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December 11, 1997

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M. St., NW, Room 222
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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

Dear Ms. Salas:

AT&T and MCI are pleased to submit the Hatfield Model, Version 5.0 for the Commission and the Federal-State Joint Board staff's examination in CC Docket Nos. 96-45 and 97-160. As indicated in the accompanying documentation, by locating most customers to their actual latitude and longitude locations, and by engineering telephone plant to these specific locations, this new release of the Hatfield Model is a major advance over previous versions of the Hatfield Model, as well as over every other competing proxy cost model.

At the request of the Commission staff, this filing of the Hatfield Model, Version 5.0 consists, of the executable code of the model, its extensive documentation, and runs at a maximum analog copper loop length of 18,000 feet and 12,000 feet for the states of FL, GA, MD, MO and MT. The input data underlying these runs are included in the model's database. AT&T and MCI intend to file the data necessary to perform runs for all 50 states (ATU in Alaska), DC and Puerto Rico on December 15, 1997. Some additional documentation of the model's data development process will also be included in that filing.

While the CD-ROM contains pre-run Expense Modules at 18 kft. and 12 kft. for all nonrural LECs in FL, GA, MD, MO and MT, an inadvertent error caused defective runs for GTE-FL, United of FL, Contel-MO dba GTE-MO, GTE North-MO and United of MO to be burned onto the CD-ROM. Correct paper copies of these runs are included with this filing. Correct electronic copies of these runs will be provided in our December 11 filing.

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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,

Richard N. Clarke

Paper Attachments and CD-ROM

cc: Universal Service Branch
Competition Division
Competitive Pricing Division
Office of the General Counsel

ITEMS IN THE PUBLIC NOTICE WITH WHICH THE HATFIELD MODEL IS IN CONFORMANCE

I. The Bureau recommends that models be capable of accepting and using geocode data to the extent that such data are available and reliable.

The Hatfield Model, release 5.0 (HM 5.0) incorporates geocode data on customer location where it is available. This dataset was developed by PNR and Associates, and is based on over 100 million residence customers address records and 11 million business customer address records. The vast majority of these 111 million addresses are geocoded (assigned latitude and longitude coordinates) accurate to within 50 feet. For the minority of addresses where no precise geocode data exists, locations are conservatively assumed to be distributed around the boundary of the Census Block. When precise geocode data are available for these addresses, or if an alternative source of geocode data for all locations is available, that data can easily be reflected in the HM 5.0 customer location algorithm.

II. [T]he Bureau recommends that models be capable of accepting wire center boundary data in standard Geographic Information System (GIS) format from any source that the Commission finds may estimate those boundaries more accurately.

The HM 5.0 uses data on wire center boundaries from BLR to assign customers to wire centers. Alternative data can be easily substituted into the customer location algorithm.

III. [T]he Bureau recommends that each proponent of a model demonstrate how their feeder routing algorithms meet the criterion of being the least-cost, most-efficient, and reasonable technology currently being deployed. In addition,...the Bureau recommends that model proponents demonstrate how every aspect of their outside plant design approach is consistent with the least-cost criterion, while maintaining the network standards established in the Order.

The HM 5.0 incorporates a number of optimization routines that ensure that the least-cost, most-efficient, and reasonable technology is being deployed, while maintaining the network standards established in the Order. First, the HM 5.0 always places fiber feeder if the analog copper distance would exceed 18 kilofeet (kft). This ensures that the network requirements for maximum permissible signal loss are always met. For distances less than 18 kft, the HM 5.0 selects between fiber and copper feeder, based on which is the lower cost technology. This choice is made based on the total life-cycle cost of the facility, including depreciation and

maintenance. This allows the HM 5.0 to select the alternative which may have a higher initial cost, but which will over the life of the plant result in lower overall costs because of lower maintenance expense.

Second, the HM 5.0 selects, within user-definable limits, between aerial and buried plant based on least-cost criteria.[1] The user can select the base levels of aerial and buried plant, as well as the percentage of plant which can be switched from one type to the other. The HM 5.0 then selects the mix of buried and aerial plant, based on these defaults and the relative life-cycle cost differential between these two types of plant. As the relative cost differential increases, a greater proportion of plant is shifted to the lower cost alternative.

