UNITED TELEPHONE COMPANY
OF FLORIDA
CENTRAL TELEPHONE COMPANY
OF FLORIDA
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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DIRECT TESTIMONY

OF

JAMES D. DUNBAR, JR.

Q. Please state your name, place of employment, and business address.

A. My name is James D. Dunbar, Jr. I am employed by Sprint/United Management Company, an affiliate of United Telephone Company of Florida and Central Telephone Company of Florida, as a Manager - Pricing and Regulatory, at 2330 Shawnee Mission Parkway, Westwood, Kansas, 66205.

I. <u>Background and Qualifications</u>

Q. What is your educational background?

A. I received a Bachelor of Science in Engineering degree from Pennsylvania Military College (now Widener University), Chester, Pennsylvania with a split emphasis in Computer and Nuclear Engineering. In 1983, I received a Master of Business Administration degree from James Madison University, Harrisonburg, Virginia with an emphasis in Business. I have also completed numerous industry engineering and related courses in General Engineering, Outside Plant Engineering, the Bell Technical Center Course in Long Range Technical Planning, Transmission Engineering, Traffic Engineering, and Transmission Noise Mitigation.

Q. What is your work experience?

A. From 1966 to 1970, I served as an Officer in the U.S. Army Signal Corps leading or commanding signal units on various communications assignments including command of a U.S. Strike Force International Communications Team. Responsibilities included the provision of FM, UHF, microwave radio, radio/wire integrated links, land line, switching, network control, and secure communications. Following active duty, I continued in a reserve status assigned primarily to the U.S. Army Air Defense School at Ft. Bliss, Texas as a senior communications instructor and course analyst.

From 1970 to 1973, I was employed by the Denver & Ephrata Telephone & Telegraph Company in Ephrata, Pennsylvania. My duties included Outside Plant Engineering, Traffic Engineering, COE Engineering, development of certain cost studies, and some Circuit Equipment maintenance.

I have been employed by Sprint Corporation or one of its predecessor companies since 1973. From 1973 to 1985, I was located in Virginia. From 1973 to 1974, I was an Outside Plant Engineer with responsibility for many projects including a complete rework of the University of Virginia loop plant. I worked as a Transmission Engineer during 1974 and then was assigned to manage the state capital budget and outside plant planning group for the 1974 to 1976 period. This group was assigned responsibility for engineering all outside plant capital projects in excess of $25,000 and budgeting for all classes of plant. From 1976 to 1978, I was District Plant Manager for the 1800 square mile Southern Virginia District where I managed the Construction, Maintenance, and Installation forces.

From 1978 to 1984, I managed various Regulatory costing functions, including the state depreciation and cost separations group. From 1984 to 1985, I was General Manager - Interexchange Services where I managed the cost separations, rates and tariffs, depreciation, and the interexchange carrier billing/contract and interface functions. I was a member of the Virginia Telephone

Association Separations Committee.

From 1985 to 1993, I was General Staff Manager - Separations for the predecessor Centel Corporate Staff in Chicago, Illinois. My job functions included managing the cost separations staff, the revenues and earnings monitoring function, the programmer and modeling support for those functions, and cost issue analysis activities such as rate of return versus price caps and FCC/NARUC rule changes. I was the primary corporate interface with USTA and NARUC for technical issues. I served on the USTA Technical Operations Committee, the Price Caps Team (from 1987 to 1991), and the Policy Analysis Committee. I also taught a portion of the USTA Separations Classes.

From 1993 to the present, I have been assigned to the Sprint/United Management Company Local Telephone Division Staff in Westwood, Kansas. From 1993 to 1994, I was Manager - Separations with responsibility for the merger of the Centel and Sprint separations functions and various other costing and monitoring activities. Since 1994, I have been in my current position with responsibility for analysis and modeling of costing issues, such as LIDB and 800, broadband implementation, and the development of the Benchmark Costing Model (BCM) sponsored by Sprint, MCI, NYNEX, and US West. I am a coauthor of Benchmark Cost Model 2 (BCM 2). In addition to the BCM activities, I have been a member of the Telecommunications Industries Analysis Project (TIAP) industry team currently sponsored by the University of Florida since its inception and am a member of the current TIAP Broadband Model development team.

II. Purpose of Testimony

Q. What is the purpose of your testimony today?

A. The purpose of my testimony is to explain the Benchmark Costing Model 2 (BCM 2). I explain the BCM 2, its assumptions, and how it develops investments and monthly cost for basic telephone service by Census Block Group (CBG). Additionally, I explain how BCM 2 determines costs of loops, from which prices can be developed.

It was my intention to address the Hatfield Model Version 2.2 mentioned in MCI's Petition and its witness Don J. Woods' Direct Testimony. However, MCI has not furnished either the Hatfield Model or its outputs in this proceeding. I will address the Hatfield Model in my rebuttal testimony, assuming that MCI will file the Model and its outputs sufficiently in advance of the date Sprint's rebuttal testimony is due. If not, then I request the right to file rebuttal testimony after that date.

III. Benchmark Costing Model 2 (BCM 2)

Q. What is the origin of the BCM 2?

A. BCM 2 was developed as a joint effort by Sprint Corporation and US West to address critical comments filed with the FCC in CC docket 80-286 in response to the Joint Board's request for comments regarding universal service and specifically the original BCM. In this testimony, when I refer to Sprint, I am talking about United Telephone Company of Florida and Central Telephone Company of Florida. I will refer to these companies' parent company as Sprint Corporation. The BCM was developed by Sprint Corporation, NYNEX, MCI and US West (joint sponsors) in response to the FCC's expressed interest in considering a model which develops "proxy" costs for the provision of basic telephone service at the CBG level. BCM 2 was filed with the FCC on July 3, 1996, for consideration in CC Docket 96-45 (Federal-State Joint Board On Universal Service).

Q. What is the purpose of BCM 2?

A. The purpose of BCM 2 is to identify those CBGs in which the cost of providing basic telephone service is so high that some form of explicit high-cost support may be necessary as part of a universal service solution at both the federal and individual state levels, including Florida. It is also a comparative tool to test the reasonableness of other costing mechanisms.

Q. What are the results of BCM 2?

A. BCM 2 produces a benchmark cost range for a defined set of basic residential telephone services assuming efficient engineering and design criteria and the deployment of current state-of-the-art transmission and switching technology. It uses the current national local exchange network topology. BCM 2 provides a benchmark measurement of the relative costs of serving customers residing in given areas such as a CBG.

Q. What does BCM 2 not do?

A. BCM 2 does not define the actual cost for any telephone company, nor the embedded cost that a company might experience in providing telephone service today. That is, it is a proxy for current engineering costs, developed from inputs such as loop distance, subscriber density, and the terrain characteristics that typically influence the investment and expenses of a carrier providing telephone facilities.

Q. Please define a Census Block Group (CBG).

A. A Census Block Group (CBG) is a geographic unit defined by the Bureau of the Census which ideally contains approximately 400 households. There are 9,087 CBGs in the State of Florida.

Q. Please define basic telephone service as it relates to the benchmark costs developed by BCM 2.

A. Basic telephone service is defined as voice grade access to the public switched network with the ability to place and receive calls, residential one party service, touch tone, a white page directory listing, and access to directory assistance, operator service, and emergency services, e.g., 911/E911.

Q. Please explain how monthly costs for basic telephone service are developed within BCM 2.

A. All cost calculations are derived in terms of efficient and state-of-the-art investment. The technology used in the model must be forward looking and actually in use today. In order to determine a monthly cost for basic local service by CBG, the individual investments for the piece parts must be summed to include loop and structure investments, electronic circuit equipment investments and switching investments. In order to determine a monthly cost for basic local service by CBG, BCM 2 uses both investment related expense factors and line related expense factors. The investment related factors are developed separately for three plant categories: cable and wire facilities, switching equipment, and circuit equipment. A separate annual cost factor is developed for line-related expenses. These factors are applied to investment or access lines, as appropriate, and the result is divided by 12 to estimate a monthly cost of basic local service.

Q. What are the three major steps of the BCM 2 process?

A. 1. Build the data input file to be used in the model.

Since CBGs consist of about 400 households, there are many times more CBGs than central offices. Each CBG is associated with the nearest central office using the distance between the centroid or geographical center of the CBG and the central office (CO) location from the Bellcore Local Exchange Routing Guide (LERG). The CBG is also assigned to a North, East, South, West quadrant based on the polar angle of the CBG from the CO. To the CO and CBG census data are added the terrain data from the U.S. Department of Agriculture Soil Conservation Service. This is accomplished using commercially available mapping programs. This results in a CBG specific data input file to load into the BCM 2 model.

2. Determine the appropriate feeder and distribution plant for the relative location of the CBGs.

The BCM assigns all CBGs in a quadrant to a single shared feeder and selects the appropriate loop technology for each CBG. The model then sizes and prices the feeder and distribution cables.

The appropriate placement costs are then developed.

This step uses U.S. government data for terrain and density to develop estimates of loop placement costs within the CBG.

3. Develop the appropriate switching costs.

This step develops the switching costs associated with serving each CBG.

IV. Methodology of BCM 2

Q. Have you prepared an exhibit that describes the methodology used in BCM 2 to develop proxy costs for basic exchange service?

