ENSURING IPTV SERVICE QUALITY WHILE MIGRATING TO MPEG4 AND HDTV

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APPLICATION NOTE

Robert Fitts, Vice-President – Product Management, Copper Access Business Unit

Many wireline-oriented network service providers have been providing IPTV to their DSL subscribers for quite some time now. In fact, with the advent of bonded ADSL2+, VDSL2, and the installation of remote DSLAMs closer to consumers, carriers are now able to offer DSL services at rates that are higher than ever. Coupled with more efficient video compression algorithms such as MPEG4, it is possible that many carriers will choose to delay fiber-to-the-home (FTTH) strategies, at least for a few more years. Instead, fiber will be brought within 3,000 to 4,000 feet of the subscriber base and VDSL2-based DSLAMs will deliver IPTV services using the installed base of outside-plant cabling.

Until recently, central office-based ADSL2+ DSLAMs delivered between 1 Mbit/s and 10 Mbit/s within reasonable customer service areas. Using this architecture, enough subscribers could be captured, given maximum DSL local-loop length limitation of around 12,000 feet. MPEG2-encoded video requires approximately 4 Mbit/s for standard-definition TV and around 15 Mbit/s for a single channel of HDTV. Therefore, typical service offerings consist of a few SDTV channels per subscriber or a single HDTV offering. MPEG4, on the other hand, can deliver roughly the same customer experience in terms of video quality using less than 3 Mbit/s for each SDTV channel, and 8 to 11 Mbit/s for each HDTV channel. With the shorter loop lengths of optimized remote-cabinet VDSL2 or, alternatively, bonded ADSL2+ being able to deliver 20 to 30 Mbit/s, MPEG4 enables two simultaneous HDTV channels and/or multiple SDTV channels. FTTH passive optical network solutions offer similar downstream rates for subscribers.

Figure 1. *Eliminating video disruption and pixelization is key to retaining subscribers.*

When upgrading networks to higher-rate DSL technologies or implementing MPEG4 video encoding, it is important to align installation and maintenance procedures to ensure rock-solid delivery of streaming IPTV that is free from pixelization, blank screens, starts and stops, and other unwanted video anomalies.

The first aspect that installers should test is the DSL connection rate. Guidelines should be set for minimum actual bit rates, both upstream and, more importantly, downstream. In the world of DSL, a fast bit rate is one which has limited error correction between the DSLAM and the customer premises modem (CPE) and the *interleaved* has additional error correction. DSL test sets will normally report the upstream and downstream rates for the bit rate mode (fast or interleaved) that is currently activated.

In addition to proper bit rates, installers should ensure that the signal-to-noise-ratio margin (SNRm) is correct. Normally, a data-only service such as web-surfing and e-mail can tolerate some errors. The applications themselves typically request a retransmission of errored packets using a TCP/IP protocol. IPTV services, on the other hand, do not tolerate errors very well. Therefore, setting the SNRm to 6 dB (a common practice for data-only services) has been found to be insufficient for IPTV. Instead, a setting of 10 to 12 dB is typical for a stable IPTV service.

Signal-to-Noise-Ratio Margin

Most installers and network engineers are familiar with a signal-to-noise ratio (SNR) measurement. Normally expressed in dB, SNR refers to the ratio between a normal signal level and the noise measured on the line. On a voice-frequency telephone line, a high SNR would mean that a listener would easily be able to hear the person talking on the other end of the line and that they would not hear much noise. Dial-up modems and fax machines require the SNR to be high enough to support a good connection speed. If the noise on the line starts to affect the transmitted analog carriers, errors in the digital transmission occur.

DSL modems (ATU-R) and DSLAMs (ATU-C) use discrete multitone (DMT) carriers to transport digital information over a pair of copper telephone wires. Each carrier at each carrier frequency is modulated in amplitude, based on a part of the overall digital sequence to be carried. For example, an ADSL2+ modem uses up to 512 simultaneous amplitude-modulated carriers in order to carry the bit stream. SNRm, a value that is set at the DSLAM, is the number of dB that the wanted signal is forced to be above the average noise on the line. By setting this value higher, the actual signals will be disrupted less often.