Finally, the HM 5.0 includes, as an option, the ability to steer feeder routes toward the preponderance of main clusters within a quadrant. The model computes an angular offset from the cardinal default values of 0°, 90°, 180° or 270° by weighting each main cluster's angular offset coordinate by its radial distance from the wire center location, and then determining the weighted average angular displacement. When feeder cable is steered in this fashion, the Feeder Module also applies a route-to-airline (R/A) distance multiplier. The value of this multiplier may be specified by the user within an allowed range of R/A values. Subfeeder cables branch off in efficient perpendicular fashion from the main feeder route, both when feeder routes go in the cardinal compass directions and when the feeder is steered.

IV. The Bureau therefore recommends that models incorporate sufficient flexibility in their loop design algorithms so that the platform of the selected model does not have to be rebuilt in the event that the Commission revises the definition of universal service.

The telephone network engineered in the HM 5.0 is fully capable of supporting voice and data services in excess of the services generally being demanded by customers today, including ISDN-level service. The network will be capable of supporting any level of service which will receive universal service in the foreseeable future. In particular, the network in the Hatfield model will allow the use of high speed modems, and through the selection of user inputs will be able to reflect the likely evolution of the network.

V. [T]he Bureau recommends that models be capable of accommodating as inputs wireless cost thresholds at the level of the wire center or a smaller geographic unit.

[1]The amount of underground plant is assumed to be determined by criteria other than cost, such as zoning or engineering requirements, and thus is not included in this optimization.

The HM 5.0 permits the specification of a user-adjustable cap on the model's wireline investments to reflect potentially more economical wireless distribution technologies. This cap, if invoked by the user, places a ceiling on the per-line investments computed in the Distribution module (i.e., NID, drop, terminal and splice, distribution cable and structure, SAI, and DLC Remote Terminal). The optional cap considers the cost of two alternative wireless systems; a "point-to-point" system serving customers on a one-to-one basis, and a "broadcast" system serving a number of customers from a shared base system. The "point-to-point" cost is assumed to be a fixed amount per line served, while the "broadcast" system cost is structured as a fixed base station cost serving up to a given maximum number of customers, with the cost of the base station distributed among the number of customers that use it, plus a per line cost of the radio terminal equipment at each customer's premises. The HM 5.0 compares the costs of the two wireless systems and the wireline system, and selects the least cost of the three options. If one of the wireless systems is selected, the wireline distribution components for the serving area are zeroed out and the more economical wireless system's cost is substituted, while the feeder portion of the wireline network is retained.

VI. [T]he Bureau recommends that proponents of models provide comparative outputs for each of the following five states, using both the 12,000 foot standard and the 18,000 foot standard: Florida, Georgia, Maryland, Missouri, and Montana.

The requested runs are included on the CD-ROM, along with a hard-copy printout of the summary data for each run.

VII. [T]he Bureau recommends that each model proponent submit detailed descriptions of all information or software alleged to be confidential, proprietary, or otherwise unavailable to the public that is used either in the model or in a preprocessing module. The descriptions should include estimates of the costs and procedures that may be associated with making the information or software available to the Commission and to the administrator of the universal service support mechanisms.

The requested information is included with this filing.

PNR Estimates of the Resources Required to Support the Customer Location Model

The following are some general estimates of what would be required to support the PNR Customer Location Model under two different scenarios. The actual requirements would need to be directly verified with a number of the third parties involved. In some cases, this would require an independent servicing organization to establish an agreement of a custom nature directly with the providers of data or services.

Since PNR does not know the exact pricing or terms of such agreements would be, Scenario #1 includes the approximate market rates for the associated products, based on the assumption that the servicing organization acts as a single user end-client. The degree to which that servicing organization would act as a third-party gateway to an indeterminate number of end-users, and the nature of their pass-through offering, will determine the actual final cost of the custom agreement. At this time, it is not clear if the third parties would allow such a relationship at all.

In all cases, it is assumed that the models used are at the Cluster level of detail. Estimated costs are based from PNR's general knowledge of standardized pricing in the information industry.

SCENARIO #1:

FCC appoints an independent organization to run and maintain the PNR Customer Location Model and other data to provide cost of service estimates to external parties.

