albeit slowly 9%) from 38.1% to 41.6%. Large LECs have done somewhat better on average as depreciation reserve ratios rose considerably from about 34% to about 40% (an 18% increase). Thus, the rural LECs rate of capital recovery increased only one-half that of the large LECs over the last five years. However, the large LECs had started back in 1989 with a depreciation reserve percentage far below that of the rural LECs and are only now catching up.

That having been said, rural LECs are now at risk of stagnating and falling behind. Large LEC depreciation rates for 1993 were 7.1% compared to only 6.2% for the small LECs (about the same as it was for 1989). In 1993 the large LECs invested in capital additions at a rate of +7.5% of the total plant in service, indicating that almost all of the financing was generated internally from depreciation charges. No comparable estimate of total capital additions over time is available for RUS companies because the exact number of companies which borrow (and report) this data to RUS varies from year to year.

4. Rural Telephone Plant Characteristics and Costs

Based on RUS company cost characteristics, one broad gauge estimate of the total cost of providing rural telephone service in the US is $19B per year[20]. This total assumes that all 22M non-MSA subscriber lines are classified as rural and an average annual cost of $871.08 or $72.59 per month.

There are significant differences in the physical characteristics of rural vs. urban telephone plants. RUS companies' markets are very thin, averaging only 4 subscriber lines per square mile of area served and only 6 lines per route mile of telephone transmission plants. For large telephone companies the average density of subscriber lines is greater by an order of magnitude[21]. Large LECs have five times more lines per switching office and almost five times less transmission facilities per line than small LECs (measured by sheath meters of copper cable - Table 2). The average length of subscriber connections to the LEC exchange switch for large LECs is about 10,000 feet vs. double that for small LECs. However, the net result is that the average investment and expense per subscriber line is only about 40% higher for the small LECs (Table 2).

Chart 2 shows a breakdown of small LEC total capital expenditures by major category of plant. Eighty-five percent of small LEC capital investment is represented by switching plant (31%) and cable and wire facilities (54%). Large LECs have 82% of total investment in switching plant(38%) and cable and wire facilities (44%). For both large and small LECs the remainder of the investment is primarily in land, building and support assets.

The average loop length for RUS companies is 20,330 feet, which is significant considering that access lines longer than 18,000 feet usually require special treatment to insure high quality basic service. The main problem is the attenuation of the analog signal, which may require boosting, using repeaters and amplifiers, or passive reduction of attenuation losses by loading coils, or both. Such loops pose a problem for the narrowband digital and new broadband services that require relatively high quality circuits for error free digital transmission. However, the mode loop length is less than the average for RUS companies. Consequently, 55% of the loops are less than 18,000 feet. The majority of RUS company loops are actually non-loaded, but many still receive treatment of some kind to improve transmission and signal quality. In contrast, about 90% of RBOC loops are less than 18,000 feet, and a large majority of those are non-loaded with an average length of only 7,500 feet.

On average, there are about 7,400 access lines per telephone company exchange in the US. Bell companies (BOCs) have about 12,000 lines per exchange[22]. Non-Bell Independent Companies (ICOs) have only about 3,000 lines per exchange. For 1993, the RUS reports an average of only 1,223 lines per exchange.

Average statistics regarding costs and network operations can be very misleading when considering any individual LEC or specific geographic region and caution must be used before ascribing average statistics to any company or group of companies. An examination of the RUS data for individual companies indicates some highly skewed distributions. Charts 3-5 illustrate the high variability in small company network characteristics including the number of exchanges, the number of subscribers and the average exchange size. For example, Chart 3 shows that the average number of exchanges per small LEC is 6 while the standard deviation is 8.5 and by far, most companies have only 1. Chart 4 shows that the average number of subscribers per company is 6,341 with a standard deviation of 14,000 with most companies having under 1000. Chart 5 shows that most RUS companies have between 200–400 subscribers per exchange, while the average is 1,223 and the standard deviation is 1,499. There are a considerable number of companies with over 2,800 subscribers per exchange.

Indeed, even within a single rural exchange area there are substantial differences in the physical characteristics of subscriber connections. This means that it is not only misleading to ascribe average company or exchange statistics to individual companies or exchanges, but that it is also problematic to apply average loop characteristics of a single exchange to individual subscribers. This has enormous implications for public policies that are trying to accurately target funding assistance to those subscribers who are truly in need.

Figure 1 is a stylized example of a representative local exchange area for a rural telephone company. The average exchange is comprised of about 1,200 households with a relatively dense downtown area containing 65% of total lines in the exchange area and 35% considered to be in the rural surrounding area of the exchange. The "typical" rural exchange as shown in Figure 1 has 768 households in the downtown area at a density of 256 subscribers per square mile, and 440 rural households with an average density of 6 per square mile. This example of a "typical" exchange shows that it is the rule rather than the exception to expect very different costs for individual subscriber connections within the same exchange area.

To illustrate the impact of subscriber density on the average cost per subscriber for rural LECs, Chart 6 provides cost estimates for the average urban and rural subscriber in the stylized exchange presented in Figure 1. The overall average per subscriber cost is $2,200. For the urban zone of the exchange the average cost is $800 and for the rural zone it is $6,000. As expected, the difference in cost is due primarily to the placement of longer loops for the rural subscriber.

A further examination of the variability of rural loop costs among small LECs can be found in Table 4 which provides a breakdown of total investment per subscriber for three density bands 1–10 lines per kilometer (km), 10–100 lines, and 100–500 lines. The per subscriber cost in the lowest density band (0-10/km) is about one third higher than for the second (10-100/km) and three times higher than the highest density band 100-500/km, with the average investment being $2,055 per line. Even within each density band, however, it would be misleading to ascribe the average cost result to any one company. For example, there could be drastic differences in topology and terrain which would dramatically affect costs but which do not appear in this data. One company may serve a relatively flat area with sandy soil, while another might be hilly or mountainous featuring solid rock. The spatial distribution of subscribers in a single exchange area could be exactly the same for both companies and yet the per subscriber costs for each could vary by an order of magnitude or more. The bottom line is that local conditions matter a lot.

Table 5 provides further support for the need to consider local conditions when assessing average cost characteristics. This Table displays statistical correlations between key publicly available measures of subscriber distance and density and investment and expense costs per line actually observed for 886 RUS companies. The subscriber density measures which were correlated with average cost per line were subscribers per route mile of cable, subscribers per square mile of serving area, and subscriber lines per switch. The very low values of the standard correlation coefficients demonstrate that there is no significant relationship between density measures and costs. Yet, it is well known that local factors like terrain notwithstanding, the primary engineering cost driver in local telephone networks is the distance of subscribers from the exchange. The second set of correlation coefficients is based on positioning all of the observed values for each variable in rank order from highest to lowest and correlating the rank ordered vectors. The very high rank correlation coefficients do indicate significant relationships, but now they have no meaning for any given company since the ranking of variable values were made without regard to which company the values belonged.

Kentucky is considered one of the most rural states in the US and Table 6 shows how small LECs average costs and revenues may vary within any given state. There are 16 rural Kentucky LECs that borrowed from the RUS in 1993. Table 6 (2 pages) provides operating and financial statistics for each of them. The weighted average revenue and cost per line and network density for the combined Kentucky rural LECs (second last row of Table 6) are fairly close to those for the national averages which appear in the last row of Table 6.

Conventional wisdom (at least to the layperson) is that rural telephone companies serve sparsely populated regions with little or no urban areas. This is not true. The available data makes it clear that inferences for any given company based on the average statistics for the group could be grossly misleading. Similar data is available for small LEC revenues and expenses. This data provides an important message for policy makers and regulators which may be tempted to develop competition policies and rural subsidy requirements based upon average cost and revenue statistics. There is no such thing as an "average" rural company, and no such thing as a "meaningful" average measure of the subsidy requirement.

5. Network Modernization

Notwithstanding the differences in individual company costs, at a broad policy level, the average statistics for loop length, transmission electronics and investment are useful for evaluating the average and total cost of rural subscriber loop upgrades. There is a great disparity between the tasks confronting large and small LECs to upgrade their loop plant to ISDN compatibility. Although bridged taps limit the ability of loop plant to support new digital service, this is no longer a serious problem for RUS companies.

In terms of digital network switching and intelligent network (i.e., switches equipped for Signaling System 7 (SS7) facilities, small LECs compare favorably to large LECs. Table 6 provides recent data on digital network facilities for Bell, other large LECs and smaller independent companies.

As the economies of scale derived from digital and fiber optic technology continue to lower the incremental per subscriber costs for advanced telephone services, the total costs associated with converting subscriber lines to narrowband and broadband digital service remains high or even prohibitive. Digital subscriber lines will allow rural subscribers to take advantage of new information age services including on-line computing, database, information and transaction services, remote monitoring, advanced facsimile and data services. These are the primary near-term applications for advanced rural telecommunications that will enable subscribers to "telecommute" or improve their productivity in the office or the home. Eventually, broadband digital service will become possible, ultimately providing for bandwidth on demand for anything from still pictures and high speed graphics to video telephony and full motion entertainment video.

Basic narrowband digital service begins with upgrading rural network functionality. Initial upgrades will support only low speed data and voice service. Expanded network capability will support higher data rates from 56Kbs service up to 144Kbs full ISDN service. This is the same modernization scenario scheduled for urban and suburban network upgrades, except that rural areas face some special challenges due to longer loop lengths. In both urban and rural areas, business customers may require broadband services, while most residential customers will probably be satisfied with narrowband capability for advanced voice and data telephone services. If residential demand for integrated broadband services takes off, narrowband network upgrades could be "leapfrogged" by the provisioning of broadband network connections capable of simultaneously supporting traditional telephone and broadband services. This scenario is very expensive and particularly risky in light of the cost effective alternatives including terrestrial wireless and satellite networks. It is especially risky for rural LECs to deploy broadband subscriber connections due to the very high sunk costs involved in the face of uncertain demand and certain competition from technological alternatives.

Not only is the broadband network infrastructure expensive, but the additional subscriber premises equipment cost must be factored in. New terminal equipment is currently very expensive. Even the basic digital set top converter box which is used to manipulate and control telephone and digital television signals coming into the house is very expensive. Early production units will retail at around $500-$700 apiece.

A second major problem with narrowband digital service network upgrades (as with next generation broadband services) is that there are no significant demand drivers, primarily because network services, almost by definition, require two-way end-to-end connectivity. Yet, physical network upgrades are gradual processes where more and more customers obtain access to the new technology over a period of many years. It takes a long time to implement widely available interconnectivity—the factor that will provide the demand-pull for further technology adoption. What good is it to be able to have advanced telecommunications equipment in your home if the people you want to communicate with do not have similar capability.

Thus, developing and deploying advanced digital telecommunication networks is a difficult and costly proposition, even in dense urban and suburban areas. Narrowband digital service, in the form of ISDN, has been in the implementation stage for almost a decade now; and there is still no residential service and only very limited access to business service. With widely available residential ISDN service not expected until late this decade, it is clear that even more advanced network upgrades will be delayed for both physical and financial reasons.

5.1 Business Subscribers

The rapid development of an advanced communication infrastructure for rural America will depend on how easy it is for businesses to access the technology. Businesses consider telecommunications capability an important factor in their location decisions. To the extent that businesses will have advanced services available to them, rural areas may become more attractive locations. Furthermore, as telecommunications capability improves in rural areas, "demand-pull" will begin to stimulate further technology adoption as businesses and their various suppliers and customers make use of more efficient network facilities. However, exactly what constitutes advanced telecommunication for businesses is an unsettled issue.

Relatively large businesses in rural areas, whether in the service or manufacturing sector, often require broadband communications capability to maximize operating efficiency and compete with their urban and suburban counterparts. Broadband in this case refers to digital transmission speeds of 45 Mb/s and higher. At such speeds, high quality data services and video telephony are possible. These speeds are much greater than the narrowband ISDN service which is gradually being deployed. Broadband service generally requires coaxial or fiber optic cable for subscriber connections, while narrowband service may be provided over more traditional copper facilities. Microwave and fiber optic transmission technologies are nominally capable of supporting both narrowband and broadband services but, as already explained, fiber is expected to be the dominant medium for shared network facilities in the future—even in rural areas.

Since fiber optic and coaxial cable subscriber connections not only allow for future broadband telecommunications but also for simultaneously providing for high quality narrowband services, there is some question as to whether incurring the costs of narrowband ISDN on copper facilities is a good long term prospect. Some analysts believe early deployment of broadband facilities is the way to go, bypassing the deployment of narrowband digital service on copper. Rural economic development depends partially on attracting businesses that require efficient telecommunications. Therefore, the focus should be on getting fiber optics deployed in the public network as far downstream as possible, so that business customers have the option of accessing the network for high speed service applications, should the need arise. It will not be necessary to subsidize business access to the fiber optic public network but it is important that they have a cost effective option to build or lease their own access lines to a high speed digital public network, since this option usually exists in urban and suburban settings. The way to accomplish this is through an aggressive statewide plan for a fiber optic network infrastructure.

5.2 Residence Subscribers

The deployment of advanced rural telecommunication facilities for residence subscribers should be addressed/viewed in several stages. Dedicated coaxial and fiber optic access lines are generally not required to support the demands of residential customers for known services. Indeed, most of the copper loops in the "downtown" portion of rural exchanges, like that in the "typical" rural exchange described earlier, are short enough to cost effectively upgrade to narrowband digital service. The larger problem is that subscribers in the rural portion of the same "typical" exchange require that expensive loop rearrangements and improvements occur to reduce or eliminate loop electronics on longer loops.

Furthermore, since the late 1970s many rural LECs pursued a plan to upgrade rural loop transmission quality and achieve economies in loop provisioning by deploying remote terminals which were placed between the central exchange and the subscriber. This upgrade strategy was endorsed and encouraged by the REA's guidelines for borrowing companies. In effect, by investing in the deployment of remote terminals (RTs) at specified locations called serving area interfaces (SAI), the placement of subscriber loop carrier (SLC) systems allowed rural LECs to save on investment in loop transmission facilities dedicated to individual subscribers while improving loop transmission quality by making the subscriber connection shorter. But, as can often happen, saving in one generation of network upgrades may be costly in transitioning to the next generation.

It turns out that the deployment of new ISDN and broadband digital network capability is somewhat easier in an environment of dedicated subscriber connections. The placement of remote electronics makes it difficult to upgrade, on demand, any given subscriber's line to provide ISDN or broadband service. No smooth and cost effective migration from POTS to ISDN is possible in these situations, and ultimately this may result in the early retirement of remote terminals if future subscriber loop upgrades are to occur in a timely fashion. This situation is typical not just in rural areas of small LECs, but for many service areas of large LECs as well (which also deployed a number of remote terminals).

This discussion provides some measure of insight as to how to conduct sound fundamental network planning. Most experts agree that the future of telecommunications demand is that households will no longer be satisfied with POTS, desiring instead their own choices of service and their own choices of service suppliers. This means that networks must be designed flexibly enough to accommodate the mix of demand which will (or might) occur. In other words, not all households will want (or be able) to pay for ISDN or broadband service. At a minimum, not all households will want it all at the same time. Thus, a cash flow oriented fundamental network plan would try to accommodate the structure of future demand, meaning LECs must invest in network facilities which allow for differentiation of service capability to match the differentiation in consumer demand.

6. Network Upgrade Costs

Figure 2 provides an illustration of an advanced digital rural subscriber connection. The basic loop architecture is similar to today's average rural POTS loop except for a few features. Assuming that the basic POTS loop meets the maximum length for high quality digital service e.g. 12-l8 kft.) and that the serving C0 already houses a modern digital switch, the placement of sophisticated electronic equipment located in the three shaded boxes between the subscriber premises and the C0 enables the subscriber to use a range of new digital services.

Upgrading the loop plant of rural telephone subscribers for digital service presents a financial dilemma. A high percentage of existing subscriber loops cannot support an acceptable level of digital transmission, even for existing services. Regular voice telephone service requires much more bandwidth in digital form than in analog form. Most rural loops are engineered to support analog voice at 3–4 kHz, and very low speed data service up to 9.6 kb/s. To attempt more than this risks intolerable errors in transmission. Thus, the motivation to upgrade the rural loop plant is that current band-widths will not support the use of many new service applications.

It would be misleading to conclude from the data on rural company loop investment that the upgrade problem is simply solved over time by replacing investment through rapid depreciation. Increased cash flow from depreciation, an important source of funds for new loop plant, also implies rate increases for current subscribers, increased subsidies from others, or both. In addition, the new loop plant is nominally more expensive than the old, even with technological advances, because of inflation in prices.

Generally, the main problem with upgrading rural subscriber loops to digital service is the presence of loading coils. These must be removed by cutting out the coils and replacing the cable at the load coil point. Alternatively, loop carrier or remote switching terminal equipment may be installed. Normally, this is all that is required in the physical loop digital upgrade. However, some rural telephone companies still have old "non-filled" cable in their loop plant. This may not support high-quality digital service even at low speeds if moisture has penetrated the cable. Nevertheless, analog voice is generally acceptable on non-filled cable. The financial requirements for upgrading "gel-filled" cable rural loops for digital service are not too much of a burden for current telephone company construction budgets over a reasonable period of time. However, for "non-filled" cable loops, a costly and aggressive rehabilitation program may require external financing. The process of replacement will speed up since the remaining non-depreciated useful life of non-filled cable is relatively short (it was last installed in the early 1970s).

6.1 Narrowband Digital Service

Chart 6 presents the base case costs for current narrowband rural LEC loops. The estimated cost of upgrading existing rural loops to provide for ISDN service is only about $100 to $200 per subscriber (again assuming that the loop is qualified in terms of length and electronics) For non qualified loops (featuring load coils, non-filled cable, etc.), the average cost can be anywhere from $50–$2,000 per subscriber[23]. This only represents the average; some customer loops will be even more expensive to upgrade, such as where spatial distribution of subscribers was not conducive to sharing facilities. One goal of the upgrade, de-loading rural loops, could be very expensive when there is no cost justified possibility for shortening the dedicated portion of the subscriber loop through the use of a ISDN compatible remote subscriber terminal (RST) or digital loop carrier (DLC) system. The state-of-the-art loop architecture assumes that a fiber trunk connects an RST to a digital host CO (see Figure 2).

6.2 Broadband Digital Service

Based on a broad based analysis of existing (1992) RUS company cost structures, the monthly cost of deploying a rural broadband network is estimated to be between $92–$132 a month per line depending upon the period for deployment (10-20 years)[24].

Whereas rural network upgrades for narrowband digital service are based on maximum loop lengths of 18 kft. from the switching node, higher bandwidth and power requirements of switched broadband networks will require a smaller serving area featuring loops of only 6–12 kft. depending on the services contemplated and the specific network design. This raises costs considerably. For example, reducing a maximum serving area distance from 18 kft. to 6 kft. means that 9 network nodes are required vs. only one.

The digital loop diagram in Figure 2 indicates where electronics may be installed to allow subscribers to upgrade service for broadband capability like entertainment video service. Recalling that the downtown area of the rural exchange might well be within the 6 kft. limit, this situation certainly favors that area over the outlying rural area in any upgrade decision. Chart 7 provides an estimate of a rural LEC's broadband loop upgrade using Hybrid Fiber Coax (HFC). Assuming that the maximum number of households served per HFC network node is 480, Chart 7 shows how per subscriber costs might be expected to vary as subscriber density varies (i.e., as one moves out from the downtown area toward the rural areas of the exchange). Subscriber access connections within the dense downtown area may be upgraded to broadband service for $1,000, while serving subscribers in the outlying rural areas of the exchange can cost up to $10,000. The illustrative costs in Chart 7 are for subscriber connections, and do not include the costs of upgrading other network and non-network functions including sophisticated broadband network system hardware and software and programming service. One estimate is that this could add another $400–$1,500 per subscriber.

Another possibility for providing broadband telecommunications to rural areas is through upgrading the existing rural coaxial cable systems with fiber optic trunk lines and interconnecting to the public switched telephone network. For a truly integrated broadband system, this usually generates per subscriber costs similar to those already discussed for telco network upgrades. There are other (even more sophisticated) methods of providing broadband services to the home, but the costs of these alternatives are generally equal to or higher than the HFC network upgrade[25]. Fiber to the Home systems are touted as being the ultimate in broadband telephony featuring high quality bandwidth on demand with capacity for any conceivable service. The costs of such systems for rural applications are currently so high as to not even be seriously considered by rural LECs, however, this conclusion in no way detracts from the great potential of fiber optic trunk network systems in rural settings[26].

6.3 Wireless Alternatives

For situations where it is simply too expensive to use the recommended loop architecture, there are several alternative choices including satellite, point or multipoint radio, and cellular radio. These alternatives must be evaluated on a case-by-case basis, including an estimation of the cost of an efficient connection to the public wireline network.[27]

Digital wireless technology could potentially become a cost effective replacement for fixed wired telephone service for everything from POTS to broadband service. In particular, new digital wireless cable networks are already competing with traditional wired cable in urban areas and it is widely believed that the new digital cellular Personal Communication Networks (PCNs) will provide a cost effective alternative to both the fixed and mobile cellular telephone systems in service today, all at competitive prices.[28] However, rural areas pose a special problem for successful deployment of cellular systems for fixed telephone service. Furthermore, while PCN systems using small cells (microcells) are optimal for low power operation in urban settings (i.e., dense market areas), they are not cost effective in rural areas because of the sparse number of subscribers who can share a single base station in a small coverage area.

Due to the distances involved in a rural setting, the power levels for transceiver base stations needs to be much higher than in urban cellular markets or it is not possible to reach enough subscribers to make the investment worthwhile. Too many low power antennae sites would be required to cover rural areas in a cost effective manner. Current microwave radio systems for rural telecommunications (dubbed BETRS by the FCC) are very expensive to deploy and operate and tend to be cost effective only in the thinnest rural markets, or where terrain will not permit wired subscriber connections.[29]

Many recent articles have touted the virtues of using wireless access at a cost effective substitute for wired access in rural areas.[30] Hatfield, Paulraj and others show that in the thinnest markets (0–100 subscribers per square km), fixed microwave radio (i.e., BETRS) systems may be cost effective to deploy. Other authors show that cellular systems using large cells (macrocells) are also cost effective in many rural markets including downtown areas. Figure 3 provides a broad gauge look at the relative cost effectiveness of macrocell and microcell wireless access systems vs. wired access.

Raw cost efficiencies aside, much of the problem with deploying wireless networks in rural areas lies more with the long head start and continuing inertia of wired service and the ingrained preferences of telephone company managers and engineers for the old (well understood) way of doing things.[31] A second important problem to overcome is the current federal rules governing the provision of digital cellular service in rural areas and the limited radio spectrum frequency which has been licensed for use by rural radio systems.[32] Currently, rural cellular service must be provided under restrictive conditions imposed by the government on radio frequency use. Rural cellular providers must share radio frequencies with existing high power paging services, causing interference problems. Channelization schemes used by current urban area cellular radio licensees are not optimal for use in rural areas. Power restrictions are too low and the radio carrier channels are too narrow to allow for a single channel to be shared cost effectively in a rural setting.

If the government would allocate sufficient dedicated radio frequency spectrum (e.g., 20 MHz) and increase permitted power levels, then cellular equipment manufacturers and network operators could use state of the art digital access techniques such as TDMA and CDMA and wide carrier channels (e.g., spread spectrum). This would allow rural cellular service to become a cost effective replacement for expensive wired POTS access arrangements and could reduce the costs of broadband network upgrades.

For subscribers in rural areas which are truly remote (perhaps even unserved), new digital satellite systems offer the best hope of obtaining high quality digital telephone service. Beginning in l996, many new systems will be launched, providing coverage over the entire continental US. Initially prices for these systems will be very high and some subsidies may be required to make it available. One of the main reasons why satellite service has not been viewed as potentially competitive with wired service is the annoying (and heretofore unavoidable) delay time associated with voice transmission on the system uplink and downlink segments (250 milliseconds). Many new digital satellite systems have overcome this quality differential by using Low Earth Orbit (LEO) satellites which feature only a fraction of the delay time.[33]

The recent (and rapid) introduction of digital satellite television using Direct Broadcast Satellite (DBS) service demonstrates that rural areas will be able to benefit substantially. The cost of this technology is not distance sensitive and therefore rural subscribers can finally obtain equivalent service at equal prices in a market setting.[34]

7. Infrastructure Development

Now and in the foreseeable future, federal state and local governments play a key role in developing the rural telecommunications infrastructure. Indeed, regulators are largely responsible (along with the industry) for creating the current complex web of industry cross subsidies which are the very lifeblood of many rural systems and which allow rural POTS subscribers to enjoy a level of service and prices that are at par with urban and suburban subscribers.

As the industry transitions from a monopoly structure to a competitive one, rural subsidies are clearly at risk. The federal government remains concerned about rural issues and both major pieces of federal legislation aimed at furthering competition in the industry contain provisions to protect subsidies for universal service including both low income subscribers and rural high cost areas.[35]

7.1 RUS Guidelines for Borrower Companies

The RUS provides low interest loans for network upgrades to the majority of small rural LECs. As the primary source of public funding for rural telephone network upgrades, the RUS's published guidelines for network upgrades has important national standing for infrastructure policy. The most recent guidelines were adopted on March 15, l995. Its major provisions are:[36]

- every State must have a modernization plan to improve the rural telecommunications net work and must submit it for RUS approval (may be drafted by the State regulatory agency or the borrower companies themselves);
- the plan must provide for the elimination of party line service;
- the plan must provide for availability of services for improved business, educational, and medical services;
- the plan must encourage and improve computer and information highways for subscribers in rural areas;

- the plan must provide for rural subscribers to receive
  - conference calling
  - video
  - data rates of at least 1 Mb/s;
- uniform deployment schedules in rural and nonrural areas;
- expeditious deployment and integration of emerging technologies;
- affordable tariff rates for medical and educational services;
- reliable powering for POTS service including alternative power sources during electric utility power outages;
- in the "short term" all new telecom network facilities shall be constructed so that all single party service subscribers have access to
  - lines capable of speed of at least 1 Mb/s
  - switching equipment that supports custom calling features
  - E9ll;
- in the medium term (6 years after plan approval) all new facilities must be capable of
  - transmitting (motion) video signals
  - E911;
- in the long term all plans should accomplish
  - an elimination of party line service
  - universal availability of digital voice and data service (56-164 kb/s)
  - service at transmission speeds of no less than 1 Mb/s
  - video service

Needless to say, the new RUS guidelines and the considerable network capabilities which are required have sparked equally considerable controversy.[37] Suffice it to say that while the RUS has laid out the rules for approving loan applications for network upgrades, it is far from clear that there is enough money available to pay for such substantial upgrades and it equally unclear whether or not non-borrower companies would otherwise plan to make such upgrades. A consistent state infrastructure upgrade policy would ideally be based on an industry consensus, but with the RUS setting the least common denominator at such a high level it may not be possible to reach an industry consensus. Keeping in mind that many large LECs serve rural areas too (in fact most rural areas of the US are served by large LECs), until the large LECs (which cannot borrow from the RUS) concur in the RUS proposals (not a likely proposition) it will not be possible for States to implement consistent network infrastructure upgrades plans.

It appears that the RUS rules were written for an era of continued monopoly provisioning of telephone service. This model is outdated in light of other federal and state initiatives promoting market entry. Large and small LECs, whether or not they are RUS borrowers, recognize that the future competitive environment means that local network upgrades involve considerable market risk, and there is no longer any good prospect of recovering all of the investment from tariff rates on captive customers. One obvious provision is lacking in the RUS's rules - that infrastructure investment plans meet the fundamental test of market viability (i.e., there is no business case called for).

This having been said, the RUS should be applauded for its vision, which, rather than a mandate, is a reasonable goal to strive for. The problem is that without large LEC concurrence it will never be implemented on a large scale. The RUS probably sensed this when they called for state PUCs, which regulate all LECs both large and small, to coordinate and submit their own infrastructure upgrade plans in accordance with RUS minimum requirements.

It will be up to the state and federal governments to try to coordinate their respective roles regarding telecommunications infrastructure policy. This is not an easy task and it has barely begun.[38]

7.2 Public Power Grid

The use of a dielectric transmission medium, such as fiber optics, provides an unprecedented opportunity for inexpensive infrastructure development by taking advantage of the new-found synergies of combining existing electric utility distribution infrastructures with those of telecommunications. Construction costs of fiber optic facilities may be substantially reduced by utilizing public power grid rights of way and pole or conduit facilities. Since optical transmission is not susceptible to the electromagnetic interference caused by power lines, fiber cables could use the distribution plant offered by the statewide power grid by purchasing or leasing facilities from rural electric utilities. Such inexpensive fiber deployment may even include lashing the fiber cable to the electric utility ground and phase wires, which often run along the tops of towers and poles. There are many possibilities. One new product on the market is a fiber cable which utilizes the metallic ground wire for strength. The ground wire in the cable supports the requirements of electric utilities, and the fiber communications capacity may be resold.

