Bob Sahr, Chair
Gary Hanson, Vice-Chair
Jim Burg, Commissioner

SOUTH DAKOTA PUBLIC UTILITIES COMMISSION

500 East Capitol Avenue
Pierre, South Dakota 57501-5070
www.state.sd.us/puc

Capitol Office
(605) 773-3201
(605) 773-3809 fax

Transportation/Warehouse
(605) 773-5280
(605) 773-3225 fax

Consumer Hotline
1-800-332-1782

June 16, 2003

Ms. Colleen Sevold
Manager-Regulatory Affairs
Qwest Corporation
125 South Dakota Avenue, 8th Floor
Sioux Falls, SD 57194

Mr. Thomas J. Welk
Attorney at Law
Boyce, Greenfield, Pashby & Welk, L.L.P.
P. O. Box 5015
Sioux Salls, SD 57117-5015

Ms. Mary S. Hobson
Attorney at Law
Stoel Rives LLP
101 South Capitol Blvd., Suite 1900
Boise, ID 83702-5958

Mr. David A. Gerdes
Attorney at Law
May, Adam, Gerdes & Thompson LLP
P. O. Box 160
Pierre, SD 57501

Mr. Steven H. Weigler
Ms. Mary B. Tribby
Attorneys at Law
AT&T Communications of the Midwest, Inc.
1875 Lawrence Street, Suite 1524
Denver, CO 80202

Re: In the Matter of Determining Prices for Unbundled Network Elements (UNES) in Qwest Corporation's Statement of Generally Available Terms (SGAT)
Docket TC01-098

Dear Folks:

Enclosed each of you will find copies of Testimony of Timothy J. Gates, Direct Testimony of Sid Morrison, Direct Testimony of Peter J. Gose and Direct Testimony of Mark L. Stacy with reference to the above captioned matter. This is intended as service upon you by mail.

Very truly yours,

Karen E. Cremer

Karen E. Cremer
Staff Attorney

KEC:dk
Enc.

CERTIFICATE OF SERVICE

I hereby certify that copies of Testimony of Timothy J. Gates, Sid Morrison, Peter J. Gose and Mark L. Stacy were served on the following by mailing the same to them by United States Post Office First Class Mail, postage thereon prepaid, at the addresses shown below on this the 17th day of June, 2003.

Ms. Colleen Sevold
Manager-Regulatory Affairs
Qwest Corporation
125 South Dakota Avenue, 8th Floor
Sioux Falls, SD 57194

Mr. Thomas J. Welk
Attorney at Law
Boyce, Greenfield, Pashby & Welk, L.L.P.
P. O. Box 5015
Sioux Falls, SD 57117-5015

Ms. Mary S. Hobson
Attorney at Law
Stoel Rives LLP
101 South Capitol Blvd., Suite 1900
Boise, ID 83702-5958

Mr. David A. Gerdes
Attorney at Law
May, Adam, Gerdes & Thompson LLP
P. O. Box 160
Pierre, SD 57501

Mr. Steven H. Weigler
Ms. Mary B. Tribby
Attorneys at Law
AT&T Communications of the Midwest, Inc.
1875 Lawrence Street, Suite 1524
Denver, CO 80202

Karen E. Cremer

Karen E. Cremer
Staff Attorney
South Dakota Public Utilities Commission
500 East Capitol
Pierre, SD 57501

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

RECEIVED

JUN 16 2003

SOUTH DAKOTA PUBLIC
UTILITIES COMMISSION

IN THE MATTER OF DETERMINING PRICES FOR UNBUNDLED NETWORK ELEMENTS (UNEs) IN QWEST CORPORATION'S STATEMENT OF GENERALLY AVAILABLE TERMS (SGAT)	)))))))	DOCKET NO. TC01-098

<u>REDACTED PUBLIC VERSION</u>

Testimony Of Timothy J Gates

On Behalf Of

The Commission Staff

June 16, 2003

TABLE OF CONTENTS

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, OCCUPATION AND BUSINESS ADDRESS.

A. My name is Timothy J Gates. I am a consultant with QSI Consulting. My business address is QSI Consulting, 917 W. Sage Sparrow Circle, Highlands Ranch, Colorado 80129.

Q. WHAT IS QSI CONSULTING, INC. AND WHAT IS YOUR POSITION WITH THE FIRM?

A. QSI Consulting, Inc. (QSI) is a consulting firm specializing in traditional and non-traditional utility industries, econometric analysis and computer aided modeling. I currently serve as Senior Vice President.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND WORK EXPERIENCE.

A. I received a Bachelor of Science degree from Oregon State University and a Master of Management degree in Finance and Quantitative Methods from Willamette University's Atkinson Graduate School of Management. Since I received my Masters, I have taken additional graduate-level courses in statistics and econometrics. I have also attended numerous courses and seminars specific to the telecommunications industry, including both the NARUC Annual and NARUC Advanced Regulatory Studies Programs.

Prior to joining QSI, I was a Senior Executive Staff Member at MCI WorldCom, Inc. (MWCOM). I was employed by MWCOM for 15 years in various public policy positions. While at MWCOM I managed various functions, including tariffing, economic and financial analysis, competitive analysis, witness training and MWCOM's use of external consultants. Prior to joining MWCOM, I was employed as a Telephone Rate Analyst in the Engineering Division at the Texas Public Utility Commission and earlier as an Economic Analyst at the Oregon Public Utility Commission. I also worked at the Bonneville Power Administration (United States Department of Energy) as a Financial Analyst doing total electric use forecasts while I attended graduate school. Prior to doing my graduate work, I worked for ten years as a forester in the Pacific Northwest for multinational and government organizations. Exhibit TJG-1 to this testimony is a summary of my work experience and education.

Q. HAVE YOU EVER TESTIFIED BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF SOUTH DAKOTA (COMMISSION)?

A. Yes. I testified in South Dakota on behalf of MCI in 1987. I provided direct testimony in Docket No. F-3652-12. (Application of Northwestern Bell Telephone Company to Introduce Its Contract Toll Plan). Most recently I provided testimony in Docket No. TC03-057 on behalf of WorldCom, Black Hills Fibercom and Midcontinent Communications.

I have testified more than 200 times in 42 states and filed comments with the FCC on various public policy issues ranging from costing, pricing, local entry and universal service to strategic planning, merger and network issues. As noted above, a list of proceedings in which I have filed testimony or provided comments is attached hereto as Attachment 1.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. QSI has been asked to provide an analysis of Qwest Corporation's (Qwest) positions and cost support in this proceeding. The primary purpose of my testimony is to review the cost documentation provided in this proceeding in support of Qwest's proposed monthly recurring loop rates. This testimony describes the results of my analysis and provides the Commission with my conclusions and recommendations regarding the propriety of Qwest's proposed unbundled loop cost study and the resulting rates. Other QSI witnesses appearing on behalf of the Staff will include Mr. Peter Gose (annual charge factors and switching issues), Mr. Mark Stacy (nonrecurring costs and engineering issues) and Mr. Sid Morrison (nonrecurring costs and engineering issues).

Q. WHAT COST STUDIES HAVE YOU REVIEWED IN PREPARING THIS TESTIMONY?

A. In reviewing the loop related cost studies, I have used and reviewed Qwest's Integrated Cost Model (ICM) and certain related sub-modules. For instance, I utilized the ICM to make changes to the Loop Module (LoopMod). As the name indicates, ICM is an integrated model consisting of five inter-related modules and an output workbook. The five modules include the Loop Module, Switching Module, Transport Module, Capital Cost Factors Module and the Expense Factors Module.[1] My testimony focuses on the inputs utilized in LoopMod and their impact on rates.

[1] See, Qwest ICM User Manual at 6.

Q. DOES YOUR TESTIMONY ADDRESS COST STUDIES SUBMITTED BY OTHER PARTIES?

A. No. QSI was asked to analyze only the Qwest studies in this proceeding. Qwest bears the burden of supporting its rates in this proceeding so it is appropriate to focus on Qwest's cost studies. While other parties may submit other studies, our focus is on the support provided by Qwest.

Q. DID YOU RELY UPON OTHER INFORMATION TO SUPPORT POSITIONS IN THIS TESTIMONY?

A. Yes. After discussions with Qwest, it was agreed that Staff and its consultants could rely upon discovery responses that Qwest provided in the recent New Mexico cost proceeding (Docket No. 3495). The issues in the New Mexico proceeding and this proceeding are very similar, if not identical, and the studies and models at issue are the same. As such, Qwest accommodated Staff's request to rely upon pertinent New Mexico responses to make discovery in this proceeding more efficient.

Q. ON WHOSE BEHALF WAS THIS TESTIMONY PREPARED?

A. QSI has been retained by the Commission to provide services to the Staff in this proceeding. This testimony was prepared on behalf of the Staff of the Commission (Staff).

III. SUMMARY OF FINDINGS AND RECOMMENDATIONS

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS AND STATE YOUR RECOMMENDATIONS.

A. Based on my education and experience in the industry, and after having reviewed Qwest's ICM and LoopMod, I conclude generally that the studies are not well documented and continue to suffer from many flaws and weaknesses identified in previous cost cases in the Qwest operating region. ICM, however, is an improvement over previous versions of Qwest studies and includes a better user interface than some other cost models that I have reviewed.

In spite of the improvements, Qwest's loop studies are flawed in three fundamental ways. First, Qwest assumes that it is building a "replacement network." This replacement theory assumes that all buildings, streets, sidewalks and other structures are in place when Qwest models the construction of its network. Qwest also assumes that all other utilities have already placed their facilities so the opportunities for sharing are miniscule. Such assumptions – which have been rejected by the FCC – artificially increase the cost of placing the network and overstate costs.

Second, the investment assumptions are based on the density group or DG assumptions created by Qwest. There is no support for the density group approach used by Qwest. Indeed, the investment and facility assumptions for DG 2, DG 3, and DG 4 are based on the arbitrary selection and review of one distribution area for each DG.[2] Further, it is clear that Qwest has continually ignored criticisms of the DG approach and has refused to "fix" the problem. The result is an overstated estimate of facilities required to serve distribution areas in South Dakota and elsewhere.

Finally, Qwest uses an "ultimate" demand theory for facilities. That is, Qwest assumes that it must place enough plant today (at the time it is estimating its loop costs) sufficient to accommodate all demand it may experience during the entire economic life of the facility. Likewise, Qwest's theory requires that today's customers pay for this enormous spare capacity through Qwest's excessive rates.

The three systemic errors discussed above result in drastically overstated costs for the network that Qwest is attempting to model. The "replacement network" assumption overstates the cost of placing the network and the "ultimate demand" assumption exaggerates the amount of plant required to serve customers. Finally, the DG approach applies unsupported investment calculations to the already overstated facilities and cost of placing those facilities. My testimony recommends adjustments to the ICM inputs in an effort to offset some portion of the overstated costs resulting from the inappropriate assumptions in Qwest's proposal. While it is obvious that my adjustments cannot completely compensate for the problems in the studies, they at least make the results more reasonable.

Q. GIVEN THESE SYSTEMIC FLAWS IN QWEST'S COST STUDIES, WHAT IS YOUR OPINION OF LOOPMOD?

A. After a thorough analysis of Qwest's new "LoopMod" cost module, it is clear that Qwest's "new" loop model retains many of the flaws identified in its predecessor – Qwest's Regional Loop Cost Analysis Program or "RLCAP" – and that the underlying theory and inputs result in grossly overstated costs. My testimony recommends changes to many of the inputs to LoopMod and requests that Qwest

[2] DG1 and DG5 are based completely on the opinions of some un-named engineers at Qwest. No plat maps or other support is provided for these DG designs.

be required to make other changes that I could not make. While changing the underlying theory and structure of Qwest's models would be next to impossible in a proceeding such as this, I have adjusted for the flaws in these models through changes in inputs and recommendations to the Commission for changes in the models going forward. These adjustments result in significantly lower, more appropriate rates than those originally proposed by Qwest in this proceeding.

The rates resulting from my adjustments are based on Total Element Long Run Incremental Cost (TELRIC) principles and reflect the forward-looking economic cost of loops more accurately than do the unadjusted rates proposed by Qwest. The adjusted rates would encourage competition and entry by virtue of the rate levels, which reflect an efficient operation

Q. YOU IDENTIFIED GENERAL PROBLEMS WITH QWEST'S MODELING ASSUMPTIONS ABOVE. CAN YOU BE MORE SPECIFIC AS TO THE FLAWS IN LOOPMOD THAT RESULT IN GROSSLY OVERSTATED COSTS AND RATES?

A. Yes. As I'll discuss below, many of the same concerns expressed by state commissions regarding Qwest's former RLCAP model are also evident in LoopMod (its most recent loop cost tool). Specifically, the remainder of my testimony will address the following concerns:

- Qwest's assumption that it is building a "replacement network" which must be constructed around, under and through existing buildings, streets, curbs, etc. artificially increases the costs that an efficient provider would experience in building the network.
- Qwest's placement activity percentages – which impact the cost of facilities dramatically – are based solely on employee opinion. The

activity percentages are further inflated by the "replacement network" assumption, and they must be reduced.

- Qwest's sharing percentages are not consistent with the FCC's *Inputs Order*, or the environment in a forward-looking construct.[3] The percentages are grossly understated, in significant part because of Qwest's replacement network assumption, thereby increasing costs.

- The "Use Fill Factor Option" in the model is not reliable and Qwest's reliance on "ultimate demand" assumptions results in excess capacity, inefficiency and overstated costs.

- Qwest's density group theory is not supported in the filing. There is little if any support for the engineering assumptions used by the company to develop the investments for the various density groups, except references to employee opinion.

- Qwest includes unwarranted costs – such as the mobilization charge for the drop – to derive its rates. The costs included are not consistent with TELRIC principles and must be removed from the cost study.

- Qwest's cable tables must be expanded to include larger cable sizes; the existing cable tables do not allow the model to reflect the economies that Qwest could achieve by the use of larger cables.

- Average drop lengths are excessive and the placement costs for aerial drops are overstated. The drop lengths are not consistent with other state commission orders. Finally, the sharing percentages for drops are too low.

- Qwest, within its derivation of unbundled loop costs, assumes a mix of non-integrated or Universal Digital Loop Carrier (UDLC) and the more efficient, and cost-effective integrated DLC (IDLC). Unbundled loops can be provisioned using IDLC and substantial cost savings can be realized in doing so. Specifically, newer GR 303 IDLC equipment like that currently purchased and deployed by Qwest is specifically designed to accommodate unbundled facilities at lower costs.

IV. GENERAL COSTING AND PRICING ISSUES

[3] Before the Federal Communications Commission; In the Matter of Federal-State Joint Board on Universal Service CC Docket No. 96-45; Forward-Looking Mechanism for High Cost Support for Non-Rural LECs CC Docket No. 97-160; **TENTH REPORT AND ORDER**; Released: November 2, 1999. (*Inputs Order*)

Q. PLEASE DISCUSS THE GENERAL COSTING PRINCIPLES BY WHICH QWEST'S COST STUDIES SHOULD BE EVALUATED.

A. In general, the cost studies must be reviewed to ensure compliance with the Total Element Long run Incremental Cost (TELRIC) principles.[4] Congress delegated to the FCC the task of enacting rules to implement the local competition provisions of the Telecom Act, with the caveat that the FCC cannot preclude "the enforcement of any regulation, order, or policy of a State commission" that establishes access and interconnection obligations of local exchange carriers and is not inconsistent with the Telecom Act.[5] In response to this mandate, the FCC's *Local Competition Order* promulgated rules that, among other requirements, established the TELRIC pricing methodology for state commissions to follow when setting rates under circumstances set forth in the Telecom Act. The pricing rules are designed to "produce rates for monopoly elements and services that approximate what the incumbent LEC would be able to charge if there were a competitive market for such services."[6]

The FCC's pricing rules are set forth at 47 C.F.R. 51.501 through 51.515. Section 51.503(a) reiterates the ILECs' obligation to "offer elements to requesting carriers at rates, terms, and conditions that are just, reasonable, and nondiscriminatory." Section 51.505(b) provides that:

> the [ILECs'] rates for each element it offers shall comply with the rate structure rules set forth in §§ 51.507 and 51.509, and shall be established, at the election of the state commission-

---

4 In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996; **FIRST REPORT AND ORDER**; CC Docket Nos. 96-98 and 95-185; Released August 8, 1996; hereinafter referred to as the "*Local Competition Order*."

5 47 U.S.C. Section 251(d)(3). See also 47 U.S.C. Sections 252(e)(3), 252 (f)(2), and 253 (b) for additional provisions preserving state commission authority.

6 *Local Competition Order at* ¶ 738.

> (1) Pursuant to the forward-looking economic cost-based pricing methodology [TELRIC] set forth in §§ 51.505 and 51.111; or
>
> (2) Consistent with the proxy ceilings and ranges set forth in § 51.503.

In general, prices for elements must be set at their forward-looking economic cost which equals the sum of the total element long run[7] incremental[8] cost[9] of the element plus a reasonable allocation of forward-looking common costs.[10] Specifically, the TELRIC of an element is:

> the forward-looking cost over the long run of the total quantity of the facilities and functions that are directly attributable to, or reasonably identifiable as incremental to, such element, calculated taking as a given the incumbent LEC's provision of other elements.[11]

Additionally, the TELRIC of an element:

> should be measured based on the use of the most efficient telecommunications technology currently available and the lowest cost network configuration, given the existing location of the incumbent LEC's wire centers.[12]

In calculating the TELRIC of an element, the forward-looking cost of capital and economic depreciation rates shall be employed.[13] The following factors, however, may **not** be considered in calculating the TELRIC of an

---

[7] '[L]ong run,' in the context of 'long run incremental cost,' refers to a period long enough so that all of a firm's costs become variable or avoided." *Local Competition Order*, ¶ 677 (fn. 1682).

[8] "'Incremental costs are the additional costs (usually expressed as a cost per unit) that a firm will incur as a result of expanding the output of a good or service by producing an additional quantity of the good or service. Incremental costs are forward-looking in the sense that these costs are incurred as the output level changes by a given increment." *Local Competition Order*, ¶ 675 (footnotes omitted).

[9] The FCC noted "economists generally agree that prices based on forward-looking long-run incremental costs (LRIC) give appropriate signals to producers and consumers and ensure efficient entry and utilization of the telecommunications infrastructure." Id. at ¶ 630 (footnote omitted).

[10] 47 C.F.R. Section 51.505(a)(1) and (2)

[11] 47 C.F.R. Section 51.505(b).

[12] 47 C.F.R. Section 51.505(b)(1).

[13] 47 C.F.R. Section 51.505(b)(2) and (3).

element: embedded costs, retail costs, opportunity costs and revenues to subsidize other services.[14] Finally, it is the ILEC's burden:

> to prove to the state commission that the rates for each element it offers do not exceed the forward-looking cost per unit of providing the element, using a cost study that complies with the methodology set forth in this section and § 51.511 [entitled Forward-looking cost per unit].[15]

The economic principles identified and embodied within the TELRIC standard can be summarized as follows:

Principle # 1: The firm should be assumed to operate in the long run. (¶ 677 and 692)

Principle # 2: The relevant increment of output should be total company demand for the unbundled network element in question. (¶ 690)

Principle # 3: Technology choices should reflect least-cost, most efficient technologies. (¶ 685 and 690)

Principle # 4: Costs should be forward-looking. (¶ 679, 682 and 692)

Principle # 5: Cost identification should follow cost causation. (¶ 622 and 691)

In summary, the use of TELRIC costing principles ensures that rates reflect a measure of the costs that would be incurred by an efficient supplier of a particular network element. In my critique of the Qwest loop model I will continuously refer to these basic but essential cost principles.

Q. WHAT POSITION HAS THE COMMISSION TAKEN ON TELRIC PRINCIPLES?

---

[14] 47 C.F.R. Section 51.505(d)(1) through (4).

[15] 47 C.F.R. Section 51.505(e).

A. This Commission has consistently referred to federal rules and regulations for pricing wholesale services. For instance, in TC96-184, the Commission referenced the FCC's rules for pricing.[16]

Q. ARE QWEST'S COST MODELS AND STUDIES TRANSPARENT, OPEN AND VERIFIABLE, SUCH THAT PARTIES CAN REVIEW AND VALIDATE THE MODELS AND STUDIES?

A. Not entirely. The current loop-modeling tool (LoopMod) is better in some respects than its predecessor – RLCAP. RLCAP was criticized in many state commission orders for not having open, verifiable algorithms and inputs. [17] LoopMod now has a better user interface, more user-definable inputs and better underlying support. Despite the improvements, however, Qwest's models still have "hard-coded" inputs and algorithms that are not transparent, open and verifiable.[18] In fact, in the Commission's 1997 Order in Docket No. TC96-184, at paragraph 106 it stated, "The Commission is also cognizant of deficiencies in U S WEST's TELRIC cost studies. A valid criticism leveled at the cost studies is the fact that they are difficult to use and contain what has been termed 'black boxes.'" Unfortunately that criticism is still valid for much of Qwest's cost support.

Q. PLEASE EXPLAIN.

---

16 FINDINGS OF FACT AND CONCLUSIONS OF LAW; AND ORDER AND NOTICE OF ENTRY OF ORDER; Docket No. TC96-184; at paragraph 89; dated March 20, 1997.

17 See, for instance, the 1998 New Mexico Order -- FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER; 96-310-TC; 96-334-TC; Consolidated; Phase I Order; dated July 15, 1998; at ¶¶ 32-34.

18 By "hardcoded" I am referring to inputs in the model that are simply numbers with no references to their source or calculation. The parties are unable to audit or verify such inputs.

A. Let me give you an example. Later in this testimony I discuss the importance of the digital loop carrier (DLC) assumptions and their impact on costs and rates. I also discuss the achievable concentration ratios for DLC systems. In order to adjust those assumptions, you must be able to find the tables and spreadsheets that contain the various technology costs, and determine how those resulting investments are applied in the model. Despite our best efforts, we were unable to find the algorithms that spread the various technology investment assumptions across the various model inputs. Indeed, in New Mexico during cross examination, Qwest's witness Mr. Pappas said that he did not now how to adjust the concentration ratio for the DLC systems.[19]

Q. GIVEN THE IMPROVEMENTS, ARE YOU RECOMMENDING THE QWEST LOOPMOD RESULTS FOR APPROVAL BY THE COMMISSION?

A. Yes, but only if the corrected inputs proposed herein and by the other Staff witnesses are adopted. As I will discuss in more detail later in this testimony, there are still remaining problems with LoopMod. While the models can be used with some comfort in their design, the models are still not open enough to allow complete review, and the inputs grossly overstate costs. We are recommending that the Commission utilize the results from LoopMod assuming the inputs are corrected as we suggest and that Qwest be required to correct other assumptions and inputs that we were unable to change.

Q. IS IT YOUR OPINION THAT QWEST'S PROPOSED LOOPMOD RESULTS ARE TELRIC COMPLIANT?

[19] See Transcript from Case No. 3495; Phase B; page 73; day six; January 6, 2003.

A. No. While it could be argued that the model is TELRIC compliant in a broad sense, the inputs and underlying assumptions certainly are not. As such, the results from the model are not TELRIC compliant. Despite the improvements made by Qwest in constructing and revising LoopMod, it still falls short in utilizing proper TELRIC guidelines.

Q. DOES QWEST CLAIM TO HAVE TELRIC COMPLIANT MODELS AND RESULTS?

A. Yes. Mr. Brigham on behalf of Qwest, describes the TELRIC principles purportedly used to develop Qwest's cost studies.[20] The TELRIC principles are also discussed in Qwest's "Cost Methodology and Processes" document, and other supporting materials submitted by Qwest in this proceeding.[21] While the theoretical discussion seems consistent with the principles adopted by the FCC, including the principles noted above, as always, "the devil is in the details."

Q. WHAT DO YOU MEAN WHEN YOU SUGGEST, "THE DEVIL IS IN THE DETAILS?"

A. It is fairly easy to espouse general policy agreement with the FCC's TELRIC requirements and to broadly suggest that a model complies with those requirements. It is quite another to build a model and populate the inputs in a manner that actually implements those rules and generates reasonable rates. While Qwest's testimony seems to have accomplished the first of these tasks (i.e., Qwest's testimony appears to say many of the right things), Qwest has failed rather substantially in actually producing a model that generates rates consistent

[20] Direct of Brigham at 4 – 8.

with the FCC's rules. The remainder of my testimony will describe areas wherein Qwest's testimony may describe a reasonable process or agreement with the FCC's rules, yet the Qwest cost model actually produces something far different.

V. QWEST'S LOOP COST MODEL

Q. HAVE YOU REVIEWED QWEST'S LOOP COST MODEL?

A. Yes. Mr. Richard Buckley testifies as to Qwest's ICM Loop Module (LoopMod), which develops loop related investments used to ultimately set prices. Mr. Brigham also describes ICM and provides the various user manuals for the modules associated with the ICM, including LoopMod. It is worth noting that while ICM is the ultimate "calculator" by which unbundled loop rates are generated, the vast majority of the inputs and analysis actually impacting Qwest's proposed loop costs, are undertaken in LoopMod, an underlying cost model (similar to the former RLCAP) specific to generating loop-specific investment information.

Q. WHAT CHARACTERISTICS OF LOOPMOD WILL YOU DISCUSS IN THE TESTIMONY THAT FOLLOWS?

A. I will focus on seven key areas – (1) the "replacement network" assumption and its impact on sharing and placement percentages; (2) fill factors, (3) the density group theory, (4) drop lengths and costs, (5) placement percentages, (6) sharing percentages, and (7) feeder-related issues including assumptions specific to digital loop carrier.

---

[21] Qwest Cost Methodology and Processes, January 2003, Market Services and Economic Analysis Organization.

A. Qwest's Replacement Network Assumption

Q. YOU STATED EARLIER THAT THE REPLACEMENT NETWORK CONSTRUCT WAS FLAWED AND HAD BEEN REJECTED BY THE FCC. PLEASE EXPLAIN.

A. Qwest has suggested that its costs – even in a forward-looking scenario – must consider the cost of building the network where current structures exist. For instance, at page 3 of Mr. Buckley's testimony he states

> … the methods LoopMod uses to place outside plant are selected based on conditions in the existing environments, with buildings, roads, and other structures assumed to remain in place.

In other words, Qwest's proposed loop prices assume an environment in which the telecommunications network is rebuilt while everything else remains in place with no opportunity to share costs with other utilities. This position is incorrect. The FCC considered Qwest's arguments on this point several years ago and rejected them. In its *Inputs Order* the FCC states:

> In general, the "scorched node or utilities" debate concerns whether the model should assume that all utilities are non-existent in developing structure sharing percentages. Commenters contend that if the model assumes that everything is in place except for the telecommunications network, then the sharing percentages used in the model should reflect fewer opportunities for sharing because it would not be possible to coordinate sharing with other utilities in the development of a new network. In particular, opportunities for sharing of underground and buried structure would be limited. [Cites omitted] While this may provide an interesting topic for academic debate, we do not believe it to be particularly useful or relevant in determining the structure sharing values in this proceeding. ***We note that, as part of the logical argument that the entire telephone network is to be rebuilt, it is also necessary to assume that the telephone industry will have at least the same opportunity to share the cost of building plant that existed when the plant was first built.*** We also note that cable and electric utilities continue to deploy service to new customers and replace

> existing technologies which provides an opportunity for carriers to share structure.[22] (emphasis added)

As such, Qwest must assume that the sharing opportunities are at least as great as they were when the plant was originally built. This same approach must be extrapolated to the activities associated with placing the network. In other words, Qwest must assume that its placement activities reflect the same amount of cut and restore, for instance, as it encountered when it initially placed the network.

Q. BUT MR. BUCKLEY'S TESTIMONY AT PAGE 22 DISCUSSES OVERBUILDS THAT MR. PAPPAS HAS OBSERVED WHERE LITTLE SHARING OCCURRED. IS THAT A RELEVANT COMPARISON TO TELRIC SHARING ASSUMPTIONS?

A. No. First of all, let me point out that the testimony Mr. Buckley references – regarding a broadband technical trial -- does not appear in Mr. Pappas' testimony. It may have appeared in that testimony in other states or in other cases, but it does not appear today in Mr. Pappas' testimony in this case. Nevertheless, I will address the issue since Mr. Buckley uses the statement to support his position.

By definition an overbuild is a situation where a network is already in place and another telephone company is duplicating that network. Of course the sharing opportunities would be minimal if the first network were already in place, and all other utilities had at least put in their initial networks as well. A TELRIC scenario, however, is not an overlay or overbuild, but is one in which the network is being initially deployed by an efficient provider.

---

22 See FCC *Inputs Order* at FN 504.

Q. ARE MUNICIPALITIES IMPACTED BY NETWORK BUILD-OUTS OR MAINTENANCE?

A. Yes. When streets are dug-up traffic and business are disrupted, and frequently various utility services are disrupted as well. It is in everybody's best interest to minimize general construction activities that disrupt traffic and services.

Q. DO MUNICIPALITIES ENCOURAGE THE SHARING OF FACILITIES AND THE COORDINATION OF CONSTRUCTION ACTIVITIES?

A. Yes, they do. As an example, the Minnesota League of Cities requires sharing and planning for sharing of facilities so as to minimize disruption to city facilities. Utilities must file a construction and major maintenance plan each year.[23] Such filings encourage the sharing of activities and structures.

Q. DOES QWEST RECOGNIZE THE VALUE THAT SHARING PROVIDES TO THE COMPANY?

A. Yes. In the LoopMod Default Values document, Qwest states, "The sharing percentages are a recognition that there will be a reduction in placing costs due to either trench provided by a land developed or multiple facility providers using the same poles, trenches or conduit systems."[24] As such the sharing percentages in the models reflect the portion of the costs "avoided" by Qwest by virtue of sharing. Unfortunately, Qwest's estimate of the savings is too low.

Q. WHAT SHARING PERCENTAGES ARE PROPOSED BY QWEST?

---

[23] League of Minnesota Cities Model Right-of-Way Ordinance, Section 108.

[24] See Loop Module Version 2.1, South Dakota Default Values, Qwest Corporation, May 23, 2002, at 6.

A. Qwest assumes only limited sharing opportunities in LoopMod. Qwest assumes only 20 percent of costs will be avoided for buried plant, 5 percent for underground conduit and 50 percent for poles.[25]

Q. ARE THESE SHARING PERCENTAGES REASONABLE?

A. No. Qwest's understated sharing percentages are a result of its rejected theory on the existence of structures during the rebuilding of the "replacement network." Further, while most companies, agencies and the FCC recognize that sharing opportunities will vary by density zone – with more sharing opportunities in the more dense zones -- Qwest incorrectly assumes the sharing opportunities will be the same across all density groups.[26]

Q. WHAT SHARING PERCENTAGES WERE ORDERED IN COLORADO FOR QWEST?

A. The Colorado Commission ordered the following sharing percentages:[27]

Sharing						
Structure Fraction Assigned to Telephone						
	Commission RRR					
	Distribution			Feeder		
Density	Buried	UG	Aerial	Buried	UG	Aerial
0	100.00%	100.00%	50.00%	100.00%	100.00%	50.00%
5	100.00%	100.00%	50.00%	100.00%	100.00%	50.00%
100	85.00%	85.00%	50.00%	85.00%	85.00%	50.00%
200	65.00%	65.00%	50.00%	65.00%	65.00%	50.00%
650	65.00%	65.00%	50.00%	65.00%	65.00%	50.00%

---

25 Id.

26 For instance, at paragraph 249 of the FCC's *Inputs Order* it states, "While disagreeing on the extent of sharing, the majority of commenters agree that sharing occurs most frequently with aerial structure and in higher density zones."

27 BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF COLORADO, DOCKET NO. 99A-577T, In the Matter of U S WEST COMMUNICATIONS, Inc.'s Statement of Generally Available Terms and Conditions, Ruling On Applications For Rehearing, Reargument, Or Reconsideration, Mailed Date: April 17, 2002; Adopted Date: April 17, 2002; at 40; hereinafter referred to as the "*Colorado Cost Case Order*."

850	65.00%	65.00%	50.00%	65.00%	65.00%	50.00%
2550	55.00%	55.00%	35.00%	55.00%	55.00%	35.00%
5000	55.00%	55.00%	35.00%	55.00%	55.00%	35.00%
10000	55.00%	55.00%	35.00%	55.00%	55.00%	35.00%
Weighted						
Average:	57.78%	57.78%	39.17%	57.78%	57.78%	39.17%
850-10000				**51.57%**		

Comments
Percentage of underground, buried and aerial structure used by telco

In Minnesota, the Commission reached similar conclusions:

> 49. U S WEST assumed it could achieve more sharing in dockets in other states. For example, in Oregon, U S WEST signed a Stipulation with OPUC Staff in which it agreed that it was reasonable to assume developers would pay 35% of the placement costs for buried cables and some entity other than U S WEST would pay 50% of pole costs. If it is reasonable to make those assumptions in Oregon, it should be assumed that U S WEST pays no more than 65% of buried placement costs and no more than 50% of pole costs in Minnesota.[28]

Q. ARE THE SHARING PERCENTAGES PROPOSED BY QWEST CONSISTENT WITH THE FCC'S DECISIONS IN THIS AREA?

A. No. The FCC has required telephone companies to assume they will bear the following percentage of supporting structure costs across various density zones (the remainder to be recovered via sharing): 50 percent of structure costs in density zones 1 through 6, 35 percent of the costs in density zones 7 through 9; 100% of the costs of underground and buried structures in density zones 1 and 2,

[28] Before the Minnesota Public Utilities Commission; **Order Resolving Cost Methodology**, adopted "the findings, conclusions and recommendations of the **Report of the Administrative Law Judge**, MPUC Docket No. P-442, 5231, 3167, 466, 421/C1-96-1540; November 17, 1998, at page 10; dated May 3, 1999. hereinafter referred to as the "*Minnesota Cost Case Order*."

85 percent in zone 3, 65 percent in zones 4 through 6, and 55 percent in zones 7 through 9.[29]

Q. WHAT IS STAFF PROPOSING FOR SHARING PERCENTAGES IN THIS PROCEEDING?

A. The Staff proposes the sharing percentages set forth in the following tables, which compare the Staff's sharing percentages to those proposed by Qwest.

---

29 See FCC *Inputs Order* at ¶ 243.

SHARING PERCENTAGES -- DISTRIBUTION

ACTIVITY	DG1 Qwest	DG1 Staff	DG2 Qwest	DG2 Staff	DG3 Qwest	DG3 Staff	DG4 Qwest	DG4 Staff	DG5 Qwest	DG5 Staff
Trench and Backfill	20	70	20	60	20	50	20	35	20	20
Rocky Trench	20	70	20	60	20	50	20	35	20	20
Plow	20	70	20	60	20	50	20	35	20	20
Rocky Plow	20	70	20	60	20	50	20	35	20	20
Cut & Rest. Concr.	20	70	20	60	20	50	20	35	20	20
Hand Dig Trench	20	70	20	60	20	50	20	35	20	20
2" Bore Cable	20	20	20	20	20	20	20	20	20	20
4" Bore Cable	20	70	20	60	20	50	20	35	20	20
Cut & Restore Asph	20	70	20	60	20	50	20	35	20	20
Cut & Restore Sod	20	70	20	60	20	50	20	35	20	20

SHARING PERCENTAGES -- FEEDER URBAN

ACTIVITY	URBAN Qwest	URBAN Staff
Trench and Backfill	20	60
Rocky Trench	20	60
Plow	20	60
Rocky Plow	20	60
Cut & Rest. Concr.	20	60
Hand Dig Trench	20	60
2" Bore Cable	20	20
4" Bore Cable	20	60
Cut & Restore Asph	20	60
Cut & Restore Sod	20	60

SHARING PERCENTAGES -- FEEDER RURAL

ACTIVITY	RURAL Qwest	RURAL Staff
Trench and Backfill	20	40
Rocky Trench	20	40
Plow	20	40
Rocky Plow	20	40
Cut & Rest. Concr.	20	40
Hand Dig Trench	20	40
2" Bore Cable	20	20
4" Bore Cable	20	40
Cut & Restore Asph	20	40
Cut & Restore Sod	20	40

Q. HOW DO YOU JUSTIFY THE PERCENTAGES PROPOSED BY STAFF?

A. The Staff's percentages reflect the sharing percentages that an efficient firm would realize. They also provide for more sharing in dense areas as opposed to rural areas. Further, unlike Qwest's proposal, the Staff's sharing percentages do not reflect Qwest's "replacement network" assumptions which the FCC and other state commissions have regularly rejected. Finally, other commissions, after having reviewed the records before them, have ordered sharing percentages similar to those Staff is proposing herein.

Qwest's 20 percent assumption indicates that sharing would occur infrequently, such that Qwest would only save 20 percent of the cost of the facility. That seems especially low for the first three density groups. Qwest is using the same sharing percentage (20%) for all buried distribution and feeder facilities. In fact, Qwest assumes the same percentage across all five of its DGs. Shared facilities occur more frequently in the higher density areas. The frequency of shared facilities decreases as the population density decreases due to the fact that the less densely populated areas have more room geographically for utility easements. To assume the same shared percentage for DG 1 as for DG 5 is absurd on its face and results in a drastic overstatement of costs.

Q. IS IT REASONABLE TO ASSUME THE SAME SHARING PERCENTAGE FOR ALL PLACEMENT ACTIVITIES?

A. No. Different activities will generally have different sharing opportunities. For instance, trenching – which is the easiest form of placement – will generally have reduced sharing as compared to cut and restore of concrete. This is because the economics provide greater incentive to share for the more expensive placement activities. Qwest assumes – evidently for simplicity in modeling – that the sharing percentages are the same for all placement activities.

Q. WHY DID YOU LEAVE THE SHARING PERCENTAGE AT 20 PERCENT FOR THE 2 INCH BORE ACTIVITY?

A. The Staff, based on its experience, understands that there are fewer opportunities for sharing a 2 inch directional bore than with larger bores or other activities. As such, we have accepted Qwest's 20 percent sharing percentage for that one activity.

Q. WHY DO YOU THINK THE 5 PERCENT SHARING FIGURE FOR UNDERGROUND CONDUIT IS LOW?

A. Underground conduit, which is common in urban areas, is almost always shared by multiple utilities or multiple users. Indeed, in an effort to minimize disruption to street and other city assets in the placement of additional support structure, substantial incentives exist in many urban environments (beyond those required by state commissions and the FCC) with respect to sharing support facilities. To suggest that Qwest will save only 5 percent of its costs in those environments doesn't appear to be a credible assumption (especially when Qwest provides no support for the assumption). As noted above, the economics suggest that providers will try and share in the costs of more expensive activities. Because the cost of conduit and placing conduit are high, utilities will attempt to share in those expenses. I have changed the underground conduit sharing percentage from 5 percent to 20 percent.

Q. AT PAGE 30 OF MR. BUCKLEY'S TESTIMONY HE STATES THAT QWEST HAS SHARED TRENCH ONLY 11.7 PERCENT OF THE TIME IN SOUTH DAKOTA FROM 1998 THROUGH 2000. DOES THAT CHANGE YOUR OPINION AS TO THE PROPER SHARING PERCENT?

A. No. Qwest's experience with sharing is not necessarily indicative of what an efficient firm might experience when placing its network. Qwest's experience from 1998 through 2000, when its network was already in place, is not a good analog for the sharing that occurred when the network was initially put in place. Further, Mr. Buckley's example was limited to Qwest's trenching activities. As noted above, because of the relatively inexpensive nature of trenching, the economic incentive to organize sharing is not as prevalent and sharing is less likely to occur absent competitive incentives to share. While Qwest's experience is interesting, it is of little value in developing assumptions for a TELRIC study.

Q. HAS THE FCC REJECTED PROPOSALS FROM THE ILECS TO RELY UPON THEIR ACTUAL EXPERIENCE?

A. Yes. In the FCC *Inputs Order* the FCC stated:

> …we reject the explicit or implicit assumption of most LEC commenters that company-specific values, which reflect the costs of their embedded plant, are the best predictor of the forward-looking cost of constructing the network investment predicted by the model. We find that, consistent with the Universal Service Order's third criterion, the forward-looking cost of constructing a plant should reflect costs that an efficient carrier would incur, not the embedded cost of the facilities, functions, or elements of a carrier.[30]

As such, the fact that Qwest has experienced 11.7 percent sharing for one placement activity is not appropriate or relevant in determining a TELRIC level of sharing for purposes of this case.

Q. IS THE ACTUAL EXPERIENCE OF OTHER PROVIDERS WHO MAY BE INSTALLING PLANT TODAY RELEVANT FOR PURPOSES OF THIS PROCEEDING?

A. No. Companies installing plant today are experiencing higher costs that what Qwest or other incumbents experienced when their plant was installed. One of the important concepts associated with the use of a TELRIC standard for pricing, is to allow the new entrants to share in the incumbent's economies of density, connectivity and scale. As the FCC noted, "…the local competition provisions of the Act require that these economies be shared with entrants."[31] Qwest's assumption of a replacement network and references to "overbuilds" is not consistent with the economies of density, connectivity and scale that it enjoyed when it placed the plant originally.

Q. WHEN SHARING DOES OCCUR, ARE THERE REVENUE OPPORTUNITIES FOR QWEST?

A. Yes, at least in some situations. Qwest seems to ignore, or at least does not include, the revenues it receives from sharing its facilities. Mr. Buckley discusses the fact that the power company pays Qwest for pole attachments, but there are no offsets identified in the study for such revenues.[32]

Q. WHAT ARE PLACEMENT ACTIVITIES?

A. Placement activities are those construction activities required to place facilities in what is generally referred to as a "revenue ready" state. That is, after having purchased the cable and wire, additional expenses are incurred by the company to install, splice and otherwise ready those facilities for use by customers. These

30 See FCC *Inputs Order* at paragraph 90.
31 See FCC's *Local Competition Order* at paragraphs 11 and 232.
32 Direct of Buckley at 26.

activities generally include trenching, plowing, cutting, boring and mulching, to name a few.[33]

Q. PLEASE IDENTIFY YOUR CONCERNS WITH THE PLACEMENT PERCENTAGES AND COSTS INCLUDED BY QWEST WITHIN ITS UNE LOOP COST DEVELOMENT MODEL.

A. As noted above, Qwest assumes that buildings, roads, curbs, etc. are already in place and that these barriers must be circumvented by Qwest in deploying the network it is modeling. As such, Qwest is assuming more barriers and higher costs than what would have been experienced when the network was initially placed.

Q. WHAT SUPPORT DOES QWEST PROVIDE FOR THESE ACTIVITIES AND THEIR COSTS?

A. Very little. One of my concerns is the lack of support for the percentages assumed in the various studies. It seems Qwest is basing the placement percentages upon the opinions of its outside plant engineers. While the opinion of experts can be helpful, it is clear that Qwest has a wealth of experience, not to mention actual work orders and job-specific information available to it. In other words, it would have been possible to track various placement activities in the DGs and provide results and percentages based on actual work orders over time as opposed to opinions. Given the impact these different activities have on the cost of placement (i.e., they are substantial), such studies would be critical to accurate

---

[33] See for instance, the activities identified in the Qwest LoopMod Default Values document at page 5.

forward-looking cost estimates.[34] Again, this is just another example of how the "LoopMod" tool lacks the TELRIC compliant assumptions the Commission should require of a cost study supporting UNE rates; especially when "LoopMod" is being supported by the very company that has the information necessary to provide a more accurate, less abstract result.

Q. ARE YOU SUGGESTING THAT ACTUAL WORK ORDERS SHOULD BE THE BASIS FOR A FORWARD-LOOKING COST STUDY?

A. No. But the actual studies would provide a benchmark from which to start the analysis. Studies based on actual work orders would certainly be preferable to basing these critical inputs on a few opinions of employees of the company being scrutinized. The results of the studies could serve as a base and then adjusted to reflect forward-looking assumptions.

Q. WHAT CHANGES TO THE PLACEMENT PERCENTAGES ARE YOU PROPOSING?

A. I am proposing some changes to the activity percentages in DG1, DG2, DG3 and DG4. A comparison of Qwest's placement percentages and Staff's placement percentages is provided below:

PLACEMENT PERCENTAGES -- DISTRIBUTION

ACTIVITY	Qwest	Staff	Qwest	Staff	Qwest	Staff	Qwest	Staff	Qwest	Staff
	DG1		DG2		DG3		DG4		DG5	
Trench and Backfill	20	25	25	30	25	30	30	30	3	3
Rocky Trench	5	14	5	10	5	10	2	3	-	-
Plow	-	5	-	10	-	10	28	33	91	91

[34] According to Mr. Buckley at page 10 of his testimony, the key cost drivers for LoopMod are cable placement activities, structure sharing percentages and plant mix.

