Everyone Wants Broadband

Meeting the Consumer Demand for DSL

Prepared by

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Executive Summary

As the explosive growth of the Internet and online multimedia content have driven the need for higher-speed network access, much of the industry's focus has turned to broadband solutions for the so-called "last mile" to end-user locations. Digital Subscriber Line (DSL) access solutions leverage existing physical connections that already cover a large number of user locations. By utilizing the ubiquitous copper loops that provide end users with POTS (Plain Old Telephone Service) over the Public Switched Telephone Network (PSTN), DSL technology has the potential to reach nearly every household with telephone service.

DSL offers significant technical advantages, such as consistent service levels and excellent network security. However, DSL providers are faced with a major dilemma in trying to capitalize on the POTS infrastructure because only portions of the telephone network actually are equipped to support DSL services. Issues such as the distance of each subscriber from the nearest Central Office (CO) and the economic challenges of deploying large-scale DSL systems in all COs have posed barriers to full market penetration of DSL services. In addition, the telecom industry's continuing migration from large Central Offices to smaller Digital Loop Carrier (DLC) remote terminals poses special challenges for economical DSL deployment.

Most of these technology barriers arise from the fact that DSL has been deployed as an "overlay" to the voice network, rather than an integral part of it. Such a data overlay network is satisfactory for the deployment of niche, business-oriented services, but it is not scalable for consumer mass-market deployment. In reality, the huge growth and importance of data services calls for a fundamental shift in thinking that instead treats DSL as an integral aspect of a new *converged access architecture* for seamlessly delivering both voice and data services.

As this white paper will discuss, new solutions from Catena Networks will provide for the rapid and economical deployment of a converged access architecture. Catena has introduced a highly integrated POTS+DSL linecard solution to address subscribers served from existing remote terminals. It also is developing a new class of access vehicle, the Broadband Loop Carrier (BLC), which will provide full availability of POTS+DSL on every port and enable line-by-line access network convergence.

Market Trends in DSL Broadband Access

From the subscriber viewpoint, DSL represents an attractive solution for leveraging existing telephone twisted-pair infrastructure to deliver download speeds from 384 kbps to as high as 8 Mbps. As consumer awareness of DSL has grown, the demand has become insatiable.

According to market research firm RHK, the high-speed DSL Internet access market is expected to grow 128 percent per year through 2003. Still, more than 40 percent of residential subscribers do not qualify for DSL service because they do not meet specific connection criteria or because deployment hasn't kept pace with demand in their area.

With more than 880 million phone lines already installed worldwide and more than 60 million new lines being added each year, the potential reach for DSL dwarfs other broadband access technologies. However, to capitalize on that potential, the fundamental limitations of the existing infrastructure must be overcome.

Limitations of the Current POTS Infrastructure

DSL is emerging with the promise to become a volume service, but service providers must be able to make DSL as ubiquitous and affordable to subscribers as POTS service is today. For DSL to become a mass-market service, service providers must have access to new network architectures that increase flexibility for deployment and line provisioning, while simultaneously reducing both capital and operational costs.

For the past 100 years, POTS has been the foundation of the public telephony access network, providing volume voice services and ubiquitous access. However, POTS is based on a Time Division Multiplexed (TDM), circuit-switched structure that was originally designed for carrying analog voice traffic and is rapidly reaching its limits. Today's DSL access network has been designed as an overlay to the TDM voice network. Treating DSL as an overlay to POTS not only requires additional investments in specialized DSL equipment; it also restricts the smooth scalability and flexible deployment/provisioning of DSL services.

The current Digital Subscriber Line Access Multiplexer (DSLAM) overlay architecture being deployed in Central Offices consists of the incumbent's POTS switch, mechanical POTS splitters and the data affiliate's or competitive carrier's DSLAM. (see Figure 1).

