AT&T

Suite 1000
1120 20th Street N.W.
Washington, DC 20036
202 457-3810

July 14, 1997

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

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

Dear Mr. Caton,

Today, Chris Frentrup, of MCI, and I met with Anthony Bush, Bryan Clopton, Mark Kennet, Bob Loube, Tejal Mehta, Tim Peterson, Bill Sharkey and Natalie Wales of the Common Carrier Bureau to submit a preliminary version of Release 4.0 of the Hatfield Model for the Federal-State Joint Board's consideration in CC Docket No. 96-45. This new release of the Hatfield Model modifies Release 3.1, submitted on February 28, 1997 to conform to the Commission's criteria for modeling the forward-looking economic costs of universal service given in the Commission's May 8, 1997 Order.

We also provided the Commission staff with the attached documentation describing the model, its data, the default values for its user-adjustable inputs and its computer user's guide.

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. Copies of the CD-ROM are being filed with the Secretary and with ITS.

Sincerely,

Mike Lieberman
Government Affairs Director

Attachments

CC: Anthony Bush, Bryan Clopton, Mark Kennet
Bob Loube, Tejal Melita, Tim Peterson
Bill Sharkey, Natalie Wales

COST MODEL CRITERIA

1. Use the least-cost, most-efficient, reasonable technology currently being deployed, subject to:
   - existing LEC wire center locations;
   - loop design should not impede the provision of advanced services;
   - wire center line counts should equal actual ILEC wire center line counts;
   - average loop length should reflect the incumbents actual average loop length.

HM4.0 provides for improved estimation of lines and household in the default dataset. Made use of USTA, USF NOI and RUS data in addition to ARMIS data for estimating the line counts of non-Tier 1 carriers.

Incorporated an automated outboard process to normalize the HM line counts by wirecenter to match data supplied by the ILEC.

Maps to a more accurate set of wireline end offices.

Displays, in the workfile, the average and maximum loop length as well as the distribution route distance.

2. Associate a cost with all network functions and elements used to provide service.

HM4.0 adds connecting cables to extend from the horizontal connecting cable to 1-lot deep into subcluster in the town situation if local RTs are not called for.

The horizontal connecting cables in the non-local RT case were estimated in HM3.1 but not captured in the final investment calculation.

While the main feeder could have spliced to feed directly into the backbone cables, it would have been more complicated engineering. Additional subfeeder is engineered in HM4.0 (relative to HM3.1) if main feeder intersects CBG. In actuality, the calculation has been simplified.

3. Include only forward-looking economic costs, based upon the current cost of purchasing facilities and equipment, rather than list prices.

Have changed some defaults to reflect more accurate market based costs (e.g. aerial drop cost) or more cost effective engineering design (e.g., 26 gauge cable for larger cable sizes)

4. Use rate of return that is either the authorized federal rate of return on interstate services, currently 11.25%, or the state's prescribed rate of return for intrastate services.

Provides for user defined input: 8.8% COD and 13.25% COE at 45/55 debt/equity ratio (per CC Dkt. No. 89-624) yields 11.25% overall cost of capital.

5. Use economic lives and future net salvage values within the FCC-authorized range.

Separately specify the economic life and the net salvage components in the depreciation.

6. Model costs based on providing service to all businesses and households, including multi-line business services, special access, private lines, and multiple residential lines, in order to reflect the economies of scale associated with the provision of these services.

Allows for the user to input the % of private line and special access voice grade equivalent circuits that are provided on DS-0, 4-wire DS-1, fiber DS-1, and DS3 to accommodate the future availability of such data on a consistently reported basis from all LECs.

7. Provide a reasonable allocation of joint and common costs to the supported services.

Currently studying the available data on overheads to study the inherent relationships between the expenses and total cost for large versus small companies.

8. Availability to all interested parties of the model and all underlying data, formulae, computations, and software, with all underlying data verifiable, engineering assumptions reasonable, and outputs plausible.

Added extensive internal documentation of the model including use of named variables to improve readability of equations. A revised Hatfield Input Portfolio (HIP) will be available.

9. Capability to examine and modify the critical assumptions and engineering principles.

While the model starts off extremely flexible and open, some additional aspects of the engineering construction were made more granular and open to modification: effects of soil types on placement costs, CBG by CBG definition of

% of population in clusters for the low density CBGs, SAI capacity, switch "slope" term.

10. Support calculations must be deaveragable to the wire center, and, if feasible, to CBG, Census Block, or grid cell level, subject to the caveat that it is more difficult to determine accurately where customers are located as the support areas grow smaller.

Currently investigating the workability of creating usable detailed clustering of actual customer locations and incorporating results into the model.

Hatfield Model

Release 4.0

Model Description

Hatfield Associates, Inc.

737 29th Street, Suite 200
Boulder, Colorado 80303

July 14,1997

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I. INTRODUCTION

A. OVERVIEW

The Hatfield Model has been developed by Hatfield Associates, Inc. (HAI), of Boulder, Colorado, at the request of AT&T and MCI for the purpose of estimating the forward-looking economic costs of 1) unbundled network elements (UNEs), based on Total Element Long Run Incremental Cost (TELRIC) principles;[1] 2) basic local telephone service, as defined by the Federal-State Joint Board on Universal Service ("Joint Board") for universal service funding purposes; and 3) carrier access to, and interconnection with, the local exchange network. All three sets of costs are calculated using a consistent set of assumptions, procedures and input data.

