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IMPROVING PROXY COST MODELS FOR USE IN FUNDING UNIVERSAL SERVICE

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This paper is one of a series of focused and timely NRRI analyses of high-priority issues in state telecommunications policy that derive from passage of the Telecommunications Act of 1996, which creates both challenges and opportunities for state regulators. The views and opinions expressed herein are those of the author. They are not necessarily those of The National Regulatory Research Institute, the National Association of Regulatory Utility Commissioners (NARUC), or any NARUC-member Commissions.

EXECUTIVE SUMMARY

The Telecommunications Act of 1996 calls for consumers in all regions of the country to have access to telecommunications and information services at rates that are reasonable compared to those in urban areas. Rural, insular and high-cost areas will continue to need supplementary funding from a central source if they are to be able to offer services and rates similar to those in urban areas. This paper recommends a change in the methodology used to measure the cost of universal service and addresses some problems with the data inputs used in existing cost models.

In its consideration of universal service funding, the Federal-State Joint Board in FCC Docket 96-45 must, among other things, determine the cost of providing basic telephone service in high-cost areas in order to determine the appropriate level and method of funding. The Joint Board is in the process of approving a funding mechanism which will require the transfer of billions of dollars in revenue. Establishing cost models that accurately reflect the variations in cost for different areas of the country is a vital issue, not only for universal service, but for access charge reform and other policies which are necessary to establish the Act's primary goal, that is, to open telecommunications markets to competition. For the board to make a sound decision in this area, basic improvements in cost models are necessary.

Current models (the Benchmark Cost Model and the Hatfield Model) identify the average cost of providing service to all consumers, but in measuring the profitability of providing universal service, they consider only the revenue derived from residential exchange service. The methodology used by OFTEL in the United Kingdom should be used instead because it mirrors the approach used by firms in evaluating the profitability of a line of business and considers the impact of one product on other lines of business. The methodology is customer-based and identifies both avoidable costs and revenues.

The total service long-run incremental cost of residential service is the cost of adding residential service to a network that *already* provides business services, including both switched business and private line services. Neither the Benchmark nor Hatfield models have been used in a manner consistent with this methodology.

If only residential services are being considered suitable for a universal service subsidy or support, the analyst should compare the *incremental* cost of the service with its *incremental* revenue. If a family of products is being studied, the analyst should compare the family's incremental costs and revenues. If the family's incremental costs exceed its incremental revenues, it is being subsidized. The methodology used by the Benchmark and Hatfield models is flawed because it compares the *average* cost of all services with the *incremental* revenue from a subset of the services. Either the revenue considered should take into account all services, including revenue derived from business customers, or the cost study should consider only the incremental cost and revenue of residential service.

If all customers in high-cost areas, including business customers, qualify for support then it is appropriate to use average costs for identify the level of support.
In addition, when measuring the difference between avoided costs and revenues, the analyst might also consider the life cycle of customers' behavior. Although a customer or geographic area may not be profitable today, a local exchange carrier (LEC) may still find it profitable to provide service because of the *potential* future earnings. Neither the Hatfield nor Benchmark models reflect these life-cycle effects or corresponding benefits. These omissions may lead to an overstatement of the amount of support required to ensure that universal telephone universal service is provided.

The National Exchange Carrier Association (NECA) has compared the loop cost estimates of the Benchmark model with the embedded costs that are used to determine eligibility for the high-cost fund. NECA found that the proxy model estimates for smaller companies vary greatly from actual costs, which could be devastating for them.

The paper contains specific recommendations on data inputs:

- No cost model should be used to set the universal service fund until the developers of the model provide better documentation
- Cost estimates of structural investment (that is, poles and conduit) should reflect suppliers’ practices
- Although conclusions cannot be reached for the Hatfield model on cost variations for topography, for the Benchmark model it appears that a different mix of operations for installing facilities should be used
- Differences in costs for aerial, underground and buried cable and whether the cable is fiber or copper should be used to calculate maintenance loading factors.
- Appropriate assumptions should be made on the current and future mix of aerial or below-ground facilities
- Information currently available suggests that adjustments should be made in calculations of non-investment related expenses (e.g., the treatment of marketing expenses)
- Wire-center boundaries, as well as census block data, should be used as fundamental units of analysis in the costing model used to set universal service funding
- The central processor should not be treated as exclusively a line-related investment.
- The existing models should be modified to reflect the cost of the type of switching technology that is actually used in low-density areas.

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INTRODUCTION

The Telecommunications Act of 1996[1] calls for consumers in all regions of the country to have access to telecommunications and information services at rates that are reasonable compared to those charged for equivalent services in urban areas.[2] Rural, insular and high-cost areas will continue to need supplementary funding from a central source if they are to be able to offer services and rates similar to those in urban areas.

In its consideration of universal service funding, the Federal State Joint Board established in FCC Docket 96-45, must, among other things, determine the cost of providing basic telephone service in high-cost areas in order to determine the appropriate level and method of funding. Establishing cost models that accurately reflect the variations in cost for different areas of the country is a vital issue, not only for universal service, but also for access charge reform, interconnection pricing, and other policies that are necessary to establish the Act's primary goal, that is, to open telecommunications markets to competition. For the Joint Board to make a sound decision in this area, basic improvements in the modeling are necessary.

> *Establishing cost models that accurately reflect the variations in cost for different areas of the country is a vital issue, not only for universal service, but also for interconnection pricing and access charge reform.*

The Joint Board is in the process of approving a funding mechanism which will require the transfer of billions of dollars in revenue. In this paper I discuss some of the methodological problems of the existing cost models used to measure the cost of universal service, recommend a change in the methodology, address issues with the

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[1] Public Law 104-104, 110 Stat. 56, codified at 47 U.S.C. 151, *et seq.*

[2] Section 251(b)(3) *Access in Rural and High Cost Areas* states that "Consumers in all regions of the Nation, including low-income consumers and those in rural, insular, and high-cost areas, should have access to telecommunications and information services, including interexchange services and advanced telecommunications and information services, that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas."

data inputs used in the existing cost models, and suggest some remedies.

USING INCREMENTAL COST DATA TO TEST FOR SUBSIDIES AND DETERMINE THE NEED FOR UNIVERSAL SERVICE SUPPORT

Much of the discussion regarding universal service has focused on the profitability of providing service to residential customers. Residential customers have been the focus of attention because of the concern that consumers in high-cost areas and low-income neighborhoods would terminate service if prices were set equal to the cost of providing universal service products. If these residential customers do not generate enough revenue to cover the cost of providing them service, they are receiving a subsidy.

A precise definition of a subsidy can be found in Gerald Faulhaber's classic article, "Cross-Subsidization: Pricing in Public Enterprise."[3] Faulhaber proposed that total service long-run incremental cost (TSLRIC) should be used to test for service subsidies. As long as a group of consumers, such as residential customers, are generating additional revenue that exceeds the cost of including them on the network, this group is not being subsidized in any way by other groups of customers or other services.

As long as a group of consumers are generating additional revenue that exceeds the cost of including them on the network, they are not being subsidized.

An economically valid estimate for the existence of a subsidy, using the TSLRIC criteria, must reflect the fact that business and private line services would still exist if residential service were eliminated. If a local service network operator did not offer

An economically valid estimate for the existence of a subsidy, using the TSLRIC criteria, must reflect the fact that business and private line services would still exist if residential service were eliminated.

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[3] Gerald Faulhaber, "Cross-Subsidization: Pricing in Public Enterprise," *American Economic Review* 85, no. 5 (December 1975): 966-77.

residential service, perhaps because it believed that it was not viable and there was no requirement to do so, it would nevertheless still wire many areas of the country in order to provide service to businesses.[4]

Therefore, the TSLRIC of residential service is the cost of adding residential service to a network that *already* provides business services, including both switched business and private line services. This means that the TSLRIC of residential service would be the cost of wiring areas containing only residential neighborhoods, as well as the cost of installing larger cables in regions that would otherwise still be wired in order to provide service to business customers. This methodology is consistent with the economic principle that the incremental cost of providing a service is the cost that would be avoided if that service were discontinued, while all other services continued.[5]

The incremental cost of providing a service is the cost that would be avoided if that service were discontinued, while all other services continued.

METHODOLOGICAL PROBLEMS OF EXISTING MODELS

Rather than identify the incremental cost-of-production, the Benchmark and Hatfield models estimate the average cost-of-production.

Neither the Benchmark nor Hatfield models are consistent with the TSLRIC methodology. They estimate the cost of serving different areas, but they do not identify the

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[4] As suggested by OFTEL (see OFTEL paragraph C.15, below), identifying uneconomic customers or areas is an iterative process. If the concentration of business and private lines is low, the network might not be constructed to serve non-residential customers only. Therefore, in an unregulated market, the supplier might provide service only if the avoidable revenues for the exchange exceed the costs for the entire exchange. For strategic reasons, a local exchange company may provide service even where the revenues from the exchange are less than the cost. See, David Gabel, "Competition in a Network Industry: The Telephone Industry, 1894-1910," *Journal of Economic History* 54 no. 3 (September 1994): 543-572.

[5] For a discussion of the concepts of long-run incremental cost (LRIC) , total service long-run incremental cost (TSLRIC), and total element long-run increment cost (TELRIC), see David Gabel, *Competition-Enhancing Costing and Pricing Standards for Telecommunications Interconnection* (Columbus, Ohio: The National Regulatory Research Institute, September 1996).

incremental cost of serving residential

customers. Rather than identify the *incremental* cost-of-production, these models estimate the *average* cost-of-production. The models estimate the total cost of installing loops, then divide this quantity by the number of working loops.[6] This quotient is an average cost, not the TSLRIC of a service.

The difference between average and incremental cost can be loosely approximated with some data generated by BCM2. The consulting firm of Economics and Technology, Inc. (ETI) has used the BCM2 to estimate the cost of serving the State of Washington under three conditions:[7]

■ Network A	A stand-alone network sized to support only first residential access line demand.
■ Network B	A stand-alone network designed to support all services *other than the* initial residential access line. (Business lines and second residential lines)
■ Combined Network	A network that is provisioned for residential first and second lines, as well as business lines.

The data presented by ETI, as summarized below in Table 1, suggest that the incremental cost can be as little as one-half the average cost-of-production.[8]

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[6] See, for example, *Benchmark Cost Model*, A Joint Submission of MCI, NYNEX, Sprint, and US West, CC Docket No. 80-286, December 1, 1995.

[7] Susan M. Baldwin and Lee L. Selwyn, *Converging on a Cost Proxy Model for Primary Line Basic Residential Service* (Boston: Economics and Technology Inc., August 1996), p. 106.

[8] The average value was derived by dividing the total cost, $3,501,878,128, by the number of combined lines, 3,293,923. ETI reports that the stand-alone cost of network B is $2,563,892,069. Therefore, the additional cost for serving the first residential line is the difference between the cost for a combined network and a network that only serves business and second line residential customers: 3,501,878,128 - 2,563,892,069 = 937,986,059. ETI reports that there are 1,875,508 households in Washington, and therefore the TSLRIC of the first residential line is 937,986,059 ÷ 1,875,508 = $500. I have used the Local Exchange Cost Optimization Model (LECOM) to evaluate the relationship between the TSLRIC and average cost-of-production (the LECOM model is discussed in David Gabel and Mark Kennet, *Estimating the Cost Structure of the Local Telephone Exchange Network* (Columbus, Ohio: The National Regulatory Research Institute, October 1991)). I generally do not find there to be as large a difference between average and incremental costs as is suggested by the results presented by ETI (Baldwin's and Selwyn's larger difference between TSLRIC and average cost may be attributable in part to their exclusion on non-plant-related expenses, *Converging*, p. 107). See, for example, David Gabel, "Is Residential Telephone Service Subsidized? Moving Past the Rhetoric Through an Empirical Analysis of the Cost and Revenue Associated with the Kiwi Share," TUANZ Universal Share Obligation Conference, Auckland, New Zealand, July 1996.

Table 1: Cost Per Line: State of Washington

Average Cost per Line on combined network	$1,063
TSLRIC Cost per Residential Line	$ 500

Source: Author's construct from data derived from BCM2 results as reported by ETI, August 1996.

If residential services, alone, are considered suitable for a universal service subsidy or support, the analyst should compare the incremental cost of those services with their revenue. If a family of products is being studied, the analyst should compare the family's incremental costs and revenues. If the family's costs exceed its revenues, it is being subsidized. The Benchmark and Hatfield models identify the cost of providing *both* business and residential loops, rather than the incremental cost of offering *only* residential loops. This being the case, the revenue from *all* the services that use the loop, not just residential exchange service, ought to be used when comparing costs and revenues.

