

AFFIDAVIT

STATE OF ALABAMA

COUNTY OF JEFFERSON

BEFORE ME, the undersigned authority, duly commissioned and qualified in and for the State and County aforesaid, personally came and appeared Gary Tennyson, who, being by me first duly sworn deposed and said that:

He is appearing as a witness before the Kentucky Public Service Commission in Case No. 2003-00379, Review of Federal Communications Commission's Triennial Review Order Regarding Unbundling Requirements for Individual Network Elements, and if present before the Commission and duly sworn, his rebuttal testimony would be set forth in the annexed testimony consisting of 16 pages and 1 exhibits.



Gary Tennyson

SWORN TO AND SUBSCRIBED BEFORE ME
THIS 23rd DAY OF MARCH, 2004



Notary Public

**NOTARY PUBLIC STATE OF ALABAMA AT LARGE
MY COMMISSION EXPIRES: May 19, 2004
BONDED THRU NOTARY PUBLIC UNDERWRITERS**

1 BELL SOUTH TELECOMMUNICATIONS, INC.
2 REBUTTAL TESTIMONY OF GARY TENNYSON
3 BEFORE THE KENTUCKY PUBLIC SERVICE COMMISSION
4 DOCKET NO. 2003-00379
5 MARCH 31, 2004
6

7 Q. PLEASE STATE YOUR NAME, YOUR BUSINESS ADDRESS, AND YOUR
8 POSITION WITH BELL SOUTH TELECOMMUNICATIONS, INC.
9 ("BELL SOUTH").
10

11 A. My name is Gary Tennyson. My business address is 1884 Data Drive,
12 Birmingham, AL 35244. My title is Principal Member – Technical Staff. I am
13 employed by BellSouth Telecommunications, Inc.
14

15 Q. PLEASE SUMMARIZE YOUR BACKGROUND AND EXPERIENCE.
16

17 A. I have a Bachelor of Science degree in Electrical Engineering from Mississippi
18 State University and a Masters of Science degree in Electrical Engineering from
19 the University of Alabama at Birmingham.
20

21 I have been employed in the telecommunications industry for more than 27
22 years, all with BellSouth, and one of its predecessors, South Central Bell. From
23 1976 through 1984, I held line and staff positions in Outside Plant Engineering,
24 where I was responsible for the planning and engineering of local loop facilities.
25 From 1984 through 1987, I held a staff position in Marketing. Since 1987, I have

1 been involved with representing BellSouth in various industry standards forums
2 dealing with loop access and associated technical interfaces. During this time, I
3 served a four-year term as the chair of T1E1.1, a Working Group of T1E1, an
4 Industry Standards forum. This Working Group dealt with Analog Interfaces.
5 Currently in BellSouth, I provide expertise on local loop transport issues,
6 particularly in the area of Digital Subscriber Line (“DSL”).

7
8 Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE ANY STATE PUBLIC
9 SERVICE COMMISSION, AND IF SO, BRIEFLY DESCRIBE THE SUBJECT OF
10 YOUR TESTIMONY?

11
12 A. Yes. I have testified before the Georgia Public Service Commission on the
13 capabilities of the hot cut process, the Electronic Loop Provisioning (“ELP”)
14 process, and technical capabilities of loop unbundling.

15
16 Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY BEING FILED
17 TODAY?

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19 A. I respond to portions of the direct testimonies of Mr. James D. Webber on behalf
20 of MCI, and Mr. Mark David Van de Water on behalf of AT&T with regard to
21 Competitive Local Exchange Carriers’ (CLECs’) proposal to mechanize the hot
22 cut process.

23
24 Q. ALL PARTIES HAVE DIRECTED THIS COMMISSION TO VARIOUS
25 PORTIONS OF THE TRO AND THE RULES IN SUPPORT OF THEIR

1 POSITIONS IN THEIR DIRECT TESTIMONY. WHAT IS THE IMPACT OF THE
2 D.C. CIRCUIT COURT OF APPEALS ORDER ON THE TRO IN THIS
3 PROCEEDING?
4

- 5 A. Currently the impact of the DC Circuit Court's opinion is unclear. At the time of
6 filing this testimony, the DC Court had vacated large portions of the rules
7 promulgated as a result of the TRO, but stayed the effective date of the opinion
8 for at least sixty days. Therefore my understanding is that the TRO remains
9 intact for now, but its content, and the rules adopted thereto, must be suspect in
10 light of the court's harsh condemnation of large portions of the order.
11 Accordingly, I will reserve judgment, and the right to supplement my testimony as
12 circumstances dictate, with regard to the ultimate impact of the DC Court's order
13 on this case.
14

