up to 3 Mbs of upstream throughput. Loop lengths up to 3 Kft currently can support these data rates. These advancements enable substantial video and/or data access to subscribers over the traditional loop plant.

This technology now enables LECs to enter the video delivery market without the "last mile" fiber optic cable and hardware costs. While DSL technology does not offer the same bandwidth equivalent of a fiber delivery platform, it can be used to "secure" a video customer base, which could then be migrated to a fiber system based on economics.

12.13 The Unbundled Loop Environment

This section provides an overview of the unbundled loop environment. It first presents background information to identify key regulatory mandates relating to whole loop and sub-loop unbundling. It then describes common configurations and options for unbundling whole loops that are served by all-copper facilities, UDLC systems, and IDLC systems, and addresses various transmission and technical issues associated with unbundled loops. Finally, it assesses the evolving loop unbundling environment in terms of quantity, quality, and types of unbundling.

12.13.1 Regulatory Mandates for Whole Loop and Sub-Loop Unbundling

The Telecommunications Act of 1996 passed by Congress defined seven Unbundled Network Elements (UNEs) that Incumbent LECs (ILECs) must unbundle and offer to Certified/Competitive LECs (CLECs). This law requires these network elements to be offered to competitors in a non-discriminatory manner and have quality equal to the same facilities that the ILEC itself uses.

The seven UNEs defined in the Telecom Act of 1996 are:

1. Local Loops
2. Network Interface Devices (at the customer premises)
3. Local and tandem switches
4. Interoffice transmission facilities
5. Operations Support Systems (OSSs)
6. Call routing signaling databases
7. Operator/directory services.

A local (whole) loop is defined as the transmission facility between the ILEC central office Main Distributing Frame (MDF), or its equivalent, and the Network Interface Device (NID) at the customer premises. Unbundled loops may be provided using a variety of transmission technologies including, but not limited to: copper wire, copper wire-based DLC, and fiber-optic DLC systems. Such technologies can be used singularly or in tandem to provide an unbundled loop.

Subsequent to the passing of the Telecommunications Act of 1996, the ILECs sought judicial relief and won an appeal at the U.S. Eighth Circuit Court to repeal the UNE mandates. Upon appeal by the FCC and CLECs, the U.S. Supreme Court issued its "FCC Remand Order," which required the FCC to re-examine all seven UNEs and justify/explain the rationale for each UNE that the FCC considers necessary.

In November 1999, the FCC released its Docket 99-238, which eliminated the Operator/Directory Services UNE, but retained the other six UNEs. In addition, the FCC added a new UNE called "Sub-Loop". A sub-loop unbundled network element refers to any portion of the ILEC's whole loop which is outside the central office and that a CLEC can access and make interconnection to offer service to a customer.

In December 1999, the FCC released its Docket 99-355, which mandated another UNE, this one relating to the high-frequency portion of the loop. The mandate requires line sharing arrangements between an ILEC and a CLEC for both whole loop and sub-loop unbundling configurations. Line sharing, which is also known as spectrum unbundling, refers to the same twisted copper pair being used by more than one carrier. The ILEC can carry traditional voice-switched telephone service within the 0- to 3-Khz spectrum, and the CLEC can provide DSL services over the spectrum above 3 Khz. All ILECs must begin line sharing implementations by mid-year 2000.

12.13.2 Loop Unbundling

There are two main types of loop unbundling. The first is called "whole loop" unbundling, which is the unbundling of a whole loop from the MDF in the ILEC's central office to the customer premises. The second type is called "sub-loop" unbundling, which refers to a portion of the ILEC's whole loop being offered to a CLEC. This section provides more information about each type of loop unbundling.

12.13.2.1 Whole Loop Unbundling Configurations

Typically, when a customer requests dial tone service from a CLEC, the ILEC removes the wired connection to the ILEC switch in the central office and rewires the customer's loop to a CLEC "meet" point in the central office. Figure 12-32 depicts whole loop transfers in the ILEC central office when the customer is served by copper facilities or by a UDLC system. In most cases, there is an analog handoff to the CLEC. If the CLEC requests a digital handoff, the ILEC may utilize a D4 channel bank to digitize the circuits. Most CLECs transport the unbundled loops back to their central offices (switches) using GR-303 IDLC systems. To do this, the CLECs deploy GR-303 RDTs within their collocation cages in the ILEC's central offices.