The methodology used by the Benchmark and Hatfield models is flawed because it compares the average cost of all services with the incremental revenue from a subset of the services.

The methodology used by the Benchmark and Hatfield models is flawed because it compares the *average* cost of *all* services with the *incremental* revenue from a *subset* of the services. Either the revenue considered should take into account revenues derived from all services, including revenue from business customers, or the cost study should consider only the incremental cost and revenue of residential service. Another flaw in the Hatfield and Benchmark models is that they aggregate business and residential loops when estimating the cost-of-service. This aggregation may result in erroneous estimates, because some costs that are considered shared in the individual service studies may become direct in the aggregated studies. For instance, if a company offers two classes of service (e.g., business and residence), and it studies the cost of those services separately, the fiber feeder cable is not likely to exhaust and it may properly be considered a shared cost in each study. The cable would not be directly attributable to either service. But, if customer access is the "service" in question, then the fiber feeder cable may properly be considered a direct cost of access service. It is my opinion that, strictly speaking, customer access is not a retail service, rather, it is an unbundled network element used to provide multiple products.[9]

Another possible source of error resulting from aggregating business and residential lines is that certain fixed costs per foot are incurred each time a copper or fiber cable is installed. In many places, such fixed cost is not part of the TSLRIC of residential services, because the same expenditure would be required for business service. In such localities, the TSLRIC of residential service should include *only* the incremental expense of additional pairs of cable and should not include the fixed cost per foot of installing the cable.[10] The TSLRIC of residential service is the cost which would be avoided if any LEC continued to provide private line and switched services to business customers.

The TSLRIC of residential service is the cost which would be avoided if any LEC continued to provide private line and switched services to business customers.

As noted above, neither the Hatfield nor Benchmark models estimate a true incremental cost; instead, they report the average cost-of-service. The difference between incremental and average costs is nicely summarized in the seminal cost study undertaken by the Australian government, *The Cost of Telecom's Community Services Obligations*:

The difference between the avoidability and FDC [fully distributed, or

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[9] There are others who view network access as a service that can, and should, be priced and sold separately. See, for example, the discussion in Alfred E. Kahn and William B. Shew, "Current Issues in Telecommunications Regulation: Pricing," *Yale Journal on Regulation* 4, no. 1 (Spring 1987): 191-256.

[10] Where the cable is used to serve *only* residential customers, the placement cost for the cable is part of the incremental cost of serving residential customers. Further, if the cable is *shared* by residential and business customers, and the capacity of the cable is exhausted, the cost of installing the cable is part of the incremental cost of serving residential customers.

> average cost] approaches essentially lies in the treatment of joint or common costs. In the avoidability approach, only avoidable costs are included in the [universal service] cost measure; in the FDC approach, all costs are allocated whether or not they would be incurred if [universal service] had not been provided. There is also a major difference in the treatment of revenue. In the avoidability approach incoming call revenue is included as well as outgoing call revenue, resulting in higher revenue being considered than in the FDC approach.[11]

This incremental methodology has not been adopted by the sponsors of the Hatfield and BCM2 models. The models identify the *average* cost of providing service to all consumers, but, in measuring the profitability of providing universal service, they consider only the revenue derived from residential exchange service.[12] This methodology is flawed because:

- The models do not identify the incremental cost of residential service.

  > Since they measure the *shared* cost of providing business *and* residential service ("consumers"), both revenues, not just residential revenue, are relevant.

- The models do not use an avoidable cost / foregone revenue approach.

  > Typically, the *average* cost is compared to the average price of residential exchange service (approximately $20 per month). However, average residential total bills are generally much higher than this. Yet the models fail to take these relevant revenues into account, while they simultaneously include some costs for non-universal service products. For example, the models include the cost of providing call-waiting, but do not explicitly include the revenue.

- The models essentially ask the question: What is the relationship between the *price* of exchange service and the *cost* of the loop, the switch, and the interoffice facilities that are used not only for providing exchange service, but also other switched services?

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[11] Australian Bureau of Transport and Communications Economics, *The Cost of Telecom's Community Service Obligations*, (Canberra, 1989), p. 17.

[12] In the Telecommunications Act of 116, "consumers" are interpreted to mean both residential and business customers. For example, §271(c)(1)(a) expressly identifies "residential and business subscribers." Elsewhere the law expressly recognizes "residential" customers [see, for example, §227(B)].

Thus, the universal service costs estimated by the existing proxy cost models are fundamentally inadequate to address the question of determining the magnitude of the universal service obligation.

THE OFTEL AVOIDABLE COST AND REVENUE APPROACH

Reed Hundt, the Chairman of the Federal Communications Commission, has recognized the reasonableness of a methodology that considers the incremental revenues derived from residential customers, and the adoption of this methodology by OFTEL in the United Kingdom:

> And where subsidies are needed for the poor or the very high cost area, as OFTEL has demonstrated for the U.K., they are modest. That is because telephone operators receive commercial benefits from broader network coverage. The benefits of broader coverage off set some of the costs of uneconomic connections to some homes and regions.[13]

In December 1995, OFTEL offered the following description of the method it uses to calculate the cost of a local exchange company's universal service obligation (USO):

> OFTEL's approach to calculating the costs of universal service in the United Kingdom is generally to identify and establish the cost to [a LEC] of customers whose revenues, including revenues from incoming calls, falls short of the long run avoidable costs of providing them with service. The estimated value of the benefits of being the universal service provider is then subtracted.[14]

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[13] "Seven Habits of Hopefully Highly Successful Deregulatory Communications Policy People." Royal Institute of International Affairs, London, England, September 4, 1996.

[14] See, OFTEL, *Universal Telecommunications Services: A Consultative Document on Universal Service in the UK from 1997* (December 1995), para. 9.3.

OFTEL's position is a restatement of a more detailed policy described in its December 1994, Consultative Document, and codified in a July 1995 Statement by the Agency's Director General. Appendix C of the Consultative Document described how the cost of universal service should be measured:[15]

> C.8 The preferred methodology is along the lines of the approach adopted in Australia for the costing of the USO (published in *The Cost of Telecom's Community Service Obligations*, Bureau of Transport and Communications Economics, Report 64, September 1989). With this methodology the revenue, net of costs, is calculated for each customer or group of customers. The cost of the USO is the sum of the negative net revenues.
>
> C.9 The methodology is a **customer-based** [original emphasis] approach and should in principle include all services...
>
> C.10 The costs relevant to each customer are the **long run avoidable costs** [original emphasis] of supplying that customer--the costs that would be avoided if the customer were not supplied. These will include the operating and maintenance costs incurred, but also depreciation and capital charges on assets which would require replacement in the long term...
>
> C.13 The relevant revenues are those that would be foregone if the customer were not connected to the telephone network. This principle implies that **incoming calls should be included in addition to outgoing calls.** [original emphasis]...
>
> C.15 In arriving at the total cost of the USO, the following may need to be considered. The more customers that are included, the larger the avoidable costs are likely to be, so it might be that the operator could save more by not serving a whole block of customers, even if some of those customers have positive net revenues. The calculation mechanism should, therefore, be iterative including an examination of the effects of excluding groups of customers from the network, perhaps even all those served by an exchange, as well as individual customers. It may also be that, when the whole group of negative net revenue customers have been identified, some further costs might need to be included that the operator would avoid if it were to exclude all those customers.

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[15] See OFTEL, *A Framework for Effective Competition: A Consultative Document on the Future of Interconnection and Related Issues*, December 1994. A Consultative Document is equivalent to an FCC "Notice of Proposed Rulemaking." In July 1995, after receiving comments from interested parties, OFTEL issued *Effective Competition: Framework for Action: A Statement on the Future of Interconnection, Competition and Related Issues;* this Statement is equivalent to an FCC "Order," and it includes a description of OFTEL's costing study (at paragraphs 4.20 to 4.28).

> C.16 The consultants should also consider the impact of factors beyond those determining current financial viability. For example, a lifetime approach to revenue (allowing for the possibility that currently unprofitable customers might become profitable in the future), the goodwill generated and the value of the ubiquity to the provider of the USO.[16]

The avoided-cost methodology identifies those expenses that would not be incurred if an area or a group of customers no longer received service. Unavoidable joint and common costs are not included in the direct cost of providing universal service products.

The purpose of the avoided-cost methodology is to identify those expenses that would not be incurred if an area or a group of customers no longer received service. In the process of developing the avoided costs, those joint and common costs that are unavoidable are not included in the measurement of the direct cost of providing universal service products. As shown below in Figure 1, the methodology identifies both the avoidable costs and revenues. The foregone revenues include not only exchange revenue, but also revenue from toll and vertical services. In addition to considering the revenue received *from* universal service customers, the revenue calculation must also take into account the revenue derived from calls made *to* universal service customers.[17] This criteria was used by AT&T during the competitive, unregulated period at the start of the twentieth century.[18] Therefore, the adoption of incremental analysis to determine USO funding is consistent with the behavior of competitive and unregulated telecommunications planning criteria and "best-practice" regulatory procedures.

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[16] See below for further discussion of the life-cycle approach.

[17] OFTEL (United Kingdom), "A Framework for Effective Competition," Appendix C, Par. C13, December 1994.

[18] See, David Gabel, "An Assessment of Universal Service," submitted to the Joint Board October 1, 1996 as Ex Parte Comments CC Docket No. 96-45, State of Florida, Office of the Public Counsel.

The OFTEL methodology merits careful attention because it mirrors the approach used by firms in evaluating the profitability of a line of business. That is, when a firm evaluates the profitability of a product, it considers not only the *direct* incremental costs and revenues, but also the *indirect* impact of the product on other lines of business. This approach has been adopted in some other countries by national regulatory agencies that have addressed the issue of cost recovery for provision of universal service.[19]

> *When a firm evaluates the profitability of a product, it considers not only the direct incremental costs and revenues, but also the indirect impact of the product on other lines of business.*

The OFTEL costing approach is considerably different from the methodologies embodied in the Hatfield and BCM2 models. OFTEL uses economic analysis to assess the cost of providing universal service. This standard has emerged around the world because it reflects the type of information that a business would use to appraise the profitability of an undertaking. In a non-regulated market, a commercial operator would measure the benefit or burden of a service by comparing its incremental costs and revenues. This framework, which is used by unregulated businesses, should be the one used to appraise the burden of the universal service obligation. I recommend that this methodology be adopted by the Joint Board.

> *The OFTEL approach uses economic analysis to assess the cost of providing universal service. It is considerably different from the methodologies embodied in the Hatfield and BCM2 models.*

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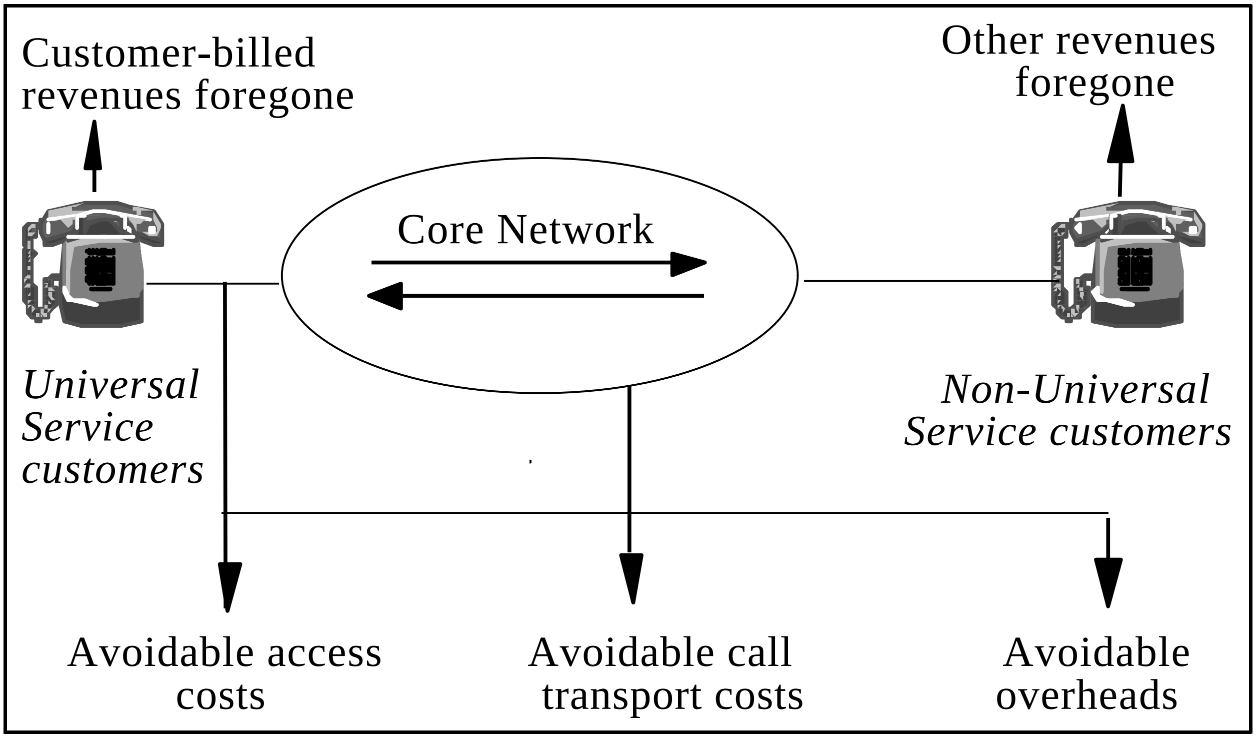
[19] This economically rational methodology has also been endorsed by the regulatory agencies of Hong Kong and Australia. See Australia Bureau of Transport and Communications Economics, *The Cost of Telecom's Community Service Obligations*, Report 64, September 1989; and Office of Telecommunications Authority, *Universal Service Arrangements: A Further Considered View,* Discussion Paper, 1 August 1996.

