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OFFICE OF SECRETARY

EX PARTE
February 5, 1997

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, DC 20554

RE: Ex Parte Notice - CC Docket No. 96-45

Dear Mr. Caton:

On February 5, 1997, Dr. Robert F. Austin, Barbara Allgaier, John Schrotenboer, and Porter Childers representing the United States Telephone Association (USTA) met with David Krech, Brad Wimmer, David Konuch, William Sharkey, Emily Hoffner, Bob Loube, Whitney Thayer, and Bryan Clopton of the Federal Communications Commission's Common Carrier Bureau. Also, Paul Pederson and Brian Roberts of the state staff on the Federal-State Joint Board on Universal Service participated by telephone.

The attached document was used during the discussion.

An original and a copy of USTA's ex parte filing are being filed in the Secretary's office on February 5, 1997. Please include this filing in the public record.

Respectfully submitted,

Porter E. Childers

Porter E. Childers
Executive Director
Legal and Regulatory Affairs

Attachment

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Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model 2.2, Release 2

Price Technical Services, Inc. and

Austin Communications Education Services, Inc.

Principal Investigator:

Robert F. Austin, Ph.D.

February 5, 1997

Executive Summary

The United States Telephone Association retained Price Technical Services to provide an engineering evaluation of cost proxy models submitted in the Federal Communication Commission's Universal Service proceeding, CC Docket 96-45. This report contains our engineering evaluation of the Hatfield Model Version 2.2, Release 2, sponsored by AT&T and MCI.

In view of its importance to the Hatfield Model, we begin our critique with an evaluation of the concept of structure sharing. We then review four aspects of the model: model structure, engineering assumptions, materials assumptions, and data inputs. In our discussion of the model structure, we consider the logic that underlies the model and defines its function. In the section on engineering, we consider the assumptions and methodologies of the engineering paradigm that supports the model. In the section on materials, we evaluate the materials recommended or specified in the model and consider possible conflicts between the materials specified and the model's assumptions. Finally, in the section addressing data inputs, we consider the default values of the model, as well as the user defined inputs to the model. We consider the implications of the input and default values specified by the model's designers for the outputs that the model produces.

We identify significant shortcomings in the model. Cumulatively, these shortcomings constitute strong evidence of an unacceptable bias in design that would preclude use of the model in any real world design or cost analysis. Perhaps the most significant issue in this regard is the failure of the model to incorporate contemporary design principles in the feeder network. These shortcomings also indicate a weak design embedded within the software, a weakness that probably could not be overcome by simply recompiling the code or transferring the underlying design to another software application package.

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Introduction

The United States Telephone Association ("USTA") retained Price Technical Services to provide an engineering evaluation of cost proxy models submitted in the Federal Communication Commission's ("FCC") Universal Service proceeding, CC Docket 96-45. These models are the Hatfield Model Version 2.2, Release 2 ("Hatfield Model"), sponsored by AT&T and MCI, and the Benchmark Cost Proxy Model ("BCPM"), sponsored by Sprint, US West and Pacific Bell. Working with Austin Communications Education Services, Price Technical Services has prepared and submits herewith this report of our engineering evaluation of the Hatfield Model

Hatfield Associates initially prepared what became the Hatfield Model under contract to AT&T. Independent of this effort MCI and various partners had authorized the preparation of a cost proxy model known as the Benchmark Cost Model ("BCM"). Subsequent to Hatfield Associate's initial design work, the firm incorporated a revised version of the BCM, known as BCM-PLUS, in the Hatfield Model. The most recent release of the Hatfield Model is Version 2.2, Release 2. To facilitate public discussion, Hatfield Associates published this version of the model, and the associated documentation, on CD-ROM on September 10, 1996.

In view of its importance to the Hatfield Model, we begin our critique with an evaluation of the concept of structure sharing. We then review four aspects of the model: model structure, engineering assumptions, materials assumptions, and data inputs. In our discussion of the model structure, we consider the logic that underlies the model and defines its function. In the section on engineering, we consider the assumptions and methodologies of the engineering paradigm that supports the model. We also evaluate the model to determine the extent of its compliance with the Joint Board's recommendations concerning supported services. (See Appendix A.)

