BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In Re: Investigation into Pricing Unbundled Network Elements	) DOCKET NO. 990649B-TP

REBUTTAL TESTIMONY OF

DR. AUGUST H. ANKUM

QSI CONSULTING, INC.

(Addressing Cost Methodologies for Recurring and Non-recurring Charges, Loops, EELs, Switching, Geographic De-averaging, Cost of Capital and Depreciation)

On Behalf of

AT&T Communications of the Southern States, Inc.
MCImetro Access Transmission Services, LLC &
MCI WorldCom Communications, Inc.
Florida Digital Network, Inc.
(collectively called the "ALEC Coalition")

January 30, 2002

THIS TESTIMONY AND THE ATTACHED EXHIBITS CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION DENOTED BY ** **

PUBLIC VERSION

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JANUARY 30, 2002

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

A. My name is Dr. August H. Ankum. I am a Senior Vice President at QSI Consulting, Inc., a consulting firm specializing in economics and telecommunications issues. My business address is 1261 North Paulina, Suite #8, Chicago, IL 60622.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND WORK EXPERIENCE.

A. I received a Ph.D. in Economics from the University of Texas at Austin in 1992, an M.A. in Economics from the University of Texas at Austin in 1987, and a B.A. in Economics from Quincy College, Illinois, in 1982.

My professional background covers work experiences in private industry and at state regulatory agencies. As a consultant, I have worked with large companies, such as AT&T, AT&T Wireless and MCI WorldCom ("MCIW"), as well as with smaller carriers, including a variety of competitive local exchange carriers ("CLECs") and wireless carriers. I have worked on many of the arbitration proceedings between new entrants and incumbent local exchange carriers ("ILECs"). Specifically, I have been involved in arbitrations between new entrants and NYNEX, Bell Atlantic, US West, BellSouth, Ameritech, SBC, GTE and Puerto Rico Telephone. Prior to practicing as a telecommunications consultant, I worked for MCI Telecommunications Corporation ("MCI") as a senior economist. At MCI, I provided expert witness testimony and conducted economic analyses for internal purposes. Before I joined MCI in early 1995, I worked for Teleport Communications Group, Inc. ("TCG"), as a Manager in the Regulatory and External Affairs Division. In this capacity, I testified on behalf of TCG in proceedings concerning local exchange competition issues, such as Ameritech's Customer First proceeding in Illinois. From 1986 until early 1994, I was employed as an economist by the Public Utility Commission of Texas ("PUCT") where I worked on a variety of electric power and telecommunications issues. During my last year at the PUCT I held the position of chief economist. Prior to joining the PUCT, I taught undergraduate courses in economics as an Assistant Instructor at the University of Texas from 1984 to 1986.

A list of proceedings in which I have filed testimony is attached hereto as Exhibit AHA-1.

I. INTRODUCTION AND PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of this testimony is to evaluate the merit of a number of Verizon, Inc.'s ("Verizon's") cost studies. In general, I will discuss cost studies for loops, switching, and Enhanced Extended Links (EELs), cost of capital, depreciation, as well as methodological issues related to TELRIC and non-recurring costs.

The cost standard by which I judge these studies is the TELRIC methodology, as established and explained in the FCC's Local Competition Order (*First Report and Order*, CC Docket No. 96-98, released August 8, 1996) and the previous TELRIC Orders of the Florida Public Service Commission.

Further, I believe that it is important to place this TELRIC proceeding in the larger context of the troubled state of the competitive telecommunications industry in general. To this purpose, I present the results of a financial analysis of the major CLECs, including the larger IXCs. This analysis shows that the CLEC industry is at a critical juncture and underscores how important it is that the Commission approve appropriate, TELRIC based rates.

Specifically, I have calculated the change in market value of the CLEC industry over the period of December 31, 1999 through April 23, 2001, based on the value of the common shares held by investors. For the IXC and CLEC industries the total decline in market capitalization over this period is a staggering *$405 billion, or 64%(see Exhibit 2).* The data for just CLECs, excluding IXCs, is $122 billion, or 69%. By contrast, the RBOCs experienced declines in market capitalization over the same period of only 16%, a percentage roughly comparable to the decline in the S&P 500 Index. While this analysis is not specific to Florida, the Commission should consider that many of the carriers operating in Florida are affected by these national trends.

Clearly, there are a large number of reasons for why the CLECs have experienced such a dramatic decline in market value. One of the more important reasons, however, is the fact that CLECs continue to pay too much to the ILECs -- their main competitors -- for network elements and collocation services, facilities and services without which they simply cannot enter local markets efficiently and viably. It is against the backdrop of this analysis that I urge the Commission to rigorously apply the TELRIC principles delineated in the FCC's First Report and Order and *reject* all attempts on the part of Verizon to pad its rates with inefficiently incurred costs or otherwise increase rates in order to erect barriers to entry. As my financial analysis shows, the CLEC industry simply can no longer afford to shoulder the burden of anti-competitive proposals.

Q. ARE THERE OTHER WITNESSES FILING ON BEHALF OF THE COALITION?

A. Yes. Also filing testimony for the CLEC Coalition are the following witnesses: Mr. Warren R. Fischer and Mr. Sidney L. Morrison. Mr. Warren Fischer discusses Verizon's shared and common costs and annual charge factors. Mr. Sidney L. Morrison discusses issues related to Verizon's proposed non-recurring charges.

II. SUMMARY OF FINDINGS AND RECOMMENDATIONS

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS AND STATE YOUR RECOMMENDATIONS.

A. From my evaluation of Verizon's studies, I have concluded that Verizon's ICM as filed in this proceeding, is not auditable, is not reliable, does not model the least cost most efficient network design and cannot be used to produce UNE rates that are compliant with FCC TELRIC pricing rules. In addition, I found a large number of errors. While some of those errors may be the result of disagreements on how to apply TELRIC principles appropriately, others seems to point to more deliberate efforts on the part of Verizon to obstruct this Commission's and intervenors' efforts to review its cost model and in an effort to create unreasonably high UNE rates and protect its customer base against competitive entry.

In general, it should be noted that Verizon rates proposed here in Florida are many times higher than Verizon rates in other jurisdictions. This is inappropriate. Verizon is the nation's largest incumbent LEC and should be able to capitalize on all the efficiencies of scale and scope afforded by the size of its operations. This is particularly true for switching studies (since switches are purchased on a serving area wide vendor contracts that reflect the purchasing power of all of Verizon's operations) and operational support systems, but it is also true for other parts of Verizon's operations. In view of this, the Commission should not treat the presented cost studies as GTE studies – based on the costs of a much smaller company – but as Verizon studies. Such treatment is essential under TELRIC because the foundation of TELRIC is that it is forward looking. The Commission must look forward in its assessment of Verizon-FL as part of the larger Verizon and not back to the old GTE Florida, Inc.'s past.

My findings and recommendations are the following:

Loop Cost Studies:

- Verizon's ICM does not model the forward-looking least cost network architecture.

  - ICM fails to place the RT as close to the customer as possible to capitalize on the efficiencies of the relatively inexpensive fiber facilities. As a result, the model assumes too much copper in the feeder and the distribution links. Often, the use of a secondary SAI (serving area interface) increases the use of copper facilities. This flaw is hard-coded in ICM and cannot be changed by the Commission or intervenors.

- ICM fails to consider that for larger buildings, it is less expensive to place the RT on the customer premises, thus avoiding the use of expensive copper feeder and distribution facilities. The efficiency of this practice is recognized by Verizon in other jurisdictions. This flaw is hard-coded in ICM and cannot be changed by the Commission or intervenors.

- The length of drop and entrance cables modeled by ICM is not accurate and is too long. Further, drop and entrance cables lengths should be de-averaged. For zones 1 through 3, the lengths should be selected as *user defined inputs* (an option is ICM) at 75, 100, and 150 feet, respectively. This flaw is hard-coded in ICM and cannot be changed by the Commission or intervenors

- Verizon's ICM fails to determine the actual location of any customer. Unlike the HAI model or BellSouth's BSTLM, Verizon's ICM does not identify were customers are located. Verizon's ICM make an erroneous assumption that customers are equally distributed throughout a fixed arbitrary grid. This erroneous assumption results in excessive amounts of plant being modeled and plant being placed to locations where no customers exist.

- Verizon's fill factors are generally too low and do not reflect a forward-looking, least cost network built for "a reasonable projection of actual demand." Verizon includes excessive amounts of spare to serve future customers. Since current customers – the CLECs – are not the cost causers of costs for facilities to serve anticipated future demand, this spare is inappropriate in a TELRIC study.

- Cost studies for Digital Loop Carrier ("DLC") based loops should be assumed to be Integrated DLC technologies. No universal service interfaces (channel units) should be used in the studies.

- Verizon fails to address the concentration ratio on the IDLC. The concentration ratio should be 6:1. (This flaw is hard-coded in ICM and cannot be changed by the Commission or intervenors.)

DS-1 Unbundled Loops:

- Verizon's proposed charges for DS-1 Loops are a multiple of the rates charged by Verizon in other jurisdictions and those charged by some other RBOCs. The costs are inflated for the most part because

Verizon assumes excessively low fill factors for its SONET based transport.

EELs:

- As with many of its other rates, Verizon's rates for multiplexing are a multiple of those charged by other ILECs and by Verizon itself in other jurisdictions. Much of the costs are calculated in the "black-box" ICM model, and thus the source of the inflated costs can not be determined with certainty. However, most likely it concerns excessively low fill factors for 357c equipment. The fills should be no lower than 90%.

<u>Switching Cost Studies:</u>

- The GTD-5 is not used by Verizon anywhere except for former GTE operations. It should be eliminated from the forward-looking, least-cost technology mix.

- Switching studies should be based on an appropriate weighting of the high discounts for new switches and low discounts for growth on existing switches -- not the lower growth discounts used by Verizon in SCIS and COSTMOD. Exhibit AHA-3 provides calculations of determining the appropriate weighing of growth and cutover lines using a method that considers the relative proportion of new and growth facilities over the entire economic life of a switch. The result is a weighing of 72% new/cutover line discounts and a 28% growth line discounts.

Verizon's rate proposal that requires CLECs to purchase features on an *a la carte* basis is generally anticompetitive and serves only to artificially inflate recurring and non-recurring charges. Monthly switch port charges should include the availability and use of all features. This eliminates the need for any service ordering activities and associated nonrecurring costs for features.

<u>Non-recurring Charges:</u>

- Nonrecurring charges should be based on forward-looking, least cost processes and exclude the need for expensive labor intensive manual processes.

Geographic De-Averaging:

- Rates should be appropriately de-averaged to reflect cost variations across geographic regions. Verizon's opposition to de-averaging based on arguments regarding universal service concerns should be ignored.

Cost of Capital:

- Based upon the Commission's decision in the BellSouth phase of this proceeding and the orders I cite from New York and New Jersey, I recommend that the Commission set Verizon's cost of capital no higher than the 10.24% approved for BellSouth and no lower than the 8.8% approved for Verizon in New Jersey. In doing so, the Commission should require that equity comprise no more than 60% of Verizon's capital structure.

Depreciation:

- I recommend that the Commission use the range of FCC approved lives. However, if the Commission does not accept my recommendation to use the range of projection lives approved by the FCC, then I recommend that the Commission adopt the lives approved for BellSouth in the earlier phase of this proceeding since they are relatively close to those approved by the FCC.

III. GENERAL RATE COMPARISON AMONG VERIZON COMPANIES

Q. HAS QSI REVIEWED VERIZON'S COST STUDIES IN OTHER JURISDICTIONS?

A. Yes. Over the last two years, QSI has participated in TELRIC proceedings for Verizon in a number of jurisdictions, such as New Jersey, New York, Maryland and Massachusetts.

Q. SHOULD VERIZON'S COSTS HERE IN FLORIDA BE COMPARABLE TO THOSE IN OTHER JURISDICTIONS AND REFLECT THAT VERIZON IS THE NATION'S *LARGEST ILEC*?

A. Yes. But reading Verizon's testimony, it is obvious that the company is using cost analysts and costs studies from the old GTE companies. The witnesses are former GTE employees and the ICM cost model is used nowhere else by Verizon but for the former GTE companies.

The Commission should make every effort, however, to evaluate the cost studies and the proposed rates against the standards that applys to *Verizon as the nations' largest local exchange carrier*. Since the merger, the former GTE companies operate under Verizon management and procedures and facilities and network equipment are being procured under Verizon contracts. The combined company -- as Verizon itself argued in its merger application -- will be able to operate more efficiently by implementing best practices and leveraging its buying powers associated with large volume purchases.

In the post-merger environment, therefore, it is important that the Commission evaluate Verizon's cost studies and rates filed in the current proceeding against, among other standards, filings made by Verizon for the same unbundled elements in proceedings in other states. Of course, this type of comparative evaluation, which involves comparisons of rates and costing procedures, is standard practice for larger ILECs, such as

Verizon, SBC, BellSouth and Qwest. In fact, the Commission itself routinely considers for comparison evidence concerning, for example, BellSouth's proposals and rates in other BellSouth states. Such cross-state comparisons reveal interesting patterns and can point the Commission to inconsistencies in company positions that may adversely affect the public interest in Florida. In short, given that the former GTE operations now operate as part of Verizon, the studies and rates should be evaluated not just against the FCC's TELRIC standard but against Verizon filings in other states as well as those of similar large ILECs such as BellSouth.

Q. ALTHOUGH COMPARISONS TO OTHER JURISDICTIONS ARE USEFUL, SHOULD RATES BE TELRIC BASED?

A. Yes. The comparison of Verizon's cost studies and rate proposals filed here in Florida against those filed by Verizon in other states only serves to detect obvious attempts to inflate costs. For example, if Verizon here in Florida proposes certain switching rates while the same switching functionality is offered by Verizon in New Jersey, New York, and other states at a fraction of the costs, then the Commission knows that Verizon's cost studies filed in Florida are artificially inflated. The rates in other states act as a "sanity check" but ultimately the Commission must set TELRIC-based rates.

Q. ARE VERIZON'S PROPOSED RATES UNREASONABLY HIGH RELATIVE TO VERIZON'S RATES FOUND IN OTHER STATES?

A. Yes. Exhibit AHA-4 compares for a select set of UNEs Verizon's rates proposed here in Florida to Verizon's rates in two other jurisdictions where Verizon's rates have recently been reviewed.

It is clear from this comparison that Verizon's proposed rates are unreasonably high relative to those that prevail in other Verizon states where rates have recently been evaluated. I believe the rates are so high because, among other reasons, the GTE witnesses and GTE cost models continue to rely on GTE's embedded operations and simply fail to reflect the post merger environment and the efficiencies of Verizon as the largest ILEC in the nation.

Q. BUT ARE THERE NO ASPECTS OF VERIZON'S OPERATIONS HERE IN FLORIDA THAT WOULD CAUSE IT TO HAVE HIGHER COSTS THAN ELSEWHERE?

A. This argument should be treated with great suspicion. First, Verizon has used this very same argument in other states, such as New York, to justify higher proposed rates. Second, this argument is unpersuasive where it concerns costs related to functions such as switching and service ordering. On a forward-looking basis, switches will be purchased under the Verizon contracts that are serving-area wide and reflect the purchasing power of the larger corporation. Given that some of the cost components of switching, such as real estate, are likely to be cheaper for Verizon's operations here in Florida than, for example, those in Manhattan, switching costs here in Florida should be comparable and possibly lower than those in New York. Also, service ordering and many functions associated with the non-recurring charges should reflect the efficiencies of Verizon's operations and should not be evaluated based on the much smaller GTE operations. GTE's former service ordering centers presumably are – or should be – consolidated with the Verizon service ordering centers (surely, they should be presumed consolidated for cost study purposes.) As such, the costs should be roughly the same as elsewhere for Verizon. Moreover, given the size of Verizon's operations, many of the non-recurring charges should, in fact, be no higher than, say, those approved by the Commission for BellSouth.

Third, as long as costs are appropriately de-averaged, the Commission should be able to make an apples-to-apples comparison between Verizon's rates proposed here and the Verizon's rates that prevail in other states. For example, it is not clear to me why Verizon's proposed loop rates in the rural areas (Zone 3) should be *more than seven times as high* as Verizon's loop rates in wooded, remote, mountainous, rural New Jersey. One is left wondering: how wild and uncultivated does Verizon think that rural Florida is?

In short, it is no longer appropriate for the former GTE analysts to rely on the notion that their cost studies are for a smaller more rural local exchange company that may need protection in order to preserve universal service, arguments heavily relied on in the past by GTE witnesses. Verizon is the largest ILEC in the nation – the Commission should treat it as such.

Q. IF THE COMMISSION ARTIFICIALLY PROTECTS VERIZON FROM COMPETITION WILL THIS BE DISCRIMINATORY TOWARDS BELLSOUTH AS WELL?

A. Yes. Obviously, at the rates proposed by Verizon, no UNE based competition will be possible in Verizon's serving area in Florida. This result should be most troublesome to BellSouth. First, to the extent that competition continues to grow in Florida, it will tend to favor the BellSouth serving area since the UNE rates are relatively more favorable. Further, as competition develops between BellSouth and Verizon, BellSouth faces an uphill battle in that Verizon will have certain territories that are relatively off limit to competition while the Commission may continue to set rates for BellSouth's UNEs that to a greater or smaller degree do allow for competitive entry. The old practice of protecting GTE as a smaller and more rural company is simply no longer appropriate and will lead to troublesome distortions not just for the CLECs but for BellSouth as well.

IV. GENERAL COSTING AND PRICING ISSUES

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

A. In general, Verizon's cost studies should be reviewed in light of the FCC's TELRIC principles as defined in the FCC's Local Competition Order and the Commission's own TELRIC Orders. In general, the TELRIC principles can be summarized as follows:

Principle # 1: *The firm should be assumed to operate in the long run.*

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

Principle # 3: *Technology choices should reflect least-cost, most efficient technologies.*

Principle # 4: *Costs should be forward-looking.*

Principle # 5: *Cost identification should follow cost causation.*

Q. HAS THE FCC MADE OTHER RELEVANT COMMENTS REGARDING

OPERABILITY OF COST MODELS?

A. Yes. In addition to these TELRIC principles, the FCC also noted that *cost models should be transparent*, *open and verifiable* by Commissions and intervenors. The FCC directed that in upcoming cases to be arbitrated by the FCC, involving VerizonVerizon and three CLECs, computerized cost models "must be submitted in a form that allows the Arbitrator and the parties to alter inputs and determine the effect on cost estimates." (Procedures Established for Arbitration of Interconnection Agreements Between Verizon, AT&T, Cox, and WorldCom, DA 01-270 (February 1, 2001), Paras. A.2.1.i; A.3.1.c.)

In my review of the cost studies I will continuously refer back to these basic but essential cost principles.

Q. IN YOUR OPINION, IS VERIZON' COST MODEL TRANSPARENT, OPEN AND VERIFIABLE BY COMMISSION'S AND INTERVENORS?

A. No. The ICM is not an open model. Cost analysts cannot verify the model itself because it is nearly impossible to audit the algorithms without extraordinary effort. Moreover, certain types of assumptions are essentially "embedded" in the software program and cannot be altered without rewriting and recompiling the programming code. I will elaborate on the problems with Verizon's cost model later in my testimony.

V. <u>THE CLECS CAN NO LONGER AFFORD INFLATED RATE PROPOSALS</u>

Q. HAVE YOU PERFORMED A FINANCIAL ANALYSIS TO SHOW THAT THE COMPETITIVE INDUSTRY IS NO LONGER ABLE TO SUPPORT VERIZON'S INFLATED RATE PROPOSALS?

A. Yes. I have performed an analysis that calculates the dramatic change in market value of the CLEC industry over the period of December 31, 1999 through April 23, 2001, based on the value of the common shares held by investors. For the IXC and CLEC industries, the total decline in market capitalization over this period is a staggering *$405 billion, or 64%.* Exhibit AHA-2 illustrates the CLECs, IXCs, and RBOCs for which the change in market capital has been calculated. The data for just CLECs, excluding IXCs, is *$122 billion, or 69%.* By contrast, the RBOCs experienced declines in market capitalization over the same period of *only 16%,* a percentage roughly comparable to the decline in the S&P 500 Index.

Q. PLEASE DESCRIBE IN MORE DETAIL HOW YOU CALCULATED THE CHANGE IN MARKET CAPITALIZATION.

A. As noted, this change in value was determined from December 31, 1999 to April 23, 2001. Market capitalization as of December 31, 1999 was used as the baseline value for two primary reasons: (1) this point in time was still within the bull market period before the first significant market correction took place in the first quarter of 2000; and (2) the components necessary to calculate market capitalization, common shares outstanding and market price, were both readily available from publicly available sources such as websites that provide current and historical price quotes and Securities Exchange Commission ("SEC") filings.

The companies included in the analysis were classified into three categories:

(1) CLECs & Wholesale Suppliers

This category includes CLECs and wholesale suppliers. Not included are the CLEC divisions of the major IXCs – they are included in the third category described below. (The companies included in this category are identified in Exhibit AHA-2.)

(2) RBOCs

This category includes the four remaining RBOCs: Qwest, SBC, BellSouth, and Verizon.

(3) Major IXCs

This category includes the major IXCs: Williams Communications, Level 3 Communications, Global Crossing, Sprint, WorldCom, and AT&T.

These categories mirror the groups of companies that are compared and contrasted within the Kellogg-Huber Report of April 5, 2001, *Competition for Special Access Service, High Capacity Loops, and Interoffice Transport*, attached to the petition filed by Verizon, SBC and BellSouth before the FCC to be relieved of their obligations to provide unbundled access to high-capacity facilities. (Joint Petition of BellSouth, SBC, and Verizon for Elimination of Mandatory Unbundling of High-Capacity Loops and Dedicated Transport, CC Docket No. 96- 98, DA 01-911, April, 2001).

Major IXCs such as AT&T, WorldCom, Level 3, and Sprint that also operate as CLECs were separated from the CLECs & Wholesale Suppliers category because the nature and scope of their operations are quite different from the other CLECs.

The Debt to Equity ratio was also determined for each company over the same time period to measure changes in relative financial strength based on the amount of debt used to fund operations versus stockholder's equity. Large ratios or ratios that increase over time indicate declining financial strength as debt becomes a larger component of the firm's capital structure. This can be attributed to a greater use of debt as equity markets dry up, declining stockholder's equity as a result of accumulated operating deficits, or a combination of both.

Q. PLEASE DISCUSS THE RESULTS OF YOUR ANALYSIS.

A. The analysis demonstrates that the competitive carriers have suffered serious financial setbacks over the last year. The decline in market capitalization for the three categories, CLECs & Wholesale providers, RBOCs and Major IXCs, is 69%, 16%, and 62% respectively.

A more detailed breakdown of the decline in market capitalization for these three categories of carriers is found in tables 1, 2, and 3 in Exhibit . AKA-5. The summary results are illustrated in the graphs.

A large number of publicly traded CLECs have filed for bankruptcy protection or liquidation in the last six months and others are on the brink within the year. The number of remaining CLECs that have reported negative stockholders' equity due to accumulated operating deficits increased to nine as of December 31, 2000 compared to five as of December 31, 1999.

Since the market capitalization decline of the CLECs and IXCs is significantly greater than for the RBOCs, the relative value of each group to the total of the three groups combined has also changed dramatically. Exhibit AHA-2 illustrates the increasing relative financial strength of the RBOCs over the last 15 months.

It is clear from revenue of this exhibit that the financial strength of the remaining four RBOCs is increasingly dominating the telecommunications industry. It is also clear that the state of the CLEC industry is not as rosy as Verizon would have the Commission believe.

Q. HAS THE FINANCIAL DECLINE IN MARKET CAPITALIZATION OF THE CLEC INDUSTRY BEEN NOTED BY THE FINANCIAL COMMUNITY AND THE PRESS?

A. Yes. The collapse in market value of the competitive telecommunications industry, including long distance, which is apparent from the financial data, has been duly noted by the financial community and the press. Not a day goes by without some pundit or another commenting on the dismal state of telecommunications competition. As Brian Adamik of the Yankee Group concludes:

> In telecommunications, we are rolling back the competitive progress made over the last ten years – disabling the enabling industry of economic growth when we need it most. (Brian Adamik, Yankee Group, *The Death of Competitive Telecom?* CBS MarketWatch, May 3, 2001).

Other articles go so far as to declare the entire competitive effort to be a failure and note that the RBOCs have slowly but steadily out-maneuvered their would-be competitors. A recent article in The New York Times declared that the battle is over:

> Of the Baby Bell local phone carriers, once seven in number, three [sic] remain — Qwest Communications, SBC Communications and Verizon Communications — and they are by far the most powerful and important communications companies in the nation. The corporations once known as long-distance carriers, like AT&T, are shells of their former

selves. ... The Bells — the race's tortoises — have won. (Seth Schiesel, *Sitting Pretty: How Baby Bells May Conquer Their World*. The New York Times, Money & Business, Section 3, page 1. Sunday, April 22, 2001.

The potential danger to the nation's economy cannot be overstated. As is well recognized, the telecommunications industry is a critical component in the "high-tech engine" that has propelled our economy forward over a period longer than any other in modern times. That "engine" is now at risk of being usurped – as a natural result of the corporate quest for profit maximization -- by a small group of very powerful companies: the RBOCs. As Wired magazine notes in yet another article on the demise of the competitive telecommunications industry:

> The Bells own 88 percent of the local lines in the US and upgrade on their own terms – conveniently, after most of their competitors have died off. (Frank Rose, Telechasm: *Can we get to the future from here? First we have to get telecom out of the Stone Age*. Wired, May 2001, page 131).

Whatever may be the merit of these somber prognoses, the fact remains that the competitive telecommunications industry is struggling to survive. In the war of attrition, waged by the RBOCs against their competitors, in the market place, in the U.S. Congress, the courts, and before regulators, it has not gone well for the CLEC industry: and the financial community knows it. Since regulatory policies are a critical component of the overall landscape, it is most important that regulators stand firm – now more than ever -- against all attempts on the part of the ILECs to raise barriers to entry any further.

V. GENERAL DISCUSSION OF VERIZON'S (GTE'S) ICM MODEL

. HAVE YOU REVIEWED VERIZON'S (GTE'S) ICM MODEL?

A. Yes, I have reviewed the written testimony, data responses, and the supporting documentation for ICM. I have also examined the ICM model itself, as it was provided on CD.

ICM is a computerized cost modeling system. It is a very complex software application that accepts certain types of inputs, and performs calculations to determine the costs of Basic Network Functions ("BNFs") and Unbundled Network Elements ("UNEs"). Included among those UNEs are the costs of loops, basic switching, vertical switch features, transport, and signaling. The ICM was written using the Delphi programming language, and also makes use of Paradox tables for data storage. This data is called on and acted upon by the Delphi programming code. Both Delphi and Paradox are software products developed by Borland International, Inc.

