With the right tools and a bit of know-how, virtually any technician can perform an asymmetric digital subscriber line (ADSL) service installation. This document is designed to simplify the job, providing an introduction to DSL technology, a step-by-step overview of the installation process, as well as valuable guidelines for troubleshooting. Since each carrier is likely to have different deployment strategies and procedures, the purpose is to provide background information and review conventional installation practices. The illustrations and explanations are intended to serve only as a supplement to established methods and procedures, and to enhance the skills and abilities of installation technicians.
Table of Contents

DSL Background ................................................................. 3
DSL Limitations ................................................................. 3
Propagation Loss ................................................................. 3
Crosstalk or Metallic Noise .................................................... 3
Bridged Taps ................................................................... 4
Load Coils ....................................................................... 4
External Electromagnetic Interference ................................... 4
ADSL Service Overview .................................................... 5
Why ADSL? ...................................................................... 5
Network and Outside Plant Infrastructure ............................... 5
ADSL Installation From the NID (a.k.a., ONI or SID) to the Customer Premises .............. 6
ADSL Installation ............................................................... 7
Loop Prequalification ......................................................... 7
Step-by-Step Provisioning To The NID ................................. 7
Customer Site Installation .................................................. 10
ADSL Modem Installation .................................................. 10
End-To-End Testing (Final Step) .......................................... 11
Troubleshooting ............................................................... 11
Information Gathering ....................................................... 11
Potential Failures at the Customer Premises ............................ 11
Potential Failure Sources in the Copper Loop ......................... 12
Poor POTS Performance on an ADSL Line ......................... 13

Acronyms

ADSL .......................................................... asymmetric DSL
ANSI ........................................ American National Standards Institute
ATM .............................................. asynchronous transfer mode
CAP ....................................... carrierless amplitude/phase modulation
CLEC ........................................ competitive local exchange carriers
CO ............................................... central office
COLO ........................................ collocation
cpe ........................................ customer premises equipment
DLC .................................................... digital loop carrier
DLC-COT .... digital loop carrier central office terminal
DLC-RT ............... digital loop carrier remote terminal
DSL .............................................. digital subscriber line
dslam ............... digital subscriber line access multiplexer
DMT ........................ discrete multitone modulation
G.DMT ................. ITU standard for ADSL encoding based on discrete multi-tone modulation (DMT)
G.Lite ............... an ADSL standard that doesn’t require a permanent data/voice splitter
HDSL, HDSL-2 ... high bit-rate symmetric DSL services
IDSL .............................................. ISDN-based DSL
ISDN .......................... Integrated Services Digital Network
ISP .......................... Internet service provider
ITU ........................ International Telecommunications Union
IW ................................ inside wiring
MDF ........................................ main distribution frame
Microfilter .......... low-pass line filter required on each telephone set with G.Lite service
NEXT .............................. near-end crosstalk
NID (a.k.a., ONI or SID) .... network interface device
NOC .......................... network operations center
PSTN ........................ public switched telephone network
POTS ................................ plain old telephone service
RADSL ........................ rate-adaptive DSL
SDSL ................................ symmetric DSL
Splitter ..................... ADSL/POTS splitter
tdr .......................... time-domain reflectometry
X-Box ..................... cross-connection box
The “ABCs” of ADSL Service Installation

DSL Background
Digital subscriber line (DSL) is a generic term used to describe a wide range of data transmission technologies using standard copper telephone wiring (i.e., “last mile” local loops). Generally, DSL can be classified as either asymmetric or symmetric. Asymmetric DSL (ADSL) yields higher data throughput downstream (from the network to the end user) than upstream. Symmetric DSL (SDSL), on the other hand, provides the same transfer rate in both directions, making it more suitable for applications like business networks, Web servers, and users that transmit and receive data in roughly equal amounts.