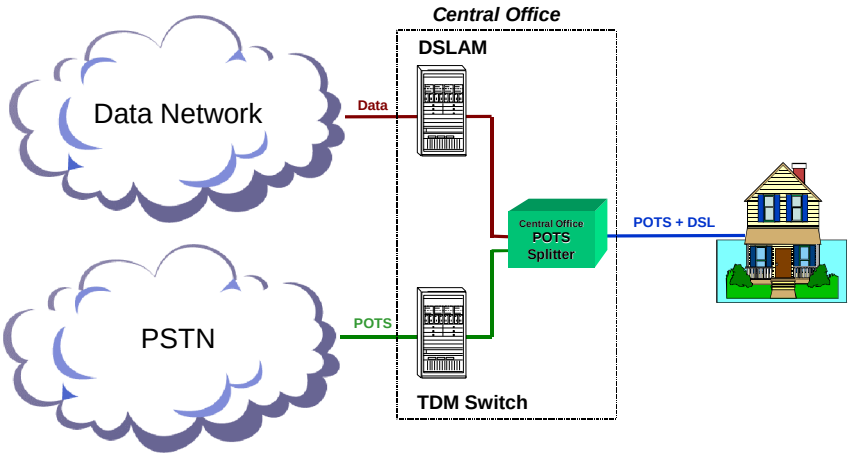

Figure 1 - Current DSL deployment model in Central Office

Although this overlay deployment model has provided a way for leveraging DSL into the existing volume POTS infrastructure, it is destined to be little more than an interim solution.

Shortcomings of current overlay DSLAM deployment model:

- It is not operationally efficient
- It is not generally extendable to Remote Terminals (RTs)
- Due to the use of POTS splitters, there is stranded and lost spectrum and bandwidth

Critical Deployment Objectives for Full DSL Availability

Ultimately, carriers must focus on providing full DSL availability, rather than pursuing a limited number of niche opportunities. For DSL availability to become as ubiquitous as POTS, carriers must implement an economically viable, converged access architecture that enables volume DSL deployment to all subscribers. In order to successfully deploy volume DSL services, service providers will need to have advanced network solutions that can address the following major objectives:

Satisfying Escalating Consumer Demand for DSL Service

Service providers are equipping Central Offices and deploying DSL service as quickly as they can. According to Telechoice, nearly 1.4 million DSL subscribers in North America were in service by mid-year 2000. DSL deployment in the U.S. grew nearly 60 percent in the second quarter and has more than doubled since the beginning of the year. However, the vast majority of subscribers are still unable to get DSL. This is either because they do not qualify (subscriber serving area is not DSL ready), or because they are waiting in a service provider's backlog, as deployment fails to keep pace with demand.

Solutions for full DSL availability must enable rapid deployment and provisioning and must be highly scalable to meet the current and growing demand.

Handling Growing Numbers of Users Served from Remote Terminals

According to the market research firm RHK, the installed base of DLC remote terminals serves about 35% of the loops deployed in today's network. Service providers are currently deploying more than 60% of new lines from RTs, and RHK predicts that within 3 years, more than 50% of all subscribers in the U.S. will be served from RTs. Network trends indicate that service providers will continue to deploy fiber closer to subscribers and that RTs will become the Central Office of the future.

Solutions to enable full DSL availability must solve the current difficulties associated with volume DSL deployment from remote terminals.

Laying a Foundation for Converged Voice & Data Network Access

The growth of the Internet has resulted in data traffic exceeding the volume of voice traffic on today's public telephone network. Service providers have been forced to significantly grow the capacity of their TDM networks to accommodate the long hold times from data calls, without the benefit of incremental revenue.

As a result, service providers are planning to displace the legacy TDM, circuit-switched infrastructure with a new converged, packet-based network — a single network infrastructure for delivering integrated voice/data services.

Solutions for full DSL availability must enable service providers to migrate gracefully to a converged, packet-based network.

Developing Highly Integrated POTS+DSL Solutions for Remote Terminals

Catena Networks is now enabling carriers to take the first major step toward offering full DSL availability through the creation of new, highly integrated POTS+DSL solutions for remote terminals.