For switching inputs, ICM relies on information generated from two external models. One model, the "Switch Cost Information System" ("SCIS"), is produced by Bellcore. SCIS calculates basic switching and vertical switching service costs for Nortel and Lucent switches. A second model, GTE's "COSTMOD," calculates basic switching and vertical switching service costs for the GTD-5 switch. The outputs from these switching models are input into the ICM.

In addition to the switching models, an activity-based cost study and a common cost study are conducted externally to the ICM. Finally, material costs and placement costs for those materials are included in database tables in ICM. This information is derived from material and labor contract information.

Q. MR.DAVID C.TUCEK CONTENDS THAT THE ICM MODEL IS OPEN TO INSPECTION AND REVIEW (TUCEK, DIRECT TESTIMONY, P. 10). IS THE ICM MODEL SUFFICIENTLY OPEN TO ALLOW FOR A COMPLETE AUDIT OF THE MODEL'S ALGORITHMS AND RESULTS?

A. No. Being open to inspection and being open to review is not the same as being sufficiently open to allow for a complete audit of the model's algorithms and results. While one can see the ICM's programming code, one cannot readily change it and evaluate the results of the changes. The ICM software program is not sufficiently flexible to allow model auditing and inputting of different assumptions in order to compare various possible outcome scenarios.

In New York and New Jersey, for example, Verizon provides almost exclusively Excel-based models that are completely open and that be can audited and *edited on a cell-by-cell* basis. The importance of open models cannot be overstated: cost analysts simply cannot verify cost studies results if they cannot verify the models themselves. ICM is not an open model in that it is nearly impossible to audit the model's algorithms without extraordinary efforts that go well beyond what should be required of intervenors in regulatory proceedings – particularly since transparent Excel-based models can do everything that the ICM model does and provide easy auditing capabilities.

Further, the ICM has been designed so that certain types of assumptions are essentially "embedded" in the software program, and cannot be altered without re-writing and re-compiling the programming code. In other words, the computer model already essentially incorporates certain decisions about issues that are controversial in these type of proceedings, making it difficult or impossible to see what the result would be of an alternate assumption. The ICM is thus not an "open" system, and this makes it difficult to use as a common platform for comparing Verizon's proposals here with those presented by the company elsewhere.

For example, ICM assumes that digital loop carrier ("DLC") equipment is placed beyond a predetermined fiber-copper cross-over point, but in many instances this costly DLC equipment may serve only a few customers. In such instances, it might be more efficient to employ longer copper loops with range extension systems. This built-in assumption greatly increases loop costs by assuming a network architecture that is illogical and wasteful, yet it cannot be easily changed within the ICM.

Q. CAN YOU PROVIDE AN EXAMPLE OF A SPECIFIC ERROR THAT INTERVENORS FOUND IN VERIZON'S LOOP MODEL IN NEW YORK THAT THEY WOULD NEVER BE ABLE TO FIND IN THE "BLACK BOX" ICM MODEL?

A. Yes. In New York, Verizon inadvertently made an error in its loop cost calculation for a type of DLC system that was one of the main cost drivers in the model. The model included DLC systems that can accommodate anywhere from 96 to 2016 lines, with a DLC system that could accommodate 672 voice grade lines being the one most common one. The model, however, recovered the cost of this 672 DLC system over 192 lines associated with a much smaller 192 DLC system as opposed to over 672 lines (prior to accounting for fill factors.) This calculation was clearly an error in the model since it differed from the manner in which the costs for the DLC systems of all other sizes were calculated. In fact, it was almost certainly a result of a "cut-and-paste" job where a Verizon cost analyst forgot to change the 192 line count (from the calculations for the 192 DLC system) to the 672 line count for the 672 DLC. The result was that the cost of the 672 DLC system was approximately 3.5 times higher than it should have been.

The important point is that while in New York other intervenors and QSI witnesses were able to examine the loop cost model in full detail and identify this type of error, here in Florida no such audit of the ICM model is possible. Quite literally, the Commission is asked to take it on faith that Verizon's analysts have made no errors in their programming of the ICM. This is a grant request that implies the heroic assumption that Verizon personnel are infallible. Given the wide and largely unexplained discrepancy between the rates proposed by Verizon in Florida and those that prevail in other Verizon states, this assumption seems entirely unwarranted. That is, there are reasons to believe that the ICM is riddled with errors that cause costs to be higher than they should be. Unfortunately, neither Staff nor intervenors are able to line edit the ICM's algorithms -- the truth is Verizon-Florida's proposed rates are based on "black box" calculations that have not been audited by either Staff or intervenors. This should trouble the Commission greatly.

Q. HOW DOES THE ICM MODEL COMPARE TO VERIZON'S EXCEL MODELS PRESENTED IN NEW YORK AND NEW JERSEY?

A. The ICM model, once one is acquainted with the model, is relatively easy to run; however, it is form over substance. The purpose of this proceeding is not to establish how *user friendly* the model is for personnel who only need to run the model for variations in a predetermined set of inputs. The purpose is to *audit* and *verify* that the model functions properly and models the least cost network design to provide the required services and network elements to the correct locations - and, for all practical purposes, that is impossible with the ICM.

VI. VERIZON'S LOOP COST MODEL

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

A. Yes. I have reviewed Verizon's testimony, discovery responses and electronic version of the ICM model and I have found a significant number of problems with Verizon's loop cost model.

Q. PLEASE SUMMARIZE THE PROBLEMS THAT YOU HAVE FOUND WITH VERIZON'S LOOP STUDY.

A. I have found the following problems:

-- Verizon's fill factors are generally too low.

-- IDLC technology, not UDLC technology as proposed by Verizon, is the least-cost, forward looking technology.

-- Verizon's studies fail to reflect an appropriate concentration ratio for IDLC based loops.

-- Verizon's assumed drop lengths are too long.

In addition to the aforementioned problems, Verizon's cost studies must also be changed to reflect the necessary adjustments to Verizon's shared and common cost mark-ups and annual charge factors.

In what follows, I will discuss each of these issues in more detail.

A. VERIZON'S LOOP FILL FACTORS ARE GENERALLY TOO LOW

Q. HAVE YOU BEEN ABLE TO EXAMINE VERIZON'S LOOP FILL FACTORS?

A. Not really. As previously discussed, the ICM's algorithms are cumbersome if not impossible to audit. As a result, I have not been able to determine for the various components of the loop what the fill factors are and, specifically, how and where in the model the fill factors are applied.

Q. DOES ICM REPORT CERTAIN GLOBAL FILL FACTORS?

A. Yes. The ICM model reports fill factors for both the feeder and the distribution facilities: they are 93.59% and 38.27% respectively. It is unclear, however, whether these fills are calculated to include spare applied in the model for administration, deficient pairs, and maintenance. Further, it is not clear which components of the feeder and distribution facilities are included in these calculations.

Q. ARE VERIZON'S PROPOSED LOOP FILLS APPROPRIATE?

A. No. I believe that Verizon's proposed fill factors are inefficiently low, particularly Verizon's distribution fills.

To see the importance of fill factors in cost studies, the Commission should consider that a fill factor of, for example, less than 40% for distribution facilities, such as proposed by Verizon, has the effect of increasing costs by no less than two and a half times. Thus, while it may cost Verizon only $3.00 to provide a distribution link of a basic loop, an assumed fill factor of 40% increases the costs to dependent competitors to $7.50.

In various sections below, I will discuss Verizon's proposed fill factors individually and explain why a number of them are inappropriately low. At this point, however, I will discuss why, in general, Verizon's proposed use of fill factors is discriminatory and anti-competitive.

Q. PLEASE DISCUSS SOME OF YOUR GENERAL OBJECTIONS TO VERIZON'S DETERMINATION OF ITS FILL FACTORS?

A. My objections are threefold.

First, Verizon typically lists a large number of considerations -- such as the need to deploy spare facilities for growth, maintenance, repair, customer-churn – to justify low fill factors. Verizon then proceeds to assign values to each of these factors and, by doing so, further reduces the utilization rate. In the process, Verizon ignores the fact that spare for growth can be used for maintenance and repair and that spare for repair can be used for maintenance, etc. By making such compounded reductions to the fill factors in such a manner, Verizon artificially reduces the level of utilization that is possible on various facilities.

By analogy, the Commission should consider that a two-car garage does not need to be twice as large as a one-car garage because it needs less spare space for cars to be able to open their doors. Clearly, a one-car garage needs space on both sides of the car for driver and passengers to be able open their doors. For a two-car garage, however, both cars can use the space between the two-cars to open their doors (though obviously not at the same time.) Thus, a two-car garage needs less *spare* space than two one-car garages. By the same reasoning, again, spare for growth can be used for other purposes. Verizon ignores this.

Second, CLECs should not be required to pay for spare for growth as Verizon's proposed fill factors require. The result of this proposal is that, if approved, CLECs will pay for facilities placed to serve Verizon's *future customers* – *i.e.*, CLECs will be required to pay for facilities that Verizon uses when competing against CLECs for such customers. Of course, CLECs will be able to use those facilities as well, but only after they pay for them once again. By contrast, Verizon 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.

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 Verizon. Further assume, for simplicity sake, that the price for those loops is based on a 50% fill factor. 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 Verizon gets to use if it so chooses. I note that different fill factors apply to different parts of the loop. This observation, however, does not alter the conclusion of the example, that VZ's proposal is discriminatory and anticompetitive.

It is important to note that Verizon 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 service (additional fax or modem lines, special lines for long distance calling, etc.), by using the 500 spare loops. Again, Verizon 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 Verizon).

The Commission should recognize that it would indeed be foolish for Verizon not to offer a steep discount package to sell tenants the 500 spare loops – they are being paid for by the CLEC and would otherwise be sitting idle. The Commission should also recognize that such a competitive asymmetry is not sustainable. *CLECs cannot viably compete if it they are forced to pay for the very "spare" facilities that Verizon will use to compete against them.*

This practice is discriminatory, anti-competitive and inconsistent with the FCC's First Report and 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 should not reflect spare for future customers – future customers should pay for their own facilities.

Q. WHAT FILL FACTORS DO YOU RECOMMEND?

A. In the sections below, I will discuss each of Verizon's proposed fill factors individually and explain why they are generally too low. If fills reflect an optimally efficient network, then they would be much closer to the levels adopted by, for example, the Michigan Public Service Commission for TELRIC studies. The fill factors adopted by the Michigan Public Service Commission and those that I recommend are found in Exhibit AHA-6.

In what follows, each of Verizon's proposed fills is discussed individually.

1. Verizon's distribution fills are too low

Q. PLEASE DESCRIBE HOW VERIZON DETERMINED ITS DISTRIBUTION FILL.

A. Verizon's ICM model reports a average weighted distribution fill of 38.27%. (See, *ICM Report Viewer Unbundled Network Elements OSP Fill*

Factors.) As noted, it is not clear how ICM calculates this fill or what components of the distribution portion of the loop are included.

Q. DOES IT APPEAR THAT VERIZON HAS USED THE FILL THAT IT ACTUALLY EXPERIENCES IN ITS NETWORK?

A. Yes. The fill factors for distribution facilities are so low that it appears that Verizon is modeling is actual embedded network and not a forward-looking, least-cost network consistent with TELRIC. Further, it appears that Verizon has included large amounts of spare facilities to accommodate anticipated growth in demand by future customers. In fact, Verizon notes that the distribution fill reflects that facilities are built "to serve ultimate demand." (See Tuceck, page 29, line 5.)

Q. IN A TELRIC SETTING IS IT APPROPRIATE TO INCLUDE SPARE FACILITIES FOR ANTICIPATED GROWTH IN DEMAND BY FUTURE CUSTOMERS?

A. No. Current customers (in this case CLECs) should only pay for the facilities that they will use. That is, they should only pay for current demand levels. Most certainly, current customers should not pay for facilities placed for future customers, as proposed by Verizon. Under the cost causation principle – essential to TELRIC – cost causers should pay. Since future customers are the cost causers for the spare facilities in

Verizon's cost studies, it is future customers that should pay for those spare facilities and not the current customers, the CLECs.

Q. DID THE FCC FIND THAT SPARE SHOULD BE BASED ON A REASONABLE PROJECTION OF ACTUAL DEMAND?

A. Yes. In paragraph 682 of its Local Competition Order the FCC found the following:

> 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.

This means that unit costs should be calculated by using as the denominator "a reasonable projection of actual usage of the element," i.e., by including in the denominator future customers. That is, by including in the denominator future customers, future customers pay for the spare facilities placed to accommodate this anticipated growth in demand. And, most importantly, current customers pay only for the facilities used to serve current demand. To be sure, Verizon's modeling practices appear to totally violate the FCC's directives in this regard.

2. Verizon's Fills For Drop Facilities Are Too Low

Q. HOW DOES VERIZON DETERMINE THE FILL ON DROP FACILITIES?

A. The fill on drop facilities is determined as a combination of user inputs and the pre-programmed algorithm of ICM. Residential and business drops are calculated separately and based on their own assumptions. The fill factor issue here is obscured, however, by how the drop facilities are identified.

Q. PLEASE EXPLAIN THIS PROBLEM IN MORE DETAIL.

A. Verizon assumes in the model that there are 3 drops to every residential unit in distribution units (distribution areas) with 500 residential units or less. For demand units with more than 500 residential units, the model assumes 25 pair entrance cables. Next, the model assumes a fill of 50%.

It is clear that this method obscures the level of effective fill since it is not apparent *how many residential units are served over the 25 pair cable*. Presumably, this information can be extracted for individual distribution areas from ICM if one were to dig deep into the code and were to do separate sensitivity runs, which would be an enormous undertaking that is simply infeasible for Staff and intervenors.

Q. IS THE FILL FACTOR ON THE DROP FACILITIES PARTICULARLY IMPORTANT IN ICM?

A. Yes. The drop is a very expensive portion of the loop in ICM due to the manner in which the ICM treats drop facilities. Most importantly, ICM assumes excessively long drops, making the facilities very expensive. This issue is discussed in more detail below. Suffice it to say for now that the combination of low fills and long drop facilities cause an inappropriate inflation in loop costs.

Q. WHAT IS YOUR RECOMMENDATION?

A. I recommend that the Commission order Verizon to base its loop cost studies on no more than 2 pairs per drop and not 3. Further, I recommend that the fills on those drops are no lower than those approved for the copper distribution links.

3. Verizon's Copper and Fiber Feeder fills are too low

Q. WHAT FILL FACTOR HAS VERIZON ASSUMED FOR VARIOUS FEEDER FACILITIES?

A. As discussed, the ICM model reports fills on feeder facilities that are on average 93.59%. However, it is entirely unclear how this number is derived and which facilities it concerns. In fact, it is unclear whether this fill factor includes spare for such reasons as deficient pairs, maintenance and administration. In view of this, I have already presented a recommendation regarding specific feeder facilities: fiber feeder, copper feeder, COT, RT and channel units. What follows is a more detailed discussion of the appropriate level of fill for these facilities.

Q. PLEASE EXPLAIN WHY VERIZON SHOULD USE AT LEAST 90% FILL ON COPPER FEEDER FACILITIES.

A. In a move toward fiber-based feeder, Verizon's own engineering guidelines explicitly *discourage the placing of new copper facilities* and *encourage the maximum use of existing copper facilities*.

The use of forward-looking technologies clearly means that there will be a migration toward fiber based feeder facilities. This means, in turn, that – on a forward-looking basis and in a least cost environment/network – little new copper feeder will be placed and existing copper feeder will grow to its objective fill of 90%. The entire dynamic used by Verizon of fill rising and falling as feeder facilities are reinforced ceases to be a relevant with respect to fill factor determinations. *Once a copper feeder facility reaches its maximum fill, it will most likely not be reinforced*; rather fiber based DLC systems will be put in place to accommodate growth. *This means that copper feeder fills should be considerably closer to the stated objective fill of 90%.*

Q. WHAT IS YOUR RECOMMENDATION FOR COPPER FEEDER FILL?

A. I recommend that the Commission order a copper feeder fill of *85%* as the appropriate fill in a forward-looking, least cost network. This figure is below the objective fill of 90% that already should exist on a large number of routes, but recognizes that on a forward-looking basis feeder facilities will be reinforced not with copper but with fiber.

4. Verizon's proposed DLC Electronic fill is too low

Q. WHAT IS A CHANNEL UNIT OR A PLUG-IN?

A. There are Channel Units for COTs and Channel units for RTs. The COT Channel Unit is the facility on which a DS1 or DS0 channel terminates between the COT and the switch (for switched circuits) or between the COT and a collocation space or some other facility for non-switched circuits. A RT Channel Unit is a plug-in card on which the copper sub-feeder or distribution cables terminate. The cards are inserted in the common equipment of the RT.

Q. WHAT LEVEL OF FILL (OR RATE OF UTILIZATION) DOES VERIZON ASSUME FOR THE CHANNEL UNITS?

A. It is not clear from either the documentation or the ICM model what level of fill is used for channel units.

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

A. Because Channel Units can be entered into the COTs and RTs as demand emerges, a very high rate of utilization can be achieved. 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.

Further, Verizon's own testimony in other jurisdictions states that Verizon places plug-ins to accommodate only six months of growth. (VZ-MA Rebuttal testimony in Massachusetts, Docket 01-02). *Thus, even if one were to assume 3% annual growth, then six months of growth would still only constitute 1.5% spare plug-ins (which is 3% time 6/12). This implies a fill of 98.5% (100% - 1.5%).* Accounting for other sources of spare, such as maintenance, deficient units, administration (all of which are quite minimal), a 95% fill is conservative.

In short, I recommend that the Commission adopt a fill for channel units of 95%.

Q. WHAT LEVEL OF FILL DOES VERIZON ASSUME FOR RT ELECTRONICS FILL?

A. Again, it is not clear from the documentation or the ICM model what level of fill is used for the RT electronics.

Q. **WHAT LEVEL OF FILL IS APPROPRIATE FOR COT AND RT ELECTRONICS?**

A. I recommend a fill of 90% for both the RTs and the COTs.

First, RTs are highly scalable pieces of equipment and can be selected to serve customers anywhere from 92 lines to 2016. RTs can also be expanded as new demand emerges. As a result, these expensive pieces of electronics can be run at high levels of utilization.

Further, the COT can achieve an even higher fill than the RT because it serves possibly up to 5 RTs. (The Dual Feeder Route software for the Litespan 2000, for example, allows a COT to serve up to 5 RTs). This means that depending on the size of the RTs, the COT can be engineered to serve the optimal level of RTs so as to achieve an optimally efficient fill. That is, when a COT has a low rate of utilization, then more RTs can be added to increase the fill on the COT.

Q. **GIVEN VERIZON'S ASSUMPTIONS ON THE DEPLOYMENT OF FIBER BASED DLC SYSTEMS, WOULD COTS BE FULLY UTILIZED?**

A. Yes. Under Verizon's forward-looking loop design, there will be deployment of fiber based DLC systems. This means that in the loop cost studies, there is a much larger number of RTs and COTs than in Verizon's actual network. As a result, these facilities are more easily engineered to achieve a very high level of fill.

Q. WHAT LEVEL OF FILL DO YOU RECOMMEND FOR THE COT?

A. I recommend a 90% level of fill for the COT.

Q. DOES VERIZON'S OWN DOCUMENTATION INDICATE THAT FEEDER ELECTRONICS BE MAINTAINED AT FILL LEVELS OF 90% OR HIGHER?

A. Yes. For example, Verizon's own engineering documents require that certain types of DLC systems (SLC-96) are used **near full capacity.**

While this concerns slightly older equipment, the principle is the same: DLC electronics can be run at very high levels of utilization.

B. IDLC IS THE LEAST COST TECHNOLOGY

1. Loops Cost Studies Should Be Based On IDLC

Q. PLEASE EXPLAIN THE FUNCTION OF THE COT, THE GR303 AND UNIVERSAL INTERFACES.

A. The COT is the facility on which the fiber optic cables terminate in the central office that converts the optical signals into electronic signals. From the COT, loops either go to one of Verizon's switches or onward to a CLEC as an unbundled loop. A simplified diagram is depicted in Exhibit AHA-7.

Q. ARE VERIZON'S LOOP COST STUDIES APPROPRIATELY BASED ON IDLC SYSTEMS?

A. It is unclear to me what configuration Verizon is assuming for its digital loop carrier system. The loop cost documentation talks in terms of Next Generation Digital Loop Carrier Systems, which seems to suggest that Verizon is assuming IDLC in its loop cost studies. However, I would caution the Commission against naively assuming that Verizon is in fact basing its loop cost studies on IDLC.

First, QSI has examined Verizon's loop cost studies in New York, New Jersey, Massachusetts and Maryland. In none of these states has Verizon assumed 100% IDLC for fiber based loops. Further, in New York, Verizon assumed that the IDLC systems would have expensive universal interfaces (channel units), which was inappropriate and artificially inflated costs.

Given that the ICM model is not sufficiently open to ascertain precisely how the loops are provisioned, I cannot verify whether or not Verizon is appropriately using the IDLC technology in its cost studies.

Q. IS THIS ISSUE (IDLC VERSUS UDLC) IMPORTANT TO CLECS?

A. Yes. 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 three reasons.

First, Verizon 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. . Allowing Verizon 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."

Second, with the general marketplace trend toward "fiber to thecurb" (i.e., deploying fiber deeper into the local exchange to allow higher bandwidth customer connections), Verizon will be deploying next generation IDLC in sharply increasing numbers. All evidence indicates that integrated DLC is the least cost, forward-looking technology for loop facilities (and that Verizon will be deploying it). This means that all of the problems described above (i.e., the "competitive gap" and the need to unbundled IDLC) will only become more prevalent in the future. It is for this reason that the Commission must address the issue now and correct Verizon's cost studies.

Third, 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 (or third) lines used to accommodate dial-up Internet connections. Given an opportunity to purchase an access line from Verizon 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 Verizon that will not be lost on customers. In essence, Verizon 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 VERIZON 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. Likewise, integrated DLC allows a carrier to aggregate individual DS0 (voice grade) circuits into larger, more efficiently transported bandwidths (DS1, DS3, 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 DLC 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 Commission need look no further than Verizon's own cost studies – flawed as they are -- to understand the significant cost savings that can be realized with the use of IDLC equipment versus Universal Interface.

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* Verizon if they use unbundled loops. As such, Verizon's proposed methodology undermines the pro-competitive intent of the Act of 1996 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 Verizon.

Q. CAN LOOPS PROVIDED ON AN IDLC SYSTEM BE UNBUNDLED WITHOUT A UNIVERSAL INTERFACE?

A. Yes. First, whether Verizon currently deploys IDLC for unbundled loops is irrelevant. Indeed, if the Commission continues to allow Verizon 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 Verizon 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 used to provision the network element in question*? Verizon's own studies show that IDLC is a least-cost alternative compared to UDLC. Likewise, the FCC indicates that it is technically feasible to use IDLC for unbundled loops. 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.

Further, attached to my testimony as Exhibit AKA-8 are three documents that discuss how unbundled loops can be provided with GR303.

Q. PLEASE BRIEFLY SUMMARIZE DSC CORPORATION'S "UNBUNDLING SOLUTIONS" PAPER.

A. A paper written by DSC Corporation (the company from which Verizon purchases its digital loop carrier equipment) entitled "Unbundling Solutions." The purpose of the paper is to tout the ability of the DSC Litespan equipment (the DLC equipment Verizon assumes are used within its TSLRIC studies) to accommodate unbundled loops in the integrated mode. This paper dispels any argument Verizon might make regarding the inability to provision unbundled loops using IDLC equipment. Indeed, Verizon's own chosen DLC equipment manufacturer has written a paper explaining in detail how the very equipment Verizon uses can accommodate unbundled loops in the integrated mode.

Q. PLEASE BRIEFLY SUMMARIZE THE SIGNIFICANCE OF MCI WORLDCOM'S "THE VIRTUAL RDT, KEY TO UNBUNDLING THE LOCAL EXCHANGE" ABSTRACT.

A. MCIWorldCom wrote a well-researched and detailed abstract 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.

Q. PLEASE BRIEFLY SUMMARIZE THE SIGNIFICANCE OF PULSECOM, INC.'S "UNBUNDLING WIRE PAIRS, SPECIAL SERVICES AND ISDN iDLC GROOMING" PAPER.

A. 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.

Q. WHAT IS YOUR RECOMMENDATION?

A. The Commission should order Verizon to use forward-looking, least cost IDLC systems (with a GR303 interface) and should prohibit the use of UDLC in its unbundled loop studies.

2. Verizon's Studies Fail To Address An Appropriate Concentration Ratio

Q. PLEASE EXPLAIN WHAT A CONCENTRATION RATIO IS AND WHY IT IS A COST DRIVER IN VERIZON'S LOOP COST "MODEL."

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 DLC 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. This concentration ratio is critical in the loop cost studies.

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	3 to 1	3000	$ 0.33
$1,000	6 to 1	6000	$ 0.17

Given that in Verizon's loop cost studies, a large portion of the costs is associated with the fiber based DLC system, the concentration ratio is one of the most important cost drives 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 from 1:1 to 44:1, based on calling patterns. (See Newton's Telecom Dictionary, Copyright 2000 Harry Newton, Published by Telecom Books, an imprint of CMP Media Inc., New York NY 10010, page 382)

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

A. Yes. Again, given the "black-box" nature of the ICM, I am simply unable to ascertain what level of concentration is assumed in the model. For certain, the level of concentration is not a user defined input into the model, but is hard-coded into the algorithm. In other jurisdictions, Verizon has typically used a concentration ratio of 3:1, which is based on their experience with business customers and which is too low.

In any event, as I will demonstrate, Verizon should be ordered to use a higher concentration ratio of 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 degree of concentration that is desirable, however, depends on the calling patterns of the community served by the DLC system and the CCS levels associated with that community.

Q. WHAT LEVEL OF CONCENTRATION DID VERIZON-NY ADVOCATE IN ITS RECENT TESTIMONY IN NEW YORK?

A. The Panel Testimony submitted by Verizon-NY stated that the concentration ratio should be between 2:1 and 4:1,

> Concentration has always taken place within the digital switch but GR303 Interface Groups allow the efficiency of concentration to be extended to the digital ports on the switch and the COT. The ratio of channel units to switch ports is set between ***2:1 and 4:1***, depending on traffic characteristics of the lines. (Case 98-C-1357, VZ-NY Panel Testimony, page137 (emphasis added)

Q. WHAT LEVEL OF CONCENTRATION DID THE ADMINISTRATIVE LAW JUDGE ORDER IN VERIZON-NY'S CURRENT TELRIC PROCEEDING IN NEW YORK?

A. In New York, having reviewed the evidence, the Administrative Law Judge found that Verizon-NY should use a 4:1 ratio, the high end of the range that Verizon-NY itself had identified. (NYPSC Case 98-C-1357, Recommended Decision, page 90)

Q. WHAT ADDITIONAL REASONS ARE THERE TO ASSUME A CONCENTRATION RATIO OF 6:1?

A. As Verizon indicates in responses to data requests, it does not yet have a high percentage of its loops on fiber. Surely, most of its residential customers are still served on copper facilities. But, if Verizon were to serve those residential customers with fiber based IDLC – *as it should, given the fiber/copper break-over point assumed in Verizon's own studies* -- then the residential calling pattern would allow for a different concentration ratio than used for business customers.