Figure 1: Avoidable Costs And Foregone Revenues Of Serving Customers



A QUANTITATIVE COMPARISON

I have pointed out that many analysts in the United States have failed to use appropriate economic analysis in identifying the magnitude of subsidy that is required in order to maintain and extend universal telephone service. In this section I provide a comparison of the subsidy requirements identified by the proponents of the BCM2 model with the subsidy requirements identified in a consultancy report done by Analysis for OFTEL. The Analysis report reflects the economic principles that have been discussed herein. As shown in Table 2, below, the British study suggests that on both a per capita and a per line basis, the annual subsidy is much lower.

Table 2: Comparative USO Per-Capita And Per-Line Costs[20]

State/Country	Population Density Per Sq. Mi.	Total Population	USO Cost in US $	USO Cost Per Capita in US $	Total Number of Phone Lines	USO Cost Per Line in US $
United States	70.3	248,709,873	14,700,000,000	59.11	140,197,000	104.85
United Kingdom	619	58,295,119	138,585,000	2.38	25,595,000	5.41
States						
CT	678.4	3,287,116	167,163,832	50.85	1,932,415	86.51
DE	340.8	666,168	34,971,795	52.50	429,375	81.45
MD	489.2	4,781,468	169,320,448	35.41	2,880,925	58.77
MA	767.6	6,016,425	232,987,711	38.73	3,626,589	64.24
RI	960.3	1,003,464	43,928,433	43.78	542,381	80.99

Source: Author’s construct from indicated data.

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[20] Costs for the UK are from the Analysis report "The Costs, Benefits, and Funding of Universal Service in the UK" Final Report for OFTEL, July 19, 1995. Summary of Findings, Section 0.2. The USO costs in this column use the alternative interpretation of the data. Case (a) in the report.

The US data is from the Benchmark Cost Model 2 Results dated July 3, 1996. The costs used are the aggregate support costs at $20 for all the states in the table.

Since the population density is considerably higher in the United Kingdom than in the United States, I have also included the BCM2 estimates for States whose population density is comparable to the United Kingdom. Table 2 shows that even after controlling for population density, the BCM2 estimates are approximately fifteen to twenty-two times higher than the value reported for the United Kingdom. As shown in Table 3, below, the difference is not due to the setting of lower rate levels in the United States, since data from the Organisation for Economic Co-operation and Development (OECD) suggests that the price of residential service is higher in the United States than Great Britain.

Table 3: Comparative Fixed Charges and Usage Rates for the US and the UK[21]

Type of User	Country	Fixed Charges	Usage Charges	Total
Residential	UK (BT)	187.93	182.69	370.61
Residential	US (NYNEX)	171.33	219.21	390.54
Business	UK (BT)	239.62	570.06	809.67
Business	US (NYNEX)	219.77	740.42	960.19

Source: Author’s construct from indicated data.

ALTERNATIVE APPROACHES

The 1996 Act states that regardless of their location, all consumers, not just residential, should be able to obtain service at prices “that are reasonably comparable to rates charged for similar services in urban areas.”[22] This wording suggests that support should be provided to business, as well as residential, customers in rural,

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[21] This Table represents telecommunications main lines as of 1991. Data for UK is from page 39 of the OECD *Communications Outlook, 1995 Report* (Paris: Organisation for Economic Co-operation and Development, 1995). Data for the states and the total US is from *Statistics of the Local Exchange Carriers 92: For the Year 1991* (Washington, DC: United States Telephone Association, 1992).

[22] See §251(b)(3).

insular, and high-cost areas.

If support is provided to both residential and business customers, both types of subscribers should be included in the support calculation, not just residential lines.

If support is provided to *both* residential and business customers, both types of subscribers should be included in the support calculation, not just residential lines. In this case, the appropriate standard is the incremental cost of providing service to all customers rather than the incremental cost of serving residential customers. If all customers qualify for support, the relevant cost are total forward looking costs, not just the avoided costs associated with incremental residential loops.

In their final calculation of support requirements, the Hatfield and BCM2 models include only residential lines. For example, after determining the cost of serving all customers, BCM2 calculates the support requirement by subtracting the monthly cost of serving a line in a census block group (CBG) from the benchmark rate. This difference is then multiplied by the number of households in a CBG.[23] The support calculation does not take into account the number of business lines and, therefore, makes no provision for providing support to business consumers in high-cost areas.

The Rural States Coalition has proposed another approach. They have suggested that support be based on the difference between the cost of serving consumers in urban and high-cost areas. They suggest that cost, rather than rates, be used for the support calculation. They feel that relative cost should be used, because, due in part, to the vast difference in calling areas, it is difficult to compare rates between localities. Thus, since the calling zones in urban and suburban areas differ significantly, comparable rates are not equivalent to comparable value. A $10 rate in an urban area may provide access to considerably larger number of subscribers than a $10 rural rate and, therefore, does not constitute comparable telecommunications service at comparable rates. If the size of local calling areas is considered when determining the extent to which rates are “reasonably comparable” for “similar services,” this difference in calling areas could conflict with the statutory requirement of

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[23] See cell FR3 in the main program of the BCM2 model

§251(b)(3).[24]

The Rural States Coalition has proposed that the subsidy be based on the difference in the average cost of serving subscribers in urban and in high-cost areas. That is, the amount of support would be calculated by subtracting the monthly cost of serving a line in urban areas from the monthly cost of serving a line in a high-cost CBG. This difference would then be multiplied by the number of households and businesses in a CBG.[25] If this method is pursued, and support is provided to *both* residential and business consumers, the BCM2 and Hatfield models must be modified so that the support mechanism takes into account both business and residential lines.

LIFE CYCLE EFFECTS

OFTEL's methodology for determining the cost of universal service was summarized above. Paragraph C.16 of the OFTEL document notes that, when measuring the difference between avoided costs and revenues, the analyst might also take into consideration the life cycle of customers' behavior. This means that, although a customer or geographic area may not be profitable today, a LEC might still find it desirable to provide service because of the potential *future* earnings. As discussed in a report commissioned by OFTEL, unregulated firms continue to provide service to some currently unprofitable customers to avoid harm to the corporation's image and because of the belief that service to these customers may *eventually* become profitable:[26]

The sheer number of uneconomic residential lines... (10 percent of

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[24] For instance, is local exchange service with the ability to place a local call to 2,500 other subscribers "similar" to local exchange service with the ability to place a local call to 1,000,000, or more, other subscribers?

[25] This description assumes that only the first line in a household or a business would qualify for a subsidy. If all lines qualified for a subsidy, the formula would have to be adjusted accordingly.

[26] See Analysis, *The Costs, Benefits and Funding of Universal Service in the UK*, pp. 22-27. See also, OFTEL, *Universal Telecommunications Services: A Consultative Document on Universal Service in the UK from 1997* (December 1995), Chapter 9.

residential lines) or ... (9 percent of residential lines) makes it seem unlikely that BT [the LEC] would withdraw from this activity even if it were allowed to. However, we must address the serious commercial issue as to whether BT would behave in this way if the universal service activities were subject to normal competitive pressures.

BT, like any other commercial company operating a primarily subscription-based service (e.g., a bank or building society), could be expected voluntarily to carry a certain number of customers who are ‘uneconomic’ at a given moment in time. Studies in the building society sector [footnote omitted] indicate that about 40 percent of ordinary accounts are uneconomic at any one moment. Of these, about three quarters are expected to become economic at some future moment, through an increase in the account balance or the purchase of related services such as a mortgage. This leaves a ‘hard core’ of 25 percent of unprofitable customers (or about 10 percent of all customers) which the building societies could, in theory, get rid of in order to increase their short-term profitability without putting future business at risk.

It can be argued that telecoms and savings are very different businesses, with different cost and revenue structures. However, these differences mainly relate to the higher proportion of uneconomic customers (40 percent in building societies versus 9 percent or 10 percent among telecoms customers), rather than the proportion of these customers which a firm in a competitive market might want to retain (75 percent). This latter figure, which building societies have calculated primarily using consumer life-cycle effects, might apply to any industry which addresses a national mass consumer market on an almost indiscriminate basis.

In practice, only one building society, the Halifax, has recently taken public action to encourage customers to close uneconomic accounts (and then only for a limited period). Building societies know which accounts are uneconomic, but in general they take little or no action to close these accounts, because:

1) uneconomic accounts may become economic in the future
2) uneconomic accounts may lead to other profitable business
3) closure of uneconomic accounts may adversely affect other accounts or alternatively some uneconomic accounts may positively contribute to the corporate image.

The first two of these points are life-cycle effects; the last relates to corporate image which has been discussed above.

Neither the Hatfield nor Benchmark models reflect these life-cycle effects or corresponding benefits. Failure to include these effects, which may influence a firm's decision to serve certain customers or areas, can lead to an overstatement of the amount of the required universal service subsidy (i.e., the minimum amount necessary to induce firms to provide the designated package of universal services at an affordable rate).

ACCURACY OF EXISTING PROXY COST MODELS

The National Exchange Carrier Association (NECA) has compared the loop cost estimates of the BCM with the embedded costs that are used to determine eligibility for the high-cost fund.[27] NECA found that the proxy model estimates:

> for smaller companies vary greatly from actual costs. These variances, which are due in part to 'mapping' problems between census block groups and actual operating territories of small companies, may not be a significant problem for larger companies because the errors produced by the models tend to 'average out' over the large number of census block groups served by these companies. For smaller companies, serving only a few census block groups, such errors can be devastating.[28]

Overall, NECA found that the BCM2 tracked the embedded cost-of-service well. Based on an analysis of 1,386 of 1,439 separations study areas, the association found that the model estimated an annual cost per loop of $277, which is $35 greater than the embedded cost of $242.[29]

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[27] The BCM2 model was not designed to yield estimates of the *level* of the required explicit subsidy. Indeed, the model's sponsors have stated that it is designed to estimate *relative* costs, not cost levels. Nevertheless, given the concerns raised herein, caution should be exercised when applying this model to estimate the relative costs of serving different areas.

[28] *In the Matter of Common Carrier Bureau Seeks Further Comment on Specific Questions in Universal Service Notice of Proposed Rulemaking*, CC Docket No. 96-45, National Exchange Carrier Association, "Further Comments," August 2, 1996, p. 22.

[29] Ibid., p. 5. Similar findings have been made by other parties. For example, Southwestern Bell reported that the BCM2 reported higher economic investments and expenses for the loop than the embedded cost-of-service in four out of the five states it serves. *In the Matter of Common Carrier Bureau Seeks Further Comment on Specific Questions in Universal Service Notice of Proposed Rulemaking*, CC Docket No. 96-45, "Supplemental Comments of Southwestern Bell Telephone Company

If matching or tracking embedded costs were a sign of a good model, there would be a reduced need to develop engineering economic models. Moreover, if embedded costs are the correct standard, then they should be the starting point for setting rates.