Assumptions:

1. Service organization takes over full production and support of the Customer Location Model and its components.
2. Lowest level of data components would be at the Cluster level of detail.
3. Pricing is based on single-user, end client pricing. Unlimited usage, networked multi-user licenses, third-party reselling rights, the amount and nature of actual data delivered to end-users, and the use at a summary analytical level will have an impact on the actual prices charged.
4. All vendors would be willing to negotiate special agreements for this firm to act as a third-party processor for the FCC and the entire telecommunications industry. This is by no means assured.
5. Data sources are priced for one version per year.

Estimated Annual Licensing Costs (Scenario #1):

Claritas, Inc.: National database at CBG level of 50 key Current Year Estimate driver variables *(approximately 250,000 records).*	**$75,000**
Dun & Bradstreet Information Services: National database of 11+ million businesses, at the firm level of detail *(approximately 11+ million records).*	**$750,000**
Metromail Corporation: National database of 103+ million households with associated HHD demographics *(approximately 103+ million records).*	**$900,000**
Qualitative Marketing Software, Inc.: CENTRUS Geocoding Software License	**$30,000**
Qualitative Marketing Software, Inc.: CENTRUS Service Bureau License. *(one-time only fixed fee)*	**$20,000**
Geographic Data Technology, Inc.: Point -Coding Reference Data for CENTRUS point-coding software	**$25,000**
Business Location Research, Inc.: Wire Center *MapInfo* Mapping Boundaries	**$15,000**
PNR and Associates, Inc.: National Access Line Model License (Block level)	**$300,000**
PNR and Associates, Inc.: Data Preparation and Clustering Software License	**$400,000**
PNR and Associates, Inc.: Training: Orientation and education on how to use the models.	**$100,000**
Total:	**$2,615,000**

Points of Consideration:

- There is a dependence on external data and software providers.
- A servicing organization has no ability to update models.
- There is a *major learning curve* for the service organization to overcome to be able to begin the process. This may be the largest cost component of all.
- There may be a significant delay associated with the various data vendors in preparing the necessary custom licensing agreements to allow the third-party processor to provide these services.
- It may take a new third-party processor 6-12 months to become fluent with the models and produce the first deliverables.
- The third-party service bureau may not have the requisite understanding of the component data sources and their limitations (Census data and geographies, telco data, geocoding data,

estimation techniques, household data, business data, custom spatial clustering, etc.) to answer technical inquires -- or enhance -- the models.

SCENARIO #2:

FCC appoints PNR and Associates, Inc. to be an external service organization to run and maintain the PNR Customer Location Model and provide resulting clusters (by Wire Center) to the organization developing cost of service estimates. The FCC, or Plan Administrator uses the pre-processed inputs to directly produce the end-user cost estimates.

Assumptions:

1. PNR continues production, maintenance and support of the Customer Location Model components.
2. PNR continues its present affiliate relationships with Dun & Bradstreet, Metromail, and Claritas.
3. Pricing is based on single-user, end client pricing. Unlimited usage, networked multi-user licenses, third-party reselling rights, the amount and nature of actual data delivered to end-users, and the use at a summary analytical level will have a major impact on the actual prices charged.
4. Data sources are priced for one version per year. No monthly or quarterly updates are included.
5. All data suppliers must be credited in documentation of the end deliverables to the users, and in methodology documentation.

Estimated Annual Licensing Costs:

Claritas, Inc.: National database at CBG level of 50 key Current Year Estimate driver variables. *(approximately 250,000 records)* **Royalties***

Dun & Bradstreet Information Services: National database of 11+ million businesses, at the firm level of detail. *(approximately 11+ million records)* **Royalties***

Metromail Corporation: National database of 103+ million households with associated HHD demographics. *(approximately 103+ million records)* **Royalties***

Qualitative Marketing Software, Inc.: CENTRUS Geocoding Software License (annual fee) **License Fee***

Geographic Data Technology, Inc.: Point -Coding Reference Data for CENTRUS point-coding software **License Fee***

PNR and Associates, Inc.: Customer Location Model *including*
National Access Line Model License (CB level)
Data Preparation and Clustering Software Use
Training and Support **$ 1,200,000***

Business Location Research, Inc.: Wire Center *MapInfo* Mapping Boundaries (annual fee)

