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January 7, 1996

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M. St., NW, Room 222
Washington, D.C. 20554

RE: Ex Parte Presentation – Proxy Cost Model Questions
CC Docket No. 96-45

Dear Mr. Caton,

Pursuant to Mr. Morabito's letter of December 12, 1996, enclosed please find AT&T's and MCI's responses to the Federal-State Joint Board staff's questions on the Hatfield proxy cost model. We will be happy to elaborate on any of these answers at the workshops the Joint Board has scheduled on January 14 and 15, or at the staff's convenience. We also look forward to providing the Joint Board with Release 3 of the Hatfield Model at an early date.

Two copies of this Notice are being submitted to the Secretary of the FCC in accordance with Section 1.1206(a)(1) of the Commission's rules.

Sincerely,

/s/ Michael Pelcovits
Michael Pelcovits
Chief Economist
MCI Telecommunications Corporation

/s/ Joel Lubin
Joel Lubin
Regulatory Vice President
AT&T Corp.

Attachments (see Contents list)

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AT&T AND MCI SUBMISSION ON THE HATFIELD PROXY MODEL

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Responses to the Federal-State Joint Board Staffs' Questions on Proxy Models

1. ***With regard to the model that you have submitted, list and explain the differences between the current model and the version of the model previously filed in CC Docket 96-45. Explain any plans for additional enhancements to the model. Provide a date certain for when the planned enhancements will be provided to the Commission.***

The Hatfield model is currently undergoing development to incorporate suggested improvements, and to respond to comments of users and outside observers. Hatfield Model, Release 3 will feature the following enhancements and changes from Release 2, the version filed previously in the above-referenced docket (complete documentation of Release 2 is included with this filing as Attachment 1). The expected date for availability of Release 3 is January 31, 1997.

* The ability to display summary results by wire center and by Census Block Group (CBG), in addition to by line density zone.

* The inclusion of several additional line density zones. In particular, Release 3 will split the highest density zone into three new zones, defined as "2,550 - 5,000 lines per square mile", "5,001 - 10,000 lines per square mile", and " over 10,000 lines per square mile". Release 3 will also divide the second least dense zone into two new zones, "5 - 100 lines per square mile" and "100 - 200 lines per square mile".

* Improvements in the method of assigning CBGs to wire centers, and of estimating the number of lines per CBG. Each CBG is now assigned to a wire center based on an analysis of NPA-NXXs serving the CBG. Procedures to estimate the number of residence and business lines per CBG have also been refined.

* Improved, more precise treatment of loop distribution cable numbers and lengths. This treatment takes into account a broad range of situations that might affect the number and length of distribution cables, such as the presence of high-rise residential and business building and multi-tenant buildings in high density zones, and the presence of unpopulated areas in low density zones.

* Output displays showing achieved fills at the Main Distributing Frame (MDF). These are calculated in a way that is consistent with typical LEC definitions of cable fill.

* A heavier gauge of cable and conditioning are employed as necessary to meet network performance standards on copper loops in excess of 18,000 feet.

* Refinements to distribution drop and Network Interface Device (NID) cost calculations. Such refinements include the addition of a drop length component to drop cost calculations, and the ability to treat buried or aerial drops.

* Improvements in the switching system cost model to better reflect the ways in which LECs actually purchase switching capacity. A line card fill factor has also been added.

* Modifications to the wire center investment calculations to show explicitly more components of serving wire center costs.

* Modifications to the interoffice transport network to assume fiber ring architectures where appropriate.

* The addition of more detailed transmission terminal investments.

* Refinements in the treatment of structure cost sharing between feeder and interoffice plant to reflect the economies involved.

* Changes in depreciation expense calculations to reflect the use of mid-year, rather than end-of-year average net investments and to adjust for net salvage value. Land has also been excluded from depreciation calculations.

* The addition of investments in buildings, vehicles and work equipment to the general support category.

* The addition of regional labor cost adjustments to certain labor-intensive investments.

* Improvements in the structure of the model and in its output report formats to improve the model's execution efficiency, accuracy and clarity of its results. For example:

* Distribution/feeder calculations formerly done in the Convergence Module have been consolidated into the Loop Module.

* Provision for multiple serving area interfaces in a CBG when the number of lines served is too large for a single serving area interface.

* Provision for additional conduit if the copper feeder cable size exceeds 4200 pairs.

* Refinement of the treatment of cost sharing among utilities to better reflect the economies involved.

* Provision for spare conduit for distribution and feeder.

* Structure sharing percentages can be specified by density zone.

* Improvements in the operation of the model to speed greatly its execution and permit it to run with less memory.

2. ***Using the current version of your model, provide study area results for Southwestern Bell-Texas (SWTX). For this study area, please provide:***

a. Summary statistics: total investment; investment per line; loop investment per line; end office switching investment per line; monthly cost per line; loop monthly cost per line; end office switching monthly cost per line; monthly transport cost per line, total households; total residential lines; total business lines; total single business lines, total switched lines; the number of residential lines per density zone, and monthly cost per line per density zone.

See Attachment 2a - SWTX.

b. Model results reported on an ARMIS basis: all expenses and plant in service rows that are contained in ARMIS report 43-03. If any of these rows can not be shown separately, provide a list of rows that have been combined and the algorithm used to combine the rows.

