USING MEDIA DELIVERY INDEX ON THE FTB-8510B PACKET BLAZERTM ETHERNET TEST MODULE (IPTV OPTION)

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IPTV Network Overview

IPTV is broadcasted over a complex IP network. Any impairment on this network can affect the video and/or audio component of a digital TV channel. The real-time nature of the service typically prevents the network to retransmit error packets and thereby correct the situation. As a result, the end users' perceived quality of experience (QoE) will be affected to various degrees. Independent studies have shown that contrary to voice services, end users of IPTV are not expected to compromise on quality, thus the signal quality across the IPTV network must be routinely tested or monitored to minimize and quickly resolve potential threats to service revenue.

Topology

IPTV technology is part of a new breed of services designed to facilitate access to video entertainment. It provides access to digital TV over the IP transport medium from a head-end device to the end user's TV set-top box (STB), as illustrated in Figure 1. Most service providers use a dedicated transport network to support IPTV. The digital channels (composed of video, audio and other programs available to the user) originate from what is typically referred to as a "national" head-end, where the bulk of the service package enters the network, whereas additional local content is added at the "regional" head-end.

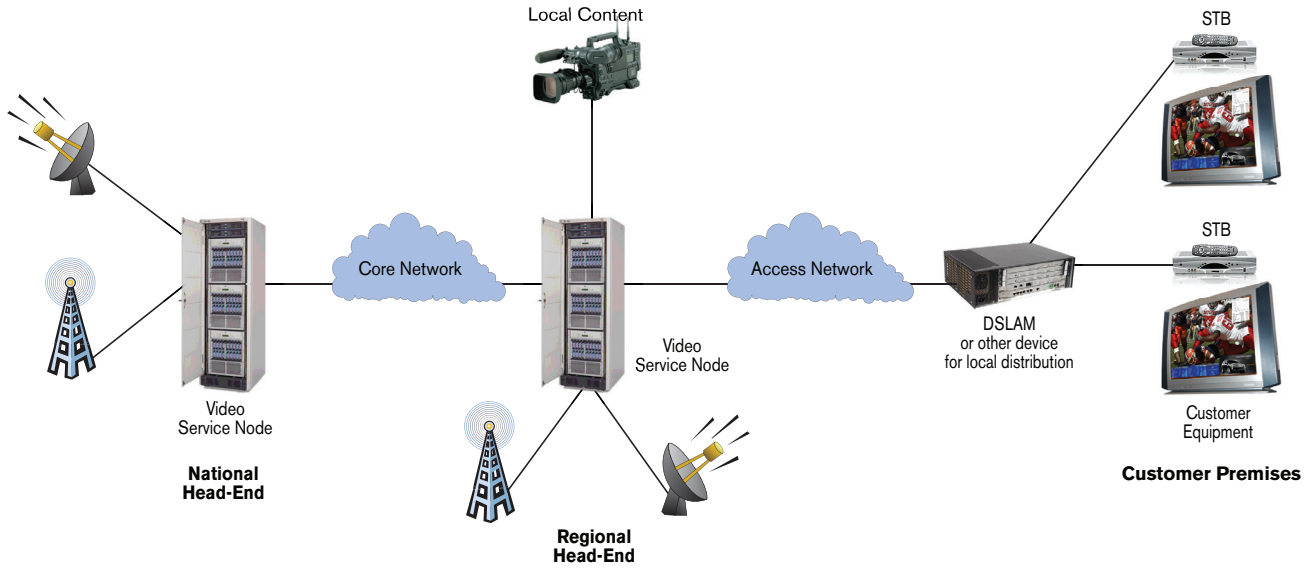

Figure 1: *IPTV General Network Architecture*

Broadcast information coming from an antenna or a satellite dish at the national head-end is mainly distributed using MPEG-2 multiprogram transport stream (or MPTS) to the video service node. Note that other more efficient, less bandwidth-hungry compression algorithms such as H.264 (MPEG-4 Part 10) or the Society of Motion Picture and Television Engineers (SMPTE) 421M (also known as VC-1) are making their way to the marketplace to complement this first offering.

The distribution of the actual SDTV or HDTV channel content is performed using various devices on the access network. Among these devices, digital subscriber line access multiplexer (DSLAM) as well as other technologies like fiber-to-the-home (FTTH) can be used to interface with the user's STB. For IPTV, each channel is distributed using a multicast IP address.