License Fee*

TOTAL: **$ 1,200,000**

(Note: All royalties and license fees will be included in PNR's contract fee.)*

Points of Consideration:

- No break in the "institutional memory" associated with the models associated with customer location. The staff of PNR who have played active roles in the development of the different model components will provide model support and maintanence.
- PNR has the ability to completely update the models as required.
- There is *no learning curve* to overcome to begin the process. This may minimize the largest cost component of all. There would be a minor learning curve for the FCC, or plan administrator, to learn how to use the data inputs to generate the end cost figures or factors.
- PNR has existing affiliate and licensing agreements with all the data vendors.
- There would be no lag-time associated with being able to produce the first deliverables.
- PNR has an intimate understanding of all of the component data sources and their limitations (Census data and geographies, telco data, geocoding data, estimation techniques, household data, business data, custom spatial clustering, etc.) to answer technical inquires about the models.
- PNR is the firm best positioned to suggest future enhancements to the models or the methodology.
- Still have dependence on external service vendors for data and support.
- Some adjustments to existing affiliate agreements may be required by PNR to cover the logistics and royalties in the above scenario.

HATFIELD MODEL, v5.0

Overview

This CD-ROM contains several files.

In the root directory are Microsoft's PatchCheck and ServiceRelease1 files for MS Office '97. The Hatfield Model 5.0 will only operate under MS Office '97 with Microsoft's Service Release 1 installed. You should first execute "PatchChk.exe" to determine whether your installation of Office '97 already incorporates Service Release 3. If it does not, please execute the "SR1Off97.exe" file. Once this is complete, you may execute "HMpre50Setup.exe" to install the preliminary 5.0 release of the Hatfield Model.

In the "Documentation" directory are the HM 5.0 Model Description, its Appendices A, B, C, D and E; and a copy of the HM 5.0 Hatfield Inputs Portfolio.

In the "HM50_Presentations" directory are two PowerPoint presentations providing high level information about HM 5.0.

In the "Runs_18kft" directory are pre-run density zone expense modules for the nonrural LECs operating in FL, GA, MD, MO, and MT

Finally, in the "Runs_12kft" directory are pre-run density zone expense modules for the nonrural LECs operating in FL, GA, MD, MO, and MT

While this 12/11/97 release of HM 5.0 is a fully functional model of the complete local exchange network (e.g., loop, switching, signaling, transport, expenses, etc.), it will differ from the 12/15/97 release in several respects. The are as follows.

- This 12/11/97 release contains data only for the five states requested for test purposes by the FCC (FL, GA, MD, MO, MT). The 12/15/97 version of HM 5.0 will contain data for all 48 continental states, plus the District of Columbia, Hawaii, Puerto Rico, and Anchorage Telephone Utility, Alaska.

- There are a few user adjustable inputs to the HM 5.0 are yet manipulable through the model's automated interface. While these inputs will be handled by the interface for 12/15/97 HM 5.0, they may be adjusted in 12/11/97 HM 5.0 by user edits to the Input sheets of the model's Excel logic modules.

Model Operation and Interface

The HM 5.0 interface has been modified from the HM 4.0 version to accommodate additional user inputs and to include new operating features. Principal new inputs include user-selectable host/remote assignments as well as an option selection that enables host/remote calculations. There are several minor input changes reflected in the interface, including the deletion of the town factor inputs from HM 4.0. These are no longer applicable because the HM 5.0's demographic database automatically classifies subscriber locations as being within main or outlier clusters, as described above. Other new inputs include user specification of T1 repeater spacing, indoor NID case investment, host/remote/standalone switch investments, and others.

The new interface allows the user to select an unlimited number of companies from one or several states to be run in automatic sequence. The model then runs all of the selected companies, and produces individual Expense Modules and Workfiles. The Expense Modules will be stored in the Results subdirectory. Workfiles, by default, will not be saved during the Multi-Company runs. The user must explicitly request that the Workfiles be saved by checking the option from the Multi-Company Selection form.