Rocky Plow	-	5	-	6	-	-	-	-	4	4
Cut & Rest. Concr.	15	10	10	5	5	5	3	3	-	-
Hand Dig Trench	5	5	5	5	5	5	4	4	-	-
2" Bore Cable	14	10	21	15	32	20	14	9		
4" Bore Cable	6	6	9	4	13	10	6	5	-	-
Cut & Restore Asph	20	10	10	5	10	5	6	6	2	2
Cut & Restore Sod	15	10	15	10	5	5	7	7	n/a	n/a
Hydro Mulch	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-	-

Q. PLEASE JUSTIFY THE PROPOSED CHANGES TO THE PLACEMENT PERCENTAGES FOR DISTRIBUTION PLANT.

A. Qwest assumes that to rebuild its "replacement" network, it will need to bore under driveways and sidewalks and cut into streets.[35] Qwest further assumes that other utilities and developers are unaffected by the disaster that was imposed upon the Qwest network, while Qwest is in a great hurry to place plant because customers want dial tone restored. Finally, Qwest assumes that it has no time to organize sharing, and other parties have little interest in sharing placement and structure costs. These assumptions are simply wrong. The only existing structures that should be considered in a TELRIC study are the wire centers. The more conservative activity percentages proposed above reflect the activities that would be used in a new development or in a network deployment where reasonable sharing occurs.

A TELRIC study must assume that the network is put in place before most structures are present – as if the network were being deployed in the normal course of business. It is improper, as Qwest suggests, to replicate a network assuming all curbs, streets, buildings, other utilities, etc. are there. Such assumptions only increase the cost of the network and do not reflect the least-cost,

[35] See Direct of Buckley at 3.

most efficient manner in which to deploy a network. Indeed, such assumptions are reflected in the overstated placement percentages in LoopMod.

Q. DID YOU ATTEMPT TO GET QWEST'S SUPPORT FOR ITS POSITION ON TELRIC COSTING ASSUMPTIONS REGARDING EXISTING STRUCTURES THROUGH THE DISCOVERY PROCESS?

A. Yes. In New Mexico Staff Request 04-022 we asked:

> Regarding the Supplemental Testimony of Ms. Million: At numerous places throughout Qwest's testimony witnesses refer to "replacement cost" when referring to TELRIC principles. See for instance Million at 4 and 13, Buckley at I, ii, 2, 3, Pappas at 7 and 12, etc. Please provide all legal support and cites to specific orders that underlies [sic] Qwest's contention that a TELRIC model assumes the rebuilding or replacement of an existing network.

Qwest did not answer the question. Instead, Qwest simply stated, "Qwest objects that this data request seeks only legal argument. Qwest will respond to this data request in its briefs or policy testimony in this case."

Q. HAVE OTHER COMMISSIONS AGREED WITH YOUR POSITION THAT TELRIC STUDIES MUST ASSUME THAT THE NETWORK IS DEPLOYED BEFORE MOST STRUCTURES ARE IN PLACE?

A. Yes. In the recent *Colorado Cost Case Order*, the Commission stated:

> We concluded that Qwest's LoopMod exaggerates placement costs because it assumes that a high percentage of all installation jobs require cutting and restoration of concrete, asphalt or landscaping. Instead, we reasoned that the HAI Model more reasonably assumes that, in a forward-looking environment, cable will be placed most often before obstructions are built.[36]

[36] *Colorado Cost Case Order* at 28.

Q. DID YOU REDUCE THE PLACEMENT ACTIVITIES PROPOSED BY QWEST TO MORE REASONABLY REFLECT A TELRIC ENVIRONMENT?

A. Yes. To more accurately reflect efficient, forward-looking placement activities, I reduced the cutting and restoring of concrete, asphalt and sod in the input tables for LoopMod in DG1, DG2 and DG3. I also reduced the amount of bore cable in DG2, DG3 and DG4. I then increased the percentage of the other placement activities likely be used instead of the more expensive cut and restore and boring activities. I believe the placement percentages proposed by the Staff more accurately reflect the manner in which an efficient provider would deploy a network, and more accurately reflect the placement activities that took place when the plant was originally installed.

Q. HAVE YOU MADE ANY OTHER CHANGES TO THE PLACEMENT PERCENTAGES?

A. Yes. Using the same logic as discussed above, I have also made changes to the Feeder Placement Percentages for urban areas. A comparison of the Staff's proposed percentages to Qwest's percentages is provided below:

PLACEMENT PERCENTAGES -- FEEDER

ACTIVITY	Urban		Rural	
	Qwest	Staff	Qwest	Staff
Trench and Backfill	30	35	3	3
Rocky Trench	5	10	-	-
Plow	-	5	91	91
Rocky Plow	-	5	4	4
Cut & Rest. Concr.	15	10	-	-
Hand Dig Trench	5	5	-	-
2" Bore Cable	2	2		
4" Bore Cable	3	3	-	-
Cut & Restore Asph	20	15	2	2
Cut & Restore Sod	15	10	n/a	n/a
Hydro Mulch	n/a	n/a	-	-

Again, these changes reflect the exaggeration of Qwest's assumptions with respect to existing structures in developed areas. As such, the Staff has limited its proposed changes to the "urban" activities.

Q. DO YOU HAVE ANY OTHER PROPOSED CHANGES TO THE PLACEMENT PARAMETERS?

A. Yes. The Staff is proposing changes to the distribution aerial percents and the feeder aerial percents. Qwest has proposed a 14 percent aerial factor for distribution plant. Aerial plant is generally less expensive than buried or underground plant. While Staff recognizes the aesthetic preferences for buried plant, a higher percentage of aerial is a good compromise, which still reflects the economics of the two methods. The Staff is recommending the following aerial percentages:

AERIAL PERCENTAGES DISTRIBUTION

DENSITY GROUP	Qwest	Staff
DG1	14	20
DG2	14	25
DG3	14	25
DG4	14	20
DG5	14	20

For feeder plant, the Staff is recommending a 20 percent aerial factor as opposed to Qwest's 14 percent aerial factor in DG1, DG4 and DG5. The Staff is recommending 25 percent in DG2 and DG3.

B. Fill Factors and Their Use in Telecommunications Planning and Cost Recovery

Q. PLEASE EXPLAIN "FILL FACTORS" AND HOW THEY ARE USED IN COST STUDIES AND IN MANAGING THE NETWORK.

A. Fill factors can be explained in two different ways depending upon the role of the fill factor in a given analysis. Generally, fill factors are used in both engineering and economic analyses.

First, fill factors can be an important engineering tool used to determine points in time when certain facilities may require reinforcement based upon the depletion of spare plant needed to support future demand. For example, if the actual fill factor of a given 100 pair cable is 85% (i.e., 85 out of 100 available cable pairs are being used by customers), an engineer may rely upon this fill factor in conjunction with anticipated demand estimates as a "trigger" to order new facility placement in that given geographic area (to ensure that future orders may be fulfilled with working, available cable pairs).

Second, a fill factor, as it is used in a cost study, can be used to ensure that the company recovers its entire investment from only those facilities that will actually be used by customers. Returning to our example above, if it is anticipated that only 85 out of 100 copper pairs will be used on average, over time, the investment for all 100 pairs must be recovered from the 85 pairs that are expected to be used by customers. Hence, a fill factor of 85% (85/100) is used to ensure proper cost recovery (i.e., instead of developing a "per pair" investment in the 100 pair cable as *total investment / 100 pairs*, you would instead use a fill factor of 85% to estimate "per pair" investment as *total investment / 85).* As such, while the term "fill factor" may be used synonymously when referring to these two different analyses (i.e., engineering and economic), grievous mistakes can be made when the two are confused.

Q. HOW DOES QWEST DEFINE "FILL FACTOR"?

A. Qwest defines "fill factor" as "...the percentage of plant capacity used when the plant is installed."[37]

Q. ARE FILL FACTORS IMPORTANT COST STUDY INPUTS?

A. Yes, they are. Indeed, it could be argued that fill factors are one of the most important cost study inputs because they impact the ultimate cost study results more substantially than other inputs. Hence, while the use of fill factors is perfectly appropriate in forward-looking cost studies for purposes of arriving at "per unit" costs, the Commission must ensure that the fill factors it approves are reasonable, based upon sound economic principles of cost recovery and consistent with the FCC's TELRIC rules.

Q. HAS THE FCC RECOGNIZED THE IMPACT OF INCORRECT FILL FACTORS?

A. Yes. The FCC in its *Inputs Order* stated the following:

> If cable fill factors are set too high, the cable will have insufficient capacity to accommodate small increases in demand or service outages. In contrast, if cable fill factors are set too low, the network would have considerable excess capacity. While carriers may choose to build excess capacity for a variety of reasons, it is necessary to determine the appropriate cable fill factors for use in the federal mechanism. We also explained that, if the fill factors are too low, the resulting excess capacity would increase the model's cost estimates to levels higher than an efficient firm's costs.....[38]

This Commission must also determine the appropriate fill factors so as to ensure rates that reflect an efficient provider's costs.

Q. HAVE YOU REVIEWED QWEST'S PROPOSED FILL FACTORS?

A. Yes. I have reviewed Qwest's proposed fill factors for its distribution plant, feeder plant and electronics. Most of Qwest's proposed fill factors are inefficiently low, and as a result, improperly increase costs.

Q. WILL LOWER FILL FACTORS – AS PROPOSED BY QWEST -- RESULT IN HIGHER ESTIMATED COSTS?

A. Yes. Lower fill factors require more plant to serve a fixed amount of capacity. Generally speaking the higher the fill factor the more efficient the network.[39] As

---

37 See, Qwest ICM Cost Model User Manual, Version 3.1, at page 14.

38 See, FCC *Inputs Order* at paragraph 186.

39 Naturally, there is a limit to this phenomenon. As fill factors increase, you eventually reach a point where blockage occurs and quality of service is degraded. The fill factors proposed by the Staff, however, are nowhere near the level where service quality or held orders would be impacted.

networks are used more efficiently and more of the installed plant is used by paying customers, engineering or actual fill factors increase and "per pair" costs decrease (because economies of scale begin to make a larger and larger downward impact on costs "per pair"). Hence, as is to be expected, the more efficiently a network is used (and higher fill factors result), the lower the costs that can be passed on to customers.

Q. PLEASE DEFINE DISTRIBUTION PLANT.

A. The distribution plant consists of facilities (cables, connectors and structures) that interconnect with the feeder cables, and spread the thousands of feeder pairs to individual subscriber premises. The distribution facilities originate at a large cabinet – sometimes called a feeder distribution interface (FDI) or serving area interface (SAI) -- and terminate at a small terminal (pedestal) usually located no more than 200 feet from the premises.[40]

Q. WHAT DISTRIBUTION FILL FACTORS HAVE BEEN RECOMMENDED BY QWEST?

A. As noted in the testimony of Mr. Buckley, Qwest does not use fill factors *per se* in the standard distribution designs. Instead, Qwest assumes a certain "network design" – based on the number of pairs per each living unit.[41] Nevertheless, LoopMod does ostensibly allow the user to insert specific fill factors to override the "network design" assumptions. Using the "Custom Model" option in the "Pairs Per Site" drop down box, a user may enter traditional fill factors.

---

[40] The FDI can be a cabinet or a pedestal. This is where the two parts of the network – feeder and distribution – cross-connect.

[41] See the direct testimony of Mr. Buckley at 33.

Q. DO THE NETWORK DESIGNS USED BY QWEST TRANSLATE INTO FILL FACTORS? IF SO, WHAT ARE THEY?

A. In response to Staff Request 01-062, Qwest states that it designs distribution plant "...at two pairs per site for DG1, DG2, and DG5. The designs for DG3 and DG4 are three pairs per site." In response to Staff Request 01-046, Qwest states "Two pairs per site is approximated using 50%, three pairs is 33% and 1.5 pairs is 67%." Given this information, Qwest's assumed fills for the density groups are as follows:[42]

DG1	50%
DG2	50%
DG 3	33%
DG4	33%
DG5	50%

Obviously the average fill assumed by Qwest for its distribution plant is less than 50 percent.

Q. DO QWEST'S DISTRIBUTION FILL FACTORS SEEM REASONABLE?

A. No. There are a number of problems with Qwest's proposed fill factors. First, Qwest's fill factors are based on current working lines and are not based upon a reasonable projection of demand in a forward-looking, efficient network.[43] For instance, in response to New Mexico Staff Request 02-030S1, Qwest confirmed the guidelines in its model user manuals by stating, "The demand (working lines) considered in the model should be and are, the current working line counts."

---

42 See also Qwest Loop Module Version 2.1, Default Values, South Dakota, May 23, 2002, at 2.

43 Id.

Q. YOU REFER TO A "REASONABLE PROJECTION" OF DEMAND? IS THAT A STANDARD TO BE APPLIED IN A TELRIC MODEL?

A. Yes. In the its *Local Competition Order*, the FCC specifically states:

> Per-unit costs shall be derived from total costs using reasonably accurate "fill factors" (estimates of the proportion of a facility that will be "filled" with network usage); that is, the per-unit costs associated with a particular element must be derived by dividing the total cost associated with the element by a **reasonable projection of the actual total usage** of the element.[44] (emphasis added)

Later in that same order, the FCC reinforced the same concept with the following statement:

> We, therefore, conclude that the forward-looking pricing methodology for interconnection and unbundled network elements should be based on costs that assume that wire centers will be placed at the incumbent LEC's current wire center locations, but that the reconstructed local network will employ the most efficient technology for **reasonably foreseeable capacity requirements**.[45] (emphasis added)

Qwest's use of current working line counts therefore conflicts with the national guidelines for a forward-looking model that reflects the network of an efficient provider. Instead of using "current" line counts to determine fills, Qwest should have used a "projection" of lines and usage to develop fills for its models.

Second, Qwest's fill factors and demand assumptions for its distribution plant are calculated using the "ultimate demand" theory. That is, Qwest assumes that it must place enough plant today (at the time it is estimating its loop costs) to accommodate all demand it may experience any time in the future. Likewise,

---

44 See, FCC's *Local Competition Order* at ¶ 682.
45 Id. at ¶ 687.

Qwest's theory requires that today's customers pay for this enormous spare capacity through today's rates.

Third, Qwest provides no real information in support of its fill factors. This simple fact, in combination with decisions by both the FCC and myriad state commissions across the country ordering fill factors substantially higher than those proposed by Qwest, seriously undercut the credibility of Qwest's fill factor proposals.

Q. WHAT IS MEANT BY "ULTIMATE CAPACITY" OR "ULTIMATE DEMAND" AS REFERENCED ABOVE?

A. There are several different names for this concept; "ultimate capacity", "ultimate demand", and "lifetime demand" are a few common names used in the industry today. There are two competing network construction/deployment strategies that have been argued in the states and before the FCC. Under one approach, which can be called the "just in time" strategy, it is assumed that network facilities are added in an amount sufficient to meet demand for a limited period of time, say three to five years. Conversely, under an "ultimate demand" strategy, it is assumed that the network facilities are deployed so that all future demand will be met, and no additional relief projects will be required over the life of the plant. As you can imagine, the two strategies result in dramatically different costs that customers must bear.

Q. WHICH APPROACH IS USED BY QWEST?

A. Qwest uses both approaches, but at different points in its network. For instance, for feeder plant, which is much easier to augment than distribution plant, Qwest uses the "just in time" approach. For distribution plant, however, Qwest typically sizes each job based on its forecast of lifetime or ultimate demand in the distribution area.[46]

Q. WHY IS IT IMPORTANT TO REJECT QWEST'S ULTIMATE DEMAND OR ULTIMATE CAPACITY ASSUMPTIONS WITH RESPECT TO ITS DISTRIBUTION PLANT?

A. The ultimate demand strategy results in excess capacity and the FCC has rejected that methodology for TELRIC studies.

Q. HAS THE FCC THOROUGHLY REVIEWED THE MERITS OF BOTH NETWORK MODELING ASSUMPTIONS, AND, IF SO, WHY DID THE FCC REJECT THE ULTIMATE DEMAND APPROACH?

A. Yes, the FCC did review extensive comments from the industry on this issue and specifically rejected the "ultimate demand" approach to calculating fill factors and network expenses. The main reason the FCC rejected "ultimate demand" is because it does not reflect efficient practices and results in excess capacity and overstated costs.[47] In the FCC's *Inputs Order*, it notes that,

> We also affirm our tentative conclusion that the fill factors selected for use in the federal mechanism generally should reflect current demand and not reflect the industry practice of building distribution plant to meet ultimate demand.[48]

In the next paragraph in that same FCC Order, it states,

> …we find that basing the fill factors on current demand rather than ultimate demand is more reasonable because it is less likely to result in excess capacity, which would increase the model's cost

---

46 In the ICM User Manual (Version 3.1; dated May 2002) at page 15, Qwest notes that it designs distribution areas "…based on ultimate capacity."

47 See, FCC *Inputs Order* at ¶ 199.

48 Id.

estimates to levels higher than an efficient firm's costs and could potentially result in excessive universal service support payments.

Q. IT SEEMS THAT THESE QUOTES FROM THE FCC'S *INPUTS ORDER* CONTRADICT YOUR QUOTES FROM THE *LOCAL COMPETITION* ORDER. PLEASE EXPLAIN.

A. These quotes do not contradict the *Local Competition* Order. In paragraph 201 of the *Inputs Order* the FCC states, "….current demand as we define it includes an amount of excess capacity to accommodate short-term growth." As such, a reasonable projection of current demand for a forward-looking model would include some excess capacity to accommodate short-term growth.

In summary, Qwest's "ultimate demand" approach results in unreasonably low fill factors. As such, it is inconsistent with the FCC's TELRIC costing methodology.

Q. CAN YOU PROVIDE AN EXAMPLE OF HOW USING "ULTIMATE DEMAND" ASSUMPTIONS AND THE RESULTING LOW FILL FACTORS CAN OVERSTATE INVESTMENT AND COSTS?

A. Yes. Assume a 100 pair distribution cable placed in service in 2002 and expected to produce economic benefits for 20 years (i.e., the economic life of the facility is 20 years). Assume that in year one the facility supports 50 working circuits (consistent with Qwest's most aggressive proposal in three out of five distribution areas). Assume further that it is experiencing approximately 2% annual growth in access line demand. The following table provides the Commission with an important piece of information given these facts; i.e., the average actual fill percentage over the life of the facility given these conservative assumptions:

FILL FACTOR ANALYSIS - QWEST
DISTRIBUTION CABLE

Assumptions:

Avg. nbr of working pairs at install:	50
Number of available pairs:	100
Economic life (in years):	20
Annual growth rate over econ life:	2.0%

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
Ln. 1	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ln. 2											
Ln. 3	**Working Pairs**	50	51.0	52.0	53.1	54.1	55.2	56.3	57.4	58.6	59.8
Ln. 4	(includes annual growth)										
Ln. 5											
Ln. 6	**Available Pairs**	100	100	100	100	100	100	100	100	100	100
Ln. 7											
Ln. 8	**Actual Fill Factor**	50.0%	51.0%	52.0%	53.1%	54.1%	55.2%	56.3%	57.4%	58.6%	59.8%
Ln. 9	Ln. 3 / Ln. 6										
Ln. 10											
Ln. 11	**Year**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ln. 12											
Ln. 13	**Working Pairs**	60.9	62.2	63.4	64.7	66.0	67.3	68.6	70.0	71.4	72.8
Ln. 14	(includes annual growth)										
Ln. 15											
Ln. 16	**Available Pairs**	100	100	100	100	100	100	100	100	100	100
Ln. 17											
Ln. 18	**Actual Fill Factor**	60.9%	62.2%	63.4%	64.7%	66.0%	67.3%	68.6%	70.0%	71.4%	72.8%
	Ln. 13 / Ln. 16										

Average fill factor from installation to retirement: 60.7%

Q. IS THE "AVERAGE FILL FACTOR FROM INSTALLATION TO RETIREMENT" FIGURE OF 60.7 PERCENT RELEVANT IN COMPARISON TO QWEST'S PROPOSED FILL FACTORS?

A. Yes, it is. If we assume that a 100 pair copper cable placed in service today would be connected to 50 working customers on average (consistent with Qwest's **most** aggressive assumption), and that over the 20 year economic life of the facility it would experience annual access line demand growth of 2%, the table above indicates that on average, over its economic life, the 100 pair cable would support 60.7 working pairs. Likewise, at the end of its economic life it would be supporting only 72.8 working pairs. This means, of course, that even over the entire 20-year life of the facility, almost 30 percent of the plant would go unused.

Q. IN THIS SCENARIO, WOULD QWEST EVER HAVE TO REINFORCE THE CABLE?

A. No. Most engineering guidelines trigger reinforcement at 85 percent or higher utilization. As such, under Qwest's scenario, this cable facility would never be reinforced and over the life of the cable almost 30 percent of the lines would go unused. Indeed, at page 34 of Mr. Buckley's testimony he admits "Distribution is designed to avoid reinforcement…." Qwest's approach would result in a waste of resources and an unnecessary overcharging of customers for this cable and the services it supports.

Even if Qwest assumed 65 percent fill, or about 1.5 pairs per living unit, under its assumptions the cable would never exhaust and wouldn't even be considered for reinforcement in South Dakota for 15 years. This example shows how inefficient Qwest's proposed fill factors are.

Q. IF THE COMMISSION ESTABLISHED A DISTRIBUTION FILL FACTOR OF ONLY 50 PERCENT, AND 30 PERCENT OF THE LINES WENT UNUSED OVER THE LIFE OF THE CABLE, WOULD QWEST

STILL RECOVER ALL OF THE COSTS OF THE CABLE?

A. Yes. If the Commission were to establish UNE rates based upon an average fill factor of only 50 percent for this distribution cable, or 2 pairs per living unit according to Qwest, Qwest would recover the entirety of its investment in the cable over its economic life from the number of customers whom it supports, on average, over that same time period.[49] This approach, however, forces today's customers to pay for facilities reserved for future customers.

Q. PLEASE EXPLAIN HOW LOW FILL FACTORS FORCE TODAY'S CUSTOMERS TO PAY FOR FACILITIES RESERVED FOR FUTURE CUSTOMERS.

A. First, the accommodation for future growth is generally reflected in a low fill factor resulting from the fact that "active pairs" used by today's customers are divided by "total pairs" placed to accommodate the usage of *all* future customers, perhaps even those customers who won't arrive on the network until nearly 20 years later. However, using this very low percentage to calculate current rates, as Qwest attempts to do, ignores a very large part of the equation: i.e., future revenues generated by customers who will use those facilities later in the equipment's economic life.

Exaggerating current costs to reflect plant made ready for future revenues places the burden of cost recovery on today's customers for facilities that will bear revenues (and zero costs) for Qwest when those facilities begin to be used. Simply put, if today's customers are paying for plant that will be used by

[49] Obviously this analysis does not consider "time value of money" impacts that should be, and are, accommodated in Qwest's annual cost factor calculations.

tomorrow's customers, won't tomorrow's customers be paying too little for the plant they are using (and today's customers paying too much)? The answer to this question is "yes." This is exactly the type of poor cost causality/recovery the FCC was attempting to avoid by rejecting the "ultimate demand" approach.

Q. HAVE STATE COMMISSION'S RECOGNIZED THIS SAME FLAW IN PREVIOUS QWEST COST CASES?

A. Yes. In its 1999 Order at page 9, the Minnesota Commission states,

> As proposed by U S WEST, RLCAP 4.0 determines costs by placing enough distribution facilities to serve ultimate future demand but divides those costs by the current level of demand. In effect, this approach has today's ratepayers and competitors paying for loops used to provide service to future customers and competitors. With this mismatch, as the demand increases in the future, U S WEST would collect more revenue than the costs to provide the distribution facilities. [50]

Despite this valid criticism, Qwest has failed to correct this problem in LoopMod.

Q. ARE THERE OTHER CONCERNS RESULTING FROM THE REQUIREMENT THAT TODAY'S CUSTOMERS PAY FOR FACILITIES RESERVED FOR TOMORROW'S CUSTOMERS THROUGH UNREASONABLY LOW FILL FACTORS?

A. Yes, there are competitive concerns that also arise. Qwest's competitors should not be required to pay for excessive spare for growth, as Qwest's proposed fill factors require. The result of this proposal is that, if approved, CLECs will pay for facilities placed to serve Qwest's *future customers* – *i.e.*, CLECs will be required to pay for facilities that Qwest uses when competing against CLECs for such customers. Of course, CLECs will be able to use those facilities as well, but

[50] *Minnesota Cost Case Order* at page 12, paragraph 46.

only after they pay for them once again. By contrast, Qwest can at any moment avail itself of the spare facilities that the CLECs are paying for and use those facilities to compete against the CLECs.

Q. CAN YOU PROVIDE AN EXAMPLE OF HOW CLECS MIGHT PAY FOR FACILITIES THAT QWEST WOULD USE?

A. Yes. Consider a situation in which a CLEC wants to serve the tenants in a new business park that is wired with 1000 lines. Now assume that the CLEC succeeds in attracting all of the tenants in this new business park and serves them by means of 500 unbundled loops from Qwest. Further assume, for simplicity sake, that the price for those loops is based on a 50% fill factor.[51] Thus, the CLEC, in effect, pays for 1000 loops: it pays for 500 loops it gets to use and it pays for an additional 500 spare loops, which Qwest gets to use if it so chooses.

It is important to note that Qwest is now in the ideal, and enviable, position to approach the tenants in the business park (served by the CLEC), and to offer them cheap, nearly free additional services (such as, additional fax or modem lines and special lines for long distance calling), by using the 500 spare loops. Again, Qwest can price these spare loops at a steep discount because the CLEC is already paying for them (and will continue to pay for them as long as it continues to lease the 500 unbundled loops from Qwest).

The Commission should recognize that it would indeed be rational for Qwest to offer a steep discount package to sell tenants the 500 spare loops -- that are being paid for by the CLEC and would otherwise be sitting idle. The

[51] Different fill factors apply to different parts of the loop. This observation, however, does not alter the conclusion of the example, that Qwest's proposal is discriminatory and anticompetitive.

Commission should also recognize that such a competitive asymmetry is not sustainable or in the public interest. *CLECs cannot viably compete if they are forced to pay for the very "spare" facilities that Qwest will use to compete against them.*

This practice is discriminatory, anti-competitive and inconsistent with the precepts identified in the FCC's *Local Competition Order*. Moreover, in the long run, CLECs will not be able to compete under this kind of a costing arrangement. The point is that fill factors that are set below reasonable, forward-looking levels will result in over-recovery and erect barriers to entry that thwart the goal of unbundling Qwest's network.

C. Qwest's Engineering Assumptions Result in Excess Capacity

Q. WHAT IMPACT DO QWEST'S ENGINEERING ASSUMPTIONS HAVE ON COSTS?

A. Qwest's engineering assumptions result in excess capacity and overstated costs. Specifically, Qwest's default values for pairs allowed per density group result in an oversized network. For example, and as discussed above, DG 1, DG 2 and DG 5 utilize two pairs per site and DG 3 and DG 4 assume three pairs per site. With the advent of new technologies, the two and three pair per site assumptions are excessive. For instance, asynchronous digital subscriber line or "ADSL" technology allows a subscriber to use one pair for both voice and data transmission simultaneously. Indeed, in the FCC's *Advanced Services Order*, the FCC stated,

> Moreover, for wireline carriers, digital subscriber line technologies are making it possible for ordinary citizens to access various networks, such as the Internet, corporate networks, and governmental networks, at high speeds through the existing copper telephone lines that connect their residences or businesses to the incumbent LEC's central office."[52]

In addition to the obvious competitive benefits of line sharing, the industry benefits because fewer resources are required to deploy service, and the consumer benefits because he or she no longer needs a second line.[53]

It is very possible for consumers to have multiple telephone numbers and services without the need to add additional lines. Common services, such as distinctive ringing, which allow multiple telephone numbers for a single pair, and ADSL, which allows a consumer to use one line for both voice and Internet access, are helping telephone companies minimize their investment in copper facilities. Further, the use of cell phones has, at least in part, reduced the demand for additional lines. It does not appear that Qwest has considered these technologies or services in sizing its network under the DG guidelines.

Q. HAS QWEST MADE THE ARGUMENT THAT WIRELESS SERVICES ARE REPLACING ITS BASIC LOCAL EXCHANGE SERVICES?

---

[52] Before the Federal Communications Commission; In the Matter of Deployment of Wireline Services Offering Advanced Telecommunications Capability and Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, CC Docket No. 98-147 & CC Docket No. 96-98, **Order on Reconsideration and Second Further Notice of Proposed Rulemaking in CC Docket No. 98-147 and Fifth Further Notice of Proposed Rulemaking in CC Docket No. 96-98,** ¶ 5 (released: August 10, 2000); hereinafter referred to as *August 10, 2000 Advanced Services Order*.

[53] Given the upcoming FCC Triennial Review Order, line sharing may be impacted. Nevertheless, the benefits to the industry and consumers associated with line sharing are significant.

A. Yes. In Idaho Qwest is seeking price deregulation for its Basic Local Exchange Services based on the assertion that wireless telephone service is competitively priced with and functionally equivalent to Qwest's basic local exchange service.[54] Qwest has a similar application pending in South Dakota wherein its witness, Mr. Teitzel states, "...wireless providers now serving South Dakota consumers represent effective competition to Qwest's traditional landline services."[55] Given Qwest's new public positions on the impact of competitive providers, including wireless providers, it is completely inconsistent to argue for the same low fill factors its has been proposing for years.

Q. ARE YOU SUGGESTING THAT QWEST'S ENGINEERING DESIGN ASSUMPTIONS IN LOOPMOD OVERSTATE THE CAPACITY REQUIRED TO SERVE CUSTOMERS EFFICIENTLY?

A. Yes. Assuming 2-3 pairs will be placed for every living unit in Qwest's serving territory is part and parcel of the "ultimate demand" ideology discussed above (and specifically rejected by the FCC). Obviously, 2-3 pairs for every premise is far in excess of the plant actually required to meet today's demand or any demand that will be realized in the near future. Other carriers are using more reasonable estimates of fill that reflect the new technologies in the market today.[56] By allowing

[54] Before the Idaho Public Utilities Commission; In the Matter of the Application of Qwest Corporation for Price Deregulation of Basic Local Exchange Services; Application of Qwest Corporation; Case No. QWE-T-02-25; at 7.

[55] Before the Public Utilities Commission of the State of South Dakota; In the Matter of the Application of Qwest Corporation to Reclassify Local Exchange Services as Fully Competitive; Direct Testimony of Mr. David L. Teitzel; dated March 14, 2003, at 5.

[56] In a Forbes article titled, "Bad Connection" by Scott Woolley, August 8, 2002, it states: "BellSouth workers used to go into new suburbs in the Southeast and confidently bury thick bundles of wires containing 1.5 to 2.4 phone lines for ever home in the neighborhood; **this year its workers began burying just one phone line for every home its wires pass.**" (emphasis added)

Qwest's model to size its network consistent with these estimates, Qwest's model overstates the size of an efficiently configured, TELRIC-compliant network.

Q. WHAT DISTRIBUTION FILL FACTORS DID THE FCC ADOPT IN THE COST MODEL *INPUTS ORDER* (FCC DOCKET NO. 96-45)?

A. The FCC adopted distribution fill factors that ranged from 50 to 75 percent based upon the density zone. For instance, the FCC adopted a 50 percent distribution fill factor for the lowest density zone and a 75 percent distribution fill factor for the highest density zone.[57]

Q. DO YOU HAVE INFORMATION FROM OTHER STATE COMMISSION'S AND THE DECISIONS THEY'VE MADE REGARDING FILL FACTORS FOR OTHER RBOCS?

A. Yes, after nearly two years of analysis regarding Ameritech's unbundled loop cost study (See Case Nos. U-11280 and U-11735), the Michigan Public Service Commission recently approved the following fill factors as being consistent with the FCC's TELRIC rules and sufficient for purposes of compensating Ameritech/SBC for the facilities it produces as UNEs:

	Michigan Commission CASE U-11280 APPROVED FILLS
Copper Feeder	80%
Copper Distribution	75%
Central Office and Remote Terminals	85%

[57] See FCC *Inputs Order* at footnote 392.

Indiana, Ohio, and Wisconsin have followed suit settling on fill factors very similar to those adopted by Michigan.

In Colorado, the Commission ordered the following fill factors for feeder and distribution in Qwest's cost proceeding:[58]

Fill Factors		
	CO Commission RRR	
Density	**Feeder**	**Distribution**
0	65.0%	50.0%
5	75.0%	55.0%
100	80.0%	55.0%
200	80.0%	60.0%
650	80.0%	70.0%
850	80.0%	75.0%
2550	80.0%	75.0%
5000	80.0%	75.0%
10000	80.0%	75.0%
Weighted Average:	79.17%	70.49%

The Colorado Commission supported its decision with the following statement: "We adopt these fill factors because they more accurately capture the fill factors in an efficient, forward-looking environment."[59]

In Utah, the Commission there found that Qwest was proposing a fill factor of 37 percent, and found that utilization rate to be "unacceptably low." Instead, the Utah Commission ordered a fill of 60 percent to be used in Qwest's cost studies.[60]

D. *Staff's Recommended Distribution Fill Factors*

---

58 *Colorado Cost Case* Order at 44.

59 Id. at 43.

60 Before the Public Service Commission of Utah, Docket No. 00-049-105; **ORDER**; Issued June 6, 2002, at pages 20-21.

Q. WHAT DISTRIBUTION FILL FACTORS IS THE STAFF RECOMMENDING FOR USE IN THIS PROCEEDING?

A. I am proposing the following distribution fill factors by Density Group:

Density Group	Fill Factor
DG1	75%
DG2	70%
DG3	65%
DG4	60%
DG5	50%

As will be discussed later, these fill factors – while still conservative -- are much more reasonable than Qwest's proposed factors.

Q. ARE YOU CONFIDENT IN THE LOOPMOD RESULTS ASSOCIATED WITH YOUR FILL FACTOR CHANGES?

A. I am confident that that proposed fill factors are much more reasonable than those proposed by Qwest. I am not completely confident in the model's ability to accurately reflect the proposed fills. The Qwest model does not accurately size cables or determine investment when using the "custom model" option. For example, Qwest's witness Mr. Buckley does not recommend changing the fill factors in the Loop Module. Specifically, Mr. Buckley states:

> Although the ICM interface allows the user to size distribution facilities based on a desired fill, I would not recommend that approach to distribution design except for use in sensitivity tests.[61]

[61] See, Buckley Direct at 34. Mr. Buckley could not explain counter-intuitive results from changing fill factors for RLCAP in previous cost cases. Mr. Buckley admitted an error in RLCAP's fill factor calculation mechanism then, and, perhaps implied in Mr. Buckley's testimony in this proceeding – is that the error was never fixed. (See *Minnesota Cost Case* Order issued May 3, 1999 at 10-11)

This statement by an ICM user and developer contradicts the user manual, wherein it states, "Under this option [the "Use Fill Factors Option"] the fill factors will determine cable sizing. This supercedes standard 1 pair, and 2 pair designs."[62] The LoopMod user manual also describes in detail the ability to do a "Custom Model" by selecting fill factors for each density group.[63] Mr. Buckley's rationale for not following the various ICM user manual instructions is that the engineers do not utilize fill when designing the network. Instead, the Qwest engineers work with a design criteria based upon various pairs per site. Nowhere in his explanation, however, does he explain why the model does not determine cable sizing as the user manual states. Nevertheless, the fact is that Qwest's model – per its own developer's admission – does not accurately size cables or determine investment by fill factors. This is just one of the shortcomings of the ICM/LoopMod that makes its use in supporting unbundled loop rates undesirable.

Q. HOW DO YOU PROPOSE TO FIX THE PROBLEM WITH LOOPMOD'S FILL FACTOR OVERRIDE?

A. I recommend that the Commission require Qwest to do various model runs that adjust the "pairs per site" such that the model reflects the fill factors recommended by the Staff. The resulting costs and rates would then be submitted to the parties in the case for review. In essence, we are recommending that Qwest re-run its models per the Staff recommendations and then provide the results in the form of a compliance filing.

---

62 See Qwest ICM User Manual, Version 3.1, at 14.
63 See Qwest LoopMod Users Manual at 2.7.

Q. MR. BUCKLEY STATES AT PAGE 35 OF HIS TESTIMONY THAT THE THREE PAIR PER RESIDENCE DESIGN ALLOWS QWEST TO AVOID HELD ORDERS. PLEASE COMMENT.

A. Fill factors within the range suggested by the Staff – including 75% in DG1 or 1.33 pairs per site – provide more than enough spare capacity to meet demand without harming quality of service or Qwest's ability to provide services on demand. There is no basis for concluding that the fill factors recommended by the Staff, which are more conservative than the fill factors ordered by the Colorado and Michigan Commissions, would increase the number of held orders actually experienced in South Dakota. Moreover, as I noted above, a number of factors are reducing the growth in demand for new lines. These factors include new technologies such as DSL, which allows consumers to use one line where two used to be required. Further, many consumers are choosing wireless phones in lieu of adding additional wire lines.

Q. WOULD FILL FACTORS ASSUMED IN LOOPMOD IMPACT QWEST'S ACTUAL FILLS IN THE NETWORK?

A. No. It is understood that the fills assumed in the cost studies are those that an efficient firm would experience. As such, it may very well be that Qwest is experiencing some held orders, but simply changing an assumption in a cost study will not cause or resolve such problems. In other words, Qwest's actual engineering guidelines and actual network placement activities are not necessarily reflected in the costing assumptions used in this proceeding. One would hope, however, that Qwest's engineering would be moving towards a more efficient utilization over time.

Q. IN THE PAST, IT APPEARS THAT QWEST HAS ATTEMPTED TO ASSESS SPECIAL CONSTRUCTION CHARGES ON CLECS WHEN THEY ORDER FACILITIES AND QWEST INDICATES SUCH FACILITIES DO NOT EXIST. WOULD YOUR FILL FACTOR RECOMMENDATION INCREASE THE LIKELIHOOD OF THIS SITUATION?

A. No, but a number of things are worth noting about such "special construction" charges. First, the fact that Qwest is telling other carriers that "no facilities are available" is a clear indication that Qwest's network is "filled" at percentages far exceeding those recommended here by Qwest or Staff. If Qwest legitimately experienced fill factors in the range of 33 to 50 percent, "held orders" should almost never occur. Second, it is important to note that TELRIC studies allow Qwest to recover the investment, and investment related expenses, including cost of capital and depreciation, for loops and other UNEs as if they were built anew. Hence, even if in any given circumstance a CLEC orders a facility wherein Qwest has no existing facility, the monthly recurring loop rate should be sufficient to compensate Qwest, even if Qwest must build a new loop to meet the request. As such, "special construction" charges are almost never appropriate in the provision of UNEs.

E. Qwest's Feeder Fill Factors

Q. PLEASE DEFINE FEEDER PLANT OR FACILITIES.

A. Feeder facilities are the large cables that extend from the central office toward the subscribers. One end of the feeder terminates at the main distribution frame (MDF) in the central office, and the other end terminates in a large cabinet (the FDI or SAI) that contains a series of terminal blocks of connecting lugs, similar to those found in the MDF. Another component of feeder plant is the digital loop carrier or "DLC". Two DLC components included in the model are remote terminals and channel units. These equipment types are discussed in some detail later in this testimony. A complete description of their use and functionality is not required for this discussion of fill.

Q. WHAT COPPER AND FIBER FEEDER FILL FACTORS HAVE BEEN RECOMMENDED BY QWEST?

A. Qwest refers to "sizing factors" as opposed to "fill factors" for its feeder design.[64] Assuming the effect on the model and resulting costs are the same, I do not object to the new phraseology. Actually, Qwest's language is more precise in that actual, calculated, objective and design fills are frequently very different.

Qwest uses an 80 percent copper feeder sizing factor and a 100 percent fiber feeder sizing factor.[65] These fill percentages are consistent with the FCC's *Inputs Order* and other cost case orders in the region.[66]

Q. WHAT FILL FACTOR (SIZING FACTOR) DOES QWEST RECOMMEND FOR REMOTE TERMINALS AND CHANNEL UNITS?

---

[64] See Qwest Response to Staff Request Nos. 01-026; 01-027; 01-031 and 01-044. Qwest notes that calculated fill is the fill achieved in a model and actual fill is the fill achieved in the field.

[65] See Loop Module Version 2.1 Default Values; South Dakota; at 3. See also Qwest Response to Staff Request No. 01-027.

A. Qwest recommends an 80 percent sizing factor for DLC terminals and 90 percent for DLC channel units.[67]

Q. WHAT LEVEL OF FILL IS APPROPRIATE FOR CHANNEL UNITS?

A. Because channel units can be placed as demand develops, a high rate of utilization can be achieved (indeed, this is the very reason that DLC equipment is engineered with circuit specific plug-in equipment). In addition, the channel units can be placed to closely match the total number of end-users that are served by DLC systems Thus, to the extent that there is growth, channel units can be placed on very short notice, eliminating the need for anything but a minimal number of spares. In view of these considerations, I recommend that the Commission accept Qwest's proposed sizing factor of 90 percent for channel units.

Q. DO YOU AGREE WITH QWEST'S PROPOSAL FOR THE TERMINAL SIZING FACTOR OF 80 PERCENT?

A. No. The fill for the remote terminal should be at least 90 percent. Because it is so easy to augment these systems, ILECs usually engineer these facilities to accommodate six months of growth.

Q. CAN FEEDER ELECTRONICS BE MAINTAINED AT FILL LEVELS OF 90 PERCENT?

A. Yes. In fact, they can be maintained at fill levels that are even higher. For example, Verizon's engineering documents require that certain types of DLC systems (SLC-96) are used at literally 100 percent. Qwest's engineering guidelines should be similar to those utilized by other LECs around the country.

---

66 See FCC *Inputs Order* at ¶¶ 190-191.

67 See Qwest Response to Staff Request No. 01-027 and 01-042.

As such, the 90 percent sizing factor recommendation is conservative and should be adopted by the Commission.

F. Qwest's Density Group Theory

Q. EARLIER YOU MENTIONED THAT YOU WOULD DISCUSS QWEST'S DENSITY GROUP ASSUMPTIONS. PLEASE CONTINUE THAT DISCUSSION.

A. Qwest's "LoopMod" study (like RLCAP before it) relies upon generic distribution network designs based on the density of access lines in distribution areas.[68] The five density groups are (a) DG 1 (Very High – High-rise buildings), (b) DG 2 (High – Industrial parks, shopping centers, apartment complexes or condominium developments), (c) DG 3 (Medium – Single-family housing development), (d) DG 4 (Low – Large acreage housing developments), and (e) DG 5 (Very Low -- Farm or ranch type properties). The manual notes that the average investment by component for each design is multiplied by the design percents to produce a distribution investment for each kilofoot of loop length. While this process seems reasonable as described, Qwest provides no support for the engineering designs or the arbitrary groupings. Likewise, further analysis shows that the density group theory relies almost exclusively on undocumented "expert opinions" and abstract network designs having very little to do with Qwest's actual network as it is, or should be, deployed in South Dakota.

Q. PLEASE EXPLAIN.

---

[68] See Qwest ICM User Manual, Version 3.1, at 10-11.

A. Nowhere in the cost study documentation can a person find the manner in which the DG designs were developed. There is no description of how the five different categories were identified or why the density characteristics chosen to segregate the areas are appropriate. Indeed, other than the vague descriptions I noted above, i.e. *DG 1 Very High – High Rise Buildings*, there is no technical description of how an area would be identified with a particular DG. Further, there is no support for the engineering design assumptions for each density group model. The LoopMod User Manual simply notes,

> The input data for the Distribution calculations are from the Loop Engineering Information System (LEIS) database. The data includes a Distribution Area (DA) code, the number of working lines in the DA, the longest loop in the DA and information on the number and size of entrance terminals. In addition, the program uses area data for each DA. The information is used in determining how to map each actual DA to the programs standard distribution designs for the various density levels.[69]

There is no support for the manner in which the engineering designs were developed, and there is no validation as to whether the designs are representative of a true forward-looking network, let alone representative of South Dakota.

Q. WAS THE LACK OF SUPPORT FOR THE DENSITY GROUP DESIGNS A CRITICISM IN OTHER COMMISSION ORDERS AS WELL?

A. Yes. In the *Minnesota Cost Case* order I cited earlier, the Minnesota Commission specifically expressed concern about the lack of support for the designs. The Order states,

> 18. U S WEST has provided little support for the five distribution designs used in RLCAP. The same five designs are used in all fourteen of U S WEST's states. U S WEST has not offered any

[69] See Qwest LoopMod User Manual, page 1.8.