Quality of Experience (QoE)

Due to the structure of Ethernet and IP networks, the quality of the video/audio traffic is primarily influenced by network jitter and packet loss. Due to the type of video encoding that is used in MPEG or other similar compression algorithms, the actual impact to the user perception depends on the packet type that is lost in the network. In MPEG-2, the transported packets that are used to form an image are divided into I-frames, P-frames and B-frames. In simple terms, I-frames contain a complete image while P-frames and B-frames contain predicted information from the other frames. Figure 2 provides a sample of the relationships between the various types of frames included in a group of picture (GOP). As shown, I-frames are independent and provide input to support the other frames; this means that an error in the I-frames will have more repercussions to the image being viewed than losing P-frames or B-frames.

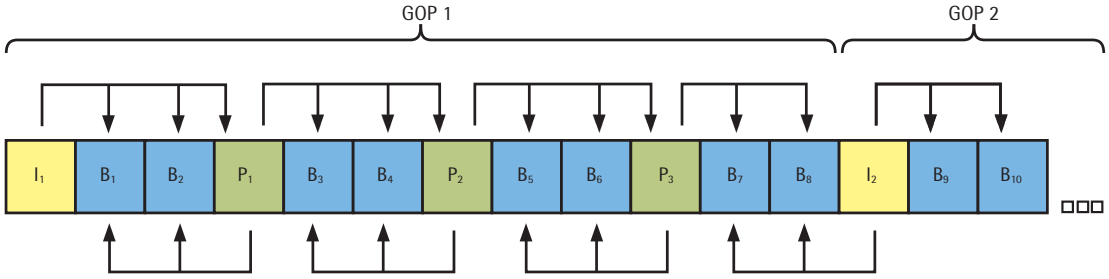

Figure 2: *Typical group of picture (GOP) relationship in MPEG*

Key QoE Parameters

Several metrics exist to quantify the impact of the network on the quality of the channel that is received by the end user. The most popular parameters are media delivery index (MDI) as well as PCR jitter for MPEG-2 transport stream (TS). Other parameters are also used in the IPTV network, but they typically require additional packet inspection to compile the information required for deeper analysis.

IPTV is an evolving technology, and it is not completely driven by specific standards for testing and monitoring. However, the aforementioned parameters must be measured as a first alert to help qualify the user's QoE of the service delivered by the network.

Why Use MDI to Test Your IPTV Service?

IPTV services have inherent characteristics that are the primary drivers affecting the quality of the image being viewed; namely, bandwidth availability, packet loss and jitter. The use of MDI as a testing metric provides users with the tools to measure and diagnose network-induced impairments for IPTV streaming media. MDI is the only standards-based (RFC 4445) video-quality metric available today, and it is endorsed by the IP Video Quality Alliance.

MDI consists of two distinct measurements: delay factor (DF) and media loss rate (MLR). Together, they provide a quality-of-service measure of a delivered media stream, which can be directly correlated to end users' ultimate QoE.

One of the key benefits of using MDI is that it does not perform any type of stream decoding to achieve its metrics; therefore, it does not require significant real-time processing power. It can also be used with encrypted media payloads. Additionally, it is not dependent on any one type of video encoding technique, so MDI can easily be scaled to monitor video quality on hundreds of simultaneous channels. MDI is typically sampled at multiple points throughout the stream path with the measurements serving as indicators of problems in the network that can be proactively addressed before it affects service. Since MDI relies on transport-layer metrics (DF and MLR), it can be used to set network margins, and it directly correlates to impending network problems with respect to video quality. Moreover, because uses packet-level metrics, it plays a key role in validating network equipment such as switches and routers since these network elements are important in determining whether a packet is delayed or dropped.

Delay Factor

The delay factor (DF) is the time difference between the arrival and the drain of the media packets. It takes into account the amount of jitter present in the media stream and provides a measure of the required buffer needed for error-free transmission at the next downstream point. Very large DF values indicate sever jitter in the network, which in turn indicates that the network requires more latency (larger buffers) in order to compensate for the time needed to fill the buffers before the packets can begin to be sent to the receiver. A network experiencing high DF and insufficient buffering will eventually experience packet loss due to buffer underflow or overflow conditions further exasperating the poor video quality.

Media Loss Rate

The media loss rate (MLR) is a measure of the number of lost or out-of-order flow packets counted over a period of time. It is important to include out-of-order packets in the MLR metric, as many stream consumer-type devices do not rearrange the order of packets that are received out of order. Therefore, any lost or out-of-order packets will introduce errors and visible distortions to the media stream, which may be perceptible to the end viewer. This fact makes the MLR component of MDI a popular measure for service-level agreements (SLAS), as it is a much better indicator of network and video quality issues than a simple mean opinion score (MOS).