Some proponents of the BCM2 have suggested that, because embedded costs are the standard against which proxy models should be evaluated, the small differences between the embedded and the estimated current cost imply that the model is accurate. However, if matching or tracking embedded costs were a sign of a good model, there would be a reduced need to develop engineering economic models. Moreover, if embedded costs are the correct standard, then they should be the starting point for setting rates.

Telephone company cost studies have shown that the cost of the loop has been decreasing over time.

Since the BCM2 tracks embedded costs well, the question naturally arises: Is it the case that there is little difference between the embedded and economic cost-of-production? Considerable evidence suggests that the economic cost-of-production is less than the embedded cost. Telephone company cost studies have shown that the cost of the loop has been decreasing over time. For example, cost studies undertaken by Indiana Bell indicate that between 1984 and 1992, the marginal cost of providing a local loop declined by 8.1 percent per year in logarithmic terms.[30] In the FCC's unbundling docket, the USTA noted that the economic cost-of-production continues to go down. The trade association suggested that the difference in the cost-of-production was in the range of $13 billion to $18.4 billion.[31]

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on Cost Proxy Models," August 9, 1996, pp. 6-7.

[30] See, Prepared Testimony of David Gabel, Cause No. 39705, Indiana Utility Regulatory Commission, January 1994.

[31] See FCC 96-325, *First Report and Order* in CC Docket No. 96-98, "In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, and CC Docket No. 95-185, "Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers" (Adopted: August 1, 1996, Released: August 8, 1996): paragraph 641, footnote 1563, and paragraph 658.

A primary catalyst in the decline of loop cost is the reduction in the price of the digital line carrier (DLC). This decrease in price of DLC has two effects on loop costs. The first order effect is that the investment per-line for subscribers who are served by DLCs should be falling. For example, in 1986, NET told the Massachusetts Department of Public Utilities that the average cost of Subscriber Line Carrier (SLC) technology[32] per 96-line system was $51,000.[33] In 1992, New England Telephone reported that the cost of a 96-line Subscriber Line Carrier (SLC) was $11,248.[34] Splitting the $51,000 between each end of the circuit, the cost of the electronics declined 56 percent between 1986 and 1992, which implies a 12.75 percent annual average rate of decrease in the cost of SLC technology.

The second order impact is suggested by NET's description of the SLC technology. The SLC system requires fewer pairs of either copper or fiber cable than does a dedicated copper line to each household. Therefore the reduction in electronic costs also leads to considerable savings in cable investments.

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[32] SLC technology multiplexes a signal, allowing as many as 96 lines to be carried on only ten (10) physical lines. It requires multiplexing/demultiplexing technology at either end.

[33] See New England Telephone, *Incremental Cost Study*, Book 1 of 3, page 4 of 23, Attachment Loop 2, Massachusetts Department of Public Utilities Docket 86-33. Note that New England Telephone is not talking about fiber-optic multiplexers, just the analog/digital bank.

[34] New England Telephone, Maine Public Utilities Commission, Docket 92-130, Marginal Cost Study, Tab IV, Table 2.1.

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ISSUES WITH THE EXISTING MODELS' DATA INPUTS

In this section, I raise some concerns regarding the inputs and organization of BCM2 and HM2.2.2.[1] In addition, I propose remedies for dealing with the concerns that are identified.

Model Organization

Without some reasonable documentation, it is difficult, if not impossible, to understand the essence of the model.

Both BCM2 and Hatfield have been constructed as Excel spreadsheets. Their programs have a extremely large number of calculations. For example, BCM2 has approximately 168 columns in which calculations are made, but no documentation is provided within the model that explains the nature of these computations. Neither have I seen any external records that chronicle the basis for the calculations. Without some reasonable documentation, it is difficult, if

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[1] To the extent that this paper is more critical of the BCM2 than the Hatfield model, this is only because I have found it easier to audit the BCM2 model.

not impossible, to understand the essence of the model. The Hatfield model also lacks adequate documentation to explain the gist of the large number of calculations embedded in the model. Neither model should be used to set the USF until their developers provide a column-by-column description of the formulas in the spreadsheets.

Proposed Remedy

The models should be held to the same standard that some State Commissions have imposed on model developers. For example, the Colorado Public Utilities Commission has established the following rule:

> When a provider submits a cost estimate to the Commission, it must simultaneously file a complete set of supporting work papers and source documents. . ..The work papers must clearly and logically present all data used in developing the estimate and provide a narrative explanation of all formulas or algorithms applied to these data. These work papers must allow others to replicate the methodology and calculate equivalent or alternative results using equivalent or alternative assumptions. **. . .**
>
> The work papers must be organized so that a person unfamiliar with the study will be able to work from the initial investment, expense, and demand data to the final cost estimate. Every number used in developing the estimate must be clearly identified in the work papers as to what it represents.[2]

The Joint Board should require that all parties who submit cost studies satisfy requirements similar to those established by the Colorado Commission. Not only should the program algorithms be explained, but the source data should be identified and provided. This requirement is important to allow others to assess the accuracy of

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[2] See *In the Matter of Proposed Rules Regarding the Costing and Pricing of Telephone Services*, Colorado Public Utilities Commission, (Docket 92R-596T, June 1, 1993), Rule 6.

A similar standard has been established by the Connecticut Department of Public Utility Control: “SNET must submit sufficient documentation so that every step of the analysis can be replicated and all source data used must be provided and documented to the degree that an audit trail is readily discernible.” See *Application of the Southern New England Telephone Company for Approval to Offer Unbundled Loops, Ports and Associated Interconnection Agreements*, (December 20, 1995), p.77.

the cost estimates. Such documentation would also allow analysts to determine the sensitivity of cost estimates to changes in assumptions and numerical inputs.

Structural Investment

BCM2 and the Hatfield model treat structural investment (that is, poles and conduit) in significantly different ways. BCM2 assumes that the poles and conduit are not shared with the cable and electric companies. Hatfield assumes that the telephone company should be responsible for only one-third of the cost of poles and conduit, the remaining two-thirds being the responsibility of the electric and cable companies.[3] The Hatfield model also assumes that only one-third of the cost of trenching is recovered from telephone operations.[4]

Proposed Remedy

Based on my experience with installing cables, rarely are buried cables installed in the same trench as facilities used by cable, electric, or water companies. Therefore I disagree with the Hatfield proposition that only one-third of the trenching cost is picked-up by telephone companies. Some value less than 100 percent may be appropriate, but one-third is unreasonable. I suggest that the Hatfield model be modified to reflect that often buried cable is plowed, an operation that is less expensive than trenching.

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[3] The Hatfield model assumes a pole investment of $450, a value that seems reasonable for an “average” installation. For installations made in 1993, the Rural Electrical Administration reported an average installed cost of $288.92 per pole for its Northeast Region. This REA value excludes guy units, but they typically ran to only $41 per guy wire. On the other hand, I have seen data for rocky terrain which suggests costs in the neighborhood of $850 per installed pole.

BCM2 does not indicate which cost levels are built into its model. They may be handled through the structure multiplier.

[4] Hatfield Model: Model Description, Version 2.2, Release 2, September 4, 1996, p. C-6.

It is difficult to use physical inspection to determine the extent to which conduit and poles are shared with other suppliers. Thus, rather than basing the sharing of structural investment on a visual examination of the local exchange companies' operations, the cost estimates should reflect the suppliers' practices.

An estimate of the structural investment per sheath or cable mile can be developed from the FCC's *Statistics of Communications Common Carriers* and some internal LEC data. The FCC document provides both embedded investments and physical counts of equipment. The embedded investment can be converted to an equivalent measure of current investment through the application of current/book investment ratios, a method that has been used by the industry for a number of years. In Table 4, below, I provide a loading that would be applied to each cable sheath foot. This loading is based largely on publicly available data.[5]

The logic of the loading formulas is simple. First, the embedded structural investment is converted to current dollars. This operation takes place in the numerator of each formula. Then the current investment is distributed among the quantity of underground or aerial sheath miles.

Indeed, these formulas may understate the effective future-loading per sheath foot, because, with the current widespread deployment of fiber, the sheath miles will likely decline, since fiber cables require fewer sheath miles than copper cables do. This would suggest a need to decrease the denominator in each model by some arbitrary amount. I recommend starting with a value of 10 percent, which leads to an "adjustment factor" of 90 percent.[6]

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[5] It may be appropriate to adjust the formula to reflect the revenue and expenses associated with conduit and pole rentals. The cash flow can be converted for embedded investments by dividing the revenue by the appropriate annual charge factor. If rent revenue is obtained, the dollars would then be divided by the annual charge factor. This quotient would provide an estimate of the portion of structural investment rented to others. The quotient would be subtracted from the embedded investment.

[6] The number of sheath miles will also be reduced because the models size cables to meet total, rather than incremental, demand. To meet incremental demand, a carrier might sequentially deploy two 100-pair cables. In order to meet the total demand, the carrier might deploy just one 200-pair cable. In the later case, the sheath miles would be reduced by a factor of two. On the other hand, because of its reduced size, more fiber cable sheaths could fit on a pole or inside conduit. Also, the embedded investment might reflect past operating inefficiencies.

Table 4: Proposed Loading Factors

Inputs

Let:

A = the embedded investment in conduit (Table 2.9 of the FCC Statistics of Communications Common Carriers)

B = the embedded investment in poles (Table 2.9 of the FCC Statistics of Communications Common Carriers)

C = the sheath miles of underground cable (Table 2.10 of the FCC Statistics of Communications Common Carriers)

D = the sheath miles of aerial cable (Table 2.10 of the FCC Statistics of Communications Common Carriers)

E = current/book ratio for Poles

F = current/book ratio for Conduit

adjustment factor = 90% (explained in text)

Loading Calculations

Loading per sheath foot of aerial cable = (B * E) / (D * adjustment factor)

Loading per sheath foot of underground cable = (A * F) / (C * adjustment factor)

Source: Author’s construct.

Table 5, below provides the results of applying this methodology to data for some local exchange carriers.

Table 5: Structural Loadings Per Sheath Foot

Component	Average	Standard Deviation
Poles	$2.51	$0.86
Conduit	$12.66	$1.75

Source: Author’s construct.

These data can be used to evaluate the reasonableness of the loadings used in the cost proxy models. As with any average value, some company’s data will be higher or lower than the average value. The analyst must evaluate the extent to which the departures from the average value are due to climatic, regulatory, or other conditions that either raise or lower the carrier’s cost, or to inefficiencies.[7]

Do the Models Accurately Capture Cost Variations Due to Topography

Traditionally, cost models have explicitly captured variations in loop costs that are due to loop length and customer density. U.S. West developed such a proxy model a few years ago and was criticized for failing to take into account the topography of the area being modeled.[8]

HM 2.2.2 has eliminated the BCM1's practice of varying the cost, which depended on “the degree of difficulty of structure placement under various soil types, bedrock depth, and water table conditions.” The Hatfield makes an adjustment for rocky terrain by increasing the loop length by 20 percent, in order “to accommodate the

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[7] In developing the data in the table, I did not take into account the renting of poles and conduit. Based on data that I have seen for a few local exchange companies, the renting of facilities has little impact on these calculations.

[8] Joel Shifman and Ron Choura, “Universal Service: Existing Proxy Models, What Can They Be Used For?” (Presented at the NRRI / NARUC *Biennial Regulatory Information Conference*, Columbus, Ohio, September 1996): 17.

routing of facilities around difficult placement conditions."[9] Based on my own experience with installing cables, this is not a reasonable assumption. Cables typically run along the side of a road; there is little opportunity to route cables around rocky terrain.

AT&T and MCI, the sponsors of the Hatfield model, correctly point out that where BCM adjusted installation costs to reflect the difficulty of constructing facilities, the cost factors were based on assumptions that were hard to audit. This leaves the Joint Board with the dilemma of how to use a forward-looking model that reflects surface variations. HM 2.2.2 largely ignores the impact of soil types, bedrock depth, and water table conditions, and when it does consider these factors, the 20 percent adjustment factor is not reasonable unless: (1) the base-case cost levels are reasonable and; (2) the cost impact of rock adds an increase in installation costs of approximately 20 percent, relative to the baseline costs.

Auditing the Hatfield model is difficult and, therefore, conclusions cannot be reached at this time regarding the reasonableness of its cable investment values.