The most critical factor associated with unbundling a customer loop is the type of loop facility that the customer is already utilizing for service, such as all-copper, UDLC system, or IDLC system.

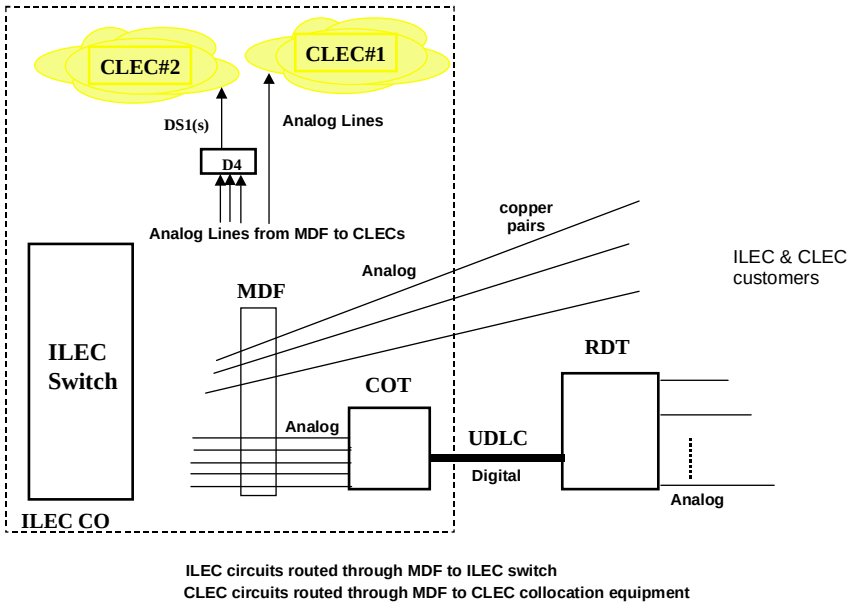

Figure 12-32. Unbundling Loops Served by Copper or UDLC Systems

- If the customer is receiving service over all-copper facilities, the transfer of the whole loop is straightforward as indicated in Figure 12-32. The ILEC removes the central office connection to its switch and places a jumper from the MDF to the meet point at the CLEC's collocation cage. There is no need to rewire the outside plant or visit the customer premises.
- If the customer is receiving service over a UDLC system, the transfer of the whole loop can be straightforward as shown in Figure 12-32. The ILEC removes the central office connection to its switch and places a jumper from the MDF to the meet point at the CLEC's collocation cage. Again, there is no need to rewire the outside plant or visit the customer premises.
- However, if the customer is served by an IDLC system, the loop is digitally transmitted to the ILEC switch. There are a variety of "technically feasible" options available to the ILEC to unbundle the loop. Each ILEC has established its own set of approved unbundling options along with the corresponding methods, procedures, and practices needed for implementing these options. Numerous unbundling options are possible because many of today's RDTs support multiple kinds of interfaces such as: GR-303, TR-08, UDLC, and D4 DS1. Also, some RDTs are capable of supporting multiple GR-303 Interface Groups, thereby permitting a single RDT to connect to multiple switches.

  Some common IDLC unbundling options are:

  1. Bypass the IDLC system and transfer the loop to an all-copper pair

     If there are available spare copper facilities serving the customer's neighborhood, transferring the IDLC customer to a spare all-copper circuit may be a viable option for the ILEC, as shown in Figure 12-33. Although this

