# Application Note – AN106

## Effects of Packet Interval Variation

Reto Brader

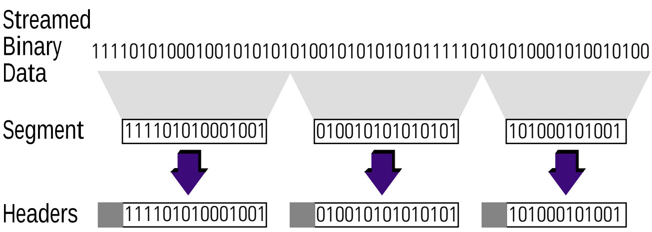
EMEA General Manager, Pixelmetrix Corporation

*While multiplexing several programs into a single MPEG-2 Transport Stream provides flexibility and numerous advantages to operators, congestion within the multiplexer can result in picture impairments or other obscure problems with service delivery.*

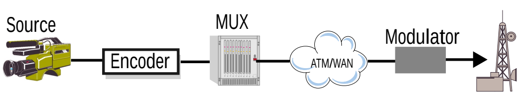
*Conventional transport stream analysis techniques – such as bandwidth or jitter analysis – are insufficient to identify problems introduced when a system operates near its maximum capacity. This paper illustrates how measuring variations of packet arrival time can help you quickly identify and resolve problems.*

## Introduction to Packet Transfer

To provide optimum utilization of network resources and flexibility for switching and routing, packet based transmission systems are widely used for transferring all kinds of information – voice, video, text, email, subtitles, and so on. The source material is first digitized and compressed, and then divided into either fixed- or variable length segments. To describe the content and assist in routing the packets through the network, additional information is added to the front to form the *packet header*. Finally, some networks will add a CRC – cyclical redundancy check code – to the end of the packet to identify errors during transmission.




For video transmission, it is essential to deliver moving images in real time and with a consistent rate of presentation in order to preserve the illusion of motion. However, delays introduced by coding, multiplexing and transmission can cause a variable amount of delay for video packets arriving at the decoder. This delay wrecks havoc in the decoding process mandating buffers in the decoder.




This is further complicated when you consider the transport stream is carrying a multiplexed mixture of other programs, interactive TV applications, and datacasting – which in turn may all be carried over a shared telecommunications network.

## Time Synchronization

The MPEG-2 standard provides a mechanism called *Program Clock Reference* to ensure video frames can be decoded and delivered to the viewer with a consistent rate of display.

PCR, or Program Clock Reference, is fundamental to the timing recovery mechanism for MPEG2 transport streams. PCR values are embedded into the adaptation field within the transport packets of defined PIDs.

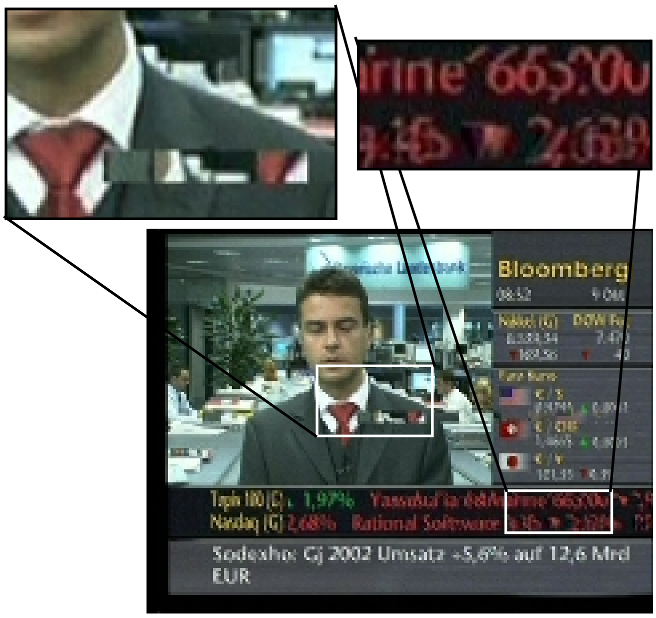
The receiver will use the PCR to derive the clock reference, any jitter or drift in the PCR clock can have damaging effect on the IRD's performance. This means that managing an appropriate level of PCR Jitter is important requirement for network operators.