The Hatfield Model calculates the costs of the following UNEs:

[1] TELRIC is the term used by the Federal Communications Commission to refer to the total service long run incremental cost (TSLRIC) of unbundled network elements.

- Network Interface Device (NID)
- Loop Distribution
- Loop Concentrator/Multiplexer
- Loop Feeder
- End Office Switching
- Common Transport
- Dedicated Transport
- Direct Transport
- Tandem Switching
- Signaling Links
- Signal Transfer Point (STP)
- Service Control Point (SCP)
- Operator Systems
- Public Telephones

The Hatfield Model uses the definition of "universal service" recommended by the Joint Board.[2] The recommendation states that the following functional components be considered as universal service:

- single-line, single-party access to the first point of switching in a local exchange network;
- usage within a local exchange area, including access to interexchange service;
- touch tone capability;
- a white pages directory listing; and
- access to 911 services, operator services, directory assistance, and telecommunications relay service for the hearing-impaired.

Excluded from this definition of universal service are many other local telephone company services, such as toll calling, custom calling and CLASS[SM] features, and private line services. The existence of such services is taken into account in developing the cost estimates for UNEs -- to the extent that the joint provision of UNEs and other services impacts the costs of UNEs. Model users also may adjust the intensity to which several specific UNEs are included in calculating universal service support requirements.

Finally, the model estimates the per-minute competitive local exchange carrier (CLEC) cost of providing local network interconnection between competitive Local Exchange Carriers (CLECs) and of interexchange carrier (IXC) access. These are estimated for connection points at end office and tandem switches.

[2] Federal-State Joint Board on Universal Service, CC Docket No. 96-45, Recommended Decision, November 8, 1996, ("Recommended Decision") Paragraph 45-53, 65-70.

The model constructs a "bottom up" estimate of the pertinent costs based upon detailed information concerning customer demand, network component prices, operational costs, network operations criteria, and other factors affecting the costs of providing local service. The model, for example, receives as an input demand data, customer locations, line demand, and traffic volumes, within the serving area of the company being studied. From these data, it builds an engineering model of a local exchange network with sufficient capacity to meet total demand, and to maintain a high level of service quality. The model's inputs also include the prices of various network components, with their associated installation and placement costs, along with various capital cost parameters. These data are used to populate detailed input tables describing, for example, the cost per foot of various sizes of copper and fiber cable, cost per line of switching, cost of debt, and depreciation lives for each specific network component.

Using these data, the model calculates the required network investments by detailed plant category. It then determines the capital carrying cost of these investments, to which are added operations expenses to compute the total monthly cost of universal service, carrier access and interconnection, and various unbundled network elements, stated on both a total cost and an appropriate per-unit basis. Costs are then displayed on a study area, density zone, wire center, or Census Block Group specific basis.

This document describes the structure and operation of the Hatfield Model, Release 4.0 ("HM 4.0"), including a discussion of various inputs to the model. Subsection B of this section describes the evolution of the Hatfield Model. Section II summarizes changes made to the model between HM 3.1 and this version. Section III provides a general overview of the local network being modeled and the model's organization. Section IV describes each module and its operation in detail. Section V summarizes the document.

Appendix A documents the data input development process to obtain demographic and geological information, residence and business line counts, wire center mappings, wire center distance calculations, and percent of the land area of each Census Block Group that is unoccupied. Appendix B identifies the user inputs to the model and their default values.

B. EVOLUTION OF THE HATFIELD MODEL

The Hatfield Model was originally developed to produce estimates of the Total Service Long Run Incremental Cost (TSLRIC) of basic local telephone service as part of an examination of the cost of universal service. This original model was a "greenfield" model in that it assumed all network facilities would be built without consideration given to the location of existing wire centers or transmission routes. When the original Benchmark Cost Model (BCM1)[3] became available, HAI revised the original Hatfield Model to incorporate certain loop investment data produced by BCM1. As a result, the Hatfield Model adopted the BCM1's "scorched node" methodology, in which efficient, forward-looking network investments and costs for basic universal service were developed using existing wire center locations to estimate more accurately the complete cost of network equipment. The outputs from the BCM1 loop modeling process, substantially modified by including the cost of items not included in BCM1, were then combined with extensive wire center and interoffice and expense calculations enhanced from the earlier Hatfield Model to develop a full set of complete TSLRIC estimates.

An expanded version of earlier Hatfield Models, referred to as the Hatfield Model, Version 2.2, Release 1, was developed early in 1996 to estimate the costs of unbundled network elements. It was submitted to the Federal Communications Commission (FCC) in CC Docket No. 96-98 on May 16 and 30, 1996, accompanied by descriptive documentation.[4] On July 3, 1996, that model was also placed into the record of CC Docket No. 96-45 to assist the Commission in determining the economic costs of universal service.[5]

Further enhancements to this model were released as Hatfield Model, Version 2.2, Release 2 ("HM2.2.2"). This version of the model estimated the efficient, forward-looking economic cost of both unbundled network elements and basic local telephone service. HM2.2.2 derived certain of its inputs and methods from the BCM-PLUS model, a derivative of BCM1 that was developed and copyrighted by MCI Telecommunications Corporation.[6]

On August 8, 1996, the FCC released its First Report and Order in CC Docket No. 96-98, Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, and CC Docket No. 95-185, Interconnection

[3] The Benchmark Cost Model is a model of basic local telephone service developed by MCI, NYNEX, Sprint, and U S WEST.