A. Yes. It is attached to my testimony as Exhibit No. JDD-1.

Q. Does this conclude your testimony?

A. Yes.

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Benchmark Cost Model 2
Methodology

Introduction

The purpose of the model is to estimate a benchmark cost of providing basic local telephone service for both business and residence customers in small geographic areas for the entire U.S. and its territories. Small geographic areas are used because the cost of providing basic telephone service varies greatly even within the geographic unit of the wire center. Thus, the use of small geographic areas allow the model to identify specific areas which are high cost to serve because of the physical characteristics of the area.

The BCM2 assumes all plant is placed at a single point in time. All facilities are created as if the entire country is a new service area. Therefore, the BCM2 reflects the costs a telephone engineer faces installing new service to existing population centers.

BCM2 is a geographically-based high level engineering model of a hypothetical local network. The basic geographic units used by the model are Census Block Groups (CBGs), as designated by the U.S. Bureau of the Census. There are over 226,000 covering the entire U.S.[1] The basic data provided by the Census Bureau are the geographic boundaries of the CBG, the geographic center (centroid) of the CBG, and the number of households in the CBG. In addition to the Census data, terrain information from the U.S. Geologic Survey (U.S.G.S.) is developed by CBG. This information includes data which impacts the cost of placing telephone plant into service. The terrain data includes water table depth, depth to bedrock, hardness of the bedrock, surface soil texture, and the slope of the terrain. Another data item developed by CBG is an estimate of the number of business lines. This number is developed based on a third party data base of employees by CBG. These preceding items contain all the CBG characteristics necessary for input to BCM2.

The BCM2 starts with the existing central office locations throughout the country. The source of the central office locations is Bellcore's Local Exchange Routing Guide (LERG). This data is input into a geographic information system where each CBG is associated with the closest central office. Once all CBGs are associated with central office locations, this information plus the relative physical locations and CBG information are input to the BCM2. This basic input information allows the BCM2 to design a local exchange network utilizing a tree and branch topology.

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[1] BCM2 is capable of using any small geographic unit, such as a census block or the "grid". Utilized by the Cost Proxy Model (CPM) developed by Pacific Telesis and INDETEC.

BCM2 methodology is presented below in the following sections:

- Assumptions for Loop Technology
- Assumptions for Feeder Plant Architecture
- Assumptions for Distribution Plant Architecture
- Assumptions for Switch Technology
- Assumptions for Density
- Algorithms to Develop Basic Local Service Costs
- User Adjustable Inputs

Prior to addressing BCM2 methodology a brief description of the major model changes from the original BCM is provided in the following section.

Major Changes From BCM to BCM2

Based upon public comments and analyses of the BCM, a number of enhancements have been incorporated into BCM2. These enhancements are designed to more accurately reflect actual engineering practices in the development of a local exchange network. BCM2 includes all costs of basic local telephone service, whereas the BCM only included the major cost drivers that differentiated high cost and low cost areas. The major changes from BCM to BCM2 follow.

Population Distribution

The BCM2 rural CBG input data are modified by a Geographic Information System module to reduce the square mile area of the CBG to an area that reflects the clustering of households. This is done utilizing a third party road network database to identify the areas within the CBGs which have the highest probability of containing households. A 500 foot buffer is created on each side of roads in CBGs with 20 households per square mile or less. A new area is calculated by the buffer area. If road buffers overlap, the area is not double-counted.

Business Line Information

The BCM2 includes business lines, private line loops, as well as residential lines by CBG. State specific counts for reported business lines and private line loops are allocated to CBGs based on a third party data base of employees by CBG. Additional residential demand beyond a single line per household is included based on the national ratio of all residential lines reported in the end of year 1994 as a ratio of 1990 households.[2] The

[2] BCM2 has a user variable input for the number of lines per household. The default value is 1.2.

inclusion of these lines allows the realization of all economies of scale associated with loop plant within the wire center.

Engineering Assumptions

Additionally, there are four major areas where the engineering assumptions changed from BCM to BCM2: switching plant, distribution plant, feeder plant, and the placing of a cap on wireline loop investment.

The BCM2 switching module changes includes five switch sizes to more closely reflect the switch application. The new switch module uses the Local Exchange Routing Guide information for remote switch locations to place remote switches in the locations where they are currently installed. Additionally, stand alone switch sizes of up to 10,000 lines, 10,000 to 60,000 lines, 60,000 to 100,000 lines and over 100,000 lines are used.

The BCM2 distribution plant engineering has been altered to reflect the distribution demands of each CBG. Varying the distribution plant engineering assumptions in urban areas aligns the BCM2 engineering designs more closely with actual engineering practices in these areas. This is done by basing the number of distribution plant cable legs on the number of housing lots in each CBG. The original BCM utilized a simplifying assumption of a constant four distribution cables per CBG.

Another distribution plant enhancement is that no copper distribution distances exceed those specified by the user. The maximum copper distribution distance is a user input with a 12,000 foot default. The limitation of copper technology serving distance has the effect of producing multiple distribution areas within rural CBGs, which in effect extends the feeder plant facilities into the CBG. This change also aligns BCM2 more closely with actual engineering practices. The original BCM assumed all plant within the CBG was copper distribution plant and that there would always be four distribution cables.

Two other areas of distribution plant engineering changes are driven by high concentrations of business lines in a CBG. The first change is that if a CBG line count exceeds 2,016, a variable percentage of lines will be terminated at the DS1 level to reflect costs of providing service to digital PBXs and providing wideband private line services. This is a user variable input. Additionally, if line demand for a single CBG exceeds the capacity of a maximum size copper cable, fiber will be deployed to the CBG regardless of the distance.

The third major area of engineering assumption change is that the costs for feeder plant digital loop carrier (DLC) systems reflect the fixed and variable nature of the costs. This ensures that the cost for DLC equipment properly reflects the effects of the equipment loading in each CBG. This is an important change since there can now be multiple remote terminals within a CBG for two reasons. First, the inclusion of business lines can cause the line demand to exceed that which can be provided by a single remote terminal. Second, the maximum copper distribution distance can cause the deployment of multiple remote terminals.

The final major area of change is the assumption that an alternative wireless loop technology is utilized for loops requiring investment levels in excess of the cost of an alternative wireless technology. Based upon ongoing trials, a value of $10,000 per loop is used in BCM2.

Other Enhancements

There are a number of other enhancements included in the BCM2. The BCM2 includes costs of the local loop not previously reflected in the original BCM[3], slope data is included in the BCM2 input data, and new variables that impact structure costs are available for future use. Another area of change provides separate annual cost factors for cost items that are plant related and a separate annual cost factor for line-related expenses. Three separate plant related factors are utilized for cable and wire facility investment, circuit equipment investment, and switch equipment investment.

Model Methods

Assumptions for Loop Technology

Feeder cable (cable placed so that it can be supplemented at a later date) is deployed as analog copper plant where the total loop distance is less than the user-specified maximum copper cable length.[4] If the loop distance exceeds the maximum loop distance value, fiber feeder plant is deployed. Fiber Feeder may extend into the CBG to maintain the maximum copper distribution cable distance.

Distribution plant may contain analog copper technology when terminating signals at a voice grade level, or may utilize fiber loop technology or digital

[3] BCM2 includes costs for the pedestal, drop wire, network interface device, in-line terminals, splicing and engineering.
[4] The user may specify maximum copper distances of 9,000 feet, 12,000 feet, 15,000 feet, or 18,000 feet.

carrier on copper, when terminations are made at the DS1 signal level for a percentage of business lines.

BCM2 uses two types of DLC equipment depending on the number of lines needed at each remote terminal location. For a remote terminal requiring line capacities greater than 240 lines, Lucent Technologies SLC Series 2000 equipment is used. For remote terminal requiring 240 lines or less capacity, Advanced Fiber Communications equipment is used. Both products are deployed in drop/add configurations, with SLC having a total capacity of 2,016 voice grade channels per four fibers and AFC having a total capacity of 672 voice grade channels per four fibers.

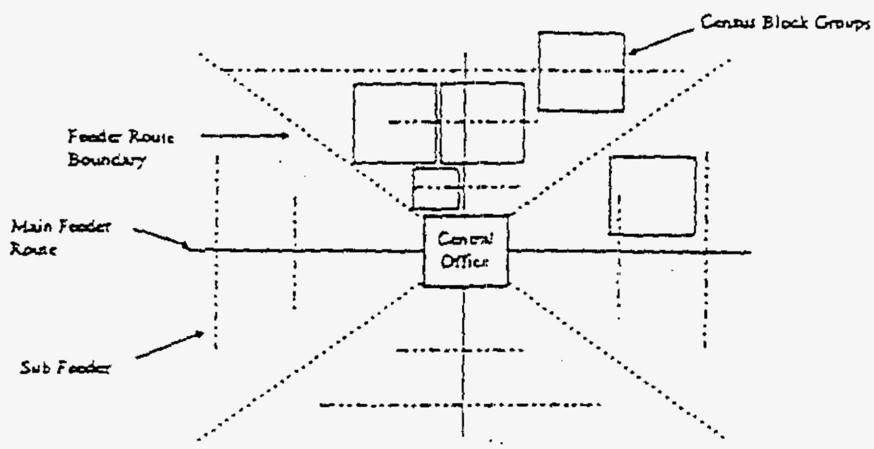
Assumptions for Feeder Plant Architecture

Feeder plant uses a tree and branch topology, with plant routes intersecting at right angles. Each feeder cable begins at the central office and generally ends at a terminal at the edge of a CBG. However, fiber feeder may extend into the CBG to ensure that the user specified maximum copper cable length is not exceeded.

