BEFORE THE WASHINGTON STATE
UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of the Petition of	**)**	
	)	**DOCKET NO. UT-033044**
QWEST CORPORATION	**)**	
	)	
To Initiate a Mass-Market Switching	**)**	
And Dedicated Transport Case	**)**	
Pursuant to the Triennial Review	**)**	
Order	**)**	

DIRECT TESTIMONY

OF

ROBERT V. FALCONE

ON BEHALF OF

AT&T COMMUNICATIONS OF THE PACIFIC NORTHWEST, INC.,
AT&T LOCAL SERVICES ON BEHALF OF TCG SEATTLE AND TCG OREGON
(COLLECTIVELY "AT&T")

NETWORK ARCHITECTURE

December 19, 2003

TABLE OF CONTENTS

PAGE

I. WITNESS INTRODUCTION AND PURPOSE OF TESTIMONY

Q. PLEASE STATE YOUR NAME FOR THE RECORD.

A. My name is Robert V. Falcone.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am a self-employed telecommunications and management consultant retained by AT&T to assist with its efforts on the TRO hearings in the states.

Q. PLEASE BRIEFLY DESCRIBE YOUR EDUCATIONAL BACKGROUND AND EMPLOYMENT EXPERIENCE.

A. I hold a B.S. in Business Administration from Adelphi University, Garden City, New York. Additionally, I attended a number of technical and business related courses offered by the AT&T School of Business when I was employed by AT&T on a full time basis. My career with AT&T began in 1970, working in a large central office in New York City. One of my first assignments with AT&T, which lasted for about eight-months was a frameman. In this assignment my responsibility was to install and remove cross connections on various central office frames. For the next seven years I worked as a switchman in a central office performing switch provisioning and maintenance activities. In 1978, I was promoted to a first level manager responsible for the software administration of the New York City 4ESS switching complexes. As a first level manager I subsequently held various assignments in AT&T's operations and engineering departments. In 1986, I was promoted to a second level manager responsible for AT&T's access engineering in the Northeast. I also held assignments as a product implementation manager in Bell Laboratories, project manager for the implementation of a new circuit switched network in Canada in a joint venture with Unitel of Canada and implementation manager for AT&T's conversion of its access network to SS7 out-of-band signaling. In 1994, I was promoted to a District Manager responsible for headquarters support of AT&T's local market network implementation. In 1997, I was promoted to a Division Manager responsible for supporting the AT&T regions with local market entry initiatives. I retired from AT&T in June of 1998. After retiring from AT&T, I have worked as a self-employed consultant for numerous clients including; AT&T, CompTel, BearingPoint (formerly KPMG Consulting) and Liberty Consulting. While working as a subcontractor with BearingPoint I was the group leader for BearingPoint's Systems Engineering Organization on the ILEC Operational Support System (OSS) testing team. In this role I was responsible for the test planning, test bed development and test execution for BearingPoint's various ILEC OSS 271 testing efforts, including the Regional "ROC" test of Qwest's OSSs.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The differences in the way end users' loops are connected to ILEC switches and the way they are connected to CLEC switches are among the most important factors that cause CLECs to face substantial operational and economic entry barriers when they seek to offer Plain Old Telephone Service ("POTS") to mass-market (residential and small business) customers using their own switches and ILEC-provided loops (i.e., via unbundled network element-loop or "UNE-L" facilities-based entry).

Accordingly my testimony:

- Compares the significantly different network architectures available to an ILEC and a CLEC when each wishes to use an ILEC-owned voice-grade loop to connect a mass market customer with its respective switch to provide POTS; and
- Provides an overview of the network architecturally-based operational and economic entry barriers to successful UNE-L facilities-based entry.
- Submits an illustrative aid in the form of a DVD describing the CLEC network and hot cut process. *See* **Exhibit RVF-2.**

Q. DID THE FCC MAKE ANY FINDINGS IN THE TRIENNIAL REVIEW ORDER ("TRO") REGARDING THE ISSUES YOU DISCUSS?

A. Yes. The FCC found on a national basis that CLECs are impaired in serving the mass market in the absence of unbundled ILEC switching.[1] This finding was based on an analysis that began with the simple, self-evident proposition that CLECs cannot use their own switches, in lieu of the ILECs', unless they can connect their switches to their end-users' loops. The FCC explained:

> Competitive LECs can use their own switches to provide services only by gaining access to customers' loop facilities, which predominately,

[1] TRO at ¶¶ 422 & 459.

> if not exclusively, are provided by the incumbent LEC. Although the record indicates that competitors can deploy duplicate switches capable of serving all customer classes, without the ability to combine those switches with customers' loops in an economic manner, competitors remain impaired in their ability to provide service. Accordingly, it is critical to consider competing carriers' ability to have customers' loops connected to their switches in a reasonable and timely manner.[2]

To emphasize the importance of the ability of CLECs to connect their switches to the loops of their end-users, the FCC noted that no party disputed that competitors need access to the ILECs' loops to compete in the mass market.[3]

Q. WHAT DO THE ISSUES YOU WILL DISCUSS HAVE TO DO WITH THESE FINDINGS BY THE FCC?

A. As discussed in the testimony of William H. Lehr and Lee L. Selwyn, the absolute cost disadvantages experienced by CLECs trying to serve mass market customers using UNE-L make it impossible to combine UNE loops and CLEC switches in an economic manner. Those cost disadvantages result in large part from the differences in network architecture that are the subject of my testimony.

In fact, the FCC found that the failure of CLECs to utilize their existing enterprise switches to be probative evidence of significant barriers making entry uneconomic.