15 **Electronic Loop Provisioning**
16

17 Q. AT&T ADVOCATES THE ELECTRONIC LOOP PROVISIONING ("ELP")
18 PROCESS (VAN DE WATER, AT PAGE 67 OF HIS TESTIMONY). WHAT IS
19 THIS PROCESS AND IS IT A VIABLE OPTION FOR THIS COMMISSION TO
20 CONSIDER?
21

- 22 A. In 2002, I participated in a meeting with AT&T Regulatory representatives at
23 which the ELP concept was discussed in full. The ELP process is as follows:
24 Where subscribers are served via copper loop facilities, i.e., no Digital Loop
25 Carrier ("DLC") equipment is employed, ELP provides for the conversion of the

1 analog voice grade signal to a digital format. When DLC is involved, the
2 conversion is already done. After this conversion from analog to digital, the ELP
3 concept provides for 'packetizing' the digital signal into Asynchronous Transfer
4 Mode ("ATM") cells. (Note that despite AT&T's claims to the contrary, this
5 packetization is not performed in any DLC systems used in BellSouth today).
6 The ATM cells then transit an ATM switch. At the ATM switch, the ATM 'address'
7 in the header of each cell is examined. Based on that destination address, the
8 cell is then switched to the interface corresponding to the Incumbent Local
9 Exchange Carrier ("ILEC") or CLEC serving that subscriber. Finally, a 'de-
10 packetizing' device is positioned between the ATM switch and each LEC's
11 switching system, to convert the digital signal in the ATM cells back into the
12 synchronous Time-Division-Multiplexed ("TDM") format necessary for
13 interconnection to the switching system.

14
15 Since all carriers would be connected to the ATM switch, the manual hot cut
16 process could be replaced with a set of commands, hence the term 'Electronic
17 Loop Provisioning.' Note that this process would require that every loop be
18 connected to an ATM switch, a switch that does not exist in BellSouth's network
19 today.

20
21 Q. IS DEPLOYING ELP A REASONABLE OR JUSTIFIED PROPOSAL?

22
23 A. No. As I will explain throughout my testimony, AT&T's ELP process cannot be
24 justified for either technical or economic reasons. First, as other BellSouth
25 witnesses explain, the existing manual hot cut process is reliable. Second, ELP

1 cannot be justified based on its cost. The hot cut costs incurred by the
2 incumbent and passed onto the CLEC that would be avoided with ELP is only a
3 one-time cost of \$13 per loop transferred versus a recurring monthly charge of
4 \$6.66 on all lines. In other words, BellSouth would need to charge an additional
5 \$6.66 per loop per month forever to both its retail and wholesale customers.
6 Moreover, it would cost BellSouth approximately \$8 billion in capital expenditures
7 to implement ELP in its network – a cost that would ultimately need to be borne
8 by consumers through higher rates or special surcharges. Third, ELP is not the
9 best architecture to enable DSL and would impede DSL innovation.

10
11 Q. HOW MUCH WOULD IT COST TO DEPLOY ELP?

12
13 A. The ELP cost estimate for copper loops is \$339 per line; for DLC loops it is \$299
14 per line. Based on the makeup of copper and DLC in BellSouth's region (roughly
15 60% of all loops are all-copper and 40% are on DLC), the melded cost per line is
16 \$323. To realize the stated goal of transferring the end user from the incumbents
17 switch to a CLEC's switch via a 'software command', **all loops** must be modified
18 to an ELP architecture. The estimated cost to implement ELP is approximately
19 \$8 billion region-wide. In addition, this strands about \$1.6 billion in analog line
20 equipment for BellSouth and provides no improvement in DSL availability.

21
22 Q. HOW LONG WOULD IT TAKE TO DEPLOY ELP IN BELLSOUTH'S REGION?

23
24 A. It would take at least several years, given the magnitude of such an undertaking
25

1 and given that each and every loop in BellSouth's region will need to be
2 modified.

3
4 Q. DOES THE EQUIPMENT NECESSARY FOR ELP ALREADY RESIDE IN
5 BELLSOUTH'S NETWORK AS THE CLECS' ALLEGE?

6
7 A. The CLECs' allegations are overly simplistic and therefore incorrect. BellSouth
8 does not have any of the DLC equipment that ELP requires. Moreover, even
9 though BellSouth has some limited ATM switching capability, BellSouth does not
10 have the quantity of switches, or the switch capacity, necessary to deploy ELP.
11 Finally, BellSouth does not have the voice gateways — needed to connect ATM
12 to the voice switches — in the necessary capacity, or quantity.

13
14 **Automated MDF**

15
16 Q. ON PAGE 21 OF HIS TESTIMONY, MR. WEBBER DISCUSSES THE
17 "AUTOMATION" OF THE HOT CUT PROCESS AND REFERS TO
18 "ELECTROMECHANICAL AND MICRO-RELAY TYPE MDFS." CAN YOU
19 DESCRIBE THIS TECHNOLOGY?