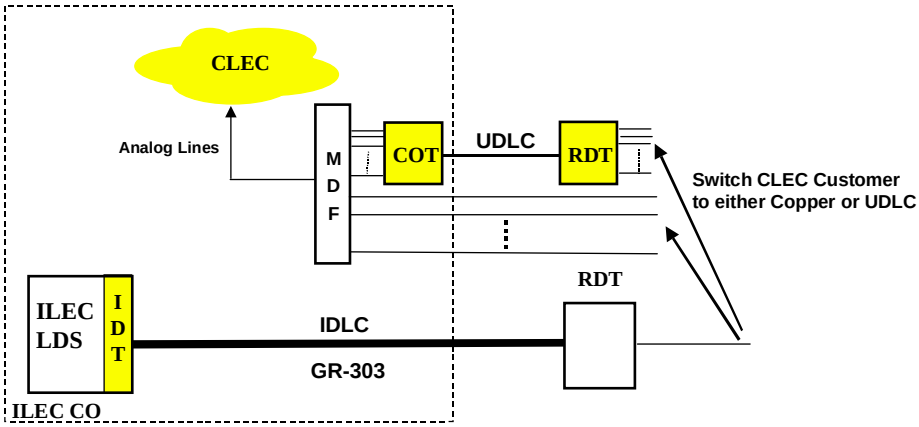

Figure 12-33. IDLC Unbundling - Bypass the IDLC System

procedure is relatively simple, it requires central office and outside plant rewiring to complete the new circuit from the MDF to the customer. The all-copper unbundled loop is the easiest unbundling architecture for the ILEC to perform maintenance and testing.

Some ILECs serve new neighborhoods/housing developments with DLC systems and install a very limited number of copper pairs to support certain services. In these areas, spare copper facilities can be quickly exhausted if used for unbundled loops.

2. Bypass the IDLC system and transfer the loop to a UDLC system

   If there are no spare copper facilities in the customer's neighborhood, the ILEC may transfer the customer's circuit from the IDLC system to a UDLC system (see Figure 12-33). This transfer will also involve both central and outside plant work activity.

   The customer fill rates at IDLC/UDLC CEV sites are typically 50 to 70%. There is a moderate amount of spare capacity on the UDLC systems to support transfers from IDLC systems.

3. Utilize the UDLC capability of the IDLC system

   If the IDLC system is equipped to support UDLC functionality, the ILEC can electronically re-provision the circuit from IDLC to UDLC (see Figure 12-34). No outside plant work activity is needed. Central office work activity is needed to run jumpers from the MDF to the collocation cage and, if necessary, place a UDLC plug-in at the COT.

4. Utilize a separate GR-303 Interface Group for the CLEC customers

   Figure 12-35 shows the use of separate GR-303 Interface Groups to carry ILEC and CLEC traffic. The RDT must support the MIG (Multiple Interface Group) capability defined in the GR-303 specification. This configuration allows a CLEC switch to connect to the ILEC's RDT at the GR-303 interface level.

