I. INTRODUCTION

In its May 16, 1996 comments and May 30, 1996 reply comments in the Federal Communications Commission's (FCC) Local Competition Investigation, AT&T introduced Version 2.2 of the Hatfield model.[1] On June 14, 1996, AT&T and MCI filed the same model in the unbundling proceeding in California.[2] The purpose of this paper is to demonstrate that the Hatfield model does *not* provide reasonable estimates of the costs of local exchange company (LEC) network elements, either for LECs in general or any particular LEC, because (1) the model departs from fundamental economics in a number of significant ways, (2) contains a number of inaccuracies in execution that depart from reality, (3) produces results that are inconsistent with what can actually be observed, and (4) implies a fantasy version of both regulation and functioning markets.[3]

Particular shortcomings of the model include the following:

- The assumption that all volumes currently served by local exchange carriers will be served by a brand new entrant that instantly materializes is inconsistent with both reality and sound economics. Accordingly, costs based on such a model will *not* be representative of the costs incumbent LECs incur in unbundling their networks.

- The model employs approximations that produce serious inaccuracies when the relationships upon which these approximations are based depart from their historical relationships. For example, the model estimates the costs of installing cable facilities as well as the structures for cable facilities by using multiplicative factors applied to the price of the cable itself. As a result, the model has the undesirable property that a reduction in the cable price itself causes the total cost of cable-related investment to fall proportionately.

- The inputs (e.g., central office equipment prices) are consistently lower than what local exchange companies actually pay.

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[1] The Hatfield model is somewhat of a moving target. For example, MCI introduced a different ("greenfield") version of the model in its May 16 comments (Hatfield Associates, Inc., "The Cost of Basic Network Elements: Theory, Modeling, and Policy Implications"). Versions of the model have received extensive attention in ongoing universal service and unbundling proceedings in California.

[2] I understand that the model has been filed in a number of other states as well.

[3] Given the recent release of the Hatfield model, my evaluation is preliminary in nature. As I understand it, working versions of the model only became available on June 21. Because the model is extremely complex and the computer hardware requirements are extensive, a thorough evaluation is necessarily time-consuming and not possible within the time period available for my evaluation.

II. ECONOMIC THEORY

The Hatfield model documentation characterizes the model as "scorched node"—it starts with the existing locations of central offices, then builds a brand new system instantaneously from the ground up.[4] While proponents of this approach claim that it approximates the textbook definition of long-run cost, it is grossly at odds with how real businesses incur costs, especially capital-intensive firms that expand their facilities by adding capacity in discrete modules.[5] Almost five years ago, Professor Alfred Kahn advised the FCC of the need to employ a realistic and practical perspective.

> In strict economic terms, the concept of long-run marginal costs relates to a hypothetical situation in which all inputs are variable, and a supplier confronts the possibility of installing entirely new facilities, in effect from the ground up. And the "marginal" relates to the incremental cost of a single unit of output. The concept of long-run incremental cost, in contrast, is more pragmatic: it takes a firm's past history as given, does not assume that it is writing on a blank slate, but recognizes that it will ordinarily be planning the installation of new capacity, at whatever that additional investment will cost given its current situation, and it spreads the costs over either the total output of that additional capacity—in that sense it is a kind of average incremental cost—or over the additional output that is likely to be induced by a price reduction under consideration (or curtailed in response to a price increase.)[6]

An additional difficulty with the Hatfield scorched view of the world is that it ignores the fact that in an industry with technological progress, which clearly characterizes

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[4] A number of long-run incremental cost studies performed by local exchange carriers have employed a different version of the "scorched node" assumption. For example, Pacific Bell and GTE have developed costs based upon consensus costing principles adopted by the California Public Utilities Commission. The Hatfield model departs from the California principles in at least two significant ways: (1) Hatfield only uses the existing locations of central offices, while the California principles require that the existing location of outside plant be used as well and (2) by positing an instantaneous network, the Hatfield version of "scorched node" ignores the impact of changes in demand on cost.

[5] Even the theoretical definition must be conditioned by reality. For example, Professor Varian has noted: "Long run and short run are of course relative concepts. Which factors are considered variable and which are considered fixed depends on the particular problem being analyzed. You must consider over what time period you wish to analyze the firm's behavior and then ask what factors can the firm adjust during that time period." Hal R. Varian, *Microeconomic Analysis, Third Edition*, New York: Norton, 1992, p. 66.