The first wave of DSL deployment was concentrated in Central Offices because COs generally offered sufficient collocation space and power to accommodate DSLAMs for multiple service providers. COs also provided controlled accessibility for servicing, configuring, etc. In contrast, DLCs are typically located at the edges of neighborhoods in small, outside plant cabinets, huts or even mounted on poles. In the majority of these deployments, there is insufficient space to accommodate overlay DSL equipment. In addition, the Subscriber Access Interface (SAI) is not always collocated with the remote DLC equipment, thereby requiring non-standard wiring methods to gain access to subscriber loops and making it more complex to interface DSL overlays.

Trying to overlay DSL on existing DLC installations can result in unacceptably high start-up costs, such as installing new cabinets, pouring pads, adding power, and even acquiring additional rights-of-way for expansion. In addition, because DLCs typically serve smaller areas with fewer subscribers than COs, the economics of adding significant costs are harder to reconcile. Because these high costs require a certain market penetration level to justify the investment, many neighborhoods served by DLCs simply have been deemed as unfeasible for deploying DSL.

From-the-Ground-Up POTS+DSL Integration

Catena's new, integrated POTS+DSL linecard solution for upgrading existing DLC systems overcomes these issues by integrating POTS and DSL into a single access termination point. As opposed to coming at the problem from an "overlay" perspective, the Catena approach is based on the integration of POTS and DSL on every subscriber line.

At the silicon level, the DSL modem and POTS line-termination functions are merged into a single universal front-end, which then allows the rest of the design (DSP, line drivers, etc.) to be structured around a common data path that minimizes cost, power and size. In the Catena architecture, the need for POTS splitters is completely eliminated because the device itself uses a patented "full spectrum connectivity" scheme to terminate the entire loop and monitor the full frequency range from 0 KHz to 1.1 MHz.

Other providers have attempted to combine POTS and DSL by building a POTS data path and a DSL data path onto the same card, with a POTS splitter at the front-end. Catena's solution integrates all POTS and DSL line functions – and all multiplexing, ATM and uplink functions – into silicon. As a result, Catena Networks delivers converged POTS+DSL ports at the same or better densities than competitors' POTS-only platforms.

Standards-Compliant POTS+DSL Linecard Building Blocks

Catena's integrated POTS+DSL linecards enable service providers to quickly and easily upgrade the large installed base of DLCs for DSL service. The upgrade involves a simple card-for-card replacement of existing POTS linecards with integrated POTS+DSL linecards resulting in full DSL capability without any loss of POTS port capacity. The architecture depicted in Figure 2 illustrates the simple and elegant solution that is enabled by integrated POTS+DSL linecards.

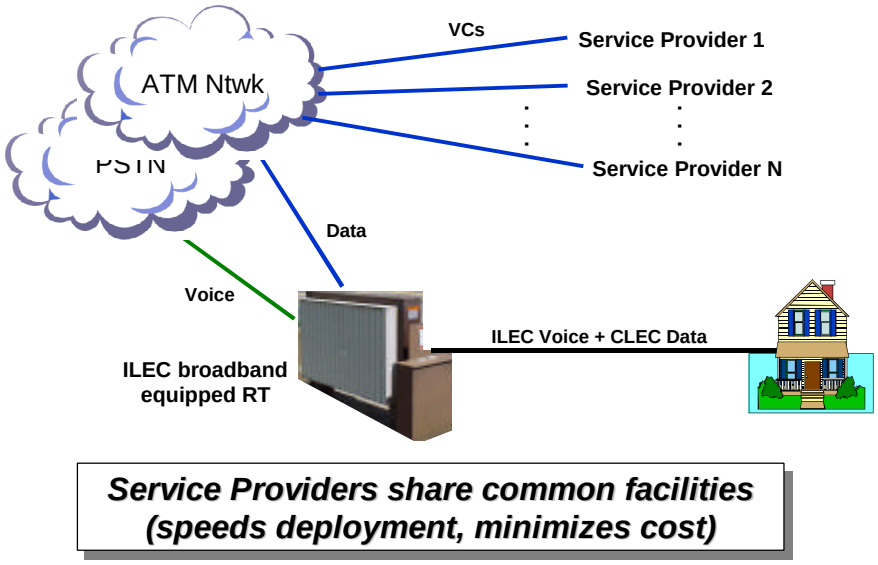

Figure 2 - DSL Deployment Model for Digital Loop Carriers

The integrated POTS+DSL linecards fit directly into existing DLC linecard slots. DSL gains access to the POTS loop appearance, thus eliminating any complex and time-consuming wiring to the protection block, SAIs, POTS splitters, etc. In addition, the integrated POTS+DSL linecard eliminates the need for incremental equipment, incremental cabinets, larger cabinets, pouring new pads and all the issues related to overlay solutions.

