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Application Series

SunSet xDSL: Prequalification of ADSL Circuits with ATU-C Emulation

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INTRODUCTION

Asymmetrical Digital Subscriber Line (ADSL) is telephony's solution for overcoming the local loop bottleneck and providing fast internet service to the bandwidth hungry consumer. Many telco carriers today are deploying systems compliant to the ANSI T1.413 specified Discrete MultiTone (DMT) modulation scheme, which has also been endorsed by the ITU as G.992.1 (G.DMT). DMT is an ingenious technology which utilizes a frequency spectrum up to 1100 kHz to simultaneously deliver high bandwidth data and voice over a single phone line. 256 discrete multitones (carriers), each with 4.3 kHz bandwidth, are transmitted in parallel to deliver rates up to 6.144 Mbps downstream, 640 kbps upstream.

But, as carriers race to deploy the technology, they must also find viable solutions to test DSL.

WHY TEST?

Mass ADSL deployment has been hindered mainly by unpredictable local loop conditions. ADSL performance has proven vulnerable to many common elements found in the local loop: load coils, bridge taps, crosstalk from other services, as well as the cable length and gauge between the central office and the customer premise. How can a provider know if ADSL service can be supported in an area before investing a large stake in installation?

Traditional test methods are inadequate to truly assess the local plant and consequently, loop prequalification has been ineffective. Previously, the only method to qualify a circuit was a "plug-and-pray" approach by connecting an actual DSLAM at the central office to an actual ATU-R modem at the customer premises. Test equipment is now available that emulates the ATU-R modem and presents crucial bit rate and noise margin data.

The inherent limitation of ATU-R emulation is that it requires a working DSLAM. ATU-R emulation is an ideal method for installing ADSL circuits, but does not address the thousand of circuits existing today whose local central office is not yet equipped with DSLAMs. Further, setting up a DSLAM for test purposes is not easy, requiring many man-hours for proper wiring, workstation setup, and operation. The foreboding question looms for service providers- will deployment be possible in those untested areas? In the war for new broadband subscribers, true ADSL circuit prequalification is paramount for telcos combating the formidable cable modem industry.

TRUE LOOP QUALIFICATION: ATU-C EMULATION

Fortunately, the solution to the prequalification dilemma has arrived. ATU-C modem emulation is the key to predicting in-service performance for the thousands of untested circuits. It enables providers to qualify and predict ADSL performance for each circuit long before a DSLAM is installed and running in the central office.

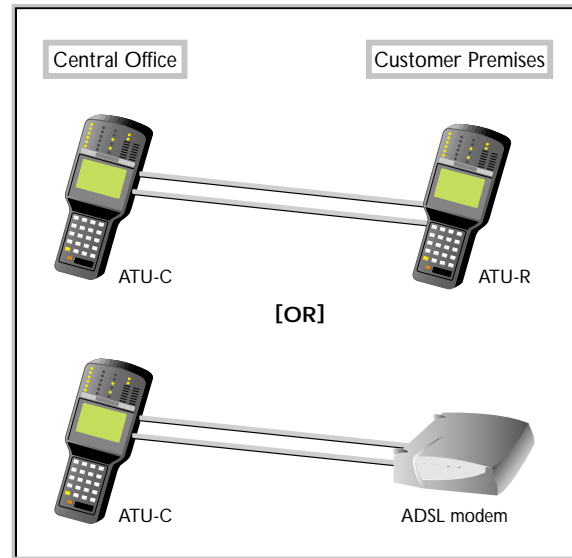


Figure 1 ATU-C Emulation

Setup

The key to testing with the SunSet xDSL ATU-C module is in the setup. One setup screen provides all the necessary parameters such as downstream rate, upstream rate, and desired noise margin. These are identical to the settings found in an actual DSLAM. To configure the SunSet's setup:

1. Press the MODULE key to enter the ATU-C menu.
2. Enter SETUP.

Selecting the Profile: Mode 1 vs. Mode 2

DMT modems have two primary modes of operation which are settable only at the ATU-C modem in the DSLAM: Fixed (Mode 1) and Rate Adaptive at start-up (Mode 2). The primary difference between Modes 1 and 2 is the *realized noise margin*. Mode 1's primary purpose is to deliver the user specified bit rate. Hence the noise margin will have a wide range, depending on line attenuation and noise conditions. In contrast, Mode 2 tries to deliver the maximum rate possible while achieving the target noise margin. Hence, Mode 2's realized noise margin will always be less than or equal

to the target noise margin. Consequently, the modems will have less noise margin to compensate for increased line noise before failure. Therefore, providers should use a high target noise margin when using Mode 2 for commercial service.