[6] Affidavit of Alfred E. Kahn, Before the Federal Communications Commission, In the Matter of Expanded Interconnection with Local Telephone Company Facilities, CC Docket No. 91-141, August 6, 1991.

telecommunications, no company would set prices based upon such costs. The reason is that when technology advances, a new entrant taking advantage of latest technologies would drive prices down. Basing prices on the Hatfield view of the world would never recover costs. Professor Kahn and I noted this phenomenon in our recent reply declaration as follows:

> In a world of continuous technological progress, it would be irrational for firms constantly to update their facilities in order completely to incorporate today's lowest-cost technology, as though starting from scratch: investments made today, totally embodying today's most modern technology, would instantaneously be outdated tomorrow and, in consequence, never earn a return sufficient to justify the investments in the first place. For this reason, as Professor William J. Fellner pointed out many years ago, firms even in competitive industries would systematically practice what he calls "anticipatory retardation," adopting the most modern technology only when the progressively declining real costs had fallen sufficiently below currently prevailing prices as to offer them a reasonable expectation of earning a return on those investments over their entire economic life. In consequence even perfectly competitive prices would not be set at the level of these (totally) current costs—unless, to put it another way, the calculated costs of the new plant included an extremely high rate of return and of depreciation, in reflection of the exposure of any such investments to costs and prices progressively declining in real terms over their life.[7]

The Hatfield model's scorched approach to cost modeling essentially assumes that an LEC's entire demand for telephone services is constantly up for grabs. In effect, the succession of incumbent LECs would hand over their entire business to the newcomer, which in turn would instantly size its plant to perfectly accommodate this demand, taking advantage of all the economies that come with serving the demand with perfectly sized facilities obtained at the maximum volume discounts. It would be nice if the world worked this way, because we would all like to pay less for what we consume. Unfortunately, it does not. A real firm grows to meet demand as it materializes. As such, it adds capacity taking into account the trade-off between the lower per unit costs of bigger modules (e.g., larger cable sizes) and the costs of carrying the unused capacity that deploying larger modules would entail.

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[7] Declaration of Alfred E. Kahn and Timothy J. Tardiff, Before the Federal Communications Commission, In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, CC Docket No. 96-98, May 30, 1996. (footnote omitted). Professor Jerry Hausman's reply affidavit, filed in this docket on the same day, makes a similar point in the context of depreciation. Professor Hausman's findings will be discussed later when depreciation issues are addressed.

In short, the Hatfield model creates a world in which the best of both competition and monopoly supply prevail.

- The firm enjoys the economies of scale from deploying larger modules and the high capacity utilization from efficient inventory management.
- The firm is subject to the cost reducing effects of using the latest technology, while at the same time its equipment depreciates at regulatorily-prescribed rates and its cost-of-capital is the same as for regulated utilities and it is guaranteed the full level of demand that a monopoly carrier would enjoy.

III. SPECIFIC COMPONENTS OF HATFIELD MODEL

The Hatfield model reports results for several networks components: (1) loops, (2) local switching, (3) signaling, (4) transport, and (5) operator systems. Because the first two components constitute a substantial proportion of the total cost and have been subject to more extensive examination in the California proceedings than the other components, my review focuses on these components.

A. Loops

For the most part, the Hatfield model's development of loop costs relies on the Benchmark Cost Model (BCM), which has been filed with the FCC by MCI, NYNEX, Sprint, and U.S. West. The BCM identifies geographic areas whose costs of basic residential access service are relatively high or low cost. The sponsors describe their model as follows.

> The BCM does not define the actual cost of any telephone company, nor the embedded cost that a company might experience in providing telephone service today. Rather the BCM provides a benchmark measurement of the relative costs of serving customers residing in given areas, i.e., the CBGs [Census Block Groups].[8]

What is noteworthy about this description of purpose is that the costs that the BCM produces are not the actual costs of any particular company. Despite this acknowledgment by

[8] MCI Telecommunications Corporation, NYNEX Corporation, Sprint Corporation, and US West Inc., "Benchmark Cost Model," Submitted to the FCC, CC Docket No. 80-286, September 12, 1995, p. 3.

the BCM's sponsors, the proponents of the Hatfield model incorrectly propose to use parts of the BCM to produce actual prices for the incumbent LEC's unbundled elements.

The BCM starts with the current locations of the LEC's central offices. The model constructs loop plant (feeder, distribution, and associated structures) from the central office locations to the households in the CBG by means of specific engineering rules, e.g., the lines served by a particular central office are the result of assigning CBGs to the closest wire centers.

This assignment does not necessarily assign the households within the CBG to the wirecenter that actually serves them. For example, in California, Pacific Bell and GTE have found that the BCM assigns substantial percentages of households to the wrong wirecenter. As a result, the network represented by the BCM departs from the LEC's actual network. The Hatfield model's proponents may argue that the BCM has assigned households more efficiently than the LECs have. A more likely explanation is that the extremely abstract representation of the network—a featureless plain[9]—ignores real world constraints, such as physical barriers, e.g., rivers, lakes, and hills, between a CBG and its closest central office.

Because the BCM assumes that loop facilities are installed instantaneously, the model selects the largest available cable sizes to serve a given static volume. In contrast, because real networks evolve as demand grows and changes, firms face a trade-off between deploying larger cable sizes (and enjoying the economies of scale that result at or near full capacity) versus using smaller sizes, thus reducing the carrying costs of the extra inventory that large cable sizes entail. In this regard, the BCM may underestimate loop cost, because it could assign larger/less costly facilities (on a per-unit basis) than an efficient firm would deploy. Such "savings" are illusory, not real. What has been left out of the BCM is the carrying charges on the unused capacity that the larger cable sizes would require for several years, until actual demand materializes.

