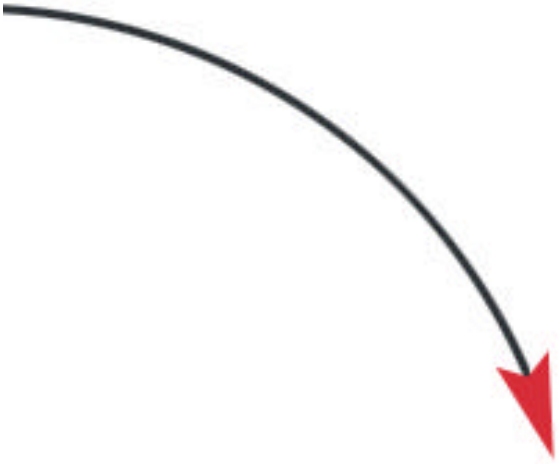

Deploying Profitable DSL Services

Reaching 100% of All Subscribers to 18,000 feet and Beyond

PARADYNE

ALCATEL
MICROELECTRONICS

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The Case for ADSL/R™

Introduction

Deploying DSL with *consistent* levels of service is one of the greatest challenges broadband access providers have to deal with. Issues such as outside plant impairments, long loops, interference, and premises wiring problems result in less subscribers served and in an increase in operational expenses. Because of this, many service providers are complementing their ADSL service with Paradyne's ReachDSL™ solution to overcome these deployment difficulties and fill in the coverage gaps.

Key Findings

- Unexpected deployment costs continue to affect DSL service profitably
- Coverage gaps still occur even on loops that are pre-qualified
- Difficult installs are due to loop plant disturbers, interference, and premises wiring issues

The new ADSL/R solution that is being jointly developed by Paradyne and Alcatel Microelectronics combines these technologies into a new generation of ADSL chipsets. Complementary to ADSL, ReachDSL technology was designed to overcome typical DSL deployment obstacles such as poor copper conditions, long loops, interference, and in-premises wiring problems. Consequently, the new dual mode ADSL/R solution extends the capabilities of ADSL chipsets, allowing service providers to dramatically expand their service offering and optimize the business case for broadband access by generating more revenue that is profitable.

The ADSL/R solution features an automatic mode selection that enables the dual mode ADSL/R modem to automatically select the best operating mode between ADSL and ReachDSL technologies. As a result, the end-user will be offered the best DSL service, while avoiding unnecessary service calls, and eliminating the need to inventory two types of modems. The automatic mode selection feature will reduce the operational expenses associated with broadband deployment.

In addition, ADSL/R technology has inherited the symmetric capabilities of ReachDSL technology. Forcing an ADSL/R subscriber line to run in the ReachDSL mode can activate this symmetric capability. Since the ReachDSL mode can share the line with POTS, it lends itself very well to residential, SOHO, and small business symmetric applications.

ADSL/R technology extends the footprint of DSL by filling in the service gaps and allows for greater utilization of the service provider's network assets by leveraging existing ADSL platforms.

Preventing Problems is Easier Than Solving Them

Overcoming deployment obstacles is the key to successfully rolling out profitable broadband services. Some of these barriers to smooth provisioning are readily identifiable, such as long copper loops – unfortunately, most are not.

The challenge for service providers to make broadband access business cases work is to identify and overcome provisioning issues *before* an installation attempt is made. After all, as the old saying goes, "an ounce of prevention is worth a pound of cure." Although broadband providers have become better at pinpointing the neighborhoods that have a high probability of successful installations, large gaps in coverage still occur, limiting the number of subscribers that qualify for service.

Every time an unexpected problem occurs, several possibilities come into play, depending on the service provider. They include dispatching a technician to modify the loop, rewiring the customer premises, or denial of service altogether to the subscriber. These will cause an installation to

become unprofitable, or worse; will result in the loss of future revenue. Too many of these problems in a service area cause the entire business case to become marginal.