See Attachment 2b - SWTX.

c. Switching: the total number of switches and lines per each switch. Please explain how the cost of the switches was determined, provide all cost input data,

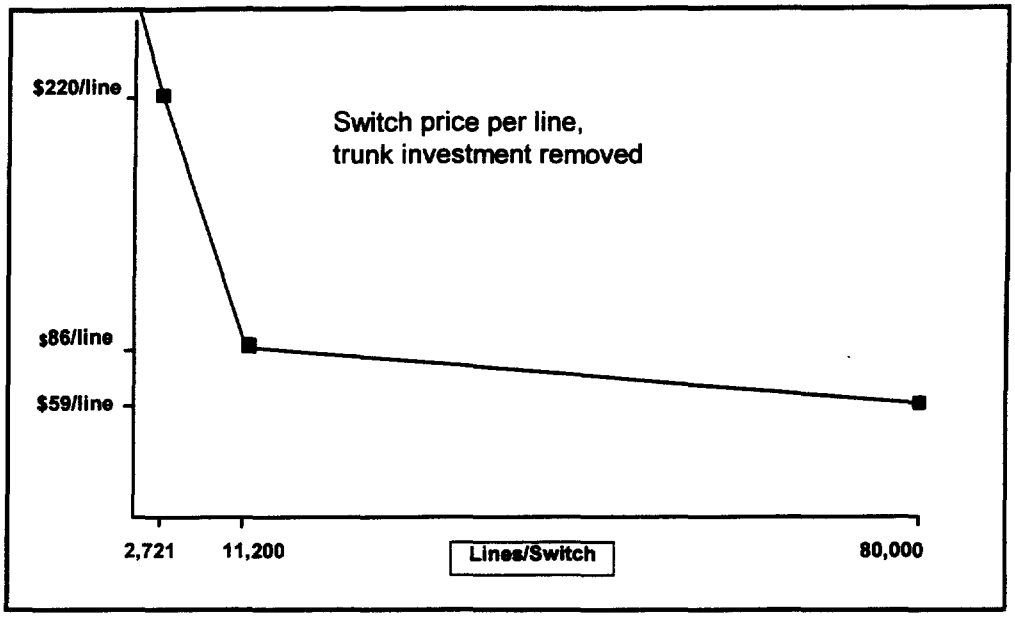
and explain how the model determines whether a switch will be a host, remote or stand alone switch.

Numerical calculations provided in Attachment 2c - SWTX.

The model assigns at least one end office switch to each wire center. It sizes switches in the wire center by adding up all the lines in the CBGs served by the wire center and then compares this line total to the maximum allowable switch size. This parameter is user-adjustable, but its default is set at 100,000 lines with a fill factor of 0.80, yielding a maximum effective switch size of 80,000 lines. The model will equip the wire center with a single switch if the number of switched access lines served by the wire center is no greater than 80,000, using the default assumptions. In general, a switch may serve any line count between zero and 80,000 (but in the HM is typically equipped with well less than 20,000 lines). Thus, if a wire center must serve 90,000 lines, the model will compute the investment required for two 45,000 line switches. The wire center module also compares the busy hour call attempts (BHCA) produced by the mix of business/residence lines served by each switch -- with a user-adjustable processor capacity (maximum of 600,000 BHCA) to determine whether the switch is line-limited or processor real-time-limited.

Once the model determines the end-office switch line size, it obtains the investment per line from an investment function that relates per-line switching investment to switch line size. The data to define this function were obtained from a publicly-available study of the central office equipment market published annually by McGraw-Hill. (Northern Business Information study: U.S. Central Office Equipment Market -- 1995, McGraw-Hill). This study shows the average investment per new line of digital switching paid by BOCs to be $102 and by Independents to be $235 in 1995. The model combined these figures with average BOC (11,200) and Independent (2,761) switch line sizes derived from data published in the FCC's Statistics of Communications Common Carriers (Federal Communications Commission, Statistics of Communications Common Carriers, Tables 2.3 and 2.4, 1994 edition), along with information on much larger switches obtained from switch manufacturers to develop the complete investment function. The per-line investment figures include the entire end office switch, including trunk ports. Because the Wire Center Investment Module calculates trunk port investment separately from the switch common equipment and line circuit investment, each of the raw per-line investment figures is reduced by $16. This reduction results from an assumption of $100 per trunk port (per DS-0) and a conservative concentration ratio of six lines per trunk. The following figure shows the resulting investment curve.

Figure 1. End office switching investment curve



The switching investment input assumptions include aggregated pricing information for host and remote switches in addition to that for stand-alone end office machines. Thus, the model investment function automatically accommodates the cost of the switching entity (e.g., host, remote, or stand-alone) equipped in a given wire center.

d. Cable and wire statistics: percent underground, buried and aerial; the length, gauge and size of copper cable used; length and size of fiber cable used; fill factors used as inputs; percent distribution fill determined by the number of lines served divided by the total number of distribution lines installed; percent feeder fill determined by the number of lines served divided by the total number of feeder lines installed (when the feeder is fiber, explain what assumptions were used to determine the capacity and use of the fiber); the distribution of households by loop length; and any factors that alter the cost of cable or the installation of cable such as additional costs associated with placing cable in dense urban areas.

* **Type of Cabling and Placement Structure**

Structure percentages are user-adjustable. The following tables show the model's default values:

Copper Distribution Cable Structure Type Default Values			
CBG Density (Lines/sq. mi.)	% Aerial	% Buried	% Under-ground
0 - 5	50%	50%	-
5 - 200	50%	50%	-
200 - 650	50%	50%	-
650 - 850	50%	50%	-
850 - 2550	40%	50%	10%
> 2550	65%	5%	30%

Copper Feeder Cable Structure Type Default Values			
CBG Density (Lines/sq mi)	% Aerial	% Buried	% Under-ground
0 - 5	50%	45%	5%
5 - 200	50%	45%	5%
200 - 650	50%	45%	5%
650 - 850	40%	40%	20%
850 - 2550	10%	10%	80%
> 2550	5%	5%	90%

Fiber Feeder Cable Structure Type Default Values			
CBG Density (Lines/sq mi)	% Aerial	% Buried	% Under-ground
0 - 5	35%	60%	5%
5 - 200	35%	60%	5%
200 - 650	35%	60%	5%
650 - 850	20%	60%	20%
850 - 2550	10%	10%	80%
> 2550	5%	5%	90%

- Copper cables of 2400 pairs and smaller are assumed to be 24 gauge copper. Cables of larger than 2400 pairs should be based on 26 gauge copper, since 24 gauge copper cables are not manufactured in sizes larger than 2400 pairs.
- All distribution cable is copper. Feeder is either copper or fiber/DLC depending on whether the feeder route exceeds 9000 feet. While the 9000 foot breakpoint between copper and fiber/DLC feeder is user-adjustable, users

are cautioned against using breakpoints in excess of 12,000 feet as this may require special conditioning to accommodate digital services.

