Generic DS0 Impairment

Technical Appendix

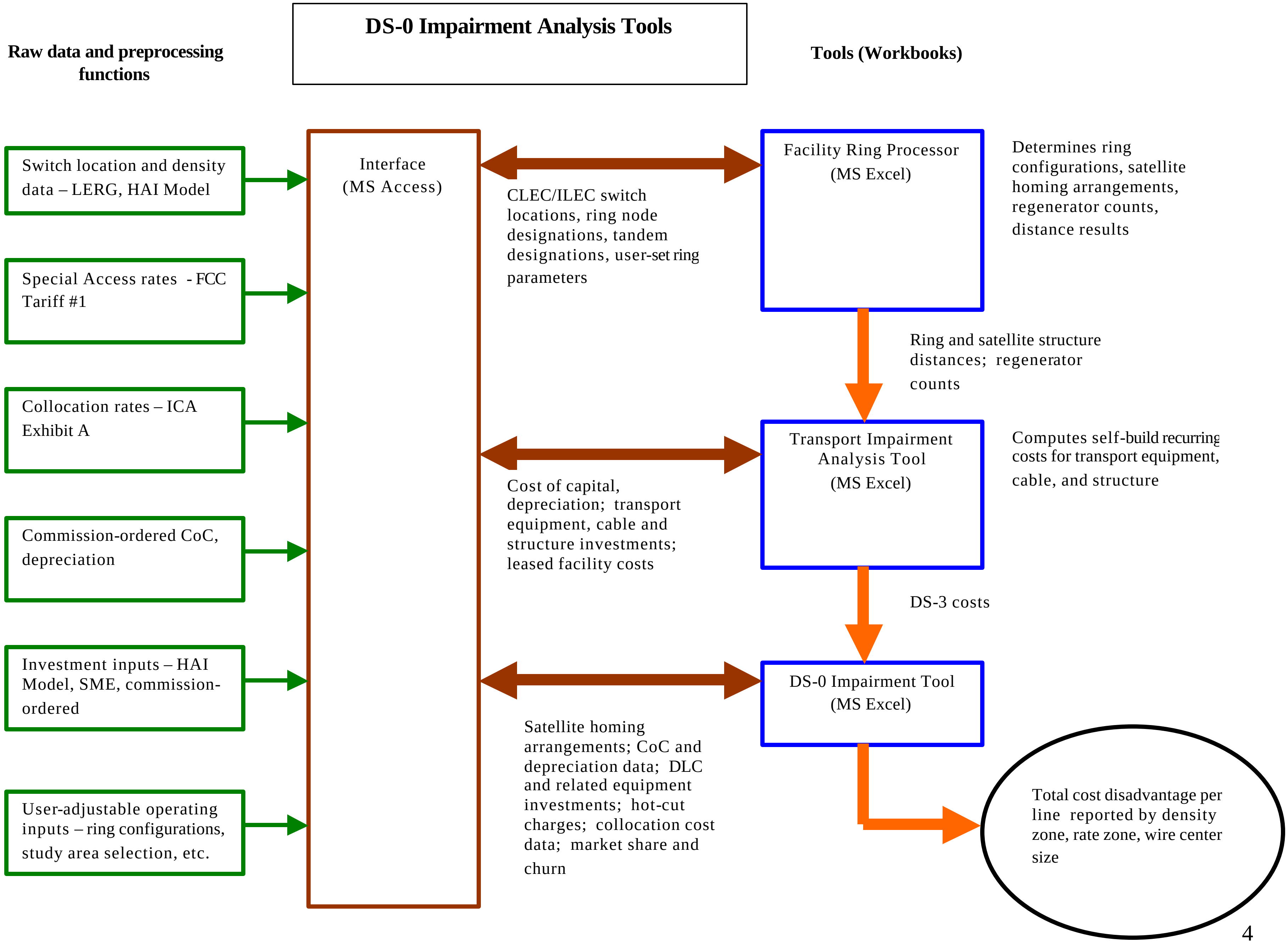
Table of Contents

I. INTRODUCTION

A. The Network Architecture Tools – The Creation of a Hypothetical CLEC Network

In order to quantify Competitive Local Exchange Carrier ("CLEC") cost disadvantages relating to local loop access and backhaul, it is necessary to model an efficient CLEC-provided backhaul network that would, in a given study area, connect end-user loops terminated at an Incumbent Local Exchange Carrier's ("ILEC's") wire center to a CLEC's local switch in another part of the study area. The model network can then serve as the basis for computing investments in cable, structure, and appropriate network elements. Because connections can be made over CLEC-provided facilities or leased facilities, the first task is to determine (1) how to efficiently connect, subject to practical engineering constraints, the largest ILEC wire centers using the CLEC's own transport facilities; and (2) how the remaining ILEC wire centers can be most efficiently connected to the CLEC's backbone network using leased transport facilities.

This document describes a set of tools developed to estimate cost impairment in a specific study area. The tools, a set of Microsoft Excel workbooks, consist of the Facility Ring Processor ("FRP"), the Transport Impairment Analysis Tool, and the DS0 Impairment Analysis Tool. A Microsoft Access-based module controls the operation of the individual Tools, provides a user interface which allows users to adjust input values and select Tool execution options, and it also contains tables consisting of all input data, including wire center locations, equipment investments, economic lives, and other parameters required by the Tools. Figure 1 shows the logical relationship among the various modules that constitute the Tools.


DS-0 Impairment Analysis Tools
Raw data and preprocessing functions
Tools (Workbooks)
Switch location and density data – LERG, HAI Model
Special Access rates - FCC Tariff #1
Collocation rates – ICA Exhibit A
Commission-ordered CoC, depreciation
Investment inputs – HAI Model, SME, commission-ordered
User-adjustable operating inputs – ring configurations, study area selection, etc.
Interface (MS Access)
CLEC/ILEC switch locations, ring node designations, tandem designations, user-set ring parameters
Facility Ring Processor (MS Excel)
Determines ring configurations, satellite homing arrangements, regenerator counts, distance results
Ring and satellite structure distances; regenerator counts
Cost of capital, depreciation; transport equipment, cable and structure investments; leased facility costs
Transport Impairment Analysis Tool (MS Excel)
Computes self-build recurring costs for transport equipment, cable, and structure
DS-3 costs
Satellite homing arrangements; CoC and depreciation data; DLC and related equipment investments; hot-cut charges; collocation cost data; market share and churn
DS-0 Impairment Tool (MS Excel)
Total cost disadvantage per line reported by density zone, rate zone, wire center size

The Facility Ring Processor constructs a hypothetical CLEC local transport network consisting of one or more SONET rings which interconnects ILEC wire centers (CLEC network nodes) located within a common geographic area – typically a Local Access and Transport Area ("LATA"). The FRP configures the rings using a set of algorithms written in Visual Basic for Applications (VBA) code.

This ring code constructs SONET rings with a user-adjustable maximum node count per ring. It computes distances between ring nodes according to geographic locations as specified by V&H coordinates for each node. The use of SONET-based transport represents a suitable forward-looking technology assumption and comports with current CLEC and ILEC practice. The VBA code computes distances between ring nodes using "right-angle" or "rectilinear" routing of the modeled facilities. This assumption is consistent with the "real-world" practice in which transport routes generally run parallel to major thoroughfares, which often run east-west and north-south. Such routing also typically allows sufficient total distance to avoid obstructions such as rivers and bluffs.

Wire centers are designated as CLEC ring nodes if they serve a sufficiently large number of access lines; generally, the set of large wire centers that collectively serve 33% of the total lines in the study area qualify as ring node candidates. The underlying assumption is that a CLEC would typically target such large wire centers because they are likely to serve large numbers of “enterprise,” or large business, customers.[1] Tandem locations are also ring node candidates.[2]

Some network locations, typically smaller offices or those that lie beyond the user-adjustable threshold distance from the nearest node location, do not appear as nodes on SONET rings. Such locations are classified as “satellite” offices, and the VBA code connects each satellite with the nearest ring node. The satellite-to-node distance is based on airline mileage, because ILECs almost universally express their leased transport rates in terms of airline distance.

The ring code proceeds to assemble SONET rings according to the input list of ring node candidates. As suggested above, if the ring code determines that a node candidate fails the distance threshold test, the code will automatically designate that location as a satellite. Section III discusses the ring formation process in detail.

Excel formulas in the Facility Ring Processor tool report the facilities mileage by density zone so that the Transport Impairment Analysis Tool can compute the investment in facilities structure. Section III contains a detailed discussion of these calculations.

---

[1] The FCC recognized that at least 12 DS-3s of demand are generally required to justify constructing facilities (Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers (CC Docket No. 01-338), Implementation of the Local Competition Provisions of the Telecommunications Act of 1996 (CC Docket No.96-98), and Deployment of Wireline Services Offering Advanced Telecommunications Capability (CC Docket No.98-147), August 21, 2003, ¶388). This is equivalent to more than 8,000 VGEs. If an individual CLEC were to capture 10% of the total market (not just mass-market POTS, but mass-market, enterprise, voice and data), that would imply a minimum office size of 80,000 VGEs.

[2] Tandem locations are included because an efficient CLEC will usually connect to the ILEC local tandem and pay usage-based transport charges. ILEC local tandem switches are either included on a ring for a particular geographic area or else appear as satellite locations if the tandem location is farther from the nearest node location than the ring node threshold distance. Because tandems operated by large ILECs typically cohabit a wire center with one or more large end office switches in major population centers, tandem locations will normally appear as ring nodes.

B. Cost Quantification

Once the CLEC transport network topology and corresponding distances and node counts have been determined, the next step is to calculate equipment investment and costs, collocation space requirements, and operational costs. The Transport Impairment Analysis Tool computes costs for transport equipment and facilities (including fiber cable and supporting structure). The DS0 Impairment Analysis tool develops costs of preparing voice-grade communications for transport, connecting CLEC equipment collocated in ILEC wire centers to the CLEC's switch location, and transferring customers from the ILEC's network to the CLEC's facilities.[3]

II. TRANSPORT COST ANALYSIS

As noted above, one element in the backhaul cost component of DS0 impairment is the cost of CLEC-provided transport between network node locations, including outside plant and associated electronics for that transport. These particular cost components are captured as an output of the Transport Impairment Analysis Tool. Using a geographic identification of potential network node locations, the Transport Impairment Analysis Tool employs a set of algorithms to size the hypothetical CLEC transport network and to develop the construction costs of that network based on publicly available unit cost data. The Facility Ring Processor is responsible for quantifying the specific components of the hypothetical CLEC transport network described above, which are used as inputs to the Transport Impairment Analysis Tool.

---

[3] The overall impairment analysis considers only the cost disadvantage implicit in extending UNE loops from the ILEC wire center to the CLEC local switching center. Any other impairment, such as customer acquisition costs, to name just one of many, are not addressed here.

A. Facility Ring Processor

1. Overview

The Facility Ring Processor ("FRP") develops a reasonable network architecture that supports the carriage of traffic from the point of UNE-L availability (i.e., the point of UNE-L termination in the ILEC wire center) to a CLEC switch. To this end, the Facility Ring Processor performs two key tasks. First, based on an input file that identifies network nodes, satellite offices, and tandem office locations,[4] the Facility Ring Processor creates a hypothetical ring architecture to connect strategic points within the service area of the ILEC. Second, the Facility Ring Processor determines which satellite offices should home on which network node locations, and which network node and satellite office locations should home on which tandem office locations.[5] In sum, the Facility Ring Processor develops a network architecture that can be used to estimate the cost of backhauling UNE-L lines to a CLEC switch. After defining this basic network architecture profile for a given study area, it is then possible to generate fundamental network statistics such as average distance between network node locations and distances

---

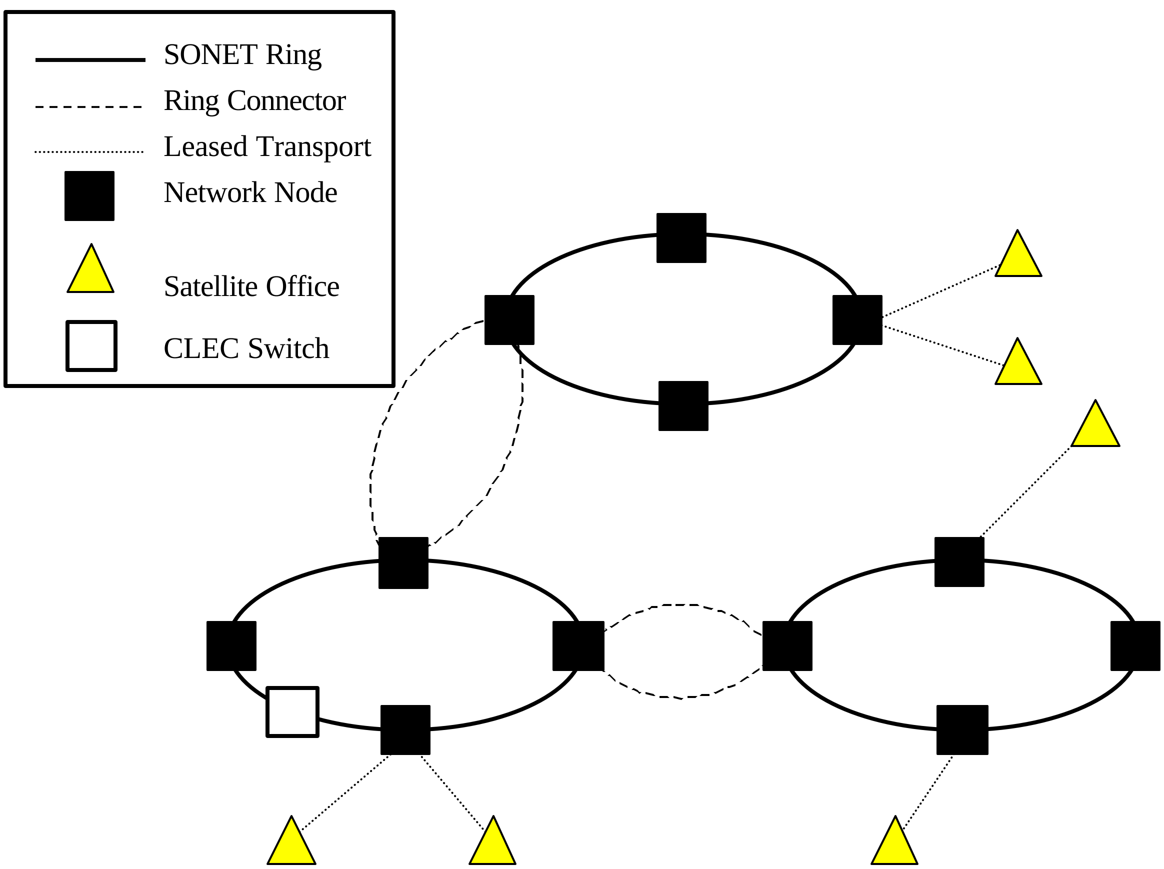
[4] Although the user may directly specify the points that must be included on the network, the general approach is to identify a subset of the largest ILEC offices within a specific geographic area, such as a LATA. If this latter approach is employed, the V H coordinates are readily available from such sources as Telcordia Routing Administration's Local Exchange Routing Guide (LERG) or NECA Tariff 4. Also, ILEC wire center sizes can be reasonably estimated by consulting input files to cost models such as those initially considered in the Local Competition dockets. The information is recalibrated by trending the VGE counts based on FCC ARMIS data for the ILEC-state and by validating the office list (e.g., 8-character CLLI) with that which appears in the LERG or NECA Tariff 4. Regardless of the source employed, the basic input necessary to run the Facility Ring Processor is a list of physical locations identified at minimum by VH coordinates and which are designated as node or satellite locations.