Four main feeder routes leave each central office[5]: directly East (quadrant 1); directly North (quadrant 2); directly West (quadrant 3) and directly South (quadrant 4). The feeder route boundaries are at 45 degree angles to the main feeder routes.

[5] A central office may have less than four feeder routes if no CBGs are located within a feeder quadrant.

Feeder Plant Architecture



Both copper and fiber feeder cables share the structure and placement costs in the main feeder systems. As the main feeder routes move away from the central office and deploy cable capacity to the CBGs, the feeder cables taper in size to the capacity necessary for each individual segment.

Copper feeder cables range in size from 25 pair cable to 4,200 pair cable, while fiber feeder cable sizes range from 12 strand cable up to 144 strand cable. Feeder plant costs include the material cost of cable and electronics, as well as the capitalized cost of structure and placing the cable, electronics costs at the central office and remote terminals, as well as costs of in-line terminals, splicing and engineering.

Assumptions for Distribution Plant Architecture

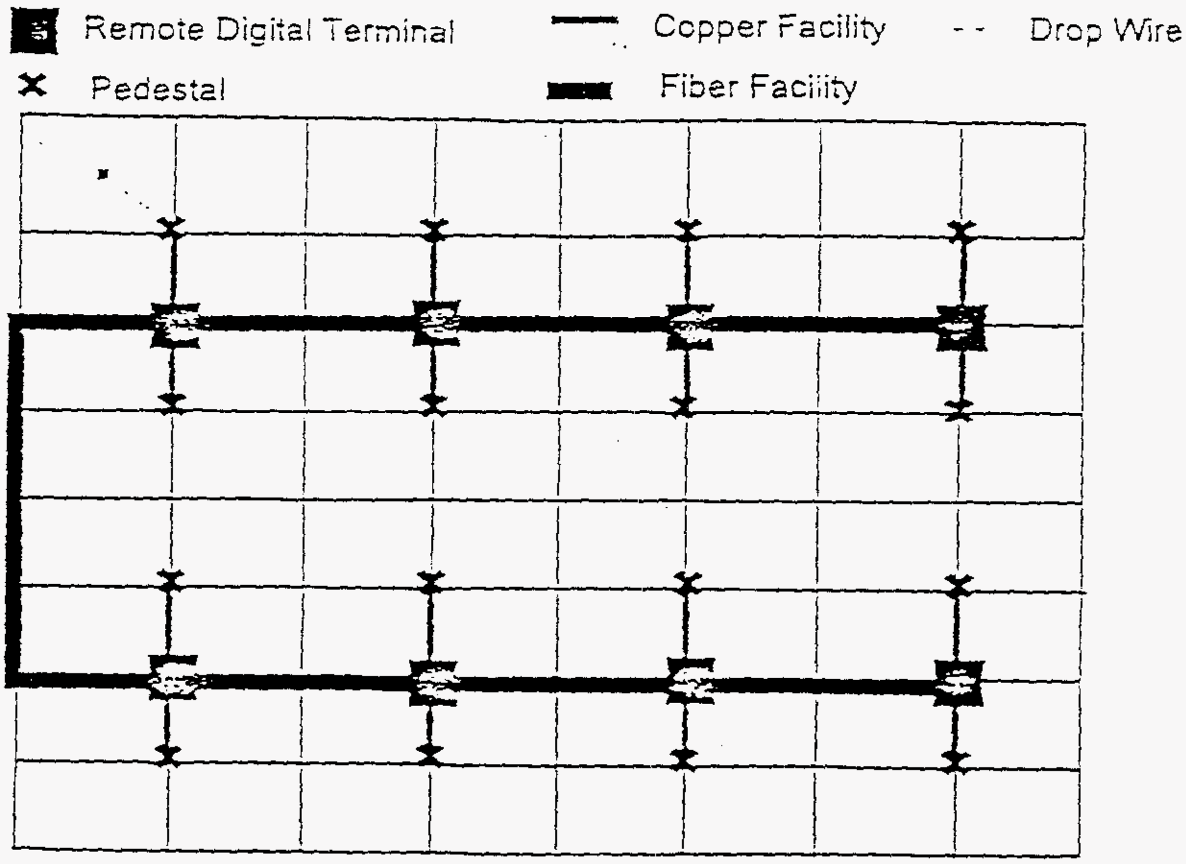
The BCM2 assumes that all households within a CBG are uniformly distributed. In rural areas, the CBG area input data has been reduced reflecting the removal of areas that do not have road access.

Distribution cable begins at the end of the feeder cable and continues to the customer premise. The distribution plant is designed to reach all households in the CBG through the placing of cables between subdivision lot lines.

BCM2 more precisely designs distribution plant for each CBG to ensure cables pass by each premise. The number of distribution cables may be as few as one for a small CBG to 20 or more cables in more densely populated CBGs.

In larger rural CBGs, it may be necessary to extend the fiber feeder into the CBG itself to maintain copper cable lengths less than the user specified maximum. An example of fiber extending into the CBG is displayed below.

Example of Distribution Plant With Fiber



Investments for distribution plant include the material cost of the cable and its cost of structure, as well as the network interface device, the drop wire, the pedestal, in-line terminals, digital terminals, splicing and engineering. Distribution cable sizes range from 12 pair cable to 3600 pair cable.

Since business lines are now included by CBG, the BCM2 distribution architecture uses fiber distribution cable in very dense CBGs that require larger cable capacity than a maximum size copper distribution cable. Additionally, BCM2 terminates a percentage of the lines in these dense CBGs at a digital DS-1 signal level, since a percentage of businesses have digital PBXs or wideband services that utilize such capacity.

Assumptions for Switch Technology

The BCM2 uses five different size generic digital switches for calculating switch investments. Using Bellcore's LERG information, a switch is designated as a remote switch or a stand-alone switch. Stand alone switches are split by line size grouping: up to 10,000 lines; 10,000 lines to 60,000 lines, 60,000 lines to 100,000, and over 100,000 lines. Each size switch has a unique fixed or start up cost and a unique per line cost. The start up cost includes central processor frames, billing and data recording equipment and frames, miscellaneous power equipment and back-up power, the main distribution frame, frames for testing, and basic software.

Assumptions for Density

CBG densities are calculated in a three step process. First, the business lines are divided by a user input density adjustment. The default value for the density adjustment is 10 business lines occupying the physical space of one household line. In the second step, the adjusted business lines are summed with the CBG households. Finally, this sum is divided by the square miles of the CBG. This insures that the proper density characteristics are assigned to the CBG.

The BCM2 uses six different density groups to determine characteristics of the plant being used. The six density groups are as follows:

- 0 < and <= 5
- 5 < and <= 200
- 200 < and < 650
- 650 < and <= 850
- 850 < and <= 2,550
- \> 2,550

The density groups determine the mixture of aerial and below ground plant, feeder fill factors, distribution fill factors, and the mix of activities in placing plant and the cost per foot to place plant. These are all user adjustable inputs.

Terrain Assumptions

U.S.G.S. data for four terrain characteristics that impact the structure and placing cost of telephone plant are included as inputs to BCM2 by CBG. These terrain variables include depth to water table, depth to bedrock, hardness of bedrock, and the surface soil texture. Combinations of these characteristics determine one of four placement cost levels. The normal placement cost for a density group occurs when neither the water table depth nor the depth to bedrock is within the placement depth for the cable and the surface soil texture does not interfere with plowing activities. The next higher level of placing cost occurs when either the surface soil texture does interfere with normal plowing activities or soft bedrock is within the cable placement depth. The third level of placing difficulty occurs when hard bedrock is within the placement depth of copper cable or fiber cable. The last level of placement cost difficulty occurs when the water table is present within the placing depth of copper or fiber cable.

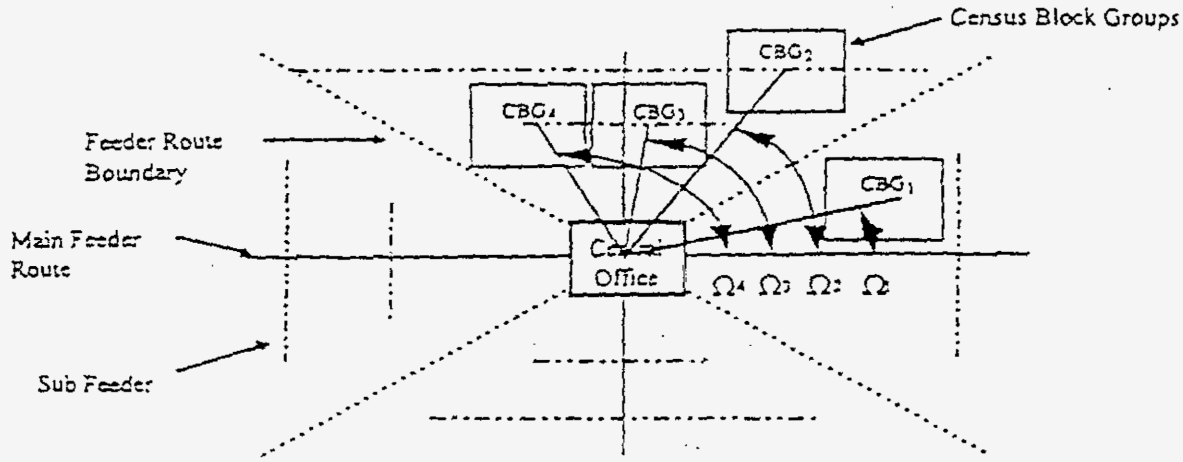
Algorithms to Develop Basic Local Service Costs

Feeder Plant Distance

Typically, each LEC central office has four main feeder routes, radiating out from the central office (BCM2 uses an East, a North, a West, and a South main feeder routes). Branching off from the main feeders are sub-feeders, typically at right angles to the main feeder, giving rise to the familiar tree and branch topology of feeder routes. Subscribers or homes are somewhat randomly spread within the route serving areas. The routes become less densely populated as the distance from the central office increases.