> evidence that these designs do in fact correspond to actual distribution areas, much less that the five designs adequately represent all distribution areas in Minnesota. The designs might be the result of least-cost, forward-looking criteria, but they might not be.[70]

The ALJ at page 8 of the Order also noted the only support in the record was that "The distribution designs were developed by several U S WEST engineers in 1988. U S WEST has not provided any other support for these designs." Unfortunately, little has changed since the Minnesota ALJ made these findings, which the Minnesota Commission adopted. There is nothing in Qwest's supporting documentation or testimony in this proceeding that would indicate how Qwest developed the five DG designs and why they are appropriate for use in a TELRIC study in South Dakota.

Q. HAVE YOU REVIEWED THE PLAT MAPS UPON WHICH QWEST BASES THE DG DESIGNS FOR DG2, DG3 AND DG4?

A. Yes. I have reviewed the three plat maps provided by Qwest in South Dakota. The plat maps, however, provide little information on the key issue of how representative the plats are. Before discussing the plat maps and their relevance, I should describe what Qwest has provided.

In South Dakota, Qwest provided three plat maps one for DG 2, one for DG 3 and one for DG 4. Staff received two sets of maps – one set in response to Staff Request No. 01-033 and another set in response to Staff Request No. 02-026. Qwest has selected one actual distribution area from Colorado as the basis

70 *Minnesota Cost Case Order* at 4-8.

for the network design and investment for DG 2, DG 3 and DG 4. But there is no information that would indicate or support Qwest's position that this is a reasonable way to model such investments.

Q. COULD THIS PROCESS HAVE SUPPORTED QWEST'S DG APPROACH?

A. Perhaps. For instance, Qwest could have used a statistical approach to selecting a random sample of distribution areas. That random sample could then have been used to develop the engineering and investment assumptions. In New Mexico Mr. Buckley recognized the benefit of such an approach:

> While it would be nice to be able to gather a statistically valid sampling of the actual distribution areas ("DAs") in the Qwest region, neither Qwest nor QSI has the resources to conduct such an analysis. Furthermore, it is questionable as to what, if any, increase in accuracy would be gained from this exercise.[71]

Even though Mr. Buckley suggests that process might not increase the accuracy of the DG construct, it would certainly give the process some credibility. I also disagree with Mr. Buckley's assertion that neither Qwest nor QSI has the resources to conduct such an analysis. Qwest certainly appears to have the resources and the information required to conduct the analysis. Perhaps the greatest risk for Qwest in conducting the analysis is that it **would not** support the assumptions in LoopMod today. There is simply no way to validate what Qwest has set forth as key engineering parameters for calculating investments for the DGs.

---

[71] Rebuttal of Mr. Buckley at page 7, New Mexico Utility Case No. 3495; dated November 13, 2002.

Q. DO THE TELRIC REQUIREMENTS INCLUDE THE NEED TO SHOW THAT THE STUDIES REFLECT LEAST-COST, FORWARD-LOOKING ASSUMPTIONS?

A. Yes. As noted by the FCC in establishing TELRIC as the standard for costing and pricing of UNEs:

> …the forward-looking economic cost for interconnection and unbundled elements would be based on the most efficient network architecture, sizing, technology, and operating decisions that are operationally feasible and currently available to the industry. Prices based on the least-cost, most efficient network design and technology replicate conditions in a highly competitive marketplace by not basing prices on existing network design and investments unless they represent the least-cost systems available for purchase.[72]

This is the standard by which the parties must review Qwest's cost studies. Given that the density group designs are fundamental to the entire loop study, they must be well supported, observable and clearly show the use of least-cost, forward-looking criteria. Qwest has provided no such information in this proceeding.

Q. DOES THE DG DESIGN APPROACH LIMIT ECONOMIES OF SCALE?

A. Yes. The Minnesota Commission specifically found that,

> The density group design approach artificially limits the economies of scale potentially achievable in a scorched node environment. For example, the largest size cable placed in any of RLCAP's density groups is 900 pair. In contrast, HAI will place larger cables in distribution areas to capture economies of scale. Distribution plant design should permit the deployment of any equipment that is available provided that such equipment is least-cost and embodies forward-looking technology.[73]

---

[72] See FCC's *Local Competition Order* at ¶ 683.

[73] See *Minnesota Cost Case Order* at 9.

Q. DID QWEST CHANGE THE CABLE SIZE LIMITATION IN LOOPMOD FOR THE DISTRIBUTION PLANT TO CAPTURE ECONOMIES OF SCALE AS NOTED BY THE MINNESOTA COMMISSION?

A. No. Even a quick review of the LoopMod Default Value document shows that certain gauges of copper cable are still limited to 900 pair.[74] While the need for larger cables may be limited, especially in distribution plant, they should be available so that the model can achieve the necessary efficiencies if and when such cable sizes are needed.

Q. YOU HAVE DISCUSSED FILL FACTORS AND NOW CABLE SIZES. ARE THE TWO CONCEPTS RELATED?

A. In a way. The fill factors refer to the amount of traffic on a specific facility or cable. My discussion of cable sizes refers to the size of facilities assumed by Qwest in its studies. The artificial limit of 900 pair (and less for certain gauges) causes Qwest to assume multiple cables when one larger cable would more efficiently handle the traffic of several smaller cables.

Q. HOW WOULD YOU PROPOSE THAT QWEST FIX THIS PROBLEM?

A. The Commission should require Qwest to update the cable tables in LoopMod to include cable sizes and costs up to 3,000 pair, and then re-run the model. This would allow the model to more closely reflect the economies available in the network. Not only would this change allow Qwest to reflect the economies associated with larger individual cables, but it would also eliminate the non-recurring costs associated with installing multiple cables when a single larger

[74] See, for instance, Buried Copper Cable, p. 7, Underground Copper Cable, p. 8, Building Copper Cable, p. 9, etc.

cable would be more efficient. For instance, if traffic warranted a 1,800 pair cable, today LoopMod would install two 900 pair cables and include the cost of installing "two" cables. With the installation of one 1,800 pair cable, there would be only one installation.

Q. IN YOUR OPINION, DO THE DGS THAT QWEST USES TO DETERMINE LOOP ARCHITECTURE REPRESENT A GEOGRAPHIC AREA WITHIN THE NETWORK?

A. No. For instance a DG1 could be one building, or there could be several DG1s in a single building. The density groups reflect the types of buildings or dwellings located within a geographic area, ignoring the fact that there are different mixes of building types located within the geographic area. The "Density Groups" do not identify any particular geographic area wherein Qwest would conceivably be required to build a network or that would provide any reasonable estimate of network costs.

Q. WHAT IMPACT DOES THE MISREPRESENTATION OF THE DENSITY GROUPS HAVE ON THE COST OF THE NETWORK?

A. The ultimate impact is overstated investment.

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION REGARDING QWEST'S USE OF DENSITY GROUP DESIGNS?

A. The vast majority of the criticisms leveled against Qwest's density group designs in the past are still valid today. Further, the complete lack of support for the reasonableness of the designs, or the TELRIC compliant nature of the designs, makes it impossible to support their use without qualifications. Finally, Qwest's

"LoopMod" study cannot be separated from the shortcomings of the density group approach. The two are inextricably intertwined. As such, even though the Commission could order Qwest to make substantial modifications to the model to make for purposes of generating more reasonable results, it seems clear that such modifications could never overcome the fact that the density group approach bears little resemblance to how Qwest's network may, or should, actually be built. As such, the model is so abstracted from the costs Qwest (or an efficiently configured provider) would incur in providing service, it is of little use in estimating accurate TELRIC costs. As such, the Commission should require the modifications identified in my testimony, or reject the Loop Module portion of the ICM.

Q. WOULD IT BE UNHEARD OF TO REJECT THE ICM/LOOPMOD FOR PURPOSES OF CALCULATING COSTS AND RATES?

A. No. Other commissions have rejected LoopMod and simply relied upon other models. For instance, Arizona (Docket No.T-00000A-00-0194), Colorado (Docket No. 99A-577T), Nebraska (Application No. C-2516/PI-49), Minnesota (MPUC Docket No. P-442, 5231, 3167, 466, 421/C1-96-1540), etc. have rejected ICM or LoopMod.

G. Average Drop Lengths are Excessive

Q. WHAT ASSUMPTIONS DOES QWEST USE REGARDING AVERAGE DROP LENGTHS FOR ITS LOOP CALCULATIONS?

A. Average drop lengths are used in DGs 3, 4, and 5. The average aerial and buried drop lengths are as follows: (a) DG 3 – 70 feet, (b) DG 4 – 200 feet, and (c) DG 5 – 300 feet.[75] There are no drops assumed for DGs 1 and 2.

Q. DID QWEST PROVIDE TESTIMONY OR OTHER SUPPORT FOR ITS PROPOSED DROP LENGTHS?

A. Qwest provided no empirical evidence to support its proposed drop lengths. Mr. Pappas provides a page or so of testimony on drop lengths.[76] The LoopMod Default Values document states:

> Support: The drop lengths are a function of the lot size. These are Qwest wide default lengths. When applied to the state specific mix of density groups they produce a statewide average drop length of approximately 110 to 120 feet. Surveys of existing drops in New Mexico, North Dakota, Minnesota and Wyoming have produced statewide averages from 150 to 180 feet. These averages are conservative as they exclude drops in excess of a certain length.

The drop survey referred to by Qwest was rejected in at least one state.

Q. PLEASE EXPLAIN.

A. In the New Mexico Commission's Phase I Order, it specifically rejected Qwest's drop survey upon which it based its proposed drop lengths.[77] The New Mexico Commission stated:

> The Commission finds that U S WEST's drop survey lacks statistical validity. Therefore, the Commission will not rely on its results. Nevertheless, the Commission appreciates U S WEST's attempt to collect this data and recommends that U S WEST conduct a more scientific study as support for future inquiries.

---

[75] See Qwest LoopMod User Manual at page 3.9. See also page 3 of LoopMod Default Values.

[76] See Direct Testimony of Mr. Pappas at pages 45-46.

[77] Before the New Mexico State Corporation Commission; In the Matter of the Consideration of the Adoption of a Rule Concerning Costing Methodologies. Docket No. 96-310-TC/97-334-TC, NMPRC Utility Case No. 2917, Findings of Fact, Conclusions of Law and Order ("Phase I Order") (July 15, 1998), paragraph 137.

In the recent New Mexico cost case (Docket No. 3495), Qwest again failed to provide a drop study with statistical validity. In South Dakota, it appears that Qwest decided to provide no support whatsoever – other than Mr. Pappas statement that "…the average drop lengths appeared to be realistic and in line with those noted in the cost model for the drop lengths."[78] As such, the Commission should adopt the drop lengths proposed below by the Staff. The Staff proposed drop lengths are similar to those adopted by other Commissions and represent a more reasonable drop length.

Q. CAN YOU PROVIDE AN EXAMPLE OF A COMMISION ORDER REDUCING THE DROP LENGTHS PROPOSED BY QWEST?

A. Yes. In Minnesota the Commission adopted the Department of Commerce's recommended drop lengths and placement percentages. Those drop lengths vary from 50 feet in the most dense areas to 250 feet in the rural areas.[79] I think this is a much more reasonable range of drop lengths. Further, the drop lengths should vary, not only by DG, but also by "aerial" versus "buried."

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION REGARDING DROP LENGTHS?

A. I recommend the following drop lengths in feet by DG:

	DG3	DG4	DG5
Aerial Drop	70	100	100
Buried Drop	70	150	200

[78] See Direct Testimony of Mr. Pappas at page 46.
[79] See Minnesota *Cost Case Order* at 25-26.

Q. WHY DO YOU RECOMMEND A 100-FOOT AERIAL DROP LENGTH FOR BOTH DG4 AND DG5?

A. Aerial drops that extend over 100 feet normally require a support structure or pole. One hundred feet of cable becomes quite heavy and may risk ripping the drop anchor off the living unit. Further, the cable itself may need a support strand for distances over 100 feet, as long spans may also be a problem in the wind. As such, companies tend to limit aerial drops to about 100 feet. Many companies will extend the buried distribution cable to within about 100 feet of the living unit and then use an aerial drop.

Q. DID YOU NOTICE ANY INPUTS FOR THE DROP CALCULATIONS THAT SEEMED EXTREME?

A. Yes. In the drop cost user interface provides the investments/costs for both buried and aerial drops. The aerial drop "per foot" cost is stated as ** .** This is almost a hundred times higher than the cost "per foot" for a buried drop in the model. The "Protector and Termination" labor, the "drop material" and the "protector material" amounts are very similar to those of the buried drops. As such, it seemed reasonable to assume that Qwest had moved the decimal and this input should really be ** ** cents. When I re-ran the model with the reduced cost per foot for the aerial drop, the statewide average rate for a 2 wire unbundled loop actually **increased**. This is a counter intuitive result, which prompted further investigation.

I went to Qwest's Loop Module Default Value document at page 13, and that document also identified the ** ** amount as the "Aerial Drop per Foot."

Given this apparent consistency in labeling, but counter-intuitive amount, I left the ICM user interface and loaded LoopMod. I restored the tabs in LoopMod and went to the "Drop" tab. In that spreadsheet it identified the ** ** amounts as "Aerial Drop Placement" and not a "per foot" amount. That same spreadsheet showed three examples of Aerial Drop Costs for DG3 (70 feet), DG4 (200 feet) and DG5 (300 feet), in each example the Aerial Drop Placement amount was the same -- ** ** As such, given the examples in the spreadsheet, it seems that the ** ** amount is not a per foot amount as the ICM user interface shows, but instead is a "per drop" amount.

Q. WERE YOU ABLE TO DETERMINE WHAT COSTS WERE INCLUDED WITHIN THE ** **?

A. No. Like so many inputs in ICM and LoopMod, the ** ** was "hard-coded" and I was not able to determine precedents or dependents with the auditing feature of Excel.

Q. IS IT REASONABLE TO ASSUME THAT THE PLACEMENT COSTS FOR AN AERIAL DROP ARE THE SAME FOR A 70 FOOT, 200 FOOT AND A 300 FOOT DROP?

A. No. As discussed above, aerial drops in excess of 100 feet require support. As such, I can only assume that the ** ** placement amount includes costs for poles, support strands, and other facilities required to support a drop in excess of 100 feet. For instance, it is reasonable to assume that a 200-foot aerial drop will have at least one pole and a 300-foot aerial drop will utilize at least two poles. The cost of the poles is evidently included in the ** ** amount.

Q. HOW DID YOU CORRECT FOR THIS GIVEN THE STAFF ASSUMPTION THAT AERIAL DROPS ARE LIMITED TO 100 FEET AND DO NOT INCLUDE POLES?

A. Since Qwest provided no support for the ** ** amount, I had to reduce the amount to reflect the elimination of the pole costs. Not knowing how many aerial drops of various lengths Qwest assumed, this was not a precise effort. I do know, however, that poles cost on average about $200 and they cost about that much to install.[80] As such, I reduced the aerial drop placement cost from ** ** to $30.

Q. DO YOU HAVE ANY OTHER BASIS TO SUPPORT THE $30 PLACEMENT COST?

A. Yes. I have seen other aerial drop placement costs around $23. As such, my $30 placement cost is conservative.

Q. HOW DO YOU JUSTIFY THE REDUCTION IN DROP LENGTHS FOR THE BURIED DROPS IN DG4 AND DG5?

A. In the recent Colorado decision, the Commission there ordered an average drop length of 87.2 feet, with a range of 50 to 300 feet.[81] Specifically, the Colorado Commission ordered the following drop lengths:

Drop Length	
	Commission RRR
Density	
0	300
5	250
100	200

[80] In my review of cost studies over the years, the cost of a 40 foot pole ranges from about $100 to about $250.

[81] See *Colorado Cost Case Order* at 41-43.

200	135
650	70
850	50
2550	50
5000	50
10000	50

Weighted Average: **87.2**

In Minnesota the Commission ordered drop lengths ranging from 50 feet to 250 feet.[82] The Arizona Commission ordered an average drop length of 90 feet.[83] So, as you can see, these three decisions result in about the same average drop length. My proposal, which utilizes a longer drop (70 feet) in the most heavily weighted DG and a shorter drop length in the more rural areas (200 feet) results in approximately the same average drop length.

Q. DO YOU HAVE OTHER CONCERNS ABOUT THE DROP LENGTHS THAT QWEST HAS PROPOSED IN THIS PROCEEDING?

A. Yes. I have some fundamental concerns about the lengths and how they vary by DG. For instance, just because the lot size is typically bigger in DG 4 and DG 5, does not mean that the drop lengths between DG4 and DG5 vary significantly. The telephone companies (and other utilities) place distribution and feeder routes so as to minimize drop lengths. Plus, one cannot assume that residences or buildings are placed in the middle of lots. Typically, if you have a five-acre lot, you do not put your residence in the middle of the lot. Aerial drops, for instance, typically span no more than 100 feet without additional support structures – such as poles and support strands – so there is incentive to minimize drop lengths.

---

82 See *Minnesota Cost Case Order* at 26.

Absent some analysis to support Qwest's proposed drop lengths, I seriously question the magnitude of the increases in drop-length from one DG category to the next. As such, and because Qwest has not provided any evidence to support these drop lengths, the Staff's recommended drop lengths should be adopted.

H. Qwest's Mobilization Charge in the Drop Cost Calculation

Q. WHAT COSTS ARE INCLUDED IN THE BURIED DROP COST CALCULATION?

A. The cost for a buried drop, network interface device (NID) and placement include a "mobilization" charge. This "mobilization" charge is significant and should not be included in a TELRIC study.

Q. WHAT IS "MOBILIZATION" AND WHAT COST DOES QWEST INCLUDE FOR MOBILIZATION IN THE COST STUDY?

A. In response to a New Mexico Staff Request, Qwest provided "General Construction and Maintenance Contracts."[84] One New Mexico contract includes the following description of "mobilization."

**
**

Qwest's South Dakota LoopMod Default Values document shows the mobilization charge as ** **.[85] In the New Mexico docket, however, the

---

83 See, Before the Arizona Corporation Commission, Docket No. T-00000A-00-0194, PHASE II OPINION AND ORDER; at 17-19.

84 See New Mexico Staff Request 04-023 and Qwest's Confidential Response – Item 199.

85 See South Dakota LoopMod Default Values Document at page 13.

numerous contracts had rates that were far below the rate used in LoopMod, and some were higher.

Q. IF A MOBILIZATION RATE WERE INCLUDED IN THE MODEL, WOULD IT BE THE HIGHEST RATE?

A. No. A TELRIC study should include only the most efficient input. As such, if any rate were to be included in the study it should be the lowest rate. In New Mexico, the rate included in LoopMod was anywhere from ** ** to ** ** percent too high, depending upon the type of wire center – urban or rural -- involved. This assumes of course that the mobilization charge should be charged to Qwest and included in a cost model.

Q. ARE YOU SUGGESTING THAT THE MOBILIZATION CHARGE SHOULD NOT BE INCLUDED IN THE COST MODEL?

A. Absolutely. First of all, this charge applies only when contractors are placing distribution facilities. By including the mobilization charge in the cost study it assumes that contractors are doing all of the drop placements. I believe Qwest has employees that place drops as well. Second, when contractors are doing the work, the mobilization charge is an additive or "penalty" for non-productive time. In other words, when the contractor has to make another trip to the area – for no fault of his own – the rate is applied. In most of the contracts I reviewed this was referred to as a "non productive trip charge." In the vast majority of situations, the mobilization charge does not apply and Qwest does not pay that charge. A quick reading of the contract language above shows that the mobilization charge is **only** applied when the contractor must go back out once the work is already done, or they cannot perform the work through no problem of their own. This is a "non-productive" charge that only occurs in very limited circumstances. Further, this charge is applied to a "work order" which could include multiple drops. As such, the charge, if and when it is applied, would need to be allocated across all drops placed per the work order.

Q. WHAT IS YOUR RECOMMENDATION REGARDING THE MOBILIZATION CHARGES?

A. These mobilization charges reflect inefficient operations – situations in which the contractor must make an additional trip through no fault of his own. A TELRIC study should not include any such costs. TELRIC studies assume efficient and least cost operations. The application of a mobilization charge is indicative of an inefficient operation. As such, I have removed the ** ** cost from the default values used in LoopMod.

Q. DID YOU MAKE ANY OTHER ADJUSTMENTS TO THE DROP CALCULATIONS?

A. Yes. I increased the sharing percentage for buried drops from 20 percent to 35 percent consistent with the other adjustments to sharing in this testimony. Utilities regularly share the drop installation to avoid multiple aerial drops or multiple trenches on the property. For instance, it is quite common to have a trench with power on the bottom, then cable TV and then telephone. Naturally the cables would be separated by a foot or so of dirt, but the three utilities would share the trench and the placement activity itself.

I. Qwest Feeder Model Assumptions on DLC

Q. WHAT IS "FEEDER"?

A. The feeder network is comprised of large cables that extend from the central office toward the subscribers. One end of the feeder typically terminates at the main distribution frame (MDF) in the central office and the other end terminates in a large cabinet (serving area interface or SAI) that contains a series of terminal blocks of connecting lugs, necessary for connecting feeder cable to the distribution and drop cables ultimately connecting a customer's premises to the public switched network. Distribution facilities originate at the SAI and terminate at a small terminal (pedestal) usually located no more than about 200 feet from the premises. This intersection of the feeder and distribution networks is sometimes referred to as the feeder distribution interface or "FDI".

Q. OF THE TWO TYPES OF NETWORK FACILITIES – DISTRIBUTION AND FEEDER – WHICH TYPE IS CURRENTLY EXPERIENCING COST SAVINGS FROM NEW TECHNOLOGY?

A. Advances in digital loop carrier or "DLC" systems have allowed ILECs to experience cost savings and efficiencies in the feeder portion of the network. These savings and efficiencies need to be recognized in properly conducted TELRIC studies.

Q. WHAT IS DIGITAL LOOP CARRIER OR DLC?

A. In its simplest form, DLC systems are the electronic equipment used to digitize and concentrate the signals carried on copper cable (or fiber) in the feeder plant of the network.[86] Today's DLC systems allow a company to replace the end-to-end copper circuit that historically comprised a telephone access line (or a "loop") with a combination of high-capacity fiber optic feeder cable and copper distribution cable. This design allows the company to place a single feeder facility with the capacity necessary to serve several hundred, even thousand, end user customers. The DLC system itself is generally comprised of some form of electronic equipment in the central office (generally referred to as a "central office terminal" or "COT") that connects the fiber optic feeder cable to an accompanying electronic device in the field wherein the fiber optic feeder cable and copper distribution cable meet (generally referred to as a "remote digital terminal" or an "RDT").

The purpose of the DLC system is both to convert optic and electrical signals between the fiber and copper cable as well as to multiplex multiple telephone circuits (or individual customer lines) into a high-bandwidth bitstream capable of supporting hundreds, even thousands of individual lines over the same fiber optic feeder cable.[87] DLC systems are being used to replace copper cabling both because they provide a more efficient (i.e., cost effective) method of delivering a local loop in some areas where extremely long copper cables were

[86] From a more technical perspective, DLC systems are wideband transmission systems used for carrying more than one channel of information. These systems use time division multiplexing to combine a number of individual signals, voice or data, into a common bit stream for transmission. The bit streams are transmitted over standard digital lines (copper or fiber) at the DS1 rate.

[87] "Multiplexing" refers to combining multiple circuits onto one channel. It is sometimes referred to as the ability to allow two or more signals to pass over one communications circuit. In its essence, it increases the efficiencies of the existing circuit or channel.

previously used, and, because they can more quickly and efficiently provide higher bandwidth services than comparable copper circuitry.[88]

Q. PLEASE EXPLAIN WHICH TYPE OF DLC CARRIER QWEST USES TO CALCULATE COSTS PRESENTED IN THIS PROCEEDING.

A. Qwest's models assume both Universal DLC (UDLC) and Integrated DLC (IDLC). LoopMod uses remote terminal sizes of 32, 96, 192, 672 and 1344 lines for the DLC systems.[89] The Qwest systems are selected for DLC routes by dividing the demand quantity by an 80 percent sizing or fill factor.[90]

Qwest's default in running LoopMod for an unbundled loop is the DSO option, as opposed to the Fiber Pair option.[91] The DSO option provides the investment for a derived pair for which Qwest would impose "grooming charges." According to Qwest, the grooming charges are required to extract individual voice grade pairs off IDLC systems before entering the switch. Qwest uses the IDLC system in the non-integrated mode, which is why grooming is necessary. But the benefit and efficiency of IDLC is that it can interface directly into the switch without the need for COTs (grooming).

The Staff opposes the modeling of UDLC – the older and less efficient DLC system which Qwest uses exclusively for 32 line systems[92] – and the use of

---

88 DLC systems have also proven to reduce maintenance expenses typically generated by copper-based network.

89 See Qwest LoopMod Default Values at page 15.

90 As discussed herein, the sizing or fill factor for the COT/RT should be set at 90 percent instead of Qwest's default of 80 percent. The lower fill factor results in more equipment and a higher investment and cost.

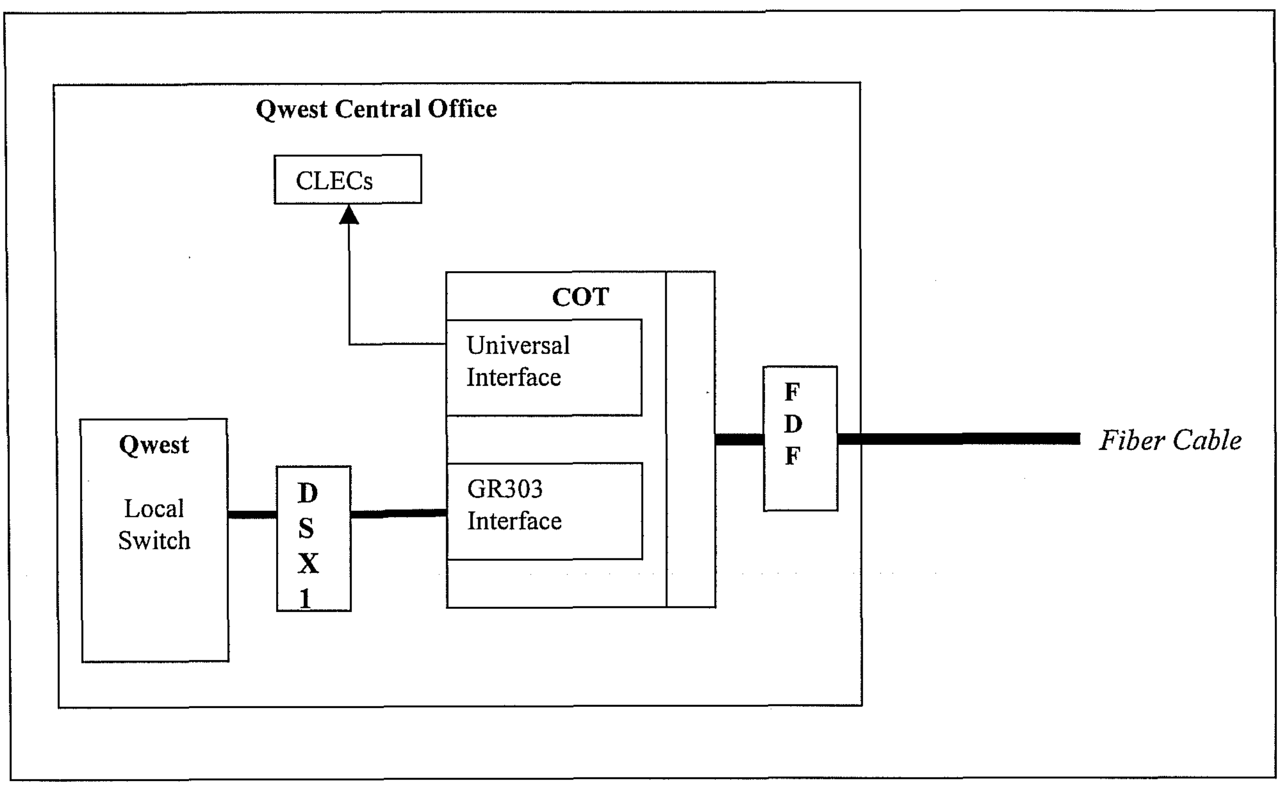
91 See Qwest LoopMod Version 2.1 User Interface

92 See Qwest Response to South Dakota Staff Request No. 01-006, and 02-008. Qwest uses E/O Networks remote terminals in the universal mode for 32 circuit applications.

IDLC in the non-integrated mode -- and recommends that the Commission order Qwest to assume 100 percent IDLC for modeling purposes.

Q. PLEASE EXPLAIN THE FUNCTION OF THE COT AND THE GR303 AND UNIVERSAL INTERFACES THAT WE OFTEN HEAR DISCUSSED IN RELATION TO DLC SYSTEMS.

A. The COT is the facility on which the fiber optic feeder cables terminate in the central office. The COT converts the optical signals into electronic signals.[93] From the COT, loops either go to one of Qwest's switches or onward to a CLEC as an unbundled loop. See a simplified diagram of the facilities below:



GR-303 is a Bellcore (now "Telcordia") standard around which multiple equipment vendors build "next generation digital loop carrier" systems

("NGDLC"). GR-303 DLC systems are being implemented in growing numbers today because they provide even more cost saving features than traditional DLC systems; i.e., (1) they allow carriers to "concentrate" multiple customers onto shared transmission paths thereby providing services to a greater number of customers with the same amount of transmission resources, (2) they allow a single COT to support multiple remote terminals (thereby significantly increasing the efficiency – i.e., fill factor – of the COT) and, (3) they are constructed so as to support the provision of unbundled loops (wherein the earlier generation of DLC systems – TR-008 – did not easily allow such unbundling). It is important to note that many DLC systems will support both integrated as well as universal DLC architectures. For example, Qwest's cost models assume the use of equipment that will support both integrated (GR-303) capabilities, as well as universal capabilities. Unfortunately, unless Qwest assumes the use of the systems' GR-303, integrated capabilities, it overestimates the costs of providing unbundled loops.

Q. DOES QWEST FAIL TO ASSUME THE USE OF GR-303, IDLC FACILITIES WHEN ESTIMATING UNBUNDLED LOOP COSTS?

A. Yes. Even though Qwest assumes equipment (Alcatel Litespan 2000 TR 303 equipment) capable of supporting the GR-303 interface, and hence, cost-effective unbundled access, Qwest assumes that it will use this equipment in its universal application (i.e., non-integrated).[94] Qwest assumes the use of the system's Universal Interface (i.e., non-integrated interface) for purposes of offering

---

[93] Sometimes referred to as "optoelectric conversion".

[94] See, Electronics Cost for New Mexico Input/Override within LoopMod.

unbundled DS0s (ultimately routing them to the CLEC's POT Bay as a standard copper-based DS0). However, the IDLC is already designed to perform the type of unbundling that Qwest is attempting to achieve far more efficiently (and less expensively) than the manner assumed by Qwest.

Q. PLEASE EXPLAIN WHY THIS ISSUE (IDLC VERSUS UDLC) IS SO IMPORTANT TO THE DEVELOPMENT OF COMPETITION IN SOUTH DAKOTA?

A. There is a significant cost difference between the GR303 interface and the universal interface. The cost differences are even larger if one accounts – as one should – for the ability of the GR303 system to concentrate traffic. Further, this particular issue is of utmost importance for competitors for the following reasons:

(1) Qwest will use integrated DLC for purposes of providing loops to its own retail customers. Integrated DLC is more efficient and less expensive than non-integrated UDLC in a number of ways (which will be explained in more detail later). Allowing Qwest to provision its retail services using more efficient, less expensive IDLC technology while allowing it to provision unbundled loops with more expensive, less efficient non-integrated UDLC, produces a "competitive gap" in the costs of production faced by a competitor versus those faced by Qwest. This "competitive gap" will provide Qwest an ongoing, unwarranted, competitive advantage.

(2) With the general marketplace trend toward "fiber to the curb" (i.e., deploying fiber deeper into the local exchange so as to allow higher bandwidth customer connections), Qwest will be deploying next generation IDLC in sharply increasing numbers. All evidence indicates that IDLC is the least cost, forward-looking technology for loop facilities (and that Qwest will be deploying it). This means that all of the problems described above (i.e., the "competitive gap" and the need to unbundle IDLC) will only become more prevalent in the future.

(3) Finally, UDLC systems are an inferior substitute for IDLC systems for a number of reasons. For example, because of the multiple digital/analog conversions that must take place to provision a loop

via non-integrated UDLC technology, customers served via this technology receive lower data speed on a typical dial-up connection. Indeed, with a UDLC system, it is difficult, if not impossible, to connect a dial-up modem at a speed exceeding 21Kbs (whereas a typical dial-up modem on an IDLC system may very well attain the 56Kbs connection it is designed to accommodate). While at first glance this may appear to be a small issue, the Commission should note that the vast majority of new lines placed into service over the past 3 years are second lines used to accommodate dial-up Internet connections. Given an opportunity to purchase an access line from Qwest that provides 56Kbs dial-up service, versus an offering by a CLEC that can accommodate only a 21Kbs connection, all else being equal customers will choose the faster dial-up service. This will be an important competitive advantage for Qwest that will not be lost on customers. In essence, Qwest will not only benefit from the "competitive gap" associated with lower costs it faces to produce a loop for use by its retail customers, it will also benefit from a higher quality product.

Q. PLEASE EXPLAIN WHY IDLC SYSTEMS ARE MORE EFFICIENT AND LESS EXPENSIVE AND HOW THIS COULD/WILL ESTABLISH A COMPETITIVE GAP BETWEEN THE COSTS TO QWEST AND THE CLECS THAT USE UNBUNDLED LOOPS.

A. Integrated DLC systems allow a circuit, once digitized at the remote terminal, to remain in digital form until it is ultimately terminated in a central office switch. Integration eliminates the digital to analog conversion in the COT and the analog to digital conversion in the analog line unit of the switch. In this configuration, the subscriber line cross-connections between the office equipment and the loop facilities are eliminated.

Likewise, IDLC allows a carrier to aggregate individual DS0 (single voice grade circuit) circuits into larger, more efficiently transported bandwidths (DS1 (24 DS0 circuits), DS3 (28 DS1s or 672 circuits), etc.). In this manner, an IDLC system not only maintains the quality of a fully digital circuit (i.e., it removes the need to convert the signal from analog to digital form on multiple occasions – as is required by non-integrated UDLC systems), it also reduces costs because there is no need for digital/analog conversion equipment like the central office terminal and associated line equipment used by non-integrated systems.

The significant cost difference between the UDLC and IDLC loop is the basis for the "competitive gap" I described earlier wherein competitors will always be at a cost disadvantage *vis a vis* Qwest if they use unbundled loops.[95] As such, Qwest's proposed methodology undermines the pro-competitive intent of the Telecom Act that envisions use of unbundled network elements as an important market entry alternative. Again, it does so by artificially inflating the economic costs incurred by CLECs relative to those incurred by Qwest.

Q. CAN LOOPS PROVIDED ON AN IDLC SYSTEM BE UNBUNDLED USING AN INTEGRATED INTERFACE, I.E. WITHOUT A UNIVERSAL INTERFACE?

A. Yes. First, whether Qwest currently deploys IDLC for unbundled loops is irrelevant. Indeed, if the Commission continues to allow Qwest to assume the use of more expensive technology to be used by its competitors while it can use cheaper technology for its own services, *it is unlikely Qwest would ever deploy cheaper technology for its competitors' use.*

The question that needs to be answered for purposes of a proper TELRIC study is: *What is the least-cost, forward looking technology available that can be*

---

[95] The Staff understands that grooming charges do not apply to UNE-P loops but do apply to UNE-L loops. See, for instance, Qwest's Response to South Dakota Staff Request 02-023 and 02-025.

used to provision the network element in question? IDLC is a least-cost alternative compared to UDLC. Hence, the obvious answer to the question above appears to be that IDLC systems, for fiber-based feeder, are the proper technology to be assumed within an unbundled loops study consistent with TELRIC principles.

Q. HAS THE FCC FOUND THAT IT IS TECHNICALLY FEASIBLE TO UNBUNDLE LOCAL LOOPS WITH IDLC TECHNOLOGY?

A. Yes. In the FCC's Advanced Services Order it stated:

> The commission concluded in the Local Competition Order that it was "technically feasible" to unbundle local loops that pass through an integrated DLC or similar remote concentration devices, and required incumbent LECs to unbundle such loops for competitive LECs.[96]

As such, the FCC has considered this type of unbundling to be technically feasible since 1996. The equipment manufacturers have been including these capabilities in their generic software since that time as well.

Q. DO YOU HAVE OTHER SUPPORT FOR THE PROPOSITION THAT IT IS TECHNICALLY FEASIBLE TO PROVIDE UNBUNDLED LOOPS WITH THE GR-303 SWITCH INTERFACE?

A. Yes. Attached hereto are the following documents that discuss how unbundled loops can be provided with GR303 (see Attachment 2.)

1. A paper written by DSC Corporation (the company from which Qwest purchases its digital loop carrier equipment) entitled "Unbundling Solutions."[97] The purpose of the paper is to tout the ability of the DSC

[96] FCC 98-188; MEMORANDUM OPINION AND ORDER, AND NOTICE OF PROPOSED RULEMAKING; Released August 7, 1998; at ¶ 153.

[97] DSC was purchased by Alcatel, Inc. Alcatel now produces the Litespan DLC systems formerly produced by DSC and assumed for use by Qwest in its cost studies.

Litespan equipment (one of the DLC equipment vendors Qwest assumes within its studies) to accommodate unbundled loops in the integrated mode. This paper dispels any argument Qwest might make regarding the inability to provision unbundled loops using IDLC equipment. Indeed, Qwest's own chosen DLC equipment manufacturer has written a paper explaining in detail how the very equipment Qwest uses can accommodate unbundled loops in the integrated mode.

2. MCI WorldCom wrote a detailed abstract entitled "Unbundling Digital Loop Carriers." The paper discusses the advantages of IDLC over UDLC and discusses the various technical unbundling alternatives.

3. Mr. Seigneur of SONeTech authored a paper entitled, "The Virtual RDT, Key to Unbundling the Local Exchange." This particular abstract not only steps the reader through a number of different ways in which an RDT (remote digital terminal) can be unbundled for access by competitive carriers, it also speaks to the urgency required for such an architecture.

4. A paper from PulseCom, Inc. entitled "Unbundling Wire Pairs, Special Services and ISDN DLC Grooming." Like DSC, PulseCom manufactures digital loop carrier equipment. This paper not only details the manner by which an IDLC system can be used to provision unbundled loops, but also details the other uses for this type of "grooming." It highlights the fact that IDLC systems have, in the past, proven to be less flexible than non-integrated systems in terms of providing "special circuits" used by incumbent LECs to serve their own retail non-switched customers (i.e., private line applications and other non-switched services). Hence, as would be expected, integrated DLC equipment manufacturers have remodeled their IDLC equipment to better accommodate these services. One result of these remodeled systems (Next Generation Digital Loop Carrier – NGDLC – equipment) is that they can now support both retail and wholesale non-switched loop applications (i.e., unbundled loops).

These articles, individually and together, surely dispel any notion that IDLC systems cannot be unbundled and/or, that this equipment is not widely available and in use. Likewise, they support the notion that using IDLC systems in the provision of unbundled loops provides a more cost effective solution than the UDLC architecture included in Qwest's LoopMod study.

Q. ARE YOU CONCERNED THAT QWEST IS NOT RECOGNIZING THE DLC SAVINGS IN ITS STUDIES?

A. Yes, for several reasons. First, Qwest is assuming only 4:1 concentration for its DLC systems.

Q. PLEASE COMPLETE YOUR DISCUSSION OF CONCENTRATION RATIO ASSUMPTIONS AND THEIR IMPACTS ON QWEST'S COSTS.

A. In an all copper network, for each end-user there is a dedicated path from the customer premises to the central office. The great advantage of using a fiber-based NGDLC system is that it allows traffic to be concentrated onto more efficient facilities. That is, because not all end-users pick-up the phone (or use their modem) at the same time, the feeder facilities do not need to have a *dedicated* path for each end-user. Instead, the DLC system assigns a path – a time slot – only to those customers who are using their line. Thus, all that is needed is a fair estimate of what percentage of the end-users use their line simultaneously in order to establish an efficient concentration that avoids blockage. The proper concentration ratio is critical in minimizing costs in the real-word network and is a critical input in a reasonable estimation of loop costs.

To see how the concentration ratio affects cost studies, consider the following example in which an increasingly higher concentration ratio lowers the fiber based DLC costs per DS0 (voice grade analog two wire loop).

Example

DLC Costs	Concentration Ratio	Number of End Users (DS0 Channels)	Cost per DS0
$1,000	1 to 1	1000	$ 1.00
$1,000	4 to 1	4000	$ 0.25
$1,000	6 to 1	6000	$ 0.17

Given that in Qwest's loop cost studies, the largest portion of the costs are associated with the fiber based DLC system, the concentration ratio is one of the most important cost drivers in the loop studies.

Q. WHAT IS THE RANGE OF CONCENTRATION THAT IS ACHIEVABLE ON A GR303 DLC BASED SYSTEM?

A. The GR303 DLC based system has a range of achievable concentration levels of 1:1 to 44:1, based on calling patterns.[98]

Q. DOES QWEST FAIL TO ACCOUNT FOR A SUFFICIENT DEGREE OF CONCENTRATION IN ITS LOOP COST STUDIES?

A. Yes. Qwest assumes that there is only a 4:1 concentration ratio. As I will demonstrate shortly, Qwest should be ordered to use a higher concentration ratio of at least 6:1.

Q. WHAT SHOULD DETERMINE THE LEVEL OF CONCENTRATION THAT IS ACCEPTABLE IN A PARTICULAR SITUATION?

A. As discussed, with GR303, variable line concentration outside of the switch is possible due to a time slot interchanger (TSI) functionality established between the switch and an RDT. The TSI in conjunction with the time slot management channel (TMC) provides administration and dynamic channel assignment. The

---

[98] See Newton's Telecom Dictionary, 16th Edition; Copyright 2000 Harry Newton, Published by Telecom Books, An imprint of CMP Media Inc., New York, NY 10010, page 382.

degree of concentration that is desirable, however, depends on the calling patterns of the community served by the DLC system and the traffic levels associated with that community.

Q. SHOULD QWEST BE ABLE TO ACHIEVE A LEVEL OF CONCENTRATION HIGHER THAN THE 4:1 ASSUMPTIONS IN ITS LOOP MODEL?

A. Yes. NGDLC systems (GR-303) are initially introduced into the network typically to serve higher-volume business customers. This results from the fact that the GR-303 system can more easily, quickly and cheaply provide high-bandwidth services that medium and large businesses have demanded in growing numbers. While Qwest may suggest that its past history shows that a 4:1 concentration ratio is best used to ensure quality of service, the Commission must keep in mind that its past history is rather specific to these high volume users. As Qwest uses GR-303 systems more pervasively throughout its system, it will begin to serve more and more low volume, small business and residential customers (customers comprising by far the majority of Qwest's subscribers). As more and more GR-303 systems serve these low volume customers, Qwest will be able to more densely concentrate those customers to fewer and fewer transmission paths (resulting in a far higher rate of concentration)

In other words, over time DLC systems will serve more residential and small business customers, allowing a higher concentration ratio. This observation is even more apt, if one considers that business customers call mostly during the day (i.e., *the business peak is during the day*) while residential customers call mostly at night (i.e., *the residential peak is in the early evening*). Thus, since business and residential customers are likely to have *two distinct peaks*, their calling patterns are complimentary and do not crowd out one another: as a result, a higher concentration ratio is appropriate.

In short, one of the consequences of Qwest's decision to assume generous quantities of fiber deployment for cost study purposes is that a higher concentration ratio can be achieved. Given that under TELRIC, one must assume a least cost network, Qwest's concentration ratio of 4:1 is simply too low.

Q. WHAT LEVEL OF CONCENTRATION DO YOU RECOMMEND?

A. I recommend that Qwest be ordered to use a 6:1 concentration ratio. This ratio is reasonable, again, because in its cost studies Qwest will now serve both business and residential customers on the fiber based DLC systems. Given that residential customers have an evening peak, their calling patterns do not interfere with or "crowd out" those of the business customers.

Q. HAVE YOU BEEN ABLE TO CORRECT QWESTS ASSUMPTIONS AND INPUTS FOR DLC?

A. No. One can view the investments for the different types of DLC equipment in LoopMod, but nowhere does the program allow a user to view how those technologies are used in the engineering assumptions. In other words, there is no way for the user to require, for instance, 100 percent use of IDLC in the feeder network.

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION REGARDING QWEST'S FEEDER MODEL AND DLC ASSUMPTIONS?

A. Qwest's LoopMod fails to utilize the least-cost, forward-looking technology assumptions (IDLC) in its feeder plant. Moreover, even if the correct assumptions were used, the model fails to recognize achievable efficiencies that may result from more extensive DLC usage and a higher concentration ratio. Unfortunately, these assumptions are largely "hardcoded" into Qwest's LoopMod architecture, and as such, cannot be effectively mitigated by input or assumption changes through the user interface.