- When fiber/DLC feeder is used, four fibers are installed to serve the DLC remote terminal. Because there is one transmit fiber and one receive fiber, this provides 100% redundancy.

  * **Fill Factors**

In the Hatfield model, cable fill is a function of two items: the maximum fill that the model allows to be engineered, and the extra spare that results from always installing a cable that has a number of pair that equals or exceeds the number of pair that the engineering specifications require. The following tables show the maximum engineered fill (which is user-adjustable). Attachment 5d demonstrates the actual effective fill in copper distribution cable when the extra pair in the cable beyond the engineering requirements are considered. As can be seen, this shows that the effective fill is substantially lower than the maximum engineered fill.

Copper Distribution Cable Default Maximum Engineered Fill Factor	
CBG Density (Lines/sq. mi.)	% Fill Factor
0 - 5	50%
5 - 200	55%
200 - 650	60%
650 - 850	65%
850 - 2,550	70%
> 2,550	75%

Copper Feeder Cable Default Maximum Engineered Fill Factor	
CBG Density (Lines/sq. mi.)	% Fill Factor
0 - 5	65%
5 - 200	75%
200 - 650	80%
650 - 850	80%
850 - 2,550	80%
> 2,550	80%

Note that fill factors for fiber feeder are not terribly meaningful. The default assumption in the Hatfield model is that the four fibers feeding a DLC remote terminal (in all but the two lowest density zones) are equipped with electronics

that can handle 2016 circuits (3 DS-3s). But, if demand on that feeder route expands beyond 2016 circuits, these four fiber feeder strands would not need to be augmented. Rather, higher capacity electronics would be added -- with the possibility to expand capacity in almost unlimited amounts. In the two lowest density zones, the four fibers are equipped to carry 100 circuits, but this figure, too, may be expanded through the installation of higher capacity electronics.

For Digital Loop Carrier (DLC), since most of the investment is in line cards, fill factor refers to the utilization of line cards, not utilization of the maximum capacity of the remote terminal cabinet. The model assumes a small DLC system, referred to as AFC for the lowest two density zones. Normal DLC (which we shall term "SLC") is used for the four higher density zones. The user may input appropriate fill factors for AFC units, as well as for SLC. Default values are to equip both AFC and SLC with enough line cards so that the cards are only 90% utilized. As growth occurs, a technician may be dispatched at biannual or annual intervals to augment the number of line cards in the cabinet.

* **Distribution of households by loop length**

See attachment 2d

* **Factors affecting the cost of cable or installation**

Increased costs associated with the placing of cable in dense urban areas is reflected in the Hatfield Model by the significantly higher cost of structure assumed as default values in the highest density zone. The following are the default values used for underground placement of copper and fiber feeder cable:

Underground Conduit Default Values per Foot of Copper Feeder Cable

CBG Density (Lines/sq. mi.)	Man-holes (ea.)	Manhole Spacing (ft.)	Manhole Cost/ft.	Conduit Installation per Trench-Foot	Under-ground Structure Cost per Trench-Ft.*	PVC Conduit Material per Duct-Foot	Total Conduit Cost per Sheath-foot
0 - 5	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
5 - 200	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
200 - 650	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
650 - 850	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
850 - 2550	$3,000	600	$5.00	$45.00	$15.00	$1.00	$16.00
> 2550	$3,000	400	$7.50	$75.00	$25.00	$1.00	$26.00

* Assumes 3-way sharing of conduit with other utilities.

Underground Conduit Default Values per Foot of Fiber Feeder Cable							
CBG Density (Lines/sq. mi.)	Man-holes (ea.)	Manhole Spacing (ft.)	Equiv. Manhole Cost/ft.	Conduit Installation per Trench-Foot	Under-ground Structure Cost per Trench-Ft.*	PVC Conduit Material per Duct-Foot	Total Conduit Cost per Sheath-Foot
0 - 5	$3,000	2,000	$1.50	$25.00	$8.83	$1.00	$9.83
5 - 200	$3,000	2,000	$1.50	$25.00	$8.83	$1.00	$9.83
200 - 650	$3,000	2,000	$1.50	$25.00	$8.83	$1.00	$9.83
650 - 850	$3,000	2,000	$1.50	$25.00	$8.83	$1.00	$9.83
850 - 2550	$3,000	2,000	$1.50	$45.00	$15.50	$1.00	$16.50
> 2550	$3,000	2,000	$1.50	$70.00	$23.83	$1.00	$24.83

* Assumes 3-way sharing of conduit with other utilities.

In addition, significantly more cable is placed in underground structure in the highest density zones. Because placement in underground structure is more expensive than aerial or buried placement, this also has the effect within the Hatfield model of elevating the cost of cable placement in dense urban areas.

e. Digital carrier: the number of lines served by carrier; the investment in carrier and investment in carrier as a percent of circuit investment.