In the section on materials, we evaluate the materials recommended or specified in the model and consider possible conflicts between the materials specified and the model's assumptions. Finally, in the section addressing data inputs, we consider the default values of the model, as well as the user defined inputs to the model. We consider the implications of the input and default values specified by the model's designers for the outputs that the model produces.

Structure Sharing

Introduction

The Federal-State Joint Board on Universal Service, CC Docket 96-45 ("Joint Board") published its *Recommended Decision* on November 8, 1996. In that document, the Joint Board specified that the "technology assumed in the model should be the least-cost, most efficient and reasonable technology for providing the supported services that is currently available for purchase."[1] Furthermore, the Joint Board specified that: "All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible." [See Appendix A for the complete list of recommendations.]

While these specifications arguably may be in conflict in some instances, they certainly constitute an endorsement for sharing network construction costs among several companies where feasible. Both models address the subject of structure sharing explicitly in several tables and implicitly in their structure. In brief, the concept assumes that several companies could use some or all support structures in a telephone network simultaneously. For example, in theory several companies could attach aerial cables to a pole.

The number of companies that may attach facilities to a pole depends primarily on the height of the pole, the class of the pole, and the number of pre-existing attachments. The height of the pole is a factor because federal, state, and local laws and ordinances, as well as safety concerns, mandate certain minimum clearances over roadways and railroad tracks below the cable span. These and other parameters, such as the weight of the cable, dictate the minimum height at which users may attach cables to poles.

The same and other regulations prescribe the spacing of cables on a pole. In combination, these constraints determine the maximum theoretical number of cables that users

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[1] Federal-State Joint Board on Universal Service, CC Docket 96-45, *Recommended Decision*, November 8, 1996, ("Joint Board Decision"), paragraph 277.

may attach. Similarly, the class of the pole, which corresponds to the diameter of the pole (six feet above ground after pole placement), determines the total load that the pole may bear and the support guying required. Pre-existing attachments, by definition, occupy space to the exclusion of newcomers.

It seems reasonable to state that high relative rates of structure sharing would best serve the interests of the Hatfield Model's sponsors. In support of this statement, we note first that a high assumed rate of structure sharing will result in a calculated reduction of the average forward-looking costs of construction, hence a reduced cost for unbundled network elements. This would result in lower network "assembly" or "element leasing" costs (as opposed to construction costs) for the sponsors. In other words, the higher the rate of sharing that the model assumes, the lower the *pro rata* cost of new network construction that the model will calculate.

Second, a higher rate of proposed structure sharing infers the existence and current availability of a larger amount of structures for immediate use in network build-out by entrants to the market. If Entrant Local Exchange Companies ("ELEC") should decide to reject the pricing of unbundled network elements, they could demand access to this hypothetical structure capacity. If the Incumbent Local Exchange Companies ("ILEC") do not make capacity available, the ELECs could claim that the ILECs were intentionally and anti-competitively withholding this hypothetical capacity.

(Interestingly, in their supplementary Hatfield Model filing, the sponsors stated that: "Present structure owners could use their control of these scarce resources to restrict entry by potential competitors."[2] If the resources are indeed scarce, where is one to find the surplus capacity that the ELECs allege is available?)

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[2] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 20.

Third, the structure sharing rates presented in the model imply that the ILECs have been prodigiously inefficient and profligate in their spending by failing to share structures at the rates recommended by the Hatfield Model sponsors. While this may be a comforting, albeit self-serving, assumption, it also, in most respects, is an unreasonable assumption. During the first 80 years of the life of the telephone industry, there were no CATV companies to share structures. Therefore, the telephone companies did not build structures to share with them.

During the same 80 years, there were no dielectric, fiber optic cable transmission facilities that could safely share a duct or feeder route trenches with power cables. The ILECs shared poles where it was possible, given concerns about induction coordination, by attaching telephone cables to power poles, by organizing joint construction in appropriate areas, and by installing larger poles, under certain circumstances, and leasing capacity to the power companies.