The Commission should require Qwest to assume 100 percent IDLC where DLC is required in its cost studies, with a 6:1 concentration ratio. The investment and assumptions regarding other DLC systems should be removed or at least not used when calculating costs for South Dakota. Qwest should then be required to re-run all of its studies with the proposed Staff recommended inputs and provide those results for review by the parties.

Q. HAVE OTHER STATE COMMISIONS ORDERED ILECS TO ASSUME 100 PERCENT GR 303 IDLC FOR COST STUDY PURPOSES?

A. Yes. States such as Michigan, Hawaii, New York, and New Jersey have required the ILEC to assume 100 percent IDLC for cost study purposes. ILECs have agreed that IDLC is the forward-looking technology and, as such, commissions have ordered the use of the IDLC assumption in the TELRIC studies.

VI. IMPACT OF STAFF RECOMMENDATIONS

Q. PLEASE SUMMARIZE THE IMPACT OF THE STAFF'S RECOMMENDATIONS ON THE ICM RESULTS.

A. The Staff has made numerous changes to the ICM inputs, and recommends that the Commission order Qwest to make those changes that I was unable to make through the model user interface. My testimony addresses primarily the inputs to LoopMod. The testimony of Mr. Gose addresses the annual charge factors, productivity adjustments, etc. The impact of these changes – the changes I was able to make and those recommended by Mr. Gose -- is to reduce Qwest's proposed statewide average 2-wire unbundled loop rate from $26.89 to $22.86. The $22.86 rate is not the Staff recommended rate, but it is illustrative of the impact associated with changes that Staff was able to make in ICM. Naturally the proposed changes impact the other rates emanating from ICM as well, but this example provides some magnitude to the impact. This does not reflect, however, the ultimate rates that should result from the ICM model. For instance, the Staff has recommended several changes that will require Qwest to adjust inputs and assumptions re-run the model. Expanding Qwest's cable tables in the model, eliminating universal DLC investment, reduced grooming charges, requiring a 6:1 concentration ratio instead of a 4:1 ratio, and assuming 100 percent IDLC in the model will certainly reduce costs and rates. Other parties to this proceeding may also make recommendations for changes in model inputs that this Commission should accept. The Staff is asking the Commission to order Qwest to make all the changes proposed and to re-run the models and provide the results for review by the parties.

Q. HAVE YOU PROVIDE A SUMMARY OF THE RATES GENERATED BY ICM AS A RESULT OF THE CHANGES YOU WERE ABLE TO MAKE TO INPUTS?

A. Yes. Attachment 3 to this testimony is the summary print-out from ICM which shows the impact on rates resulting from the Staff's changes. Attachment 4 to this testimony is a printout of the override inputs for ICM as recommended by Staff.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

QSI CONSULTING
Market Solutions • Litigation Support

Qualifications of Timothy J Gates
Docket No. TC01-098

Q. PLEASE DESCRIBE YOUR PROFESSIONAL EXPERIENCE.

A. Prior to my current position with QSI Consulting, I was a Senior Executive Staff Member in MCI WorldCom's ("MCIW") National Public Policy Group. In this position, I was responsible for providing public policy expertise in key cases across the country and for managing external consultants for MCIW's state public policy organization. In certain situations, I also provided testimony in regulatory and legislative proceedings.

Prior to my position with MCIW in Denver, I was an Executive Staff Member II at MCI Telecommunications ("MCI") World Headquarters in Washington D.C.. In that position I managed economists, external consultants, and provided training and policy support for regional regulatory staffs. Prior to that position I was a Senior Manager in MCI's Regulatory Analysis Department, which provided support in state regulatory and legislative matters to the various operating regions of MCI. In that position I was given responsibility for assigning resources from our group for state regulatory proceedings throughout the United States. At the same time, I prepared and presented testimony on various telecommunications issues before state regulatory and legislative bodies. I was also responsible for managing federal tariff reviews and presenting MCI's position on regulatory matters to the Federal Communications Commission. Prior to my assignment in the Regulatory Analysis Department, I was the Senior Manager of Economic Analysis and Regulatory Policy in the Legal, Regulatory and Legislative Affairs Department for the Midwest Division of MCI. In that position I developed and promoted regulatory policy within what was then a five-state operating division of MCI. I promoted MCI policy positions through negotiations, testimony and participation in industry forums.

Prior to my positions in the Midwest, I was employed as Manager of Tariffs and Economic Analysis with MCI's West Division in Denver, Colorado. In that position I was responsible for managing the development and application of MCI's tariffs in the fifteen MCI West states. I was also responsible for managing regulatory dockets and for providing economic and financial expertise in the areas of discovery and issue analysis. Prior to joining the West Division, I was a Financial Analyst III and then a Senior Staff Specialist with MCI's Southwest Division in Austin, Texas. In those positions, I was responsible for the management of regulatory dockets and liaison with outside counsel. I was also responsible for discovery, issue analysis, and for the development of working relationships with consumer and business groups. Just prior to joining MCI, I was employed by the Texas Public Utility Commission as a Telephone Rate

Analyst in the Engineering Division responsible for examining telecommunications cost studies and rate structures.

I was employed as an Economic Analyst with the Public Utility Commissioner of Oregon from July, 1983 to December, 1984. In that position, I examined and analyzed cost studies and rate structures in telecommunications rate cases and investigations. I also testified in rate cases and in private and public hearings regarding telecommunications services. Before joining the Oregon Commissioner's Staff, I was employed by the Bonneville Power Administration (United States Department of Energy) as a Financial Analyst, where I made total regional electric use forecasts and automated the Average System Cost Review Methodology. Prior to joining the Bonneville Power Administration, I held numerous positions of increasing responsibility in areas of forest management for both public and private forestry concerns.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL CREDENTIALS.

A. I received a Bachelor of Science degree from Oregon State University and a Master of Management degree in Finance and Quantitative Methods from Willamette University's Atkinson Graduate School of Management. I have also attended numerous courses and seminars specific to the telecommunications industry, including the NARUC Annual and Advanced Regulatory Studies Program.

Q. WHAT ARE YOUR CURRENT RESPONSIBILITIES?

A. Effective April 1, 2000, I joined QSI Consulting as Senior Vice President and Partner. In this position I provide analysis and testimony for QSI's many clients. The deliverables include written and oral testimony, analysis of rates, cost studies and policy positions, position papers, presentations on industry issues and training.

Q. PLEASE IDENTIFY THE JURISDICTIONS IN WHICH YOU HAVE TESTIFIED.

A. I have filed testimony or comments on telecommunications issues in Alabama, Arizona, California, Colorado, Delaware, Georgia, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Washington, West Virginia, Wisconsin and Wyoming. I have also filed comments with the FCC and made presentations to the Department of Justice.

I have testified or presented formal comments in the following proceedings and forums:

Alabama:

October 18, 2000; Docket No. 27867; Adelphia Business Solutions Arbitration with BellSouth Telecommunications; Direct Testimony on Behalf of Adelphia.

January 31, 2001; Docket No. 27867; Adelphia Business Solutions Arbitration with BellSouth Telecommunications; Rebuttal Testimony on Behalf of Adelphia.

Arizona:

September 23, 1987; Arizona Corporation Commission Workshop on Special Access Services; Comments on Behalf of MCI.

August 21, 1996; Affidavit in Opposition to USWC Motion for Partial Summary Judgment; No. CV 95-14284, No. CV-96-03355, No. CV-96-03356, (consolidated); On Behalf of MCI.

October 24, 1997; Comments to the Universal Service Fund Working Group; Docket No. R-0000-97-137; On Behalf of MCI.

May 8, 1998; Comments to the Universal Service Fund Working Group; Docket No.R-0000-97-137; On Behalf of MCI.

November 9, 1998; Docket No. T-03175A-97-0251; Application of MCImetro Access Transmission Services, Inc. to Expand It's CCN to Provide IntraLATA Services and to Determine that Its IntraLATA Services are Competitive; Direct Testimony on Behalf of MCI WorldCom, Inc.

September 20, 1999; Docket No. T-00000B-97-238; USWC OSS Workshop; Comments on Behalf of MCI WorldCom, Inc.

January 8, 2001; Docket Nos. T-03654A-00-0882, T-01051B-00-0882; Petition of Level 3 Communications, LLC, for Arbitration with Qwest Corporation; Direct Testimony on Behalf of Level 3.

September 2, 2001; Docket No. T-00000A-00-0194 Phase II – A; Investigation into Qwest's Compliance with Wholesale Pricing Requirements for Unbundled Network Elements and Resale Discounts; Rebuttal Testimony on Behalf of WorldCom, Inc.

California:

August 30, 1996; Application No. 96-08-068; MCI Petition for Arbitration with Pacific Bell; Direct Testimony on Behalf of MCI.

September 10, 1996; Application No. 96-09-012; MCI Petition for Arbitration with GTE California, Inc.; Direct Testimony on Behalf of MCI.

June 5, 2000; Petition of Level 3 Communications for Arbitration of an Interconnection Agreement with Pacific Bell Telephone Company; Direct Testimony on Behalf of Level (3) Communications, LLC.

Colorado:

December 1, 1986; Investigation and Suspension Docket No. 1720; Rate Case of Mountain States Telephone and Telegraph Company; Direct Testimony on Behalf of MCI.

October 26, 1988; Investigation and Suspension Docket No. 1766; Mountain States Telephone and Telegraph Company's Local Calling Access Plan; Direct Testimony of Behalf of MCI.

September 6, 1996; MCImetro Petition for Arbitration with U S WEST Communications, Inc.; Docket No. 96A-366T (consolidated); Direct Testimony on Behalf of MCI.

September 17, 1996; MCImetro Petition for Arbitration with U S WEST Communications, Inc.; Docket No. 96A-366T (consolidated); Rebuttal Testimony on Behalf of MCI.

September 26, 1996; Application of U S WEST Communications, Inc. To Modify Its Rate and Service Regulation Plan; Docket No. Docket No. 90A-665T (consolidated); Direct Testimony on Behalf of MCI.

October 7, 1996; Application of U S WEST Communications, Inc. To Modify Its Rate and Service Regulation Plan; Docket No. Docket No. 90A-665T (consolidated); Rebuttal Testimony on Behalf of MCI.

July 18, 1997; Complaint of MCI to Reduce USWC Access Charges to Economic Cost; Docket Nos. 97K-237T, 97F-175T (consolidated) and 97F-212T (consolidated); Direct Testimony on Behalf of MCI.

August 15, 1997; Complaint of MCI to Reduce USWC Access Charges to Economic Cost; Docket Nos. 97K-237T, 97F-175T (consolidated) and 97F-212T (consolidated); Rebuttal Testimony on Behalf of MCI.

March 10, 1998; Application of WorldCom, Inc. for Approval to Transfer Control of MCI to WorldCom, Inc.; Docket No. 97A-494T; Supplemental Direct Testimony on Behalf of MCI.

March 26, 1998; Application of WorldCom, Inc. for Approval to Transfer Control of MCI to WorldCom, Inc.; Docket No. 97A-494T; Rebuttal Testimony on Behalf of MCI.

May 8, 1998; Application of WorldCom, Inc. for Approval to Transfer Control of MCI to WorldCom, Inc.; Docket No. 97A-494T; Affidavit in Response to GTE.

November 4, 1998; Proposed Amendments to the Rules Prescribing IntraLATA Equal Access; Docket No. 98R-426T; Comments to the Commission on Behalf of MCI WorldCom and AT&T Communications of the Mountain States, Inc.

May 13, 1999; Proposed Amendments to the Rules on Local Calling Area Standards; Docket No. 99R-128T; Oral Comments before the Commissioners on Behalf of MCIW.

January 4, 2001; Petition of Level 3 Communications, LLC for Arbitration with Qwest Corporation; Docket No. 00B-601T; Direct Testimony on Behalf of Level 3.

January 16, 2001; Petition of Level 3 Communications, LLC for Arbitration with Qwest Corporation; Docket No. 00B-601T; Rebuttal Testimony on Behalf of Level 3.

January 29, 2001; Qwest Corporation, Inc., Plaintiff, v. IP Telephony, Inc., Defendant. District Court, City and County of Denver, State of Colorado; Case No. 99CV8252; Direct Testimony on Behalf of IP Telephony.

June 27, 2001; US WEST Statement of Generally Available Terms and Conditions; Docket No. 991-577T; Direct Testimony on Behalf of Covad Communications Company, Rhythms Links, Inc., and New Edge Networks, Inc.

Delaware:

February 12, 1993; Diamond State Telephone Company's Application for a Rate Increase; Docket No. 92-47; Direct Testimony on Behalf of MCI.

Florida:

July 1, 1994; Investigation into IntraLATA Presubscription; Docket No. 930330-TP; Direct Testimony on Behalf of MCI.

October 5, 2000; Petition of Level 3 for Arbitration with BellSouth; Docket No. 000907-TP; Direct Testimony On Behalf of Level 3.

October 13, 2000; Petition of BellSouth for Arbitration with US LEC of Florida Inc.; Docket No. 000084-TP; Direct Testimony On Behalf of US LEC.

October 27, 2000; Petition of BellSouth for Arbitration with US LEC of Florida Inc.; Docket No. 000084-TP; Rebuttal Testimony On Behalf of US LEC.

November 1, 2000; Petition of Level 3 for Arbitration with BellSouth; Docket No. 000907-TP; Rebuttal Testimony On Behalf of Level 3.

Georgia:

December 6, 2000; Docket No. 12645-U; Petition of Level 3 for Arbitration with BellSouth; Direct Testimony on Behalf of Level 3.

December 20, 2000; Docket No. 12645-U; Petition of Level 3 for Arbitration with BellSouth; Rebuttal Testimony on Behalf of Level 3.

Idaho:

November 20, 1987; Case No. U_1150_1; Petition of MCI for a Certificate of Public Convenience and Necessity; Direct Testimony on Behalf of MCI.

March 17, 1988; Case No. U_1500_177; Investigation of the Universal Local Access Service Tariff; Direct Testimony on Behalf of MCI.

April 26, 1988; Case No. U_1500_177; Investigation of the Universal Local Access Service Tariff; Rebuttal Testimony on Behalf of MCI.

November 25, 2002; Case No. GNR-T-02-16; Petition of Potlatch, CenturyTel, the Idaho Telephone Association for Declaratory Order Prohibiting the Use of "Virtual" NXX Calling; Comments/Presentation on Behalf of Level 3, AT&T, WorldCom, and Time Warner Telecom.

Illinois:

January 16, 1989; Docket No. 83_0142; Appropriate Methodology for Intrastate Access Charges; Rebuttal Testimony Regarding Toll Access Denial on Behalf of MCI.

February 16, 1989; Docket No. 83_0142; Appropriate Methodology for Intrastate Access Charges; Testimony Regarding ICTC's Access Charge Proposal on Behalf of MCI.

May 3, 1989; Docket No. 89_0033; Illinois Bell Telephone Company's Rate Restructuring; Direct Testimony on Behalf of MCI.

July 14, 1989; Docket No. 89-0033; Illinois Bell Telephone Company's Rate Restructuring; Rebuttal Testimony on Behalf of MCI.

November 22, 1989; Docket No. 88-0091; IntraMSA Dialing Arrangements; Direct Testimony on Behalf of MCI.

February 9, 1990; Docket No. 88-0091; IntraMSA Dialing Arrangements; Rebuttal Testimony on Behalf of MCI.

November 19, 1990; Docket No. 83-0142; Industry presentation to the Commission re Docket No. 83-0142 and issues for next generic access docket; Comments re the Imputation Trial and Unitary Pricing/Building Blocks on Behalf of MCI.

July 29, 1991; Case No. 90-0425; Presentation to the Industry Regarding MCI's Position on Imputation.

November 18, 1993; Docket No. 93-0044; Complaint of MCI and LDDS re Illinois Bell Additional Aggregated Discount and Growth Incentive Discount Services; Direct Testimony on Behalf of MCI and LDDS.

January 10, 1994; Docket No. 93-0044; Complaint of MCI and LDDS re Illinois Bell Additional Aggregated Discount and Growth Incentive Discount Services; Rebuttal Testimony on Behalf of MCI and LDDS.

May 30, 2000; Docket No. 00-0332; Level 3 Petition for Arbitration to Establish and Interconnection Agreement with Illinois Bell Telephone Company; Direct Testimony on Behalf of Level (3) Communications, LLC.

July 11, 2000: Docket No. 00-0332; Level 3 Petition for Arbitration to Establish and Interconnection Agreement with Illinois Bell Telephone Company; Supplemental Verified Statement on Behalf of Level (3) Communications, LLC.

Indiana:

October 28, 1988; Cause No. 38561; Deregulation of Customer Specific Offerings of Indiana Telephone Companies; Direct Testimony on Behalf of MCI.

December 16, 1988; Cause No. 38561; Deregulation of Customer Specific Offerings of Indiana Telephone Companies; Direct Testimony on Behalf of MCI Regarding GTE.

April 14, 1989; Cause No. 38561; Deregulation of Customer Specific Offerings of Indiana Telephone Companies; Direct Testimony on Behalf of MCI Regarding Staff Reports.

June 21, 1989; Cause No. 37905; Intrastate Access Tariffs -- Parity with Federal Rates; Direct Testimony on Behalf of MCI.

June 29, 1989; Cause No. 38560; Reseller Complaint Regarding 1+ IntraLATA Calling; Direct Testimony on Behalf of MCI.

October 25, 1990; Cause No. 39032; MCI Request for IntraLATA Authority; Direct Testimony on Behalf of MCI.

April 4, 1991; Rebuttal Testimony in Cause No. 39032 re MCI's Request for IntraLATA Authority on Behalf of MCI.

Iowa:

September 1, 1988; Docket No. RPU 88_6; IntraLATA Competition in Iowa; Direct Testimony on Behalf of MCI.

September 20, 1988; Docket No. RPU_88_1; Regarding the Access Charges of Northwestern Bell Telephone Company; Direct Testimony on Behalf of MCI.

September 25, 1991; Docket No. RPU-91-4; Investigation of the Earnings of US WEST Communications, Inc.; Direct Testimony on Behalf of MCI.

October 3, 1991; Docket No. NOI-90-1; Presentation on Imputation of Access Charges and the Other Costs of Providing Toll Services; On Behalf of MCI.

November 5, 1991; Docket No. RPU-91-4; Investigation of the Earnings of US WEST Communications, Inc.; Rebuttal Testimony on Behalf of MCI.

December 23, 1991; Docket No. RPU-91-4; Investigation of the Earnings of US WEST Communications; Inc.; Supplemental Testimony on Behalf of MCI.

January 10, 1992; Docket No. RPU-91-4; Investigation of the Earnings of US WEST Communications, Inc.; Rebuttal Testimony on Behalf of MCI.

January 20, 1992; Docket No. RPU-91-4; Investigation of the Earnings of US WEST Communications, Inc.; Surrebuttal Testimony on Behalf of MCI.

June 8, 1999; Docket NOI-99-1; Universal Service Workshop; Participated on numerous panels during two day workshop; Comments on Behalf of MCIW.

October 27, 1999: Docket NOI-99-1; Universal Service Workshop; Responded to questions posed by the Staff of the Board during one day workshop; Comments on Behalf of MCIW and AT&T.

Kansas:

June 10, 1992; Docket No. 181,097-U; General Investigation into IntraLATA Competition within the State of Kansas; Direct Testimony on Behalf of MCI.

September 16, 1992; Docket No. 181,097-U; General Investigation into IntraLATA Competition within the State of Kansas; Rebuttal Testimony on Behalf of MCI.

Kentucky:

May 20, 1993; Administrative Case No. 323, Phase I; An Inquiry into IntraLATA Toll Competition, an Appropriate Compensation Scheme for Completion of IntraLATA Calls by Interexchange Carriers, and WATS Jurisdictionality; Direct Testimony on Behalf of MCI.

December 21, 2000; Case No. 2000-404; Petition of Level 3 Communications, LLC for Arbitration with BellSouth; Direct Testimony on Behalf of Level 3.

January 12, 2001; Case No. 2000-477; Petition of Adelphia Business Solutions for Arbitration with BellSouth; Direct Testimony on Behalf of Adelphia.

Louisiana:

December 28, 2000; Docket No. U-25301; Petition of Adelphia Business Solutions for Arbitration with BellSouth; Direct Testimony on Behalf of Adelphia.

January 5, 2001; Docket No. U-25301; Petition of Adelphia Business Solutions for Arbitration with BellSouth; Rebuttal Testimony on Behalf of Adelphia.

Maryland:

November 12, 1993; Case No. 8585; Competitive Safeguards Required re C&P's Centrex Extend Service; Direct Testimony on Behalf of MCI.

January 14, 1994; Case No. 8585; Competitive Safeguards Required re C&P's Centrex Extend Service; Rebuttal Testimony on Behalf of MCI.

May 19, 1994; Case No. 8585; Re Bell Atlantic Maryland, Inc.'s Transmittal No. 878; Testimony on Behalf of MCI.

June 2, 1994; Case No. 8585; Competitive Safeguards Required re C&P's Centrex Extend Service; Rebuttal Testimony on Behalf of MCI.

September 5, 2001; Case No. 8879; Rates for Unbundled Network Elements Pursuant to the Telecommunications Act of 1996; Rebuttal Testimony on behalf of the Staff of the Public Service Commission of Maryland.

October 15, 2001; Case No. 8879; Rates for Unbundled Network Elements Pursuant to the Telecommunications Act of 1996; Surrebuttal Testimony on behalf of the Staff of the Public Service Commission of Maryland.

Massachusetts:

April 22, 1993; D.P.U. 93-45; New England Telephone Implementation of Interchangeable NPAs; Direct Testimony on Behalf of MCI.

May 10, 1993; D.P.U. 93-45; New England Telephone Implementation of Interchangeable NPAs; Rebuttal Testimony on Behalf of MCI.

Michigan:

September 29, 1988; Case Nos. U_9004, U_9006, U_9007 (Consolidated); Industry Framework for IntraLATA Toll Competition; Direct Testimony on Behalf of MCI.

November 30, 1988; Case Nos. U_9004, U_9006, U_9007 (Consolidated); Industry Framework for IntraLATA Toll Competition; Rebuttal Testimony on Behalf of MCI.

June 30, 1989; Case No. U-8987; Michigan Bell Telephone Company Incentive Regulation Plan; Direct Testimony on Behalf of MCI.

July 31, 1992; Case No. U-10138; MCI v Michigan Bell and GTE re IntraLATA Equal Access; Direct Testimony on Behalf of MCI.

November 17, 1992; Case No. U-10138; MCI v Michigan Bell and GTE re IntraLATA Equal Access; Rebuttal Testimony on Behalf of MCI.

July 22, 1993; Case No. U-10138 (Reopener); MCI v Michigan Bell and GTE re IntraLATA Equal Access; Direct Testimony on Behalf of MCI.

February 16, 2000; Case No. U-12321; AT&T Communications of Michigan, Inc. Complainant v. GTE North Inc. and Contel of the South, Inc., d/b/a GTE Systems of Michigan; Direct Testimony on Behalf of AT&T. (Adopted Testimony of Michael Starkey)

May 11, 2000; Case No. U-12321; AT&T Communications of Michigan, Inc. Complainant v. GTE North Inc. and Contel of the South, Inc., d/b/a GTE Systems of Michigan; Rebuttal Testimony on Behalf of AT&T.

June 8, 2000; Case No. U-12460; Petition of Level 3 Communications for Arbitration to Establish an Interconnection Agreement with Ameritech Michigan; Direct Testimony on Behalf of Level (3) Communications, LLC.

September 27, 2000; Case No. U-12528; In the Matter of the Implementation of the Local Calling Area Provisions of the MTA; Rebuttal Testimony on Behalf of Focal Communications, Inc.

Minnesota:

January 30, 1987; Docket No. P_421/CI_86_88; Summary Investigation into Alternative Methods for Recovery of Non-traffic Sensitive Costs; Comments to the Commission on Behalf of MCI.

September 7, 1993; Docket No. P-999/CI-85-582, P-999/CI-87-697 and P-999/CI-87-695, In the Matter of an Investigation into IntraLATA Equal Access and Presubscription; Comments of MCI on the Report of the Equal Access and Presubscription Study Committee on Behalf of MCI.

September 20, 1996; Petition for Arbitration with U S WEST Communications, Inc.; Docket No. P-442, 421/M-96-855; P-5321, 421/M-96-909; and P-3167, 421/M-96-729 (consolidated); Direct Testimony on Behalf of MCI.

September 30, 1996; Petition for Arbitration with U S WEST Communications, Inc.; Docket No. P-442, 421/M-96-855; P-5321, 421/M-96-909; and P-3167, 421/M-96-729 (consolidated); Rebuttal Testimony on Behalf of MCI.

September 14-16, 1999; USWC OSS Workshop; Comments on Behalf of MCI WorldCom, Inc. re OSS Issues.

September 28, 1999; Docket No. P-999/R-97-609; Universal Service Group; Comments on Behalf of MCI WorldCom, Inc. and AT&T Communications.

April 18, 2002; Commission Investigation of Qwest's Pricing of Certain Unbundled Network Elements; Docket Nos. P-442, 421, 3012/M-01-1916; P-421/C1-01-1375; OAH Docket No. 12-2500-14490; Rebuttal Testimony on Behalf of McLeod USA Telecommunications Services, Inc., Eschelon Telecom of Minnesota, Inc., US Link, Inc., Northstar Access, LLC, Otter Tail Telecomm LLC, VAL-Ed Joint Venture, LLP, dba 702 Communications.

Mississippi:

February 2, 2001; Docket No. 2000-AD-846; Petition of Adelphia Business Solutions for Arbitration with BellSouth Telecommunications; Direct Testimony on Behalf of Adelphia.

February 16, 2001; Docket No. 2000-AD-846; Petition of Adelphia Business Solutions for Arbitration with BellSouth Telecommunications; Rebuttal Testimony on Behalf of Adelphia.

Montana:

May 1, 1987; Docket No. 86.12.67; Rate Case of AT&T Communications of the Mountain States, Inc.; Direct Testimony on Behalf of MCI.

September 12, 1988; Docket No. 88.1.2; Rate Case of Mountain States Telephone and Telegraph Company; Direct Testimony on Behalf of MCI.

May 12, 1998; Docket No. D97.10.191; Application of WorldCom, Inc. for Approval to Transfer Control of MCI Communications Corporation to WorldCom, Inc.; Rebuttal Testimony on Behalf of MCI.

June 1, 1998; Docket No. D97.10.191; Application of WorldCom, Inc. for Approval to Transfer Control of MCI Communications Corporation to WorldCom, Inc.; Amended Rebuttal Testimony on Behalf of MCI.

Nebraska:

November 6, 1986; Application No. C_627; Nebraska Telephone Association Access Charge Proceeding; Direct Testimony on Behalf of MCI.

March 31, 1988; Application No. C_749; Application of United Telephone Long Distance Company of the Midwest for a Certificate of Public Convenience and Necessity; Direct Testimony on Behalf of MCI.

New Hampshire:

April 30, 1993; Docket DE 93-003; Investigation into New England Telephone's Proposal to Implement Seven Digit Dialing for Intrastate Toll Calls; Direct Testimony on Behalf of MCI.

January 12, 2001; Docket No. DT 00-223; Investigation Into Whether Certain Calls are Local; Direct Testimony on Behalf of BayRing Communications.

April 5, 2002; Docket No. DT 00-223; Investigation Into Whether Certain Calls are Local; Rebuttal Testimony on Behalf of BayRing Communications.

New Jersey:

September 15, 1993; Docket No. TX93060259; Notice of Pre-Proposal re IntraLATA Competition; Comments in Response to the Board of Regulatory Commissioners on Behalf of MCI.

October 1, 1993; Docket No. TX93060259; Notice of Pre-Proposal re IntraLATA Competition; Reply Comments in Response to the Board of Regulatory Commissioners on Behalf of MCI.

April 7, 1994; Docket Nos. TX90050349, TE92111047, and TE93060211; Petitions of MCI, Sprint and AT&T for Authorization of IntraLATA Competition and Elimination of Compensation; Direct Testimony on Behalf of MCI.

April 25, 1994; Docket Nos. TX90050349, TE92111047, and TE93060211; Petitions of MCI, Sprint and AT&T for Authorization of IntraLATA Competition and Elimination of Compensation; Rebuttal Testimony on Behalf of MCI.

New Mexico:

September 28, 1987; Docket No. 87_61_TC; Application of MCI for a Certificate of Public Convenience and Necessity; Direct Testimony on Behalf of MCI.

August 30, 1996: Docket No. 95-572-TC; Petition of AT&T for IntraLATA Equal Access; Rebuttal Testimony on Behalf of MCI.

September 16, 2002; Utility Case No. 3495, Phase B; Consideration of Costing and Pricing Rules for OSS, Collocation, Shared Transport, Nonrecurring Charges, Spot Frames, Combination of Network Elements and Switching; Direct Testimony on Behalf of the Staff of the New Mexico Public Regulation Commission.

New York:

April 30, 1992; Case 28425; Comments of MCI Telecommunications Corporation on IntraLATA Presubscription.

June 8, 1992; Case 28425; Reply Comments of MCI Telecommunications Corporation on IntraLATA Presubscription.

North Carolina:

August 4, 2000; Docket No. P779 SUB4; Petition of Level (3) Communications, LLC for Arbitration with Bell South; Direct Testimony on Behalf of Level (3) Communications, LLC.

September 18, 2000; Docket No. P779 SUB4; Petition of Level (3) Communications, LLC for Arbitration with Bell South; Rebuttal Testimony on Behalf of Level (3) Communications, LLC.

October 18, 2000; Docket No. P-886, SUB 1; Petition of Adelphia Business Solutions or North Carolina, LP for Arbitration with BellSouth; Direct Testimony on Behalf of Adelphia.

December 8, 2000; Docket No. P-886, SUB 1; Petition of Adelphia Business Solutions or North Carolina, LP for Arbitration with BellSouth; Rebuttal Testimony on Behalf of Adelphia.

North Dakota:

June 24, 1991; Case No. PU-2320-90-183 (Implementation of SB 2320 -- Subsidy Investigation); Direct Testimony on Behalf of MCI.

October 24, 1991; Case No. PU-2320-90-183 (Implementation of SB 2320 -- Subsidy Investigation); Rebuttal Testimony on Behalf of MCI.

December 4, 2002; Case No. PU-2065-02-465; Petition of Level 3 for Arbitration with SRT Communications Cooperative; Direct Testimony on Behalf of Level (3) Communications, LLC.

May 2, 2003; Case No. PU-2342-01-296; Qwest Corporation Price Investigation; Direct Testimony on Behalf of the CLEC Coalition (US Link, Inc., VAL-ED Joint Venture LLP d/b/a 702 Communications, McLeodUSA Telecommunications, Inc. and IdeaOne Telecom Group, LLC).

Oklahoma:

April 2, 1992; Cause No. 28713; Application of MCI for Additional CCN Authority to Provide IntraLATA Services; Direct Testimony on Behalf of MCI.

June 22, 1992; Cause No. 28713; Application of MCI for Additional CCN Authority to Provide IntraLATA Services; Rebuttal Testimony on Behalf of MCI.

Oregon:

October 27, 1983; Docket No. UT 9; Pacific Northwest Bell Telephone Company Business Measured Service; Direct Testimony on Behalf of the Public Utility Commissioner of Oregon.

April 23, 1984; Docket No. UT 17; Pacific Northwest Bell Telephone Company Business Measured Service; Direct Testimony on Behalf of the Public Utility Commissioner of Oregon.

May 7, 1984; Docket No. UT 17; Pacific Northwest Bell Telephone Company Business Measured Service; Rebuttal Testimony on Behalf of the Public Utility Commissioner of Oregon.

October 31, 1986; Docket No. AR 154; Administrative Rules Relating to the Universal Service Protection Plan; Rebuttal Testimony on Behalf of MCI.

September 6, 1996; Docket ARB3/ARB6; Petition of MCI for Arbitration with U S WEST Communications, Inc.; Direct Testimony on Behalf of MCI.

October 11, 1996; Docket No. ARB 9; Interconnection Contract Negotiations Between MCImetro and GTE; Direct Testimony on Behalf of MCI.

November 5, 1996; Docket No. ARB 9; Interconnection Contract Negotiations Between MCImetro and GTE; Rebuttal Testimony on Behalf of MCI.

November 6, 2002; Docket No. UM 1058; Investigation into the Use of Virtual NPA/NXX Calling Patterns; Comments/Presentation on Behalf of Level (3) Communications, LLC.

Pennsylvania:

December 9, 1994; Docket No. I-00940034; Investigation Into IntraLATA Interconnection Arrangements (Presubscription); Direct Testimony on Behalf of MCI.

September 5, 2002; Docket No. C-20028114; Level 3 Communications, LLC v. Marianna & Scenery Hill Telephone Company; Direct Testimony on Behalf of Level (3) Communications, LLC.

Rhode Island:

April 30, 1993; Docket No. 2089; Dialing Pattern Proposal Made by the New England Telephone Company; Direct Testimony on Behalf of MCI.

South Carolina:

Oct. ??, 2000; Docket No. 2000-0446-C; US LEC of South Carolina Inc. Arbitration with BellSouth Telecommunications; Direct Testimony on Behalf of US LEC.

November 22, 2000; Docket No. 2000-516-C; Adelphia Business Solutions of

South Carolina, Inc. Arbitration with BellSouth Telecommunications; Direct Testimony on Behalf of Adelphia.

December 14, 2000; Docket No. 2000-516-C; Adelphia Business Solutions of South Carolina, Inc. Arbitration with BellSouth Telecommunications; Rebuttal Testimony on Behalf of Adelphia.

South Dakota:

November 11, 1987; Docket No. F_3652_12; Application of Northwestern Bell Telephone Company to Introduce Its Contract Toll Plan; Direct Testimony on Behalf of MCI.

May 27, 2003; Docket No. TC03-057; Application of Qwest to Reclassify Local Exchange Services as Fully Competitive; Direct Testimony on Behalf of WorldCom, Inc., Black Hills FiberCom and Midcontinent Communications.

Tennessee:

January 31, 2001; Petition of Adelphia Business Solutions for Arbitration with BellSouth Telecommunications; Direct Testimony on Behalf of Adelphia.

February 7, 2001; Petition of Adelphia Business Solutions for Arbitration with BellSouth Telecommunications; Rebuttal Testimony on Behalf of Adelphia.

Texas:

June 5, 2000; PUC Docket No. 22441; Petition of Level 3 for Arbitration with Southwestern Bell Telephone Company; Direct Testimony on Behalf of Level (3) Communications, LLC.

June 12, 2000; PUC Docket No. 22441; Petition of Level 3 for Arbitration with Southwestern Bell Telephone Company; Rebuttal Testimony on Behalf of Level (3) Communications, LLC.

October 10, 2002; PUC Docket No. 26431; Petition of Level 3 for Arbitration with CenturyTel of Lake Dallas, Inc. and CenturyTel of San Marcos, Inc.; Direct Testimony on Behalf of Level (3) Communications, LLC.

October 16, 2002; PUC Docket No. 26431; Petition of Level 3 for Arbitration with CenturyTel of Lake Dallas, Inc. and CenturyTel of San Marcos, Inc.; Reply Testimony on Behalf of Level (3) Communications, LLC.

Utah:

November 16, 1987; Case No. 87_049_05; Petition of the Mountain State Telephone and Telegraph Company for Exemption from Regulation of Various Transport Services; Direct Testimony on Behalf of MCI.

July 7, 1988; Case No. 83_999_11; Investigation of Access Charges for Intrastate InterLATA and IntraLATA Telephone Services; Direct Testimony on Behalf of MCI.

November 8, 1996; Docket No. 96-095-01; MCImetro Petition for Arbitration with USWC Pursuant to 47 U.S.C. Section 252; Direct Testimony on Behalf of MCI.

November 22, 1996; Docket No. 96-095-01; MCImetro Petition for Arbitration with USWC Pursuant to 47 U.S.C. Section 252; Rebuttal Testimony on Behalf of MCI.

September 3, 1997; Docket No. 97-049-08; USWC Rate Case; Surrebuttal Testimony on Behalf of MCI.

September 29, 1997; Docket No. 97-049-08; USWC Rate Case; Revised Direct Testimony on Behalf of MCI.

February 2, 2001; Docket No. 00-999-05; In the Matter of the Investigation of Inter-Carrier Compensation for Exchanged ESP Traffic; Direct Testimony on Behalf of Level 3 Communications, LLP.

Washington:

September 27, 1988; Docket No. U-88-2052_P; Petition of Pacific Northwest Bell Telephone Company for Classification of Services as Competitive; Direct Testimony on Behalf of MCI.

October 11, 1996; Docket No. UT-96-0338; Petition of MCImetro for Arbitration with GTE Northwest, Inc., Pursuant to 47 U.S.C.252; Direct Testimony on Behalf of MCI.

November 20, 1996; Docket No. UT-96-0338; Petition of MCImetro for Arbitration with GTE Northwest, Inc., Pursuant to 47 U.S.C.252; Rebuttal Testimony on Behalf of MCI.

January 13, 1998; Docket No. UT-97-0325; Rulemaking Workshop re Access Charge Reform and the Cost of Universal Service; Comments and Presentation on Behalf of MCI.

December 21, 2001; Docket No. UT-003013, Part D; Continued Costing and Pricing of Unbundled Network Elements, Transport, and Termination; Direct Testimony on Behalf of WorldCom, Inc.

October 18, 2002; Docket No. UT-023043; Petition of Level 3 for Arbitration with CenturyTel of Washington, Inc.; Direct Testimony on Behalf of Level (3) Communications, LLC.

November 1, 2002; Docket No. UT-023043; Petition of Level 3 for Arbitration with CenturyTel of Washington, Inc.; Rebuttal Testimony on Behalf of Level (3) Communications, LLC.

January 31, 2003; Docket No. UT-021569; Developing an Interpretive or Policy Statement relating to the Use of Virtual NPA/NXX Calling Patterns; Comments on Behalf of WorldCom, Inc. and KMC Telecom.

May 1, 2003; UT-021569; Developing an Interpretive or Policy Statement relating to the Use of Virtual NPA/NXX Calling Patterns; Workshop Participation on Behalf of MCI, KMC Telecom, and Level (3) Communications, LLC.

West Virginia:

October 11, 1994; Case No. 94-0725-T-PC; Bell Atlantic - West Virginia Incentive Regulation Plan; Direct Testimony on Behalf of MCI.

June 18, 1998; Case No. 97-1338-T-PC; Petition of WorldCom, Inc. for Approval to Transfer Control of MCI Communications Corporation to WorldCom, Inc.; Rebuttal Testimony on Behalf of MCI.

Wisconsin:

October 31, 1988; Docket No. 05_TR_102; Investigation of Intrastate Access Costs, Settlements, and IntraLATA Access Charges; Direct Testimony on Behalf of MCI.

November 14, 1988; Docket No. 05_TR_102; Investigation of Intrastate Access Costs, Settlements, and IntraLATA Access Charges; Rebuttal Testimony on Behalf of MCI.

December 12, 1988; Docket No. 05_TI_116; In the Matter of Provision of Operator Services; Rebuttal Testimony on Behalf of MCI.

March 6, 1989; Docket No. 6720_TI_102; Review of Financial Data Filed by Wisconsin Bell, Inc.; Direct Testimony on Behalf of MCI.

May 1, 1989; Docket No. 05_NC_100; Amendment of MCI's CCN for Authority to Provide IntraLATA Dedicated Access Services; Direct Testimony on Behalf of MCI.

May 11, 1989; Docket No. 6720_TR_103; Investigation Into the Financial Data and Regulation of Wisconsin Bell, Inc.; Rebuttal Testimony on Behalf of MCI.

July 5, 1989; Docket No. 05-TI-112; Disconnection of Local and Toll Services for Nonpayment -- Part A; Direct Testimony on Behalf of MCI.

July 5, 1989; Docket No. 05-TI-112; Examination of Industry Wide Billing and Collection Practices -- Part B; Direct Testimony on Behalf of MCI.

July 12, 1989; Docket No. 05-TI-112; Rebuttal Testimony in Parts A and B on Behalf of MCI.

October 9, 1989; Docket No. 6720-TI-102; Review of the WBI Rate Moratorium; Direct Testimony on Behalf of MCI.

November 17, 1989; Docket No. 6720-TI-102; Review of the WBI Rate Moratorium; Rebuttal Testimony on Behalf of MCI.

December 1, 1989; Docket No. 05-TR-102; Investigation of Intrastate Access Costs, Settlements, and IntraLATA Access Charges; Direct Testimony on Behalf of MCI.

April 16, 1990; Docket No. 6720-TR-104; Wisconsin Bell Rate Case; Direct Testimony of Behalf of MCI.

October 1, 1990; Docket No. 2180-TR-102; GTE Rate Case and Request for Alternative Regulatory Plan; Direct Testimony on Behalf of MCI.

October 15, 1990; Docket No. 2180-TR-102; GTE Rate Case and Request for Alternative Regulatory Plan; Rebuttal Testimony on Behalf of MCI.

November 15, 1990; Docket No. 05-TR-103; Investigation of Intrastate Access Costs and Intrastate Access Charges; Direct Testimony on Behalf of MCI.

April 3, 1992; Docket No. 05-NC-102; Petition of MCI for IntraLATA 10XXX 1+ Authority; Direct Testimony on Behalf of MCI.

September 30, 2002; Docket No. 05-MA-130; Petition of Level 3 for Arbitration with CenturyTel; Direct Testimony on Behalf of Level (3) Communications, LLC.

October 9, 2002; Docket No. 05-MA-130; Petition of Level 3 for Arbitration with CenturyTel; Reply Testimony on Behalf of Level (3) Communications, LLC.

Wyoming:

June 17, 1987; Docket No. 9746 Sub 1; Application of MCI for a Certificate of Public Convenience and Necessity; Direct Testimony on Behalf of MCI.

May 19, 1997; Docket No. 72000-TC-97-99; In the Matter of Compliance with Federal Regulations of Payphones; Oral Testimony on Behalf of MCI.

Comments Submitted to the Federal Communications Commission and/or the Department of Justice

March 6, 1991; Ameritech Transmittal No. 518; Petition to Suspend and Investigate on Behalf of MCI re Proposed Rates for OPTINET 64 Kbps Service.

April 17, 1991; Ameritech Transmittal No. 526; Petition to Suspend and Investigate on Behalf of MCI re Proposed Flexible ANI Service.

August 30, 1991; Ameritech Transmittal No. 555; Petition to Suspend and Investigate on Behalf of MCI re Ameritech Directory Search Service.

September 30, 1991; Ameritech Transmittal No. 562; Petition to Suspend and Investigate on Behalf of MCI re Proposed Rates and Possible MFJ Violations Associated with Ameritech's OPTINET Reconfiguration Service (AORS).

October 15, 1991; CC Docket No. 91-215; Opposition to Direct Cases of Ameritech and United (Ameritech Transmittal No. 518; United Transmittal No. 273) on Behalf of MCI re the introduction of 64 Kbps Special Access Service.

November 27, 1991; Ameritech Transmittal No. 578; Petition to Suspend and Investigate on Behalf of MCI re Ameritech Directory Search Service.

September 4, 1992; Ameritech Transmittal No. 650; Petition to Suspend and Investigate on Behalf of MCI re Ameritech 64 Clear Channel Capability Service.

February 16, 1995; Presentation to FCC Staff on the Status of Intrastate Competition on Behalf of MCI.

November 9, 1999; Comments to FCC Staff of Common Carrier Bureau on the Status of OSS Testing in Arizona on Behalf of MCI WorldCom, Inc.

November 9, 1999; Comments to the Department of Justice (Task Force on Telecommunications) on the Status of OSS Testing in Arizona and the USWC Collaborative on Behalf of MCI WorldCom, Inc.

Presentations Before Legislative Bodies:

April 8, 1987; Minnesota; Senate File 677; Proposed Deregulation Legislation; Comments before the House Committee on Telecommunications.

October 30, 1989; Michigan; Presentation Before the Michigan House and Senate Staff Working Group on Telecommunications; "A First Look at Nebraska, Incentive Rates and Price Caps," Comments on Behalf of MCI.

May 16, 1990; Wisconsin; Comments Before the Wisconsin Assembly Utilities Committee Regarding the Wisconsin Bell Plan for Flexible Regulation, on Behalf of MCI.

March 20, 1991; Michigan; Presentation to the Michigan Senate Technology and Energy Committee re SB 124 on behalf of MCI.

May 15, 1991; Michigan; Presentation to the Michigan Senate Technology and Energy Commission and the House Public Utilities Committee re MCI's Building Blocks Proposal and SB 124/HB 4343.

March 8, 2000; Illinois; Presentation to the Environment & Energy Senate Committee re Emerging Technologies and Their Impact on Public Policy, on Behalf of MCI WorldCom, Inc.