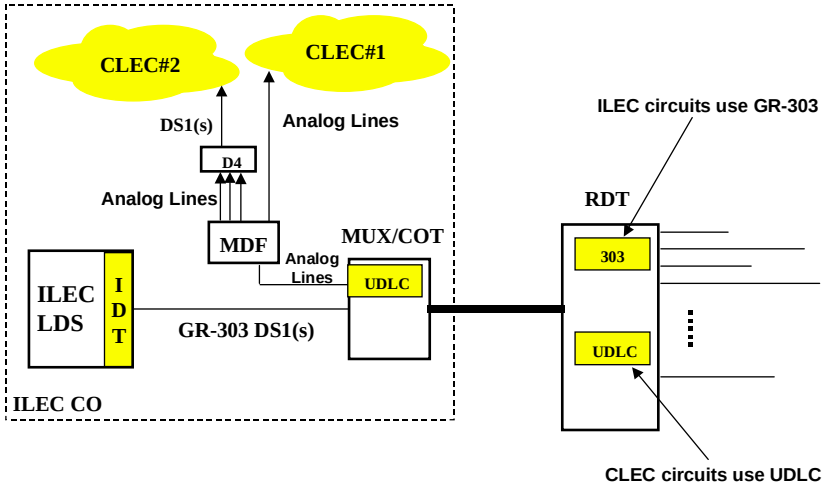

Figure 12-34. IDLC Unbundling Using the UDLC Capability of RDT

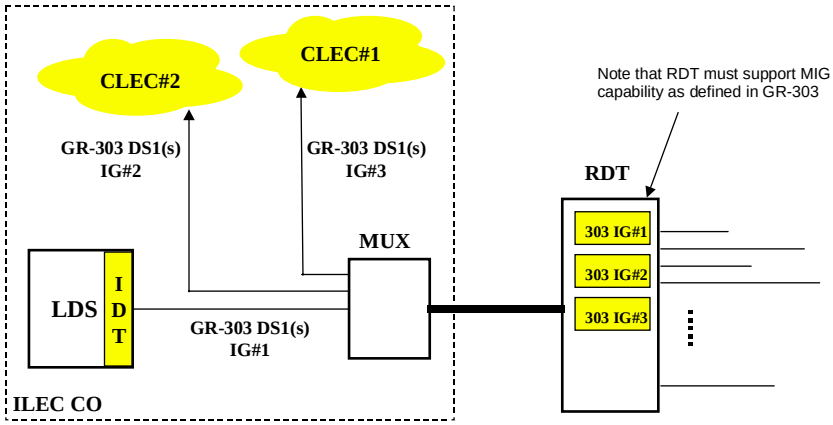

Figure 12-35. IDLC Unbundling Using Separate GR-303 Interface Groups

This arrangement may be cost effective for those CLECs having a "critical mass" of subscribers served by the RDT or group of RDTs in a CEV. Since the GR-303 Interface Group supports operations functionality, there are a variety of issues (provisioning, alarm reporting, sharing of test resources, etc.) that are currently being addressed by the industry.

In response to the Telecommunications Act of 1996, GR-303 requirements were changed in 1997 to permit a single DS1 to be called a 303 Interface Group. A minimum of two DS1s was previously required. This change allows a CLEC to serve a small base of customers at an RDT more economically (but at the risk of lower service availability and reliability).

5. Share a GR-303 Interface Group and use the sidedoor port of the switch to transport CLEC traffic out of the ILEC switch

Figure 12-36 shows the use of a GR-303 Interface Group sharing ILEC and CLEC traffic where all CLEC traffic is routed through sidedoor port DS1s out of the ILEC's switch.

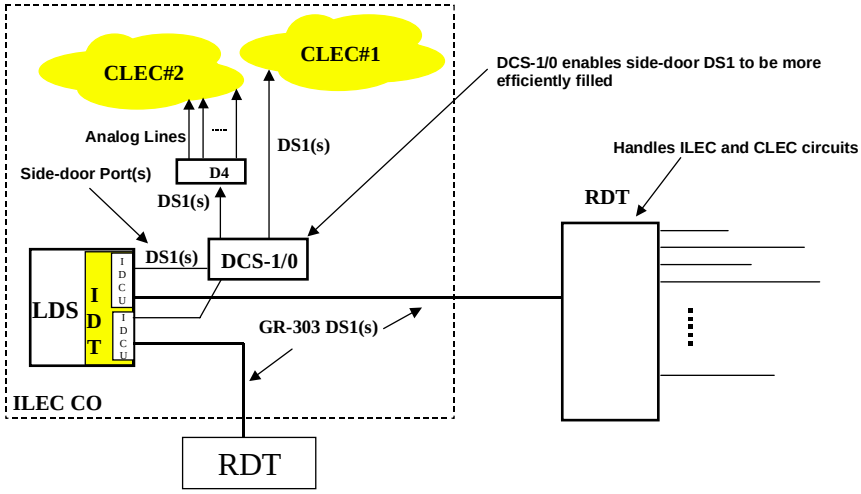

Figure 12-36. IDLC Unbundling Using Sidedoor Port

CLEC circuits are provisioned as non-switched, non-locally switched circuits within the IDLC system. While the DCS-1/0 is shown in the figure, it is not a requirement of this architecture. The advantage of using a DCS-1/0 is realized if the CLEC is not fully utilizing a DS1 from the ILEC LDS to the CLEC, and multiple switch modules with IDCUs are used by the ILEC. If a DCS-1/0 is placed between the LDS DS1 sidedoor port and the CLEC DS1s, it would permit full utilization of the sidedoor LDS/IDCU hardware by enabling CLEC DS0s to be rearranged in the DCS-1/0 and placed on the individual CLEC DS1s.