Because of several lingering incompatibilities of Microsoft Office '97 with Office '95, the model may terminate abnormally the first time that a company is run after the installation of the HM 5.0 program. Thus, the user should select a small LEC for a "break-in" run of the model. After the abnormal termination, simply exit the model and re-enter it. Also, be sure that all instances of the Excel application are closed before running the model again. From this point on, all runs should pass through to successful completion. In any event, no incorrect outputs are ever produced by this systems "bug." Microsoft has been informed of this situation, but so far have not yet been able to offer a solution.

Hatfield Model
Release 5.0

Model Description

HAI Consulting, Inc.

737 29th Street, Suite 200
Boulder, Colorado 80303

December 11, 1997

TABLE OF CONTENTS

1. Introduction 1

1.1. Overview 1

1.2. Evolution of the Hatfield Model 3

2. Summary of Changes Between HM 4.0 and HM 5.0 4

2.1. User Interface 4

2.2. Input Data 5

2.3. Outside Plant Selection 5

2.4. Distribution Module 6

2.5. Feeder Module 6

2.6. Switching and Interoffice Module 7

2.7. Expense Modules 7

3. Fundamental Structure of Local Network 8

3.1. Components of the Local Exchange Network 8

3.1.1. Loop Description 8

3.1.2. Switching and Interoffice Network Description 11

4. HM 5.0 Model Organization, Structure and Logic 14

4.1. Overview of HM 5.0 Organization 14

4.2. Input Data 15

4.3. Workfiles 16

4.4. User Interface 16

4.5. Distribution Module 16

4.6. Feeder Module 18

4.7. Switching and Interoffice Module 18

4.8. Expense Modules 19

5. Input Data 19

5.1. Line Type Counts by Study Area 19

5.2. Wire Center List 20

5.3. Customer Counts by Census Block and Wire Center 21
5.3.1. Residence Counts 21
5.3.2. Business Counts 22
5.3.3. Location and Line Counts by Wire Center 23

5.4. Customer Location 23
5.4.1. Residence Location Data 23
5.4.2. Business Location Data 24
5.4.3. Geocoding 24
5.4.4. Gross-up 26

5.5. Customer Location Clustering 26
5.5.1. General Criteria 26
5.5.2. Clustering Algorithm 27

5.6. PointCode Translation Processes 29

6. Module Descriptions 29

6.1. Input Data Files 29
6.1.1. Demographic and Geological Parameters 29
6.1.2. Wire Center Locations and Interoffice Distances 30
6.1.3. ARMIS Data 30
6.1.4. User Inputs 31

6.2. Outside Plant Engineering 31
6.2.1. Outside Plant Structures 33
6.2.2. Terrain and Its Impact on Placement Costs 34
6.2.3. Structure Sharing 35
6.2.4. Lines Density Considerations 35
6.2.5. Economic Adjustment of Structure Fractions 36

6.3. Distribution Module 36
6.3.1. Treatment of Main Clusters 36
6.3.2. Treatment of Outlier Clusters 38
6.3.3. Customer Drop Arrangement 38
6.3.4. Investment Cap to Reflect Potential Wireless Technologies 39
6.3.5. Determination of Feeder Technology 39
6.3.6. "Steering" Feeder Routes 40
6.3.7. Calculation of Distribution Investments 40
6.3.8. Calculation of SAI and DLC Investments 41
6.3.9. Calculation of Drop Investments 42

6.4. Feeder Module 43
6.4.1. Overview 43
6.4.2. Development of Feeder Investments 45

6.5. Switching and Interoffice Module 48
6.5.1. Overview 48
6.5.2. Description of Inputs and Assumptions 49

6.5.3. Explanation of Calculations 50

6.6. Expense Modules 58
6.6.1. Overview 58
6.6.2. Capital Carrying Costs 59
6.6.3. Operating Expenses 61
6.6.4. Expense Module Outputs 64

7. Summary 67

1. Introduction

1.1. Overview

The Hatfield Model, Release 5.0 ("HM 5.0") has been developed by HAI Consulting, Inc. ("HAI"), of Boulder, Colorado,[1] at the request of AT&T and MCI for the purpose of estimating the forward-looking economic costs of:

a) Basic local telephone service;

b) Unbundled network elements ("UNEs"); and

c) Carrier access to, and interconnection with, the local exchange network.