[5] The FRP also determines the homing of local offices to local tandems. This step is independent of whether one or more local tandems are selected as network nodes and is used to determine the average

between satellite offices and the network node locations to which they home. These basic statistics are critical inputs to subsequent calculations of the cost of (a) CLEC-provisioned transport between network node locations and (b) purchased transport (e.g., special access or dedicated UNE transport from the ILEC) between network node locations and their subtending satellite offices.

The following figure shows the architecture assumed by the Facility Ring Processor:

Figure 2 – Network Architecture Assumed by the Facility Ring Processor



---

tandem-to-end office distances for separate analysis of reciprocal compensation, such as may be involved in a business case analysis.

2. Source Data

The Facility Ring Processor requires as inputs the designation of network nodes and satellite offices that are to home to network node locations, along with the identification of tandem office locations. The Facility Ring Processor then constructs a transport network consisting of one or more SONET rings, dedicated point-to-point connections between satellite offices and network nodes, and ring connectors.

The default input database contains ILEC locations that house local switches (i.e., ILEC wire centers). By default the largest wire centers that cover at least 33% of the total lines are designated as network nodes. These CLEC network node locations represent the locations judged to have the most significant potential total telecommunications demand. In rural areas where little entry has occurred, at least two of the largest wire centers are selected.

In addition, the node selection must ensure that tandem switches are considered for placement on rings as network nodes. This is because, generally, a CLEC will connect to the ILEC local tandem and terminate all its traffic at the tandem for all of the subtending offices and pay usage-based transport charges to terminate this traffic. Thus, ILEC local tandem switches are always included either as ring nodes or as satellite locations for a particular geographic area, regardless of demand.

The relevant information concerning these node locations was derived from wire center demand data in conjunction with LERG data. Among various other data elements that are used outside of the Facility Ring Processor, the wire center data provide the user with wire center VGE demand by major ILEC and by CLLI.[6] The LERG is in turn used to confirm and update the wire center data (i.e., switch existence) and to provide the vertical (V) and horizontal (H) coordinates of each wire center location,[7] the LATA and the deploying operating company.

Because a wire center might contain multiple switches, and because the records are manually input by different individuals, there is a chance that the V and H coordinates may not precisely match for switches that occupy the same building.[8] In those cases where multiple switches are at the same physical location but have different V&H coordinates, the V and H coordinate values are averaged across all occurrences of the same eight-digit CLLI.[9]

Each ILEC wire center location record contains an eight character CLLI, a state abbreviation, a LATA number, MSA and ILEC designation (to facilitate data extraction for detailed analysis) and VH coordinates, among other data elements.[10] The user must

---

[6] COMMON LANGUAGE® Location Identifier. COMMON LANGUAGE is a registered trademark of Telcordia Technologies, Inc. CLLI codes are unique alphanumeric codes that identify a network location (first eight characters) and equipment (e.g., a switch) or an interconnection point within that location. For example, "CDKNNJCK" indicates a unique network location (e.g., building) in Cedar Knolls, NJ while a digital circuit switch in that building might be designated as "CDKNNJCKDS0."

[7] V and H coordinates are commonly used to specify the geographic location of network locations. They are the result of a mathematical transformation of spherical coordinates (usually expressed as longitude and latitude) to coordinates defining a location on a plane surface (*i.e.*, they are adjusted for the curvature in the earth) so that distance between two locations may be easily calculated from the difference in the V and H values.

[8] The unit of distance in the V&H coordinate system is $\sqrt{0.1}$ mile, or 1670 feet.

[9] In most instances, where a discrepancy existed, it was in the last digit of the 4-digit coordinate and was generally only different by ± 1. Such a discrepancy amounts to a deviation 0.316 miles. As a result, when averaged, the net effect on cost is minor.

[10] Although they are not used in the Facility Ring Processor, certain additional data are also associated with each ILEC wire center in the "ILEC WC Detail File" and are used in other tools downstream of the FRP. For example, the DS0 Impairment Analysis tool uses Total Lines, Business Lines, Residential Lines, Special Lines, Public Lines, Single-Line Business, Households, UNE Zone, % DLC, Density, Density Zone, Special Access Zone, Price Flexibility Status, and Copper Length Distributions.

designate which offices in the study area are to be network node candidates. The user can manually designate any subset of offices (in addition to those chosen by the default node selection process) for the given study area as network node offices.[11] Similarly, the user can manually remove a location from the default network node list. The Facility Ring Processor classifies as satellite offices all ILEC wire center locations within the study area that are not designated as network node office locations. A "1" in the Core Flag field of the "Offices" tab within the Facility Ring Processor denotes a location as a network node candidate, and it will appear as an on-ring network node if it does not violate the user-adjustable ring distance limit.[12]

3. Required User Inputs

In addition to the identification of network node and satellite offices in the Facility Ring Processor as described above, the Facility Ring Processor employs a set of user-adjustable inputs:

- **Maximum Nodes per Ring**: This determines how many network nodes can be placed on an individual physical ring.

[11] The ILEC wire center list was derived from the LERG database. In particular, as certain wire center statistics such as line counts are required in the impairment analysis, the data file containing these line data serves as the basis of the node preselection process. The LERG was used to verify that the ILEC wire centers are active and owned by the ILEC, and it also provides the location (e.g., by address, state, LATA, etc.) of each ILEC wire center. The line count data are based on estimated 1998 line counts adjusted to 2002 according to the line counts that the ILECs periodically report to the FCC for use in its ARMIS database. Specifically, we used the growth in lines from 1996 to 2000 reported in ARMIS along with the distribution of line counts in each wire center and each line type (e.g., residential, business, etc.) in 1998 to estimate the wire center specific line counts.

[12] The segment distance limits were established to prevent outlying large offices from being placed on a ring when, as a practical matter, they would be too distant to include. This safeguard prevents inflation of the structure miles and associated costs. In these cases, the Facility Ring Processor will reclassify network nodes and tandem offices as satellite offices. See discussion in "Module Structure" section *infra*.

- **Regenerator Spacing**: This input is used to determine how many regenerators will be required on each ring and lateral connection. Regenerators are inserted into the optical cable path to overcome transmission loss due to long fiber lengths. This input specifies the optical segment distance at which a regenerator will be inserted.

- **CLLI Rejection Threshold:** This input is used to determine whether offices classified as network nodes will be moved off-ring and become satellite offices. Network nodes with on-ring distances exceeding the CLLI Rejection Threshold are moved off-ring and become satellite offices (See footnote 16).

4. Module Structure

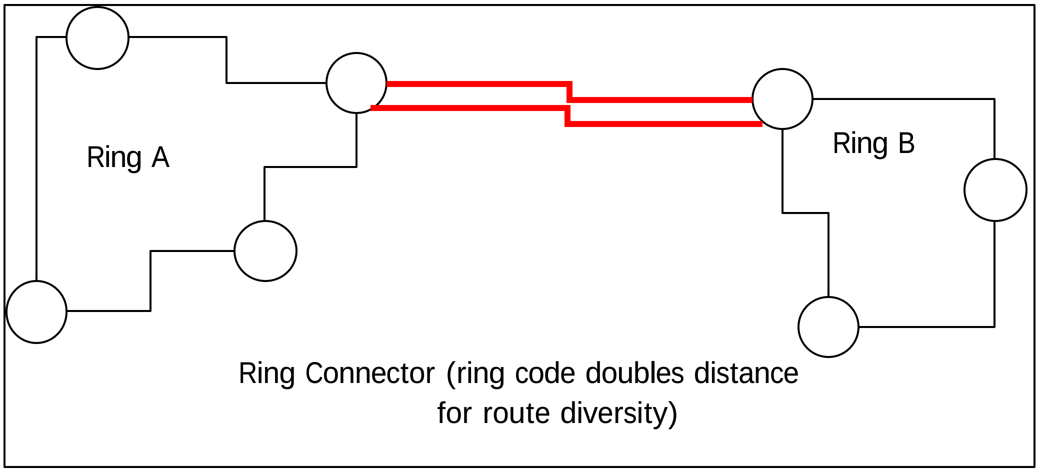
The first step performed by the Facility Ring Processor is to incorporate network node locations, in the selected study area, onto one or more rings. The Facility Ring Processor builds rings by connecting each network node to two neighboring network nodes, with the constraint that no more than the user-specified maximum number of network nodes may be on a single ring. An additional constraint prohibits wire centers from being placed on the ring if they exceed the CLLI rejection threshold distance. When the Facility Ring Processor determines the need to create more than one ring per study area, individual rings are connected to adjacent rings using "ring connectors,"[13] which are effectively "two-node" rings that connect the closest network nodes on

---

[13] "Ring Connector" segments are redundant in that the mileage calculated for a given ring connector is doubled in order to account for a second diverse routing path for this segment.

adjacent rings. Figure 3 illustrates the ring interconnection modeling performed by the Facility Ring Processor.

Figure 3 – Ring Interconnection



An algorithm written in Visual Basic for Applications ("VBA") code groups network nodes into rings and builds connections between rings. The ring determination process begins by identifying a central network node location (referred to as the "seed location") that is situated roughly in the middle of the entire set of locations. This seed location is determined by selecting the network node location that is the closest to the average V and H coordinates for the entire group of network nodes for the selected study area.

Once the seed location is identified, the algorithm begins forming rings by connecting all network nodes and tandem offices to the seed location. Therefore, in the initial case, there are typically numerous two-node rings, each consisting of the seed location, and a network or tandem node. Following the first iteration of the algorithm, two of the two-node rings will merge, resulting in a three-node ring that is comprised of two Network or Tandem nodes and the seed location.[14] Merging rings in this way presumes that the total distance of the entire "ring system" can be reduced by allowing the two-node rings to merge. Also, rings with four nodes or more are allowed to close on themselves. That is, rings with four or more nodes may divorce themselves from the seed location and become standalone rings. Rings will continue to merge and close in this way until all nodes have been merged into larger rings or until it is no longer possible to reduce the total ring system distance by merging or closing any rings.

To determine the order in which rings are merged, the algorithm determines the "savings" associated with merging every possible ring combination and then merges the rings that yield the greatest distance savings. The savings that are produced by merging any two rings is the difference between the sum of all the distances between all connected nodes prior to merging any two rings and the sum of all the distances between connected nodes after merging those rings. For each node in the study area, the algorithm merges the pair of rings that yields the greatest distance savings.

The process of computing savings, merging rings, and closing rings will continue until no additional savings are possible, or other constraints, such as maximum allowable ring size, are realized. The end result of the merging and closing process is a set of interconnected nodes (i.e., rings) that have been arranged in a fashion that strives to reduce total distance.

---

[14] For example, seed node A is initially connected to nodes B and C via redundant paths, which covers a total distance of [(A to B) + (A to C)]*2. The FRP examines the distance associated with merging rings AB and AC with each other to form ring ABC, and determines whether the new distance [(A to B) + (B to C) + (C to A)] is less than the distance associated with the non-merged rings [(A to B) + (A to C)]*2. If merged distance is less than the non-merged distance, the FRP will allow ring AB to merge with ring AC, and a larger ring, ABC, is formed. In subsequent evaluations, other rings may merge with ring ABC, as long as the newly formed ring does not exceed the user-defined maximum allowable number of nodes per ring.

After all network nodes and tandem offices have been incorporated into rings by the FRP, the distances associated with each node are examined.[15] If both of the distances associated with a given node exceed the user-specified "CLLI rejection threshold," that node will be reclassified as a satellite office (and later processed as such), and the ring construction algorithm will be rerun.[16] This process continues until all network nodes and tandem offices can be placed on a ring without violating the CLLI distance rejection threshold.

Following the formation of rings, the FRP runs a process that identifies a set of "ring connectors" that are used to interconnect the formed rings with each other. This ensures that every node has a physical path to every other node in the study area. The FRP identifies ring connectors by finding the shortest rectilinear path between any two nodes on any two rings; the red lines in Figure 3 illustrate a ring connector.