The effect of the cost study assumptions is that – in contrast to the Verizon's real network – a *mix of customers*, consisting of both *business* and *residential* customers, will be served by fiber based DLC systems. Given that the concentration ratio for business customers, a mix of residential and business customers will allow a higher concentration ratio. This observation is even more true, 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 possible.

In short, one of the consequences of Verizon's decision to assume larger quantities of fiber deployment for cost study purposes than actually deployed in its real network is that a higher concentration ratio can be achieved. Given that under TELRIC, one must assume a least-cost, forward-looking network, a concentration ratio of 6:1 is appropriate.

Q. WHAT LEVEL OF CONCENTRATION DO YOU RECOMMEND?

A. I recommend that Verizon be ordered to use a 6:1 concentration ratio. This ratio is reasonable because in its cost studies Verizon 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/crowd out those of the business customers.

C. VERIZON's ASSUMED DROP LENGTHS ARE TOO LONG

Q. PLEASE DISCUSS HOW ICM DETERMINES DROP LENGTHS IN THE LOOP COST STUDIES.

A. The drop lengths are calculated in the model per demand unit (distribution area) based on an algorithm that assumes that drop wires and entrance cables (for larger units) terminate at the center of each lot on which a residential or business resides. As a result of this algorithm, drop lengths and entrance cables can vary from 15 to nearly 500 feet.

Q. WHAT DROP LENGTHS DO YOU RECOMMEND?

A. I have not been able to calculate the average length of the drop and entrance cable facilities assumed in ICM. ICM does have, however, the ability to specify the lengths of the drop and the entrance facilities as user inputs. Given the highly hypothetical nature of the loop architecture in ICM and the uncertainty about how the fill factors for the drop and entrance facilities are deployed in ICM, I recommend that the Commission order user defined inputs for the length of the drop and the entrance cables. Further, I recommend that the length and the drop facilities are de-averaged by zone to reflect that the greater density and generally shorter lengths in urban areas. My specific recommendations are 75 feet for Zone 1; 100 feet for Zone 2; and 150 feet for Zone 3.

Again, these recommendations reflect that drops tend to be shorter in densely populated urban areas, where one might find more apartment complexes and town houses, than in suburban and rural areas.

D. THE NETWORK ARCHITECTURE IS NOT FORWARD-LOOKING, LEAST COST

Q. HAS VERIZON GENERALLY MODELED A FORWARD-LOOKING, LEAST-COST NETWORK?

A. No. There are a number of methodological errors and logical inconsistencies hard-coded in the ICM model that cause loop costs to be artificially high. Perhaps most important are (1) the failure of ICM to construct a network to where the demand is actually located; (2) the failure of the ICM to fully capitalize on the efficiencies of fiber for loops that use DLC systems; and (3) to recognize the efficiency of placing the RT on the customer premises for larger buildings.

1. ICM Fails to Construct a Network Where it is Demanded.

Q. DOES THE ICM CONSTRUCT IS MODEL NETWORK TO REACH ACTUAL DEMAND?

A. No. The ICM does not know the actual location of any demand and "constructs" its network to locations where customers do not exist. The ICM assumes that demand will be dispersed across an arbitrary grid structure and then "constructs" its network to provide service to these surrogate locations. This is a fundamental flaw in the ICM. Back in 1997, AT&T/WorldCom's HAI model contained a similar flaw. However, this flaw was corrected a number of years ago by AT&T/WorldCom's HAI model by geocoding customer locations and building the model network to the actual customer locations. In addition, BellSouth's loop model, the BSTLM, geocodes customer locations in a manner similar to the HAI model. Given that this cost modeling flaw can and has been eliminated, the Commission would be delinquent if it were to adopt an inferior cost model such as Verizon's ICM to develop UNE rates.

2. ICM Fails To Capture The Efficiencies Of Fiber Facilities

Q. DOES THE ICM ADEQUATELY REFLECT THAT FIBER FACILITIES ARE RELATIVELY CHEAP AND THAT THE RT SHOULD BE DEPLOYED AS CLOSE TO THE CUSTOMER AS POSSIBLE?

A. No. In other jurisdictions Verizon recognizes that fiber is relatively cheap as compared to copper. This means that once the decision is made to deploy a fiber based DLC system – as is the case for longer loops – it is important to capitalize on the efficiencies of the fiber and to drive the fiber as deeply into the distribution area as possible so as to minimize the use of expensive copper facilities (feeder and distribution.)

This notion is well captured by Verizon recent testimony in Massachusetts: "the economics of fiber versus copper always favor extending *the RT as close to the customer as possible* as long as two conditions can be met: that a site for the RT can be obtained at reasonable cost and that the fill of the system exceeds a threshold level." (Emphasis added.) (Verizon-MA, D.T.E. Docket 01-20. Surrebuttal Panel Testimony, page 59.)

By contrast, this consideration is entirely absent in Verizon's ICM model here in Florida. The ICM model assumes that there is always a portion of the feeder that is copper based even if the loop uses a fiber based DLC system. Further, the ICM model assumes that in many instances there is even a secondary SAI (serving Area Interface) in addition to the first SAI, thus further increasing the use of copper facilities rather than diminishing it. In any event, there is no attempt in the model to place the FDI (with the RT) close to the customer and to extend the cheaper fiber facilities so as to conserve on expensive copper facilities.

<u>3. The ICM Model Fails To Consider Placing The RT On The Customer Premises</u>

Q. DOES THE ICM MODEL EVER RECOGNIZE THAT IT IS CHEAPER TO PLACE RT'S ON THE CUSTOMER PREMISES FOR LARGER CUSTOMERS?

A. No. In other jurisdictions Verizon recognizes that where it concerns larger buildings, it may be more efficient to locate a RT on the customer premises. This eliminates the need for expensive copper feeder and distribution facilities altogether. Further, the RT is cheaply housed on the customer premises and can still be used to serve customer is adjacent buildings. In Massachusetts, for example, Verizon assumed that for building with more than 160 customers, a RT would be located on the premises. As noted by Verizon-MA: "Locating RT's within a building involves minimum site cost and the line size threshold used in the study insures that reasonable fill is achieved." (See Verizon-MA, D.T.E. Docket 01-20, Surrebuttal Testimony, page 59.) (In Massachusetts, Verizon has erred in its deployment of the RT by dedicating the RT to only the particular building in question. Be that as it may, the initial consideration to place the RT on the customer premises is a valid one.) Likewise, in New York, Verizon assumed that in certain instances the RT would be placed on the customer premises for larger buildings.

VI. DS-1 UNBUNDLED LOOPS

Q. HAVE YOU HAD AN OPPORTUNITY TO REVIEW VERIZON'S PROPOSED RATES FOR DS-1 UNBUNDLED LOOPS?

A. Yes, I have. Verizon proposes a statewide average DS-1 unbundled loop rate of $240.52 with corresponding deaveraged prices as follows: Zone 1: $235.24, Zone 2: $252.20, Zone 3: $309.27.

Q. DO YOU HAVE CONCERNS WITH THESE PROPOSED RATES?

A. Yes, I do. These rates far exceed rates for DS1 unbundled loops recently approved by this Commission for BellSouth and far exceed similar rates adopted by other Commissions throughout the country. The table in Exhibit AHA-9 provides a limited comparison supporting this point.

As the table above demonstrates, Verizon's proposed DS-1 unbundled loop rates in this proceeding exceed other comparable rates by nearly 400% in some circumstances.

Q. HAVE YOU BEEN ABLE TO IDENTIFY WITHIN VERIZON'S COST MODELS WHY SUCH A DISCREPANCY MIGHT EXIST?

A. Yes, to some extent. Verizon's DS1 unbundled loop study is very problematic because it allows only for limited auditing. (For example, the file "FLHiCapWtg", sheet "WC DATA" wherein the actual cost results per wire center for DS1 unbundled loops are "hardcoded" such that the analyst is unable to determine their origin or discern the manner by which they are calculated.) However, I have been able to identify a number of problems that tend to substantially overestimate Verizon's actual forward looking costs as proposed. First, Verizon assumes a very low fill factor for its most prevalent DS1 delivery architecture causing the resultant costs to soar far beyond those attributable to other substitutable architectures.

Q. PLEASE EXPLAIN THIS POINT IN MORE DETAIL.

A. Cost study file "FLHiCapWtg" sheet "Reports" identifies the four potential DS1 delivery architectures for which Verizon derives forward looking costs (see rows 12 through 18). Verizon ultimately weights each of these four delivery architectures in arriving a single, weighted average cost for DS1 delivery in each wire center. It is this weighted average DS1 cost

($**   **) that Verizon ultimately proposes as the TELRIC basis for its DS1 unbundled loop rates. (See file "FLHiCapWtg," shee "WC DATA").

Q. PLEASE IDENTIFY THE FOUR DELIVERY METHODS INCLUDED IN THE VERIZON ANALYSIS.

A. Verizon's cost study identifies the following DS1 delivering methods and applies the following relative weights for purposes of identifying the most and least common delivery method used:

CONFIDENTIAL DATA

a. DS1 via metallic facility	***	**
b. OC3 e/w 28 DS1s	***	**
c. OC3 e/w 84 DS1s	***	**
d. OC-12 e/w 12 DS3 & 336 DS1 Mux	***	**
		100%

Q. WHY ARE FOUR DELIVERY METHODS STUDIED?

A. DS1 transmission facilities can be accommodated in the telecommunications network via a number of delivery methods. For example, a 4-wire metallic loop facility with applicable electronics can support a single DS1 transmission signal while fiber-optic based "Optical Carrier" ("OC-N") systems can be used to accommodate a large number of DS1 transmissions. In some circumstances an ALEC may order a DS1 facility in an area where Verizon has an active OC-3 or OC-12 system thereby allowing Verizon to simply assign a small portion of the much larger OC-N system for purposes of accommodating the DS1 request. In general terms, the larger the system being used to deliver the DS1 signal (all else being equal), the lower the per DS1 cost (because of substantial production-economies of scale). In support to of this point, Verizon's cost study indicates that costs per DS1 signal fall precipitously as DS1s are provisioned on larger and larger facilities (e.g., information taken from VerizonVerizon's DS1 cost study shows that costs per DS1 delivered fall by nearly 75% when comparing the single DS1 loop provisioned over metallic facilities with those DS1s delivered via an OC-12 system).

Q. PLEASE FURTHER EXPLAIN YOUR CONCERN REGARDING VERIZON'S FILL FACTORS AND THEIR ROLE IN THE ENORMOUS DS1 COSTS PROPOSED BY VERIZON.

A. Attached as Exhibit AHA-10 is a table extracted directly from Verizon's DS1 study. Notice the fact that as the delivery method involves equipment capable of producing a greater number of DS1 transmissions, the price per DS1 transmission (column B) falls dramatically. Notice also, that the most expensive DS1 delivering method is the "DS1 via Metallic Facility" method at $** ** per DS1 per month.

Column (E) indicates the likelihood that any of the individual delivery methods will be used and weights the corresponding cost figures in an effort to arrive at a weighted average cost for DS1 delivery. Notice, however, Column (C). Column (C) applies the individual fill factors used to derive what Verizon entitles "Fill Cost per DS1" (Column D). Notice further that even though the "OC3 e/w 28 DS1s" is a less expensive delivery method than the simple metallic facility method in Column (B), when the abysmally low fill factor associated with the OC3 method is applied (** **%), the picture dramatically changes. Indeed, the OC3 method becomes the second most expensive method available.

Q. IS THIS PROBLEMATIC?

A. Absolutely. Consider the result above given the following discussion. The most expensive method by which to provision a DS1 facility is via the use of a dedicated 4-wire metallic facility. Verizon's cost study makes this very point (see Column B above). Hence, if we assumed that 100% of the DS1s ordered by ALECs in Verizon's territory were provisioned via 4-wire metallic facilities, we could derive a "Maximum TELRIC Cost" upon which we could only improve with the use of more efficient equipment (e.g., OC-N). Using Verizon's study, I assumed that 100% of the DS1s provisioned would be provided via 4-wire metallic facilities (in doing so I zeroed out the other delivery methods). The resultant "Circuit Equipment Cost" was ** ** compared to the ** ** arrived at by the Verizon model. Said another way, using only the most expensive delivery method available, I arrived at costs more than one-half those that Verizon estimates.

Q. HOW IS THIS POSSIBLE?

A. This result follows from a fundamental conceptual error in the Verizon model. That is, Verizon assumes within its model that it will deliver DS1 transmission via OC-N facilities, even when it would be cheaper (given the results of this own analysis), to provide the DS1s via 4-wire metallic facilities. Verizon's analysis in this respect certainly does not match with the "least cost" requirements of a rationale TELRIC methodology and tends only to overestimate Verizon's actual costs of provisioning DS1 facilities.

Q. HOW SHOULD THE COMMISSION CORRECT VERIZON'S ERROR?

A. Verizon's error can be found in abysmally low fill factor assumptions made with respect to the utilization of its OC-N equipment. Fill factors ranging from ** **% to ** **% (as proposed by Verizon) are not consistent with the TELRIC methodology wherein facilities are assumed to be used efficiently. As discussed above, at these levels of utilization, Verizon would actually be incurring higher costs associated with more efficient equipment. In other words, if Verizon's utilization levels were accurate, Verizon (and its ALEC customers) would be better off never having installed those facilities for the provision of DS1 services. The Commission should correct this error by requiring Verizon to utilize realistic fill factor assumptions for its OC-N equipment (I would recommend a fill factor of approximately 90% which is consistent with other Field Reporting Code 357 - central office transmission equipment).

In the alternative, the Commission should require Verizon to recalculate its DS1 costs using only the least expensive delivery method as identified by its own cost study (i.e., the 4-wire metallic method).

Q. WOULD REQUIRING VERIZON TO ASSUME ONLY THE USE OF 4-WIRE METALLIC DS1 DELIVERING RESULT IN TELRIC BASED RATES?

A. Though it would be an improvement over the cost study Verizon has proposed and which I have critiqued above, it would not result in reasonable TELRIC-based rates. As I described above, such an assumption would result in a type of maximum TELRIC-based rate. Obviously there will be circumstances wherein economies of scale will allow the delivery of DS1 transmission on OC-N facilities at costs less than those experienced in dedicating a 4-wire metallic facility to the job. Hence, proper TELRIC-based rates would be lower than rates established assuming 100% metallic delivery. It is for this reason that I would recommend that the Commission correct the error in the Verizon model in a more appropriate fashion and require Verizon to re-run its DS1 study assuming that all fiber-based "circuit equipment" achieve at least a 90% fill.

VII. ENHANCED EXTENDED LINK (EEL) RATES ARE INAPPROPRIATELY HIGH

Q. HAVE YOU HAD AN OPPORTUNITY TO REVIEW MR. TRIMBLE'S TESTIMONY REGARDING THE COMBINATION OF UNBUNDLED LOOPS AND INTEROFFICE TRANSPORT COMMONLY REFERRED TO AS AN ENHANCED EXTENDED LINK ("EEL")?

A. Yes, I have. The majority of Mr. Trimble's direct testimony (pp. 54-58) addresses what Verizon believes to be its legal obligation to provide this particular combination as well as the circumstances wherein Verizon believes it is required to migrate existing special access arrangements to an EEL. I'll not respond to Mr. Trimble's arguments in this respect as they are largely legal in nature and can be addressed by the attorneys in brief. I will, however, address two issues that arise from Mr. Trimble's testimony regarding this issue.

First, I'll address Mr. Trimble's proposal that "the rate for each EEL UNE combination be the sum of the individual loop, transport and multiplexing rates for each of the individual UNEs that make up the combination." I'll explain that this approach will almost undoubtedly lead to over recovery. Second, I'll address the specific multiplexing rates proposed by Mr. Trimble in Exhibit DBT-2 to be used in combining loops and transport in an EEL arrangement. I'll explain for the Commission why Verizon's proposed multiplexing rates (monthly recurring) appear to be in excess of reasonable forward looking costs.

Q. PLEASE EXPLAIN YOUR CONTENTION ABOVE THAT VERIZON WILL MOST LIKELY BE ALLOWED TO OVER RECOVER ITS ACTUAL COSTS IF THE COMMISSION ALLOWS VERIZON TO ASSESS THE INDIVIDUAL LOOP, TRANSPORT AND MULTIPLEXING RATES ESTABLISHED IN THIS PROCEEDING WHENEVER AN ALEC PURCHASES AN EEL.

A. When an ALEC purchases an EEL it is actually purchasing a transmission path that will in most circumstances reach from a customer's premises, through Central Office A and ultimately to Central Office B. When compared to an ALEC purchasing an unbundled loop, multiplexing (or cross-connection), and interoffice transport separately, the facilities provisioned (and indeed the manner by which they are provisioned) will likely vary substantially with costs varying accordingly. An example best illustrates the potential differences.

Consider an unbundled loop that currently serves a customer using a digital loop carrier architecture. If an ALEC were to order that unbundled loop on a stand-alone basis, Verizon would terminate that unbundled loop via a 2-wire analog jumper directed to the ALEC's collocation space. In doing so, Verizon would include in the cost of that unbundled loop the central office terminal ("COT") costs of the digital loop carrier system required to multiplex the signal associated with that individual loop (likely from a DS1 transmission embedded in an OC3 bitstream) into a DS0 equivalent (the COT would also do the digital to analog conversion necessary to arrive at an analog 2-wire interface). These COT costs are a substantial component of Verizon's 2-wire unbundled loop rate.

Consider now that the same ALEC purchases the same loop but instead of terminating that loop in its collocation space, the ALEC chooses to combine that loop with interoffice transport for purposes of gathering that loop at a distant central office (i.e., and EEL arrangement). In such a circumstance, there would be no need for Verizon to de-multiplex that original signal from its original DS1 or OC3 format (or to execute a digital to analog conversion) because that signal will simply be loaded onto a central office facility (of at least that bandwidth) for delivery to the distance central office). Because the signal need not be converted at this point to an analog, 2-wire electrical signal for delivery to the collocation space, costs can be saved. Indeed, if Verizon were to demultiplex and convert the DS0 signal representing the ALECs unbundled loop used in the EEL arrangement, it would simply be required to re-multiplex and convert the signal again before it could ready the signal for interoffice transmission. This would be duplicative and inefficient. Unfortunately, however, if the Commission adopts Verizon's simple "sum of the UNEs involved" approach, it will be sanctioning such inefficient cost recovery (whether Verizon actually undertakes this action or not).

Q. IN YOUR EXAMPLE ABOVE, WOULDN'T THE SAME DEMULTIPLEXING AND/OR DIGITAL TO ANALOG CONVERSION BE REQUIRED AT THE TERMINATING CENTRAL OFFICE ANYWAY?

A. Not likely. Many ALECs will aggregate individual DS0 unbundled loops at a Verizon central office, multiplex those DS0s onto a higher bandwidth trunk (likely DS1) and transport those DSOs across the interoffice network in bulk. In doing so, they will, at the terminating central office, receive those DS0 signals representing individual unbundled loops, at a DS1 or higher level. In this circumstance, no de-multiplexing or digital to analog conversion is necessary (indeed, the cost savings associated with avoiding these actives is one of the greatest benefits of the EEL arrangement). Unfortunately, Verizon's proposal to simply add the individual UNE rates together to arrive at EEL rates negates any of these benefits by allowing Verizon to recover costs that it never incurs (multiplexing and conversion) instead of passing savings associated with avoiding these costs onto the ALEC in lower rates.

Q. HOW CAN THE COMMISSION ENSURE VERIZON RECOVERS ONLY THE COSTS IT INCURS IN PROVIDING EELS?

A Verizon should be required to undertake an individual TELRIC study for at least the most common EEL arrangements (i.e., DS0 loop-DS1 interoffice transport, DS1 loop-DS1 transport and DS1 loop-DS3 transport). Likewise, Verizon should be required to establish rates for EELs recognizing any cost reductions associated with purchasing the respective elements in combination. Special attention should be paid to recognizing the cost savings resulting from an integrated combination of transmission facilities for purposes of avoiding unnecessary multiplexing and conversion.

Q. **DOES BELLSOUTH FLORIDA IDENTIFY RATES SPECIFIC TO THE MOST COMMON EEL ARRANGEMENTS?**

A. Yes, BellSouth provides rates specific to the most common EELs as stand alone rate elements. Verizon should be required to do the same after having filed (and approved) a cost study recognizing the cost savings associated with combining the individual UNEs comprising an EEL.

Q. **EARLIER YOU ALLUDED TO CONCERNS REGARDING THE MULTIPLEXING RATES PROPOSED BY VERIZON FOR USE WITH EEL ARRANGEMENTS. PLEASE ELABORATE.**

A. Comparing Verizon's proposed multiplexing rates with those approved for other carriers across the country again raises concern. For example, Verizon proposes a monthly recurring rate of $517.71 per month for DS3 to DS1 multiplexing. By comparison, BellSouth is allowed to charge $211.19 for this same function. (See Order No. PSC-01-2051-FOF-TP, Docket No. 990649-TP, page 51). Likewise, Verizon in New Jersey is allowed to charge $364.60. (See NJ Board of Public Utilities, Docket No.

TO00060356, Attachment , page 3 of 5) Ameritech Michigan charges $262.31. (See Ameritech tariff M.P.S.C. No. 20R, Part 19, Section 12, 2nd Revised Sheet No. 27) Again, Verizon's proposed rate exceeds the average of these comparable rates offered by other carriers by approximately 185%.

Q. WHAT IS THE CAUSE OF VERIZON EXAGGERATED RATES?

A. Unlike DS1 loops, Verizon calculates multiplexing costs via its ICM model. As a result, I am unable to view the actual calculation that translates Verizon's material costs into what Verizon terms as TELRIC. I can only review the computer code that is used to compute the Verizon numbers and these provide little additional information. As a result, I cannot pinpoint where in Verizon's calculation it errs to the degree of allowing its rates to more than double those of most other carriers for this specific rate element. My expectation, however, is that an abysmally low fill factor (like that evidenced in Verizon's DS1 study) is to blame. As a result, I would recommend that the Commission extend its finding that a 90% fill factor for all 357c equipment (central office non-switch equipment) is a reasonable assumption that must be instituted by Verizon throughout its studies including its multiplexing analysis. It is my expectation that such a decision would go along way toward correcting the exaggerated result evidenced by Verizon's overstated multiplexing charges.

VIII. SWITCHING COST STUDIES

Q. HAVE YOU REVIEWED VERIZON'S SWITCHING COST STUDIES?

A. Yes. For switching inputs, ICM relies on information generated from two external models. One model, the "Switch Cost Information System" ("SCIS"), is produced by Bellcore. SCIS calculates basic switching and vertical switching service costs for Nortel and Lucent switches. A second model, GTE's "COSTMOD," calculates basic switching and vertical switching service costs for the GTD-5 switch. The outputs from these switching models are input into the ICM.

Q. HAVE YOU FOUND ANY PROBLEMS WITH VERIZON'S SWITCHING COST STUDIES?

A. Yes. There are a number of problems with Verizon's switching cost studies:

- Verizon includes in its technology mix an expensive and outdated switch, the GTD-5, produced by GTE. To the best of my knowledge, the GTD-5 is not used by Verizon elsewhere (other than in former GTE companies), nor is the switch used by any other large ILECs. It should not be included in the forward-looking, least cost switch technology mix.

- Verizon has not made available the switch vendor prices – and discounts – that are the most important inputs into the SCIS model and into switching studies in general.

- Feature costs are artificially inflated and ignore that the switch resources to run the features are already part of the switch and should properly be included in the monthly port charges.

- The nonrecurring costs for the features are not based on efficient operations. If features are made available as part of the unbundled port, then no costs of individually ordering features would ever come about. That is, the nonrecurring charges for features – which are exorbitantly high – are entirely the result of the rate structure and service ordering processes imposed by Verizon itself.

A. THE GTD-5 IS NOT A FORWARD-LOOKING, LEAST-COST TECHNOLOGY

Q. PLEASE DISCUSS THE SWITCH MIX PROPOSED BY VERIZON.

A. Verizon proposes to use a mix of switches that include switches form the world's larger switch vendors, Lucent and Nortel, but also switches produced by the former production arm of GTE. Specifically, the cost studies are based on a significant number of GTD-5 switches.

Q. SHOULD THE GTD-5 SWITCH BE INCLUDED IN THE FORWARD-LOOKING, LEAST COST TECHNOLOGY MIX?

A. No. To the best of my knowledge, the GTD-5 is not used by Verizon elsewhere (other than in former GTE companies), nor is the switch used by any other large ILECs. It should not be included in the forward-looking, least cost switch technology mix.

This contention is supported, for example, by the Texas Public Utility Commission. In PUC Docket No. 14943 (released on July 29, 1996), the TPUC made the following findings of fact, numbered 46-49:

- The manufacturer of the GTD-5 switch is concentrated on providing support functions to maintaining the switches in operation.

- Except for ordering a remote switch to connect to an existing GTE-5 host, GTE would not buy a GTD-5 switch today, but would buy either a Lucent 5ESS or a Nortel DMS series switch.

- The GTD-5 switch is not included in GTE's five year investment planning horizon.

- The GTD-5 switch cannot support ISDN service.

The Commission should recognize that the TPUC made this finding about six years ago – if the GTD-5 was not forward-looking then, it is hard to imagine that it is forward-looking now.

Q. WHAT DO YOU RECOMMEND?

A. I recommend that the Commission order Verizon to remove – for cost study purposes –the GTD-5 from the technology mix.

B. SWITCHING STUDIES SHOULD USE AN APPROPRIATE WEIGHTING OF NEW AND GROWTH DISCOUNTS

Q. HAS VERIZON APPROPRIATELY ACCOUNTED FOR ITS SWITCH VENDOR CONTRACTS?

A. No. Typically, switch vendor contracts have a bifurcated price/discount structure. Different prices apply for facilities when the switch is initially placed and put into service than for facilities that are placed to accommodate growth. To determine Verizon's switch investments, it is of utmost importance, therefore, to appropriately reflect what portion of Verizon's facilities have been placed at switch installation and what facilities have subsequently been placed to accommodate growth.

Verizon has based its switching studies on the discounts it will receive for growth lines. (See Tucek, page 6, lines 8 – 11.) As such, Verizon appears to ignore large numbers of facilities that would receive the large discounts if and when switches are newly installed. In other words, Verizon skewed its analysis heavily toward the expensive facilities that are placed to accommodate growth. As a result, Verizon's switch investments are greatly overstated.