[4] See Appendix E of the *Comments* of AT&T in CC Docket No. 96-98, In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, and Appendix D of AT&T's *Reply Comments*. In the same proceeding, MCI submitted results based on an earlier "greenfield" version of the Model as Attachment 1 to its *Comments*.

[5] See FCC Public Notice, DA-96-1078, Released July 3, 1996 and DA 1094, Released July 10, 1996 ("Cost Model Public Notice").

[6] On July 3, 1996, Sprint Corporation and U S WEST presented version 2 of the BCM (called BCM2) to the FCC. NYNEX and MCI are not sponsors of BCM2. A careful review by HAI indicated that all of BCM2's relevant enhancements over BCM1 were already present in the HM 2.2.2. Furthermore, the HM 2.2.2 has important attributes and capabilities that are not available in the BCM2.

between Local Exchange Carriers and Commercial Mobile Radio Service Providers ("Interconnection Order"). The Interconnection Order provided a comprehensive set of criteria for the arrangements through which the incumbent Local Exchange Carriers (ILECs) would offer unbundled network elements to potential CLECs. The criteria included a definition of a cost-based methodology that should be used in setting the price of unbundled network elements. The methodology was termed the Total Element Long Run Incremental Cost, or TELRIC. The methodology of the Hatfield Model is fully consistent with the TELRIC principles set forth in the Order.

AT&T and MCI used HM2.2.2 as the basis for their recommended prices for unbundled network elements in a large number of state jurisdictions during the latter part of 1996. As a result, the model has already been examined thoroughly in arbitration proceedings by the ILECs, state commission staffs, and other parties. Its results have also been adopted in several of these proceedings.

On November 8, 1996, the Joint Board issued its Recommended Decision in CC Docket No. 96-45.[7] In addition to defining Universal Service, the Board also addressed the issue of determining the level of support required for universal service. In doing so, it found that:

> . . . a properly crafted proxy model can be used to calculate the forward-looking economic costs for specific geographic areas, and be used as the cost input in determining the level of support a carrier may need to serve a high cost area. The Joint Board therefore recommends that the Commission continue to work with the state commissions to develop an adequate proxy model that can be used to determine the cost of providing supported services in a particular geographic area . . .[8]

An in-depth review of these issues was also provided in the Competitive Pricing Division Staff Analysis of "The Use of Computer Models for Estimating Forward-Looking Economic Costs."[9] Further suggestions for the improvement of proxy models were advanced at workshops conducted by the Joint Board on January 14 and 15, 1997. Although the Board has so far declined to recommend any particular proxy model, it has provided an extensive review of the existing models, and established a number of criteria such models should meet.[10]

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[7] Op. cit., Recommended Decision.

[8] Ibid., paragraph 268.

[9] Released January, 9, 1997.

[10] Ibid., paragraphs 273-277 and Appendix F.

On February 7, 1997, AT&T and MCI submitted to the Joint Board a preliminary version of a new release of the Hatfield Model, Release 3.0, with accompanying documentation. The submission included data and results for five states: California, Colorado, New Jersey, Texas, and Washington.[11] HM 3.0 addressed the concerns raised by the Joint Board in its consideration of proxy cost models and the FCC in its consideration of modeling the forward looking economic cost of interconnection. It was responsive to the principles established and concerns raised about existing models, in the Interconnection Order, the Joint Board Recommendation and in Staff Papers and Workshops.

Later the same month, on February 28, AT&T and MCI submitted Hatfield Model Release 3.1 (HM 3.1). It incorporated certain minor modifications to HM 3.0; further, it contained data for 49 states plus the District of Columbia.

In April, 1997, the state members of the Universal Service Joint Board issued several reports about proxy cost modeling. Although these reports provided very useful analyses of desired features within the models, they came to no clear final conclusion on choice of a model.

On May 7, 1997, the FCC released its Order implementing the mandate for universal service contained in the Telecommunications Act of 1996. In the Order, it concluded that cost methodologies presented so far for estimating the level of universal service support were not sufficiently reliable, and indicated it would issue a Notice of Proposed Rulemaking (NPRM) detailing what it believed to be the appropriate requirements and guidelines that such a cost methodology should incorporate. Pending release of the NPRM, the Order provides a substantial amount of information about what the Commission believes are the appropriate properties a proxy cost methodology should incorporate. The Commission indicated its intent of selecting a model for determining support by the end of 1997.

HM 4.0 is responsive to the Commission's requirements as presented in the Order, pending release of its NPRM on cost modeling. Furthermore, several enhancements have been placed in HM 4.0 to reduce the additional model development effort that will be required to meet the Commission's requirements in regard to refinement of methods to locate customers.[12] HM 4.0 provides a number of enhancements to HM 3.1, including, but not limited to, the several outlined in an ex parte submission to the Commission on June 5, 1997. In addition, HM 4.0 contains

[11] Results from Release 3.0 were submitted in three state proceedings: Kansas, Virginia, and Washington, that took place later in February.

[12] Because this effort is both extremely complex and sensitive to the results of the Commission's current efforts to seek more detailed data from the ILECs as to the quantity and character of customer demand, it will be incorporated in a subsequent revision of the Hatfield Model.

an improved and more accurate version of the demographic database used by the model.

II. A SUMMARY OF CHANGES BETWEEN HM 3.1 AND HM 4.0

A number of significant changes have been made to HM 3.1 in developing HM 4.0. These changes are reflected in the discussion of how the new version operates, presented in Section III. They can be summarized as follows:

USF NOI (Universal Service Fund-Notice of Inquiry Data Request from 1994); USTA (United States Telephone Association); and RUS (Rural Utilities Service).