These craft difficulties can by far be the most expensive part of the cost of providing broadband service on a per-subscriber basis. The costs associated with dispatching a service technician to solve a problem on the loop or in the premises represent significant operating expense. They fall into three major categories:

Outside plant impairments – bridged taps, stray (single) load coils, untwisted drop wire, changing environmental factors such as temperature fluctuations and moisture, and long loops over about 12,000 feet (3.5 km);

Interference and disturbers – radio interference such as AM and crosstalk from T1/E1 lines in a nearby cable binder, as well as crosstalk from DSL;

Premises issues – wiring issues such as untwisted pairs and unterminated telephone jacks (bridged taps) as well as noise ingress from AC lines and common household devices such as light dimmers, hair dryers, and fluorescent lights.

The key is coverage – extending service to the entire addressable market of service providers, by filling in *all* the gaps inside the service area or well beyond it.

Targeting the Unserved

Pre-qualifying subscribers keeps provisioning and premises installation problems to a minimum by restricting which customers get broadband service. However, if the qualifications rules are too limiting, then the percentage of customers able to be offered DSL based services can drop well under 50% of the number people that want it. On the other hand, loosening the rules may increase coverage to 80% or more, but the number of difficult installations resulting in truck rolls will increase, adding to the operational costs.

Key Findings

- The real number of unserved customers is as high as 30% - 50%
- Subscribers that can't get DSL *will* turn to other types of access
- Losing customers will lead to lost future revenue opportunities
- DSL customers spend more on high-margin calling features than the average user

In either case, even when on paper the subscriber appears to easily qualify, there will always be unexpected coverage gaps and difficult installations that require truck rolls and loop plant upgrades. These loops that appear to be "qualified" but cannot be provisioned are called 'false positives' and are most troublesome installations since the customer expects service, yet attempts to bring up the line fail. A technician then has to be dispatched to determine and correct the trouble, but even then, the customer is not guaranteed service.

In far too many instances, today's pre-qualification rules result in a large number of wireline subscribers that are either automatically excluded from DSL based service offerings or have a high probability of requiring truck rolls. The outcome is a large subscriber base that can not be served by DSL and thus the creation of an unserved market that is estimated to range from 30%[1] to as much as 50%[2] worldwide. This results in the loss of future revenue streams and opens these subscribers to competitive data and telephony services, particularly from cable providers.

There are two consequences of difficult or restrictive service deployments:

1. Increased operational expense issues due to the outside plant disturbers, interference, and premises issues described above, and

[1] Broadband 2001: A Comprehensive Analysis of Demand, Supply, Economics, Industry Dynamics in the U.S. Broadband Market. A joint study by McKinsey & Company and JPMorgan H&Q, April 2, 2001.
[2] 2001 North American xDSL Market Forecast. RHK, February 21, 2001.

2. Not offering broadband to these subscribers represents a huge lost revenue opportunity from existing customers that today are telephony-only subscribers.

Not reaching all subscribers who want DSL service will cost service providers in terms of customer churn and lost current and future revenues. For example, current voice customers that can't get DSL service may end up using a competitive broadband offering and eventually will be enticed to use alternative local, long distance, and content services. The result is not just the loss of monthly broadband, local and long distance revenue from these customers, but also the loss of revenue from current users of popular high margin enhanced calling features including:

- Call waiting;
- Caller ID;
- Call forwarding;
- Voice mail.

The lost revenue potential from broadband content and value-added services that will never be provided to subscribers that switch to competitive offerings from other providers is large. Studies have shown that the penetration rate for advanced services is higher among broadband service users than the average for the entire customer base – as much as 65% versus 30% respectively.[3] Thus, losing even 5% to 10% of these customers will have a disproportionate impact on revenue streams and margins.

Improving the amount of revenue generated per customer and overall revenue mix is crucial for profitability goals and reducing customer churn. Increasing competition in the local and long distance markets along with the competition for higher margin value-added services requires service providers to create greater value from the existing customer base. Ignoring the 30% to 50% of customers that are difficult to reach will cost service providers in terms of customer churn, lost revenues and lower profit margins, today and in the future.

Increasing Coverage Economically with ADSL/R Solutions

The above pre-qualification and provisioning issues describe the two major problems facing DSL access providers when addressing their customer base:

- They have a large group of unserved customers, because those customers are connected to long or impaired loops;
- They have a substantial group of served customers within the stated service area, for which provisioning was/is troublesome due to mostly unexpected impairments, which may in the end lead to sub-par service or customer abandonment.