> We found significantly more probative the evidence that in areas where competitors have their own switches for other purposes (e.g., enterprise switches), they are not converting them to serve mass

[2] TRO at ¶ 429 (emphasis added).
[3] TRO at n. 1316.

> market customers and instead relying on unbundled loops combined with unbundled local circuit switching. Given the fixed costs already invested in these switches, competitors have every incentive to spread the costs over a broader base. Their failure to do so bolsters our finding that significant barriers caused by hot cuts and other factors make such entry uneconomic.[4]

> We find . . . that the fact that competitors have not converted unbundled loops combined with unbundled local switching or served residential customers with existing switches only serves to demonstrate the barriers to such service.[5]

In addition, these network architecture issues are relevant to understanding the batch cut process and to understanding the operational impairment CLECs face. They also are important to understanding how to categorize carriers as part of the FCC's trigger analysis.

Q. FROM A NETWORK ARCHITECTURE PERSPECTIVE, WHAT IS THE FUNDAMENTAL OR CENTRAL PROBLEM THAT CAUSES CLECS TO BE IMPAIRED IN THEIR ABILITY TO SERVE MASS MARKET CUSTOMERS USING UNE-L?

A. As discussed in detail below, the central problem is that the ILECs' legacy network architecture was designed to support a single regulated monopoly provider, not a competitive market with multiple service providers seeking access to the ILEC's loops. This architecture allows an ILEC to connect its legacy loops to its own switches within the ILEC's wire center to provide service to end user customers. However, the legacy ILEC network architecture provides an inefficient and

[4] TRO at ¶ 447, fn.1365
[5] TRO at ¶ 449, fn.1371 (citations omitted)

uneconomic means for a CLEC that tries to connect those same loops to its switch which, in Washington, is always remotely located from the ILEC central office where these loops terminate. This fundamental structural difference creates overwhelming operational and economic advantages for the ILEC – advantages that make it both impractical and uneconomic for CLEC competitors to compete with the ILEC to serve mass market customers ubiquitously using a UNE-L architecture.

Q. WHAT ARE THE KEY COMPONENTS OF THIS STRUCTURAL DISADVANTAGE?

A. There are five key components to this structural disadvantage.

First, a CLEC must incur the time and cost to install and maintain a significant "backhaul" network infrastructure to connect its switch to the ILEC loops that terminate in the ILEC's wire center, which may also be referred to as a central office ("CO") or local serving office ("LSO"). The ILEC has no such need for backhaul facilities. As the FCC explained in the TRO, "The need to backhaul the circuit derives from the use of a switch located in a location relatively far from the end user's premises, which effectively requires competitors to deploy much longer loops than the incumbent"[6] These CLEC backhaul costs include the non-recurring costs necessary to establish a collocation arrangement in every ILEC wire center in which the CLEC wishes to offer mass market services, the recurring costs paid to the ILEC for maintaining these collocation arrangements, as well as the transport equipment

[6] TRO at ¶ 480 (citations omitted); see also TRO at ¶ 464, n. 1406; TRO at ¶ 424, n. 1298; and TRO at ¶ 429.

and facilities necessary to extend the ILEC's loops to the remotely located CLEC switch.

Second, a CLEC using UNE-L must aggregate traffic from many locations to achieve the same switch economies of scale realized by an ILEC at a single location. This forces the CLEC to incur its backhaul cost disadvantage in many wire centers to achieve the type of switch scale economies that the ILEC achieves at a single wire center.

Third, the CLEC must pay the ILEC for transferring loops from the ILEC switch to a CLEC collocation facility, or from one CLEC to another. This transfer process, commonly known as a "hot cut," also forces the CLEC's customers to suffer an inferior experience in converting to the CLEC's service compared with the treatment they can receive using UNE-P, or that interexchange carriers -- including the ILECs -- can offer customers using the Primary Interexchange Carrier ("PIC") change process for allowing customers to change their long distance service provider.

Fourth, because of the way ILECs have chosen to provision UNE-Ls that pass through integrated digital loop carrier ("IDLC") systems, CLECs may be precluded from serving an entire segment of retail customers unless the ILEC has the spare non-IDLC loop plant in place to replace these customer's lines so that they are eligible for a UNE-L migration to a CLEC.

Finally, because the CLECs do not have the traffic volumes that the ILEC does, they cannot efficiently exchange inter-switch traffic at a switch-to-switch level. As a result the CLECs will be reliant on the ILEC's tandem network for the exchange of this traffic. This reliance will both increase CLEC costs and potentially cause CLECs to experience additional operational impairments, such as inadequate subtending trunking.

Q. PLEASE DESCRIBE HOW THE REMAINDER OF YOUR TESTIMONY IS ORGANIZED.

A. **Section II** provides a historical overview of how the ILECs' networks developed and the principles underlying their evolution in a monopoly environment.

Section III describes how end-user locations are connected to ILEC switches and why that service configuration has serious implications for mass-market competition.

Section IV describes CLEC networks and how the incumbents' closed and integrated network architecture causes quantifiable and significant cost, operation disadvantages and barriers for a new entrant.

Section V briefly describes the impairment created by the way ILECs deploy IDLC technology and have chosen to provision UNE-L around it.

Section VI provides my concluding opinions.