All three sets of costs are calculated based on Total Service Long Run Incremental Cost ("TSLRIC") principles, and use a consistent set of assumptions, procedures and input data.[2]

The Hatfield Model uses the definition of basic local telephone service adopted by the Federal-State Joint Board on Universal Service ("Joint Board") for universal service funding purposes. The Joint Board states that the following functional elements are to be considered as required components of universal service:[3]

- 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;
- 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 exchange company ("LEC") services, such as toll calling, custom calling and CLASS^{SM} features,

[1] Hatfield Associates, Inc., the firm that developed prior versions of the Hatfield Model no longer performs telecommunications consulting. All of the staff of Hatfield Associates who have played an active role in developing the Hatfield Model have formed a successor firm, called HAI Consulting, Inc.

[2] When applied to the costing of unbundled network elements, TSLRIC equates to Total Element Long Run Incremental Costs, or TELRIC as the term is used by the Federal Communications Commission.

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

private line services and white pages directory listings.[4] 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 degree to which several specific UNEs are included in calculating universal service support requirements.

The Hatfield Model calculates the costs of the following UNEs:

- 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

Finally, the model estimates the per-minute economic cost of providing local network interconnection and access. These are estimated for connection points at end office and tandem switches.

The model constructs a "bottom up" estimate of the pertinent costs based upon detailed data describing demand quantities, network component prices, operational costs, network operations costs, and other factors affecting the costs of providing local service. The model's demand data, particularly data describing customer locations, line demand, and traffic volumes, serve as the key initial drivers. From these data, the model engineers and costs a local exchange network with sufficient capacity to meet total demand, and to maintain a high level of service quality.[5] 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.

[4] Although previous versions of the Hatfield Model included the monthly cost of maintaining a white pages telephone listing for each subscriber, the Joint Board and FCC have explicitly excluded this item from the definition of supported universal service. Thus, in HM 5.0, its inclusion in cost calculations for basic service is only at the user's express direction.

[5] In general, the level of service quality engineered into the Hatfield Model exceeds, by a substantial margin, the customary level of basic service quality offered by the LECs over their embedded networks.

Using these data, the model calculates required network investments by detailed plant category. Next, the capital carrying cost of these investments is calculated. Operations expenses are then added to compute the total monthly cost of universal service, various unbundled network elements, stated on both a total cost and an appropriate per-unit basis, and carrier access to and interconnection with the local exchange network. Costs can then be displayed on a study area, density zone, wire center, or Census Block Group ("CBG") basis.[6]

This document describes the structure and operation of the HM 5.0, including a discussion of various inputs to the model. Section 1.2 describes the recent evolution of the Hatfield Model. Section 2 summarizes changes made to the model between HM 4.0 and this version. Section 3 provides a general overview of the local network being modeled. Section 4 reviews briefly the structure of the model and its data. Section 5 focuses on the method by which customer locations are determined and clustered. Section 6 describes in detail each module and its operation. Section 7 summarizes the document.

Appendix A provides a brief history of the Hatfield Model. Appendix B identifies the user inputs to the model and their default values. Appendix C provides flow charts describing the data input development process used to obtain demographic and geological information, residence and business line counts, wire center mappings and loop distances. Appendix D describes the HM 5.0's calculation of interoffice network distances. Finally, Appendix E displays flow charts of the HM 5.0's network engineering logic modules.

1.2. Evolution of the Hatfield 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 declined, on the basis of its current record, including the Report of the State Members of the Joint Board, to endorse a model, and indicated it would issue a Further Notice of Proposed Rulemaking (FNPRM) detailing what it believed to be the appropriate requirements and guidelines that such a cost methodology should incorporate. This FNPRM was released on July 18, 1997. In this FNPRM the FCC provided a wealth of information about what the Commission believes are the appropriate properties to be incorporated into a proxy cost methodology. These include:

- A more sophisticated and precise method of locating customers;
- A choice of outside plant technologies and structures that reflects more closely local cost conditions;
- Explicit modeling of host/remote relationships between end office switches; and

[6] A CBG is a unit defined by the U.S. Bureau of the Census, and nominally comprises between 400 and 600 households.

- More flexible assignments of expenses based either on lines or relative investments.

The Commission set up a series of weekly meetings, and Comment and Reply cycles to address each of these and other related issues in greater depth. The Commission also indicated its intention to select a model for determining universal service support for nonrural carriers by the end of 1997.