As part of my ongoing evaluation of the BCM, I have identified a number of calculations built into the BCM that can produce inaccurate estimates of efficient loop costs.

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[9] The only distinguishing characteristics are a number of topological factors used to estimate the cost of installation and support structures.

1. Installation and Structure Multipliers

For loop plant, both feeder and distribution, the BCM calculates the investment costs of installation and structures by multiplying the cost of cable by factors that represent the installation labor cost and support structure investments. While properly developed factors can give reasonable representations of average installation and structure costs if current conditions are similar to those from which the factors were based, there are two features of the BCM that make these factors problematic.

The first problem comes from the fact that changes in the cost of cable pass through directly into changes in the cost of installation and structures. In other words, the model would predict that two otherwise identical areas would have different installation and structure costs if they were served by companies that paid different amounts for their cable. Similarly, the model would predict that cost of installation and structures would decrease when a company is able to secure a better discount on the cost of the cable itself.

If installation and structures were a modest proportion of total loop investment, the conceptual problem with the multiplier, albeit troublesome, may not have a large impact on estimated total costs. Unfortunately, installation and structures account for a substantial proportion of the investment cost of loop plant. For example, GTE's calculations indicate that the cost of feeder and distribution cable accounts for only about 15 percent of its total loop costs. Similarly, Pacific Bell recently reported that structures and installation account for over 80 percent of their loop costs, implying that cable itself accounts for less than 20 percent of loop costs.[10] That is, because structure and installation costs appear to account for a majority of loop costs, the use of structure multipliers is truly an example of the tail wagging the dog.

To illustrate the inaccuracies that arise from using factors to estimate the bulk of investment expenses, GTE compares the outcome of BCM to its own actual costs when the price of cable is halved. The BCM reduces total loop investment by 37 percent.[11] In contrast,

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[10] Opening Brief of Pacific Bell, Before the California Public Utilities Commission, Rulemaking/Investigation on the Commission's Own Motion into Universal Service and to Comply with Mandates of Assembly Bill 3643, R.95-01-020/I.95-01-021, June 4, 1996.

[11] The reduction in total cost is less than 50 percent, because loop costs also include fiber electronics, the costs of which vary independently with cable costs in the BCM.

GTE estimates that its actual cost would decline by only 7 percent. The difference between these two outcomes, of course, comes from the fact that the BCM reduces the cost of installation and structures proportionately with the cost of cable, which simply does not happen in GTE's own operations.

2. Modeling Distribution Facilities

The BCM constructs feeder plant from the central office to the edge of the CBG. All loop plant within a CBG is assumed to be distribution plant. The BCM assumes that CBGs are square in shape and that households are uniformly distributed over the area of the CBG, neither of which is true of real CBGs. The BCM also uses an abstract representation of the distribution plant within a CBG. CBGs have exactly four distribution cables of length equal to three-fourths of the square-root of the area of the CBG.[12]

The abstract representation of distribution plant can produce results that differ from reality, i.e., loop lengths can be inaccurate, cable sizes can be incorrect, and the number of cables within a CBG can differ from the four cables assigned by the BCM.

First, as the sponsors of the CBG acknowledge, in sparsely populated areas, the uniform distribution assumption can cause substantial errors in cost estimation.[13] The basic problem is that the average loop length depends on the distribution of households within an area. When the assumed distribution differs from the actual, an average based on the former will be inaccurate.

Second, although the BCM documentation describes CBGs as containing on average 400 households, there is, in fact, considerable variation in the number of households within a CBG. The consequence is that CBGs with a large number of households exceed the size of the distribution areas that at least one LEC, Pacific Bell, employs. In turn, the BCM allows larger copper cable sizes than that LEC actually employs. In particular, Pacific's maximum feeder cable is 3,600 pairs (GTE's maximum size is 3,000 pairs), compared to the 4,200 maximum in the BCM. For distribution cable, the corresponding values are 1,800 and 3,600 for Pacific and the BCM, respectively. If support structure can accommodate larger cables, there are economies in larger cable sizes. Because Pacific has found that its support structures cannot

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[12] The model assumes that CBGs are square. Therefore, the square root of the area is the side of the square.

[13] BCM, p. 38.

accommodate the largest cables assumed by the BCM, the BCM's assumptions would understate the true cost of Pacific's loop plant.

Third, the use of exactly four distribution cables in the BCM can cause substantial bias. To see how this abstract representation of distribution plant may introduce distortions, observe first that there are two basic cost drivers of distribution (and feeder) installation and support structure: (1) sheath miles and (2) pair miles. Further observe that BCM estimates the cost of installation and structures by applying multipliers to the price of the cable itself. Accordingly, if there are more than four distribution cables, the BCM will understate the costs that vary with sheath miles.