Power companies are heavy users of communication services, and many large utilities already operate major private communication networks. Smaller rural electric companies also require communications for load management, monitoring, internal communication and the like. Rural Electric Cooperatives serve geographically large and thin rural markets which often span many independent telephone company exchanges. Because they cannot justify "stand alone" internal communication networks, small electric utilities must rely on many rural telephone companies, and pay relatively high tariff rates. The sharing of power company facilities with local telephone companies can provide economies for both, providing a "win-win" situation. In addition, some large businesses who choose to locate in rural areas are often able to get sufficient power, while advanced communications capability is lacking. If the shared infrastructure were available, businesses might be more likely to locate and expand in rural areas. Safety communications for fire and alarms are other new service applications which place only nominal bandwidth requirements on the communications infrastructure. There seems to be a natural synergy here for rural communication infrastructure development, but one that is under-exploited. The electric power industry tends to be very conservative, but many firms are now examining novel arrangements with communication service providers.

7.3 Toll Service

Rural telephone companies, long desiring direct entry into the lucrative toll market, could begin taking advantage of the revenue opportunities that a fiber optic infrastructure could provide, including the possibility of providing new data and video services. This is very important if the traditional large telephone company toll subsidies enjoyed by small rural telephone companies truly disappear due to increasing competition. Small rural telephone utilities may pool traffic and interconnect with the fiber optic backbone trunk network to efficiently, and profitably, provide high quality toll voice and data services. Fiber optic backbone networks may also allow rural subscribers to purchase digital services and access remote databases of enhanced service vendors.

7.4 State Planning

The process of rural telecommunication infrastructure development is an evolutionary one that will occur only gradually as advanced facilities become available. For this reason it is important that the process begin as soon as possible. State telecommunication planners must take on the role of coordinating network interconnection and development activities, exploiting potential synergies for the benefit of all subscribers In the early stages, such coordination will concentrate on surveying all of the communication facilities, public and private, and evaluating short and long term interconnection and compatibility potential. At first, microwave and satellite network facilities will be evaluated, along with existing coaxial cable network facilities, to determine interim infrastructure possibilities. The long term focus will be on migrating to a more efficient infrastructure based on digital fiber optics and radio technology; the goal will be to share network facilities whenever it is cost effective to do so, and guide the replacement of older network facilities with advanced facilities, stressing network compatibility along the way. Without compatibility, interconnection of communication networks will be inefficient or even impossible, and potential synergies are lost.

The rate of development for rural telecommunication infrastructures may depend largely on demand drivers. There are some logical ways to pursue network technology adoption, paying close attention to demand patterns in the current infrastructure. For example, secondary and tertiary schools, libraries, hospitals, and regional airports tend to be among the heaviest consumers of information and telecommunication services in rural areas. Public power utilities and other rural infrastructure firms, including occasional large manufacturing or service companies, also represent logical node points for rural networks. Existing telephone company switching offices, combined with the aforementioned, represent demand drivers and potential network hub sites, providing for efficient communication infrastructures. This set of candidates for network node (hub) points should generate a number of alternative deployment scenarios for state telecommunication planners to consider. Hubbing allows the economies of satellite, microwave, and fiber transmission to be used cost effectively in relatively thin markets, thereby maximizing the net present value of the rural construction program.

7.5 Regulatory Issues

Planning for an advanced rural telecommunication infrastructure raises many regulatory and public policy issues. Prominent among them is: Who should own and control the infrastructure and how should it be financed? There are obviously no "right" answers to such questions, but some general economic principles may guide the thinking on these issues First, private ownership and control is generally preferred to public ownership and control, for reasons of operating efficiency incentives that competition provides.[39] Second, government must have a pro-active role as an overseer, enabler, and planner. As discussed previously, private network development may help support infrastructure development in a "win-win" situation where net revenue opportunities accrue to both private and public network participants through efficient interconnection and compatibility. The role of state government may be most helpful in identifying where public and private communications network activities may complement one another and strengthen the overall infrastructure.

As a rule, an infrastructure approach does not imply centralized ownership or control. It does imply cooperation among the various players, however, and this is the enabling role of government bringing together the players and encouraging infrastructure development. Much more can be done than we observe today. Most states have not yet placed sufficient emphasis on telecommunication infrastructure and its role in economic development, even in rural areas. New technologies just beginning to be deployed have very low unit costs once demand thresholds are met, but have very high up front capital costs. For this reason, an infrastructure approach to planning, which maximizes capacity sharing through a "hubbing" network architecture, holds great promise for dealing with the problem of thin rural markets. For example, even in Kentucky, which is considered a rural state, there are many locations which could generate enough traffic demand to justify a fiber, radio or satellite hub, depending upon the specific demand application(s) required.[40] Eventually fiber hubbing would dominate as the technology of choice for most new shared network applications, while microwave radio, coaxial and copper cable will be used for dedicated short haul subscriber plant; with satellite and microwave radio utilized whenever wireline facilities cannot be deployed cost effectively, especially in physically remote applications.

Finally, there are a host of important pricing issues associated with recovering the costs of advanced telecommunications infrastructure development. Two primary issues, are broad toll rate averaging across the nation and toll-to-local service subsidies. Trends in both of these areas are troubling for rural telephone companies, and will no doubt become the subject of extensive public policy debates. A full discussion of these issues is beyond the scope of this paper but a few observations deserve brief discussion.

Increasing competition in toll services, and the absence of regulatory rules for retail tariffs of competitive toll carriers is slowly eroding the broad rate averaging rules which have been in effect for many years. The effect of rate averaging is to subsidize subscribers in thin rural markets relative to those in dense markets. New volume discounts for heavy toll users, especially business customers, have already been undermining traditional rate averaging. Regional rate de-averaging is likely to occur eventually. The toll subsidy which generally flows from larger telephone companies to smaller ones is also going to decrease as competition continues to drive prices down. The best solution here is probably to target subsidies more carefully toward only those companies who are most in need rather than toward entire classes of small companies as is currently the case.

7.6 Rural Telephone Service Subsidies

Using REA data as a representative proxy for high cost rural areas of the US, the total rural subsidy is estimated to be $5B per year based on revenues of $14B and costs of $19B.[41] This means that rural rates on average would have to rise about 35% in order to pat the full costs of providing rural POTS service. This means an increase in average monthly tariff rates of about $19.

But this is a broad average figure is substantially understated if open competition were allowed. Competitive entrants will tend to pursue only the profitable rural LEC subscribers, like those which reside in relatively dense downtown areas of the rural exchange, larger business subscribers, and those subscribers who purchase a lot of non-basic services. These subscribers also provide substantial contributions toward funding the high costs, and supporting the low average tariff rates for the high cost, low (or no) profit subscribers. Without individual subscriber data on costs and corresponding revenues it is not possible to estimate what the cross subsidy flows within the rural LEC exchanges would be, but it is well known that the most profitable subscribers who are responsible for generating the most revenue, provide an inordinate amount of funds to support the costs of the remaining majority. Thus it is easy to see that the rural subsidy to truly high cost unprofitable subscribers who need to be much more heavily subsidized, is at least two times or more than the $19 per month quoted earlier.

If competition and subsidies for small LECs are to coexist, then there are some general economic principles which should underlie the subsidy funding mechanism. The mechanism should be:

- fundamentally fair for consumers;
- competitively neutral for competitors; and,
- long term sustainable.

Furthermore, pursuant to a host of recent federal and state investigations of Universal Service it appears that almost all parties to the debate have agreed on certain aspects of various plans and proposals:

- All charges for telephone service should be cost compensatory except for a narrowly defined and highly targeted set of basic service subscribers (e.g., low income, high cost).
- Subsidy funding requirements should be shared by a broad base of market players and the funding mechanism should be administered by an independent third party.

Beyond the need to define exactly what constitutes the benefited service and subscriber group deserving of subsidies, there are some primary unresolved issues:

1. What is the cost of the current and future public service obligations (e.g., Universal Service Obligation (USO) and Carrier of Last Resort (COLR)) and how should the cost be determined?
2. Exactly how should the subsidy funding mechanism work? (e. g., How to administer the subsidy fund? Who should administer the fund? How to collect and distribute funds within any given geographic area—local, regional or statewide.)

Assuming, for purposes of discussion, that subsidies should only apply to covering a portion of the costs of providing Plain Old Telephone Service (POTS) for certain residential PSTN subscribers (e.g., high cost/low income), and assuming also that all other subscribers should directly pay the cost of their POTS service, then it becomes clear that the proper cost "object" for quantifying a subsidy requirement for USO and COLR is the total PSTN investment and expense cost of the LEC minus the cost of the (hypothetical) PSTN if there were no such obligation to serve or be ready to serve. (Put it another way, had the LEC not had the social compact with the certification authority that it would be the only service provider and that it would be allowed to recover its total costs from tariff rates charged to its subscribers what would its investment and expense cost be.)

A cost study method must be developed which establishes both the historical and going forward costs of the USO. In particular, the total (or average per line) cost of the USO is simply the cost of providing POTS service to residential subscribers. When this cost is compared to POTS revenues, the difference is the net cost (subsidy requirement) of the obligation to serve.

In the current local monopoly environment, the funding of this subsidy amount comes from numerous sources, namely, mark ups of prices over costs (i. e., cross subsidies) for LEC business services and residential non-POTS services. In the new competitive environment, all carriers must be required, in a competitively neutral way, to share in the funding of the costs of public service obligations.

Historical Perspective

The reason that the historical cost of the LEC's public service obligations must be considered is that the monthly subscriber bills now and in the future simply represent the time payment plan that regulators (on behalf of PSTN subscribers) and the LECs agreed to under the pre-competitive regulatory regime. Thus, in the post-competitive regulatory environment, the LEC must still be enabled to reimburse its historical investors. Had the LEC and its investors known that the regulatory regime would change such that it would not have the future opportunity to compete at the margin and still recover the cost of its regulatorily imposed historical public service obligations, then the LEC would not have kept investing in network infrastructure to certain customers and locations which it viewed as too risky without good prospects for cost recovery.

Incremental Perspective

The definition of the going forward cost of a LEC's public service obligations is the same as the historical one except that the costs would be based on the total incremental cost of the obligation instead of the total historical cost. Thus, the cost calculations would reflect incremental instead of embedded technology and business practices.

LRSIC vs. Total (Average) Cost

Some parties to the subsidy debate have asserted that the cost and funding of LEC public service obligations should be based on the incremental cost of POTS, not the total or average cost. Unless the Long Run Service Incremental Cost (LRSIC) study methodology they espouse is carefully constructed to approximate the total cost of the obligation; then it is flawed. This is unjustifiable from an economic perspective. This theoretical and practical distinction is important since it is the total (average) cost of a business enterprise which must be covered by total (average) revenues for the firm to be sustainable. Open market entry and competition will, over time, force rates for all services to be driven toward their costs (unless subsidies are provided).

Thus, a subsidy system which relies on continued price cost margins on competitive services to fund a portion of the costs for residential POTS service is an inherently unsustainable system. Competition is the natural enemy of cross subsidies. Indeed, a LEC, and, in turn, the LECs customers, which must incur the costs of regulatorily imposed public service obligations which are not similarly borne by market entrants (and their subscribers) will be disadvantaged in the market place The end result is a shift in consumer welfare from the LEC’s customer base toward the entrant's subscribers.

To avoid such discrimination and inadvertent shifts of wealth between subscriber groups, regulators should adopt a consumer friendly and competitively neutral subsidy funding mechanism before competitive entry forces a de facto rate deaveraging where one group of subscribers must pay for regulatorily imposed obligations and one does not. Fundamentally, there are only two types of POTS subscribers: those low cost subscribers in relatively dense areas served by relatively short loops who have relatively low local calling rates (subsidizers); and those relatively high cost subscribers served by relatively long loops which have relatively high local calling rates (subsidizees). Of course, even in high cost (long loop) geographic locations there will almost always be highly profitable subscribers who purchase a lot of non-POTS services. For this reason, a proper cost analysis must be conducted at the individual customer level. In other words, classifying a particular subscriber as a net subsidizer or a net subsidizee requires monitoring individual subscriber characteristics. Obviously, this is not practical even though it is the only way to guarantee that subsidies flow to subscribers who would otherwise not be able to obtain POTS service (or at least that quality of POTS which "profitable" PSTN subscribers receive).

Because LECs were historically monopoly providers of residential POTS, it is straightforward to calculate the total cost of any given LEC's public service obligation by examining the embedded accounting cost data for PSTN investment and expense and converting it to an annual or monthly per subscriber amount.

In a historical context, LECs, as regulated common carrier monopoly providers of POTS, were obligated to serve (or be ready to serve) all subscribers on demand in a given service area at broadly averaged affordable POTS prices. Thus, the historical cost of the obligation to serve would be the cost a LEC would have incurred. The average subsidy requirement for rural telephone subscribers in the US was previously provided. Even this broad gauge level of analysis provides the regulators with a "ballpark" estimate of the total and average per subscriber subsidy. It is important to keep in mind, however, that this broad gauge estimate cannot be used to evaluate the cost (subsidy requirement) for any given subscriber or location because the available information is not sufficiently granular to make that determination. The average is the net total subsidy requirement from all POTS subscribers; the sum of those subscribers which are subsidizers and subsidizees. Nevertheless, the estimate does establish the total (average) amount of the subsidy funding requirement for the (as yet to be determined) subsidy recovery mechanism.

The total and average subsidy amounts determined in stage one of the costing process may begin to be deaveraged into density cells by examining the available data for a LEC's POTS subscriber density characteristics. This Phase is made somewhat easier because it is also possible to examine the PSTN investment and expense costs of smaller rural (less dense) LECs and comparing that to the same embedded accounting data for larger (more dense) LECs (see Table 4). The results from density cell analysis may be further disaggregated down to customer specific analysis via a computerized cost "proxy" model which calculates the costs for each subscriber location.[42]

7.7 Funding Mechanism

The mechanism for collecting funds to pay the cost (subsidy requirement) of LEC public service obligations must be competitively neutral with respect to incumbent LECs, which have the obligations, and competitive entrants, which do not. In other words the contributions toward covering the subsidy costs should be shared equitably by all telecommunication service providers. In order to be sustainable, no service providers should be able to avoid payments via bypass of the LECs PSTN. Many such funding mechanisms have been proposed by industry groups and most involve a revenue surcharge mechanism.[43]

7.8 Financing Alternatives

The costs of the deployment of efficient communication infrastructures are high compared to any historical measure of the costs of technology adoption. The reason is that the technological trends are toward lower on-going usage costs, and higher up front capital costs. Digital network equipment has few moving parts and features very large scale capacity relative to older generation network equipment. As such, the new equipment is more cost efficient from a maintenance and repair expense perspective, but is more capital intensive and is typically purchased in greater "lumps", because it is well suited for large scale operations. The same tends to be true of fiber optic transmission equipment, although for many network applications fiber will soon be cost effective even relative to the older generation copper and coaxial cable costs. The bonus with fiber optics is not only its very high capacity, but also its high quality and reliable service as compared to metallic and radio technologies. Nevertheless, up front deployment costs for fiber optics are substantial, and every effort to cost it effectively is important.

Telephone rates are the obvious first choice for financing advanced rural network infrastructures. Indeed, most of the financing must come from this source. Fortunately, it appears likely that the internal capital flows of telephone utilities will fund much of infrastructure deployment costs. But as was pointed out previously, these traditional internal cash flows are at risk due to increasing competition and the advance of technological alternatives.

Borrowing is the next alternative to consider. The U.S. Department of Agriculture's Rural Utilities Service and others provide subsidized loans to rural telephone companies. Without government assistance these telephone companies would have to go to other capital markets that offer less attractive terms.

Unlike large telephone utilities, many rural companies are already highly leveraged. This is not bad in and of itself, but it does impact the propensity of lenders to approve more funds on favorable terms. Regulators may also become concerned about the level of business risk which leverage implies, even though ratepayers may benefit from the lower average cost of debt capital relative to equity finance.

The RUS and some other lender's practices are basically sound for financing advanced rural telecommunication infrastructures because they operate within an incentive structure which tends to signal borrowers to make good investments (not to mention the new aggressive network upgrade guidelines). The RUS uses "equity based" financing and loans that are usually "self liquidating". The proposed investments of borrowers must meet general technical guidelines for acceptable and approved equipment purchases. This system prevents speculation and abuse of government loan funds. Even though the RUS program is a loan subsidy program, only the interest rate discount is truly "subsidized", and this is a relatively small portion of the entire loan and repayment sum. The loans are self liquidating from revenue and cash flow from telephone rates. Overall this approach seems socially efficient since it allows the private sector to determine the market requirements and opportunities for sound investment decisions, and requires the borrower to have a substantial equity stake. The only government role is to provide an inexpensive source of funds, technical support, and monitoring.

Direct subsidies, especially of the current untargeted variety, are much worse and are often not socially efficient. The current flow of toll-to-local subsidies from many large telephone companies to many smaller ones is generally inefficient because it is not based on need; instead, it is based simply on a grand formula for broad rate averaging and revenue sharing. In fact, some of the vast sums of money in the toll revenue pool now divided among telephone companies through the use of a broad formula could be used to increase the RUS's loan authority or could be distributed based on bonafide financial need Whenever subsidies are not targeted there are potentially wasted resources. The introduction of basic telephone "lifeline" service based on a "need" (income) test is a good example; this has proven to be much more socially efficient than a blanket subsidy for all local service subscribers, many of whom can afford it. As the financial data provided earlier indicate, many small rural telephone companies have very healthy cash flow situations and do not really need subsidies.

Direct government subsidies for rural telecommunications should be discouraged since the investments funded will presumably generate some level of on going subscriber revenue and should therefore always be included in any loan repayment formula, even if the repayment is only a partial one.

8. Conclusions

Perhaps one of the most important policy conclusions from the analysis herein is a firm recognition that there is a notable difference between the costs of local network upgrades for the base of existing rural telephone subscribers, and the costs of serving brand new and physically remote subscribers. From a public policy perspective the latter group must be treated as special cases requiring significant cost subsidies, otherwise policy for the masses could fall victim to debates of subsidies for the few. Overall, the existing body of rural subscribers is currently being served cost effectively and profitably, and a timely digital network upgrade is a reasonable proposition without necessitating large rate increases.

The second important message is that small rural LECs cannot be classified according to average costs and subsidy requirements. There is just too much variability based on the local market conditions and geography, which presents a major problem for policy makers desiring to better target subsidies to those companies and subscribers who really need it. Average statistics just will not do. There is no such thing as an average rural LEC. This revelation has tremendous implications for state and federal government competition policy. If open market entry is allowed, existing subsidies will dry up—period. Therefore if the government is serious about having both competition and subsidies, the current system is in bad need of reform. The alternative is the natural market solution which is to drive out cross subsidies. This may not be bad since the subsidies may not all have been justified in the first place. Nevertheless, if it remains a public policy objective that rural areas of the US should be able to continue to obtain a comparable level of basic service (e.g., POTS however defined) at prices comparable to those in urban areas of the US, then the subsidy system must be reformed as soon as possible.

Third, the key to rapid adoption of advanced technology for rural subscribers is to take an infrastructure approach to the problem. This implies significant coordination and monitoring of public and private network investment and business activity, preferably at the state level. Specifically, in the current environment, there appear to be significant lost opportunities for the realization of public benefits and potential synergies from cooperation of the energy, transportation and telecommunication sectors.

The infrastructure approach could go a long way toward solving this problem and actually follows from the technology itself. First and foremost, new telecommunications technologies can be very efficient, but that efficiency depends on two critical factors which are often non-existent in rural areas of the country, economies of scale and end-to-end service capability. The first factor operates on the supply side of the equation and simply says that technologies such as digital fiber optics require relatively large scale operations to achieve the low unit costs which are ultimately available. End-to-end service operates on the demand side of the equation and simply says that unless advanced network functionality is adopted on a very wide scale, demand drivers will be unable to speed up the technology adoption process. It is no good to have ISDN service capability unless the other party to the call also has it. Thus, the critical issue for efficient technology adoption in rural telecommunications is sharing of network facilities, both to achieve scale economies and to stimulate demand drivers.

Fiber optics is generally the most cost effective technology for shared network service applications, and new digital wireless technology has tremendous potential for reducing the cost of dedicated subscriber connections. (Fiber is not cost effective for dedicated (non-shared) customer connections). Most businesses, especially large ones, share network facilities among a number of telephones and therefore may cost effectively adopt fiber technology before residential customers. However, both businesses and residences must share facilities as much as possible to take advantage of the superior economies of scale which fiber exhibits relative to competing technologies.

Another important advantage with fiber optics is that it can support new broadband services like video telephony, multimedia services, and very high speed data service. It is not necessary that demand for broadband services precede fiber optic technology adoption because fiber is also very cost efficient for simultaneously transmitting narrowband services. Sharing and multiplexing allow fiber to become cost effective even when only narrowband service applications are used.

An infrastructure approach to rural telecommunications technology adoption should maximize the possibilities for sharing, thereby stimulating investment in those technologies offering the greatest cost efficiencies. The bonus with adopting digital fiber optic technology early on is that the network will be robust with respect to almost any conceivable demand scenario that ultimately develops.

ENDNOTES

1. For background reading on the relationship between rural development and telecommunications infrastructure see: E. B. Parker et al, “Electronic Byways: State Policies For Rural Development Through Telecommunications”, and Parker et al, “Rural America in the Information Age: Telecommunications Policy for Rural Development”, University Press, 1989. See also:” Rural America at the Crossroads: Networking for the Future”, and the many references therein, US Congress Office of Technology Assessment (OTA-TCT-471), April 1991.

2. For a dose of healthy skepticism (or even cynicism) on the prospects for deployment of information superhighways in a competitive market place see: B. L. Egan, “Building Value Through Telecommunications: Regulatory Roadblocks on the Information Superhighway”, Telecommunications Policy, 1994.

3. "Economics of Wireless Communications Systems in the National Information Infrastructure," U.S. Congress Office of Technology Assessment, draft, November 1994 and the subcontractor report by B. L. Egan, "Economics of Wireless Communications Systems in the National Information Infrastructure," U.S. Congress Office of Technology Assessment, draft, November 1994.

4. For a recent discussion of the goals and public policy concerns about continued subsidies of rural telephone companies see the testimony of Margot Smiley Humphrey on behalf of the National Rural Telecom Association before the U.S. Senate Commerce Science and Transportation Committee, May 19, 1994. See also: National Association of Development Organization (NADO) Research Foundation, “Telecommunications and its Impact on Rural America,” April 1994.

5. Cite FCC NPRM (1995) and Congress (H.F. 1555: Communications Act of 1995 and S.652: Telecommunications Competition and Deregulation Act of 1995).

6. This is not to say that fundamental network planning should not pay very close attention to life-cycle costs of network equipment including all of its software dimensions. Planned and unanticipated network software upgrades for network switching, monitoring, control and service functions often represent a large share of total network costs and the cost savings associated with compatible or single-supplier purchases of software right-to-use fees must be considered.

7. Of course, while non-proprietary flexible network software and interface devices may lower the costs for telephone companies which purchase from competing vendors, such standardization can reduce profits of vendors which make money on sales of proprietary hardware and software systems. When rural telcos are faced with purchasing in an environment of competing proprietary network systems, more often than not a least cost strategy is to select a single vendor of choice so that life cycle costs are minimized.

8. This is contrary to the conclusions reached in my prior study of this issue nearly five years ago when the industry's regulatory regime was still based on monopoly supply and the threat to cross subsidies to rural areas was much smaller. See: B. L. Egan, "Bringing Advanced Telecommunications to Rural America: The Cost of Technology Adoption," Telecommunications Policy, February, 1992.

9. This estimate is a broad average and depends heavily on embedded subscriber loop plant characteristics. For example, where digital switching is already available and the subscriber line is relatively short (< 18kft.) with no signal repeaters or amplifiers, the average cost of a digital upgrade is about one third this amount or $300. In older plant (about half of the embedded base), the per subscriber costs are much higher (about $2,500) due to digital switch replacement and rehabilitation of "non-filled" cable plant

which generally will not support digital service. For a description of rural telephone plant characteristics see Gerald S. Schrage, Chief, Systems Engineering Branch, Rural Electrification Administration, "Rural Subscriber Loop Performance." TE&M. January 15, 1988.

10. For a recent survey and discussion of the costs of residential broadband networks, see: B. L. Egan, supra at note 2.

11. The round-trip transmission delay for two-way satellite service is 250 milliseconds which usually results in poor quality voice conversations, though some researchers believe this problem could be mitigated somewhat using advanced electronics. In cases like rural Alaska, where customers never had a high-quality wireline option for voice service, satellite is more readily acceptable. However the costs for voice satellite service in thin rural markets can be very high even when transponder capacity is leased from others (thereby removing up-front manufacturing and launch costs from the calculation). The delay does not present a serious problem for data transmissions.

12. For more information on new digital satellite systems see: G. Gilder, "Ethersphere," Forbes ASAP TELECOSM, October 10, 1994. The entire Gilder series of articles featured in Forbes ASAP sections over the last three years provides a thought provoking discussion of future telecommunications technology trends, especially regarding new digital wireless systems.

13. For example, in a recent investigation of rural radio service, the Oregon Public Utility Commission concluded: "BETRS is not now a viable system. There are too few BETRS systems in operation. No additional BETRS systems are planned for Oregon. BETRS appears to have significant drawbacks in terms of relatively high maintenance and investment costs. These drawbacks have resulted in low use of BETRS in Oregon.", Oregon PUC Staff Discussion Paper, "The Economics of Wireless and Wireline Telephone", draft, April 20, 1995.

14. See: A. Paulraj, "Wireless Local Loop for Developing Countries - A Technology Perspective", 1994-95 Annual Review of Telecommunications, International Engineering Consortium, Chicago, 1995. Two North American manufacturers, Motorola and SR Telecom, are each deploying (or plan to deploy) many such systems, see: J. Gifford, "Wireline Local Loop Applications in the Global Environment", Telecommunications, July 1995; and, "Rural Network Possibilities", Interlink 2000, August 1992.

15. For a more detailed discussion of the problem see: US Congress OTA (1991), supra at note 1, p. 36-38.

16. See Parker et al, p. 67, *supra* note 1. This book classifies about 20M households as "rural" on a base of about 92M households in the U.S. Other estimates of remote subscribers appears in FCC Report No. DC-1066, CC Docket 86-495 "New Radio Service (BETRS) Established to Improve Rural Phone Service," December 10, 1987.

17. The source of 1993 financial and investment data for small telephone companies is: REA "1994 Statistical Report, Rural Telephone Borrowers," US Department of Agriculture.

18. Statistical data for non-RUS companies is based on the Federal Communications Commission (FCC) "Statistics of Communications Common Carriers", 1993-1994 Edition, US Government Printing Office. LECs with annual revenues exceeding $100M are included in the report.

19. Caution must be exercised when reporting trends in RUS data because annual data only applies to the companies which borrow money from the RUS, and this mix of companies changes from year to year. For example, from 1989 to 1993, the time period covered by this study, RUS borrower companies

numbered 803, 897, 902, 899, and 883 respectively. Thus total and average per subscriber financial results are not directly comparable from year to year.

20. C. Weinhaus, et al, “Redefining Universal Service: The Cost of Mandating the Deployment of New Technology in Rural Areas”, 1994-95 Annual Review of Communications, International Engineering Consortium, Chicago, 1995.

21. Detailed data for subscriber loop characteristics for both Bell and REA companies are available in Egan, “Bringing Advanced Telecommunications to Rural America: The Cost of Technology Adoption," Columbia Institute for Tele-Information, Research Working Paper #393, Columbia Business School, October, 1990, Table 4.

22. "Statistics of the Local Exchange Carriers 1994 - for the year 1993", USTA July 1994.

23. It should be kept in mind that all of reported per line cost results make no assumptions about the demand side of the equation, if they did the costs would be higher. For example, the cost numbers presented do not include any costs associated with either customer premises equipment and terminals, so-called set top boxes, or network service software and programming services provided by the LEC or another vendor.

24. Weinhaus et al, supra note 20.

25. For a discussion of such systems and what types of services they might be used for see: R. V. Henry, "Video and Broadband Services in Rural America", 1994-95 Annual Review of Communications, International Engineering Consortium, Chicago, 1995.

26. D. W. J. Deutscher, "Rural Fiber Network in Service", 1994-95 Annual Review of Communications International Engineering Consortium, Chicago, 1995.

27. Many case studies of alternative loop technologies are provided in Egan, *supra* note 21, Section 5.

28. See B. L. Egan supra note 3.

29. See Oregon PUC (1995) supra note 13 and Egan supra note 3.

30. See: Hatfield associates, "The Cost of Basic Universal Service", draft, Boulder, July 1994; and Paulraj, supra note 14; and "Wireless Technologies and the National Information Infrastructure," US Congress Office of Technology Assessment, August 1995, p. 45-46, 95-98 and ch. 9.

31. For a detailed discussion and some rather piercing commentary on this problem see: G. Calhoun, Digital Cellular Radio, Artech House, Norwood MA, 1988; and, *Wireless Access and the Local Telephone Network*, Artech House, Norwood MA, 1992.

32. See the discussion of the governments role in the OTA report supra, note 30 and the FCC's most recent decisions on rural radio service (BETRS).

33. See Egan, supra note 3.

34. B. Murphy, "Rural Americans Want Their DirecTV", Satellite Communications, March 1995.

35. See draft legislation supra note 5.

36. 7 CFR Part 1751, RUS Telecommunications System and Design Criteria, and Procedures.

