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Overview

What does the Telecom Model do?

The Telecom Economic Cost Model (Telecom Model) has been designed to estimate the long run economic costs of local telephone networks. It can estimate the costs of unbundled network elements (UNEs) as well as the costs of services that use the local network, like local exchange, switched access and special access.

What types of costs are modeled?

Modeling options include the following types of economic costs:

- Total Service Long Run Incremental Cost (TSLRIC)
- Total Element Long Run Incremental Cost (TELRIC)
- Long Run Stand-alone Cost of a Service (LRSAC)
- Long Run Marginal Cost of a Service (LRMCS)
- Long Run Marginal Cost of an Element (LRMCE)
- Long Run Total Cost (LRTC)

Numerous variations are possible with the TSLRIC and LRSAC options, allowing the user to focus on the incremental or stand-alone cost of specific geographic areas, customer groups, or services. (For specific discussions of the various cost types, please see Section 4, Key Attributes.)

What networks can be modeled?

The Telecom Model is versatile enough to model virtually any local telephone network–historic or forward looking, operated by an incumbent or a new entrant. Using company-specific and state-specific GIS input data, it builds the appropriate network to serve the specified customer locations within each wire center serving area.

What are GIS input data?

GIS stands for geographic information system, a way of linking various kinds of physical and demographic data to points on the earth’s surface. The Telecom Model relies upon a data base containing GIS data describing the location and demand requirements of subscribers as well as physical terrain features like soil conditions, water table depths, and populated road miles within each wire center.

What are the advantages of this approach?

The GIS-based approach allows highly precise modeling of the network, and it allows users to analyze and compare network and cost data relative to any geographic area (e.g., census block groups, zip code areas, counties).

The model also allows users to isolate and separately estimate the economic costs of serving specific groups of customers (e.g., single-line residence customers, PBX-line business customers, Centrex customers), taking into account their geographic characteristics. It can even isolate the cost of serving a specific customer pursuant to a contract serving arrangement.

Is the model limited to monopoly carriers?

No. Users can specify the percentage market share served by the network—from 100 percent for an incumbent monopolist down to a single-digit percentage for a minor competitive carrier. It also allows different specification of a competitive carrier's shares of the residence market, the business market, and the special access market, and of up to ten submarkets within each of these categories.

How flexible are the model's network design parameters?

Almost complete variability is possible in the physical and technical properties of the network within each wire center. However, in accordance with prevalent state and federal rules, the GIS input data normally assume existing central office locations within each wire center (a "scorched node" rather than a "scorched earth" approach).

What are the geographical units used in estimated costs?

The model can estimate costs over geographic areas ranging from individual distribution areas (DAs) to an entire state. Accuracy is limited only by the quality of the input GIS data.

Assuming adequate GIS data are available to pinpoint the specified end-user population, the model will build a network appropriately connecting that population to the central office. Generally, the GIS input data describe forward looking feeder routes efficiently connecting the population to the wire center. The model can also be used in conjunction with GIS data describing the actual routes of an existing network. Either way, the model will build a network conforming to the specified routes, with their specified geographic characteristics, while allowing the user to vary the technology, size of plant, and other attributes. For a full discussion of the GIS approach, please refer to the GIS entry under *Terms and Concepts*, accessed from the Main Menu.

Can users monitor and modify the model's operations?

Yes. The Telecom Model is an open model. That is, you can study all the algorithms used to develop the cost estimates and can trace from each input to each output, or vice versa, by studying the formulas in each cell or by using the built-in auditing function.

The user has nearly complete control over the cost modeling process through more than 1,700 adjustable input variables and can easily save and restore specific settings for these variables. At your option, any variables can be left undisturbed from one study to the next--for example, labor requirements and materials costs for specific items of plant and equipment.

What are the model's potential applications?

Its breadth of modeling possibilities makes the Telecom Model useful in a wide range of situations:

- Estimating the costs of providing universal service
- Identifying high cost areas
- Pricing unbundled elements
- Designing retail tariffs
- Developing or validating business plans
- Developing or testing the reasonableness of individual contract pricing arrangements

Is the model "user friendly"?

Yes. The selection procedure will guide you through a basic set of choices specifying the type of economic cost study to be created and defining the key attributes of the network to be studied. The model will then allow you to review and modify a complete array of user inputs, inserting values where relevant and customizing to the extent you wish. In all, there are 45 screen displays presenting choices and providing opportunities for customizing the model to suit the user's needs.

Getting Started

Computer software and hardware requirements

Telecom Model Release 5.3 runs on the Windows 95 and Windows 98 operating system with Microsoft Excel 97 (part of Microsoft's Office 97).

The application's functions are executed by source code and macros written in Visual Basic. In order for the Telecom Economic Cost Model to run, Microsoft Excel needs to be installed with some additional components that are not part of the default installation. When installing Excel or Office 97, you must choose the "Data Access" option and all the options available within "Data Access." In addition, Excel or Office 97 must be installed in the recommended default directory.

The minimum hardware requirements are a 486 computer with 66 MHz processor speed and 16 megabytes of RAM. However, we strongly recommend a Pentium or Pentium II processor running at 200 MHz or better and at least 32 megabytes of RAM. The recommended clock speed and RAM substantially reduce the time required for the computer to process the studies--particularly marginal cost studies and those involving large numbers of wire centers.