The POTS service remains intact and the voice traffic continues to be backhauled to the Central Office over the existing POTS transport infrastructure. There are no changes or impact to the existing ILEC voice operations, maintenance or procedures.

The DSL traffic is directed to a new, common ATM network interface card, placed in an available slot with backplane access to each linecard. The DSL traffic is aggregated on the ATM card and interfaces to the carrier's transport system via T1s or DS-3.

The DSL traffic is backhauled to an Optical Concentration Device (OCD) at the Central Office. The DSL traffic is unbundled at the OCD and available to the data affiliate and competitive carriers via virtual circuits (VCs).

Evolving to Broadband Loop Carrier (BLC) Systems

In addition to its solution for upgrading existing Digital Loop Carrier systems, Catena is developing new-generation Broadband Loop Carrier (BLC) systems that are fully optimized for mass-market deployment of volume POTS and DSL services.

Catena's Broadband Loop Carrier efficiently provides POTS+DSL on every subscriber line and enables a line-by-line migration to a converged packet-based network architecture. By enabling POTS+DSL on every single line in the system, Catena's BLC will empower service providers to deliver broadband services on a mass-market basis, at costs approaching POTS-only services.

Because both POTS and DSL are available on all lines in the system, the BLC architecture greatly reduces the cost, time delays and hassles that have traditionally been associated with provisioning DSL services. When a subscriber orders DSL service, the entire provisioning process can be conducted remotely with nothing more than a software update. No expensive "truck rolls" are needed.

Enabling the Converged, packet-based Public Network

By efficiently addressing the merger of POTS and DSL at the linecard level, the Catena BLC architecture elegantly moves the packet-based network as close to the individual subscribers as possible. The Catena BLC architecture is optimized for TDM, ATM and IP traffic, allowing the service provider the flexibility to migrate traffic on a line-by-line basis, in order to maximize operational efficiencies.

Catena's BLC system makes it easy for carriers to decide where and how to implement their service-convergence strategies. In addition, the BLC's inherent flexibility, software programmability and universal support for both POTS and DSL give service providers total control over forward migration of their service strategies, without requiring wholesale network redesign or fork-lift equipment replacement along the way.

Catena Networks Corporate Overview

Mission and Philosophy

Catena Networks' primary mission is to enable full DSL availability and to "Create the New Access Architecture for the Converged, packet-based Public Network." By approaching these objectives with a philosophy of elegant, converged designs that are built from the ground up, Catena Networks avoids the discontinuities of overlays and sub-optimal compromises that have plagued previous attempts at service convergence.

Core Competencies and Corporate Strengths

Headquartered in Redwood Shores, Calif., Catena Networks is a privately held corporation with its research and development operation in Kanata, Ontario, Canada (near Ottawa). The company has more than 240 employees, including 200 engineers – each averaging more than 10 years of telecommunications experience.

Catena's founding team previously developed nearly all of Nortel Networks' mass-market, copper-loop solutions. These solutions include the World Line Card, Nortel's highest volume POTS linecard – with more than 150 million lines in service worldwide – and the 1-Meg Modem, Nortel's pre-ADSL modem solution.

Further, all of the company's solutions have been designed for full compliance with all relevant standards and are rigorously required to meet five-9's uptime and reliability requirements.

The bottom line is that Catena Networks' integrated POTS+DSL solutions enable carriers to meet consumer demands for full DSL availability. In addition, these highly integrated POTS+DSL solutions are launching a whole new generation of access vehicles: Broadband Loop Carriers. These new BLC systems from Catena will provide both an elegant and cost-effective architecture for enabling service providers to drive fiber closer to subscribers and merge POTS and DSL in advanced, packet-based public access networks.