After interconnecting network nodes, the Facility Ring Processor associates each satellite office with its nearest network node. The transport analysis process assumes that satellite offices will be connected to network nodes using ILEC-supplied (*i.e.*, UNE and/or Special Access) interoffice transport. Because the ILEC charges for these types of connectivity are based on airline distance, the Transport Impairment Analysis Tool must

---

[15] Because every node on a ring connects to two other nodes on the same ring, there are two distances associated with each network node. See Facility Ring Processor.xls at the "Ring IO" worksheet, fields 'Core Office', 'Core Office Connects to CLLI (CLLI #1)', and 'Core Office Connects to CLLI (CLLI #2)'. Also see Facility Ring Processor.xls at the "Summary" worksheet, cell "E11," "CLLI Rejection Threshold, mi."

[16] In some cases, the Facility Ring Processor will reclassify network nodes and tandem offices as satellite offices. As the FRP builds rings, it examines the distances associated with each on-ring node. If the distances associated with the on-ring node exceed the user-defined "CLLI rejection threshold," that on-ring node is reclassified as a satellite office. Application of the CLLI Rejection Threshold is useful because it can identify situations where either the V & H coordinates associated with an on-ring node may have been miscoded or a node location is so geographically remote that its inclusion on a ring is not prudent. tandem offices that are reclassified as satellite offices retain their tandem switching functionality.

determine the closest network node to each particular satellite office, measured on the basis of airline distance. The DS0 Impairment Analysis tool uses the satellite to node distances to determine pricing of leased facilities in the calculation of backhaul costs.

Identifying the homing assignments for satellite nodes is a straightforward process that is based on minimizing the total airline distance between the satellite node and its serving network node. The FRP assigns satellite nodes to network nodes by computing the airline distance between every satellite node and every on-ring network node in the study area; after these distances are calculated, the FRP simply associates the satellite node with the nearest network node. The FRP also calculates the average satellite node to network node distance for all satellite offices within the study area.

The process of identifying the homing arrangements for tandem office locations is similar to that used when assigning satellite nodes to their associated network nodes. Again, the goal is to minimize the airline distance between each Node (both satellite nodes and network nodes) and its assigned tandem office.[17] To make the tandem office to node assignments, the FRP first looks for on-ring tandem offices. If the FRP finds tandem offices on rings, it will compute the airline distance between all nodes in the study area and each on-ring tandem.[18] Node-to-tandem office associations are then made on the basis of minimum airline distance. If the FRP does not identify any on-ring tandem offices, it will compute the distance between all nodes in the study area and each

---

[17] Tandem homing assignments are computed for satellite nodes and network nodes (i.e., all nodes in the study area).

[18] Although study areas may include both off-ring and on-ring tandems, off-ring tandems will be ignored in cases where at least one on-ring tandem is found.

off-ring tandem office and then make its node-to-Tandem assignments on the basis of minimum airline distance.

The Facility Ring Processor calculates the distances for all the rings and ring connectors in the study area and divides the sum of these results by the ring node total to produce the average distance per node. These values are used downstream in the Transport Impairment Analysis Tool to calculate costs for cable and structure.

The FRP also computes the satellite office to network node distance and the average node to tandem office distance, as well as the number of regenerators required for rings and ring connectors. Finally, the Processor calculates the distribution of ring distances by density zone. This serves as a proxy for the density-zone distribution of outside plant for the entire study area.[19]

In sum, the Facility Ring Processor does the following:

- Forms rings up to a user-specified maximum node count
- Classifies node exceeding the distance threshold as satellite offices
- Calculates node-to-node distances
- Calculates average internodal distance for all rings
- Calculates ring connector distances
- Assigns satellite locations to the nearest ring node
- Computes satellite-to-node distances (airline and rectilinear)
- Determines the number of regenerators required for rings, ring connectors and satellite offices
- Assigns network and satellite nodes to the nearest tandem switching location
- Computes node to tandem and satellite to tandem distances.

[19] The DS0 Impairment tool allows separate structure construction investment inputs for nine density zones.

- Produces distance distribution by density zone

B. Transport Impairment Analysis Tool

1. Overview

The Transport Impairment Analysis Tool uses ring data calculated by the Facility Ring Processor to compute transport costs, including the recurring costs of the cable and supporting structure in the ring systems, the transmission equipment used in the rings, and the collocation space in the nodes and satellite locations required for the transmission equipment. [20]

2. Facility Construction

The transmission facility investment includes the optical fiber cable interconnecting the ring nodes, along with the supporting structure (poles, trenches, conduit, etc.) for the cable.[21] The Tool uses the average distance per node and the distance distribution by density zone produced by the Facility Ring Processor to calculate the transmission facility recurring cost, as described below.

The Tool calculates the structure cost as follows:

- **Gross Structure Investment** = [(Structure miles per node segment) * (Structure cost per foot) * 5,280 ft/mi. + (Fiber strands per OC-48 system) *

---

[20] This space is in addition to collocation space required to house the DLC equipment discussed earlier.

[21] The structure investment calculations allow for sharing of structure among possibly several service providers. Trenches, for example, commonly contain cables owned by several telecommunications carriers. In such cases, it is appropriate to assume that several entities share the structure investment.

(Cost per strand foot) + (Fixed cable cost per foot)] * 5,280 ft/mi. * (Structure miles per node segment) * Number of Nodes + [(Leased cost per foot) * (Structure miles per node segment) * 5,280 ft/mi.][22]

The structure cost per foot is the weighted average of aerial, buried and underground construction, determined by multiplying the unit cost for each type of structure by the estimated frequency of occurrence of each, adjusted for structure sharing among multiple users of the structure. The leased structure cost per foot is the fraction leased by density zone weighted by the density zone distribution of the structure distance.

- **Cost per Foot** = [(Aerial structure cost) * (Aerial weighted structure distribution) * (Aerial weighted structure sharing)] + [(Buried structure cost) * (Buried weighted structure distribution) * (Buried weighted structure sharing)] + [(Underground structure cost) * (Underground weighted structure distribution) * (Underground weighted structure sharing)],[23]

where

- **Aerial Weighted Structure Distribution** = Sum for all density zones of (Structure distance density zone distribution * Aerial structure fraction)

[22] *See* Transport Impairment Analysis tool at the "Facility Cost Calculator" tab, cell E80 and E81 for detailed calculations.

[23] *See* Transport Impairment Analysis tool at the "Fiber Structure" tab for calculation of structure cost per foot and structure cost per foot leased.

- **Aerial Weighted Structure Sharing** = Sum for all density zones of (Structure distance density zone distribution * Aerial structure sharing)

- **Aerial Structure Cost** = [(Cost per pole) ÷ (Pole Spacing)] * [1 – (fraction aerial structure leased)]

- **Buried Structure Cost** = (Buried Excavation-Restoration per ft)

- **Underground Structure Cost** = [(Conduit per ft.) + [(Pull box investment) ÷ (pullbox spacing)] + (Underground Excavation & Restoration per ft.)] * [1 – (fraction underground structure leased)]

3. Annual Cost Factors

Calculation of recurring costs requires inputs for cost of capital, economic lives, depreciation type, salvage values, and various taxes in addition to investment. The Tool uses corresponding user-adjustable input factors to compute annual cost factors for the three structure types:[24]

- **Fiber ACF** = (Aerial ACF) + (Buried ACF) + (Underground ACF),

where

[24] These inputs are usually ordered by state commissions in TELRIC cases.

- **Aerial ACF** = {[(Ratio of pole cost to total aerial cost) * (Pole ACF)] + [(Ratio of non-pole aerial cost to total aerial cost) * (Aerial fiber ACF)]} * (Aerial weighting)

- **Buried ACF** = (Buried fiber ACF) * (Buried weighting)

- **Underground ACF** = {[(Ratio of conduit cost to total underground cost) * (Conduit ACF)] + [(Ratio of non-conduit underground cost to total underground cost) * (Underground fiber ACF)]} * (Underground weighting)[25]

4. Transmission Equipment

Equipment required in the transport network includes SONET add-drop multiplexers (ADMs), optical and electrical patch panels, and power distribution equipment, all of which is installed in collocation spaces in ILEC wire centers where UNE-L loops terminate.

The Tool assumes OC-48 transport on all rings. The DS-1 and DS-3 signals generated by the DLC equipment collocated at each ILEC wire center must be multiplexed up to OC-48 at network nodes for transport to the CLEC switch location. Suitable leased transport carries these signals between satellite offices and the network nodes to which they are assigned. The ADM investment in the Tool include a fixed component for common equipment and a variable component for modules that provide the DS-3 interfaces at the node.

---

[25] *See* Transport Impairment Analysis tool.xls at the "Fiber Structure" tab, cells B90:B93 for calculation of the fiber ACF.

- **Gross Investment (OC-48)** = [(OC-48 ADM base module fixed cost) + (Installation labor cost per OC-48 base module)] * (Number of OC-48 base modules)] + [(Cost per added DS-3) * (Number of DS-3s)] + (Number of frames required for OC-48) * (Cost per frame)][26]

User-adjustable inputs in the "Equipment Inputs" tab allow the user to specify the cost, capacity, and current drain (for assigning power distribution costs) for the base unit and the sub-modules. The Tool also allows the user to specify engineering and installation costs. Table 4 lists the Tool's inputs and their default values.[27]

[26] *See* Transport Impairment Analysis tool.xls at the "Facility Cost Calculator" tab, Cell E26 for detailed calculations.

[27] The values contained in the tables in this document are examples; see the Impairments Inputs Portfolio for the specific values filed in a given jurisdiction.

Table 4

OC-48 Costs in Transport Impairment Analysis Tool

Item	Cost
Fixed	$28,632
Cost per added module	$12,600
Capacity per module (DS-3)	12
Engineered DS-3 fill	80%
Frames required per base module	0.5
Current drain amps (per base module)	10
Current drain amps (per sub-module)	2.5
Labor type	1
Labor rate – Labor type 1[28]	$50
Hours - Labor type 1	21
Labor type	2
Labor rate – Labor type 2	$50
Hours - Labor type 2	18
Frame Cost	$350

5. Fiber Distribution Panel Investment

The fiber distribution panel terminates the fiber cable and allows manual cross-connection of optical level transmission signals using fiber jumpers. The "Equipment

[28] In the model, the user adjustable labor rate (set here at $50) has a state specific wage index applied to it.

Inputs" tab contains user-adjustable inputs for the capacity and the practical fill of the panel, the number of panels that can fit in a collocation frame, and the expected life, net salvage and annual maintenance factors for the optical patch panel. Table 5 shows these inputs and their default values.

Table 5

Fiber Distribution Panel Costs in the Transport Impairment Analysis Tool

Item	Cost
Panel	$200
Capacity (fiber strands)	24
Equipment Fill	100%
Cost to terminate a strand	$60
Panels per frame	5
Labor type	1
Labor rate – Labor type 1	$50
Hours - Labor 1	0.5
Labor type	2
Labor rate – Labor type 2	$50
Hours - Labor 2	5

The investment in the fiber distribution panel is based on the number of fiber terminations required by the ring connections. The Tool assumes four-fiber bidirectional line-switched rings, so that four fiber strands are equipped per OC-48. Eight strands are thus required per OC-48 for the ring connection: four each in the eastbound and westbound directions. Another eight terminations per OC-48 are required for the ADM The calculations for the fiber distribution panel investment are as follows:[29]

- **Gross Investment** = [(Number of panels required * Cost per panel) + (Installation labor per connection * Number of connections required) + (Labor cost per panel * Number of panels required)],

where

- **Connections Required** = 4 * OC-48 base modules required

- **Panels Required** = Number of connections required ÷ (panel capacity * equipment fill)

6. Battery Distribution Fuse Bay Investment

A CLEC collocation space normally requires a single Battery Distribution Fuse Bay (BDFB) frame, so the BDFB serves the DLC equipment in addition to the transmission equipment. The Tool assumes a default 300-amp BDFB, with the BDFB investment assigned to transport proportional to the fraction of the total BDFB current capacity required by the ADM. Table 6 lists the BDFB-related inputs.

[29] *See* Transport Impairment Analysis tool.xls at the "Facility Cost Calculator" tab for detailed calculations.

Table 6

Power Costs in Transport Cost tool

Battery Distribution Fuse Bay - Node

Capacity (amps)	300
Net price per panel	$5,500
Maximum fill	100%
Labor type	3
Labor Rate – Labor type 1	$50
Hours - Labor 1	24.0

- **Gross Investment** = [(Cost of BDFB) + (Installation labor cost per BDFB)] * (BDFB prorating factor)

The BDFB Prorating Factor is calculated as:

- **BDFB Prorating Factor** = [(Current drain of OC-48 base module) * (Quantity of base modules) + (Current drain of OC-48 sub-modules) * (Quantity of OC-48 sub-modules)] ÷ (BDFB current capacity)

The user has the option of including the costs of the BDFB in the impairment analysis. Conservatively, for the filing in Washington, the costs of the BDFB are not included.

7. Collocation Space

The OC-48 multiplexers, optical patch panels, and BDFB equipment identified in the Transport Impairment Analysis Tool occupy collocation space along with the DLC equipment identified in the DS0 Impairment Analysis tool. Both tools use a consistent methodology for calculating collocation costs.[30]

8. Maintenance and Taxes

The "Facility Cost Calculator" tab adds maintenance expense and taxes to the monthly transport cos. The Tool uses a maintenance factor representing the ratio of annual maintenance expense to gross investment to calculate average monthly maintenance cost. The default value is based on the Circuit Equipment maintenance factor adopted by the FCC for use in its Synthesis Model, and the tax rate is region-specific. .