Q. PLEASE DISCUSS THE BIFURCATED PRICE/DISCOUNT STRUCTURE IN THE SWITCH VENDOR CONTRACTS IN MORE DETAIL.

A. Generally, while various components of a switch can be purchased on a standalone basis, switch vendors tend to charge carriers switching costs on a per line or per trunk basis. The prices and discounts vary, however, based on whether a line was turned up when the switch was installed or subsequently turned up to accommodate customer growth. For example, if a new switch is placed and the switch serves 50,000 lines at cutover (i.e., at the time the switch is installed and put into service), the switch vendor will charge Verizon 50,000 *times* a per line price for the switch. The lines that are served by the switch upon switch installation (i.e., when the switch is put into service) are called the *cutover or replacement* lines; the prices/discounts are referred to as *cutover or replacement* prices/discounts. There are also lines for new switches that do not replace older existing switches. These lines are referred to as new lines and they are, understandably, priced/discounted at levels comparable to the cutover or replacement lines.

Then, after switch installation, higher prices (lower discounts) apply for lines that are placed subsequently to accommodate customer growth. Lines that are put into service to accommodate customer growth are called *growth lines*; the prices are referred to as *growth* prices.

This observation important because Verizon has not properly accounted for its growth and cutover lines and prices.

Q. IS THERE A SIGNIFICANT DIFFERENCE BETWEEN CUTOVER AND GROWTH PRICES/DISCOUNTS?

A. Yes. Typically the difference between the prices and discounts for growth lines versus cutover lines is enormous. In fact, growth lines can easily be two or three time as expensive as cutover lines. The difference between new/cutover trunk prices and growth trunk prices/discounts is typically no less dramatic.

It is important to note at this point that the contracts are generally expressed in terms of list prices and that the carrier will receive discounts for cut-over and growth lines that are then applied against those discounts. Ultimately, however, after the discounts are applied, cutover and growth prices become apparent.

Q. IN VIEW OF THE DRAMATIC DIFFERENCE IN CUTOVER AND GROWTH PRICES/DISCOUNTS, IS IT IMPORTANT TO PROPERLY REFLECT THE NUMBER OF CUTOVER LINES AND TRUNKS AND THE NUMBER OF GROWTH LINES AND TRUNKS?

A. Yes, it is critically important. For example, if one does not properly account for the number of cutover lines and trunks, one will end up greatly overstating per unit switch investments and, hence, switch related UNE costs.

Further, the SCIS model used by Verizon uses a table of list prices. It also requires that a discount be input into the input tables. The discussion here, then, concerns the proper calculation of the switch vendor discounts to be input into SCIS. Because I have already recommended that the GTD-5 switch be eliminated from the switch mix, this obviates the need to discuss the use of switch vendor discounts in COSTMOD. To the extent the Commission considers the GTD-5 in its determination of switching costs, the flaws in Verizon's modeling of switching costs are equally present for the GTD-5.

Q. CAN YOU PROVIDE AN EXAMPLE OF HOW THE WEIGHING OF CUTOVER AND GROWTH LINES AFFECTS THE PER UNIT INVESTMENT IN SWITCH FACILITIES?

A. Yes. The two tables below show how a change in the relative proportion of cutover and growth lines results in a radically different average per line price. While the example is a simplification of the calculations that are needed to calculate the average price that Verizon pays – and hence the average per line investment that should form the basis for UNE studies -- the results do realistically reflect the magnitude of understating the number of cutover lines, as Verizon did. (see Exhibit AHA-11)

Q. DID VERIZON PERFORM AN APPROPRIATE WEIGHING OF CUTOVER AND GROWTH PRICES?

A. I do not believe that they did. Pending responses to discovery, my understanding is that the switching studies are primarily weighted towards the more expensive growth lines. Verizon's rationale, as I understand it, is that the company will predominately be buying growth lines. However, this type of reasoning fails to recognize that under a TELRIC scenario – in which the network is newly constructed based on existing contracts – existing lines must be valued at the cutover prices.

Q. HAS VERIZON IN FACT FAILED TO PERFORM A TELRIC STUDY?

A. Yes. The "T" in TELRIC stands for "Total," meaning that a cost study should consider the total volume of demand for a network facility/element. This means that under TELRIC, cost studies should reflect costs for the entirety of Verizon's network, using the existing switch vendor contracts and the prices to calculate the costs that Verizon would incur if it were to rebuild its switching facilities using forward-looking, least cost switching technologies.

Q. DID THE FCC EXPLICITLY FIND THAT TELRIC STUDIES SHOULD CONSIDER THE TOTAL VOLUME OF DEMAND?

A. Yes. Section 51.505(b) of the FCC's pricing rules provides:

> (b) *Total element long-run incremental cost.* The total element long-run incremental cost 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. (Emphasis added.)

This point was further emphasized in paragraph 685 of the FCC Local Competition Order, where the Commission adopted a scorched node approach:

> 685. 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.

Clearly, because Verizon focuses primarily on facilities yet to be purchased at growth discounts, its analysis is more like a Short-Run Marginal Cost study.

Q. DID THE MICHIGAN PUBLIC SERVICE COMMISSION ("MPSC") FIND THAT SWITCHING STUDIES SHOULD BE HEAVILLY WEIGHTED TOWARD CUTOVER LINES?

A. Yes. In its Order in a recent TELRIC case, the MPSC found that Ameritech's switching cost studies were too heavily weighted toward the more expensive growth lines on the switch:

> The Staff is concerned that Ameritech Michigan used a completely new model to derive costs for switching services and placed *too much weight on growth lines* (i.e., lines added after the switch is installed) for which vendors charge more per line than they charge for lines that are connected when the switch is first installed (cut-over lines). The Staff says that, by doing this, Ameritech *Michigan computed the cost for only incremental lines rather than all of its lines* as costing principle no. 3 requires. The Staff recommends that Ameritech Michigan be required to rerun the study assuming *30% growth lines rather than 70% growth lines.* (Page 13 and 14.) (*In the matter, on the Commission's own motion, to consider the total service long run incremental costs for all access, toll, and local exchange services provided by VZ Michigan*, MPSC Case No. U-11831, November 16, 1999.)

Q. IN A PURE TELRIC SETTING, SHOULD COST STUDIES BE BASED ON CUTOVER LINE PRICES AND CUTOVER TRUNK PRICES?

A. In a pure TELRIC setting, switch investments should be based on a scorched node the approach, in which all switches – for all lines -- are replaced with new state-of-the art switching facilities at cutover prices. Thus, in a pure TELRIC approach, switch investments should be based *only on the cutover prices.*

Q. HAS THE U. S. DISTRICT COURT OF DELAWARE STATED THAT THE LARGER CUT-OVER DISCOUNTS – I.E., LOWER CUTOVER PRICES -- ARE APPROPRIATE UNDER THE TELRIC METHODOLOGY?

A. Yes. The U.S. District Court of Delaware just recently stated that the larger cut-over discounts are appropriate under the TELRIC methodology. Specifically, the court stated:

> Indeed, Bell's own expert witness admitted in testimony before the Hearing Examiners that the Local Competition Order "says rip every switch out. All of them... Every switch in the network, rip them out. Leave the ... wire center location where they [sic]are. And build the network that you would build today to serve the demand." First SGAT Report, p 31, at 16 (J.A. 1325) (quoting testimony of William E. Taylor). [FN17]

In the long-run (a period of time that varies according to the technology at issue), an efficient and rational competitor would replace *__all of its existing switches__* *with the most current technology and receive* *__the bulk-rate discounts__*. Viewed in this light, Bell's proposed switch costs, which it premised upon the *smaller add-on discounts* for which it will qualify "in the coming years," looks only to the *short-run.* The Hearing Examiners correctly concluded that Bell's cost analysis was "deficient in that it does not reflect a long-run approach, but rather a series of short-run cost estimates." First Report p 33, at 18 (J.A. 1327). Therefore, the court shall affirm the Commission's SGAT Order as it relates to switch discounts.

(Emphasis added.) (BELL ATLANTIC-DELAWARE, INC., Plaintiff, v. Robert J. McMAHON, Chairman, et al., Defendants. AT & T Communications of Delaware, Inc., Plaintiff,v. Bell Atlantic-Delaware, Inc., et al., Defendants. No. 97-511-SLR, 97-616-SLR. United States District Court, D. Delaware. Jan. 6, 2000).

Q. HAS THE FCC ALSO RECOGNIZED THAT THE CUTOVER LINE PRICES SHOULD BE USED IN THE ILEC'S FORWARD-LOOKING ECONOMIC COST STUDIES?

A. Yes. The FCC found the following:

> the suggestions of Ameritech, Bell Atlantic, BellSouth, GTE, and Sprint that the costs associated with purchasing and installing switching equipment upgrades should be included in our cost estimates. The model platform we adopted is intended to use the most cost-effective, forward-looking technology available at a particular period in time. ***The installation costs of switches estimated above reflect***

> ***the most cost-effective forward-looking technology*** for meeting industry performance requirements. Switches, augmented by upgrades, may provide carriers the ability to provide supported services, but do so at greater costs. Therefore, such augmented switches do not constitute cost-effective forward-looking technology." (FCC Docket No. 99-304, para. 317) (Emphasis added.)

Q. WHAT DO YOU RECOMMEND?

A. If the Commission rejects the FCC's scorched node TELRIC method, which requires Verizon's switch related cost studies to be based on the cutover prices, I recommend that the Commission adjust Verizon's approach to reflect the entire base of Verizon cutover lines and growth lines. Again, Verizon ignored that most lines were placed at the cheaper cutover prices and based its calculation mostly on the expensive growth lines. This is wrong – in fact, misleading -- under all circumstances.

Q. WHAT WEIGHING OF CUTOVER AND GROWTH LINES COULD THE COMMISSION ORDER IF IT REJECTS A PURE TELRIC APPROACH?

A. An alternative weighing of cutover and growth lines is easily calculated as follows. Assuming an annual rate of growth for switch ports (lines), an appropriate weighing of cutover and growth lines is determined by applying the annual growth rate – for each year over the entire economic life of the switches -- against a base of cutover lines. For example, assume that 50,000 lines are installed at cutover, the economic life is 18 years, and that the annual growth rate is 3%. Note that in this instance, a longer life is conservative, since it permits more growth on the switch, and hence, weighs the analysis more toward the expensive growth lines. By contrast, a short economic life would reduce the number of years over which the switch is able to grow, and hence, weighs the analysis toward inexpensive cutover lines. The appropriate number of growth lines is then determined by calculating 18 years of growth at 3%. Of course, given that the growth lines are installed over the course of 18 years, each year of growth would have to be *discounted* to the present period. The *weighted average per line switch vendor price* is then calculated as follows:

$$\frac{PV(\text{cutover price x number cutover lines}) + PV(\text{growth price x number of growth lines})}{\text{sum of cutover and growth lines}}$$

Exhibit AHA-3 provides calculations of determining the weighing of growth and cutover lines using this method. *The result is a weighing of 72% cutover line discount and a 28% growth line discount.*

Q. IS THE RELATIVE WEIGHING OF CUTOVER AND GROWTH DISCOUNTS APPROXIMATELY COMPARABLE TO THE ONE JUST RECENTLY ORDERED BY THE NEW JERSEY BOARD OF PUBLIC UTILITIES?

A. Yes. Based on Verizon's own switch vendor contracts, the NJ BPU reversed Verizon's proposals and ordered a weighing roughly comparable to the one calculated in this testimony.

Q. **WHAT DO YOU RECOMMEND?**

A. I recommend that the Commission use a pure TELRIC approach and order Verizon to calculate switch costs based on just the cutover discounts. If the Commission rejects this approach, then I recommend that the Commission use the switch vendor discount weighing *of 72% cutover discounts and a 28% growth discounts.*

C. VERIZON'S FEATURE COSTS ARE EXCESSIVE

Q. **IS VERIZON PROPOSAL FOR FEATURES IN FLORIDA DIFFERENT THAN VERIZON PROPOSAL IN OTHER STATES?**

A. Yes. Typically, feature costs are recovered in monthly port charges. The reason is that most of the feature costs are non-traffic sensitive costs and as such are most efficiently recovered on a non-measured basis. In any event, Verizon typically recovers its feature costs in either the monthly charges for the unbundled port or in the per minute of use charges for unbundled switching. Most importantly, in other jurisdictions, the cost for *all* features is included in either the port or the per minute of use charges so that the CLEC can offer the entire bundle of features to its customers without incremental charges for individual features. This practice is also true for the other RBOCs, SBC, BellSouth and Qwest.

By contrast, here in Florida, Verizon is proposing to offer switch features on an *a la carte* basis. As Mr. Trimble notes, "Verizon Florida has never included the cost of various switch features in the cost of its switch ports or end-office switching UNEs. The rational method for recovery of switch features costs is to charge the CLECs only for what they use – i.e., on a per switch feature usage basis."

Q. DO YOU AGREE WITH VERIZON'S PROPOSAL FOR SWITCH FEATURE CHARGES?

A. No. The proposal is highly anticompetitive and not consistent with cost causation. The cost of switch features is interwined in the fabric of the switch software and is most efficiently recovered in the monthly port charges. As noted, there are little or no usage related costs associated with features.

Verizon's proposal is cumbersome and imposes artificial costs. By forcing CLECs to order features on an individual basis, the costs are artificially increased. It is analogous to being in a restaurant and ordering French fries on an individual basis rather than all at once on a plate. Clearly, the costs to the restaurant would greatly increase. So it is with the switch features.

Verizon's proposed method here artificially increases both the recurring costs for the features and the non-recurring costs.

Q. WITH RESPECT TO THE NON-RECURRING COSTS, ARE THESE AVOIDED ALL TOGETHER IF THE FEATURES COME AUTOMATICALLY WITH THE SWITCH PORT?

A. Yes. The non-recurring charges for the individual features – which are exorbitantly and prohibitively high -- are entirely avoided if the features come automatically with the switch port. Thus, while under Verizon's proposal CLECs may incur literally over a hundred dollars in non-recurring charges for basic features, a slightly different rate proposal would eliminate such charges by making the ordering process itself unnecessary. Again, in no other states in which QSI has participated has Verizon introduced this anticompetitive proposal. It should be rejected.

Q. WHAT IS YOUR RECOMMENDATION?

A. I recommend that the Commission order Verizon to include all features in the monthly port costs. Further, given that Verizon is the largest ILEC in the country and must be able to avail itself of switching facilities at costs no higher than those incurred by BellSouth, I recommend that the Commission reject Verizon's feature rates altogether and adopt switch rates no higher than those just recently adopted by the Commission for BellSouth. This recommendation is reasonable in view of Verizon's proposal for a rate structure and associated cost studies for features that can only be construed as deliberately anticompetitive.

IX. NONRECURRING CHARGES SHOULD BE TELRIC BASED

Q. COULD NONRECURRING CHARGES POTENTIALLY POSE A SERIOUS BARRIER-TO-ENTRY?

A. Yes. As discussed previously, prices for unbundled network elements that are based on TELRIC promote efficient entry. But, while TELRIC based recurring and non-recurring prices for unbundled network elements are a necessary condition for efficient entry, they are not a sufficient condition. If the incumbent LECs are allowed to impose unreasonably high nonrecurring charges, then efficient carriers can still be prevented from operating viably in local exchange markets. That is, if nonrecurring charges are set above economic cost, then these charges could in effect create a barrier-to-entry that would protect and prolong the incumbent LEC's monopoly position in local markets.

Q. IN GENERAL, WHAT TYPES OF COSTS SHOULD BE RECOVERED THROUGH RECURRING CHARGES AND WHAT TYPES OF COSTS SHOULD BE RECOVERED THROUGH NONRECURRING CHARGES?

A. Consistent with the previously discussed TELRIC principles, cost should be recovered in the manner in which they are incurred. This means that in general, recurring costs should be recovered through recurring charges and nonrecurring, one-time, costs should be recovered through nonrecurring charges. Furthermore, with respect to the costs of operational support systems and activities, nonrecurring costs should only be recovered through nonrecurring charges (for a network element) if the costs are a *direct cost* to a specific unbundled network element (for example, an unbundled loop for customer X) that is ordered and provisioned. If the nonrecurring cost is a *common cost* to the ordering and provisioning of *all* network elements, such costs should be recovered through recurring charges.

The rationale here is simple. In general, direct costs associated with the ordering and provisioning of a specific unbundled network element should be recovered from the ALEC customer ordering and using the network element: that is, the costs must be recovered from the cost-causers.

Common costs, on the other hand, are not caused by an individual ALEC customer but rather by all customers collectively. It is appropriate, therefore, to spread these costs over the total projected output of all network elements (for which these costs were incurred) in the form of recurring charges. This ensures that the totality of the costs are recovered without disproportionately burdening some customers (ALEC) more than others. That is, by including the common costs in recurring charges for unbundled network elements, each ALEC customer will pay for a share of the common costs of ordering and provisioning processes that is *directly* *proportional* to the length of time that the unbundled elements are used by that customer.

Q. IF ILECS ARE PERMITTED TO RECOVER RECURRING COSTS THROUGH NONRECURRING CHARGES, THEN COULD THIS CREATE A BARRIER TO ENTRY AND IMPAIR THE COMPETITIVE PROCESS?

A. Yes. CLECs will attempt to enter local markets without an existing customer base. As such, they face nonrecurring charges for every customer they want to serve by means of unbundled network elements. If nonrecurring charges contain front-loaded recurring costs that will periodically be incurred by the ILEC *in the future*, then the CLECs' up-front costs for entering local markets may be increased significantly. Given that these nonrecurring charges apply disproportionately to CLECs (relative to the incumbent LECs), they constitute a barrier to entry. The FCC recognized the potentially anti-competitive nature of nonrecurring charges in paragraph 747 of its Local Competition Order:

> ...we find that *imposing nonrecurring charges for recurring costs could pose a barrier to entry* because these charges may be excessive, reflecting costs that may (1) not actually occur; (2) be incurred later than predicted; (3) not be incurred for as long as predicted; (4) be incurred at a level that is lower than predicted; (5) be incurred less frequently than predicted;

and (6) be discounted to the present using a cost of capital that is too low. (Emphasis added.)

Q. ARE THERE INSTANCES IN WHICH DIRECT NON-RECURRING COSTS MAY BE RECOVERED THROUGH RECURRING CHARGES?

Yes. There are situations in which the LECs can make reasonable predictions as to the average non-recurring costs incurred in the provision of a network element. In such instances, it could make sense to spread those costs out over the economic life of the facilities by recovering them through recurring rather than through non-recurring charges. As the FCC noted in section 51.507(e) of its Local Competition rules: "State commissions may, where reasonable, require incumbent LECs to recover nonrecurring costs through recurring charges over a reasonable period of time."

This practice is perfectly consistent with the workings of competitive markets. After all, firms in competitive markets often seek to lower the up-front costs to customers by spreading any nonrecurring costs over subsequent recurring charges.

Q. SHOULD NONRECURRING CHARGES BE BASED ON TELRIC?

A. Yes. All activities and products that local exchange companies – ILECs and CLECs – provide to one another should be based on TELRIC. As explained previously, TELRIC based prices are compensatory, ensure efficient entry and generally promote the public interest.

Q. DID THE FCC FIND THAT NONRECURRING CHARGES SHOULD BE BASED ON TELRIC?

A. Yes. Section 51.507(e) of the FCC Local Competition Rules states:

> State commissions may, where reasonable, require incumbent LECs to recover nonrecurring costs through recurring charges over a reasonable period of time. Nonrecurring charges shall be allocated efficiently among requesting telecommunications carriers, and shall not permit an incumbent LEC to recover more than the *total forward-looking economic cost* of providing the applicable element. (Emphasis added.)

Q. DOES THIS MEAN THAT NONRECURRING CHARGES SHOULD BE BASED ON THE MOST EFFICIENT, FORWARD-LOOKING ELECTRONIC OPERATIONAL SUPPORT SYSTEMS?

A. Yes. ILECs often base cost studies for NRCs on inefficient OSS that entail large amounts of labor to complete CLECs' service orders, etc. – this is inappropriate. Particularly, these labor related inefficiencies drive up the costs for NRCs dramatically. Instead, cost studies for NRCs should be on the most efficient electronic systems available. Since labor is often such an expensive component of taking service orders, etc., the OSS should allow to the maximum degree an integration of the CLECs electronic systems with those of the ILECs. If this is done appropriately, then the costs for NRCs are reduced significantly or they become negligibly small.

Further, the Commission should recognize that if it permits the ILECs to set nonrecurring charges based on inefficient systems, that it is rewarding these companies for inefficiencies. That is, since ILECs would be able to recoup the costs associated with inefficient systems, they would never have an incentive to enhance the efficiency of these systems. The incentives for ILECs to implement efficient systems is even further reduced by the fact that it is the CLECs that will be handicapped in their ability to compete by higher nonrecurring charges. Conversely, if prices are set based on the costs of efficient OSS, then ILECs are more likely to actually implement such systems.

Q. IN APPROVING THE ILECS' NONRECURRING CHARGES, SHOULD THE COMMISSION PAY SPECIAL ATTENTION TO THE POSSIBILITY OF DOUBLE RECOVERY OF COSTS?

A. Yes. I have already discussed how nonrecurring charges may derail the development of local competition. In view of this, it is particularly important that the Commission pay special attention that certain types of costs are not included in both the recurring and in the nonrecurring charges. While it is obvious that as a matter of costing methodology this would be inappropriate, in practice, one is likely to find many instances of such double counts if cost studies are patiently and thoroughly scrutinized. In recognition of the potential for double recovery of costs, the FCC stated the following in its local Competition Order:

> We require, however, that state commissions take steps to ensure that incumbent LECs do not recover nonrecurring costs twice and that nonrecurring charges are imposed equitably among entrants. (Paragraph 750)

X. COSTS FOR UNEs SHOULD BE DE-AVERAGED TO REFLECT GEOGRAPHIC DIFFERENCES

Q. SHOULD RATES BE DE-AVERAGED TO REFLECT COST DIFFERENCES ACROSS GEOGRAPHIC AREAS?

A. Yes. In order to comply with section 252(d)(1)'s requirement that rates be "based on the cost . . . of providing the . . . network element," rates for unbundled network elements must accurately and fully reflect each of the "cost drivers" that have a direct impact on the costs calculatedChecklist items (i) and (ii) require interconnection and nondiscriminatory access to network elements in accordance with section 252(d)(1) of the Act. <u>See</u> 47 U.S.C. §§ 271(c)(2)(B)(i) and (ii).

Q. IS THE NEED TO DETERMINE DE-AVERAGED COSTS

PARTICULARLY IMPORTANT WITH RESPECT TO LOOP COST STUDIES?

A. Yes. While this mandate pertains to all unbundled network elements, it is particularly important with respect to unbundled loops. First, new entrant's access to loops at efficient, cost-based rates is critical to the development of local competition. The local loop is the most expensive and difficult portion of the local network to replicate on a ubiquitous basis. For this reason, many competitors will be forced to rely, in varying degrees, on being able to use the loop facilities of the incumbent LECs. Second, loop costs, perhaps more than the costs for any other element, vary significantly across geographic regions.

The primary cost drivers of loop costs are loop length and customer density; both vary in predictable and demonstrable ways across different geographic areas. All else being equal, longer loops in low density areas are more costly than shorter loops placed in high density areas. As a result, loop costs vary significantly across geographic areas.

The development of cost-based rates requires that these significant geographic variations in costs be accurately and fully reflected in the rates for loops. Therefore, only loop rates that are appropriately geographically de-averaged can be found to be cost-based and in compliance with section 252(d)(1) of the Act. In paragraph 764 of the Local Competition order the FCC stated that:

> de-averaged rates more closely reflect the actual costs of providing interconnection and unbundled elements. Thus, we conclude that rates for interconnection and unbundled elements must be geographically de-averaged.

In paragraph 765 of the Local Competition order, the FCC further concluded that the Act requires at least three "de-averaged" rate zones.

The principle that policy decisions should be based on de-averaged -- rather than averaged -- cost information was reconfirmed by the FCC in its Universal Service Order, CC Docket No. 96-45, May 7, 1997. In paragraph 250 of this Order, the FCC found that, for USF purposes, "the cost study or model must de-average support calculations to the wire center serving area level at least, and, if feasible, to even smaller areas such as a Census Block Group, Census Block, or grid cell." Thus, the FCC reconfirmed the consensus among cost analysts that loop costs vary from wire center to wire center and that those cost variations are significant and should not be ignored.

Q. IF LOOP COSTS ARE NOT DE-AVERAGED, WILL THIS LEAD TO INEFFICIENCIES THAT DIMINISH OVERALL WELFARE IN FLORIDA?

A. Yes. If the loop costs, and hence loop prices, are not de-averaged, the pricing scheme will discourage efficient use of existing resources. When deciding to offer service in a given area, new entrants will be making decisions regarding whether to build their own facilities or purchase unbundled loops from the incumbent LEC. In the simplest terms, new entrants may be expected to build their own facilities when they can do so for less than the unbundled loop rates, and will lease an unbundled loop when they cannot. In order for a new entrant to make this analysis on an informed basis, however, it is essential that loop rates accurately reflect an underlying cost that is specific to the geographic area being evaluated.

In addition, the incumbent LEC will receive an artificial competitive advantage in those geographic areas in which the actual loop costs are less than the adopted rate for loops, if no de-averaging were ordered. This artificial advantage, gained through the establishment of an inefficient rate structure for elements rather than by virtue of superior efficiency on the incumbent LEC's part, will allow the incumbent to prevent the development of local exchange competition in the more metropolitan areas of the state. That is, an otherwise equally efficient CLEC would have to pay more than the actual economic costs for loops in metropolitan areas with a high density of customers and relatively shorter loop lengths. The incumbent LEC, therefore, has an artificial cost advantage and, in a competitive setting, can underprice the CLEC for competitive retail service and thereby discourage competition. Moreover, the incumbent LEC will also be able to use a portion of its inflated loop rate to subsidize other services and thereby gain a competitive advantage over its competitors. In short, if prices do not reflect cost, then the development of competition will be impaired and the ratepayers of Florida will be deprived of an optimally efficient network at competitive prices.

XI. COST OF CAPITAL

Q. DO YOU AGREE WITH VERIZONS PROPOSED COST OF CAPITAL?

A. No, I do not. Through the direct testimony of Dr. Vander Weide filed on November 7, 2001, Verizon is requesting a 12.95% cost of capital using a market value-based capital structure that assumes a 25% debt / 75% equity ratio, a cost of debt of 7.55% and a cost of equity of 14.75%. (See Direct Testimony of Dr. James H. Vander Weide, Florida Docket 990649-TP, page 51).

Q. HAVE YOU PREPARED AN ANALYSIS OF THE WEIGHTED AVERAGE COST OF CAPITAL VERIZON – FL SHOULD USE IN THIS PROCEEDING?

A. No, I have not. However, I am providing the Commission comparative information that demonstrates the unreasonableness of Verizon – FL's request for a 12.95% cost of capital. This information demonstrates that Dr. Vander Weide's (1) recommended market value capital structure be rejected, (2) proposed debt / equity ratio of 25% / 75% is too heavily weighted towards equity, and (3) use of the S&P Industrials as a benchmark for competitive risk is without merit.