The ADSL/R solution targets these unserved subscribers, as illustrated in Figure 1, by providing a dual mode DSL platform combining Alcatel's market leading standardized ADSL technology with Paradyne's patented ReachDSL technology. In this way a DSL solution is deployed that is more robust against loop impairments, can handle longer loops, and that maintains the ADSL bandwidth capabilities.

ADSL/R technology combines ADSL and ReachDSL technologies into a single chip that automatically selects the best mode of operation for each loop. The Auto Mode feature allows service providers to avoid the issues of selecting the right DSL transceiver or modifying the loop

[3] BellSouth has said that its penetration of calling features was 30% for the entire consumer customer segment but 65% for customers that have DSL service. Fat Pipe Magazine, September 2001.

on a subscriber-by-subscriber basis. Installing ADSL/R solutions help to ensure that a consistent level of service covers the entire market area by overcoming or minimizing the impairments that other types of DSL cannot perform against.

Dual mode ADSL/R technology transparently fills the coverage gap and extends ADSL performance, allowing guaranteed operation on all non-loaded loops or stray load coil loops. This will keep operational costs of DSL deployments in check and will allow DSL to cost effectively scale to the market's demand.

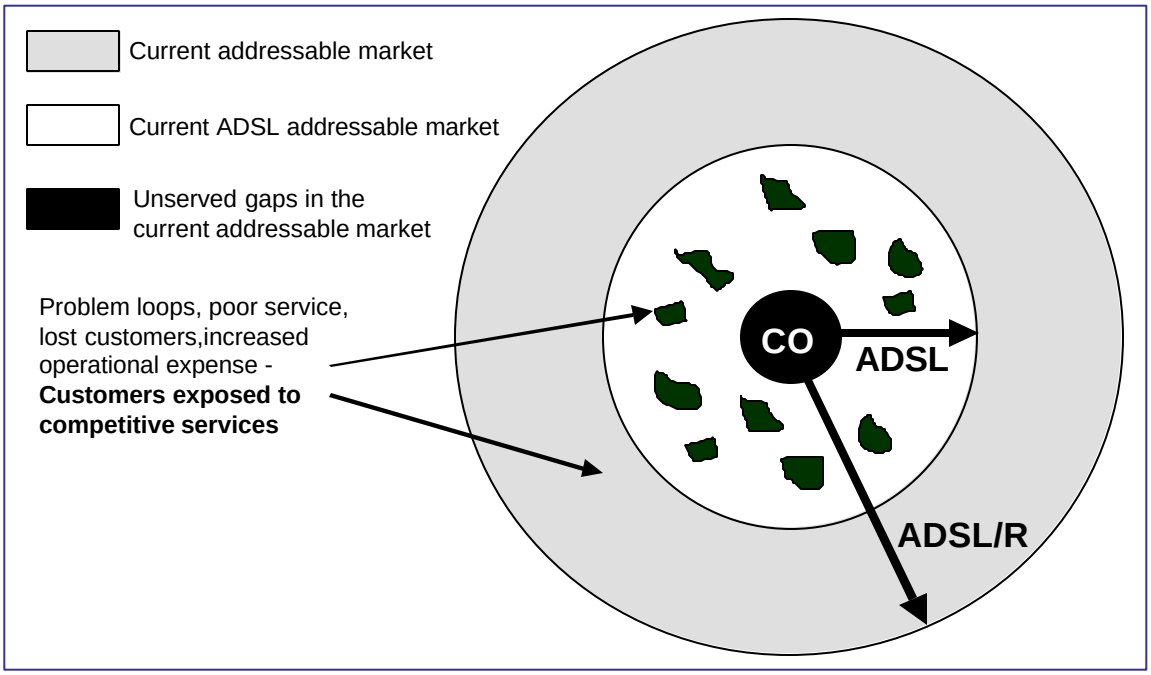

Figure 1: The extended coverage offered through ADSL/R

Covering 100% of the Addressable Market

As stated earlier, the key to the successful roll out of DSL-based services centers on covering the entire service area or potential addressable market as seamlessly as possible. Otherwise, the costs associated with dispatching a service technician to solve a problem on the loop or in the premises will represent significant operating expense.