A hypothetical example will illustrate the problem. Consider an area requiring 1,000 loops with an average distribution length of 5,000. The following prices prevail:

Cable[14]: $0.01 (per pair foot)

Installation and structure cost (per pair foot): $0.02

Installation and structure cost (per sheath foot): $5.00

The number of pair feet is 5,000,000 (1,000 loops x 5,000 feet). The number of sheath feet is 20,000 (4 sheaths x 5,000 feet). Therefore, the distribution investment is

Cable: $50,000 (5,000,000 pair feet x $0.01)

Installation and structure (pair-feet driven): $100,000 (5,000,000 pair feet x $0.02)

Installation and structure (sheath-feet driven): $100,000 (20,000 sheath feet x $5.00)

Total cost: $250,000

If the area were actually served by eight cables, rather than the four specified by the BCM, sheath feet would increase to 40,000 and total cost would increase by $100,000, which is 40 percent higher than the costs produced by the BCM.

In fact, GTE examined the impacts of doubling the number of distribution cables, accounting for installation and structural costs the way they are actually incurred. The estimated increase in cost was 49 percent, which is considerably higher than the 17 percent cost increase produced by the BCM. The BCM figure accounts primarily for the loss in economies of scale

[14] This is roughly the cost per pair-foot for cable sizes in the 1000 pair range reported in the Hatfield Model documentation. As a simplification, I assume that changing the number of routes does not change the required capacity or cable size, so that the same unit price is used.

due to deployment of smaller cable sizes (and possibly lower utilization because of the modularity of extra capacity) and thus ignores the bulk of the extra structural costs that would be incurred in deploying more, less dense distribution cables.

Finally, the representation of the interface between the distribution cable and the subscriber (the drop wire and subscriber terminal) is not described in the Hatfield model documentation.[15] The cost assumed for drop wire may be inconsistent with drop wire lengths that are compatible with the use of four distribution cables. For example, under a particular geometric representation of the distribution cables and drop wire, I estimate that the average drop wire length would be about 25 percent of the distribution cable length. In contrast, GTE estimates that the cost employed in the Hatfield model implies a drop distance of only about 25 feet, which is considerably shorter than 25 percent of the average length of distribution cable. For example, for a low density CBG of one square mile, one-quarter of the BCM's distribution cable length is 3/16 of a mile. GTE estimates that the drop wire investment for this length to be about $1,700. This is equivalent to a monthly cost of $32, which is about 55 percent of the Hatfield model's loop cost in the lowest density group (0 - 5 households per square mile) in California.

The abstract nature of the BCM's distribution model is of more than academic interest. In the network cost elements reported in the May 30 documentation, distribution plant accounted for 43 percent of the total cost of switched network elements in California. Percentages are similar in other states, e.g., distribution plant accounts for 51 percent of Hatfield's total cost for switched network elements in Texas.

3. Fill Factors[16]

Because telephone capacity is modular, i.e., it comes in sizes greater than a single unit, there is more capacity in place than volumes in service. Capacity exceeds volume even when the

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[15] The Hatfield model has included these costs, which were not included in the BCM. The model employs average costs for the drop wire and the network interface device, which can be changed as a user input.

[16] A theoretical discussion of these issues appears in Richard D. Emmerson, "Theoretical Foundation of Network Costs," in W. Pollard, editor, *Marginal Cost Techniques for Telephone Services*, National Regulatory Research Institute, 1991, pp. 145-189.

most efficient engineering practices are followed. The ratio of volume in service to capacity is the fill factor.

The spare capacity represented by a fill factor less than 1.0 is a *current* economic cost of providing service. In a previous evaluation of the BCM, I participated with Pacific Bell's cost experts in reviewing that model.[17] As part of their review of the BCM engineering rules, Pacific's experts compared the model's fill factors with the actual fill factors that would result from the best engineering practices. In general, the fill factors for feeder plant in the BCM were moderately higher than best practice and the fill factors for distribution plant in high density areas were substantially higher than best practice. Distribution fill factors are relatively low because of the high cost of adding capacity after the support structure has been built. Accordingly, capacity for an indefinitely long planning horizon is installed initially and utilization of that capacity is low as a result.

Unfortunately, Version 2.2 of the Hatfield model has increased the already somewhat high distribution fill factors in the original BCM, as shown in the table below. This would cause the underestimation of loop costs to be even greater.

	BCM		Hatfield	
Density Zone	Feeder	Distribution	Feeder	Distribution
1	0.65	0.25	0.65	0.50
2	0.75	0.35	0.75	0.55
3	0.80	0.45	0.80	0.60
4	0.80	0.55	0.80	0.65
5	0.80	0.65	0.80	0.70
6	0.80	0.75	0.80	0.75

[17] Timothy J. Tardiff, "Evaluation of the Benchmark Cost Model," prepared on behalf of Pacific Bell, for filing with the California Public Utilities Commission, Rulemaking/Investigation on the Commission's Own Motion into Universal Service and to Comply with Mandates of Assembly Bill 3643, R.95-01-020/I.95-01-021, December 1, 1995.