BCM2, on the other hand, takes into consideration variations in topographical conditions, but the reasonableness of the adjustments are hard to evaluate. The sponsors of the BCM2 have provided me with their estimates of how installation costs vary by method and soil condition. The next section, "Evaluating the Installation Costs Used in BCM2 and HM 2.2.2," provides a comparison of the BCM2 data with some publicly available data. These data lead to the conclusion that the majority of these cost elements appear to be reasonable, but the weighted cost of the same activities is too high. This suggests that the model is using the wrong mix of operations for installing facilities.

Maintenance Cost Loading Factors

There are three types of cables installed in the network: aerial, underground, and buried. The latter two are combined by the BCM2 into one category, below-ground. The proportion of underground cable appropriately increases proportionately

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[9] AT&T's and MCI's responses to the Federal-State Joint Board's request for information, submitted August 19, 1996, CC Docket No. 96-45, p. 2 (second quote), 7 (first quote).

with population density. The investment in buried cable, as well as aerial cable, is converted to a yearly cost by applying an annual charge factor that is independent of the population density and the type of cable.

Normally the annual cost factor for below-ground cable varies depending on the type of cable and its construction. Table 6, below, illustrates that not only is copper more expensive to maintain than fiber, but underground cable is less expensive to maintain than aerial or buried cable.[10] The failure of BCM2 to distinguish between the costs of maintaining fiber and copper is especially problematic because the future mix of fiber and copper differs significantly from the current embedded base of facilities.

Table 6: Cable Carrying Charge Factors (Bell Atlantic)

Cable Placement	**Cable Type**	
	Fiber	**Copper**
Aerial	.0127	.0561
Underground	.0103	.0237
Buried	.0103	.0643

Source: Author’s construct from Bell Atlantic data.

Proposed Remedy

The maintenance factors provided in Table 6 can serve as benchmarks for judging the reasonableness of the maintenance factors used in forward-looking cost studies.[11]

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[10] "Bell Atlantic's Direct Case" CC Docket No. 94-97, Phase II, Exhibit 2 p. 3 of 4, October 19, 1995. Pennsylvania data is used because these are the state data Bell Atlantic characterized as typical during the case. (p. 16).

[11] Pacific Bell’s factors for underground cable (0.031) and buried cable (0.068) are in the same range as the Bell Atlantic values. Testimony of R.L. Scholl, Pacific Bell, April 17, 1996, p. 9, in *Rulemaking on the Commission’s Motion into Universal Service*, R.95-01-020.

Inappropriate Facility Mix

The models make assumptions regarding the mix of below-ground and aerial facilities that, in some instances, have little to do with the actual construction of an area's network. For example, aerial cable constitutes 89 percent of New England Telephone's sheath miles, and there are 37 households per square mile in Maine. With this population density, BCM2 assumes that only 28 percent of the copper feeder cable would be aerial and that only 20 percent of the distribution cable would be aerial. The Hatfield model is a bit more on target; it assumes that 50 percent of the cable will be aerial.

Proposed Remedy

When a model is used in a proceeding before a State PUC, this issue can easily be remedied by changing the mix of facilities through the Table Inputs Folder. But if the model were being used at the FCC, it would be difficult for the Staff to make these adjustments. The models' developers should be encouraged to substitute, on a per-company basis, the outside plant statistics located in Table 2.10 of the FCC's *Statistics of Communications Common Carriers*. Also, whenever available, they should use the outside plant statistics found in the internal reports of the local exchange companies. For example, many of the companies produce a report that shows the facility mix on a state-by-state basis (e.g., report QR7A, Plant Mileage).

The models' sponsors should also take into account that the future mix of facilities may change. For instance, in areas served by REA companies, aerial cable is rarely deployed today. The government agency has determined that borrowers should use buried, not aerial, cable. Nevertheless, in some areas, such as the rocky terrain of Maine, aerial cable will remain the primary mode of delivery.

Non-Investment-Related Expenses

Non-facility-based costs are added on as a non-plant-related expense factor (i.e., expenditures unrelated to depreciation, return, taxes, and maintenance of the facilities). Using data from ARMIS, the developers of BCM2 summed the costs for non-plant-related expenses (customer operations—marketing, customer operations—services, corporate operations, and miscellaneous depreciation expenses), and divided this value by the number of lines. The quotient was $133.39 annually, or $11.12 per month. They then assumed that 75 percent of this expense ($8.34 per month) was related to providing universal service.

This is a very poor assumption. For example, it is not reasonable to assume that 75 percent of marketing costs are related to providing universal-service-related products.[12] In contrast, the Hatfield Model includes a $1.37 monthly line charge for billing, billing inquiries, and directory listing.

Table 7, below, lists some of the TSLRIC expenses identified by Pacific Bell in a recent universal cost study presented to the California Commission. The largest cost, customer service, is associated with billing, collections, and billing inquiries. Pacific Bell argued that non-recurring costs are arguably part of the cost of universal service because of the California Commission’s decision to set the price of installation below-cost.[13] The remaining costs reported in Table 7 are associated with recurring expenses. The Administrative Law Judge (ALJ) found that Pacific Bell’s non-investment-related expenses allocated an inappropriately large share of common and shared costs, particularly customer service expenses, to universal-service-related products. As a result, the ALJ reduced the expenses by $2.00 per line. Table 7 reflects this change.[14]   The ALJ also decreased Pacific Bell’s estimate of the cost of non-recurring costs and directory assistance estimates by $1.13 and $0.42 per line, respectively.[15]

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[12] If the revenue from non-exchange services, such as vertical services, are included in the USO calculation, it is then appropriate to include some of the marketing costs.

[13] Testimony of R.L. Scholl, Pacific Bell, April 17, 1996, p. 11-12, in *Rulemaking on the Commission’s Motion into Universal Service*, R.95-01-020. I have excluded from the Table, the cost of switch maintenance ($0.50), loop maintenance ($2.48), and network operations ($1.91) since these expenses are estimated elsewhere in the BCM2 and Hatfield models.

The directory assistance cost of $0.93 presumably represents the monthly cost based on the typical number of calls made by residential subscribers.

[14] *Rulemaking on the Commission’s Motion into Universal Service*, R.95-01-020, August 5, 1996, p. 141.

[15] Ibid., p. 144.

Table 7: Non-Investment-Related Expenses (California)

Non-Investment Related Expense Item	California Cost Proxy Model
Directory Assistance	$0.93 @$0.33 per call
Directory White Pages	$0.31
Customer Services	$3.39
“Operator Minus”	$0.11
Non-recurring costs	$1.51
General and Administrative	$1.90
ALJ adjustment for Customer Services	-$2.00
ALJ adjustment for non-recurring costs	-$1.13
ALJ adjustment for Directory Assistance	-$0.42
Total	$4.59

Source: Author’s construct from Pacific Bell data.

The Pacific Bell data, as modified by the Administrative Law Judge, suggests that non-investment related expense is somewhere between the levels used in BCM2 and HM2.2.2.

Use of Census Block Group Data

A common criticism of both the BCM2 and Hatfield models is that they match census block groups with inappropriate wire centers. Furthermore, census block groups, the fundamental unit of analysis in the models, cover territory that has little or no relationship to the carrier and serving areas that are the fundamental building blocks in telephone networks. Currently, neither the Hatfield nor BCM2 models use serving-area configurations that comport with the way telephone systems are engineered. In rural areas, some of their census block groups are too large and lead to improper assumptions regarding the length of the distribution portion of the network. In more densely populated areas, the census block groups can be too small and lead to an overstatement of the cost-of-service. The cost estimate is inflated because the models deploy more fiber-optic multiplexers than are economically sensible. In short, the current modeling procedures misrepresent the layout of the network and these errors cause a significant distortion in the cost-of-production.

Proposed Remedy

More appropriate matching has been accomplished in some work that Mark Kennet has done for the consulting firm, JSI. He developed a program that combines data bases to provide wire-center boundaries, as well as census block data. (The Cost Proxy Model also uses a data base that provides wire center boundaries. This type of data should be employed in future versions of the model.) The use of this information would not only ensure that customers are attached to the appropriate wire center, but also that the size of the serving area could be modified to better reflect the engineering practices of the telephone companies. Because census blocks are smaller than census block groups, they can be combined or split to better comport with the size of the serving areas.

Traffic-Sensitive Proportion of Switch

The Hatfield model assumes that 70 percent of the cost of a digital switch is traffic sensitive. In contrast, BCM2 assumes that 30 percent of the switch is traffic sensitive. Neither model provides documentation on how these values were derived. I have created Table 8, below, to clarify how cost data could be used to support *either* position. In 1986, New England Telephone presented a study to the Massachusetts Department of Public Utilities that identified the central processor, line, and CCS (one CCS equals one hundred calling seconds) investment for both the #5ESS and DMS-100 host switches. I have used these data to estimate the investment for a switch that has 13,057 lines and a 3.55 busy-hour CCS per line.[16]

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[16] See, New England Telephone, Incremental Cost Study, Book 1 of 3, Tab 2, page 3 of 15, Docket 86-33.

Table 8: Cost Components of DMS-100 and #5ESS Switches

Switch Type	Total	Line	CCS	Central Processor
#5ESS	$4,457,421	$1,462,384 (33%)	$1,715,037 (38%)	$1,280,000 (29%)
DMS-100	$3,967,701	$2,023,835 (51%)	$1,297,865 (33%)	$646,000 (16%)

Source: Author's construct.

The portion of the switch that is characterized as non-traffic sensitive (NTS) depends on the treatment of the central processor. For instance, the central processor could be characterized as non-traffic sensitive, because, once a switch is constructed, the cost of the central processor may not change when additional CCS are carried. In this scenario, only the CCS column would be characterized as a traffic-sensitive (TS) investment. I will call this the "BCM2 view." On the other hand, central processors cannot handle an unlimited number of calls. Digital switches have been deloaded at times because the central processor could not process all of the calls. This would suggest that the central processor *is* a traffic-sensitive investment. Under this approach, the CCS and central processor dollars are TS investments. This could be the "Hatfield Model view" of the world.

If the DMS-100 data are used as the model office, the "BCM2 approach" would suggest that 33 percent of the investment is TS. If the "Hatfield argument" is accepted, and the #5ESS switch is used as the model technology, then the TS percent is 67 percent (38 + 29).

Proposed Remedy

The principal task of the central processor is to process calls. The monitoring for an off-hook signal is done by the line equipment, not the central processor. Therefore, the central processor could be characterized as a traffic-sensitive investment. On the other hand, a *minimum* size central processor is needed at each central office, regardless of the level of traffic. Therefore the central processor can be characterized as NTS investment. NTS equipment is not synonymous with line related investment. The cost of the smallest sized central processor is, in a sense, a fixed cost, but this cost is not caused by lines, rather it is incurred in order that multiple tasks can be carried out.

When the central processor is enlarged to process additional calls, the incremental cost of the expansion should be classified as traffic sensitive. To determine the fixed (or getting started) cost of a central processor, I recommend that the cost be split in one of two ways. Either allocate the getting started cost of the central processor evenly to lines and calls, or assume that 58 percent of the switch investment is traffic sensitive.[17]

Table 8, above, reflects my arbitrary assumptions regarding CCS usage and the number of lines on the switch. The models' developers should feel free to provide data that do a better job of identifying the number of lines and typical busy-hour usage on a switch. These data could then be used to recalculate the TS ratio.

For the development of unbundled rates, the models should move toward assigning the cost of the central processor on the basis of the time that the computer spends carrying out different tasks (e.g., the number of milliseconds spent processing local and toll calls, vertical services, etc.).

Switching Technology Used in Rural Areas

Neither BCM2 nor HM 2.2.2 include cost algorithms that are appropriate for the small switches that are used by the Independents. In rural areas, many Independents use switches (e.g., the Redcom Switch) that have cost characteristics which are much different than the values used in BCM2 or the Hatfield model.

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[17] The 58 percent value was derived by assuming: (a) that the central processor is a traffic-sensitive investment; and (b) that there is an equal likelihood that a #5ESS or DMS-100 switch would be deployed. I.e., 58% = .5 * (38 + 29) + .5 * (33 + 16). If the model's sponsors can provide more current or representative data, these values should be reevaluated.

Proposed Remedy

The models should be modified to reflect the cost of the type of technology that is used in low-density areas. The models should consider using these algorithms or developing their own cost estimates that reflect the technology used in low density markets.

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EVALUATING THE INSTALLATION COSTS USED IN BCM2 AND HM 2.2.2

This section discusses the reasonableness of some of the data used in the models. Much of the data used for this analysis were obtained from *Heavy Construction Cost Data: 1996*, published by Means [(800) 448-8182]. Means provides construction companies and buyers of services with an independent estimate of the construction's cost. Included in Means' total cost estimate is an allowance for a 10 percent profit by the contractor (p.3), material, labor, equipment, and overhead. The installation costs reflect the labor costs of urban areas (p. vi).