Although ADSL can deal with loops of up to 18K ft (5.5 km), service providers can only reliably provision ADSL on loops of up to 13K ft (4 km) or 14K ft (4.3 km). Beyond this range, loop impairments and disturbers often cause low quality connections or prohibitive provisioning costs. The ADSL/R solution resolves these problems. Inside this range, unexpected gaps in service coverage typically appear. When short heavily impaired loops are encountered, they will most probably operate in the ReachDSL mode. In such situations, the expected data rates of the ReachDSL mode are commonly 768 Kbps, downstream and upstream, or better.

For each loop, ADSL/R will select the service mode (ADSL or ReachDSL) that offers the best performance on that loop. In practice, this means that most loops below 12K ft (3.7 km) will run in the ADSL mode, while most loops above 15K ft (4.6 km) will run in the ReachDSL mode. The 12K to 15K ft range will be a mix of ADSL and ReachDSL operation.

ADSL and ReachDSL together allow all subscribers to be served more economically, regardless of the impairment or type of interference. Combing these technologies into a single ADSL/R solution solves two very real problems for service providers – expanding coverage to all possible subscribers and reducing operating costs. As a result, ADSL/R:

- Substantially grows the addressable market;
- Reduces install process complexity and lowers support staff sizing requirements;
- Reduces churn, accelerates revenue growth, generates greater profits;
- Fully leverages the existing ADSL service infrastructure, network model, and OSS systems and;
- Simplifies the retail distribution of CPE.

Attributes of ADSL/R Technology

ADSL/R leverages the lower frequency operation of ReachDSL in those circumstances where the wider frequency benefits of ADSL can not be realized.

Standard ADSL operates in the downstream frequency range from about 160 kHz to about 1.1 MHz that allows it to offer a wide range of bandwidth capabilities (up to 8 Mbps downstream). ReachDSL technology, on the other hand, has its passband frequency range from about 25 kHz to less than 120 kHz for unrestricted deployment. This lower frequency operation and advanced modulation employing up to 16 bits per symbol allows for data rates to 2.2 Mbps, upstream *and* downstream, and offers better resilience against the detrimental effects of significant loop impairments. Figure 2 compares the energy spectra of ADSL, ReachDSL, and G.shdsl technologies.

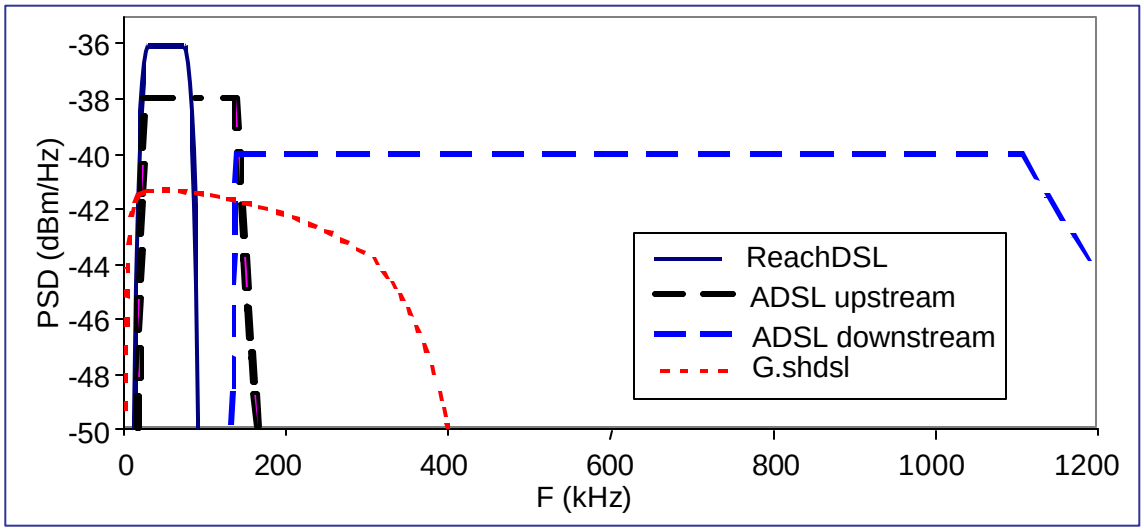

Figure 2: Comparing DSL Frequency Characteristics

It is well known that an efficient transceiver design operating in the lowest frequency spectrum improves loop performance by substantially decreasing or even eliminating the effects of impairments. For instance, as the operating frequency required by a DSL technology decreases:

- *Crosstalk coupling decreases significantly* by about 15 dB per decade. By operating in the lower frequency spectrum, ReachDSL technology is affected much less by crosstalk than other DSL technologies;
- *Loop loss (attenuation) improves significantly*;
- *Bridged tap effects become less pronounced*. In fact, short bridged taps (500 feet is average in North America) have little to no effect on ReachDSL performance;
- *Radio frequency interference (RFI) decreases or is eliminated*. For example, RFI from AM radio (550 kHz to 1200 kHz in most countries) has absolutely no effect on ReachDSL technology;
- *Premises wiring infrastructure problems become less pronounced*. Poor balance, and little or no twists in the wiring that is problematic at higher frequencies, is not nearly as harmful at lower frequencies.

The above five factors minimize configuration and deployment problems, which lowers the operating costs associated with difficult deployments. They also enable DSL services to the full 18kft. coverage range. Figure 3 shows measured performance results for the ReachDSL technology over 26 gauge (0.4 mm) wire.

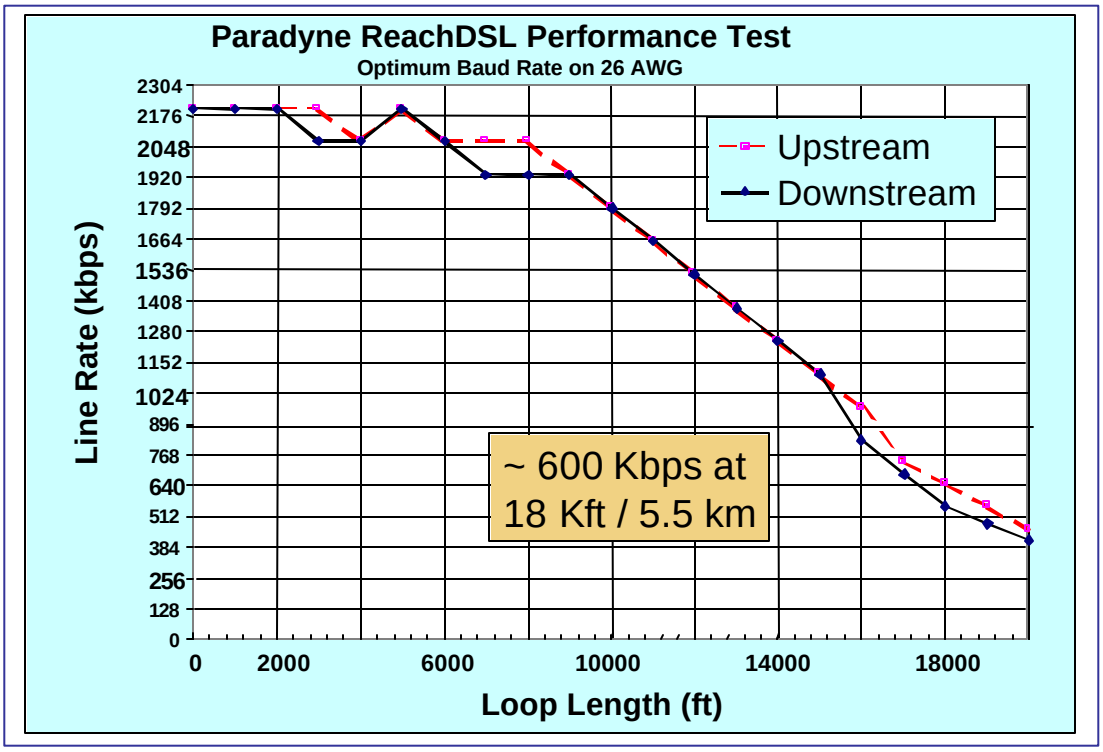

Figure 3: ReachDSL Technology Performance Characteristics

Figure 4 shows the rate-reach performance of an ADSL/R modem over a 26 AWG loop without impairments or noise. The ADSL/R performance is given by the upper envelope of the ADSL and ReachDSL performance curves. Due to its higher reach and robustness ADSL/R will also outperform traditional ADSL modems when noise and loop impairments are present.