The Hatfield model's use of unrealistically high fill factors causes costs to be understated in two ways. First, because (1) the fill factor, in part, determines how much cable is needed and (2) the cost of all the associated installation and structures are estimated by multiplicative factors, overestimation of the fill factor will cause an unrealistically large drop in the Hatfield model's loop costs.[18] Because a higher fill factor would produce less cable investment, the Hatfield model produces proportionately less installation and structure investment as well. In reality, even if the Hatfield fill factors were realistic, the savings in installation and structure would be considerably less than proportionate, e.g., a smaller cable would be placed in the same conduit.

Second, the Hatfield model appears to be based on the belief that competitive firms would have minimal spare capacity. In this regard, the FCC's finding on spare capacity in interstate long-distance, which was one of the bases for granting AT&T non-dominant status, contradicts this apparent belief:

> AT&T asserts, and no one disputes, that MCI and Sprint alone can absorb overnight as much as fifteen percent of AT&T's total 1993 switched demand at no incremental capacity cost; that within 90 days MCI, Sprint, LDDS/Wiltel, using their existing equipment, could absorb almost one-third of AT&T's total switched capacity; or that within twelve months, AT&T's largest competitors could absorb almost two thirds of total switched traffic for a combined investment of $660 million. Thus, AT&T's competitors possess the ability to accommodate a substantial number of new customers on their networks with little or no investment immediately, and relatively modest investment in the short term. We therefore conclude that AT&T's competitors have sufficient excess capacity available to constrain AT&T's pricing behavior.[19]

To cast the FCC findings in terms relevant to the current discussion, note that MCI and Sprint combined are roughly one-half of AT&T's size. Overnight they can absorb 15 percent of AT&T's capacity. This implies that MCI and Sprint have at least 30 percent spare capacity that could be deployed overnight.

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[18] For example, GTE found that decreasing the fill factor by 20 percent increases loop investment by 11 percent in the Hatfield model. This sensitivity of total investment to the fill factor is extreme, because apart from savings in the cable itself, there would be very little savings in other associated costs.

[19] Federal Communication Commission, In the Matter of Motion of AT&T Corp. to be Reclassified as a Non-Dominant Carrier, FCC 95-427, October 15, 1995, paragraph 59.

The implication of these findings is that, if anything, competition may require more, rather than less spare capacity to be flexible enough to respond the vicissitudes of the market. Failure to recover in current revenues the current cost of business caused by the spare capacity necessary to operate in the competitive environment would be detrimental to the shareholders of such companies, perhaps even forcing some of them out of business.

B. Switching

Version 2.2 of the Hatfield model systematically understates the cost of local switching. By selectively using heavily discounted prices for new switches and by assuming that a local service provider would instantly install all of the switching capacity it needs at once, the Hatfield model produces results that are substantially lower than the forward-looking local switching costs that real telephone providers actually incur.

Hatfield developed a relationship between switching cost per line and the size of the switch by piecing together information from various sources. In particular, the algorithm is driven by three data points constructed as follows.

- Small switch: the cost per line ($241 for 1994) was taken from the Northern Business Information report on the average cost of *new* lines for independent companies. Hatfield associated the average *installed* switch size of 2,782 lines for small LECs (LEC industry less RBOCs), calculated from statistics on lines and switches reported to the FCC for 1993.

- Medium switch: the cost per line ($104 for 1994) was taken from the Northern Business Information report on the average cost of *new* lines for RBOCs. Hatfield associated the average *installed* switch size of 11,200 for RBOCs, calculated from statistics on lines and switches reported to the FCC for 1993.

- Large switch: cost per line of $75 for a 80,000 line switch, "obtained from switch manufacturers."

Hatfield then drew straight lines between the three points to complete the relationship.

Hatfield's approach suffers from two problems. First, there is a mismatch between the data sources he employs. Note, for example, he matches a 1994 forecasted price with a 1993 average embedded switch size. In addition, while Hatfield uses independents (excluding GTE) for the small switch price, GTE is included in the calculation of the switch size. Finally, the approach assumes that the *average* installed switch is of the same size as the average *new* switch, an assumption that is not necessarily valid

Second, and more fundamental, the Hatfield model ignores the fact that LECs buy additional lines for installed switches as well as new lines for new switches. These additional lines cost more, as the study that Hatfield used for his switch prices describes.