Installing the model

1. In a Windows 95 or 98 environment, click the *Start* button on the lower left of your screen.

2. Click *Run*.

3. Click *Browse* and find the **setup.exe** file under the **Telecom** folder on the supplied disk.

4. Click *OK*. The program will now lead you through the installation procedure. Also, be sure to run the **setup.exe** file under the **Reader** folder in order to install the *Adobe Acrobat Reader*. This enables you to view the documentation on screen.

After installation you can run the Telecom Model from your Windows 95 or 98 program menu, or you can insert a shortcut to the Telecom.exe file onto your desktop or Start menu.

License agreement

When the model opens, you will be presented with a License Agreement, which you should read carefully. If you need to engage in activities not authorized by the agreement on screen, contact Ben Johnson Associates, Inc. at (850) 893-8600. If you choose to reject the agreement, the model will automatically close. If you choose to accept, you will be taken to the Main Menu page.

Main Menu

The Main Menu panel offers six choices. Three of these provide access to stored information: *User guide*, *Terminology and concepts*, and *Review existing study*. The other three control the model's operations and allow you to enter, change, generate, and delete data: *Create new study*, *Create baseline data*, and *Data maintenance*.

User guide

Clicking the *User guide* button will take you to on-screen documentation that explains the model's concepts, definitions, assumptions, and procedures. A review of this documentation should aid you in understanding the workings of the model and learning to use it efficiently.

Terminology and concepts

This selection presents a glossary of terms along with brief explanations of key concepts. It is organized in a hypertext format that allows you to review brief definitions of concepts and then optionally link to a more detailed explanation in essay form.

Reviewing existing study

With this option you can view the inputs, algorithms, and outputs from any study already completed and stored. You initiate the process by inputting the study ID (if you know it), or by selecting from the menu of existing studies.

Where the list of study titles is unhelpful, you can initiate a search process to identify the specific study you want. The search program will ask you to enter certain choices about the study:

1. Which are you estimating--the costs of switched services or the costs of unbundled network elements?
2. What specific type of economic cost?
3. What type of customers?
4. What type of services?
5. What market shares?
6. What feeder technologies?

The program will then display a list of existing studies (if any) that meet the chosen specifications. In some instances (for example, where a series of similar studies have been generated with slightly different inputs), the list may be fairly long. In that case, you must select the specific study to be reviewed, based upon the study name, comment or ID number. If you specify a type of study that is not resident within the data base, no studies will be listed. In that case, just return to the Main Menu, select *Create new study* and generate a study with the specifications you want. Alternatively, you can retrace a few steps and modify or broaden the study specifications to pull up a new list of existing studies.

Once you have selected a study from the list, you can review its results on screen, print standard reports based on it, or look over the algorithms and inputs used in creating it.

Creating new study

This path leads you through the steps needed to develop a new study. The choice tree for key attributes resembles the one used in searching for an existing study, with some additional steps.

Once the baseline data have been selected and the key attributes defined, it is time to select the inputs. Since there is little to be gained (except practice time at the keyboard) by typing new numbers into thousands of blanks, you will start with a set of inputs that can be modified to the extent you wish.

You can opt to use a set of standard (default) values, or you can select a set of inputs associated with an existing study. You will then need to wait a minute or two while the inputs are loaded from the database into the Excel portion of the model. Viewing the input loading process can relieve the tedium of waiting, but it slows the process.

Once the inputs have been loaded, a screen pops up with a long list of major input categories. At this point, you may accept the selected inputs without modification, or you may proceed to review and modify inputs at will. The inputs give you nearly complete control over the cost estimation process.

As the display indicates, you are now at the major input category level in a tree diagram. Double clicking on any item in the tree will open the specific portion of the model that stores these inputs and will place your cursor on the first input within the selected group. The model displays the inputs in the white cells and allows you to modify or replace them. Your changed values will replace the original ones when you create a study, and they will be stored in the data base, along with the results of your study. If you click on the small "T" button floating in the lower right portion of your screen, you will return to the tree diagram, allowing you to quickly navigate to another group of inputs, or to move to the *NEXT* step in the process of creating a study.

NEXT you are asked to choose between studying a particular wire center on screen and studying a group of wire centers in a batch processing mode.

Testing and auditing

If you choose the *Study a wire center on screen* option, data will be loaded into the model for that wire center only. The advantage of doing this is two-fold. First, it is a “What If” device--it allows you to see how alternative inputs affect results without requiring you to save those results. Second, it lets you look inside the model to audit the algorithms and gain a deeper understanding of how the model works. The Excel auditing feature lets you generate blue arrows on screen that trace the chain of logic backward or forward through the model, beginning with any selected input, algorithm, or output.

Batch processing

In order to save your results to the data base, or to run a study that includes more than one wire center, you will want to use batch processing. Selecting this option will start an iterative process: baseline data are loaded into the model for a single wire center, costs are computed, and the results are saved to the data base. This process is repeated for each of the selected wire centers. The results, both for individual wire centers and cumulatively, can be used to generate various reports. You can preview any and all reports on screen before sending them to the printer.

Planning ahead

You should plan carefully before initiating batch processing, since this can be very time-consuming, depending upon the computer's capabilities and the number of wire centers being studied.

You should process a small group of wire centers and review the results before using the batch processing option for a large number of wire centers. Running the model for a single wire center, or a small sample of wire centers, is particularly advisable when you are experimenting with alternative input values. It can allow you to see the effect of a wide variety of different combinations of inputs without excessive thumb-twiddling. If you plan your work carefully, you may be able to complete time-consuming studies (e.g. TSLRIC or marginal cost studies involving a large number of wire centers) over the lunch hour, or at night.