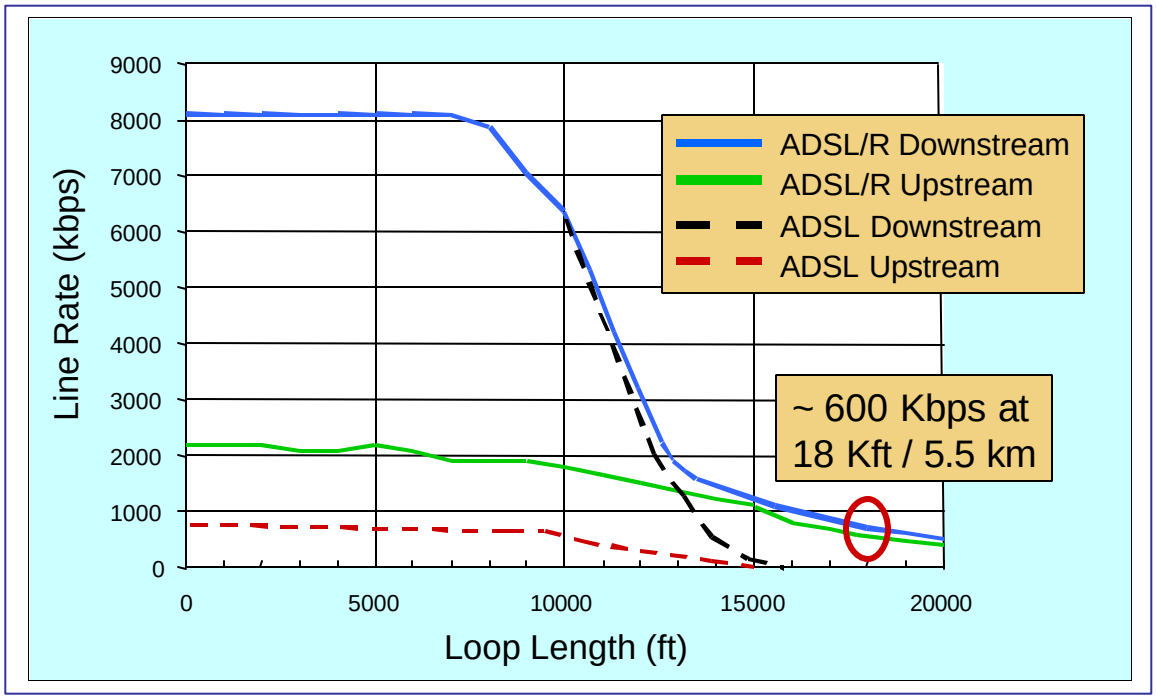

Figure 4: ADSL/R Technology Performance Characteristics

Operation in the lower spectrum also results in lower power requirements due to less attenuation. In essence, ReachDSL technology has the lowest power consumption among all DSL alternatives.

In addition, Alcatel Microelectronics' market leading ADSL technology has the lowest power consumption per line compared to all other ADSL chip vendors. Therefore, the combination of low power ReachDSL technology with the lowest power ADSL solution in the market creates a very power efficient ADSL/R solution. Reduced power dissipation is important to improve port densities, leading directly to more efficient and cost effective scaling in Central Offices (CO) and digital loop carrier (DLC) remote terminal cabinets.

Deploying with Existing DSLAM and Remote Terminal Systems

Current DSL platforms can easily be equipped with ADSL/R technology through the insertion of new line cards that carry ADSL/R CO chipsets. Such line cards are similar to the existing ADSL line cards.

Existing splitter topologies remain in effect and the power requirements of ADSL/R technology compare favorably to ADSL-only deployments, which makes higher port densities possible. In fact, if several of the ports are operating in the ReachDSL mode, the overall power dissipation of the line card would be less than in an ADSL-only operation.

The Management Information Base (MIB) of ADSL/R technology is designed to be compliant with the DSL Forum requirements for the ADSL MIB, meaning that existing element managers will be able to readily manage ADSL/R modems. Element managers that are made 'ADSL/R aware' will offer extended capabilities, such as forced mode selection in addition to automatic mode selection thus enabling a service provider to tailor ADSL/R technology to their specific service needs.