DSL services commonly deployed in the U.S. today include ADSL, SDSL, HDSL (High bit-rate symmetric DSL), and IDSL — a hybrid of DSL and ISDN (Integrated Services Digital Network). Table 1 summarizes the most common DSL variations in use today.

DSL Limitations
Ultimately, the ability to provide DSL service to a subscriber, as well as the quality and maximum data rate of the service, is dependent on the condition of the copper loop and the spectral compatibility with other services carried in the wire bundle. Critical factors affecting the loop’s suitability are line balance and loading. Voice-grade repeaters and load coils can severely degrade transmission characteristics of high frequency DSL signals, putting additional restrictions on loop length, bridged taps, and spectral compatibility with other services in the wire bundle.

Propagation Loss
A primary limitation for DSL service is cable propagation loss, which can reduce the maximum bit rate. Propagation loss varies unpredictably as a function of frequency, and is typically caused by poor splices, low-quality drop cable, or water ingress.

Crosstalk or Metallic Noise
Crosstalk or metallic noise consists of signals that are coupled to the DSL signal on the intended service pair. The source may be other pairs in the binder group or even pairs in adjacent binder groups. Ideally, if capacitances are perfectly balanced between each wire in the pair and the rest of the cable, all disturbing signals will couple equally and the resulting signal will be zero. Ultimately though, some signal bleed occurs, and the amount of crosstalk increases as a function of higher frequency.

Table 1: Prevailing DSL Technologies

<table>
<thead>
<tr>
<th>DSL Service</th>
<th>Speed(s)</th>
<th>Max. Loop Length (ft)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.Lite or “splitterless” ADSL (asymmetric)</td>
<td>1 to 1.5 Mbps downstream, 64 to 384 Kbps upstream</td>
<td>18,000</td>
<td>Based on carrierless amplitude phase (CAP) encoding.</td>
</tr>
<tr>
<td>G.DMT or “full-rate” ADSL (asymmetric)</td>
<td>0.5 to 8 Mbps downstream, 64 to 800 Kbps upstream</td>
<td>18,000</td>
<td>Based on discrete multitone (DMT) encoding. Requires a “splitter” at customer premises to separate data and voice traffic.</td>
</tr>
<tr>
<td>RADSL (rate-adaptive asymmetric DSL)</td>
<td>0.6 to 7 Mbps downstream, 128 to 1024 Kbps upstream</td>
<td>25,000</td>
<td>Same bandwidth as ADSL. Adjusts speed on the fly to match line quality, like an analog modem.</td>
</tr>
<tr>
<td>HDSL (high bit-rate DSL, symmetric)</td>
<td>768 to 1.5 Mbps, (2 Mbps with three lines)</td>
<td>12,000</td>
<td>Requires two wire pairs. Often used as an alternative to T1 service. Longer distances can be supported with a signal repeater.</td>
</tr>
<tr>
<td>SDSL (symmetric DSL)</td>
<td>384 to 768 Kbps</td>
<td>10,000</td>
<td>The forerunner to HDSL-2. Common configurations include 764 Kbps (2B1Q line coding) and 400 Kbps (CAP line coding).</td>
</tr>
<tr>
<td>HDSL-2 (symmetric)</td>
<td>1.5 - 2 Mbps</td>
<td>12,000</td>
<td>The same performance as HDSL, but uses a single phone line. Longer distances can be supported with a signal repeater.</td>
</tr>
<tr>
<td>IDSL (ISDN DSL, symmetric)</td>
<td>144 Kbps</td>
<td>18,000</td>
<td>Uses the same 2B1Q line coding as ISDN. Bypasses the congested phone network — a big plus. Can handle distances up to 30,000 feet with signal repeaters.</td>
</tr>
</tbody>
</table>
Crosstalk comes from a variety of sources or “disturbers,” and the severity of the affect is largely dependent on the line coding used for the specific service. In addition to conventional services, crosstalk incompatibilities exist between different DSL services themselves (see table 2).