Manholes

HM 2.2.2 assumes that the price of an installed manhole is $3,000. Means (p. 78) reports that the cost varies from $2,750 for a 4' x 6' x 6' to $5,775 for a 8' x 14' x 7' utility vault. Therefore, the reasonableness of the HM 2.2.2 value depends on what constitutes a typical installation. If manholes larger than the minimum size are installed, the $3,000 value will be less than the typical cost. The REA reported that for 1993, the average installed cost of a manhole unit was $5,925. This suggests that the $3,000 estimate is on the low side.

Conduit

HM 2.2.2 assumes that the cost of installing conduit varies from $25 to $75 per foot, depending on the population density.[1] Means provides the following cost for conduit, exclusive of trenching (pp. 264-65). The variation in conduit cost is largely driven by the cost of the material, not the installation.

Table 9: Conduit Installation Costs

Rigid Galvanized Steel Conduit--Size	Investment Per Foot
2"	$ 6.70
2.5"	11.10
3"	14.20
4"	17.50

Source: *Heavy Construction Cost Data: 1996*, published by Means.

If the conduit is placed in an area that can be trenched and then backfilled by hand, the additional investment per foot is no more than $2.00 per foot (Means, p. 53). Significant additional costs are incurred when asphalt must be removed and then reinstalled. The cost of installing asphalt can be in the range of $7.50 to $9.00 per square foot (Means, p. 72), but it often runs considerably higher. Additional expenses will be incurred ripping out the old asphalt and digging through the compact dirt and rocks. The overall range of $25 to $75 per foot therefore seems reasonable.

Variation in Installation Costs by Soil Type

The beauty of the BCM2 model is its modeling of how installation costs vary depending on the type of activity. The models’ sponsors have collected data which suggest that the cost of installing below-ground cable can vary from as little as 70¢ per

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[1] AT&T’s and MCI’s responses to the Federal-State Joint Board’s Request For Information, submitted August 19, 1996, CC Docket No. 96-45, p. 17. BCM2 uses a constant value of $40 per foot for conduit regardless of the population density.

foot for a straight plow, to over $12 a foot for boring cable (see Table 10, below). This is potentially a very important contribution of the model; it can help explain variations in installation costs that are independent of density and loop length. The data presented below are my attempt to judge the reasonableness of the values proposed by the models' developers.

Table 10: The Cost-of-Service in a Densely Populated State

BCM2 Metro Weighting Multiplier for Normal Soil and Density of 650 - 850 per Square Mile			
Activity	**Cost**	**% of Activity**	**Weighted Cost**
Plow	$0.70		$0.00
Rocky Plow	$1.15		$0.00
Trench & Backfill	$1.95	25.00%	$0.49
Rocky Trench	$2.23		$0.00
Backhoe Trench	$2.04	5.00%	$0.10
Hand Dig Trench	$2.23	5.00%	$0.11
Bore Cable	$12.12	20.00%	$2.42
Push Pipe & Pull Cable	$9.80	5.00%	$0.49
Cut & Restore Asphalt	$8.23	10.00%	$0.82
Cut & Restore Concrete	$10.84	10.00%	$1.08
Cut & Restore Sod	$2.06	20.00%	$0.41
Subtotal		100.00%	**$5.93**
Conduit	$40.00	0.50%	$0.20
Total			**$6.13**

Table 10 suggests that for normal soil, with a density range of 650 to 850 lines, the cost of installing below-soil cables is $5.93, exclusive of the cost of conduit. For soft and hard rock, the cost of installation, exclusive of conduit, is $7.61 and $14.27, respectively.

In 1990, Massachusetts had a population of 6,016,425 spread over 8,257 squares miles. This works out to roughly 724 persons per square mile.[2] The State is served by one telephone company, New England Telephone (NET). In 1986, NET provided the State Commission with data for the cost per foot of installing buried and underground cable. The following Table provides the fixed and marginal cost per foot for the various gauges of copper wire used in the loop. I have followed the convention of estimating a linear cost function from broad-gauge cost data.[3] The cost of different size cables was the dependent variable, and the size of the cables, along with the intercept term, were the explanatory variables. The estimated coefficient of the intercept measures the per-foot, fixed cost of installing a cable.

The BCM2 model works with 24-gauge wire. Since the data in the Table 11 were collected, the price index for installing cable has increased only slightly. Table 11 suggests that the per-foot cost of installing cable in Massachusetts is in the range of $2 to $3, not the $6 to $14 suggested by the data used in BCM2.

The difference between the values suggested by BCM2 and the forward-looking costs identified by NET are likely due to an inappropriate mix of activities rather than that the cost levels for the individual activities are too high. In order to try to isolate the importance of each of these factors, in the next section I use data from the REA to evaluate the reasonableness of the BCM2 cost levels.

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[2] The actual telephone density is higher than this because some areas do not receive service (e.g. forests, farms), and the calculation excludes business lines. If these adjustments were taken into account, the density would be higher than 724, but this would have no effect on the conclusions that I reach below.

[3] See, for example, Rural Electrical Administration, "Design Techniques of Feeder-Distribution Cable Engineering," *Telecommunications Engineering and Construction Manual*, section 231, February 1986, p. B-41; New England Telephone, Massachusetts Department of Public Utility, Docket 86-33, Work Papers, Book 1, tab 1, p. 20 of Attachment 4; and Response of Bell Atlantic-Pennsylvania to Set VI, Interrogatory No. 7(F) of the Office of the Consumer Advocate Dated June 23, 1995, Docket M-00940587 ("Competitive Safeguards").

Cost of Service in a Rural Area

For the least densely populated areas, zero to five customers, BCM2 uses the following costs for installing a foot of cable in normal, soft rock, and hard rock, respectively:

Table 11: Fixed and Marginal Investment Per Foot of Copper Cable

Wire Gauge / Cable Placement	Fixed Investment per Foot	Marginal Investment per Pair Foot	Capacity
26			
Underground	$1.68	$.0075	3600
Buried	2.17	.0099	3600
24			
Underground	1.91	.0097	2400
Buried	2.41	.012	2400
22			
Underground	1.74	.013	1800
Buried	2.23	.016	1800
19			
Underground	2.58	.013	400
Buried	3.06	.015	400

Source: New England Telephone, work papers, book 1, tab 1, p. 1-2, attachment 1, in Massachusetts D.P.U. Docket 86-33. Data for 1987.

Tables 12-14 show, not surprisingly, that as the soil becomes more rocky, the cost of trenching increases.

I have used data from the northeastern region served by REA companies to identify the cost of plowing and trenching cable. The REA data include the price of materials, something that is not included in BCM2 cost estimates provided on the Figures.

Table 12: BCM2 Rural Weighting Multiplier Development

(0-5 Customers, Normal Soil)

Activity	**Cost**	**% of Activity**	**Weighted Cost**
Plow	$0.70	88.00%	$0.62
Rocky Plow	$1.15	0.00%	$0.00
Trench & Backfill	$1.95	0.00%	$0.00
Rocky Trench	$2.23	0.00%	$0.00
Backhoe Trench	$2.04	0.00%	$0.00
Hand Dig Trench	$2.23	0.00%	$0.00
Bore Cable	$12.12	0.00%	$0.00
Push Pipe & Pull Cable	$9.80	0.00%	$0.00
Cut & Restore Asphalt	$8.23	5.00%	$0.41
Cut & Restore Concrete	$10.84	5.00%	$0.54
Cut & Restore Sod	$2.06	2.00%	$0.04
Subtotal		100.00%	**$1.61**
Conduit	$40.00	0.10%	$0.04
Total			**$1.65**

Source: Author’s construct from REA data.

Table 13: BCM2 Rural Weighting Multiplier Development
(0-5 Customers, Soft Rock)

Activity	Cost	% of Activity	Weighted Cost
Plow	$0.70	5.00%	$0.04
Rocky Plow	$1.15	40.00%	$0.46
Trench & Backfill	$1.95	0.00%	$0.00
Rocky Trench	$2.23	8.00%	$0.18
Backhoe Trench	$2.04	10.00%	$0.20
Hand Dig Trench	$2.23	5.00%	$0.11
Bore Cable	$12.12	10.00%	$1.21
Push Pipe & Pull Cable	$9.80	10.00%	$0.98
Cut & Restore Asphalt	$14.23	5.00%	$0.71
Cut & Restore Concrete	$16.84	5.00%	$0.84
Cut & Restore Sod	$4.10	2.00%	$0.08
Subtotal		100.00%	**$4.82**
Conduit	$40.00	0.10%	$0.04
Total			**$4.86**

Source: Author’s construct from REA data.

Table 14: BCM2 Rural weighting Multiplier Development
(0-5 Customers, Hard Rock)

Activity	Cost	% of Activity	Weighted Cost
Plow	$0.70	0.00%	$0.00
Rocky Plow	$1.15	0.00%	$0.00
Trench & Backfill	$1.95	0.00%	$0.00
Rocky Trench	$10.23	38.00%	$3.89
Backhoe Trench	$2.04	0.00%	$0.00
Hand Dig Trench	$10.23	20.00%	$2.05
Bore Cable	$12.12	10.00%	$1.21
Push Pipe & Pull Cable	$14.80	10.00%	$1.48
Cut & Restore Asphalt	$16.50	10.00%	$1.65
Cut & Restore Concrete	$19.20	10.00%	$1.92
Cut & Restore Sod	$11.15	2.00%	$0.22
Subtotal		100.00%	**$12.42**
Conduit	$40.00	0.10%	$0.04
Total			**$12.46**

Source: Author’s construct from REA data.

Table 15: Cost Per Foot of Installing Buried Cable in Rural Areas (REA Competitive Bid Data)

SUMMARY OUTPUT -- 24 Gauge Wire -- Labor and Materials

Investment Per foot

Regression Statistics	
Multiple R	0.96979316
R Square	0.94049877
Adjusted R Square	0.938447
Standard Error	0.73646556
Observations	61

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	497.238993	248.6194965	458.384894
Residual	58	31.45812827	0.542381522	
Total	60	528.6971213		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.37243791	0.138359472	2.691813582	0.00927179
pairs	0.01044202	0.000345353	30.23582308	3.355E-37
trenching	1.04628261	0.215620792	4.852419856	9.5609E-06

Source: Author's construct, estimated from REA data.

This regression result, based on REA data, suggests that the BCM2 plowing cost of $0.70 is high. The intercept coefficient in the regression indicates that the investment per foot for installing copper cable is 37¢. When trenching is required, the installation cost increases by $1.05 (the value of the "trenching" coefficient in the regression) to a total of $1.42 per foot (.37 + 1.05). Both REA's plowing and trenching costs are lower than the values used in the BCM2.[4]

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[4] To the extent that the REA data do not include engineering costs, outside plant engineering costs should increase costs by approximately 5 percent, a suggestion made to me by a LEC. The BCM2 data that appears on the tables above exclude engineering costs.

The REA data also includes some useful information regarding the cost of installing cable in more congested areas. Their account system has a field code of P which stands for difficult. P is defined in the organization manual as follows:

> Predesignated buried filled cable which will, in the judgment of the Engineer, be <u>much</u> [original emphasis] more difficult to install than normal for this project because of the presence of underground facilities or severe right-of-way restrictions.[5]

As Table 16, below, indicates, when obstacles are encountered in more densely populated areas, the cost of plowing increases dramatically. When there are no impediments, the cost of installing a foot of buried is $0.37 per foot. Where obstacles are incurred, the cost increases to $1.61 per foot (see the intercept coefficient in the regression).[6] Therefore the models should reflect that the cost of installing a foot of cable increases with population density, all else being equal.

The BCM2 data can also be compared with the standard construction costs found in Means' *Heavy Construction*. Means explains that its trenching costs include excavation, backfill and removal of soil, and compaction (p.314). Assuming a zero-to-one-foot slope for the trench, Means reports that the cost per linear foot for trenching with a backhoe is $2.08 and $2.91, for depths of two and three feet, respectively. With the exception of rocky trench in hard rock, these values are in line with the BCM2 data, Means does not identify how the trenching costs vary by soil type.