The geographic centers (centroids) of the CBGs may fall in any of the four feeder route serving areas. In order to determine on which of the four main feeder routes (or quadrants) a CBG is served, an angle Ω is calculated. The angle Ω represents the counter-clockwise rotational angle between a line connecting the CBG with the closest central office and a line headed directly east from the central office. This is displayed in the figure below.

Determination of Feeder Quadrant



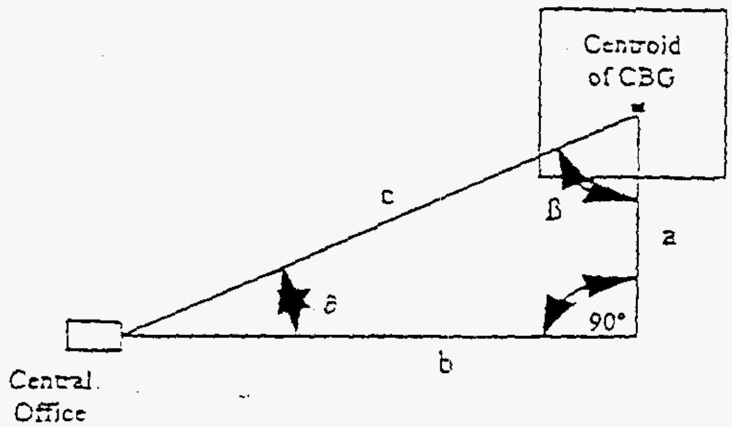
The relationship between the angle Ω and the feeder route is found in the table below:

East Feeder Route (Quadrant 1)	315°	<=	45°
North Feeder Route (Quadrant 2)	45°	<=	135°
West Feeder Route (Quadrant 3)	135°	<=	225°
South Feeder Route (Quadrant 4)	225°	=	315°

To estimate feeder plant costs for a given CBG, the length of the feeder cable from the closest central office to the CBG is approximated. For purposes of simplification, it is assumed that each CBG is square in shape, with the households within the CBG distributed uniformly. As discussed, in CBGs with less than 20 households per square mile, CBG area is reduced to eliminate non-populated areas. Additionally, it is assumed that sub-feeder cable generally ends at the edge of the CBG, unless the CBG boundary overlaps the main feeder route, in which case no sub-feeder plant is used. Thus, calculating the feeder distance becomes a two-step process.

First, an airline distance is calculated using the latitude and longitude of the closest central office and the latitude and longitude of the centroid of the CBG. Next, the airline distance is converted to an equivalent feeder plant route length. This conversion becomes a simple mathematical model.

Feeder Distance Calculation



Airline distance between the central office and CBG centroid = Line c

Angle between Main Feeder Route (Line b) and Line c = α

Main Feeder Route Distance to CBG = Line b = c* cos α

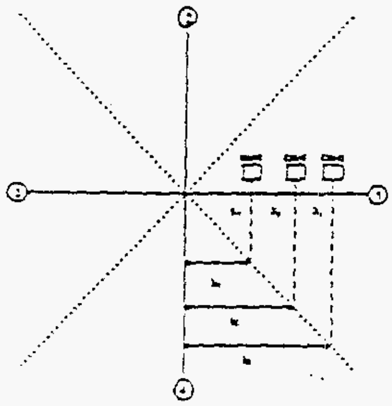
Sub-feeder route distance is calculated in a similar manner, however, the sub-feeder does not extend into the CBG.

The preceding distance calculations may be increased if the minimum or maximum slope measurements for a CBG reach the trigger values. If the slope is greater than the trigger value, then the feeder and sub-feeder distance are increased by a user specified factor.

Shared Feeder Plant Distance

CBGs that are served along a common feeder route share feeder facilities. The BCM2 calculates the distances for the shared feeder segments by calculating the Line b distance described above for each CBG in a quadrant. Once the Line b distances are calculated, the model sorts the CBG data first by central office, then by quadrant, and finally by Line b distance. An example of three CBGs in main feeder quadrant 1 is shown below.

SHARED FEEDER DISTANCE CALCULATION



In this example, there are three feeder segments in quadrant 1, main feeder segment X_1, main feeder segment X_2, and main feeder segment X_3. The formula for calculating the feeder segment distance is:

For n (the number of CBGs within a quadrant) > 1,

Main feeder segment $X_n = b_n - b_{n-1}$

The total feeder distance for a CBG is the sum of main feeder distance and sub-feeder distance.

Cable Capacity and Material Investments for Shared Feeder Plant

The required capacity of a segment of copper feeder plant is determined by the sum of the lines of all CBGs utilizing that particular segment and copper technology. Next, the sum of these lines is divided by the fill factor for the density group associated with the segment. This calculation yields the copper cable capacity required for the segment. The BCM2 then "looks up" the cable capacity in a table to determine the actual cable size available (and its associated cost per foot) to meet the segment capacity. If the required capacity is greater than the size of the largest available cable, the BCM2 determines the number of maximum size cables and the next size cable to meet the capacity needs of the segment. The copper feeder cable sizes available in the model are 25, 50, 100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, 3600, and 4200 pair.

The required capacity for a segment of fiber feeder plant is determined in a similar manner, however, SLC technology and AFC technology cannot share fiber strands because of differing transmission parameters. For SLC systems, four fibers can carry up to 2,016 voice grade paths. If the segment capacity exceeds this limit, four additional fibers are required for each increment of 2,016 voice grade paths. For AFC systems, four fibers can carry up to 672 voice grade paths. Like SLC, each additional increment of 672 voice grade paths capacity requires an additional four fibers. The voice grade paths are determined by technology by summing the lines by CBG utilizing the particular technology and dividing the sum by the fill factor associated with the density group of the feeder segment.

The total capacity for a fiber feeder segment is the sum of the required SLC fiber strands and required AFC fiber strands. The BCM2 determines the number of maximum size fiber cables and the size of the additional fiber cable to meet the capacity needs of the segment. The fiber feeder cable sizes available in the model are 12, 18, 24, 36, 48, 60, 72, 96, and 144 strands.

Once each feeder segment's cable size and cost per foot is determined, a total material cost is calculated for the segment. This calculation is the material cost per foot multiplied by the number of feet of the feeder segment. Each CBG that utilizes the segment facilities shares the material cost on an equal cost per unit (per line).

Distribution Plant Distances

The design of the plant within a CBG is dependent upon the number of square miles within the CBG, as well as the number of households served within the CBG. First, the CBG is checked to determine if the width of the CBG is greater than twice the maximum copper serving distance (specified by the user). If the width is greater, then the appropriate number of feeder-type legs will be extended into the CBG to sub-divide the area into multiple distribution areas.

The vertical distribution distance per feeder-type leg within the CBG is calculated as width of the CBG divided by the number of feeder-type legs, less two base lot side lengths. The horizontal serving distances for copper facilities within the CBG are calculated as the maximum copper serving distance less one-half the width of the CBG and one base lot side length. However, if the horizontal distances are so large as to require the use of remote terminals on the horizontal legs then the horizontal copper facility distance is calculated as one half the number of base lots between remote terminals multiplied by the base lot side length. Fiber is deployed into the horizontal plant legs when remote terminals are used. In this case, the horizontal plant length is calculated as the width of the CBG, less the distance between remote terminals, less a base side lot length.

Cable Capacity and Material Investments for Distribution Plant

Copper cable and fiber cable capacities for distribution plant are determined in a similar manner as feeder plant. However, distribution plant only provides capacity to serve lines within the CBG. Thus, for distribution plant each of the horizontal plant legs serves an equal portion of the CBG line capacity as do the vertical legs. As with feeder plant the cable sizes (and their cost per foot) deployed by the model are determined by utilizing a "look up" table of the number of lines served by each cable leg (done separately for horizontal and vertical cables) divided by the fill factor for the CBG's specific density group.). The copper distribution cable sizes available in the model are 12, 25, 50,100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, and 3600 pair. The fiber distribution cable sizes available in the model are 12, 18, 24, 36, 48, 60, 72, 96, and 144 strands.