II. PRINCIPLES UNDERLYING THE DEVELOPMENT OF ILEC NETWORKS

Q. PLEASE PROVIDE AN OVERVIEW OF THE PRINCIPLES UNDERLYING THE HISTORICAL DEVELOPMENT OF ILEC NETWORKS.

A. The essence of the telephone network is *connecting* one party to another, whether they are physically located near each other or separated by considerable distance. There is value in merely being *able* to call any party on the network, or likewise being *able* to receive calls from any party on the network. In theory, the more parties that can be reached, the greater the value of the network. The nature of voice communication is that even brief conversations, such as emergency calls, can be of great value. Telephone networks are predominantly designed to facilitate relatively short, private, one-to-one, bidirectional communications. The telephone network must stand ready to complete any particular call (or tens of millions of calls) at any time customers want to call, but stand partly idle when customers do not wish to use it.

Because of the high fixed cost required to maintain the ability to make direct connections between all customers, and the relatively small proportion of time that those connections are required (coupled with the practical impossibility of directly connecting every customer to every other customer), the goal of an efficient telephone network is to balance the callers' ability to connect to any other customer with the cost of making the connection. This is accomplished by minimizing the proportion of assets dedicated to any particular customer and by creating "on-demand" connections whenever practical.

Q. HOW IS THE NEED FOR DEDICATED CONNECTIONS TO SERVE CUSTOMERS REDUCED?

A. Switching reduces the need for dedicated connections. In fact, a single switch in the ILEC's network permits any customer terminated on that switch to connect with any other customer terminating on that same switch without the need for any transport facilities at all. Depending on population density, these "intra-switch" local calls between people who live in a community can account for a very large percentage of all of the ILEC's traffic. By connecting switches to each other using transport and tandem switching, all customers on those switches can connect with others in neighboring communities.

Q. BECAUSE A SINGLE SWITCH OBVIOUSLY CANNOT BE USED TO SERVE ALL CUSTOMERS, HOW DID THE INDUSTRY RESOLVE THIS PROBLEM?

A. Once central offices were established, two more questions rapidly came upon the industry: how many switches are needed to serve a given geographic area and how can the network connect customers in one switch to those in another?

The decision to invest in more switches was an economic trade off between (1) the cost of an additional switch in a territory and (2) the cost of building long customer loops.

A typical copper loop without *any* enhancement can provide good telephone service out to a distance of 18,000 feet (3.4 miles) from a switch. For decades, telephone companies extended service, grew, and added switches by comparing the economics of long loops versus additional switches. In urbanized areas, larger switches are located closer to the customers they serve. In rural areas, with lower population densities, smaller switches with longer average loop lengths are more common.

Connecting all individual switches to each other with dedicated facilities may at first seem to create a problem because of the costs associated with building a facility from one switch to every other switch; however, the connections between switches, known as "trunks" and "trunk groups," are not dedicated to individual customers, but are used by multiple customers on an as needed basis. As a result, a key characteristic of trunks is that they carry concentrated traffic. Concentration is possible because it is unlikely that all potential users will want to make calls simultaneously. This permits the sharing of facilities by more users than could be accommodated if all users sought service at the same time. Concentration is limited by the level of service blockage probability that is deemed acceptable.

Trunk facilities are also less costly than individual loop facilities because trunks can be "multiplexed" – several trunks can be placed on the same facility. Multiplexing is the process of allowing multiple channels to share a single transmission facility.

Further, "switching between switches", known as "tandem switching," can also be used, eliminating the need to build individual trunk groups from any one switch to all the other switches in the network until it is economical to do so. Such an individual trunk group would be built only when the volume of calling between any two switches warrants such a direct trunk group connection. By connecting one switch to another using tandem transport (including tandem switching), all customers of those switches can connect with each other.

Q. WHAT IS THE SITUATION TODAY RELATIVE TO LOOPS SERVING MASS MARKET CUSTOMERS?

A. The local loop – that is, the transmission facility between a customer premises and the first point of switching – remains fundamentally a dedicated connection with little opportunity for cost sharing through multiplexing or concentration. The use of digital loop carrier (DLC), which only began to be deployed in the loop plant within the last two decades, provides some opportunity for cost sharing. Depending on the type and vintage of the DLC, both multiplexing and concentration may occur. However, as I will discuss below, in Sections IV and V, the deployment of certain kinds of DLC in the loop plant can create additional sources of impairment because of the way ILECs typically prevent access to the more advanced features of that equipment. Loops were originally a simple copper cable pair between the customer's premise and the local switch, and for the mass market that remains predominantly the case today, over 100 years later. The loop plant represents a high fixed cost infrastructure with little opportunity to share costs.

This is the very infrastructure the FCC found that incumbents must unbundle because competitors cannot duplicate or replace it. As the FCC explained:

> No party seriously asserts that competitive LECs are self-deploying copper loops to provide telecommunication services to the mass market.[7]

> When the incumbent LECs installed most of their loop plant, they had exclusive franchises and, as such, the record shows that they secured right-of-way at preferential terms and at minimal costs. By contrast, [the] record shows that new entrants have no such advantage.[8]

III. ILEC NETWORKS

Q. PLEASE DESCRIBE HOW LOOPS SERVING MASS MARKET CUSTOMERS ARE CONNECTED TO THE ILEC'S NETWORK.

A. To use an analog loop to provision traditional retail local voice service (*i.e.*, POTS), a local exchange carrier must connect that loop to a local circuit switch. The local loop is typically a copper transmission facility that originates at the customer's premise and terminates on a Main Distribution Frame ("MDF") in the incumbent LEC's wire center. *See* diagram at **Exhibit RVF-3**. The MDF is a large metal framework that serves the simple purpose of terminating cable pairs in a manner that permits a cable

[7] TRO at ¶ 226
[8] TRO at ¶ 238

pair on one side of the frame to be connected to a specific piece of central office equipment on the other side of the frame. *See* **Exhibit RVF-3**.