See Attachment 2e - SWTX.

f. Depreciation: the model depreciation rate and expected life by type of plant.

Plant Category	HM 2.2.2 Service Life	HM 2.2.2 Depr. Rate	ARMIS 43-03 Accts.
Loop distribution	20.2	5.0%	2421, 2422, 2423 metallic
Loop feeder	20.1	5.0%	2421, 2422, 2423 combo metallic & fiber
Loop concentrator	10.4	9.6%	2232
End office switching	14.3	7.0%	2212
Wire center	37	2.7%	2121
Tandem switching	14.3	7.0%	2212
OS investment	8	12.5%	2220
Transport facilities	19	5.3%	2421, 2422, 2423, 2426 fiber
STP	14.3	7.0%	2212
SCP	14.3	7.0%	2212

Links	19	5.3%	2421, 2422, 2423, 2426 fiber
Public telephones	9.2	10.9%	2351
General support	7.1	14.1%	2112, 2115, 2116, 2122, 2123, 2124

g. Expenses: direct network expenses; indirect expenses; and common and overhead expenses. Please explain how the model allocates expenses among these various expense categories.

Because the Hatfield model applies TELRIC/TSLRIC principles in estimating costs, any costs that are attributable to a particular network element or service, regardless of whether traditional USOA conventions would have called such a cost "direct," "indirect," "common" or "overhead," is included in the element or service's economic cost. In general, direct network expenses are allocated to the network element that these expenses support based on that element's investment. Indirect expenses are calculated based on the number of lines served by the LEC, and are distributed among network elements based on investment. Common and overhead expense (in traditional USOA parlance), to the extent that these costs are shared across network elements, are divided equiproportionately across the network elements that benefit them. To the extent that there are costs shared between network elements and the rest of the LEC, these are captured through a user-adjustable corporate overhead factor (default value of 10%) that is distributed equiproportionately across elements.

h. Capital Costs: return on capital; and taxes. Please explain how the percentage return on capital was calculated; and how tax gross-ups were determined.

Cost of Capital

The cost of capital used in the Hatfield Model is a weighted average cost of capital. It is based on the relative quantity of debt in the LEC's capital structure and the cost of that debt, and the relative quantity of equity in the LEC's capital structure and the cost of that equity. These parameters are all user-adjustable inputs to the Hatfield model.

The default capital structure in HM 2.2.2 is assumed to be 45% debt and 55% equity with a cost of debt of 7.7% and a cost of equity of 11.9%. These figures are consistent with several RBOC cost of capital analyses sponsored by AT&T or MCI. Weighting these costs of debt and equity by their assumed relative portions in the LEC's capital structure yields an overall weighted average cost of capital of 10.01% (= .45*7.7% + .55*11.9%).

Tax Gross-Ups

The above cost of capital is an after-tax cost of capital. Thus, the LEC's actual return on capital must be grossed-up to a level sufficient to both pay the LEC's Federal Income Tax (FIT) and to leave the LEC with net earnings equal to its after-tax cost of capital. Because interest payments on debt are a tax-deductible expense, only the return on average net investment (total plant less accumulated depreciation) associated with payments to equity requires a tax gross-up.

This FIT gross-up amount is calculated by dividing the dollars-of-return weighted equity portion of the FIT on the total return on investment by the gross-up factor. The tax gross-up factor is 1 - the tax rate. This calculations produces the correct level of additional return to provide a company with sufficient after tax income to pay its shareholders a market return on their investments.

The formula for calculating the FIT gross-up can be expressed as follows:

Tax Gross-Up = (**EquityP** * **Return** * **FITR**) / (1 - **FITR**)

where:

EquityP = the dollars-of-return weighted equity percentage of LEC's capital structure (default assumption is 60.7%)
Return = **Cost of Capital** * **Average Net Investment**
FITR = the FIT tax rate (default assumption is 40%)

i. Support: the aggregate support at $20, $30 and $40 support levels and the number of households by cost category, where cost categories are ranges of cost per month such as greater than and equal to $5 and less than $10.

See Attachment 2i - SWTX

3. ***Explain how the model complies with the criteria for evaluating proxy models set forth in paragraph 277 of the Joint Board's Recommended Decision.***

3.1 *The technology assumed in the model is the least-cost, most efficient and reasonable technology for providing supported services that is currently available for purchase (assuming continued use of existing wire centers).*

The HM is specifically designed to meet the above criteria completely. The HM assumes continued use of existing wire centers – even though it is easily demonstrated that total network costs could be reduced if the current

number of wire centers were reduced. The HM assumes copper loop distribution, and copper or fiber feeder depending on the length of the feeder run. When feeder runs are sufficiently long to require fiber feeder, digital loop carrier that is integrated into the serving digital end office switch is used. All switching is digital, interoffice trunks run on SONET fiber, signaling is SS7, and databases are of modern design. That the network engineered by the HM is the least-cost generally available technology is best evidenced by the fact that it is the technology currently being installed by the LECs – when their installation decisions are not controlled by a need to interface to certain existing, but obsolescent technologies (e.g., if the LEC currently uses an in-place analog 1AESS® end office switch, it would be impractical to equip any required loop carrier systems with IDLC.)

3.2. *Any network function or element, such as loop, switching, transport, or signaling, necessary to produce supported services must have an associated cost.*

The HM is specifically designed to meet these criteria because it constructs all elements of a complete local network from the ground up (e.g., loop distribution, concentration, feeder, end office switching, tandem switching, common transport, dedicated transport, signaling links, signal transfer point, service control points, operator service positions) without the use of obscuring factors or other implicit constructions. This is best evidenced by the fact that rather than creating the cost only of a bundled output called "universal service," the HM modularly builds the costs of the more than eleven unbundled network elements that comprise local service. The HM is thus able to accommodate dynamically alternative definitions of "universal service."