The total distribution cable material investment is calculated as follows for both copper cable and fiber cable:

Distribution Cable Investment = Number of Horizontal Distribution Legs * Horizontal Distribution Distance * Horizontal Cable Cost Per Foot + Number of Vertical Distribution Legs * Vertical Distribution Distance * Vertical Cable Cost Per Foot

Structure and Placement Costs

Structure and the cost of placing plant include the costs of poles, conduit, innerduct, etc., and the capitalized costs of installing cable and wire facilities plant. The BCM2 uses a cost per foot for structure that varies by plant type, terrain, and density group. It represents the cost of structure and placing the smallest size cables. Each density group and terrain difficulty reflects a different mix of placing activities and structures. The basic structure calculations are done outside the BCM2. Following is an example of the calculations for below ground plant for the three different levels of terrain difficulty associated with the 650 to 850 Households per Sq. Mi. density group.

		650-850 Normal	
Activity	$/FT	% of Activity	
Plow	0.7		$ -
Rocky Plow	1.15		$ -
Trench & Backfill	1.95	25.00%	$ 0.49
Rocky Trench	2.23		$ -
Backhoe Trench	2.04	5.00%	$ 0.10
Hand Dig Trench	2.23	5.00%	$ 0.11
Bore Cable	12.12	20.00%	$ 2.42
Push Pipe & Pull Cable	9.8	5.00%	$ 0.49
Cut & Restore Asphalt	8.23	10.00%	$ 0.82
Cut & Restore Concrete	10.84	10.00%	$ 1.08
Cut & Restore Sod	2.06	20.00%	$ 0.41
		100.00%	$ 5.93
Conduit	40	0.50%	$ 0.20
			6.13

Activity	$/FT	650-850 Rock Soft	
		% of Activity	
Plow	0.7		$ -
Rocky Plow	1.15		$ -
Trench & Backfill	1.95		$ -
Rocky Trench	2.23	25.00%	$ 0.56
Backhoe Trench	2.04	5.00%	$ 0.10
Hand Dig Trench	2.23	5.00%	$ 0.11
Bore Cable	12.12	20.00%	$ 2.42
Push Pipe & Pull Cable	9.8	5.00%	$ 0.49
Cut & Restore Asphalt	14.23	10.00%	$ 1.42
Cut & Restore Concrete	16.84	10.00%	$ 1.68
Cut & Restore Sod	4.1	20.00%	$ 0.82
		100.00%	$ 7.61
Conduit	40	0.50%	$ 0.20
			7.81

Activity	$/FT	650-850 Rock Hard	
		% of Activity	
Plow	0.7		$ -
Rocky Plow	1.15		$ -
Trench & Backfill	1.95	5.00%	$ 0.10
Rocky Trench	10.23		$ -
Backhoe Trench	2.04		$ -
Hand Dig Trench	10.23	25.00%	$ 2.56
Bore Cable	12.12	10.00%	$ 1.21
Push Pipe & Pull Cable	14.8	10.00%	$ 1.48
Cut & Restore Asphalt	16.5	25.00%	$ 4.13
Cut & Restore Concrete	19.2	25.00%	$ 4.80
Cut & Restore Sod	11.15		$ -
		100.00%	$ 14.27
Conduit	40	0.60%	$ 0.24
			14.51

The tables above display the development of a weighted cost per foot for below ground structure. The first column shows the activity. The second column displays the cost per foot of the activity in that row. The cost per foot data used as the default values in the BCM2 are based on a national average of available contractor prices for that activity. The third column displays the percent of the activity in the specific density group and terrain difficulty. The final column represents the multiplication of the cost per foot and the percent occurrence of the activity. The final weighted average above is the sum of specific activity prices times the percent occurrence.

The Cost Factor Table in the BCM2 includes a weighted average structure cost per foot for below ground plant and aerial plant. This table includes separate entries for distribution plant, copper feeder plant, and fiber feeder plant by density group by terrain difficulty. Structure costs are adjusted for cable size in the structure cost calculations. As copper cable sizes increase, there are additional handling costs because each cable reel holds less cable. The BCM2 structure costs recognizes these additional handling costs separately for three copper cable size groupings: 600 - 900 pair, 1200 pair, and 1800 pair and above. Additional handling costs for fiber cables are less pronounced and only occur with fiber cables of 72 fiber strands or more. The final element of the structure and placement cost is the cost to pull the largest size cables through conduit. The structure cost calculation follows:

Structure Cost = Density Group Terrain Specific Cost Per Foot * Cable Length * Cable Size Factor + Number of Maximum Size Cables * Cost Per Foot to Pull Underground Cable Through Conduit

Switch Equipment Investments

Switching investments are calculated based on current central office locations as reported in the LERG. Investments are calculated using generic digital switch investments for five sizes of switch. The BCM2 categorizes the switch at each location either as a remote (if designated as a remote switch in the LERG) or by the number of CBG lines, both residence and business associated with the switch location. The total switching plus interoffice investment per line is calculated as follows:

Location Specific Fixed Costs Per Line =

((Fixed Cost for Specific Remote/Line Size) * (NTS % of Switch + (1 - NTS % of Switch) * (% Local DEM)) / Lines at Location

Total Switch and Inter-Office Investment Per Line =

Land & Building Factor * Switch Equip Discount * Switch Engineering Factor * Switch InterOffice Investment Ratio * (Fixed Switch Cost Per Line + Switch Size Specific Per Line Cost)

Circuit Equipment Investments

The BCM2 uses SLC and AFC digital loop carrier equipment investments split between the fixed costs of the remote terminal and digital loop carrier costs that vary by line. The fixed remote terminal costs include the optical line interface units, software, cabinet, power, and the access resource manager common card kit. The per line component includes the line card and shelves at the remote terminal, as well as all the components of the central office terminal.

The circuit equipment investments by CBG are developed through the use of a "look up" table which provides the appropriate fixed terminal cost for the number of lines using the terminal, as well as the cost per line for the individual terminal size. When these investments are found in the table, the discount factor is applied, as well as the engineering and installation factor.

Annual Cost Factors

Throughout the BCM2 process, all cost calculations are derived in terms of investment. In order to determine a monthly cost for basic local service by CBG, the BCM2 uses both investment related expense factors and line related expense factors.

The investment related factors are developed separately for three plant categories: cable and wire facilities, switching equipment, and circuit equipment. For each of these three investment categories, 1995 ARMIS data is used to derive the historical ratio of certain investment related expenses to the gross investment for the plant category. The expense categories include:

- Return on Investment at 11.25 %
- FIT, State, and Local Taxes
- Plant Specific Expenses
- Plant Non-Specific Expenses
- Depreciation/Amortization

Using national 1995 ARMIS data the historical booked expenses were developed. Thus, the factors reflect the historical maintenance expense to investment relationship as well as regulatory-approved depreciation lives. These factors are user adjustable. The BCM2 default values for the three plant category annual cost factors are:

Cable & Wire	.23276
Circuit Equipment	.24241
Switching Equipment	.25703

The expenses that vary based on the number of lines includes customer operations - marketing, customer operations - services, corporate operations, and other depreciation/amortization. This cost per line is also developed from 1995 ARMIS. This annual cost per line is $133.39. The BCM2 uses an allocation factor to associate non-plant related expenses to local service. Both the annual cost per line and the allocation factor are user adjustable. The BCM2 default value for the allocation factor is .75.

User Adjustable Inputs

Nearly all the variables included in the BCM2 are user adjustable. U S WEST and Sprint have set default values for the inputs at levels that they feel represent forward-looking practices for the deployment of basic local telephone service. Attachment A is a map of the User Inputs and Tables. This map indicates where specific input tables are located on the Input Tables worksheet.

Below are listed the BCM2's user inputs. Following the user input list are user adjustable tables used in the calculations of investments.

USER INPUTS TO MODEL

Variable	Value	Description
NormalUGDepth	24	Normal Placement Depth in inches for Buried/Underground Copper Cable
NormalFiberDepth	36	Normal Placement Depth in inches for Buried/Underground Fiber
CriticalWaterDepth	3	Depth in feet at which water impacts placement costs
WaterFactor	50	% Cost increase for presence of water within critical depth
ResLinesMultiplier	1.21	Residence Lines per household multiplier
MaxFiberSize	144	Maximum Fiber Cable Size
MaxFeederSize	4200	Maximum Copper Feeder Cable Size
Max DistSize	3600	Maximum Copper Distribution Cable Size
CprMaxDist	12000	Maximum length of copper cable in the CBG distribution area
NewTerrainTrigger	5	Value that triggers new terrain variable multiplier
NewTerrainFactor	1	Cost multiplier when new terrain variable exceeds trigger point
MinSlopeTrigger	12	Point at which minimum slope effects placement distance