The noise from primary disturbers is measured across the entire band of frequencies used by the specific DSL service to ensure that crosstalk is not present within the modem’s power spectral density. As little as -90dBm of noise can exclude deployment of some DSL services.

Surprisingly, a significant source of noise can come from POTS lines. The voice signal poses no hazard, but the impulse noise created by the telephone going off-hook during the ringing signal can momentarily disrupt a DSL signal, requiring it to resynchronize. This problem is extremely difficult to isolate, since the ring-trip impulse could come from a neighbor’s line. With ADSL service, a POTS splitter or microfilters are used to reduce the impact of impulse noise.

**Bridged Taps**

Bridged taps, or non-terminated pairs spliced onto the service pair, pose another potential problem for DSL services. Laterals connected to the main cable carry the same signals transmitted on the main cable, causing a reflection to propagate from the end of the lateral back to the main cable. At certain frequencies, the additive effects of these reflections can significantly reduce the integrity of the DSL signal. For ADSL, less than 2,500 feet of bridged tap in total and less than 200 feet per tap are recommended. For best performance, bridged taps should be avoided within 1,000 feet of the network interface device or NID (Note: this is also referred to as the outside network interface [ONI] or the subscriber interface device [SID]).

<table>
<thead>
<tr>
<th>DSL Service</th>
<th>Primary Disturbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADSL G.DMT</td>
<td>SDSL (784K 2B1Q and 400K CAP), HDSL, ISDN/IDSL, T1, ADSL G.Lite, RADSL</td>
</tr>
<tr>
<td>ADSL G.Lite</td>
<td>SDSL (784K 2B1Q and 400K CAP), HDSL, ISDN/IDSL, T1, RADSL</td>
</tr>
<tr>
<td>IDSL</td>
<td>NEXT,* ISDN, HDSL, 160K SDSL, 160K CAP SDSL, ADSL G.DMT and G.Lite</td>
</tr>
<tr>
<td>HDSL</td>
<td>NEXT,* ISDN, SDSL, ADSL G.DMT and G.Lite</td>
</tr>
<tr>
<td>SDSL</td>
<td>NEXT,* HDSL, ISDN, ADSL G.DMT and G.Lite</td>
</tr>
</tbody>
</table>

*Near-end crosstalk

**Load Coils**

On long local loops, analog voice quality can deteriorate from capacitive effects. This capacitance effect alters the phase of the current relative to the voltage on the loop (i.e., variations in voltage go out of “synch” with corresponding variations in current). This effect limits the maximum power that can be delivered over the wire. Load coils can remedy this problem, and improve analog voice quality. A load coil permits the inductance of the line to be adjusted in just the right amount, so that the phase of voltage and current are resynchronized. While this is great for voice service, load coils can cause serious problems for broadband services. Most load coils only condition the loop up to about 3,300 Hz. Signals over 4 KHz become attenuated. Further, ADSL signals operating in the 25 KHz to 1100 KHz band are not allowed to pass through the load coil with sufficient energy. Therefore, load coils cannot be present on loops intended for ADSL services.

**External Electromagnetic Interference**

In addition to noise from services in close proximity, other potential external disturbers to DSL include impulse noise from AC motors or electrical equipment located close to the customer premises equipment (CPE). Radio emissions from sources such as AM radio, analog cellular, and HAM radio are also a potential source of noise. These emissions are coupled to the pair as longitudinal or “common-mode” noise. Due to imperfections in balance, splices, or the cable, some of the longitudinal noise is converted to metallic noise.
**ADSL Service Overview**

**Why ADSL?**

Generally, ADSL is the most suitable DSL service for telecommuters or home-based users since much more data is typically downloaded than is transmitted, especially when browsing the Internet. With ADSL equipment installed at both ends of the local loop, standard voice service can coexist with ADSL over the same copper pair, making the technology even more attractive for broadband data network access from the home. Secondary line pairs are not required to provide Federally-mandated “lifeline” voice service.