37. After the RUS released its proposed interim rules on December 20, 1993, there was an overwhelming response with concerns regarding the new requirements for State modernization plans. Over 39 parties commented and a good summary of these appears in the Federal Register Vol. 60 No. 29, 7 CFR Part 1751, February 13, 1995.

38. This is also the conclusion reached in a recent Congressional Study, see US Congress OTA Report (1995) supra note 3, p. 45-46.

39. Many rural electric utility cooperatives are very successful operations, thus publically owned and operated arrangements are not necessarily worse than strictly private ones.

40. For a more detailed discussion of the existing Kentucky infrastructure for power, transportation, and telecommunications, see Egan supra note 21, Section 6 and the Appendix.

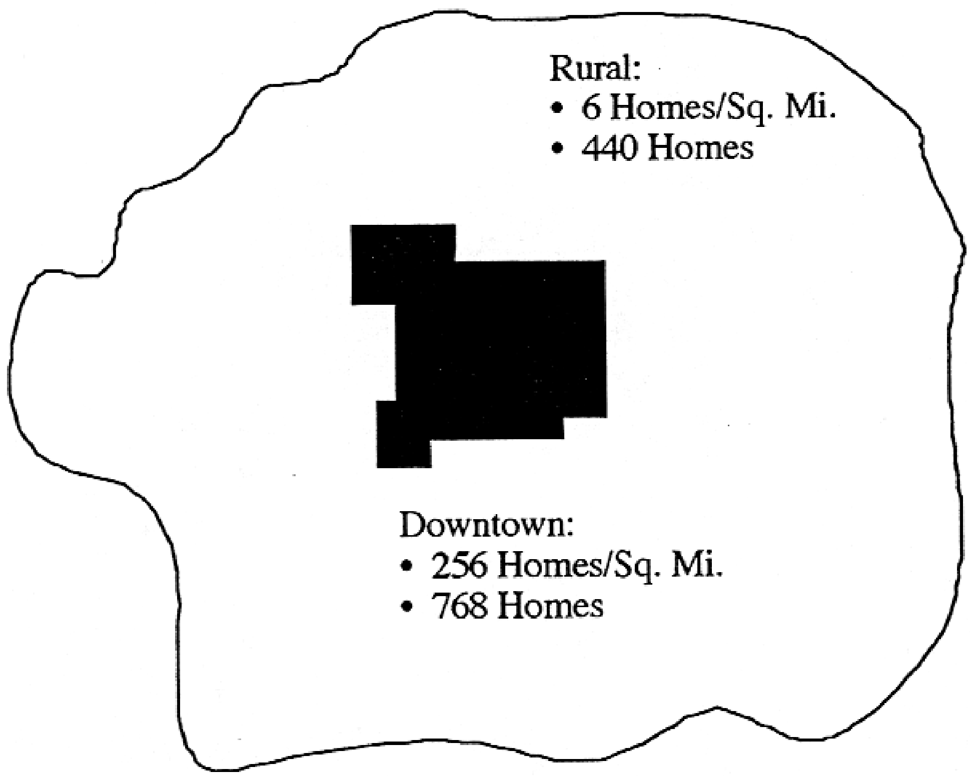
41. Weinhaus et al. *supra* at note 20.

42. Such a model was recently used by US West to calculate costs by US Census block groups, "Targeting High Cost Funding to High Cost Areas Using US Census Block Groups", draft US West, October 28, 1994.

43. Such Mechanism vary in detail but all follow the general mechanism described in: B. L. Egan, and S. S. Wildman,"Funding the Public Telecommunications Infrastructure", Telematics and Informatics, Vol. 11, No. 3 1994 (with Steven S. Wildman), also see the references therein.

FIGURE 1

Typical Rural Telecom Exchange



Approximately: 65% of subscribers in downtown area
35% of subscribers in rural area

FIGURE 2

Rural Loop Design

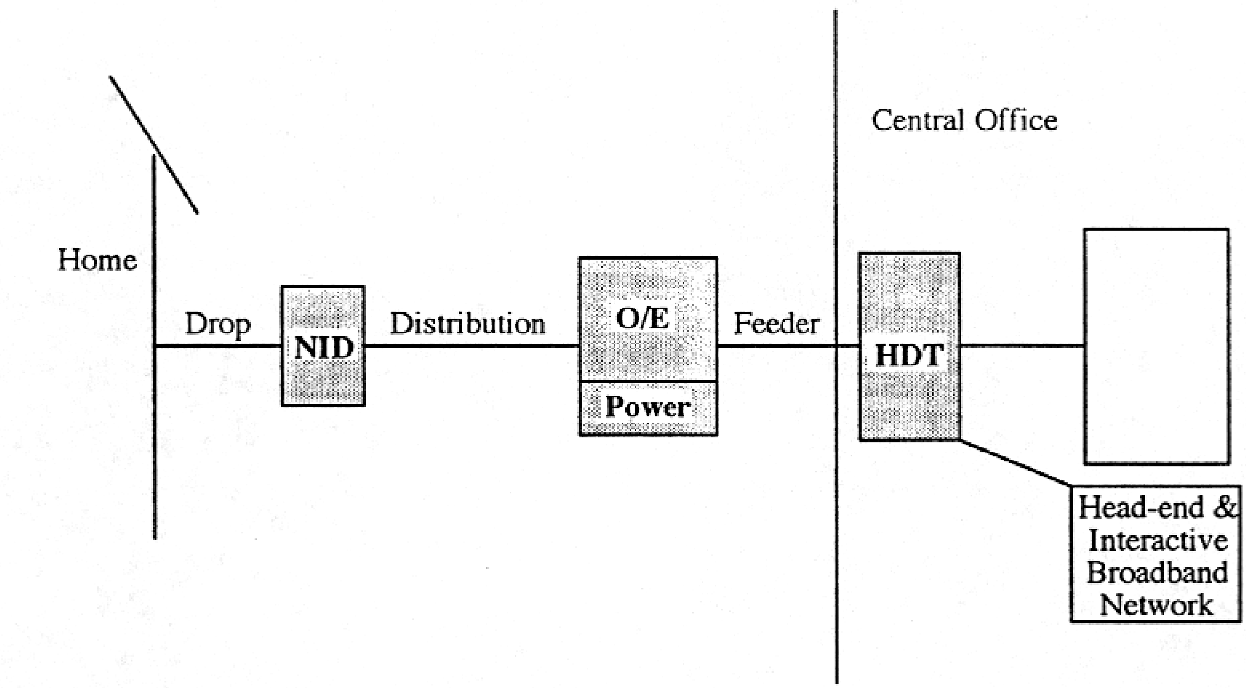


FIGURE 3 (page 1)

Cost Comparison for Wireline and Wireless - Large Cells

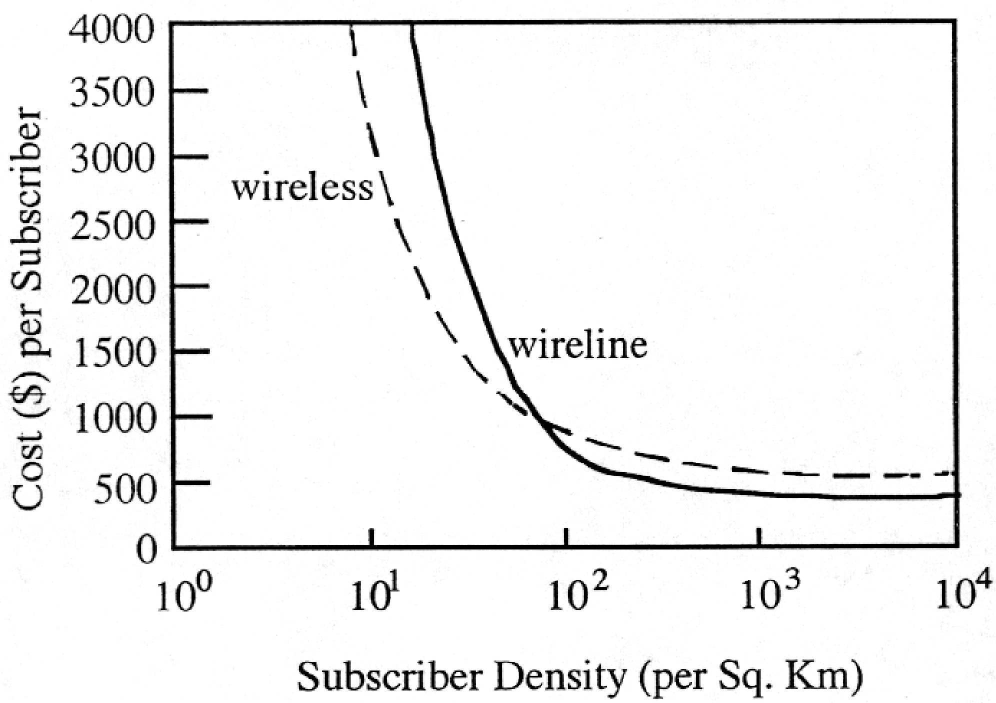


FIGURE 3 (page 2)

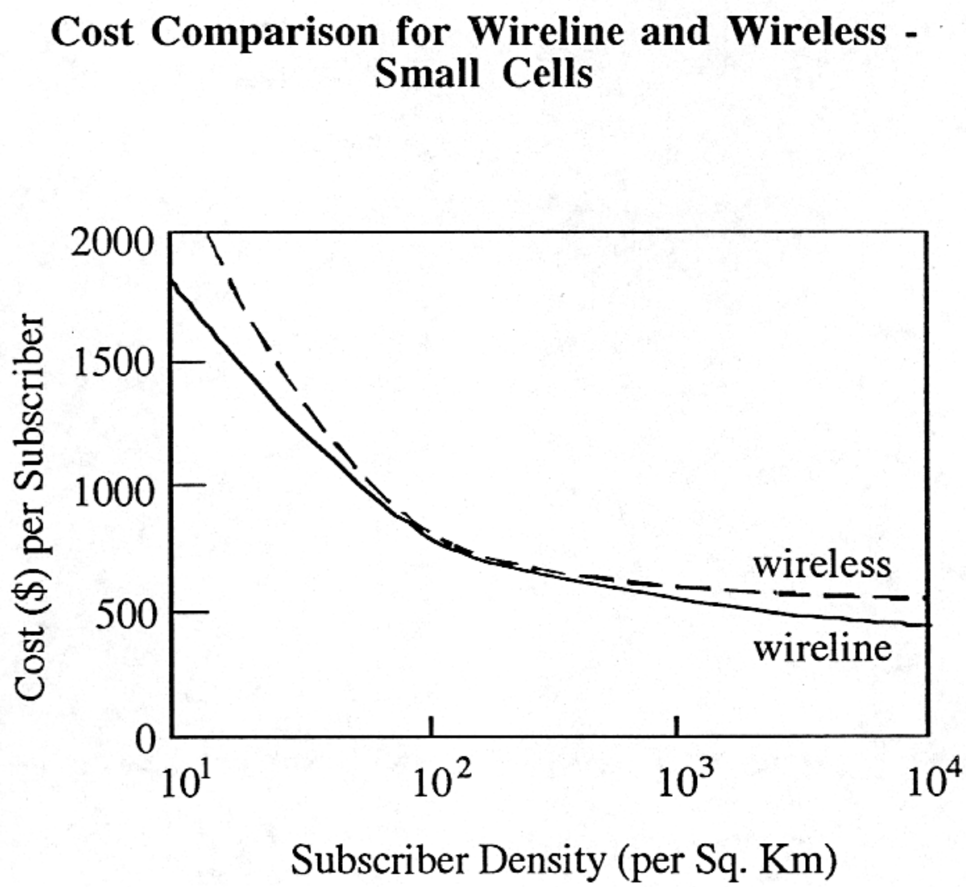
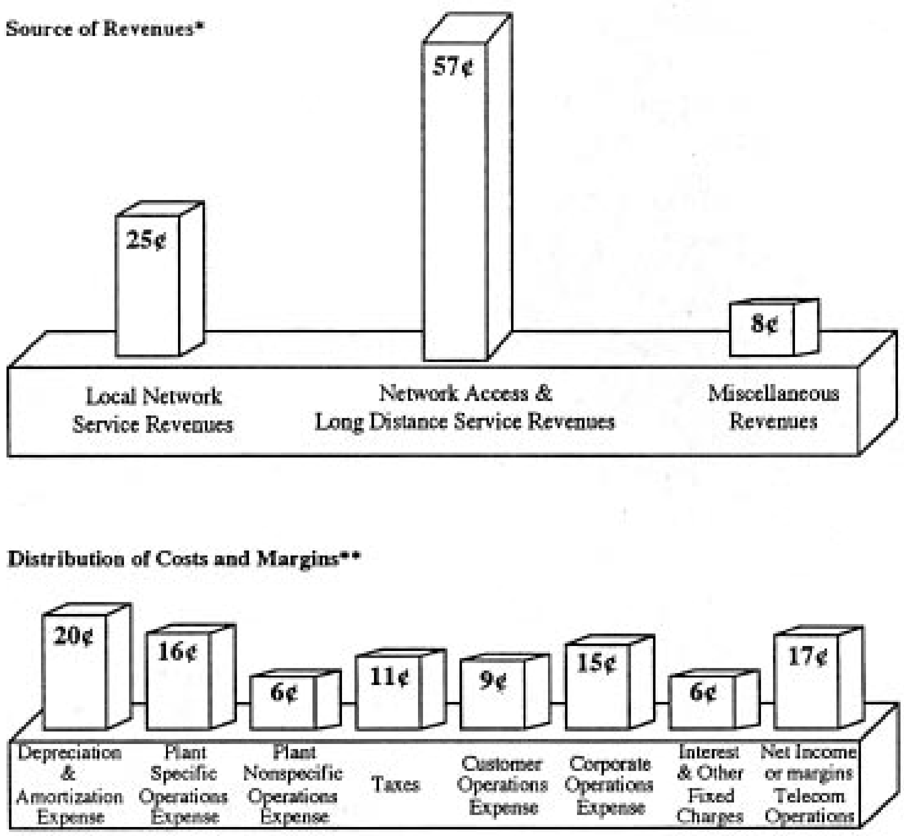


CHART 1

Source of Revenues, Distribution of Costs, and Margins

by borrowers operating telephone systems - calendar year 1993



* Adjusted for uncollectible revenues.

** Excludes other operating income and expense.

CHART 2

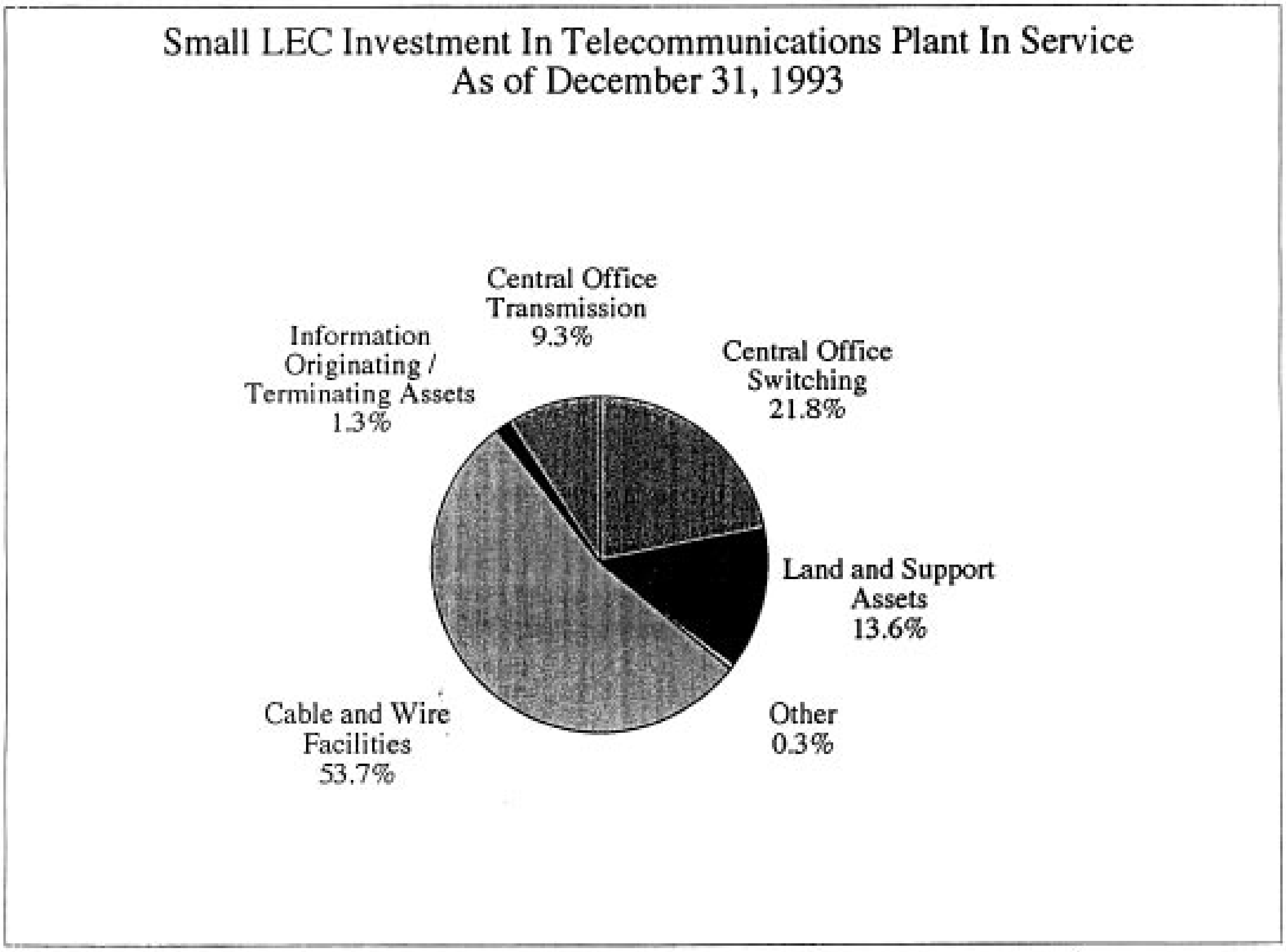

Small LEC Investment In Telecommunications Plant In Service
As of December 31, 1993
Central Office
Transmission
9.3%
Information
Originating /
Terminating Assets
1.3%
Central Office
Switching
21.8%
Land and Support
Assets
13.6%
Cable and Wire
Facilities
53.7%
Other
0.3%

CHART 3

Distribution of Number of Exchanges Per Borrower
as of December 31, 1993

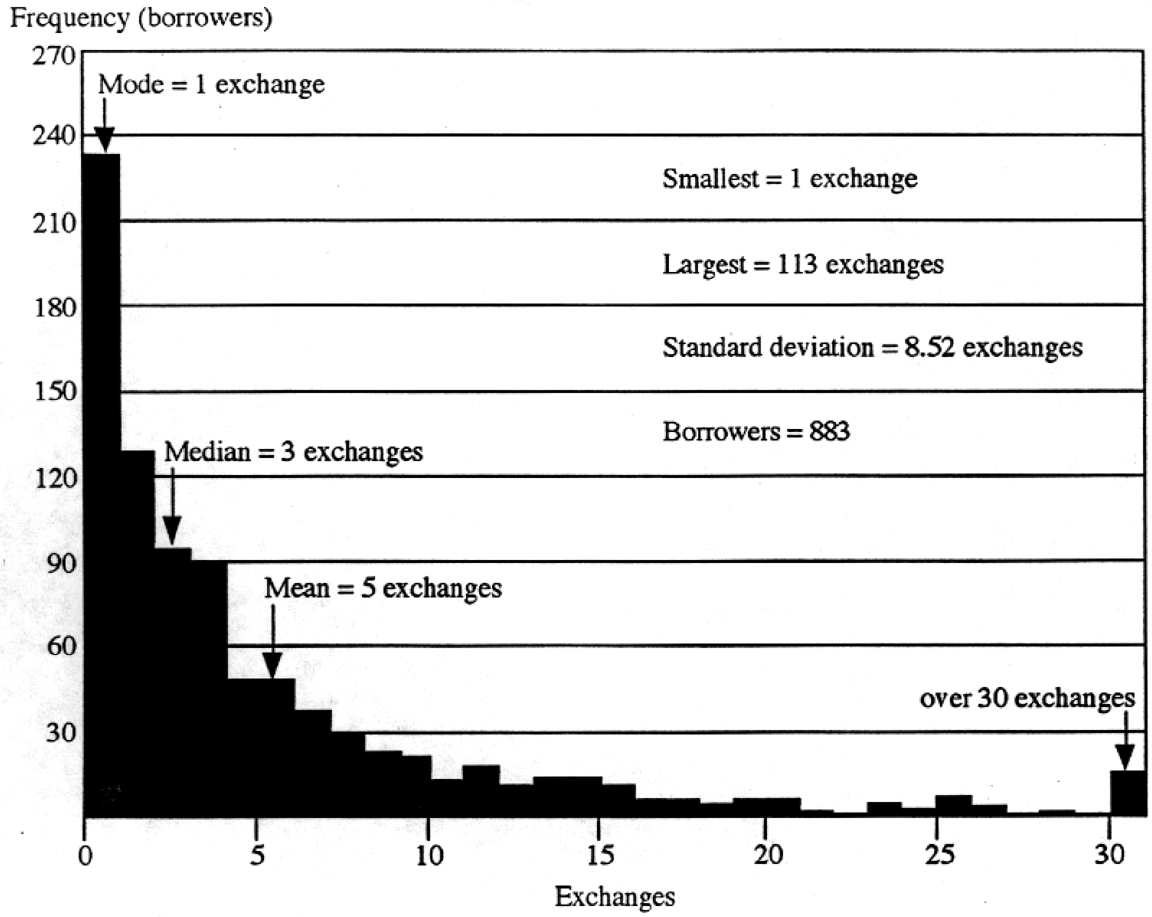


CHART 4

Distribution of Number of Subscribers Per Borrower
as of December 31, 1993

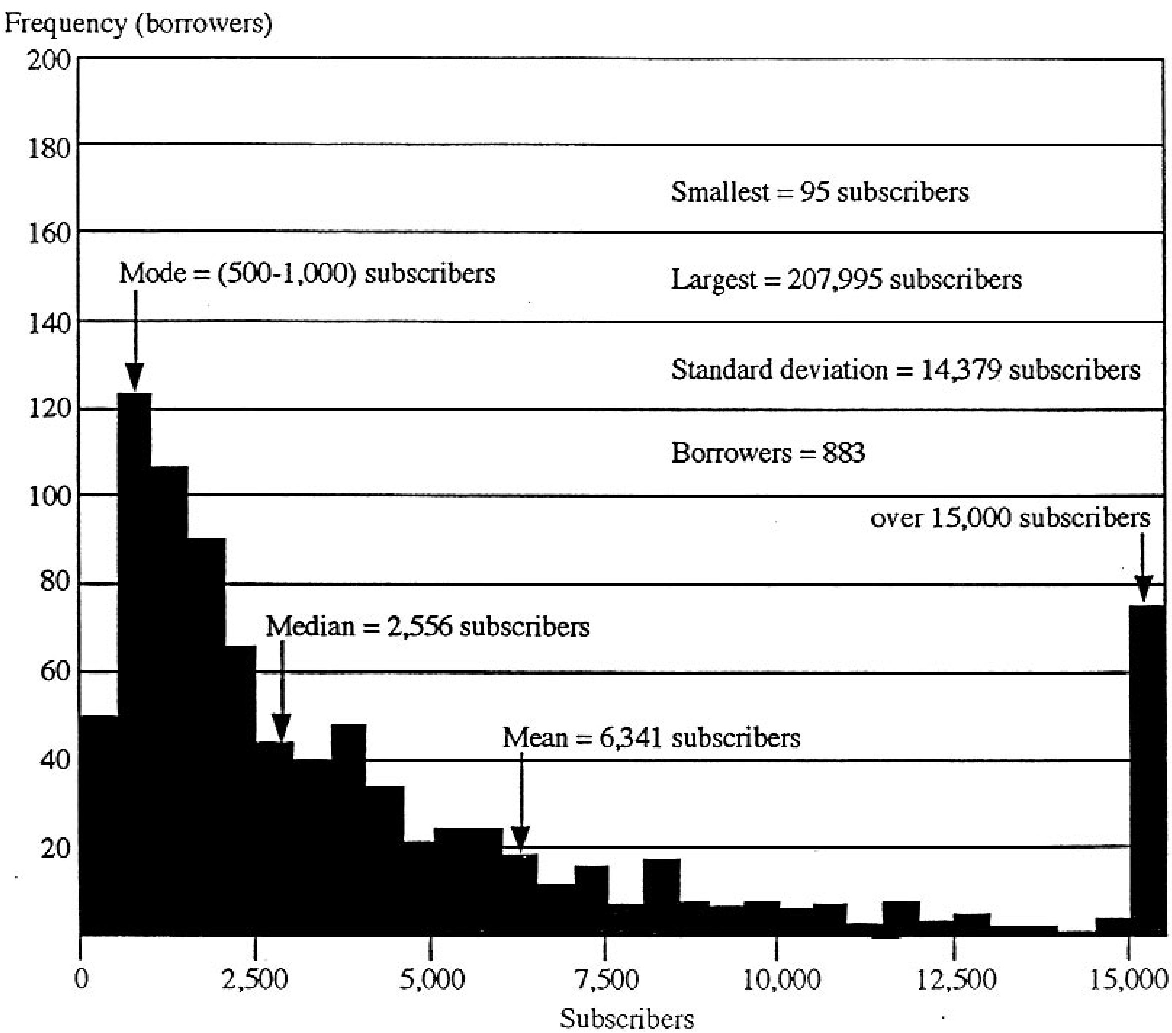


CHART 5

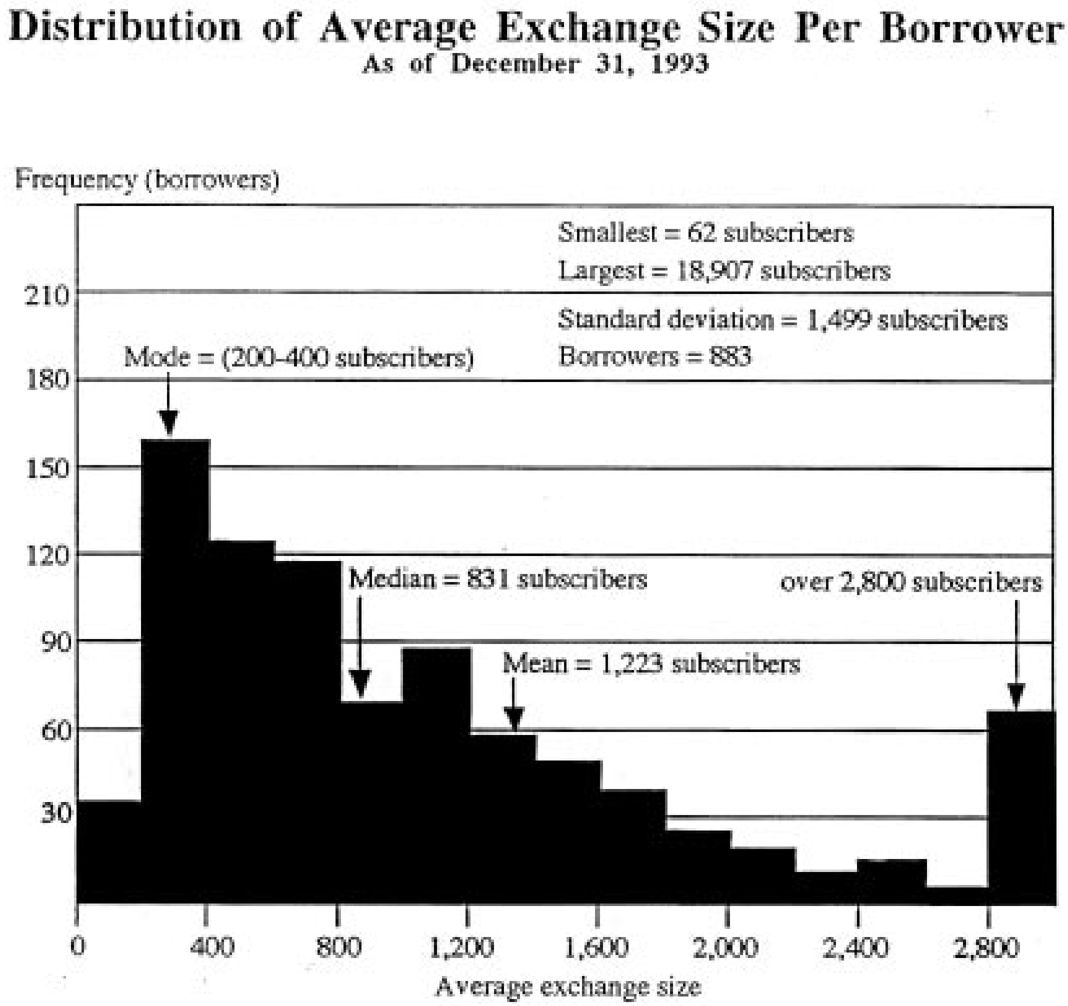

Distribution of Average Exchange Size Per Borrower
As of December 31, 1993
Frequency (borrowers)
Smallest = 62 subscribers
Largest = 18,907 subscribers
Standard deviation = 1,499 subscribers
Borrowers = 883
Mode = (200-400 subscribers)
Median = 831 subscribers
Mean = 1,223 subscribers
over 2,800 subscribers
210
180
150
120
90
60
30
0
400
800
1,200
1,600
2,000
2,400
2,800
Average exchange size