Local Loop Repair

From time to time, the minimum demands for upstream and downstream bit rates may not be met. Typically, the installer tests the DSL SYNC rate at the customer premises using a purpose-built DSL test set, such as EXFO's CoLT-250+ or CoLT-450P. If the rates are below the minimum values, the first thing the technician should do is look at the make-up of the loop to determine if, fundamentally, that particular loop can support those rates. Longer loops and loops with bridge taps reduce the achieved bit rates. If the local loop make-up is suitable for the connection rates required but still does not pass a connection rate test, the technician should turn that loop over to cable repair crews for troubleshooting. Repair crews use a product such as EXFO's CableSHARK P3 portable test set in order to quickly identify the nature of line faults that prevent faster connections and pinpoint the location of the fault.

Figure 2. *EXFO's CableSHARK P3 is the fastest way to locate loop faults.*

Confirmation of the Provisioning

Once the installer has confirmed that a stable DSL connection with suitable rates has been established, they should ensure that ordered services are functional. Too often, a clean connection between the DSLAM and the customer modem is achieved but, behind the DSLAM, the routing and provisioning of the actual customer services are not successful, are wrong, or perform poorly.

One of the first tests to perform in terms of digital-information quality testing is the connection layer between the DSLAM and the modem. The DSL chip sets in these two devices send information in frames, cells and packets. A typical test set will report any errors that occur between the chip sets. DSL connections use one of two digital transmission schemes: Internet Protocol (IP) packets over asynchronous transmission node (ATM); or IP packets directly over Ethernet. For those systems that use the first of these two possibilities, a test set that displays errors in the ATM should be used. Part of this testing is to configure the test set to the normal virtual channel indicator (VCI) and virtual path indicator (VPI) that are used for the delivery of Internet data (i.e., web-browsing, e-mail, FTP, etc.). It should be noted that data-only DSL services generally use a single ATM channel and path such as 0.35. Triple-play services generally use a single VCI/VPI for Internet data and other VCI/VPI for video (such as IPTV). There are some systems that use one VCI/VPI for voice-over-IP, another VCI/VPI pair for Internet data, and multiple VCI/VPIs to support multiple simultaneous IPTV/video-on-demand channels.

It is important to make sure that test equipment supports currently deployed and planned services. If any of the aforementioned ATM "pipes" contain errors, they are generally caused by errors between the DSL devices over the local loop. To eliminate these errors, the first thing to do is to make sure the settings in the DSLAM are correct. For example, the settings of downstream and upstream rates must not exceed the loop's capacity to deliver, and the SNRm must be correct. If such actions cannot minimize DSL- and ATM-layer errors, test the quality of the local loop, locate the faults and eliminate them. If that still does not minimize the errors, the only solution is to turn away the customer or lower the delivered rates. For IPTV subscribers, that often means fewer simultaneous SDTV channels (i.e., fewer TVs in one house showing different channels) or fewer HDTV channels.

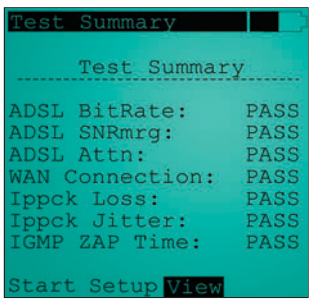

Figure 3. *CoLT-450P IPTV Test Summary*

The next item that should be checked is the configuration of the high-speed Internet service; is it correctly configured and functioning? To verify this, the installer needs to establish DSL "SYNC" (synchronization), connect to the Internet using an encapsulation such as PPPoE, and then log on to the providers' network. Test sets that routinely do this, such as EXFO's CoLT-450P, are widely available. Once logged on to the service, technicians can perform a PING test to confirm that the test set can detect the appropriate server(s), or they can download a file from a known URL in order to measure the true speed of the network.