Input Data and User Interface

- Includes improved counts of lines served by certain small LECs based on data from USF NOI (Universal Service Fund Notice of Inquiry Data Request from 1994); USTA (United States Telephone Association); and RUS (Rural Utilities Service)
- Incorporates a more accurate list of wireline end offices and associates CBGs with these wire centers more accurately.
- Allows the user to input the percent of private line and special access voice grade equivalent circuits that are carried on 4-wire DS-1, fiber DS-1, and DS-3 and higher-speed facilities to accommodate such data when available;
- contains more user-adjustable inputs, including effects of soil types on placement difficulty, cable placement activity factors, and others;
- allows the count of residence and business lines to be normalized to the counts reported by the ILEC for each wire center, to the extent that information is provided or available, rather than on a study area-wide basis.

Distribution Module and Feeder Module

- Changes the default impact of difficult soil conditions from increasing route distances to increasing the cost of placement;
- explicitly accounts for various activities associated with the placement of outside plant, and provides user-adjustable inputs for the amount and cost of such activities;
- increases the cost of cable placement linearly as a function of bedrock depth

rather than as a step function increase when the bedrock depth is less than the user threshold.

Distribution Module

- Allows the user to set the percentage of customers located in population clusters on a CBG-by-CBG basis, or, alternatively, to use an overall percentage as at present;
- replaces the treatment of long loops using coarse-gauge cable and load coils by extending T1 technology to within 18,000 feet of each customer;
- provides a more sophisticated calculation of the investment in the Serving Area Interface (SAI) as a function of the number of lines served from the SAI;
- computes drop investment per location using detailed input demographic information for each CBG;
- computes the distribution fill at the cluster level instead of at the branch cable;
- assumes the use of 26-gauge cable rather than 24-gauge cable for cable sizes of 400 pairs and larger, consistent with loop resistance design and the limitation of copper loop lengths to 18,000 feet.

Switching and Interoffice Module

- Provides the user additional flexibility in specifying the switching cost by being able to vary through the interface the "slope" term in the switching cost function, in addition to the ability to vary the constant term.

Expense Module

- Allows the user to control via "toggles" the line categories -- primary residence lines, secondary residence lines, single-line businesses, multi-line businesses, public -- that are included in supported universal service;
- separates the economic lives and salvage values of the capital plant categories;
- includes general support and miscellaneous expenses in the calculation of carrier-to-carrier expenses;
- displays the versions of Distribution, Feeder, and Switching/Interoffice Modules used to compute investment;

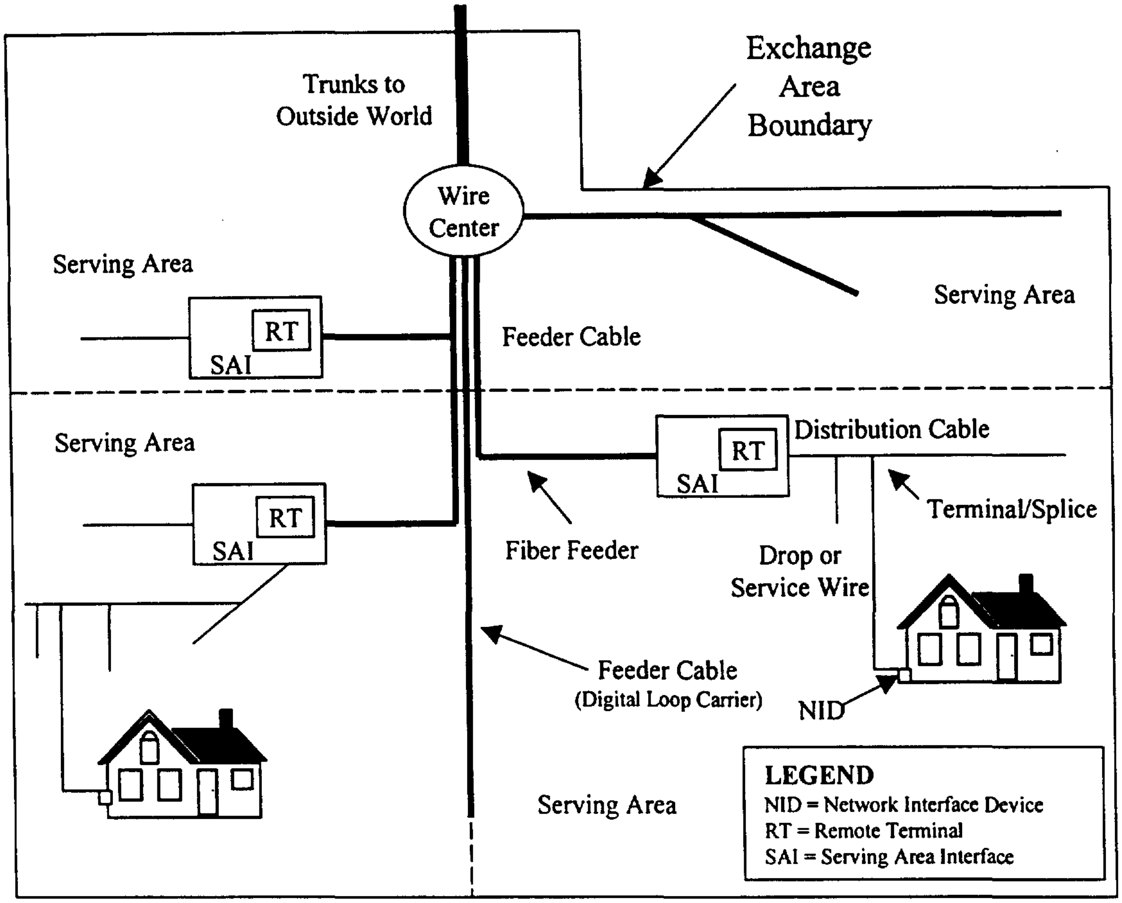
- includes a more sophisticated universal service output sheet that displays significantly more detailed support results;
- provides sharing of manhole costs between utilities other than electric;
- explicitly accounts for the difference in business and residence dial equipment minutes (DEMs) in determining usage costs for Universal Service Fund calculations.