CHART 6 (page 1)

Present Narrowband Access Model Costs Per Home

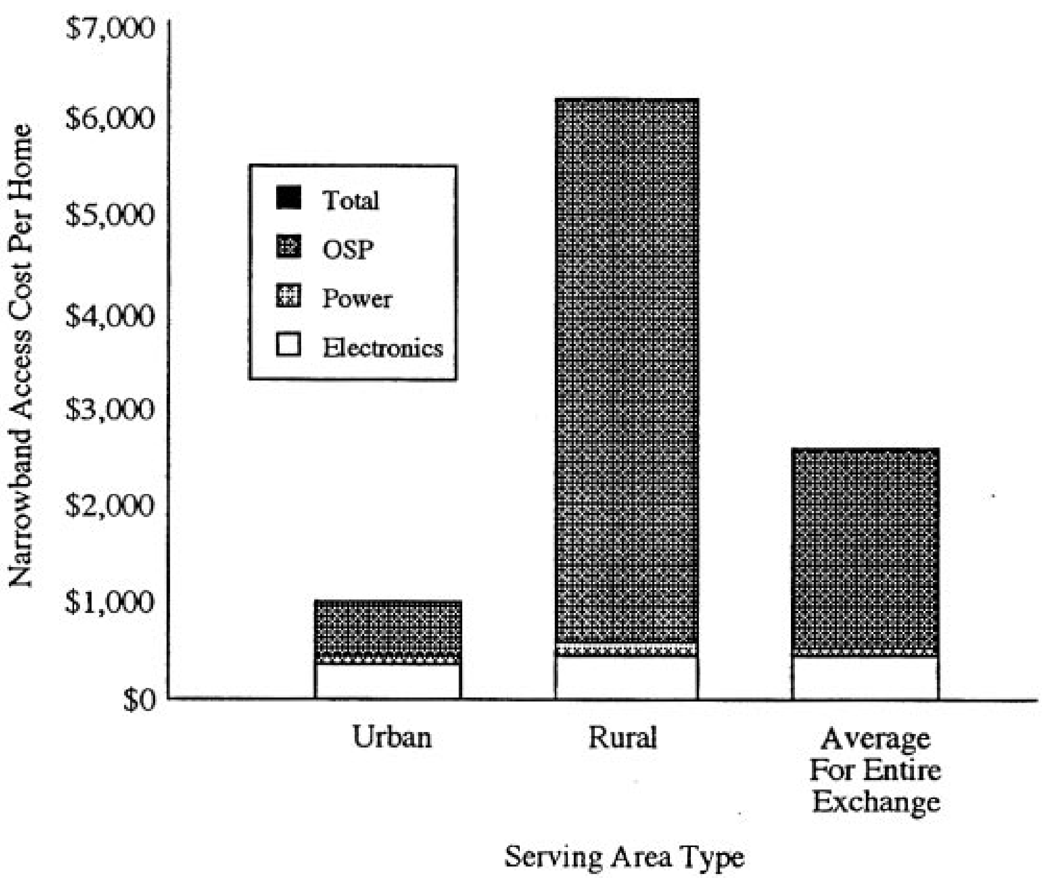


CHART 6 (page 2)

Current Narrowband Cost Per Home Passed

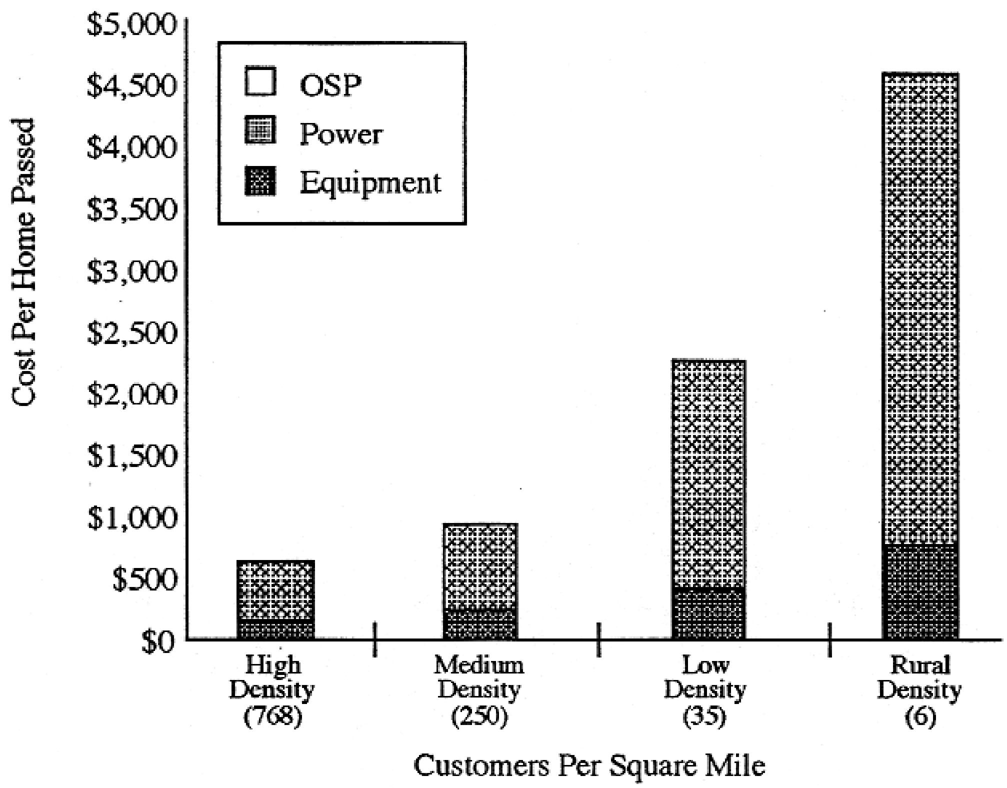


CHART 7

Cost Per Home vs. Serving Area Density
Broadband Hybrid Fiber Coax System

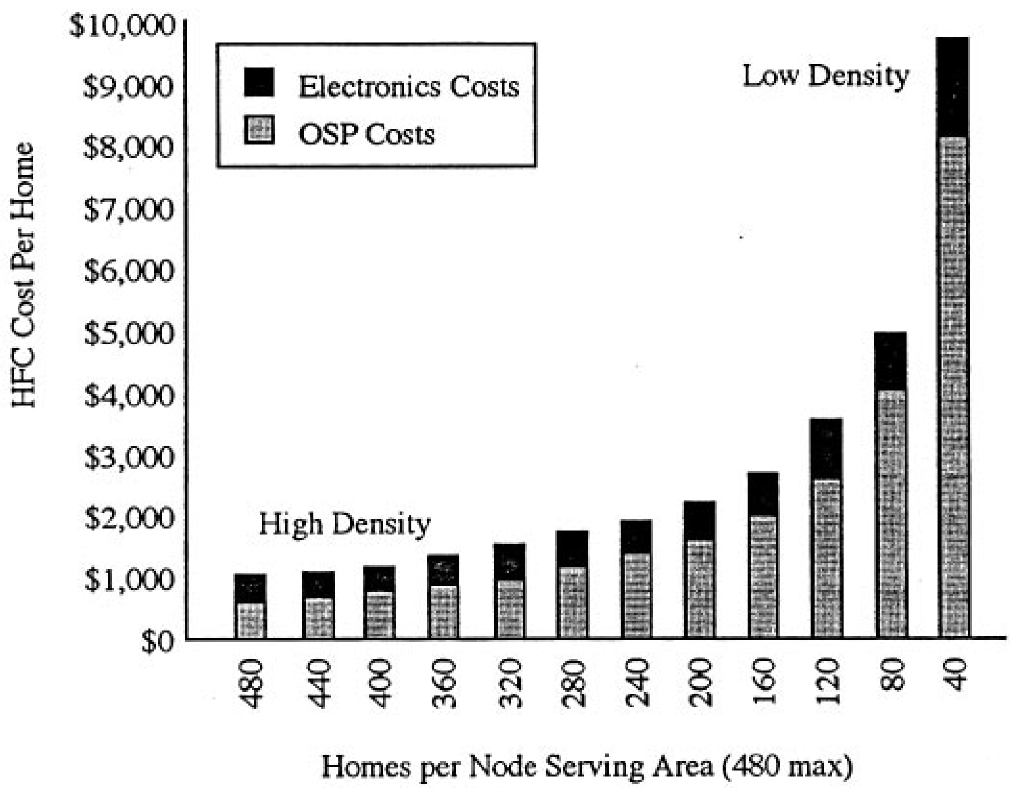


TABLE 1

LEC Financial Benchmarking (1993)

Companies	Access Lines Per Employee	Total Operating Revenue per line	Regulated Operating Revenue per line	Basic Area Revenue per line	Total Toll and Network Access Revenue per line	Total Operating Expense per line	Operating Margin per line
Large LECs (53 FCC Reporting)	293.87	$ 605.36	$ 543.10	$ 193.44	$ 270.54	$ 446.23	$ 159.13
Small LECs (833 REA Reporting)	228.22	$ 799.10	$ 733.97	$ 198.74	$ 535.23	$ 607.73	$ 191.37

TABLE 2

LEC Financial Benchmarking (1993)

Companies	Total Plant in Service per line	Net Plant in Service per line	Depreciation Reserve Percent	Sheath Meters of Copper per line	Lines per Switch
Large LECs (53 FCC Reporting)	$ 1,736.64	$ 1,049.44	39.57%	38.33	7742.14
Small LECs (833 REA Reporting)	$ 2,532.95	$ 1,478.29	41.60%	177.94	1499.3

TABLE 3

Calendar Year 1993

	Composite Revenue and Expense Ratios of Reporting Borrowers - Average Amount Per Subscriber		Per Subscriber Medians for Revenues and Expenses of Reporting Borrowers	Per Subscriber Middle Ranges for Revenues and Expenses of Reporting Borrowers
Number of borrowers		883	883	883
REVENUES				
Net operating revenues	$	799.10	798.3	659.09 - 1,056.86
Local network service revenues	$	198.74	157.14	123.75 - 208.47
Network access & long distance service revenues	$	535.23	556.7	432.37 - 798.42
Miscellaneous revenues	$	88.28	74.4	49.02 - 94.68
Uncollectible revenues (debit)	$	3.15	0.98	0 .00 - 3.1
EXPENSES				
Total operating expenses	$	607.73	611.73	499.52 - 824.57
Plant specific operations expense	$	128.25	113.13	78.35 - 165.47
Plant non-specific operations expense	$	44.83	32.57	18.84 - 49.87
Depreciation and Amortization expense	$	157.46	150.09	116.78 - 202.77
Customer operations expense	$	70.51	78.44	59.36 - 101.98
Corporate operations expense	$	120.79	138.41	97.54 - 227.20
Other operating income and expense (cr)	$	0.39		
Federal taxes	$	48.21	35.58	1.86 - 74.04
Other taxes	$	38.08	37.2	22.35 - 58.08
Net operating income or margins	$	191.37	194.51	134.27 - 264.54
Interest on funded debt	$	50.93		
Allowance for funds used during const (cr)	$	0.74		
Other interest expense	$	2.34		
Total fixes charges	$	52.53	51.52	31.96 - 81.60
Nonoperating income & expense	$	15.72	22.21	5.84 - 52.07
Extraordinary items	$	.36cr		
Jurisdictional differences	$	0.04		
Nonregulated net income	$	6.00	0.92	0.30 - 8.33
Total net income or margins	$	160.22	171.93	109.42 - 261.58

TABLE 4

Density Band Cost Results for Small Rural LECs

Subscriber Density Range	Total Plant In Service Per Line
0-10 per square km	$2667.91
10-100 per square km	$1893.15
100-500 per square km	$882.83
All LECs	$2054.7

TABLE 5

Correlations of Average Costs and Subscriber Density

The Data

There are 886 observations where each observation represents a different company.

TPS/L	=	total plant service per line
TOE/L	=	total operating expense per line
S/RM	=	subscribers per route mile
S/SM	=	subscribers per square mile
L/S	=	lines per switch

Standard Correlation Matrix

	TPS/L	TOE/L	S/RM	S/SM	L/S
TPS/L	1.00	0.50	-0.09	-0.11	-0.15
TOE/L	0.50	1.00	-0.01	0.09	0.3
S/RM	-0.09	-0.01	1.00	0.87	0.18
S/SM	-0.11	0.09	0.87	1.00	0.49
L/S	-0.15	0.30	0.18	0.49	1.00

Rank Correlation Matrix

	TPS/L	TOE/L	S/RM	S/SM	L/S
TPS/L	1.00	0.73	0.65	0.84	0.98
TOE/L	0.73	1.00	0.99	0.93	0.73
S/RM	0.65	0.99	1.00	0.92	0.67
S/SM	0.84	0.93	0.92	1.00	0.88
L/S	0.98	0.73	0.67	0.88	1.00

Table 6 (page 1)

Financial Benchmarking (1993)
Kentucky REA Borrower LECs

Company	Access Lines	Access Lines per Employee	Total Operating Revenue per line	Regulated Operating Revenue per line	Basic Area Revenue per line	Total Toll and Network Access Revenue per line	Total Operating Expense per line	Operating Margin per line
South Central Rural Tel. Coop. Corp., Inc.	21,923	249.13	$653.10	$592.56	$258.87	$333.69	$457.29	$149.04
Mountain Rural Tel. Coop. Corp., Inc.	12,028	245.47	$597.55	$527.42	$146.41	$381.01	$365.10	$206.59
Peoples Rur Tel. Coop. Corp., Inc.	6,059	195.45	$571.16	$528.22	$158.70	$369.52	$388.58	$137.30
Ballard Rural Tel. Coop. Corp., Inc.	5,571	232.13	$607.97	$567.81	$110.02	$457.79	$372.83	$126.39
Foothills Rural Tel. Coop. Corp., Inc.	11,897	321.54	$553.63	$482.70	$157.38	$325.31	$327.47	$189.79
Brandenburg Telephone Company	20,860	221.91	$560.96	$496.41	$139.28	$357.12	$410.09	$165.05
West Kentucky Rural Tel. Coop. Corp., Inc.	15,039	268.55	$562.02	$499.74	$165.79	$333.95	$414.50	$100.08
Continental Tel. Co. of Kentucky	78,597	727.75	$720.93	$669.05	$249.89	$419.16	$529.68	$115.70
Duo County Tel. Coop. Corp., Inc.	9,849	266.19	$629.76	$563.52	$194.25	$369.27	$410.39	$203.41
Alltell Kentucky Incorporated	20,046	435.78	$572.73	$466.17	$164.76	$301.41	$424.00	$126.88
Logan Telephone Cooperative, Inc.	5,671	283.55	$687.92	$609.91	$211.16	$398.75	$481.17	$148.02
Harold Telephone Company, Inc.	5,145	135.39	$635.59	$606.51	$190.14	$416.37	$471.17	$128.11
Thacker-Grigsby Telephone Co., Inc.	6,411	188.56	$607.20	$567.84	$96.87	$470.98	$415.99	$196.59
Leslie County Telephone	6,986	268.69	$666.55	$580.33	$190.26	$390.07	$538.30	$82.88
Salem Telephone Company	1,807	258.14	$462.93	$409.27	$131.34	$277.93	$455.92	($54.48)
Lewisport Telephone Company	1,146	143.25	$626.96	$538.23	$112.12	$426.11	$504.80	$41.86
Weighted Average - Kentucky Companies		427.72	$640.58	$578.17	$199.23	$378.95	$457.08	$137.19
Total for all REA Borrower Companies	9,487,560	228.22	$880.23	$907.83	$351.17	$556.66	$662.81	$217.42

Table 6 (page 2)

Financial Benchmarking (1993)
Kentucky REA Borrower LECs

Company	Access Lines	Total Plant in Service per line	Net Plant in Service per line	Depreciation Reserve Percent	Sheath Meters of Copper per line	Lines per Switch
South Central Rural Tel. Coop. Corp., Inc.	21,923	$2,643.02	$1,808.38	31.58%	321.24	1,370.19
Mountain Rural Tel. Coop. Corp., Inc.	12,028	$2,135.25	$1,422.96	33.36%	297.37	1,718.29
Peoples Rur Tel. Coop. Corp., Inc.	6,059	$2,745.34	$1,785.87	34.95%	292.38	1,514.75
Ballard Rural Tel. Coop. Corp., Inc.	5,571	$2,128.02	$1,524.60	28.36%	283.62	795.86
Foothills Rural Tel. Coop. Corp., Inc.	11,897	$2,482.64	$1,719.97	30.72%	227.75	1,487.13
Brandenburg Telephone Company	20,860	$1,632.82	$889.08	45.55%	115.16	2,607.50
West Kentucky Rural Tel. Coop. Corp., Inc.	15,039	$2,923.16	$2,261.11	22.65%	280.74	835.50
Continental Tel. Co. of Kentucky	78,597	$2,460.24	$1,648.60	32.99%	226.72	1,827.84
Duo County Tel. Coop. Corp., Inc.	9,849	$2,114.19	$1,210.85	42.73%	197.02	2,462.25
Alltell Kentucky Incorporated	20,046	$1,374.49	$774.29	43.67%	130.35	6,682.00
Logan Telephone Cooperative, Inc.	5,671	$2,542.57	$1,631.73	35.82%	289.97	945.17
Harold Telephone Company, Inc.	5,145	$1,888.08	$1,110.61	41.18%	103.51	1,715.00
Thacker-Grigsby Telephone Co., Inc.	6,411	$1,967.37	$1,004.83	48.93%	155.35	1,068.50
Leslie County Telephone	6,986	$2,588.36	$2,056.82	20.54%	201.53	998.00
Salem Telephone Company	1,807	$1,900.74	$826.62	56.51%	332.13	1,807.00
Lewisport Telephone Company	1,146	$2,271.78	$2,247.15	1.08%	172.69	1,146.00
Weighted Average - Kentucky Companies		$2,280.36	$1,510.50	34.86%	222.92	2,110.65
Total for all REA Borrower Companies	9,487,560	$2,054.70	$1,455.17	29.18%	177.94	1,499.30

TABLE 7

Telecommunications Infrastructure Upgrades in Large and Small Telephone Companies (1992)

Local Exchange Company	% of Digital Access Lines	% of SS7 Access Lines
Bell Companies		
Ameritech	74%	55%
Bell Atlantic	63	95
US West	45	54
Large Independents		
Centel	100	72
Century Telephone	82	13
GTE	83	30
TDS Telecom	94	0
Small Independents		
NECA interstate access tariff participants	91	15

TELECOMMUNICATIONS TECHNOLOGY AND AMERICAN RURAL DEVELOPMENT IN THE 21ST CENTURY

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1. Introduction

Among the "seven wonders of the modern world" listed by The Economist in 1993 were the microprocessor (labeled "the thinker") and the telephone network ("the messenger"). The microprocessor is perhaps the most influential man-made wonder of all, being integrated into machines and into our lives more each day. It also has greatly affected two wonders that have done most to collapse space and time: the jumbo jet and the telephone network. Both of these have made distant places nearer and both have allowed people mobility and rapid interaction not imagined. Jet travel has made global tourism a possibility for many, and links people of different cultures on a scale never seen before this century.

The telephone network is the technological wonder that seems to fit least in this list. It is the oldest, having been invented over a century ago. Yet it has been transformed dramatically in the past generation. Together with the microprocessor, the technologies that fall under the umbrella term telematics have literally brought people closer together, made interactions easier, and opened up possibilities not imagined to our grandparents. Microwave, satellite, and fiber-optic cables continue to transform the telephone, and we now expect it to deliver not only voices, but fax images, data, and pictures.

The earlier telephone network, while still not available outside rich countries, is seen as a basic infrastructure, along with electricity, water, and transportation (World Bank 1995). The rich countries of Europe, North America and the Pacific have progressed beyond plain old telephone service (POTS), and it is in the emergence of these new technologies that we see that the "new information infrastructure" also requires a strong public presence. Without a government commitment to connect all places, it is likely that many of the new technologies will be unavailable to those remote from "adequate-sized markets." Competition will ensure that large, dense markets are the first to obtain new telecommunications technologies. The policy objective of "universal service" is becoming more difficult to attain than when the technologies were fewer and simpler (Office of Technology Assessment 1991; Ypsilanti and Kelly 1994). Added to the complication is a tidal wave of deregulation that imposes competition into often ill-equipped regulatory bodies that were created for much simpler times (Paltridge 1995).

"Instead of a homogeneous market for telematics, we are now witnessing an increasingly segmented and dynamic market in search of specific solutions to specific problems. . . Power is shifting to competing suppliers, to specific user groups, to policy makers, and to local and regional communities themselves" (Millard 1995: 4).

A second issue faces rural areas most severely: the fact that the technologies have become so varied and so technically complicated that only specialists can truly understand them. The new technologies are difficult to learn, and lower densities make learning difficult for rural residents. Rural areas, often short of technical expertise, are likely to lag further behind as the pace of change increases. The demographic character of the new technologies also works against rural areas, where entrepreneurs and a educated, wealthier population are less likely to be found. The impacts of telematics and its potential benefits are closely related to the location of jobs.

In this paper, I sketch briefly the history of telecommunications technologies, including the Internet and business use of telematics. This is followed by a discussion of the Internet and its impact on demand for telecommunications. Next, telecommunications as a factor of production for location of firms is considered, especially knowledge-based activities and the telecommunications-travel tradeoff. The specific problems of rural areas is the focus of the next section. The paper concludes with policy concerns in the light of regional development.

2. Telecommunications: An Introduction and a Brief History

The electronic revolution has permitted a flood of innovations to collect, store, display, and transmit information. Computers, office products, and telecommunications have converged into a single "new information technology" or information-processing industry based on digital telecommunications (Forester 1987; Hall and Preston 1988; Saunders, Warford, and Wellenius 1994). Communications, along with transportation technologies, are the "enabling technologies" which have enabled multisite even global business operations (Dicken 1992: 103). At the same time, the growing globalization and spatial division of labor within firms has induced ever larger communications needs (Nicol 1985). Indeed, new communications technologies are developing in tandem with both globalization of the economy and the emergence of a knowledge-based economy and society.

Telecommunications began with the telegraph a wire-based technology that formed the foundation for the telephone networks with which most of the world is connected. Transoceanic cables linked much of the world by 1900 (Headrick 1991). Demands by businesses for the means to control information relating to production and distribution drove early applications of telematics (Beniger 1986). It was not until the 1960s, however, that the technologies of computers and electronics merged with those of broadcasting and wire-based telecommunications. As occurred a century earlier, most applications have been driven by a growing set of information technologies for business applications, such as computer-aided design, remote sensing devices, management information systems, and data bases (Arnold and Guy 1989).

Military and imperial demands also prompted innovation, especially in wireless technologies during the Second World War (Headrick 1991). Military uses, where many of the current technologies originated, have begun to utilize the dizzying array of applications and technologies now available: the system of systems, based on advanced command, control, communications, computing, and intelligence (C4I), extended information dominance providing bitstreams of information instead of providing arms, and hacker warfare, to corrupt information systems of potential foes without force (Clawson 1996). Indeed, telematics (combined with specialized software and systems) is the principal new "weapon" of the 21st century (Morton 1995).

A massive degree of innovation in telecommunications has come about only in the past 25 years since about 1970. In that time, copper wire, the basis of the world's telecommunications systems for over a century, has begun to be replaced by fiber optic cables and by satellite and other wireless technologies, such as microwave and cellular. During the same time period, computer technology evolved from word-processing and accounting to embrace image and graphic processing, requiring large quantities of data, and computers themselves evolved from large, room-sized machines to portable, personal tools. The ability to send and receive data and images, in addition to voice, effectively merged the two distinct technologies (Heldman 1994). The Internet and the World Wide Web are the present forms of this merger of the two technologies (Anderson 1995). The blending of capabilities of firms in previously distinct sectors has led to a purposeful blurring of industry boundaries (Nicholls-Nixon and Jasinski 1995). Telematics now combines at least four industries: computers, communications, software, and entertainment.

Satellite systems are a central element in global communications, providing two-thirds of all overseas telephone capacity, virtually all trans-oceanic television transmission, and private circuits for large corporations (Langdale 1989; Wheelon 1988). Fiber-optic cables have provided a new vitality to submarine cables, which had been "declared dead twice" with the introduction of the radio, and with the growing application of satellites in the 1970s. Steady decreases in the price for satellite users have created "an efficient division of business between cables and satellites." Satellites are more profitable for the transmission of pictures, and are effective for serving areas with low population density, whereas high-traffic routes are best served by fiber-optic cable (Hottes 1993: 102-103). By being able to transmit to any ground-based receiver, satellites create a more dispersed and equitable network, whereas fiber-optic cables require physical links and are point-to-point in nature (Moss 1987).

3. The Internet and the Bandwidth Issue

Perhaps the most important new technology is one which grew out of the military effort in the USA -- the Internet. This dispersed network of computers was designed to function as a communications system without the need for a central computer. Its dispersed nature has made it the medium of choice among those who prize democracy over centralized control (Anderson 1995). However, a closer examination of the Internet reveals some characteristics that suggest potential shortcomings. First, connection to the Internet, especially to its graphical, multimedia counterpart, the World Wide Web, closely follows the pattern of telephone usage and of income. This means that on a global basis this "democratic" medium benefits primarily wealthy democrats rather than poor ones. The principal reason for this is that telephone connectivity varies greatly around the world, being best in North America, Western Europe, and Australia and New Zealand (Warf 1995). For example, many rural areas in the USA do not have direct access to the Internet, and many have no Internet Access Provider without a long-distance (toll) charge; telephone line quality also varies (James 1996). All of these can reduce or eliminate Internet access.

The quantity of telephone service is closely related to the second shortcoming identified by the spread of Internet use. The World Wide Web demands greater bandwidth and transmission speed than is typically available even in wealthy countries. This means that even when telephone infrastructure is made available to remote and rural areas, they will in most cases not have access to wide bandwidth capability and therefore still be unable to take advantage of full Internet usage (Preston 1995).

Most generalizations about telecommunications overlook the issue of bandwidth and the heavy presence of existing telephone infrastructure. The new wireless technologies are confined to voice, facsimile and low-speed data, and they fail to provide the bandwidth needed for World Wide Web access provided by wire-based infrastructures (Preston 1995: 257-258; Rupley 1996). The new technologies (microwave towers and satellites) also are costly (The Economist 1993: 48-49). The cost of new "cyber-cellular phones" $2,000 including connectors, modem and software is prohibitive for most users, and although able to access the Internet, is still, like radio modems, not capable of efficiently surfing the Web or of sending long documents, graphics or multimedia (Brown 1996; Hickman 1996). It is likely that wireless networks in the future (ten years or so in the future) will be able to provide multimedia service (Zysman 1995).

While many see wireless (radio) technologies as central to future lifestyles and workstyles (Forge 1996; Haynes 1993), "mobile or other wireless services do not yet constitute comprehensive and viable substitutes for wire-based systems" (Preston 1995: 258; Egan 1996). The potential of these systems lies mainly in their ability to provide basic (voice, fax, and data transmission) service to remote places (Wright 1995). For these and other technologies, economic criteria are often downplayed, and suggest that substantial subsidies would be required to serve rural and peripheral areas. The question that must be answered is: "Would people rather have bandwidth or mobility?" (Cairncross 1995: 11). The two suggest very different futures for rural areas.

As an answer to the bandwidth problem, integrated services digital network (ISDN) standards allow shared voice, data, facsimile (fax), and pictures to move in digital mode over copper wires (Heldman 1994). The principal advantage of ISDN is to permit a range of communication over existing telephone networks, rather than requiring new infrastructure. Widespread availability in the US has been slow, except for "islands" of use concentrated in large cities, because of continuing government regulation, costs and lack of standardization (Gregg 1992). Recent demand for Internet access has spurred ISDN in the U.S.; it is already widespread in France, Germany, Japan, and the U.K. (The Economist 1995b). Other, newer technologies include cable modems (The Economist 1996a), which obviously require cable infrastructure not present in many rural areas, and asymmetric digital subscriber line (ASDL) modems, which expand greatly the speed at which transmission takes place over copper wires (falling somewhere between cable modems and ISDN) (The Economist 1996b). Both of these technologies are being implemented first in urban not rural areas, and investment costs (for digital backbone systems and two-way cable capability) suggest that neither will be widespread soon (Derfler 1996). Satellites and other wireless technologies are commonly proposed solutions for rural development (OTA 1991). Wireless Internet access, seemingly an answer for rural areas, require radios to be spaced on utility poles at half-mile intervals. Thus, it too is being aimed at dense urban areas, such as the San Francisco Bay and Washington, DC, areas (Matzkin 1996).

The principal dilemma is between the continual development of new technologies, which are certain to favor urban areas, and new concepts of universal service. Technological change has greatly changed the concept of universal service. Traditionally, voice grade or dial-tone (narrowband) service was considered the standard level of service to be provided universally. The Internet and personal computers require digital capability, and preferably interactive video (broadband), which is not universally available, especially in rural areas. This raises the question: "Which services should be included in universal service?" (Weinhaus et al. 1994: 3).