20
21 A. Yes. What Mr. Webber wants is for BellSouth to replace the functionality of its
22 Main Distributing Frames ("MDFs"). Some vendors are beginning to sell
23 automated cross-connect devices that employ a physical, electrical connection.
24 It is important to distinguish these from the 'digital cross-connect' devices that are
25 prevalent in the network today, and from the ATM switch employed in the AT&T

1 ELP proposal. These new automated cross-connect devices provide for an
2 electrical connection. They do not, therefore, require that the input signal
3 conform to some defined format, e.g., DS-1, DS-3, etc, as do 'digital cross-
4 connect' devices. They also do not require that the signal be in an ATM format,
5 as does the ELP proposal. Importantly, BellSouth is not aware of any
6 manufacturer that offers a device of sufficient scale to replace large MDFs.
7 Thus, today this solution is not technically available.

8
9 Q. IS THE DETERRENT TO IMPLEMENTING THIS TECHNOLOGY TO
10 PRECLUDE THE GROWTH OF UNE-L AS MR. WEBBER ALLEGES ON PAGE
11 23 OF HIS TESTIMONY?

12
13 A. No, the deterrent is scalability and feasibility. Let me explain. Consider a
14 hypothetical situation involving a small Central Office ("CO") with only a thousand
15 lines. If we assume that practically all of the loops would connect directly to the
16 switch ports, then such an automated cross-connect may be economically
17 feasible. In such an instance, the cross-connect device could be built with a
18 thousand loop-side connections, a thousand switch-side connections, and could
19 be built to be capable of cross-connecting any loop to any switch port. In fact,
20 there are devices on the market today that have some limited capability in this
21 regard, and BellSouth is looking at deploying such products in very small COs.

22
23 Problems arise when something other than a simple loop to switch port
24 connection is required. For example, when it becomes necessary to connect a
25 loop to something other than a switch, such as a Digital Subscriber Line Access

1 Multiplexer (“DSLAM”), the ‘switching matrix’ becomes much more complex. In
2 larger COs, the size and complexity of the ‘switching matrix’ makes such
3 products financially impractical. BellSouth is not aware of any implementation
4 offering more than sixteen thousand (16,000) terminations, combined loop-side
5 and switch-side. Another constraint, of course, would be the requirement to
6 accommodate a number of interfaces to the various CLECs offering service in a
7 given central office. Given that each carrier (including both the incumbent and
8 the CLECs) would need some capacity above and beyond that currently used,
9 the capacity would be considerably less the eight thousand (8,000) lines as
10 suggested above. In summary, the technology is simply not capable of operating
11 at the scale needed to address the need.

12
13 **GR-303**

14
15 Q. PLEASE DISCUSS THE SPECIFIC ELECTRONIC UNBUNDLING METHODS
16 FOR GR-303 COMPLIANT IDLC MR. WEBBER DISCUSSES ON PAGES 35-38
17 OF HIS TESTIMONY.

18
19 A. Mr. Webber talks about improving loop unbundling using GR-303-compliant
20 equipment. This is impractical for several reasons.

21
22 First, only a small percentage of IDLC systems, in Kentucky and elsewhere in
23 BellSouth, are Next Generation Digital Loop Carrier (“NGDLC”) systems, capable
24 of employing GR-303 Interface Groups. Second, wherever these systems do
25 exist, there is a limit on the number of GR-303 Interface Groups that can be

1 accommodated. BellSouth has deployed two (2) different types of NGDLC
2 systems. In one type, the limit is one (1) Interface Group. For this type system,
3 no CLEC could have its own dedicated Interface Group since only one (1) exists.
4 In the other type, the limit is four (4) Interface Groups meaning that only three (3)
5 CLECs could have their own dedicated Interface Group. Third, this option would
6 require extensive Operation Support Systems (“OSS”) development to manage
7 each dedicated Interface Group.

8
9 To summarize, all of BellSouth’s DLC (which comprises only about 40% of its
10 network) is not NGDLC. Second, even where BellSouth has NGDLC, there are
11 not sufficient facilities to serve all CLECs. Finally, even if BellSouth spent the
12 money to replace its network with NGDLC, OSS would need to be developed.

13
14 **IDLC**

15
16 Q. DO THE UNBUNDLED LOOPS BELLSOUTH PROVIDES TO CLECS MEET
17 APPROPRIATE TECHNICAL STANDARDS?

18
19 A. Yes. In an open industry forum, Technical Committee T1 has adopted certain
20 minimum technical criteria for unbundled loops. This document is entitled T1
21 Technical Report # 60 “Unbundled Voicegrade Analog Loops.” The loops
22 BellSouth uses for its own retail service as well as the unbundled analog loops
23 supplied to requesting CLECs conform to that Technical Report. BellSouth is not
24 aware of any unbundled loop facility that, by design, fails to meet the criteria
25 contained in that document. Furthermore, loops like this, i.e., either loaded

1 copper loops, or loops provided via Universal Digital Loop Carrier (“UDLC”), are
2 very commonly used to provide BellSouth’s retail service.