III. STRUCTURE OF THE HATFIELD MODEL

A. GENERAL NETWORK COMPONENTS

This section describes the network configuration and components modeled in HM 4.0. Figures 1, 2 and 3 depict the relationships among the network components discussed in the following subsections.

1. Loop description



Adapted from Engineering and Operations in the Bell System 2nd Edition, 1983

Figure 1 Loop Components

a) General loop description

The feeder portion of the loop terminates within the central office building, or "wire center." Copper cable feeder facilities terminate on the "vertical side" of the MDF (main distributing frame) in the wire center, and fiber optic feeder cable serving integrated digital loop carrier (IDLC) systems terminates on a fiber distribution frame in the wire center.

Copper feeder cable extends from the wire center to an SAI where it is cross-connected to copper distribution cables. If the feeder is fiber, it extends to a digital loop carrier (DLC) remote terminal (RT), where optical digital signals are demultiplexed and converted to analog signals. Individual circuits from the DLC are cross-connected to copper distribution cables at the adjacent SAI. Copper distribution cable extends from the SAI to the individual customer premises. At the distant end of these distribution cables, the local loop terminates at a network interface device, or NID, at the customer's premises.

Loop cables are supported by "structures." These structures may be underground conduit, poles, or trenches for buried cable and underground conduit. Underground cable is distinguished from buried cable in that underground cable is placed in conduit, while buried cable comes into direct contact with soil.[13]

b) Local Loop Components

(1) Network Interface Device

The NID is the demarcation point between the local carrier's network and the customer's inside wiring. This device terminates the drop wire and is an access point that may be used to isolate trouble between the carrier's network and the customer's premises wiring.

(2) Drop

A copper drop wire extends from the NID at the customer's premises to the block terminal at the distribution cable that runs along the street or the lot line. The drop can be aerial or buried; generally it is aerial if the distribution cable is aerial, and buried if the distribution cable is buried or underground.

(3) Block Terminal

The "block terminal" is the interface between the drop and the distribution cable. When aerial distribution cable is used, the block terminal is attached to a pole in the subscriber's backyard or at the edge of a road. A pedestal contains the block terminal when distribution cable is buried.

(4) Distribution Cable

Distribution cable runs between the block terminals and the SAI. In the Model, distribution cable connects the feeder cable with all customer premises within a Census Block Group (CBG). The model assumes that each CBG contains at least one SAI; limits on the capacity of an SAI and/or the distribution

[13] Although the conduit supporting underground cable is always placed in a trench, buried cable may either be placed in a trench or be directly plowed into the earth.

design assumed in particular CBGs may lead to multiple SAIs. Distribution structure components may consist of poles, trenches and conduit.[14]

(5) Conduit and Feeder Facilities

Feeder facilities constitute the transmission system between the SAI and the wire center. These facilities may consist of either pairs of copper wire or a DLC system that uses optical fiber cables as the transmission medium. In a DLC system, the analog signals for multiple individual lines are converted to a digital format and multiplexed into a composite digital bit stream. The Hatfield Model assumes that there is a standard (but user-adjustable) feeder distance beyond which optical feeder cable will be installed and DLC equipment will be used to serve subscribers.

Feeder structure components include poles, trenches and conduit. Manholes for copper feeder or pullboxes for fiber feeder are also normally installed in conjunction with underground feeder cable. Manhole spacing is a function of population density and the type of feeder cable used. Pullboxes that are installed for underground fiber cable are normally farther apart than manholes used with copper cables, because the lightness and flexibility of fiber cable permits it to be pulled over longer distances than copper cable.

The costs of structure components normally are shared among several utilities, e.g., electric utilities, LECs, IXCs and cable television (CATV) operators. The amount of sharing may differ in different density zones and between feeder and current distribution.

2. Switching and Interoffice Network Description

This section provides a general description of the network components comprising the wire center and interoffice facilities. Figures 2 and 3 illustrate the relationships among the components described below.

[14] Because underground distribution exists only in the highest density zones where runs are relatively short, and because in such zones it commonly shares structure with feeder, distribution facilities typically do not include manholes.

