IPTV Testing

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IPTV stands for Internet Protocol Television, and is proving to be an interesting new chapter for television. This exciting technology uses DSL to deliver the content to the subscribers and offers new business opportunities to service providers. ADSL2+ and VDSL2 data rates make it possible to easily integrate voice, video, and data services over a single telephone line, commonly denominated triple-play services. With all these technological developments, it is now practical and economical to simultaneously provide multiple standard and high-definition television channels (SDTV and HDTV) to the residential user.

The term IPTV usually includes a broad range of programs or TV channels provided by one or multiple service providers. Additionally, it might include some specialized programming like special events and movies, provided only when requested by the user; i.e., Video on Demand (VoD).

Quality of IPTV

On any ADSL-based deployment, the quality of the consumer’s video is not just a function of the network bandwidth (ADSL2+/ADSL) or the data stream, as there are a number of parameters that contribute to the customers’ perception of good vs. bad quality. As the video stream arrives to the Set Top Box and ultimately the television, it has gone through various protocol layers (e.g., physical ADSL layer, ATM (Asynchronous Transfer Mode) layer, IP layer, transport layer, etc.). It is the interaction between these layers and the effect of external influences that affect the quality of the video perceived by the consumer; this is often referred to as Quality of Experience (QoE). Some of the parameters that influence the customer’s QoE include image pixelization and tiling, picture blurring, macroblocking and edge distortion, as well as audio dropouts and channel-change time.

A typical IPTV configuration from the Digital Subscriber Line Access Multiplexer (DSLAM) to the customer premises is like the following: the video stream is delivered using ADSL2+ from the IP based DSLAM to the user’s ADSL2+ broadband router. The router, while supporting Voice and Internet services, passes the video stream to the STB for decoding. The STB converts the video stream into required signals for displaying on the consumer’s TV.

Factors Affecting Service

Encoding and Compression

The quality of the video being distributed across the network can be affected right at the source; i.e. at the video head end. The encoding and compression process usually creates a trade-off
between the quality of the video and the desired compression level. In addition, the amount of video information per IP packet will vary depending on the encoding and compression technique used. Therefore, an IP packet loss can represent a single unnoticeable missing point of the video sequence or a large period of degraded, pixelated, or unavailable image.

**Jitter**

A typical IP packet carrying MPEG-2 video-streaming data consists of seven MPEG transport stream packets, each containing 184 bytes of payload and 4 bytes of header. This results in 1316 bytes, plus the packet overhead – 8 bytes for the UDP header, 20 bytes for the IP header, 14 bytes for the Ethernet header and 10 bytes for ATM overhead – for a total frame size of 1368 bytes.

Jitter is defined as a short-term variation in the packet arrival time, typically caused by network or server congestion. If the Ethernet frames arrive at the STB at a rate that is slower or faster, as determined by the network conditions, buffering is required to help smooth out the variations. Based on the size of the buffer, there are delivery conditions that can make the buffer overflow or underflow, which results in a degradation of the perceived video. Similarly, knowing the characteristics of a specific STB, the service provider might be able to characterize the maximum jitter supported by the IPTV network before noticing a considerable video degradation. This value will be a decisive factor when analyzing the video QoS at the customer premises.

**Limited Bandwidth**

The total amount of video-stream data that can be sent is limited ultimately by the customer’s actual ADSL/ADSL2+ rate. Core IP infrastructure is usually based on optical networks with a low level of congestion; therefore, bandwidth limitations are commonly located only within the access network or the customer’s home network. When traffic levels hit the maximum bandwidth available, packets are discarded, leading to video quality degradation. ADSL2+ rates may be temporarily affected by external factors, which in turn can generate pixelization of the image.

Another situation might occur when, in addition to the IPTV service, a high amount of data is downloaded simultaneously to a PC and the traffic priorities have not been assigned correctly by the service provider; in these cases, video streaming packets are lost. A less common but important case is when video is streamed in variable-rate mode, in which considerable changes in the video sequences lead to an increase in the bandwidth requirement. This can generate packet loss and result in quality degradation.

Bandwidth limitation is one of the main factors to be evaluated during the network design stage.

**Packet Loss**

Loss of IP packets may occur for multiple reasons — bandwidth limitations, failed links, and transmission errors, but usually relates to periods of network congestion. Depending on the type
of transport protocol used for the video streaming, a packet loss will have different impact on the quality of the perceived video. When UDP is used, the lost packets will directly affect the image, as the information cannot be recovered and the image will simply be corrupt or unavailable. When using TCP, packet loss will generate retransmission, which can produce buffer underflow and, consequently, the possibility of a frozen image.

Ensuring High-Quality IPTV Services

Below is a five-step approach for IPTV service installation and troubleshooting. This method provides the technician with an easy-to-remember procedure that can be performed from the network interface device (NID) or from the customer TV room.

**Step 1: Check the rates of the ADSL/ADSL2+ link**

Data rates for the downstream and upstream must be high enough to support IPTV. Even with MPEG-2 or MPEG-4 video compression, a speed of at least 3 Mb/s per channel is required in the downstream direction — and much more if HDTV is contemplated.

**Step 2: Ensure that DSL rates are stable**

Signal-to-noise ratio margin (SNRm) must be better than 6 dB and preferably more than 10 dB. Some DSL modems and DSLAMs are pre-configured to operate at the highest possible rate with longest reach by trimming the SNRm. Although this trimming would produce a higher rate, it would introduce errors. This situation was somewhat tolerable for data being delivered in TCP/IP when dealing only with Internet traffic, but it is highly detrimental to IPTV quality. Typically, errors manifest themselves in a pixelization of the video or a complete loss of video feed.

**Step 3: Be sure that ATM errors are consistently low**

Presence of impulse noise can generate multiple errors at the DSL layer, especially if the SNRm is low, as previously indicated. Some other loop issues can also affect the ATM payload directly. These errors are most likely related to the local loop, and therefore a thorough narrowband and wideband evaluation of the cooper loop is recommended.

**Step 4: Test IP and MPEG video layers**

Once the ADSL or ADSL2+ link has been tested for rates, SNRm and ATM-layer errors, the next step is to test the IP and MPEG video layers. If a video channel is being streamed over the DSL line, the IP and video transport stream can also be evaluated for rates and errors. Any existing correlation between errors and sudden variations of the stream data rate may be an indication that the video is exceeding the available bandwidth; therefore, some adjustments will be needed at the video streaming source.
On the other hand, the user must ensure that Internet Group Management Protocol (IGMP) requests, used to join and leave IPTV channels, are being properly handled by the network. Channels must change correctly and under a certain amount of time, as determined by the target zapping time.

**Step 5: Confirm the video quality for at least 15 minutes**

Evaluate the quality of video over a certain period of time; at least 15 minutes is recommended. If an error on the ATM layer results in an IP-layer error, it will also affect the video quality. An IP-layer error that does not coexist with an ATM-layer error generally originates further back in the IP network and will be usually experienced by multiple subscribers. Therefore, no remedial action is possible on the local loop.

QoS indicators like jitter, packet-loss percentage and zapping time must be monitored during this entire time, as they will provide an objective confirmation that the video being received complies with the minimum standard of quality as set by the IPTV service provider. Due to the different network topologies and network environments, thresholds for these parameters are often defined by each service provider.