Creating baseline data

This option from the Main Menu permits you to create or modify baseline data from an existing set of GIS data. You can use a series of numerical inputs in conjunction with the model's algorithms to derive a set of baseline data from a set of GIS data. Alternatively, you can manually override the algorithms, or cut and paste data from another source. Either way, the baseline data must be appropriately synchronized with GIS data for the wire centers in question.

A explanation of the GIS approach is provided in *Terminology and concepts*, accessed from the Main Menu or at any time from the *Documentation* menu. Typically, when customizing the model for a state or for a LEC within a state, we supply the relevant GIS data, converted to database format. However, the baseline data can reflect other data sources, as well. For example, if the GIS data fail to reflect an unusual concentration of access lines within a specific area, the discrepancy can be eliminated by appropriately increasing the estimated number of access lines within the distribution area in question.

Baseline inputs

To observe the effect of changing inputs or blending in data from another source, calculate the baseline results by recalculating the baseline workbook. With large data sets, it can take a while for Excel to complete the calculations. The recalculation can be accomplished more efficiently by pressing “Shift+F9" on the keyboard while accessing each of the following worksheets in order: DACount, BaseData1, and BaseData2. Once you are satisfied with the baseline data, click the small “T” and continue to follow the prompts.

Line demand

Raw GIS data typically contains residential, business, and government white page listings organized by distribution area. The inputs in this section convert the phone listing data to customer line counts within each distribution area. For example, individual residence lines within each distribution area can be estimated using the number of residence listings, but other data may also be useful (e.g. business listings). Similarly, government listings may be useful in estimating the number of Centrex lines. The inputs can be selected on a judgmental basis, through trial and error, or through the use of statistical techniques.

In order to select appropriate inputs, an analysis of line counts is typically performed for a cross section of wire centers. The resulting constant and coefficients (e.g. establishing a statistical relationship between listings and line counts) is then applied in the model to estimate the number of lines in each distribution area. Using this process, the user can readily adjust for unlisted and unpublished numbers.

This section also includes inputs that establish line equivalency factors for special access lines. The value of the input depends on the line type (analog or digital) and its voice equivalency (e.g., 1 for analog or DS-0, 24 for DS-1 and 672 for DS-3). The user must be careful to match the assumptions made here with the labeling used throughout the modeling process .

Feeder and distribution network factors

If the feeder lengths included in the GIS data do not precisely match the actual route distance, the user can include an adjustment factor to properly match the distances from the wire center to the distribution area (DA) nodes. This is analogous to converting distances as the crow flies to distances following roads.

These same factors can also be used to convert from a given set of GIS data to a given set of loop lengths (e.g. data that describes an existing network).

The number of routes per DA is user adjustable and allows the user maximum flexibility in determining them--by a user adjustable range, by road miles, or by a combination of the range and the road miles.

The Telecom Model can also model distribution cable on both sides of the roads, as may be required in the case of underground and buried distribution plant. The user can estimate the presence of such a plant configuration based upon a user adjustable density coefficient. It may be cost effective to place buried or underground cable on both sides of the road in order to avoid running drop wires across the road, in order to serve customers on both sides of the road.

The length of a typical drop can also be varied. The user can input a density factor which determines the average drop length in each distribution area, constrained by user specified minimum and maximum drop lengths. These can be separately determined for residence, business, and special access customers. The can user specify a constant drop length for each category by setting the density factor to zero and inserting the target drop length as the minimum drop length.

Structure percentage

The mix of plant structures (aerial, underground and buried) is controlled by the user with these inputs. The structure percentages are separately determined for feeder, distribution, and drop plant, based upon density, terrain, and other factors (e.g. engineering practices or zoning ordinances). The inputs include a constant, a density factor, and a terrain factor. The density factor is typically used to ensure that underground plant is deployed in more densely populated areas (e.g. downtown business districts). The aerial terrain factor can be used to ensure that aerial plant is deployed in areas where hard rock is present within 36 inches of the surface, since this makes trenching costly. The underground terrain coefficient can be used to ensure that conduit is installed in areas with a high water table. Note that buried plant is residually determined from the aerial and underground percentages.

The model computes nominal structure percentages based on these user inputs. At the user's option, the Telecom Model will narrow the choice to one or two types of plant within each distribution area and along each feeder cable segment, derived from these nominal values. This option can provide enhanced realism, since it will prevent placement of all three types of plant in a single distribution area, or along each feeder cable segment. Thus, for example, if the user limits the selection to two plant types, and the nominal percentages computed by the model are 61% aerial, 36% buried and 3% underground, the model will deploy 63% aerial, 37% buried and no underground plant.

Zone designation

One aspect of the baseline data that you may want to experiment with is the classification of specific distribution areas (defined by the GIS data set) into two zones within each wire center.

The zone designations let you distinguish areas within the wire center that have differing demographic or market characteristics. For example, you can separately specify the carrier's market share percentages for each zone, and you can incrementally add zone 2 service to a network that would otherwise serve only zone 1. Zone designations can also be used in summarizing and reporting the cost results.

Typically, zone 1 covers the high density distribution areas near the central office or end office switch, and zone 2 covers the surrounding area, with its greater loop lengths, lower concentration of customers, and resulting higher per-line costs.

However, the user has complete control over the zone designations and can adjust them in various ways--by specifying a minimum or maximum number of loops, or loop length in the DA, or some other attribute, such as the presence or absence of facilities-based competition.

Once zone identities have been established for a set of baseline data, the model can use this baseline data set to answer such questions as the following: "Given the cost of a network serving only zone 1, what is the additional (incremental) cost of building out that network to serve zone 2 as well?"