Incorporating Structure Sharing in a Model

The Joint Board's specifications regarding universal service costs are clear and unequivocal. Only forward-looking costs may be considered. The scenario they specify dictates that, for modeling purposes, there are no existing telephone network structures or facilities. The scenario also specifies that models should assume that the locations of the existing wire centers persist. (Although with the benefit of 100 years of hindsight some observers may judge these wire center locations to be less than optimal, their selection for modeling is a neutral assumption: all models will work from the same given location to build new networks. In any event, their locations reflect the distribution of population reasonably well.)

One option for a cost model would be to consider the use of existing facilities placed by other industries. For the most part, the nation's CATV and power networks are in-place

and in-service. (The Joint Board quite correctly does not suggest that a model of telephone network construction costs should assume "green fields" for every utility or be predicated on the complete reconstruction or new construction of these other utilities' networks.) If these utilities sized their structures to permit leasing of excess capacity to another company or companies, there might be capacity available for use by a new telephone company. The Hatfield Model does not appear to incorporate such ELEC costs (that is, leasing facilities from utilities other than ILECs), a shortcoming that we recommend for correction in future model releases.

In their supplementary Hatfield Model filing, the sponsors stated that: "It is more than reasonable to assume that, *on a forward-looking basis*, ... ILECs will be able to recover an increasing portion of their structure costs through joint ownership or rental arrangements."[3] This appears to be an unreasonable assumption, given that the electric companies and CATV companies already have their networks built.

If, on the other hand, the ILECs were to place all new structures for their new, forward-looking network, we must assume they would size them in compliance with the FCC's constraints on the model, including the "least cost" constraint that precludes construction of surplus structure capacity. A design engineer might assume that under some circumstances the true "least cost" might be a shared new construction cost and that the telephone company should build and lease excess new, forward-looking structure capacity to reduce aggregate costs. In this case, the telephone company will face a marketing problem: the networks of the other utilities already exist. There are no other companies with whom to share these structures, except, perhaps, a hypothetical ELEC. (We must exclude the cases of new sub-divisions because the guidelines given to the model developers preclude considerations of future growth in demand.)

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[3] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 20.

Practical Considerations

Beyond the philosophical issues associated, there are several tangible practical issues associated with structure sharing that the Hatfield Model ignores. Regarding aerial plant, currently accepted, industry-wide engineering practices dictate minimal use of aerial facilities. This design principal recognizes: 1) the higher whole-life costs (including maintenance) of the facilities, 2) the exposure of the aerial facilities to more and greater environmental hazard, and 3) the zoning requirements of many local governments regarding design aesthetics. Consequently, the assumption regarding the mix of aerial, buried and underground plant is untenable. While the model does permit adjustment of this mix, the selection of the defaults shown in the model reflects antiquated thinking about outside plant design. It also obviates the usefulness of the Southern California Joint Pole Committee cited in the supplementary Hatfield Model filing.[4]

Regarding manhole-conduit system use, there are several cable placement problems ignored by the Hatfield Model. For example, there is a significant problem raised in the size of the manhole specified in the model. The model should specify a precast manhole with standard dimensions of 6 feet X 12 feet X 7 feet (excluding the mid-section), as recommended in the *AT&T Outside Plant Engineering Handbook*. Instead, the model specifies a much smaller Type A handhole with dimensions 4 feet X 6 feet X 7 feet.[5]

A manhole with these dimensions does not provide the capacity suggested by the model as being available for sharing or lease. Indeed, it would be difficult for a manhole with these dimensions to accommodate multiple splices and cable entries as the number of

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[4] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 21.

[5] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, Section 8. The sponsors of the model cite as support for this selection a publication called the National Construction Estimator, 44th edition, page 442.

cables and their sizes increase. As confirmed by the AT&T handbook, engineers should only use this manhole for "light, secondary conduit runs or buried cable runs."[6] This practice serves to reduce the cost of manholes in the model's calculation, and therefore understates the true cost of network construction. More significant to the present discussion, it precludes the volume of sharing assumed by the model.