> The add-on market continues to retain revenue potential for the suppliers, particularly as the margins on new switches remain below the margins for the add-on market. A digital line shipped and in place will generate hundreds of dollars in add-on software and hardware revenue during the life of the switch. Suppliers can afford to forego losing (sic) a few dollars on the initial line sale in exchange for the increased revenue in the aftermarket, when prices are less likely to be set by competitive bidding.[20]

The local switching component of the Hatfield model graphically illustrates the fallacy of its scorched view of cost studies. In order for the approach to produce realistic costs (ignoring the data problems identified earlier), a new entrant would have to serve customers with initial lines only and also have the volumes to command the discounts that existing LECs apparently command. The fact that LECs expand their switches as demand grows and the existence of a lucrative aftermarket for this expansion demonstrate that the "instant LECs" posited by the Hatfield model are inconsistent with reality.

C. Converting Investments to Annual and Monthly Costs

As described earlier, the various manifestations of the Hatfield model are essentially models of the *investment* component of an LEC's cost structure. These investments are converted into annual and monthly amounts by (1) annualizing the investments through the use of cost-of-capital and depreciation rates and (2) estimating out-of-pocket operating expenses through the use of historical expense to investment ratios.

1. The Hatfield Model Underestimates the Cost of Capital

The annual charges related to investment are based on a rate of return of 8.91 percent, which assumes an equity ratio of 38.2 percent, a cost of equity of 11.25 percent, and a cost of debt of 7.5 percent. This rate is lower than the rate of return of 10 percent used in the

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[20] Northern Business Information, *US Central Office Equipment Market—1994*, McGraw-Hill, p. 71.

"greenfield version" of the Hatfield model attached to MCI's May 16, 1996 comments in the FCC's local competition investigation. The primary reason why cost of capital in Version 2.2 of the Hatfield model is lower than the "greenfield" version is the unrealistically low equity ratio in the former. The latter model uses a more plausible 60 percent ratio for equity. Based upon the relationship in the original 1994 Hatfield Report that a 175 basis point difference increases the cost per line by 11 percent, increasing the cost of capital to the one used in the "greenfield" version of the Hatfield alone would increase costs by about seven percent (109/175 x 11 percent).[21]

The 10 percent return in the "greenfield" version is also too low for two reasons. First, both the FCC and the California Commission established rates of return for the early 1990s of 11.25 percent (which remains as the current rate) and 11.5 percent, respectively. The California rate of return was part of the price cap plan for Pacific Bell and GTE.[22] The California plan links reviews of the rate of return to the 30 year treasury bond rate, which was 7.99 percent when the California plan was adopted in 1989. Recently, the 30 year rate has been about 7.2 percent, suggesting that current capital costs are much closer the to 11 percent range than the 8.91 percent return contained in Version 2.2 of the Hatfield model. Based upon the 1994 Hatfield Report relationship, if the current rate of return were 10.7 percent (the 11.5 percent return originally adopted for the California plan, reduced by the approximately 80 basis point difference between the 1989 and current treasury bond rates), costs would increase by about 11 percent over Hatfield's estimates.[23]

Second, the whole premise behind Hatfield's cost estimates is that they emulate the effects of competition. One of these effects is to raise the riskiness, and therefore the cost of capital, of competing firms (incumbents as well as entrants). This, in turn, increases the annual capital cost for local exchange services.

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[21] Hatfield Associates, "The Cost of Basic Universal Service," Prepared for MCI Communications Corporation, July 1994. These sensitivity tests are primarily illustrative. When the computer files for Version 2.2 are available, sensitivity tests on the cost-of-capital and depreciation factors can be performed in a more direct manner (if the program code allows these factors to be changed by the user).

[22] California Public Utilities Commission, In the Matter of Alternative Regulatory Frameworks for Local Exchange Carriers, Decision 89-10-031, October 12, 1989.

[23] Similarly, use of the FCC's current rate of return of 11.25 percent would raise costs by 14.7 percent over Hatfield's estimates.

2. The Hatfield Model's Depreciation Rates Are Lower Than Economic Depreciation

The Hatfield model uses extremely long depreciation rates in estimating the annual costs of network investments. While long investment lives may have been appropriate for a regulated monopoly provider, the competitive environment fostered by the Telecommunications Act is a different world. The forces of competition itself, as well as the technological change that permeates this industry, invalidate the use of the old long depreciation lives. In fact, Professor Hausman's May 30, 1996 reply affidavit demonstrates that accounting for the increased risk and uncertainty of competition increases the annual cost related to investments by a multiple of at least 3.

The Version 2.2 of the Hatfield model lists asset lives by type of facility, e.g., end office switches have a life of 20 years in the model. In contrast, earlier versions utilized an average life. For example, the BCM posited an average life of 18 years for all plant. Inspection of the lives in Version 2.2 suggest an average life of at least 18 years, which is equivalent to an annual depreciation rate of 5.7 percent. This rate is well short of the 1994 book depreciation of 7.16 percent for RBOCs, let alone the higher true economic depreciation rate.[24]

The 1994 Hatfield Report indicates that changing depreciation from an average 20 year life (5 percent rate) to 15 years (6.7 percent rate) would increase basic service costs by 13 percent. Applying this relationship to the difference between the depreciation rate implied by an 18 year life and the RBOC's current book depreciation rate produces a cost increase of 12.6 percent.