IPTV Testing

IPTV services require the greatest amount of testing of all. Because applications such as e-mail and Internet browsers automatically request the retransmission of packets (using TCP) that contain errors, Internet data-only lines can tolerate a certain level of impairment. It is also fair to say that users generally consider any speeds above 1 Mbit/s to be a good web-surfing experience (excluding online gamers). In most cases, the DSL circuit is able to provide much more than that. However, delivering an IPTV service, especially multiple-channel HDTV, often utilizes nearly all of the available downstream capacity of the DSL link. Therefore, a relatively small degradation in the DSL connection rate may greatly affect the performance of the IPTV service.

What's more, video requires a relatively constant communications channel. Subscribers will not tolerate video that stops and starts or "freezes", so it is important to ensure that there is enough overhead of downstream channel to accommodate the planned maximum use of the DSL connection. For example, the minimum requirement for an offered ADSL2+ service might be 16 Mbit/s downstream that will support one MPEG4-encoded HDTV channel plus two standard-definition channels. Each MPEG4 channel might be set up in a way that it requires 9 Mbit/s and each standard-definition channel requires 3 Mbit/s. In total, that is 9 + 3 + 3, plus some provision for Internet data and some provision for VoIP. With such provisioning, the total requirement is close to the DSL connection rate (16 Mbit/s vs. 15 Mbit/s). Test equipment should be used to ensure that the actual DSL connection rate is achieved and that the whole circuit runs error-free with all three channels simultaneously.

There are two ways to perform such a test. The first uses a test set to emulate all subscriber equipment. This is called *Terminated* mode. The other uses a test set to replace the subscriber modem but relies upon the subscriber set-top box, TV and remote control to select channels. This is called *Through* mode. The advantage of *Terminated* mode is that such tests can easily be performed outside of the customer premises at the demarcation point between network and subscriber; in other words, at the network interface device (NID).