9. Summary of Approach

The Transport Impairment Analysis Tool produces the average cost per DS-3 as a function of the total number of DS-3s active at a network node by calculating costs for equipment and collocation space required for input demand ranging from one to forty-eight DS-3s. The critical output for the backhaul portion of the impairment analysis is

---

[30] The calculations are based on the same collocation charges. The primary difference is that the node collocation is sized to 300 square feet and is assumed to require a 300 Amp BDFB and power feed. The equipment required for the backhaul of voice grade loops is assigned a pro-rata share of the costs. For example, the floor space related collocation costs are divided by 300 and then assigned based on the number of frames required (which could be fractional) times 11.5 sq ft per frame. Similarly, power related charges are assigned based on the current drain of an OC-48 divided by 300 amps.

the cost of a CLEC-provided DS-3, and the Tool computes this cost by dividing the levelized costs of collocation, equipment and facilities by the capacity of the equipment for which the investment was calculated. The Tool is designed to calculate a CLEC's *minimum* cost disadvantage under the assumption that its physical transport assets are fully utilized. Thus, the ultimate transport impairment calculation in the DS0 Impairment tool assumes a utilization of 80% on the fiber ring. In other words, backhaul costs are calculated assuming 39 of the 48 DS-3 channels in the OC-48 fiber ring are utilized even though the maximum demand at any wire center in the analysis is 2 and the median demand across all study areas is only 1 DS-3. The assumption of 80% utilization is extraordinarily conservative.

III. THE DS0 IMPAIRMENT ANALYSIS TOOL

A. Overview

A CLEC's cost disadvantage relative to the ILEC, with respect to mass-market local voice services, is due in large part to the cost the CLEC must incur to extend UNE loops to its own switch location. This impairment arises because of the additional cost required to overcome the closed network of the incumbent. To establish service over a voice grade loop, an ILEC need only connect the vertical side of its Main Distribution Frame ("MDF") to the horizontal side of the frame using an MDF tie pair that is nothing more than a few feet of 24-gauge copper wire, at a cost of only about 24 cents for a 10-foot length.[31] In other words, a simple inexpensive cross-connect between an end-user's

[31] See for example pricing information at http://www.phonegeeks.com/croswir1pair.html. In fact, in many instances, the retail customer's location is already pre-wired to the ILEC's switch port. Only a software instruction is required, rather than physical work, to initiate service.

loop and the ILEC's switch represents the extent and complexity of the ILEC's backhaul requirement. However, a facilities-based new entrant (*i.e.*, a CLEC providing its own switching) must pre-establish an extensive network of facilities and equipment to serve the same purpose achieved by the ILEC's MDF tie pair.[32] Because of the design of the ILEC's local network, the CLEC must incur very large sunk investments to cross-connect the first customer to be served, while the ILEC has a sunk investment of only a few pennies.

The analytical framework of the DS0 Impairment Analysis tool quantifies the minimum added equipment and network capability a CLEC would require to achieve the equivalent functionality of an MDF tie pair for the ILEC.[33] The DS0 Impairment Analysis tool computes the relevant costs in each of the appropriate categories based on information specific to each ILEC wire center in the study area.

The total number of lines the particular entrant might practically serve in an individual ILEC office must be known to compute a local service cost disadvantage. The DS0 Impairment Analysis tool calculates the lines addressed by the CLEC by multiplying the eligible local service VGEs (voice-grade equivalents) of the incumbent for a specific office in the study area by the market share the new entrant is expected to achieve and maintain. The result is the number of lines in each ILEC wire center that the CLEC will

---

[32] See Figure 1 in the direct testimony.

[33] The costs for loops connecting the customer premises to the ILECs serving wire center are not included in the backhaul cost calculation. It is assumed that whether the new entrant or the ILEC provides service, the same loop is required. This is generally accurate except for the instances where the ILEC employs integrated digital loop carrier ("IDLC"). To the extent the customer must be moved from IDLC and there is a charge for the transfer, these costs are captured in the hot cut expenses included in the DS0 Impairment Analysis tool.

engineer its equipment and network to serve.[34] The DS0 Impairment Analysis tool calculates the number of "CLEC addressable lines" in a wire center as the sum of the following:[35]

<u>Addressable Business Lines</u> = B x {1 – [D x I x (1 – T)]} x (1 – E)

<u>Addressable Residential Lines</u> = R x {1 – [D x I x (1 – T)]},

where B = Total Business VGEs in service
R = Total Residential VGEs in service
E = % Enterprise Customers
D = % of VGEs Served by DLC
I = % of DLC Lines Served via IDLC
T = % of IDLC Lines Transferable to UDLC or Copper Pairs
and thus [D*I*(1-T)] = % of all loops not addressable because of IDLC unbundling issues

- **% of VGEs Served by DLC** = User adjustable input that indicates the proportion of local loops in a geographic area that employ digital loop carrier in the feeder network. The default assumption relies on the ILEC's DLC line counts reported in its ARMIS filing.

---

[34] Because the cost disadvantage is a function of number of lines served in a particular office by an individual competitor, and because few of the costs vary by the particular office under consideration, precisely specifying the market share of a single competitor in a single office is not critical. Rather, it is important that the market penetration percentage produces a representative number of lines that would be addressed by a single CLEC in a single office.

[35] CLECs will only be able to compete for a subset of the total voice grade equivalents (VGEs) in a given wire center. Residential lines served by IDLC would be excluded, in addition to any customer locations where it is otherwise deemed economic to serve the location with a DS-1 loop (it is highly unlikely that a CLEC could or would price its single line/multi-line local services so as to capture such customers). As a

- **% of DLC Lines Served via IDLC** = User adjustable input required to develop the proportion of DLC lines served using IDLC technology. Different percentages of IDLC penetration can be input based on the density of the wire center.

- **% of IDLC Lines Transferable to UDLC or Copper Pairs** = Proportion of DLC loops that employ IDLC technology for which the ILEC can transfer the loop to UDLC or spare copper.[36]

The calculation of the percentage of enterprise customers is based on a bottom-up formulation involving separate inputs for the study area. First, the model uses an input matrix estimating the business line distribution by customer location size for the study area in question by UNE zone:

result, these VGEs should be excluded from the addressable market. The DS0 Impairment Analysis tool refers to the lines that *do not* fall into one of these groups as "CLEC addressable lines."

[36] When IDLC is used to provision an ILEC loop, individual circuits remain multiplexed within a DS-1 at the ILEC's DSX-1 from its DLC Central Office Terminal ("COT"). Although such circuits can technically be groomed onto a DS-1 dedicated to the CLEC, most ILECs are not offering that type of connectivity to CLECs. CLECs are therefore usually forced to have the ILEC transfer UNE-L loops to a spare copper pair if available, or to spare Universal DLC equipment, also if available. Given the mandated requirement of

Percent Lines Above Crossover (for Enterprise Customers)

	UNE Zone				
Lines	**1**	**2**	**3**	**4**	**5**
1	95%	95%	96%	93%	91%
2	90%	91%	94%	89%	86%
3	88%	87%	90%	85%	82%
4	88%	83%	87%	80%	77%
5	83%	81%	84%	77%	74%
6	83%	77%	81%	74%	71%
7	80%	77%	80%	71%	67%
8	80%	76%	78%	71%	67%
10	74%	70%	76%	63%	60%
12	74%	66%	70%	59%	58%
16	70%	60%	65%	55%	51%
20	66%	57%	63%	48%	49%
24	66%	50%	60%	44%	43%
999	75%	66%	72%	58%	62%

full subloop unbundling in the FCC's Third Report and Order, this figure should be 100%; in practice, however, this is often not the case.

The business line threshold percentages are used in conjunction with an input that specifies the DS-1 crossover, that is, when it becomes more economical for the CLEC to provision customers via a DS-1 (in which case these customers will not be served via voice-grade loops and are excluded, as per the equation above). This input assumption can be made to vary for each UNE zone in the model. For our purposes here, we assume a weighted crossover of twelve lines.

Given the projected number of mass-market voice grade loops that must be accommodated in an ILEC wire center,[37] the DS0 Impairment Analysis tool determines the following:

- The quantity of equipment a CLEC will need to collocate to extend the UNE-L loops from a particular office to its own switch that, by necessity, is in a different location.[38] In general terms, this equipment includes
    - DLC remote terminal equipment in the ILEC's wire center serving retail customer loops.
    - Corresponding DLC central office terminal equipment at the CLEC switch location.
    - Cross-connection equipment in both the ILEC office and the CLEC switch locations.

---

[37] Because the FCC has determined that a particular location will be assigned to the mass or enterprise market based upon whether the location could economically be served by a DS-1 loop, most enterprise customers (even though they could in principle have a large number of individual locations that have all the characteristics of a mass-market location) will normally be served via DS-1 or higher capacity facilities.

[38] Even an efficient CLEC could not achieve the scale economies necessary to collocate switches. The CLEC would almost always have fewer lines per switch than the ILEC and lower utilization of inter-switch trunks. Furthermore, CLEC circuit switching equipment is either barred from ILEC collocation space, or the rules for permitting such collocation are so onerous as to make it infeasible.

- o Power distribution equipment.

- The costs of collocation space, power, facility cross-connection, construction and other collocation-related costs based on state-specific and ILEC-specific collocation charges.

- The cost of connecting CLEC circuits at the ILEC wire center to the CLEC switch location, otherwise referred to as CLEC backhaul. These costs involve leased transport connecting small satellite offices to CLEC network nodes, plus costs for CLEC-provided transport facilities from a CLEC network node to the CLEC switch location. Leased transport facility costs are calculated based on three factors: (1) the distance between the satellite office and its associated network node,[39] (2) the capacity of the facility required,[40] and (3) the applicable charges for leased facilities or the unit cost of CLEC-provided facilities.[41] A later section discusses quantification of the CLEC-provided transport facility costs.[42]

---

[39] See Section III.A for further explanation of how this distance is determined.

[40] The capacity of the facility is governed by the type of DLC equipment used (which will require either a DS-1 or DS-3 interface), the number of lines served at the location, and the concentration ratio used by the DLC system.

[41] The tool employs, as a default, interstate access rates because the service can be obtained between any ILEC offices. The same is not generally true for UNE transport. As specified by the user, the tool employs the selected short (1 year), mid-range (2 to 3 year), or long-term (4 to 5 year) price(s), applies any umbrella discounts, and determines the applicable recurring and non-recurring charges based on the rate regulation applicable at the end-points of the span and on the capacity of the leased channel(s).

[42] The costs reflected in the DS0 Impairment Analysis tool are designed to calculate the *minimum* cost disadvantage that a CLEC would suffer, assuming its physical transport assets were used at an extremely high rate of fill for a typical CLEC (80% utilization is assumed as the steady-state once the full ramp-up of demand is complete). This corresponds to the assumption that 39 of 48 DS-3 channels are used in the OC-48 fiber ring, a very conservative assumption. See Section II.C below.

- The costs charged by the incumbent when customers are transferred from the ILEC network to the CLEC network (*i.e.*, to execute the "hot-cut"), and, to the extent quantified, any corresponding costs to the CLEC for completing the customer transfer.

The tool also adjusts the calculated costs for the timing of the cash flows and (for the effects of customer demand "ramping-up" to the projected demand level in the office.

B. First DS0 Cost Component – Costs of Preparing the Loop for Transport Out of ILEC Wire Centers

As noted above, the ILECs' loop plant terminates at its wire centers – the first points at which a CLEC can feasibly access UNE voice-grade loops. Unlike the ILEC, whose switch is nearly always located where its loops terminate, for any customer served by the CLEC, the CLEC must incur *additional* costs to prepare the communications for transport to the location at which the loop will ultimately terminate on the CLEC's local switch port.

The CLEC must install equipment that terminates, digitizes, concentrates, and multiplexes the customer communications in each ILEC wire center where it hopes to provide competitive local service. This equipment must be placed in collocation space and use power and cross-connection services obtained from the ILEC.

1. Equipment Costs

A CLEC requires three principal types of equipment when it provides voice grade local services using UNE-L and backhauls them to its own circuit switch:

- **Digital Loop Carrier (DLC) equipment** - the electronics necessary to digitize, concentrate, and multiplex the individual voice grade loops for transmission to the switch;[43]

- **Facility terminating equipment** - the cross-connection equipment within the CLEC's collocation facilities in each ILEC wire center on which the incoming voice grade loops and the outbound interoffice facilities terminate and where collocated equipment is interconnected.

- **Power Distribution Equipment –** Battery Distribution Fuse Bay and related equipment

a) Digital Loop Carrier (DLC)

To calculate the DLC investment component at a particular wire center, the DS0 Impairment Analysis tool considers three DLC size options, based on the maximum

[43] Although this discussion is in terms of the cost of equipment in the local wire center, some node equipment is also included (see Section III below). For example, terminal equipment associated with the DLC remote terminal in the wire center is included with the investment required in the collocation space. Although this equipment is not physically placed within the wire center, it is an investment that is necessitated by the equipment deployed within the collocation space. DLC costs are further disaggregated according to four potential cost drivers, which are derived based on the number of projected CLEC lines to be served. These include common equipment, frames, in-frame submodules (shelves), and line cards.

number of lines per unit: Type 1 = 2016 lines; Type 2 = 120 lines; and Type 3 = 24 lines. For each ILEC wire center, the DS0 Impairment Analysis tool determines the bottom-up gross investment associated with each of the three types of DLC equipment and then selects the DLC type that minimizes the gross investment for the number of lines, based on market share, to be served in an office.[44]

When quantifying the cost of a DLC installation, the DS0 Impairment Analysis tool establishes the number of lines the CLEC would potentially serve, determines the equipment that must be placed both at the ILEC collocation site and at the CLEC switching node, and employs bottom-up estimates of the material plus total hours and labor rates for engineering, installing, turning up and testing the DLC equipment. The following table shows an example of the components included in the DLC cost investment calculation.[45]

---

[44] *See* DS0 impairment analysis tool.xls at tabs titled "DLC type 1", "DLC type 2", and "DLC type 3". Note that employing three different DLC options is very conservative. A CLEC entrant would probably deploy a single type to simplify its maintenance procedures and maximize the size of its equipment purchases, thereby incurring unacceptably low fill rates.

[45] The highlighted variables are user adjustable inputs.