Q. WHY DO YOU DISAGREE WITH DR. VANDER WEIDE'S RECOMMENDATION THAT THE COMMISSION ACCEPT A MARKET VALUE CAPITAL STRUCTURE?

A. Dr. Vander Weide's recommended market value-based capital structure is inconsistent with this Commission's previous ruling in the BellSouth phase of this docket. In Order No. PSC-01-1181-FOF-TP, the Commission determined "...that market value capital structures have not been widely accepted and produce aberrant coverage ratios." (See Florida Public Service Commission Order No. PSC-01-1181-FOF-TP in Docket No. 990649-TP, issued May 25, 2001, page 188)

In reaching this conclusion, the Commission noted that the Telecommunications Act of 1996 requires the use of forward-looking costs, but not the use of a market value capital structure. (Id., page 187).

In rejecting BellSouth's request, the Commission determined that a 40% debt and 60% equity ratio is appropriate in part because it is close to the standards set by bond rating agencies.

Q. HAVE OTHER STATE COMMISSIONS WITHIN VERIZONS OPERATING REGION MADE DETERMINATIONS ON THE APPROPRIATENESS OF VERIZON'S REQUESTED COST OF CAPTIAL FOR UNES?

A. I know of at least two states, New Jersey and New York, where a decision has been reached rejecting Verizons proposed cost of capital.

Q. WHAT COST OF CAPITAL WAS APPROVED IN THE NEW JERSEY UNE PROCEEDING?

A. The New Jersey Board of Public Utilities adopted a cost of capital of **8.8%** as recommended by the Ratepayer Advocate in an order dated November 20, 2001. (See *In the Matter of the Board's Review of Unbundled Network Element Rates, Terms and Conditions of Bell Atlantic New Jersey, Inc.*, Summary Order of Approval in New Jersey Docket No. TO00060356, November 20, 2001, Part I(d), page 5. (*New Jersey Summary Order of Approval*))

The New Jersey Board of Public Utilities found that Ratepayer Advocate's analysis was the most reasonable and forward-looking in the record. This analysis was based upon Verizon's existing debt / equity ratio where debt comprises a larger proportion of Verizon's total capital structure, an 8.07% cost of debt derived from the interest rate of "A" rated utility debt, and a 10% cost of equity based upon data from Value Line Reports adjusted for risk (I interpret Verizon's existing debt / equity ratio to be its book value capital structure. Based upon the cost of debt, cost of equity and weighted average cost of capital calculated, the book value capital structure is approximately 60% debt and 40% equity.) (See *New Jersey Summary Order of Approval*, page 5).

Q. WHAT WAS THE RECOMMENDED COST OF CAPITAL IN THE NEW YORK UNE PROCEEDING?

A. The Administrative Law Judge recommended a weighted average cost of capital of 10.5% derived from a debt / equity ratio of 35% / 65%, a cost of debt of 7.39% and a cost of equity of 12.19%. ((See *Proceeding on Motion of the Commission to Examine New York Telephone Company's Rates for Unbundled Network Elements*, Recommended Decision by Administrative Law Judge Joel A. Linsider, New York Case 98-C-1357, Issued May 16, 2001, pages 82 –83).

Verizon had requested a 12.6% cost of capital while Dr. Vander Weide concluded that a 13.03% cost of capital based upon a debt / equity ratio of 25% / 75%, a cost of debt of 7.77% and a cost of equity of 14.78% would have been reasonable. *Id. at 68.* In reaching his recommendation, the judge appeared to be most concerned with Verizon's risk assumptions as it pertains to the cost of equity determination.

Q. WHAT WAS THE NEW YORK ADMINISTRATIVE LAW JUDGE MOST CONCERNED WITH IN VERIZON'S COST OF EQUITY CALCULATION?

A. The Administrative Law Judge was concerned with the risk profile presented by Verizon. In laying the foundation for his decision, the judge referenced the New York Public Service Commission's previous finding on NYNEX's (the predecessor of Verizon in New York) risk profile.

> New York Telephone greatly strains the FCC's forward-looking concept in taking it as warrant for regarding NYNEX as

> comparable, for cost of capital purposes, to certain industrial firms operating in different, if fully competitive markets. One can recognize the consequences of competition in telecommunications without concluding that NYNEX will operate in the same environment and face the same risks as the S&P Industrials. ... (*Id. at 78)*

The judge then noted that this observation was no less pertinent today than when first made. In supporting his decision, the judge emphatically stated that:

> Verizon correctly argues that TELRIC should not bé understood to contemplate a "fantasy network" that makes use of speculative technology. But neither should it be taken to require basing the cost of capital on a "fantasy marketplace," in which the provision of local telephone service is as competitive as the sale of detergent. Such a market is our goal; together with federal regulators we are fostering it; and significant progress in that direction has been made. But one cannot realistically claim that the goal will be reached with respect to local service within the next few years. With respect to UNEs, vibrant competition seems even more remote; indeed, were it achieved, there would be no need for regulators to require TELRIC pricing in the first place. (*Id.* at 79)

The judge concluded that the proxy group used by AT&T in its analysis should be used to determine the cost of equity. The judge's conclusion on Verizon's use of the S&P Industrials in its cost of equity analysis is also relevant in this proceeding because Dr. Vander Weide uses the S&P Industrials in his Discounted Cash Flow analysis in his Exhibit JVW-1. He claims that, "The forward-looking risk of investing in the facilities required to provide UNEs in Florida is at least as great as the forward-looking risk of investing in the S&P Industrials.(Dr. Vander Weide, Direct, page 45) Based on the foregoing, I urge this Commission to reject this argument.

Q. WHAT COST OF CAPTIAL DO YOU RECOMMEND THE COMMISSION APPROVE IN THIS PROCEEDING?

A. Based upon the Commission's decision in the BellSouth phase of this proceeding and the orders I cite from New York and New Jersey, I recommend that the Commission set Verizon's cost of capital no higher than the 10.24% approved for BellSouth and no lower than the 8.8% approved for Verizon in New Jersey. In doing so, the Commission should require that equity comprise no more than 60% of Verizon's capital structure.

XII. DEPRECIATION

Q. DO YOU AGREE WITH MR. SOVEREIGN'S RECOMMENDATION THAT THE COMMISSION APPROVE THE USE OF ECONOMIC LIVES IN CALCULATING DEPRECIATION FOR VERIZON'S UNE COST STUDIES?

A. No, I do not. Verizon – FL should be required to set its projection lives within the range approved by the FCC.

Q. ARE THE PROJECTION LIVES PRESCRIBED BY THE FCC FORWARD-LOOKING?

A. Yes, they are. As the FCC noted in its "1999 Update" order, in 1980, it "departed from its previous practice of relying largely on historical experience to project equipment lives and began to rely on analysis of company plans, technological developments, and other future-oriented studies(FCC, 1998 Biennial Regulatory Review-Review of Depreciation Requirements for Incumbent Local Exchange Carriers, CC Docket 98-137, Report and Order, FCC 99-397, released December 30, 1999 ("1999 Update"), para. 5).

In 1995, the FCC reaffirmed its forward-looking orientation in connection with the simplification of its depreciation represcription practices. The FCC prescribed a range of projection lives that could be selected by carriers for prescription on a streamlined basis. The FCC stated that these ranges were based upon "statistical studies of the most recently prescribed factors. These statistical studies required detailed analysis of each carrier's most recent retirement patterns, the carriers' plans, and the current technological developments and trends."(See *Simplification of the Depreciation Prescription Process*, CC Docket

No. 92-296 ("Prescription Simplification" proceeding), Third Report and Order, FCC 95-181, released May 4, 1995, p. 6).

In 1999, the FCC completed a review of these ranges and updated them as appropriate (1999 Update, para. 14) The FCC stated:

> These ranges can be relied upon by Federal and state regulatory commissions for determining the appropriate depreciation factors for use in establishing high cost support and interconnection and UNE prices. (*Id.*, para. 34)

Indeed, the FCC further stated:

> In adopting a forward-looking mechanism for high-cost support, we found that depreciation expense calculations based on the Commission's prescribed projection lives and salvage factors represent the best forward-looking estimates of depreciation lives and net salvage percentages.(FCC, United States Telephone Association's Petition for Forbearance from Depreciation Regulation of Price Cap Local Exchange Carriers, ASD 98-91, Memorandum Opinion and Order, FCC 99-397, released December 30, 1999, para. 61 (emphasis added)).

Q. WHAT IS YOUR ALTERNATIVE RECOMMENDATION IF THE COMMISSION DOES NOT APPROVE PROJECTION LIVES WITHIN THE RANGE PRESCRIBED BY THE FCC?

A. If the Commission does not accept my recommendation to use the range of projection lives approved by the FCC, then I recommend that the Commission adopt the lives approved for BellSouth in the earlier phase of this proceeding since they are relatively close to those approved by the FCC. The Commission should reject Mr. Sovereign's proposal requesting projection lives shorter than those approved for BellSouth for Digital Switching and the Copper Cable accounts because his claim that Verizon is subject to more competitive pressures in its serving area than BellSouth should have no bearing on the Commission's determination. Additionally, it is difficult to believe that Verizon is subject to more competitive pressures than BellSouth when BellSouth serves the majority of the access lines in the state.

Q. DO YOU HAVE A COMPARISON OF THE VARIOUS PROJECTION LIVES YOU RECOMMEND VERSUS THOSE PROPOSED BY VERIZON – FL?

A. Yes, I do. I have prepared a matrix comparing the projection lives proposed by Verizon, the FCC-approved projection lives, and the Commission's approved lives in the BellSouth phase of this proceeding (Exhibit AHA-12).

CONCLUSION

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

Curriculum Vitae

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I am an economist and consultant, specializing in public utility regulation. In this capacity, I have provided consulting services in the major telecommunications markets of the United States, such as New York, Texas, Illinois, Michigan, Tennessee, Georgia, and in a variety of smaller states. My consulting activities focus mostly on telecommunications regulation. Specifically, I work with large corporate clients, such as MCIWorldCom, AT&T, AT&T Wireless, and a variety of smaller competitive local exchange carriers and PCS providers. I have represented these clients before state and federal regulatory agencies in various proceedings concerning the introduction of competition in telecommunications markets. Recently, these proceedings focus largely on the implementation of the pro-competition provisions of Telecommunications Act of 1996.

Professional experience:

My professional background includes work experiences in private industry, a state regulatory agency, and academia. I have worked for MCI Telecommunications Corporation ("MCI") as a senior economist. At MCI, I provided expert witness testimony and conducted economic analyses for internal purposes. Prior to joining MCI in early 1995, I worked for Teleport Communications Group, Inc. ("TCG"), as a Manager in the Regulatory and External Affairs Division. In this capacity, I testified on behalf of TCG in proceedings concerning local exchange competition issues. From 1986 until early 1994, I was employed as an economist by the Public Utility Commission of Texas ("PUCT") where I worked on a variety of electric power and telecommunications issues. During my last year at the PUCT I held the position of chief economist. Prior to joining the PUCT, I taught undergraduate courses in economics as an Assistant Instructor at the University of Texas from 1984 to 1986.

Education:

I received a Ph.D. in Economics from the University of Texas at Austin in 1992, an M.A. in Economics from the University of Texas at Austin in 1987, and a B.A. in Economics from Quincy College, Illinois, in 1982.

PROCEEDINGS IN WHICH DR. ANKUM HAS FILED EXPERT WITNESS TESTIMONY:

New York

Commission Investigation into Resale, Universal Service and Link and Port Pricing, New York Public Service Commission, Case Nos. 95-C-0657, 94-C-0095, and 91-C-1174, July 4, 1996. On behalf of MCI Telecommunications Corporation.

In the Matter of Proceeding on Motion of the Commission To Reexamine Reciprocal Compensation, New York Public Service Commission, Case 99-C-0529. Direct Testimony, July 1999. On Behalf Of Cablevision LightPath, Inc.

Proceeding on the Motion of the Commission To Examine New York Telephone Company's Rates for Unbundled Network Elements, New York Public Service Commission, Case 98-C-1357. Direct Testimony, October 1999. On behalf of Corecomm New York, Inc.

Proceeding on Motion of the Commission to Examine New York Telephone Company's Rates for Unbundled Network Elements, New York Public Service Commission Case 98-C-1357, Direct Testimony, June 2000, on behalf of MCIWorldCom.

New Jersey

Petition of Focal Communications Corporation of New Jersey For Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish an Interconnection Agreement with Bell Atlantic – New Jersey Board of Public Utilities, May 2000. On behalf of Focal Communications Corporation of New Jersey.

Delaware

Petition of Focal Communications Corporation of Pennsylvania For Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish an Interconnection Agreement with Bell Atlantic – Delaware, Inc. Delaware Public Service Commission, PSC Docket No. 00-025. Direct Testimony, May 2000. On behalf of Focal Communications Corporation of Pennsylvania.

Texas

Petition of The General Counsel for an Evidentiary Proceeding to Determine Market Dominance, PUC of Texas, Docket No. 7790, Direct Testimony, June 1988. On behalf of the Public Utility Commission of Texas.

Application of Southwestern Bell Telephone Company for Revisions to the Customer Specific Pricing Plan Tariff, PUC of Texas, Docket No. 8665, Direct Testimony, July 1989. On behalf of the Public Utility Commission of Texas.

Application of Southwestern Bell Telephone Company to Amend its Existing Customer Specific Pricing Plan Tariff: As it Relates to Local Exchange Access through Integrated Voice/Data Multiplexers, PUC of Texas, Docket No. 8478, Direct Testimony, August 1989. On behalf of the Public Utility Commission of Texas.

Application of Southwestern Bell Telephone Company to Provide Custom Service to Specific Customers, PUC of Texas, Docket No. 8672, Direct Testimony, September 1989. On behalf of the Public Utility Commission of Texas.

Inquiry of the General Counsel into the Reasonableness of the Rates and Services of Southwestern Bell Telephone Company, PUC of Texas, Docket No. 8585, Direct Testimony, November 1989. On behalf of the Public Utility Commission of Texas.

Southwestern Bell Telephone Company Application to Declare the Service Market for CO LAN Service to be Subject to Significant Competition, PUC of Texas, Docket No. 9301, Direct Testimony, June 1990. On behalf of the Public Utility Commission of Texas.

Petition of Southwestern Bell Telephone Company for Authority to Change Rates, PUC of Texas, Docket No. 10382, Direct Testimony, September 1991. On behalf of the Public Utility Commission of Texas.

Application of Southwestern Bell Telephone Company, GTE Southwest, Inc., and Contel of Texas, Inc. For Approval of Flat-rated Local Exchange Resale Tariffs Pursuant to PURA 1995 Section 3.2532, Public Utility Commission of Texas, Docket No. 14658, January 24, 1996. On behalf of Office of Public Utility Counsel of Texas.

Application of Southwestern Bell Telephone Company, GTE Southwest, Inc., and Contel of Texas, Inc. For Interim Number Portability Pursuant to Section 3.455 of the Public Utility Regulatory Act, Public Utility Commission of Texas, Docket No. 14658, March 22, 1996. On behalf of Office of Public Utility Counsel of Texas.

Application of AT&T Communications for Compulsory Arbitration to Establish an Interconnection Agreement Between AT&T and Southwestern Bell Telephone Company, and Petition of MCI for Arbitration under the FTA96, Public Utility Commission of Texas, Consl. Docket Nos. 16226 and 16285. September 15, 1997. On behalf of AT&T and MCI.

Proceeding to examine reciprocal compensation pursuant to section 252 of the Federal Telecommunications of 1996, Public Utility Commission of Texas, Docket No. 21982. May 2000. On behalf of Taylor Communications.

Iowa

US West Communications, Inc., Iowa Department of Commerce – Utilities Board, Docket No: RPU – 00 – 01. Direct Testimony, July 2000. On behalf of McLeodUSA.

Illinois

Adoption of Rules on Line-Side Interconnection and Reciprocal Interconnection, Illinois Commerce Commission, Docket No. 94-0048. September 30, 1994. On behalf of Teleport Communications Group, Inc.

Proposed Introduction of a Trial of Ameritech's Customer First Plan in Illinois, Illinois Commerce Commission, Docket No. 94-0096. September 30, 1994. On behalf of Teleport Communications Group, Inc.

Addendum to Proposed Introduction of a Trial of Ameritech's Customer First Plan in Illinois, Illinois Commerce Commission, Docket No. 94-0117. September 30, 1994. On behalf of Teleport Communications Group, Inc.

AT&T's Petition for an Investigation and Order Establishing Conditions Necessary to Permit Effective Exchange Competition to the Extent Feasible in Areas Served by Illinois Bell Telephone Company, Illinois Commerce Commission, Docket No. 94-0146. September 30, 1994. On behalf of Teleport Communications Group, Inc.

Proposed Reclassification of Bands B and C Business Usage and Business Operator Assistance/Credit Surcharges to Competitive Status, Illinois Commerce Commission, Docket No. 95-0315, May 19, 1995. On behalf of MCI Telecommunications Corporation.

Investigation Into Amending the Physical Collocation Requirements of 83 Ill. Adm. Code 790, Illinois Commerce Commission, Docket 94-480, July 13, 1995. On behalf of MCI Telecommunications Corporation.

Petition for a Total Local Exchange Wholesale Tariff from Illinois Bell Telephone Company d/b/a Ameritech Illinois and Central Telephone Company Pursuant to Section 13-505.5 of the Illinois Public Utilities Act, Illinois Commerce Commission, Docket No. 95-0458, December 1995. On behalf of MCI Telecommunications Corporation.

Citation to Investigate Illinois Bell Telephone Company's Rates, Rules and regulations For its Unbundled Network Component Elements, Local Transport Facilities, and End office Integration Services, Illinois Commerce Commission, Docket No. 95-0296, January 4, 1996. On behalf of MCI Telecommunications Corporation.

In the Matter of MCI Telecommunications Corporation Petition for Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish and Interconnection Agreement with Illinois Bell Telephone Company d/b/a Ameritech Illinois, Illinois Commerce Commission, Docket No. 96-AB-006, October, 1996. On behalf of MCI Telecommunications Corporation.

In the Matter of MCI Telecommunications Corporation Petition for Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish and Interconnection Agreement with Central Telephone Company of Illinois ("Sprint"), Illinois Commerce Commission, Docket No. 96-AB-007, January, 1997. On behalf of MCI Telecommunications Corporation.

Investigation into forward looking cost studies and rates of Ameritech Illinois for interconnection, network elements, transport and termination of traffic. Illinois Commerce Commission, Docket No. 96-0486, February, 1997. On behalf of MCI Telecommunications Corporation.

Phase II of Ameritech Illinois TELRIC proceeding. Illinois Commerce Commission Docket No. 98-0396, May 2000. On behalf of MCIWorldCom.

Massachusetts

NYNEX/MCI Arbitration, Common Wealth of Massachusetts, Department of Public Utilities, D.P.U. 96-83, October 1996. On behalf of MCI Telecommunications Corporation.

New Mexico

Brooks Fiber Communications of New Mexico, Inc. Petition for Arbitration, New Mexico State Corporation Commission, Docket No. 96-307-TC, December, 1996. On behalf of Brooks Fiber Communications of New Mexico, Inc.

Michigan

In the Matter of the Application of City Signal, Inc. for an Order Establishing and Approving Interconnection Arrangements with Michigan Bell Telephone Company, Michigan Public Service Commission, Case No. U-10647, October 12, 1994. On behalf of Teleport Communications Group, Inc.

In the Matter, on the Commission's Own Motion, to Establish Permanent Interconnection Arrangements Between Basic Local Exchange Providers, Michigan Public Service Commission, Case No. U-10860, July 24, 1995. On behalf of MCI Telecommunications Corporation.

In the Matter, on the Commission's Own Motion, to consider the total service long run incremental costs and to determine the prices for unbundled network elements, interconnection services, resold services, and basic local exchange services for Ameritech Michigan, Michigan Public Service Commission, Case No. U-11280, March 31, 1997. On behalf of MCI Telecommunications Corporation.

In the matter of the application under Section 310(2) and 204, and the complaint under Section 205(2) and 203, of MCI Telecommunications Corporation against AMERITECH requesting a reduction in intrastate switched access charges, Case No. U-11366. April, 1997. On behalf of MCI Telecommunications Corporation.

Ohio

In the Matter of MCI Telecommunications Corporation Petition for Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish and Interconnection Agreement with Ameritech Ohio, The Public Utilities Commission of Ohio, Case No. 96-888-TP-ARB, October, 1996. On behalf of MCI Telecommunications Corporation.

In the matter of the review of Ameritech Ohio's economic costs for interconnection, unbundled network elements, and reciprocal compensation for transport and termination of local telecommunications traffic, The Public Utilities Commission of Ohio, Case No. 96-922-TP-UNC, Jan 17, 1997. On behalf of MCI Telecommunications Corporation.

In the Matter of the Review of Ameritech Ohio's Economic Costs for Interconnection, Unbundled Network Elements, and Reciprocal Compensation for Transport and Termination of Local Telecommunications Traffic. Case No. 96-922-TP-UNC and In the Matter of the Application of Ameritech Ohio for Approval of Carrier to Carrier Tariff. Case No. 00-1368-TP-ATA. Ohio Public Utilities Commission. Direct Testimony, October 2000. On behalf of MCIWorldCom and ATT of the Central Region.

Indiana

In the matter of the Petition of MCI Telecommunications Corporation for the Commission to Modify its Existing Certificate of Public Convenience and Necessity and to Authorize the Petitioner to Provide certain Centrex-like Intra-Exchange Services in the Indianapolis LATA Pursuant to I.C. 8-1-2-88, and to Decline the Exercise in Part of its Jurisdiction over Petitioner's Provision of such Service, Pursuant to I.C. 8-1-2.6., Indiana Regulatory Commission, Cause No. 39948, March 20, 1995. On behalf of MCI Telecommunications Corporation.

In the matter of the Petition of Indiana Bell Telephone company, Inc. For Authorization to Apply a Customer Specific Offering Tariff to Provide the Business Exchange Services Portion of Centrex and PBX Trunking Services and for the Commission to Decline to Exercise in Part Jurisdiction over the Petitioner's Provision of such Services, Pursuant to I.C. 8-1-2.6, Indiana regulatory Commission, Cause No. 40178, October 1995. On behalf of MCI Telecommunications Corporation.

MCI Telecommunications Corporation Petition for Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996.to Establish and Interconnection Agreement with Indiana Bell

Telephone Company d/b/a Ameritech Indiana, Indiana Public Utility Regulatory Commission, Cause No. 40603-INT-01, October 1996. On behalf of MCI Telecommunications Corporation.

In the matter of the Commission Investigation and Generic Proceeding on Ameritech Indiana's Rates for Interconnection Service, Unbundled Elements and Transport and Termination under the Telecommunications Act of 1996 and Related Indiana Statutes, Indiana Public Utility Regulatory Commission, Cause No. 40611. April 18, 1997. On behalf of MCI Telecommunications Corporation.

In the Matter of the Commission Investigation and Generic Proceeding on GTE's Rates for Interconnection, Service, Unbundled Elements, and Transport under the FTA 96 and related Indiana Statutes, Indiana Public Utility Regulatory Commission, Cause No. 40618. October 10, 1997. On behalf of MCI Telecommunication Corporation.

Rhode Island

Comprehensive Review of Intrastate Telecommunications Competition, State of Rhode Island and Providence Plantations Public Utilities Commission, Docket No. 2252, November, 1995. On behalf of MCI Telecommunications Corporation.

Vermont

Investigation into NET's tariff filing re: Open Network Architecture, including the Unbundling of NET's Network, Expanded Interconnection, and Intelligent Networks, Vermont Public Service Board, Docket No. 5713, June 8, 1995. On behalf of MCI Telecommunications Corporation.

Wisconsin

Investigation of the Appropriate Standards to Promote Effective Competition in the Local Exchange Telecommunications Market in Wisconsin, Public Service Commission of Wisconsin, Cause No. 05-TI-138, November, 1995. On behalf of MCI Telecommunications Corporation.

Matters relating to the satisfaction of conditions for offering interLATA services (Wisconsin Bell, Inc. d/b/a Ameritech Wisconsin) Wisconsin Public Service Commission, 670-TI-120, March 25, 1997. On behalf of MCI Telecommunications Corporation.

In the Matter of MCI Telecommunications Corporation Petition for Arbitration Pursuant to Section 252(b) of the Telecommunications Act of 1996 to Establish an Interconnection Agreement with Wisconsin Bell, Inc. d/b/a Ameritech Wisconsin, Wisconsin Public Service Commission, Docket Nos. 6720-MA-104 and 3258-MA-101. On behalf of MCI Telecommunications Corporation.

Investigation Into The Establishment of Cost-Related Zones For Unbundled Network Elements, Docket No. 05-TI-349. Rebuttal Testimony, September 2000. On behalf of AT&T Communications of Wisconsin, McLEODUSA Telecommunications Services, Inc., TDS MetroCom, Inc., and Time Warner Telecom.

Pennsylvania

In Re: Formal Investigation to Examine Updated Universal Service Principles and Policies for telecommunications Services in the Commonwealth Interlocutory order, Initiation of Oral Hearing Phase, Pennsylvania Public Utility Commission, Docket No. I-00940035, February 28, 1996. On behalf of MCI Telecommunications Corporation.

Structural Separation of Verizon, Pennsylvania Public Utility Commission - Docket No. M-0001352. Direct Testimony, October, 2000. On behalf of MCI WorldCom.

Georgia

AT&T Petition for the Commission to Establish Resale Rules, Rates and terms and Conditions and the Initial Unbundling of Services, Georgia Public Service Commission, Docket No. 6352-U, March 22, 1996.On behalf of MCI Telecommunications Corporation.

Tennessee

Avoidable Costs of Providing Bundled Services for Resale by Local Exchange Telephone Companies, Tennessee Public Service Commission, Docket No. 96-00067, May 31, 1996. On behalf of MCI Telecommunications Corporation.

Commonwealth of Puerto Rico

Petition for Arbitration Pursuant to 47 U.S.C. & (b) and the Puerto Rico Telecommunications Act of 1996, regarding Interconnection Rates Terms and Conditions with Puerto Rico Telephone Company, Puerto Rico Telecommunications Regulatory Board, Docket No. 97-0034-AR, April 15, 1997. On behalf of Cellular Communications of Puerto Rico, Inc.
Cellular Communications of Puerto Rico, Inc.