Creating a new baseline data set

If you choose to create a new baseline data set rather than modify an existing set, you have all the flexibility just mentioned, plus additional options. For example, you have a wide choice of labels to describe particular customer categories and can also create custom labels. Customizing is particularly useful when you are using the model to analyze a contract service arrangement.

A word of caution: if you modify any preset customer category labels, you may have to make corresponding changes to all input values that correspond to the affected categories, including the percent of lines within each category using specific services, the number of lines per customer location, custom calling/other switching features investment, usage characteristics, and the designation of digital and analog special access services (related to copper electronics investment).

Data maintenance

This option from the Main Menu keeps the database manageable by letting you delete obsolete or unwanted baseline data sets and cost studies. You need this option because the model can rapidly generate enormous amounts of data, particularly when running in batch processing mode for a large number of wire centers. When you are just learning to use the model or are experimenting with alternative input values, your studies can quickly multiply, cluttering the database and taking up hard-drive space. The quick-delete feature solves this problem.

When you select this option from the Main Menu, the screen will display two windows. One lets you scroll through the full set of existing studies and click-delete any or all of them. The other window does the same for existing baseline data sets.

Remember that a deleted study can always be created again, provided the underlying baseline data are intact; but a deleted baseline data set may be hard to replicate.

Key Attributes

Two of the Main Menu choices--*Review existing study* and *Create new study*--let you identify or define a study by specifying some of its most fundamental parameters, its *Key Attributes*. These include the specific type of cost, the particular service(s) and customer class(es), the carrier's market share, and the kind(s) of feeder technology.

Type of economic cost

The Telecom Model allows users to compare and contrast a wide variety of cost results, often using the same data set but interpreting the data according to distinct economic cost concepts.

The model can develop four broad categories of long run economic cost estimates for telecommunications services: total service long run incremental cost (TSLRIC), long run stand-alone cost (LRSAC), long run marginal cost of a service (LRMCS), and long run total cost (LRTC). For unbundled network elements, it can develop two such categories: total element long run incremental cost (TELRIC) and long-run marginal cost of an element (LRMCE). For definitions and additional information about these and other costing terms, please refer to the *Terminology and concepts* section, accessible from the Main Menu or at any time from the *Documentation* menu.

Total Service Long Run Incremental Cost (TSLRIC)

Total service long run incremental cost is the firm's total cost of producing all of its services assuming the service (or group of services) in question is offered, minus the firm's total cost of producing all of its services excluding the service (or group of services) in question.

This option allows you to compute the additional cost incurred when a network is expanded (or contracted) to serve (or not serve) a specified block of customers, a particular geographic zone, a specific service, or virtually any combination of specific customers, zones and services. You have almost complete flexibility in targeting the specific group of customers or service which is of interest, ranging all the way down to a contract service arrangement provided to a single customer at one or two specific geographic locations.

For example, if you wish to determine the TSLRIC of residence subscribers in zone 1 of a particular wire center, the model will build two networks serving that wire center--one that provides all services to all subscribers (the all-inclusive costs, called *Configuration 2* in the model), and one that provides all services to all subscribers except the residence subscribers in zone 1 (the costs exclusive of the subject costs, called *Configuration 1*). The cost difference between these two represents the incremental direct costs of the service provided to those subscribers.

TSLRIC can be useful in public policy and pricing decisions. For example, TSLRIC estimates can indicate the presence or absence of subsidies for a specific service or a group of customers in the aggregate. Similarly, incremental costs can be useful in developing or examining regulatory or pricing policies applicable to a particular service or group of customers. Care should be used in interpreting TSLRIC results: joint and common costs tend to be excluded from TSLRIC estimates, yet these costs must also be considered in the pricing process, if total costs are to be recovered.

Long Run Stand-alone Cost (LRSAC)

LRSAC options are available for a variety of different customer categories, services and geographic zones. Selection of a narrow market category (e.g., business customers in zone one only) will cause the model to build a network serving the locations specific to those customers and with facilities scaled to meet their needs alone. By contrast, selecting a wider group of customers (e.g., both residence and business customers) will cause the model to build a larger, more extensive network serving all and only the members of the combined categories.

The larger the scope of the study, the higher the total stand-alone costs tend to be; for example, it costs more to serve both business and residence customers than to serve either group alone. However, when the total costs are restated on a per-unit basis, the resulting average costs tend to decline as the scope of the study is expanded. That is, economies of scope tend to reduce per-unit costs when different customer groups or services are provided over the same network. The LRSAC option, which allows you to observe and document this phenomenon, can be useful in establishing reasonable price ceilings.

Long Run Marginal Cost for a Service (LRMCS)

Properly applied, a marginal cost study focuses on the effect of very small changes in output occurring at the point in the total cost curve at which the firm is operating and decisions are being made. In practical applications, however, it is difficult to meaningfully isolate the cost of a minimal change (e.g., the loss or addition of one subscriber loop). In the Telecom Model, marginal cost is measured by estimating the slope of the total cost curve over a discrete interval (a small portion of the overall total cost curve).

When you select this option, the Telecom Model will produce an iterative series of total cost estimates, over a range of output volumes in the immediate vicinity of the specified point, then it computes the slope of the total cost curve within this range. Be advised that the iterative nature of the procedure can make it very time consuming, especially when analyzing more than one wire center. The LRMCS can be useful in predicting the lower limit on price levels in an intensely competitive market (e.g., during a price war). Such a study can also be useful in answering questions about a firm's profit-maximizing point of production--i.e., at what price level would marginal revenue equal marginal cost? It can also be useful in establishing the floor price for specific services under a price-capping or alternative price regulation regime.