3.3 *Only forward-looking costs should be included. The costs should not be the embedded costs of the facilities, functions or elements.*

Because the HM builds the network costs of all unbundled elements from the bottom up – based on best engineering judgments about the equipment required and costs incurred without inappropriate reference to embedded levels of cost that may in fact have been incurred by LECs to construct this or similar networks, its costs are of necessity, forward-looking. While certain guidance as to the forward-looking level of certain operations, maintenance and other support expenses is gleaned from LEC embedded levels of these expenses, this guidance is suggestive, only. From these embedded data, appropriate quantitative or "best in class" inferences are made to estimate the forward-looking levels of these types of expense.

3.4 *The model should measure the long-run costs of providing service by including a forward-looking cost of capital and the recovery of capital through economic depreciation expenses. The long run period used should be a period long enough that all costs are treated as variable.*

By using DCF and CAPM-based methodologies for estimating the cost of capital incurred currently by the ILECs, the HM appropriately captures the forward-looking long-run economic costs of providing service. It is well-known that these methods of calculating the cost of capital capture all currently-known expectations of the risk that the LEC may encounter in its provision of these services.

Similarly, the HM uses depreciation rates based on current best estimates of the projection lives (adjusted for the net salvage value of the equipment) of newly placed, modern telecommunications equipment. These depreciation rates more accurately measure forward-looking economic depreciation than a LEC's current embedded depreciation rates. Because the HM separately and explicitly depreciates thirteen different classes of telecommunications plant, the model also captures correctly the different overall levels of depreciation expense that the LEC may experience as its plant mix shifts from embedded to forward-looking technology. Furthermore, because the HM combines explicitly the return to capital, its depreciation and its tax expense into an overall carrying cost of capital, adjustments to any of these parameters may be made independently in a straightforward, traceable fashion.

3.5 *The model should estimate the cost of providing service for all businesses and households within a geographic region. This includes the provision of multi-line business services. Such inclusion allows the models to reflect the economies of scale associated with the provision of these services.*

The HM estimates the cost of a reconstructed network capable of serving all narrowband demand from single and multiple line residences and businesses, and for public and special access lines. Because the costs of a network are driven in largest part by the total network demand (and not differentially by particular classes of service offered over this total network), the HM's construction of a network capable of satisfying all demand ensures that all services offered over this network enjoy a pro rata share of the scale economies engendered by the construction of this complete network.

3.6 *A reasonable allocation of joint and common costs should be assigned to the cost of supported services. This allocation will ensure that the forward-looking costs of providing the supported services do not include*

an unreasonable share of the joint and common costs incurred in the provision of both supported and non-supported services, e.g., multi-line business and toll services.

Because the HM builds the costs of universal service up from the forward-looking economic costs of the unbundled network elements that are the constituent parts of universal service, supported universal service is assessed for no more than its pro rata share of the joint and common costs associated with its provision. This is evident for two reasons. The first is that due to the modular, bottoms up construction of unbundled element costs, any costs that are joint or common among network elements, or between network elements and other portions of the firm, are incorporated on a pro rata basis into the costs of the network elements that benefit from such joint or common costs. Because of this, an appropriate share of these costs becomes included in supported universal service expense when these unbundled element costs are used to build universal service costs. Furthermore, because the Joint Board has wisely chosen to define universal service costs broadly (e.g., dial tone with unlimited local calling, access to interexchange services, emergency services and operator/DA services, etc.) very few joint and common costs exist between this supported package of "universal service" and other services. To the extent that such costs exist, the HM divides these costs among supported and non-supported services on an equiproportional basis.

3.7 *The model and all underlying data, formulae, computations, and software associated with the model should be available to all interested partied for review and comment. All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible.*

For close to half a year, the HM model has been freely and widely distributed on a CD-ROM that includes all of its input data. All of the data underlying the HM are publicly revealed – without any requirements for persons wishing to view the model or its data to sign confidentiality agreements or any restrictions on the dissemination of the data or their use in other proceedings beyond standard copyright limitations. The model is constructed in a series of Microsoft Excel spreadsheets that contain no hidden cells or any other impediment to careful review by competent parties. The Microsoft Excel program itself is widely available at nominal cost, and is used extensively by telecommunications analysts. Furthermore, the data entered into the HM all derive from public sources that may be examined by interested parties and have been documented extensively by HAI.

3.8 The model should include the capability to examine and modify the critical assumptions and engineering principles. These assumptions and principles include, but are not limited to, the cost of capital, depreciation rates, fill factors, input costs, overhead adjustments, retail costs, structure sharing percentages, fiber-copper cross-over points, and terrain factors. The models should also allow for different costs of capital, depreciation, and expenses for different facilities, functions or elements.

The HM contains, roughly, 419 user-adjustable inputs that cover every aspect of the local exchange network engineered by the model. (See Attachments 5A and 5B for a list of the user adjustable inputs and their national default values.) These include not only all of the critical assumptions listed above, but many, many more. In addition, because the HM builds up all of its costs in a granular, structural fashion, it is possible to alter directly the values for any of the above variables and to recompute the model. It is not necessary to disentangle the effects of any particular variable through the off-line manipulation of an opaque reduced-form or proprietary input into the model.

4. ***In its Recommended Decision, the Joint Board recommended that universal service support be provided for single line businesses in high cost areas. How do models calculate costs for single line businesses?***

The HM constructs and costs a local exchange network sized to service all demand – including that of single and multi-line businesses in addition to residences. Thus, the only modification to HM2.2.2 needed to calculate the costs of universal service support to single-line business service is an identification of the number of single line businesses in each CBG. This can be performed by taking the fraction of single-line businesses to total business lines (as calculable from LEC ARMIS 43-01 reports on a study area basis) and applying this fraction to the total number of business lines that the HM Line Converter Module computes for each CBG. This figure may also be adjusted by use of additional data to refine further differences in the relative numbers of single business lines to total business lines that may exist across CBGs of varying overall lines-densities.