MinSlopeFactor	1.1	Change in distance due to increased average slope
MaxSlopeTrigger	30	Point where presence of very high slope causes yet more cable distance
MaxSlopeFactor	1.05	Change in distance due to a maximum only slope presence
CombSlopeFactor	1.2	Secondary change in distance due to substantial slope presence
EngrInstall	35	Engineering and installation loading factor for electronics
ElectronicFill	0.85	Fill Factors for Electronics
HiCapFill	0.95	Fill Factors for High Capacity Optic Multiplexers
SpecAccRatio	0.13	Ratio of Special Access Lines to Business and Special Access
DensAdjUnits	10	Average Number of Business lines per location
OpticsCost	162000	Average cost for each DS-3 for CO and field DS3 to DS1 multiplexers
CopperT1	1133	Average Cost per DS-1 on copper (both terminals & repeater)
InterofficeSwRatio	1.03	Multiplier to add interoffice trunking cost
	20	Digital Switching Discount % (Enter whole %)
	20	Fiber Cable Discount % (Enter whole %)
	20	Copper Cable Discount % (Enter whole %)
	10	AFC Electronics Discount % (Enter whole %)
	20	SLC Electronics Discount % (Enter whole %)
DropCostPerFoot	0.1	Drop Cost per FT
PedestalCost	48.22	Cost of Pedestal
NidCost	30	Cost per NID
Input Variables for switching and overheads[1]		
SwitchEngrFactor	1.07	Loading Factor for Switch Engineering
SwitchFillFactor	0.8	Switch Fill Factor
SwLandBldgFactor	1.043	Sw Land & Building Factor
NonTrfSen	70.00%	% Non Traffic Sensitive (Enter as decimal)
TrfSen	73.93%	% of Traffic Sensitive that is local (Enter as decimal)
OSPEngrFactor	1.05	Loading Factor for Outside Plant Engineering
FiberSpliceRatio	0.045	Loading Factor for splicing of fiber cable (Enter as decimal)
FiberInLineRatio	0.07	Additive for in line pedestals, cross connects, etc. (fiber)
CopperSpliceRatio	0.07	Loading Factor for splicing of copper cable (Enter as decimal)
CopperInLineRatio	0.1	Additive for in line pedestals, cross connects, etc. (Copper)
CableWireFactor1	0.23276	Factor 1 for cable & Wire Facilities
ElectronicsFactor1	0.24241	Factor 1 for circuit Facilities
SwitchingFactor1	0.25703	Factor 1 for Switching facilities
OtherFactor1	133.391	Factor 1 for other loading per line served
OtherAllocRatio1	0.75	Allocation Factor 1 applied to non-plant related expenses

CableWireFactor2	0.23276	Factor 2 for cable & Wire Facilities
ElectronicsFactor2	0.24241	Factor 2 for circuit Facilities
SwitchingFactor2	0.25703	Factor 2 for Switching facilities
OtherFactor2	133.391	Factor 2 for other loading per line served
OtherAllocRatio2	0.45	Allocation Factor 2 applied to non-plant related expenses
CprSizeFctr1	1.2	Structure Cost multiplier for cables 401 to 900 pr versus < 400 pr
CprSizeFctr2	1.3	Structure Cost multiplier for cables 901 to 1500 pr versus < 400 pr
CprSizeFctr3	1.4	Structure Cost multiplier for cables 1501 to max size versus < 400 pr
FbrSizeFctr	1.2	Structure Cost Multiplier for fiber cables >60 fibers versus < 60 fibers
UGPullCost	0.77	Cost per ft to pull UG cables into conduit duct

Miscellaneous Calculations (Do not change any value!)		
AfcDiscount	0.9	AFC Pricing ratio after Discount
SlcDiscount	0.8	SLC Pricing ratio after Discount
FiberCostRatio	0.8	Fiber cable cost factor
CopperCostRatio	0.8	Copper Cable Cost factor
SwitchingCostRatio	0.8	Digital Switching cost ratio after discount
OptionalBenchMark		Optional Benchmark to replace 80
LoopInvCap	10000	Loop Investment Cap
Breakpoint	12000	Fiber/Copper breakpoint

Miscellaneous Notes

1. Switching costs are entered as a fixed cost per switch plus the per line additive. Both costs must be included to accurately reflect switching costs. The fixed cost will be converted to a per line cost and added to the per line additive to determine final switching cost per line. Costs are in the switch cost matrix above and to the right. The % Non traffic sensitive is applied to the fixed cost portion of the switch.

TABLES

Surface Type	
RockH	=Hard rock above plowing depth - requires dynamite or rock saw to place
RockS	=Soft rock above plowing depth - requires more costly trenching, backhoeing, etc.
Normal	=Straight plowing with minimal surface impact

Urban Copper Cable Table		
Cost Multiplier		
Structure	Below Ground $	Aerial $

Urban Fiber Table		
Cost Multiplier		
Structure	Below Ground $	Aerial $

RockH		20.84	14.18
RockS		13.92	10.59
Normal		10.7	7.62

Rural Copper Cable Table		
Cost Multiplier		
Structure	Below Ground $	Aerial $
RockH	13.59	8.07
RockS	5.76	5.86
Normal	2.92	4.08

Distribution UG/Aerial Mix Table		
Density	Below Ground %	Aerial%
0-5	90	10
5-200	80	20
200-650	70	30
650-850	70	30
850-2550	80	20
>2550	90	10

Fiber Feeder UG/Aerial Mix Table		
Density	Below Ground %	Aerial%
0-5	95	5
5-200	85	15
200-650	70	30
650-850	70	30
850-2550	80	20
>2550	90	10

RockH		20.84	14.18
RockS		13.92	10.59
Normal		10.7	7.62

Rural Fiber Table		
Cost Multiplier		
Structure	Below Ground $	Aerial $
RockH	13.59	8.07
RockS	5.76	5.86
Normal	2.92	4.08

Copper Feeder UG/Aerial Mix Table		
Density	Below Ground %	Aerial%
0-5	70	30
5-200	72	28
200-650	75	25
650-850	75	25
850-2550	80	20
>2550	90	10

Density/Fill Table

Density	Feeder	Distribution	
0	0.75	0.4	4
5	0.8	0.45	5
200	0.8	0.55	6
650	0.85	0.65	7
850	0.85	0.75	8
2550	0.85	0.8	9

StructureAllocationTable		
Cable Size	Cable Structure %	Fiber Structure %
0	50	50
200	55	45
900	60	40
2400	65	35
4200	75	25

Cost for AFC/SLC 200/LightSpan equipment		
DigitalCarrierCost	(Non-discounted material cost only)	
0	7700	250
48	8500	250
120	10500	250
240	77330	184
672	94909	184
1334	105409	184

CO Switch Size Table
COSwitchSize
500000
100000
60000
10000

CO Switch Cost Table		
COSwitchCost	Fixed/Startup $	Per Line $
Remote	250000	100
10000	400000	100
60000	600000	100
100000	900000	100
500000	1500000	100

Voice Grade Ratio Table				
# switched lines in CBG	% switched to VG	% switched to DS1	% special to VG	% special to DS1
0	1	0	1	0
2016	0.65	0.35	0.5	0.5
10000	0.5	0.5	0.3	0.7
20000	0.75	0.25	0.1	0.9

Distribution Cable Size Table		DISTRIBUTION CABLE COST							
Cable Distr Cost	Cable Size	Cost UG/Brd	Cost Aerial	Density= 0-5	Density= 5-200	Density= 200-650	Density= 650-850	Density= 850-2550	Density >2550
	3600	22.20	21.90	17.74	17.71	17.69	17.69	17.71	17.74
	3000	18.80	18.50	15.02	14.99	14.97	14.97	14.99	15.02
	2400	14.30	14.10	11.42	11.41	11.39	11.39	11.41	11.42
	1800	12.44	12.24	9.94	9.92	9.90	9.90	9.92	9.94
	1200	10.68	10.00	8.49	8.43	8.38	8.38	8.43	8.49
	900	7.82	7.51	6.23	6.21	6.18	6.18	6.21	6.23
	600	7.13	7.05	5.70	5.69	5.69	5.69	5.69	5.70
	400	4.62	4.56	3.69	3.68	3.68	3.68	3.68	3.69
	200	2.36	2.33	1.89	1.89	1.88	1.88	1.89	1.89
	100	1.27	1.26	1.01	1.01	1.01	1.01	1.01	1.01
	50	0.68	0.67	0.54	0.54	0.54	0.54	0.54	0.54
	25	0.37	0.36	0.29	0.29	0.29	0.29	0.29	0.29
	18	0.32	0.31	0.26	0.25	0.25	0.25	0.25	0.26
	12	0.28	0.28	0.22	0.22	0.22	0.22	0.22	0.22

Feeder Cable Size Table		COPPER FEEDER COST							
FeederCableCost	Cable Size	Cost UG/Brd	Cost Aerial	Density= 0-5	Density= 5-200	Density= 200-650	Density= 650-850	Density= 850-2550	Density >2550
	4200	25.70	25.40	20.49	20.49	20.50	20.50	20.51	20.54
	3600	22.20	21.90	17.69	17.69	17.70	17.70	17.71	17.74
	3000	18.80	18.50	14.97	14.97	14.98	14.98	14.99	15.02
	2400	14.30	14.10	11.39	11.40	11.40	11.40	11.41	11.42
	1800	12.44	12.24	9.90	9.91	9.91	9.91	9.92	9.94
	1200	10.68	10.00	8.38	8.39	8.41	8.41	8.44	8.49
	900	7.82	7.51	6.18	6.19	6.19	6.19	6.21	6.23
	600	7.13	7.05	5.68	5.69	5.69	5.69	5.69	5.70
	400	4.62	4.56	3.68	3.68	3.68	3.68	3.68	3.69
	200	2.36	2.33	1.88	1.88	1.88	1.88	1.88	1.89
	100	1.27	1.26	1.01	1.01	1.01	1.01	1.01	1.01
	50	0.68	0.67	0.54	0.54	0.54	0.54	0.54	0.54
	25	0.37	0.36	0.29	0.29	0.29	0.29	0.29	0.29