Docket No. 990649B-TP
Ankum Exhibit No. AHA-2
FPSC Exhibit No. _______

FINANCIAL ANALYSIS

Decline in market capitalization for CLECs and Wholesale providers (Category 1)
December 31, 1999 to April 23, 2001

	COMPANY	CHANGE IN MARKET CAP	% CHANGE
1	Advanced Radio Telecom Corp.	$ (671,232,000)	-100.0%
2	Convergent	$ (454,691,750)	-100.0%
3	E.spire	$ (297,308,213)	-100.0%
4	ICG	$ (895,518,750)	-100.0%
5	NorthPoint	$ (590,232,000)	-100.0%
6	WinStar	$ (6,293,910,000)	-100.0%
7	CoreComm	$ (2,272,163,940)	-99.3%
8	Teligent	$ (3,225,250,990)	-99.2%
9	Rhythms	$ (2,358,818,570)	-98.5%
10	Network Access	$ (1,455,879,200)	-97.4%
11	Covad	$ (5,092,290,540)	-96.2%
12	XO	$ (21,035,186,250)	-94.5%
13	Mpower	$ (1,655,831,750)	-93.6%
14	RCN Corp.	$ (3,438,536,190)	-91.9%
15	DSL.net, Inc.	$ (766,029,353)	-90.9%
16	Adelphia	$ (3,018,455,740)	-90.6%
17	Net2000	$ (810,360,150)	-90.6%
18	Z-tel	$ (1,139,292,100)	-89.3%
19	Metromedia Fiber Networks	$ (20,206,149,523)	-88.1%
20	CTC Comm.	$ (995,923,270)	-87.8%
21	Pac-West	$ (822,203,800)	-87.7%
22	Electric Lightwave	$ (816,273,470)	-86.8%
23	NetworkPlus	$ (979,484,070)	-85.1%
24	US LEC	$ (752,198,180)	-84.8%
25	McLeodUSA	$ (23,073,189,055)	-82.9%
26	Allegiance	$ (7,355,564,550)	-81.9%
27	ITC DeltaCom	$ (1,306,396,125)	-79.4%
28	FiberNet	$ (300,686,625)	-76.7%
29	Focal Comm.	$ (1,101,644,765)	-75.2%
30	Choice One	$ (499,530,300)	-63.9%
31	Intermedia	$ (1,249,108,138)	-58.4%
32	Optelecom	$ (4,311,250)	-52.4%
33	Cox	$ (6,794,000,500)	-21.8%
34	Time Warner	$ (606,882,060)	-11.6%
35	Cablevision	$ (893,720,500)	-6.8%
	CLEC & WHOLESALE SUPPLIERS	*$ (122,332,734,915)*	*-68.8%*

Decline in market capitalization for RBOCs (Category 2)
December 31, 1999 to April 23, 2001

	COMPANY	CHANGE IN MARKET CAP	% CHANGE
36	Qwest	$ (24,171,892,240)	-28.2%
37	SBC	$ (34,504,732,000)	-20.6%
38	BellSouth	$ (11,404,868,430)	-13.0%
39	Verizon	$ (8,731,037,000)	-5.8%
	RBOCS	$ (78,812,529,670)	-16.0%

Decline in market capitalization for Major IXCs (Category 3)
December 31, 1999 to April 23, 2001

	COMPANY	CHANGE IN MARKET CAP	% CHANGE
1	Williams Communications	$ (11,425,918,600)	-85.2%
2	Level 3 Communications	$ (25,157,193,250)	-82.9%
3	Global Crossing	$ (30,081,852,500)	-75.3%
4	Sprint	$ (40,062,140,460)	-68.1%
5	WorldCom	$ (96,757,337,250)	-64.1%
6	AT&T	$ (79,783,364,683)	-49.1%
	MAJOR IXCs	$ (283,267,806,743)	-62.1%

THIS PAGE CALCULATES THE RELATIVE PERCENTAGE OF CUTOVER TO GROWTH LINES BASED ON AMERITECH PROVIDED GROWTH RATES

	Cutover Lines	NPV Growth Lines
LINES	100	39.7
PERCENTAGE	72%	28%

Year	Growth Rate	Base	Annual Growth Lines	NPV Line Growth	CUMULATIVE GROWTH
		100.0			
1	4.00%	104.0	4.0	4.0	4.0
2	4.00%	108.2	4.2	3.7	7.7
3	4.00%	112.5	4.3	3.4	11.1
4	4.00%	117.0	4.5	3.1	14.2
5	4.00%	121.7	4.7	2.9	17.2
6	4.00%	126.5	4.9	2.7	19.8
7	4.00%	131.6	5.1	2.5	22.3
8	4.00%	136.9	5.3	2.3	24.6
9	4.00%	142.3	5.5	2.1	26.7
10	4.00%	148.0	5.7	1.9	28.7
11	4.00%	153.9	5.9	1.8	30.5
12	4.00%	160.1	6.2	1.7	32.1
13	4.00%	166.5	6.4	1.5	33.7
14	4.00%	173.2	6.7	1.4	35.1
15	4.00%	180.1	6.9	1.3	36.4
16	4.00%	187.3	7.2	1.2	37.6
17	4.00%	194.8	7.5	1.1	38.7
18	4.00%	202.6	7.8	1.0	39.7

Notes:
18 year economic life is conservative for this calculation since it permits growth lines a longer period to grow
Cost of capital for discounting the growth lines is 12.65% as provided by VZ
The growth rate is assumed to be 4% per year to favor VZ.

Docket No. 990649B-TP
Ankum Exhibit No. AHA-4
FPSC Exhibit No. _______

	Florida	New York	New Jersey
UNE	Verizon Proposed RC	ALJ Recommended	BPU Approved
Zone 1	$ 22.17	$ 7.27	$ 8.12
Zone 2	$ 30.91	$ 10.18	$ 9.59
Zone 3	$ 77.39	$ 14.67	$ 10.92
Statewide	$ 26.17		$ 9.52
DS1 Loop			
Zone 1	$ 235.24		$ 68.88
Zone 2	$ 252.20		$ 70.99
Zone 3	$ 309.27		$ 75.89
Statewide	$ 240.52		$ 71.34
DS0 Port	$ 3.37		$ 0.73
Zone 1*		$ 2.66	
Zone 2*		$ 3.14	
Zone 3*		$ 3.15	
EO Switch Usage**	$ 0.00295		
Orig. Zone 1**		$ 0.00107	$ 0.00277
Orig. Zone 2**		$ 0.00083	$ 0.00277
Orig. Zone 3**		$ 0.00158	$ 0.00277
Term. Zone 1**		$ 0.00097	$ 0.00251
Term. Zone 2**		$ 0.00081	$ 0.00251

DIAGRAM 1

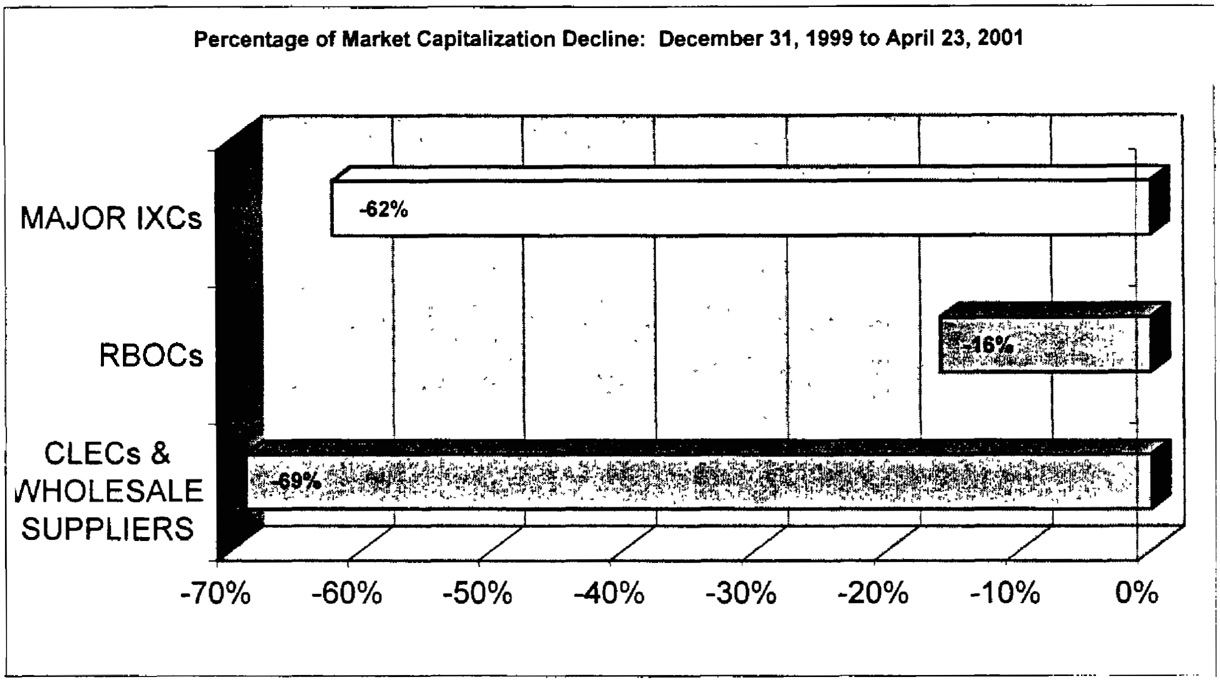


DIAGRAM 2

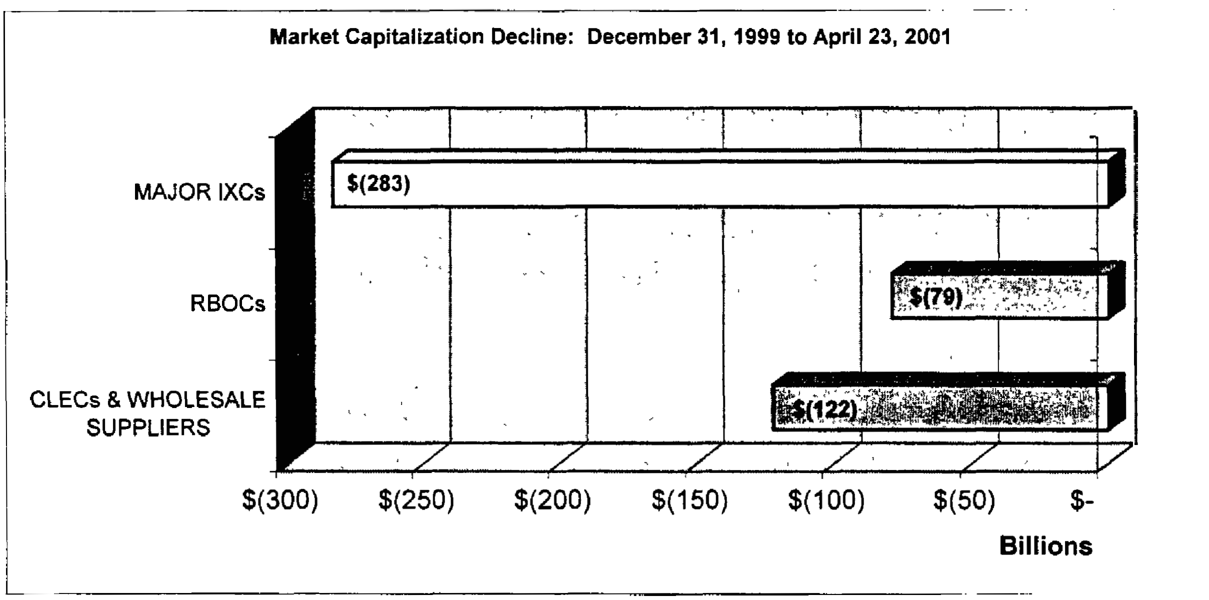


DIAGRAM 3

Proportion of Total Market Capitalization as of December 31, 1999

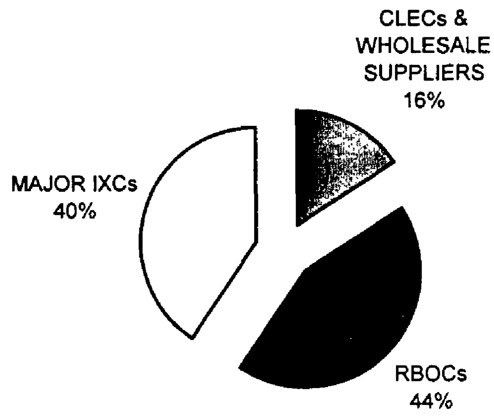
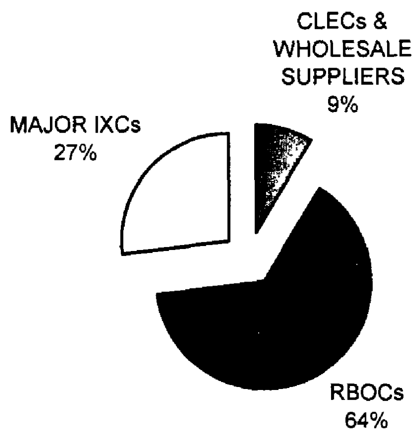


DIAGRAM 4

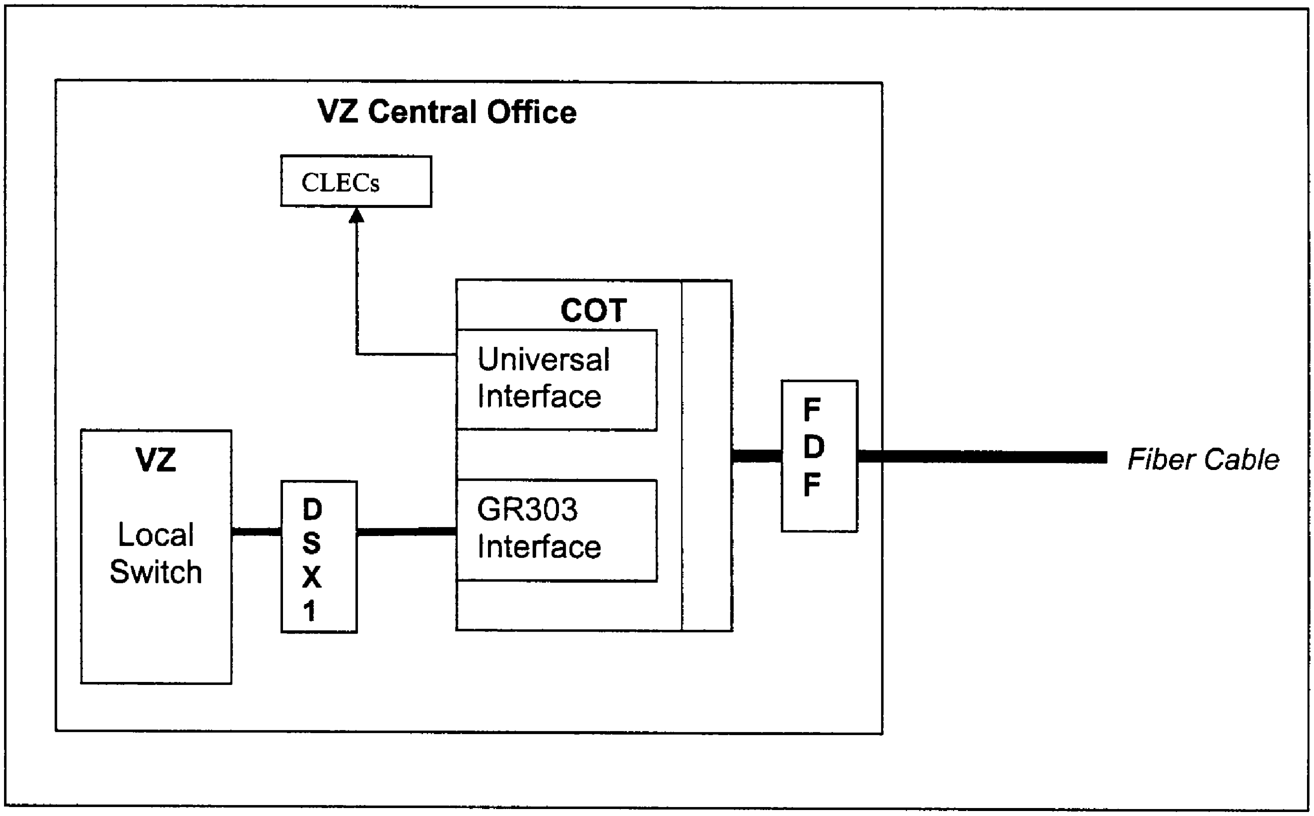
Proportion of Total Market Capitalization as of April 23, 2001



FILL FACTORS

	CLEC Coalition Recommended Fills	Michigan Commission CASE U-11280 APPROVED FILLS
Feeder Copper fill	85%	80%
Distribution Copper fill	75%	75%
COTs, RTs	90%	85%
Channel Units	95%	--
Conduit	60%	--

COT AND DLC INTERFACES



Docket No. 990649-TP
Ankum Exhibit AHA-8
FPSC Exhibit _______

IDLC TECHNICAL PAPERS

DSC
COMMUNICATIONS

Unbundling Solutions

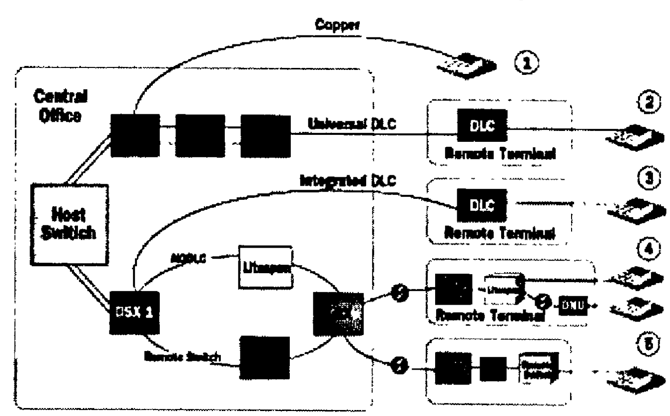
The Challenge

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



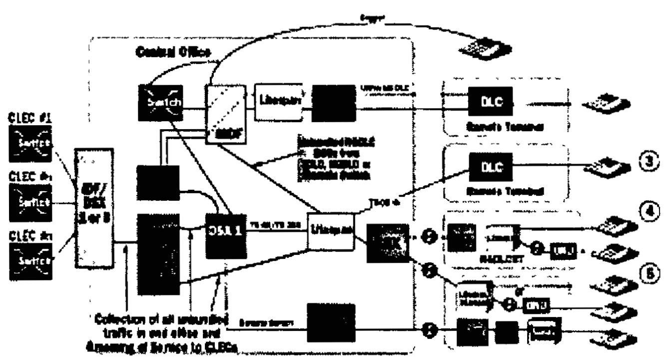
Service is provided to the local loop over one of five different and distinctly different technical means. The five different methods of providing local loop terminations are:

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



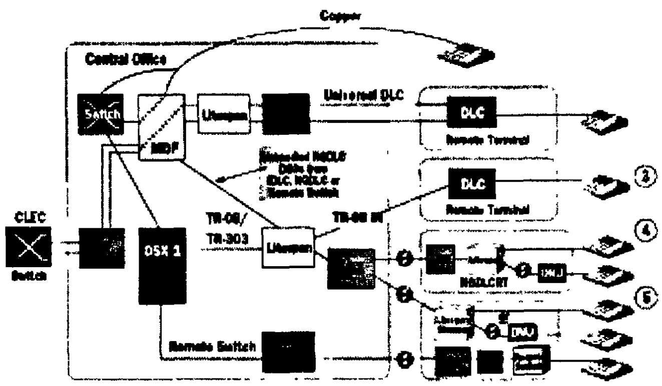
DSC Unbundling Solutions

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



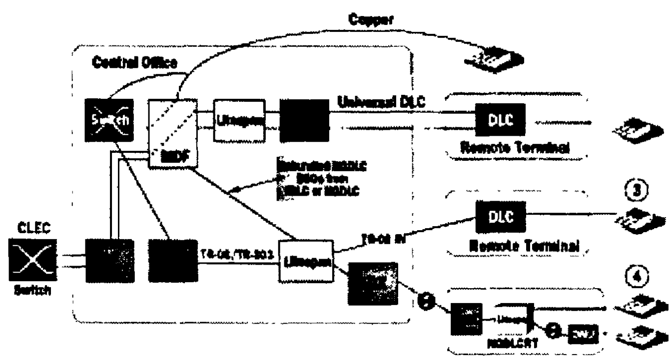
The second part of unbundling support is the mapping of the unbundled loops into the transport and IOF network. This critical network component is supported by the DSC DEXCS platform. The DSC DEXCS used in conjunction with Litespan addresses both: terminating and routing traffic from multiple CLECs into 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



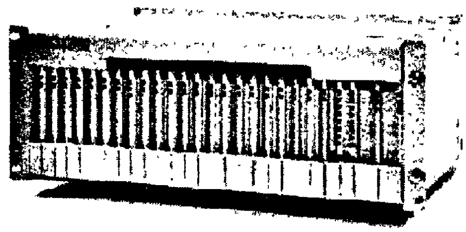
The DSC product offerings for support of the unbundling provide key benefits including:

- 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...

MCI WORLDCOM
Law and Public Policy

Unbundling Digital Loop Carriers



March 1999

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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.

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[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.

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[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

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[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.

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[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

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[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

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[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

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[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

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[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.

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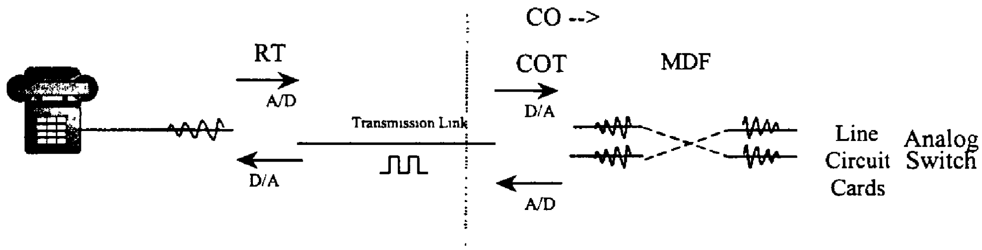


Figure 1 (a) - UDLC with an analog switch

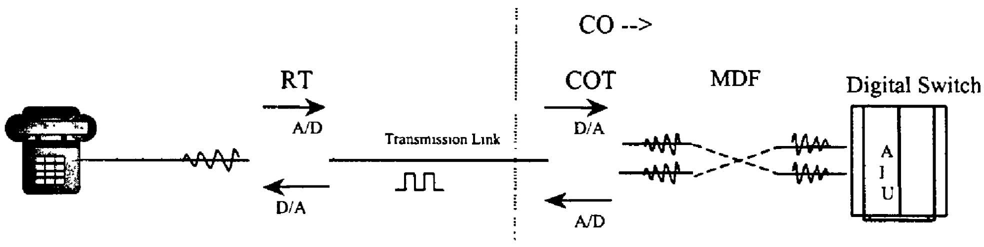


Figure 1 (b) - UDLC with a digital switch

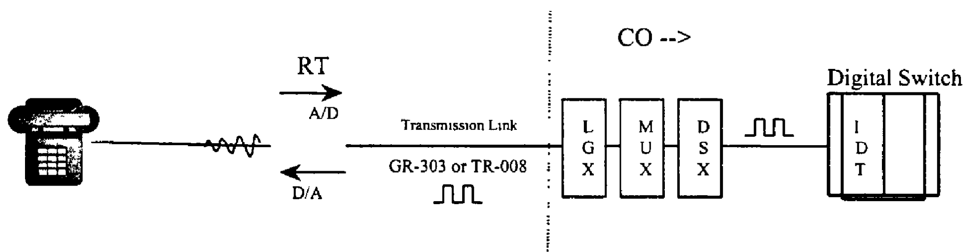


Figure 1 (c) - IDLC with a digital switch

Figure 1 UDLC / IDLC with a local switch

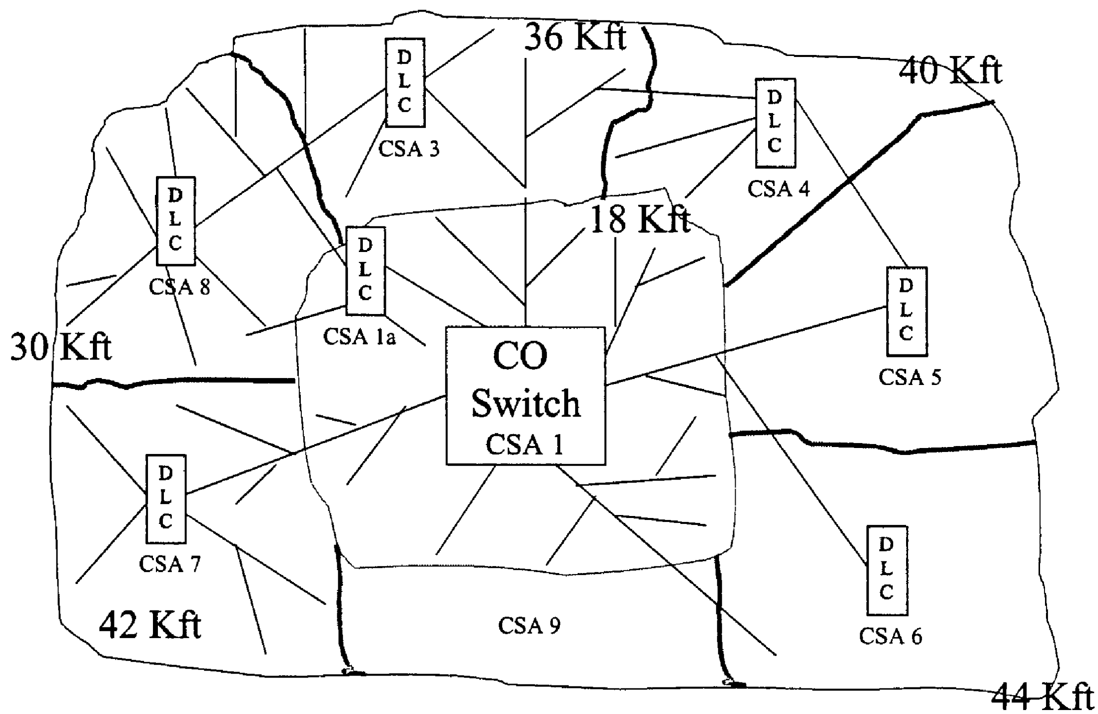
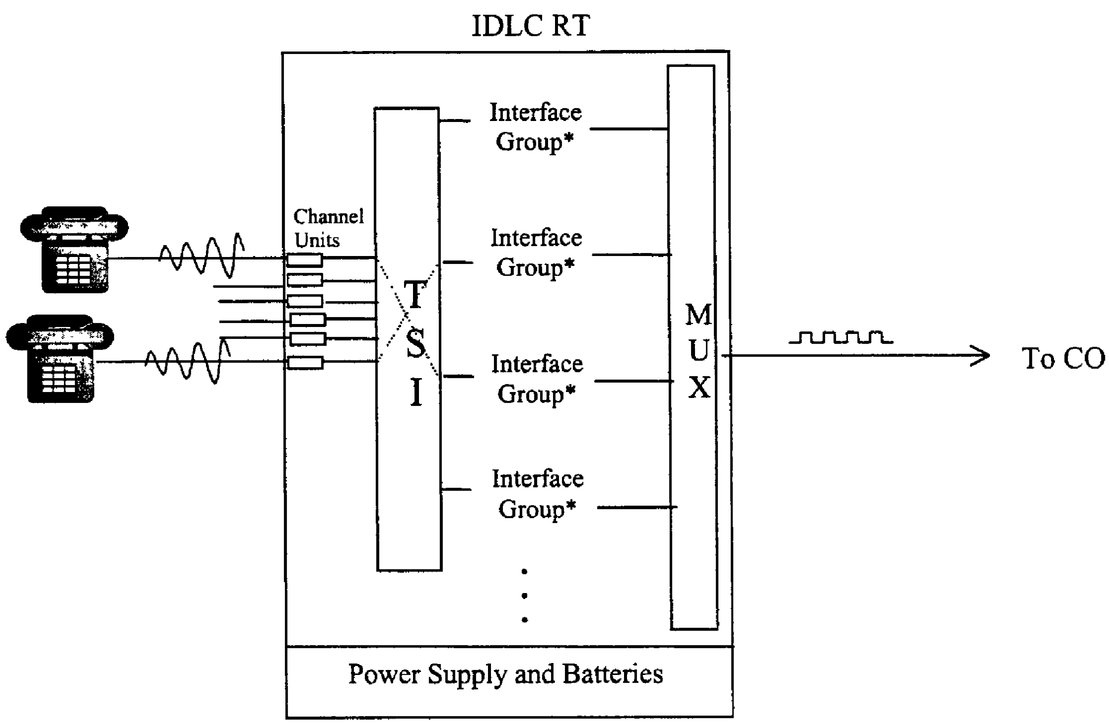