The ILEC must address the following issues associated with the sidedoor port arrangement:

A. The cost of a DS1 switch termination for a sidedoor port is about ten times the cost for a DS1 line card on a RDT.

B. Since each CLEC circuit requires a nailed up DS0, the ILEC may encounter blocking over the IDLC system as other circuits compete for DS0 channels.

C. The number of sidedoor ports that can be engineered varies depending on the LDS supplier.

D. There is limited support in existing special services design systems and databases to support sidedoor port circuits.

E. The ILEC may need field visits to install special service D4 channel units at the RDT.

6. Utilize separate TR-08 Interface Groups to transport CLEC traffic

   Figure 12-37 shows the use of separate TR-08 Interface Groups to carry CLEC traffic while utilizing the GR-303 Interface for ILEC traffic. In the figure, the RDT supports both GR-303 and TR-08 generic interface capabilities. CLEC switches can interconnect with the ILEC's RDT utilizing the DS1 handoff from the TR-08 interface.

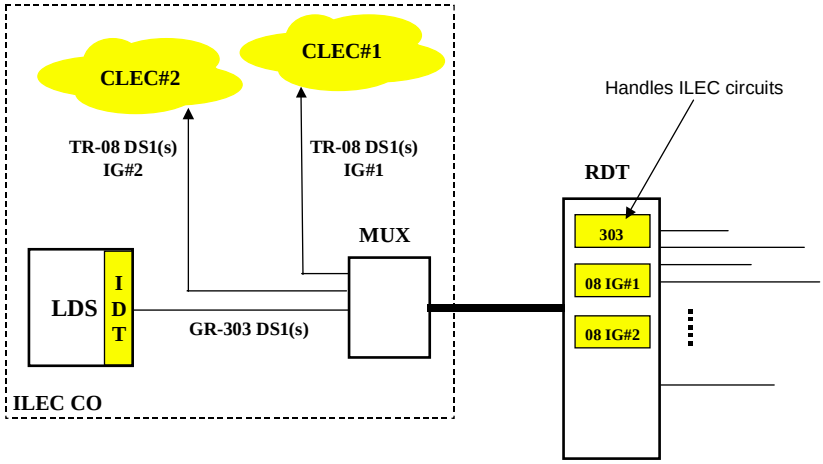

Figure 12-37. IDLC Unbundling Using Separate TR-08 Interface Groups

7. CLEC leases entire RDT

   Figure 12-38 shows the configuration when a CLEC leases an entire RDT from the ILEC.

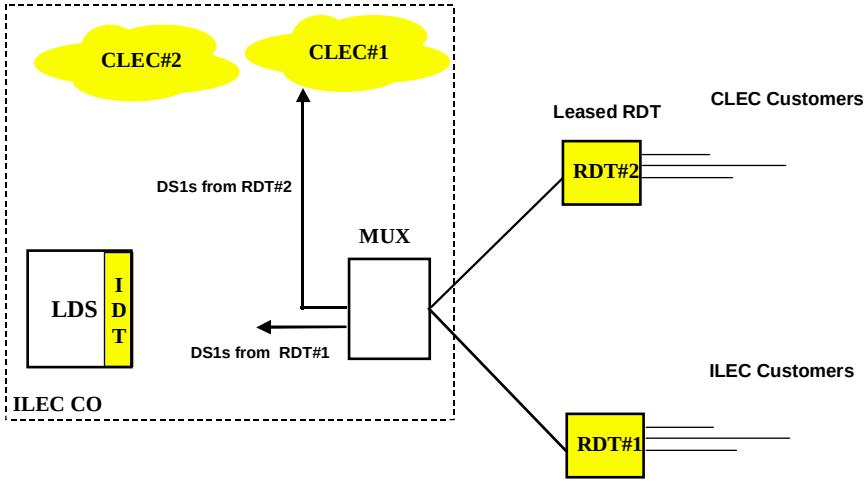

Figure 12-38. IDLC Unbundling - CLEC Leases Entire RDT

RDT#1 serves the ILEC customers, and RDT#2 serves the CLEC customers. This unbundling option may be cost-effective for the CLEC if the CLEC has a significant number of residential customers in the neighborhood or is serving a business park or campus.