Of course economic depreciation rates are much higher. For example, Schmalensee and Rohlfs reported that AT&T's depreciation rate is 18.5 percent.[25] Even AT&T's 1994 book depreciation rate of about 11 percent is much higher than the rates used in the Hatfield model.

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[24] Federal Communications Commission, Statistics of Communications Common Carriers, 1995/1995 Edition, Table 2.9.

[25] Richard Schmalensee and Jeffrey H. Rohlfs, "Productivity Gains Resulting From Interstate Price Caps for AT&T," National Economic Research Associates, September 1992.

Using the Schmalensee-Rohlfs and AT&T's book depreciation rates in the relationship from the 1994 Hatfield report increases costs by 100 percent and 42 percent, respectively.

3. The Operating Expense Estimates in the Hatfield Report Are Questionable

The Hatfield Report develops expense estimates based upon ratios of *booked* expenses to investment. This approach is problematic. Operating expense ratios based on historical *investment may be a poor approximation of the forward-looking relationship.* Consider, *for* example, an expense whose costs are unrelated to the underlying technology. As capital equipment becomes more (or less) productive, the expense to capital ratio changes, even though the absolute level of unit expenses does not.

The central office switching example discussed earlier illustrates the pitfalls of using annual factors. By employing the unrealistic assumption that an LEC can buy switching at the initial prices, the model assumes that annual cost (which I understand include the generic upgrades) would be lower as well. In fact, the very report that Hatfield relies on to develop the switch model suggests that such additional costs may increase when switch vendors discount initial prices.

The factor approach also suffers from the general problem that any decrease in an *investment will cause a proportionate decrease in expenses. For example, if one* LEC, *for* whatever reason, obtained a higher discount on its equipment, the model implies that it would enjoy lower out-of-pocket expenses, an implication that defies common sense.

IV. COMPARISONS WITH EXTERNAL SOURCES

Version 2.2 of the Hatfield model produces estimates of network element costs, based on the abstract representations of network service costs. In contrast, the LECs have information on their current forward-looking costs of doing business. Because the prices for unbundled network elements obtained from the LECs must at least recover their costs, such a comparison is extremely informative.

Pacific Bell has provided this Commission with results from its Cost Proxy Model (CPM) in the context of universal service. Based upon my participation in the California unbundling and universal service proceedings, I understand that the CPM is designed to replicate the forward looking costs of Pacific's operations, because the model represents the engineering rules and cost-of-equipment Pacific actually uses.

The following table compares the respective costs of network elements from the competing models for California.[26]

	Hatfield[27]	CPM[28]
Loop (per month)	$8.26	$14.96
Switching		
Line (per month)	$1.14	$1.77
Usage (per minute)[29]	$0.0022	$0.0035

In short, the Hatfield model produces loop costs that are barely half of those produced by Pacific's model and switching costs that are about two-thirds as high as Pacific's.[30] In light of the various shortcomings I discussed previously which would tend to understate the costs produced by the Hatfield model, the CPM's results are clearly the more plausible.

To shed further light on the discrepancies between the Hatfield model and real world practices, GTE performed various sensitivity tests of loop portion of the Hatfield model. Among the most interesting of these tests is the use of the terms of its 1995 contract with AT&T to install outside plant in place of the structural multipliers discussed earlier. Use of the real world installation values ***more than doubled*** the loop costs estimated by the BCM. And

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[26] Because the CPM estimates the cost of residential exchange service in the context of universal service, I have judgmentally excluded cost items that are associated with the service and not the underlying network component.

[27] May 30, 1996 update.

[28] Pacific Bell and INDETEC International, The Cost Proxy Model, California Universal Service Subsidy, 1996.

[29] The CPM reports a total usage cost for flat residential service. I assume 500 minutes per month to convert to a per minute cost.

[30] Pacific has also reported that an earlier version of the Hatfield model produces loop investments that are less than 50 percent of those produced by the CPM. Opening Brief of Pacific Bell, *Op. Cit.*, p. 50.

even these costs are evidently insufficient to compensate AT&T for installing loops facilities for GTE in California.[31]

V. CONCLUDING REMARKS

The fundamental flaws in the Hatfield model are that (1) it models the cost of no realistic local service provider and certainly not the incumbent LECs who will actually sell the unbundled elements it attempts to cost and (2) particular inputs and processes appear to systematically understate the costs of network elements. Indeed, at the same time that AT&T reported to the FCC that it would cost $1,240 per customer if AT&T provided local service to 20 percent of the market (likely the least costly part of the market), it and MCI are supporting models that produce investment costs of only $840 per line.[32]

Like any model, the Hatfield model is best interpreted in the context of why it was built and what objectives it is intended to foster. The architects and sponsors of the Hatfield model are quite clear in their purpose—they want to buy elements from the LECs, most prominently switched access, at rates far below current rates and even below the costs of the LECs require to produce these elements. While we would all like to pay lower prices, markets only permit this when those prices are commensurate with the costs of production.