3
4 Q. ON PAGES 33-34 OF HIS TESTIMONY, MR. WEBBER STATES “WHERE END
5 USERS ARE TAKEN OFF IDLCs AND UNBUNDLED LOOPS PROVISIONED
6 VIA UDLC, SUCH LOOPS WILL NECESSARILY INCLUDE MULTIPLE A/D
7 CONVERSIONS AND MODEMS OPERATING ON THOSE LOOPS WILL,
8 THEREFORE, BE INCAPABLE OF SUPPORTING A V.90 DIAL-UP
9 PROTOCOL. INSTEAD, MODEMS WILL DROP TO A V.34 PROTOCOL,
10 WHICH IS LIMITED TO 33.6 Kbps.” MR. WEBBER THEN CONTENDS THAT
11 IT IS UNCLEAR WHETHER BELLSOUTH’S PROVISIONING OF THESE TYPE
12 LOOPS IS CONSISTENT WITH PROVIDING SERVICE “EQUIVALENT TO DS0
13 CAPACITY” AS PER FCC RULE 51.319(a)(2)(iii). PLEASE COMMENT.

14
15 A. I disagree with Mr. Webber’s conclusion. The term ‘equivalent to DS0 capacity’
16 is not tightly defined in industry fora. In fact, even using an IDLC loop, a V.90
17 modem can connect at about 50 kbps or so. If we construe the ‘equivalent to
18 DS0 capacity’ to require exactly 64 kbps through a dial-up data connection, then
19 no loop meets that requirement. One could also interpret the phrase ‘equivalent
20 to a DS0 capacity’ to require that the ILEC not employ, through transcoding
21 technology, less than 64 kbps in the DLC backhaul. In this sense, UDLC meets
22 the requirement. As referenced above, a better-defined set of requirements for
23 unbundled loops can be found in T1 Technical Report #60.

24
25 Q. MR. WEBBER ALLEGES, ON PAGE 26 OF HIS TESTIMONY, THAT WHEN

1 IDLC LOOPS ARE UNBUNDLED, “[I]N MANY CIRCUMSTANCES, THE
2 FACILITY TO WHICH THE CUSTOMER IS REASSIGNED IS
3 TECHNOLOGICALLY INFERIOR TO THE EXISTING FACILITY OR MAY
4 SIMPLY BE A FACILITY THAT HAS BEEN POORLY MAINTAINED.” IS HE
5 CORRECT?

6
7 A. No. First, the allegation that a loop in BellSouth’s network is “poorly maintained”
8 is not correct. BellSouth maintains its network facilities to the applicable
9 technical standards. It would make no sense for BellSouth to allow deployed
10 plant to deteriorate in the ground especially considering that BellSouth uses
11 those same facilities over which it provides service to its own retail customers.

12
13 Second, the “technologically inferior” condition of the new facility to which Mr.
14 Webber refers is applicable only to the situation in which the end user is using a
15 dial-up modem. It is not applicable to voice services. What Mr. Webber is really
16 complaining about is degradation in a service for which MCI has not paid.

17 Specifically, while true that, in some instances, the unbundled loop to which the
18 subscriber is transferred cannot support dial-up data at the data rate that might
19 have been possible when the subscriber was on IDLC, at present there is no
20 technology solution to that situation. Recently I participated in cooperation with
21 one CLEC (Deltacom) to determine whether a solution is available. I will discuss
22 the technical trial in more detail later in this testimony.

23
24 Q. MR. WEBBER CLAIMS, ON PAGE 30 OF HIS TESTIMONY, THAT CLECS ARE
25 UNABLE TO BENEFIT FROM IDLC TECHNOLOGY. IS HE CORRECT?

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A. No. IDLC is a very efficient serving arrangement, when practically all of the lines served by the DLC system terminate on the local switching system into which the IDLC is integrated. CLECs could benefit from the use of IDLC technology, if the number of subscribers served at a DLC remote terminal site warrants an investment in a DLC system terminating in their switch.

Q. MR. WEBBER COMPLAINS ABOUT MODEM SPEED REDUCTION IN UNIVERSAL DLC (“UDLC”) SYSTEMS. PLEASE COMMENT.

A. It is true that multiple A/D conversions — inherent to UDLC — make a dial-up data connection using the V.90 protocol impossible, and necessitates that the modems ‘fall back’ to a lower data rate. The key point here, however, is that CLECs are purchasing voice grade circuits from BellSouth and there is no degradation in the voice service.