12.13.2.2 Sub-Loop Unbundling Configurations

Sub-loop unbundling occurs when a CLEC interconnects to a loop facility at a point outside the ILEC's central office. The Sub-Loop UNE is defined by the FCC as portions of the loop that can be accessed at terminals in the ILEC's outside plant. An accessible terminal is a point on the loop where technicians can access the wire or fiber within the cable without removing a splice case to reach the wire or fiber within. Examples of access terminals are: poles, pedestals, the NID, the Minimum Point Of Entry (MPOE) to the customer premises, the MDF, and the Feeder/ Distribution Interface (including CEVs, utility rooms, and DLC Remote Terminals). Figure12-39 shows sub-loop unbundling at a GR-303 Remote Terminal (RDT) where a CLEC interconnects at the ILEC's RDT using its own GR-303 Interface Group facilities to provide service to its customers. In this configuration, the CLEC leases from the ILEC the RDT equipment and the RDT line facilities to each of its customer premises.

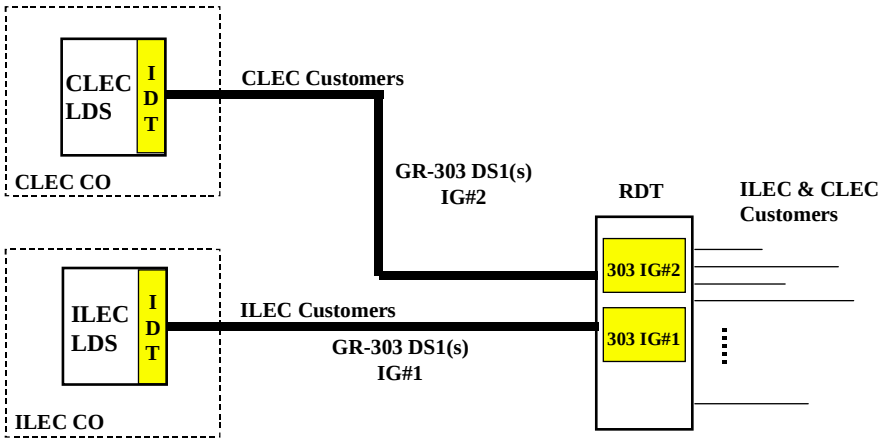

Figure 12-39. Sub-Loop Unbundling at an RDT

The FCC mandate on sub-loop network elements places the burden on each state regulatory commission to determine whether specific interconnection points in the outside plant are "technically feasible". The law directs the state commission to examine the ILEC's specific architecture and the specific technology used over the loop to determine whether it is really technically feasible to unbundle the sub-loop at a potential access point where a competing carrier requests access. Two key factors that are considered in this "technically feasible" determination are whether there is adequate space for collocated CLEC equipment to be installed and if the site has sufficient security safeguards to prevent mischief or sabotage. The FCC has

indicated that its central office collocation rules are also applicable to collocation in outside plant locations.

Since the FCC sub-loop unbundling mandate was announced in 1999, there has been little time for ILECs, CLECs, and state commissions to deal with this UNE. Sub-loop UNEs are an emerging market and, at this time, it is not clear which portions of the ILEC outside plant will be aggressively pursued by CLECs.

Numerous sub-loop unbundling configurations are possible. A CLEC may lease facilities from multiple carriers to create circuits, or it may deploy some of its own facilities and lease other facilities to extend its network to reach a greater customer base. Depending on the CLEC's network architecture, some of the transmission and technical issues associated with IDLC and UDLC configurations (described in Section 12.13.3) may be observed.