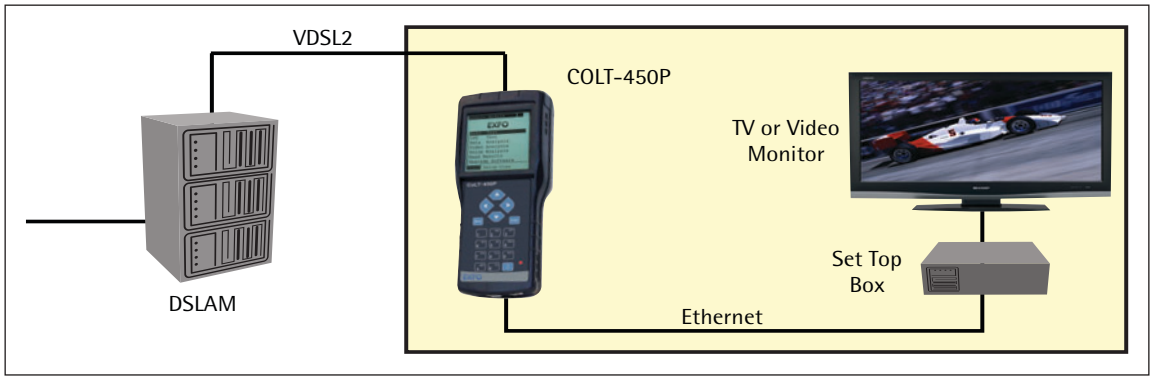

Figure 4. *Test set connection for IPTV (Through Mode)*

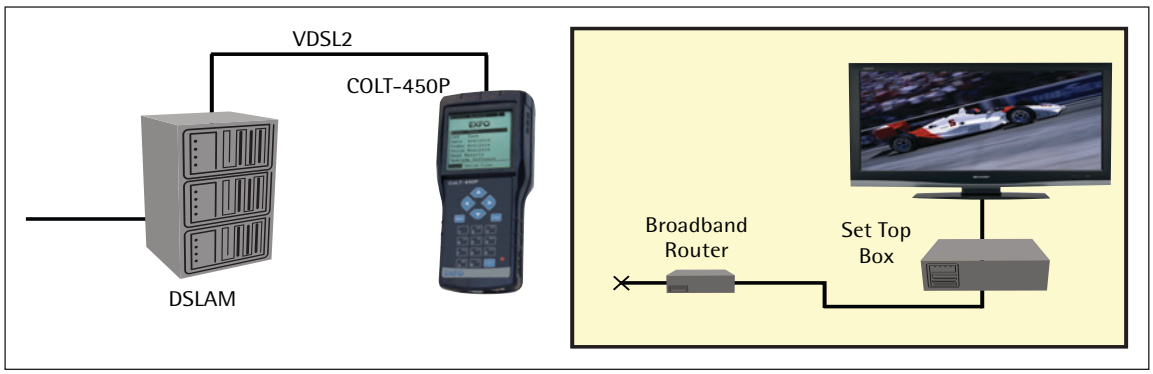

Figure 5. *Test set connection for IPTV (Terminate Mode)*

In either case, the test set is used to view a comparison of the DSL downstream connection rate along with a real-time display that shows the bandwidth being consumed by the total of three simultaneous IPTV streams. The technician uses the test set to send IGMP commands towards the network, joining one HDTV channel and two SDTV channels. Various menu-selectable screens show if there are any errors in the video streams and, if so, the source of those errors. For instance, an error that manifests itself in the physical layer between the DSLAM and the modem will cause errors in all layers above it. In contrast, layers at the MPEG4 layer may be seen but not on any layer below (IP, ATM, chip to chip, etc.). Such errors indicate that the problem is in the transport part of the network or are being created at the source.

The quality of both IP networks and DSL connections can change over time. Technicians should monitor an installation of an IPTV service for 15 minutes in order to check the stability of the overall customer experience. Some IPTV/DSL test sets, such as EXFO's CoLT-450P, provide the ability to monitor the quality of the delivered MPEG2, MPEG4 or MPEG-VC1 video using a measurement called *media delivery index* (MDI). After monitoring for 15 minutes, technicians should view the accumulated MDI results. If the results are within limits, the installation can be deemed as stable. Please see application note 163, entitled ***Using Media Delivery Index on the FTB-8510B Packet Blazer™ Ethernet Test Module (IPTV Option)*** for a detailed description of MDI and other video-assessment tools.

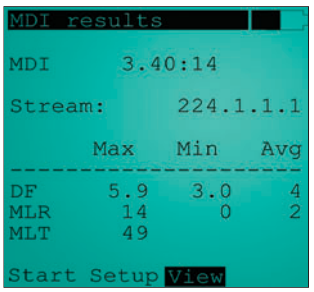

Figure 6. *CoLT-450P MDI Results*

Conclusion

Triple-play services (i.e., data, voice, and IPTV video) can be affected by many factors in many locations. Technicians armed with a good triple-play/DSL test set can quickly determine if a problem truly exists. Furthermore, the test set quickly helps technicians identify which part of the network is at fault, which leads to fast remedial action that saves money and satisfies customers.

EXFO Corporate Headquarters > 400 Godin Avenue, Quebec City (Quebec) G1M 2K2 CANADA | Tel.: 1 418 683-0211 | Fax: 1 418 683-2170 | info@EXFO.com

Toll-free: 1 800 663-3936 (USA and Canada) | www.EXFO.com

EXFO America	3701 Plano Parkway, Suite 160	Plano, TX 75075 USA	Tel.: 1 800 663-3936	Fax: 1 972 836-0164
EXFO Europe	Omega Enterprise Park, Electron Way	Chandlers Ford, Hampshire S053 4SE ENGLAND	Tel.: +44 2380 246810	Fax: +44 2380 246801
EXFO Asia	151 Chin Swee Road, #03-29 Manhattan House	SINGAPORE 169876	Tel.: +65 6333 8241	Fax: +65 6333 8242
EXFO China	No.88 Fuhua, First Road Central Tower, Room 801, Futian District	Shenzhen 518048, CHINA	Tel.: +86 (755) 8203 2300	Fax: +86 (755) 8203 2306
	Beijing New Century Hotel Office Tower, Room 1754-1755 No. 6 Southern Capital Gym Road	Beijing 100044 P. R. CHINA	Tel.: +86 (10) 6849 2738	Fax: +86 (10) 6849 2662

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