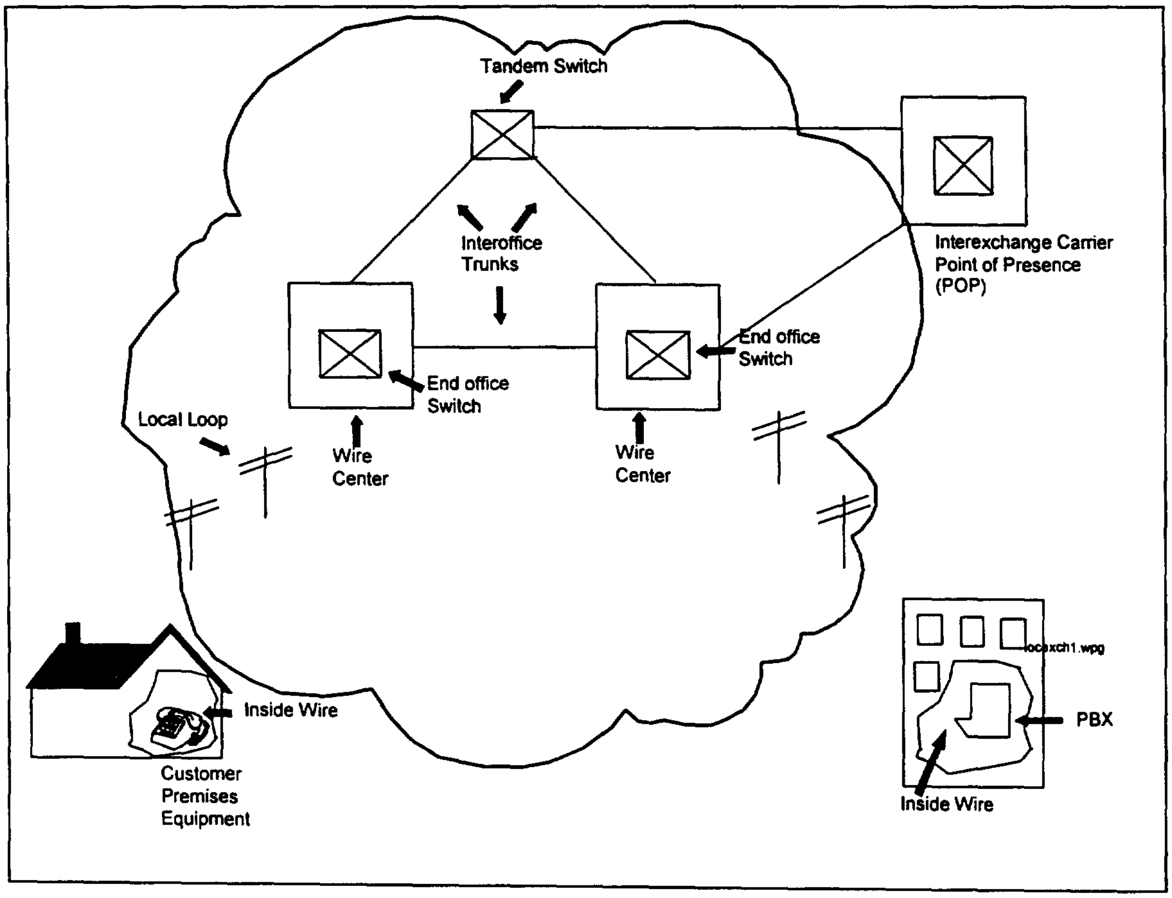


Figure 2 Interoffice Network

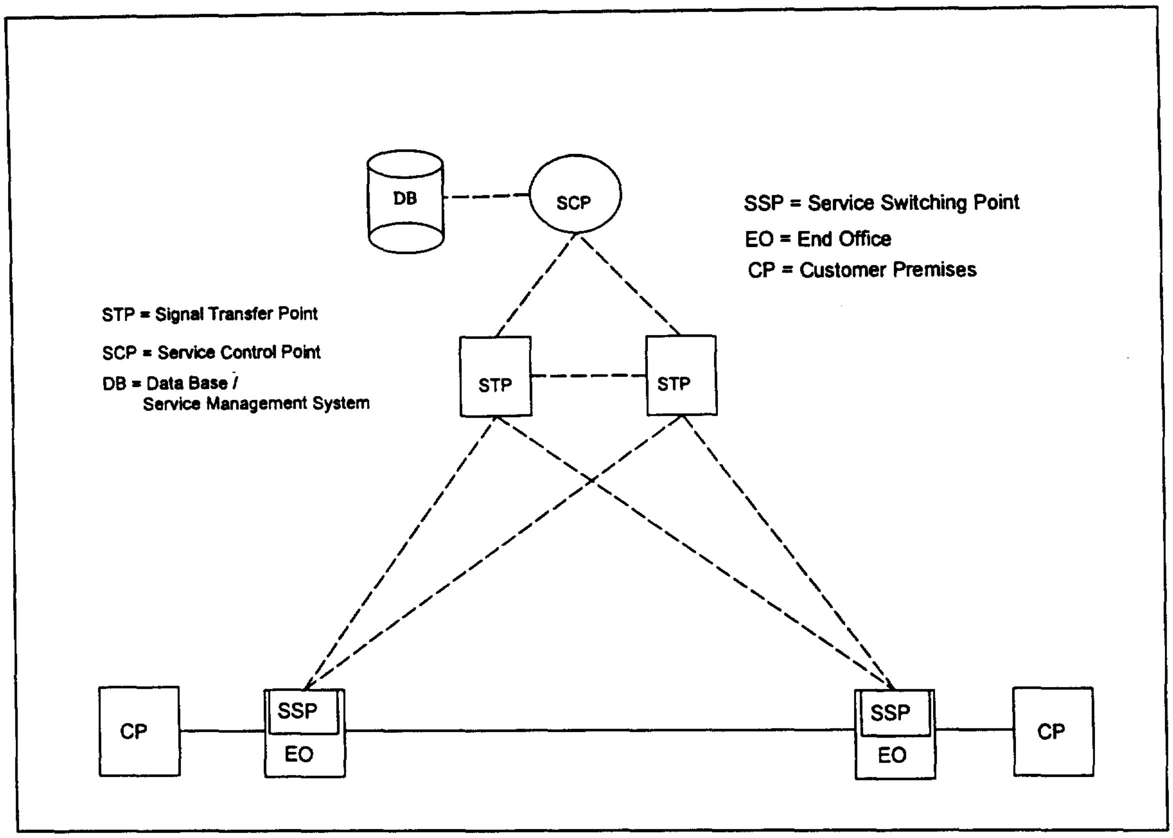


Figure 3 Interoffice signaling network components

a) Wire centers

The wire center is a location from which feeder routes extend towards customer premises and from which interoffice circuits or "trunks" connect with other wire centers. A wire center normally contains at least one end office (EO) switch and may also contain a tandem switch, an STP, an operator tandem, or some combination of these facilities. Wire center physical facilities include a building, power and air conditioning systems, rooms housing different switches, transmission equipment, distributing frames and entrance vaults for interoffice and loop feeder cables.

b) End office switches

The end office switch provides dial tone to the switched access lines it serves. It also provides on-demand connections to other end offices via direct trunks, to tandem switches via common trunks, to IXC POPs via dedicated trunks, and to operator tandems via operator trunks. The model computes the required number of trunks for each route according to input traffic assumptions and the breakdown of business, residential, special and public access lines served by each end office switch.

c) Tandem switches

Tandem switches interconnect end office switches via common trunks, and may also provide connections to IXC POPs via dedicated trunks. Common trunks also provide alternatives to direct routes for traffic between end offices. Tandem switching functions often are performed by switches that also perform end office functions. At a minimum, tandems normally are located in wire centers that also house end office switches.

d) Interoffice Transmission Facilities

Interoffice transmission facilities carry the trunks that connect end offices to each other and to tandem switches. The signaling links in a SS7 signaling network are also normally carried over these interoffice facilities.