Q. PLEASE BRIEFLY DESCRIBE THE GOALS OF THE IDLC TECHNICAL TRIAL THAT BELL SOUTH CONDUCTED WITH RESPECT TO REDUCED MODEM SPEEDS.

A. On January 13, 2003, I and others from BellSouth met with Deltacom in Anniston, Alabama, to discuss the benefits and goals of BellSouth engaging in a technical trial of some technical alternatives that, if successful, might be useful in addressing Deltacom’s concerns regarding analog to digital conversions that are inherent when loops are provided over certain technology. Several other

1 conference calls between BellSouth's and Deltacom's technical experts ensued.
2 In a spirit of cooperation, BellSouth agreed to shoulder the expense of this trial
3 even though ordinarily a CLEC would detail the type loop it desired and, if that
4 loop type is not currently offered, use the New Business Request process to
5 have BellSouth analyze the feasibility of such a development. I was chosen to
6 coordinate the trial and marshalled appropriate resources within BellSouth to
7 conduct the technical trial and to document the findings of that trial.

8
9 Essentially, the trial was meant to determine if loops provided over IDLC could be
10 provisioned without any additional analog to digital conversions (compared to the
11 quantity of analog to digital conversions when the end user was a BellSouth retail
12 customer) using functionality referred to as "side-door" or "hairpin" arrangements
13 within the BellSouth switch and additional equipment referred to as Digital Cross-
14 connect System ("DCS") to aggregate unbundled loops for a given CLEC. For
15 the trial, Deltacom furnished a list of telephone numbers of 'friendly customers'
16 who had BellSouth service. From this list, two (2) lines were selected. These
17 customers were served via a Nortel DMS100 office in BellSouth's network, and
18 DCS equipment was already installed in that building.

19
20 DMS100 switch peripheral (SMS) assignments were obtained for the loops in
21 question. The availability of vacant DS1 terminations on the associated SMS
22 was verified. DS1 terminations in the DCS were obtained, and BellSouth built
23 circuits from the DCS to the SMS. The DS1 facilities between Deltacom's
24 collocation arrangement and the DCS were also built.

25

1 Q. WHAT WAS THE OUTCOME OF THE TECHNICAL TRIAL?

2

3 A. The trial was unsuccessful. Unfortunately, two (2) unforeseen issues arose. It
4 turns out that the loops to be converted were working in Mode II, i.e.,
5 concentrated mode. Concentration, in this setting, is the sharing of transmission
6 paths between the DLC Remote Terminal ("RT") and the switch. For example,
7 two (2) end users might share a single path and this is referred to as 2:1
8 concentration. In the DMS100 switch, a Mode II channel must be in the four (4)
9 right-most line card slots, i.e., channels 17-24, of the digital transmission facility
10 in order to be 'hairpinned' in the switch.

11

12 BellSouth also learned during the trial that only one (1) customer may be
13 assigned to the RT card (which normally accommodates two lines) serving the
14 loop to be unbundled. This limitation arises due to the fact that the DMS100
15 'nails up' both channels on the line card. Because it's extremely unlikely that
16 both end-users would be converting simultaneously to the same CLEC, this
17 effectively means that the other channel must be vacant, resulting in stranded
18 investment. To overcome these limitations, the end-users to be converted would
19 have to be re-assigned to other DLC cards or other facilities. This would involve,
20 among other things, a transfer at the crossbox.

21

22 When the unanticipated cost of the line rearrangements (necessary to 'hairpin' a
23 mode II IDLC channel in a DMS100 office) became known, the process was
24 viewed to be even less viable. No effort was made to transfer the end-users or
25 continue the trial. Finally, when BellSouth better understood the effect of multiple

1 links of robbed-bit signaling on V.90 modem performance, there was simply no
2 point in continuing the work. BellSouth removed the temporary arrangements it
3 had made and informed Deltacom, in a conference call of both parties' technical
4 subject matter experts participating, that the trial was unsuccessful.

5
6 Q. WHAT DOCUMENTATION OF THE TECHNICAL TRIAL DID BELLSOUTH
7 PROVIDE TO DELTACOM?

8
9 A. The best description of the trial outcome is documented in the "white paper" that I
10 produced at the end of the trial. A copy of that "white paper" was furnished to
11 Deltacom at the end of the trial and is attached to this testimony as Exhibit GT-1.

12
13 Q. HAS DELTACOM RESPONDED FORMALLY TO BELLSOUTH'S "WHITE
14 PAPER" DISCUSSING THE OUTCOME OF THE TECHNICAL TRIAL?

15
16 A. No. I was on the conference call I mentioned earlier and I believe Deltacom's
17 representative appreciated the candor with which BellSouth explained its
18 findings. From BellSouth's viewpoint, I believe the technical trial demonstrates
19 that the technical solutions attempted are not technically feasible. At the
20 conclusion of the conference call, BellSouth invited Deltacom to suggest other
21 technical solutions but so far, Deltacom has made no such suggestion. To
22 summarize, it is my belief that BellSouth and Deltacom worked together in good
23 faith to solve a technical problem for which at present there is no technically
24 feasible solution.