At the other end of the equation, competition from the cable industry and exploding Internet usage are putting pressure on telecommunications carriers to respond. These carriers are turning to ADSL instead of other DSL technologies because it satisfactorily meets both their bandwidth requirements and time-to-market needs.

ADSL is an exciting new service that will help carriers retain customers and maintain a leadership role in the communication market. However, rolling out the service presents a host of challenges since it typically reveals limitations in the outside plant infrastructure that require special attention by line technicians. Further, line technicians must be made aware of the ways that ADSL service can affect their work. For instance, how will ADSL technology impact existing services already deployed?

**Network and Outside Plant Infrastructure**

In the outside plant, ADSL hardware installation varies depending on the distance from the CO. For example, with ADSL service the current specified limitation for the loop length is 18,000 feet, or a maximum of 1300 Ohms of resistance. These length and impedance restrictions are due to copper’s vulnerability to noise interference as well as signal propagation loss. For customers served by copper loops of 18,000 feet or less, ADSL service can be installed as illustrated in figure 1.

The CO must be equipped with a digital subscriber line access multiplexer (DSLAM) and a corresponding ADSL line card. The DSLAM converts incoming and outgoing data on the carrier’s asynchronous transfer mode (ATM) backbone network into high frequency ADSL signals, and vice-versa. Furthermore, low frequency voice-band signals (POTS or plain old telephone service) can be transmitted over the same copper wires as the ADSL signal, without causing any interference (see figure 2).

---

Figure 1: This figure illustrates the simplest scenario for an ADSL installation, which requires a loop length of 18,000 feet or less AND maximum impedance of 1300 Ohms.

Figure 2: This graph shows the typical allocation of frequencies for high (ADSL) and voice (POTS) band signals on the local loop.
Customers located further than 18,000 feet from the CO can get access to ADSL service if the neighborhood is served by digital loop carrier (DLC) extension. In this scenario, a DSLAM and voice/data splitter must be remotely located near or inside the remote DLC cabinet at the upstream termination of the final copper loop as shown in figure 3. By multiplexing the data signals and then carrying them via the DLC, ADSL availability can be offered over a much wider service area. The remote DSLAM serves the same function as a CO-based DSLAM, except that it can be located many miles from the CO. The 18,000 foot and 1300 Ohm limits are still required for the final copper service tap, downstream from the remote DSLAM.

Instead of the splitter, G.Lite ADSL requires the installation of low-pass microfilters between every telephone jack and telephone set—a task that can be performed by the customer. The microfilter passes the low frequency voice signal to the telephone set without interruption to ADSL service. The downside is that every telephone set requires a microfilter, and each telephone connection represents a bridged tap.

Some G.DMT service installations can be converted to G.Lite by performing a simple software upgrade to the DSLAM and ADSL modem, removing the ADSL/POTS splitter, and adding microfilters. The feasibility of performing this conversion must be verified with the CO facility as well as checking the specific type of equipment deployed to the customer premises.
ADSL Installation

Loop Prequalification

If possible, the network operations center (NOC) performs a series of pre-qualification tests to ensure that the copper loop is of sufficient quality to handle ADSL service prior to dispatching a truck for final installation. These tests are typically performed using a CO-based line test system, such as the Lucent Mechanized Loop Test (MLT) or Harris Remote Test Unit (RTU). These systems can accurately predict the performance of analog service that can be provided on a given line. These tests commonly include AC/DC performance, resistive faults, loop length, draw break dial tone, and load coil detection.

Unfortunately, DSL services operate at a higher and wider range of frequencies than voice service, meaning that additional testing capabilities are required. Enhanced systems such as the Harris Wideband Test Pack (WTP) permit high frequency testing via existing Harris RTUs, providing accurate detection and measurement of high-frequency losses, noise margins, bridged taps, impulse noise and longitudinal balance. This tool enables the CO technician to prequalify the line for DSL service, and accurately predict the performance (or maximum bit rate) that can be achieved.