Fiber Cable Cost Table		FIBER CABLE COST							
Fiber Cable Cost	Cable Size	Cost UG/Brd	Cost Aerial	Density= 0-5	Density= 5-200	Density= 200-650	Density= 650-850	Density= 850-2550	Density >2550
	144	5.56	5.24	4.44	4.41	4.37	4.37	4.40	4.42
	96	3.80	3.53	3.03	3.01	2.98	2.98	3.00	3.02
	72	2.84	2.65	2.26	2.25	2.23	2.23	2.24	2.26
	60	2.41	2.23	1.92	1.91	1.88	1.88	1.90	1.91
	48	1.98	1.84	1.58	1.57	1.55	1.55	1.56	1.57
	36	1.60	1.46	1.27	1.26	1.25	1.25	1.26	1.27
	24	1.18	1.05	0.94	0.93	0.91	0.91	0.92	0.93
	18	0.98	0.85	0.78	0.77	0.75	0.75	0.76	0.77
	12	0.79	0.66	0.63	0.62	0.60	0.60	0.61	0.62

CostFactorTable

Row #	Plant Type	Urban/ RuraL	Density	Surface Category	Weighted Cost Factor	Below Ground Density Adjustment	Aerial Density Adjustment
1	Distribution	Urban	>2550	RockH	23.59262	1.18	1.03
2				RockS	17.56779	1.30	1.21
3				Normal	13.31148	1.30	1.04
4	Distribution	Urban	850-2550	RockH	16.58868	0.83	0.97
5				RockS	10.07238	0.72	0.97
6				Normal	7.62624	0.72	0.96
7	Distribution	Rural	650-850	RockH	13.13253	1.07	1.22
8				RockS	7.76892	1.36	1.30
9				Normal	6.07944	2.10	1.46
10	Distribution	Rural	200-650	RockH	12.43557	1.04	1.05
11				RockS	6.43722	1.13	1.07
12				Normal	3.48428	1.01	1.16
13	Distribution	Rural	5-200	RockH	11.922	0.96	0.92
14				RockS	4.95988	0.85	0.89
15				Normal	2.45968	0.77	0.81
16	Distribution	Rural	0-5	RockH	11.95461	0.92	0.87
17				RockS	4.83508	0.84	0.82
18				Normal	1.77132	0.57	0.67
19	Feeder	Urban	>2550	RockH	23.59262	1.18	1.03
20				RockS	17.56779	1.30	1.21
21				Normal	13.31148	1.30	1.04
22	Feeder	Urban	850-2550	RockH	16.58868	0.83	0.97
23				RockS	10.07238	0.72	0.97
24				Normal	7.62624	0.72	0.96
25	Feeder	Rural	650-850	RockH	13.367325	1.07	1.22
26				RockS	7.7797	1.36	1.30
27				Normal	6.0882	2.10	1.46
28	Feeder	Rural	200-650	RockH	12.718575	1.04	1.05
29				RockS	6.44915	1.13	1.07
30				Normal	3.3951	1.01	1.16
31	Feeder	Rural	5-200	RockH	11.47224	0.96	0.92
32				RockS	4.985432	0.85	0.89
33				Normal	2.544192	0.77	0.81
34	Feeder	Rural	0-5	RockH	10.85823	0.92	0.87
35				RockS	4.82844	0.84	0.82
36				Normal	1.98516	0.57	0.67
37	Fiber	Urban	>2550	RockH	23.59262	1.18	1.03
38				RockS	17.44071	1.30	1.09
39				Normal	13.31148	1.30	1.04
40	Fiber	Urban	850-2550	RockH	16.58868	0.83	0.97
41				RockS	10.07238	0.72	0.97
42				Normal	7.62624	0.72	0.96
43	Fiber	Rural	650-850	RockH	13.13253	1.07	1.22

44				RockS	7.76892	1.36	1.30
45				Normal	6.07944	2.10	1.46
46	Fiber	Rural	200-650	RockH	12.43557	1.04	1.05
47				RockS	6.43722	1.13	1.07
48				Normal	3.48428	1.01	1.16
49	Fiber	Rural	5-200	RockH	12.20311	0.96	0.92
50				RockS	4.94391	0.85	0.89
51				Normal	2.40686	0.77	0.81
52	Fiber	Rural	0-5	RockH	12.228705	0.92	0.87
53				RockS	4.83674	0.84	0.82
54				Normal	1.71786	0.57	0.67

Surface Texture Table

Texture	Impact?	Description of Texture
	0	Blank
BY	1	Bouldery
BY-COS	1	Bouldery Course Sand
BY-FSL	1	Bouldery & Fine Sandy Loam
BY-L	1	Bouldery & Loam
BY-LS	1	Bouldery & Sandy Loam
BY-SICL	1	Bouldery & Silty Clay Loam
BY-SL	1	Bouldery & Sandy Loam
BYV	1	Very Bouldery
BYV-FSL	1	Very Bouldery & Fine Sandy Loam
BYV-L	1	Very bouldery & Loamy
BYV-LS	1	Very Bouldery & Loamy Sand
BYV-SIL	1	Very Bouldery & Silt
BYV-SL	1	Very Bouldery & Sandy Loam
BYX	1	Extremely Bouldery
BYX-FSL	1	Extremely Bouldery & Fine Sandy Loam
BYX-L	1	Extremely Bouldery & Loamy
BYX-SIL	1	Extremely Bouldery & Silt Loam
BYX-SL	1	Extremely Bouldery & Sandy Loam
C	0	Clay
CB	0	Cobbly
CBA	1	Angular Cobbly
CBA-FSL	1	Angular Cobbly & Fine Sandy Loam
CB-C	0	Cobbly & Clay
CB-CL	0	Cobbly & Clay Loam
CB-COSL	0	Cobbly & Coarse Sandy Loam
CB-FS	0	Cobbly & Fine Sand
CB-FSL	0	Cobbly & Fine Sandy Loam
CB-L	0	Cobbly & Loamy
CB-LCOS	0	Cobbly & Loamy CourseSand
CB-LS	0	Cobbly & Loamy Sand
CB-S	0	Cobbly & Sand
CB-SCL	0	Cobbly & Sandy Clay Loam
CB-SICL	0	Cobbly & Silty Clay Loam

CB-SIL	0	Cobbly & Silt Loam
CB-SL	1	Cobbly & Sandy Loam
CBV	1	Very Cobbly
CBV-C	1	Very Cobbly & Clay
CBV-CL	1	Very Cobbly & Clay Loam
CBV-FSL	1	Very Cobbly & Fine Sandy Loam
CBV-L	1	Very Cobbly & Loamy
CBV-LFS	1	Very Cobbly & Fine Loamy Sand
CBV-LS	1	Very Cobbly & Loamy Sand
CBV-MUCK	1	Very Cobbly & Muck
CBV-SCL	1	Very Cobbly & Sandy Clay Loam
CBV-SIL	1	Very Cobbly & Silt
CBV-SL	1	Very Cobbly & Sandy Loam
CBV-VFS	1	Very Cobbly & Very Fine Sand
CBX	1	Extremely Cobbly
CBX-L	1	Extremely Cobbly Loam
CBX-CL	1	Extremely Cobbly & Clay
CBX-SIL	1	Extremely Cobbly & Silt
CBX-SL	1	Extremely Cobbly &Sandy Loam
CBX-VFSL	1	Extremely Cobbly Very Fine Sandy Loam
CE	0	Coprogenous Earth
CIND	0	Cinders
CL	0	Clay Loam
CM	1	Cemented
CN	0	Channery
CN-CL	0	Channery & Clay Loam
CN-FSL	0	Channery & Fine Sandy Loam
CN-L	0	Channery & Loam
CN-SICL	0	Channery & Silty Clay Loam
CN-SIL	0	Channery & Silty Loam
CN-SL	0	Channery & Sandy Loam
CNV	0	Very Channery
CNV-CL	0	Very Channery & Clay
CNV-L	0	Very Channery & Loam
CNV-SCL	0	Channery & Sandy Clay Loam
CNV-SIL	0	Very Channery & Silty Loam
CNV-SL	0	Very Channery & Sandy Loam
CNX	0	Extremely Channery
CNX-SL	0	Extremely Channery & Sandy Loam
COS	0	Coarse Sand
COSL	0	Coarse Sandy Loam
CR	0	Cherty
CRC	1	Coarse Cherty
CR-L	1	Cherty & Loam
CR-SICL	1	Cherty & Silty Clay Loam
CR-SIL	1	Cherty & Silty Loam
CR-SL	1	Cherty & Sandy Loam
CRV	1	Very Cherty
CRV-L	1	Very Cherty & Loam