Under certain circumstances, regulatory authorities or responsible outside plant planning design principles dictate the sharing of duct. In these cases, users must make substantial modifications to the model, including changes in the size and price of the manholes and in the number and cost of multiple ducts. Moreover, users would need to incorporate the costs attributable to "proving" the duct and to cable pulling in the duct. Neither cost is evident in the Hatfield Model.

The Hatfield Model does not properly apply additional cost burdens before assuming the split in costs associated with the conduit/direct buried/ aerial applications. There will be an increase in construction placement costs in most cases if trenches or other facilities are shared or jointly occupied. In most cases, a shared trench must be deeper and wider to accommodate the additional utilities that are participating in the shared or common trenching. This is a function of the requirements for minimum separation in horizontal and vertical planes mandated by the governing authorities.

To expand on this subject, the *AT&T Outside Plant Engineering Handbook* specifies: "**Joint trenching with power facilities should be employed only for distribution cables and service wires, not for feeder or trunk cables**" [emphasis in original publication].[7] The same document also specifies the minimum separation distances that en-

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[6] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 8-35, Table: "Precast General Use Manholes".

[7] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 9-5.

gineers must maintain between power and telephone plant to ensure public safety and the integrity of the facilities. The separation distance is 12 inches in most cases. More importantly, however, higher voltage power lines must be placed at a greater depth (for example, 42 inches for voltages over 50,000), which will increase the cost of trenching substantially.[8] In addition, some municipalities, counties and parishes require additional protection such as concrete caps, concrete encasement, or steel casings for shared facility use.

Sample Calculation

In the calculation of the cost of support structures such as poles and conduit systems, the Hatfield Model first estimates the total cost of the structures. Based on its assumption that three users will share each structure, the model then allocates 33 percent of the total structure costs to the telephone network. Such an approach to cost identification leads to logical contradictions in many instances.

We observe such contradiction in the following example from the State of Florida. In the calculations of cable requirements for one Florida Census Block Group ("CBG"), the Hatfield Model specified the placement of five 4,200 pair copper feeder cables, one 1,800 pair copper feeder cable, and one fiber cable in one conduit. The model specifies that these cables will occupy only 1/3 of a single duct that costs just $1 per foot (exclusive of placement costs). The diameter of a 4,200 pair, 26 gauge air core copper cable (DUCTPIC® Bonded Stalpeth) is 3.35 inches. The diameter of a 1,800 pair, 24 gauge (as specified by the sponsors of the Hatfield Model) air core copper cable (DUCTPIC® Bonded Stalpeth) is 2.88 inches. The diameter of the fiber feeder cable would be at least one-half inch. Because the diameter of a duct is 4 inches, an engineer obviously will require more than one duct to design the network. Consequently, the duct

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[8] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 9-6.

will have a material cost much higher than the cost per foot suggested by the model's calculations.

Summary

The principle of "least-cost" dictates that ELECs and ILECs model their networks with facilities of dimensions and capacities suitable for present service rather than future service. Therefore, an ELEC or ILEC probably would perform forward-looking new construction with "least cost" poles that power companies could not share because of the short pole height. In any event, the power and CATV companies probably would not share these "least cost" poles because their systems already exist. The shorter pole size also would mean that ELECs that chose to attach to ILEC-owned poles might encounter difficulty ensuring road clearances at mid-span.

Similarly, the ELECs or ILECs would perform the forward-looking new construction using "least cost" manholes and fully occupied ducts. Under these circumstances, users obviously will invoke the ability to modify default values during actual cost studies. However, use of these default values by the sponsors of the Hatfield Model will skew the results of analysis during public discussion. The Hatfield Model's input and structure assumptions are inappropriate to the constraints imposed by reality.

Furthermore, we believe that users of the Hatfield Model should give some consideration to issues of public safety and security. The model does provide for user intervention in the presumed sharing rates. We believe that engineers should use this feature for reasons other than economic considerations. For example, Pacific Bell does not share conduit with gas companies or power companies. The risk of explosion or inadvertent exposure of, or damage to, a power cable is too great to justify the financial savings.