When an ILEC provides POTS to a retail customer, the customer's loop must be connected to a port on the ILEC's switch. The switch port recognizes when a customer wishes to make a call (*i.e.*, goes "off-hook"), indicates to the customer that a call may be placed (*i.e.*, provides dial tone) and receives the dialed digits necessary to make the call. Similarly, the switch port notifies the customer when someone is calling (initiates ringing for incoming calls). For mass-market customers served by analog voice-grade loops, the switch port connection is generally accomplished using a "jumper" wire pair at the MDF in the ILEC central office. To make the connection, an ILEC frame technician runs a pair of wires from one side of the frame to the other side of the frame to make a continuous path between the customer's loop and the switch port.

Individual loops enter the ILEC central office as part of a large cable that collects many loops from a particular neighborhood. The cable typically runs to an underground cable vault in the basement of the central office, and then up into the building to the MDF. The individual loops within the cable are then "fanned out" onto wiring blocks on the "customer facing" side of the MDF. Twisted pairs of insulated wire, commonly referred to as "jumper wires," are used to cross-connect customer loops, which appear on the customer facing side of the MDF, to wiring blocks on the "network facing" side of the frame. The latter contain the wiring blocks onto which cables from the ILEC's local switch ports are terminated. Using this technique, customer loops can be assigned to a specific analog switch port on the ILEC's circuit switch by placing or repositioning the jumper wire on the MDF. Exhibit **RVF-4** depicts a generic MDF cross-connect arrangement.

To provide POTS service, each customer's individual loop must be connected to an assigned switch port. Currently, the vast majority of end-user loops are serviced by the ILEC, so the vast majority of end-user loops already are connected to the ILEC's circuit switch by way of the MDF. This is true whether or not service is currently active on the particular loop. When a customer terminates service, *e.g.*, when he or she moves from a location, the ILEC typically does not remove the jumper wires that connect that loop to the ILEC switch. Rather than disrupting the physical connection to the premises, the loop is typically placed in an "inactive" status by software commands issued to the switch's software table. In such cases, no physical work is required to restore full service when a new customer requests it. Instead, the switch software table is merely updated through the use of keystrokes from a computer workstation to show the line is no longer "inactive." This practice of leaving the ILEC loop connected to the ILEC switch port is commonly known in the industry as "dedicated inside plant" and "dedicated outside plant," or as "connect through."

IV. CLEC NETWORKS

Q. HOW DO CLEC NETWORKS DIFFER FROM THE ILEC NETWORK YOU HAVE DESCRIBED?

A. In contrast to the incumbents, new entrants do not have the opportunity to achieve scale economies for their switches *and at the same time* minimize loop distances and costs by locating their switches where these loops terminate. The FCC summarized the problem as follows: "The [CLECs'] need to backhaul the circuit . . . effectively requires competitors to deploy much longer loops than the incumbent."[9] In any event, even if a CLEC were allowed to place a circuit switch in every local serving office, it could not achieve acceptable scale economies, nor anywhere near the scale economies enjoyed by the ILEC.

Thus, CLECs must deploy individual switches to serve much larger areas than the ILEC, because that is the only way they could possibly aggregate enough users to justify the cost of a switch. The FCC recognized this problem in the TRO, noting that "[The RBOCs' cost studies] suggest that it would be uneconomic for a competing carrier to serve customers in smaller wire centers. All the studies found that in such wire centers, entry would be much more expensive for the competitive LEC than for the incumbent, or simply would be uneconomic."[10]

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[9] TRO at ¶ 480

[10] *See* TRO at ¶ 484.

Accordingly, CLECs cannot use the same kind of connections, *i.e.*, merely the MDF jumper wire pairs used by ILECs, to link their customers' loops to their distant switches. Rather, CLECs must deploy an extensive *backhaul network* that extends the existing customer loops – all of which terminate at ILEC wire centers – to a distant CLEC switching location. In California, there are 607 SBC and 277 Verizon wire centers from which CLECs must "backhaul" end-user loops if they want to use their own switching to serve customers in all of the incumbent LECs' wire centers.

Q. WHAT MUST A CLEC DO TO "BACKHAUL" ITS CUSTOMERS' TRAFFIC TO ITS OWN SWITCH?

A. For a CLEC to "backhaul" its customers' traffic to its own switch, the CLEC must first create an overlay network infrastructure that is largely dedicated to the subset of customers won from the incumbent in a specific wire center. In essence, the CLEC must add a very long, costly and dedicated "extension cord" to connect its end-users' loops to its switches. This requires the CLEC to:

(1) establish and maintain collocations at ILEC wire centers, where customers' loops are "collected;"

(2) install and maintain the equipment necessary to digitize and, using concentration and multiplexing techniques, aggregate the traffic on those loops to permit connections to the CLEC's switch at acceptable quality levels; and

(3) establish the necessary transport facilities that provide the physical path connecting the CLEC's collocations and its switch.

Only after all of this infrastructure and these functionalities are in place and operational in each ILEC wire center in which it wishes to compete can a switch-based CLEC begin to offer service to customers in those incumbent's wire centers. Thereafter, for each individual customer line it seeks to serve, the CLEC must then arrange and pay for a manual, volume limited, and costly "hot cut" process to have the customer's loop connection transferred to its collocation, and the customer's telephone number ported to the CLEC's switch.