CRV-SIL		1	Very Cherty & Silty Loam
CRX		1	Extremely Cherty
CRX-SIL		1	Extremely Cherty & Silty Loam
DE		0	Diotomaceous Earth
FB		0	Fibric Material
FINE		0	Fine
FL		0	Flaggy
FL-FSL		0	Flaggy & Fine Sandy Loam
FL-L		0	Flaggy & Loam
FL-SIC		0	Flaggy & Silty Clay
FL-SICL		0	Flaggy & Silty Clay Loam
FL-SIL		0	Flaggy & Silty Loam
FL-SL		0	Flaggy & Sandy Loam
FLV		1	Very Flaggy
FLV-COSL		1	Very Flaggy & Coarse Sandy Loam
FLV-L		1	Very Flaggy & Loam
FLV-SICL		1	Very Flaggy & Silty Clay Loam
FLV-SL		1	Very Flaggy & Sandy Loam
FLX		1	Extremely Flaggy
FLX-L		1	Extremely Flaggy & Loamy
FRAG		0	Fragmental Material
FS		0	Fine Sand
FSL		0	Fine Sandy Loam
G		0	Gravel
GR		0	Gravelly
GRC		0	Course Gravelly
GR-C		0	Gravel & Clay
GR-CL		0	Gravel & Clay Loam
GR-COS		0	Gravel & Course Sand
GR-COSL		0	Gravel & Coarse Sandy Loam
GRF		0	Fine Gravel
GRF-SIL		0	Fine Gravel Silty Loam
GR-FS		0	Gravel & Fine Sand
GR-FSL		0	Gravel & Fine Sandy Loam
GR-L		0	Gravel & Loam
GR-LCOS		0	Gravel & Loamy Course Sand
GR-LFS		0	Gravel & Loamy Fine Sand
GR-LS		0	Gravel & Loamy Sand
GR-MUCK		0	Gravel & Muck
GR-S		0	Gravel & Sand
GR-SCL		0	Gravel & Sandy Clay Loam
GR-SIC		0	Gravel & Silty Clay
GR-SICL		0	Gravel & Silty Clay Loam
GR-SIL		0	Gravel & Silty Loam
GR-SL		0	Gravel & Sandy Loam
GR-VFSL		0	Gravel & Very Fine Sandy Loam
GRV		1	Very Gravelly
GRV-CL		1	Very gravelly & Clay Loam
GRV-COS		1	Very Gravelly & Course Sand
GRV-COSL		1	Very Gravelly & Course Sandy

		Loam
GRV-FSL	1	Very Gravelly & Fine Sandy Loam
GRV-L	1	Very Gravelly & Loam
GRV-LCOS	1	Very Gravelly & Loamy Course Sand
GRV-LS	1	Very Gravelly & Loamy Sand
GRV-S	1	Very Gravelly & Sand
GRV-SCL	1	Very Gravelly & Sandy Clay Loam
GRV-SICL	1	Very Gravelly & Silty Clay Loam
GRV-SIL	1	Very Gravelly & Silt
GRV-SL	1	Very Gravelly & Sandy Loam
GRV-VFS	1	Very Gravelly & Very Fine Sand
GRV-VFSL	1	Very Gravelly & Very Fine Sandy Loam
GRX	1	Extremely Gravelly
GRX-CL	1	Extremely Gravelly & Coarse Loam
GRX-COS	1	Extremely Gravelly & Coarse Sand
GRX-COSL	1	Extremely Gravelly & Coarse Sandy Loam
GRX-FSL	1	Extremely Gravelly & Fine Sand Loam
GRX-L	1	Extremely Gravelly & Loam
GRX-LCOS	1	Extremely Gravelly & Loamy Coarse
GRX-LS	1	Extremely Gravelly & Loamy Sand
GRX-S	1	Extremely Gravelly & Sand
GRX-SIL	1	Extremely Gravelly & Silty Loam
GRX-SL	1	Extremely Gravelly & Sandy Loam
GYP	1	Gypsiferous Material
HM	0	Hemic Material
ICE	1	Ice or Frozen Soil
IND	1	Indurated
L	0	Loam
LCOS	0	Loamy Course Sand
LFS	0	Loamy Fine Sand
LS	0	Loamy Sand
LVFS	0	Loamy Very Fine Sand
MARL	0	Marl
MEDIUM COURSE	0	Medium Course
MK	0	Mucky
MK-C	0	Mucky Clay
MK-CL	0	Mucky Clay Loam
MK-FS	0	Muck & Fine Sand
MK-FSL	0	Muck & Fine Sandy Loam
MK-L	0	Mucky Loam
MK-LFS	0	Mucky Loamy Fine Sand
MK-LS	0	Mucky Loamy Sand
MK-S	0	Muck & Sand
MK-SI	0	Mucky & Silty
MK-SICL	0	Mucky & Silty Clay Loam
MK-SIL	0	Mucky Silt

MK-SL	0	Mucky & Sandy Loam
MK-VFSL	0	Mucky & Very Fine Sandy Loam
MPT	0	Mucky Peat
MUCK	0	Muck
PEAT	0	Peat
PT	0	Peaty
RB	1	Rubbly
RB-FSL	1	Rubbly Fine Sandy Loam
S	0	Sand
SC	0	Sandy Clay
SCL	0	Sandy Clay Loam
SG	0	Sand & Gravel
SH	0	Shaly
SH-CL	0	Shaly & Clay
SH-L	0	Shale & Loam
SH-SICL	0	Shaly & Silty Clay Loam
SH-SIL	0	Shaly & Silt Loam
SHV	1	Very Shaly
SHV-CL	1	Very Shaly & Clay Loam
SHX	1	Extremely Shaly
SI	0	Silt
SIC	0	Silty Clay
SICL	0	Silty Clay Loam
SIL	0	Silt Loam
SL	0	Sandy Loam
SP	0	Sapric Material
SR	0	Stratified
ST	0	Stony
ST-C	0	Stony & Clay
ST-CL	0	Stony & Clay Loam
ST-COSL	0	Stony & Course Sandy Loam
ST-FSL	0	Stony & Fine Sandy Loam
ST-L	0	Stony & Loamy
ST-LCOS	0	Stony & Loamy Course Sand
ST-LFS	0	Stony & Loamy Fine Sand
ST-LS	0	Stony & Loamy Sand
ST-SIC	0	Stony & Silty Clay
ST-SICL	0	Stony & Silty Clay Loam
ST-SIL	0	Stony & Silt Loam
ST-SL	0	Stony & Sandy Loam
ST-VFSL	0	Stony & Sandy Very Fine Silty Loam
STV	1	Very Stony
STV-C	1	Very Stony & Clay
STV-CL	1	Very Stony & Clay Loam
STV-VFSL	1	Very Stony & Very Fine Sandy Loam
STV-FSL	1	Very Stony & Fine Sandy Loam
STV-L	1	Very Stony & Loamy
STV-LFS	1	Very Stony & Loamy Fine Sand
STV-LS	1	Very Stony & Loamy Sand

STV-MPT		1	Very Stony & Mucky Peat
STV-MUCK		1	Very Stony & Muck
STV-SICL		1	Very Stony & Silty Clay Loam
STV-SIL		1	Very Stony & Silty Loam
STV-SL		1	Very Stony & Sandy Loam
STV-VFSL		1	Very Stony & Very Fine Sandy Loam
STX		1	Extremely Stony
STX-C		1	Extremely Stony & Clay
STX-CL		1	Extremely Stony & Clay Loam
STX-COS		1	Extremely Stony & Course Sand
STX-COSL		1	Extremely Stony & Course Sand Loam
STX-FSL		1	Extremely Stony & Fine Sandy Loam
STX-L		1	Extremely Stony & Loamy
STX-LCOS		1	Extremely Stony & Loamy Course Sand
STX-LS		1	Extremely Stony & Loamy Sand
STX-MUCK		1	Extremely Stony & Muck
STX-SIC		1	Extremely Stony & Silty Clay
STX-SICL		1	Extremely Stony & Silty Clay Loam
STX-SIL		1	Extremely Stony & Silty Loam
STX-SL		1	Extremely Stony & Sandy Loam
STX-VFSL		1	Extremely Stony & Very Fine Sandy Loam
SY		1	Slaty
SY-L		1	Slaty & Loam
SY-SIL		1	Slaty & Silty Loam
SYV		1	Very Slaty
SYX		1	Extremely Slaty
UNK		0	Unknown
UWB		1	Unweathered Bedrock
VAR		0	Variable
VFS		0	Very Fine Sand
VFSL		0	Very Fine Sandy loam
WB		1	Weathered Bedrock

ATTACHMENT A

TABLES

User Inputs to Model
A1 : C60

Urban Copper Cable Table
E6 : A12

Rural Copper Cable Table
E14 : G19

Distribution UG/Aerial Mix
E21 : G28

Fiber Feeder UG/Aerial Mix
E30 : G37

Urban Fiber Table
I7 : K12

Rural Fiber Table
I14 : K19

Copper Feeder UG/Aerial Mix Table
I21 : K28

Density/Fill Table
I30 : K37

Structure Allocation Table
M2 : O8

Cost for AFC/SLC 200 Equipment
M12 : O19

CO Switch Cost Table
O22 : Q28

Voice Grade Ratio Table
N31 : R36

Miscellaneous Calculations (Do not change any value)
A62 : C70

Miscellaneous Notes
A73 : C77

Distribution Cable size Table
H40 : I55

Feeder Cable Size Table
H59 : I73

Fiber Cable Cost Table
H76 : I86

Cost Factor Table
E88 : L143

Surface Texture Table
E145 : I405