5. ***List all equations used in the model For each variable used in an equation, provide the definition of the variable, the default value of the variable, identify the source of the variable, and state whether the user can change the value of the variable.***

The Data Dictionary tables in Attachment 5A lists all user-adjustable inputs, their default values, and equations used in the Hatfield model. Attachment 5B provides a further explanation of these variables and provides support for the default values initialized in the model.

6. ***What sources are available to verify that a network derived by a model is capable of delivering telecommunications services consistent with the standard of service adopted in the Joint Board's Recommended Decision?***

There is no reason to believe that a network derived from a cost proxy model is any less capable of delivering a high quality telecommunications service than is a network costed by more traditional LEC methods. Any company considering facilities-based expansion into a new market must estimate its expected costs and revenues in an effort to decide how to proceed. Those estimates don't simply extrapolate from costs and revenues earned historically elsewhere on the company's existing system. Instead, they bring to bear engineering, operating, economic, marketing and financial expertise in an effort to provide estimates that are sufficiently reliable to decide.

Computer simulation has become a standard tool of research for improving our understanding of theoretical constructs. It is an efficient method for analyzing hypotheses and it facilitates experimental testing. The Hatfield Model incorporates sound engineering, operating, marketing, financial and economic costing principles to calculate the costs of unbundled network elements. The Hatfield Model is based upon engineering standards and methods applicable to the local exchange network that are consistent with all relevant Bellcore specifications and which meet the standard of service adopted in the Joint Board's Recommended Decision. Attachment 5B provides exhaustive documentation of sources attesting to the Hatfield model's validity.

7. ***Your model assumes that vendors typically offer a discount off their list prices for switches and digital loop carrier equipment. Purchasers, however, may be prohibited from disclosing the size of such discounts. Given the inability to provide such information, what alternatives are available to acquire such information?***

The HM uses publicly available data about the prices paid for DLC and other telecommunications equipment. These public data are also checked for reasonableness by experts who have been responsible for the purchasing of many millions of dollars worth of similar equipment. If a LEC who happens to be in possession of actual data on the level of prices and discounts chooses to dispute

these publicly available figures, it should face a very heavy burden of proof. It is not at all unreasonable to require the disputing LEC to reveal its actual receipts for such equipment.[1] Such requirements already exist for small LECs desiring to receive REA/RUS subsidies for their purchases of equipment.

8. ***Describe the specific manner in which network design parameters (cable gauge, capacitance, loading, resistance, attenuation, cable fill, and concentrator or repeater placement) are used in the development of the models.***

The HM models outside plant in a manner similar to how an outside plant planning design engineer would model or design the network. That design meets generally accepted outside plant engineering rules.

Cable gauge describes the diameter of copper wire used to provide an electrical path that does not exceed the maximum resistance allowed in the loop. The HM calls for 24 gauge cable up through a size of 2400 pairs, and 26 gauge cable for larger sized cables up to a maximum cable size of 4200 pairs. The HM embraces the Carrier Serving Area design as described in "*BOC Notes on the LEC Networks - 1994*", pg. 12-5. The HM recommends (but does not require) use of fiber feeder beyond 9,000 foot feeder lengths to ensure that the use of 24 gauge distribution cable meets appropriate resistance design. It is rare that distribution cables larger than 2400 pair are fed by DLC.

Capacitance affects loss of high frequency signals, and becomes an important factor on copper loops beyond 18,000 feet for normal POTS design. The HM's recommended use of fiber feeder beyond 9,000 feet, and the use of 24 gauge distribution cable ensures that capacitance restrictions do not apply.

Loading involves the placement of inductors (load coils) to compensate for excessive capacitance loss on POTS loops, when such loops reach a total length of 18,000 feet on copper. Load Coils would be spliced to individual copper cable pairs at 6,000 foot intervals, starting at 3,000 feet from the central office or DLC remote terminal. The HM's recommended use of fiber feeder beyond 9,000 feet, and the use of 24 gauge distribution cable ensures loading restrictions do not apply.

Resistance is affected by the length and gauge of copper loops. The HM recommended use of fiber feeder beyond 9,000 feet ensures that the use of 24 gauge distribution cable meets appropriate resistance design.

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[1] Verification of the actual cost paid by the LEC may require the production of more than the invoices for just the equipment items in question. Rather, the entire collection of business transactions between the LEC and its supplier may need to be examined. This because particular

Attenuation refers to signal degradation or loss, normally measured in decibels (dB). Extensive use of fiber fed Integrated Digital Loop Carrier in the feeder network, with its attendant 0 dB loss at the Remote Terminal point, provides for a robust feeder facility that minimizes attenuation in its use of copper cable for distribution, and short feeder cable distances from the central office.

Cable Fill is a term that can have different meanings in engineering the network. Incumbent Local Exchange Carriers typically measure fill at the Main Distributing Frame (MDF) for copper feeder cable, and at the distribution side of the Serving Area Interface (SAI) for copper distribution cable.

Engineers typically use cable fill levels as indicators in designing individual sections of copper cable plant. Engineers use a combination of factors to economically size and time copper feeder cable relief. Those factors include the number of spare structure spaces remaining, and the growth rate of service. Therefore, the engineer will use as relief indicators the cable fill on a cable section, rather than simply at the MDF or SAI.