Long Run Total Cost (LRTC)

This option allows you to compute the total cost of a network serving all categories of customers and all services in both geographic zones of the wire center--e.g., the network of the carrier of last resort. This can be particularly useful in identifying the extent to which high costs exist within particular wire centers; it thus addresses important universal service questions. The LRTC results are typically the same as those generated as Configuration 2 under the TSLRIC option. The LRTIC results are also similar to those generated by the TELRIC option, with the exception of differences in classification and presentation, and the exclusion of certain retail service-specific costs (e.g., billing and collection).

Total Element Long Run Incremental Cost (TELRIC)

The FCC developed its own version of economic cost for purposes of implementing the 1996 Telecom Act, coining the term TELRIC (total *element* long run incremental cost) to describe the method of economic cost calculation that it believes is most appropriate. The TELRIC of each unbundled network element is determined by isolating the specific costs associated with particular network elements within the context of a network providing all services to all customers and geographic zones (analogous to Configuration 2 of TSLRIC.). In most cases, TELRIC can be computed by simply identifying the network element to which a specific cost is related. In a few minor cases (e.g., the cost of the building and main distribution frame at the wire center), it is necessary to resort to an allocation procedure, since the cost is shared by two or more elements (e.g., loops and switching), and the FCC has specified that TELRIC must include an allocated share of these costs. Aside from these minor exceptions, TELRIC is equivalent to the difference in cost (stated in per-unit terms) between a firm's total output including and excluding production of that element.

Long-Run Marginal Cost of an Element (LRMCE)

Whereas a TELRIC study takes total cost and converts it into a statement of cost per unit for individual network elements, a LRMCE study calculates the rate of change in total cost as the volume of network elements changes. Such a study is useful in judging how a firm might price network elements if it were allowed to follow a profit-maximizing pricing strategy--i.e., at what price level would marginal revenue equal marginal cost? For regulators, LRMCE could also be useful in establishing a price floor.

Customer categories and services

Once you have selected the general type of economic cost, you will be asked to choose the specific type of study. For instance, in the case of a stand-alone cost study, you must decide which particular customer categories (residence, business, and special access) will "stand alone." Similarly, you must specify which particular switched service type(s)--local exchange, switched access/toll, and directory assistance/911/operator access--will be included in the stand-alone study. Finally, you must specify whether the scope of the study covers zone 1, zone 2, or both.

Market share

You will also be asked to define the market share served by the network being studied. Economies of scale and scope can cause per-unit costs to vary widely with the size of the network. As telecom markets become more competitive, it becomes increasingly important to consider how a carrier's costs are related to its network's market share as well as to that network's geographic scope.

The model will build a network optimally sized to serve the specified portion of the market. For instance, if you specify 100 percent market share, the model will build the optimally sized network for serving all relevant customers in the specified geographic area. (The total number of customers is specified by the baseline data, which are derived from the GIS data.) If you specify a 25 percent market share, the model will build a smaller network in that geographic area, one just large enough to serve one-fourth of the customers.

It should be apparent that a 25 percent market share will generally translate into substantially higher per-unit costs than will 100 percent market share--all other factors being equal. It costs nearly as much to install enough cable to serve every fourth house along a street as it would to install enough cable to serve every house. The Telecom Model allows you to analyze this phenomenon very precisely and to observe the extent to which costs increase as market shares declines. (The impact of economies of scale is not uniform across all geographic areas.)

To minimize the adverse impact of this phenomenon, new entrants may install facilities that are concentrated in certain distribution areas or among certain customer classes--in niche markets.

The Telecom Model allows you to analyze networks that serve very specific niche markets. For example, the carrier's share of the special access market can differ from its share of the business and residence market. Through the judicious use of this option, you can analyze virtually any specific situation, including a "cream skimming" scenario in which the carrier builds its own network facilities to serve a particular share of certain geographic areas and customer niches.

Feeder technology

Subscriber loops are the individual network channels connecting end users with the central office--that is, each loop utilizes feeder cable, distribution cable, and customer drop cable. These three parts of the network are separately analyzed within the Telecom Model.

Feeder includes the various cable segments that connect the main distribution frame (MDF) in the central office or wire center with feeder/distribution interfaces (FDIs) located throughout the wire center serving area. The placement of these interfaces (and thus the length and capacity of the various feeder segments) is determined by the customer dispersement pattern, which is specified via GIS data inputs.

The model allows four ways of specifying feeder technology: *Copper, Fiber, Engineering Criteria,* and *Minimum Cost.* Once you make this basic choice, the model will request additional information.

Copper

All-copper is the most prevalent technology currently in use. In most instances it consists of analog copper pairs from the network interface devices (NIDs) at the customer end of drops, all the way to the MDF. If a loop exceeds a certain length, its signal strength must be boosted with load coils, or a digital loop carrier (DLC) system must be deployed. Since load coils are considered an obsolete technology, the Telecom Model makes no provision for them. Instead, an all-copper network will include digital loop carrier technology whenever the loop length exceeds the user-specified maximum distance. The default setting is 18,000 feet, which corresponds to the point beyond which ordinary analog loops cannot adequately support high speed modems. However, a more conservative network design can be specified by using a shorter break point such as 12,000 feet.

Fiber

If you select the all-fiber option, the model will build a network with optical fiber on all feeder segments and remote electronics deployed at every DA node. Distribution cable and drops will still be copper, however.