Presentations Before Industry Groups -- Seminars:

May 17, 1989; Wisconsin Public Utility Institute -- Telecommunications Utilities and Regulation; May 15-18, 1989; Panel Presentation -- Interexchange Service Pricing Practices Under Price Cap Regulation; Comments on Behalf of MCI.

July 24, 1989; National Association of Regulatory Utility Commissioners -- Summer Committee Meeting, San Francisco, California. Panel Presentation -- Specific IntraLATA Market Concerns of Interexchange Carriers; Comments on Behalf of MCI.

May 16, 1990; Wisconsin Public Utility Institute -- Telecommunications Utilities and Regulation; May 14-18, 1990; Presentation on Alternative Forms of Regulation.

October 29, 1990; Illinois Telecommunications Sunset Review Forum; Two Panel Presentations: Discussion of the Illinois Commerce Commission's Decision in Docket No. 88-0091 for the Technology Working Group; and, Discussion of the Treatment of Competitive Services for the Rate of Return Regulation Working Group; Comments on Behalf of MCI.

May 16, 1991; Wisconsin Public Utility Institute -- Telecommunications Utilities and Regulation Course; May 13-16, 1991; Participated in IntraLATA Toll Competition Debate on Behalf of MCI.

November 19, 1991; TeleStrategies Conference -- "Local Exchange Competition: The $70 Billion Opportunity." Presentation as part of a panel on "IntraLATA 1+ Presubscription" on Behalf of MCI.

July 9, 1992; North Dakota Association of Telephone Cooperatives Summer Conference, July 8-10, 1992. Panel presentations on "Equal Access in North Dakota: Implementation of PSC Mandate" and "Open Network Access in North Dakota" on Behalf of MCI.

December 2-3, 1992; TeleStrategies Conference -- "IntraLATA Toll Competition -- A Multi-Billion Dollar Market Opportunity." Presentations on the interexchange carriers' position on intraLATA dialing parity and presubscription and on technical considerations on behalf of MCI.

March 14-17, 1993; NARUC Introductory Regulatory Training Program; Panel Presentation on Competition in Telecommunications on Behalf of MCI.

May 13-14, 1993; TeleStrategies Conference -- "IntraLATA Toll Competition -- Gaining the Competitive Edge"; Presentation on Carriers and IntraLATA Toll Competition on Behalf of MCI.

May 23-26, 1994; The 12th Annual National Telecommunications Forecasting Conference; Represented IXCs in Special Town Meeting Segment Regarding the Convergence of CATV and Telecommunications and other Local Competition Issues.

March 14-15, 1995; "The LEC-IXC Conference"; Sponsored by Telecommunications Reports and Telco Competition Report; Panel on Redefining the IntraLATA Service Market -- Toll Competition, Extended Area Calling and Local Resale.

August 28-30, 1995; "Phone+ Supershow '95"; Playing Fair: An Update on IntraLATA Equal Access; Panel Presentation.

August 29, 1995; "TDS Annual Regulatory Meeting"; Panel Presentation on Local Competition Issues.

December 13-14, 1995; "NECA/Century Access Conference"; Panel Presentation on Local Exchange Competition.

October 23, 1997; "Interpreting the FCC Rules of 1997"; The Annenberg School for Communication at the University of Southern California; Panel Presentation on Universal Service and Access Reform.

February 5-6, 2002; "Litigating Telecommunications Cost Cases and Other Sources of Enlightenment"; Educational Seminar for State Commission and Attorney General Employees on Litigating TELRIC Cases; Denver, Colorado.

February 19-20, 2003; Seminar for the New York State Department of Public Service entitled "Emerging Technologies and Convergence in the Telecommunications Network". Presented with Ken Wilson of Boulder Telecommunications Consultants, LLC.

DSC COMMUNICATIONS

Unbundling Solutions

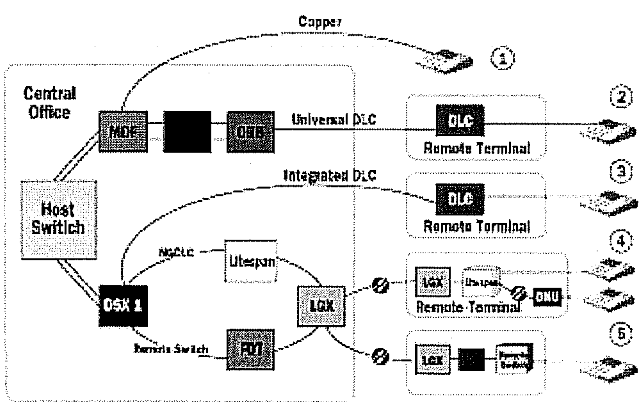
The Challenge

One of the three key principle goals set forth by the Telecom Act of 1996 is "opening of the local exchange and exchange access markets to competitive entry". This has created a demand for low-risk, low-cost, easily implementable solutions that support continued profitability.

Section 251 of the legislation imposes specific obligations on telecommunication carriers including, Sec 251 (c), which states that an ILEC must provide to any requesting telecommunication carrier, LEC retail services for resale to at wholesale rates and interconnection and access to network elements on an unbundled basis at any technically feasible point. Network Elements are defined as a facility or equipment used in the provision of a telecommunication service. Interconnection refers to the physical linking of two networks for mutual exchange of traffic. One of the technically feasible points is the local loop, defined in the Act as a transmission facility between the distribution frame of the ILECs Central Office and the NID.

Unbundling of the local loop is essentially the leasing of the local loop facility from the end office to the subscriber. The type of loops include: 2&4 wire analog voice grade, 2&4 wire unconditioned loops supporting ISDN, ADSL, HDSL, LNP and DS1 signals.

Unbundling: Five methods of providing local loop access



Service is provided to the local loop over one of five different and distinctly

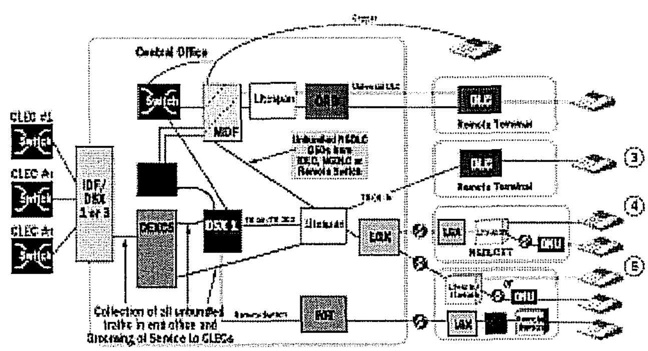
Service is provided to the local loop over one of five different and distinctly different technical means. The five different methods of providing local loop terminations are:

1. Host Switch, direct VF terminations
2. Universal Digital Loop Carrier VF terminations
3. Integrated Digital Loop Carrier Digital terminations
4. Integrated Digital Loop Carrier Digital terminations
5. Remote Switch terminations

All five methods of service delivery provide equivalent service to subscribers, but are impacted differently when required to be unbundled.

There is no problem with unbundling of a host switch and universal Digital Loop Carrier VF termination since they appear directly on the MDF in the most basic form, at the VF level. In some ILECs as much as 40% of the existing loops are digitally derived. The problem with digital derived switch interfaces, however, is that they do not allow for unbundled access to the individual subscriber loops in the central office.

Unbundling for NGDLCs. IDLCs and Remote Switches with DEXCS Collecting and Grooming CLECs service



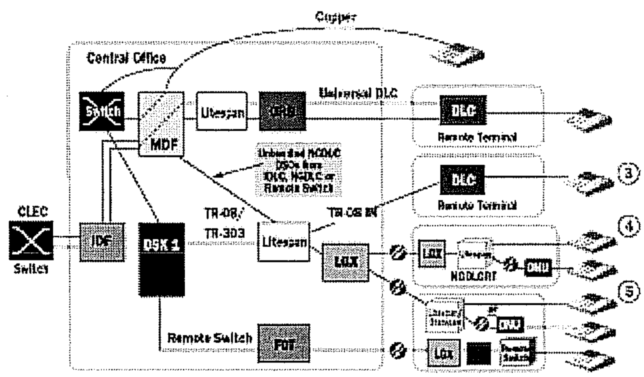
DSC Unbundling Solutions

Unbundling for Integrated Digital Loop Carriers can be performed by utilizing the DSC Litespan Next Generation Digital Loop Carrier (NGDLC) with its Time Slot Interchanger. The TSI allows "mapping" of the DSOs in the digital interface to be mapped to an analog interface. Any of the subscribers that remain terminated in the ILECs domain are digitally interfaced, same as before. The subscriber making the transition to the CLEC can be "mapped" to a VF circuit at the MDF for re-route. By implementing the Litespan NGDLC, only the required unbundled derived loops have to be treated. The only other option is to deploy Central Office terminals to gain VF access of a digitally terminated subscriber. In many cases, switch expansion and switch re-balancing must occur to support the treatment of the IDLC unbundled loops by implementing a COT.

Remote switches present a different problem. Remote switches are placed to provide service and are connected to the host serving switch with a proprietary digital umbilical link. This link is concentrated with the remote switch taking an appearance as an extended line peripheral bay off the host switch. Any unbundled loop request will require the "nailing up" of the derived loop. The circuit is nailed up over the umbilical link and also through the switch fabric eventually to the MDF. To support unbundling in the remote switch option, a Litespan Remote Terminal or Starspan Optical Network Unit can be placed with the remote switch. The local loops required to be unbundled are transferred to the Litespan system for MDF access in the host serving office.

Implementing a Litespan solution is the most effective way of providing unbundled loop access to digitally derived local loops. Another key benefit is the capability to provide "flow through" service order provisioning with the established loop OS systems. This includes the capability to provide Metallic Loop Testing (MLT) of any unbundled loop.

Unbundling for NGDLCs, IDLCs and Remote Switches



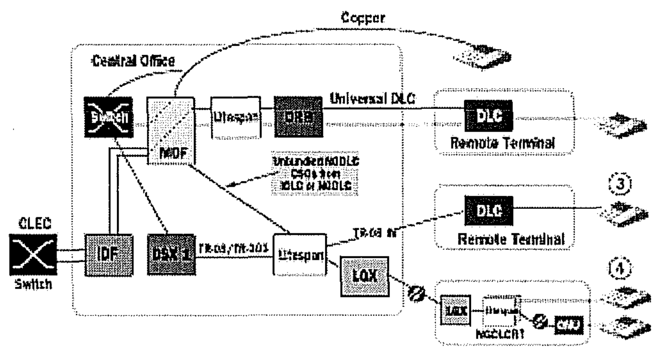
The second part of unbundling support is the mapping of the unbundled loops into the transport and IOF network. This critical network component is supported by the DSC DEXCS platform. The DSC DEXCS used in conjunction with Litespan addresses both: terminating and routing traffic from multiple CLECs into the end office; and collecting and routing traffic from the end office to a hub office where multiple CLECs are co-located.

In the end office domain, the DEXCS collects the service at a DS1 or TR-008 interface level and provides the capability to re-route the unbundled loops in a digital format to the required CLEC. DEXCS is compatible with IOF testing methods.

There is also the option of implementing the DEXCS at a hub site in which a single collection point of unbundled traffic from the end offices occurs. At this hub office, the DEXCS can terminate DS1 traffic (DS1 or TR-008 formatted), DS3 or at a STS-1 interface. The DEXCS provides DS0 observation and mapping of the unbundled loop to any CLEC that has an appearance in the hub office.

The DSC unbundling solutions are also supported by the foundation Operational Support Systems (OSS) deployed today. The access network is maintained and provisioned by OSSs designed to log data and support the service delivery of a mass market offering. The transport network OSSs differ in that they were designed to maintain records from the serving wire center, to the Inter Office Facilities (IOF) domain and to the terminating wire center. The OSSs bond since they both link at the point of interconnection as the services transverse each domain.

Unbundling for NGDLCs and IDLCs



The DSC product offerings for support of the unbundling provide key benefits including:

- Complete TSI capability to support grooming, routing and mapping of the unbundled loop.
- Network compliant interfaces of:VF interface (2 wire & 4 wire), ISDN, DS1, TR-008, GR-303, and DS3 rate.
- Tested interoperability with established TR-008 DLCs
- Embedded Operational Support capabilities of both the loop and Inter-Office environment for end to end flow through order capabilities and testing.
- Software controlled network elements supporting new and merging services including SDSL, HDSL, LNP and ADSL.
- Opportunity to increase the Return On Net Assets of existing infrastructure by implementing other DSC Asset Value Drivers on Litespan and DEXCS platform.
- Network solution supporting the initial demand for unbundling and future opportunity to transition unbundled loop to other CLECs, or back to the ILEC domain on a remote order provisioning basis.

Return to find the DSC Solution for your challenge...

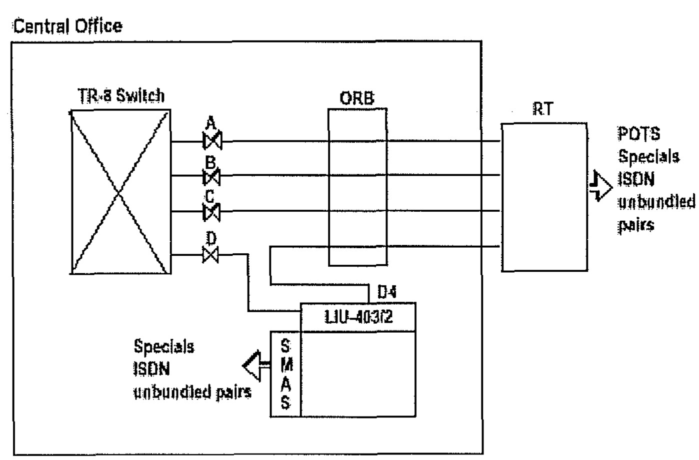
Unbundled Wire Pairs, Special Services, and ISDN DLC Grooming

The Challenge

For years telcos have struggled with the trade-off between Integrated DLC economies and Universal DLC flexibility. By eliminating the COT, TR-8 Integrated DLCs provide low-cost POTS, SPOTS™, and coin services. On the other hand, Universal DLCs accommodate these services, in addition to Special Services, ISDN, and today's new requirements for "unbundled loops" — i.e. wire pairs routed to a competitive local exchange carrier (CLEC).

While large COs may have a DCS or NGDLC capability to groom some of these circuits, such an approach can be quite expensive. And, in small COs, these costs can be still more problematic. Some applications have even required an expensive conversion from Integrated Mode back to Universal Mode just to provide a few ISDN circuits.

What telcos need, therefore, is a solution that combines the benefits of both systems: the low costs of Integrated DLCs and the flexibility of Universal DLCs. Pulsecom's LIU-403/2 supplies this solution with a highly cost-effective tool for Integrated DLC grooming of ISDN, Special Services, and unbundled wire pairs.



The Pulsecom Solution: *The LIU-403/2 can be used to groom ISDN, Special Services, and unbundled wire pair circuits much*

ISDN, Special Services, and unbundled wire pair circuits much more cost-effectively than Universal DLCs or other alternatives.

The Pulsecom Solution

Pulsecom's LIU-403/2 provides an immediate, ubiquitous, and cost-effective solution. Deployed in the LIU common slot of a standard D4 or WECO/AT&T/Lucent chassis, the LIU-403/2 is placed between the ORB and a Mode I TR-8 switch, where it serves digroups B, C, or D, and a conventional Integrated DLC RT. Then, by utilizing simple local provisioning, ISDN, Special Services, or even POTS/SPOTS circuits can be routed to local, conventional VF/DDS terminations. Other than this circuit pack, all other mountings, as well as all common and most VF/DDS terminations, are standard office/PICS inventory.

Locations utilizing SMAS may choose to perform circuit tests with standard unitized or stand-alone Pulsecom or WECo/AT&T/Lucent SMAS equipment.

The LIU-403/2 makes use of the fact that digroups B, C, and D of a Mode I TR-8 Integrated DLC system utilize standard D4 framing. The DS1 from the ORB is routed to the standard "D4 digroup A" connections on a D4 chassis. Special Service/ISDN or POTS/SPOTS channels that are to be dropped at this chassis are selected by front panel switches on the LIU-403/2, and the remaining DS0 circuits are passed to the "D4 digroup B" D4 chassis terminations for connection to the TR-8 switch. To accommodate various office cable lengths, DSX-1 levels are selected via standard TPU equalizers.

The LIU-403/2, along with the existing D4 chassis, common units and, in most cases, channel units are utilized to provide virtual universal access in Integrated DLC systems. Exceptions include: "unbundled" POTS/SPOTS terminations, which require a D4 2FXO that supports TR-8 signaling, such as Pulsecom's DPTGT-FXOGT, and coin service, which is supported via digital tandem connections rather than VF pairs.

Major Benefits

- **Cost-Effective** — The LIU-403/2 makes use of the existing infrastructure to provide a highly cost-effective method for grooming a wide variety of circuits.
- **Flexible** — Like Universal DLCs, the LIU-403/2 supports an entire range of services, including POTS, SPOTS, coin, Special Services, ISDN, and unbundled loops.
- **High Quality** — Unlike Universal DLC access, LIU-403/2 grooming need not introduce additional analog-to-digital or digital-to-analog conversions.

SPOTS is a registered trademark of Lucent.

About Us | Products | Solutions | Service & Support | News & Events | Contact Us | Customer Gateway | Search | Home

THE DSL EXPERTS

For more information on Pulsecom products and solutions, please call our Customer Service Department at 1-800-381-1997 (or 703-471-2950).

2900 Towerview Road
Herndon, Virginia 20171
(703) 471-2900

The Virtual RDT, Key to Unbundling the Local Exchange

W. Fred Seigneur
SONeTech
109 Kale Avenue
Sterling, VA 20164
(703) 450-6670/ (703) 406-3646 FAX
Internet: fred@sonetech.com

1. Abstract.

Competition in the Local Exchange is no longer merely a topic of speculation. It is happening, now, at a blinding pace. Local Exchange Carriers (LECs) are being forced to make some serious decisions that will effect their future for decades to come. Both the business and technical foundations of over 100 years are now rapidly changing.

Some RBOCs and other LECs are "unbundling"; divesting themselves of some part of their current holdings in order to receive the required Regulatory and Judicial blessings to enter competitive markets. At this point (May 1993), Rochester Tel, Pacific Telesis and Ameritech have either unbundled or stated their intention to do so. A keystone in the LEC's unbundling strategies is Open Network Architecture (ONA).

This paper builds on a technical concept introduced at last year's NFOEC by John Eaves and Paul Zimmerman of Bellcore in a paper titled "Impact of SONET on the Evolution of Telecommunications Network Architectures and Switched-Service Capabilities". Their paper showed how the capabilities of Integrated Digital Loop Carrier (IDLC) systems conforming to Bellcore TR-303 [1] can be used to provide sophisticated switched services to any subscriber in a LATA from a small number of host switches.

2. Overview of Integrated Digital Loop Carrier as defined in TR-303.

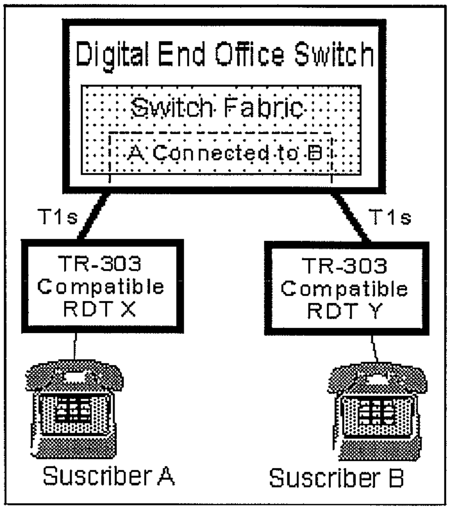
The focus of much attention these days is the local loop. Synchronous Optical Network (SONET), Fiber in the Loop (FITL) and IDLC as defined in TR-303 are closely related key technologies which are helping to redefine the local loop. Figure 1 shows a pair of IDLC Remote Digital Terminals (RDTs) subtended from a digital switch using an integrated interface over copper DS1s. The blocks on this figure could just as well represent the previous generation of DLCs, such as the SLC®-96(1). But, the similarity is only skin deep.

A TR-303 compatible RDT is more like a Remote Switch Unit (RSU), with an open, non-proprietary, interface to the host switch, than it is like a conventional DLC. While a TR-303 RDT does not switch calls locally, a single RDT can handle up to 668 simultaneous DS0 bearer connections to a switch. By comparison, a standard 5ESS Switching Module handles 255 DS0 bearer connections to the 5ESS Time Multiplex Switch [2]. A typical IDLC contains more computer processing power than many currently deployed 5ESS Switching Modules [2] or even the NT-40 processor which is the core of a standard DMS-100 [3] switch. An IDLC uses common channel signaling to communicate at 64 Kbps with the host switch. This Common Signaling Channel uses a version of the Q.931 protocol to support call setup which allows more subscriber lines to be served than there are DS0 circuits back to the host switch. This concentration feature can efficiently support concentration ratios of 8 or 9 to 1 while maintaining required grade of service to residential subscribers [4,5].

Figure 1. Call setup between two TR-303 compatible Remote Digital Terminals (RDTs) attached to digital End Office Switch via point to point DS1 copper facilities.

Subscriber A goes off-hook. RDT X sends CSC message to Switch. Switch selects available time-slot to RDT X and sends X a CSC message directing X to connect A to the specified time-slot back to the switch.
Switch provides dial tone to subscriber A.

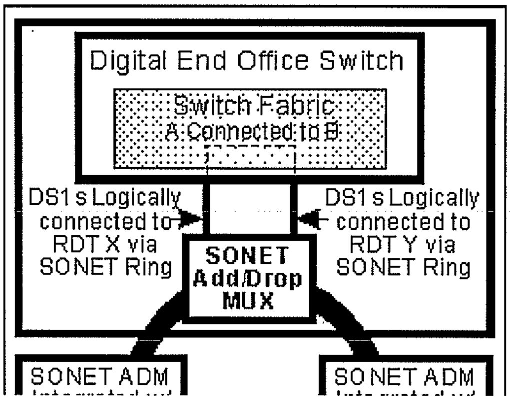
Subscriber A dials destination number. If DTMF dialing is used, switch collects digits. If subscriber uses dial pulse, digits are collected by RDT X and sent to Switch via a CSC message.
Switch determines that call is destined to subscriber B on RDT Y.



Switch connects time-slot from A to a time-slot goint to RDT Y using Internal Switch Fabric.
Switch sends CSC message to RDT Y specifying the time-slot from subscriber A and an alerting cadence for ringing.
RDT Y connects specified time-slot from switch to subscriber B and rings subscriber B's phone.
When subscriber B answers, RDT Y sends a CONNECT CSC message to the Switch to indicate that the call setup is complete.

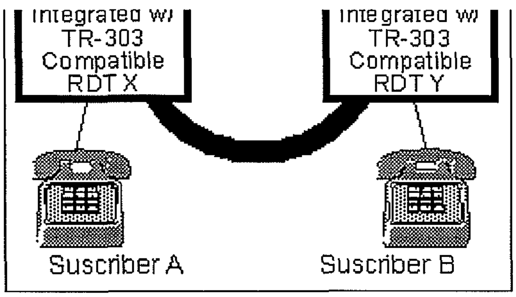
Figure 2. Call setup between two TR-303 compatible DLCs attached to digital End Office Switch via SONET Ring.

Subscriber A goes off-hook.
RDT X sends CSC message to Switch. Switch selects available time-slot to RDT X and sends X a CSC message directing X to connect A to the specified time-slot back to the switch.
Switch provides dial tone to subscriber A.
Subscriber A dials



Switch connects time-slot from A to a time-slot going to RDT Y using Internal Switch Fabric.
Switch sends CSC msg to RDT Y specifying the time-slot from subscriber A and an alerting cadence for ringing.
RDT Y connects specified time-slot from

destination number.
If DTMF dialing is used, switch collects digits.
If pulse dialing is used, digits are collected by RDT X and sent to Switch via a CSC message.
Switch determines that call is destined to subscriber B on RDT Y.



specified time-slot from switch to subscriber B and rings subscriber B's phone.
When subscriber B answers, RDT Y sends a CONNECT CSC message to the Switch to indicate that the call setup is complete.

Figure 1 illustrates how call setup is performed using a TR-303 RDT over the Common Signaling Channel[(2)] (CSC). The RDT on the left is shown originating a call which terminates to a subscriber on another RDT connected to the same switch. Figure 2 shows a comparable configuration with the two RDTs in Figure 1 integrated with a SONET Add/Drop Multiplexer (ADM) [6]. This permits direct connection onto a SONET OC3 fiber in either a linear or ring configuration.

The original intent of the TR-303 based IDLC was a higher capacity more efficient (concentrating) version of the traditional Digital Loop Carrier. Like its predecessors, the IDLC RDT would be installed in the loop plant.

3. Overview of Eaves and Zimmerman Paper.

In the referenced paper presented at the 1992 NFOEC, the authors presented a concept which would allow LECs to introduce new services throughout a LATA without having to upgrade hardware and software at each Central Office (CO) in the LATA. To accomplish this, TR-303 RDTs would be installed in COs, like RSUs (presumably in addition to those RDTs deployed in the loop). Such an approach limits a carrier's financial risk in introducing a new service, such as ISDN, where customer demand is uncertain. Furthermore, the service could be provided using a single switch vendor's switch(es) throughout the LATA, regardless of the switch type in the local CO, thus, ensuring that such a service would appear uniform to all subscribers. See Figure 3.

To introduce a service like ISDN, subscribers desiring ISDN would have their copper loops removed from the CO switch in their serving wire center which formerly provided them with dial tone. An ISDN subscriber's pair would be connected to an ISDN channel unit on the RDT, also located in the subscriber's serving wire center. All such subscribers within a LATA would then be provided with service from a single host switch equipped with the hardware and software to support ISDN. After reading the Eaves and Zimmerman paper, I queried numerous people within various RBOC organizations about their feelings on the idea. The intent of these inquiries was to validate Eaves' and Zimmerman's concept and to determine the degree of support it had within the Bellcore Client Companies. All those contacted were in favor. Many said that they believed that this is the only way that ISDN may ever be successfully introduced.

If additional capacity is needed for the service provided by the Host Switch, or if different services are to be provided from different Host Switches, it must be possible to provide the services from several Host Switches using the same TR-303 Remote Digital Terminal in a CO (rather than requiring a separate RDT in each CO for each Host). This is supported by what is called the "Virtual RDT" or "Multihosting". While Multihosting was not mentioned previously in TR-303, the December 1992 revision [1] addresses the subject as an optional capability in Section 12.5.10.

Figure 4 shows two Host Switches using the same RDTs in various other wire centers for access to subscribers. Those customers at each wire center who have subscribed to the services provided on Host Switch A are logically partitioned in Host Switch A's Virtual RDT while customers subscribing to the services provided by Host Switch B are assigned to B's Virtual RDT. Like ISDN, other Advanced Intelligent Network (AIN) services, or even ONA could be provided in an ubiquitous manner without upgrading all the switches in a LATA to be capable of delivering the services locally.

4. Potential Challenges.

Eaves and Zimmerman mentioned a few potential challenges associated with their approach which needed further study.

Figure 3. Host Switch in Wire Center 3 provides ISDN or other services to subscribers subtended from TR-303 compatible RDTs in each Wire Center. The single Host Switch "owns" the entire RDT at each Wire Center.

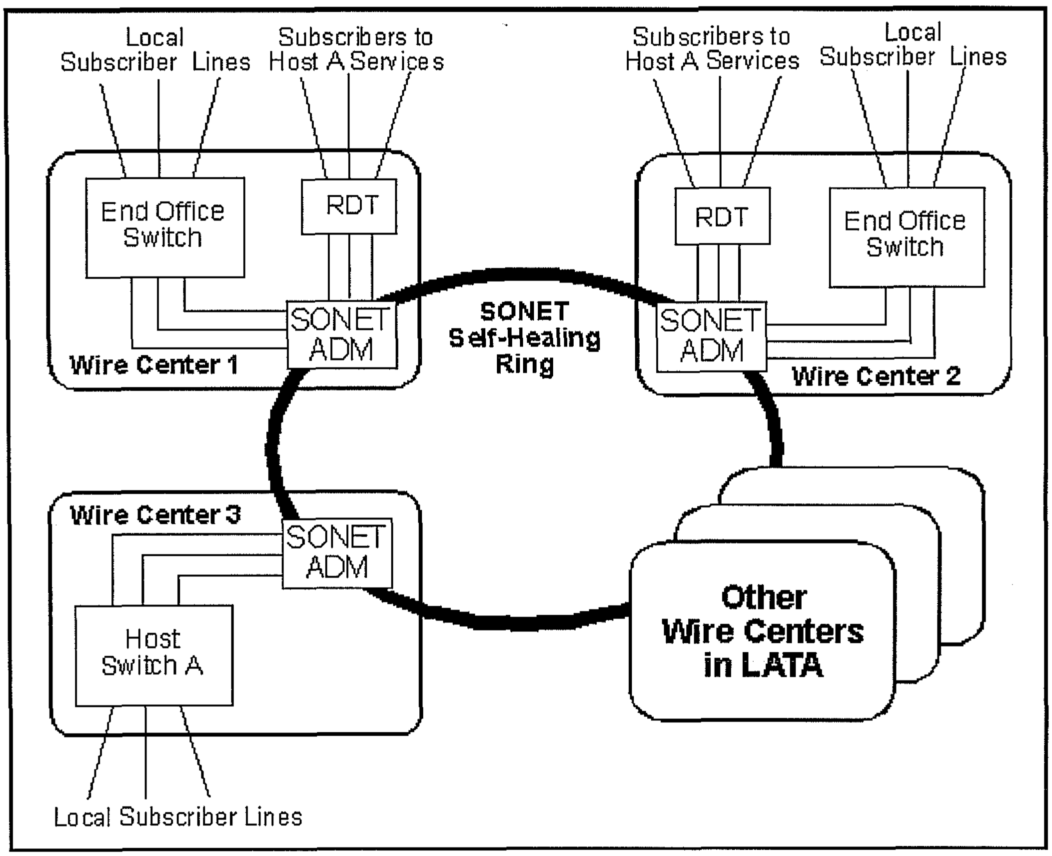
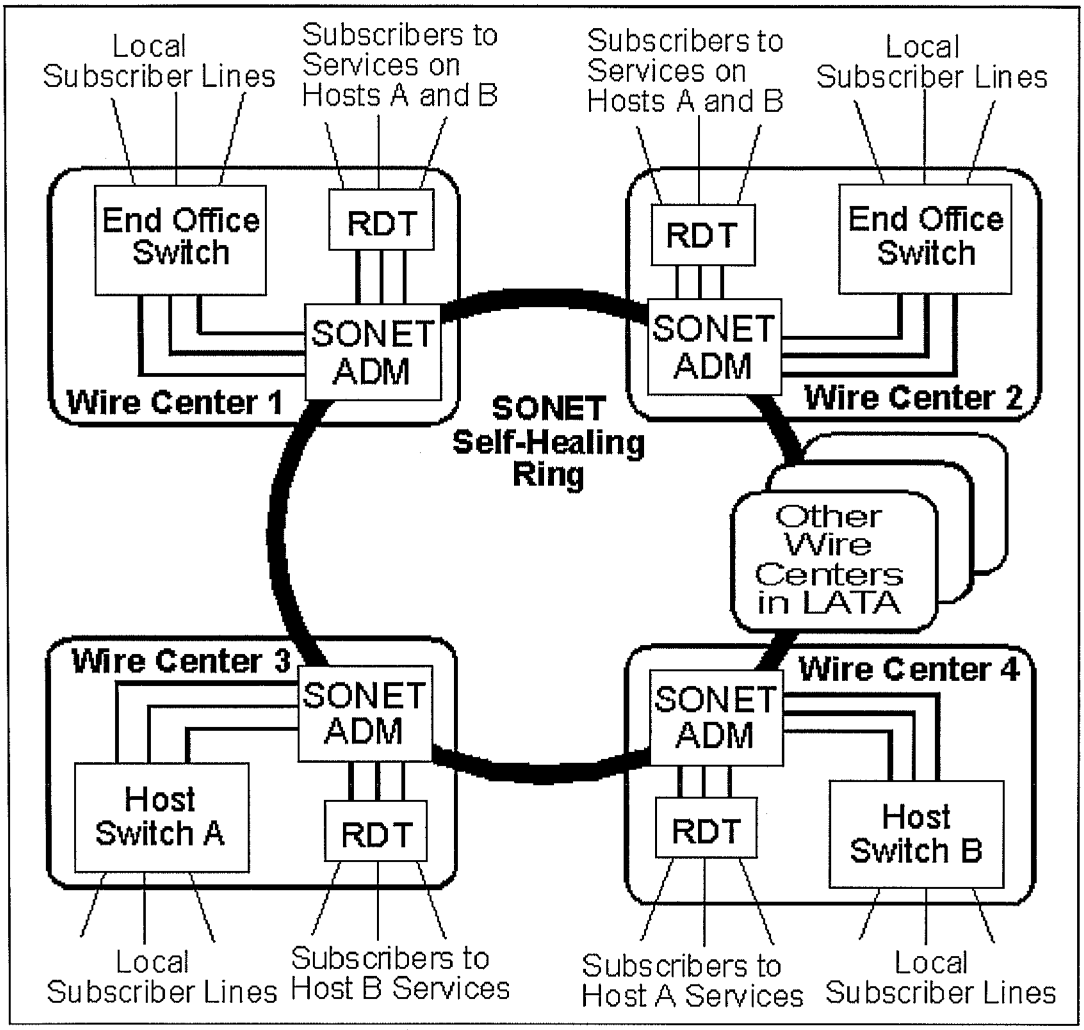


Figure 4. When services are provided using 2 or more Host switches, each physical RDT in a Wire Center provides each Host Switch with a Virtual RDT Interface. Thus, subscriber lines on each RDT are associated with a respective Host Switch based on which switch provides the service subscribed to by each subscriber.



4.1 Wire Center Boundaries.

One area of concern related to current tariffs based on existing wire center boundaries. Without regulatory relief from this artificial way of looking at the local exchange network, subscribers served from a switch outside their own local wire center might be assessed an additional Foreign Exchange (FX) charge.

Using a conventional DLC to extend a line from a subscriber in a certain serving wire center to a switch in another wire center is a common way of providing FX service. Thus, when a TR-303 RDT is used as described by Eaves and Zimmerman, it is easy to see how regulators might be led to consider this to be another case of FX service. If, however, a LEC installs a Remote Switch Unit or Remote Switching Module (RSM) in a wire center to serve local subscribers, the subscriber is considered to be served from the local wire center even though some services are being provided from the remotely located host switch. If Eaves' and Zimmerman's concept is presented to regulators using the RSU comparison, rather than the conventional DLC scenario, perhaps the anticipated regulatory problems will be moot.

As mentioned previously, a TR-303 compatible RDT can be viewed as an open interface RSU. The subscriber's line terminates in the local wire center. The channel unit which digitizes the POTS subscriber's voice is in the local wire center. A time-slot interchanger (circuit switch) is located in the local wire center as part of the RDT. The access provided is not dedicated as with a Foreign Exchange line (even when provided using a conventional DLC) in that a DS0 bearer circuit between the RDT and the Host Switch is not connected until the subscriber goes off-hook or until a call is received by the Host Switch which is destined for the subscriber. The facilities from a TR-303 RDT to a remote host switch are more like interoffice trunks than FX lines. Interoffice trunks are considered part of the overall switched network and are tariffed by minutes of use.

What has been described by Eaves and Zimmerman **represents an entirely new form of local access**. It is not Special Access because DS0 circuits for individual subscriber lines are not dedicated. It is not Switched Access as currently defined in that the local CO switch has no involvement in providing the access. I propose that this type of local access be called "Concentrated Access".

4.2 Number Retention/Number Portability.

With the technique proposed by Eaves and Zimmerman, a subscriber's line is logically moved from the End Office Switch to which it is currently homed, to a switch in another Central Office. The current organization of the North American Numbering Plan (NANP) and the inability of existing Central Office switches to efficiently support full 7 digit routing for individual calls would require that such a subscriber be assigned a new telephone number. This is considered a possible problem in the Eaves and Zimmerman paper.

It should first be noted that number retention is a real problem only for terminating, rather than originating, calls. True, the subscriber may frequently call a company which is making use of his originating phone number (Caller-ID) to look up his account information, for example. However, the next time he calls the company with a Caller-ID which is not in the company's database (because his number changed), the subscriber will be asked for his account information and this, along with the subscriber's new phone number will be stored in the database for future reference.

If a subscriber is "moving up" to a more sophisticated service, changing his local phone number may not be a very serious problem. The proliferation of addressable devices on an ISDN "line" has generated activity which may result in an expanded numbering plan for ISDN in the future. This would force a number change anyway. Similarly, if a subscriber is being connected to a remote host switch to access an Advanced Intelligent Network service, his actual POTS phone number may be immaterial. For example with a service like a Private Virtual Network or Area Wide Centrex, the subscriber's new POTS number at the new host would simply be placed in the translations database used to route calls to the subscriber based on his Centrex extension number or his private network directory number.

However, for a business with an investment in advertising, letterhead, etc. with the company's current phone number on it, changing of a phone number may have a significant financial down side. In this case, the subscriber should be willing to pay for a feature to retain the ability to receive calls to his previous telephone number. The essential requirement when a subscriber's phone number is changed is that callers using the subscriber's previous number must continue to be able to reach him.

If the subscriber is currently served from an end office with call forwarding, this would be the easiest solution. The subscriber's old number would simply be call-forwarded to the new number. The cost for such a feature should be much the same as conventional call forwarding. No switch equipment is dedicated to the subscriber (only database storage). The subscriber's line is no longer connected to the local CO, thus a channel unit is not required to connect to his line.

For an end office switch without call forwarding capability, the following DLC based approach is proposed. For purposes of discussion, let us consider a hypothetical customer who has decided to subscribe to an advanced service provided only from a remote host switch. This same subscriber wishes to retain his existing phone number. A call made to this example subscriber's new phone number will be routed normally to the new host switch and will terminate via the TR-303 RDT to the subscriber's line. A call to the subscriber's old number will be routed by the network to the subscriber's former End Office switch. In this example the switch is not capable of forwarding the call to the subscriber's new number on the remote host.

A software feature can be added to the TR-303 RDT to allow terminating calls from either the remote host or the local CO to connect to the subscriber's line. Some background is required in order to explain how this can be accomplished. Few if any TR-303 compatible RDTs are currently deployed in LEC networks because very few switches have TR-303 capabilities installed. However, recently deployed DLC equipment from most manufacturers is "TR-303 ready". Such systems are sometimes referred to as New Generation Digital Loop Carriers (NGDLCs). These systems currently interface to digital switches or Central Office Terminals (COTs) using Bellcore TR-08 [7] and TR-57 [8] specifications.

TR-08 is a essentially a codification of the SLC-96 DLC interface. Of course a SLC-96 only supports 96 lines, usually over 4 DS1s (with an optional protection DS1). A single RDT of a New Generation DLC can support many more lines and DS1 circuits than are defined in TR-08 (because it is really just waiting to be converted to TR-303 operation with it's much increased line and trunk capacity). Thus, in the interim, before TR-303 switch capabilities are deployed, these NGDLCs use software to support the notion of several "Virtual" TR-08 compatible RDTs. Virtual TR-08 RDTs from the same physical NGDLC can each connect to the same, or multiple, host switches or COTs (see Figure 5).

Because switches will likely be transitioned to support TR-303 one at a time, it might reasonably be necessary for a currently installed NGDLC RDT to connect to a TR-303 compatible host switch while continuing to support Virtual TR-08 interfaces to one or more other host switches (see Figure 6).

Now back to our example. The required functionality in this case is to be able to terminate a call from either the new host, or the old CO, to the subscriber's line. A contention situation must be dealt with where the subscriber is off-hook with a call connected through one switch when a terminating call for the subscriber arrives at the other switch.

Figure 5. An NGDLC RDT installed today can support more lines and DS1s than a TR-08 RDT. Thus, a single physical RDT may be configured with as many as 7 virtual TR-08 RDTs. As illustrated, these virtual TR-08 RDTs may terminate on two or more Switches in one or more Central Offices.

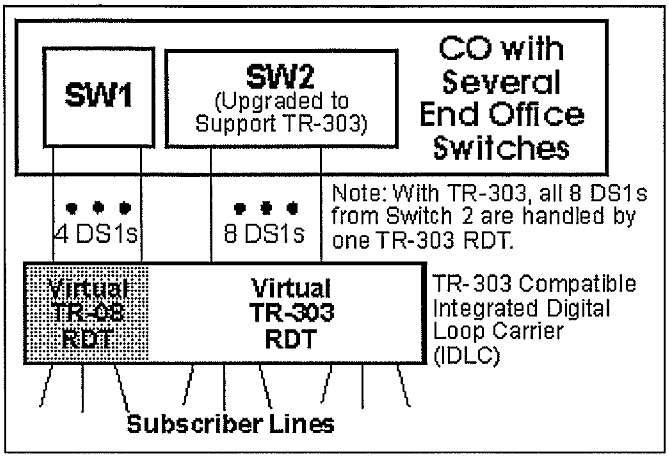
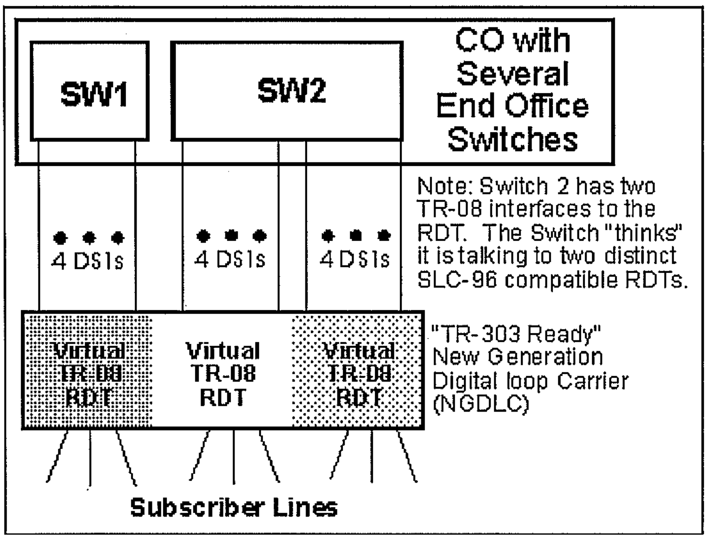


Figure 6. With a single NGDLC supporting two or more Switches, when one of the Switches is upgraded to support TR-303, it is desireable to support a configuration where the RDT connects to one Switch using TR-303 and another using TR-08.



A method is required to block (with busy signal or other appropriate treatment) an incoming call arriving either:

- at the old (local) switch when the subscriber is involved in a call connected through the new host switch; or
- at the new host switch when the subscriber is off hook connected to a call terminating through the old switch.

TR-08 defines a simplistic method for concentration of subscriber lines called Mode-II concentration. Two lines contend for a single DS0 to a digital switch or COT. This means that it is possible for a subscriber on one of a pair of concentrated lines (contending for the same DS0) to be off-hook, and thus consuming the shared DS0 resource, when the other subscriber receives an incoming call. With an integrated TR-08 interface, the RDT can notify the switch that the DS0 is busy and the incoming call can be blocked in the switch by connecting it to a busy signal or other treatment.

In our example, the subscriber's old End Office was not capable of call forwarding. Since an Integrated TR-08 interface to the switch requires a digital switch, and such a switch would probably have call forwarding, the fact that call forwarding is not available probably means that the local End Office is an analog switch. In order to access ISDN, etc., the subscriber's line was moved from the local switch to a TR-303 compatible RDT in the subscriber's serving wire center and the subscriber would draw dial tone from a new, remote, host switch. Meanwhile, the channel unit on the local switch which was previously connected to the subscriber's line would be connected to a TR-08 compatible COT which supports Mode-II concentration (see Figure 7). One or more DS1s from the COT (as required for the number of subscribers) are connected to the same TR-303 RDT to which the subscriber's line is now attached. They use the RDT's software capabilities to act as a Virtual TR-08 RDT to the COT while simultaneously functioning as a Virtual TR-303 RDT to the TR-303 capable remote host switch.