In addition, ADSL/R solutions work well where remote subscribers are traditionally served by the installation of remote DSLAMs, remote mini-RAMs or next generation broadband DLCs. All these solutions require the installation of critical and expensive equipment in the outside loop plant and access to fiber feeders for back-hauling the DSL traffic from the access multiplexers. Such solutions allow DSL access providers to offer ADSL services to remote users, but their deployment is expensive and their pay back period will usually exceed the payback period of CO based solutions.

With ADSL/R technology, broadband services can be deployed to most of the subscriber base from the CO, thereby allowing for a more economically feasible deployment of remote solutions. ADSL/R technology is not a replacement of remote DSLAM/DLC solutions but an enabler. ADSL/R solutions allow for a more precisely controlled capitalized upgrade of the loop plant. In other words, DSL provisioning and roll out plans can be de-coupled from planned loop plant upgrades.

By servicing remote subscribers, initially from the CO through ADSL/R enabled equipment, operators can first create an active DSL subscriber base before deploying remote equipment.

Spectral Compatibility

The ADSL/R solution marries two spectrally compatible technologies, as established by a combination of conservative design, standards-based worst case analysis, and extensive field and laboratory testing. ReachDSL technology was designed to be compatible with all continuous transmission and non-stationary transmission systems.

ReachDSL technology was designed for high ADSL spectral compatibility by applying criteria significantly beyond the minimum requirements established by existing spectrum management standards such as T1.417. Worst-case analysis using standards-based methodology[4] establishes ReachDSL's spectral compatibility with all basis systems, including ISDN, G.shdsl, HDSL, HDSL2, 2B1Q SDSL, DDS, ADSL, and voice grade services.

Finally, extensive hardware-based testing has been done to evaluate the compatibility of ADSL and ReachDSL technologies in the same binder. Measured results demonstrate that ReachDSL and ADSL systems coexist extremely well and that ReachDSL is more compatible with ADSL than most other DSL technologies such as ISDN.

The ADSL/R Business Case – Beyond Total Cost of Ownership

The goal seems simple – expand broadband coverage while keeping operating expenses under control. However, the reality is different. Service providers strive for a self-install success rate of 95% or better in order to keep truck rolls and other operational costs down. To make this happen, loops are pre-qualified for DSL service.

Unfortunately, service denial of certain loops cannot solve the overall problem. In fact, it creates a larger problem. While it may improve the success rate of self-install it does that by creating an unserved market. Intentionally limiting the addressable market constrains the broadband business case making it difficult to achieve financial goals and exposing the current voice customer footprint to competitive entry.

Gaps in service coverage will still occur on lines that have been pre-qualified. Trying to deploy DSL services without knowing where these gaps are can be costly. Issues, ranging from

[4] Method B analysis, ANSI T1.417.

inadequate house wiring, stray load coils, to radio frequency interference as well as loop and noise conditions that change over time, still arise that will cause a technician to be dispatched.

Eliminating these gaps and economically expanding service to the current full voice footprint generates new revenue in the short term *and* prevents existing users of basic telephone service from defecting to a competitive service provider, such as cable.