Figure 2 CSA design



* interface groups can be TR-008 or INA

Figure 3 Generic IDLC RT

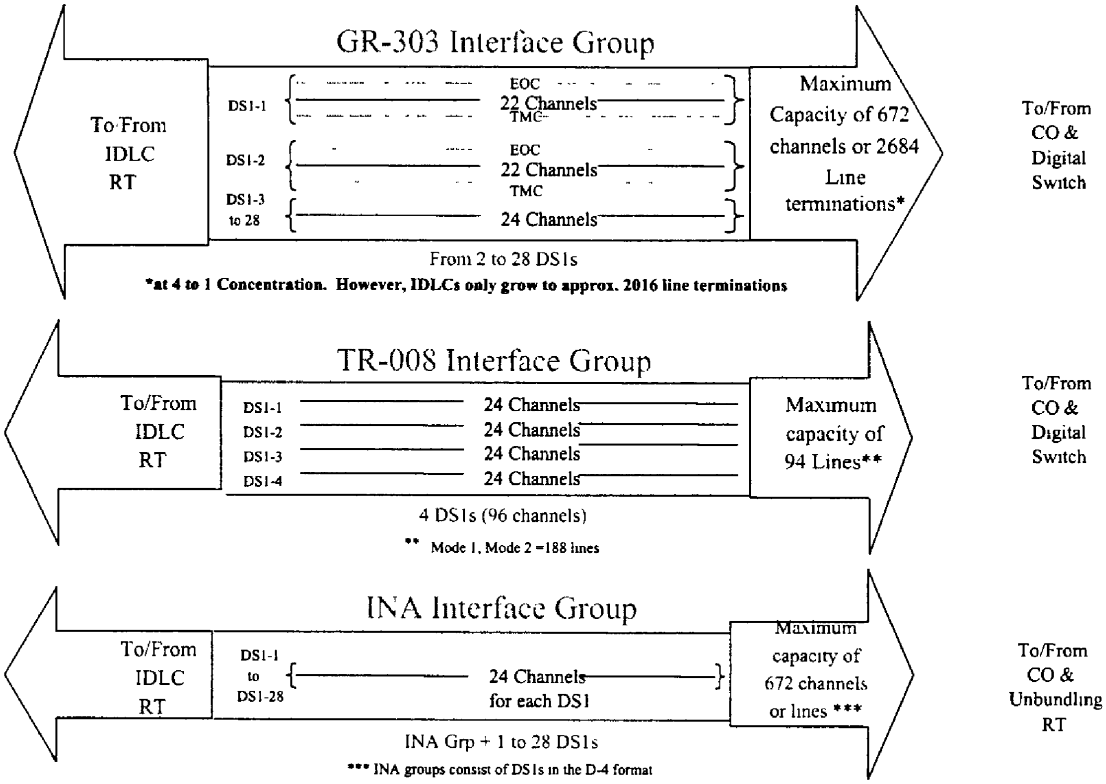


Figure 4 Interface Groups

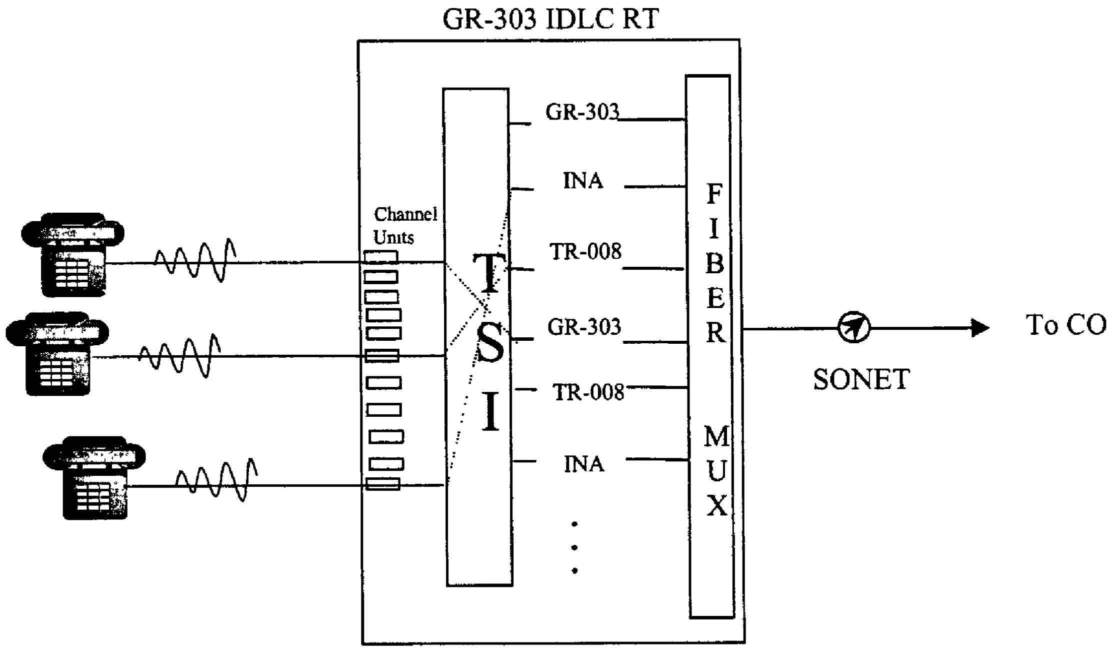


Figure 5 GR-303 IDLC RT

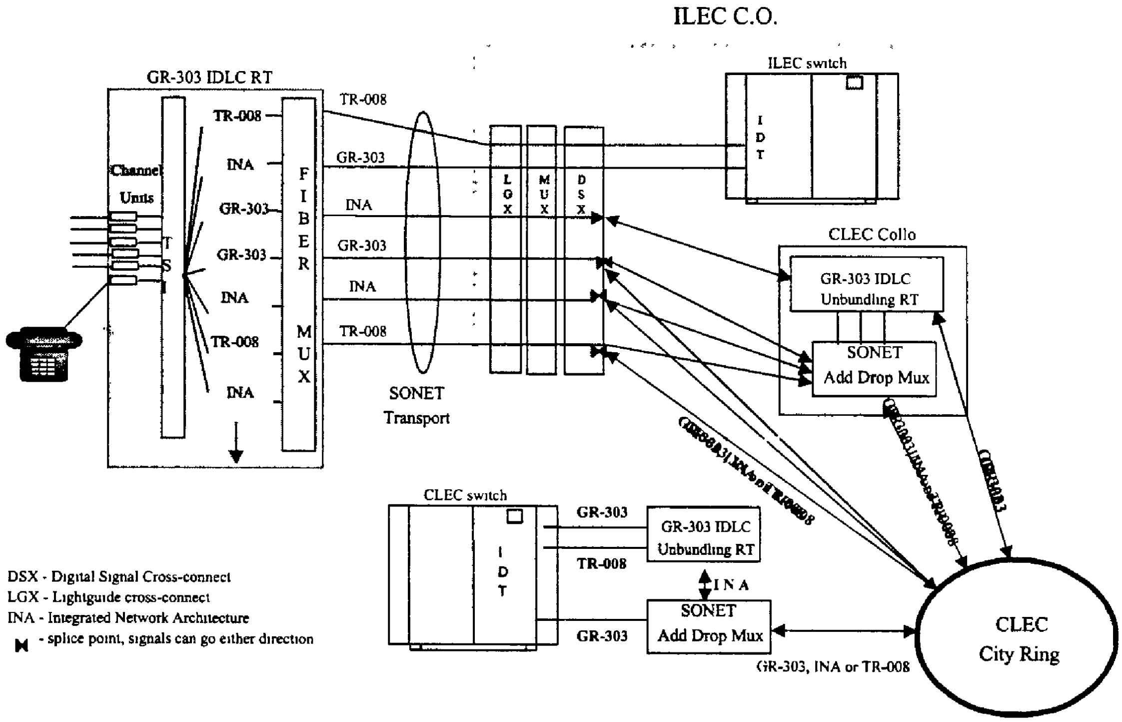
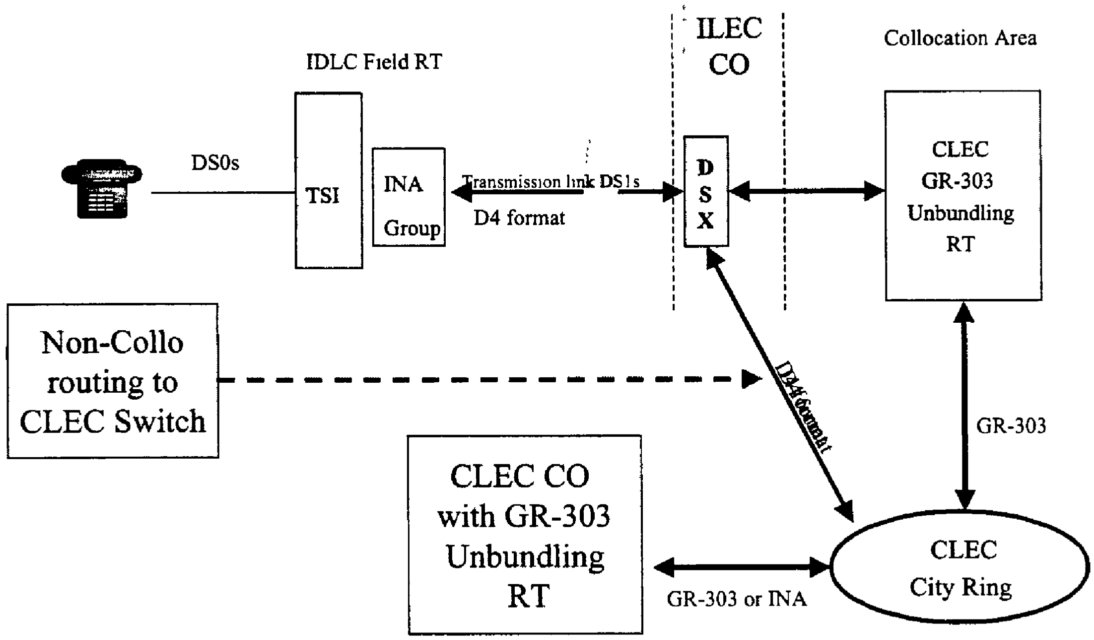
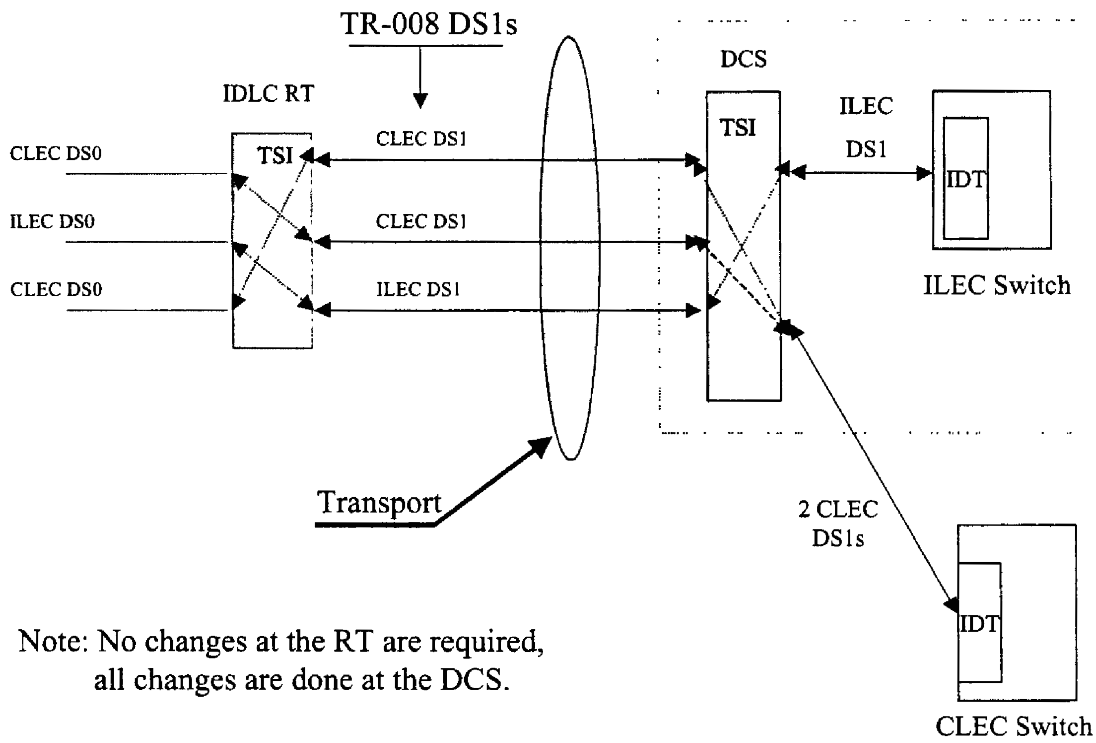


Figure 6 Multiple Switch Hosting



(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

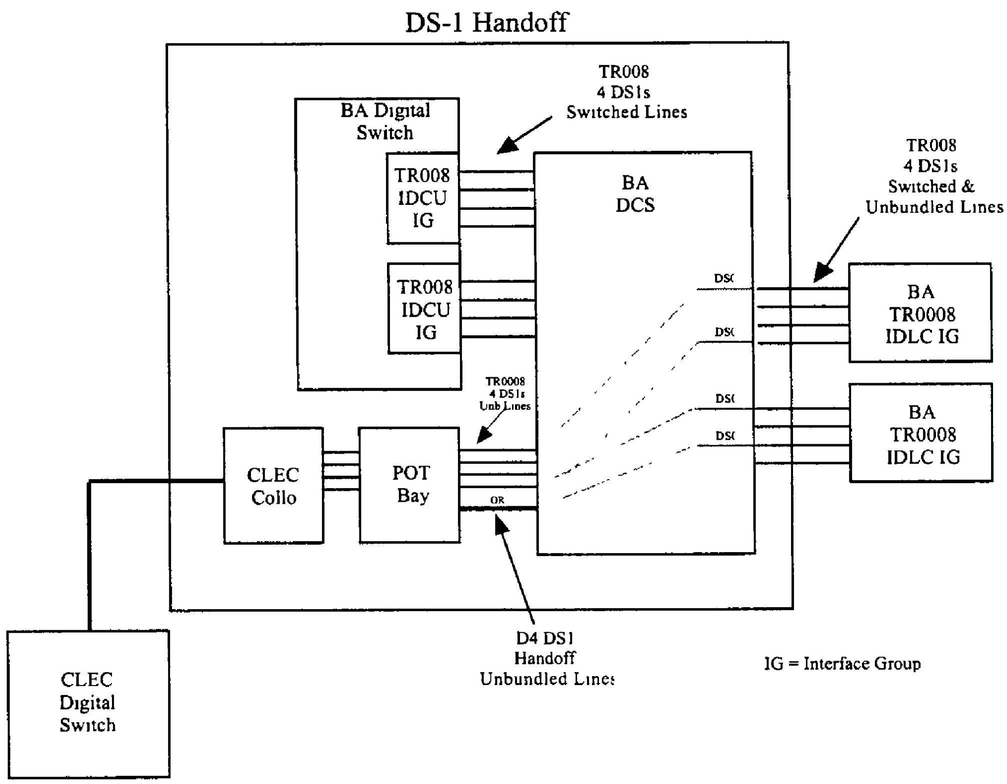


Figure 9 DCS grooming handoff to CLECs by Bell Atlantic-NY

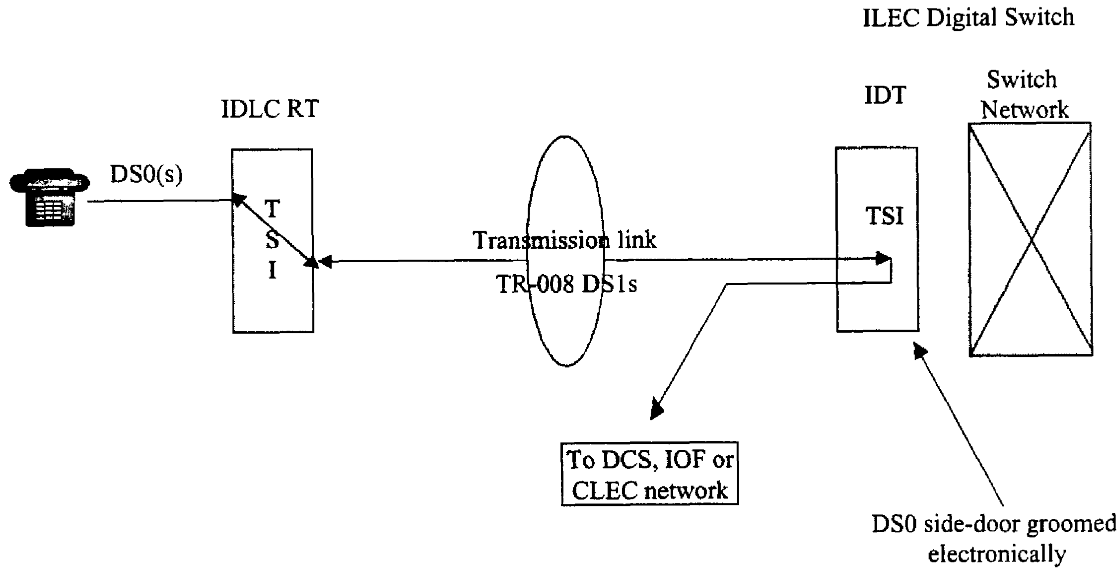


Figure 10 Side-door grooming

Transform your D4 channel banks into high powered Frame Relay Access Concentrators . . . Go!

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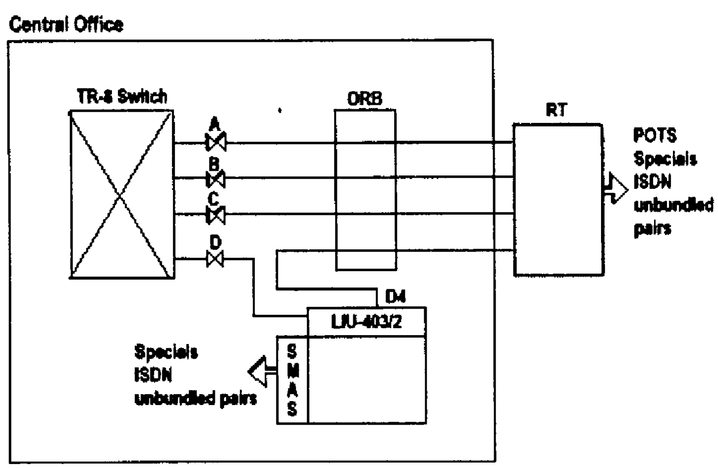
Unbundled Wire Pairs, Special Services, and ISDN DLC Grooming

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* *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.

For more information on Pulsecom products and solutions, please call our Customer Service Department at 1-800-381-1997 (or 703-471-2950).

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The Virtual RDT, Key to Unbundling the Local Exchange

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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.

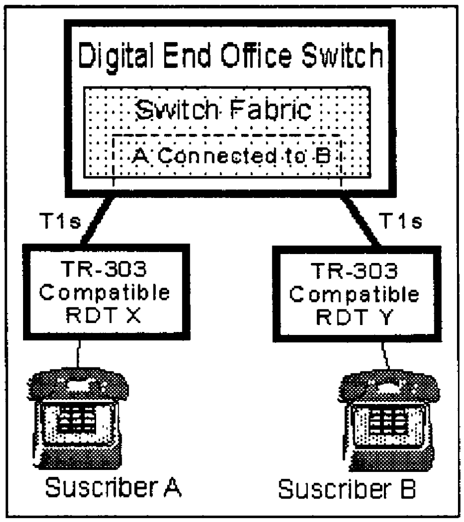
The focus of much attention these days is the local loop. Synchronous Optical Network (SONET), Fiber in the Loop (FITL) and IDLC as defined in TR-303 are closely related key technologies which are helping to redefine the local loop. Figure 1 shows a pair of IDLC Remote Digital Terminals (RDTs) subtended 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.

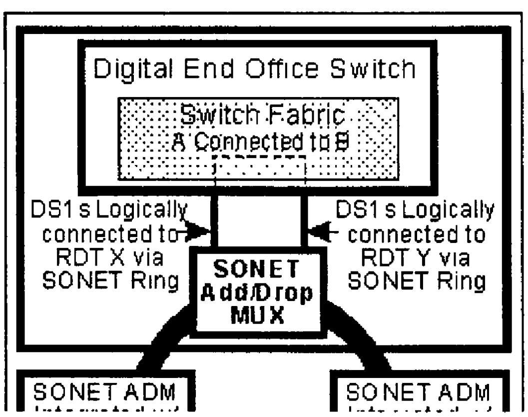
Subscriber A dials destination number. If DTMF dialing is used, switch collects digits. If subscriber uses dial pulse, digits are collected by RDT X and sent to Switch via a CSC message.
Switch determines that call is destined to subscriber B on RDT Y.



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.

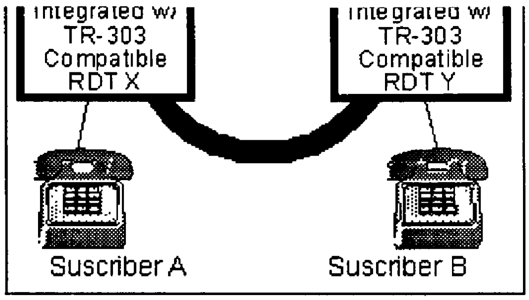
Figure 2. Call setup between two TR-303 compatible DLCs attached to digital End Office Switch via SONET Ring.

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

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.

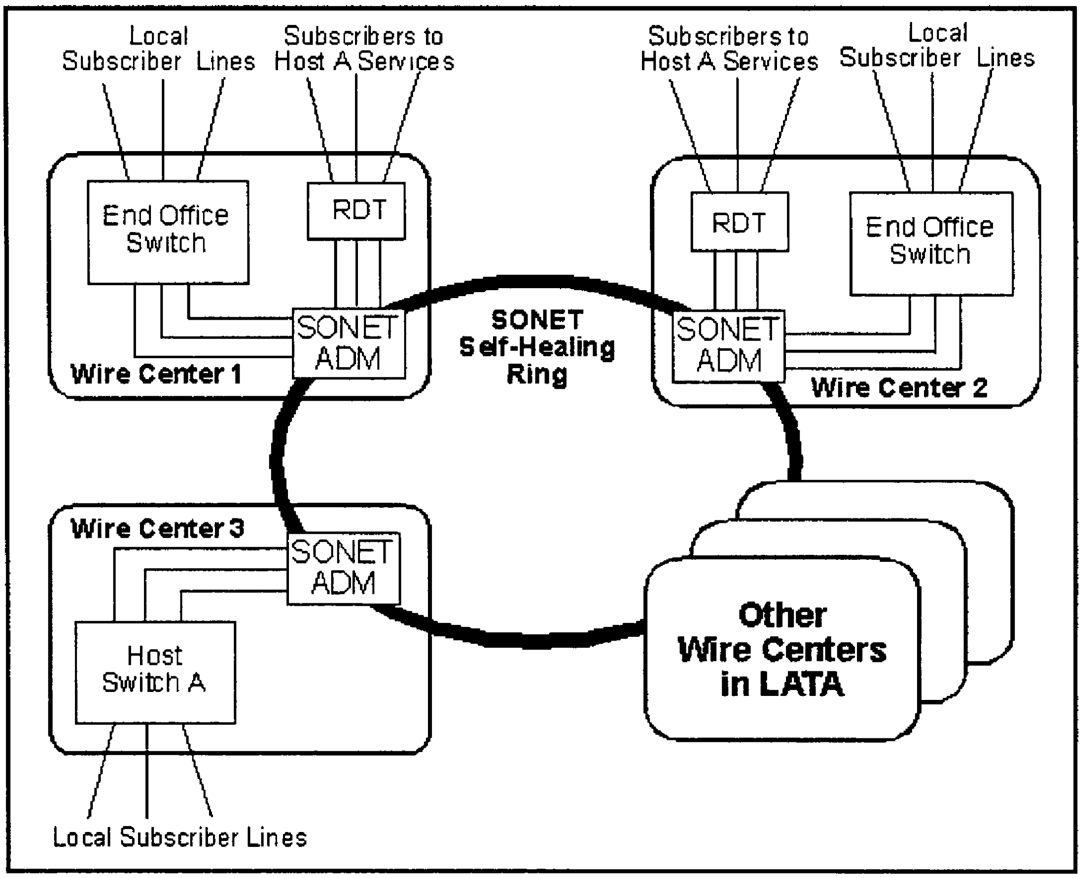
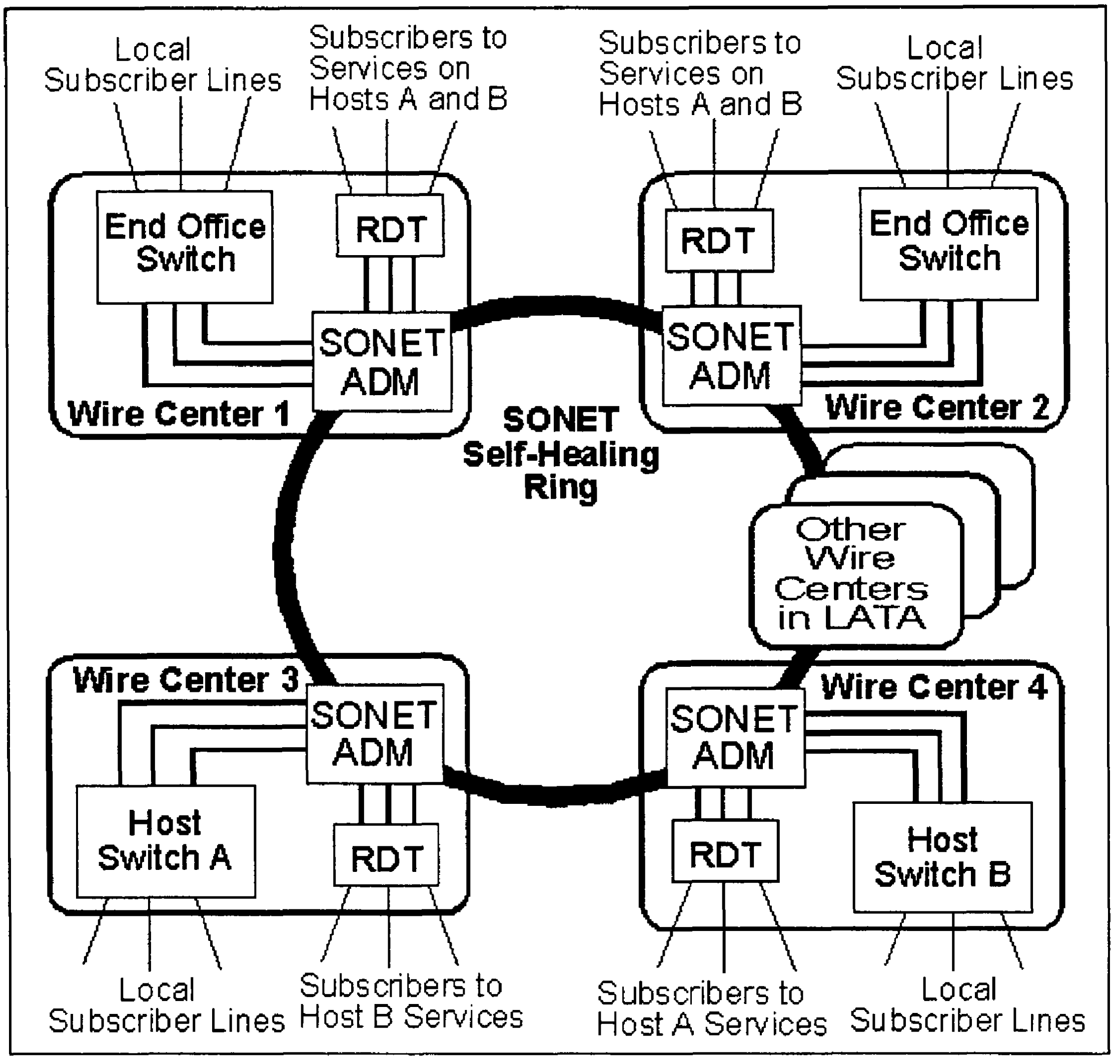


Figure 4. When services are provided using 2 or more Host switches, each physical RDT in a Wire Center provides each Host Switch with a Virtual RDT Interface. Thus, subscriber lines on each RDT are associated with a respective Host Switch based on which switch provides the service subscribed to by each 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.