Mode 1: Fixed

Mode 1 is useful for the provider who has determined fixed rates for commercial service. For example, a provider is offering a service rate of 1504 kbps downstream and 384 kbps upstream. Using the ATU-C test set, the user simply enters in this data and trains the modems.

```

12:09:21
>ATTEMPTING TO OPEN LINK <
> <
      SETUP
OPERATING MODE :ANSI
PROFILE        :MODE 1

FAST PLN DN RATE:1504 kbps
FAST PLN UP RATE: 384 kbps
INT PLN DN RATE : 0 kbps
INT PLN UP RATE : 0 kbps
TARGET MAR DN   : 6 dB
TARGET MAR UP   : 6 dB

ANSI  G.DMT  RETRAIN  more

```

Figure 2 Mode 1 Setup screen

Mode 2: Rate Adaptive

The Rate Adaptive at start-up mode is useful for assessing the total capabilities of the circuit. Mode 2 is valuable for the provider considering various speed combinations. In Mode 2 the modems try to achieve the following:

- Meet the minimum bit rate threshold.
- Deliver the highest bit rate possible while maintaining the Target Noise Margin threshold.

```

12:09:21
>LINK UP <
> <
      SETUP
OPERATING MODE :ANSI
PROFILE        :MODE 2

FAST MAX DN RATE:9856 kbps
FAST MAX UP RATE: 832 kbps
INT MAX DN RATE : 0 kbps
INT MAX UP RATE : 0 kbps
TARGET MAR DN   : 6 dB
TARGET MAR UP   : 6 dB

MODE 1  MODE 2  RETRAIN  more

```

Figure 3 Mode 2 Setup screen

Selecting the Path: Fast vs. Interleaved

Notice that there are two latency paths that may be used: fast and interleaved. For either path, DMT systems employ a forward error correction (FEC) scheme which ensures higher data integrity. To ensure maximum noise immunity, an interleaver may be used to supplement FEC. An interleaver is essentially a buffer used to introduce a delay, allowing for additional error correction techniques to handle noise. Interleaving will slow the data flow and may not be optimal for real time signals such as video transmission. Interleaving is ideal for internet traffic and is utilized in ITU G.992.2 compliant G.lite systems. With the SunSet xDSL ATU-C module, both the fast path and interleaved path may be tested with simple menu choices to forecast performance for various applications.

Selecting the Noise Margin: Critical

Proper noise margin settings are critical for running meaningful tests. The Target Noise Margin parameter represents the signal-to-noise ratio modems must achieve at turn-up. A 6 dB target noise margin setting is common industry practice in these early stages of deployment. Upon link up, the modems will maintain synchronization (also known as Showtime), as long as the realized noise margin is above the Minimum Noise Margin threshold, which is typically set at 0 dB. For the Alcatel ADSL system, 0 dB noise margin is the minimum level that ensures the G.DMT BER performance requirement of 10⁻⁷.

Testing various target noise margin settings is invaluable. Disturber effects are still an unknown factor in ADSL deployment. For instance, impulse noise has been known to cause a sudden 10 dB drop in the noise margin for longer circuits, often resulting in brief modem failure. Hence, a higher Target Noise Margin setting may prove wise in the long run, at the cost of disqualifying a few marginal circuits. The payback is fewer angry customers. For problem circuits where synchronization cannot be achieved, a lower Target Noise Margin setting should be used for troubleshooting. For instance, a 3 dB Target Noise Margin may produce a synchronization, providing valuable diagnostic information.