In sum, due to the underlying integrated, and effectively closed, design of the incumbents' local network architecture, competitors must invest in and deploy all of the functionalities described above to replace a simple jumper pair across the incumbent's MDF. That is why the FCC correctly found that the barriers CLECs face in attempting to provide a UNE-L based service

> are directly associated with incumbent LECs' historical local monopoly, and thus go beyond the burdens usually associated with competitive entry. Specifically, the *incumbent LECs' networks were designed for use in a single carrier, non-competitive environment* and, as a result, the incumbent LEC connection between most voice-grade loops and the incumbent LEC switch consists of a pair of wires that is generally only a few feet long and hardwired to the incumbent LEC switch.[11]

These barriers generate very significant costs for the CLECs – costs that ILECs do not incur.

The following subsections describe in greater detail the general infrastructure and equipment that a CLEC must install and operate to provide service to mass market

[11] TRO at ¶ 465 (emphasis added) (citations omitted).

customers using analog voice grade loops (*i.e*., collocation, collocation equipment, transport, and hot-cuts).

A. Collocation

Q. WHAT IS THE FUNCTION OF A COLLOCATION ARRANGEMENT AND WHY ARE THEY PROBLEMATIC?

A. A CLEC cannot provide any telecommunications service employing a UNE-L architecture until the retail customer is physically connected to its network switch. To provide POTS service, as explained above, a CLEC must deploy the equipment required to digitize, encode, multiplex and concentrate its customers' traffic so that the unbundled loops terminating in the ILEC's wire center can be extended to the CLEC's switch. To do so, *i.e.*, to make an ILEC loop useable at a CLEC switch, the CLEC must rent space to establish a collocation in the ILEC's wire center. *See* **Exhibit RVF-5**.

Establishing a collocation involves a number of activities and costs that will vary depending on the type of collocation established. The ILECs offer various collocation arrangements including physical collocation, in which the CLECs equipment can either be secured in a "caged" space or unsecured in a "cageless" space, and virtual collocation, in which the CLEC's equipment is leased to the ILEC and is installed and maintained by the ILEC on the CLEC's behalf.

In general, the activities required to establish a collocation include: (1) obtaining the necessary space in the wire center, which is predicated upon the ILEC having sufficient collocation space in its central office;[12] (2) engineering the collocation; (3) arranging construction (for physical caged collocations); and (4) installing the required equipment in the collocated space.

Because the CLEC's equipment in the collocated space requires electric power, the CLEC must also pay the incumbent for delivery of direct current ("DC") power and emergency power to operate the collocated equipment. In some instances, the CLEC may opt to invest in additional equipment to deploy power distribution, i.e., a battery distribution fuse bay ("BDFB") within its own collocation to provide for more flexibility and to minimize the need for a subsequent (and generally very costly) power augment. In general terms, the collocation power charges are driven by the charges for redundant power feeds (sized for the maximum demand in the collocation) and the necessary Heating, Ventilating and Air-Conditioning ("HVAC") for the collocated equipment.

[12] *See* TRO at ¶ 477

B. Collocation Electronics

Q. PLEASE DESCRIBE THE KEY ELECTRONIC COMPONENTS NECESSARY WITHIN A COLLOCATION ARRANGEMENT.

A. Obviously, having an empty collocation space does not by itself provide the CLEC with any of the functionality necessary to connect customers on ILEC loops to the CLEC's switch. Additional equipment is necessary to make the loop connection work. *See* **Exhibit RVF-6**. For example, analog voice signals degrade and unwanted noise increases as the length of a copper facility increases. Thus, the longer a copper loop, the less a voice signal can be distinguished from noise on the line. This is known as "signal degradation". The incumbent's loop plant is designed so that many voice grade loops consume all but a "safety margin" of the allowable signal degradation on the conductor. Therefore, once the analog loop is delivered to the CLEC collocation arrangement, the analog telecommunications signals on the loop cannot travel much farther and still retain acceptable voice and analog modem quality levels.

Accordingly, for a CLEC's mass-market customers' communications to transit back and forth between the customer's premises and the CLEC's remotely located switch at an acceptable level of quality, the CLEC must install digital loop carrier ("DLC") transmission equipment. While this DLC equipment is absolutely mandatory for the CLEC, it is not usually required for the ILEC when serving the same customers.

The CLEC's DLC equipment must be placed in the collocation arrangement that is located in the wire center where the end-user loops terminate. The equipment digitizes, encodes, concentrates and multiplexes the analog signals received from the customer so that the CLEC can extend the loop signal back to its remote switch in a manner that (1) provides service quality that will meet customer expectations and (2) minimizes the CLEC's costs to transport its customers' traffic back and forth from its switch. Collocation equipment includes the cross-connection frame (also known as a POTS bay) between the incumbent's MDF where the loops terminate and the CLEC's DLC equipment, the DLC equipment itself, and high capacity digital cross-connection frames ("DSX-1" or "DSX-3") necessary to manually cross-connect the digital output from the DLC to the transmission facilities that ultimately connect to the CLEC's remotely located switch. In addition, CLEC test access and monitoring equipment must be deployed in the collocation arrangement to allow the CLEC to properly operate its equipment.

As noted above, the CLEC DLC equipment, which is not normally required in the ILEC's network, receives analog communications from the loop and digitizes, concentrates and multiplexes the communications on the CLEC customers' loops to permit connection to the CLEC transport facility. The DLC also interoperates with the CLEC's switch to provide and receive the signaling necessary for call supervision, including the provision of loop current, ringing voltage and other basic loop interface functions. Thus, the DLC equipment is not only needed to extend the

CLEC's loops, it is also essential to providing loop current and ringing voltage necessary for POTS service – functions that are performed by the ILEC's switch port as described in Section III above.