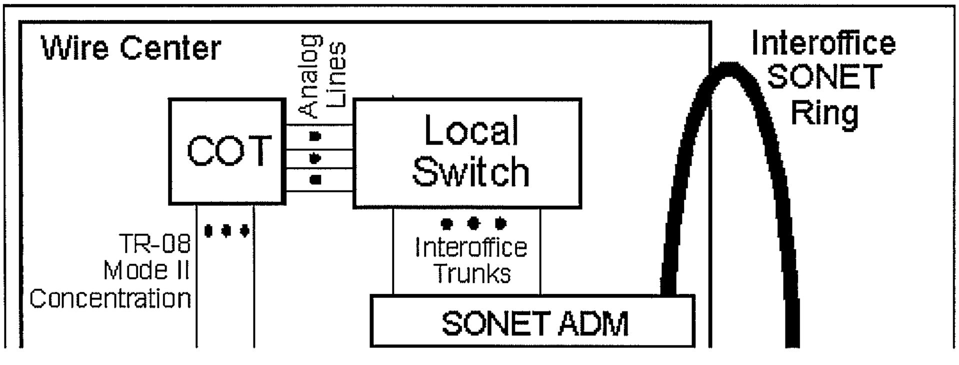
A call made to the example subscriber's new phone number will be routed normally to the new host switch and will terminate via the TR-303 RDT to the subscriber's line. If an incoming call arrives at the subscribers old End Office, the call will ring the line connected to the COT. If the subscriber's actual line is on-hook, the call can be connected to the subscriber's line on the RDT. If the subscriber is off hook when the call arrives, the RDT can send the "All Available Channels Busy" indication to the COT which causes the COT to connect the incoming call to reorder tone in accordance with TR-57 Section 7.3 [8], effectively blocking the call to resolve the contention situation.

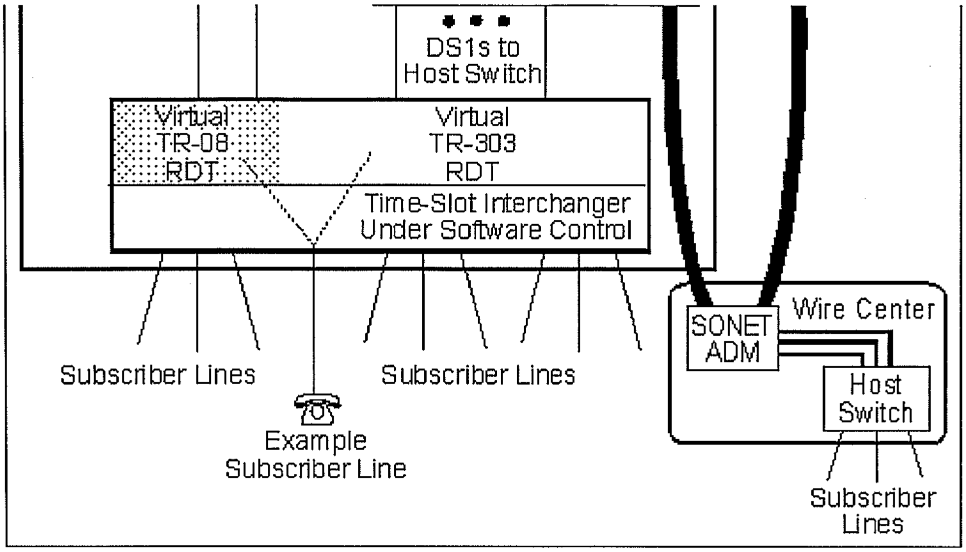
If the subscriber is talking on a call connected through the local CO when an incoming call arrives at the new host switch, the RDT can detect the condition and send an appropriate TR-303 CSC message to tell the TR-303 host switch that the subscriber is off hook and cannot receive the call. The new host switch would then connect the incoming call to a busy signal or other appropriate treatment.

4.3 Survivability.

Eaves and Zimmerman concluded that future LEC networks should migrate from today's "dense" architecture with many switches at Central Offices throughout a LATA to a "sparse" network with perhaps only three large end office switches. An obvious problem with a sparse network is survivability.

Figure 7. With the actual connection of a line to a Time-Slot under RDT software control, calls originating from the example line can be directed via the Virtual TR-303 RDT to the remote host switch. Terminating calls from either the remote host or local Switch can terminate to the same subscriber line. Terminating calls from either switch can be blocked and sent to a proper treatment if the subscriber is busy with a call from the other switch.





Survivability should not be confused with reliability. Reliability addresses failures of equipment or software within the network, whereas survivability relates to external natural or man-made events which threaten the network. Threats to survivability include: earthquakes, tornadoes, floods, hurricanes, cable cuts, hackers, terrorism and war. Switches within the network are implemented with redundant hardware for reliability. Battery power and backup generators provide reliable power. SONET self-healing rings will provide survivable transmission facilities. However, if an emergency such as an earthquake, hurricane or flood occurs, more dispersed switching resources offer greater survivability than sparse resources. Recent Government studies have shown that a sparse network is also more vulnerable to attack by terrorists and hackers [9,10].

Peter Huber and other contributors to his 1987 [11] and updated 1993 reports [12] foresaw a densely connected "Geodesic Network" (Figure 8). Such a highly interconnected network architecture would be extremely survivable [13]. In general, today's network with switching at each end office approaches the geodesic concept because the end offices are connected with many diversely routed physical facilities [13]. However, even the most sophisticated Central Office switches lack the ability to effectively utilize this connectivity because they cannot perform non-hierarchical routing [13]. Inter-exchange networks have long been capable of non-hierarchical routing using common channel signaling [14]. However, non-hierarchical routing is not supported by CO switch software, even with Common Channel Signaling System 7 (SS7) deployed in the Local Exchange [13]. With a sparse network of switches as proposed in the Eaves and Zimmerman paper, network survivability would, indeed, be lessened.

However, TR-303 multihosting offers the opportunity for an additional feature: multihoming, which could help mitigate this risk. The previous section explained how a TR-303 based RDT could terminate calls from multiple local or remote switches which are destined to the same subscriber line. With Multihoming, a subscriber would be homed to a primary switch for "primary dial tone". The RDT can tell if the subscriber's primary switch is out of service (because the switch fails to respond over the Common Signaling Channel and the Embedded Operations Channel within established timeout durations). Thus, the RDT can request service from the subscribers chosen "backup switch" (by sending a TR-303 "SETUP" message to the backup switch). Figure 9 illustrates this.

If the subscriber's main concern is being able to originate calls when his Primary Host is out of service, Multihoming meets the need with no additional effort. Suppose a subscriber is concerned with being able to receive, rather than just originate, calls in the event of an emergency (as with 800 service for example). In this case, the 800 database could store both the subscriber's POTS numbers (the one to reach the subscriber via the Primary Switch and the one to connect via the Backup Switch). If calls to the 800 number are unable to complete to the Primary Switch, the call can be routed to the subscriber's corresponding number at the Backup Switch with calls from either switch terminated to the subscriber's line via the RDT.

The section below discusses how Alternate Service Providers or Enhanced Service Providers (ESP) could use "Concentrated Access" provided with Multihomed TR-303 RDTs to provide switched services to subscribers anywhere in a LATA. With additional options available from such competitive providers, the survivability of the overall Local Exchange Network should be increased, even if existing LECs choose to implement sparse switching networks in the future.

Figure 8. Geodesic Network Example

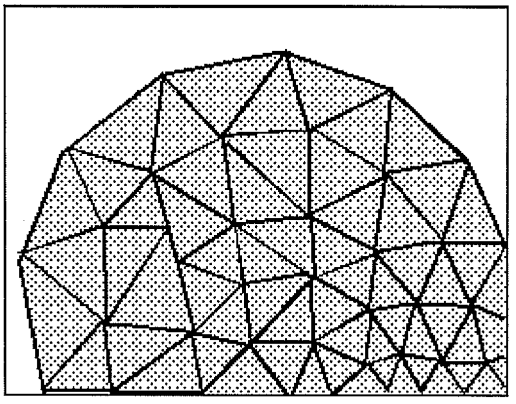
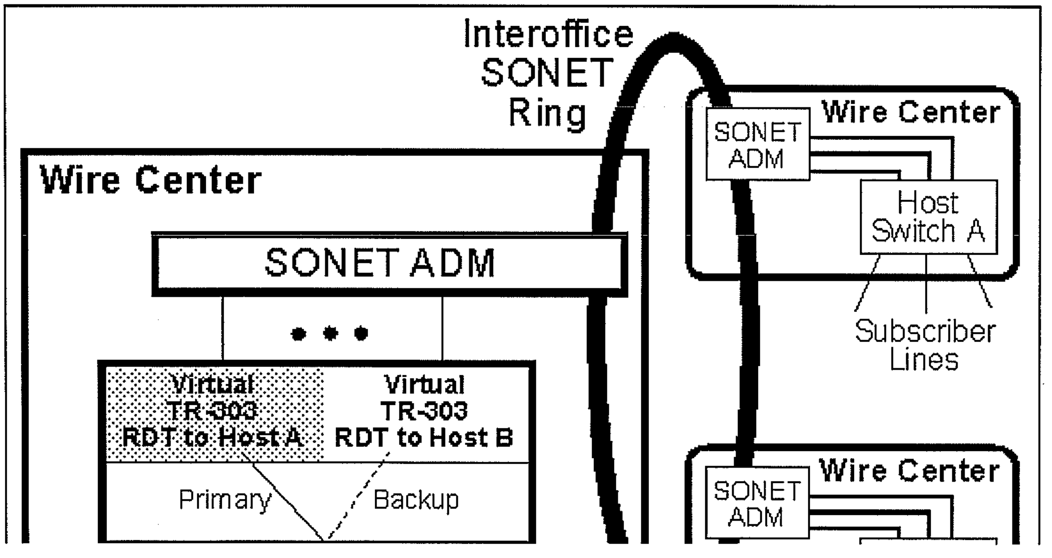
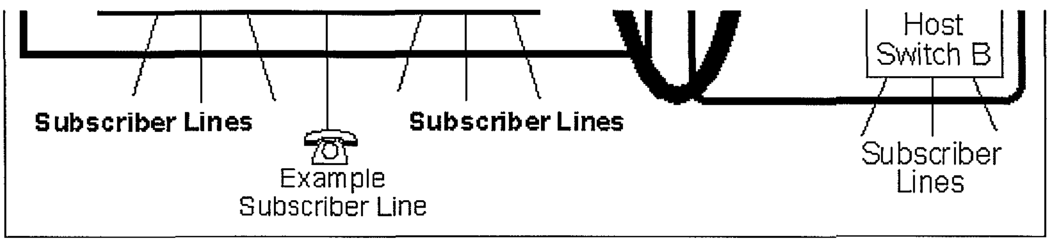


Figure 9. A subscriber could be "Multihomed" to both Host A and B with A being the Primary Host Switch and B providing backup. This would allow the subscriber to originate a call even if the Primary Host Switch were down. For terminating calls to an 800 number, for instance, alternate POTS numbers for the line on both hosts could be stored in the 800 routing database. If calls could not successfully terminate to the primary number, the alternate would be used, thus connecting via the backup host.





5. Concentrated Access.

As briefly mentioned in section 4.1, the concept presented by Eaves and Zimmerman, combined with Multihosting, defines a new form of Local Access. In addition to Special Access and Switched Access, we now have Concentrated Access.

The access provided is concentrated in that:

- Subscriber lines generate modest network traffic and can generally be served by fewer trunks to the host switch than actual subscriber lines terminated at an RDT.
- A DS0 bearer circuit between the RDT and the Host Switch is not connected until the subscriber goes off-hook or until a call is received by the Host Switch which is destined for the subscriber.
- When a connection between a subscriber's line and a Host Switch is necessary, it is set up dynamically using signaling messages between the Host Switch and the RDT.
- When a call is terminated, the DS0 circuit between the RDT and the host switch is disconnected from the line and is made available for use by other subscribers.

If you purchase an item "FOB Chicago", you own the item, but you still must get it from Chicago to wherever you need it. Concentrated Access would be provided "FOB" at the RDT location. Connectivity between the RDT and an Alternative or Enhanced Service Provider's Host Switch requires dedicated transport (DS1s or VT1.5s) for the trunks from the RDT to the switch. An Enhanced Service Provider without his own alternative network could obtain Concentrated Access by leasing dedicated DS1s or VT1.5s from the RDT to his location from Special Access tariffs. A Competitive Access Provider (CAP) with an existing transport network could obtain Concentrated Access from the LEC and provide transport for trunks from the RDT to the CAP's switch using indigenous CAP facilities.

If Concentrated Access is made a tariffed service, a potential Alternate Service Provider or Enhanced Service Provider could go into business with the limited risk of only one Host Switch and still provide his unique service(s) to any subscriber in the LATA (see Figure 10).

Many of the functional capabilities desired by organizations such as the Coalition of Open Network Architecture Parties (CONAP) [15, 16] can be provided using Concentrated Access. An Enhanced Service Provider does not have a functional requirement to control the call processing of an End Office switch belonging to a LEC. The functionality required is to economically and efficiently get access to subscriber lines anywhere in a LATA and somehow avail these subscribers of the ESP's unique features. This can be accomplished by using Concentrated Access to connect subscribers to a switch under the Enhanced Service Provider's direct control. Figure 11 illustrates this. A switch is connected to an Adjunct which executes the Enhanced Service Provider's unique service logic.

If an ESP prefers not to own its own switch, access to an ONA capable switch within the LATA can be provided using Concentrated Access just as explained previously for ISDN. However, the time required to develop and deploy ONA, combined with its technical risk would seem counterproductive when the low risk RDT based solution can be available sooner and with far less software development.

Figure 10. Using Concentrated Access, an Enhanced Service Provider's host switch can be located anywhere. It connects via DS1s to a SONET ADM, then to Virtual RDTs in each wire center which serves subscribers who have chosen the Alternate or Enhanced Service Provider for local service. As with an RBOC introducing ISDN, Provider A's financial risk is limited to one switch until his market penetration justifies adding more capacity. Also, as with ISDN, an Enhanced Service Provider need not wait for ONA to be deployed throughout a LATA in order to offer services to any potential subscriber in the LATA.

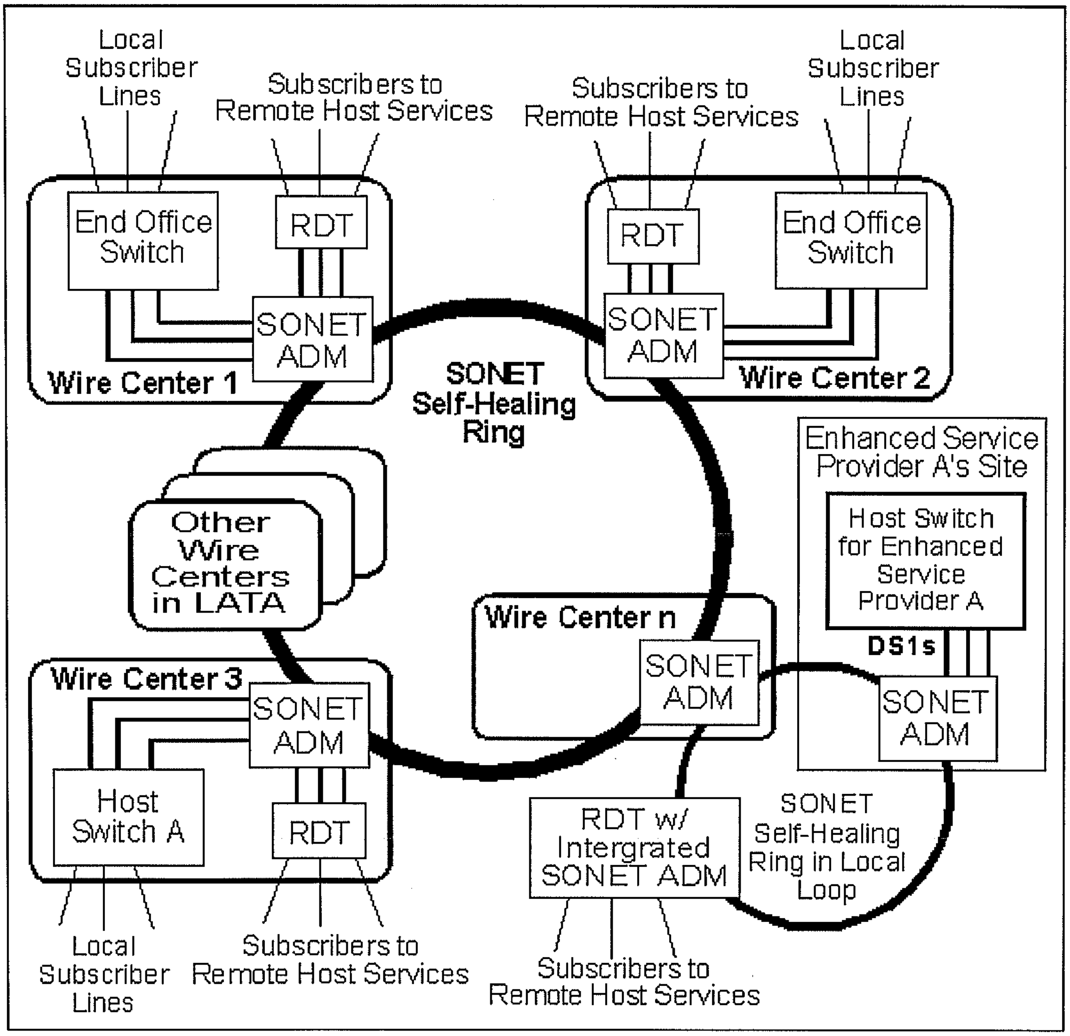
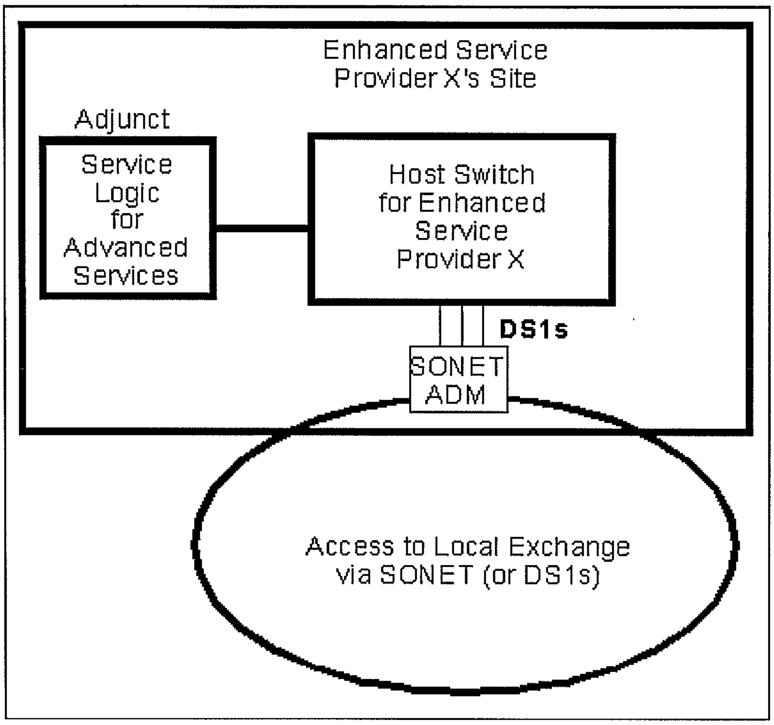


Figure 11. An Enhanced Service Provider might offer traditional switch-based services while an ESP could offer advanced services via an Adjunct programmed with the ESP's own proprietary Service Logic.



While an IDLC must conform to strict environmental requirements to be installed by a LEC in the Loop or a CO, a device which conforms to TR-303 interface specifications using the Common Signaling Channel can easily be built using a Personal Computer equipped with an assortment of boards built for "Voice Processing". Available boards include T1 interface cards, Time-Slot Interchangers and Line Interface Cards. Without the redundancy required for high availability in the Public Switched Network (PSN), such a box could be produced at a relatively low cost. This could provide an intelligent digital interface between the customer's computer applications and either LEC or Enhanced Service Provider switches using Concentrated Access (see Figure 12). Many of the capabilities available with emerging interface standards such as the Switch to Computer Applications Interface (SCAI) and the Open Application Interface (OAI) [17] could be provided simply and efficiently using this technique.

This example suggests that a service provider might consider allowing a Customer Premise Equipment (CPE) based RDT to connect to it's switches using Concentrated Access. However, Concentrated Access as proposed herein merely refers to being able to connect a LEC's Multihosting RDT to a non-LEC switch. If an existing LEC is concerned about allowing customer owned (and programmed) RDTs to connect to their switches they need not permit it. In today's competitive environment someone will be willing to address this potential market, even if they initially sell integrated CPE and host based enhanced services to ensure that the CPE does not compromise their switch security.

6. Other Brief Comments.

The deployment of TR-303 compatible RDTs in the typical loop applications could be limited by the same problem which delays ISDN deployment. That is, CO switches must first be digital and second must be configured with special hardware, the Integrated Digital Terminal (IDT), and companion software. Upgrading many COs to TR-303, like upgrading many switches to ISDN, would thus, be a slow and expensive process. However, the approach introduced by Eaves and Zimmerman will enable the rapid deployment of IDLC capabilities. By hosting RDTs to a few TR-303 equipped switches in a LATA, the advantages of TR-303 RDTs, including flexible provisioning and maintenance, can be achieved more rapidly than otherwise envisioned. With FITL systems complying with TR-909 [18] also using the TR-303 interface to the host switch, such installations could also be expedited without the need to use the limited TR-08 Integrated interface or a COT type interface to local analog switches (see Figure 13).

7. Conclusion.

Providing Concentrated Access using the Multihosting or Virtual RDT concept is the essence of local access. It provides access to subscriber lines without the need for dedicated special access circuits for each subscriber's line. It decouples switching and software based services (which can be provided from a remote host) from functions which can be performed by standardized commodity transmission products available from many vendors. Concentrated Access can provide the key which unlocks the Local Exchange Network to open and fair access to all.

Figure 12. Using available PC compatible Voice Processing boards, a TR-303 compatible RDT can be integrated providing Computer Integrated Telephony capabilities coupled with the advanced services available from the Enhanced Service Provider.

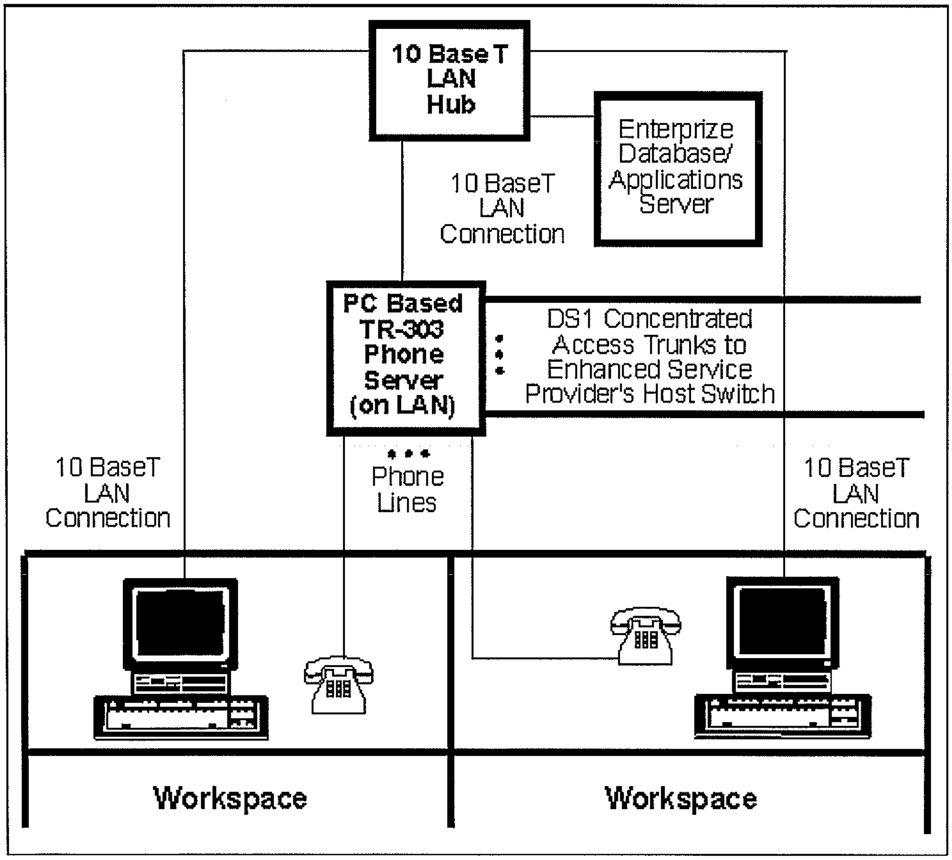
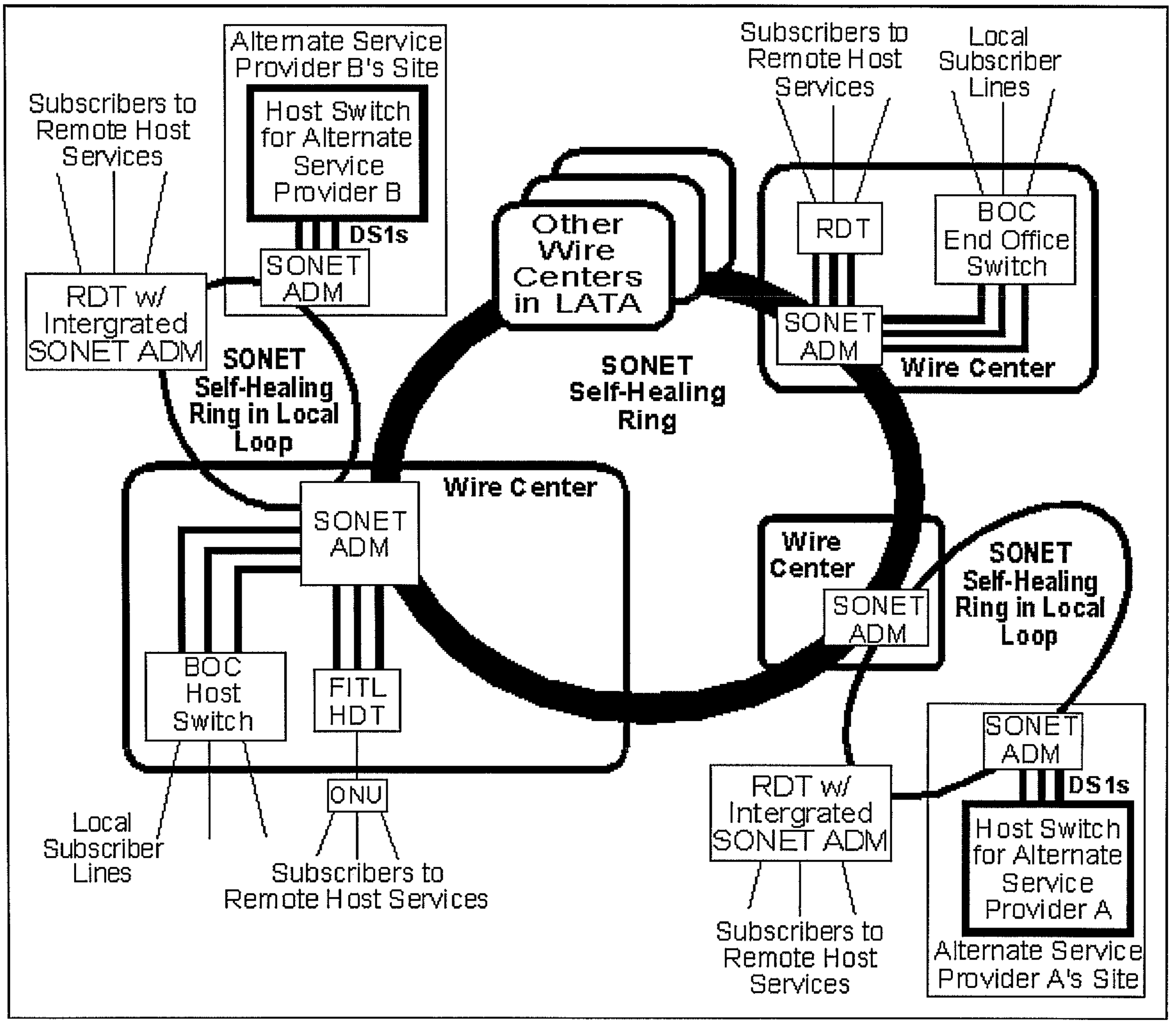


Figure 13. A TR-909 compliant fiber-in-the-loop Host Digital Terminal (HDT) interfaces to an End Office Switch like a TR-303 RDT. Thus, Alternate Service Providers would have access to subscribers subtended from an Optical Network Unit (ONU). Furthermore, provision of a tariffed Concentrated Access service using TR-303 would provide access to lines subtended from TR-303 RDTs dispersed within the Loop plant.



Footnotes

1. SLC is a Registered Trademark of AT&T.

2. For the sake of simplicity, references to the Time-slot Management Channel (TMC) used for hybrid signaling are not discussed in this paper.

REFERENCES

1. Integrated Digital Loop Carrier System Generic Requirements, Objectives, and Interface, TR-NWT-000303, Issue 2, Bell Communications Research, December 1992.

2. 5ESS Switch System Description and Product Specification, AT&T 5D5-900-103, AT&T, June 1986.

3. DMS-100 Family System Description, Northern Telecom, December 1988.

4. Section 17, TRAFFIC ENVIRONMENT, TR-TSY-000064, LSSGR Issue 1, Revision 2, Bell Communications Research, June 1985.

5. Appendix D, Results of CSC Traffic Study, TR-TSY-000303, Issue 1, Bell Communications Research, September 1986.

6. IDLC System Generic Requirements, Objectives, and Interface: Feature Set C - SONET Interface, TR-TSY-000303, Supplement 2, Issue 1, Bell Communications Research, October 1989.

7. Digital Interface Between the SLC®96 Digital Loop Carrier System and a Local Digital Switch, TR-TSY-000008, Issue 2, Bell Communications Research, August 1987.

8. Functional Criteria for Digital Loop Carrier Systems, TR-TSY-000057, Issue 1, Revision 1, Bell Communications Research, November 1988.

9. NETS Network Management Methodology Report, SR-NPL-000846, Bell Communications Research, December 1987.

10. LEC Network Routing Description, Final Report, Martin Marietta, April 1990.

11. "The Geodesic Network: 1987 Report on Competition in the Telephone Industry", Peter Huber, 1987.

12. "The Geodesic Network II 1993 Report on Competition in the Telephone Industry", Peter W. Huber, Michael K. Kellogg, John Thorne, The Geodesic Company, 1992.

13. LEC Recommended Systematic Routing Changes, Final Report, Martin Marietta, October 1990.

14. "A Survey of Dynamic Routing Methods for Circuit Switched Traffic", B. R. Hurley, C. J. R. Seldl, and W. F. Sewell, IEEE COMMUNICATIONS, Vol 25, No. 9, September 1987.

15. In the Matter of Intelligent Networks, Comments Before the Federal Communications Commission, CC Docket No. 91-346, Coalition of Open Network Architecture Parties, March 3, 1992.

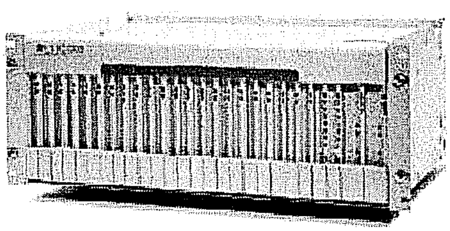
16. In the Matter of Intelligent Networks, Reply Comments of CONAP Before the Federal Communications Commission, CC Docket No. 91-346, Coalition of Open Network Architecture Parties, April 6, 1992.

17. OAI Open Application Interface, Second Edition, Ed Leibowitz, Telecom Library, Inc., 1991.

18. Generic Requirements and Objectives for Fiber In The Loop Systems, TR-NWT-000909, Issue 1, Bell Communications Research, December 1991.

MCI WORLDCOM
Law and Public Policy

Unbundling
Digital Loop Carriers



March 1999

Table of Contents

Table of Figures

I. INTRODUCTION

The purposes of this paper are to show:

- that Integrated Digital Loop Carriers (IDLCs) can be unbundled;
- that there are four technically feasible ways of unbundling IDLCs with equipment that is in-place or generally available today;
- that CLECs can access their IDLC served customers' signals in a digital format *without* collocation; and
- that converting an IDLC-served customer to all copper facilities or an older form of DLC is a backward step in technology that actually degrades the customer's service.

Digital Loop Carriers are widely deployed in the telecommunications network in place of expensive copper feeder. In addition to providing a cost-effective alternative to copper feeder in many situations, DLCs can extend potentially distance-restricted services such as ISDN farther away from the central office and can push switch-based functionality farther into the field to remote terminals.

Currently, 20 percent of the access lines in the United States are served by DLCs, and that penetration is projected to increase ultimately to 50 percent in urban areas and 80 percent in rural areas.[1]

DLC technology has been around since the 1970s, but there have been significant advances in the technology over the past two decades. Today there are two major types of DLC – Universal (UDLC), which was developed for an analog environment but can work, albeit inefficiently, in a digital environment, and Integrated (IDLC), which was developed specifically for a digital environment. There have been two "generations" of IDLC technology, which conform to two sets of specifications developed by Bellcore -- TR-008 and GR-303.[2] The Bellcore GR-303-capable IDLCs are the forward-looking technology being deployed today.

---

[1] GR-303 technology and its deployment were the topic of Bellcore's GR-303 Integrated Access Symposium, San Diego, CA. July 29-30, 1998. www.bellcore.com/gr/gr303.html#forum.

[2] Some manufacturers have called their GR-303 IDLCs "Next Generation DLCs" (or NGDLCs) for marketing purposes, but these simply represent the manufacturers' latest GR-303-compatible IDLC offerings.

UDLC enters the central office switch in analog form, and therefore requires an analog-to-digital conversion when used with digital switches. By contrast, IDLC stays in digital form as it enters the local digital switch. Today, an incumbent local exchange carrier (ILEC) is unlikely to deploy a UDLC unless an analog switch serves the loop(s).

The notion that IDLC technology cannot be unbundled because it is integrated into the local digital switch is incorrect. As this paper will show, "integrated" does not mean inseparable or incapable of being unbundled. It is technically feasible to unbundle all IDLCs, including TR-008 and GR-303 IDLCs.

While older DLCs were only designed for voice services, the most recent products are designed with broadband applications in mind and can simultaneously support voice as well as advanced technologies such as Digital Subscriber Line (DSL). This paper only focuses on unbundling the voice capabilities of Digital Loop Carriers. Another MCI WorldCom white paper on providing ADSL with a Digital Loop Carrier is under development and will be available shortly.

II. WHY LECs DEPLOY DLCs

A DLC is an electronic device that connects to customers' copper distribution pairs at a remote terminal, converts the analog signals to a digital multiplexed format, and then transports the digital signal over a fiber or copper transport to the local switch in the central office. Figures 1 (a), 1 (b), and 1 (c) show three scenarios that will be described in greater detail in this paper: UDLC connecting to an analog switch such as a Western Electric 1AESS or crossbar; UDLC connecting to a digital switch; and IDLC connecting to a digital switch.

The multiplexing of the copper pairs reduces the number of pairs needed in the feeder portion of the loop plant (or eliminates the need for copper pairs altogether in the feeder network as they are replaced by fiber). Indeed, for that reason, when DLC technology was first introduced it was often referred to as "pair gain" technology. In addition, DLCs are often more economical to deploy for feeder lengths greater than 9,000 feet than are large, expensive copper feeder cables. Companies sometimes perform a cost-benefit analysis to prove in DLCs by comparing the DLC costs to the cost savings from not having to reinforce existing cables or not having to obtain additional room on poles or place additional conduits.

Also, deployment of DLCs in concert with the Carrier Serving Area (CSA) and/or ISDN design criteria developed by the industry, allows a carrier to provide digital services such as ISDN service that cannot otherwise be provided over loops that exceed 18,000 feet (see Figure 2).[3] In addition, DLCs bring some switch-based functions out to the field. For example, many GR-303-equipped DLCs poll customer lines for an off-hook condition, perform concentration functions, and extend services such as ISDN further out into the central office serving area.

III. UDLC vs. IDLC

The first generation of DLC, now known as UDLC, consists of a remote terminal (RT), a transmission (transport) facility to link the RT to the central office (CO), and a central office terminal (COT). (See Figures 1 (a) and 1 (b).) The RT aggregates the copper pairs and performs conversions -- converting the customer's analog signal to a digital multiplexed format going to the central office, and (in the opposite direction) converting the digital signal from the central office to the customer to an analog signal. The transport carries the digital signal from the RT to the COT, and vice versa. The COT equipment converts the digital signal from the RT to an analog signal before the signal is terminated on the Main Distributing Frame (MDF)[4] and cross-connected to the switch port.

It is at this point that the equipment needed differs depending on whether the CO switch is analog or digital. Where a UDLC is connected to an analog switch (see Figure 1 (a)), after the individual voice-grade analog circuits are terminated on the MDF, they are cross-connected into and out of the switch through an analog line circuit card.

In the case where a UDLC is connected to a digital switch (see Figure 1 (b)), the signal is cross-connected on the MDF to an analog port (called an Analog Interface Unit or AIU) on the switching system. At the AIU, the signal that was converted from digital to analog at the COT is now converted back to digital -- and, in the other direction, the digital signal from the switch is converted to analog before being sent to the COT where it will be converted back to digital.

As digital switches were deployed, the required digital-to-analog conversion at the central office for UDLCs became redundant, inefficient, expensive and degraded voice quality. Thus, the "integrated" DLC was developed and introduced.

---

[3] The CSA design copper loop limit is 12,000 feet with limited bridged taps. ISDN design specifies that loops be less than 18,000 feet, non-loaded, and have limited bridged taps (over 24 AWG wire). Both the CSA and ISDN designs enable more efficient and cost effective deployment of DLC technology, make more efficient use of the in-place cables, and reduce ongoing cable reinforcement costs.

[4] The COT equipment also converts the analog signal coming from the switching system to a digital signal to be sent to the RT.

The term "integrated" DLC was coined to differentiate the IDLC from the older UDLC technology. Specifically, it allowed the elimination of the DLC central office terminal, of switch line cards, and of the central office analog-to-digital (A/D) or digital-to-analog (D/A) conversions. In short, the IDLC could be directly connected to the digital switching system. However, this does not mean that the DLC is inseparable, indivisible, or incapable of being unbundled, nor that the service is inseparable from the ILEC switch. As will be described in detail below, an IDLC can be digitally connected to more than one switch simultaneously (this is called Multiple Switch Hosting) by separating and unbundling digitally encoded voice (and data) channels.

As shown in Figure 1 (c), the basic IDLC system consists of an IDLC RT, a digital transmission facility with various pieces of equipment and an Integrated Digital Terminal (IDT) in the switch.

The IDLC RT (see Figure 3) consists of channel units (customer interface cards), power supply, a Time Slot Interchanger (TSI) that assigns loops to time slots, interface groups that aggregate traffic into specific interface formats,[5] and a multiplexer (mux) to consolidate or aggregate the signals for transport to the CO. These main components of an IDLC RT are all contained within a cabinet that ranges from the size of a Network Interface Device (NID), a wall mount, to a large wall-to-wall bookshelf (for example, a Lucent 80D cabinet) depending on the vendor and number of lines served. Currently IDLC RTs can handle from 24 to 2,016 lines. Copper distribution cable, as opposed to coax or fiber, connects the customer to the RT and is still the most economical way to provide basic telephone service.

A digital transport facility connects the RT to the central office.[6] In the digital transport connecting the RT to the central office, various pieces of equipment

---

[5] These will be described in greater detail later and are shown in Figure 4.

[6] Early DLC applications used T-1 carrier on copper pairs. In addition to T-1 over copper, both Synchronous (SONET) and asynchronous fiber optic transport are utilized, depending on the application, size, location, and condition of the outside plant. Generally, larger DLC systems transport is on fiber at the SONET OC-3 (155 Mb/s or 84 DS1s or 2,016 DS0s) rate. In addition to OC-3, OC-1, OC-12, and DS-2 over fiber are also common options. SONET technology is preferred and has replaced other transport mediums because it dramatically reduces multiplexer costs and because of its inherent Add-Drop and Ring capabilities. Add-drop capability is the ability to accept or drop-off groups of circuits (virtual tributaries) from the SONET device without any additional multiplexing equipment while simultaneously providing transport to preceding and succeeding SONET muxes. Ring capability is the ability to connect multiple SONET muxes into one of several types of ring topologies such that service is maintained when one "leg" of the (ring topography) transport is severed. This is a common technique used to ensure survivability of the fiber transport.

must be used to de-multiplex (break down) the transport medium into individual DS1s in order to "hand-off" the DS1s to the digital switch. (See Figure 1 (c)). If the transmission medium is fiber, the signal goes through a Light Guide Cross-Connect (LGX),[7] a fiber multiplexer (mux),[8] and a digital signal cross connect (DSX) device. If the transmission medium is copper, the copper first terminates on the MDF (for lightning protection) and is then extended to the DSX. The DSX is similar to a MDF and allows DS1s[9] to be cross-connected to various devices in the CO. For either fiber or copper transport, the signal remains digital and terminates at the Integrated Digital Terminal (IDT) in the digital switch. The IDT is a digital interface component of the local digital switch where the DS1s from the IDLC RT are terminated and includes a Time Slot Interchanger that assigns loops to time slots on a per call basis.

Because of the digital nature of IDLCs, the MDF, which is the traditional demarcation point between the copper loop and the switch, is not the demarcation point for the IDLC-served loop. Instead, an IDLC loop is assigned electronically to time slots at the RT, and the physical demarcation point for an IDLC-served loop is in the CO at the Digital Signal Cross-Connect (DSX). The DSX is a passive electrical patch panel that allows manual cross-connects for DS1 or higher level signals. IDLC loops are transported in groups of up to 24 circuits within each DS1, which is typically terminated and cross-connected at the DSX.

From the DSX, CLECs can take their traffic to their CO over leased or owned transport without having to collocate. This option is particularly attractive to CLECs because collocation is expensive, time-consuming, and often said to be unavailable.

---

[7] The Light Guide Cross-Connect is a device upon which the fiber from the outside is terminated and cross-connected with fiber "pigtails" to the fiber mux in the CO. The pigtails are single fibers designed to be inserted into the LGX to mix and match fiber inputs from the outside fiber cables. Essentially, the LGX is a fiber MDF.

[8] The fiber mux or SONET mux is a device that takes (electrical) digital signals (cross-connected via the DSX) and converts them into optical signals or vice-versa. For instance, an OC-3 mux can take a maximum of 84 DS1s and convert them into a single optical bit rate of approximately 155 Mbps with a multiplexing technique called Time Division Multiplexing, hence, the term mux. There are synchronous (SONET) and asynchronous muxes. An Add-Drop Mux (ADM) is a SONET mux that is capable of dropping off or accepting groups of DS1s while simultaneously providing transport to preceding and succeeding muxes.

[9] DS1s terminate on a DSX-1 and DS3s terminate on a DSX-3.

1. ADVANTAGES OF IDLC

Local loops connected to a digital circuit switch are provided more efficiently and cost effectively over IDLC than UDLC-provisioned loops because an IDLC requires neither an analog conversion at the CO, nor the AIU line card at the switch, nor manual MDF wiring. As a result, compared to today's IDLCs, UDLCs require a lot of unnecessary investment for digital-to-analog and analog-to-digital conversion equipment and MDF wiring in the central office. UDLCs also require substantial and unnecessary investment for switching equipment and the associated real estate and power requirements to convert the analog signal back to digital because today's digital switches require a digital signal.

In addition, the back-to-back digital-to-analog and analog-to-digital conversions inherent in the UDLC configuration reduce bit rate speeds for voice band data connections such as faxes or analog modems. Moreover, customers served by UDLC technology cannot receive ISDN and ADSL services without the installation of additional external loop electronics and digital transmission bandwidth at the UDLC, because UDLCs were neither designed nor have the capability to handle the bandwidth requirements of ADSL and ISDN.[10]

Consequently, the UDLC configuration is inefficient in today's digital network, would not be the technology of choice today for ILECs putting in additional DLCs served by digital switches, and does not represent a forward-looking technology.

2. TYPES OF IDLC CONFIGURATIONS

TR-008

The most prevalent IDLC configuration in place is the Bellcore TR-008 digital switch interface. This configuration evolved from the proprietary interface existing at divestiture, when the RBOCs had a large embedded base of Western Electric (now Lucent Technologies) SLC® 96 IDLCs that were only compatible with Western Electric switches.

With the break-up of the vertically integrated Bell System, the RBOCs could look to other equipment vendors. Given their large embedded base, these companies demanded that other switch vendors, such as Northern Telecom and Siemens

[10] Therefore, where ILECs have proposed to provide CLECs seeking unbundled DLC loops only UDLC loops, but not IDLC loops, CLECs would be precluded from offering ISDN and ADSL services over those loops.

Stromberg-Carlson, make their switch interfaces SLC 96-compatible. Because of this customer demand, Bellcore defined the TR-008 specifications so switch vendors could make their products compatible with the Western Electric SLC 96 IDLC. The existence of non-proprietary specifications helped spawn new DLC vendors. Today many vendors' IDLCs can integrate with the TR-008 digital switch interface. The TR-008 interface was vastly superior to UDLC systems, as explained earlier, and gave the telephone companies a choice in DLC equipment.