Showtime

After you have configured the setup screen as desired, press the RETRAIN F-key. This resets the link connection using your settings. Once synchronization is achieved, the modems will continue to deliver the bit rates attained at start-up. The modems will maintain showtime until line conditions force the noise margin below the minimum noise margin setting, upon which the modems will fail.

```

14:21:12
>LINK UP
>
LINK TURN-UP RESULTS

[DOWNSTREAM]          [UPSTREAM]
FAST :1504 kbps      FAST : 384 kbps
INTER:0 kbps        INTER: 0 kbps
MAX :3856 kbps      MAX : 783 kbps
MARGN:16.5 dB       MARGN: 22.0 dB
ATTEN:58.0 dB       ATTEN: 31.5 dB
POWER:20.0 dBm      POWER: 12.0 dBm
CAPAC:39 %          CAPAC: 49 %
ATU-R MFR: ALCATEL
ATU-R VER: 2.0
CONTINUE

```

Figure 4 Link turn-up results

CARRIER MASK: SPECTRUM MANAGEMENT TOOL

A powerful feature of the ATU-C module is the Carrier Mask, which enables the user to manually control each of the 256 carriers. Masking carriers aids in combating crosstalk interference- the insidious phenomena that can potentially cause major havoc for service providers. Many DSLs and other services such as ISDN and T1 share the same frequency region within the DMT spectrum. While DMT systems are expected to compensate for crosstalk, more traditional line codes such as T1 B8ZS/AMI or 2B1Q may be adversely affected. Carrier masking enables the provider to experiment and determine optimum settings. For example, if there are known T1 lines in the same or adjacent binder groups to various ADSL DMT circuits, the operator can mask the tones surrounding the T1 Nyquist frequency of 772 kHz. This action may reduce the harmful crosstalk effects on the T1 services.

Carrier masking can also help conserve power for DMT systems. In regions where AM radio stations are present, the ineffective tones sharing the same frequency band can be shut off. The troubleshooting results obtained from Carrier Mask testing will prove invaluable to the provisioning center, which can adjust the customer's profile to avoid future circuit problems.

Carrier Mask, an example (Figure 5)

After turning up an ADSL circuit, you notice that a T1 signal in an adjacent binder group is beginning to have problems. You suspect that noise from the ADSL circuit is disturbing the adjacent T1. You can use the carrier mask tool to prove this.

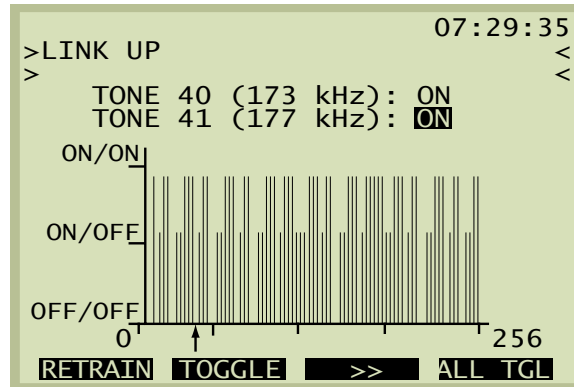


Figure 5 Carrier Mask

1. Turn up the ADSL link with the ATU-C module.
2. Escape from the Link Turn-Up Results screen to the ATU-C menu. Enter MODEM STATUS.
3. Enter CARRIER MASK.
4. The Nyquist frequency for T1 is 772 kHz (half of 1.544 Mbps). Move the cursor to this frequency area (refer to the tone levels given in the top lines).
5. Stop moving the cursor when the arrow reaches the tones surrounding 772 kHz-the area between 771 kHz and 776 kHz might be a good start.
6. Check the status of the two displayed tones. If they are turned on, you want to deactivate them. Press the TOGGLE (F3) key to change the tone's status.
7. Press the down arrow key to move the cursor to the lower tone; remember that each interval represents two tones.
8. Press the TOGGLE (F3) key to turn off the other tone.
9. Press the RETRAIN (F1) key to reset the link. The test set will now optimize different tone levels to achieve the same bit rate.
10. The T1 is now running cleanly. When you actually turn-up this link, you should use the same settings in the DSLAM.