Step-by-Step Provisioning To The NID

After the CO has prequalified the copper pair and verified that the DSLAM is available for service, a technician will be dispatched to complete the installation to the NID and the customer premises. With different deployment strategies and service offerings (i.e., G.Lite versus G.DMT), carriers are bound to have different procedures and requirements for ADSL service installation. With that in mind, the following section represents the typical installation procedure. To complete an ADSL installation, the service technician will require the equipment described in table 4.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Loop Length</td>
<td>18,000 feet over 24 AWG wire, including bridged tabs</td>
</tr>
<tr>
<td>Impedance Relative to Signal Loss</td>
<td>Up to 1300 Ohms</td>
</tr>
<tr>
<td>Load coils</td>
<td>None</td>
</tr>
<tr>
<td>Repeaters</td>
<td>None</td>
</tr>
<tr>
<td>Bridged Taps</td>
<td>Less than 2500 feet total with no single tap greater than 1000 feet. Avoid bridged taps within 1000 feet of the NID (a.k.a. ONI or SID).</td>
</tr>
<tr>
<td>Crosstalk or Metallic Noise</td>
<td>These faults can compromise the maximum bit rate of the line during synchronization, and potentially cause service failure after synchronization.</td>
</tr>
<tr>
<td>Spectral Compatibility</td>
<td>Avoid placing jumpers near T1 or other higher-bandwidth services. Avoid using pair from the same wire bundle that has T1 or other high bandwidth services.</td>
</tr>
</tbody>
</table>

Table 3: Standard line conditions required for ADSL service.
Figure 5: This illustration sums up the entire ADSL installation process.

Table 4: Representative tools required for an ADSL installation include an ADSL modem, splitter or microfilters, handheld splitter, test meter, load coil detector, and a data safe butt set.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handheld ADSL Modem</td>
<td>This tool is used to verify end-to-end service turn up.</td>
</tr>
<tr>
<td>Microfilter or Splitter</td>
<td>A splitter is installed permanently near the NID for G.DMT ADSL. Microfilters are required on the line of every voice device for G.Lite ADSL.</td>
</tr>
<tr>
<td>Handheld Splitter</td>
<td>This tool is used to troubleshoot a problem splitter or microfilter, or can be used to safely draw dial tone on “splitterless” ADSL.</td>
</tr>
<tr>
<td>Test Meter</td>
<td>This device can be used to assess quality and troubleshoot inside wiring. (digital multimeter recommended)</td>
</tr>
<tr>
<td>Load Coil Detector</td>
<td>This tool is used to detect unwanted or misplaced loads.</td>
</tr>
<tr>
<td>Data-Safe Butt Set</td>
<td>This device is used to verify that the voice line works properly with ADSL. Data lock-out feature is required to detect the presence of data being transmitted before going off-hook.</td>
</tr>
<tr>
<td>Short Range TDR</td>
<td>Use this device to locate the distance of open, shorts, and unbalance lines in the short distance.</td>
</tr>
</tbody>
</table>
Step 1: Line verification and testing at the x-box
At the cross-connection box, verify that the correct copper pair is assigned for service. Once the target service pair is identified, confirm that it is an unloaded and balanced pair using the load coil detector and the test meter. At this point, use the test meter to perform the basic conditioning tests summarized in Table 5. Confirm that a dial tone can be established by connecting a butt set across the line. No data should be detected using the data lock-out butt set, since the far end modem will not be connected yet.

Step 2: DSLAM "sync" and bit rate confirmation at the x-box
Terminate the service pair with an ADSL test set (ADSL “golden” modem emulation), turn on the power, and attempt to establish synchronization with the upstream DSLAM. If synchronization is achieved and the test set displays the required downstream and upstream bit rates, the DSLAM is operating correctly and the line is ready for service. If the ADSL test set fails to establish synchronization with the DSLAM, call the help desk to verify that the line has been assigned to a DSLAM. If a synchronous connection is established, but the downstream or upstream bit rates are either higher or lower than the requested service, contact the help desk to confirm that the DSLAM has been configured correctly. Once again, qualify the facility using the basic conditioning tests in Table 5, then complete the cross connect, and proceed to the NID.