The TR-008 interface comes in two flavors: mode 1 and mode 2. Mode 1 provides no concentration while mode 2 provides a 2:1 concentration. Mode 1 consists of four DS1s (96 DS0s) that serve up to 96 lines resulting in one DS0 dedicated per line. Mode 2 uses two DS1s to serve up to 96 lines.

As Bellcore released the more technologically advanced GR-303 specification, many equipment manufacturers developed equipment to meet this newer specification.[11] Anticipating the release of the GR-303 specification, many built their TR-008 IDLCs such that they could be upgraded to GR-303. Consequently, many of the IDLCs deployed by ILECs today are capable of complying with both Bellcore's TR-008 and GR-303 standards. However, there are some older TR-008 IDLCs that cannot be upgraded to GR-303.

GR-303

In response to telephone companies' demand for an IDLC that could interface more efficiently than the TR-008 with the digital switch, and could extend the ISDN signal to customers served by facilities exceeding the maximum copper loop length requirements for ISDN, Bellcore developed GR-303. These specifications are defined in Bellcore's Generic Requirements "GR-303, Integrated Digital Loop Carrier System Generic Requirements, Objectives and Interface." GR-303 enabled the IDLC to dynamically allocate transport bandwidth by assigning a channel to a line on a call-by-call basis rather than dedicating channels to lines. It improved transport efficiency by extending the switch concentration ratio out to the IDLC. For example, at a 4:1 concentration ratio, a GR-303 IDLC can serve approximately twice as many lines as a TR-008 mode 1 (4 DS1s) IDLC, with half as many DS1s. That is, a GR-303 IDLC can serve 188[12] lines with 2 DS1s. The concentration ratio is also scaleable,

[11] Vendors and products include DSC Litespan 2000, Lucent SLC 2000, NORTEL Access Node, and RELTEC DISC*S. The latest IDLCs which can provide voice and advanced services such as DSL include Lucent's AnyMedia, Fujitsu's FACTR, AFC UMC-1000, and DSC's Litespan ADSL

[12] Twice as many lines would be 192 but four DS0s are reserved; one each for primary and backup EOC channels and one each for primary and backup TMC channels.

depending on the customer's traffic usage requirements.[13] As shown in Figure 4 and described in detail in Section IV, the GR-303 interface group can handle far more traffic than the TR-008 interface group. Also, GR-303 IDLCs efficiently support ISDN, resulting in more efficient transport and switching utilization.

The GR-303 interface has capacity for a minimum of two DS1s[14] and a maximum of twenty-eight DS1s. As shown in Figure 4, the first DS1 in the GR-303 Interface Group contains an Embedded Operations Channel (EOC) and a Time Slot Management Channel (TMC), and 22 channels available for customers. The EOC provides a communication path for operations and maintenance. The TMC assigns time slots for voice grade circuits and the ISDN B-channels. These functions – and thus the two channels – are needed for GR-303 to provide variable concentration and bandwidth assignment.

The second DS1 has backups for the EOC and TMC channels to provide redundancy, and 22 subscriber channels. The remaining DS1s do not need their own EOC or TMC, and thus each has the full complement of 24 channels.

As shown in Figure 5, the GR-303 IDLC RT can simultaneously accommodate TR-008 interface groups, GR-303 interface groups, and Integrated Network Access (INA) [15] interface groups. As discussed in greater detail in Section IV, this capability allows a GR-303 IDLC to integrate with several switches simultaneously.

The GR-303 IDLC technology provides a highly efficient and very powerful DLC network for local loops. Most GR-303 IDLCs have been constructed to support UDLC operation and/or TR-008 integration because manufacturers have had to be sensitive to carriers' embedded base of analog switches. While these GR-303 IDLCs can be configured to operate in UDLC mode, they are not UDLCs.

Many ILECs are deploying GR-303 capable IDLCs in their networks today,[16] and the trend is expected to increase because GR-303 is much more efficient, and

---

[13] The concentration ratio is determined by the number of DS1s provisioned, which is engineered based on IDLC customers' traffic requirements and is usually engineered to the same requirements as a direct line-side analog interface at the digital switch.

[14] One DS1 may be used if redundancy is not required.

[15] INA will be discussed in the next section of this paper.

[16] See, for example, DLC Trends presentation by Bellcore at GR-303 Integrated Access Symposium, San Diego, CA, July 29-30, 1998 - www.bellcore.com/gr/GR303.html#forum. Nationally, the average annual increase in DLC served lines is approximately 20 percent, compared to an annual growth in access lines of 3 to 5 percent.

IDLC costs are decreasing while other outside plant costs increase.[17] Table 1, from the Bellcore DLC Trends presentation at the GR-303 Integrated Access Symposium, shows the percentage of working lines served by all DLC technologies and by GR-303-capable DLC, for the RBOCs and GTE. This suggests an overall DLC penetration rate of about 20 percent and a GR-303-capable DLC penetration rate of 10 percent.[18]

Table 1
Percent of Working Lines Served by DLCs

	GR-303 Capable DLC	All DLC Technologies
Ameritech	6%	13%
Bell Atlantic	18%	32%
BellSouth	17%	36%
GTE	6%	16%
NYNEX	7%	13%
Pacific Telesis	3%	6%
Southwestern Bell	7%	14%
US West	10%	17%
National Total	10%	20%

3. SUMMING UP GR-303 ADVANTAGES

Bandwidth Efficiency

The GR-303 IDLC provides for significant efficiencies by moving the concentration function from the switch to the RT. GR-303 makes very efficient

[17] Since the use of GR-303 technology requires both software and hardware upgrades to many embedded switches, at least one ILEC (PacBell) has stated that in many situations GR-303 does not "cost out" and therefore it does not intend to deploy it widely. This raises an important public policy issue. Is the PacBell decision based strictly on the merits of the technology or is it skewed by the strategic consideration that deployment of GR-303 will remove a barrier to competitive entry? That is, is a decision not to deploy the technology beneficial to PacBell shareholders but inconsistent with the public interest in fostering competition?

[18] Data presented by Westell at a recent DSL conference corroborates these numbers. Of the approximately 35 million lines served by DLC (out of approximately 172 million access lines nationwide), 7.5 million are SLC96, 15 million SLC5, 2.5 million SLC2000, 7 million DSC Litespan, and 3 million others (Nortel, Fujitsu, AFC, Reltec, etc.). Source: Westell, Commercializing DSL Technologies presentation, September 25, 1998, Atlanta GA.

use of the transport bandwidth medium and switch terminations by assigning a channel to the customer on a call-by-call basis as opposed to "nailing up" or dedicating the channel, as in TR-008. Hence GR-303 requires less bandwidth and switch terminating capacity than a TR-008 IDLC or a UDLC.

ISDN Provisioning

Prior to the availability of GR-303, ISDN provisioning on DLCs was expensive because it required using Basic Rate ISDN Terminal Extender (BRITE) plug-in cards. ISDN provisioning was inefficient because three DS0s with a total capacity of 192 Kbps were needed to carry the ISDN 2B+D channels with a total required capacity of 144 Kbps. Because GR-303 IDLCs are designed to deliver ISDN, ISDN can be provisioned easier and more efficiently than before because a single DS0 can be used to carry four D channels.

Optimizing OSS

GR-303 has been developed to operate in conjunction with forward-looking operations support systems such as OPS/INE, which provide for highly automated, centralized, and remotely located operations centers. GR-303 also supports digital connectivity for non-locally-switched services, such as foreign exchange lines, and non-switched services, such as Digital Data Service or DS0 private lines.

IV. UNBUNDLING ALTERNATIVES

Some parties have claimed that since an IDLC signal is digital and is connected to the switch IDT there is no way to unbundle the IDLC. They further contend that because it is allegedly technically unfeasible to unbundle IDLC loops, an ILEC customer currently being served by an IDLC loop who chooses to get service from a CLEC using unbundled ILEC loops could not stay on the IDLC loop. Rather, the customer's service would have to be put onto an analog loop (spare or retired copper loop or a UDLC).

In fact, there are no technical impediments to a customer receiving service from a CLEC via an unbundled ILEC IDLC loop as long as the ILEC controls and administers the RT and the network. If the ILEC manages the network (e.g., assigns CLECs to software groups in the RT, handles alarms, handles testing, etc.) it can simply hand off traffic to the CLEC through interconnection, which is done all the time today. If, however, CLECs want to jointly manage the RT, provision services themselves, handle their own alarms, etc. some technical problems may occur such as security and access to a single alarm group in the RT. These problems are being addressed by vendors and Bellcore's GR-303 Forum.

Unbundling of IDLCs is technically feasible, provides non-discriminatory access to end-to-end digital services, and is less disruptive to the customer than moving the service off of the IDLC. Placing an IDLC served customer onto a UDLC harms the customer because it is a lesser grade of service due to the extra analog–to-digital conversions required. The customer's analog signals would not be at parity with the IDLC-provided service. In addition, the customer probably would experience provisioning delays because UDLC or copper-fed service requires manual MDF cross-connects as opposed to electronic provisioning with IDLCs.

There currently are four technically feasible unbundling methods that can provide CLECs with non-discriminatory access to the customers served by IDLCs:

1. Multiple Switch Hosting
2. Integrated Network Architecture (INA)
3. Digital Cross-Connect System (DCS) Grooming
4. Side-Door Grooming

1. Multiple Switch Hosting

Multiple Switch Hosting is the ability of one IDLC RT to interface with multiple switches simultaneously. It allows the IDLC technology residing in the RT to serve the ILEC plus multiple CLEC switches.[19] Multiple Switch Hosting is possible because all GR-303 IDLCs have a Time Slot Interchanger (TSI) that allows a CLEC customer(s) to be assigned to CLEC-specific channelized DS1s served by the RT. That is, the ILEC and each CLEC can be assigned one or more DS1s (with each DS1 having up to 24 distinct DS0 voice grade channels), with their customer traffic routed to their assigned DS1s. This is accomplished by "field grooming"[20] at the RT – the process of using the TSI in the RT to map specific DS0s to specific DS1s or groups of DS1s, called "interface groups," as shown in Figure 5. If the customer changes his or her service back to the ILEC

---

[19] See DSC Communications web site http://www.dsccc.com/lsp2000.htm. "The Litespan can simultaneously support different switch interfaces from the same common control, making the system ideal for the transition to future network service and service to *multi-entity* [emphasis added] offices."

[20] The grooming is done in software and no field visits are ever required. Field grooming simply means that the grooming occurs electronically in the field as opposed to the central office.

or to another CLEC, field grooming allows the appropriate cross-connects to be made electronically in the same manner as described above.[21]

As mentioned earlier and shown in Figure 5, the GR-303 IDLC RT can simultaneously support interface groups for the TR-008 interface format, the GR-303 interface format, and the INA interface format. This Multiple Switch Hosting capability allows a single IDLC to interface with several ILEC and/or CLEC switches simultaneously,[22] with more than one type of switch interface (GR-303, TR-008, and/or INA) protocol. The Multiple Switch Hosting capability exists in most of today's IDLCs, and Bellcore's GR-303 specifications require the capability to be integrated with a minimum of two switches. Some vendors already provide Multiple Switch Hosting with up to five different switches and may soon be able to do so with up to eight.

Multiple Switch Hosting requires the use of one of the forward-looking operational support systems currently available, such as OPS/INE, and software provided by the IDLC vendor, in conjunction with the Time Slot Interchanger, to migrate a customer among local service providers.

First, the RT's Time Slot Interchanger electronically assigns the signal where it is placed on a DS1 in the appropriate GR-303, TR-008, or INA interface group. The traffic is fed into the RT's fiber mux and then transported over fiber (on a CLEC or ILEC channelized DS1) to the CO, where the fiber is terminated onto the LGX and cross-connected to the CO fiber mux (see Figure 6). The fiber mux decodes the optical signal into electrical DS1s that are then connected to the DSX patch panel, where the respective DS1s are handed off to the ILEC or CLEC equipment. The reverse is true for traffic flowing in the other direction. A CLEC can use leased or owned transport from the ILECs DSX panel to the CLEC CO, and interface the DS1 signal into its own IDT. This is the simplest and quickest option for CLECs to get the digital loop. Alternatively, a CLEC can take the DS1 signal from the DSX to its collocation cage. Collocation, while sometimes

---

[21] Field grooming at the RT requires that each customer be assigned a Line Circuit Address (LCA) and Call Reference Value (CRV). The customer's copper pair is terminated at the RT and is assigned a CRV in the appropriate GR-303 Interface Group, via the OSS interface. With multiple GR-303 Interface Groups, a CRV of any Interface Group can be assigned to the LCA corresponding to a customer's number. The GR-303 Interface Group uses the CRV in the Timeslot Management Channel to dynamically assign DS0s or fractional DS0s to a circuit on a call by call basis as directed by the TSI. This means, unlike TR-008, no DS0s are permanently assigned to any line. The CRV is assigned to an interface group (in software) to a LCA via a table in both the switch IDT TSI and the IDLC TSI. Figure 5 depicts a multi hosting capable IDLC.

[22] The number of integrated switches to a RT is a software capability inherent in the GR-303 specification.

desirable for things such as testing, is technically unnecessary for DS-1 level signals.

The Multiple Switch Hosting capability is the recommended forward-looking network architecture for unbundling in a competitive environment because, regardless of the local service provider, carriers have equal and non-discriminatory access to the capabilities of this highly efficient, high-quality digital local loop facility.

2. INTEGRATED NETWORK ACCESS (INA)

INA is an architecture inherent in IDLCs that allows specific DS0s to be mapped (groomed) into a unique interface group. This offers another method of unbundling GR-303 IDLC, albeit less efficiently than the GR-303 or TR-008 interface groups described by the Multiple Switch Hosting section above.

Originally, INA was designed to enable non-locally switched (FX service) and non-switched service (private line) DS0s to be terminated and redirected to the interoffice transmission network.[23] INA is another method of unbundling a GR-303 IDLC because the TSI can map (field groom) specific DS0s into specific Integrated Network Access groups as D4 formatted[24] DS1s. (See Figure 7.) This D4 format signal then goes to a CLEC "city ring" or collocation area where the INA DS1s are first terminated onto another IDLC (often called the unbundling RT) that converts the INA DS1 to GR-303 DS1s, which then go to the CLEC's switch IDT.

In this scenario, the CLEC would have the technologically feasible option of collocating or not collocating the unbundling RT. In most situations, it is more efficient for the CLEC to access the INA DS1s without any sort of collocation arrangement.

The INA option may force a CLEC to invest in an unbundling RT in its collocation area or CO, and therefore is less efficient than the Multiple Switch Hosting (GR-303, TR-008) solution. Multiple Switch Hosting is not widely available today, however, and in its absence some CLECs currently are using the (INA) unbundling technique to provide service to IDLC-served customers.

---

[23] Bellcore, GR-303, IDLC Generic Requirements, Objectives and Interface, page 1-3, paragraph 1.3.1.

[24] D4 is a T1 framing format that does not have bit error rate detection.

In the past, INA use was limited to special services provisioning. Some CLECs, facing the current paucity of GR-303 interface groups supported by some DLC products, have resorted to a second-best solution and used INA for regular POTS switched services. This essentially allows any number of CLECs to interconnect to the IDLC. The number of available INAs is only limited by the DS1 capacity of the transport system (e.g., 84 DS1s for a SONET OC-3 system) minus any DS1s used for GR-303 or TR-008.

3. DIGITAL CROSS-CONNECT SYSTEM (DCS) GROOMING

A DCS is an intelligent software-based network device used in the central office to electronically cross-connect DS0s between multiple DS1s using its inherent Time Slot Interchanger.[25] This is called DS0/DS1 grooming. When unbundling the large embedded base of TR-008 systems, a DCS can be used to unbundle IDLC remotes by grooming the DS1s and redirecting DS0s within specific DS1s to the ILEC or CLEC(s) (see Figure 8). Figure 9 shows one ILEC's view of DCS grooming.[26] While a DCS can support TR-008 integrated interfaces, it is incompatible with GR-303 because it does not support the Embedded Operations Channel and Time Slot Management Channel that dynamically assign time slots on a call-by-call basis and communicate with the IDLC and IDT. It thus cannot take advantage of GR-303 efficiencies.

Using a DCS may be the most efficient method of unbundling those DLCs (such as the SLC 96) that cannot support GR-303, INA, or Multiple Switch Hosting. Also, DCS grooming can be used where the TR-008 IDLC has a limited quantity of TR-008 interface groups. In addition, DCS grooming makes it unnecessary to undertake any changes at the IDLC RT, as all of the DS0 redirecting is done electronically by the DCS in the CO. It can also be used for small quantities of loops as an interim measure, until either Multiple Switch Hosting or INA is available. New facility-based service providers can use a DCS to interconnect with the embedded base of TR-008 IDLCs operating in Mode 1, eliminating the need to first convert the signal to analog or incur replacement or upgrade costs on older IDLCs.

---

[25] Lucent Technologies – DACS II Release 7.0 PDS Operations and Maintenance Manual Volume 1 – Acceptance and Operations – 365-353-051 Issue 1, Section 1.2.1 --- DACSII Overview.

[26] DCS grooming as depicted in Appendix C of Bell Atlantic's report to the New York State PSC in Cases 95-C-0657, 94-C-0095, and 91-C-1174. See *Report of Bell Atlantic – New York on the feasibility of alternative means for implementing central office cross-connections,* dated November 23, 1998.

4. SIDE-DOOR GROOMING

Side-door grooming (also known as hair-pinning) is a switch-based technology that requires that the Time Slot Interchanger in the IDT of the digital switch collect and route DS0s from a DS1 port connected to the GR-303 IDLC remote to another DS1 port on the IDT for interoffice connection. See Figure 10. Side-door grooming is done in the D4 format and is only utilized for special circuits where the quantities are insufficient to warrant the cost of deploying a DCS. A major disadvantage of the side-door technique (in addition to the D-4 format) is it unnecessarily and quickly consumes ILEC IDT switch resources, since an IDT time slot is nailed up to the IDLC DS0s. Multiple Switch Hosting and INA are more efficient unbundling techniques.

Until Multiple Switch Hosting or INA is more widely available, side-door grooming may be used to unbundle a few lines since the Time Slot Interchanger at the IDT provides the same functionality as the Time Slot Interchanger at the RT. However, this is the least desirable unbundling technique.

V. CONCLUSION

GR-303 IDLC is the forward-looking DLC technology deployed in the network today because of its transmission quality, range of service capabilities, and cost efficiencies. Many CLECs have deployed Bellcore GR-303-compliant IDLC technology in their networks because it expands network capability and is cost-effective, thus benefiting consumers in two ways. But consumers will not benefit from the new technology if their decision to be served by a CLEC using unbundled ILEC loops results in their being forced off IDLC loops.

Today it is technically feasible to unbundle IDLCs. The most efficient way to provide unbundled GR-303 IDLCs is through Multiple Switch Hosting. Absent sufficient GR-303 interface groups at the IDLC RTs, Multiple Switch Hosting can also be accomplished via TR-008 and INA interface groups. Multiple Switch Hosting, as well as the other techniques described in this paper, enables IDLC unbundling and digital signal handoff to CLECs.

The UDLC and all copper facility forms of DLC unbundling are inferior. Placing a CLEC customer on a UDLC from a GR-303-capable or TR-008 IDLC is unnecessary and unacceptable because of the signal degradation and longer provisioning time for this archaic analog manual technology. TR-008 handoff, while better than a UDLC solution, is inferior to GR-303 because it does not offer variable concentration and does not utilize transport efficiently. However, where GR-303 is not available, TR-008 and INA are adequate interim unbundling solutions.

Upgrading of GR-303 IDLC systems represents a normal and necessary network modernization path because the technology is more efficient and offers better service to customers served by IDLCs. But ILECs will have an incentive to delay these network upgrades to curtail CLEC access to unbundled IDLCs. The public policy problem that regulators must grapple with is how to foster deployment of these new, efficient technologies when incumbent LECs recognize that such deployment also fosters competition.

To ensure that the advantages of these new technologies are available to CLECs and their customers, regulatory authorities should:

1. Rule that it is technologically feasible to digitally unbundle IDLCs and require CLEC access to unbundled IDLCs without manual cross connects.
2. Identify GR-303 and Multiple Switch Hosting as the forward-looking IDLC technology to be used in determining recurring and non-recurring rates for unbundled loops.
3. Ensure that CLECs receive GR-303 digital signal from GR-303 capable IDLCs whenever technologically feasible.
4. Require IDLCs to be unbundled using Multiple Switch Hosting whenever and wherever technically feasible.
5. Order TR-008 or INA unbundling until GR-303 is deployed.
6. Ensure future GR-303 requirements provide open equivalent interfaces to all carriers on an equal and non-discriminatory basis.

For further information, contact:

Chandan Choudhary
MCI WorldCom
1801 Pennsylvania Avenue
Washington, D.C. 20006
(202) 887-2667
chandan.choudhary@mci.com

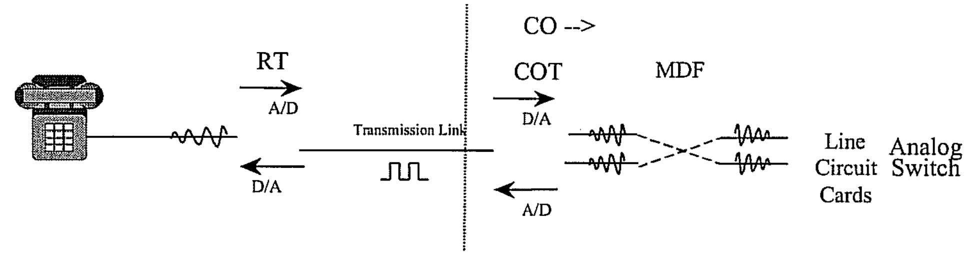


Figure 1 (a) - UDLC with an analog switch

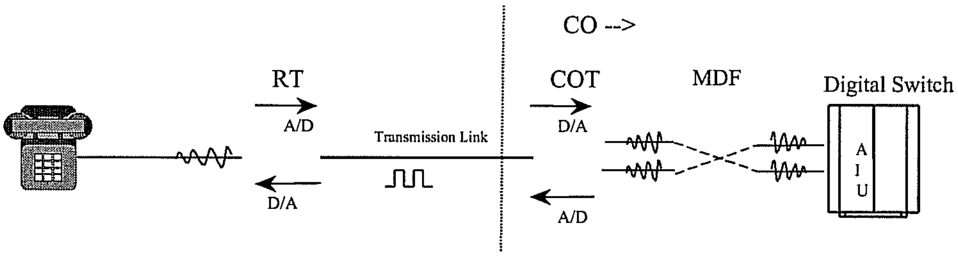


Figure 1 (b) - UDLC with a digital switch

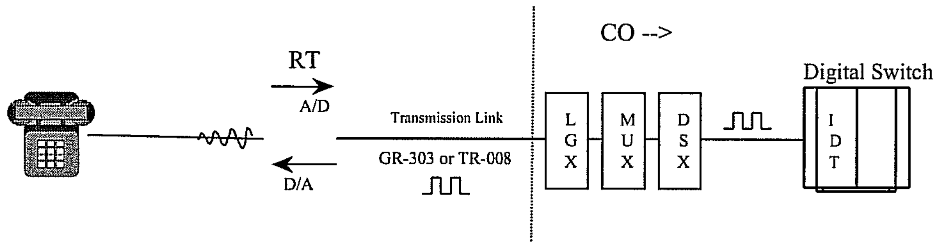


Figure 1 (c) - IDLC with a digital switch

Figure 1 UDLC / IDLC with a local switch

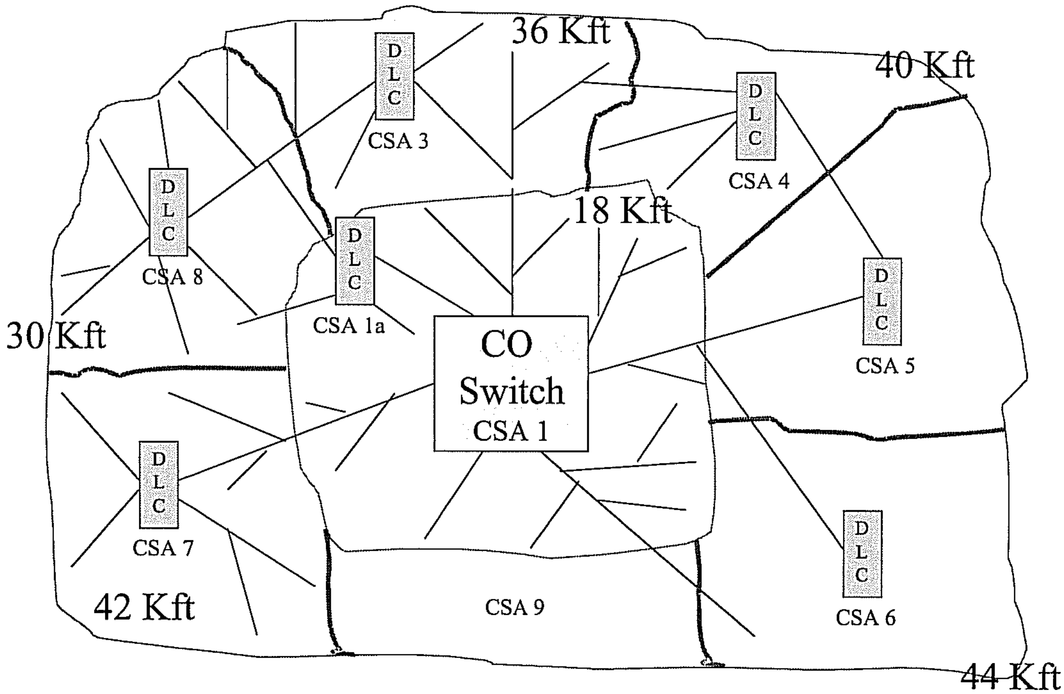


Figure 2 CSA design

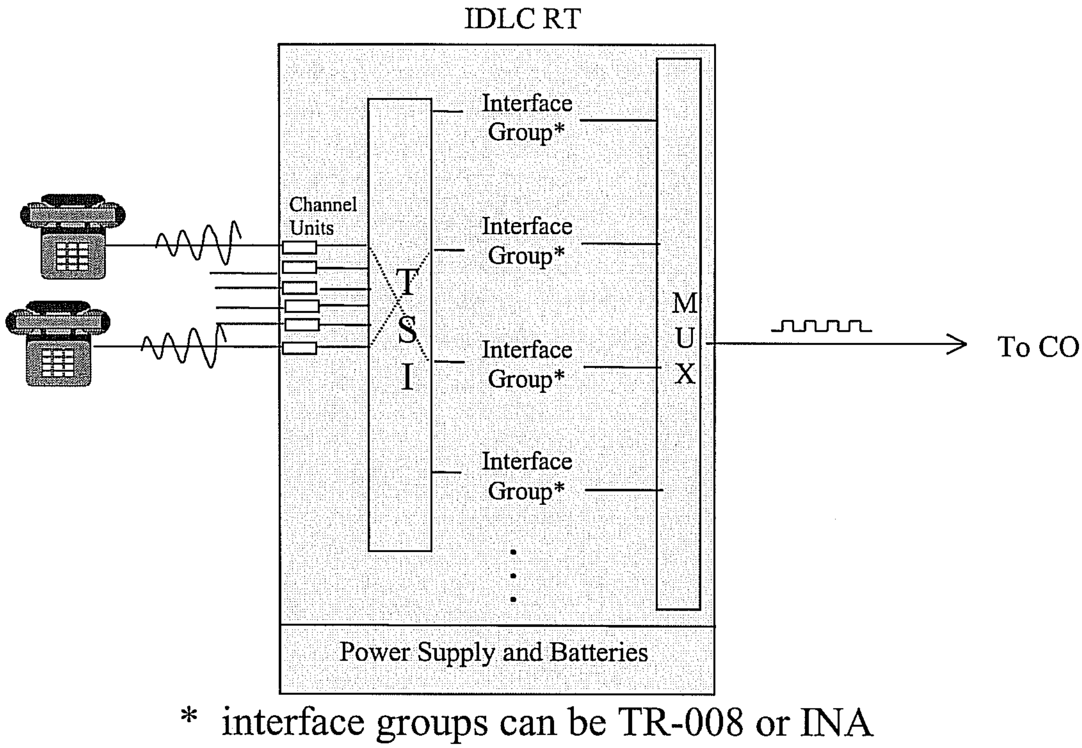


Figure 3 Generic IDLC RT

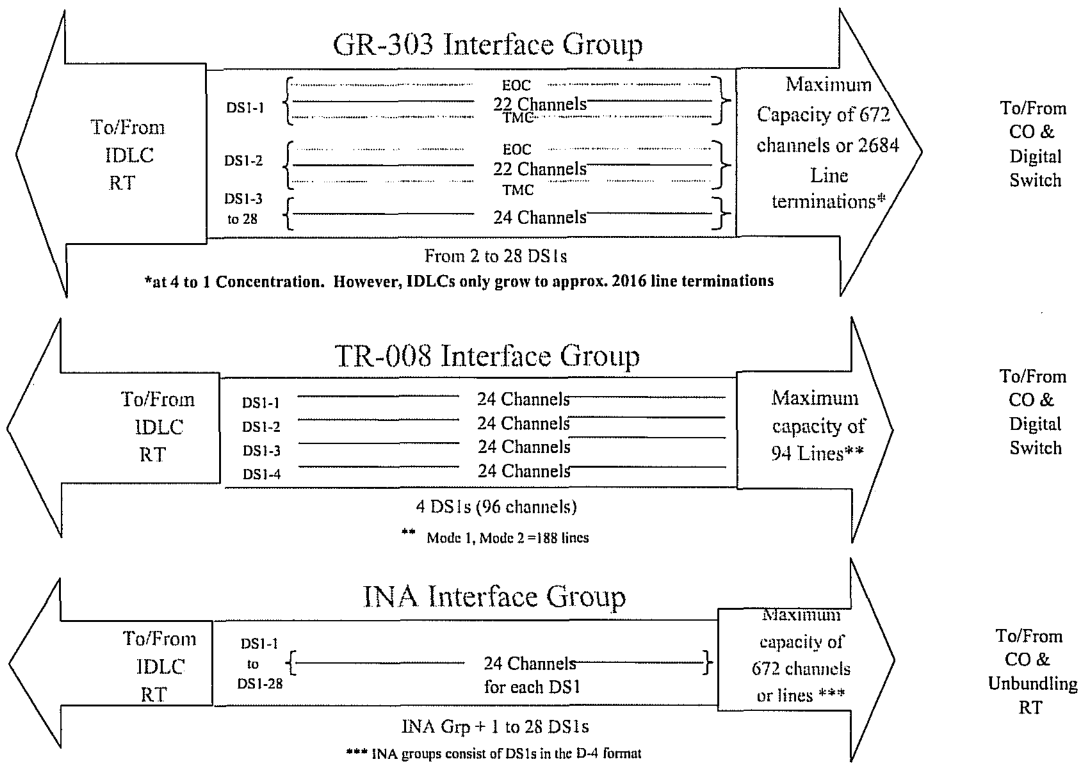


Figure 4 Interface Groups

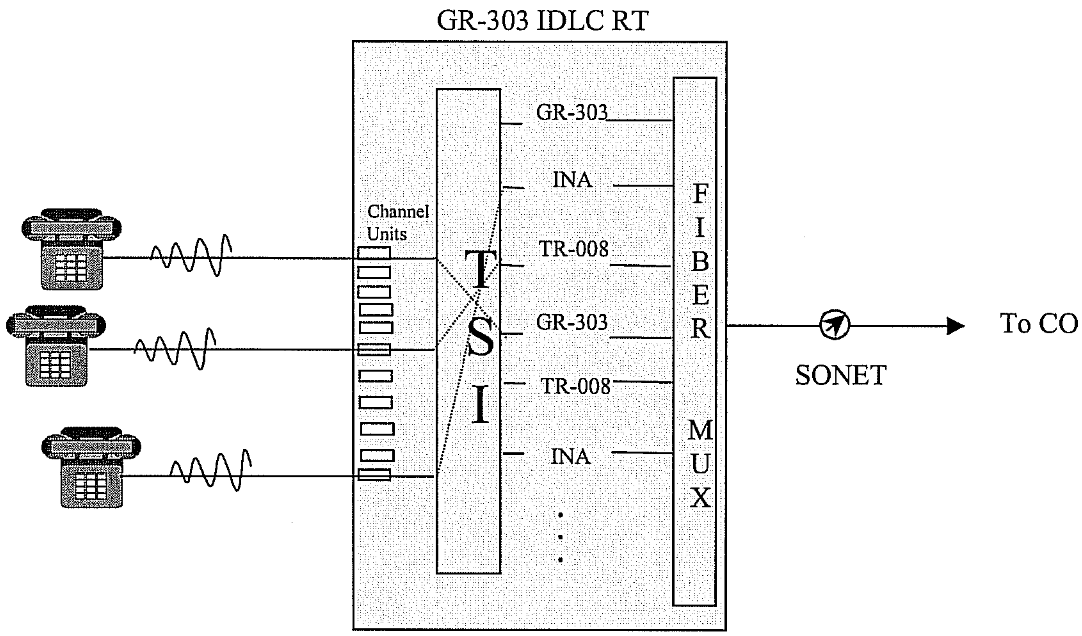


Figure 5 GR-303 IDLC RT

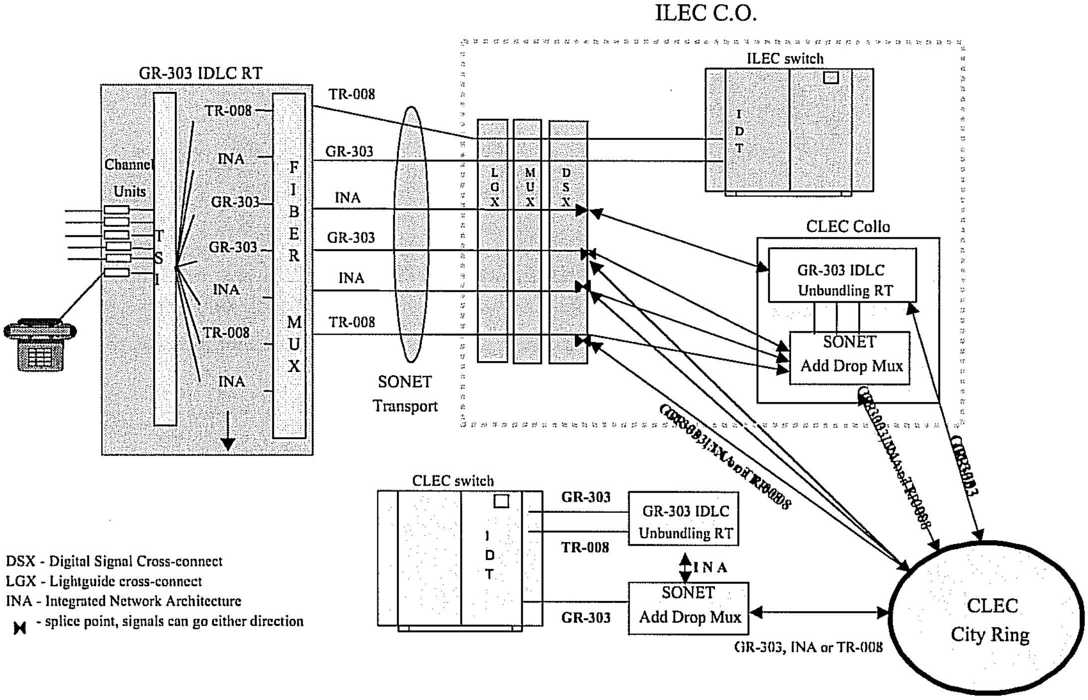
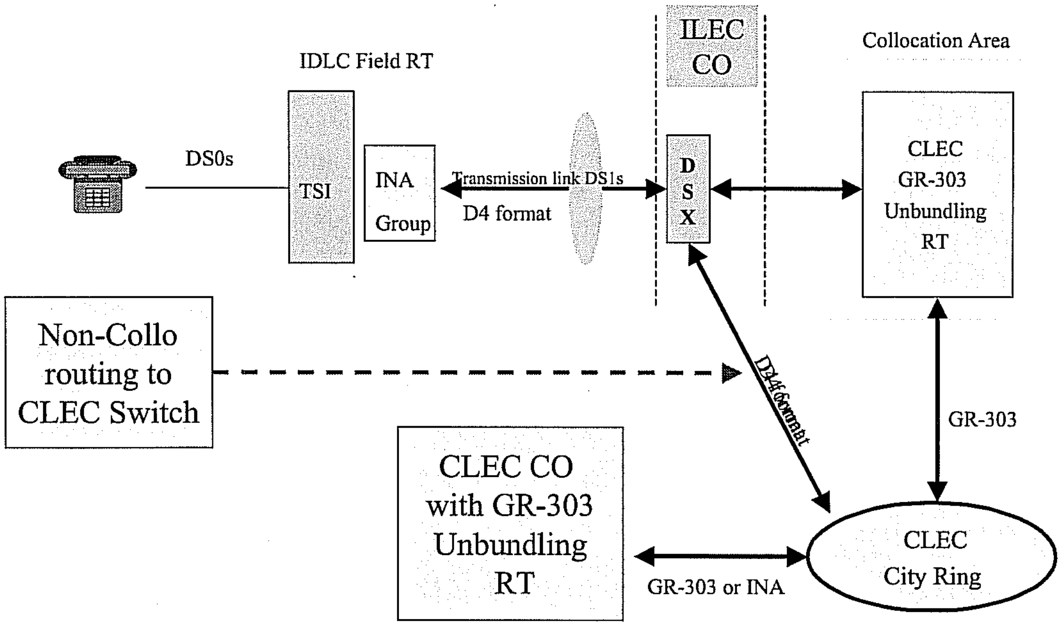
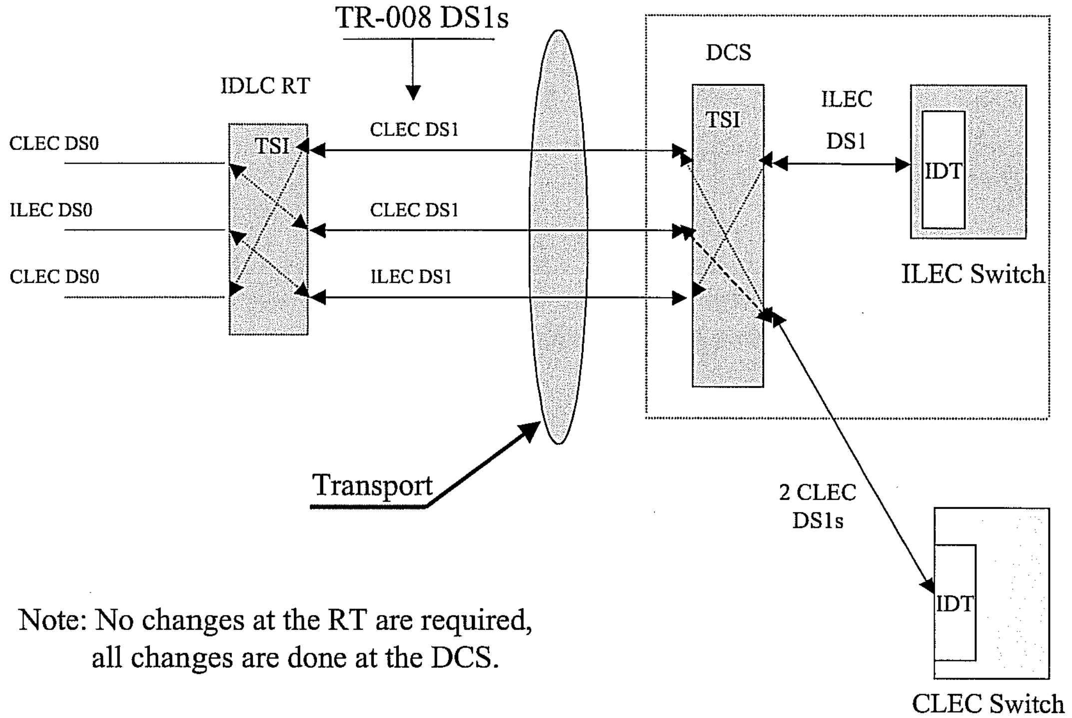


Figure 6 Multiple Switch Hosting



(D-4 conversion via an unbundling RT)

Figure 7 INA grooming



Note: No changes at the RT are required,
all changes are done at the DCS.