25

1 Q. ON PAGE 26 OF HIS TESTIMONY, MR. WEBBER HYPOTHESIZES ABOUT
2 THE DEVELOPMENT OF "TWO NETWORKS." IS HIS HYPOTHETICAL A
3 LIKELY OUTCOME?

4 A. One can only guess that the two networks to which Mr. Webber alludes are 1)
5 Loops provided via IDLC, and 2) Loops provided via loaded copper and UDLC.
6 As mentioned above, though, BellSouth uses the latter technologies extensively
7 to provide its own retail offering. Given that it is in BellSouth's best interest to
8 provide the best service possible, I do not agree that this hypothesis is a likely
9 outcome.

10

11 Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY?

12

13 A. Yes.

Overview

This paper documents the lessons learned in a trial with ITC/DeltaCom. The trial attempted to unbundle a loop delivered via Integrated Digital Loop Carrier (IDLC) without incurring an additional Analog to Digital conversion. The trial was not successful.

Analog to Digital Conversions

Analog to Digital (A/D) conversions occur at analog interfaces to digital transport and digital switching. The latest dial-up modem protocol (as documented in ITU Recommendations V.90 and V.92) requires that there be only one A/D conversion, between the server modem pool (usually designated as a Remote Access Server) and the end-user. In the case of a digital switch serving metallic loops, with a digital trunk to a RAS, there is one A/D conversion in the line interface card in the digital switch. The V.90 protocol can be supported.

In the case of a digital switch serving Universal Digital Loop Carrier (UDLC), there is another A/D conversion in the channel unit at the DLC Remote Terminal (RT). The V.90 protocol cannot be accommodated, and the modems 'fall back' to the previous generation protocol, documented in ITU Recommendation V.34.

When IDLC to an ILEC switch is employed, there is no A/D conversion at the switch. The V.90 protocol can be supported.

Conversion to a UNE Loop

All three loop-types described above, i.e., metallic, UDLC, and IDLC, can be unbundled. Conversion of a metallic loop is straightforward. The A/D conversion point moves to the CLEC. Similarly, when a UDLC loop is unbundled, there are no additional A/D conversions. There were two A/D conversions when the end-user was served by the ILEC and there are two conversions when the end-user is served by the CLEC.

It is when the end-user is served via IDLC that the problem gets interesting. In different places, we have documented the various alternatives that are available when making such a conversion. They are as follows:

- Transfer the loop to copper feeder, if available
- Transfer the loop to a UDLC channel, if available
- Route the T1 lines serving the IDLC through a Digital Cross-Connect System. Subsequently, digitally cross-connect the channel to either a UDLC COT or a DS1 interface to the CLEC
- Use the switch-based 'hairpin' capability to route the channel back out of the switch, for connection to either a UDLC COT or a Digital Cross-Connect System, for further grooming to a DS1 interface toward the CLEC
- Convert the IDLC system to UDLC

If the IDLC system is an NGDLC system, it is — at least theoretically — possible to use the time-slot interchanger to connect the channel to either a UDLC COT, or a Digital

Cross-Connect System, for further grooming to a DS1 interface toward the CLEC. We do not, however, have the OAM&P systems in place to utilize this capability.

Note that some of these alternatives add an A/D Conversion. Those alternatives that do not add an A/D conversion are as follows:

- Transfer the loop to copper feeder, if available
- Route the T1 lines serving the IDLC through a Digital Cross-Connect System. Subsequently, digitally cross-connect the channel to either a DS1 interface to the CLEC
- Use the switch-based 'hairpin' capability to route the channel back out of the switch, for connection to a Digital Cross-Connect System, for further grooming to a DS1 interface toward the CLEC

Multiple Robbed-Bit Signaling Links

The fact that the V.90 protocol cannot be supported across multiple A/D conversions is well known in the industry. It's less well known, though, that the presence of only 1 A/D conversion does not — in itself — guarantee that the V.90 protocol can be supported. Another limiting factor is multiple links of robbed-bit signaling.

DLC systems employ robbed-bit signaling, where the least-significant bit of the 8 bit encoded sample is overwritten with signaling information every 6th frame. The V.90 protocol is designed to recognize the robbed bit every 6th frame, so this isn't a problem with IDLC (into an ILEC switch).