IPTV Testing with the FTB-8510B

The FTB-8510B module's IPTV option, combined with the FTB-400 Universal Test System platform, provide users with a powerful portable testing tool to measure the quality of the video traffic over the network. The portability of this solution allows technicians to quickly deploy at different points in the network to collect data and help isolate a network fault affecting the quality of the IPTV service.

Where to Measure

A typical IPTV network is comprised of the following functional blocks (see Figure 3):

- National head-end: Where most of the IPTV channels enter the network from national broadcasters
- Core network: Usually an IP/MPLS network transporting traffic to the access network
- Access network: Distributes the IPTV streams to the DSLAMs
- Regional head-end: Where local content is added to the network
- Customer premises: Where the IPTV stream is terminated and viewed

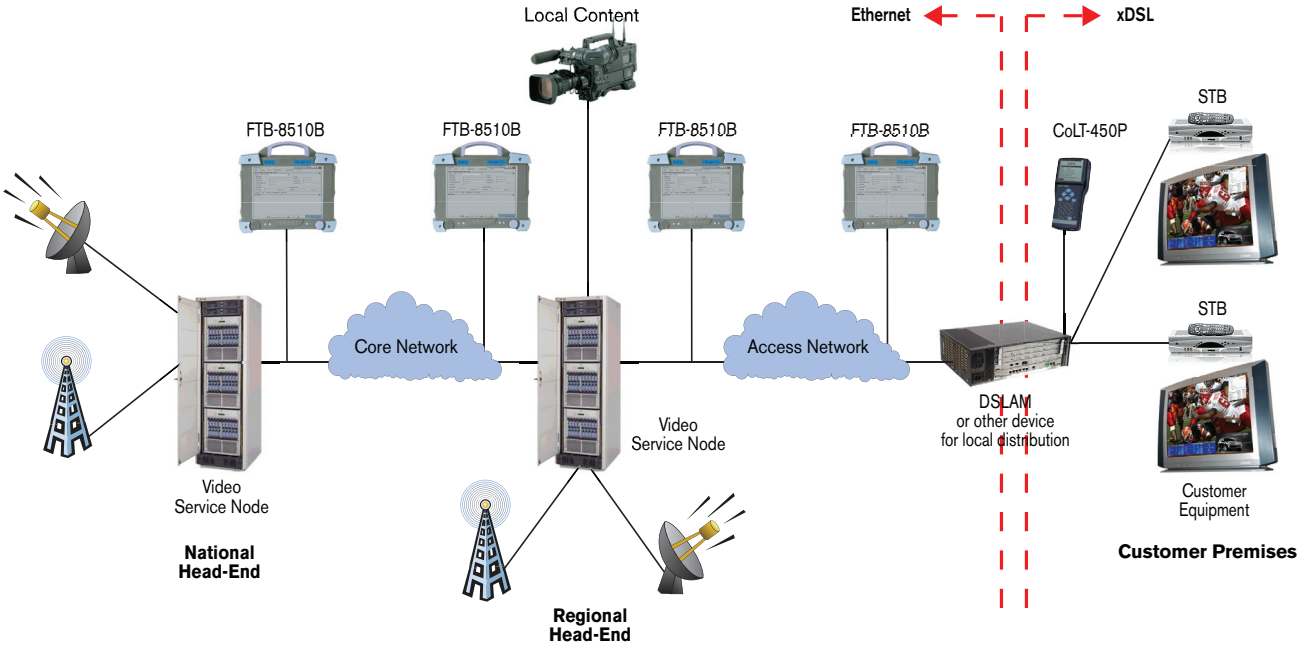

Figure 3: *Typical IPTV Network Infrastructure*

Using the FTB-8510B, IPTV testing can be performed at multiple points in the network, where an electrical or optical Ethernet interface supporting rates from 10 Mbits/s to 1 Gbits/s is available; testing is typically conducted through a test port where the test set cannot affect the live traffic.

There are three points in the network that are critical to monitor for IPTV quality: national head-end, regional head-end and at the closest point to the customer (typically the input to the DSLAM). For a more detailed consolidated view of the network status, IPTV streams should be monitored at every major routing point in the network. The more sample points you have in the network, the easier it will be to isolate network faults when they occur. The IPTV network must also be tested upon introduction of new services, so as to characterize the network. In addition, it should be monitored constantly to limit unexpected service degradation. Figure 4 presents a typical test configuration where the FTB-8510B can be used to monitor a specific section of the IPTV network using a single-port test topology. Test connections can be established to monitor the IPTV streams at appropriate test points available from the core or access network devices (video streamers, routers, switches, etc.).