This, however, is not sufficient to guarantee a reliable and error-free delivery of services to the receiver.

## Case Study: All Is Well But Bad Picture

One digital transmission operator observed periodic instances of poor picture quality. This occurred even though the multiplexer showed a total load of less than 97% and everything else seemed to be configured and working fine. The support engineers of the equipment manufacturer flew in to diagnose and rectify the problem.

Transport stream analysis showed no problems. The TS contained approximately 3% null packets and all configuration parameters were correct. Despite this, however, the random block artifacts continued.



In attempting to trouble shoot the problem the engineer was limited to simply recording as much Transport Stream information as possible, take it back for analysis in the Lab, and hope he actually had captured enough information to allow in-depth post analysis and problem determination — which is exactly what the client did.

## Cause of the Problem

After several days of manual analysis, the engineers in the lab found that the inbound data stream to the MUX was very bursty. This in turn created bandwidth allocation difficulties and subsequent data loss in the multiplexer.

This painful process consisted of analyzing the distribution of null packets and looking for short moments where no null packets were sent at all. That would point to the MUX running out of bandwidth for a short period of time.

However, using this technique in the lab completely failed to discover the cause of the problem – no commercial transport analyzer available can display bandwidth over such a short integration period. The short periods of zero bandwidth went by undetected by the equipment. (Measuring transport stream bandwidth always does so over a specific integration period. This integration interval is typically too big to capture the short moment of zero bandwidth for PID 0x1FFF)

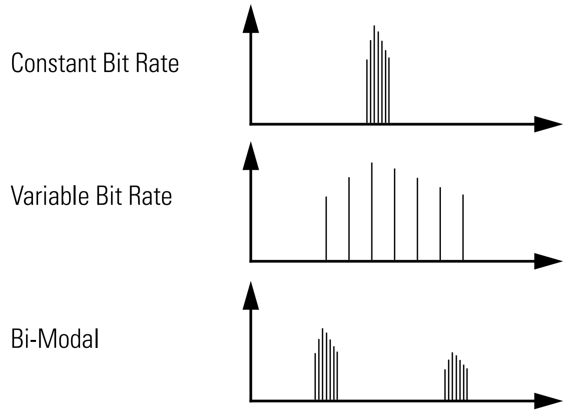
## Problem Solving with Pixelmetrix

The engineer suspected that the periodic picture quality impairments were related to misbehaving traffic patterns which in turn caused short moments of bandwidth starvation in the multiplexer. The question was how to more efficiently identify these moments in real time when analyzing other customer's problems. Thanks to the Pixelmetrix DVStation, he found a powerful and efficient solution.

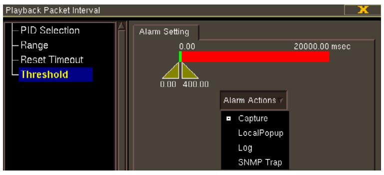
The key to the solution is real time *packet interval measurement*. This allows the measurement of how frequently a specific packet (in this case null packets) actually arrives. If no null packets leave the Mux for a certain amount of time, it could indicate a typical stressed situation for a multiplexer and therefore is worth investigating further.

Independently on multiple input ports, DVStation plots a real time histogram of the inter-arrival times of the specific PIDs within the transport stream. The result is a graph showing the statistical distribution of packet arrival – with arrival time on the horizontal axis and number of packets on the vertical axis.

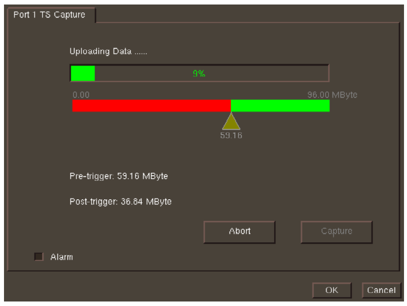
A single, concentrated grouping indicates constant arrival rate (CBR), while other patterns indicate more random arrival. A bi-modal distribution could point to the periodic overflow of an internal buffer within the MUX.