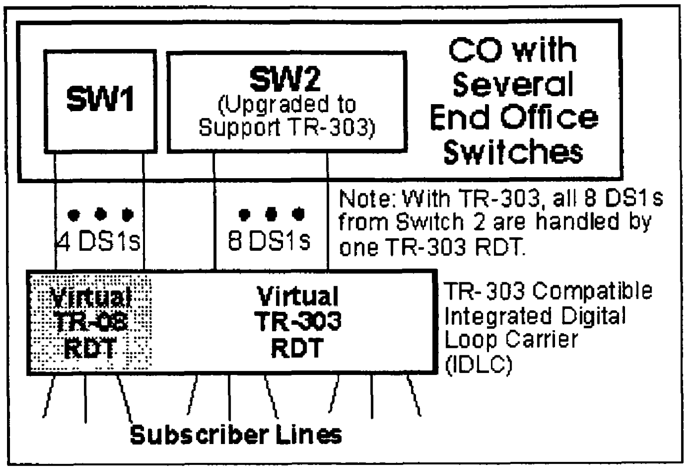
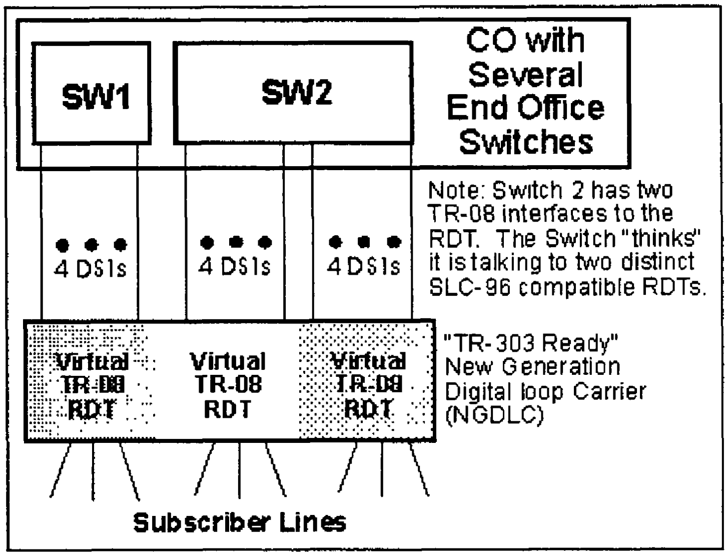


Figure 6. With a single NGDLC supporting two or more Switches, when one of the Switches is upgraded to support TR-303, it is desireable to support a configuration where the RDT connects to one Switch using TR-303 and another using TR-08.



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.

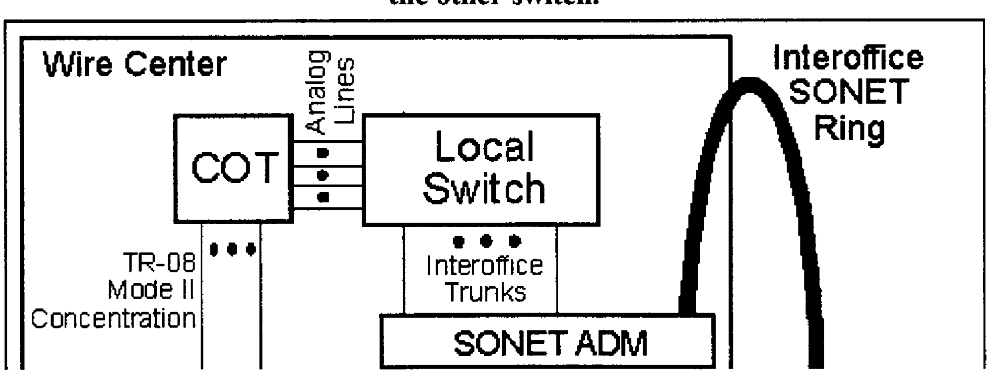
A call made to the example subscriber's new phone number will be routed normally to the new host switch and will terminate via the TR-303 RDT to the subscriber's line. If an incoming call arrives at the subscribers old End Office, the call will ring the line connected to the COT. If the subscriber's 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.

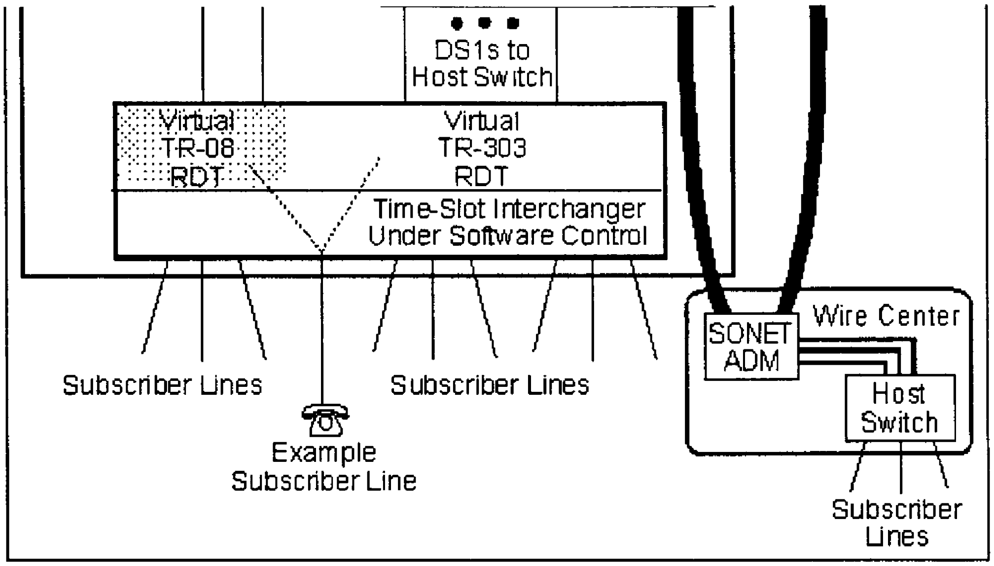
If the subscriber is talking on a call connected through the local CO when an incoming call arrives at the new host switch, the RDT can detect the condition and send an appropriate TR-303 CSC message to tell the TR-303 host switch that the subscriber is off hook and cannot receive the call. The new host 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

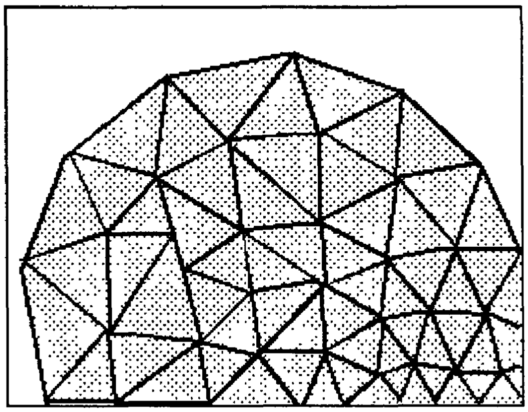
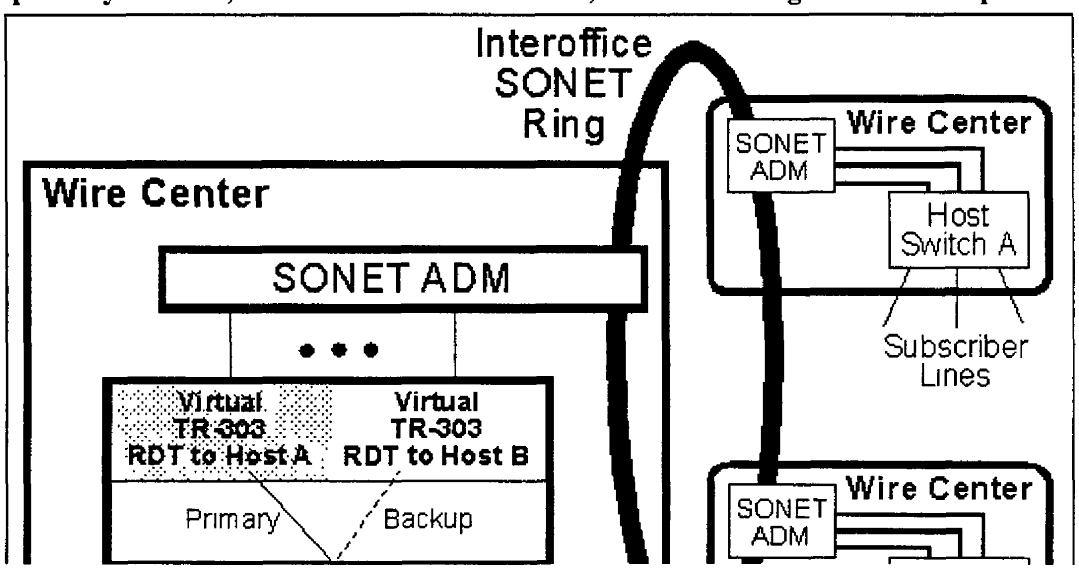
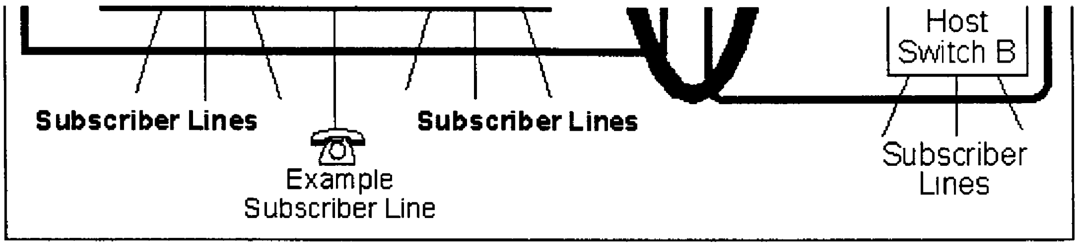


Figure 9. A subscriber could be "Multihomed" to both Host A and B with A being the Primary Host Switch and B providing backup. This would allow the subscriber to originate a call even if the Primary Host Switch were down. For terminating calls to an 800 number, for instance, alternate POTS numbers for 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.

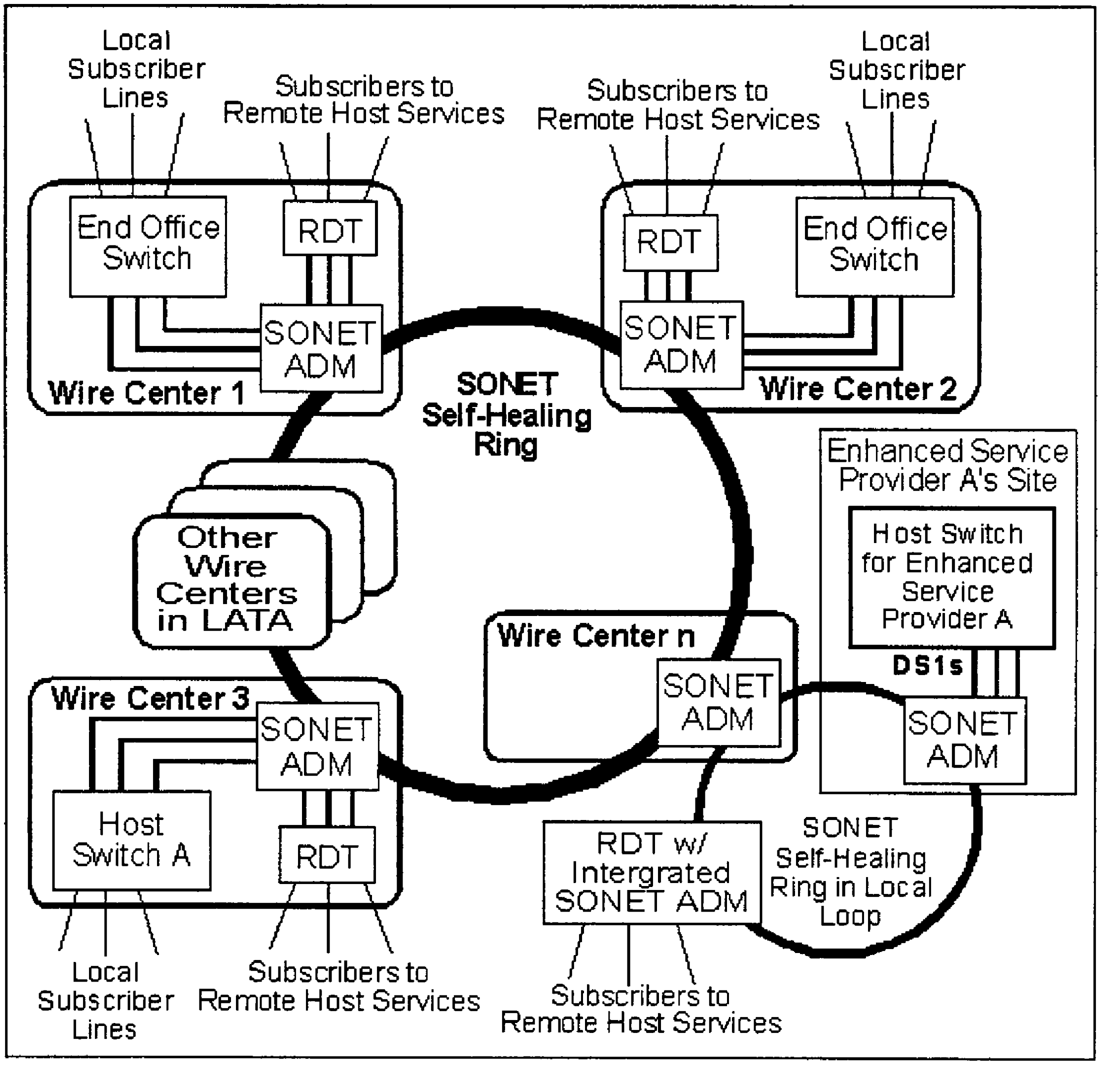
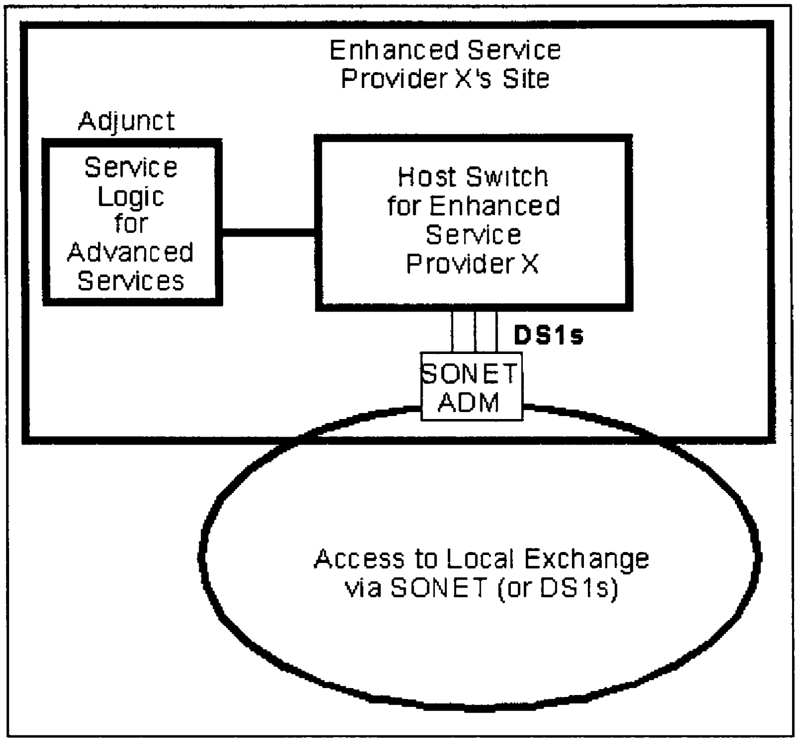


Figure 11. An Enhanced Service Provider might offer traditional switch-based services while an ESP could offer advanced services via an Adjunct programmed with the ESP's own proprietary Service Logic.



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.

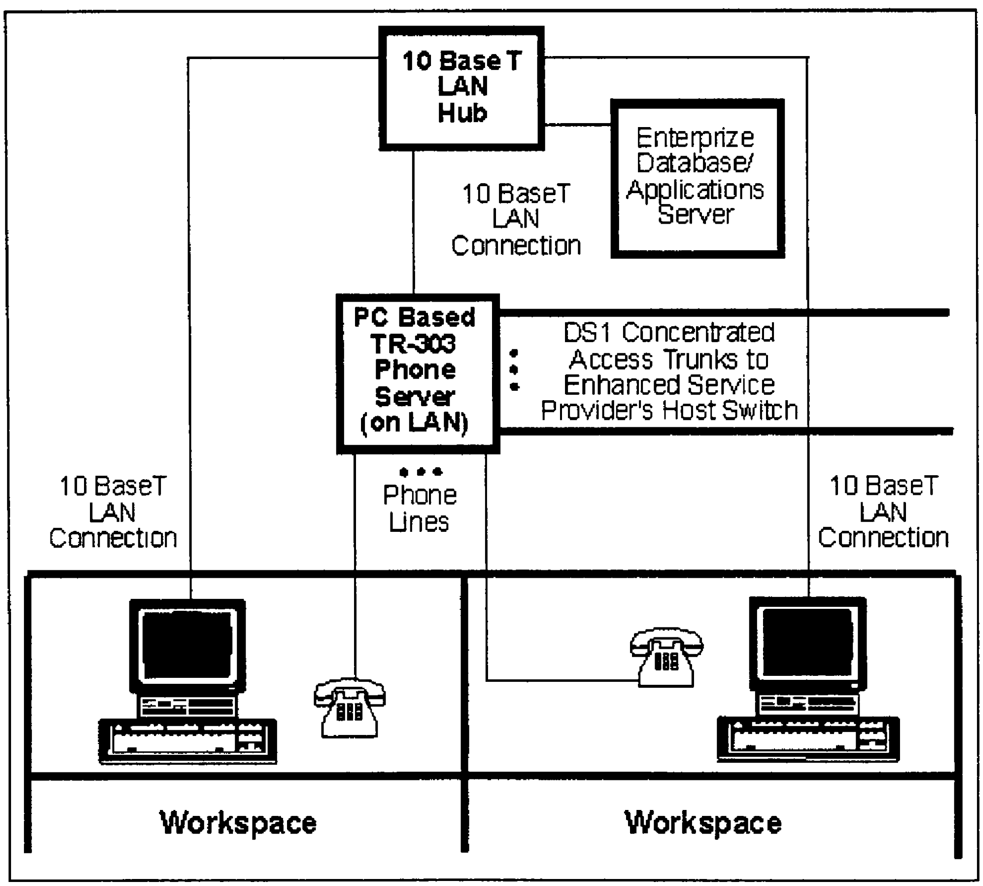
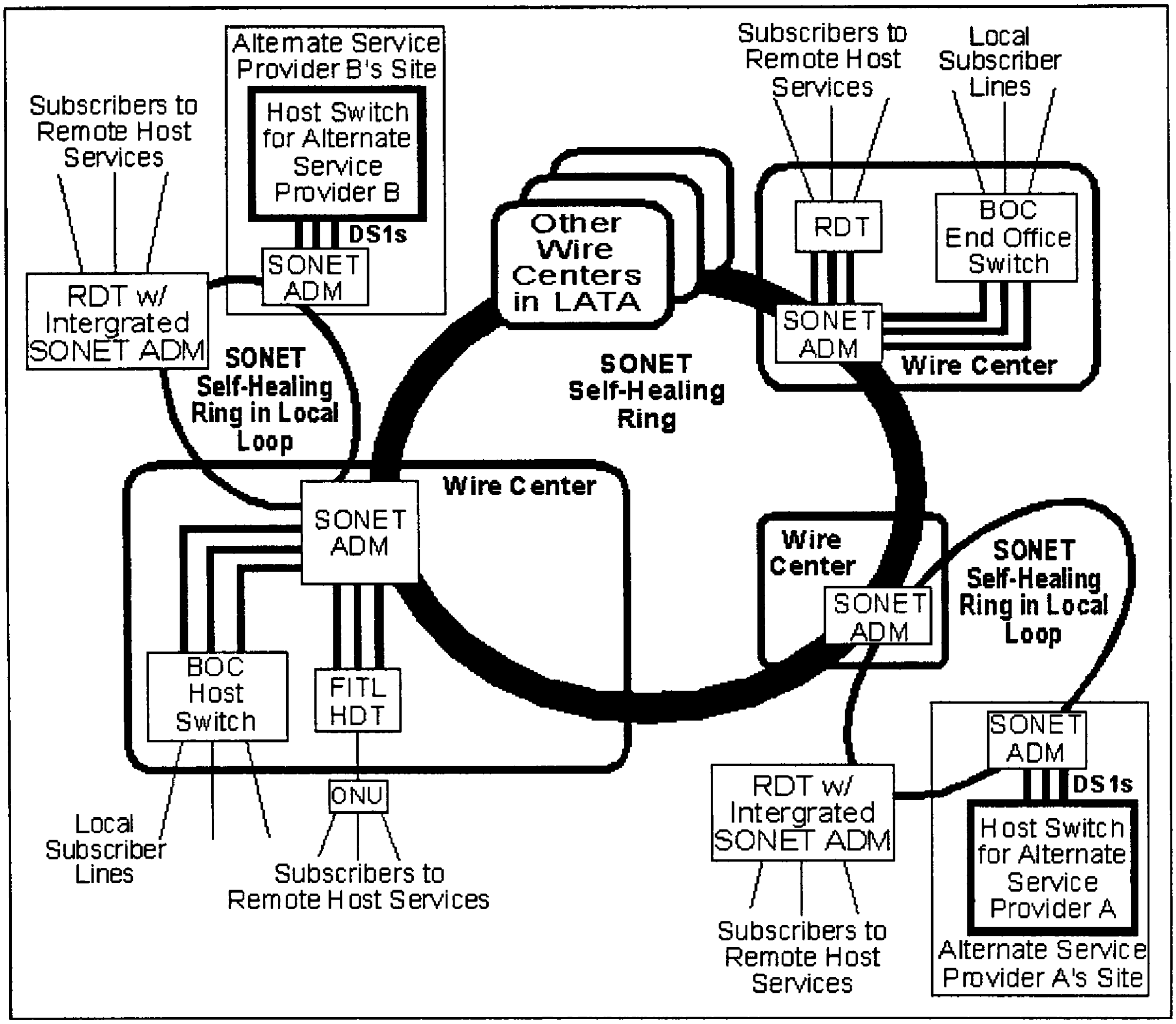


Figure 13. A TR-909 compliant fiber-in-the-loop Host Digital Terminal (HDT) interfaces to an End Office Switch like a TR-303 RDT. Thus, Alternate Service Providers would have access to subscribers subtended from an Optical Network Unit (ONU). Furthermore, provision of a tariffed Concentrated Access service 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.

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Docket No. 990649B-TP
Ankum Exhibit No. AHA-9
FPSC Exhibit No. _______

DS-1 RATE COMPARISON

DS1 Unbundled Loop	Verizon-FL Proposed	BellSouth-FL Adopted[1]	Ameritech - MI Adopted[2]	Verizon-NJ Adopted[3]	% by which VZ proposal exceeds avg. of other rates
Density Zone 1	$235.24	$73.44	$34.66	$68.88	399%
Density Zone 2	$252.20	$99.13	$41.57	$70.99	357%
Density Zone 3	$309.27	$191.51	$47.26	$75.89	295%

Notes
1 Order No PSC-01-2051-FOF-TP, Docket No. 990649-TP, Appendix A, Page 45
2 Ameritech Tariff M P.S.C No 20R, Part 19, Section 2, 8th Revised Sheet No 7
3 NJ Board of Public Utilities, Docket No. TO00060356, Attachment A, Page 1 of 5

DOCKET NO. 990649B-TP

WITNESS: ANKUM

EXHIBIT _____ (AHA-10)

PROPRIETARY

DOCKET NO. 990649B-TP

WITNESS: ANKUM

EXHIBIT _____ (AHA-11)

PROPRIETARY

DOCKET NO. 990649B-TP

WITNESS: ANKUM

EXHIBIT _____ (AHA-12)

PROPRIETARY