Figure 8 Digital Cross-Connect System (DCS) grooming

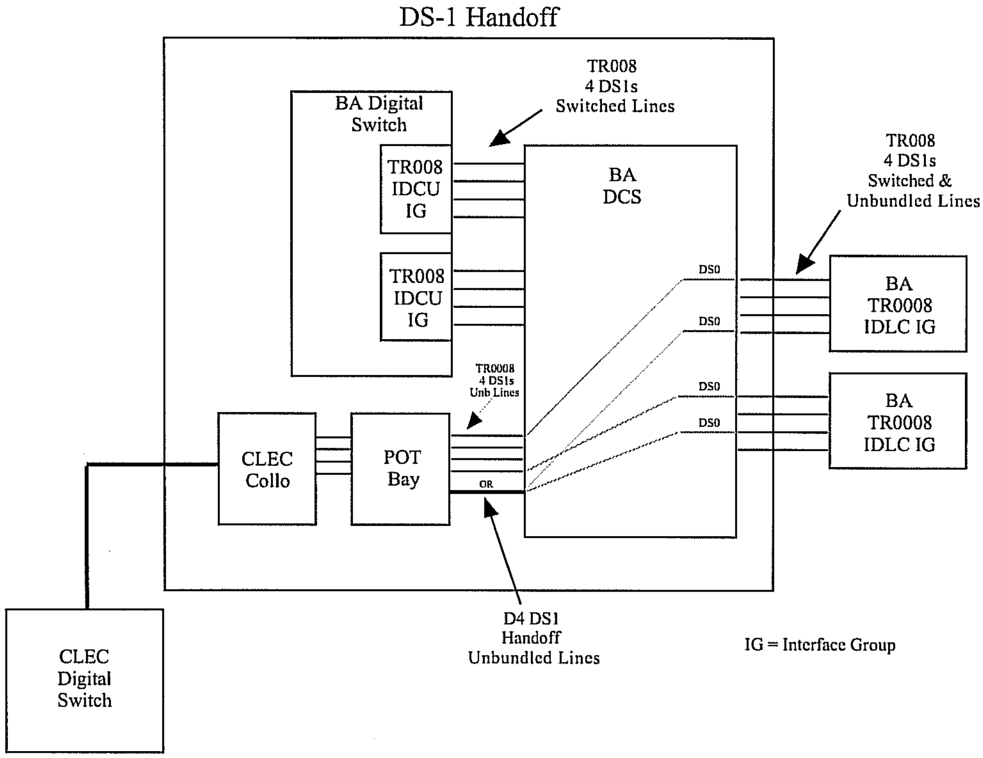


Figure 9 DCS grooming handoff to CLECs by Bell Atlantic-NY

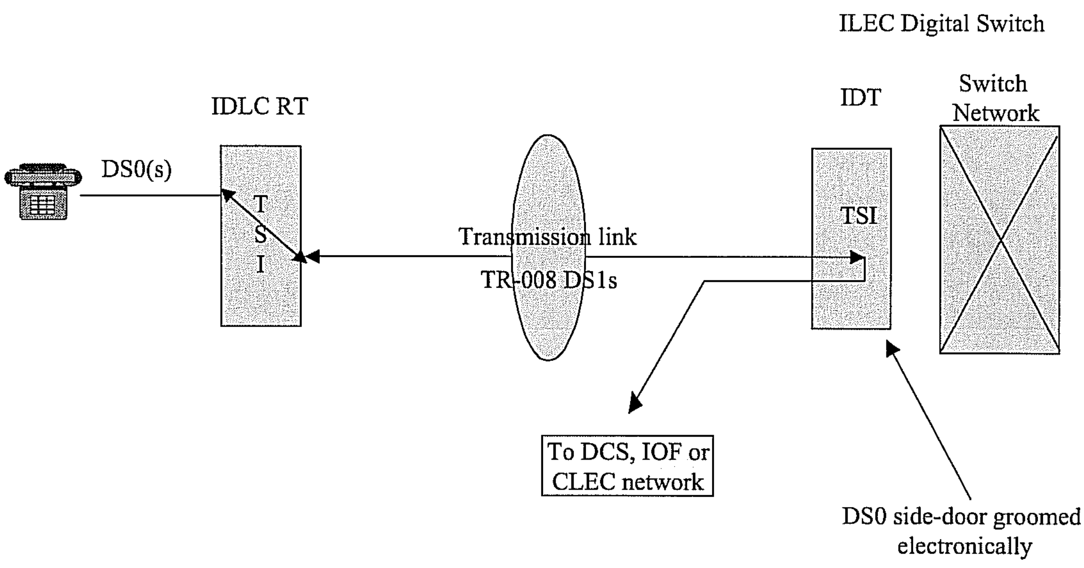


Figure 10 Side-door grooming

Summary of Results

SD#3 6/13/03 7:06:24 AM			ICM Version	2.3
Recurring Costs South Dakota				
Cost Element	**Investment**	**TELRIC**	**Common**	**TELRIC + Common**
Section A - Unbundled Loop				
2 Wire				
Unbundled Loop (2 Wire) Statewide Average	1137.59	21.64	1.23	**22.86**
Unbundled Loop (2 Wire) Zone 1	582.81	13.16	1.23	**14.38**
Unbundled Loop (2 Wire) Zone 2	1063.05	20.59	1.23	**21.81**
Unbundled Loop (2 Wire) Zone 3	1579.89	28.36	1.23	**29.59**
4 Wire				
Unbundled Loop (4 Wire) Statewide Average	2275.19	43.26	2.45	**45.71**
Unbundled Loop (4 Wire) Zone 1	1165.62	26.30	2.45	**28.75**
Unbundled Loop (4 Wire) Zone 2	2126.10	41.16	2.45	**43.61**
Unbundled Loop (4 Wire) Zone 3	3159.78	56.71	2.45	**59.16**
Unbundled Loop Grooming				
Unbundled Loop Grooming (2 Wire)	72.60	1.41	0.08	**1.49**
Unbundled Loop Grooming (4 Wire)	172.00	3.31	0.19	**3.50**
Network Interface Device (NID)				
Network Interface Device (2 Wire) Statewide Average	41.72	0.86	0.05	**0.91**
Section B - Extension Technology				
2-Wire Extension Technology	217.63	4.19	0.24	**4.43**
2-Wire Extension Technology - Unbundled Loop Grooming	98.53	2.03	0.11	**2.14**
Section C - Line and Trunk Ports				
DS0 Analog Line Port	72.226	1.3950	0.0790	**1.4740**
Each Addditional DS0 Analog Line Port	72.226	1.3950	0.0790	**1.4740**
DS0 Trunk Port	1009.616	19.3290	1.0946	**20.424**
DS1 Trunk Port	4081.228	77.6904	4.3996	**82.090**
ISDN BRI Port	360.431	9.4119	0.5330	**9.9449**
ISDN PRI Port	9069.126	172.6152	9.7751	**182.39**
DID/PBX Trunk Port per DS0	188.504	3.6082	0.2043	**3.8125**
Section D - Local Usage				
Local Switching UNE per Minute of Use	0.0146776	0.0037325	0.0002114	**0.003944**
Tandem Switching UNE per Minute of Use	0.0086717	0.0023410	0.0001326	**0.002474**
Local Switching LIS per Minute of Use	0.0085970	0.0023981	0.0001358	**0.002534**
Tandem Switching LIS per Minute of Use	0.0057219	0.0013067	0.0000740	**0.001381**
Tandem Switched Local Transport				
Fixed per Minute of Use 0 to 8 Miles	0.0046303	0.0011313	0.0000641	**0.001195**
Fixed per Minute of Use 8 to 25 Miles	0.0046303	0.0011313	0.0000641	**0.001195**
Fixed per Minute of Use 25 to 50 Miles	0.0046303	0.0011313	0.0000641	**0.001195**
Fixed per Minute of Use Over 50 Miles	0.0041331	0.0010098	0.0000572	**0.001067**
Distance Sensitive per Minute of Use per Mile from 0 to 8 miles	0.0001160	0.0000244	0.0000014	**0.0000258**
Distance Sensitive per Minute of Use per Mile from 8 to 25 miles	0.0001160	0.0000244	0.0000014	**0.0000258**
Distance Sensitive per Minute of Use per Mile from 25 to 50 miles	0.0001160	0.0000244	0.0000014	**0.0000258**
Distance Sensitive per Minute of Use per Mile over 50 miles	0.0000724	0.0000157	0.0000009	**0.0000166**
Section E - Entrance Facilities and Direct Trunked Transport				
Entrance Facilities				

Summary of Results

SD#3 6/13/03 7:06:24 AM			ICM Version	2.3
Recurring Costs South Dakota				
Cost Element	Investment	TELRIC	Common	TELRIC + Common
DS1 Entrance Facility	5859.48	112.34	6.36	**118.71**
DS3 Entrance Facility	23800.79	454.07	25.71	**479.78**
Multiplexing				
Multiplexing DS3 to DS1	15554.00	299.18	16.94	**316.12**
Multiplexing DS1 to DS0	13662.97	262.81	14.88	**277.69**
DS1 Direct Trunked Transport				
Over 0 to 8 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 0 to 8 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 8 to 25 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 8 to 25 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 25 to 50 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 25 to 50 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 50 Miles, Fixed	2968.98	60.71	3.44	**64.15**
Over 50 Miles, Per Air Mile	102.85	1.86	0.11	**1.97**
DS3 Direct Trunked Transport				
Over 0 to 8 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 0 to 8 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 8 to 25 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 8 to 25 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 25 to 50 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 25 to 50 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 50 Miles, Fixed	16242.92	332.13	18.81	**350.93**
Over 50 Miles, Per Air Mile	886.87	16.13	0.91	**17.05**
Section F - Intentionally Left Blank				
Section G - 8XX Database Services				
Basic Query	0.00178522	0.01838830	0.00104132	**0.019430**
Call Handling and Destination	0.00000706	0.00000161	0.00000009	**0.00000170**
POTS Translation	0.00000235	0.00000054	0.00000003	**0.00000057**
Section H - Line Information Database				
LIDB per Query	0.0019475	0.0008095	0.0000458	**0.0008553**
Section I - Signaling				
ISUP Signal Formulation	0.002589	0.0005913	0.0000335	**0.0006248**
ISUP Signal Transport	0.000810	0.0001899	0.0000108	**0.0002006**
TCAP Signal Transport	0.000091	0.0000210	0.0000012	**0.0000222**
ISUP Signal Switching	0.002966	0.0009523	0.0000539	**0.0010062**
TCAP Signal Switching	0.002245	0.0007876	0.0000446	**0.0008322**
STP Port	12738.33	242.42	13.73	**256.15**
Section J - Shared Transport				
Shared Transport per MOU	0.007064	0.001997	0.000113	**0.002110**
Section K - UDIT/EEL				
Multiplexing				
Multiplexing DS3 to DS1	15554.00	299.18	16.94	**316.12**
Multiplexing DS1 to DS0	13662.97	262.81	14.88	**277.69**
DS0 UDIT/EEL				
Over 0 to 8 Miles, Fixed	1468.20	30.02	1.70	**31.72**

Summary of Results

SD#3 6/13/03 7:06:24 AM			ICM Version	2.3

Recurring Costs
South Dakota

Cost Element	Investment	TELRIC	Common	TELRIC + Common
Over 0 to 8 Miles, Per Air Mile	14.94	0.26	0.01	**0.28**
Over 8 to 25 Miles, Fixed	1468.20	30.02	1.70	**31.72**
Over 8 to 25 Miles, Per Air Mile	14.94	0.26	0.01	**0.28**
Over 25 to 50 Miles, Fixed	1468.20	30.02	1.70	**31.72**
Over 25 to 50 Miles, Per Air Mile	14.94	0.26	0.01	**0.28**
Over 50 Miles, Fixed	1436.31	29.37	1.66	**31.03**
Over 50 Miles, Per Air Mile	10.76	0.19	0.01	**0.21**
DS1 UDIT/EEL				
Over 0 to 8 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 0 to 8 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 8 to 25 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 8 to 25 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 25 to 50 Miles, Fixed	3333.85	68.17	3.86	**72.03**
Over 25 to 50 Miles, Per Air Mile	157.51	2.74	0.16	**2.90**
Over 50 Miles, Fixed	2968.98	60.71	3.44	**64.15**
Over 50 Miles, Per Air Mile	102.85	1.86	0.11	**1.97**
DS3 UDIT/EEL				
Over 0 to 8 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 0 to 8 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 8 to 25 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 8 to 25 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 25 to 50 Miles, Fixed	18992.72	388.35	21.99	**410.34**
Over 25 to 50 Miles, Per Air Mile	1581.99	27.09	1.53	**28.62**
Over 50 Miles, Fixed	16242.92	332.13	18.81	**350.93**
Over 50 Miles, Per Air Mile	886.87	16.13	0.91	**17.05**
OC3 UDIT/EEL				
Over 0 to 8 Miles, Fixed	32703.21	668.70	37.87	**706.57**
Over 0 to 8 Miles, Per Air Mile	2425.94	41.54	2.35	**43.90**
Over 8 to 25 Miles, Fixed	32703.21	668.70	37.87	**706.57**
Over 8 to 25 Miles, Per Air Mile	2425.94	41.54	2.35	**43.90**
Over 25 to 50 Miles, Fixed	32703.21	668.70	37.87	**706.57**
Over 25 to 50 Miles, Per Air Mile	2425.94	41.54	2.35	**43.90**
Over 50 Miles, Fixed	32703.21	668.70	37.87	**706.57**
Over 50 Miles, Per Air Mile	3371.74	59.52	3.37	**62.89**
OC12 UDIT/EEL				
Over 0 to 8 Miles, Fixed	92776.29	1897.04	107.43	**2004.47**
Over 0 to 8 Miles, Per Air Mile	4815.98	82.47	4.67	**87.14**
Over 8 to 25 Miles, Fixed	92776.29	1897.04	107.43	**2004.47**
Over 8 to 25 Miles, Per Air Mile	4815.98	82.47	4.67	**87.14**
Over 25 to 50 Miles, Fixed	92776.29	1897.04	107.43	**2004.47**
Over 25 to 50 Miles, Per Air Mile	4815.98	82.47	4.67	**87.14**
Over 50 Miles, Fixed	92776.29	1897.04	107.43	**2004.47**
Over 50 Miles, Per Air Mile	6955.05	123.50	6.99	**130.50**
OC48 UDIT/EEL				
Over 0 to 8 Miles, Fixed	189444.34	3873.65	219.36	**4093.02**
Over 0 to 8 Miles, Per Air Mile	12179.09	208.56	11.81	**220.37**
Over 8 to 25 Miles, Fixed	189444.34	3873.65	219.36	**4093.02**
Over 8 to 25 Miles, Per Air Mile	12179.09	208.56	11.81	**220.37**
Over 25 to 50 Miles, Fixed	189444.34	3873.65	219.36	**4093.02**
Over 25 to 50 Miles, Per Air Mile	12179.09	208.56	11.81	**220.37**
Over 50 Miles, Fixed	189444.34	3873.65	219.36	**4093.02**
Over 50 Miles, Per Air Mile	17782.46	316.29	17.91	**334.21**
E-UDIT				

Summary of Results

SD#3 6/13/03 7:06:24 AM — ICM Version 2.3

Recurring Costs
South Dakota

Cost Element	Investment	TELRIC	Common	TELRIC + Common
DS1 E-UDIT	5859.48	112.34	6.36	**118.71**
DS3 E-UDIT	23800.79	454.07	25.71	**479.78**
OC3 E-UDIT	45904.82	816.90	46.26	**863.16**
OC12 E-UDIT	65472.60	1193.29	67.58	**1260.86**
OC48 E-UDIT	182787.95	3449.85	195.36	**3645.21**

Summary of Results

Cell: A2
Comment: Results are from the Develop Total Product Costs Spreadsheets which are the first pages in each section.

Cell: A6
Comment: Section A - UNBUNDLED LOOP

Description

Unbundled Loops establish a transmission path between the Qwest distribution frame (or equivalent) and the network interface (NI) of the Competitive Local Exchange Carrier's (CLEC) end user. Unbundled loop is available in either a two-wire or four-wire configuration. The actual loop facilities that provide the service may utilize various technologies.

The investments in Unbundled Loops are calculated on a statewide average basis and on a de-averaged basis in up to five zones. Zones are calculated on a MSA (wire center) basis or on the basis of distance from the wire center. Investments are also separated into Feeder, Distribution and Network Interface Device (NID). NID is only on a statewide average basis.

Investment Development

Feeder

Feeder is the main cable leaving the central office, extending to the point where distribution facilities are interconnected. LoopMod builds facilities from the most distant location in each quadrant back to central office, adding demand along the route. The data includes the line demand at the SAI (also sometimes referred to as a Feeder Distribution Interface or FDI), the sub-feeder or lateral length and the main feeder length. At each taper point the line demand is incremented to show total demand used for cable sizing. In addition the distance at each location is used in determining the technology and placement methodology that will be utilized. If the technology used is fiber based DLC, the demand is shown as number of fibers required to support the DLC remote terminals. If the technology selection is copper cable, the demand is shown as copper pairs required. The engineering fill factor is applied to this demand to determine the copper cable size or to determine the DLC size the program will utilize.

Distribution

Distribution is the cable that connects with the feeder and extends the loop to a termination point (i.e., pole or pedestal) near a home or workplace. Distribution is modeled differently than feeder. Generic distribution designs are specified for a range of neighborhoods and business districts, based on the density of access lines. The average investment by component for each design is multiplied by the design percents to produce a distribution investment for each kilofoot of loop length within each wire center group.

The Distribution Group designs are adjusted in LoopMod V2.0 to reflect the density differences that occur DA to DA. Information about each DA is matched against density and building entrance terminal rules to map each DA to the appropriate DG design. The lot oriented designs (DG3, DG4 & DG5) are then adjusted based on a cable multiplier that reflects the difference between the standard design lot frontage and the frontage calculated for each individual DA.

Network Interface Device (NID) Costs are included in the Distribution costs. NID cost is also calculated separately for sell as a separate UNE when the customer does not purchase distribution.

Drop

The service wire or drop is a two to six pair facility that extends from the NID to the terminal on the distribution cable. The terminal contains a connecting block with lugs for terminating the drop wires. Where demand exceeds a certain level, entrance cables, not drops, are used and are terminated on building terminals. The costs for drop are included in the distribution costs.

Network Interface Device (NID)

The NID provides electrical protection and a point of interface between the drop or building entrance cable and the customers' inside wire. The NID may be housed in a small case on the side of residence or business, or it may be in a larger outside wall mounted building terminal for apartment buildings or small office buildings. In high density situations the NID would likely be associated with a terminal in the building basement or equipment closet.

Loop Grooming

The demultiplexing of unbundled loops on integrated digital loop carrier (DLC) uses two options. The first is based on a scenario involving TR-303 DLC in which the unbundled loops are pre-assigned to particular DS1s. These DS1s are routed from the DLC CO multiplexer through a DSX to a Universal DLC COT to demultiplex to a DS0 level and connect to a Main Distribution Frame. The second scenario option assumes a TR-008 DLC with all DS1s passing through the UDLC to groom out the unbundled DS0s and connect them to a Main Distribution Frame. Both options use a Litespan 2000 UDLC COT. Loop Grooming costs are included in Unbudled Loop and Feeder costs.

Billing and Collections

Per line Billing and Collections investments and direct expenses are calculated in a separate study and are input to the QwestICM model.
All Loop costs include Billing and Collections.

Summary of Results

Cell: A30
Comment: Section B - EXTENSION TECHNOLOGY
Description
2 Wire Extension Technology for Integrated Services Digital Network (ISDN) Basic Rate Interface (BRI) is an unbundled element which extends the ISDN BRI signal when the Competitive Local Exchange Carrier's (CLEC's) end user's unbundled loop has more than 40 decibels in loss measured at 40 kHz (based upon 2 Binary 1 Quantinary (2B1Q) line encoding), or the distance is beyond approximately 18 kilofeet between the Company's distribution frame (or equivalent) and the Network Interface (NI) of the Competitive Local Exchange Carrier's (CLEC) end user, where facilities are available.

Investment Development

Unbundled loop investments were obtained from the LoopMod cost model. The model was run twice, once at 100 percent pair gain with POTS and once at 100 percent ISDN with pair gain. The difference between the two sets of investments is the loop investment associated with 2-Wire Extension Technology for ISDN BRI Service.

In order to hand off the ISDN BRS line at a DS0 level, two additional DACS channels, two additional AD4 channel bank channels and one D4 BRITE card are required. The investments associated with this additional equipment are calculated in the Extension Technology cost study via a spreadsheet named DEMUXBRI.XLS.

The incremental loop investment and the investments for the additional equipment are added together to produce the total investment for Extension Technology.

Cell: A35
Comment: Section C - Line Ports
ANALOG LINE PORT
Description
Analog Line Port provides for the interconnection of individual loops to the switching components of the QWEST network. Ports provide access to the basic functionality of the switch, including signaling digit reception and translations, routing and rating, call supervision as well as access to interoffice services. An analog end office port is a two-wire, POTS type line side switch connection.

Cost Methodology
A monthly End Office Port cost is the cost associated with connecting a CLEC line to a QWEST end office switch. The line is assumed to be a copper DS0 pair - not an ISDN line nor a TR-303 or TR-008 integrated line, which has been traditionally referred to as a digital line. It is assumed to be connected to an analog line unit. This cost element is the NTS COE in the switch itself and the associated use of an OE (office equipment) block on the MDF. The labor to cross connect the OE block to the Tie Pair block which terminates the Expanded Interconnect Channel Termination (EICT) is not included in this rate element.

The methodology was to take the Investment per Analog Line and the Investment per MDF OSP Pair from the Switch Module. Because the Investment per Analog Line includes both the MDF OE block and the MDF OSP block, the OSP block investment was removed by subtracting the Investment per MDF OSP Pair from the Investment per Analog Line. Because the cost for the MDF is only broken down for the 5ESS and DMS host switches, the weighted average Investment per MDF OSP Pair for these two switches was subtracted from the weighted average Investment per Analog Line for all switches.

The following switches were eliminated from the statewide average: switches that had no analog lines - e.g., hosts without any lines directly connected to the host or remote switches that were ISDN only.

Cell: A37
Comment: DS0 Trunk Port
DESCRIPTION
The DS0 analog trunk port connects the co-provider to a metallic interface at the common ICDF (or equivalent) in a Qwest central office. The interfaces support a 2-wire or a 4-wire transmission.
STUDY METHODOLOGY
DS0 ANALOG TRUNK Port investment was developed by dividing the DS1 Trunk Port in the Switch Usage Model (SUM) by 24 channels. Then adding the DS1 – DS0 multiplexing investment divided by 24 channels. The sum of the two was divided by the utilization factor.
Billing and collections are also part of this study.

Cell: A38
Comment: DS1 Trunk Port
DESCRIPTION

Summary of Results

A DS1 Trunk Port is an unbundled switching product that provides a Co-Provider 4-wire DS1 metallic interface at the common ICDF (or equivalent) within the Qwest central office. The DS1 unbundled trunk port supports up to 24 DS0 channelized trunks. This DS1 trunk port does not provide ISDN PRI capabilities.

STUDY METHODOLOGY
The DS1 Trunk Port investment was developed in the Switch Model (SM).

Billing and collections are also part of this study.

Cell: A39
Comment: Local switching LIS consists of:
1) Terminating Interoffice end office switching for one office.
2) Non-Chargable Intercept which includes limited mechanical announcements informing callers of new numbers, referral numbers and/or line status.
3) Billing and Collections which provides the billing mechanism for Qwest to charge Competitive Local Exchange Carriers for use of the Qwest local network.
4) Hewlett Packard measurement equipment which collects information regarding each call that is required for billing purposes.

Local Switching LIS does not include costs for SS7.

Cell: A40
Comment: ISDN PRI Port
DESCRIPTION
Primary Rate Interface Digital ISDN trunk port is a switch termination supporting PRI ISDN functionality. PRI trunk port requires a digital four wire full duplex transmission path between ISDN compatible Customer Premises Equipment (CPE) and a PRI ISDN equipped central office.

The PRI central office equipped trunk port is a DS1 which provides 24 64 Kb/s channels. This product is dedicated call type of PRI with a maximum of 23 possible B channels. The 24th channel must be configured as a D channel, which will carry the signaling and control information. The B channels transmit voice and data.

The PRI – ISDN Port includes the following:
Software Right to Use
Standard Features
Billing and Collections

The standard feature list includes:
Direct inward Dialing (Incoming) (PRI)
Direct Outward Dialing (Dial 9) Incoming (PRI)
PRI Without Packet (23B+D)
Multiline Hunt - Circular

Any additional features available in the switch requested by the customer will be handled on an ICB basis.

STUDY METHODOLOGY
These direct costs occur as a result of providing a PRI ISDN Port.

Central office switching feature costs are calculated by first determining incremental switching feature investments. These feature investments are obtained through the use of the Switch. The switch investments include processor time, memory and hardware appropriate for each feature. Feature utilization data pertaining to each type of feature is input into SM to develop an incremental Engineered, Furnished and Installed (EF&I) feature investment. SM input data is projected by using historical traffic data and best estimates of feature utilization. The switch investments are at a 2000 level.

Billing and collections are also part of this study.

Cell: A41
Comment: Tandem Switching LIS consists of the usage sensitive cost of switching a call through a local tandem switch.

It does not inlude the cost of SS7.

Cell: A44
Comment: Section D Local Usage

Local switching UNE consists of:
1) Terminating Interoffice end office switching for one office.
2) Non-Chargable Intercept which includes limited mechanical announcements informing callers of new numbers, referral numbers and/or line status.
3) Billing and Collections which provides the billing mechanism for QWest to charge Competitive Local Exchange Carriers for use of the Qwest local network.
4) AMA measurement equipment which stores information regarding each call that is required for billing purposes.
5) End office measurement investment

Cell: A45
Comment: Tandem Switching UNE consists of:
1) This includes the usage sensitive cost of switching a call through a local tandem switch.
2) AMA measurement equipment which stores information regarding each call that is required for billing purposes.
3) Billing and Collections which provides the billing mechanism for Qwest to charge Competitive Local Exchange Carriers for use of the Qwest local network.

Cell: A46
Comment: Local switching LIS consists of:
1) Terminating Interoffice end office switching for one office.
2) Non-Chargable Intercept which includes limited mechanical announcements informing callers of new numbers, referral numbers and/or line status.
3) Billing and Collections which provides the billing mechanism for U S WEST to charge Competitive Local Exchange Carriers for use of the USWC local network.
4) Hewlett Packard measurement equipment which collects information regarding each call that is required for billing purposes.

Local Switching LIS does not include costs for SS7.

Cell: A47
Comment: Tandem Switching LIS consists of the usage sensitive cost of switching a call through a local tandem switch.

It does not inlude the cost of SS7.

Cell: A49
Comment: Tandem Switched Local Transport

Tandem Switched Local Transport provides the transmission path from the end office which originates a call through the local tandem switch to the end office which terminates the call. Tandem Switched Transport consists of two elements:

1) Fixed

This element identifies the usage sensitive costs associated with terminating interoffice facilities in end offices and tandem switches. These termination costs are stated on a per minute of use basis for each of the mileage bands.

2) Distance Sensitive

The costs identified in this element are also usage sensitive and are associated with the outside plant facilities and intermediate multiplexing equipment which is required to connect central offices and tandem switches in the Qwest network. The costs are different by mileage bands as the costs vary by the distances between the offices. Costs are stated on a per minute of use per mile basis.

Cell: A59
Comment: Section E - Entrance Facility and Direct Trunk Transport
Description
DS1 and DS3 Entrance Facility provides for the communications path between the CLEC's Point of Interface (POI) and the Qwest Serving Wire Center (SWC) of that POI for the sole use of the CLEC. The Entrance Facility includes the fiber facility and supporting structure, transmission and terminating equipment at the serving wire center and the CLEC's POI.

DS1 and DS3 Direct Trunk Transport: Direct Trunk Transport (DTT) provides the transmission path without utilizing tandem switching functions on circuits dedicated to the use of a single CLEC between:

- the CLEC's SWC and an end office, or
- the CLEC's SWC and a local tandem, or
- the CLEC's SWC and a Qwest Hub where multiplexing functions are performed, or

- a Qwest Hub and an end office, or
- a Qwest Hub and a local tandem.

Direct Trunk Transport consists of two elements; fixed and per mile costs. The fixed element contains the costs associated with the terminating equipment at both ends of the transmission path. The per mile costs contain the costs associated with cable, repeaters, and intermediate central office equipment. The fixed are expressed per DS1 or DS3 circuit and the per mile costs are expressed per DS1 or DS3 circuit, per airline mile.

DS3 to DS1 Multiplexing: Central Office Multiplexing includes the equipment necessary for an arrangement that converts a DS3 channel to twenty-eight DS1 (1.544 Mbps) channels utilizing time division multiplexing.

DS1 to DS0 Multiplexing: Central Office Multiplexing includes the equipment necessary for an arrangement that converts a DS1 channel to twenty-four DS0 channels utilizing time division multiplexing.

Investment Development

DS1 and DS3 Entrance Facility investments are calculated using a Microsoft Excel spreadsheet based model called the NAC (Network Access Channel) model. The NAC model estimates the forward looking installed investment associated with DS1 and DS3 circuits between a SWC and a CLEC's POI.

DS1 and DS3 Direct Trunk Transport

The Interoffice Transport investments for DS1 and DS3 were calculated using the Transport Module (TM). TM calculates the weighted average installed investment required for transport over the Qwest interoffice network. A weighted average investment is obtained by weighting the investments for various forward looking interoffice facility configurations by a state specific probability of occurrence.

Multiplexing

The installed investments for the Central Office Multiplexing were calculated using an Excel spreadsheet based on the required equipment specified by Network Standard Configurations.

Qwest Cost Models Used

QwestICM
NAC
Transport Model

Cell: A90
Comment: Section G - 800 Database Service
DESCRIPTION OF SERVICE
800 Database Query Service is an originating service which provides for the forwarding of CLEC end-user-dialed 8XX-NXX-XXXX calls to a toll carrier, based on the dialed 8XX number. When an 8XX call is originated by a CLEC end user, the CLEC Service Switching Point (SSP) will send an 8XX query to the Qwest 8XX Service Control Point (SCP) through the Qwest Signaling Transfer Point (STP). The Qwest SCP will perform the Carrier Identification Function based on the dialed digits to determine the toll carrier trunk group to which the call should be routed in accordance with the SMS/800 information residing in the Qwest SCP. The SCP will transmit the results of the Carrier Identification Function back to the CLEC SSP through the Qwest STP/Access Tandem. The results of the Carrier Identification Function will be the Carrier Identification Code (CIC) and/or the vertical feature(s) associated with the 8XX number. Call routing information in the SMS/800 reflects the desires of the owner of the 8XX number as entered in the SMS/800 by its chosen Responsible Organization (Resp. Org.).

Vertical Features:
In addition to the basic carrier identification function, 800Database Query Service subscribers may request vertical features through a Responsible Organization in accordance with the SMS/800 User Guide. Vertical features will be maintained within the Qwest SCP when technically feasible.

POTS Translation:
The POTS Translation vertical feature provides the option of having the ten-digit POTS number (i.e., NPA-NXX-XXXX) delivered instead of the 8XX dialed number (i.e., 1+8XX-XXXX) delivered to the service provider.

Call Handling and Destination Features:
Call Handling and Destination Features allow service subscriber's variable routing options by specifying a single carrier, multiple carriers (Exchange and/or Inter-exchange Carriers), single termination or multiple terminations.

STUDY METHODOLOGY
The hardware and software equipment costs were identified using the Switching Cost Model (SCM) Signaling System 7 (SS7) model. This model was developed to determine the economic costs of Qwest's Common Channel Signaling (CCS)/SS7 network. These

economic costs are used to estimate the costs of services that use the SS7 network. One of these services is the InterLATA and IntraLATA 8XX Service. The term "cost" used in the model refers to initial cash outlays for hardware and software. Because software may be expensed, the term investment is not used. The model outputs expressed in terms of costs represent only the initial cash outlays. These outputs are the basis upon which the capital-related and operating expenses associated with these initial cash outlays are computed.

The SCM outputs were input to the TELRIC Cost Model. Factors were applied, including maintenance, ad valorem tax, administrative expense, common, business fees, power, sales tax, telco, interest during construction (IDC), land and building, sales expense, attributed costs and product management expense.

All costs, one time and recurring, were spread over the total levelized 8XX Database calls. The onetime costs are the 8XX Database Application Software and CRIS/CABS programming costs. The recurring costs include ISCP Expenses (Software On-site Installation and Support, Telegate Support per Year, Telecordia Software Support, IBM Software Mtce. Support, SMS/800 Management Team Billing).

Costs are developed for a "Basic Query", "POTS Translation" and "Call Handling".

Cell: A95
Comment: Section H - LIDB
DESCRIPTION
LIDB Query Service is a per query Switched Access Service. The query is assessed on all completed queries regardless of the output of the data. The query represents the transport from the Local Signaling Transfer Point (LSTP) to the Regional Signaling Transfer Point (RSTP) through the Message Relay Service (MRS) to the Service Control Point (SCP) and the actual retrieval of the data from the database. The query also is assessed on queries from the LSTP to the RSTP through the MRS then launched to another provider's SCP.

LIDB Query Service allows a CLEC to query QWEST's LIDB and secure the information to:
Validate a calling card
Automatically identify acceptance or rejection of collect or billed or third number calls, identify the billed number as a QWEST public or semi-public number, identify central office codes as vacant or active
Identify originating screening profiles associated with working telephone numbers,
Retrieve CLEC-defined data that the CLEC has stored in the QWEST LIDB

Thus, when a CLEC sends a Calling Card Verification query, a Billing Number Service query, an Originating Line Number Screening query or a GetData query to the QWEST SS7 network through the interconnection at the LSTP, the CLEC will be assessed a LIDB Query Service query charge.

STUDY METHODOLOGY
The costs are those which result from providing LIDB Query Service. Included in the per query cost are the following:

1. LSTP hardware, LSTP software, LSTP to RSTP data link hardware and software, RSTP hardware, RSTP software, RSTP to MRS SCP data link hardware and software, RSTP to LIDB SCP data link hardware and software, LIDB SCP hardware and software, MRS SCP hardware and software.

2. Database costs and associated labor.

Cell: A98
Comment: Section I - SIGNALING
DESCRIPTION
SS7 Signaling provides a means for transporting signaling information across our network. The following message types were studied:

Signal formulation is the capability of a Common Channel Signaling (CCS) end office or tandem switch to create or decode a CCS message. The ISUP Signal Formulation rate element recovers the costs associated with the formulation of call-related signaling messages for call setup, Integrated Services Digital Network (ISDN) User Part (ISUP), on a per signal message basis. ISUP message length and content specifications are described in CCS/Signaling System 7 protocol.

Signal transport is the capability of the Common Channel Signaling (CCS) data links to carry a signaling message from one signaling network element to another. The ISUP and TCAP Signal Transport rate elements recover the costs associated with the transmission of signaling data between the local Signal Transfer Point (STP) and the Service Switching Point (SSP) end office on a per signal message basis.

Summary of Results

Signal switching is the capability performed by the STP to route a signal message to its proper destination. The ISUP and TCAP Signal Switching rate elements recover the costs associated with switching and routing ISUP and TCAP signaling messages at the local and regional STP on a per signal message basis.

STUDY METHODOLOGY
This study uses the SS7 model to identify the investment and expenses associated with SS7 Signaling. The model identifies the type and amount of hardware and/or software required for each component. Appropriate factors are then applied to convert the per octet or millisecond investments from SCM to per signaled message investments and to convert busy season busy hour investments to annualized per unit investments.

This study also includes the costs associated with measuring and billing the Signaling Unbundled Network Elements (UNE). Investment and direct expense costs of the CROSS7/AMAT7 systems are a part of each UNE signaling rate element cost per signaled message.

Cell: A104
Comment: The STP Port is the customer dedicated point of termination to the signal switching capability of the STP. Each STP port requires an STP link.

The STP port costs were developed from vendor purchase prices. Monthly costs relative to these investments were developed through the use of the STP Port Model, v1.1.xls spreadsheet.

Cell: A106
Comment: Section J - Shared Transport
DESCRIPTION OF SERVICES
Shared Transport is defined as the Co-Provider use of capacity on the U S WEST interoffice message trunk network and central office routing tables for the delivery of switched, voice grade traffic between USW end offices and tandem switches within the local calling area.

Shared Transport is only provided with Unbundled Local Switch Port elements. The existing routing tables resident in the switch will direct both U S WEST and Co-Provider traffic over U S WEST interoffice message trunk network. The Co-Provider may custom route operator services and directory assistance calls to unique trunks. The Co-Provider may not mix unbundled dedicated interoffice message trunk transport and shared transport in the same local calling area.

STUDY METHODOLOGY
This study uses the U S WEST Transport Module (TM) and Switching Module (SM) to calculate the investments associated with transporting calls over the U S WEST interoffice network. The output workbook converts TM and SM outputs to monthly equivalent investments using monthly traffic and mileage data. These investments are in turn converted to monthly costs using the factors calculated by the Expense Factors Module and Capital Costs Module.

STUDY ASSUMPTIONS

a. Costs are based on a least cost scorched node scenario and represent the cost of fully replacing the network required to provision the service, beginning from the existing grid of network nodes used by U S WEST today.
b. Costs do not reflect the emergence of widespread competition in the local exchange market.
c. All network investments are forward-looking:
i. Switching and transport equipment and facilities are digital.
ii. SONET is the forward looking technology in the interoffice network.
d. Standby capacity is a volume-sensitive cost. Non-volume sensitive spare switching capacity (e.g., modular spare) is a shared cost. Please refer to documentation for the Switching Module for further explanation.

Cell: A110
Comment: Section K - UDIT/EEL
Unbundled Dedicated Interoffice Transport (UDIT) provides the CLEC with a network element of a single transmission path between USW Wire Centers in the same LATA and state. UDIT is a bandwidth-specific interoffice transmission path designed to a DSX panel (or equivalent) in each Qwest Wire Center. The CLEC must have collocation in the USW serving wire center and have requested termination capacity through the collocation process. UDIT is available in DS0, DS1, DS3, OC-3, OC-12 and OC-48 where facilities are available. UDIT is distance sensitive and is for the sole use of the CLEC. The CLEC can assign channels and transport its choice of voice or data. UDIT is a point-to-point transmission path and not a self healing product.

UDIT consists of two elements; fixed and per mile costs. The fixed element contains the costs associated with the terminating equipment at both ends of the transmission path. The per mile costs contain the costs associated with cable, repeaters, and intermediate central office equipment. The fixed are expressed per DS0, DS1, DS3, OC-3, OC-12 or OC-48 circuit and the per mile costs are expressed per DS0, DS1, DS3, OC-3, OC-12 or OC-48 circuit, per airline mile.

The costs of DS0, DS1, DS3, OC3, OC12 or OC48 EEL are equivalent to the costs of the corresponding UDIT.

Summary of Results

Investment Development

The Interoffice Transport investments for DS0, DS1, DS3, OC-3, OC-12 and OC-48 were calculated using the Transport Module (TM). TM calculates the weighted average installed investment required for transport over the Qwest interoffice network. A weighted average investment is obtained by weighting the investments for various forward looking interoffice facility configurations by a state specific probability of occurrence.

Cell: A111
Comment: DS3 to DS1 Multiplexing: Central Office Multiplexing includes the equipment necessary for an arrangement that converts a DS3 channel to twenty-eight DS1 (1.544 Mbps) channels utilizing time division multiplexing.

DS1 to DS0 Multiplexing: Central Office Multiplexing includes the equipment necessary for an arrangement that converts a DS1 channel to twenty-four DS0 channels utilizing time division multiplexing.

The multiplexing costs are aqual to the multiplexing costs provided in this study for Direct Trunked Transport.

Cell: A175
Comment: E-UDIT:
Extended Unbundled Dedicated Interoffice Transport (EUDIT) provides the CLEC with a bandwidth specific transmission path between the Qwest Serving Wire Center to the CLEC's wire center or an IXC's point of presence located within the same Qwest Serving Wire Center area. EUDIT is available in DS0, DS1, DS3, OC-3, OC-12, and OC-48 bandwidths where facilities are available. CLEC can assign channels and transport its choice of voice or data. Specifications, interfaces and parameters are described in Qwest Technical Publication 77389.

EUDIT investments are calculated using a Microsoft Excel spreadsheet based model called the NAC (Network Access Channel) model. The NAC model estimates the forward looking installed investment associated with circuits between a SWC and a CLEC's POI.

Input Summary

Changed Input Item	Base	This Run
Distribution Fill - DG1	0.5	0.75
Distribution Fill - DG2	0.5	0.7
Distribution Fill - DG3	0.33	0.65
Distribution Fill - DG4	0.33	0.6
Distribution Aerial Pct. - DG1	0.14	0.2
Distribution Aerial Pct. - DG2	0.14	0.25
Distribution Aerial Pct. - DG3	0.14	0.25
Distribution Aerial Pct. - DG4	0.14	0.2
Distribution Aerial Pct. - DG5	0.14	0.2
Feeder Aerial Pct	0.14	0.2
Buried Drop Sharing - DG3	0.2	0.35
Buried Drop Sharing - DG4	0.2	0.35
Buried Drop Sharing - DG5	0.2	0.35
Underground Shared Percentage	0.05	0.2
Dist. Plcmt. Use - Trench & Backfill in DG1	0.2	0.25
Dist. Plcmt. Use - Rocky Trench in DG1	0.05	0.14
Dist. Plcmt. Use - Plow in DG1	0	0.05
Dist. Plcmt. Use - Rocky Plow in DG1	0	0.05
Dist. Plcmt. Use - Cut & Restore Concrete in DG1	0.15	0.1
Dist. Plcmt. Use - 2 Inch Bore Cable in DG1	0.14	0.1
Dist. Plcmt. Use - Cut & Restore Asphalt in DG1	0.2	0.1
Dist. Plcmt. Use - Cut & Restore Sod in DG1	0.15	0.1
Dist. Plcmt. Use - Trench & Backfill in DG2	0.25	0.3
Dist. Plcmt. Use - Rocky Trench in DG2	0.05	0.1
Dist. Plcmt. Use - Plow in DG2	0	0.1
Dist. Plcmt. Use - Rocky Plow in DG2	0	0.06
Dist. Plcmt. Use - Cut & Restore Concrete in DG2	0.1	0.05

Changed Input Item	Base	This Run
Dist. Plcmt. Use - 2 Inch Bore Cable in DG2	0.21	0.15
Dist. Plcmt. Use - 4 Inch Bore Cable in DG2	0.09	0.04
Dist. Plcmt. Use - Cut & Restore Asphalt in DG2	0.1	0.05
Dist. Plcmt. Use - Cut & Restore Sod in DG2	0.15	0.11
Dist. Plcmt. Use - Trench & Backfill in DG3	0.25	0.3
Dist. Plcmt. Use - Rocky Trench in DG3	0.05	0.1
Dist. Plcmt. Use - Plow in DG3	0	0.1
Dist. Plcmt. Use - 2 Inch Bore Cable in DG3	0.32	0.2
Dist. Plcmt. Use - 4 Inch Bore Cable in DG3	0.13	0.1
Dist. Plcmt. Use - Cut & Restore Asphalt in DG3	0.1	0.05
Dist. Plcmt. Use - Rocky Trench in DG4	0.02	0.03
Dist. Plcmt. Use - Plow in DG4	0.28	0.33
Dist. Plcmt. Use - 2 Inch Bore Cable in DG4	0.14	0.09
Dist. Plcmt. Use - 4 Inch Bore Cable in DG4	0.06	0.05
Dist. Plcmt. Sharing - Trench & Backfill in DG1	0.2	0.7
Dist. Plcmt. Sharing - Rocky Trench in DG1	0.2	0.7
Dist. Plcmt. Sharing - Plow in DG1	0.2	0.7
Dist. Plcmt. Sharing - Rocky Plow in DG1	0.2	0.7
Dist. Plcmt. Sharing - Cut & Restore Concrete in DG1	0.2	0.7
Dist. Plcmt. Sharing - Hand Dig Trench in DG1	0.2	0.7
Dist. Plcmt. Sharing - 4 Inch Bore Cable in DG1	0.2	0.5
Dist. Plcmt. Sharing - Cut & Restore Asphalt in DG1	0.2	0.7
Dist. Plcmt. Sharing - Cut & Restore Sod in DG1	0.2	0.7
Dist. Plcmt. Sharing - Trench & Backfill in DG2	0.2	0.6
Dist. Plcmt. Sharing - Rocky Trench in DG2	0.2	0.6
Dist. Plcmt. Sharing - Plow in DG2	0.2	0.6
Dist. Plcmt. Sharing - Rocky Plow in DG2	0.2	0.6

Changed Input Item	Base	This Run
Dist. Plcmt. Sharing - Cut & Restore Concrete in DG2	0.2	0.6
Dist. Plcmt. Sharing - Hand Dig Trench in DG2	0.2	0.6
Dist. Plcmt. Sharing - 4 Inch Bore Cable in DG2	0.2	0.5
Dist. Plcmt. Sharing - Cut & Restore Asphalt in DG2	0.2	0.6
Dist. Plcmt. Sharing - Cut & Restore Sod in DG2	0.2	0.6
Dist. Plcmt. Sharing - Trench & Backfill in DG3	0.2	0.5
Dist. Plcmt. Sharing - Rocky Trench in DG3	0.2	0.5
Dist. Plcmt. Sharing - Plow in DG3	0.2	0.5
Dist. Plcmt. Sharing - Rocky Plow in DG3	0.2	0.5
Dist. Plcmt. Sharing - Cut & Restore Concrete in DG3	0.2	0.5
Dist. Plcmt. Sharing - Hand Dig Trench in DG3	0.2	0.5
Dist. Plcmt. Sharing - 4 Inch Bore Cable in DG3	0.2	0.5
Dist. Plcmt. Sharing - Cut & Restore Asphalt in DG3	0.2	0.5
Dist. Plcmt. Sharing - Cut & Restore Sod in DG3	0.2	0.5
Dist. Plcmt. Sharing - Trench & Backfill in DG4	0.2	0.35
Dist. Plcmt. Sharing - Rocky Trench in DG4	0.2	0.35
Dist. Plcmt. Sharing - Plow in DG4	0.2	0.35
Dist. Plcmt. Sharing - Rocky Plow in DG4	0.2	0.35
Dist. Plcmt. Sharing - Cut & Restore Concrete in DG4	0.2	0.35
Dist. Plcmt. Sharing - Hand Dig Trench in DG4	0.2	0.35
Dist. Plcmt. Sharing - 4 Inch Bore Cable in DG4	0.2	0.35
Dist. Plcmt. Sharing - Cut & Restore Asphalt in DG4	0.2	0.35
Dist. Plcmt. Sharing - Cut & Restore Sod in DG4	0.2	0.35
Fdr. Plcmt. Use - Trench & Backfill - Urban	0.3	0.35
Fdr. Plcmt. Use - Rocky Trench - Urban	0.05	0.1
Fdr. Plcmt. Use - Plow - Urban	0	0.05
Fdr. Plcmt. Use - Rocky Plow - Urban	0	0.05

Input Summary

Changed Input Item	Base	This Run
Fdr. Plcmt. Use - Cut & Restore Concrete - Urban	0.15	0.1
Fdr. Plcmt. Use - 2 Inch Bore Cable - Urban	0.07	0.02
Fdr. Plcmt. Use - Cut & Restore Asphalt - Urban	0.2	0.15
Fdr. Plcmt. Use - Cut & Restore Sod - Urban	0.15	0.1
Fdr. Plcmt. Sharing - Trench & Backfill - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Rocky Trench - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Plow - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Rocky Plow - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Cut & Restore Concrete - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Hand Dig Trench - Urban	0.2	0.6
Fdr. Plcmt. Sharing - 4 Inch Bore Cable - Urban	0.2	0.5
Fdr. Plcmt. Sharing - Cut & Restore Asphalt - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Cut & Restore Sod - Urban	0.2	0.6
Fdr. Plcmt. Sharing - Trench & Backfill - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Rocky Trench - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Plow - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Rocky Plow - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Cut & Restore Concrete - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Hand Dig Trench - Rural	0.2	0.4
Fdr. Plcmt. Sharing - 4 Inch Bore Cable - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Cut & Restore Asphalt - Rural	0.2	0.4
Fdr. Plcmt. Sharing - Hydro Mulch - Rural	0.2	0.4
Buried Drop - 2 Pair - Mobilization	40.15	0
Buried Drop - 3 Pair - Mobilization	40.15	0
Aerial Drop - Aerial Drop -per foot	61.43	30
Aerial Drop Length - Distribution Group 4:	200	100
Aerial Drop Length - Distribution Group 5:	300	100

Input Summary

Changed Input Item	Base	This Run
Buried Drop Length - Distribution Group 4:	200	150
Buried Drop Length - Distribution Group 5:	300	200