HM 5.0 as here submitted is responsive to each the Commission's requirements as presented in the Order, the requirements outlined in the FNPRM on cost modeling, and the public notice guidance provided by the Commission subsequent to its release of the FNPRM. Indeed, HM 5.0 represents a revolutionary advance in the modeling of local telephone network costs by its incorporation of:

- Actual gecoded customer locations;
- An algorithm that identifies clusters of customers that may be served efficiently together – without recourse to arbitrary geographic limitations;
- Numerous optimization routines that ensure the use of outside plant that is most technically and economically suited to particular local conditions;
- Explicit specification of host, remote and stand-alone switches;
- An optimizing algorithm for the creation of efficient interoffice SONET transport rings; and
- Opportunities to allocate flexibly expenses based on lines or relative investments.

As a result of these many changes, HM 5.0 has refined greatly the task of identifying actual customer locations, and clustering them into units logically served by telecommunications outside plant. The model has thus moved well ahead of other models that employ more geographically limited, rule-of-thumb calculation techniques.

2. Summary of Changes Between HM 4.0 and HM 5.0

The changes between HM 5.0 and the previous release of the model, HM 4.0, are summarized in this section. These changes are reflected in the discussion of how HM 5.0 operates, presented in Sections 4 and 6.

2.1. User Interface

- The new features of the user interface provide the user with many additional inputs and options. Among the new inputs included are the ability to designate

specific end office switches as hosts, remotes, or standalones – as well as to assign remotes to a particular host; ability to specify variable T1 repeater spacing; ability to enable the steering of feeder toward population clusters within a quadrant, the ability to invoke a wireless distribution option if its cost is less than wireline, and many more.

- The interface also now allows the user to select multiple companies from one or more states (limited only by hard drive space) to be run in automatic sequence by the model. Expense Modules and workfiles are then produced for each individual company, and their universal service calculations rolled up.

2.2. Input Data

- The HM 5.0 input data locate customers much more precisely. These data determine the actual precise locations of as many customers as possible through latitude and longitude geocoding of their addresses. The remainder are located to at least the Census Block ("CB") level of precision and are assumed to be placed along the CB's periphery.[7]

- A clustering algorithm is used to determine groupings of customers that have extremely realistic correlation to efficient distribution areas.

- The August 1997 Local Exchange Routing Guide ("LERG") is used to identify and locate LEC wire centers.

- Business Location Research ("BLR") wire center boundaries are used to associate customer locations with LEC wire centers. This ensures that all identified clusters are restricted to include only customer locations that fall within the boundaries of a single wire center.

- Company line count totals are determined from the most recent available data, including that provided in the 1996 ARMIS data and NECA USF Loops filing for 1996.

- The method of estimating line counts by LEC wire center is refined, and line counts can be determined by CB.

- 1996 ARMIS data (rather than 1995 ARMIS data) are used to estimate traffic volumes and expense inputs.

2.3. Outside Plant Selection

[7] Previous versions of the HM only located customers precisely to their Census Block Group (CBG). Within high density CBGs, customers were assumed either to be spread uniformly across the CBG. In low density CBGs, a portion of customers was assumed to be clustered in quadrants, while another portion was assumed to spread along outlying roads.

- HM 5.0 automatically adjusts buried and aerial structure fractions to account for varying maintenance costs and placement costs occasioned by local soil conditions and bedrock. The amount of one type of structure substituted for another depends both on differences in placement costs and on a life-cycle analysis of maintenance and capital carrying costs of the two types of structure.

2.4. Distribution Module

- HM 5.0 lays its distribution plant directly over the actual identified locations of customer clusters.

- Rather than assuming that the distribution area is square, HM 5.0 engineers its distribution grid as a rectangle. The aspect ratio (height-to-width) of this rectangle is determined by the data input development process for each cluster, and lots are arranged within each clusters to reflect the aspect ratio input of that cluster.

- HM 5.0 serves "outlier" clusters from "main clusters" on which they home, using a "road cable" technology similar to that employed in HM 4.0.[8] The cables carrying T1 signals to the outlier clusters are separate from the analog copper cables that extend from the T1 terminal in each outlier cluster to the customer locations within the outlier cluster.