Complicating the question is the entry of numerous new providers. As video and computer technologies merge with voice telecommunications, cable TV and computer network firms have (or will soon have) the capability to provide the full array of telecommunications services. Should information services, high-speed transmission, and two-way interactive video be considered within the scope of universal service? For rural areas, the cost of upgrading voice or dial-tone lines to broadband service would be prohibitive. Urban and suburban (metropolitan) areas have been the principal markets for new services, because their customer base includes larger numbers of customers who are willing even eager to adopt new services. The much smaller number of rural customers in any service area, as well as nationwide, means that rural areas are certain to be late in the service provision sequence.

Complicating the policy choices concerning construction of local ISDN (or other broadband or high-capacity) networks is the fact that many firms have already built their own local area networks (LANs) and even connections to existing wide area networks (WANs). WANs include public data networks and private data networks, whether owned by a corporation or managed by a communications carrier. The technological capabilities and regulatory issues are far from resolved at this time (Linhart, Radner, and Tewari 1992; Steinfield, Bauer, and Caby 1994). The major regulatory issues tend to revolve around the details of, and fees for, interconnection with local exchange companies (Brock 1994: 243-256). At the same time, new players are entering the business as telecommunications providers, including electric utility companies, cable television firms, and gas pipeline companies (Arnst, Kelly and Burrows 1995). Technological issues are unresolved as well, and some observers believe that broadband ISDN and fiber optics could replace satellites completely (Solomon 1990). The uncertain nature of telecommunications technology, combined with its tendency to be cited as a major force for the future, has led Mansell (1990) to refer to telecommunications infrastructure as "the new black box'." Much of the uncertainty centers on standards which now must interface myriad national systems in order to provide a seamless global network of a greater number of more complex technologies (Drahos and Joseph 1995; Drake 1994).

The regulatory structure that once provided rural areas equal access to communications technology "is coming unraveled" (OTA 1991: 7). It is not only deregulation, however. Equally involved is the unrelenting development of private networks by large firms, which has siphoned off revenues from traditional carriers. Most government-run telecommunications projects, including distance education and telemedicine, are effectively private networks as well, bypassing the public networks (E. Parker 1995).

4. Telecommunications as a Factor of Production

Let us examine briefly how telecommunications makes places different. This is most easily done in the context of business firms and their efforts to operate, or have a presence, in all feasible and profitable locations. Although telecommunications as a factor in location is a relatively new concept, transportation costs have been central to the analysis of the location of economic activity for a long time. Overcoming distance for the movement of goods has led to a simple (weight times distance) calculation of total transportation costs. "Transporting" ideas via telecommunications is more difficult to consider in this way. For instance, it is easy to distinguish a train from its load by allocating the first to transportation and the second to industry, but it often is difficult to separate a message or piece of information from the software and hardware that processes it (Kellerman 1984: 229). Thus, telecommunications is interdependent with the other (computer- and electronic-based) technologies which comprise telematics.

If distance has been destroyed by telematics, the new technologies have made a "space of flows" more important (Castells 1989). In particular, the creation of networks means that anyone can be a node in the network, but what begins to matter most is to whom one has connections. This means that old-fashioned connections have begun to matter more, now that anyone can be linked to everywhere, in order to make sense of the complexity. For people in local places, it is important perhaps crucial to have links to the global networks of large firms where information, commerce, and decisions are centered. Links to global networks no longer require proximity, but they do require having links and using them to obtain and exchange information. The "links" are those of individuals' personal networks and the business networks of highly competitive firms with their suppliers, customers, and other sources of knowledge. The cost of being unconnected or remote is a higher cost of operation, usually in the form of a time penalty, rather than as a penalty. Time is often the most important variable for a person or firm to control. Local nodes (places) need know-how and skills, an adaptive socio-cultural and institutional infrastructure, and entrepreneurial traditions (Amin and Thrift 1992).

The front-line and cutting edge places are big cities. Everywhere else must rely on their connections to big cities and their capabilities in other factors, especially labor skills. Gillespie and Williams (1988) provide a useful perspective on the spatial impact of telecommunications:

Although the effect of telecommunications has the potential to collapse distance rather than just to shrink it, the effect is not uniform either between different combinations of regions or between different organisations occupying the same region. . . [T]he key to understanding the significance of telecommunications is to see it within a computer network context. The computer network innovations which are redefining the basis of competitive advantage cannot be divorced from the organisations within which they are embedded. . . Although computer networks may, or may not, incorporate parts of the public telecommunications infrastructure, each computer network is essentially private and proprietary (Gillespie and Williams 1988: 1317).

Are there technologies for the unconnected? Rural and peripheral areas face special challenges, to which the paper returns after discussing the imperatives of business location.

5. Business Use of Telematics

To businesses, telecommunications networks used to be like electricity, water distribution, and other utility networks. They were an important resource, but one over which a firm had very little control or influence. Firms had little choice about the equipment they could get or the services they were offered by monopoly providers. That was when all that was available was POTS plain old telephone service. Today, corporate users put together entire networks, either completely under their control or using circuits leased from common carriers, bypassing the public network partly or entirely. Together, deregulation and the new digital technologies have permitted firms to consciously design and operate private, internal telecommunications networks to decisively enhance their competitive position (Bar et al. 1989: 47-48; Hagstr"m 1992). "What used to be a cost of doing business is becoming a source of competitive advantage" (quoted in Cohen and Zysman 1987: 179; Keen 1991; Li 1995). Telecommunications services are used by all economic sectors, from mining and agriculture to manufacturing and tourism (Miles and Thomas 1990). These private networks are present in all global industries, where multinational companies have become true network firms. In all such global sectors, such as agriculture, autos, electronics, and financial services, sophisticated and constantly changing use of telecommunications is now a fact of everyday life and business operation (Mansell 1994).

Large business users have sophisticated needs and demands for systems that are cost-effective, flexible, secure, automated, integrated, and dependable. When local providers do not meet these needs, at a reasonable cost, firms do not hesitate to develop private networks and other solutions (Schmandt et al. 1990: 293). Multinational firms typically coordinate production and marketing by means of satellite-based communication systems. Ford Motor Company, for example, has built a transatlantic system of linked computer networks with video-conferencing capability in order to coordinate product development and manufacturing design (The Economist 1995a). The system grew out of earlier networks initiated within Ford of Europe, designed to centralize design and facilitate transfer of CAD/CAM (computer-aided design and computer-aided manufacturing) data among company locations (Dixon 1992). In the retailing sector, Wal-Mart Stores uses a leased satellite transponder to link its 1700 stores to its Bentonville, Arkansas headquarters and 14 distribution centers, in order to track every item sold at each checkout and to play the same background music in each store (Heenan 1991: 69; Bernal, Stuller, and Sung 1991: 36-43).

While information flows within corporations take place in many forms (personal contact, mail, courier), leased networks offer numerous advantages, such as lower costs, security, and compatibility of computer standards (Langdale 1989: 503). Most users of leased networks are large multinational firms. Smaller companies are generally unable to operate leased networks because of their cost; they are economical only if the organization is large enough to generate sufficient traffic to save on the more expensive public switched services).

Global firms were among the first to exploit telematics, and remain both large users and early users of new technologies. Sectors and specific operations that depend heavily on telecommunications include: those with credit card authorizations and billing operations, toll-free customer service numbers, outbound active telemarketing using automatic or human dialing systems, central publishing and facsimile transmission to remote printing locations, central transactional processing for accounting and other types of record-keeping, and financial transactions including brokerage, consumer loans, mortgage loans, and other bank-related transactions (Hack 1992b: 71). Among the largest users of telecommunications technologies are financial service firms (Warf 1989). Companies that are large telematics users rate demonstrated reliability, fiber-optic cabling, and ISDN as the most important elements of telecommunications infrastructure in business parks (Lyne 1991).

Just as the construction of new infrastructure networks of earlier eras such as the railroads and the interstate highway system altered the relative value of locations, the new telecommunications infrastructure is doing the same thing today (Cohen and Zysman 1987: 185-186). Flexible production processes and segmented markets demand advanced communications services (Twenhafel et al. 1989). A recent survey of economic development executives in the USA found that 38% of them say their area's telecommunications infrastructure recently played a primary role in attracting a new corporate facility (Venable 1993). Wilson and Teske (1990) cite numerous examples (rural as well as urban) of location decisions based on availability of superior tele- communications.

Most studies of location factors, or influences on the location of economic activities, have not considered telecommunications as a separate item. Hack (1992b: 71) reports that "a review of almost every list of plant location factors that has been published in the last 20 years reveals the absence of the telecommunications factor." Despite limited research, it is clear that telecommunication technologies have significantly reduced the technical constraints on the decentralization of business activities. This greater locational flexibility permits a firm to "follow locational factors to the far corners of the earth without losing its internal cohesion" (Chapman and Walker 1991: 11-12). The principal effects of improved telecommunications are both to disperse some operations to take advantage of other location factors, such as low-wage labor, and to concentrate other activities in a small number of urban agglomerations.

Back-office jobs (computer operations, accounting, payroll, billing, credit card services, and centralized word processing) have shifted from nearby suburbs, to small towns in rural areas, to offshore sites in the Caribbean, Asia, and elsewhere (Glasmeier and Howland 1995; Grimes 1993; Hepworth 1990). U.S. companies routinely do credit-card processing and other back-office paperwork via satellite in locations such as Barbados, China, India, Ireland, Jamaica, Korea, and the Philippines (Heenan 1991). The availability of state-of-the-art telecommunication service, a requirement for company back-office operations, can be found in many potential locations, not just in industrial countries (Hack 1992a).

In contrast to manufacturing facilities, office functions, such as business services and research and development (R&D) facilities, rely to a large degree on face-to-face contact for nonroutine information exchange (Czamanski 1981; Goddard 1978; Hessels 1992: 164; Malecki 1991). R&D facilities need to locate near company headquarters because of the need for managers to meet with scientific and technical personnel on a face-to-face basis, allowing close integration with marketing and product planning (Lund 1986: 10). Salomon (1988: 313) concludes that "the total communications costs and benefits (by both physical travel and telecommunications) are more likely to determine location than merely the availability of new technologies." Because businesses always have a certain amount of communications which requires physical travel, "it follows that remote location is a disadvantage, even if advanced telecommunications are available" (Salomon 1988: 322).

Consultants include state-of-the-art global telecommunications as an "imperative" in headquarters location, followed by a trained workforce, incentives, proximity to international airports, and labor costs and stability (Ady 1994). The critical nature of air transportation has emerged in other studies (Mahmassani and Toft 1985; Malecki 1987), but the issue is more complex for rural communities (Reeder and Wanek 1995). A recent European study by the Netherlands Economic Institute (1993: 11) suggests that

Quality of telecommunications is important to a significant minority of office, service sector and distribution projects. For these projects, companies sometimes require a minimum standard of services to be available and locations where the quality of telecommunications is below that initial level may not even be considered.

The NEI study clearly illustrates the difference between location factors for manufacturing plants and those for offices and knowledge functions. Quality of telecommunications was 18th among 23 factors for manufacturing but, for office location, quality of telecommunications is tied for 3rd among a set of 13 factors. For services, telecommunications stood out as first among a set of 17 location factors (Netherlands Economic Institute 1993: 73-92).

The same holds true in the USA, where "virtually everything that we do in today's modern business environment involves the transfer of enormous quantities of information over telephone lines" (Zall 1993: 32). Firms' requirements for telecommunications fall into two categories: first, basic technology requirements, including digital switching, fiber-optic loop facilities, route diversity and disaster-recovery capabilities, ISDN, and multiple-carrier capability (for using public as well as private networks), and, second, a set of service and support requirements, such as outsourcing communications operations, rapid response for maintenance and service, multivendor coordination, and long-term relationships (Harbaugh and McMahan 1992: 28-30). Needless to say, these characteristics will vary greatly, with the highest levels generally available in large (metropolitan) markets. Experts suggest that in the US, "the quality of telecommunication facilities and their costs vary enormously [according to geographic area]. There can be price differentials as high as five-to-one" (Zall 1993: 32; Hack 1992a: 138). Digital switching technology is a prerequisite for almost all telecommunications-based businesses and is the basic technological requirement for computer modems and fax machines. Wide variation exists across the U.S. in the availability of digital switching equipment, and analog equipment is not projected to be completely replaced until 2016 (Parker et al. 1989: 76-81). A related issue is line quality, which can prevent transmission of electronic data. We know too little about these cost and quality differences.

Despite the appearance of equal global accessibility and fully footloose firms, an "equal opportunity space" does not exist, mainly because of long-standing inequalities in telephone networks, which remain the "backbone" of newer systems (Salomon 1988). He stresses the need to look not only at networks and links, but also at level-of-service, which generally is a function of bandwidth but which comprises the ease, convenience, quality and rates of telecommunications services (see also Langdale 1991). Newer technologies have essentially enhanced the capability of utilizing greater bandwidths to provide higher quantity and quality of service, but these technologies diffuse first to where there is greatest demand, again to largest cities first because business customers are the largest users. However, large firms, wherever they are found, demand and use high levels of telecommunications technology. This is behind some of the pioneering efforts in the Great Plains (Richards 1994).

6. The Location of Knowledge-Based Economic Activities

Are cities necessarily the best or only locations for business in a world of telematics? The almost universal availability of telecommunications capability is "creating a footloose economy that permits firms to locate where they want to be, not where the traditional centers of finance and commerce dictate they have to be" (Heenan 1991: 9; Hack 1993). Saunders, Warford, and Wellenius (1994: 121-134) similarly conclude that investment to provide telecommunications connectivity reduces the relative concentration of economic activity in large cities. The situation two decades ago was "unclear," with some information activities potentially quite footloose and others firmly rooted in central metropolitan locations (Abler 1974: 334). Britton and Gertler (1986), a decade later, were more certain of the situation. They conclude that the best location continues to be large urban centers. . . Regardless of their size, technology-intensive firms are dependent on both private- and public-sector contacts, and there is, therefore, an imperative for such producers to cluster in locations that afford them the best opportunities for face-to-face contact with actual and potential customers (Britton and Gertler 1986: 162-163).

In short, "cities are primarily focal points of power based on communication; their power reflects their accessibility the range and quality of contacts and relationship that the city has with the rest of the world. Their communication channels, skills, and knowledge resources develop as locally based organizations extend their operations worldwide" (Knight 1989: 40).

The importance of knowledge-intensive activities is critical to understanding the potential role of telecommunications as a factor of production. The advanced services sector, including many government and non-profit organizations, is especially dependent on communication links (Table 1). However, the number of cities whose economies are based on knowledge-intensive activities, such as headquarters, advertising and accounting firms, and foreign banks, is quite small (Daniels 1993; Moss 1987).

The geography of corporate networks shows a persistent concentration of headquarters in large urban areas. It is not merely a coincidence that new technologies are put in place earliest in the largest cities, where demand by large business and government customers justifies the investment (Castells, 1989: 142-151; Moss 1987). The spread of a series of improvements in the USA by both AT&T and its competitors shows convincingly that the large-city business routes, connecting markets in New York, the Boston-Washington corridor, and then Chicago and Los Angeles, are the priority of telecommunications providers (Langdale 1983). The fiber-optic network has been evolving in the same pattern (Warf 1995). Salomon (1988: 324-325) provides an explanation:

> A key economic factor in the development of telecommunications systems is the spatial density of demand. The returns on investments are dependent on usage level more than on access rates. Therefore, suppliers prefer investments in areas where the market is big enough to generate high returns per line. This is not likely to occur in sparsely populated areas, and investments there will take place, either under regulators' requirements or under a belief by suppliers that a particular area will in the future develop to a point where demand per line will be substantial.

Corporate telecommunications and computer networks, despite a growing locational flexibility in production and labor processes, remain coordinated by a centralized headquarters (Hepworth 1990). "Network firms" are able to take advantage of telecommunications technology for purchasing, manufacturing, and marketing functions, in addition to conventional control activities, such as accounting, forecasting, and planning. Despite the development of a standardized global network, which allows firms to reduce coordination costs, both internally and with other firms, footloose firms remain geographically concentrated in large cities.

But will cities and urban concentration diminish as telematics continue to develop and find new uses in business? Most observers foresee little decline in urban concentration (J. Parker 1995). Cities that are centers for face-to-face communication also will benefit most from the spread of advanced telecommunications systems. The absence of a sophisticated telecommunications infrastructure may act as a deterrent in attracting information-based service firms. The infrastructure may be built to serve existing firms, but access to sophisticated telecommunications service can stimulate new uses and users, generating even further expansion of the telecommunications infrastructure (Moss 1987: 539).

More research on the locational factors in office location has taken place in Europe than in the USA. Ease and quality of air connections took only slight precedence over ease and quality of telecommunications in the choice of location for European regional offices; these were the two most important location factors for the firms surveyed (Dunning and Norman 1983). A later study (Dunning and Norman 1987) included both "telephone and telex quality" and "telecommunication costs" among 40 factors influencing location of an overseas office of multinational companies in six sectors. Communication quality was the most important location factor for branch offices of trade and finance firms, followed closely by proximity to clients. A recent survey by Plant Location International found that availability and quality of telephone, fax and data lines ranked highest when it came to choosing locations for various operational functions (Schaefer 1994).

The continuing centralization of office-based activities is accounted for by the argument that "the greater the extent of the geographic decentralization of production activities . . . the greater the need for the centralization of key control activities" (Coffey and Pol_se 1989: 19). Coffey and Pol_se (1989) see producer service location as a result of three factors: a pool of highly skilled labor, complementary economic activities, and the costs involved in "delivering" the "product" to the market. All of these are most available in large urban centers. It is clear that new technologies are put in place earliest in large markets, meaning large urban areas with a high density of business users. Moss (1987: 544) summarizes: "telecommunications is creating a new urban hierarchy, in which those cities that are already information-intensive are becoming even stronger as telecommunications hubs."

7. The Telecommunications-Travel Tradeoff

Perhaps the greatest controversy of telecommunications technology is the degree to which it enables firms and people to eliminate travel and face-to-face meetings, and to interact instead electronically. Skeptics contend that even as videoconferencing catches on, "the consequence will be more business travel than ever. . . If electronic meetings could deliver the subtlety and richness of a face-to-face encounter, maybe we really could substitute screens for airplanes. . . Travel substitution is a phantom" (Saffo 1993: 112-116). Firms select from a growing menu of communications and transportation choices. For a global team, voice telephony is perfect for spontaneous two-person conversations, E-mail and fax work well for swapping text and documents, voice mail is a good antidote to time-zone differences, and videoconferencing is just the thing for weekly meetings. These technologies do not replace face-to-face gatherings, but allow team members to keep contact and coordination hot' between the inevitable trips to one another's locations (Saffo 1993: 117).

Reinforcing this view, Thorngren (1977) found that face-to-face contacts tend to create new telephone contacts, but the reverse is not true. Claims that telecommunications substitute for transportation "simply ignore the synergetic effects of improved communications on the need for face-to-face contacts that, for institutional or cultural reasons, cannot be handled on-line. The point is that better telecommunications services are likely to both encourage substitution away from transportation and induce new transportation demands" (Nicol 1985: 105). Recent research on 55 multinational corporations found that high and growing levels of telephone, fax, and e-mail communication did not decrease the need for travel and face-to-face meetings, which are seen as the only way to develop and maintain trust (Wooldridge 1995).

Electronic communication, such as in team design work integrating international R&D, is likely to be effective only if a level of confidence has been built previously through personal face-to-face contact (De Meyer 1993). Moreover, even with the best electronic communication systems, confidence between team members of a project team spread out over the globe seems to decay, even if they have real time contacts through electronic mail . . . computer conferences, videoconferencing systems and the telephone. Confidence between engineers has perhaps, like nuclear radiation, a half-life time. Thus regular face-to-face contact seems still necessary, to boost that confidence to a level high enough to have effective team work (De Meyer 1993: 116).

The purpose of external contacts conducted face-to-face include giving and receiving advice, exchanging information, negotiations, and general discussion. By contrast, routine giving and receiving of orders and of information is more likely to be conducted by telephone. Thus, the relocation away from cities is most likely for routine office work (back offices), whose workers have few external contacts. Face-to-face interaction is essential for knowledge activities, in order to build and reinforce trust. Personal contacts are the medium in which communication takes place between organizations (H'kansson 1987). Personal contact also is needed for the transfer of "sticky information" in activities such as new-product development, which often requires several trips for the exchange of context-specific information (von Hippel 1994). For communication of more routine information, such as various clothing designs, electronic means are adequate and provide significant savings over travel (Keen and Cummins 1994).

Rather than to attempt simply to substitute one for another, firms effectively utilize different means of communication for different purposes (Thorngren 1970). Business and contacts by telephone are important means of communication to establish confidence and make it possible to solve problems in a short time. Electronic mail and fax are needed when the receiver is hard to reach, as when there are time differences. Electronic data interchange (EDI) makes it easier to perform routine orders, and mail and delivery services are still needed for larger deliveries (Lorentzon 1993). The issue of substitution is rendered meaningless by the vast number of transactions directly between communicating computers. Without telecommunications, "such interactions clearly could not exist. They neither substitute for nor complement existing forms of communication but are an entirely new form of communication with profound implications for geographical relationships" (Gillespie and Williams 1988: 1318). The demand for this variety of forms of communications and the related variety of telecommunications technologies also works against remote areas that are not able to acquire each new technology as it comes into existence.

8. Telecommunications and Rural Regions

The research reviewed thus far suggests that there are both positive and negative effects of telecommunications technology for rural areas. However, it still is an issue that often fails to be raised in rural development circles (Sears and Reid 1995). The positive view is that greater access is provided by mobile technologies to rural areas, thereby reducing the relative concentration of communication capability in large cities. The negative view focuses on the "rural penalty" of continuing concentration of the newest and most advanced technology in large cities, combined with the presence of large corporations whose demand for telecommunications technology ensures that they will not be deprived in the near future. This section briefly examines these two positions.

The "rural penalty" stems from three factors: (1) lower population densities, (2) the distance of rural communities from urban centers, and (3) economic specialization in sectors other than information- or knowledge-intensive ones (Parker et al. 1989: 24-27). Many dismiss the distance factor, citing the fact that telecommunications has effectively eliminated distance and remoteness (Cairncross 1995; O'Brien 1992; Parker et al. 1989: 34-35). Indeed, the least dense and most remote areas may benefit most from telecommunications (Parker et al. 1989: 35). But Internet access does not favor the remote user: urban users can obtain network services and Internet access with a local phone call, whereas rural users typically must pay a long-distance charge for the same access (James 1996; E. Parker 1995).

The third penalty factor is more difficult to dismiss. In general, rural areas have disproportionately low shares of producer services compared to their population (Glasmeier and Howland 1995; Grimes and Lyons 1994). A significant exception to this is emerging in many countries: high-amenity locations, where a significant number of producer service firms have been founded by amenity-seeking entrepreneurs. However, even this exception illustrates the critical nature of face-to-face contact along with the growing use of telecommunications. Face-to-face is the most frequent mode of service delivery, followed by telephone and mail/courier, and fax; computer file transfer was cited by only 14% of the firms studied (Beyers 1994).

It is clear that all rural areas are not alike. The three key characteristics of rural areas that put them at a disadvantage in economic development are: small scale and low density, economic specialization in low-wage, low-skill jobs, and remoteness (Deavers 1991, 1992). Nonmetropolitan counties tend to be dependent on one of five economic activities: farming, mining, manufacturing, government, services; a minority are nonspecialized (Cook and Mizer 1994; ERS 1995). Remoteness affects the competitiveness of rural firms, which are distant from information and technical resources (Rosenfeld 1992). In addition to remoteness, topology and terrain constrain telecommunications deployment, adding significantly to costs (Egan 1996).

There are reasons for continued caution about the prospects of small communities. In general, entrepreneurs who are technologically sophisticated are relatively rare in most rural areas. Rural areas also differ significantly in the degree to which small businesses are integrated into global communication networks (Gillespie, Coombes, and Raybould 1994; Sawhney 1993). How small firms do business determines the type of communications interfaces they use in their day-to-day operations. Sawhney (1993) suggests that there are three types of small businesses: (1) those with a dispersed clientele; (2) those interfacing with large firms; and (3) those with local markets. Each of these has distinct telecommunications needs. Indeed, to those firms which had international as opposed to national, regional, or local markets, telecommunications facilities were considered most important (Hessels 1992: 207).

Rural businesses also frequently are less skilled in management and technological issues concerning telecommunications (Parker et al. 1989: 138-139). Small firms, the economic foundation of rural nonfarm economies, are not able to command the infrastructure improvements that have been provided to large firms. Even where farmers are significant users of telecommunications, they represent little aggregate demand, which often is not matched in small-town communities, especially as the best-educated migrate to cities (Allen and Dillman 1994; Deavers 1991). Upgrading skills in rural areas, particularly in innovative ways to use telecommunications, is a key recommendation of experts (Freshwater 1996: 12). However, the issue of skills and technical expertise is growing as technological advances mushroom the array of choices available. Perhaps most important is the observation made by the OTA (1991: 13):

In an information-based economy, communication needs are relative. In evaluating a rural community's technological requirements, one must not only consider a community's own economic activities, but also and increasingly the activities of its competitors, whether they be businesses in urban areas or in other countries.

This is difficult to do, especially for businesses, such as rural manufacturers, that already lack information about competitors, suppliers, and technology (Rosenfeld 1992). In addition to "high supply costs relative to slow payback time, compared to richer and more populated" areas, rural and peripheral areas tend "lack awareness and understanding of advanced telematics services, products, and applications, and experience a slower introduction of them" (Millard 1995: 4).

The cost of achieving broadband capability in rural areas a necessity for multimedia applications such as the Internet is "a very costly proposition" (Egan 1996: 5), yet it is essential for many business opportunities related to the Internet. Coaxial cable is available in some areas, but satellite and microwave radio technology have limited bandwidth and delay times.

Deploying broadband facilities in rural areas would more than double the cost per line (from $54 per month to $129-142 per month, depending on a 10-year or 20-year deployment schedule, including loop and non-loop costs). The shortfall of revenues to costs for current voice service are already $19 per month. There is potential for generating additional revenues from broadband services, but there is little research basis for estimates beyond cable TV (Weinhaus et al. 1994: 12).

This demand-based contrast between urban and rural areas has enormous implications for public policy. Many rural schools would be unable to access the Internet and other computer and video-based services. Even a second-best case, that of upgrades to digital service to permit Internet access, would still be slower and therefore provide less opportunity compared to schools with fiber-optic connections.

Rural incomes are generally well below urban incomes. In addition to the increased cost for telecommunications service, a customer would also have to have computer and other capabilities to make use of them. As Weinhaus et al. (1994: 15) note, there are conflicting signals in national policy. For example, "the REA's legislative mandate appears to be premised on the belief that competition (and new technologies) won't come to rural areas." Subsidies for rural service conflict with the competitive environment created by the National Communications Competition and Information Infrastructure Act of 1994.

In states and areas with flat terrain, telecommunications upgrades to fiber-optic quality has been relatively easy and inexpensive. Iowa, Nebraska and other states in the Great Plains have been widely-cited as pioneers in rural broadband service. In the Southeast and the TVA service area, mountainous terrain makes the cost of installing fiber-optic service much higher.

Telecottages, proposed as a solution for rural regions, provide useful services of training and of building awareness and confidence of telematics potential (Qvortrup 1989). Telecottages, regional center telecommuting, or "neighborhood offices" equipped with appropriate technology and technical support, are a collective solution for a dispersed population, but they also require travel and support (European Commission 1995). However, to comprise an effective infrastructure for rural firms, they "face considerable difficulties in winning and retaining telework from remote clients" largely because links to clients must be formed and maintained, the work must meet standards set elsewhere, and any place must keep pace with competition and technological change (Gillespie, Richardson, and Cornford 1995: viii). Teleworking in remote areas can take several forms, ranging from remote back-office tasks, in which the only electronic link is to the firm's mainframe computer, to fully interactive connections to any and all Internet sites. Qvortrup (1992) listed 111 ongoing telework schemes within the OECD countries, 34 of them in the USA and nearly all of them home-based for urban and suburban workers of large organizations. Urban teleworking arrangements are very diverse, and is giving way to portable work that can take place in several locations throughout the day, week, and year (Storgaard 1993). Rural telework arrangements are less common and, where tried, are less successful (European Commission 1995). However, the notion of portable work seems most applicable to "lone eagles" such as consultants and other knowledge workers taking up (at least part-time) residence in rural areas (Atchison 1993). Only these firms tended to be major users of the Internet in rural areas (Allen et al. 1996).

The contribution that telecommunications can make to rural economic development varies considerably from one area to another, depending on the presence or absence of other features of the rural economy. Regions dominated by branch plants tend to rely on intra-firm communication, whereas those with home-grown firms communicate with customers, most of which are outside the region. Thus, the latter regions have developed greater local control over their telecommunications when compared with the branch-plant regions, where links are with parent firms and with a few suppliers (Gillespie, Coombes, and Raybould 1994; Bernal, Stuller, and Sung 1991).