Additional equipment is needed to take the output of the DLC and place it on transport facilities for transmission out of the retail customer's wire center. The cross connection frame (i.e., the DSX panel) provides for this functionality by permitting the DLC to be manually cross-connected to the backhaul transport facility. DSX-1 panels allow for connections to DS-1 transport facilities, and DSX-3 panels allow for connections at the DS-3 level. The volume of traffic that will be served from the wire center dictates the type of equipment used at a particular location. As described in greater detail in the Transport section below, when transport is leased from the incumbent (rather than utilizing CLEC-provided transport), the DSX equipment cross-connects DLC transmissions from the CLEC's collocation to the ILEC's transport facilities. In cases where the CLEC provides its own transport to its switches, connections from the DLC are typically to an optical multiplexer which, in turn, is connected to the CLEC's fiber optic cable transport facilities. *See* **Exhibit RVF-7.**

Q. CAN DLC EQUIPMENT AND DSX EQUIPMENT BE INSTALLED IN A MANNER THAT GROWS SMOOTHLY, ON A LINE-BY-LINE BASIS WITH THE GROWTH OF CLEC CUSTOMERS IN AN AREA SERVED FROM A COLLOCATION?

A. No. DLC equipment is not designed to, and therefore cannot, scale precisely with the level of demand (or number of lines) served in a wire center. Rather, there is a minimum amount of DLC equipment that must be purchased and installed. Accordingly, DLC investment is very "lumpy". The first module of collocated DLC equipment typically includes equipment that manages the interface with both the transmission facility and the sub-modules of DLC equipment where the lines physically terminate.

For example, common equipment in the Litespan 2000 product line, manufactured by Alcatel, can serve up to 2,016 POTS lines. Subtending equipment, referred to as a channel bank assembly, houses individual line cards and manages the interface between the analog lines and the DLC common equipment, facilitating the sharing (concentration of lines) of the transmission facility. The channel bank assembly for the Litespan 2000 product handles up to 224 POTS lines. Finally, individual POTS lines terminate on electronic devices called line cards. Line cards terminate the loop and provide the electrical interface to the DLC channel bank assembly. For the Litespan 2000 product, 4 POTS lines can terminate on a single line card. In the Litespan example, a CLEC would need one line card capable of serving up to four lines to serve a single POTS line, one channel bank assembly capable of serving up to 224 lines, and one DLC common unit capable of serving up to 2,016 lines. No additional investment would be needed until the fifth line is served, when a second line card would be required. A new channel bank would be required when the 225th line is added, and when the 10th channel bank assembly is required (*i.e.*, when the 2,017th line is added) the whole process would start again with a new common unit, a new channel bank assembly and a new line card.

The digital cross connection frame (whether a DSX-1 or DSX-3) takes the output of the DLC as a digital electrical signal and connects it to either a DS1 (in the case of a DSX-1 panel) or a DS-3 (in the case of a DSX-3 panel) transport facility that extends the loops from the CLEC's collocation arrangement to the CLEC switch. DSX equipment is also not designed to scale smoothly with growth. A typical DSX-3 panel can terminate 24 DS-3 transport circuits. Each DS-3 is equivalent to 672 DS-0 (voice grade) channels, and DLCs typically permit 4 lines to share a single channel through the unit's concentration capabilities. A single DSX-3 panel when used in conjunction with DLCs, therefore, has capacity to handle more than 64,000 (24 x 672 x 4 = 64,512) POTS lines – approximately the equivalent capacity of a large incumbent LEC wire center.

C. Transport

Q. PLEASE DESCRIBE HOW THE TRANSPORT FUNCTION IS ACCOMPLISHED.

A. What I have described so far brings the loop into the collocation space and prepares it to be extended, along with numerous other loops, to the CLEC's distant switch. Once a CLEC customers' signals have been prepared for transport to the CLEC switch, the CLEC must arrange for transmission capability to deliver traffic from the collocation to its remotely located switch. Here again, the ILEC is not required to invest in this kind of transport for its own customers' loops.

In some cases, a CLEC's collocation will be connected to another collocation through the purchase of ILEC transport facilities (*e.g.*, DS1 and DS-3 capacity facilities) as the CLEC traffic volumes at most incumbent wire centers are typically too low to justify CLEC construction and use of owned transport facilities. *See* **Exhibit RVF-8**. When used, this second CLEC collocation typically serves as a "hub" location to aggregate loops from several sub-tending collocations in the area and subsequently transport the loops to the CLEC's switching location, either over higher capacity leased facilities or using self-provided CLEC transport. The FCC commented on this type of arrangement in the TRO: "Competing carriers generally use interoffice transport as a means to aggregate end-user traffic to achieve economies of scale. They do so by using dedicated transport to carry traffic from their end users' loops, often terminating at incumbent LEC central offices, through other central offices to a point of aggregation."[13]

Self-provided transport between ILEC wire centers is the exception rather than the rule for mass-market service. Indeed, POTS volumes from a single wire center alone could not justify a CLEC's deployment of its own transmission facility. This is corroborated by the FCC's finding of national impairment when a CLEC requires 12 or fewer DS-3s of capacity.[14] Twelve DS-3s are equivalent to 32,256 POTS lines, with a four-to-one DLC concentration ratio, which is greater than the number of loops that terminate in the majority of central offices.

In other cases, rather then linking two collocations together, single collocations will be equipped to extend the loops collected directly to the CLEC's switch location (See Exhibit RVF-5).