Each section of copper cable in the Hatfield Model is analyzed and sized based on a cable fill factor that varies by density zone. The higher the density zone, the higher the default value for cable fill in the model input tables. This is because cable sizes will be larger in higher density zones, with greater statistical stability of demand fluctuations. Thus, a smaller percentage of a large cable need be kept for spare than of a small cable with equal assurance against unforeseen exhaust.

Concentrator Placement, or Digital Loop Carrier placements are made whenever the model calls for fiber feeder facilities. The default value in the model is a 9,000 foot cross-over distance from copper feeder to fiber feeder. The Hatfield Model uses an Integrated Digital Loop Carrier Remote Terminal at the end of a fiber feeder cable; that terminal is collocated with the SAI to serve a Census Block Group (CBG).

Repeater Placement is not necessary for copper facilities in the Hatfield Model, because copper is used only for short distances. Digital signals carried over fiber cable require optical repeaters at long distances. The model provides for these in the interoffice portion, which assumes optical repeaters are required beyond 40 miles. In the investment unit cost calculation, a user-definable interoffice distance of 41 miles is used to ensure that optical repeater costs are reflected. The optical repeater is expected to be housed in a central office along the interoffice route, rather than in an outdoor housing, since there is normally an appropriate wire center location along the route to provide for this equipment installation.

9. ***What service capability will local loops have if built to the specifications used in the model? Will all local loops provide (1) full time (non-traffic sensitive and non-party line) service between the customer and the serving wire center and/or (2) digital subscriber line (DSL) capability as described in "BOC Notes on the LEC Networks - 1994"? Will all local loops be capable of providing (1) basic rate ISDN service (2B+D) and/or (2) full duplex service at the DS1 level (commonly called T1) of 1.544 Mbps?***

9.1. The Hatfield model engineers no party line service. The model engineers sufficient distribution facilities and feeder facilities to provide for full-time circuits to each customer location. And if fiber feeder facilities are employed, these facilities feed non-blocking, non-concentrated integrated Digital Loop Carrier facilities.

9.2. The referenced document "BOC Notes on the LEC Networks - 1994" describes digital subscriber line capabilities as follows:

> " The DSL for ISDN Basic Rate Access (BRA) transmits 160 kbps in both directions simultaneously on a nonloaded cable pair. The DSL is intended to operate with cable loss of up to 42 dB at 40 kHz. To minimize crosstalk between DSLs in the same cable binder group, the signal is recoded into 2 Binary 1 Quaternary (2B1Q) form, that is, two binary pulses become one quaternary pulse on the line (see Section 12). Almost all loops designed to resistance design criteria, whether RRD or its predecessors, will transmit a DSL signal out to 18 kft. The customer provides a Network Termination 1 (NT1) device on the customer side of the demarcation point to operate into the DSL transceiver in the central office. With suitable channel units, a DSL can be extended out to a CSA on DLC facilities."

The Hatfield model has been designed to meet these requirements. The full switching costs of ISDN, however, have not been included in the present version of the model because only POTS service has been considered. The robustness of the Hatfield model, its granularity and its open architecture readily permit the additional switching costs involved in ISDN to be overlaid on the costs derived for POTS service. Specifically, the Hatfield model engineers nearly all of its loops to support ISDN. Extensive use of fiber-fed Integrated Digital Loop Carrier in the feeder, with its attendant 0 dB loss at the Remote Terminal point, provides for a robust feeder facility that minimizes attenuation in its use of copper cable for distribution. Full duplex service at the DS1 level of 1.544 Mbps is not specifically modeled, although extensive use of fiber feeder will position facilities far enough out in the local loop to extend DS1 service to customers with minimal additional loop conditioning.

10. ***The Hatfield and BCM2 models differ with regard to the sharing of structure investments, the mix of aerial, underground and buried cable, and the relationship between the costs of installation and the terrain. For example, the Hatfield model shares structure costs among three utilities, while the BCM2 models assigns 100% of the cost of structures to the telephone company. The Hatfield model assumes that cable will be extended by 20 percent when encountering difficult terrain rather than using terrain specific cost characteristics, while the BCM2 uses terrain specific cost characteristics. The BCM2, however, aggregates the terrain specific costs by activities, such as trenching in hard rock or restoring asphalt. Please provide documentation that supports the assumptions used in the models. Alternatively, please provide documentation that refutes these assumptions.***

10.1. The Hatfield model incorporates assumptions concerning "shared" structure costs that reflect best, forward-looking use of the facilities in question. These assumptions are fully consistent with both the intent of the Federal Telecommunications Act, and present structure sharing practices within the industry. The Act properly recognizes that nondiscriminatory access to poles, conduit, trenches and other rights-of-way is essential to the promotion of competition in local telecommunications markets. State and municipal rules and restrictions sharply curtail the ability of new entrants to construct such facilities for their sole use. Under these circumstances, present structure owners could use their control of these scarce resources to restrict entry by potential competitors. The Act, therefore, imposes on all utilities the duty to provide access to structure on a nondiscriminatory basis, and establishes a new legal and regulatory framework under which the terms and conditions of such access can be determined.

Given this framework, 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 with competing carriers, including cable companies and electric utilities. Indeed, many competing local competitors, including AT&T, MCI, Comcast, Time-Warner, and CableVision have already indicated through state regulatory proceedings their intent to use existing ILEC structure in developing their own facilities-based local networks, and the terms and conditions of such access have been included in many arbitration agreements.

Present practices within the industry strongly support the realism of the Hatfield model's assumptions concerning structure sharing. Such sharing is strongly implied by the existence of tariffed rates for pole attachments

and conduit space. Furthermore, both expert opinion and the available statistical information indicate that the practice of sharing poles through joint ownership or monthly lease arrangements is widespread, and that, indeed, the typical pole carries the facilities of all classes of potential users, telecommunications companies, cable companies, and electric utilities. It is also not uncommon for property developers to pay for substantial portions of structure cost to serve their new properties.