Engineering criteria

With this method of specifying feeder technology, the model deploys a combination of fiber and copper cable, based upon user-specified criteria. For example, the user can use fiber cable to serve all DA nodes which are beyond a specified distance from the wire center; this is accomplished by specifying the maximum length of feeder which will be served by copper cable, thereby ensuring that fiber is sent to all distribution areas which are farther from the wire center. Alternatively, the user can deploy fiber based upon total loop length, including feeder, distribution, and drop. Either way, the engineering criteria need not select the lowest cost technology; instead, it will simply deploy fiber along routes that meet the specified engineering criteria.

Minimum cost

With this option, the model selects and deploys the cost minimizing technology or combination of technologies on each feeder segment and identifies the least costly locations (nodes) for remote digital loop carrier (DLC) electronics. The model identifies the least-cost solution by systematically sorting through thousands of potential configurations, segment by segment and node by node, searching for the least costly combinations. It takes into account all the relevant costs (for instance, it reduces manhole and conduit costs along routes where fiberoptic cable is deployed). It is also sensitive to carrier market share, considering whether a given technology will be cost-effective at the posited levels of scope and scale.

The approach resembles the way IBM's “Deep Blue” solves a chess problem by successively exhausting the set of possibilities. However, a genetic algorithm is used by the Telecom Model to increase the efficiency of this process. In effect, the Telecom Model "learns" as it sorts through possibilities, evolving towards the absolute lowest cost solution.

The user should bear in mind that this option requires a higher level of computing power, and is much more time consuming, than the others. It is therefore wise to first prepare a study based on an engineering criterion that is roughly cost minimizing (e.g., a total loop length of 12,000 or 15,000 feet) and use it as the starting point for running the cost minimization process. Similarly, once a study has been prepared using the cost minimization option, additional studies can be prepared for the same wire center(s) using the previous cost minimization solution as the starting point.

User Inputs

As noted earlier, the Telecom Model has more than 1,700 different input variables. While this allows you nearly complete control over the cost modeling process, it is highly unlikely that you would want to enter more than a minor fraction of the total data for each new modeling effort. The model therefore offers at least one standard set of default values for all inputs and allows you to load it with two clicks of the mouse.

Alternatively, you can load a new study with the input values from any existing study. Either way, once a full set of variables is in place, you have the freedom to modify or adjust any particular values.

There are two major reasons to change default or established values. One is to make them more appropriate for a particular context or to improve the accuracy of the cost estimates in a particular situation.

The other is to perform sensitivity tests: to analyze the effect of a changed input or set of inputs on a particular output (e.g., what happens to loop costs when fill factors are scaled up or down).

In verifying or modifying input values, you can turn to various available sources, including price lists, invoices, purchase contracts, engineering judgments, and special studies.

The model presents input categories in a tree diagram format. In general, the sequence of presentation moves outward from the wire center toward the end users--that is, first switching, then feeder segments, then distribution nodes and segments, then drops and NIDs. But the category list starts and ends with inputs that relate to the study as a whole.

Double clicking an input category label takes you to the corresponding input data location, so you can review and/or change input values. Clicking the box with a T returns you to the tree diagram and category list. While inside the model, you can use the automated tracing function to follow the path of any input cell forward through the model.

Here are brief discussions of some major user input categories.

Annual depreciation and capital cost factors

Cost factors convert investment amounts into annual (and then monthly) costs, based on a constellation of inputs: debt/equity ratios, capital cost rates, income tax rates, and depreciation lives. By selecting *"Create carrying cost factors,"* you can use a module within the Telecom Model to develop annual cost factors from the default inputs or from modifications of them. The module uses a levelizing process to spread the investment over the entire economic life of the item.

Alternatively, you can modify the factors to match those used or developed in another cost model, or you can enter factors derived by an external analytical process (e.g., from a capital cost factor software package).

Plant specific expenses

Plant specific expense factors allow the user to estimate annual maintenance expenses associated with telecommunications plant. Plant-specific expense inputs for the USOA plant accounts are generally expressed as a percent of investment. However, the Telecom Model also gives the user the flexibility to estimate some expenses for on a per-line basis for major accounts (e.g., *Central office switching*, *Other switching features*, and *Cable and wire facilities*). If you populate the per-line expense inputs, you may need to decrease the investment-related expense inputs, to ensure an appropriate overall level of expense for each account.

Wire center investments

Wire center investment for buildings, land, MDF, and other miscellaneous investments are derived from inputs which have fixed (per central office) and variable (per line) components. The building and land inputs are organized as non-switch-specific and switch-specific investments. There are also inputs available to the user to allocate these investments to the switching, trunking and loop investment categories.

Switching investments

Switching investment amounts are specified on an engineered, furnished, and installed (EF&I) basis, and the total investment is built up through a series of subcategories. These include building and other miscellaneous investments, as well as distinctions between various traffic-sensitive and non-traffic-sensitive facilities.

These costs are for the end-office switching equipment located at the wire center. The model also estimates the cost of tandem switching, interoffice trunking, and associated signaling for each wire center. It develops these estimates on a simplified basis, thereby providing an estimate of the cost of the interoffice trunks leaving the wire center, and a fractional share of the tandem switching and signaling equipment used in routing some calls to and from the wire center.

It does not model tandem switching costs in detail for the entire exchange or LATA, but it does provide an allowance for these costs in developing service cost estimates. These costs, which are external to the specific end-office serving the customer, are not included in the unbundled cost estimates, which focus on unbundled switching costs for serving an end-use customer.