Step 3: ADSL/POTS splitter installation (G.DMT only)
Locate the NID box at the customer premises, and install the ADSL/POTS splitter in a convenient location (see Figure 6). Set a jumper on the network port, then terminate the wire pair for voice service on the voice port and the wire pair for ADSL service on the data port.

Step 4: Basic conditioning, supervision, and voice-grade tests
At the NID, basic conditioning tests (Table 5) should be performed once again. In addition, the supervision tests should be performed to confirm that the circuit will support high-speed ADSL data service. Finally, voice-grade service is verified by connecting a butt set across the voice port, setting it to “talk” mode, and listening for dial tone.

Step 5: DSLAM synchronization and bit rate confirmation at the NID (a.k.a., ONI or SID)
(G.DMT Only) Terminate the data port on the splitter with an ADSL test set, turn on the power, and once again confirm synchronization and required downstream and upstream bit rates.

Table 5: Customary field tests for ADSL service installation. (Note: A CO-based conditioning device can improve the efficiency of this process, allowing the technician to control conditioning of the line remotely.)

<table>
<thead>
<tr>
<th>Function</th>
<th>Test</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Conditioning</td>
<td>• AC/DC Voltage</td>
<td>These are “dry circuit” tests that are performed with the central office or remote terminal battery removed.</td>
</tr>
<tr>
<td></td>
<td>• Resistance Fault (Ohms)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Capacitance (opens)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Load Coil Count</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hi-Resistance Open</td>
<td></td>
</tr>
<tr>
<td>Supervision</td>
<td>• Current Flow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Circuit Loss @ 1000Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Power Influence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Circuit Noise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Circuit Balance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Station Protection Ground</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Slope Test</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6: This shows the location of the NID and permanent ADSL/POTS splitter at the customer premises for ADSL G.DMT.
rates. If synchronization fails or the bit rates are lower than required, contact the help desk.

(G.Lite Only) For splitterless G.Lite ADSL installations, first verify dial tone at the NID with a butt set. Disconnect the butt set, terminate the pair with an ADSL test set, turn on the power, and confirm synchronization and required downstream and upstream bit rates.

!! NOTE: A device called a “half ringer” is often installed at the NID by the incumbent carrier, and is used to identify the far end of the line using the Lucent MLT system. The device adds a known resistance that enables it to be detected. Unfortunately, some devices introduce just enough line impedance to block the ADSL signal. As a precaution, half ringers should be removed from the NID prior to installing inside wiring or CPE.

Customer Site Installation
Determine where the customer wants to connect their PC to ADSL service. Find the location of the nearest phone jack in the room and verify that the line pair is active.

G.DMT (permanent splitter)
If the customer does not require voice on the existing phone jack, jump the same pair assigned to the data port at the NID. If the customer requires voice and ADSL service, install a dual port wall jack if one is not already available. Confirm that the pair for voice service is on port number one and jump the pair for data service to port number two (see figure 7). Standard convention dictates that the pin out for the modem should be connected to the second pair.

G.Lite (splitterless ADSL)
The live line pair should carry both ADSL and voice service on the same line. If necessary, rewire the jack to match the modem pin out, or use a patch cord for pair conversion.

ADSL Modem Installation
There are three common ADSL modem configurations in use today. They include two external (with either Ethernet or USB interface to the PC) and an internal version with a PCI interface. If the specified CPE is an internal modem, some PC knowledge or experience will be required to complete the installation.

!! NOTE: Some types of inside wiring (e.g., IW flat wires) cannot support more than one service, and should be replaced with Category 3 twisted pair wiring.