The Hatfield model developers defend their costs by arguing that any difference between the costs of their model and costs reported by the LECs (either accounting costs that are required by law and by regulators or the cost produced by LEC incremental cost models) represent the costs of overinvestment. For example, the report describing the "greenfield" version of the Hatfield model that was attached to MCI's opening comments claims that about half of the LEC's current plant represents overinvestment. Apart from the facts that this label is entirely circular and Hatfield's estimate of the so-called gap is fatally flawed by the theoretical and measurement problems with the Hatfield models, it defies common sense to believe that the

[31] GTE has informed me that AT&T did not bid to renew the contract. Evidently, AT&T believes that the terms of that contract were inadequate to cover its costs. As I understand it, the current contract is more costly to GTE than the former arrangement with AT&T.

[32] The FCC's April 19, 1996 Notice of Proposed Rulemaking listed the costs AT&T reported it would incur. The Hatfield investment per line is calculated from the "greenfield" version of the model.

overinvestment of this degree could take place.[33] Regulators (both at the federal and state level) would have to have been quite derelict in their public responsibilities in order for this event to have occurred, an unlikely event given the scrutiny this industry receives. Perhaps even more telling, employees and representatives of the IXCs and other companies purchasing inputs from the LECs would have had to have been asleep at the switch to allow their companies to pay allegedly bloated prices for inputs for years without insisting on immediate correction of the situation.

Of course, the more important concern is how network elements are unbundled in a way that promotes competition. Basing prices on costs that no real-world provider could hope to meet is *anti-competitive*, because it would stifle, not promote the most effective type of competition—facilities-based. In addition, requiring incumbent LECs to sell inputs at non-compensatory rates would have the deleterious effects of forcing whatever captive customers that may remain to subsidize the below-cost input prices and/or severely handicapping firms that represent a substantial proportion of this dynamic industry.

[33] Some of the gap between book investment and forward looking investment could represent the effect of the decline in prices for facilities such as end office switches. The fact that current prices recover some of these costs is entirely consistent with the economic fact that with technological change, no firm could survive by charging prices that completely reflect the decline in new equipment prices, as Professor Hausman's recent affidavit cogently demonstrates.

15

NARUC

Universal Service

Existing Proxy Models

What can they be used for?

Submitted to:

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TABLE OF CONTENTS

CHAPTER 0

UNIVERSAL SERVICE THE EARLY HISTORY

Background to Universal Service Prior To 1996 Communications Act

The topic of universal service continues to be subject to numerous papers, seminars, industry meetings, regulatory and legislative activities, including numerous Federal State Joint Board and Federal Communications Commission (FCC) proceedings. In 1981, the FCC was proposed to implement a flat rate interstate charge on local customers which would have raised local rates a minimum of $8 per month. In response to this proposal the state of Michigan filed a petition with the FCC stating that it believed Universal Service would be at risk if the FCC were to shift all the loop cost from interstate carriers to the local customers. National Association of Regulatory Utility Commissioners (NARUC) supported the petition, however Illinois Commerce Commission did not support the position that interexchange carriers should pay some portion of the cost for the local loop.

To address the issue of universal service the Joint Board in FCC Docket 80-286 established a transition mechanism and the existing central office equipment dial equipment minutes of use (DEM) weighting, high cost fund, lifeline programs and the Link up Program to mitigate the various shifts in revenue from the interstate jurisdiction to the state jurisdiction. The Joint Board/FCC orders adopted in 1983 (Subscriber Line Charge (SLC) Order in CC Docket 80-286 & 78-72) and 1987 (Uniform System of Accounts (USOA) Part 32 Conformance Order and SLC increase) which shifted more that $8 billion dollars to the states or the local rate payers. That shift in jurisdictional revenue requirement caused the intrastate local or toll rates to increase and interstate long distance rates to go down. The changes were phased in over a period which ended in 1992.

At the completion of the phase in of the separations changes and shift of revenue requirements to the states, NARUC passed a resolution (July 25, 1990) stating that there was a need for comprehensive review of the jurisdictional cost allocation (separation process) process including the universal service mechanisms (high cost fund, dial equipment minutes of use weighting and circuit equipment allocators). In the mean time the Joint Board identified the universal service fund as one of the issues that should be looked at. NARUC also established a work group in July, 1993 to study universal service and issued a report in July 1994.

The Universal Service Fund (USF) program was identified as a "short term" issue at the March 2, 1992 Joint Board meeting on Comprehensive Review. Questions have been raised about USF growth and targeting which could lead to an evaluation of how the fund is working. In response to this situation, the USF Industry Task Force developed and distributed a USF Discussion Paper on May 6, 1992.

The USF Industry Task Force was chaired by NECA and is made up of representatives from small and large exchange carriers, consultants, and other national associations including NTCA, OPASTCO, and USTA. Statistics presented in the paper indicate that the current USF