Traffic-sensitive investments are specified as a function of call setup (per hundred calls per day), as a function of minutes of use (per hundred minutes per day) and as a function of per trunkside port based on switch size. The user can also provide an allowance for right-to-use fees and other costs of providing other switching features and functions, such as custom calling, rotary, caller ID, and voice mail. The model does not estimate these costs in detail; they are simply input on a per-line investment basis.

The *miscellaneous switching inputs* variables let you specify the proportion of calls placed to other end offices (interoffice calls) relative to the number of calls that originate and terminate in the same end office (intraoffice calls). You can also specify the fraction of calls handled by a tandem switch and the average monthly minutes of use handled by each interoffice trunk. Another input allows the user to specify the maximum line size of a switch. When the number of switched lines in a wire center exceeds this input value, multiple identically sized switches are installed in the wire center

The *calling volume* variables allow you to specify the number of calls per month and the average call duration for each category of customer (e.g., residence, individual line business, PBX, and coin). These data are input separately for local calls, switched access/toll calls, and directory assistance/911/operator access calls.

Interoffice trunking

The model does not estimate interoffice trunking costs in detail for the entire exchange or LATA, but you can specify the investment in electronics, cable, and other facilities used in providing interoffice trunking on an engineered, furnished, and installed (EF&I) basis per central office and per trunk. You can also allocate the interoffice structure percentages between aerial, underground, and buried plant.

Circuit equipment

You can separately specify the material costs of electronics used to provision digital circuits over fiber optic or copper cable, at both the wire center and the remote location. At either location you can specify the fixed, minimum cost of the system (not including any channel capacity), and the variable cost associated with increases in the size of the system. The latter costs are specified through a table that lets you accurately capture economies of scale. The model uses this information to estimate the material cost of a complete system of the required size. By choosing the appropriate input values, you can model either a specific type of system or the overall array of systems available from various manufacturers.

You can separately specify the labor requirements for the design, engineering, and installation of the circuit electronics used at the wire center and the remote location. Both fixed and variable inputs are provided, to reflect the fact that larger, more complex systems are more time consuming to design and install.

Miscellaneous feeder and distribution investments

Cross-connects and other miscellaneous material investments are specified here with a fixed and variable component for the feeder segments and the distribution areas. The fixed investments are per feeder segment and per distribution area. The variable investments are per line per feeder segment and per distribution area.

Distribution cable taper and termination points

Consistent with usual industry practice, the distribution cable connecting the DA node to the individual end-user premises is modeled as a tapering tree/branches configuration, with the sheath size of the branches diminishing as one moves away from the feeder/distribution interface (DA node) toward the customers. These inputs control the general design and deployment of distribution cable within each distribution area, in conjunction with GIS data which reflects the distance from customers to the DA node, measured along rights of way (roads) within that distribution area. Note that unlike feeder segments, individual distribution cable segments are not modeled in detail. Rather, the model estimates the overall cost of the distribution cable required within each distribution area.

Copper cable

The copper cable inputs determine the investment in copper cable, including the loaded material costs of the various cable segments and the cost of engineering, placement, and splicing.

The model selects the minimum cable size to accommodate the number of loops served by each cable without exceeding the specified *utilization rates*. In so doing, the model will often round up--thereby providing spare capacity beyond the minimum set by the utilization factor itself. Since the lumpiness of specific facilities is taken into account, the effective fill factor (actual ratio of working facilities as a percentage of total installed capacity) as developed within the model will generally be lower than the selected utilization rate.

You can input the *design and engineering* hours per kilofoot for aerial, underground, and buried copper cable, and you can specify the labor requirements per kilofoot for *placement* of aerial, underground, and buried copper cable.

It can be cheaper to simultaneously design or place multiple sheaths of cable along a single route than to design or place the same number of sheaths at different times or along different but equivalent routes. These input cells let you specify the size of the resulting cost savings. For example, if the engineering hours required for a bundle of two cable sheaths are the same as for a single sheath, the engineering variable would be set at -100%. Similarly, if second and subsequent sheaths can be placed with 70% less labor than required for a single sheath, the placement cell would be set at -70%. The model uses these inputs only on routes where multiple sheaths are required by the network design.

You can specify the number of minutes for *Copper Cable Splicing* stated in minutes per segment, minutes per pair, and minutes per pair per kilofoot. The model combines the effect of all three variables in determining the total splicing labor requirements.

Fiber cable

These inputs determine the capacity and investment in optical fiber cable, including the loaded material costs of the various cable segments and the cost of engineering, placement, and splicing.

The fiber capacity inputs let you specify the maximum number of loops derivable from a single fiber pair, consistent with any assumed limitations on the speed of the lasers and other constraints inherent in the systems being modeled. You can also choose the amount of fiber to be deployed for redundancy (reliability) purposes. In addition, you can specify a fiber safety reserve, stated as a percentage of the required amount of fiber and a minimum number of extra pairs per segment.

The model uses these inputs, along with the utilization rate, in determining the effective fill factor for fiber cable. The model selects the smallest cable size to accommodate the number of loops served by each cable without exceeding the specified *utilization rates*. When this is accomplished, the model "rounds up," which provides additional spare capacity beyond the minimum mandated by the utilization factor. Because most routes require a relatively small number of fibers, in most cases the total amount of spare capacity, or effective fill, is largely determined by the allowances made for *redundancy and safety reserve* rather than the selected utilization rate, which has a relatively minor influence.

The user can input the *design and engineering* hours per kilofoot for aerial, underground, and buried copper cable. The user can also specify the labor requirements per kilofoot for *placement* of aerial, underground, and buried copper cable.