In 1965, the Air Force printed a manual, “Broad Gauge Unit Costs for Outside Plant Telephone Installation and Remove,” that provides some useful data on this issue.[7] The manual identifies the additional hours of work required for trenching relative to normal conditions. The Air Force identifies the additional labor hours

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[5] REA Bulletin 345-150, "Specifications and Drawings for Construction of Direct Buried Plant," (1989) p. 5.

[6] Unlike with the prior data set, there were no observations for trenching. All installations were plow installations.

[7] The Air Force no longer publishes this guidebook.

required for each 1,000 feet of trenching for buried cable under adverse conditions. I have converted the hourly time to a per-foot cost based on a loaded hourly wage of $41.10 for an equipment operator (Means, p. 333). The additional trenching cost is in the range of one to three cents per foot when the construction is done in sand, gravel, coral rock, or rock fragmentation. While, at first, this value strikes me as low, it is consistent with the BCM2 data for soft rock relative to normal conditions. The BCM2 data show no difference in installation costs until the installer confronts hard rock.

Table 16: Investment Per Foot
(24 Gauge Wire, Buried Cable, Difficult Placement)

Regression Statistics	
Multiple R	0.954843839
R Square	0.911726756
Adjusted R Square	0.90857414
Standard Error	0.824786169
Observations	30

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	196.7326243	196.7326	289.1969
Residual	28	19.04762229	0.680272	
Total	29	215.7802466		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.607529622	0.194200875	8.277664	5.23E-09
pairs	0.010859722	0.00063859	17.00579	2.72E-16

Source: Author’s construct, estimated from REA data.

Based on the trenching data summarized above, with the exception of trenching in hard rock, I find that, on average, the BCM2 trenching numbers appear to be reasonable. The sponsors of the model should consider using the REA data for rural areas. I have been unable to locate data that allow me to benchmark the BCM2 data for the cost of trenching in hard rock.

Continuing down the BCM2 list, the bore cable cost is hard to verify. Means provides data on boring (pp. 46-47), but the unit of measurement, the cubic yard, is different than the unit of measurement used in a telephone cost study, a linear foot. Therefore, I am unable to judge the reasonableness of the bore cable value. Neither am I able to comment on the merit of the value for pushed pipe. Means has lots of data on piping, but it not clear which activity is most like the installations that the BCM2 developers had in mind when they included this cost.

The last group of cost items involves cutting and restoring asphalt, concrete, and sod. The cost of installing asphalt can be in the range of $7.50 to $9.00 per square foot (Means, p. 72), but it often runs considerably higher. The additional costs are associated with cutting the existing asphalt and digging the trench. Based on job estimates that I have seen, the BCM2 model appears to *underestimate* the cost of cutting and restoring asphalt. The additional costs associated with working on asphalt may be reflected in the models estimate of the cost of installing conduit, $40 per foot. Because of the lack of documentation, it is hard to tell if this is a correct characterization.

BCM2 uses a value of $10.84 for cutting and restoring concrete. Means reports that the cost of two-inch thick asphaltic concrete for sidewalks and driveways is $5.70 per square *yard* (p.71) and that the cost of cutting the concrete is approximately $1.47 per square foot (Means, p. 30). This data, along with an approximate $2.00 cost per foot for digging the trench, suggests that the BCM2 reported cost of $10.84 per foot is on the high side.

Finally, BCM2 reports a value of $2.06 for cutting and restoring sod. Means reports that the cost of sodding a thousand square foot area is approximately $400 (p.112). Sodding a thousand square feet is much different than patching up a small area that has been cut for installing cable. Consequently, I am unable to judge the reasonableness of the $2.06 value used in the BCM2.

Summary of Comparison Between BCM2 and Installation Costs Reported by Means

From the data that I am able to verify, I find the values in BCM2 to be generally reasonable. My greatest concern is that the estimate for cutting and restoring asphalt may be too low and the cost of plowing too high. However, the low value for asphalt may be due to the way the data are constructed. The model assumes that the cost of installing conduit is $40 per foot. This charge might be picking up the high reinstatement costs that I expect to see when asphalt is cut and repaired.

Implications for Costs Used in the Model

BCM2 uses a weighted cost for the different activities. Although I have found that the cost of the individual activities appears to be reasonable, the composite numbers appear to be high. Thus, the weighting factors are probably incorrect. The weighting factors appear in the column headed, "% of Activity," and are difficult to validate. However, since the weighted cost estimates do not comport with the prospective values reported by NET, I conclude that they are incorrect.

Future Method for Validating Cost Values

I have used NET's data to judge the reasonableness of the Benchmark Model's cable installation costs. Prospective cable cost data can be obtained from other LECs and may serve as a basis for judging the reasonableness of the models' values. The models' sponsors should be requested to provide the effective installation investment costs for different types of cables for each of a LEC's study areas.[8] The data should then be compared with the installation costs that can be derived from LEC's broad-gauge unit costs.

When the comparison is made, if there is a difference, no *a priori* assumption should be made regarding which value is correct. For example, if the model reports an installed cost per foot that is less than the value identified by the carrier, the difference could be due to the model's understatement of the economic cost-of-production that would be incurred by an efficient firm, or the values reported by the LEC could exceed the costs incurred by an efficient firm. The LEC may be inefficient or misallocating costs to its loop facilities. Where significant differences arise, the Joint Board will have to exercise its judgment concerning what constitutes a reasonable value.

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[8] The comparison should be done at the study area level, because a LEC's costs can vary greatly within a State.   For example, in a 1985 cost study undertaken by New York Telephone, the Company found that the current cost per foot of installing a 100-pair aerial cable on Long Island was $6.11 per foot. In the more rural setting of western New York, the cost was $3.22 per foot for the same size cable. New York Telephone's response to New York Consumer Protection Board Request 280, Case No. 28978, May 24, 1985.

WHERE DO WE GO FROM HERE?

Considerable progress has been made in identifying the cost of providing universal service. BCM1 provided the Joint-Board with the first systematic study of how the cost of installing a loop varied depending on such geological parameters as the bedrock depth, bedrock hardness, soil type, and the depth of the water table.

The derivatives of BCM1, BCM2 and Hatfield 2.2.2 incorporate significant enhancements. However, before either model, or a hybrid cost model is adopted, I recommend that the Joint-Board address the series of issues identified in this section. The following diagram illustrates how I believe the assessment of the cost of providing universal service should be addressed:

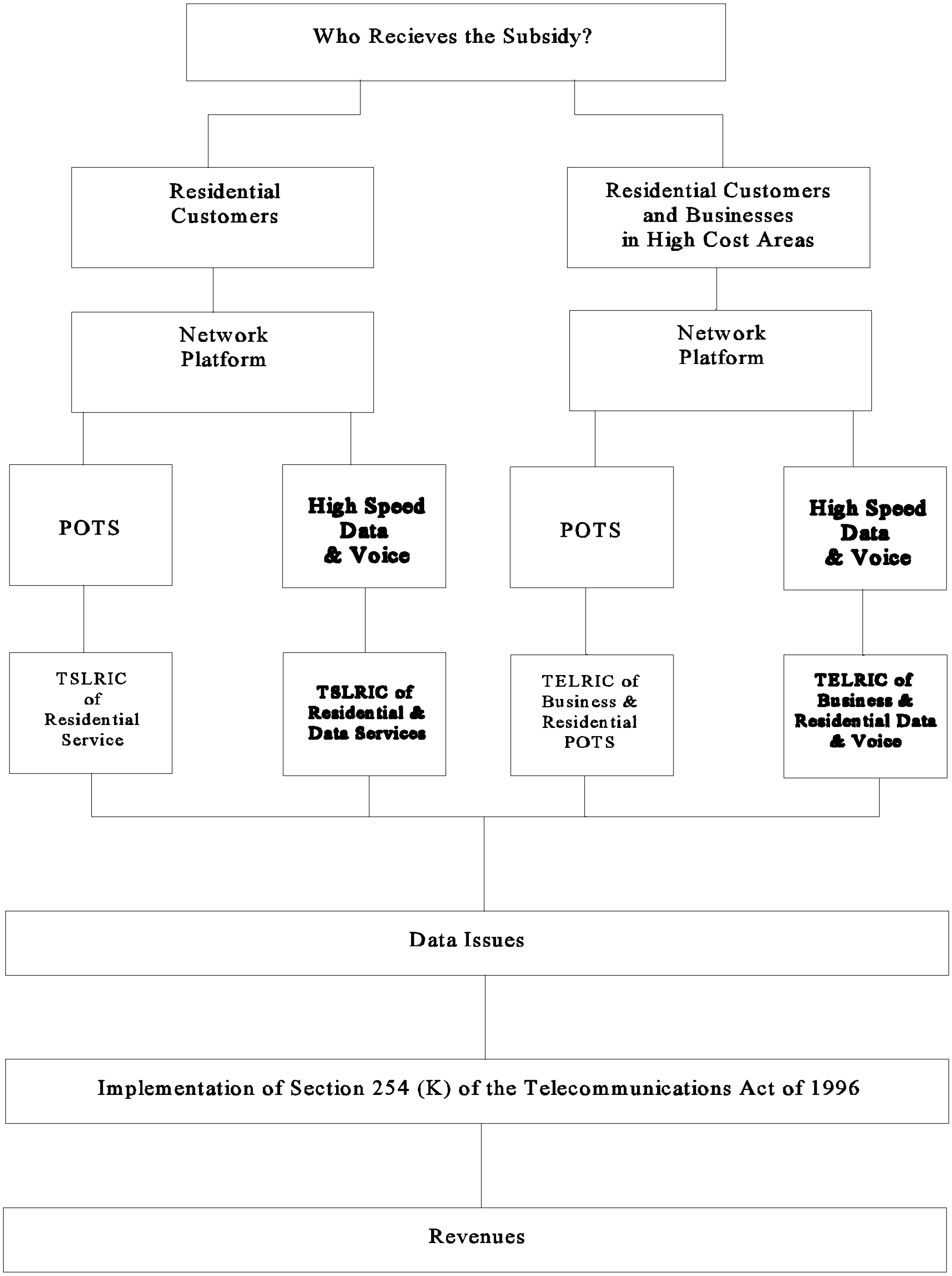
What is the Objective of the Universal Service Fund?

The costing tool should be designed to provide the information that is needed to implement the policies that are consistent with the 1996 Telecommunications Act. The Joint Board must determine whether the fund will be used to subsidize only residential customers, or if it should be expanded to recover a portion of the cost of serving business customers in high-cost areas. If the Joint Board concludes that both groups should receive subsidies, then the fund should be designed to measure the shared and the direct cost of providing service to both sets of customers. This is equivalent to measuring the total element long-run incremental cost-of-service (TELRIC). If the Joint Board concludes that the Act is designed to provide support only to residential customers, then the cost tool should measure only the incremental cost of providing residential services. This is equivalent to measuring the total service long-run incremental cost-of-service (TSLRIC).

Network Platform

There is an important distinction between basic local telephone service and the local common exchange plant. Basic local service is simply voice telephone connections within a specifically defined local area. Local exchange plant is comprised of those facilities that are physically located within the given area, but that are used to supply both basic local and premium services.

Figure 1: What's Left to be Done



The loop and port on the switch are not used only for exchange service. These facilities are a common input for the provision of all switched service. Thus, local exchange facilities, generally referred to in the industry as “local exchange plant,” are an essential input to almost all services. So, local exchange plant is used as a common facility to supply “basic” service—as well as an increasing variety of “premium” services.

Local exchange facilities are used by different kinds of services that are provided over them, and such facilities are engineered and designed to provide multiple services. The costs of the common facilities are caused by multiple services, and recovery of those costs must be shared by the multiple services provided over them.

Local exchange facilities are used by different kinds of services that are provided over them. As such, the engineering design standards, the functional characteristics of the facilities, and the investment and expenses incurred, are determined by the variety of functions for which those facilities will be used. This means that the costs of the common facilities are *caused* by the multiple services and, therefore, the recovery of the costs must be shared among the services provided over them. The principle that the cost-causing services should be responsible for recovering the costs associated with their demand[9] requires that the recovery of the local exchange plant costs be based on the traffic and engineering parameters of all the services that share the facilities, rather than just recovering all of the common and joint costs from local exchange services.

BCM2 reflects only partially the engineering assumptions that are driven by the LEC’s development of integrated service digital networks (ISDN). In order to maintain transmission integrity for high-speed data, the maximum copper distance on a loop must be in the range of 12,000 to 18,000 feet. In the BCM2, the maximum copper distribution distance is set at a default level of 12,000 feet.[10] In a voice-only network,

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[9] Mountain States Telephone & Telegraph, 82 PUR4th 64, 82 (1987).