Finally, the Expense Module appears to suggest that maintenance costs are part of the

total shared structure costs. We believe this is a difficult assumption to sustain, because it implies that non-owners will incur some liability for the on-going expenses associated with maintaining the structures. It is difficult to conceive of such a relationship (as opposed to a lease or attachment arrangement). If the Expense Module does include provisions for sharing maintenance costs, we recommend reconsideration of the cost allocation for expenses.

Model

Introduction

It appears that the Hatfield Model contains no individual hidden cells. In general, however, the logic of the model is not readily apparent. The model embeds the logic within multiple worksheets and cells whose cross-references are unclear. Consequently, and in view of the time required to load and review the physical model, we have not attempted to perform a detailed analysis of the data flow within the model.[9] Moreover, we have performed no statistical significance testing on the constituent algorithms. Complicating these issues is the fact that the Hatfield Model requires (at least) two distinct models to run: the BCM-PLUS model and the Hatfield Model *per se*.

Nevertheless, we have evaluated constituents of the model and have identified certain flaws in the components of the model that appear to affect its overall utility. Most of these flaws are intrinsic to the model logic and do not appear to be changeable by the user.

Missing Inputs

There are several areas in the model that inappropriately preclude user input. In other words, the model does not consider all the units necessary to build a functioning telephone network. The cumulative effect of these omissions and related errors (for example, the model ignores many costs associated with the units that it does define) is to understate significantly the cost of constructing a network. These omissions result in the model being unsuitable to its stated purpose without major revisions.

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[9] Using a 133 megahertz Pentium processor notebook equipped with 1.3 gigabytes of storage and 24 magabytes of memory, the model required 769 minutes to load and process the model and data for the state of Rhode Island, the smallest data set provided with the model. While we recognize that the model's designers recommend using a computer equipped with 128 megabytes of memory, we also recognize that design engineers will typically work with a system more closely approximating our test machine.

This is a particular problem for the design of the basic service loop. As currently configured, the Hatfield Model generates loop costs that are implausible and unreasonable by professional standards. Our engineering critique focuses on the problems associated with loop design. The remainder of this section considers other significant omissions from the Hatfield Model.

Construction Equipment

The Hatfield Model does not appear to make any provisions for vehicles, buildings, tools, equipment and similar network construction costs, as opposed to system operation and maintenance costs. If confirmed, this would have a significant impact on the cost of network construction. For example, fusion splicing equipment costs $45,000 or more per unit and optical time domain reflectometers ("OTDR") cost $15,000 or more per unit. Given the production capacity of these devices, these specific equipment costs will be particularly significant if the ELECs or ILECs attempt to build the network within the time frames implicitly assumed by the Hatfield Model. Similar costs appear in the Expense Module, but it is unclear if these are for maintenance or original construction. This is of particular importance if structure sharing is to recover the costs of operation as well as construction.

The Hatfield Model excludes the cost of Operational Support Systems ("OSS"). The true cost of a network must include the cost of numerous support systems, including switching software systems and their associated routing tables and data bases. Other functions for which an operating company must develop and use support systems include the following:

- customer care
- job management
- alarm management
- network management
- circuit management
- account management
- work force management
- network distribution mapping
- inventory
- charging and billing systems

- fault management
- materials management

The costs of these systems, which we estimate to be approximately five to eight percent of the network construction costs, should be included in the cost of building a network. It is unclear from the model's documentation if the model considers these costs only as expenses of operation.

The Hatfield Model makes several questionable assumptions regarding demand and system usage. For example, the Hatfield Model assumes a very high average amount of traffic that, in our opinion, is unlikely, particularly in a competitive environment where multiple service providers share the traffic. The Hatfield Model also assumes an excessive amount of directly trunked traffic, with only 20 percent of all traffic assumed to go through a tandem. We recommend review of these issues in future revisions of the model.

The Hatfield Model assumes a square CBG with a uniform distribution of households. The model attempts to lessen the impact of this unrealistic assumption by placing a Serving Area Interface ("SAI") farther into the CBG than is customary, a distance equal to one quarter of the length of one side of the CBG. However, this is equally unrealistic: the designed distribution cable lengths remain extremely long because the model assumes that each CBG contains only one SAI. In reality, design engineers may place many SAIs or cross-connects within large CBGs to reduce the high cost of distribution facilities. The model does not accommodate this problem, which we discuss in detail elsewhere in this evaluation.