Table 1 - Example of DLC Cost Calculations (DLC Type 1)

	Per	2016	Line Increment			
	Inputs			Allocation		Cost
	Material			LSO (RT)	POP (COT)	
Firmware & Common Plug Ins	$ 12,600.00			1.00	0.20	$ 15,120.00
Electrical Transceiver	$ 800.00			1.00	0.20	$ 960.00
Channel Bank Assembly & Commons	$ 2,166.00			-	0.20	$ 433.20
DSX-1 and Cabling	$ 800.00			-	0.20	$ 160.00
Test Access System & Equipment	$ -			-	0.20	$ -
						$ 16,673.20
		Labor Hrs	Labor Type			
Engineering (hrs.)		12.00	1	1.00	0.20	$ 654.05
Place, Wire, Turn Up & Test Equipment		7.50	2	1.00	0.20	$ 408.78
Install & Cross Connect DSX		1.75	2	-	0.20	$ 15.90
						$ 1,078.73
					2,016	$ 17,751.93

	Per	672	Line Increment			
	Inputs			Allocation		Cost
	Material			LSO (RT)	POP (COT)	
Time Slot Interchangers	$ 2,200.00			1.00	0.20	$ 2,640.00
					672	$ 2,640.00

	Per	224	Line Increment			
	Inputs			Allocation		Cost
	Material			LSO (RT)	POP (COT)	
Channel Bank Assembly, Commons & Cables	$ 2,166.00			1.00	-	$ 2,166.00
		Labor Hrs	Labor Type			
Place CBA, Place and Terminate DS0 Cabling		6.00	2	1.00	-	$ 272.52
					224	$ 2,438.52

	Per	4	Line Increment			
	Inputs			Allocation		Cost
	Material			LSO (RT)	POP (COT)	
DS0 Line Card	$180.00			1.00	-	$ 180.00
DS1/U Interface Card	$288.00			-	0.0417	$ 12.00
					4	$ 192.00

The table shows the inputs for the tool based on an Alcatel Litespan® 2000 DLC installed in a central office environment. The calculations assume that Integrated Digital Loop Carrier ("IDLC") equipment is deployed with five remote terminals at ILEC collocation arrangements per one central office terminal at the CLEC switch location. Total installed costs consist of four main cost categories:

- Common equipment (one per 2,016 lines of capacity at each ILEC collocation end plus 1/5th of a unit at the CLEC switch end) for a total of $17,752;

- Time Slot Interchange (one set per 672 lines of capacity at each ILEC collocation end plus 1/5th of a set at the CLEC switch end) for a total of $2,640;

- Channel Bank Assemblies (channel card frames) (one per 224 lines of capacity at each ILEC collocation end and 1/5th of one Channel Bank Assembly per 2,016 lines of capacity at the CLEC switch location) for a total of $2,438;

- The cost per POTS channel unit card (one per 4 lines of capacity at each ILEC collocation end plus 1/24th of a DS-1/U IDLC switch interface card per POTS line card)[46] of $192.

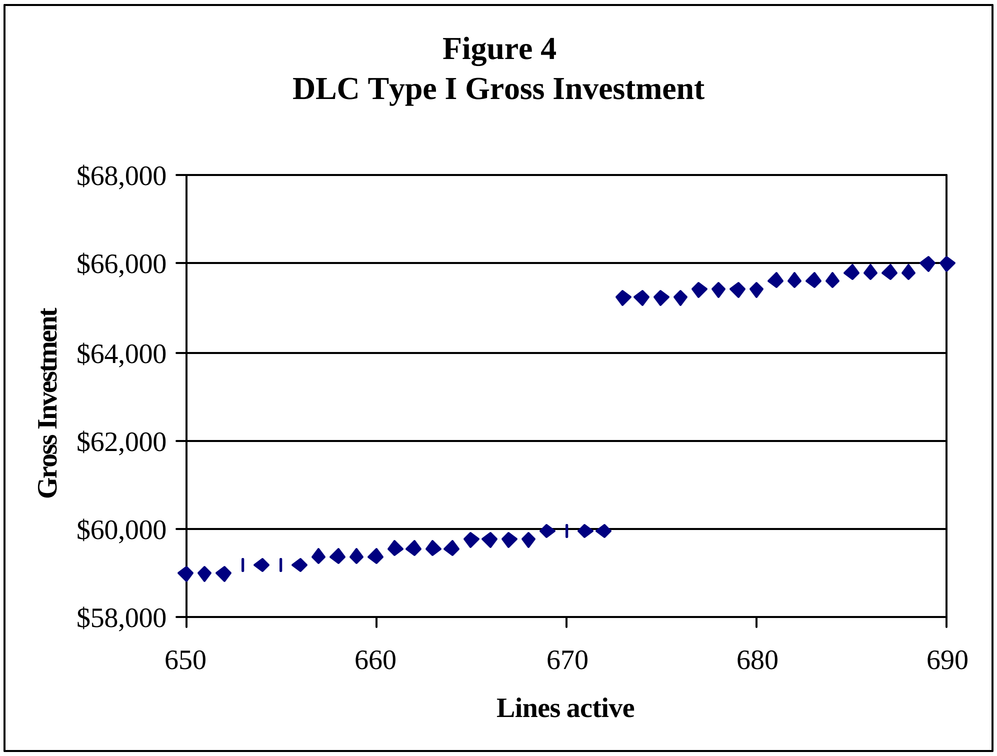
Therefore, the total installed cost necessary to serve the first four lines is $17,752 + $2,640 + $2,438 + $192 = $23,022.[47] Figure 4 illustrates how the gross investment

---

[46] This assumes a traffic concentration ratio of 4:1 and a DS-1/U card with 24 DS-0 time slots per card. Therefore one DS-1/U card can handle 96 POTS channels at a 4:1 concentration ratio. Since each POTS channel unit card handles 4 POTS lines, one DS-1/U card is required for every 24 POTS line cards (96 ÷ 4 = 24).

[47] Inputs for the Type 2 and Type 3 DLC equipments are based on the use of Advanced Fibre Communications ("AFC") Model UMC-1000.

changes as the number of lines served



increases.

Figure 4 graphically depicts the "lumpy" nature of the gross investment. In particular, the incremental investment for the time slot interchangers is apparent at 672 line capacity intervals, and the increment for the line card investment is evident every four lines.

As discussed above, the DS0 Impairment Analysis tool determines whether Type 1, Type 2 or Type 3 DLC equipment results in the least gross investment for each ILEC wire center by calculating the total DLC investment for each of the three types of DLC equipment (based on the number of lines the CLEC is projected to serve at that wire center).[48] In general, the DLC investment is calculated as follows:[49]

- **DLC Type 1 Investment** = $L \div F \div 2016 \times C_1$
  $+ L \div F \div 672 \times T$
  $+ L \div F \div 224 \times B$
  $+ L \div F \div 4 \times P_1$

- **DLC Type 2 Investment** = $L \div F \div 120 \times C_2$
  $+ L \div F \div 6 \times P_2$

- **DLC Type 3 Investment** = $L \div F \div 24 \times C_3$
  $+ L \div F \div 6 \times P_2$,

where

L = Line Capacity Required
F = Engineered Fill
C_1 = Common Equipment Investment for Type 1 DLC
C_2 = Common Equipment Investment for Type 2 DLC
C_3 = Common Equipment Investment for Type 3 DLC
T = Time Slot Interchanger Investment for Type 1 DLC
B = Channel Bank Equipment Investment for Type 1 DLC.

---

[48] *See* DS0 impairment analysis tool.xls at tabs "DLC type 1", "DLC type 2" and "DLC type 3" as well as the "Impairment by office" tab at columns titled *DLC Type 1 Investment (both Common & Line Related)*, *DLC Type 2 Investment (both Common & Line Related)*, and *DLC Type 3 Investment (both Common & Line Related)* for the DLC investment calculations.

[49] Note that, in each case, when the number of projected lines to be served is divided by the engineered fill, the result is rounded up (to an integer) before being multiplied by the installed unit cost. This is necessary to provide the correct cost by equipment group. For example, if there are four lines per line card and five lines are to be served, two line cards are required.

P_1 = POTS Line Card Investment for Type 1 DLC
P_2 = POTS Line Card Investment for Types 2 & 3 DLC

In addition to selecting the option that minimizes total investment per line, the tool determines the number of frames required (which is used to determine collocation space requirements), the transport interface associated with the selected DLC, the designed line concentration ratio (which is used to determine the type and quantity of transport facilities), the maximum power consumption (used to size power feeders), and average power consumption (used to determine total power consumption). In addition, a certain proportion of copper fed loops will require the use of extended range cards in the CLEC collocation arrangement. Therefore, the tool allows the user to specify both the power usage for range extended loops[50] as well as the expected number of range extended loops for each wire center based on density.[51]

b) Facility Terminating Equipment (Cross-connection Panels)

The DS0 Impairment Analysis tool calculates termination equipment costs based on equipment characteristics supplied by the user, including the wholesale price of the equipment (including any discounts from list prices), the maximum fill rate, the termination capacity, the unit height (to determine frame deployment), labor costs and

---

[50] Long loops, such as those terminating at more than 18,000 feet from the central office, pose electrical challenges. When the subscriber goes off-hook, a cable pair behaves like a single loop inductance coil with a -48 Volts DC potential and an electrical current flow of between 20 - 50 mA DC (Electrical current values vary with cable length and gauge). A minimum current of approximately 20 milliamps DC is required to convey terminal signaling information to the network. There is also a minimum power level required to provide adequate volume for the voice signal. An extended range line card increases the line voltage and amplifies the signal to account for these difficulties.

labor hours associated with engineering and installing the equipment, the useable vertical height and footprint for the frame, and power capacity/requirements.[52] As a first step, the number of transport backhaul facilities required by the CLEC at each ILEC wire center is established. This calculation is based on the projected line count served by the CLEC in a particular wire center, the concentration ratio of the DLC, and the type of transport interface employed by the selected DLC size (either DS-1 or DS-3). This general calculation is as follows:

- **Number of Required Transport Backhaul Facilities**[53] = Rounded up integer {(Projected lines) ÷ [(Facility capacity)[54] * (Concentration ratio)]}

The number of transport backhaul facilities required for each wire center, generated by the above equation, is then used both to determine the required number of cross connection panels and to price-out the backhaul. Based on the type of transport (DS-1 or DS-3), the cross-connect panel requirements are determined (*i.e.*, DSX-1 for DS-1s and DSX-3 for DS-3s) using the following general computation:

---

[51] Because many range extended loops have already been converted to DLC, the DS0 Impairment tool allows the user to specify the percentage of loops greater than 18,000 feet in length, and the proportion of loops greater than 18,000 feet in length requiring range extension, separately.

[52] Forward-looking economic costs for an efficient carrier are employed. These inputs are in general consistent with those underlying state-approved TELRIC studies. Where they are not available, the study relies on the experience of independent consultants and/or trade press publications or websites.

[53] *See* column titled Number of Transport Facilities in DS0 impairment analysis tool.xls at the "Impairment by Office" tab.

[54] For a DS-1 interface, the facility capacity is 24 DS0s; for a DS-3 facility, it is 24*28=672 DS0s.

- **Number of Required DS-1/DS-3 Cross-Connection Panels**[55] = Rounded up integer {[(Terminations required per active transport backhaul facility) * (Number of transport backhaul facilities required)] ÷ [(Termination capacity of panel * Maximum fill)]}

A similar calculation is performed for the DS0 termination panels except that the number of active voice grade lines is used instead of the number of active transport backhaul facilities:

- **Number of Required DS0 Cross-Connection panels**[56] = Rounded up integer {[(Terminations required per active voice grade line) * (Projected Lines)] ÷ [(Termination capacity of panel) * (Maximum fill)}

The DS0 Impairment Analysis tool assumes that all the termination panels are placed in the same rack but that rack is separate from the DLC equipment.[57] Accordingly, the number of termination racks (or frames) is determined by the following formula:

---

[55] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled *DS-1 panels* and *DS-3 panels*.

[56] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, column titled *DS0 panels*.

[57] This comports with generally accepted engineering practice that designates powered frames separate from termination frames.

- **Number of Termination Frames**[58] = Rounded up integer {[(DS0 termination panels required * DS0 panel height) + (DS-1 termination panels * DS-1 panel height) + (DS-3 panels required * DS-3 panel height)] ÷ (Standard frame capacity in inches of height)}

The DS0 Impairment Analysis tool computes total termination costs by multiplying the total number of termination frames by the total installed cost of a standard 23 inch rack (iron work only).[59] The installed cost of a standard rack is developed with a bottom-up calculation that combines the total material cost, labor hours, and labor rates as appropriate for the work required.[60]

The tool accumulates the count of all the frames deployed for DLC and termination equipment and multiplies the total frame count by the floor space footprint requirements:

[58] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, column titled "Termination Frames".

[59] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, row titled "Total Termination Investment".

[60] *See* DS0 impairment analysis tool.xls at the "Basic Inputs" tab, row titled "Standard Rack".

Table 2 User Adjustable Input Assumptions for Frame Calculations

satellite office			network node Office	
Number of frames for initial 100 square feet	Number of frames for 100-200 square feet	Number of frames for 200-300 square feet		
6.0	10.0	10.0		
16.7	10.0	10.0	11.5	300.0
Square feet per frame, 100 square feet	Square feet per frame, 100-200 square feet	Square feet per frame, 200-300 square feet	Square feet per frame	Minimum Square Footage Requirement

The square footage requirements are computed differently for the CLEC's network nodes and satellite offices.[61] In satellite offices, although the above defaults are available, the tool allows the user to specify the number of frames per 100 square feet separately for the initial 100, second 100, and third 100 square feet of collocation space. The operative assumption is that, as the total collocation space increases, space is also used more efficiently and thus the default values reflect a proportionately larger number of frames in the second and third blocks of space (*e.g.*, a 200 square-foot collocation space can accommodate 16 frames). At the CLEC network node offices, the square footage per frame is also user adjustable, but fixed over the entire range of collocation

[61] Nevertheless as the size of a satellite collocation approaches the size of a typical node collocation (i.e., 300 square feet), the average square footage per frame numbers converge. More specifically, a 300 square

space. Because a network node collocation is generally established to address a number of services and a wide variety of equipment from the outset (i.e., mass-market, enterprise customers etc.), large initial space arrangements will typically be made, and more efficient placement of equipment will be possible.