12.13.3 Unbundling Issues Associated with UDLC and IDLC Systems

There are various transmission and other technical issues associated with the use of UDLC and IDLC systems in the unbundling environment. In many loop unbundling configurations, the CLEC utilizes an IDLC system to economically transport unbundled loops from the ILEC's central office to the CLEC's central office. Issues arise when the ILEC terminates long length all-copper loops or DLC-transported loops to the CLEC's RDT (meet points at the collocation cage).

When an unbundled all-copper loop greater than 900 ohms or 12 Kft long is terminated at the CLEC's RDT, the customer may encounter degraded voice frequency transmission. To maintain the POTS grade of service, the CLEC may need to install an RDT line unit with a higher DC supervisory range to accommodate the long loop.

When an unbundled UDLC loop is terminated at the CLEC's RDT, the following impacts may be observed:

— Increased dial tone delay

— Degradation of on-hook transmission services, such as caller ID (due to delays)

— Degradation of signal quality (as a result of multiple A/D and D/A conversions)

— Reduction in analog modem operation speed (connection speed depends on loop length, number of A/D conversions, local switch type, and interoffice facility type).

Figure 12-40 shows the back-to-back DLC configuration.

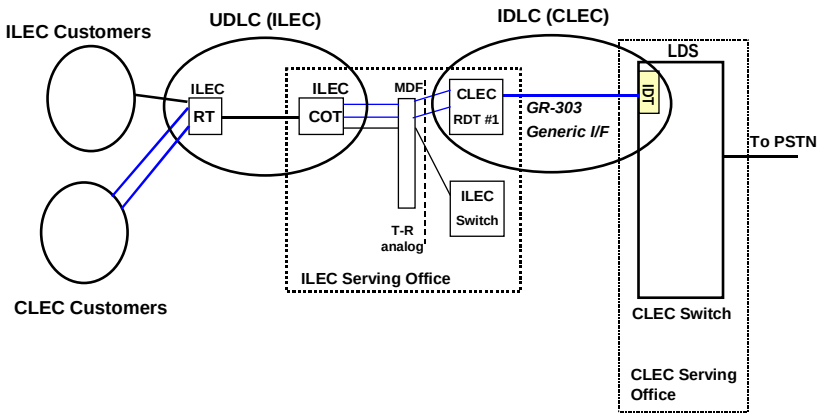

Figure 12-40. ILEC/CLEC Back-To-Back DLC Configuration

12.13.4 The Evolving Loop Unbundling Environment

Initially, ILECs offered and provided unbundled circuits to CLECs as analog handoffs to the collocation cages of the CLECs. Many ILECs now offer DS-0 digital connectivity to the CLEC collocation cages. DS-1 interconnection is emerging. Less than 2% of all access lines in the U.S. are currently unbundled, but this may rise to as much as 30% in the next 5 to 10 years. The factors that will significantly impact the potential growth in unbundled loops are: additional FCC regulatory/court changes, rate of implementation of ILEC/CLEC line sharing, and decisions by individual state commissions.

In the current loop unbundling environment, CLECs are largely focusing on unbundling ILEC business customers. The drivers behind this approach are economics and scalability. Provisioning and maintaining multiple unbundled loops from a single business customer lets the CLEC use digital subscriber lines over ILEC facilities. CLECs are requesting copper unbundled pairs and placing DSL equipment on these pairs to provide multiple POTS lines over no more than two unbundled copper pairs. The residence unbundling architecture presents a greater economic challenge to the CLEC because residential customers will generally request a single unbundled loop. CLECs find serving business customers much more profitable than serving residential customers. The FCC mandates on sub-loop unbundling and line sharing are expected to have a significant impact on CLEC expansion into the xDSL marketplace because CLECs will no longer be forced to incur the full cost of a separate copper line to serve customers.

The FCC orders mandating sub-loop unbundling and line sharing will likely be challenged in the courts. While this process evolves, CLECs will press for access to the local loop at the interconnection point nearest to the customer. When DLC systems are used to provide ILEC services, the CLEC will want to interconnect at the RDT. The reasoning for gaining access to the RDT on the analog customer side is to have the ability to provide all of the offered ILEC services without the