Cost

The Hatfield Model uses a multiplier factor in its pricing calculations of the total cost of cable placement. The model uses this multiplier to incorporate the cost of materials and the cost of installation. However, there is some question as to the validity of this ap-

proach to cost identification. Indeed, the sponsors of the Hatfield Model criticized the use of this approach in the original BCM, observing that: "The effect of this multiplier ... which is itself computed based on unviewable input assumptions ... was to understate the investment."[10] We expect the team that is performing an economic evaluation of the model will review this issue in greater detail.

The Hatfield Model does not appear to consider the costs and design of Digital Cross-Connects ("DSX"). We consider this to be a significant omission because it indicates a lack of forward looking thinking in design. This omission constitutes evidence of, among other problems, the failure of the model's designers to consider the use of Synchronous Optical NETwork ("SONET") design principles for construction of the feeder portion of the network. Given the "green fields" approach advocated by the Joint Board, this is a particularly peculiar assumption that we consider in the conclusion of this review.

Logic

The Hatfield Model contains unreasonable, unrealistic, and decidedly not "forward looking" assumptions concerning the relative mix of aerial, buried, and underground facilities. For example, the model assumes that 65 percent of all facilities will be aerial in areas with population densities greater than 2,550 households per square mile. There are numerous contemporary engineering considerations that dictate use of underground or buried plant in preference to aerial plant in such areas. Moreover, many, if not most, cities and towns with population densities of this magnitude now require the placement of "out of sight" (underground or buried) facilities.

In other words, the mix as shown for the distribution plant is unbalanced and impractical. The current model shows distribution levels at the density mix of 850 - 2550+ dropping to

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[10] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), August 16, 1997, page 7.

40% from a 50 % level and then increasing to a mix of 65% at the density level of 2550+. The mix as shown for feeder is more appropriate for both feeder and distribution. It is our opinion that the model should use, as initial default assumptions, the following values:

Density	Aerial	Buried	Underground
850 - 2550	15%	15%	70%
2550+	10%	20%	70%

Engineering

Cable

The Hatfield Model default value for the distance from the central office for the transition from copper cable to fiber cable is 9,000 feet. The sponsors of the Hatfield Model criticized this value in numerous hearings related to competing models. Nevertheless, the designers retained this value -- inappropriately -- in the model.

A design that is both forward looking and "least cost" approach must examine and integrate not only initial costs but also at least short term (three to five years) operating and perhaps whole life costs. Under these circumstances, and considering sound engineering design practices, it may be most appropriate to use fiber technology in all feeder plant design. The Hatfield Model specifies installed costs for 4,200 pair copper cable of $73.54 per foot. In terms of capacity, this is substantially more than the installed costs of $3.50 per foot for 24 fiber cable. The cost savings from placing all fiber feeder would support the installation of the necessary electronics at the COs and the remote terminals. The reduction in copper feeder costs would allow commensurate increases in copper plant distribution utilization.

In earlier versions of the Hatfield Model, the cost tables for copper cable included splicing costs. The current version of the Hatfield Model makes no reference in its inputs and assumptions to any splicing costs. If the copper cable costs include the cost of splicing, then clarification of the cost tables is necessary because they would appear to understate the actual costs.

The Hatfield Model does not include provisions for small cable sizes for copper feeder and distribution cables. This will prove to be a problem for many small and medium size operating companies that will be sizing distribution systems in more rural areas where 12 pair copper cable and 18 pair copper cable are economical and rational choices for sys-

tem design. (This would not be an issue with fiber feeder, which would reduce the impact on transmission quality in the copper distribution portion of the loop.)

The model makes no provision for changes in gauge in the distribution system, an extraordinary weakness given the extra long loops they design with the model. Similarly, the model makes no provision for loading these extraordinarily long loops.