Like all measurements made by DVStation, the Packet Interval Measurement can be set to execute an alarm action when the parameter exceeds a user-set threshold.




In this case, the user simply sets the alarm threshold for the delay between null Packets (in this case it is 400 ms). When that threshold is exceeded the deviation can be logged and an action can be set to **capture** a portion of the transport stream.




The capture sub-system of DVStation contains a *variable pre-trigger*. This allows the engineer to configure how much transport stream to acquire *before* and *after* the trigger point. For example, setting a zero megabyte pre-trigger means that data acquisition starts at the exact trigger point. Setting a 100% trigger results in all the data *leading up to* the trigger point – essentially similar to the *black box* flight data recorder used on commercial aircraft, showing you everything leading up to the crash.

Once configured, the engineer can then walk away and let DVStation do its job, knowing that each error condition will be logged and a recording of the transport stream is safely stored for later analysis.

## Test Results

After running for a short while the results are in. The engineer's theory is justified in a straightforward, graphical representation.

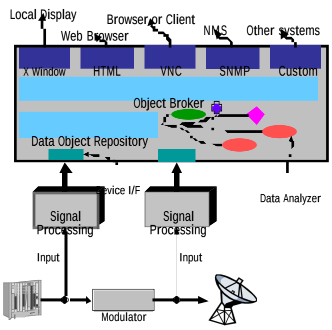
Looking at the DVStation Bandwidth Display we saw earlier that, on average, 97% of all packets are used for transport of data while 3% were null packets.

However, the Packet Interval Display shows a situation where no null packets have been inserted for more than half a second! Such a long period between null packets is strong evidence of possible stress within the multiplexer.


Since the transport stream was automatically captured at the time of the error, the support engineer can quickly inspect the captured file for further analysis. Thus saving time since it is no longer necessary to scroll through huge amounts of data looking for the problem.

This particular method of transport stream analysis applies equally well to the DVStation ASI interface, or the other DVStation interfaces for QPSK/L-Band, DVB-T/COFDM, ATM/OC-3c, etc.

## DVStation Software Architecture




DVStation employs a multi-process architecture, dividing tasks between user/program interfacing and data collection, correlation, and storage.

Internal systems communication is based on CORBA, allowing additional software processes and/or control interfaces to be added – either locally or via a remotely located computer attached via LAN or WAN.

### About the Author

Reto Brader is the Regional General Manager for Europe, Middle East and Africa with Pixelmetrix Corporation, manufacturer of the DVStation, a preventative monitoring solution for digital broadcast networks.

## DVStation


DVStation monitors RF, ATM MPEG-2 TS, and content within an easy-to-use and integrated environment. Offering the highest port density in the industry, DVStation is ideal in environments with *many signals in one place* – such as satellite uplink centers, DTH operators, or cable head ends.

Plug-in line interface modules fully analyze physical layer signals (QPSK, QAM, COFDM, ATM, etc.) and extract the transport stream for further analysis by a Transport Stream Processor.

## DVStation-Remote

Ideal for remote deployments with *a few signals in many places*, the DVStation-Remote consists of a 1U control unit and up to four interface adaptors. Remote diagnostics can be conducted simultaneously from several locations, or, alternatively, staff can access telemetry directly by attaching a standard keyboard and CRT.

Log files and recorded transport streams can be accessed remotely or downloaded for further analysis.

## DVStation-Pod

Featuring the same software and user interface of the DVStation and DVStation-Remote, the DVStation-Pod product line consists of several book sized modules containing the interface circuitry. Each module connects to a laptop or desktop PC.

Light and portable, DVStation-Pod offers all the power and functionality of its bigger brothers in an extremely affordable package.

## For More Information

To learn more about the DVStation, request a demo, or learn how Pixelmetrix might help you optimize video network integrity, contact us today!


On the Internet: sales@pixelmetrix.com
www.pixelmetrix.com

North America: 1-866-PIXEL-US
Europe: +41-79742-7454
Asia Pacific: +65-547-4935