When a DS0 with robbed-bit signaling traverses multiple DS1 links without intermediate conversions to analog, using a Digital Cross-Connect System (DCS) for instance, it's necessary that the signaling bits be written to multiple frames. This is necessary because the DS1's are not aligned on these six-frame groups (denoted superframes), or even frames, for that matter). The 6th frame in the first link, for instance, may be the 3rd frame in the next link. To overcome this problem, the product connecting the links (the DCS, to use the above example) must find the incoming superframe boundaries, detect the incoming signaling state, find the outgoing superframe boundaries, and repeat the signaling bits. It can be seen that 5/6 of the time, this will involve overwriting of a bit that was valid data.

As one might expect, multiple links of robbed-bit signaling impair the performance of V.90 modems. *This is a very important point that wasn't fully appreciated at the onset of the trial.* This problem is described in more detail in Annex A of ANSI T1.403.02a-2001, **Network and Customer Installation Interfaces — DS1 Robbed-bit Signaling State Definitions**. While the problem is well documented in the reference, the impact, i.e., that percentage of modems that can run V.90 across a specific number of robbed-bit links, isn't documented in the public domain. Discussions with vendors, though, indicate that most V.90 modems cannot employ the V.90 protocol when exposed to 3 such links. They 'fall back' to the V.34 protocol at 33.6 kbps or less.

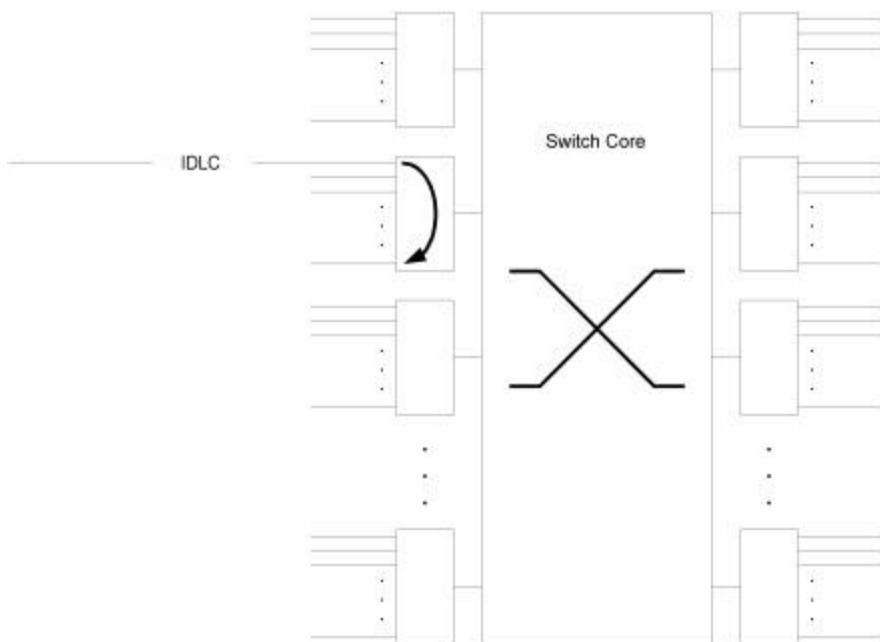
ITC/DeltaCom

ITC/DeltaCom initiated discussions with BellSouth regarding the unbundling of IDLC loops without incurring additional A/D conversions. After initial discussions, a decision was made to conduct a trial.

Although both parties recognized that the alternative of transferring a loop to copper feeder (if the copper is available) was a means of unbundling a loop without incurring an additional A/D conversion, such a conversion was not part of the trial. Early in the discussion, ITC/DeltaCom indicated that they has tried such conversions in the past, and had experienced various voicegrade transmission impairments. This avenue was not further pursued.

The second alternative, i.e., grooming of IDLC Channels in a Digital Cross-Connect System (DCS) was discussed. This alternative has a number of shortcomings. For one thing, a DCS not available in all CO's. For another, the DS1 circuits serving the DLC system must be routed through the DCS. This activity has a long lead time, and cannot be accommodated on a service-order basis. There is also a significant cost associated with the required DCS ports, and the associated maintenance activity. It should also be noted that any service outages during these rearrangements would affect all users served by the DLC system, not just those users converting to the CLEC. For these reasons, this alternative was not pursued.

The remaining alternative, i.e., using the switch-based 'hairpin' capability was the focus of the trial. We recognized at that time that, in a DMS100, the 'nail-up' could only be made within the switch peripheral, as illustrated in Figure 1, below:



DMS-100
Nail-Up only in Peripheral

Figure 1

We also recognized that lines served via GR-303 IDLC and via Nortel DMS-1 Urban could not be 'nailed-up.'

We thought that the 5ESS and the EWSD did not suffer from the first limitation. The documentation on those switches suggested that they offered the ability to 'nail-up' a connection across an office, i.e., from one peripheral to another. Subsequent testing in the BellSouth technology Assessment Center proved that not to be the case. Only connections within the same switch peripheral can be 'nailed-up.'