Consistent with the evolving practice, interoffice transmission facilities are predominantly optical fiber systems that carry signals in Synchronous Optical Network (SONET) format. Efficient practice also prescribes the use of a fiber optic ring configuration to link switches, except for switches that serve few lines or that are remote from other switches. This provides a redundant path between any two switches, and the potential for substantial cost savings relative to more traditional point-to-point facilities.

e) Signal Transfer Points

STPs route signaling messages between switching and control entities in a Signaling System 7 (SS7) network. Signaling links connect STPs and Service Switching Points (SSPs). STPs are equipped in mated pairs, with at least one pair in each Local Access Transport Area (LATA).

f) Service Switching Points and Signaling Links

SSPs are SS7-compatible end office or tandem switches. They communicate with each other and with SCPs through signaling links, which are 56 kbps dedicated circuits connecting SSPs with the mated STP pair serving the LATA.

g) Service Control Points

SCPs are databases residing in an SS7 network that contain various types of information, such as IXC identification or routing instructions for 800 numbers in regional 800 databases, or customer line information in Line Information

Databases (LIDB).

B. OVERVIEW OF MODEL ORGANIZATION

Figure 4 shows the relationships among the various modules contained within HM 4.0. An overview of each component module follows.

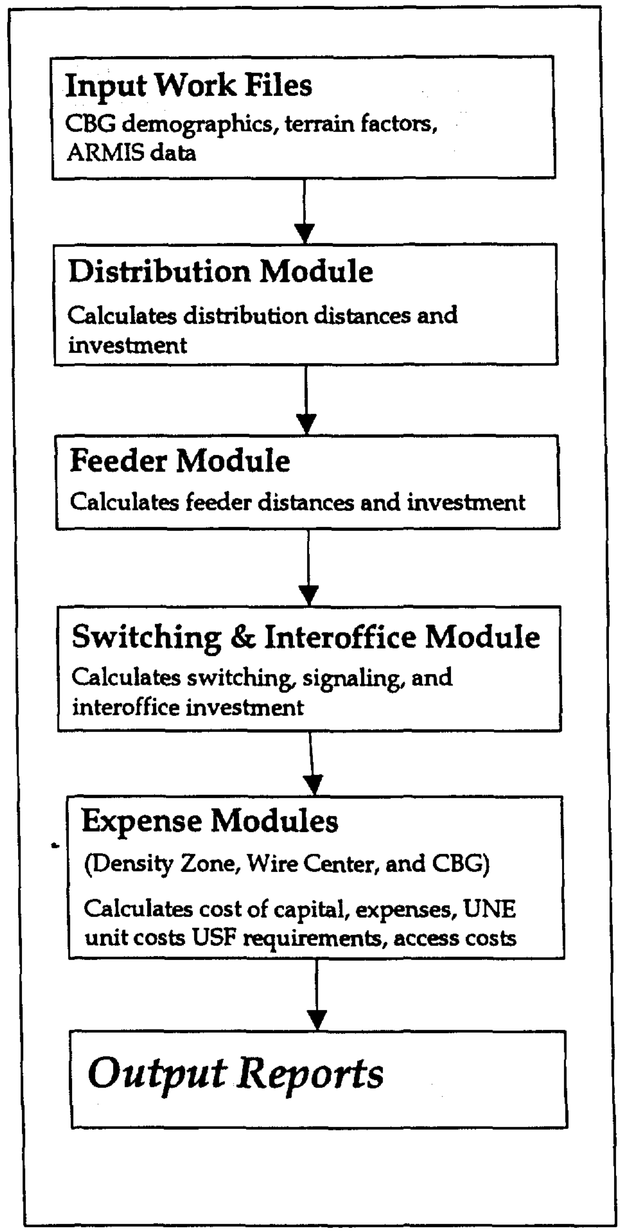


Figure 4 Hatfield Model 4.0 Organization Flow Chart

1. Input Workfiles

Workfiles contain inputs to HM 4.0 and include the following:

- Demographic, geographic and geological characteristics of CBGs, used to locate geographically the number of customers requiring telephone service, the wire center that serves them, and the type of terrain within that CBG.