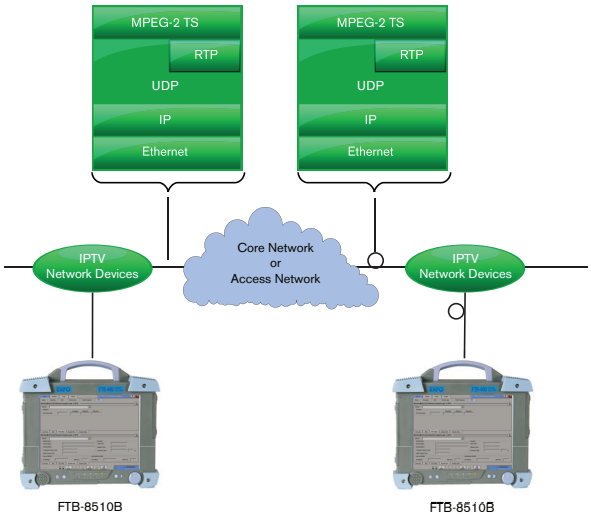

Figure 4: *Single Port IPTV Test*

FTB-8510B IPTV Setup

Once the FTB-8510B Packet Blazer module (with IPTV option) is inserted into the FTB-400 platform and initialized, testing is relatively simple:

1) From the Smart User Interface (SUI), go to *Topology*, and select *Single Port*. Likewise, go to *Application Type*, and select *Frame Analyzer*.

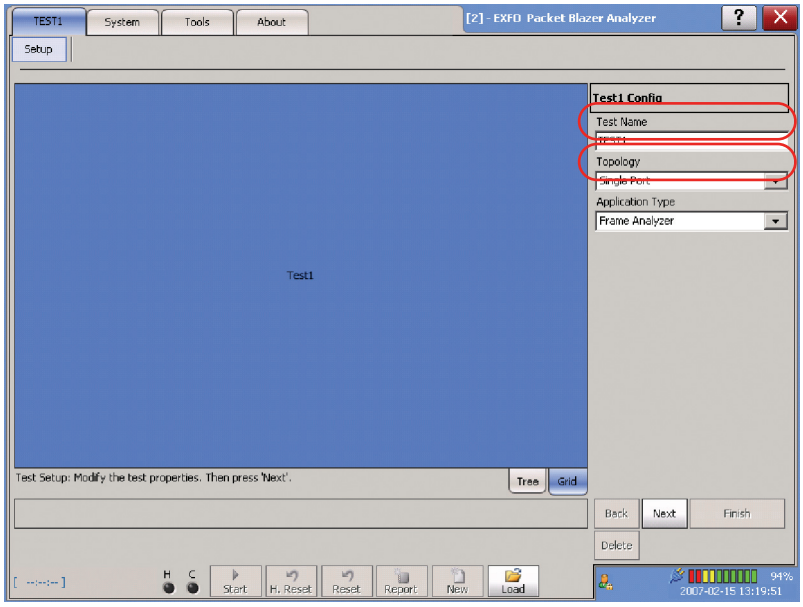

Figure 5: *FTB-8510B Test Setup Page*

2) Select the type of interface to be used–optical or electrical (RJ-45). Click on *Finish* to complete the test setup.

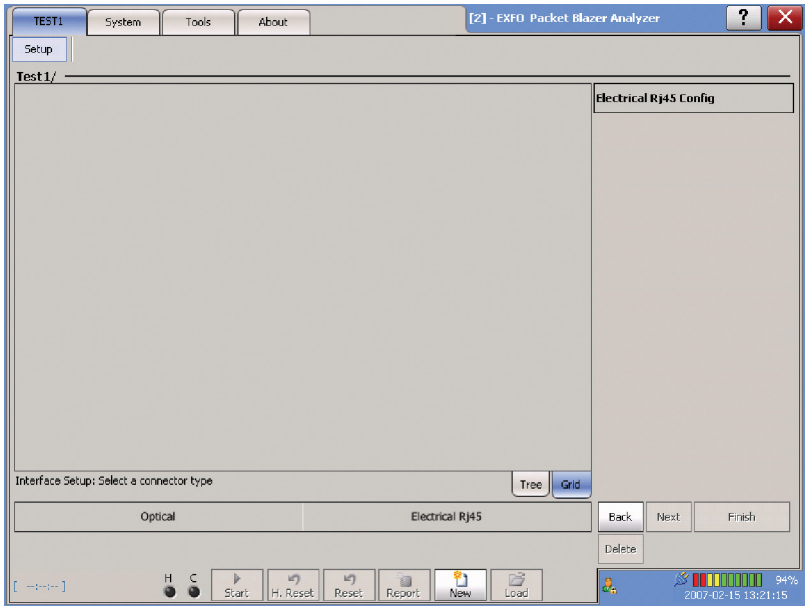

Figure 6: *Frame Analysis Port Type Selection Page*

3) From the IPTV tab, click on *Add* to enter the required information for the IPTV stream under test. This includes the stream name and the destination IP address.