The issue of multiple links of robbed-bit signaling (arising from chaining together these DS1's), and its effect on V.90 performance, was not discussed.

We recognized other limitations. We knew, for instance, that there are a limited number of ports per peripheral. We also recognized that this arrangement would have a very low DS1 fill unless a DCS were added, as illustrated in Figure 2, below.

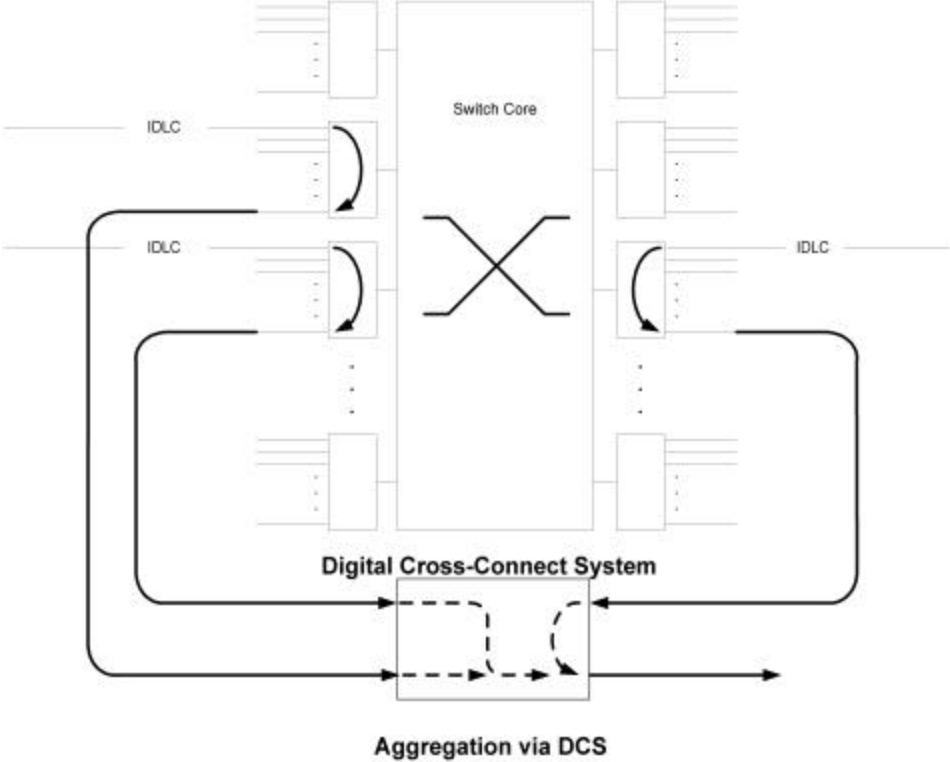


Figure 2

For the trial, ITC/DeltaCom furnished a list of telephone numbers of 'friendly customers' who has BST service. From this list, two lines were selected. These customers were served via a DMS100 office, and a DCS was in the building.

DMS100 switch peripheral (SMS) assignments were obtained for the loops in question. The availability of vacant DS1 terminations on the associated SMS was verified. DS1 terminations in the DCS were obtained, and circuits were built from the DCS to the SMS's. The DS1 between DeltaCom's collocation and the DCS was also built.

Lessons Learned

Unfortunately, two unforeseen issues arose. It turns out that the loops to be converted were working in Mode II, i.e., concentrated mode. In the DMS100 switch, a Mode II channel must be in the four right-most slots, i.e., channels 17-24, of a digroup in order to be 'hairpinned'¹.

We also found that only one customer may be assigned to the RT card (which normally accommodates two lines) serving the loop to be unbundled. This limitation arises due to the fact that the DMS100 'nails up' both channels on the card. Because it's extremely unlikely that both end-users would be converting simultaneously to the same CLEC, this effectively means that the other channel must be vacant.

To overcome these limitations, the end-users to be converted would have to be re-assigned. This would involve, among other things, a transfer at the crossbox.

Conclusion

We recognized, going into this trial, that it would be expensive. Anticipated costs included the following:

- Determining the availability of spare switch peripheral ports,
- Determining the availability of a Digital Cross-Connect System and spare ports
- The provisioning of DS1 links between the switch peripherals and the Digital Cross-Connect ports
- The use of the Digital Cross-Connect system

When the unanticipated cost of the line rearrangements (necessary to 'hairpin' a mode II IDLC channel in a DMS100 office) became known, the process was viewed to be even less viable. No effort was made to transfer the end-users or continue the trial.

When we better understood the effect of concatenated links of robbed-bit signaling on V.90 modem performance, there was simply no point in continuing the work.

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¹ These slots were the only ones available for services requiring full-period assignment, i.e., coin and special services, in a SLC-96 system. A Series 5 system has no such slot restrictions, but it appears that the DMS100 retains the limitation even with the Series 5.