Although we see greater mobility and the potential for teleworking from remote locations, this demand for rural lifestyles "is rural in location and amenities, but urban in its communication patterns. Significant development of infrastructure is necessary to support high-tech or information-intensive activities and the variety of services their employees may demand. . . Remote locations, even if the most advanced telecommunications systems are available, will always be disadvantaged relative to central locations, at the very least, with regard to those activities which do require physical travel" (Salomon 1988: 325).

The conclusion, then, is that some rural areas in industrial countries are able to serve as locations for consultants and other high-mobility professionals. These "lone eagles" demand locations high in amenities and with relatively good access to air connections (Atchison 1993). Other locations, where low-wage labor is coupled with a high level of literacy and numeracy, will attract back-office operations. Generally, however, services are not expected to decentralize in as widespread a manner as manufacturing did. Satellite technology allows many firms to be even more footloose and to seek out lower-wage sites with appropriate skill levels, wherever in the world they may be located. Rural areas are advised not to rely on a service-sector base for their economies (Glasmeier and Howland 1994: 219; Howland 1993).

In rural as well as urban areas, telematics users tend to have higher incomes and higher levels of education than nonusers (Leistritz et al. 1996). Even in places which have attracted knowledge workers, it is not clear that mobile technologies (portable computers with fax modems and Internet capability, linked by satellite to global networks) will be affordable by many people other than those who are part of, or linked closely with, large organizations. The non-nodality of mobile technologies reduces the significance of physical infrastructure (Eskelinen 1993). However, to paraphrase the biblical advice, "man cannot live by telematics alone." It was emphasized earlier that tele- communications has increased rather than decreased travel. This suggests that, although a larger number of activities can be profitably conducted in remote locations, the remoteness of many rural areas will continue to be a problem.

This may be overly pessimistic. Labor-cost concerns must be balanced against other skills and traits, such as "sales ability" for telemarketing, knowledge of medical terminology for processing medical claims (Leistritz 1992). Howland (1993) calls such a market niche "contextual" work, and cites library bibliographies as a data processing task that was difficult for a firm's contract workers in the Philippines to perform accurately. A second rural niche Howland identifies is that for quick- turnaround tasks and some sensitive government work. Offshore data entry takes at least 48 hours from the Caribbean, and at least five days from Asia, whereas rural sites are able to return data in 12-24 hours (Howland 1993: 189-190). Despite these niches, Howland is not optimistic about the prospects for the rural telecommunications-based service sector. Several technological changes suggest that rural areas in the USA have perhaps ten years of competitiveness in their current market niches. These include a trend toward specialized, custom services (which rely on face-to-face contact), improvements in optical scanners (which eliminate many data entry jobs), and point-of-transaction data entry. Data entry jobs will be locate either in the major urban centers where knowledge-based businesses are based, or in offshore locations with high-skill, low-cost labor (Howland 1993).

Despite some separate fiber-optic networks, "there has been no concerted strategy for bringing fiber-optics to rural America" (Reich 1988: 6). The reasons for delayed investment in rural areas include the cost of greater "loop length" in rural areas, the need for fiber-optic facilities as opposed to ISDN on existing copper wires and the existence of several subnetworks (those of small telephone companies, public networks, as well as private networks) that remain not fully interconnected (Egan 1992).

In order to overcome the shortcomings of rural areas, demand aggregation strategies have allowed 125 small-town telephone companies in Iowa to combine into a single point of presence for long-distance facilities. Other strategies include small firms "piggybacking" onto larger firms' nodes (Sawhney 1992: 169). Such Rural Area Networks (RANs) are among several schemes for sharing or pooling demand in rural regions (Office of Technology Assessment 1991). Weinhaus et al. (1993) estimate the cost of telecommunications service to rural customers if the full cost of service must be paid i.e. if subsidies and cross-subsidies were ended. Based on 1991 data, rural customers paid slightly less than urban customers ($601 vs. $622), in part because lower rural population densities mean that a rural customer has access to fewer other people, and therefore to less "value" from telephone service. Under competitive conditions, ending the averaging of prices across many markets, would increase rural customer bills by 36% (REA customers) to 39% (all rural customers nationwide). This amounts to an estimated $300-316 per year, or $25-29 per month. Weinhaus et al. (1993: 18) estimate that this increase would result in 7.3% of rural households no longer being able or willing to pay the additional cost. A revised analysis based on 1992 data (Weinhaus et al. 1994) provides similar but slightly different numbers: a 35% increase in rural customer bills and an increase in average monthly bills of $19 per month.

However, rural rates already vary tremendously. Weinhaus et al. (1993) draw on NARUC (National Association of Regulatory Utility Commissioners) data, which show that telephone rates range in the Southeast from $8.50 for a residential line and $30.50 for a business line in rural Tennessee to $36.15 (residential line) and $60.00 (business line) in West Virginia. (The national range is from $6.75 and $14.70 in New Jersey to the West Virginia rates.) If rural rates were to be subsidized directly to replace urban-rural rate averaging, the total cost of providing nationwide rural service is $30.9 billion (in 1991 dollars).

9. Telecommunications Infrastructure as a Policy Priority

Telematics "are the central physical technologies of the postindustrial society" (Coates 1982: 181). In order to combat the tendency for spatial concentration, many governments have invested in telecommunications infrastructure, often in order to attract firms for data-entry and data-processing activities (Grimes 1993). At the national scale, Porter (1990: 75) includes infrastructure among the factor endowments which determine national competitive advantage. Among the elements of infrastructure are the transportation system, the communications system, mail and parcel delivery, and payments or funds transfer. However, Porter (1990: 76-77) contends that these are advanced factors, along with highly educated personnel and university research institutes, which are scarcer because their development demands large and often sustained investment in both human and
physical capital.

Policy choices are made more difficult because of the fact that telecommunications networks are a non-standard infrastructure, made up of juxtaposed sub-networks, based on different hardware, software, and standards (Bar et al. 1989: 52). The decentralized U.S. federal system has led to few national policies, and many local or state-based programs (Lewyn 1994). Such a decentralized approach fails to ensure compatibility across state borders (Wilson and Teske 1990). Plans for upgrading the country's telecommunications infrastructure are largely internal to the national and regional telecom operating companies and to the local exchange carriers (LECs), with city and state governments playing minor roles. There are many rural telephone companies in the United States, many serving only small numbers of subscribers. However, these LECs (local exchange carriers) are very diverse, as are the rural areas that they serve (Egan 1992; 1996).

Since the onset of deregulation and telecoms competition, the situation in the 1990s shows greater variation from place to place. Deregulation immediately shifts priorities in decision-making from equity and universal service to new criteria the favor economic efficiency and profitability. Thus, it is large cities, where large firms (and large telematics customers) are found, as well as concentrations of small businesses, organizations, and households. The attraction of a market size will not diminish as increasingly sophisticated technologies are developed to attract customers who can afford them. Government programs seem to be necessary to counteract the tendency for urban bias (Eskelinen 1993).

In rural regions, telecommunications-led development does not occur on its own. Nor is there a simple correlation between telecommunications and regional development (Qvortrup 1994). Using county-level data in Pennsylvania from 1965-1991, Cronin et al. (1993) found that investment in central office equipment causes income growth, generally with a two- to four-year lag. Variation in investment in cable and wire had no significant effect on income. Within two individual counties, their findings suggest that investment in both types of infrastructure enhance county employment. Given the chicken-and-egg nature of telecommunications and income-employment measures, Cronin et al. (1993) also tested whether economic activity causes investment in telecommunications. Their results were much weaker in this direction, especially for individual counties.

Dholakia and Harlam (1994) analyzed data for all 50 states, including telecommunications as only one of several independent variables influencing average annual pay and per capita income. Their variable for telecommunications (number of business access lines per non-farm employee) is perhaps not the best measure, but it explains 67% of the variance in average annual pay across states. When all variables are included, telecommunications remains the most important determinant of annual pay. When a five-year lag between resources and pay is modeled, telecommunications becomes the second-most important variable behind education in explaining interstate variations in pay. No analysis thus far has examined broadband services, but it is evident that rural regions with low population densities are considered low priority for these technologies (Qvortrup 1994).

Qvortrup (1994) suggests that these correlation analyses fail to consider the economic, social, organizational and cultural factors involved in regional development. There is not a simple linear model of development, but a complex, synergistic one demanding integrated strategies. The issue is one of jobs, as it always is in rural development, and these jobs can come from exogenous sources (branch plants and other externally-controlled operations) or endogenous sources or local firms (Freshwater 1996). Both approaches, but especially the endogenous or locally-based one, require cooperation and partnership between public and private sector actors through which learning and synergy develop (Millard and O'Shea 1995: 35-36; OTA 1991: 31-32).

10. Conclusion

This review of telecommunications has several lingering implications for those concerned with rural and regional development. The new technologies of "the messenger" and "the thinker" are powerful forces of change that have been neglected by the research of most location and development analysts. In several ways, regional considerations are downplayed in comparison to, for example, regulatory issues. There is much we do not know about how telecommunications varies from place to place and how it has affected locational choices and constraints. The effect, despite greater mobility, seems to be something other than a world of completely footloose firms.

Second, rural areas will not suddenly become ideal locations for economic activity because they acquire state-of-the-art telecommunications facilities. The hard fact remains that no rural area has been first to obtain such a system, lagging years behind the large urban areas where such new technologies inevitably locate first. A variety of technologies rather than a single solution will be needed, depending on the particular situation (OTA 1991; Wright 1995).

Third, technological and industrial changes make it increasingly difficult to assume that rural areas will be able to keep the telecommunication-based activities that they have acquired, as the same capabilities are found in much lower-wage locations overseas. The best hope for the economies and societies of rural areas is home-grown manufacturing and service firms that address the needs of the new flexible economy, producing custom and high-quality products for many customers with turnaround times that offshore competitors are unable to beat. These firms will require modern and high-quality, if not quite state-of-the-art, telecommunications systems. Links to global networks are possible essential for successful firms anywhere. Telematics permits these links, but telematics alone is not enough to assure successful development in rural regions.

Specific users with specific needs, such as tourism providers, will be able to indeed, will be forced to take advantage of telecommunications in order to remain competitive (Poon 1993). But, overall, it is unrealistic to expect universal service to continue to mean a ubiquitous and flexible network for all users. Mansell (1993: 192) posits several characteristics of the emerging telecommunications network:

- fragmented networks
- reduced ubiquity in service diffusion
- a supply-led industry, under pressure from multinational users
- weak stimuli for competition in most submarkets
- less transparent network access

Overall, deregulation and competition are likely to lead to less, rather than more, access for most rural users. A few, sophisticated users the lone eagles will be early adopters of new technologies, such as wireless connections. Others, such as large farmers, will continue to utilize satellite links for their specific needs. The ordinary rural citizen, employee, and businessperson, however, may be dependent on policy initiatives that will come about in some places and not in others. As in most areas of rural development, it is the places with strong visionary leaders and institutional thickness that will succeed. Telecommunications is much like other challenges facing rural America. It is not easy to fix, and takes the effort of many participants (Rowley and Porterfield 1993).

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Table 1
Elements in the Advanced Services Sector

Industrial Corporations	Specialized Technical and Business Service Firms	Public and Not-for-Profit Organizations
• Corporate headquarters • Research and development • Regional offices • Divisional offices • Computer centers • Training centers	• Law • Engineering • Accounting • Finance • Advertising • Public Relations • Insurance • Seminars and conventions • Communications • Airlines • Consultants • Business Information Services	• Federal/national agencies • Local/regional agencies • Universities • Music and the arts • Hospitals and clinics • Cancer centers • Professional associations • Central banks • Foundations • Museums • Consulates

Source: Adapted from Knight (1982: 56).

TELECOMMUNICATIONS AND RURAL DEVELOPMENT: THREATS AND OPPORTUNITIES[1]

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TABLE OF CONTENTS

1. Summary

The Information Superhighway is now under construction in many rural communities in the United States. The information services carried over these new digital superhighways will transform rural economies as much as the interstate highway system and the railroads changed rural American communities in earlier times. There is one major similarity and one major difference between the information highways and the ribbons of concrete and steel that make up the physical transportation network. The US economy could not support bringing railroads and multi-lane interstate freeways to every rural community. Those rural communities with good access to the railroads and the interstate freeways became more prosperous than those communities left off the beaten paths. The similarity is that those rural communities with good access to the national and international information superhighways will have stronger local economies than those without good access. The difference is that it is economically feasible for every rural community in the United States, no matter how remote, to have good access to the information highways of the twenty-first century. Some communities will have better access or have it sooner. Which rural communities will benefit the most and the soonest will depend not on Federal or state information highway engineers (or Federal and state regulators), but on local action by local communities.

The Telecommunications Act of 1996 sets in place the ground rules and guidelines for implementation of the national information highways. They will be built by many competitive private enterprise businesses. Telecommunications will no longer be the preserve of regulated monopolies. The new Federal legislation guarantees that the same competitive forces that brought us stunningly rapid change in computer technology will also drive future changes in telecommunications. State laws and regulations protecting local monopolies are no longer valid. Subsidy mechanisms will continue to support the traditional telecommunications goal of "universal service" but in significantly revised forms. Federal Communications Commission regulations and state laws and regulations are in the process of being revised to conform to the new Federal law. These changes will affect some of the details but not the main thrust of this historic change.

The venue for action now shifts to local communities. Those rural communities wishing to take advantage of the exciting new potential for economic development or to protect themselves from being hurt by the changes should move ahead with local action plans. Competitive forces by themselves may be sufficient to create the inter-urban links and urban access lines for new high capacity digital networks. In rural communities the problem will be to bring together enough combined demand from government, business and residential users to ensure that at least one high capacity digital link is available to connect users in their community to the emerging information superhighway. There is so much economic opportunity in urban areas that the major telephone and cable companies are likely to focus their competitive attention there instead of on smaller rural markets. Local rural communities that fail to take action may be left behind. It is currently economically feasible to bring high capacity telecommunications networks to every community in the US. (This is not the same as a longer term goal of bringing high capacity networks to every rural household.) Rural communities that take advantage of the opportunities can remove the traditional barriers of distance and small scale that were barriers to local economic improvement. With sufficiently improved communications, the competitive playing field, instead of being tilted in the urban direction, can now become level. Rural communities can use their environmental and social advantages in competition with urban rivals. Nevertheless, the telecommunications changes will be a two-edged sword. The information superhighways will permit travel in both directions. Small rural markets will no longer be insulated from urban rivals. Rural communities that fail to grasp the opportunities will be more economically disadvantaged than they are today.

2. Global Transformations

No place in the United States is exempt from the changes being brought about by the current revolution in information technologies. The economy of not just the United States but of the entire world is in the midst of a structural transformation that is taking place faster than the historic changes that we now call the Industrial Revolution. Viewed from an historical perspective, the Information Revolution is transforming society faster and more deeply than the massive changes of the Industrial Age. There is nowhere to escape the pressures of change. As always, when there is change on this massive scale, the pace of change is uneven. Some places are on the cutting edge and others appear to be peaceful backwaters. Appearances are deceiving because the peacefulness is only temporary.

Better communication has made competition for good and services, and for jobs, national or international instead of local. Better computer processing of information permits businesses and other organizations to operate more efficiently, with less need for "middle management" jobs or people who perform routine clerical tasks. The "mass markets" of recent times have given way to a much wider variety of targeted specialized markets. We receive mail order catalogs and telephone solicitations based on precise demographic measurements and records of our past purchases. Highly automated factories produce short runs of specialized products that operators quickly change in response to market demands. We order computers and other products by telephone and get delivery within days, unaware that the vendor assembled the products to our specifications after we placed the order.

Businesses have transformed themselves with computer and telecommunications technologies, and laid-off many former employees in the process. Successful survivors have increased their productivity (that is, they have provided more and higher quality of output per unit of labor input (and improved responsiveness to markets to achieve a competitive advantage in the changed global economy. Governments and schools have been slower to make the organizational and technical transformations that businesses are making. Taxpayers, conditioned by their experiences with businesses, may participate in taxpayer revolts when governments fail to improve the quality and responsiveness of government services with reduced government costs.

Competition is spreading the advantages of technical and organizational transformations to formerly isolated regions. The Iron Curtain (symbolized by the Berlin Wall) crumbled in response to the unstoppable flow of information from the rest of the world to the people behind the wall. Competitive enterprises are beginning to bring to the peoples of Eastern Europe some of the goods and services their monopoly government enterprises were unable to provide. In the past decade, China has unleashed the competitive entrepreneurial spirit of its people to achieve rapid economic growth, while shrinking to less than 30 percent the portion of its national product provided by nationalized enterprises. Improved access to, manipulation of, and rapid response to information is stimulating increased competition in all parts of the globe.

No rural community in the United States can long remain a peaceful backwater in this river of global change. To remain viable as communities, all must adapt to the changed environment by using information and information technology to keep their communities competitive. Communities that fail to do so will have fates similar to small communities that were bypassed by canals, railroads and highways in earlier times.

3. Rural Development Essentials

Information technology, primarily telecommunications and computers, is part of the problem that requires rural communities to adapt, whether they want to or not, and at the same is time part of the solution available to make successful adaptation possible. Telecommunications and other information technology do not offer a magic solution for rural economic development, however. The process of rural development is more complex than that.

The essentials of rural economic development can be classified into three categories. The first is investment in human capital, which means providing education and health care for the residents of each rural community. People are the only important resource. All else depends on their thoughts and actions.

The second essential category is investment in the physical infrastructure necessary for economic development—water, power, transportation, and telecommunications. The telecommunications infrastructure is important today because of the dramatic changes in what is possible and because failure to change may leave rural communities at a serious competitive disadvantage. Nevertheless, we must not forget that telecommunications is only one element of essential infrastructure. An adequate supply of clean water, adequate waste disposal, electricity and transportation networks are also essential. It may be true that humans cannot live by bread alone. It is at least equally true that humans cannot live by information alone.

The third essential, but most difficult, category is reform of our social organizations—the ways in which we collectively relate to each other. The potential accomplishment of an individual acting alone is minuscule compared to the potential of organized groups working together. Individuals are shaped by their families, schools, peer groups, communities, employers, governments, and the businesses and social organizations they contact. Social pressures are strong, particularly in small rural communities. The changes necessary for rural economic development require local leadership. Change involves risk, which makes change difficult in some risk-averse rural cultures. Much of the economic development in rural communities will depend on risk-taking entrepreneurial small businesses. Role models, incentives, social support, and a variety of services—including financial, technical, accounting, legal, consulting, training, and marketing services—may all be required. Installing computers and telecommunications equipment and networks will not magically change rural culture and bring about development. It may take strong leadership and organized social pressure to obtain the necessary infrastructure in the first place. Once obtained, silicon and fiber optics (or other technologies) by themselves do not bring about economic development. Innovative, organized uses of the technologies to enhance or provide competitive advantages to rural communities are the real stuff of development.

4. The Information Superhighway

The overused “superhighway” metaphor means different things to different people, and is often used as a catchy label for a hoped for outcome of the profound changes now taking place. Dramatic changes in telecommunications and information processing technologies may be the root cause of the changes. The consequences include a complete restructuring of telecommunications institutions, bringing competition to former telecommunications monopolies. In the process, laws and regulations are changing and Federal, state and local governments are launching new initiatives intended to shape the revolution to better serve public purposes. Many business opportunities abound in the rapid transformation. As with any change of this magnitude, there are both opportunities and threats. Rural communities and the people and small and medium sized businesses located in them have both the most to lose and the most to gain. The only certainty is change. The key question is how can rural communities take advantage of the opportunities and avoid the threats.

Telecommunications switches use the same electronic information technology that brings a dizzying rate of increased capacity and lower costs in computing. Fiber optic and radio technologies are bringing comparable technical revolutions to the transmission side of telecommunications. The technologies of telephony, broadcasting, cable television and computing are converging and becoming less costly. Our personal computers are becoming multi-media and teleconferencing machines. Formerly separate analog communications technologies are converting to digital and becoming indistinguishable digital bits of information on multi-purpose broadband digital communication channels.

Telephone companies will soon be offering video services and cable television companies will soon be offering telephone services. Wireless telephones, including established cellular telephone services and emerging “personal communications services (PCS)”, will provide competition for both. Electric power utilities, which already have extensive telecommunications capacity for their own internal communications needs or can easily install it on their rights of way, are likely to be selling telecommunications services in competition with established telecommunications providers. Local telephone carriers will bring additional competition to the already competitive long distance telephone market. Long distance competitors, including AT&T, MCI and Sprint, will bring increased local telephone competition. Since nobody has all the answers and the costs of entry to specialized markets will be small, new entrepreneurial companies will expand in a variety of specialized niche businesses.

The Communications Act of 1996[3] is the most extensive revision of telecommunications law in the United States since 1934. The legislation removed most remaining barriers to widespread telecommunications competition, including preempting state legislation and regulation that might otherwise inhibit competition. The legislation recognizes that these changes could harm rural communities and businesses and therefore contains some rural safeguards to help minimize the potential damage. It does not exempt rural locations from competition nor protect rural areas from potential benign neglect by present rural monopoly providers focused on responding to competitive threats in their more lucrative urban markets.

The new Federal legislation includes some elements of the Clinton-Gore National Information Infrastructure Initiative, including some assistance for services to rural schools, libraries and medical facilities[4]. The Federal Communications Commission has issued a notice of proposed rulemaking and established a Federal-State Joint Board to reconsider universal service policies and support mechanisms in the light of the new legislation.[5]

Some potential competitors view the information superhighway as a broadband communications network permitting customers to rent movies from the comfort of their homes, without having to go to a video store to rent a VCR. Others see it as a vehicle for selling interactive video games and other multimedia entertainment.

Some consumer advocates argue for advanced universal service, "To make available as far as possible, to all people of the United States, regardless of race, color, national origin, income, residence in rural or urban area, or disability, high capacity two-way communications networks capable of enabling users to originate and receive affordable and accessible high quality, voice, data, graphics, video and other types of telecommunications services."[6]

Meanwhile, not waiting for any legislative or regulatory changes, the Internet (a global network of interconnected computer networks) continues its explosive exponential growth. To many, the Internet with its global digital interconnections, is the Information Superhighway. For many rural communities, the issue of on-ramps to the Information Superhighway is really a question of whether residents and businesses have local access to the Internet or must pay long distance toll calls to make their Internet connections. Already many Internet users have become dissatisfied with the slowness of Internet access using standard modems over typical analog telephone lines. The next major Internet access issue is certain to be more universal availability of high speed digital access instead of (or in addition to) the current low-speed access over analog telephone lines.

Many businesses view the Information Superhighway as an electronic means to connect with their suppliers and customers with lower transaction costs than those required by current means of buying and selling goods and services. Making the Internet secure for electronic commerce is their primary goal. Rural retailers without appropriate access to the Internet will face tough new competition, just as they did from Wal-Mart or other discount super stores and from mail- and telephone-order catalog sales. On the other hand, rural businesses with appropriate products and with Internet access may find major opportunities to reach beyond their local market to other rural areas, and to urban and international locations, either directly or through distributors.

Whatever form the Information Superhighway ultimately takes, it will be unlike the construction of railroads and interstate highways in one important respect. Because of the enormous costs of major transportation infrastructure, railroads and interstate highways could not be available everywhere. They primarily connected urban centers and only incidentally brought economic advantage to the rural areas they passed through. Rural communities left off the major transportation networks were disadvantaged. The Information Superhighway is different. The costs of construction, although huge, are not so prohibitive that some rural communities must be left out. Instead of battling to have transportation routes pass through their community at the expense of other communities, every rural community can fight successfully for local access to the Information Superhighway. Just as with major railroad and interstate highway construction, those communities not connected to the emerging Information Superhighway will have a serious economic disadvantage. The good news is that with determined local action, every rural community wanting access should be able to be connected.

5. Telecommunications for Rural Development

Many researchers have studied the effects of telecommunications investment. They have consistently found that investment in telecommunications infrastructure and the resulting improvement in telecommunications services have consistently led to economic growth. Improved telecommunications has helped both urban and rural communities. Recent books have reported or summarized many of the studies on the subject of telecommunications and rural development.[7,8]

Cronin and others, in a landmark study published in 1991, conducted a detailed economic analysis of the US economy from 1958 to 1988.[9] They found a "cyclical, positive feedback process" in which telecommunications investment in any year led to growth in the US economy in later years, which in turn led to more demand for and investment in telecommunications infrastructure. A related study found that the mechanism by which this telecommunications-induced economic growth took place was productivity gains in other sectors of the economy that were able to operate more efficiently with improved telecommunications.[10] The research team extended the analyses they had done on US national economic statistics by replicating the study in a single state, Pennsylvania, and in rural counties within Pennsylvania.[11] They found that the significant causal relationship between telecommunications investment and economic growth evident in national statistics was also seen in rural counties.

These statistically rigorous new studies are consistent with all of the prior studies on the subject of telecommunications and rural development. Earlier studies had found that both business and residential services contribute to economic growth and that the most rural and remote locations benefited even more than more densely populated areas.[12] Studies have consistently found that economic benefits of telecommunications investment stem from the increased productivity of businesses using telecommunications and the improved education, health and social services the telecommunications made possible. In all cases, telecommunications is a catalyst for or a complement of other development activities. Laying fiber optics across a desert will not make it green, but may well improve the economy of any oasis it reaches.

A disturbing finding in the various studies is that there was consistently less investment than would have been ideal for economic development. This is understandable, because other parts of the economy, not the telecommunications companies making the investment, gained most of the economic benefits of the investment. This result is consistent with standard economic theory which shows that the optimal investment for a profit seeking monopoly is substantially less than the optimal investment for the society as a whole. One of the justifications for the shift in telecommunications policy to encourage competition is to stimulate more investment in telecommunications infrastructure and services.

Several different types of telecommunications applications can help improve the economy and quality of life in rural communities. Networks that electronically link the parts of an organization together, including computer local area networks (LANs) and wide area networks (WANs), improve productivity in the businesses and other organizations so connected. External electronic networks connecting businesses to their suppliers and customers permit cost reductions and service quality improvements. The computer and telecommunications networks of the Wal-Mart chain provided a significant part of the cost advantages permitting them to offer lower prices than independent rural retailers. Independent retailers without electronic connections with their distributors are competitively disadvantaged. For rural manufacturers to be competitive in this age of "just in time" inventory systems, they must have network connections for electronic data interchange (EDI) with their customers. Flexible manufacturing networks in rural areas permit a number of smaller businesses to team together so they can collectively respond to larger orders and bigger projects than any of them could handle alone. Many telephone- and mail-order businesses have located in rural communities because of the quality of life and cost advantages, provided that the most advanced telecommunications network services were available to meet their needs. A variety of telemarketing businesses prefer rural locations when the telecommunications network infrastructure permits. Many business consultants, software developers and other people with information-intensive small businesses would prefer to live and work in rural communities if the data networking capabilities permitted.

Distance learning networks may be an ideal way for rural schools to pool their resources and to draw on outside talents not available locally, in order to provide their students with the best education available anywhere. It is hard to offer advanced placement courses or a wide variety of math, science and foreign language courses in small rural schools. With appropriate distance learning networks, these options are all possible. Distance learning networks may also permit lifelong continuing education for rural residents who cannot afford the relocation or the long drive time required to attend courses in distant locations.

Telemedicine networks can improve the quality of rural health care by permitting medical specialists in distant urban medical centers to consult with rural patients and primary health care providers. Improved remote diagnostic and monitoring capabilities may improve home health care services for rural residents. Improved computer networking may help local governments improve the quality and reduce the costs of their services while making government information more accessible to their citizens. Library networks allow rural libraries to share resources more effectively.

The explosive growth of the Internet and its World Wide Web has made a wealth of information from around the globe available to businesses and consumers everywhere. Rural residents who can access the Internet with a local phone call are privileged. Most pay long distance toll calls to get access, or do not have access at all. The "Net" is an important business opportunity for rural businesses seeking to expand their markets, but that avenue of growth is blocked for them if no local Internet provider can offer a network server on which local businesses could put up their "home pages" or give consulting help to show them how to do it. Currently, the best guide for rural access to the Internet is *The Farmer's Guide to the Internet*. [13]

Personal computers have already become exciting multi-media devices for a wide variety of business and consumer applications. Current generation personal computers, when equipped with add-on hardware and software currently priced between one and two thousand dollars, can serve as desktop videoconferencing terminals. The videoconferencing hardware and software permit voice and video communication between distant humans as well as collaborative uses of computer applications on their computers. This capability, like other telecommunications advances, is likely to be even more valuable in rural communities than in urban communities because of greater savings in travel costs. Unfortunately, the telecommunications networks necessary for this application, while becoming common in urban areas, are still rare in rural communities. (Most desktop videoconferencing applications require an Integrated Services Digital Network (ISDN) connection from the telephone company.)

These and other specific telecommunications-intensive applications will be the way rural communities use improved telecommunications to improve their economies and their quality of life. The relationship between telecommunications investment and rural development is not some distant, abstract concept. It is the practical business of installing in rural communities the networking capabilities that will make a difference to the lives and work of rural residents.

6. Rural Telecommunications Needs

Most rural communities already have significant telecommunications assets to exploit for rural development. Telephones generally work well for voice communications. Line quality is usually satisfactory for facsimile transmission an essential for business communication. Computer data modems work over the telephone lines, at least for relatively low speed data transmission, even if the new 28,800 bit per second modems now shipping with personal computers do not run at full speed on some rural lines. A number of the advanced telephone services available to urban residents, including call waiting, call forwarding, three-way calling, caller identification and voice mail, are also available to many rural residents.