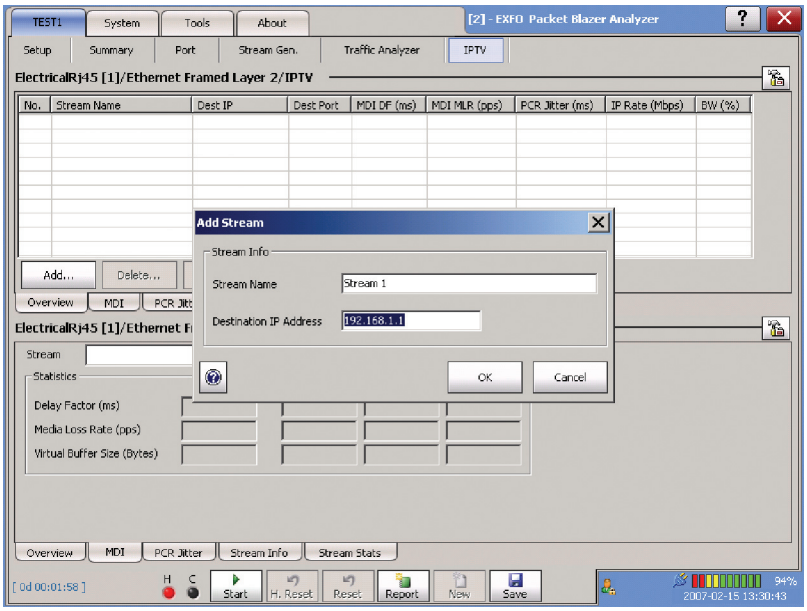

Figure 7: *IPTV Overview Page*

4) Once a valid IP address is added, the corresponding stream is detected and the MDI metrics, as well as the other IPTV metrics supported, begin to be measured. Details on the metrics can be found in the corresponding sub-pages.

The FTB-8510B module provides the capability to simultaneously monitor up to ten unicast or multicast IP addresses to support IPTV monitoring (including basic VoD monitoring). The monitoring function includes the ability to report statistics on MDI and PCR jitter in addition to other key statistics such as IP packet metrics, stream rate and presence measurements, as well as bandwidth utilization, all of which are essential to correctly characterize an IPTV stream. As previously stated, the FTB-8510B's support of MDI metrics makes it a very useful tool for detecting and isolating network faults that are directly linked to video quality of service and ultimately the end user's QoE. MDI measurements made through the video stream path can be used to help isolate error points in the network. For example, if there is a large increase in DF between two successive points, it may be an indication of congestion at a routing point that is causing excessive delay. This can also potentially cause packets to be dropped; therefore, the MLR metric will increase as well. Similarly, a spike in MLR values can indicate that a router is corrupting MPEG TS packets or receiving out-of-sequence packets due to latencies in the network.

MDI measurement guidelines that correspond to an acceptable QoE is highly dependent on the network architecture and on the amount of buffering in the set-top box. Typically, set-top box manufacturers try to limit the amount of buffering capability in order to reduce the cost of the unit. As a loose guideline, DF values should range between 0 to 50 ms (based on ITU G.1050, which describes a well-managed network for video and audio transmission). This has been further corroborated by independent studies, which have shown that a DF of less than 40 ms will still provide acceptable video quality. The goal for MLR is obviously 0, as any MPEG-2 TS packet loss can potentially cause visual impairments. However, in reality, all networks experience some level of IP packet loss. Since each IP packet contains seven MPEG-2 TS packets, losing one IP packet will directly affect the video quality since MPEG-2 is usually transported over UDP (IPv4/UDP), which does not allow for packet retransmission or reordering. Practically, less than 0.5 % packet loss can still provide good quality video to the end user.

Another key feature of the FTB-8510B IPTV testing solution is that while monitoring the selected media stream in the IPTV network, all the functions supported via the Frame Analyzer application are also simultaneously available so as to optimize time-sensitive services like real-time video. These capabilities provide additional insight into troubleshooting and detecting IPTV issues that could originate from the Ethernet layer.

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