In either case, regardless of which carrier provides it, a CLEC must procure transport facilities between its collocations and switching locations to backhaul customers' traffic to its switch. Ironically, when the transmission capability is procured from the ILEC rather than self-provisioned, the CLEC's transport cost has potentially increased as a result of the TRO. In the TRO, the FCC determined for the first time that ILECs are no longer required to unbundle transport facilities for requesting CLECs when such facilities are used to backhaul traffic from the CLEC end user

[13] *See* TRO at ¶ 361; s*ee also* TRO at ¶ 370.
[14] TRO at ¶ 388.

loops to their switches.[15] As a result, CLECs may now be required to pay above-cost special access rates to ILECs for such transport.

D. Physical Transfer Of Loops

Q. ONCE THE CLEC HAS PURCHASED, INSTALLED AND ACTIVATED ALL OF THE COLLOCATION SPACE, EQUIPMENT ELEMENTS AND TRANSPORT ARRANGEMENTS, WHAT ELSE MUST OCCUR FOR CLECS TO PROVIDE SERVICE TO CUSTOMERS USING UNE-L LOOPS?

A. Once the necessary network infrastructure described above is in place, the CLEC is finally in a position to have individual customer loops from the incumbent's network transferred to its collocation and ultimately to its switch. To accomplish this, the CLEC must arrange for what is typically referred to as a hot cut. The hot-cut process, which is described in detail in my separate hot cut testimony, involves multiple manual steps and coordinated activities of both CLEC and ILEC personnel.

These include, among other things: (1) interrupting the customer's service while changing the customer's loop cross-connection at the MDF from a terminal pair connected to the incumbent's switch port to a terminal pair that connects to a pair of terminals in the CLEC collocation; and (2) coordinating the porting of the customer's telephone number to the CLEC's switch so that calls dialed to the customer's number can be properly completed. Once the hot-cut has been successfully completed, a

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[15] TRO, at ¶¶ 365-369.

CLEC can finally provide service to its end-user using its own switch. In contrast, as discussed above, the ILEC can provide service to that same customer on the same loop through a software change command. Because of all of the physical work and manual touch points, and the associated human error involved with a hot cut, the process is inadequate to serve mass market customers.

As the FCC noted, the shortcomings of the hot cut process also stem from the ILECs' legacy network created for a monopoly environment:

> The barriers associated with the manual hot cut process are directly associated with incumbent LECs' historical local monopoly, and thus go beyond the burdens usually associated with competitive entry. Specifically, the incumbent LECs' networks were designed for use in a single carrier, non-competitive environment and, as a result, the incumbent LEC connection between most voice-grade loops and the incumbent LEC switch consists of a pair of wires that is generally only a few feet long and hardwired to the incumbent LEC switch. Accordingly, for the incumbent, connecting or disconnecting a customer is generally merely a matter of a software change. In contrast, a competitive carrier must overcome the operational and economic barriers associated with manual hot cuts. Our finding concerning operational and economic barriers associated with loop access reflects these significant differences between how the incumbent LEC provides service and how competitive LECs provide service using their own or third-party switches.[16]

[16] TRO at ¶ 465 (citations omitted).

Q. PLEASE SUMMARIZE THE DIFFERENCES BETWEEN THE ILEC NETWORK ARCHITECTURE AND THE NETWORK ARCHITECTURE THAT CLECS MUST ADOPT TO SERVE CUSTOMERS USING UNE-L.

A. **Exhibit RVF-9** provides an overview of the CLEC network architecture required to collect and extend customers' loops from the ILEC wire center to the CLEC switch. The contrast with Exhibits RVF-3 and RVF-4, which show what is required for the ILEC to perform the same function by merely cross connecting a loop to a switch port using a jumper on the MDF, is clear.

Q. CAN THE FUNDAMENTAL CHARACTERISTICS OF ACCESS TO LOOPS BE CHANGED IN A MANNER THAT BENEFITS CONSUMERS BY EXPANDING THE DEVELOPMENT OF MASS MARKET COMPETITION?

A. Yes. There is a means available that uses currently available technology and allows the provisioning of loops to be operationally and competitively neutral, making it the local service equivalent to "equal access" in the long distance market. This is a process that AT&T has generically referred to as "electronic loop provisioning" ("ELP").

As discussed above, the underlying single user local network architecture and technology that ILECs deployed over the decades, and have resisted changing since the passage of the Telecom Act, impose on CLECs the burdens of a vast investment in backhaul infrastructure (*e.g.*, collocation, collocation electronics, and transport facilities) and of an inefficient and costly loop migration process (*e.g.*, hot cuts) that ILECs do not have to incur in order to serve end-users. The "batch" hot cut process does not erase any of these problems that make the use of UNE-L for the mass market infeasible. Change is required -- and possible. In fact, many of the components necessary to make the change are already in use in the ILEC network.

Competitively neutral, efficient access to customer loops is required for mass-market competition to develop and be sustainable in a UNE-L environment. From a technical perspective, no carrier should be advantaged or disadvantaged with regard to how customers are physically connected to competing networks. The ILECs' current networks were designed to accommodate a single firm operating as a monopoly. They cannot functionally support a competitive, multi-carrier environment without significant modification. Fortunately, however, modern technology has opened new opportunities for responsibly converting the ILEC network into an efficient multi-carrier network.