The resulting square footage is the minimum amount of collocation space required to serve the specified lines in service, which is used in a subsequent step of the impairment calculation related to collocation costs. Note that the actual space required may be substantially less than the minimum offered by the ILEC, particularly in Satellite collocations. This situation results in added CLEC expense for space not really required.

c) Power Equipment

ILEC collocation charges generally include the functionality of an ILEC-supplied Battery Distribution Fuse Bay (BDFB), however, if the CLEC misjudges its fusing requirements, it may incur substantial future cost of power augments and rearrangements. Accordingly, CLECs may opt to deploy an in-cage BDFB panel to allow a large capacity feed to the cage and insert fusing and filtering within its cage to minimize the need to reconfigure power arrangements. The user has the option to include this equipment or set its costs to zero. If the BDFB costs are included[62], the DS0 Impairment Analysis tool determines the optimally sized BDFB, based on the power consumption of the equipment and, if the collocation is a network node, apportions the cost between the voice grade

---

foot satellite collocation accommodates 26 frames for an average footprint of (300/26) = 11.54 square feet per frame.

[62] The BDFB costs are conservatively not included in the Washington impairment calculations.

service infrastructure and the transport infrastructure. The apportionment factor is the ratio of the maximum power drain of the DLC being provided divided by 300 amps – the maximum capacity judged reasonable for a network node collocation.[63]

The total installed cost of the BDFB is developed from user-adjustable inputs that identify the total material cost plus the labor hours and costs required to install a BDFB. Based on the current drain for the equipment, a look-up is performed to select the panel that has the smallest capacity still large enough to serve the identified current drain. If the user decides to exclude the BDFB, the investment can be set to zero.

[63] Note that because the BDFB is generally only an 8-inch panel, no assignment of floor space or rack space is made for this item.

Table 3

BDFB Costs in the DS0 Impairment Analysis tool

	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5 (Node)**[64]
Net Price per panel	$200	$500	$800	$1,000	$5,500
Capacity (DC Amps)	**20**	**50**	**100**	**200**	**300**
Maximum fill	100%	100%	100%	100%	100%
Labor type	3	3	3	3	3
Labor rate	$50	$50	$50	$50	$50
Hours	14.0	16.5	19.0	21.5	24.0
Total Installed Cost	**$900**	**$1,325**	**$1,750**	**$2,075**	**$6,700**

- **BDFB Prorating Factor** = [(BDFB capacity required for DLC equipment) ÷ (BDFB capacity required in a node collocation based on user-adjustable minimum)]

- **Gross Investment** = (cost of BDFB + installation labor per BDFB) * (BDFB prorating factor)

2. Costs of Collocation Space

Before a CLEC can deploy the equipment required to prepare a loop for transport, it must obtain collocation space from the ILEC in each ILEC wire center. The source data for the DS0 Impairment Analysis Tool includes data on prevailing collocation rates as approved by [the state commission] for the ILEC in [the jurisdiction]. An external process was used to identify the collocation charges relevant to caged physical collocation and to aggregate a number of individual charges to common drivers. For example, there may be separate charges for the collocation application, a space availability report, and engineering of the application. These would be summed together as a single charge with a driver of "per collocation cage" because they all generally apply only to the establishment of the new cage.[65] The DS0 Impairment Analysis tool calculates bottom-up estimates of new entrant collocation costs in each ILEC wire center used to provide service to the customers transferred from the ILEC network. These charges are based on the requirements of the new entrant as determined by the equipment required for the office, as dictated by the number of lines projected to be served in that particular office. The tool accumulates and evaluates current collocation charges organized in the following categories (which tend to have common cost drivers):

---

[64] There is a user adjustable input for minimum power requirements at each network node. The current default is set at 300 amps DC. This is based on the presumption that a typical efficient CLEC could have equipment at such an office for other services (e.g., trunking, data, etc.).

[65] The process treats recurring and non-recurring charges separately. Furthermore, some charges may be converted to an alternative basis so as to simplify computations. For example, if a charge is $0.10 per foot per feed for a 50A power feed, it may be restated to a $10.00 per feed charge if the average feed length is determined to be around 100 feet. This adjustment simplifies the modeling without significantly sacrificing accuracy.

- Power Costs
- Space Occupancy and Construction Charges
- Administrative Charge
- Connectivity Charges
- Transport Connectivity Charges

Depending on the particular ILEC and state, AC power costs are computed as the sum of the charge per feed and the charge per AC amp. The tool employs user adjustable inputs with defaults of two feeds and 20 amps per feed. AC power is typically required for purposes such as lighting and to run ancillary equipment in the collocation. Because DC current powers the telecommunications equipment and the DC current is not generally obtained by rectifying AC power at the collocation cage, AC power requirements are not likely to be substantial or highly variable from cage to cage. The formula for AC power costs is as follows:

- **AC Power Cost** = [(Number of AC power feeds required) * (ILEC charge per AC power feed) + (AC power drain) * (ILEC charge AC amp)][66]

DC power costs are based on the actual power consumption and the size of the feed required for peak demand period. In some cases, the charges may vary by zone and, in such cases, the variations are taken into account by the tool (i.e., the appropriate zone

[66] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "AC Power Recurring" and "AC Power Non-recurring."

charge table is used based on the specific ILEC office under consideration). The tool also accommodates charges based on load amps or fused amps.[67] DC power charges are computed similarly according to the following formula:

- **DC Power Cost** = [(Number of DC power feeds required) * (Appropriate ILEC charge per DC power feed[68]) + (DC power drain) * (Appropriate ILEC charge per DC amp) * (DC load amp:fuse amp conversion factor)][69]

Note that the power requirements at satellite offices are solely due to DLC equipment. At network node offices, the relevant power drains are increased to include the power requirements of an OC-48 multiplexer.[70] The power drain of the multiplexer is considered because, in many instances, the cost of the power feed and/or power, expressed as dollars per DC amp, decreases when more power is purchased. The backhaul infrastructure is assigned a share of the overall power cost at the network node, based on its relative share of the total power drain.

---

[67] In some instances, the ILEC applies power charges according to actual usage; in other instances, it may apply the charge based on a percentage of the maximum potential drain of the equipment. In the latter case, the user may specify a factor that increments the calculated average drain to a different figure more in line with the manner in which the ILEC applies its charges. *See* DS0 impairment analysis tool.xls at the "I" tab, cell D27 "DC peak load:average load conversion factor".

[68] ILEC tariffs for DC power feeds tend to be in fixed increments (e.g., 40 amps, 60 amps, 100 amps, etc.) with capacity determined by peak period potential usage. Accordingly, the DS0 tool determines the peak period drain and then selects the feed that is large enough to carry that level of demand. In some instances, the charges for power drain are "banded." In those cases the tool determines the average current drain for the equipment, determines the appropriate charge band (e.g., greater than 60 amps) and applies the appropriate charge per amp to the average current drain. *See* DS0 impairment analysis tool.xls at tab "S", columns BE:BF and BI:BR.

[69] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "DC Power (Sat) Recurring" and "DC Power (Sat) Non-recurring."

[70] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "DC Power (Node) Recurring" and "DC Power (Node) Non-recurring."

The relevant collocation space occupancy and construction charges can vary by minimum and additional square footage breakpoints as well as by geographic zone. The DS0 Impairment Analysis tool first determines the minimum square footage required to house the equipment that would be deployed in a particular ILEC office (largely based on the estimated number of lines projected for service). This determination is accomplished in a two-step process. First, the number of frames is accumulated (*see* prior discussions regarding how frame counts are derived). Then, according to whether the location is a Satellite or network node, the frame count is multiplied by the appropriate number of square feet required per frame. In the case of network node offices, the default value is 11.5 square feet per frame. In the case of satellite offices, the frame footprint varies by the total number of frames deployed.[71] The tool then selects the smallest block of caged physical collocation the ILEC offers that is sufficiently large to house the frames.[72] For example, if 3 frames are required with a footprint of 11.45 feet per frame, 34.5 square feet of space is required. If the smallest block of collocation is 50 square feet, the tool selects that block. On the other hand, if the minimum size is 100 square feet, that block is selected. To the extent the requirements exceed the minimum collocation block size, the tool selects the least expensive option of a single standard block of collocation space or a smaller standard block combined with additional standard increments.[73] Once the

---

[71] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "Collocation Occupancy Charge Recurring" and "Collocation Occupancy Charge Non-Recurring."

[72] In the case of a network node office, the standard cage size is 300 square feet. Accordingly, the charges selected by the tool for the 300 square feet of collocation are accumulated, divided by 300 and then multiplied by the voice grade space requirements.

[73] Different ILECs offer different initial and additional square footage breakpoints for the computation of relevant collocation construction costs. In addition, these charges may also vary by UNE density zone. Because of the varied nature of ILEC construction and space related charges, the DS0 Impairment tool computes construction charges for every possible collocation size from 1 square foot through 300 square

relevant units of collocation space demand are established, the tool selects the appropriate charges based on the blocks required (by geographic zone, if appropriate) and multiplies the two to establish the space related costs at each wire center:

- **Space Occupancy Cost** = [(Collocation block required based on square footage requirements of equipment) * (Appropriate ILEC charge per unit of space)][74]

The appropriate ILEC administrative charges (both recurring and non-recurring) are added to the specific collocation costs.[75] These are ILEC collocation charges that are independent of the scope or volume of service undertaken by the new entrant. In other words, these charges are the fixed overheads of collocation. Examples of such fees are the collocation application charge, space availability report charges, construction planning fees, charges for light fixtures or keys for locks, and others. Because these items are not demand-driven, they are simply summed, separately, by recurring and non-recurring charge types. In network node offices, these administrative charges are apportioned to voice grade and transport functions separately, based on the frame (i.e., space) requirements of the relevant equipment.

DS0 connectivity (i.e., termination) charges are those imposed to provide the physical connectivity between the ILEC's MDF, where the voice grade loop UNEs of the

---

feet using all the possible minimum and additional combinations, and then selects the minimum charge based on that square footage. The tool then selects the appropriate charge based on the actual square footage requirements for the particular wire center being analyzed. *See* DS0 impairment analysis tool.xls at tab "S", columns CM:DY.

[74] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "Collocation Occupancy Charge (Sat) Recurring" and "Collocation Occupancy Charge (Sat) Recurring."

ILEC terminate, and the collocation space of the new entrant, where its equipment is housed. The charges are applied in proportion to the number of active lines the CLEC will serve.[76] In some instances, the ILEC charges do not include the installation of the cable between the collocation and the first cross-connection frame within ILEC space. In these cases, the new entrant must still incur these costs, which are generally paid to an ILEC-approved contractor. The tool provides for the input of these costs, which are generally expressed as a "per cable, one time charge" and, to the extent they are relevant, they are added to any ILEC charges applied on the same basis.[77] The relevant formula, expressed in general terms, follows:

- **DS0 Connectivity Charges** = {[(Projected CLEC Lines * ILEC charge per 2-wire termination) + Rounded up integer (Projected CLEC Lines ÷ 25) * (ILEC charge per 25 2-wire pairs) + Rounded up integer (Projected CLEC Lines ÷ 100) * (ILEC charge per 100 2-wire pairs) + Rounded up integer (Projected CLEC Lines ÷ 250) * (ILEC charge per 250 2-wire pairs)[78]] + [(Projected CLEC Lines ÷ Maximum 2-wire cable size) * (ILEC standard cable charge + ILEC fixed 2-wire cable charge)]}[79]

---

[75] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "Collocation Administrative Charge Recurring" and "Collocation Administrative Charge Non-Recurring."

[76] Costs include charges per 2-wire termination, per standard block of pairs (such as 25, 100, 200 or 300), and/or per cable installed.

[77] Despite the fact that the costs are neither ILEC applied nor pursuant to a tariff or interconnection agreement, they are, nonetheless, legitimate economic costs that add to the potential impairment of the new entrant. Furthermore, many times ILECs place an intermediate frame called an IDF that also requires cabling and cross-connects, for which the CLEC pays.

[78] Generally each ILEC tariff will include only one charge, either per 25, 100, or 250 terminations.

[79] *See* DS0 impairment analysis tool.xls at the "Impairment by Office", columns titled "DS0 Connectivity Charge Recurring" and "DS0 Connectivity Charge Non-Recurring."

Naturally, if a particular ILEC does not apply a charge, such as one per 25 pairs, the tool will calculate a zero charge and the term will effectively "drop out" of the preceding equation. It is important to note, at this point, that the cost of physically transferring a customer, known as a hot-cut, is *not* part of the DS0 Connectivity Charges. The hot-cut charges and other associated costs are discussed in section D.1 below.

There is a second set of connectivity charges that relate to transport. In effect, the preceding connectivity charges were for the "customer connections" to the collocation. The connectivity charges that are the topic of the next discussion are for the "outputs" of the collocation – the connectivity that links the collocation to its CLEC switching node. Such connectivity is either leased, in which case it will be a DS-1 or DS-3 facility as determined by the demand at the collocation, or it will be a self-constructed facility of the new entrant. Despite the fact that the new entrant may have access to its own facility, it must generally still pay connectivity charges to the ILEC for the segment connecting the manhole outside the ILEC central office (where the new entrant's fiber exits) and the fiber termination panel in the new entrant's collocation. Transport connectivity charges are developed according to the situation that exists in each ILEC central office. If the office is a satellite location, the charges will be DS-1 or DS-3 transport connectivity (but not both). If it is a network node, the connectivity charges will be for fiber-based transmission.

For satellite offices, connectivity charges are computed based on each office's unique situation. First, the tool determines the bandwidth of the connectivity required.