The user can specify the number of minutes required for *Fiber Cable Splicing* stated in minutes per segment, minutes per pair, and minutes per pair per kilofoot. The combined effect of all three variables is used by the model in determining the total splicing labor requirements.

Structures

The *structure sharing factors* specify how much sharing of structure costs (e.g., poles, conduit, and trenches) is assumed between the carrier and other entities. If the carrier will not install all its own poles but will rent space from another firm (e.g., an electric utility), a factor below 100% should be selected. Similarly, if the carrier can rent pole attachment space to others (e.g., to a CATV firm), this variable can recognize an offset to the cost of the pole. Most studies should estimate something less than the full cost of aerial structures--particularly studies of smaller entrants, who should be able to attach at least some of their facilities to the incumbent's poles.

The cost of support structures (including trenching required for buried cable) includes *material costs* for poles, conduit, and manholes, as well as labor requirements and labor cost rates for various *installation* and engineering functions. In estimating these costs (especially labor time requirements), the model will take into account the presence of bedrock in the soil, the depth of the underground water table, and other terrain factors, such as the probability of encountering man-made obstacles.

Aerial investment is specified per pole. For underground structures, you can specify the materials cost of handholes, manholes, and underground vaults, using both fixed and variable inputs. Where there is a mix of sizes and types of manholes, the selected inputs should be consistent with the average cost of the facilities. The variable component lets you model the higher cost associated with larger cable cross sections, which are harder to install and likely to require a larger manhole or vault.

Likewise, the material cost of conduit is specified as a fixed amount per foot and a variable amount per cable pair per foot. The variable component allows modeling of the higher cost of larger cable sheath sizes and/or multiple sheaths. Where appropriate, you can also specify the cost of re-sodding above buried and underground installations.

For aerial structures, you can set the engineering and labor hours per pole and the distance (in feet) between poles. Where soil conditions make pole installation either difficult or very difficult, you can specify the added labor time per pole.

Underground placement tends to be costly and is generally avoided. However, conduits are desirable (or mandatory) in certain locations: in highly urbanized areas with their concrete sidewalks and busy city streets; where aerial installation is not allowed or feasible; where a high water table makes direct burial impractical; and wherever trenching costs are very high. If trenching is costly (e.g., due to rocky conditions) but poles are not an option, the higher cost of conduit may be justified in consideration of future growth and expansion of the network (since more cable can be pulled through spare conduit without the need to dig another trench). Hence, the percentage of underground structures should be higher in denser, more urbanized wire centers and wherever less costly options have problems.

For either buried cable or underground conduit, you can separately specify a trenching/plowing depth of either 36 or 24 inches for copper and fiber, differentiating between feeder and distribution segments. Farther from the wire center central office, where fewer customers would be affected by a cable cut, a shallower depth may be acceptable.

You can also specify the labor required for these installations in minutes per running foot for each depth, as well as the added labor needed for: (1) difficult or very difficult soil conditions (e.g., the presence of soft or hard rock); (2) groundwater conditions; (3) man-made obstacles like concrete, asphalt, water lines or sewer lines. The portion of the run that encounters man-made obstacles can also be specified, both as a function of density and as a function of other factors.

Engineering hours per mile, which will typically be greater for underground than for buried cable, can also be specified, as can other cost factors like the average spacing of manholes and installation time.

Customer premises termination

This group of inputs is used by the model to estimate the cost of facilities at or adjacent to the customer's premises. These include the network interface device (NID) which separates the drop wire/building cable from the customer's inside wiring and premises equipment (telephone set or phone system); the drop wire and/or building riser cable running between the NID and the network terminal; and the network terminal where the drop wire/building riser cable attaches to the distribution cable.

You can specify the drop wire material investment by drop size (i.e., pairs per sheath) and by the plant type (aerial, underground or buried). Inputs for drop wire installation include time per pair and per foot, with different values for residence, business and special access customers. Other investments such as NID and remote terminal investment are specified as an EF&I investment for various customer sizes. IntraBuilding riser cable investment is specified as EF&I per sheath foot.

Billing and collection

This section compiles a monthly estimate of the cost of billing and collection for typical retail customers, segregated into joint and direct cost items. Joint billing and collection costs include preparation and handling of a bill of minimum size, the envelope, and minimum postage--items which do not vary regardless of the number or type of services used. Direct billing and collection costs (attributable to individual services) include all other costs: data processing to compute the service's billing amount, the additional costs of bills of more than minimum length, centralized mail remittance, customer service, and bill inquiry.

Percentage of customers receiving services

You can specify the percentage of customers within each category that uses each of the four major categories of switched service. For most, if not all, business and residence customer categories, these inputs are typically set at 100 percent for local exchange, switched access/toll, and directory assistance/911/operator access. A lesser percentage would typically be used for custom calling/other switching features. The appropriate factor may vary depending upon the customer category and the average buy-up rate experienced by the particular carrier.

Welcome

Using your mouse, there are several ways **to navigate within the user guide:** On the left side of your screen are a set of bookmarks corresponding to the major sections of the user guide. You can click on the right arrows to expand the list to include sub-sections. Click on the down arrows to contract the list. To jump to a section or sub-section of the user guide simply click on that item within the list. You can also navigate by clicking on any item on the Table of Contents. To scroll through the user guide you can use the Page Up/Down buttons or the up/down arrows on your keyboard. You can also click on the scroll bar toward the right edge of your screen.

To close the user guide and return to the Main Menu, click on the X in the upper right hand corner of your screen.