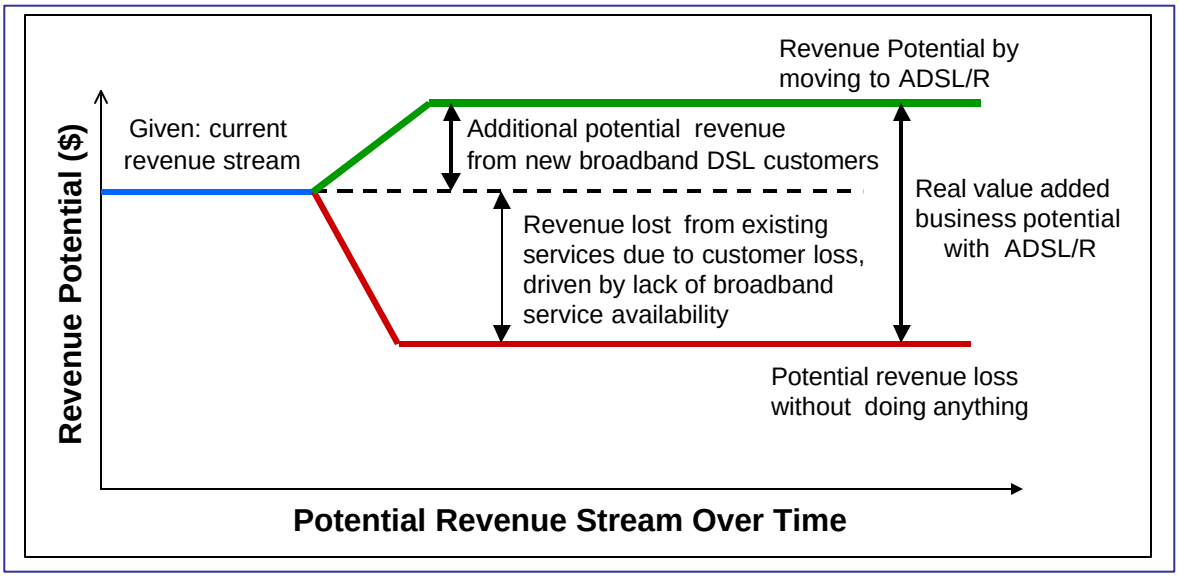

Figure 5: The impact of ADSL/R deployment on service provider revenue

If the subscriber cannot get service from the incumbent provider, they will sign up for cable service, and may eventually switch local and long distance services. Add to this the loss of other high margin services such as call waiting, voice mail, and future broadband content. Figure 5 illustrates the dual impact and full potential of ADSL/R on the revenue of a DSL service provider: increased revenue due to extended coverage and less revenue loss from existing services due to customer churn.

Key Findings

- The ADSL/R solution increases DSL coverage to the entire addressable market
- The ADSL/R Auto Mode feature automates the provisioning process and results in fewer infrastructure upgrades, truck rolls, and lower overall operating costs
- Increased coverage and customer satisfaction will result in greater revenue *and* profits

Service providers that take advantage of ADSL/R solutions cannot only greatly improve the revenue side of their business but also the cost side. The highly increased likelihood of successful DSL service delivery, results in fewer infrastructure upgrades and truck rolls, lowers overall operating costs, and increases customer satisfaction. In many cases the cost savings introduced by ADSL/R will be sufficient to justify the business case for the roll-out of ADSL/R.

Conclusion

Alcatel Microelectronics and Paradyne have joined forces to bring a new and innovative solution to the market. ADSL/R technology's effect is where it matters most, the bottom line. It significantly augments the broadband business case by growing the revenue line and reducing the expense line. The results are a higher quality customer base thus improving future marketing efforts to generate higher margin advanced services, reduced

customer defections and greater service quality. ADSL/R technology is designed with the current ADSL installed base in mind and ADSL/R modems can readily be integrated into the existing DSLAM and remote terminal footprint.

In addition, ADSL/R technology offers the best rate reach performance in the market at the lowest power consumption, making it a forward looking solution that solves many of today's problems.

About Alcatel Microelectonics

Alcatel designs and manufacturers leading-edge system-on-chip (SoC) solutions for telecom equipment manufacturers, various application-specific standard products (ASSPs) and application-specific integrated circuits (ASICs) for automotive and peripheral customers. Alcatel is the number one supplier of ADSL chipsets worldwide and is the fourth largest semiconductor supplier in Europe, with 28 offices worldwide. More information about Alcatel's semiconductor solutions can be found at http://www.alcatel.com/microelectronics.

About Paradyne

Paradyne is a leading developer of carrier-class, high-speed network access solutions. A recognized market leader in digital subscriber line (DSL) and service level management (SLM) solutions, Paradyne markets its award-winning GranDSLAM™ and BitStorm™ DSL systems, ReachDSL™ and EtherLoop™ products, and FrameSaver® Service Level Management systems to service providers and business customers worldwide. More than 20,100 GranDSLAM DSL Access Multiplexers have been deployed around the world. Paradyne has shipped over 296,000 ports of its unique ReachDSL solution, giving carriers the ability to deliver broadband over almost any copper line, even those that are very long or severely impaired. The leading carriers, including AT&T, Bell Canada, Broadwing, SBC, Sprint, Verizon, and WorldCom, have deployed Paradyne's SLM solutions into mission-critical enterprise networks.

Paradyne is headquartered in the Tampa Bay area. More information is available by calling 1-800-PARADYNE (U.S. and Canada), 1-727-530-8623 or visiting http://www.paradyne.com.