- Interoffice distances between end offices, tandems, and STPs, used in estimating route miles required for interoffice transmission and signaling facilities - developed from the Bellcore LERG.

- 1995 ARMIS data reported by the LECs, which provide investment, traffic, and expense information; and

- User-adjustable inputs that allow users to set carrier- or locale-specific parameters, and perform various sensitivity analyses. These inputs have preset default values based on the engineering experience and judgment of HAI personnel as well as that of subject matter experts consulting with HAI.

2. Distribution Module

The Distribution Module addresses the portion of the network extending from SAIs to the customers' premises. The module determines the lengths and sizes of distribution cable, the associated structures (poles and trenching), the number of terminals, splices, drops, and NIDs required to provide service to the specified number and type of customers in each CBG, and the number and type of SAIs and DLC terminals required. It determines whether to serve a CBG using feeder transmission facilities consisting of copper wire pairs or DLC running over fiber optic cable. The selection is made according to a user-adjustable parameter that specifies the maximum feeder distance to the CBG beyond which fiber is to be installed. The module also calculates certain distances required by the Feeder Module.

The HM 4.0 Distribution Module serves loops having copper components longer than 18,000 ft with digital loop carrier equipment using copper-based T1 transmission. This technology does not require the use ofloading coils or coarse-gauge cable, and it also permits basic rate ISDN and other advanced narrowband services to be provided to all subscriber locations in the model.

Once the module has determined the quantities of all distribution elements, it calculates the investment associated with these elements, using as inputs the user-adjustable unit prices of each element. It provides these investments to the Feeder Module. The numbers and types of elements engineered can be examined in the intermediate outputs of the Distribution Module as recorded in the workfile.

3. Feeder Module

The Feeder Module configures the portion of the network that extends from the wire center to the SAIs. Based on information it receives from the Distribution Module, it determines the size and type of cables required to reach the SAIs located in each CBG, along with supporting structures (poles, trenching, conduit, manholes, and fiber optics pullboxes). The Feeder Module then calculates the investment associated with these elements, using as inputs the unit prices of each such element. It provides these investments to the Expense Module. The numbers and types of elements required can be examined in the intermediate outputs of the Feeder Module as recorded in the workfile.

4. Switching and Interoffice Module

The Switching and Interoffice Module computes investments for end office switching, tandem switching, signaling, and interoffice transmission facilities. It determines the required line, traffic, and call processing capacity of switches based on line totals by customer type across all CBGs served by the wire center, and based on ARMIS-derived traffic and calling volume inputs. It also determines the required capacity and distances of interoffice transmission facilities, using the traffic data and the interoffice distances that are input to the Module. These investments are then provided to the Expense Module. The numbers and types of elements involved can be examined in the intermediate outputs of the Switching and Interoffice Module as recorded in the workfile.

5. Expense Modules

The Expense Modules calculate the monthly costs for unbundled network elements, universal service and carrier access and network interconnection. These costs include both the capital carrying costs associated with the investments, and the costs of operating the network. Capital carrying costs include depreciation, return on the debt and equity investment required to build the network, and income taxes on equity return. Network-related expenses include maintenance and network operations. Non-network related expenses include customer operations expenses, general support expenses, other taxes and variable overhead expenses.

Information used in developing these monthly costs is obtained from several sources. Network investments by specific plant category are provided by the Distribution, Feeder, and Switching and Interoffice Modules. Information on network operating and maintenance expenses is derived from ARMIS and other sources.

The Expense Modules produce reports showing the key outputs of the model, including the costs of providing universal service, unbundled network elements, interconnection and IXC access. Results may be displayed by density zone, study area, individual wire center, or CBG. These outputs are all based on investments calculated at the CBG level.

IV. MODULE DESCRIPTIONS

A. WORKFILES

Work files contain four categories of information, as follows.

1. Demographic and geological parameters

Demographic and geological parameters are obtained from a database developed by PNR and Associates of Jenkintown, Pa. Appendix A explains in detail how these data were derived. Highlights of the development process are as follows.

PNR's estimates of residential lines per CBG are based on the number of households in each CBG, using 1995 census estimates provided by Claritas and current Donnelley Marketing household data. These household counts were adjusted to reflect first and second telephone line penetration rates. The percent of households without telephones was obtained from the 1990 Census for every CBG. Second residential lines were estimated as functions of CBG demographic information. The results were projected to every CBG in the United States using census age and income distributions, and to every Census Block (CB) within a CBG using census household data at the CB level.

PNR geocoded the entire Donnelley DQI database of approximately 95 million household street addresses and telephone numbers with latitude/longitude values and their CB codes. A correspondence table was created to link each CB