Carrier

The Hatfield Model uses population density groups to design and size Digital Loop Carrier ("DLC"). This methodology is likely to yield inconsistencies in design.[11]

The Hatfield Model does not include tables for DLC cabinets for Advanced Fibre Communication ("AFC") and Subscriber Loop Carrier ("SLC") 2000 equipment. The single maximum line capacity per AFC terminal in the Hatfield Model's Convergence Module does not match the capacity of any currently manufactured AFC cabinet. AFC cabinets are available in 48, 120, 240, and 672 line sizes. The SLC 2000 cabinet capacity of 672 lines shown is the smallest SLC 2000 cabinet available, not the largest as the table indicates. SLC terminal sizes are 672 lines, 1,334 lines, and 2,016 lines.

The Hatfield Model does not correctly calculate the number of fibers required to carry the SLC 2000 DLC to its correct maximum capacity. In the Main Logic sheet of the Hatfield Model Loop Master module, the model assigns 4 fibers to each CBG regardless of the number of lines served in that CBG. It does not design SLC terminals that share fibers to a maximum capacity of 2,016 as the documentation states. While not a fatal network flaw, this does provide evidence of poor design.

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[11] Susan M. Baldwin and Lee L. Selwyn, "Continuing Evaluation of Cost Proxy Models for Sizing the Universal Service Fund: Analysis of the Similarities and Differences Between the Hatfield Model and the BCM2," Economics and Technology, Inc., October 1996, p. 73.

The model understates AFC equipment costs substantially. One reason is that the model does not include Local Exchange Terminal ("LET") costs. More generally, DLC costs do not include the costs for Central Office Terminals ("COT") or Fiber Optic Terminals ("FOT"). If fiber cable serves the DLC, the system will require at least one such device to convert optical signals to electrical signals. The model also understates DLC costs due to the exclusion of costs for the site, housing, and power supplies for these devices.

Conduit

The Hatfield Model appears to assume the placement of only one duct. However, the model also assumes the placement of a larger (variable) number of cables in that single duct. In general, in the feeder network, multiple copper cables cannot share a single duct. A 4,200 pair, 26 gauge air core copper cable is 3.35 inches, while the standard duct diameter is 4 inches. A filled 3,600 pair cable is 3.75 inches in diameter. Only one of either such cable can occupy a given duct.

Even with a design plan that utilizes fiber cabling for the feeder system, a conduit and manhole system would require a minimum of a four-way duct system to be both effective and efficient. This becomes even more important when tabled with the supposed planning of a shared or common trenching system. Only in the case of fiber cables, which have a substantially smaller diameter than copper cables, could construction workers place multiple cables in a single duct in a feeder network. However, if the company places a single fiber cable in a single duct, it is not possible to place an additional cable later because of the twist (curl) imparted to the cable from its storage and transport on a reel. To place multiple cables in a single duct, the engineer must design using one of three methods.

The first option is to place all cables (up to four or five, depending on their diameters) in the duct simultaneously. Although this may be an option with telephone cables, it is unlikely that safety regulations will allow placement of power cables in the same duct as telephone cables. In any event, the power and CATV utilities already have facilities in service and do not need to share duct. We judge this option inappropriate based on its unreasonable assumptions regarding construction coordination. Moreover, laborers could not place multiple copper cables in the duct in equal numbers due to the larger diameter of the cable.

The second option is to use special purpose duct equipped with multiple, preformed innerducts. Up to seven fiber optic cables could be placed in the most advanced such preformed duct that is currently available. We judge this option inappropriate based on its violation of the directive that "least cost" technology be used. Moreover, we could not place copper cables in the preformed innerducts due to the cables' larger diameter.

The third option would be to place up to four innerducts inside a 4 inch diameter duct and pull cables into the innerduct. We judge this option inappropriate based on its violation of the directive that least cost technology be used. Again, we could not place copper cables in the preformed innerducts due to the larger diameter of the cable.

Design

Quality of service parameters are dictated by all relevant state authorities. Among the most significant, relevant quality of service parameters is the requirement for the provision of service within some time frames. System designs must comply and any reasonable engineering model must be adaptable to this requirement. It does not appear that the Hatfield Model satisfies this demand for flexibility in scheduling service.

In their supplementary filing, the sponsors note that the model provides for the placement