[10] "Benchmark Cost Model 2: Methodology,” n.d., n.a., p. 3.

the copper feeder and the distribution distances can be considerably greater than

18,000 feet. Therefore, compliance with the ISDN standards necessitates the design of a network that does not minimize the cost of providing voice service.

If the intent of the universal service cost modeling exercise is to obtain an estimate of the LECs' prospective costs, the ISDN standard should be built into the models.

The Joint Board should determine whether the models should be designed to meet the resistance design standards for voice or for ISDN. If the latter standard is adopted, this will raise the cost of providing universal service; it will, in fact, essentially redefine the nature of universal service. Rather than limiting universal service to ordinary voice communications, it would be expanded under §254(c)(1) to include LECs' provisioning their networks to provide at least 64 kbs transmission speeds to each household in America. For a number of years, the ISDN standard has guided the engineering of loops. If the intent of the universal service cost modeling exercise is to obtain an estimate of the LECs' prospective costs, the ISDN standard should be built into the models.

If the policy objective is to fund the provision of voice services only, then the ISDN standards should not be built into the models.

If the cost models are designed to measure the cost-of-service on an ISDN network, it would be inappropriate to consider only the revenue from traditional exchange services. Since the provision of new services is driving the design of the network, the revenues from ISDN and other enhanced products should be included in the analysis. To do otherwise would involve a mismatch between the cost drivers, the provision of new services, and the profitability of universal service products. If the policy objective is to fund the provision of voice services only, then the ISDN standards should not be built into the models.

Data Issues

A number of data issues have been raised in this paper. I have relied on publicly available information to evaluate the reasonableness of the network's largest cost, the cables that link customers to the wire center. The sponsors should be encouraged either to adopt the values presented in this paper or to provide better documentation as to why their current or some other alternative values should be used. The Joint Board should also provide guidance on the following issues:

Depreciation

Depreciation rates used by the industry are very much a function of the services which are available currently, or are likely to be introduced in the foreseeable future. For example, the LECs' interest in providing broadband services has encouraged them to shorten the remaining life of copper cables. The provision of CLASS services compelled the local exchange companies to replace modules in both the DMS-100 and #5ESS switching machines because they were unable to provide these new enhanced services; however, they were quite capable of providing voice services.

For example, New England Telephone's 1993 Depreciation Rate Study for Maine contains a poignant description of the factors that are driving the reduction in the life of this class of plant:

> At the core of the evolution to broadband is the demand to transport data, image and video information. Today's digital switches are designed to handle up to 64 Kb/s of bandwidth. However, new and emerging data services such as computer-based imaging and multimedia communications require much higher bandwidths. <u>In order to handle these high-capacity communications, the existing digital switching equipment must be upgraded or replaced</u> [emphasis added]. These data services will require an integrated broadband architecture which includes Metropolitan Area Networks (MANs), Broadband ISDN/Asynchronous Transfer Mode (BISDN/ATM) and features planned for the Photonic switch of the future.
>
> Providing the capability of bandwidth on demand through the adoption of BISDN (broadband integrated services digital network) along with Synchronous Optical NETwork (SONET) transmission standards will eventually cause the replacement of the majority of today's digital switching equipment, including line cards and networks, and eventually cause wholesale switch replacements. The evolution to broadband switching is expected to begin soon and complete over a shortened time

frame as compared to previous technologies.[11]

These two paragraphs from NET's Depreciation Rate Study exemplify the overall driving force behind the shortened, expected life of digital switching. NET believes that the switches need to be replaced in order to enhance its marketing of high-speed data and video services. These services, rather than exchange voice-grade service, are responsible for the shortened life, and hence, the increased depreciation expenses. If not for the increased effort to market these new services, there would be a reduced need to accelerate the retirement of digital switches. Therefore, for the universal service study, the Joint-Board should either adopt lives that are appropriate for a voice-only network or include the earnings from these new services in the profitability analysis. If the cost impact of the new services is to be reflected in the cost studies' depreciation rates, the earnings should be as well.

NET, like other LECs, expects a continued need to upgrade the processor of the switching machines: "These [core processor] upgrades are continuing to occur <u>and are required to increase overall capacity of the digital switch Custom Calling Services on a per line basis and the implementation of new digital only features under the service mark of NYNEX Pathway Services</u>.[12] [emphasis added]

Signaling System Seven (SS7) was installed to a large degree to meet the needs of the interexchange carriers, and to allow the LECs to offer new, enhanced services. NET's depreciation rate study points out that

> Since the 1990 (depreciation) Study, the level of retirements ... have increased significantly...due to the accelerated deployment of SS7 and CLASS features.[13]

NET adds that

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[11] NET's 1993 Depreciation Rate Study for Maine, filed December 8, 1992, section Electronic Digital Switch, p. 13-14.

[12] Ibid., p. 8.

[13] Ibid., p. 7.

> SS7 requires major switch replacements of earlier trunking units, extensive modification to current trunking modules and entire network fabric change-outs to support higher transmission rates. These retirements and replacements represent a significant portion of the switch investment.[14]

Explaining the need to increase the depreciation rate for the #5ESS switching machine and remotes, NET pointed out that

> as the switches upgrade to the higher levels of more complicated software generic programs that offer CLASS, AIN (advanced intelligent network), ACD capabilities, major change-outs are occurring within the switch. The software upgrades not only provide CLASS, AIN, etc. capacity, but are mandatory requirements for 800 Numbers Portability, CIC Code Expansion and National ISDN-1.[15]

These passages all illustrate that the shortened life of digital switches is being driven by non-exchange services. When measuring the cost of universal service, the depreciation rates should either be based on the technological life of the equipment required for voice exchange service, or the profitability analysis should include the earnings from broadband digital and CLASS services. If the former option is selected, the Joint Board should consider basing the depreciation lives and salvage values for POTS on the mid-point values established by the FCC.[16]

Cost-of-Money

BCM2 currently uses an 11.25 percent cost-of-money, which was adopted by the FCC a few years ago. The current interest rate on telephone bonds is 7.86 percent.[17] Assuming a 45/55 debt/equity structure, a composite 11.25 percent return is equivalent

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[14] Ibid., p. 8.

[15] Ibid., p. 8.

[16] These rates are summarized in Connecticut Department of Public Utilities, “Investigation into the Southern New England Telephone Company’s Intrastate Depreciation,” Docket No. 94-10-03, November 21, 1995, pp. 23-24, and Table E.

[17] New York Times, October 10, 1996, p. D18.

to a 14.025 percent return on equity. This level of return is quite high, relative to the cost of capital determined in recent State regulatory proceedings. For instance, in March of this year, the Connecticut Department of Public Utility Control determined that 11.90 percent was the appropriate cost of equity.[18] The Joint Board should recommend a cost of capital that is in-line with the recent findings of the State Commissions.

How Many Loops are Eligible for a Subsidy

Presumably the Joint Board will recommend that the universal service fund be used to subsidize only one line at any given household. In order to comply with the Act's objective of technological neutrality, the subsidy should be portable. The subscriber should be able to apply the credit to any authorized local exchange operator that provides service in the high-cost areas. If the size of the fund is calculated by identifying those areas within a wire center in which the revenues are less than the cost-of-service, the subsidy should not be available to suppliers that serve only a portion of a wire center. The subsidy should be available only to suppliers that are serving high-cost census blocks, CBGs, or whatever unit of analysis is adopted by the Joint Board.

It is sensible to subsidize only the primary line because that is all that is required to obtain access to the voice network. Second lines are often installed for fax lines or for access to the Internet. Separate lines for these services are not a necessity and therefore, should not be included in the universal service funding mechanism.

If only one line per household is eligible for a subsidy, the costing of the USF should reflect this policy decision, and the utilization rate built into the model should reflect this policy objective. Fewer spare cable pairs are required if there is no need to provision the network for a second household line. If, on the other hand, a decision is made to subsidize more than one line per household, then the revenue from the second line should be included in the analysis. Both revenues and costs for products should

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[18] *Application of the Southern New England Telephone Company for Financial Review and Proposed Framework for Alternative Regulation*, Docket No. 95-03-01, p. 139, March 13, 1996.

be treated in like fashion.

A third approach, and the one I recommend, is to provision the network for two lines to each household. The profitability analysis should then take into account the earnings from both lines. The advantage of this approach is that the Joint Board will not have to decide the appropriate level of spare facilities in a network designed for only single-line households. The adoption of this study technique does not conflict with a policy of providing universal service support for only one line.

Cost Allocation Requirements of §254k

The 1996 Telecommunications Act requires that

> The Commission, with respect to interstate services, and the States, with respect to intrastate services, shall establish any necessary cost allocation rules, accounting safeguards, and guidelines to ensure that services included in the definition of universal service bear no more than a reasonable share of the joint and common costs of facilities used to provide those services.[19]

Section 254(k)'s requirement is not limited to high-cost areas. Regardless of the cost-of-service, the law requires that the price of these essential services not be set to recover the total cost of joint and common inputs. This section of the law precludes the Commission from adopting policies that effectively require the recovery of 100 percent of the joint cost of the loop from exchange service. The universal service fund and/or the access fees must be designed to recover a portion of the joint and common costs of facilities as mandated by §254(k).

Defining Relevant Revenue

The purpose of undertaking a cost study for universal service is to identify the cost of providing service to unprofitable areas. The cost data should be used in the same manner in which a business would use this information; cost data should be used to access the profitability of the relevant products. Areas should qualify for universal service support where the cost-of-service exceeds the relevant revenues, based on the funding requirements of §254(k).

The relevant revenues depend upon how the cost model has been constructed. As a starting point, if the cost of serving all customers, including business subscribers, is considered, then the relevant exchange revenue is not limited to residential service. Both BCM2 and HM2.2.2 have been used to identify the direct and shared costs of business and residential service. Since costs that are not part of the direct cost of

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[19] §254(k).

residential service have been included in the cost estimates, the revenue derived from business exchange service should also be included. The revenue from business lines is considerably higher than it is for residential customers. For example, in 1992 small business paid an average of $42 per month for single line service, while residential customers paid $18.66.[20]

Furthermore, both models include costs that are incurred for the provision of vertical services. The investment for the central processors in digital switching machines enables the companies to provide such features as call-waiting and call-forwarding. Since the BCM2 and HM2.2.2 include some or all of the cost of providing these vertical features in their estimates of the cost of providing universal service, the revenues from these enhanced features should be treated in a consistent manner. To date they have not been; rather, the focus has been on the revenue which has been derived from residential exchange service and the subscriber line charge.

HM2.2.2 also appears to include signaling system seven functions in the cost of basic local service investment.[21] SS7 is used in signalling, routing calls, and in providing the new family of CLASS vertical features. If the costs and expenses of providing CLASS services are included in HM2.2.2's USO estimates, then the revenue derived from these facilities should also be included.

- When a subscriber is connected to the network, call revenue is derived on both outgoing and incoming calls. If the Commission maintains the common carrier line charge (CCLC), the CCLC revenue should be included in the profitability analysis. The CCLC revenue should be included because the profitability of serving a customer in a high-cost area is also a function of access revenues. If the Commission eliminates

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[20] Common Carrier Bureau: Industry Analysis Division, “Reference Book: Rates, Price Indexes, and Household Expenditures for Telephone Service,” May 1993.

[21] Michael Pelcovits and Joel Lubin responses to the Federal-State Joint Board’s request for information, August 26, 1996.

> the CCLC, as suggested in its interconnection order,[22] it must adopt some other mechanism which satisfies the requirement of 251(k) that "universal service bear no more than a reasonable share of the joint and common costs of facilities used to provide those services." These revenues should be included in the profitability analysis. If these revenues are not considered, connecting carriers may be asked to pay twice for the same facility. That is, they may be required to pay for a portion of the common and joint costs through the access fee, and then a second time through their universal service fund contribution.

As demonstrated in the discussion of depreciation, the introduction of new vertical services has been an important factor in the reduced life of facilities. If the cost studies are based on the service lives associated with a non-POTS network, the revenue analysis should also reflect the profits earned on these new services, products that may be sold in competitive markets. To do otherwise would violate the cost allocation standards established in §254(k). The cost of these network upgrades cannot be assigned and recovered totally from universal service products.

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[22] See FCC 96-325, *First Report and Order* in CC Docket No. 96-98, "In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, and CC Docket No. 95-185, "Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers" (Adopted: August 1, 1996, Released: August 8, 1996), paragraph 31.