- Assuming that the distance of a cable run is sufficiently short so that use of copper feeder is a technically acceptable option, the HM 5.0 performs an analysis of the relative life-cycle costs of copper versus fiber feeder to determine which feeder technology should be used to serve the given main cluster.

- The HM 5.0 also incorporates an optional, user-adjustable "cap" on distribution investment. This cap is structured to reflect the potential cost structure of wireless distribution technologies.

2.5. Feeder Module

- HM 5.0 engineers feeder to serve actual population main clusters (and uses distribution cable to serve main clusters' subtending outlier clusters), rather than simply engineering to each CBG.

- At the user's option, the HM 5.0 "steers" feeder routes toward the preponderant location of main clusters within a given wire center quadrant.[9] When this steering

[8] Outlier clusters are clusters that contain fewer than five lines. Main clusters are cluster containing five or more lines. These clusters are served by feeder linking them to their serving wire center. See Section 6.3.2 for more detail.

[9] The default treatment, if steering is not invoked, is for the Feeder Module to calculate feeder distances using "right angle routing" in the four cardinal compass point directions, as employed in HM 4.0.

is invoked, the user may also apply an adjustable route-to-airline distance multiplier to the amounts of cable placed along these "steered" feeder routes.

- Manhole placement costs are increased by a user-specified amount whenever the local water table depth is less than the user-specified threshold.

2.6. Switching and Interoffice Module

- At the user's discretion, HM 5.0 will both engineer and cost explicit combinations of host, remote and stand-alone end office switches. If the user does not make such a specification, the HM 5.0 defaults to computing end office switching investments using input values that provide average per-line investments for an efficient portfolio of host, remote, and stand-alone switches.[10] If the host/remote/standalone designation option is invoked, the user is required to specify whether a wire center houses switches that are hosts or remotes, as well as to assign the correspondence between host and remote switches.

- Further, when the user chooses the model to distinguish explicitly between switch types, the HM 5.0 assumes that each host and its remotes are on a Synchronous Optical Network ("SONET") fiber optics ring separate from the interoffice rings used to interconnect host, standalone and tandem switches with each other.

- The HM 5.0 calculates explicitly a set of interoffice SONET rings that interconnect host, standalone, and tandem switches with each other. Based on this explicit specification of what wire centers are on each interoffice ring, the HM 5.0 determines associated ring distances using the actual locations of the wire centers along the ring. In addition, the rings are appropriately interconnected with each other, and tandem switches are also interconnected.

- The HM 5.0 engineers redundant paths and associated transmission terminal equipment for the point-to-point (folded) rings that may be specified to connect small offices to the larger wire centers on which they home.[11]

2.7. Expense Modules

- A Uniform System of Accounts ("USOA") detail worksheet is included that breaks out HM 5.0 investments and expenses by Part 32 account for comparison purposes.

[10] The Model defaults to an average per-line mix because accurate data on the purchase prices of a portfolio of host, remote and standalone switches of varying capacities, and on the identification of hosts, remotes, and stand-alone switches, may not be available to the user.

[11] The user may specify a minimum number of lines that a wire center must serve (possibly zero) before that wire center is placed on an interoffice ring with other end office switches – rather than being interconnected directly only to its "home" wire center.

- The proportion of total expenses that are assigned to loop network elements (i.e., NID, distribution, concentration and feeder) can be varied based either on relative number of lines, or on the relative amount of direct expenses (direct expenses include both maintenance expenses and capital carrying costs for the specific network elements).

- Both federal and state universal service fund requirements can be calculated in the density zone USF worksheet. This separate calculation permits differing state and federal cost benchmarks to be specified, as well as different collections of local services (e.g., primary and secondary residential lines, single line business, etc.) to receive universal service support.

3. Fundamental Structure of Local Network

3.1. Components of the Local Exchange Network

This section describes the network configuration and components modeled in HM 5.0. Figures 1, 2 and 3 depict the relationships among the loop, switching, interoffice, and signaling network components.

3.1.1. Loop Description

Figure 1 depicts the loop model utilized in HM 5.0. Section 3.1.1.1 defines the serving area. Section 3.1.1.2 provides a general description of the loop, depicted in Figure 1. Section 3.1.1.3 describes the loop components in more detail.