External ADSL modem with Ethernet interface
If the specified CPE is an external modem with Ethernet interface, an Ethernet-ready connection must be available on the PC to complete the installation. If not, this capability will need to be added by installing a Ethernet network interface card (NIC) in the PC.

Once Ethernet capability is confirmed or installed on the PC, verify that the Ethernet connectors on the PC will be compatible with the Ethernet patch cord (Note: RJ-45 connections are the most prevalent used for Ethernet today, but some older computers have different connectors that will require an adapter.) Once cord connector compatibility is confirmed, install the Ethernet patch cord between the modem and the Ethernet port on the PC. Then connect a patch cord between the modem and the wall jack data port and install the appropriate software drivers on the PC.
External ADSL modem with USB interface
If the CPE is an external ADSL modem with a USB interface, the USB port on the PC should already be activated. Connect a USB cable between the ADSL modem and the PC, connect a patch cord between the modem and the wall jack data port, and install the appropriate software drivers on the PC.

Internal ADSL modem with PCI interface
If the specified CPE is an internal ADSL modem with a PCI interface, the only requirement is that an empty PCI slot is available in the PC. (NOTE: When working inside a PC, it is critical that proper grounding procedures be observed, including wearing a properly grounded electrostatic discharge (ESD) wrist strap. In addition, prior to opening the computer enclosure, the PC and all connected devices should be turned off and their power cords disconnected.) Install the ADSL modem card in an empty PCI slot in the PC. Connect a patch cord between the modem and wall jack data port, turn on the computer and install the software driver on the PC.

End-To-End Testing (Final Step)
ADSL
Turn on the modem (external only) and PC. Configure the PC according to the specific requirements of the Internet service provider (ISP). At this point, a permanent or dynamic IP address may need to be set up on the PC. (NOTE: It is recommended that the installation technician become familiar with setting up the PC by consulting with the technical support staff at the ISP or else the ADSL help desk before attempting this portion of the installation.)

If the external modem includes a “sync” LED, it should indicate that the modem has established a connection with the DSLAM (on most ADSL modem equipment, the sync LED will flash amber on power up and then change to solid green to indicated network synchronization with the DSLAM). For internal modems, the software driver usually includes some type of on-screen status icon that can be used to monitor the activity of the modem. Documentation included with the modem can be should be helpful here.

Once the IP address is configured correctly, test the connection by launching an Internet browser. At this point, the default home page should load, indicating a successful end-to-end connection with the ISP.

POTS
After the end-to-end ADSL service verification, the technician should also verify the telephone service in the house. Keep in mind that the ADSL service should be unaffected by the telephone service. See the section in troubleshooting if failure or loss of quality are noted for telephone service.

Troubleshooting
Information Gathering
Problems discovered during or after ADSL service installation may require the technician to locate failures in either the CPE or wiring. When trouble is reported, it is critical that a detailed description of the problem be documented before troubleshooting. For example, customers have been known to forget to turn on the modem. On other occasions, problem resolution may require cutting over a new line because of marginal quality on the original line. Table 6 summarizes four basic questions that should be answered before troubleshooting ADSL service problems.

Potential Failures at the Customer Premises
Once the basic problems covered in table 6 have been ruled out, further troubleshooting should start at the customer premises. If the modem maintains a good connection with the DSLAM, begin by looking for the problem on the PC. The customer may have changed a setting or the IP address accidentally — a common problem when installing a network-related application using the “default” configuration option. If the problem still exists, call the ADSL help desk to verify that the account is still active and to check for any recent deactivations or work done on the network in the same neighborhood.
If a problem with the PC can be ruled out, disconnect the modem from the wall jack, terminate the line with an ADSL test set and run a modem emulation test. If the ADSL test set synchronizes with the DSLAM, the customer’s ADSL modem may be defective. Connect another ADSL modem and try to establish a connection.