This is a function of the DLC equipment selected. Next, it determines the quantity of transport facilities required.[80] The relevant formulas are as follows:

- **DS-1 Transport (DLC Types 2 and 3)** = [(Number of transport facilities required) * (ILEC fixed charge per DS-1) + Rounded up integer (Number of transport facilities required ÷ 6) * (ILEC charge per 6 DS-1s) + Rounded up integer (Number of transport facilities required ÷ 28) * (ILEC charge per 28 DS-1s) + (Number of transport facilities required ÷ Maximum DS-1 cable size) * (ILEC standard cable charge + DS-1 cable charge)][81]

- **DS-3 Transport (DLC Type 1)** = [(Number of transport facilities required) * (ILEC charge per DS-3) + Rounded up integer (Number of transport facilities required ÷ 6) * (ILEC charge per 6 DS-3s) + (Number of transport facilities required ÷ Maximum DS-3 cable size) * (ILEC standard cable charge + ILEC DS-3 cable charge)][82]

As was the case with DS0 connectivity, connectivity costs may vary based on the number of facilities, blocks of facilities, and/or number of cables.

---

[80] The number of facilities required is the rounded-up result of dividing the lines served by the practical facility fill. The preceding result is then divided by the number of DS0s that can simultaneously operate on the facility (i.e., 24 for a DS-1 and 672 for a DS-3) with that result divided by the concentration ratio associated with the selected DLC equipment.

[81] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "Transport (DS-1/DS-3) Connectivity Recurring" and "Transport (DS-1/DS-3) Connectivity Recurring."

[82] *See* DS0 impairment analysis tool.xls at the "Impairment by Office" tab, columns titled "Transport (DS-1/DS-3) Connectivity Recurring" and "Transport (DS-1/DS-3) Connectivity Recurring."

The relevant formula for the cost of collocation connectivity for leased fiber transport is:

- **Leased Fiber Transport Cost** = [(Number of fibers) * (ILEC charge per fiber) + (Number of fiber pairs ÷ 2) * (ILEC charge per fiber pair) + (Number of fibers ÷ 4) * (ILEC charge per four fibers) + (Number of fibers ÷ 12) * (ILEC charge per 12 fibers) + (ILEC standard cable charge + ILEC fiber cable charge)] * (Number of fiber cables delivered to the collocation)[83]

Where the new entrant has voice grade service equipment in a facility-based collocation (i.e., a network node office), only a small portion of the fiber transport connectivity costs will be attributable to the voice grade services. Accordingly, the above costs include an attribution factor that results in a very conservative assignment of the cost to the DS0 infrastructure (i.e., the ratio of the DS0 backhaul DS-3s required to the DS-3 capacity of the 12-fiber facility * 48 DS-3s per fiber).

The DS0 Impairment Analysis tool offers the option of computing collocation charges at satellite offices in two ways: by the actual amount of space needed, or by imposing minimum purchase blocks for collocation space – thereby forcing the payment of so-called "breakage." In general terms, the collocation cost as described above is as follows:

[83] *See* DS0 impairment analysis tool.xls at the "Impairment by Office", columns titled "Leased Fiber Transport Recurring" and "Leased Fiber Transport Non-Recurring."

- **Monthly collocation cost (breakage):** (Recurring administrative) + (Recurring DS0 connectivity)[84] + (Recurring space occupancy) + (Recurring space construction) + (Recurring transport connectivity) + (Recurring AC power) + (Recurring AC power feed) + (Recurring DC power) + (Recurring DC power feed)] + [(Non-recurring administrative) + (Non-recurring DS0 connectivity) + (Non-recurring space occupancy) + (Non-recurring space construction) + (Non-recurring transport connectivity) + (Non-recurring AC power) + (Non-recurring AC power feed) + (Non-recurring DC power) + (Non-recurring DC power feed)] * (annuity from present amount factor)

- **Monthly collocation cost (no breakage):**[85] {(Recurring administrative) + (Recurring DS0 connectivity) + [(Recurring space occupancy) + (Recurring space construction)] * **(space required/space acquired)** + (Recurring transport connectivity) + [(Recurring AC power) + (Recurring AC power feed) + (Recurring DC power) + (Recurring DC power feed)] * **(power required/power acquired)**} + {(Non-recurring administrative) + (Non-recurring DS0 connectivity) + [(Non-recurring space occupancy) + (Non-recurring space construction)] *** (space required/space acquired)** + (Non-recurring transport connectivity) + [(Non-recurring AC power) + (Non-recurring AC power feed) + (Non-recurring DC power) + (Non-recurring DC

[84] Because DS0 connectivity charges and DC power related charges are purchased only as demand arises, these two collocation cost elements receive an investment adjustment factor prior to the ramp-up adjustment which is later applied to all collocation charges. See Section B.3 below for a discussion of this investment adjustment factor.

[85] Because of the manner in which Node office space requirements are calculated and costed, there is no breakage. Thus, the monthly collocation cost with and without breakage are identical.

power feed)] * **(power required/power acquired)**} * (annuity from present amount factor)

3. Ramp-Up

A new entrant does not acquire all of its customers instantaneously. The gross investment recovery calculations, within the unit costs in the DS0 Impairment Analysis tool, are adjusted to reflect the effect of a "ramp-up" of demand.[86] For example, the DLC common equipment (*i.e.*, the firmware and common plug-ins, the time slot interchangers, and the channel bank assemblies, common cards and cables) is sized to meet projected demand. In other words, the tool selects Type 1, 2 or 3 DLC equipment based on the *final* CLEC market share assumed in the study, even though this demand will obviously not materialize on day one.[87] Use of a ramp-up assumption reflects the greater per line impairment cost associated with common equipment investments being recovered over a smaller number of customer lines than would be the case if the projected demand existed for the entire economic life of the DLC common equipment.

The ramp-up adjustment is best understood as an adjustment to the standard Annual Cost Factor ("ACF") used to derive the annual (or in this case, monthly) costs associated with forward-looking investments incurred to provide service. The ramp-up calculations rely on several user-adjustable inputs to reflect the implications of different

---

[86] The tool does not, however, account for the carrying costs of investments made before service is initiated in a particular area. Those costs alone can constitute a significant barrier to entry.

[87] Likewise, collocation is sized for projected use so as to minimize the likelihood of costly space and/or power augments and to better assure availability of contiguous floor space. Contiguous floor space is important to permit appropriate and economical cross connection of CLEC equipment items.

starting and ending office market share assumptions and the time period required to achieve intermediate and final levels of demand.

For example, assume a 10-year asset life, a 15% cost of money, and a total investment of $1.00. The correct mid-period ACF (assuming straight-line depreciation) in this case is 0.18580. The following table proves that this ACF calculation is correct by demonstrating that it produces just enough revenue to cover the initial $1.00 investment:

Year	Annual Payment	Mid-Year Present Value Factor	Present Value of Annual Payment
1	0.18580	0.93250	0.17326
2	0.18580	0.81087	0.15066
3	0.18580	0.70511	0.13101
4	0.18580	0.61314	0.11392
5	0.18580	0.53316	0.09906
6	0.18580	0.46362	0.08614
7	0.18580	0.40315	0.07491
8	0.18580	0.35056	0.06514
9	0.18580	0.30484	0.05664
10	0.18580	0.26508	0.04925
			1.00000

Assuming a 1,000-line projected demand, the ACF per line is 0.18580/1000 = 0.00018580. Further assume that the fixed investment required to serve these 1,000 lines is $20,000 plus a per-line cost of $2, and that this demand occurs instantaneously. Because the full demand is present immediately, the present value of the investment is $22,000. Once we have calculated the correct ACF, we compute the cost per line as 0.00018580 x $22,000 = $4.0876 per line.

Next, we note that this same cost per line can also be calculated by dividing the initial investment by the present value of the lines, using the cost of capital as the discount rate. Conceptually, we are simply calculating an "annuity" per line by discounting lines instead of the number of periods. Because the total cost recovery occurring in each year is equal to the cost per line multiplied by the number of lines in service in that year, and we want the cost per line to be identical in all years, this approach makes mathematical sense. In the example above, the initial investment required is $22,000. The present value of the lines is computed using the same Present Value factor as in the table above:

Year	Number of Lines in Service	Mid-Year Present Value Factor	Present Value of Lines in Service
1	1,000	0.93250	933
2	1,000	0.81087	811
3	1,000	0.70511	705
4	1,000	0.61314	613
5	1,000	0.53316	533
6	1,000	0.46362	464
7	1,000	0.40315	403
8	1,000	0.35056	351
9	1,000	0.30484	305
10	1,000	0.26508	265
			5,382.0

The $4.0876 computed above can now be computed as $22,000/5,382 = $4.0876 per line.

Now, suppose we will achieve the 1,000 line market share over a linear ramp-up period of five years instead of immediately. We still must invest the $20,000 fixed investment immediately, but that investment is spread out over a number of lines for which the present value will be *lower*, due to the time required to achieve target market share. This translates directly into higher average costs per line. The variable investment per line, however, will not be incurred immediately, but rather will track with market share penetration. Thus, the variable investment will have a present value that is lower than if all of the investments occurred immediately. While costs for both the fixed and variable investments will be developed by spreading the present value of the investment over the present value of the lines, the investment timing differences dictate slightly different treatments for each.

For the fixed investment, because all of the costs are incurred immediately, the present value of the investment is equal to the fixed investment amount. We can show that the ACF necessary to recover the investment is merely the ACF assuming instantaneous market share, multiplied by the ratio of the present value of lines assuming instantaneous market share, and the present value of lines assuming ramp-up. Thus, if we assume mid-period cash flows and a 5-year ramp-up, we produce the following results:

Year	Number of Lines in Service	Mid-Year Present Value Factor	Present Value of Lines in Service
1	200	0.93250	186.5
2	400	0.81087	324.3
3	600	0.70511	423.1
4	800	0.61314	490.5
5	1,000	0.53316	533.2
6	1,000	0.46362	463.6
7	1,000	0.40315	403.2
8	1,000	0.35056	350.6
9	1,000	0.30484	304.8
10	1,000	0.26508	265.1
			3,744.8

Now we compute the ratio of the two line counts 5,382.0/3,744.8 = 1.437187 multiplied by the original ACF of 0.00018580 = 0.0002670. Multiplying this adjusted ACF by the $20,000 initial investment yields $5.34 per line. To demonstrate that this recovers our full investment of $20,000 while yielding a return of 15%, we perform the following calculation:

Year	Lines in Service	Cost per Line	Total Cost Recovered	Mid-Year Present Value Factor	Present Value of Cost Recovered
1	200	$5.34	$1,068.12	0.93250	$996
2	400	$5.34	$2,136.23	0.81087	$1,732
3	600	$5.34	$3,204.35	0.70511	$2,259
4	800	$5.34	$4,272.47	0.61314	$2,620
5	1,000	$5.34	$5,340.59	0.53316	$2,847
6	1,000	$5.34	$5,340.59	0.46362	$2,476
7	1,000	$5.34	$5,340.59	0.40315	$2,153
8	1,000	$5.34	$5,340.59	0.35056	$1,872
9	1,000	$5.34	$5,340.59	0.30484	$1,628
10	1,000	$5.34	$5,340.59	0.26508	$1,416
					$20,000

The calculation differs slightly for the variable investment. Because that investment will occur over time as the number of lines increase toward the target demand levels, the present value of the variable investment is lower than the nominal cost of $2.00 per line. Thus, in order to avoid a cost over-recovery, the present value of the variable investment stream must first be computed as set forth in the following table:

Year	Gross Number of Lines Added	Nominal Cost per Line	Total Cost	Mid-Year Present Value Factor	Present Value of Cost
1	200	$2.00	$400.00	0.93250	$373.00
2	200	$2.00	$400.00	0.81087	$324.35
3	200	$2.00	$400.00	0.70511	$282.04
4	200	$2.00	$400.00	0.61314	$245.26
5	200	$2.00	$400.00	0.53316	$213.26
6	0	0	0	0.46362	$0
7	0	0	0	0.40315	$0
8	0	0	0	0.35056	$0
9	0	0	0	0.30484	$0
10	0	0	0	0.26508	$0
					$1,438

The present value of the variable investment can now be spread over the present value of the lines in a manner similar to the fixed investment. Dividing the $1,438 investment figure by the present value of the lines under this ramp-up scenario computed above of 3,744 yields a cost for variable investments of $0.3839720 per line. This figure is added to the $5.34 per line figure computed above to yield the correct per line investment figure of $5.72. The following table demonstrates that this cost per line is sufficient just to cover the cash flows that are required to be spent over the 10-year period:

Year	Common Equipment Investment	Variable Investments	Lines in Service	Cost Recovery per Line	Total Cost Recovery	Net Cash Flow	Mid-Year Present Value Factor	Present Value of Net Cash Flow
0	($20,000)		0			($20,000)	1.00000	($20,000.00)
1		($400.00)	200	$5.72456	$1,144.91	$744.91	0.93250	$694.63
2		($400.00)	400	$5.72456	$2,289.82	$1,889.82	0.81087	$1,532.40
3		($400.00)	600	$5.72456	$3,434.74	$3,034.74	0.70511	$2,139.83
4		($400.00)	800	$5.72456	$4,579.65	$4,179.65	0.61314	$2,562.71
5		($400.00)	1,000	$5.72456	$5,724.56	$5,324.56	0.53316	$2,838.84
6			1,000	$5.72456	$5,724.56	$5,724.56	0.46362	$2,654.02
7			1,000	$5.72456	$5,724.56	$5,724.56	0.40315	$2,307.86
8			1,000	$5.72456	$5,724.56	$5,724.56	0.35056	$2,006.80
9			1,000	$5.72456	$5,724.56	$5,724.56	0.30484	$1,745.07
10			1,000	$5.72456	$5,724.56	$5,724.56	0.26508	$1,517.47
								0

The ramp-up adjustment to the ACF is computed within the DS0 Impairment Analysis tool as follows:

1. Calculate the present value of lines served over the economic life of the particular equipment (e.g., DLC common equipment) assuming projected service levels occur instantaneously.

2. Compute the present value of lines served assuming projected market share is achieved over the user-specified ramp-up period.