Many rural communities could use cable television networks for distance learning. Rural communities without cable television have near-equivalent video services available through antennas that receive signals from communication satellites located in outer space. Many of the services available via telephone in urban areas are also available in rural areas, through a long distance toll call that adds a substantial rural cost penalty. Cellular telephone services may provide additional communication links for rural people, who, because of rural distances, often have more “drive time” than urban folks. The wider local calling areas of cellular providers sometimes provide some relief from the high cost of short haul long distance charges from the wireline telephone carriers.

One important step in a development plan for any rural community is to prepare an inventory of the telecommunications infrastructure and services already available. Rural communities can often better utilize for rural development what is already available.

For some rural communities the first and most urgent telecommunications need is to bring their basic local telephone service up to current minimum acceptable standards, with single-party, touch-tone service provided with digital switching, and line quality sufficient for voice, facsimile and data transmission at the 28,800 bits per second speed supported by the modems in current personal computers. For a tiny number of small settlements and remote agricultural or resource extraction businesses, mostly located in western states, getting any kind of telephone service is the first priority.

Rural communities and rural residents pay in several ways the rural penalty that results from the greater distances and lower population densities that are the defining characteristic of rural. One of prices they pay that is harmful to rural economic development is long distance telephone toll charges. For the past 50 years telephone regulators have kept long distance telephone rates artificially high (substantially above costs) in order to provide subsidies for local service. FCC studies have shown that rural residents pay a higher proportion of their income for telephone service than do urban residents. Most of that difference results from the higher long distance charges rural residents pay because needed services that would be a local call in an urban area require long distance calls in rural areas.

This artificial distortion of prices harms rural businesses because they pay above cost rates for necessary services that urban businesses have included with their basic rates. It harms rural businesses because customers are reluctant to pay the high telephone toll charges to reach them. It is a perverse subsidy that harms rural residents by having their greater use of long distances services at artificially high rates subsidize lower basic phone rates for urban residents. This is a case where public policy has created a situation in which the poor (rural people) subsidize the rich (urban people). Rural people, businesses and communities need the lower long distance rates that they could have if long distance services prices were closer to the costs of providing such services instead of kept artificially high to provide subsidies for people who may not need them. A rebalancing of the telephone rate structure to bring prices more in line with costs, combined with explicit subsidies for low income people, both rural and urban, would cost much less than the present system of keeping local rates artificially low for people who can easily afford the cost. The economic benefit to rural communities would be considerable.

Rural people need local access to the Internet and other on-line services. Urban residents can reach the Internet, or CompuServe or America Online with a local call. They use it for electronic mail, information access, electronic shopping, computer games and a wide variety of business and entertainment purposes. Many rural people also use these services, but pay long distance toll calls to reach them. The most urgent rural data networking need at the moment is local access to the Internet. In some rural communities, independent local telephone carriers are providing local Internet access through modems located in their local telephone central offices. The long distance data communications link back to the Internet is shared by many users instead of being paid for separately by each. Other communities are working to recruit Internet providers to provide services in their communities or are developing their own home-grown Internet access businesses. In still other communities local schools or public libraries may be the place to turn when a commercial Internet provider is not available locally. The Salem, Oregon, public library, admittedly an urban library, could be a model for rural libraries to follow. They have begun offering Internet access to everyone with a Salem public library card who wishes it. Service is available free on public terminals in the library. For a fee of $60 per year they provide software, training and dial-in Internet access for library patrons wishing to access the net from their own computers at home.

Merely providing local Internet access for consumers to be entertained by surfing the net will not be sufficient for rural economic development. Providing ways for rural consumers to have better electronic access to vendors outside their local community many improve their quality of life, but will not necessarily improve the local economy. The real economic advantage for rural businesses will be for them to be able to provide information about their goods and services to the rest of the world through the Internet. For this they need a knowledgeable local Internet provider that can provide the database server and the technical support needed to help novice users put their information onto the net. Rural examples include NewportNet in Oregon, PalouseNet in Washington and CivicNet (a project that makes a small town in Ohio an Internet neighbor to a small town in Hawaii).[14] In many rural communities it may not be easy to recruit experienced professionals from outside the community to provide such services. That may be a blessing, because there are more local economic development advantages when a local learns the necessary skills. In some cases it may not be necessary to look further than the local school. For an example of a world wide web page prepared by middle school students in a rural community, see the work of Lincoln City, Oregon's Taft Middle School on the world wide web.[15]

Not everyone in rural communities needs high speed, broadband data communications services. Many schools, medical facilities, government offices and businesses do need these advanced services to interconnect their local area networks into wide area networks and for a variety of other specialized applications. Urban areas have access to higher data rate digital services, such as switched 56 kilobit data circuits, frame relay (fast packet switching), higher data rate leased line services and ISDN services. In many rural areas, such services are not available at any price. Rural areas need to have such services available on demand to their local institutions and businesses. It is not yet time to include high data rate services for every household as a universal service goal because the costs would currently be prohibitive. (Technology promised for the near future, such as cable modems, may change that.) What is economically feasible now is to have broadband services accessible from every telephone exchange and optionally available for any businesses or residences that can afford them.

Telephone companies sometimes use the excuse that the local telephone switch cannot handle the higher data rate digital services. For example, many rural telephone companies use the Nortel Model DMS-10 digital telephone switch, but Nortel has not yet released the software needed for that switch to provide ISDN service. However, the local switch may not be a real barrier. For some rural communities the real bottleneck may be the lack of sufficient broadband network capacity linking their community to the rest of the national and international telephone network. When there is sufficient capacity on the trunk lines linking rural telephone exchanges with urban locations, carriers can provide services from a larger, more distant telephone switch. Rural areas need not wait until carriers upgrade every rural telephone switch. Carriers could price services as if they were provided locally, while they postpone the cost of upgrading the local switch until the level of demand rises to point where it is cheaper to provide the services locally. Expanding the network capacity that interconnects telephone switches (exchanges) to permit higher data rate long distance services, including meeting the rising tide of demand for Internet access, is a particularly important rural economic development need.

In urban locations, telephone companies routinely offer a wide variety of optional services, including voicemail and caller identification. Voicemail is important to small businesses because, unlike answering machines, voicemail can record messages from incoming callers when the phone line is busy. Caller identification is an important business productivity tool for many computerized businesses. The caller ID feature permits the business to have the computer records of the calling customer or vendor retrieved from the computer database and available on the computer screen of the person answering the phone almost as fast as they can pick up the phone. This improves quality of service and saves costs. Rural businesses could take advantage of these and other advanced optional services if they were available locally. Many telephone companies are reluctant to make the investment needed to provide advanced optional services on their rural telephone switches. Like broadband data services, however, carriers could provide most such optional services from a distant telephone switch, provided only that there is sufficient interexchange trunk capacity. Rural communities wanting advanced services might have more success if they can persuade their telephone carrier, or the state regulatory authority, to establish pricing based on what services would cost if installed locally, independently of what switch provides them.

7. Federal and State Telecommunications Policy Issues

Federal and State telecommunications policy makers have been struggling with rural telecommunications policy issues for years. Universal service has been a policy goal since the Communications Act of 1934 established the Federal Communications Commission, "to make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide, and world-wide wire and radio communications service with adequate facilities at reasonable charge ..." [16] This 1934 language has remained, even through Congress has amended the act many times over the years.

The current version of that universal service policy issue is how to protect and expand rural services at a time when the telecommunications industry is in transition from monopoly to competition. The traditional methods of subsidizing rural service are at risk in the transition, and the likelihood of competitive providers offering service in small rural communities is slim. Rural residents may be doubly harmed. First, current monopoly providers may ignore rural markets while they focus their competitive attention and their investments on the urban locations where they face competition. Secondly, new providers may fail to enter rural markets.

The Organization for the Protection and Advancement of Small Telephone Companies (OPASTCO), along with its partners in the Rural Telecommunications Coalition, the National Telephone Cooperative Association (NTCA) and the National Rural Telecom Association (NRTA), has been an effective lobbyist for the interests of rural telephone carriers and their subscribers in the legislative and regulatory policy debates. To provide a factual background for the debates, OPASTCO in 1994 issued a detailed report on the current methods of providing subsidies for rural telephony, quantifying state by state how much the removal of each of the current subsidies would increase rural telephone rates.[17]

The Telecommunications Act of 1996 has language providing some rural safeguards and encouraging universal service in rural locations. The bill mandates competition in both urban and rural areas and preempts any state laws or regulations that protect monopoly services. The Federal Communications Commission is currently working with state regulatory authorities in a "Joint Board" proceeding to revise their universal service regulations to comply with the new law.

The Office of Technology Assessment (OTA) of the US Congress anticipated many of the current policy issues in 1991 in a major report, “Rural America at the Crossroads: Networking for the Future.”[18] That report reviewed the potential for telecommunications technology and telecommunications policy to aid the development of communities throughout rural America. The report identified telecommunications as a major opportunity for rural economic development, and identified the relatively small size of rural markets as the main barrier to getting the necessary telecommunications infrastructure in place. The requirements in rural locations were the same as those in urban locations network capability suitable for a variety of voice and data (and, in some cases, video) applications.

The OTA report recommended development of Rural Area Networks (RANs) that combined public sector and private sector networking in rural areas to ensure that at least one advanced network was available in rural locations. In urban locations a variety of private networks for large businesses and governments emerged, and a variety of competitive providers offered networking services to large and small businesses and to the general public. The problem in many rural communities was that if government or large businesses in the community established a private network, then there was insufficient remaining demand for a commercial provider to offer advanced network services to small businesses and residential users. Rural areas could avoid this blockage of their basic public access infrastructure needs if they pool together their public sector, large business, small business and public access requirements in a shared Rural Area Network that permitted access by all.

Many rural areas have data network connections for local access to government applications, including, in some states, state lottery networks. At the same time, many schools, small businesses and consumers do not have access to the Internet or on-line information providers without paying prohibitively expensive long distance toll calls. Oregon is one state that is working to solve this problem by encouraging the combination of public and private services on shared networks. The state government is replacing the dedicated leased-line networks connecting lottery terminals and government offices throughout the state with the procurement of data networking services from providers to encourage them to offer comparable services to others in rural communities using the same facilities. (The state procurement is for so-called frame relay or fast packet data networking services.) The Rural Area Network recommendation of the OTA study is still excellent advice for other states and rural regions that, unlike Oregon, have not yet followed the OTA advice.

A recent book sponsored by the Aspen Institute summarizes state and local policy issues related to telecommunications and rural development.[19] Much of the following discussion parallels or expands upon the discussion in that book.

For those concerned with rural development in the United States there are three key telecommunications issues. The first is how to protect rural users during the transition from monopoly to competition. The second is how stimulate investment in the rural “information highways” needed for economic development. The third is how to make the needed applications, services and training available, affordable and usable in rural communities.

Rural economies are different from urban economies. The lower population density and greater distances that are the defining characteristics of rural lead to higher costs and fewer economies of scale in most businesses. Of course, some costs may be lower, particularly for land and building rental and some labor costs. The lack of congestion and rural quality of life are often positive attractions for businesses to relocate to rural areas, provided other costs are competitive with urban rivals. Telecommunications offers the promise and potential to help rural businesses overcome problems of distance and lack of economies of scale. Through advanced telecommunications technology and services, many rural businesses, especially information-intensive businesses, can bridge wide distances to serve an enlarged customer base, including urban customers.

This is why many catalog sales and other “telemarketing” businesses have grown in rural areas in the past decade and why many software developers and lone eagle entrepreneurs have moved to rural communities. (Lone eagle is the term given to independent consultants or entrepreneurs with small businesses that can readily move to desirable rural locations.) As the US economy continues the global trend to businesses more dependent on computers and telecommunications, these rural opportunities will increase.

An “information superhighway,” unlike the interstate highway system, could benefit all communities, not just those in corridors of highest population density. The challenge will be to get past all the “information superhighway” hype and on to implementation of policies and practices that together provide the incentives for the necessary investments and service development.

8. Competition and Regulation

Some forms of telecommunications competition are already evident in rural communities. A telephone instrument owned by the telephone carrier and paid for as part of the monthly phone bill is no longer the only means to connect to the telephone network. A wide variety of telephones, some "smart" and some traditional, are available for subscribers to buy or lease from a variety of different sources. Subscribers connect computers, fax machines, answering machines and other "customer premises equipment" from a variety of competitive sources to the former monopoly network.

Competitive long distance carriers compete for the interstate and some intrastate business of both urban and rural telephone users. Local telephone companies that had been barred from providing long distance services will now, under the terms of the 1996 legislation, be permitted to enter the competitive long distance business once they have met a "competitive checklist" to ensure that their local phone service markets are open to competition. Cellular and other wireless carriers compete with the traditional wireline carriers for rural as well as urban business. Some rural subscribers have found that even through the monthly base rates for cellular service are higher than for wireline telephones, the wider "local" calling areas for cellular service result in lower monthly bills.

The long run benefits of telecommunications competition in rural areas are likely to come from alternate technologies that provide services at lower costs than traditional wireline telephone and cable technologies. Wireless technologies are particularly promising for rural areas. Since Federal law and FCC regulations have largely preempted state authority over wireless services, states cannot stop the rising tide of wireless competition. Virtually the only state regulatory role will be oversight of the rates charged by wireline telephone carriers for intrastate interconnection with radio (wireless) carriers.

The alliance of Sprint and three major cable companies, TCI, Cox and Comcast, announced in October 1994, is a harbinger of the coming competition. The alliance was successful in winning bids for PCS frequencies in the FCC radio spectrum auctions completed in 1995. Their longer term goal is to combine Sprint long distance service, cable television channels for local phone service, and wireless PCS customer access, completely bypassing the existing networks for many connections, while interconnecting with it to reach phone numbers not on their own national network. Their long range plan is to build a seamless national network with telephones that will work as cordless home telephones connected to the telephone network via cable when in range of the home base station and that will also work as a cellular phone (with the same phone number) when outside of the range of the home base station. The cable members of the new alliance together own a controlling interest in the Teleport Communications Group, which operates alternative voice and data networks in major US cities.

The merger of McCaw Cellular (Cellular One) into AT&T creates another formidable national competitor. AT&T won PCS licenses that will permit it to fill in holes in its current cellular coverage and therefore be able to provide close to national coverage for both local and long distance services. Since passage of the Telecommunications Act of 1996, AT&T also has filed applications for authority to provide local telephone service in all 50 states, either with its own facilities or by resale of the services of other carriers. Analysts anticipate that MCI will build a wireless national network through joint venture arrangements with other winning bidders in the PCS auctions, which permitted up to six competitors in each market.

The 1994 start of direct broadcast satellite services to rural locations with 18-inch diameter satellite antennas at prices comparable to urban cable prices is another indicator of things to come. Removal of regulatory restraints will also permit satellite and wireless competition for voice and data services. The major small dish satellite direct broadcast vendor, DirecTV, a business of Hughes Communications in which AT&T recently made a major investment, plans to start in late 1996 a satellite data network business, called DirectPC, with services to personal computers.

In some rural areas with local concentrations of population, cable television operators also may offer competition for voice and data services. The 1996 telecommunications legislation permits such competition. Cable television operators may compete for voice and data telephone business as telephone carriers consider whether to deliver video services that compete with cable and satellite vendors. Cable modems may permit cable companies to compete with telephone carriers for high speed Internet access.

Rural electric utilities also may be rural telecommunications competitors. With the advent of fiber optic technology, power line rights of way are more hospitable to telecommunications because electric power does not interfere with fiber optic communications as it does with standard telephone wire and cable. Furthermore, besides hospitable rights of way and existing connections to most rural homes, electric utilities have an internal telecommunications application that could justify most of the telecommunications investment. Real time monitoring, control and pricing of power usage could lower peak load utilization enough to pay for most of the communications investment with power cost savings. Once in place for justifiable power utility reasons, the incremental costs to provide voice, data or video communications services are likely to be very competitive with present telecommunications providers. The main barrier to competitive entry by electric utilities has been regulatory, not technical. The 1996 telecommunications legislation removes regulatory barriers by overturning prior Federal prohibitions and preempting state laws and regulations that would prohibit electric utility entry into telecommunications. Rural electric utilities could provide fiber optic trunk capacity along their power poles and rights of way. They could team with PCS or other wireless providers to offer local wireless access to telecommunications services in their territories.

Competition in local and other intrastate telecommunications services will continue to increase, driven by Federal policies and technological imperatives that are outside the control of state authorities. Eventually that competition will inevitably reach rural areas also. In the long run, telecommunications competition may bring benefits to rural areas. During the lengthy transition period, rural telecommunications, and consequently the economies of rural communities, are at risk. This is ironic considering the potential of advanced telecommunications infrastructure to uplift rural economies by spreading economic development benefits outside the populated corridors linked by interstate freeways.

New technologies provide both a promise and a threat for rural telephone users. Newer satellite and wireless technologies provide opportunities to reach currently unserved rural customers and to provide telephone service with lower costs than those of traditional telephone carriers. However, new competitors are more likely to address more densely populated markets first. The subsidized prices of incumbent carriers provide a formidable entry barrier for potential rural competitors. State monopoly telephone franchises traditionally provided a regulatory barrier to competitive entry, but the new Federal legislation now prohibits such franchises.

Current carriers have sunk costs in existing physical plant and have commitments to be the "carrier of last resort," that is, to provide service to every household within their franchised territory. Competitive entrants might not be able to accept that responsibility to serve the most distant or most remote users. In some rural areas there may not be sufficient market to support multiple competitors. Full competition implies that businesses may fail if they are not competitive. Failure of a rural telephone carrier could wreak havoc on the rural communities they serve.

These are somewhat more distant problems for telecommunications policy makers and local community leaders. The nearer term problem will be the impact of urban competition on rural telecommunications. Urban competition will put increasing pressure on the subsidy mechanisms used to support rural telephony. Carriers with both urban and rural properties, for understandable competitive reasons, will focus their new investments on markets where they must respond to competitive threats rather than on markets where they have a protected monopoly. The result of these two trends may be higher prices and deteriorating service for rural users, with consequent damage to fragile rural economies.

Whatever the eventual long term outcome with respect to rural competition, the short and medium term prospects are bleak for rural communities because their fragile economies are at risk during a difficult transition. Communities served by carriers that also have urban telecommunications franchises are likely to be hurt most. Many smaller rural independent telephone carriers, using the current subsidy mechanisms and a lower cost of capital available through government subsidized Rural Utilities Service loans, have been aggressively modernizing their telecommunications infrastructure. Many independent rural carriers brought digital switching and fiber optic trunk lines to their service areas before larger carriers brought such enhancements to their rural properties. Larger carriers with both rural and urban franchises are not eligible to receive all of the subsidies that smaller independents get. Furthermore, the larger carriers will be facing competition first in their urban areas. Therefore they will understandably focus their investments on urban areas where they are vulnerable to competition. This does not bode well for rural areas with a monopoly telephone franchise held by major telephone companies gearing up for urban competition.

Eventually, we may reach a point where competition provides alternate technologies and services to rural communities at costs that do not require the massive subsidies of current rural wireline telephony. Meanwhile, even if wireless costs were below wireline costs, wireless carriers may not find it profitable to compete against the subsidized wireline prices. To permit such lower cost competition to emerge, it will be necessary to modify the current system of cost-plus rural subsidies to provide incentives for rural carriers to use least cost technologies. The current subsidy mechanism is arcane. Appendix A provides a summary of the current Federal subsidy mechanisms for rural telephone service. In addition, most states have their own arrangements for providing further subsidies to rural telephone carriers. If the current Federal subsidies were removed and the resulting loss of revenues by independent rural telephone carriers was all passed on to subscribers, rural telephone rates would increase by 72 percent, from a current average of $43.20 to $74.53 per month.

The transition from monopoly to competition may eventually help rural communities, but the transition will be a difficult one. If state and Federal regulators do not manage the transition carefully, they could severely harm fragile rural economies. The potential of enhanced rural telecommunications to improve rural economies is considerable, but the risks in the transition are also very great. Regulators should change rural subsidy mechanisms slowly enough to avoid severe economic shock to rural communities. Meanwhile, the best defense for rural communities at risk is to begin active local planning for modernized local telecommunications facilities and broadband connections from their communities to the rest of the country. Rural communities that adopt a passive wait and see approach may find themselves in serious economic difficulty. Minor inadvertent side effects of well-intentioned Federal and state regulations could have disastrous unintended consequences for some rural communities.

9. Constructing Rural Information Highways

Private businesses or rural cooperatives will construct rural information highways. In many communities, the present telephone service provider will make the investment needed to provide advanced "information highway" infrastructure and services. In others, new competitors will enter the arena. In still others, local leaders may need to coordinate actions of local governments and businesses to ensure that at least one provider meets the local needs. Currently, potential builders of rural information highways are delaying the start of construction because of uncertainties about the economic returns they can obtain from such construction. Even through the new legislation is now in effect, FCC regulations to implement the new law have not been completed. Changes in state laws and regulations to comply with new Federal requirements are still pending. Changes in the subsidy mechanisms supporting rural telephone service are pending at the FCC and state regulatory commissions. Many of the needed services are new and the size of the total demand is unknown, making market demand projections risky. Uncertainty is the major enemy of investment. Market uncertainties will remain, but removal of legislative and regulatory uncertainties should spur investment, provided, of course, that the new regulations for a competitive telecommunications industry provide appropriate incentives for rural investment.

In metropolitan areas, vigorous competition, including the proliferation of dedicated private networks, is the engine for major service improvements. In rural areas, it is difficult to bring together enough demand to establish even one network of new telecommunications services. The best solution, as recommended in the 1991 OTA study, is to combine the requirements of multiple entities into a single network. Communities could combine the multiple needs of education, health, government, business and consumers and serve them through a single network. Innovative organizational arrangements and regulatory flexibility will help achieve such a rural network. Innovative rural cooperation is worth pursuing because it could help bring modern telecommunications services to rural America, thereby creating new economic development opportunities. The new Federal legislation supports such rural cooperation by removing prior legal impediments to innovative rural arrangements.

In pursuit of the largest markets, large telecommunications carriers tend to focus on the needs of large companies and urban markets. Small businesses and rural communities that are captive to a single carrier, individually do not have the clout to obtain better telecommunications infrastructure—so their needs may go unfilled. To remedy this problem, communities should bring together the demand of rural users, so that collectively they will get the attention of the carriers.

Some communities and small businesses may need outside help to bring together enough demand to get the attention of their telephone carrier. Development agencies can fill the void by working with rural communities and small businesses to help them identify needs and pool their requirements. They can then serve as advocates with the telecommunications carriers and the state regulatory commission.

In some states, rural telephone carriers themselves have aggregated demand from their rural customers. A group of small Iowa rural telephone carriers organized Iowa Network Services to share a centralized advanced digital switch linked by optical fiber to each rural telephone carrier. This approach gave rural communities equal access to competitive long distance carriers and the advanced features available through the shared central switch. A group of independent rural telephone carriers in Minnesota organized a similar shared network in their state.

In many states, the largest single user of rural telecommunications may be the state government. State and local government requirements, including distance education applications, may be the most promising nucleus for a shared rural network. The state government's telecommunications procurement process will be central to bringing together rural demand.

Most states could benefit from a state authority that focuses on telecommunications, information technology and information services—just as many large corporations have combined these functions under the leadership of a Chief Information Officer. Combining the strategic planning responsibility for these functions at a senior level in the executive branch of government can yield valuable benefits. States can deploy telecommunications and information technologies more effectively and efficiently, and make state government information and services more accessible to the state's citizens.

All citizens, rural and urban, could interact more effectively with state government if state agencies had voice mail systems, toll-free 800 numbers, electronic mail access, and audio information access services. (Audio information services provide recorded answers to frequently asked questions, with citizens selecting which to hear by pressing buttons on their touch-tone phones.) All state residents also could benefit from computer network access to non-confidential state government databases. Both voice and data systems would allow governments to provide information about services more efficiently and make them more widely accessible. State government video networks, including those designed for distance education applications, could allow citizens living in rural locations to gain teleconferencing access to government hearings.

Unfortunately, state governments have two compelling reasons to establish dedicated networks separate from the public switched network offered by the telephone companies. The first is price; a dedicated network, which may use lines leased from the telephone company, costs a lot less. The second is technical features; the capabilities needed for most government data and image networks are not universally available on the public switched telephone network.

In urban areas, the resulting bypass of the public switched network has not created serious problems for other users. There are competitive alternatives for specialized services and a large enough volume of general business to stimulate telephone carrier investment in the public network. In rural areas, however, a dedicated government network may hinder development. If the major state government applications bypass the public switched network, the remaining rural business may not be sufficient for carriers to make the investments needed to offer advanced telecommunications services.

There is an alternative, but it requires close cooperation among the state agency responsible for telecommunications procurement, telecommunications carriers, and the state regulatory commission. The challenge is to obtain the advanced features needed by state government through the public switched network at a reasonable cost—and in so doing, make similar features available to other users. For such a plan to make economic sense to government agencies trying to be frugal with taxpayer funds, telecommunications carriers would have to offer special high-volume government discount rates to match the costs of a dedicated network. Carriers also would have to add to the public switched network the kinds of features needed for government applications. Before volume discount prices could go into effect, the state regulatory commission may have to approve the special prices and, perhaps, the necessary network investments. The contracts between state government and the carriers should provide a virtual network or networks for state applications, conditioned on carriers making those services publicly available for all customers, not just the state government. In this way, small business and residential users in rural America could have access to advanced network services as well as improved access to state government.

Rural communities should not wait for Federal or state actions to aid the construction of the "information superhighway" to and within their communities. Local community leaders should work directly with their local telecommunications providers to ensure that the telecommunications needs of all segments of the local community—government, schools, businesses and consumers—are met. For rural communities served by a telephone cooperative or locally managed independent telephone company, the process may be easy. The local provider may already be in a position of community leadership and understand the importance of modernizing local rural facilities. They will have access to low cost capital and continuing operational subsidies to finance such investment. For rural communities served by one of the Bell operating companies or GTE, it may be harder to find a sympathetic ear in some distant urban headquarters, especially if lack of access to the subsidy mechanisms open to smaller independents and cooperatives make the necessary investments harder to justify. In such cases local leaders should pressure the telephone company, both directly and through intervention at the state public utility commission, to either make the necessary investments or sell the rural community portion of their business to a local cooperative or independent that will make the investments. Over the past several years, many rural telephone exchanges were sold by regional bell telephone companies or GTE to smaller independents. In most cases the result was improved facilities and services and an improved local economy. In some cases, community leaders may need to coordinate their activities with a potential buyer for the telephone exchanges in order to have a credible alternative.

In some cases, organizing and combining the demands and needs of public and private sector users in the rural community may be sufficient to demonstrate that there is indeed sufficient business to justify the necessary investment. One individual business or consumer may not have sufficient clout to persuade the local provider to invest in modernized facilities. A combination of local government, school district and multiple business and residential demands may be persuasive, just as a single large order from a very large business can be persuasive to the telecommunications provider.

In other cases it may be necessary to develop a credible alternative in order to get leverage on the local provider. If the telephone company is not responsive, start talks with the local cable operator, a local wireless communications provider or the local electric utility. Of course, the potential competitive threat will have to be credible, or the current provider may not feel a need to respond. If the current local provider is not responsive, then development of an alternative, whether through a cable television operator, a wireless communications provider or an electric utility may be the only recourse. The good news is that there are alternatives and. Determined local leadership concerned with the well-being of their rural economy no longer have to take no for an answer. A recent special report of ICMA (International City/County Management Association) provides guidance for municipal governments attempting to improve local telecommunications and provides examples of what other communities have done.[20]

10. Bringing Telecommunications Applications to Rural Users

The benefits of telecommunications investment will only come to rural users when they have access to applications that will make a difference in their quality of life or the productivity or their organizations. Making applications accessible to users requires more than installing appropriate telecommunications networks. It also requires: (1) the availability of terminal equipment to attach to the networks, including computers and application software, (2) the information content or services that will be transported to those terminals over the networks, and (3) the availability of training and technical support services to teach users the skills needed to take advantage of the applications. Rural users are already skilled in using telecommunications networks for voice and facsimile transmission applications. Two new clusters of application types are now emerging in rural areas. The first is data networking, electronic mail and Internet access. The second is distance learning, telemedicine and videoconferencing.

Rural businesses and rural residents are increasing their use of computers at a rapid rate. Small rural businesses throughout the country are finding that they need computer access to customers and suppliers. The use of electronic mail and access to the Internet is now growing faster than the explosive growth of facsimile transmission in the past ten years. Urban residents and businesses have an advantage over rural residents and businesses, because those in urban areas can connect with electronic mail services, electronic bulletin boards and on-line databases with a local call. Many rural residents pay long distance toll calls to connect via modem to these services.

In urban areas, Internet providers and on-line services such as CompuServe, Prodigy and America Online provide local access numbers. Alternately, urban subscribers may dial the local urban number for one of the value-added data network services such as SprintNet or BT Tymnet for data network connections via a local call. Many of the services and networks also offer 800 number access, which rural users can use. Such "free" services are often uneconomic for rural users because the information service providers add a surcharge to their information services to cover the higher costs of 800 number access. The resulting higher charges are usually as much as or more than telephone toll charges from rural locations to the nearest urban information service node.