If terminating the line with an ADSL test set fails to establish synchronization with the DSLAM (when connected at the same point as the customer’s modem), try to isolate the failure between the wall jack and the NID. If the ADSL test set synchronizes with the DSLAM when connected at the NID, the inside wiring is the culprit. Confirm the severity of the failure with a test meter and run new wire to the wall jack if necessary.

**Potential Failure Sources in the Copper Loop**

If problems at the customer premises can be ruled out, and the ADSL test set fails to synchronize with the DSLAM at the NID, the problem is probably in the outside plant. Perform a modem emulation test with the ADSL test set terminated on the line at the next upstream access point on the loop (i.e., probably a cross-connection box, a pedestal, or an MPOLE). Continue to the next upstream access point until a successful connection is acquired. At the point where a successful connection is established, check the downstream portion of the loop for loading, bridged tabs, resistive faults, or unbalanced capacitance pair.

When all else fails, and the decision is made to cut over another line to repair the problem, ensure that the line has been prequalified for bridged taps and other required conditions, and that load coils are not present. Basic conditioning and supervision tests should then be run on the new line (see table 5). As a rule of thumb, run a modem emulation test with the ADSL test set at the customer site before closing the repair ticket. This will ensure the line has been properly terminated for service.

!! Note: Poor bit rate performance may be caused by an excessive number or length of bridged taps in the house. This is especially common with splitterless ADSL, which utilizes bridged taps for voice service. The bit rate can be improved by shortening or reducing the number of bridged taps, or by installing a permanent ADSL/POTS splitter. However, the bit rate should first be verified at the NID and the ADSL jack to determine if the limitation is caused by inside wiring or the outside plant loop conditions. If the exhibited bit rate is significantly better at the NID, then inside wiring or bridged taps are most likely the problem, and the method described above may help (see figure 8).

<table>
<thead>
<tr>
<th>Question</th>
<th>If Yes</th>
<th>If No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is voice service still functioning on the line?</td>
<td>The problem is probably limited to the ADSL service.</td>
<td>The problem is on the line (i.e., an open circuit).</td>
</tr>
<tr>
<td>Does the modem indicate synchronization with the DSLAM?</td>
<td>The problem is probably an incorrect configuration on the PC, or a failure in the ISP network.</td>
<td>Isolate the failure using an ADSL test set.</td>
</tr>
<tr>
<td>Does the modem work sporadically or only at certain time of the day?</td>
<td>There may be periodic radio frequency (RF) interference from equipment or other high frequency sources. Contact the ADSL help desk and try reconfiguring the line with better noise margin (this may also decrease the maximum connection speed and effective bit rate).</td>
<td>Isolate the failure using an ADSL test set.</td>
</tr>
<tr>
<td>(External Modem only) Is the modem correctly connected to the PC and the power turned on?</td>
<td>Isolate the failure using an ADSL test set.</td>
<td>Reconnect the modem and turn it on.</td>
</tr>
</tbody>
</table>
Poor POTS Performance on an ADSL Line
If the telephone service is inactive, but the ADSL service is working properly, verify the dial tone with a portable ADSL splitter and data safe butt-set at the next upstream access point (see figure 9). Reduce the trouble area and look for continuity on the pair. In the case of one open line, the ADSL service may still be functioning. The DSLAM and the ADSL modem are self-powered, unlike POTS service, which relies on power from the CO (typically 48V DC) and requires the tip and rings to be grounded. The short range TDR can be used to locate the fault, and then repaired.

To receive more information or make suggestions regarding this document, please contact Harris Technical Support at 1 (800) 437-2266.
Additional white papers available from Harris:

- Test Strategies For DSL Deployment
- Testing in the Unbundled Loop
- Advanced DSL Provisioning Strategies: Leveraging IVA (Interactive Voice Access) in the ILEC-to-CLEC Local Loop Hand-Off

© 2000 Harris Corporation, All Rights Reserved
All trademarks or registered trademarks used herein belong to their respective owners.

Specifications subject to change without notice.