3. Calculate the adjustment factor by dividing the Step 1 result by the Step 2 result. In the preceding example, the numerator is 5,382 and the denominator is 3,744 for a resulting factor of 1.437187.

4. Adjust the ACF for that equipment, based on projected demand, by multiplying the ACF by the ratio calculated in Step 3.

5. Calculate the monthly cost per line for the particular equipment by multiplying total investment from Step 4 by the appropriate ACF, and then dividing by 12.

Like the DLC example provided above, the ramp-up adjustment is applied to all categories of investment that require up-front investments sized to total demand, as well as to any investments which are not demand sensitive. Thus, DLC infrastructure investments, termination investments, most collocation investments, and backhaul costs are also adjusted to incorporate the effect of ramp-up. For example, power feed related charges are incurred immediately based on the maximum expected lines in service, and collocation space construction is based on the projected number of frames, rather than incrementally as each frame is added.[88] Costs which are not incurred on day one, but only as demand materializes, are treated as variable investments in the above example. For example, the line-card related investment portion of total DLC investment is not incurred until new customers subscribe. In addition, collocation amperage-related charges (including HVAC) as well as DS0 termination charges are incurred only as actual demand materializes. Using the procedure demonstrated in the variable investment example above, the ramp-up treatment for these items accounts for this timing difference.

C. Transport Connectivity Component – Costs of Connecting the Collocation to the New Entrants Network (Backhaul Infrastructure)

A backhaul infrastructure connects each ILEC wire center, at which the CLEC's DLC equipment is collocated, and the network node where the CLEC switch is located. The UNE loop is effectively extended to the CLEC's switch location. If a wire center is designated as a satellite office, the total backhaul cost must include the cost to get from the satellite office to its nearest network node and, once at the closest network node office, the cost of getting from the network node office to the local switch of the new entrant. In this case, the backhaul cost (from a satellite office) includes the recurring and non-recurring rates charged by the ILEC for connectivity – using DS-1 or DS-3 transport as appropriate, under price cap or pricing flexibility[89] – multiplied by the distance

[88] Indeed it would not only be cost prohibitive (in light of space augmentation charges) but also technically and administratively impossible or impractical (because of required lead times and risk of contiguous space being unavailable) to employ a "pay as you grow" approach.

[89] The choices are between "price capped" and "price flexibility" regulation. "Price Cap" effectively means that Phase II Pricing Flexibility has not been granted for a given ILEC wire center. Conversely, "Price Flexibility" means that some form of Phase II Pricing Flexibility has been granted for a given ILEC wire

between the satellite office and its nearest network node.[90,91] The preceding results must then be increased by the CLEC-provided backhaul infrastructure costs.

The CLEC-provided backhaul infrastructure costs are developed in the Transport Impairment Analysis Tool, which is discussed below in Section III. For each wire center, the DS0 Impairment Analysis tool uses the average cost per DS-3 developed in the Transport Impairment Analysis Tool (assuming 80% utilization, i.e., 39 of 48 DS-3s are active) to calculate the wire center backhaul cost. The following equations summarize the backhaul costs in the DS0 Impairment Analysis tool.

Network Node Offices

- **DS-1 Backhaul =** [(Cost per CLEC-provided DS-1 per month per DS-1) ÷ 28] * [1+ (Other Taxes Percent)]

- **DS-3 Backhaul =** (Cost per CLEC-provided DS-3 per month per DS-3) * [1+ (Other Taxes Percent)]

---

center. "CT" means that PF has been granted for channel terminations only. "Both" means that PF has been granted for both transport and end-user channel terms. "None" means that no PF has been granted at all.

[90] The costs for DS-1 and DS-3 connectivity are input from a connectivity charge database, which reflects monthly recurring and non-recurring charges for DS-1 and DS-3 ILEC special access applied pursuant to various term commitments (month-to-month, two-year and five-year). Special access charges are those submitted in the July 2003 interstate tariff revisions.

[91] These calculations appear in the "WC homing input" tab of the DS0 Impairment Analysis tool at columns AM and AN.

Satellite Offices[92]

- **DS-1 Backhaul** = {[(Total Air miles) * (DS-1 Cost per mile per month) + (DS-1 Fixed Cost per month) + [(Cost per CLEC-provided DS-3 per month per DS-3) ÷ 28]} * (1+ Other Taxes Percent)

- **DS-3 Backhaul =** {[(Total Air miles) * (DS-3 Cost per mile per month) + (DS-3 Fixed Cost per month) + [(Cost per CLEC-provided DS-3 per month per DS-3)]} * [1+ (Other Taxes Percent)]

D. Costs of Transferring Customers from the ILEC to the CLEC Network

1. Customer Transfer Costs

A major component of the CLEC cost disadvantage is the cost associated with moving customers from the ILEC to a termination connecting to the new entrant's collocation. Such a customer transfer is referred to in the industry as a "hot cut." These costs include both the hot cut charges imposed by the ILEC as well as the costs

[92] Non-recurring charges are amortized over the expected life of the collocation (a user-adjustable input) and then added to the recurring charges.

associated with work that the CLEC must perform to complete the transfer with minimal customer impact.

Furthermore, in some instances, the ILEC may find it necessary to dispatch its personnel to transfer an existing ILEC retail customer loop from IDLC to either UDLC or to available copper facilities that are capable of supporting voice service.[93] Where this occurs, and the ILEC applies an additional dispatch charge, the costs are included as part of the hot cut cost.

2. Preliminary Hot Cut Calculations

The DS0 Impairment tool calculates hot cut costs separately for business and residential customers. For residential customers, the DS0 tool uses two input tables to determine hot cut charges. First, the following input table is used to specify hot cut charges for the ILEC, both in situations where the ILEC is required to dispatch a technician and when such a dispatch is not required, for both connects and disconnects.[94] The residential hot cut charges reflect the total average per line ILEC cost associated with

---

[93] When IDLC is used to provision an ILEC loop, individual circuits remain multiplexed within a DS-1 at the ILEC's DSX-1 from its DLC Central Office Terminal ("COT"). Although such circuits can be technically groomed onto a DS-1 dedicated to the CLEC, most ILECs are not offering that type of connectivity to CLECs. CLECs are therefore usually forced to have the ILEC transfer UNE-L loops to a spare copper pair if available, to spare Universal DLC equipment if available (or to abandon the potential customer). Both options are technically inferior, and normally incur additional CLEC costs. Transfer of a customer from IDLC involves dispatching an ILEC technician to the Serving Area Interface ("SAI") who removes the existing cross connection wire from the copper distribution - derived feeder terminations, and runs a new cross connection wire from the copper distribution termination to either a spare copper feeder termination or to a derived feeder termination from UDLC remote terminal equipment. In addition, the central office end of the circuit must now be cross connected from either the copper feeder MDF termination, or from the UDLC central office terminal equipment appearance at the MDF, to the CLEC termination point in the central office.

[94] The current UNE rates for the rate elements that comprise hot cut functions have been used. These rates include OSS charges which are applied in Washington per local service request.

all of the hot cut charges applied when transferring the residential customer over to the CLEC assuming that all lines for a multi-line premises are transferred simultaneously and to the same CLEC. The percentage of such multi-line transfers is equal to the presence of multi-line households in the study market area.

Residential Hot Cut Charges			
Company **LEC-State**	**Connect** **Type**	**Dispatch** **Action**	**Residential** **Hot Cut**
ILEC	connect	no dispatch	$ 64.92
ILEC	connect	dispatch	$ 0
ILEC	disconnect	no dispatch	$ 6.03
ILEC	disconnect	dispatch	$ 0

The user further inputs whether a dispatch is required for the ILEC. The fraction of times a dispatch is expected is computed as the product of the fraction of all loops which are fiber-served, the fraction of DLC loops which are served by IDLC systems, and the overall fraction of IDLC loops transferable to UDLC or copper feeder.

These results are then used to compute the effective residential hot cut charges for both connects and disconnects. In addition to these charges, there is a user-adjustable input that allows the user to enter costs borne by the CLEC's internal operations associated with transferring the customer to its network.

For business hot cuts, the DS0 Impairment Analysis tool contains an input matrix for the average costs (connects and disconnects with and without a dispatch) over a wide range of potential business mass-market location sizes. This is necessary because some charges apply once per location while others apply only to the initial line converted at the location or only to each additional line converted at a location. The matrix reflects the weighted average cost per line based on the distribution of locations and lines at or below the line cut-off specified in the matrix. The per-line business hot cut costs reflect the average per line ILEC charges associated with all of the hot cut functions required to transfer business customers to the CLEC assuming a distribution of line reflecting the different size customer locations within that ILEC study area.

	Business Hot Cut Charges at or Below Line			
Lines	**Connect, no dispatch**	**Connect, dispatch**	**Disconnect, no dispatch**	**Disconnect, dispatch**
1	$66.84		$7.03	
2	$64.37		$5.74	
3	$62.48		$4.77	
4	$61.19		$4.09	
5	$60.48		$3.72	
6	$59.81		$3.37	
7	$59.50		$3.21	
8	$59.34		$3.13	
10	$58.55		$2.72	
12	$58.04		$2.46	
16	$57.49		$2.17	
20	$57.24		$2.04	

The tool then uses a second input matrix to select the appropriate connect and disconnect costs associated with the crossover point where DS-1s more economically serve business customers. Next, it selects the hot cut charge that pertains to all of the lines at or below that threshold. This calculation also uses the matrix for residential services to determine whether a dispatch is required for the ILEC and the percentage of times a dispatch is expected.

UNE Zone	Crossover
1	20.6
2	13.8
3	12.6
4	11.5
5	9.4

Using this crossover point, the tool selects the appropriate connect and disconnect charges and calculates an effective hot cut cost per line. As is the case for residential lines, any CLEC hot cut charges are input by the user as well.

3. Hot cut per line Calculations

Churn, a user-adjustable input, also affects per-line costs for hot cuts. There is little dispute that customer churn occurs in a competitive market, leading to shorter customer retention lives than those historically seen by ILECs. Churn is a function of competitive forces, customer experience, and external factors such as relocations and business closures. Churn is critical because the disconnections resulting from churn must be overcome *before* net market share can grow. The DS0 Impairment Analysis tool computes the hot cut expense stream by converting the total cost to a levelized cost per line based on churn, the pre-tax cost of capital, and an expected study period assumption. The calculation is performed separately for mass-market residential and small business segments to provide for different churn rates. The DS0 Impairment tool assumes a monthly gross churn rate of 4.6% for both business and residential customers based on assumptions regarding the CLEC industry contained in an April 2003 Banc of America Equity Research report.[95]

The first step in computing per-line hot cut costs is multiplying the hot cut charge by the expected number of customers by calculating the total of the gross new customer additions over the life of the collocation. This represents the gross investment involved in hot cuts. Continuing with the example from section II.B.3 above, the following table shows the total gross customer additions, assuming a churn rate of 10% annually:[96]

---

[95] "AT&T Corporation - A Case for Consumer Services", Banc of America Equity Research, April 30, 2003, page 10-11.

[96] The use of 10% annual churn is used for illustrative purposes only and is not consistent with the proposed inputs to the DS-0 tool. As discussed above, the actual churn rates in the DS0 Impairment Analysis tool are based on assumptions regarding the CLEC industry contained in an April 2003 Banc of America Equity Research report (see previous footnote).

Year	Net Number of Lines Added	Gross Number of Lines Added
1	200	220
2	200	240
3	200	260
4	200	280
5	200	300
6	0	100
7	0	100
8	0	100
9	0	100
10	0	100
	1,000	**1,800**

In this example, a total of 1,800 customers are added over the 10 year period; 800 of these are entirely due to churn.

Because the hot cut payments are due only as new customers are added, the gross cost figure must be adjusted before it is amortized. The DS0 Impairment Analysis tool computes an adjustment to the ACF that reduces the gross investment to the level justified by the demand being served. This adjustment is the ratio of the total lines (including churn) to the present value of the total lines. The following table shows the adjustment factor:

Year	Gross Number of Lines Added	Mid Year Present Value Factor	Present Value of Lines in Service
1	220	0.9325	205.2
2	240	0.81087	194.6
3	260	0.70511	183.3
4	280	0.61314	171.7
5	300	0.53316	159.9
6	100	0.46362	46.4
7	100	0.40315	40.3
8	100	0.35056	35.1
9	100	0.30484	30.5
10	100	0.26508	26.5
	1,800		**1,093.4**

The correct adjustment factor is the ratio 1,093.4/1,800 = 0.6075. This is multiplied by the gross investment before the ramp-up adjustment is applied.

Finally, the ramp-up adjustment factor is applied to the hot cut investment, which is then multiplied by the standard ACF applying to collocation, and dividing this product

12 produces a levelized monthly cost.[97] The DS0 Impairment Analysis tool Summary Table shows the per-line hot cut charge for the ILEC.

E. Total CLEC DS0 Impairment

At this point, the tool has calculated the monthly cost incurred by the CLEC, at the wire center level, for the DS0 infrastructure equipment, collocation, backhaul costs, and transfer of the customers from the ILEC to the CLEC network. Based on the projected number of lines to be served by the CLEC in each office, the results are expressed as a cost disadvantage for the CLEC, per line served in each wire center. These are the added costs that the new entrant must incur to connect a retail mass-market customer to its local switch and thereby provide basic telephone service.[98] The "DS0 summary" tab summarizes the net impairment by wire center.

---

[97] Because a new entrant, unlike the ILEC, must almost always *by definition* take share away from the incumbent in order to gain new customers, hot cut costs are in some sense an investment in developing a stable customer base. It is thus appropriate from the perspective of an efficient CLEC entering the market to treat hot cuts as an investment expense.

[98] The costs are not the total cost of service for the new entrant, as the loop UNE cost is not reflected, nor are any switched local network costs or customer servicing costs, such as marketing, sales, billing, and repair. Likewise, these costs do not reflect any operational impairment, particularly with respect to customer acquisition, retention, or servicing that the new entrant may incur.