One goal should be to have data network access to the Internet and to the major information services providers available as a local call from all rural areas of every US state. One way to achieve that would be to share network access services with a state government data network. Another would be for rural carriers to offer to the information network providers a shared data network access tariff or rate. For example, each information provider willing to pay for the service could get a unique local phone number within each local service area, without paying for an unneeded local access line. The number would connect to shared data network line back to the nearest urban area with a connection to the Internet or the appropriate information service provider. Information service providers would pay for their portion of the shared data network access line until such time as their volume of business from that location was sufficient to justify the costs of dedicated leased line services. Because the local phone number would be unique to each provider, even though they used a shared long distance leased line, the information service providers would be able to market services to rural areas as if they had their own dedicated network in place. Rural telephone carriers would need to learn something about the data business and have authority to offer flexible local access rates in order to make it a profitable service.

Many rural business users, like business users in urban areas, are likely to quickly outgrow the data capacity of a voice-grade telephone line with modem attached. The next level of capacity need, however, is less likely to be the capacity of a T1 circuit or similarly wide-band channel. (A T1 circuit provides capacity equivalent to 24 voice channels or 24 data channels each with 56 kilobit per second capacity.) More likely, they will need switched 56 kilobit data services or the data networking capacity of a basic rate ISDN channel (two 64 kilobit channels). Most digital switches in rural telephone service can handle 56 kilobit data service. Many rural telephone switches cannot provide ISDN services however, because the necessary software is not yet available from the switch vendors.

In cases where there is insufficient demand to justify the cost of adding a feature to the rural switch, it is still possible to provide service by offering it from another switch that does have the desired feature. If there is adequate capacity on the interexchange trunk lines, for example when interoffice fiber optic capacity has been installed, then the incremental cost of providing the service from another switch would be minimal. Nevertheless, if the carrier bills the customer for a leased dedicated toll line to another switch, the price to the customer would be prohibitive.

Rural carriers should get regulatory authority to provide free or incremental cost backhaul, when they can provide customer service in that manner more cheaply than adding costs to the local switch. This will allow the offering of rural service and the chance to develop the market to the point where, eventually, it will be cost-effective to add the desired feature to the local switch. Otherwise, rural users may be trapped forever in the chicken and egg problem of never getting service because there is not enough initial demand to add the desired data capability to the local switch. Once the service is available from a remote switch (permitting aggregation of business from a wider number of locations) then carriers can market the service and benefit from growing demand.

Rural schools, much more than urban schools, need access to broadband video distance learning networks. Rural schools may not be able to offer with local on-site staff all the technical and specialty courses their students need. Distance learning options are particularly attractive to rural schools with a shortage of science and foreign language teachers. Rural medical clinics and hospitals could particularly benefit from broadband telemedicine applications permitting medical consultations without requiring transport of rural patients to urban medical centers. Rural businesses could often benefit from access to business videoconferencing facilities. Rural businesses are likely to save more travel costs than comparable urban businesses because of the greater distances involved.

Such broadband services are beginning to appear in rural locations throughout the country, but usually as specialized dedicated applications instead of switched public access services. In rural Lincoln County, Oregon there are two videoconferencing facilities, neither of which is available for general small business and public access. One is an educational network facility (Oregon EdNet), and the other is a dedicated facility located in the mill that is the county's largest commercial employer. That facility permits local management to videoconference with their corporate management at an east coast facility. At this time, there does not appear to be enough market demand from the remaining businesses and institutions in the rural county to support a public access facility. Lodging facilities might attract more conference business if they had local videoconferencing capabilities to connect multiple sites or bring in speakers by remote conferencing hookups. The local economy would benefit if businesses could share conferencing facilities. Unfortunately, if the major customers provide private, dedicated facilities the remaining market will be too small for public access videoconferencing to be profitable. Similar situations may exist in other rural communities. Local committees could perhaps work with telecommunications providers and the potential large users to see if they can work out a sharing arrangement to create at least one public access videoconferencing facility.

The next large market in videoconferencing is likely to be desktop videoconferencing to personal computers. The retail price per computer is now down to about $2000 per computer for the necessary hardware and software. Some analysts predict that rate will drop to $500 within the next two years. Unfortunately, this application requires basic rate ISDN lines to work satisfactorily. This desktop videoconferencing application may bring substantial additional business to those rural carriers able to offer ISDN service, either directly from the local switch or via backhaul to an appropriately equipped switch.

11. Six Important Questions

In 1991 the Office of Technology Assessment prepared a report to address six questions asked by the Joint Economic Committee of Congress. This is an appropriate occasion to revisit those six questions and to provide a current answer to each.

Question 1. *Will technological advances be available in a timely manner to rural America?*

The answer is a mixed one. Independent rural telephone carriers that benefit from current subsidies and are eligible to borrow funds from the Rural Utilities Service have provided advanced telephone technology to their territories. If pending changes in the Federal and state regulatory mechanisms continue the availability of funds to those carriers, this trend will continue. Reduction or removal of the rural subsidy mechanisms could reduce the incentive to provide technological advances. Since the current subsidy mechanism permits recovery of cost plus return on investment, the carriers may not have incentives to deploy lower cost technologies. Since the licensing structures are different for wireline carriers than for wireless carriers, it may not always be legally possible for current wireline telephone carriers to integrate lower cost wireless technology into their networks.

The larger telephone carriers serving rural America are not eligible to receive subsidies for rural service and will almost certainly not provide advanced technology in a timely manner in their smaller rural communities. The current disparity between the quality of rural service provided by subsidized independent carriers and that provided by GTE and the Regional Bell Operating Companies is likely to widen even further. The larger carriers do not have economic incentives to make the necessary investments in rural areas. This disparity has led to a number of sales of rural telephone exchanges by larger carriers to smaller independents that are eligible for rural subsidies. The smaller subsidized carriers do have the economic incentive to upgrade the technology and consequently the quality of service in those territories.

In the longer run, the emergence of competition will bring technological advances to rural America. Entrepreneurial competitors will bring new technologies and the threat of competition may make incumbent providers more responsive to rural needs. Nevertheless, changes in the current subsidy mechanisms to accommodate the change from monopoly to competition may deter some deployment of advanced technology. Rural America will need regulatory protection during the transition to new regulations that hopefully will provide incentives to make timely and cost-effective rural technological advances.

Question 2. *Does information-age technology involve economies of scale and scope that will enable rural businesses and communities to adopt these technologies?*

Widespread adoption of information-age technologies in urban areas and some rural areas is driving down the costs, making them affordable for many rural telecommunications providers. Larger markets are likely to be more profitable. Network providers incur high fixed costs for purchase and installation of technology and low variable costs for adding additional users. Therefore providers may be reluctant to install new telecommunications technology in rural areas without demonstrated demand. Nevertheless, the costs of telecommunications infrastructure are so much less than transportation and other infrastructure that it should be cost-effective to provide modern telecommunications technology to all rural communities. Rural communities with advanced telecommunications become more effectively integrated into the global economy. They thus lose some of the rural disadvantage of small market size and large distances, because their businesses have access to larger markets. At the same time, their exposure to national competition increases.

Question 3. *What are the expected economic effects of information-age technologies in rural areas, particularly on employment (including job creation, training needs, and job displacement) and investment (including capital requirements and public infrastructure)?*

Technology alone will not bring about job creation, but can be an important catalyst. With adequate information technology, rural communities can establish, expand or recruit a wider range of businesses offering goods and services to larger urban markets. Rural communities can use the rural advantages of quality of life, attractive natural environments, and lower land and labor costs to improve their economies once the economic disadvantages of distance and small market size are reduced by information technology. With strong local leadership, rural communities with improved information technology have the opportunity to attract the capital for further investment and have improved access to training. Rural businesses must understand the paradox of creating more jobs by being more productive and thereby attracting larger markets. If they resist improving the information technology in their businesses in a short-sighted attempt to save jobs, they will lose even more jobs by losing market share. Information technology is a double-edged sword for rural communities. If they do not adapt to the new technologies in ways that make their businesses operate with lower costs and achieve larger market size, then they will lose to competitors elsewhere that do. Telecommunications networks that permit rural businesses to reach urban markets also permit urban businesses to better reach rural markets. The technology can reduce two of the major problems for rural business, distance and lack of scale, but they do not bring an automatic advantage. Once the playing field is more level between rural and urban, rural players must work hard to succeed in that tougher competition. Fortunately, a strong work ethic is still very much a part of the culture of rural America.

Question 4. *Which rural areas are likely to have the greatest ability to make use of these new technologies?*

Those rural areas with the local leadership needed to help guide their communities through a difficult time of transition and to encourage a rural culture of entrepreneurship and risk-taking will fare best. The current technological revolution creates opportunities; not all communities will have the vision to take advantage of the opportunities. Most rural communities have native sons and daughters who would love to return home, if only they could support themselves and their families there. Rural communities, by definition, have less congestion than urban locales, which makes them attractive to those seeking to escape urban congestion. Some communities will welcome newcomers and prosper. Others will resist and decline. The rural communities with the greatest potential are those with attractive natural environments and climates or those than can add more value to local products before exporting them. All rural communities have advantages. What will distinguish the successful ones from the less successful will be local leadership and vision.

Question 5. *What roles can the various levels of government play in fostering information-age technology?*

The Federal government is a major player setting the national framework for the current telecommunications technology transition. Congress has removed barriers to competition, while retaining some rural safeguards during a risky transition. FCC policies protect universal service, particularly in rural areas. The Rural Utilities Service in the US Department of Agriculture continues to provide financial and technical consultation support for rural telephone carriers.

State governments have a particularly large role to play in helping their states use telecommunications technology for rural development. Three different areas of state policy are all important. First is the state public utility commission's regulations. State regulatory policy has a major effect on the incentives of rural telecommunications providers. State regulators control subsidy mechanisms that determine whether carriers invest in new technology, and provide services at reasonable prices.

Second is the policy of other branches of state government for the procurement and use of telecommunications. State governments that buy dedicated leased lines for their "private" networks connecting rural locations to state governments are seriously harming rural development, because they make it unlikely that there will be sufficient other demand to put enhanced public access networks in place. State governments that use their own network requirements to leverage the development of rural data and video networks that are accessible to all rural businesses and citizens are major contributors to the economic development of their rural communities. The State of Oregon is replacing its leased lines for dedicated data networks throughout the state, including networks connecting lottery terminals, with the procurement of fast-packet, frame-relay services that have encouraged the network providers to make comparable data services available to all business and residential users, including those in rural areas. Rural Oregon communities have benefited from this policy. Other states might find it an instructive example.

Third is the effectiveness of state government agencies in using information-intensive applications to accomplish their missions and to make themselves accessible to citizens in all parts of their states. Projects from rural distance learning, to rural telemedicine, to providing rural areas with access to kiosks and on-line information services from state agencies will play key roles in improving the cost-effectiveness of state government and in providing role models for rural communities. Idaho is one rural state that did a particularly good job of planning for effective use of telecommunications.[21]

For rural communities and rural counties, local government is particularly important because rural people can use their own governments to achieve local goals. Successful rural distance learning projects depend on the leadership of local school districts. Rural governments can make their information more accessible to their constituents through local computer bulletin board or Internet access. Local schools and community colleges can provide the training needed to help local residents and businesses take advantage of new information technology. Local rural governments can be a focal point to bring to the attention of state government the issues that affect rural people, but cannot be resolved with local jurisdiction. On the central Oregon Coast, a group of 37 local government and non-profit organizations organized CoastNet in order to take advantage of fiber optic telecommunications capability being installed by one of their group, the Central Lincoln Peoples' Utility District. The rural electric utility was prevented by both Federal and state law from providing telecommunications services. (The Telecommunications Act of 1996 removed some, but not all of these regulatory barriers. State legislation amending its charter may be required before it can legally offer telecommunications services to the public.) However, it was able to make services available to other governmental entities and as a "carrier's carrier" to provide facilities to telecommunications providers licensed by the Oregon Public Utility Commission. Whether getting service from a traditional telephone carrier or a new entity, such as a rural electric utility, local governments can play the key role of helping bring together a combined volume of public and private sector business sufficient to attract at least one supplier to meet the local needs.

Question 6. *Can rural America expect to be competitive serving national and international markets for the goods and services of this new era?*

Rural America will have an equal or near-equal opportunity to compete for national and international markets. Rural America cannot reasonably expect to be competitive unless, like their urban and international competitors, they work aggressively to reduce costs, improve quality and become rapidly responsive to the changing needs and desires of their customers. Improved telecommunications alone will not make rural communities competitive in national and international markets. They will have to find and make their own competitive advantages. Telecommunications reduces the disadvantages, so that they have an opportunity to compete. Flexible manufacturing networks connecting small rural manufacturing businesses can permit them to respond collectively to larger orders that otherwise would go only to large businesses. Better communications will permit them to stay in closer touch with customers and suppliers. It will not be automatic and it will not be easy, but rural America will have the opportunity.

12. Conclusion

It is never easy to navigate safely a difficult transition from the known to the unknown, particularly when the participants are reluctant to change or to take risks. Nevertheless, once rural communities understand that preserving the past as it was is no longer a viable option, most will rise to the challenge of using new information technologies to better their lives and communities. Those communities interested in rural development will understand that there is no simple magic way to improve rural economies, and that telecommunications technology and applications can play an important role in helping revitalize rural communities. The path will be difficult, but the rewards should be worth the risks.

Appendix A

Current Rural Support Mechanisms and Related Regulatory Issues

Traditionally, the rates paid for residential telephone service have not been directly connected to the costs of providing such service. State regulators allowed telephone carriers to set prices to collect a total "revenue requirement," based on total costs plus a reasonable profit. Even though total prices related to total costs, the prices for each particular service had no necessary connection to the costs of that service. Consequently, business and long distance rates may be priced well above cost to help maintain lower residential rates.

Regulators in many states required carriers to charge the same price for long distance calls between two rural locations as they did for calls between two urban locations the same distance apart, despite the higher costs on the rural routes. The costs of long distance service fell faster than the costs of local service because of technical advances, but carriers and regulators were slow to lower long distance rates, partly to avoid having to raise local rates. "Access charges" paid to local carriers by long distance carriers to complete long distance calls pay for much of the fixed cost of telephone equipment required for both local and long distance services.

In addition to such support provided by state regulation, a variety of Federal support mechanisms help keep prices low for basic residential service to rural subscribers. The National Exchange Carriers Association (NECA) files average interstate access tariffs at the FCC under which local exchange carriers receive payments from long distance carriers for interstate long distance calls. Long distance carriers pay each local carrier the average rate, but local carriers than pay into or draw from the NECA "pool" according to their actual costs. High cost rural carriers receive extra financial support through this "pooling" mechanism. Currently, Bell Operating Companies pay into this "pool," but do not draw funds from the pool. This BOC contribution to costs of smaller telephone carriers is called "Long Term Support." Without this long term support, the average phone bill of rural US subscribers to carriers other than the Bell companies would increase by $3.72 per subscriber per month.[22]

Local exchange carriers serving fewer than 50,000 telephone lines allocate a higher proportion of their switching costs to the interstate jurisdiction for cost recovery through interstate long distance rates. Even though switching costs are largely the fixed costs of the local telephone switch, carriers allocate those costs in proportion to the minutes of use for intrastate versus interstate calls. Local carriers with fewer than 10,000 lines allocate three times the amount of switching costs to the Federal jurisdiction, through a procedure called Dial Equipment Minute (DEM) weighting. Local carriers with 10,001 to 20,000 access lines have a DEM weighting factor of 2.5 and carriers with 20,001 to 50,000 access lines have a DEM weighting factor of 2. In no case can carriers allocate more than 85 percent of the total switching costs for recovery through interstate rates. Without this Federal subsidy through the DEM weighting factor for small telephone carriers, intrastate rates for customers of such telephone carriers would increase by $3.92 per month per subscriber.

The FCC allocates 25 percent of the costs of the "local loops," the lines between the subscriber's telephone and the local telephone switch, to the interstate jurisdiction. Carriers recover those costs through the access charges paid by long distance carriers to complete interstate calls. For most local carriers, fewer than 25 percent of the calls are interstate. Some long distance carriers argue that subscribers should pay all of the costs of their lines to the local telephone switch as part of local telephone service. Others argue that the allocation of costs should be proportionate to usage. If interstate long distance calls bore only their proportional cost of local lines, the price to rural telephone subscribers would increase by an average of $9.98 per subscriber per month.

Because some rural telephone carriers have particularly low subscriber densities and consequently high costs per subscriber, the FCC created a "Universal Service Fund," sometimes called the "high cost fund." Local carriers with costs greater than 115 percent of the national average are eligible for additional support from this fund. They collect these additional funds from interstate long distance carriers through the access charges long distance carriers pay to local carriers. NECA administers the fund. Without this subsidy, rural telephone subscribers would see an average increase of $6.04 in their monthly phone bills.

Without any of these subsidies, the interstate access charges of rural telephone carriers would still be higher than the access charges of Bell Operating Companies. Currently, under the process of geographic rate averaging, long distance prices on calls to those rural locations are the same as interurban calls of similar distance. If carriers "de-averaged" rates and rural subscribers paid the correspondingly higher costs of their interstate long distance calls, rural phone bills would increase by a further $3.72 per month per subscriber. This does not include any higher costs the long distance carrier may have in its network to reach rural subscribers, merely the amounts paid by the long distance carriers to the local carriers to cover local costs.

The combined effect of de-averaging long distance rates and removing the four main Federal support mechanisms for rural telephony would be to increase the average monthly phone bill for rural subscribers (including both local and long distance charges) by 72 percent, from $43.20 to $74.53 per month. Of course these are only averages. The changes in rural phone bills, without these subsidies, would range from an increase of $4.13 per month for subscribers to one rural telephone carrier in Wisconsin to an increase of $395.93 per month for subscribers to another rural telephone carrier in Texas.

As the level of telecommunications competition continues to increase the FCC will come under increasing political pressures to reduce subsidies so that rates move closer to costs. As a result, carriers and state regulators will be under increasing pressure to find ways to compensate for cost allocation shifts from the Federal to the state jurisdiction and reduced Federal subsidies. These Federal pressures resulting from increased interstate telecommunications competition, will be in addition to the pressures to move intrastate rates closer to costs as intrastate telecommunications competition increases.

These traditional methods of supporting rural telephone service are increasingly vulnerable to the pressures of competition. It will not be possible to retain all of the traditional support mechanisms in their present form indefinitely. (The FCC has begun a proceeding to revise the subsidy mechanisms of the Universal Service Fund.[23]) States should minimize the risks of catastrophic change later by starting a gradual transition to a system of support for rural telecommunications services they can maintain in a competitive environment.

State regulators and policy makers have the particularly difficult task of protecting the interests of rural users during a long and difficult, but inevitable, transition to competition. New technologies offer great promise for both urban and rural telecommunications users. Devising policies for transition to competition that help rather than harm rural economies will be a challenging task.

Local Rates, Access Fees, Depreciation Rates and Universal Service

In most states, state regulators have kept local rates low by recovering much of the cost of local lines and switches from intrastate long distance users. They permit local carriers to charge high "access fees" to intrastate long distance carriers. They also allow carriers that offer both local and intrastate long distance to recover a large portion of their local line and switching costs from the intrastate long distance charges. They also keep current local rates low by requiring long depreciation rates, so that carriers charge current users a smaller percentage of capital investment costs. (Long depreciation rates actually cost users more because they pay over a longer period of time and pay more cost of capital charges, the carriers' return on investment, in the process. The process is analogous to deferring current payments for consumer goods by putting them on a credit card: consumers must pay the total bill sometime and deferring the payments adds substantial interest charges.)

The policy goal served by keeping local rates low was the laudable one of "universal service." The regulatory theory was that low local rates would make telephone service affordable to more people. Some commentators now suggest that the task of achieving universal service is largely finished and state policy makers should therefore abandon that goal. They suggest instead that policy makers focus on the newer goals of stimulating new competitive services and ensuring that the competition is fair.

The facts do not support abandonment of the policy goal of universal service. The latest FCC study of telephone subscribership showed that, in November of 1995, 93.9 percent of US households had telephone service.[24] This level of telephone penetration is not evenly distributed across the country. In many rural counties throughout the country the telephone penetration rate is below 85 percent.

Achieving or even approaching universal service with the remaining six percent of US households without telephone service will not be easy. The percentage of US household with telephone service is currently less than the peak of 94.2 percent achieved in 1993. Maintaining local rates at their present levels will not be sufficient to achieve the goal. If it were, those households would already have telephones. Lowering local phone rates sufficiently to create a significant increase in penetration rates is not a plausible alternative. Keeping telephone rates low for everybody with subsidy mechanisms built into the rate structure is no longer the best strategy to achieve universal service. Specific policies aimed at removing the particular barriers for the remaining six percent of households without telephone service are preferable to maintaining rates below the underlying costs for the 94 percent of US households that do have telephone service. Targeting subsidies at those most in need will be more effective than distorting the rates away from economic costs for those who can well afford to pay.

Several years ago, when the FCC proposed increasing local rates by a flat $3.50 per month per subscriber interstate access fee, many complained that it would reduce the percentage of US households with telephone service. In fact, telephone penetration continued to rise during the time those charges were being phased in. This was partly because the FCC concurrently introduced a targeted subsidy called "lifeline service" to provide a way for low income households to continue to afford telephone service.

Intrastate Long Distance Rates and Access Charges

The major telecommunications barrier to rural economies becoming competitive in this "information age" is not the price of local telephone service—it is the high price of intrastate long distance service. High long distance toll calls are both a financial and a psychological barrier that blocks potential customers from reaching rural businesses. The rationale of high intrastate toll rates and low local rates does not make sense for rural users. FCC studies have shown that rural users, who are poorer than urban users on the average, spend a higher proportion of their income on telephone service. Rural users make more intrastate long distance calls than urban users because rural users can reach a much smaller number of rural businesses and residences with a local call. That system of high toll and low local rates may be attractive to urban users who do not have as much need for toll services. However, it does not make political or economic sense to have poorer rural users subsidize richer urban users. That was not the intent of the current subsidy mechanism.

The current situation is an anachronism dating back to days when toll calls were a luxury used by the rich and a necessity for the rest of us only in emergencies. The US economy has changed since then. Intrastate toll calls have become necessities for rural residents and rural businesses. Complaints about intrastate calls being priced significantly higher than out of state rates are not just an absurdity to laugh at. They are legitimate complaints from people concerned about their local economy. Keeping business in state that would otherwise go out of state should be one of the first concerns of state economic development in the age of the "information superhighway."

Arguments pointing out that the FCC $3.50 per month access charge is the primary cause of the differential are irrelevant. (That Federal monthly access charge resulted in lower per minute long distance charges for out of state calls.) The Federal access charge exists. State actions cannot change it. No amount of explanation will take away the obvious fact that intrastate toll calls are more expensive than interstate calls for comparable distances. Blaming the FCC and wishing they had not done it will not change the facts on the ground and in people's minds. State regulators should deal with the problem, instead of pointing fingers elsewhere.

The main reason intrastate toll rates are so high is the access charges intrastate toll carriers pay to local exchange carriers to cover much of the fixed cost of the local telephone lines and switches. Regulators can take several approaches concurrently to reduce intrastate toll rates. The goal should be to reduce rates to the point where intrastate toll rates are no higher than interstate rates for comparable distances.

The first step is that regulators should apply any rate reductions resulting from previous over-earnings to reduction of intrastate toll rates. Credits on local phone bills or other adjustments to local rates are an inappropriate place for those adjustments, given the magnitude of the rate rebalancing necessary to prepare the economy for the onslaught of telecommunications competition.

The second step should be the use of competition as a tool to reduce rates. The best way to ensure lower intrastate toll rates will be to encourage further competition in intrastate long distance services. The next step in stimulating such competition will be to require equal access (1+ dialing) for all intrastate toll calls. With equal access, customers could preselect a long distance carrier of their choice for intrastate services, just as they do now for interstate services. It is likely that local exchange carriers, especially those that now provide intrastate calling on an exclusive basis, will suggest that the expense of converting to intrastate equal access will be prohibitive. Carriers made similar arguments before the FCC ordered equal access for interstate toll calling. Any state order for equal access should include as a condition a *bona fide* request from a qualified competitor and should provide a reasonable amount of time for the upgrade of facilities. (The FCC allowed three years.) In special hardship cases, if any, state regulators could consider waivers of the general requirements.

These two steps are unlikely to be sufficient to get intrastate toll rates down to the level of interstate toll rates for comparable mileage. To meet such a goal, state regulatory commissions also will need to take a third step. They should rebalance toll and local rates, perhaps by instituting an intrastate subscriber access charge similar to that used by the FCC for interstate subscriber access. It will be difficult to get intrastate rates down to the level of interstate rates if local carriers charge long distance carriers a higher carrier access charge for intrastate access than they do for interstate access. To ensure that the benefits of lower access charges to long distance carriers reach users, regulators should obtain agreements from major long distance carriers that they will lower prices to users by the amount of the resulting cost reductions.

Competition, Interconnection and Carriers of Last Resort

Since the FCC controls licenses for wireless services and has preempted most state authority to regulate such services, increased local telephone competition from cellular and PCS service providers is inevitable. Federal legislation now permits cable television companies to compete for local telephone service. This is a *quid pro quo* for letting telephone carriers enter the cable television business. States will be unable to prevent local telephone competition. States should use the regulatory power they do have to put in place rules for competition and interconnection that take advantage of the transition to competition to achieve their policy goals.

The rules concerning interconnection of competing networks into a transparent switched network of networks will be the main area of state control. States may be able to stimulate investment in advanced telecommunications infrastructure and services throughout the state by encouraging competitive entry and establishing fair rules for competition and interconnection. Establishing the rules of the game early may provide incentives for carriers to invest in their state before making investments in other states that have not established clear rules encouraging competition. Both incumbent carriers and new entrants are likely to make investments. Equal access rules, including equal access for intrastate toll carriers, as discussed in the preceding section, will be an important part of the "level playing field" necessary for the competition to be fair for all participants.

The trickiest part of the transition from monopoly to competition will be revision of rules with respect to carriers of last resort. In a truly competitive industry there would be no barriers to entry or exit. Carriers unable to remain profitable in a competitive environment could go bankrupt or otherwise stop offering service. Historically, states regulated both entry to and exit from the business of providing telecommunications services.

Traditionally, local exchange carriers had a monopoly franchise in a geographically defined service area and, in exchange for that monopoly franchise, accepted responsibility to serve all qualified customers within that territory. The standard argument of monopoly incumbents against permitting competitive entry is that the new entrant will not be required to serve all customers within the territory of the current carrier. Therefore the new entrant will engage in cream-skimming, that is, serving only the most profitable customers. Furthermore, new entrants may not face the same barriers to exit from the business should they fail to achieve the level of profitability desired by their owners. Regulators, acting to protect the public interest, have a responsibility to ensure that at least one provider is willing to continue to serve. Rural telephone subscribers depend on their regulatory commission to protect their right to continue to receive service. For subscribers in larger urban markets, the issue is a hypothetical one unlikely to arise in practice. However, rural subscribers may still need this regulatory protection.

State regulators might choose to require new entrants to define the geographic territory within which they propose to offer service. Given such a definition by the competitive entrant, the regulatory commission could require that they provide service at their standard rates to all qualified potential customers requesting service within the territory defined by the new entrant. New entrants would thus be defining for themselves the areas in which they are willing to be “carriers of last resort”. When such territory only partially overlaps the territory of an incumbent with pre-existing carrier of last resort responsibility, regulators could permit the incumbent to propose withdrawing from carrier of last resort responsibility for part of its territory. Such proposed withdrawal should include an offer to sell all of its facilities in the territory it no longer desires to serve, at a pre-determined price (possibly the depreciated book value of those facilities). Since carriers rarely like to give up franchise territory, such a mechanism may never be needed. Nevertheless, the availability of such a mechanism may be necessary as a safety valve to protect vulnerable rural customers.

ENDNOTES

1. Paper prepared for the Tennessee Valley Authority Center for Rural Studies, University of Kentucky, Lexington, KY, May 1996.

2. Edwin B. Parker is President of Parker Telecommunications, P.O. Box 402, Gleneden Beach, OR 97388, telephone (541) 764-3058, facsimile (541) 764-3059, e-mail edparker@teleport.com.

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15. See http://www.peak.org/lincoln/html/ on the Internet's world wide web.

16. Communications Act of 1934, title I, Section 1, "Purposes of act, creation of Federal Communications Commission."

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18. US Congress, Office of Technology Assessment, *Rural America at the Crossroads: Networking for the Future*, OTA-TCT-471, Washington, DC: US Government Printing Office, April 1991.

19. Edwin B. Parker and Heather E. Hudson. See reference 8, above.

20. *Telecommunications: Planning for the Future*. International City/County Management Association (ICMA). Washington, DC, 1996.

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22. The source of that number and others in this appendix is the 1994 OPASTCO study cited in Note 17, above.

23. Federal Communications Commission. Notice of Proposed Rulemaking and Order Establishing Joint Board. Common Carrier Bureau Docket No. 96-45, Adopted March 8, 1996, Washington, DC.

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