The Southern California Joint Pole Committee, for example provides with its monthly financial statements a report displaying joint pole units and annual pole line charges for its member utilities. This report indicates that the telephone companies, GTE, Contel and Pacific Bell, together account for 50 percent of pole units on an embedded basis. Other utilities account for 47.3 percent, cellular companies for 0.3 percent, and municipalities account for the remainder, about 2.2 percent. Note that the cable companies are not represented in this report because they lease, rather than own the pole units.

Trenching and conduit systems are also shared, particularly in urban areas where the use of aerial facilities is sharply curtailed. It is not uncommon for municipalities or state regulatory authorities to impose trenching and conduit sharing requirements as a means of minimizing the inconvenience and disruption associated with construction of these facilities. Regulatory authorities have, furthermore, imposed requirements for excess capacity in conduit systems, both to reduce the need for construction, and to ensure the existence of sufficient conduit capacity for municipal use. Given expectations regarding the development of facilities-based competition in urban areas, ILECs will be able to recover a portion of the costs of these systems from competing carriers.

Current ARMIS data provides additional support for the sharing of poles and conduits. Part 32 accounting rules require all reporting carriers to provide subsidiary records within expense accounts to identify rental expenses associated with each operating expense category. These data demonstrate that pole sharing and rental by LECs is significant and widespread.

Users can fully adjust the mix of aerial, underground and buried cable assumed within the Hatfield model. These parameters are readily input, with unique values for each density zone, for fiber feeder, copper feeder, and copper distribution cables.

10.2. The Hatfield Model Version 2.2 Release 2 assumes that cable will be extended by 20% when encountering difficult terrain rather than using terrain specific cost characteristics. Costs associated with structures that support the placement of cable have a variety of input variables that can be adjusted by the user. However, default values are supplied for each input, and are recommended unless special conditions exist. The structure input variables may differ by density zone, and defaults are as follows:

Buried Cable (Structure) Default Values			
CBG Density (HH/sq.mi.)	Trench Cost per Foot	Allocated Cost* per Sheath Foot	Additional Material Cost for Armored Cable
0 - 5	$2.00	$.67	+10%
5 - 200	$2.00	$.67	+10%
200 - 650	$2.00	$.67	+10%
650 - 850	$3.00	$1.00	+10%
850 - 2550	$3.00	$1.00	+10%
> 2550	$20.00	$6.67	+10%

*Assumes 3-Way Sharing

Underground Conduit Default Values per Foot of Copper Distribution Cable				
CBG Density (HH/sq.mi.)	Conduit Installation per Trench Foot	Under-ground Structure Cost* per Trench Ft	PVC Conduit Material per Duct Foot	Total Conduit Cost per Sheath Foot
0 - 5	$25.00	$8.33	$1.00	$9.33
5 - 200	$25.00	$8.33	$1.00	$9.33
200 - 650	$25.00	$8.33	$1.00	$9.33
650 - 850	$25.00	$8.33	$1.00	$9.33
850 - 2550	$45.00	$15.00	$1.00	$16.00
> 2550	$70.00	$23.33	$1.00	$24.33

*Assumes 3-Way Sharing

Underground conduit is only used occasionally for distribution cable plant.

Underground Conduit Default Values per Foot of Copper Feeder Cable							
CBG Density (HH/sq.mi.)	Man-holes (ea.)	Manhole Spacing (ft.)	Manhole Cost/ft.	Conduit Installation per Trench Foot	Under-ground Structure Cost* per Trench Ft	PVC Conduit Material per Duct Foot	Total Conduit Cost per Sheath Foot

0 - 5	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
5 - 200	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
200 - 650	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
650 - 850	$3,000	800	$3.75	$25.00	$8.33	$1.00	$9.33
850 - 2550	$3,000	600	$5.00	$45.00	$15.00	$1.00	$16.00
> 2550	$3,000	400	$7.50	$75.00	$25.00	$1.00	$26.00

*Assumes 3-Way Sharing

Note that trenching costs are significantly higher in the denser areas because underground conduit is normally done where trenching in pavement is involved. See Attachment 5B for further documentation,

Those factors that might be considered difficulty factors, and how they are treated by the Hatfield Model are as follows:

a. Water Tables:
Cable is generally placed within 2 to 3 feet of the surface. Conditions are rare where the water table is less than 2 feet. Ordinary variation in bids, which routinely differ by at least plus or minus 25%, swamps any cost variation due to water table depth.

b. Soil Texture:
Cable is generally placed within 2 to 3 feet of the surface. With the exception of hard rock, conditions are rare where soil texture in the top 2 feet of soil greatly affects bid prices. Ordinary bid variation exceeds soil texture effects.

c. Hard Rock:
The typical response to hard rock conditions is not to blast away the rock for telecommunications cable, but to simply route cable around those conditions where rock is at a depth of one foot or less. The danger, the cost, and the environmental impacts are simply not worth the additional length of cable involved. Therefore, the Hatfield Model increases the length of cables by 20% for those rare occasions where hard rock is less than one foot from the surface.

It should also be noted that the HM conservatively assigns an additional 20 percent to the cable length every time it encounters bedrock at less than 1 foot or less depth. Assigning this extra 20% represents application of good engineering judgment, and adequately accounts for those situations that require additional length beyond what is described above.

d. Elevation:
The Hatfield Model computes cable distances in a rectilinear fashion. In other words, all cables route at right angles, rather than via straight airline distance at slight angles. Rectilinear routing allows for the routing of cable around most natural and manmade obstacles without additional cable. However, the