The characteristics of such a network are fairly easy to define. Loops should be readily accessible at a few centralized locations, and the interface to the loops should be electronic, as it is today when ILECs provision loops for themselves and when UNE-P is used. Centralized availability of digital, packetized customer signals (rather than dispersed access to physical, analog loops) would address and resolve many of the problems. First, transmitting voice signals in a digital and packet format eliminates the need for CLECs, and only CLECs, to deploy costly electronics that do not augment the types of services that may be deployed. Centralized access, highly feasible with a packet-based network infrastructure, can significantly reduce the need for, and the cost of, collocation. Equally important, packetized signals are readily redirected by software commands. This feature offers the speed, cost structure, capacity and ease of change fundamental to unconstrained competition. It removes the manual hot cut process from consideration and replaces it with electronic provisioning that is equal to that which exists for UNE-P and in the long distance marketplace. Lastly, a packet-based loop architecture would eliminate the need for competitors to adopt a circuit-switched infrastructure and permit the introduction of new services that leverage the computer controlled and higher bandwidth features of a packet-based network.

The technology and equipment necessary to realize non-discriminatory digital, centralized and packet-based loops are available today. Indeed, the digitization and packetization of voice communications can be seen as a logical extension of equipment and technology already in use by the ILECs in association with their deployment of DSL. The three major components necessary to support the necessary changes are already in service, Next Generation Digital Loop Carriers ("NGDLC"), Asynchronous Transmission Mode ("ATM") modules, and ATM-compatible equipment known as "voice gateways" or "VoATM Gateways".

V. ENHANCED LOOP TECHNOLOGY DEPLOYMENT AND CALL TERMINATION

Q. ARE THERE ADDITIONAL IMPAIRMENTS THAT RESULT FROM THE ILECS DEPLOYMENT OF ENHANCED LOOP TECHNOLOGY?

A. Yes. CLECs are further impaired by ILECs in offering service to mass market customers when the customer is served by loops on IDLC facilities.

IDLC can significantly limit a CLEC's ability to provide competing service if denied access to UNE-P because ILECs traditionally only offer access to customer's loops served by IDLC by physically removing the customer off of the IDLC facilities and reestablishing the customer's service on copper or UDLC facilities.[17] To serve these customers CLECs are therefore forced to have the ILEC transfer the IDLC loops to a spare copper pair if available, or to spare Universal DLC equipment if available (or to abandon the potential customer). Both service options are technically inferior, and normally incur additional CLEC costs. Transfer of a customer from IDLC involves dispatching an ILEC technician to the Serving Area Interface ("SAI"), removing the connection between the existing customer's copper distribution wire pair and the IDLC feeder terminations, and reconnecting the customer's copper distribution wire pair to either a spare copper feeder termination or to a derived feeder termination from UDLC remote terminal equipment. In addition, the central office end of the circuit must now be cross connected from the new analog copper or analog copper

[17] Some ILECs offer other alternatives such as switch "hairpinning" which are not being addressed here because of the limitations regarding of such options.

UDLC-derived loop feeder termination on the MDF to the CLEC collocation termination point in the central office.

As the above description indicates, IDLC can exacerbate impairment in two ways. The first way IDLCs further impairs a CLEC is by increasing costs and operational problems because of the required truck roll to move the IDLC loop to UDLC or copper technologies. The second impairment happens if and when the ILEC runs out of spare facilities that can be used to swap-out lines for customers that are on IDLC facilities and wish to change their local service provider. At that point, the CLEC is forced into being unable to serve customers whose loops pass through the ILECs choice of IDLC. This can be a significant problem in new housing developments or office buildings where IDLC loops are the only available transmission facilities for reaching the ILEC's customers.

Q. DOES THE MANNER IN WHICH CLECS MUST DEPLOY SWITCHES TO SERVE UNE-L CREATE ADDITIONAL IMPAIRMENT ISSUES?

A. Yes. CLECs will also be impaired when trying to serve the mass market with unbundled loops by an inability to exchange traffic with the ILEC at a switch-to-switch level. Because the CLEC does not have the economies of scale to direct connect its switch with efficient inter-office trunk groups to each of the ILEC's local switches, the CLEC will be more reliant on the ILEC's tandem network for the exchange of traffic. This reliance will put the CLEC at a cost disadvantage because of the additional tandem switching costs and transport facilities that will be needed to complete each of its calls. Additionally, because the CLEC will route a large percentage of its traffic to the ILEC's tandem switch, it will face the potential for operational impairments such as inadequate subtending trunking from the ILEC's tandems to its end offices (See Exhibit RVF-9).

VI. CONCLUSION

Q. CAN THE FUNDAMENTAL CHARACTERISTICS OF THE EXISTING SINGLE-USE ILEC NETWORK BE MITIGATED WITHOUT TECHNOLOGICAL CHANGE?

A. No. Until the underlying local network architecture that has created these impairments is changed, CLECs will continue to face significant practical and economic impairments in serving mass market end-users on ILEC loops *via* their own switches.

Q. PLEASE SUMMARIZE THE CRITICAL ISSUES YOU DISCUSS IN YOUR TESTIMONY.

A. The critical issue of this proceeding is not whether CLECs can "deploy" their own switches. Instead, the critical issue upon which this Commission should focus is whether a CLEC can "efficiently use" its own switch to connect to the local loops of end users. The differences in the way end users' loops are connected to carriers' switches are among the most important factors that cause CLECs to face substantial operational and economic entry barriers when they seek to offer POTS to mass-market (residential and small business) customers using their own switches and ILEC-provided loops (i.e., UNE-L facilities-based entry). The barriers to which I refer relate primarily to the requirements that CLECs backhaul UNE-L traffic from the serving ILEC wire center to the CLEC switch.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, at this time.